1. WIRING MULTIPLE TURNOUTS IN A LADDER (and similar situations)

Track power wiring standards apply to all track segments equally without regard to mainline, secondary, or any other railroad definitions. A rail joiner is not to be considered as an adequate power supply connector unless the joiner connection is soldered and tested. Joiners are not soldered at turnouts or crossings. Additional power drops must be made to ensure reliable electrical connectivity for turnouts.

This discussion specifically covers ladder groupings of multiple turnouts at the end of a conventional segment of EASTBOUND – WESTBOUND mainline or secondary track. For this discussion at least two turnouts are in a contiguous ladder grouping, any two connecting adjacent pairs are juxtaposed with the frog end of the first connected to the point end of the second as, for example, in a yard ladder. However, the discussion applies to closely grouped turnouts on any segment of track that take on the same appearance. No upper limit is imposed on the number of turnouts in a ladder grouping by the methods discussed herein.

While much of this information is applicable to a multi-track yard throat or an interchange or a double track mainline crossing another double track mainline, it is not intended for direct use in situations that complicated.

While two turnouts may actually be physically as tightly packed as is geometrically feasible in a ladder grouping, they may also be physically separated by up to twenty inches and still be in a grouping. A judgment call is sometimes required. The following rule applies:

> *If even a portion of one train occupies any part of a grouping, then it would be unsafe to allow another train to enter that grouping until after the first train has exited it.*

That rule was automatically enforced in the discussion of wiring a single turnout, but may require special attention in this situation.

This discussion further assumes that the Tortoise switch machines are mounted directly below the throw rod of the turnout in either of the two possible ***conventional*** installation orientations.

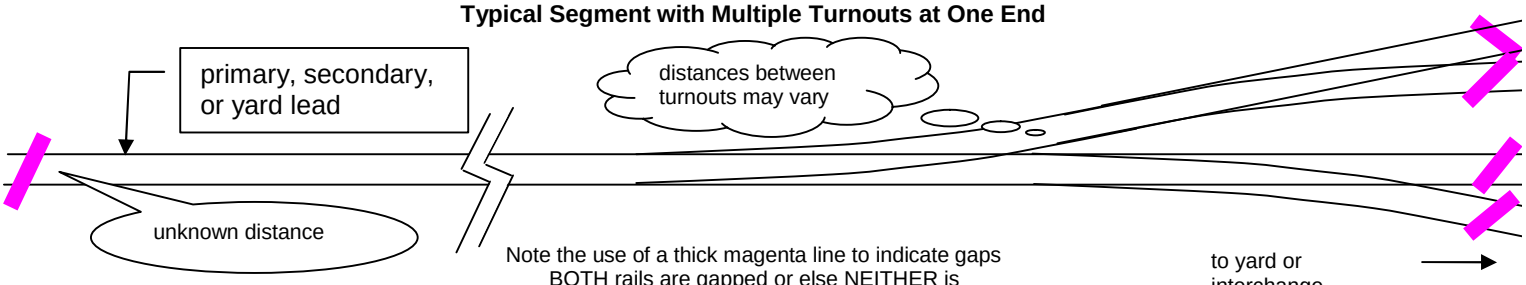
Other instruction sets cover a single turnout at the end of a conventional segment, even more complicated configurations, and ad hoc mounting methods of a Tortoise.

One ramification of direction of trains convention is that for any conventional portion of track, there is a NORTH rail and a SOUTH rail.

The NORTH rail is ALWAYS connected to the BLUE wire, and the SOUTH rail is ALWAYS connected to the GRAY wire. All frogs should have been connected to green wires (because frogs are usually green), but in our case we have been invaded with a peculiar species of YELLOW frogs that have BROWN STRIPES.

For the sake of simplicity, all of the diagrams shown in this discussion are built with the assumption that the far rail is the NORTH rail and that the eastbound trains move to the observer's right.

Typical Segment with Multiple Turnouts at One End



Note the use of a thick magenta line to indicate gaps
BOTH rails are gapped or else NEITHER is
NONE of the point end rails are gapped for any of the turnouts
Gaps may be provided with insulating joiners or by making cuts in the rail
Gaps requiring cuts in the rail should be staggered by at least one or two ties
Gaps should be on straight track, or else extra mechanical reinforcement must be provided to protect alignment
Gaps internal to the turnouts for hot frogs are not shown here

An abstraction of a treelike structure is formed and reference to trunks and branches and terminal branch and other tree components are used freely in this discussion.

Each track segment has a unique identification code that allows the wiring and maintenance crews to easily recognize it from above and below the benchwork. Track segments are labeled by numbers from 1 through 64 inclusive.

A typical example of an identification for a conventional track segment might look like:

DCC 12

to indicate that this segment is connected to terminal block 12 in the power distribution circuit box.

ALL of the flex track and all of the turnouts shown between the bounding gaps in the **"Typical Segment with Multiple Turnouts at One End"** diagram are powered by a single power distribution circuit and belong to a single track segment.

Blue-Gray twisted pair power wires should have both ends wrapped with either a single strip of electrical marking tape similar to:

12
12
12
12
12

or else a pair:

1 2
1 2
1 2
1 2
1 2

A short segment of the same type of tape is also applied to each Tortoise wiring harness in the grouping to remind the maintenance workers what power division the turnout rails are connected to. Note that a Tortoise may be replaced rather than repaired on the spot, so the identification applies to the harness, rather than to the switch machine.

With rare exception, the rail joiners at the ends of a turnout are not soldered for maintenance reasons. A three wire drop is provided for each turnout with one for each of the outer rails and the additional drop for the center frog and connected rail.

At the top of the roadbed, the drop is soldered to the outside or bottom of the rail. Keep the visible solder and wire to the minimum required to make a good mechanical and electrical connection at the rail. If there are options, such as in the case of a frog, use the far side of the nearer rail. A soldered connection to a rail must NEVER be the suspected cause of a derailment!

Drops are always kept short. Many of the drops are fine uninsulated wires and must be kept physically isolated from each other even if accidentally tugged. For safety and for electrical reasons, the bare wires are best connected to the color coded 22 gauge or heavier wire within a half inch or so of the hole in the roadbed and below the turnout. Firmly affix the heavier wire to the bottom of the roadbed so that the fine wire will not receive any stress from an accidental tug.

A segment boundary is forced at the occurrence of a pair of electrical gaps on BOTH the rails of a track. The use of plastic rail joiners for all four rails at the frog end of a final turnout at the terminal end of a branch of the tree is allowed when mechanical integrity of the track is maintained. Otherwise, when cuts are required, the rail gaps should be staggered by at least two ties along the track. Gaps should be on straight track, or else extra mechanical reinforcement must be provided to protect the track alignment.

The turnout rails are always powered by the segment adjacent to the point end of that turnout. This rule applies to ALL of the multiple turnouts as in a ladder or an interchange. If the turnout is a single turnout with flex track at both of the routes at the frog end, see the separate discussion of that wiring situation.

All mainline turnouts and many secondary track turnouts have an identification code that allows the wiring and maintenance crews to easily recognize it from above and below the benchwork. That identification code consists of a three or four digit number and is also the number assigned to the stationary decoder for the DCC control of that turnout. A separate discussion note explains how those code numbers are assigned.

NOTE: a temporary label for each turnout of a one or two digit number is for the Tortoise installation crew's identification purposes only.

All of the switch machines owned by the NCMRS are Tortoise machines with printed circuit board male edge connector. Club made wiring harnesses with female edge connectors are fitted onto the male edge connector portion of the Tortoise. Color standards for the female edge connector harness wires are described elsewhere.

The following description takes into account the fact that the Tortoise may normally be mounted in one of two possible positions under the roadbed. Since those two positions are 180 degrees in opposition, some care is required to consistently provide a working and maintainable installation. Other ad hoc mountings are not described here.

Before doing any wiring, the safest procedure is to make a drawing of the entire ladder grouping showing both rails for each turnout. The switch points may be omitted for convenience. Then with colored pencils, convert that drawing to a frog isolation and connection schematic resembling the **"Simplified Connectivity Schematic"** found at the end of this discussion. A correctly done drawing will save much time and frustration.

Start at the base of the trunk of the tree and connect that harness following the instructions below keeping consistent with the drawing of the entire ladder grouping, and test it first.

The harness must ALWAYS be installed so that the red wire end of the female connector is pointing towards the diverging route of the turnout and the gray wire end of the female connector is pointing towards the normal route. The harness must be provided with a

mechanical wire wrap support tied to the bottom of the roadbed so that the harness female edge connector cannot slip off of the Tortoise male edge connector. The red and gray pair should be twisted and left long enough for future connection to the controlling power. All other connections should be kept reasonably short but not tight and be snugly affixed to the benchwork or to the bottom of the roadbed.

The yellow wire of the harness is always connected to the hot frog wire (GREEN or YELLOW/BROWN) from the turnout. Unless this turnout is a terminal end of a branch of the tree, additional rails further out on the same tree branch will also be powered through this yellow harness wire. As needed add one or two extending rail power leads to the connection from the yellow harness wire for the turnouts further out on those connecting branches.

The orange and blue wires from the harness are then connected to the blue and gray drop wires from the turnout and the blue and gray wires from the power distribution, but the *harness color match is not predictable*. Each turnout must be verified in both it's normal and diverging positions due to the 50/50 chance of the track power color selection. Verification requires DCC power to the track, application of a test indication for track power, and moving the points of the switch manually via the position of the moving portion of the Tortoise to test the presence of track power on the other route.

The Green, Purple, and Black harness wires are for future signaling purposes and should be rolled and tied and snuggly affixed to the benchwork for later access.

Finally, the red and gray wires from the harness are connected to the stationary decoder or other controlling electrical device dedicated to the switch machine.

If the power supply and control for the switch machine is an CVP AD4 stationary decoder, the red wire from the harness will be connected to one of the positions labeled with and odd number 1, 3, 5, or 7 and the gray wire will be connected to the adjacent position with the next larger even number, 2, 4, 6, or 8. If another form of power is supplied, when the red wire is held 9 to 12 volts positive with respect to the gray wire, the switch will be stable in the normal position.

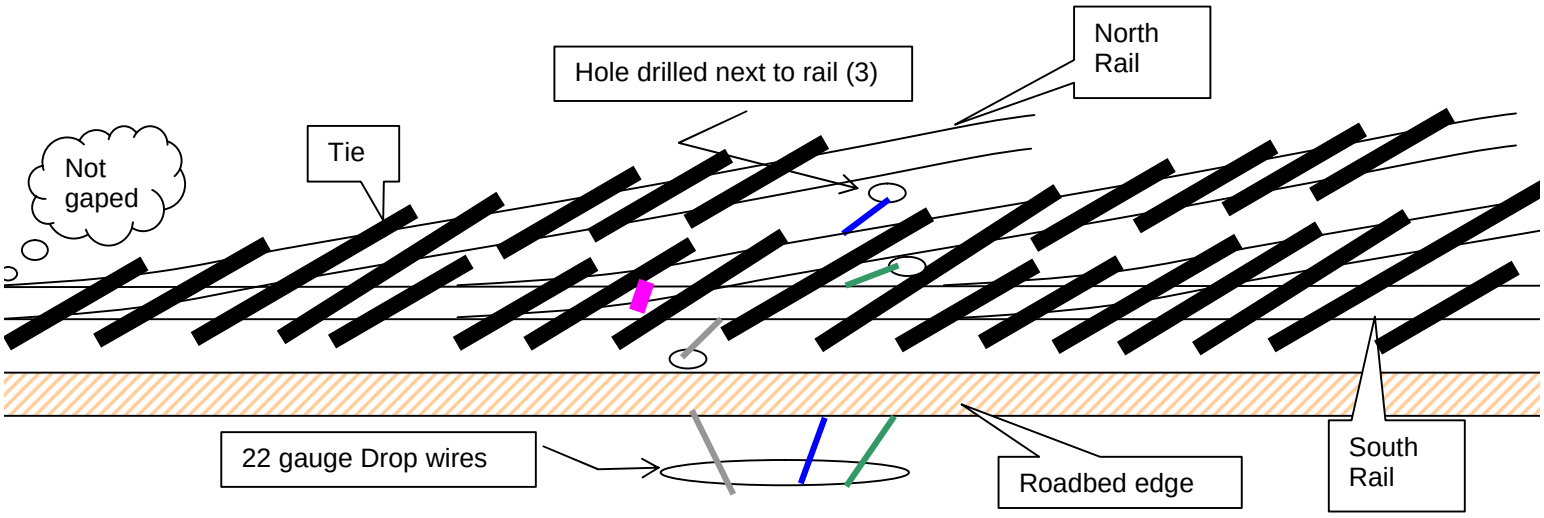
The red wire end of the harness pointing towards the diverging route convention when applied to crossover turnouts yields the two red harness wires connected together and the two gray harness wires connected together and both Tortoises controlled by the same decoder address.

After the testing of any turnout is complete, pick a nearest branch and work the next turnout and harness repeating the above instructions. At the terminal end of a branch the extending rail power leads are not needed.

Testing the second and subsequent turnouts requires attention to the position of each and every switch between the turnout under test and the turnout at the base of the tree. If any one of those switches is thrown against the traffic through the current turnout under test, there should be either North or South power on both of the rails of all turnouts wired further out on the branch and they cannot be tested until the alignment is cleared as if a train were to be coming through.

Repeat the above procedure until all turnouts in the ladder grouping are wired and tested. Finally go back and re-verify each turnout in the grouping checking all possible combinations of routes.

Generic Turnout in a Ladder Grouping



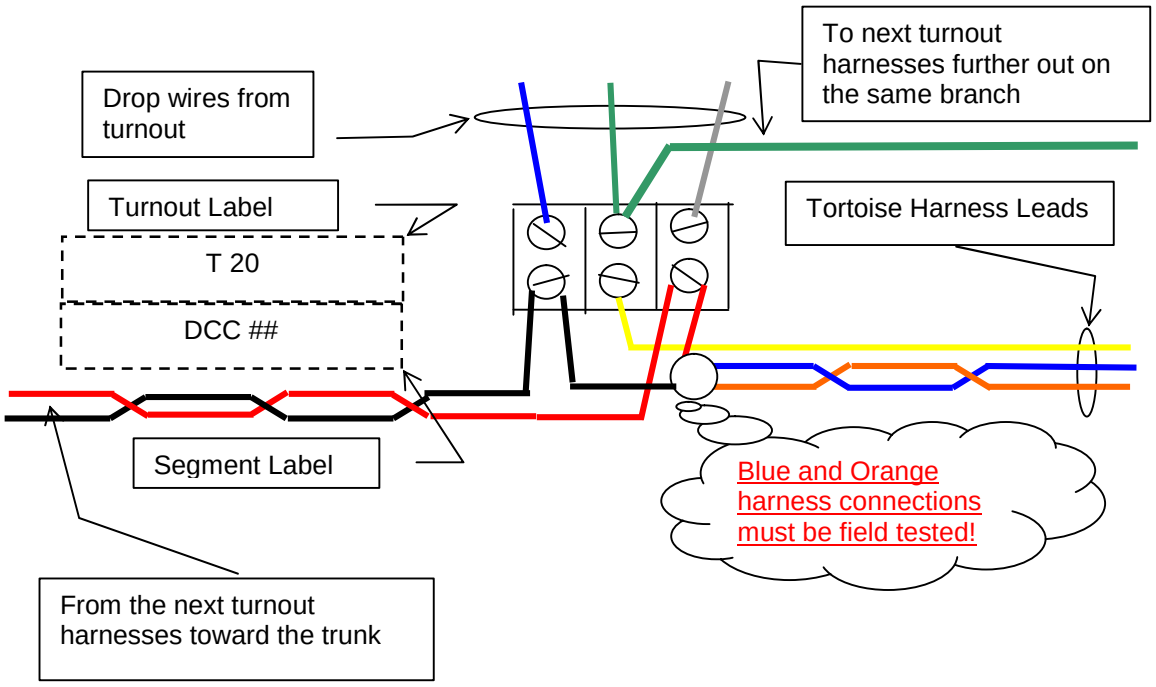
Joiners are not soldered

North and South for any one turnout are relative terms except at the tree base
Gaps in point rails may be a feature of the turnout
A drop should be near the frog end of the turnout
Drops should be soldered to the outside or bottom of their respective rail near the frog area of the turnout
Holes in roadbed for drop leads should be close to outside of rails and easily covered with ballast later

The turnout illustrated in the **"Generic Turnout in a Ladder Grouping"** diagram still retains it's NORTH and SOUTH orientation with respect to the rest of the track segment and other turnouts. However, only the very far outside rails of the tree are firmly wired to a NORTH or SOUTH feeder. All of the internal feed rails may be either NORTH or SOUTH at any time and dependent ONLY on the way that ALL of the switches from the base of the trunk of the tree up to that position have been thrown.

Generic Turnout Connections

Shown with provision for Hot Frog Turnout

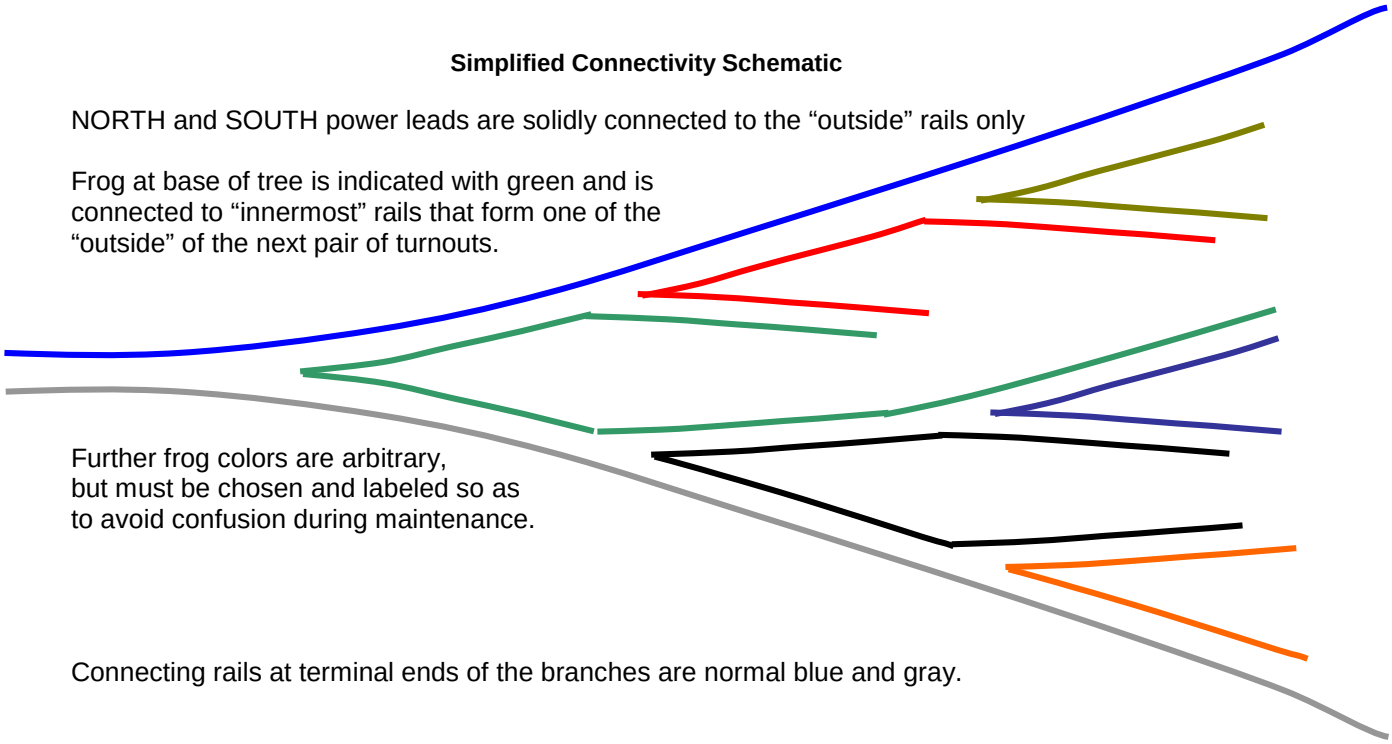


Actual terminal blocks may bear only slightly similar appearance
Wires terminating at screw head connectors must have crimped spade lugs attached first.
Each connection to the Tortoise MUST be verified to match the polarity of the Frog with the position of the Turnout Normal versus Diverging routes and the actual mounting position of the Tortoise MUST be dealt with and verified in each case.

Simplified Connectivity Schematic

NORTH and SOUTH power leads are solidly connected to the “outside” rails only

Frog at base of tree is indicated with green and is connected to “innermost” rails that form one of the “outside” of the next pair of turnouts.



Further frog colors are arbitrary, but must be chosen and labeled so as to avoid confusion during maintenance.

Connecting rails at terminal ends of the branches are normal blue and gray.