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For more detailed information, refer to the documents at:
http://www.ocean-server.com/download/

Section 1: The Intelligent Battery and Power System (IBPS)

1) What is an IBPS?

An IBPS is a power management system that can:
- Manage all aspects powering a system with battery power
- Manage charging of batteries using almost any external power source from power supplies to solar panels
- Switch power to load between external power and battery power.
- Simultaneously power system and charge batteries
- Monitoring all the aspects of the battery power

It is fully autonomous, just hook it up and go.
It is also fully configurable to meet specific needs of your system.

2) What makes up an IBPS?

An IBPS is made up of one or more battery controller modules, rechargeable Smart Battery Packs, and an external power source. The battery controller module manages all aspects of supplying power to your system and charging the batteries. The Smart Battery Packs communicate with the battery controller module to supply battery status information while charging and discharging the battery packs. The external power source is used to recharge the batteries. The

external power source can also power your system while at the same time charging the batteries.

More advanced systems can include DC-DC modules for regulated power and a host system for monitoring the status of the batteries.

For more information on this subject, reference the Product Selection Guide. http://www.ocean-server.com/download/Selection_Guide.pdf

3) What are the advantages of the IBPS?

The IBPS is a pre-engineered power system that allows you to manage and control all aspects of your battery-powered application. The IBPS contains all of the software and hardware necessary to easily customize your battery power subsystem to meet specific needs. This allows you to spend less time worrying about your power and more time focusing on your core application.

4) What are some applications for an IBPS system?

Any application that needs portable power: With all of the features available and the autonomous operation of an IBPS, an IBPS can meet almost any portable power application requirements. From small systems requiring 1 or 2 battery packs to large systems that requiring 128+ battery packs. Both regulated and unregulated power can be supplied. Software is available to customize the behavior of the battery system and to monitor its status.

UPS system: By routing your power through a battery controller module, your system now has battery backup. When external power is supplied, it will be used to power your system. Any excess power will be used to charge the batteries. If external power is removed the power from the batteries is automatically supplied to your system. The system will see no interruption of power and will continue to run. Once external power is restored, the battery controller will use it to power your system and recharge the batteries if needed.

Solar powered system: An IBPS can be used for backup in a solar powered system for remote off the grid power for any number of devices (ie..sensor or mesh boxes). Just like in the above UPS system, power can be switched from the solar power source to the batteries as needed. When solar power is available it will be used to power the system and charge the batteries (if needed). When solar power is removed due to clouds or during the night, the power will automatically be switched to the battery power. The charging of the batteries is very efficient at harvesting the excess solar power. See OceanServer Application Note AN101 on Solar Charging.

Portable PC's: By powering your PC with an IBPS system, it instantly becomes portable. Even high-end systems can be made portable. You can use an IBPS to

extend the run time by connecting more batteries. Software is available to monitor the batteries and provide shutdown functionality similar to laptops.

Robotics: An IBPS is ideal for robotic systems. For small robotic systems, 1 battery controller with 1-4 batteries can be used to supply almost 400Ah of power. For larger robotic systems up to 16 controllers can be used to support up to 128 batteries, which can supply over 12,000Ah of power.

Section 2: IBPS operation

1) What does the battery controller do?

The design of the battery controllers (the BB-04SR/FR, MP-04SR/FR, MP-04R MP-08SR/FR and XP-04SR/FR) allows them to handle all aspects of powering a system with batteries. If external power is present, it will be used to support the load. If there is any excess power available it will automatically be used to charge the batteries. If external power is not available, power to the system will automatically be sourced from the batteries. The switching between power sources is done without having to bring down the system. The batteries and external power are all hot swappable.

The controller communicates to the batteries via the SMBus to the Smart battery controller in the battery pack. It uses this information during operation to maintain safe operating conditions. The status and measurements are taken right at the batteries so they are more accurate. Losses from external cables and circuits do not affect the measurements. This provides a high degree of monitoring accuracy (voltage and current to 0.2%) and high efficiency power conversion.

Battery current, voltage, and temperature are monitored throughout the charge and discharge cycles. Current is monitored to maintain safe levels during all phases of operation. If over current condition occurs, the batteries will be switched off. The voltage is monitored for maximum and minimum values to keep the batteries within safe operating conditions. The temperature is also monitored and will disable charging and discharging if the temperature falls outside the safe operating range.

2) How much power can I draw from a controller?

a. BB-04SR and BB-04FR (Same board different sizes)

The BB-04SR/FR supports up to four battery packs and a max current draw of about 13.25 Amps and 160 Watts (40 Watts per pack). The BB-04SR/FR Base Battery Management Module can support most computer

and electronics applications such as portable instruments, integrated UPS, etc.

b. MP-04SR and MP-04FR (Same board different sizes)

The MP-04SR/FR Mid Current Battery Management Modules support up to four battery packs on a single controller and can support higher power levels. The MP-04SR/FR controller provides up to 20 Amps and 240 Watts (60 Watts per pack).

c. MP-08SR and MP-08FR (Same board different sizes)

The MP-08SR/FR Mid Current Battery Management Modules support up to eight battery packs on a single controller and can support much higher power levels. The MP-08SR/FR controller provides up to 40 Amps and 480 Watts (60 Watts per pack).

d. BBDC-02R

The BBDC-02R supports up to two battery packs and has a max current draw of about 8.25 Amps and 100 Watts (50 Watts per pack). The BBDC also includes ATX power supply outputs +12V, 5V, 3.3V, and –12V. This module can be connected directly to a PC motherboard through an ATX style power connector.

e. XP-04SR and XP-04FR (Same board different sizes)

The MP-04SR/FR High Current Battery Management Modules support up to four battery packs on a single controller and can support higher power levels. The MP-04SR/FR controller provides up to 26.5 Amps and 320 Watts (80 Watts per pack).

f. XP-08SR and XP-08FR (Same board different sizes)

The XP-08SR/FR High Current Battery Management Modules support up to eight battery packs on a single controller and can support much higher power levels. The XP-08SR/FR controller provides up to 53.25 Amps and 640 Watts (80 Watts per pack).

Additional Notes:

Older First Generation Boards: BB-04 Discontinued, MP-04R and MP-08R still sold but not recommend for new designs.

Visit OceanServer's download page for mechanical drawings and 3D Models. Boards ending in "FR" are PC104 size (3.6" x 3.8"). Boards ending in "SR" boards are (2.91" x 3.58").

Boards ending in "R" are RoHS compliant.

3) Charging:

a. How does the controller charge the batteries?

The batteries are arranged in pairs. Each pair has its own power supply input for charging and supplying power to the system Each battery control pair will supply a maximum of 4 Amps of charge current at 16.8V to the batteries. They will charge simultaneously so they will charge in approximately 3.5Hours for the pair (using 95Whr, 14.4V packs). If you attach a single battery to the pair of connections leaving one unconnected, the packs will charge in under 2 hours. This wastes slots but can be used to create a system with fast charging. This will charge at the 4Amp maximum of the BA-95 pack.

There are two connections for an external supply on the BB-04SR/FR, MP-04SR/FR and XP-04SR/FR, and four connections on an MP-08SR/FR and XP-08SR/FR. Each connection is able to source up to 12 Amps of current to the system load. If the system load requires more than 12A of power per connection you could damage the IBPS. The BBDC-02R is the only exception with a only a single external supply connection.

In addition to the current being supplied to the system, excess available current will be used to charge the batteries. The excess available charge current is determined by individually monitoring the current being supplied by each external connection. The controller will divert all excess current to charge the batteries up until the total current (current to the system plus the current to charge the batteries) equals 6.6 Amps (or until the maximum battery charge current is reached).

Note, even "weak" power sources such as small solar panels can be used to power the system and charge the batteries (see OceanServer Application Note AN101 on Solar Charging). The solar panels should have an open circuit voltage of above 20V and the charger will take as much current as is produced from the solar panels. Using a 10Watt output panel it is possible to charge all eight battery packs on an MP-08 with very good efficiency at capturing the energy delivered. The DC-DC that creates the

charge voltage is ultra efficient, about 95%, harvesting most of the energy to the battery packs.

b. How long will it take to charge my batteries?

The batteries are arranged in pairs. Each pair has its own power supply input for charging and supplying power to the system Each battery control pair will supply a maximum of 4 Amps of charge current at 16.8V to the batteries. They will charge simultaneously so they will charge in approximately 3.5Hours for the pair (using 95Whr, 14.4V packs). If you attach a single battery to the pair of connections leaving one unconnected, the packs will charge in under 2 hours. This wastes slots but can be used to create a system with fast charging. This will charge at the 4Amp maximum of the BA-95 pack.

c. What voltage do I need to charge my batteries?

The input voltage range for the battery controllers is the maximum battery voltage of the battery plus 1V up to a maximum of 24V. For a BA-95, 14.4V pack that has a maximum voltage of 16.8V, an 18V power supply can be used.

d. Can I charge my batteries and run my system at the same time?

Yes, the power from an external supply can be used for two purposes. One is to charge the batteries and the other to supply power to your system. If configured properly, both objectives can be met simultaneously. The IBPS will only charge the batteries if there is sufficient current available. See question "How does the controller charge the batteries?".

e. How do I determine what size power supply I need?

If you want to simultaneously power your system and charge the batteries at the maximum rate, you will need to add the power requirements of your system and the maximum power that is used to charge the batteries up to a total of 6.6A per power supply connection. The controller can supply up to 4A of current at 16.8V for each pair of batteries (about 70W). Note that the batteries are grouped in pairs and the 4A will be divided between the two batteries if both are installed. If only one battery is installed, it can still source up to 4A.

4) What type of information can I get from an IBPS system?

Basically any info you need to fully monitor your battery subsystem (to much to list here). The most useful information that is provided is each individual batteries voltage, current, capacity, and temperature. The information is provided in a number of different formats for almost any need (real time graphs, current and voltage meters, log data, etc, all organized by battery, controller, and system). See Software section for some more details.

a. How do I get access to the battery information and status?

There are 3 ways of getting status on your batteries, on board LEDs, an optional external LCD display, or by connecting to a host system.

b. What type of information do the LED's provide?

There are 3 LEDs on the module. The first LED can give you an indication of the remaining capacity of the batteries during discharge. The second LED will give you an indication of the capacity during a charge cycle. Both of these LEDs blink about once a second and the duty cycle indicates the capacity of the batteries. The third is used in conjunction with the DC-123SR ATX Power Supply Module. This LED can be used to monitor the PS_ON# signal from the ATX power connector on the DC-123SR.

The "capacity" LEDs are routed to an external connector and can be used to control remote LEDs.

The LEDs are turned off by default to save on battery power.

c. What type of information does the LCD display provide?

The external LCD display can be used by systems that want detailed battery information without connecting to a host system. The LCD has two lines of information.

The first line displays the percentage of capacity remaining, a bar graph of the remaining capacity, which also indicates whether the batteries are charging or discharging, and the number of batteries connected to the controller.

The second line can display the current and power being sourced from or supplied to the batteries, the remaining time to fully charged during a charge cycle, or the remaining time to empty during a discharge cycle. There is also an indicator of the status of the external on/off signal.

The LCD display will also display several other status messages based on the state of the battery controller (status, shutdown, and fault conditions).

d. What information can a host system provide?

When you connect the battery controller to a host system, there are three different methods for getting information. Each method serves a different purpose depending on your application.

The battery controller contains embedded Firmware that allows it to safely operate autonomously without any host intervention. The firmware can be used to configure the battery controller and to report the status of the device operation back to a host via a serial port connection and by the LCD screen. Connecting to the firmware through a HyperTerminal will provide detailed information about each battery connected to the controller including each individual battery's status, voltage, current, capacity, and temperature. It also allows you customize the behavior of the controller to meet your specific applications needs.

The MINIBATS software application is designed to be run on the target system and monitor the fuel gauges of the battery system. It provides the basic functionality found on a laptop computer including; Shutdown when discharged, log of power consumption information and overall fuel gauge for the battery configuration.

The FULLBATS software is a useful development tool when testing or evaluating system power consumption. The tool also allows users to monitor the operation of each controller in larger configurations. The software can support up to 16 controllers (128 batteries). With this program, you can get detailed information about each battery pack.

See Software section for more details.

e. Can I save the information?

Each of the above methods of monitoring the batteries via a host system allows for logging data. FULLBATS allows for the most detailed logging. The data can be imported into spreadsheets to be reformatted into graphs etc… for more detailed analysis.

5) How do I shutdown my system when my battery power is low?

There are two methods for controlling your system when the battery power is getting low. If the battery controller is being used to power a PC, you can install the MINIBATS software. This software allows you to have the same power monitoring functionality as a laptop does. It can be configured to give a warning when the remaining battery capacity is below a user-defined percentage. It can run a user-defined program at another user-defined

remaining capacity value. It can also be configured to shut off the system at a third user-defined remaining capacity value.

The second method can be used for all other systems. The battery controller module has an external on/off signal. The behavior of the signal can be configured through the Firmware. The controller can be configured to turn your system off based on battery voltage, remaining capacity, over current conditions, number of battery packs installed, and the number of battery packs fully discharged. Each parameter can be individually set up and enabled so that if any of the above conditions are satisfied, your system will be told to shutdown.

6) How should I configure the IBPS if my system will be off for and extended period?

If your system will remain idle for an extended period, the best thing to do is to disconnect the batteries. This will reduce the discharge of the batteries. If it is impractical to disconnect the batteries, configure the Firmware to put the IBPS microcontroller to sleep.

7) Can I swap batteries while my system is running?

Care must be taken when swapping out batteries from a running system when the batteries are sourcing the power. Swapping batteries when the system is being power by the external power source is not an issue. This assumes that the power source is at a higher voltage than the batteries that are being installed.

If the power to the system is low enough that it can be supported by one battery pack, then swapping out batteries should not be an issue. If more than one battery is needed to source the power, there are two conditions that you need to worry about.

The first is condition occurs when you remove the battery that is being replaced. When the battery is removed, the current that it was sourcing will now get distributed to the remaining batteries. You need to make sure that the remaining batteries can support the extra load. Extra care must be taken when the remaining batteries are at the end of their discharge cycle.

The second condition is when the new battery is installed. If the battery being installed is at a lower capacity (ie; lower voltage) then there should be no problems installing the battery. If however, the battery is at a higher capacity (ie; higher voltage) than the current batteries in the system, you could cause an over current condition in the battery. The current being sourced from the system is shared among the batteries. The closer they are in capacity the more evenly the current is shared. If a fully charged battery is installed in a system with batteries that are at the end of the discharge cycle, most of the current will be sourced from

the fully charged battery. If the current requirement for the system is high enough and the difference in the battery capacity is great enough, you could cause an over current condition in the battery.

Section 3: Basic installation of an IBPS system

1) What are the differences between the battery controllers?

There are three classes of Battery Management Modules: The "BB" Base Battery Management Module can support most computer and electronics applications such as portable instruments, integrated UPS, etc.

Each "MP" Base Battery Management Module can have its own battery cluster of up to 4 or 8 batteries. By using an "MP" Base Battery Management Module, multiple groups of batteries can be clustered together in parallel to create one large Battery Cluster™ that is capable of outputting over 12,000 Watt-hours of power while still monitoring each individual battery pack. The "XP" family of Base Battery Management Modules are for high current application beyond what the "MP" family can support.

The BB04SR/FR, MP04SR/FR, MP08SR/FR and XP-04SR/FR, can be directly cabled to the DC-123SR ATX power module to for connecting directly to a PC motherboard ATX power connector. The BBDC-02R module has the ATX power supply on board.

The BB04FR, MP04FR, XP-04FR, MP-08FR and XP08FR are in a PC104 form factor. These can also be ordered in a slightly small formfactor ending in "SR" (2.91"x3.58"). The BBDC-02R is slightly longer and narrower than the PC104 form factor, but has mounting holes such that it can be added to a PC104 stack.

a. BB-04SR and BB-04FR (Same board different sizes)

The BB-04SR/FR supports up to four battery packs and a max current draw of about 13.25 Amps and 160 Watts (40 Watts per pack). The BB-04SR/FR Base Battery Management Module can support most computer and electronics applications such as portable instruments, integrated UPS, etc.

b. MP-04SR and MP-04FR (Same board different sizes)

The MP-04SR/FR Mid Current Battery Management Modules support up to four battery packs on a single controller and can support higher power levels. The MP-04SR/FR controller provides up to 20 Amps and 240 Watts (60 Watts per pack).

c. MP-08SR and MP-08FR (Same board different sizes)

The MP-08SR/FR Mid Current Battery Management Modules support up to eight battery packs on a single controller and can support much higher power levels. The MP-08SR/FR controller provides up to 40 Amps and 480 Watts (60 Watts per pack).

d. BBDC-02R

The BBDC-02R supports up to two battery packs and has a max current draw of about 8.25 Amps and 100 Watts (50 Watts per pack). The BBDC also includes ATX power supply outputs +12V, 5V, 3.3V, and –12V. This module can be connected directly to a PC motherboard through an ATX style power connector.

e. XP-04SR and XP-04FR (Same board different sizes)

The MP-04SR/FR High Current Battery Management Modules support up to four battery packs on a single controller and can support higher power levels. The MP-04SR/FR controller provides up to 26.5 Amps and 320 Watts (80 Watts per pack).

f. XP-08SR and XP-08FR (Same board different sizes)

The XP-08SR/FR High Current Battery Management Modules support up to eight battery packs on a single controller and can support much higher power levels. The XP-08SR/FR controller provides up to 53.25 Amps and 640 Watts (80 Watts per pack).

Additional Notes on older models: BB-04 Discontinued, MP-04R and MP-08R still sold but not recommend for new designs

2) How do you connect to the Battery Controller module?

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

3) How do you connect to the external power supply?

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

4) How do you connect to a host system?

Reference the Quick start guides and IBPS hardware manual

http://www.ocean-server.com/download.html

5) **How do you connect to an LCD display?**

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

6) **How do you connect to an external switch?**

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

7) **How do you connect to your system (load)?**

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

8) **How do you connect to a PC?**

Reference the Quick start guides and IBPS hardware manual
http://www.ocean-server.com/download.html

9) **Are there any configurable jumpers on the controller?**

There are no jumpers to configure. All configuring is done through software.

10) **What are the dimension of the various IBPS boards?**

The mechanical specs for all modules and batteries can be found at:
http://www.ocean-server.com/download.html

Also on this page are 3D IGES files (.IGS) that can be used by OEMs to help design in all IBPS components (battery controllers, batteries, and DCDC modules).

Section 4: Raw power and Regulated power

1) **What is the capacity of the batteries?**

OceanServer batteries are 95Wh batteries.

2) **How much power can the batteries supply?**

The standard battery packs allow a maximum of 6A or 8A (depending on the model) current that can be drawn from each pack at ~12V. When you add parallel packs the maximum total current supported is about 4 amps for each pack to allow margin for load balancing. These values should be used for sizing the minimum configuration needed to source your PEAK load current. Be conservative if you don't know your system peak load.

3) What is a "good" discharge rate for the battery packs?

C/3, this has the battery pack fully discharging in 3hrs.

4) What is the voltage range of a battery pack?

OceanServers 14.4V 95Wh battery packs have a voltage range from 16.8V when fully charged down to as low as 11V when fully discharged.

5) What types of regulators are available?

OceanServer has several DCDC regulators to meet almost any need. These units take the raw battery voltage from BB/MP/XP controller boards and out put various regulated voltages

a. Single output voltages

DC1U-1VR – The DC1U-1V family of regulators can output 75W and are up to 96% efficient. Output voltage range from 19V – 28V.

DC2U-1VR – The DC2U-1V family of regulators can output 240W and are up to 96% efficient. Output voltage range from 19V – 48V. Multiple regulators can be put in parallel for higher power output.

b. Multiple output voltages

DC-123SR - The DC-123SR is specially designed for the OceanServer battery controllers. The DC-123SR is cabled to the IBPS controllers to provide a completely integrated PC power system. The DC-123SR supplies 3.3V (up to 10A), 5V (up to 10A), 12V (up to 12A), and –12V through an ATX style power connector. The DC-123SR supports PS_ON# and POK# to become a battery powered ATX power supply.

BBDC-02R – The BBDC combines a dual battery controller and DC-023 onto 1 module for a very cost effective a battery powered ATX power supply. The BBDC supports 2 battery packs that supply raw battery voltage along with 3.3V (up to 10A), 5V (up to 10A), 12V (up to 7A), and –12V through an ATX style power connector. The BBDC-02R also

supports PS_ON# and POK# so it can plug right into an ATX powered motherboard.

6) What considerations do I need to consider if I am connecting an external regulator?

When connecting to an external regulator or any load, it is important that you don't overstress the battery controllers do to a high initial inrush current. If this occurs the battery controllers will create a "Power_no_good_fault". If this occurs, it may be necessary to create a special power cable that can be used to pre-charge the system. This cable can be created by putting some resistance in series with the input power. If multiple controllers are used, then the "pre-charge" cable can be removed and replaced with a regular cable.

Section 5: Software

1) What software is available?

The software for the battery controllers can be broken up into 3 parts, the Firmware, Minibats, and Fullbats (more information regarding the software, refer to the Intelligent Battery and Power System Firmware and Software User's Guide which can be found at: http://www.ocean-server.com/download.html).

a. Firmware

The Firmware controls all of the basic operation of the battery controller. It monitors charge and discharge operations. Enables the internal DC/DC converter and external user devices to shut off at the end of discharge. Provides data to a host or user via its serial communication interface. Has option for an LCD Display for charge/discharge time to full/empty and amount of current entering or leaving the batteries. Implements a user interface and menu in ASCII/English for the configuration of the device.

b. Minibats

MINIBATS operates on a Windows™ system that is being powered by the battery controller. The MINIBATS program provides functionality similar to the battery ICON located on the taskbar on laptop computers. The user can see the amount of power they are consuming and the amount of time till empty. It provides the functionality that lets the user cleanly shutdown the operating system or run user applications when the battery power is reaching the end of its capacity. This allows the user to close the program operation and save any files before the power is depleted.

c. Fullbats

The second application, FULLBATS, can be run on any Windows™ host and is used to monitor the operation of the battery system as a system

design / development tool. This program allows the user to monitor the detailed behavior of each battery in the system. The FULLBATS program is useful when developing systems. FULLBATS will monitor the status and proper operation of the battery system and log detailed data for power consumption analysis.

2) Can you get laptop power functionality with an IBPS system?

With an IBPS battery controller and software you can give any PC or other device (ie..robot, instrument) the same power functionality as a laptop. It will run on batteries when no external power is applied and when external power is applied it will be used to power your system and charge the batteries at the same time. External power can be applied and removed with out causing any power interruption to the system.

The Minibats program will also allow you to monitor the batteries and do a clean shutdown if when battery power gets low.

3) What if I don't use Window™?

If your IBPS system is connected to a host system that doesn't use Windows™, it is possible to set up the battery controller to send battery status and data to the system so it can be used by user application. The data comes in as ACII text and complies with the RS232 NEMA format.

Section 6: Batteries

1) What batteries are available?

All OceanServer batteries are 14.4V, 6.6Ah, 95Wh Lithium Ion Smart battery packs. They are organized as 4S3P and have integrated safety and fuel gauge circuits. The size of the pack is the maximum that can be shipped without falling under the DOT Class 9 hazardous goods categories. They must be shipped unplugged from our controllers when shipped.

The following table summarizes the differences between the batteries.

Battery	Cable Length*	Rough Dimensions**	Max Current
BA-95	N/A	6.25" x 4.3"	6.6A
BA-95HC	N/A	6.25" x 4.3"	8A
BA-95-FL* **	~2"	6.25" x 4.3"	6.6A
BA-95HC-FL	~10"	6.25" x 4.3"	8A
BA-95HCL-FL	~10"	11.00" x 2.4"	8A

* The cable length can be increased by using extension cables (6" extension cable 19-00035-06 and 12" extension cable 19-00035-12). The BA-95 and BA-95HC can be used to plug directly into OceanServer backplanes.
** Length dimension does not include housing for battery contacts (~.35"). See specification for exact dimensions.
*** Replaced by the BA-95HC-FL

2) What is a Smart Battery Pack?

A Smart Battery Pack is a battery pack that has integrated electronics to allow it to control the charging of the batteries instead of relying on the battery charger to control the charging. By allowing the battery pack to control the charging, the battery can specify the optimum algorithm to maximize safety and performance. It also allows the Smart Battery Charger to multiple battery configurations and chemical types.

A smart battery pack has a communication bus that reports power on each battery pack and monitors health and functionality of the individual packs. The smart battery pack provides key safety circuits and devices to keep the Li-ion cells within normal safe operating conditions, voltage, temperature, current, and charging. This technology is chemistry independent and allows support of other battery technologies such as Nickel Metal Hydride.

The original standard battery concept was launched in late 1996 by the Smart Battery System Implementers Forum - an industry body set up to create more consumer-friendly versions of the expensive, custom battery packs found in many notebook computers. In order to achieve their goals, the Smart Battery System Implementers Forum established the use of the SMBus as the method of smart battery communications and developed formal specifications for smart batteries and smart battery chargers. For more information on the Smart Battery System Implementers Forum visit http://www.sbs-forum.org/

3) What are the benefits of a Smart Battery Pack?

Smart battery packs control the charging and discharging of the battery cells within the battery pack. This allows for the batteries themselves to optimize their performance and safety and not rely on external circuits or devices to operate at its best performance. The Smart Battery Pack allows monitoring of the voltage, current and temperature of each pack to make sure it is operating within safe limits. This also allows for fully charging the packs using the IBPS Level III charger, which measures the voltage and current at the battery internal terminals. The fuel gauge and status reporting allows our composite system to use much more of the power on discharge.

Another benefit is low cost, since the cells are used in notebook computers, volumes drive production and therefore costs. Another benefit is safety electronics required for consumer products such as notebook computers.

4) What Smart Battery Packs do you support?

The OceanServer battery controllers work with all batteries that support the level 3 SMbus interface.

5) What other types of batteries do you support besides Lithium Ion?

The OceanServer controllers use standard SMB battery communications to operate battery packs so most battery packs should work. However, we only certify that our packs work with the design, the system integration / testing and battery packs support for other packs falls on the user.

6) What is the life cycle of your batteries?

OceanServer battery packs can have 300+ cycles and still maintain more than 80% of the original energy. Lithium Ion batteries also have no memory issues and low internal resistance and low self discharge.

7) How do I mount the battery packs in my system?

OceanServer has two different styles of batteries. The first are like typical laptop batteries and can be installed into OceanServer backplanes. The second type of batteries have cables that can be directly attached to the battery controllers.

8) What is the capacity of the batteries?

The BA95HC, BA95HC-FL and BA95HCL-FL batteries have a capacity of 95Whrs

9) How much power can the batteries supply?

The BA95 family of batteries can supply up to 6.6A or 8A depending on which battery. See question 6.1.

10) What is a "good" discharge rate for the battery packs?

The discharge rate of Lithium Ion battery packs should be kept below C/3 to reduce stress on the battery. The maximum supported current is about C/2 or a 2 hour discharge rate. Contact support@ocean-server.com for higher discharge rate systems.

11) What is the voltage range of a battery pack?

The BA-95 family of batteries output voltage can range from 11V – 16.8V. The system output voltage SYSPOWER is the battery voltage or the charge voltage when charging, 18V typically (24V absolute maximum)

12) How do I store my batteries?

Battery should be stored at room temperature, charged to 25% -50% charge.

Section 7: Advanced IBPS configurations

1) What are the features are available to help integrate the battery power into my application?

The battery controllers have a number of features to help integrate them seamlessly into your application some include:

- An external on/off switch input on/off signal output that can be used to turn your system off and on.
- User defined automatic shutdown of your system based on power status.
- Host monitoring software
- External LCD display support for getting detailed battery status.

See the IBPS Software User's Guide and the IBPS Hardware User's Guide for more information.

2) What are the features on the controller that can be configured?

The IBPS battery controllers have a number of settings that can be configured in firmware to fully integrate the battery power system into your application. By connecting the IBPS to a host system through a HyperTerminal (see the IBPS Software User's Guide for more information on connecting to a host system) default settings can be modified to fit your specific application needs. Some of the available parameters are listed below:

- Controller ID for systems with multiple controllers
- Switch type to support either a toggle or pushbutton switch
- External LCD display
- Sleep mode to reduce power when controller is turned off
- Automatic shutdown based on power status:
    i. Shutdown when battery capacity goes below a user defined level.
    ii. Shutdown when a user defined minimum battery voltage is reached.

iii. Shutdown if a user defined minimum number of batteries aren't present.
iv. Shutdown when a user defined number of battery packs are fully discharged.
v. Shutdown when a user defined maximum current is measured at the controller or the batteries.

Note: When building a battery cluster where the load draws much more current than a single battery can source it's critical to shutdown the load as some of the battery packs reach the end of discharge and can't provide their share of current to source the load. The automatic shutdown feature will turn off any DC-DC converters when the controller has reached the shutdown point. An external signal is driven so that user devices can turn off their load (This pin is J1-pin6, LOW=off, HIGH=on. J1-pin8 is the ground reference for this signal)

3) How do I determine the number of batteries and controllers needed for my system?

Maximum Current per battery, Discharge rate:
In our system we support a maximum battery discharge rate of C/2 for sustained operation. This works out to about 3.5 Amps per battery pack (BB family) and 5 Amps (MP family) and slightly higher draws 6.6 Amps for the XP family . If only a single battery is used in the system you can draw a higher current due to no load sharing and ½ loading of the discharge transistors.

Peak surge currents can be about 80 watts per battery pack (XP family lower for the BB and MP family). Systems with lower current draw are much more efficient (less waste heat generated) and the power loss is proportional to the square of the current. To reduce the current you need to add more battery packs to share the current.

Controller Maximum Current Limits:
The standard BB-04SR/FR controller is limited to 13.25 Amps maximum, the MP04SR/FR is limited to 20A, and the XP-04SR/FR is limited to 26.5 Amps maximum when configured with a sufficient amount of batteries (4 packs). The MP-08SR/FR can support up to 40A and the XP-08SR/FR is limited to 53.25A when configured with 8 battery packs. Note, you would never want to run a system at the maximum current limit for an extend period of time.

Over current Protection:
All of the controllers are organized as pairs of battery packs (Dual circuit). There is a fault current detector for each pair of battery packs that will OPEN CIRCUIT the path for safety reasons if it detects a current too high for the pair or a voltage too low (short circuit).

The fault will cause the POWER_NO_GOOD bit will be set on that channel. This fault should **never** happen in a properly designed and configured system. Often times it's a result of the end of discharge condition not turning off the load. As the battery packs reach the end of discharge (FULLY_DISCHARGED) they will open circuit shifting the remaining load to other battery packs.

To reset this condition all batteries and charge voltages must be removed from the system. The design of the system should avoid this condition under normal operation. The lower power limits per channel are to allow for current sharing and adding of the batteries while maintaining a safety margin.

System run time calculations:
Calculating run time: Runtime = battery's energy rating (watt-hours)/power requirements (watts). A PC motherboard that takes 20W would run for 4.75 hours with an OceanServer 95Whr battery (runtime = 95Whr/20W).

For more details see the IBPS Hardware User's Guide.

4) What does a "small" system look like?

A small system would be made up of a BB-04SR and 4 batteries. This could put out about 160W of raw battery power, about 40 watts if a single battery pack is used.

If the system is being used to power a PC, adding a DC123SR will give you a battery powered ATX style power supply. It would provide all voltages and control signals to power a PC.

If only 2 batteries were needed to power your PC, then a BBDC-02R could be used. It supports 2 batteries and has the regulated voltages integrated right on the battery controller module.

5) What does a "medium" system look like?

A medium size system would consist of an MP04SR or MP08SR with 4-8 batteries. This could supply between 240W – 480W of raw battery power. The XP-xxxx family goes up to 640 Watts with 8 batteries.

If regulated voltages were needed to power a PC, then a DC123SR could be added to support ATX voltages. For higher regulated voltages, a DC2U-1VR regulator could be added. This could support applications up to 48V.

6) What does a large system look like?

A large system would be made up of multiple MP08SR or XP-08SR controllers. Configurations can be made with up 16 controllers and 128 batteries. This is over

12,000Whr of power and almost 5000W. Even larger systems are possible and all batteries are controlled and managed individually. Each battery is monitored for safety and proper operation.

Section 8: Safety

1) What safety features are in the IBPS?

The BB, MP and XP controllers monitor the current to each individual battery. The controller is configured to shut off the system load if it detects and over current based on an individual battery or the total battery current on the controller.

The controller monitors the discharge current of each pair of batteries and looks for a short circuit (over current or low voltage). If this happens the pair of batteries is disabled and **all** power must be removed from the system to clear this POWER_NO_GOOD fault. This fault should **never** occur in a properly configured system.

During charging the controller dynamically reads the current, voltage and temperature of each battery pack in a loop. It controls the charge voltage of each battery pair so that it can be charged as quickly as possible, CC(constant current) then CV (Constant voltage). If the input current of any pack exceeds its declared maximum the voltage is lowered to bring the current back into spec. The voltage is also capped at the maximum charge voltage declared by each battery pack.

The voltage is measured at the battery pack to allow for negating any IR drops in the cables, for the maximum capacity charge. Also if the pack temperature exceeds 45C it will not charge the pack. If this happens due to self-heating during charging the charging will automatically restart when the temperature of the pack drops below 45C, this is not a fault, but may slow down the charging. The controller has what is called an SMB bus Level III charger.

2) What safety features are in the batteries?

The battery packs monitor current, voltage, and temperature. If the current gets to high on charge or discharge, the battery will open circuit to prevent damage.

It also monitors voltage to make sure the voltage on each individual cell doesn't get to high or to low. In either case the battery pack will open circuit.

The battery temperature in monitored during battery charging and discharging. If the temperature goes to high or low for charging or discharging, the battery will open circuit.

Section 9: Other info

1) What is the power consumption of some typical embedded systems or Mini-ITX motherboards?

There are various Mini-ITX motherboards and embedded systems. Typical systems take between 20 Watts and 80Watts when configured. An embedded system in this range can usually be powered from either the DC-123SR or BBDC-02R regulated DC power supplies. You can measure the total drain on the battery system using the Minibats or Fullbats programs to calculate the run-time-on-battery-power

2) Shipping info

The battery packs used with an IBPS system are designed to be no larger than 95 watt-hours and are under the DOT class 9 and UN limits so packaged properly they are shipped with hazarders goods restrictions. The assumption is that they are properly packaged in a shipping box with less that 33% remaining charge with no more than 12 smart packs in a box. When configured into your system design you need to consider the shipping restrictions.

3) Where can I find more information?

Contact OceanServer by
phone at 508 678-0550
email: info@ocean-server.com or support@ocean-server.com
or visit our website http://www.ocean-server.com/
Documentation, Mechanical Drawings and 3D Models
http://www.ocean-server.com/download.html

Section 10: Debug questions

1) Power no good status comes up
    a. Disconnect all power look for cause of over current
    b. Load requires more current than battery(ies) can support
    c. Initial in-rush current to large

2) Batteries won't charge
    a. Power supply can't support charging all batteries
    b. Power supply can't support charging all batteries and powering the load
    c. Batteries are in a "Charge Inhibit" state
    d. Battery is already 90% charged
    e. Batteries have been deep discharged, the charger provides a very weak trickle charge current, leave the batteries connected for 48 hours and see it comes alive.

3) Host can't connect management module

a. Verify COM port settings - An RS232 port that is operating at 19,200 baud, Data Bits 8, Parity None, Stop Bits 1, and no handshake
b. Make sure serial cable is a straight through
c. PIC doesn't have any power - No batteries or external power connected to the Base Controller (any power on an expander module doesn't reach the PIC).
d. PIC is asleep - Use off/on switch to turn on the controller

4) Fullbats™ doesn't see all Management Modules
   a. Make sure all Base Modules (BB-04SR, MP-04SR, or XP-04SR) are physically connected
   b. Make sure each Base Module has a unique number (see software manual for modifying the controller number)
   c. Make sure that all COM ports are configured in Fullbats.

Customer Support

Send technical questions to: support@ocean-server.com

Or call us at 508-678-0550 during normal business hours.

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