

Part 1 – What is Power, How to use a Power Meter and Power Software

In this article, Part 1, I will be defining power and discussing how training with a Power meter is different and in most cases much better than using metrics such as miles, heart rate and time alone. You will learn how a Power meter will allow you to measure your actual training load or work load and will help direct your training. You will learn how this method of measuring training load is superior to these other metrics and in some ways show that these other metrics cannot compare with power. I will lastly discuss how the current market of power meters measure power, their accuracy and their advantages and disadvantages. My personal recommendation on power analysis software is also in the last section.

So, what is power and why exactly should you be using it, especially as compared to what you already know and use (which could be Miles, Time, and Heart Rate etc). Let's start by defining Power. Power is the amount of work completed divided by the amount of time it takes to do the work or simply stated: $Power = Work/Time$

Time is simple enough for us to understand but how about the variable work? Well, here in lies the advantage of training with a power meter. Work is a performance measurement. You see, work is the measurement of the effective use of force. Here is an example that should help you understand work and effective use of force; if you push extremely hard against a brick wall you would be creating a huge amount of force but, since the wall doesn't move, you have done zero work. So, power can be better defined as the effective use of force over time, or basically energy efficiency.

How about other training metrics? Heart rate for example, is extremely popular. Isn't that a performance measurement? No, it is not. Heart rate is your body's subjective response to exercise. That is why you can't compare your heart rate numbers or zones to others. Some people have higher heart rates than others but that has little to no bearing on the outcome of a competition between individuals. And I am sure you already realize that not all "miles" are created equal.

So, power is a performance metric that measures our work and efficiency of work. How does that help us? It helps us in many ways and I will list a few but the most important factor is the actual measurement of Training Load.

Adaptation (change in fitness) to exercise can be positive, negative or flat lined. There are a few variables that determine the direction of the progress. There is load, recovery from load and time. Recovery still remains the elusive \$1,000,000 question. Time we can easily measure and with the invention of Power meters we know can precisely measure load. We are able to measure not only overall load but load in specific physiological zones such as the aerobic zone, the lactate power zone, lactic capacity zone and so on. Over time, applying load in different blends with properly timed recovery produce the adaptation that athletes are in search of. When ever you train with a power meter you are simultaneously testing, all the time recording how much work you do and in which

intensity zone you performed the work. In time you will be able to measure the results of the formula you are using.

Other advantages of training with power include:

- Complete and accurate records of all your training and Racing
- Power adds an additional dimension to your heart rate data
- You have an objective record of your training to add to your subjective notes
- Power meters are a mobile testing lab
- It greatly enhances indoor training
- You can track variables that will show evidence and proof of fitness changes
- Many more!

So, stated simply, the question a power meter can answer for you is, “is your training program producing the desired fitness adaptations (more efficiency and higher workload capacity) or are you pushing against that wall?” You don’t want to waste energy or time.

How do power meters measure work? Each power meter on the market uses different technologies to measure or estimate power outputs. A math professor reminded me that all measurements are estimates (that is why I used the word in the last sentence). The current power meters on the market are SRM, Powertap, Ergomo, Computrainer, iBike and soon to be released Quarq. SRM is known as the best and is priced accordingly. It has strain gauges built into the crank spider which measure the force applied to the crank arms. This information added to cadence, your speed and time and the SRM calculates power and records it to a downloadable handlebar mounted computer head. The Powertap uses a similar system with a torque tube built into the rear hub. It also records ride information into a downloadable handlebar mounted computer. Ergomo built their power meter into the bottom bracket itself. There are optical lenses built into bottom bracket that measure the deflection of the spindle and then calculate power using the information about how much force it takes to deflect the spindle said distance. It also has a downloadable handlebar mounted computer. The Ergomo is the only unit that has Andy Coggan’s Training Stress Score (TSS) and Intensity Factor (IF) information built into the display. The Computrainer is a computerized indoor training ergo meter that applies resistance to the rear wheel. Lastly, the iBike is a downloadable handlebar mounted computer that is measuring wind speed, bike speed, grade of road and uses rolling resistance and aerodynamic drag (measured in a roll down from 20mph when you first start your ride) to calculate power. All of these devices provide accuracy within themselves and record data for downloading. Accuracy versus precision, I said accurate within themselves. All of the manufactures argue, and would like us to argue about “precision.” It is my opinion, that as an athlete you are looking for accuracy or the duplication of load from usage to usage, your usage, rather than precision. All the power meters mentioned have shown a margin of error in precision. As for accuracy they are all very close.

So, which power meter is for you? That depends on many different factors. Price is an obvious factor but so is usage. Getting bound to special wheels or even a particular bike (in the case of Ergomo) isn’t optimal when you do time trials on a time trial bike with

your disc wheel one day and then do a road race with your road bike and super light carbon wheels the next day. But, swallowing \$3,400 for an SRM isn't the best either. To answer the question, "which power meter is for me?" I have created spreadsheets below for each model listing what I feel are their advantages and disadvantages:



SRMpro

Advantages	Disadvantages
Uses many different BB patterns: Dura Ace version Integrates using Shimano Dura10 outboard bearing BB; Super easy to swap bike to bike; two bolts; 2 minutes.	Cost: \$3700
Very light; Rated as light as the stock Dura 10 Hollowtech Crank set – no weight penalty	Battery must be changed in factory (does NOT need to be done for years)
Allows you to use your range of custom/stock wheels without requiring wheel swap; Race Ready;	Software complicated and not as useful as Cyclingpeaks WKO+
Durability – Sealed unit with minimal maintenance; Calibrate in “2 seconds” before each ride.	
Measures force directly on Crank spider; measures watts you're putting on the arms; energy loss elsewhere possible	
Considered “elite” product used by Pro riders.	
Now has Coded Polar Chip for Coded HRM transmission; Soon to be Wireless using the new ANT+ technology allowing communication with other ANT+ devices like the Garmin GPS	



Powertap Pro, SL, 2.4

Advantages	Disadvantages
Integrates into proprietary hub; Easy install; real-time data viewable on small cyclo-computer	Locks you into a more limited range of wheels, though custom wheels are available for more \$\$\$;
3 models and price points to choose from including new 2.4 wireless unit (\$700-1600)	Non-coded HRM strap and non-coded Transmission; can get patchy;
Light; Not as light as SRM but weight/cost is attractive	Cost: Pro (\$700 up to 2.4 wireless at \$1600)
Saris, parent-company is Larger Company than other power meter companies	Software is weak, but improving. Can be offset by using Cycling Peaks WKO+



Computrainer

Advantages	Disadvantages
Very advanced; highly accurate; 3D software for increased attention-span; Data is presented back on PC; all data;	Cost \$1500
Wide range of software, 3D course, Intellicoach = “Coaching in custom built Ergo mode”; Topo course to replicate impending races; athletes can mirror grade and distance of course to be raced in advance using GPS	Non-mobile; would not be ideal if this was your only power solution
SpinScan; Multirider - Ability to race against others; Race against previous efforts;	Ideally, it makes for a great home, “foul” weather, indoor training mechanism
Records up to 30 data points per second, Real time view of all data	At home training only
Works with coded and non-coded straps	HR is an Option/Add-on



Ergomo

Advantages	Disadvantages
Light and waterproof	Cost \$1600
Can use any wheel set	Most expensive part (the power BB) is what you need to equip second bike (\$850)
Only power meter to display TSS, IF and normalized power (CyclingPeaks metrics)	Still one of the new kids on the block with growing pains
Comes with great software (Cyclingpeaks WKO+)	



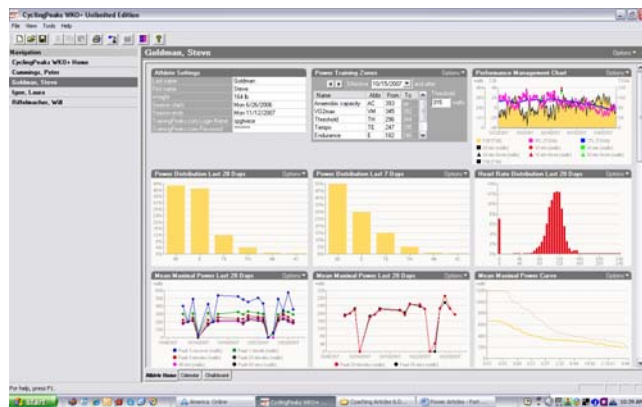
iBike

Advantages	Disadvantages
Accuracy issue with changes in rolling resistance, claimed to be addressing this with firmware updates	Many people outspoken about feasibility. But initial testing by consumers has shown potential.
Firmware updateable	No force data
Lightest Power meter	One of the New kids on the block and will probably continue to have growing pains
Only power meter capable of measuring CdA (portable windtunnel) Soon to be displayed on CPU	Heart rate data is an option. Adapter just released and not proven but does use the new ANT+ technology.
Least expensive by FAR (\$399)	Cadence is measured only virtually
Gets you into power cheap	



Quarq

Advantages	Disadvantages
Crank based, wireless unit that will allow any wheel option	Cinco is crank attachment priced at \$1195 and Cranium is computer head and is \$995 on the pricey side
ANT+ compatible so user can use other ANT+ compatible devices in conjunction (like GPS). Head unit it not necessary if using new Garmin 700 series GPS to collect data	New to market (due to release first Quarter of 2008) but my initial feeling is this company will not overextend and will have solid product from the start.
Light weight	Software may not be included but will be Cyclingpeaks WKO+ compatible
Wireless system, at this price point, outboard bearing compatible: holds great promise of high value	Compatible with limited number of cranks at this point



CyclingPeaks Software

As you might have noticed I didn't mention much about the software that is included with these meters. The reason is the manufacturer's software all pale in comparison to the CyclingPeaks. I see no use for any other software out there. If you are investing in a power meter the extra few dollars for this software is worth every penny. I will be going over using this software in the next part of this series. As for comment about the software in the Ergomo review they provide a version of CyclingPeaks and that is why I refer to it as great.

As you can plainly see there is much to be digested about power meters. While you are taking time to digest realize this, and I can almost promise it, a power meter will be a good investment. They are not inexpensive even at the iBike price (\$399). When you consider what I have outlined and the other advantages such as the measuring of actual work done in kilojoules which can be converted to calories, for nutritional guidance and the ability to communicate with a coach via the files and the internet the upsides of training with power greatly outweigh the costs. Take time to think about your needs and budget before investing and be patient getting to know your new training partner. It will take time.

In the next article, Part 2 of this series, I will be discussing how to use a power meter and the CyclingPeaks software, how to get started, testing, and how to establish your personal power training levels.



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