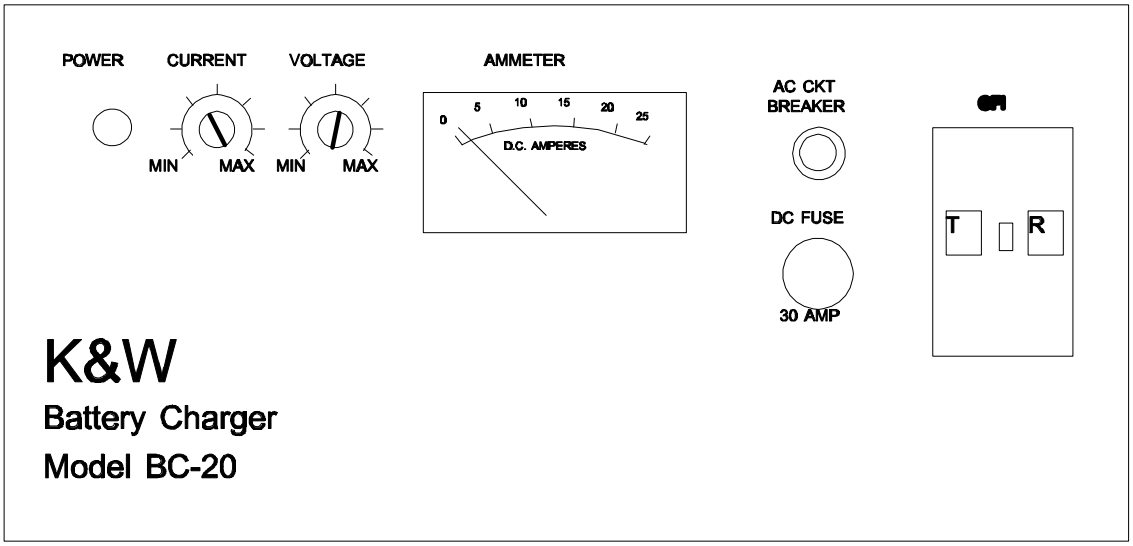
Instruction Manual
for
BC-20 Battery Charger
and
LB-20 Line Booster



K&W Engineering, Inc.
Marion, Iowa

Revision 3
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Instruction Manual
for
BC-20 Instruction Manual
and
LB-20 Line Booster

K&W Engineering, Inc.
3298 County Home Road
Marion, Iowa 52302

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INTRODUCTION

Congratulations! You have just purchased the world's finest electric vehicle battery charger! This instruction manual will give you the information necessary to safely and properly use your K&W Model BC-20 battery charger and optional LB-20 Line Booster. This manual includes:

Section 1 lists the charger specifications.

Section 2 provides installation instructions.

Section 3 explains how to operate the charger.

Section 4 offers hints in the unlikely event of problems.

Section 5 describes how the charger works.

Section 6 tells how to obtain help from K&W.

Section 7 tells how to use the optional LB-20 Line Booster.

SECTION 1 - Specifications

Description

The K&W Model BC-20 Battery Charger is a compact, lightweight, transformerless charger intended for onboard installation in electric vehicles. Charging occurs in a constant current mode until the battery voltage rises to the desired set level, then continues in a constant-voltage mode to finish charging the battery pack. Separate current and voltage controls, in conjunction with a built-in ammeter, permit user adjustment of the charging current and float voltage. The Model BC-20 Battery Charger can accommodate battery packs ranging from 72 volts to 108 volts, in 6 volt steps, by means of a range-select resistor installed internally during set-up and installation of the unit in the vehicle.

Using the optional LB-20 Line Boost Adapter, the BC-20 can also charge 120 volt battery packs.

The rugged, reliable design of the BC-20 incorporates the following key features:

-- State-of-the-art all solid-state design eliminates the heavy power transformer found in most chargers.

-- Adjustable for various voltage battery packs

-- Filtered to prevent radio and TV interference

-- Heavy-gauge corrosion-resistant aluminum case

-- Derating of components far below their manufacturer's maximum specifications to assure a long service life.

-- Internal ball-bearing fan keeps components cool for long life.

-- Multiple safety and protective features to prevent injury/damage

-- Soft-start circuit to eliminate current in-rush

-- Delay-start circuit to prevent arcing of contacts when AC power plug is inserted into outlet

-- Automatic temperature compensation of float voltage to match battery characteristics with varying ambient temperature (see Figure 1-1)

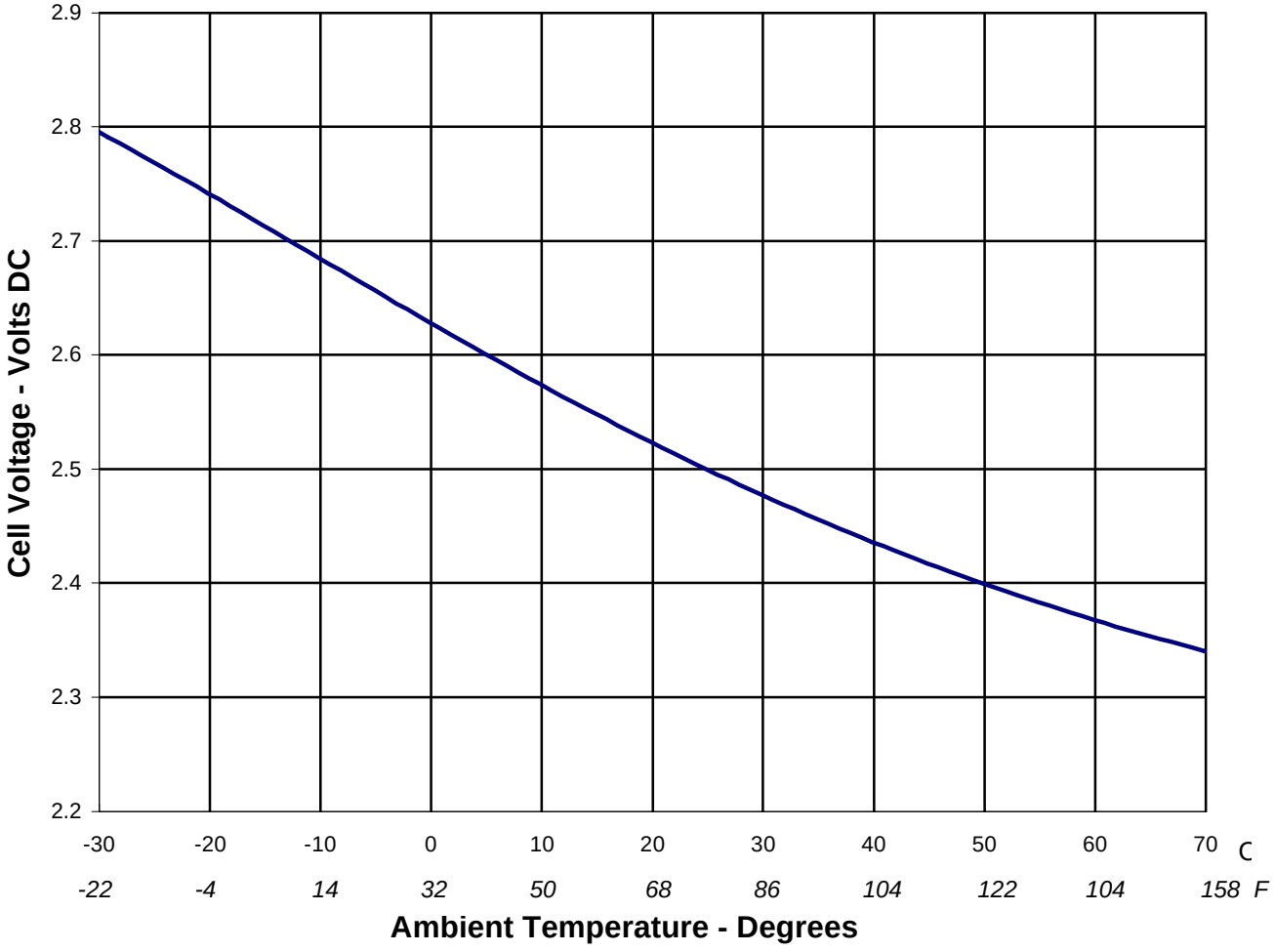


Figure 1-1 BC-20 Temperature Compensation

BC-20 Technical Specifications

Input voltage:	110 to 132 volts AC, 50/60 Hz
Brownout/blackout protection:	Protected, automatic resumption.
Battery pack voltage (user selectable):	72,78,84,90,96,102,108 volts DC; 120 volts with optional LB-20 Line Booster.
Charging current:	Adjustable 0-20 amperes. 0-25 ampere front panel meter.
Float voltage:	Adjustable 2.0 to 2.5 volts/cell.
Input/output connections:	Screw terminals on barrier-style terminal block.
Safety protection:	30 ampere AC circuit breaker. AC Ground Fault Interrupter. 30 Ampere DC output fuse. Overheat sensor (shuts unit off, automatic resumption after unit cools down).
Radio Frequency Interference (RFI) suppression:	AC RFI filtering included.
Size:	Height: 6 inches (15.2 cm) Width: 10.5 inches (26.7 cm) Depth: 4.25 inches (10.8 cm)
Weight:	10 lbs (4.5 kg)
Cooling:	Internal ball-bearing fan.
Mounting:	Threaded inserts (1/4-20) back and bottom (four each surface).
Environmental restrictions:	Splash-resistant

SECTION 2 - Installation

This section describes the installation procedure for mounting the BC-20 in the vehicle, configuring the charger for the proper battery voltage, connecting the input and output, and providing AC power.

Vehicle Mounting Considerations

The BC-20 is designed to be permanently mounted in electric vehicles. Thanks to its light weight and compact size, it is easily mounted in virtually any electric vehicle. The following information and hints are intended to assist you in obtaining a long, reliable service life from the BC-20.

Mounting provisions - The BC-20 is supplied with four 1/4-20 threaded inserts on the rear surface, and four more 1/4-20 threaded inserts on the bottom surface. Any combination of these inserts may be used with user-supplied 1/4-20 bolts and lock washers to affix the BC-20 to the desired location. A minimum of four bolts is required. The case fasteners are self-locking, so lock washers are not necessary. The vehicle mounting brackets or mounting surface should be true so that the charger chassis will not be distorted when the bolts are tightened.

Mounting considerations

-- The BC-20 is not waterproof, so it must be located in an area free from rain and splashed water

-- The cooling air intake on the left end and the exhaust louvers on the right end must not be blocked! Do not mount the unit with either end flush against another surface. While the unit will not be damaged if the air flow path is blocked, it may overheat. Too high a temperature will cause the charging current to cycle off and on, thus preventing charging of the battery in a timely manner.

-- The BC-20 should be located and oriented so that the front panel controls are easily accessible.

-- Cable routes should exit from the right end of the charger for both the AC input power and the charger output to the battery pack.

-- The charger is intended to have its output permanently connected to the battery. There is no need to disconnect the charger connections while the vehicle is in use.

Supplying Primary 120 VAC Power

The BC-20 is designed to operate from 120 VAC house current. Because of the nature of the charging current waveform, which consists of pulses of current, the current has a heating effect on wiring, switches, circuit breakers, fuses, etc., that is greater than that of the average DC current. A further explanation will be helpful in understanding why this is so.

The rectified current from the BC-20 consists of a combination of AC and DC components. While only the DC component charges the battery, both the AC and DC components cause heating of wires, circuit breakers, fuses, switches, etc. A more detailed discussion of charging current waveforms is contained in the Theory of Operation, Section 5.

The significance of the discussion of DC and AC currents is that the AC circuit used to power the BC-20 requires fuses and circuit breakers rated at least 50% above the maximum intended charging current, but not exceeding the amperage the circuit is rated for. For example, if the supply circuit is rated at 25 amperes, do not install a 30 ampere fuse or circuit breaker. Instead, set the charging current to 16 amperes or less. The following table shows needed input circuit capacity versus the actual charging current:

Needed Circuit Capacity	Charging Current
20 amperes	12 amperes
25	16
30	20

The BC-20 is a high input current device, similar to a space heater or an air conditioner. The following primary power considerations should be carefully observed to avoid possible damage to the building wiring:

-- The wiring used to supply AC current to the BC-20 should be installed in strict accordance with the National Electrical Code (NEC) and all applicable local ordinances.

-- The AC supply circuit used for the BC-20 must be rated for at least 50% above the maximum desired charging current of your battery pack, as explained above. The maximum output current of the BC-20 is 20 amperes DC. Therefore the 120 VAC supply circuit must be rated for a minimum of 30 amperes and use 12 gauge wire. A standard 25 ampere circuit with 14 gauge wire will allow a charging current of 16 amperes. It is good practice to observe a 10% loading margin.

-- Because of the high current draw of the BC-20, no other appliances or devices should be connected to the BC-20's AC circuit unless the circuit is rated to carry the extra load.

Thanks to the delay start circuit of the BC-20, you will not cause an electrical arc when the BC-20 is first plugged into the AC outlet. This important feature prevents connector damage from arcing.

Configuring the BC-20

Prior to installing and using your BC-20, it must be configured for the particular battery voltage of your vehicle. Follow these simple steps to configure the BC-20:

WARNING!!! Be sure that both AC input and DC output wires are DISCONNECTED from the outlet and battery before opening the BC-20!!! Potentially lethal voltages are present inside the BC-20 from both the AC input and the DC load!!!

1. Set the BC-20 upright with the front panel facing you.

2. Remove the sixteen screws from around the edge of the front panel and gently let the front panel rest on its face. (Resting the panel on a soft cloth will prevent marring its finish).

3. Referring to Figure 2-1, locate the small printed circuit board-mounted terminal block on the back (component/wiring side) of the front panel.

4. From the small paper envelope of resistors included with your BC-20 (refer to Figure 2-1 to identify these resistors), select the one from the following table for your vehicle's battery voltage:

Battery Voltage	Resistor Value	Resistor Color Bands (Fig 2-1)			
120 VDC	97.6 k-ohm	White	-Violet	-Blue	-Red
108 VDC	86.6 k-ohm	Gray	-Blue	-Blue	-Red
102 VDC	82.5 k-ohm	Gray	-Red	-Green	-Red
96 VDC	76.8 k-ohm	Violet	-Blue	-Gray	-Red
90 VDC	71.5 k-ohm	Violet	-Brown	-Green	-Red
84 VDC	66.5 k-ohm	Blue	-Blue	-Green	-Red
78 VDC	61.9 k-ohm	Blue	-Brown	-White	-Red
72 VDC	56.2 k-ohm	Green	-Blue	-Red	-Red
		1st	2nd	3rd	4th

(Note that the BC-20 is shipped with the resistor installed to charge a 96 volt battery pack)

After selecting the proper resistor, cut and bend the leads as shown in Figure 2-1.

5. Using a small flat blade screwdriver, install the resistor between the two

terminals of the terminal block shown in Figure 2-1. These two terminals are labeled "**1**" and "**2**" with metal numbers on the printed circuit board. The resistor can be inserted with either lead in either terminal.

6. If you are also connecting input and output wiring, then proceed to the next section without reassembling the BC-20. Otherwise, carefully reposition the front panel and reinstall the sixteen screws removed previously. This completes the configuration procedure. If the battery voltage or vehicle are ever changed, this procedure must be repeated. We suggest saving the small envelope of unused resistors inside the BC-20 so that they do not become lost.

Connecting AC Input and DC Output Wires

When first installing the BC-20 in your vehicle, or if changing the installation, it will be necessary to connect AC input and DC output wires. This section explains how to make those connections.

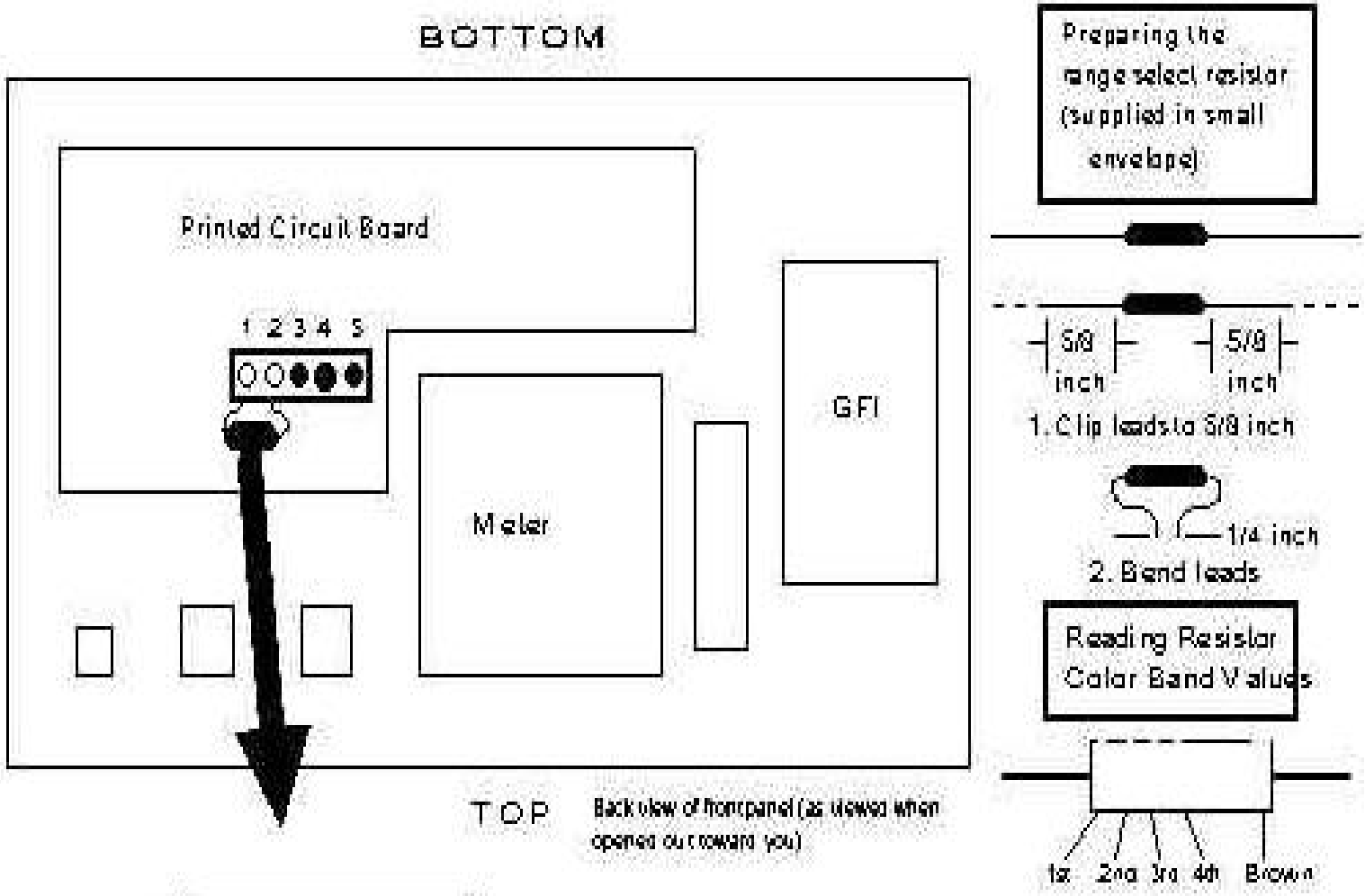
WARNING!!! Be sure that both AC input and DC output wires are DISCONNECTED from the outlet and battery before opening the BC-20!!! Potentially lethal voltages are present inside the BC-20 from both the AC input and the DC load!!!

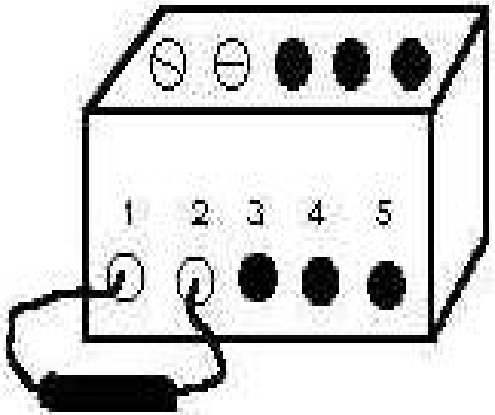
1. Set the BC-20 upright with the front panel facing you.

2. Remove the sixteen screws from around the edge of the front panel and gently let the front panel rest on its face. (Resting the panel on a soft cloth will prevent marring its finish).

3. Referring to Figure 2-2, locate the terminal block on the rear inside wall of the chassis. A number label adjacent to the terminal block identifies each screw of the terminal block.

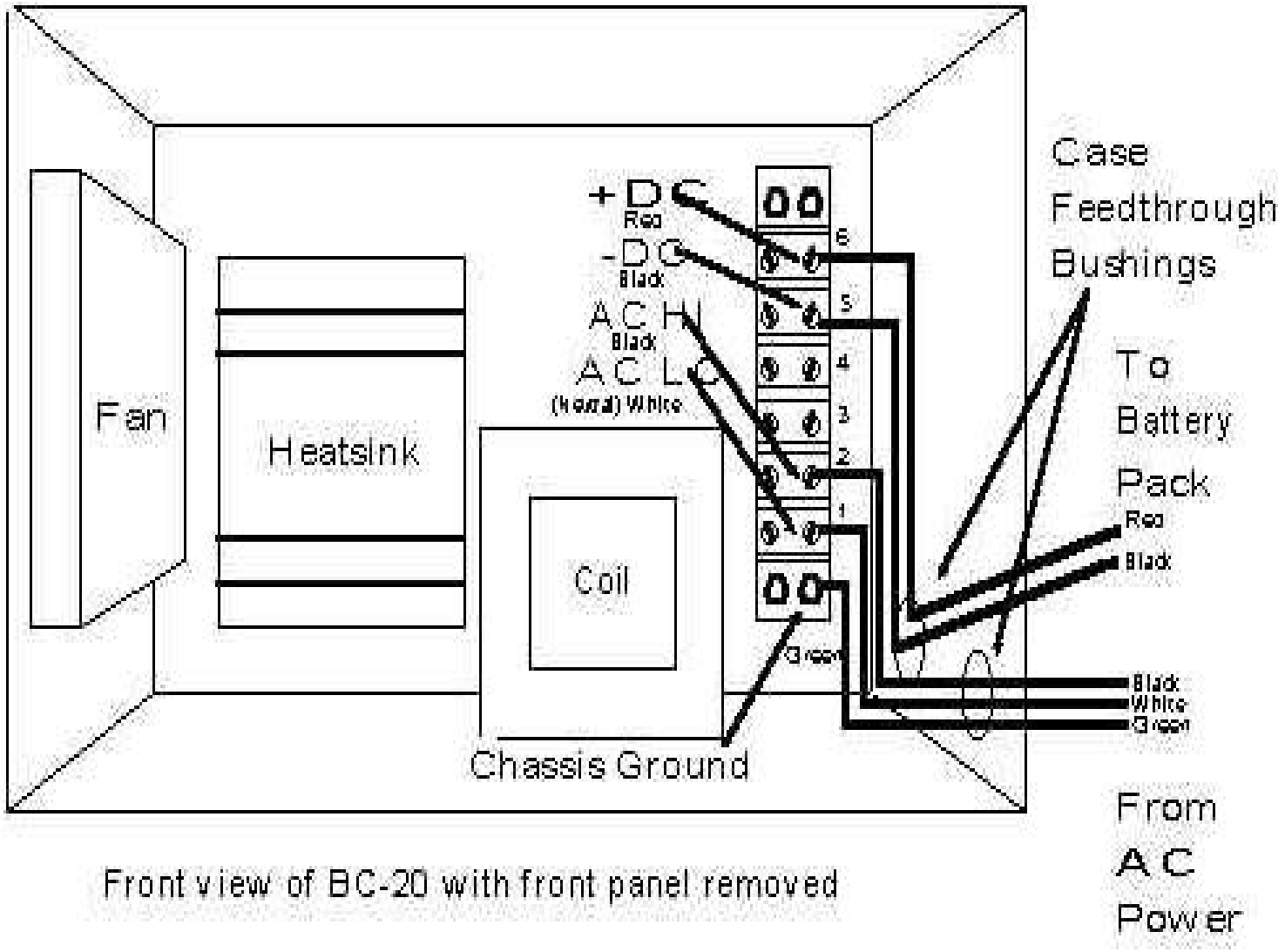
NOTE: There should be a jumper connecting terminals #3 and #4 together. Do not remove this jumper unless you are using an LB-20 Line Booster (refer to Section 7).





Insert resistor horizontally into two holes shown.
Tighten two screws from top to fasten it in place.
Be sure leads do not touch anything.

Figure 2-1 Installing the Voltage Range Select Resistor



Front view of BC-20 with front panel removed

Figure 2-2 Connecting the BC-20

4. Insert the AC input cable through the cable bushing marked "120 VAC INPUT" on the right side of the BC-20. Terminate each wire with a lug sized to fit the #8 screw of the terminal block.

> CAUTION: Terminal lugs must be properly and securely crimped onto wires. Because of the high current being carried by these lugs, an inadequate or improper crimp will eventually lead to overheating of the joint. Failure will soon follow, often with severe damage spreading beyond the immediate crimp joint.

5. To the terminal block screw marked "2", connect the HI side AC input wire (normally a BLACK wire). 12 gauge wire is recommended; 10 gauge is preferred.

6. Similarly, to the terminal block screw marked "1" connect the LO side AC input wire (normally a WHITE wire).

> WARNING: Recheck that the DC output leads are DISCONNECTED from the battery before continuing with installation!

7. Insert the DC charger output cable through the cable bushing marked "CHARGER OUTPUT" on the right side of the BC-20. Terminate each wire with a lug sized to fit the #8 screw of the terminal block.

8. To the terminal block screw marked "6", connect the POSITIVE wire to your battery (normally a RED wire). 12 gauge wire is recommended; 10 gauge is preferred..

9. Similarly, to the terminal block screw marked "5" connect the NEGATIVE wire (normally a BLACK wire).

10. Referring to Figure 2-2, loosen the terminal block mounting nut indicated. Install the AC primary power safety ground wire lug (normally a GREEN wire) under the nut, and retighten the nut over the lug.

11. Double check the connections carefully! If wires are accidentally misconnected, serious damage to the BC-20 can result!

12. Carefully reposition the front panel and reinstall the sixteen screws removed previously. This completes the cabling procedure. If the cabling is ever changed, this procedure must be repeated.

This completes the installation of the BC-20.

SECTION 3 - Operation of the BC-20

The following sequence of simple adjustments will set your BC-20 to safely and consistently charge your vehicle's battery. Normally, these adjustments need only be made one time and not changed. The BC-20 will hold those adjustments until such time as you change them. However, the float voltage may eventually have to be readjusted slightly to compensate for the aging of the battery pack.

The setup and operating instructions for the BC-20 assume that you have correctly installed the BC-20 per Section 2. If not, refer to Section 2 before operating. Refer to Figure 3-1 for location of front panel controls.

Setting the charging current and float voltage assumes that you know the specifications of your vehicle's battery pack. The battery voltage, maximum charging current, and float voltage are critical parameters; be sure you know what they are! If in doubt, look them up! Don't guess, or you may reduce the life of an expensive set of batteries!

The two adjustments that must be made are the charging current and the float voltage. The charging current must be set with the battery in a partially discharged state, while the float voltage should be set with the battery "peaked" to full charge. The normal range of float voltage for most batteries is 2.33 to 2.5 VDC per cell. Setting the float voltage is more critical if the battery is to be left on charge for several days. If the battery is being charged only overnight, then the float voltage is not as critical. The BC-20 will provide a float voltage of 2.5 VDC at its MAX setting. Thus the float adjustment may be set to MAX without risk for overnight charging, if you are unsure of your battery's float voltage.

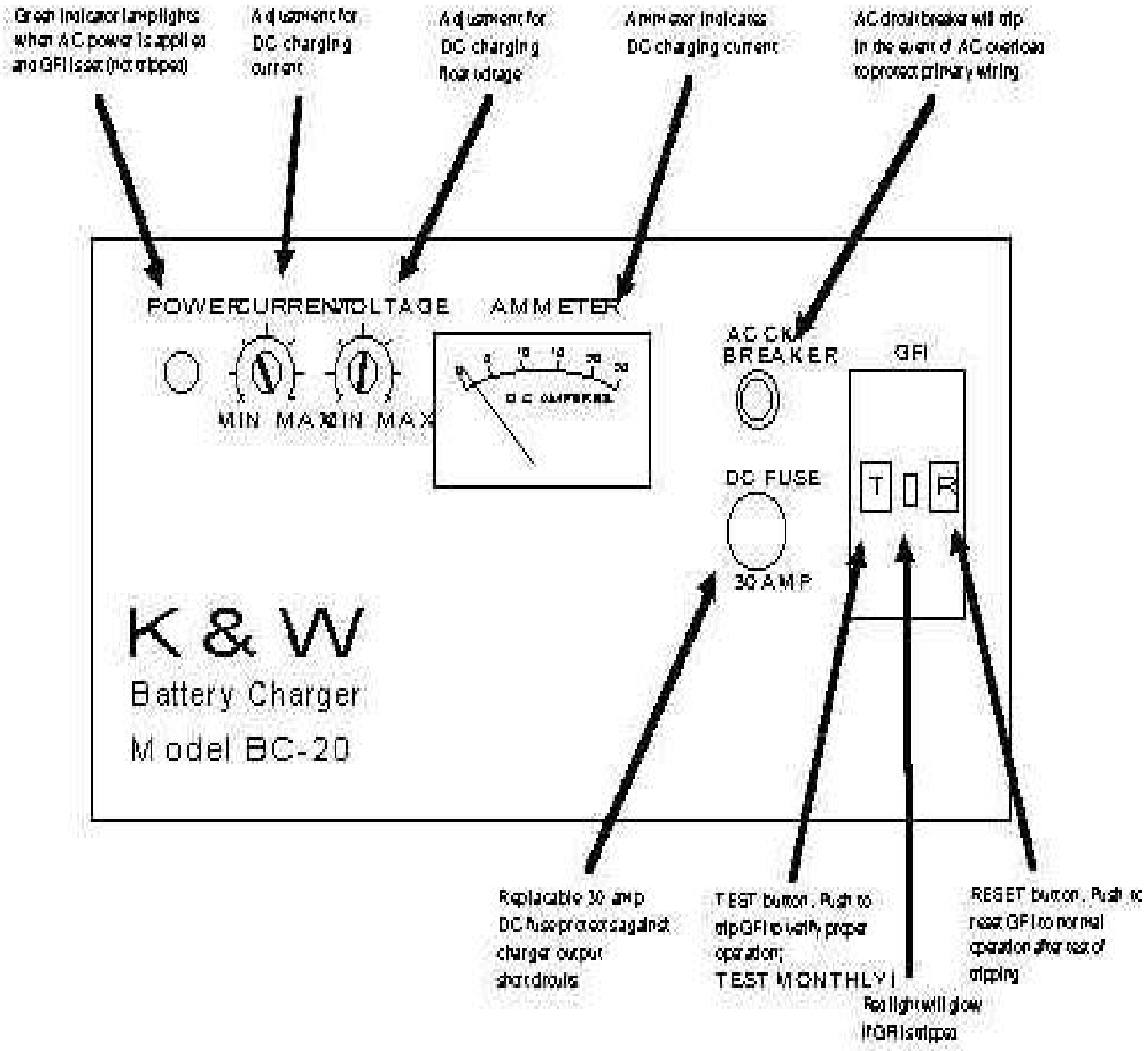


Figure 3-1 BC-20 Front Panel Controls

There are three steps to adjusting the BC-20 for operation with your vehicle:

STEP 1 - Determine the charge state of the battery.

A. With NO AC primary power applied, set the front panel CURRENT adjustment to MIN (fully counterclockwise) and the front panel VOLTAGE adjustment to MAX (fully clockwise).

B. Connect the BC-20 to AC primary power. Observe that the green light on the front panel is lit, indicating that AC power is present, and that the GFI light is out. If necessary, press the R (reset) button on the GFI. If necessary, also push in the AC circuit breaker front panel button to reset it. Refer to Section 4 in case of difficulty.

C. Rotate the front panel CURRENT adjustment approximately half-way toward MAX. Observe the ammeter and note one of the two following conditions:

1. The ammeter shows a current of approximately 2-5 amperes. The battery is at least partially discharged. Proceed to Step 2 to set charging current.

2. The ammeter shows only 1-2 amperes of current. The battery is fully charged, or "peaked". Proceed to Step 3 to set float voltage.

STEP 2 - Set the charging current.

A. With NO AC primary power applied, set the front panel CURRENT adjustment to MIN (counterclockwise). (NOTE: the VOLTAGE adjustment was set to MAX in Step 1A; do not change it).

B. Connect the BC-20 to AC primary power. Observe that the green light on the front panel is lit indicating that AC power is present, and that the GFI light is out. If necessary, press the R (reset) button on the GFI. If necessary, also push in the AC circuit breaker front panel button to reset it. Refer to Section 4 in case of difficulty.

C. Rotate the front panel CURRENT adjustment slowly toward MAX (clockwise) until the front panel ammeter reads the desired charge current. DO NOT EXCEED 20 AMPS ACTUAL CHARGING CURRENT!

STEP 3 - Set the float voltage.

> NOTE: The battery usually must be charged to peak it before setting the float voltage. Fifteen minutes of additional charging time is usually sufficient once the battery has been brought up to full charge. When the charge current drops to 1-2 amperes with the voltage front panel set to MAX, the battery pack is peaked.

A. With NO AC primary power applied, set the front panel VOLTAGE adjustment to MAX (fully clockwise).

B. Connect the BC-20 to AC primary power. Observe that the green light on the front panel is lit indicating that AC power is present, and that the GFI light is out. If necessary, press the R (reset) button on the GFI. If necessary, also push in the AC circuit breaker front panel button to reset it. Refer to Section 4 in case of difficulty.

C. Slowly rotate the front panel VOLTAGE control counterclockwise until the desired float voltage is reached. Use an external meter to set float voltage. Alternatively, adjust the VOLTAGE to achieve the desired charging current in the float condition. The float charging current will normally be set lower for extended charging than for overnight charging.

This completes adjustment of the BC-20 for your vehicle battery.

Testing the Ground Fault Interrupter (GFI)

The GFI on the BC-20 should be tested periodically. A monthly test is recommended. CAUTION: DO NOT test the GFI at full charging current. Testing the GFI trip at full charging current will eventually result in burned and/or pitted GFI contacts, shortening the life of the GFI.

SECTION 4 - Troubleshooting

This section contains some helpful advice in case the BC-20 does not function properly. It consists of a table of symptoms, probable causes, and things to check.

Symptom	Check
Green light not lit	1. Is primary power outlet "hot"? 2. Is AC breaker tripped? (Press to reset) 3. Is GFI tripped? (Press "Reset") 4. Is charger plugged in? 5. Is AC wired to BC-20 correctly?
GFI light is on (tripped)	1. Push "R" button to reset. 2. Disconnect DC outputs, then try reset. 3. There is a leakage to ground: - May be dirt on battery. - DC lead short or leakage path. - Motor or controller short or leakage path.
Green light on, no DC out	1. Verify battery is connected. 2. Verify adjustments (Section 2). 3. Verify DC fuse is not blown. 4. Battery may have an open cell. 5. If charger has been operating, problem may be overheat shutdown. Let cool, should resume charging. 6. Verify fan is running and not obstructed.
Unit "hums"/"buzzes"	1. Normal for coil to "buzz"/"hum". 2. Normal for blower to "hum".
Cannot set float voltage	1. Verify correct resistor installed for the voltage of your battery pack.
No longer maintains float voltage	1. One end of voltage-select resistor may have come loose from its terminal block. 2. Voltage-select resistor may have "opened".

If you still experience difficulty in getting your BC-20 charger to operate properly after performing the above checks, please contact the distributor from whom you purchased the charger or contact K&W directly for further assistance. Section 6 explains how to get in contact with K&W.

SECTION 5 - Theory of Operation

This section provides a brief functional description of how the BC-20 operates. No detailed schematic diagrams or parts lists are included in this manual because K&W is concerned for the user's safety in attempting to perform repair work on a system that is not isolated from the AC line, and hence has lethal voltages exposed inside.

Figure 5-1 shows a functional block diagram of the BC-20.

The AC primary power is applied through the Ground Fault Interrupter (GFI), which removes AC power in the event of a short or leakage path to ground from either side of the AC line input. This is primarily for user safety. The output of the GFI is applied to the AC circuit breaker, which protects the primary wiring from damage in the unlikely event of an overload or short circuit failure within the BC-20 circuits.

AC primary power is then applied through a smoothing choke to a triac in the AC HI side, and then to a full-wave bridge rectifier. The choke serves the dual purposes of reducing the magnitude of current peaks to minimize heating effects, and of suppressing the generation of Radio Frequency Interference (RFI) by preventing abrupt changes (step changes) in the current flowing through the BC-20 charger. The output of the rectifier is applied through the DC output fuse to the battery. The fuse protects the BC-20 from short circuits or excessive charging current.

The control circuits contained on the printed circuit board measure the charging current and voltage every half cycle of AC power (120 Hertz rate, or every 8.3 milliseconds) and fire the triac at the proper phase angle to provide the user-set charging current and float voltage. The control circuits also include an overheat sensor/shutdown circuit and a temperature compensation circuit that automatically increases the charging voltage at low temperatures, and decreases it at high temperatures. Refer to Figure 1-1 for a graph of the voltage/temperature compensation curve.

The pulsed charging current can be viewed as consisting of two superimposed waveforms: a steady-state DC current plus an AC current. The DC component is the average value of the complex output current waveform, and is the current indicated by the ammeter. This DC component is also the actual charging current. The AC component, which has an average DC value of zero amperes, does not contribute to ammeter deflection or battery charging. It does, however, generate heat in resistive elements such as wiring, switches, fuses, etc. This heating is in addition to the heating caused by the DC component of the current. The value of the composite current can be measured by a true RMS ammeter in line with the AC input. The true RMS current will be approximately 50% greater than the DC output charging current.

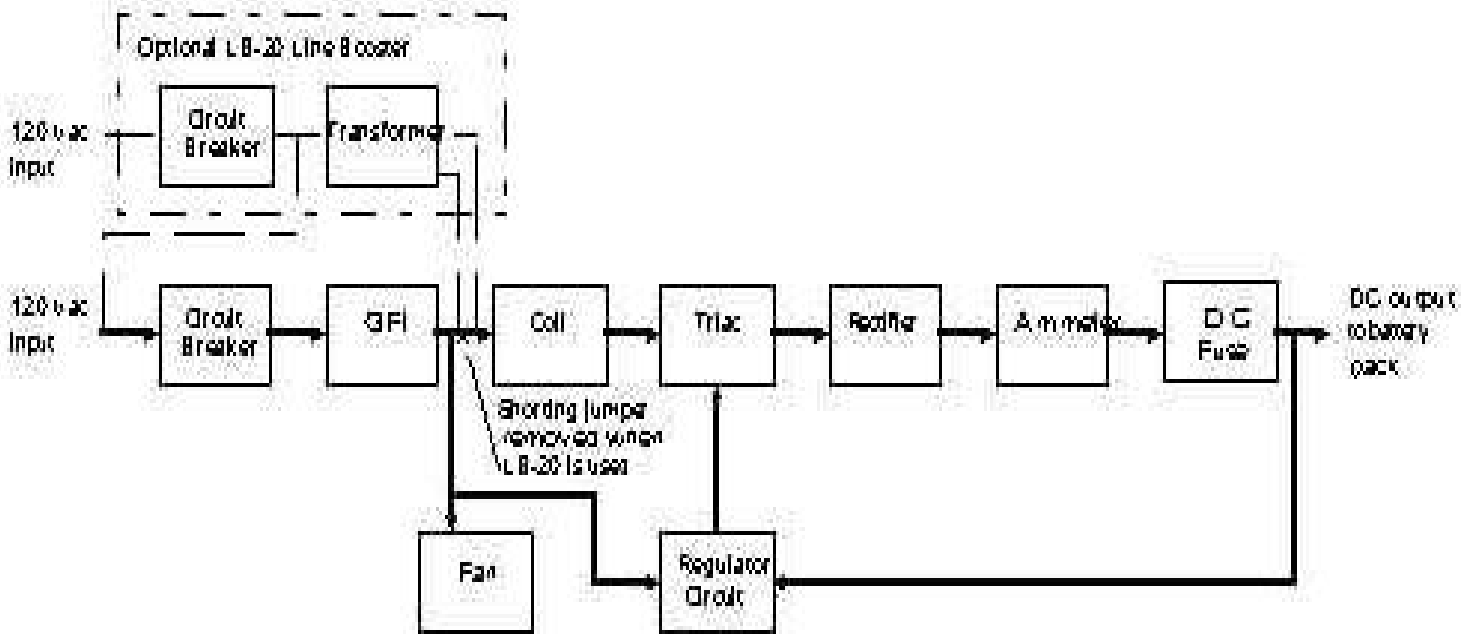


Figure 5-1 BC-20 Block Diagram

Very little of the difference between the input RMS and output DC currents represents lost power. Instead, it shows up as a reduction in the power factor of the charger-battery pack combination. A power factor of less than 1.00 indicates that the input current and voltage waveforms are not in phase. This will be obvious when considering how the BC-20 charger regulates charging rate. For each half-cycle of the AC input, charging current will be applied to the battery pack only when the triac is fired. This typically occurs approximately half way (about 90 electrical degrees) through each half cycle at normal load (later for lower charging currents). Thus it can be seen that the input current waveform lags the input voltage waveform.

The significance of this discussion of DC and AC currents is that the AC circuit used to power the BC-20 requires fuses and circuit breakers rated at least 50% above the maximum intended charging current, but not exceeding the amperage the circuit is rated for.

SECTION 6 - Getting in Contact with K&W Engineering

In case of questions or difficulties with your BC-20 charger, please feel free to contact K&W via mail or telephone. The address and numbers are:

K&W Engineering, Inc.
3298 County Home Road
Marion, Iowa 52302
Telephone: 319-378-0866

SECTION 7 - Use of the Optional LB-20 Line Booster for 120 VDC Battery Packs

In order to charge a 120 VDC battery pack, more primary input voltage than the normal 120 VAC line voltage is required. The LB-20 is a Line Booster that increases the input voltage to the BC-20 by 20 VAC so that it can charge a 120 VDC battery pack.

The LB-20 will handle the maximum 20 ampere charging current of the BC-20. It consists of a transformer whose isolated secondary provides a 20 VAC voltage which is connected in series with the primary input voltage to the BC-20 just before the coil, thus raising the BC-20 input voltage to 140 VAC. The LB-20 has its own AC circuit breaker to protect against short circuit damage to primary power wiring. The LB-20 also supplies 120 VAC line voltage to the BC-20 to power the GFI, fan, and control board.

Vehicle Mounting Considerations

Like the BC-20, the LB-20 is designed to be permanently mounted in electric vehicles. Thanks to its light weight and very compact size, it is easily mounted in most electric vehicles along with the BC-20. The following information and hints are intended to assist you in obtaining a long, reliable service life from the LB-20.

Mounting provisions - The LB-20 is supplied with four 1/4-20 threaded inserts on the rear surface, and four more 1/4-20 threaded inserts on the bottom surface. Any combination of these inserts may be used with user-supplied 1/4-20 bolts to affix the LB-20 to the desired location. A minimum of four bolts is required. The case fasteners are self-locking, so lock washers are not necessary. The vehicle mounting brackets or mounting surface should be true so that the LB-20 chassis will not be distorted when the bolts are tightened.

Mounting considerations

-- The LB-20 is not waterproof, so it must be located in an area free from rain and splashed water.

-- The LB-20 requires no special cooling considerations (unlike the BC-20) because it dissipates very little power.

-- The LB-20 should be located and oriented so that the front panel circuit breaker is easily accessible.

-- Cable routes for the AC input power and AC output power connections to the BC-20 should exit from the left end of the LB-20.

-- The LB-20 is normally mounted next to the BC-20 to minimize the

wiring length between the two units.

Supplying Primary 120 VAC Power

The LB-20 is designed to operate from 120 VAC house current. Because the LB-20 boosts the input voltage, the charging system will draw more line current than it did without the LB-20. Specifically, the 120 VAC line must supply an additional 4 amperes AC current at full charging current (20 amperes) when used with the LB-20.

The LB-20/BC-20 charging system is a high input current device, similar to a space heater or an air conditioner. The following primary power considerations should be carefully observed to avoid possible damage to the building wiring:

-- The wiring used to supply AC current to the LB-20 should be installed in strict accordance with the National Electrical Code (NEC) and all applicable local ordinances.

-- The AC circuit used for the LB-20/BC-20 system must have an additional current allowance for the LB-20 booster. Use a 15-20% adjustment factor to ensure the AC supply circuit is adequate for the intended charging current. The following table presents AC supply circuit rating needed versus charging current for the LB-20/BC-20 system:

Charging Current	Needed Circuit Capacity	Wire Size
10 amperes	20 amperes AC	#14
13	25	#14
16	30	#12
20	35	#10

-- Because of the high current draw of the LB-20/BC-20 charging system, no other appliances or devices should be connected to the LB-20's AC circuit unless the circuit is rated to carry the extra load.

Thanks to the delay start circuit of the BC-20, you will not cause an electrical arc when the LB-20/BC-20 is first plugged into the AC outlet. This important feature prevents connector damage from arcing.

Connecting AC Input and AC Output Wires

When first installing the LB-20 in your vehicle, or if changing the installation, it will be necessary to connect AC input and output wires. This section explains how to make those connections.

If this will be the initial installation of the BC-20 in the vehicle, refer to Section 2, Installation, Connecting AC Input and DC Output Wires, Steps 7, 8 and 9, to connect the DC output leads.

WARNING!!! Be sure that both AC input and DC output wires are DISCONNECTED from the outlet and battery before opening the LB-20 or BC-20!!! Potentially lethal voltages are present inside both the LB-20 and BC-20 from both the AC input and the DC load!!!

1. Set the BC-20 upright with the front panel facing you.

2. Remove the sixteen screws from around the edge of the front panel and gently let the front panel rest on its face. (Resting the panel on a soft cloth will prevent marring its finish).

3. Set the LB-20 upright with the front panel facing you.

4. Remove the twelve screws from around the edge of the front panel and gently let the front panel rest on its face. (Resting the panel on a soft cloth will prevent marring its finish).

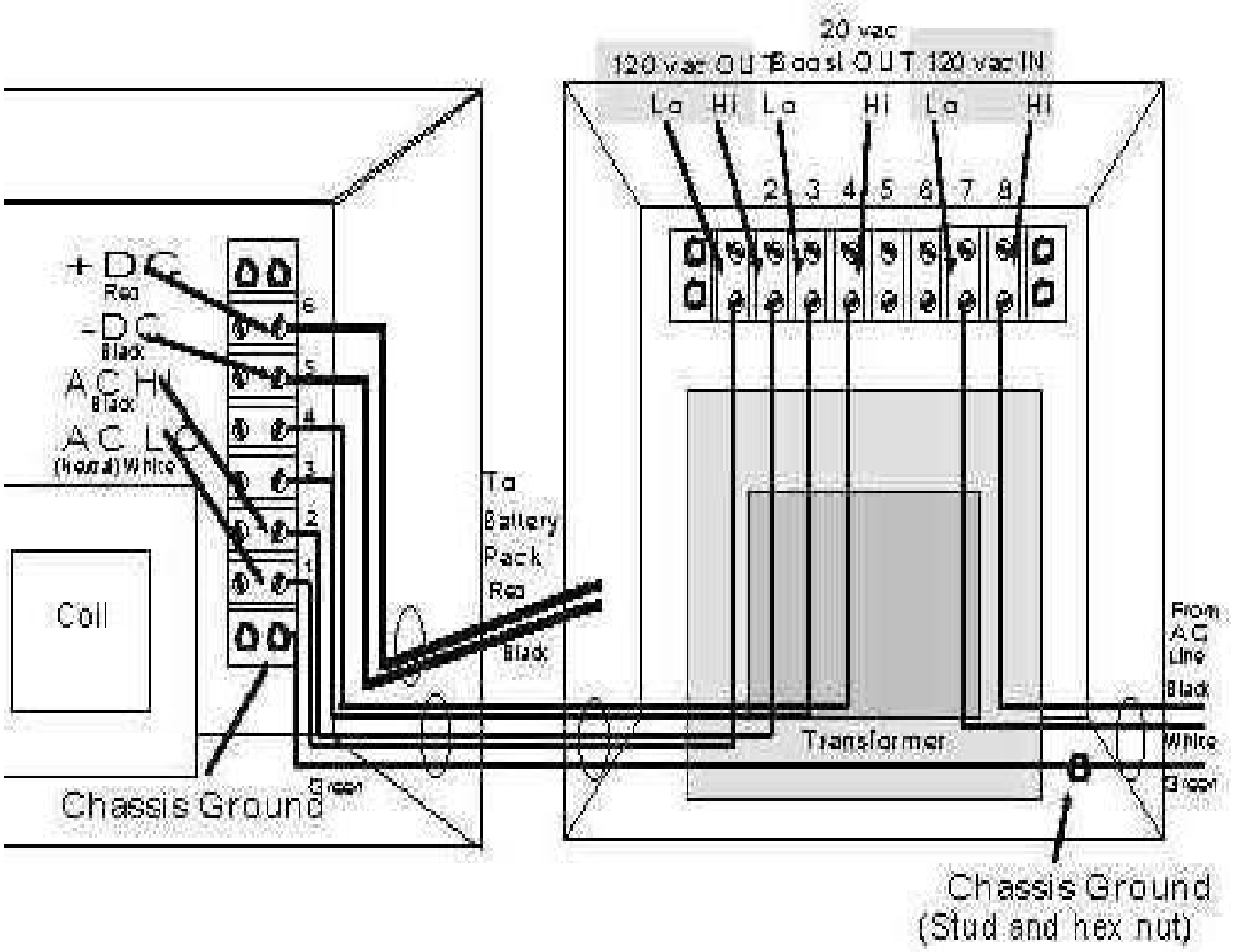
5. Referring to Figure 7-1, locate the terminal block on the rear inside wall of the BC-20 chassis. Number labels adjacent to the terminal block identify each screw of the terminal block.

6. Insert the AC input and boost wires through the cable bushing marked "120 VAC INPUT" on the right side of the BC-20. Terminate each wire with a lug sized to fit the #8 screw of the terminal block.

7. To the terminal block screw marked "2", connect the HI side AC input wire (normally a BLACK wire). 12 gauge wire is recommended; 10 gauge is preferred.

8. Similarly, to the terminal block screw marked "1" connect the LO side AC input wire (normally a WHITE wire).

9. Remove the jumper between terminals #3 and #4.



Front view of BC-20
with front panel removed

Front view of LB-20
with front panel removed

Figure 7-1 Connecting the LB-20 and BC-20

10. To the terminal block screw marked "4" connect the BOOST HI input wire.

11. Similarly, to the terminal block screw marked "3" connect the BOOST LO input wire. This completes the BC-20 portion of the wiring.

12. Referring to Figure 7-1, locate the terminal block on the rear inside wall of the LB-20 chassis. Number labels adjacent to the terminal block identify each screw of the terminal block.

13. Insert the AC interconnect wires from the BC-20 through the cable bushing on the left side of the LB-20. Terminate each wire with a lug sized to fit the #8 screw of the terminal block.

14. To the terminal block screw marked "2", connect the HI side AC input wire (normally a BLACK wire). 12 gauge wire is recommended; 10 gauge is preferred.

15. Similarly, to the terminal block screw marked "1" connect the LO side AC input wire (normally a WHITE wire).

16. To the terminal block screw marked "4" connect the BOOST HI input wire.

17. Similarly, to the terminal block screw marked "3" connect the BOOST LO input wire.

18. Insert the AC input cable through the cable bushing on the right side of the LB-20. Terminate each wire with a lug sized to fit the #8 screw of the terminal block.

19. To the terminal block screw marked "8", connect the HI side AC input wire (normally a BLACK wire). 12 gauge wire is recommended; 10 gauge is preferred.

20. Similarly, to the terminal block screw marked "7" connect the LO side AC input wire (normally a WHITE wire).

21. Referring to Figure 7-1, loosen the nut shown for the safety ground. Connect the safety ground wires from both the BC-20 and the AC input under that nut, and tighten securely. This completes the LB-20 portion of the wiring.

22. Double check the connections carefully! If wires are accidentally connected to the wrong terminals, serious damage to the BC-20 may result!

23. Carefully reposition the BC-20 front panel and reinstall the sixteen

screws removed previously. Similarly, reposition the LB-20 front panel and reinstall the twelve screws removed previously. This completes the cabling procedure.

This completes the installation of the LB-20 and BC-20.

Operation of the LB-20

No adjustments are required to the LB-20. Simply connect 120 VAC line power to the LB-20 and adjust the BC-20 per section 3.

Be sure that the LB-20 circuit breaker button is pushed IN to enable it.

Testing the BC-20 Ground Fault Interrupter (GFI)

The GFI on the BC-20 should be tested periodically. A monthly test is recommended. CAUTION: DO NOT test the GFI at full charging current. Testing the GFI trip at full charging current will eventually result in burned and/or pitted GFI contacts, shortening the life of the GFI.

Troubleshooting the LB-20

The following symptoms and corrective actions may be of assistance in the unlikely event that you encounter difficulty in getting your LB-20/BC-20 to function properly. Refer also to the BC-20 Troubleshooting section.

Symptom	Check
BC-20 cannot be adjusted for desired charging current	1. Is correct range resistor installed?
	2. Verify that LB-20 terminals 3 and 4 or BC-20 terminals 3 and 4 are not reversed.
	3. Recheck all interconnect wiring after first removing AC power!
Circuit breaker trips	1. Is correct range resistor installed?
	2. Was CURRENT control set to MIN before initial turn-on?

K&W Engineering Limited Warranty

K&W Engineering Inc. warrants the Model BC-20 battery charger to be free from defects in material and workmanship for a period of one year (12 months) from the date of retail purchase. Warranty coverage does not extend to units which, in the judgment of K&W Engineering, have been subject to physical or electrical abuse, including damage from improper connections, improper wiring, improper installation, user modifications, and/or attempted repair (there are no user serviceable components inside the BC-20 Battery Charger). "Proper" connections, wiring, and installation shall be as defined in the Instruction Manual for the BC-20.

For service/repair, whether in warranty or out of warranty, contact the dealer from which you purchased the unit or K&W Engineering directly. You will be given instructions for shipping the unit prepaid to your dealer or direct to K&W Engineering.

Units in warranty, subject to the preceding qualifications, will be repaired and/or replaced, at the discretion of K&W Engineering, and returned to you prepaid. Proof of purchase date (i.e., copy of sales receipt, invoice, etc.), is required.

Units no longer under warranty will be diagnosed, and a repair cost estimate provided to you. No repairs will be done without authorization based on that estimate. If repairs are declined, you will be billed $20.00 for the service estimate, and the unit will be returned to you prepaid.