PH5000A/E/U Desktop Smart Charger/Calibrator Instructions

The PH5000 is a standalone desktop smart battery charger with the ability to recalibrate the fuel gauge on all Inspired Energy® brand "P"-series high power smart battery packs.

What's in the box?

1. One PH5000A desktop charger/calibrator, with 36VDC power supply unit.
2. One US mains cable. European Chargers (PH5000E) are packed with a European 2-pin mains cord, UK Chargers (PH5000U) are packed with a UK 3-pin mains cord.

Safety

1. **Do not expose the charger or power supply to water or conductive liquids.**
2. **Do not open the charger or power supply case. There are no user serviceable parts inside.**
3. **Do not cover the charger case, as this could cause overheating.**
4. **Place the charger in a cool spot, away from external heat sources**
3. **Caution - during recalibration the battery connector and the charger will become warm.**

Setting up your Charger

Place the charger unit on a flat, level surface away from sources of heat and moisture. Plug the power supply into the mains AC supply using the cable supplied.

Charging

Connect the high power battery connector to the charger connector. The connector is fully seated when the charger and battery cases touch. The LEDs in the charger status window will provide status information as detailed below, and the charger will automatically begin to charge the battery. The LCD fuel gauge on the battery will flash to indicate charging is in process.

LED Indication:

The status of the battery is indicated by the LEDs visible in the status window:

Green flashing:	**Battery charging**
Green solid:	**Battery fully charged**
Blue flashing:	**Battery in calibration mode**
Blue solid:	**Battery fuel gauge calibrated**
Red flashing:	**Battery fuel gauge in need of recalibration**
Red solid:	**Error**

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Recharge Time:

Different battery packs will require differing recharge times. The times given below are for a full charge from 0% to 100% state of charge.

Battery Chemistry	Battery Model	Typical Recharge Time
Li Ion	PG3665A29	3 hrs

Recalibration

If the battery is in need of fuel gauge recalibration, the red LED will flash upon insertion of the battery.

This indicator provides feedback to the user on the accuracy of the fuel gauge and avoids unnecessary battery calibration cycles.

The user has the option to calibrate the fuel gauge and charge the battery, or to only charge the battery.

This option is given because a recalibration cycle is longer than a charge cycle.

To recalibrate the battery, press the calibrate button on the front of the PH5000.

No action is required if only a recharge is required, as the charger will automatically begin to charge the battery.

The blue calibration LED will flash to indicate that the battery is undergoing the recalibration cycle.

There may be a short delay before the calibration begins. During calibration the discharge resistors will heat up. A thermistor is used to maintain charger temperature within acceptable limits

At the end of this procedure the blue LED will stay constant indicating a fully charged, fully calibrated battery.

The most common cause of calibration failure is overheating of the pack during discharge. Please keep the charger away from direct sunlight or heat sources during calibration.

Recalibration Time

The recalibration cycle begins by charging the battery. This is followed by a calibration discharge. Finally the battery is given a regular charge. A calibration cycle will be faster if the battery is fully charged to begin with. Once the calibration button is pressed, the recalibration cycle is started and this switch is then inactive until the calibration cycle is completed. Removing the battery or powering down the charger will abort the calibration cycle.

Battery Chemistry	Battery Model	Min. Recalibration Time	Max. Recalibration Time
Li Ion	PG3665A29	9 hrs	12 hrs

What is recalibration & why is it needed?

The fuel gauge in the battery uses a highly accurate voltmeter, ammeter and time clock to measure actual charge in & out of the battery pack. In addition there are algorithms to compensate for the effects of discharge rate, discharge temperature, self-discharge and charging efficiency etc.

All this combines to provide a highly accurate fuel gauging system. What is also required is the means to ensure the continued reliability of this system throughout the life of the battery pack.

Even with all this technology, the only time at which the battery is absolutely certain of its real capacity is when it is either completely full or completely empty. Anywhere in between is a calculated estimate - albeit a highly accurately calculated one.

Also, as the battery ages, the amount of available capacity shrinks - so each cycle the "full" point gets a little bit lower. Imagine if the fuel tank in your car got smaller as your car got older – you'd need to occasionally recalibrate your car's fuel gauge too.

What's more, if the battery only sees partial charges and discharges during its application, then it may not get the benefit of a "full" or "empty" reference point for some time and must rely more and more on its calculated figure. So the fuel gauging system may be subject to drift during use.

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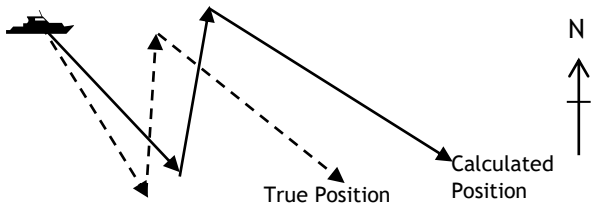
This is analogous to navigating by dead reckoning - you take compass readings & set off on your heading to your waypoint & then change course etc. After a few changes in course, the minor errors in your execution of the course can become amplified and your true position can drift from your calculated position.



In use, as the fuel gauge mathematically works out the battery's remaining capacity. It will also work out an estimated accuracy figure known as the "Max Error". This keeps track of the overall accuracy of the system. In this way the battery can tell the device not only how much capacity is remaining, but also how accurate this estimate is. When an Inspired Energy battery achieves a max error of 10% the recalibration bit is set.

Some devices use this recalibration bit to trigger a note on the device screen to tell the user to recalibrate the battery. Other systems simply put a note in their instruction manual to recalibrate the battery every so often. The PH5000 uses the recalibration bit to tell the user if recalibration is necessary during charging and flashes the red LED to let the user know that the battery fuel gauge is becoming inaccurate.

Recalibration is used to re-set the fuel gauge algorithms, re-establish the full and empty points, and re-calculate the actual capacity in the battery. In this way, even as the battery ages and things change, the accuracy and reliability of the fuel gauge can be retained throughout the life of the battery.

Now, in order to carry out a full recalibration, the following must occur:

- Either; begin with a fully charged battery, or fully charge the battery (this establishes the "Full" point.)

- Fully discharge the battery (This tells the system how much of the full charge input is available for discharging, and re-sets the Max Error)

At this point the battery is calibrated, but it is also empty - so it needs a full recharge to return it to use.

This process can be achieved inside the device (e.g., fully charge it, leave the device on until it shuts down & then fully charge it again) but this can be time consuming and inconvenient. Also many devices operate a device shut-down before the battery is discharged to the point at which the battery fully-discharged bit is set. These devices will not be capable of recalibration smart battery packs and an external device such as the PH5000 must be used instead.

A desktop device like the PH5000, which automatically takes the batteries through this process, is a useful alternative, ensuring accuracy and reliability of the fuel gauge throughout the life of the battery. As the process of recalibration includes the charging process it is most convenient to build in this functionality into a charger and give the user the option of a regular charge or a recalibration with a charge.

What are the SMBus and the SBS?

The Smart Battery System (SBS) defines the parameters that are stored by the battery. This includes battery status and fuel gauging data. The System Management Bus (SMB) is the language by which these parameters are communicated between the battery, the charger and the host device. For details of the SBS data available from your battery please refer to the battery specification sheet available at www.inspired-energy.com

How does the charger know what charge to deliver?

The PH5000 charger is capable of sensing and delivering an appropriate charge to all Inspired Energy high power battery packs. Upon inserting the battery into the charger, the battery communicates to the charger over the SMBus telling the charger what type of cell chemistry it is and what type of charge regime it needs. The PH5000 then configures its output to provide the charge regime requested by the battery.

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Compatibility

The PH5000 is fully compatible with all Inspired Energy® brand high power "P"-Series battery packs. For optimum results we recommend using only Inspired Energy® brand smart batteries. For a full list of all compatible Inspired Energy batteries, please visit:

http://www.inspired-energy.com

PH5000 Specification Summary	
Weight:	235g / 8oz
H x L x W	38mm x 115mm x 86.4mm / 1.50" x 4.53" x 3.40"
Mating Connector:	Amphenol L177TWA7W2S male connector shell with female signal pins Amphenol L17DM53744-1 40A female solder cup inserts (2 required) Amphenol L17DTZK15K optional protective backshell
Communications Compliances.	System Management Bus Rev 1.0, Smart Battery Data Specification rev 1.0 and Smart Battery Charger specification Rev 1.0 compliant
Attached Power Supply	100-240VAC, 36V, 2.78A DC, 150x35x70mm, 600g /21oz UL listed, CE Compliant
Mains Cord	PH5000A - 110V N. American 3-pin connector PH5000E – 220V European 2-pin connector with ground recess PH5000U – 240V UK 3-pin connector