Green is life
tmg

ABN 43 064 478 842
231 osborne avenue clayton south, vic 3169
PO box 1548, clayton south, vic 3169
t 03 9265 7400 f 03 9558 0875
freecall 1800 680 680
www.tmgtestequipment.com.au

Test & Measurement

- sales
- rentals
- calibration
- repair
- disposal

Complimentary Reference Material

This PDF has been made available as a complimentary service for you to assist in evaluating this model for your testing requirements.

TMG offers a wide range of test equipment solutions, from renting short to long term, buying refurbished and purchasing new. Financing options, such as Financial Rental, and Leasing are also available on application.

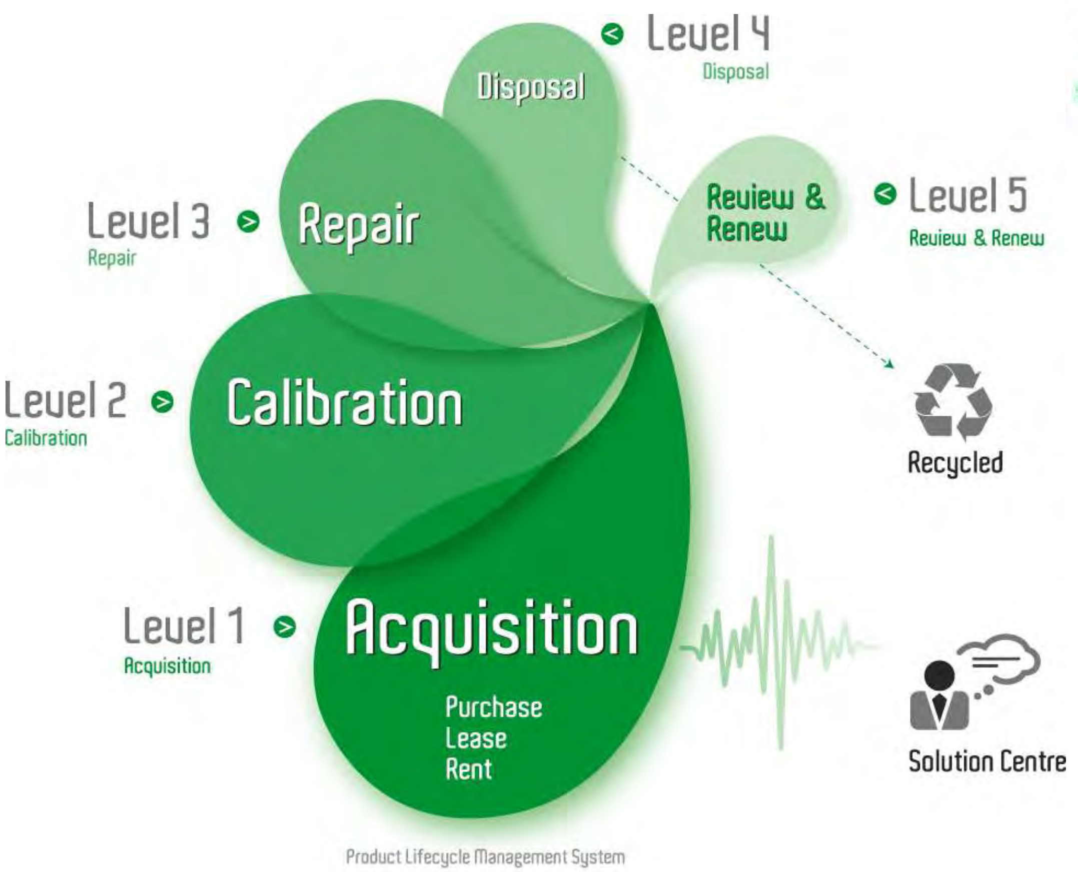
TMG will assist if you are unsure whether this model will suit your requirements.

Call TMG if you need to organise repair and/or calibrate your unit.

If you click on the "Click-to-Call" logo below, you can all us for FREE!

TMG Corporate Website **TMG Products Website**

Click-to-Call TMG Now



Form 080/01

INSTRUCTION SHEET

TERMINATING POWER SENSOR
MODEL 5011

Instruction Book Part Number 920-5011 Rev. D

Description

The Bird 5011 Terminating Power Sensor (TPS) is a diode-based power sensor that measures true average power from 40 MHz to 4 GHz and from –20 dBm to +10 dBm. It can be used with the Bird 5000 Digital Power Meter and the Bird Site Analyzer.

☞ NOTE: DPM firmware version 2.1 or SA firmware version 18DEC01, or later, is required. For the latest firmware upgrade, contact Bird Customer Service at (440) 248-1200 or visit our website at *http://www.bird-electronic.com*

For best results, wait 5 minutes after applying power to the sensor before taking readings.

CAUTION
Do not exceed 2 W average or 125 W peak power for 5 µs. Doing so will render the sensor inoperative.

Accuracy

The Bird TPS is highly accurate. The accuracy under normal conditions is ± (5% of reading + 1.0 µW). For example, for a 10 mW signal the uncertainty is ± 0.501 mW. For a 1 mW signal the measurement uncertainty is ± 0.051 mW. While this value is a good estimate, the sensor is actually more accurate. For the true measurement uncertainty use the process below.

Sensor Uncertainty

The sensor’s accuracy depends on the temperature, and the power and frequency of the source; Figure 1 lists the uncertainty factors. If an uncertainty is given as a power, divide this value by the measured RF power and convert to a percentage. For example, an uncertainty of ± 0.25 µW with a RF power of 10 µW is a 2.5% uncertainty. Figure 2 lists external factors, such as using attenuators or using a cable to connect the TPS to the transmitter, which could affect the measurement uncertainty.

Figure 1 TPS Uncertainty Contributions

Error Source	Conditions	Uncertainty
Calibration Uncertainty		± 1.13%
Frequency Response	40 MHz to 4 GHz	± 3.42%
Temperature Linearity	–10 to +50 °C	± 3.43%
Other*	< 40 °C or > 100 MHz	± 0.50%
Resolution	± ½ smallest displayed digit (e.g. for a mW scale, three decimal places are displayed. ½ the smallest is 0.5 µW)	
Zero Set†		± 0.125 µW
Noise†	above 1.05 mW	± 0.7 µW
	105 µW to 1.05 mW	± 0.4 µW
	below 105 µW	± 0.2 µW

* Above 40 °C, when making measurements at frequencies between 40 and 100 MHz, add 1.1%.

† After a 5 minute warmup, measured over a 5 minute interval and 2 standard deviations

Figure 2 External Uncertainty Contributions

Error Source	Conditions
Attenuator Uncertainty	Frequency dependent
Cable Uncertainty	Frequency and length dependent (± 5% at 1 GHz for a 'reasonable' 1.5 m cable)

The root sum square (RSS) uncertainty is the industry standard method for combining independent uncertainties. To determine the TPS's RSS uncertainty:

1. Square each uncertainty factor.
2. Add these values together.
3. Take the square root of this sum.

Figure 3 has two examples of uncertainty calculations. The first is a 10 mW signal at room temperature. The second is a 10 µW, 40 MHz signal at 50°C. Since this measurement is at both low frequency *and* high temperature, the uncertainty will be increased. Note that the RSS uncertainties are smaller than the values from the rough estimate. This will always be the case.

Figure 3 *TPS Uncertainty Examples*

	Example 1 (10 mW, Room Temp)		**Example 2 (10 µW, 40 MHz, 50°C)**	
Error Source	**Percent Uncert.**	**RSS Term**	**Percent Uncert.**	**RSS Term**
Cal. Uncert.	1.13 %	1.28	1.13 %	1.28
Freq. Resp.	3.42 %	11.70	3.42 %	11.70
Temp. Lin.	3.43 %	11.76	3.43 %	11.76
Other	0.5 %	0.25	1.6 %	2.56
Res.	0.005 %	0.00	0.5 %	0.25
Zero Set	0.00125 %	0.00	1.25 %	1.56
Noise	0.007 %	0.00	2 %	4.00
Sum Uncert.		24.99		33.11
RSS Uncert.		5.00 %		5.75 %
Quick Uncert.		5.01 %		16 %

Mismatch Uncertainty

Another factor of measurement accuracy is mismatch uncertainty. When a source and a load have different impedances, some signal will be reflected back to the source. This uncertainty depends not on both the VSWR of the TPS and the VSWR of the rest of the system. For a system VSWR of 1.0, the mismatch uncertainty would be 0. For a VSWR of 5.0, the mismatch uncertainty would be 12.5%. Given the VSWR of the TPS and the source, the mismatch uncertainty can be calculated as follows.

Mismatch uncertainty (MU) is related to the reflection coefficient (ρ) by the formula:

$$MU\ (\%) = [(1 + \rho_s \rho_l)^2 - 1] \times 100$$

where ρ_s = reflection coefficient of the source,
and ρ_l = reflection coefficient of the load (the TPS)

The reflection coefficients can be calculated from the VSWR by the formula:

$$\rho = (VSWR - 1) / (VSWR + 1)$$

For example, if you were to use a source with a 1.50:1 VSWR with the Terminating Power Sensor, which has a max VSWR of 1.20:1, the mismatch uncertainty would be calculated as follows:

$$\rho_s = (1.50 - 1) / (1.50 + 1) = 0.200$$
$$\rho_l = (1.20 - 1) / (1.20 + 1) = 0.091$$
$$MU = [(1 + 0.200 \times 0.091)^2 - 1] \times 100 = \pm 3.67\%$$

If you were to use a source with a 1.30:1 VSWR instead, the mismatch uncertainty would be:

$$\rho_s = (1.30 - 1) / (1.30 + 1) = 0.130$$
$$\rho_l = (1.20 - 1) / (1.20 + 1) = 0.091$$
$$MU = [(1 + 0.130 \times 0.091)^2 - 1] \times 100 = \pm 2.39\%$$

Using a lower VSWR source can drastically reduce the mismatch uncertainty. Keep in mind that that the typical VSWR of the Model 5011 is 1.03:1, which gives a much lower mismatch uncertainty. For example, with the 1.50:1 source, the mismatch uncertainty would be:

$$\rho_s = (1.50 - 1) / (1.50 + 1) = 0.200$$
$$\rho_l = (1.03 - 1) / (1.03 + 1) = 0.015$$
$$MU = [(1 + 0.200 \times 0.015)^2 - 1] \times 100 = \pm 0.59\%$$

To determine the total uncertainty of your measurement, combine the RSS uncertainty with the mismatch uncertainty using the RSS method. Square the RSS uncertainty, add it to the square of the mismatch uncertainty, and take the square root.

Using Example 1 in Figure 3 with a source VSWR of 1.50 and a TPS VSWR of 1.20, the total uncertainty would be:

$$\sqrt{5.00^2 + 3.67^2} = 6.20\ \%$$

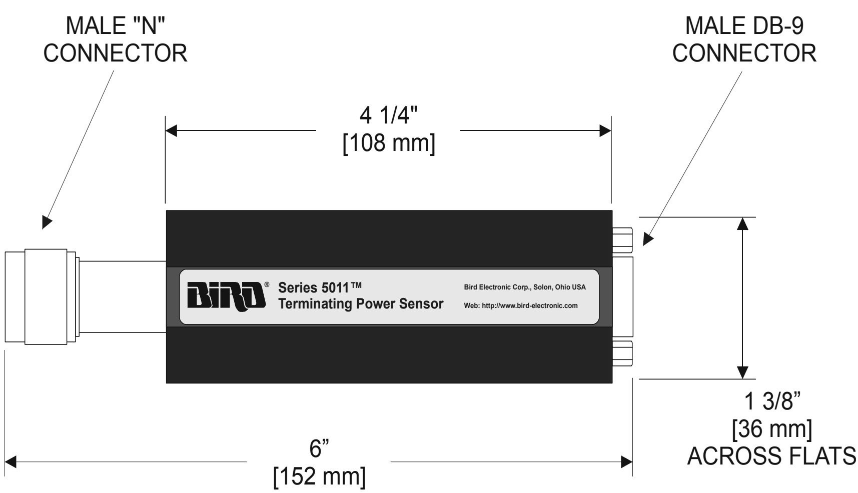
For example 2, the total uncertainty would be 6.82 %.

Display Resolution and Filter Length

The TPS has three power “ranges” that set the display resolution and the noise level, as shown in Figure 4. As the power decreases, the noise decreases but the time before the display updates also increases.

Figure 4 TPS Display Resolution

Input Power	**Display Resolution (# digits)**	**Update Time (s)**	**2σ Noise (µW)**
+10 to 0 dBm	4	1	0.7
0 to –10 dBm	3	2	0.4
–10 to –20 dBm	3	3	0.2



Specifications

Power Measurement Characteristics

General	Terminated average power
Frequency Range	40 MHz to 4 GHz
Power Measurement Range	–20.0 to +10.0 dBm (10 μW to 10 mW)
Maximum Power	2 W avg., 125 W peak for 5 μs
Peak/Average Ratio	12 dB maximum
Accuracy	±(5% of reading* + 1.0 μW) (excluding mismatch uncertainty) No correction factors necessary
Input Impedance	50 Ohms (nominal)
Input VSWR:	
Typical	1.03 (36.6 dB return loss)
Maximum	1.20 (20.8 dB return loss)
Input Connector	Precision N Male
Output Connector	Male DB-9 to host instrument
Power Supply	From host instrument via cable connection

* Above 40 °C, when measuring frequencies between 40 and 100 MHz, add 1%.

Physical and Environmental Specifications

Operating Temp.	–10 to +50 °C (+14 to +122 °F)
Storage Temp.	–40 to +80 °C (–40 to +176 °F)
Mechanical Shock	IAW MIL-PRF-28800F class 3
Vibration	IAW MIL-PRF-28800F class 3
Humidity	95% maximum (non-condensing)
Altitude	15,000 ft. operating
Dimensions	6” long max (including connectors); 1.5” diameter nominal
Weight	3/4 lb. max.
Recommended Calibration Interval	12 months

DECLARATION OF CONFORMITY

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

Product: Terminating Power Sensor
Models: 5011

The undersigned hereby declares, on behalf of Bird Electronic Corporation of Cleveland, Ohio, that the above-referenced product, to which this declaration relates, is in conformity with the provisions of the following standards with exceptions noted;

- European Standard EN 55011:1998 - Radiated Emissions
- European Standard EN 61000-4-2:1995 - ESD Immunity
- European Standard EN 61000-4-3:1995 - Radiated RF / EMF Immunity
- European Standard EN 61000-4-4:1995 - Fast Transient / Burst Immunity
- European Standard EN 61000-4-6:1995 - Conducted Immunity

These standards are in accordance with EMC Directive (89/336/EEC). Electrical equipment for measurement, control and laboratory use, EN 61326-1, 1997 edition.

- European Standard EN 61010-1:1993 - Part 1: General Requirements Including Amendment 2: 1995

This standard is in accordance with Low Voltage Directive (73/23/EEC), 1973

The technical documentation file required by this directive is maintained at the corporate headquarters of Bird Electronic Corporation, 30303 Aurora Road, Cleveland, Ohio 44139.

Robert Gardiner

Bob Gardiner
Director of Quality
Bird Electronic Corporation