# A Beginners Guide to Installing DCC Decoders

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Copies of this presentation can be found at

http://www.markschutzer.com

# Clinic Overview

## Installing DCC decoders

- This clinic will show beginners how to install DCC decoders in both Steam and Diesel locomotives.

- After presenting some general decoder information I will guide you thorough a step by step installation example in both Steam and Diesel locomotives.

- Some advanced sound decoders will also be discussed

Electrical pickup review for steam locomotives

Typical Instructions

Motors

Decoder selection – size, type, and current rating

Lighting – Incandescent bulbs and LED's

Connectors and wiring techniques

Steam and Diesel installation examples
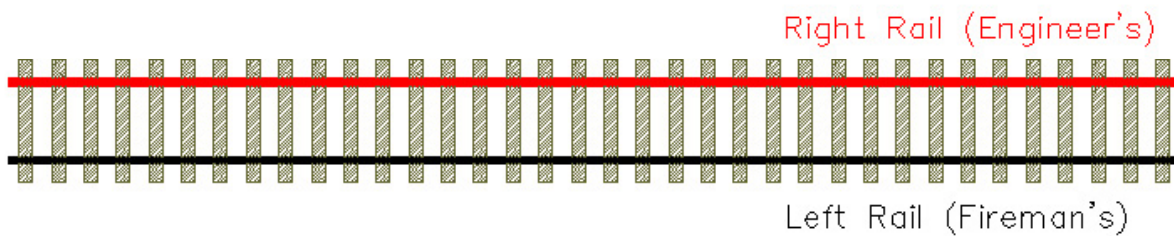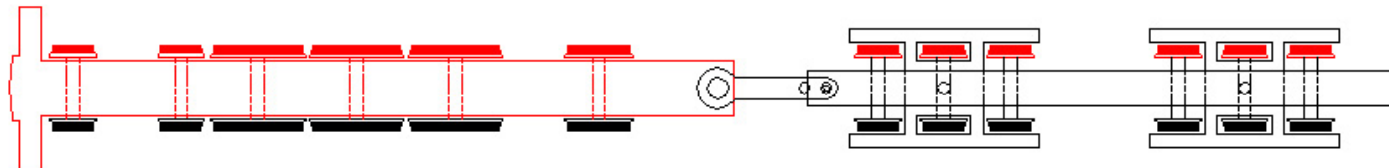
Advanced installations - Sound

More examples…

Sources

# Electrical Pickup – Steam Locomotives

Locomotive Frame is connected to right rail.

Tender Frame is connected to left rail.

Right Rail (Engineer's)

Left Rail (Fireman's)
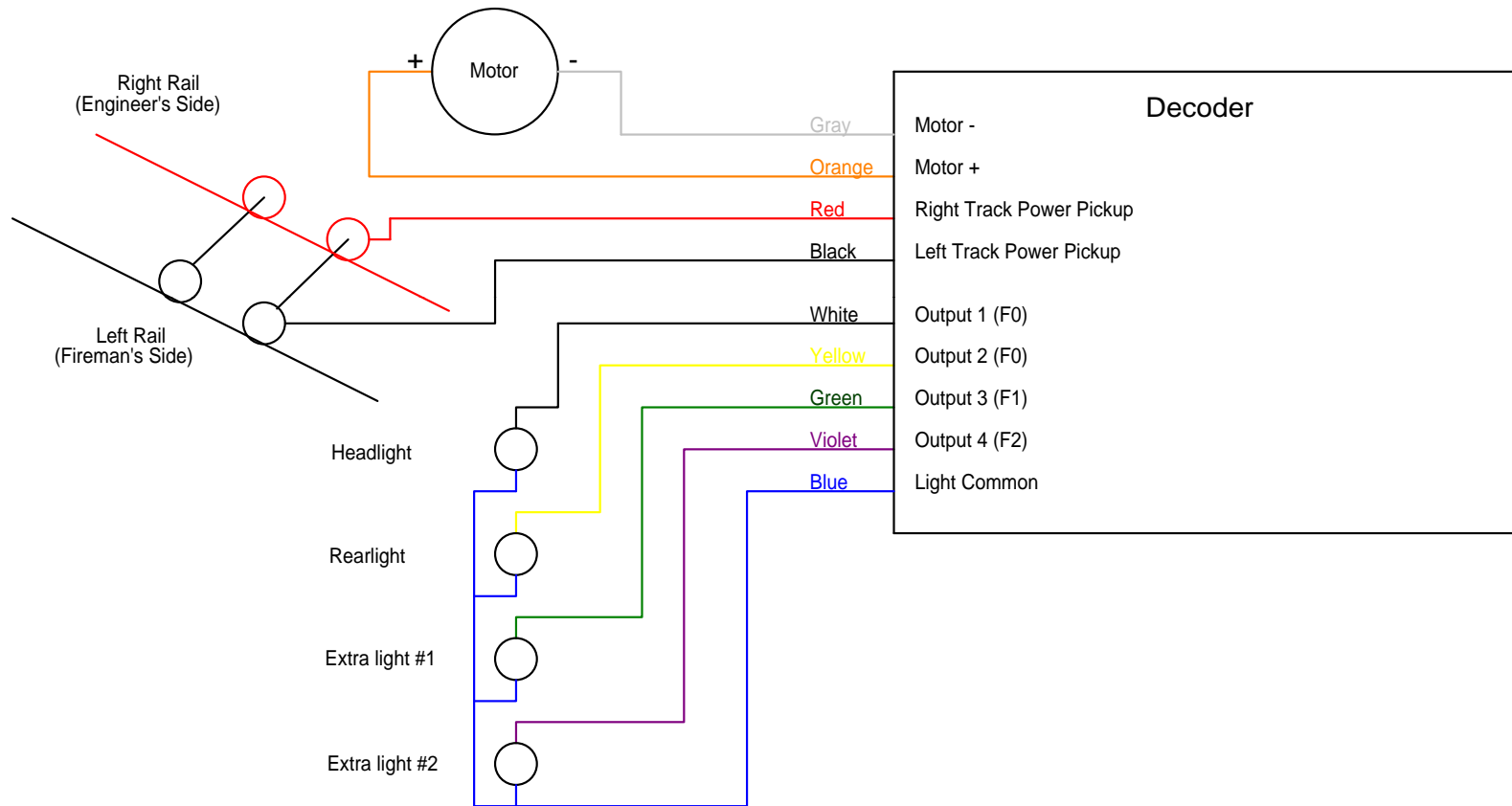
# Typical Instructions

## Generic Instructions

- Mount decoder
- Isolate motor contacts from track and frame
- Wire motor connections
  - Red wire to right rail, Orange wire to motor positive
  - Black wire to left rail, Grey wire to motor negative
- Replace 1.5 volt bulbs or add limiting resistors
- Wire lighting circuits
  - Blue wire is positive common for all function outputs
  - White wire is headlight output (F0 forward)
  - Yellow wire is rear light output (F0 reverse)
  - Green wire is F1 output (if supported)
  - Violet wire is F2 output (if supported)
- Test on the programming track
- Program as desired…

Right Rail
(Engineer's Side)

Left Rail
(Fireman's Side)

+ Motor -

| | Decoder |
|---|---|
| Gray | Motor - |
| Orange | Motor + |
| Red | Right Track Power Pickup |
| Black | Left Track Power Pickup |
| White | Output 1 (F0) |
| Yellow | Output 2 (F0) |
| Green | Output 3 (F1) |
| Violet | Output 4 (F2) |
| Blue | Light Common |

Headlight

Rearlight

Extra light #1

Extra light #2

# Motors – Early Brass Locos

## Original Motors

- Most early motors are open frame types
- Poor slow speed operation
- High starting voltage and current
- Not very efficient
- High slip and stall currents
- Require a higher rated decoder, costing more money $$$
- Sometimes require work to isolate from frame

- Replacement strongly recommended!

## Some typical open frame motor numbers

| Motor Type Open Frame KTM | Free Running Current (Amps) 12 volts | Typical loaded Current (Amps) 12 volts | Stall Current (Amps) 12 volts |
|---|---|---|---|
| Small | 0.6 | 1.0 or more | 2.0 |
| Medium | 0.6 | 1.2 or more | 2.9 – 3.0 |
| Large | 0.7 | 1.5 or more | > 3.5 |
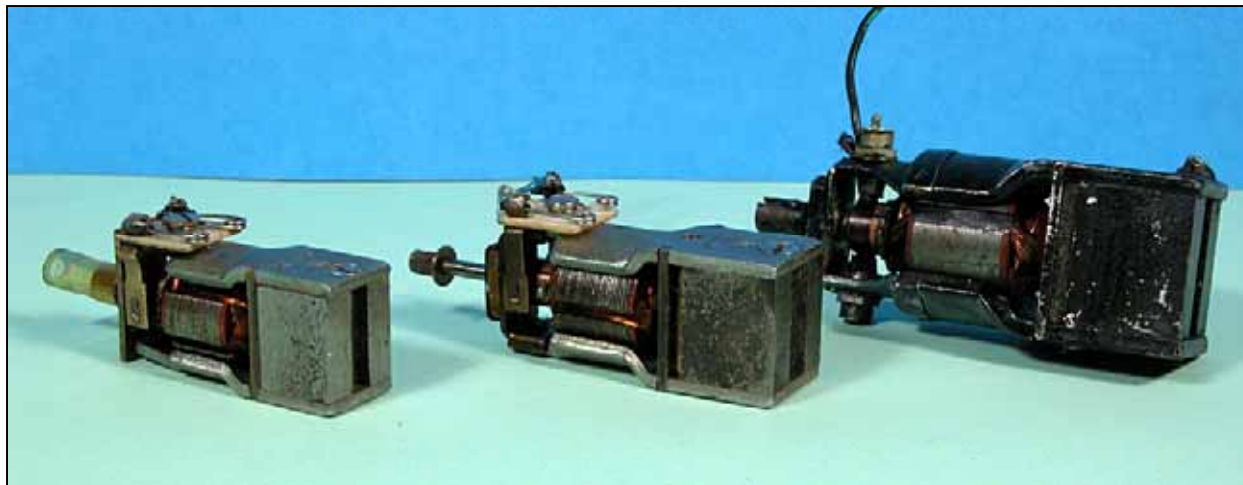
# Can Motors

## Can motor advantages

- More efficient, much lower current draw
- Most are skew wound for very good slow speed performance
- Slower starting speeds and excellent slow speed torque
- Better slow speed performance allows lower gearbox ratios to be used reducing the top end noise.
- DCC friendly; isolated terminals, and most HO sized motors have stall currents under or about 1 amp.

# Can Motors

Some typical can motor numbers

| Motor Type NWSL | Free Running Current (Amps) 12 volts | Max. Continuous Current (Amps) 12 volts | Stall Current (Amps) 12 volts | Stall Torque (Oz.-in.) |
|---|---|---|---|---|
| 12270-9 | 0.08 | 0.25 | 0.54 | 0.61 |
| 16307-9 | 0.05 | 0.34 | 0.95 | 0.79 |
| 18367-9 | 0.19 | 0.40 | 1.20 | 2.50 |
| 20324-9 | 0.05 | 0.36 | 0.90 | 1.40 |

N scale decoders okay for all of these!

- 1 amp continuous rated

## Choices, choices, choices…

- Decoder rating should be in excess of full slip current at 12 volts
- Sized to fit locomotive
- Feature selection
  - Number of lighting outputs
  - Silent running
  - Torque compensation
  - Back EMF; also known as load compensation
  - Advanced consisting support
  - Automation features
  - Sound, Tsunami, Micro Tsunami
- Choose your favorite supplier
- Lots of decoders rated in the 1.0 to 1.3 amp range

## Lighting

- Function outputs are used for lights
- Function 0 is direction sensitive and has 2 outputs associated with it by default. Controls headlight and back up light.
- Almost all decoders have at least 2 function outputs, many have 4 outputs or more.
- Most decoders support a variety of special lighting effects.
- Decoders supply 12.5 volts to the lights
- Modify existing bulbs, several options…
  - Add resistor in line with 1.5 volt bulbs
  - Replace 1.5 volt bulbs with 14 volt bulbs
  - Replace 1.5 volt bulb with sunny white LED and 1k resistor
- Use a spare lighting output to provide a firebox flickering effect.

## Lamps and Resistors

| Lamp Type | Current | Resistor |
|---|---|---|
| 12 to 14 volt bulb | < 50 mA<br>> 50 mA | None<br>22 ohm, ¼ Watt |
| 1.5 volt bulb | 15 mA<br>30 mA | 820 ohm, ¼ Watt<br>390 ohm, ½ Watt |
| White LED | 10 mA | 1000 ohm, ¼ Watt |

## Wiring techniques

- Install decoder so that boiler can be easily removed
    - Use connectors on wires inside of boiler (headlight)
    - If decoder is captive in boiler use connectors for everything
    - Use connectors for all boiler to tender wiring
- Solder all wire connections
    - Use a water, or Rosin based flux  (Not acid based!)
    - Clean off flux with water, or isopropyl alcohol
- Use heat shrink tubing on all exposed connections to keep the wiring both insulated and neat.  Get several different sizes.

## Connectors

- Available from Miniatronics
  - Expensive, $10 dollars for a pair of 2 pin connector sets
- Easy to make from low cost pin strips and sockets
  - Several sizes available
  - Pin spacings of 0.1 inch, 2 mm, 0.05 inches
  - 40 pin strips are best cost value, about $2 dollars each
  - Cut to the number of pins needed
- Solder wire to pin leads and insulate with heat shrink tubing
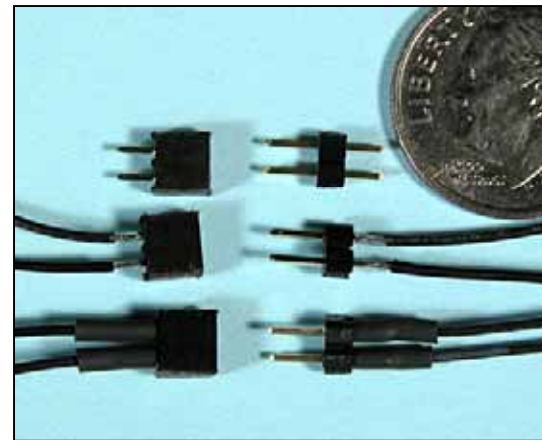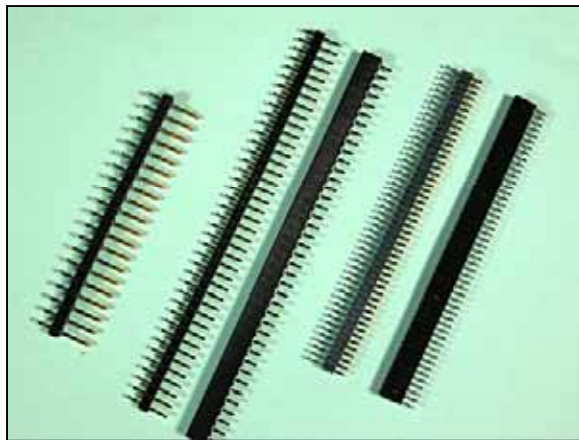
# Steam Installation Example

## Decoder Installation – Max Gray, Ten Wheeler

## Removing the boiler

- The boiler is usually secured to the frame with three screws.

- The front screw usually also secures the pilot trucks in place.

- The two rear screws are either under the cab, or in this case in the back wall of the cab.

- Remove the two cab screws and the pilot truck mounting stud to loosen the boiler.
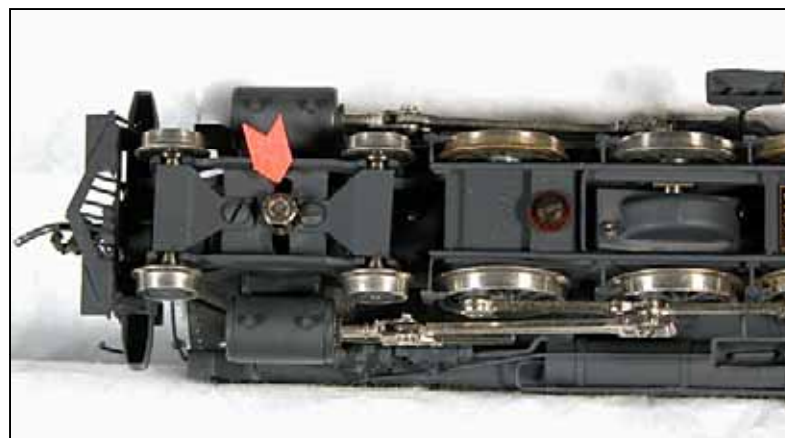
## Boiler Removed

- Note motor wiring, identify right and left rail connections.

- Note headlight connector.
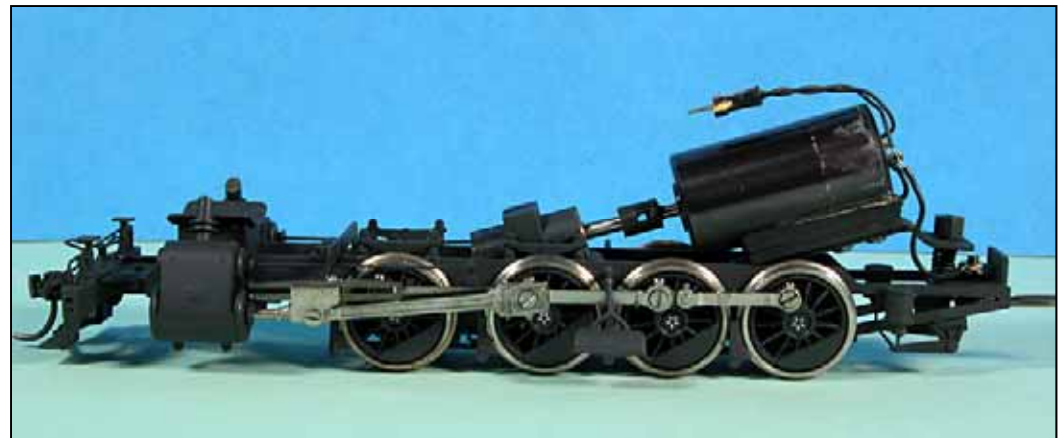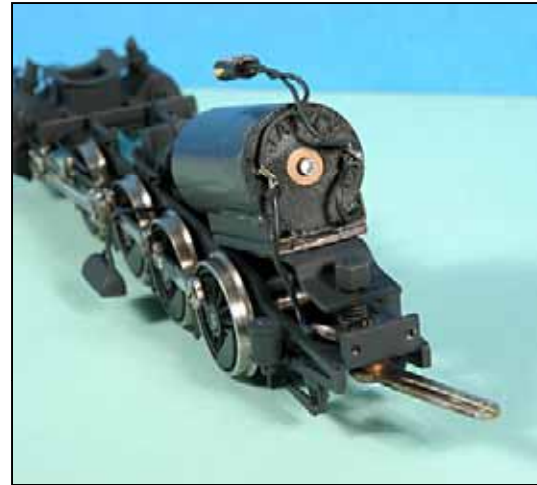
## Test fit selected decoder

- Decoder N14SR

- Test fit decoder to determine ideal position.

- Usually place decoder on top of motor.

- With decoder in place verify boiler clearance, adjust location as needed.
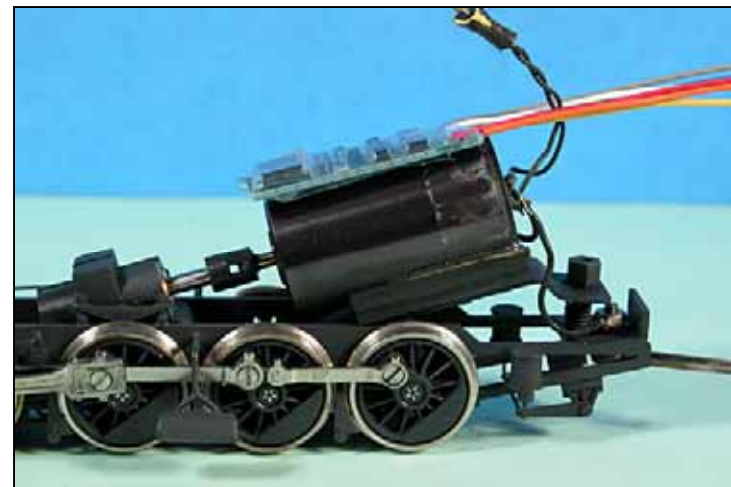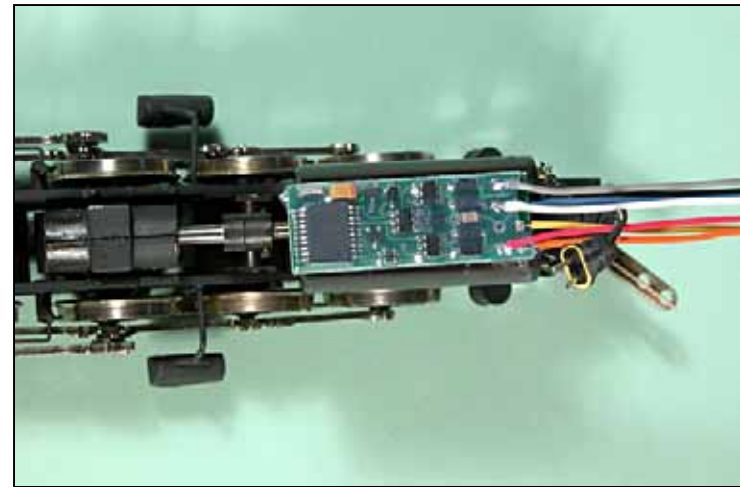
## Preparing Decoder

- Original decoder shown to right.

- Add resistor to headlight connector.

- Solder headlight connector to decoder.

- Solder firebox flicker light to decoder.

- Use heat shrink tubing to insulate connections.

- Heat shrink decoder (if not already)
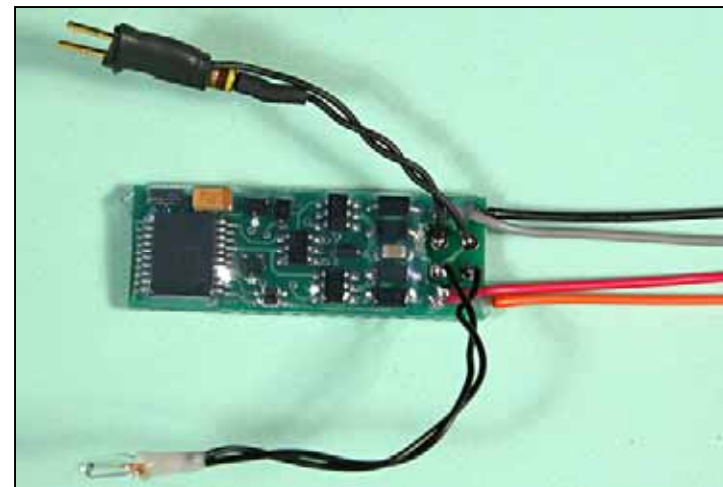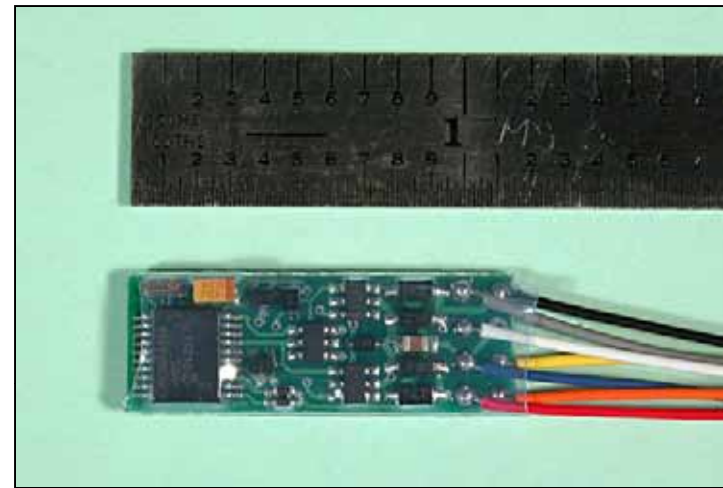
## Wiring Motor Connections

- Reference original motor connections.
- Connect red wire to right side pickup (locomotive frame).
- Connect orange wire to the motor terminal that was connected to the right side rail (frame connection).
- Connect black wire to the tender drawbar.
- Connect grey wire to the motor terminal that was connected to the tender drawbar.
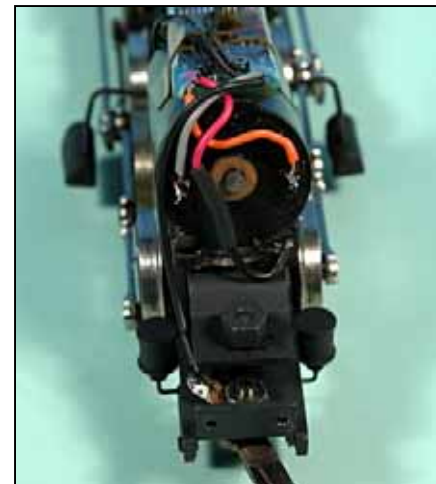
# Installing

Secure decoder with Kapton tape or electrical tape.

Place firebox flicker light in position.

Test first on programming track, and then on main.

Reinstall boiler to complete.

Recheck operation.
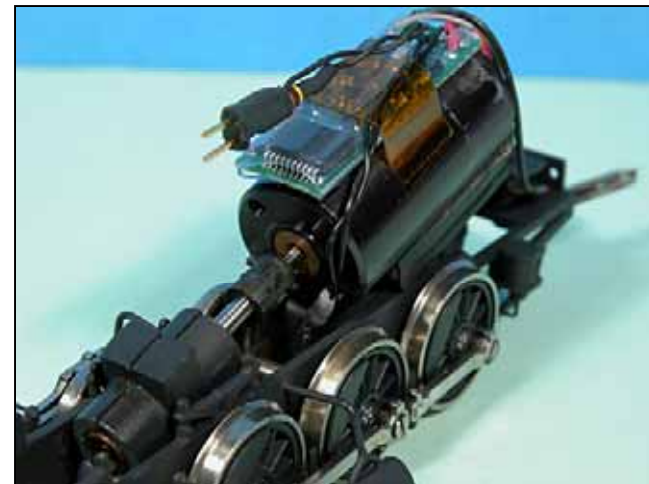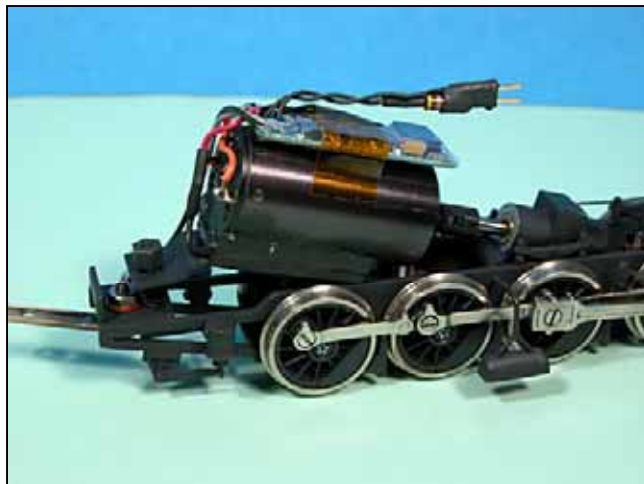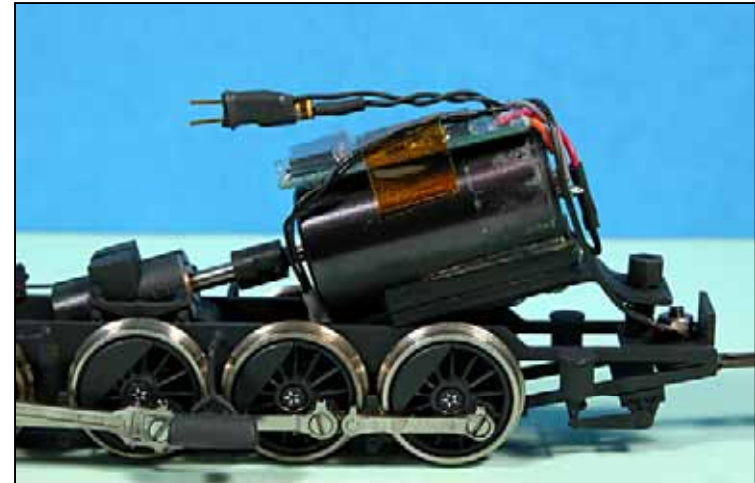
# Diesel Installation Example

Decoder Installation – Stewart – F7

# Shell Removal

## Removing the shell

- Remove the front coupler retainer and remove the front coupler.

- Gently pry the shell apart along the bottom and remove the shell.

## Wiring Board Removal

- Remove 2 screws, unplug all the connectors
- Slip motor connections from underneath retainer wires
- Remove board and discard
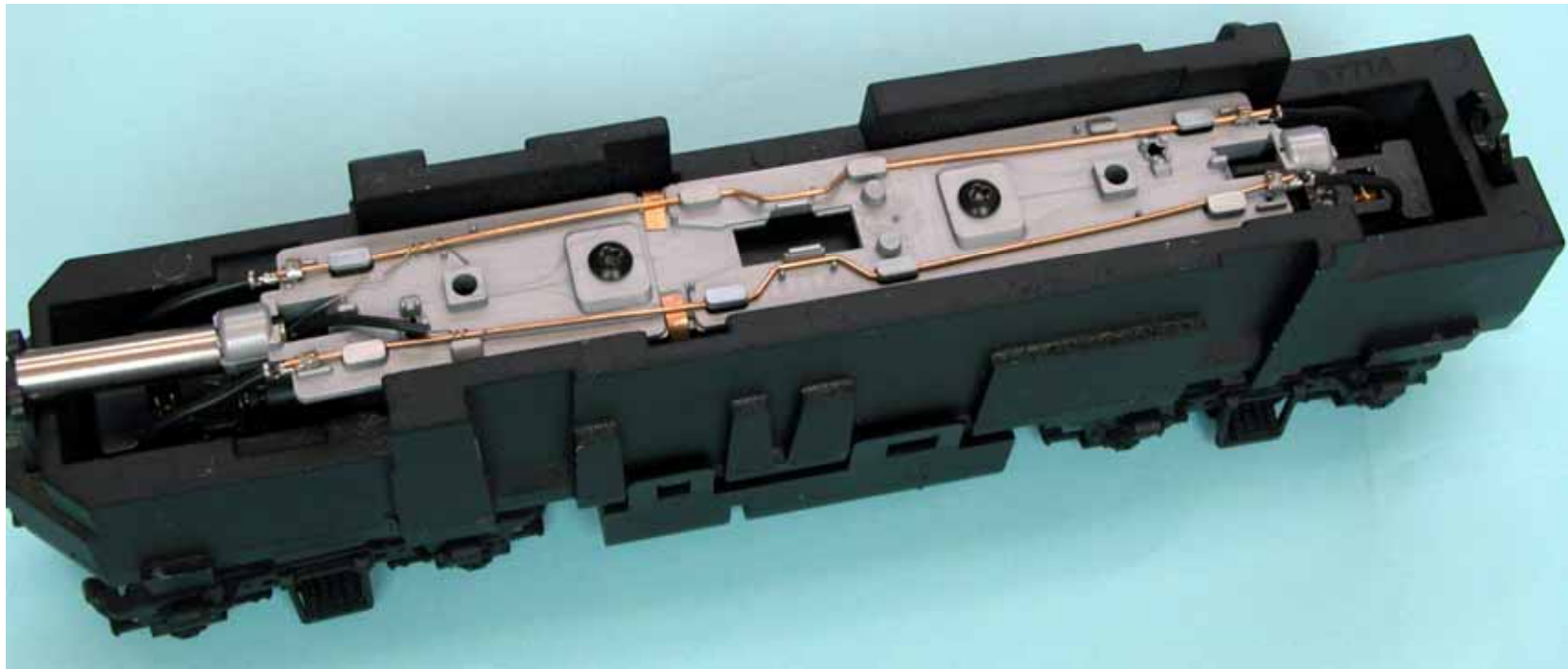
## Wiring Board Removed
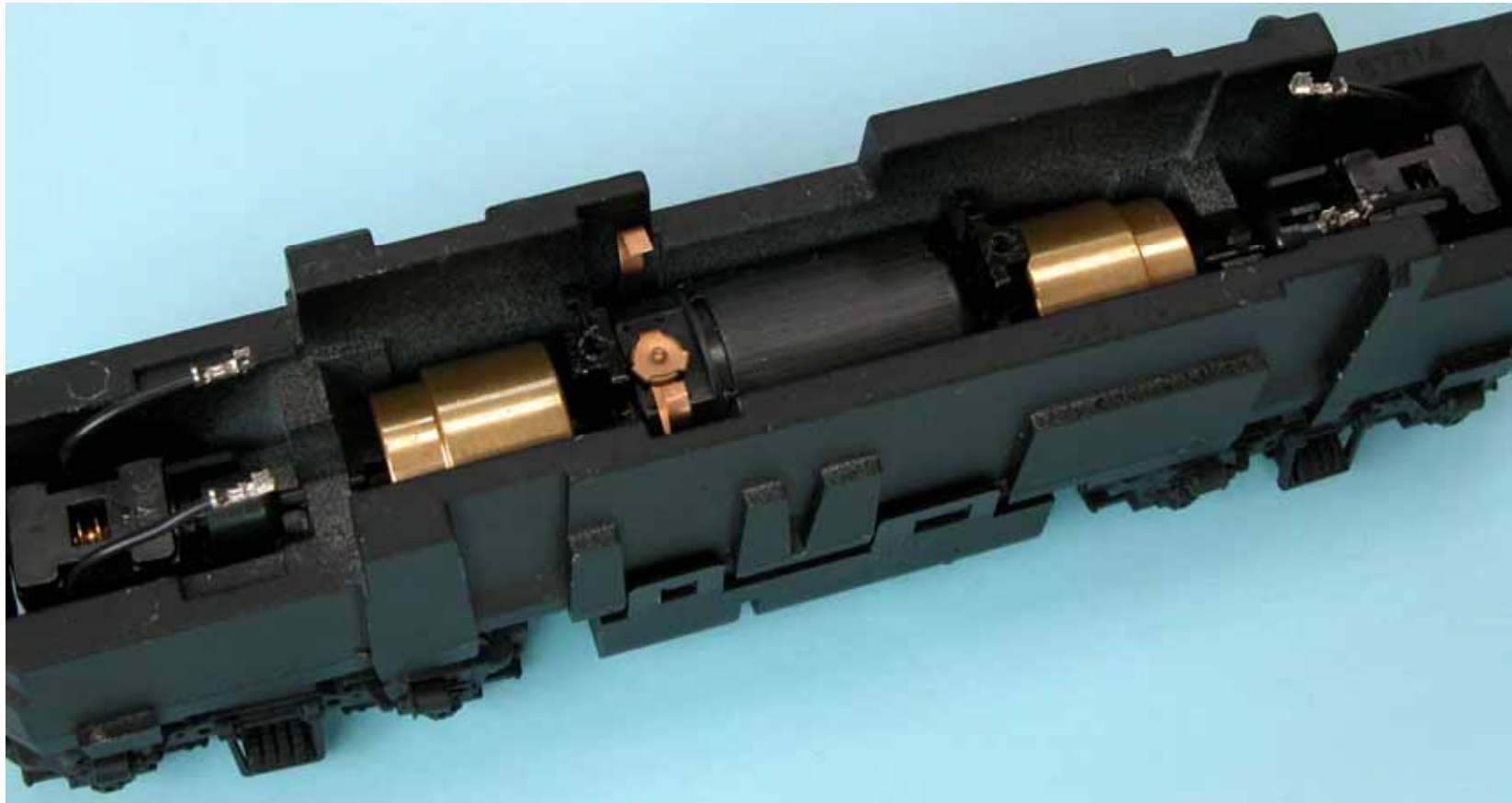
## NCE DASR

**Atlas  GP38, GP40, RS1/2/3, C424/5, GP7, RSD4/5/12, C30-7, U23B, U33/36C
Athearn "Genesis" series locomotives; F7, F3, SD70, SD75, SD80, etc
Kato GP35, SD40, C44-9W  Stewart AS16, F3A, F3B, F7A, F7B, F9A, F9B, U25B**

### This is an EPF (extended packet format) decoder supporting:

- ✓ Silent Running $^{TM}$ motor drive
- ✓ Improved DC operation (with lighting effects)
- ✓ Torque Compensation (dither)  for ultra smooth low speed performance
- ✓ Programmable Start, Mid and Maximum speed works for all speed modes
- ✓ Motor rating 1.3 Amp continuous, 2 Amp peak (stall)
- ✓ All five function outputs have lighting effects generators
- ✓ Select from 15 different lighting effects (Mars, strobes, beacon, flicker, etc)
- ✓ Lighting outputs can be mapped to different functions
- ✓ Uploadable speed table interpolated to 128 speed steps
- ✓ Decoder assisted consisting
- ✓ Support for all forms of DCC programming
- ✓ Decoder programming lock mechanism
- ✓ Brake on DC feature assists automatic train control

# Decoder Selection

## Connection diagram

- NCE DASR
- Connection diagram shown below.



DA-SR decoder connection diagram
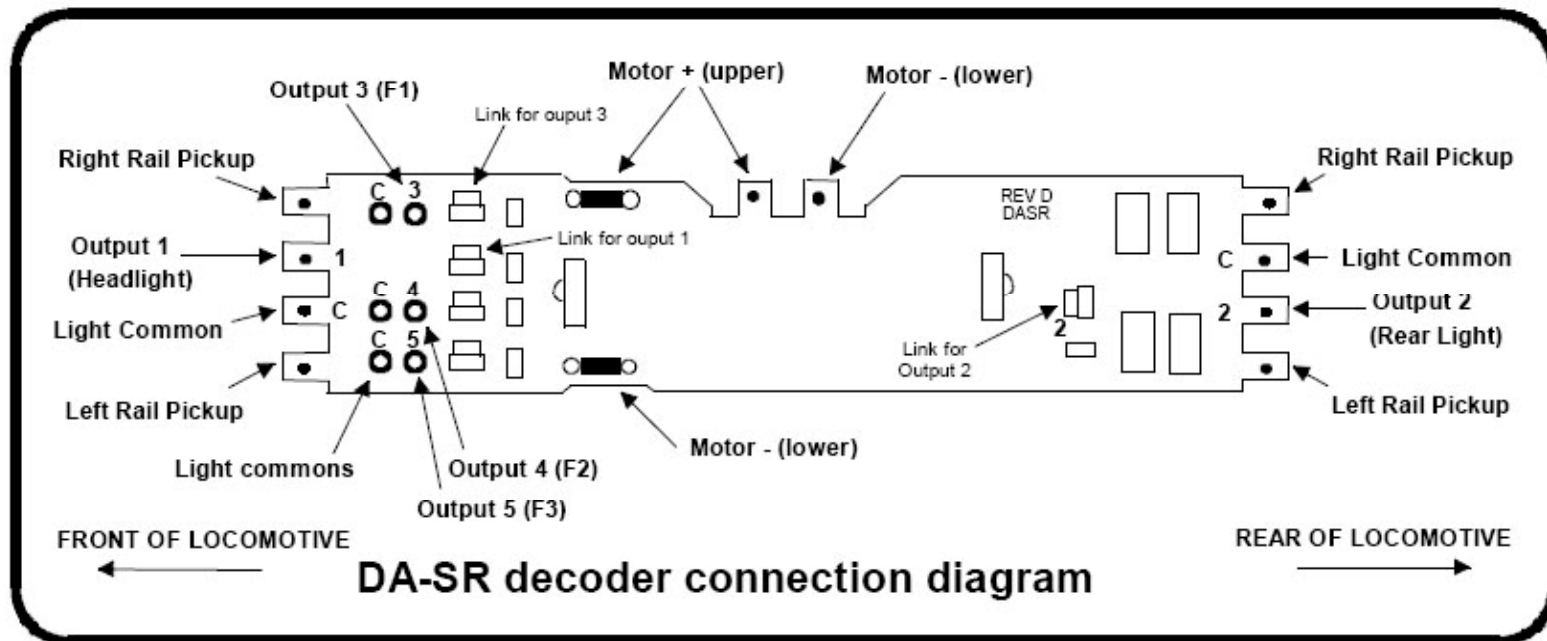
# Decoder Fitting

## Fit selected decoder

- Decoder NCE DASR, or any Atlas form factor decoder
- Use original screws to secure
- Solder motor tabs to traces on board.
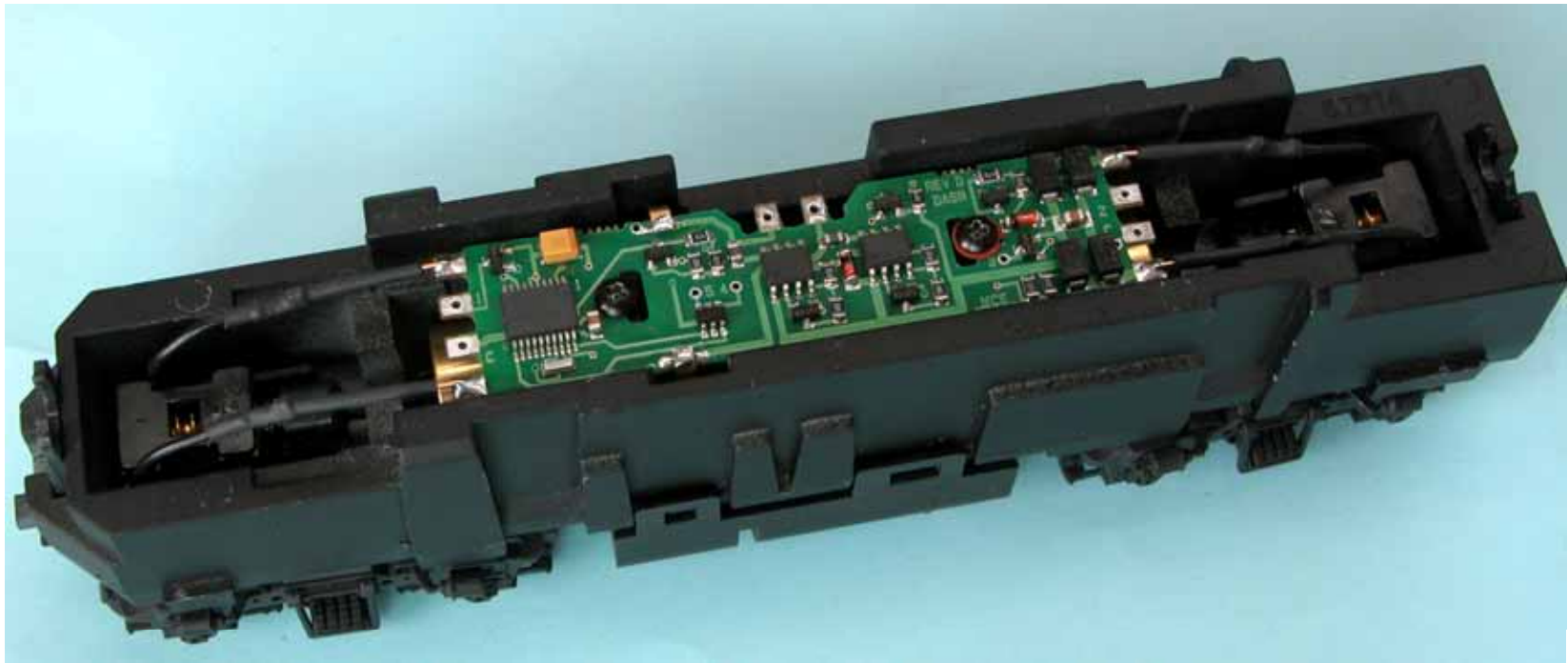- Solder wire extensions to truck pickup wires
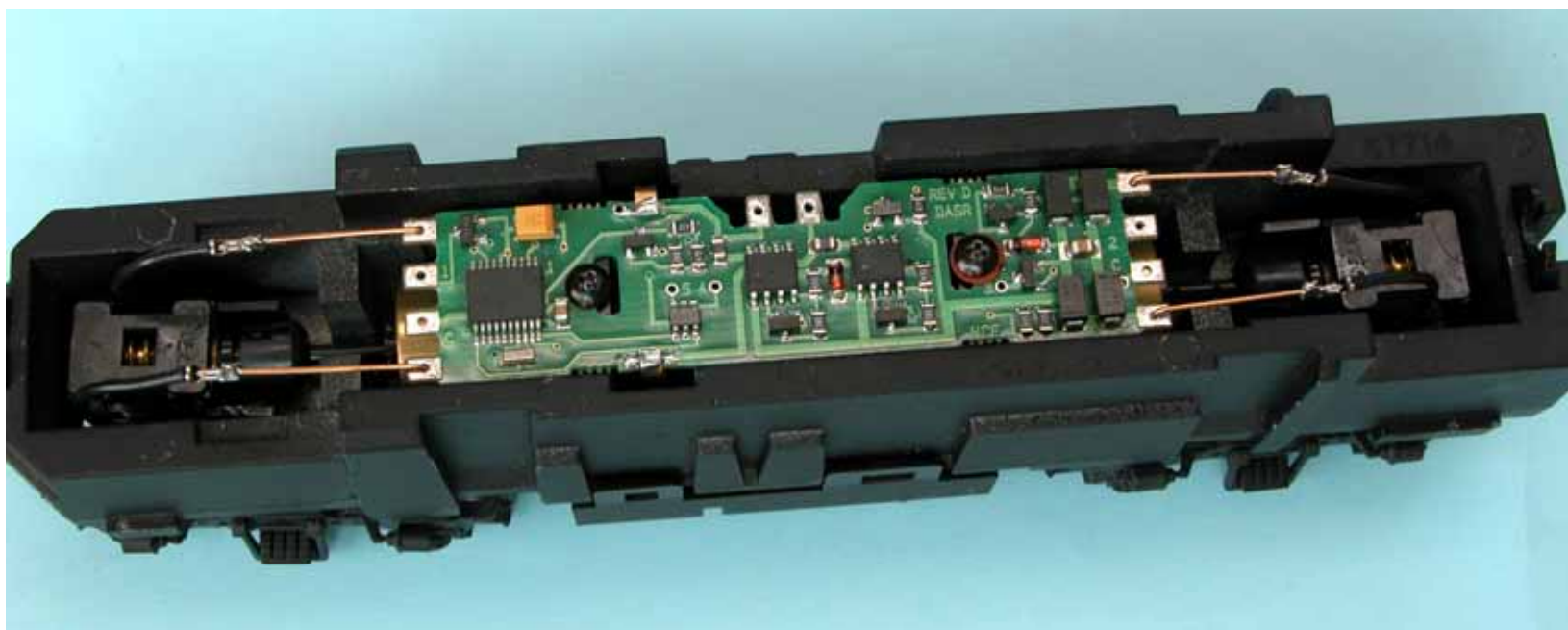
# Decoder Fitting

## Fitting decoder

- Apply heat shrink tubing over exposed wires before soldering
- Solder pickup wire connections in place

## Prepare lighting

- A 3mm golden white LED will be used for the upper headlight. Solder a 1000 ohm 1/4W limiting resistor in line as shown.

- For the lower headlight a 0603 surface mount golden white LED will be used. Shown on a small circuit board with 1000 ohm limiting resistor.

# Lighting

## Upper headlight

- Solder 3mm LED and resistor to the pads on the end of the decoder as shown.
- Anode, or positive side of LED goes to the common pad (C).
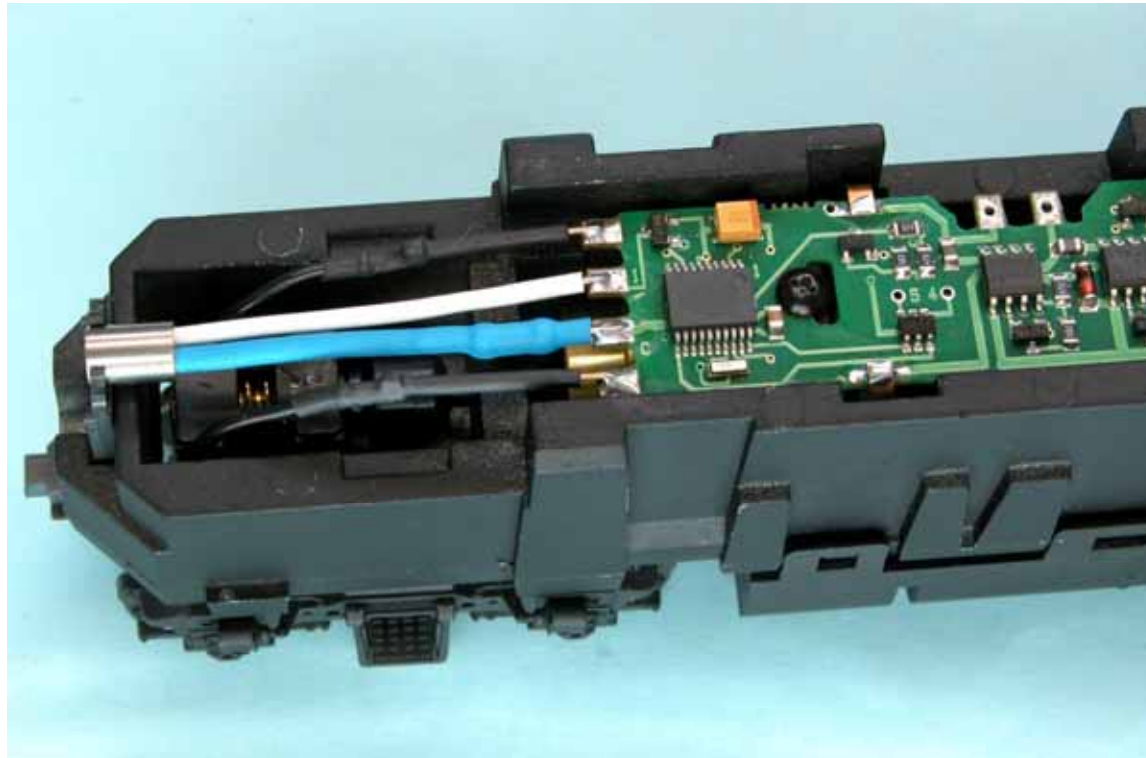
# Lighting

## Lower headlight

- Secure circuit board in place with double sided foam tape
- Run wires to decoder output #3 and the other common terminal
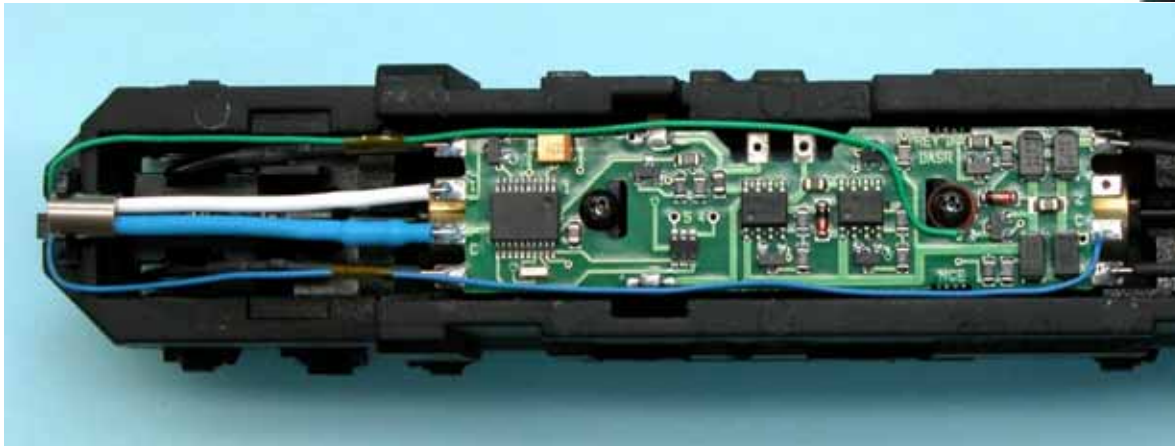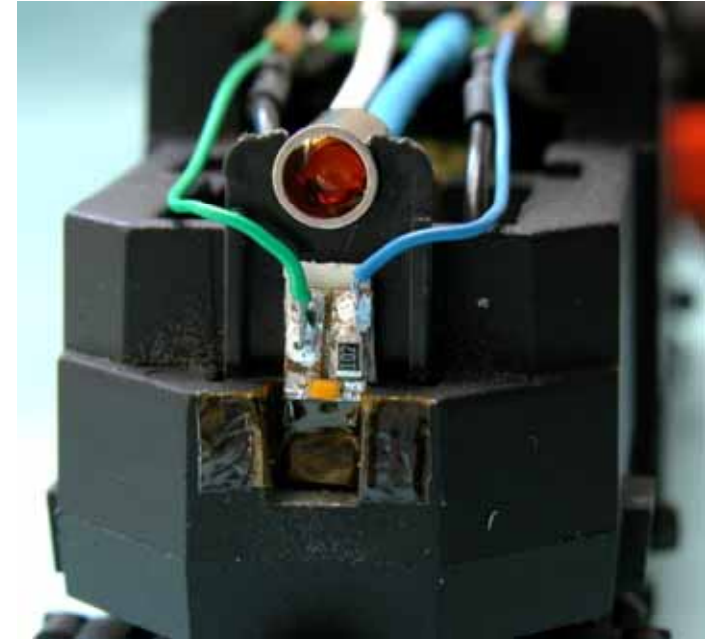
- Reinstall the shell, program, and enjoy your new DCC locomotive.
- LED headlights in the finished installation shown below…

# Sound in Steam Locomotives

## Sound Decoders

- Sound decoders, Soundtraxx Tsunami, Best in class sound with silent BEMF motor control.
- Installation the same as a regular decoder but with more wires
  - Two additional wires to connect to speaker
  - One wire for optional synchronization cam
- Speaker usually mounted in tender
  - Requires holes to be drilled in tender frame or body
  - Tender shell can act as the speaker enclosure
  - Two wire connector between locomotive and tender

- Optimal chuff synchronization requires a sound cam
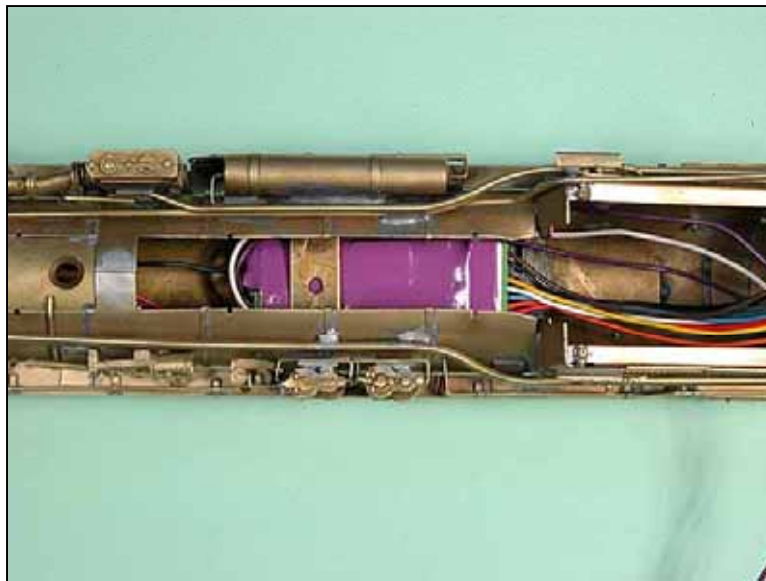
## Tsunami in Boiler



- Decoder tucked up above boiler weight
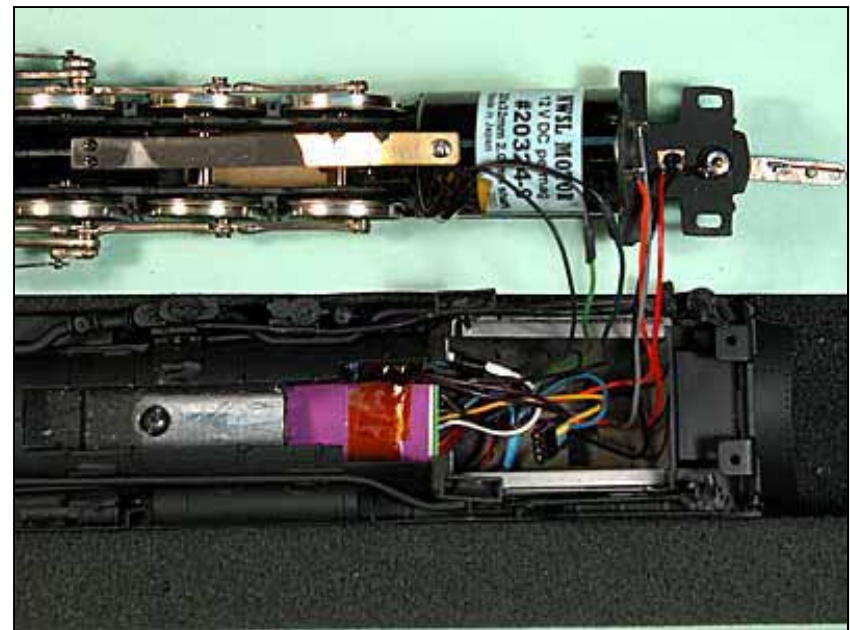
## Micro Tsunami in a Consolidation

- Decoder tucked up above boiler weight
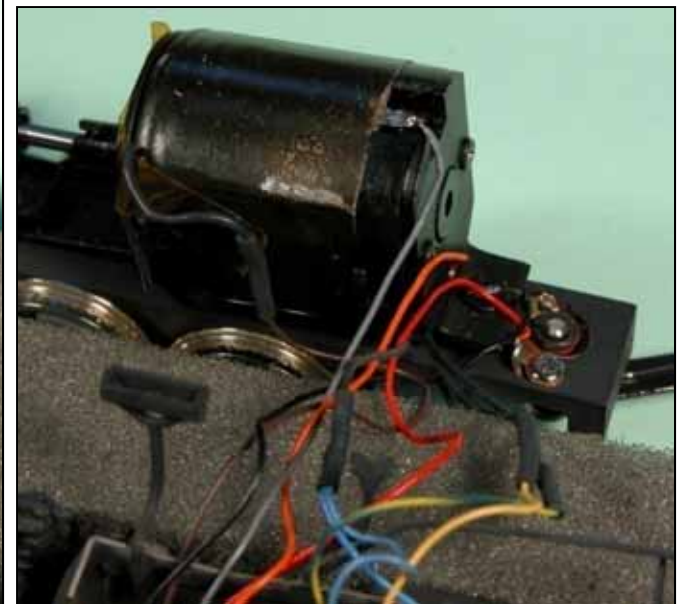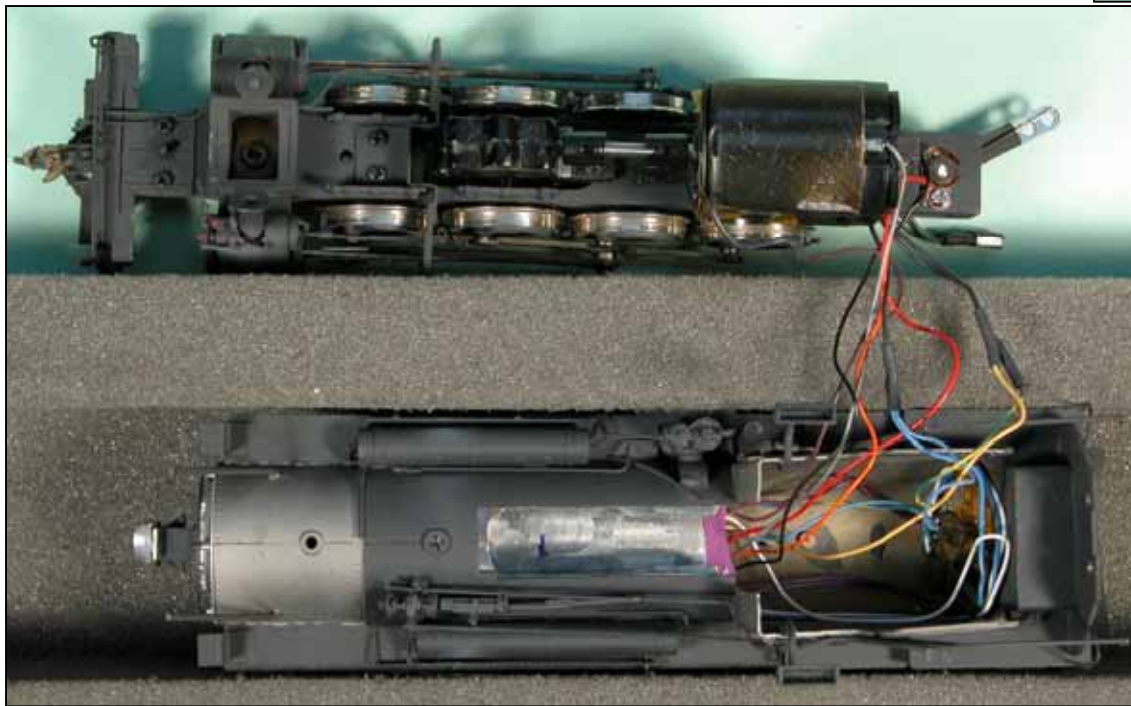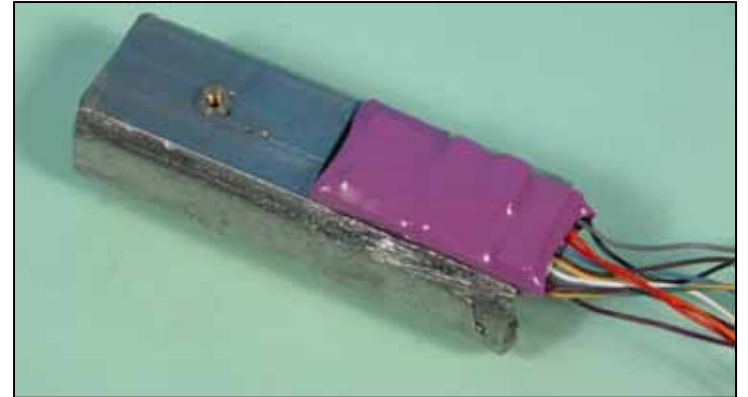
## Micro Tsunami in a Consolidation

- Keep alive caps in tender



- Speaker in smoke box

## Additional Sound work

- Sound cams



- Sound cam installation
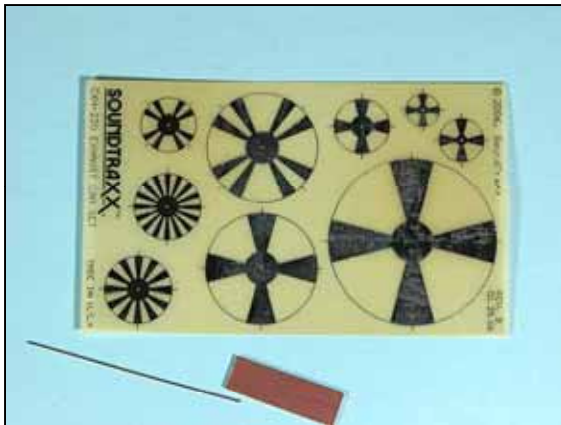- Make wiper from small circuit board, use phosphor bronze wire for contact
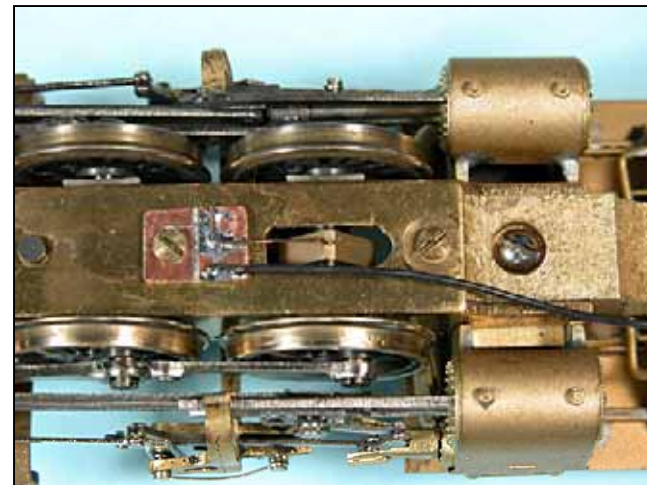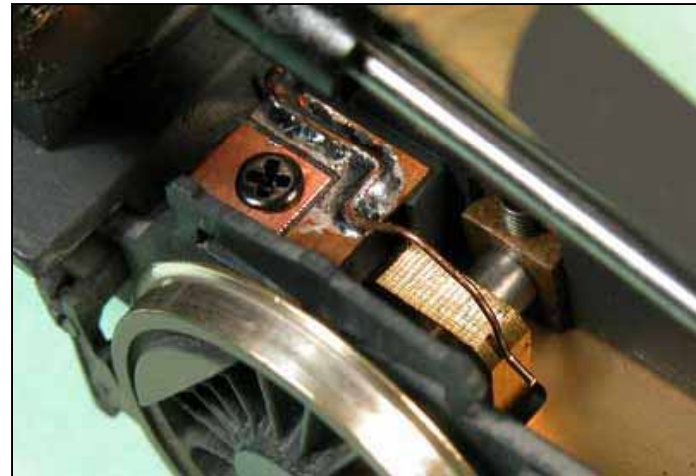
# Sound Installation

## Other Sound Cam options

- Soundtraxx printed circuit board cams





Cam installed

- Grizzly Mountain Engineering Cams, split cams that attached with conductive Epoxy, wiper kits also available

- No driver pulling required with these cams



Wiper Mounting Kit

## Speaker installation

- Usually installed in tender



- Requires drilling hole pattern in tender for sound outlet

- Use the biggest speaker that will fit!
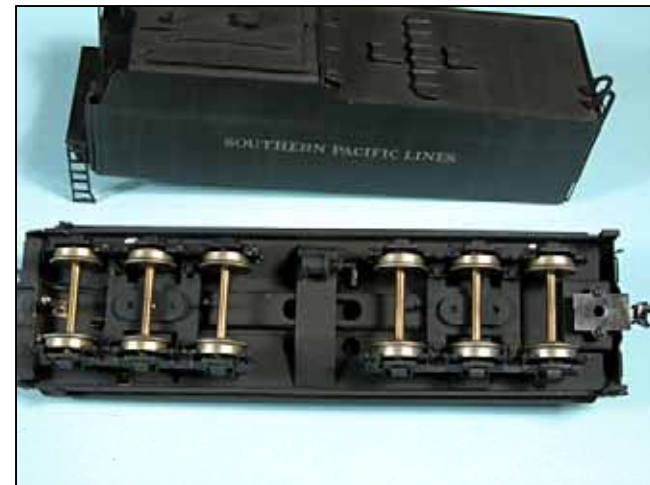
# Speakers

- Another example.





- Small speakers allow for mounting in the boiler.

# Sound in Diesel Locomotives

## Sound Decoders

- Sound decoders, Soundtraxx Tsunami, QSI, MRC, Digitrax, lots of choices. Tsunami and QSI are the best quality
- Installation the same as a regular decoder but with more wires
  - Two additional wires to connect to speaker
- Speaker usually requires some frame modifications
  - Speaker enclosure is Very important for proper sound levels

## Tsunami installation in a Proto 2k

- Original light board removed and prepared for decoder installation

## Test fitting the speaker

- Speaker mounting shown
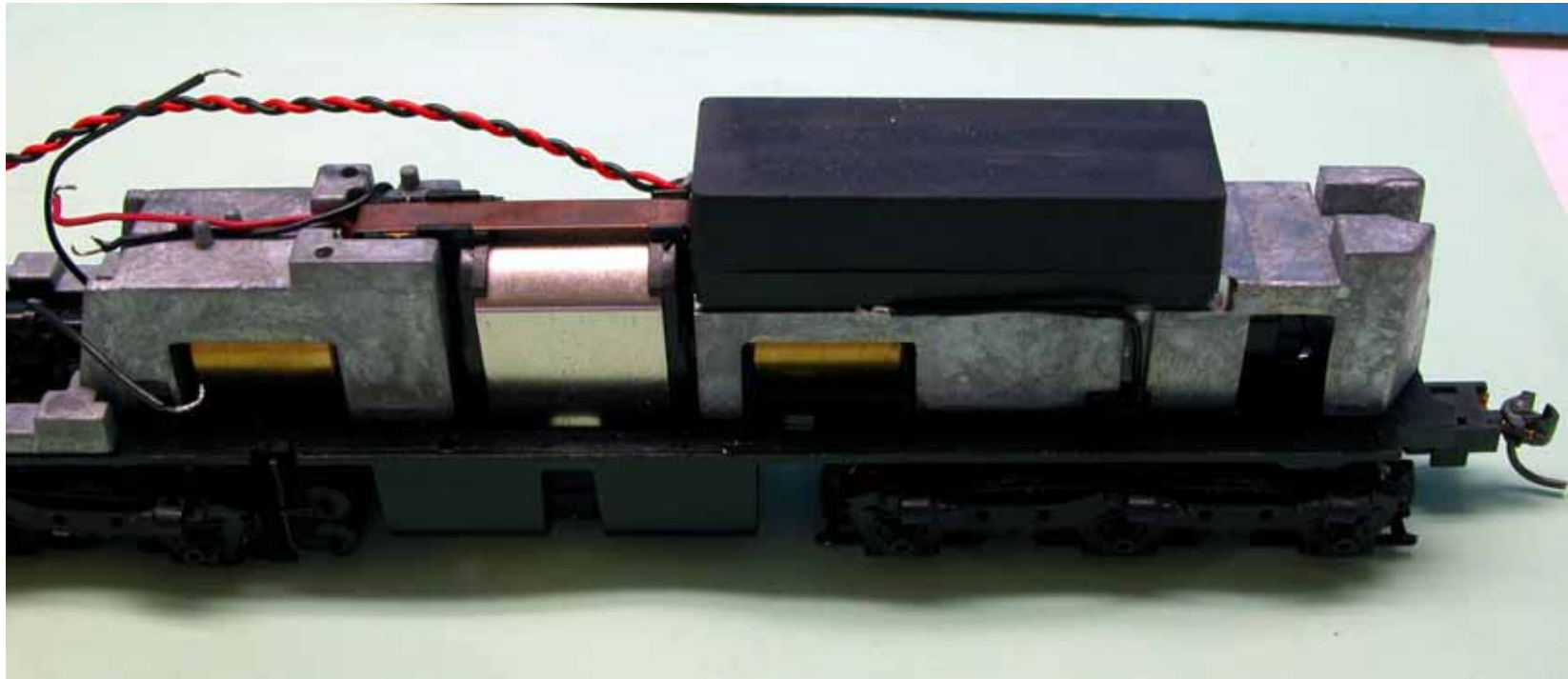
# Sound in Diesel Locomotives

## Finished installation

- Decoder, speaker, and lights installed
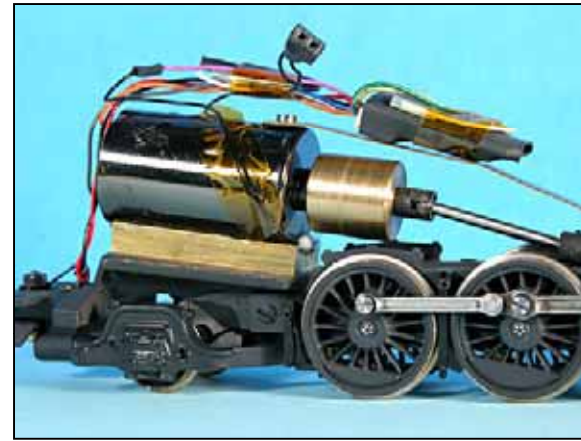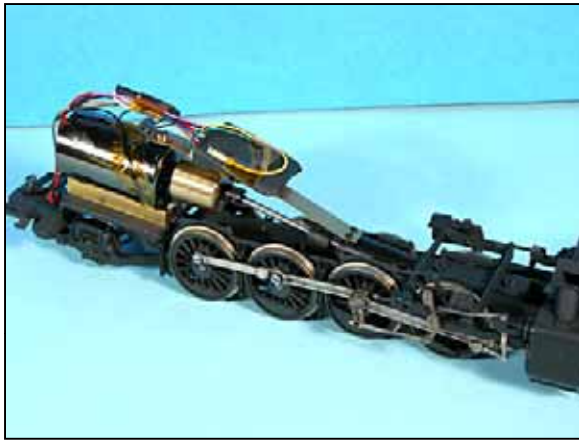
# More Steam Examples

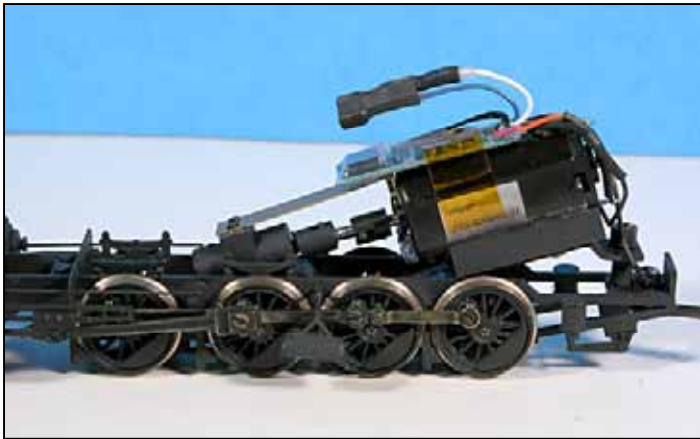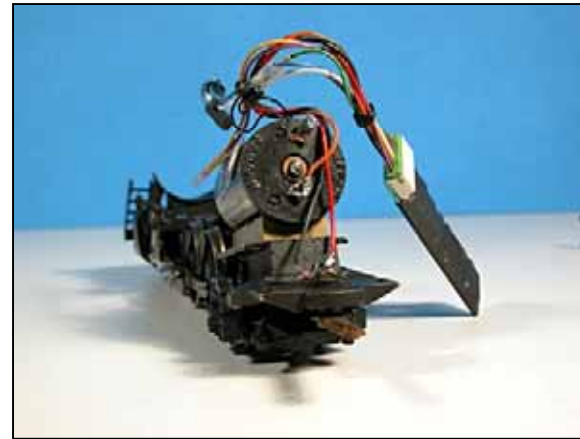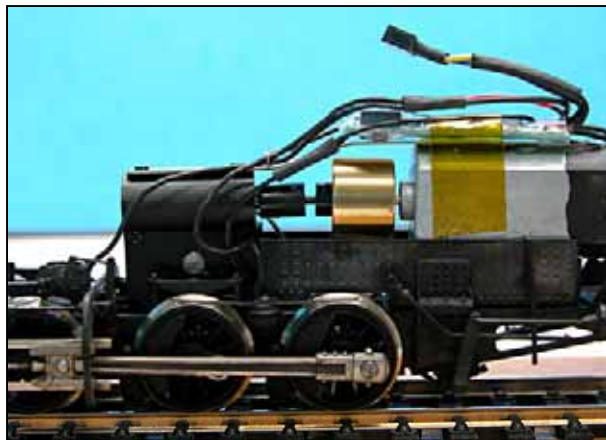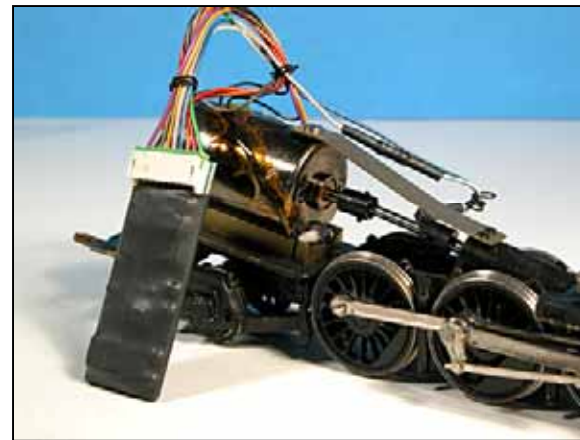## Balboa MT-4, Lenz Gold decoder
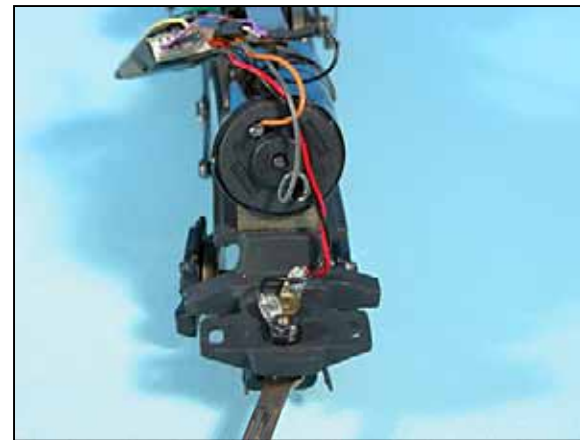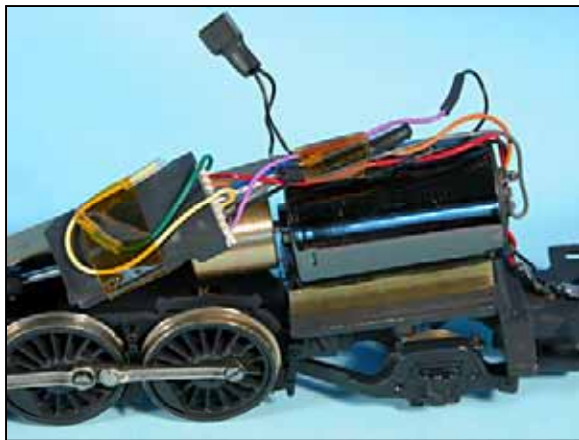
Max Grey TW-8, N14SR decoder



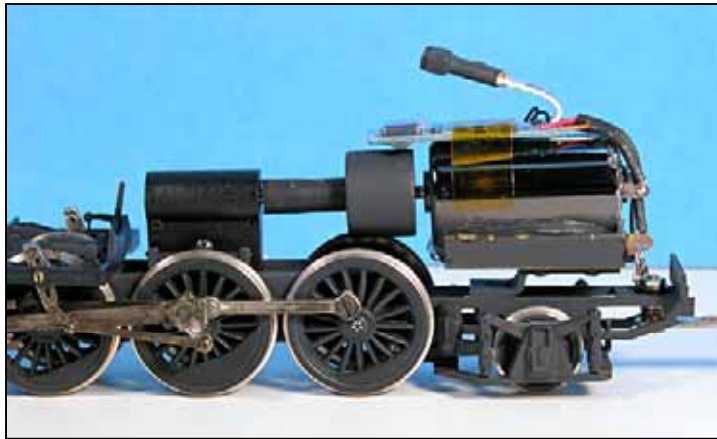Balboa P-10 #2486, D13SRJ



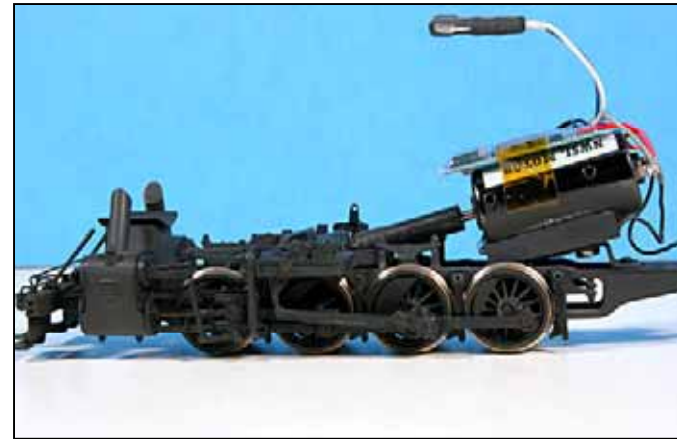Westside 0-6-0T, N14SR decoder



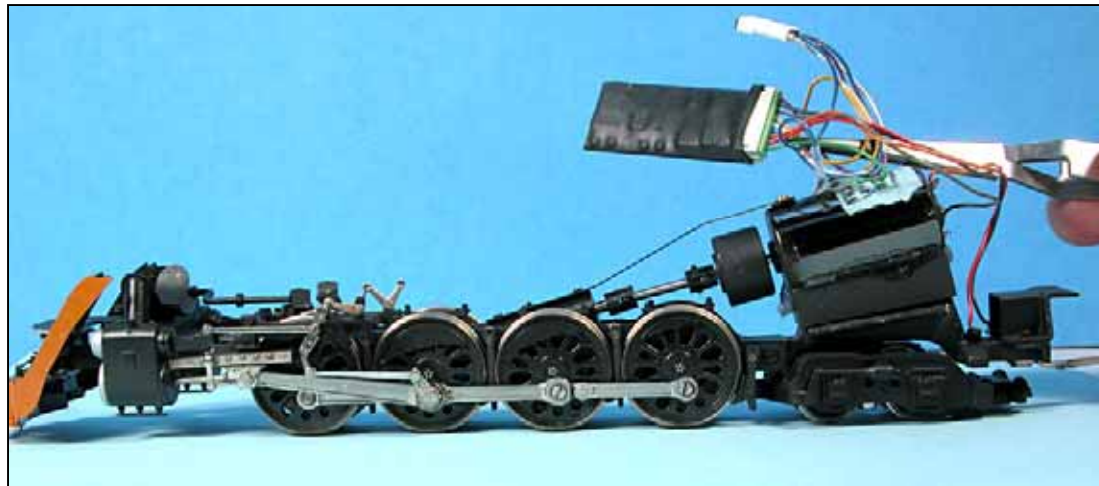Balboa P-10 #2486, D13SRJ

## Tenshodo P-5, N14SR decoder

## Balboa SE-4, N14SR decoder

## Balboa GS-4, D13SRJ decoder

# Sources

## Digi-Key Electronics - www.digikey.com

- Resistors
- Heat Shrink tubing
  - Various different sizes, 3/32", 1/16", 1/8", 3/16", etc.
- Pin strip headers / sockets
  - 40 pin 2mm header strip, part number S5800-40-ND
  - 40 pin 2mm socket strip, part number S5751-40-ND
- Kapton tape
- Speakers

## Miniatronics - www.miniatronics.com

- Miniature connectors
- Various miniature bulbs, 1.5 volt, 12 volt, and 14 volt flavors

## Richmond Controls - www.richmondcontrols.com

- Sunny white and golden white LED's, 3mm and 5mm diameter

# Sources

## Grizzly Mountain Engineering – www.g-m-e.com

- Sound cams
- Sound pickup wipers
- 2 Pin strip headers / sockets
- Speakers

## Soundtraxx - www.soundtraxx.com

- Decoders, Tsunami, Micro Tsunami
- PC board sound cams
- Speakers

# Questions?