HIGH POWER SEMICONDUCTOR CAL CART

Operation Manual

Instruction Book Part Number 920-HPCC Rev. L

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.

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.

	This symbol indicates that a shock hazard exists if the precautions in the instruction manual are not followed.
	The caution symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area.
	This symbol indicates that the unit radiates heat and should not be touched while hot.

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

Do not attempt to lift the cart by the handle.

On page 4.

WARNING

Ethylene glycol is toxic. Do not take internally. Avoid contact with eyes, skin, and clothing. Avoid breathing vapor. Wash thoroughly after handling.

On page 5.

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 7, 9, 14, 15, 18 and 24.

WARNING

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

On pages 14, 18, 21, 22, 24, 25 and 26.

WARNING

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

On page 14.

Caution Statements

The following equipment cautions appear in the text and are repeated here for emphasis.

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.

On page 4.

CAUTION

Do not block air flow. The air intake vents on the side of the heat exchanger and the exhaust on top must not be obstructed.

On page 4.

CAUTION

Use only distilled water or ethylene glycol as coolant. Do not use tap water, automotive antifreeze, sealants, or leak stopping material. Use of these materials will damage the instrument and void all warranties.

On pages 5 and 15.

CAUTION

Operation without sufficient coolant will damage the unit.

On pages 5, 9 and 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 17 and 21.

CAUTION

Failure to install a properly rated fuse may result in damage to equipment or nuisance failure.

On page 22.

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 HACERIO.

WARTUNG

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

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

ENTRENTIEN

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 EFFETTUARRE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.

About This Manual

This manual covers the operating & maintenance instructions for models in the following table:

Table 1 Model Identification

SCC8	X	XX	XX	XX	X
	Meter	Sensor	Load	Connector	Voltage
	2) 4421A802-3 Meter, Serial	01) 4028B10M 10-15 MHz 02) 4028A250K 250-400 kHz 03) 4028A400K 400-550 kHz 04) 4028A2M 1.5-2.5 MHz 05) 4028A3M 2.5-3.5 MHz 06) 4028A4M 3.5-4.5 MHz 07) 4028A10M 10-15 MHz 08) 4028A25M 25-30 MHz 09) 4027A10M 10-15 MHz 10) 4027A250K 250-400 kHz 11) 4027A400K 400-550 kHz 12) 4027A800K 800-950 kHz 13) 4027A2M 1.5 - 2.5 MHz 14) 4027A4M 3 - 5 MHz 15) 4027A12M 10-15 MHz 16) 4027A25M 25-30 MHz 17) 4027A35M 35-45 MHz 18) 4027A60M 45-35 MHz 19) 4021 1.8-32 MHz 20) 4022 25-1000 MHz 21) 4024 1.5-32 MHz 22) 4025 0.1-2.5 MHz 23) 4027A100M 95-105 MHz 24) 4027A150M 150-170 MHz 25) 4027F10M 13.56 MHz 26) 4027F2M 1.8-2.2 MHz 27) 4027AF60M 57-63 MHz 28) 4028B3M 2.5-4 MHz	02) 8640 1 kW Load	01) 4240-096 1-5/8" Flanged 02) 4240-062 N, Female 03) 4240-344 IEC 7/16 04) 4240-031 LC, Female 05) 4240-268 HN, Female 06) 4240-371 TRU 6934F 07) 4240-372 TRU 7958F 08) 4240-063 N, Male 09) 4240-025 LC, Male 10) 4240-363 IEC 7/16 M	1) 115V 60 Hz 2) 230V 50 Hz 3) 115V 50 Hz 4) 230V 60 Hz

Note: *Not all combinations are possible, this table is meant to provide definition of existing model numbers. Contact a Bird Sales Associate for help with specific requirements.*

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.

Terminology

There are some unique terms used throughout this literature. They are defined here to clarify any misunderstanding.

Cal Cart — The entire unit.

Sensor — The power sensor

Meter — The power meter and display

Load — The entire load (water-cooled RF termination).

Resistor Assembly — The load component which connects directly to the RF line. It is inside the HEAT EXCHANGER, connected by two hoses.

Heat Exchanger — The parts of the Moduload left when the LOAD is removed. It contains the pump, fans, coolant reservoir, and controls.

Resistor — A subcomponent of the RESISTOR ASSEMBLY. This is the ceramic resistor which actually absorbs the RF power.

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.

4421A Instructions — All instructions necessary to operate the 4421A 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.

Table of Contents

Chapter 1 Introduction

This instruction book is intended for use by operators of the Bird High Power Cal Cart (HPCC). This chapter contains introductory information including component descriptions and items supplied.

The HPCC is designed for immediate, effortless use. It has three primary components. The Bird 4421A RF Power Meter displays RF power measurements. Bird 4028 Series Power Sensors are highly accurate sensors that measure RF power without requiring calibration or external couplers or attenuators. Bird Moduloads are low reflection 50 Ω terminations that can dissipate 25 kW. These components are installed on a cart for easy transportation. The cart is suitable for use in a cleanroom environment, and is equipped with four swivel casters for maximum maneuverability. The only setup required is adding coolant and connecting AC and RF power.

Items Supplied

Stainless Steel Cart with the following items installed:

- Bird 4421A RF Power Meter
- Bird 4028 Series Sensor
- Bird 8640B Series Moduload
- Cabling
- Instruction Manual

RF Power Meter

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

Power Sensor

Bird 4028 Series Power Sensors are designed for use in semiconductor processing and calibration applications. 4028 Sensors are accurate to ±2%(2σ) at specified calibration frequencies and power levels. Sensors are controlled by the Power Meter.

Load

Bird Moduloads are self-cooling, nonradiating, low reflection terminations for high power RF lines. They dissipate up to 25 kW with a VSWR of less than 1.1:1 from 1 kHz to 900 MHz.

Features

- Useable with CW, AM, FM, SSB, and TV modulation, and certain pulse types.

  Note: *Contact Bird Technologies for information on using Moduloads with pulsed signals.*

- Self-contained water-based cooling system.

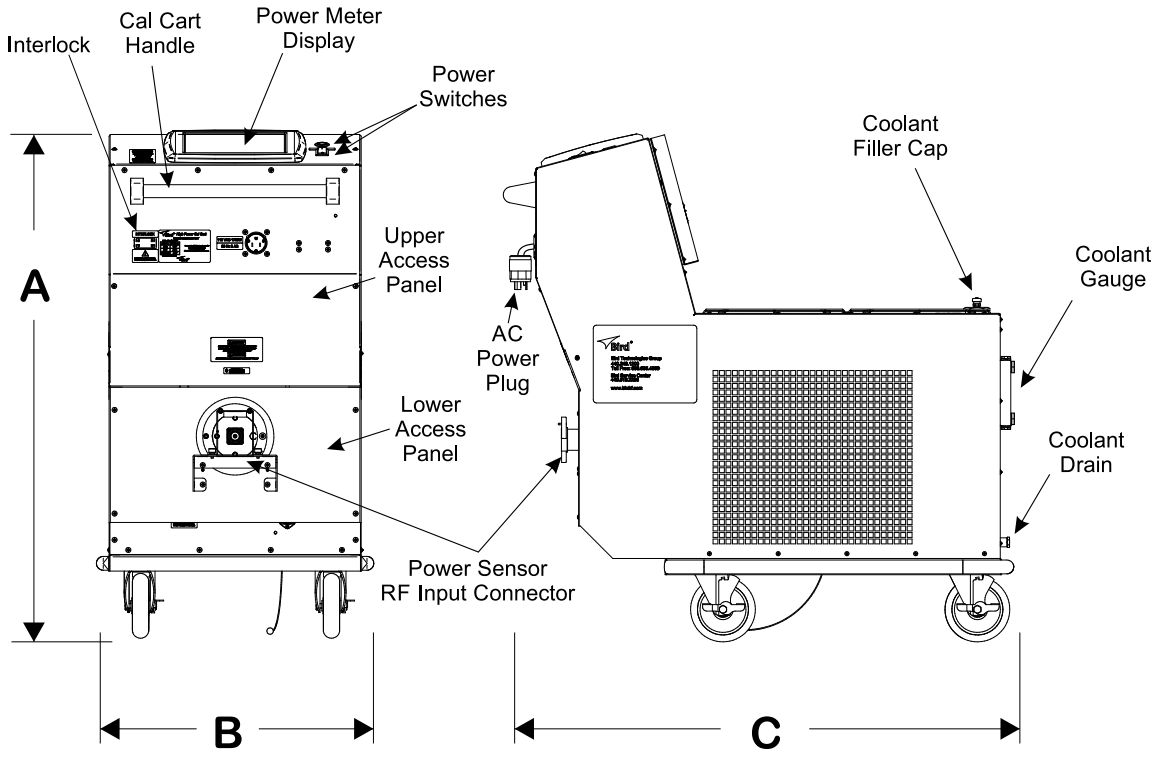
Indicators

- Coolant Level Gauge.

Interlock

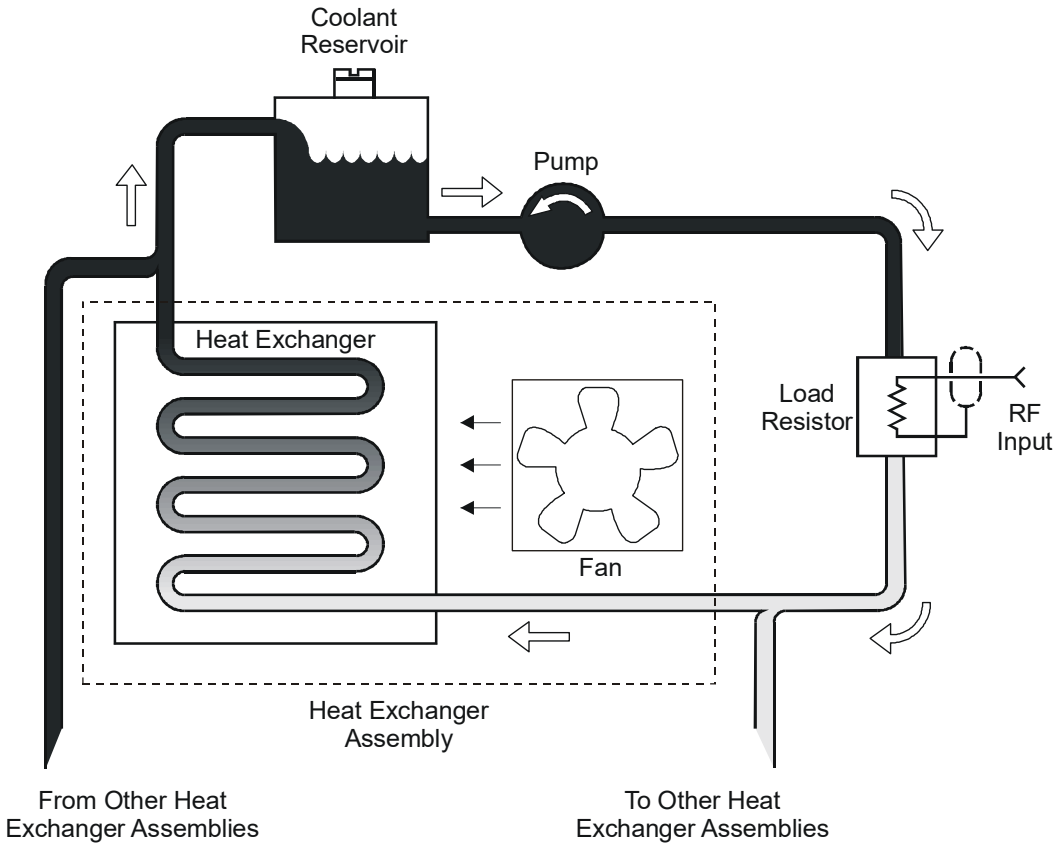
- The transmitter interlock triggers as a result of either high coolant temperature or low coolant flow. It will also be active for about 2 seconds after power up or reset to ensure proper operation of the cooling system before allowing RF power.

Figure 1 Cal Cart Outline



DIM. A	DIM. B	DIM. C
39” (1001 mm)	21” (544 mm)	39” (1001 mm)

Figure 2 Load Cooling System Block Diagram



Chapter 2 Setup

This chapter provides information for on-site requirements, unpacking, inspection, and preparing the Bird High Power Cal Cart for use.

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 unit into position, adding coolant, 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.

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

Do not block air flow. The air intake vents on the side of the heat exchanger and the exhaust on top must not be obstructed.

- Use the HPCC in a dry, dust-free and vibration-free environment.

  Note: *Do not use outdoors or in areas of condensing humidity.*
- Allow a minimum of one foot clearance along the sides and three feet over the top to allow unobstructed air intake and exhaust.
- Surrounding air must be free of contaminants or particles that could be drawn into the air intakes.
- The AC power supply required is 115/230 V @ 50/60 Hz, 1ϕ.

  Note: *The unit is equipped with an unterminated, retractable power cord. Connect a power plug to this cord, appropriate to local power source.*

Coolant

WARNING

Ethylene glycol is toxic. Do not take internally.
Avoid contact with eyes, skin, and clothing. Avoid breathing vapor. Wash thoroughly after handling.

CAUTION

Use only distilled water or a distilled water/ethylene glycol mixture (with a maximum of 35% ethylene glycol) as coolant. Do not use tap water, automotive antifreeze, sealants, or leak stopping material. Use of these materials will damage the instrument and void all warranties.

Distilled water is the primary coolant for the unit. Ethylene glycol can be added to prevent bacterial growth and freezing; 10% to 35% ethylene glycol is recommended. Using at least 10% will prevent bacterial growth and at least 35% will prevent freezing to –20°C.

Note: *When using both ethylene glycol and distilled water, add the water first, then the ethylene glycol, to ensure proper mixing.*

Figure 3 on page 6 shows the coolant's freezing point for a given percentage of ethylene glycol in the mix. The following example shows the weights to make a 65% distilled water to 35% ethylene glycol mixture in 5 and 55 gallon quantities.

	5 Gal. (18.9 L)	55 Gal. (208.2 L)
Distilled Water	28.0 lb (12.7 kg)	310 lb (140.6 kg)
Ethylene Glycol	15.2 lb (6.9 kg)	167 lb (75.7 kg)

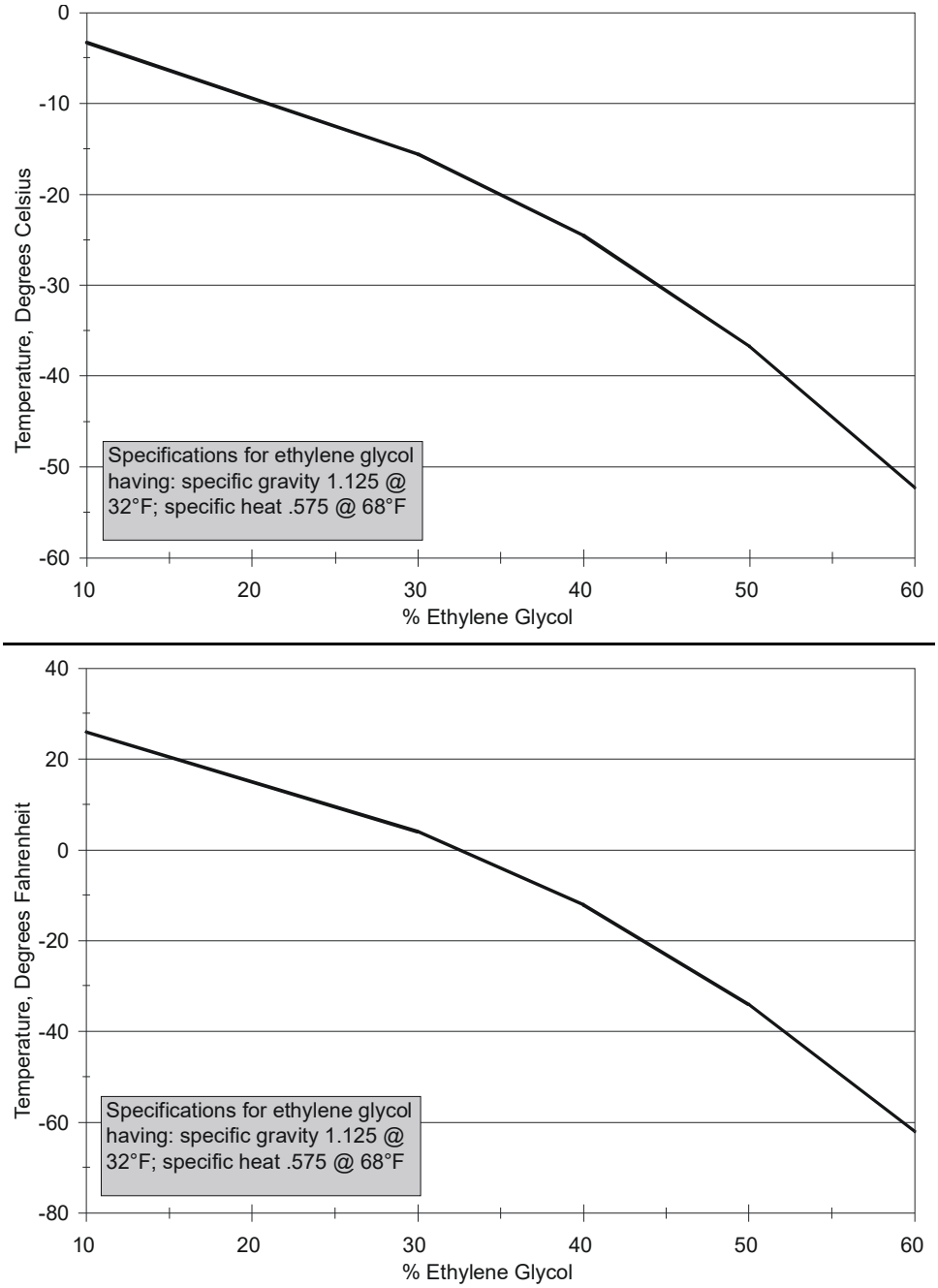
Adding Coolant

CAUTION

Operation without sufficient coolant will damage the unit.

1. Make sure that the drain plug is in place.
2. Remove the filler cap on the top and at the rear of the unit.
3. Add about 3 quarts (2.9 L) of coolant.
4. Turn the unit on for a few seconds to draw coolant into the system.
5. Repeat steps 3 and 4 twice more, until the coolant remains steady at or just below the high mark on the level gauge.
6. Replace the filler cap.
7. Turn the unit on
8. Run the unit for five minutes to remove any air trapped in the system.

Figure 3 Freezing Point of Ethylene Glycol / Distilled Water Mixture



Connecting RF Power

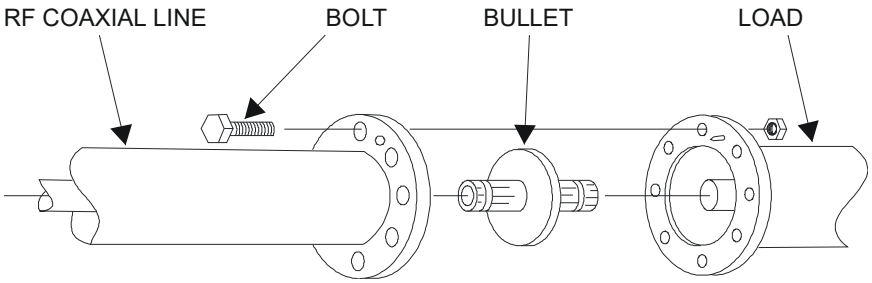
CAUTION

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.

After installing the Bird High Power Cal Cart, the RF transmission line can be attached using standard coaxial line coupling kits.

To couple the swivel flange with a flanged RF transmission line refer to Figure 4 while following the instructions below:

Figure 4 Swivel Flanged Coupling



1. Insert the center bullet and push it in until it is fully seated.
2. Connect the coaxial input in a straight line and push carefully on the center conductor to close.

   Note: *The swivel flange on the load makes connection independent of the orientation of the fixed flange on the coaxial input outer conductor.*
3. Insert the bolt sets and tighten evenly all around to transmission line manufacturer's recommended torque. Use all of the bolts.

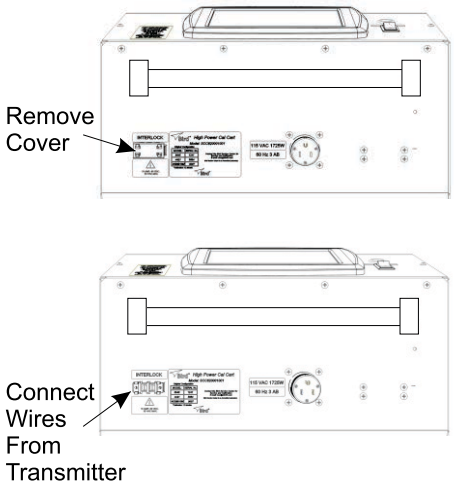
Interlock Connection

CAUTION
Do not operate without the interlock or with the load protection switch disabled or disconnected. Even momentary application of RF power while coolant is not circulating could cause immediate destruction of the load.

- Normally Closed (NC) circuit during normal operation. Opens for inadequate coolant flow or over temperature condition.
- 10A @ 30 VAC/60 VDC
- Use number 22 AWG (or heavier) wire for interlock connection. Attach solderless ring terminals to the wire for ease of installation.
- Connect the interlock wires to the interlock terminal strip as required for the transmitter.

Note: *Interlock contact resistance could be as high as 10 ohms for circuits drawing less than 250 mA.*

Figure 5 Interlock Connection



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.

CAUTION

Operation without sufficient coolant will damage the unit.

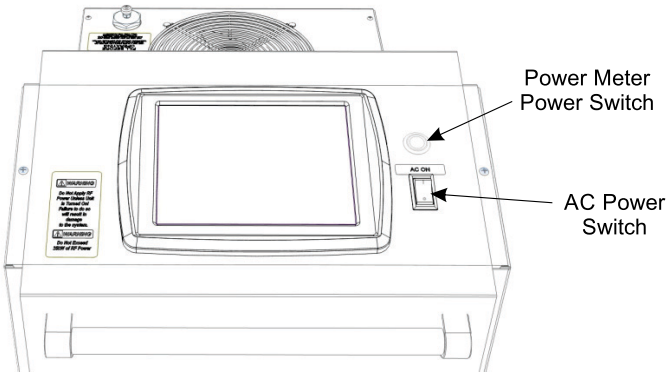
Normal Operation

After setting up the Bird High Power Cal Cart:

1. Check that the coolant level is above the minimum mark on the rear coolant gauge.
2. Connect the unit to the AC line.
3. Set AC power switch to ON. See Figure 6.
4. Check that the fans are running properly.
5. Press the Bird 4421A power meter power switch.
6. Wait about 10 seconds for proper coolant flow.
7. Apply RF power.
8. Make measurements.

Note: *See "4421A User Interface" on page 10 for specific instructions on controlling the meter.*

Figure 6 Cal Cart Power Switches



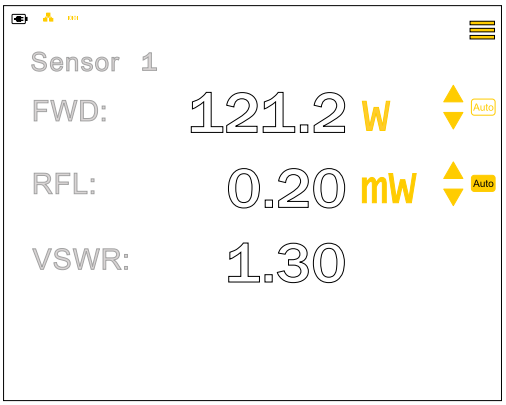
Shutdown

1. Turn off RF power at the source.
2. Press the 4421A power meter power switch to power off the power meter.
3. Wait approximately 5 minutes for the load to cool to room temperature to prevent heat stress.
4. Set AC Power Switch to OFF.
5. Disconnect the AC line.

The 4421A displays the measurement information from the Cal Cart's sensor. See Figure 7.
The display may be configured to display the following measurements from a sensor:

- Forward Power
- Reflected Power
- VSWR
- Return Loss
- Reflection Coefficient

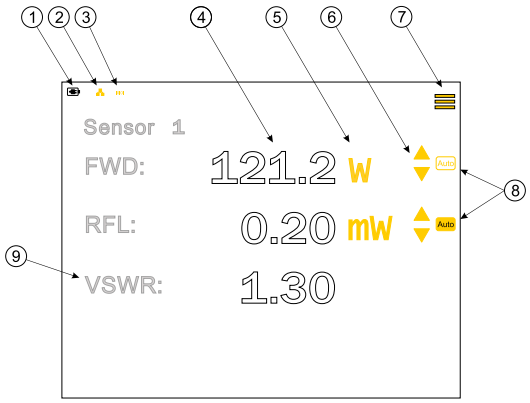
Figure 7 Sensor Measurements Display



Display Controls and Indicators

The display is used for presenting information and controlling the behavior of the 4421A. The controls are those items displayed on the screen, that, when tapped cause a change in the 4421A's behavior. Controls can be identified by their color, on screen controls are yellow. The table in Figure 8 describes the on screen controls and indicators.

Figure 8 Display Controls

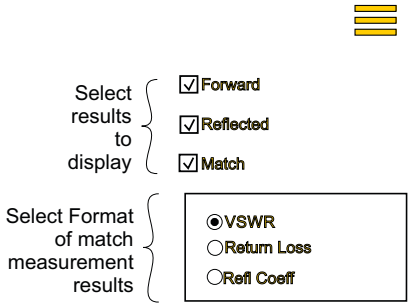


Item	Indicator	Description
1	AC Power indicator	When AC power is applied, a facsimile of an AC Power Plug is displayed.
2	IP Address Icon	When tapped, displays the 4421A's IP address, if connected to an Ethernet Network.
3	Serial Settings Icon	When tapped, displays the serial settings dialog box. See "Serial Port Settings Menu" on page 13.
4	Forward and Reflected Power	The sensor readings for Forward and Reflected power may be displayed in milliwatts, Watts, or Kilowatts.
5	Measurement Unit	The 4421A will display the signal measurements in Watts or dBm.
6	Manual Range Controls	Up and Down arrows are used to change the scale of the displayed power readings. X.xxx mW → X.xxx W → X.xxx KW XX.xx mW → XX.xx W → XX.xx KW XXX.x mW → XXX.x W → XXX.x KW **Note:** *Stops automatic scaling. Auto indicator (9) turns off.*
7	Settings Menu	The settings menu is used to configure what measurement information is displayed. See "Settings Menu" on page 12.
8	Auto Range	Auto - When button is on, indicates range scale is set to auto. Auto - When button is off, indicates range scale is in manual control, see item 7.
9	VSWR / Return Loss/ Reflection Coefficient	This line on the display can be set to display one of three measurements: VSWR, Return Loss, or Reflection Coefficient The Settings Menu is used to select which measurement is displayed.

Settings Menu

The setting menu is used to select what information will appear on the 4421A's display. Figure 9 describes the options available via the setting menu.

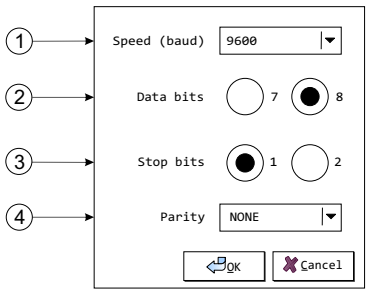
Figure 9 Settings Menu



Serial Port Settings Menu

Menu is used to define serial connection settings. Refer to the 4421A Operation Manual for a description of the 4421A's Serial Interface (www.birdrf.com).

Figure 10 Serial Settings Menu



Item	Indicator	Description
1	Baud Rate	The Baud rate may be set to one of the following options: 300 600 1200 2400 4800 9600
2	Data Bits (word length)	Select either 7 or 8 bit data.
3	Stop Bits	Select 1 or 2 stop bits sent at the end of every character,
4	Parity	Options are: NONE - no parity bit is sent EVEN - parity bit is set so the number of "logical ones" is even. ODD - parity bit is set so the number of "logical ones" is odd.

Chapter 5 Maintenance

This chapter describes routine maintenance, along with troubleshooting instructions for the power meter and power sensor. Disassembly instructions for the Bird High Power 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.

WARNING

The Bird 4421A contains no user-serviceable parts.
Do not open the cover.

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.

Routine Maintenance

Inspection

The HPCC 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.
- If dust has collected on the radiator coils, remove the screws around the edge of the top panel, remove the panel, and vacuum the coils.
- The coolant level should be checked once a week, more often if the Cal Cart is used continuously or in high ambient temperatures.

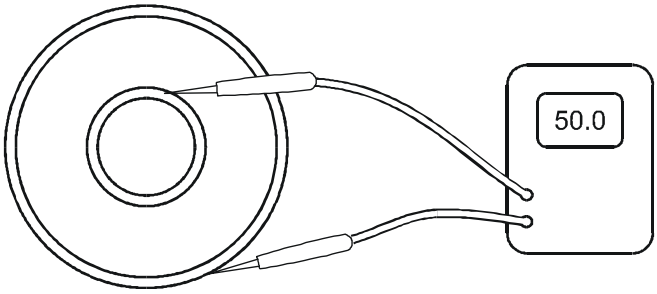
  Note: *The coolant level should be above the minimum mark on the gauge even when the unit is on. To add coolant, See* "Changing the Coolant" on page 16.

DC Resistance

Measuring the DC resistance between the inner and outer conductors of the RF connector shows changes in the load over time, a good check of the resistor's condition. Under normal operating conditions, the resistor should provide at least 5,000 hours of operation before requiring any additional service. DC resistance tracking must start before the load is put into service, and should be measured annually.

Perform the following steps and record the value for future comparison. Make sure that you have an ohmmeter with an accuracy of ±1% at 50 ohms and that the load temperature is between 20 and 25 °C (68 to 77 °F) before starting.

Figure 11 Measuring Resistance



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.

1. Turn off the RF power.
2. Disconnect the RF cables from the RF connectors on the load.
3. Check the load's center and outer conductors for visible damage or excessive wear.
4. Connect the multimeter test leads to the center and outer conductors. Refer to Figure 11.
5. Compare the measured value with the previous measurement and with the baseline resistance, measured when the load was put into service.

Note: *If the new value differs from either of these by more than 2 ohms this could indicate a failing resistor.*

WARNING
Ethylene glycol is toxic. Do not take internally. Avoid contact with eyes, skin, and clothing. Avoid breathing vapor. Wash thoroughly after handling.

CAUTION
Use only distilled water or the supplied mixture of distilled water and ethylene glycol (with a maximum of 35% ethylene glycol) as coolant. Do not use tap water, automotive antifreeze, sealants, or leak stopping material. Use of these materials will damage the instrument and void all warranties.

CAUTION
Operation without sufficient coolant can damage the unit.

Changing the Coolant

Note: *To just add coolant, go to step 6. To just drain the coolant, follow steps 1 – 4.*

1. Get a clean container, with a capacity of 3 gal. (11 L), to hold the old coolant.
2. Remove the filler cap on the top and at the rear of the unit.

   Note: *This will allow the coolant to drain faster.*
3. Unscrew and remove the drain plug at the bottom rear.
4. Drain the coolant into the container.

   Note: *If the coolant has no contaminants it may be reused.*
5. Replace the drain plug and screw it tightly into place.
6. Add about 3 quarts (2.9 L) of coolant.
7. Turn the unit on for a few seconds to draw coolant into the system.
8. Repeat steps 6 and 7 twice more, until the coolant remains steady at or just below the high mark on the level gauge.
9. Replace the filler cap.
10. Turn the unit on and run it for five minutes to remove any air trapped in the system.

Flushing the Coolant

Note: *If the coolant is contaminated, for example by pipe sealant or a broken resistor, the system should be thoroughly flushed.*

1. Fill the unit with clean, potable water.
2. Run the unit for five minutes with no RF power applied.
3. Drain the coolant and discard it.
4. Repeat steps 1 – 3 until the drained liquid is clear.
5. Refill the system with proper coolant (distilled water or a distilled water/ethylene glycol mixture) as described above.

Power Meter and Sensor Troubleshooting

Since the power meter and power sensor can only work together, the first step is to determine which is malfunctioning. 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.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Power meter has no power	Is the power meter's AC power cord connected to the terminal strip?	Connect the power cord.
	Is the Cal Cart's AC power cord connected to the AC line?	Connect AC power.
	Is the AC Power ON/OFF rocker switch set to OFF?	Set the switch to ON.
	Is the Power Meter ON/OFF switch set to OFF?	Set the switch to ON.
	Unplug the Cal Cart. Has the power meter fuse blown?	Replace fuse (See "Replace Power Meter Fuses" on page 22).

Load Troubleshooting

PROBLEM	POSSIBLE CAUSE	CORRECTION
Blower not operating	Is the load's AC power cord connected to the terminal strip?	Connect the power cord.
	Is the Cal Cart's AC power cord connected to the AC line?	Connect AC power.
	Unit turned off.	Set the line switch to ON.
	Fuse burnout.	Replace fuse (See "Replace Power Meter Fuses" on page 22).
Coolant leaking	Loose connections.	Tighten drain plug and all connections.
	Worn or cracked tubing.	Replace defective tubing.
Excessive reflected power	Resistor's DC resistance has changed.	Check DC resistance. See "DC Resistance" on page 15).

Repair

WARNING

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

WARNING

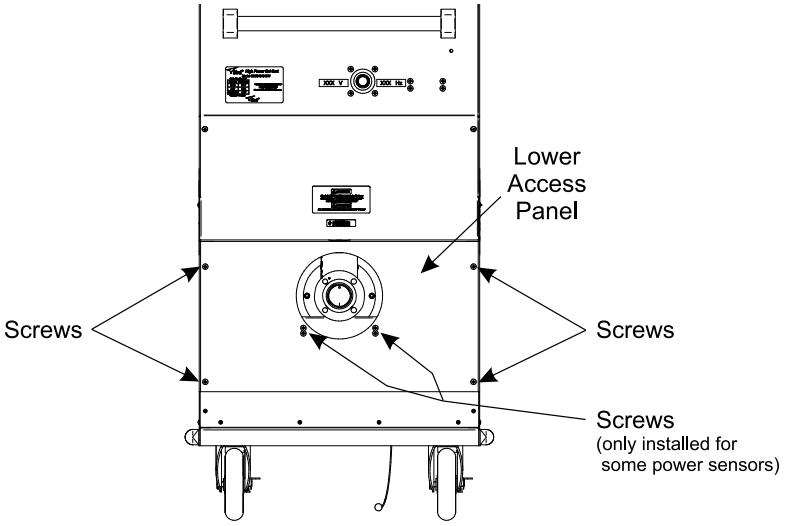
Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied.
Leaking RF energy is a potential health hazard.

Lower Access Panel Removal

Note: *To access the power sensor, it is necessary to remove the cart's lower access panel.*

1. Remove the screws on the lower access panel (the number of screws vary, depending on the power sensor installed). See Figure 12.
2. Pull the lower access panel away from the Cal Cart.

Figure 12 Lower Access Panel Fasteners



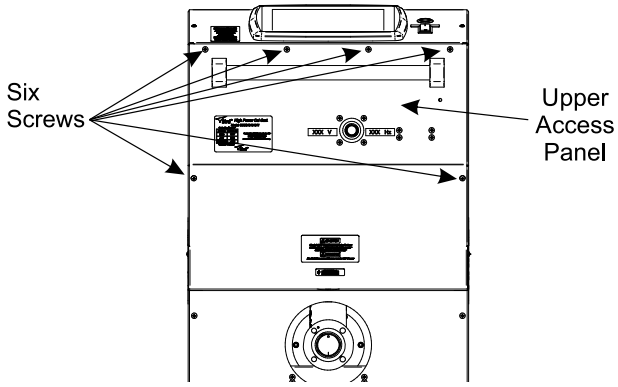
3. To install the lower access panel, position the panel and install the screws removed in step 1.

Upper Access Panel Removal

Note: *To access power meter fuses, cord reel, and system wiring, it is necessary to remove the cart's upper access panel.*

1. Remove six screws on the upper access panel. See Figure 13.
2. Pull the Cal Cart handle to lower the upper access panel.

Figure 13 Upper Access Panel Fasteners

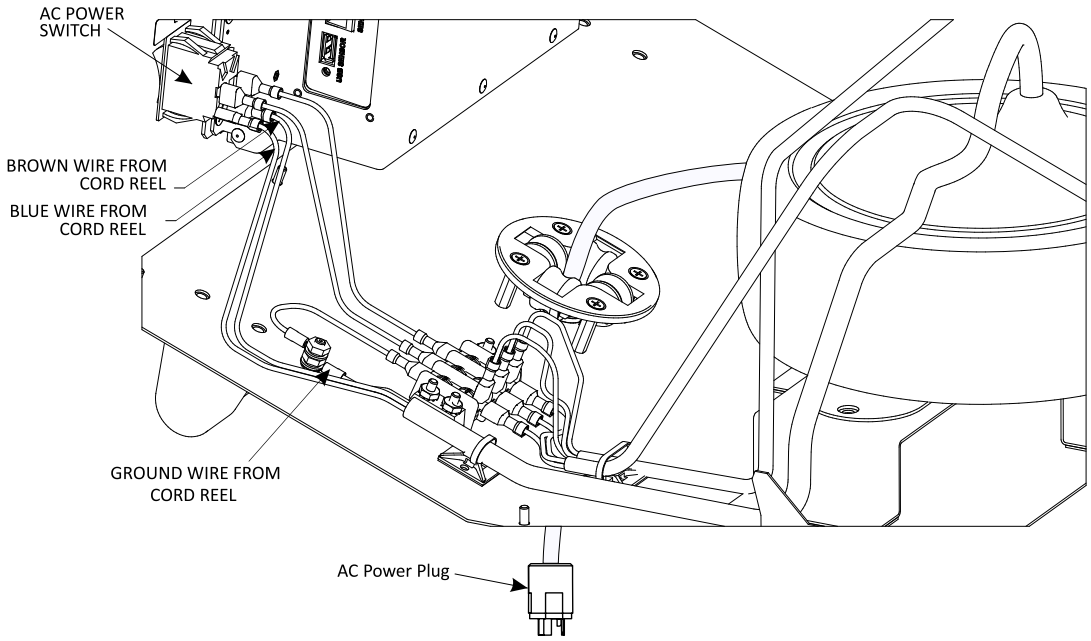


3. To install the upper access panel, raise the panel and install the screws removed in step 1.

Replacing the Cord Reel

1. Open the upper access panel, see "Upper Access Panel Removal" on page 19.
2. Disconnect the cord reel wires. See Figure 14.
    a. Disconnect blue and brown wire from the AC Power Switch.
    b. Disconnect ground wire from the ground stud.
3. Disconnect the AC Plug from the supply cable on the outside of the upper access panel.
4. Unscrew and remove the cord reel.
5. Screw the replacement cord reel into place.
6. Install ring terminal and quick disconnects on the cord reel wires.
7. Connect the cord reel wires to the Power switch and ground terminal.
    a. Connect blue and brown wire to the AC Power Switch.
    b. Connect ground wire to the ground stud.
8. Thread the cord reel wires on the reel through the Access panel.
9. Attach AC Plug to the cord reel wires (See Figure 14).

Figure 14 Cal Cart Wiring Schematic



Replacing the Power Sensor

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

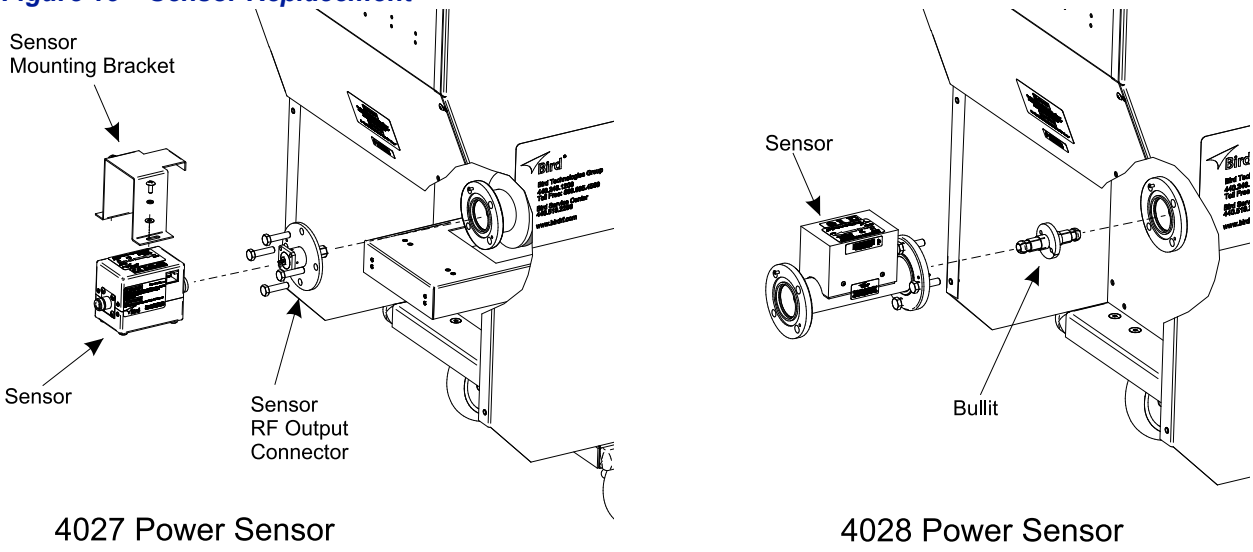
Due to the complexity of the Bird Power Sensor, field repairs beyond general maintenance should not be attempted.
Removal or disturbance of the power sensor cover can result in cancellation of lifetime warranty.

1. Disconnect the RF line from the HPCC.
2. Remove the unit's lower access panel (see "Lower Access Panel Removal" on page 18).
3. Disconnect the power meter cable from the power sensor.
4. Disconnect the RF sensor from the Cal Cart's load. See Figure 15 on page 22.
   - 4027 Sensors
     - ✓ Remove two screws on the sensor mounting bracket and remove bracket.
     - ✓ Remove four screws securing the sensor's RF output connector to the Cal Cart's Load.
     - ✓ Remove the sensor from the Cal Cart.
   - 4028 sensors
     - ✓ Remove four screws securing the sensor's RF output connector to the Cal Cart's Load.
     - ✓ Remove the sensor and bullit from the Cal Cart.
5. Install new sensor onto the Cal Cart.

   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.*

   - 4027 Sensors
     - ✓ Position the output connector of the sensor on the input connector for the load.
     - ✓ Install four screws to secure the sensor's RF output connector.
     - ✓ Place the mounting bracket over the sensor.
     - ✓ Install two screws to secure the mounting bracket over the sensor.
   - 4028 sensors
     - ✓ Position the bullit in the output of the sensor.
     - ✓ Position the sensor and bullit at the input connector for the load.
     - ✓ Install four screws to secure the sensor to the Cal Cart.
6. Connect power meter cable to the sensor.
7. Replace the unit's front panel. See "Lower Access Panel Removal" on page 18.

Figure 15 Sensor Replacement



Replace Power Meter Fuses

WARNING

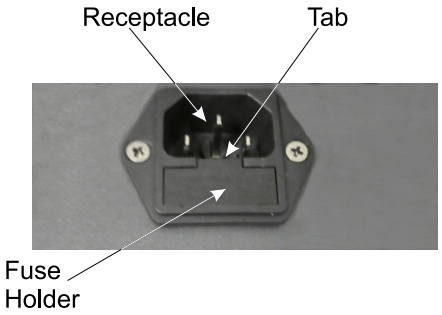
To avoid personal injury, disconnect the power cord from the AC line before performing any maintenance, including fuse replacement.

CAUTION

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

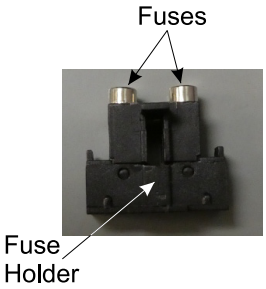
1. Lower the Cal Cart's upper access panel. See "Upper Access Panel Removal" on page 19.
2. Disconnect the AC power Cable from the receptacle on the left side of the 4421A Power Meter. See Figure 16.
3. Gently pry on the fuse holder tab and pull the fuse holder out of the AC receptacle.

Figure 16 4421A AC Power Receptacle



4. Pull the two fuses out of the fuse holder. See Figure 17.
5. Insert two new fuses into the fuse holder.

Figure 17 AC Line Fuses



Fuse Rating
FUSE,SLO-BLO,5x20mm, 1 AMP TYPE T

6. With fuse holder tab facing up (Figure 16), press fuse holder into the 4421A AC receptacle until fully seated.
7. Connect the AC power Cable to the receptacle on the left side of the 4421A Power Meter.
8. Install the Cal Cart's upper access panel. See "Upper Access Panel Removal" on page 19.

Load Servicing

Replacing Resistor Assembly

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.

1. Disconnect the RF line from the Cal Cart
2. Disconnect the Sensor from the Load.
3. Remove the Cal Cart front panel (see "Lower Access Panel Removal" on page 18).
4. Disconnect the load's AC line from the terminal strip.
5. Drain the coolant (See "Changing the Coolant" on page 16).
6. Remove the screws around the edge of the top panel
7. Raise the top panel only high enough to gain access to the fan supply plug.
8. Disconnect the fan-supply plug on top of the radiator block by pressing the latch in the center of the plug while pulling away from the mating connector.
9. Unscrew the hose clamps on both water connections to the resistor assembly.
10. Remove the nuts, on the inside of the front panel, holding the assembly to the front panel.

    Note: *Remove the nuts only. Do not disturb the screws. The screws also secure the outer conductor assembly to the resistor. Hold this assembly to keep it from falling and being damaged.*

11. Unscrew the mounting clamp holding the resistor assembly to the rest of the unit.
12. Remove the top half of the clamp.
13. Carefully push the assembly forward a few inches to access the wires and water connection fittings.
14. Note the position and direction of the output elbow then unscrew it from the load.
15. The resistor assembly can now be removed.

Removing the Pump

WARNING

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

1. Drain the coolant (See "Changing the Coolant" on page 16).
2. Remove the load (See "Replacing Resistor Assembly" on page 24).
3. Disconnect the pump wire leads from the terminal block on the inside of the front panel.
4. Loosen the hose clamps on the input and output hoses to the pump, and remove the hoses.
5. Unscrew the hex nut on the drain tube at the base of the pump. Remove the drain tube.
6. Unscrew the bolts securing the base of the pump to the unit.
7. Remove the pump, carefully, from the unit.
8. Note the position and direction of the fittings, then twist them off counterclockwise.
9. To replace the pump, reverse the above steps.

Note: *When replacing the threaded fittings, carefully coat the external threads, ONLY, with a pipe sealing compound. Coating only the external threads reduces the chances of contaminating the coolant.*

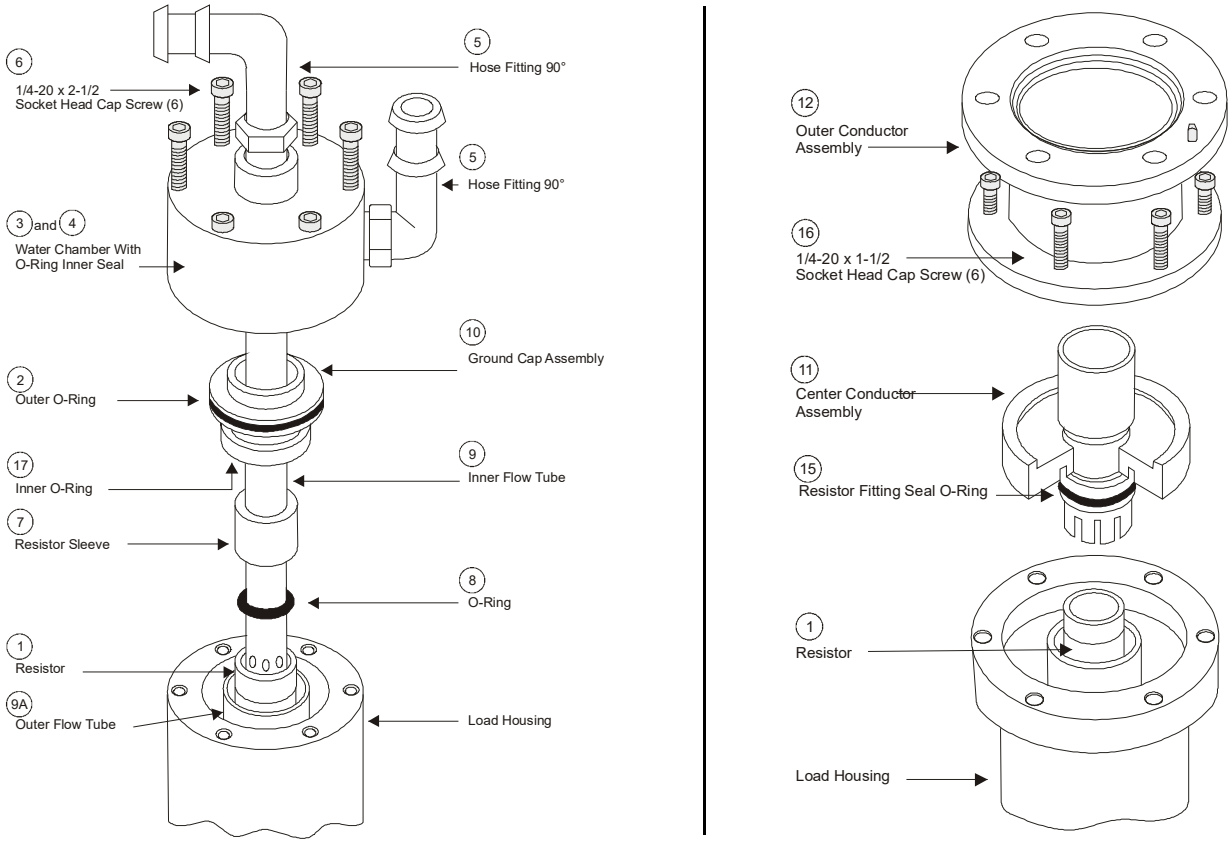
Resistor Assembly

The load is designed to be quickly and easily repaired in the field. If a significant change in the DC resistance is noted or if the resistor should fail, inexpensive replacement resistors are available.

WARNING

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

Figure 18 Load Exploded View



Removing the Resistor

Note: *Numbers in brackets [ ] refer to the labeled parts in* Figure 18*.*

1. Remove the resistor assembly. (see "Replacing Resistor Assembly" on page 24).
2. Turn the assembly on end with the hose fitting up.

   Note: *Use a $^{3}/_{16}$ hex socket wrench to tighten the cap screws [6] approximately $^{1}/_{2}$ inch-lbs.*
3. Pull the water chamber assembly out.

   Note: *It may be necessary to rock the chamber gently while pulling.*
4. Remove the following parts and set them aside for reassembly:
   - Inner flow tube [9]
   - Resistor sleeve [7]

- Cushioning O-ring [8]

5. Remove the ground cap assembly by gently prying it upward using the flat blade of a screw driver and working around the circumference of the part until is free.

   Note: *The ground cap assembly [10] should now be exposed on the resistor at the end of the load housing.*

6. Pull the resistor [1] straight out using a gentle rocking motion.

   Note: *Do this only if the resistor [1] is intact.*

   Note: *The resistor sleeve [7] has a small escape hole at the side and an access counter bore leading to it. If the sleeve is removed, be sure this counterbore faces the O-Ring and the resistor [1] during reassembly. This is essential for internal water venting. The base of the inner flow tube has water outlet holes and a small shoulder. At reassembly, these must fit into mating recesses in the input fitting.*

Inspecting the Resistor

1. Carefully check the resistor [1] for fractures.

   Note: *Even in the event of failure the resistor substrate will usually remain intact.*

2. Check the inside of the housing for damage to the internal parts.
3. Do one of the following:
   - If the resistor is broken, other internal parts are damaged, or if the parts do not fit together properly, proceed to "Replacing a Fractured Resistor" on page 27.
   - If no damage has been found, proceed to "Replacing the Resistor" on page 28.

Replacing a Fractured Resistor

1. Turn the assembly on end with the RF input connector up to allow any loose pieces of the resistor to fall out of the housing.
2. Use a $^{3}/_{16}$ hex socket wrench to remove the cap screws [16].
3. Remove the outer conductor assembly [12].
4. Pull out the center conductor assembly [11].
5. Remove, carefully, any remaining pieces of the resistor.

   Note: *Normally the outer flow tube will remain with the housing. If it comes out, return it after inspection and cleaning.*

6. Check the inside of the housing for damage.
7. Remove the inner flow tube [9] and ground cap assembly [10].
8. Check inner flow tube and ground cap assembly for broken pieces.
9. Wash, thoroughly, the inside of the conductor assemblies, housing and water chamber under clear running water.
10. Replace the ground cap assembly and the inner flow tube.

Replacing the Resistor

1. Insert the new resistor [1] into the resistor fitting of the center conductor assembly [15] to test its tightness.

   Note: *The resistor should be snug but should not have to be forced into the fitting. If the resistor is too loose:*

   a. Press the fitting fingers together slightly
   b. Insert the resistor again.
   c. Continue closing the ends of the resistor fitting until a snug fit is obtained.
2. Bottom the resistor in the fitting.
3. Insert the resistor and center conductor assembly into the housing.
4. Replace the outer conductor assembly [12] and screw it into place.
5. Stand the load on its end with the RF connector down.
6. Replace the ground cap assembly onto the exposed end of the resistor.

   Note: *Make sure that it seats on the load housing.*
7. Do one of the following:
   - If the inner flow tube [9] is separated from the water chamber assembly [3]:
     a. Place it inside the resistor
     b. Lower until it reaches the resistor fitting.
     c. Twist, gently, the flow tube until it seats in the bottom of the resistor fitting.
   - If the inner flow tube [9] is not separated from the water chamber assembly [3], proceed to Step 4.
8. Check that the O-Ring [8] is on the inner flow tube next to the resistor and the resistor sleeve [7] is right behind it.

   Note: *Make sure the counterbore faces the O-Ring and the resistor.*
9. Replace the water chamber [3], gently rocking and twisting the chamber to achieve a flat seat on the outer housing.

   Note: *If the water chamber does not fit properly make sure that the inner flow tube is properly placed.*
10. Tighten the water chamber screws [6].
11. Check the DC resistance between the inner and outer conductors; it should be about 50 ohms.

    Note: *Record this measurement as the new baseline reading.*
12. Install the resistor assembly on the heat exchanger.
13. Connect the hoses and fill with coolant.
14. Run the pump for five minutes and check for leaks before applying RF power.

Replacing the Conductor

1. Remove the cap screws [16] from the RF connector, using a $^{3}/_{16}$ Allen wrench.
2. Remove the outer conductor assembly [12].

   Note: *If only the outer conductor needs replaced, install it now and screw it into place.*
3. Remove the center conductor assembly [11] by pulling it carefully out of the load housing.

   Note: *Make sure the resistor [1] and inner flow tube [9] do not come out with the center conductor.*
4. Insert the new center conductor assembly into load housing.

   Note: *Make sure the resistor fitting makes a snug fit with the resistor.*
5. Replace the outer conductor and screw it into place.

Storage and Shipment

Storing the Load Resistor

1. Cover Bird HPCC Loads before storing to keep out dust and dirt.
2. It is not necessary to install the shipping plug.
3. 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

The Cal Cart's maximum power is the MINIMUM of the max. power of the sensor and the max. power of the load, under normal conditions.

Bird High Power Cal Cart

Note: *Unit for use indoors only.*

Frequency Range	Sensor dependent
Power Range	Dependent on sensor, sensor connectors, and load
Connectors	1-5/8" Flanged
Dimensions	40"L x 22"W x 39"H (1005 x 550 x 991 mm)
Weight, Nominal	240 lbs. (109 kg)
AC Power	100 - 240 VAC @ 50 / 60 Hz, 1725 W, Depending on model, See Table 1 on page vii
Main supply voltage fluctuations	+/- 10%
Altitude	5,000 ft (1,524 m)
Overvoltage Category	II
Pollution Degree	1
Means of protection	Class I
Operating Temperature	0° to 40° C (32° to 104° F) If water only is used in the Moduload, the operating temperature is more restrictive, see "Bird 8640S Series Moduloads" on page 34.
Humidity	85% max (non condensing)
Operating conditions	Continuous
Interlock Rating	NO or NC Connection, 10A @ 30 VAC/60 VDC
Calibration Cycle	1 year

Bird 4421A RF Power Meter

Frequency Range	Sensor dependent
Power Range	Sensor dependent
VSWR Display	1.0 – 199.9 max
Return Loss Display	0 to 40 dB max
AC Power	100 - 240 VAC @ 50/60 Hz, 30 W
Display	9.7 in TFT full color LCD with touch screen
Interfaces	RS-232, LAN
Fuse Rating	1A, IEC (5 x 20 mm), time-delay
CE	CE Compliant. Refer to Declaration of Conformity for specific standards.

Humidity	95% max. (non condensing)
Altitude	Up to 15,000 feet (4572 m)
Operating Temperature	0° to 40° C (32° to 104° F)
Storage Temperature	Load coolant dependent, see "Bird 8640S Series Moduloads" on page 34.
Dimensions	10.6 in x 9.7 in x 3.6 in (269 mm x 246 mm x 91 mm)
Weight, Nominal	Less than 5 lb, 2.3 kg

Bird 4028B Series RF Power Sensors

Frequency Range 4028B10M	 10 – 15 MHz
RF Power Range	1 kW – 25 kW
Accuracy, Fwd, Best Case[1]	± 2.0% (2σ)
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 $\text{VSWR} = \left(1 + \sqrt{\frac{P_R}{P_F}}\right) / \left(1 - \sqrt{\frac{P_R}{P_F}}\right)$
Calibration Frequencies, Typical (MHz)[2] 4028B10M	 10.0, 13.56, 15.0
Calibration Power, Typical	1.7 kW
VSWR, Max.	1.05:1
Insertion Loss, Max.	0.05 dB
Directivity, Min.	28 dB
Impedance, Nominal	50 ohms
VSWR Range	1.00 to 2.00 (40.0 to 9.5 dB Return Loss)
Max. Allowable Terminating VSWR	2.00:1
Calibration Technique	Calibration vs. frequency curve stored in nonvolatile memory in each sensor. Sensor output corrected at frequency of measurement within rated range.
Sampling Rate, Nominal	2 readings/second
Operating Power	Supplied by power meter via sensor cable
Dimensions, Nominal	6.75”L x 3.5”W x 4.75”H (175 x 89 x 121 mm)
Weight, Nominal	5 lb. 2 oz. (2.33 kg)

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

2 Other calibration frequencies available upon request

Bird 8640S Series Moduloads

Frequency Range	1 kHz – 900 MHz
Power Rating	25 kW continuous duty
Mode	CW, AM, FM, SSB, TV and certain pulse types
Impedance, Nominal	50 ohms
VSWR, Max	1.10:1
Cooling Method	Water dielectric and forced air convection
Coolant [1]	Distilled water or distilled water/ethylene glycol mixture
Coolant Capacity	9 qts. (8.5 L) nominal
AC Power	115/230 Vac @ 50/60 Hz
Fuse Rating 115 Vac 230 Vac	 15 A (3AB time delay) 8 A (5x20 mm time delay)
Operating Temperature [2] Water only 35% Ethylene Glycol	 5 to 45 °C (41 to 113 °F) 2 0 to 35 °C (32 to 95 °F) 2
Storage Temperature Water only 35% E.G.	 +5 to +50 °C (41 to 122 °F) –20 to +50 °C (–4 to +122 °F)

1 Below 5°C, ONLY use 35% E.G. and 65% Dist. H_2O mixture
2 Above 30°C (86 °F) with water only, or 25°C (77 °F) with a 35% ethylene glycol mixture, derate power to 20 kW max.

Replacement Parts

Cal Cart

Description	Qty	Part Number
Fuse, Slo-Blo,5x20mm, 1 Amp Type T	2	5A2257-16
Cord, AC Power, Power Meter, Harmonized	1	5A2416
Plug, 115 Vac	1	5A2626
Cable, Sensor	1	4421-038
Grommet	1	SA2617-20
Cordreel	1	4421A383-2
Handle	1	4421A385
Casters	4	4421A384

Resistor Assembly

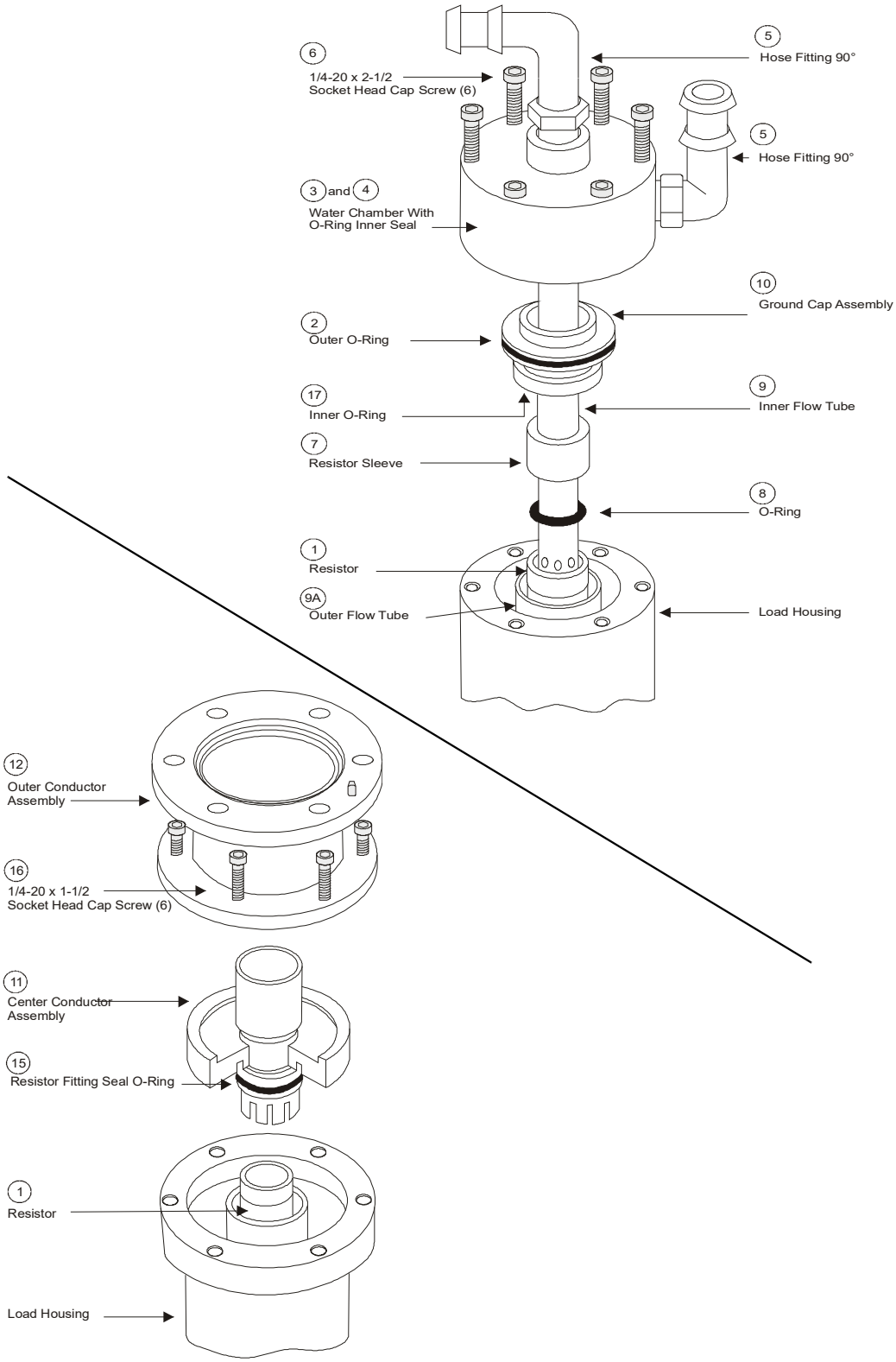
Exploded views are used to illustrate the parts below and indicate their relation to each other. Each part in the exploded view has an item number referencing this list. See Figure 19 on page 36.

Item No.	Description	Qty	Part Number
1	Resistor	1	8755-027
2	Outer O-Ring	1	8410-009
3	Water Chamber	1	8755-014
4	Water Chamber Inner O-Ring	1	5-099
5	Fitting, 90°	2	8640-089
6	Screw $\frac{1}{4}$-20 x 2-$\frac{1}{2}$”	6	1121-2508-00
7	Resistor Sleeve	1	8755-026
8	Sleeve O-Ring	1	8110-059
9	Inner Flow Tube	1	8755-025
9A	Outer Flow Tube	1	8755-024
10	Resistor Ground Cap	1	8755-005
15	Center Conductor O-Ring	1	5-1127
16	Screw $\frac{1}{4}$-20 x 1$\frac{1}{2}$”	6	1121-1808-00
17	Inner O-Ring	1	5-567

Heat Exchanger

Description	Qty	Part Number
Cord, AC Power 115 Vac 230 Vac	 1	 5-1836 5-1837
Fuse 115 Vac, 15 A (3AB time delay) 230 Vac, 8 A (5x20 mm time delay	 2	 5-1828-36 5A2257-25
Coolant Gauge Kit	1	5-1200
Ethylene Glycol	1 Gal.	5-1134-3

Figure 19 Resistor Assembly Exploded View



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.