INSTRUCTION BOOK

for

Model 4310

-

Peak Reading

THRULINE Wattmeter

Model 4310

Peak Reading THRULINE Wattmeter

SUMMARY SHEET

Electrical Characteristics

Circuit	-	50-ohm impedance - THRULINE
Insertion VSWR	-	1.05 max
Measures	-	Peak Pulsed Power, 50W to 10KW 2 to 1260 MHz in Element Selections as listed below.
RF pulse width	-	$\frac{100\ \mu sec}{\text{low freq. of Element range (MHz)}}$ min.
Pulse Interval	-	same as above.
Connectors	-	Bird Quick-Change (QC) type. Two Female N Connectors normally supplied.
Oscilloscope	-	Not furnished. Use hi-sensitivity, good sized display screen instrument.
Accuracy	-	± 10% of full scale

Mechanical Characteristics

Dimensions	-	Basic overall 7" lg x 4" w x 3" h
Weight	-	3-1/2 pounds, w/o Plug-In Elements
Operating Position	-	Any

TABLE OF PEAK POWER ELEMENTS

Full Scale Power Value

Freq. Bands	50	100	250	500	1 KW	2.5 KW	5 KW	10 KW
2-30	-	*	*	*	*	*	*	*
25-60	*	*	*	*	*	*		
50-125	*	*	*	*	*	*		
100-250	*	*	*	*	*	*		
200-500	*	*	*	*	*	*		
400-1000	*	*	*	*	*	*		
950-1260	*	*	*	*	*	*		

* Elements Available

Special Note:-

These Peak Power Elements are not interchangeable with regular Bird THRULINE Elements.

Model 4310
Peak Reading THRULINE Wattmeter

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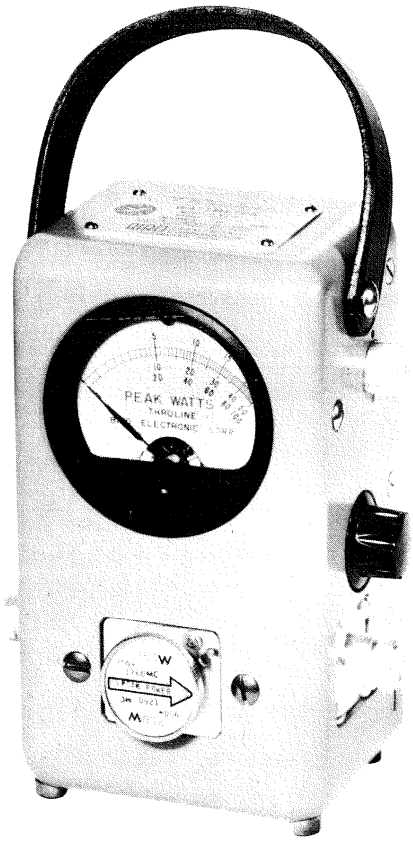


Fig. 1. Model 4310 Peak THRULINE Wattmeter

Section I

GENERAL DESCRIPTION

The Bird Model #4310 Peak Reading Wattmeter is a directional power indicator similar to the Bird Model 43 THRULINE Wattmeter, in both appearance and function, but different in basic method; it will measure power in coaxial lines at any point of time which can be defined from an oscilloscope display of the modulated pattern.

It is for use with modulated RF and pulsed power signals. Designed for 50-ohm application, the insertion VSWR is less than 1.05 for frequencies up to 1260 MHz in a standard 50-ohm circuit. The meter is direct reading (1 volt full scale), expanded down-scale for easy reading. The meter is inscribed in three scale ranges, having full scale integers of 25, 50 and 100, and is read according to the full scale value of the measuring (Plug-In) Element used. See Summary Sheet on Page A further characteristics.

The RF rectifier diode in the instrument provides an output to an oscilloscope which permits viewing of the modulation pattern. By adjusting a knob on the instrument, a variable dc bias is applied to the RF rectifier. The RF voltage applied to the diode (from the detecting coupler) must exceed the dc bias or the diode will not conduct. Thus we can refer RF voltage out of our coupler circuit (at any point in time) to a dc potential from a small mercury cell in the instrument, which can then be made by a meter. By suitable calibration we achieve a reading of RF power at any point of time directly on the meter if the bias voltage is adjusted to depress the modulated signal (as seen on the oscilloscope) for that point in time precisely into the base line.

From the above discussion it can be seen that we have derived a means of

measuring peak power of pulse (or otherwise) modulated signals; and also a means of measuring steps on the pulses, small pulses spaced closely in time from larger pulses; or in a broader sense, power at any point in time as power varies with respect to time.

SECTION II

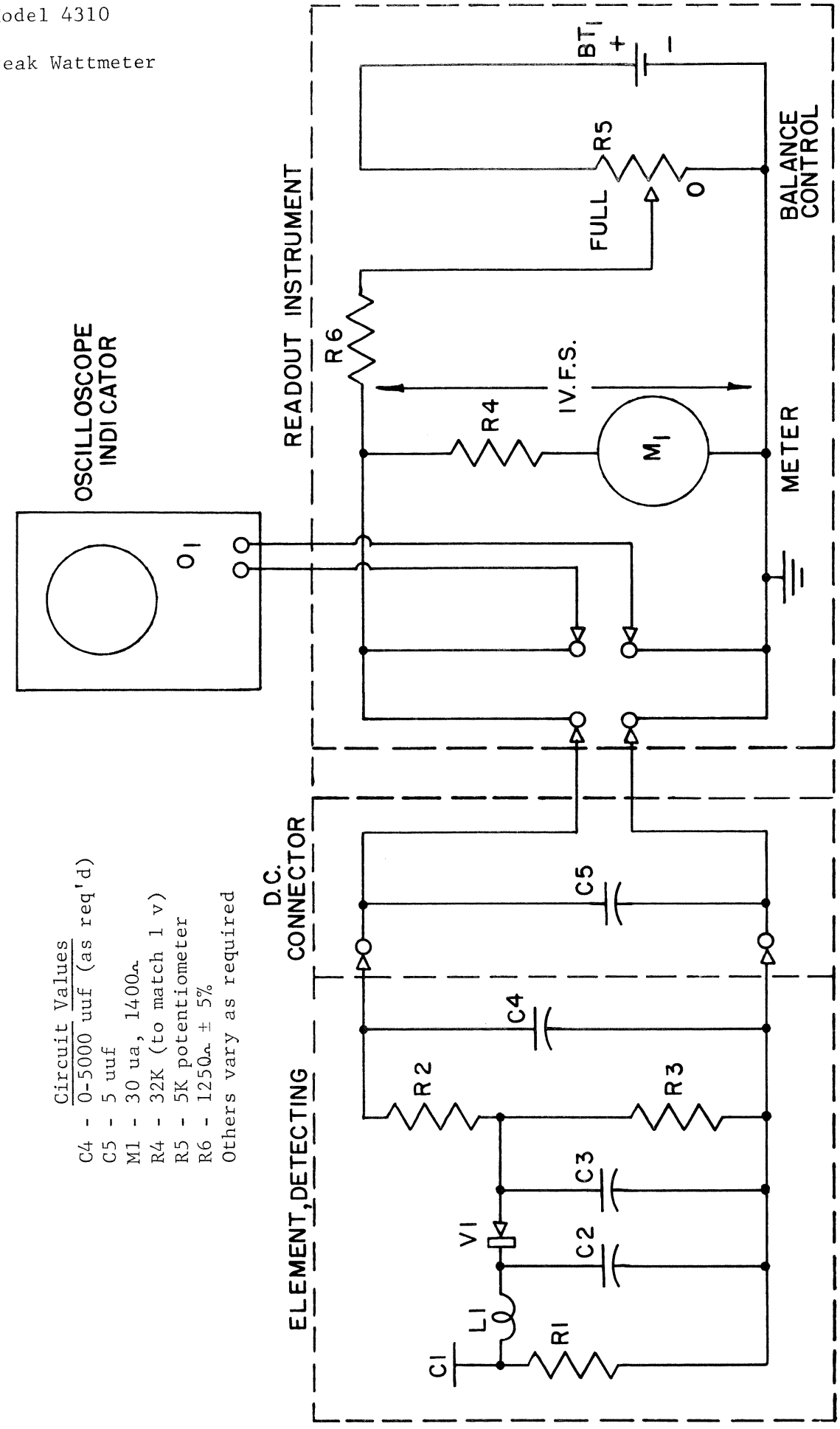
THEORY OF OPERATION

In Fig. 2, Schematic Diagram, C1 forms a capacitive coupling with the transmission line center conductor and provides a voltage sample from line. L1 couples inductively to the line and provides a current sample from it. A vector sum of the E and I samples is impressed upon the diode V1. By proper selection of the values of C1, C2, L1, and R1, the resultant of these amounts in the reverse direction may be brought so close to zero that the couplers have a directivity of 30 db or better (25 db on 2-30 MHz Elements).

R2 and R3 form a voltage divider which serves to calibrate the power value of the Plug-In Element to the dc measuring circuit contained around the voltmeter. These values will be varied in respective Elements to suit their proper calibration. Capacitors C4 and C5 are by-pass capacitances operating to prevent entrance of stray RF energy into the dc circuit. The net sum of these capacitances must not be too large, as it would create too much load on the high-frequency pulse charges, whereas the low frequency Elements require a large capacity for adequate protection of the dc circuit. Therefore, C5 mounted in the output connector, serves as a constant minimum by-pass capacitance value in all cases, and C4 is valued to suit.

The demodulation signal is fed from the Detecting Element (in the THRULINE Line Section) and thru the output connector to the metering circuit, which has the microammeter M1 and the oscilloscope connected in parallel across the diode output. Note also that the back bias from the battery BT1 is also connected across this same point, and is controlled by the potentiometer, R5. The bias polarity is the same as that of the output voltage of the peak voltmeter. This provides a DC variable back bias on the diode V1. With no back bias,

the signal on the oscilloscope terminal will, with proper sychronization, provide a demodulated representation of the RF signal. As the DC back bias is increased however, the diode will shift its operating cutoff characteristic, which is exhibited on the oscilloscope by the zero signal base line moving toward the peak signal. By adjusting the control, R5, the base line may be positioned to any visible signal trace power level that is desired to be measured. The meter M1, indicating back bias voltage, is directly calibrated in RF power. This amount of back bias is necessary to bring the signal base line to the selected trace point may thus be read directly on the meter, during or following RF power application (if the control is left as adjusted). Power measurement is unaffected by oscilloscope or cell voltage. An oscilloscope with high power sensitivity will yield better signal resolution, permitting better reading accuracy.



Circuit Values
0-5000 uuf (as req'd)

C4 -
C5 - 5 uuf
M1 - 30 ua, 1400Ω
R4 - 32K (to match 1 v)
R5 - 5K potentiometer
R6 - 125Ω ± 5%
Others vary as required

Fig. 2. Schematic Wiring Diagram

SECTION III

INSTALLATION

PORTABILITY

The Model 4310 is essentially a portable instrument. A strap is provided for carrying purposes. When transporting THRULINE, secure spare Plug-In Element firmly by use of the thumscrew latch on the socket. A fall could disrupt the calibration of the Elements, and they should always be handled with reasonable care.

DO NOT DROP THE THRULINE or subject it to hard blows. The microammeter is shock mounted in the housing to protect it against ordinary hazards, but its delicate mechanism may be damaged by severe impact.

REMOTE INSTALLATION

Similar to the regular type THRULINE Wattmeter, the 50-ohm Line Section is removable from the housing for installation separate from the meter. However, this procedure is recommended for the Model 4310 only under certain circumstances. The 10-inch meter cable, Item 10, must be kept short to avoid excess capacitance, which will cause degradation of short duration pulses. For use on pulses of 25 microseconds or more the cable may be extended to almost any practical length. Over 10 usec the cable may be somewhat longer than 10 inches. On pulses of less than 5 usec duration any lengthening of this cable will produce undesirable results.

To remove the Line Section remove back cover. (Follow procedure of par. 2, page 12). The Line Section may be panel mounted, or wall mounted (special bracket) #4230-056 available from the company), but observe carefully the limitations of Meter Cable, Item 10 as described above.

CONNECTIONS

The THRULINE is inserted in an RF circuit with suitable coaxial cable of 50 ohms impedance only. It is indifferent to which respective side the power source and the load connections are made.

The equipment is normally supplied with two Female N type connectors. Connection is readily made with Male N cable plugs. However, the following types of these Quick-Change connectors are currently available:

Female N	Female BNC	Female LC
Male N	Male BNC	Male LC
Female HN	Female C	Female LT
Male HN	Male C	Male LT
Female UHF	Female UHF	7/8" EIA Air Line

These may be secured from Bird Electronic Corp. as required. Any of these above connectors can be changed readily by removing the #8-32 round head machine screws at each corner of the square flanges, and pulling straight outwards, carefully disengaging the spring fingers of the center conductor. Reverse this procedure to attach the connectors.

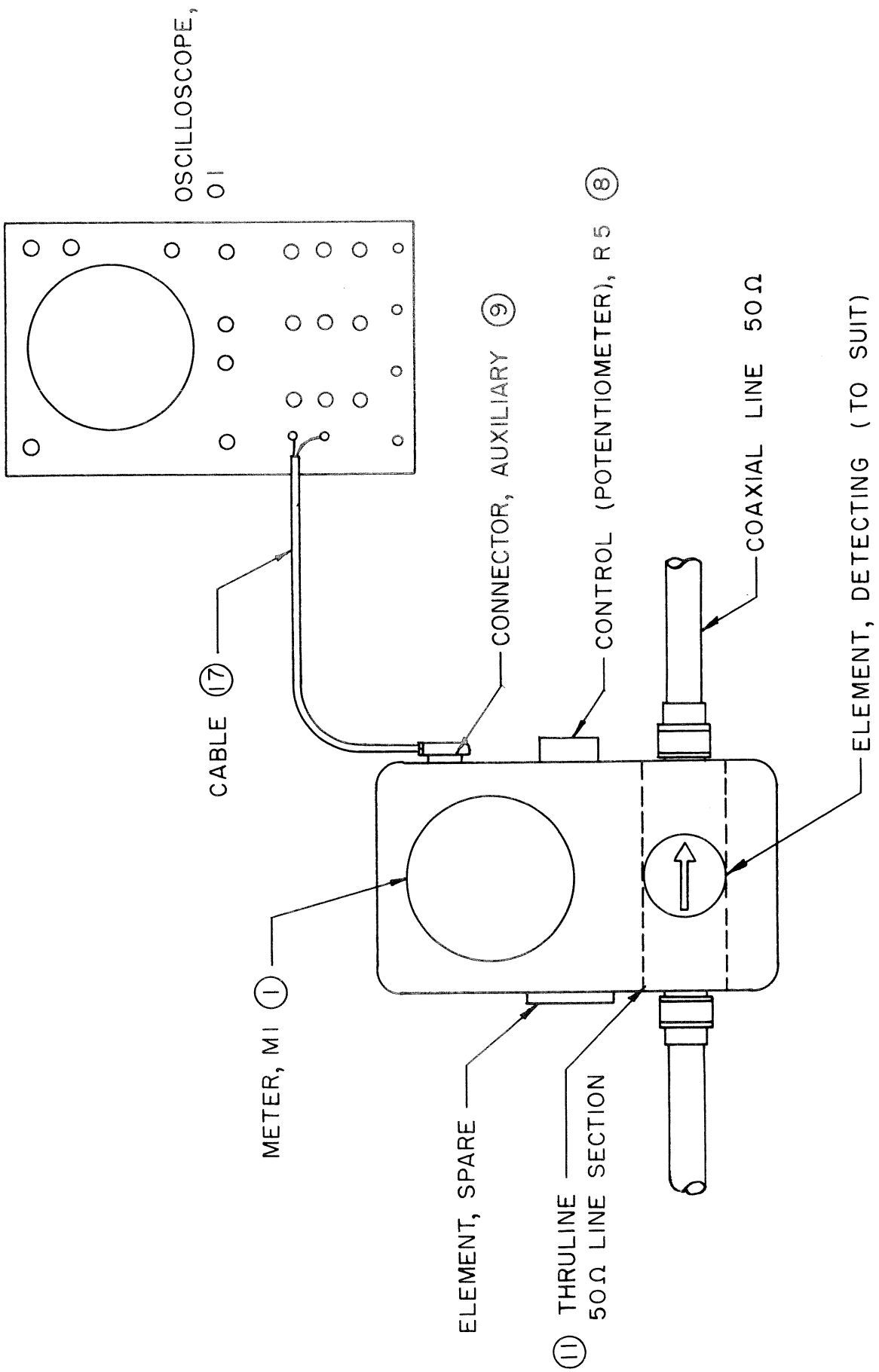


Fig. 3. Installation Drawing

SECTION IV

OPERATION

Operating Procedure

1. Place the THRULINE Section in the 50-ohm coaxial line where measurement is desired. The Operation of the Peak Reading Wattmeter is independent of position in the transmission line.

2. Insert the appropriate Plug-In Element, for frequency used and full scale* power, into the measuring socket on front face of the wattmeter. Point the arrow in direction of power to be read, forward or reflected.

3. Fasten the plug on furnished coax cable to jack on right side of wattmeter. With suitable attachment, connect opposite end of cable to vertical input of oscilloscope. Use an oscilloscope capable of clearly displaying the demodulated signal to be measured. An oscilloscope with high sensitivity provides proportionately greater reading accuracy.

4. Turn diode bias potentiometer knob fully counter-clockwise.

5. Adjust oscilloscope for suitable signal display for best measuring pattern. Adjust the time base (horizontal axis) for suitable display width of the pulse to be measured and adjust for enough vertical amplitude to secure good screen coverage.

6. Visually select the particular point on the signal you desire to measure.

7. While observing the trace on the oscilloscope, turn the potentiometer knob clockwise, to increase diode bias, until the trace base line moves to the selected measuring point on the signal trace. (Adjust bias knob so that line is directly on the selected point).

8. Read the meter. The meter now indicates directional power at that point (in time) in watts according to full scale value of measuring Element used.

9. Readings may be taken at any other desired point in time on the trace simply by readjusting the bias control to such selected points.

Potentiometer Control

1. The resistance of the potentiometer control, see Schematic Diagram, Fig. 2, is fixed in shunt with the 1.345 volt battery, and its 5K constitutes close to the continuous maximum load on this cell. At this load value the expected cell life is about 5 years, and breaking the circuit will not benefit cell life.

2. The potentiomenter is therefore not provided with a shut-off switch. The bias control may be left in any position without effect on the Model 4310 equipment.

*See Summary Sheet A for available Element.

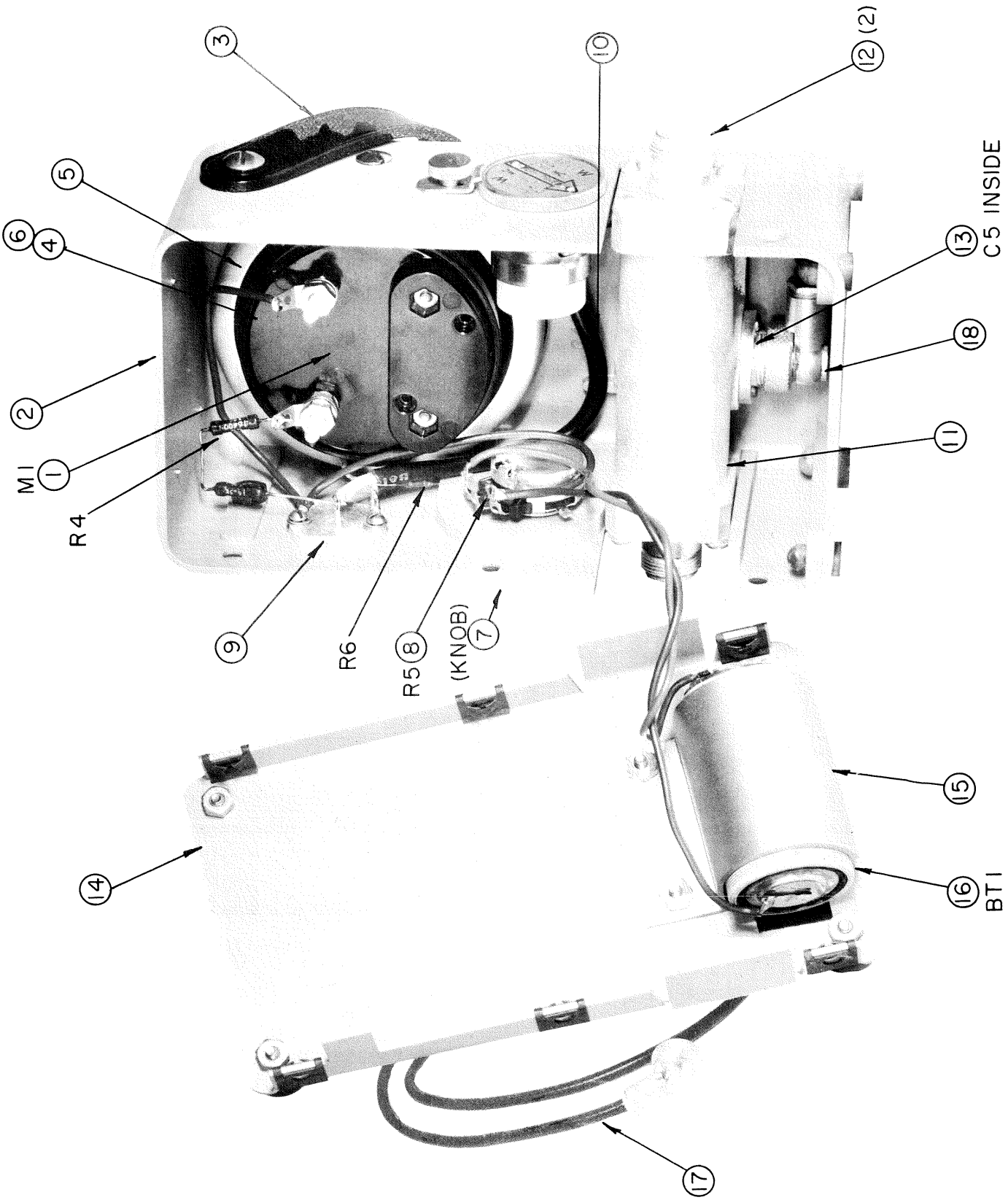


Fig. 4. Parts Designation

SECTION V

MAINTENANCE

GENERAL CARE - RF SECTION

With the simple construction and generally self contained nature of the THRULINE equipment, there is only a moderate amount of maintenance required. One of the major precautions is in handling; use reasonable care and do not drop the THRULINE equipment or the Plug-In Elements.

A main factor in maintenance of this equipment is care and cleanliness. The Element socket should be kept plugged as much as possible against the intrusion of dust. When a Plug-In Element is used for this purpose (use highest power element available), it should be positioned with the ARROW pointing upwards. This disconnects the Plug-In Element from the meter circuit, and also protects the Element against possible damage from inadvertent application of high line voltages.

The RF connectors should be also protected against dirt and grime, either by keeping cable plugs in place, or by other suitable means. If the RF connectors become dirty, they should be cleaned with a cotton swab stick using a dry solvent such as Inhibisol, trichlorethylene, or carbon tetrachloride. If the latter solvents are used, exercise caution in handling to avoid contact with skin and do not breath fumes when using. Clean all contact areas and especially the exposed faces of the teflon insulators.

It is particularly important to keep the mating surfaces of the socket and the Plug-In Element clean. This applies to the bore of the socket and the circumference of the cylinder body, but most importantly to the bottom rim of the body and the seat and the base of the socket in the line section. Also check the ends of the insulated dc contacts on the Element body to see

that they are clean and smooth. These parts should be carefully cleaned with cotton swab stick and dry solvents as above. There must be good contact between the base of the Plug-In Element and its socket to assure stable operation of the THRULINE.

MAINTENANCE - RF LINE SECTION

In cleaning the socket bore, the operator should be careful not to disturb the spring finger of the dc contact. It is important that the operating position of this part be properly maintained. If the spring finger of the dc contact requires adjustment, this may be done manually if carried out with care. The button must be positioned far enough out to maintain good contact with the Element, but not so as to interfere with easy entry of the Element body.

To release the RF Line Section, Item 11 from its housing, first remove the housing Cover, Item 14, from the rear of the THRULINE case. Unscrew (6) #8-32 x 3/8 Flat Hd. M.S. from around the sides of the Housing (Item 2) at the back, and pull the rear Cover, grasping it by the connector slot tabs, straight back. Now unscrew the two #10-32 x 1/2 Oval Hd. M.S. from the front face of the housing, adjacent to the Element socket, and pull the Line Section straight out the back end of the housing. The dc jack Item 13 (with spring finger) may be removed by unscrewing the two #4-40 fillister head machine screws that fasten it to the side of the RF line section. Then retract this assembly, watching carefully not to lose the small teflon positioning bead that straddles the base of the phosphor bronze spring and nests in a counterbore on the side of the RF body. When replacing the assembly, be sure that the bead is again properly inserted.

If there is any evidence of contamination inside the RF line section, the reachable portions should be likewise wiped and the interior carefully blown out. Under no circumstances attempt to remove the RF center conductor.

It is tightly frozen in place, and any effort to move it will ruin the assembly. Keep all connections tight, and keep the nut of the meter cord plug turned tight on the line section dc jack. This connection may often be serviced by simply loosening the nut of the dc plug, swinging the body several times through a fraction of a turn, and retightening the knurled nut securely.

COMPONENT MAINTENANCE

1. Element, Detecting (Plug-In)

The Plug-In Elements are intregal units, and are not intended to be disassembled or repaired by field personnel. If and Element does not produce satisfactory results, return it to the factory for repair or replacement - consult the company. Overloading Element by placing a circuit with excessively high power over its rating might produce damage; exert caution in use of the measuring Element. The Bird THRULINE Elements reading Peak Power are not interchangeable with the regular THRULINE Wattmeter Elements. Use care in handling the Plug-In Elements - do not drop.

2. Microammeter, M1

This meter is a high sensitivity measuring instrument and under normal circumstances should give continued and reliable service. Generally, the calibration of the meter circuit may be checked by the one volt test as described below. The mechanism of the microammeter is very delicate - do not tamper with it. If it is desired to individually check performance of a meter, it may be done, but this testing should be attempted only by one familiar with methods for checking sensitive instruments, because of the danger of damage in unsuitable circuits. Test the meter M1 as a microammeter in series with a low voltage battery, variable resistor and an external microammeter. Full scale current on M1 should be 30 microamperes.

To change a faulty meter, remove the back cover as described in par. 1 above. Unscrew the terminal stud and nuts (#8-32 hex - 11/32 flats) and remove the lead lugs. Place the wattmeter case face down on the table (use cloth to prevent scratching and hold firmly the formed ring surrounding the meter - press just enough to overcome compression of the contained shock rings. Using the screwdriver, remove the #10-32 oval hd. retaining screws on each side of the meter case. This releases the Mount Ring, Item 5, and with it the entire meter mounting. Remove three stem (rubber) bumpers from the face of meter flange and transpose to new meter. Reverse foregoing to install meter. Be sure that the neoprene Shock Ring, Item 4, is also transferred to the rear of the meter flange, and that the rubber Shock Mount Strip, Item 6, is properly nested inside the mounting ring before re-attaching the #10-32 retaining screws.

3. Meter Calibration

For practical purpose, the meter need only be checked for its full scale reading when properly measured with an accurate voltmeter. Use a meter with an accuracy of ±1% or better, not an ordinary VTVM, and attach it to the terminals of the oscilloscope jack or equivalent points. Exactly one volt should produce a precise full scale reading on M1. The calibrating resistor R4 (normally 32K) should be adjusted, if necessary, to produce this result.

The values of R5 and R6 are not expressly critical, so long as it is possible to adequately develop, from the Battery BT1, the one volt potential across the oscilloscope-input circuit. However, the ratings of these resistors should not be too much lower than as listed on the diagram, or shunting of the pulse voltage will occur. If R6 is made excessively large, it may be impossible to produce one volt across the meter circuit.

4. Battery, BT1

As stated in Operation, Section IV, the long-life Mercury Battery BT1 needs relatively little care. Inadvertent shorting of the cell for a duration of time might damage it. If the voltmeter cannot be driven to read full scale when the potentiometer is turned all the way up, the battery voltage is probably down. Check with a voltmeter directly across R5, see Fig. 2, Schematic Diagram.

If it is necessary to change the battery, proceed as follows: - Remove back cover of housing as described in par. 2 above. Unsolder leads from terminal of battery, noting carefully the polarities - red on the positive terminal and violet (ground) on negative. Positive is cell base (as marked) and negative is insulated center cap. Remove the #6-32 screws that fasten the battery Clamp Item 15 to lid and slip out the cell. Reverse procedure to restore.

5. Potentiometer, R5

If bias adjustment is erratic, or if voltage cannot be applied on a verified meter from a good battery, the Potentiometer R5 may be faulty. These Items may be easily checked by jump leads (from BT1 + to R6) see Schematic Diagram, Fig. 2. To replace the potentiometer, slip off Control Knob, Item 7, by loosening its side set screw (opposite indicator line) with a small screwdriver; then unscrew the shaft nut with a 9/16-inch wrench.

DC CABLE

Dc Cables, Item 10 and 17, are made from RG-58/U coaxial conductor, and provide fully shielded and reliable wiring components. If it is desired to check the cable remove plug from jack and unsolder leads from lugs of connector or detach from terminals. Use an ohmmeter and megger, and check cables carefully for continuity and leakage.

To change Dc Plugs Item 18 or to refit them when shortening cables, proceed according to instructions in Dc Plug Service Sheet attached hereto.

CHECK HINTS

If the oscilloscope signals depress in normal fashion when the potentiometer bias is turned up but the meter does not respond, this would indicate that the meter or its multiplier resistor R4 is open. Refer to par. D in TROUBLESHOOTING CHART, and pars. 2 and 3 above.

If moving the potentiometer bias all the way up depresses the signal only slightly, or not at all, then the signal strength is too high for the measuring Element being used. Use higher value Element. Caution - If signal power ever exceeds 10 times the full scale rating of the Plug-In Element used, damage to the diode may result and the performance of the Element will be impaired.

If pulse degradation is experienced in measuring extremely short pulses, it may be caused by excess capacitance in the oscilloscope cable. In this case, shorten the cable between the oscilloscope and instrument as much as possible.

TABLE I

TROUBLESHOOTING CHART

Symptom	Possible Causes	Remedies
A. Meter does not respond to bias control.	1. Meter M1 defective. 2. Components defective. a. Potentiometer R5. b. Resistor R4, R6. 3. Battery BT1 voltage low. 4. Wiring defective.	1. Check meter, par. 2 & 3. 2. Per sub. a. Check par. 5. b. Check par. 2 & 3. 3. Check par. 4. 4. Check wiring.
B. No signal on Oscilloscope	1. No pulse power. 2. Oscilloscope not operating properly. 3. Diode overbiased. 4. Defective Element. 5. No pickup from RF section.	1. Check transmitter, RF lines and connections. 2. Check scope switches and settings. Check dc connections to oscilloscope. 3. Reduce diode bias to restore signal to screen. 4. Replace Element. 5. Check dc pickup on Element and dc connections from RF line section. See RF Line Section Maintenance above.
C. Signal trace present but will not depress.	1. No meter bias. 2. Signal power level too high for power range of Element. 3. Defective circuit.	1. Check as in A.1 to 4 above. 2. Change Element to proper level. 3. Check circuit.
D. Signal depresses, meter does not read bias values.	1. Defective meter or resistor R4. 2. Defective wiring.	1. Check meter or resistor. 2. Check wiring to meter.

Service for Dc Cable and Plug

DC PLUG AND CABLE TESTS

These tests may be made with an ohmmeter and a megger. Disconnect the cable from jacks or terminals at both ends, and check for continuity and leakage.

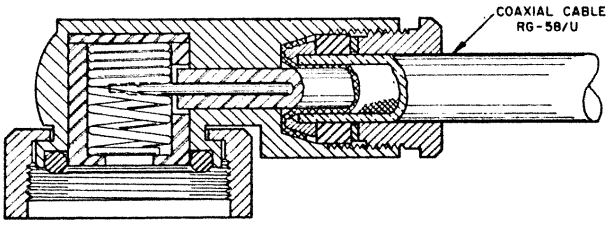


Fig. 5 Connector, Plug

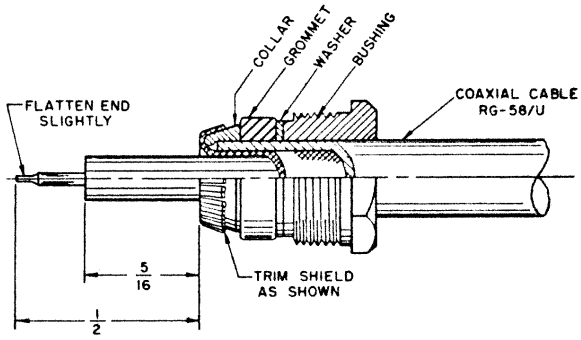


Fig. 6 Cable Service for Connector, Plug

DC PLUG - CABLE SERVICE

Fig. 5 shows construction of the dc plug in section, and Fig. 6 shows the proper service of the RG-58/U with the fittings on it for use with these plugs. To remove cable from the plug unscrew the hex flanged bushing from the body shank and pull cable out. The chisel point of the center conductor of the cable makes tight contact between the turns of coil spring when assembled.

Assembly of the RG-58/U to Dc Plug is as follows:

(1) Slip the bushing washer, and grommet over end of cable.
(2) Remove outer insulation 9/16 inch from end.
(3) Slip collar over shielding (unbraided).
(4) Fold back braids and trim as illustrated, Fig. 6.
(5) Remove inside insulation to dimension shown.
(6) Flatten end of center conductor to sharp chisel edge, push into Dc Plug, aligning edge with turns of coil spring.
(7) Push in grommet and washer and screw bushing down slowly.

SECTION VI

REPLACEABLE PARTS LIST

Item	Qty	Dwg.	Description
1	1	2080-007	Meter, (M1)
2	1	4310-003	Assy, Housing
3	(1)	4210-023	Strap, Carry, p/o Item 2
4	1	4220-086	Ring, Shock
5	1	4220-087	Assy, Shock Mount
6	1	7500-155	Strip, Shock Mount, Meter
7	1	5-367	Knob, Control
8	1	5-366	Control, Potentiometer - 5K (R5)
9	1	4210-021	Assy, Auxiliary D.C. Connector - Osc.
10	1	4310-010	Assy, Cable, Meter
11	1	4310-013	Assy, Line Section
12	(2)	4240-062	Assy, Connector, Female "N", p/o Item 11
13	(1)	4310-007	Assy, D.C. Connector, p/o Item 11
14	1	4310-004	Assy, Cover, Housing
15	1	4310-009	Clamp, Battery
16	1	5-368	Battery, Mercury, 1.345v (BT1)
17	1	4220-096-2	Assy, Cable - (Oscilloscope)
18	(2)	7500-259	Plug, D.C. Cable, p/o Item 10 and 17