Precision RF Power Test Set

4022A200 -3

Technical Manual

With

Illustrated Parts Breakdown

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Technical Manual Part Number 920-4022A200-3 Rev A

Safety Precautions

The following are general safety precautions that are not necessarily related to any specific part or procedure, and do not necessarily appear elsewhere in this publication. These precautions must be thoroughly understood and apply to all phases of operation and maintenance.

WARNING

Keep Away From Live Circuits

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

WARNING

Shock Hazard

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

WARNING

Do Not Service Or Adjust Alone

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

WARNING

Safety Earth Ground

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

WARNING

Resuscitation

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

WARNING

Remove Power

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

Safety Symbols

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc, which, if not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc, which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, condition, or statement

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

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

See page 2-6, 7-1, and 7-4.

WARNING

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

See page 2-8, and 7-1.

WARNING

Unless otherwise designated, and prior to beginning the Calibration Process, ensure that all test equipment voltage and/or current outputs are set to zero (0) or turned off, where applicable. Ensure that all equipment switches are set to the proper position before making connections or applying power. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

See page 6-2.

WARNING

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

See page 7-5, 7-6, 7-8, 7-10, 7-11, and 7-12.

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.

See page 7-6.

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

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

See page 2-6 and 7-4.

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 (see page 2-6). Failure to comply may result in reduced battery charge and shortened battery life.

See page 2-7.

CAUTION

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

See page 2-7 and 5-1.

CAUTION

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

See page 2-8.

CAUTION

Do not apply RF power to the power sensor that exceeds the maximum power rating of the sensor. Damage to the power sensor could occur.

See page 5-2.

CAUTION

Do not use harsh or abrasive detergents for cleaning.

See page 7-1

CAUTION

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

See page 7-1 and 7-13.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

See page 7-5, 7-6, 7-8, 7-9, 7-10, 7-11, and 7-12

CAUTION

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

See page A-1 and A-6.

Safety Statements

USAGE

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

USO

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

BENUTZUNG

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

UTILISATION

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

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 HACERIO.

WARTUNG

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

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

ENTRENTIEN

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

ASSISTENZA TECNICA

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

UNITS ARE EQUIPPED WITH RECHAREABLE BATTERIES. THESE ARE TO BE REPLACED BY AUTHORIZED SERVICE PERSONNEL ONLY!!!

LAS UNIDADES VIENEN EQUIPADAS CON BATERIAS RECARGABLES. ¡¡¡Y SOLAMENTE EL PERSONAL DE SERVICIO AUTORIZADO PUEDE REEMPLAZARLAS!!!

GERÄTE SIND MIT WIEDER AUFLADBAREN BATTERIEN BESTÜCKT. BATTERIEN SIND NUR VON QUALIFIZIERTEM SERICE PERSONAL AUSZUWECHSELN!!!

CES DISPOSITIFS SONT ÉQUIPÉS DE BATTERIES RECHARGEABLES. SEUL LE PERSONNEL D'ENTRETIEN AUTORISÉ EST HABILITÉ À LES REMPLACER !

LE UNITÀ SONO DOTATE DI BATTERIE RICARICABILI, CHE DEVONO DA COME SPECIFICATO DAL PRODUTTORE LA PROTEZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

About This Manual

This manual covers the Bird 4022A200-3 Precision RF Power Test Set including RF Power Meter and sensors.

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.

Table of Contents

List of Figures

Chapter 1 General Description

1.1 PRECISION RF POWER TEST SET

The Bird 4022A200-3 Precision RF Power Test Set is meant for use as high power coaxial standard. The Sensors included in the RF Test Set are accurate to within 3%. The purpose of the Precision RF Power Test Set is to provide a means of calibrating wattmeters and couplers.

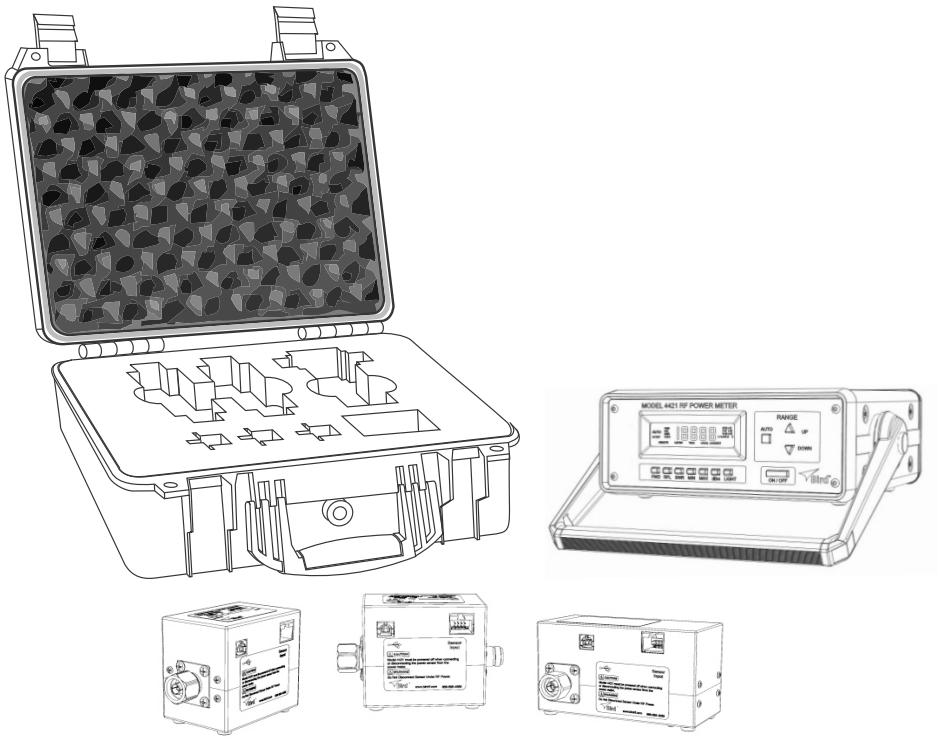


Figure 1-1 Precision RF Power Test Set

1.1.1 Items Supplied.

- Bird RF Power Meter (P/N 4421)
  - AC Power Cord
  - Sensor Cable
- 1-10 MHz Sensor (P/N: 4022A200-31)
- 10-100 MHz Sensor (P/N: 4022A200-32)
- 100-1000 MHz Sensor (P/N: 4022A200-33)
- User Manual

1.1.2 Optional Accessories. The following optional accessories are available for the 4421 Power Meter.

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

b. 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.

Chapter 2 Equipment Description

2.1 UNPACKING AND INSPECTION

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

b. Inspect unit for visual signs of damage.

NOTE

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

c. Verify the contents of the test set is complete, see Chapter 1, General Description, on page 1-1.

2.2 EQUIPMENT DESCRIPTION

The major components of the of the Precision RF Power Test Set are the Precision Power Sensors and the RF Power meter.

2.2.1 RF Power Meter. The 4421 RF Power Meter is a precision RF measurement instrument. The Power meter is used with highly accurate power sensors to make precision measurements and is capable of either AC or DC operation. The RF Power Meter is equipped with RS-232 and GPIB (IEEE-488) communications interfaces for remote operation.

2.2.1.1 RF Power Meter Controls and Indicators. The Controls and indicators for the RF Power Meter are defined in Figure 2-1, Figure 2-2, Figure 2-3, Table 2-1, Table 2-2, and Table 2-3.

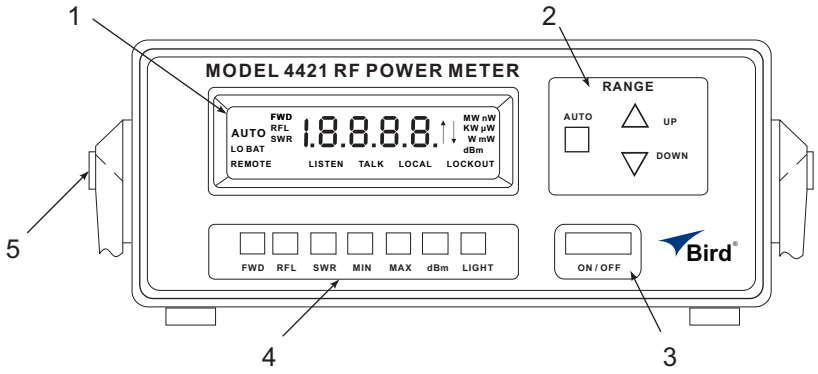


Figure 2-1 RF Power Meter Front Panel

Table 2-1. RF Power Meter Front Panel Controls and Indicators

Item	Name	Description
1	LCD Display	See Figure 2-2 on page 2-3
2	**Range controls**	
	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. **NOTE** Stops automatic scaling, if used while AUTO indicator is on, AUTO indicator turns off.
3	Power Switch	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. **NOTE** The display flashes for about 30 seconds when the unit is first turned on.
4	**Display Controls**	
	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 1.0000 and 199.99
	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. **NOTE** 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.
5	Handle Pushbutton	Pressing buttons on both sides allow handle to be rotated to one of four positions. See Handle Operation on page 2-7.

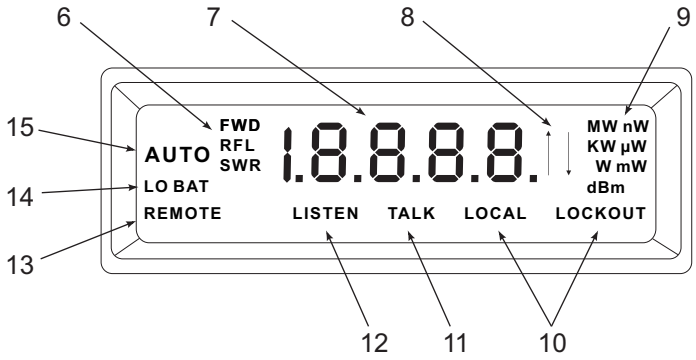


Figure 2-2 LCD Display Indicators

Table 2-2. LCD Display Indicators

Item	Name	Description
6	FWD, RFL, SWR	Indicates the currently selected measurement on display.
7	Numerical Value	Indicates the numerical value of the signal measured by the attached sensor.
8	Up, Down Arrows	Arrows indicate direction of movement of signal strength
9	Unit of measure	Unit of measure is displayed based on the selected range.
10	Local Lockout	When LOCAL LOCKOUT is displayed, the push buttons are disabled and the power meter's functions are being remotely controlled.
11	Talk	When TALK is displayed, the power meter is transmitting data. This is always shown when the unit is in "talker-only" mode.
12	Listen	When LISTEN is displayed, the power meter is receiving data.
13	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.
14	Lo Bat	Indicates the batteries are in a discharged state. If batteries are not charged the power meter will automatically power down. AC power should be connected as soon as possible to charge the batteries.
15	Auto	Auto is displayed when AUTO range pushbutton is pressed, enabling automatic range selection.

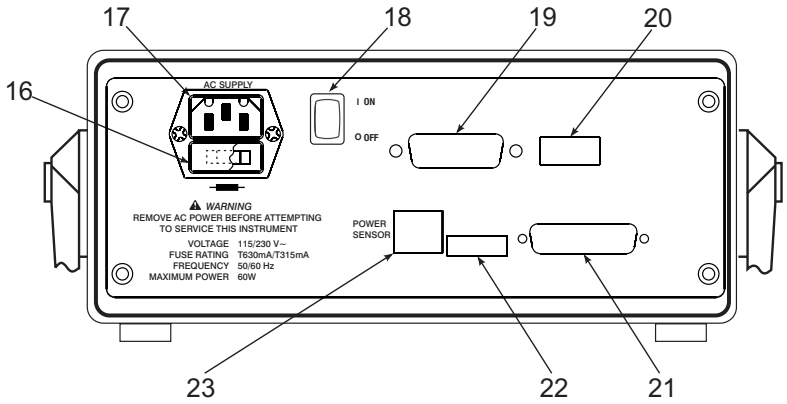


Figure 2-3 RF Power Meter Rear Panel

Table 2-3. RF Power Meter Rear Panel Controls and Indicators

Item	Name	Description
16	Fuse	AC over-current protection, fuse must be sized for voltage selection, see Table 2-5 on page 2-6.
17	AC Power Connector	AC appliance inlet C-14 connector with fuse holder
18	Power Switch	AC Power Switch, rocker switch controls AC power to the
19	GPIB Connector	IEEE 488 connector, used for remote control of the Power Meter via GPIB.
20	GPIB DIP Switches	Eight-position DIP switch that sets the GPIB operational conditions and interface addresses.
21	RS-232 Connector	Standard 25-pin, RS-232, serial interface connector used for remote control of the Power Meter.
22	RS-232 DIP Switches	Eight-position DIP switch is used to set RS-232 bus operational conditions such as baud rate, parity, and stop bits.
23	Power Sensor Socket	Power Sensor cable connector, used to transfer data to and from power sensor and provide operating voltage for the sensor.

2.2.2 Power Sensors. The Power Sensors included in the Precision RF Power Test Set are used to measure frequencies between 1 MHz and 1 GHz at power levels between 1 to 1000 Watts. The Power Sensors are insertion-type, Thruline® directional power sensors that simultaneously measures forward and reflected power in 50 Ω coaxial transmission lines. The accuracy of the Power Sensors are accurate to within ± 3% of reading. The sensors are designed for use only with unmodulated continuous-wave (CW) or frequency-modulated (FM) signals. During normal operation, the power sensor is connected to the power meter by an interface cable assembly that provides a path for serial data communication between the power sensor and the power meter. The cable socket on the power sensor is recessed to protect it from damage. An identification label affixed to the top of the power sensor indicates power range, frequency band, and direction of the applied traveling wave.

2.2.2.1 Quick-Change Connectors. The power sensors are equipped with quick-change (QC) type N connector. The power sensors are shipped from the factory with one male and one female receptacle connector. However, the QC connectors allow connectors of other types to be employed.

2.2.2.2 Power Sensor Controls and Indicators. The Controls and indicators for the RF Power Sensors are defined in the Figure 2-4 and Table 2-4.

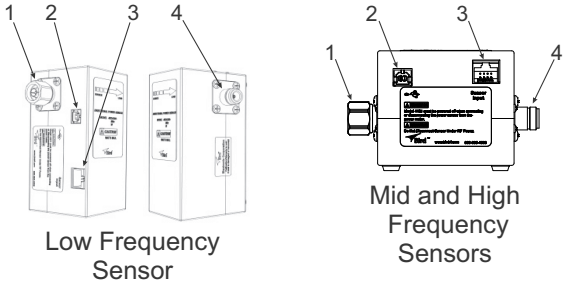


Figure 2-4 Power Sensor Controls and Indicators

Table 2-4. Power Sensor Controls and Indicators

Item	Name	Description
1	RF Input Connector	Power Sensors are supplied with N-type, male, RF input connectors.
2	USB Interface Connector[1]	USB Interface Connector provides the capability of controlling the power sensor using Standard Commands for Programmable Instruments (SCPI) language. This allows a computer interface to be used to send requests and receive messages from the sensor without the use of a Power Meter.
3	Power Meter Interface Connector[1]	The Power Meter Interface Connector is used by the 4421 RF Power Meter. The 4421 can be used to display measurement data from the 4022A200 Power Sensors. The 4421 provides the capability of extending the power sensor operation over RS-232 and IEEE-488 (GPIB) data buses.
4	RF Output Connector	Power Sensors are supplied with N-type, female, RF output connectors.

1 Only one interface connector at a time may be used for sensor operation. The Power Sensor will not communicate over both interfaces simultaneously.

2.3 PREPARATION FOR USE

2.3.1 Power Meter AC Operation. The Power Meter is capable of operating on 115 VAC or 230 VAC. 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, the correct fuse must be installed for the line voltage being used (See Fuse Selection and Installation). The Power Meter is shipped ready for 115 volt operation with a 630 mA time-delay fuse installed. If 230 volt operation is desired a 315 mA time-delay fuse must be installed in the fuse holder in the rear panel of the unit.

2.3.1.1 Fuse Selection and Installation. Ensure the correct fuse is installed for the AC power supply being used.

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.

NOTE

The 4421 RF Power Meter is shipped with a 630 mA time-delay fuse installed for 115 volt operation. A 315 mA time-delay fuse for 230 volt operation is supplied as an accessory.

a. Gently pry the fuse drawer out of the AC module.

NOTE

The fuse holder does not detach from the AC module.

b. Install the proper fuse for AC voltage supplied. Refer to Table 2-5, Fuse Ratings.

NOTE

Fuse 1 is a spare fuse (not supplied) and fuse 2 is the active fuse.

Table 2-5. Fuse Ratings

AC Line Voltage	Fuse Rating
115 VAC	T630 mA, 5x20 mm Time Lag Fuse (630-MA time-delay Fuse)
230 VAC	T315 mA, 5x20 mm Time Lag Fuse (315-MA time-delay Fuse)

c. Close and secure the fuse holder.

2.3.2 Power Meter DC Operation. The Power Meter is capable of operating on internal rechargeable nickel metal hydride batteries. The Power Meter will operate on the batteries, with continuous use, for approximately eight hours.

2.3.2.1 Battery Charging. The batteries are shipped in a low charge state. It is recommended that you charge the batteries for approximately 28 hours before using them for continuous operation.

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. Failure to comply may result in reduced battery charge and shortened battery life.

NOTE

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

a. Verify correct fuse is installed for the available AC power Supply. See Power Meter AC Operation on page 2-6.

b. Connect AC Power Supply cable to AC power Connector on Power Meter rear panel.

c. Connect the AC Power Supply cable to an available AC Outlet.

d. Turn on the Power Switch on the Power Meter rear panel.

e. Allow the batteries to charge for approximately 28 hours.

2.3.3 Handle Operation. The handle on the 4421 Power Meter can be set to four different positions (see Figure 2-5). To adjust the handle, press the center buttons on both sides. Releasing the buttons will lock the handle into position.

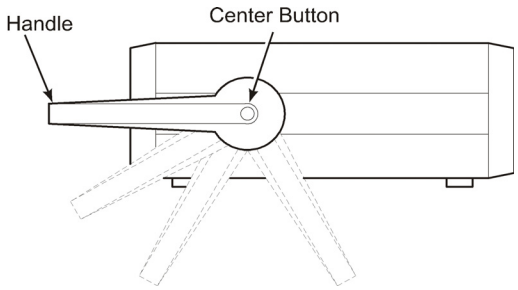


Figure 2-5 Handle Positions

2.3.4 Sensor/Power Meter Connection.

CAUTION

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

NOTE

Do not attempt to use the Power Meter Connection and the USB Connection on the Power Sensor simultaneously. The Power Sensor cannot communicate over two interface connections at the same time, if the USB interface will be used, do not connect the Power Meter to the Power Sensor.

a. Turn OFF the ON/OFF rocker switch on the meter's *rear* panel.

b. Align the latch on the cable with the notch of the "Power Sensor" socket on the power meter's rear panel. See Figure 2-6.

c. Insert the cable until it clicks into place.

d. Connect the other end of the sensor cable to the sensor.

e. Insert the cable until it clicks into place.

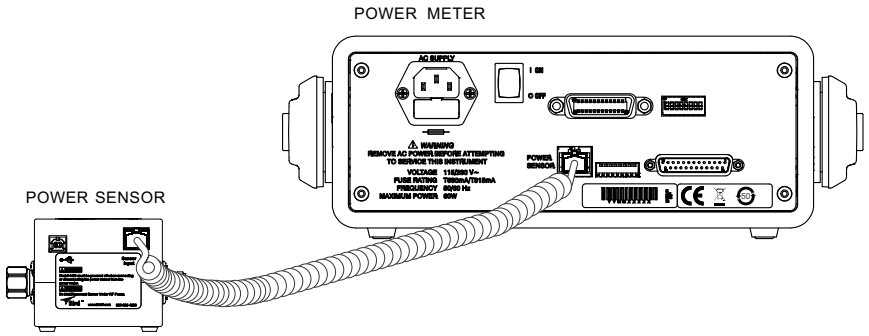


Figure 2-6 Power Sensor to Power Meter Connection

2.3.5 RF Line Connection. 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.

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 then 2:1. Damage to the power meter, power sensor, or the RF power source could occur.

a. Disable the output of the RF Source, if required.

b. Connect the output cable from the RF Source to the input port of the power sensor. See Figure 2-7.

c. Connect the input cable from the load to the output of the of the power sensor.

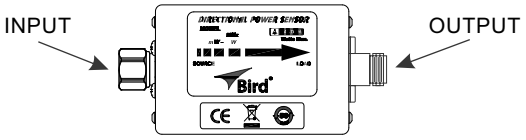


Figure 2-7 Power Sensor Top View

Chapter 3 Specifications

3.1 SPECIFICATIONS, 4421 RF POWER METER

Table 3-1. Bird 4421 RF Power Meter Specifications

Frequency Range	Sensor dependent
Power Range	Sensor dependent
VSWR Display	1.0000 – 199.99 max
Return Loss Display	0 to 40 dB max
Display Accuracy	± 1 on least significant digit
AC Power	115/230 Vac @ 50/60 Hz; 60 W
Batteries	8 Nickel Metal Hydride 1.2 v cells, rechargeable
Battery Life	Approximately 8 hours continuous usage (reduced after high temperature charging)
Battery Charger	Built-in battery charger. Drained batteries require approximately 28 hours to recharge.
Display	LCD, 4½ digit display. Indicates mode, measurement units, battery condition, remote status, and signal increase/ decrease. Self contained backlight.
Interfaces	IEEE-488 GPIB RS-232
Fuse Rating	IEC (5 x 20 mm) Time Lag Type T
115 VAC 230 VAC	T630 mA T315 mA
CE	CE Compliant. Refer to EU Declaration of Conformity for specific standards.
Humidity	95% max. (noncondensing)
Altitude	Up to 10,000 feet (3,000 m)
Temperature Range Operating Storage	 0 to 50 °C (32 to 122 °F) –20 to +50 °C (–4 to +122 °F)
Dimensions	10.7”L x 12.2”W x 4.2”H (271 x 309 x 103 mm)
Weight, Nominal	9.5 lbs. (4.3 kg)

3.1.1 Specifications, RS-232 Interface.

Table 3-2. RS-232 Interface

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

3.1.2 Specifications, IEEE-488 GPIB Interface.

Table 3-3. IEEE-488 Interface

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

3.2 SPECIFICATIONS, POWER SENSORS

Table 3-4. Power Sensor Specifications

Electrical Specifications	
Connectors Input, all sensors Output, all sensors	 Type-N male, hexagonal, QC, Changeable Type-N female, QC, Changeable
Frequency Range 4022A200-31 4022A200-32 4022A200-33	 1 – 10 MHz 10 – 100 MHz 100 – 1000 MHz
Power Range 4022A200-31, 4022A200-32, 4022A200-33	 1W - 1000W
4022A200-31, Calibration Frequencies	1, 1.135, 1.495, 1.63, 2.53, 2.845, 3.295, 4, 6, 8, 9.91, 10
4022A200-32, Calibration Frequencies	10, 11, 12, 13, 13.7, 15, 16.1, 17, 18, 19, 20.9, 23, 25, 27, 28.3, 29.5, 31, 33, 36.5, 37.8, 40, 43.2, 45, 50, 52.5, 55.2, 57, 59, 60, 61.5, 63.6, 65.7, 70, 82, 95, 100
4022A200-33, Calibration Frequencies	100, 110, 120, 130, 146, 160, 182.5, 200, 211.8, 230, 250, 270, 300, 324, 360, 400, 410, 445, 500, 540, 580, 600, 640, 700, 720, 730, 750, 799, 830, 858, 868.8, 900, 946, 980, 1000
Directivity, all sensors	28 dB
Insertion Loss, all sensors	<0.05 dB
Insertion VSWR, all sensors	< 1.10
Impedance, all sensors	50 Ohms
Measurement Specifications	
Forward Power, Uncertainty, k=2	
4022A200-31, 4022A200-32, 4022A200-33	3% of reading
Conditions for Measurement Harmonics VSWR of Load AM modulation	 < 35 dBc < 1.1 < 1%
Calibration Plane	Output Connector
Reflected Power, Uncertainty, k=2	
4022A200-31, 4022A200-32, 4022A200-33	3% of reading
Conditions for Measurement Harmonics	 < 35 dBc
Calibration Plane	Output Connector
VSWR, all sensors Range	 -27 dB to -10 dB

Table 3-4. Power Sensor Specifications

Environmental	
Temperature	
Operating Range	73° +/- 6° F (19.4° to 26.1° C)
Storage Range	-4° to 158° F (-20° to 70° C)
Humidity, Operating	
Low	20%
High	50%
Weight	5 lbs
Dimensions, Max	6”x6”x3”

4.1 GENERAL THEORY

The Bird Precision RF Test set is a calibration standard, composed of a trio of RF power sensors and an RF power meter. Each Power Sensor covers a portion of the frequency range from 1 MHz to 1 GHz. The power sensors are used in conjunction with the RF power Meter to measure the output of an RF power Source. The Bird RF Test Set measurements are used to calibrate the test instrument (TI). Figure 4-1 shows one possible configuration for a calibration system setup.

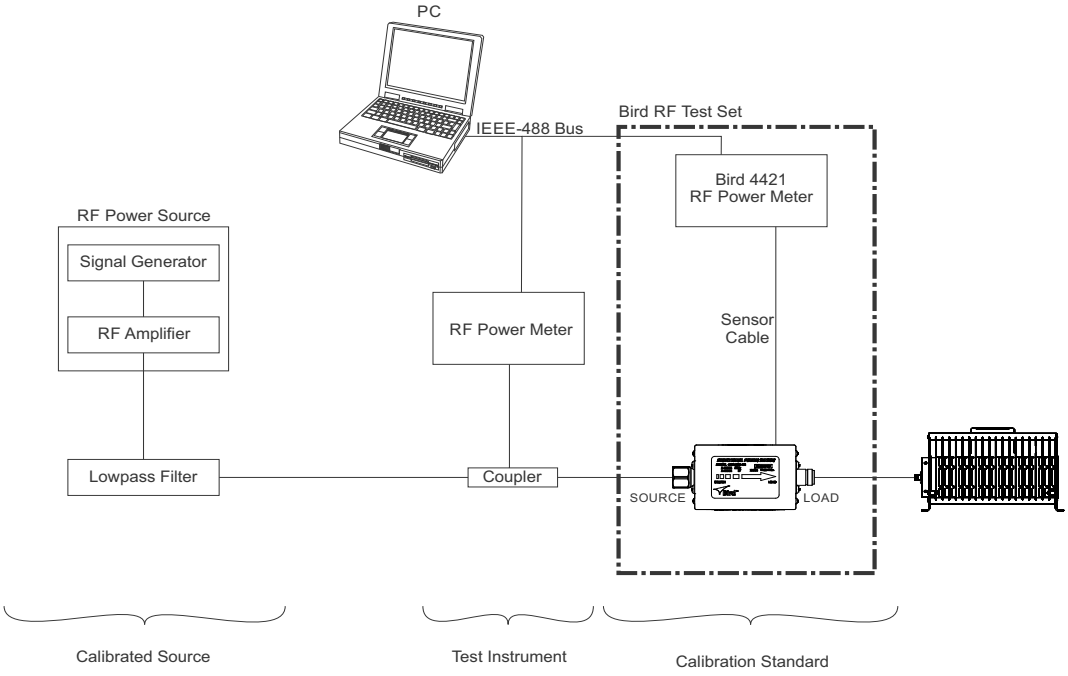


Figure 4-1 Calibration Diagram

4.2 POWER METER THEORY OF OPERATION

The Power Meter operation is driven by a single board computer system. The computer board is the central processor for all front panel inputs and signals from the power sensor.

4.2.1 I/O Board. The I/O Board is the communication hub for the Power Meter. The I/O Board contains the circuitry for both RS-232 and IEEE-488 (GPIB) communication. The RS-232 or IEEE-488 communication buses allow the Power Meter to be remotely controlled using a PC equipped with RS-232 or IEEE-488 communication ports. When calibrating a sensor connected to the 4421, you must use the IEEE-488 connector as part of the calibration process for connection to a personal computer. The I/O Board routes signals from a connected power sensor and from the front panel keys to the Computer Board (Figure 4-2). Buttons on the front panel select the function and range for the display. When you press a button, the keypad circuit board passes the signal through the I/O Board to the single board computer. The RF Power sensor sends a digital signal through the I/O Board to the Computer Board where it is processed for display.

4.2.2 LCD Display. After processing the signal, the computer board sends the function, range, and signal value through the I/O Board to the front panel liquid crystal display (LCD). Behind the LCD is a backlight that can be used to illuminate the display when the ambient lighting is insufficient. The backlight requires an AC voltage which is provided by an inverter module mounted on the Main I/O circuit board. Also mounted on the Main I/O circuit board is an audible alarm module that can be turned on to alert the user when the RF power input exceeds 120% of the sensor's maximum rating.

4.2.3 4421 Power Input Options. The 4421 RF Power Meter can be operated from AC power (115 VAC or 230 VAC) or from internal batteries. When the unit operates from AC power, it can charge the internal batteries. To charge the internal batteries, the ON/OFF switch on the rear panel must be set to ON. The unit uses NiMH rechargeable batteries.

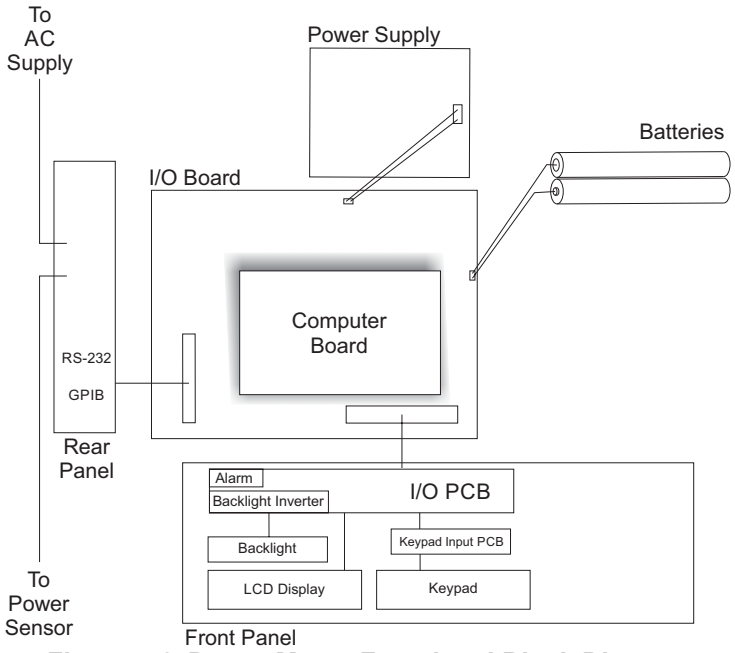


Figure 4-2 Power Meter, Functional Block Diagram

4.3 POWER SENSOR THEORY OF OPERATION

The directional power sensor consists of two directional power-sensing plates, one frequency coupling plate, a prescaler circuit card assembly, diode detection circuitry, A/D converter, and microprocessor with on-board RAM/ROM memory. Openings in the outer conductor of the line section contain the coupler plate and diode detector assemblies. These assemblies sample the RF signal traveling in either the forward or reflected direction and produce a DC output voltage related to the power level (Figure 4-3).

4.3.1 Sensor Components. Each sensor consists of the following general components:

- Directional coupler with 28 dB of directivity or better.
- A frequency counter that is coupled to the main RF line.
- Microprocessor which controls all communication to the display unit and measurement calculations. The power calculations are corrected for errors in the coupler frequency flatness by measuring the frequency and applying a cal factor automatically.
- USB connector and latch-n-lock connector that allows computer control and calibration of the sensor using SCPI commands with a USB-TMC interface.
- A high resolution A/D converter.
- Temperature sensor.
- RF detectors connected to the forward and reflected ports of the coupler. The RF detectors operate in the square law region and as such are insensitive to harmonics and close in AM sidebands.

4.3.2 Measurement process. The measurement process consists of measuring the RF frequency using a prescaler circuit to divide down the RF signal to a manageable signal that the microprocessor can measure. Once the frequency is known, the microprocessor uses the A/D converter to measure the voltages coming from the forward detector board and the reflected detector board. The two voltages from each detector board are converted to power by applying the cal factor from the frequency look up table. Then a correction factor for temperature is also applied.

4.3.2.1 All the calculations for power, VSWR, return loss, and frequency are made in the sensor. No measurements are made in the display unit.

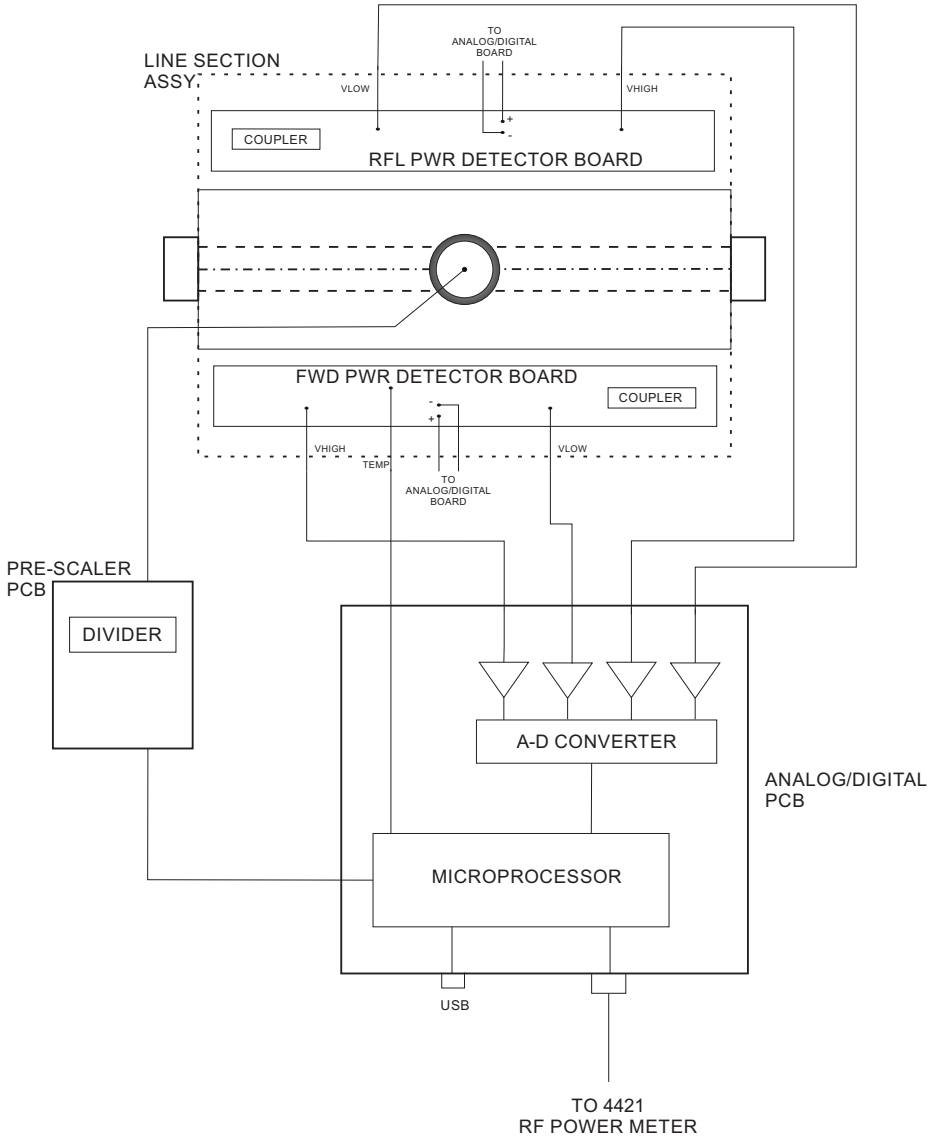


Figure 4-3 Power Sensor Functional Block Diagram

Chapter 5 Operating Instructions

5.1 GENERAL DESCRIPTION

This chapter provides instructions for the operation of the Model 4421 Power Meter. Remote operation of the 4421 is accomplished through the IEEE-488 general purpose interface bus (GPIB) (Appendix A) or RS-232 serial bus (Appendix B).

5.2 START UP

This section describes the operation of the 4421 Power Meter.

CAUTION

The 4421 Power Meter must be powered off when making connections or disconnections between 4421 Power Meter and a power sensor.

NOTE

Before proceeding to operate the 4421 Power Meter, verify the requirements in section 2.3 Preparation for Use on page 2-6 have been completed.

a. Connect sensor cable to the 4421 Power Meter and the power sensor.

b. Set the ON/OFF switch on the 4421 Power Meter's rear panel to the ON position.

c. Press ON/OFF push button on 4421 Power Meter's front panel to ON.

NOTE

The display flashes for approximately 60 seconds and then changes to the normal operating display. The 4421 Power Meter is now ready for operation.

d. Perform measurements and/or calibrations, as required.

e. When operation is finished, Press ON/OFF push button on 4421 Power Meter's front panel to OFF.

f. Set ON/OFF power switch on 4421 Power Meter’s rear panel to OFF position.

g. Unplug AC power cord from AC supply.

h. Unplug sensor cable from 4421 Power Meter and from power sensor.

5.2.1 Range Scales. The 4421 Power Meter provides four range scales which may be selected by using either automatic or manual ranging. Both methods of ranging can be selected with either local or remote control. When powered on, the power meter defaults to automatic ranging and AUTO is displayed. The four ranges are as follows:

- 0.180 - 1.999 kW
- 18.0 - 199.9 W
- 1.80 - 19.99 W
- 0.180 - 1.999 W

5.2.1.1 Range Selection in Local Control. Manual ranging is selected by pressing either UP or DOWN push buttons on the front panel of the 4421 Power Meter. Each time the UP push button is pressed, the next higher scale is selected and displayed. When the highest scale is reached, pressing UP will no longer have any effect. Each time the DOWN push button is pressed, the next lower scale will be selected. When the lowest scale is reached, pressing DOWN will no longer have any effect. If the selected scale is too high or too low for the directional power sensor, an error will be displayed, see paragraph 5.2.2 Error Codes on page 5-2. Pressing the AUTO push button will select the automatic ranging. During automatic ranging, the power meter automatically selects the range scale as determined by the RF input level of the power sensor. If the RF input level is 120% of the power sensor’s maximum power capability, an audible warning is sounded, see paragraph 5.3 Audible Warning on page 5-2.

5.2.1.2 Range Selection in Remote Control. Remote commands are received over an IEEE-488 bus or RS-232 from a personal computer (PC). The remote commands select either manual or automatic ranging depending on the command sent.

5.2.2 Error Codes. The 4421 Power Meter displays error codes when the RF power is either below the selected range (underrange) or above the selected range (overrange). Table 5-1 displays the error codes and Table 5-2 lists the function limits.

Table 5-1. Error Codes

Symbol	Explanation
⊓⊓	Value greater than overrange limit of function
⊔⊔	Value less than underrange limit of function

Table 5-2. Function Limits

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

5.3 AUDIBLE WARNING

CAUTION

Do not apply RF power to the power sensor that exceeds the maximum power rating of the sensor. Damage to the power sensor could occur.

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

Chapter 6 Calibration Procedure

6.1 DESCRIPTION

This procedure describes the calibration of the Bird 4022A200-31, 4022A200-32, and 4022A200-33 power sensors. These sensors are part of the Bird 4022A200-3 RF Test Set.

6.2 CALIBRATION DESCRIPTION

Table 6-1. Calibration Description

Test Instrument (TI) Characteristics	Performance Specifications	Test Method
POWER SENSORS		
4022A200-31	Frequency Range: 1 MHz - 10 MHz Power Range: 1W - 1000W	
4022A200-32	Frequency Range: 10 MHz - 100 MHz Power Range: 1W - 1000W	
4022A200-33	Frequency Range: 100 MHz - 1000 MHz Power Range: 1W - 1000W	

See 3.2Specifications, Power Sensors on page 3-3 for calibration frequencies.

6.3 EQUIPMENT REQUIREMENTS

Table 6-2. Equipment Requirements

Noun	Minimum Specifications	Calibration Equipment
RF Amplifier	Frequency Range: 1 MHz - 1000 MHz Power: 100W Total Harmonic Energy: <30dBc (may be achieved using low pass filter)	
Power Meter		Bird 4421
Standard	Frequency Range: 1 MHz - 10 MHz	Bird 4022A200-11
	Frequency Range: 10 MHz - 100 MHz	Bird 4022A200-12
	Frequency Range: 100 MHz - 1000 MHz	Bird 4022A200-13

Table 6-2. Equipment Requirements

Noun	Minimum Specifications	Calibration Equipment
Computer	USB Interface GPIB Interface USB test and measurement device drivers/Utility USB Cable (Type B connector required for Power Sensor)	
High Power RF Termination	Power: >1000 W VSWR: 1.1 Max Frequency Range: 1 MHz - 1000 MHz	
Lowpass Filter		
Adapters	As required	
Cables	As required	

6.4 PRELIMINARY OPERATIONS

6.4.1 Review and become familiar with entire procedure before beginning calibration process.

WARNING

Unless otherwise designated, and prior to beginning the Calibration Process, ensure that all test equipment voltage and/or current outputs are set to zero (0) or turned off, where applicable. Ensure that all equipment switches are set to the proper position before making connections or applying power. If not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

6.4.2 Connect all equipment to their respective power sources. Set all POWER switches to ON and allow a 30 minute warm-up period. Allow test equipment warm-up period as per manufacturer of test equipment.

6.4.3 Room temperature must be maintained between 15 to 25° C (59 to 77° F).

6.4.4 If 'As Found' data is required then the before calibration is performed, measure 100W power at all the frequency points of both the TI and 1% Standard sensor within the frequency range of the sensor and record the data. Alternatively, the calibration points in the TI could be read from the TI (see paragraph 6.5 c. on page 6- 3) and stored for comparison to the new calibration points which will indicate how the TI's calibration has changed since the last calibration.

6.5 CALIBRATION PROCESS

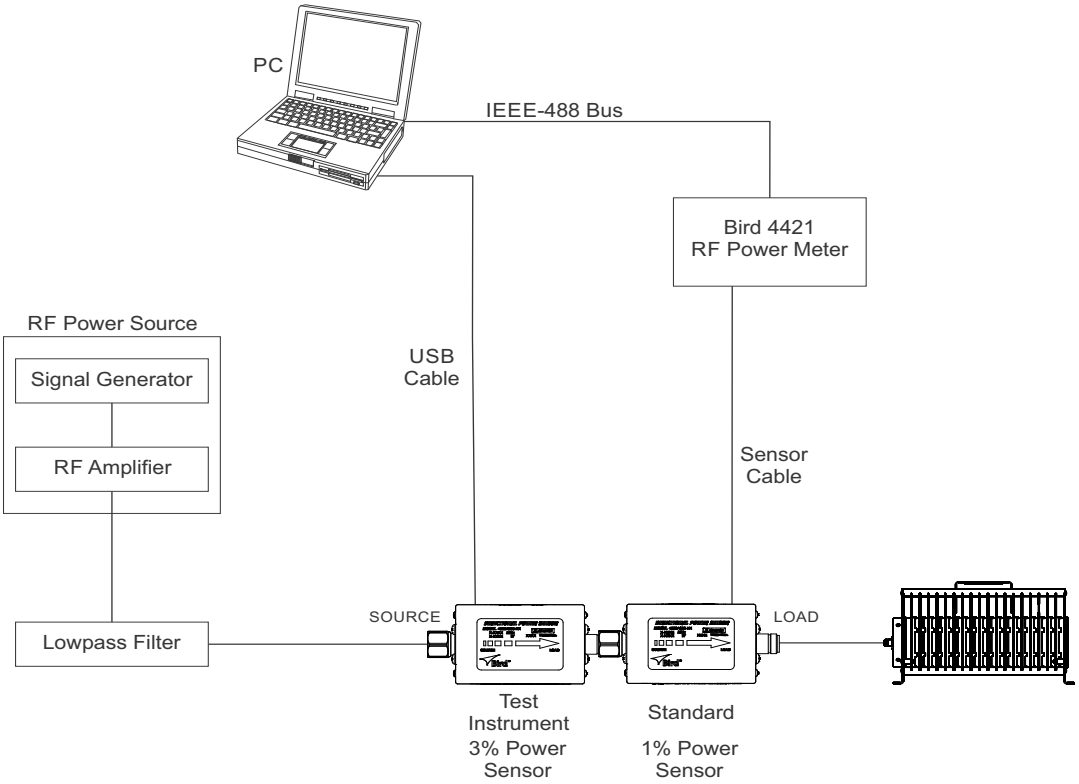


Figure 6-1 Calibration Setup

a. The first time 100W power is applied to the system, allow the setup to thermally stabilize for 30 minutes. This is to allow the components in the system to come to thermal equilibrium.

b. To prepare the TI, send the SCPI command to the TI to unlock the calibration. See FACTory:USER:UNLock on page C-21.

c. If 'As Found' data is required then the before calibration is performed, measure 100W power at all the frequency points of both the TI and 1% Standard sensor within the frequency range of the sensor and record the data. Alternatively, the calibration points in the TI could be read from the TI. See the code examples in C.4.1 Read Forward Calibration Points on page C-29 and C.4.2 Read Reflected Calibration Points on page C-30.

d. Erase calibration points in the sensor.
The sensor contains both forward and reflected power calibration points.

CAUTION

Only erase calibration points which will be calibrated during this procedure.

(1) Erase Forward Calibration Points. See the code examples in C.4.3 Erase Forward Calibration Points on page C-31.

(2) Erase Reflected Calibration Point. see the code examples in C.4.4 Erase Reflected Calibration Points on page C-32.

e. Verify the input connection to the TI is disconnected from RF Power Source. Any RF at the input to the TI will invalidate the zero calibration of the TI.

CAUTION

Disconnect TI sensor input prior to issuing the zero sensor command, any RF at the input to the TI will invalidate the zero calibration.

f. Zero Sensor. see the code examples in C.4.5 Perform Zero Offset Calibration on page C-33.

g. Commit Zero Calibration Data. see the code examples in C.4.5 Perform Zero Offset Calibration on page C-33.

h. Read the Zero Offset. see the code examples in C.4.6 Read Zero Offset on page C-34.

NOTE

Figure 6-1 shows the TI positioned for calibrating the forward calibration points.

i. Connect calibration equipment and TI as shown in Figure 6-1.

j. Apply 100W +/-5% to the TI and standard at the desired frequency, letting the system stabilize for 1-5 minutes.

NOTE

Monitor the power to see if it drifts, to determine how much time is actually needed.

k. When the system has been allowed to stabilize, use the RF Power Source, computer and USB interface to:

(1) Set the calibration frequency at the RF Power source.

(2) Set the calibration power (100 W ± 1%) as measured by the 1% Standard sensor.

(3) Calibrate the sensor frequency point. see the code examples in C.4.7 Perform Forward Calibration Point on page C-35 and C.4.8 Perform Reflected Calibration Point on page C-36.

i Check sensor for errors.

NOTE

Check sensor for errors following each step.

ii Send calibration frequency command to TI.

iii Send the calibrate forward or calibrate reflected command to the TI depending on the orientation of the TI.

iv Send the commit calibration command to the TI.

(4) Read the power back from the TI.Verify the measurement is within 0.5% of the 1% Standard sensor. Command: FETC:AVER. See FETCh[:SCALar][:POWer][:FORWard]:AVERage? on page C-28.

i If measurement is within 0.5% of the 1% Standard sensor measurement, go to step l.

ii If measurement is greater than 0.5% of the 1% Standard sensor measurement, repeat step (3) and (4).

l. Repeat step k at each frequency calibration point for the TI.

m. Turn off RF power and disconnect TI.

n. If the opposite direction is to be calibrated, turn the TI around while keeping the 1% Standard sensor in the forward orientation. Repeat the calibration steps d trough l for the opposite direction initially performed on the TI.

Chapter 7 Maintenance

7.1 MAINTENANCE INTRODUCTION

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

WARNING

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

WARNING

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

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.

7.2 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.

7.3 TROUBLESHOOTING

If a malfunction occurs, 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 7-3. 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 should not be attempted. Removal or disturbance of the power sensor cover can result in cancellation of the 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.

Table 7-1. Troubleshooting Table

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.
	Blown fuse?	Check fuse rating and replace fuse (See 7.4.1 Replace Fuse, on page 7-4).
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 YES: Return meter for service.
Power meter turns off while on battery power	Is "LO BAT" displayed?	YES: Recharge battery NO: Return meter for service.
Push buttons do not respond	Test the push buttons (See 7.3.2 Push Button Test, on page 7-3). 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 A.3.1 Dip Switch, on page A-2).
	Send the "J0" self test command, then check the status. Does the power meter fail the self test?	Replace I/O hub PCB. See 7.4.9 Remove I/O Hub Circuit Board Assembly, on page 7-10
	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. See B.3.1 DIP Switch, on page B-2.
	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 B.3.1 DIP Switch, on page B-2.

7.3.1 Functional Test.

a. Turn the power meter off. The ON/OFF switch on the *rear* panel should be OFF and the AC power cable should be connected.

b. Turn ON the ON/OFF switch on the *rear* panel of the meter.

c. 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.

d. 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.

e. 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.

7.3.2 Push Button Test.

NOTE

If a push button is malfunctioning, return the power meter.

a. Disconnect the power sensor.

b. Turn the power meter ON.

NOTE

After the power up display disappears, a dash "–" should scroll across the display.

c. Turn the power meter OFF.

d. Connect the power sensor.

e. Turn the power meter ON.

NOTE

"AUTO" and "FWD" should be displayed, and a reading of "0.00 W" (or a very low number).

f. Press RFL.

NOTE

"FWD" should change to "RFL" on the display. The reading should remain the same.

g. Press SWR.

NOTE

"RFL" should change to "SWR". "0.00 W" should change to "⌴ ⌴" (underrange error).

h. Hold down MIN.

NOTE

"⌴ ⌴" should change to "⊓ ⊓" (overrange error).

i. Release MIN.

NOTE

"⊓ ⊓" should change to "⌴ ⌴".

j. Press dBm.

NOTE

"SWR" should turn OFF and "dBm" should turn ON.

k. Press dBm.

NOTE

"dBm" should change to "SWR".

l. Press FWD.

NOTE

"SWR" should change to "FWD" and " " to ".0000 W" (or a very low number).

m. Hold down MAX.

NOTE

".0000" should change to "1.0000".

n. Release MAX.

NOTE

"1.0000" should change to ".0000" (or a very low number).

o. Press LIGHT.

NOTE

The back-light should turn on.

p. Press LIGHT.

NOTE

The back-light should turn off.

q. Press s (up).

NOTE

The power meter should change ranges each time it is pressed until it reaches "0.000 KW".

r. Press t (down).

NOTE

The power meter should change ranges each time it is pressed until it reaches "0.00 W".

s. Turn the power meter OFF.

7.4 POWER METER REPAIR

WARNING

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

7.4.1 Replace Fuse. Fuses are used in the AC supply connector for overload protection. Ensure the correct fuse is installed for the AC power supply being used, see Table 7-2.

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.

a. Gently pry the fuse drawer out of the AC module. The fuse holder does not detach from the AC module. See Figure 7-1.

b. Install the replacement fuses then close and secure the fuse holder. Fuse 1 is a spare fuse and fuse 2 is the active fuse.

Table 7-2. Fuse Ratings

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

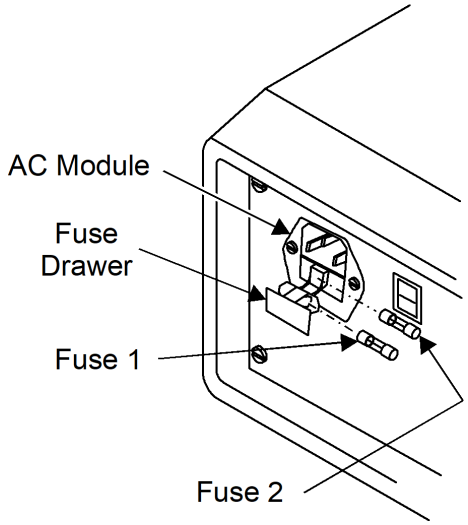


Figure 7-1 AC Line Fuse

7.4.2 Remove the Top Cover.

WARNING

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

a. Disconnect the unit AC power cord from the AC mains supply.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Remove the four screws that secure the cover (Figure 7-2).

c. Lift the cover and disconnect the ground wire then remove the cover and set it aside.

Item	Description
1	Cover
2	Screw, cover
3	Cover ground connection
4	Cover ground wire

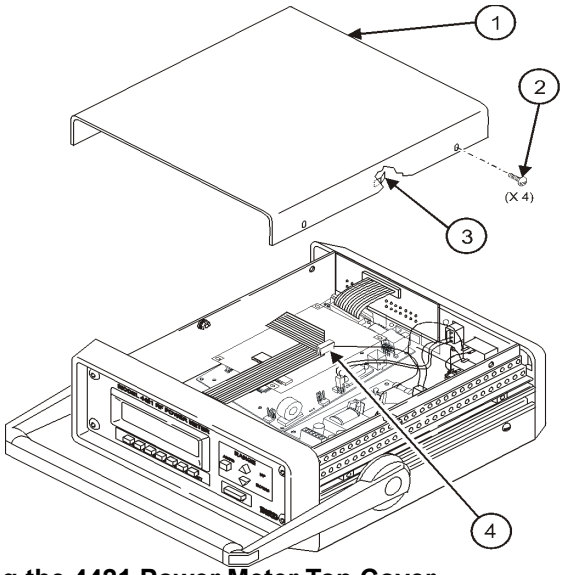


Figure 7-2 Removing the 4421 Power Meter Top Cover

7.4.3 Replace the Top Cover.

a. Connect the ground wire to the cover.

b. Position cover onto power meter.

c. Install four screws to secure the cover.

7.4.4 Remove and Replace Batteries.

WARNING

Exposed AC line voltage (115 VAC or 230 VAC). Disconnect the power cord from the AC line before opening the unit. 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.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

a. Remove top cover. See 7.4.2 Remove the Top Cover, on page 7-5.

b. Remove two retaining screws securing the battery assembly. See Figure 7-3.

c. Disconnect battery assembly power supply connector.

Item	Description
1	Battery assembly power supply connector
2	Battery assembly
3	Retaining screws

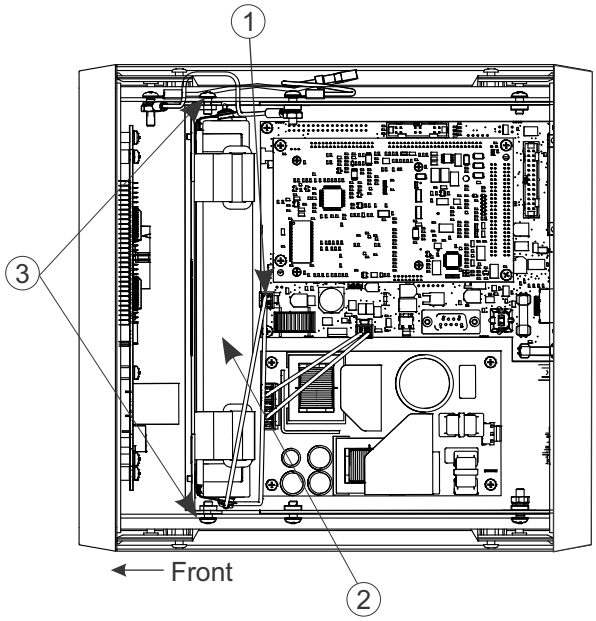


Figure 7-3 Battery Assembly Removal

d. Lift the battery assembly out of the Power Meter.

e. Unfasten the battery retaining belts then remove the battery tubes (Figure 7-4). Be sure to note the polarity and orientation of the battery tubes before removing them.

Item	Description
1	Battery tubes
2	Batteries
3	Retaining belts

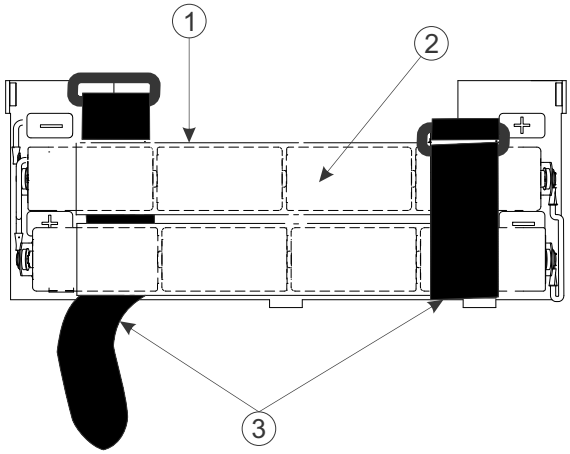


Figure 7-4 Battery Assembly

f. Remove the batteries from each tube and insert replacement batteries. Be sure to note the polarity (positive and negative) arrangement of the batteries.

g. Install the battery tubes into the battery assembly and secure with the retaining belts. Be sure to position the retaining belts as they were before removal and tighten them securely.

h. Install battery assembly in the Power Meter. Align tabs on battery assembly with slots in Power Meter.

i. Install two screws to secure battery assembly to Power Meter.

j. Connect the battery assembly power supply connector to the main board.

k. Install top cover. See 7.4.3 Replace the Top Cover, on page 7-6.

7.4.5 Remove Power Supply Assembly.

WARNING

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

a. Remove top cover. See 7.4.2 Remove the Top Cover, on page 7-5.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Disconnect the two connectors (CN1 and CN2) from the power supply assembly (Figure 7-5). Take note or record the orientation of each connector and its locking tabs.

c. Remove the four screws and washers that secure the power supply circuit board.

d. Remove the power supply circuit board assembly.

Item	Description
1	Washer, lock
2	Screw, mounting, power supply assembly
3	Fuse, 4 A, 250 V
4	Connector, CN1
5	Assembly, power supply
6	Connector, CN2

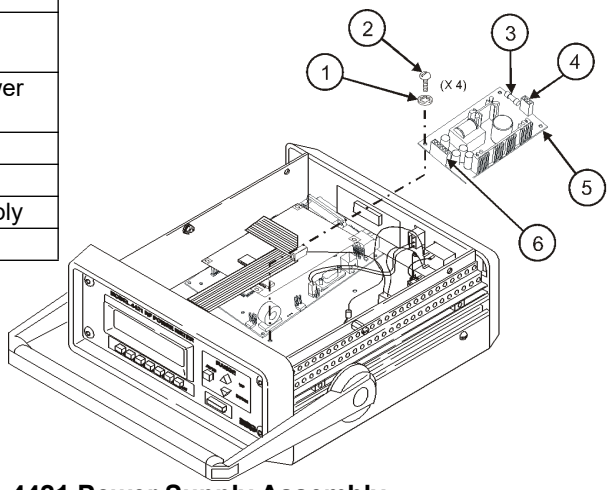


Figure 7-5 4421 Power Supply Assembly

7.4.6 Replace Power Supply Assembly.

a. Position the power supply circuit board assembly in the power meter.

b. Install four screws and washers to secure the power supply assembly.

c. Connect two connectors (CN1 and CN2) to the power supply assembly (Figure 7-5).

7.4.7 Remove Single Board Computer.

WARNING

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

a. Remove top cover. See 7.4.2 Remove the Top Cover, on page 7-5.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Remove the four screws and lock washers that secure the single board computer to the I/O Hub circuit board assembly (Figure 7-6).

c. Remove the Single Board Computer by gently rocking the circuit board while pulling it upward to disconnect the four on-board connector headers from their sockets on the I/O Hub circuit board assembly.

NOTE

There is an insulating washer under the circuit board at each mounting screw location. Take care to locate and keep these insulating washers for use in installation.

d. Locate insulating washer under the circuit board at each mounting screw location. Retain insulating washers for installation.

e. Store and transport the circuit board assembly in suitable ESD container.

NOTE

Item	Description
1	Screw
2	Lock washer4
3	Single Board computer
4	Insulated washer

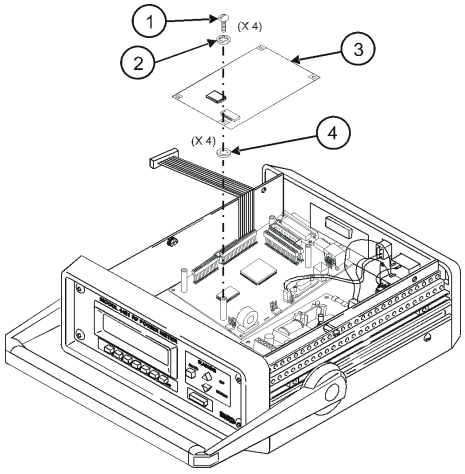


Figure 7-6 4421 Single Board Computer

7.4.8 Replace Single Board Computer.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

a. Position the Single Board Computer in the power meter above the I/O Hub circuit board assembly.

b. Align the four on-board connector headers with the sockets on the I/O Hub circuit board assembly.

c. Position insulating washers under the circuit board at each mounting screw location.

d. Press down gently to seat the Single Board Computer on the I/O Hub circuit board assembly.

NOTE

Ensure insulating washers are under the circuit board at each mounting screw location.

e. Install four screws and lock washers to secure the single board computer and insulating washers to the I/O Hub circuit board assembly.

f. Install top cover. See 7.4.3 Replace the Top Cover, on page 7-6

7.4.9 Remove I/O Hub Circuit Board Assembly.

WARNING

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

a. Remove Single Board Computer. See 7.4.7 Remove Single Board Computer, on page 7-8.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Record the positions of the DIP switches on the I/O Hub circuit board assembly.

c. Disconnect the IEEE-488 ribbon cable from connector J1.

d. Disconnect the rear panel switch cable from connector J38.

e. Disconnect the power supply cable from connector J37.

f. Disconnect the battery cable from connector J36.

g. Remove the two jack screws that secure the RS-232 connector to the rear panel.

h. Remove the four screws and lock washers that secure the I/O Hub circuit board assembly to the chassis then remove the circuit board assembly.

i. Disconnect the ribbon cable from connector J34 on the circuit board assembly.

NOTE

If the I/O Hub PCB is defective, perform the following step:

j. Remove the stand-offs and insulating washers from the defective PCB.

Item	Description
1	Lock washer
2	Mounting screw
3	Ribbon cable (connects to J34)
4	Connector J1 (IEEE-488 ribbon cable)
5	RS-232 DIP switches
6	J38 (connects to rear panel switch)
7	Jack screw (secures RS-232 connector to rear panel)
8	J37 (connects to power supply)
9	J36 (connects to batteries)

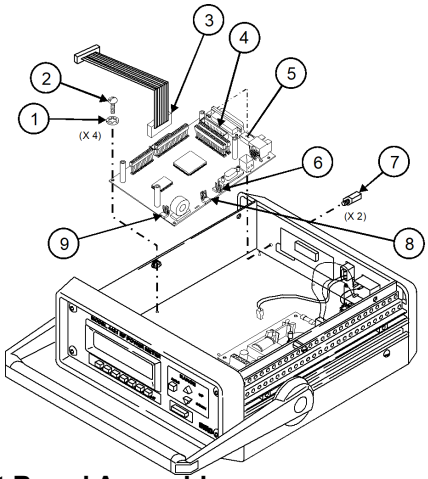


Figure 7-7 I/O Hub Circuit Board Assembly

7.4.10 Replace I/O Hub Circuit Board Assembly.

a. Install the stand-offs and insulating washers onto the new circuit board, if required.

b. Connect the ribbon cable to connector J34 on the circuit board assembly.

c. Position circuit board assembly in the chassis.
d. Install four screws and lock washers to secure the I/O Hub circuit board assembly to the chassis.
e. Install two jack screws to secure the RS-232 connector to the rear panel.
f. Connect the battery cable to connector J36.
g. Connect the power supply cable to connector J37.
h. Connect the rear panel switch cable to connector J38.
i. Connect the IEEE-488 ribbon cable to connector J1.
j. Set the DIP switches on the I/O Hub circuit board assembly to the positions recorded in 7.4.9 step b.
k. Install Single Board Computer. See 7.4.8 Replace Single Board Computer, on page 7-9.

7.4.11 Remove IEEE-488 Circuit Board Assembly.

WARNING

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

a. Remove top cover. See 7.4.2 Remove the Top Cover, on page 7-5.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Record the positions of the DIP switches on the IEEE-488 circuit board assembly.
c. Disconnect the IEEE-488 ribbon cable from the I/O Hub circuit board assembly.
d. Remove the two jack screws that secure the IEEE-488 connector to the rear panel (Figure 7-8).
e. Remove the IEEE-488 circuit board assembly from the rear panel.

Item	Description
1	IEEE-488 ribbon cable connector
2	IEEE-488 circuit card assembly
3	Jack screws

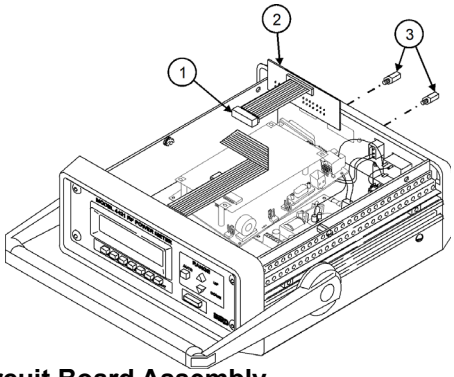


Figure 7-8 EEE-488 Circuit Board Assembly

7.4.12 Replace IEEE-488 Circuit Board Assembly.

a. Position the IEEE-488 circuit board assembly on the rear panel.
b. Install the two jack screws to secure the IEEE-488 connector to the rear panel (Figure 7-8).
c. Connect the IEEE-488 ribbon cable from the I/O Hub circuit board assembly.
d. Set the DIP switches on the IEEE-488 circuit board assembly to the positions recorded in 7.4.11 step b.
e. Install top cover. See 7.4.3 Replace the Top Cover, on page 7-6.

7.4.13 Remove the Main I/O and Keypad Circuit Boards.

WARNING

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

a. Remove top cover. See 7.4.2 Remove the Top Cover, on page 7-5.

CAUTION

Sensitive electronic components. Use ESD handling precautions when working inside of the 4421 RF Power Meter. Failure to comply may result in permanent damage to the equipment.

b. Remove the four screws that secure the front panel assembly to the bezel (Figure 7-9 on page 7-13).

c. Remove the screw that secures the ground wire and star washer to the Main I/O circuit board assembly.

d. Remove the ribbon cable that is connected to the Main I/O circuit board assembly.

e. Place the front panel and circuit board assembly on a clean anti-static work surface.

f. Remove the four screws and lock washers that secure the two circuit boards to the front panel.

g. Remove the four screws and lock washers that secure the Main I/O circuit board to the Keypad circuit board.

NOTE

If the LCD and backlight are not defective, skip step h and step i.

h. Remove the LCD display and backlight assembly.

- If replacing a backlight, existing LCD display may be reused.
- If replacing an LCD display, backlight should be replaced.

i. Separate the LCD from the backlight.

7.4.14 Replace the Main I/O and Keypad Circuit Boards.

NOTE

If the keypad electrical contacts on the circuit board show signs of oxidation, use a pencil eraser to remove the oxidation and then clean the contacts with 100% denatured alcohol.

a. Clean the back side of the keypad buttons and the corresponding contact surfaces on the keypad circuit board with 100% denatured alcohol.

b. Install the LCD display and backlight assembly on the Main I/O circuit board.

c. Connect ribbon cable from the Main I/O circuit board to the Keypad circuit board.

d. Install the four screws and lock washers to secure the Main I/O circuit board to the Keypad circuit board.

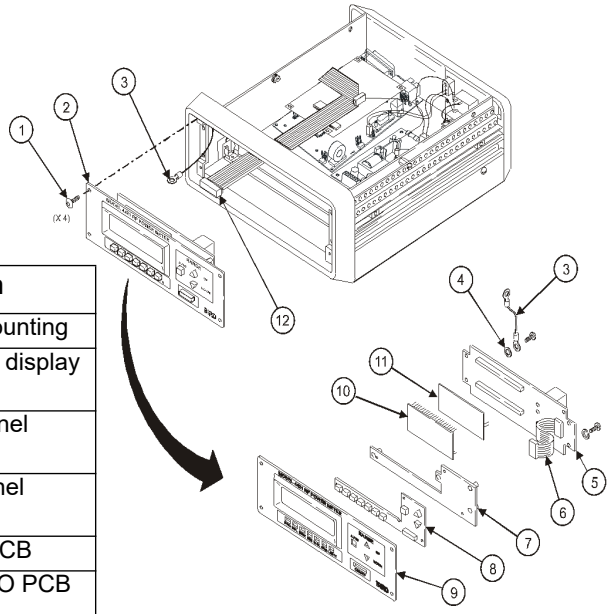
e. Install the four screws and lock washers to secure the two circuit boards to the front panel.

f. Connect the ribbon cable from the Main Control PCB to the Main I/O circuit board assembly.

g. Install screw to secure the ground wire and star washer to the Main I/O circuit board assembly.

h. Install the four screws to secure the front panel assembly to the bezel (Figure 7-9 on page 7-13).

i. Install top cover. See 7.4.3 Replace the Top Cover, on page 7-6.



Item	Description
1	Screw, front panel mounting
2	Assembly, front panel display and keypad
3	Ground wire, front panel assembly
4	Star washer, front panel assembly grounding
5	Assembly, Main I/O PCB
6	Ribbon cable, Main I/O PCB to Keypad PCB
7	Assembly, Keypad PCB
8	Keypad
9	Front panel
10	Liquid Crystal Display (LCD)
11	Backlight
12	Ribbon cable, Main I/O PCB to Main Control PCB

Figure 7-9 4421 Display and Front Circuit Boards

7.4.15 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.

7.5 POWER SENSOR REPAIR

Power Sensor Repair is limited to exchanging the input and output RF connectors. There are no internal components that can be replaced without returning the unit to the factory.

CAUTION

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

7.5.1 Remove Power Sensor RF Connector. The following procedure may be used to remove the Bird QC connectors.

a. Remove four 8-32 round head machine screws from the corners of the connector flange.

b. Pull the connector straight out.

7.5.2 Replace Power Sensor RF Connector. The following procedure may be used to replace the Bird QC connectors.

a. Align the replacement connectors center contact pin with the socket and seat QC connector.

b. Install four 8-32 round head machine screws in the corners of the connector flange to secure the QC connector in place.

7.6 CUSTOMER SERVICE

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

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

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

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

http://www.birdrf.com

Chapter 8 Illustrated Parts Breakdown

8.1 ILLUSTRATIONS

Parts on the illustrations are identified by index numbers. Cross reference from index number to part number is provided in the table associated with the figure. The following illustrations contain the illustrated Parts Breakdown (IPB) for the Lowest Replaceable Units (LRU) within the Precision RF Power Test Set.

8.2 PARTS LIST

The following paragraphs explain the information contained in the parts list.

a. The FIG. AND INDEX NUMBER column lists the figure number of the illustration on which the part is located and gives the index number assigned to that part.

b. The PART NUMBER column contains Bird Electronic Corporation part numbers or original manufacturer part numbers, if available.

c. The DESCRIPTION column gives the name of the part, and the parts are indented to indicate the relationship of each part to the next higher assembly (NHA).

d. The CAGE CODE column gives the vendor number of a part or subassembly. Cross reference from CAGE code to vendor's name and address is provided in Table 8-1.

e. The UNITS PER ASSY column indicates the quantity of parts used in the illustrated application but not necessarily the total quantity used in the end item.

Table 8-1. Cage Code

Cage Code	Vendor
70998	BIRD ELECTRONIC CORPORATION 30303 Aurora Rd. Solon, OH 44139

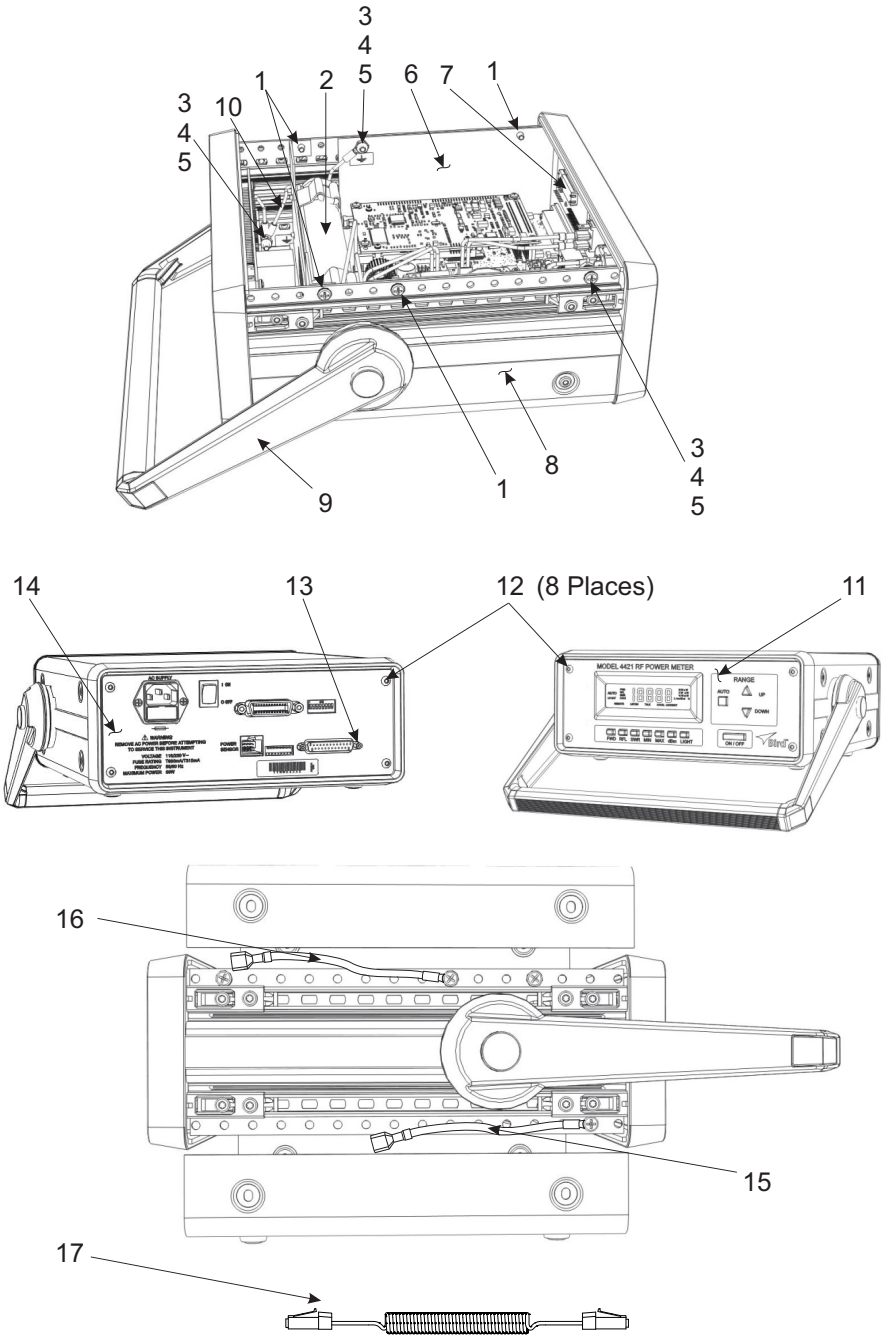


Figure 8-1 4421 RF Power Meter, Complete Assembly

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-1, 1	1118-0613-00	#8-32x3/8 Phillips Pan MS SS	70998	4
8-1, 2	4421C012	Battery Bracket Assembly	70998	1
8-1, 3	1118-1013-00	#8-32x5/8 Phillips Pan MS SS	70998	3
8-1, 4	1131-0300-00	#8-32 Hex Nut SS	70998	3

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-1, 5	1132-0305-00	#8 Internal Lock Washer SS	70998	9
8-1, 6	4421C002	Frame, Main Assembly	70998	1
8-1, 7	4421B063	PCBA GPIB Interface	70998	1
8-1, 8	4421A036	Case Assembly	70998	1
8-1, 9	4421-037	Handle Assembly	70998	1
8-1, 10	4421-015-91	Wire, Serviced Green 6in	70998	1
8-1, 11	4421A003	Front Panel Assembly	70998	1
8-1, 12	1151-0317-00	M4x8mm Button MS SS	70998	8
8-1, 13	5-1312	Standoff, Stud Mount	70998	2
8-1, 14	4421C004	Panel, Rear Assembly	70998	1
8-1, 15	4421-015-43	Wire, Serviced Green 3 in	70998	1
8-1, 16	4421-015-92	Wire, Serviced Green 4in	70998	1
8-1, 17	4421-038	Cable, Sensor Interface	70998	1

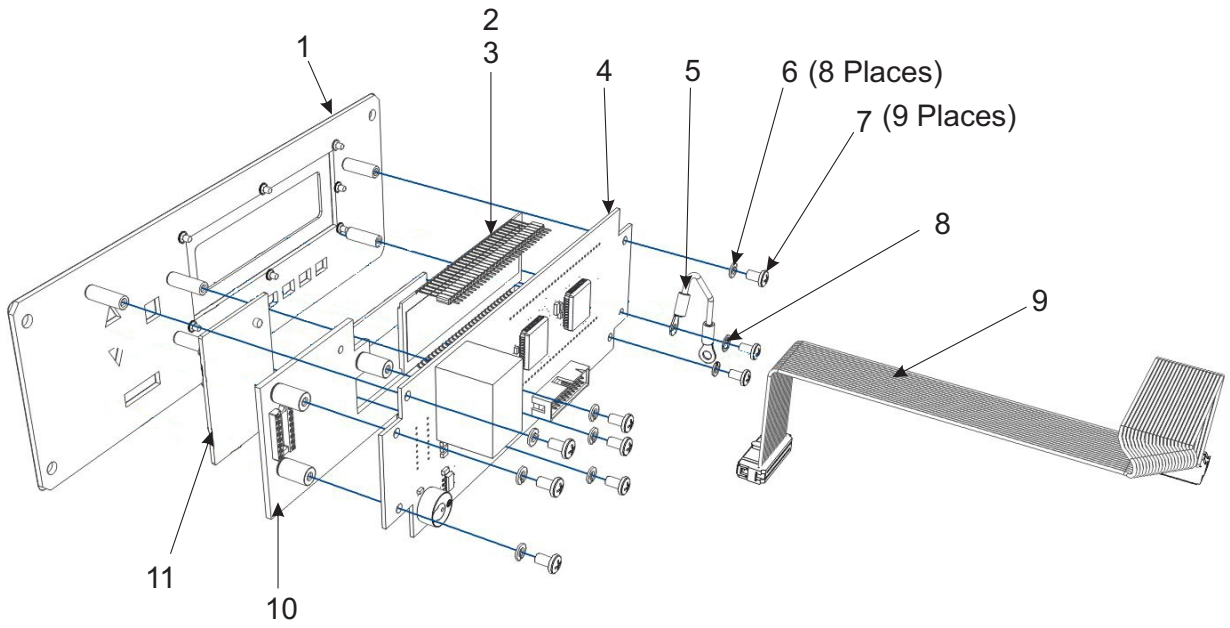


Figure 8-2 4421 RF Power Meter, Front Panel Assembly

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-2, 1	4421A006	Front Panel, sub-assembly	70998	1
8-2, 2	4421B033	LCD Assembly (with backlight)	70998	1
8-2, 3		Backlight	70998	1
8-2, 4	4421B026	PCBA, Main I/O	70998	1
8-2, 5	4421-015-7	Wire, Serviced Green 2 in	70998	1
8-2, 6	1132-0201-00	#6 Split Lock Washer SS	70998	8
8-2, 7	1116-0413-00	#6-32x1/4 Phillips Pan MS SS	70998	9
8-2, 8	1132-0205-00	#6 Internal Lock Washer SS	70998	1
8-2, 9	4421-010	Cable, Ribbon/Assembly Main Control	70998	1
8-2, 10	4421-023	Keypad /Assembly PCB	70998	1
8-2, 11	4421-034	Switch, Keypad, Gray	70998	1

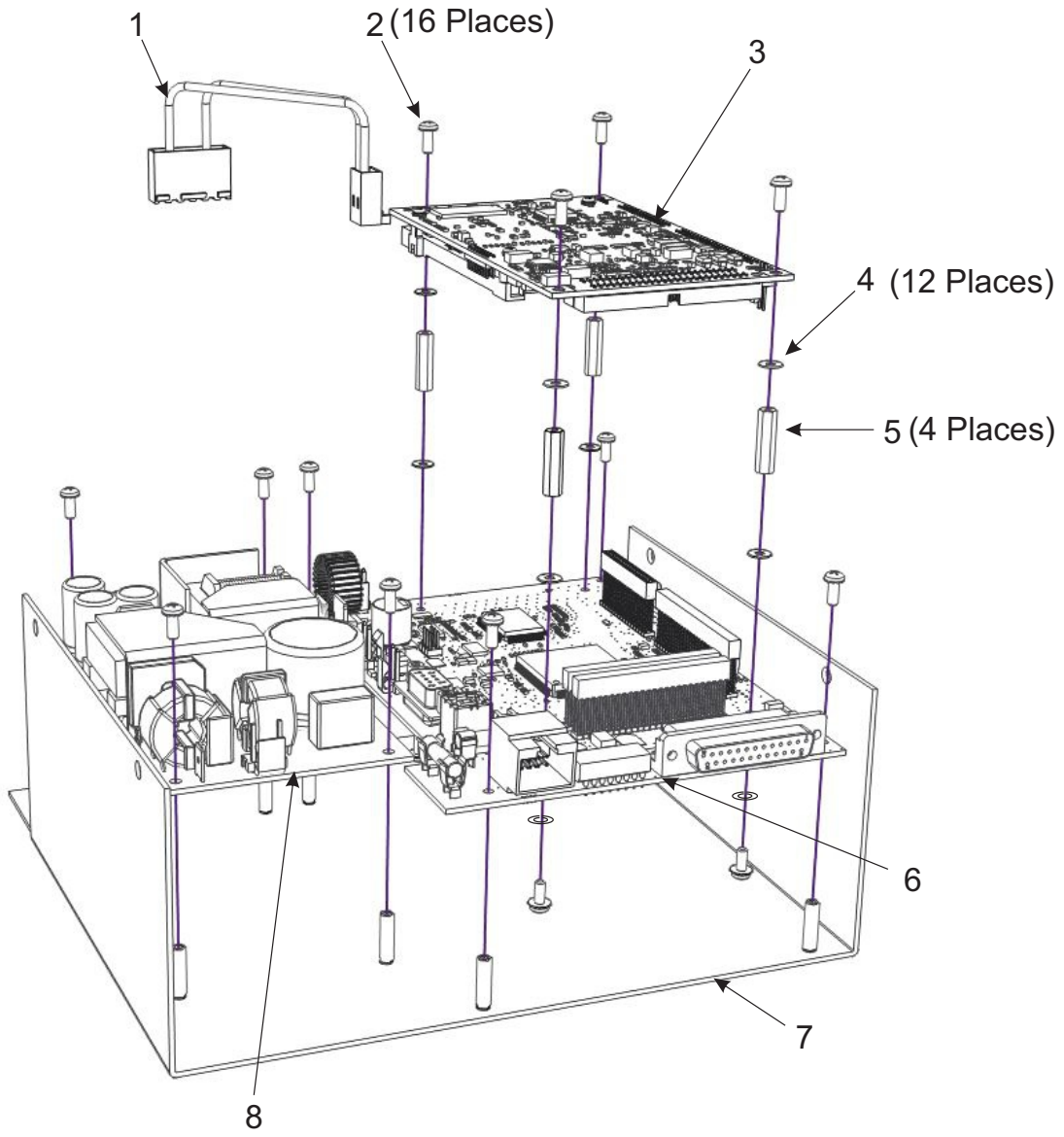


Figure 8-3 4421 RF Power Meter, Main Frame Assembly

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-3, 1	4421B068	Wire Assembly, Power to Main	70998	1
8-3, 2	1146-1-0512-00	#4-40 x 5/16 Phil Pan HD w/Captive Ext Lock washer	70998	16
8-3, 3	4421C065	Computer, Single Board	70998	1
8-3, 4	1132-0103-60	#4 Washer Plain, Type A Nylon	70998	12
8-3, 5	5A2742-74A	Standoff, Threaded 3/16" Hex #4-40 3/4" long	70998	4
8-3, 6	4421D061	PCBA, Main I/O Board	70998	1

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-3, 7	4421C048	Frame, Main	70998	1
8-3, 8	5A2703-1	Power Supply	70998	1

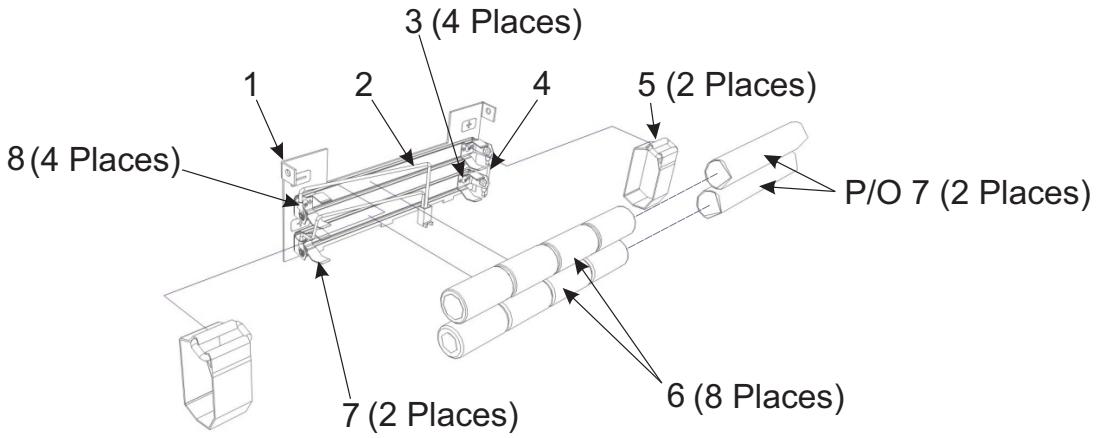


Figure 8-4 4421 RF Power Meter, Battery Bracket Assembly

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-4, 1	4421C075	Battery Bracket	70998	1
8-4, 2	4421A067-1	Power Connector wiring Harness Assembly	70998	1
8-4, 3	1112-0419-00	#4-40 x 1/4 Phil Truss HD MS SS	70998	4
8-4, 4	4421A069-1	Wire, Serviced	70998	1
8-4, 5	5A2450	Velcro Battery Straps	70998	2
8-4, 6	5A1230	Battery, NIMH “C” Cell	70998	8
8-4, 7	5A2449	Battery Holder, with insulating tubes	70998	2
8-4, 8	5-566-6	Heat Shrink Tubing, 0.166”	70998	4

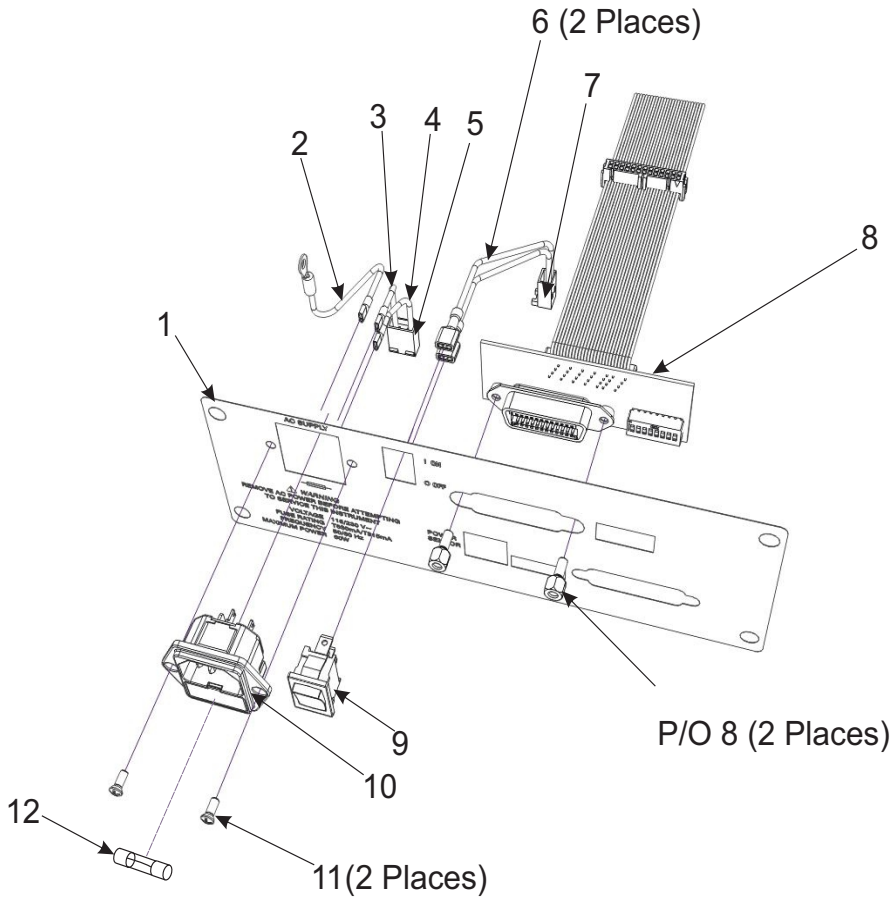


Figure 8-5 4421 RF Power Meter, Rear Panel Assembly

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-5, 1	4421C007	Rear Panel	70998	1
8-5, 2	4421-015-44	Wire, Serviced, Green/Yellow	70998	1
8-5, 3	4421-015-61	Wire, Serviced, White	70998	1
8-5, 4	4421-015-60	Wire, Serviced, Black	70998	1
8-5, 5	5A2709-03-3	Connector	70998	1
8-5, 6	4421-015-62	Wire, Serviced, White	70998	2
8-5, 7	5A2709-02-1	Connector	70998	1
8-5, 8	4421B063	GPIB Connector and Switch Assembly	70998	1
8-5, 9	5-1722	Switch, AC Power	70998	1
8-5, 10	5A2704-1	Receptacle, AC Power with Fuse Holder	70998	1
8-5, 11	1112-0520-00	#4-40 x5/16 PHIL OVAL HD MS SS	70998	2
8-5, 12	5A2257-11	FUSE,time-delay,5x20mm,TYPE T	70998	2

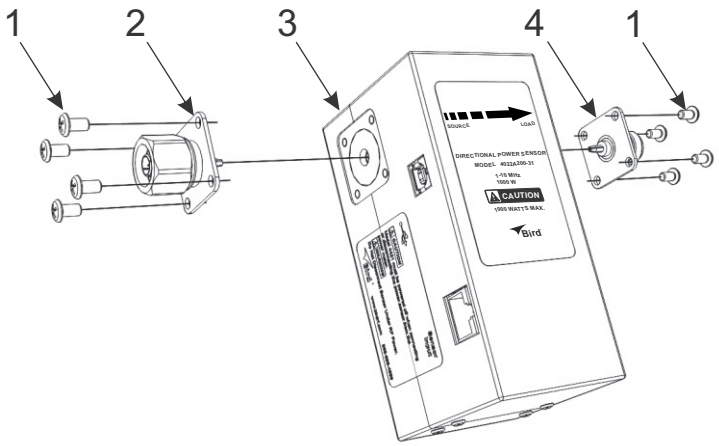


Figure 8-6 Power Sensor, 3%, 1-10 MHz

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-6, 1	1118-0513-00	#8-32x5/16 Phillips Pan MS SS	70998	8
8-6, 2	4240-063-4	Connector, QC N(m)	70998	1
8-6, 3	4022A200-31	Power Sensor, 3%, 1-10 MHz	70998	1
8-6, 4	4240-062-4	Connector, QC N(f) Stainless Steel	70998	1

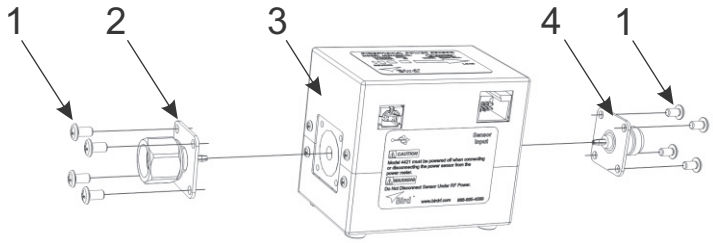


Figure 8-7 Power Sensor, 3%, 10-100 MHz

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-7, 1	1118-0513-00	#8-32x5/16 Phillips Pan MS SS	70998	8
8-7, 2	4240-063-4	Connector, QC N(m)	70998	1
8-7, 3	4022A200-32	Power Sensor, 3%, 10-100 MHz	70998	1
8-7, 4	4240-062-4	Connector, QC N(f) Stainless Steel	70998	1

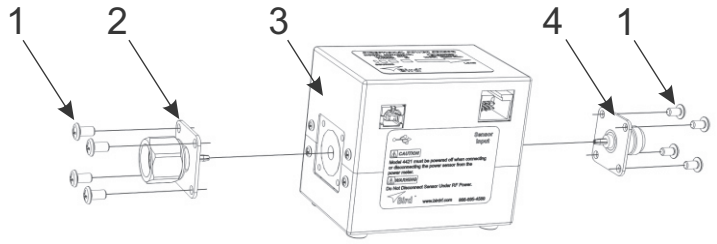


Figure 8-8 Power Sensor, 3%, 100-1000 MHz

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-8, 1	1118-0513-00	#8-32x5/16 Phillips Pan MS SS	70998	8
8-8, 2	4240-063-4	Connector, QC N(m)	70998	1
8-8, 3	4022A200-33	Power Sensor, 3%, 100-1000 MHz	70998	1
8-8, 4	4240-062-4	Connector, QC N(f) Stainless Steel	70998	1

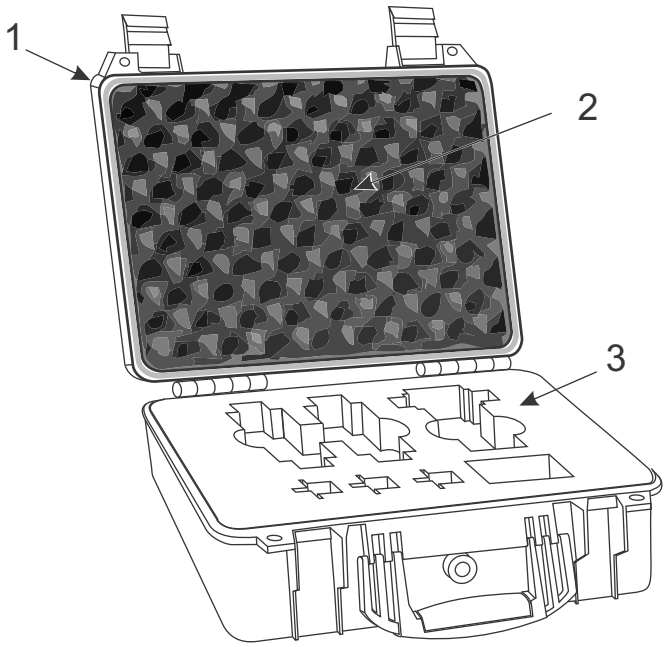


Figure 8-9 Case, Transit

Figure & Index	Part Number	Description	Cage	Units Per Assy
8-9, 1	4421A302-3	Case, Transit	70998	1
8-9, 2	5000-035-2	Foam Insert, Case Lid	70998	1
8-9, 3	5000-035-7	Foam Insert, Case Bottom	70998	1

Appendix A 4421 RF Power Meter IEEE-488 Interface

A.1 INTRODUCTION

This section 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.

A.2 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.

A.2.1 Cable Connector . The interface uses a standard IEEE-488 cable connector. Pin assignments are listed in Table A-1.

Table A-1. 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

A.2.2 Interface Capabilities.

Table A-2. 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.

A.2.3 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.

A.3 SETUP

A.3.1 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.

A.3.2 Primary Address. 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 A-1 on page A-3, the address is set to 6 (the off switches have values of 4 and 2).

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.

Figure A-1 IEEE Interface Default DIP Switch Settings

A.3.3 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.

A.4 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.

A.5 GENERAL BUS COMMANDS

The general bus commands supported by the IEEE-488 interface feature are listed in Table A-3. The syntax for executing general commands varies among controllers; check the documentation supplied with your controller for the proper command structure.

Table A-3. IEEE-488 General Bus Commands

Command	Effect on Bird 4421
IDN?	Gives product identification
REN	Goes into remote mode when next addressed
GTL	Cancels 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

IDentificatio**N** (IDN?)

Function	Product identifies itself
Remarks	Replies command same as U2

Remote **EN**able (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 **T**o **L**ocal (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 **LO**ckout (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.

Inter**F**ace **C**lear (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 canceled, and its indicator is turned off.

Device **CL**ear (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 Table A-4.

Table A-4. 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 **D**evice **C**lear (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 **E**xecute **T**rigger (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 **P**olling **E**nable/**D**isable (SPE/SPD)

Function Enables or disables the serial polling sequence.

CAUTION

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

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 A-5 lists the bits used, along with a description and how to reset them.

Table A-5. 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.
		Cleared by a serial poll of the 4421.
3	Measurement Complete	Set when the power meter has completed a reading.
		Cleared by requesting a reading over the bus.
2	Reading Underflow	Set when the RF power is underrange and a reading has been completed.
		Cleared by requesting a reading over the bus.
1	Reading Overflow	Set when the RF power is overrange and a reading has been completed.
		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.
		Cleared by reading the U1 status word. The U1 word contains details on the error, see "Status (Ux)" on page A-11.

A.6 DEVICE DEPENDENT COMMANDS

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

NOTE

The programming card also has a complete command list.

Table A-6. 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 **C**arrier Wave (FC)
Forward **d**Bm (FD)
Reflected **C**arrier Wave (RC)
Reflected **d**Bm (RD)

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

Standing **W**ave Ratio (SW)
Return **L**oss (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 A-7.

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

Table A-7. 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 µW
R04	1.80 – 19.99 µW
R03	0.180 – 1.999 µW
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 A-8 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 A-8. 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 A-9).

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 A-9. 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 **M**ask (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 A-10. 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 A-2. The default values are also shown.

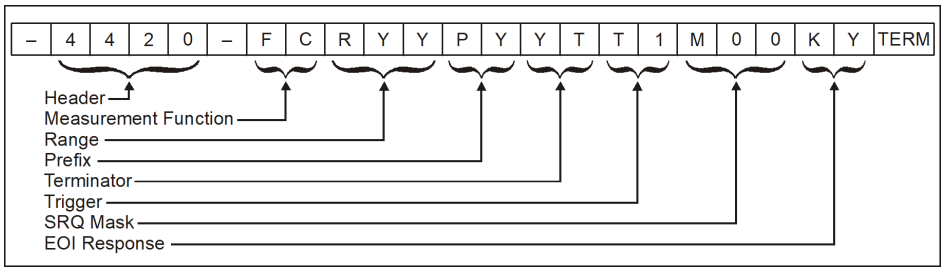


Figure A-2 Machine Status Word Format

Error Status Word (U1) — The format of the error status word and the possible error messages are shown in Figure A-3. When an error occurs, an error is also flagged in the status (serial poll) byte, and a SRQ may be generated ("SRQ Mask (Mxx)" on page A-11). All flags will revert to their non-error states after the U1 command is sent.

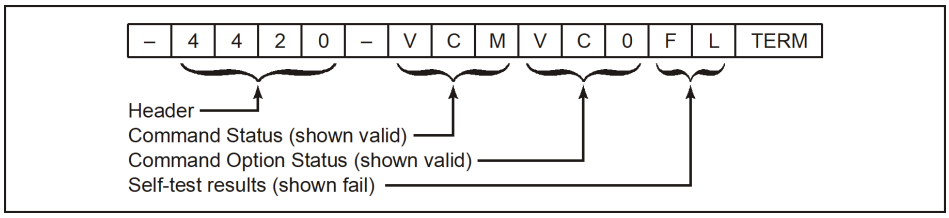


Figure A-3 Error Status Word Format

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 A-4.

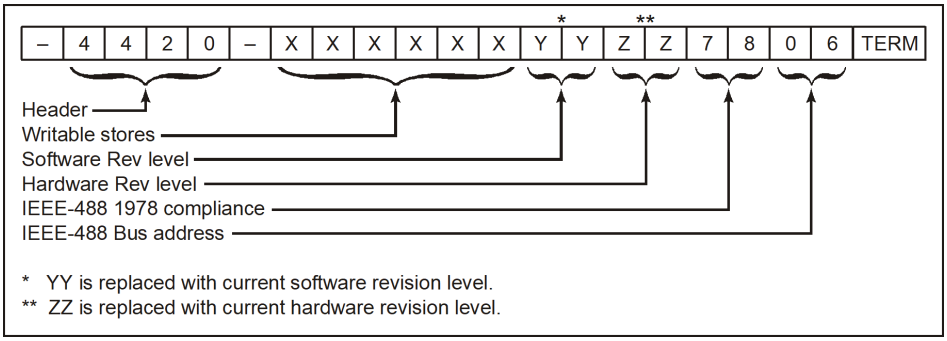


Figure A-4 Revision History Word Format

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 ("Status (Ux)" on page A-11).

"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.

Appendix B 4421 RF Power Meter RS-232 Interface

B.1 INTRODUCTION

This section 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.

B.2 DESCRIPTION

The Bird 4421 RS-232 interface feature is an integral part of the I/O hub circuit board inside of the 4421. 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.

B.2.1 Cable Connector. The interface uses a standard 25-pin RS-232 connector. Pin assignments are listed in Table B-1. 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 B-1. 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

B.2.2 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.

B.3 SETUP

B.3.1 DIP Switch. Set the DIP switches according to application needs and the requirements of the controller. Available settings and factory defaults are shown in Table B-2.

NOTE

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

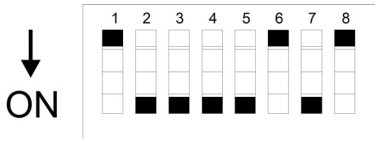


Figure B-1 RS-232 Interface DIP Switch Default Settings

NOTE

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

Table B-2. RS-232 Interface DIP Switch Settings

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

† Default factory setting

†† For more information see "Auto Baud" on page B-3.

B.3.2 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:

a. Set DIP switches 6, 7, and 8 to ON.

b. Connect a controller to the power meter.

c. Turn the power meter on.

d. Send the character U (hexadecimal 55) from the controller to the power meter.

e. Wait 1 second.

f. 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.

B.3.3 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.

B.4 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.

B.5 GENERAL BUS COMMANDS

The general bus commands supported by the RS-232 interface module are listed in Table B-3.

Table B-3. 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 B-4.

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 B-4. 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.

B.6 DEVICE DEPENDENT COMMANDS

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

Table B-5. RS-232 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 ENT
	T1	One shot on ENT
	T3	One shot on TRG
	T5	One shot on measurement command
Status	U0	Send back current machine state
	U1	Send back error conditions
	U2	Send back revision levels
Self-Test	J0	Run self-test
Writable Store	WXXXXXX	Place XXXXXX in RAM

Forward **C**arrier Wave (FC)
Forward **d**Bm (FD)
Reflected **C**arrier Wave (RC)
Reflected **d**Bm (RD)

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

Standing **W**ave Ratio (SW)
Return **L**oss (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 B-6.

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

Table B-6. 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 µW
R04	1.80 – 19.99 µW
R03	0.180 – 1.999 µW
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 B-7 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 B-7. 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 B-8).

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 B-8. 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 B-2. The default values are also shown.

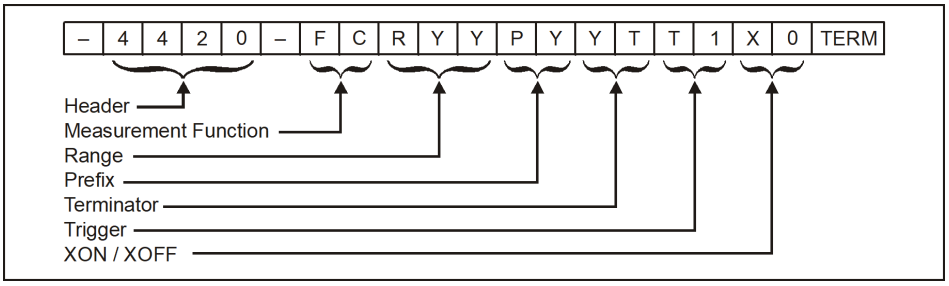


Figure B-2 Machine Status Word Format

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 B-3. All flags will revert to their non-error states after the U1 command is sent.

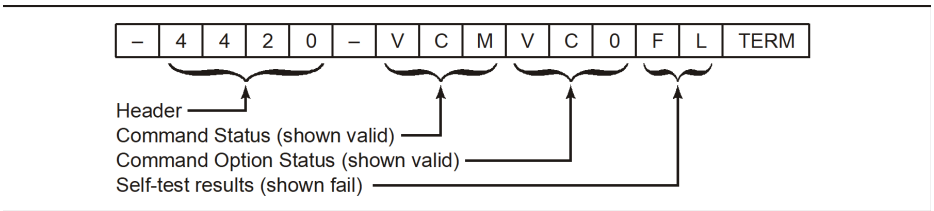


Figure B-3 Error Status Word Format

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 B-4.

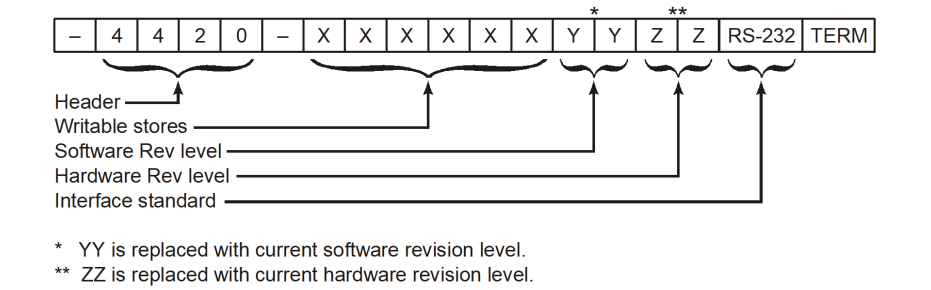


Figure B-4 Revision History Word Format

Self Test (J0)

Function Initiates a hardware and software test.

Remarks Results are stored in the U1 status word (see "Status (Ux)" on page B-9).

"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

Appendix C Power Sensor USB/SCPI Interface

C.1 INTRODUCTION

This chapter provides an overview of the Standard Commands for Programmable Instruments (SCPI) language. The sensor in the 4022A200-3 Precision RF Power Test Set can be control via USB using the SCPI commands shown in paragraph C.3 "4022A200 Power Sensor SCPI Commands" on page C-6. Several programming examples are provided to provide context to many of the commands, the examples are shown in paragraph C.4 "Programming Code Examples" on page C-29.

C.2 SCPI BASICS

This section describes the general use of the SCPI language for the Power Sensors in the Precision RF Power Test Set. It is not intended to teach you everything about the SCPI language; the SCPI Consortium or IEEE can provide that level of detailed information. For a list of the specific commands available for the Precision RF Power Test Set, See C.3 "4022A200 Power Sensor SCPI Commands" on page C-6.

C.2.1 Common Terms. The following terms are used throughout the remainder of this section:

C.2.1.1 Command. A command is an instruction in SCPI consisting of mnemonics (keywords), parameters (arguments), and punctuation. Commands are used to control the instrument.

C.2.1.2 Controller. A controller is any device used to control the Precision RF Power Test Set Power Sensors, for example a computer or another instrument.

C.2.1.3 Program Message. A program message is a combination of one or more properly formatted commands. Program messages are sent by the controller to the Precision RF Power Test Set Power Sensors.

C.2.1.4 Query. A query is a special type of command used to instruct the Precision RF Power Test Set Power Sensors to make response data available to the controller. A query ends with a question mark. Generally you can query any command value that you set.

C.2.1.5 Response. A response message is a collection of data in specific SCPI formats sent from the Precision RF Power Test Set Power Sensors to the controller. Response messages tell the controller about the internal state of the Power Sensor.

C.2.2 Command Syntax. A command is made up of one or more keywords. Consecutive keywords are separated with colons (:). The keywords are followed by a parameter.

Table C-1. Optional Keywords and Parameters

Characters	Meaning	Example
[ ]	Square brackets indicate that the enclosed keywords or parameters are optional when composing the command. These implied keywords or parameters will be executed even if they are omitted.	FETCh[:SCALar][:POWer][:FORWard]:AVERage? SCALar, POWer, and FORWard are optional items.

Table C-2. Command Syntax

Characters, Keywords, and Syntax	Example
Upper- case lettering indicates the minimum set of characters required to execute the command. But, each mode of the command must be in either short form or the complete long form (no in between). Example: Correct: :FREQ :FREQuency Incorrect: :FREQuenc	SENSe:FREQuency?, SENS:FREQ? is the minimum requirement.
Lower- case lettering indicates the portion of the command that is optional; it can either be included with the upper- case portion of the command or omitted. This is the flexible format principle called forgiving listening. See C.2.4 "Command Parameters and Responses" on page C-3 for more information.	:FREQuency Either :FREQ, :FREQuency, or :FREQUENCY is correct.
A colon must be placed between two command mnemonics.	STATus:OPERation:ENABle
White space characters, such as <tab> and <space>, are generally ignored as long as they do not occur within or between keywords. However, you must use white space to separate the command from the parameter.	:FREQ uency or SENSe :REFLected :ENABle are not allowed. A <space> between :ENABle and 1 is mandatory. SENSe:REFLected:ENABle 1

C.2.3 Command Types. Commands can be separated into two groups: common commands and subsystem commands. See Figure C-1.

C.2.3.1 Common commands. Common commands are used to manage status registers, synchronization, and data storage and are defined by IEEE 488.2. They are easy to recognize because they all begin with an asterisk. For example *IDN?, *OPC, and *RST are common commands. Common commands are not part of any subsystem and the Precision RF Power Test Set Power Sensors interpret them in the same way, regardless of the current path setting.

C.2.3.2 Subsystem commands . Subsystem commands are distinguished by the colon (:). The colon is used between keywords, as in SENSe:FREQuency:RANGe:UPPer?

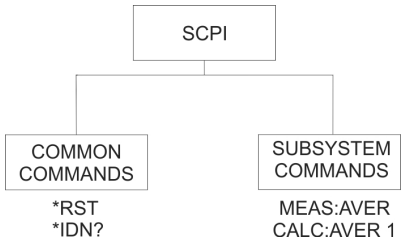


Figure C-1 Command Types

C.2.4 Command Parameters and Responses. SCPI defines different data formats for use in program and response messages. It does this to accommodate the principle of forgiving listening and precise talking. For more information on program data types refer to IEEE 488.2.

C.2.4.1 Forgiving Listening. Forgiving listening means the command and parameter formats are flexible. For example, with the CALCulate:AVERage[:STATe] command, the Precision RF Power Test Set Power Sensors accept CALCulate:AVERage:STATe 1, :CALC:AVER 1 to turn on the averaging mode.

C.2.4.2 Precise talking. Each parameter type has one or more corresponding response data types. A setting that you program using a numeric parameter returns either real or integer response data when queried. Response data (data returned to the controller) is more concise and restricted, and is called precise talking. Precise talking means that the response format for a particular query is always the same.

Table C-3. Parameter and Response Types

Parameter Types	Response Data Types
Numeric	Real, Integer
Extended Numeric	Real, Integer
Discrete	Discrete
Boolean	Numeric Boolean
String	String
Definite Block	Arbitrary byte data

C.2.4.3 Numeric Parameters. Numeric parameters are used in both common and subsystem commands. They accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation.
If a signal generator setting is programmed with a numeric parameter which can only assume a finite value, it automatically rounds any entered parameter which is greater or less than the finite value. For example, if a signal generator has a programmable output impedance of 50 or 75 ohms, and you specified 76.1 for the output impedance, the value is rounded to 75.

Table C-4. Examples of Numeric Parameters

100	no decimal point required
100.	fractional digits optional
-1.23	leading signs allowed
4.56E<space>3	space allowed after the E in exponential
-7.89E-001	use either E or e in exponential
+256	leading + allowed
.5	digits left of decimal point optional

C.2.4.4 Extended Numeric Parameters. Most subsystems use extended numeric parameters to specify physical quantities. Extended numeric parameters accept all numeric parameter values and other special values as well.

Table C-5. Examples of Extended Numeric Parameters

100	any simple numeric value
4 usec	usec can be used for exponential (E-6)
200MHz	MHz can be used for exponential (E006)

C.2.4.5 Boolean Parameters. Boolean parameters represent a single binary condition that is either true or false. The two- state boolean parameter has four arguments. The following list shows the arguments for the two-state boolean parameter:

Table C-6. Boolean Parameters

ON	boolean true, upper/lower case allowed
OFF	boolean false, upper/lower case allowed
1	boolean true
0	boolean false

C.2.4.6 Real Response Data. Real response data represent decimal numbers in either fixed decimal or scientific notation. Most high- level programming languages handle either decimal or scientific notation transparently.

Table C-7. Examples of Real Response Data

+4.000000E+010, -9.990000E+002
-9.990000E+002
+4.0000000000000E+010
+1
0

C.2.4.7 Integer Response Data. Integer response data are decimal representations of integer values including optional signs. Most status register related queries return integer response data.

Table C-8. Examples of Integer Response Data

0	signs are optional
+100	leading + allowed
-100	leading - allowed
256	never any decimal point

C.2.4.8 String Response Data. String response data are similar to string parameters. The main difference is that string response data returns double quotes, rather than single quotes. Embedded double quotes may be present in string response data. Embedded quotes appear as two adjacent double quotes with no characters between them.

Table C-9. examples of string response data

"This is a string"
"one double quote inside brackets: [""]"
"Hello!"

C.2.5 Parameter Types. Some SCPI commands have specific parameter types for the formatting of data. Table C-3 lists the parameter types and provides details about each parameter type.

Table C-10. Parameter Types

arbitrary_ascii	Arbitrary 7-bit ASCII response data. Not enclosed in quotes.
block_data	Definite length block of binary data. Has the form #nsss...sddd...d<LF>, where '#' indicates a block data type, n gives the number of characters that follow, s is the size of the block in bytes (the number of binary data bytes), d represents a binary data byte, and <LF> is a line feed character that signifies the end of the block. Example: A block of 6 bytes: #40006<b0><b1><b2><b3><b4><b5><LF>
boolean	Represents ON|OFF|<NRf>. Has a value of 0 or 1 and is unitless. NRf is rounded to an integer and a non-zero result is interpreted as 1. Queries always return 1 or 0, never ON or OFF.
character_data	Represents character data, that is, A -Z, a -z, 0 -9 and _ (underscore). START and R6_5F are examples of character data. The first character must be an alphanumeric, followed by either alphanumeric or underscore characters up to a maximum of 12 characters. Character data represents a discrete parameter and not an arbitrary string of characters.
error_resp	Error response structure having the form: code,"Description;timestamp", where code is the signed 16-bit error code followed by a comma and then a description string enclosed in double quotes. The description string can be an empty string (""). The timestamp is given as an unsigned integer value representing the number of milliseconds since power-on/reset. Example: -102,"Invalid syntax was found in the command string.;50123" Error code values range from -32768 to 32767.
NAN	Not a number (NAN) is represented as 9.91E37
non-decimal numeric	Represents numeric information in bases other than 10 (i.e. hexadecimal, octal, and binary). Examples of non-decimal numeric include #HA2F, #ha4e, #Q62, #q15, and #B01011
NR1	Signed integer numeric response data. Examples: 123, +456, -789
NR2	Floating point numeric response data without exponent. Examples: 1.23, +4.56, -0.789
NR3	Floating point numeric response data with exponent. Examples: +1.234E+03, +4.567E-06, -78.900E+12
NRf	Denotes a flexible numeric representation. Examples: +200, -56, +9.9E36
numeric_list	Comma separated list of <NR3> elements. All elements in the list have the same data format. For example: +1.234E+03, +4.567E-06, -78.900E+12
numeric_value	Decimal numeric element. Also includes character program data constants defined in SCPI. Includes the following: <NRf>, <NR1>, <NR2>, <NR3>, MINimum, MAXimum, DEFault, UP, DOWN, NAN,INFinity, NINFinity.
string	ASCII character string. Program data encloses a string in single or double quotes. Example "hello" or 'hello'. Response data always encloses a string in double quotes. Example: "A RESPONSE STRING"

C.3 4022A200 POWER SENSOR SCPI COMMANDS

C.3.1 Common.

*CLS

Description: Clear Status Command
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Clears all status structures and forces the device into an idle state. Also clears command and error queues.

*ESE

Description: Standard Event Status Enable Command
Parameter Type: <NRf>
Min: 0 Max: 255 Unit: N/A
Default: 255 Parameter Values: N/A

Notes:

Sets the Standard Event Status Enable Register bits as defined in section 11.5.1.3 of IEEE488.2. This determines which events are enabled.

*ESE?

Description: Standard Event Status Enable Query
Parameter Type: <NR1>
Min: 0 Max: 255 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Get the Standard Event Enable mask which indicates which events are enabled.

*ESR?

Description: Standard Event Status Register Query
Parameter Type: <NR1>
Min: 0 Max: 255 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Get the Standard Event Register which indicates which events have occurred.

*IDN?

Description: Identification Query
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

ASCII character string data having the format: MFG,MODEL,SN,FWREV, where MFG is the company name, MODEL is the product model (and does not contain the word "MODEL"), SN is the product serial number (ASCII character 0 if unavailable), and FWREV is the firmware revision, containing information about all revisable (updateable) systems (ASCII character 0 if unavailable). Maximum string length is 72 characters. For example: BIRD,4022,133900777,FW: 1.1

*OPC

Description: Operation Complete Command
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Request a check for all commands to be executed. For overlapped command synchronization. Can result in no-op if overlapped commands are not used.

*OPC?

Description: Operation Complete Query
Parameter Type: <boolean>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Places a "1" in the output queue after all commands have been executed. For overlapped command synchronization. Can simply return 1 if overlapped commands are not used.

*RST

Description: Reset Command
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Performs a software device reset, placing the device into a known state. Does not clear the output queue or status enable register settings.

*SRE

Description: Service Request Enable Command
Parameter Type: <NRf>
Min: 0 Max: 255 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Not applicable.

*SRE?

Description: Service Request Enable Query
Parameter Type: <NR1>
Min: 0 Max: 255 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Not applicable.

*STB?

Description: Read Status Byte Query
Parameter Type: <NR1>
Min: 0 Max: 255 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Reads the status byte.

Each bit in the status byte has the following significance:

Bit Description

---

0 A bit is set in the Measurement Available condition register.

1 A bit is set in the Measurement Available event register.

2 Error queue is not empty.

3 A bit is set in the Questionable status register.

4 The output queue is not empty. A response message is available.

5 A bit is set in the Standard Event status register.

6 Service request from host controller.

7 A bit is set in the Operational status register.

*TRG

Description: Initiate trigger
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Not applicable.

*TST?

Description: Self-Test Query
Parameter Type: <NR1>
Min: -32767 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Performs a self-test and places the result of the test in the output queue.

*WAI

Description: Wait-to-Continue Command
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

For overlapped command synchronization. Can result in no-op if overlapped commands are not used.

C.3.2 System.

SYSTem:VERSion?

Description: Get the SCPI version.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

SCPI version formatted as an <NR2> response. Has the form: YYYY.V, where YYYY is the year-version and V is the approved revision for the year.

SYSTem:CAPability?

Description: Get device capability.
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Arbitrary 7-bit ASCII response data giving instrument capability. See SCPI-99 section 4, chapter 1.4 "Instrument Classification" for details. For example: (PSENSOR | DIGITIZER | SPSENSOR)

SYSTem:ERRor:COUNt?

Description: Get the number of errors in the error queue.
Parameter Type: <NR1>
Min: 0 Max: 20 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Get the number of errors in the error queue.

SYSTem:ERRor[:NEXT]?

Description: Get the next error from the error queue.
Parameter Type: <error_resp>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Get the next (oldest) entry in the system error queue.

SYSTem:IDENtity:MODel?

Description: Get the device model name.
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Model name as a string value. This is the same model given in the *IDN? response. Example: "4022".

SYSTem:IDENtity:SN?

Description: Get the device serial number.
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Model serial number as a string value. This is the same S/N given in the *IDN? response. Example: "133400777".

SYSTem:IDENtity:MFGDate?

Description: Get the device manufacture date.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Manufacture date as a 32-bit integer value with the format YYYYMMDD. For example January 18th 2013: 20130118

SYSTem:IDENtity:CALDate?

Description: Get the device factory calibration date.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Calibration date as a 32-bit integer value with the format YYYYMMDD. For example January 18th 2013: 20130118

SYSTem:IDENtity:HWRev?

Description: Get the hardware revision(s).
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Hardware revision string. Lists all hardware revisions. Follows the same field rules as the *IDN? response data: 7-bit ASCII byte range 0x20 through 0x7E except commas (0x2C) and semicolons (0x3B). Follows the same field rules as the *IDN? response data: 7-bit ASCII byte range 0x20 through

SYSTem:IDENtity:FWRev?

Description: Get the firmware revision(s).
Parameter Type: <arbitrary_ascii>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Firmware revision strings. Lists all software/firmware/FPGA revisions. Follows the same field rules as the *IDN? response data: 7-bit ASCII byte range 0x20 through 0x7E except commas (0x2C) and semicolons (0x3B).

SYSTem:TIMestamp?

Description: Get the latest system timestamp.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the number of milliseconds since the unit was powered on.

SYSTem:PRESet

Description: Restores factory settings without clearing status or errors.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Restore factory presets, but do not clear status & error messages.

C.3.3 Status.

STATus:PRESet

Description: Restore status to factory presets.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Restores status subsystem and error queue to the factory preset settings.

STATus:OPERation[:EVENt]?

Description: Read the OPER event register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the contents of the Operational Event Register and clears the register.

STATus:OPERation:ENABle

Description: Set the OPER enable register bits.
Parameter Type: <NRf> | <non-decimal numeric>
Min: 0 Max: 65535 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the enable mask which allows conditions in the Operational Event Register to be reported in the

summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true,

a positive transition will occur in the associated summary bit.

STATus:OPERation:ENABle?

Description: Read the OPER enable register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the enable mask which allows conditions in the Operational Event Register to be reported in the

summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true,

a positive transition will occur in the associated summary bit.

STATus:OPERation:CONDition?

Description: Read the OPER condition register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the contents of the condition register associated with the status structure defined in the command. Reading the condition register does not clear it.

STATus:OPERation:NTRansition

Description: Sets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the negative transition filter. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:OPERation:NTRansition?

Description: Gets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the negative transition filter. See STATus:OPERation:NTRansition, OPER Negative Transition Filter Command.

STATus:OPERation:PTRansition

Description: Sets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the positive transition filter. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:OPERation:PTRansition?

Description: Gets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the negative transition filter. See STATus:OPERation:PTRansition, OPER Positive Transition Filter Command.

STATus:QUEStionable[:EVENt]?

Description: Read the QUES event register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the contents of the event register associated with the status structure defined in the command. Note that reading the event register also clears it.

STATus:QUEStionable:ENABle

Description: Set the QUES enable register bits.
Parameter Type: <NRf> | <non-decimal numeric>
Min: 0 Max: 65535 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the enable mask which allows true conditions in the event register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the associated summary bit.

STATus:QUEStionable:ENABle?

Description: Read the QUES enable register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the enable mask which allows true conditions in the event register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the associated summary bit.

STATus:QUEStionable:CONDition?

Description: Read the QUES condition register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the contents of the condition register associated with the status structure defined in the command. Reading the condition register does not clear it.

STATus:QUEStionable:NTRansition

Description: Sets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the negative transition filter. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:QUEStionable:NTRansition?

Description: Gets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the negative transition filter. See STATus:QUEStionable:NTRansition, QUES Negative Transition Filter Command.

STATus:QUEStionable:PTRansition

Description: Sets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the positive transition filter. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:QUEStionable:PTRansition?

Description: Gets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the negative transition filter. See STATus:QUEStionable:PTRansition, QUES Positive Transition Filter Command.

STATus:MEASurement[:EVENt]?

Description: Read the measurement event register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the contents of the event register associated with the status structure defined in the command. Note that reading the event register also clears it.

STATus:MEASurement:ENABle

Description: Set the measurement enable register bits.
Parameter Type: <NRf> | <non-decimal numeric>
Min: 0 Max: 65535 Unit: N/A
Default: 254 Parameter Values: N/A

Notes:

Sets the enable mask which allows true conditions in the event register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the associated summary bit.

STATus:MEASurement:ENABle?

Description: Read the measurement enable register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the enable mask which allows true conditions in the event register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the associated summary bit.

STATus:MEASurement:CONDition?

Description: Read the measurement condition register bits.
Parameter Type: <NR1> | <non-decimal numeric>
Min: 0 Max: 32767 Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the contents of the condition register associated with the status structure defined in the command. Reading the condition register does not clear it.

STATus:MEASurement:NTRansition

Description: Sets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the negative transition filter. Setting a bit in the negative transition filter shall cause a 1 to 0 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:MEASurement:NTRansition?

Description: Gets the negative transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the negative transition filter. See STATus:MEASurement:NTRansition, MEASurement Negative Transition Filter Command.

STATus:MEASurement:PTRansition

Description: Sets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the positive transition filter. Setting a bit in the positive transition filter shall cause a 0 to 1 transition in the corresponding bit of the associated condition register to cause a 1 to be written in the associated bit of the corresponding event register.

STATus:MEASurement:PTRansition?

Description: Gets the positive transition filter.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the positive transition filter. See STATus:MEASurement:PTRansition, MEASurement Positive Transition Filter Command.

C.3.4 Format.

FORMat:SREGister?

Description: Gets the format of the status registers.
Parameter Type: <character_data>
Min: N/A Max: N/A Unit: N/A
Default: 0 Parameter Values: ASCii

Notes:

Gets the format of the status registers. Status registers are always formatted as ASCII.

C.3.5 PnP.

PNP[:AVAilable]?

Description: Bird PnP parameters file availability query.
Parameter Type: <boolean>
Min: N/A Max: N/A Unit: N/A
Default: 1 Parameter Values: N/A

Notes:

Determines if the Bird Plug and Play parameters file is available or not.

PNP:VERSion?

Description: Get Bird PnP version info.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the Bird PnP protocol revision number. Has the format major.minor. Example: 1.19

PNP:ITRansfer

Description: Initiate a PnP file transfer.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Initiates a (read-only) file transfer. This reads file header details into memory and updates the file size and total number of blocks fields. The command is issued once before blocks of file data can be transferred from the device.

PNP:FILE:SIZE?

Description: PnP file size query.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the Plug and Play file size.

PNP:FILE:BLOCk:TOTal?

Description: PnP file transfer total number of blocks.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the total number of blocks for the Plug and Play file transfer.

PNP:FILE:BLOCk:NUMBer

Description: PnP file transfer block number.
Parameter Type: <NRf>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Sets the Plug and Play file block number to transfer.

PNP:FILE:BLOCk:NUMBer?

Description: PnP file transfer block number.
Parameter Type: <NR1>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the Plug and Play file block number to transfer.

PNP:FILE:BLOCk:DATA?

Description: PnP file block data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Gets the Plug and Play file block data.

C.3.6 Factory.

FACTory:USER:UNLock

Description: Unlocks the User calibration commands
Parameter Type: <string>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: k8DjFl2nOvJWrW0g

Notes:

Secondary unlock command to allow end user to calibrate sensor but leave all other factory registers locked.

FACTory:CALibration:POINt

Description: Sets the current calibration point number.
Parameter Type: <NRf>
Min: 1 Max: 1 Unit: N/A
Default: 100 Parameter Values: N/A

Notes:

Specifies the calibration point number. It is a 1-based integer index into the calibration table which specifies the point in the calibration table on which an operation is to be performed. Note that this applies to both the forward and reflected tables, and the operation specifies the table to be operated on.

FACTory:CALibration:POINt?

Description: Gets the current calibration point number.
Parameter Type: <NR1>
Min: 1 Max: 1 Unit: N/A
Default: 100 Parameter Values: N/A

Notes:

Returns the calibration point number. It is a 1-based integer index into the calibration table which specifies the point in the calibration table on which an operation is to be performed.

FACTory:CALibration:POWer

Description: Sets the power level of the current cal point.
Parameter Type: <NRf>
Min: 0 Max: 0 Unit: W
Default: 0 Parameter Values: N/A

Notes:

Specifies the power level for calibration.

FACTory:CALibration:POWer?

Description: Gets the power level of the current cal point.
Parameter Type: <NR2>
Min: 0 Max: 0 Unit: W
Default: 0 Parameter Values: N/A

Notes:

Returns the power level for calibration.

FACTory:CALibration:FREQuency

Description: Specifies the frequency set point.
Parameter Type: <NRf>
Min: 0 Max: 0 Unit: MHZ
Default: 0 Parameter Values: N/A

Notes:

Specifies the frequency for calibration.

FACTory:CALibration:FREQuency?

Description: Gets the frequency set point.
Parameter Type: <NR2>
Min: 0 Max: 0 Unit: MHZ
Default: 0 Parameter Values: N/A

Notes:

Returns the frequency for calibration.

FACTory:CALibration:FORWard:NPO?

Description: Get the total number of forward calibration points.
Parameter Type: <NRf>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

FACTory:CALibration:FORWard:STARt

Description: Begins a calibration of the forward point.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Determines the conversion factor from the forward power applied to the sensor and the power specified by FACTory:CALibration:POWer and adds a point to the forward calibration table for the frequency specified by FACTory:CALibration:FREQuency .

FACTory:CALibration:FORWard:DATA

Description: Sets forward point calibration data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Specifies the frequency and conversion factor for the calibration point specified by FACTory:CALibration:POINt in the forward calibration table. It is sent as the following binary structure contained within a <block_data> parameter:

```
struct {
 float frequencyMHz; // Frequency in MHz
 float wattsPerCount; // Conversion factor in watts/count
};
```

All fields are sent in little-endian byte order with the LSB sent first.

FACTory:CALibration:FORWard:DATA?

Description: Gets forward point calibration data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the frequency and conversion factor for the calibration point specified by FACTory:CALibration:POINt in the forward calibration table. It is recieved as the following binary structure contained within a <block_data> response:

```
struct {
 float frequencyMHz; // Frequency in MHz
 float wattsPerCount; // Conversion factor in watts/count
};
```

All fields are recieved in little-endian byte order with the LSB sent first.

FACTory:CALibration:FORWard:DELete

Description: Delete forward calibration point.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Delete the calibration point specified by FACTory:CALibration:POINt from the forward calibration table.

FACTory:CALibration:REFLected:NPO?

Description: Get the total number of reflected calibration points.
Parameter Type: <NRf>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the total number of forward calibration points.

FACTory:CALibration:REFLected:STARt

Description: Begins a calibration of the reflected point.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Determines the conversion factor from the reflected power applied to the sensor and the power specified by FACTory:CALibration:POWer and adds a point to the reflected calibration table for the frequency specified by FACTory:CALibration:FREQuency .

FACTory:CALibration:REFLected:DATA

Description: Sets reflected point calibraton data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Specifies the frequency and conversion factor for the calibration point specified by FAC-Tory:CALibration:POINt in the reflected calibration table. It is sent as the following binary structure contained within a <block_data> parameter:

```
struct {
 float frequencyMHz; // Frequency in MHz
 float wattsPerCount; // Conversion factor in watts/count
};
```

All fields are sent in little-endian byte order with the LSB sent first.

FACTory:CALibration:REFLected:DATA?

Description: Gets reflected point calibration data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the frequency and conversion factor for the calibration point specified by FACTory:CALibration:POINt in the reflected calibration table. It is recieved as the following binary structure contained within a <block_data> response:

```
struct {
 float frequencyMHz; // Frequency in MHz
 float wattsPerCount; // Conversion factor in watts/count
};
```

All fields are recieved in little-endian byte order with the LSB sent first.

FACTory:CALibration:REFLected:DELete

Description: Delete reflected calibration point.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Delete the calibration point specified by FACTory:CALibration:POINt from the reflected calibration table.

FACTory:CALibration:ZERO:STARt

Description: Begins the zero offset calibration.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Starts a zero offset calibration. This uses the same process as the field zero cal, but the data is stored in a separate (protected) area with the rest of the factory cal data.

FACTory:CALibration:ZERO:DATA

Description: Sets the zero offset calibration data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

FACTory:CALibration:ZERO:DATA?

Description: Gets the zero offset calibration data.
Parameter Type: <block_data>
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Returns the zero offset calibration dataset. The dataset is returned as a binary structure contained within a <block_data> response. All fields are transmitted in little-endian byte order with the LSB sent first. See Zero Calibration Dataset in the Structures worksheet.

FACTory:CALibration:COMMit

Description: Commits all calibration data to storage.
Parameter Type: N/A
Min: N/A Max: N/A Unit: N/A
Default: N/A Parameter Values: N/A

Notes:

Commit calibration data to non-volatile memory.

C.3.7 Measure.

FETCh[:SCALar][:POWer][:FORWard]:AVERage?

Description: Retrieve a forward average power measurement.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: W
Default: N/A Parameter Values: N/A

Notes:

Retrieves the measurement(s) taken by the INITiate command (for the active mode) and places them into the output buffer.

FETCh[:SCALar][:POWer]:REFLected:AVERage?

Description: Retrieve a reflected average power measurement.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: W
Default: N/A Parameter Values: N/A

Notes:

Retrieves the measurement(s) taken by the INITiate command (for the active mode) and places them into the output buffer.

FETCh[:SCALar][:POWer]:FREQuency?

Description: Retrieve a carrier frequency measurement.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: MHZ
Default: N/A Parameter Values: N/A

Notes:

Retrieves the measurement(s) taken by the INITiate command (for the active mode) and places them into the output buffer.

FETCh[:SCALar]:TEMPerature?

Description: Retrieve a temperature measurement.
Parameter Type: <NR2>
Min: N/A Max: N/A Unit: C
Default: N/A Parameter Values: N/A

Notes:

Retrieves the measurement(s) taken by the INITiate command (for the active mode) and places them into the output buffer.

C.4 PROGRAMMING CODE EXAMPLES

The following examples are shown only to aid in development of a customized system for calibration of the sensors contained in the 4022A200-3 Precision RF Test Set. Any program created using these examples should be throughly tested to ensure error free operation. These programming examples were authored in the Python 3 programming language.

Python is a registered trademark of the Python Software Foundation (PSF).

C.4.1 Read Forward Calibration Points. This code example will display the forward calibration points currently stored on the sensor.

```
"""Show forward calibration
"""
import ctypes
import bird.model4022.scpi


class CalData(ctypes.LittleEndianStructure):
    _fields_ = [
            ("frequency_mhz", ctypes.c_float),
            ("watts_per_count", ctypes.c_float * 2),
            ]


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
    # User unlock
    sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')

    # Get the number of forward calibration points
    sensor.send("FACT:CAL:FORW:NPO?")
    result = sensor.receive()
    point_count = int(result)

    # Show all points
    print("index, frequency_mhz, watts_per_count_high_range, watts_per_count_low_range")
    for index in range(point_count):
        # Specify the index of the point
        sensor.send("FACT:CAL:POIN {}".format(index+1))
        # Get the calibration data for the point
        sensor.send("FACT:CAL:FORW:DATA?")
        buffer = sensor.receive_block_data()
        data = CalData.from_buffer_copy(buffer)
        print("{}, {}, {}, {}".format(index, data.frequency_mhz, data.watts_per_count[0], data.watts_per_count[1]))
        index -= 1

finally:
    sensor.close()
```

C.4.2 Read Reflected Calibration Points. This code example will display the reflected calibration points currently stored on the sensor.

```
"""Show reflected calibration
"""
import ctypes
import bird.model4022.scpi


class CalData(ctypes.LittleEndianStructure):
   _fields_ = [
            ("frequency_mhz", ctypes.c_float),
            ("watts_per_count", ctypes.c_float * 2),
            ]


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
   # User unlock
   sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')

   # Get the number of reflected calibration points
   sensor.send("FACT:CAL:REFL:NPO?")
   result = sensor.receive()
   point_count = int(result)

   # Show all points
   print("index, frequency_mhz, watts_per_count_high_range, watts_per_count_low_range")
   for index in range(point_count):
      # Specify the index of the point
      sensor.send("FACT:CAL:POIN {}".format(index+1))
      # Get the calibration data for the point
      sensor.send("FACT:CAL:REFL:DATA?")
      buffer = sensor.receive_block_data()
      data = CalData.from_buffer_copy(buffer)
      print("{}, {}, {}, {}".format(index, data.frequency_mhz, data.watts_per_count[0], data.watts_per_count[1]))
      index -= 1

finally:
   sensor.close()
```

C.4.3 Erase Forward Calibration Points. This code example will erase ALL the forward calibration points currently stored on the sensor.

```
"""Erase forward calibration
"""
import bird.model4022.scpi

sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
   # User unlock
   sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')

   # Get the number of forward calibration points
   sensor.send("FACT:CAL:FORW:NPO?")
   result = sensor.receive()
   point_count = int(result)

   # Delete all points
   index = point_count
   while index > 0:
      # Specify the index of the point to delete
      sensor.send("FACT:CAL:POIN {}".format(index))
      # Delete the point
      sensor.send("FACT:CAL:FORW:DEL")
      index -= 1

   # Commit the changes to non-volatile memory
   sensor.send("FACT:CAL:COMM")
finally:
   sensor.close()
```

C.4.4 Erase Reflected Calibration Points. This code example will erase ALL the reflected calibration points currently stored on the sensor.

```
"""Erase reflected calibration
"""
import bird.model4022.scpi

sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
   # User unlock
   sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')

   # Get the number of reflected calibration points
   sensor.send("FACT:CAL:REFL:NPO?")
   result = sensor.receive()
   point_count = int(result)

   # Delete all points
   index = point_count
   while index > 0:
      # Specify the index of the point to delete
      sensor.send("FACT:CAL:POIN {}".format(index))
      # Delete the point
      sensor.send("FACT:CAL:REFL:DEL")
      index -= 1

   # Commit the changes to non-volatile memory
   sensor.send("FACT:CAL:COMM")
finally:
   sensor.close()
```

C.4.5 Perform Zero Offset Calibration. This code example will calibrate the zero point calibration of sensor. This code assumes no RF power is applied to the sensor input.

CAUTION

Disconnect the sensor input prior to issuing the zero sensor command, any RF at the input to the sensor will invalidate the zero calibration.

```
"""Calibrate Zero
"""
import bird.model4022.scpi


def check_for_errors():
    # Check for errors
    errors = []
    while True:
        sensor.send("SYST:ERR:COUN?")
        result = sensor.receive()
        error_count = int(result)
        if error_count == 0:
            break
        sensor.send("SYST:ERR:NEXT?")
        result = sensor.receive()
        errors.append(result)

    if len(errors) > 0:
        raise Exception("Sensor errors:  {}".format(errors))


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
    check_for_errors()

    # User unlock
    sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')
    check_for_errors()

    # Start calibration
    sensor.send("FACT:CAL:ZERO:STAR\n")

    # Wait until calibration is finished
    sensor.send("*OPC?\n")
    result = sensor.receive(timeout_sec=4)
    check_for_errors()

    # Commit calibration to non-volatile memory
    sensor.send("FACT:CAL:COMM")
    check_for_errors()

finally:
    sensor.close()
```

C.4.6 Read Zero Offset. This code example will display the zero offset calibration currently stored on the sensor.

```
"""Show zero offset calibration
"""
import ctypes
import bird.model4022.scpi


class ZeroOffsetData(ctypes.LittleEndianStructure):
   _fields_ = [
            ("counts", ctypes.c_uint32 * 4)
            ]


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
   # User unlock
   sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')

   sensor.send("FACT:CAL:ZERO:DATA?")
   buffer = sensor.receive_block_data()
   data = ZeroOffsetData.from_buffer_copy(buffer)
   print("channel, zero_offset")
   for index in range(4):
      print("{}, {}".format(index, data.counts[index]))

finally:
   sensor.close()
```

C.4.7 Perform Forward Calibration Point. This code example will create a forward calibration point and store it in the sensor calibration table.

This example will perform a forward calibration for a single frequency, 50 MHz, at 100 watts.

```
"""Calibrate Forward
"""
import bird.model4022.scpi


def check_for_errors():
    # Check for errors
    errors = []
    while True:
        sensor.send("SYST:ERR:COUN?")
        result = sensor.receive()
        error_count = int(result)
        if error_count == 0:
            break
        sensor.send("SYST:ERR:NEXT?")
        result = sensor.receive()
        errors.append(result)

    if len(errors) > 0:
        raise Exception("Sensor errors:  {}".format(errors))


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
    check_for_errors()

    # User unlock
    sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')
    check_for_errors()

    # Set calibration frequency to 50 MHz
    sensor.send("FACT:CAL:FREQ 50")
    check_for_errors()

    # Set calibration power to 100 W
    sensor.send("FACT:CAL:POW 100")
    check_for_errors()

    # Start calibration
    sensor.send("FACT:CAL:FORW:STAR")

    # Wait until calibration is finished
    sensor.send("*OPC?\n")
    result = sensor.receive(timeout_sec=4)
    check_for_errors()

    # Commit calibration to non-volatile memory
    sensor.send("FACT:CAL:COMM")
    check_for_errors()

finally:
    sensor.close()
```

C.4.8 Perform Reflected Calibration Point. This code example will create a reflected calibration point and store it in the sensor calibration table.

This example will perform a reflected calibration for a single frequency, 50 MHz, at 10 watts.

```
"""Calibrate Reflected
"""
import bird.model4022.scpi


def check_for_errors():
   # Check for errors
   errors = []
   while True:
      sensor.send("SYST:ERR:COUN?")
      result = sensor.receive()
      error_count = int(result)
      if error_count == 0:
         break
      sensor.send("SYST:ERR:NEXT?")
      result = sensor.receive()
      errors.append(result)

   if len(errors) > 0:
      raise Exception("Sensor errors:  {}".format(errors))


sensor = bird.model4022.scpi.Scpi()
sensor.open()
try:
   check_for_errors()

   # User unlock
   sensor.send('FACT:USER:UNL \"k8DjFl2nOvJWrW0g\"')
   check_for_errors()

   # Set calibration frequency to 50 MHz
   sensor.send("FACT:CAL:FREQ 50")
   check_for_errors()

   # Set calibration power to 10 W
   sensor.send("FACT:CAL:POW 10")
   check_for_errors()

   # Start calibration
   sensor.send("FACT:CAL:REFL:STAR")

   # Wait until calibration is finished
   sensor.send("*OPC?\n")
   result = sensor.receive(timeout_sec=4)
   check_for_errors()

   # Commit calibration to non-volatile memory
   sensor.send("FACT:CAL:COMM")
   check_for_errors()

finally:
   sensor.close()
```

Appendix D 4421 RF Power Meter Panel Mounting

D.1 PANEL MOUNTING THE 4421 POWER METER

The 4421 Power Meter may be installed in an equipment rack with the optional panel mount kit (refer to "Optional Accessories" on page 1-1). The panel mount kit includes complete installation instructions. Figure D-1 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).

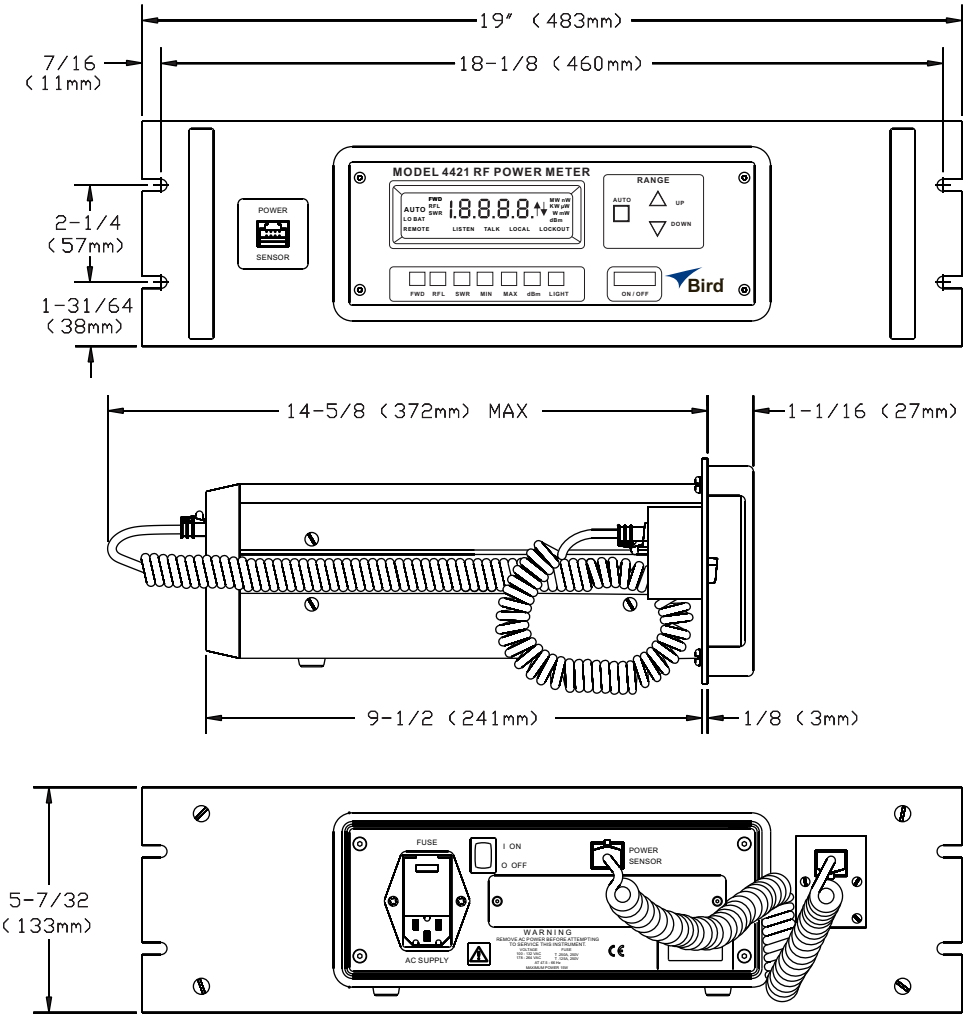


Figure D-1 Panel Mounting Dimensions

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