



Battery Charger

INSTALLATION/OPERATION MANUAL



Model:
ABC-12-6

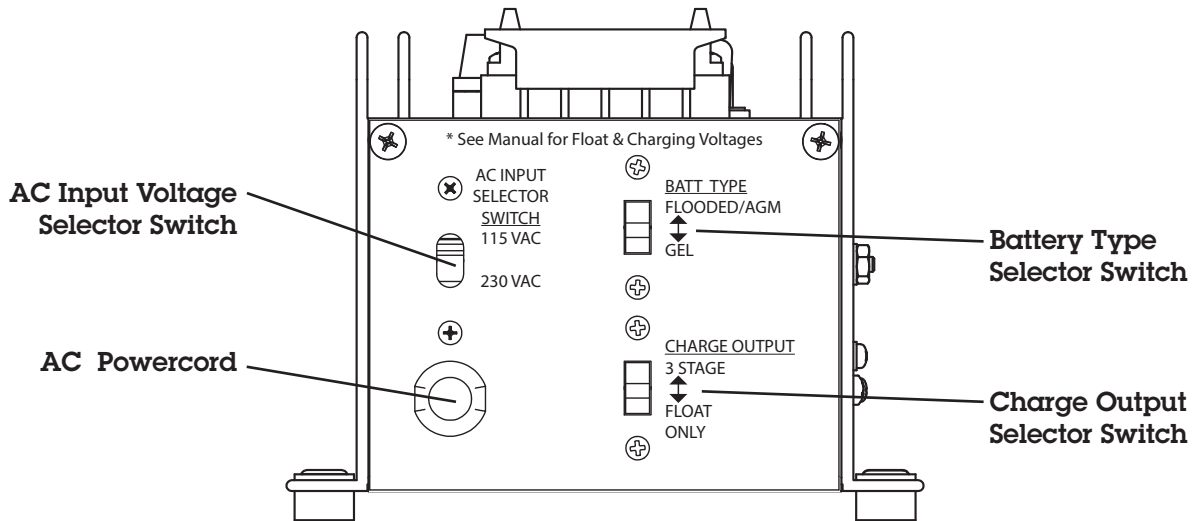
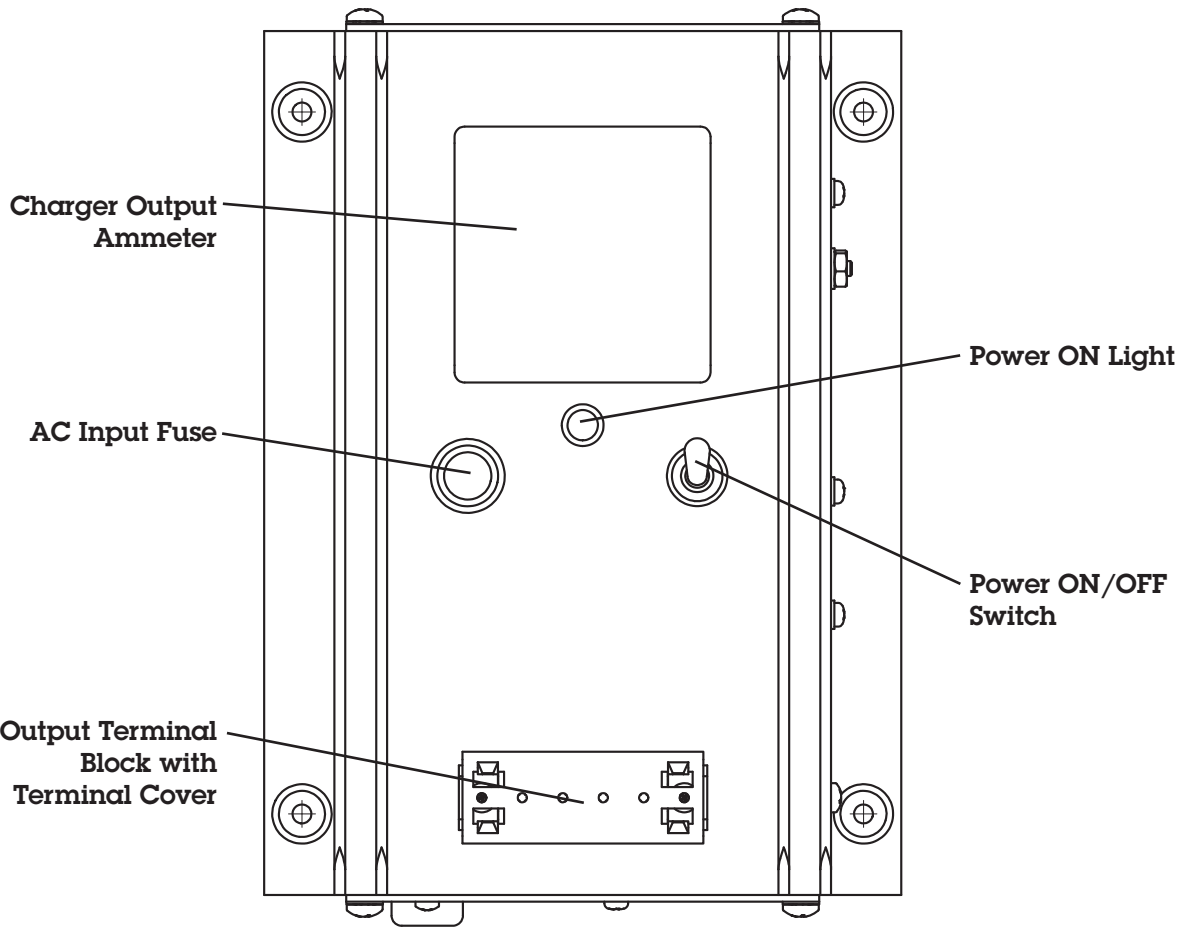
CONTENTS

Section	Topic	Page
	Quick Start Guide	2
I)	GENERAL INFORMATION	3
II)	IMPORTANT SAFETY INFORMATION	3
III)	INSTALLATION	4
	A) Materials Provided.....	4
	B) Location.....	5
	C) Mounting.....	5
	D) DC Output Wiring.....	5
	E) AC Input Wiring.....	7
	F) Gel-Cell/Lead-Acid Selector Switch.....	7
IV)	OPERATION	7
	A) Three Stage Charge Regimen.....	7
	B) Start-Up.....	8
	C) Constant Versus Occasional Use.....	9
	D) Proper Load Sizing.....	9
	E) Operation with Engine.....	9
	F) Operation as a DC Power Supply.....	9
V	SPECIFICATIONS	10
VI	TROUBLESHOOTING	11
VII)	WARRANTY INFORMATION	12
VIII)	BATTERY CARE TIPS	12

**M-ABC126
As of 102316**



Quick Start Guide



I) **GENERAL INFORMATION**

Your ABC 12-6 Battery Charger represents a new phase in charger design and performance, employing "smart" switching circuitry which puts batteries through the optimum three-step charge process, adapts for gel-cell or lead-acid batteries, is rated for continuous duty and is housed in a rugged stainless steel case.

Following is a brief listing of some of the more important features/options of your ABC 12-6. Each is fully detailed later in this manual:

- **Three step "smart" charging: bulk, absorption, float**
- **Gel cell/lead-acid switch selects optimum charge/float voltages based on battery type**
- **Dual output banks charge independently based on demand**
- **AC Input Select Switch - operates anywhere in the world**
- **Current limiting prevents damage from overload**
- **Use as a power supply without in-line battery; allows continued use of DC powered electronics (when AC is available) in the event that batteries must be taken off-line or removed.**
- **"Float" selector switch protects batteries when charging under continuous load**
- **Carries the CE mark.**

In addition, your ABC 12-6 carries a full three year warranty against defects in materials or workmanship from the date of purchase. Careful attention to these instructions should help you to enjoy years of trouble-free service.

II) **IMPORTANT SAFETY INSTRUCTIONS**

1. **SAVE THESE INSTRUCTIONS** — This manual contains important safety and operating instructions for the ABC 12-6 Battery Charger.
2. Before using this battery charger, read all instructions and cautionary markings on (1) the battery charger (2) the battery, and (3) any product powered by the battery.
3. **CAUTION** — To reduce the risk of injury, charge only 6 cell lead-acid rechargeable batteries (flooded, AGM, Gel or sealed). Other types of batteries may burst, causing personal injury and damage.
4. Do not expose charger to rain or spray.
5. Use of an attachment not recommended or sold by NEWMAR may result in a risk of fire, electric shock or injury to persons.
6. To reduce the risk of damage to the electric plug and cord (if plugged into an AC outlet), pull by plug rather than cord when disconnecting the charger.
7. Make sure the cord is located so that it will not be stepped on, tripped over, or otherwise subjected to damage or stress.
8. An extension cord should not be used. Use of an improper cord could result in a risk of fire and electric shock.
9. Do not operate the charger with a damaged cord or plug; replace them immediately.
10. Do not operate the charger if it has received a sharp blow, been dropped, or otherwise damaged; take it to a qualified serviceman.
11. Do not disassemble the charger; take it to a qualified serviceman when service or repair is necessary. Incorrect reassembly may result in a risk of electric shock and fire.
12. To reduce the risk of electric shock, disconnect the charger from AC source before attempting any maintenance or cleaning.



WARNING—RISK OF EXPLOSIVE GASES

1. WORKING IN THE VICINITY OF A LEAD-ACID BATTERY IS DANGEROUS. BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL BATTERY OPERATION. FOR THIS REASON, IT IS OF UTMOST IMPORTANCE THAT BEFORE INSTALLING AND USING YOUR CHARGER, YOU READ THIS MANUAL AND FOLLOW THE INSTRUCTIONS EXACTLY.
2. To reduce the risk of battery explosion, follow these instructions and those published by the battery manufacturer and by the manufacturer of any equipment you intend to use in the vicinity of the battery. Review all cautionary markings on these products.

PERSONAL PRECAUTIONS

1. Someone should be within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
2. Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing or eyes.
3. Wear complete eye protection and clothing protection. Avoid touching your eyes while working near a battery.
4. If battery acid contacts skin or clothing, wash immediately with soap and water. If battery acid enters the eye, immediately flood the eye with running cold water for at least 10 minutes and get medical attention immediately.
5. NEVER smoke or allow a spark or flame in the vicinity of the battery or engine.
6. Be extra cautious to reduce the risk of dropping a metal tool onto the battery. It might spark or short-circuit the battery or other electrical part and cause an explosion.
7. Remove personal metal items such as rings, bracelets, necklaces and watches when working with a lead-acid battery. A lead-acid battery can produce a short-circuit current high enough to weld a ring or the like to metal, causing a severe burn.
8. Use the battery charger for charging gel-cell, AGM or flooded lead-acid batteries only. Do not use the charger for charging dry-cell batteries that are commonly used with home appliances. These batteries may burst and cause injury to persons and damage to property.
9. NEVER charge a frozen battery.

PREPARING TO CHARGE

1. Be sure the area around the battery is well ventilated.
2. Clean battery terminals. Be careful to keep corrosion from coming in contact with eyes.
3. Add distilled water in each cell until battery acid reaches level specified by battery manufacturer. This helps purge excessive gas from cells. Do not overfill. For a battery without cell caps, carefully follow manufacturer's recharging instructions.
4. Study all battery manufacturer's specific precautions such as removing or not removing cell caps while charging and recommended rates of charge.

GROUNDING AND AC POWER CORD CONNECTION

1. The charger should be grounded to reduce the risk of electric shock.

III) INSTALLATION

A) Materials Provided

Your NEWMAR ABC Series Battery Charger comes with the following materials:

- (4) Ring lug crimp connectors for 12/10 AWG wire size
- (4) Rubber grommets
- (4) Eyelet washers
- (1) Installation/Operation manual

The ABC 12-6 charger is provided completely assembled and ready for installation. The installer must provide mounting hardware and DC output wiring. Proper sizes and gauges for the hardware and wire are noted in Sections C and D following.



B) Location

The charger should be mounted on a wall, bulkhead or other suitable mounting surface as close to the batteries to be charged as possible. Do not mount the charger directly over the batteries as battery fumes may cause excessive corrosion. The charger is ignition protected so it is acceptable to locate the unit in an area where ignition protected equipment is required. The area should be well ventilated and free from excessive moisture, exhaust manifolds and battery fumes.

Vertical mounting is preferred. However, horizontal mounting is acceptable where absolutely necessary. **Do not mount the charger where water, spray or condensation can occur, as this will shorten charger life.** A minimum of 6" clearance above and below the charger is recommended for proper cooling.

If the charger is located in an extreme heat area, such as an unventilated engine compartment, and maximum operating temperature is exceeded, an automatic thermal protection circuit will shut the charger off. Although it will return to service automatically after cooling sufficiently, thermal cycling will shorten the life of the charger. If this condition occurs repeatedly, the charger should be relocated. For optimum performance and longer life the charger should not be located in an area of extreme high temperature.

C) Mounting

The charger may be mounted on either a metal or non-metal surface.

Four #8 or #10 screws (self tapping sheet metal or machine screws, depending on mounting surface) with washers, are required to mount the charger.

IMPORTANT: Although the charger is constructed of materials and in a manner which makes it highly resistive to the corrosive effects of moisture in the environment, the charger is not waterproof. Do not mount the charger where there is a possibility of water dripping or spraying onto the unit. Evidence of water entry into the charger will void the warranty.

D) DC Output Wiring

Note: Only qualified service personnel should access the output terminals of the charger.

The installer must provide output wires for attaching the charger to the battery. Use the table below to determine the correct gauge wire, based on the length of the wire run from the charger to the batteries.

Length of Wire from Charger to Batteries (in feet)

10'	15'	20'
Minimum Wire Gauge AWG		
#14	#12	#10

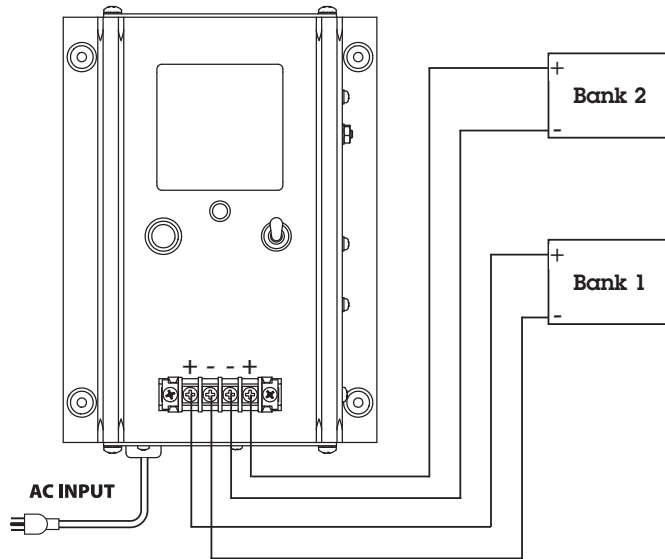
***Based on N.E.C. Minimum Wire Size Chart**

ENSURE THAT LEADS ARE PROPERLY FUSED AT THE BATTERY.

Typical DC wiring configurations are illustrated in FIGURES 1 and 2.

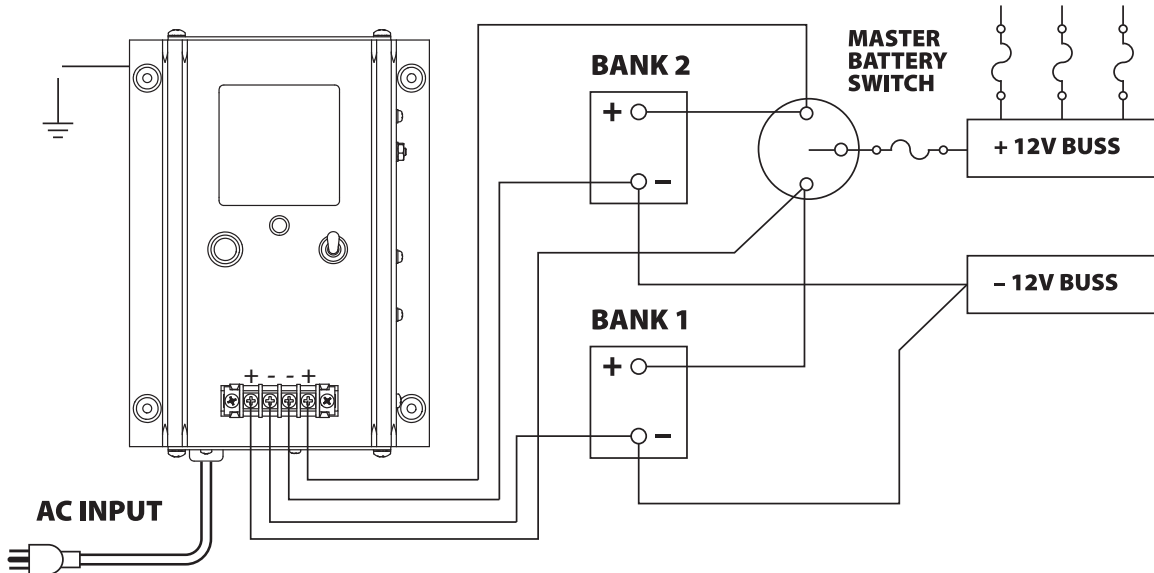
Remove the output terminal cover using the crimp lug connectors provided. Attach your DC cables to the output terminals of the charger.

FIGURE 1: Simple DC Wiring (Preferred Method)



IMPORTANT: Install fuses on battery hot (+) leads at battery to protect charging leads

FIGURE 2: Wiring With Battery Switch



An Important Note about the DC Output Fuse: DC output wiring is protected by an internally mounted 1/4" x 1-1/4" output fuse (ABC-20 Fast Blow). The current limiting circuit of the ABC 12-6 charger should prevent the fuse from blowing under normal operating conditions. If the fuse blows, this may indicate a reverse polarity hook-up or an internal short. If the battery is connected to the charger backwards, the fuse should blow to prevent a dangerous short circuit, however damage to the internal components is possible, as well. If, after replacing this fuse, it blows again upon application of power, return the charger to an electronics service professional or to the factory for a thorough inspection.

Always replace the fuse with another of the same type and value: ABC-20.

E) AC Input Wiring/Voltage Selection

For the convenience of the installer an AC power cord has been factory installed. It is a three-conductor stranded type, 18 AWG. The cord is terminated with a plug suitable for standard USA outlets and uses standard USA color coding of conductors.

The ABC 12-6 operates within a "universal" range of 82-132 or 176-264V AC, 47-63 Hz input. Input voltage selection is made via a slide switch on the bottom of the charger. It is factory set for 115V. For 230V AC applications use a ball point pen or similar tool to slide the switch into the 230V position.

AC input for the charger must be routed through a fuse or circuit breaker on an AC distribution panel with proper safety/earth chassis ground in accordance with all applicable local codes and ordinances.

Color coding of the installed AC cord is as follows:

Black.....AC Hot (fused)
White.....AC Neutral
Green.....AC Ground (safety, earth)

If the plug on the factory-installed cord is unsuitable for the available outlet it may be cut off and replaced. Pay careful attention to color coding of the wires as noted above. **Do not attempt to replace the entire cord by removing the charger cover. Evidence of entry into the charger will void the warranty.**

F) Setting the Gel-Cell — Flooded/AGM Switch

According to most battery manufacturers, the ideal charge regimen for gel-cell and flooded (wet) lead-acid or AGM (Absorbed Glass Mat) batteries differs somewhat.

The gelled electrolyte in a sealed battery may be lost or damaged by high voltage and, once lost, cannot be replaced as it can with a wet lead acid battery. Manufacturers of gel-cells usually recommend an ideal charge voltage which is slightly lower for a gel-cell than a lead-acid battery. (The charge regimen recommended for AGM batteries is typically similar to that of flooded lead-acid batteries.)

However, when the charger is in the float voltage mode over lengthier periods of time, gelled electrolyte in a sealed battery is not susceptible to evaporation, as is the non-immobilized electrolyte of a wet lead acid battery. This evaporation can be accelerated by the applied voltage. Consequently, the ideal float voltage is slightly higher for a gel-cell than a lead-acid or AGM battery.

The ideal charge/float regimen has been programmed into the ABC 12-6 for either sealed gel-cell or flooded lead-acid/AGM batteries. Simply make the proper selection for your battery type via the slide switch on the front of the charger, prior to turning the unit on.

Note: A wide variety of batteries are now available which do not conform to conventional descriptions as "gel-cell" or "lead-acid". You are advised to consult the manufacturer of your particular battery as to proper charging regimen, and use the battery type selection switch setting which most closely conforms to the recommended voltages.

See the **SPECIFICATIONS** section for the actual preset charge and float voltages for each model.

IV) OPERATION

A) Three Stage Charge Regimen

The ABC 12-6 Battery Charger utilizes the three stage charge regimen which is widely recommended by battery manufacturers for allowing the fastest possible recharge time without loss of batteries' electrolyte (gel or liquid) which may be caused by sustained charging at higher voltages.

This three stage regimen is initiated each time AC is first applied, when drained batteries are most likely to be encountered, and proceeds slowly or quickly through each stage depending on the battery's relative state of charge.

Note: The Charge Cycle Select switch on the bottom end panel must be in the "Charge" position for the three stage cycle to occur. In the "Float" position, the charger will have a fixed output voltage which depends on the setting of the Battery Type Selector. (See Specifications section for output voltages. See also the warning about the switch setting at the end of this section.)

The charge regimen proceeds as follows:

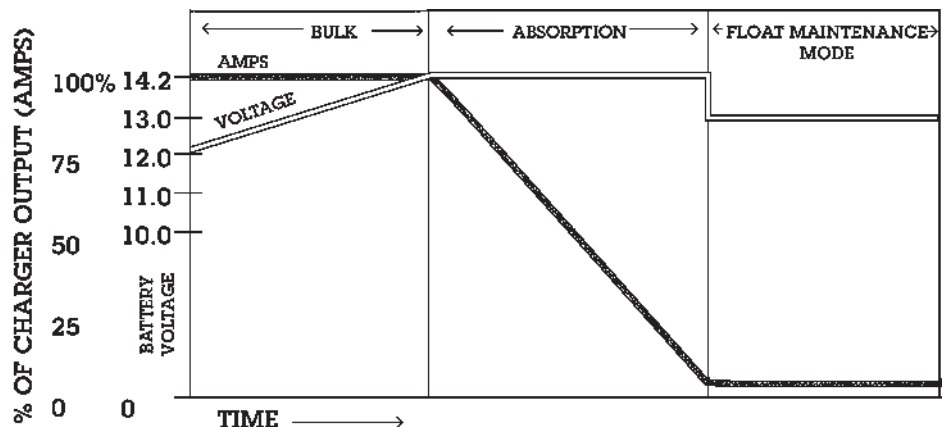
1) Bulk Phase: When batteries are significantly discharged the charger responds initially by delivering a high amount of DC current, at or near the charger's maximum rated output, in order to rapidly replenish them. It is during this stage that charging current is maintained at a high level as battery voltage increases. Bulk charging continues until battery voltage reaches the "charge" voltage level (where batteries are at about 75-80% of capacity). At this point the charger switches to the second stage.

2) Absorption Phase: During this second stage of the charge cycle, battery voltage is maintained at the "charge" voltage level. Output current begins to taper off as the battery plates become saturated. Charge voltage is maintained until the current sensing circuit detects that output current has tapered to about 5-15 % of charger rating. At this point the batteries are at about 95 % of full charge and the Phase Three charger switches to the third and final stage of the charge cycle.

3) Float Phase: For extended battery life, the ABC 12-6 then automatically switches to a lower float voltage level. This float charge keeps batteries at peak condition without overcharging. The charger may be left in this stage for lengthy periods of time without attention (though periodic checks of electrolyte level in flooded batteries is recommended). It is not necessary or recommended to shut the charger off when this stage is reached.

A typical three stage charging cycle is illustrated in FIGURE 3.

FIGURE 3: Typical Charger Output Graph (into battery without load)



A WARNING ABOUT THE CHARGE CYCLE SELECT SWITCH: Whenever a load of approximately 3 amps or more is applied, the charger will go into the elevated voltage "Charge" mode. (See specifications for actual charge/float voltages.) Battery electrolyte may be damaged or lost by extended exposure to this higher voltage. If there is a DC load on the battery system of 3 amps or more for periods lasting 8 hours or more, it is strongly recommended that the Charge Cycle Select switch on the front panel be placed in the "Float" position.

B) Start Up

1) Before powering up your charger, check for tight electrical connections to each battery in your system. Switch off any DC loads on the batteries. Apply AC power. Observe the charge current ammeter on the front panel. If it shows full or near output current for a while, it is an indication that the batteries are in a relatively low state of charge. The charger, sensing this, is supplying high current to the batteries. If the charge current ammeter needle is at or near zero amps, it is an indication that the batteries are at or nearing full charge, and the charger has switched to the "Float" (maintenance) mode.

2) After the charge current ammeter needle sits at or near zero amps, apply a load to the charger by switching on some lights, a pump or some other DC appliance. Observe the ammeter. As current is demanded from the battery system, the charger will automatically increase its output in response to the increased load demand and the charger will switch to the higher current (and higher voltage) "Charge" mode. As long as the load current exceeds approximately 3 amps, the charger will remain in the charge mode (unless the Charge Cycle Select switch is put into the "Float" position).

C) Constant Versus Occasional Use

In general, it is recommended that the charger be left connected continuously to the AC distribution system so that it will be in operation whenever AC is available. This will maintain batteries at peak voltage and will automatically compensate for the natural self-discharge of the battery system. When a load is applied to the battery system the charger's output will automatically increase to supply the current which would otherwise draw battery voltage down. **Repeatedly allowing batteries to become completely discharged before recharging will greatly shorten their life. Leaving the charger on continuously will prevent this.**

While the output regulation of the charger will minimize battery gassing and water loss, monthly checks of the electrolyte level (for wet lead acid batteries) are still strongly recommended. Some water loss is an inevitable aspect of the charging process, and maintaining the correct electrolyte level in your batteries is the most important thing you can do to assure their maximum performance and long life.

D) Proper Load Sizing

The ABC 12-6 is rated 6 amps for 2 hours or 5 amps continuous. While the charger cannot be damaged by overloads that exceed this continuous rating, excessive load demands may draw battery voltage down faster than the charger can resupply it. If battery voltage continues to drop and the output current is at maximum while the charger is in service, check to see that your average DC loads are not exceeding the charger's rated output.

E) Operation With Engine

It is perfectly acceptable to allow the charger to remain on when the engine is started and while it is running. The current limit feature of the ABC 12-6 will protect against any damage due to the high current demands of engine cranking. Output diodes will prevent any back-feed of current into the charger from the alternator while the engine runs.

As the alternator starts to charge the battery, the charger output will decrease. When the battery voltage exceeds the rated output voltage of the charger it will shut off and stay off as long as the batteries are in this high state of charge. If the battery voltage should drop below the charger's rated output voltage it will automatically return to service.

F) Operation as a DC Power Supply (stand-alone DC power source)

Most battery chargers are not suitable for powering electronic devices directly, without a battery attached to the output, as the high ripple and pulsing d.c output (i.e., rectified AC output) can interfere with the operation of the device. However, the ABC 12-6 employs a circuit that produces an extremely well-filtered DC output. Therefore it is able to power virtually any DC powered device (within the unit's rating) without the battery attached in-line (if, for instance, the battery must be removed for any purpose and AC is still available). All but the most sensitive DC powered electronic devices will function as normally as if powered by a battery. When using the ABC 12-6 as a regulated power supply without battery in-line, place the Charger Cycle select switch in the "FLOAT" position for maximum regulation.

SPECIFICATIONS

Model: ABC 12-6

Input VAC (50-60 Hz.): 82-132 or 164-264

Input Amps @ Full Load:

@ 115 VAC = 2

@ 230 VAC = 1

AC Input Fuse: 2 amp, fast blow (AGC-2, 250VAC)

Output Voltage (Nominal VDC): 12

Output Amps: Intermittent: 6 amps

Continuous: 5 amps

Output Banks: 2

Battery Capacity (Amp-Hours): 14-70

Weight (Lbs./Kg.): 4.25/2

Compliances:

Carries the CE Mark

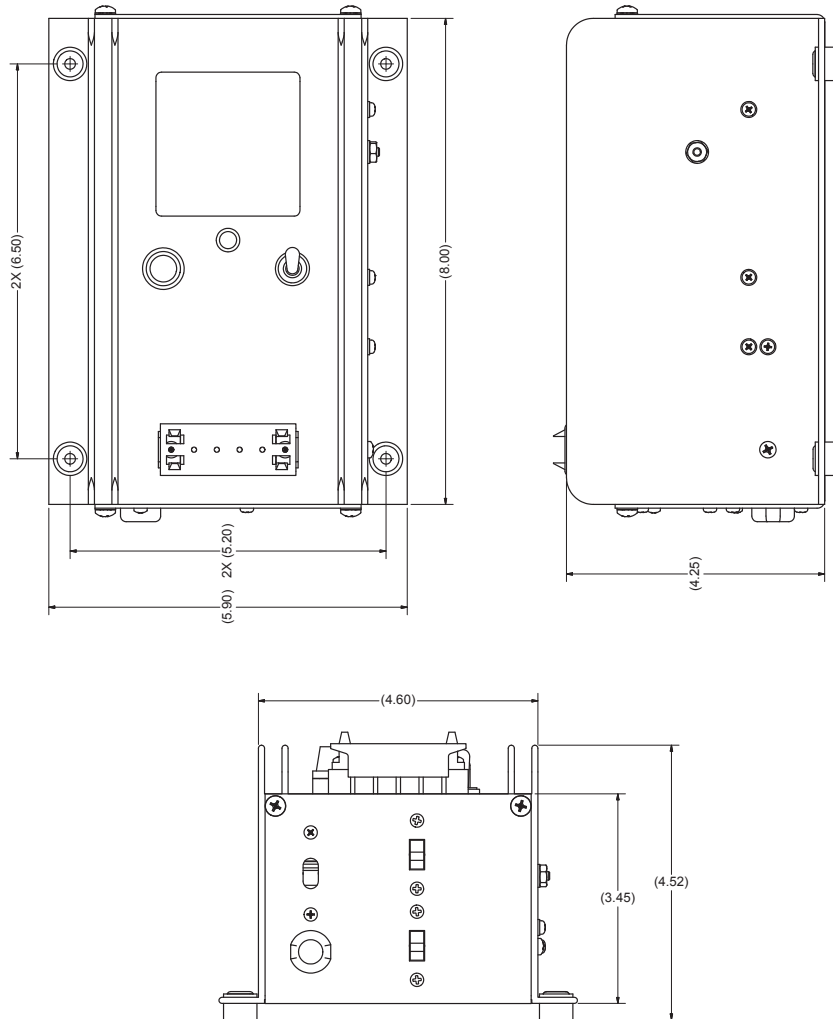
Temperature Rating: 0°C to +40°C

Nominal Output Voltages at Gel/Flooded Switch Settings:

Setting	Charge	
	@ 50 % load	@ .5 amp load
Flooded/AGM	14.0-14.2V DC	13.4V DC
Gel-Cell	13.8-14.0V DC	13.6V DC

Protection: Input/Output Fuses, Current Limiting, Thermal Protection, Convection Cooling

Case Dimensions (Inches):



VII) TROUBLESHOOTING

PROBLEM

POSSIBLE CAUSE

SOLUTION

A. Batteries not coming up to full charge

1. Extremely discharged batteries requiring long recharge time

1. Turn off all DC loads and allow charger 24-48 hours to recharge batteries

2. Charger limiting its output due to overload or over-temperature conditions

2. Reduce DC load and/or determine cause of over-temperature condition (see section III-B, Location)

B. Charger continues to charge at 3 amps or more - does not taper back

1. DC load connected to batteries drawing current (not a problem condition)

1. Turn off main battery switch to DC electrical panel or turn off all DC loads if you wish to confirm charger will output minimal amperage to fully charged batteries

2. Bad cell in one of the batteries to which the charger is connected

2. Check for shorted cell in wet lead-acid batteries using a hydrometer. Refer to manufacturer for testing maintenance-free batteries

C. No charger output, even when all connections have been checked, a.c. is applied to the charger, and d.c. load is applied to the batteries

1) Blown input fuse

1) Replace with AGC-2 Fuse. If input fuse continues to blow, return to servicing dealer.

2) Internal defect

2) Return to servicing dealer for failure analysis or contact NEWMAR for Return Authorization Number

D. Reverse polarity connection has caused charger to have no output

DC output fuse and other internal components likely blown

Contact NEWMAR Technical Support regarding blown output fuse diagnosis

E. High voltage measured across charger output terminals

Batteries not connected to charger. It is normal to read 1/2 volt higher across any output bank when no batteries are connected.

Check for tight connection of charging leads to batteries

VI) Warranty Information

We warrant this product against defects in materials and workmanship for a period of 12 months from the date of purchase and will repair or replace any defective power inverter when directly returned (postage paid) to us. Please call Technical Service for an RMA number.

This warranty will be considered void if the unit has suffered any obvious damage by natural and man-made factors, or alteration either internal or external and does not cover damage arising from improper use such as plugging the unit into an unsuitable power sources attempts to operate products with excessive power consumption requirement, or use in unsuitable environments.

If you have a problem with your ABC 12-6, or have any questions about the installation and proper operation of the unit, please contact NEWMAR's Technical Services Department:

Phone: 714-751-0488 - From the hours of 7:30 a.m. to 5:00 p.m. weekdays, P.S.T.

Fax: 714-957-1621

E-mail: techservice@newmarpower.com

VIII) BATTERY CARE TIPS

Regular maintenance and proper care will assure you reliable service from the most depended upon and sometimes most neglected items, your batteries and battery charger. NEWMAR battery chargers are designed to keep your batteries fully charged but your batteries also need proper regular maintenance to provide a maximum life of service.

ALWAYS READ AND FOLLOW THE BATTERY MANUFACTURER'S INSTRUCTIONS

Battery Installation

Batteries must be securely mounted to prevent them from falling over when the vehicle or boat is in motion. A loose battery can do serious damage. Batteries should be mounted in a battery box to contain any acid spill. Batteries give off a certain amount of hydrogen gas when they are charging. When concentrated, this gas is highly explosive. Therefore make sure they are in an accessible place with adequate ventilation for any hydrogen gas discharge.

Cleaning Batteries

Dirt and electrolyte salts can build up on the top of your batteries. This accumulation conducts electricity stored in the battery and can cause the battery to discharge by itself. Therefore, at least twice a year, it is a good idea to disconnect the battery cables and scrub the battery with a baking soda solution. Rinse with fresh water and dry with a clean cloth.

You may wish to purchase a set of terminal post corrosion prevention rings. These are alkali-saturated felt rings that slip over the battery post to reduce corrosion. Do not apply grease to any part of the battery terminals, but you may use an occasional light spray of silicone lubricant.

Routine Checks and Maintenance

Batteries should periodically be "exercised" (slowly discharged and then recharged) to keep them in top condition. New batteries may need to be exercised before they will be capable of their full rating.

If your batteries are not the sealed type, distilled water should be added to them whenever needed. The electrolyte should cover the plates by about 1/2", allowing a small air space at the top. Do not fill the cells up to the filler cap as this could cause the battery to sputter out electrolyte when it is being charged. Only distilled water should be used never plain tap water. Tap water contains chemicals and elements that can alter the properties of the electrolyte, including specific gravity. Some chemicals may also create an insulating coating on the battery plates which will retard current flow.

The rate that water is lost by the battery is dependent on several factors; battery condition, ambient temperature, battery use, charge voltage, etc. It is normal for batteries which are not maintenance-free to require topping off about once a month.

A battery's state of charge may be monitored by checking the specific gravity or by open circuit voltage. You may use the following table to evaluate the condition of your batteries:

Battery Condition Table

Specific Gravity Measured by Hydrometer	Open Circuit Voltage	State of Discharge @ 80° F
	12 Volt System	
1.265	12.6 or more	Fully Charged
1.225	12.4	25% Discharged
1.190	12.2	50% Discharged
1.155	12.0	75% Discharged
1.120	11.7 or less	100% Discharged

* Note: Wait at least 5 minutes after charging or discharging before checking specific gravity or open circuit voltage. The battery's voltage needs to stabilize in order to get an accurate reading.

Troubleshooting Your Battery System

If your battery will not accept or hold a charge, one of the following conditions may exist:

1. A BAD BATTERY. You may have a battery with an open or shorted cell, a battery without any "life" left. Check by charging the battery until all cells have a specific gravity of 1.225 or greater at 80° F. If you are unable to obtain 1.225 in each cell, replace the battery.

2. A BAD BATTERY CHARGER. If the battery open circuit voltage is low and/or the hydrometer indicates your batteries are low, the battery charger should be providing current to the batteries. If it is not, check the input fuse and check to see that you have charging voltage on the output with no battery attached. Note: You will not get an accurate voltage reading on the output of the charger with no batteries attached. This is checked merely to ensure that you do not have an open circuit on the output.

The battery charger has a thermal power reduction circuit to protect the charger from overheating. If you suspect this is the case, refer to the INSTALLATION section for information about proper charger location.

3. ELECTRICAL LEAKAGE. You may have a previously unsuspected source of current drain from the battery. To check for a leakage of this sort, disconnect the battery ground cable and connect an ammeter between the negative battery post and ground. If you have a reading over .1 amp, there is a source of current drain from the batteries which must be located and removed.