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INSTRUCTION BOOK

**THRULINE<sup>®</sup> RF POWER METER MODEL 4421  
AND  
THRULINE<sup>®</sup> DIRECTIONAL  
RF POWER SENSORS  
4020 SERIES, 4027A SERIES,  
4027F SERIES, AND 4028 SERIES**



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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.

### 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

#### Chemical Hazard

Dry cleaning solvents for cleaning parts may be potentially dangerous. Avoid inhalation of fumes or prolonged contact with skin.

### 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**  
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.

Refer to page 5, 35, and 41.

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

Refer to page 35, 38, 39, and 41.

**WARNING**  
Use only Nickel Metal Hydride (NiMH) batteries that have a minimum capacity of 4500 milliamper 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.

Refer to page 40.

**WARNING**  
Heavy load. Do not attempt to lift unaided.

Refer to page 41.

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

Refer to page 2, 41, 43, 45, and 49.

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

Refer to page 5 and 41.

**CAUTION**  
Do not use the power sensor with a load VSWR greater than 2:1. Damage to the power meter, power sensor, or the RF power source could occur.

Refer to page 5.

**CAUTION**

Long-term storage of this instrument can affect battery performance and reduce battery life. Do not store the instrument for long periods of time without recharging the batteries (refer to page 40). Failure to comply may result in reduced battery charge and shortened battery life.

Refer to page 7

**CAUTION**

During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.

Refer to page 11 and 16.

**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.

Refer to page 35 and 41.

**CAUTION**

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

Refer to page 39.

## **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.

### **IMPRIEGO**

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

**SERVICE**

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

**SERVICIO**

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

**WARTUNG**

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

ZUR VERMEIDUNG GEFÄHRLICHER, ELEKTRISCHER 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 SERVICE 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.**

**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 Bird 4421 RF Power Meter and the its sensors. This manual covers the operating and maintenance instructions for the following models:

| Power Meter                 | 4421                             |                                   |                                    |                                  |
|-----------------------------|----------------------------------|-----------------------------------|------------------------------------|----------------------------------|
| <b>4020 Series Sensors</b>  | 4021                             | 4022                              | 4024                               | 4025                             |
| <b>4027A Series Sensors</b> | 4027A250K<br>4027A4M<br>4027A35M | 4027A400K<br>4027A10M<br>4027A60M | 4027A800K<br>4027A12M<br>4027A100M | 4027A2M<br>4027A25M<br>4027A150M |
| <b>4027F Series Sensors</b> | 4027F2M                          | 4027F10M                          | 4027F60M                           |                                  |
| <b>4028A Series Sensors</b> | 4028A250K<br>4028A4M             | 4028A400K<br>4028A10M             | 4028A2M<br>4028A25M                | 4028A3M                          |
| <b>4028B Series Sensors</b> | 4028B10M                         | 4028B3M                           |                                    |                                  |
| <b>4028C Series Sensors</b> | 4028C10M                         |                                   |                                    |                                  |

## Changes to this Manual

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

## Contents

### Chapter Layout

**Introduction** - Describes the purpose and function of the Power Meter as well as a general overview of the product.

**Installation** - Describes the installation instructions for the power meter models covered in this manual.

**Operating Instructions** - Describes the features of the power meters and provides power-up instructions.

**IEEE-488 GPIB Interface** - Describes the features of the IEEE-488 GPIB Interface.

**RS-232 Interface** - Describes the features of the RS-232 Interface.

**Maintenance** - Contains preventative maintenance information, troubleshooting section, and a list of replacement parts with part numbers.

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**Power Meter**

The Bird 4421 RF Power Meter is one component of a complete RF power measurement system. An RF power sensor such as a Bird 4021 is also required. The system can be controlled with the front panel buttons, or remotely through an RS-232 connection or a GPIB-488 connection.

**Items Supplied**

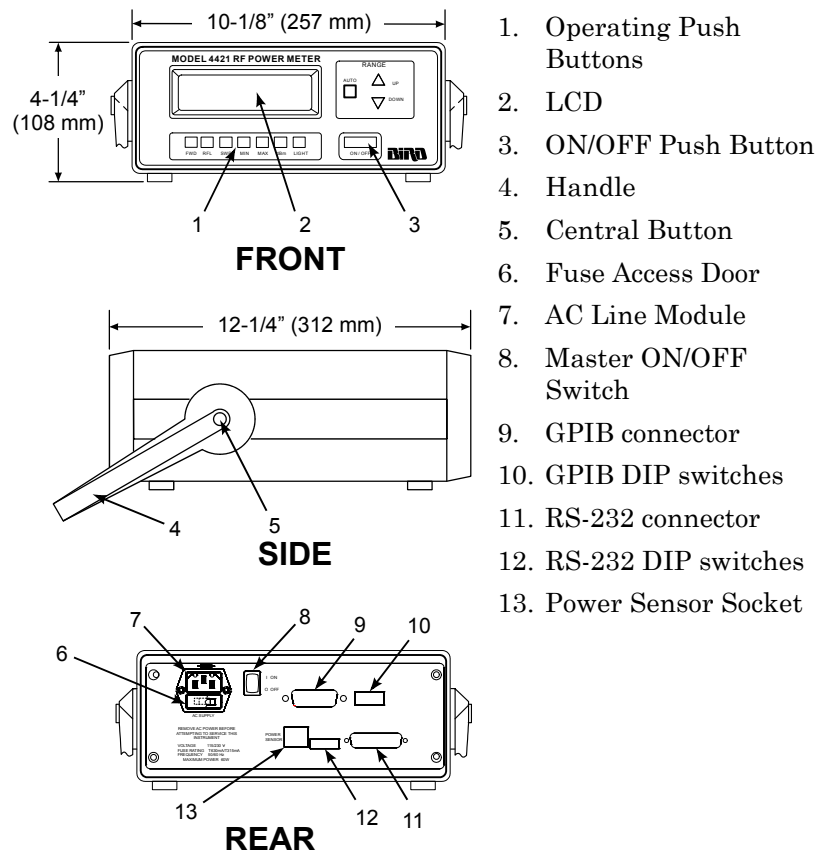
- Bird 4421 RF Power Meter
- AC Power Cord
- Sensor Cable
- Instruction Manual

**Optional Accessories**

**Panel Mount Kit (P/N 4421-250)** - Allows the Bird 4421 to be installed in a standard 19" panel for rack mount applications.

**Null Modem Kit (P/N 4380-250)** - Contains the hardware necessary to allow the 4421 to be remotely controlled by controllers with different wiring arrangements. Requires an RS-232 interface module.

**Figure 1 Bird 4421 Meter Outline Drawing**



## Power Sensors

Power sensors are available with a variety of connectors; see "Available Connectors" on page 49 for a complete list. Since the accuracy is critically dependent on the connectors used at calibration, do not remove or change the connectors.



### 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  $\pm 3\%(1\sigma)$  of reading.

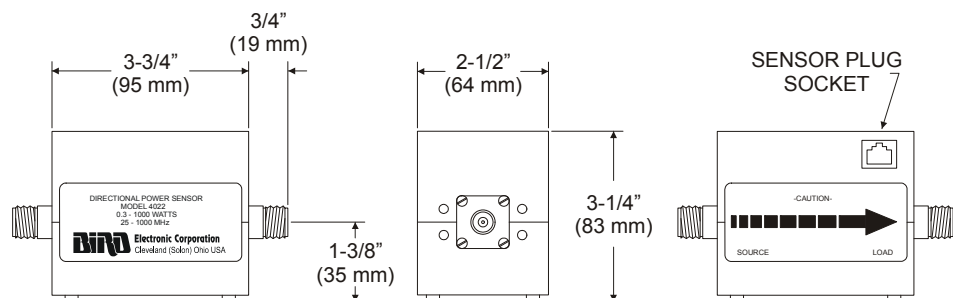
### 4027A Series

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  $\pm 1\%(1\sigma)$  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  $\pm 1\%(2\sigma)$  at specified calibration frequencies and power levels.

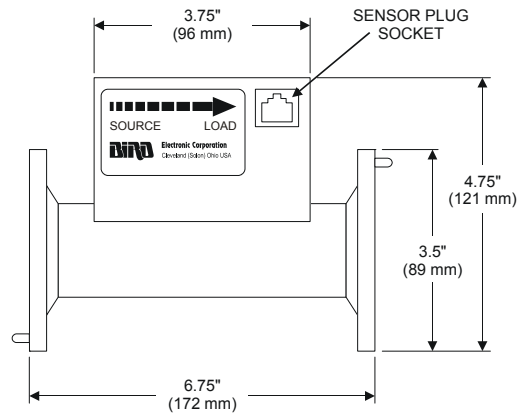
**Figure 2 Power Sensor Outline Drawing, 4020, 4027A, 4027F, & 4028A Series**



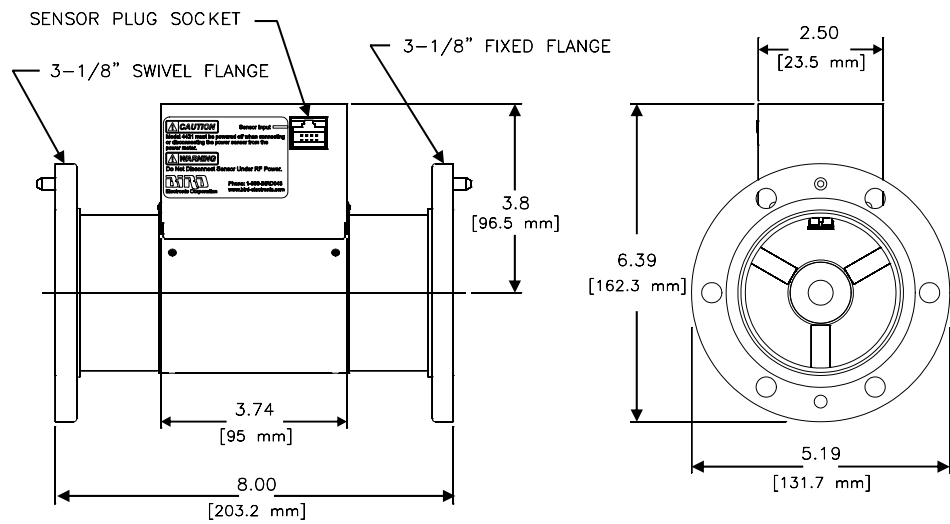
### 4028 Series

Bird 4028 Series Power Sensors are high power sensors otherwise similar to the 4027A series. 4028A sensors are based on a 7/8" line, 4028B sensors use a 1-5/8" line, and 4028C sensors use a 3-1/8" line. 4028 Sensors are accurate to  $\pm 2\%$  at specified calibration frequencies and power levels.

**Figure 3 Power Sensor Outline Drawing 4028B Series only**



**Figure 4 Power Sensor Outline Drawing 4028C Series only**



## Frequency and Power Ranges

### 4020 Series

| Model | Frequency Range   | RF Power Range |
|-------|-------------------|----------------|
| 4021  | 1.8 – 32 MHz      | 300 mW – 1 kW  |
| 4022  | 25 – 1000 MHz     | 300 mW – 1 kW  |
| 4024  | 1.5 – 32 MHz      | 3 W – 10 kW    |
| 4025  | 100 kHz – 2.5 MHz | 3 W – 10 kW    |

### 4027A Series

| Model     | Frequency Range | RF Power Range  |
|-----------|-----------------|-----------------|
| 4027A250K | 250 – 400 kHz   | 3 W – 10 kW     |
| 4027A400K | 400 – 550 kHz   | 3 W – 10 kW     |
| 4027A800K | 800 – 950 kHz   | 3 W – 10 kW     |
| 4027A2M   | 1.5 – 2.5 MHz   | 3 W – 10 kW     |
| 4027A4M   | 3 – 5 MHz       | 3 W – 10 kW     |
| 4027A10M  | 10 – 15 MHz     | 3 W – 10 kW     |
| 4027A12M  | 10 – 15 MHz     | 300 mW – 1 kW   |
| 4027A25M  | 25 – 30 MHz     | 3 W – 9 kW      |
| 4027A35M  | 35 – 45 MHz     | 3 W – 7.5 kW    |
| 4027A60M  | 45 – 65 MHz     | 3 W – 6 kW      |
| 4027A100M | 95 – 105 MHz    | 3 W – 4 kW      |
| 4027A150M | 150 – 170 MHz   | 3.75 W – 3.75kW |

### 4027F Series

| Model    | Frequency Range | RF Power Range   |
|----------|-----------------|------------------|
| 4027F2M  | 1.8 – 2.2 MHz   | 100 W – 10 kW    |
| 4027F10M | 12 – 15 MHz     | 3 W – 4 kW       |
| 4027F60M | 57 – 63 MHz     | 3.75 W – 3.75 kW |

### 4028 Series

| Model     | Frequency Range | RF Power Range |
|-----------|-----------------|----------------|
| 4028A250K | 250 – 400 kHz   | 1 kW – 20 kW   |
| 4028A400K | 400 – 550 kHz   | 1 kW – 20 kW   |
| 4028A2M   | 1.5 – 2.5 MHz   | 1 kW – 25 kW   |
| 4028A3M   | 2.5 – 3.5 MHz   | 1 kW – 25 kW   |
| 4028A4M   | 3.5 – 4.5 MHz   | 1 kW – 25 kW   |
| 4028A10M  | 10 – 15 MHz     | 1 kW – 25 kW   |
| 4028A25M  | 25 – 30 MHz     | 1 kW – 25 kW   |
| 4028B3M   | 2.5 – 4 MHz     | 1 kW – 25 kW   |
| 4028B10M  | 10 – 15 MHz     | 1 kW – 25 kW   |
| 4028C10M  | 10 – 15 MHz     | 500W – 50 kW   |

This chapter provides information about preparing the Bird 4421 for use.

## Sensor Connection

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

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

1. Turn OFF the ON/OFF rocker switch on the meter's rear panel.
2. Align the latch on the cable with the notch of the "Power Sensor" socket on the power meters rear panel.
3. Insert the cable until it clicks into place.
4. Connect the other end of the sensor cable to the sensor.

## RF Line Connection


**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**  
Do not use the power sensor with a load VSWR greater than 2:1. Damage to the power meter, power sensor, or the RF power source could occur.

Connect the end of the power sensor labeled "SOURCE" to the RF source. Connect the end labeled "LOAD" to the load or antenna. Reversing these connections will cause measurement errors.

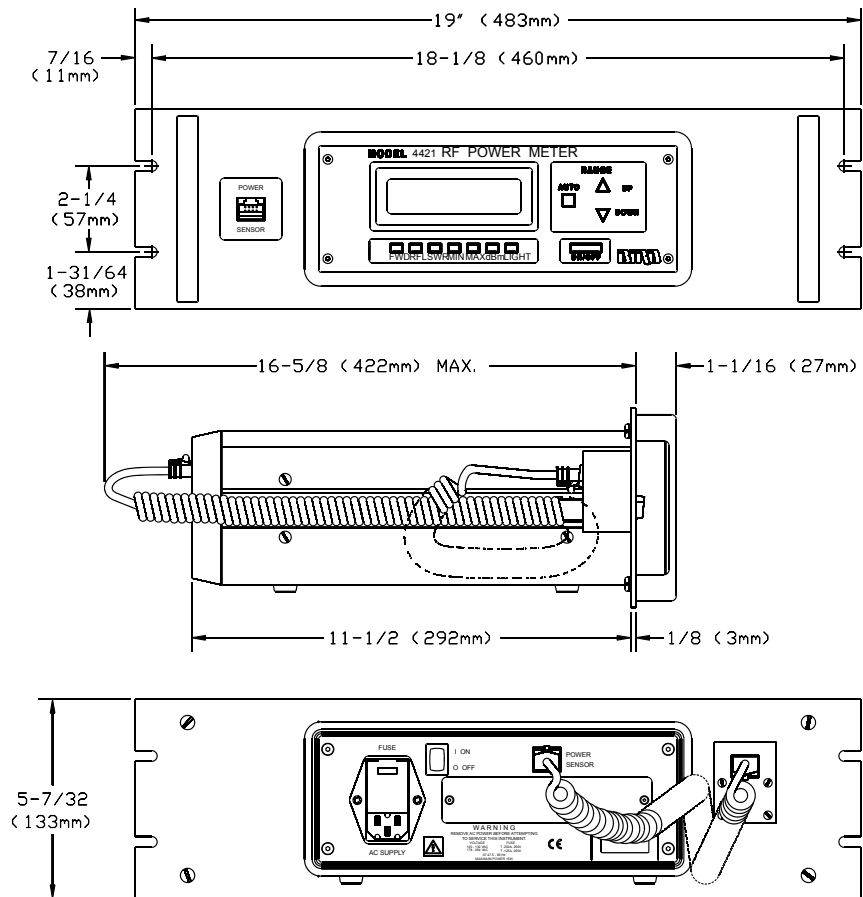
## Panel Mounting the 4421 Power Meter

You can install the 4421 Power Meter in an equipment rack if you have the optional panel mount kit (refer to Optional Accessories, page 1). The panel mount kit includes complete installation instructions. Figure shows the overall dimensions and mounting points for a 4421 Power Meter installed in a panel mount kit.

 **Note:** *The power supply interrupt switch for the 4421 Power Meter is located on the rear panel. When you install a unit in a panel mount kit, you need to provide a means to interrupt the power supply that is easily accessible to the user (such as a switch mounted in the panel).*



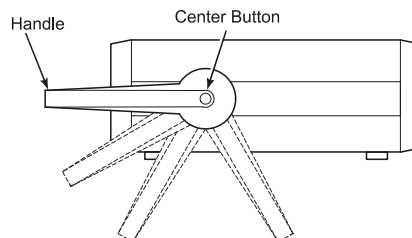
**Figure 5 Panel Mounting Dimensions**



## Handle Operation

The handle on the Bird 4421 can be set to four different positions (see Figure 6). To adjust the handle, press the center buttons on both sides. Releasing the buttons will lock the handle into position.

**Figure 6 Handle Positions**



## 115/230V AC Input Power

The internal power supply can operate at 115 VAC or 230 VAC. There is no user setting to select the input voltage because the power supply automatically senses the input voltage. However, you must make sure that you have the correct power cord plug and fuses installed for the line voltage you are using (refer to Replacing Fuses, page 39).

## AC Line Connectors

To make the AC line cord compatible with non-U.S. voltages, users must install the appropriate connector on the power cord.

## Batteries

The Bird 4421 RF Power Meter is completely portable and is powered from internal rechargeable nickel metal hydride batteries.

The batteries are shipped in a low charge state. It is, therefore, recommended that you charge the instrument for approximately 28 hours before using it for continuous operation.

**Note:** *Battery charging at temperatures greater than 45° C (113° F) can result in reduced operational time.*

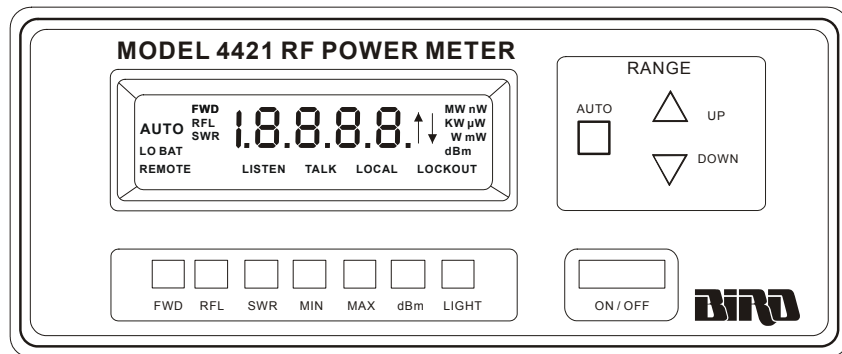
### CAUTION

Long-term storage of this instrument can affect battery performance and reduce battery life. Do not store the instrument for long periods of time without recharging the batteries (refer to page 40). Failure to comply may result in reduced battery charge and shortened battery life.

This chapter describes operator controls and indicators on the Bird 4421 RF Power Meter. For remote operation using a GPIB or RS-232 controller, refer to the instructions in Chapter 4 or Chapter 5 respectively.

Push Button Functions

Figure 7 Push Buttons



| Push Button | Description   |
|-------------|---|
| FWD, RFL    | Press to measure forward or reflected RF power. FWD or 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.<br><b>Note:</b> Used after pressing SWR. Return loss is displayed.   |
| LIGHT       | Press to turn on or turn off the display's backlight. 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.<br><b>Note:</b> Used while AUTO indicator is on. Stops automatic scaling. AUTO indicator turns off. |
| ON/OFF      | Press to turn the power meter on or off. This switch will not work if the master power switch on the rear panel is OFF.<br><b>Note:</b> The display flashes for about 30 seconds when the unit is first turned on.            |

## 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). Table 4-1 displays the error codes and Table 4-2 lists the function limits.

**Table 4-1 Error Codes**

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

**Table 4-2 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                        | Ovrange    |
|                  | Power < 3% of low range                           | Underrange |
| SWR              | FWD < 20% of low range                            | Underrange |
|                  | FWD – RFL = 0                                     | Ovrange    |
| Return Loss      | FWD < 20% of low range                            | Underrange |
|                  | RFL < 20% of low range                            | Underrange |
|                  | Return Loss > 40 dB                               | 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 discusses setup of the IEEE-488 interface feature and describes the IEEE commands that apply to the Bird 4421. Operators should understand IEEE standard 488-1978 and have basic computer programming skills before attempting to write any programs.

**CAUTION**

During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.

### Description

The Bird 4421 IEEE-488 (GPIB) interface has an eight-position DIP switch that sets operational conditions and interface addresses. The bottom line of the display indicates the current bus status.

### Cable Connector

The interface uses a standard IEEE-488 cable connector. Pin assignments are listed in Table 5-3.

**Table 5-3 IEEE-488 Pin Assignments**

| Pin | Designation   | Type       |
|-----|---------------|------------|
| 1   | D101          | Data       |
| 2   | D102          | Data       |
| 3   | D103          | Data       |
| 4   | D104          | Data       |
| 5   | EOI           | Management |
| 6   | DAV           | Handshake  |
| 7   | NRFD          | Handshake  |
| 8   | NDAC          | Handshake  |
| 9   | IFC           | Management |
| 10  | SRQ           | Management |
| 11  | ATN           | Management |
| 12  | SHIELD        | Ground     |
| 13  | D105          | Data       |
| 14  | D106          | Data       |
| 15  | D107          | Data       |
| 16  | D108          | Data       |
| 17  | REN           | Management |
| 18  | GROUND        | Ground     |
| 19  | GROUND        | Ground     |
| 20  | GROUND        | Ground     |
| 21  | GROUND        | Ground     |
| 22  | GROUND        | Ground     |
| 23  | GROUND        | Ground     |
| 24  | GROUND, LOGIC | Ground     |

## Interface Capabilities

**Table 5-4 IEEE-488 Interface Module Capabilities**

| Code | Name              | Description   |
|------|-------------------|---|
| SH1  | Source Handshake  | Can handshake data or command bytes when the unit is acting as a source.  |
| AH1  | Acceptor          | Can handshake the bus when it is acting as the acceptor of data or commands.  |
| T5   | Talker            | Can send data over the bus to other devices. This capability exists only after the instrument has been addressed to talk, or after a reading in talk-only mode. |
| L4   | Listener          | Can receive device-dependent data over the bus. This capability exists only after the unit has been addressed to listen.  |
| SR1  | Service Request   | Can request service from the controller.  |
| RL1  | Remote-Local      | Can be placed in remote or local mode.  |
| PP0  | Parallel Poll     | Does not have parallel polling capability.  |
| DC1  | Device Clear      | Can be reset to factory settings.   |
| DT1  | Device Trigger    | Can have its readings triggered.  |
| C0   | Controller        | Does not have controller capability.  |
| E1   | Bus Driver Type   | Has open-collector bus drivers.   |
| TE0  | Extended Talker   | Does not have extended talker capability.   |
| LE0  | Extended Listener | Does not have extended listener capability.   |

## Indicators

The bottom line of the power meter's display shows indicators describing the status of the Bird 4421 when used with the IEEE interface. These are:

**REMOTE** - When REMOTE is displayed, the power meter is being controlled through the interface. Measurements, units of measure, and certain other parameters may be changed from a remote location.

**LISTEN** - When LISTEN is displayed, the power meter is receiving data.

**TALK** - When TALK is displayed, the power meter is transmitting data. This is always shown when the unit is in "talker-only" mode.

**LOCAL LOCKOUT** - When LOCAL LOCKOUT is displayed, the push buttons are disabled and the power meter's functions are being remotely controlled.

## Setup

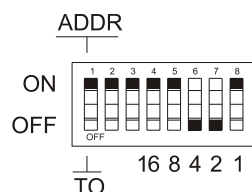
### Dip Switch

Set the interface to ADDR (Addressable) by positioning DIP switch 1 to ON. This makes the 4421 respond to controller commands.

**Note:** There are several button styles on DIP switches (slide, rocker, lever). Examine the DIP switch to determine the ON and OFF positions.

Set the primary address using the DIP switches. The primary address is factory set to 6, but can be set to any value between 1 and 31 (0 is reserved for the controller). To set the primary address, turn OFF switches 4 – 8 so that the sum of the bits turned off equals the desired primary address. In Figure 8 below, the address is set to 6 (the off switches have values of 4 and 2).

**Figure 8 IEEE Interface Default DIP Switch Settings**



**Note:** The primary address is used by the controller to refer to specific devices on the bus. When programming the controller, the address in the program must be the same as the address set on the interface module. Each device on the bus must have a different primary address.

## Talker-Only Mode

The Bird 4421 can be set up for manual operation while automatically sending data to an output device (Talker-Only Mode). To do so, turn DIP switch 1 OFF and cycle the power. TALK will be displayed.

In Talker-Only mode, pressing a button on the meter triggers a measurement. When the measurement is complete, the information is sent to the bus and LISTEN turns on momentarily. A listen-only device on the bus, such as a printer, can read the value. The power meter is then ready to accept another button press.

## Command Syntax

The Bird 4421 accepts two types of commands. General bus commands are commands, such as Device Clear (DCL), that apply to any IEEE interfaced device. Device-dependent commands are specific to the 4421.

If an invalid command is sent to the unit, an error condition is placed in the serial poll byte and the offending command is not executed.

A group of device-dependent commands can be sent as a single string as long as like command categories are not repeated, for example: "PNFCFDT3TRG". This string sets up the 4421 to send no prefixes, read forward dBm, make one reading on "TRG", and triggers a measurement.

**Note:** *Commands can be entered in either upper or lower case.*

**Note:** *Only the last command entered of each category will be executed. As a command string is processed by the 4421, each category of command is stored in a separate location. Two commands of the same category will be stored in the same location, so that the second will overwrite and erase the first one.*

## General Bus Commands

The general bus commands supported by the IEEE-488 interface feature are listed in Figure 5-5. The syntax for executing general commands varies among controllers; check the documentation supplied with your controller for the proper command structure.

**Table 5-5 IEEE-488 General Bus Commands**

| Command  | Effect on Bird 4421                          |
|----------|--|
| IDN?     | Gives product identification                 |
| REN      | Goes into remote mode when next addressed    |
| GTL      | Cancel remote mode, restores local operation |
| LLO      | Locks out local operation                    |
| IFC      | Goes into talker and listener-idle status    |
| DCL      | Returns to default conditions                |
| SDC      | Returns to default conditions                |
| GET      | Triggers reading in T2 and T3 modes          |
| SPE, SPD | Puts the status byte on the bus              |

---

**IDentificatioN** (IDN?)

---

**Function** Product identifies itself

**Remarks** Replies command same as U2

---

---

**Remote ENable** (REN)

---

**Function** Enables remote operation.

**Remarks** The unit must be addressed to listen after setting REN true.  
The REMOTE indicator turns on when this command is received.

---

---

**Go To Local** (GTL)

---

**Function** Returns device to local operation.

**Remarks** Issuing a GTL command while the device is in Local Lockout mode does not clear the lockout condition.

The REMOTE indicator turns off.

The LISTEN indicator remains on.

---

---

**Local LOkout** (LLO)

---

**Function** Disables local operation of all devices on the bus.

**Remarks** REN must be true to use LLO.

LLO is cleared by setting REN false.

---

---

**InterFace Clear** (IFC)

---

**Function** Terminates all bus activity and passes control to the system controller.

**Remarks** All devices are set to talker and listener idle states.

LISTEN mode is cancelled, and its indicator is turned off.

---



---

**Device CLear (DCL)**

---

**Function** Resets the status of all devices to an initialized state.

**Remarks** Does not change the current interface mode.

The 4421 returns to the factory default condition listed in Figure 5-6.

**Table 5-6 IEEE-488 Default Conditions**

| Default Condition                  | Related Command |
|------------------------------------|-----------------|
| Forward Carrier Wave               | FC              |
| Auto Range ON                      | RYY             |
| Two Terminators (CR LF)            | YT              |
| Prefixes YES                       | PY              |
| Trigger One Shot on Talk Address   | T1              |
| All SRQ's OFF                      | M00             |
| Send EOI with last byte of message | KY              |

---

**Selective Device Clear (SDC)**

---

**Function** Resets the status of a selected device to an initialized state.

**Remarks** Only the device addressed will be cleared.

The 4421 returns to the factory default condition.

---

**Group Execute Trigger (GET)**

---

**Function** Initiates a measurement for all devices set to trigger on GET.

**Remarks** The 4421 must be already set to trigger on GET.

Used to synchronize measurements of multiple instruments.

---

**Serial Polling Enable/Disable (SPE/SPD)**


---

**Function** Enables or disables the serial polling sequence.

|                |
|----------------|
| <b>CAUTION</b> |
|----------------|

|  |
|--|
| <p>During remote operation, periodically monitor the bus service request line. Failure to detect a service request could result in equipment damage.</p> |
|--|

**Remarks** The SPE command puts all devices in serial poll mode waiting to be addressed. The SPD command clears the SRQ bit (bit 6) and ends the polling sequence.

When addressed a device sends its status byte to the controller. A value of 1 for a bit means that the device condition that bit refers to is true. A value of 0 means that the condition is false.


The 4421 does not use all bits of the status byte. Table 5-7 lists the bits used, along with a description and how to reset them.

**Table 5-7 IEEE Status Byte Description**

| Bit | Name                 | Condition   |
|-----|----------------------|---|
| 6   | SRQ                  | Set if a service request is generated by the 4421. If an SRQ has been received by the controller and this bit is cleared, other instruments on the bus should be checked to determine where the SRQ occurred.<br>Cleared by a serial poll of the 4421.                      |
| 3   | Measurement Complete | Set when the power meter has completed a reading.<br>Cleared by requesting a reading over the bus.  |
| 2   | Reading Underflow    | Set when the RF power is underrange and a reading has been completed.<br>Cleared by requesting a reading over the bus.  |
| 1   | Reading Overflow     | Set when the RF power is overrange and a reading has been completed.<br>Cleared by requesting a reading over the bus.   |
| 0   | Error                | Set if an illegal device-dependent command (IDDC) or illegal device-dependent command option (IDDCO) was received, or if the power meter fails the self test.<br>Cleared by reading the U1 status word. The U1 word contains details on the error, see "Status" on page 21. |

## Device Dependent Commands

The device-dependent commands used by the 4421 Power Meter are listed in Table 5-8, organized by category.

 **Note:** *The programming card also has a complete command list.*

**Table 5-8 IEEE-488 Device Dependent Command Summary**

| Category       | Command    | Description                            |
|----------------|------------|--|
| Measurement    | FC         | Forward carrier wave                   |
|                | FD         | Forward dBm                            |
|                | RC         | Reflected carrier wave                 |
|                | RD         | Reflected dBm                          |
|                | SW         | Standing wave ratio                    |
|                | RL         | Return loss                            |
|                | MN         | Minimum value                          |
|                | MX         | Maximum value                          |
| Range          | RYY        | Auto range on                          |
|                | R00 to R17 | Manual ranges                          |
|                | RNN        | Auto range off, stay at present range  |
| Terminators    | YT         | Two terminators: CR, LF                |
|                | YO         | One terminator: CR                     |
|                | YN         | No terminator                          |
| Prefixes       | PY         | Prefix YES                             |
|                | PN         | Prefix NO                              |
| Triggers       | T0         | Continuous on TALK                     |
|                | T1         | One shot on TALK                       |
|                | T2         | Continuous on GET                      |
|                | T3         | One shot on GET                        |
|                | T4         | Continuous on measurement command      |
|                | T5         | One shot on measurement command        |
| Serial Polling | M00        | Do not generate SRQ                    |
|                | M01        | Generate SRQ on error                  |
|                | M02        | Generate SRQ on measurement overrange  |
|                | M04        | Generate SRQ on measurement underrange |
|                | M08        | Generate SRQ on operation complete     |
| Status         | U0         | Send back current machine state        |
|                | U1         | Send back error conditions             |
|                | U2         | Send back revision levels              |
| Self-Test      | J0         | Run self-test                          |
| EOI Response   | KY         | Send EOI on last byte                  |
|                | KN         | Do not send EOI on last byte           |
| Writable Store | WXXXXXX    | Place XXXXXX in RAM                    |

---

**Forward Carrier Wave** (FC)  
**Forward dBm** (FD)  
**Reflected Carrier Wave** (RC)  
**Reflected dBm** (RD)

---

**Function** Selects forward or reflected RF power measurement mode.

**Remarks** Measurement results are returned in Watts or dBm.

---

**Standing Wave Ratio** (SW)  
**Return Loss** (RL)

---

**Function** Selects SWR or return loss match measurement mode.

**Remarks** Measurement results are returned in VSWR or dB.

---

**Minimum Value** (MN)  
**Maximum Value** (MX)

---

**Function** Selects minimum or maximum measurement mode.

**Remarks** Another measurement must be selected before selecting min or max.

Returns the minimum (or maximum) value of the previous measurement type.

---

**Range** (Rxx)
 

---

**Function** Selects a measurement range listed in Table 5-9.

**Remarks** If the selected range is outside the range of the connected power sensor, the command is ignored.

**Table 5-9 Measurement Ranges**

| Command | Power Range                             |
|---------|---|
| RYY     | Turn auto range on                      |
| RNN     | Turn auto range off. Keep present range |
| R17     | 18.0 – 199.9 MW                         |
| R16     | 1.80 – 19.99 MW                         |
| R15     | 0.180 – 1.999 MW                        |
| R14     | 18.0 – 199.9 kW                         |
| R13     | 1.80 – 19.99 kW                         |
| R12     | 0.180 – 1.999 kW                        |
| R11     | 18.0 – 199.9 W                          |
| R10     | 1.80 – 19.99 W                          |
| R09     | 0.180 – 1.999 W                         |
| R08     | 18.0 – 199.9 mW                         |
| R07     | 1.80 – 19.99 mW                         |
| R06     | 0.180 – 1.999 mW                        |
| R05     | 18.0 – 199.9 $\mu$ W                    |
| R04     | 1.80 – 19.99 $\mu$ W                    |
| R03     | 0.180 – 1.999 $\mu$ W                   |
| R02     | 18.0 – 199.9 nW                         |
| R01     | 1.80 – 19.99 nW                         |
| R00     | 0.180 – 1.999 nW                        |

---

**Terminators** (Yx)
 

---

**Function** Selects the characters that follow the end of a data string. Set x to:

- “T” for two terminators; a carriage return(CR) and a line feed(LF).
- “O” for one terminator; a carriage return(CR).
- “N” for no terminator; message can be terminated by EOI.

**Remarks** Many controllers use the terminator sequence to recognize the end of an input string. Using incorrect terminators can lock the bus.

---

**Prefixes (Px)**


---

- Function** Turns the prefix mode on or off. Set x to:
- “Y” to enable prefixes.
  - “N” to disable prefixes.
- Remarks** Prefixes are sent over the bus with the measurement, and indicate the status of the current measurement (see Table 5-10 for examples):
- “FC”, “FD”, “RC”, “RD”, “SW”, “RL”, “MN”, “MX” indicates the measurement type.
  - “U” indicates underflow; the value sent is “.000”.
  - “O” indicates overflow; the value sent is “199.9”.
  - “N” indicates normal; the value sent is a normal on-scale reading.
  - “4421” indicates the Bird model number.

**Table 5-10 Prefix Examples**

| Data String          | Description   |
|----------------------|---|
| NFC.0.123W (CR) (LF) | Normal (N) forward carrier wave (FC), prefixes on     |
| OFC 199.9W (CR) (LF) | Overflowed (O) forward carrier wave (FC), prefixes on |
| 199.9W (CR) (LF)     | Overflowed forward carrier wave, prefixes off         |
| URD .000W (CR) (LF)  | Underflowed (U) reflected dBm (RD), prefixes on       |

---

**Triggers (Tx)**


---

- Function** Selects the condition which will trigger a reading (see Table 5-11).
- Remarks** Failure to trigger device before requesting a reading will lock the bus. T1 halts the bus until a reading is available. T0 and T1 do not set the measurement complete SRQ. T2, T3, T4, and T5 set a SRQ when the measurement is complete. Fastest reading rate is 2.4 readings/second; slowest is 1 reading/sec.

**Table 5-11 Trigger Conditions**

| Command | Trigger Condition  |
|---------|--|
| T0      | Continuous on talk   |
| T1      | One shot on talk   |
| T2      | Continuous on GET  |
| T3      | One shot on GET  |
| T4      | Continuous on measurement command (FC, FD, RC, RD, SW, RL, MN, MX) |
| T5      | One shot on measurement command (FC, FD, RC, RD, SW, RL, MN, MX)   |

---

**SRQ Mask** (Mxx)
 

---

**Function** Selectively masks status bits to prevent unwanted service requests.

Set xx to the sum of the binary values of the desired SRQ trigger bits. For example, M12 would set the SRQ for both operation complete and underrange (values 8 and 4). Set xx to "00" to never generate an SRQ.

**Remarks** If a status bit is masked (bit set to 0), SRQs won't be generated for that condition.

**Table 5-12 SRQ Mask Bits**

| Binary Value | Bit Number | Message                             |
|--------------|------------|-------------------------------------|
| 1            | 0 (LSB)    | Error (IDDC, IDDCO, self-test fail) |
| 2            | 1          | Measurement overrange               |
| 4            | 2          | Measurement underrange              |
| 8            | 3          | Operation complete                  |
|              | 4          | Not Used                            |
|              | 5          | Not Used                            |
|              | 6          | Can't mask                          |
|              | 7 (MSB)    | Not Used                            |

---

**Status** (Ux)
 

---

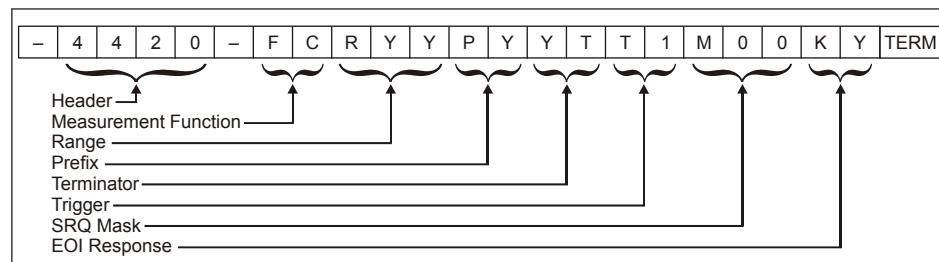
**Function** Reads a status word and returns the information as a string. Set x to:

- "0" for machine status.
- "1" for error status.
- "2" for revision history.

**Remarks** After sending the status command, a status word is sent the next time the unit is addressed to talk. To ensure the correct status is transmitted, the status word should be requested as soon as possible after the command is sent.

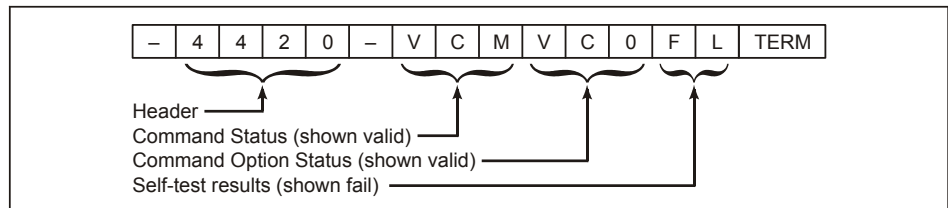
**Machine Status Word (U0)** - The format of the machine status word is shown in Figure 9. The default values are also shown.

**Figure 9 Machine Status Word Format**



**Error Status Word (U1)** - The format of the error status word and the possible error messages are shown in Figure 10. When an error occurs, an error is also flagged in the status (serial poll) byte, and a SRQ may be generated (See “SRQ Mask” on page 21). All flags will revert to their non-error states after the U1 command is sent.

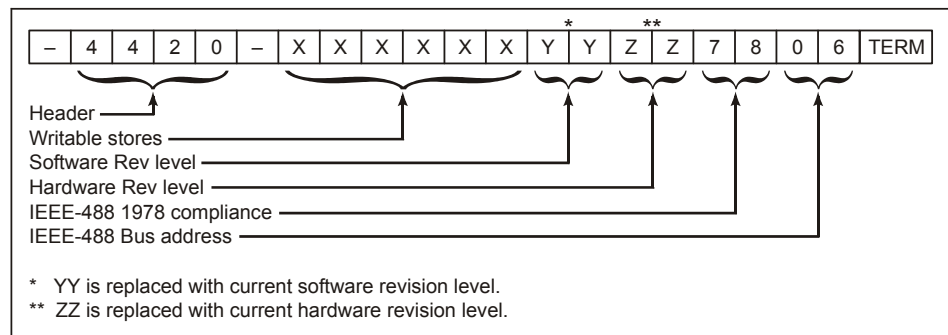
**Figure 10 Error Status Word Format**



| Status | Meaning                | Description  |
|--------|------------------------|--|
| ICM    | Invalid Command        | Set when an illegal device-dependent command (IDDC) such as V2 is received. (V is illegal)         |
| VCM    | Valid Command          | Set when no IDDC is received.  |
| ICO    | Invalid Command Option | Set when an illegal device-dependent command option (IDDCO) such as T6 is received. (6 is illegal) |
| VCO    | Valid Command Option   | Set when no IDDCO is received.   |
| PS     | Self-Test Pass         | Set when a self-test has been initiated by the J0 command and the test result is acceptable.       |
| FL     | Self-Test Fail         | Set when the self-test has failed. (This is the default condition.)                                |

**Revision History Word (U2)** - The format of the revision history word is shown in Figure 11.

**Figure 11 Revision History Word Format**



**Note:** If Writable stores parameter has not been set, this command responds only with -4420-.



---

**Self Test** (J0)

---

**Function** Initiates a hardware and software test.

**Remarks** Results are stored in the U1 status word (see “Status” on page 21).  
“J0” must be sent each time before reading the result.

---

---

**End Or Identify (Kx)**

---

**Function** Enables or disables the End or Identify (EOI) signal. Set x to:

- “Y” to enable.
- “N” to disable.

**Remarks** Disabling EOI can cause some controllers to lock unless another terminator is used.  
When enabled, EOI is only asserted at the end of a multiple byte string.

---

---

**Writable Store** (Wxxxxxx)

---

**Function** Storage for six bytes of ASCII data.

**Remarks** Data stored is lost when the 4421 is turned off.  
Data is sent back as part of the U2 status word.

This chapter discusses setup of the RS-232 interface feature and describes the RS-232 commands that apply to the Bird 4421. Operators should understand EIA Standard RS-232-C and have basic computer programming skills before writing any programs.

## Description

The Bird 4421 RS-232 interface feature is an integral part of the I/O hub circuit board inside of the mm21. An eight-position DIP switch is used to set operational conditions such as baud rate, parity, and stop bits. The bottom line of the display indicates the current bus status.

## Cable Connector

The interface uses a standard 25-pin RS-232 connector. Pin assignments are listed in Table 6-13. If the controller uses a different wiring arrangement, do not attempt to rewire the interface module's connector. A null modem kit should be used for rewiring instead.

**Table 6-13 RS-232 Pin Assignments**

| Pin | Designation         | Notes  |
|-----|---------------------|--|
| 1   | Protection Ground   | Chassis Ground   |
| 2   | Transmit Data       |  |
| 3   | Receive Data        |  |
| 4   | Request to Send     | (Output) Set true after module power up  |
| 5   | Clear to Send       | (Input) Set by input device. When true, it enables the module to transmit. When false, it disables transmission. |
| 6   | Data Set Ready      | (Input) Set internally true by module  |
| 7   | Signal Ground       | Return path for data and control signals   |
| 8   | Receive Signal DET  | (Input) Set true by module   |
| 20  | Data Terminal Ready | (Output) Set true after module power up  |

## Indicators

The bottom line of the power meter's display shows indicators describing the status of the Bird 4421 when used with the RS-232 interface. These are:

**TALK** - When TALK is displayed, the power meter is transmitting data. This is always shown when the unit is in "talker-only" mode.

**LISTEN** - When LISTEN is displayed, the power meter is receiving data.

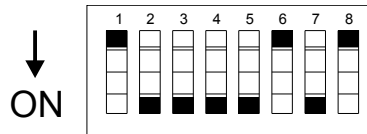
## Setup

### DIP Switch

Set the DIP switches according to application needs and the requirements of the controller. Available settings and factory defaults are listed in Figure 12.

**Note:** There are several button styles on DIP switches (slide, rocker, lever). Examine the DIP switch to determine the ON and OFF positions.

**Figure 12 RS-232 Interface Default DIP Switch Settings**



**Note:** If you change switch settings when the unit is ON, the new settings will not become effective until you turn power OFF and then back ON.

| Switch | Function     | Description  |   |
|--------|--------------|--|---|
| 1      | Stop Bit     | ON 1 Stop Bit<br>OFF 2 Stop Bits*  |   |
| 2      | Command Mode | ON ENT command needed before sending reading to controller*<br>OFF Trigger automatically sends reading<br>Reading also sent when front panel push button pressed |   |
| 3      | Word Length  | ON 8 Data Bits*<br>OFF 7 Data Bits   |   |
| 4,5    | Parity       | (4) (5)<br>ON ON<br>ON OFF<br>OFF ON<br>OFF OFF  | No Parity*<br>Odd Parity<br>Even Parity<br>Mark Parity    |
| 6,7,8  | Baud Rate    | (6) (7) (8)<br>ON ON ON<br>ON OFF ON<br>ON OFF OFF<br>OFF ON ON<br>OFF ON OFF<br>OFF OFF ON<br>OFF OFF OFF   | Auto Baud†<br>300<br>600<br>1200<br>2400*<br>4800<br>9600 |

\* Default factory setting

† For more information see “Auto Baud”

## Auto Baud

Auto Baud is used to automatically determine the correct transmission rate. After setting DIP switches 1 through 5, follow the steps below to use auto baud:

1. Set DIP switches 6, 7, and 8 to ON.
2. Connect a controller to the power meter.
3. Turn the power meter on.
4. Send the character U (hexadecimal 55) from the controller to the power meter.
5. Wait 1 second.
6. If the power meter's front panel displays LISTEN, the baud rate has been determined. If not, repeat steps 4 and 5.

If, after 30 seconds, the module cannot absolutely determine a baud rate, it will choose a rate based on data acquired during the test.

**Note:** *Auto Baud is the only automatically chosen setting. Other items such as parity and stop bits must be manually selected.*

## Talker-Only Mode

The Bird 4421 can be set up for manual operation while automatically sending data to an output device (Talker-Only Mode). To do so, turn DIP switch 2 OFF and cycle the power. TALK will be displayed.

In Talker-Only mode, pressing a button on the meter triggers a measurement. When the measurement is complete, the information is sent to the bus.

## Command Syntax

The Bird 4421 accepts two types of commands. General bus commands are commands, such as Initialize (INT), that apply to any RS-232 interfaced device. Device-dependent commands are specific to the 4421.

If an invalid command is sent to the unit, an error condition is placed in the serial poll byte and the offending command is not executed.

A group of device-dependent commands can be sent as a single string as long as like command categories are not repeated. For example: "PNFCFDT3TRG". This string sets up the 4421 to send no prefixes, read forward dBm, make one reading on "TRG", and triggers a measurement.

**Note:** *Commands can be entered in either upper or lower case.*

**Note:** *Only the last command entered of each category will be executed. As a command string is processed by the 4421, each category of command is stored in a separate location. Two commands of the same category will be stored in the same location, so that the second will overwrite and erase the first one.*

## General Bus Commands

The general bus commands supported by the RS-232 interface module are listed in Table 6-14.

**Table 6-14 RS-232 General Bus Commands**

| Command  | Effect on Bird 4421                 |
|----------|-------------------------------------|
| INT      | Returns to default conditions       |
| ENT      | Sends a reading to the controller   |
| TRG      | Triggers reading in T3 mode         |
| B1 to B7 | Selects a baud rate                 |
| XO/XF    | Enables/disables software handshake |

---

**INiTialize** (INT)

---

- Function** Resets the Bird 4421 and returns it to the factory defaults.
- Remarks** If INT is linked with any other command within a string, it must be separated from that command by a space.

---

**ENTer** (ENT)

---

- Function** Makes the power meter transmit a reading to the controller.
- Remarks** A measurement must have already been triggered, placing a reading in the output buffer.
- To send a reading whenever a measurement is triggered, set DIP switch 2 to OFF. The ENT command will not need to be sent.

---

**TRiGger** (TRG)

---

- Function** Initiates a measurement if the power meter is in trigger mode (T3).

---

**Baud Select** (Bx)

---

- Function** Selects a baud rate listed in Table 6-15.
- Remarks** When the meter recognizes a valid Bx command, its baud rate is immediately changed. (The controller is assumed to be transmitting at the new rate; otherwise sending commands would not be possible.)
- This command overrides the DIP switch setting.

**Table 6-15 Baud Rates**

| Command | Baud Rate |
|---------|-----------|
| B2      | 300       |
| B3      | 600       |
| B4      | 1200      |
| B5      | 2400      |
| B6      | 4800      |
| B7      | 9600      |

---

**Xmission Flow Control** (XO/XF)

---

- Function** Enables or disables the XON/XOFF flow control.
- XO enables flow control.
  - XF disables flow control.
- Remarks** When data is being sent from the power meter to the computer and flow control is enabled, data transmission will be suspended when the XOFF character (hexadecimal 13) is sent by the computer. Transmission will resume when XON (hex 11) is sent by the computer.
- When data is being sent from the computer to the power meter, XOFF will be sent to the computer when the input buffer fills up. XON will be sent to the computer when the buffer has emptied.

## Device Dependent Commands

The device-dependent commands used by the 4421 Power Meter are listed in Table 6-16, organized by category.

**Table 6-16 RS-232 Device Dependent Command Summary**

| Category              | Command    | Description                           |
|-----------------------|------------|---------------------------------------|
| <b>Measurement</b>    | FC         | Forward carrier wave                  |
|                       | FD         | Forward dBm                           |
|                       | RC         | Reflected carrier wave                |
|                       | RD         | Reflected dBm                         |
|                       | SW         | Standing wave ratio                   |
|                       | RL         | Return loss                           |
|                       | MN         | Minimum value                         |
|                       | MX         | Maximum value                         |
| <b>Range</b>          | RYY        | Auto range on                         |
|                       | R00 to R17 | Manual ranges                         |
|                       | RNN        | Auto range off, stay at present range |
| <b>Terminators</b>    | YT         | Two terminators: CR, LF               |
|                       | YO         | One terminator: CR                    |
|                       | YN         | No terminator                         |
| <b>Prefixes</b>       | PY         | Prefix YES                            |
|                       | PN         | Prefix NO                             |
| <b>Triggers</b>       | T0         | Continuous on ENT                     |
|                       | T1         | One shot on ENT                       |
|                       | T3         | One shot on TRG                       |
|                       | T5         | One shot on measurement command       |
| <b>Status</b>         | U0         | Send back current machine state       |
|                       | U1         | Send back error conditions            |
|                       | U2         | Send back revision levels             |
| <b>Self-Test</b>      | J0         | Run self-test                         |
| <b>Writable Store</b> | WXXXXXX    | Place XXXXXX in RAM                   |

---

**Forward Carrier Wave** (FC)  
**Forward dBm** (FD)  
**Reflected Carrier Wave** (RC)  
**Reflected dBm** (RD)

---

**Function** Selects forward or reflected RF power measurement mode.  
**Remarks** Measurement results are returned in Watts or dBm.

---

**Standing Wave Ratio** (SW)  
**Return Loss** (RL)

---

**Function** Selects SWR or return loss match measurement mode.  
**Remarks** Measurement results are returned in VSWR or dB.

---

**Minimum Value** (MN)  
**Maximum Value** (MX)

---

**Function** Selects minimum or maximum measurement mode.

**Remarks** Another measurement must be selected before selecting min or max.  
Returns the minimum (or maximum) value of the previous measurement type.

---

**Range** (Rxx)

---

**Function** Selects a measurement range listed in Figure 6-17.

**Remarks** If the selected range is outside the range of the connected power sensor, the command is ignored.

**Table 6-17 Measurement Ranges**

| Command | Power Range                             |
|---------|---|
| RYY     | Turn auto range on                      |
| RNN     | Turn auto range off. Keep present range |
| R17     | 18.0 – 199.9 MW                         |
| R16     | 1.80 – 19.99 MW                         |
| R15     | 0.180 – 1.999 MW                        |
| R14     | 18.0 – 199.9 kW                         |
| R13     | 1.80 – 19.99 kW                         |
| R12     | 0.180 – 1.999 kW                        |
| R11     | 18.0 – 199.9 W                          |
| R10     | 1.80 – 19.99 W                          |
| R09     | 0.180 – 1.999 W                         |
| R08     | 18.0 – 199.9 mW                         |
| R07     | 1.80 – 19.99 mW                         |
| R06     | 0.180 – 1.999 mW                        |
| R05     | 18.0 – 199.9 $\mu$ W                    |
| R04     | 1.80 – 19.99 $\mu$ W                    |
| R03     | 0.180 – 1.999 $\mu$ W                   |
| R02     | 18.0 – 199.9 nW                         |
| R01     | 1.80 – 19.99 nW                         |
| R00     | 0.180 – 1.999 nW                        |

---

**Terminators** (Yx)

---

**Function** Selects the characters that follow the end of a data string. Set x to:

- “T” for two terminators; a carriage return(CR) and a line feed(LF).
- “O” for one terminator; a carriage return(CR).
- “N” for no terminator.

**Remarks** Many controllers use the terminator sequence to recognize the end of an input string. Using incorrect terminators can lock the bus.

---

**Prefixes** (Px)

---

**Function** Turns the prefix mode on or off. Set x to:

- “Y” to enable prefixes.
- “N” to disable prefixes.

**Remarks** Prefixes are sent over the bus with the measurement, and indicate the status of the current measurement (see Table 6-18 for examples):

- “FC”, “FD”, “RC”, “RD”, “SW”, “RL”, “MN”, “MX” indicates the measurement type.
- “U” indicates underflow; the value sent is “.000”.
- “O” indicates overflow; the value sent is “199.9”.
- “N” indicates normal; the value sent is a normal on-scale reading.
- “4421” indicates the Bird model number.

**Table 6-18 Prefix Examples**

| Data String              | Description   |
|--------------------------|---|
| NFC . 0 . 123W (CR) (LF) | Normal (N) forward carrier wave (FC), prefixes on     |
| OFC 199 . 9W (CR) (LF)   | Overflowed (O) forward carrier wave (FC), prefixes on |
| 199 . 9W (CR) (LF)       | Overflowed forward carrier wave, prefixes off         |
| URD . 000W (CR) (LF)     | Underflowed (U) reflected dBm (RD), prefixes on       |

---

## Triggers (Tx)

---

**Function** Selects the condition which will trigger a reading (see Table 6-19).

**Remarks** Failure to trigger device before requesting a reading will lock the bus. Fastest reading rate is 2.4 readings/second; slowest is 1 reading/sec.

**Table 6-19 Trigger Conditions**

| Command | Trigger Condition  |
|---------|--|
| T0      | Continuous on ENT  |
| T1      | One shot on ENT  |
| T3      | One shot on TRG  |
| T5      | One shot on measurement command (FC, FD, RC, RD, SW, RL, MN, MX) |

---

## Status (Ux)

---

**Function** Reads a status word and returns the information as a string. Set x to:

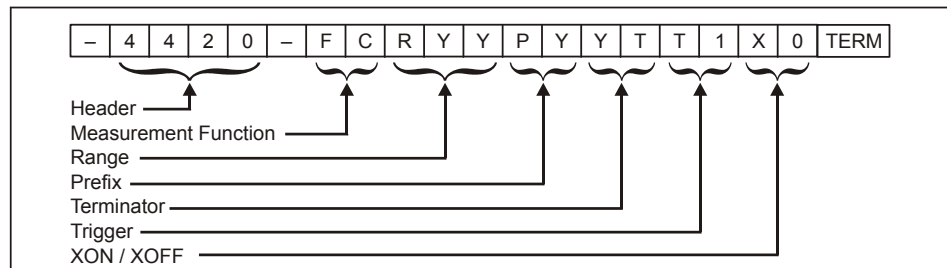
- “0” for machine status.
- “1” for error status.
- “2” for revision history.

**Remarks** After sending the status command, a status word is sent the next time the unit is addressed to talk. To ensure the correct status is transmitted, the status word should be requested as soon as possible after the command is sent.



**Machine Status Word (U0)** - The format of the machine status word is shown in Figure 13. The default values are also shown.

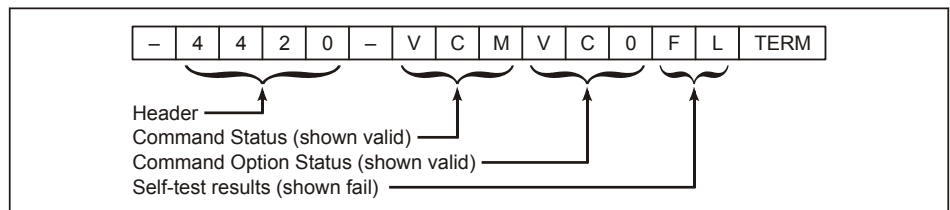
**Figure 13 Machine Status Word Format**



**Note:** This command sets the unit to the settings that were last issued remotely (through RS-232 or GPIB). Therefore, it will over ride any manual changes selected at the front panel of the unit.

**Error Status Word (U1)** - The format of the error status word and the possible error messages are shown in Figure 14. All flags will revert to their non-error states after the U1 command is sent.

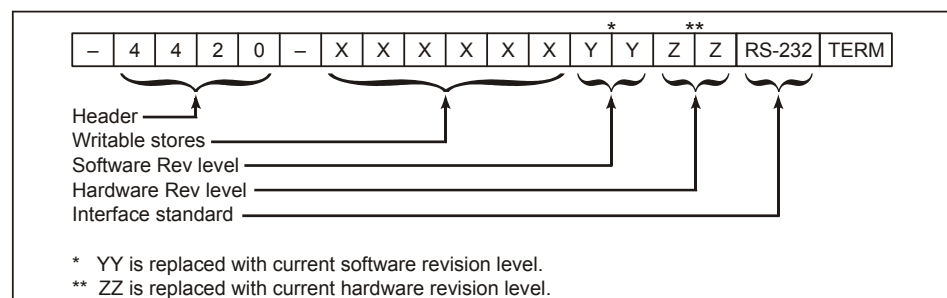
**Figure 14 Error Status Word Format**



| Status | Meaning                | Description  |
|--------|------------------------|--|
| ICM    | Invalid Command        | Set when an illegal device-dependent command (IDDC) such as V2 is received. (V is illegal)         |
| VCM    | Valid Command          | Set when no IDDC is received.  |
| ICO    | Invalid Command Option | Set when an illegal device-dependent command option (IDDCO) such as T6 is received. (6 is illegal) |
| VCO    | Valid Command Option   | Set when no IDDCO is received.   |
| PS     | Self-test Pass         | Set when a self-test has been initiated by the J0 command and the test result is acceptable.       |
| FL     | Self-test Fail         | Set when the self-test has failed. (This is the default condition.)                                |

**Revision History Word (U2)** The format of the revision history word is shown in Figure 15.

**Figure 15 Revision History Word Format**



---

**Self Test** (J0)

---

**Function** Initiates a hardware and software test.

**Remarks** Results are stored in the U1 status word (see “Status” on page 31).  
“J0” must be sent each time before reading the result.

---

**Writable Store** (Wxxxxxx)

---

**Function** Storage for six bytes of ASCII data.

**Remarks** Data stored is lost when the 4421 is turned off.  
Data is sent back as part of the U2 status word.

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 or changing the line voltage setting.

**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 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.

## Cleaning

**CAUTION**

Do not use harsh or abrasive detergents for cleaning.

Clean the Bird 4421 Power Meter and its display with a soft cloth dampened with mild detergent and water only. Clean sensors with a dry cleaning solvent that leaves no residue.


## 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 37. 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 power sensors in Cal Carts, 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.

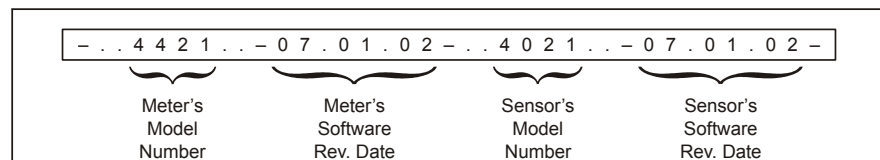
| PROBLEM  | POSSIBLE CAUSE   | CORRECTION   |
|--|--|--|
| Power meter has no power   | Have the batteries been charged?   | Recharge the batteries.  |
|  | Is the power meter's ac power cord connected?  | Connect the power cord.  |
|  | Is the ON/OFF rocker switch on the rear panel set to OFF?  | Set the switch to ON.  |
|  | <i>(Cal Cart only)</i><br>Is the Cal Cart's AC power cord connected to the AC line?                                    | Connect AC power.  |
|  | Blown fuse?  | Check fuse rating and replace fuse (See "Replacing Fuses" on page 39).                                     |
| Dash moves across the display  | Is the sensor cable connected to both the power meter and power sensor?  | Connect sensor cable.  |
|  | Is the sensor cable defective?   | Replace sensor cable.  |
| Display blank or not updating  | Have the batteries been charged?   | NO: Recharge battery<br>YES: Return meter for service.   |
| Power meter turns off while on battery power   | Is "LO BAT" displayed?   | YES: Recharge battery<br>NO: Return meter for service.   |
| Push buttons do not respond  | Test the push buttons (See "Push Button Test" on page 37). Are they defective?   | Return meter for service.  |
| Every segment on the display is lit  |  | Return meter for service.  |
| IEEE-488 Interface does not respond to the interface link                            | Are the address in the interface program and the address setting on the DIP switches on the interface module the same? | Change the program or DIP switch setting so that the addresses are the same (See "Dip Switch" on page 12). |
|  | Send the "J0" self test command, then check the status. Does the power meter fail the self test?                       | Replace I/O hub PCB.   |
|  | Is the IEEE cable defective?   | Replace IEEE interface cable.  |
| RS-232 Interface does not respond to the interface link. Fails J0 self-test command. | Are the DIP switches set correctly?  | Set DIP switches.  |
|  | Is the RS-232 cable defective?   | Replace RS-232 interface cable.  |
| With the RS-232, the power meter displays "TALK" but does not operate as expected.   | Is DIP switch 2 set correctly?   | For "talk/listen" operation, set this switch to ON. For "talk always" set this switch to OFF.              |
|  | Is DIP switch 1 set correctly?   | Set DIP switch 1 as indicated in Figure 8.   |

## Functional Test

1. Turn the power meter off. The ON/OFF switch on the *rear* panel should be OFF and the ac power cable should be connected.
2. Turn ON the ON/OFF switch on the *rear* panel of the meter.
3. While holding down the FWD and SWR push buttons, press the ON/OFF button on the *front* panel of the power meter. Immediately release all three.
 

**Note:** *The unit tests the display on power up cycling through and activating each segment two times and then activating all segments at once two times.*
4. 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.
5. The power sensor's model number and revision date should scroll across the display. If a dash is displayed after the power meter data, then the power sensor is malfunctioning.

**Figure 16 Test Display, No Malfunction**



## Push Button Test

- Note:** *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, a dash “-” should scroll across the display.*
  3. Turn the power meter OFF.
  4. Connect the power sensor.
  5. Turn the power meter ON.
 

**Note:** *“AUTO” and “FWD” should be displayed, and a reading of “0.00 W” (or a very low number).*
  6. Press RFL.
 

**Note:** *“FWD” should change to “RFL” on the display. The reading should remain the same.*
  7. Press SWR.
 

**Note:** *“RFL” should change to “SWR”. “0.00 W” should change to “□□” (underrange error).*
  8. Hold down MIN.
 

**Note:** *“□□” should change to “□□□” (overrange error).*
  9. Release MIN.
 

**Note:** *“□□□” should change to “□□”.*
  10. Press dBm.
 

**Note:** *“SWR” should turn OFF and “dBm” should turn ON.*

11. Press dBm.

**Note:** “dBm” should change to “SWR”.

12. Press FWD.

**Note:** “SWR” should change to “FWD” and “ ” to “.0000 W” (or a very low number).

13. Hold down MAX.

**Note:** “.0000” should change to “1.0000”.

14. Release MAX.

**Note:** “1.0000” should change to “.0000” (or a very low number).

15. Press LIGHT.

**Note:** The back-light should turn on.

16. Press LIGHT.

**Note:** The back-light should turn off.

17. Press s (up).

**Note:** The power meter should change ranges each time it is pressed until it reaches “0.000 KW”.

18. Press t (down).

**Note:** The power meter should change ranges each time it is pressed until it reaches “0.00 W”.

19. 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 or changing the line voltage setting.

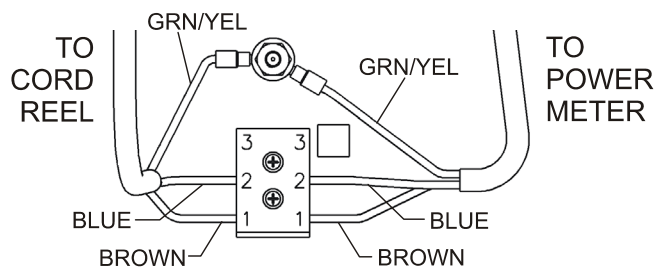
### Front Panel (Cal Cart only)

**Note:** If the power meter is mounted in a Cal Cart, 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.

**Note:** When making AC connections, refer to the following wiring diagram.

**Figure 17 Cal Cart Wiring Schematic**



### Cord Reel (Cal Cart only)

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, and connect the wires on the other end to the terminal strip (See Figure 18).

### Replacing Fuses

**WARNING**

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

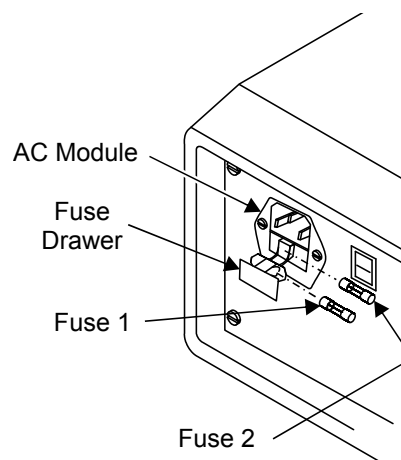
**CAUTION**

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

1. Gently pry the fuse drawer out of the ac module. The fuse holder does not detach from the AC module.
2. Install the replacement fuses then close and secure the fuse holder. Fuse 1 is a spare fuse and fuse 2 is the active fuse.

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

**Figure 18 AC Line Fuse**



## Replacing Batteries

**WARNING**

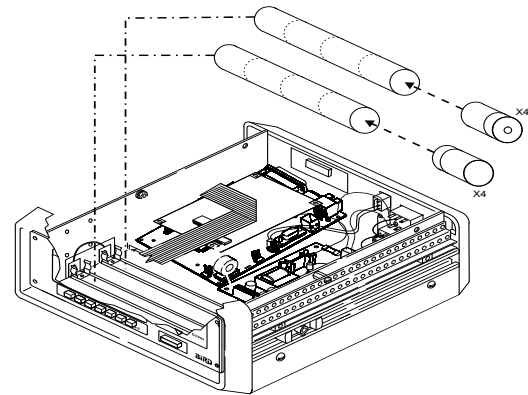
Exposed AC line voltage (115 VAC or 230 VAC). Disconnect the power cord from the AC line before replacing the batteries. Failure to comply may result in severe electrical shock or death.

**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. Unfasten the battery retaining belts then remove the battery tubes (Figure 19). Be sure to note the polarity and orientation of the battery tubes before removing them.
5. Remove the batteries from each tube and insert replacement batteries. Be sure to note the polarity (positive and negative) arrangement of the batteries.
6. Install the battery tubes into the unit and secure with the retaining belts. Be sure to position the retaining belts as they were before removal and tighten them securely.
7. Connect the ground wire to the top cover.
8. Install the top cover and secure it with the four screws removed earlier.

**Figure 19 Batteries**



| Item | Description                     |
|------|---------------------------------|
| 1    | Battery retaining belt          |
| 2    | Battery tube (batteries inside) |

### Long Term Storage

Do not store the instrument for long periods of time without recharging the batteries. When the instrument is stored for long periods of time without use, the batteries will lose their charge and also lose the ability to reach full charge when put into service. To restore the battery charge, perform a full charge for 28 hours. If the batteries are not fully charged after 28 hours, completely discharge the batteries then perform a full charge again. If necessary, repeat this discharge and charge cycle up to three times. If the batteries do not remain charged after three discharge-charge cycles, replace the batteries.



**Power Sensor (Cal Cart only)**



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

**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 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 "Front Panel (Cal Cart only)" on page 38).
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". Connect the sensor cable.
9. Replace the Cal Cart front panel.

**Load**

**WARNING**  
Heavy load. Do not attempt to lift unaided.

1. Disconnect all RF cables from the RF connectors on the load.
2. Unplug the blower assembly on blower-equipped loads.
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.

**Casters**

1. Remove the load (See "Load" on page 41).
2. Flip the cart over.
3. Unscrew the defective caster.
4. Screw the new caster into place and replace the load.

**Handle**

1. Unscrew the handle
2. Remove the old handle.
3. Screw the new handle into place.

## Storage and Shipment (Cal Cart only)

Cover the unit 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  $-20$  and  $+50$  °C ( $-4$  to  $+122$  °F).

Before shipping the Bird Cal Cart, take the following precautions:

- Remove the vent plugs and replace them with the shipping plugs. Wrap the vent plugs with padding and tape them to the side of the load for protection.
  - ☞ **Note:** *With the shipping plugs installed, it is not necessary to empty out the coolant.*
- Repack in the original carton or contact Bird for a transit case.

## Specifications, Cal Cart

To determine the model numbers of the Cal Cart components, refer to "About This Manual" on page x. For load specifications, refer to the load manual included.

☞ **Note:** *Certain sensors or connectors may be incompatible with some models. Refer to "About This Manual" on page x for a list of available components, or contact Customer Service.*

### 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:

- Above 65 MHz, derate the load's max. power. See "High Frequency Derating 1" on page 47.
- 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.
- Derate RF power by 2.5% for every 305m (1,000 ft.) above 1,520m (5,000 ft.).

**Table 7-20 Bird Cal Cart**

|                                   |  |
|-----------------------------------|--|
| <b>Frequency Range</b>            | Sensor dependent, 30 MHz max.  |
| <b>Power Range</b>                | Dependent on sensor, sensor connectors, and load                         |
| <b>Connectors</b>                 | Customer specified (See "Available Connectors" on page 49)               |
| <b>Dimensions</b>                 |  |
| Short Cart                        | 42"L x 20"W x 42"H (1067 x 508 x 1067 mm)                                |
| Long Cart                         | 52"L x 20"W x 42"H (1321 x 508 x 1067 mm)                                |
| <b>Weight, Nominal</b>            |  |
| Short Cart                        | 175 lbs. (80 kg)   |
| Long Cart                         | 290 lbs. (114 kg)  |
| <b>Temperature Range</b>          |  |
| Operating                         | 0 to +35 °C (32 to +95 °F)   |
| Storage                           | -20 to +70 °C (-4 °F to +158 °F)   |
| <b>Altitude</b>                   | 1520 m (5000 ft.)  |
| <b>Humidity</b>                   | 85% noncondensing max  |
| <b>Calibration Cycle, Nominal</b> | 1 year   |
| <b>CE</b>                         | CE Compliant. Refer to Declaration of Conformity for specific standards. |

## Specifications, 4421 Power Meter

### Specifications, Power Sensors

**Table 7-21 Bird 4421 RF Power Meter**

|                            |  |
|----------------------------|--|
| <b>Frequency Range</b>     | Sensor dependent   |
| <b>Power Range</b>         | Sensor dependent   |
| <b>VSWR Display</b>        | 1.0 – 199.9 max  |
| <b>Return Loss Display</b> | 0 to 40 dB max   |
| <b>Display Accuracy</b>    | ± 1 on least significant digit   |
| <b>AC Power</b>            | 115/230 Vac @ 50/60 Hz; 60 W   |
| <b>Batteries</b>           | 8 Nickel Metal Hydride 1.2 v cells, rechargeable   |
| <b>Battery Life</b>        | Approximately 8 hours continuous usage (reduced after high temperature charging)   |
| <b>Battery Charger</b>     | Built-in battery charger. Drained batteries require approximately 28 hours to recharge.  |
| <b>Display</b>             | LCD, 4½ digit display. Indicates mode, measurement units, battery condition, remote status, and signal increase/ decrease. Self contained backlight. |
| <b>Optional Interfaces</b> | IEEE-488 GPIB<br>RS-232  |
| <b>Fuse Rating</b>         | IEC (5 x 20 mm) Time Lag Type T  |
| <b>115 Vac</b>             | T630 mA  |
| <b>230 Vac</b>             | T315 mA  |
| <b>CE</b>                  | CE Compliant. Refer to Declaration of Conformity for specific standards.   |
| <b>Humidity</b>            | 95% max. (noncondensing)   |
| <b>Altitude</b>            | Up to 10,000 feet (3,000 m)  |
| <b>Temperature Range</b>   |  |
| <b>Operating</b>           | 0 to 50 °C (32 to 122 °F)  |
| <b>Storage</b>             | –20 to +50 °C (–4 to +122 °F)  |
| <b>Dimensions</b>          | 15.5"L x 12.25"W x 4.25"H (393 x 311 x 108 mm)   |
| <b>Weight, Nominal</b>     | 9.5 lbs. (4.3 kg)  |



**CAUTION**

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

**Table 7-22 Specifications Common to all Sensors**

|  |  |
|--|--|
| <b>Impedance, Nominal</b>  | 50 ohms  |
| <b>Max. Allowable Terminating VSWR</b>   | 2.00:1   |
| <b>Calibration Technique</b>   | Frequency-specific calibration factors stored in nonvolatile memory in each sensor. Sensor output corrected for frequency and temperature within specified ranges. |
| <b>Calibration Cycle, Nominal</b>  | 4027A and 4027F, 6 months<br>All other models, 1 year  |
| <b>Accuracy, Reflected</b>   | Calculated from FWD accuracy and FWD power<br>$\text{RFL Accuracy} = \text{FWD Accuracy} + \frac{\text{FWD Power}}{10^{\text{Directivity}/10}}$                    |
| <b>Accuracy, VSWR</b>  | Calculated from FWD and RFL power<br>$\text{VSWR} = \left(1 + \sqrt{\frac{P_R}{P_F}}\right) / \left(1 - \sqrt{\frac{P_R}{P_F}}\right)$                             |
| <b>Sampling Rate, Nominal</b>  | 2 readings/second  |
| <b>Operating Power</b>   | Supplied by power meter via sensor cable   |
| <b>Connectors</b><br>4028B10M<br>4028C10M<br>4028A Series<br>All other models  | 1-5/8" EIA Flanged<br>3-1/8" EIA Flanged<br>7-16 DIN, LC, HN, or 7/8"<br>Customer specified from QC list, appropriate for frequency and power.                     |
| <b>CE</b>  | CE Compliant. Refer to Declaration of Conformity for specific standards.   |
| <b>Humidity, Max.</b>  | 95% (noncondensing)  |
| <b>Altitude, Max.</b>  | 10,000 feet (3,000 m)  |
| <b>Temperature Range</b><br>Operating<br>Storage   | 0 to 50 °C (32 to 122 °F)<br>-20 to +70 °C (-4 to +158 °F)   |
| <b>Dimensions</b><br>4028B3M, 4028B10M<br>4028A Series<br>All other models   | 6.75"L x 3.5"W x 4.75"H (175 x 89 x 121 mm)<br>4.7"L x 3.2"W x 3.8"H (120 x 82 x 97mm)<br>5.2"L x 2.5"W x 3.25"H (137 x 64 x 83 mm)                                |
| <b>Weight, Nominal</b><br>4028B3M, 4028B10M,<br>4028C10M<br><br>4028A2M, 3M, 4M, 10M,<br>and 25M<br><br>All other models | 5 lb. 2 oz. (2.33 kg)<br><br>3 lb. 5 oz. (1.5 kg)<br><br>1 lb. 13 oz. (0.8 kg)   |

**Table 7-23 Bird 4020 Series RF Power Sensors**

|   |   |
|---|---|
| <b>RF Power Range</b><br>4021, 4022<br>4024, 4025       | 300 mW – 1 kW<br>3 W – 10 kW  |
| <b>Frequency Range</b><br>4021<br>4022<br>4024<br>4025  | 1.8 – 32 MHz<br>25 MHz – 1 GHz<br>1.5 – 32 MHz<br>100 kHz – 2.5 MHz   |
| <b>Accuracy, Fwd, Best Case*</b>                        | ± 3% (1σ)   |
| <b>VSWR, Max.</b><br>4021, 4024, 4025<br>4022           | 1.05:1<br>1.05:1, 25 – 512 MHz and 1.10:1, 512 MHz – 1 GHz  |
| <b>Insertion Loss, Max.</b><br>4021, 4024, 4025<br>4022 | 0.05 dB<br>0.05 dB, 25 – 512 MHz and 0.13 dB, 512 MHz – 1 GHz   |
| <b>Directivity, Min.</b><br>4021, 4022<br>4024<br>4025  | 30 dB<br>28 dB, 1.5 – 2.5 and 25 – 32 MHz and 30 dB, 2.5 – 25 MHz<br>28 dB, 100 – 125 kHz and 30 dB, 125 – 2500 kHz |

\* 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.

**Table 7-24 Bird 4027A Series RF Power Sensors**

|  |                   |                                      |                     |
|--|-------------------|--------------------------------------|---------------------|
| <b>Frequency Range</b>                         |                   |                                      |                     |
| 4027A250K                                      | 250 – 400 kHz     | 4027A12M                             | 10 – 15 MHz         |
| 4027A400K                                      | 400 – 550 kHz     | 4027A25M                             | 25 – 30 MHz         |
| 4027A800K                                      | 800 – 950 kHz     | 4027A35M                             | 35 – 45 MHz         |
| 4027A2M  | 1.5 – 2.5 MHz     | 4027A60M                             | 45 – 65 MHz         |
| 4027A4M  | 3 – 5 MHz         | 4027A100M                            | 95 – 105 MHz        |
| 4027A10M                                       | 10 – 15 MHz       | 4027A150M                            | 150 – 170 MHz       |
| <b>RF Power Range</b>                          |                   |                                      |                     |
| 4027A12M                                       | 300 mW – 1 kW     | 4027A100M                            | 3 W – 4 kW          |
| 4027A25M                                       | 3 W – 9 kW        | 4027A150M                            | 3.75 W – 3.75 kW    |
| 4027A35M                                       | 3 W – 7.5 kW      | All other models                     | 3 W – 10 kW         |
| 4027A60M                                       | 3 W – 6 kW        |                                      |                     |
| <b>Accuracy, Fwd, Best Case*</b>               |                   | ± 1.0% (1σ)                          |                     |
| <b>Calibration Frequencies, Typical (MHz)†</b> |                   |                                      |                     |
| 4027A250K                                      | 0.25, 0.40        | 4027A12M                             | 10.0, 13.56, 15.0   |
| 4027A400K                                      | 0.40              | 4027A25M                             | 25.76, 27.12, 28.48 |
| 4027A800K                                      | 0.90              | 4027A35M                             | 40.68               |
| 4027A2M  | 1.8, 2.0, 2.17    | 4027A60M                             | 55.0, 60.0          |
| 4027A4M  | 4.0, 5.0          | 4027A100M                            | 95.0, 100.0         |
| 4027A10M                                       | 10.0, 13.56, 15.0 | 4027A150M                            | 162.0               |
| <b>Calibration Power, Typical</b>              |                   |                                      |                     |
| 4027A12M                                       |                   | 700 W                                |                     |
| All other models                               |                   | 1.7 kW                               |                     |
| <b>VSWR, Max.</b>                              |                   | 1.05:1                               |                     |
| <b>Insertion Loss, Max.</b>                    |                   | 0.05 dB (with female “N” connectors) |                     |
| <b>Directivity, Min.</b>                       |                   |                                      |                     |
| 4027A12M                                       |                   | 30 dB                                |                     |
| All other models                               |                   | 28 dB                                |                     |

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

† Other calibration frequencies available upon request

**Table 7-25 Bird 4027F Series RF Power Sensors**

|   |   |
|---|---|
| <b>Frequency Range</b><br>4027F2M<br>4027F10M<br>4027F60M                   | 1.8 – 2.2 MHz<br>12 – 15 MHz<br>57 – 63 MHz   |
| <b>RF Power Range</b><br>4027F2M, 4027F10M<br>4027F60M                      | 0.1 – 10 kW<br>0.1 – 3 kW   |
| <b>Accuracy, Fwd, Best Case</b>   | ± 1.0% (2σ)   |
| <b>Calibration Frequencies, Typical*</b><br>4027F2M<br>4027F10M<br>4027F60M | 1.8, 2.0, 2.17 MHz<br>12.0, 12.5, 13.56, 14.0, 15.0 MHz<br>57.0, 58.5, 60.0, 61.5, 63.0 MHz |
| <b>Calibration Power, Typical</b>   | 1.7 kW  |
| <b>Harmonic Rejection, Min.</b><br>4027F2M<br>4027F10M<br>4027F60M          | 26 dB @ 3.6 – 3.8 MHz, 30 dB @ > 3.8 MHz<br>30 dB @ > 25 MHz<br>30 dB @ > 114 MHz           |
| <b>Low Frequency Rejection, Min.</b><br>4027F10M<br>4027F60M                | 30 dB @ < 1 MHz<br>30 dB @ < 15 MHz   |
| <b>Max Error Induced by 10% AM</b><br>4027F2M, 4027F10M<br>4027F60M         | 0.2% @ < 5 kW, 1.0% @ 5 – 10 kW<br>0.2% @ < 1.5 kW, 1.0% @ 1.5 – 3 kW                       |
| <b>VSWR, Max.</b>   | 1.05:1  |
| <b>Insertion Loss, Max.</b>   | 0.05 dB (with female “N” connectors)  |
| <b>Directivity, Min.</b>  | 28 dB   |

\* Other calibration frequencies available upon request

**Table 7-26 Bird 4028A and 4028B Series RF Power Sensors**

|   |   |
|---|---|
| <b>Frequency Range</b><br>4028A250K<br>4028A400K<br>4028A2M<br>4028A3M<br>4028A4M<br>4028A10M, 4028B10M,<br>4028C10M<br>4028A25M<br>4028B3M                         | 250 – 400 kHz<br>400 – 550 kHz<br>1.5 – 2.5 MHz<br>2.5 – 3.5 MHz<br>3.5 – 4.5 MHz<br>10 – 15 MHz<br>25 – 30 MHz<br>2.5 – 4 MHz      |
| <b>RF Power Range</b><br>4028A250K, 4028A400K<br>4028C10M<br>All other models   | 1 kW – 20 kW<br>500W – 50 kW<br>1 kW – 25 kW  |
| <b>Accuracy, Fwd, Best Case</b>   | ± 2.0% (2σ)   |
| <b>Calibration Frequencies, Typical (MHz)†</b><br>4028A250K<br>4028A400K<br>4028A2M<br>4028A3M<br>4028A4M<br>4028A10M, 4028B10M,<br>4028C10M<br>4028A25M<br>4028B3M | 0.25, 0.40<br>0.40<br>1.8, 2.0, 2.17<br>2.5, 3.2, 3.5<br>3.5, 4.0<br>10.0, 13.56, 15.0<br>25.76, 27.12, 28.48<br>2.5, 3.2, 3.5, 4.0 |
| <b>Calibration Power, Typical</b>   | 3.5 kW  |
| <b>VSWR, Max.</b>   | 1.05:1  |
| <b>Insertion Loss, Max.</b>   | 0.05 dB (with female 7-16 DIN connectors)   |
| <b>Directivity, Min.</b>  | 28 dB   |

\* 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

† Other calibration frequencies available upon request

## Specifications, RS-232 Interface

**Table 7-27 RS-232 Interface Module**

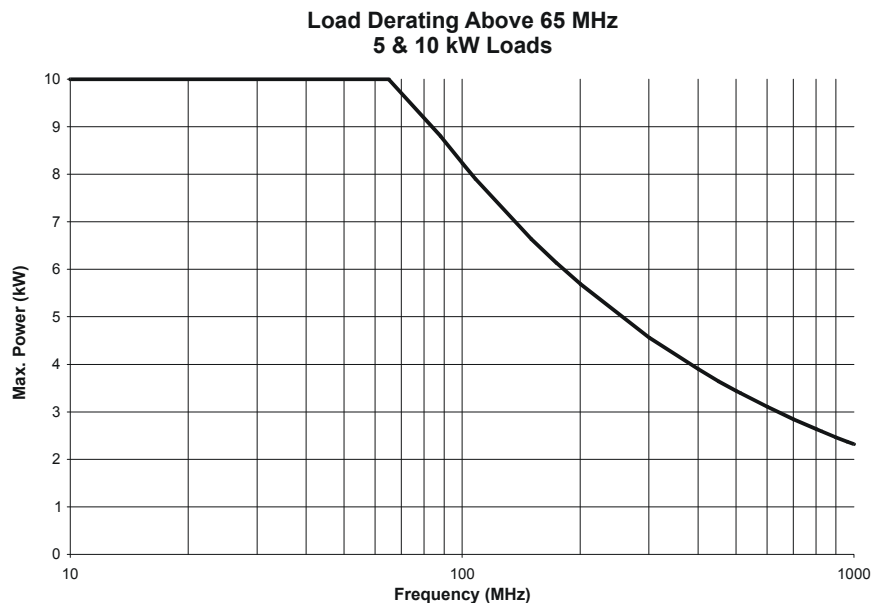
|                           |   |
|---------------------------|---|
| <b>Logic Levels</b>       | Meets all EIA Standard RS-232-C specifications                          |
| <b>Modes of Operation</b> | Switch and bus selectable   |
| <b>Talk Always</b>        | Allows the 4421 to send to the bus keyboard-initiated measurements only |
| <b>Addressable</b>        | Allows the 4421 to be commanded by an RS-232 interface controller       |
| <b>Connector</b>          | RS-232 Interface Type   |
| <b>Humidity, Max</b>      | 95% (non-condensing)  |
| <b>Altitude, Max</b>      | 10,000 feet (3,000 m)   |
| <b>Temperature Range</b>  |   |
| Operating                 | 0 to 50° C (32 to 122° F)   |
| Storage                   | -20 to +50° C (-4 to +122° F)   |
| <b>Dimensions</b>         | 6.5"L x 4.5" W (165 x 115 mm)   |
| <b>Weight</b>             | 0.5 lbs (0.23 kg) nominal   |

## Specifications, IEEE-488 GPIB Interface

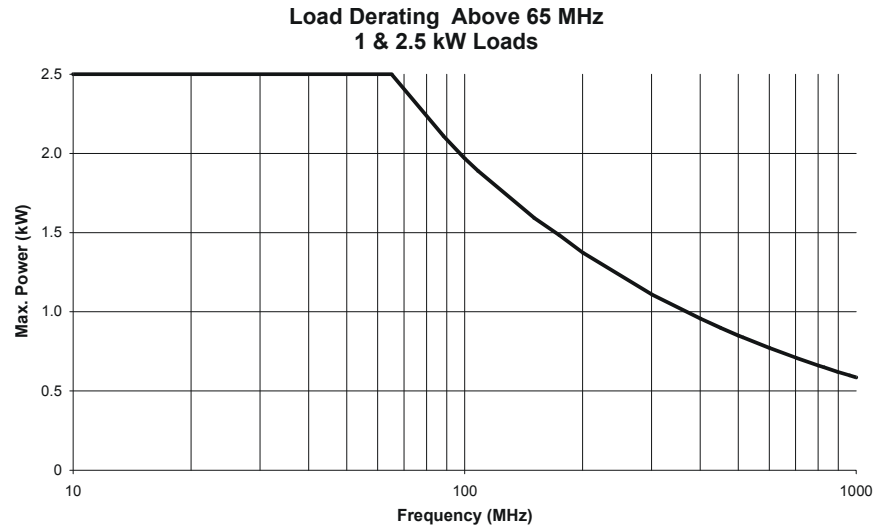
**Table 7-28 IEEE-488 Interface**

|                           |   |
|---------------------------|---|
| <b>Logic Levels</b>       | Meets all IEEE Standard 488-1978 specifications   |
| <b>Modes of Operation</b> | Switch and bus selectable   |
| <b>Talk Only</b>          | Allows the 4421 to send to the bus keyboard-initiated measurements only                               |
| <b>Addressable</b>        | Allows the 4422 to be addressed as talker or listener under the command of an IEEE-488 bus controller |
| <b>Connector</b>          | Standard IEEE-488 bus type  |
| <b>Humidity, Max</b>      | 95% (non-condensing)  |
| <b>Altitude, Max</b>      | 10,000 feet (3,000 m)   |
| <b>Temperature Range</b>  |   |
| Operating                 | 0 to 50° C (32 to 122° F)   |
| Storage                   | -20 to +50° C (-4 to +122° F)   |
| <b>Dimensions</b>         | 6.5"L x 4.5" W (165 x 115 mm)   |
| <b>Weight, Nominal</b>    | 0.5 lbs (0.23 kg)   |

**Figure 20 High Frequency Derating 1**



**Figure 21 High Frequency Derating 2**



**Table 7-29 Replacement Parts**

| Description  | Qty | Part Number            |
|--|-----|------------------------|
| <b>Fuse, IEC (5 x 20 mm) Time Lag Type T</b><br>115 Vac, T630 mA<br>230 Vac, T315 mA | 1   | 5A2257-14<br>5A2257-11 |
| <b>Cord, AC Power</b><br>115 Vac<br>230 Vac Harmonized                               | 1   | 5-1286<br>5A2416       |
| <b>Plug, 115 Vac</b>   | 1   | 5A2626                 |
| <b>Cable, Sensor</b>   | 1   | 4421-038               |
| <b>Grommet</b>   | 1   | 4421A372               |
| <b>Cordreel</b>  | 1   | 4421A383               |
| <b>Casters</b>   | 4   | 4421A384               |
| <b>Handle</b>  | 1   | 4421A385               |
| <b>IEEE-488 Bus Interface Module</b>   | 1   | 4421-489-2             |
| <b>Cable, IEEE-488</b><br>2 m<br>1 m   | 1   | 5-1317-2<br>5-1317-1   |
| <b>RS-232 Bus Interface Module</b>   | 1   | 4421-233-1             |
| <b>Cable, RS-232</b><br>10 ft.<br>5 ft.  | 1   | 5-1662-2<br>5-1662-1   |
| <b>Null Modem Kit (RS-232 only)</b>  | 1   | 4380-250               |
| <b>Panel Mount Kit</b>   | 1   | 4421-250               |
| <b>Battery, C size, NiMH</b>   | 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                 | P/N      |
|---------------------------|----------|
| HN (F)                    | 4240-268 |
| LC (F)                    | 4240-031 |
| BNC-Female                | 4240-125 |
| BNC-Male                  | 4240-132 |
| C-Female                  | 4240-100 |
| C-Male                    | 4240-110 |
| HN-Female                 | 4240-268 |
| HN-Male                   | 4240-278 |
| LC-Female                 | 4240-031 |
| LC-Male                   | 4240-025 |
| Open Term. # 10-32 Nut    | 4240-080 |
| N (F)                     | 4240-062 |
| 7/16 Jack, IEC Type 169-4 | 4240-344 |
| LT-Female                 | 4240-018 |
| LT-Male                   | 4240-012 |
| N-Female                  | 4240-062 |
| N-Male                    | 4240-063 |
| SC-Female                 | 4240-090 |
| SMA-Female                | 4240-336 |
| SMA-Male                  | 4240-334 |
| 7/16 Jack, IEC Type 169-4 | 4240-344 |
| 7/16 Plug, IEC Type 169-4 | 4240-363 |
| TRU 6934 (F)              | 4240-371 |
| TRU 7958 (F)              | 4240-372 |
| Mini UHF-Female           | 4240-346 |
| UHF-Female                | 4240-050 |
| UHF-Male                  | 4240-179 |
| 1-5/8" EIA Fixed          | 4240-096 |
| 1-5/8" EIA Swivel         | 4240-208 |
| 7/8" EIA                  | 4240-002 |
| TNC-Female                | 4240-156 |
| TNC-Male                  | 4240-160 |

## Customer Service

If you need to return the unit for any reason, contact the Bird Service Center for a return authorization. All instruments returned must be shipped prepaid and to the attention of Bird Service Center.

### **Bird Service Center**

30303 Aurora Road  
Cleveland (Solon), Ohio 44139-2794  
Phone: (440) 519-2298  
Fax: (440) 519-2326  
E-mail: *bsc@bird-technologies.com*

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

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

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## Limited Warranty

All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

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

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. 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.