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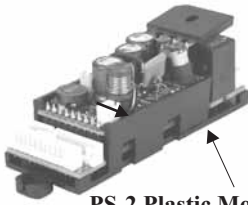
**WARNING:** This product is not covered by a warranty unless installed by an M.T.H. Authorized Conversion Center.

# Contents Of The Kit

- A) PS-2 Board and Plastic Bracket
- AA) PS-2 Heat Sink Bracket
- B) Mars Light (2)
- C) Proto-Coupler (2)
- CC) Coupler Insulator (2)
- D) Backup Light
- E) Marker Lights- Red
- EE) Marker Lights- Green
- F) 7-Pin Pickup Harness w/Tach Reader
- FF) Tach Reader Bracket
- FFF) Tach Tape
- G) Headlight
- H) Speaker
- I) AA Ni-Cd battery pack  
(Charge before use)
- II) Battery Charging Jack
- III) Battery Charging Jack Hardware (2)
- J) Ditch Lights (2)
- K) Interior Lights
- L) Overhead Blinking Light
- M) 6/32 x 6mm Screws (3)
- N) 6/32 Nuts (3)
- O) 6/32 x 8mm Screw
- P) Shrink Tubing
- Q) Wire Management Coil
- R) Wire Ties (6) 4"
- S) Foam Tape
- T) Wire Nuts (2)
- U) Speaker Plug
- V) Smoke Unit Wire Harness
- W) 8-Pin Chassis Harness
- X) 5-Pin Motor Harness
- Y) 12-Pin Chassis Harness

## (A) Proto-Sound 2.0 Circuit Board

AE-0000010, AE-0000011



PS-2 Plastic Mounting Bracket

## (AA) PS-2 Heat Sink



## (C) Proto-Coupler (2)

DD-0000032  
(w/out wires)



## CC) Coupler Insulator (2)

ID-0000123



## (B) Mars Light (2)



## (D) Backup Light



**(E) Marker Light- Red**



**(G) Headlight**



**(EE) Marker Light - Green**



**(H) Speaker**  
BF-000034



**(F) 7-Pin Chassis Harness w/Tach Reader**



**(I) AA NiCad Battery Pack**  
BG-400003



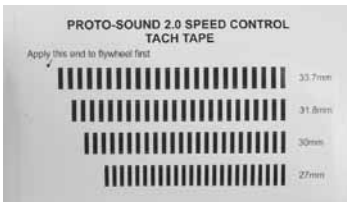
**(FF) Tach Reader Bracket**  
IH-0000389



**(II) Battery Charging Jack**  
BC-1000004



**(FFF) Tach Tape**  
BE-0000151



**(III) Battery Charging Jack**  
Hardware



**(J) Ditch Lights**



**(K) Interior Lights**



**(L) Overhead Blinking Light**



**(M) 6/32 x 6mm Screws**

IA-0000027



**(N) 6/32 Nuts**

TP-MS00075



**(O) 6/32 x 8mm Screw**

IA-0000050



**(P) Shrink Tubing**



**(Q) Wire Management Coil**



**(R) Wire Ties**



**(S) Foam Tape**



**(T) Wire Nuts**

(BI-4500003)



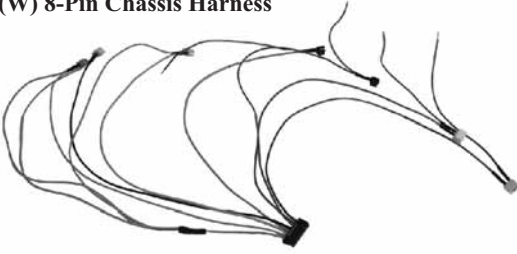
**(U) Speaker Plug**



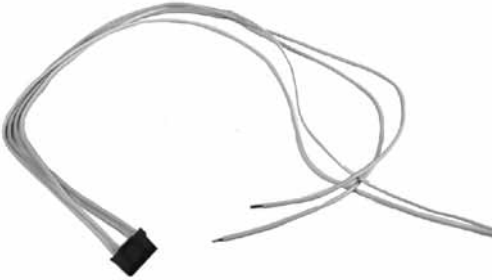
**(V) Smoke Unit Wire Harness**



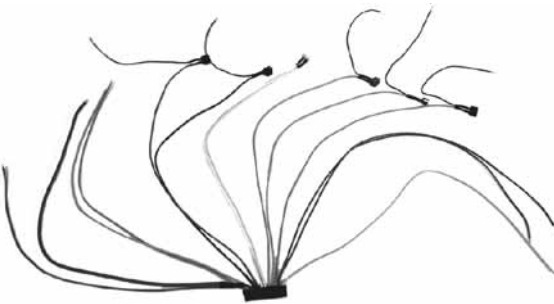
**(W) 8-Pin Chassis Harness**



**(X) 5-Pin Motor Harness**



**(Y) 12-Pin Chassis Harness**

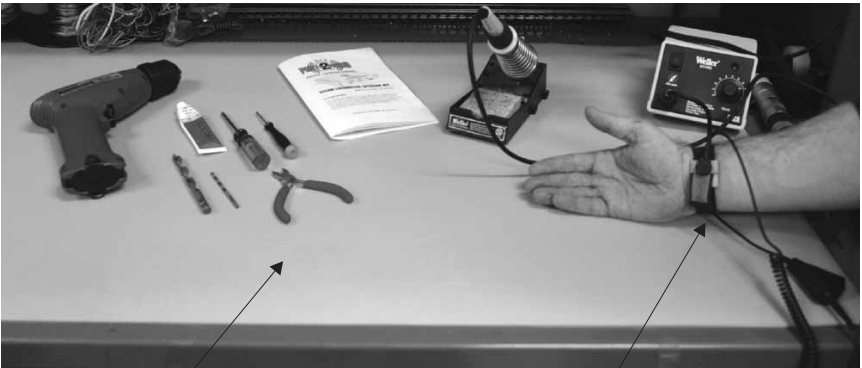


# Required Tools

- Soldering iron
- ESD safe work area
- White thermally conductive grease
- Screw drivers, Philips #2 & #00
- Wire cutters
- Drill
- Drill bits (1/8", 5/32")
- Drill bit (3/8" or 1/2") or de-burring tool
- Electrical Tape
- Razor Saw
- Proto-Sound Battery Charger (*M.T.H.*  
*Part number 50-1019*)

## What Is An ESD?

As ESD safe work area is an area set aside in your workshop that is electrically grounded and includes anti-static mats and grounding straps



## ESD Mat

Work Only in an ESD Safe Zone

## Grounding Strap

# Upgrading Multiple-Unit Diesels

This kit is designed for single diesel or electric locomotives only. There is no provision for wiring a coupler and/or back-up light into a dummy or non-powered trailing unit. Similarly, the kit does not provide a way to control powered trailing units. See the note below on four-motored locomotives as serious damage can occur to the Proto-Sound 2.0 electronics if warnings are not heeded.

## Four-Motored Locomotives

This kit is designed to upgrade only a single locomotive with one or two motors. Engines with four motors in two separate body shells will require two upgrade kits- and thus become two separate PS-2 locomotives that can be operated as a lash-up or as separate units.

***Warning: Attempting to run three or four motors off of a single PS-2 board will damage the motor drive circuit and require board replacement.***

## Lighting In Non-Powered Units

This kit does not provide connections for lights in non-powered (dummy) units. Non-powered Proto-Sound One units with constant-voltage lighting boards will work under DCS with no modifications. If the non-powered trailing unit is equipped with lighting (ie: back-up light) that is connected to the powered unit through a harness, you can use that existing harness to connect those lights up to the PS-2 kit.

## Proto-Couplers In Non-Powered Units

This kit does not provide connections for Proto-Couplers in non-powered (dummy) units, although it does include two PS-2 Proto-Couplers. **Note: Original Proto-Sound Proto-Couplers will not work consistently with the PS-2 board. The original Proto-Sound Proto-Couplers require higher voltage to operate and therefore do not open consistently when commanded with the PS-2 board.** If your unit came with a Proto-Coupler on the non-powered trailing unit, you can use the existing harness to connect the newly installed Proto-Coupler on the trailing unit.



# Inspection & Review

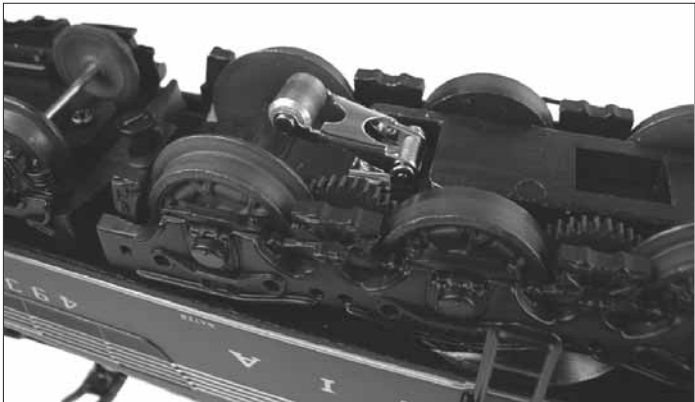
Before beginning the installation, inspect the engine to be upgraded and verify the following are in good working order:

- Pick-up rollers
- Motor w/flywheels
- Smoke unit (*if equipped*)
- Speaker mounting hardware
- Volume pot
- Coupler mounting hardware, “T” bar, spring, c-clip
- Constant voltage lighting board and connected bulbs.

**Note:** Before beginning installation, see discussion on page 27 on “wire management” which should be planned as you proceed during the installation. Part of the plastic wire tube (Q) may be used for this purpose.

*Note:* If any of the above items are missing or not in working order, procure the required parts before continuing.

*Note:* It might be helpful to label the Front and rear of the chassis as a reminder which direction the engine should first move when powered up.



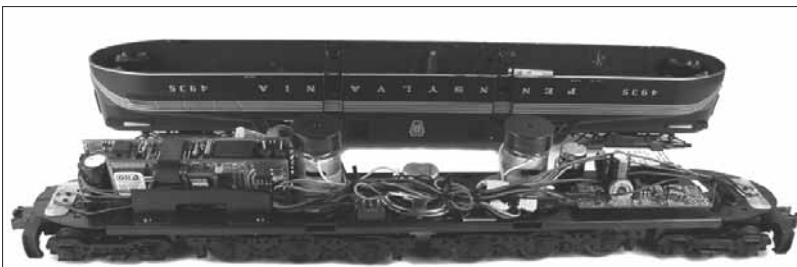
*Make sure pickup rollers are clean and roll freely.*

# Preparing The Chassis For The PS-2 Upgrade

Before you can install the PS-2 components into your locomotive, any existing sound boards or reversing units must be removed. The PS-2 Kit contains all the necessary electronics your locomotive requires to operate. Some existing mounting brackets may be utilized during the installation of the PS-2 components. Follow the instructions below taking care to save the parts when noted.

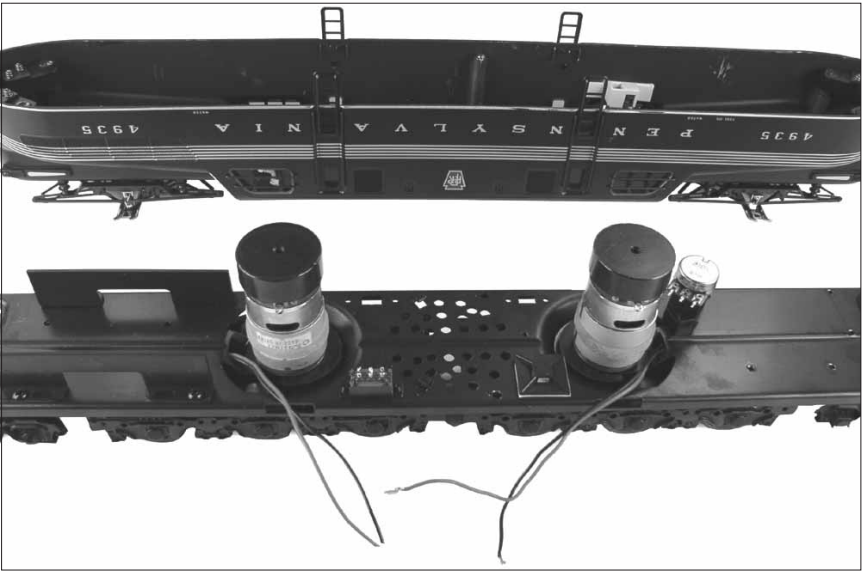
## Remove The Following Items From The Locomotive Chassis

- Body shell (save the mounting screws).
- Proto-Sound 1, DCRU Reverse Unit, Mechanical Whistle, Electronic Whistle, any other electronics and harnesses.
- Speaker (save mounting hardware).
- Existing couplers (save the “T” bars, springs, and c-clips).
- Any lights including the headlight and marker LEDs (if present). These will likely be mounted inside the body shell.
- Do **NOT** remove the volume pot or smoke unit ON/OFF switch (if present) used on Proto-Sound 1 models. If your locomotive does not have a volume pot, order BI-0000040 (volume pot), IA-0000035 (screw), ID-0000071 (spacer), And IC-0000006 (nut).
- Do **NOT** remove red wires connected to pickup roller assemblies.
- **Note:** *Leaving a short piece of color coded wire on each motor terminal will help ensure that the new motor wires are hooked up to the correct motor Terminals and allow each motor to run in the same direction.*

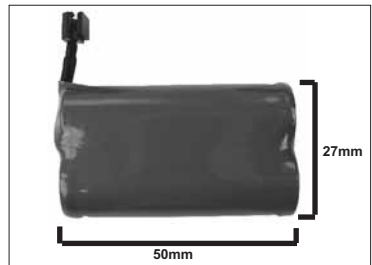
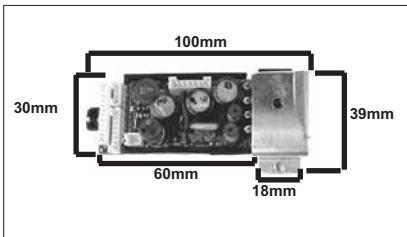


# Installing The PS-2 Components Onto The Locomotive Chassis

Once the existing electronic components have been removed from your locomotive, begin locating the best mounting position for the PS-2 components. The major components are the PS-2 board, PS-2 Heat Sink Bracket, the speaker and the rechargeable battery pack. The speaker can often be installed in the fuel tank (if your locomotive is so equipped) leaving the chassis areas in front of, between, and behind the motors for the remaining PS-2 equipment.



*This Premier Line GG-1 features no fuel tank, so the speaker must be mounted onto the chassis.*

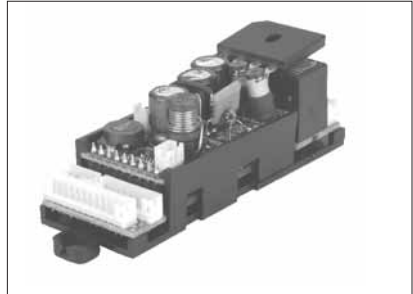


## Mounting The PS-2 Board

- Remove the PS-2 Board (A) from the sealed anti-static bag
- Verify PS-2 board is securely inserted into its plastic mounting bracket.

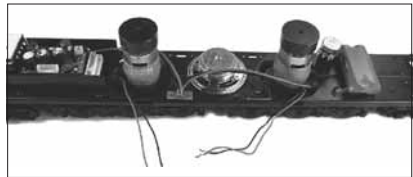
**NOTE:** If you are not a participating MTH Authorized Service Center there is **NO** warranty once the bag is opened

**NOTE:** Use ESD safe work area and procedures when handling the PS-2 board.



*Make sure the PS-2 board is firmly inserted into the plastic mounting bracket. If not, gently push the board into the bracket until fully “captured” by the bracket. **DO NOT REMOVE THE BOARD FROM THE BRACKET.***

- Remove the speaker (H) from the protective packaging (*NOTE: be careful not to damage the speaker cone*).
- Place the PS-2 board/plastic mounting bracket (A) on the chassis to verify the best location to mount the plastic mounting bracket and the metal heat sink bracket (AA) to the chassis. Also locate a place to put the battery pack (I) And battery charging jack (II).



*Place the components on the chassis floor in the best position given the space. It may be necessary to turn the battery pack on its side as seen above.*

***Note:** Position the battery pack close enough to the PS-2 board so it does **NOT** require lengthening of the battery pack or battery recharging port harnesses. Lengthening either of these harnesses will reduce the battery voltage to the board and may affect operation.*

## Mounting The PS-2 Board *Cont'd*

- Once you have determined the best locations for mounting the PS-2 Board bracket (A), metal heat sink bracket (AA), battery pack (I), and battery charging jack (II), mark the chassis floor locations using a pencil or silver marker so you can drill the holes in the proper locations. If necessary, determine the location of the smoke unit switch as well.

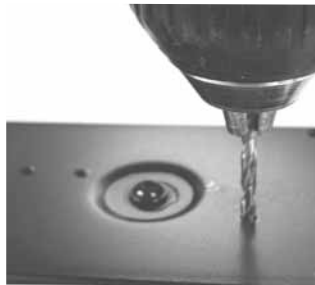


*Drill the appropriate mounting holes as determined from positioning the PS-2 board and other components*

- Remove the PS-2 board with plastic mounting bracket (A), metal heat sink bracket (AA), speaker and battery from the chassis and place on an ESD safe area on your workbench. Removing the motors & trucks will help protect them from Any stray metal chips when drilling mounting holes.

- Drill the holes as marked with the proper drill size. A 5/32" bit will be required for the PS-2 plastic mounting bracket (A) and heat sink bracket (AA). Use a 1/8" bit for the battery charging jack mounting holes.

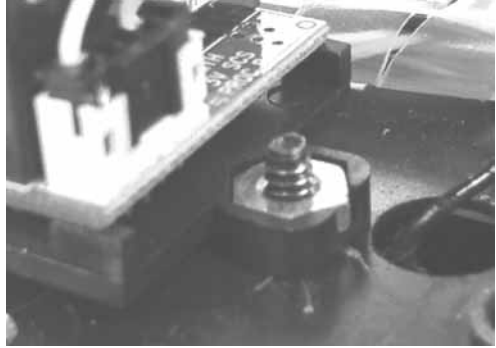
- De-burr the holes slightly using a larger drill bit (3/8") or a deburring tool. Clean all metal burrs or chips from the chassis before proceeding.



*Carefully remove any metal burrs resulting from drilling the mounting holes. Loose metal burrs can damage the PS-2 circuit board!*

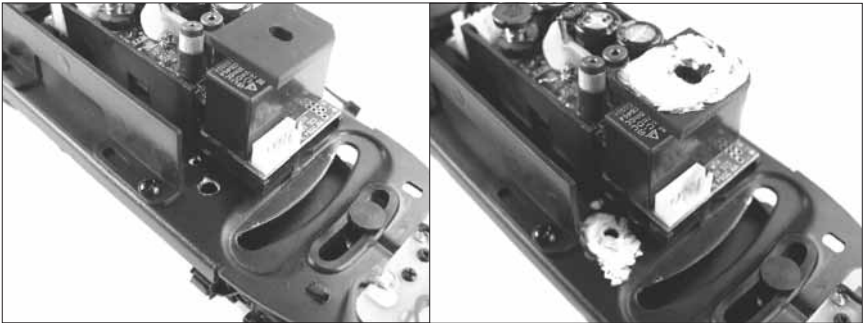
## Mounting The PS-2 Board *Cont'd*

- Mount the plastic mounting bracket (A) containing the PS-2 board using 2 of the screws (M) and nuts (N)



*Mount the PS-2 plastic mounting bracket*

- Apply white thermally conductive grease to the bridge rectifier on the PS-2 board.



*Apply white thermally conductive grease to bridge rectifier & the mounting spot for the metal heat sink bracket.*

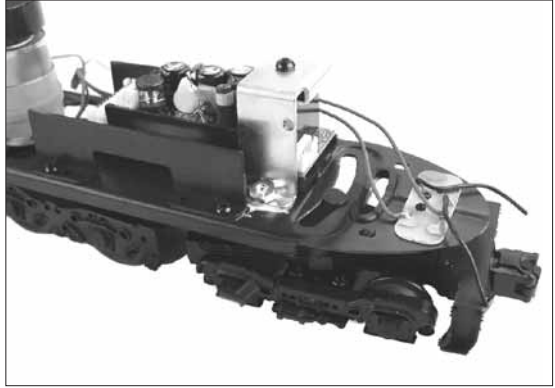
## Mounting The PS-2 Board *Cont'd*

- Secure the metal heat sink bracket (AA) to the bridge rectifier using screw (O)

*Note: If screw is too long, cut it down so it does not hit the relay*

-Secure the heat sink bracket to the chassis floor using screw (M) and nut (N).

*Note: The screw comes up from the bottom of the chassis.*

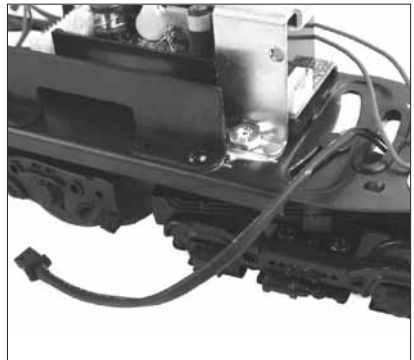


## Installing The Proto-Couplers

-Install the proto-couplers (C) onto the existing locomotive trucks or coupler mount locations using the existing hardware. Be sure to route the coupler wire harness through the chassis floor as shown.

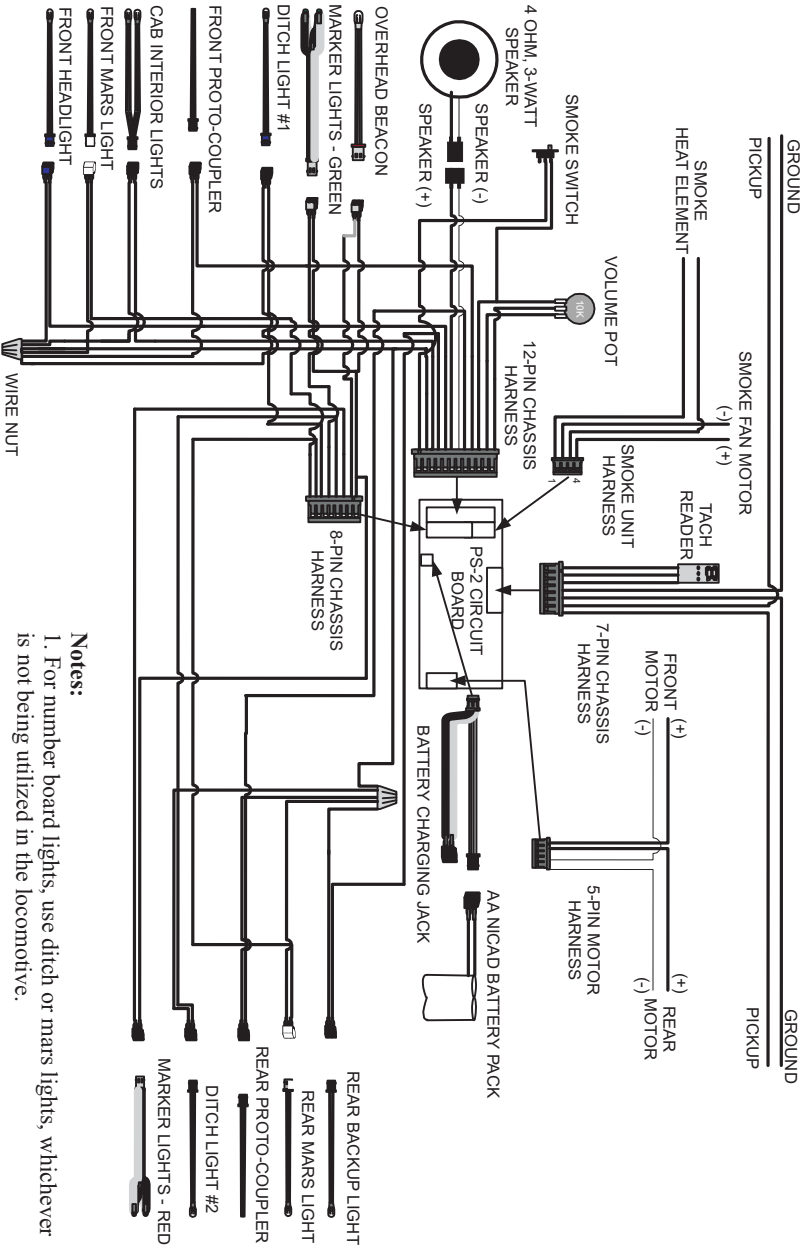
-The front truck Proto-Coupler connector attaches to the black & purple harness from the 12-Pin chassis harness.

*-Note: Use coupler insulator (CC) as required to prevent shorts from coupler solder connections to truck axle. Reference page 42 for detailed instructions.*



*The Proto-Coupler installs in the same location as the original engine coupler.*

# PS-2 Chassis Wiring Diagram

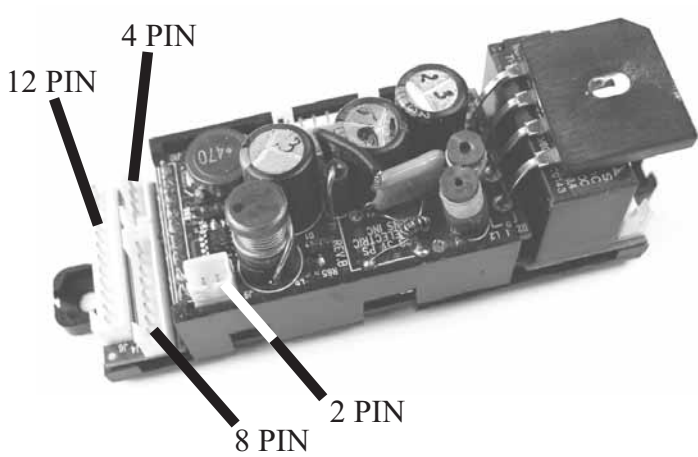
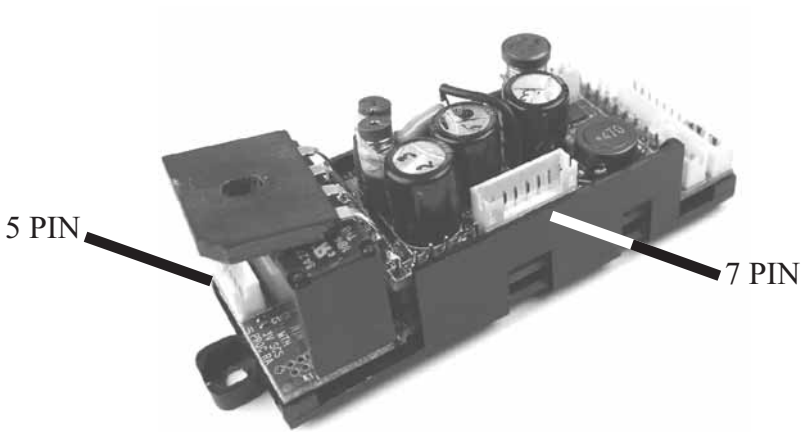


**Notes:**

1. For number board lights, use ditch or mars lights, whichever is not being utilized in the locomotive.
2. If ditch lights are used as ditch lights, move ditch 2 to front of the locomotive.

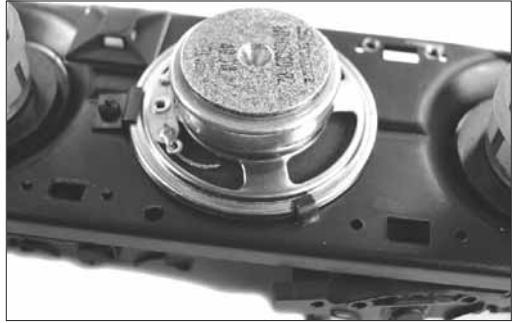


## PS-2 Board Connections



## Installing the Chassis Harnesses, Speaker & Smoke

-Attach 12, 8, 7, and 5-Pin Chassis Harnesses to the PS-2 board (A) noting that each plug is polarized and has a different number of pins. Take care to insert the correct plug into the correct connector on the PS-2 board. See previous pages for locations.

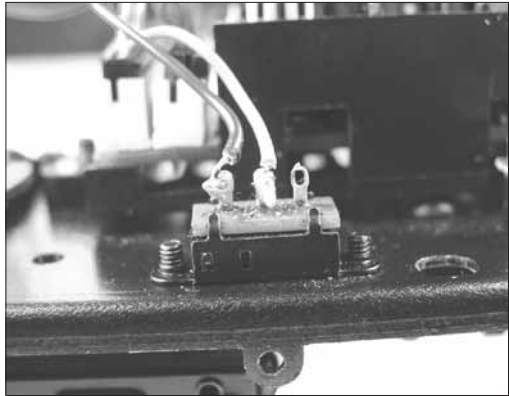


*Use the existing speaker location (if applicable) to mount the new speaker. Many diesel engines will use the fuel tank to house the speaker. Use the same mounting hardware for the original speaker.*

-Install the speaker (H) into the previous speaker mounting location (if applicable) using the existing hardware.

-Re-use the existing smoke unit switch.

-Solder one blue wire from Pin 10 of the 12-Pin Chassis Harness to smoke unit switch center pin. Many locomotives featuring a smoke unit switch have engraved ON & OFF on the floor. Choose the appropriate pin for the blue wire. *(If a smoke unit is not present on your model, remove the pink and one of the blue wires from the 12-pin Chassis Harness.)*



*Wire the smoke unit switch wires into the existing smoke unit switch.*

## Soldering Speaker Connections

-Solder the yellow and white wires (U) to the speaker (H) making sure to get the polarity correct, yellow(+), and white(-)

-Connect speaker plug to harness plug (white) with yellow & white wires coming from the 12-Pin Chassis Harness (Y).

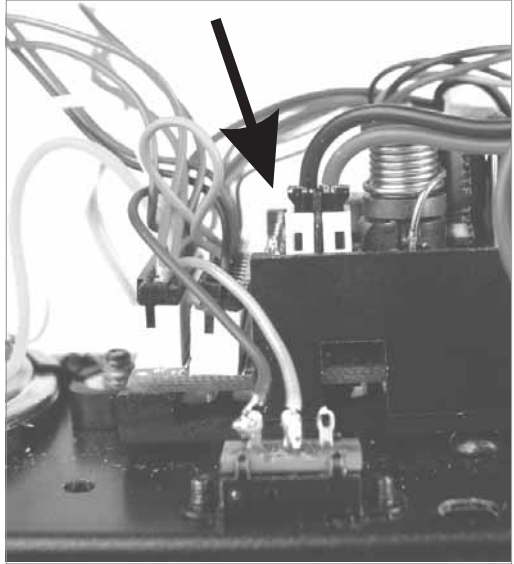


**CAUTION: If either wire shorts to the speaker frame, the PS-2 electronics will be damaged.**

## Installing The Battery, Recharging Jack and Volume Pot

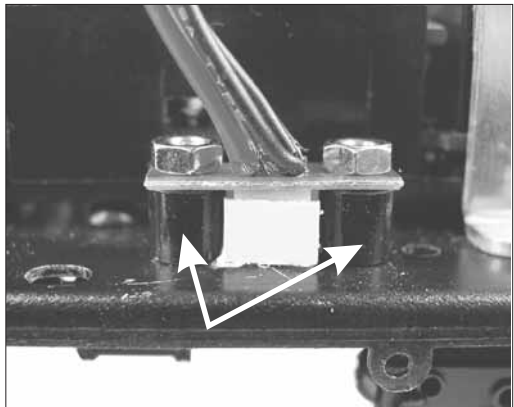
-Plug the 2 pin battery pack connector into the PS-2 board.

**CAUTION:** Position the battery pack close enough to the PS-2 board so it does NOT require lengthening of the battery pack or battery recharging port harnesses. Lengthening either of these harnesses will reduce the battery voltage to the board and may affect operation.



*The battery pack connector comes pre-mounted to the recharging jack and battery pack cable. It plugs into the PS-2 Circuit board as indicated by the arrow.*

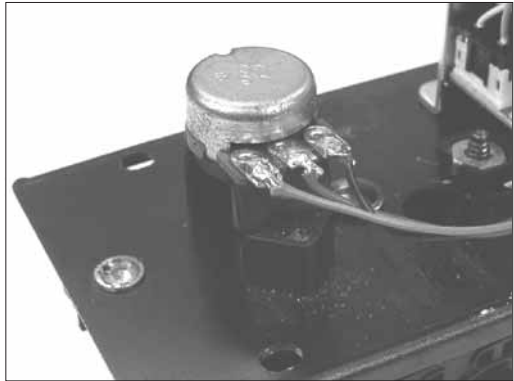
-Mount the 2-Pin battery recharging jack (II) to chassis floor using hardware (III) as shown on the right.



*Insert the spacers (III) between the recharging jack board and the chassis floor to prevent the recharging jack from extending below the chassis floor. Secure with screws from underside of frame and nuts.*

-Solder the wires from the 12-pin chassis harness to the existing volume pot. Red wire to the center terminal, blue to one outer terminal and gray to the other outer terminal.

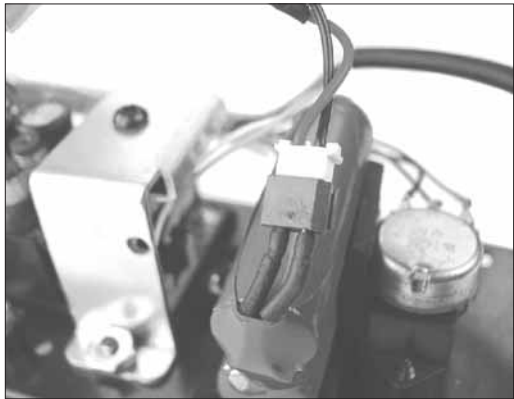
Note: Volume pot not required for command operation. Solder gray and red wires together to get full volume in conventional mode and insulate the blue wire from chassis ground.



*Solder the red, blue and gray volume pot wires to the volume pot. Red to the center terminal and blue and gray to the outside terminals.*

-Place the double-sided foam tape (S) on the chassis floor in the location established previously.

-Secure the AA rechargeable Ni-Cd battery pack (I) using the double-sided foam tape.



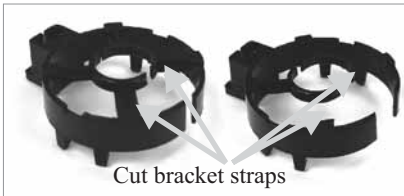
*Use the double-sided tape to secure the battery pack to the chassis floor. Connect the battery harness to the battery pack. Note in the example above how the foam tape is also located between the volume pot and the battery pack.*

## Installing Tach Reader Bracket

-Based on the motor type, install the tach reader mounting bracket (FF). The bracket is snapped into place on a Mabuchi or similar motor by spreading it open and sliding it under the flywheel. It may be necessary to use tape or epoxy glue to hold the bracket in position. Ensure the tach reader is attached to the motor whose truck has traction tires.



*Spread the Tach Reader bracket apart and slip between the flywheel and motor for engines equipped with Mabuchi or similar motors.*



*Some can motors are larger than others and will require that the tach reader bracket be modified in order to fit around the motor. Cut the bracket straps as shown.*



*Push the bracket all the way onto the top of the motor. The small tabs extending down will "lock" onto motor casing.*

## Installing Tach Tape Onto Motor Flywheel

-Clean the flywheel with a cleaning solution and then install the tach tape (FFF) to the flywheel diameter and select proper tape). If the tape is wider than the flywheel, trim with a razor and straight edge before installing. Apply tape end with the largest white portion first, wrap the tape around the flywheel until it overlaps.



*Wrap the tach tape around the flywheel by starting with white end first.*

## Mounting Tach Reader To Tach Reader Bracket

-Insert the tach reader into the tach reader bracket.

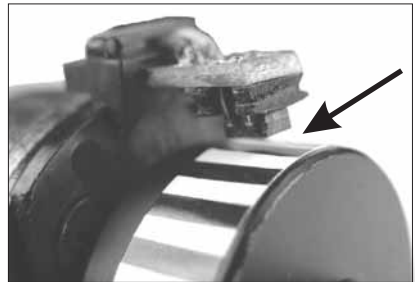
-The gap between the optical sensor and flywheel should be 0.5mm (0.022")-1.5mm (0.060"); 0.75mm (.030") is optimum.

-If the gap is too large, decrease the tach reader space between reader and flywheel as detailed below.

-Spark plug feeler gauges are useful to establish the proper gap.



*When inserted into the tach reader bracket, the distance between the tach reader and the flywheel should be between .5mm & 1.5mm.*



*Check the distance between the flywheel and tach reader. Adjust if necessary as detailed below.*



*If the tach reader spacing is too large, it may be necessary to increase the gap between the tach reader and the tach reader circuit board.*



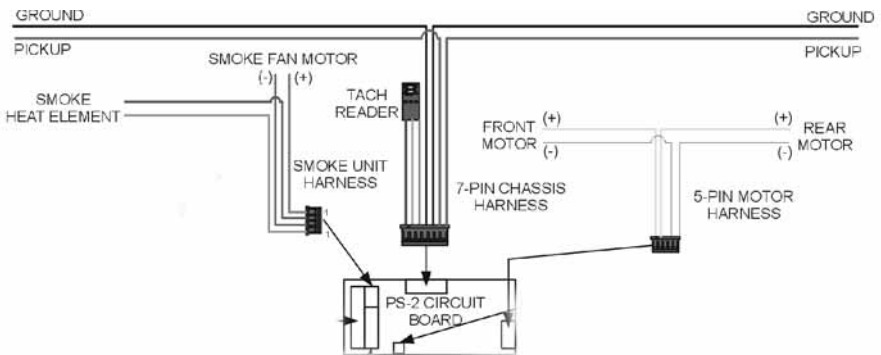
*Unsolder the tach reader from the circuit board at the four tach reader prongs. Once unsoldered, resolder with the proper gap between the reader and board.*

## Connecting Motor, Ground & Pickup Wires

-Solder the yellow and white wires from the 5-pin motor harness to the motors. As noted on page 10, observe the wire color code of the previous electronics to ensure both motors turn in the same direction. If the engine starts out in the reverse direction, you will later need to reverse the yellow and white wires to the motor. This will not be tested until installation is complete- see page 30.

-Connect the red wire from the 7-Pin Chassis Harness to the existing wires from the pick-up rollers.

-Connect the black wires from the 7-Pin Chassis Harness to chassis ground.



## Connecting Lights

-Install the Ditch, Headlight, Marker, Mars, Overhead Blinking & Cab Interior bulbs into the proper engine & wire harness locations as seen in the diagram on page 16 and the instructions on page 25.

-On RailKing diesel locomotives, the headlight and backup light are usually a screw or bayonet based bulb inserted into a bracket mounted to the chassis. This bulb must be replaced with headlight bulbs (D&G) in the kit in order to have constant voltage, directional lighting. Secure the bulbs in place with tape or hot glue. **Do NOT** wire the existing bracket and bulb into the PS-2 harness. It will damage the lighting circuit.

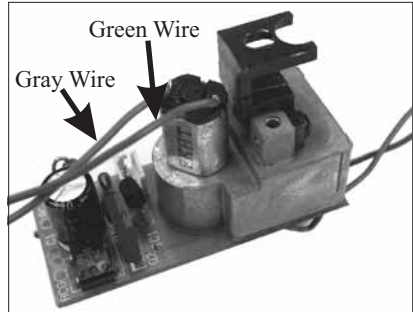


## Connecting Lights (cont'd)

1. Connect the Front Headlight with blue connector (G) to blue connector with sky blue & purple wires. Install the Rear Backup Light with green connector (D) to the green connector with green & purple wires.
  2. Connect Marker light with yellow connector to the yellow connector with orange w/white stripe & gray wires. Connect the Marker Light with yellow connector to the yellow connector with black w/white stripe & gray wires.  
*Note: Generally the green marker lights will be located at the front of the engine and the red markers at the rear of the engine.*
  3. Connect the Interior Light to the black plug with purple & orange wires.
  4. Connect the Mars light to white plug with purple & purple w/white stripe wires for the front engine location and to the white plug with purple & brown w/white stripe wires for the rear engine location.
  5. Connect the Ditch lights to black plug with purple & blue w/white stripe wires for Ditch 1 and to the black plug with purple & green wires with white stripe wires for Ditch 2.
  6. Connect the Overhead Blinking light to the red plug with gray w/white stripe & gray wires.
  7. For number board function, choose either Ditch or Mars lights (whichever is NOT being used on your model).
  8. All loose purple wires need to be connected. Notice on Pin 2 of the 12 Pin Chassis Harness that there are two purple wires. Route one wire to the front and the other to the rear of the engine. Using one of the yellow wire nuts, tie all the loose purple wires in the front of the engine (Front Coupler, Headlight, Cab Interior Light, Mars Light, Ditch Light, etc.) together. Using the remaining yellow wire nut to tie all the other loose purple wires at the rear of the engine together (Rear Coupler, Backup Light, Ditch, Mars Light, etc.)
- Note:** The PS-2 lighting circuit is not powerful enough to power more than two bulbs from each connector. Do NOT use the existing headlight and backup light bulbs in your engine with the PS-2 circuit. Use ONLY the 6V headlight and backup light bulbs provided in the kit. If your locomotive is equipped with a constant voltage lighting circuit, you can use any of those 6V bulbs with the PS-2 Kit. This might be useful when you need more bulbs than supplied in the kit (ie: to light number boards, etc.). Configure any single bulb harness like the Interior Light harness (K).

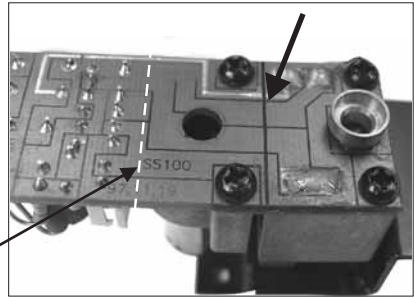
## Connecting The PS-2 Harness To The Smoke Unit

-Soldering Gray and Green wires to the smoke unit fan motor. If the smoke unit motor terminals are hooked up backward, the impeller will spin in reverse and fail to pump out the smoke. When properly wired, most impellers should rotate clockwise.



*Follow the above wiring directions to the smoke unit motor:*

-Cut through the traces on the top of the smoke unit board. **The heating elements MUST be isolated from the electronics on the board or the PS-2 board will be permanently damaged.** Another alternative is to cut the printed circuit board such that the electrical components are no longer present since the PS-2 hardware will be managing the smoke unit heating elements and motor- *see alternate cut line.*

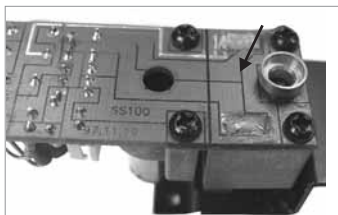


### **CRITICAL STEP!!**

*Use a razor saw to cut the bottom of the smoke unit circuit board, isolating the no longer required components on the left. **FAILURE TO CUT TRACE COMPLETELY WILL PERMANENTLY DAMAGE PS-2 BOARD.** Make sure saw cut is free of debris that could form an electrical contact.*

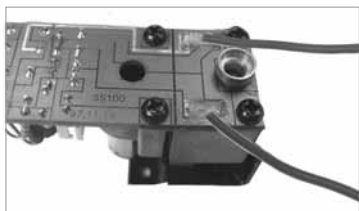
## Connecting The PS-2 Harness To The Smoke Unit Cont'd

-Solder the heating pads together at both sides on the top of the board by adding more solder. Then solder the Brown wire from the smoke unit wiring harness to one pad and the Purple to the other (the pads are interchangeable). Soldering to the trace for each end of the element is also acceptable.



### CRITICAL STEP!!

*Solder together the pads connecting the heating element to the circuit board as shown above. **Make sure the heating elements are in parallel.** You should measure 8 ohms across the pads. Failure to place the heating elements in parallel will permanently damage the PS-2 board.*

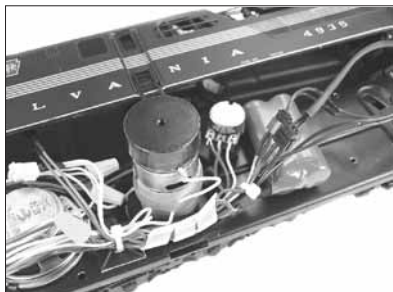
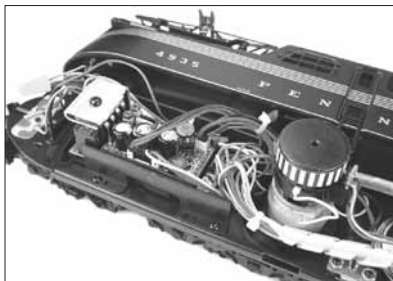


*Connect the purple and brown wires to the solder pad locations as seen above.*

## Wire Management/Short Circuit Protection

-Route the wires around the motor and chassis such that the wires will not be pinched when the body is installed. Use pieces of wire management coil (Q) to hold various cables in place.

**NOTE:** The wires may need to be cut and spliced together to shorten the length of the wires. Use the shrink tubing (S) supplied in the kit for this purpose whenever necessary.



# Testing The PS-2 Upgrade Installation

Place the engine chassis on a test section of a track.

-Apply 12 volts of power (in conventional mode) to the engine and tender. If you have a Z4000 look at the current display. The engine should not draw more than 1.5 amps. If the engine draws more than 1.5 amps, shut down power to the engine immediately and check your wiring for any pinched or cut wires. Turn the smoke unit switch off and power up again in conventional mode. The engine without the smoke unit on should not draw more than 1.0 amp. Troubleshoot any problem in the smoke unit or wire harness accordingly.

-Check the smoke unit for operation. If no smoke is coming out or you can't feel the fan blowing air out, the gray/green wires connected to the fan motor may be reversed.

-Press the direction button and verify the locomotive moves in the forward direction. If the two motors in a twin-motored unit appear to be fighting each other, reverse the white and yellow motor wires on one motor. If the engine starts in reverse, reverse the yellow and white wires to both motors. If the engine does not move, the battery most likely needs to be charged. *(See battery charging instructions on page 39)*

-Press the whistle button and verify the horn test sound. The sound is not a normal horn but a test tone.

-Press the bell button and verify the bell test sound. The sound is not a normal bell but a test tone.

-Fire the coupler using the combination signal in conventional mode or the digital signal with the DCS remote.

-Press the direction button and verify the engine stops.

-Press the direction button again and verify the engine moves in reverse direction and that the headlight and back-up lights work properly.

-Install the body on the engine chassis being very careful not to pinch any wires in the process and repeat the tests above.

# Loading The PS-2 Sound File Into The Upgraded Engine

Before your upgraded locomotive will play locomotive sounds, the PS-2 circuit board needs to be programmed with the appropriate PS-2 Conversion File for your engine type. Programming can only be accomplished with the M.T.H. DCS Digital Command System and the free DCS Loader Program. Both the Loader Program and the PS-2 Conversion Files can be found on the Proto-Sound website ([www.protosound2.com](http://www.protosound2.com)). Complete instructions for downloading the Loader Program and the PS-2 Conversion files are found on the website.

*Note: It is important to remember that only the PS-2 Conversion Files can be used to program your PS-2 Upgrade circuit board. The sound files found on the regular M.T.H. Website will not work in the PS-2 Upgrade circuit board.*

Once you have the DCS equipment and have downloaded the DCS Loader Program, you will need to visit the PS-2 Upgrade page on the Proto-Sound 2 website and search for your locomotive model or one similar to it in order to find the sound file you will need to download. Each PS-2 Conversion File has been optimized for its intended locomotive and takes into consideration the type of motor, the gear ratio and most importantly, the size of the drive wheels to govern the speed of the locomotive. Users trying to install a steam switcher locomotive (i.e.: 0-6-0) PS-2 Conversion File into a large mainline steam engine (ie: 4-8-4 Northern), for example, will find that the locomotive cannot run at the same scale speed as other engines and that the chuff rate will not be properly timed with the driver revolutions. This is because the driver sizes of the two different locomotives are drastically different from one another.

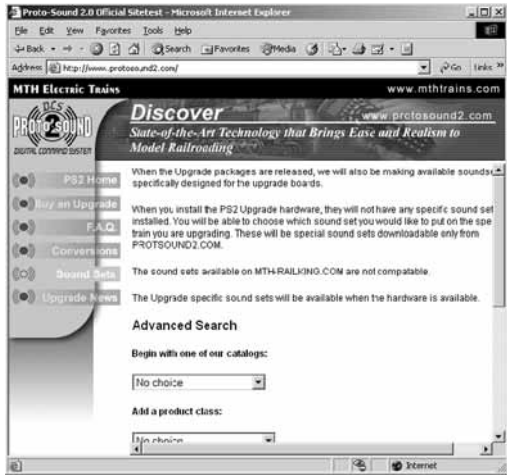
Follow the illustrations on the following pages to learn how to search for the locomotive you are upgrading and download the appropriate sound file. Once The sound file has been downloaded into the engine, it will be necessary to program the engine name using the DCS remote. Follow the DCS instructions for renaming a locomotive.

*Note: Charge the battery prior to loading a sound file into the upgraded locomotive.*

*Note: If you are upgrading a non-M.T.H. Locomotive, pick a model in the search engine similar to the model you are upgrading. It is possible that the scale speeds and chuff rates may be slightly off for the reasons discussed above.*

**STEP 1:**

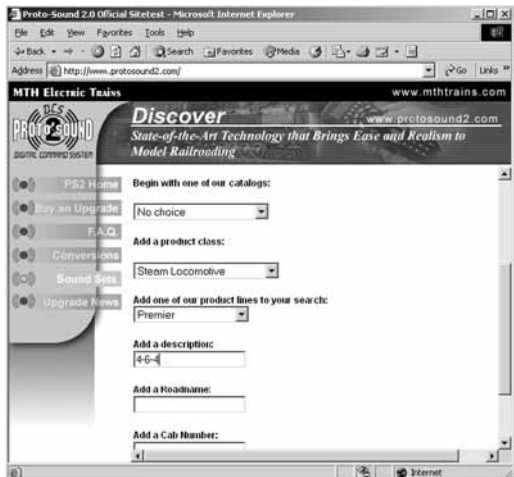
Go to the Sound Sets page on the Proto-Sound website



Go to the Sound Sets page of the Proto-Sound 2.0 Website ([www.protosound2.com/upg/soundssets.htm](http://www.protosound2.com/upg/soundssets.htm)) to search for the correct sound set for your

**STEP 2:**

Fill out the Search Fields to find the locomotive you are upgrading.



Fill out the appropriate search fields to search for your locomotive. It is not necessary to fill out all the fields.

**STEP 3:**  
Click on the photo of the engine you are upgrading.



Select your locomotive from the search results by clicking on the appropriate photo.

**STEP 4:**  
Scroll to the bottom of the page and right click the Proto-Sound 2.0 Conversion File link to download it to your computer.



Scroll to the bottom of the page and right click on the bottom sound file link to download the file to your computer. You will be prompted for the location where you want to save the file prior to the download beginning.

# Conventional PS-2 Operation

This manual contains the operating instructions for Proto-Sound 2.0 in conventional mode only. Instructions for accessing DCS command mode features accompany the DCS Remote Control System equipment.

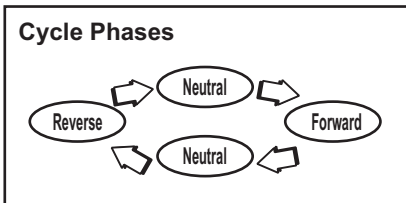
## Activating Features

**Throttle** To increase or decrease track voltage, and therefore train speed, turn the throttle control knob. Turning clockwise will increase voltage and speed, while turning counterclockwise will decrease voltage and speed. The engine will maintain the speed you set after you release the throttle until you turn it again to change the voltage and speed.

**Bell** - To sound the bell, in an engine equipped with a bell firmly press and release the Bell button. To turn the bell off, press and release the Bell button again. The bell will continue to ring from the time you turn it on until you press and release the button again to turn it off.

**Horn/Whistle** - To sound the whistle, firmly press the Horn/Whistle button. The whistle will sound for as long as you continue to depress the button. It will stop when you release the button.

**Direction** Your train is programmed to start in neutral. The train will always cycle neutral-forward-neutral-reverse with each press and release of the direction button. The engine is programmed to restart in neutral each time the track voltage is turned off for 25 seconds or more. Manual Volume Control To adjust the volume of all sounds made by this engine, turn the master volume control knob located under the left water hatch on the tender deck clockwise to increase the volume and counter-clockwise to decrease the volume.





# Activating Proto-Sound 2.0 Conventional Mode Features

Proto-Sound 2.0 features are activated by sequences of Bell and Horn button pushes described below. Please read the full descriptions of each feature before using it. To use these buttons to activate features rather than to blow the horn or ring the bell, you should tap the buttons very quickly with a 1/2-second pause between button presses. You may need to practice your timing to make this work smoothly.

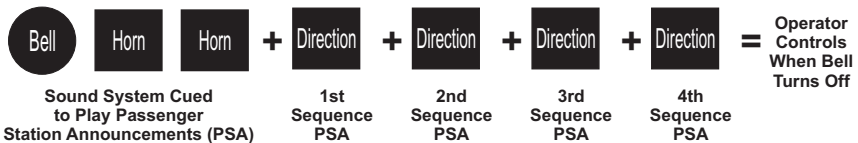
Timing Chart				
Press Horn Short & Firm	1/2 Sec. Pause	Press Bell Short & Firm	1/2 Sec. Pause	Press Bell Short & Firm
Total Time Lapse: 1 1/2 Seconds				

Feature to Be Activated	Button Code:
Passenger Station Announcements	1 Bell, 2 Horns
Fire the Rear Coupler	1 Bell, 3 Horns
Fire the Front Coupler	1 Bell, 4 Horns
Speed Control On/Off	1 Horn, 2 Bells (from Neutral only)
Lock into a Direction	1 Horn, 3 Bells
Reset to Factory Defaults	1 Horn, 5 Bells (from Neutral only)

# Passenger Station Announcements (PSA)

Your engine is equipped with a sound package of passenger station announcements that you can play when you pull into a station. Each sequence described below will play as long as it is left on, randomly generating sounds, but be sure to allow approximately 30 seconds between the button pushes described below to allow the PSA sufficient time to run through each sequence.

- To cue the sound system to play the PSA, quickly but firmly tap the Bell button once followed by 2 quick taps of the Horn button while the engine is moving. Tap the buttons quickly but allow approximately ½ second between each press.
- Press the Direction button once to stop the engine. This will trigger the first sequence of PSA. The reverse unit is temporarily disabled so that the train will not move as you use the Direction button to trigger the sounds, and Proto-Sound 2.0 has disabled operator control over the Horn and Bell buttons until the full PSA sequence is complete.
- After waiting about 30 seconds for that sequence to run, press the Direction button again to trigger the second sequence of PSA. After about 30 seconds, press the Direction button again to trigger the third PSA sequence.
- Again, after allowing about 30 seconds for that sequence to run, press the Direction button one more time to trigger the fourth and final PSA sequence. The PSA will continue, and within a few seconds, the engine and bell will start and move out on its own at the current throttle setting, in the same direction it was traveling when you began the sequence. Once the bell turns off, the operator regains control of the transformer's bell and Horn buttons and can ring the bell or blow the Horn as usual.



### Tips on Using PSA

- You can terminate PSA at any time by turning off power to the track for 15 seconds.
- You do not have to be in Forward to use PSA. At the conclusion of the full sequence, the train will pull away from the station in whatever direction you were going when you activated the feature.
- You can use PSA even if you are double-heading with another engine. If the second engine is not equipped with Proto-Sound 2.0, you must remember not to leave the throttle at a high voltage level once you have stopped the engine to run the PSA. Otherwise, the engine without PSA will begin vibrating on the track as its motors strain to move the train, since they cannot be automatically disabled during the PSA cycle (or if an original Proto-Sound engine, PSA are triggered differently and that engine's motor-disable feature will not be active when you run PSA in Proto-Sound 2.0).
- PSA can be triggered from Neutral. It will operate the same as if triggered while in motion except that, at the conclusion of the PSA, the engine will depart in the next direction of travel, as opposed to the direction it was Traveling before entering Neutral.

## Proto-Coupler® Operation

This locomotive is equipped with one or more coil-wound Proto-Couplers for remote uncoupling action. Because Proto-Couplers are controlled through the Proto-Sound 2.0 microprocessor, they do not require an uncoupling track section or modification to your layout to function. You can fire a coupler from neutral or while in motion. Use the code shown below (and in the chart on p. 7) to fire the coupler(s).

### Rear Coupler:

To fire the rear coupler, quickly tap the Bell button once followed by three quick taps of the Horn button, allowing approximately ½ second to lapse between each quick button press. The sound of the liftbar and air line depletion will play, and the knuckle will be released.



### Front Coupler:

To fire the front coupler (if your engine has one), quickly tap the Bell button once followed by four quick taps of the Horn button, allowing approximately 1/2 second to lapse between each quick button press. The sound of the lift bar and air line depletion will play, and the knuckle will be released.



## Speed Control

M.T.H. engines equipped with Proto-Sound 2.0 have speed control capabilities that allow the engine to maintain a constant speed up and down grades and around curves, much like an automobile cruise control. You can add or drop cars on the run, and the engine will maintain the speed you set.

While the engine is programmed to start with the speed control feature activated, you can opt to turn it off. This means the engine's speed will fall as it labors up a hill and increase as it travels downward. It is also affected by the addition or releasing of cars while on the run. Because the engine will run more slowly at a given throttle voltage when speed control is on than when it is off, you should adjust the throttle to a lower power level for operation with speed control off to avoid high-speed derailments. When speed control is off, the volume will drop to allow for better low voltage operation.

**To turn speed control on and off**, put the engine in neutral, then quickly tap the transformer's Horn button one time then quickly tap the Bell button two times, allowing approximately 1/2 second to lapse between each quick button press. Two horn blasts will indicate that the engine has made the change. Repeat the 1 horn, 2 bells code to return it to the other condition. You will want to do this during the initial neutral upon start-up if you ever couple this engine to another engine that is not equipped with speed control to avoid damaging the motors in either engine. Each time you shut down the engine completely, it will automatically turn speed control on.



# Locking Locomotive Into a Direction

You can lock your engine into a direction (forward, neutral, or reverse) so that it will not change directions. To do this, put the engine into the direction you want (or into neutral to lock it into neutral), run it at a very slow crawl (as slowly as it will move without halting), and quickly but firmly tap the Horn button once followed by three quick taps of the Bell button, allowing approximately ½ second to lapse between each quick button press. Two horn blasts will indicate that the engine has made the change. The engine will not change direction (including going into neutral) until you repeat the 1 horn, 3 bells code to return the engine to its normal condition, even if the engine is kept without power for extended periods of time.



# Reset To Factory Default

To override the settings you currently have assigned to the engine and reset it to its factory defaults, while in Neutral tap the Horn button quickly once, followed by five quick taps of the Bell button, allowing approximately ½ second to lapse between each quick button press. Two horn blasts will indicate that the engine has made the change.



# Automatic Sound Effects

Certain Proto-Sound 2.0 sound effects automatically play in programmed conventional mode conditions:

- Squealing Brakes play any time the engine's speed decreases rapidly.
- Cab Chatter plays at random intervals when the engine idles in neutral.
- Engine Start-up and Shut-down sounds play when the engine is initially powered on or is powered off for five seconds or more.

## Self-Charging Battery Back-Up

The two special AA 2.4 NiCad Battery Pack recharges continuously during train operation and should last for up to five years. The batteries are dry battery that should not leak or cause any damage to your engine. Depending upon when your engine was built, they may need to be charged right out of the box.

If engine sounds seem distorted or garbled at low voltages or become silent when power from the transformer is turned off, test the batteries to determine whether they should be recharged or replaced.

**Test:** Put the engine in neutral and leave the track voltage at 10-12 volts (high enough for the lights to shine brightly and the engine to move steadily) for 15 minutes.

**Recharge:** If the sounds are improved at the end of the 15-minute test charge, the batteries charge has run down and can be recharged. There are a number of ways you can do this:

Leave the engine in neutral with track voltage at 10-12 volts for 6-7 hours so the batteries can fully recharge (if your engine has a smoke unit, be sure it is turned off).

Use M.T.H.'s battery recharger (sold separately) that plugs into a wall outlet and a special port under the tender water hatch to recharge the batteries overnight without leaving it on the track.

**Replace:** If the sounds are not improved at the end of the 15-minute test charge, it is time to replace the batteries. Available through M.T.H. Parts.

**DO NOT** substitute alkaline batteries for these NiCad batteries. Using alkaline batteries in this system will result in damage to the PS 2.0 circuit board and/or the batteries.

# Troubleshooting Proto-Sound® 2.0 Problems

Although Proto-Sound 2.0 has been designed and engineered for ease of use, you may have some questions during initial operation. The following table should answer most questions. If your problem cannot be resolved with this table, contact M.T.H. for assistance (telephone: 410-381-2580; fax: 410-423-0009; service@mth-railking.com, 7020 Columbia Gateway Drive, Columbia MD 21046-1532).

<b>Starting Up</b>	<b>Remedy</b>
When I first turn the power on, the engine will not begin to run. I have to turn the throttle off and then on again to get the engine to operate.	This is normal behavior. To prevent accidental high-speed start-ups, Proto-Sound 2.0 is programmed to start up in neutral anytime track power has been turned off for several seconds. See the "Basic Operation" section for more details.
<b>Whistle/Horn</b>	<b>Remedy</b>
When I press the whistle/horn button, the bell comes on instead.	Reverse the transformer leads.
I can't get the horn to blow when I press the whistle button.	You may be pressing the button too quickly. Try pressing the whistle/horn button more slowly, taking approximately one full second to fully depress the button.
<b>Bell</b>	<b>Remedy</b>
When I press the whistle button, the bell sounds.	Reverse the transformer leads.
I can't get the bell to ring when I press the bell button.	You may be pressing the button too quickly. Try pressing the bell button more slowly, taking approximately one full second to fully depress the button.
The bell won't work on a separate bell button.	Check the wiring of the separate button.
<b>Coupler</b>	<b>Remedy</b>
When I try to fire the coupler, FYS starts.	You are waiting too long between whistle button presses.
The Proto-Coupler won't let the engine uncouple on the fly.	Try lubricating the coupler knuckle with a dry graphite lubricant. Do NOT use oil.
The coupler does not fire or stay coupled.	The coupler needs to be cleaned. Wipe with denatured alcohol (not rubbing alcohol) and let dry.

<b>Cab Chatter</b>	<b>Remedy</b>
Sometimes the Cab Chatter sounds don't play.	Cab Chatter plays only in neutral at random intervals.
<b>Lock-out</b>	<b>Remedy</b>
I can't get the engine to run after I power up the transformer. It sits still with the engine sounds running.	The engine is locked into the neutral position. Follow the procedure in the "Lock into a Direction" section.
The engine won't lock into forward, neutral, or reverse.	Engine speed must be below 10 scale mph (approx. 10 volts or less in conventional mode).
<b>Volume</b>	<b>Remedy</b>
The sounds seem distorted, especially when the whistle or bell is activated.	Proto-Sound 2.0 volume is set too high. Turn the volume control knob on the bottom of the chassis counter-clockwise to reduce the volume.
<b>Battery</b>	<b>Remedy</b>
The engine will not leave the initial neutral setting.	Check to be sure the battery is installed and fully charged. See the "Self-Charging Battery Back-Up" section.
I get no sounds when the engine shifts between directions.	The battery may be dead or need to be charged. See the "Self-Charging Battery Back-Up" section.
After I turn off my transformer, my engine continues to make sounds before quitting.	Proto-Sound 2.0 is designed to continue to sound for a few seconds after power to the track has been shut off.
<b>FYS</b>	<b>Remedy</b>
The FYS sounds occasionally repeat themselves.	Proto-Sound 2.0 has a built-in random number generator that randomly selects each sound clip to play. Because there are a limited number of sound clips available in each FYS sequence, it is probable that some of these sound clips will be repeated from time to time.



FYS	Remedy
Once in FYS, the engine doesn't go into reverse.	So that FYS effects can be as realistic as possible, Proto-Sound 2.0 disables the reversing unit whenever FYS is enabled. This way the engine remains still at its stop as the operator cycles through the FYS sequences.
When the FYS enters its last sequence the bell automatically comes on.	FYS is programmed to start ringing the bell at that point. After approximately 12 rings of the bell, it will automatically turn off.
When FYS is enabled, pressing the whistle and bell buttons has no effect.	Because FYS must control various effects in each sequence, Proto-Sound 2.0 takes control of these sound effects until you exit FYS.
I push the direction button but the next sound clip in the sequence does not play or the engine does not come out of FYS after fourth press of the direction button.	Each FYS clip must play for approx. 30 seconds before FYS will advance to the next step in the FYS cycle. Wait at least 30 seconds in each FYS sound clip before pressing the direction button.

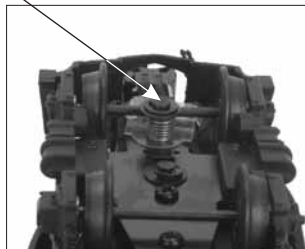
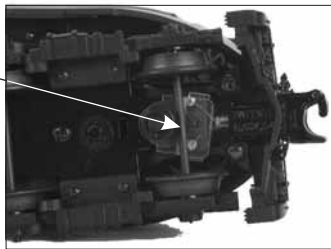
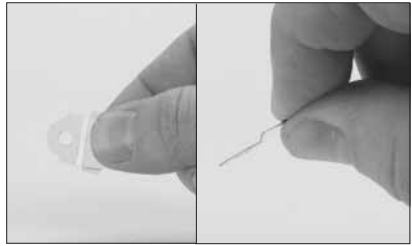
# PS-2 Upgrade Kit- Coupler Installation

A plastic insulator, item CC in the parts list of your Proto-Sound 2.0 Upgrade Kit, has been included with the rest of your PS-2 Upgrade Kit parts.



Shown above is the coupler unassembled.

This insulator should be inserted between the coupler and the spring, washer and the coupler to the T-Bar and truck bolster. The insulator prevents the coupler wiring from contacting and short circuiting against the truck's axle. Failure to insert the insulator could permanently damage the coupler and PS-2 board. Shown here is the insulator attached to the truck and coupler. Ensure that the part of the insulator which protects the coupler's wires extends up not down when installed.



# Service & Warranty Information

## How to Get Service Under the Terms of the Limited Warranty

When you suspect an item is defective, please check the operator's manual for standard operation and trouble-shooting techniques that may correct the problem. Additional information may be found on the M.T.H. Website. Should you still require service, follow the instructions below to obtain warranty service.

First, e-mail, write, call or fax the M.T.H. Authorized Proto-Sound 2.0 Conversion Center that installed the kit to obtain Repair Authorization. You can find the list of conversion centers on the M.T.H. Website, [www.mth-railking.com](http://www.mth-railking.com). The center that installed the kit will provide service during the warranty period. Should the warranty no longer apply, you may choose either an ASC or NASC retailer to service your M.T.H. Product. A reasonable service fee will be charged.

**CAUTION:** Make sure the product is packed in its original factory packaging including its foam and plastic wrapping material to prevent damage to the merchandise. There is no need to return the entire set if only one of the components is in need of repair *unless otherwise instructed by the Service Center*. ***The shipment must be prepaid and we recommend that it be insured. A cover letter including your name, address, daytime phone number, e-mail address (if available), Return Authorization number (if required by the service center, a copy of your sales receipt and a full description of the problem must be included to facilitate the repairs. Please include the description regardless of whether you discussed the problem with a service technician when contacting the Service Center for your Return Authorization.***

Please make sure you have followed the instructions carefully before returning any merchandise for service. Authorized M.T.H. Service Centers are independently owned and operated and are not agents or representatives of M.T.H. Electric Trains. M.T.H. assumes no responsibility, financial or otherwise, for material left in their possession, or work done, by privately owned M.T.H. Authorized Service Centers.

If you installed the PS-2 Upgrade Kit yourself, there is no warranty. Contact M.T.H. for replacement parts. Any required parts, plus shipping and handling fees will be charged. If you need assistance at any time email MTH Service at [service@mth-railking.com](mailto:service@mth-railking.com), or call 410-381-2580.

## Limited 90-Day Warranty

**This product, when installed by an Authorized M.T.H. Proto-Sound 2.0 Conversion Center, is covered by this warranty.**

See our website at [www.protosound2.com](http://www.protosound2.com) or call 410-381-2580 to identify an Authorized M.T.H. Proto-Sound 2.0 Conversion Center near you.

M.T.H. Proto-Sound 2.0 Upgrade Kits are warranted for 90 Days from the date of installation by an Authorized M.T.H. Proto-sound 2.0 Conversion Center against defects in material or workmanship. We will repair or replace (at our option) the defective part without charge for the parts or labor, if the item is returned to the M.T.H. Authorized Proto-Sound 2.0 Conversion Center who installed the kit within 90 Days of the installation. This warranty does not cover damages caused by improper care, handling, or use. Transportation costs incurred by the customer are not covered under this warranty. This warranty does not cover any installation charges incurred from installing the conversion kit.

Items sent for repair must be accompanied by a return authorization number, a description of the problem, and a **copy of the original sales receipt from an Authorized M.T.H. Proto-Sound 2.0 Conversion Center**, which gives the date of purchase and installation of the kit. If you are sending this product to an Authorized Proto-Sound 2.0 Conversion Center, contact that Center for their return authorization. This warranty gives you specific legal rights, and you may have other rights that vary from state to state. Specific questions regarding the warranty may be forwarded to M.T.H. directly.

Service Department  
M.T.H. Electric Trains  
7020 Columbia Gateway Drive  
.Columbia MD 21046-1532

**CAUTION: ELECTRICALLY OPERATED PRODUCT:**

**Not recommended for children under 10 years of age. M.T.H. Recommends supervision with children ages 10-16. As with all electric products, precautions should be observed during handling and use to reduce the risk of electric shock.**

WARNING: When using electrical products, basic safety precautions should be observed, including the following: Read this manual through before using this device.

- M.T.H. Recommends that all users and persons supervising use examine the hobby transformer and other electronic equipment periodically for conditions that may result in the risk of fire, electric shock, or injury to persons, such as damage to the primary cord, plug blades, housing, output jacks or other parts. In the event such conditions exist, the trains set should not be used until properly repaired.
- Do not operate your layout unattended. Obstructed accessories or stalled trains may overheat resulting in damage to your layout.
- This train set is intended for indoor use. Do not use if water is present. Serious injury or fatality may result.
- Do not operate the hobby transformer with damaged cord, plug, switches, buttons or case.