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## User's Manual

# Automatic Switching-Mode Battery Charger

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MODEL HB600-24B

## IMPORTANT

Read, understand, and follow these safety rules and operating instructions before using this battery charger. Only authorized and trained service personnel shall be permitted to operate or perform any maintenance or service. This manual should be considered a permanent part of your machine and should remain with the machine at all times.

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# Safety


## Danger

Failure to obey the safety rules and instructions in this manual will result in death or serious injury.

## Label and Safety Rules Legend

 **DANGER** Indicates the presence of a hazard that **will** cause death or serious injury

 **WARNING** Indicates the presence of a hazard that **may** cause death or serious injury.

 **CAUTION** Indicates the presence of a hazard that **will** or **may** cause serious injury or property damage.

## **Safety: General**

- Do not operate a charger that is not working correctly. An electric shock hazard or battery explosion hazard from overcharging may exist.
- Do not attempt to service the charger yourself unless you are a trained service technician. The warranty is void if the charger case has been opened. Always follow installation instructions closely. The high voltages inside the charger are a shock hazard and can cause serious injury or death.
- Though the charger is resistant to water and spray washing do not fully immerse or spray wash for an extended (more the 5 seconds in one position) time. Liquid can get inside charger and may cause serious injury or death.
- The charger is designed for use in industrial areas. It is not designed to be used in medical (hospital) environments where interference with life critical equipment could cause death or serious injury.
- There could be a spark during charging. Be careful when using fuels, solvents or other flammables near the charger or batteries. An explosion could result causing death or serious injury.
- The charger surface can get hot while operating and contact with the skin or surrounding materials should be avoided.

## **Safety: Power**

- To reduce the risk of an electric shock, connect only to a properly grounded single-phase (3wire) outlet.
- Ensure that the AC voltage supplied to the charger is within the ranges in the specification table. Voltages outside this range, particularly high voltages, can result in an electric shock and fire hazard.
- If you use an extension power cable with your charger, ensure the total current draw of the items plugged into the extension power cable do not exceed the current rating of the extension cable and meet all national and

local electrical code requirements. See Specifications page for current draw of charger. Overloaded extension cords can catch fire and cause property damage, serious injury or death.

- Do not operate charger if wiring is damaged including cut insulation or pinched wires. An electric shock could cause serious injury, or death.
- The charger includes an interlock relay to prevent the machine from operating while charging. Please see the machine manufacturer's documentation for correct wiring and test to ensure correct operation.

## **Safety: Batteries**

- See battery suppliers guide for proper care of batteries and follow directions carefully. Failure to follow battery care instructions can result in battery explosion and property damage, severe injury, or death during charging.
- When attaching charger leads to battery terminals be careful that tools do not short between battery terminals. Shorting between battery terminals may cause extreme arcing resulting in explosion or extreme heat that can cause burns.
- Do not disconnect charger terminals while batteries are charging. Sparking can occur which could ignite flammable battery gases and cause an explosion. Always turn the charger off first (unplug from AC).
- Do not touch battery terminals or any exposed electrical parts. Contact with battery terminals or other exposed electrical parts may cause an electric shock. Remove all watches, rings, and jewelry to avoid arcing and electric shock.

# Operation



**WARNING:** There could be a spark during charging. Be careful when using fuels, solvents or other flammables near the charger or batteries. An explosion may result causing serious injury or death.



**WARNING:** To reduce the risk of an electric shock, connect only to a properly grounded single phase (3wire) outlet. Electric shock hazard may cause serious injury or death.



**CAUTION:** To reduce the risk of fire, use this charger only on AC circuits and extension cords capable of handling the AC Input currents (Max. Amps) defined in the electrical specifications. Use must be in accordance with all National and Local Electrical Codes for the location of use. Overloaded cords or circuits present a fire and shock hazard and may result in property damage, serious injury, or death.







**CAUTION:** The charger surface may get hot while charging. Avoid skin contact with the charger surface. Keep surrounding materials away from charger surface to avoid heat damage and to allow cooling.

- 1) Determine whether flooded or GEL (sealed) type batteries are being charged. The charge profile is set by a yellow wire loop at the back of the charger. If the yellow wire is a loop (connected) at the time of the charger start up (plugged into AC voltage), then the charging will be for a flooded battery. If the yellow wire loop has been cut (opened) before charger start up then charging will be for a GEL type battery. The selected profile is valid until AC power is turned off
- 2) Plug the charger into a single phase AC socket with a nominal voltage rating of 100V, 110V, 115V, 120V, 220V, 230V, or 240V and a frequency rating of 50 or 60Hz. The charger automatically senses and adjusts to the AC voltage and frequency
- 3) The charger will start charging the batteries automatically within a few seconds. Even severely discharged batteries will be charged as long as the battery voltage is greater than 1V.
- 4) The four LED's indicate the charging progress and problems. The first (leftmost) yellow LED lights to show there is AC power to the charger. The second from left, yellow, "75%" LED lights to show that the batteries are being charged. When the batteries are fully charged the third, "100%" green LED lights as well.

- 5) If the charger is left plugged in after charging is complete (all LEDs on) the charger goes into maintenance mode to keep batteries charged while in storage. The charger continuously measures battery voltage and restarts the charging cycle if the battery voltage drops below about 25V. This keeps batteries charged while in storage but does not boil-out the electrolyte over time.
- 6) Turn-off charger by unplugging (disconnect from AC voltage).

### **Charging State & LED Display**

<b>LED</b>	<b>50%(YEW)</b>	<b>75%(YEW)</b>	<b>100%(GR)</b>	<b>GEL(RED)</b>
<b>Charging State</b>				
No AC Power to charger	Off	Off	Off	Off
Normal, battery is charging (Battery Connected)	On	On	Off	Off
Normal, battery is 100% charged	On	On	On	Off
Charger has timed-out at 24 hrs – battery pack probably bad or a bad cell	On	On	Off	On
Completely charger Charging cycle done, Battery voltage drop within 1/2hour under 25V. Charger is not off, charger is in Maintenance mode. – battery pack probably bad, weak or a bad cell	On	On	On	On
Output open circuit or short circuit or reverse polarity connection of charger to battery Battery voltage is too high (may be connected to wrong voltage battery)	On	Off	x	x

-

Note:

1. X in the table means “don’t care”, LED may be off or on
  2. The charging time is affected by numerous factors including battery Amp-Hour capacity, depth of discharge, battery temperature, and battery condition (new, old, or defective).
  3. Batteries are weak or bad → can’t charge batteries normally due to condition or can’t maintain battery voltage. → Battery Voltage drops sharply.
- In the previous situations, maintenance charging (float) can sometimes bring the voltage up but can’t bring the voltage back up to 100% normal battery voltage. If the charger is unable to get the battery voltage up to normal levels within 1-2days (BAD LED stays on) while in maintenance mode (float), then the batteries are bad and should be replaced.

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Technical Operation Summary – The charger is an advanced, microprocessor controlled, high frequency switching type charger. The charging curve is an IEl type for flooded and IE type for GEL (sealed) batteries. The IEl curve is constant current, then constant voltage, then constant current at a reduced level. Charging is complete when the battery voltage is rising at a very low rate (dV/dt) showing the battery has accepted all the charging it can. The IE curve is constant current then constant voltage with shut-off when the current reaches a low level.

The charger will work even with batteries in a severe discharge state with terminal voltages as low as 1V and there is no need to “boost charge” weak batteries before charging. The charger has an 24hour timer in case charging can not be completed due to battery problems – see troubleshooting section. .

# Maintenance



**WARNING: Disconnect from AC voltage before doing any service. When plugged-in the AC wiring is an electric shock hazard. Disconnecting the DC output wires near the batteries when the charger is ON may cause the batteries to explode resulting in serious injury or death.**



**WARNING: Risk of an electric shock causing serious injury or death. Do not touch un-insulated parts of the charger wires, battery connector or battery terminals. Be careful with tools as shock or arcing from shorting of electrical parts may cause serious injury or death. Remove rings, watches, and jewelry to avoid arcing and electric shock.**

- 1) All electrical connections must be kept clean and tight. Sometimes connections can look good outside but be corroded inside causing an output connection error.
- 2) The charger cools through the case fins. If the fins become covered with debris the charger's over-temperature protection system may reduce charging power. Clean-off fins to improve cooling.
- 3) Replace the charger if case damage breaks the water-tight seal.
- 4) Inspect wiring weekly, including AC plug, AC cord, DC wires to battery, and interlock wires for cut insulation, pinching, or other damage. Repair to avoid electric shock.

AC Ground – green with yellow stripe

AC Neutral – light blue

AC Line (Hot) – brown

DC Battery Negative (-) – black

DC Battery Positive (+) – red

Interlock wires – black and white

- 5) Follow battery supplier recommendations for battery care and maintenance.

**Note – most battery charging problems relate to battery care and not charger problems.**



# Troubleshooting



**WARNING:** Do not operate the charger if it is malfunctioning. Personal injury or property damage could result. Electric shock hazard may cause serious injury or death.



**WARNING:** Do not disassemble the charger. High voltages inside the charger are an electric shock hazard and may result in serious injury or death.

1. Charger does not turn - no yellow “ON” LED (leftmost)
2. AC power is getting to the charger but batteries are not charging –
3. “75%(Battery Connected)” LED is off
4. Red “GEL” LED is on
5. Batteries do not fully charge
6. Batteries “gas” or “bubble” causing over-charging concerns
7. The AC supply circuit breaker is tripped

## 1. CHARGER DOES NOT TURN ON – NO YELLOW (LEFTMOST) “ON” LED

Double check the outlet to ensure it is working by trying out another known good piece of equipment on the outlet. Check the circuit breaker to see if it has tripped and if it is a 15A rating and that there is no other draw on the circuit. Check the AC plug and wire to ensure both are in good condition. Replace charger if everything else is correct.



**CAUTION:** If the AC plug or receptacle is broken, twisted, bent or loose, it cannot make a good electrical connection and an electric shock hazard may exist. Have it repaired or replaced by a qualified person immediately. **DO NOT USE THE CHARGER UNDER THIS CONDITION.** Fire, injury, or death may result if not corrected.

## 2. LEFT “ON” LED IS ON BUT YELLOW “75%” LED IS OFF

Power is getting to the charger but the charger is unable to charge the batteries because there is a problem with the battery connection. The charger output may not be securely connected to the batteries or the connections between batteries may have corroded or loosened. The output may be shorted due to improper connection to the batteries or pinched wires. The output may be connected in reverse polarity to the batteries. The battery may be too high a voltage (higher than a 24V battery pack). The charger is not damaged by any of these problems except possibly when connected to a battery over 48V. **Note** – The battery charging circuit is a low voltage/high current circuit and connections must be good to the batteries and between batteries. Sometimes connections look good but they are not; when in doubt remove all connections, clean to shiny metal, reinstall, and properly tighten.

### **3a. “ON” LED IS ON, “75%” LED IS ON, “100%” LED IS OFF, and "GEL" RED LED IS ON**

The charger has timed-out at 24 hours. In 24 hours of charging the battery did not come-up to full charge. This can be caused by: one or more bad batteries, batteries with low electrolyte (need water), or by discharging the batteries too much. After checking battery electrolyte levels, the charge cycle can be re-started by unplugging the AC plug, counting to 20, then plugging back in. If the problem continues to occur replace the batteries.

### **3b. “ON” LED IS ON, “75%” LED IS ON, “100%” LED IS ON, and "GEL" RED LED IS ON**

The charger completed a charge cycle but the battery pack did not hold voltage after charging stopped. The battery voltage dropped below 25V within ½ hour after charging stopped showing that there is/are one or more bad batteries. The machine can be used but running time will be reduced and the batteries should be replaced for best machine operation.

## **4. BATTERIES DO NOT FULLY CHARGE**

- If the batteries are charged overnight, make sure the AC supply is not being switched-off at night with other building items.
- If batteries are new they sometimes need 20 to 30 charge/discharge cycles before they charge normally. With new batteries the charger LEDs may only show the yellow “75%” LED on after overnight charging. The batteries and charger are fine – the machine should be used and charged overnight. Within a few weeks the 100% LED will go on at the end of charge.
- If batteries are old, check the battery condition following the battery supplier’s instructions. Check for dead cells or reduced capacity. Replace charger only if other problems are not found. If the charger yellow “75%” LED is on showing charging and charger case gets warm after several hours the charger is probably good and the batteries bad.

## **5. BATTERIES “GAS” OR “BUBBLE” - CONCERN ABOUT OVER-CHARGING**

Gassing or bubbling is normal during charging and is required to mix the electrolyte in the battery. Batteries in poor condition or over-discharged will gas hard for long periods of time as the charger works hard to bring the battery back to full charge. The charger can be run on a known good set of batteries that have already been fully charged to see if it turns-off and is not over-charging. This kind of charger failure is extremely rare.

## **6. THE AC CIRCUIT BREAKER OR FUSE IS BLOWN**

An overloaded AC circuit, defective circuit breaker or defective fuse can cause this condition. First, check the total load on the AC circuit to avoid overload. If total AC load is OK connect the charger to a different AC outlet (on a different circuit) in the building. If the charger operates properly on other AC outlets, a qualified person should correct the AC circuit problem. AC circuit breakers sometimes trip at lower current levels with aging.

Note: Over 1/2 of all battery chargers returned as "failed" are good. Please follow the troubleshooting procedures carefully and check all other items before returning the charger as failed.

# Replacing the Charger



**WARNING:** Disconnect from AC voltage before doing any service. When plugged-in the AC wiring is an electric shock hazard. Disconnecting the DC output wires near the batteries when the charger is ON may cause arcing and the batteries to explode resulting in serious injury or death.



**WARNING:** Risk of an electric shock causing serious injury or death. Do not touch un-insulated parts of the charger wires, battery connector or battery terminals. Be careful with tools as shock or arcing from shorting of electrical parts can cause serious injury or death. Remove rings, watches, and jewelry to avoid arcing and electric shock.



**WARNING:** Do not disassemble the charger. Take it to a factory-authorized service agent when service or repair is required. High voltages inside the charger are an electric shock hazard and can result in serious injury or death.

Replace only with charger designed for use with the batteries and machine to ensure compatibility with all machine systems. Make sure the charger is unplugged before replacing and be careful tools do not short battery connections which can cause electric sparks. Ensure connections are the same as the original charger with wires connected by a qualified person.

AC Ground – green with yellow stripe

AC Neutral – light blue

AC Line (Hot) – brown

DC Battery Negative (-) – black

DC Battery Positive (+) – red

Interlock wires - White and black

Make sure all connections are clean and tight to provide a good electrical connection. Check all machine operating systems after replacement to ensure proper operation (see manual).

## Specifications

Electrical Specifications		
Item	AC Input	DC Output
Voltage	115V (85-132V) 230V (170-264V) (Automatically Selects)	24V nominal
Max. Current	9A at 85V 4.5A at 170V	Max. 19 ADC
Frequency	60 / 50 Hz	-
Phase	SINGLE	-
Output Power Max		600 Watts



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