PATCO

BATTERY MANAGEMENT

PRIMARY MISSION

Military preparedness dictates that portable power be available at an affordable price. Primary batteries can be very expensive. From a long term cost perspective, the simple fact of discarding a partially used primary battery used in a training exercise yields an unacceptable dollar per watt hour. By selecting rechargable packages as the primary solution, significant amounts of money can be saved. Patco manufactures two predominant rechargable batteries, and a range of charging solutions to accompany them.

The first complete solution is found in the Patco **PB-LW-01** battery, pictured here, and described more fully later in the catalog.

This battery, used extensively in military training programs, represents an available 150 watt-hour source of renewable energy. To support the use of the PB-LW and other batteries of the same form factor, Patco provides four levels of chargers. The first, a 32 station gang charger, Model PC-3200M, has the unique feature of limiting primary power requirements to under 15 amps, so a standard wall outlet will suffice. The next, Model PC-6800 is an 8 station charger that provides for DC as one of its two recommended sources of power, and limits the DC drain to under 10 amps from a 24 VDC source. Finally, also pictured in the Li-Ion section are the PC-6200, single station charger, and the PC-6500 dual station charger. These are two bench-top chargers, a 2 station and a single station charger for individual laboratory work or limited field use.

The Model PC-3200M Lithium-Ion Charger is designed to support 32 PB-LW or UBBL03 Lithium-Ion battery packs simultaneously. The Model 3200M has a power envelope available at the batteries during charging of up to 85 watts, and comes configured for a nominal 3 amp charge rate and a four hour time out. The Model 3200M has the following basic operational characteristics.

1. Stand-by Mode - Before the battery is first connected to the charger, a voltage of 21volts is present on the charger's output pin. When a battery is dropped into a cavity, contact by the charger's pins to the battery's terminals causes that voltage to drop to between 10 and 16.8 volts per cell, the charger acknowledges the presence of a battery, and charging begins.
2. Charge Mode - The Model 3200M delivers a pulse of approximately 3 amps, for approximately 900 milliseconds. A wait period of 5 milliseconds is followed by a discharge pulse of approximately the same amplitude for a period of 5 milliseconds. Another wait period of 85 milliseconds preceeds a battery voltage measurement. If the voltage is below the established maximum voltage, another charge cycle is initiated.
3. Charge Terminate- Following the discharge pulse, and a wait time, a voltage measurement is made. If, during a period of 3 seconds or less, the voltage drops below 16.8 volts, a cycle is reinitiated. If, after 3 seconds, the voltage still has not dropped below the preset voltage, the battery is considered fully charged.

DISPLAY

Two LED's provide a status report for each battery to the user of the charger's operations. With no battery present, the Red light is on, indicating "Ready to Charge". When a battery is detected, the Green light begins to blink, meaning charging is in progress. When fully charged, the Green light will come on steadily.

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While the Model PC-3200M is designed to simultaneously charge 32 individual PB-LW or BBL03 batteries, it will charge any number less than 32 batteries placed at any station in exactly the same manner. The input voltage can be either DC or AC, with an input power requirement of 1.25 KWatts.

Specifications

Model PC-3200M

Current Limit	3Amps each battery
Voltage Limit	16.8 Volts
Terminate wait time	3 seconds
Time limit	4 Hours
DC Voltage In (Option)	22-30 VDC
AC Voltage In	95-265 VAC
Frequency In	48-70 Hz
Max Power In	1.25 KWatts

Size:
24.25" Wide, 21" Deep, 19.5" High

Construction:
Aluminium

Weight:
79 lbs., 36 Kg

Operating Temperature:
-30 to +50 Degrees C

Options:
DC Input
Fiberglass enclosure

Model PC-6800M The Model PC-6800M is an 8 station charger designed for a mobile environment. Powered by either universal AC power, or 22-30 VDC, the PC-6800 will recharge 8 PB-LW or equivalent batteries overnight, while limiting the primary power current requirement to 10 amps or less at 24 VDC.

Operations: The PC-6800 uses the same charger, pictured here, as the PC-3200. A control system monitors the insertion of batteries, and gives a "Clear to Charge" command to the first three batteries loaded. As additional batteries are inserted, the control processor assigns each a place in the queue, and as each battery charges fully, the next battery loaded begins to charge. Should any battery fail to charge within four hours, the next battery in sequence begins to charge anyway. If the battery that failed to charge had a terminal voltage above 16 volts, the Green LED is lit. If the battery voltage was below 16 volts at time-out, the Red LED will blink.

Specifications

Batteries Supported	8 PB-LW or UBBL03 in any combination
Typical recharge time	4hrs
Batteries active at one time	3
Primary power	
AC	95-265VAC, 50/60Hz
DC	22-30VDC, 10A
Maximum charge output	16.8VDC
Maximum current/battery	3A
Size	21"x17"x10"
Weight (empty)	31 lbs
Weight (w/8 batteries)	55 lbs

PATCO

The second complete solution is found in the manufacture and support of the BB2590/U battery. Possibly the most widely used form factor, the BB2590, as described in detail further in this catalog, is supported by a number of charging solutions. The Model PC-6400M is a 150 watt charger that charges a single BB2590/U, addressing each side independently while charging.

The PC-6400M uses either universal AC power, or 22-30 VDC as its primary power, drawing up to 175 watts from its source. The charge algorithm employed is the same as the previous chargers, i.e., a pulse for less than a second, a short discharge pulse, followed by a wait and measure interval. The status lights on the front panel represent the status of each individual side of the BB-2590; Red ON indicating ready to charge or no battery present. Flashing Green indicates the battery is present and charging has begun. Steady Green indicates charge complete. Flashing Red indicates the charge process failed for some reason. By charging each side independently, the PC-6400M will recharge the BB-2590/U faster than any other charger, or in less than 3 hours.

Specifications

Power in:		
	AC	95-265 VAC,50/60 Hz
	DC	22-30 VDC, 7 Amps max
Charge out:		
	Each side:	16.8VDC @ 3.5A
Case:		Hermetic sealed fiberglass
Size:		10”x16”x8”
Weight:		8 lbs, 3.5 Kg

The Model PC-6500M address two BB-2590/U at the same time. Paralleling both sides at each connector, the PC-6500M charges two from full depletion to full charge in just under 5 hours.

Specifications

Power in:		
	AC	95-265 VAC,50/60 Hz
	DC	22-30 VDC, 7 Amps max
Charge out:		
	Each battery:	16.8VDC @ 5A
Case:		Hermetic sealed fiberglass
Size:		10”x16”x8”
Weight:		8 lbs, 3.5 Kg

PATCO

Lithium Ion Batteries

Patco provides cylindrical 18650 cells, configured into a number of unique batteries. These batteries are available in a variety of capacities, and can be combined in series/parallel combinations to cover four basic voltage packages.

Effective Protection Circuit

Every Li-Ion pack is equipped with the appropriate electronic protection circuits, from 1 to 4 cells in series, and from 1 to 4 cells in parallel. These provide reliable protection against overcharge (4.2 V/cell), over discharge (2.5 V/cell), and over current (charge and discharge). In addition, Patco can incorporate state-of-the-art capacity monitoring circuits in the batteries. These can range from simple gas gauge measuring to more complete data reporting via smart battery technology such as SMBus.

PB-LW-01

An example of Patco's packaging capability is shown, a PB-LW-01. The PB-LW-01 is a 4S4P Li-Ion pack of 2.4 Amp-Hour 18650 cylindrical cells, having a total capacity of 9+ amp-hours at an average of 15.6 volts. This model comes with all protect electronics, gas gauge, and SMBus technology. It represents an excellent energy value for the cost.

Specifications

Voltage Range:	12 to 16.8 volts
Average Voltage:	15.6 volts
Nominal Capacity:	9 Amp Hours
Energy Density:	193 Whr/L, 120 Whr/Kg
Weight:	1000 grams, 2.2 lbs
Oper.Temp.Range	-20^0 to 60^0 C
Storage Temp.Range	-20^0 to 50^0 C
Housing:	Hard plastic case
Max. Discharge:	5 Amps
Self-Discharge:	<10% per month
Cycle Life:	>350 Cycles @ C/2

A further example of Patco's expertise in battery packaging is found in a typical military battery, the BB-2590/U. This battery contains two independent 4S3P packs of the Li-Ion cylindrical 18650s, two independent State of Charge Indicators, and pack protection electronics with short circuit proof controls. In addition, the control processor for each side monitors the stack voltage, shutting off the output when the output voltage indicates the cells have expended 99% of their available energy. This significantly extends the useful cycle life of the battery.

BB-2590/U

Specifications

Description:	Two independent 15V Sections, each with separate pack protection circuits and capacity gauge	
System:	Lithium Ion Rechargeable 2 each 4S3P 18650 cell packs	
Voltage:		
	Maximum:	16.8 or 33.6 Volts
	Typical:	15.6 or 31.8 Volts
	Final:	13.2 or 26.4 Volts
Connections:	At the connector, each section can be connected in parallel or in series	
Capacity:		
	15 Volt mode (20C):	12 AHr
	30 Volt mode (20C)	6 AHr
Max. Discharge:	10 Amps Continuous, parallel mode	
Weight:	1500 grams, 3.3 lbs	
Oper.Temp.Range	-20^0 to 60^0 C	
Storage Temp.Range	-20^0 to 50^0 C	
Terminals:	Floating Type per U.S.Army Drawing # SC-C-179495	
Housing:	Hard plastic case	

PATCO

Lithium Ion Chargers

Patco manufactures four commercial Li-Ion chargers, designated Model PC-6040, Model PC-6050, Model PC -6200 and Model PC-6500. All four of these chargers utilize the Li-ion charge algorithm described in the section on algorithms. These chargers differ in power out to the battery, and how the charge voltage is generated.

Model PC-6040 The model PC-6040 uses a low voltage input, generated by a wall mounted transformer, with a power envelope of 30 watts. The bulk charge current is then determined by dividing the battery voltage into 30, with a current limitation of 2 amps. The low voltage input is determined by the voltage of the battery to be charged. The unit is available for domestic use with a wall transformer using 115 VAC, 60Hz as its input. The Model 6050 uses a universal input power supply, and a power envelope to the battery of 30 watts. The bulk charge current is determined by dividing the battery voltage into 30, with a current limitation of 2 amps.

Model PC-6050

To specify the charger, select the appropriate model as before, then the number of cells, finally the constant current charge current. Use the format:

AAAA-B-CC

AAAA is the model number, such as 6040. B is the cell count, from one to four. CC is the constant current charge current specified to two significant figures. For a Model PC-6040, charging 2 each 2.4 AHr cells in series, the specification would read:

6040-2-12.

Model PC-6200

The Model 6200 Lion Charger is designed to support Li-Ion batteries in the range from 1 to 10 Amp Hours of capacity, with full charge pack voltages from 4.1 to 16.8 Volts. The Model 6200 has a power envelope available at the battery during charging of 80 watts, and comes configured for a nominal C/2 charge rate and a nine hour time out.

Ordering Information

6200-4-50

4 is the number of cells in series, 5 is the initial charge current in amperes to two significant figures.

Model PC-6500

The Model 6500 Lion Charger is designed to support 2 Li-Ion batteries simultaneously in the range from 1 to10 Amp Hours of capacity each, with full charge pack voltages from 4.1 to 16.8 Volts. The Model 6500 has a power envelope available at the batteries during charging of 160 watts, and comes configured for a nominal C/2 charge rate and a nine hour time out.

PATCO

Lithium Ion

Lithium Ion, or Li-Ion, uses two charge algorithms in Patco chargers. For most applications, especially those characterized by short wiring harnesses within the battery, the Pulse Charge algorithm works best. It is relatively impervious to contact resistance, wire length, etc., because it does not make voltage measurements at the battery while current is flowing. For situations where attention to proper wire dress within the battery is missing, Patco employs a linear charger with the conventional current limited, constant voltage charge curve. In either case, if a voltage measurement were made at the battery terminals, a curve such as **Fig. 1** would result. **Fig. 2** is a representative charge cycle for the Pulse Charger.

1. Stand-by Mode - Before the battery is first connected to the charger, a voltage of 4.95 volts per cell is present on the charger's output pin. When a battery is connected that causes that voltage to drop to between 2 and 4.35 volts per cell, the charger acknowledges the presence of a battery, and charging begins.
2. Charge Mode - The charger delivers a pulse of approximately C/2 rate to the battery for approximately 900 milliseconds. A wait period of 5 milliseconds is followed by a discharge pulse of C for 5 milliseconds. Another wait period of 85 milliseconds preceeds a battery voltage measurement. If the voltage is below 4.2 volts per cell, another cycle is initiated.
3. Charge Terminate - Following the discharge pulse, and a wait time, a voltage measurement is made. If, during a period of 3 seconds or less, the voltage drops below a preset voltage per cell, typically 4.2 volts/cell, a cycle is reinitiated. If, after 3 seconds, the voltage still has not dropped below the preset voltage, the battery is considerd fully charged, and the process is completed.

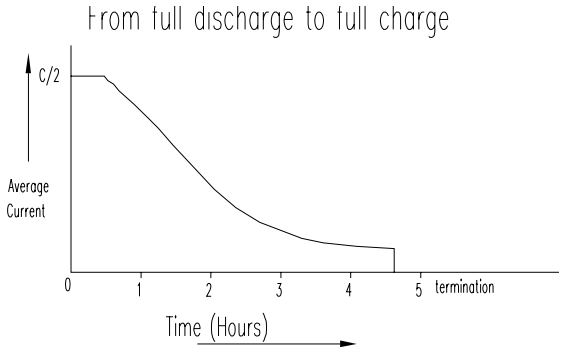

Fig. 1

In this case, a constant current is supplied to the battery until the battery terminal voltage reaches 4.2 volts per cell. The charger then changes to a constant voltage source at 4.2 volts per cell, and the current tapers until it reaches 1/10 of the original constant current. The constant current, referred to as the bulk charge current is nominally set to the battery capacity divided by 2, and expressed in amperes. **Fig.1** shows the current to a Li-ion battery as it is brought from full discharge to full charge.

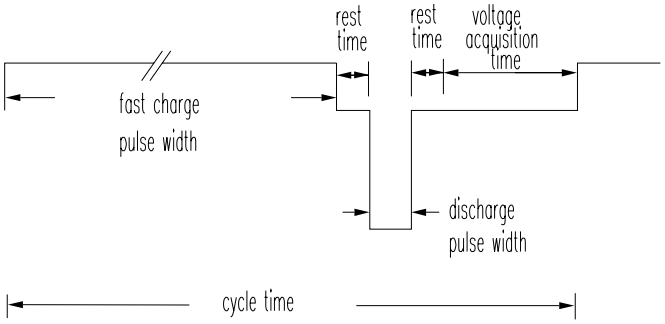

Fig. 2

Specifications

	Model PC-6050	Model PC-6200	Model PC-6500
Current Limit	1.5 Amps	5 Amps	5 Amps each battery
Voltage Range	4.2-16.8 volts	4.2-16.8 volts	4.2-16.8 Volts
AC Voltage In	95-265VAC	95-265 VAC	95-265 VAC
Frequency In	50/60 Hz	50/60 Hz	50/60 Hz
Max Power In	40 watts	125 watts	250 Watts
Max Power to Battery	30 watts	80 watts	80 watts each
Size	5.25"x3.5"x2.5"	8"x5.5"x3"	8"x5.5"x3"
Weight	1.75 lbs, .8 Kg	3.25 lbs, 1.5 Kg	3.5 lbs, 1.6 Kg

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Nickel

Nickel cadmium batteries utilize the same charge algorithm as nickel metal hydride. This algorithm, as discussed under Nickel algorithm is implemented in Patco's 4 charger NickleMinder product line.

Model 8040 These chargers are primarily differentiated by their source of primary power. The Model 8050 can be powered by any AC voltage from 95 to 265, 50/60 Hz. The Model 8040 is powered by a UL approved external transformer.

To charge a nickel cell, end of charge voltages approximating 1.6 volts per cell must be anticipated. The chargers have a power out envelope of 30 watts to the battery. Therefore, when determining the charge rate, the number of cells to be charged must be multiplied by 1.6, and the resultant number divided into 30. This will determine the maximum charge current available, thus determining the time for charge in hours.

To specify the charger, select the appropriate model number, select the charge rate, such as 1, 2, or 4 hour charge. Specify the cell count, and the battery capacity in amp hours.

AAAA-BB-CC-DD

How a charge is terminated is consequential for repeated performance and safety. For battery packs employing cells smaller than "C", Patco typically employs voltage termination. That is, a point of inflection is calculated from repeated voltage measurements, and when the point occurs, charge is terminated. For larger cells, temperature termination is recommended (dT/dt). The termination is communicated in the charger specification by affixing the letter T or V to the end of the part number.

Model 8200 These chargers are differentiated by the number of batteries they can charge, hence the power of the platform. The Model 8200 can charge one battery, up to 80 watts. The Model 8500 can charge up to two batteries, at up to 80 watts per battery, for a platform power of 160 watts. Their model numbers are specified as the previous examples. **Model 8500**

NiCad and NiMH Batteries

Patco provides both Nickel Cadmium and Nickel Metal Hydride batteries. These batteries are available in a wide range of conventional packages. Quotations for individual cells or battery packs with or without internal intelligence are available on request.

PATCO

Specifications

	Model PC-8050	Model PC-8200	Model PC-8500
Current Limit	1.5 Amps	5 Amps	5 Amps each battery
Voltage Limit	3 - 30 volts	3-30 volts	3-30 Volts
AC Voltage In	95-265VAC	95-265 VAC	95-265 VAC
Frequency In	50/60 Hz	50/60 Hz	50/60 Hz
Max Power In	40 watts	120 watts	240 Watts
Max Power to Battery	30 watts	80 watts	80 watts each
Size	5.25”x3.5”x2.5”	8”x5.5”x3”	8”x5.5”x3”
Weight	1.75 lbs, .8 Kg	3.25 lbs, 1.5 Kg	3.5 lbs, 1.6 Kg

Nickel

For both Nickel Cadmium (NiCAD) and Nickel Metal Hydride (NiMH), we use a common algorithm. The charge process consists of a four phase charging cycle, producing superior results in both chemistries.

1. Soft Start Mode - Used when the battery has been discharged. This gradually increases the charge current over the first two minutes of the charge process.
2. Fast Charge Mode - A constant current applied until termination.
3. Topping Mode - This mode completes the charge process, supplying C/10 for two hours after termination of the Fast Charge Mode.
4. Maintenance Mode - This mode supplies C/40 continuously to counter the self discharge of the battery.

Fig. 3, shows the complete charge process. During the first two minutes of the charge cycle, the battery is supplied an increasing current, starting at .2 times the selected fast charge current. At the end of two minutes, full fast charge current is reached. Once termination has occurred, charge current switches to a C/10 charge rate to “top off” the battery. This process lasts for about two hours. The final mode of operation is a steady current at C/40 to compensate for the natural self-discharge of the battery.

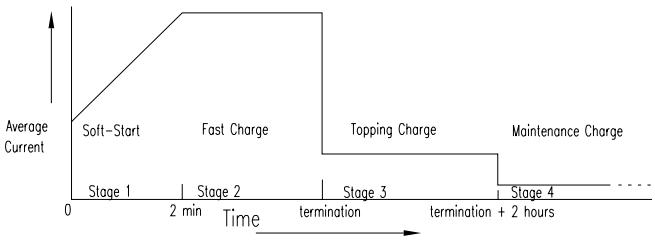


Fig. 3

These modes of operation are unchanged regardless of the termination method used. For smaller cells (smaller than C), the classic charge voltage curve, with a peak at the end of charge is dependable. For these circumstances, and for those situations that cannot have a thermocouple installed, we use Voltage Terminate.

The charge controller samples battery voltage once per second, constructs a voltage curve from the data points, and calculates the first derivative of the voltage curve. When the slope of the voltage curve goes to zero, the fast charge mode terminates. For larger cells, such as D and F, there are oscillations in the charge voltage curve that occur at about 20% of charge, and can be confused with end of charge curve characteristics.

When it is possible to embed a thermocouple (we use a 10K NTC thermocouple), the user receives two advantages. The first is safety, because the controller not only uses the temperature information to determine termination, but an absolute temperature is set that will prevent the battery from overheating if end of charge is missed.

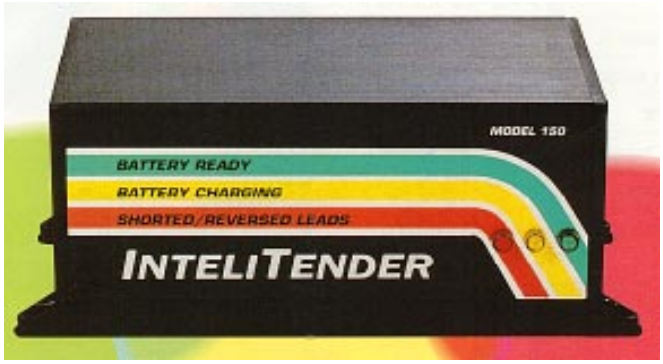
When Temperature Terminate is chosen, a dT/dt of 1 degree C per second is established as the termination criteria. There are circumstances, especially with NiMH cells, that cause rapid increases in temperature throughout the charge. For this reason, Patco asks that the final battery configuration and sample be provided for a “First Article” test before production.

When generating a specification for any of Patco’s NickleMinders, a “V” at the end of the specification denotes voltage termination, and a “T” denotes temperature terminate.

PATCO

Lead Acid

Patco utilizes different charge algorithms for lead acid batteries, depending on the battery construction. For parallel plate Sealed Lead Acid (SLA) and GEL batteries, Patco employs the Unitrode 2906/3906 charge controller. The algorithm is primarily a constant current up to 80% of charge, switching to constant voltage through full charge, finally switching to a temperature compensated float charger to maintain the battery at full charge.



The InteliTender **Model 150** is the most economical of Patco's lead acid chargers. It can be purchased for three different battery voltages, 6 - 8 - 12 volts, and a wide range of charge currents. To order a Model 150, the following part number must be developed.

150-AA/BBB

AA is the specification for nominal charge voltage. BBB is the bulk charge current in milliamps. The Model 150 is available with an external UL approved transformer supplying the low voltage input, or as a DC input version. For these two situations, the suffix UL or D is appended to the model number.

BBB is the bulk charge current. If left blank, the charge current for the 6,8, and 12 volt chargers is 1.5 amps. For batteries whose capacity is less than 12 amp hours, the charge current should approximate a ten hour charge. For a 7 amp hour battery, the charge current should be set to 750 milliamps.

An example of this model number scheme for a 12 volt battery, battery capacity 5 amp hours:

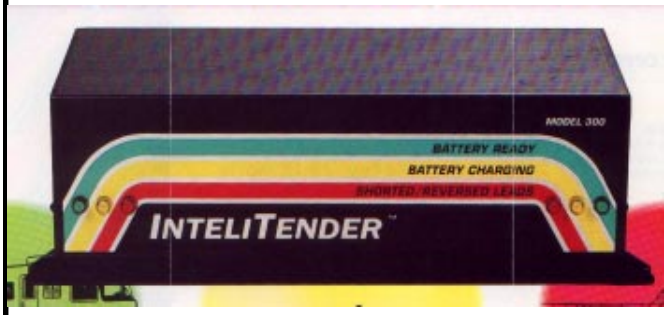
150-12-500.

This translates into a Model 150, charging a 12 volt battery with a bulk charge current of 500 milliamps.

For a portable application where the charger needed to operate from a vehicle's 12 volt system, a D would be appended. For a 12 volt , 1.5 amp charger with DC power, the specification is:

150 - 12D

The **Model 300** is a dual output version of the Model 150. With two fully independent outputs, the Model 300 is an ideal charger for any two battery configuration. While lacking the Model 150's input power versatility, the Model 300 can be configured for three different battery voltages and the same versatility in output current.



The Model 300 part number is configured much the same as the Model 150. Its format is:

300-AA-BBB

AA is the battery voltage, and can be 6,8, or 12 volts. BBB is the bulk charge current. If omitted, the output current is 1.5 amps. The Model 300 is only available with a self contained transformer, operating at a nominal 120 VAC, 60 Hz. An example of a Model 300 designed to charge two 7 amp hour, 12 volt batteries connected in series would be:

300-12-750.

Universal Input Lead-acid chargers
Model PC-7050

PC-7050

PATCO

For parallel plate lead acid, Patco manufactures chargers capable of bulk charge currents of up to 5 amps. These are referred to as the 7000 series, and are available in either single or dual output configurations. The single output five amp charger is the **Model 7200**. It can be purchased in three output voltages, with universal input power. An example of the model number for a 12 volt Model 7200 charging at the maximum rate of 5 amps would be:

7200-12-50

The same basic instrument is available in a dual output version, the **Model 7500**. Like the Model 7200, the Model 7500 is available in 6,8, or 12 volt outputs, with universal input power. To order a Model 7500 for 12 volt batteries, charging at a rate of 5 amps each, the model number would be:

7500-12-50

Charge Algorithms

The shape of the charge curves for battery voltage and the current supplied to the battery during charging is referred to as its charge algorithm. Not only do various battery chemistries differ in how they must be charged, but within a particular chemistry, the actual cell construction can require a unique charge algorithm. While it is beyond the scope of this catalog to explain the complex chemistry behind each charge algorithm, we will attempt to define the more basic algorithms employed at Patco, and illustrate their basic characteristics.

Lead Acid

Conventional parallel plate lead acid batteries need approximately 1/10 of their capacity in amp hours supplied as a constant current during the first eighty percent of the charge restoration process. Since the basic chemical reaction changes at that time, and additional gas is produced, the charge current needs to taper during the completion of the charging process, ending at 1/3 to 1/10 of the current supplied during the bulk charge phase. If a constant current source is used for the bulk charge phase, then a constant voltage source used during the second phase, the basic requirements will be met, and the resultant battery charge current curve approximates that shown in **Figure 4**.

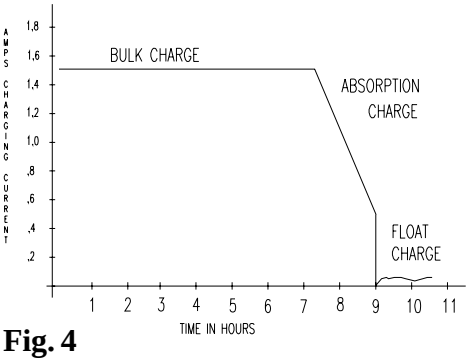


Fig. 4

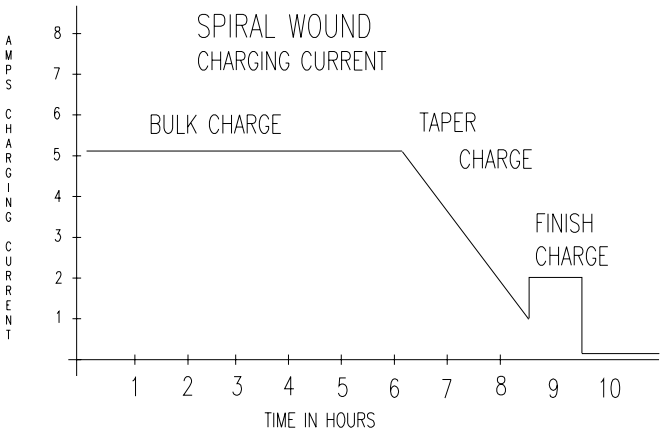
Specifications

	Model PC-7050	Model PC-7200	Model PC-7500
Current Limit	1.5 Amps	5 Amps	5 Amps each battery
Voltage Limit	6 - 24 Volts	6-12 Volts	6-12 Volts
AC Voltage In	95-265VAC	95-265 VAC	95-265 VAC
Frequency In	50/60 Hz	50/60 Hz	50/60 Hz
Max Power In	45 watts	125 watts	250 watts
Max Power to Battery	30 watts	80 watts	80 watts each
Size	5.25”x 3.5”x 2.5”	8”x 5.5”x 3”	8”x 5.5”x 3”
Weight	1.75 lbs, .8 Kg	3.25 lbs, 1.5 Kg	3.5 lbs, 1.6 Kg

PATCO

Spiral Wound Lead Acid

Identical in size and power to the parallel plate Series 7000 chargers, the 7000C series address a unique construction style within the lead acid family. Specifically designed to work with Spiral Wound lead acid cells, the chargers begin charging using a current limited constant voltage source set to 14.75 volts. When the charge current tapers to 1 amp, the charger switches to a constant current mode, supplying 2 amps for one hour. At the end of this hour, the charger changes to a constant current set to .1 amps as a maintenance mode current.



Patco makes the same basic instrument as the 7000 series in a Spiral Wound version. To specify the Spiral wound algorithm, add the letter C to the end of the model number.

7500-12-50C

This is an example of a 12 volt, 65 amp hour spiral wound battery manufactured by Optima Batteries, Inc. Note the cylindrical shape of the individual cells.

PATCO

ZIPCORD™

Patco Electronics announces the ZipCord, an exciting new source of renewable energy. Utilizing the latest technology in SAFT Lithium Ion cells, and a precision converter for charging, the ZipCord offers 50 watt-hours of renewable energy in a two pound package.

The ZipCord can be recharged from its supplied power source or from an optional DC power source supplied for your instrument. Recharge times vary from 6 hours for the standard power source, to 3hours for the optional supply. In addition to this flexibility, the ZipCord contains a "Gas Gauge" that indicates the remaining available energy to an accuracy of better than 5%. Because the ZipCord keeps the heat away from the batteries, battery life is more than doubled.

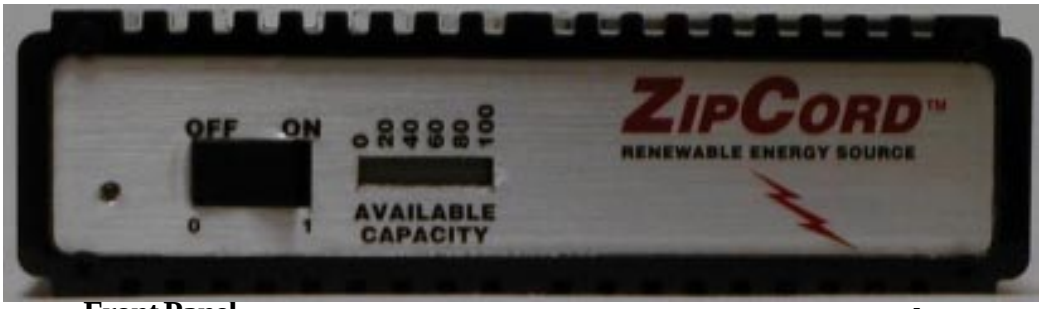
Specifications

Weight:	2 lbs.,8 oz
Dimensions:	5.6"w,5.5"l,1.6"h
Charging voltage:	24 VDC
Charging current:	.8 to 2 amps
Output voltage:	5 - 24 VDC
Output power:	50 watts maximum
Total Energy available:	60 WHrs,10 hr rate

Accessories

Carrying Case provides a convenient way of keeping the ZipCord nearby. A detachable shoulder strap may be used, or a belt threaded through two slots on the back side are used for convenience. If the ZipCord is ordered with a twelve volt output, a lighter socket is attached to the end panel for conveniently attaching a power cord.

High Speed Charger provides 24 VDC at 2 amps yielding a 3 hour recharge from full discharge.



Front Panel

Rear Panel

Indicators:

1. A Green light on means the ZipCord has been connected to external power, and is monitoring the battery's State Of Charge.

2. A Flashing Green light means the computer determined that the battery needed charging, and is proceeding to restore full charge to the battery.

3.The Gas Gauge informs the user of the battery's State Of Charge, and is continuously available, during both charge and discharge.

Controls:

The On/Off switch activates the DC-DC converter that regulates the output of the ZipCord. Switching this to the off position when not in use eliminates the drain on the batteries, significantly extending the time between recharges.

Power Jacks:

The Round jack provides for power into the ZipCord for recharging its battery. Employing an advanced charger, the ZipCord can be recharged using the supplied power pack, or from an optional power pack providing universal AC input. The AC wall adapter supplied with the ZipCord recharges in approximately 5 hours.

The Rectangular jack provides for power out of the ZipCord. When ordering, the plug size of the instrument to be powered must be specified. A six foot cord, coiled for compact storage, can be ordered with the appropriate mating connector to connect the ZipCord to its load.

PATCO

Non-Volatile
State of Charge Indicators

Patco offers two Non-volatile SOCI's. One with an LCD display and one with an LED display. Representing the State of the Art in "Fuel Gauging", these SOCI's store their Net Available Charge every measurement cycle. Then if power should be removed, and later restored, the data presented by the display would represent the last measured State of Charge, instead of the usual reset value. Their features include:

1. 8-bit microcontroller architecture
2. 14-bit analog-to-digital conversion
3. LCD or LED battery status display
4. Accurate "Fuel Gauging"
5. Low power consumption
6. Programmable cell model parameters
7. Programmable discharge termination thresholds

Applications

Lithium Ion/Polymer: Lithium rechargeables have pack protection devices that open the pack to the outside world under certain circumstances. Because the SOCI is located "downstream" of the pack protect, power may be interrupted to the SOCI even when the State of Charge is above 90% of capacity. When that happens, power is interrupted to the SOCI as well as the outside world. When the error condition that caused the pack protect to open has been removed, the SOCI should accurately reflect the true SOC for the pack. By using a non-volatile storage device, the SOCI resets to the last measured SOC, instead of some nominal pack capacity or zero.

Lithium primary: When Lithium primary batteries, such as LiSO2 and LiMnO2 are discharged, they can go to zero volts if the load is applied. When the load is removed, they may recover to full battery voltage, although with only a few percent of deliverable capacity. It is vital that a SOCI reflect the true depleted value of the pack, even though the battery voltage returned to near normal status. By continuously storing the true SOC, when battery voltage returns, the true Net Available Charge will be displayed.

General Description

The State of Charge Indicator (SOCI) has the primary function of providing accurate fuel-gauging information allowing the user to make intelligent decisions regarding the use of portable power.

The fuel gauge calculates the State-of-Charge (SOC) by integrating the discharge current of the attached battery, and subtracting that value from the Net Available Capacity prior to the measured discharge. To achieve the desired accuracy, compensation factors are continually applied to account for battery non-linearity and environmental conditions. This approach provides the user a more meaningful and repeatable capacity measure with minimal risk of overstating run time.

The system has two modes of operation: the suspend mode and the active mode. In the suspend mode, battery energy is conserved to minimize battery drain. The suspend mode is entered when the system senses no activity present. While in this mode, battery parameters continue to be monitored at regular intervals to compensate for the self-discharge capacity losses. The system will continue in this mode until it senses activity.

The active mode is entered when charge or discharge current is detected. The system determines that charge or discharge current is flowing, and enters the active mode.

The SOCI displays the battery capacity information using either a five segment LCD or a 5 LED display. Each element represents a percentage range of the full charge capacity. The first segment/LED will blink when net available capacity is between 1% and 5% of total capacity. That display element will be stable on between 5 and 20% of total capacity. Each additional element represents Available Charge within its respective 20 percentile. The relative percentages for each display element are programmable.

Power Consumption:	Active	1.5 mA
	Suspend	100 uA

PATCO

Inside the Pack

Patco's electronics move inside the pack with several offerings. One example is the SOCI combined with a Complete Discharge Device (CDD) employed with high energy Lithium based primary batteries. Using a simple pull-tab, Patco combines the 5 segment LCD SOCI with the CDD on a footprint .9" x 2.4".

For Lithium Ion rechargeables, Patco combines the 5 segment LCD SOCI with a pack manager, available for 1,2,3, or 4 series configurations of Lithium-Ion. This board comes in a 1.5" x 2.6" footprint. For those who prefer, the same basic circuit is also available in a LED version. Since it is always a question of why, when the pack protect activates, Patco uses the combined intelligence of the pack protect and the SOCI computer to report the failure mode of the battery. Each of the five display devices will blink independently when the pack manager restores power, giving the most probable cause of power interruption.

Patco makes an "in-the-pack" charger. Using a universal charge chip, the Patco charger can be configured for 1 to 4 cells in series, and charge current in 125 milliamp increments from 250 ma to 4 amps. The charger footprint is 1.5" x 2.6".

Patco also makes a DC-DC converter that operates up to 50 watts, with up to 93% efficiency. This unit is available combined on one board with a charger, pack manager, and LCD SOCI for a complete portable power solution. Designed to support up to a 120 watt-hour Lithium Ion pack, the output power envelope is 50 watts, with output voltages up to 30 volts.

PATCO

A Brief history

Patco was founded in the fall of 1992, for the purpose of providing the electronics industry with state of the art battery management tools spanning the chemistries employed in secondary batteries. The first product was a battery manager for lead acid batteries designed around the Unitrode 3906 lead acid controller. From there Patco has expanded the lead acid line to include higher current managers for larger batteries, and algorithms for unique construction of lead acid batteries. NiCAD and NiMH managers designed around specialized controllers came next. A third product line addresses the medium prismatic Lithium Ion batteries manufactured by Saft America.

Patco has developed a new technology for battery management equipment. Heat is the enemy of electronics, interfering with both the life expectancy of electrical elements employed in the battery manager itself, and the sensing of temperature in the battery being managed. Through a proprietary method of control, Patco's engineering group has developed a technique of feeding back control information from the battery management chip to control a primary switching circuit producing the low voltage power for the battery. This approach eliminates much of the heat that would have to be dealt with by conventional approaches.

As of the fall of 1996, Patco Electronics occupies its own 10,000 square foot facility, situated on five acres in Spaceport Center Industrial Park, just outside Kennedy Space Center.

Frequently Asked Questions

How do I determine if Patco can help?

Patco's business is the intelligent application of technology in such a way as to cause a battery to perform at its optimum. If the application is simply throwing charge at a battery, such as a car or boat, then inexpensive chargers available at mass market outlets will suffice. If the battery is used in a consumer application where charge time is not critical, then trickle chargers available through local hardware or electronic outlets will suffice. If the battery must perform nominally under unusual circumstances such as temperature, recharge time, or if storage capacity is marginal, then Patco can be of substantial assistance.

What do I need to know when contacting Patco?

Patco engineers will need to know first the chemistry of the battery in question, and any uniqueness in the battery construction such as Spiral Wound lead acid as differentiated from conventional parallel plate GEL or SLA batteries. Further, the conditions surrounding the application will permit critical analysis of the battery type and characteristics to ensure adequate performance. Finally, information such as capacity in amp hours, ending battery voltage after charge and after discharge will permit the selection of the best charger characteristics for the particular application.

Can Patco supply my battery requirements?

Patco frequently is involved with the selection and supply of batteries. Key characteristics such as buried intelligence in the battery pack, data reported between the battery and its application, as well as the battery and its charger dictate that Patco assist in the design of the battery/charger combination, as well as supplying the finished, tested product for inclusion in the customer's end product.

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