III. DCRU and Original ProtoSound System

Replacement Tender Harness Wiring Instructions

When wiring the replacement tender harness to a non-plug-in DCRU or OEM P4 ProtoSound board, please use the following guide for proper connection and operation.

Wire Color	Board Connection
Red	AC
Black	ACG
Yellow	M1
White	M2

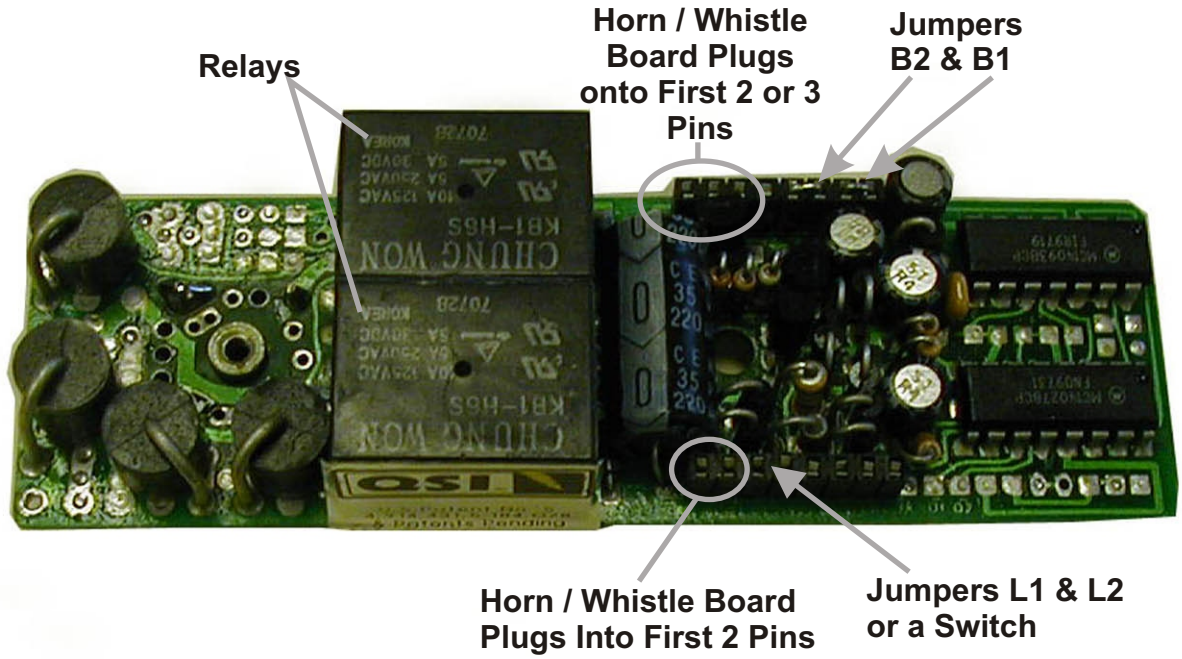
You should clip the connectors from the harness leads, strip a short length of insulation, and solder the wire leads to the appropriate points on the board.

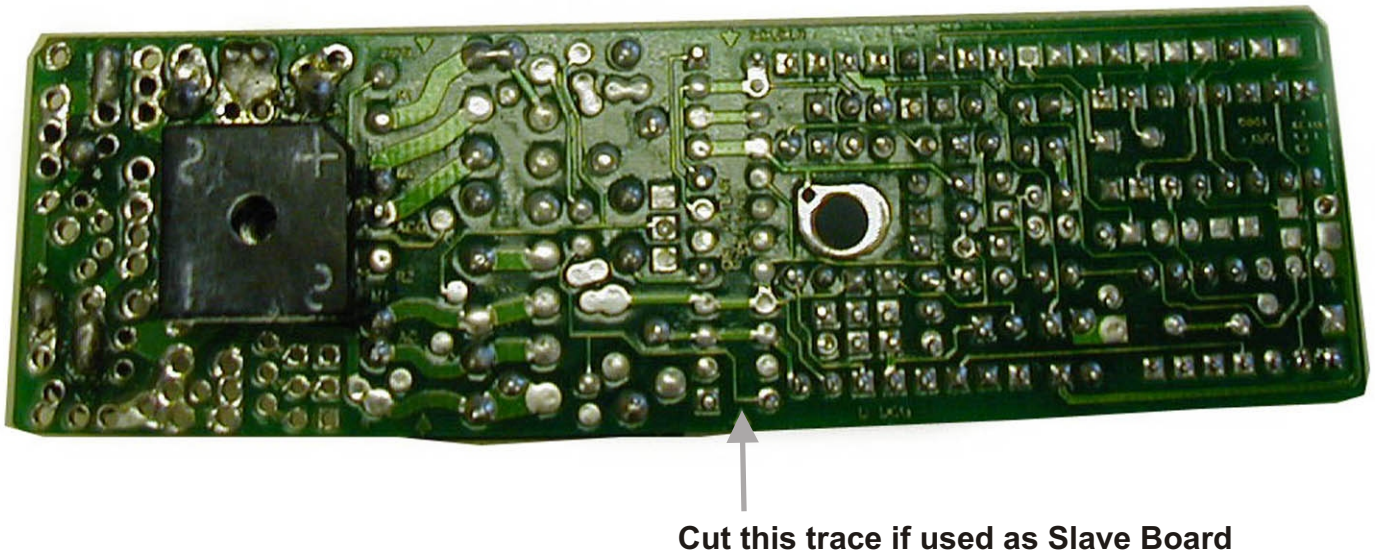
Caution: Failure to follow above instructions may cause damage to the circuit Boards.

Short harness (10”) MTH part number BC-0000028
Long harness (15”) MTH part number BC-0000099

DCRU and Horn / Whistle

Normal Operation (F-N-R) - Jumpers in B1-B2, L1-L2
Forward Only - Jumper in B1, L1-L2
Reverse Only - Jumper in B2, L1-L2





NOTE: MTH no longer stocks the DCRU Board. Please contact QSI if a replacement is required.

Low Battery Indicators

The Following symptoms are Common indicators of an under charged or dead ProtoSound battery:

1. When the track power is interrupted, the sounds stop abruptly in less than the normal 10 to 15 second, often there is a “sputter.”
2. While running with less than 10 V on the track, the whistle or horn sounds distorted when activated.
3. When attempting to shift from either forward or reverse into neutral, the sound sputters and the engine will not shift properly.
4. When attempting to program in Reset, the engine will not lock the changes.
5. If the engine locks itself into forward, neutral or reverse and will not unlock following the unlocking procedures in the operating instructions.
6. When shifting between directional states no sounds are heard.

If any of these occur, it will be necessary to charge the battery. To fully charge the battery, place the engine in neutral with the throttle set at 15 Volts. With the smoke unit (if equipped) turned off charge for 6 hours. The sound can be manually turned down with the control underneath the diesel or electric engine. On a steam engines the sound control is located underneath the tender.

If the engine is locked into forward or reverse and can not be unlocked due to a low battery condition a quick charge will be necessary. To quick charge the battery run the engine in forward or reverse (neutral preferred) with the throttle set to 15 Volts. Do this for an hour, with the smoke unit (if equipped) turned off. After an hour, follow the directions in the operating instructions to unlock the engine. After unlocking the engine from the state it was locked into place in neutral and charge (following the previous instructions) for an additional 5 hours. If this does not work the battery may need to be replaced or if any of the above symptoms persist, further action may be required.

Testing the Battery Charging Circuit

1) Connect the *positive terminal only* of the battery to the positive terminal of the snap connector.

2) Connect the black (negative) lead of a DMM/current meter to the negative terminal of the battery.

3) Connect the red (positive) lead of the DMM/current meter to the negative terminal of the snap connector.

4) Set the DMM/current meter to the 200mA DC range and turn the meter ON.

5) With no power applied to the unit under test, and the battery in shutdown, check that the meter reads zero current.

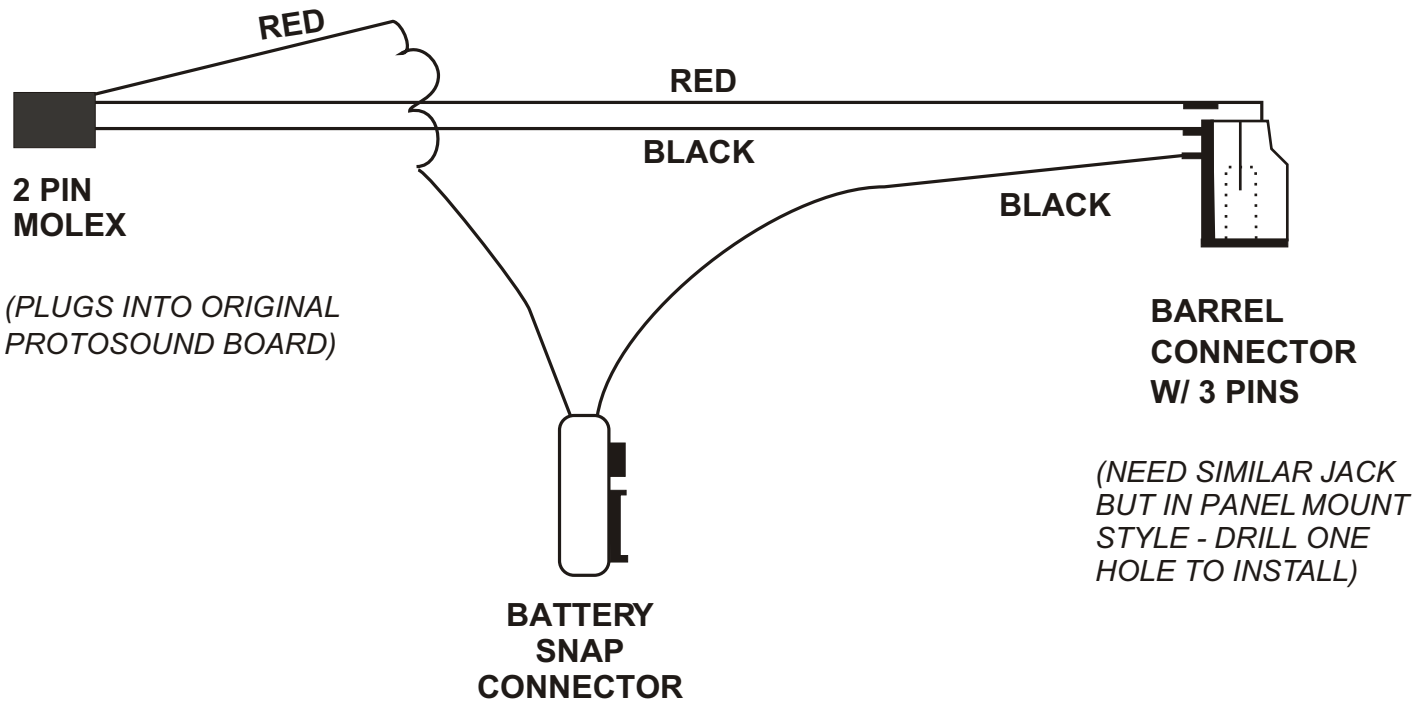
6) Apply power (approximately 12VAC) to the unit under test. Check that the meter reads a negative current flow of approximately -10 to -30mA DC with a fully charged battery. If the battery is not fully charged, the measured current can show in a lower range, but still have a negative flow. This will verify that the charging system is functioning correctly.

7) Remove power from the unit under test. Check that the meter reads a positive current flow. This reading will vary from 75mA to 25mA as the ProtoSound unit progresses through shutdown. This will verify that the battery backup function is working correctly.
Note: Higher current readings may be seen very briefly after track power is turned off.

8) When the unit under test completes it's shutdown sequence, and the battery is in complete shutdown, check that the meter again reads zero current. This will again verify that the battery circuit does completely shut off, and no leakage current is flowing through the ProtoSound circuits.

9) If the unit passes all of the above tests, turn the meter OFF, disconnect the meter leads from the unit under test, connect the negative terminal of the battery to the negative terminal of the snap connector, and complete any other service required for the unit.

Wiring Diagram for Original Proto-Sound®
Battery Charging Harness



(WHEN BATTERY CHARGER IS PLUGGED IN POWER IS SUPPLIED TO THE BATTERY ONLY, PROTOSOUND BOARD IS ISOLATED FROM VOLTAGE.)

(MTH PART NUMBER BC-0000204)

Operating Proto-Sound® Passenger Station Sound Effects

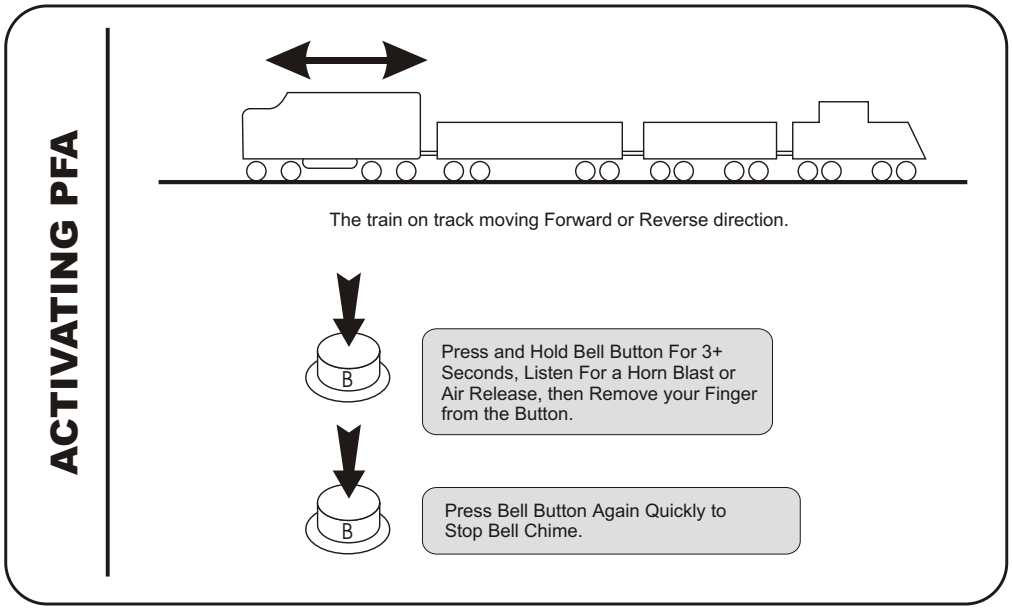
Passenger Station Announcements (PFA)

Proto-Sound® is equipped with operator controlled Passenger Station Sounds, referred to as PFA. The PFA Sequence is designed to simulate the arrival, disembarking, embarking and departure of a passenger train in a Passenger Station. This easy-to-use feature allows you to play digitally recorded sounds of Passenger Station sounds while your engine is parked in the Neutral State. No additional wires or modifications are needed to enjoy these amazing sound effects. The sounds themselves are randomly "shuffled" by the Proto-Sound® computer. This gives the system the ability to play the various sounds in a different order each time PFA is Enabled.

PFA can not be activated in RESET. Once the engine has left RESET and is moving, PFA can be activated as follows.

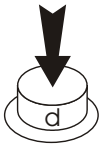
Activating Passenger Sounds -Quick Overview-

The following is a quick overview on how you can operate PFA.



Your train is now ready for you to play the PFA.

EVENT 1



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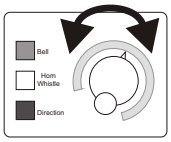
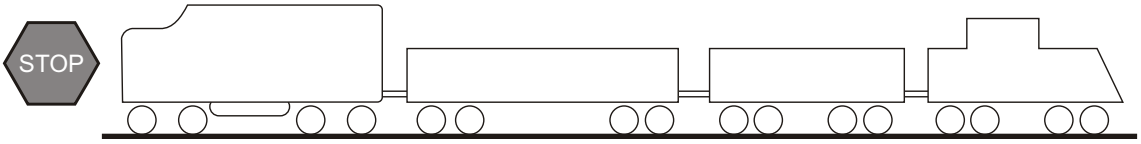
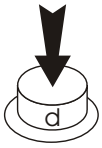


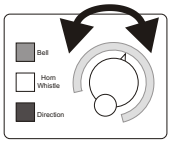
- To Play PFA, Stop Train Direction. This Can Be Done by Pressing the DIRECTION Button or Cycling the Transformer Handle.
- At This Time the Train Will Stop in Neutral.
- In a Few Seconds, An Arrival Message Plays, Followed by a Background Noise



EVENT 2

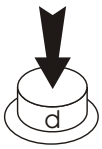


OR



- Change/Press Direction- The Train Will Remain In Neutral. It Will Continue to Play More Background Noises.

EVENT 3



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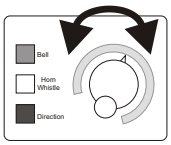
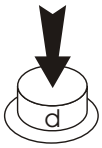


- Change/Press Direction- The Train Will Remain In Neutral. You Will Hear a Double Air Release, Departure Message Plays More Background Noises.

EVENT 4



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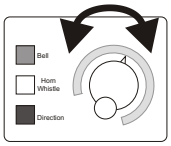
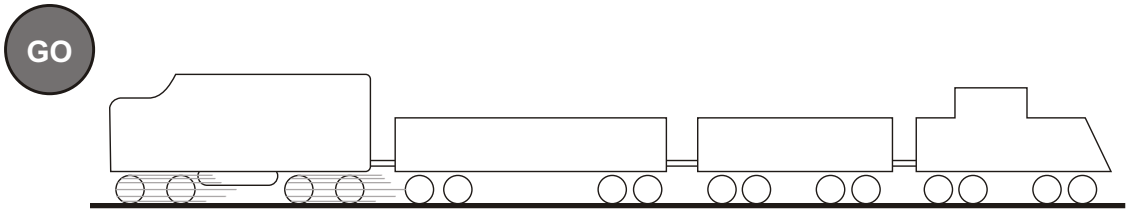


- Change/Press Direction- The Train Will Remain In Neutral. You Will Hear Closing Doors, Horn Blast, a Few Bell Chimes and Train Departs in the Direction the Train First Stopped.



PFA Activation with Whistle Button Only

1) Put the engine into Neutral, with Forward being the next direction of travel.
2) Set the Throttle to about 8 VAC.
3) Slowly press the whistle control until the bell just begins to ring, and hold it there.
4) After about 3 seconds, if you listen closely, you will hear an air release (WHOOSH!). When you hear this sound, you may release the whistle control. The bell will still be ringing.
5) Press and release the whistle control to turn off the bell.
6) Interrupt power to switch the engine into Forward.

While the engine continues to run in Forward, the Squealing Brakes will be active. When you next enter Neutral, the Freight Yard Sounds or Passenger Station Announcements will begin.

Reset Operation

A. Reset Defined. RESET is a state in which the operator is able to modify how a ProtoSound equipped engine will Operate. This state, similar to Neutral before Forward, is entered when the engine is initially powered, or any time power is interrupted for greater than 3 seconds Within RESET, the operator can access several programming feature levels.

B. Accessing Reset Levels. In order to change specific program features, the operator must access the correct Reset level. Raising the transformer's throttle to full voltage, then lowering the voltage to 8V AC, will advance the Reset level. Each time this is completed, an air release sound will be played, and the engine will advance one Reset level (Reset 0 to Reset 1 to Reset 2, etc.). ProtoSound will indicate the current Reset level by then playing a series of "Clinks" and "Clanks." If you pass the desired Reset level, you must reenter RESET at Reset 0 and begin counting over.

C. "Clinks" and "Clanks". Clinks and Clanks are used by ProtoSounds to indicate the current Reset level. They operate similar to Roman numerals in that a Clank indicates a "one," and one Clank equals five Clinks. As you advance through the Reset levels, the Clinks and Clanks will count the levels. (1 Clink, 2 Clinks, 3 Clinks, 4 Clinks, 1 Clank, 1 Clank & 1 Clink, 1 Clank & 2 Clinks, etc.) Just add the Clinks and Clanks to get the Reset number.

D. Common Reset Levels and Operation. The following is a list of common Resets used in factory ProtoSound equipped engines:

1) Reset 6 – Motor/Chuff Volume. (1 Clank, 1 Clink) Reset 6 allows you to change the volume setting of the motor sound (diesel & electric engines) or chuff (steam engines), without effecting the volume of other sounds, such as whistle/horn, bell, cab chatter, etc. To use, cycle to Reset 6 and press the Whistle control. A single bell will play, and the motor/chuff will begin at the current volume. Each time the Whistle is pressed, the volume setting will cycle down. The levels available are 100%, 50%, 25%, and 0%. When the desired level is reached, lock the changes by interrupting the throttle and cycling the engine into forward.

2) Reset 10 – ProtoCoupler ON/OFF. (2 Clanks) Reset 10 allows you to turn the operation of the ProtoCoupler on or off. When OFF, the coupler will not arm or fire from Neutral. To use, cycle to Reset 10 and press the Whistle control. The engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 10 are 1 Bell = ON, 2 Bells = OFF. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.

3) Reset 18 – Factory Defaults. (3 Clanks, 3 Clinks) Reset 18 is the most powerful of the Reset features available. Using Reset 18 allows you to override all changes in programming and return all Resets to the original, out of the box settings. To use, cycle to Reset 18 and press the Whistle control. The engine will play a distorted bell, followed by a clear bell sound. This indicates that the ProtoSound system has restored all settings to factory default settings. Lock the changes by interrupting the throttle and cycling the engine into forward.

4) Reset 23 – Cab Chatter ON/OFF (Diesel/Electric engines only). (4 Clanks, 3 Clinks) Reset 23 allows you to turn the operation of the Cab Chatter system on or off. When OFF, the Cab Chatter recordings will not be played when the engine is in Neutral. To use, cycle to Reset 23 and press the Whistle control. The engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 23 are 1 Bell = ON, 2 Bells = OFF. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.

5) Reset 25 – Whistle/Horn in Neutral. (5 Clanks) Reset 25 allows you to operate the Whistle or Horn while the engine is in the Neutral state. When ON, pressing the Whistle control while in Neutral, with 10V AC or less on the track, will cause the Whistle or Horn recording to sound. To use, cycle to Reset 25 and press the Whistle control. The

engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 25 are 1 Bell = OFF, 2 Bells = ON. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.

6) Reset 28 – PFA system ON/OFF. (5 Clanks, 3 Clinks) Reset 28 allows you to turn the operation of the PSA or FYS sequence on or off. When OFF, the PFA will not activate. To use, cycle to Reset 28 and press the Whistle control. The engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 28 are 1 Bell = ON, 2 Bells = OFF. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.
7) Reset 40 – Lockout Enable. (8 Clanks, 0 Clinks) Reset 40 allows you to enable the Reverse Unit Lockout feature of ProtoSounds. When enabled, you are able to lock the engine to run in only one of the directional states (Forward, Neutral or Reverse) whenever power is applied. The most common use for locking out an engine is in the use of power blocks on a layout. To use, cycle to Reset 40 and press the Whistle control. The engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 40 are 1 Bell = OFF, 2 Bells = ON. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.
8) Reset 45 – Squeaking Brakes. (9 Clanks, 0 Clinks) Reset 45 allows you to determine if and how the Squeaking Brakes recording will be activated. To use, cycle to Reset 45 and press the Whistle control. The engine will play a series of bells. This indicates the current setting. Each time the Whistle is pressed, ProtoSound will cycle to the next available setting and provide the appropriate bell indicator. The settings for Reset 45 are 1 Bell = On Demand (Enabled when PSA or FYS is activated), 2 Bells = Always On, 3 Bells = Off. When the desired setting is reached, lock the changes by interrupting the throttle and cycling the engine into forward.

Using "Z-4000" to Program Feature-18 in ProtoSound®

What is ProtoSound®?

ProtoSound® Is a computer controlled, digital sound and train control system offered in MTH engines. It offers digital recordings of real train sounds including steam chuffing, diesel motors, whistles, horns and bells. Additionally, **ProtoSound®** offers features such as remote controlled **ProtoCouplers**, which allow the operator to uncouple an engine anywhere on the layout, and **ProtoEffects** like Passenger Station Announcements (PSA) and Freight Yard Sounds (FYS).

Feature 18

ProtoSounds® **Feature 18 is** a **RESET STATE** that **"SETS"** all programmable options back to their original factory settings. This is a useful feature if you find your engine not operating the way you think it should.

EXCEPTION:

Some very early versions of ProtoSounds did not have feature 18. see the operating instructions included with your locomotive

What is RESET?

When power is first applied to the track, the control unit begins in **RESET** or what seems like a neutral state. You will hear two dings and approximately 2 seconds later you will hear the engine's startup sounds begin. It is this first **RESET STATE** that allows ProtoSound® options and functions to be set into the computer program. The system will enter **RESET** whenever power to the track is off for five seconds or more or after the throttle is turned off and you hear a single bell ding. When the engine first enters **RESET**, the microprocessor initiates a system check to determine if the system, transformer and engine are operating correctly.

You will notice that when in **RESET**, your engine will not respond to the whistle button. In fact, when in **RESET** and the whistle button is depressed, only one single bell chime will be heard. When you are in **RESET** mode for more than five seconds and have the track voltage set to less than 10 volts and push the direction button the locomotive should go in the forward direction. If your are in **RESET** and the track voltage is set for more than 15 volts and you push the direction button, nothing will happen. You will still be in **RESET.**

Entering RESET Options:

ProtoSound® is equipped with programmable features that are accessed in the **RESET** State. Special "**Clank** " and "**Clink**" sounds to tell you what RESET position you are in.

Each "CLINK " = 1

5 "CLINKS" equals one "CLANK"

For example, if you are in RESET Feature 7. **ProtoSound®** will respond with a "Clank " and two Clinks "(= Feature 7.)

Programming RESET Feature 18:

To **SET** all the features back to their original factory settings with a Z-4000, enter **RESET Mode** and go to **Feature 18**. Using the following steps

NOTE: Make sure that the ProtoSounds® battery is fully charged any time that you try to **RESET** program options

Put the locomotive on the track that a Z-4000 throttle is connected to.

On the Z-4000 press the black **Program Button** on the throttle that is connected to your locomotive

The indicators on the active throttle side will read " 00" in the volts window And read "PG" in the AMPS window the other side LED display will go out (off)

At this point you are in the **Program mode.** On the panel you will see indicators that are outlined in blue. These are the function indicators that are active while in the Program Mode

Press and release the **Whistle/Horn** button next to the blue **UP ARROW** until you see **"18 "** in the LED indicator panel, (the **Direction button** will move the number down).

Now press and release the **Bell / Select button**, wait for engine to cycle the reset function you will hear a series of short steam chuffs followed by **3 clank** and **3 clink** sounds. You now have set Protosound to **feature 18.**

Press and hold the **Bell / Select button** again and wait for the engine. To sound a garbled bell (warbling sound) then release. Press 2nd time, wait for single bell, release.

Press and release the black **"program"** button and advance the selected throttle immediately so your engine moves forward.

Normal Operation

To start a locomotive up from a **cold power up** (after the locomotive has had power off for more that three seconds). Remember the system will enter RESET whenever power to the track is off for three or more seconds Do not advance the transformer throttle past 10 volts when you first enter RESET if you want your engine to start normal. Wait for the engine startup sounds to begin (at least 4 Seconds).
If the system is set above 10 volts, move forward with the press of the direction button. Turn the throttle down until you hear the steam discharge sound before turning the transformer throttle to the off position and back again (or pressing the direction button) to enter the forward phase. Interrupting The power too quickly may cause the System to re-enter RESET (signaled by two dings of the bell).

Should this happen, wait longer before interrupting the power to enter the Forward Phase. After you leave RESET; your engine will operate normally in all the direction States of FORWARD, NEUTRAL and REVERSE.

NOTE: **NEUTRAL** is the state between Forward and Reverse and is not the same as **RESET.**

Reset Feature 27 Operation with the Z-4000 Transformer

NOTE: These instructions explain how to perform a Reset 27 (chuff rate) using a Z-4000. If you are using another type of transformer then you will need to put the engine into Reset 27 following the instructions in your operator's instructions. After hearing the five clanks and two clinks then start at step four of these instructions.

One of the most popular features on the Z-4000 Transformer is the simplicity of programming your ProtoSound equipped engines by using Program Mode. With a scrolling menu and push button access, MTH has eliminated the need to run the throttle up and down while counting the "Clinks" and "Clanks" to set up the operation of the engine. Program operation is explained in detail in the Operating Instructions shipped with each transformer. However, use of Reset Feature 27, Chuff Thresholds for Steam Engines, which operates differently than the other features, was not included in the initial printing.

Reset Feature 27 allows the operator to "fine tune" the rate of chuff relative to the speed of the engine by setting the minimum and maximum chuff points. To do this with the Z-4000, follow the steps below:

1) With the steam engine on the track, and the transformer throttles in the "OFF" position, press the "PROGRAM" button for the track in use. The display will read "00" and "PG".
2) Using the "WST/HRN" button, scroll the top display up to "27," then press "BELL SELECT." The transformer will power the engine in Reset, and run the ProtoSounds to Reset Feature 27 (5 Clanks, 2 Clinks).
3) Raise the throttle from the "OFF" position and press the "PROGRAM" button. This will release the transformer from the Program Mode without the engine leaving Reset Feature 27.
4) With the throttle set low, press the "WST/HRN" button. You will hear a single bell, and the engine will begin to move forward with no chuff.
5) Reduce the throttle until the engine just stalls, and press "WST/HRN." You will hear a double bell. This is the motor speed where the chuff will Begin. (Normally around 6.0 volts).
6) Raise the throttle until the engine is running at the speed that you want the chuff to be the fastest, and press "WST/HRN." You will hear three bells, and the engine will Stop. (MTH suggests 12-13 volts).
7) Bring the throttle to the "OFF" position to complete the Reset feature.

Test the settings by running the engine. You may need to repeat the procedure to further adjust the thresholds. And remember you can always return to the Default Settings by using Reset Feature 18.

If you have any questions or comments please do not hesitate to contact the MTH Service Department at 410-381-2580.

MAKE, FIX, & Force Chips for Resetting (Original) Proto-Sound

The MAKE, FIX, & Force chips were designed to reprogram ProtoSound1 sound systems when certain sounds are heard or not heard. These chips should be used ONLY as described below. Do NOT use of any of these chips when the problems described below do NOT exist. Use of one of these chips on a good board will most likely result in damage to the top board.

There are 4 types of chips:

1. **MAKE PS** (for use ONLY when **"3 clanks"** are heard)
2. **FIX 1011** (for use when there is no sound or motion, but lights)
3. Force 10 (reconfigure 2/4Meg boards, contact MTH Service for instructions)
4. Force 11 (reconfigure 2/4Meg boards, contact MTH Service for instructions)

"3 CLANKS"

The MAKE PS chip is used to reprogram Proto-Sounds (original) when the engine starts up and "3 clanks" are heard. This is the only time to use this chip. This signals a software compatibility issue caused by a low battery. Follow the instructions below when using the Make PS chip.

1. Replace the battery with a known good battery (test under load).
2. Completely power the engine down, turn off power to the Proto-Sound board and allow 20 seconds to occur after turning the power off. Listen for the confirming battery chirp sound after the engine sound has stopped.
3. Remove the original chip using a chip extractor tool.
4. Install the "Make PS" chip. Make sure to align the chip in the socket properly.
5. Apply power (16-18 volts) to the board and listen for 2 bell sounds.
6. Completely power the engine down (reference 1. Above).
7. Remove the "Make PS" chip using the chip extractor tool.
8. Install the original sound chip. Make sure to align the chip in the socket properly.
9. Perform Reset 18 to return the unit to factory default settings and check operation of the engine and Proto-Sound system.

If after using the "Make PS" chip and checking the operation of the engine (step 9.) the engine gives 2 bells but won't come out of reset perform the following.

10. Check the battery to be sure it has an adequate charge to maintain power to the Proto-Sound board during momentary power interruption signal to exit reset.

11. Verify voltage to the track is below 10 Volts. Remember, Proto-Sound equipped engines come up in RESET mode and will not leave the stationary RESET mode unless track voltage is less than 10 volts when power is momentary interrupted to signal the direction change.

12. If the engine still will not leave RESET, listen to the sounds the engine makes at start up and call MTH Service for further instructions

LIGHTS, But NO SOUND and NO MOTION

If you have an engine equipped with Original ProtoSounds with lights that are operating but no sound and motion. Check the speaker and volume pot first to make sure they are working properly and use the Force 1011 chip using the following instructions.

13. Check the battery to be sure it has an adequate charge to maintain power to the Proto-Sound board during momentary power interruption signal to exit reset.
14. Verify voltage to the track is below 10 Volts. Remember, Proto-Sound equipped engines come up in RESET mode and will not leave the stationary RESET mode unless track voltage is less than 10 volts when power is momentary interrupted to signal the direction change.
15. Try using a transformer with a pure sine wave output and not and electronically chopped output since early (pre 1996 models required pure sine wave power). The Z4000 is a pure sine wave output. The Z1000, Z750, and Z500 are electronically chopped outputs run 1997 and later models.
16. Check the speaker wires and speaker. Make sure the wires are not broken and the connection to the board and speaker are secure. Also check the speaker using a battery, you should hear a pop sound when 8.4Volt DC is applied across the terminals.
17. Verify the Volume POT is functioning properly. Make sure the wires are not broken and the connection to the board and POT are secure. Also check the POT terminals, you should read 10K ohms across the outer terminals and 0-10K from the center terminal to either outer terminal when adjusting the POT.
18. If steps 13 17 all check out OK, repeat steps 1 - 9 using the "FIX 1011" chip.

Replacing ProtoSound Boards in OLD Engines (1994 & 1995)

If you have a locomotive equipped with ProtoSounds and it does not have sound or does not move. Please try using a pure sine wave transformer to operate the model first see step 15. Since early ProtoSound systems operated only with pure sine wave outputs, check the train model and production date to determine if the locomotive requires a pure sine wave operation. If the engine does not operate with a pure sine wave transformer and the board needs to be replaced, please contact MTH about steps to force a 4 meg top board for use with a 2 meg chip or vice versa.

If you have any questions during the use of any of these chips, please contact a MTH Service Technician using the ASC technician hotline.

Corrective Software for Engine I.D. Condition

(also referred to as a Deselect for "Original ProtoSound")

New software is available for the following MTH engines equipped with "Original ProtoSounds" to eliminate the ID situation. This software will override the Deselect bit and allow the engine to operate. However, other reset programming may also be affected. Install the new EE PROM chip, then perform a Reset 18 to the factory default settings. *(This does NOT apply to engines equipped with ProtoSound2.0)*

STEAM

RK Dreyfuss Hudson *NYC* (30-1113-1)
RK L-3 Mohawk *Texas & Pacific* (30-1114-1)
RK K-4 *PRR* (30-1115-1)
RK H-8 Allegheny *C&O* (30-1116-1)
RK Torpedo *PRR* (30-1118-1)
RK GS-4 *Southern Pacific Daylight* (30-1119-1)
RK NYC Hudson w/FYS (30-1121-1)
RK 0-8-0 (with second run whistle) (30-1123-1, 30-1124-1))
RK Big Boy *UP* (30-1129-1)
Premier J1e Hudson, 20th Century Limited *NYC* (20-3020-1)
Premier Big Boy *UP* (20-3021-1)
Premier Shay *WP&P* (20-3023-1)

DIESEL

RK F-3 *WP & FEC* (30-2007-1, 30-2008-1)
RK F-3 *Chessie from Construction set* (30-2118-1, 30-4016-1)
RK SD-60/SD60M *CSX & UP* (30-2116-1, 30-2117-1)
RK Dash-8 *NS & SF* (30-2114-1, 30-2115-1)
Premier SD-70MAC *BNSF & CN*
Premier F-3 SF *Chief, L&N, and SF El Capitan Set* (20-2151-1, 20-2152-1, 20-2153-1)
Premier FP-45 *Susquehanna, BN, SF, & EMD* (20-2143-1, 20-2144-1, 20-2145-1, 20-2146-1)
Premier F40PH *Amtrak, Mass Bay, Metra, CalTrain* (20-2147-1, 20-2148-1, 20-2149-1, 20-2150-1)
Premier GP-20 *ACL, BN, WP, EMD* (20-2139-1, 20-214-1, 20-2141-1, 20-2142-1)

ELECTRIC

Premier GG-1 *PRR w/PFA & Conrail w/FYS* (20-5501-1, 20-5502-1)

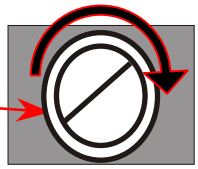
TURBINE

RK Gas Turbine *UP* (30-2009-1)

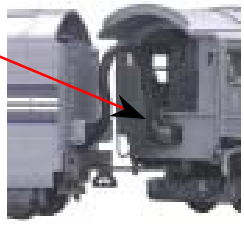
If any of the above engines come in showing an ID condition, please request a EE PROM with the new software and install the new chip in the engine top board.

Troubleshooting Original Proto-Sound Steam

Testing Procedure



1. On the underside of the engine/tender, make sure the smoke switch is turned to the "ON" position.
2. On the underside of the tender, verify the volume adjustment knob is rotated clockwise to the stop position. Close the coupler on the rear of the tender.
3. Place engine and tender on the rails. Connect the tender harness, making sure the wire is routed out from the top of the plug. Connect the draw bar to the tender's pin.



4. Turn the transformer throttle on so that 10 to 12 volts are placed on the track. This will cause the engine to power up in neutral.
   If the transformer indicates a high current draw (meters read above 1.5 amps or the breaker trips), proceed to the section **Short at Power On**.
   If "3 Clanks" are heard immediately after power is applied, charge or replace the battery and use the "Make PS" chip to clear the low battery related software problem.
5. Perform a Reset to Default Settings. This is done using the Z4000 program button and selecting Reset Feature 18.
   If the engine does not respond to voltage on the track (no lights or sound), proceed to the section **No Response**.
   If the engine lights are not showing, proceed to the section **No Lights**.
   If the engine sounds are not heard, proceed to the section **No Sounds**.
   If the engine does not smoke, proceed to the section **No Smoke**.
   If only 1 clink is heard, order a replacement chip.
6. Reduce the track voltage to 7-8 volts and interrupt power so that the engine cycles into Forward. The engine should begin to roll forward slowly.
   If the transformer indicates a high current draw (meters read above 5 amps or the breaker trips), proceed to the section **Short with Forward/Reverse Operation**.
   If the engine does not move, proceed to the section **Engine Will Not Move**.
   If the engine runs but there is no chuffing sound, proceed to the section **No Sounds**.
7. Interrupt power so that the engine cycles into Neutral. The engine should come to a stop.
   If the tender back-up light does not light, proceed to the section **No Lights**.
8. Trigger the rear coupler by raising the voltage above 16 volts in neutral and pressing the whistle/horn button. Press the whistle/horn button again to fire the coupler.
   If the sound does not play and the coupler does not open, increase the voltage and repeat the whistle button presses.
   If the coupler release sound plays but the coupler does not open, make sure the coupler switch (if present on the model) is in the proper position to the fire the coupler. If the same results are found, check the coupler wire connections to the coupler and the P4 board.
   If the wiring has continuity, replace the coupler.
   If the coupler does not correct the problem, **Contact MTH Service** for further instructions.
9. Interrupt power so that the engine cycles into Reverse. The engine should begin to roll backwards.
   See the notes for Number 6 above.

10. Remove power from the track.
    Sounds should continue for about 8 – 10 seconds. If the sound shuts down immediately, check your battery connections and charge or replace the battery.
    If the sounds continue to play longer 10 seconds, consult the instruction manual for that model and look for a manual battery shut off switch to turn the sounds off.

Short at Power On

1. Remove boiler and tender shells and inspect for obvious shorts – pinched/cut wires, scorch marks, etc. Check insulators on the voltage regulator mounting. Should have a mica insulator between the back of the regulator and its mount, and a shouldered insulating washer on the screw.
2. Place chassis on rails and power up. If no short is present, examine the shell for anything that may be shorting on the boards when installed.
3. If short still exists with chassis only on the track, turn smoke unit switch to OFF position. If no short is present, check wires to smoke unit and remove smoke unit circuit board and make sure heating elements do not touch the inside of the smoke unit casting.
4. Disconnect the volume pot, speaker, directional lighting, and coupler connectors from the boards. Place engine back on rails and power up. If short is no longer present, check the volume pot, speaker, directional lighting, and coupler for shorts.
5. If short remains with boards disconnected, inspect all wiring and insulators (especially on the pick-up assemblies) for any shorts.
6. If the problem persists, **Contact MTH Service** for further instructions.

Short with Forward/Reverse Operation

1. Disconnect the white and yellow Molex plugs on the bottom of the P4 board and apply track power to the engine. If short remains, **Contact MTH Service** for further instructions.
2. If no short, check motor wires for damage (pinch or cut, wire rub on flywheel). If found, repair or replace the damaged wire(s).
3. Check motor for binding or damage. Smell the motor to check for heat damage, turn flywheel and check for resistance. Replace motor if defect found.
4. Check the drive system for binding or damage. Make sure all rods and linkage are installed properly, bolts are tightened, and wheels are properly quartered. Check for any debris in external gearing. Replace any damaged rods or assemblies.
5. If the problem persists, **Contact MTH Service** for further instructions.

Engine Will Not Move

1. If sounds cut out immediately (or within less than 10 seconds) after track power is removed, check that the battery is charged and correctly installed. A regular 9-volt battery can be used as a temporary substitute for testing. Order MTH replacement part BG-4000001.
2. Make sure tender harness is plugged in correctly and tight. If the engine stalls or loses power when wiggling the plug, check the solder joints on the engine connector for cold solder joints or cracks.
3. Check the pins in the engine connector (accepts tender harness) for any damage. If bent, carefully straighten before reconnecting the tender harness.
4. Perform a reset 18. If you can not hear 3 clanks and 3 clinks from the engine, look at the Corrective Software or Engine ID (or Deselect). Replace the chip if the engine is on the list.
5. Try using a pure sine wave transformer such as the Z4000 or older Lionel 1033 or ZW. Some older engines (1996 and older) equipped with Original ProtoSound will only run on a pure sine wave power source.

6. Try the unlock procedure (Z4000 Macro 51) or Press and hold the whistle button down and while holding the whistle button down, turn track power off and then let go of the whistle button. After 3 seconds without power you will hear on e chime of the Reset Bell. Turn on track power. The engine is in Reset and should operate normally once you interrupt power and enter the forward direction.
7. Verify the motor leads yellow and white Molex plugs are plugged into the P4 board and wires (yellow and white) are connected to the motor terminals.
8. If there is still no movement, try the "FIX 1011" chip.
9. If still no movement, see section **Short with Forward/Reverse Operation**.

No Sounds

1. Check to see that volume pot is turned up (clockwise for higher volume). See Testing Procedure #2 **above**.
2. Perform a Reset 18 procedure.
3. Remove the tender shell and check the speaker. Measure resistance across the coil using an Ohmmeter. The speaker should measure 8 ohms. Replace speaker if "open" measurement is found.
4. Check the wiring connections to the volume pot and speaker for broken wires or bad solder joints. Reconnect plug connections or replace volume pot assemblies if found defective.
5. If engine runs with lights and smoke ON, but sounds are off it may be a chip program issue. Try a pure sine wave power source, older (<1996) engines may run on chopped sine wave transformer but not produce any sounds.
6. If still no sounds, try a known good chip.
7. If still no sounds, try the FIX 1011 chip.
8. If the problem persists, **Contact MTH Service** for further instructions.

No Lights

1. Check to see the bulb is installed correctly and is not damaged. Correct installation or replace damaged bulb as required.
2. Check bulb by supplying 1.5, 6, or 16 volts to the bulb depending on the bulb type and power source. If it does not light up, replace defective bulb.
3. Check wiring between the bulb(s) and the boards, including any spring contacts. Look for track voltage, 6 volts, or 1.5 volts at the bulb or contact pad depending on how the bulb is powered. If you do not measure track voltage at the bulb or contact pad, make sure there is continuity through the wires to the pick-up rollers and the outer rail through chassis ground. If you do not measure 6 volts at the bulb or contact pad, make sure there is continuity through the wires to the constant voltage board and there is track power to the constant voltage board. If you do not measure 1.5 volts at the bulb or contact pad, make sure there is continuity through the wires to the P4 board and make sure the engine direction is correct for directional lighting.
4. If the problem persists, **Contact MTH Service** for further instructions.

No Smoke

1. Verify the smoke switch is in the proper position as stated above in testing section. Try turning smoke switch to OFF position. Rewire switch if smoke comes ON when switch is in the OFF position. If no smoke, return smoke switch to ON position.
2. Check wiring between the smoke unit and the pick-up roller and chassis ground for damage.
3. Check the smoke unit switch and the wires from the switch to the boards for damage.

4. If heat is present but no fan, remove the circuit board and make sure the fan spins freely, remove any obstructions.
5. Verify fan fits snugly on fan motor shaft and does not spin around a stationary motor shaft. If fan spins on stationary shaft, replace fan impeller. If still no fan operation with track power, see smoke unit troubleshooting in Shop Basics section and try replacing the fan motor (MTH part # BE-0000041).
6. If fan runs but no heat is present, check smoke wick for charred areas and replaced smoke wick (prime smoke unit with 25 - 40 drops of ProtoSmoke fluid before operation).
7. If still no heat, check the heating elements. Reposition or replace defective heating elements (MTH part # AI-0000018) and see troubleshooting section in Shop Basics for the smoke unit.
8. If still no heat or fan output after rebuilding the smoke unit, replace the smoke unit or **Contact MTH Service** for more instructions.

No Response

1. Check that power is present on the track from the transformer.
2. Remove the boiler and tender shell and check the wiring from the pick-up assemblies to the board, especially check the connections at any wire nuts in the engine.
3. Check that all wiring connections to the boards are in place and tight, and that the C5 board in securely seated in the P4 board.
4. If there are lights but no movement or sound, try the "FIX 1011" chip.
5. If the problem persists, try a known good P4 or C5 board, or **Contact MTH Service** for more instructions..

Contact MTH Service

1. Call Technician Hotline, "Call Back" voicemail box, or email with description of problem.
2. Provide Train Model Number
3. Describe problem and actions taken to troubleshoot along with observations.

DCRU Original ProtoSound Operation

Common Terms

- **Original Equipment Manufacturer (OEM)** - Item produced by MTH and installed at the time of initial construction.
- **Aftermarket** - Item produced for later installation. Not part of the original product.
- **Reverse Unit** - Device in an engine that controls the direction of travel of the engine. These can be mechanical or electronic in design.
- **Chuff** - The "chugging" sound made by a real steam engine as it runs
- **Coupler Device** - found on either end of an engine or car that allows two cars to be connected. MTH uses three types of couplers; 1) ProtoCoupler which is electronically opened by ProtoSounds, 2) Operating which is opened by pulling down on an armature (either by hand or using an uncoupling track section), and 3) Dummy which does not open at all.
- **Factory Default** - The settings for ProtoSound that are originally programmed into the unit when it is manufactured.

What is ProtoSound?

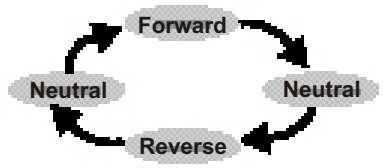
ProtoSound is a computer controlled, digital sound and train control system offered in MTH engines. The system was designed by QSI for the exclusive use by MTH. It offers digital recordings of real train sounds including steam chuffing, diesel motors, whistles, horns and bells. Additionally, ProtoSound offers features such as remote controlled ProtoCouplers, which allow the operator to uncouple an engine anywhere on the layout, and ProtoEffects like Passenger Station Announcements and Freight Yard Sounds. All features can be operated using a compatible AC hobby transformer equipped with a whistle button.

In addition to factory ProtoSound, an aftermarket sound system, ProtoLoco has been available to customers who wish to add sound to engines that did not originally have it. MTH has sold three "levels" of ProtoLoco: ProtoOne, ProtoPlus and ProtoDeluxe-2. ProtoOne is a basic sound system, offering motor or chuff sound, whistle/horn and bell. ProtoPlus adds the option of supporting the ProtoCoupler circuit to the ProtoOne. ProtoDeluxe-2 is the "top of the line" system, offering additional features such as ID numbers, Demo mode and Reversal of Start-up to the ProtoPlus system. ProtoDeluxe-2 is the closest system available to factory ProtoSound, but does not offer Passenger Station Announcements or Freight Yard Sounds (see below). (Note: At this time, MTH is no longer carrying ProtoLoco systems for sale. All inquiries should be directed to QSI.)

Basic Information

A DCRU Direct Current Reversing Unit. The DCRU is a solid state electronic unit designed to convert AC track voltage to DC motor voltage, and apply it to the DC motors so as to control the direction of travel of the engine. Motor direction is determined by the polarity of the DC voltage applied to the motor. The DCRU uses an electronic logic circuit to set the motor polarity, and therefore cycle from Forward to Neutral to Reverse. This reverse unit is used in most MTH engines which are not equipped with Original Equipment Manufacturer (OEM) ProtoSound. The OEM ProtoSound system includes the DCRU circuits in its design.

B Directional sequence. The sequence of operation for most AC powered 3-rail engines is Forward Neutral Reverse Neutral Forward. Change of direction is accompli by interrupting the track power for 1 second, then reapplying power. Each interr will change the state one time. In MTH engines, the initial starting direction is RESET, which functions as a neutral before forward. (See below for further explanation of the RESET State.)



C Horn/Whistle Operation. ProtoSound equipped engines have a digitally recorded whistle or horn as part of the software. Normally, steam engines will have a whistle, and diesel or electric engines will have a horn. In either case, pressing the Whistle control on the transformer while the engine is running in either Forward of Reverse plays the recording. The whistle/horn will continue to sound until the Whistle control is released. The whistle control operates by placing a positive DC signal onto the track in addition to the AC voltage.

D Bell Operation. ProtoSound equipped engines have a digitally recorded bell as part of the software. The bell is turned on or off by either pressing the Bell control on the transformer, or pressing the Whistle control while the engine is in neutral and the throttle set below 10V AC on the track. The ProtoSound computer will remember whether the bell is on or off even when the engine is shut down for extended periods of time. The signal produced by a Bell control is a negative DC signal placed on the track in addition to the AC voltage.

E ProtoCoupler. Most ProtoSound equipped O-gauge engines have coil wound couplers, which are controlled by the ProtoSound system. This allows the engine to uncouple from another car anywhere on the layout. Operation of the coupler is accomplished by placing the engine in the Neutral state, with the throttle set to full power, and pressing the Whistle control. A "Clank" sound is heard, and the coupler is now armed to operate. The next time the Whistle control is pressed, a "Cha-Chushh" sound is played, and the coupler will open. The engine can be in any direction except RESET when the coupler is fired. On engines with two or more ProtoCouplers, a switch located on the chassis allows the operator to choose which coupler will operate when fired. Only one coupler will fire at one time.

F Reverse Unit Lockout. ProtoSound equipped engine can have their reversing sequence locked into a single direction (Forward, Neutral or Reverse), so that whenever power is applied to the track, the engine will always run in the same direction. This is very useful for automatically or time controlled layouts. In order to lock out and engine, the feature must first be enabled by using Reset Feature 40 (described below). Once enabled, the following sequence is used to lock the engine.
Cycle the engine into the desired directional state, and set the throttle to 8V AC.
Press and hold the Whistle control. In Forward or Reverse, the whistle or horn will be sounding. In Neutral, the bell will begin to ring.
Without releasing the Whistle control, bring the throttle to the OFF position (0V AC on the track).
Once power is off, release the Whistle control.
After 2 seconds, a short whistle/horn blast will be heard. Immediately turn power to the track on. The engine will remain in the directional state it was last in. The unit is now locked out.

The engine can be unlocked by following a similar procedure:

1. Set the throttle to 8V AC.
2. Press and hold the Whistle control. In Forward or Reverse, the whistle or horn will be sounding. In Neutral, the bell will begin to ring.
3. Without releasing the Whistle control, bring the throttle to the OFF position (0V AC on the track). Once power is off, release the Whistle control.
4. After 3 seconds, a single bell will be heard. Application of track power will place the engine in the Reset mode, and normal operation is restored.

ProtoEffects

A Cab Chatter (Diesel and Electric Engines only). Diesel and electric engines are equipped with Cab Chatter, an automatic feature that plays recordings of radio communications similar to those heard from a real railroad. These recordings play in a random sequence any time the engine is placed in the neutral state. To hear the Cab Chatter, cycle the engine into neutral, keep power to the track, and allow the engine to idle. Cab Chatter will normally begin within 30 to 60 seconds of entering neutral.

B Passenger Station Announcements (PSA) and Freight Yard Sounds (FYS). The PSA and FYS sequences are designed to simulate the operational activities of real trains. PSA includes recordings of the sounds of a passenger platform and station. FYS includes recordings of tow motors, shifting freight and boxcars being moved. At the time of production, one of the systems is designated for use in the engine. MTH does not offer a choice to the customer. Both systems are operated as follows:

With only a Whistle control available:
1. Put the engine into the Neutral State with Forward being the next direction of travel.
2. Set the Throttle to about 8 VAC.
3. Slowly press the whistle control until the bell just begins to ring, and hold it there.
4. After about 3 seconds, if you listen closely, you will hear either an air release (WHOOSH!) or a short whistle/horn blast. When you hear this sound, you may release the whistle control. The bell will still be ringing.
5. Press and release the whistle control to turn off the bell.
6. Interrupt power to switch the engine into Forward.

With a Bell control available:
1. While the engine is running in Forward, press and hold the Bell control.
2. After about 3 seconds, if you listen closely, you will hear either an air release (WHOOSH!) or a short whistle/horn blast. When you hear this sound, you may release the Bell control. The bell will still be ringing.
3. Press and release the Bell control to turn off the bell.

When you next enter Neutral, the Freight Yard Sounds or Passenger Station Announcements will begin. The sequence consists of several "events," which are advanced in the same manner as changing direction of the engine. The first event is entered by cycling the engine into the Neutral State. After a few seconds, an arrival message will play, and ambient sound recordings will begin to play in a random sequence. Cycling power to change direction (this would be Reverse if the sequence is followed) begins the second event. The motors will be disabled in this event. An indicator will play (conductor in PSA, a "rumbling sound" in FYS) signaling the second event has begun. Again cycling power will move the engine into the third event (Neutral by directional sequence). A double air release sound is played, followed by the departure message. The final event occurs by cycling power again, and setting the throttle to the "take-off" speed. A departure confirmation is played, followed by the bell beginning to ring. After several rings of the bell, the engine will start to run, the bell will stop, and the engine is released to normal operation. To run the PSA or FYS again, the arming sequence must be repeated.

C Trolley Announcement System (TAS). In the RailKing PCC Car and Subway sets, a modified version of PSA is used to simulate the start and stop operation of transit systems. TAS can only be operated using a Bell control. The default method for TAS operation is for automatic stops. This means that the stop is completed without changing the throttle setting. (This system allows the layout builder to create completely automated station stops. The engine will complete the stop with no action by the operator. See the operating instructions for a detailed explanation of this feature.) To activate the TAS, with the engine running in forward, press and hold the Bell control. After two seconds, the "Next Stop" recording will play. If the Bell control is held for three seconds or longer, the "Next Stop" indicator will play, and the automatic stop is triggered. When the Bell control is released for a stop, the engine will come to a stop, the stop recordings will play for approximately 20 to 30 seconds, and the engine will start again. Repeat this sequence each time you want a stop played.

D Squeaking Brakes. The Squeaking Brakes effect is a 3-second recording of brakes being applied by an engine. On current productions, this feature is on at all times. The recording is played by running an engine at 14V AC or higher (this arms the feature), and then reducing throttle to 8V AC or lower (this triggers the recording). The recording will always play for 3 seconds. The feature can be changed to "on demand" or turned off.

Reset Operation see page 10

Powered "B" Unit Operation / Wiring

BACKGROUND

The recently released MTH Premier Line F-3 Powered "B" units were made to operate with any MTH Premier Line Powered "A" right out of the box, which they do. Each Powered "B" unit contains a DCRU® Electronic Reverse Unit which allows the locomotive to start up in neutral, go forward, return to neutral, and then enter reverse in exactly the same manner as the lead Powered "A" unit in the F-3 set (or any DCRU® or Proto-Sound® equipped locomotive).

In normal operating modes, the "stand-alone" DCRU® configuration used on the powered B unit functions just like the powered A unit locomotive. The entire locomotive consist will stay synchronized with one another during reverse unit operations. However, when the PFA or FYS Proto-Effect™ features found on certain Proto-Sound® equipped models is employed, the stand alone DCRU® will cease to act in synchronization with the powered Proto-Sound® equipped A unit. This is because the PFA and FYS features, when employed, temporarily "disables" the reverse unit state. This is required to prevent the consist from "backing up" during the PFA or FYS sequence. On newer MTH four-motored F-3, PA and E-8 ABA diesel engine sets, the second powered A unit is "slaved" to the lead powered A unit through a cable harness. In effect, the lead powered A unit in these consists controls the DCRU® in the second A unit and "disables" the reverse unit state in the second A unit when PFA or FYS is employed.

Because the MTH Premier Line Powered B Unit was marketed and sold to customers wishing to increase 2-motored F-3 AA and ABA consists to 4-motored consists, there was no way to ensure that the Powered B Unit could be "slaved" to the powered A unit without modifying the powered A unit wire harness. In fact, the powered A, non-powered A unit and the powered B Unit in these consists would require wire harness modification in order to ensure that the non-powered A unit lights and Proto-Coupler® continue to function when mated with the powered B unit wire harness.

Fortunately, while the reverse unit state is disabled in Proto-Sound® equipped engines during PFA or FYS operation, it has not been eliminated in the cycle. In short, the Proto-Sound® equipped locomotive reverse unit still thinks it is in reverse, but no power is being forwarded to the motors. This allows a non-slaved powered unit (i.e.: the powered B Unit) to match the reverse unit cycling of the

Proto-Sound® equipped powered A unit when PFA or FYS is employed. The only difference is that the powered B unit can "move" if the voltage setting is too high. The operator need only remember that when employing PFA or FYS, the transformer voltage should be set to around 8 volts during the PFA process. If the voltage is set any higher, the B unit will try to move as it cycles into reverse. The lower the voltage, the less discernible any movement may be. The MTH Engineering Department has checked the operation of the powered B Unit with PFA and FYS equipped locomotives and has determined this operation will not damage the motors in the Powered "B".

WHY THE POWERED B UNIT WAS DESIGNED THIS WAY

Simply put, previously manufactured MTH Premier Line F-3 locomotive sets employ different wire harness configurations. Therefore, it was impossible for MTH to create a universal Powered "B" unit that would function as a stand alone or slaved unit without requiring modifications to both the Powered B Unit and the Proto-Sound® equipped Powered and Non-Powered A Units. Again, this was the only way to make the Powered "B" unit operate with any Powered "A" unit right out of the box.

WHAT THE CUSTOMER CAN DO TO CREATE A SLAVED B-UNIT

If a customer wants the Powered "B" unit to operate as a slave to the Lead Power "A" unit (like our newest sets), MTH can perform the modification for a charge of $44.95 MSRP plus shipping and handling. Due to the complexity of the installation this modification is available only through the MTH Service Department. Separate sale kit will not be available.

All that is required is that the customer return the "Lead" Powered "A" unit, the dummy "A" unit and the Powered "B" unit to MTH for modification.

When this modification is installed the original ABA will operate properly without the Powered "B". But due to these modifications the directional lighting in the dummy "A" will not work without running the Powered "B". Additionally, the Powered "B" unit will no longer function as an independent unit. It must be run in conjunction with the Proto-Sound equipped Powered "A".

Remember, the Powered "B" unit does work properly as described in the instruction manual. The Powered "A" unit and the dummy "A" unit requires rewiring and the DCRU® in the Powered "B" needs to be re-configured for slave operation. MTH believes this was the best and only approach to make the Powered "B" units work together with any F-3 Powered "A" version previously produced by MTH.

#80 Coal Turbine

The large, impressive #80 Coal Turbine (20-2214-1) has been released. One note your customers need to know is that each draw bar on the B-unit is marked with either an F for FRONT or R for REAR. The B-unit must be installed with the F on the draw bar connecting to the A-unit and the R toward the tender. If these directions are not followed damage may occur. The 1999 Vol 3 catalog picture shows the B-unit installed backwards. If you have any questions please contact the MTH Service Department by e-mail at Service@mth-railking.com by phone at 410-381-2580 or by fax at 410-423-0009.

Wiring GG-1

To rewire the engine for pantograph operation, remove the screws that hold the pickups on. Early Premier GG-1 and all RK GG-1engines have two screws to remove the pickup rollers. Remove the orange or hot wires going to the pickups. The pickup rollers can then be removed. Take the shell off and remove the brass nut from inside the shell, making sure the insulating washer stays in place. Without the insulating washer a short will result. Install the pickup or hot wire to the threaded stud and replace nut. Repeat procedure for second pantograph with other pickup wire.