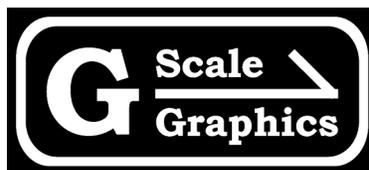
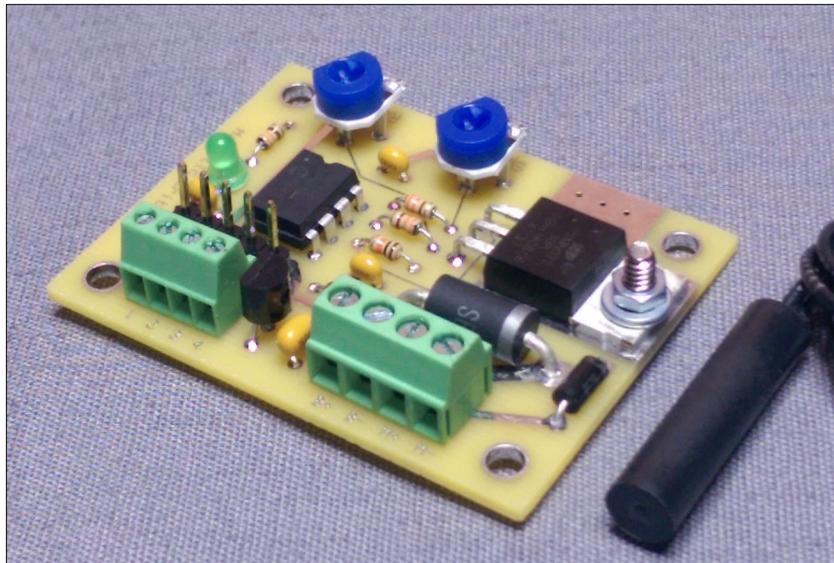


# Magnetic Critter Control

Operation and Installation Manual



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## Overview

The Magnetic Critter Control is designed for continuous running of your trains. Start the train and watch it run making automated station stops (if desired), with controlled deceleration and acceleration into and out of the station.

The operator uses a hand-held magnet to activate a reed switch hidden under the roof of the cab to start the locomotive. It will then accelerate at a prototypical rate to running speed. Another pass of the hand magnet as the loco comes into reach will cause it to quickly decelerate to a stop. The use of a hand-held magnet eliminates the need for a switch protruding from the roof. But if you prefer, you can use a roof mounted push-button switch instead of the magnet and reed switch.

Automated station stops can be obtained using track mounted magnets. They can be programmed for 100% (stop every time), or 50% (random stops 50% of the time).

Running speed and the rate of acceleration are controlled using adjustment pots on the circuit board. Once set for your loco and running taste, there is no need to change them. Just a pass of the hand-held magnet, and you are up and running.

There is no built-in direction change, but running in reverse can be accomplished, if desired, using an optional DPDT switch in series with the motor output.

A powerful micro-controller handles all of the control logic and sends signals to a 4 amp motor driver, which is large enough to handle most locomotives pulling a full train.

Critter Controls are a low cost alternative to radio control, as there are no radio receivers or transmitters to purchase. And the small size of the circuit board makes them ideal for installation in smaller locomotives.

**Manual Hands-On operation** - The Control reed switch is mounted under the roof of the cab or any other convenient location. Simply hold a magnet over that location until the loco starts moving. Use the magnet again to make a quick stop that is gentle on gears. Running speed is set by the "Speed" pot on the circuit board.

**Automated operation** - Continuous loop operation with multiple station stops is built into the Magnetic Critter Control system. Track mounted magnets and an optional loco mounted reed switch initiate deceleration to a stop at the station, where it will stay for 10,20, or 30 seconds (depending on the option you ordered), and then accelerate back to running speed. The Accel/decal rate is determined by the "Rate" pot on the circuit board.

Note: A train sitting at the station for only 30 seconds may not seem very long, but to a visitor wondering when something is going to happen, it is quite a long time.

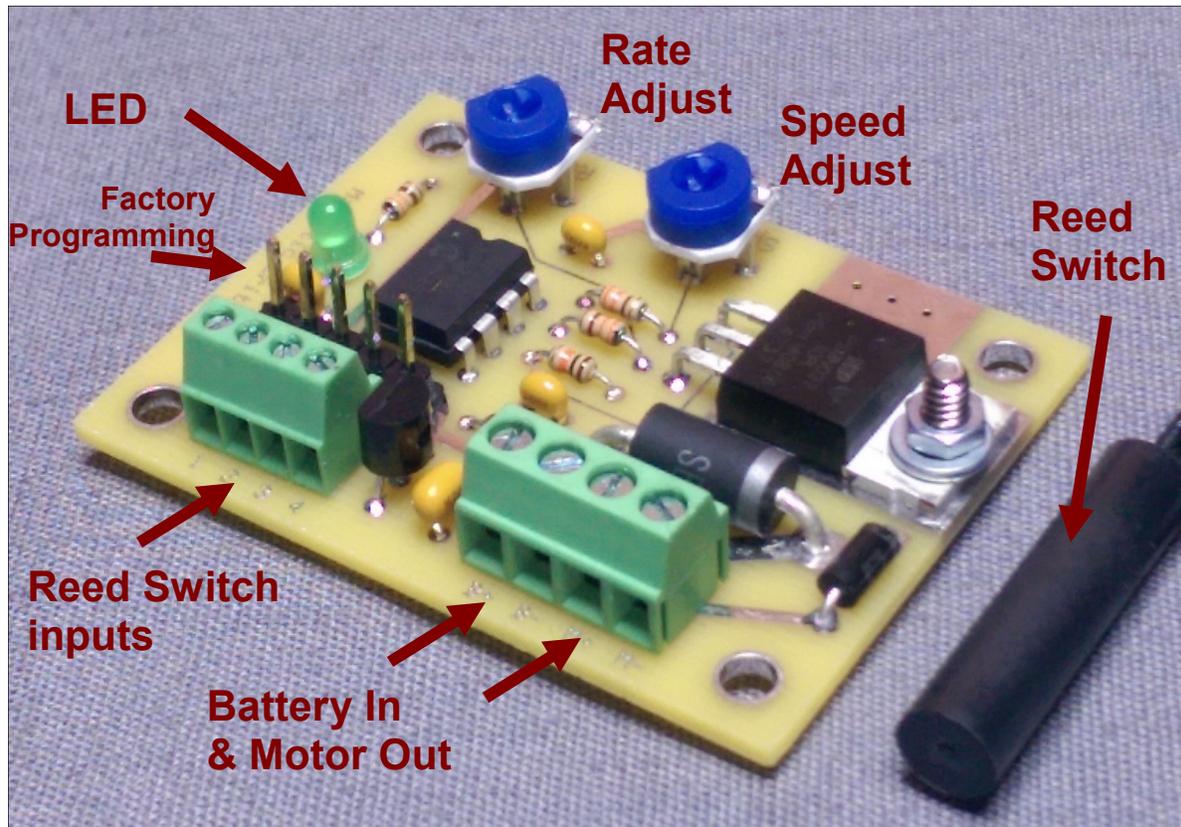
To change from 100% station stops to random station stops, or vice versa, hold the magnet over the control reed switch during power-up. If the LED on the circuit board stays ON, you are in 100% mode. If the LED goes OFF, you are in random mode. The mode is saved in memory and will remain in that mode until you change it again.

The Magnetic Critter Control consists of a small circuit board; 2.0"L X 1.5"W X 0.5"H and a control reed switch. An optional station stop reed switch can be mounted under your loco to implement automated station stops.

**Note: To complete your battery power conversion, you will also need to provide a power on/off switch, battery pack, battery charger, and battery charging jack (optional). The G-Scale Graphics "Battery Conversion Modules" combine some of these functions and reduce wiring.**

The on-board LED and built-in diagnostics provides a visual indication of proper reed switch operation.

## 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 the motor. 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 battery voltage available.

14.8V Lithium-Ion battery packs are a popular value for steam locomotives. Many critters can run on 11.2V. Diesels may 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 connected 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. Understanding existing wiring and/or circuit boards without 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 must 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 all of the components and wire them together (battery pack, power on/off switch, charging jack, controller, and lights)



Power On/Off switch

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?



Charging Jack

#### 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 10 can be smaller gauge wire (26 Ga.). Wiring for the power input and motor output circuitry on terminals 11 thru 14 needs to be heavier gauge wire (20 or 22 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 Rotary Critter Control can be made via screw terminals. However, basic wiring and soldering skills are required to make proper connections to the toggle speed switch version, 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, PCB stand-offs, and double-sided foam tape 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. No metal should be in contact with the board. The power components (heat sink and large metal tab) will get hot, so keep them out of direct contact with plastic. Mounting holes in the corners of the board may be used along with stand-offs for a professional installation, or simply use double-sided foam tape on the bottom side of board 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, but the control will not operate. Voltage in excess of 25V may cause damage.

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.

**Note: Make sure terminal B+ is positive (+) and terminal B- is negative (-). This product is not intended for track power applications where polarity reverses.**

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. **Warning! The metal tab on the motor driver may be extremely hot; enough to burn you if touched, or melt any plastic it comes in contact with.**

**Warning ! A 5 amp fuse should be installed in-line with the positive battery lead to protect against accidental short circuits, which may damage the control, and melt wiring and/or plastic.**

### **Motor Output**

Connect terminals M+ and M- directly to the motor. All other unknown circuitry must be disconnected from the motor. A maximum of 4 amps continuous current is available from the board. **Warning! At 4 amps the power transistor on the board (metal tab) will be extremely hot. Enough to burn you if touched, or melt any plastic it contacts.** If the loco runs backwards, simply reverse the wiring at terminals M+,M-.

### **Reed Switches**

The controls reed switch can be mounted at any convenient location accessible by the operator. Mounting it horizontally (parallel to the roof) will provide the best operation since the reed switch can be activated on either end of the switch. The magnet will need to be within 1/4" of the switch with minimal plastic material between it and the switch.



A station stop reed switch is only required for automated operation. It must be installed within 1/4" of track magnets, in either a horizontal or vertical orientation. You can usually mount it on the underside of a truck in the horizontal position parallel with the track. Silicone adhesive works well. Or, it can be vertically mounted through a 1/4" diameter hole in the floor of the vehicle. Do not mount the reed switch below the level of rail tops, as it will hit the rails in turnouts.

### **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+, 2-. If there is a problem, check the voltage and polarity at terminals B+, B-. It should measure between +7.0 and +25.0 VDC.

#### **Reed Switch (LED OFF when activated)**

While in the stopped mode, anytime a magnet is passed within range of either reed switch, the LED will blink OFF. This is very handy to check your reed switch and magnet alignment. Slide the loco back and forth over the magnet, while watching the LED. Your magnet height should be just under the top of the rail. The reed switch should be just above the top of the rail. There should be less than 1/4" spacing between the magnet and the reed switch. Measure the voltage at terminal 1+, 2 for the Control Reed Switch, or 3+,4- for the Track Reed Switch. The voltage should momentarily drop from 5V to 0V. If not, check the reed switch wiring.

### **Setup**

Running speed is adjustable using the "Speed" pot on the circuit board. Clockwise rotation increases running speed.

Acceleration/Deceleration rate is adjustable using the "Rate" pot on the circuit board. Clockwise rotation increases rate of change. This sets the rate for both manual starts and automated starts and stops.

Dwell time at a station stop is fixed at either 10, 20 or 30 seconds, depending on the software option selected at time of purchase. Times will be slightly longer than this due to the short delay between the time the motor voltage starts to ramp up and the loco actually starts moving.

## **Trouble Shooting**

### **Manual Operation**

- Nothing seems to be working ...  
Check the power. The on-board LED should be ON when you first power-up.  
You should measure between 7 and 25 volts DC applied to terminals B+, B-.  
Make sure the polarity is correct.  
You should measure 5 volts DC on terminals 1(+), 2(-)  
Verify all wiring connections.
- Control Reed Switch: Activating with a magnet, but it won't go ...  
Make sure you can see the LED blink when using the magnet.
- Station Stop Reed Switch: Activating with a magnet, but it won't stop at the station ...  
LED on the board should blink when you pass over the magnet.  
You may be in "Random station stop mode". It will only stop about 50% of the time. Reprogram for 100% stops by holding magnet over the Control reed switch (not the Station Stop reed switch) during power up.  
LED will stay on if you are in 100% mode.
- When I first power up and accelerate to speed, the loco runs in reverse ...  
Reverse the wires at the motor output, terminals M+.M-.
- 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 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.
- There is a delay between activating the control reed switch and the loco actually moving. ...  
The control starts ramping up the motor voltage from zero volts. When the voltage gets high enough for the motor to run it will start moving. Starting voltage is not adjustable on this control.

## **Automated Operation**

An automated station stop slows down the train, waits at the station for 10, 20 or 30 seconds (depending on option ordered), then accelerates back to running speed. Station stops add interest to your open house or public displays.

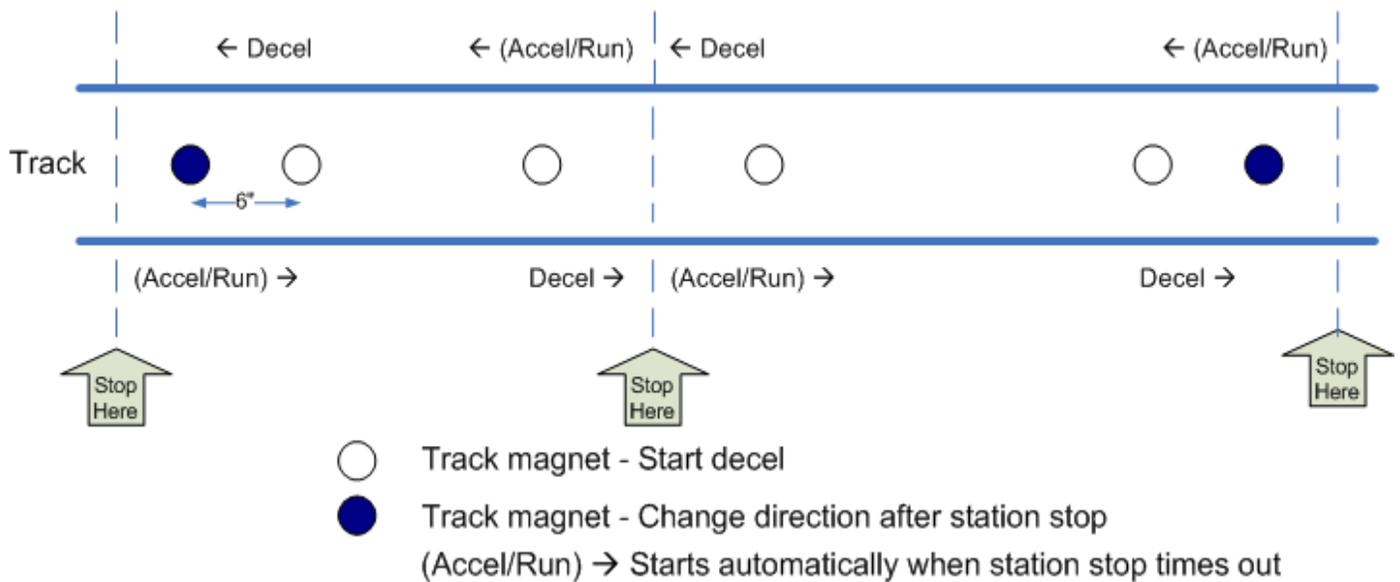
Automated operation is easily achieved with the Magnetic Critter Control. You just need to add a reed switch to your locomotive and place some track magnets on your layout.

Automated station stops are initiated by a track magnet placed ahead of the station. The magnet initiates deceleration to a stop. You can make as many stops as you like, one magnet per station. When running in both directions, two magnets per station are required, one for each direction. Place the magnets such that the loco stops at the same location when running from either direction. The magnet in front of the locomotive when leaving the station will be ignored.

The distance the magnet is located from the station will depend on your running speed. Some trial and error will be required to find the proper location. First, establish your running speed. Since your running speed is maintained in memory, the distance will never change unless you vary the running speed.

Avoid the repetition of a station stop every time a magnet is encountered by programming random station stops. This adds an incredible amount interest to your layout for both you and your visitors.

Radio Shack 1/2" round ceramic magnets make good track magnets. They can be glued to the top of a rail tie or placed between the ties. Any magnet of suitable size and strength can be used. But they must be located no more than 1/4" from the reed switch passing overhead. Track magnets mounted higher than the rail tops will be susceptible to damage by track cleaners and snow plows.



Note: Direction changes are not possible with the Magnetic Critter Control. You must use the Enhanced Critter Control.

**But I already use magnets to trigger my sound system!**

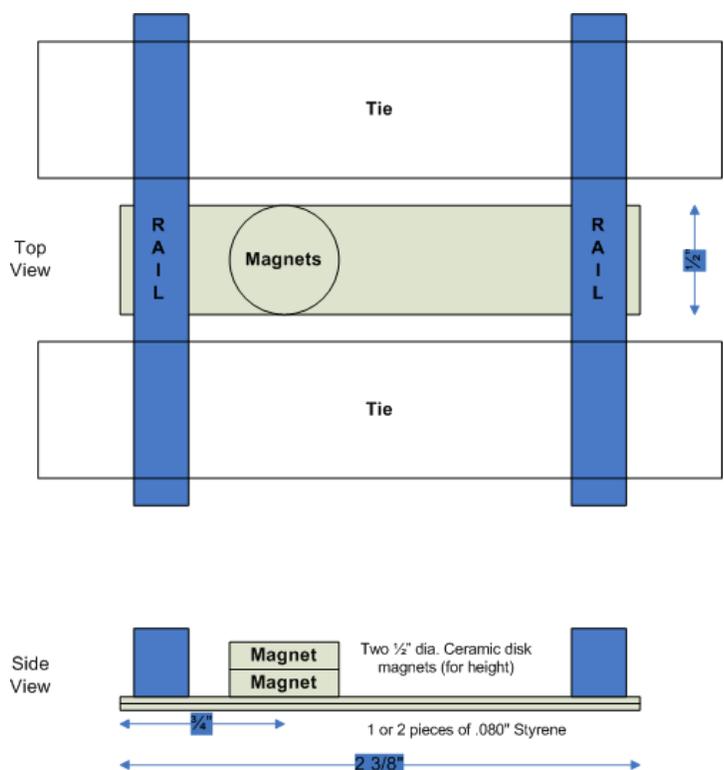
You may have existing track magnets used to trigger the bell and whistle of your sound system. For example; whistle magnet on the right, bell on the left. Both systems can share the same magnets fairly easily. Install your Critter Control reed switch on the same side you use to trigger the bell. The bell will ring as you approach the station, and the whistle will still blow in your favorite locations. If your sound board uses the negative battery terminal for common, you can also share the same reed switch. One side to common, the other side to both the sound board and the Critter Control.

**Movable Magnets**

Being able to easily move your magnets to new track locations makes it much easier to set up your station stops, or change things as the need arises. If you just place a loose magnet in between ties, the metal of the loco may pick it up as it passes. Glue your magnets to a strip of styrene as shown. When placed under the rails, the magnet will stay in place. Magnet can be on the left or right by simply rotating the strip.

**Trouble Shooting Automated Operation**

- Loco fails to stop after crossing the track mounted decel magnet. Verify proper installation of reed switch and magnet.
- If you can't get the loco to make a proper intermediate station stop in both directions after making the above adjustments, it may be due to excessive grade of the track. Intermediate station stops work best with a flat approach from both directions but should tolerate 3% grades.
- The location of the station stop changes over time. Magnet locations are only precise for one given speed setting. As the battery discharges, the loco will slow somewhat, even though the speed setting has not been changed. This effects the stopping distance after a magnet trig-



# Magnetic Critter Control Specifications

## Board Revision "New"

### Mechanical

Physical Size: PCB – 2.0" X 1.5", Max component height – 0.5". Weight: 0.5 oz.

User Connections: Screw clamp terminal strips accept individual wires, 30 to 20 AWG.

Requires a 1/16" or 5/64" slotted screwdriver

### Electrical

Power Input from battery pack (Terminals B+,B-)

7.0V min to 25.0V max

Reverse polarity protection

Power Consumption (due to board, no motor load)

12 ma (25V supply)

Motor Output (Terminals M+,M-)

4 amps max, continuous (7-25V Input)

PWM (Pulse Width Modulated)

Polarity reversal: Optional, via user installed DPDT switch in series with motor output

Max voltage: Battery voltage minus driver loss

Typical voltage loss across driver: 0.4V @ 1A: 1.0V@ 4A.

### Control Inputs

Reed Switches

(drill 1/4" hole)

SPST - Normally Open, installed within 1/4" of track magnet, vertical or horizontal orientation

Track Magnets

Radio Shack 1/2" round ceramic magnets, or equivalent, placed on roadbed within 1/4" of reed switch.

Piko track magnets work well.

### Battery Power Accessories (available from G-Scale Graphics)

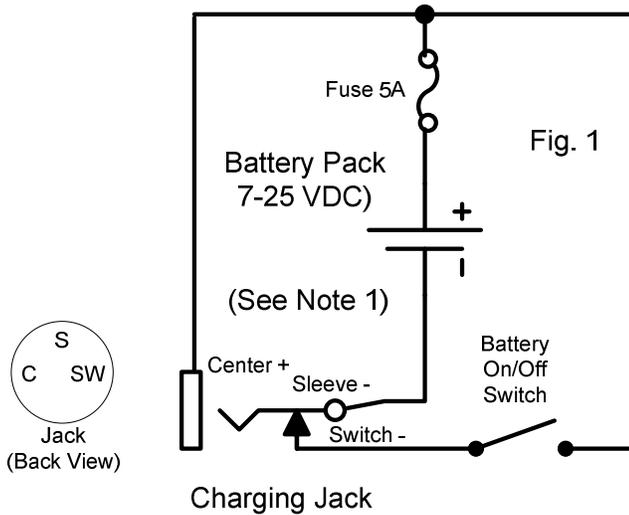
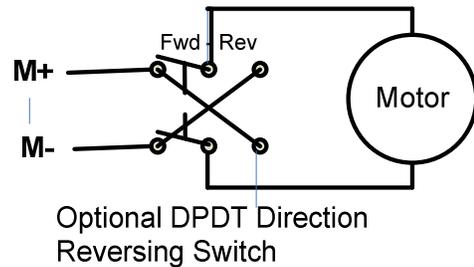
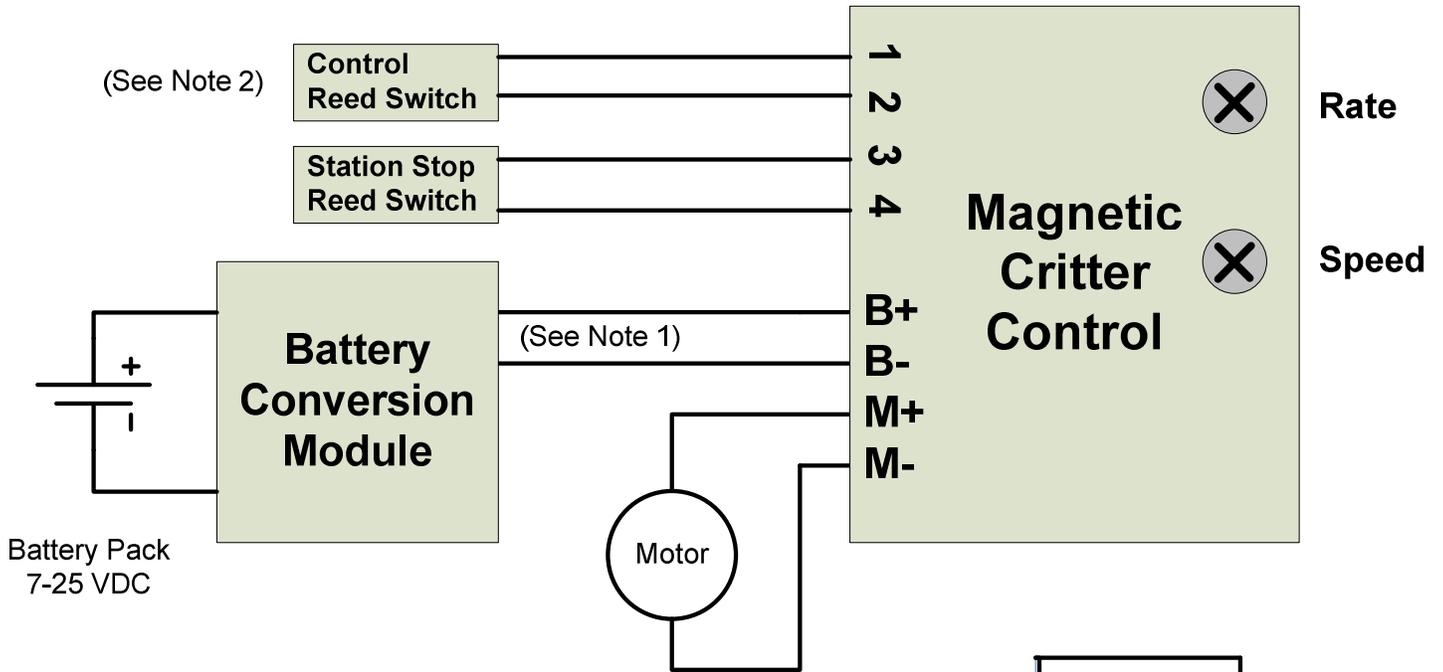
Battery Conversion Module; (built-in Power on/off Sw, Charging Jack, 5A fuse, power distribution)

Power On/Off Switch: Sub-Miniature w/short handle, SPDT (On-On), 3A, 28 VDC (drill 3/16" hole)

Charging Jack: 2.5mm, 5A, w/switch (drill 5/16" hole)

# Magnetic Criter Control

## Wiring Diagram



### 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 a Battery Conversion Module. Plugging in charger, isolates all electronics from the battery during charging.

2) A normally open push-button switch can also be used for hand operation without a magnet.