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Sweep Frequency Signal Generator Design Techniques

JOHN H. MENNIE and CHI LUNG KANG, *Development Engineers*

Figure 1. Dr. C. L. Kang, co-author, adjusts the Sweep Signal Generator Type 240–A.

Sweep frequency testing techniques have been used in one form or another for a number of years. Even before the cathode ray oscilloscope became available as a laboratory instrument, very slow sweep frequency devices were used in conjunction with mechanical recording systems to provide a graphic representation of frequency response. The commercial development of the cathode ray oscilloscope plus the increasing need for a rapid, accurate and convenient technique for aligning multi-stage wide-band IF amplifiers used in radar, FM and TV systems created the need for the sweeping oscillator as a laboratory and production tool.

Although many sweeping oscillators have been developed for this purpose, it has been felt that in general no one instrument incorporated all of the desirable features, such as good center frequency stability, adequate shielding, flat high-level output, precision-calibrated attenuator for operation in the low microvolt region, low sweep rate, satisfactory marking system, and ability to operate as a CW signal generator.

NATURE OF SWEEP FREQUENCY METHOD

To get a physical picture of how the sweep method works, consider a signal whose frequency is periodically varied (or swept) about a center frequency at a slow repetition rate. At a certain instant of each sweep cycle, the instantaneous frequency, i.e. the rate of change of phase angle, passes a certain value. The signal can be considered to be a single frequency equal to the instantaneous frequency over a short interval of time around that particular instant of each cycle.

Now the response of the network under test will be the steady state response at the instantaneous frequency plus a transient term. If the network is not highly frequency sensitice, i.e., low Q, its steady-state response changes gradually with frequency. Hence, the transient term will have small amplitude and, furthermore, it dies down quickly.

When the rate of frequency change is low, the time interval over which the frequency can be considered constant is appreciable and enough time will be allowed for the transients to die down. In short, in low Q circuits with low rates of frequency change, the transient term will be small and therefore the response while sweeping is a close approximation of the steady state response. This is the basis of the sweep frequency method.

SYSTEM REQUIREMENTS

Before beginning the detailed development of a sweeping signal generator it is wise to carefully consider each of several fundamental and inter-related problems inherent in all such devices. The first, of course, is to decide on the most practical means for sweeping frequency in a linear fashion with sufficient controllability and stability to satisfy both wide and narrow band requirements.

Providing adequate isolation between the generator and the load with constant amplitude high-level output and low distortion are inter-related problems made difficult by the desirability of a broadband, untuned output-buffer system.

It is often erroneously assumed that a high order of frequency stability is not essential in a sweeping device, because the frequency is constantly changing and some form of precision marker is always used to determine the exact frequency location on the display pattern. Good frequency stability has been found to be quite essential, however, to avoid jitter in the display of narrow band sweeps, for zero sweep or CW applications, and for proper identification of markers by means of an accurately calibrated center-frequency dial. A fundamental problem exists in attempting to attain good frequency stability in a sweep generator since the parameter used for sweeping is usually unstable by nature and therefore must be protected from extraneous effects

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such as temperature, voltage and current variations, magnetic fields, vibration, hysteresis, etc.

Another problem is that of providing adequate identification of all significant frequencies under test. A continuously variable marker frequency cannot be generated having the crystal-controlled accuracy often required. Although it is sometime possible to use special crystals ground to the specific frequencies required for a particular test, this procedure is impractical for a general purpose, continuously-tuned sweep generator. It is also quite difficult to set up a system of multiple crystal-controlled markers that permits identification of marker frequencies anywhere in the spectrum. The number and spacing of markers is of extreme importance as too many will be hard to identify at high frequencies and too few will not provide sufficient accuracy at low frequencies.

METHODS FOR GENERATING BROAD - BAND FREQUENCY DEVIATIONS

There are several methods commonly used for generating wide frequency deviations in sweeping oscillator circuits. These may be divided into two groups; one consisting of the mechanical methods of driving a capacitor or inductor by means of a motor, vibrator or speaker coil, and the other group consisting of all electronic variable-frequency devices such as reactance tubes, klystrons, saturable reactors, and ferroelectric capacitors. None of these is ideal in every respect, each method having definite advantages and disadvantages as listed in Table I.

IDENTIFICATION OR MARKING FREQUENCY

The fundamental problem confronted in frequency identification or marking is to indicate or mark the instant at which some varying frequency signal passes a certain value, f_k.

The two cases 1. $f_k = o$

2. $f_k \neq o$

are distinctly different and will be discussed separately.

1. $f_k = o$ This is the zero beat case. The varying or swept frequency is beat with a fixed reference frequency to obtain a difference frequency as observed on an oscillo-coincidental with the reference frequency, the difference frequency becomes zero. The difference frequency as observed on an oscilloscope has a characteristic notch, when the difference is zero, which unfortunately is quite wide and jumps up and down due to random phase relations. Thus it is rather difficult to derive some triggering signal at the instant of zero beat to initiate a mark. It has been done by using the sum of squared integrals of quadrature zero beat wave forms.[1] The circuitry used is by no means simple. However, if the zero beat wave form is displayed on an oscilloscope, its center, i.e. the instant of zero beat, can be located quite accurately with the minimum amount of circuitry.

2. $f_k \neq o$ In this case, we do not use the characteristic zero beat notch. However, the response of a frequency-sensitive network to the varying, or swept, frequency signal can be used to initiate a mark. The sweeping frequency will produce a given difference frequency twice; once as it approaches the reference frequency and again as it recedes from the reference frequency after going through zero beat. The problem is of the same general nature as detection of an FM signal, but the rate of frequency change encountered in sweep frequency technique is usually much higher and FM detection concerns chiefly change of frequency while here the actual value of the frequency is of importance.

Different methods fall into two general categories:

(a) Frequency marked by a maximum or minimum response.—The absolute level of response is therefore not important. The main difficulties with this are:

(1) Shift of envelope peak due to rate of frequency sweep.—The network used must be highly frequency sensitive in order to get a sharp peak. This very feature, however, leads to a shift of the peak when swept, which results in inaccuracy. Furthermore, this shift is not constant. It depends not only on the rate of sweep and sweep width, but also on the direction of frequency change. The process of deriving a trigger from the peak response also introduces some additional inaccuracy, especially if the peak is not very sharp.

(2) It would be difficult to design a trigger circuit which would handle a wide range of amplitudes from the frequency sensitive circuit.

(3 At a low rate of frequency change or for a narrow sweep width it may be difficult to get a high enough Q to give a sharp peak.

(4) Any envelope detector will add an additional delay in the marker display.

(b) Frequency marked by a reference amplitude of response of a frequency sensitive network:

The problems encountered are:

(1) A network of high selectivity is needed to obtain sensititivy and resolution; this feature introduces undesirable effects due to the sweeping rate.

(2) The performance or accuracy of the

TABLE I

SWEEP METHOD	ADVANTAGES	DISADVANTAGES
Mechanical Devices	High Q at all frequencies. High output possible (without buffer stage). Workable over wide range of output frequencies. Wide sweep range.	Microphonism causing frequency jitter. Non-linear sweep. Mechanical maintenance problems.
Reactance Tube	Good stability and accuracy. Non-microphonic. Linear sweep.	Limited to narrow sweep at low frequencies.
Saturable Reactor	Wide sweep range. Good stability and accuracy. Non-microphonic. Linear sweep.	Low Q at high frequencies. Susceptable to AC magnetic fields. Hysteresis effects.
Klystron Beat Method	Wide sweep range. Workable over wide range of output frequencies. Linear sweep. Non-microphonic.	Frequency jitter. Low output. Poor accuracy at low freqs.
Ferroelectric Capacitor	Non-microphonic. Linear sweep.	Excessive temperature Coeff. Low Q. Hysteresis effects.

1. D. Sunstein and J. Teller, "Automatic Calibrator for Frequency Meters". Electronics, vol. 17, May 1944.

system will depend very much on the stability of the frequency sensitive network and also on the performance of the amplitude comparison circuit used to initiate the marker.

The frequency markers may form a fixed scale with a mark appearing at 5 mc or 10 mc spacings or there may be a variable marker which can be set at any specific value of frequency. For a fixed scale, it is desirable to have a choice of marker spacings to fit different sweep widths. The output indications super-imposed on the response curve may be zero beat signals between sweep and reference signals (usually referred to as "birdies"), short pulses, or intensity modulation of the scope. In this respect, the "birdie" markers have the drawback that they tend to confuse the display more than the other methods do.

The signal whose frequency is marked can either be the input or the output from the circuit under test. In the latter case, the possible wide range of variation of output amplitude poses a difficult problem for mixing. Also the R.F. output may not be easily accessible without disturbing the system under test. It is therefore generally desirable to sample the input signal for marking.

Markers are not labeled directly in frequency, and therefore a positive and convenient way to identify a mark is of importance.

SYSTEM DISCUSSION OF SWEEP SIGNAL GENERATOR TYPE 240-A

Having discussed the various aspects of sweep frequency measurements we will describe the BRC Sweep Signal Generator Type 240-A and indicate various techniques employed to satisfy the essential requirements.

Referring to Table I, it becomes apparent that the saturable reactor system offers many advantages for attaining the required wide linear sweep with good frequency stability and accuracy at frequencies below 150 mc. Although the low Q limitation of the best commercially available ferrite material suitable for high frequency use was found to be quite severe, a satisfactory oscillator was developed utilizing two high Gm triodes (type 5718) in a push-pull Colpitts circuit. Sufficient output with good waveform was thus attained under this low Q condition without exceeding plate dissipation ratings.

The R.F. Section of the Generator is shown in the photograph in Figure 2 and the block diagram in Figure 3. Center frequency tuning of the Sweep Oscillator is accomplished by means of a split stator capacitor in conjunction with a band selector switch for connecting any one of five saturable reactors. These reactors are driven by a specially shaped saw-tooth current developed and stabilized by the sweep circuitry. The problem of 60 cycle field modulation of the ferrite reactor by the power supply was solved by use of double magnetic shielding plus proper location and phasing of the power transformers. The resulting hum modulation was thus reduced to less than 0.001% of the carrier frequency.

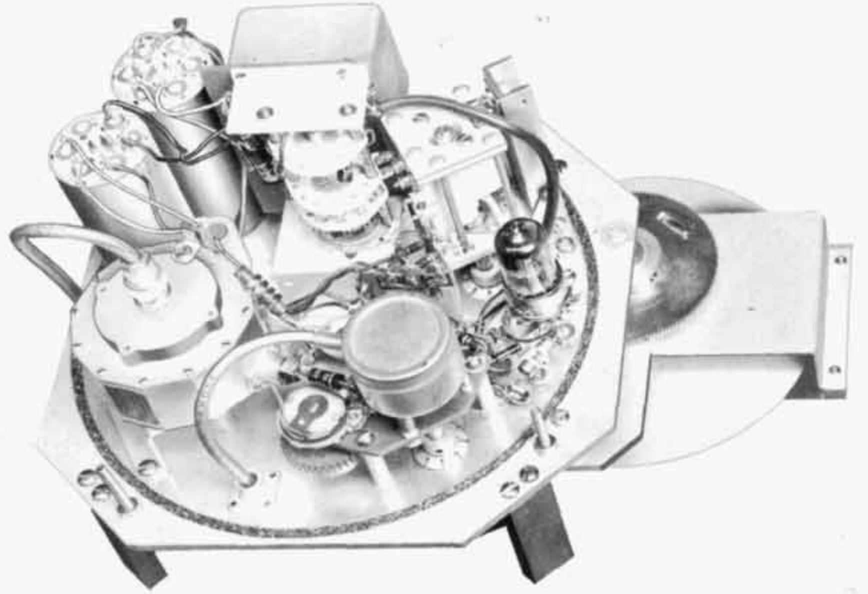

Figure 2. The Type 240–A RF Head. Switched saturable reactor windings, tuned by a variable air capacitor, control the 4.5-120 MC frequency of the oscillator. The swept frequency signal is monitored for flatness at the output of the buffer and for level at the continuously variable and the step attenuators. Special shielding, filtering, and grounding keep stray leakage at a low level.

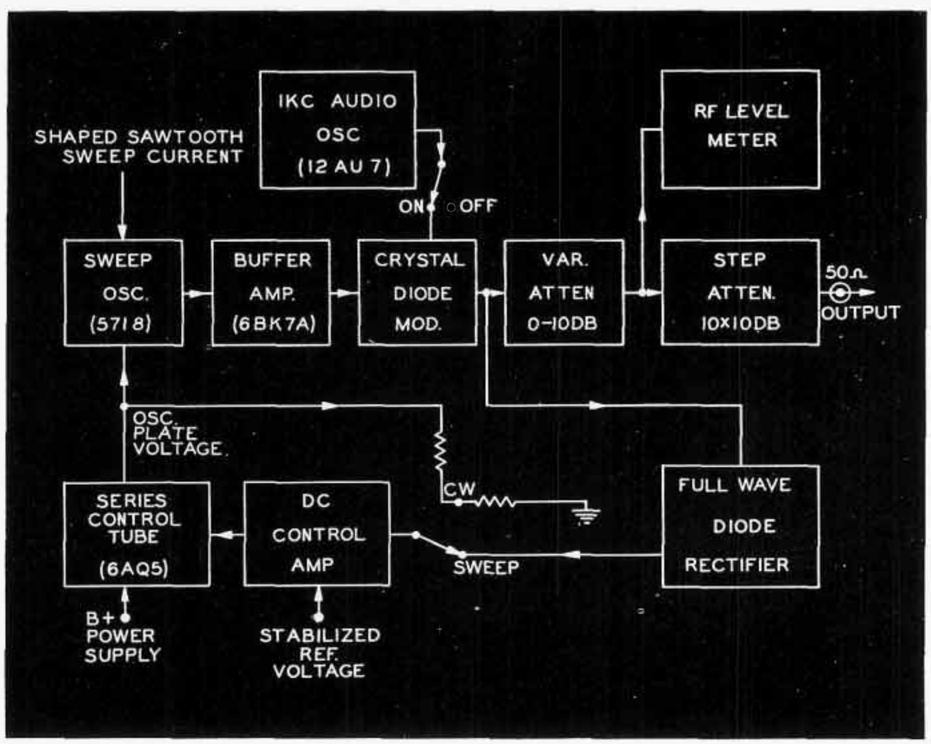

Figure 3. Block Diagram - RF Unit

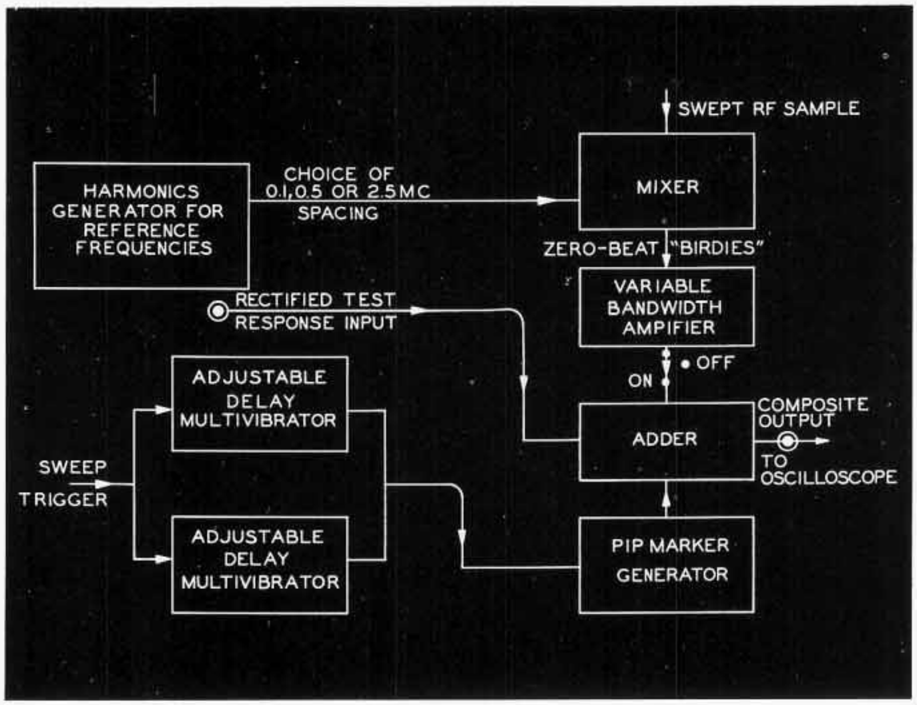

Figure 4. Block Diagram — Marker System.

The hysteresis effect in saturable reactors can be extremely serious in some designs, causing erratic frequency changes by as much as 50% each time the bias current and sweep voltage is applied to the system. It was found that this effect could be reduced to tolerable levels of less than 1% by proper choice of magnetic material in the reactor yoke assembly as well as the ferrite material used for the reactor itself. Proper design of switching circuits to eliminate transients also proved effective in reducing erratic hysteresis effects.

A grounded-grid 6BK7A buffer-amplifier follows the oscillator to reduce the effects of output impedance variations and AM modulation on oscillator frequency. Following the buffer stage is a shunt crystal diode modulator capable of providing 30% audio modulation from a low power 12AU7 RC oscillator.

The swept RF output is monitored by means of a full wave crystal diode peak-to-peak rectifier circuit that delivers to the control amplifier a DC voltage proportional to the fundamental RF level. The difference voltage between this rectifier and a stabilized DC reference voltage is amplified by a high gain DC amplifier to provide control of the oscillator plate voltage through the 6AQ5 series control tube. The resulting sweep flatness does not vary more than 0.7db as measured on a bolometer bridge. To permit audio modulation under CW conditions the AGC loop is opened up as indicated in the block diagram Figure 3.

The output attenuator system consists of a continuously variable 0-10 db pad for adjusting the RF voltage at the input to a ladder type step attenuator having 10 steps of 10 db each. The output level is thus continuously adjustable by utilizing the R.F. Level Meter to interpolate between the 10 db steps of the step attenuator. The attenuator dial is calibrated to show the RF output in terms of full scale meter reading in either volts, millivolts or microvolts as attenuation is increased.

The Sweep Signal Generator Type 240-A has a linear frequency sweep of triangular wave form. The Sweep Width Control changes the frequency excursion symmetrically above and below the center frequency which remains constant at the value set on the continuously tuned dial. In order to extend the use of the signal generator to more frequency-sensitive networks, the sweep rate is made variable from 70 cps down to 20 cps.

A variable-frequency multivibrator produces a square wave which is integrated to give a triangular wave. This triangular voltage waveform is made available through the sweep circuit amplifier for producing deflection on the oscilloscope horizontal axis. The same triangular voltage is amplified and shaped by three diodes to develop the required current waveform necessary to obtain a linear frequency sweep. During the decreasing frequency portion of the sweep, the r.f. oscillator output is reduced to zero to provide a zero level reference line. Provisions are also made so that the sweep circuit can be driven from an external source.

For frequency marking, the zero beat type marker system was adopted not only because of circuit simplicity, but also because of its good accuracy. (See Figure 4.) The problem of avoiding confusion of display due to the presence of too many "birdie" (zero beat type) markers is uniquely solved by providing two movable pips (short rectangular pulses) which can be set anywhere on the pattern in reference to the birdie markers which can then be turned off leaving only two clean pip markers.

The harmonic generator generates a fence of crystal-controlled reference frequencies with a choice of spacings; 2.5 mc., 0.5 mc or 0.1 mc. The sweep signal beats with the reference fence, giving birdie markers at the same spacing as the reference fence. The swept signal sample is taken at constant level from the buffer stage following the oscillator.

The movable pip markers are generated by a monostable multivibrator which is triggered by two adjustable delay multivibrators. The two delay circuits are themselves triggered by a pulse from the multivibrator in the sweep circuit. The time delays, and hence the pip marker positions, therefore, both have the begining of each sweep as reference. The calibration of the CW frequency to an accuracy of $\pm 1\%$ provides a satisfactory way of identifying the frequency markers.

CONCLUSION

A sweep frequency signal generator has been developed possessing many desirable features heretofore unavailable in a commercial instrument of this type. These include a high order of frequency stability, continuous center frequency adjustment from 4.5 to 120 mc, wide range of sweep width in conjunction with variable sweep rate, good linearity and constant amplitude high level output with good isolation between oscillator and load.

Additional features include ability to operate as a well-shielded CW signal generator with AM modulation and precision output voltage calibration down to 1.0 microvolt. Last, but not least, is a self-contained marker system providing a versatile display of crystal-controlled beat type markers and two movable pip markers, thus offering the unique combination of very accurate marking, a clean display, and easy identification.

THE AUTHORS

Chi Lung Kang was graduated from Chiaotung University in Shanghai in 1945 with a BS degree in ME and was awarded degrees of MS in ME, MS in EE, and Ph D in EE in 1948, 1949 and 1951 respectivily from the University of Illinois. Dr. Kang joined Boonton Radio Corporation in 1951 as a Development Engineer. He has been active in analysis and experimental work in connection with Glide Slope Generators, the Q Standard and the Sweep Signal Generator Type 240–A and other technical development work. He was particularly concerned with the frequency identification system used in the Sweep Signal Generator described here.

For biographical material on John H. Mennie see page 4 of the Summer 1954 issue Number 2 of The Notebook. Mr. Mennie was particularily concerned with sweep circuits and the RF section of the Sweep Signal Generator Type 240-A.

Audio Frequency Measurements Using The Coupling Unit Type 564-A

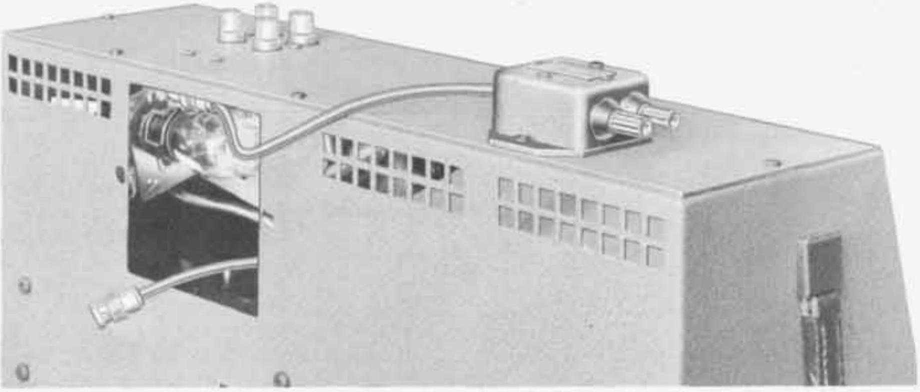

Figure 1. The Coupling Unit Type 564–A mounted on a Q Meter Type 260–A.

The voltage injection and Q-measuring circuits of the Q Meters Type 160-A and Type 260-A will perform satisfactorily at frequencies well below the lower limit of 50 kc provided by the self-contained oscillator.

Since the impedance of the thermocouple circuit is quite low (0.3 ohms in the Q Meter Type 260-A), it is often inconvenient to locate a source of audio-frequency voltage having a low enough output impedance to supply the current required to drive the Q Meter injection circuit.

To overcome this restriction BRC now offers the Coupling Unit Type 564-A which makes feasible Q measurements in the frequency range of 1 kc to 50 kc. This unit contains an impedance-matching transformer whose response varies less than 2 db over the above frequency range.

When working into the 0.3 ohm impedance of the Q Meter Type 260-A injection circuit, it presents an impedance of 500 ohms to the output of the auxiliary oscillator. Any suitable commercial audio oscillator having a variable output of up to 22 volts may be used.

The coupling transformer is mounted in a steel housing which may be fastened directly to the top of the Q Meter cabinet. Two binding posts, one insulated from ground (red insulator) and one grounded inside the housing (black insulator), provide for the connection of the auxiliary oscillator output. A 12 inch coaxial cable with a UG-88/U plug serves to connect the transformer secondary to the Q Meter injection circuit.

A. Mounting

The Coupling Unit may be firmly mounted by fastening it to the top of the Q Meter cabinet. This may be done in the following manner. Facing the Q Meter, remove the left-hand Phillips screw from the row at the top rear of the cabinet. Using the longer screw supplied with the Coupling Unit, fasten the unit to the Q Meter at this point by means of the drilled base flange, as shown in Fig. 1.

B. Connection

1. Set the frequency range indicator midway between any two ranges (i.e. between detents).
2. Remove the small panel on the rear of the Q Meter cabinet.
3. Disconnect the local oscillator by removing the BNC type plug from the injection circuit receptacle, located near the top of the opening.
4. Attach the Coupling Unit coaxial connecting cable to the injection circuit receptacle.
5. To avoid measurement errors from leakage into the measuring circuit, connect the output of the auxiliary oscillator to the binding posts of the Coupling Unit with a length of *SHIELDED CABLE,* connecting the center conductor to the red and the shield to the black insulated post. (CAUTION: Turn voltage output of oscillator to zero before making this connection.)
6. Select the desired frequency on the auxiliary oscillator, and increase the output voltage slowly until the Multiply Q By meter indicates X1.

C. Measurement Procedure

For low frequency measurement instructions, refer to the Q Meter Type 260-A instruction manual.

D. Input Voltage Requirements

Because the response of the Coupling Unit varies slightly with frequency (largely because of the capacitance of the output cable), the oscillator output voltage required to produce a X1 reading on the Multiply Q By meter will increase at frequencies approaching 50 kc. Fig. II indicates the signal voltage requirements within the frequency range of the Coupling Unit.

E. Low Frequency Q Voltmeter Correction

The Q-indicating voltmeter circuit of the Q Meter has been bypassed in order to provide optimum performance at frequencies between 50 kc and 50 mc. For this reason the response of the voltmeter to low audio frequencies is not flat, and a correction, indicated in Fig. III, must be applied to the observed Q or LO Q reading to obtain the corrected value of indicated Q.

F. Use With Q Meter Type 160–A

Although designed primarily for operation with the Q Meter Type 260-A, the Coupling Unit may be used with the older Q Meter Type 160-A if the following requirements are observed:

1. The auxiliary oscillator used must have a maximum output of at least 30 volts. Input voltages higher than those indicated in Fig. II will be required.
2. An adapter must be prepared to permit connection of the Coupling Unit output to the phone jack on the top of the Q Meter cabinet. Such an adapter may consist of a standard phone plug and a UG-291/U receptacle, connected by a short length of RG-58/U cable.

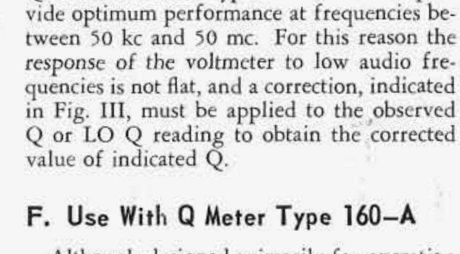

Figure 2. Input voltage required for X1 reading on a Multiply Q By meter, over frequency range of Coupling Unit.

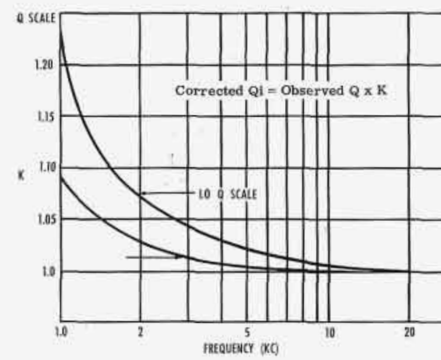

Figure 3. Low frequency corrections for indicated Q observed on Q Meter Type 260–A.

An RF Voltage Standard Supplies A Standard Signal At A Level Of One Microvolt

CHARLES G. GORSS, *Development Engineer*

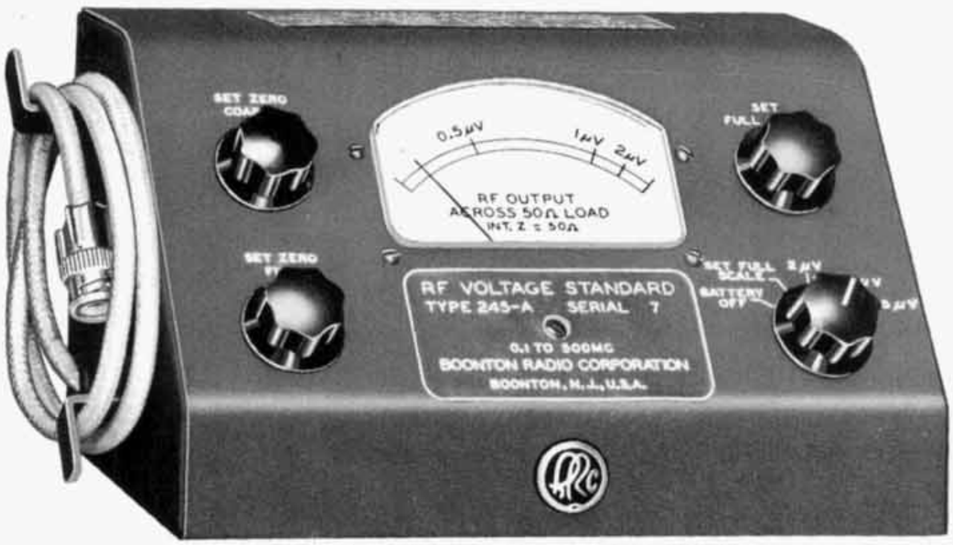

Figure 1. The RF Voltage Standard Type 245–A.

The sensitivity of a radio receiver is a well advertised feature, and properly so since it is one of the most important attributes of a receiver. This sensitivity often is in the order of one microvolt or less, and the direct measurement of rf voltages at this level is seldom possible and never accurate.

The generation of a level of voltage which cannot be accurately measured presents a problem since the receivers under test are the only devices capable of even detecting the presence of these diminuative voltages. To use a receiver of unknown sensitivity to measure these levels would not be an accurate process. A solution to the problem is a source of rf voltages, at microvolt levels, which can be established with a definite and reasonable accuracy without actually measuring it at the low levels.

GENERATOR OUTPUT SYSTEMS

Numerous signal generators are in existence with an output range including 1 microvolt. They usually depend on a voltmeter which monitors the voltage input to an attenuator system having a very large attenuation ratio and whose internal impedance generally varies with frequency and often is not accurately known. Both the voltmeter accuracy and the coupling to the attenuator may vary with frequency.

The piston, or mode cutoff, attenuator is regarded as one of the best types of attenuators commonly used in signal generators today. However, there are serious drawbacks to high precision over a broad band of frequencies. The fact that there are spurious modes generated in the attenuator detracts from its accuracy. Of course, the effect can be calculated for a mechanically perfect unit.[1] However, the dimensions, the roundness of the tube or lack thereof, and the angular alignment of the input and output loops all influence the accuracy of such an attenuator to a great degree. Besides this, the apparent diameter of the tube changes as the frequency drops, due to an increasing penetration of the metal of the tube by the field. One last and serious drawback is that no check with precise direct current instruments is possible.

VOLTAGE TRANSFER PROBLEMS

Even if one were capable of producing an accurate output of one microvolt level from a system, there must be a way to accurately transfer it to a receiver. The device should therefore have a resistive output impedance equal to the characteristic impedance of the cable to be used to connect the standard source to the receiver. The subject of connecting signal generators to receivers has been adequately covered in a previous article[2] in The Notebook.

A device which could produce an accurate level of one microvolt through a known impedance would be a powerful tool for standardizing signal generators being used to check sensitivity of receivers. In the development laboratory, or on the manufacturing line, or in the calibration laboratories of a large receiver user, such as an airline which wants to be sure of receiver performance, there is an immediate need for an instrument of this kind. The RF Voltage Standard Type 245-A is such a device.

CALIBRATED RF VOLTAGE SOURCE

The RF Voltage Standard Type 245-A, shown in Figure 1, takes approximately the full output of an average signal generator over the frequency range of 1-500 mc, precisely monitors the high level input to an attenuator system, and accurately attenuates this voltage to the microvolt region. The now-accurately-known signal at microvolt level appears in the output circuit in series with a 50 ohm resistive impedance.

The use of this device to calibrate a signal generator is relatively simple as illustrated in Figures 2 and 3. The signal generator is connected to the RF Voltage Standard by the integral input cable, and the generator rf output increased until the RF Voltage Standard monitor meter reaches the reference line corresponding to the desired output level. The output is connected to the receiver antenna terminals by an output cable with a 50 ohm termination such as a Type 501-B.

Once the receiver output indication has been recorded, the Type 501-B cable is connected to the signal generator output in place of the RF Voltage Standard as shown in Figure 3. The signal generator attenuator is turned down till the same output indication is observed on the receiver as had been previously recorded for the output of the RF Voltage Standard. The signal generator is now furnishing the same level as the RF Voltage Standard had been and the signal generator attenuator setting is recorded as a standardized point.

ACCURACY REQUIREMENTS

Of course, no comparison Standard can correct for errors arising from voltage standing waves on the output induced by incorrect values of the generator output or load input impedance and this impedance must be close to 50 ohms for maximum accuracy.

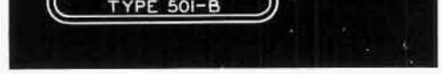

Figure 2. Step No. 1 RF voltage at high level is obtained from the signal generator and measured. The attenuated output is detected at low level on a receiver and a reference reading noted. Calibration applies to the end of the terminated output cable.

ATTENUATOR SYSTEM

The accurate attenuator system, which is the heart of the RF Voltage Standard, is a variation of the Micropotentiometer principle described by M. C. Selby of the National Bureau of Standards.[3] The output voltage is generated by causing a monitored current to flow through a 2 milliohm concentric disc resistor. This disc resistor is thinner than the penetration depth of the current by several times at all useable frequencies. The consequence of this fact is that the resistance can be determined very accurately by DC means and will not vary from this appreciably in the frequency range of this device. By the very nature of the symetrical annular design the inductance of the disc is of a negligible magnitude.

The current into the disc is controlled by placing the disc in a coaxial system at the terminus of a resistive concentric line which is designed to have no frequency dependance as shown in Figure 4. The resistance of the line is 50 ohms, and the line appears at its input as a non-reactive 50 ohm termination.[4] As far as the input is concerned, the 2 milliohm disc is a short circuit.

A diode voltmeter monitors the input to the termination. The VSWR of the resistive line is very low to well above 500 mc and therefore the current flowing in it will remain constant with frequency changes if the voltage at the input is constant. The output impedance of the device is controlled by a 50 ohm resistive section on the output side of the disc resistor. This resistive line is designed exactly like the input section. The output connector is joined to this section by a fifty ohm loss-less air line having negligible discontinuities.

MONITORING SYSTEM

The crystal voltmeter system uses a new UHF crystal diode in a specially designed coaxial mounting. The crystal is operated in a rather unique fashion. A 100 microampere current flows through the crystal at zero rf input. This bias stabilizes the characteristics of the diode to a much greater degree than they would be in a no bias state. The DC output current of the diode is taken from the rf assembly through an rf filter which prevents any leakage from the high level side of the attenuator.

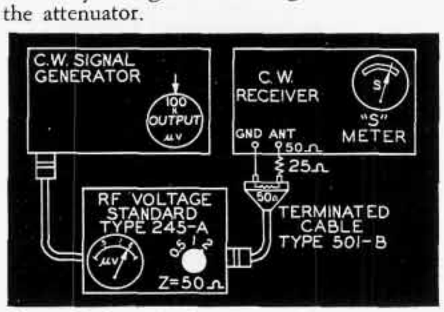

Figure 3. Step No. 2. The low level output of the signal generator is adjusted to produce the same reference level reading on the receiver as was produced by the unknown low level output of the RF Voltage Standard.

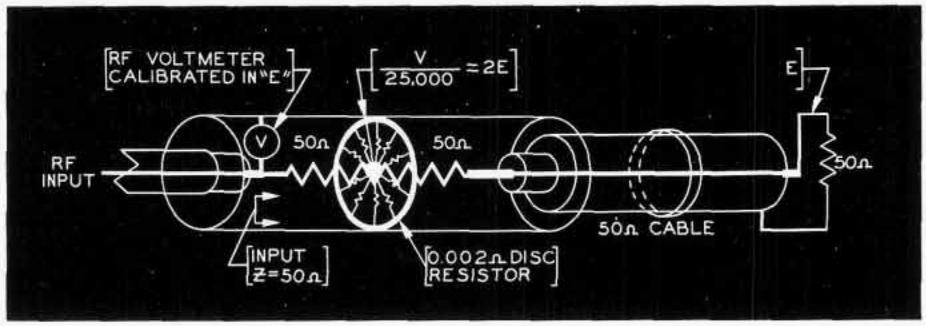

Figure 4. RF Voltage Monitor and Control Attenuator System of the RF Voltage Standard Type 245–A.

In order to keep the low impedance of the crystal detector from seriously damping the 20 microampere dc output meter, a common base transitor amplifier is used. The output impedance of this configuration is high enough to leave the meter just about critically damped. The current amplification of such a device is essentially α or about 0.98 times the input current for the RD2521A transistor which is used in this instrument. This represents no serious loss in output, and since it is a very stable property of a transistor there is no serious loss of stability.

Power to operate the transistor and the crystal bias circuitry comes from a small self-contained battery used at low current drain. Battery life is essentially "shelf life".

CONCLUSION

In conclusion, the RF Voltage Standard Type.245-A is a simple, self-contained, portable and accurate solution to the problem of low rf level measurements. It offers outputs of 0.5, 1, and 2 microvolts with significant accuracy and has an output impedance of 50 ohms with a low Voltage Standing Wave Ratio. This instrument can offer great assistance toward resolving the existing confusion in the comparison of signal generators and receiver sensitivity measurements.

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4. "Radio Frequency Resistors as Uniform Transmission Lines", D. R. Crosby and C. H. Pennypacker—Proc. IRE, Feb., 1946, p. 62P.

NOTE FROM THE EDITOR

Every Spring your editor hears the noise of unusual activity in the Sales Department. This Spring the noises have reached an unusual volume. We were finally approached with a request for permission to include some descriptive information on new equipment in the envelope with this issue of The Notebook. It is our policy to include in these pages information of the most general technical interest possible. We are not, however, insensitive to the value of really new information on new equipment. The new equipment will be on display at the IRE Convention in New York City at Kingsbridge Armory. However, many of our readers may not be able to attend the Convention. For them especially we have included some extra information in our envelope. We believe you'll profit by reviewing our enclosure.

We published our first issue of the Notebook one year ago this month. In the first issue we indicated our intention of distributing information of value on the theory and practice of radio frequency and measurement. We believe that an article on the last page of the current issue listing an "INDEX" to previous issues of The Notebook is worth reviewing to determine how we have implemented our intention. Our editorial plan for The Notebook requires the publication of five articles in each issue; one article in each of the following categories:

1. Articles of broad technical interest of general and lasting usefulness in the measurement field.

2. Articles of more popular technical interest and practical nature.

3. Articles covering instrument application or service material.

4. Non-technical articles of general interest.

5. Notes from the Editor.

IF YOU FIND MATERIAL OF INTEREST IN THE INDEX WHICH IS NOT IN YOUR HANDS, PLEASE, LET US HEAR FROM YOU. We still have a few extra copies of past issues.

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