SMK-3000 Series

RF Calibration Kit

User Manual

Technical Manual Part Number 920-4022A600 Rev B

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

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 15, 17, and 18.

WARNING

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

See page 18.

WARNING

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

See page 18.

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

Only connectors that are in good condition should be used with the RF Power Sensor. Damaged, worn, or improperly fitting connectors could impact the accuracy of field RF measurements.

See page 3 and 19.

CAUTION

Do not exceed the RF Power or RF frequency specifications of the RF Power Sensor.

See page 15.

CAUTION

Do not over tighten the screws. Over tightening will strip the plastic and the screw will not hold the 4421A to the VESA mount.

See page 16 and 21.

CAUTION

Do not use harsh or abrasive detergents for cleaning.

See page 18.

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 19.

CAUTION

Do not store the 4421A outside the following temperature ranges
-10° to 50°C, ≤ 1 month
-10° to 35°C, ≤ 6 months
-10° to 25°C, > 6 months
Storage outside these temperature ranges may degrade battery capacity.

See page 26.

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.

About This Manual

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

SMK-3003A

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

RF Calibration Kit

The Bird RF Calibration Kit is meant for operation wherever RF power must be measured at high accuracy and high power levels. Additionally, the sensors may be used as a standard to calibrate general field power sensors. The RF Calibration Kit may be used to calibrate RF radios, wattmeters, directional couplers and other high-power RF test equipment in the field or metrology lab.

Figure 1 RF Calibration Kit

Items Supplied in the SMK-3003, 3% Accuracy RF Calibration Kit

- Bird RF Power Meter (P/N 4421A-10-11-0)
  - AC Power Cord
  - Sensor Cable
- 1-10 MHz RF Power Sensor (P/N: SMK-3003-LB)
- 10-100 MHz RF Power Sensor (P/N: SMK-3003-MB)
- 100-1000 MHz RF Power Sensor (P/N: SMK-3003-HB)
- User Manual

RF Power Sensor Theory of Operation

The precision directional RF Power Sensor contains all necessary components to provide an accurate measurement of forward and reflected power over the entire specified operating range. They contain the following functional blocks:

RF measurement — The RF Power Sensor uses directional coupler technology and square-law diode detection to measure the RF signals. Excellent coupler directivity allows for accurate separation of forward and reflected power. Square-law detection allows for accurate measurement of true average power for signals of all continuous wave (CW) modulation types, including complex digital modulation.

Frequency sensing — The RF Power Sensor contains a frequency measurement circuit that enables automatic correction of measurements based on frequency specific calibration data that is stored in the sensor during factory calibration.

Microprocessor control — The on-board microprocessor manages all functions of the sensor including data collection, processing, calibration, and communication to external devices. The microprocessor and other circuitry are powered from either of the communication interfaces (USB or serial).

Communication interface — The sensor supports two types of communication interfaces for accessing its power measurements, USB and serial. Connection to the Bird 4421A RF Power Meter is available through the Sensor Input (serial) interface. The 4421A RF Power Meter provides the simplest means of reading measurements from the sensor. Connection to a computer is available through the USB interface, which enumerates as a USB-TMC device. Measurements can be retrieved from the sensor using Standard Commands for Programmable Instruments (SCPI). Some advanced features are also available through the USB interface, such as modifying the factory calibration.

4421A RF Power Meter

The 4421A RF Power Meter is used to display the measurements of the Bird RF Power Sensors in the RF Calibration Kit. The 4421A is equipped with a touchscreen interface.

Figure 2 Bird 4421A RF Power Meter Assembly

One Sensor Operation — The 4421A RF Power Meter will display the RF power measurements of one RF Power Sensor. The sensor may be connected to either of the Sensor connectors, see "4421A Controls and Indicators" on page 6.

Remote Operation — The 4421A's operation may be controlled from a remote computer/controller and RF Sensor measurements from the sensor connected to the 4421A may be received on the remote computer. The remote interfaces include RS-232 and Ethernet.

> **Note:** *There are two protocols supported by the 4421A for remote operation, the legacy 4421 protocol and the new SCPI protocol. Either command protocol may be used to remotely access a single sensor.*

Optional Rack Mount Kit

A rack mounting kit is available for the 4421A, see Appendix 1 on page 29.

RF Power Sensor Equipment Description

The RF Power Sensors are used to measure frequencies between 1 and 1000 MHz at power levels between 1 to 1000 Watts. The power sensors are Thruline® directional power sensors that simultaneously measure forward and reflected power in 50 Ω coaxial transmission lines. Assuming the operating condition of the sensor is within operating specification limits, then the power sensors are accurate to within ± 3% of reading. An identification label affixed to the top of the power sensor indicates power range, specified frequency band, and direction of the forward traveling RF wave.

Display Options

The power sensors may be connected to a Bird 4421A RF Power Meter or a computer.

The Bird 4421A RF Power Meter connects to the sensor using an interface cable that provides a path for serial data communication between the power sensor and the power meter.

A computer connects to the sensor using the USB Interface. The sensor is controlled using Standard Commands for Programmable Instruments (SCPI) language. This interface allows a computer to send requests and receive messages from the sensor without the use of a Power Meter.

Quick-Change Connectors

The RF Power Sensors are equipped with quick-change (QC) type N connectors. The power sensors are shipped from the factory with one male (input) and one female (output) receptacle connector. However, the QC connectors allow connectors of other types to be employed.

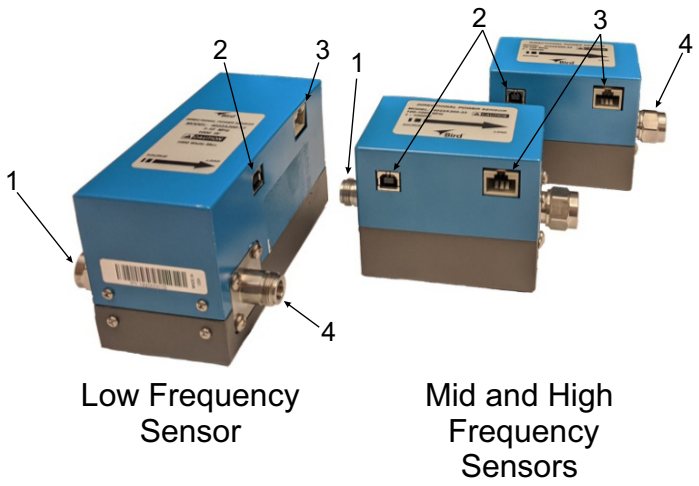
CAUTION

Only connectors that are in good condition should be used with the RF Power Sensor. Damaged, worn, or improperly fitting connectors could impact the accuracy of field RF measurements.

Power Sensor RF / Interface Connectors

The RF Power Sensors have the following connectors.

Figure 3 RF Power Sensor Connectors



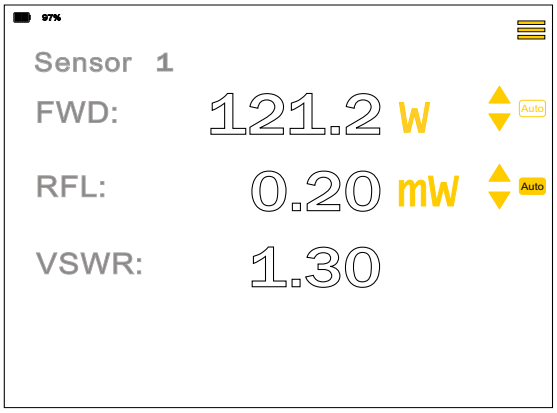
Item	Name	Description
1	RF Input Connector	RF Power Sensors are supplied with N-type, male, RF input connectors.
2	USB Interface Connector	USB interface connector provides the capability of controlling the power sensor using Standard Commands for Programmable Instruments (SCPI) language. This interface allows a computer to send requests and receive messages from the sensor without the use of a power meter.
3	Sensor Input Interface Connector	The Sensor Input interface connector is used to connect the sensor to the 4421A RF Power Meter. The 4421A displays the measurement data from the RF Power Sensors. The 4421A also provides the capability of extending the power sensor operation over an RS-232 data bus.
4	RF Output Connector	RF Power Sensors are supplied with N-type, female, RF output connectors.

4421A RF Power Meter Equipment Description

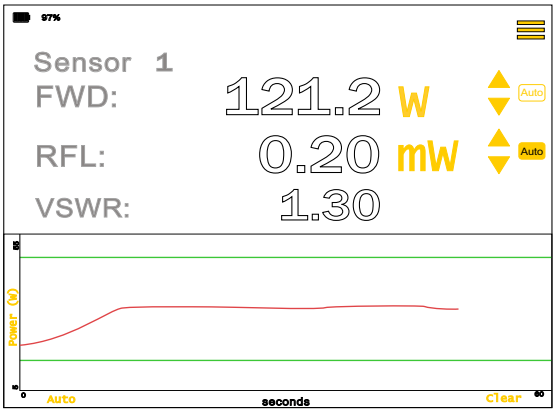
The 4421A RF Power Meter is capable of displaying the measurement information from an RF Power Sensor, see Figure 4. The measurements maybe be displayed alone, or with an accompanying graph. The display may be configured to display the following sensor measurements:

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

Figure 4 Sensor Measurements Display



Sensor Measurement



Sensor Measurement with Graph Displayed

4421A Controls and Indicators

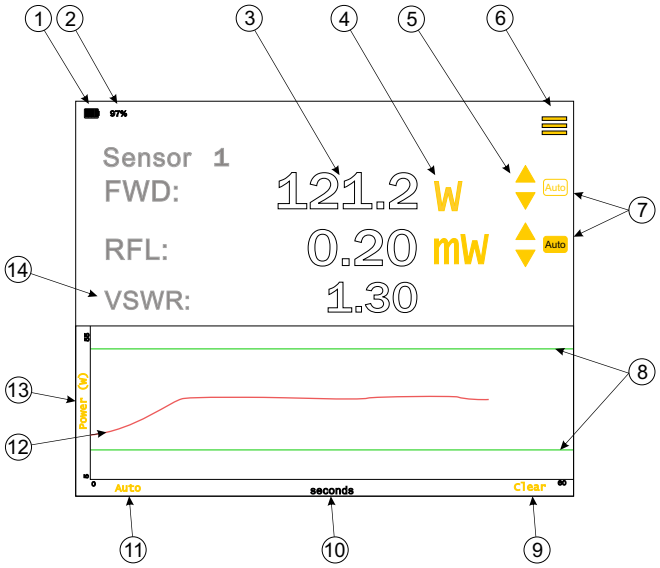
Figure 5 Power Meter

Item	Indicator	Description
1	Display/Touch Screen	Displays RF Power Sensor information and acts as the user interface.
2	Power Switch	Used to apply and remove power from the unit. Illuminated ring indicates power is applied to the unit. • Normal Power ON/OFF - Press and release (short press) the power button. • Forced Power Down - Press and hold (long press) the power button for 3 seconds.
3	AC Power Input Connector	Power input connector (C-14, male), 100-240 VAC, 50-60 Hz, with integrated fuse holder, requires 1A, 5x20mm, slow-blow fuses.
4	LAN Connector	LAN connector provides access to the device's web UI and firmware update capability.
5	Serial Interface	The RS-232 serial Interface allows computer interface capability with the 4421A using either the "4421A SCPI Commands" on page 18 or the"Legacy RS-232 Commands" on page 23. Either command protocol may be used to remotely access a single sensor.
6	Sensor connectors	Two sensor cable connectors. Either connector may be used to connect an RF Power Sensor.

Display Controls and Indicators

The display is used for presenting information and controlling the behavior of the 4421A. The controls are those items displayed on the screen, that, when tapped cause a change in the 4421A's behavior. Controls can be identified by their color, on screen controls are yellow. The table in Figure 6 describes the on screen controls and indicators.

Figure 6 Display Controls



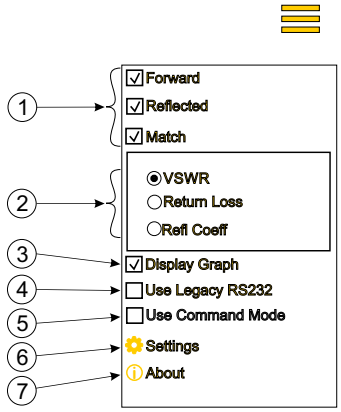
Item	Indicator	Description
1	Battery/AC Power indicator	When connected to AC power, and battery is below 100%, the charge indicator is displayed.  When connected to AC power and battery is fully charged, a facsimile of an AC Power Plug is displayed.  When on battery power, the charge level of the battery in displayed. 
2	Battery Remaining	Indicates the remaining charge of the internal battery.
3	Forward and Reflected Power	The sensor readings for Forward and Reflected power may be displayed in milliwatts, Watts, Kilowatts, or dBm. In overrange situations, the 4421A will display the word "RANGE" in place of the actual power reading. When Reflected power measurement is dBm, -inf dBm means the reflected power was 0 W (exactly).
4	Measurement Unit	The 4421A will display the signal measurements in Watts or dBm.
5	Manual Range Controls	Up and Down arrows are used to change the scale of the displayed power readings. X.xxx mW ↔ X.xxx W ↔ X.xxx KW XX.xx mW ↔ XX.xx W ↔ XX.xx KW XXX.x mW ↔ XXX.x W ↔ XXX.x KW **Note:** *Stops automatic scaling. Auto indicator (item 7) turns off.* **Note:** Manual Range not available when measurement unit is dBm.

6	Settings Menu	The settings menu is used to configure what measurement information is displayed, and to configure LAN and Serial Port settings. See "Settings Menu" on page 9.
7	Auto Range	Auto - When button is on, indicates range scale is set to auto. Auto - When button is off, indicates range scale is in manual control, see item 5. **Note:** *Auto Range not available when measurement unit is dBm.*
8	Limit Lines	Min and max limit lines (green horizontal lines) may be set to display in the graph's display area. The position of the two lines are set in the "Graph Settings Menu" on page 10.
9	Clear	Tapping Clear discards the graph's accumulated data and resets time scale to 60 seconds.
10	Time Scale	The graph's time scale auto expands as data accumulates with the following scales: • 60, 120, 240, 480 seconds • 15, 30, 60, 120, 240 minutes • 8, 16, 24 hours Data accumulation stops at 24 hours. When graph is turned off then back on the accumulated data is discarded and time scale resets to 60 second span.
11	Auto	Tap Auto to adjust the graph's power scale to fit accumulated data.
12	Measurement Trace	Forward Power is plotted on the graph in watts on the vertical axis (y) versus time in the horizontal axis (x). The trace is displayed as a red line. The graph accumulates data at 1 sample/sec as long as a sensor is connected. • If no sensor is connected, accumulation pauses until a sensor is connected. • The graph does not account for any gap while a sensor is disconnected. That is, accumulation will resume as if only 1 second has elapsed since the last sample. • The graph does not account for mixing sensors (i.e. switching sensors in the middle of accumulation). • Plotted data is either raw data or averaged data. Mode is set in the power dialog.
13	Power	Power scale defaults to the min/max power specification for a connected sensor. The measurement unit will match that selected by the measurement unit selection (see item 4). • Power scale may be adjusted automatically (see item 11, Auto) or via the "Graph Settings Menu" on page 10 • Tap to open Graph Settings Menu.
14	VSWR / Return Loss/ Reflection Coefficient	This line on the display can be set to display one of three measurements: VSWR, Return Loss, or Reflection Coefficient. The Settings Menu is used to select which measurement is displayed. +inf will be displayed if Reflected power = Forward power (an uncommon scenario, but could occur with an open circuit).

Settings Menu

The settings menu is used to select what information will appear on the 4421A's display as well as configuration of the LAN and Serial Ports. Figure 7 describes the options available via the setting menu.

Figure 7 Settings Menu

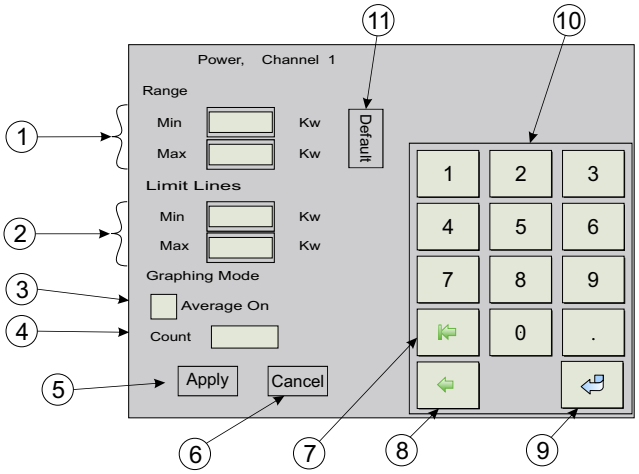


Item	Title	Description
1	Measurements	Check boxes used to select which measurements are displayed for the attached sensor(s).
2	Match Format	Radio buttons used to select the format for the match measurement.
3	Display Graph	When check box is selected, a graph is displayed on the screen with the associated measurements.
4	Use Legacy RS232	When check box is selected, the 4421A will accept the RS-232 command set used with legacy 4421 power meters. See Chapter 6, Legacy RS-232 Commands on page 23.
5	Use Command Mode	Command mode emulates the command mode dip switch setting from the legacy 4421 power meter's RS-232 command set.
6	Settings Icon	When tapped, a menu is displayed for selecting the LAN or Serial configuration menus. • When LAN is tapped, the 4421A's IP address configuration menu is displayed. See "IP Address Settings Display" on page 11. • When Serial is tapped, the 4421A's serial port settings dialog box is displayed. See "Serial Port Setup" on page 12.
7	About	Displays the unit's Model Number, Serial Number, and Firmware ID. Compliance and software licensing information may also be viewed from the About menu.

Graph Settings Menu

The Graph Settings menu is accessed by tapping the power scale on the graph. Figure 8 describes the options in the Graph Settings menu.

Figure 8 Graph Settings Menu



Item	Title	Description
1	Range	Text entry boxes for the entry of Min and Max range for the Power Scale on the Graph. Min and Max values specify the upper and lower limit of the power scale of the graph.
2	Limit Lines	Text entry boxes for the entry of Min and Max value for the limit lines displayed on the Graph. Two horizontal limit lines may be set to user specified levels on the power scale. The Min value sets the location of the lower limit line, while the Max value sets the location of the upper limit line.
3	Average On, Graphing Mode	Graphing Mode allows the measurement results to be displayed either raw or averaged. When Average On is checked, each point plotted on the graph is the arithmetic mean of several raw graph samples.
4	Count, Graphing Mode	Numeric entry for specifying the number of samples used for the moving average. Applied when Average On is selected.
5	Apply	When tapped, applies all menu changes and closes the dialog box.
6	Cancel	When tapped, cancels all menu changes and closes the dialog box.
7	Clear Text	When tapped, clears all characters in a selected text box.
8	Backspace	When tapped, while entering a new value in a text box, deletes the character at the end of the entry. Deletes entire value when highlighted.
9	Enter	Advances cursor to next text entry box without effecting entered values.
10	Keypad	Numerical keypad used to enter values into the various text boxes within the dialog box.
11	Default	When tapped, sets all text entry boxes in the dialog box to default values.

Remote Interfaces

Remote interface capabilities offer control and measurement reporting over the interfaces.

Ethernet Interface

The Ethernet interface uses a standard RJ-45 connector. The Bird 4421A's Ethernet interface serves two purposes.

Webpage User Interface — the webpage user interface provides for firmware updates and touchscreen calibration reset. Features available for this interface are provided in "Web User Interface" on page 20.

Remote Measurement Control — The Ethernet interface allows a remote computer to control the 4421A. Standard Commands for Programmable Instruments (SCPI) commands are used to control the 4421A, see "4421A SCPI Commands" on page 18 or "Legacy RS-232 Commands" on page 23.

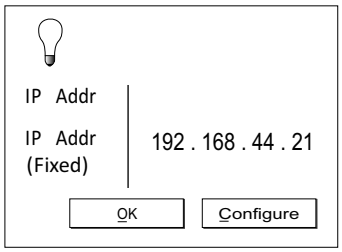
IP Address Settings Display

The LAN option on the Settings menu is used to access the IP Address configuration menu. This menu displays the current IP Addresses for the 4421A.

The 4421A has a dual IP Address configuration.

- Fixed IP Address: 192.168.44.21 (this address cannot be changed)
- Configurable IP Address: DHCP or Static

Figure 9 IP Address Settings Display



See "Configure Static IP Address" on page 21 or "Configure DHCP" on page 22 for procedures to configure IP Address settings.

RS-232 Serial Interface

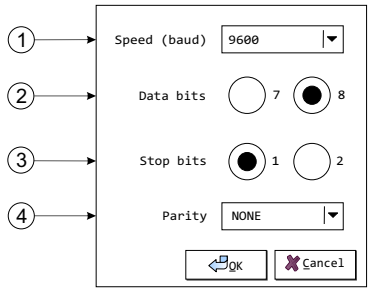
The Bird 4421A's RS-232 interface feature is provided to allow remote measurement control. The RS-232 interface uses a standard 9-pin connector. The commands available for this interface are provided in Chapter 5, 4421A SCPI Commands on page 18.

Serial Port Setup

The Serial option on the Settings menu is used to access the serial port settings menu, see Figure 10.

The Serial Port Settings Menu is used to define serial connection settings.
See "4421A SCPI Commands" on page 18 for details on serial commands.

Figure 10 Serial Port Settings Menu



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

RS-232 Cable Connector

Pin assignments for the serial interface's 9-pin connector are listed in Table 1. The 4421A serial port is wired as a "null modem" with all the handshaking signals looped back. The only active pins are 2 and 3, referenced to ground on pin 5.

Table 1 RS-232 Pin Assignments

Pin	Designation	Notes
1	Carrier Detected	Looped back to pins 4 & 6
2	Transmit Data	Transmit data from 4421A
3	Receive Data	Receive data from host
4	Data Terminal Ready	Looped back to pins 1 & 6
5	Ground	Ground
6	Data Set Ready	Looped back to pins 1 & 4
7	Clear to Send	Looped back to pin 8
8	Request to Send	Looped back to pin 7
9	Ring Indicator	Not connected

The 4421A supports legacy RS-232 commands (used by Bird's legacy 4421 Power Meter) and SCPI compliant commands over RS-232 or Ethernet.

- 4421A SCPI Commands - 4421A SCPI commands used RS-232 or Ethernet interfaces. See "4421A SCPI Commands" on page 18.
- Legacy RS-232 Commands - these commands are used by Bird's legacy 4421 Power Meter, these commands will also work for the 4421A, if the Use Legacy RS232 check box on the settings menu is selected, see "Settings Menu" on page 9.
  See "Legacy RS-232 Commands" on page 23 for available commands.

Chapter 3 Setup

This chapter provides information for unpacking, inspection, and preparing the Bird Power Meter for use.

Unpacking and Inspection

1. Carefully inspect shipping container for signs of damage.
2. Do one of the following:
   - If the shipping container is damaged, do not unpack the unit. Immediately notify the shipping carrier and Bird Electronic Corporation.
   - If the shipping container is not damaged, unpack the unit. Save shipping materials for repackaging.
3. Inspect unit for visual signs of damage.

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

Preparation for Use

Note: The RF Calibration Kit is intended for indoor use only.

Charge the Battery

Note: *The internal batteries have built-in protection against overcharging.*

It is recommended that the batteries be charged before initial use.

- The AC power source required is 100 - 240 V @ 50-60 Hz, 1ϕ, 30 W

1. Place the 4421A Power Meter on a stable work area.
2. Connect Power Cord to AC power input connector on the 4421A.
3. Plug the cable into the AC power source.
4. Turn on the 4421A and make sure the charge icon is displayed.
5. Leave the 4421A on and connected to AC until the first full charge has been reached and the plug icon is displayed.

Note: *This will ensure that the battery remaining % is accurate going forward.*

Setup

Setup consists of ensuring the 4421A has a power source, internal batteries or AC power source, and attaching a Bird Power Sensor.

- Use the 4421A in a dry, dust-free environment.
- AC power source, if used, is 100 - 240 V @ 50/60 Hz, 1ϕ, 30 W.

1. Press the power button on the left side of the 4421A.
2. Connect the sensor cable to one of the sensor cable connectors on the right side of the 4421A. See Figure 11.
3. Connect the remaining end of the sensor cable to a power sensor.

   Note: *The 4421A's display should indicate a sensor has been connected.*

Sensor RF Connections

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

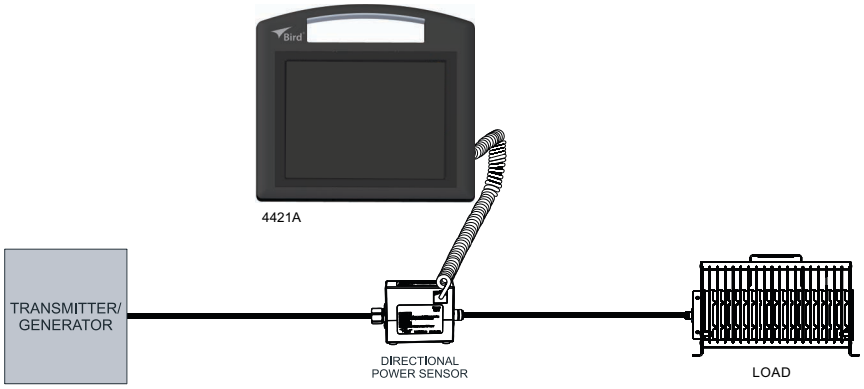
Never attempt to connect or disconnect RF equipment from the transmission line while RF power is applied.
Leaking RF energy is a potential health hazard.

CAUTION

Do not exceed the RF Power or RF frequency specifications of the RF Power Sensor.

1. Disable the output of the RF Source, if required.
2. Connect the RF Power Sensor’s output connector to the load.
3. Connect the RF Power Sensor’s input connector to the RF source.

Figure 11 4421A Connections



VESA Mount

The 4421A is designed to attach a VESA mount with two 75mm spacing holes. There are two screw locations located on the rear of the 4421A enclosure, see Figure 12.

Mounting Hardware

The following hardware is required (not supplied) to mount the 4421A.

- Two screws, thread-Forming, for thin plastic, M2.5 size, 10 mm long
- Two oversized washers, M2.5 screw size, 2.7 mm ID, 8 mm OD
- VESA Mount with 75mm hole spacing

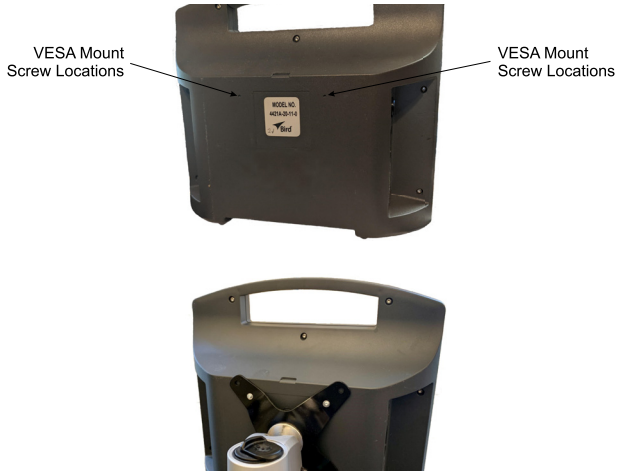
VESA Mount Installation

1. Position the VESA mount on the rear of the 4421A enclosure.
2. Insert the recommended screws into the washers, then drive screws into the indented holes on the rear of the 4421A. The screw will break through a thin plastic barrier.

CAUTION
Do not over tighten the screws. Over tightening will strip the plastic and the screw will not hold the 4421A to the VESA mount.

3. Lightly hand tighten until snug.

Figure 12 VESA Mount



Normal Operation

WARNING

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

Note: *The RF Calibration Kit is intended for indoor use only.*

Power On

Note: *This procedure assumes the RF Power Sensor is already installed in the RF transmission line. See* "Setup" on page 14 *for additional information regarding setup of the 4421A.*

1. Press Power button on the Bird 4421A power meter side panel.
2. The 4421A takes approximately 30 seconds to complete the boot-up sequence.
3. If required, connect the AC power cable to the 4421A.
4. Connect the sensor cable to one of the sensor cable connectors on the right side of the 4421A.
5. Connect the remaining end of the sensor cable to a power sensor.

Note: *The 4421A's display should indicate a sensor has been connected.*

Power Off

1. Press and release the power button for normal power down.
2. If required, disconnect the AC power supply cable.
3. If required, disconnect the sensor cable(s) from the sensor cable connector(s) on the right side of the 4421A.

4421A Standard Commands for Programmable Instruments (SCPI) commands are used to control the 4421A over Ethernet or RS-232 serial interface.

4421A SCPI 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 2 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.	MEASure[:SCALar][:POWer][:FORWard]:AVERage?

Table 3 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: :IDEN :IDENtity Incorrect: :IDENti	SYSTem:IDENtity:FWRev? SYST:IDEN:FWR? 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 "4421A SCPI Commands" on page 20 for more information.	:IDENtity Either :IDEN, :IDENtity, or :IDENTITY is correct.
A colon must be placed between two command mnemonics.	SYSTem:IDENtity:FWRev?
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.	:POW er or MEASure :POWer :AVERage? are not allowed. A <space> between :AVERage? and 1 is mandatory. MEASure :POWer :AVERage? 1

Table 4 Data Types

Data Type	Description	Maps to Internal
<NR1>	Signed integer numeric response data. Examples: 123, +456, -789	PARAM_TYPE_SIGNED_INTEGER
<NR2>	Floating point numeric response data without exponent. Examples: 1.23, +4.56, -0.789	PARAM_TYPE_FLOAT
<arbitrary_ascii>	Arbitrary 7-bit ASCII response data. Not enclosed in quotes.	PARAM_TYPE_ARB_ASCII

4421A SCPI Commands

Common Commands

*IDN?

Description — Identification Query
Parameter Type — <arbitrary_ascii>
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Returns device identification in the following format:

BIRD-TECHNOLOGIES,{model},{serial number},{firmware revision}

Measure Commands

MEASure[:SCALar][:POWer][:FORWard]:AVERage? [1 or 2]

Description — initiate, and retrieve a forward average power measurment. The sensor channel to read (1 or 2) is omitted, channel 1 is returned.
Parameter Type — <NR1>
Parameter Minimum — 1
Parameter Maximum — 2
Parameter Default — 1
Parameter Values —
Parameter Units —
Response — Returns the forward average power in W from the specified sensor channel. Parameter Type: <NR2>, Parameter Units: W.

MEASure[:SCALar][:POWer]:REFLected:AVERage? [1 or 2]

Description — initiate, and retrieve a reflected average power measurement.
Parameter Type — <NR1>
Parameter Minimum — 1
Parameter Maximum — 2
Parameter Default — 1
Parameter Values —
Parameter Units —
Response — Returns the Reflected average power in W from the specified sensor channel. Parameter Type: <NR2>, Parameter Units: W.

System Commands

SYSTem:IDENtity:FWRev?

Description — Get the firmware revision(s).
Parameter Type — <arbitrary_ascii>
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Reads the MCU firmware revision.

SYSTem:IDENtity:MODel?

Description — Get the device model name.
Parameter Type — <arbitrary_ascii>
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Returns the model number as given in the *IDN? response.

SYSTem:IDENtity:SN?

Description — Get the device serial number.
Parameter Type — <arbitrary_ascii>
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Returns the serial number as given in the *IDN? response.

SYSTem:PRESet

Description — Restores factory settings without changing the RS232 or LAN settings.
Parameter Type —
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Restore factory default values for all operating parameters with the exception of the RS232 and LAN parameters.

SYSTem:VERSion?

Description — Get the SCPI version.
Parameter Type — <NR2>
Parameter Minimum —
Parameter Maximum —
Parameter Default —
Parameter Values —
Parameter Units —
Response — Returns the SCPI version.

Chapter 6 Legacy RS-232 Commands

The legacy commands are those commands that are original to the predecessor 4421. To use these commands the Use Legacy RS232 check box on the settings menu is selected, see "Settings Menu" on page 9.

> **Note:** *Measurement commands in the legacy protocol only support one sensor. If two sensors are connected to the 4421A, the measurements will come exclusively from channel 1 (Sensor 1).*

Legacy Command Syntax

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

A group of device-dependent commands can be sent as a single string as long as like command categories are not repeated. For example: “FCT1ENT”. This string sets up the 4421A to read forward carrier wave, make one reading on “T1”, and triggers (ENT) a measurement.

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

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

General Bus Commands

The general bus commands supported by the RS-232 interface module are listed in Table 5.

Table 5 RS-232 General Bus Commands

Command	Effect on Bird 4421
INT	Returns to default conditions
ENT	Sends a reading to the controller

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, deselect the **Use Command Mode** check box on the settings menu. The ENT command will not need to be sent.

Device Dependent Commands

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

Table 6 RS-232 Device Dependent Command Summary

Category	Command	Description
Measurement	FC	Forward carrier wave
	RC	Reflected carrier wave
Range	RYY	Auto range on[1]
Terminators	YT	Two terminators: CR, LF1
Prefixes	PY	Prefix YES1
Triggers	T1	One shot on ENT
	T5	One shot on measurement command

1 dummy command, the setting they control has only one option.

Forward **C**arrier Wave (FC)
Reflected **C**arrier Wave (RC)

Function Selects forward or reflected RF power measurement mode.

Remarks Measurement results are returned in Watts.

Range (RYY)

Function Sets the 4421A to auto range, legacy command to provide compatibility with previous 4421 units.

Remarks Auto is the only range setting available.

Terminators (YT)

Function Selects the characters that follow the end of a data string. YT indicates for two terminators; a carriage return (CR) and a line feed (LF).

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

Prefixes (PY)

Function Turns the prefix mode on.

Remarks Prefixes are sent over the bus with the measurement, and indicate the status of the current measurement (see Table 7 for examples):

- "FC","RC" 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 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
`URC .000W(CR)(LF)`	Underflowed (U) reflected carrier wave (RC), prefixes on

Triggers (Tx)

Function Selects the condition which will trigger a reading (see Table 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 8 Trigger Conditions

Command	Trigger Condition
T1	One shot on ENT
T5	One shot on measurement command (FC, FD, RC, RD, SW, RL, MN, MX)

Bird 4421A Power Meter Specifications

Note: The RF Calibration Kit is intended for indoor use only.

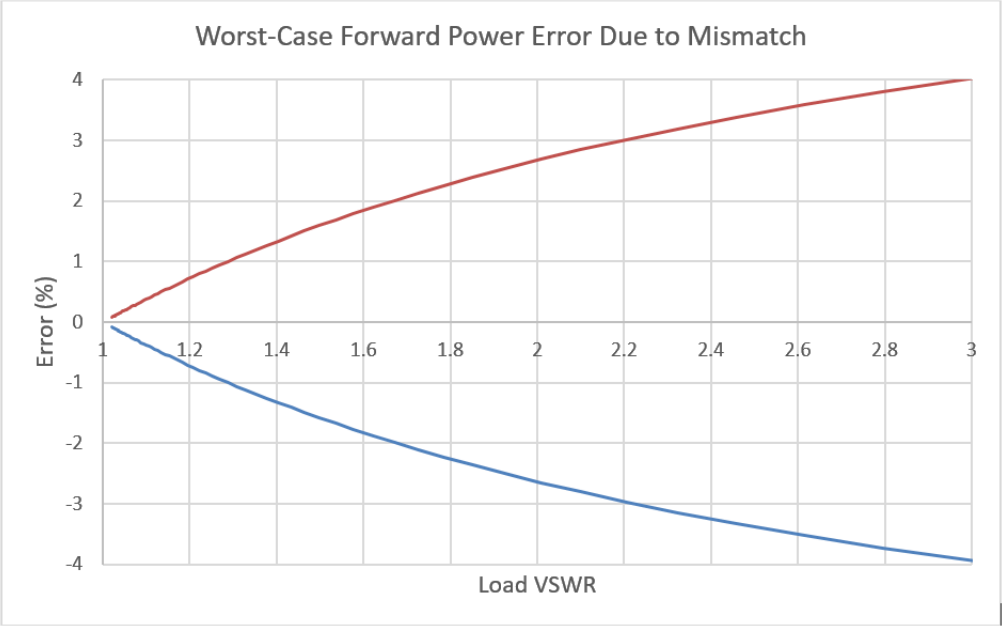
Compatible Bird Power Sensors	4021, 4022, 4023, 4024, 4025, 4027, 4028, SMK-3003-XX
Sensor Detection	Automatic Sensor detection
Dual sensor support	Two sensors may be connected and measurements displayed simultaneously. **Note:** *Dual-sensor support requires dual-sensor license is purchased and activated.*
Connection to sensor	Wired
Display	
Type	9.7" TFT full color LCD (LED back light), touch screen
Resolution	1024x768
Calibration interval	Not required
I/O Connectors RS-485 (Sensor) Ethernet Serial, RS-232	 2 1 1
Environment	
Operating Temperature	0° to 40° C (32° to 104° F)
Storage Temperature	-10° to 50°C, ≤ 1 month -10° to 35°C, ≤ 6 months -10° to 25°C, > 6 months **Note:** *Storage temperature limited by battery specification. Storage outside this range may degrade battery capacity. For best performance, a full recharge is recommended every 6 months or if stored below 0°C.*
Operating Relative Humidity	95% Max (non condensing)
Max Operating Altitude	6400 m
AC/DC Power Supply	
Input Voltage	100 - 240 V @ 50-60 Hz, 1ϕ, 30 W.
Main Supply Voltage Fluctuations	± 10 %
Over-voltage Category	Category II
Pollution Degree	2
Certifications	MIL28800 CLASS 4; SGS
Physical Characteristics	
Dimensions, nominal:	H x W x D 9 11/16 in. x 10 5/8 in. x 3 37/64 in. (246 mm x 270 mm x 91 mm)

Power Sensor Specifications

Electrical Specifications	
Connectors Input Output	 Type-N male, hexagonal, QC, Changeable Type-N female, QC, Changeable
Frequency Range SMK-3003-LB SMK-3003-MB SMK-3003-HB	 1 – 10 MHz 10 – 100 MHz 100 – 1000 MHz
Power Range	1W - 1000W
Directivity	28 dB
Insertion Loss	<0.05 dB
Insertion VSWR	< 1.10
Impedance	50 Ohms
Measurement Specifications	
Note: Sensor accuracy can change with load VSWR, See Figure 13 on page 28.	
Forward Power, Accuracy, k=2	3% of reading†
Conditions for Measurement Harmonics	 < 35 dBc
Calibration Plane	Output Connector
Reflected Power, Accuracy, k=2	3% of reading†
VSWR Measurement Range	-27 dB to -10 dB
Environmental	
Temperature Operating Range Storage Range	 32° to 122° F (0° to 50° C) -4° to 158° F (-20° to 70° C)
Humidity, Operating	95%, non-condensing
Weight SMK-3003-LB SMK-3003-MB, SMK-3003-HB	 2.30 lbs (1.04 kg) 1.50 lbs (0.68 kg)
Dimensions, Max SMK-3003-LB SMK-3003-MB, SMK-3003-HB	L x W x H, Inches (mm) 5-17/32 x 2-17/32 x 3-15/32 (140 x 64 x 88) 3-47/64 x 2-1/2 x 3-9/32(95 x 64 x 83)

† The measurement accuracy includes the factory calibration uncertainty, 1 year of drift, short term repeatability, and temperature affects over the specified range.

Figure 13 Sensor Accuracy Vs. Load VSWR



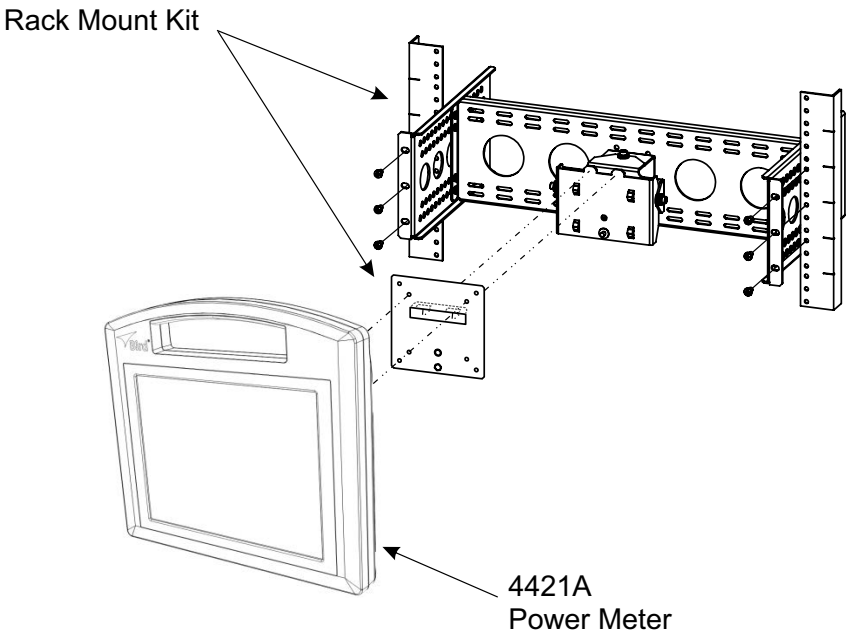
4421A Rack Mounting Kit

The Bird 4421A Rack Mounting Kit lets you mount the 4421A into any EIA standard 19" rack. The pan/tilt feature allows four direction movement of the 4421A, making it easy to find the perfect viewing angle.

The 4421A can be mounted anywhere from 1/2" up to 9-1/2" depth in a rack in increments of 1/4".

All Rack Mount assembly hardware and rack mounting hardware is included.

Figure 14 Rack Mount Kit



After the Rack Mounting kit is installed in a rack, the 4421A can be removed and reinstalled without the use of any tools.

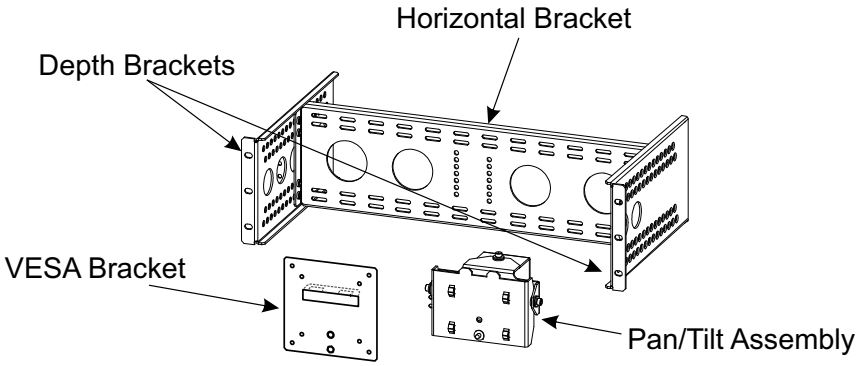
Rack Mount Kit Assembly

This section provides unpacking, inspection, and assembly instructions for the 4421A Rack Mount Kit.

Rack Mount Kit Contents

The Rack mount kit includes the brackets and sub-assembly shown in Figure 15 and attaching hardware listed below.

Figure 15 Rack Kit Contents



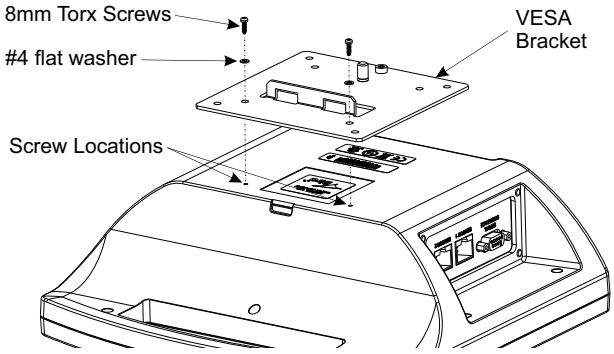
Assembly Instructions

Attaching Hardware	Quantity	Description
VESA Bracket Hardware	3	#4 flat washers
	3	8mm Torx Screws
Assembly Hardware	2	10-32 Pan Head Screws
	4	10-32 Flat Head Screws
Rack Mount Hardware	8	12-24 Square Nuts
	8	12-24 Cage Nuts (Black)
	8	12-24 Pan Head Screws
	8	10-32 Pan Head Screws

Attach VESA Bracket to the 4421A

1. Lay the 4421A face down on a flat work surface.
2. Position the VESA bracket on the rear panel of the 4421A enclosure. See Figure 16.

Figure 16 Attach VESA Bracket



3. Insert the screws into the washers, then drive screws into the indented holes on the rear of the 4421A. The screw will break through a thin plastic barrier.

> **CAUTION**
>
> Do not over tighten the screws. Over tightening will strip the plastic and the screw will not hold the 4421A to the VESA bracket.

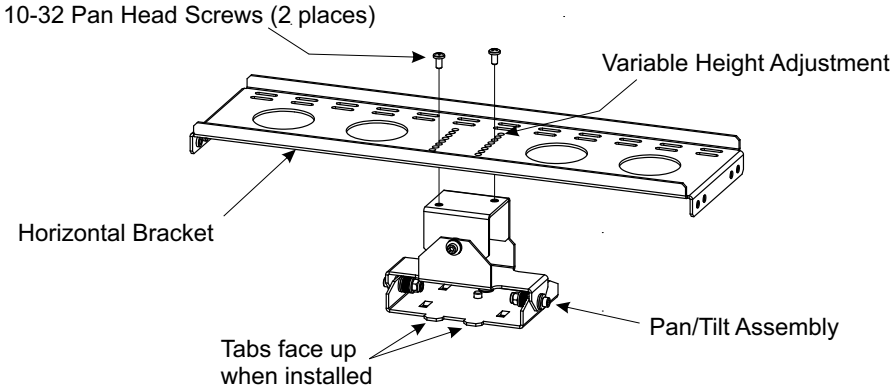
4. Lightly hand tighten until snug.

Rack Kit Assembly

Pan/Tilt Assembly Attachment

1. Lay the Pan/Tilt Assembly face down on a flat work surface, see Figure 17.

Figure 17 Pan/Tilt Assembly Attachment



2. Position the Horizontal Bracket over the Pan/Tilt Assembly.

   Note: *Multiple holes in the Horizontal Bracket allow for the vertical adjustment of the 4421A position when installed in the rack.*

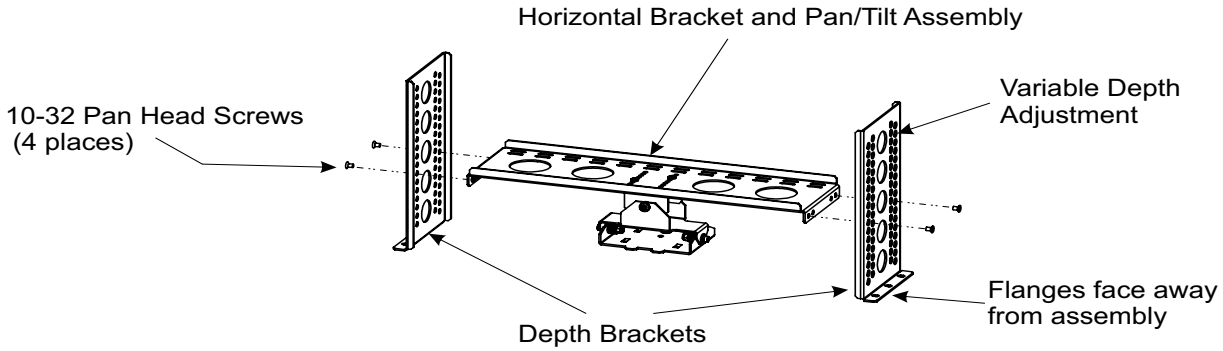
3. Align holes in the Horizontal Bracket, at the desired vertical height, with the threaded holes in the Pan/Tilt Assembly.
4. Install two 10-32 Pan Head Screws.

Depth Bracket Attachment

Note: *The holes in the Depth Brackets determine how far into the rack the 4421A will be when mounted to the Rack Mount Assembly.*

1. Secure one of the Depth Brackets to the Horizontal Bracket using two 10-32 Flat Head Screws.
2. Secure remaining Depth Bracket to the Horizontal Bracket using two 10-32 Flat Head Screws. Ensure same depth measurement is used for both Depth Brackets.

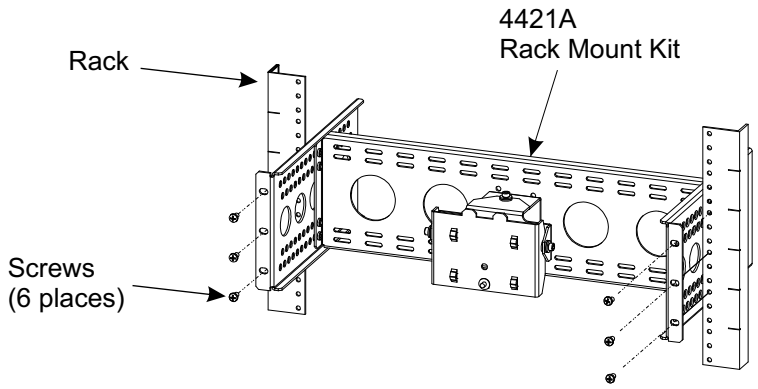
Figure 18 Depth Bracket Attachment



Rack Installation

Attach the Assembly to the Rack using six (6) of the appropriate Rack Mounting Hardware.

Figure 19 Rack Instalation



The Rack Hardware Kit provides various screws and nuts for the four most common types of racks.

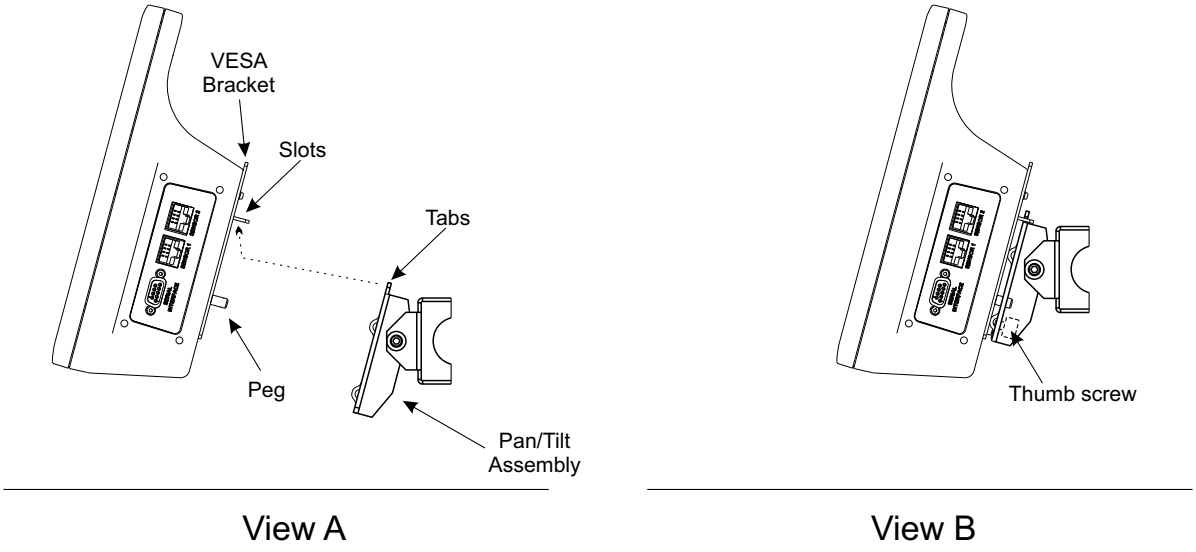
- Square Hole Racks: Install Cage Nuts in appropriate positions. Attach with the larger 12-24 Screws.
- Round Hole Racks (non-threaded): Attach with the larger 12-24 Screws and the square nuts.
- 12-24 Threaded Racks: Attach with the larger 12-24 Screws.
- 10-32 Threaded Racks: Attach with the smaller 10-32 Screws.

Attach 4421A to Rack Mount

The VESA bracket attached to the 4421A allows the unit to easily connect and disconnect with the rack mount.

1. Position the slots on the 4421A VESA Mount over the tabs on the top of the Pan/Tilt Assembly.

Figure 20 Attach 4421A to Rack Mount



2. Insert the peg on the VESA Mount into the hole on the Pan/Tilt Assembly.
3. Tighten the Thumb Screw on the back of the Pan/Tilt Assembly to secure the 4421A to the Rack Mount Assembly.

Limited Warranty

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

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

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. Routine (regularly required) calibration is not covered under this limited warranty. In addition, Seller's warranties do not extend to the failure of tubes, transistors, fuses and batteries, or to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to Seller.

The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu of all other remedies including claims for special or consequential damages. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR SELLER ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.