



MULTI-SENSOR
CAL CART
SYSTEM

OPERATION MANUAL

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INSTRUCTION BOOK PART NUMBER 920-MSCC REV. K

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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 apply to all phases of operation and maintenance.

WARNING

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.

WARNING

Shock Hazard

Do not attempt to remove the RF transmission line while RF power is present. Capacitors can store a dangerous electrical charge. Avoid contact with all system capacitors. If it is necessary to perform work near a system capacitor, be sure to discharge the capacitor through a low resistance.

WARNING

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.

WARNING

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.

WARNING

Resuscitation

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

WARNING

Remove Power

Observe general safety precautions. Do not open the instrument with the power on.

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.



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

Note: *Calls attention to supplemental information.*

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
Potential Fire Hazard
Do not regularly exchange the power sensors installed in this Cal-Cart. Frequent interchange of power sensors can lead to cable / connector interface stresses that may impact the integrity of the cable outer conductor, resulting in points of high current density in the cable outer conductor. When this condition occurs, failure of the interconnecting RF cable is likely due to heating.

On pages 2, 6, and 15

WARNING
Refer to the supplied load manual for load-specific warnings and cautions.

On pages 3 and 6.

WARNING
All vent plugs must be installed on the load at all times when the unit is operating or cooling. Failure to do so could result in an explosion or severe burns.

On page 4.

WARNING
Do not attempt to lift the cart by the handle.

On page 4.

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

On pages 4, 6, 9, and 15.

WARNING
RF Safety Cover provides protection against RF power. Do not defeat this safety device.

On page 5.

WARNING
To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

On pages 9 and 12.

WARNING
Heavy load. Do not attempt to lift unaided.

On page 16.

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

The Bird 4421 contains no user-serviceable parts. Do not remove its cover.

On pages 9.

CAUTION

The Bird 4421 must be powered off when connecting or disconnecting the power sensor from the power meter.

On pages 15.

CAUTION

Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted. Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

On pages 9 and 16.

CAUTION

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

On pages 2, 4, 16, 18, 19, and 22.

CAUTION

Check the local electrical code for proper AC hookup prior to operation of the unit. Make sure the neutral or return hookup is only used for that purpose.

On pages 4.

CAUTION

Use the Bird Cal Cart in a dry, dust and vibration free environment. Do not use outdoors or in areas of condensing humidity. Allow at least 12" (30 cm) of clearance around the load.

On page 4.

CAUTION

Maximum power dissipation is severely reduced when the blower is not running. If the indicator light should turn off, immediately reduce RF power by 75%.

On page 6.

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 PROIZIONE 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.

UNITS ARE EQUIPPED WITH RECHARGEABLE BATTERIES.

THESE ARE TO BE REPLACED BY AUTHORIZED SERVICE PERSONNEL ONLY!!!

LAS UNIDADES VIENEN EQUIPADAS CON BATERIAS RECARGABLES.

!!!Y SOLAMENTE EL PERSONAL DE SERVICIO AUTORIZADO PUEDE REEMPLAZARLAS!!!

GERÄTE SIND MIT WIEDER AUFLADBAREN BATTERIEN BESTÜCKT.

BATTERIEN SIND NUR VON QUALIFIZIERTEM SERICE PERSONAL AUSZUWECHSELN!!!

CES DISPOSITIFS SONT ÉQUIPÉS DE BATTERIES RECHARGEABLES.

SEUL LE PERSONNEL D'ENTRETIEN AUTORISÉ EST HABILITÉ À LES REMPLACER !

LE UNITÀ SONO DOTATE DI BATTERIE RICARICABILI,

CHE DEVONO DA COME SPECIFICATO DAL PRODUTTORE LA PROTEZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

USE CORRECT VOLTAGE SETTING AND FUSE - SEE MANUAL.

UTILISER UNE TENSION ET UN FUSIBLE CORRECTS - CONSULTER LE MODE D'EMPLOI.

USE LA INSTALACION Y FUSIBLE DE VOLTAJE CORRECTO - VEA EL MANUAL.

AUSSCHLIESSLICH VORSCHRIFTSMÄSSIGE WECHSELSPANNUNGS-EINSTELLUNG UND SICHERUNG BENUTZEN - SIEHE DAZU HANDBUCH.

UTILIZZARE TENSIONE E FUSIBLE ADATTI - FARE RIFERIMENTO AL MANUALE.

BE SURE THE 115/230V AC VOLTAGE SELECTOR IS SET TO THE PROPER LINE VOLTAGE, AND THE CORRECT AC LINE FUSE IS INSTALLED BEFORE AC POWER IS APPLIED.

S'ASSURER QUE LE SÉLECTEUR DE TENSION 115/230V C.A. EST BIEN RÉGLÉ POUR LA TENSION DU RÉSEAU ET QUE LE FUSIBLE DE LIGNE C.A. CORRECT EST EN PLACE AVANT DE METTRE SOUS TENSION C.A.

CERCIORESE QUE EL SELECTOR DE VOLTAJE DE 115/230V CA ESTE COLOCADO A LA LINEA DE VOLTAJE APROPIADA Y QUE EL FUSIBLE ESTE INSTALADO A LA LINEA CA ANTES DE APLICAR LA CORRIENTE ALTERNA.

VOR EINSCHALTEN DER WECHSELSTROMZUFUHR SICHERSTELLEN, DASS DER 115/230V WECHSELSPANNUNGS-SELEKTOR AUF DIE VORSCHRIFTSMÄSSIGE LEITUNGSSPANNUNG EINGESTELLT UND DIE RICHTIGE WECHSELSTROM-HAUPTSICHERUNG EINGESETZT IST.

PRIMA DI EROGARE CORRENTE, ASSICURARSI CHE IL SELETTORE DI VOLTAGGIO 115/230 V.C.A. SIA REGOLATO CORRETTAMENTE E CHE IL FUSIBLE ADATTO ALLA LINEA DI ALIMENTAZIONE C.A. SIA INSTALLATO.

About This Manual

This manual covers the operating & maintenance instructions for models with part numbers beginning with:

MSCC71

Changes to this Manual

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

Chapter Layout

Introduction — Describes the features of the Cal Cart, lists equipment supplied and optional equipment, and provides power-up instructions.

Setup — Describes the power supply and connection instructions.

Operating Instructions — Describes the base level operation instructions.

4421 Instructions — All instructions necessary to operate the 4421 Power Meter in conjunction with the Bird Semiconductor Cal Cart.

Maintenance — Lists routine maintenance tasks as well as troubleshooting for common problems. Specifications and parts information are also included.

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The Bird Cal Cart is designed for immediate, effortless use. It has three primary components. The Bird 4421 RF Power Meter displays radio frequency (RF) power. Bird 4020, 4027A, and 4027F Series Power Sensors are highly accurate sensors that measure RF power without requiring calibration or external couplers or attenuators. Bird Loads are low reflection $50\ \Omega$ terminations that can dissipate 1 kW to 10 kW max., depending on the model. These components are installed on a cart for easy transportation, and connected so that the only setup required is connecting AC and RF power. The cart is suitable for use in a cleanroom environment, and is equipped with four swivel casters for maximum maneuverability.

Items Supplied

Stainless Steel Cart with the following items installed:

- Bird 4421 RF Power Meter
- Two (2) Bird 4020, 4027A, or 4027F Series Sensors
- Bird Load with Shipping and Vent Plugs
- Cabling
- Instruction Manual

RF Power Meter

The Bird 4421 RF Power Meter measures forward and reflected RF power when used in conjunction with a Bird power sensor. Measurements can be made in units of either Watts or dBm. Because of the precision of the attached load, reflected power will be negligible and can usually be ignored.

Note: *The 4421 is equipped with rechargeable batteries. These are shipped uncharged. Connect the unit to AC power the first time you use it to charge the batteries.*

Power Sensor

Sensors are available with a variety of connectors. Since the accuracy is critically dependent on the connectors used at calibration, do not remove or change the connectors. Sensors are controlled by the Bird 4421 Power Meter.

WARNING

Potential Fire Hazard

Do not regularly exchange the power sensors installed in this Cal-Cart. Frequent interchange of power sensors can lead to cable / connector interface stresses that may impact the integrity of the cable outer conductor, resulting in points of high current density in the cable outer conductor. When this condition occurs, failure of the interconnecting RF cable is likely due to heating.



CAUTION

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

4020 Series

Bird 4020 Series Power Sensors are designed for lab or field use and are accurate to within $\pm 3\%$ of reading.

4027A Series

Bird 4027A Series Power Sensors are designed for use in semiconductor processing and calibration applications. Stringent calibration provides long-term unit-to-unit repeatability, allowing consistent amounts of RF energy to be applied to the etch process over many etch cycles. 4027A Sensors are accurate to $\pm 1\%$ at specified calibration frequencies and power levels.

4027F Series

Bird 4027F Series Power Sensors are similar to the 4027A series. However, additional filtering allows the 4027F to ignore harmonics of the signal being measured. The 4027F is also less sensitive to AM components of the signal. 4027F Sensors are accurate to $\pm 1\%$ at specified calibration frequencies and power levels.

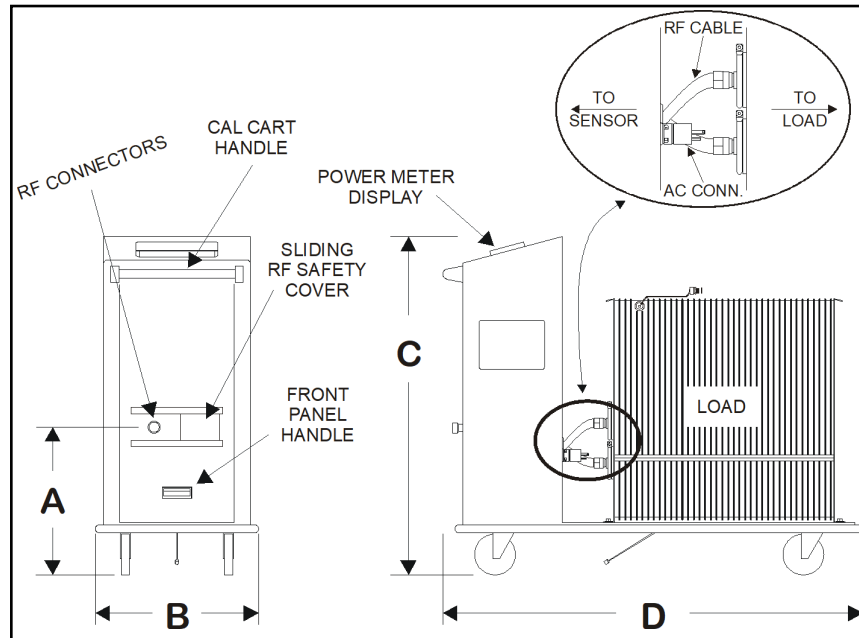
Load

Bird loads are available in power ranges from 1 – 10 kW. The loads have a coolant chamber surrounded by radiator fins. The front and rear fins form mounting flanges which are used as brackets for mounting the load on the Cal Cart. Vent plug(s) at the top of the load relieve internal pressure from coolant expansion. For further information, refer to the load manual included.

WARNING

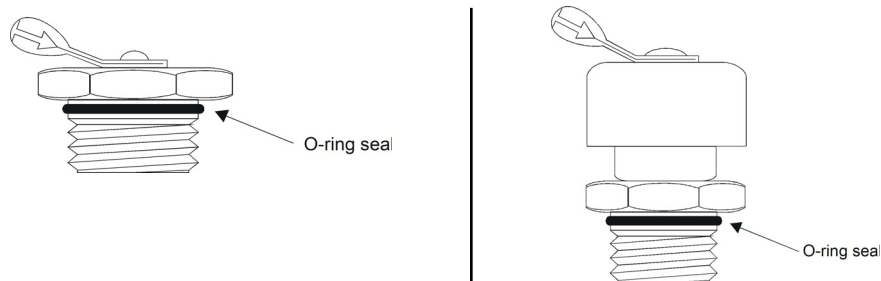
Refer to the supplied load manual for load-specific warnings and cautions.

Figure 1 Cal Cart Outline Drawing



DIM. A	DIM. B	DIM. C	DIM. D
22.5" (572 mm)	20" (508 mm)	42" (1067 mm)	42" (1067 mm)

Figure 2 Shipping and Vent Plug



CHAPTER 2

SETUP

Unpacking and Inspection

1. Carefully inspect shipping container for signs of damage.
 - If the shipping container is damaged, do not unpack the unit. Immediately notify the shipping carrier and Bird Technologies.
 - If the shipping container is not damaged, unpack the unit. Save shipping materials for repackaging.
2. Inspect unit for visual signs of damage.

Note: *If there is damage, immediately notify the shipping carrier and Bird Technologies.*

Setup

Setup consists of three basic steps: moving the Cal Cart into position, installing the vent plugs, and connecting AC power and the RF line. These steps are explained in more detail below.

WARNING

Do not attempt to lift the cart by the handle.

WARNING

All vent plugs must be installed on the load at all times when the unit is operating or cooling. Failure to do so could result in an explosion or severe burns.

WARNING

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

CAUTION

Check the electrical code for proper AC hookup prior to operation of the unit. Make sure the neutral or return hookup is only used for that purpose.

**CAUTION**

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

CAUTION

Use the Bird Cal Cart in a dry, dust and vibration free environment. Do not use outdoors or in areas of condensing humidity. Allow at least 12" (30 cm) of clearance around the load.

1. Remove the shipping plugs from the load.

2. Install the vent plugs, shown in [Figure 2](#).

Note: *The AC power supply required is 115/230 V @ 50/60 Hz, 1ϕ. The unit is equipped with an IEC 320 “cold” (65°C) AC inlet.*

Note: *If the load is not equipped with a blower, then the Bird Cal Cart may run on battery power after the 4421’s batteries have been charged.*

WARNING

RF Safety Cover provides protection against RF power.
Do not defeat this safety device.

3. Slide the safety cover to expose the desired sensor connector.

Note: *To connect the Cal Cart to the RF source, use 50 ohm coaxial cable suitable for the frequency and power level of operation. Use a connector which will mate with the cart’s exposed RF connector.*

CHAPTER 3

OPERATING INSTRUCTIONS

WARNING

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

WARNING

Refer to the supplied load manual for load-specific warnings and cautions.

Normal Operation**WARNING****Potential Fire Hazard**

Do not regularly exchange the power sensors installed in this Cal-Cart. Frequent interchange of power sensors can lead to cable / connector interface stresses that may impact the integrity of the cable outer conductor, resulting in points of high current density in the cable outer conductor. When this condition occurs, failure of the interconnecting RF cable is likely due to heating.

Note: After setting up the Bird Cal Cart:

1. Connect the unit to the AC line, if necessary.
2. Press the ON/OFF button on the Bird 4421.

Note: The power up display will appear for approximately one second and then change to the normal operating display.

For the 8931 and other loads with attached blowers ONLY:**CAUTION**

Maximum power dissipation is severely reduced when the blower is not running. If the indicator light should turn off, immediately reduce RF power by 75%.

1. Check that the indicator light is on.
2. Check that the switch is set to MANUAL.
3. Apply RF power.
4. Make measurements.

Note: See "[4421 Operating Instructions](#)" on page 7 for specific instructions on controlling the meter.

Shutdown

1. Turn off RF power at the source.
2. Press the ON/OFF button on the 4421.

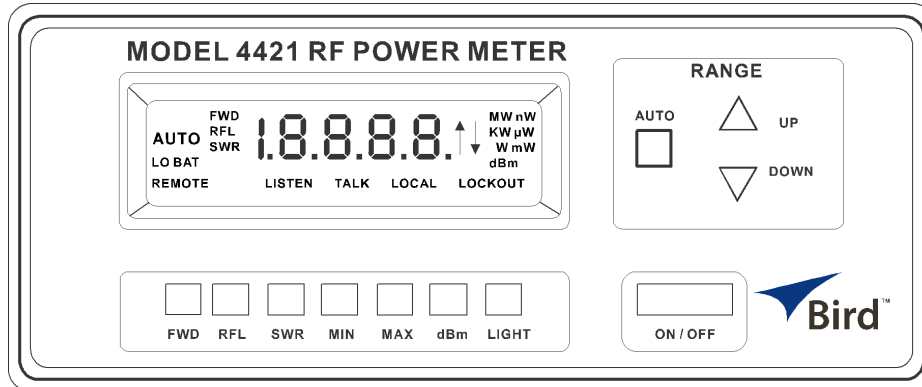
Note: For blower-equipped loads, wait approximately 15 minutes or for the fans to stop running. This will allow the load to cool without causing heat stress.

3. Disconnect the AC line.

This chapter describes operator controls and indicators on the Bird 4421 RF Power Meter.

Push Button Functions

Figure 3 Push Buttons



Push Button	Description
FWD, RFL	Press to measure forward (reflected) RF power. FWD (RFL) indicator and current unit of measure turn on.
SWR	Press to measure standing wave ratio. SWR indicator turns on. Value displayed will be between 1.0 and 199.9
MIN, MAX	Used after pressing FWD, RFL, SWR, or dBm. Displays the minimum (maximum) measured value of the previous function as long as MIN (MAX) is held down.
dBm	Used after pressing FWD or RFL. dBm indicator turns on. Power is displayed in dBm units. Used after pressing SWR. Return loss is displayed.
LIGHT	Press to turn on or turn off the display's back light. If left on, the light automatically shuts off after 30 minutes.
AUTO	Press to automatically set the scale. AUTO turns on.
UP, DOWN	Press to select the next higher (lower) scale. If the scale is too high for the power sensor, an error will be displayed. Used while AUTO indicator is on. Stops automatic scaling. AUTO indicator turns off.
ON/OFF	Press to turn the power meter on or off.

Error Codes

The Bird 4421 displays error codes when the RF power is either below the selected range (underrange) or above the selected range (overrange). [Figure 4](#) displays the error codes and [Figure 5](#) lists the function limits.

Figure 4 Error Codes

Symbol	Explanation
□□	Value greater than overrange limit of function
□□	Value less than underrange limit of function

Figure 5 Function Limits

Function	Limit	Error
FWD, RFL	Power > 199.9% of full scale or 120% of top range	Ovrange
FWD dBm, RFL dBm	Power > 120% of full scale Power < 3% of low range	Ovrange Underrange
SWR	FWD < 20% of low range FWD – RFL = 0	Underrange Ovrange
Return Loss	FWD < 20% of low range RFL < 20% of low range Return Loss > 40 dB	Underrange Underrange Underrange

Audible Warning

If the RF power level exceeds 120% of the power sensor's maximum power capability, the power meter will sound a warning buzzer.

This chapter describes routine maintenance, along with troubleshooting instructions for the power meter and power sensor. Disassembly instructions for the Bird Cal Cart are also provided. For service beyond this level, return the unit to a qualified service center.

WARNING

To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

WARNING

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

CAUTION

The Bird 4421 contains no user-serviceable parts. Do not remove its cover.

The Bird 4421 Power Meter requires only simple, routine maintenance.

- Wipe off dust and dirt regularly.
- Check the connectors and cables for damage.
- Clean the connector contacts with alcohol or dry cleaning solvent.

Power Meter Troubleshooting

Since the power meter and power sensor can only work together, the first step is to determine which is malfunctioning. Connect the power sensor to the meter and perform the functional test on [page 10](#). If the power meter is malfunctioning, refer to the troubleshooting table below. If the power sensor is malfunctioning, return it for service.

CAUTION

Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted. Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

This manual cannot list all malfunctions that may occur, or corrective actions. If a malfunction is not listed or is not corrected by the listed corrective actions, contact a qualified service center.

Note: *For all power sensor tests, following the test procedure will check the sensor not covered by the safety cover. To test the other sensor slide the safety cover over, then proceed as normal.*

PROBLEM	POSSIBLE CAUSE	CORRECTION
Power meter has no power	The batteries are not charged.	Recharge the batteries.
	The power meter's AC power cord is not connected to the terminal strip	Connect the power cord
	The Cal Cart's AC power cord is not connected to the AC line.	Connect AC power.
	The ON/OFF rocker switch on the rear panel set to OFF.	Set the switch to ON.
	The power meter fuse is blown. Note: <i>To check fuse, unplug the Cal Cart.</i>	Check fuse rating & replace fuse. See " Replace Power Meter Fuse " on page 12.
Dash moves across the display	The AC power cord is defective.	Replace AC power cord.
	The sensor cable is not connected to the power meter and/or power sensor.	Connect sensor cable.
	The sensor cable defective.	Replace sensor cable.
Display blank or not updating	The batteries are not charged.	Recharge battery.
	The meter is defective.	Return meter for service.
Power meter turns off while on battery power	"LO BAT" displayed.	Recharge battery.
	The meter is defective.	Return meter for service.
Push buttons do not respond to testing. See " Push Button Test " on page 11.	Push buttons are defective.	Return meter for service.
Every segment on the display is lit.	The meter is defective.	Return meter for service.

Functional Test

This test determines whether the power meter or the sensor is malfunctioning.

1. Disconnect the AC power cable and turn the power meter off.

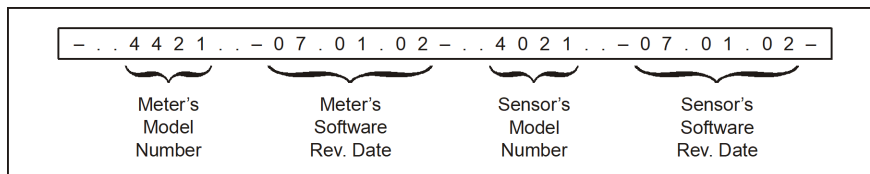
Note: *The ON/OFF switch on the rear panel of the meter should be ON.*

2. Connect the AC power cable.
3. Hold down the FWD and SWR push buttons and press the ON/OFF button on the *front* panel of the power meter.
4. Immediately release all three.

Note: *The power meter's model number and revision date should scroll across the display.*

- If a dash "-" is displayed instead, then the meter is malfunctioning.
- If a dash is displayed after the power meter data, then the power sensor is malfunctioning.

Figure 6 Test Display, No Malfunction



Push Button Test

This test checks that the push buttons and display are functioning properly. If a push button is malfunctioning, return the power meter.

1. Disconnect the power sensor.
2. Turn the power meter ON.
Note: *After the power up display disappears, three dashes “— — —” should scroll across the display.*
Note: *“AUTO” and “FWD” should be displayed, and a reading of “.000 W”.*
3. Press RFL.
Note: *“FWD” should change to “RFL” on the display. The reading should remain the same.*
4. Press SWR. “RFL” should change to “SWR”.
Note: *“.000 W” should change to “□□” (underrange error).*
5. Hold down MIN.
Note: *“□□” should change to “□□” (overrange error).*
6. Release MIN.
Note: *“□□” should change to “□□”.*
7. Hold down MAX.
Note: *“□□” should change to “.000”.*
8. Release MAX.
Note: *“.000” should change to “□□”.*
9. Press dBm.
Note: *“SWR” should change to “dBm”.*
10. Press dBm.
Note: *“dBm” should change to “SWR”.*
11. Press FWD.
Note: *“SWR” should change to “FWD” and “□□” to “.000 W”.*
12. Press LIGHT.
Note: *The back-light should turn on.*
13. Press LIGHT.
Note: *The back-light should turn off.*
14. Press S (up).
Note: *The power meter should change ranges each time it is pressed until it reaches “.000 KW”.*
15. Press t (down).
Note: *The power meter should change ranges each time it is pressed until it reaches “.000 W”.*
16. Turn the power meter OFF.

Repair

WARNING

To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

Remove Front Panel

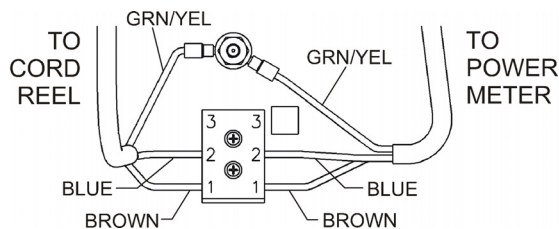
To access the power sensor or the AC connections, it will be necessary to remove the front panel of the Cal Cart.

1. Remove both screws on the front panel, between the RF connector and the handle.
2. Pull on the handle set into the base of the front panel to remove it.

Replace Cord Reel

1. Disconnect the cord reel from the terminal strip.
2. Unscrew the AC connector.
3. Unscrew and remove the cord reel.
4. Screw the replacement cord reel into place.
5. Thread the AC connector through the grommet.
6. Replace the ring terminal on the green/yellow wire.
7. Connect the wires on the other end to the terminal strip (See [Figure 7](#)).

Figure 7 Cal Cart Wiring Schematic



Replace Power Meter Fuse

WARNING

To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

CAUTION

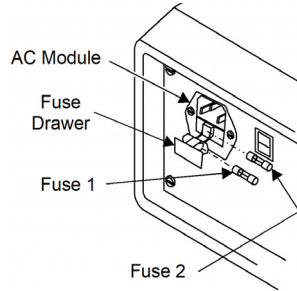
Failure to install the properly rated fuse may result in equipment damage or nuisance failures.

1. Gently pry the fuse drawer out of the AC module. See [Figure 8 on page 13](#).

Note: The fuse holder does not detach from the AC module.

2. Install the replacement fuses.
3. Close and secure the fuse holder.

Note: Fuse 1 is a spare fuse and fuse 2 is the active fuse.

Figure 8 AC Line Fuse

AC Line Voltage	Fuse Rating
115 VAC	T630 mA, 5x20 mm Time Lag Fuse
230 VAC	T315 mA, 5x20 mm Time Lag Fuse

Replacing Power Meter Batteries

There are two battery configurations in the 4421 Power Meter. In the larger case models (before 2016), the batteries are horizontally arranged, in units with a smaller case the batteries are vertically arranged in a battery assembly

Replace Batteries (Older models)

WARNING

Exposed AC line voltage (115 VAC or 230 VAC). Disconnect the power cord from the AC line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

1. Disconnect the AC power cord from the AC mains supply.
2. Remove the four screws securing Power Meter top cover.
3. Lift the top cover to access the attached ground wire.
4. Disconnect the ground wire.
5. Remove the cover.
6. Unfasten the battery retaining belts. See [Figure 9 on page 14](#).
7. Remove the battery tubes.

Note: Be sure to note the polarity and orientation of the battery tubes before removing them.

8. Remove the batteries from each tube.
9. Insert replacement batteries in each tube.

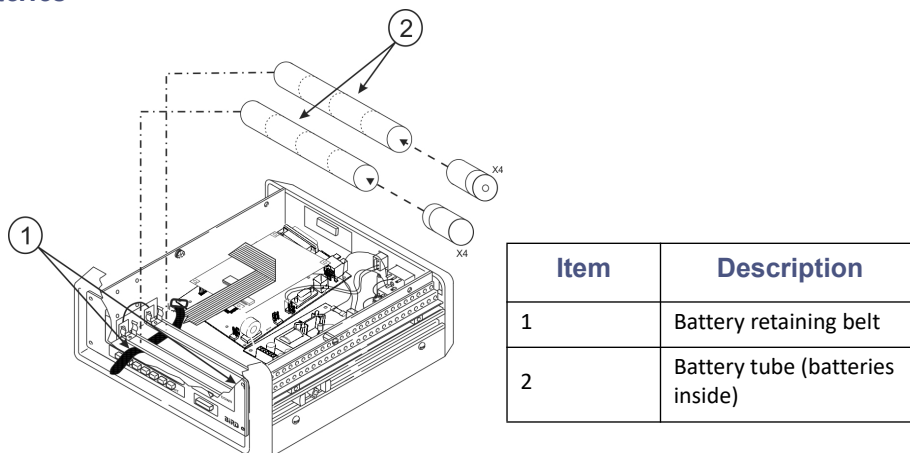
Note: Be sure to note the polarity (positive and negative) arrangement of the batteries.

10. Install the battery tubes into the unit and secure with the retaining belts.

Note: Be sure to position the retaining belts as they were before removal and tighten them securely.

11. Connect the ground wire to the top cover.
12. Install the top cover.
13. Secure it with the four screws removed earlier.

Figure 9 Batteries



Replace Batteries (Newer models)

WARNING

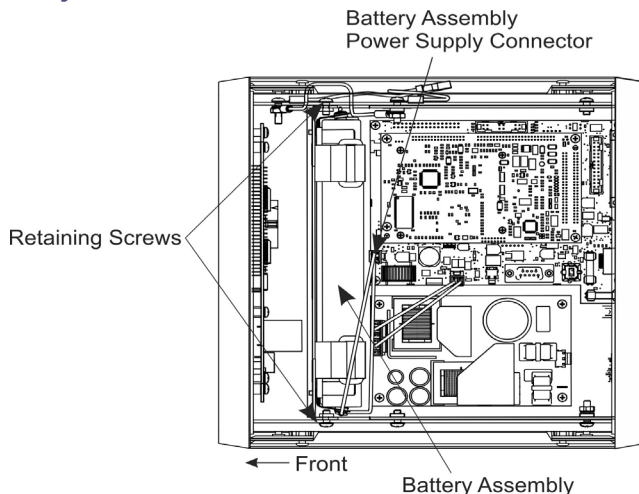
Exposed AC line voltage (115 VAC or 230 VAC). Disconnect the power cord from the AC line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

WARNING

Use only Nickel Metal Hydride (NiMH) batteries that have a minimum capacity of 4500 milliampere hours (mAh). Do not install batteries that are not Nickel Metal Hydride. Do not install NiMH batteries that have less than 4500 mAh capacity. Failure to comply may result in damage to the batteries, damage to the instrument, and injury to personnel from battery chemicals.

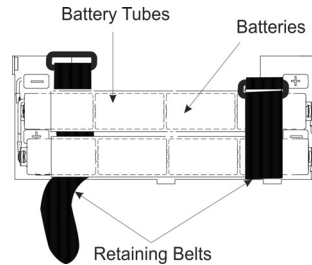
1. Disconnect the AC power cord from the ac mains supply.
2. Remove the four screws that secure the top cover.
3. Lift the top cover to access the attached ground wire then disconnect the ground wire and remove the cover.
4. Remove two retaining screws securing the battery assembly. See [Figure 10](#).
5. Disconnect battery assembly power supply connector.

Figure 10 Battery Assembly Removal



- Lift the battery assembly out of the Power Meter.
- Unfasten the battery retaining belts then remove the battery tubes ([Figure 11](#)). Be sure to note the polarity and orientation of the battery tubes before removing them.

Figure 11 Battery Assembly



- Remove the batteries from each tube and insert replacement batteries. Be sure to note the polarity (positive and negative) arrangement of the batteries.
- Install the battery tubes into the battery assembly and secure with the retaining belts. Be sure to position the retaining belts as they were before removal and tighten them securely.
- Install battery assembly in the Power Meter. Align tabs on battery assembly with slots in Power Meter.
- Install two screws to secure battery assembly to Power Meter.
- Connect the battery assembly power supply connector to the main board.
- Connect the ground wire to the top cover.
- Install the top cover and secure it with the four screws removed earlier.

Replace Power Sensor

Replacement of the power sensor is only recommended when replacing failed or malfunctioning units. Power Sensors should not be changed as a regular operational activity.

WARNING

To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

WARNING

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

WARNING

Potential Fire Hazard

Do not regularly exchange the power sensors installed in this Cal-Cart. Frequent interchange of power sensors can lead to cable / connector interface stresses that may impact the integrity of the cable outer conductor, resulting in points of high current density in the cable outer conductor. When this condition occurs, failure of the interconnecting RF cable is likely due to heating.

CAUTION

The Bird 4421 must be powered off when connecting or disconnecting the power sensor from the power meter.

**CAUTION**

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

CAUTION

Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted. Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

1. Disconnect the RF line from the Cal Cart.
2. Remove the Cal Cart front panel (see ["Remove Front Panel" on page 12](#)).
3. Disconnect the sensor cable from the power sensor.
4. Disconnect the RF cable from the sensor output port.
5. Remove the screws on the sensor mounting bracket.
6. Remove the sensor from the mounting bracket.
7. Put the new sensor in the bracket and screw it into place.

Note: Make sure the arrow on the side of the sensor points towards the load, and that the end labeled "SOURCE" points towards the front of the Cal Cart.

8. Connect the RF cable to the sensor end labeled "LOAD".

Note: Connect the sensor cable.

9. Replace the Cal Cart front panel.

Remove Load

WARNING

Heavy load. Do not attempt to lift unaided.

1. Disconnect the RF cables from the RF connectors on the load.
2. On blower-equipped loads, unplug the blower assembly.
3. Replace the vent plugs with the shipping plugs.
4. Remove the mounting bolts connecting the load to the Cal Cart.
5. Remove the load.

Replace Casters

1. Remove the load (See ["Remove Load" on page 16](#)).
2. Flip the cart over.
3. Unscrew the defective caster.
4. Screw the new caster into place and replace the load.

Replace Handle

1. Unscrew and remove the old handle.
2. Screw the new handle into place.

Storage and Shipment

Storing the Load Resistor

- Cover the cal cart before storing to keep out dust and dirt.
- It is not necessary to install the shipping plug.
- Store in a dry, dust-free environment where the ambient temperature will remain between -40 and $+45$ °C (-40 to $+113$ °F).

Shipping the Load Resistor

1. Remove the vent plug.
2. Install the shipping plug.
3. Wrap the vent plug with padding and tape it to the side of the load for protection.

Note: *With the shipping plug installed, it is not necessary to empty out the coolant.*

4. Wrap the connector in padding.
5. Pack and brace the load in a sturdy wooden crate for shipment.

Customer Service

Any maintenance or service procedure beyond the scope of those in this chapter should be referred to a qualified service center.

If the unit needs to be returned for any reason, request an Return Material Authorization (RMA) through the Bird Technologies website. All instruments returned must be shipped prepaid and to the attention of the RMA number.

Bird Service Center

30303 Aurora Road
Cleveland (Solon), Ohio 44139-2794
Fax: (440) 248-5426
E-mail: bsc@birdrf.com

For the location of the Sales Office nearest you, visit our Web site at:

<http://www.birdrf.com>

Specifications

Note: Certain sensors or connectors may be incompatible with some models. For a list of available components, contact Bird Applications Engineering.

Max. Power

Under normal operating conditions, the Cal Cart's maximum power is the MINIMUM of the max. power of the sensor and the max. power of the load. The following modifiers apply:

Note: Due to the wide variety of available connectors, frequency range and maximum power may be reduced. Insertion loss is specified with female N connectors. Choose connectors appropriate for the frequency and power of operation.

Note: Derate RF power by 2.5% for every 305m (1,000 ft.) above 1,520m (5,000 ft.).

Bird Cal Cart

Frequency Range	Sensor dependent, 30 MHz max.
Power Range	Dependent on sensor, sensor connectors, and load
Connectors	Customer specified (See " Available Connectors " on page 22)
Dimensions	52"L x 20"W x 42"H (1321 x 508 x 1067 mm)
Weight, Nominal	290 lbs. (114 kg)
Temperature Range	
Operating	0 to +35 °C (32 to +95 °F)
Storage	-20 to +70 °C (-4 °F to +158 °F)
Altitude	1520 m (5000 ft.)
Humidity	85% noncondensing max
Calibration Cycle, Nominal	1 year
CE	CE Compliant. Refer to Declaration of Conformity for specific standards.



CAUTION

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Specifications Common to all Sensors

Impedance, Nominal	50 ohms
Max. Allowable Terminating VSWR	2.00:1
Calibration Technique	Frequency-specific calibration factors stored in nonvolatile memory in each sensor. Sensor output corrected for frequency and temperature within specified ranges.
Accuracy, Reflected	Calculated from FWD accuracy and FWD power $\text{RFL Accuracy} = \text{FWD Accuracy} + \frac{\text{FWD Power}}{10^{\text{Directivity}/10}}$
Accuracy, VSWR	Calculated from FWD and RFL power $\text{VSWR} = \left(1 + \sqrt{\frac{P_R}{P_F}} \right) / \left(1 - \sqrt{\frac{P_R}{P_F}} \right)$

Sampling Rate, Nominal	2 readings/second
Operating Power	Supplied by power meter via sensor cable
Dimensions 4028B10M 4028A Series All other models	6.75" L x 3.5" W x 4.75" H (175 x 89 x 121 mm) 4.7" L x 3.2" W x 3.8" H (120 x 82 x 97mm) 5.2" L x 2.5" W x 3.25" H (137 x 64 x 83 mm)
Weight, Nominal 4028B10M 4028A2M, 3M, 4M, 10M, & 25M All other models	5 lb. 2 oz. (2.33 kg) 3 lb. 5 oz. (1.5 kg) 1 lb. 13 oz. (0.8 kg)

Bird 4020 Series RF Power Sensors

RF Power Range 4021, 4022 4024, 4025	300 mW – 1 kW 3 W – 10 kW
Frequency Range 4021 4022 4024 4025	1.8 – 32 MHz 25 MHz – 1 GHz 1.5 – 32 MHz 100 kHz – 2.5 MHz
Accuracy, Fwd, Best Case¹	± 3% (1σ)
VSWR, Max. 4021, 4024, 4025 4022	1.05:1 1.05:1, 25 – 512 MHz 1.10:1, 512 MHz – 1 GHz
Insertion Loss, Max. 4021, 4024, 4025 4022	0.05 dB 0.05 dB, 25 – 512 MHz 0.13 dB, 512 MHz – 1 GHz
Directivity, Min. 4021 4022 4024 4025	30 dB 26 dB (28 dB typ), 400 – 1000 MHz 30 dB, 25 – 400 MHz 28 dB, 1.5 – 2.5 and 25 – 32 MHz 30 dB, 2.5 – 25 MHz 28 dB, 100 – 125 kHz 30 dB, 125 – 2500 kHz

1 For rated accuracy, no more than 1% AM; Harmonics –50 dBc or less
Derate accuracy by 3.0% (1σ) below 15 °C and above 35 °C



CAUTION

Changing the sensor’s connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Bird 4027A Series RF Power Sensors

Frequency Range			
4027A250K	250 – 400 kHz		
4027A400K	400 – 550 kHz		
4027A800K	800 – 950 kHz	4027A12M	10 – 15 MHz
4027A2M	1.5 – 2.5 MHz	4027A25M	25 – 30 MHz
4027A4M	3 – 5 MHz		
4027A10M	10 – 15 MHz		
RF Power Range			
4027A12M	300 mW – 1 kW	All other models	3 W – 10 kW
4027A25M	3 W – 9 kW		
Accuracy, Fwd, Best Case¹		± 1.0% (1 σ)	
Calibration Frequencies, Typical (MHz)²			
4027A250K	0.25, 0.40		
4027A400K	0.40		
4027A800K	0.90	4027A12M	10.0, 13.56, 15.0
4027A2M	1.8, 2.0, 2.17	4027A25M	25.76, 27.12, 28.48
4027A4M	4.0, 5.0		
4027A10M	10.0, 13.56, 15.0		
Calibration Power, Typical			
4027A12M		700 W	
All other models		1.7 kW	
VSWR, Max.		1.05:1	
Insertion Loss, Max.		0.05 dB (with female “N” connectors)	
Directivity, Min.			
4027A12M		30 dB	
All other models		28 dB	

- 1 For rated accuracy, no more than 1% AM; Harmonics –50 dBc or less
Derate accuracy by 1% (1 σ) outside cal. power or cal. frequency
Derate accuracy by 1% (1 σ) below 15 °C and above 35 °C
- 2 Other calibration frequencies available upon request

Bird 4027F Series RF Power Sensors

Frequency Range	
4027F2M	1.8 – 2.2 MHz
4027F10M	12 – 15 MHz
RF Power Range	
4027F2M, 4027F10M	0.1 – 10 kW
Accuracy, Fwd, Best Case	
± 1.0% (2 σ)	
Calibration Frequencies, Typical¹	
4027F2M	1.8, 2.0, 2.17 MHz
4027F10M	12.0, 12.5, 13.56, 14.0, 15.0 MHz
Calibration Power, Typical	
1.7 kW	
Harmonic Rejection, Min.	
4027F2M	26 dB @ 3.6 – 3.8 MHz, 30 dB @ > 3.8 MHz
4027F10M	30 dB @ > 25 MHz
Low Frequency Rejection, Min.	
4027F10M	30 dB @ < 1 MHz

Max Error Induced by 10% AM 4027F2M, 4027F10M	0.2% @ < 5 kW, 1.0% @ 5 – 10 kW
VSWR, Max.	1.05:1
Insertion Loss, Max.	0.05 dB (with female “N” connectors)
Directivity, Min.	28 dB

1 Other calibration frequencies available upon request

Uncertainty Budget, 4027F Series¹		4027F2M	4027F10M
Frequency Error...	at cal freq	± 0.1%	± 0.1%
	not at cal freq	± 0.5%	± 1.5%
Power Linearity...	at cal power	± 0.1%	± 0.1%
	not at cal power	± 1.0%	± 0.5%
Temperature Uncert...	within 20 to 30°C	± 0.65%	± 0.6%
	outside 20 to 30°C	± 3.2%	-3.0, +0.75%
Calibration Uncertainty		± 0.6%	± 0.6%
Resolution Uncert...	at cal power	± 0.06%	± 0.06%
	not at cal power ²	± 0.34%	± 0.34%
Other sources of error		± 0.4%	± 0.5%
Best Case RSS Uncertainty		± 1.0%	± 1.0%

1 All values 2σ

2 Resolution uncertainty is error due to limited display digits. Actual uncertainty can be calculated as
 $\pm (1 \text{ in least significant digit}) / \text{Reading}$
 For a 3.5-digit display, worst case is at 300W. Least significant digit is one watt, uncertainty is ± 1W out of 300 or 0.34%. For a 4.5-digit display, least significant digit is 0.1W, so the uncertainty is 0.034%

Replacement Parts

Description	Qty	Part Number
Fuse, IEC (5 x 20 mm) Time Lag Type T 115 VAC, T630 mA 230 VAC, T315 mA	1	5A2257-14 5A2257-11
Cord, AC Power 115 VAC 230 VAC Harmonized	1	5-1286 5A2416
Plug, 115 VAC	1	5A2626
Cable, Sensor	1	4421-038
Grommet	1	4421A372
Cordreel	1	4421A383
Casters	4	4421A384
Handle	1	4421A385
Battery, C size, NiMH	8	5A1230

Available Connectors



CAUTION

Changing the sensor's connectors will invalidate calibration data, and may reduce the maximum power rating of the unit.

Connector	Part Number
HN (F)	4240-268
LC (F)	4240-031
N (F)	4240-062
7/16 Jack, IEC Type 169-4	4240-344
TRU 6934 (F)	4240-371
TRU 7958 (F)	4240-372

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 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. Routine (regularly required) calibration is not covered under this limited warranty. 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. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR 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.

Special Lifetime Warranty - Series 4020, Series 4027A, Series 4027F, and Series 4028 Power Sensor Head

In addition to its standard warranty, the Bird Electronic Corporation warrants its Series 4020, Series 4027A, Series 4027F, and Series 4028 Thruline Power Sensor Heads for lifetime to original purchaser. This extended warranty is against burnout. For the warranty to apply, the Sensor Head must be used with the correct Bird Electronic Corporation Display Unit, the maximum power rating of the Sensor must not be exceeded, the Sensor RF circuit must be properly terminated and the Sensor not subjected to physical abuse.

Bird Electronic Corporation, at its option, will repair or replace the defective Sensor at its world Headquarters at 30303 Aurora Road, Solon, Ohio 44139.

The customer is responsible to pay transportation charges to return the defective sensor to Bird.