ELECTRICALLY-RELIABLE TURNOUTS

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INTRODUCTION

When this clinic was first presented 7 years ago most turnouts had to be modified to reduce the risk of electrical shorts and to assure the most reliable operation with DCC (Digital Command Control). A lot has changed. Now manufacturers are producing turnouts that are "improved for DCC" or "DCC-compatible." However, are these new turnouts "electrically reliable" for smooth operation over the long term?

The focus of this clinic is commercial prefabricated turnouts in HO scale, but much of the information can apply to other scales as well. Keep in mind that this is not the final word on the subject and you may find other sources with a different viewpoint.

The mention of proprietary products and specific publications is only for the information of clinic attendees and does not represent any endorsement. The terminology related to turnouts is shown in Figure 1.

Many thanks to Allan Gartner for material from his very informative website http://www.WiringForDCC.com.

DCC HAS SPECIAL NEEDS

• **Short circuits are an annoying and disruptive problem and should be avoided.** Full voltage is always on the rails (14-16 volts in HO scale) and a short circuit will cause a high current flow. Typical power station capacity is 5 amps or more in HO scale (some stations may be only 2.5 amps). A persistent short circuit could cause welding or pitting of electrical contacts and melting of plastic ties.

A power station (booster) usually has a fast-acting circuit breaker that's very sensitive to short circuits, even momentary shorts that are easily tolerated with the traditional analog DC. The power station will shut down very quickly, shutting off power to that entire portion of the layout (power district).

• **Locomotives need uninterrupted electrical contact** with the rails to be sure the locomotive operates smoothly and the command control signal is error free. Rolling wheels on rail is already a less-than-perfect electrical connection. Frogs should be powered (with some exceptions) and switch points and closure rails should have secure electrical connections.

• **Careless operation**. The engineer who runs a train into a turnout with the switch-points thrown against it may cause a short when the locomotive wheels run onto the frog powered at the wrong polarity, shutting down the DCC power station.

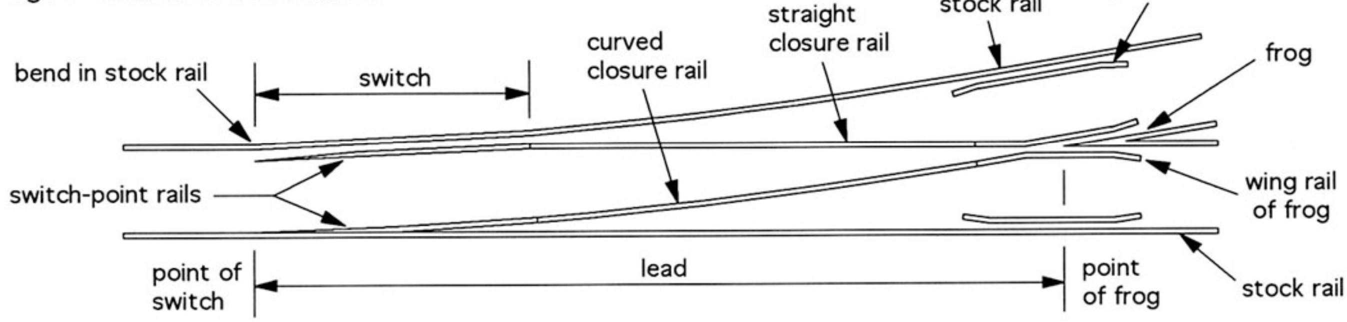
• **So what?** Some modelers argue that their layout with DCC works just fine with turnouts that apparently don't meet all the criteria for electrical reliability, so why all the fuss? It's about the enjoyment of running trains, which requires long-term reliability and avoiding the aggravation of sudden power station (booster) shutdowns.

CRITERIA FOR RELIABILITY

Turnouts that are "improved for DCC" or "DCC compatible" are an important improvement. However, these turnouts may not meet all the criteria for electrical reliability, depending on the electrical configuration used by each manufacturer. Handbooks, magazine articles, and internet websites recommend the basic electrical configuration referred to as "DCC-friendly."

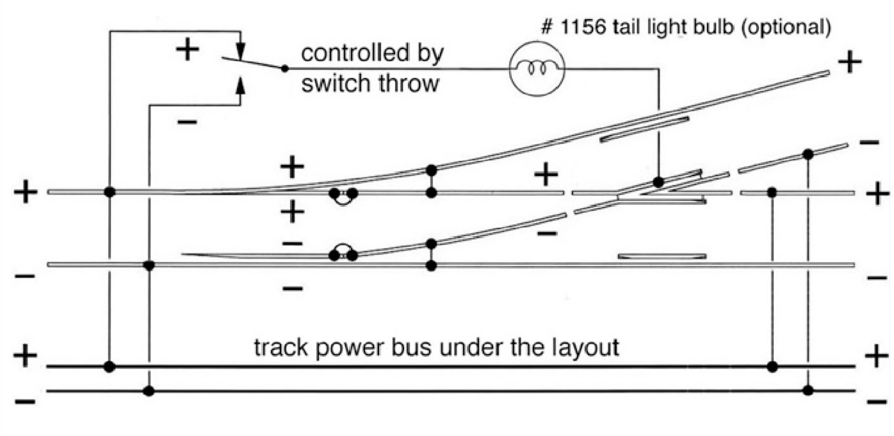
For purposes of this clinic, "electrically reliable" means the basic "DCC-friendly" configuration with the additional

Fig. 1 - PARTS OF A TURNOUT



provision of good electrical connections to all parts of the turnout, as illustrated in Figure 2. This is also ideal for turnouts on layouts operating with traditional analog DC, but the need is not as critical.

Fig. 2 – DCC friendly / electrically reliable turnout



The basic DCC-friendly configuration includes the following two features:

- **Each switch-point rail is always the same polarity as its adjacent stock rail**. This key design feature avoids potential short circuits caused by metal wheels that may be out-of-gage or not tracking properly, and allows a more-realistic, properly gaged, gap between the switch-point rails and their adjacent stock rails. It follows that each closure rail is the same polarity as the switch-point rail connected to it.
- **The frog is electrically isolated with a separate switched electrical feed**. Because the switch-point rails and closure rails are always the same polarity as their adjacent stock rails, the frog has to be isolated from them. The frog should be metal for continuity of electrical pickup. The polarity of the frog is controlled by electrical contacts connected to the switch-throw device (see Figure 2 and *Feeding the Frog* later in this handout).

An isolated non-powered metal frog or a plastic frog may be tolerable if the locomotive wheels can span that "dead" length with reliable and continuous contact with the rails. A non-powered or plastic frog would interrupt the pickup of power and command control signals by small steam locomotives and diesels with short wheelbases, and it is less reliable for larger locomotives.

For complete long-term reliability turnouts should also include the following:

- **Provide good electrical connections to all parts of the turnout** for long-term electrical reliability**.** That means secure electrical connections to each switch-point rail and to each closure rail. It may require installation of soldered jumper wires if the built-in jumpers are not secure (they may be hidden in the molded plastic ties).

Switch-point contact with the adjacent stock rail is not a reliable electrical connection because over time there may be a buildup of dirt and oxidation. Likewise, rail joiners, rivets, or under-rail tabs are not reliable electrical connections between the closure rails and switch-point rails. Some turnouts have a continuous closure and switch-point rail with no pivot joints.

- **Avoid other potential short-circuit conditions.** Insulated frogs which are partly plastic may have opposing-polarity frog-point rails so close together that metal wheels can cause a short when rolling across the frog point.

NOTE: The May 2007 issue of *Model Railroader* magazine on page 64 has a sidebar article **"Tips for operating turnouts in DCC"** with comments on the same subject.

AVAILABLE TURNOUTS

When shopping for prefabricated turnouts, you should first understand what electrical features are built into the manufacturers' design with regard to the frog, the closure rails, and the switch-point rails and pivots. And then, what you might have to do to make them completely electrically reliable. Most of the newer prefabricated turnouts only need additional soldered electrical connections to the closure rails and switch-point rails. (Of course, the quality and appearance of the turnout as trackwork are also important considerations when shopping for turnouts.)

The following commercial turnouts in HO scale are described or labeled as "improved for DCC" or "DCC compatible." They were selected for this clinic because they are generally available as of this writing, and may be found in hobby shops, in mail order ads or catalogs, or on the internet. This list does not include turnouts already mounted on roadbed nor sharp-radius sectional-track type turnouts.

- **Atlas** code 83 turnouts are DCC friendly; however, the hidden electrical connection between the stock rails and the closure rails is not secure. In addition, the switch-point rails depend on loose pivots and switch-point contact with the stock rails for power. For long-term electrical reliability install soldered jumper wires to feed the closure rails and switch-point rails. Some Atlas turnouts have isolated metal frogs, which may be impossible to solder; however, you can put a small brass screw in the hole provided and then solder a wire to the screw. The plastic frog on other Atlas turnouts creates a gap in power and control signal pickup which cannot be fixed.
- **Micro Engineering** code 83 turnouts are DCC friendly with secure electrical jumpers from the stock rails to the closure rails. The switch-point rails depend on rail joiner pivots and switch-point contact with the stock rails for power. For long-term electrical reliability install soldered jumper wires to feed the switch-point rails. The older Micro Engineering turnouts (configured as illustrated in Figure 3) are not DCC compatible and would have to be modified significantly.

• **Peco** ***Electrofrog*** code 83 turnouts are DCC friendly with simple modifications. To create an electrically isolated frog cut the built-in jumper wires at the rail gap between the closure rails and the frog and install insulated rail joiners on the outside end of the frog point rails. The switch-point rails depend on loose pivots and switch-point contact with the stock rails for power. For long-term electrical reliability install soldered jumper wires to feed the closure rails and switch-point rails. Spaces are provided on the underside of the turnout ftoor to solder jumpers from the stock rails to the closure rails.

• **Peco** ***Insulfrog*** code 83 turnouts are DCC friendly, but the frog, which has a plastic (insulated) frog point, cannot be electrically isolated and powered separately. The switch-point rails depend on loose pivots and switch-point contact with the stock rails for power. For long-term electrical reliability install soldered jumper wires to feed the closure rails and switch-point rails. Spaces are provided on the underside of the turnout to solder jumpers from the stock rails to the closure rails. With the code 75 and 100 British-style turnouts, the two rails imbedded in the plastic frog point may be very close together and metal wheels can easily cause a short circuit (it says so on the Peco instruction sheet).

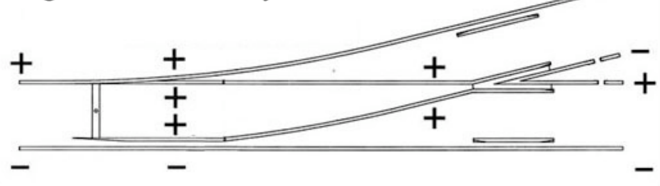
• **Walthers** code 83 turnouts (by Shinohara) are DCC friendly with secure electrical jumpers from the stock rails to the closure rails. The switch-point rails depend on rail joiner pivots and switch-point contact with the stock rails for power. For long-term electrical reliability install soldered jumper wires to feed the switch-point rails. The older Walthers (and Shinohara) turnouts (configured as illustrated in Figure 3) are not DCC compatible and would have to be modified significantly.

MODIFICATION OF TURNOUTS

Some of the older design turnouts by Micro Engineering, Walthers, and Shinohara may still available in hobby shops or at swap meets or may be on your layout. Their general design is illustrated in Figure 3, where the frog is electrically connected to both closure rails and both switch-point rails. This is often called a "power routed turnout."

Modifications to make theese turnouts DCC friendly and electrically reliable requires the following:

Fig. 3 – unfriendly turnout



• Rebuild the switch-point rails. Remove the metal strip(s) connecting the two switch-point rails. Then insulate the rails from each other by soldering them to a new throw bar, such as *Clover House* precut strips of circuit board; file notches in the copper plating to insulate the switch-point rails from each other. If needed, install new rail-joiner pivots at the closure rails. Also, this is the opportunity to make a narrower gap between the open switch-point and adjacent stock rail so the appearance is more realistic (following NMRA standards).

• Isolate the frog. Cut insulating gaps in the rails at each end of the frog and insert styrene pieces (gray) glued to keep the gaps from closing.

• Install soldered jumper wires. For long-term electrical reliability install soldered jumper wires to feed power and the control signal to the closure rails and switch-point rails.

NOTE: The February 2001 issue of *Model Railroader* magazine has an article entitled **"Fail-safe turnouts"** by Tony Capato, which describes his approach to improving the electrical continuity of *Shinohara* turnouts.

FEEDING THE FROG

The electrical feed to the isolated frog is controlled through electrical contacts or an electrical switch (like a micro switch) mechanically linked to the switch machine, manual throw, or other switch-throwing device. This changes the polarity of the frog when the switch points are thrown, to maintain continuity of power and control signal pickup. The electrical contacts or electrical switch must have adequate current-carrying capacity for DCC (see *DCC has Special Needs* earlier in this handout). Additional short circuit protection with a #1156 tail-light bulb is suggested, but optional (see Figure 2).

The *Circuitron Tortoise* switch machine has built-in electrical contacts. Many modelers operating with DCC have successfully used these contacts for powering the frog even though the contacts are rated for 1 amp.

The *Switchmaster* and *Torquemaster* motor-type switch machines require a separate micro-switch. While normal installation is with the motor shaft vertical, the machines can be installed with the motor shaft horizontal. The *Rix-Rax 2* adapter is one way of doing this. It has mounting slots for easy installation of a micro-switch with adequate electrical contacts for DCC.

The new *Blue Point* manual turnout controller has two sets of built-in electrical contracts, which can be used to feed power to the frog.

Twin-coil solenoid switch machines may have built-in electrical contacts or will require a micro-switch or supplemental electrical contacts. Sometimes a simple slide switch (electrical SPDT) is used as a track switch throw, with the contacts available to control the polarity of the frog.