# OPERATING MANUAL

*for*

# PACO

## MODEL G-15W GRID-DIP METER AND MODULATION INDICATOR

PACO ELECTRONICS CO., INC.

A DIVISION OF PRECISION APPARATUS CO., INC. 70-31 84th STREET, GLENDALE 27, L. I., N. Y.

(A SUBSIDIARY OF PACOTRONICS, INC.)

MODEL G-15W (3-61)1

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## GENERAL DESCRIPTION

The rugged all-new PACO G-15 Grid Dip Meter is a variable frequency oscillator and absorption wavemeter providing continuous coverage of broadcast, FM, ham and TV bands. The G-15 can also operate as a crystal-controlled oscillator merely by plugging in a crystal of the desired frequency. A multitude of test applications are at your fingertips with the new G-15, including a visual and aural modulation check-exclusive with PACO.

## FEATURES AND SPECIFICATIONS

MAJOR FUNCTIONS - (1) Variable frequency oscillator covering frequency range of 400 kc up to 250 mc in eight bands. (2) Absorption wavemeter, 400 kc to 250 mc. (3) Modulation indicator to indicate transmitter modulation and to help retain a proper, easy-to-copy speech level.

ANTENNA TESTING - Assures accurate antenna tuning and standing wave checks, as well as stub measurements.

TRANSMITTER APPLICATIONS - These include neutralizing, TVI suppression, parasitic checking, tank frequency measurements, and carrier monitoring. May also be used as an emergency substitute for a master oscillator.

FIELD STRENGTH MEASUREMENTS - May be used as a diode detector for measuring field or carrier strengths and for "cold" alignment of filters and wavetraps.

SIGNAL SOURCE - May be used as a signal or marker generator, providing calibrated signals in the 400 kc to 250 mc frequency range.

COMPLETE FREQUENCY COVERAGE - No skip bands.

SIMPLE, ONE-HAND OPERATION - Small, conveniently shaped case with self-contained power supply, eight probe type coils, and large, easy-to-read, thumb-actuated dial.

FREQUENCY RANGE - Eight plug-in coils are supplied covering 400 kc to 250 mc frequency range as follows: Coil A - 400 kc to 760 kc; Coil B - 760 kc to 1.6 mc; Coil C - 1.6 mc to 4.5 mc; Coil D - 4.5 mc to 9.6 mc; Coil E - 9.6 mc to 20.5 mc; Coil F - 20.5 mc to 49 mc; Coil G - 49 mc to 110 mc; Coil H - 110 mc to 250 mc.

POWER REQUIREMENT - 115 volts, 60 cycles ac.

DIMENSIONS - 2-3/4 x 7-1/2 x 2-1/2 inches.

SHIPPING WEIGHT - 3 pounds.

## CIRCUIT DESCRIPTION

The PACO G-15 Grid-Dip Meter is a variable frequency oscillator and absorption wavemeter that provides continuous coverage within the 400-kc to 250-mc range. When operating as a variable-frequency oscillator of the Colpitts type, a meter in the grid circuit provides an indication of power flowing in the tank circuit. A tuned circuit, placed near the oscillator and tuned near the same frequency, absorbs energy from the tank circuit, causing a reduction in the meter indication. This grid current reduction is referred to as the "grid dip". When the oscillator is tuned to the same frequency as the resonant circuit, maximum energy is absorbed from the tank circuit and a maximum grid dip occurs.

With a pair of earphones plugged into the PHONES jack, the oscillator is converted to an oscillating detector. This detector can be used to measure the frequency of an r-f source by heterodyning or "zero-beating" the oscillator signal with the signal from the r-f source. At "zero-beat" the frequency of the r-f source is read on the G-15 frequency dial. At either side of "zero-beat", a whistle or beat note is heard in the earphones.

When the Modulation Switch is placed in the READ MOD. position, a network is introduced into the oscillator grid circuit which enables the 100% relative modulation level of a transmitter to be determined. The determination is indicated by a maximum grid meter reading just prior to a strong dip, as the transmitter audio control is adjusted upwards.

Removing the plate voltage from the oscillator by setting the function switch to the DIODE position, converts it to a diode detector with the grid acting as the diode plate and the meter indicating diode current. In this mode, the G-15 is an absorption wave meter which can be used to indicate the frequency and strength of nearby r-f sources and fields.

## HOW TO USE THE GRID DIP METER

NOTE: Normally no calibration of the PACO Model G-15 Grid Dip Meter is required. However, if it is desired to touch up the calibration somewhat, it can be done using an auxiliary receiver and a local broadcast or short wave station. The local station is tuned in on the receiver. The Grid-Dip Meter is used in the OSC. position, with the modulation switch at NORM. The Grid-Dip Meter is tuned until a whistle is heard in the receiver. Adjust the instrument to a "zero beat" and move the hairline so that the dial reading corresponds to the frequency of the local station being received. If trouble is encountered, refer to the WHAT TO TO IN CASE OF TROUBLE section.

This instrument can be used as a grid-dip meter with the function switch in the OSC. position or as an absorption meter with the function switch in the DIODE position. When used as a grid-dip meter, this instrument can be either inductively or capacitively coupled to the circuit

under test (see figure 13). For the most accurate readings, coupling should be as loose as possible; however, in some very low-power or low-Q circuits, close coupling may be needed to obtain an easily observable dip. In checking circuits employing transistors, the grid-dip oscillator should be coupled loosely to prevent excessive power from being dissipated in the transistor.

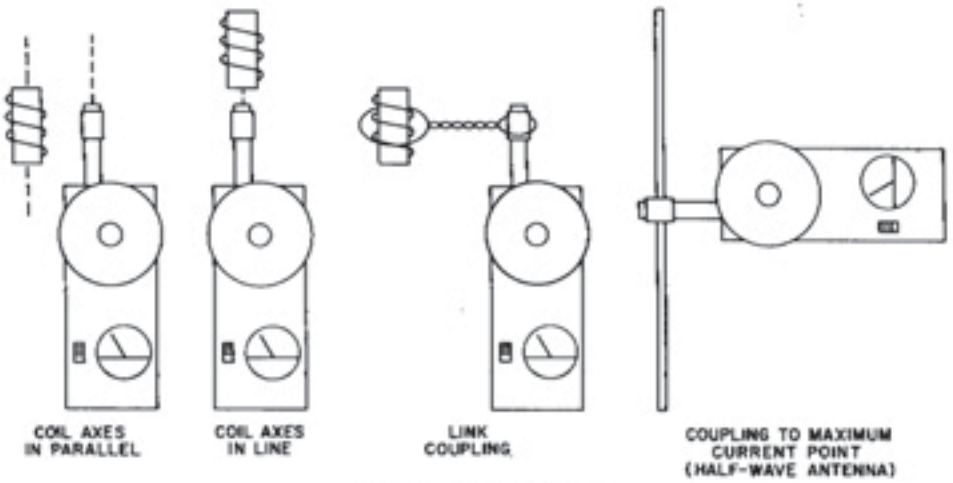


Figure 13. Methods of Coupling

## PREPARATION FOR USE

1. Plug line cord into 110- to 120-volt, 60-cycle, a-c source.
2. Turn sensitivity control to the on position.
3. Set function switch to OSC. or DIODE position depending upon application.
4. Set modulation switch to MOD. or NORM. position depending upon application.
5. Select coil of proper frequency, and plug into coil socket.

## TUNING A TRANSMITTER

To tune a transmitter, all transmitter voltages must be removed. The various tuned circuits are adjusted with the grid-dip meter function switch at the OSC. position. The grid-dip meter is set to the frequency of the various tuned circuits and coupled to the circuit. The circuits are then adjusted for the maximum dip on the grid-dip meter. Coupling should be decreased as the circuits are resonated so that a very fine dip can be seen. The instrument should be far enough away from other tuned circuits so that only one circuit can be resonated at a time. After the circuits are adjusted, the transmitter voltages can be applied and the stages checked for spurious responses by using the grid-dip meter as an oscillating detector. Plug headphones into the PHONES jack and tune the grid-dip meter. If a beat is heard at a frequency remote from the transmitter frequency, it is an indication of a parasitic oscillation. The relative amplitude of harmonics can be checked with the function switch in the DIODE position.

## CRYSTAL OPERATION

The G-15 may be used as a crystal controlled oscillator by plugging a crystal into the coil socket. The Function Switch is set to 'OSC.' and Modulation Switch to 'NORM.' Rotate the dial until the meter reads a maximum and set the Sensitivity Control for 2/3 full scale reading. The Grid Dip Meter is now crystal controlled. Relative crystal activity can be observed by plugging in different crystals and tuning the dial for a maximum indication, with the Sensitivity Control remaining at the fixed setting. The highest readings (maximum meter current) will indicate the more active crystals.

## NEUTRALIZING AN AMPLIFIER

To neutralize a receiver, or transmitter stage, turn all power off. Couple the grid-dip meter to the input circuit and tune for a dip. Adjust the neutralizing control so that no change in the grid-dip meter reading is noticed when the output circuit of the stage under test is tuned through its range.

## MODULATION MONITORING

To monitor an AM transmitter, place the modulation switch in the READ MOD. position. As the transmitter is modulated, the meter will deflect upward, indicating a relative modulation level. Advance the audio gain on the transmitter, noting the increase in the grid-dip meter reading. A point will be reached where any further increase in gain will cause a drop in the grid-dip meter indication. Transmitter modulation of 100% is indicated just before the grid-dip meter readingdecreases. By plugging a headset into the PHONES jack, an aural modulation check can be made.

## ANTENNA TESTING

The resonant frequency of antennae can be determined by using the OSC. position of the function switch. Disconnect the feed line and short the antenna feed point with a short wire. This is done because most transmission lines are not closely matched to the antenna. As a result, stray resonances that interact with antenna resonances sometimes may give false readings. If an untuned transmission line matches an antenna closely, its resonant frequency can be checked at the feed end of the transmission line. If a tuned feed line is used, couple the grid-dip meter to the antenna link at the transmitter after disconnecting the transmitter tank circuit. If capacitive coupling is used, the antenna should be fed at a voltage maximum point; if inductive coupling is used, the antenna should be fed at a current maximum point of the antenna. In a half-wave antenna, a maximum current point is at the center; for longer wire antennae, it is at points of odd quarter wave lengths measured from the ends.

## RECEIVER ALIGNMENT

The grid-dip meter can be used as a substitute for a signal generator in receiver alignment. Manufacturer's alignment instructions can be followed using the receiver S meter as an indicator. Where the receiver is not equipped with an S meter, a high impedance voltmeter (such as the PACO Model V-70 VTVM) must be connected at the output of the detector. The receiver is aligned so that maximum DC voltage is read on the VTVM. If it is suspected that the local oscillator is not working, it can be checked by using the DIODE position of the function switch. The local oscillator should give an indication on the grid-dip meter when it is brought close to the oscillator coil.

## RELATIVE FIELD STRENGTH INDICATION

The grid-dip oscillator can be used as a field strength meter by putting the function switch in the DIODE position. The antenna and transmitter loading are tuned for a maximum indication on the instrument.

## R. F. CHOKES AND COILS

With the function switch in the OSC. position, the self-resonant frequency of unloaded RF chokes and coils can be determined. The grid-dip meter is adjusted for a maximum dip and the self-resonant frequency is read directly from the dial.

## MEASURING CIRCUIT Q

To determine the Q of a tuned circuit, a VTVM will be needed. Connect the VTVM across the tuned circuit and couple the grid-dip meter close enough to give nearly full scale readings on the VTVM using a sensitive a-c range, such as the 1.5-volt, a-c range of the PACO Model V-70 VTVM. Tune the grid-dip meter for a maximum reading on the VTVM. Record the dial reading of the grid-dip meter. This is the center frequency ($f_0$) of the tuned circuit. (See figure 14.) Without changing the position of the circuit or the coupling, retune the grid-dip meter slightly lower in frequency until the VTVM reads 0.707 (-3DB) of the previous maximum VTVM reading (at $f_0$). Record the dial reading of the grid-dip meter. This is the lower 3DB frequency ($f_1$) of the tuned circuit. Once again, retune the grid-dip meter slightly higher in frequency than ($f_0$), passing through ($f_0$), and then stop tuning when the VTVM reading is again 0.707 of the ($f_0$) reading. Record the dial reading of the grid-dip meter. This is the upper 3DB frequency ($f_2$) of the tuned circuit. The resulting Q of the tuned circuit is computed as follows:

$$Q = \frac{f_0}{f_2 - f_1}$$





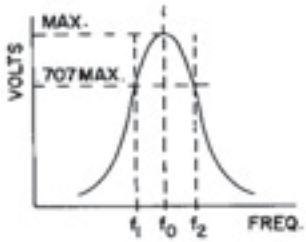


Figure 14. Measuring Circuit Q

## MEASURING CAPACITY AND INDUCTANCE

Unknown values of capacitors between the range of 50 mmf to 7000 mmf can be measured using the Grid-Dip Meter as the measuring instrument. Figure 15 illustrates the basic principle used for this measurement. The unknown capacitor is connected in parallel with one of the coils supplied with the G-15. This coil and condenser combination forms a resonant circuit. The Grid-Dip Meter, in conjunction with "D" coil, is now used to obtain a resonance indication. The resonance indication, in conjunction with the graphs of figure 16, is finally used to ascertain the value of capacitance.

The step-by-step procedure is as follows:

1. Using the alligator clip adapters illustrated in figure 15, connect the unknown capacitor across any one of coils "E", "F", or "G".

2. The Grid Dip Meter, with "D" coil inserted, is then used as illustrated in the figure to obtain a meter dip. Set the G-15 function switch to OSC. and the modulation switch to NORM. Decrease the degree of coupling and find the point of maximum dip.

3. Read the value on the outermost 0- to 100-linear scale.

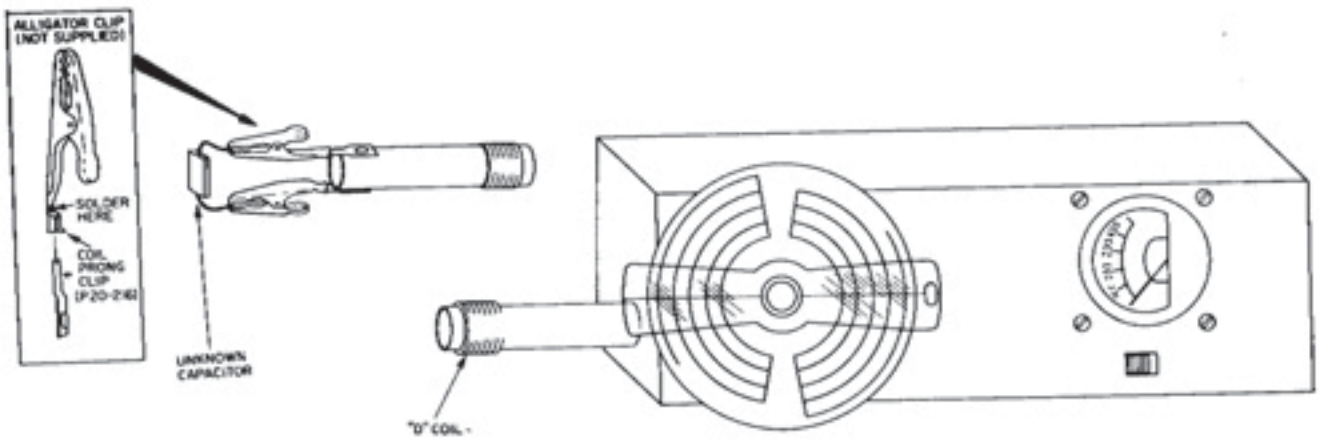


Figure 15. Measuring Capacitance

4. Use the appropriate curve in figure 16 that applies to the coil used in the above test. Project the dial reading obtained onto the curve, and obtain the capacitance reading on the vertical capacitance scale of the graph.

Unknown values of inductance can be measured by using the grid-dip oscillator and a known capacitor of low tolerance of about 75 mmf. Connect the unknown inductance and known capacitance in parallel. Set the grid-dip meter controls as when measuring capacitance. Then couple the grid-dip oscillator to the resonant circuit and tune for a maximum dip. With the value of capacitor used and the frequency as read from the grid-dip oscillator, compute the value of inductance as follows:

$$L = \frac{1}{39.48\, f^2\, C}$$

L is in henrys, C is in farads, and f is in cycles per second

Small errors (usually negligible) will affect the results in these readings. For example, the capacity presented between adjacent turns of a coil is effectively in parallel with the capacitor C shown in the equation above. This is usually about 0.5 mmf and is negligible.

## OTHER USES

After becoming familiar with the instrument, other uses, such as aligning filters and IF strips, and checking stubs and traps, will become apparent.

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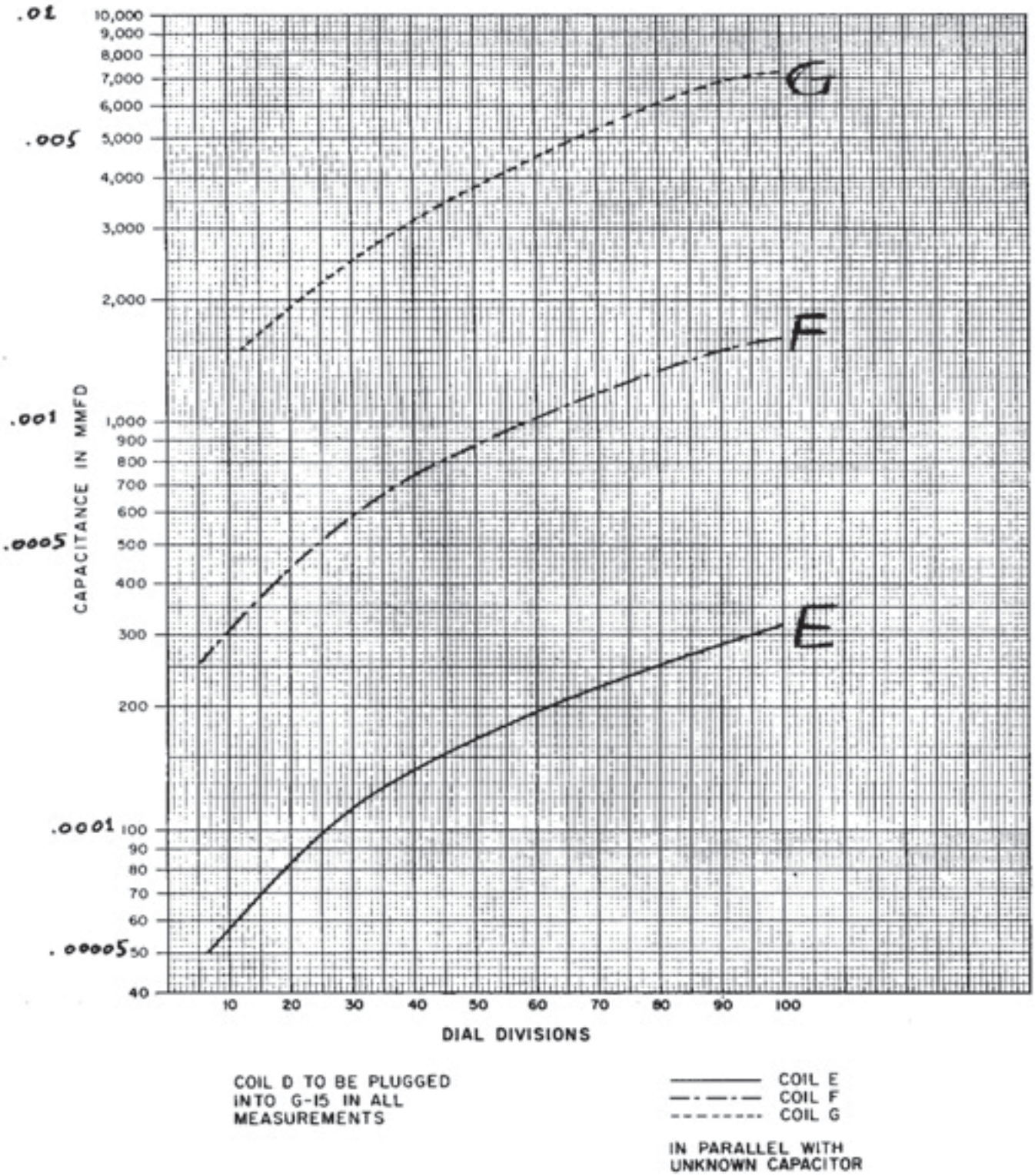



Capacitance Versus Frequency Chart

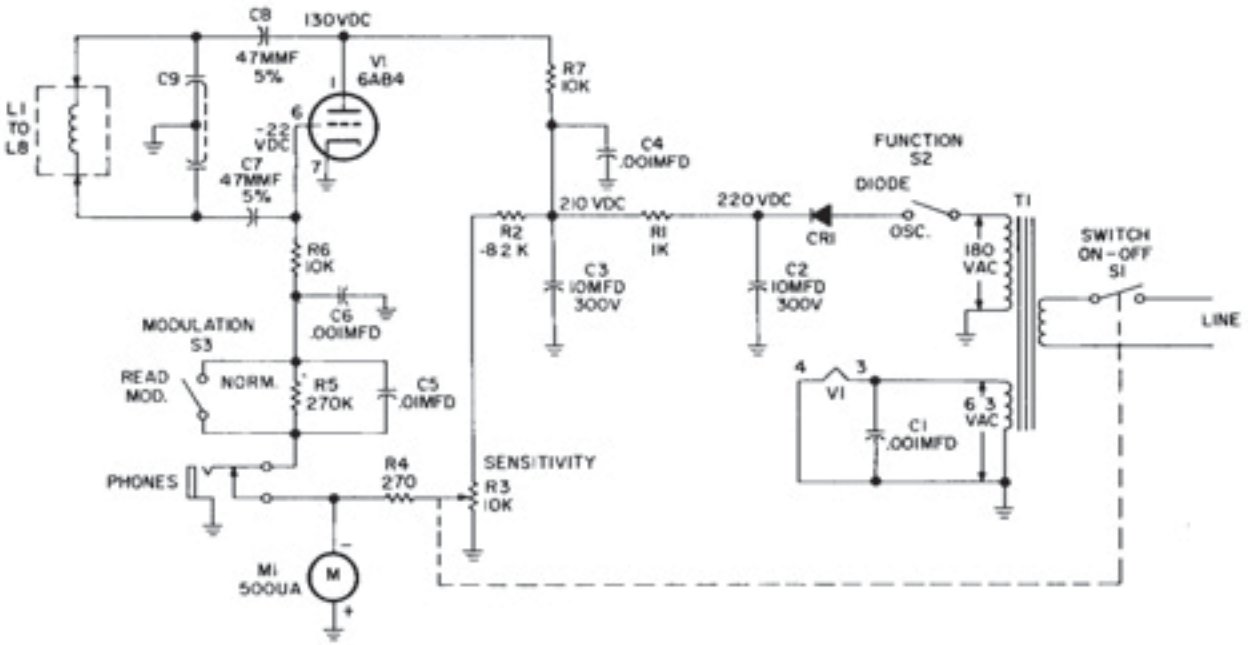
## WHAT TO DO IN CASE OF TROUBLE

If the instrument does not operate properly, we suggest that the following check procedure be observed:

1. Recheck all wiring and make certain all connections have been properly made. Most troubles encountered after completion of kit assembly result from incorrect wiring. Having someone else check the wiring often reveals mistakes that are consistently overlooked.

2. Check the 6AB4 tube, using a reliable tube tester (such as PACO Model T-60). The tube used in this instrument requires no special selection, and replacement should be no problem.

3. Insert plug-in coil A in the coil socket, set the function switch to OSC. position, set modulation switch to READ MOD. position, and apply power. Measure voltages from tube socket pins to ground, using a vacuum tube voltmeter with a high AC input impedance (such as PACO Model V-70 VTVM). Compare the measured voltages with those on the schematic diagram figure 16. If any voltage reading differs by more than ±15%, disconnect power and perform appropriate resistance and continuity checks. Resistance readings should not differ by more than ±20% from the values shown on the schematic diagram.




NOTE:
1. VOLTAGES MEASURED WITH PACO V-70 VTVM FROM INDICATED POINTS TO GROUND, USING COIL 'A' AND SETTING SWITCHES AND CONTROLS AS FOLLOWS: MODULATION SWITCH TO NORM., FUNCTION SWITCH TO OSC., SENSITIVITY CONTROL FULLY CLOCKWISE AND CALIBRATED DIAL FULLY COUNTERCLOCKWISE.

Figure 16. Schematic Diagram

## MAINTENANCE

In those cases where faulty operation of the instrument cannot be rectified through reference to the Trouble-Shooting Data listed above, the Service Department of Paco Electronics Co., Inc., should be consulted. Should the Service Department recommend return of the instrument to the factory, the complete instrument should be carefully packed in a well padded, strong corrugated shipping carton and addressed to PACO's Service Department.

IMPORTANT: If at any time the Model G-15 is to be returned to the factory for repair, a COMPLETE description of suspected faulty operation, as noted by the operator, MUST accompany the instrument. The more details submitted to the Service Department of PACO, the more quickly and efficiently the instrument can be repaired and returned. It is very important that this description of suspected faulty operation be given in unusually exact detail due to the fact that in many cases, faulty operation can be traced to difficulties in other items of test equipment and/or improper analysis of results obtained.

## SHIPPING INSTRUCTIONS

When returning a PACO instrument for repair or service, be sure that all parts are securely mounted. Always pack carefully in a rugged, oversized container, using a generous supply of padding such as excelsior, shredded paper, or crumpled newspaper. Attach a tag to the instrument giving your name, address, and trouble experienced. Never return an instrument unless it is accompanied by a full explanation of difficulties encountered. The more explicit the details, the more rapidly your instrument can be handled and processed.

Please ship PREPAID and address to:

PACO ELECTRONICS CO., INC.,
70-31 -- 84th STREET
GLENDALE 27, L. I., N. Y.

ATT: SERVICE DIVISION

A FRAGILE label should appear on at least four sides of the carton.

Return shipment to you will be made via Parcel Post COLLECT, including repair-service charges unless otherwise requested by previous correspondence.

Please take note that a Carrier cannot be held liable for damage in transit if, in HIS OPINION, packing is insufficient.

ANY WRITTEN INQUIRIES TO THE FACTORY REGARDING YOUR MODEL G-15 MUST INCLUDE COMPLETE SERIAL NUMBER OF YOUR INSTRUMENT. IF YOU NEGLECT TO INCLUDE THE SERIAL NUMBER, IT WILL BE NECESSARY FOR THE FACTORY TO REQUEST THE NUMBER IN ORDER TO ANALYZE YOUR PROBLEM.

Your Model G-15 is a relatively critical and delicate instrument. Do not attempt any major repairs before consulting the Service Department of Paco Electronics Co., Inc.

# PACO WIRED INSTRUMENT GUARANTEE

This is to certify that we, the PACO ELECTRONICS COMPANY, INC., guarantee this Instrument, manufactured by us, to be free from defects in material and workmanship under normal use and service. Our obligation under the guarantee is limited to repairing or replacing this instrument through the Service Department, provided that original purchase has been duly registered and instrument is returned *prepaid* within 90 days from date of sale. *Addressed registration card is furnished with every instrument.*

This guarantee is expressly in lieu of all other guarantees, expressed or implied and of all other obligations on our part, and no other Representative or person is authorized or permitted to make any guarantee or to assume for this Company any liability not strictly in accordance with the foregoing.

This guarantee will not apply to any product which has been tampered with or altered, in any way, or which has been subjected to misuse, negligence or accident, or which has the serial number altered, effaced or removed.

PACO ELECTRONICS COMPANY, INC.
70-31 84th Street • Glendale 27, L. I., N. Y.





MODEL G-15W (3-61)13

## PARTS LIST

| Ref. | Part No. | Quan. | Description |
|---|---|---|---|
| | **RESISTORS** | | |
| R1 | P15-824 | 1 | 1K ohms 10% 1/2W |
| R2 | P15-968 | 1 | 82K ohms 10% 1/2W |
| R4 | P15-904 | 1 | 270 ohms 10% 1/2W |
| R5 | P15-866 | 1 | 270K ohms 10% 1/2W |
| R6, R7 | P15-726 | 2 | 10K ohms 10% 1/2W |
| | **CAPACITORS** | | |
| C1, C4, C6 | P16-170 | 3 | 0.001 mfd 20% Ceramic |
| C2, C3 | P16-303 | 1 | Dual 10 mfd 300WVDC Electrolytic |
| C5 | P16-143 | 1 | 0.01 mfd 20% Ceramic |
| C7, C8 | P16-134-2 | 2 | 47 mmfd 5% Disc |
| C9 | P16-302 | 1 | Variable Capacitor, 2-gang |
| | **CONTROLS-SWITCHES** | | |
| R3-S1 | P17-241 | 1 | 10K ohms 20% Pot., with Switch |
| S2, S3 | P14-171-1 | 2 | Slide Switch, Single Pole, Single Throw |
| | **TUBES-SOCKETS** | | |
| V1 | P19-170 | 1 | Type 6AB4 Tube |
| | P20-193 | 1 | 7-Pin Miniature Tube Socket |
| | P20-213 | 1 | 3-Contact Coil Socket |

| Ref. | Part No. | Quan. | Description |
|---|---|---|---|
| | **SHEET METAL PARTS** | | |
| | P11-367 | 1 | Tube Mount Bracket |
| | P13-410 | 1 | Panel |
| | P13-412 | 1 | Dial |
| | P22-178 | 1 | Case |
| | **COILS-TRANSFORMERS** | | |
| A Coil | P18-204 | 1 | .4 - .76 mc Coil |
| B Coil | P18-205 | 1 | .76 - 1.6 mc Coil |
| C Coil | P18-206 | 1 | 1.6 - 4.5 mc Coil |
| D Coil | P18-207 | 1 | 4.5 - 9.6 mc Coil |
| E Coil | P18-208 | 1 | 9.6 - 20.5 mc Coil |
| F Coil | P18-209 | 1 | 20.5 - 49 mc Coil |
| G Coil | P18-210 | 1 | 49 - 110 mc Coil |
| H Coil | P18-211 | 1 | 110 - 250 mc Coil |
| T1 | P18-221C | 1 | Power Transformer |
| | **MISCELLANEOUS** | | |
| | P10-180 | 1 | Black Knob |
| M1 | P12-168 | 1 | Meter, 0-500 ua. |
| | P13-411 | 1 | Clear Plastic Pointer |
| | P20-215 | 1 | Phone Jack with Hdwe. |
| | P20-216 | 2 | Coil Prong Clip |
| | P26-284A | 1 | Instruction Manual |
| CR1 | P32-124 | 1 | Silicon Rectifier |
| | P33-197 | 1 | Dial Hub |

# K4XL's BAMA

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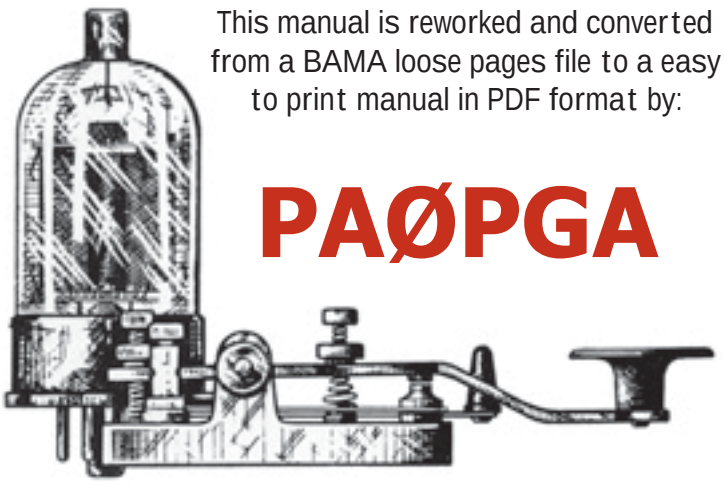

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