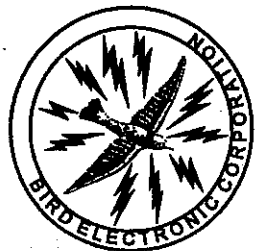


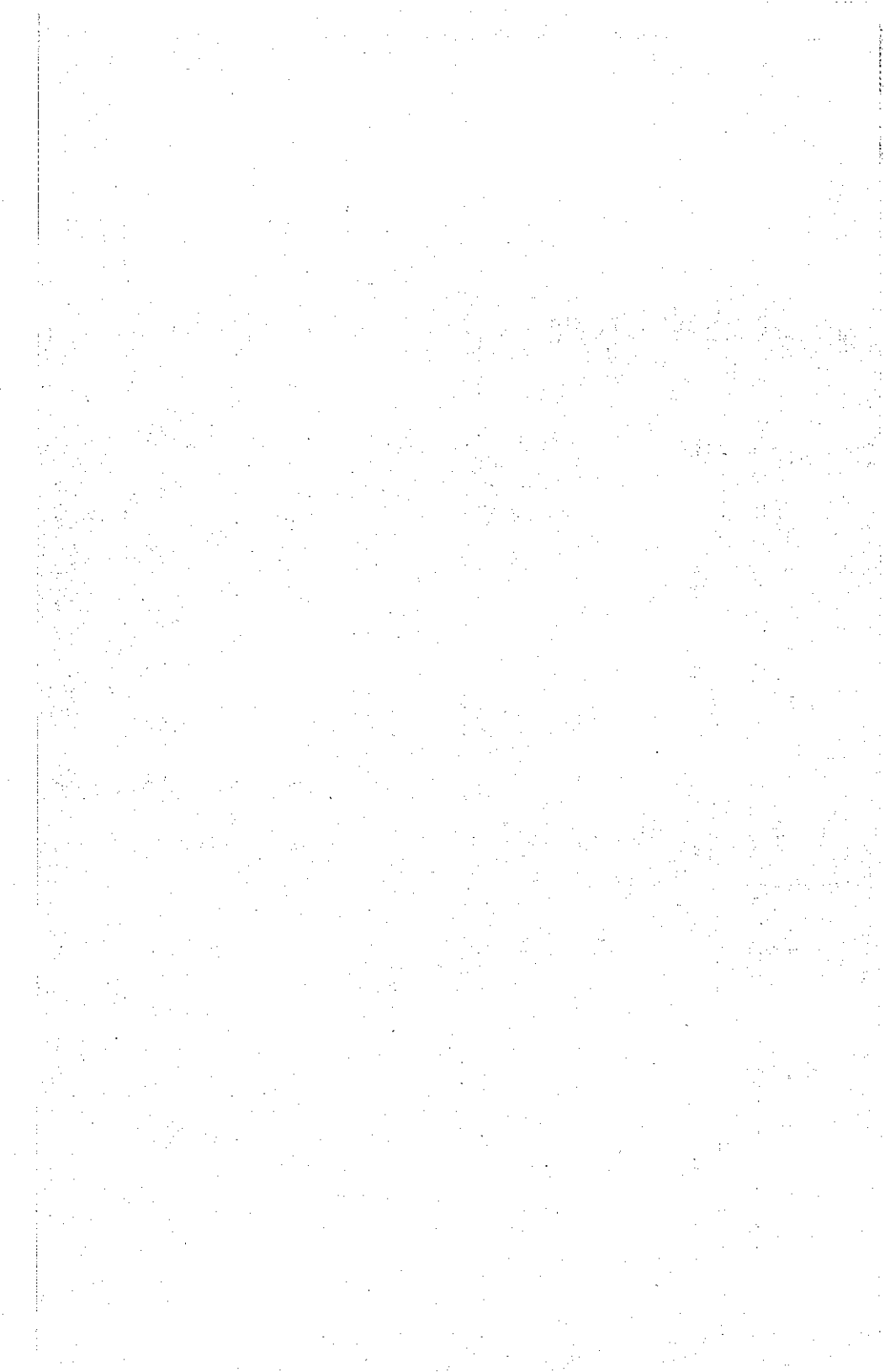
BIRD

OPERATING INSTRUCTIONS

TERMALINE[®] WATTMETER

**SERIES 4600A
AND
SERIES 4800A**





OPERATING INSTRUCTIONS

**THRULINE[®] WATTMETER
SERIES
4600A & 4800A**

BIRD

Electronic Corporation
Cleveland (Solon) Ohio USA

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Safety Precautions



USAGE

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

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

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

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

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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 OPERATIONS 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 EFFETTUARRE 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. PEAT 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.

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 apply to all phases of operation and maintenance.

Keep Away From Live Circuits

Operating personnel must at all times observe general safety precautions. Do not replace components or make adjustments to the inside of the test equipment with the high voltage supply turned on. To avoid casualties, always remove power.

Shock Hazard

Do not attempt to remove RF transmission line while RF power is present.

Chemical Hazard

Dry cleaning solvents used to clean parts may be dangerous. Avoid inhalation of fumes and also prolonged contact with skin.

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.

Series 4600A/4800A Warning Statements

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

WARNING

Use dry cleaning solvents only in a well ventilated area away from open flames or sparks. Do not breathe the fumes. Avoid direct skin contact with solvent.

WARNING

Never attempt to connect or disconnect an RF cable while power is on at the RF power source. Radiated RF energy may present a potential health hazard.

Series 4600A/4800A Caution Statements

The following equipment cautions appear in the text whenever the equipment is in danger of damage and are repeated here for emphasis.

CAUTION

Do not attempt to check the microammeters with an ohmmeter. Damage to the movement or pointer will result.

CAUTION

The Thruline wattmeter, elements, and line section have been calibrated together. Replacing any component without recalibrating all the components as a unit may affect accuracy.

CAUTION

Do not remove RF center conductor. Placement is critical for proper calibration and obtaining specified accuracy.

About This Manual

This instruction manual covers the 4600A and 4800A Series Wattmeters, which specifically includes the following models.

460A	4641-037A	4802-300A	4843-080A
4600-037A	4641-080A	4805A	4844-200A
4610-200A	4642-200A	4805-037A	4844-300A
4610-300A	4642-300A	4843A	
4641A	4802-200A	4843-037A	

This instruction book is arranged so that essential information on safety is contained 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.

- Operation** First time operators should read Chapter 1 - Introduction, and Chapter 3 - Installation to get an overview of equipment capabilities and how to install it. An experienced operator can refer to Chapter 4 - Operating Instructions. All instructions necessary to operate the equipment, are contained in this section.
- Maintenance** All personnel should be familiar with preventive maintenance found in Chapter 5 - Maintenance. If a failure should occur, the troubleshooting section will aid in isolating and repairing the failure.
- Changes** Changes to this publication will made as required. To keep your instruction book accurate and up to date, it is recommended that a periodic request of the latest supplement be made. It will be supplied at no cost. When requesting updates, reference your instruction book part number and its revision level listed on the title page.
- Reporting Errors** It is our goal to provide our users with the information needed to operate and maintain the Thruline Wattmeters models listed above. If you should discover any errors in this publication, or if you have suggestions for improving this instruction manual, please send your comments to our factory.

Table Of Contents

Safety Precautions.	i
Warning Statements.	iv
Caution Statements.	iv
About This Manual.	v
Introduction.	1
Purpose and Function.	1
Performance Characteristics and Capabilities.	1
Dimensions and Weight.	1
Power And Utility Requirements.	2
Environmental Requirements.	2
Items Supplied.	2
Items Required But Not Supplied.	2
Tools And Test Equipment Required.	2
Specifications.	5
Theory Of Operation.	7
Element.	7
Traveling Wave Viewpoint.	7
Coupling Circuit.	7
Element Socket.	8
Matching.	9
Load Power.	9
P vs. Φ and its Significance.	10
Measuring & Monitoring Transmitter Power.	10
Installation.	13
Items Required.	13
General.	13
Coupling Kits.	13
Models With Flanged Line Sections.	13
Models With Unflanged Line Sections.	14

Elements.	15
Meter.	15
Operating Instructions.	17
Zero Adjust.	17
Use And Function Of Controls.	17
Initial Control Setting.	18
Start-up.	18
Normal Operation.	18
Operation Under Abnormal Conditions.	18
Shutdown.	18
Emergency Shutdown.	18
Maintenance.	19
Sales/Repair Facility.	19
Sales Facilities.	19
Troubleshooting.	19
Cleaning.	20
Inspection.	21
Line Section Care.	21
Disassembly.	21
Repairs.	22
Contact Adjustment.	22
Preparation For Reshipment.	22
Elements.	22
Line Section.	22
DC Cables.	22
Meter.	23
Storage.	23
Replacement Parts.	23

This publication refers to the ThruLine Wattmeter Series 4600A and 4800A. The differences between models are listed in the specifications. All models will generally be referred to as a Wattmeter throughout this manual.

The information in this instruction book pertains to all models except noted differences referred to in the text.

Purpose and Function

The Bird ThruLine wattmeters are directional RF wattmeters designed to detect and measure power flow in either direction in 3-1/8 inch coaxial transmission lines. They are designed for a 50 ohm characteristic impedance. Therefore, they are useful for load matching in standard coaxial lines. Power levels are indicated on a direct reading meter corresponding with the elements selected by the user.

Performance Characteristics and Capabilities

Elements are available for measuring power levels up to 100 kW (30 kW for Models 4600/41-037A, 4610/42-300A, 4805/43-037A and 4802/44-300A) full scale in stated frequency bands from 2 to 1000 MHz (50 to 250 MHz for models 4600/41-037A, 4610/42-300A, 4805/43-037A and 4802/44-300A). Models 4641-080A and 4843-080A, 4-1/16 inch lines are used for measuring power up to 80 kW at frequencies from 50 to 125 MHz. The maximum measurement error ± 5 percent of the full scale power rating of the element. The insertion VSWR (voltage standing wave ratio) will not exceed 1.05 to 1.00 over the stated frequency band.

Dimensions and Weight

The flanged line sections of Models 460A, 4610-200A, 4600-037A and 4610-300A are 7-1/32 inch from flange face to flange face. The barrel of the line section is 3-1/8 inch diameter and the flange fittings are 5-1/8 inch. The weight of the single socket line section is 7 lb (3 kg) and the double socket 7-1/4 lb (3.3 kg). The unflanged line sections of Models 4805A, 4802-200A, 4805-037A and 4802-300A are 6-1/2 inch from end to end and the barrel 3-1/8 inch diameter. The single socket line section weighs 4 lb (2 kg) and the double socket 4-1/4 lb (2.02 kg). The meter and housing are 5-9/16 inch W x 6-1/2 inch H x 3-1/8 inch L (141 x 165 x 86 mm) and weighs 5 lb (2.3 kg). Add 2 lb (0.9 kg) for the overall shipping weight. The Model 4641 and 4643 series line sections are 8-1/8 inch and 7-1/2 inch respectively in length and weigh approximately 1/2 lb more than the 3 inch lines.

Power and Utility Requirements

Because ThruLine Wattmeters are passive and self-contained devices, they do not require power or utility service other than the RF power in the coaxial line.

Environmental Requirements

ThruLine Wattmeters should be used in a dust and vibration free environment. Measurements should be made at $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($77^{\circ}\text{F} \pm 9^{\circ}\text{F}$) for maximum measurement accuracy.

**Items
Supplied**

Series 4600A and 4800A Thruline Wattmeters consist of a line section, a meter in a housing and connecting cables.

The line section is a short length of matching inch coaxial transmission line. The Model 4600A series, line sections have bolt flanges that are fixed on one end and swivel type on the other. Model 4800A series are unflanged line sections.

The meter is scaled in 5, 10 and 25 kW ranges for Models 460A, 4610-200A, 4805A, and 4802-200A. Models 4600-037A, 4610-30GA, 4805-037A and 4802-300A are scaled for 15, 30 and 60 kW ranges. The Models 4641-080A and 4643-080A are scaled for 8 and 80 kW ranges.

A standard ten foot (3 meter) cable/s is supplied with each wattmeter and is equipped with a dc connector plug on one end and meter assembly connections on the other. Alternate lengths are available on request. This instruction book is the only other item supplied.

**Items
Required**

The coaxial transmission line must be equipped with flanged or unflanged connectors to match the line section. An appropriate coupling kit will be required. Additional elements may be ordered for the desired frequency bands and power levels.

**Tools and
Test
Equipment**

Screwdrivers and an adjustable wrench or end-wrench for the flange nut and bolt sets are the only tools required for the Series 4600A and 4800A Wattmeters.

Specifications

Impedance, Nominal	50 ohms
Insertion VSWR	1.05:1.00 Maximum
Connectors Models: 460A, 4610-200A, 4600-037A & 4610-300A	3-1/8" EIA flanged
Models: 4805A, 4802-200A, 4805-038A & 4802-300A	3-1/8" unflanged
Models: 4614A, 4641-037A, 4641-080A, 4642-200A & 4642-300A	4-1/16" flanged
Models: 4843A, 4843-037A, 4873-080A, 4844-0200A & 4844-300A	4-1/16" unflanged
Power Range* Models: 460A, 4610-200A, 4805A & 4802-200A	1-100 kW Maximum
Models: 4600-037A, 4610-300A, 4805-037A & 4802-300A	1.5-30 kW Maximum
Models: 4641A, 4642-200A, 4843A & 4844-200A	2.5-50 kW Maximum
Models: 4641-037A, 4642-300A, 4843-037A & 4844-300A	3-60 kW Maximum
Models: 4641-080A & 4843-080A	8-80 kW Maximum
Frequency Range* Models: 460A, 4610-200A, 4805A & 4802-200A	2-1000 MHz
Models 4600-037A, 4610-300A, 4805-037A, 4641A, 4642-200A, 4843A, 4844-200A, 4641-037A, 4642-300A, 4843-037A, 4802-300A & 4844-300A	50-250 MHz
Models: 4641-037A, 4642-300A, 4843-037A & 4844-300A	470-750 MHz
Models: 4641-080A, 4843-080A	50-125 MHz
*Note: Actual frequency and power ranges are determined by the element used.	
Accuracy	±5% of full scale
Dimensions 3-1/8" Flanged line section 4-1/16" Flanged line section 3-1/8" Unflanged line section 4-1/16" Unflanged line section Meter: 4-11/64"L x 5-9/16"W x 6-1/2"H (106 x 141 x 165 mm)	7-1/32" L (179 mm) 8-1/8" L (206.4 mm) 6-1/2" L (165 mm) 7-1/2" L (191 mm)

Specifications Con't

Weight Flanged Line Section Approx. Unflanged Line Section Approx. Meter Approx.	7.25 lb. (3.3 kg) 4.25 lb. (2.0 kg) 3 lb (1.36 kg)
Ambient Temperature	25°C ±5°C (77°F ±9°F)
Finish Meter Housing Line Section	Grey Powder Coat Bright Silver Plate

Model Number	Freq. Range (MHz)	Power Range (kW)	Scale	Connector Type	Sockets
460A	2-1000	1-100	5/10/25	3-1/8" Flg	Single
4610-200A	2-1000	1-100	5/10/25	3-1/8" Flg	Double
4805A	2-1000	1-100	5/10/25/	3-1/8" Unflg	Single
4802-200A	2-1000	1-100	5/10/25	3-1/8" Unflg	Double
4600-037A	50-250	1.5-30	15/30/60	3-1/8" Flg	Single
4610-300A	50-250	1.5-30	15/30/60	3-1/8" Flg	Double
4805-037A	50-250	1.5-30	15/30/60	3-1/8" Unflg	Single
4641A	50-250	2.5-50	5/10/25	4-1/16" Flg	Single
4641-037A	50-250	3-60	15/30/60	4-1/16" Flg	Single
4641-080A	50-125	8-80	8/80	4-1/16" Flg	Single
4642-200A	50-250	2.5-50	5/10/25	4-1/16" Flg	Double
4642-300A	50-250	3-60	15/30/60	4-1/16" Flg	Double
4843A	50-250	2.5-50	5/10/25	4-1/16" Flg	Double
4843-037A	50-250	3-60	15/30/60	4-1/16" Unflg	Single
4843-080A	50-125	8-80	8/80	4-1/16" Unflg	Single
4844-200A	50-250	2.5-50	5/10/25	4-1/16" Unflg	Double
4844-300A	50-250	3-60	15/30/60	4-1/16" Unflg	Double
4802-300A	50-250	1.5-30	15/30/60	3-1/8" Unflg	Double

Note:

a. Models 460A, 4805A, 4641A, and 4843A utilize meter in housing assembly, P/N 6810-309-7 and replacement meter, P/N 2150-230.

b. Models 4610-200A, 4802-200A, 4642-200A, and 4843-200A utilize meter in housing assembly, P/N 6810-220 and replacement meter, P/N 2150-230.

c. Models 4600-037A, 4641-037A, and 4843-037A utilize meter in housing assembly, P/N 6810-307 and replacement meter, P/N 2150-259.

d. Models 4610-300A, 4802-300A, 4642-300A, and 4844-300A utilize meter in housing assembly, P/N 6810-230 and replacement meter, P/N 2150-259.

e. Models 4641-080A, and 4843-080A utilize meter in housing assembly, P/N 6810-250 and replacement meter, P/N 2150-268.

Options

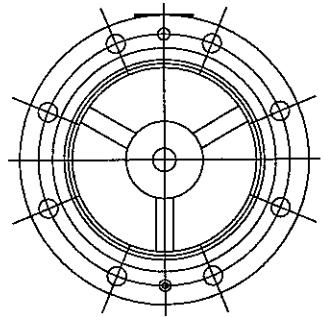
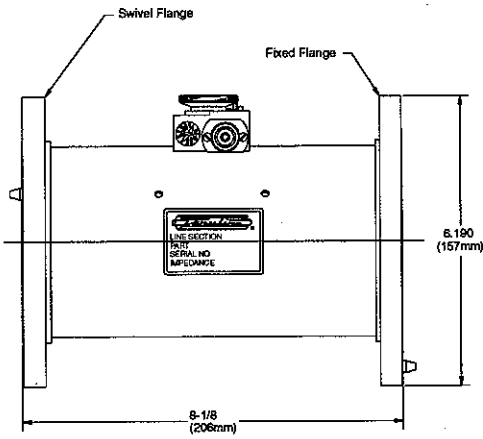
Line Sections & Elements

Frequency and power range are governed by the line section and elements selected. Refer to sales catalog for available models.

Cable Assemblies

DC Cable Assemblies are available for remote rigid line installation. The assemblies are various length of RG-58/U cable with a dc plug, P/N 7500-076 on one end and a BNC(m) connector installed on the opposite end. Refer to the cable section of the parts list for cable lengths and part numbers.

4600A Outline Drawing



4800A Outline Drawing

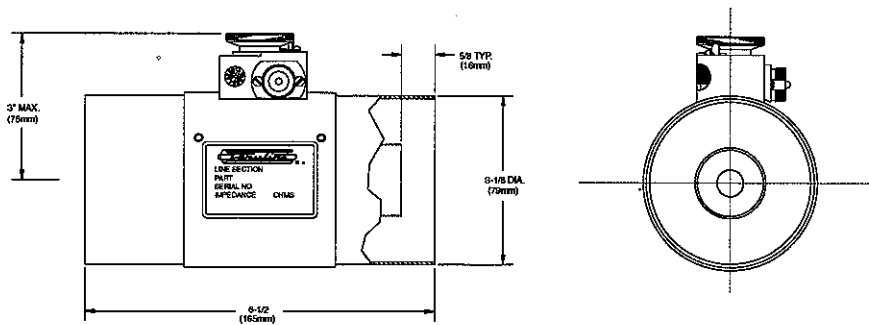
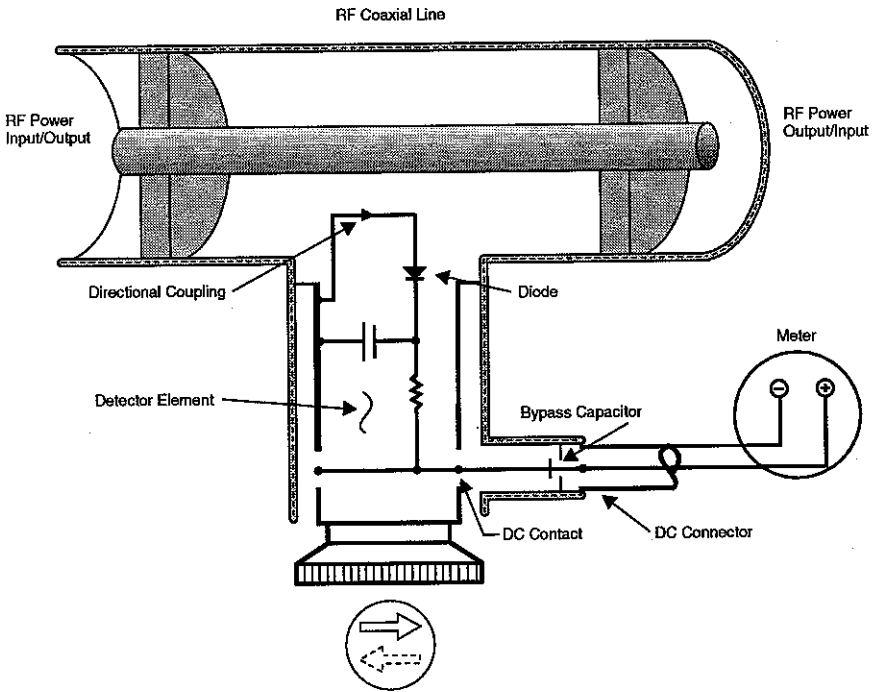


Figure 1
Schematic Diagram



Element	The function of the element is to detect (sense) the forward or reflected RF power in the line section at any given time. The direction in which the "arrow" on the element cap is oriented indicates the direction in which it is sensing the RF power flow in the system.
Traveling Wave Viewpoint	The best way to visualize the Thru-line Wattmeter idea is from the Traveling Wave viewpoint on transmission lines, which illustrates that the voltages, currents, standing waves, etc., on any uniform line section are the resultants of two traveling waves, forward and reflected.
Coupling Circuit	The coupling circuit which samples the traveling waves is in the Plug-In Element (Refer to figure 1). Energy will be produced in the coupling circuit of the element by both mutual inductance and capacitance from the traveling RF waves of the line section. Of course, the inductive currents will flow according to the direction of the traveling waves producing them.

The capacitive portion of these currents is naturally independent of the direction of the traveling waves. Therefore, it is apparent that the inductive portion of the current produced from the waves of one direction will add in phase to the capacitive portion of the current, and those of the opposite direction will subtract in phase. The additive direction is the forward or *arrow* direction of the element.

The forward wave travels and its power flows from the source to the load. It has an 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. It 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 a pure resistance, usually 50 ohms for useful lines. The main RF line circuit of the Thru-line Wattmeter is a short piece of uniform air line section, whose Z_0 is 50 ohms, in which accurate measurements may be made.

The electrical values of the element circuits are carefully balanced and so designed that the inductive current produced from the reverse direction 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 Thurline Wattmeter is sensitive at either one of its settings, but to only one of the two traveling waves which produce standing waves by interference. Thurline Wattmeter measurements are also independent of their position along the standing waves.

Element Socket

An accurately positioned socket for inserting a radio frequency coupling device, called a Thurline Plug-In Element, is mounted on the outer conductor. The socket is precision bored to hold the rotatable element in its calibrated position, with a spring-loaded clasp to keep the element firmly seated. The machined step on the top face of the socket engages a stop-pin on the element. Rotary movement of the element is thereby restricted to 180 degrees and is stopped on the axial center line.

The measuring socket has a hole bored through the wall through which an insulated phosphor bronze contact finger projects. The Plug-In Element has terminals on diametrically opposite sides of its body, so that pickup can be made from either side. A small silvered button tip can contact the element only in the precise forward and reflected measuring positions, against the end stops. A specially designed jack mounted on the side of the socket mates with the plug on the dc cable furnished with the read-out meter. The dc jack assembly has a built-in filter capacitor shunted across the meter circuit. This more fully protects meter readings against the adverse effects of any stray RF energy generated in the Plug-In Element. The line section is bright silver plated over practically all of its metal parts.

Matching

CAUTION

The Thurline Wattmeter, elements and line section have been calibrated together. Replacing any component without recalibrating all the components as a unit may affect accuracy.

The scale on the read-out meter reads full scale for the power rating stamped on the cap of the Plug-In Element. The Thurline Wattmeter, the plug-in element, and the line section are all stamped with matching serial numbers. The equipment is supplied as a matched and calibrated set and the parts, particularly the elements, should not be interchanged with any other like equipment. Such an interchange of the measuring elements could produce readings with an error greater than the stated 5 percent of full scale accuracy.

Load Power

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

$$W_L = \text{Load In Watts} = W_f - W_r$$

Where appreciable power is reflected, as with an antenna, it is necessary to subtract the reflected power from the forward power to get the effective power. This correction is negligible, less than 1 percent, if the loading device has a VSWR of 1.2 to 1 or less.

VSWR scales, and their attendant controls for setting the reference point, have been intentionally omitted from the Thurline Wattmeter for two reasons.

- a. Why make something similar to a hypothetical dc volt ohmmeter with control potentiometers for the voltmeter multipliers? Even more complications arise when diodes at RF are involved.
- b. Experience using the Thurline Wattmeter on operating problems, such as transmitter tune-up, antenna matching etc., shows that the power ratio ϕ is no mean competitor, in practical usefulness, to the standing wave ratio $\rho = \text{VSWR}$.

A trial is suggested for a few days - forget VSWR and try thinking in terms of $\phi = W_r / W_f$ when the Thurline 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, in an antenna matching problem the main objective usually is to minimize W_r , and anything done experimentally to this end is noted directly when the Thurline 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 between standing wave ratio ρ and the reflected/forward power ratio ϕ indicated by the Thurline Wattmeter, the latter may be conveniently used to measure VSWR.

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

Note that around $\phi = 10$ percent, below which W_r will appear insignificant and may be hard to read, you are close to the commonly accepted lower limit $\rho = 2$. Trying to adjust to an even lower value of ϕ , in order to improve antenna match still further, becomes less and less worthwhile in many systems. Experimentally by using the Thurline Wattmeter it can be readily shown that reducing ϕ below 10 percent produces little in the way of increased W_L . 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. A very

small level of reflected power, e.g., $\phi = .06$ percent, corresponds to $\rho = 1.05$. With just a single element suitable for measuring W_f , detection of reflected power is possible down to about $\phi = 1$ percent ($\rho = 1.2$), providing W_f approaches full scale. However, measurement is possible only down to about $\phi = 5$ percent ($\rho = 1.5$).

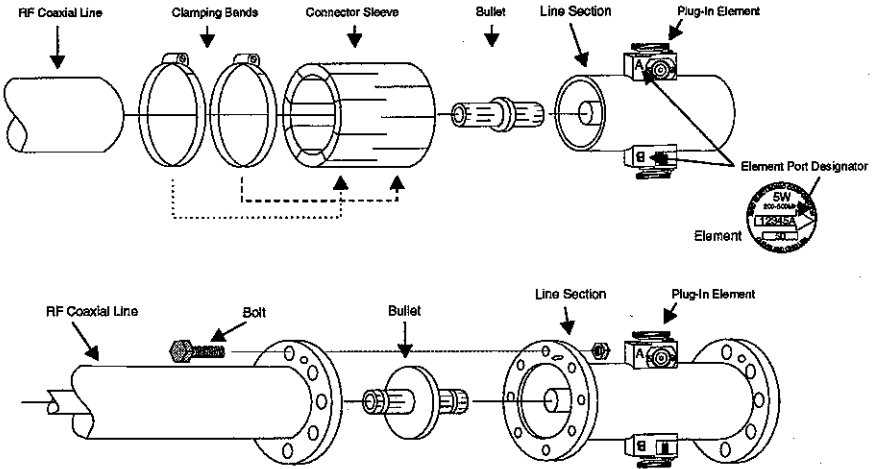
**Measuring &
Monitoring
Transmitter
Power**

Little more need be said about this in view of the preceding load power discussion. 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 Thruline meter indicates the carrier component on amplitude modulation, with very little response to side band components added by modulation.

Items Required	Thru-line Wattmeter Elements (ordered separately, P/N depends on Wattmeter model, power level and frequency ranges) Coupling Kit (ordered separately, P/N depends on transmission line type) DC Cable
Line Section	<p>A coupling kit is required for connecting the line section to the transmission line. The coupling kit will be similar to one of the coupling kits shown. Review the following and refer to the diagram (figure 2) to install the line section.</p> <ol style="list-style-type: none">1. Locate the line section so that element sockets are oriented for easy access.2. Be sure center conductor anchor bullets have been positioned with insulators properly seated in the counter-bores.3. For flanged connectors, tighten evenly around flange to obtain a firm uniform contact.4. For unflanged connectors, bullets should firmly seat in the center conductor. The ends of the line section should be butted snugly against the ends of the transmission line.5. Position clamp bands approximately 3/4" from ends of sleeve and tighten securely.6. The coaxial line should be continuous with no bends or offsets in its axial line.
Elements	The element port designator is stamped on the line section ports and after the serial numbers on the elements. Be sure to match these designators to achieve stated accuracy.
Meter	<p>The meter may be placed anywhere within the reach of the dc cable. Do not place in locations that are dusty or subject to temperature extremes.</p> <ol style="list-style-type: none">1. Connect the dc cable plug to the jack on the measuring element socket.2. Ensure the connection is tight and clean for accurate readings.

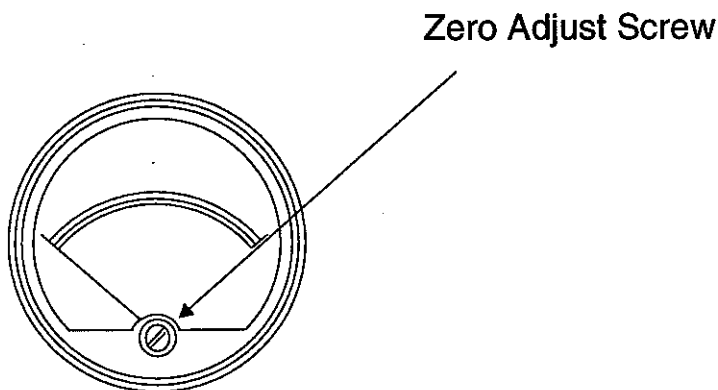
Figure 2
Coupling Kits



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 3).

Figure 3
Zero
Adjustment
of Meter



CAUTION

The Thruline wattmeter, elements, and line section have been calibrated together. Replacing any component without recalibrating all the components as a unit may affect accuracy

Start-Up

Once the line section is properly installed in the transmission line, and the dc connector cables from the element socket to the meter have been attached, nothing more is required.

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.

Abnormal Operation

The elements for the Wattmeter can withstand a 20 percent overload. If the power to be measured is greater, by a reasonable amount, than the maximum value of the element available, the Wattmeter and element may be used to give an indication of power

flow even though the pointer is overranged and it is not possible to ascertain the true maximum power.

Shutdown

These Wattmeters are passive devices and require no external source of power, they cannot be shut off. The RF source must be shut off instead.

**Emergency
Shutdown**

WARNING

Never attempt to connect or disconnect an RF cable while power is on at the RF power source. Radiated RF energy may present a potential health hazard

In case of an overload, rotate the element to the midpoint between the forward and reflected positions to electrically decouple the element from the meter. Do not remove the element while RF power is still flowing through the line section.

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 complete repair and calibration facilities at the following address:

**Sales/Repair
Facility**

U.S.A. Sales and Manufacturing
Bird Electronic Corporation
30303 Aurora Road
Cleveland (Solon), Ohio 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>

All instruments return for service must be shipped prepaid and to the attention of the Customer Service Group.

Preparation for Shipment

Elements	The elements can be left in the sockets of the line section with their ARROWS turned midway between the measuring positions. Any additional elements should be well padded and wrapped before being put in the shipping container.
Line Section	Wrap the connectors on the flanged models with padding and tape them securely in place. Cover both ends of the line section and the socket to keep out dust and foreign material. Place the line section in a sturdy shipping container such as a corrugated paper box.
DC Cables	Pad and wrap the dc connector plugs and then coil the cables tightly.
Meter	Cover the meter face with padding to protect the glass window, then wrap the housing and place it in the same box as the line section.
Storage	No special preparations for storage are necessary other than to cover the equipment to keep out dust and dirt. For an extra precaution, leave an element in the socket with the arrow turned midway between the measuring positions.

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.

CAUTION

Do not attempt to check the microammeters with an ohmmeter. Damage to the movement or pointer will result.

Problem	Possible Cause	Corrective Action
No meter indication	No RF power.	Check RF source.
	"Arrow" on Plug-In Element pointing in wrong direction.	Change position of element.
	No pickup from dc contact finger.	Adjust per contact adjustment paragraph.
	Open or Short circuit.	Replace defective cable on dc meter cable (RG-58/U).
	Meter burned out or damaged.	Return wattmeter, line section, and elements to the factory for meter replacement and recalibration.
Intermittent or inconsistent meter readings.	Faulty transmission line.	Inspect line.
	Sticky or defective meter.	Return wattmeter, line section, and elements to the factory for meter replacement and recalibration.
	Dirty dc contact on elements.	Clean contacts.
High VSWR or reflected power	Bad load or poor connectors.	Replace load or connectors.
	Shorted or open transmission line.	Have line serviced.
	Foreign material in the line section or in the RF connector bodies.	Refer to the line section care paragraph.

Cleaning

WARNING

When using dry cleaning solvents, provide adequate ventilation and observe normal safety precautions. Many dry cleaning agents emit toxic fumes that may be harmful to your health, if inhaled.

If any of the contacts or line connectors become dirty, they should be wiped off with a clean cloth and a dry cleaning solvent. Use an aerosol contact cleaner that is self-drying, but forms no residue, on the inaccessible internal parts. 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 element body
- Seat at the base 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.

WARNING

Never attempt to disconnect the transmission line while RF power is being applied. Leaking RF energy is a potential health hazard.

Inspection Inspect the Unit for cleanliness, proper adjustment, and with the RF power removed, check the ZERO setting and adjust if necessary.

Preventive Maintenance

The element socket should be kept plugged as much as possible to prevent the intrusion of dust. If a Plug-In Element is to be used for this purpose, use the highest power element available. The element should be positioned so that the "arrow" is pointing midway between the FWD and RFL measuring positions. This will not only protect the meter by shunting the movement, but will also avoid exposing the element's diode to dangerous potentials if the RF line section should be energized.

Line Section Care

CAUTION

Do not remove RF center conductor. Placement is critical for proper calibration and obtaining specified accuracy.

If there is any evidence of contamination inside the RF line section, the accessible portions should be cleaned and the interior carefully blown out. 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, rotating 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 carefully done manually. The tip 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 attached spring finger, may be detached for service by removing the two 4-40 fillister head machine screws which fasten it to the side of the RF line section. Then lift off the jack assembly carefully to avoid losing the small Teflon insulating bead that straddles the base of the phosphor bronze spring and nests in a counterbore on the side of

the RF body. When replacing the assembly, be sure that the bead is again properly inserted.

CAUTION

The Thruline wattmeter, elements, and line section have been calibrated together. Replacing any component without recalibrating all the components as a unit may affect accuracy.

Repairs

Components of these matched units cannot be interchanged or individually replaced. The only replaceable portions of the line section are standard parts or coaxial line fastenings.

Repairs beyond those covered in this instruction book will require return of the equipment to the factory for service.

Item	Qty.	Description	Part Number
1	1 or 2	DC connector plug	7500-076
2	1 or 2	Cable assembly	6810-214-1
3	1 or 2	DC connector assembly	4230-010

The following listings are for reference only.

Item	Qty.	Description	Part Number
4	1	Meter:	
		Models 4712A, 4715A, 4715-200A, 4720A, 4723-200A	2150-230
		Models: 4712-037A, 4715-300A	2150-259
		Models for 8 kW use	2150-268
5	1	Meter and Housing assembly:	
		Models 4712A, 4720A	6810-309-7
		Models 4715-200A, 4723-200A	6810-220
		Models 4712-037A	6810-307
		Models 4715-300A	6810-230
		Models with 8 kW wattmeter combinations	6810-265

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 pre-paid 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 of all other remedies including claims for special or consequential damages. IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR SELLER ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.

DECLARATION OF CONFORMITY

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

Product: Thruline RF Directional Wattmeters
Models: 460A 4600-037A 4610-200A 4610-300A
4641A 4641-037A 4641-080A 4642-200A
4642-300A 4802-200A 4802-300A 4805A
4805-037A 4843-037A 4843-080A 4844-200A
4844-300A

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.

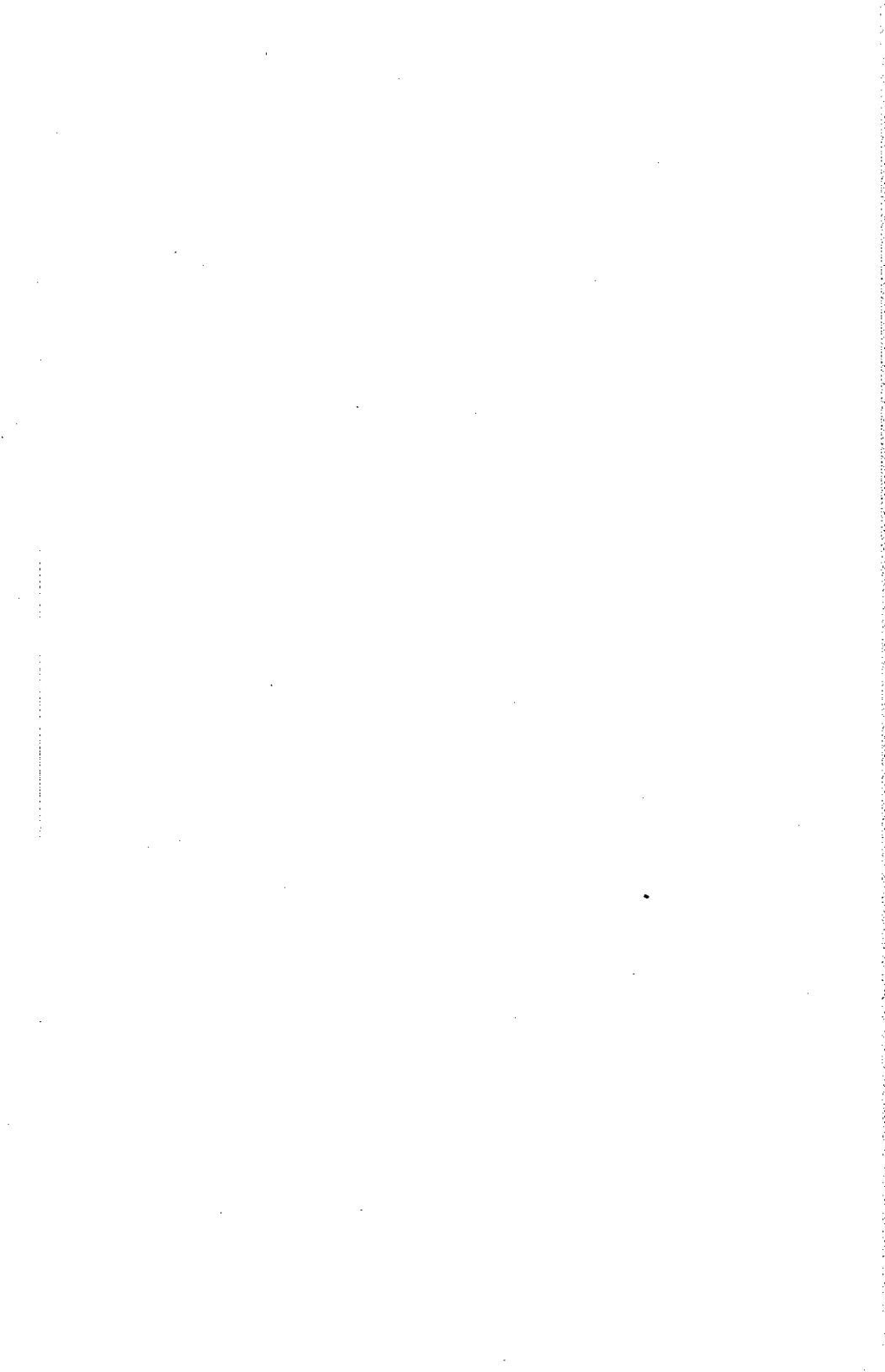
This standard is in accordance with Council Directive 73/23/EEC and 93/68/EEC.

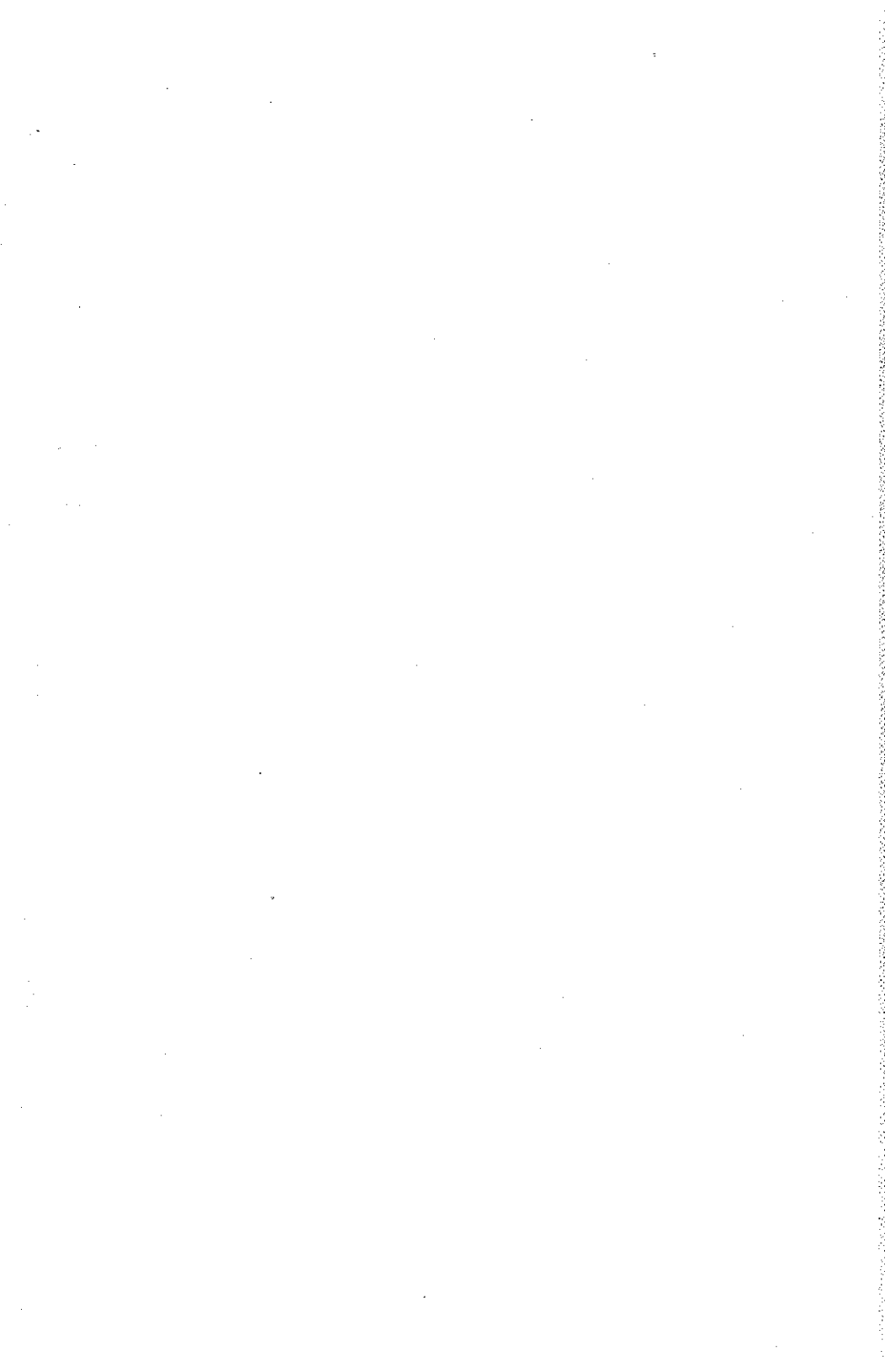
The technical documentation file required by this directive is maintained at the corporate headquarters of Bird Electronic Corporation, 30303 Aurora Road, Cleveland, Ohio.

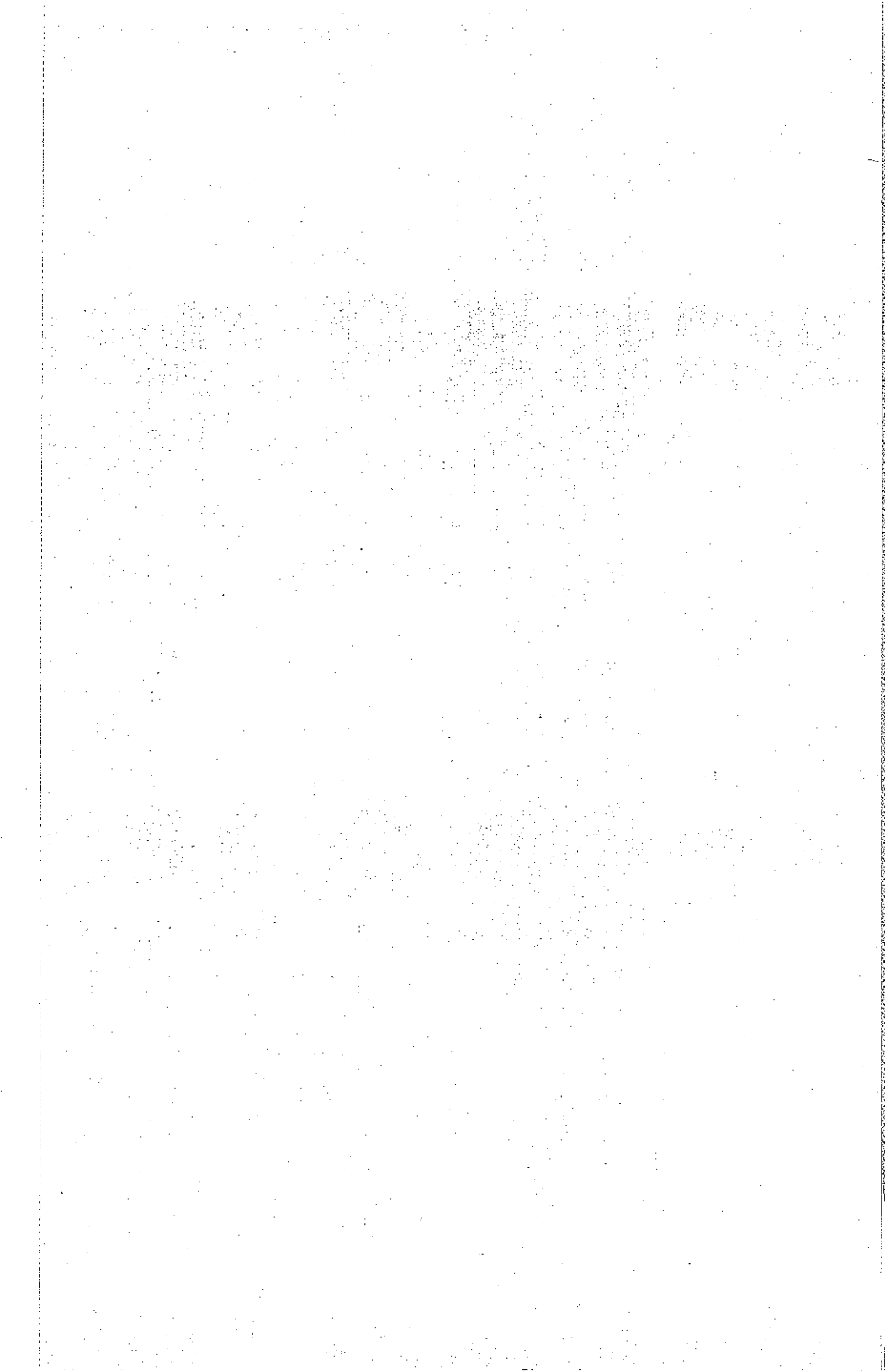


Ken DeVore
QA/Metrology Manager
Bird Electronic Corporation









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