INSTRUCTION SHEET

WIDEBAND POWER SENSOR
MODEL 5012

Instruction Book P/N 920-5012 Rev. A

Description

The Bird 5012 Wideband Power Sensor (WPS) is a Thruline sensor that can measure average, peak, or burst power, VSWR, crest factor, and Complementary Cumulative Distribution Function (CCDF). It can be used with the Bird 5000-EX Digital Power Meter (DPM) and the Bird Virtual Power Meter Software (VPM).

☞ NOTE: Firmware upgrades extending the WPS's capabilities may be periodically released. For the latest firmware upgrade, contact Bird Customer Service at (440) 248-1200 or visit our website at *http://www.bird-electronic.com*

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.

To connect the WPS to the Digital Power Meter, use the serial cable provided. Connect the male end of the cable to the DPM and the female end to the WPS. A separate power supply for the WPS is *not* required when using a DPM.

There are two ways to connect the WPS to a PC running the Virtual Power Meter Software:

- To connect using the serial port, first connect a 12V DC power supply to the WPS. Once the STATUS LED turns on and begins blinking, use the serial cable provided and connect the female end of the cable to the computer and the male end to the WPS. The WPS *must* be powered up before connecting to the PC.
- To connect using the USB port, connect the USB cable to the computer and to the WPS. A separate power supply is *not* required when using the USB port.

☞ NOTE: When using the optional serial to USB adapter, connect the WPS serial port to the adapter's serial port, and the adapter's USB connector to the PC.

Zeroing Sensor

Over time, the sensor's "zero value" (reading with no applied RF power) can drift, making all readings inaccurate by this value. For example, if the zero value is –0.02 W, measuring a 50 W signal will give a reading of 49.98 W, a 0.04% error. Measuring a 1 W signal will give a reading of 0.98 W, a 2% error. If the drift would be a significant error, rezero the sensor:

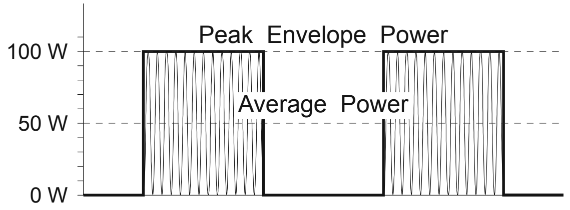
- Make sure the sensor has reached a stable operating temperature.
- Make sure no RF power is applied to the sensor.
- Press "Zero". Calibration will begin.
- Calibration will take about 30 seconds. *Do not interrupt the calibration!* A bar on the screen will display calibration progress.
- After successful calibration, "Cal Pass" or "Calibration Complete" will be displayed. Press any key to return to normal operation.
- If calibration fails, "Cal Fail" will be displayed. Press a key to return to normal operation, then check that the WPS is properly connected, and that the RF is off. Rezero.

Function Descriptions

Figure 1

Average and Peak Envelope Power

Square Wave Signal



Average Power

Average power is a measure of the equivalent "heating" power of a signal, as measured with a calorimeter. It measures the total RF power in the system, and does not depend on number of carriers or modulation scheme. The WPS is a broadband sensor that measures power across its entire frequency range. Its diodes operate in their 'square law' region so that the detector output is directly proportional to the average power, without any additional error correction.

Average power is the most important measurement of any transmission system since the average power is normally specified on the operating license. It is also valuable as a maintenance tool, showing overall system health, and for calibration.

VSWR

VSWR measures the relation between forward and reflected average power. The Bird Wideband Power Sensor calculates the VSWR from the Forward and Reflected Average Power measurements. Rho and Return Loss are also the same measurement, but in different units:

$$\text{Rho } (\rho) = \sqrt{P_F / P_R} \quad , \quad \text{VSWR} = \frac{1+\rho}{1-\rho} \quad \text{, and}$$

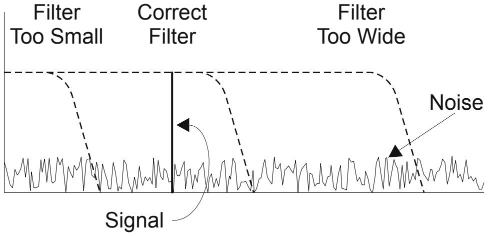
$$\text{Return Loss (dB)} = 20 \times \log \rho$$

The health of the feedline and antenna systems can be monitored using VSWR measurement under full power operating conditions. High VSWR is an indicator of feed line damage, overtightened cable or feed line clamps, or antenna changes/damage due to weather conditions, icing, or structural damage to the tower.

Video Filter

Figure 2

Video Filter Settings, 300 kHz Signal



Except for average power and VSWR measurements, all WPS measurements rely on a variable video filter to improve accuracy. This filter can be set to either 4.5 kHz, 400 kHz, or full bandwidth. It should be as narrow as possible while still being larger than the demodulated signal bandwidth (video bandwidth). Narrowing the filter limits the noise contribution caused by interfering signals. Listed below are some common modulation schemes and the appropriate video filter.

Video Filter	Modulation Type
4.5 kHz	CW Burst (Burst width > 150 µs), Voice Band AM, FM, Phase Modulation, Tetra
400 kHz	CW Burst (b.w. > 3 µs), GSM, 50 kHz AM, DQPSK
Full Bandwidth	CW Burst (b.w. > 200 ns), CDMA, WCDMA, DQPSK, DAB/DVB-T

Peak Envelope Power

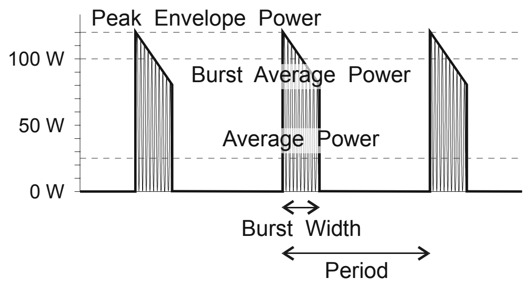
Peak power measurements detect amplitude changes as a signal modulates the carrier envelope. The WPS operates in an asynchronous cycle: 300 ms of waveform sampling followed by a 50 ms reset period. The peak power is then displayed and the cycle repeats. The display therefore updates about three times per second.

Transmitter overdrive can be detected with peak measurements. Common problems are overshoot at the beginning of burst packets, amplitude modulation, and excessive transients. These damage system components with excessive peak power and also cause data degradation, increasing the Bit Error Rate. For TDMA applications, Peak and Burst Power measurements are used to detect overshoot in single timeslots. Other timeslots must be turned off for this test.

Burst Average Power

Figure 3

Burst Average Power



Burst width (BW) is the duration of a pulse. Period (P) is the time from the start of one pulse to the start of the next pulse. Duty cycle (D) is the percentage of time that the transmitter is on. To calculate the duty cycle simply divide the burst width by the period (D = BW / P). Low duty cycles mean that the burst width is much less than the period; a large amount of dead time surrounds each burst. For low duty cycles, the burst average power will be much larger than the average power.

After peak power is measured, a threshold of ½ the peak is set. The sampled power crosses that threshold at the beginning and end of each burst. The time between crossings is used to calculate the duty cycle. Burst Average Power is calculated by dividing the Average Power by the Duty Cycle.

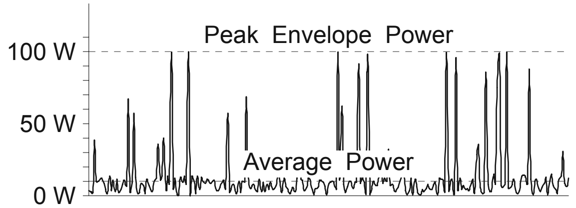
Burst power measurements provide accurate, stable measurements in bursting applications such as TDMA and radar. Accurately measuring the output signal strength is essential for optimizing radar coverage patterns. Actual transmitted power in a single timeslot can be determined in TDMA. The other timeslots must be off during this test.

Crest Factor

Figure 4

Crest Factor

10 dB CDMA Signal
100 W Peak
10 W Ave



Crest factor (CF) is the ratio of the peak and average powers, in dB. The WPS calculates the Crest Factor from the Forward Peak and Average Power measurements.

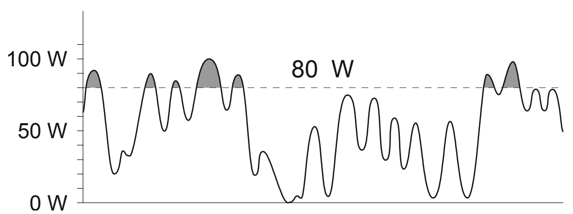
Crest factor is becoming one of the most important measurements as communication systems move into the digital age. For CDMA and similar modulation types the CF may reach 10 dB. If the crest factor is too large, the transmitter will not be able to handle the peak powers and amplitude distortion will occur. Crest factor can also detect overdrive and overshoot problems. Knowing the CF allows end-users to more accurately set base station power and lower operating costs.

Complementary Cumulative Distribution Function (CCDF)

Figure 5

CCDF

100 W Signal
80 W Threshold
20% CCDF



CCDF measures the amount of time the power is above a threshold. Equivalently, it is the probability that any single measurement will be above the threshold. The WPS samples the power over a 300 ms window and compares it to a user-specified threshold, in Watts. The time above the threshold relative to the total time is the CCDF.

CCDF measurements are most useful for pseudo-random signals, such as WCDMA, where a high CCDF means that the transmitter is being overdriven. CCDF can also detect amplitude distortion within an envelope caused by unwanted modulating signals. In TDMA systems, CCDF indicates the health of power amplifier stages and their ability to sustain rated power over an appropriate timeframe. As a trouble-shooting aid, CCDF allows tracking of trends such as amplifier overdrive (which can cause dropped calls and high bit error rates).

Specifications

Sensor Characteristics

Frequency Range	350 MHz to 4 GHz
RF Power Range	0.15 W – 150 W Average, 4 – 400 W Peak
Maximum Power	See Figure 7 on page 9
Impedance, Nominal	50 ohms
Insertion Loss, Max:	
0.35 – 1 GHz	0.05 dB
1 – 4 GHz	0.1 dB
Input VSWR, Max:	
0.35 – 2.5 GHz	1.05:1
2.5 – 4 GHz	1.10:1
Directivity, Min:	
0.35 – 3 GHz	30 dB
3 – 4 GHz	28 dB
RF Connectors	N Female
Interface:	
DPM	Male DB-9, EIA-232, 9600 Baud, no parity, 8 data bits, 1 stop bit
PC Serial Port	Female DB-9, EIA-232, 9600 Baud, no parity, 8 data bits, 1 stop bit
PC USB Port	USB 1.1 interface
Power Supply:	
DPM	From host instrument via cable
USB Port	less than one low-power USB load
DC Connector	7 – 18 Vdc, < 100 mA

Average Power

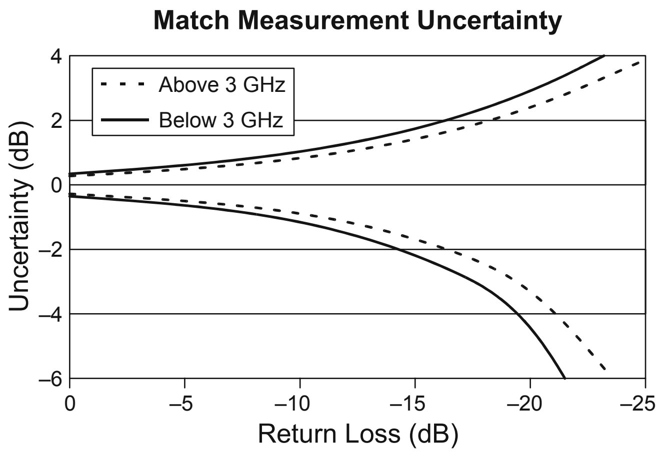
RF Power Range	0.15 – 150 W
Peak/Average Ratio, Max	12 dB
Measurement Uncert.	± (4% of reading + 0.05 W)*

* Above 35 °C or below 15 °C add 3%

Match Measurement

Measurement Range:	
Return Loss	0 to 23 dB
Rho (ρ)	0.07 to 1.0
VSWR	1.15 to 99.9
Forward Power, Min	0.5 W
Measurement Uncert.	See Figure 6 on page 8

Figure 6
Match
Measure
Uncertainty

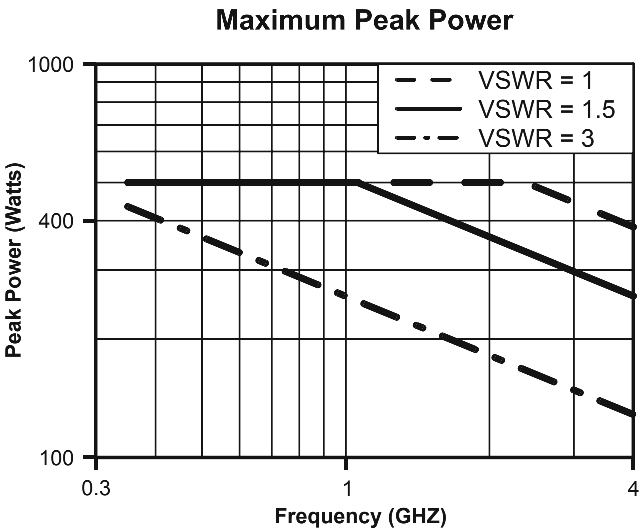


Peak Envelope Power

RF Power Range	4.0 – 400 W*
Measurement Uncert.:	
burst width > 200 μs	± (7% of reading + 0.2 W)†
1 μs < b.w. < 200 μs	± (10% of reading + 0.4 W)†
burst width < 1 μs	± (15% of reading + 0.4 W)†
burst width < 0.5 μs	± (20% of reading + 0.4 W)†

* Max. power depends on frequency and system VSWR. See Figure 7 on page 9
† 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 7
Max. Peak Power



Burst Average Power

Power Range	2 – 150 W average
Burst Width	1 µs – 50 ms
Repetition Rate, Min	15 Hz
Duty Cycle (D)	0.001 – 1 (D = Burst Width / Period)
Measurement Uncert.	± (6% of reading + 0.05/D W)*

* Above 35 °C or below 15 °C add 3%

Crest Factor

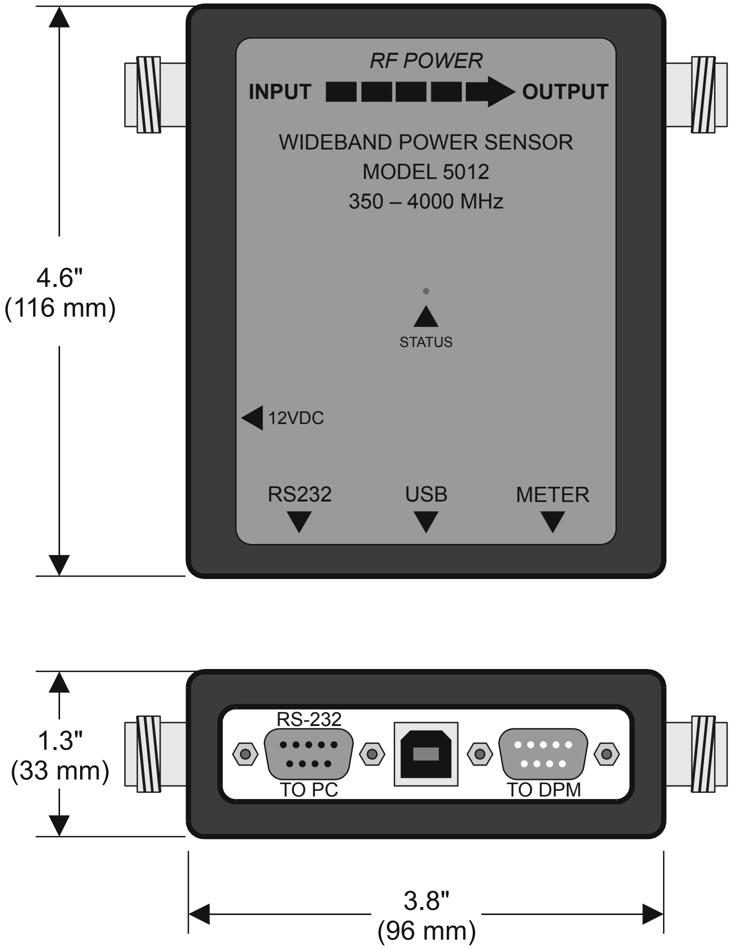
RF Power Range	0.15 – 150 W
Measurement Uncert.	Linear sum of peak and average power uncertainty

Complementary Cumulative Distribution Function (CCDF)

Measurement Range	0.1 – 100%
Measurement Uncert.	± 0.2%
Threshold Level Range	2 – 400 W
Level Set Accuracy	As peak power uncert. + 2%

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	MIL-PRF-28800F class 3
Humidity, Max	95% (non-condensing)
Altitude, Max	15,000 ft. (4,500 m)
Dimensions, Nominal	4.75” x 4.6” x 1.3” (121 x 117 x 33 mm)
Weight, Max	1.2 lb. (0.55 kg)


4.6"
(116 mm)
RF POWER
INPUT
OUTPUT
WIDEBAND POWER SENSOR
MODEL 5012
350 – 4000 MHz
STATUS
12VDC
RS232
USB
METER
1.3"
(33 mm)
RS-232
TO PC
TO DPM
3.8"
(96 mm)

DECLARATION OF CONFORMITY

Manufacturer: Bird Electronic Corporation
30303 Aurora Road
Cleveland, Ohio 44139-2794

Products: Wideband Power Sensor
Models: 5012

The undersigned hereby declares, on behalf of Bird Electronic Corporation of Cleveland, Ohio, that the above-referenced products, to which this declaration relates, are in conformance with the provisions of the following standards;

- European Standard EN 61326-1:1997 + Addendums A1:1998 and A2:2001 – Electrical Equipment for Measurement, Control, and Laboratory Use – EMC Requirements
- European Standard EN 61010-1:2001 – Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

These standards are in accordance with EMC Directive (89/336/EEC) and Low Voltage Directive (73/23/EEC), 1973 Including Amendment (93/68/EEC), 1993

The technical documentation supporting compliance with these directives is maintained at Bird Electronic Corporation, 30303 Aurora Road, Cleveland, Ohio 44139.

Bob Gardiner
Director of Quality
Bird Electronic Corporation