TYPE 105 SQUARE WAVE GENERATOR

SUGGESTED FIELD RECALIBRATION PROCEDURE

(1) Before applying power or making any other connections, do the following:

a. Observe the resting point of the meter needle. If it is not exactly at zero, mechanically adjust it to that point.

b. Preset controls and internal adjustments as follows (Front panel controls are underlined):

<u>RANGE</u> control to 10 KC.

Set to fully counter-clockwise position: <u>OUTPUT AMPLITUDE</u>, <u>SYNC INPUT AMPLITUDE</u>, and ADJ 175V.

Set to middle of range or midscale position: <u>SYMMETRY</u>, <u>FREQUENCY</u>, ADJ TO -150, METER ADJ and M.V. SCREEN ADJ.

(2) Connect a terminating resistor, 52Ω or 93Ω, to the OUTPUT jack and attach a cable of the same impedance.

(3) Measure power supply resistances. The resistance between "A" (Terminal 8 of T1) and "A -150V" (Terminal 15 of T1) should be about 4 to 5K Ω. The resistance from "A" to ground should be about 100KΩ or more.

(4) Apply power (AC and DC on) and measure the voltage from "A" to "A -150V". Set the ADJ TO -150 pot so that there is exactly 150 volts difference in potential.

(5) With the <u>OUTPUT AMPLITUDE</u> control fully counter-clockwise, measure the ripple content of the "A -150" power supply with an oscilloscope. The peak-to-peak value of the power-frequency component should not exceed 60 mv. ("Hash" from the multivibrator and other circuits will give a greater over-all amplitude). Measure between "A" and "A -150V".

(6) Adjust the -175V ("A") supply as follows:

a. Measure the "A" voltage (between Terminal 8 of T1 and chassis) and slowly rotate the ADJ 175V control in the clockwise direction. The negative potential should decrease to a low value and then begin to increase. Set the control for an output of -6V on the increasing slope.

b. Increase the potential by rotating the <u>OUTPUT AMPLITUDE</u> control to the fully clockwise position. At the end of its range, the voltage should be within a few volts of -175. If it is, retouch the ADJ 175V control for an exact reading of -175. Rotate the <u>OUTPUT AMPLITUDE</u> control to the fully counter-clockwise position and if the voltage is between -5V and -7V, the adjustment is completed.

NOTE: In case the dipping action in step a. fails to occur, indications are that the series regulator tubes for the supply should be replaced. If, in step b., the first measurement of the -175V supply at the clockwise position of the <u>OUTPUT AMPLITUDE</u> control is not satisfactory, be sure that the line voltage to the instrument is near 117 VAC. If it is, and results are still unsatisfactory, R98.1 should be replaced, perhaps with a different value of resistance. R98.1 is a composition resistor shunting the <u>OUTPUT</u>

AMPLITUDE control and was originally selected at the factory in the procedure outlined above.

(7) Measure the ripple content of the -175V supply (Point "A" to ground) with an oscilloscope. The peak-to-peak value of the power-frequency compononent should not exceed 50 mv at the counter-clockwise setting of the OUTPUT AMPLITUDE control.

(8) Place a VOM or VTVM between pins 1 and 7 of V11. Pin 7 will be about 65V negative with respect to pin 1. Set the METER ADJ. control so that the reading is exactly -65V.

(9) Connect the screen grids of the multivibrator tubes (pins 6 of V1 and V2) with a jumper and measure their voltage with respect to the -150 supply. Set the M.V. SCREEN ADJ so that the screens are at +80V. Remove jumper.

(10) Check for satisfactory symmetry of the output wave on each frequency range, except the 1 MC range. This may be accomplished by observing the wave on an oscilloscope. On each setting of the RANGE control it should be possible to obtain a wave with equal time duration of the positive and negative halves at a setting of the SYMMETRY control within about ±90 degrees of center position.

NOTE: Unsatisfactory performance may be due to several reasons. If there is a tendency to be off in the same direction on all or most ranges, suspect a basic unbalance in the unswitched portions of the multivibrator circuit, e.g. V1 and V2 not balanced; screen resistors not balanced; plate or cathode resistors not balanced, etc. A random pattern of output unbalance may indicate the plate-to-grid RC coupling networks on the RANGE switch are not balanced on various ranges. On the 1 MC range, these will be adjusted later in the procedure.

(11) Calibrate the frequency meter at full scale on each setting of the RANGE control. This is generally accomplished with the use of a type 180 time mark generator and an oscilloscope (530 or 540 series) with a "C" unit plug-in preamplifier. If these are not available, refer to the note at the end of this step. Proceed as follows:

a. Connect the output of the Type 105 to the input of either "A" or "B" channel of the "C" unit. Connect the output of the Type 180 to the input of the other channel and also to the SYNC INPUT jack of the Type 105. Set the MODE switch to ALTERNATE SWEEPS. Set the oscilloscope triggering controls to +INT and AC SLOW. With the RANGE control of the Type 105 on 100 CPS and the output from the Type 180 a 10 Msec. marker, operate the channel position and sensitivity controls, and the oscilloscope sweep TIME/CM and STABILITY and TRIGGERING LEVEL controls so that there is obtained a stable display of both 10 Msec. markers and several cycles of the square wave.

b. Operate the Type 105 FREQUENCY control so that the time duration of each complete cycle is slightly greater than the interval between 10 Msec. markers; about 10.5 Msec. should be satisfactory. Rotate the SYNC INPUT AMPLITUDE control until the second half of the square wave suddenly shortens, with the result that there is exactly one square wave for each 10 Msec. marker. The frequency of the 105 is now 100 CPS, to the accuracy of the Type 180. Set the 100 CPS control for exactly full scale reading.

The full scale indication on the 100 CPS range is now correct. Removing the input sync signal should result in the multivibrator dropping to its original frequency and a corresponding decrease in meter deflection. Rotating the FREQUENCY control clockwise until full scale indication is again reached should provide a free-running output which also displays exactly one full cycle for each time mark. The chief limitation of the accuracy at frequencies below full scale is the meter movement itself; this will be checked for tolerance later in the procedure.

c. Repeat the basic procedure of step b. on the ranges through 250 KC, with the chart below as a guide to cycle-marker combinations.

FULL SCALE FREQ.	TIME DURATION OF CYCLE AT FREQ.	TIME MARK	MARKS/CYCLE
100 CPS	.01 sec.	10 Msec.	1
250 CPS	.004 sec.	1 Msec.	4
1 KC	.001 sec.	1 Msec.	1
2.5 KC	400 μsec.	100 μsec.	4
10 KC	100 μsec.	100 μsec.	1
25 KC	40 μsec.	10 μsec.	4
100 KC	10 μsec.	10 μsec.	1
250 KC*	4 μsec.	1 μsec.	4

* Proper indication is obtained by adjusting C30.

d. Adjust symmetry, frequency and meter indication on the 1 MC range. The major difference between the circuitry of this range and those previously adjusted is that the plate-to-grid RC coupling networks contain a variable amount of capacitance rather than a fixed amount. Changing the settings of those capacitors will change the period of time for which each half of the multivibrator may hold the other half cut off; therefore their settings will interact with the FREQUENCY and SYMMETRY controls.

Set the SYMMETRY control with the white dot straight up. Set the FREQUENCY control for full scale reading on the 250 KC range with no sync signal applied; or to 3 o'clock, whichever is farther clockwise. This is the setting to use on the 1 MC range in the following adjustments. Observe the frequency and symmetry of the 1 MC wave by comparing it to 1 μsec. markers. Use the same set-up as in previous portions of step 11.* Adjust C11 and C12 so that the frequency is exactly 1 MC and the wave is symmetrical. It may be desirable to use the positioning controls of the "C" unit to superimpose the two signals. Upon being

*But allow the Type 105 to free-run rather than run synchronized.

satisfied the square wave frequency is 1 MC, adjust C31 for full scale meter indication.

NOTE: If the above procedure is unusable because of lack of the proper test equipment, a substitute procedure may be improvised using an external time or frequency standard other than the Type 180. The basic principle involved is to use the external standard and a comparing device to obtain an accurate full scale frequency on each range and adjust the meter controls accordingly.

(12) Check linearity of the meter movement at 40% full scale. Set the Type 105 RANGE control to 2.5 KC and operate the FREQUENCY control for an indication on the meter of 1 KC. Compare the output wave to a 1 Msec. marker as in step 11. Readjust the control so that the actual (not meter-indicated) frequency is just below 1 KC (total time duration slightly greater than 1 Msec.) and sync the Type 105 with 1 Msec. markers. Observe the indicated frequency on the meter. Accuracy should be ± 3%.

NOTE: Although frequency is actually being read on the lower scale, one minor division of the upper scale represents 1% of full scale and is the easiest to use on this check.

(13) Check maximum and minimum frequency output on each range. With the FREQUENCY control fully clockwise, the meter should be pegged on each setting of the RANGE control. At a fully counter-clockwise position, the reading should drop to 20% or less of full scale. (With the DC switch in the OFF position, there will be a deflection due to Edison effect in V12.)

CAUTION: SYNC INPUT AMPLITUDE control should be turned fully counter-clockwise and all trigger sources removed from the SYNC INPUT binding post for this step.

(14) Check sensitivity to an external synchronizing signal. Turn the SYNC INPUT AMPLITUDE control fully clockwise. Apply 100 MV signal from the calibrator of the test oscilloscope to one channel of the "C" unit and the output of the Type 105 to the other. On the 2.5 KC position of the RANGE control operate the FREQUENCY control so that the free-running frequency of the Type 105 is slightly below that of the calibrator wave, as observed on an ALTERNATE SWEEPS display. Apply the calibrator signal also to the SYNC INPUT jack of the Type 105. If the 105 does not synchronize, increase the calibrator voltage to 200 MV or 500 MV as necessary. No more than 500 MV should be required to obtain reliable synchronization.

(15) Observe the SYNC OUTPUT waveform for proper amplitude. This is done with the Type 105 free-running at a frequency of 10 KC. The SYNC OUTPUT waveform is a differentiated square wave with an unbalance of amplitude in the positive and negative halves. Measure the amplitude of the positive portion with an oscilloscope; it should be at least 5V.

(16) Observe the peak-to-peak amplitude of the output waveform at a frequency of 1 MC. If a 93Ω termination is being used, the voltage should be about 19V with fresh output amplifier tubes. Older tubes may give an output down to about 15V. The output with a 52Ω termination will be correspondingly lower, about 10V for fresh tubes.

NOTE: The Type 105 is normally thought of as a current generator. As external terminations are added, they parallel the internal load and reduce the peak-to-peak voltage swing. Also, since the output capacity of the final stage is being discharged through a lower impedance, risetime decreases, producing higher frequency equivalents in the output.

(17) Check 1 MC wave for correct shape and adjust L2 if necessary. The output should be coupled to the examining device with a cable terminated in its characteristic impedance at both ends. If 93Ω equipment is used, the risetime should be about .02 μsec. With 52Ω equipment, about .013 μsec. is correct.

NOTE: The total risetime of cascaded units is equal to the square-root of the sum of the individual squares. Therefore, a generator and an oscilloscope with equal risetimes will display a risetime equal to 1.414 times the risetime of either one. A direct reading of the risetime of the Type 105 may be made by applying the signal to the plates of a CRT of sufficient sensitivity.

A Type 517 or a Type 541 or 545 with "K" unit (known to be in proper adjustment), will present the wave well enough to determine quality but will not allow a direct measurement of risetime. The wave should have a square corner at the top of the rise and a flat top. Overshoot on the bottom of the fall may be caused by cathode interface in the 6AG7's in the final amplifier. L2 should be adjusted so that the leading edge has its most rapid rise just short of the point of inductive overshoot on the falling edge. Combined interface and inductive overshoot on the falling edge should not exceed 2 or 3 percent.

(18) It may be desirable to check the total power consumption of the instrument, which is normally about 240 watts at 117 line volts and the <u>OUTPUT AMPLITUDE</u> control fully clockwise.