# *POWERING T-TRAK WITH THE NTTT CABLING SYSTEM*

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VERSION 1.0: 2018-02-12

*ttrak.wikidot.com/nttt-cabling-system*

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# Powering T-TRAK with the NTTT Cabling System

## Overview

This document describes the components for an easy-to-use bus wiring system, and a methodology that will work for any independent loop in a T-TRAK layout regardless of scale.

Powering T-TRAK layouts is a straightforward task and has the same principles as powering any other model railroad layout. However, it is important to note that although T-TRAK modules have two mainlines on them it does not necessarily mean all T-TRAK layouts will consist of only two loops. T-TRAK layouts, comprised of two-line T-TRAK modules, can be constructed with one to a multitude of independent loops. Loops within a T-TRAK layout can be independent, or by the inclusion of modules with switching track, be joined together. T-TRAK modules can also be used to construct point to point layouts. Thus, wiring a TTRAK layout is similar to wiring any model railroad in that the challenge is ensuring the layout is wired with polarity preserved for each independent loop.

## The Issue

Before the issue can be adequately described there must be a brief definition of terms. Any model railroad layout that uses rails to deliver power to the locomotives consists of three sub-systems for power distribution: 1) the power source, 2) the bus cable, and 3) the rails. These items are required for every independent loop on a layout. Even the simplest train starter set has these three components – the power source is the throttle; the bus cable is a pair of wires; and the rails of the track.

The crux of the problem is that everything that conducts electricity has some resistance. The track rails have significantly more resistance than the bus cable. Add enough track to the layout and it will eventually cause a noticeable voltage drop at the furthest point from where the bus cable is connected to the track rails. This point will be obvious because locomotives will move slower at this point of the layout. The solution is to add another connection from the bus cable to the track rails where the voltage drop is greatest. This works because the resistance in the bus cable is significantly less than the resistance in the rails, thus restoring near normal voltage levels on the rails. For T-TRAK-N, the rule of thumb is to connect a module to the Kato bus cables every six to eight feet (2 – 2.6 meters) of track to mitigate the resistance

in the track rails. It is assumed the T-TRAK-N electrical standards[1] are being followed and a Kato connector is being used for the module power drop.

The bus cable for small T-TRAK-N and T-TRAK-HO loops (less than 24 feet long) typically consists of Kato extensions and Kato 3-way extensions chained together. The gauge of the Kato wiring is 22 AWG which works great for T-TRAK-N layouts up to 24 feet. If the power source is in a central location of the layout, the bus cable could extend 24 feet in both directions thus potentially permitting a layout of 48 feet. A wise man once said that you can never eliminate a bottleneck, you can only move it. This adage perfectly applies to our wiring situation. We can continue to add modules and increase the length of the track on the layout but at some point, the resistance in the Kato extensions and 3-way extensions become too much of a bottleneck and we then experience a noticeable voltage drop at the ends of our bus cables.

The essential parameter of a better bus cable is a larger gauge wire. Steve Jackson and Glenn McLain of North Virginia NTRAK recognized the need for a better bus cable and documented it in their 2011 paper "T-TRAK Powerpole Bus Wires"[2]. Their concept of 12 AWG low voltage outdoor cable and Anderson Powerpole connectors has been a popular choice by many clubs. The Anderson Powerpole connectors have also been adopted by a T-TRAK module kit manufacturer.

The problem statement would not be complete without acknowledging that the Australian TTRAK Guidelines[3] specify the use of RCA phono sockets for the modules and the corresponding RCA phono plugs for the bus. Adding to the confusion is the specification[4] from the Russians for the use of PC mini-Molex connectors for their own module to module power bus.

In summary, a universal bus system is needed that can interwork with the variety of module wiring systems already in existence and still be adaptable in the future.

## The Solution

As previously mentioned, the Anderson Powerpole connectors are very popular within the model railroad community due to a unique feature of the connector. Individual Anderson Powerpole connectors are genderless. A plug connector and a socket connector are not required as the Anderson Powerpole connectors connect to each other. The connectors also have mortises and tenons along their sides which permit the connectors to be easily ganged together into multi-wire assemblies. However, this is an easily overlooked flaw with the Anderson Powerpole connectors with regard to T-TRAK.

There are several idioms in usage, such as "getting your wires crossed" or "short circuit", that are a direct result of the negative consequences of incorrectly reversing polarity in an electric circuit. In general, reversing polarity of wires is considered to be a very bad thing. To protect us from that situation, manufacturers go to great lengths to prevent it from being an option. The arrangement of the mortises and tenons on the Powerpole connectors are such an example. The problem is that once multiple Powerpole connectors are ganged together using the built-in dovetail joint, the assembly loses the genderless feature of the individual connector. A corresponding reversed assembly must be constructed

[1] 1 http://www.t-trak.org/standards.html section "Electrical Standards"
[2] T-TRAK Powerpole Bus Wires - http://ttrak.wdfiles.com/local--files/northern-virginia-ntrak-t-trakdivision/T-TRAK_PowerPole_Feeders_Ver_2-1.pdf
[3] http://t-trak.nscale.org.au/guidelines
[4] http://ttrak.ru/ Electrics Section

to mate with the previous assembly. The cable assembly becomes just like a garden hose or an electrical cord, only one end will work for a given location. Pick the wrong end and the assembly must be flipped end to end in order for it to properly connect. This prevents accidental polarity changes by creating a gender on the cable assembly. Polarity reversal is not generally a good thing, except when needed in T-TRAK.

What T-TRAK needs is a dual conductor genderless cable and, with a bit of super glue, this can be accomplished with the Anderson Powerpole connectors. Looking at the Powerpole connector from the connector end reveals a feature of the connector known as the "hood". Using the same connector end viewpoint, the North Texas T-TRAK (NTTT) cabling system uses the "left hood down – right hood up" configuration for a blue/white set of Powerpole PP15-45 Standard Housing[5] connectors. This configuration requires the two Powerpole connectors to be glued together at their mortises (cavity sides) but when assembled on the cable yields a genderless cable assembly (Figure 1). When a polarity reversal is required it is simply a matter of rotating the connectors 180 degrees instead of flipping the cable end to end. The secondary benefit of the genderless NTTT cabling system is that every cable connection is the same. There is no need to specify an arrangement for the power source side or the module side nor to have a complex matrix of options to define every possible configuration.

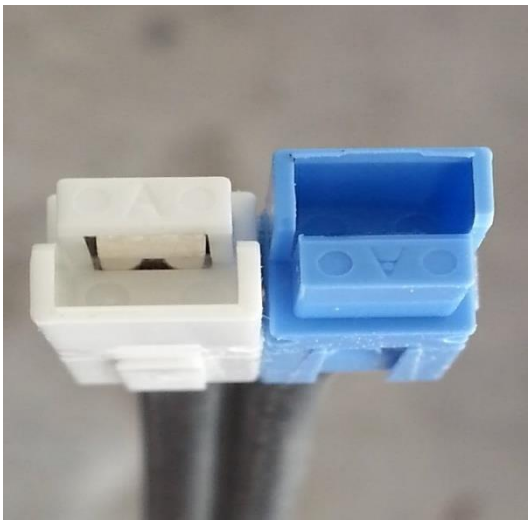

*Figure 1 - Genderless Cable Connector Assembly*

The blue and white Powerpole connectors are used to match the color coding inherent with the Kato wiring at the module. Color coding bus cables for different circuits is done with colored Velcro strips at both ends of every cable. While the connector colors are part of the specification the colors of the Velcro strips to represent each circuit are at the discretion of the club, region, or layout coordinator. The benefit of this methodology is that every bus cable is the same and can be used for any circuit of a layout. Changing two pieces of Velcro at the ends of a cable to identify to which circuit it belongs is a simple and cost-effective solution.

The genderless NTTT cabling system uses 12 AWG low voltage, two-conductor, outdoor wiring cable and consists of five component types:

- Power Source Cable
- Optional Y Cables
- Bus Cables
- Pigtail Cables
- RC Filters

[5] https://powerwerx.com/anderson-powerpole-colored-housings, Blue – 1327G8, White – 1327G7.

The contacts used for the Anderson Powerpole connectors include both the 30 Amp and 45 Amp contacts. The 30 Amp contact is used for connections involving only the 12 AWG wire. The larger 45 Amp contact is used for multiple wire connections. Both of these contacts fit the Powerpole Standard Housings.

## Power Source Cable

The power source cable is dependent on the power source used and the typical layouts configured but it can be as simple as a six-inch (150 mm) piece of 12 AWG two-conductor cable with blue/white Powerpole connectors in the "left hood down - right hood up" configuration on one end. The other end is connected to the power source with spade terminals for the example shown in Figure 2.

*Figure 2 - Single Bus Power Source Cable*

A more flexible arrangement for layouts is to incorporate a terminal block on the power source cable so that multiple bus cables can radiate from the power source. When the power source is positioned in the center of the layout, multiple connectors permit bus cables to follow each branch of the layout. This minimizes the source-to-end bus length which minimizes voltage drop issues due to the bus cable. This type of power source cable (Figure 3) consists of a six-inch (150 mm) piece of cable attached to the power source and to a terminal block with ring or spade terminals. The terminals on the terminal block are connected appropriately so that multiple, typically two to four, six-inch cables can be attached to the terminal block. Each of these cables have a blue/white Powerpole connector in the "left hood down - right hood up" configuration on the other end.

*Figure 3 - Dual Bus Power Source Cable*

## Optional Wye Cables

The Wye bus cable is similar to a dual ended power source cable with the exception that all ends of the six-inch (150mm) two-conductor cables are terminated with blue/white Powerpole connectors in the “left hood down - right hood up” configuration. This specialty cable permits the bus cable to follow bifurcating branches of a layout.

*Figure 4 - Optional Wye Cable*

## Bus Cables

The bus cable is simply 12 AWG low voltage, two-conductor, outdoor wiring cable. Other 12 AWG wires could be used but the black outdoor wiring cable is less conspicuous on the layout. Since layouts work best when there is a power drop every six to eight feet, the typical NTTT bus cable is six feet (2 m) long. Cables of other lengths can be created but are generally not needed. The bus cable only has blue and white Powerpole connectors on each end in the aforementioned “left hood down - right hood up” configuration. As with any cable construction, care must be taken during assembly to ensure that the cable polarity is preserved during construction (i.e. one wire only has blue connectors, the other wire has white connectors). Most of the outdoor lighting cable has ribbing on one conductor so that it can be differentiated by feel.

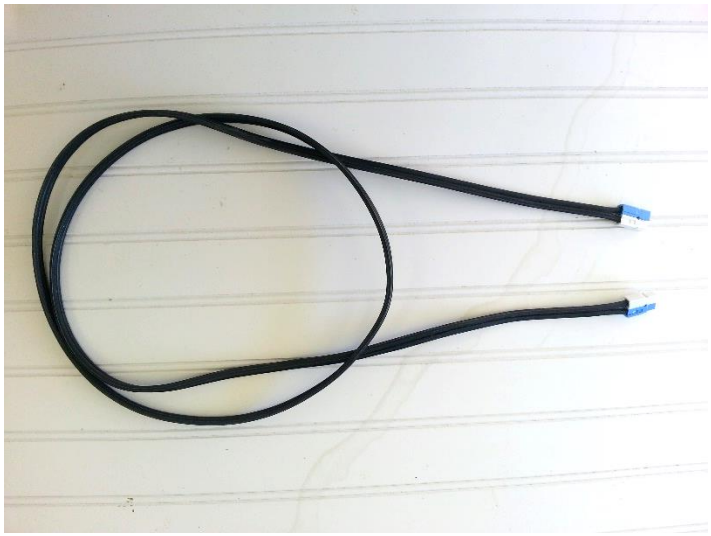

*Figure 5 - Six Foot (2m) Bus Cable*

## Pigtail Cables

The pigtail cables are the links between the bus cable and the modules. The pigtail cables consist of a six-inch (150 mm) piece of the same 12 AWG low voltage, two-conductor, outdoor wiring cable. However, in addition to the Powerpole connectors on each end there is also one, or more, module connector cables. The module connector cable types for the pigtail cables are:

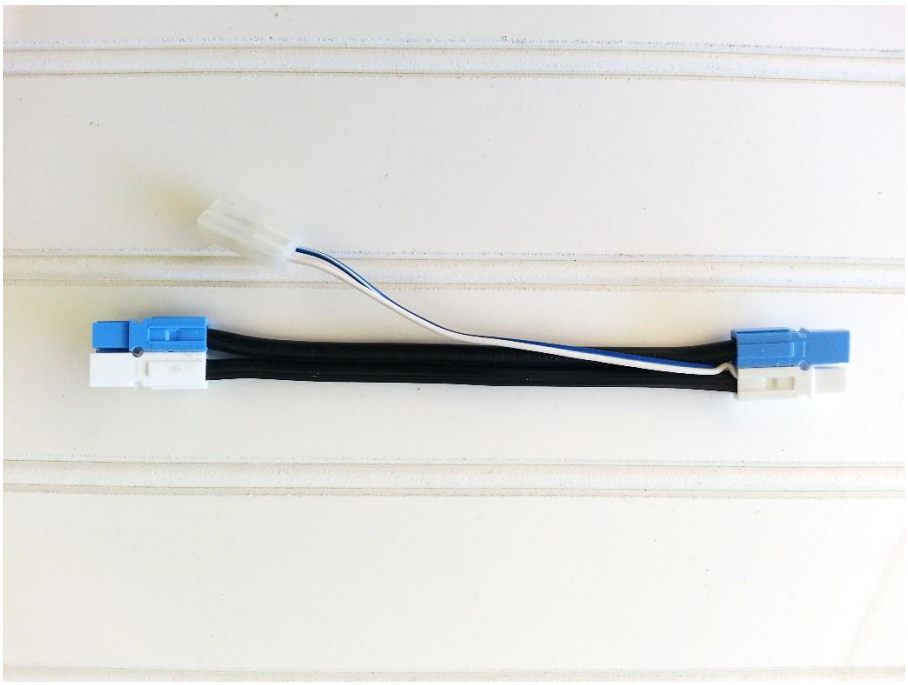

*Figure 6 - Single Kato Mini-Tamiya Connector*

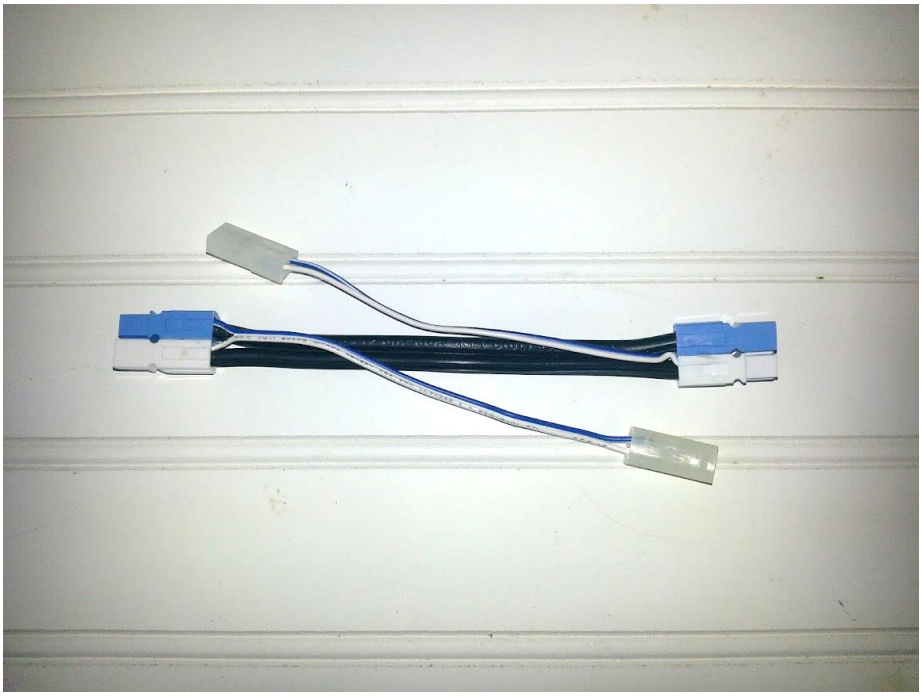

*Figure 7 - Dual Kato Mini-Tamiya Connectors*

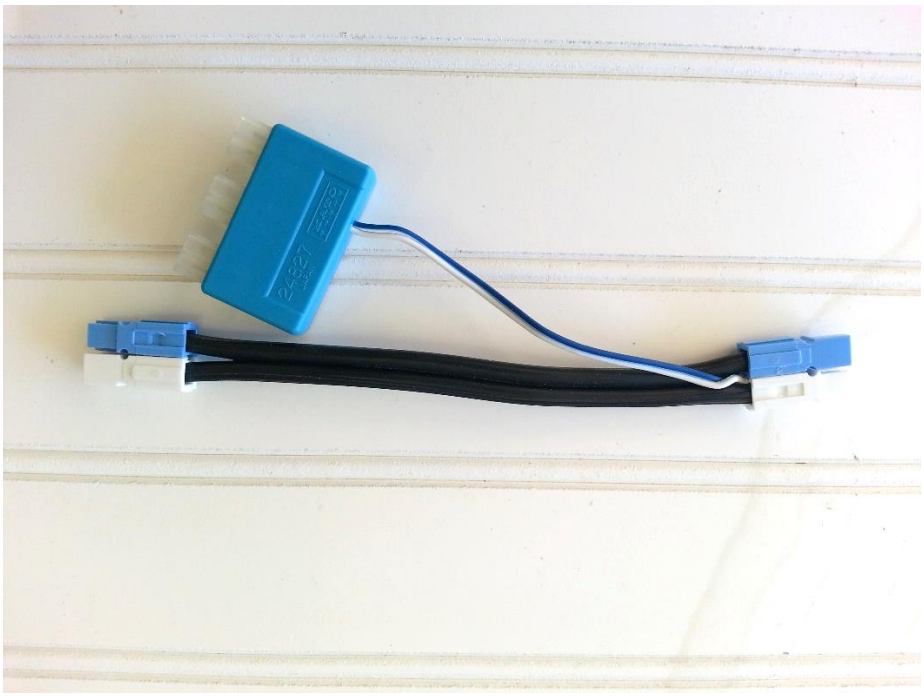

*Figure 8 - Single Kato 3-Way Extension*

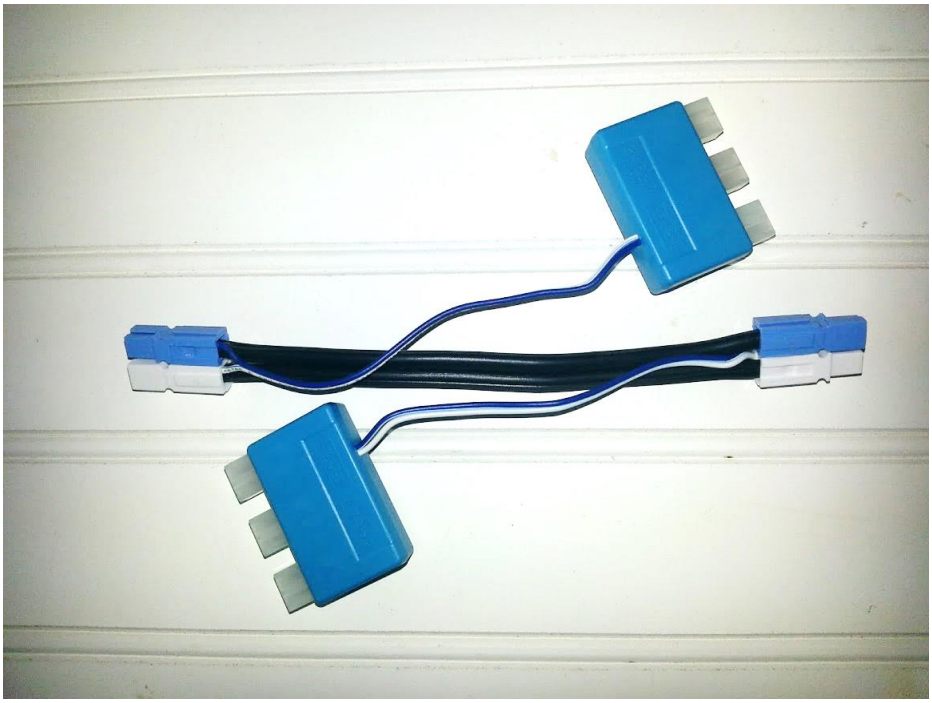

*Figure 9 - Dual Kato 3-Way Extension*

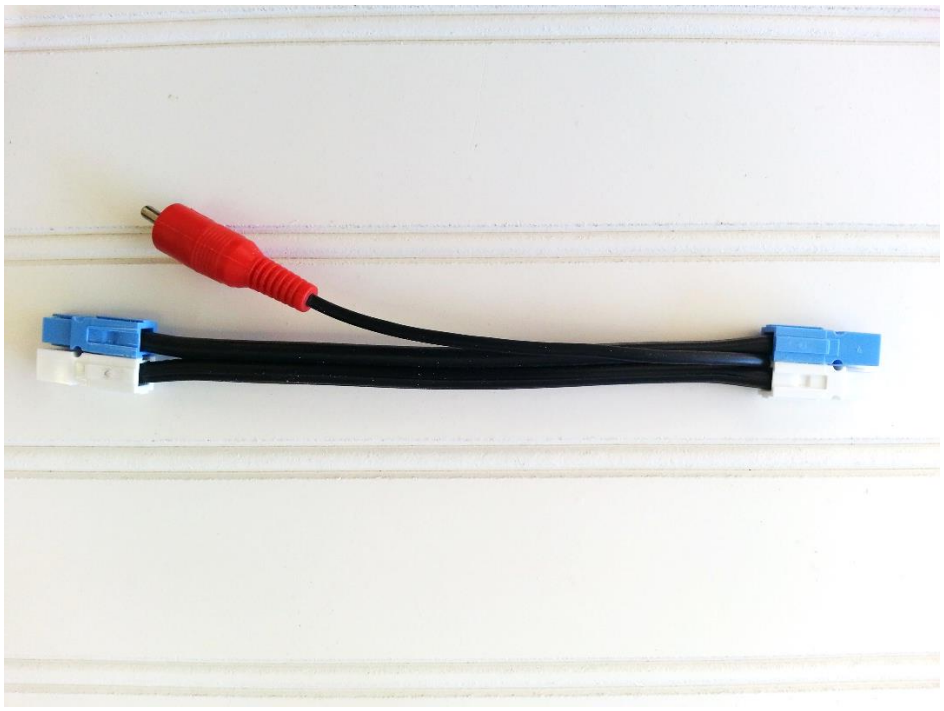

*Figure 10 - Single RCA Phono Plug*

*Figure 11 - Dual RCA Phono Plug*

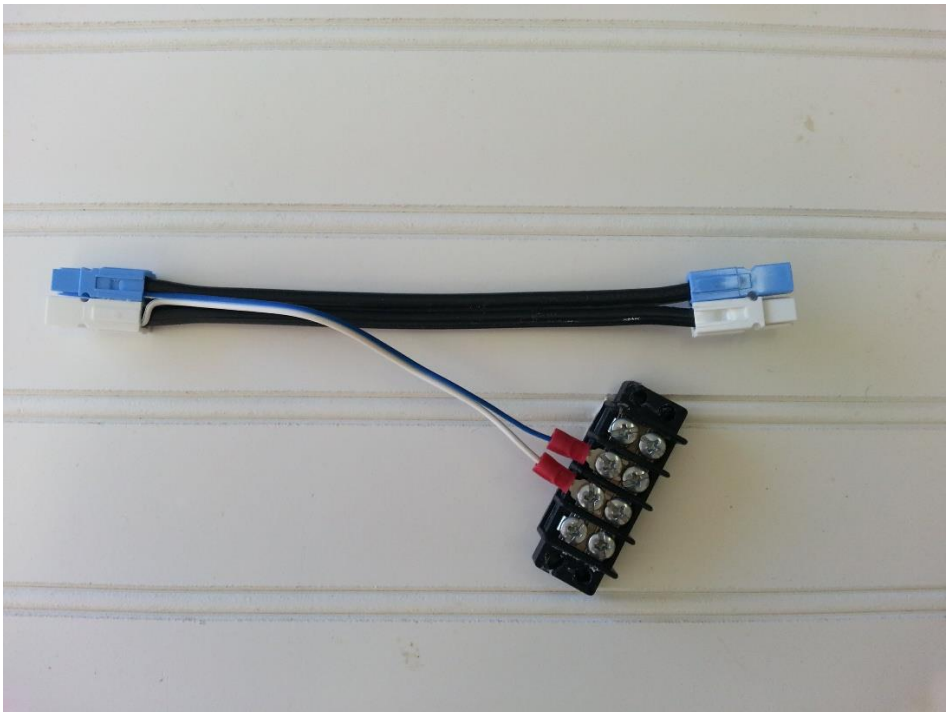

*Figure 12 - Terminal Block*

Not shown, but possible, is a pigtail that includes Powerpole connectors for modules that use proprietary module wiring systems. These module connector cable types should accommodate all variations as described in the Issue Section as well as work for all scales, not just T-TRAK-N. This methodology is also adaptable to other potential arrangements or module connector types.

## RC Filters

The final component of the genderless NTTT cabling system are the RC Filters. These are optional and only used at the end, or ends, of the bus for a DCC circuit. They are Resistor-Capacitor Filters and function as a power snubber on the bus as well as a signal noise filter for the encoded DCC signal[6]. The 100 ohm, ½ watt resistor (1 watt for scales larger than HO) and 0.1 µF ceramic capacitor are housed in a small project box with the blue/white Powerpole connectors in the "left hood down - right hood up" configuration.

[6] Mark Gurries – Snubber/RC Filter - https://sites.google.com/site/markgurries/home/dcc-general-best-practices/wiring-planing/snubbers-rc-filter

## Wiring Examples

The wiring in Figure 13 represents the NTTT bus cable system on a small portion at the end of one spine of a large layout. It is only being used for the outer track on this layout to connect to the only two modules nearby with power drops (labeled with POWER). The modules are wired BWWB as per the T-TRAK electrical specifications. The 3-way pigtail is attached with normal polarity (i.e. blue to blue, white to white) to the bus cable. The Kato Connector for the outer tracks (O) for the two modules with power drops are connected to the 3-way pigtail. In this diagram the power for the inner track is not shown.

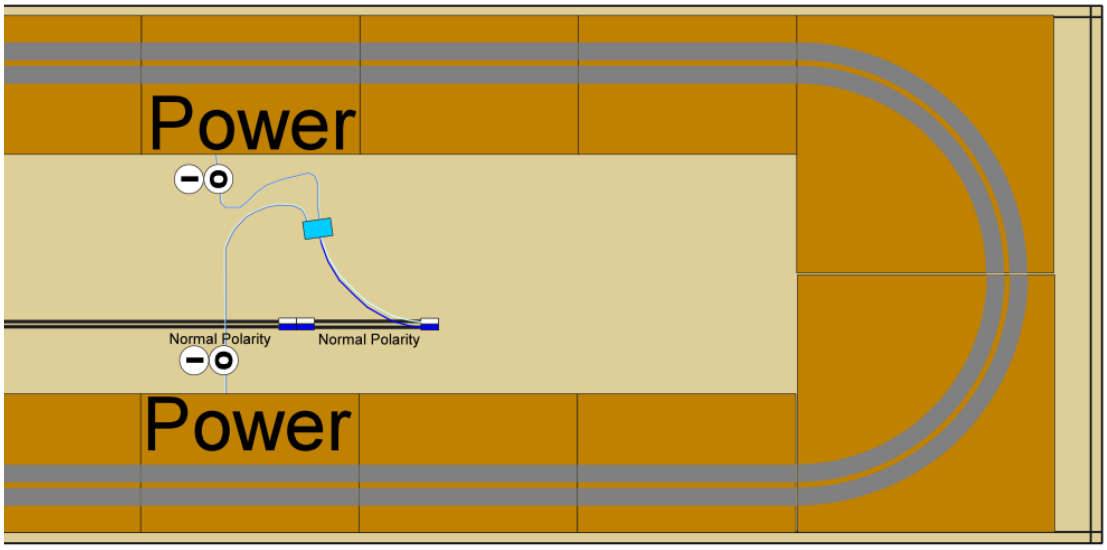


*Figure 13 - Connecting power to the outer track*

The layout in Figure 14 is the same as before with the exception that a double crossover has been included in the layout to permit switching trains between the two tracks. The two modules with power drops are still in the same place but this time the connectors for both tracks for both modules will be connected to the bus. An additional 3-way pigtail is connected to the bus cable (blue to white, white to blue) in order to reverse the polarity for that pigtail. The inner connectors (I) for each module are connected to the 3-way pigtail with reversed polarity.

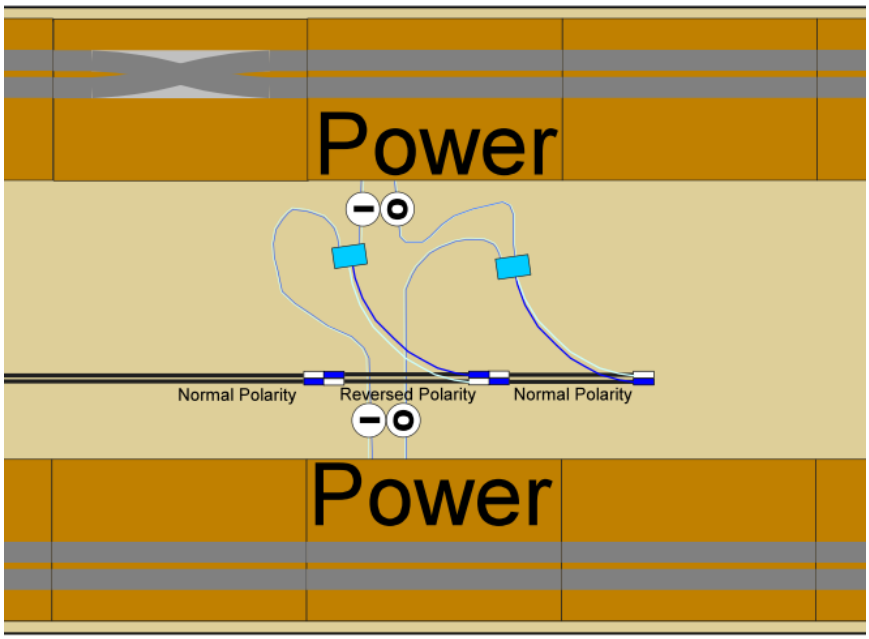


*Figure 14 - Connecting power to the outer and inner tracks*

The polarity is reversed again for the next 3-way pigtail thus creating normal polarity for the outer connectors (O) for both modules.

## Summary

The NTTT cabling system improves upon the North Virginia NTRAK cabling system by removing the gender from the cabling system which eases layout wiring. All cabling system components use the same “left hood down - right hood up” configuration greatly simplifying the cable system construction. The six-foot (2m) cables and shorter pigtails put the power drops at the correct distance on the layout and the greater variety of pigtail types accommodate the existing needs for all known T-TRAK wiring systems and scales. And finally, the system is extensible as new pigtail types can easily be created to fulfill specific needs or future requirements without the need to replace other components of the system.