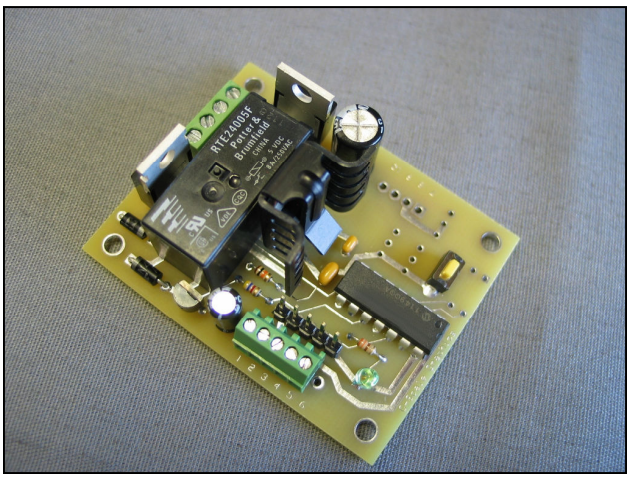
Basic Critter Control

Operation and Installation Manual



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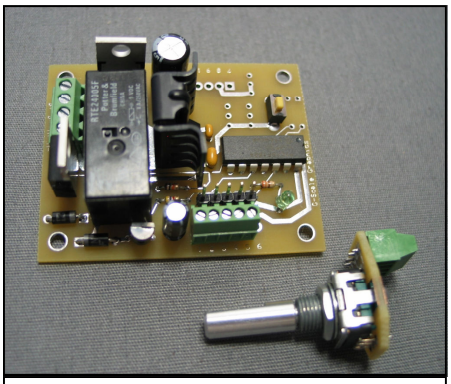
Overview

The Basic Critter Control is a simple way to manually control large scale battery powered "Critters" or locomotives, Hands-On, without the expense and frustration of radio control systems or complex track wiring. Whether you simply want to run your trains continuously or do switching in the yards, this control system will meet your needs.



Basic Critter Control board and rotary speed switch module with built-in push button.

The Critter Control is also a simple way to control a 2nd train on your layout. Speed is readily adjustable, so just set it close to that of your other train, then run at a fixed speed while you control the primary train using your power-pack or radio control as needed to keep them separated.

Unlike a simple on/off battery power scheme, the Critter Control smoothly accelerates and decelerates prototypically, and only allows direction reversal at a full stop, which avoids gear damage.

A powerful little micro-controller handles all of the control logic and sends signals to a 5 amp motor driver. The driver is large enough to handle most locomotives pulling a full train, yet the board is small enough to fit in most "Critters".

Manual Hands-On operation - A roof mounted rotary switch with built-in push-button is the primary control. Push the button to start the train. It will smoothly accelerate to your previously set running speed. Push the button again and it decelerates to a stop. The same button can be used to reverse direction or make emergency stops. Running speed is adjusted by rotating the switch as your train passes by. Your speed setting is retained in non-volatile memory, so it will still be there the next time you power up. Just push the button, and accelerate back to your set running speed.

The Basic Critter Control consists of a small circuit board (2.4" X 1.9") and off-board controls. This gives you the freedom to mount them where ever you want. A rotary switch with built-in push button makes for a simple one-piece control that can be easily disguised as a smoke stack or vent.

To complete your battery power conversion, you will also need to provide a power on/off switch, fuse, charging jack, battery pack, and battery charger. You may want to purchase our "Battery Conversion Module" which will simplify the battery power input wiring for you, and also provide convenient power outputs for sound boards, etc.

Installation

Track Power to Battery Power Conversion

All track powered locomotives are very simple, electrically. Track power is picked up from the rails via pickups and usually connected directly to the motor. Sometimes there are switches in the circuit to reverse polarity or turn off track power. These connections need to be modified in order to properly connect the battery powered driver board.

Converting to battery power consists of these basic steps.

1. **Determine battery voltage requirements.**
   Before you disturb any wiring, run your locomotive at the fastest speed you like to run on your layout and measure the track voltage. Add at least 2 volts to this measurement to account for low batteries and driver losses. Round this value up to the nearest 1.2v increment, and you have the number of cells you need.

   For example: Track voltage measures 11.6V at speed. (11.6 + 2)/ 1.2 = 11.3. You will need at least 12 cells. 12 X 1.2V = 14.4V. (14.4V is a popular value for steam locomotives. Many critters can run on 12V. Diesels usually require 18V or more).

2. **Disconnect the track power pickups.**
   By isolating your locomotive from track power, you can run more than one locomotive on the same track at the same time, either battery powered or track powered. If you don't do this, your battery will be directly con-

nected to your track power supply, resulting in damage. Note that in doing this, you have also removed power from all lighting circuits, smoke units, and any other accessories that were running from track power. For battery power, smoke units are usually not used due to the high current requirements that will quickly drain the battery pack. Lights can be powered from the battery for constant lighting. Understanding existing wiring and/or circuit boards without the proper documentation can be difficult. You may choose to just remove it all and wire directly to things you can see and understand.

3. **Find a direct connection to the motor.**
   The output of the controller needs to be connected directly to the motor. All other control boards and switches should be removed from the circuit. Depending on the design of the locomotive, this may be an extremely simple process, or it may be difficult. Some motor blocks make it very simple. You will find two pairs of wires. One set goes to the track pickups, and the other goes to the motor. You can verify which pair goes to the track pickups using a continuity checker or ohmmeter. Track pickups will have continuity from one pin to one set of wheels. The motor will read a small resistance value across the two wires (e.g. 18 ohms). Simply disconnect the track pickup pair and connect the motor pair to the controller.

4. **Install the discrete components and wire them together (battery pack, power on/off switch, fuse, charging jack, controller, and lights)**

   Installing the new components is a packaging exercise. Where will it all fit? Space for the battery pack and control board is usually the biggest consideration. And, where to locate the switches so they are accessible? Our "Battery conversion Modules" will simplify this process for you.

Wiring
Always use stranded wire and tin the ends with solder prior to making any connections. Wiring for the control inputs at terminals 1 thru 5 can be smaller gauge wire (26-22 Ga.). Wiring for the power input and motor output circuitry on terminals 6 thru 9 needs to be heavier gauge wire (22-18 Ga.) Any wiring connections or splices not directly connected to a component must be covered. Use heat shrink tubing or wire nuts.

Skills
All connections to the Critter Control can be made via screw terminals. However, basic wiring and soldering skills are required to make proper connections to the power on/off switch and charging jack. Some drilling and minor fabrication or modifications to the unit under conversion may also be required.

Tools & Materials
A low wattage soldering iron, side cutters, needle-nose pliers, wire strippers, a 1/16" or 5/64" slotted screwdriver, resin core solder, 26 and/or 22 Ga. Wire, and heat shrink tubing are recommended to properly complete the wiring. A suitable drill, double-sided foam tape, and Velcro may be useful for mounting components.

Installation of the Critter Control Board
The Critter Control board can be mounted most anywhere, but allow space for access to wiring, and no metal should be in contact with the board. The power components (heat sink and large metal tabs) will get hot, so keep them out of direct contact with plastic. Holes in the corners of the circuit board can be used in conjunction with stand-offs and machine screws for a solid mount. Or Double-sided foam tape on the bottom side of board can be used to secure the board to a plastic surface. Handle the board by the edges, avoiding direct contact with the circuitry. Static electricity can damage the components. Try to ground yourself by touching something metal prior to handling the board. Refer to the wiring diagrams at the end of this manual.

Power Input (Battery)
The Critter Control will not function below 7v input at terminals B+, B-. Reverse polarity will not cause damage, however, the control will not function. Voltage in excess of 30V may cause damage. Battery packs of 8 to 20 cells are suitable (nominal 9.6 to 24.0V). A 20 cell pack can charge up to 30.0V. An 8 cell pack can discharge to 8.0V.

When making wiring connections to the battery pack, use extreme caution to avoid shorting the leads together. Do not connect the battery to the circuit until all other wiring has been completed. The battery pack should have a quick disconnect connector for safety and ease of replacement.

Make sure terminal B+ is positive (+) and terminal B- is negative (-).
This product is not intended for track power applications where polarity reverses.
Reverse polarity will not damage the control, but it will not function.

Power On/Off switch

The power on/off switch can be located on the floor under the loco. If you have a critter, the charging jack can also be floor mounted, since you will probably take it off the track for charging. For a full size locomotive and/or tender, you may want to locate the charging jack on the end of the car to enable charging in place on the track. The switch in the charging jack isolates the battery from all other electronics when a jack is plugged in, regardless of the position of the power on/off switch.

Charging Jack

Warning! The heat sink on the voltage regulator may be extremely hot, especially when running in reverse. Enough to burn you if touched, or melt any plastic it comes in contact with.

A 5-amp fuse should be installed in-line with the battery pack to protect the battery pack from short circuits, which can not only burn up wiring, but melt plastic! (This fuse is built in to the Battery Conversion Modules).

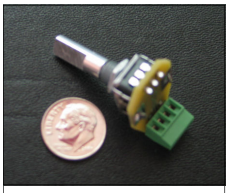
Motor Output

Connect terminals M+ and M- directly to the motor. All other unknown circuitry should be disconnected from the motor. You can use this output to power both the motor and incandescent lights. However, light intensity will vary with motor speed. For constant lighting, power incandescent lamps directly from the battery. A maximum of 5 amps continuous current is available from the board. *Warning! At 5 amps the power transistors on the board (metal tabs) will be extremely hot. Enough to burn you if touched, or melt any plastic it comes in contact with.*

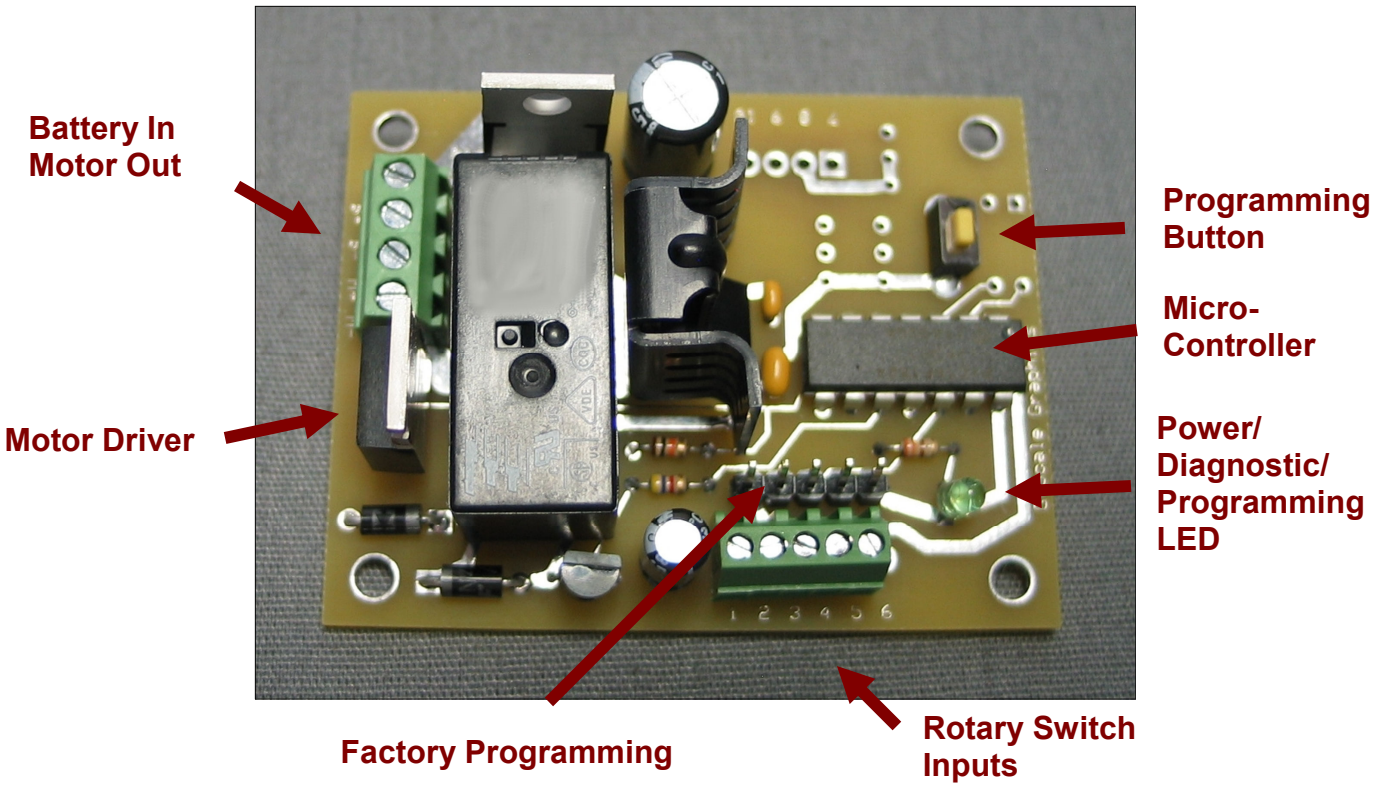
At power-up the motor output will provide a voltage to the motor that is positive on terminal 13, negative on 14. This is intended to be the forward direction of the locomotive. It will work either way. But with this polarity the board will draw considerably less current in the forward direction, thus reducing heat, and extending battery life, assuming you do most of your running in the forward direction.

Control Inputs

The rotary switch should be mounted where it can be easily reached as the critter or train passes by, usually roof mounted. The rotary switch is designed to accept a radio knob using a set screw. A false smoke stack or vent can be fabricated to act as the knob. The shaft can also be shortened. Drill a 9/32” mounting hole to clear the threads on the shaft. Wiring connections are made via screw terminals.



Rotary Switch (& dime)



Testing
The on-board green LED can be used to check out your wiring and most of the board functions. This should be all you need to get going, but if you are still having problems and you have a volt-ohm meter you can also take the measurements indicated below.

Power-up (LED ON)
When power is first applied to the board, the LED should be ON steady. This tells you the power input polarity is correct and the Critter Control's 5V power supply is working. Measure +5.0 +- 0.5 VDC at terminal 1+, 5-. If there is a problem, check the voltage and polarity at terminals M+, M-. It should measure between +7.0 and +30.0 VDC.

Speed Setting Switch (LED flashes OFF)
Rotate the switch in either direction. The LED should flash rapidly. You could also measure the voltage at terminal 2+, 5-, and terminal 3+, 5-. The voltage should momentarily drop from 5V to 0V. If not check the wiring of the speed switch.

Push-Button (LED flashes, then OFF)
When you press the button, the LED will flash a couple of times, then turn OFF. This indicates the button worked and you are now in the run mode. The motor should accel to the set running speed. CW rotation increases speed. CCW decreases speed. Pressing again should decel the motor to a full stop and turn on the LED. If the LED won't flash when the control button is pressed, check the rotary switch/control button wiring. Measure the voltage at terminal 4+, 5-. The voltage should drop from 5V to 0V when the button is pressed. If the motor doesn't run after increasing the speed setting, check the motor wiring. Voltage at terminals M+, M- should increase with increasing speed, to a maximum of your battery voltage. If the loco runs backwards, reverse the wiring at terminals M+ and M-.

Changing Direction
At power-up, direction is always set to "forward". While stopped, a short momentary button press, followed by a longer press will start the loco in the opposite direction. You may hear the relay click.

Manual Operation

Power-Up
When you first power-up your Critter Control it will be in the "Fully Stopped" mode (LED ON).

Changing Acceleration Rates during Operation -
"Fast" and a "Slow" accel rates are available. Slow will provide longer more prototypical starts and stops. Fast may be useful when doing switching operations. By default, the control uses the Slow rate. To select Fast rate, hold down the control button for about 1 second while turning on the power. To go back to Slow rate, cycle power off, then back on (control button not used).

Starting and Stopping
Press the control button to start. The locomotive will accelerate to running speed. Press it again, and it will decelerate to a stop. Press and *hold* the button anytime for an emergency stop.

Speed Changes
Changes to running speed can only be made while actually running at speed. Controls will have no effect during stops or while accelerating or decelerating. Roof mounted controls make it easy to adjust speed as the locomotive passes by.

Approximately two full turns will change speed from minimum to maximum (approximately 48 speed steps). There are no physical stops but you can feel detent positions as it is turned. CW rotation increases speed, CCW rotation decreases speed.

Memory -
The current speed setting is always retained in non-volatile memory. So, upon power-up you will be able to return to the same speed you were running during your last operating session. The speed setting is saved every time you initiate a stop.

Changing Direction
While fully stopped, a momentary button press (< 1/2 sec) followed by a longer press (about 1 sec) and release will cause the locomotive to accelerate in the opposite direction that is was running prior to the stop.

Set-Up

Motor Starting Voltage
When you press the control button to start your loco, the voltage starts ramping up from 0 volts. However, your motor will require something greater than 0 volts to start moving, perhaps 1 or 2 volts. The result may be a considerable delay between the time you press the button and motion of your locomotive. This can be adjusted, but try it at the factory setting of 0 volts first. Then if you need to change it, here's how ...

1. Prior to turning on the battery power, hold down the control button.
2. Turn on the battery power and continue to hold the control button for at least 5 seconds. After 5 sec, the on-board diagnostic LED will flash 5 times. You are now in the motor starting voltage calibration mode.
3. Increase the speed setting until the motor just starts moving, then decrease it slightly.
4. Press the control button. The on-board LED will flash 5 times, indicating your new motor starting voltage has been saved and you are now back in the stopped mode, and can resume normal manual operation.
5. Experiment with starting and stopping the loco. If there is still a significant delay, you may need to raise the starting voltage a bit. If the loco jumps when starting, instead of smoothly accelerating, you may have the starting voltage set too high.
6. If you power down and go back into the motor starting voltage mode again, the motor voltage will return to the last setting you made. You can now raise or lower it from that point.

Note: Upon exiting the motor starting voltage mode, fast accel rate will be selected. To restore the slow rate, cycle battery power off and back on.

Trouble Shooting

Manual Operation

- Nothing seems to be working …
  Check the power. The LED should be ON. You should measure between 7 and 30 volts DC applied to terminals B+ and B-.
  You should measure 5 volts DC on terminals 1(+), 5(-)
  Verify all wiring connections.

- Pressing the button, but it won't go …
  Press and hold the control button for a couple of seconds to insure you are in the "Fully Stopped" mode.
  Then momentarily press the control button. If it doesn't go, increase the speed setting.
  (Also try decreasing the speed setting, in case it is wired backwards.)
  If it still doesn't accelerate, remove power and try again.

- When I first power up and accelerate to speed, the loco runs in reverse ...
  Reverse the wires at the motor output, terminals M+, M-.
  It is preferable to run in the forward direction after power-up to conserve battery life.
- The loco won't run as fast as I like even though I keep trying to increase the speed setting …
  Maximum speed is determined by your battery voltage. You need more cells/voltage.

- The speed setting control is working backwards …
  Reverse the wiring at terminals 2 & 3.

- Can't change the speed ...
  The speed setting switch will only work while running at speed. Speed cannot be changed while stopped, accelerating, or decelerating.

- The speed setting seems to be changing on me...
  The "Speed Setting" is actually a "% of battery voltage setting". Hence, as the battery voltage decreases during discharge, the speed will slow down some. Also, changes in load, such as adding more rolling stock to the train, will decrease speed slightly.

  (Also, see Testing on page 5)

Programming Procedure for the Accel/Decel rate

The “Slow” accel/decel rate can be programmed using the on-board push-button switch, and on-board LED.

Enter Programming Mode
With power on, momentarily press the yellow push-button. The LED will begin flashing.

View Current Option Code
The LED will flash the option code currently programmed; e.g. two flashes followed by a pause indicate option 2.

Change the Option Code
Momentarily press the push-button during the pause to advance the option to the next higher number, until you get the desired number of flashes.

Save the Option Code
Press and hold down the push-button for about 4 secs until the LED starts flashing rapidly, which indicates the save is complete.

Exit Programming Mode
Turn off power.

Upon return to power, the new option will be activated.

Option	Button Press Accel/Decel Time
1	Fastest
2	Faster
3	[factory setting]
4	Slower
5	Slowest

Basic Critter Control Specifications
Enhanced Board Revision "D"

Mechanical

Physical Size: PCB – 2.4" X 1.9", Max component height – 1.0". Weight: 1.3oz.
User Connections: Screw clamp terminal strips accept individual wires
TB1: 30 to 20 AWG Requires a 1/16" or 5/64" slotted screwdriver
TB3: 22 to 18 AWG Requires a 5/64" slotted screwdriver
Hole size for Rotary Speed Switch: 9/32"

Electrical

Power Input from battery pack (Terminals B+,B-)
7.0V min to 30.0V absolute max
8-20 cell battery packs
Nominal 9.6V to 24.0V battery packs (1.2V per cell)
8 cells can discharge to 8.0V (1.0V per cell)
20 cells can charge to 30.0V (1.5V per cell)
Reverse voltage protection - (control will not function while reversed)

Power Consumption (due to board, no motor load)
Forward motor direction: < 30 ma (30V supply)
Reverse motor direction: < 130 ma (Relay energized, 30V supply))

Motor Output (Terminals M+,M-)
5 amps max, continuous
PWM (Pulse Width Modulated), 20 KHZ
Polarity reversal via relay contacts
Max amplitude: Battery voltage minus driver loss
Typical voltage loss across driver: 0.1V @14.4V, 1A: 0.3V @24.0V, 2.5A.

+5V output (Terminals 1+,5-)
Do not use.

Control Inputs

Control Switch Input (Terminal 4)
Momentary push-button switch (NO), contacts normally open
(Push-button is built into the rotary speed switch)

Speed Setting Inputs (Terminals 2,3)
Rotary Encoder switch; quadrature output, 24 pulses per revolution
approximately 2 full turns min to max speed

Battery Power Accessories (available from G-Scale Graphics)

Battery Conversion Module: Built-in power on/off switch, charging jack, fuse, power distribution
Battery connectors
Power On/Off Switch: Sub-Miniature w/short handle, SPDT (On-On), 3A, 28 VDC
Charging Jack: 2.5mm I.D., 5.5mm O.D., 5A, w/switch (mating power plug: Radio Shack #274-1573)
2 and 4 wire locking connector pairs

Basic Critter Control Wiring Diagram

Rotary Switch with built-in push-button

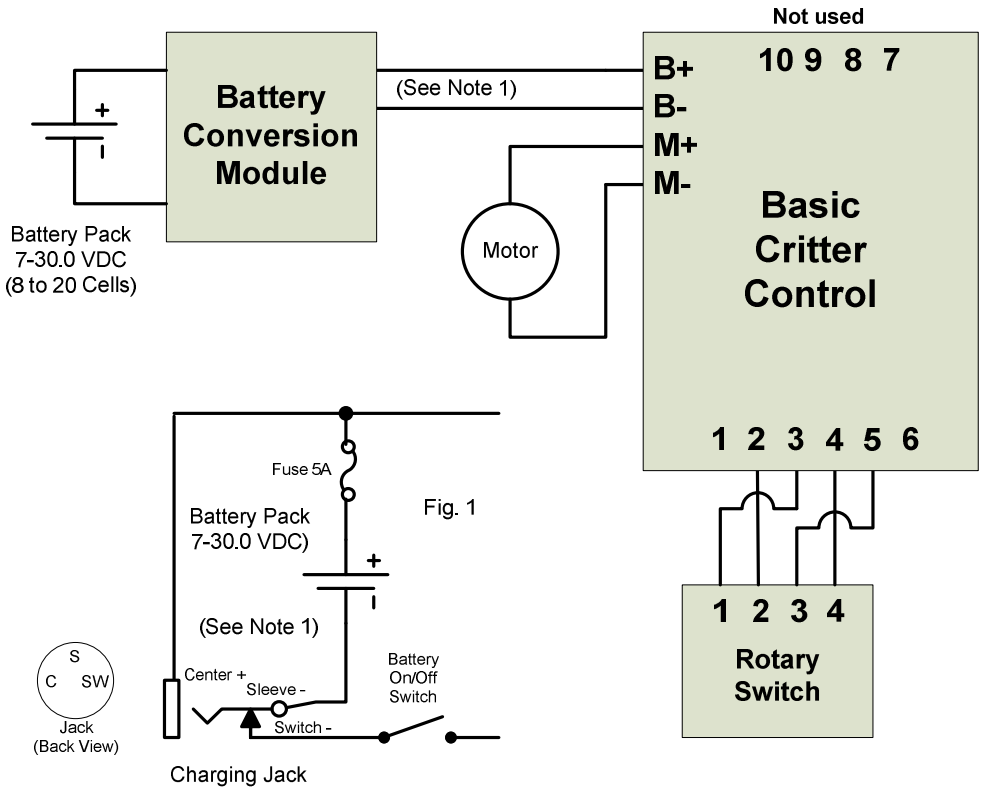


Fig. 1

Notes
1) Power input is protected from reverse polarity, but control will not function.

The circuit in Fig 1 can be used in lieu of Battery Conversion Module. Plugging in charger, isolates all electronics from the battery during charging.