INSTRUCTION BOOK

FOR

MODEL 3900

FREQUENCY COUNTER WATTMETER

Bird Electronic Corporation

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SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedures 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.

****
* W A R N I N G *
*
* When using dry cleaning solvents, provide adequate *
* ventilation and observe normal safety precautions. *
* Many dry cleaning agents emit toxic fumes that *
* could be harmful to your health. *
****

****
* C A U T I O N *
*
* Do not use any dry cleaning solvents or aerosol type *
* contact cleaners for cleaning the case. Most dry *
* cleaning solvents will attack the plastic housing of *
* this instrument. *
****

****
* W A R N I N G *
*
* Disconnect this unit from ac power source before any *
* disassembly for repair or replacement procedures. *
* The potential for electrical shock exists. *
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MODEL 3900 FREQUENCY COUNTER WATTMETER

INTRODUCTION

GENERAL

The Model 3900 Wattmeter/Frequency Counter operates in the frequency range from 5MHz to 1GHz with an input impedance of 50 ohms. Further information can be found on the Specifications page. The front panel contains two indicating meters (power and frequency), an ON/OFF switch, a range switch, RF input and output connectors, and a variable coupling control.

CAPABILITIES

The Bird Model 3900 will quickly and efficiently test the output power and frequency of a transmitter with a high degree of accuracy when used within the specified ambient temperature, power and frequency ranges.

PERFORMANCE CHARACTERISTICS

The wattmeter portion of this test set requires no other source of power for operation other than the RF input source. It will indicate RF input power directly in watts even though the ON/OFF switch is in the OFF position. The frequency counter will function and display the input power frequency only when the ON/OFF switch is in the ON position. A flashing decimal will signify a power ON condition when no or insufficient RF power is applied.

SPECIFICATIONS FOR MODEL 3900 FREQUENCY COUNTER WATTMETER

Wattmeter	
Impedance	50 ohms nominal
Power	100mW - 10000W full scale direct reading
Frequency Range	45 - 2300MHz
Elements	Tables 1,2,3,4 and 6 found in Section V
Accuracy	5% of full scale
Connectors	Female N "QC" type (normally supplied)
Indicating Meter	30.0uA Full Scale
Insertion VSWR	1.05 maximum
Frequency Counter	
Frequency Range	5MHz - 1.0GHz
Accuracy	±1ppm @ 17° to 35°C (62.6°F to 94°F)
Display	8 digit red L.E.D., 0.3" seven segment displays, leading zero suppression
Power Requirements	7.2 - 14V dc, 100 to 250mA typical 110/220V ac with AC-12 adapter (supplied) center pin positive
Batteries	BAC-5 rechargeable nicad battery pack will last approximately 4 hours of continuous duty before recharging is required.
Weight	
Model 3900	6 lbs. 1 oz. (2.75kg)
Element	3 oz. (85g)
Dimensions	5-19/32"H x 9-11/64"W x 9-1/16"L (142 x 233 x 230mm)

SECTION I - INSTALLATION

1-1. LOCATION

1-2. Model 3900 is a portable fully contained instrument and may be placed in any convenient location. This unit should be installed at a suitable height for ease of reading and accessibility for RF connections.

1-3. MOUNTING

1-4. There is no special provision for mounting the test set. It is a portable unit and is not intended for fixed installation. The unit may be placed on a shelf, workbench or any flat surface where it will be convenient for operation. The carrying handle doubles as an underprop to support the front of the unit for easy viewing of the meters. To release the handle for adjustment, press the orange buttons in the center of the pivot, swing the handle to desired position and release buttons.

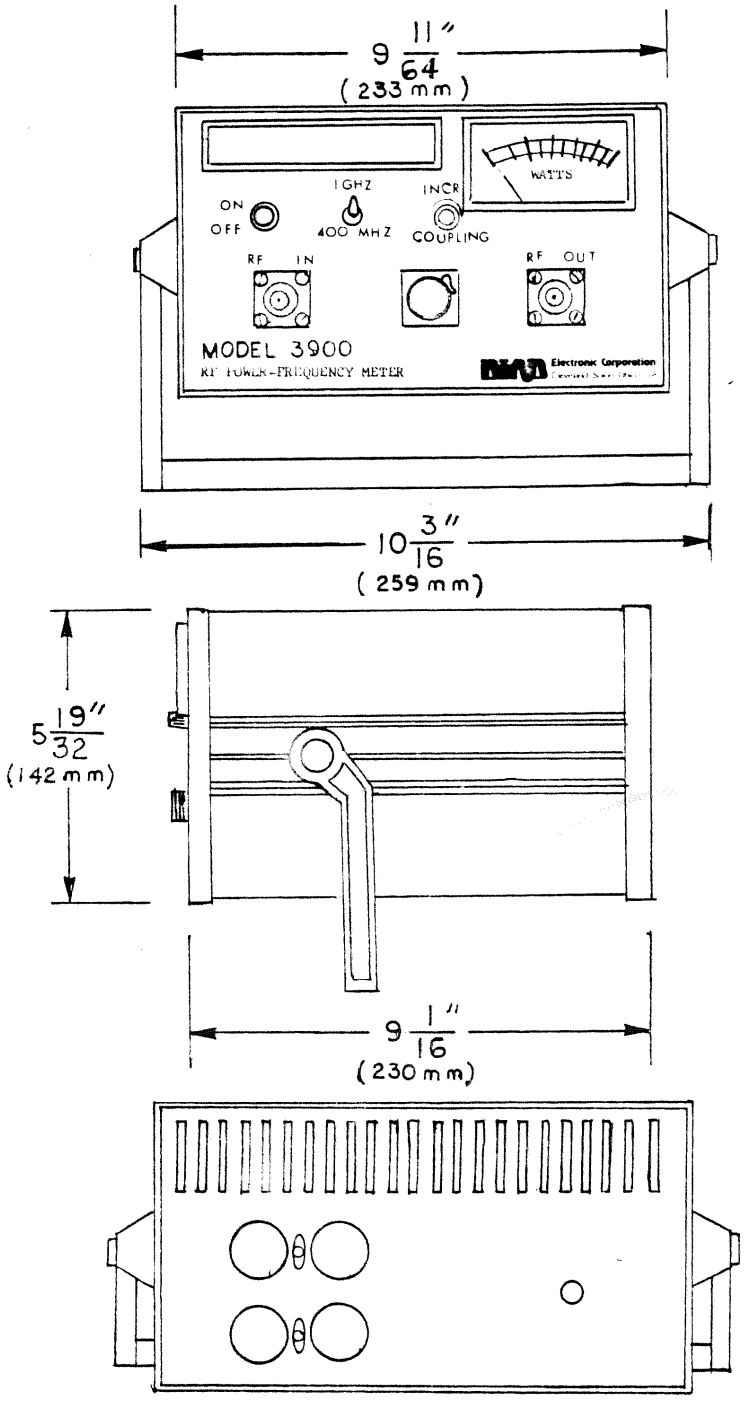
1-5. REMOTE OPERATION

1-6. If the unit is to be used remotely where 110/220 line voltage is not accessible for recharging, the rechargeable batteries will sustain operation of the frequency counter from 4 to 6 hours. When the batteries begin to lose their charge, the frequency meter indication will become erratic and then the display will fade. Recharge immediately.

1-7. RF LINE CONNECTION

1-8. The RF line connection from the transmitter to the test set is made through a Female N Quick Change "QC" type connector. This connector is labeled RF IN. The RF output to load connector, also a "QC" Female N type, is labeled RF OUT.

Figure 1-1. Outline Drawing.



SECTION II - THEORY OF OPERATION

2-1. WATTMETER SECTION

2-2. The main RF circuit of the Model 3900 is a short piece of uniform air type line section. On any uniform RF line section there are voltages, currents and standing waves present when RF power is applied. A coupler circuit, sensing element, is inserted into this line section. The circuitry of the sensing element and its relationship to other components of the wattmeter section are illustrated in Figure 2-1. Energy will be produced in the coupling circuit of the sensing element by both mutual inductance and capacitance from the traveling RF waves of the line section. This energy is rectified to a dc current and calibrated to a proportional amount of RF power flowing in the line section. This dc current can then be utilized by the microammeter to indicate power.

2-3. FREQUENCY COUNTER SECTION

2-4. A portion of the RF power flowing through the line section is picked up by a variable coupler probe. This sampling of RF power is then directed to the input of the frequency counter.

2-5. This frequency is accepted by the frequency counter, amplified, processed and delivered to the LED display of the DPM.

Figure 2-1. Wattmeter Coupling Circuit Schematic Diagram.

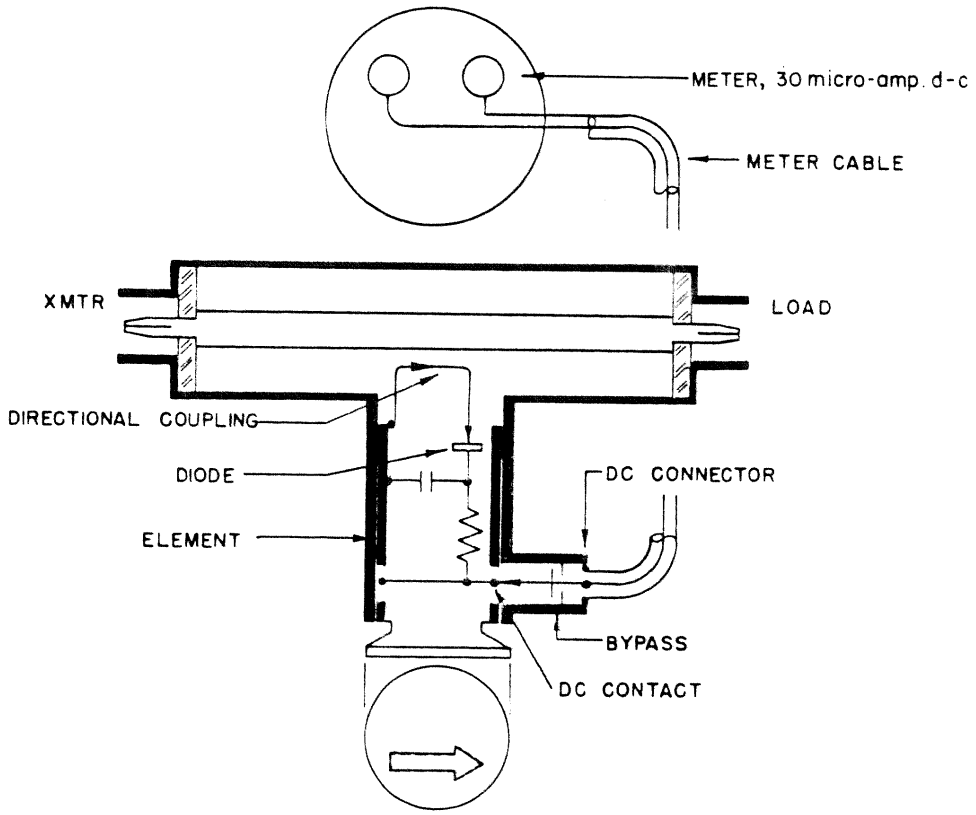
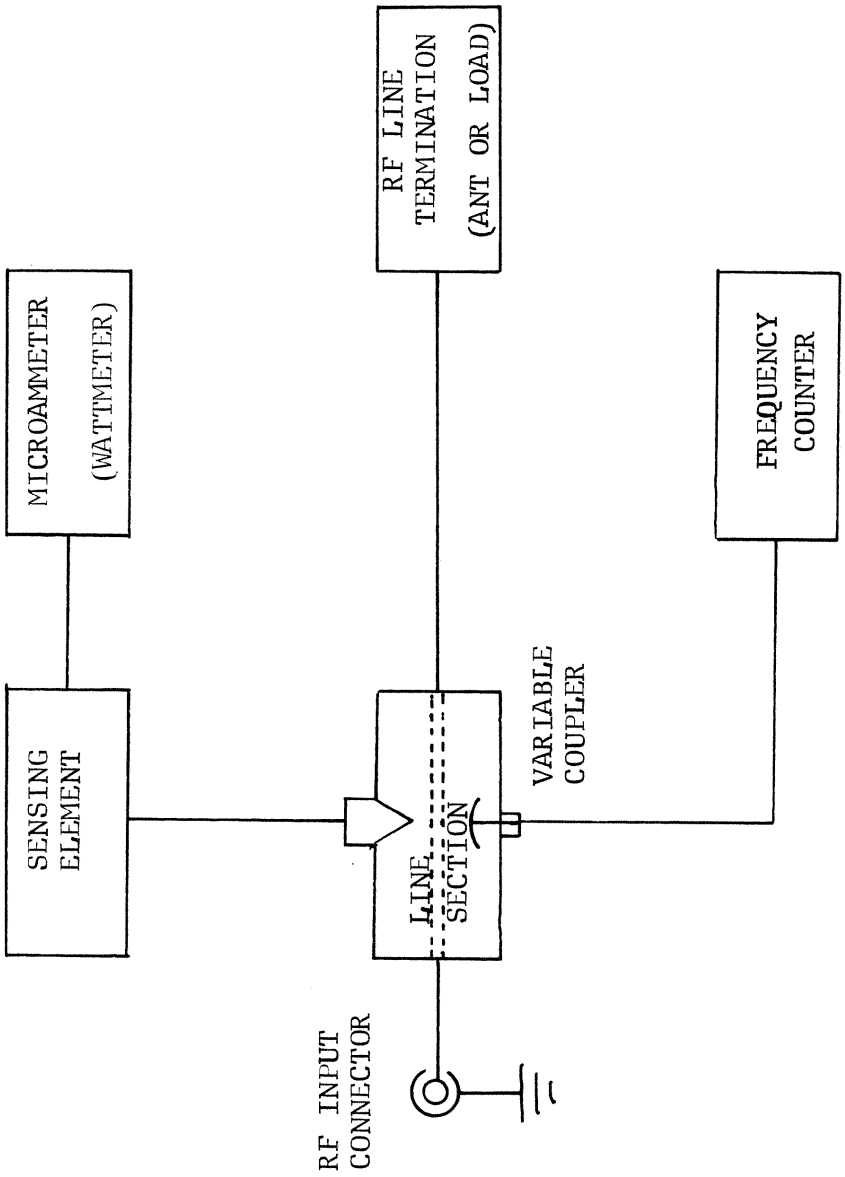


Figure 2-2. Block Diagram.



BLOCK DIAGRAM, MODEL 3900 FREQUENCY COUNTER-WATTMETER

SECTION III - OPERATING INSTRUCTIONS

3-1. GENERAL

3-2. The Model 3900 is very simple in operation. It has three controls which are located on the front panel. They are the ON/OFF switch, the variable coupler and the range switch. The only other control is the zero set adjustment screw on the wattmeter. This adjustment screw is on the bezel of the meter just below the scale.

3-3. INITIAL ADJUSTMENT

3-4. Before operating the test set and without any RF power applied, check the zero set of the meter's pointer. If the pointer of the meter is not at the lowest scale mark, or zero setting, adjust the zero set screw clockwise or counterclockwise until the pointer is at an exact zero setting. It is very seldom that this zero adjustment will have to be made.

3-5. NORMAL OPERATION

a. Turn the test set on by pushing the ON/OFF switch on the front panel. The number one "1" will be displayed as the last digit on the frequency counter and a flashing decimal point will signify the unit is on.

b. Set the range switch on the front panel to the appropriate position (400MHz or less) = 400MHz range, (401MHz or more) = 1GHz range.

1. Power Measurement - Power indications are read directly in watts. The elements determine and power range to be read on the meter scale, and the value on the element plate (viz. 50W, 100W, etc.) is the full scale power value for that element.

2. Frequency Measurement - The output frequency of the transmitter is given by direct reading in megahertz on the digital display of the frequency meter.

3-6. OPERATIONS UNDER ABNORMAL CONDITIONS

3-7. Loss of ac line power - In the event of a loss of ac line power to the test set, the wattmeter section of the test set will continue to function normally. The frequency counter will also function without ac power as long as the internal rechargeable battery maintains a charge. If the batteries are weak the LED display will dim and the frequency displayed will be erratic or otherwise questionable. If the LED display becomes dim recharge or replace the battery pack immediately.

3-8. Temperature extremes - The test set will operate above and below the operating temperatures range, however, accuracy will be affected. Allowances must be made for this condition. The higher or lower the temperature beyond the operating temperature, the greater the inaccuracies.

3-9. SHUTDOWN

3-10. When operation of the test set is complete, turn off the RF power first then disconnect the transmitter or RF power source and depress the ON/OFF switch. The power is off when the digital frequency display is not lit.

SECTION IV - MAINTENANCE

4-1. GENERAL

4-2. The Model 3900 is simple yet rugged in construction and should provide years of trouble free service if care is taken not to greatly exceed its power handling capabilities. Only a very little amount of maintenance is required. One of the major precautions is usage of the unit is use reasonable care and do not drop it or subject it to hard blows or jarring. The sensitive movement of the microammeter used in the wattmeter section could be damaged if subjected to hard blows. The accuracy of the sensing element could also be impaired if subjected to hard blows.

4-3. CLEANING

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**********************************************************
*                      W A R N I N G                     *
*                                                        *
*  When using dry cleaning solvents, provide adequate    *
*  ventilation and observe normal safety precautions.    *
*  Many dry cleaning agents emit toxic fumes that        *
*  could be harmful to your health.                      *
**********************************************************

**********************************************************
*                      C A U T I O N                     *
*                                                        *
*  Do not use any dry cleaning solvents or aerosol type  *
*  contact cleaners for cleaning the case. Most dry      *
*  cleaning solvents will attack the plastic housing of  *
*  this instrument.                                      *
**********************************************************
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4-4. The main factor in maintenance is cleanliness. When necessary, wipe the unit with a cloth dampened with a mild detergent solution. Clean the RF connection occasionally with an aerosol type contact cleaner or any dry cleaning solvent on a cotton swab stick. Cleaning inside the plastic housing may be restricted to times when disassembly for parts replacement is required.

4-5. UNIT TEST

4-6. If the units accuracy is in doubt or if it has been subjected to abusive treatment, the unit should be checked by the following methods.

a. A standard power meter and calibrated frequency counter. These are used for primary reference of the transmitter's output.

b. An RF signal source of known accuracy of power and frequency. A 10MHz laboratory standard is preferred.

4-7. Before any calibration checks are made, be sure the battery is fully charged. The measured voltage of the battery pack should be above 7.2V dc.

4-8. RECALIBRATION

4-9. Usually recalibration of the wattmeter section is accomplished by replacement of the sensing element. Further recalibration will not be necessary.

4-10. Frequency counter adjustment can be made by a variable capacitor on the circuit board. This capacitor is found on the rear right side of the circuit board. Adjustment is made through a small hole provided using a small screw driver.

4-11. TROUBLESHOOTING

4-12. For all other problems, a troubleshooting chart is provided to help in determining a problem and correcting it.

PROBLEM	POSSIBLE CAUSE	REMEDY
No Indication On Wattmeter	No RF input	Check transmitter output.
	Defective dc cable	Check lead from line section to microammeter. Repair or replace if necessary.
	Defective meter	Replace meter.
	Defect in sensing element circuit	Check continuity element circuit and line section contact - clean and adjust spring contact.
Erratic Wattmeter Indications	Defective dc cable	Check lead from line section to microammeter. Repair or replace if necessary.
	Defective meter	Replace meter.
	Defect in sensing element circuit	Check continuity element circuit and line section contact - clean and adjust spring contact.
	Poor connection	Check and clean or replace RF connectors.
Frequency Counter Not Lit	No power or defective power source	Check power source. Check battery pack, replace if necessary.
		Defective frequency counter, replace.

PROBLEM	POSSIBLE CAUSE	REMEDY
DPM Lit but No (frequency) Display	Defective frequency counter	Replace frequency counter.
	Insufficient RF coupling	Adjust RF coupling control.
	Defective RF cable	Check continuity, repair defect or replace cable.

4-13. REPAIR

4-14. Repairs in the field are basically restricted to assembly replacement. It is advised that the entire unit be returned to the factory for repairs and recalibration if possible. This is especially true for the first year while the unit is covered by the one year warranty. Any disassembly during the first year voids the guarantee. Please contact the factory before returning a unit for repair or recalibration.

4-15. All repairs of the Model 3900 test set are limited to replacement of assemblies. When replacing a defective part, first disconnect the unit from the coaxial RF power line and unplug the unit from the ac power source.

4-16. All assembly replacements require the disassembly of the plastic housing. To open the case, place the unit on its top, upside down, and remove the four plastic feet. The bottom half will pull straight off. Generally all replacement of assemblies can be made with no further disassembly. The case is reassembled by reversing the above procedure.

4-17. WATTMETER REMOVAL

a. Loosen the two nuts on the terminal posts of the meter and disconnect the leads.

b. Remove the two 6-32 hex nuts from the studs that secure the meter in the housing. Do not lose these nuts.

c. Pull the meter straight out through the front panel.

d. Reverse the procedure above to reinstall the meter. Observe correct polarity when reconnecting the terminal leads.

4-18. FREQUENCY COUNTER REMOVAL

a. Unsolder the RF input and power supply leads from the circuit board. Carefully observe the position of these leads before removing and replace to same position when reconnecting.

b. Unscrew the three 4-40 pan head screws that secure the circuit board to the mounting bracket. Lift the circuit board straight out.

c. When reassembling, reverse the procedure above. Be sure to observe polarity when resoldering the leads to the board.

4-19. LINE SECTION AND RF COUPLER REMOVAL

a. Unsolder RF input pick up cable from the p.c. board.

b. Unscrew the two 10-32 screws that secure the line section to the front panel.

c. Unscrew and disconnect the dc cable connector on the line section.

d. The RF line section is now free and may be removed from the housing.

e. Reassembly is accomplished by simply reversing the disassembly procedure.

4-20. BATTERY PACK REMOVAL

a. Remove the two 6-32 x 3/8 pan head screws that hold the battery clamp bracket in place.

b. The battery pack can be lifted sufficiently out of the housing to easily unsolder the connecting wires.

c. Before disconnecting, mark the leads to the power supply so that they may be returned to their original position when reassembling.

d. Reverse the above procedure to reinstall. Reconnect leads to their original position and observe dc polarity.

4-21. Recalibration or accuracy check are not normally required after any of the preceding replacement procedures. If, however, the unit has been dropped or subjected to a hard blow, damage may occur in more than one assembly. In this case it is advised that the entire unit be returned to the factory for repair and recalibration.

SECTION V - REPLACEMENT PARTS LIST

5-1. MODEL 3900

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Meter (Microammeters)	2080-061 TA
2	1	Line Section	3900-031
3	1	Frequency Counter Assembly	5-1581
4	1	On Off Switch	5-1577
5	1	Range Switch	5-1589
6	1	Battery Pack (NICAD)	5-1588
7	1	DC Cable Assembly	3900-006
8	1	RF Cable Assembly	3900-007
9	2	QC Connectors	*See Below
10		Elements	*See Table 5-1
11	1	Charger Unit	5-1591

* When ordering please refer to these numbers.

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
BNC-Female	4240-125	UHF-Female (SO-239)	4240-050

7/8" EIA Air Line 4240-002

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
250W	250H	250A	250B	250C	250D	250E
500W	500H	500A	500B	500C	500D	500E
1000W	1000H	1000A	1000B	1000C	1000D	1000E
2500W	2500H					
5000W	5000H					

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			
250W	250J			

Table 4 - Low Frequency Elements

Power Range	Frequency Band .45 to 2.5MHz
1000W	1000P
2500W	2500P
5000W	5000P
10000W	10000P

Table 6 - Milliwatt Elements

100mW	Cat. No.	250mW	Cat. No.	500mW	Cat. No.
72-76MHz	430-2	70MHz	430-34	72-76MHz	430-33
105-120MHz	430-6	72-76MHz	430-22	105-120MHz	430-26
136MHz	430-9	108-118MHz	430-24	240-290MHz	430-27
174MHz	430-10	130-150MHz	430-13	328-336MHz	430-28
328-336MHz	430-3	150-180MHz	430-15	455-470MHz	430-30
400MHz	430-7	328-336MHz	430-16		
470MHz	430-8	1700-1750MHz	430-17		

LIMITED WARRANTY

We are proud of the high quality of our product and we warrant to the original purchaser that each new instrument of our manufacture will for a period of one year after original shipment be free from defects in material and workmanship under normal and proper operating conditions and that properly used during such period it will perform in accordance with our applicable specifications.

Our obligation and the purchaser's exclusive remedy for any defect or failure to meet specifications shall be limited, at our option, to repair or replacement, or if we determine said defect or failure to be so defective as to preclude remedying by repair or replacement, the purchaser's sole and exclusive remedy shall be limited to refund of the purchase price. We shall have no obligation if defects result from improper use, operation above rated capacities, repairs not made by us, or misapplication of the equipment. Our warranty does not extend to the failure of semiconductor devices and batteries, or to equipment and parts made by others except to the extent of the original manufacturer's warranty to us. No other warranty is expressed or implied. Bird Electronic Corporation is not liable for consequential damages.

Warranty returns must be first authorized by the factory office and are to be shipped prepaid.