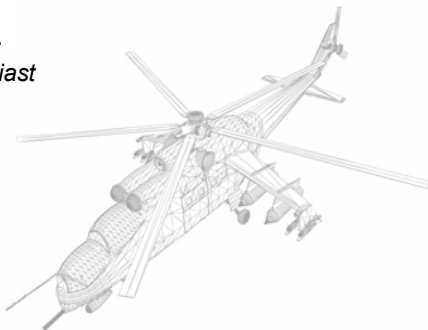
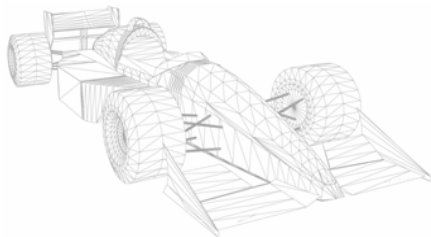




**medusa
research Inc.**

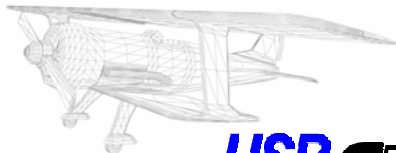
Engineered Products for the RC Enthusiast



POWER ANALYZER //

Operation Manual

Models: MR-PA-60100T
MR-PA-60100TP



USB 
Universal Serial Bus

www.MedusaProducts.com

Improving the performance of your electric flight system just got easier!

Do you want to accurately predict flight time?

How can you tell if a battery should be retired?

Could you benefit by choosing the best propeller or the most efficient motor?

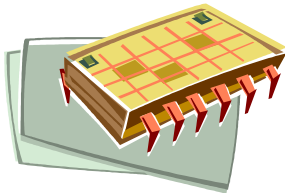
The ability to tweak particular elements of your system will improve the overall efficiency . . . and doesn't have to be a guessing game.

In the past, hobbyists would experiment to improve flight performance. They would guess, hope and wish for a predictable outcome. Now, with the Power Analyzer from Medusa Research, precise measurements enable any enthusiast to "nail down" all critical factors. You'll achieve better results with far less time, expense and aggravation.



The Power Analyzer II is a precision measurement instrument.

The Power Analyzer is an essential tool for the electronic R/C hobbyist. It has the ability to measure and calculate all the performance information the hobbyist needs to get the most from their electric model.



FEATURES

- ◆ **Measures 5 parameters:**
 - 0-60 Volts
 - -30 to +100 Amps
 - -1800 to +6000 Watts
 - +/- 999.999 Amp-Hours
 - +/- 9999.9 Watt-Hours
- ◆ **Factory calibrated**, no startup calibration sequence
- ◆ **USB connection** (Requires POWER-Link accessory)
- ◆ **Customizable** Add a personal power-up screen or re-arrange the measurements on the display (Requires POWERLink and PowerPROview software)
- ◆ **Powerful PC software** included to monitor and chart system parameters (Requires POWERLink accessory)

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CAUTION CURRENT HANDLING LIMITATIONS

The Power Analyzer is designed and built for safe use in systems carrying currents up to 100 Amps. Exceeding 100 Amps could result in damage to the equipment and possible personal injury.

CAUTION INPUT VOLTAGE LIMITATIONS

The Power Analyzer is designed and built for safe use in systems with less than 60 Volts. Exceeding 60V will permanently damage the Power Analyzer.

CAUTION HARDWARE AND CONNECTIONS

Follow proper assembly and ratings for wires and connectors. The user is responsible for attaching connectors rated to handle the voltage and current that will be applied in the user's application. **Ensure that all wiring and connections are rated to handle the input or output current, and are assembled appropriately for each application.** High current connections should be made by those experienced to do so.

CAUTION APPLYING POWER

Before connecting a battery to the Power Analyzer, make certain there are no exposed wires or connectors that may short circuit. Connectors with exposed male conductors should never be used on batteries, use female connectors for batteries. Both the "SOURCE" and "LOAD" leads of the Power Analyzer are hot when a battery is connected to either side. **A shorted Power Analyzer connected to a battery can supply massive amounts of current, causing fire, explosions, personal injury, and damage to the equipment.**

INTRODUCTION TO CURRENT AND VOLTAGE

Electricity in a wire is often compared to water flowing through a hose.

At the end of the hose, you can see how fast the water is flowing out of the hose, this is like electric current flowing in a wire. Current is a measure of how fast electricity is flowing.

If you press your thumb over the end of the hose, you can feel the pressure of the water, this is like electric voltage in a wire. Voltage is how much pressure the electricity has at the terminals of a battery. Watts, amp-hours and watt-hours, are calculated from voltage, current, and time. These calculations are done automatically by the Power Analyzer

MEASURING POWER WITH WATTS

A watt is a unit that defines how much power is being used or supplied.

For an R/C model, we can measure how much power a battery is supplying, and how much power a motor is using.

To use the hose analogy again, a watt would be used to measure the amount of power it takes to move the water through the hose. Increasing the pressure or speed of the water would require more power from the pump pushing the water through the hose.

The definition of a watt is simple:

$$\text{Watts} = \text{Volts} \times \text{Amps}$$

This means a watt is a unit that measures of the pressure and speed of electricity in a wire.

MEASURING CAPACITY WITH AMP-HOURS

Amp-hours is a measurement of current (in amps) multiplied by the duration (in hours.)

$$\text{Amp-Hours} = \text{Average Amps} \times \text{Hours}$$

Imagine charging a battery is like filling a bucket with water. Amp-hours is equivalent to how much water is in the bucket. If you were to fill the bucket at a rate of 5 gallons per hour for 1 hour, the bucket would have 5 gallons of water in it. In the case of the battery, if you were to charge it at 5 Amps for 1 hour, 5 Amp-Hours of electricity would have flowed into the battery.

MEASURING WORK WITH WATT-HOURS

Watt-Hours measures power, multiplied by time, to determine how much "work" the electricity has done. Watt-Hours are calculated by:

$$\text{Watt-Hours} = \text{Average Watts} \times \text{Hours}$$

A 3000mAh battery pack holds about 3000 milliamp-hours no matter how many cells it has, however it is obvious that the battery pack with more cells can hold more power. Measuring watt-hours allows you to see and compare the power capacity of your batteries.

For more information about electricity, and how you can use your Power Analyzer to get more from you model, visit our website at:

www.medusaproducts.com

STOP! READ THE FOLLOWING

Due to the wide variety of applications the Power Analyzer may be used in, your Power Analyzer is supplied without connectors. Please read the **SAFETY FIRST** section before continuing.

ATTACHING CONNECTORS

Before using the Power Analyzer, you will need to attach connectors to the SOURCE and LOAD leads. For convenience, you can use the same connectors you use in your models. You need to have two of the same type of connector, one a female and one male.

Using the procedures from the documentation provided with your connectors, attach the female connector to the LOAD leads and the male connector to the SOURCE leads. **PAY ATTENTION TO POLARITY!** Carefully insulate the connector with shrink tube or electrical tape. Make sure the positive and negative leads on both sides are insulated from each other, or a dangerous short circuit may occur.

POWERING UP FOR THE FIRST TIME

The minimum requirement to turn on the Power Analyzer is a battery that has at least 6 Volts. A NiCd or NiMH pack will need at least 5 cells to do this, a Lithium pack will need 2 cells (see Appendix A for different battery pack voltages.) If the battery has fewer cells or the measured power source is lower than 6 volts, connect an external power supply to the EXTERNAL/POWER port. See page 9 for more details.

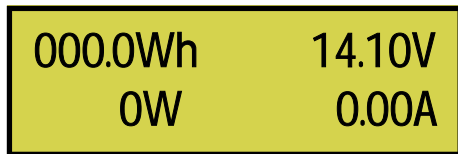
After applying power to the SOURCE leads or the EXTERNAL/POWER port, the LCD will show a short power up screen then show the measurements.

OPERATION

After applying power, a startup screen is displayed, then the measurements appear a few seconds later.

The Power Analyzer displays the following:

- Voltage (V),
- Current (A),
- Watts (W),
- Amp-hours (Ah),
- Watt-hours (Wh)



Power Analyzer - Watt Hours

Amp-hours and watt-hours share the same space, in the upper left-hand corner of the display, alternating every 2 seconds by default.



Power Analyzer - Amp Hours

VOLTS

Voltage is measured at the SOURCE side of the Power Analyzer

AMPS

Current is measured through the negative leads of the Power Analyzer. Positive current flow from the SOURCE to the LOAD side is forward current. The Power Analyzer // also measures reverse current flow from the LOAD to the SOURCE side up to -30 amps. Reverse current flow is shown on the display as negative current. Bi-directional capability is useful when cycling a battery pack

WATTS

The amount of power flowing from the SOURCE to the LOAD.

$$\text{Watts} = \text{Amps} \times \text{Voltage}$$

AMP-HOURS

Indicates the quantity of current that has moved from the SOURCE to the LOAD. Forward current increments the Amp-Hours, reverse current decrements the Amp-Hours.

$$\text{Amp-Hours} = \text{Amps} \times \text{Time (Hours)}$$

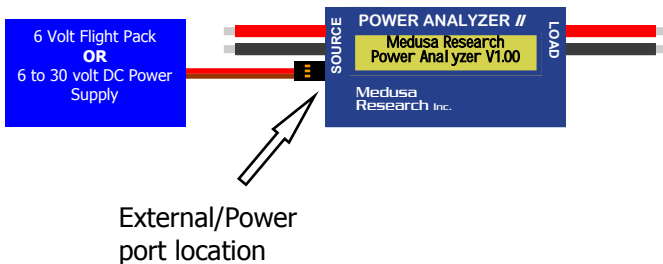
WATT-HOURS

The displayed watt-hour value indicates how much power has flowed from the SOURCE to the LOAD.

$$\text{Watt-Hours} = \text{Amps} \times \text{Volts} \times \text{Time (Hours)}$$

USING EXTERNAL POWER

The Power Analyzer // includes an external power port allowing it to measure down to zero volts. The connector will accept a plug from a standard flight pack. The polarity for the port is shown on the case with the negative polarity marked "B" for the black or brown wire from the flight pack. The positive polarity is marked "R" for the red wire from the flight pack. Other power supplies may be used as long as they can supply 6 to 30 Volts DC and more than 30 mA. A flight pack will need to supply at least 6 volts to the power port



USING THE POWERLink

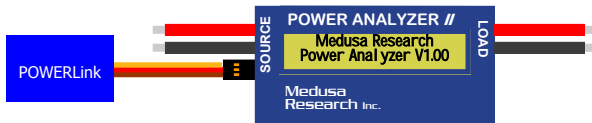
Minimum System Requirements

400mHz Pentium II or equivalent, 128mb RAM, 50 mb free disc space
800x600 minimum graphics resolution, USB v1.1 compatible port

BEFORE CONNECTING POWERLink TO YOUR COMPUTER:

1. Review the Quickstart guide included with the POWERLink package.
2. Download **and install** the latest POWERLink compatible software from <http://www.medusaproducts.com>

After installing the drivers and connecting the POWERLink to your computer, insert the plug into the EXTERNAL/POWER port of the Power Analyzer as shown. The POWERLink will only work if the polarity is correct. Line up the brown wire with the "B" marked on the side of the case. POWERLink will also supply power to the Power Analyzer so it can measure down to zero volts.



MEASURING THE CAPACITY OF A BATTERY



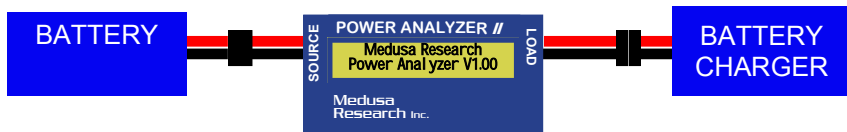
The capacity of a battery can be measured by completely discharging a fully charged battery. In order to do this, first connect a load to the LOAD side of the Power Analyzer. A load may be a battery charger with a discharge feature, or an ESC and motor. Second, connect a battery to the SOURCE side of the Power Analyzer. Run the motor or discharge until the battery is at its discharged voltage (see the "Battery Voltages" table in Appendix A). When the battery is discharged, the final battery capacity (in Amp Hours) will be displayed.

NOTE: Never discharge a Lithium cell battery below the "Discharged" voltage (see Appendix A). Doing so may permanently damage the battery.



Amp-hours are displayed in the upper-left corner every 2 seconds

MEASURING THE CHARGE PUT INTO A BATTERY

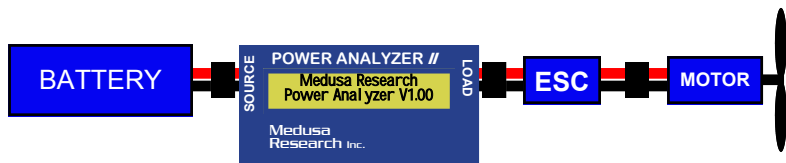


The Power Analyzer can also be used to monitor the charge being put into a rechargeable battery. In this configuration, the battery charger is putting current into the battery instead of drawing it out like a motor. Therefore, the battery becomes the load and the current flows in reverse, from the LOAD to the SOURCE. The current will show up as negative to indicate the reverse direction.

Follow your battery charger's instructions, and charge the battery as you normally would. At the end of the charge cycle, the amount of charge put into the battery will be displayed in amp-hours on the display.

NOTE: Always follow the charging procedure recommended by the battery manufacturer to safely and effectively charge the battery

MEASURING MOTOR LOAD



Measuring motor load is critical in finding the optimal propeller size and gearbox ratio.

To measure motor load, first connect the LOAD side of the Power Analyzer to an ESC, and connect the ESC to a motor. Then, connect a fully charged battery to the SOURCE lead. This step will energize your ESC, so make sure you follow your ESC's instructions and safety procedures for connecting a battery.

Verify the Power Analyzer is on, and move the throttle up and down to observe your motor's power consumption at different speeds.

SYMPTOM	SOLUTIONS
<p>I just attached my connectors and followed the "First Power On" instructions, but my Power Analyzer won't turn on.</p>	<ol style="list-style-type: none">1. Check that your battery pack is fully charged, and provides enough voltage to turn the power analyzer on. The Power Analyzer needs a 6 volt input or an external power source to run properly.2. Check the polarity of your connections. The Power Analyzer will not turn on if the battery polarity is reversed.
<p>There is nothing connected to the SOURCE or LOAD wires, but the voltage is not showing zero.</p>	<ol style="list-style-type: none">1. When powering the Power Analyzer through the external power port and the SOURCE and LOAD leads are not connected, the voltage will "float" up off zero. This is common behavior of standard multi-meters as well as our Power Analyzer. If you short the SOURCE leads together (make sure there is nothing connected on the LOAD side!), the voltage will go to zero.

Display Range	
Parameter	Range
Voltage	0 to 60 V
Current	-30 to +100 Amps
Power	-1800 to +6000 Watts
Amp-Hours	+/-999.999Ah
Watt-Hours	+/-9999.9Wh

External/Power port	
Mechanical	3 pin male socket. Fits standard flight pack plugs
Input Voltage	6 to 30 volts DC
Input Current	30mA maximum current draw
Resolution	
Parameter	Value
Voltage	0.005V
Current	0.01A
Watts	1 W
Amp-Hours	0.001 Ah (6 digits displayed)
Watt-Hours	0.1 Ah

NOTE: This table shows only the capabilities of the analyzer, and does not imply that the system to which measurements are being made has the same capabilities. It is the responsibility of the user to ensure that all external connections at the 'INPUT' and 'OUTPUT' wires of the Power Analyzer are rated to carry the currents and voltages being supplied.

Operation outside of the limits shown can cause permanent damage to the Power Analyzer and may pose other safety hazards.

NiMH/NiCd Voltages			
Cells	Discharged Voltage	Normal Voltage	Max Voltage
5	3.75	6.00	6.75
6	4.50	7.20	8.10
7	5.25	8.40	9.45
8	6.00	9.60	10.80
9	6.75	10.80	12.15
10	7.50	12.00	13.50
11	8.25	13.20	14.85
12	9.00	14.40	16.20
13	9.75	15.60	17.55
14	10.50	16.80	18.90
15	11.25	18.00	20.25
16	12.00	19.20	21.60
17	12.75	20.40	22.95
18	13.50	21.60	24.30
19	14.25	22.80	25.65

Lithium and LiPoly Voltages			
Cells	Discharged Voltage	Normal Voltage	Max Voltage
1	2.9	3.7	4.3
2	5.8	7.4	8.6
3	8.7	11.1	12.9
4	11.6	14.8	17.2
5	14.5	18.5	21.5
6	17.4	22.2	25.8
7	20.3	25.9	30.1
8	23.2	29.6	34.4
9	26.1	33.3	38.7

NOTE: The “Discharged Voltage” column shows the voltage for a battery pack under load. When discharging a battery through the Power Analyzer, the “Discharged Voltage” is the recommended voltage at which the discharging should be stopped. Consult your battery datasheet for more detailed information.

SUPPORT

If you are still having difficulties, or have questions that aren't covered in this manual, you can contact Medusa Research for support.

Our contact information is:

World Wide Web

<http://www.medusaproducts.com>

E-Mail

support@medusaproducts.com

Telephone Support

Hours: Monday-Friday 10am to 5pm eastern time, excluding business holidays

Phone Number: 508.675.0200 (in Fall River, Massachusetts)

LIMITED WARRANTY

Medusa Research Incorporated warrants all Power Analyzer to be free of manufacturing defects in material and workmanship for a period of 12 months from the original date of purchase. Should any defects covered by this warranty be found, the Power Analyzer shall be repaired or replaced with a unit of equal performance by Medusa Research Incorporated.

In the event of a product defect during the warranty period, see the directions in the "Returns and Return Authorization" section.

LIMITS AND EXCLUSIONS:

This warranty may be enforced only by the original purchaser, who uses the Power Analyzer in strict accordance with the information provided in this operation guide.

This Warranty does not apply to:

1. Damage resulting from failure to follow instructions provided in this operations guideline
2. Damage resulting from misuse, reverse polarity on input or output wires, abuse or neglect.
3. Damage occurring as a result of poor solder joints, connector incompatibility, or mechanical failure of user installed input and output connections.
4. Damage resulting from any repair or alteration performed by someone other than Medusa Research Inc.

LIMITATION OF LIABILITY

- (i) UNDER NO CIRCUMSTANCES WILL MEDUSA RESEARCH, INC. BE LIABLE FOR ANY INDIRECT, THIRD PARTY, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY EXPENSES, COSTS, LIABILITY, LOSS, OR DAMAGE WHATSOEVER IN ANY CONNECTION WITH THE USE OR MISUSE OF, OR INABILITY TO USE THIS PRODUCT;
- (ii) that Medusa Research, Inc. shall not be liable for any harm, loss, damages, expenses, costs, suit, claim or demand whatsoever against the user of this product;
- (iii) that neither Medusa Research, Inc., nor any of its representatives, employees, officers, directors, agents, distributors, affiliated corporations or any other person, shall be responsible for nor shall incur, any liability, damages, loss, obligations or responsibility whatsoever (whether in equity, contract, tort or otherwise) for any harm, loss, reliance, or damages, whatsoever, that may arise in any connection with or result from any promise, advice, arrangement, agreement, statement, technical support or maintenance, representation, warranty, or information whatsoever, that may have been made to by Medusa Research, Inc.;

RETURNS AND RETURN AUTHORIZATION:

For warranty and repair returns, please download a *returns form* from our website. Instructions for packaging and shipping returns are also on our website. If you do not have access to the internet, please call or fax us at the number below.

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