



**Bren-Tronics, Inc.**

Intelligent Military Batteries & Charging Systems™

10 BRAYTON COURT, COMMACK, NY 11725



# 6-PACK PORTABLE POWER SYSTEM

## OPERATION MANUAL

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**BREN-TRONICS, INC**

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850069 Rev E

**BTE-70791A-T1B**

**BTE-70791A-G1B**

NSN: 6130-01-588-5188

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## WARNING

### HIGH VOLTAGES ARE PRESENT IN THE OPERATION OF THIS EQUIPMENT

Avoid contact with AC supply voltage connections during installation, operation and/or maintenance.

### CAUTION

To prevent electric shock, make sure that pin E of the AC input is connected to the ground (earth) of the utility power mains when using AC power!

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Other CAUTIONS pertaining to the equipment output are located in the  
INTERFACE WIRING section.

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Input-power and output ratings are located in the INTERFACE WIRING section.

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# 6-PACK OPERATION MANUAL

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# 1 BASIC CONFIGURATION

The 6-PACK consists of two electrically-independent battery banks; each bank can hold one to three Bren-Tronics BB-2590/U lithium-ion batteries to form a high-capacity, 14.4Vdc (nominal) battery bank. The two banks can be connected in series or parallel, to provide a nominal output of 28.8Vdc or 14.4Vdc with a total energy-storage capacity of 1.2, 1.5, or 1.8kWh (depending on which capacity version of the BB-2590/U is used) with the potential to grow as higher-capacity versions of the BB-2590/U become available.

Number of BB-2590/U batteries installed:	Nominal capacity of 6-PACK (Ah, series/parallel)						
	BT-70791A	BT-70791BK	BT-70791BE	BT-70791BG	BT-70791CK	BT-70791CE	BT-70791CG
-							
2 (one per bank)	13.6/27.2	15.0/30.0	17.4/34.8	19.8/39.6	15.0/30.0	17.4/34.8	19.8/39.6
4 (two per bank)	27.2/54.4	30.0/60.0	34.8/69.6	39.6/79.2	30.0/60.0	34.8/69.6	39.6/79.2
6 (three per bank)	40.8/81.6	45.0/90.0	52.2/104.4	59.4/118.8	45.0/90.0	52.2/104.4	59.4/118.8

Number of BB-2590/U batteries installed:	Nominal capacity of 6-PACK (Wh)						
	BT-70791A	BT-70791BK	BT-70791BE	BT-70791BG	BT-70791CK	BT-70791CE	BT-70791CG
-							
2 (one per bank)	400	450	500	588	450	500	588
4 (two per bank)	800	900	1000	1176	900	1000	1176
6 (three per bank)	1200	1350	1500	1764	1350	1500	1764

Each bank is equipped with a communication interface that emulates “SMBus” smart-battery operation via a RS-485 serial link.

Each bank also has its own microcontroller-based charger, which operates independently to assure proper charging of all the installed batteries. These chargers can be powered from 24V “NATO” vehicular DC power, 12V automotive DC power, 115V/230V utility AC power, or from solar panels (or other alternative power sources).

Mechanically, the 6-PACK consists of a lower enclosure that holds the batteries for both banks, and an upper enclosure that houses the chargers, battery monitors, connectors, and controls.

## 2 TECHNICAL SPECIFICATIONS

*Dimensions*.....12.8 in. (325 mm) W x 10.8 in. (274 mm) D x 11.3 in. (287 mm) H

*Weight*.....39.0 lbs (18.0 kg) with six (6) BB-2590/U batteries  
20.0 lbs (9.5 kg) without batteries

### *Power Requirements*

AC operation.....Automatic selection: 90-264Vac, 250 VA

DC operation..... 11-18Vdc, 20A; 20-33Vdc, 15A;12-36Vdc Solar, 20A

*Duty Cycle*..... Continuous

*Operating Temp. Range*....-4°F (-20°C) to +122°F (+50°C)

*Storage Temp. Range*.....-40°F (-40°C) to +158°F (+70°C)

*Loose Cargo Bounce*.....Meets requirements of MIL-STD-810G, Method 514.6, Procedure II

*Enclosure Rating*.....IP67 (1 meter/1 hour water immersion)

*Input and Output Ratings*...See Interface Wiring (section 5)

*Case Material*..... Heavy Duty Aluminum

*Case Color*..... Tan (other colors optional)

*Shipment*..... No restrictions

### 3 DECLARATION OF CONFORMITY



#### DECLARATION OF CONFORMITY – EU LOW VOLTAGE DIRECTIVE

**Bren-Tronics Inc.**, located at the Commack, NY, USA address shown above, certifies and declares under our sole responsibility that the following apparatus:

**6-PACK Power Source**  
**Model numbers:**  
**BTE-70791A-T1B      BTE-70791A-G1B**  
**BTE-70791A-T1      BTE-70791A-G1**

conforms with the essential requirements of European Community Council Directive 2006/95/EC, based on the following specification applied:

IEC 60950-1:2005 (2nd Edition)

The supporting Technical File is maintained at the Commack, NY, USA address shown above.

**Certified and Declared as described above:**

\_\_\_\_\_  
**Peter Burke**  
**Vice President, Engineering**  
**BREN-TRONICS Inc.**

21 AUG 2009  
Date

09

**DECLARATION OF CONFORMITY – EU EMC DIRECTIVE**

Bren-Tronics Inc., located at the Commack, NY, USA address shown above, certifies and declares under our sole responsibility that the following apparatus:

**6-PACK Power Source**

**Model numbers:**

**BTE-70791A-T1B      BTE-70791A-G1B**  
**BTE-70791A-T1      BTE-70791A-G1**

conforms with the essential requirements of European Community Council Directive 2004/108/EC, based on the following specifications applied:

**EMISSIONS:**

EN 61000-6-4:2007+A1 2011  
 CISPR 16-1-2 Edition 1.2:2003 Conducted Emissions  
 CISPR 16-2-1 Edition 1.1:2003 Radiated Emissions  
 IEC 61000-3-2:2005+A1:2009+A2:2009 Harmonics  
 IEC 61000-3-3:2008 Flicker

**IMMUNITY:**

EN 61000-6-2:2005;  
 IEC 61000-4-2 Edition 1.2:2001-04 Electrostatic Discharge  
 IEC 61000-4-3 Edition 3.1:2008-04 Radiated Immunity  
 IEC 61000-4-4 Edition 2.0:2004-07 EFT/Burst, Power and I/O Leads  
 IEC 61000-4-5 Edition 2.0:2005-11 Surge, Power Leads  
 IEC 61000-4-6 Edition 3.0:2008-10 Conducted Immunity, Power and I/O Leads  
 IEC 61000-4-11 Edition 2.0:2004-03 Voltage Dips and Interrupts

The supporting technical documentation is maintained at the Commack, NY USA, address shown above.

**Certified and Declared as described above:**

  
 \_\_\_\_\_  
**Donald Fagon**  
 Vice President, Quality Assurance  
 BREN-TRONICS Inc.

29 MAR 2016  
 \_\_\_\_\_  
 Date

## 4 ACCESSORIES

### 4-1 INPUT CABLES

TABLE 1

DESCRIPTION	PART NUMBER	NSN
12V DC POWER CABLE (Ring Lugs)	BTA-70856-1B	---
12V DC POWER CABLE (Alligator Clips)	BTA-70856-12AL	---
SOLAR POWER CABLE	BTA-70857-2B	6150-01-598-1960
12V/24V DC POWER CONNECTOR	BTA-70863-C	5935-01-606-9492
DC POWER EXTENSION CABLE	BTA-70863-EX	---
24V DC POWER CABLE (Ring Lugs)	BTA-70863-24	6150-01-601-5147
24V DC POWER CABLE (Alligator Clips)	BTA-70863-24AL	6150-01-606-5685
24V DC HUMMER CABLE	BTA-70835B	---
DC CABLE SPLITTER	BTA-70816B	---
AC POWER CONNECTOR	BTA-70864-C	5935-01-606-9494
AC POWER CORD, US	BTA-70864-2	6150-01-606-5871
AC POWER CORD, US 6 ft.	BTA-70864-3	6150-01-606-5671
AC POWER CORD, EU	BTA-70864-5	6150-01-606-9493
AC POWER CORD, UK	BTA-70864-6	6150-01-606-5681
AC POWER CORD, US, DUAL	BTA-70864-7	---

### 4-2 OUTPUT CABLES

TABLE 2

DESCRIPTION	PART NUMBER	NSN
12V/24V DC CONNECTOR	BTA-70791A-C	5935-01-609-0354
12V/24V DC CONNECTOR, 90 DEG	BTA-70791A-C90	---
24V DC CABLE (Screw Terminal)	BTA-70791A-1	---
24V DC CABLE (Bayonet Terminal)	BTA-70791A-1B	6150-01-606-5655
24V DC CABLE (Ring Lugs)	BTA-70791A-2	6150-01-598-1957
24V DC CABLE, 90 DEG (Ring Lugs)	BTA-70791A-2-RA	---
24V DC CABLE (w/ 4 Screw Terminal)	BTA-70791A-3	---
24V DC CABLE for SWE-DISH	BTA-70791A-4	---
12V/24V DC CABLE (Ring Lugs)	BTA-70791A-5	6150-01-606-9489
12V DC CABLE (w/ 2 X90 Terminals)	BTA-70791A-6	---
12V DC CABLE (X90 Terminal)	BTA-70791A-7	---



12V/24V DC CABLE (BB-2590/U Connector)	BTA-70791A-8	---
24V DC CABLE (PR4G Terminal)	BTA-70791A-9	6150-01-606-9490
12V DC CABLE (120 Key Terminal)	BTA-70791A-10	---
12V DC CABLE (2 Pin Terminal)	BTA-70791A-11	---
24V DC CABLE (Ring Lugs, 54 ft.)	BTA-70791A-12	---
DC CABLE (Female Cigarette Lighter)	BTA-70791A-13	---
24V DC CABLE (LRAS)	BTA-70791A-14	---

### 4-3 OPTIONAL EQUIPMENT

TABLE 3

DESCRIPTION	PART NUMBER	NSN
AC BOOSTER	BTC-70772-T1	6130-01-606-5302
DC BOOSTER	BTC-70772-T2	6130-01-606-4541
BOOSTER INPUT CONNECTOR, 90 DEG	BTA-70772-C90	---
BOOSTER TO 6-PACK CABLE	BTA-70772-1	6150-01-606-0339
24V DC BOOSTER POWER CABLE (Ring Lugs)	BTA-70772-2	---
6-PACK VOLTAGE LIMITER, 32V, 250W	BTA-70695	6110-01-609-0350
6-PACK VOLTAGE LIMITER, 32V, 30A	BTA-70695H	---
DUEL 6-PACK TO LIMITER Y CABLE	BTA-70695-1	6150-01-609-0349
6-PACK TO LIMITER CABLE	BTA-70695-2	---
POWER CONDITIONER	BTJ-70893-T1	6110-01-606-2644
POWER CONDITIONER TO 6-PACK CABLE	BTA-70893-1	6150-01-609-0345
POWER CONDITIONER SOLAR INPUT CABLE	BTA-70893-2	6150-01-609-0346
POWER CONDITIONER GROUNDING CABLE	BTA-70893-3	6150-01-609-0343
DC/AC 120V AC INVERTER	BTP-70888-T3	---
DC/AC 230V AC INVERTER	BTP-70888-T4	---
WIND TURBINE	BTP-70889	6115-01-606-9500
WIND TURBINE MAST ASSEMBLY	BTP-70889M	3950-01-606-9502
4 IN, 1 OUT J-BOX	BTJ-70862B	---
24V SOLAR J-BOX	BTJ-70861	---
124W SOLAR PANEL	BTP-70227-T	6117-01-606-9499

Bren-Tronics also can design/manufacture cables to meet user-specific requirements.

## 5 THE BATTERIES

**The 6-PACK is designed to use only US Department of Defense-approved BB-2590/U batteries.** If non-approved lithium-ion battery types are installed, the unit will inhibit charging and indicate a BATTERY FAULT condition. This inhibition prevents damage to battery and/or charger from misapplication of the 6-PACK charge profile to batteries not designed to accept it. Do not install NiMH (BB-390x), NiCd (BB-590), or primary batteries in the 6-PACK, as the charge profile is also not compatible with these battery types. **Mixing battery types is NEVER recommended!**

The 6-PACK is normally shipped without batteries installed. To install batteries, first unlatch the four latches that hold the upper and lower enclosures together. Place the upper enclosure, upside down, on a level, flat surface.

Inspect the contacts to make sure that all are clean and none are missing or bent; correct as needed. (Contacts may be cleaned with electronic-grade spray cleaner or isopropyl alcohol. Ensure that all components are dry before use.) Also inspect/clean all socket and button contacts on the batteries being installed. ***If the batteries are new, make sure that the tape over the SMBus contacts has been removed.***

Then, take one BB-2590/U battery, align its connector surface with one of the (numbered) battery connectors on the 6-PACK, and place the battery on the plastic interface plate (Figures 1, 2, and 3), making sure the circular and “pogo pin” connectors are fully engaged. Repeat for the other batteries, until all batteries are installed. Batteries 1, 2, and 3 are connected in parallel to form one 14.4Vdc battery bank; batteries 4, 5 and 6 form the second bank.

### **NOTE:**

If fewer than three batteries are installed in a bank, installation of the same number of batteries in each bank is **required** if the 6-PACK output is connected in series (for 28.8Vdc output), so that the two banks are maintained at approximately the same state-of-charge during operation. Such “balanced” loading of the banks is also recommended in all modes of operation, to minimize charge time. Batteries may be installed in any bank position when only one or two are being installed in a bank.



Figure 1



Figure 2



Figure 3

Then, place the lower enclosure over the batteries, aligning it with the upper enclosure so that the handle and serial-number tag are on the same side. Carefully move the lower enclosure until it slips down over the batteries, and the gasketed tongue-and-groove joint between the two enclosures is fully mated. Maintaining pressure on the lower enclosure as needed, secure the two enclosures together with the four latches, and turn the assembled 6-PACK upright.

After the battery installation is complete, press and hold the backlight pushbutton (on the front panel) for at least three seconds to activate the “**comm check**” feature, and verify that the LCD display shows a bar for each installed battery, according to location (Section 7). If a bar is not seen for an installed battery, open the 6-PACK (the batteries will remain secured in the lower enclosure), check/clean the “button” contacts of that battery and the 6-PACK pogo pins for that battery location – then remove the batteries from the lower enclosure and repeat the above installation process and comm check.

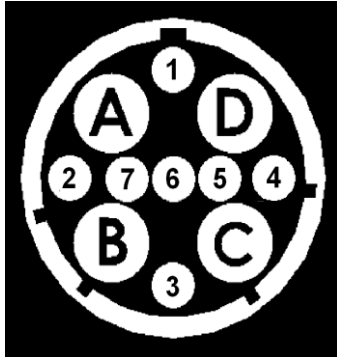
**CAUTION:**

**Keep in mind that the charge voltage of the 6-PACK, in all charging modes, is 16.8Vdc – which is significantly above the normal 16.5Vdc full-charge level used for the BB-2590/U in its other applications. The BB-2590/U can safely/reliably/efficiently accept the higher voltage; however, if a battery is removed from a 6-PACK it should be discharged to 16.5Vdc or less before being installed in other equipment.**

## 6 INTERFACE WIRING

### 6-1 OUTPUT CONNECTOR

The 6-PACK utilizes a single, bayonet twist-lock connector for the outputs of both battery banks.



Pin:	Size:	Max. current	Function:
A	8	30A	Positive (+) power output, battery bank "1-3", <b>14.4Vdc / 30A</b>
B	8	30A	Negative (-) power return, battery bank "1-3", <b>14.4Vdc / 30A</b>
C	8	30A	Positive (+) power output, battery bank "4-6", <b>14.4Vdc / 30A</b>
D	8	30A	Negative (-) power return, battery bank "4-6", <b>14.4Vdc / 30A</b>
1	20	signal-level	RS-485 (+), battery bank "1-3", referenced to pin B
2	20	signal-level	RS-485 (-), battery bank "1-3", referenced to pin B
3	20	signal-level	RS-485 (+), battery bank "4-6", referenced to pin D
4	20	signal-level	RS-485 (-), battery bank "4-6", referenced to pin D
5	20	signal-level	Reserved for future use.
6	20	signal-level	Reserved for future use.
7	20	signal-level	Reserved for future use.

Connecting pin A to pin C (via external wiring) and pin B to pin D (via external wiring) parallels the two banks to produce a single output capable of 60A at 14.4Vdc.

Connecting pins B and C (via external wiring) places the two banks in series to form a single output capable of 30A at 28.8Vdc, with pin A being the (+) output and pin D being the (-) output.

The RS-485 connection details are described in the COMMUNICATIONS INTERFACE section XXX, below.

#### **CAUTION:**

To avoid inadvertent arcing of the contacts, turn the output switch **OFF** when making connections. Such arcing can be generated by inrush currents, or if a miss-wired/shorted load is accidentally connected to the 6-PACK.

#### **CAUTION:**

Note the different ground references for the two RS-485 inputs. To avoid damage to connected equipment, make sure that the RS-485 input of the connected equipment is referenced to the same negative power return as the 6-PACK port being connected to it.

#### **CAUTION:**

Whenever the outputs of the 6-PACK are connected in series (i.e., by connecting pins B and C, as described above), make sure that all equipment connected to the 6-PACK output includes an under voltage lockout function that interrupts input-current flow whenever the input voltage drops below **20Vdc**.

**NOTE:**

EMC performance is optimized when the output cable also includes an overall braid (or foil) shield, that is connected (utilizing best practices for EMC compliance) to the chassis of the 6-PACK via the connector shell, and connected to earth/chassis of the equipment being powered. This also assures compliance with the requirements of the EU EMC directive.

**NOTE:**

14.4Vdc is the nominal output voltage of each bank; the output voltage varies with the state-of-charge of the batteries when operating, from 16.8Vdc (at full charge) to 12Vdc (rated end-of-discharge voltage).


Available output connectors/cables are listed in section 3-2. Bren-Tronics also can design/manufacture cables to meet user specific requirements.

## 6-2 INPUT CONNECTORS

Each 6-PACK is equipped with one of two types of input connectors. The –T1B/-G1B models are equipped with bayonet-type circular connectors, while the –T1/-G1 models utilize MIL-C-5015 circular/threaded-collar connectors. Also, input cables do not require shielding.

### 6-2-1 DC INPUT

The 6-PACK utilizes a four-pin connector for 24V NATO, 12V Auto and Solar power input. Pins A and B are the power-input pins for all modes; pins C and D are connected to configure the 6-PACK for the input power source being used for charging, per the table below:

	Pin:	Size:	Max. current	Function:	Connections to source (+) and (-)		
					24V NATO	12V Auto	Solar
	A	12	20A	Positive (-) power input	(+)	(+)	(+)
	B	12	20A	Negative (-) power return	(-)	(-)	(-)
	C	12	signal-level	Mode select pin	(+) or (-) or NC	(+)	(-) or NC
	D	12	signal-level	Mode select pin	(-) or NC	(+)	(+)
<b>MAX. INPUT CURRENT:</b>					<b>15A</b>	<b>20A</b>	<b>20A</b>
<b>INPUT VOLTAGE RANGE:</b>					<b>20-33Vdc</b>	<b>10.5-18Vdc</b>	<b>14-36Vdc</b>

DC input is MIL-STD-1275-compliant

NC = No connection

Available DC input connectors/cables are listed in section 4-1. Bren-Tronics also can design/manufacture cables to meet user specific requirements.

## 6-2-2 AC INPUT

The 6-PACK utilizes a five-pin connector for AC power input. **The 6-PACK can accept 90-264Vac/47-440Hz power**, and adjusts its operation automatically to the applied voltage/frequency – it is compatible with AC utility power mains, worldwide.



Pin:	Size:	Max. current	Function:
A	12	2.2A	AC line terminal
B	12	zero	No connection
C	12	2.2A	AC neutral terminal
D	12	zero	No connection
E	12	**Ground**	Chassis ground

**MAXIMUM INPUT CURRENT: 2.2A AT 115V – 1.1A AT 230V**

**WARNING: to prevent electric shock, make sure that pin E of the AC input is connected to the ground (earth) of the utility power mains when using AC power!**

Available AC input connectors/cables are listed in section 3-1. Bren-Tronics also can design/manufacture cables to meet user specific requirements.

## 7 CONTROLS

The **charger ON/OFF switch** is located next to the power-input connectors. One switch provides ON-OFF control of the charger in all input-power modes.

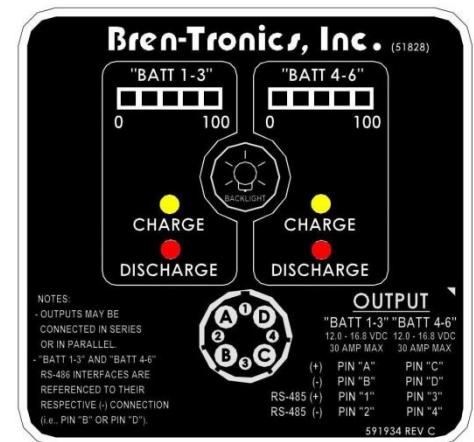
The **output ON/OFF switch** is located next to the output connector. This switch is a circuit breaker that will trip if the connected equipment applies an overload/short-circuit to the output of the 6-PACK. If tripped, it can be reset by manually pushing the toggle back to the ON position. The output breaker is a “trip-free” type; manually holding the toggle in the ON position will NOT inhibit tripping. One pole of the breaker protects each battery bank – if EITHER section experiences an overload/short-circuit, the breaker interrupts current from BOTH battery banks.

The **backlight pushbutton** is located on the front panel, between the indicators (see below). Momentarily pressing this button backlights the LCD displays for viewing in low-ambient-light conditions. Holding the button down for longer than three seconds activates the “**comm check**” feature described in the next section.

## 8 INDICATORS

### 8-1 LCD DISPLAYS

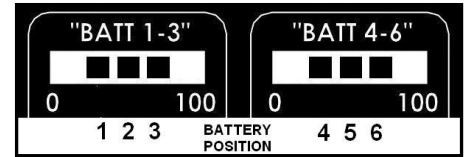
There are two five-segment bar-graph-type LCD indicators – one for each battery bank – located on the front panel. Each LCD indicates the state-of-charge (SOC) for its associated bank, **as a percentage of the total design capacity of the 6-PACK with all batteries installed in**



**that bank.** If only one or two batteries are installed instead of all three (or if the older, non-SMBus variant of the BB-2590/U is being used) the LCD will indicate a lower SOC than that shown by the individual battery indicator(s),

Bars	0	1	2	3	4	5
SOC	0%	1 to 20%	21 to 40%	41 to 60%	61 to 80%	81 to 100%

A backlight is included in each indicator; momentarily pressing the backlight pushbutton activates the backlights for five seconds, allowing the user to read the LCDs in low-ambient-light conditions.



Holding the button down for three seconds activates the “**comm check**” feature. The normal, left-justified bar-graph displays are replaced by a set of bars in the center of each LCD. The presence of a bar indicates that communications is properly operating to/from BOTH sections of a particular battery in the 6-PACK. The regular SOC display returns after ten seconds.

If a bar does not appear for an installed battery, open the 6-PACK and check/clean the “button” contacts on that battery and the 6-PACK pogo pins for that battery position, then re-install the batteries. If the problem persists, replace the battery.

**NOTE:**

If a battery bank is discharged, the backlight for that bank’s SOC display may not operate properly, and/or the comm check display may indicate a problem where none exists. Check the SOC display; if no bars are present, or only one bar is present, allow the unit to charge for a few minutes and check the backlight and comm check function again, before looking for contact/battery problems.

**8-2 LED INDICATORS**

Two sets of LED indicators – one set for each battery bank – are located below the LCD displays on the front panel. These indicators illuminate to indicate operational status, as described in the table below.

CHARGE LED:	Indicates the operational status of the section charger
<b>DARK</b>	Charge power turned off/not applied.
<b>Slow blinking YELLOW</b>	Idle – charger powered, but not presently charging because: <ul style="list-style-type: none"> <li>• Power-up or charger reset has just occurred (display will change to indicate charging, see below)</li> <li>• Charging was complete, but battery voltage has dropped and the charger is initiating a recharge (display will change to indicate charging, see below)</li> <li>• Charger internal temperature above Temperature-Optimized Charging operating limit (will automatically restart once temperature falls)</li> </ul>
<b>Steady YELLOW</b>	Charging in progress
<b>Steady GREEN</b>	Charging complete
<b>Flashing RED</b>	Battery Fault – charging inhibited because: <ul style="list-style-type: none"> <li>• Charger has detected the presence of illegal battery types</li> </ul>

	<ul style="list-style-type: none"> <li>Charger does not detect the presence of any batteries (If this indication occurs with Bren-Tronics BB-2590/U batteries installed, checking/cleaning the “pogo pin” contacts of the 6-PACK and/or the “gold button” contacts of the batteries is recommended)</li> </ul>
<b>Steady RED</b>	Charger Fault – charging inhibited because bank overvoltage is detected by batteries. Resets when voltage drops below overvoltage threshold.
<b>DISCHARGE LED:</b>	<b>Indicates whether the battery is being discharged.</b>
<b>Steady RED</b>	Battery is being discharged - continued operation with this indicator illuminated will eventually discharge the battery. This can occur even when the charger is operating, if the load current is higher than the charge current.
<b>Flashing RED</b>	Power-up LED check – occurs when charger is mated to batteries

## 9 POWER INPUT PRIORITY

When multiple power sources are connected to the 6-PACK inputs, the priority of use is shown in the table below. Primary power is used as long as it is available; if it is interrupted, the unit automatically switches to operation from secondary power.

Combination	Primary	Secondary
AC and 24V	24V	AC
AC and Solar	SOLAR	AC
AC and 12V	AC	12V

## 10 PROTECTIVE DEVICES

In addition to the output breaker described above, the 6-PACK utilizes electronic protection to prevent unsafe/damaging conditions from occurring:

- The internal protection circuit in each BB-2590/U battery is always active, protecting the battery from unsafe/damaging conditions such as overvoltage, under voltage, over current, and over temperature.
- The operating temperature of each charger is monitored. Charging is paused if the temperature starts to exceed the safe limit, and automatically restarts once temperature drops back below that limit.
- Each charger microcontroller includes redundant firmware and hardware overvoltage protection, which inhibits charging if a bank-overvoltage condition is detected.
- The voltage of each bank is also monitored via the SMBus interface to the batteries; charging is interrupted if bank voltage exceeds its safe limit.
- The chargers and power converters (for 12V and AC operation) are protected from transient over voltages in accordance with the requirements of EN61000-6-2 and MIL-STD-1275 by passive and active electronic protection.
- Each power converter includes an integral output current limit.
- DC input current is monitored; charging operation is interrupted when excessive input current is detected.



As backup, the DC power source feeding the 6-PACK is protected by a 30A automotive-type time-delay fuse, located adjacent to the battery contacts/pogo pins. A spare 30A fuse is also provided. The AC input is internally fused. If the DC fuse blows, and the spare blows when installed in its place – or if the 6-PACK will not power up on AC with a known-good power cord -- the 6-PACK is permanently inoperative and in need of repair.

## **11 OPERATOR MAINTENANCE INSTRUCTIONS**

Periodic maintenance, inspection and cleaning will help insure the 6-PACK is kept at full readiness.

### **11-1 CLEANING**

1. Brush loose dirt and dust from the charger. Low-pressure air may be used to remove heavy dust from the case, connectors and power switches. Avoid blowing dust into the unit. Low-pressure air may be blown into the left and right air vents at the edge of the control panel to help remove internal dust.
2. Wipe surfaces with a damp (not wet) rag. Non-solvent cleaners maybe used (Windex™, Fantastix™, 409™). Do not spray or drip water or cleaners onto the panel or into the connectors.
3. The battery connections may be cleaned with electronic grade spray cleaner or isopropyl alcohol. Insure the connections are dry before using them.

### **11-2 WARRANTY / REPAIR INFORMATION**

If the 6-PACK or accessories fail to function they must be returned to Bren-Tronics for repair. The warranty label gives the expiration date on each unit. Contact Bren-Tronics for a Return Material Authorization (RMA) number before returning any hardware to Bren-Tronics. The part numbers, serial numbers and failure descriptions must be included for Bren-Tronics to issue an RMA number. Products that have been damaged by abuse or that are no longer under warranty may be returned for a repair quotation. There are no user repairable parts in the 6-PACK. Opening the 6-PACK will void the warranty.

For return authorization call (631) 499-5155 or email [sales@bren-tronics.com](mailto:sales@bren-tronics.com)

## APPENDIX A: COMMUNICATIONS INTERFACE

As noted above, each battery bank of the 6-PACK is equipped with an RS-485 serial link for use in battery-management communications. This is a non-addressable, half-duplex link that operates at 57.6 Kbaud, using 8 data bits and one stop bit with no parity.

The (differential) data link for each bank is referenced to the negative return for that bank (i.e., Pin B of the output connector for battery packs 1-3, Pin D for battery packs 4-6).

### **CAUTION:**

**Note the different ground references for the two RS-485 inputs. To avoid damage to connected equipment, make sure that the RS-485 input of the connected equipment is referenced to the same negative power return as the 6-PACK port being connected to it.**

The battery-monitoring electronics associated with the bank utilize the SMBus interfaces of the individual battery packs to collect operating data. This data is then aggregated and presented to the user (via the RS-485 link) as data from a single “emulated” smart battery, with a capacity equal to the total capacity of all SMBus-equipped batteries in the bank.

The interface also supports “single-link” operation, where the data from both batteries can be accessed via the data link for Batteries 4-6. This significantly simplifies the user’s power-system configuration, when both banks of the 6-PACK are series- or parallel-connected to form a single power source. For single-link operation, connect the 6-PACK output so that the negative return of Batteries 4-6 (pin D) is connected to the same ground as the (RS-485) battery-management communications interface of the host system.

The complete SBData V1.1 smart-battery data set (in accordance with the Smart Battery System (SBS) specifications) is available from this “emulated” battery. Commands are transmitted to the 6-PACK via the protocol defined below:

## 6-PACK COMMUNICATONS PROTOCOL DESCRIPTION

<b>Command Packet</b>	Byte 1	“Z” (ASCII)
	Byte 2	Battery Bank Number (ASCII): “0” Comm Options. “1” Bank associated with this RS-485 port. “2” Other bank in unit. (only available when connected to Bank 4-6; used to read Bank 1-3 in single-link mode)
	Byte 3	SMBus Command (per SBDData V1.1) (Binary)
	Byte 4	Read / Write: “r” Read Data - “w” Write Data (ASCII)
	Byte 5	Number of data bytes to follow (Binary) – Zero if reading data
	Byte 6	Start of data bytes, if any (Binary)
	Last Byte	CRC-8 (PEC)
<ul style="list-style-type: none"> <li>• Data is in Little Endian Format.</li> <li>• Communication parameters are RS-485, 57600 Baud, 8 bits, 1 Stop, No Parity.</li> <li>• The CRC-8 (PEC) is the same as described in the System Management Bus Specification Revision 1.1 using the polynomial, <math>C(x) = x^8 + x^2 + x + 1</math>.</li> <li>• All SMBus Command codes are supported as listed in the V1.1 Specification.</li> <li>• SMBus broadcast alerts are not supported.</li> <li>• Only Bank “B” (Batteries 4-6) can communicate with the other bank. Connect to that bank if the host system needs to communicate to both channels via a single RS-485 link.</li> </ul>		

<b>Return Packet</b>	Byte 1	“R” (ASCII)
	Byte 2	Number of bytes in the packet including CRC (Binary)
	Byte 3	Error code (Binary, per table below)
	Byte 4...N-1	Data values (if any – Binary)
	Byte N	CRC-8 (PEC)
<ul style="list-style-type: none"> <li>• Data is in Little Endian format, and arranged as shown in the next table below.</li> <li>• If the error code is non-zero, no data will be returned.</li> <li>• There should be an error code for each command.</li> <li>• Note that a bad command may return several error codes. Since it cannot be sure where a partial command begins or ends, after an error any byte received will return error 49 until the ‘S’ start of packet. The host should clear its receive buffer before sending the next command.</li> </ul>		

Arrangement of data bytes in return packet	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12	Byte 13
All SMBus 16bit Signed Data:	Low Byte	High Byte								
All SMBus 16bit Unsigned Data:	Low Byte	High Byte								
All SMBus String Data:	Byte	Byte	Byte	Byte	Byte	Byte	Byte	Byte	Byte	10 Bytes Max

Error Code	Description
0	No Error. The command has succeeded and returned the requested data
49	‘1’ Command Parameter 1 is invalid “Start Code”
50	‘2’ Command Parameter 2 is invalid “Battery Number”
51	‘3’ Command Parameter 3 is invalid “Command”
52	‘4’ Command Parameter 4 is invalid “Read / Write”
53	‘5’ Command Parameter 5 is invalid “Byte Count”
54	‘6’ CRC-8 / PEC is invalid
55	‘7’ Data is Invalid
68	‘D’ Unexpected Packet Start Code
83	‘S’ Data size invalid
66	‘B’ Internal Busy is Busy
84	‘T’ Battery Box could not complete the command in time

## APPENDIX B: NOMINAL CHARGE TIMES / APPLICATION DATA FOR UPS USAGE

**VEHICULAR/UTILITY SOURCES:** All charge times assume fully-discharged packs prior to charging, and no load applied to the 6-PACK output during charging. Charge times may vary due to production tolerances of the battery packs and charger, as well as the age of the installed battery packs.

### CHARGE TIMES

Input Power	BB-2590/U packs installed in each bank:		
	3	2	1
24V NATO	7-10 hr.	5-7 hr.	3-4 hr.
12V AUTO	11-16.5 hr.	7.5-11 hr.	4-6 hr.
AC	11-16.6 hr.	7.5-11 hr.	4-6 hr.

Longer charge times based on high capacity batteries.

When used as an uninterruptible power supply (UPS), load current/power can be drawn from the 6-PACK above the levels shown at right, as long as:

- (1) The average pack voltage is maintained at or above 14.8Vdc.
- (2) The pack voltage never drops below 12.0Vdc.
- (3) The average power drawn from the 6-PACK does not exceed the maximum average power shown at right.

### UPS OUTPUT CAPABILITY (both banks in use)

Input Power	Maximum average output power (W):	Maximum average current (A dc)	
		Series connected:	Parallel connected:
24V NATO	180	6.2	12.4
12V AUTO	105	3.7	7.4
AC	105	3.7	7.4

Prior to starting operation as a UPS, fully charging the 6-PACK is recommended if feasible.

**SOLAR POWER:** The 6-PACK is designed to use solar panels with an open-circuit voltage of 36V or less, and a maximum power point (MPP) voltage between 14V and 20Vdc. The 6-PACK never draws more than 300W from a solar panel array, and will not charge its batteries any faster if more than 300W is made available to it. **Charge times under solar power will always be at least as long as charge times under 24V NATO power.**

However, solar panels usually put out only a fraction of their rated power, due to environmental conditions (see below). **An array of panels with a total power rating of more than 300W may be required for minimum charge times.** There is no limit to the number of panels that can be connected in parallel to a 6-pack, except the limit on how many that the user can efficiently carry and deploy.

When the panel array is delivering less than the power required for normal charger operation, the 6-PACK enters MPP-tracking mode, adjusting operation to maximize power output from the panel array (and, in turn, maximize power input to the batteries).

Taking into account both 6-PACK efficiency and charge-acceptance characteristics of the BB-2590/U, the solar panels must deliver approximately 310Wh of energy per installed BB-2590/U to the 6-PACK input to achieve full charge (assuming the batteries started at full discharge). This translates to around 1860Wh that must be delivered by the panels to charge a fully-loaded 6-PACK.

**EXAMPLE:** Under typical spring-day conditions in a clear, dry climate around 33°N latitude, using a panel array rated for 330W (at 1000W/m<sup>2</sup> insolation level), laid flat on the ground (*i.e., not turned up towards the sun, which increases panel power output at the expense of complicating setup and increasing visibility to hostile forces*) the time needed to fully charge a fully-loaded 6-PACK from full discharge is approximately ten hours, if charging is initiated within one hour after sunup.

**Available solar-power levels vary GREATLY in response to environmental conditions, so the user should assess the prevailing conditions in the area where the 6-PACK/panel array is being used – making sure to consider the worst-case environmental conditions therein.**

Similar guidelines for UPS usage as those associated with vehicular/utility sources apply to solar-power usage:

- (1) The average pack voltage must be maintained at or above 14.4Vdc.
- (2) The pack voltage must never drop below 12.0Vdc.
- (3) The energy (Wh) drawn from the 6-PACK does not exceed 65% of the energy harvested by the panels over the same time period (assuming all panel energy is applied to the 6-PACK, and not diverted to other loads). **Be sure to consider worst-case environmental conditions seen by the solar panels.** The 65% factor compensates for 6-PACK efficiency and BB-2590/U charge-acceptance characteristics.

**The Solar input configuration can also be used with other intermittent/high-impedance (“soft”) alternative power sources such as fuel cells and wind/hand-crank generators, as long as all operational limitations – input voltage/MPP/UPS characteristics - described above for operation with solar power are adhered to.**