INSTRUCTION BOOK

for the

TERMALINE® 6100 Series RF WATTMETERS

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SPECIFICATIONS

Frequency Range	30-500 MHz or 30-1000 MHz with special calibration.
VSWR	1.1:1 dc to 1000 MHz
Input Impedance	50 ohms nominal
Input Connector	Female N
Load Power Rating	80 watts continuous
Power Scales	
Model 61	Special (per customer)
Model 611	0-15 and 0-60 watts
Model 612	0-20 and 0-80 watts
Accuracy	±5% of full scale (30-500 MHz) ±10% of full scale (500-1000 MHz)
Weight	7 pounds
Overall Dimensions	9-5/8" x 3-61/64" x 6-3/8"
Operating Position	Load horizontal

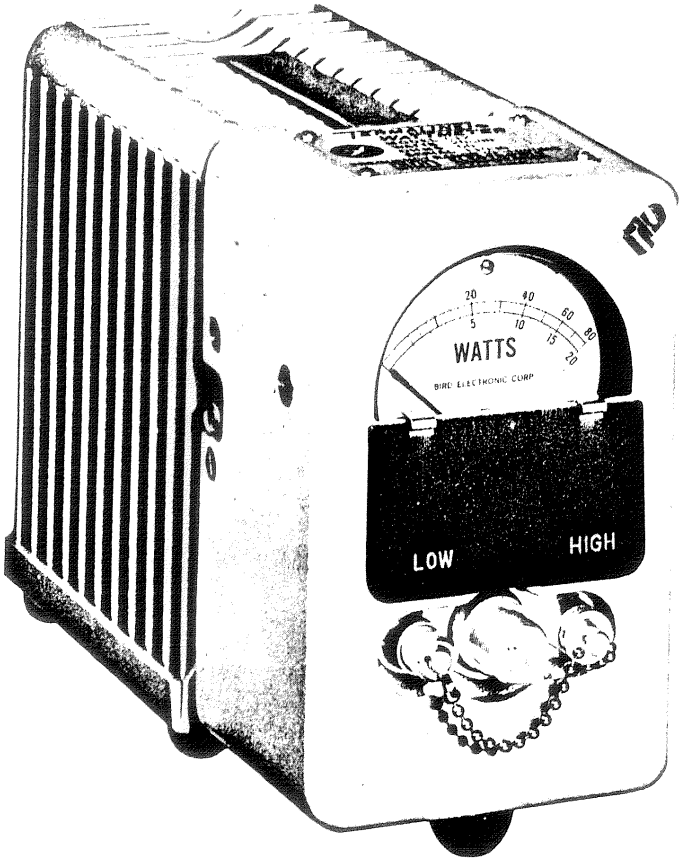


Fig. 1-1. Front View 6100 Series RF Wattmeter Model 612

SECTION 1
GENERAL DESCRIPTION

1-1. GENERAL

The Bird 6100 Series Termaline® RF Wattmeters are designed to measure RF power under non-radiating conditions. The wattmeters are built around an accurate 50-ohm coaxial load resistor which becomes the transmitter load element, providing a practically reflectionless coaxial line termination up to 1000 MHz.

Power input to the load resistor is measured by a dual-range crystal voltmeter reading directly in watts. Scale ranges are dependent on the specific model of the 6100 Series.

1-2. SPECIFIC USES

a. Troubleshooting and routine maintenance.

b. Transmitting tests.

c. Transmission line loss measurements.

d. Testing of coaxial line insertion devices such as connectors, switches, relays, filters, tuning stubs, patch cords etc.

e. As an RF load resistor, substantially independent of frequency and line length.

f. Modulation monitor. Audio frequency AM may be monitored by connecting phones, amplifiers, or audio voltmeters to the dc meter circuit.

1-3. MAJOR COMPONENTS

Figure 1-2 illustrates all components of the 6100 Series Wattmeter; consisting of coaxial load, dc cable, meter and its housing.

The load portion is comprised of the coaxial load resistor encased in a finned radiator on which the resistor-voltmeter assembly is mounted. A 3-1/2 foot coaxial cable (RG-58/U) connects the resistor-voltmeter assembly to the meter. On special order, a 25 foot cable may be obtained for remote meter readings. The meter is sealed, and shock mounted in its housing.

Two specially selected 1N79 crystal diodes (one working and one spare) are furnished with the wattmeter. Both diodes are interchangeable, and may be used as a cross-check of the instrument's accuracy. The working diode is housed in the resistor-voltmeter assembly, and the spare on the upper left face of the front radiator fin.

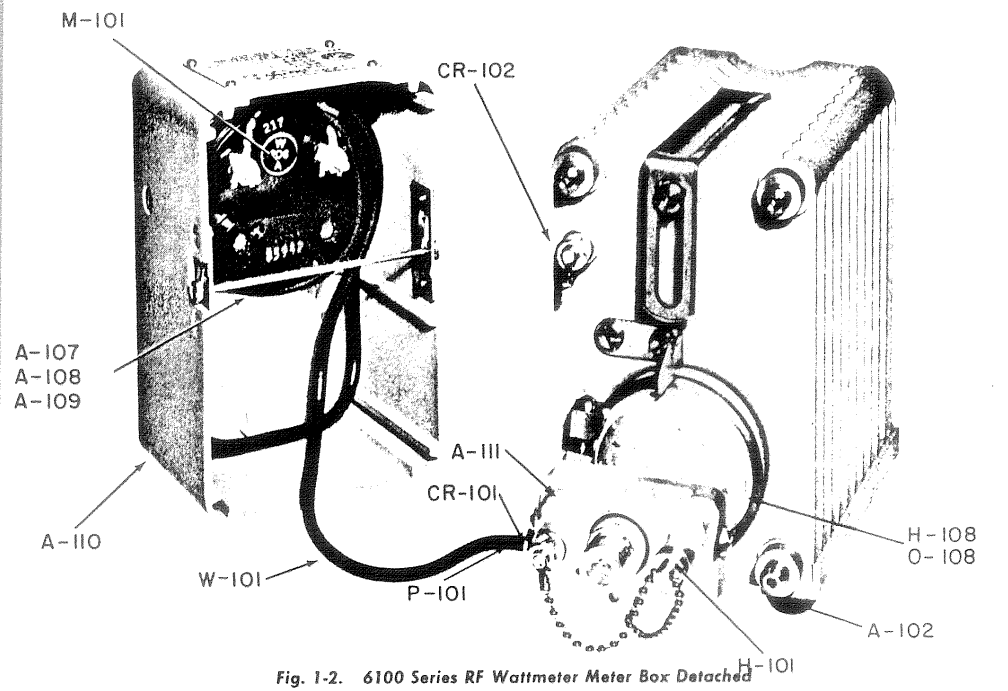


Fig. 1-2. 6100 Series RF Wattmeter Meter Box Detached

SECTION 2
THEORY OF OPERATION

2-1. BASIC PRINCIPLES

The method of power determination used in the 6100 Series Termaline® Wattmeters may be expressed as $W = E^2/R$, where E is the voltage across the resistor R, and W is the power in watts. Figure 2-1 illustrates the E^2/R power measurement used in the 6100 Series. RF energy flows from the transmitter through the resistor R, producing a voltage drop across this resistor, with voltmeter E recording the drop. It is important that the output impedance of the wattmeter be equal to the resistance R, and that the voltmeter is accurate at the operating frequency. Figure 2-2 indicates the parts arrangement of the 6100 Series.

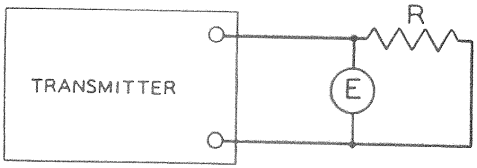


Fig. 2-1. E^2/R Method of Power Measurement

2-2. VOLTMETER CIRCUIT

Basically, the voltmeter consists of two separate filtered half wave rectifier circuits. The active circuit is selected by inserting the crystal diode into the desired socket.

For the same meter deflection, the voltmeter circuits require a 2:1 voltage ratio or 4:1 power ratio. Since the same crystal is used in both circuits, and the scale shape (curve of power vs current) depends on the crystal diode, both ranges will read accurately on one set of divisions, when calibrated at one point on the scale.

2-3. RF LOAD RESISTOR

The RF Load Resistor of the 6100 Series Wattmeters consists essentially of a cylinderical film type resistor immersed in a dielectric coolant. The resistor, individually selected for its accuracy, is enclosed in a special tapered housing which provides a linear reduction in surge impedance directly proportional to the distance along the resistor. This produces the uniform, practically reflectionless line termination over the frequency range of the wattmeter.

The dielectric coolant is chosen for its desireable dielectric properties and thermal characteristics. Cooling of the load is accomplished by natural fluid and air convection. The dielectric coolant carries the electrically generated heat from the resistor to the walls of the cylindrical cooling tank. The tank is encased in a set of metal radiating fins, which are firmly pressed on the cylinder. The heat from the dielectric oil is transferred to the surrounding air by the radiating fins.

A synthetic rubber diaphragm located in the rear dome on the load allows the coolant to expand as the temperature rises.

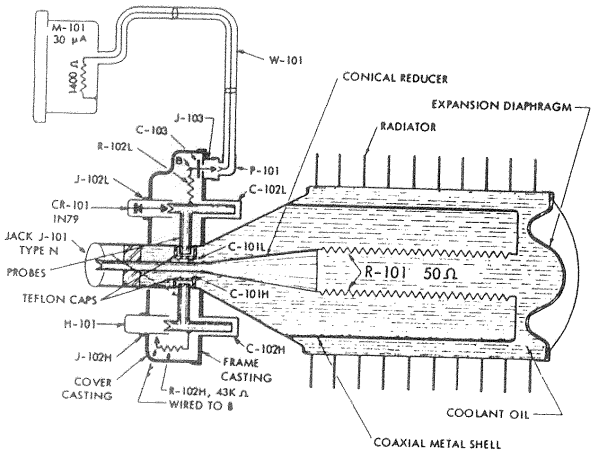


Fig. 2-2. Pictorial Diagram, 6100 Series RF Wattmeter

SECTION 3
INSTALLATION

3-1. LOCATION

Free air circulation around the wattmeter is essential. Keep the equipment in the clear, and do not place it near heated surfaces. The wattmeter should have at least a 4-inch clearance on all sides. The space above the equipment should be kept unobstructed for good heat transfer. Use the 6100 Series Wattmeters in a horizontal position only.

3-2. MOUNTING

The 6100 Series Termaline® RF Wattmeters are essentially portable test instruments. They should be placed as close as possible to the equipment whose power is being measured.

The wattmeters may be fastened to a work or test bench by removing the four rubber bumpers from the bottom of the radiator. These bumpers are fastened to the radiator brace by #8-32 studs which are set permanently into the rubber feet. The bumpers unscrew easily by hand. The holes are threaded for #8-32 screws, and fasteners must be placed up through the bench and into the radiator. These holes are on a 3 by 7 inch rectangle.

3-3. LATCH MECHANISM

If desired to use meter remotely, refer to Figure 3-1. The meter case is retained on the radiator by the bowed-spring action of the latch spring, which is a rod of heavy music wire.

To remove the meter case, raise the buttons at the sides of the case, one at a time, to lift the spring above the notch in the hook. The meter may be read either standing or on its back.

To reassemble, coil the dc cable in such a manner that it will allow the meter case to be replaced properly on the load. Engage the spring per Figure 3-1, first one button, then the other. The second will be found to resist with stiff spring action. Check by pulling on the meter case.

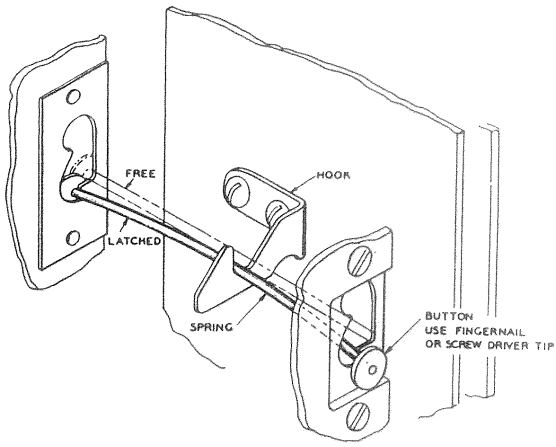


Fig. 3-1. Latch Operation

SECTION 4
OPERATION

GENERAL OPERATING NOTES

a. Operating Precautions.

(1) Carefully check the condition of the RF cable and connectors used in the RF circuitry to the 6100 Series Wattmeter.

(2) RF cable lengths, adapters, and connectors should be kept to a minimum. Type N or other constant-impedance 50-ohm connectors and adapters should be used throughout. A Male N connector (UG-21/U) must be used for connection to the 6100 Series Wattmeter.

(3) When other than 50-ohm connectors are used, keep at the transmitter jack only. This will keep the RF cable free from standing waves.

b. Operator's Test for Accuracy. Operating checks should consist mainly of comparison between this wattmeter and others of the same type. This will indicate an accuracy of ±10% full scale. A cross-check with results within 3% of full scale may be made between the working and spare crystals. Repeat either method several times to eliminate possible error from transmitter variations.

c. Frequency Response. As the 6100 Series Wattmeters are broad band instruments, their action with a presence of harmonics or spurious frequencies should be considered.

The wattmeter's sensitivity decreases above 500 MHz and below 1400 MHz. Laboratory and field experience indicate that low order harmonics in this range do not appear to be serious sources of error. However, to avoid measurement error and interference, use a low pass filter to eliminate all frequencies except the desired. The filter should be used as illustrated in Figure 4-1.

In the wattmeter sensitivity curve, two peaks are present above 1400 MHz. These are approximately 1700 and 2600 MHz, where resonance occurs in the voltmeter circuit and cannot be eliminated without sacrifice of the flat sensitivity obtained in the design frequencies. They are about 20 dB above the normal sensitivity. When spurious responses occur on these frequencies, they will cause erratic readings. These usually occur only at certain carrier frequencies. A low pass filter will eliminate them.

CAUTION

DO NOT continue operation of the wattmeter when large spurious responses are present.

d. Frequency Calibration Correction. The blue tag (Figure 4-2) attached to the 6100 Series Wattmeter lists indicated power, scale correction in watts, and a K Factor for specific frequencies. The tag may be used to obtain a more accurate reading for a given power at a specific frequency. For example:

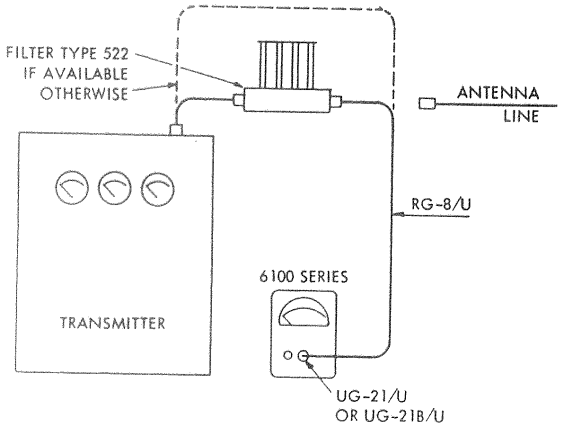
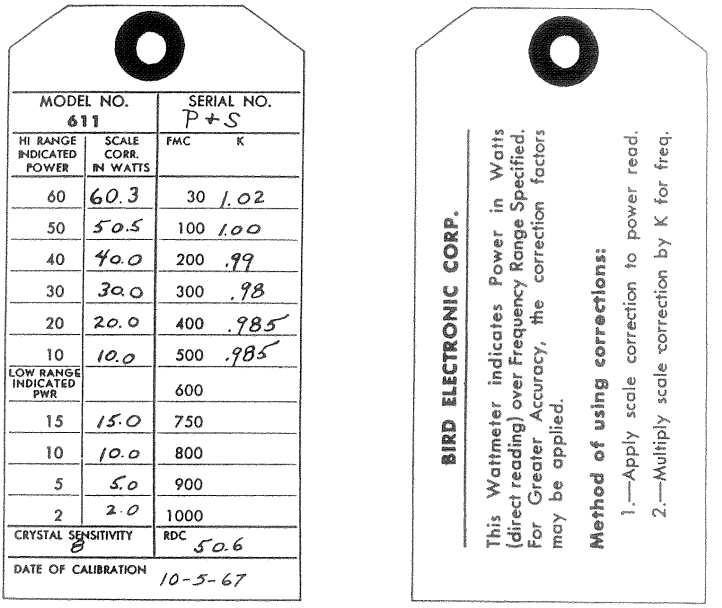


Fig. 4-1. Typical Connections to Transmitter



MODEL NO. 611		SERIAL NO. P+S	
HI RANGE INDICATED POWER	SCALE CORR. IN WATTS	FMC	K
60	60.3	30	1.02
50	50.5	100	1.00
40	40.0	200	.99
30	30.0	300	.98
20	20.0	400	.985
10	10.0	500	.985
LOW RANGE INDICATED PWR		600	
15	15.0	750	
10	10.0	800	
5	5.0	900	
2	2.0	1000	
CRYSTAL SENSITIVITY		RDC	
DATE OF CALIBRATION		10-5-67	

Fig. 4-2. Power Calibration vs. Frequency - 6100 Series RF Wattmeter

Meter indicates 50 watts
Scale correction is 50.5 watts
(on blue tag)
K Factor at 300 MHz is 0.98
Corrected Power Reading = 50.5 x 0.98
= 49.5 watts

NOTE

The example above and Figure 4-2 are samples, and do not apply to any specific meter.

4-2. MEASURING TRANSMITTER POWER

Place the 6100 Series Wattmeter in a position where the meter can be read while the transmitter is being adjusted. If the meter pointer does not read zero under no-load conditions, turn the zero adjust screw (located below the meter face) slightly with a small screwdriver until the meter is exactly on zero; then follow the procedures below.

a. Connect the wattmeter to the transmitter with a short piece of 50-ohm cable such as RG-58C/U (preferably under 5 feet in length). If transmitter power output is not known, make sure the crystal diode is plugged into the high range. DO NOT EXCEED THE RATING OF THE 6100 SERIES WATTMETER BEING USED.

b. The wattmeter is ready to make power measurements. The meter indicates the power dissipated in the load portion of the instrument. Losses introduced by the cable between the transmitter and the wattmeter, if significant, must be added to the power indicated by the 6100 Series Wattmeter.

c. During the process of switching from the wattmeter back to the antenna, it may become necessary to retune the transmitter slightly because of the difference in VSWR between the wattmeter and the transmitter's antenna.

4-3. USING AS A DUMMY ANTENNA

The 6100 Series may be used without the meter and crystal diode as a 50-ohm coaxial termination load for transmitters with a power output up to 80 watts from dc to 4000 MHz.

To protect the meter and crystal diode when using the equipment as a dummy antenna, remove the diode from the voltmeter block and disconnect the meter at the dc plug.

SECTION 5
TROUBLESHOOTING

5-1. PERIODIC INSPECTION

The 6100 Series Termaline® Wattmeters are ruggedly constructed, and periodic inspection will be necessary at only about six month intervals. Inspection should include the items listed below.

a. Oil Leakage. Check for coolant oil seepage around the radiator tank, and particularly around the front and rear clamping bands. The level of the dielectric coolant should remain constant under normal use. The filler plug is on the conical reducer (behind voltmeter block) at the lower right. Place plug in "up" position before removing. Use a 3/16" allen wrench to remove plug. The coolant level should be within 1/4" of the inside thread of the socket. If the coolant appears to be contaminated, replace. The load has a capacity of 0.1 gallon.

b. Crystal Diodes. Occasionally lubricate the O-ring seal on the crystal diode unit (Figure 5-1) with a non-melting dielectric compound such as Dow Corning #4. Check contact fingers of shield for proper contact to voltmeter socket. Bend slightly, making sure not to damage the center pin of the diode. Do not allow the two crystal diodes supplied with the instrument to be interchanged with any other 6100 Series Wattmeter.

c. DC Resistance. Check the condition of the load resistor by accurate measurement of the dc resistance between the inner and outer conductors of the RF input connector. Use a resistance bridge with an accuracy of one percent or better at 50 ohms (such as the Leeds & Northrup 5305 Test Set). The resistance should be a nominal 50 ohms.

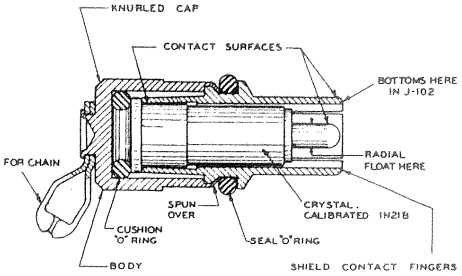


Fig. 5-1. Crystal Unit, Rectifying Crystal Diode, CR-101, CR-102

5-2. TROUBLESHOOTING CHART

The troubleshooting chart lists the symptoms of commonly encountered troubles, causes, and suggested corrective measures. Use this chart as a guide when analyzing symptoms.

Trouble	Probable Cause	Remedy
1. No Meter Indication.	1a. No RF signal.	1a. Check that transmitter is turned ON. If ON, check instructions for proper set-up and operations of the transmitter. If other remedies below check ok, test transmitter.
	b. No power input.	b. Check RF power cable and connections to wattmeter. Do not adjust any connections with RF power on.
	c. Crystal diode.	c. Check seating (contact) of crystal diode. Try the spare crystal.
	d. DC meter cord defective.	d. Tighten connection of plug on dc jacks. Test cord for open or short circuit.
	e. Defective meter.	e. Test for stuck pointer. Replace if necessary.
2. Irregular or Improbable Indications.	2a. Faulty Transmitter.	2a. Check transmitter.
	b. Loose connections.	b. Check RF connectors.
	c. Faulty crystal diode.	c. Try spare diode.

Note: Always be sure the transmitter is operating properly.

SECTION 6
MAINTENANCE

6-1. PREVENTIVE MAINTENANCE

The 6100 Series Wattmeters require only simple and routine maintenance. Do not subject the meter and crystal diodes to rough treatment. Keep the dc plug connected to the voltmeter block and the diodes in their sockets at all times. This will prevent dust and dirt from accumulating in the sockets.

Wipe dust and dirt off regularly. Clean contacts with a dry cleaning solvent such as Inhibisol or trichlorethylene on a cotton swab stick.

CAUTION

Prolonged breathing of dry cleaning solvents is dangerous. Make certain adequate ventilation is provided.

If any portions of the radiator or meter housing are corroded or scratched, clean area with a fine flint sandpaper and touch up with gray enamel.

6-2. RESISTOR VOLTMETER ASSEMBLY REPLACEMENT

A faulty resistor voltmeter assembly (A-111) must be replaced in its entirety. No attempt should be made to repair the assembly. To replace, follow the procedure below:

a. Remove the meter case from the load per paragraph 3-3.

b. Disconnect the dc plug from the voltmeter block.

c. Place the load in a vertical position with the voltmeter up.

d. Loosen the #8-32 by 1" screw from the clamping band and remove the clamping band.

e. Lift out the resistor voltmeter assembly from the radiator, allowing the coolant to drain off before removing from over the cylinder.

f. Inspect the O-ring seal. Do not re-use if it appears to be deteriorated.

g. Inspect the oil. If it is contaminated, replace. Use only oil specified by Bird Electronic Corporation. (Part No. 5-030)

h. Reverse the above procedure to replace.

6-3. DIAPHRAGM REPLACEMENT

a. Stand the wattmeter vertically, with the back end up.

b. Loosen the clamp screw until the clamping band is released.

c. Remove the diaphragm cover and lift the diaphragm from the back end of the radiator tank.

d. Reverse the above procedure to replace.

6-4. METER REPLACEMENT

The microammeter is a sealed and ruggedized instrument which is shock mounted in its housing. When properly used (not subjected to abuse and overloads), should not break down. Do not attempt to repair the meter. Follow the procedure below to replace.

a. Remove meter case from load per paragraph 3-3.

b. Remove the dc cable from the meter by loosening the two #8-32 hex nuts on the meter terminals. (Note: The Model 61, depending on scale chosen, may have solder lugs instead of hex nuts. Then remove cable by unsoldering from meter terminals.)

c. Place meter face down on a smooth, clean surface.

d. Using thumb and fingers of one hand, press down evenly on the retainer ring.

e. Unscrew the two #10-32 flat-head machine screws on the sides of the meter case. There is one screw on each side.

f. Remove meter with the retainer ring and sponge-rubber strips.

g. To install new meter, reverse the above.

6-5. DC CABLE AND PLUG SERVICE

For replacement and service to the dc cable and plug, refer to Figures 6-1 and 6-2, and proceed as follows:

a. To remove cable from the plug, unscrew the bushing and pull cable out. The center conductor of the cable makes tight contact between the turns of the coil spring when assembled.

b. To assemble the RG-58/U cable to the dc connector plug, slip the bushing, washer, and grommet over the end of the cable.

c. Remove the outer insulation 9/16" from the end.

d. Slip collar over the shielding (unbraided).

e. Fold back the braids, and trim them as shown in Figure 6-2; remove the insulation to the dimension shown.

f. Flatten the end on the center conductor to a sharp chisel edge. Push it into the dc plug, making sure the edge of the center conductor is aligned with the turns of the coil spring.

g. Push in the grommet and washer, and screw the bushing down snug.

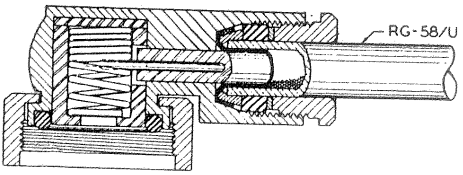


Fig. 6-1. Connector, Plug (D-C Plug P-101)

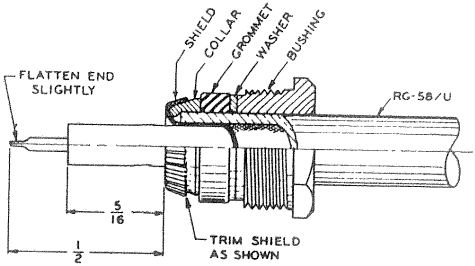


Fig. 6-2. Cable Service For Connector, Plug (D-C Plug P-101)

PARTS LIST

SYMBOL	PART NAME AND DESCRIPTION		QTY.
A-107	SHOCK STRIP, Meter Mount: Neoprene tubing 5/16 O.D. x 9-1/2 in. long. Circled to fit A-108. Bird Electronic Corp. part/dwg. #7500-155.	Vibration mount for meter	1
A-108	SHOCK MOUNT, Meter: Al alloy anodize, 3-1/2 O.D. x 3/32 thick. Circular shape formed to quarter round section. Two 10-32 steel nuts opposite diams. to fasten. Bird Electronic Corp. part/dwg. #4220-087.	Holder for shock strip A-107	1
A-111	RESISTOR-VOLTMETER ASSEMBLY: Tapered and slotted coaxial line section with 51.5 ohm film resistor as center conductor. Female N connector. Includes 2 crystals (one spare), dummy crystal, O-ring O-108 and clamping ring H-108. Bird Electronic Corp. part/dwg. #7500-214.	Coaxial load resistor and voltmeter block assembly.	1
CR-101 CR-102	RECTIFIER, Crystal: Silicon diode 1N79 calibrated, permanently installed in holder, 1-1/16 x 7/16 OA dimension. Bird Electronic Corp. part/dwg. #7500-147	RF rectifier. When ordering, specify Model and Serial Number of instrument.	2
E-101	COOLANT: Dielectric fluid, 7500-147. Bird Electronic Corp. part/dwg #5-030. (one pint can)	Dielectric coolant.	-
H-108	RING, Clamping: V-band Stainless steel, nickel plate 2-5/8 OD with two clamping blocks (one threaded) including #8-32 x 1 Rd. Hd MS. Bird Electronic Corp. part/dwg. #7500-047.	Holds resistor-voltmeter ass'y. A-111 to radiator.	1
M-101	METER AND CABLE ASSEMBLY: DC microammeter, 3-1/2 in. dia., 39" dc cable fixed to meter has dc connector P-101 at free end. Scaled as follows: Model 61 - specify scale Model 611 - 0-15, 0-60 watts-BEC part/dwg. 200009 Model 612 - 0-20, 0-80 watts-BEC part/dwg. 200008	Indicating meter.	1
O-102	STEM BUMPER, Meter mount: Neoprene. Tapered pin 7/32 max. dia. x 11/32 lg. Bird Electronic Corp. part/dwg. #7500-148.	Shock absorber for front of meter flange.	3
O-108	SEAL, O-ring: Synthetic rubber ring 2 x 2-1/4 x 1/8 nominal. Bird Electronic Corp. part/dwg. #7500-065.	Seal under clamping ring H-108.	1
P-101	PLUG, DC: Part of Cable Ass'y. W-101. Nickel plate 1-1/4 x 3/4 x 5/8 OA dimensions. Bird Electronic Corp. part/dwg. #7500-076.	DC cable connector.	1
W-101	CABLE, DC: Supplied with meter assembly. 39 in. RG-58/U with dc connector P-101 at one end. Bird Electronic Corp. part/dwg. #8180-021-6.	DC meter cable	1
W-102	CABLE, DC: Can be supplied in of place of W-101 RG-58/U in any length for remote meter installation. Includes connector P-101.	Special dc meter cable	(1)

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