Blue Sky ENERGY

IPN-ProRemote

IPN™ NETWORK CHARGE CONTROLLER AND BATTERY SYSTEM MONITOR

INSTALLATION AND OPERATION MANUAL

THIS MANUAL INCLUDES IMPORTANT SAFETY INSTRUCTIONS FOR MODELS IPNPRO and IPNPRO-S. SAVE THESE INSTRUCTIONS.

430-0019 B

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IMPORTANT SAFETY INSTRUCTIONS

This manual contains important instructions for Models IPNPRO and IPNPRO-S
SAVE THESE INSTRUCTIONS

1. Refer installation and servicing to qualified service personnel. Incorrect installation or use may result in risk of electric shock or fire. No user serviceable parts in this unit.

2. To reduce the risk of electric shock, fire or personal injury, the following symbols are placed throughout this manual to indicate dangerous conditions, or important safety or operational instructions.

WARNING	CAUTION	IMPORTANT
		
Indicates dangerous conditions or electric shock potential. Use extreme caution.	Indicates items critical to safe installation or operation of the unit.	Follow these instructions closely for proper operation of the unit

3. PERSONAL PRECAUTIONS
   a) Working in the vicinity of lead-acid batteries is dangerous. Batteries produce explosive gasses during normal operation.
   b) To reduce risk of battery explosion, follow these instructions and those published by battery manufacturer and manufacturer of any equipment you intend to use in vicinity of battery.
   c) Someone should be within range of your voice or close enough to come to your aid when you work near a lead-acid battery.
   d) Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing or eyes.
   e) Wear complete eye protection and clothing protection. Avoid touching eyes while working near battery.
   f) If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 10 minutes and get medical attention immediately.
   g) NEVER SMOKE or allow a spark or flame in vicinity of battery.
   h) Be extra cautious to reduce risk of dropping metal tool onto battery. It might spark or short circuit battery or other electrical part that may cause explosion.
   i) Remove personal metal items such as rings, bracelets 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.
   j) Remove all sources of power, photovoltaic and battery before servicing or installing.

4. CHARGER LOCATION & INSTALLATION
   a) This unit is designed to control the charge of flooded or sealed type lead-acid chemistry batteries. Follow battery manufacturers charging recommendations when considering this unit for use with other battery chemistry, i.e., NiCd.
   b) This unit employs components that tend to produce arcs or sparks. NEVER install in battery compartment or in the presence of explosive gases.
   c) This unit must be installed and wired in accordance with National Electrical Code, ANSI/NFPA 70.
   d) Insure that unit is properly configured for the battery being charged.
   e) Unit is not water tight. Do not expose to rain or snow.
   f) Insure all terminating connections are clean and tight. Battery shunt compression terminals are to be tightened to 2.1 in-lb (0.24 nm).
   g) This unit is designed to be used with Integrated Power Net™ (IPN™) compatible power devices. Do not plug this unit into anything other than an IPN compatible communications port.

5. PREPARING TO CHARGE
   a) Never charge a frozen battery.
   b) Be sure battery is mounted in a well ventilated compartment.
   c) Add distilled water in each cell of a lead-acid battery until battery acid reaches level specified by battery manufacturer. This helps purge excessive gas from the cells. Do not overfill. For batteries other than flooded lead-acid type, or sealed batteries without cell caps, carefully follow manufacturers charging instructions.

PRODUCT DESCRIPTION

The full featured IPN-ProRemote incorporates a multi-line backlit LCD display and three function keys to provide enhanced setup and monitoring of IPN based charge controllers on Blue Sky Energy's IPN network. Depending on the accompanying charge controller, the IPN-ProRemote can provide the ability to access additional setup parameters and adjust setup parameters to wider ranges that those available with the accompanying charge controller alone. Both the individual status and combined total of up to 8 IPN based charge controllers can be monitored.

The IPN-ProRemote also provides complete battery system monitoring and eliminates the need for a separate battery monitor. Some of the many displays include; battery and PV voltage, current and amp-hours, a highly accurate battery capacity "fuel gage", and much more. With the IPN-ProRemote, the accompanying charge controller can be configured to determine end-of-charge based on net battery current matched to battery capacity in amp-hours to provide the most highly optimized charge process.

IPN NETWORK

The Integrated Power Net™, or IPN network is a simple yet robust digital network which allows Blue Sky Energy's IPN compatible products to communicate with each other and work together. It is based on the RS-485 communication standard which is commonly used in harsh industrial environments. Without the IPN network multiple charge controllers charging a common battery would operate as separate machines, each with their own charge parameters, display, temperature sensor and so on. While IPN compatible charge controllers work quite well alone, when multiple IPN controllers are combined they no longer behave as separate machines. They work together and operate as a single machine.

Up to 8 IPN compatible charge controllers can reside on a single network and be monitored by one IPN-ProRemote. The IPN network does not require special communication hardware. There is simply a twisted pair cable daisy chained controller-to-controller. The IPN-ProRemote accesses the network by plugging into the IPN Display connector in any charge controller on the network.

PART NUMBERS AND OPTIONS

- IPNPRO .....IPN-ProRemote, full featured IPN charge control and battery system monitor w/25' cable
- IPNPRO-S.....IPN-ProRemote with required 500A/50mV current shunt
- CS-500 .....500V/50m millivolt current shunt

OPERATION

A four level menu structure with plain English language text and three user keys are used to simplify operation. Information typically of interest to the casual user such as battery voltage, net battery current and remaining battery capacity are available in the Top menu. More technically inclined users may want to see additional information in the Advanced Display menu, whereas installers may need to access the Setup or Battery Charge Parameters menus.

> ➢ The unit operates on power supplied from the accompanying IPN compatible charge controller. The charge controller must have proper power applied for the IPN-ProRemote to operate.

USING THE THREE FUNCTION KEYS

All IPN-ProRemote operations and displays are controlled with the three function keys, BACK, NEXT and SELECT. Operation of the keys is consistent across all functions and screens.

NEXT

The NEXT key is used primarily to scroll through menus. Each press of the NEXT key advances the display to the next screen in that menu. One more press once you reach the bottom of a menu returns you to the top of that menu.

A special case for NEXT is when you are in a "parameter setting" screen where the word "SETTING" flashes in the display. Pressing NEXT in a parameter setting screen causes the parameter to go to the next value or in the case of a numeric setting to increase the number. Pressing BACK while holding NEXT pressed in a parameter setting screen causes numeric settings to decrease.

BACK

The primary function of the BACK key is to back out of functions, setting screens, or advanced menus and behaves in much the same way as the "escape" key on a computer. Each press of the BACK key backs you out of a selected function or setting screen without performing the function or making a change. If you should enter a setting screen you did not intend,

become lost in the menus or are unsure of what to do, repeated presses of the BACK key will return you to the Top menu. Once in the Top menu pressing BACK toggles between the most commonly used screens, Battery Volt/Amp and Remaining Battery Capacity.

Another function performed by the BACK key is to decrease numeric settings in a parameter setting screen when used in combination with the NEXT key. In a parameter setting screen, pressing BACK while holding NEXT pressed causes numeric settings to decrease. If you press BACK without holding NEXT pressed, BACK will perform it's normal function and back out of the parameter setting screen without making a change. To decrease a setting it is often easier pass the desired value going down and then increase the setting to the desired value using NEXT.

SELECT

The SELECT key takes action. Action taken is based on the indicator in the lower right of the display, which may show SEL►, SET►, or CLR►. To minimize the possibility of taking unintended action, the SELECT key does not act immediately. You must press and hold the SELECT for three seconds before the action is taken.

- SEL► is used to select a next level menu, or enter a parameter setting screen.
- SET► is shown in parameter setting screens where the word "SETTING" flashes in the display. Once the parameter is raised or lowered to the desired value in a setting screen, pressing SET► stores the new value into memory and returns to the previous screen. SET► is also shown in the Restore Default Settings and Reset Current Shunt Zero screens where SET► directly executes these functions following the normal 3 second countdown delay.
- CLR► is used to clear or reset the values in stored data screens such as Min or Max Battery Voltage, Total Charge Amp-hours, etc. It will also appear in the Equalize Enabled screen and will manually cancel the present equalize cycle.

DISPLAY PANEL

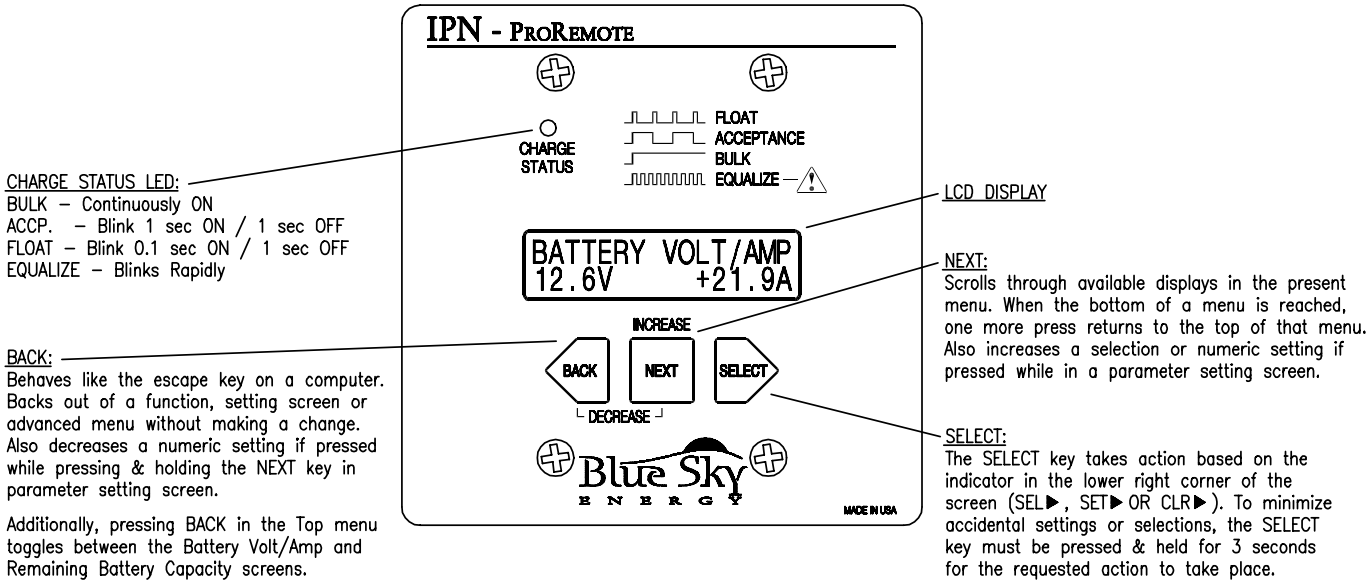


FIGURE 1

LCD DISPLAY AND BACKLIGHT

A 2-line by 16-character Liquid Crystal Display (LCD) is used for good readability and low power consumption. In low light situations the LCD may be backlit for improved readability. Backlight uses more power, and when ON increases IPN-ProRemote power consumption from roughly 0.25W to 1.0W. Backlight can be set for ON, OFF or AUTO from the Advanced Setup menu. AUTO mode is the default setting and will cause backlight to remain ON for one minute following the last key press. When backlight has turned OFF in AUTO, the first press of any key turns backlight ON only without performing that key's normal function. Once backlight is ON the keys perform their normal function.

CHARGE STATUS INDICATOR

An LED charge status indicator is provided on the face of the unit. The LED will be off when the charge controller is not charging, and will be on solid or blinking when the battery is being charged.

CHARGE STATUS INDICATOR

CHARGE STATUS LED	CHARGE MODE
OFF [0]	CHARGE OFF
CONTINUOUSLY ON [1]	BULK
BLINKING 1 SEC ON [1] / 1 SEC OFF [0]	ACCEPTANCE
BLINKING 0.1 SEC ON [1] / 1 SEC OFF [0]	FLOAT
BLINKING RAPIDLY 0.1 SEC ON [1] / 0.1 SEC OFF [0]	EQUALIZE

TABLE 1

REMAINING BATTERY CAPACITY

A particularly useful feature of the IPN-ProRemote is the Remaining Battery Capacity calculation and display. A battery stores electrical charge in units referred to as “amp-hours” (AH), and the IPN-ProRemote keeps track of remaining battery capacity by counting amp-hours into and out of the battery. An amp-hour is the product of current (in amps) and time (in hours). 10 Amp-hours could be consumed by a 10 amp load operating for 1 hour. 10 Amp-hours could also be consumed by operating a 20 amp load for ½ hour, or a 0.2 amp load for 50 hours.

Accuracy

While the Remaining Battery Capacity display shows 1% increments the actual accuracy of the calculated value may vary by up to 3% to 5% relative to specified capacity of the battery. Since the Remaining Battery Capacity calculation is predictive in nature accuracy will vary depending on how the battery charged and discharged. Accuracy will tend to be better if;

- Charge Efficiency Mode is set to AUTO ADJUST.
- The accompanying charge controller delivers at least 3 amps of charge per 100 amp-hours of battery capacity.
- The accompanying charge controller is typically what brings the battery back to full charge.
- The battery is fully charged by the accompanying charge controller often to reset internal amp-hour counters and minimize error build up resulting from the non-ideal characteristics of batteries. The more the battery is charged and discharged without becoming fully charged, the greater the error buildup.
- Depth of discharge is relatively similar for each charge/discharge cycle.

How Remaining Battery Capacity Works

The IPN-ProRemote counts amp-hours into and out of the battery and compares this to the amp-hour rating of the battery to determine remaining battery capacity. Think of the battery simply as a “tank of amp-hours”. We can tell when the tank is full from the charge controller completing a charge cycle, but we can’t see into the tank to determine the level when it is not full. Since we can’t see into the tank, we count amp-hours into and out of the tank in an effort to predict the level. But the tank has leaks and these leaks change with temperature. The pipe filling the tank also has leaks, and the size of the tank changes with temperature. The IPN-ProRemote accounts for these non-ideal characteristics of batteries by the use of two factors, Charge Efficiency and Self Discharge Rate. If the accompanying charge controller includes a battery temperature sensor, the effects of temperature are also taken into account.

Self Discharge Rate

If a battery is left in a charged state with no charge or discharge current, it will slowly loose charge on it’s own. This is referred to as self discharge. The Self Discharge Rate is expressed in “percent per month” (%/Month) and varies with battery type and temperature. If the accompanying charge controller includes a battery temperature sensor, Self Discharge Rate will be automatically corrected for battery temperature. Self discharge amp-hours are added into the Amp-Hours From Full counter once per day.

Charge Efficiency

Charge efficiency refers to how many amp-hours are absorbed by the battery compared to how many charge amp-hours are delivered. A charge efficiency factor of 94% means that for each 100 amp-hours of charge delivered, the battery increases charge by 94 amp-hours. Charge efficiency is typically very high when the battery is highly discharged, and somewhat lower when the battery is near full charge. The factory default setting of 94% is a good average for typical systems.

The Charge Efficiency factor can be set to a FIXED number or can be set to automatically update based on past battery behavior. Most systems will benefit from the AUTO ADJUST setting which is the factory default. In AUTO ADJUST, the IPN-ProRemote will recalculate actual charge efficiency if the battery was discharged at least 10%, **-and-** the accompanying charge controller is what brought the battery back to full charge. If the Amp-Hours From Full counter is brought back to 0 (zero) by a charger other than the accompanying IPN based charger, the battery will be considered fully charged but this charge/discharge cycle will not be used to recalculate charge efficiency. Also, if Equalize was enabled at any time during a charge/discharge cycle, this cycle will not be used to recalculate charge efficiency. The Charge Efficiency factor update rate is filtered so that it takes approximately 5 charge/discharge cycles to completely update the Charge Efficiency factor.

Amp-Hours and the Remaining Battery Capacity Display

Counting amp-hours into and out of the battery and using charge efficiency and self discharge rate arrives at an Amp-Hours From Full counter value. This value is used with the battery's published "20hr rate" amp-hour rating to calculate remaining battery capacity. If the battery was 220 amp-hours and the Amp-Hours From Full counter value was at –110 amp-hours, remaining battery capacity would show 50%. The published amp-hour rating typically assumes the battery is at 25°C, but actual battery capacity changes with temperature. If the accompanying charge controller includes a battery temperature sensor, the IPN-ProRemote will correct battery amp-hours based on battery temperature per the graph of Figure 2. If battery temperature in this example the was at 0°C, then actual battery capacity is reduced to 79% of 220 amp-hours and remaining capacity becomes 37%.

BATTERY AMP-HOURS VS. TEMPERATURE

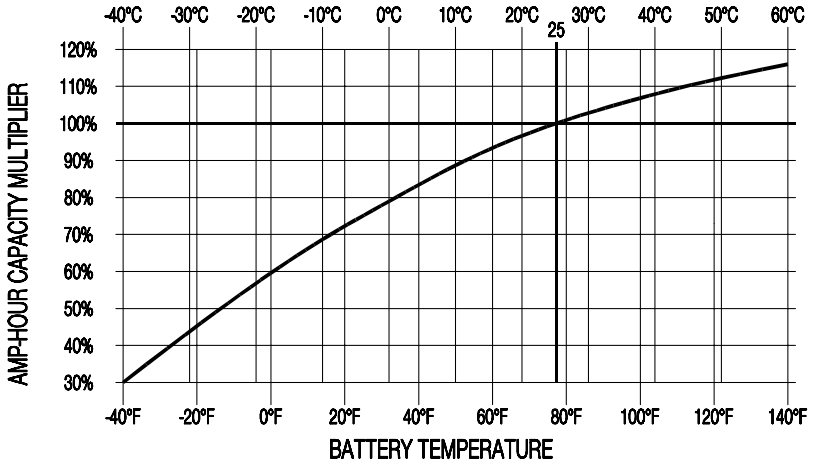


FIGURE 2

EQUALIZATION

➢ **WARNING:** Equalization can be activated and monitored from the IPN-ProRemote unless equalization is disabled in the accompanying charge controller. Not all batteries can be safely equalized. Equalization should only be performed on vented liquid electrolyte lead-acid batteries. Follow battery manufacturers recommendations pertaining to equalization.

Since each cell of a battery is not identical, repeated charge/discharge cycles can lead to an imbalance in the specific gravity of individual cells and electrolyte stratification. Equalization is essentially a controlled overcharge which brings all battery cells up to the same specific gravity and eliminates electrolyte stratification. Note that for proper equalization a minimum net charge current of approximately 3 amps per 100 amp-hours of battery capacity is required. If insufficient current is available equalization may have to be canceled manually since the equalization time accumulator may not be able to complete count down.

➢ **CAUTION:** Equalization is a controlled over charge of the battery at a relatively high voltage producing heavy battery gassing. While the IPN-ProRemote and accompanying charge controller can be configured for manual or automatic equalization it is strongly recommended that a qualified operator always plan and monitor the process. The operator should ensure that connected equipment can tolerate the high equalization voltage. Note that the voltage shown in the Equalize Enable screen on the Top menu is the basic setpoint and does not include the effects of temperature compensation.

Equalize Time Accumulator

The equalize time period is not a simple timer but rather a "time at voltage" time accumulator. The equalization timer will not count unless the battery is at or above the equalization voltage setpoint for the required time period to assure that a proper equalization cycle has taken place. The equalize timer counts in 3 minute increments. If battery voltage reached the equalization

voltage setpoint during a given 3 minute period, that period is considered good. Unless manually disabled, the unit will stay in equalize for as long as it takes to accumulate the required time at voltage. This may take hours or even days. If equalize does not complete by the time the charging day ends, it will pick up where it left off when the next charging day begins. The Equalize cycle may be enabled or canceled whether or not the accompanying charge controller has input power.

MENUS

There are four separate menus. The menus are arranged so that displays or functions typically desired by most users such as battery voltage, current and remaining capacity are available in the Top menu. Many users will find all the information they need in the Top menu. More advanced users or installers may want to go into the more advanced menus where advanced displays and setup capability reside. Refer to menu Figures 3, 4, 5 and 6.

- Top
- Advanced Display
- Setup
- Battery Charge Parameters

TOP MENU

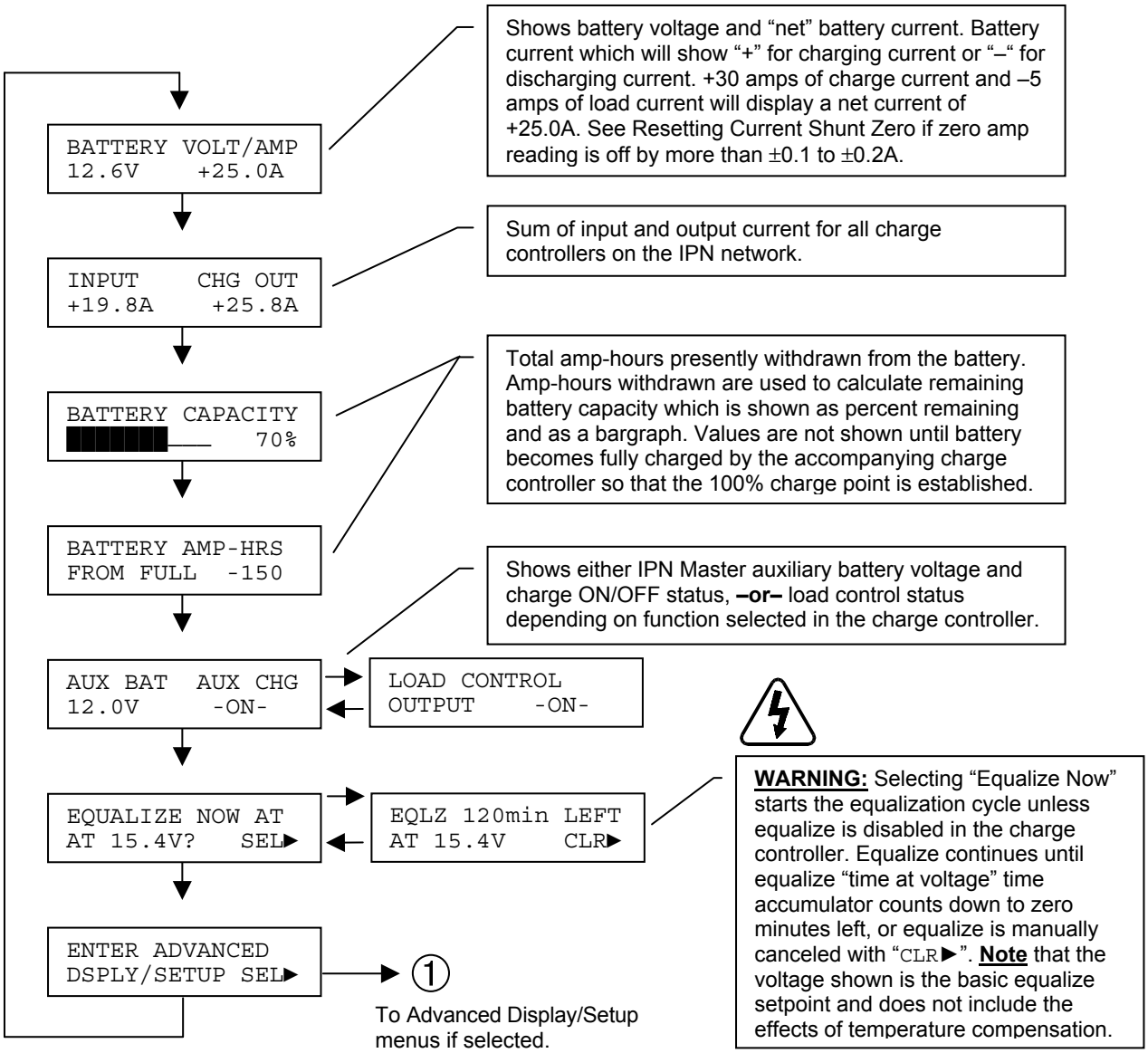


FIGURE 3

ADVANCED DISPLAY Menu

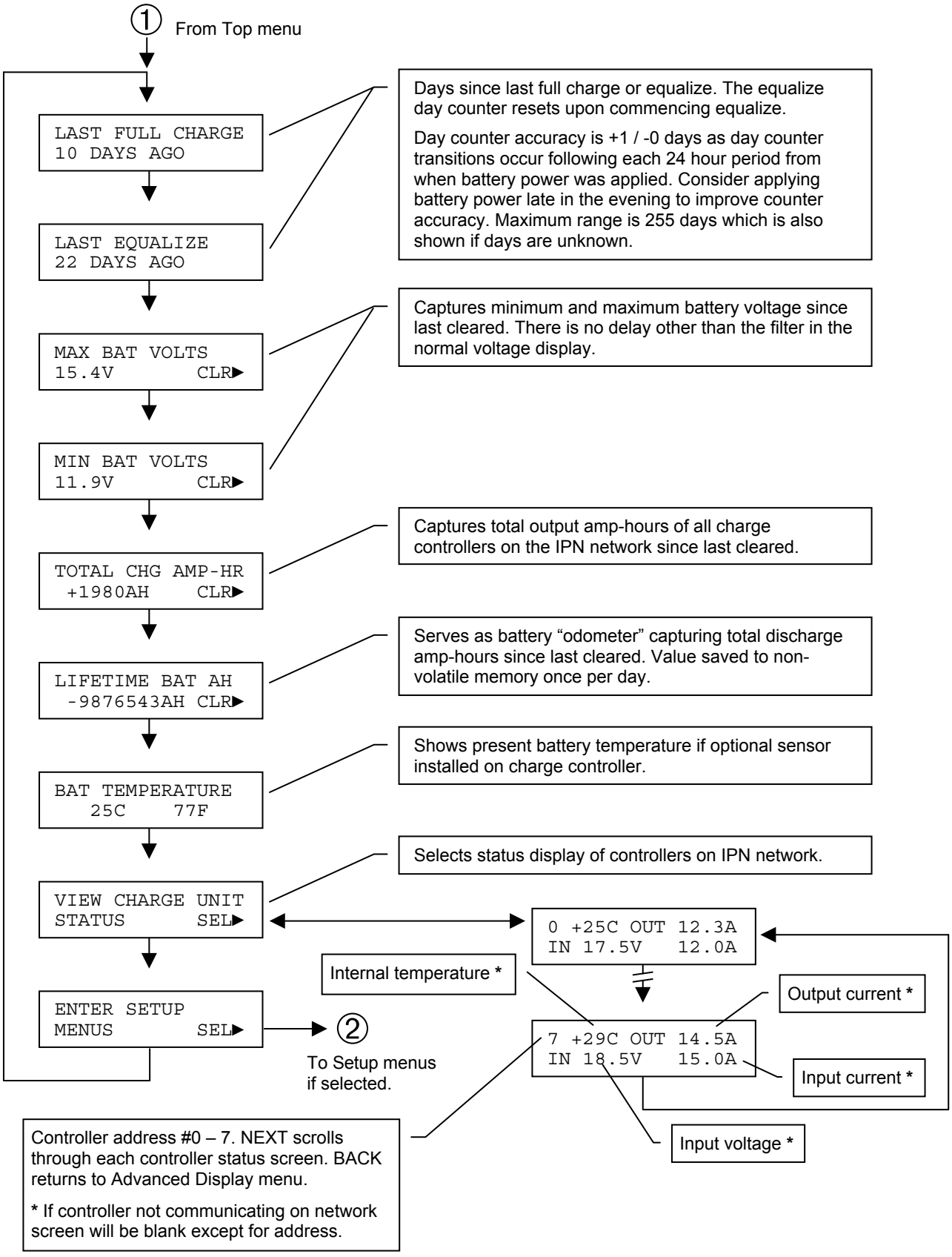


FIGURE 4

SETUP Menu

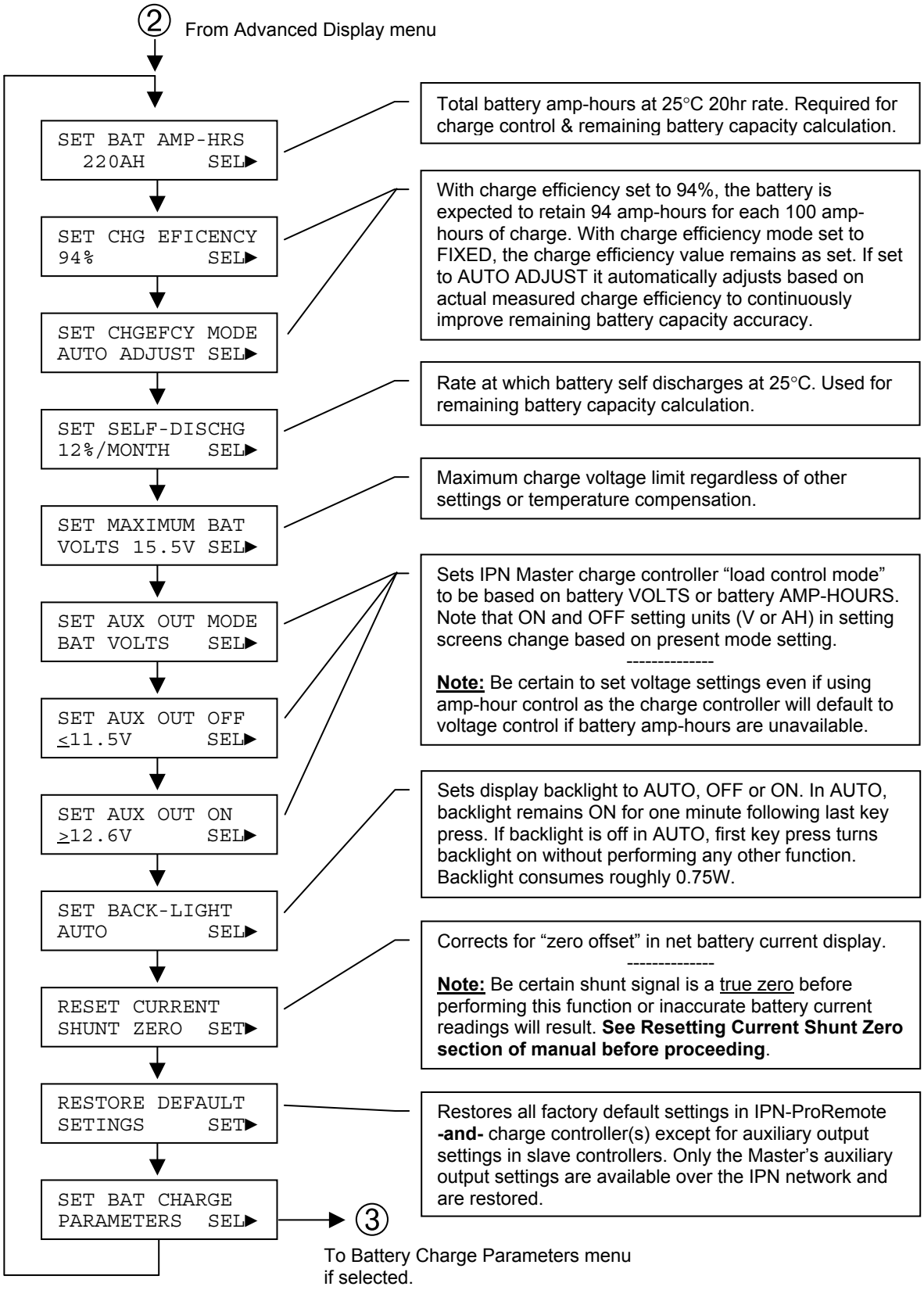


FIGURE 5

BATTERY CHARGE PARAMETERS Menu

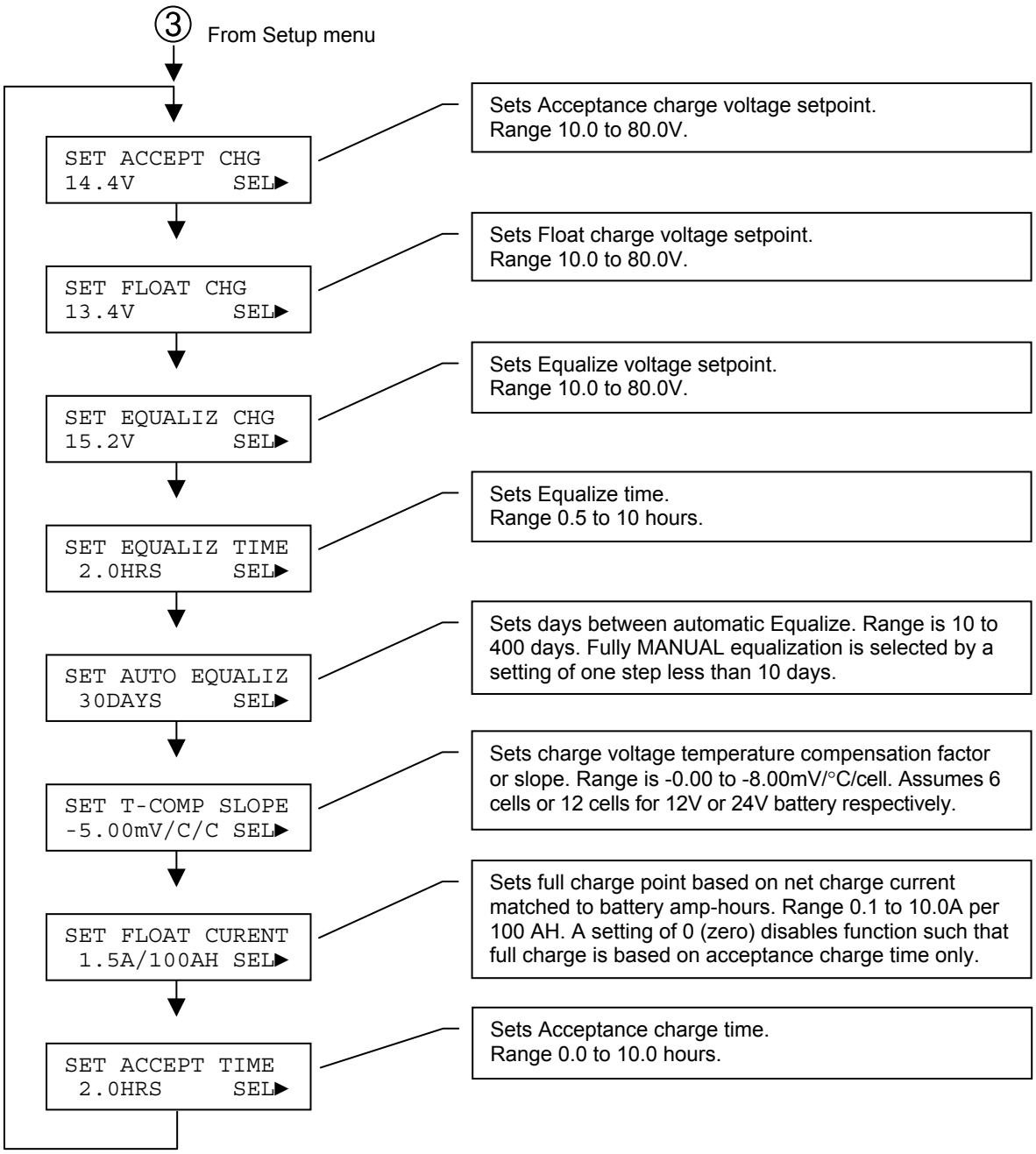
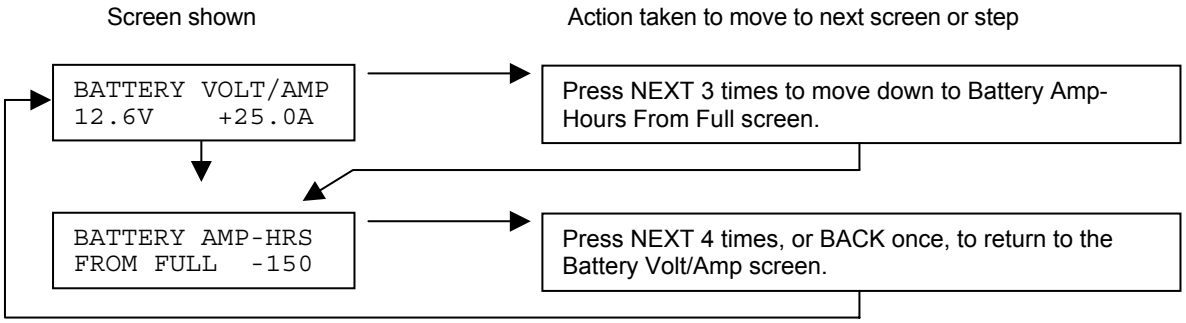


FIGURE 6

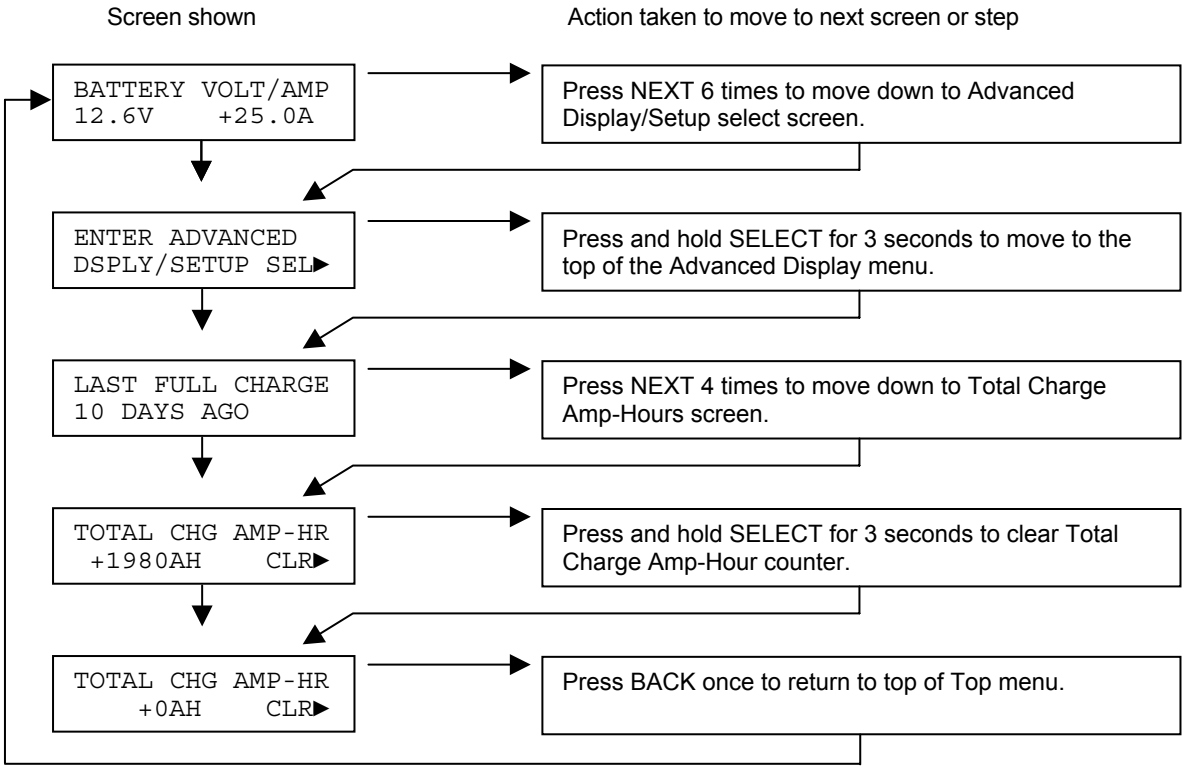
USING THE MENUS AND KEYS

Moving through the menus, functions and changing settings is consistent throughout all functions and screens. Three examples are shown to illustrate typical operation.

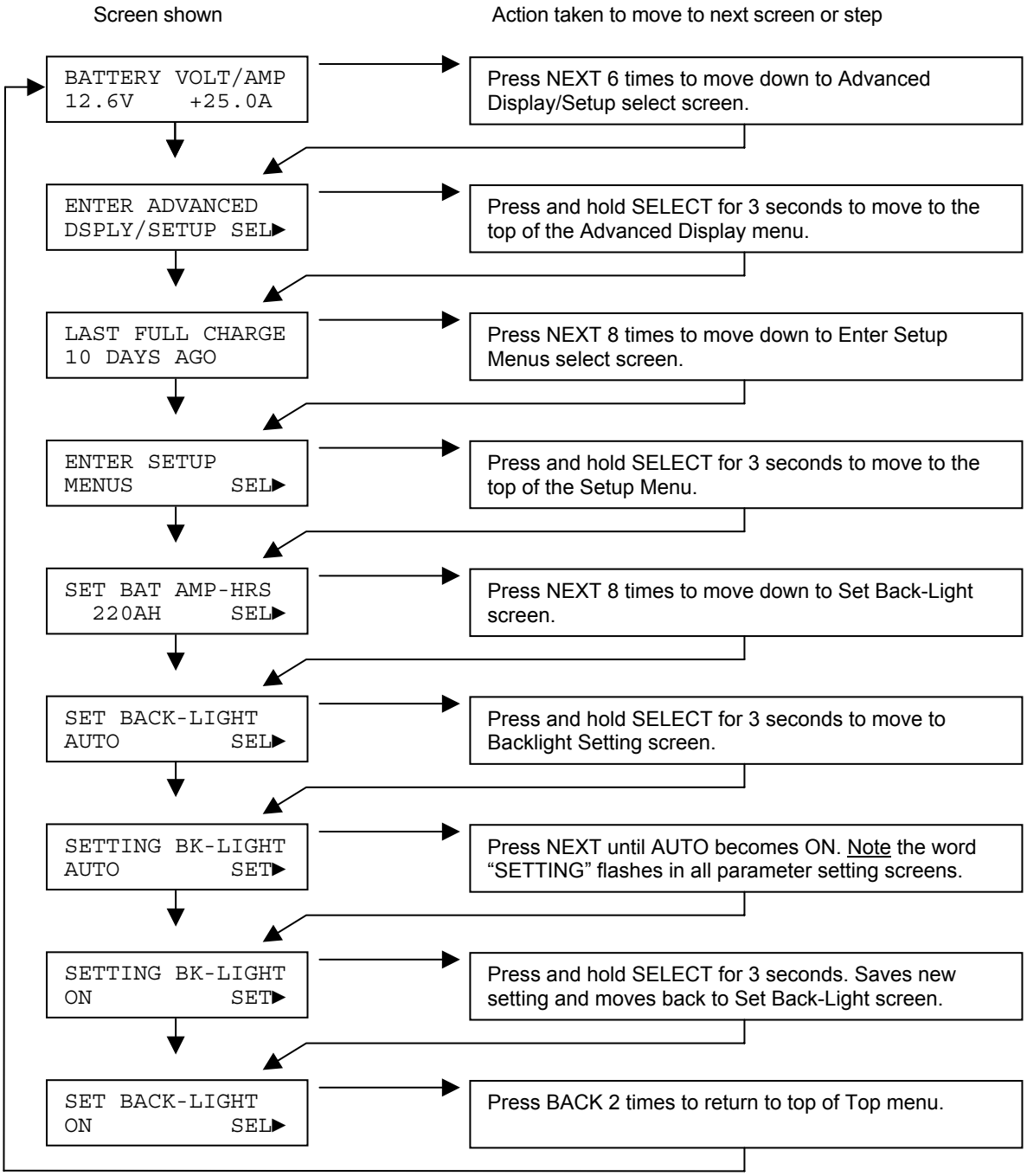
Example 1 – Viewing Amp-Hours From Full



Example 2 – Viewing And Clearing Total Charge Amp-hours



Example 3 – Setting Backlight To Always ON



INSTALLATION

➢ **WARNING:** Read, understand and follow the Important Safety Instructions in the beginning of this manual before proceeding. Install in accordance with National Electrical Code, ANSI/NFPA 70. To reduce risk of electric shock, remove all sources of power, PV and battery before installing. Adjustments or connections other than those shown in Figures 7 & 8 void the limited warranty. Note that Figures 7 & 8 are not meant to show all wiring, circuit protection and safety requirements for a photovoltaic electrical system.

ELECTROSTATIC HANDLING PRECAUTIONS

All electronic circuits may be damaged by static electricity. To minimize the likelihood of electrostatic damage, discharge yourself by touching a water faucet or other electrical ground prior to handling the unit and avoid touching components on the circuit boards. The risk of electrostatic damage is highest when relative humidity is below 40%.

IPN-ProRemote SETUP

➢ The IPN-ProRemote has various setup parameters all of which are preconfigured at the factory. Excluding charge controller setup, most installations require no IPN-ProRemote setup changes other than increasing **Acceptance Charge Time** to 4 hours, and entering actual **Battery Amp-Hours** and **Self Discharge Rate**. Refer to menu Figures 5 and 6 for detail on these setting screens and their functions.

➢ Note that many of the parameters configurable with the IPN-ProRemote do not reside in the IPN-ProRemote but rather reside in the accompanying charge controller. Factory default settings shown below are those that reside in the IPN-ProRemote, whereas all other settings shown in the Setup and Battery Charge Parameters menus reside in the charge controller. If these charge controller settings are changed with the IPN-ProRemote, the IPN-ProRemote does not need to remain in the system for these settings to stay in effect. The IPN-ProRemote can be used as a setup tool only and then removed.

Factory Default Settings

Factory defaults are configured for a system consisting two or four (12V or 24V respectively) lead-antimony 6V deep cycle golf cart batteries in series.

- Amp-hours (25°C 20hr rate) ..... 220 amp-hours
- Charge Efficiency 94%
- Charge Efficiency Mode ..... Auto Adjust
- Self Discharge Rate 12%/month
- LCD Backlight ..... Auto

Restoring Factory Default Settings

➢ Factory defaults can be easily restored into the IPN-ProRemote and accompanying charge controller using the Restore Default Setings function in the Setup menu. Note that this Restore Defaults function restores ALL defaults in both the IPN-ProRemote AND accompanying charge controller(s). It does not restore auxiliary output settings in slave charge controllers.

Battery Amp-Hour Rating

The amp-hours setting is used by both the Remaining Battery Capacity function and Advanced Charge Control. The setting should be the total published 25°C 20hr rate amp-hour rating of the total battery bank. For systems with more than one battery, battery amp-hours add when batteries are placed in parallel. When batteries are placed in series battery voltage adds and amp-hours do not. Four 220 amp-hour 6V batteries combined 2-in-series 2-in-parallel produce a 12V 440 amp-hour battery bank.

Charge Efficiency & Charge Efficiency Mode

Charge Efficiency describes how much charge is absorbed by the battery compared to how much charge is delivered. With charge efficiency set to 94%, the battery is expected to retain 94 amp-hours for each 100 amp-hours of charge delivered. Charge Efficiency Mode controls whether Charge Efficiency remains at a fixed number or automatically updates based on actual battery charge efficiency behavior. The factory settings of 94% (Charge Efficiency) and AUTO ADJUST (Charge Efficiency Mode) are typically suitable for most systems and do not require adjustment.

With AUTO ADJUST selected the IPN-ProRemote will recalculate actual charge efficiency if the battery was discharged at least 10%, and the accompanying IPN based charge controller is what brought the battery back to full charge. The Charge

Efficiency factor update rate is filtered to prevent sudden changes in the Charge Efficiency factor. Approximately 5 charge/discharge cycles are required to completely update the Charge Efficiency factor. If the Amp-Hours From Full counter is brought back to 0 (zero) by a charger other than the accompanying IPN based charger, the battery will be considered full but this charge/discharge cycle will not be used to recalculate charge efficiency. Also, if Equalize was enabled at any time during a charge/discharge cycle, this cycle will not be used to recalculate charge efficiency.

Systems most likely to benefit from a FIXED Charge Efficiency Mode are those with very low charge current compared to battery size. In these systems battery charge voltage may spend a great deal of time just below the charge voltage setpoint where charge efficiency tends to be low. Other systems that may benefit from a FIXED Charge Efficiency Mode are those with very widely varying charge or discharge current or time. For these systems a suitable Charge Efficiency value needs to be determined experimentally. Try AUTO ADJUST first and see what charge efficiency the IPN-ProRemote calculates over 5 –10 "normal" charge/discharge cycles. You may then want to lock this value in place by setting Charge Efficiency Mode to FIXED. A perfect Charge Efficiency factor will cause the Amp-hours From Full counter to reach 0 (zero) just as the charge controller indicates the battery is fully charged.

Self Discharge Rate

With no load connected, all batteries will self discharge at some rate. The Self Discharge Rate varies greatly based on battery type and battery temperature. The Self Discharge Rate entered should be the 25°C value provided by the battery manufacturer. If this cannot be determined, use an appropriate value from Table 2 below. In renewable energy systems which charge and cycle regularly, self discharge is typically a small contributor to total discharge compared to load current and an accurate Self Discharge Rate value is not particularly important. In systems where load current is low and full charge is infrequent, Self Discharge Rate is more important and an accurate value from the battery manufacturer should be entered. Actual self discharge varies greatly with battery temperature. The Self Discharge Rate will be automatically corrected for temperature if the accompanying charge controller includes a battery temperature sensor.

TYPICAL SELF DISCHARGE RATE

BATTERY CONSTRUCTION	SELF DISCHARGE RATE
Vented Liquid Electrolyte Lead-Antimony	12%/Month
Vented Liquid Electrolyte Lead-Calcium	5%/Month
Gel Lead-Calcium	3%/month
AGM Lead-Calcium	2%/month

TABLE 2

Advanced Charge Control

The most highly optimized battery charge process is provided by: A) Using the battery manufacturers recommended charge voltages, B) Using the optional battery temperature sensor for temperature compensation of charge voltage, and C) Using net battery charge current matched to battery size in amp-hours to determine when the battery is full. The accompanying charge controller alone can provide items A and B. Item C is provided by adding the IPN-ProRemote.

With the IPN-ProRemote added, the charge controller will consider the battery fully charged and switch to Float if either;

1. Battery voltage has been continuously at or above the Acceptance voltage setpoint for the Acceptance Charge Time period. (As the charge controller would do alone.)

– OR –

2. Net battery charge current drops below the Float Transition Current factory set to 1.5A per 100 amp-hours of battery capacity while the battery is at or above the Acceptance voltage setpoint.

While "time in Acceptance" is a reasonable way to determine when the battery is fully charged if net charge current is not known, time does not directly relate to battery state of charge if charge current is variable. By contrast, net battery charge current matched to battery size in amp-hours relates directly to battery state of charge. The factory default Float Transition Current (FLOAT CURRENT in the Battery Charge Parameters menu) setting of 1.5 amps per 100 amp-hours of battery capacity is suitable for most batteries. With the factory default BATTERY AMP-HOUR setting of 220 amp hours, the battery would be considered fully charged when net charge current dropped to 3.7 amps.

To assure that net charge current is what determines when the battery is full, charge time should be increased to roughly double the normal setting or 4 hours. This is so that if battery current is unable to decrease to the Float Transition Current due to battery age or damage, the charge will terminate after a reasonable time period in Acceptance.

CURRENT SHUNT

➢ **CAUTION:** A 500A/50mV current shunt must be used with the IPN-ProRemote. The current shunt is used to measure net battery current and must be installed in series with the negative battery cable. Do not install in series with the positive battery cable or damage not covered by the limited warranty may result. All negative connections for all charging and discharging sources must connect to the charge controller side of the shunt. No current carrying conductors other than the shunt cable may be connected to battery negative. Note that the battery temperature sensor lug is not a current carrying conductor and may remain on battery negative. Shunt signal cable length should be limited to roughly 300 feet (91.5m) maximum. IPN-ProRemote shunt signal wire compression terminals are to be tightened to 2.1 in-lb (0.24 nm).

WIRING DIAGRAM

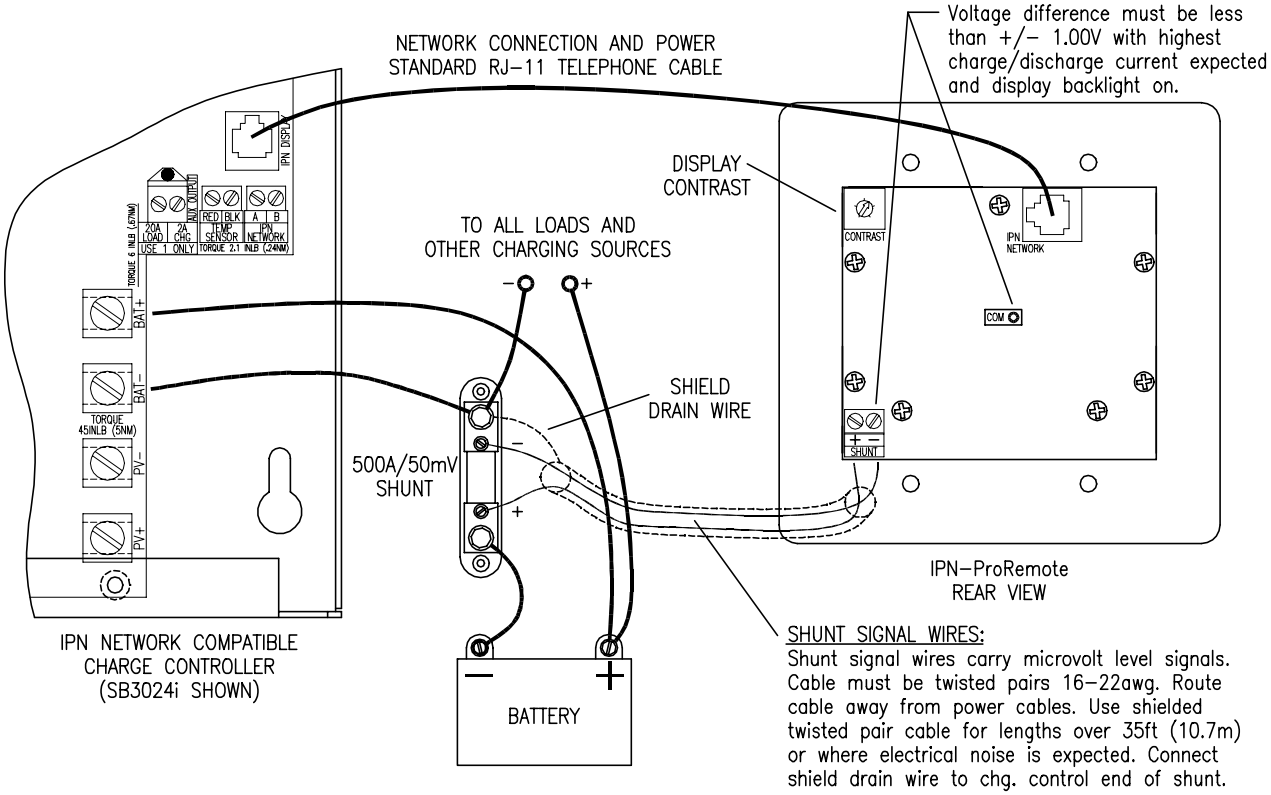


FIGURE 7

Current Shunt Signal Wiring

The current shunt produces very sensitive microvolt level signals. Shunt signal wires must be twisted pairs. Lengths less than 35 feet (10.7m) can be unshielded twisted pairs if routed away from power carrying or noise generating conductors. Lengths greater than 35 feet (10.7m) should use shielded twisted pair cable. The shield drain wire should be terminated at one end only, either to the shunt as shown in Figure 7 or to earth ground. Be certain connections are clean and tight.

Resetting Current Shunt Zero

The microvolt level shunt signals are displayed by the IPN-ProRemote as Net Battery Current. The sensitive nature of these signals can produce a slight drift or offset in the zero reading (0.0A) due electrical noise pickup, shunt wire type or length, temperature extremes or normal electronic component aging. A Reset Current Shunt Zero function is provided to compensate for zero offset and provide an accurate zero reading. The Reset Current Shunt Zero function should be performed upon initial system installation and at any time the zero reading with no charge or discharge current flowing in the current shunt produces a zero reading of more than ±0.1 to ±0.2A. Do not confuse small discharge current flowing in the shunt as zero offset or drift.

➢ **CAUTION:** Do not perform the Reset Current Shunt Zero function without first providing a true zero signal to the IPN-ProRemote by temporarily placing both shunt sensing wires under the same shunt sense signal screw. Failure to provide a true zero signal input before executing the Reset Current Shunt Zero function will result in inaccurate battery current readings and amp-hour counting.

To reset current shunt zero and remove zero offset:

1. Turn off electrical noise producing devices such as inverters and charge controllers.
2. Place both shunt signal wires under the SAME shunt sense signal screw to provide a true zero signal.
3. Execute the Reset Current Shunt Zero function from the Setup Menu.
4. Press BACK twice to return to the Battery Volt/Amp screen to examine the new battery current zero reading. If zero is not within ±0.1A or better repeat the Reset Current Shunt Zero function and check again.
5. Zero offset correction data is now stored in memory and retained if power is lost.
6. Return shunt signal wires to their normal shunt sense screw positions.

Network And Power Connection

Network connection and power are provided by the accompanying IPN based charge controller. Each charge controller includes an IPN DISPLAY connector. The IPN-ProRemote does not need to plug into the network Master and can plug into any controller on the network. A standard 4 conductor RJ-11 telephone cable is used.

➢ Note that standard 4-pin telephone cables swap pin numbers end-to-end. This end-to-end pin swap is required for the IPN-ProRemote to operate properly. If cables are custom terminated or cable couplers are used, be certain the pin swap is maintained as shown in Figure 8. Total maximum cable length should be limited to approximately 500 feet (152.4m).

NETWORK/POWER CABLE SCHEMATIC

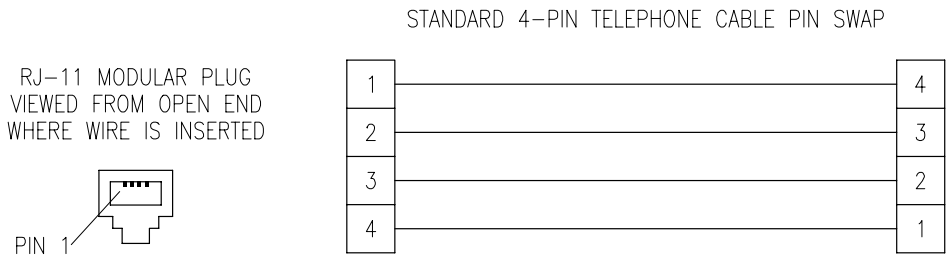


FIGURE 8

➢ When Backlight is on, the IPN-ProRemote can draw up to 100mA from the charge controller. For proper operation of the shunt current measurement circuits, total voltage difference between the IPN-ProRemote circuit common and the shunt must be kept to less than ±1.0V when Backlight is ON and maximum charge or discharge current is flowing in the system. If long network/power cables are used, wire size may need to be increased to keep voltage difference between the "COM test point" and "SHUNT –" on the back of the IPN-ProRemote to within ±1.0V or less at all times. Table 3 below shows wire size for a more conservative recommended voltage drop limit of 0.50V maximum.

MAXIMUM NETWORK/POWER CABLE LENGTH FOR 0.50V DROP

WIRE GAUGE AWG	MAXIMUM RECOMMENDED CABLE LENGTH FEET / METERS
30 AWG	45 / 13.7
28 AWG	73 / 22.2
26 AWG	117 / 35.7
24 AWG	187 / 57.0
22 AWG	295 / 89.9
20 AWG	475 / 144.8
18 AWG	753 / 229.6

TABLE 3

MOUNTING

➢ **CAUTION:**. The unit is not watertight and must be protected from rain, snow and excessive moisture.

DETAILED DIMENSIONAL DRAWING

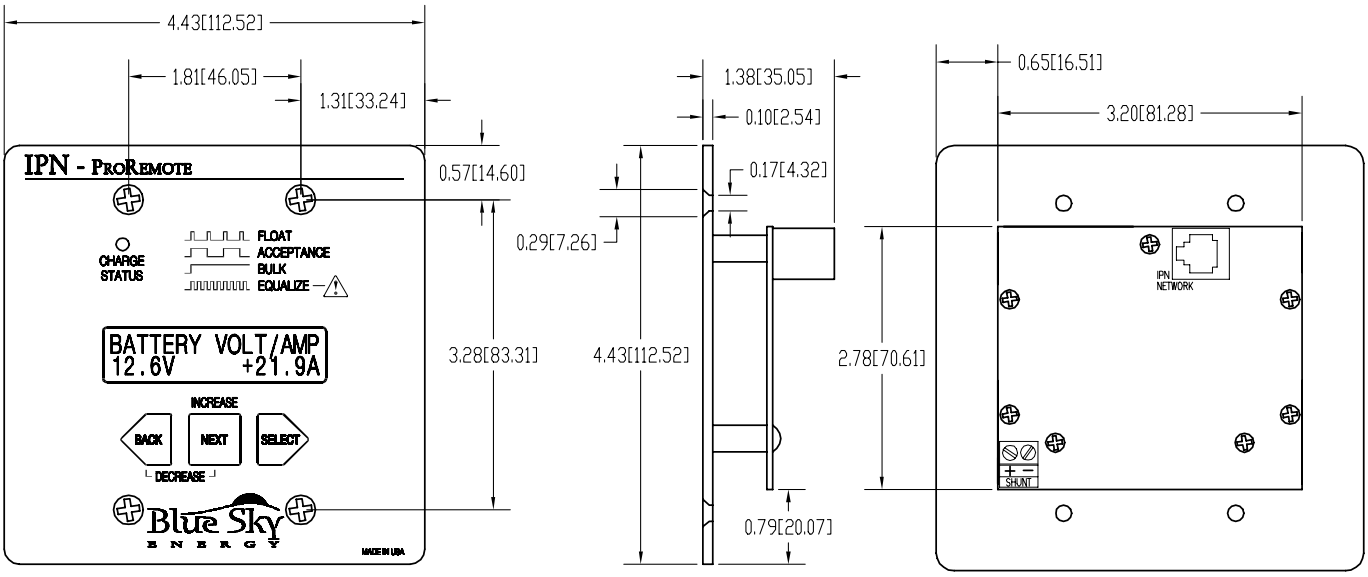


FIGURE 9

TROUBLESHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	ITEMS TO EXAMINE OR CORRECT
Completely dead, no display	No power	Charge controller not properly powered. Network cable faulty, not plugged in or cable pins do not swap per Figure 8.
Display turns on, but battery voltage display shows – –.–V rather than a number	IPN-ProRemote not communicating with charge controller	Network cable faulty. One or more charge controllers on network has open Bat – connection preventing communication. One charge controller is not set to be Master, or more than one charge controller is set to be Master. Controller-to-controller network cable not wired A-to-A, B-to-B, or wires are open or short.
No data shows in the View Charge Unit Status screen	Charge controller not communicating with IPN-ProRemote	Controller-to-controller network cable not wired A-to-A, B-to-B, or wires are open or short. More than one charge controller is set to be Master or more one charge controller set to same slave address.
Days since last equalize or last full charge show 1 day too many	Day counter updates only once per day	Normal operation. The day counter increments once each 24 hours since battery power was applied. This may at times cause the day counter to show one day too many. If bothersome, this can be corrected by removing and reapplying battery power late in the evening or early in the morning so that the counter increments at this time each day rather than in the middle of the day.
Days since last equalize reset without equalize completing	Day counter updates when equalize starts	Normal operation. The equalize day counter is reset when equalize starts rather than when it ends, and will therefore reset if equalize is canceled manually before the cycle completes.
Battery current polarity reversed	Power or signal wires on shunt reversed	Swap either power or signal wires on shunt, do not swap both.

SYMPTOM	PROBABLE CAUSE	ITEMS TO EXAMINE OR CORRECT
Battery current seems inaccurate	Some charging sources or loads do not go through shunt	Confirm that no other current carrying conductors other than the shunt cable is connected to battery negative.
	Shunt wiring incorrect or faulty.	Shunt wired in series with battery positive, should be negative.
		One or both shunt signal wires open or short.
	Shunt signal wires picking up electrical noise	Confirm signal wires are twisted pairs.
		Consider using shielded twisted pair cable for signal wires. Confirm shield drain wire connection to shunt. Consider test of drain wire to earth ground instead.
		Relocate signal wires away from power or noise generating wiring.
	Excessive voltage drop in network cable to IPN-ProRemote or in system power wiring	Confirm that with backlight ON (if used) and with highest possible charge or discharge current flowing in system, voltage difference between "COM test point" and "SHUNT –" on the back of the IPN-ProRemote is less than ±1.0V at all times, with less voltage drop being better. Correct wiring as necessary. If problem is due to network cable, consider not using Backlight.
	Zero current in shunt not reading zero (00.0A)	Perform Reset Current Shunt Zero function to remove zero offset.
Remaining Battery Capacity & Amp-Hours From Full show – – –	Charge controller has not finished charging battery	Normal operation. Until the battery is fully charged by the IPN charge controller, Remaining Battery Capacity & Amp-Hours From Full displays show – – – because the full charge point is unknown.
Remaining Battery Capacity or Amp-Hours From Full seem inaccurate	Shunt not properly reading battery current	Shunt **must** read correctly to properly count Amp-Hours From Full, which is then used to calculate Remaining Battery Capacity. See Battery Current Seems Inaccurate above.
	Incorrect battery amp-hours entered	Confirm correct amp-hour value is entered. Must be total amp-hour rating at 25°C and 20Hr rate.
	Incorrect Charge Efficiency factor	Confirm Charge Efficiency factor and Charge Efficiency Mode are set correctly. Charge Efficiency Mode should normally be set to AUTO ADJUST.
Remaining Battery Capacity or Amp-Hours From Full seem inaccurate (Continued)	Battery not fully charged for a long time	Normal operation. Since battery charge acceptance and delivery are not ideal, error in the Amp-Hours From Full counter builds as the battery charges and discharges without becoming full. Try to charge the battery fully and often to both improve accuracy and promote long battery life.
	IPN charge controller is not what normally beings the battery back to full charge	To get the best accuracy, the IPN charge controller should be what normally or at least regularly brings the battery back to full charge. Self tuning Charge Efficiency will not recalculate if the IPN charge controller is not what brings the battery back to full charge.
	Self Discharge Rate set incorrectly	Confirm proper setting.
	Temperature sensor faulty	Amp-hours are corrected for temperature and if temperature is wildly inaccurate, amp-hours can be improperly corrected for temperature.
Days since last equalize or last full charge show 1 day too many	Day counter updates only once per day	Normal operation. The day counter increments once each 24 hours since battery power was applied. This may at times cause the day counter to show one day too many. If bothersome, this can be corrected by removing and reapplying battery power late in the evening or early in the morning so that the counter increments at this time each day rather than in the middle of the day.
Days since last equalize reset without equalize completing	Day counter updates when equalize starts	Normal operation. The equalize day counter is reset when equalize starts rather than when it ends, and will therefore reset if equalize is canceled manually before the cycle completes.

SPECIFICATIONS

SPECIFICATIONS	IPN-ProRemote
Current Shunt	Requires current shunt in battery negative line, 50mV / 500 amp
Battery Ammeter	Range ±773.3A FS • Accuracy ±0.5% FS
Other Meters	Accuracy/range of other volt/amp meters determined by IPN charge controller
Battery Size	20 – 10,000 Amp-hours
Power Consumption	0.25W Typical • 1.0W Typical with backlight on
Remaining Battery Capacity	0 – 100% in 1% increments, based on charge/discharge amp-hour counting, self discharge rate and self tuning charge efficiency. Appropriate factors temperature compensated[①].
Amp-hours From Full	0 – 16,383 Amp-hours
Full Charge Determination	Automatically matched to IPN charge controller setup. Adds ability to determine full charge based on net battery current matched to battery size in amp-hours
Total Charge Amp-hours	0 – 16,383 Amp-hours, user resetable
Lifetime Battery Amp-hours	0 – 9,999,999 Amp-hours
Days Since Full Charge	0 – 255 Days
Days Since Equalize	0 – 255 Days
Backlight	Can be set to ON, OFF or AUTO (on for 1 minute following key press)
Panel Dimensions	4½"H x 4½"W x 1½"D (11.4cm x 11.4cm x 3.8cm) Fits standard duplex wall mount box
Communication, Power & Cabling	Receives power and communication from IPN compatible charge controller via 4-pin telephone cable. Charge controller cable length to 500' (152.5m) with proper cabling. Current shunt connection via twisted pair cable. Length to 300' (91.5m) with proper cabling. RS-232 interface available with -232 option.
Environmental	-40 – +40°C, 10 – 90% RH non-condensing

As a part of our continuous improvement process specifications are subject to change without prior notice

[①] With optional battery temperature sensor

TWO YEAR LIMITED WARRANTY

Blue Sky Energy, Inc. (hereinafter BSE), hereby warrants to the original consumer purchaser, that the product or any part thereof will be free from defects due to defective workmanship or materials for a period of two (2) years subject to the conditions set fourth below. If within the coverage of this limited warranty, BSE will repair or replace the product at BSE's discretion. The original consumer purchaser is responsible for all transportation costs and insurance related to returning the product to BSE. BSE will cover standard ground transportation costs and insurance to return the product to the original consumer within the continental US.

1. This limited warranty is extended to the original consumer purchaser of the product, and is not extended to any other party.
2. The limited warranty period commences on the date the product is sold to original consumer purchaser.
3. This limited warranty does not apply to any product or part thereof damaged by; a) alteration or disassembly, b) repair or service not rendered by a BSE authorized repair facility, c) accident or abuse, d) corrosion, e) lighting or other act of God, or f) operation or installation contrary to instructions pertaining to the product.
4. BSE's liability for any defective product or any part thereof shall be limited to the repair or replacement of the product, at BSE's discretion. BSE will not be liable for any loss or damage to person or property, or any other damages, whether incidental, consequential or otherwise, caused by any defect in the product or any part thereof. Some states do not allow exclusions or limitations of incidental or consequential damages, so the above limitation may not apply to you.
5. Any implied warranty for merchantability or fitness for a particular purpose is limited in duration to the length of this warranty. Some states do not allow exclusions or limitations on how long an implied warranty lasts, so the above limitation may not apply to you.
6. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.
7. To obtain warranty repairs, contact BSE at 800-493-7877 or 760-597-1642 to obtain a Returned Goods Authorization (RGA) number. Mark the outside of the package with the RGA number and return the product, postage prepaid and insured to the address below. A copy of the purchase receipt identifying original consumer purchaser and date purchased must accompany the product to obtain warranty repairs.

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