Simple Low Cost Battery Power

Del Tapparo
2009 NGRC
Denver, Colorado
My Credentials

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- 2009 – Totally committed to battery power
- An “Expert” in Battery Power?
We will cover ...

- Battery Power Basics
- Conversion / Installation
- Control Systems
  (primarily G-Scale Graphics)

Questions or comments are welcome at any time, so jump in! 😊
Track Power

Each locomotive contains simple wiring
(all you really need are 2 connections to the motor)
Track Power

And one common control system

External Support System

115 VAC → DC / DCC Controls → Track & Rail Joiners → Wheels & Pickups → Motor

(Setup Time)
Battery Power

Self-contained, Self-propelled system

- Antenna
- Receiver
- Control Board
- Motor
- Battery
- Power Switch
- On-Board

Diagram:

- Battery
- Power Switch
- Control Board
- Motor
Battery Power

External Support System

Battery Charger

On-Board

Battery

Power Switch

Control Board

Motor

Antenna

(Setup Time - Offline)
Loco Wiring

- Factory Electronics
  - ???
- Motor
  - Track Pickups
Loco Wiring

- PWM Motor Driver
- Factory Electronics ???
- Motor
- Track Pickups
Loco Wiring

PWM Motor Driver

Factory Electronics ???

Motor

Track Pickups
Loco Wiring

PWM Motor Driver

Factory Electronics ???

Motor

Track Pickups
Motor Blocks

What do these wires do?
Motor Blocks

Motor Block

Open = Track Pickups
18 Ohms = Motor

Ohm Meter
18 Ohms

Motor

0 Ohms
Battery Specs

Voltage
More Volts = More Speed
Measure your track voltage
14.4V for steam
24V for diesel
Control’s voltage drop?
Battery Specs

Mah (Milli amp hours)

More Mah = longer run times

A battery pack rated for 2000 mah (2 amp hours) will run a train drawing 1 amp for 2 hours, or a train drawing 0.5 amps for 4 hours.

1500 mah for Critters

4000 mah for Trains

Target run time: 3-5 hours
Battery Chemistry

SLA (Sealed Lead Acid or Gel Cell)
Least expensive, lowest energy density (heavy)

NiCad (Nickel Cadmium)
NiMh (Nickel Metal Hydride)

Lithium-Ion
Most expensive, highest energy density (lighter weight)

Lithium-Polymer (Li-Po)
(Can be very dangerous. Not worth the risk in my opinion)

www.BatteryUniversity.com
Battery Format

Individual Cells in a Battery Holder

- Usually AA or C size cells
- Disposable or Rechargeable

- Allows charging or replacement of individual cells, if needed.
- May have poor contact
- Use at least 22 AWG wire
Battery Format

Battery Packs

Many different configurations (voltage, mah, shape)

Build your own (with solder tabs)

Ready made (recommended)
Battery Format

Tool Batteries

Readily available

Place in a trailing car for easy swap out

May require some disassembly to fit
Battery Location

Loco or Tender

Allows independent running

Space may be limited due to sound system, etc.
Battery Location

Trailing Car

- Plenty of space for batteries and controller
- Easy access
- Reduces cost
- Trail car must always be coupled to loco
Battery Location

Both

Small battery pack in loco for switching

Large battery pack in trail car for extended run times
Battery Charging

Swap Out

Requires easy access for battery removal

Good for continuous running / Open house
Battery Charging

On-Board Charging

Requires charging jack in loco or trailing car
Best for hard to access batteries
Loco is out of service during charging
Charge at the end of the day
Battery Charging

Charging Safety

Use only the proper charger for your battery type
Choose a location you can periodically monitor
Charge batteries on a fire-proof surface
Run Times

How long will it run?

More mah = more time

Typically 2-5 hours
Run Times

How long will it run?

- More mah = more time
- Typically 2-5 hours

How many locos do you have?

One loco?

- Swap battery packs for continuous running
Run Times

How long will it run?

More mah = more time
Typically 2-5 hours

How many locos do you have?

One loco?
Swap battery packs for continuous running

Several Locos?
Swap locos as needed
Buying Batteries

Local Stores

Local Hobby Shop (R/C cars & planes)
Electronic Stores (Radio Shack, Best Buy)
Home Improvement Stores (Home Depot, Lowes)

On-line

www.All-Battery.com
www.BatterySpace.com
www.BatteryStation.com
Power Input Circuits

Battery Connectors

Two exposed leads = arc welder
Quick and safe disconnect

Power On/Off switch

Insures no battery drain
Locate under chassis
Power Input Circuits

Fuse

- High currents will melt things: wires, plastic bodies
- Fast acting (glass)
- PTC / Poly fuse / Re-settable

Charging Jack

- Allows on-board battery charging
- Jacks with a switch automatically isolate battery
Power Input Circuits

**SPST Switch** (Remove battery for charging)
Power Input Circuits

Add a Charging Jack (Charge battery in loco)

![Diagram of power input circuits with a charging jack, battery pack, fuse, and control board for lights and sound board.]
Power Input Circuits

Power Distribution

- Control board
- Sound board
- Lights
- Wire nuts?
- Terminal strips?
- Connectors?
Power Input Circuits

Battery Conversion Module

Simplifies Wiring
Through the floor or open door mounting.

5 Amps
Small: 1 ¼” X 1 ½”

Price: $29
Battery Conversion Module
Wiring Diagram

Battery Charger
Charge Plug
Polarized Male/Female Connectors
Battery Pack
Center (Red)
Sleeve (Blk)
Remote Jack
S C Sw
Remote Jack Options
For use as a Remote Charging Jack - Connect Switch to terminal 4, Sleeve to terminal 5.
For use as a Remote Battery Input - Connect Switch to terminal 5, Sleeve to terminal 4.
For NO REMOTE JACK - Jumper terminal 4 to terminal 5.

Functions
- Power Control & distribution – On/Off switch with up to four 22 ga. fast-acting fuse protected power outputs.
- Local/Remote Battery Charging – Use local jack on board or a remote mounted jack.
- Local/Remote Battery location – Remote jack can be used to connect batteries in a trailing car for extended run times.
- Flexible mounting - Mount with switch extended through the floor or bulkhead, or taped to the floor for access through door or roof.
Motor Control

Two Speeds: On & Off

One Direction: Forward
Motor Control

Direction Control: Cross Wired DPDT Switch
Motor Control

Variable Speed Control with a Rheostat

High wattage Rheostat – large and hard to find.

Very inefficient – Rheostat wastes power, reduces run time.
Motor Control

Voltage Regulator

Requires a heat sink and more wiring.

Also very inefficient
Motor Control

PWM
Pulse Width Modulation
Duty Cycle is averaged by the motor.

Very efficient
Motor Control

How many amps do I need?

It depends on the locomotive -

Running under load? (usually < 1 amp)

Wheels slipping? (maybe 2-3 amps)

Stall current? (perhaps 3-5 amps)
Motor Control

How do we do it?

PWM Driver – 20 KHZ  (No motor whine)
Motor Control

How do we do it?

PWM Driver – 20 KHZ (No motor whine)

Rated for a Full 5 amps, continuous operation
(Enough power for “Critters” or Full Size Locomotives)
Hands-On Control

Manual controls mounted on the locomotive?

Hands-on doesn’t mean you have to chase your train!
Hands-On Control

On/Off Switch

Place loco on the track and just turn it on
Could be hard on the drive train
No speed control
Reversing switch - optional
Hands-On Control

General Purpose PWM Motor Driver

- Speed control; may be hard to access
- Circuit board; large, hard to hide
- Limited voltage range
- Low frequency PWM; motor whine
- Spade terminals
- Huge heat sink
Hands-On Control

Simple Critter Control

Speed Control – 0 to 100%

Built-in Speed Control

Set the speed as loco passes by

Great for continuous running
Hands-On Control

Simple Critter Control

- Fits in the tight spots - only 1” square
- Roof or Floor mount
- Shaft can be shortened or disguised
- Reverse requires DPDT switch
Hands-On Control

Simple Critter Control

PWM motor driver – 5 amps
4 wires: Power in, Motor out
7-20 volt battery power
Price: $29
Semi-Automated Control

**Basic Critter Control**

- Push-button starts/stops
- Smooth accel/decel
- Speed Control with memory
- Forward & Reverse
Semi-Automated Control

Basic Critter Control

Off-board Controls

Rotary switch combines functions

Works like your car radio volume control

Easy screw terminal connections
Semi-Automated Control

Basic Critter Control

Toggle switch option
Push-button start/stops
Speed raise/lower
Basic Critter Control

1.9” X 1.45” X 1.25”

8-30 volts, built-in circuit breaker

Wiring diagnostics LED

Full 5 amp PWM motor driver with adjustable motor offset voltage.

Price: $69
Semi-Automated Control

Enhanced Critter Control

All the features of the Basic plus …

Automated Station Stops
Automated Reversing (back ‘n forth)
Directional LED lighting
Auto / Manual operating modes
User selectable rates & stop times
Semi-Automated Control

Station Stops

- Decel
- (Accel/Run)
- Decel
- (Accel/Run)

Track magnet - Start decel

Track magnet - Change direction after station stop

(Accel/Run) → Starts automatically when station stop times out
Semi-Automated Control

Station Stops

Radio Shack ½” disk magnets
Make magnets portable
Share magnets with sound system
Semi-Automated Control

Enhanced Critter Control

2.35” X 1.55” X 1.0”

8-30 volts, built-in circuit breaker

Wiring diagnostics LED

Full 5 amp PWM motor driver with adjustable motor offset voltage.

Price: $89

Also available:

Toggle switch & push-button

6-16 volt input range.
Radio Control

**Basic Railboss R/C**

Uses standard 75MHZ AM hobby radios

Speed & Direction control

Automated station stops via transmitter

“Glitching” is not a problem
Radio Control

**Basic Railboss R/C**

Left stick - Speed increase/decrease
Right stick - Fwd/Rev, SS enable/disable
Quick stop - Down and Left
Run with transmitter off
Radio Control

**Basic RailBoss R/C**

1.9” X 1.45” X 1.25”

Same board as Basic Critter Control

Price: $69

(Radio Tx/Rx not included)

Purchase radio at local hobby shop or on-line. $40-$50
Radio Control

Enhanced Railboss R/C

All of the Basic features plus …

- Smart Sound Triggers
- Random Station Stops
- Directional LED/Lamp drivers
- 8 User Programmable parameters
Radio Control

**Enhanced RailBoss R/C**

2.9” X 1.9” X 1.0”

Enhanced RailBoss Bd, Rx cables, Reed switch

Price: $99

(Radio Tx/Rx purchased separately)
Radio Control Issues

EMI (Electro-Magnetic Interference)
- Motors generate noise
- Filters may be needed
- 0.1uf capacitors

RFI (Radio Frequency Interference)
- Not a problem
- Software filters out any “Glitching”
Radio Control Issues

Range Issues

Keep antenna high
String around roof interior

Better antenna

Black-Kat antenna 75MHZ

www.ecubedRC.com
Coming Soon!

2.4GHZ Spektrum DX5E / AR500 Joins RailBoss R/C
2.4GHZ Enhanced RailBoss

- 2.4 GHZ DSM2 Technology using the Spektrum DX5E Tx and AR500 Rx (5 channel R/C)
- Eliminates motor noise and other EMI
- Eliminates frequency/channel conflicts
- Superior range (even with metal bodies)
2.4GHZ Enhanced RailBoss

- Low cost: Tx and Rx for only $99
- Proportional Throttle Control (not raise/lower)
- Automated Station Stops
- Randomized Sound Triggers
- Consist (MU) locos (with speed curve matching)
## Product Summary

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>Battery Conversion Module</td>
<td>$29</td>
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<tr>
<td>Custom Vinyl Lettering &amp; Paint Masks</td>
<td>Quote</td>
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</tbody>
</table>
Show Specials

Win a Free Control of your choice
   Sign up at our booth for the drawing
   Winner will be posted on our web site, July 13th

10% Off all orders placed at the convention
   Not selling here, but will take orders
   Stop by our booth and tell us what you want
Support

Quality
   Industrial quality parts
   100% Functional Test

Warranty
   One year from date of purchase (flexible)

Help is always available
   e-mail: GSscaleGraphics@comcast.net
   Phone: 970-581-3567    7 days a week; 9 am to 9 pm
Ask our competition about

- Low voltage drop motor drivers; <0.3V (Every 1.2V is one wasted battery cell)
- Opto-Isolated sound triggers? (Does it require an extra board?)
- LED drivers? (Do you have to install resistors?)
- Do they have Built-In Diagnostics? (LED checks your wiring without a meter)
And ...

- Proportional R/C throttle stick
  (no guessing with up/down buttons)
- Automation? (station stops, back ‘n forth, randomization of events)
- Wide range battery voltage; 8-30 V
  (Critters to Diesels)
- Made in the USA?
Questions?

Huh?  What did he say?

Copies of this presentation will be available on our web-site

GScaleGraphics.net
Come see us

Booth #1203
Demo track
Free Control

D&L Garden Railroad
Del & Linda Tapparo
Fort Collins, Colorado
Saturday 10 - 4

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