INSTRUCTION BOOK FOR

BIRD

MODEL 6151

TERMALINE® WATTMETER

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All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

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MODELS COVERED IN THIS INSTRUCTION BOOK

6151

INSTRUCTION BOOK

FOR

MODEL 6151

TERMALINE® WATTMETER

Bird Electronic Corporation
30303 Aurora Road, Cleveland, Ohio 44139-2794

SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication.

Keep away from live circuits.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts or disconnect a RF transmission or any other high voltage line while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

The following will appear in the text of this publication and is shown here for emphasis.

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* C A U T I O N *
*
* Do not drop the instrument of Plug-In Elements as *
* damage to the meter could result or impair the accuracy *
* of the elements. *
****

****
* W A R N I N G *
*
* Exposure to RF power radiation and the possibility of *
* RF shock or burns exists with some operating conditions. *
* Always be sure to turn off transmitter when connecting *
* or disconnecting wattmeter. When Plug-In Element is *
* removed from the RF line socket, the line section *
* center conductor is exposed. Do not put fingers or *
* other objects into this Plug-In Element socket while RF *
* power is applied. *
****

****
* W A R N I N G *
*
* When using dry cleaning solvents or pressurized spray *
* cleaner, take necessary precautions and supply adequate *
* ventilation. Avoid breathing fumes. *
****

Continued

SAFETY PRECAUTIONS

****
* CAUTION *
* *
* If other than Female N type connectors are used, limit *
* power and frequency to the capabilities of the RF *
* coaxial cable or connectors used. Damage to connectors *
* or errors in reading could result. *
****

TABLE OF CONTENTS

MODEL 6151 TERMALINE® WATTMETER

INTRODUCTION

PURPOSE AND FUNCTION

The Bird Model 6151 TERMALINE® RF Wattmeter is designed to measure RF power under non-radiating conditions. The Wattmeter is coupled to an accurate 50 ohm coaxial load resistor which becomes the transmitter load element, providing a practically reflectionless coaxial line termination up to 2.3GHz.

Power input to the load resistor is sampled by coupler-detector type voltmeter indicating directly in watts.

The Model 6151 is intended for general field and laboratory service use on CW, AM and FM modulation envelopes, but not on pulsed modes.

DESCRIPTION

The Model 6151 TERMALINE® Wattmeter consists of a coaxial load resistor, detector circuit, dc cable, panel meter and its housing.

The load portion is comprised of a RF coaxial resistor assembly encased in a finned radiator. The detector circuit is in the Plug-in Element inserted in a short length of 50 ohm coaxial line mounted on the front of the load portion. A 2-3/4 foot coaxial cable (RG-58/U) connects the detector circuit to the meter which is sealed and shock mounted in its housing.

The detector circuit in the Plug-in Element samples the RF energy travelling toward the load, converts it to a small dc voltage for readout on the meter. The meter scale is designed to indicate power directly in watts.

SPECIFICATIONS FOR MODEL 6151 TERMALINE® RF WATTMETER

Power Rating	100W continuous
Power Ranges	25/50/100 Determined by Plug-in Elements*
Input Impedance	50 ohms nominal
Frequency Range	2 to 2300MHz Determined by Plug-in Elements*
VSWR	1.1 to 1.0 max. dc to 1GHz 1.25 to 1.0 max. 1 to 2.3GHz
Accuracy	±5% of full scale to 1GHz ±8% of full scale to 2.3GHz
Input Connector	Bird Quick Change "QC" Type Female N Normally Supplied.
Dimensions, Overall	12-27/32" L x 3-15/16"W x 6-11/32"H (326 x 100 x 161 mm)
Weight	8 lbs. (3.6 kg)
Finish	Light Navy Grey Enamel (Per MIL-E-15090B)

*Refer to Section V, Tables for Element Section.

Any Element, up to 100 watts, may be selected from Tables I, II or III of the Catalog.

SECTION I - INSTALLATION

1-1. LOCATION

1-2. Free air circulation around the wattmeter is essential. Position the Model 6151 in the clear, and do not place near heated surfaces. The wattmeter should have at least a 4-inch clearance on all sides. Keep the space above the Model 6151 unobstructed to provide adequate natural air convection for good heat transfer. Use the wattmeter in a horizontal position only.

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**************************************************************
*                        C A U T I O N                       *
*                                                            *
* Do not drop the instrument of Plug-In Elements as          *
* damage to the meter could result or impair the accuracy    *
* of the elements.                                           *
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1-3. MOUNTING

1-4. The Model 6151 TERMALINE® Wattmeter is essentially a portable test instruments. It should be placed as close as possible to the equipment of which the RF power is being measured.

1-5. The wattmeter may be fastened to a work or test surface 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 molded 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 work surface and into the radiator. These holes are on a 3 by 7 inch rectangle, (76 x 178 mm).

1-6. LATCH MECHANISM

1-7. The meter housing 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 housing may be then pulled straight off of the radiator. The meter may be read standing or on its back.

1-8. To assemble, 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, first one button, then the other. The second button will resist with stiff spring action. Check for proper engagement by pulling on the meter case.

1-9. INPUT CONNECTOR

****
* CAUTION *
*
* If other than Female N type connectors are used, limit *
* power and frequency to the capabilities of the RF *
* coaxial cable or connectors used. Damage to connectors *
* or errors in reading could result. *
****

1-10. The Model 6151 is normally supplied with a Female N type connector which is of the Bird Quick-Change design. Other "QC" connectors are available and may be purchased from Bird Electronic Corporation as required. A list of available connectors is given in section V - Replacement Parts List.

1-11. The connectors are Quickly changed by removing the four 8-32 pan head machine screws from the corners of the connector flange, and pulling the connector straight out. Reverse this procedure to install a connector, making sure the center contact pin is properly aligned with the socket.

1-12. Connection to the transmitter is made through a suitable coaxial cable equipped with appropriate RF connectors. It is advisable to keep the length of this cable as short as possible.
Note; There may be a slight deviation in the electrical specifications if a connector, other than a Female N type (normally supplied) is used.

SECTION II - THEORY OF OPERATION

2-1. TRAVELLING WAVES

2-2. The voltage and current present on a transmission line are expressed as the sum of the voltages and currents of two waves; forward and reverse. Both waves are identical except in the direction of travel. The Model 6151 measurement concept basically samples the voltage and current only of the wave travelling from the source to load.

2-3. The forward wave travels (and its power flows) from source to the load, and has RF voltage E and current I in phase, with $E/I = Zo$. Note that the component wave is mathematically simple, and is completely described by a single figure for power; Watts $= E^2/R = I^2R = EI$. Zo is the characteristic impedance of the detector circuit and the coaxial termination, simplifying matters by being a reasonably pure resistance of 50 ohms.

2-4. COUPLING CIRCUIT

2-5. The coupling circuit which samples the RF power from the standing waves is a special coupler-detector voltmeter. Energy will be produced in the coupling circuit of the detector by both mutual inductance and capacitance from the travelling waves within the detector block. The inductive currents will, of course, flow according to the direction of the travelling waves. The capacitive portion of these currents are independent of the direction of the travelling waves.

2-6. The electrical values of the detector circuit are carefully balanced and designed to be sensitive to the current produced from only the forward wave. Also, due to the practically non-reflective characteristics of the termination, almost no reflected wave will exist.

2-7. RF LOAD SECTION

2-8. The RF load resistor of the Model 6151 Wattmeter consists of a cylindrical film type resistor immersed in a dielectric coolant. The resistor, individually selected for its resistive film 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 stated frequency range of the wattmeter.

2-9. The coolant is chosen for its desirable 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 radiation fins to which heat is conducted and carried off by air convection.

2-10. A synthetic rubber diaphragm located in the rear dome on the load allows the coolant to expand as the temperature rises.

SECTION III - OPERATING INSTRUCTION

3-1. GENERAL OPERATING NOTES

****
* W A R N I N G *
*
* Exposure to RF power radiation and the possibility of *
* RF shock or burns exists with some operating conditions.*
* Always be sure to turn off transmitter when connecting *
* or disconnecting wattmeter. When Plug-In Element is *
* removed from the RF line socket, the line section *
* center conductor is exposed. Do not put fingers or *
* other objects into this Plug-In Element socket while RF *
* power is applied. *
****

a. Operating Precautions - Carefully check the condition of the RF cable and connectors used in the circuitry to the Model 6151. RF cable lengths, adapters and connectors should be kept to a minimum. Type N or other constant impedance connectors and adapters should be used throughout. 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 a THRULINE® wattmeter or other wattmeters of the same type. This will indicate an accuracy of within ±10% full scale due to the ±5% full scale limits of each instrument. Repeat cross-check several times to eliminate possible error from transmitter variations.

3-2. MEASURING TRANSMITTER POWER

3-3. Place the Model 6151 TERMALINE® Wattmeter in a position where the meter can be easily 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 to the right or left with a small screwdriver until the pointer is exactly on the zero mark; then follow the procedure below.

a. Connect the wattmeter to the transmitter with a short length of 50 ohm coaxial cable such as RG-58C/U (preferably under 5 feet in length), DO NOT EXCEED THE POWER RATING OF THE MODEL 6151.

b. The wattmeter is now ready to be used for 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 Model 6151 Wattmeter.

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

3-4. USE AS A DUMMY ANTENNA

3-5. The Model 6151 may be used, without the meter and Plug-In Element, as a 50 ohm coaxial termination load for transmitters with a power output up to 100 watts from dc to 2.3GHz.

3-6. To protect the meter when using as a dummy antenna, the meter can be disconnected at the dc plug. Also turn the element so that the arrow on the identification plate points up i.e. at 90° to direction of power flow.

3-7. The load portion will accept an overload of RF power for short periods of time as long as sufficient time between overloading is allowed for cooling.

SECTION IV - MAINTENANCE

4-1. INSPECTION

4-2. The Model 6151 TERMALINE® RF Wattmeter is of rugged construction, and inspection will be necessary at only about six month intervals. Inspection should include the items below.

a. Oil Leakage - Check for coolant oil seepage around the radiator tank, particularly around the front and rear clamping bands. The level of the dielectric coolant should remain constant under normal use. Only Bird P/N 5-030 dielectric coolant should be used for replacement purposes.

b. 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 or ohmmeter with an accuracy of one percent or better at 50 ohms for this measurement. Use low resistance leads or a length of 50 ohm coaxial cable fitted with a suitable coupler for connection. The resistance at room ambient should be within ±2% of the nominal 50 ohms.

4-3. PREVENTIVE MAINTENANCE

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*                        W A R N I N G                       *
*                                                            *
* When using dry cleaning solvents or pressurized spray      *
* cleaner, take necessary precautions and supply adequate    *
* ventilation.  Avoid breathing fumes.                       *
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4-4. The Model 6151 requires only simple and routine maintenance. Do not subject the meter and Plug-In Element to rough treatment. DO NOT DROP as a sharp blow may damage meter or alter the ±5% accuracy of the Plug-In Element. Keep the dc plug connected to the detector block and the Plug-In Element. in its socket at all times. This will prevent dust and dirt from accumulating in the sockets. Note: when using as a termination only, point the Element arrow up or at a right angle to the Line Section.

4-5. Wipe dust and dirt off regularly. Clean contacts with a dry cleaning solvent such as Freon, its equivalent, or any dry cleaning solvent on a cotton swab stick. Use caution when using dry cleaning solvents. Provide adequate ventilation.

SECTION V - ELEMENT SELECTION

TABLE 5-1. ELEMENT TABLES

Table 1 - Standard Elements

Power Range	Frequency Bands (MHz) 2-30	25-60	50-125	100-250	200-500	400-1000
5W		5A	5B	5C	5D	5E
10W		10A	10B	10C	10D	10E
25W		25A	25B	25C	25D	25E
50W	50H	50A	50B	50C	50D	50E
100W	100H	100A	100B	100C	100D	100E

Table 2 - Low Power Elements

1 Watt	Cat. No.	2.5 Watts	Cat. No.
60-80MHz	060-1	60-80MHz	060-2
80-95MHz	080-1	80-95MHz	080-2
95-125MHz	095-1	95-150MHz	095-2
110-160MHz	110-1	150-250MHz	150-2
150-250MHz	150-1	200-300MHz	200-2
200-300MHz	200-1	250-450MHz	250-2
425-850MHz	425-1	800-950MHz	800-2
800-950MHz	800-1		

Table 3 - High Frequency Elements

Power Range	Frequency Bands (MHz) 950-1260	1100-1800	1700-2200	2200-2300
1W	1J	1K	1L	1M
2.5W	2.5J	2.5K	2.5L	2.5M
5W	5J	5K	5L	5M
10W	10J	10K	10L	10M
25W	25J	25K	25L	25M
50W	50J			
100W	100J			

SECTION VI - REPLACEMENT PARTS LIST

7-1. MODEL 6151

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	RF Section Assy.	8130-015
2	1	Line Section Assy.	6151-006
3	1	RF Input Connector	See Below
4	1	Meter Housing Assy.	6151-027
5	1	Meter	2080-002
6	1	Cable Assy.	4220-097-1
7	1	DC Plug	7500-076
8	1	Radiator Assy.	2400-053
9	4	Bumper Feet	5-049
10	1	Handle	2400-017
11	2	Clamp Band	7500-254
12	1	Diaphragm Cap	2400-050
13	1	Dielectric Coolant	5-030-1
14	1	Diaphragm	2400-015

Available "QC" Type Connectors

N-Female	4240-062*	BNC-Male	4240-132
N-Male	4240-063	LT-Female	4240-018
HN-Female	4240-268	LT-Male	4240-012
HN-Male	4240-278	C-Female	4240-100
LC-Female	4240-031	C-Male	4240-110
LC-Male	4240-025	UHF-Female (SO-239)	4240-050
BNC-Female	4240-125	UHF-Male (PL-259)	4240-179
	7/8" EIA Air Line	4240-002	

*Normally Supplied