
INSTRUCTION BOOK FOR

**RF DIRECTIONAL
THRULINE[®] WATTMETER
MODEL 43**

**Also Covers Models
4305, 4330, 4431, 4521-27, and 43P**

BIRD
Electronic Corporation
Cleveland (Solon) Ohio USA

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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. These precautions must be thoroughly understood and applied to all phases of operation and maintenance.

Keep Away From Live Circuits

Operating personnel must at all times observe normal safety precautions. Do not replace components inside equipment with the high voltage supply turned on. To avoid casualties, always remove power.

Do Not Service Or Adjust Alone

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

Safety Earth Ground

An uninterruptible earth safety ground must be supplied from the main power source to test instruments. Grounding one conductor of a two conductor power cable is not sufficient protection. Serious injury or death can occur if this grounding is not properly supplied.

Shock Hazard

Do not attempt to remove RF transmission line while power is present. Radiated RF power is a potential health hazard.

Resuscitation

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

Safety Symbols

WARNING

Warning notes call attention to a procedure which, if not correctly performed, could result in personal injury.

CAUTION

Caution notes call attention to a procedure which, if not correctly performed, could result in damage to the instrument.



This symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area.

Warning Statements

The following warnings appear in the text where there is danger to operating and maintenance personnel, and are repeated here for emphasis.

WARNING

When operating this equipment in conjunction with RF power of 200 watts or higher, the potential of the center conductor of the RF line section will be 100 volts or higher. Do not contact the center conductor. If cleaning becomes necessary, shut off the RF power.

WARNING

Leaking RF energy is a potential health hazard. Never attempt to connect or disconnect equipment from the transmission line while RF power is being applied. Severe burns, electrical shock, or death can occur.

Caution Statement

The following equipment caution appears in the text whenever the equipment is in danger of damage, and is repeated here for emphasis.

CAUTION

When making low reflection readings using a more sensitive element, take care to insert the element so that it senses reflected power only.

Do not rotate the element in the socket so that it is subjected to forward power. This can result in damage to the Plug-In Element, the microammeter, or both.

Safety Statements



USAGE

ANY USE OF THIS INSTRUMENT IN A MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE INSTRUMENT'S SAFETY PROTECTION.

USO

EL USO DE ESTE INSTRUMENTO DE MANERA NO ESPECIFICADA POR EL FABRICANTE, PUEDE ANULAR LA PROTECCIÓN DE SEGURIDAD DEL INSTRUMENTO.

BENUTZUNG

WIRD DAS GERÄT AUF ANDERE WEISE VERWENDET ALS VOM HERSTELLER BESCHRIEBEN, KANN DIE GERÄTESICHERHEIT BEEINTRÄCHTIGT WERDEN.

UTILISATION

TOUTE UTILISATION DE CET INSTRUMENT QUI N'EST PAS EXPLICITEMENT PRÉVUE PAR LE FABRICANT PEUT ENDOMMAGER LE DISPOSITIF DE PROTECTION DE L'INSTRUMENT.

IMPIEGO

QUALORA QUESTO STRUMENTO VENISSE UTILIZZATO IN MODO DIVERSO DA COME SPECIFICATO DAL PRODUTTORE LA PROZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

SERVICE

SERVICING INSTRUCTIONS ARE FOR USE BY SERVICE-TRAINED PERSONNEL ONLY. TO AVOID DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

SERVICIO

LAS INSTRUCCIONES DE SERVICIO SON PARA USO EXCLUSIVO DEL PERSONAL DE SERVICIO CAPACITADO. PARA EVITAR EL PELIGRO DE DESCARGAS ELÉCTRICAS, NO REALICE NINGÚN SERVICIO A MENOS QUE ESTÉ CAPACITADO PARA HACERLO.



WARTUNG

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL.

ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SIND WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

ENTRETIEN

L'EMPLOI DES INSTRUCTIONS D'ENTRETIEN DOIT ÊTRE RÉSERVÉ AU PERSONNEL FORMÉ AUX OPÉRATIONS D'ENTRETIEN. POUR PRÉVENIR UN CHOC ÉLECTRIQUE DANGEREUX, NE PAS EFFECTUER D'ENTRETIEN SI L'ON N'A PAS ÉTÉ QUALIFIÉ POUR CE FAIRE.

ASSISTENZA TECNICA

LE ISTRUZIONI RELATIVE ALL'ASSISTENZA SONO PREVISTE ESCLUSIVAMENTE PER IL PERSONALE OPPORTUNAMENTE ADDESTRATO. PER EVITARE PERICOLOSE SCOSSE ELETTRICHE NON EFFETTUARE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.



RF VOLTAGE MAY BE PRESENT IN RF ELEMENT SOCKET -KEEP ELEMENT IN SOCKET DURING OPERATION.

DE LA TENSION H.F. PEUT ÊTRE PRÉSENTE DANS LA PRISE DE L'ÉLÉMENT H.F. - CONSERVER L'ÉLÉMENT DANS LA PRISE LORS DE L'EMPLOI.

HF-SPANNUNG KANN IN DER HF-ELEMENT-BUCHSE ANSTEHEN - ELEMENT WÄHREND DES BETRIEBS EINGESTÖPSELT LASSEN.

PUEDE HABER VOLTAJE RF EN EL ENCHUFE DEL ELEMENTO RF - MANTENGA EL ELEMENTO EN EL ENCHUFE DURANTE LA OPERACION.

IL PORTAELEMENTO RF PUÒ PRESENTARE VOLTAGGIO RF -TENERE L'ELEMENTO NELLA PRESA DURANTE IL FUNZIONAMENTO.

About This Manual

This instruction book covers Thruline RF Directional Wattmeters Models:

43	43P	4305A	4331
4431	4521	4522	4523
4525	4526	4527	

This instruction book is arranged so that the essential safety information appears in the front of the book. Reading the Safety Precautions Section before operating the equipment is strongly advised.

The remainder of this instruction book is divided into Chapters and Sections. At the beginning of each chapter, a general overview describes the contents of that chapter.

Operation

First time users should read Chapter 1 — Introduction, Chapter 2 — Theory of Operation, and Chapter 3 — Installation, to get an overview of equipment capabilities and installation. An experienced operator can refer to Chapter 4 — Operating Instructions. All instructions necessary to operate the equipment appear in this chapter.

Maintenance

All personnel should be familiar with preventative maintenance found in Chapter 5 — Maintenance. If a failure should occur, the troubleshooting section will aid in isolating and repairing the failure.

Parts

For location of parts, refer to the parts list and associated drawings in Chapter 5.

Changes To The Manual

We have made every effort to ensure this manual is accurate. If you should discover any errors or if you have suggestions for improving this manual, please send your comments to our factory. This manual may be periodically updated. When inquiring about updates to this manual, refer to the part number and revision level on the title page.

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Purpose and Function

This instruction book covers the use and operation of the basic Model 43 Thruline Wattmeter. These instructions also apply to other units that are very similar to the Model 43 in electrical characteristics and operation.

These different models and their variations (refer to About This Manual for a complete listing) are also included in this book; however, the operational procedures and, in most cases, the electrical specifications of the Model 43 apply to these units as well. The basic difference in the majority of these units is physical, being panel rack mounted versions of the Model 43 Thruline Wattmeter. However, two of the units are similar in appearance but differ in as much as they have an RF sampler port included. The Model 43P has peak power handling capabilities.

All differences pertinent to these units can be found in the specifications for each of these models, in the back of this book.

The Model 43 Thruline Wattmeter is an insertion-type RF wattmeter, designed to measure power flow and load match in 50 ohm coaxial transmission lines. It is intended for use on CW, AM, FM, and TV modulation envelopes, but not pulsed modes. The Model 43, when used in 50 ohm applications, has an insertion VSWR of less than 1.05 to 1, up to a frequency of 1000 MHz. The meter is direct reading in watts, expanded down scale for easy reading and is graduated 25, 50, and 100 watts full scale. The power ranges used are determined by the Plug-In Elements, which fall in various power and frequency ranges (refer to the Bird Electronic Corporation Catalog).

Performance Characteristics and Capabilities

The Model 43 Thruline Wattmeter is a portable unit contained in a die cast aluminum housing, with a formed metal enclosure on the back which is easily removed. Included with the unit is a carrying strap, four rubber bumpers on

Bird Model 43 Wattmeter

the base, and four rubber bumpers on the back, which allow the Model 43 to stand (vertical) or lie flat (horizontal) when used. For additional protection, the microammeter is specially shock mounted. A slotted screw is provided on the lower front face of the meter for zeroing the pointer. Below the meter, the RF line section face protrudes slightly from the wattmeter housing with the Plug-In Element socket in the center.

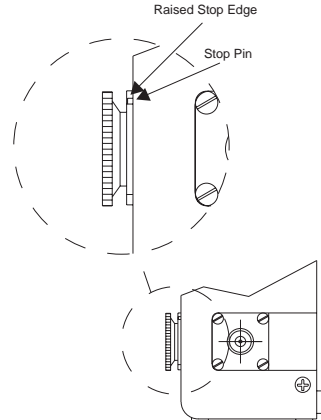
A shielded cable connects the microammeter to the dc jack which is attached to the side of the RF line section casting. This cable, 32 inches long, permits removal of the RF line section from the wattmeter housing. Meter connections may be maintained with any installations outside of the housing.

Inside the dc jack assembly, there is a filter capacitor which shunts the meter circuit to prevent misreadings caused by stray RF energy existing in the Plug-In Element. Mounted on the dc jack is a phosphor bronze spring finger, which protrudes through a lateral hole and into the Plug-In Element socket of the RF line section.

The spring finger has a button on its end which mates with the contacts of the Plug-In Element. The silver plated brass RF line section is precision made to provide the best possible impedance match to the coaxial RF transmission line in which the Model 43 is inserted. The ends of the line section are nested in mating slots to provide additional mechanical support. At each end of the line section are Bird Quick-Change (QC) type RF connectors, which may be quickly interchanged with any other Bird "QC" connector by removing the four screws on the mounting flanges. The wattmeter housing does not interfere with any connector changes.

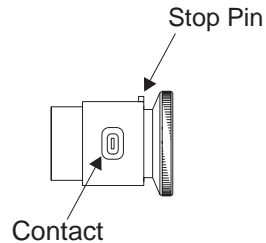
To make measurements, the cylindrical shaped Plug-In Element is inserted into the line section socket and rotated against one of the two stops. A small catch in the upper right hand corner of the casting face presses on the shoulder of the Plug-In Element to keep it in proper alignment and assure a good contact with the dc jack and between the lower edge of the element and line section body, refer to figure 1.

Figure 1
Stop Pin



On diametrically opposite sides of the Plug-In Element body are contacts to provide dc pickup in either direction of power flow, refer to figure 2. These contacts make connection with the spring finger of the dc jack only when the Plug-In Element is in the precise forward or reverse position, which occurs only when the stop pin on the element is in the lower level of the stepped line section casting face and against its respective stop.

Figure 2
Stop pin and
contact



The Model 43P Thruline Wattmeter has the same abilities as the Model 43 with the added feature of peak power measurement capabilities. A conversion kit (P/N 4300-400) is available to convert any standard Bird Model 43 to peak reading capabilities. This kit comes complete with all necessary parts and easy to follow instructions for simple and quick conversion.

Specifications

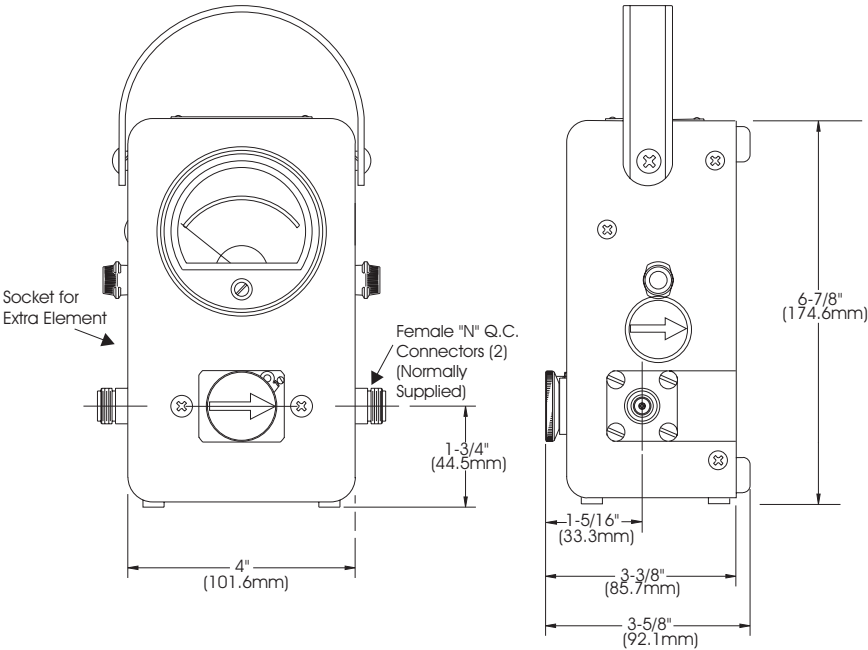
These specifications include data covering Models 43, 43P, 4305A, 4330, 4431, 4521, 4522, 4523, 4525, 4526, and 4527. Specifications for models not listed are identical to the Model 43. Any specifications pertaining to a particular model will be found in the section for that model number, located at the back of this book.

Impedance, Nominal (All Models)	50 ohms
Insertion VSWR All models except 4431 4431	Less than 1.05:1 maximum 1.07 (when coupling is less than 30dB)
Connectors RF Sampling (if applicable) Primary Line	Female BNC Bird "QC" Female N normally supplied
Power and Frequency Range Models: 43, 43P, 4521/22/23/25/26	100mW-10kW Frequency range from 0.45 to 2700 MHz (depending on element).
Model 4527	1000W maximum 2-200MHz 500W maximum from 200-512MHz
Model 4431	5000W maximum from 2-30MHz 1000W maximum from 30-1000MHz (applicable only when coupling is less than 30dB).
Model 4305	25kW Maximum from 0.45-2.5 MHz, 10kW from 2-30 MHz.
Model 4330	5000 W Maximum from 2-30 MHz. 1000 W Maximum from 30-1000 MHz (applicable only when coupling is less than 30 dB).

Accuracy (All Models CW) (Model 43P, Peak Power)	± 5% of full scale. ± 8% of full scale.
Dimensions, Nominal Models 43	3-5/8"L x 4"W x 6-7/8"H (92.1 x 101.6 x 174.6 mm)
Model 4431	3-27/32"L x 4"W x 6-7/8"H (97.6 x 101.6 x 174.6 mm)
Model 4305A	4-5/32"L x 3-27/32"W x 6-53/64"H (105.6 x 98 x 173 mm)
Models 4521/22/23/25/26/27	19" W x 5-7/32" H x 1-11/16" D (483 x 133 x 43mm)
Weight, Nominal Model 43	3 lb. (1.36 kg)
Model 43P	4 lb. (1.8 kg)
Model 4431	3-1/2 lb. (1.59 kg)
Model 4305A	3-1/4 lb. (1.47 kg)
Operating Position	Any
Finish (All Models)	Grey Powder Coat
RF Coupling Model 4527	Approx. -53 dB from 512 MHz down to 10 MHz decreasing to -70 dB between 10 and 2 MHz.
Model 4431	Adjustable, 15-70 dB
Insertion Loss (Model 4431) 2-512 MHz.	0.1dB Maximum
512-1000 MHz	0.2dB Maximum*

*Above listed specifications are applicable only if maximum coupling used does not exceed 30 dB. This requires a minimum decoupling of four full turns counterclockwise (CCW) above 200 MHz and a minimum decoupling of seven full turns (CCW) above 800 MHz.

Model 43 Outline Drawing



Travelling Wave Viewpoint

The best way to visualize the Thruline Wattmeter principle is from the Travelling Wave viewpoint. In transmission lines, the voltages, currents, standing waves, etc., on any uniform line section are the result of the interaction of two Travelling waves:

- ♦ The forward wave travels (and its power flows) from the source to the load. It has RF Voltage E_f and current I_f in phase, with $E_f / I_f = Z_0$.
- ♦ The reflected wave originates by reflection at the load, travels (and its power flows) from the load back to the source, and also has an RF voltage E_r and current I_r in phase, with $E_r / I_r = Z_0$.
- ♦ Note that each component wave is mathematically simple, and is completely described by a single figure for power, for instance:

$$W_f = \text{Watts Forward} = E_f^2 / Z_0 = I_f^2 Z_0 = E_f I_f$$

$$W_r = \text{Watts Reflected} = E_r^2 / Z_0 = I_r^2 Z_0 = E_r I_r$$

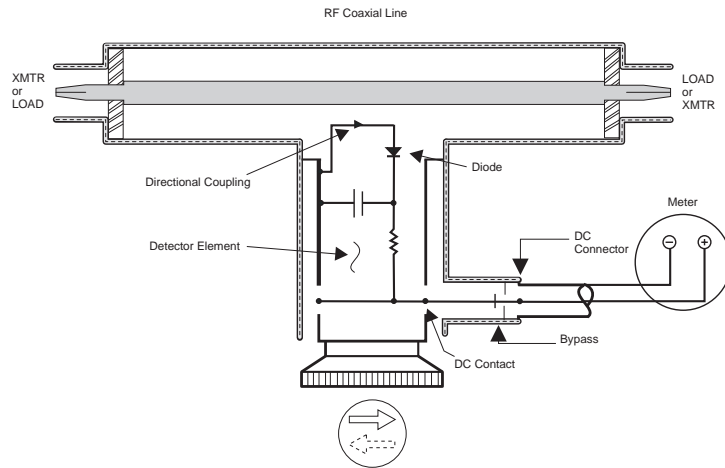
Z_0 is the characteristic impedance of the uniform line, and simplifies matters by being nearly a pure resistance, usually 50 ohms, for useful lines. The main RF circuit of the Model 43 is a short piece of uniform air type line section, whose Z_0 is 50 ohms, in which accurate measurements may be made.

Coupling Circuit

The coupling circuit which samples the travelling waves is in the Plug-In Element. The circuitry of the element and its relationship to the other

components of the Model 43 are illustrated in the Schematic diagram, figure 3.

Figure 3
Element
Schematic
Diagram



Energy will be produced in the coupling circuit of the element by both mutual inductance and capacitance from the travelling RF waves in the line section. The inductive currents will flow according to the direction of the travelling waves producing them. The capacitive portion of these currents is independent of the direction of the travelling waves. Therefore, assuming that the Plug-In Element remains stationary, it is apparent that the coupling currents produced from the waves of one direction will add in phase, while those produced from the waves of the opposite direction will subtract in phase. The additive or "arrow" direction is assigned to the forward wave.

The electrical values of the element circuits are carefully balanced and so designed that the inductive current produced from the reverse wave will cancel its portion of the capacitive current almost completely. The result is a directivity always higher than 25 dB, which means that the element is highly insensitive (nulled) to the reverse direction wave. By being highly directional, the element is sensitive at either one of its settings, but to only one of the two travelling waves which produce standing waves by interfer-

ence. Thru-line Wattmeter measurements are also independent of their position along the standing waves.

Standing Wave Ratio vs Reflected/Forward Power Ratio

As mentioned above, the Thru-line Wattmeter technique uses the Travelling Wave viewpoint to measure most of the outstanding facts about transmission line operation. Another widely used and related viewpoint, is the Standing Wave one, which is quite elaborately developed both mathematically and in existing equipment. This technique can be traced to the early development of slotted lines as tools of exploration.

The slotted line is a standing wave instrument and emphasizes this viewpoint. However, the slotted line is too long, too expensive if good, not portable, and slow in operation. These objections increase rapidly as the frequency drops below 1000 MHz. Whereas the Thru-line Wattmeter is surprisingly quick, convenient, and accurate by comparison. With the exception of phase angle reflection (distance, load to minimum), it tells everything a slotted line will.

The relationship between the Travelling Wave and the Standing Wave viewpoints is given in most high frequency textbooks.

Load Power

Power delivered to and dissipated in a load is given by:

$$W_1 = \text{Watts into Load} = W_f - W_r$$

Where appreciable power is reflected, as with an antenna, it is necessary to subtract the reflected power from the forward power to get the actual load power. This correction is negligible (less than one percent) if the load has a VSWR of 1.2 or less. Good load resistors, such as Bird Termination loads, will show negligible or unreadable reflected power.

VSWR scales and their attendant controls for setting the reference point have been intentionally omitted from the Model 43 for two reasons.

1. Why make something similar to a hypothetical dc volt-ohm-meter with control pots for the voltmeter multipliers? Even more complications arise when diodes at RF are involved.
2. Experience using the Thruline Wattmeter for transmitter tune-up, antenna matching, etc. (i.e., on operating problems), shows that the power ratio ϕ is as useful in practice as the standing wave ratio $p = \text{VSWR}$.

A trial is suggested for a few days - forget VSWR and try thinking in terms of $\phi = W_r / W_f$ when the Thruline Wattmeter is used. It will be noted that even without bothering to calculate the ratio exactly, the two meter readings W_r and W_f give an automatic mental impression which pictures the situation. Thus, for an antenna matching problem, the main objective usually is to minimize W_r . Anything done experimentally to this end is noted directly when the Model 43 element is turned to the reflected position. Furthermore, the ratio of readings, even if only mentally evaluated, is a reliable guide to the significance of the remaining reflected power.

ρ vs. ϕ and Its Significance

Since there are definite simple relationships:

$$p = \frac{1 + \sqrt{\phi}}{1 - \sqrt{\phi}} \quad \text{and} \quad \phi = \left[\frac{p - 1}{p + 1} \right]^2 \quad \text{Where } p = \text{VSWR} \quad \text{and} \quad \phi = \frac{W_r}{W_f}$$

between standing wave ratio p and the reflected/forward power ratio ϕ , indicated by the Thruline Wattmeter, the latter may be conveniently used to measure VSWR. The relationship is given in figures 4 and 5.

Note that when $\phi = 10$ percent, below which W_r will appear insignificant and may be hard to read, you are close to the commonly accepted lower limit $p = 2$, below which improved antenna match becomes less and less worthwhile in many systems. Experimentally, by using the Thruline Wattmeter, it can

be readily shown that reducing ϕ below 10 percent produces little gain in the way of increased W_1 . TV transmitter antenna lines, and VHF omnirange transmitters are among those systems that require much lower levels of reflected power but for reasons other than simple power transmission. Note that in figure 4, the very small level of reflected power, i.e., $\phi = 0.06$ percent corresponds to $p = 1.05$. While both forward and reflected power levels can be measured with the same element, detection of reflected power is possible down to about $\phi = 1$ percent ($p = 1.2$), provided W_f approaches full scale. However actual measurement is possible only down to about $\phi = 5$ percent ($p = 1.5$). For more accurate measurements of reflected power levels, an element rated at one tenth of the full scale power value of the element used to measure forward power is recommended.

CAUTION

When making low reflection readings using a more sensitive element, take care to insert the element so that it senses reflected power only. Do not rotate the element in the socket so that it is subjected to forward power. This can result in damage to the Plug-In Element, the microammeter, or both.

Low reflection measurements may be extended below this with two elements. Say 80 watts are available, and you have 100 watt and ten watt elements. Measure W_f with the 100 watt element. Remove the 100 watt element and insert the ten watt element. The ten watt element must be inserted only in the reflected direction, "arrow" toward transmitter. Insert and remove only this way. Now read W_r on the ten watt element.

In this case, measurement down to at least 0.5 watt reflected is possible, which means to say:

$$\phi = \frac{0.5}{80} \quad \text{or close to 0.6\% or to roughly } p = 1.16$$

Figure 4
Percent Reflected Power VS. VSWR (1.0:1.3)

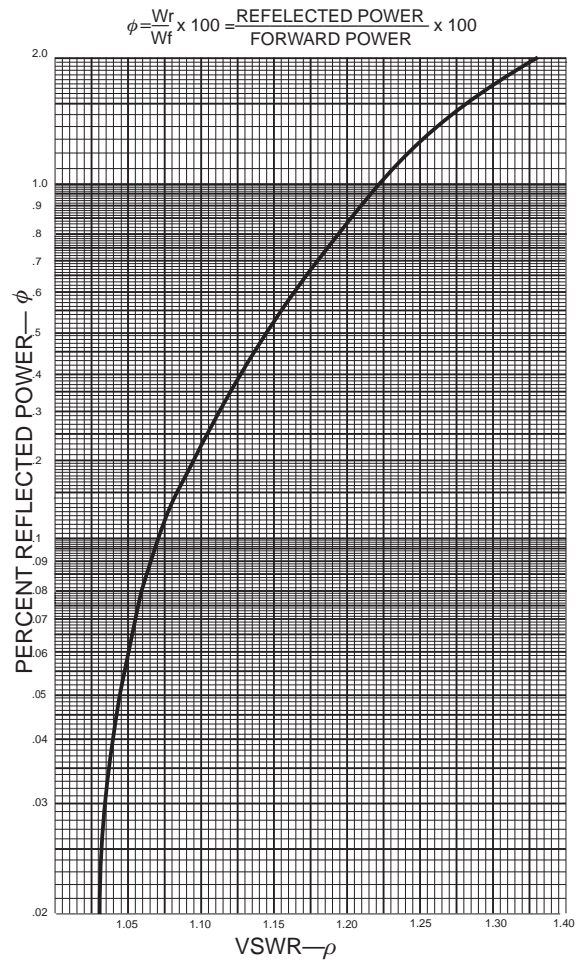
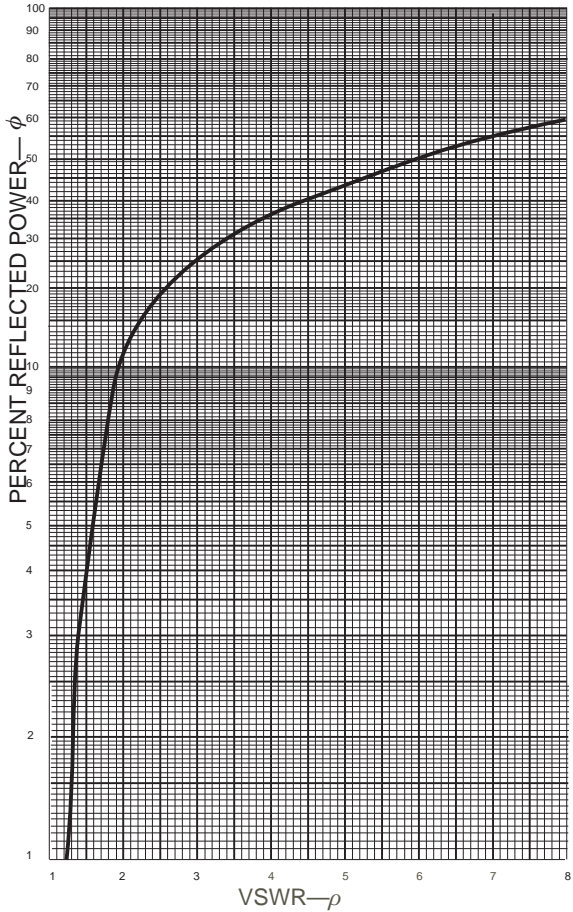


Figure 5
Percent Reflected Power VS. VSWR (1.0:8.0)

$$\phi = \frac{W_r}{W_f} \times 100 = \frac{\text{REFLECTED POWER}}{\text{FORWARD POWER}} \times 100$$



and detection of reflected power is possible down to about 0.1 watt.

$$\phi = \frac{0.1}{80} = 0.00125 \text{ or close to } 0.1\% \text{ or to roughly } p = 1.06$$

Caution is necessary in the above method and preferably it should not be used with element ranges differing by more than 10 to 1 although 25 to 1 can be used with extreme caution. With elements available having ranges down to one watt or less full scale, this method is usable with medium and low power transmitters.

Measurement And Monitoring of Transmitter Power

The Thruline Wattmeter is useful for the continuous monitoring of transmitter output and is also helpful for the continuous monitoring of reflected power, for instance in checking intermittent antenna or line faults.

Like diode devices in general, the Model 43 indicates the carrier component on amplitude modulation, with very little response to side band components added by modulation.

Testing of Lines, Connectors, Filters, Etc.

The Thruline Wattmeter is highly useful for this purpose, and may be employed in several ways.

1. VSWR (Insertion) or ϕ (Insertion) may be measured with the line terminated in a good Termaline Load Resistor.
2. Attenuation (power lost by heat in the line) as well as VSWR (Insertion) and ϕ (Insertion) may be measured by inserting the unknown line between Thruline Wattmeter units, or between two RF line sections using only one meter and one set of elements (the end of the line to be terminated in a good load resistor). This method applies also to insertion between a Thruline Wattmeter and a Termaline Absorption Wattmeter. Very small values of at-

tenuation require allowance for normal instrument errors. The correction may be determined by direct rigid connection of the Thruline Wattmeter units, or of the Thruline Wattmeter - Termline Load combination, in cascade. Slight juggling of the zero settings is permissible for convenience in eliminating computation, provided readings are being taken fairly well up on the scale.

3. **Attenuation By Open Or Short Circuit Method.** More clever by far than method (2) is one depending on the high directivity (null balance) to which the Thruline Wattmeter elements are held. They should, and do, exhibit good equality between forward and reflected readings when the load connector is open or short circuited. In this condition, $\phi = 100$ percent, the forward and reflected waves being equal in magnitude, and $p = \text{infinity}$. Say that this is checked on open circuit, and then a length of line of unknown attenuation, also open circuited, is connected to the load connector. The ratio ϕ then shown is the attenuation in two passes along the line (down and back).

Expressed in dB,

$$\left(\text{using the equation: } N_{\text{dB}} = 10 \log \frac{W_r}{W_f} \right),$$

the dB figure may be compared with published data for line type and length by remembering to halve N_{dB} or to double the line length, because twice the line length is actually being measured.

This measurement should be supplemented by one of ϕ (Insertion), or at least by dc continuity and leakage checks, since the attenuation measurement alone can be in error from faults such as open or short circuits part of the way down the line.

Open circuit testing is somewhat to be preferred to short circuit, since the reference short (used to check equality initially) must be good, and because the initial equality is somewhat better on open than on short circuit.

Again, for quite low values of attenuation, it is advisable to note exact readings, or difference, on the initial equality check, and to allow for this difference.

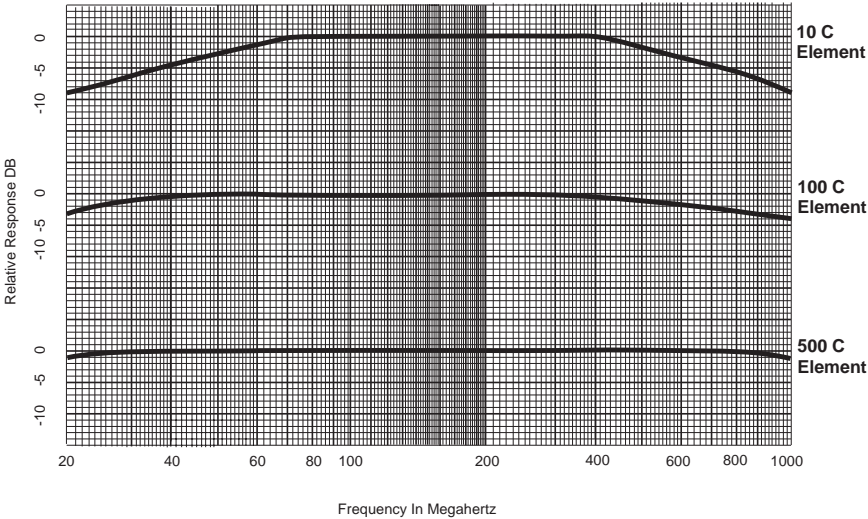
Frequency Response

The Plug-In Elements have a very flat frequency response over a frequency ratio of more than 2-1/2 to 1. This characteristic provides a practically flat response within the assigned frequency ranges for all the elements. An illustrative set of curves for three elements of one of these frequency bands is shown in figure 6. Notice that on the low power element, the fall-off above and below the assigned frequency band is more pronounced than it is for the high power element. The degree of drop in response varies progressively less for each power level from low to high. For example, at 40 MHz, the 10C element will typically read about 4 dB low which is about 40 percent of the true value or 4 watts. The 100C will read only about 1 dB low or about 80 percent of the true value (80 W) and the 500C should read within the normal five percent of full scale tolerance. These curves may be assumed to be about typical for all of the band types (H, A, B, C, D, etc.) at their respective stated frequencies.

Harmonics, or subharmonics, may be known to exist in the measured circuit, outside of the element frequency band. If so, a rough approximation of the response of the element to these harmonics may be made by the use of these curves. The frequency ordinate to be read on the graph will be obtained by proportioning the frequency of the element used with that of the one illustrated. Interpolation of the curve values will give an approximation of the extent to which these harmonic signals are being measured by your element.

Nevertheless, the use of an element for direct power measurements outside of its stated frequency range is not recommended. The responses given are only typical, and are by no means guaranteed.

Figure 6
Representative Frequency Response



Impedance Mismatch

There may be cases where it is necessary to use the Model 43 on other than the 50 ohm circuit for which it is designed. When using the Thurline Wattmeter, you will be inserting a four-inch length of 50 ohm air line into the circuit and therefore the load on the transmitter will be changed from its original condition without the Thurline Wattmeter. If the reflected power

Bird Model 43 Wattmeter

is less than 10 percent and the frequency is below 200 MHz, the four-inch length will produce a mismatch that is not too serious. But going any higher than these values, even if the transmitter is tuned up with the Model 43 in place, the load impedance will be very different after the Thru-line Wattmeter is removed.

The Model 43 in a 50 ohm line will indicate zero reflection when the load, at its load connector, is 50 ohms, pure resistive. However, even an ideal condition on a 70 ohm line on the load side of the wattmeter will show three percent reflected power and cause a VSWR of 1.4 to 1.0. (If Thru-line Wattmeter is 50 ohms and load is 70 ohms resistive, VSWR in the wattmeter is $70/50 = 1.4$.) The Thru-line Wattmeter could also show this same reflected percentage with a $50/1.4 = 35.7$ ohms pure resistive load which could exist with 10 percent reflected power on the 70 ohm line (VSWR = 2). From this you can see that the 70 ohm line could actually have as much as 10 percent reflected power and a VSWR = 2 even though the Thru-line Wattmeter indicates only three percent reflected power, and a VSWR = 1.4.

It should be especially remembered that with 70 ohm lines it is most important to measure the reflected power and subtract it from the forward, because of this factor being so much more critical here than with a 50 ohm line.

Portability

The Model 43 is a portable instrument, and the housing is not designed for fixed mounting (see Outline Drawing, page 8). A strap is provided for carrying purposes.

While transporting the Thruline Wattmeter, it is best to reinsert the original dust plug, or a Plug-In Element with the “arrow” pointed upward, in the measuring socket, and secure with the catch. This will shunt the meter circuit and serve to protect the meter by dampening needle action during handling or shipping. Also, secure spare Plug-In Elements in their receptacles with the pivoting knob clamps; just insert the element to seat and twist the knob one-quarter turn to hold. Handle the Plug-In Elements with care at all times. Calibration could be disturbed if they are dropped.

Connections

WARNING
Leaking RF energy is a potential health hazard. Never attempt to connect or disconnect equipment from the transmission line while RF power is being applied. Severe burns, electrical shock, or death can occur.

Insert the Model 43 Wattmeter in coaxial transmission lines of 50 ohms nominal impedance. It is indifferent to which respective side the power source and the load connections are made. If cables other than 50 ohm type are used, a mismatch will occur causing inaccuracies in readings. However, if a mismatch cannot be avoided, the results may be calculated per the Impedance Mismatch paragraph. It is strongly advised that this condition be avoided.

The Model 43 is normally supplied with two Female N type connectors which are of the Bird Quick-Change design. Other "QC" connectors are available, refer to the Replacement Parts List in the Maintenance Chapter.

Follow these steps to change the "QC" connectors.

1. Remove the four 8-32 pan head machine screws from the corners of the connector flange.
2. Pull the connector straight out.
3. Reverse this procedure to attach connector, making sure the center contact pin aligns properly with the socket.

Remote Installation

The RF line section can be removed from the meter housing for remote installation. To remove the line section from its housing:

1. Unscrew the four 8-32 flat head machine screws holding the back cover.
2. Grasp the cover by the side filler tabs and pull directly backwards. The back cover assembly will come off with the speed nuts remaining attached.
3. Remove the two 10-32 oval head machine screws on the front of the housing.
4. Slide the line section backwards out of the housing. Do not loosen the two oval head screws on the sides of the housing in line with the meter. These hold the meter supporting shock ring in place.
5. Substitute the cable which attaches the line section to the meter with a sufficient length of cable to make the remote installation.
6. To replace the RF line section, reverse the above listed procedures.

It may be desirable to have two or more line sections permanently installed in continuous operating equipment. In this case, one set of elements and one

meter may be used to measure several RF transmission lines without interruption of RF lines for insertion of the Thruline Wattmeter. Additional RF line sections are available (see figure 7).

The RF line section of the Model 43 lends itself very readily to panel type mounting. A layout for the panel mount cut is given in figure 8. The thickness of the panel should be about 1/4 inch. On panels less than this, build up the thickness with pads or washers to achieve a flush-face mounting. Cable connections are simplified because the RF line section may be mounted in any convenient direction. Attach the line section so that the finger catch is in the most accessible position.

Bird Model 43 Wattmeter

Figure 7
RF Line
Section

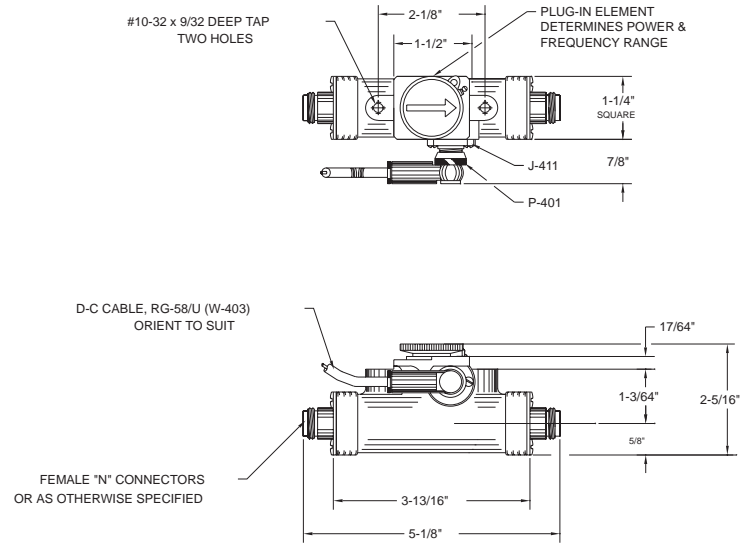
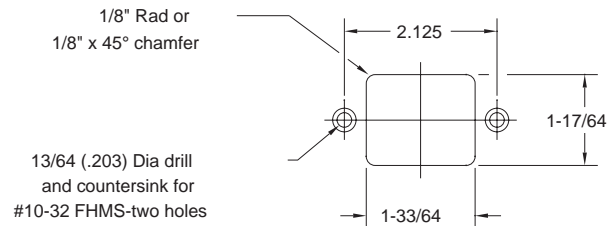


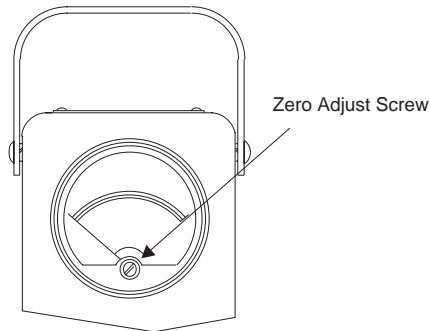
Figure 8
Panel Cut for
Mounting RF
Body



Zero Adjust

The meter should be checked for zero set under no power conditions. With no power applied the meter pointer should set exactly on zero. If adjustment is required, turn the adjustment screw until the pointer is set at zero (refer to figure 9).

Figure 9
Zero Adjust



WARNING

When operating this equipment in conjunction with RF power of 200 watts or higher, the potential of the center conductor of the RF line section will be 100 volts or higher. Do not contact the center conductor. If cleaning becomes necessary, shut off the RF power.

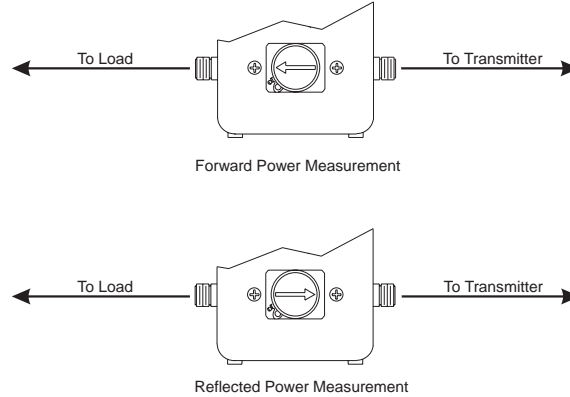
General

Measurements are made by the insertion and operation of the Plug-In Elements. The elements determine the power range to be read on the meter scale, and the major marking (e.g. 50 W, 100 W, etc.) are the full scale power value for the element. Elements are also marked for frequency range. The transmitter frequency must be within the band of the element used. Refer to the Bird Catalog for a large selection of elements.

Refer to the Frequency Response paragraph for frequency band flatness and performance of the elements outside of their stated frequencies. Elements for additional ranges (power or frequency) may be ordered without returning the Model 43 for calibration, since the RF bodies and meters are standardized, and are designed for a wide range of coaxial transmission power value and frequencies.

The "arrow" on Plug-In Elements indicate sensitive direction; i.e., the direction of power flow which the meter will read. "Arrow" and "Reverse" are directional terms used in reference to the Thruline Wattmeter Element, and mean respectively the sensitive and insensitive directions of the element. Rotate the element to reverse the sensitive direction. "Forward" and "Reflected" are directional terms used in reference to the source-load circuit. The transmitter may attach to either connector of the wattmeter. It makes no difference which external RF connection is selected, since the elements are reversible and the RF circuit is symmetrical end for end. Refer to figure 10. The Thruline Wattmeter used with a Termline Load Resistor of proper power rating forms a highly useful absorption wattmeter. With the "arrow" set toward the load, it is unnecessary to reverse the element, because the reflected power should be negligible.

Figure
10
Direction of
Element



Normal Operation

1. Insert the appropriate element in the socket of the line section.
2. Rotate the element so that the “arrow” on the nameplate is pointed away from the RF source for forward power and towards the source for reflected power.
3. Turn on the RF source.
4. Read the power level indicated on the appropriate meter scale.

In cases where readings are being made when the meter unit is connected to an auxiliary RF line section, always remove any measuring element from the unused RF line section. Otherwise, the dc circuit will be unbalanced or shorted according to the “arrow” position of the other element, causing inaccurate or no indication on the meter.

For the convenience of users, a set of VSWR conversion nomographs is included in this instruction book. With these charts, VSWR may be directly determined from forward and reflected power values read from the ThruLine Wattmeter.

When a Model 43 is used to match a load to a transmitter and a good match is obtained, removing the instrument will not cause any change in the

conditions, since a good 50 ohm load can be placed at the end of a 50 ohm transmission line of any length without altering conditions at the transmitter. Using the VSWR Nomograph, determine the intersection of the forward and reflected power values. The slanted line passing closest to this point indicates the VSWR.

What happens when the load is not well matched, like an antenna with a VSWR of 1.5 or 2.0? Since the length of line between a mismatched load and the source transforms the impedance of the load as seen at the source, line length now becomes critical. If the adjustments for maximum power transfer were made with the Model 43 in place, removing it shortens the line by four inches, plus two connectors. This still is no cause for concern at low frequencies where four to five inches is a small fraction of a wavelength. At higher frequencies; e.g., above 100 MHz, power output and frequency of the source may be affected.

It is a principle of transmission line theory that the impedance is identical on either side of a $1/2$ wavelength. In order to duplicate the conditions in your transmission line with the Model 43 either in or out of the line, it is only necessary to insert or remove a $1/2$ wavelength.

This is easily done by making up a length of cable which, when added to the Thru-line Wattmeter, equals $1/2$ wavelength at the frequency of measurement. If more than one frequency is involved, a separate cable is needed for each frequency.

Figure 11
VSWR Conversion Nomograph

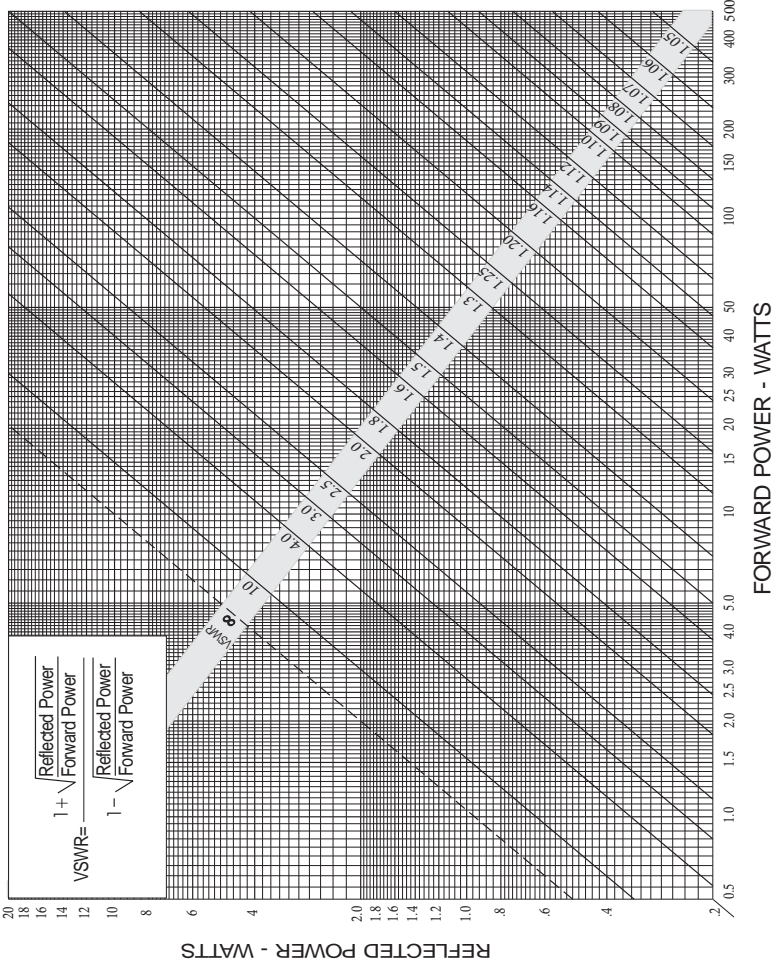


Figure 12
VSWR Conversion Nomograph

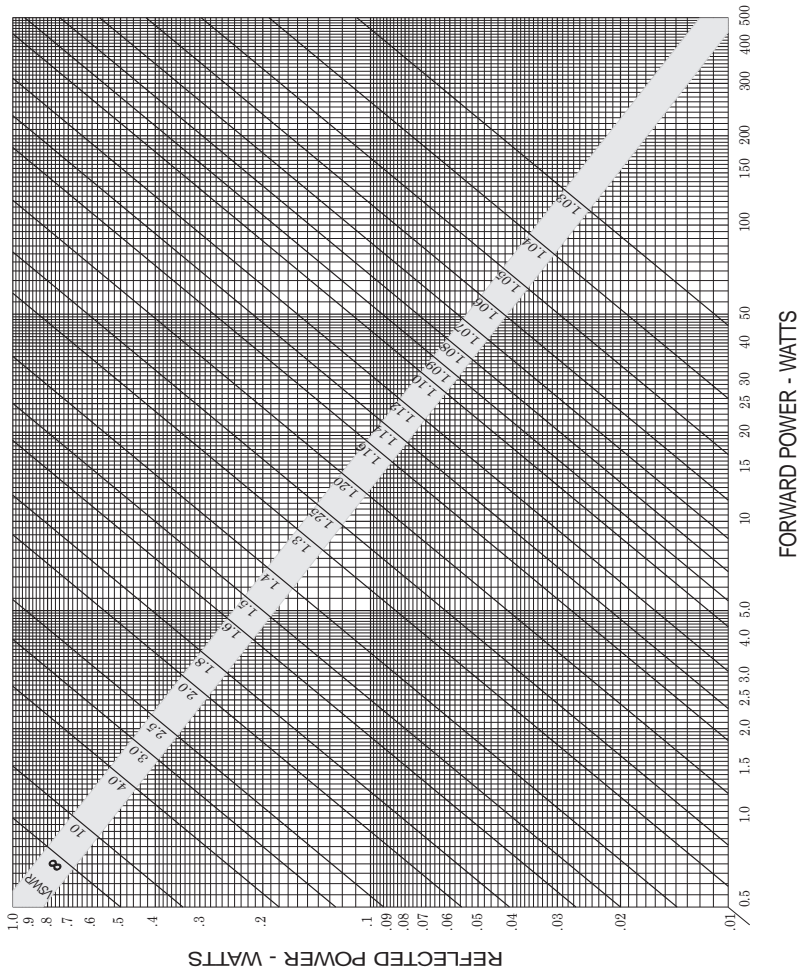
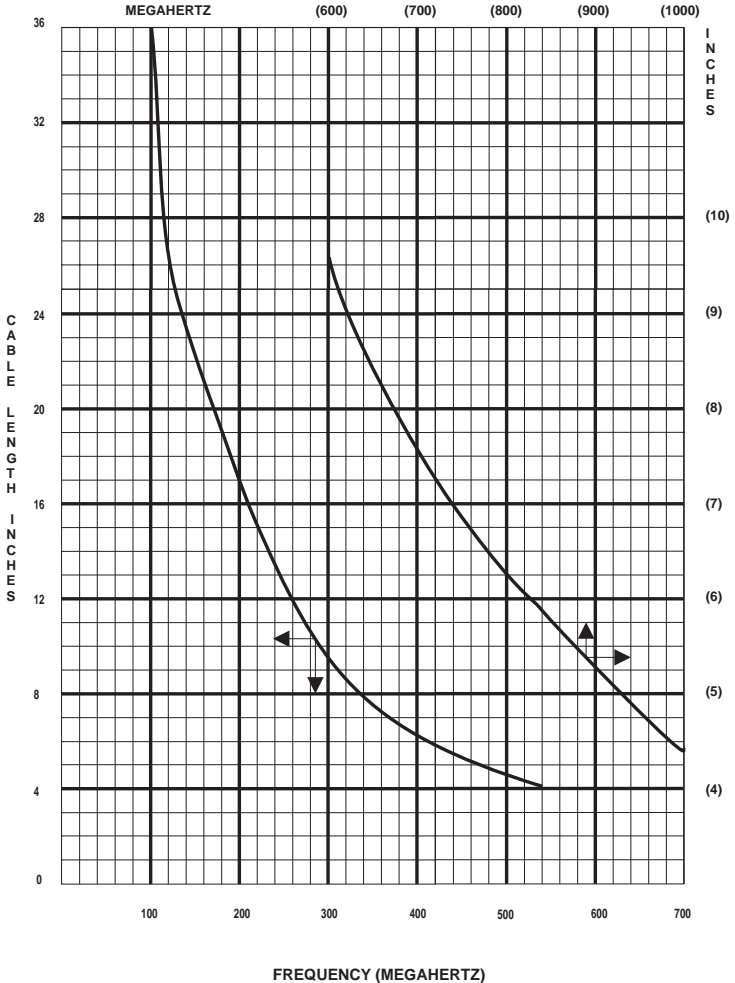


Figure 13
Cable Wavelength Matching Graph



Notes:

1. Physical cable length shown in inches is measured from end to end of outer conductor of connectors (TNC and N Male connectors), except for cables with UHF or Mini-UHF plugs where the cable length is measured from tip to tip of the center pins.
2. Dimensions shown are for *solid* polyethylene cable (e.g. RG-58C/U, RG-8/U) which has 66 percent the velocity of propagation relative to air. If so-called "RG-58 type" or "RG-8 type" cables (which often contain foam polyethylene) are used, the dimensions in the graph must be multiplied by that cable's relative velocity (say 79 percent) divided by 66 percent (i.e. by a factor of $79\% \div 66\% = 1.2$).

Chapter 5

Maintenance

This chapter contains operator maintenance instructions, troubleshooting and parts information.

The rugged and simple design of the Model 43 Wattmeter requires minimum routine maintenance.

Troubleshooting

The following table contains troubleshooting information for problems which can occur during normal operation. Locate the problem, review the possible cause, and perform the corrective action listed.

Only those functions within the scope of normal maintenance are listed. This manual cannot list all malfunctions that may occur, or all corrective actions. If a malfunction is not listed or not corrected by the listed corrective actions, notify a qualified service center.

Problem	Possible Cause	Corrective Action
No meter indication	No RF power	Check RF source
	“Arrow” on Plug-in element pointing in wrong direction	Reposition element
	No pick-up from dc contact finger	Adjust per the Contact Adjustment paragraph
	Open or short circuit in dc meter	Replace defective cable (RG-58/U)
	Meter burned out or damaged	Replace or return wattmeter to the factory for meter replacement and recalibration.
Intermittent or inconsistent meter readings	Sticky or defective meter	Replace or return wattmeter to the factory for meter replacement and recalibration
	Dirty dc contact on elements	Clean per cleaning paragraph
	Faulty transmission line or antenna	Inspect line
High VSWR or Reflected Power	Bad load or poor connectors	Replace load, antenna or connectors
	Shorted or open transmission line	Service or replace line
	Foreign material in line section or in RF connector bodies	See Cleaning paragraph

Cleaning

If any of the contacts or line connectors become dirty, they should be cleaned with a good contact cleaner or dry cleaning solvent on a cotton swab stick. Clean all contact areas and especially the exposed faces of the Teflon insulators.

It is important to keep the following surfaces clean:

- ♦ Socket bore
- ♦ Element body circumference
- ♦ Bottom rim of the socket in the line section
- ♦ DC contacts on the element

The outside surface of the meter housing can be cleaned with a soft cloth dampened with a mild detergent solution. Do not wipe the meter glass with a dry cloth, a static charge could develop causing an erroneous indication on the meter.

Preventive Maintenance

The element socket should be kept plugged as much as possible to prevent the intrusion of dust, and to prevent damage to the meter. Use the dummy plug provided, or use an Element. When an Element is used for this purpose, use the highest power element available. It should be positioned with the “arrow” pointing upwards (midway between the FWD and RFL measuring positions). This protects the meter and will not expose the element diode to dangerous potentials if the RF line section should be energized.

Line Section Care

If there is any evidence of contamination inside the RF line section, the reachable portions should be cleaned and the interior carefully blown out. Under no circumstances attempt to remove the RF center conductor. It is tightly frozen in place and any attempt to remove 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.

Contact Adjustment

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, it may be done manually if done carefully. The button must be positioned far enough out to maintain good contact with the element, but not so far as to interfere with easy entry of the element body. The dc jack, with spring finger, may be removed for access by:

1. Unscrewing the two 4-40 fillister head machine screws which fasten it to the side of the RF line section.
2. Retract its assembly, watching carefully so as 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.
3. Replace the assembly (be sure that the bead is again properly inserted) and the two screws previously removed.

Calibration Checks - Thruline Wattmeter vs Termaline Wattmeters

It is recognized that calibration of absorption wattmeters is difficult and likely to be inaccurate unless comparison is made with a transmission, through, type of standard. With the Thruline Wattmeter being of such type, a natural question is: Can a Thruline Wattmeter be used to check or recalibrate absorption wattmeters, such as the Bird Electronic Corporation Termaline Wattmeter, when both are rated at ± 5 percent of full scale accuracy? The main question is one of exact power calibration.

The answer is a qualified yes, although with both instruments being about equally old and known to be undamaged, there is not too much reason to prefer either on probable accuracy. The edge is somewhat in favor of the Thruline Wattmeter because each element covers a range of only 2-1/2 to 1 in frequency and will be flatter originally over this range than the Termaline Wattmeter can be held initially over its very much wider, 16.7 to 1, frequency range. Also the Thruline Wattmeter will probably exhibit smaller changes with time, because of the narrower frequency range. It is simpler in general design and easier in function (does not have to serve as a power load), and it does not become heated in operation.

Certainly if the absorption wattmeter has gone for years since its last calibration, or is reasonably suspected of inaccuracy, it may well be calibrated against the Thru-line Wattmeter as the standard. Rather than use correction factors, one can, with Termaline Wattmeters, make use of the calibration adjustment screws used in factory calibration. These are concealed and not mentioned in the instruction book to discourage tampering. Consult the factory before changing the adjustment.

If such calibration is undertaken, care and thoroughness are advised.

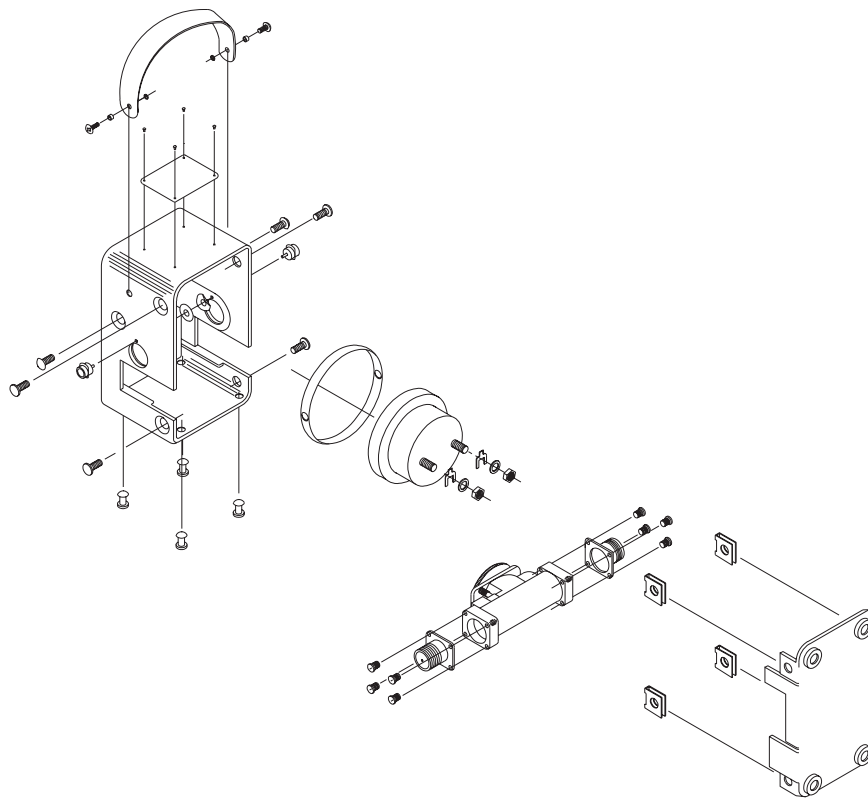
Model 43 Replacement Parts List

Item	Qty.	Description	Part Number
1	1	Housing Assembly	4210-018
2	1	Cover Assembly	4210-005-1
3	1	Line Section Assembly	4230-018
4	1	Carrying Strap	8580A003
5	1	Dust Plug, Aluminum	3610-031
6	1	DC connector Assembly	4230-010
7	1	Microammeter	2080-002
8	1	DC Connector	7500-076
9	1	Coaxial Cable Assembly	4220-097-1
10	2	Turnbutton	4300-015
11	2	Spring Washer	5-1144-1
12	8	Rubber Stem Bumper	5-1388
13	2	Pushnut	5-1076-1
14	1	Replacement Meter Kit consisting of: 1 Meter 1 Cable Assembly 3 Bumper Feet	8-000 2080-002 4220-097-1 5-040
15	2	RF Connectors	*See List on next page

***Available "QC" Type Connectors**

Connector	Part Number	Connector	Part Number
N-Female	4240-062	LT-Female	4240-018
N-Male	4240-063	LT-Male	4240-012
HN-Female	4240-268	C-Female	4240-100
HN-Male	4240-278	C-Male	4240-110
LC-Female	4240-031	UHF-Female	4240-050
LC-Male	4240-025	UHF-Male	4240-179
BNC-Female	4240-125	TNC-Female	4240-156
BNC-Male	4240-132	TNC-Male	4240-160
SMA-Female	4240-336	SC-Female	4240-090
SMA-Male	4240-334	Mini UHF-Female	4240-346
7/8" EIA	4240-002	7/16" IEC (Plug) Type 169-4	4240-363
1-5/8" EIA Fixed	4240-096	1-5/8" EIA Swivel	4240-208
7/16" IEC (Jack) Type 169-4	4240-344	Open Term. #10-32 Nut	4240-080

Figure 14
Exploded View Of The Model 43



Model 4431 Thruline Wattmeter

The Model 4431 RF Sampling Wattmeter is essentially the same as the Model 43 Thruline Wattmeter described in this instruction book except for the extra provision of the adjustable RF signal sampler probe.

Theory of Operation

The RF sampler, as its name implies, provides a low level signal or sample of the energy being transmitted through the line section of the wattmeter. This signal is available at a Female BNC connector located on the right side of the meter housing, labeled "RF SAMPLE", and the level of this signal can be varied by means of the control knob located on the front of the meter housing. This adjustment is accomplished by means of mechanical linkage connecting the sample adjustment (control) knob to the RF probe, so that turning the knob varies the proximity of the RF probe to the center conductor of the line section. Placing the probe closer (clockwise) to the center conductor increases the coupling and the signal level at the RF sample port, and moving the RF probe away from the center conductor (counterclockwise) decreases the coupling. Refer to table 1 for an approximate guide for the levels of coupling, and for a note on the maximum suggested adjustment of the sampler. In the operation of the unit, the sampler output may be fed to any suitable RF signal monitoring device; i.e., frequency counter, spectrum analyzer, oscilloscope, etc.

Table 1
Model 4431 Coupling Data

Maximum		Counterclockwise	
Frequency (MHz)	Sensitivity (Fully Clockwise)	4 Full Turns From Max. Position	7 Full Turns From Max. Position
2	69	(Approximate dB attenuation)	(Approximate dB attenuation)
10	57		
25	46		
50	42		
75	39		
100	36		
200	31		
300		38	
400		34	
500		30	
600		29.5	
700		29	
800		28.5	36
900		28	35.5
1000			35

Note: It is important to decouple the RF sampler as indicated above for frequencies above 200 MHz. The basic specifications of this instrument will be maintained with the above settings for the RF sampler. Decouple or turn counterclockwise beyond the above settings as much as possible, when possible.

Operation


The basic operations and maintenance procedures for the Model 4431 are the same as those of the Model 43 as described in this instruction book.

Maintenance

The maintenance procedures for this model are essentially the same as for the Model 43 except for the inclusion of the variable probe equipment. It is not recommended that user make repairs on the probe assembly. If the sampler malfunctions, we suggest the unit be returned to the factory. If for a particular urgency, the user wants to make field replacement of the probe assembly themselves, proceed as follows:

1. To reach the probe, remove the four 8-32 x 3/8 inch Phillips flat head screws on the sides of the case near the back.
2. Grasp the back cover firmly, by the tabs behind the line connectors, and pull straight backward to remove the back cover.
3. Use a 1/16 hex socket Hex wrench to loosen and remove the small coupling control knob on the front of the wattmeter, just above the Plug-In Element socket.
4. Remove the two 8-32 x 1/4 inch pan head screws fastening the guide and movable plate assembly to the back of the line section.
5. Restore the control knob to the front of the shaft temporarily, then rotate the shaft counterclockwise until the threaded collar is free of the screw shaft and pull the movable probe plate straight out of the pin and guide bushing.
6. Unscrew the 5/8 hex instrument nut on the BNC connector (outside) and pull the sampler connector inside the case. The probe plate assembly, P/N 4431-003, is now released and may be replaced in its entirety.

7. The sampler cable (RG-58/U) solid wire center conductor is soldered to the rear stub of the probe piece itself. The cable is secured to the side sleeve of the probe with the same washer and screw parts used in the dc connector plug assembly, P/N 7500-076. It may be removed by unscrewing the threaded sleeve washer, 3/8 hex head, unsoldering the lead tip and pulling out the cable. The probe assembly is formed into the socket and is not replaceable.
8. Replace by carefully reversing the above procedure.

 Note - When inserting the threaded control bushing, be sure the alignment pin is properly positioned.

Model 4431 Replacement Parts List

Item	Qty.	Description	Part Number
1	1	Modified housing (instead of 4210-018)	4431-011
2	1	Guide plate assembly	4431-002
3	1	Movable plate assembly	4431-003
4	1	Line section assembly (Instead of 4230-018)	4431-004
5	1	RF cable sampler assembly consisting of: 1 BNC connector, Female 1 RF cable - RG58/U 1 BNC connector eyelet 1 Washer* 1 Wedge* 1 Seal* 1 Screw*	5-953 5-773-1 5-414-1 7500-074 7500-080 7500-081 7500-082
6	1	Sampler control knob	5-1193
7	1	DC meter cable (Instead of 097-1)	4220-097-8

* Connector parts for probe sleeve

Series 4520 Thruline Wattmeters

The Series 4520 RF Thruline Wattmeter units are essentially the same as the Model 43 Wattmeter, in that their electrical components and performance characteristics are alike. These models are panel mounted for rack-type installation instead of the all purpose portable housing of the Model 43 Wattmeter. Except for the Model 4527, which has an added feature of a Female BNC RF Sampler output connector on the panel, the data and operating instructions contained in this instruction book are applicable to the Models 4521/22/23/25/26/27 in all respects, except as explained in the following:

These units are intended for fixed installation, generally in rack mounts requiring 19 inch panels. According to each of the model types concerned, the various panels are punched out for the component arrangements involved. The first line of the Replacement Parts List attached, lists the panel styles for the respective Models 4521, 4522, etc. The remainder of this list carries the replaceable items for each model. Only those items that are referred to in this attached parts list, apply herein. The schematic diagram figure in this instruction book is not applicable to these units.

Installation

Four 12-24 machine screws fasten the wattmeter panel in the selected position on a relay rack, using the pattern of tapped holes regularly provided in standard racks.

1. Choose a location for easy reading and operation of the wattmeter; try to place it where the coaxial cable lengths will be short and may be installed without sharp bends.
2. Avoid the use of angles and adapters.
3. Ensure all cable plugs and connectors are screwed on securely.

Theory of Operation, Operating Instructions and Maintenance Sections

Although the physical configuration of these models is different, the provisions in these sections of the Model 43 Instruction Book are fully applicable. The Model 4527 is electrically identical to the Model 43 in every way except for having an RF sampler port. The RF sampler port provides a low level signal or sample of the energy being transmitted through the line section of the wattmeter. This signal is available at a Female BNC connector located on the right side of the panel, labeled "RF SAMPLE".

Series 4520 Replacement Parts List

Item	Qty.	Description	Part Number
1	1	Mounting panel (Comprises: M=meter, E=element socket, S=switch Model 4521 (1M, 1E) Model 4522 (1M, 2E, 1S) Model 4523 (1M, 1E) Model 4525 (1M, 1E) Model 4526 (2M, 2E) Model 4527 (2M, 2E)	4521-002 4522-006 4523-002 4525-002 4526-004 4527-005
2	1	Line section assembly Model 4521/23/25 Model 4522/26 Model 4527	4230-018 4522-002 4527-002
3	2	RF connectors	See Model 43 Replacement parts list

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Item	Qty.	Description	Part Number
4	1 2	DC connector assembly Model 4521/23/25 Model 4522/26/27	4230-010
5	1 1 1 2	Microammeter Model 4521/22/27 Model 4523 Model 4525 Model 4526	2080-002 2150-015 2080-005 2080-002
6	1	Switch control knob (Model 4522 only)	5-709
7	1	Plug connector Model 4521/23/25 Model 4522/26/27	7500-076
8	1	Rotary Switch (Model 4522 only)	5-634
9	1 1 1 2	Cable assembly Model 4521/25 (16"L) Model 4522 (Harness) Model 4523 (16.5"L) Model 4526/27 (16"L)	4220-097-5 4522-013 4523-003-1 4220-097-5
10	1	RF cable assembly (Model 4257 only)	4430-002

Model 4305A Thruline Wattmeter

The Model 4305A Thruline RF Directional Wattmeter is similar to the Model 43 except for the following items:

1. The housing assembly for the Model 4305A is different from the Model 43. The overall physical dimensions of the Model 4305A housing are 4-5/16"L x 4"W x 6-7/8"H including element and bumper feet (110 x 102 x 175 mm). The weight, including the element, is 3-1/4 lb (1.5 kg).

2. The line section has higher power capability and is larger, being 1-5/8 inch in diameter instead of 15/16 inch as in the Model 43, but this is not externally visible.

The Theory of Operation, and Maintenance Sections for the Model 43 are all appropriate to the Model 4305A except for changes mentioned previously. The Model 4305A Thru-line Wattmeter does not have provisions for holding spare elements in the sides of the housing.

Model 4305A Replacement Parts List

The following part numbers differ from those for the Model 43 Parts List.

Item	Description	Part Number
1	Housing assembly	4305A003
2	Cover assembly	4305A002
3	Line section assembly	4305-005

Model 4330 Thru-line Wattmeter

The Model 4330 is very similar to the Model 43 and all the instructions and provisions apply except as outlined below:

1. The Model 4330 is a low power indicating device with full scale direct reading levels of 200 and 800 milliwatts.
2. This model uses special 0.2 and 0.8 watt dual-range elements that cover frequency ranges from 60 to 2300 MHz. Standard higher power elements must *not* be used with the Model 4330.

With these low power type elements, the discrete frequency band widths are considerably less than the usual 2.5:1 ratio for standard higher power elements. These band widths (ratios) vary, but tend to be broad in the middle frequencies of the overall range and becomes narrow at the ends. Likewise, the relative response fall off beyond the stated bands will have to be considered as somewhat greater than depicted on the 10W element curve.

Bird Model 43 Wattmeter

To maintain accuracy, it is important to have operating frequencies within those stated.

The elements for the Model 4330 have a dual power range. The slide switch on the face of the element is moved sideways to select either 800 mW or 200 mW full scale deflection as indicated by the element nameplate. The scales on the meter dial coincide with the position selected. For protection of the meter, always select the higher value first. Do not switch to the lower position when a higher power is indicated in the direction selected.

The following parts are applicable to the Model 4330 and are different from those listed for the Model 43. All other parts not listed here are applicable.

Model 4330/31 Replacement Parts List

Item	Description	Part Number
1	Housing assembly	4330-004
2	Microammeter, 10 μ A full scale, 3-1/2" rectangular	2160-027
3	Meter cable assembly 33" cable e/w spade lugs and dc connector	4220-097-12

Model 43P Peak Wattmeter

The Bird Model 43P Thruline Wattmeter is capable of measuring peak power in AM, SSB, and certain limited pulse applications. It also possesses the Model 43's ability to measure CW power (no amplitude modulation) with just the press of a button.

No special elements are required for peak power measurements. However, element power rating must match the peak power to be measured. For example, if power output peaks of 1000 watts are to be measured, a 1000 watt element must be used in the line section port.

Model 43P Specifications

RF Frequency Range	0.450-2700 MHz. depending on element selected.
RF Power Rating	100 mW to 10kW, depending on element selected.
Accuracy	CW mode $\pm 5\%$ of full scale Peak mode $\pm 8\%$ of full scale
When measuring rectangular pulse power, the following parameters must be observed: Duty cycle - 2% minimum Rep. rate - 100 pps minimum Pulse width - 200 μ sec. minimum	
Power Requirement	(2) 9V alkaline batteries (NEDA 1604)
Battery Life	48 hours typical

Operation

There is a PUSH ON/PUSH OFF switch on the right side of the meter housing as you face the unit. To read peak power:

1. Push the switch in.
2. Notice that the red LED is lit. The unit is now ready to indicate peak power.

To read CW power (no AM modulation):

1. Push the switch again to the OFF position.
2. Notice that the red LED is no longer illuminated. The unit will once again function to indicate CW power.

Peak Detector Response

The electrical time constant of the peak detector circuit is set at one second, although the actual response time may be slightly longer than this due to meter damping. Therefore, a short delay may be noticed between the time that the transmitter is energized, and the meter reading stabilizes. This delay

will also be noticed upon transmitter de-energization as the meter needle sweeps back to zero. Also, the meter reading may be expected to waver approximately 2-3 minor scale divisions when voice modulation is used as the peak detector attempts to follow peak power variations associated with voice modulation.

Model 43P Peak Calibration

If it is felt that the peak readings are questionable, or for any reason recalibration is required, proceed as described.

Remove the rear cover, follow these instructions.

1. Remove the four 8-32 Phillips flat head screws that secure the rear cover. There are two on either side of the meter housing.
2. Pull the cover straight off.

Refer to figure 15 for the following calibration instructions:

1. Insert the Model 43P between an RF (CW) signal source and a 50 ohm load.
2. Insert an element for the appropriate power and frequency range into the Model 43.
3. Turn the element in the direction to read forward power.
4. Place the mode switch, on the side of the Model 43P, in the CW position (LED off).
5. Turn on the signal source.
6. Adjust power to give a stable reading on the Model 43P Wattmeter in the upper half of the scale.
7. Switch to the PEAK mode (LED on).
8. The RF power reading should remain the same. If it does not read the same, adjust potentiometer (R9 -top center of the PC board) until the PEAK reading is the same as

the CW reading. When the CW and PEAK readings are the same, calibration is complete.

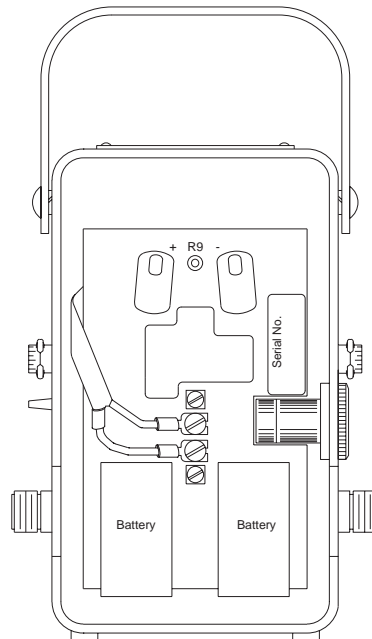
9. Replace the back cover, using the four 8-32 Phillips flat head screws.

Maintenance

Maintenance of the Model 43P in general will be the same as for the Model 43 except for battery replacement.

If the unit does not function properly in peak mode, or calibration cannot be achieved, the batteries may be low. Replace the batteries with new ones, preferably alkaline or lithium type. The batteries fit very tightly in their retaining clips and may have to be pried out one at a time (refer to figure 15).

Figure 15
Model 43P



Customer Service

Any maintenance or service procedure beyond the scope of those provided in this section should be referred to a qualified service center. Bird Electronic Corporation maintains a complete repair and calibration facility at the following address.

Service Group

U.S.A. Sales and Service
Bird Electronic Corporation
30303 Aurora Road
Cleveland (Solon), OH 44139-2794
Phone: (440) 248-1200
Fax: (440) 248-5426

Sales Offices

For the location of the sales office nearest you, give us a call or visit our Web site at:

<http://www.bird-electronic.com>

Limited Warranty

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.

If Seller's products are claimed to be defective in material or workmanship or not to conform to specifications, drawings, blueprints and/or samples, Seller shall, upon prompt notice thereof, either examine the products where they are located or issue shipping instructions for return to Seller (transportation-charges prepaid by Buyer). In the event any of our products are proved to be other than as warranted, transportation costs (cheapest way) to and from Seller's plant, will be borne by Seller and reimbursement or credit will be made for amounts so expended by Buyer. Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing within ten (10) days from the date of discovery of the defect.

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. In addition, Seller's warranties do not extend to the failure of tubes, transistors, fuses and batteries, or to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to Seller.

The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu

DECLARATION OF CONFORMITY

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

Product: Thruline RF Directional Wattmeters
Models: 43 4305A 43P 4330
 4431 4521 4522
 4523 4525 4526 4527

The undersigned hereby declares, on behalf of Bird Electronic Corporation of Cleveland, Ohio, that the above-referenced product, to which this declaration relates, is in conformity with the provisions of the following standards;

1. European Standard EN 55011:1991 - Emissions: Class B.
2. European Standard EN 50082-2:1995 - Immunity: Residential, Commercial, and Light Industrial Environments.

These standards are in accordance with Council Directive 89/336/EEC, on Electromagnetic Compatibility, as amended by Council Directive 92/31/EEC.

3. European Standard EN 61010-1:1993 - Safety, Group II.

This standard is in accordance with Council Directive 73/23/EEC and 93/68/EEC.

The technical documentation file required by this directive is maintained at the corporate headquarters of Bird Electronic Corporation, 30303 Aurora Road, Cleveland, Ohio.



Ken DeVore
QA/Metrology Manager
Bird Electronic Corporation