Stat Power Sensor
Model 7022

Operation Manual

Instruction Book Part Number 920-7022 Rev. E

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 uniterruptible 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.

Safety Symbols

WARNING

Warning notes call attention to a procedure, which if not correctly performed, could result in personal injury.

CAUTION

Caution notes call attention to a procedure, which if not correctly performed, could result in damage to the instrument.

Note: *Calls attention to supplemental information.*

Warning Statements

The following safety warnings appear in the text where there is danger to operating and maintenance personnel, and are repeated here for emphasis.

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

On page 3.

Safety Statements

USAGE

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

USO

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

BENUTZUNG

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

UTILISATION

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

IMPIEGO

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

SERVICE

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

SERVICIO

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

WARTUNG

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL. ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SIND WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

ENTRENTIEN

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

ASSISTENZA TECNICA

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

About This Manual

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

7022-1-020201

Changes to this Manual

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

Literature Contents

Chapter Layout

Introduction — Describes the features of the Statistical Power Sensor.

Installation — Describes how to connect and install the Statistical Power Sensor into the system that is being monitored.

Operation — Describes how to run and maintain the Statistical Power Sensor.

Specifications — Describes the basic information, settings, and ranges of the Statistical Power Sensor.

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Chapter 1 Introduction

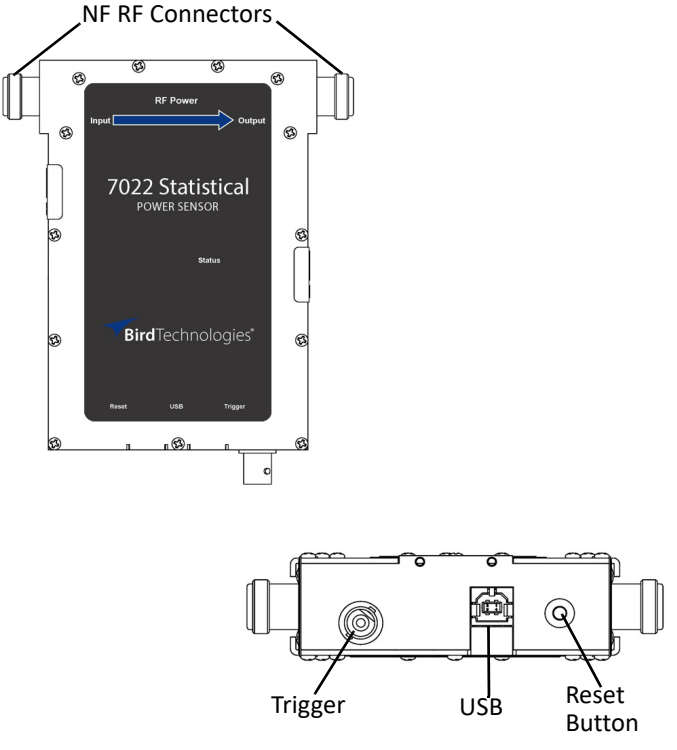
Description

The Bird Statistical Power Sensor (SPS) is a Thruline sensor that can measure Average, Real Time, Peak and Statistical. It is used with the Bird Virtual Power Meter Software (VPM3) or with the Bird RF meter App.

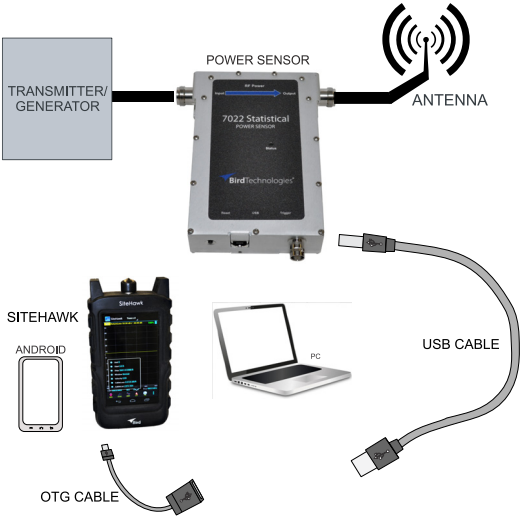
> **Note:** *Firmware upgrades extending the SPS's capabilities may be periodically released. For the latest firmware upgrade, contact Bird Customer Service at 866-695-4569 or visit our website at http://www.birdrf.com*

Outline

Figure 1 Sensor Outline



Connections



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.

Note: *Connect the SPS to the RF line so that the arrow on the sensor points towards the load/ antenna.*

To connect using the USB port, connect the USB cable between the computer and the SPS. A separate power supply is *not* required when using the USB port.

Zeroing Sensor

Note: *This procedures uses VPM3.*

1. Check that no RF is in the system.

   Note: *The sensor will read "~0."*

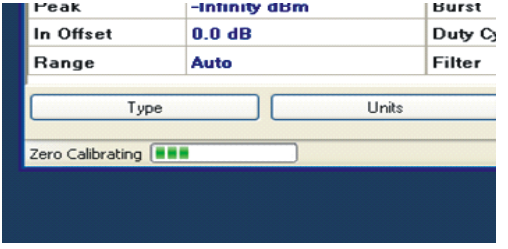
2. Do one of the following:
   - Press the Amplitude menu button.
   - Go to the Amplitude menu item.
3. Press the Zero menu key.

   Note: *Zeroing will take about 10 seconds. A progress bar for the calibration will be displayed on the screen.*

   Note: *If the calibration is interrupted for any reason, the sensor will need to be re-zeroed.*

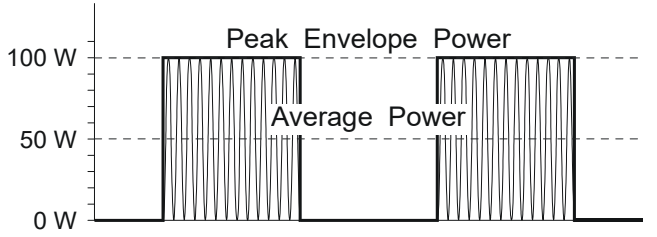
4. Press "Run" to resume data collection with the new Zero offset.

Figure 2 Zeroing Sensor



Function Descriptions

Figure 3 Average and Peak Envelope Power - Square Wave Signal



Average Power

Diodes and “square law” output is directly proportional to the average power, which provides the measure of the equivalent heating power of a signal, as measured with a calorimeter. The measurement is the total RF power in the system, and does not depend on the number of carriers or modulation scheme. The statistical power sensor measures forward and reflected power so that VSWR, return loss or Rho (reflection coefficient) can be displayed.

Statistical Power

Most modern wireless communication systems employ complex modulation methods like orthogonal frequency division multiplexing (OFDM) or Quadrature Amplitude Modulation (QAM). These methods use a combination amplitude, frequency, or phase to create symbol based multichannel or multi-carrier systems that result in pseudorandom or noise-like power envelops. The peak-to-average power ratio of such a waveform can be a complex function of the data stream content rather than just amplitude. Since digitally modulated signals often appear noise-like, statistical analysis may be used in order to characterize them.

The Statistical Power Sensor collects samples of the envelope of a carrier and accumulates them in a series of bins. This information is useful for qualitative assessment of complex waveforms that have a finite number of discrete amplitude levels, like QAM.

A more useful measurement is one that shows how often various power levels occur as a percentage of data ensemble length. This is done by calculating the cumulative distribution function (CDF) from the PDF.

- **CDF -** Shows the probability in percent that the measured power is less than or equal to a specified power level.
- **Complementary CDF (CCDF) -** The probability that the measured power is greater than a specified power level.
- **Crest Factor -** Peak-to-average ratio, or Crest Factor, displays the number of samples analyzed, elapsed time, and confidence band.

Time Domain Mode

The Statistical Power Sensor time domain mode operates very much like a modern digital oscilloscope that has its vertical axis accurately calibrated in power. Time base and trigger functions are available to present a stable time domain graphic that permits markers to be set to display.

- Peak (Envelope) Power
- Burst Power
- Power at Marker
- Power between Markers
- IIEE Thirteen Pulse Related Parametric Measurements (rise time, overshoot, fall time, etc.)

LED Codes

LED Code	Condition	Action
Solid **Red**	Fatal Error	Return for service.
Slow Blink **Red**	Device Error	Return for service.
Fast Blink **Red**	Storage Media Error	Return for service.
Red/Green Slow Blink	Cal Memory Error	Return for service.
Red/Yellow Slow Blink	Config Memory Error	Return for service.
Solid **Green**	Ready	Device is ready to execute commands.

LED Code	Condition	Action
Solid **Blue**	Loading FPGA	Normally displays for less than 30 seconds when sensor is started. Otherwise return for service.
Fast Blinking **Blue**	FPGA Self Test Failed	Return for service.
Blue/White Slow Blink	FPGA Prog Init Error	Return for service.
Blue/Red Slow Blink	Failed to Load FPGA	Update the firmware, see "Updating the Sensor Firmware" on page 9. If problem persists, return for service.
Blue/Magenta Slow Blink	FPGA Register Failure	Return for service
Slow Blink **Yellow**	Execution Error	Invalid command or parameter value. Cycle power.
Fast Blink **Magenta**	Insufficient Memory	Sensor is waiting for a firmware update. See "Updating the Sensor Firmware" on page 9. If an update is not desired, disconnect then reconnect the USB cable. Ensure the button is not pressed.

Updating the Sensor Firmware

1. Go to http://www.birdrf.com/
2. Download new version of firmware.
3. Connect the sensor to a PC via the USB cable.
4. Press and hold the Reset button.

   Note: *This will switch the sensor to bootloader mode.*

   Note: *The firmware/FPGA version to be updated to the sensor will show in the "Update Version" field.*

5. Click the "Details" button to display detail message in the message screen.
6. Click the "Update" button will start to update in the order firmware first then FPGA.

   Note: *The progress bar will indicate the progress.*

   Note: *Right after the firmware update finishes it expects a long time delay before updating FPGA as the sensor will restart and reload FPGA. It may take more than 3 mins to finish FPGA update depending on the size of FPGA image.*

   Note: *Right after FPGA completing, the sensor version number will be read back and show in the "Sensor Version" field to replace "Unavailable" to complete entire update.*

7. Close the Application.
8. Disconnect the sensor from the PC.

Chapter 4 Specifications

7022-1-020201 Specifications

Sensor Characteristics

Frequency Range	350 MHz to 6 GHz
RF Power Range	0.25 W to 500 W average, 1500 W peak
Maximum Power	See "Max. Peak Power" on page 12.
Impedance, Nominal	50 ohms
Insertion Loss, Max	0.05
Input VSWR, Max	1.065, 350 to 2500 MHz 1.12, 2500 to 6000 MHz
Directivity, Min	-30 dB, 350 to 1000 MHz -28dB, 1000 to 4000 MHz -24dB, 4000 to 6000 MHz
RF Connectors	N Female
Interface	USB 2.0 Type B
Power Supply: USB Port DC Connector	 Less than one high-power USB load 7 – 18 VDC, < 500 mA
Data Logging	In VPM3 Software

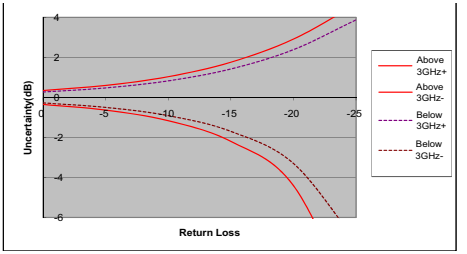
Average Power

RF Power Range	0.25 – 500 W
Peak/Average Ratio, Max	12 dB
Measurement Accuracy.	± 3 MHz with CW signals

Statistical Power

Measurement Range:	
Return Loss	0 to 23 dB
Rho (ρ)	0.07 to 0.999
VSWR	1.15 to 99.9
Forward Power, Min	.5 W
Measurement Accuracy	See Figure 4 on page 11.

Figure 4 Match Measure Uncertainty



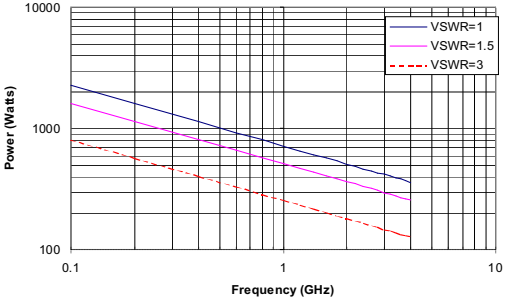
Time Domain

RF Power Range	4.0 – 400 W[a]
Measurement Accuracy.:	
burst width > 200 µs	± (7% of reading + 0.2 W)[b]
1 µs < b.w. < 200 µs	± (10% of reading + 0.4 W)[b]
burst width < 1 µs	± (15% of reading + 0.4 W)[b]
burst width < 0.5 µs	± (20% of reading + 0.4 W)[b]
Minimum Pulse Width:	400 ns

a. Max. power depends on frequency and system VSWR. See Figure 5 on page 12.

b. Above 35 °C or below 15 °C add 3%
For D < 0.1 add 0.1 W
For period > 0.1s add (1.5% + 0.15 W)

Figure 5 Max. Peak Power

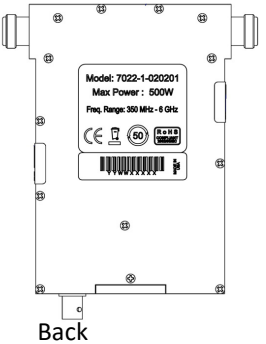


Physical and Environmental Specifications

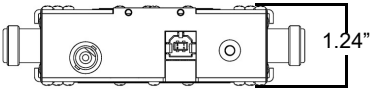
Temp, Operating	–10 to +50 °C (+14 to +122 °F)
Temp, Storage	–40 to +80 °C (–40 to +176 °F)
Mechanical Shock and Vibration	IAW MIL-PRF-28800F class 3
Humidity, Max	95% (non-condensing)
Altitude, Max	15,000 ft. (4,500 m)
Dimensions, Nominal	3.79” x 5.36” x 1.24” (96 x 163 x 37.7 cm)
Weight, Max	1.5 lb. (0.68 kg)
CE Mark	Compliant
RoHS	Compliant
EMC	EMC Directive (2004/108/EC) European Standard: EN 61326— Electrical Equipment for measurement, control and laboratory use.


3.79”
RF Power
Input
Output
7022 Statistical
POWER SENSOR
Status
BirdTechnologies
Reset
USB
Trigger
5.36”

Front


Model: 7022-1-020201
Max Power : 500W
Freq. Range: 350 MHz - 6 GHz
50
RoHS

Back


1.24”

Limited Warranty

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

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

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

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