Installing a DCC decoder in an older (non-DCC) KATO EMD F7 N scale loco

applies to F7A, F7B, F3A & F3B units

Revision 1.5, March 2015

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Introduction

KATO, Inc. has been making finely detailed and great running model trains for decades. They were designed to run on traditional direct current (DC) powered layouts, which pick up power from the tracks and pass it directly to the loco's motor and lights. The speed of the loco (and brightness of its lights) varies as the voltage applied to the track is changed – affecting all the locos simultaneously.

In the early 1980s Digital Command Control was introduced, which uses a constant AC voltage applied to the track along with encoded control signals. DCC allows for individual control of a locomotive by way of a decoder board installed in each loco. The board intercepts the power from the track and processes it according to the control signals intended for that loco, controlling its speed and lighting individually.

These advantages and the popularity of DCC have prompted manufacturers to redesign the innards of their locomotives to allow for the interposition of a decoder board between the track power pickups and the motor and lights, and to re-release them in DCC-ready versions. But for those models not available in DCC-ready form, or for those already owned, it is possible to alter older mechanisms to allow for the installation of a decoder. These instructions will show the steps involved in retrofitting a decoder in one of the most popular, a KATO model of Electro-Motive's F7 locomotive (both A and B units, as well as the F3A and F3B units)

Requirements

There are two primary tasks involved in fitting a decoder: removing some material from the internal metal frame of the locomotive ('A' units only) to make room for the decoder board, and soldering the various wire leads of the decoder to the motor and lights. The disassembly and reassembly of the internal mechanism requires some dexterity and organization. Finally, it is a good practice to test the various connections with a multi-meter if available.

Altering the frame is the most challenging task for most, and the cutting or grinding away of metal does entail the risk of injury. Safety glasses must be worn, and proper procedures followed depending on the method chosen. Alternatively, the frame can be sent to one of several vendors to perform the work for a small fee.

Depending on the level of skill in the above areas, the conversion can take from one to three hours. Tools required are small screwdrivers and pliers, a hobby knife, four toothpicks, a small soldering iron and multi-meter, and a choice of equipment used to alter the frame. The only cost is that of the decoder itself (plus frame work if it is farmed out).

Ingredients

Kato EMD F7 (or F3) N scale locomotive (A or B unit)
Digitrax DZ126 DCC decoder

Small Phillips and slotted screwdrivers
Small pliers / tweezers / hemostats
Small file

Hobby knife (e.g. X-ACTO)
Four thin toothpicks
Kapton insulating tape

Soldering iron, 15-30 watt and solder

Multi-meter

'A' units: Metal grinding / cutting tools (see frame alterations section for details)

Work area where loco can be disassembled and left undisturbed until reassembly

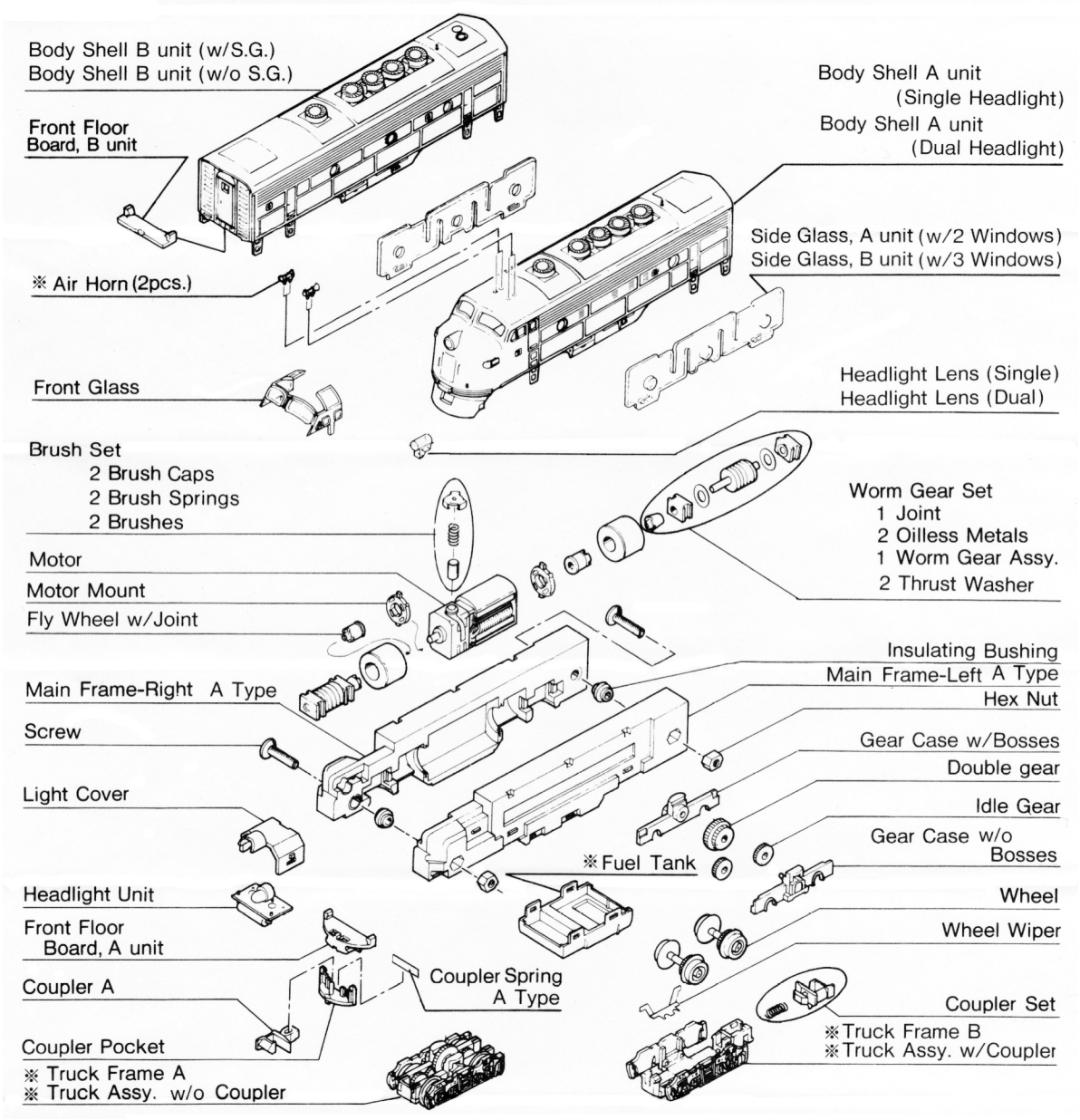


figure 1

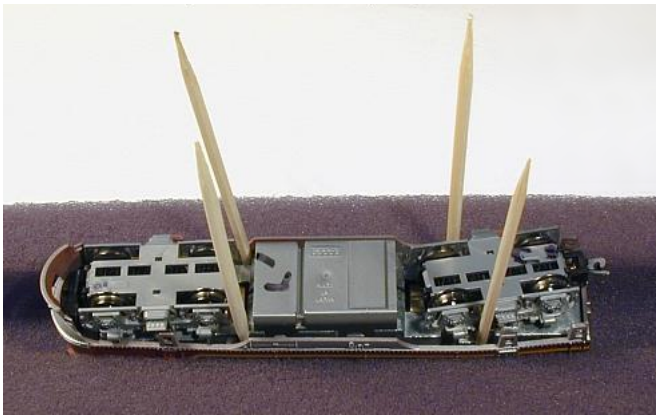
Procedure

Most steps apply to both body styles, but there are several that apply solely to 'A' units. They appear with a grey background and can be skipped for 'B' units.

i. Disassemble locomotive (15 minutes)

Remove body shell

- ☐ Turn loco over. The foam packing material from the model's storage case can be used to cradle the unit and prevent damage to the Air Horns and other details of the shell.
- ☐ On an 'A' unit only: remove the front coupler by prying each side of the coupler pocket up away from the front floor board. The coupler spring will come off with the coupler pocket. Slide the coupler out through the front of the body shell.
- ☐ Insert a toothpick into each of the four corners between the fuel tank and the truck assembly. The goal is to get the toothpick between the metal frame and the side glass so the slot in the glass is moved away from the tab in the frame. You should then be able to lift the frame up and out of the body shell. Store the shell in a safe place as it is not needed until final reassembly.



Split frame

- ☐ Unclip the fuel tank from the bottom of the frame by inserting a very thin screwdriver or hobby blade between the metal and the plastic, just above the slots in the tank. Pry just enough to move the tank's slots over the metal tabs. Usually undoing one side will be enough to free the tank.
- ☐ On an 'A' unit only: remove the light cover using the same technique.
- ☐ Remove the two screws holding the frame halves together, then separate them. The front and rear trucks will fall out and can be set aside. The fore and aft worm gear sets may be dislodged from the frame; they should be removed by sliding them out of the brass flywheels. Take care not to lose the parts labeled as 'Oilless metals' which are the rectangular pieces with a central hole at then end of the worm gear assembly. Collect and set aside all these pieces along with the screws, insulating bushings, and hex nuts.
- ☐ Mark the top of the motor assembly before removing it from the frame. Retrieve the headlight unit ('A' unit only). These parts and the frames (which should now be bare) are the pieces that will be modified.

ii. Modify frame – for 'A' units only (60 minutes)

Determine method. For 'A' units, material must be removed from the metal frame to make room for the decoder. Metal can be ground away, cut away, or the frames can be sent to a vendor who will make the modifications for a small fee.

✚ **Sending frames:** the easiest, safest and surest method as the vendors who offer this service know what needs to be done and have the right equipment to do it. Disadvantages are the cost and waiting time, although both are minimal. See the appendix for vendor information.

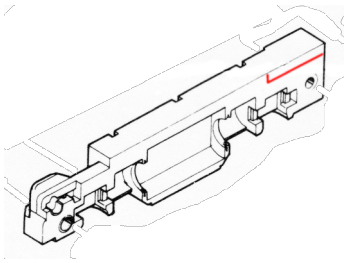
✚ **Grinding frames:** the slowest method. If a bench grinder is used, a safe way of holding the frame securely must be devised. If a portable grinder is used the frames should be clamped in a bench vise. Care must be taken as a large amount of heat will be generated during the process – enough to cause burns or distort the frame.

✚ **Cutting frames:** the best DIY method. A hand saw can be used for the utmost in safety, or a motorized rotary tool care be used to speed the work but will generate more heat. As with grinding, a bench vise should be used to hold the frame securely during cutting, and the frame must not be allowed to become too hot.

- ☐ Choose the option that best matches the available equipment, skill and comfort level. If the frames are sent out, follow the instructions provided by the vendor. If being ground or cut, proceed with the steps below.

Mark frame

- ☐ Examine the frame and note there is less metal towards the front end to make room for the nose and cab of the locomotive. Even on 'B' units without a nose or cab, the same cavity exists in the frame – and since it is just the right amount of space to fit the decoder, it can be used as a guide for creating space for the decoder.
- ☐ Flip one half of the frame front-to-back and hold it against the other half. Use a permanent marker to mark the size of the cavity onto the upper rear corner of the frame. Repeat this procedure for both halves of the frame, on both the inside and outside faces.



Remove frame material

Safety glasses must be worn when milling the frames.
Perform this work in a separate area where the debris can be contained.

- ☐ Cut or grind away the marked portion of the frame. As one half of the frame heats up, place it in a bowl of cool water and switch to the other half. Continue until the desired cavity is created, which should be of the same depth and length as the front. Place the two halves together and make sure the cavity is uniform. Smooth over all corners so there are no sharp edges, and bevel the corner between the cavity and the top of the frame to allow safe passage of the wires leading out of the decoder.
- ☐ Clean the frame completely so there is no chance of metal shavings coming near the motor.

iii. Prepare decoder (10 minutes)

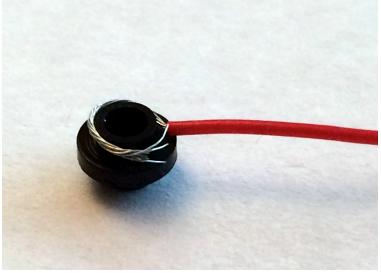
Trim decoder leads

- ☐ Cut the decoder leads to the lengths shown according to unit type.

Color	'A' unit length	'B' unit length
Red	60mm	20mm
White	55mm	0mm (not used)
Grey	30mm	30mm
Yellow	0mm (not used)	0mm (not used)

Color	'A' unit length	'B' unit length
Black	60mm	60mm
Blue	65mm	0mm (not used)
Orange	15mm	15mm

- ☐ Strip 2mm of insulation from the end of each of the wires and tin them with solder.
- ☐ For 'B' units only: strip a total of about 8mm of insulation from the red and black wires. Using the plastic frame insulator as a guide, form the bare wire into a loop about 4mm in diameter, and tin the circle with solder to hold its shape. The circle should fit around the smaller diameter of the insulator and rest on the larger platform at its equator.

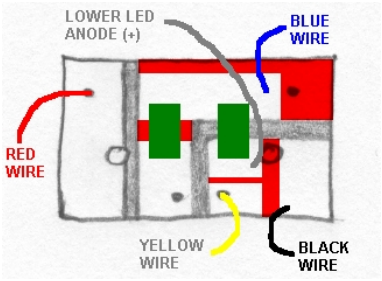


iv. Modify light board – for 'A' units only (20 minutes)

Cut traces

✚ **LED:** Light Emitting Diode. Modern replacement for a light bulb, longer life, less heat, but needs resistor and proper polarity.

- ☐ Place the headlight unit printed circuit board upside down so the silver pads and solder points are accessible. Beneath the green film are copper pathways connecting the silver pads to the resistor and the LED.
- ☐ Using a hobby knife, cut the pathways in the places shown to isolate the pads from the resistor and LED. Make parallel cuts and then scrape out the material between to be sure the copper is removed and the pathway is broken.

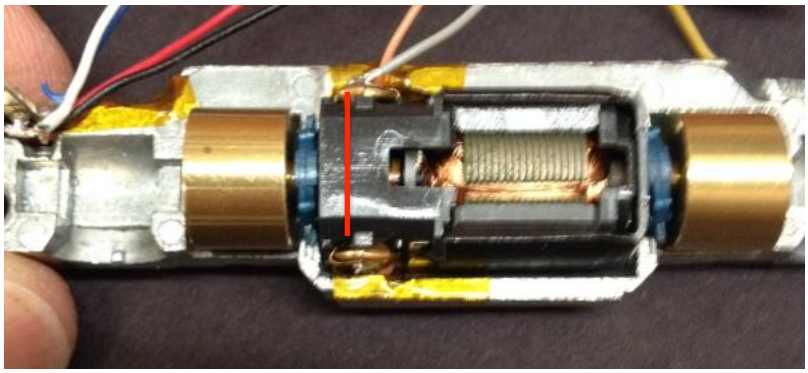


- ☐ Using the hobby blade, carve a divot in the end of the circuit board between the legs of the LED large enough to fit four decoder wires.
- ☐ Solder the red wire to the edge of one of the silver pads and the black wire to the edge of the other. Solder the blue wire to the outer leg of the resistor, and the white wire to one leg of the LED as shown.

v. Modify motor (40 minutes)

Cut groove

- ☐ Using a small file or several passes with the blade of a hobby knife, create a groove from top to bottom in the plastic on one side of the motor as shown by the red line. It should be just deep



enough to allow for one decoder wire to lay in the groove flush with the plastic housing of the motor. **Do not cut through the plastic or the motor may be ruined.**

- Clean up any plastic shavings so they do not foul the motor.

Convert brushes

- Remove the two brush sets from the motor by inserting a small flat screwdriver or hobby knife between the metal brush housing and plastic motor housing and prying them out. Take care not to loose any pieces since the brushes are spring loaded. The 'b' shaped contact strips sandwiched between the housings are no longer needed.
- Solder the grey decoder wire to one brush cap, and the orange wire to the other, using as little solder as possible so there is not a bump of solder.
- Reassemble the brush set that has the grey wire attached by first placing the spring, then the rounded end of the brush into the brush housing. The visible end of the brush should be slightly concave.
- Reinstall this brush housing assembly into the bottom of the motor. It should slide in freely until about 1mm of travel remains. Press firmly to snap the brush assembly into final position.
- Reassemble and reinstall the other brush (with the orange wire) at the top of the motor.
- Cover each brush cap with a length of Kapton tape about 1cm long so there is no chance either cap, its soldered wire or the solder will contact the frame halves when the motor in in place.
- Route the grey wire into the groove on the side of the motor so both wires now depart the motor assemble on the top side.

vi. Reassemble core (20 minutes)

Electronics

- Place the motor into one of the frame halves, ensuring the grey wire remains in its groove. The worm gear sets must be inserted into the flywheels as the motor is installed. The two motor mounts and all four 'Oilless metal' bearing blocks must be simultaneously wiggled into position.
- Double check to ensure the brush caps and soldered wires are not in contact with the frame. If they do the loco will not work and the decoder will likely be damaged.
- On an 'A' unit only: reinstall the light board, routing the wires through the gap carved in the board to avoid pinching them against the frame.

Mechanics

- Place the insulators in the holes at either end of the frame. On a 'B' unit only, place the loop of the red lead under the front insulator before installing it, and the loop of the black lead

over the rear insulator after installing it. In this way the red lead will contact one frame half and the black lead will contact the other.

- Check the alignment of all parts and then replace the other frame half and squeeze together slowly until there is a uniform gap all the way around. If not, inspect and correct any misaligned part or pinched wire that is preventing reassembly.
- While gently holding frame together, insert the front and rear trucks. Doing so will require the frame to spread apart slightly but not enough for anything to become misplaced. The arrow molded on the bottom of each truck should point away from the center of the loco.
- Place the decoder in the recess in the frame: for 'A' units it goes in the newly created cavity in the rear, while for cab-less 'B' units it is placed in the existing cavity at the front of the frame not used for a cab.
- Tighten the screws and nuts, and use Kapton tape to secure the decoder and wires down to the top of the frame.

vii. Testing (5 minutes)

DCC

- Place the loco on the track and turn on the power. Listen for any sound – there should be none. If there is any sound turn off power immediately. The most common trouble is motor leads not sufficiently insulated from the frame halves, of the light board white and blue leads contacting the frame. Disassemble loco and make sure each wire connects only to its destination.
- Test the headlight and motor using your DCC controller. With the grey wire at the bottom and orange at the top of the motor, the loco should move forward when in forward gear, but if it is backwards the decoder can be reprogrammed rather than physically switching the wires. See the decoder manual for this as well as changing the address, headlight behavior, etc.

✚ New decoders come from the factory assigned to address #3

Running

- Operate the loco at various speeds and in both directions. It should run as quietly as before, but if not it must be disassembled and the motor mounts and bearings checked to be sure they are in their exact correct positions. Be sure they and the worm gears and truck gears are free from dust and lint. They can be cleaned and lightly lubricated according to KATO's recommendations.

ix. Final reassembly (5 minutes)

Ancillary pieces

- On an 'A' unit only: route the four wires from the light board into the gap between frame halves so the light cover can be snapped into place.

- Snap the floor back onto the front of the underside of the frame.
- On ‘A’ unit only: confirm the front glass (windshield) is in place.
- Confirm the windows are in place in the body shell. They should be flat against the inside of the shell.
- Slide the loco into its shell. It will snap into place as the window slots go over and then down onto the tabs on the frame, leaving the shell flat against the frame. If not, check for wiring that is not flat or windows that have fallen out of place.
- On ‘A’ unit only: reinstall the coupler, coupler pocket and spring, ensuring the coupler is right side up.
- Snap the fuel tank into place, ensuring it is facing the right direction. The slots are offset and will only mate to the frame tabs in one orientation.

Your loco should now be fully reassembled and look the same as it did before it was converted, but its behavior will be much improved. Congratulations and enjoy the advantages afforded by a locomotive converted to Digital Command Control.

Appendix

Manufacturer contact information

Kato USA
www.katousa.com

Digtrax
www.digitrax.com

Frame modifications / replacements vendors

Aztec Manufacturing
http://www.aztectrains.com/dccframes.html

Streamlined Backshop
http://store.sbs4dcc.com/sbs4dccnscaleframemillingservice.aspx

Southern Digital
http://www.sodigi.com/DigiFrame.htm

DCC information

National Model Railroad Association
www.nmra.org

Sumida Crossing
http://sumidacrossing.org

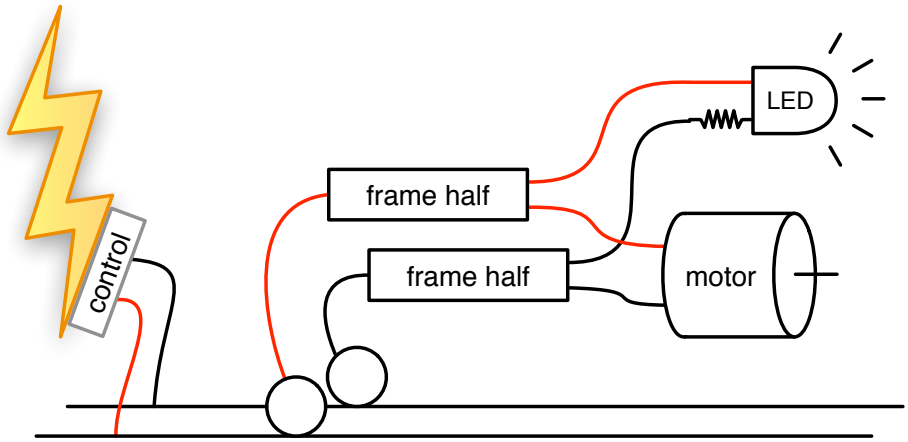
Decoder wiring color code

Red	AC power from track input
Black	AC power from track input
Orange	DC motor positive output
Grey	DC motor negative output
Blue	Common function output DC positive output
White	Function 0 forward (light) DC negative output
Yellow	Function 0 backwards (light) DC negative output
Green	Function 1 negative output
Purple	Function 2 negative output

Control Schemes

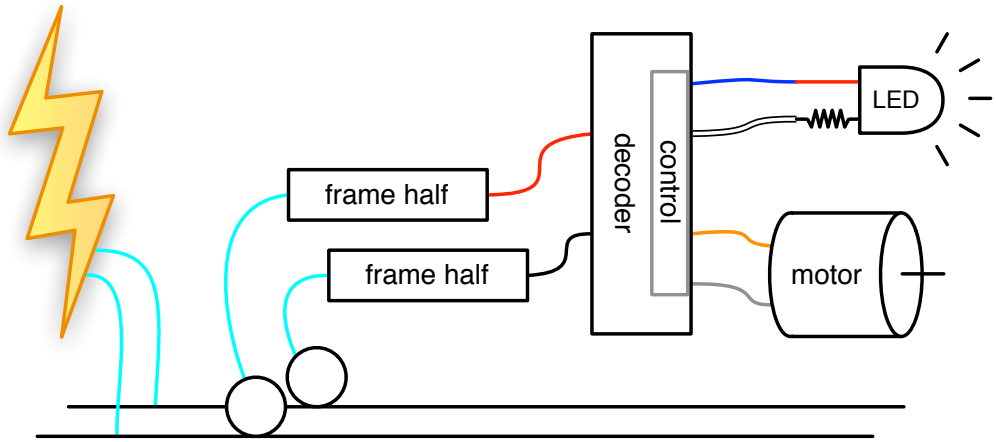
Each scheme begins with a power supply shown below as the lightning bolt (use of actual lightning not recommended).

Traditional direct current



In traditional layouts, the power level is controlled before it is sent to the track, where it then affects all locomotives simultaneously.

Digital Command Control



For DCC the power to the track in constant and the control occurs within each loco's decoder, allowing individual control of each loco and its functions.