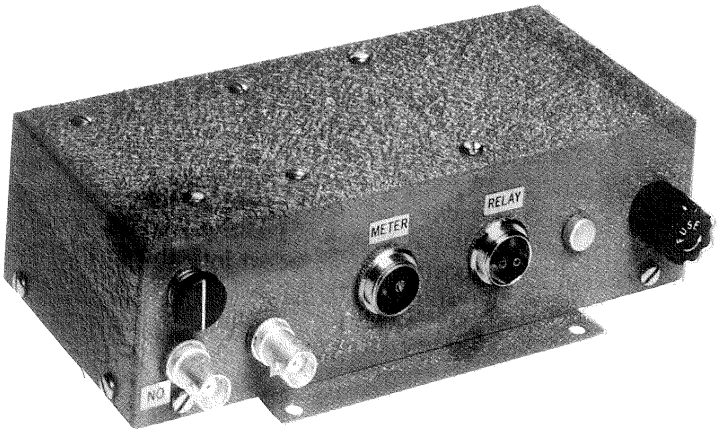
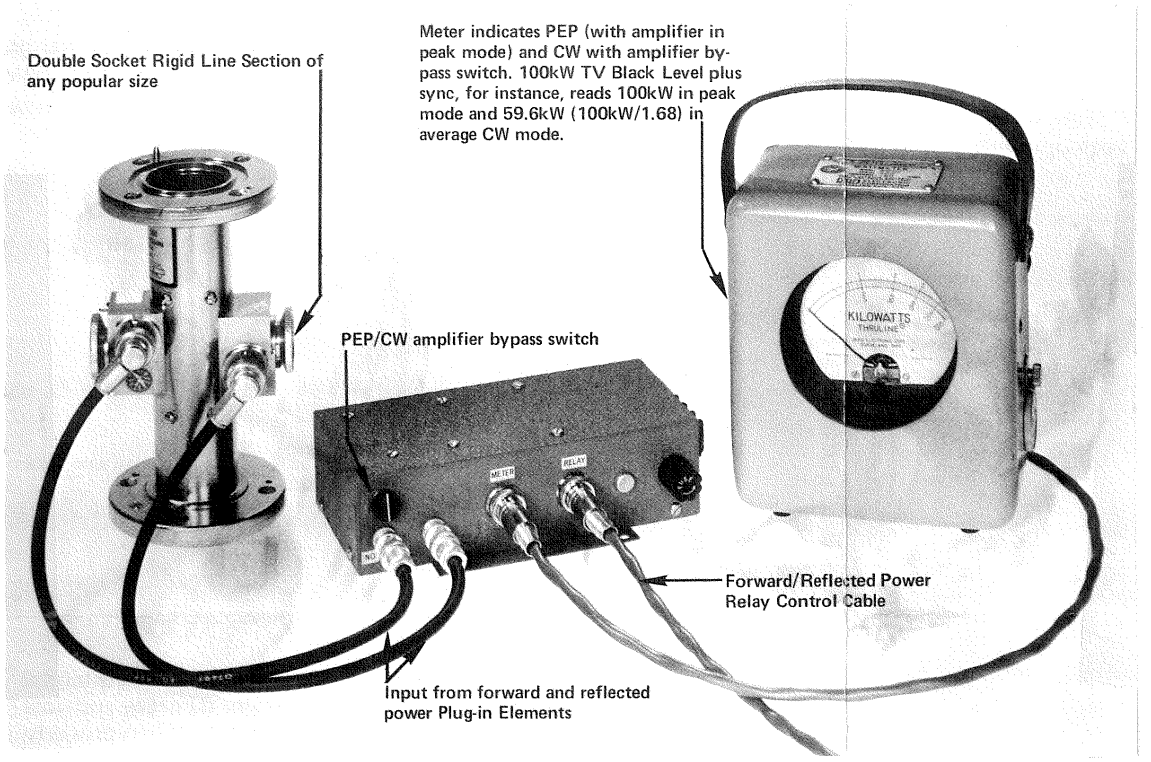
Instruction Manual
for
Peak Reading
AMPLIFIERS
-
Models
4320 and 4321



Model 4320/21 Amplifier



Peak Reading Setup

Figure 1

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Models 4320 and 4321
RF Peak Reading Amplifiers

SECTION I

Introduction and Description

1. General

This is a combination Instruction Manual for the RF Peak Reading Amplifier Models 4320 and 4321, See Figure 1. Information for the operation, service, troubleshooting, and repair of these units has been incorporated in its contents.

The Models 4320/4321 RF Peak Reading Amplifiers are auxiliary items designed for use with regular Bird THRULINE Wattmeter Equipment. When inserted between the line section and the read-out meter, these amplifiers furnish additional peak reading capability to the RF Wattmeter measurements.

The Models 4320 and 4321 are essentially alike except that 4320 is for lower power Wattmeters, using the 30uA meter; primarily the Bird Model 43 THRULINE Wattmeter. The Model 4321 is for higher power levels, using a 100uA meter with the larger rigid-line Wattmeters, such as Bird Models 4712/15, 4600/4610, and 4902/05 respectively. See Table I, Leading Particulars, below.

Table I. Leading Particulars

Measuring Medium	RF transmission in 50-ohm lines
RF power ranges:-	
Average (CW) mode:-	
Model 4320	1 watt to 10 kW* (±5% full scale)
" 4321	250 watts to 250 kW (±5% full scale)
Peak pulse or envelope-power mode:-	
Model 4320	1 watt to 10 kW (±8% full scale)
" 4321	250 watts to 250 kW (±8% full scale)

*Maximum power depends upon frequency of transmission and measuring section used - refer to Par. 3, this Section.

Plug-In Elements for Cable-Connected and the Rigid-Line RF Measuring Sections.

Frequency Range . . . . . (per elements used)	0.45 to 2300 MHz (either mode)

Pulse Parameters

Square Pulses:	
Minimum duty factor . .	1.0×10^{-4}
Minimum repetition rate.	30 pps
Minimum pulse width. . .	0.4 microseconds at 100-2300 MHz
	1.5 microseconds at 26-99 MHz
	15 microseconds at 2-25 MHz
Gaussian Pulses:	
Minimum duty factor . .	3.5×10^{-4}
Minimum repetition rate	30 pps
Minimum pulse base width (at 10% of height)	3 microseconds at 26-2300 MHz
	15 microseconds at 2-25 MHz

Line Connectors:

Model 4320	
Bird Model 43 Line . . Section (Cable Type)	Bird "QC" Type
Standard	Female N (Std. AN)
Optional	Any "QC" in Std AN Types
7/8" Rigid Line Section	7/8" EIA Flange
Model 4321	
1-5/8" Rigid Line.	Std. 1-5/8" EIA Flange
3-1/8" " "	Std. EIA Flg. or Unflanged
6-1/8" " "	Std. 6-1/8 EIA Flange

Weights:

Amplifier Only	2 lbs, 2 oz (0.96 kg)
Plug-In Elements	3 oz. (0.09 kg)

Basic Overall Dimensions

Length	7-3/4" (197mm)
Width	4-1/4" (108mm)
Depth	2-1/8" (54mm)

Input Power Requirements:

Voltage.	115-230 volts
Frequency	50-60 Hz
Power	10 watts

2. Description

The Model 4320/4321 equipment consists of a single box approximately 7-3/4" long (incl. terminal cover) x 3-1/4 W x 2 H. The base edge has mounting flanges at the sides. For use in fixed mounting, the flanges have four 3/16 holes on a 3-5/8 x 3-3/4 (4.76mm holes x 92mm x 95mm) rectangle. The terminals for AC power connection are at one end of the box (under a protective cover), and all external components are mounted on one side. These components consist of: - push button switch for CW power selection, 2 coaxial RF inputs, connectors for the meter and the relay control, the pilot light, and a fuse-holder.

The operation of this equipment is much the same as with basic THRULINE Wattmeters. Single-socket line sections require only one pulse cable, and the change from forward to reflected power is made by rotating the single Plug-In-Element. Double-socket type line sections use two pulse cables connecting to two inputs on the amplifier. Forward and reflected power indications are then selected by means of a remote switch operating the internal relay.

3. Element Section

Plug-In-Element selection is virtually the same (on both Models 4320 and 4321) as those for the respective Line Sections used, with the wide range of frequencies and full scale power levels presently available. Consult Manual for applicable RF Wattmeter being used. The single exception is that Peak High Power Elements (to 10 kW) are also available with the Model 4320, for Model 43 and 7/8" Line Sections. The data on these Elements is listed in Table II, below.

Table II High-Power Elements (Peak Only)

Use	Frequency (MHz)	Power Ranges (watts)
Pulse Mode only	25-60, 50-125, 100-250 200-500, 400-1000	2.5kW, 5kW, 10kW,
	950-1260	500W, 1kW, 2.5kW, 5kW

4. Power Supply

These units require a nominal 115 or 230 volt, 50/60 Hz supply, with a power consumption of approximately 10 watts. The FUSE, for the protection of the unit from excessive AC power loads, is at the right of the instrument face of the box. The POWER-ON pilot light is next to it, indicating when AC power is applied.

SECTION II
THEORY OF OPERATION

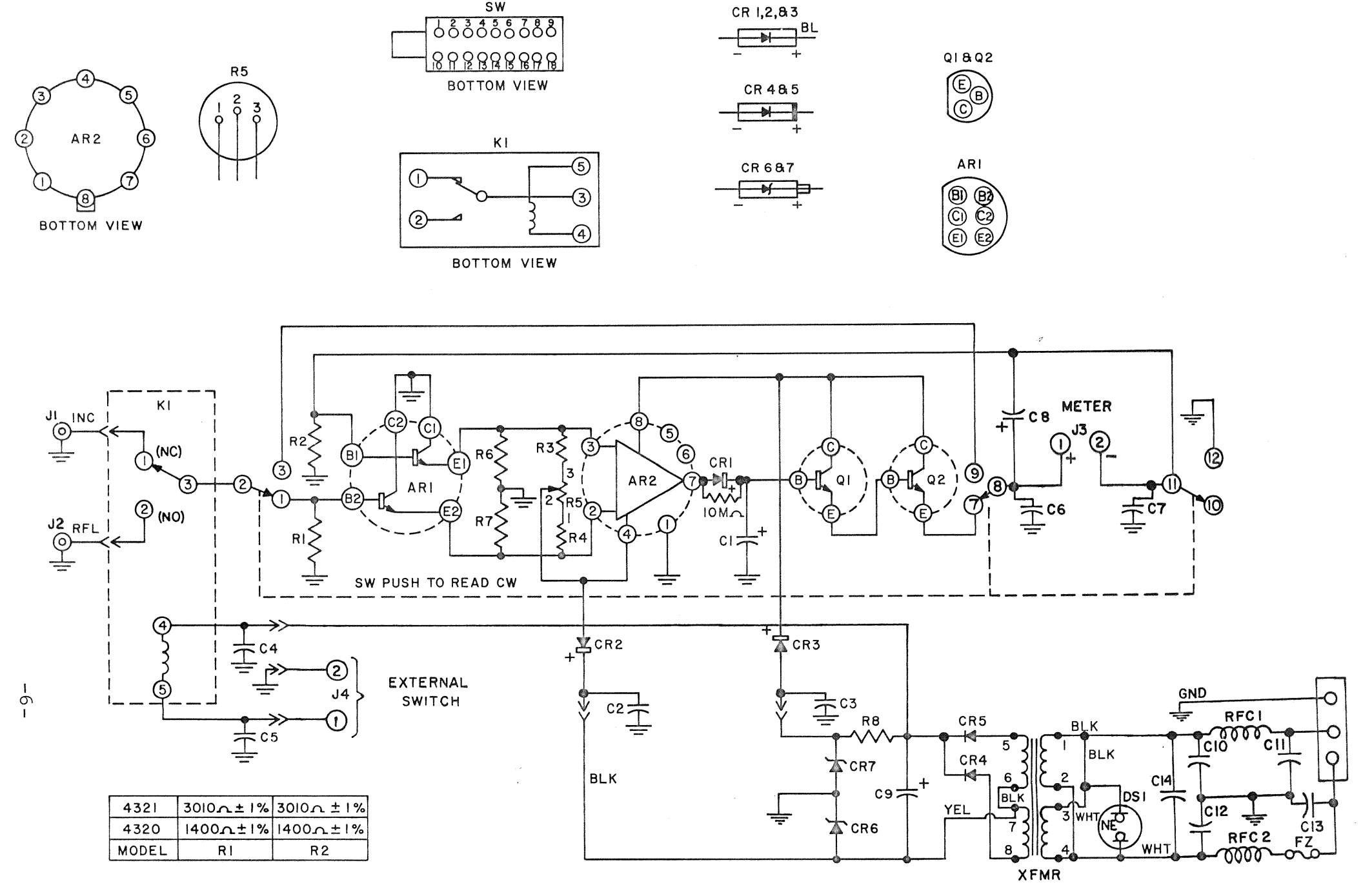
1. RF Wattmeter - Basic Theory

The Theory of Operation for measurement of average RF power (CW, AM, FM, and TV Modulation) in the THRULINE® Wattmeter is discussed in the Manual provided with the Meter and Line Section for the primary Wattmeter used with this Amplifier so need not be repeated here.

2. Peak-Power Measurement Theory

As intended by the equipment herewith the Peak Pulse Amplifiers Models 4320/21 are especially to provide peak power measurements as installed with the original RF equipment. This is accomplished by means of the amplifier system shown in Figure 2.

a. Power Supply. The input circuit is fused (0.3A, or 0.15A for 230V) and AC power is indicated by pilot light. This indicator is always attached to only one of the primary coils, so will receive only 115V at either supply voltage. The particular feature of this input section is a special RF filter to protect the amplifier circuitry against the effects of AC line noise. The output of the center-tapped secondary of the transformer is applied to rectifiers CR4 and CR5 to supply fullwave rectification. The Zener Diodes CR6 and CR7, regulate and control the output level of the transformer output. A center tap between the series-connected Zener Diodes provides the common of the circuit. Resistor R8 is a voltage-dropping resistor.



4321	3010Ω ± 1%	3010Ω ± 1%
4320	1400Ω ± 1%	1400Ω ± 1%
MODEL	R1	R2

Fig. 2 - Schematic Circuit Diagram

ARTWORK,
SCHEMATIC DIAGRAM
MODEL 4320 & 4321

4320-011

b. Meter Current Input. The amplifier circuit is designed to provide current to the meter which will indicate at a steady state the peak of the power applied to resistor R1. Resistor R1 exactly matches the resistance of meter M1, so that the existing circuit in the Plug-in Element is loaded exactly the same as during the average reading mode.

c. Amplifier Circuitry

As usually connected, and with the circuit selector switch in the normal (Peak Read) position, the pulse signal is applied to resistor R1 and differential amplifier AR1 which gives a current gain ratio of approximately 100:1. This output is applied to a resistance bridge consisting of resistors R3, R4, R5, R6, and R7. Variable resistor R5 of this bridge permits zero calibration of the amplifier circuit. Bridge output is applied to differential amplifier AR2 which provides a voltage gain of about 1000:1. The voltage gain ratio of this is extremely important in determining the minimum pulse duration which can be indicated, since it is the surge of voltage from this amplifier which charges capacitor C1. Capacitor C1 applies a potential to differential amplifiers Q1 and Q2 as long as the capacitor remains charged. These amplifiers provide a massive current gain ratio, but unity or slightly less voltage gain. This is applied to meter M1 to indicate the peak power in the line. A portion of the dc output of amplifiers Q1 and Q2 is fed back to resistor R2 and to amplifier AR1. Resistor R2 is matched to resistor R1 to provide unity gain to the amplifier. This feedback circuit maintains the output from AR1 and in turn from AR2 to keep capacitor C1 charged to that value which yields unity closed loop gain. The capacitor continues to energize Q1 and Q2 to maintain

the reading of the meter even though the peak of the pulse is no longer applied to the amplifier assembly input. In this manner, only peak power is indicated, even though there is a wide fluctuation of input power.

d. Circuit Decay. Because of capacitor leakage, diode back resistance, and transistor input current (low as it may be), there will be a decay in the circuit to limit the time the amplifier system will retain its output level. As the circuit decays, the meter will return to zero provided no additional pulses are received at resistor R1.

SECTION III

INSTALLATION

1. Line Section Types

The Model 4320 Amplifier is for use with 30uAmp. meters, and primarily for use with Bird Model 43 THRULINE® Wattmeter. The Line Section of this Model attaches to cable type RF installations. (The 7/8" EIA rigid Line Sections, Models 4501/4502, are also usable with the Model 43 meter).

The Model 4321 Amplifier is for use with 100uAmp. meters, which comprise essentially the rigid-line (1-5/8", 3-1/8" or 6-1/8" coaxial) installations such as the Bird 4712/15, 4600/4610, and 4902/4905 Series THRULINE® Wattmeters. Connections are made according to procedures prescribed for the Line Section involved.

a. Install the Wattmeter into an RF circuit having a 50-ohm impedance only. Connecting into lines of other impedance values will cause a mismatch, resulting in seriously inaccurate readings.

Avoid this condition if possible. In case of exceptional need, the unit can be connected to lines of mismatched impedance. Refer to Impedance Mismatch, par. 5, Operation, Section IV for an indication of the degree of inaccuracy caused by this mismatch.

Take care that the Plug-In Element installed in the socket of the line section has a sufficiently high wattage rating to indicate the line load when it is first applied to the RF line. Severe damage to the Plug-In Element or meter can result from an overloading of the meter or the power rating (Watts) of the Element.

2. Amplifier Installation and Wattmeter Conversion (See Fig. 3)

Conversion should be made as follows:-

a. Disconnect the original meter cable of the Wattmeter by unscrewing the knurled nut of the cable plug from the DC output jack at the side of the THRULINE Line Section.

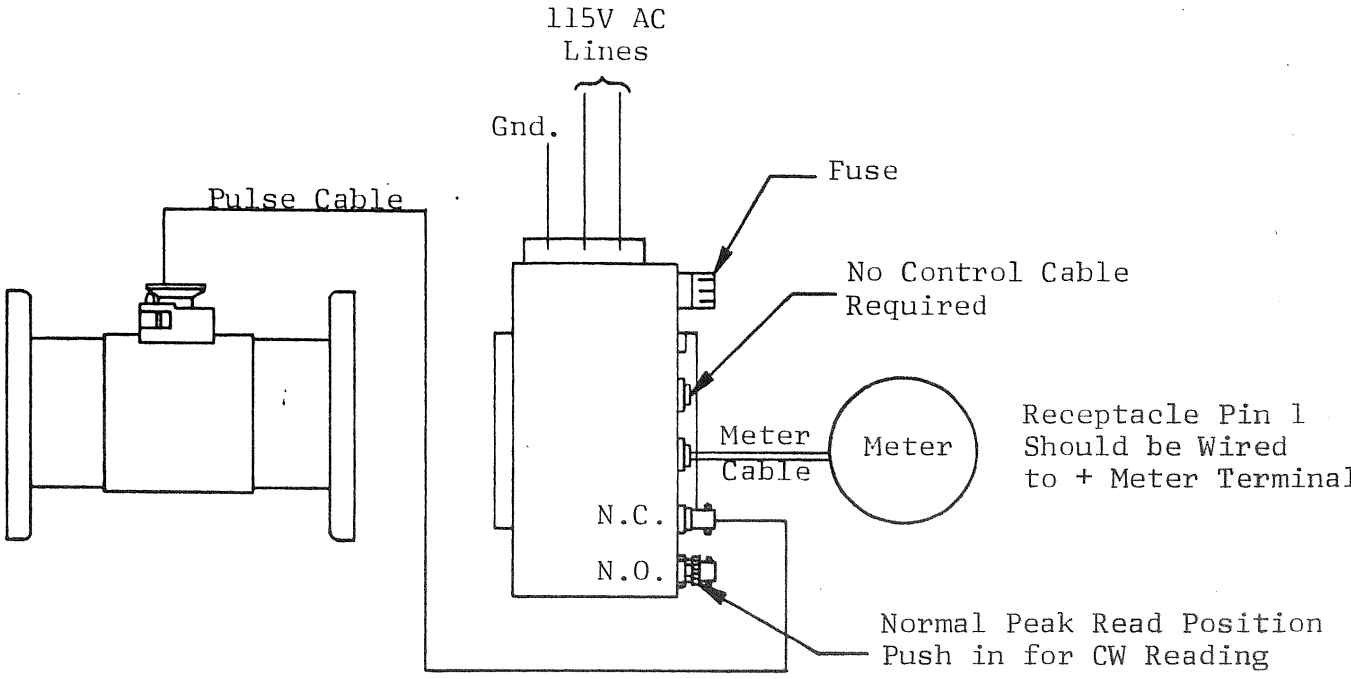
b. Replace this connection with a new pulse-type cable. The cables are provided in various lengths as listed on the last sheet of this book. A short pulse cable is not critical for use with this amplifier: The cable has an impedance high enough to have only a neglible dampening effect of the pulsed signals, and the very low capacitance presented by this cable does not alter the pulse form. Fasten the DC plug of the new cable to the line section jack in the same manner as that just removed.

c. Connect the BNC Male (UG-260B/U) connector on the opposite end of the pulse cable to the input jack marked NC located on side of peak reading amplifier. If a double socket THRULINE line section is used, the procedure is repeated and the reflected power measuring

INSTALLATION BLOCK DIAGRAM FOR RF PEAK READING AMPLIFIERS

MODELS 4320 & 4321

SINGLE ELEMENT THRULINE® WATTMETER



DUAL ELEMENT THRULINE® WATTMETER

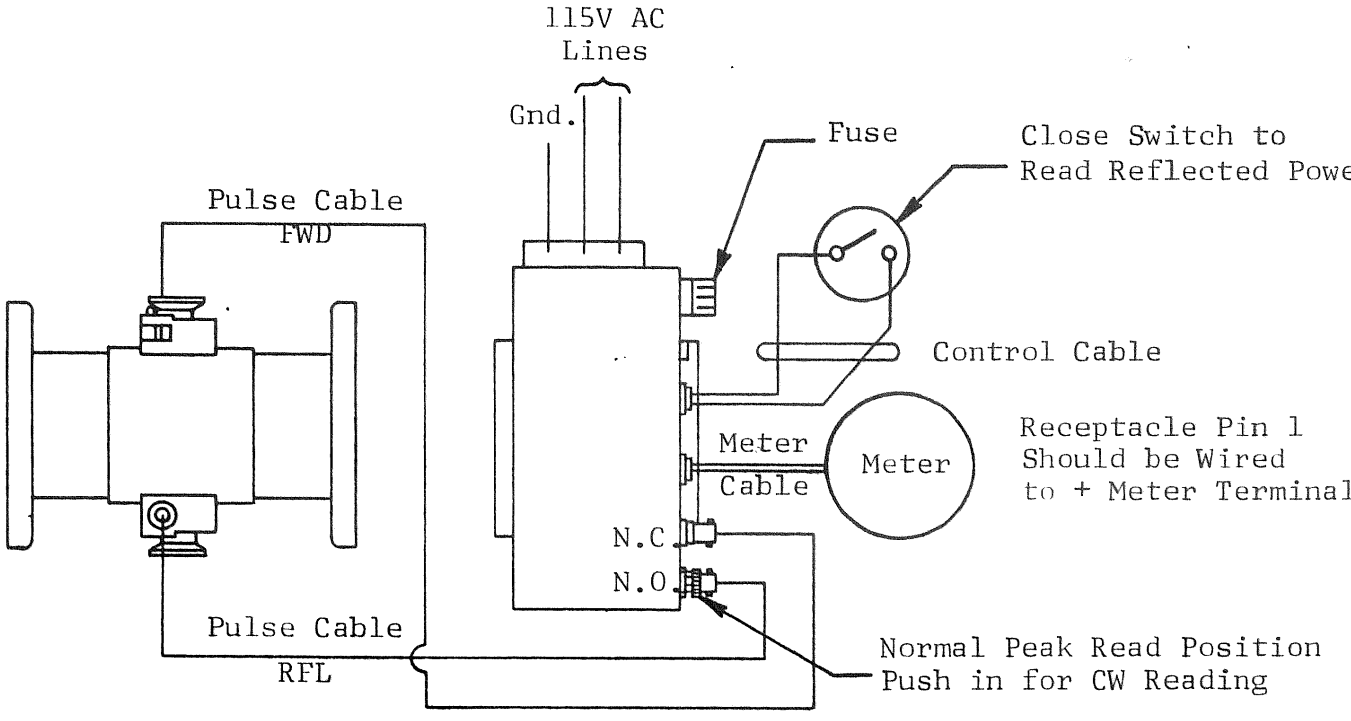


Figure 3

Plug-In Element is connected to the BNC jack marked NO (NC - normally closed, NO - normally open)

d. Replace the original meter cable with the new two conductor shielded cable. The length is not critical but the meter polarity must be maintained with connector pin number one (white) being connected to the positive meter terminal. Attach the male meter cable connector to the left receptacle on the Peak Reading Amplifier.

e. If a double socket Line Section is used for forward and reflected power measurement, an external single-pole (single-throw) switch is required to actuate the internal transfer relay. The cable length is not critical nor is the polarity. The female cable connector mates to the right receptable on the Peak Reading Amplifier.

f. Connect the AC power supply to the terminal strip on the Peak Reading Amplifier. Right hand terminal is provided for chassis ground if desired. Be sure the line voltage supplied agrees with that stencilled on the box (just below the terminals) and on the outside of respective terminal strip cover box. Attachment of AC line lights the POWER ON Indicator. Equipment is now ready for operation. As installed, and previously described, the amplifier connection remains normally in the Peak-Read mode.

SECTION IV

OPERATION

1. Controls

Connected as described in preceding Section, the Amplifier is ready for use. The instrument ordinarily will read in the Peak Power mode. To make CW measurements, depress the push-button at the extreme left side of instrument face. This by-passes the input signal past the Peak Amplifier directly to meter. To lock in the CW mode, depress button and rotate a quarter-turn clockwise.

2. Zero Adjust

Before taking readings, it is advisable to zero adjust the meter under no-power conditions. Position Plug-In-Element with arrow pointing up. Use a small screwdriver and rotate the meter-zero screw (at base of dial) as necessary to align the meter pointer directly on the zero line.

3. Measurements - Routine, Attenuation, etc.

Proceed according to the regular instructions of the Wattmeter Manual with Line Section equipment.

4. Measuring Percentage of Positive Modulation

Measuring the percentage of positive modulation in an amplitude modulation system is easily done by employing the average and peak reading characteristics of the unit, since:

$$\text{Percent pos. mod.} = \frac{E_{max} - E_{carrier}}{E_{carrier}} \times 100$$

By substitution we get:

Percentage pos. mod. =

$$\left(\frac{\sqrt{P_p} - \sqrt{P_c}}{\sqrt{P_c}} \right) \times 100$$

When:

P_p = peak power as read with PEAK READ switch out.

P_c = carrier power as read with PEAK READ switch in.

or:

Percent pos. mod. =

$$\left(\frac{\sqrt{P_p}}{\sqrt{P_c}} - \frac{\sqrt{P_c}}{\sqrt{P_c}} \right) \times 100$$

and by cancellation

Percent pos. mod. =

$$\left(\frac{\sqrt{P_p}}{\sqrt{P_c}} - 1 \right) \times 100$$

5. Impedance Mismatch

This test set is designed to check power in a 50-ohm circuit. When the test set is connected into the RF line, it inserts a 4-inch section of 50-ohm line into that circuit. When this is inserted into a line having an impedance other than 50 ohms, the load on the transmitter will change because of the insertion. This change is not

to serious if the power reflection factor is less than 10 percent or if the frequency is less than 200 MHz. At values higher than these, the insertion of the 50-ohm line will result in a different load impedance even if the transmitter is tuned up with the test set inserted into the line. The test will indicate zero reflection when the unit is connected into a 50-ohm, pure resistive line. When a 70-ohm line is connected on the load side of the test set, under ideal conditions, the 50-ohm test set will indicate 3 percent reflected power or a VSWR of 70/50 = 1.4. The test set can show this same reflected percentage when a 50/1.4 = 35.7-ohm, pure resistive load is applied to the 70-ohm line. This could exist with 10 percent reflected power on the 70-ohm line (VSWR = 2). From this it can be seen that when the 50-ohm test set is applied to a 70-ohm line, the line could have 10 percent reflected power with a VSWR of 2.0, but the meter would indicate only 3 percent reflected power (VSWR-1.4). If it is necessary to make wattage readings on a 70-ohm line with the 50-ohm test set, it is especially important to subtract the reflected power from the forward power.

SECTION V
MAINTENANCE

1. General

Field repair on amplifier units by the user is not recommended. Otherwise, for recalibration or other repair work, consult with Bird Electronic Corp. and return equipment to the factory. Repair work on the amplifier by the user during the guarantee period could be cause to void equipment warranty.

2. Amplifier Repair

As stated, the equipment is not considered suitable for field repairs. The internal components are printed-circuit mounted, and wired together in a very carefully assembled mechanical package. However, for those desiring to do so, a schematic circuit and pin locating diagram, Fig. 2 on page 6, is included with Section II. The significant parts are given in Replacement Parts List, Section VI.

3. Calibration

Peak-Read Amplifier Models 4320/21 normally require no calibration other than zero adjustment of the meter. This should be done any time the meter pointer is not exactly aligned with the zero mark on the meter scale when no readings are being made. (Any other adjustments are discouraged unless one or more components are replaced in the amplifier section.) If this has been done, proceed as directed below.

4. Average-to-Peak voltage level adjustment

To assure that the meter reads correctly for both average and peak operation, a direct current from a battery source is applied to the input of the amplifier circuit. Refer to Figure 2.

The steady direct-current peak level should be the same as the average current level, because no peaks exist in this current. Apply a direct current and adjust as necessary so that the same reading is attained in both average and peak modes.

Proceed as follows:

a. Install a voltage-dropping variable voltage dividing potentiometer and a battery in series with the input of the amplifier. Make sure the resistor is set for zero output. Connect the positive (+) side of the circuit to input and the negative(-) side to ground. Install a voltmeter across the circuit. Slowly operate the potentiometer to adjust output to apply approximately 21 millivolts. A suitable resistive network must be used to assure that the battery voltage is properly reduced.

b. Check the reading of the meter. It should indicate about half of total scale reading. Press the push button of PEAK POWER switch SW while watching the meter pointer. There should be no deviation of the pointer from average to peak reading.

c. If the pointer reads a different value for peak reading than for average reading, rotate the adjusting cap on resistor R5 on the amplifier until the two readings coincide.

5. Troubleshooting Chart

This chart provides a list of the most probable causes of trouble which might develop in the equipment. For each trouble there is a list of probable causes and remedies. Refer to the troubleshooting chart in the event of trouble in the unit.

TABLE III- TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
No meter indication (Average or Peak)	Arrow on plug-in in wrong direction.	Correct arrow direction.
	No radio frequency power.	Check transmitter for faults.
	No pick-up from dc contact finger.	Adjust spring finger.
	Open or shorted dc meter cable.	Replace cable.
	Meter burned out or damaged.	Replace meter.
No meter indication	No ac input (POWER ON lamp fails to light).	Check ac power source.
	Blown fuse FZ	Replace fuse
	Defective component in section.	Consult manual
Intermittent or inconsistent meter readings	Faulty load	Correct fault in load.
	Faulty transmission line	Correct fault in transmission line.
	Dirty dc contacts on elements.	Clean dc contacts
	Sticking or defective meter.	Replace meter.

TABLE III- TROUBLESHOOTING CHART (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
High percentage or reflected power	Faulty load.	Correct fault in load.
	Poor connectors.	Check for high-resistance connections.
	Shorted or open transmission line	Correct fault in transmission line.
	Foreign material in line section.	Clean line sections thoroughly.

6. Routine Repairs

With the proper care and materials, the connecting cables for the Peak RF Amplifier may however, be replaced or repaired in the field. See Parts List for these items in the "Cable Selection" paragraph below.

a. Meter Cable Assembly (4230-030-), Figure 4. Use Male Connector Plug P/N 5-665, a two-conductor #18 wire cable, Bird P/N 5-704, of the length desired. To attach the plug, loosen the set screw at the back of plug body and pull out the coil spring. Remove and keep the small flat-head retaining screw body. With parts facing the proper direction, slide first the body then the coil sleeve (small turns inward) onto the end of the cable.

Service the end of the cable; remove jacket for 3/4-inch back, smooth and twist the shielding braid into a trim cord. Strip each lead 3/8-inch back and tin. Solder the White lead to contact #1, and the Red lead to contact #2. Bring up the coil spring, turning the sleeve to clamp the braid between turns. Twist until snug

against contact piece, then clip off excess braid. Slide the Body up to align its side hole (under captive nut) with the contact plug hole, replace the flat-head screw and tighten securely. Turn down set screw at rear to hold spring coils. Opposite end of cable is serviced according to applicable Meter connection. Note, as in Installation paragraph, White lead goes to Meter positive.

b. Relay Cable Assembly (4230-031*). Use Female Connector Plug P/N 5-663, other material is the same. Procedure same as above, except: Trim jacket only 3/8-inch and strip and tin leads 1/4-inch back. On this cable (Relay), Red lead goes to contact #1, and White goes to contact #2. Polarity is not critical in servicing the Relay switch connection.

c. Pulse Cable Assembly (4230-053-). The pulse conductor for the input signal to this Amplifier is MIL. Std. RG-59B/U coaxial cable, 75-ohm nominal impedance. One end, attaching to the Amplifier, is fitted with a standard BNC Male Plug (UG-206B/U). For connection to the Line Section output jack, the other end of the pulse cable is fitted with a Bird DC plug (7500-245), for 1/4-inch size cable.

The BNC Plug is affixed by the regular procedures for attaching fittings to coaxial cables (MIL-HDBK-216, pp 3.72/3.73 for BNC). The Bird DC Plug is assembled to the RG-59B/U cable by procedures outlined 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.
(5) Remove inside insulation 3/16-inch back from end.
(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.

The connecting cables for these Models are separately furnished as ordered by the customer. Tables of standard lengths for the respective cable types are given below. The performance of the Meter Cable and of the Control Cable is independent of length, and the relatively high impedance characteristic of the Pulse Cable allows up to 25-foot length without deterioration of the pulsed signals.

Table of
Standard Length Cable Selections.

Pulse Cables		Meter Cables		Relay Cables	
4320-053-1	9"	4230-030-1	24"	4230-031-1	24"
4320-053-3	4-1/2"	4230-030-2	72"	4230-031-2	72"
4320-053-5	1'	4230-030-3	120" (10')	4230-031-2	120"
4320-053-6	2'	4230-030-4	300" (25')	4230-031-4	300"
4320-053-7	6'	4230-030-5	Specify on Request	4230-031-5	Specify on Request

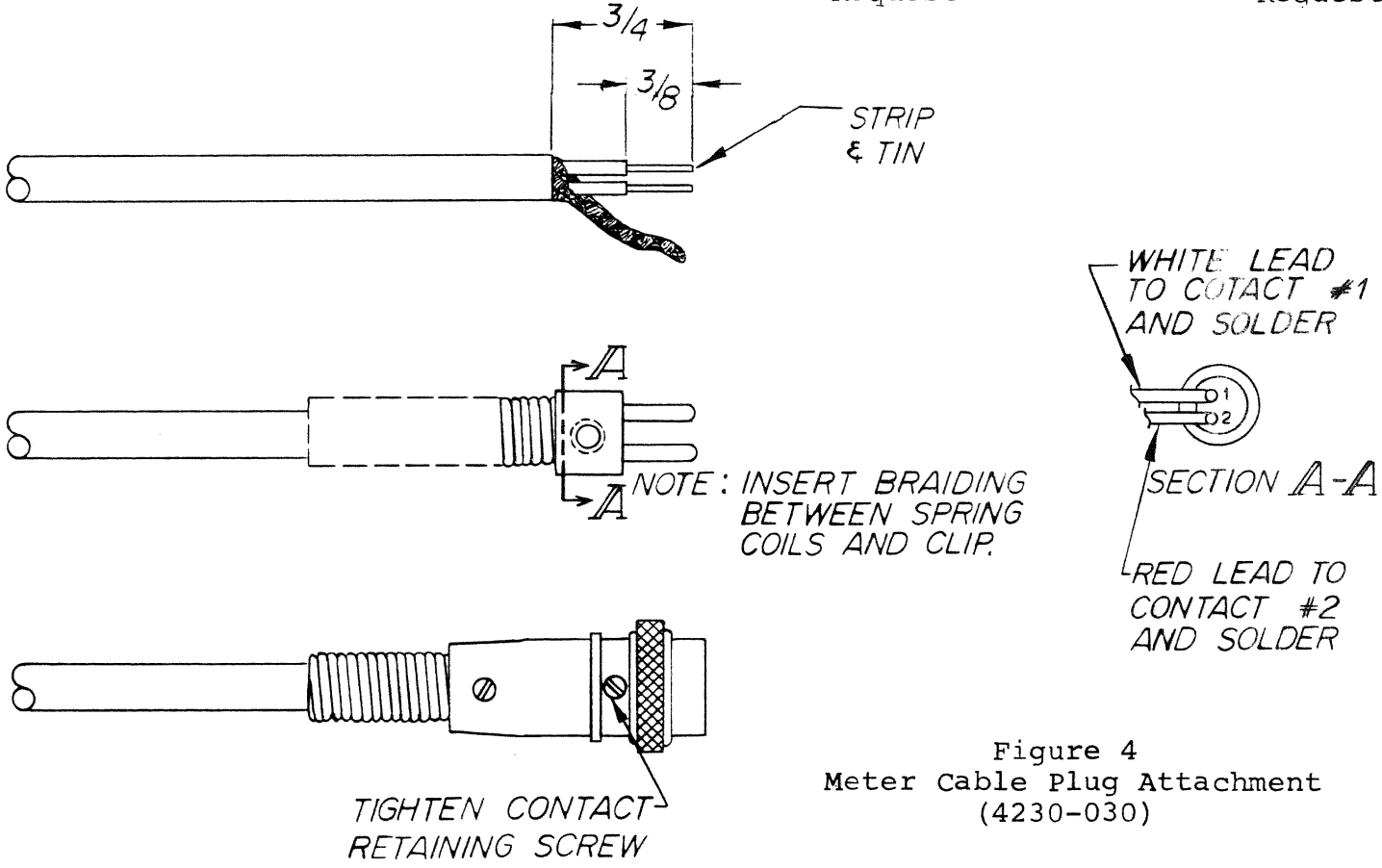


Figure 4
Meter Cable Plug Attachment
(4230-030)

SECTION VI

Models 4320 & 4321

REPLACEMENT PARTS LIST

Symbol	Qty	Description	Bird Part No.
-	-1-	Pre-Assy., PC Bd - Model 4320	4320-018-1
or	-1-	" " " " - Model 4321	4320-018-2
AR1	1	Amplifier	4311-058
AR2	1	Amplifier	4311-050-1
C1	1	Capacitor, 0.1 uF, 35V Elect	5-525-2
C2-C7	6	Capacitor, 0.01 uF	5-688-3
C8	1	Capacitor, 10 uF 20V Elect	5-522-1
C9	1	" 47 uF, 35V "	5-551
C10-C13	4	Capacitor, 0.01 uF	5-946
C14	1	" 0.25 uF	5-1177
CR1	1	Diode - FD700	5-526-2
CR2-3	2	Diode - FD600	5-526-1
CR4-5	2	Diode - 1N4002	5-553
CR6	1	Diode, Zener - 1N3828A	5-552-2
CR7	1	Diode, Zener - 1N3023B	5-552-1
FH	1	Holder, Fuse	5-673
FZ	1	Fuse, 3AG 0.3A (115V)	P5-579
or	(1)	" " 0.15A (230V)	"
L1	1	Light, Indicator	5-561
M	(1)	Meter, 30 uA, 4320 Models	Furn. with
or	(1)	" 100 uA 4321 Models	Wattmeter Equip.
Q1-2	2	Amplifier, Differential (5-635)	4311-056-1
SW	1	Switch - CW to Peak (Push)	5-497
(S)K1	1	Relay - Inc. to Rfl Switch	5-648

REPLACEMENT PARTS LIST (Continued)

Symbol	Qty	Description	Bird Part No.
R1-2	2	Resistor, 4320, 1400 ohm ±1%	5-157
or	(2)	" 4321, 3010 ohm ±1%	5-157
R3-4	2	Resistor, 31.6K ohm	5-521-6
R5	1	Potentiometer, 20K ohm	5-671-1
R6	1	Resistor, 4750 ohm	5-521-5
R7	1	" 4990 ohm	5-521-4
R8	1	" 680 ohm, 1/2W	5-537-3
RFC1-2	2	Choke, RF - 1000 uH	5-1178
RFCX	(1)	Assy. P.C. Board, Filter	4320-065
XFMR	1	Transformer, Power	5-944