North Raleigh Model Railroad Club

Standards and Recommended Practices

Electrical Standards for NTRAK Module Wiring

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Questions, comments, corrections and suggestions should be addressed to the NRMRC Standards Committee at wallisjm@att.net

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Introduction

Thousands of NTRAK modules have been constructed using the original 1974 NTRAK electrical standards as then defined in the NTRAK manual. These standards were based on the use of special throttles developed for NTRAK where a single train occupied an electrical block and the throttle controlled only that train. An NTRAK layout was divided into electrical blocks, and there was one NTRAK throttle per track per block. Thus an NTRAK layout with 5 electrical blocks and the three NTRAK main lines would require 15 NTRAK throttles. The NTRAK throttles received their power from a white-coded wire that connected all modules to a high capacity 12V DC supply.

These standards remain as the minimum electrical standard for NTRAK existing modules. However, electrical control of model railroads has significantly advanced since these original NTRAK wiring standards were defined in 1974. With straight DC power, some layouts are operated with a power pack per track for the entire layout, sometimes controlling 2 or 3 trains while maintaining a safe distance between trains through the use of slowing blocks. Other layouts are controlled using wireless DC throttles which are surprisingly similar to the concept of a throttle per electrical block per track.

The most significant advance in the control of model railroads is Digital Command Control (DCC) meeting NMRA Standards and Recommended Practices established originally in 1994. DCC allows the independent control of multiple trains per electrical block. The number of electrical blocks depends on the capacity of the DCC Power Boosters and not totally on the number of trains being run. This provides a great deal more flexibility in the operation of trains, including more prototypical operation such as bi-directional running on the same track.

The standards challenge is the requirement to be able to handle larger current in the module wiring, possibly up to 10A although the more likely norm will be 3A – 5A, while keeping voltage drop in the track and module wiring to acceptable levels, and allowing the DCC booster or power manager short circuit protection to reliably operate. This compares with the existing NTRAK standard of approximately 1A per electrical district.

The next section lists the current NTRAK Electrical Standard, effective 2011, for the electrical wiring for new module construction and for retrofit to existing modules where those

modules will be part of a DCC-controlled layout, as well as the former 1974 NTRAK Electrical Standard.

When the 1974 NTRAK Electrical Standard was initially established, a 100-plus module layout probably seemed inconceivable. Now, 500-plus module layouts are setup at national gatherings, and voltage drop has become a significant factor with the higher constant voltage and amperage of DCC power supplies. For this reason, any modules undergoing significant repair or renovation — and ALL new construction modules — must conform to the current (2011) NTRAK Electrical Standard below, particularly as they apply to wiring bus and track feeders, even if you and/or your club are not currently using DCC. This will help guarantee that your module will not be the "weak link" in a large multi-club layout where DCC may be run on one or more lines.

NTRAK Electrical Standard for Module Wiring

All NTRAK modules must be wired according to the NTRAK Electrical Standards, as a minimum. Following are the current NTRAK Electrical Standards.

General Information

Module wiring is essentially identical for each of the tracks, and is totally independent from one track to another — common rail wiring is prohibited. Where there is a crossover from one track to another, both rails must be gapped to preserve the electrical independence.

Module wiring consists of the following components:

- the track on the module
- the connecting tracks to the adjoining modules and their rail joiners
- the electrical bus underneath the module and its connectors that join to other modules
- the feeder wire that runs between the track and the electrical bus.

Standard — Electrical Bus

Each NTRAK track (red, yellow, blue, green, etc.) must have a continuous (unbroken) electrical bus running the length of the module, located beneath the track to which it is connected. The bus must be 12-gauge stranded copper zip wire (red/black zip wire, outdoor low-voltage lighting wire or speaker wire), or equivalent. This wire has a thin section between the two wires and can be "zipped" apart. One side of the covering has a rib molded along its length; connect the ribbed wire (or red wire in the case of red/black zip wire) to the front rail of the associated track and to the red or colored connector at the end of each bus.

The length of the bus wire is the length of the module plus 12" at each end.

Each bus will be connected to other modules using Anderson PP30 30 Amp Powerpole connectors at each end of the module, as shown in the diagram at the top of the next page.

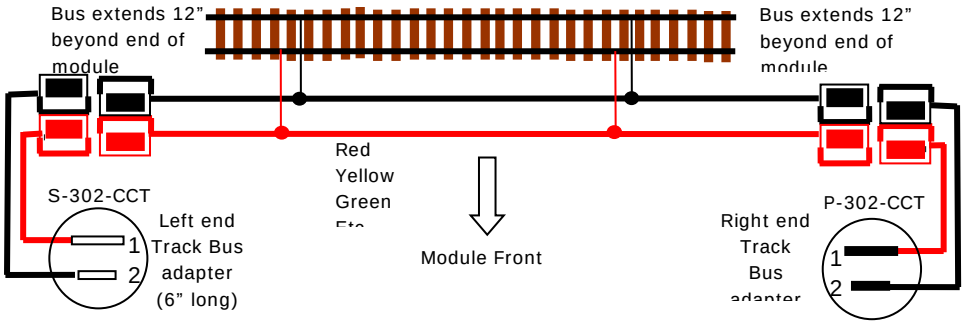
The following table is a summary of the Powerpole configuration as shown in the diagram.

Module End	Stacking	Configuration
Right	Vertical	Red over Black
Left	Vertical	Black over Red

The Powerpole housings are to be stacked *vertically* using the built-in dovetails, hood up, tongue down, *black over red* on the *left* end of the module and *red over black* on the *right* end. See the photos on the left and right ends of the diagram .

NTRAK Module Wiring Standard — Electrical Bus

Left End Track Bus Connector



Right End Track Bus Connector

Note in the diagram that the solid color represents the tongue while the white space represents the contact opening of the Powerpole housing. Using this convention you can determine we have black over red at the left end of the track bus and red over black at the right end. The red or colored connector will always be connected to the front rail, while the black connector will always be connected to the rear rail.

Color Coding of Connectors / Tape

Track Designation	Color Designation	Cinch-Jones or Red/Black Powerpoles Taped or Painted	Powerpole Colored Shells (Front / Rear Rail)
Front Passing Track	Orange	Orange	Orange / Black
Front Main	Red	Red	Red / Black
Inner Main	Yellow	Yellow	Yellow / Black
Branch Line 1	Blue	Blue	Blue / Black
Branch Line 2	Alternate Blue	Blue / Yellow	Blue / Yellow
Mountain Division	Green	Green	Green /Black
Set-Up Track	Green / Yellow	Green / Yellow	Green / Yellow
Nn3 Front Track	Red / Green	Red / Green	Red / Green
Nn3 Center Track	Yellow / Green	Yellow / Green	Yellow / Green
Nn3 Rear Track	Blue / Green	Blue / Green	Blue / Green
DC Supply	White	White	White / Black
Throttle/Booster Output	None	Purple	Purple / Black

Table courtesy of Glenn McLain & Doug Stuard

Accessory or fixed decoders MUST NOT be connected to any of the track electrical bus wires (since a DCC signal may not always be available, which would render these inoperable). However, accessory decoders may tap the track bus via Powerpole pairs inserted at the end of the module. Track detectors, if installed, must be of a type that will operate when the track is controlled by either an Analog or Digital controller.

Standard — Color Coding

Powerpole connectors may be used in red/black pairs and color coded with tape or paint in accordance with NTRAK standards for track color. Alternately, appropriate colored Powerpole housings may be used as shown in the table above:

Standard — Track Feeders

The track and its electrical bus must be interconnected by pairs of feeder wires. Solid core 18–22-gauge insulated wire must be soldered to the outside or bottom of the rails and to the electrical bus. Feeder wires should be kept as short as possible.

Alternatively, the track feeder may be soldered to the rails as described in the paragraph above and connected to a terminal strip. The unbroken electrical bus must connect to the terminal strip by wrapping the electrical bus around one screw or by a drop wire soldered to the bus which is then terminated on the terminal strip for distribution. This will permit correcting any wiring errors easily. Screw terminals must be securely tightened and checked for tightness before each train show.

Track feeders should be located as shown in the table on the next page.

Standard — Private Tracks

If the track(s) will only be powered from the connecting NTRAK track, then simply connect a pair of feeders from the connecting track to the private track. (If the turnouts are electrofrog be sure to gap both (2) frog rails at the frog end of the turnout.)

If there is need to switch the private track between DC and DCC when the connecting NTRAK track is DCC-powered, use a DPDT, center-off switch. This is, in effect, two cab wiring with the connecting NTRAK track as the DCC cab and a separate DC power pack as the DC cab.

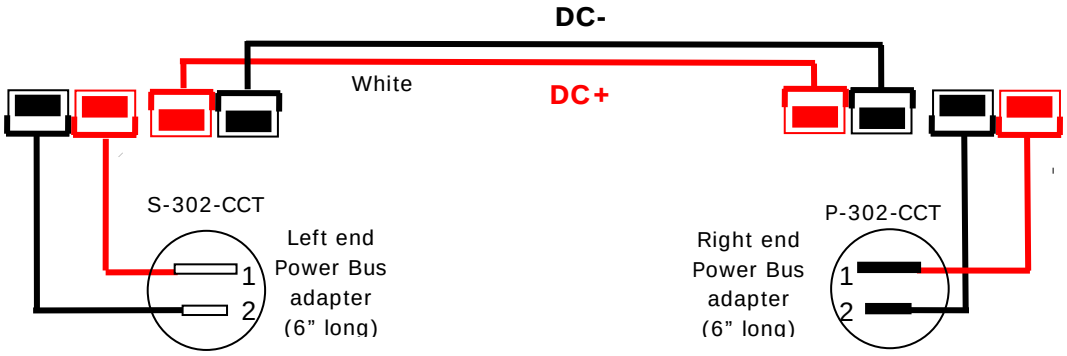
Track Feeders

Module Length (Feet)	Number of Feeder Pairs	Location of Track Feeder Pairs
1 or 2	1	Center of Module
4	2	12” from each end
6	3	12” from each end + center of module
8	4	12” and 36” from each end

1. Turnouts must have feeders installed at both ends for all mainline tracks, with appropriate insulated joiners/gaps at the frog end.
2. If unsoldered rail joints are used at any location on the mainline tracks a feeder must be present on both sides of the unsoldered joint.

Electrical Standard for White Wire

Power Bus Connector



Note in the diagram that the solid color represents the tongue while the white space represents the contact opening of the housing. Using this convention you can determine we have red on the left of the DC power bus and black on the right.

Standard — White Wire

The White Wire is NOT required for DCC operation; however, for compatibility with existing NTRAK modules the white wire MUST be included in the module wiring. The same 12-gauge wire used for the Electrical Bus is required. See the diagram above. Note that the connectors are horizontal rather than vertical, as shown in the table below.

Module End	Stacking	Configuration
Both	Horizontal	Red on Left; Black on Right (viewed from contact end)

The use of the White Wire for 16VAC supply to Boosters is not permitted, for safety reasons. Boosters must be powered with a dedicated 120V to 16VAC power supply for each Booster powered from the 120VAC line.

Note that this wire must have nothing soldered/connected (i.e., hardwired) to it except the Powerpole connectors at each end; use of this wire is by means of additional Powerpole connectors plugged in at the module end(s).

Standard — Brown Wire

The Brown Wire is used to provide 14–16VAC to power accessories on modules. The same 12-gauge wire used for the Electrical Bus is required. See the diagram above. Note that the connectors are horizontal rather than vertical, as shown in the table below.

Module End	Stacking	Configuration
Both	Horizontal	Brown on Left; Black on Right (viewed from contact end)

The use of the Brown Wire for 16VAC supply to Boosters is not permitted, for safety reasons. Boosters must be powered with a dedicated 120V to 16VAC power supply for each Booster powered from the 120VAC line.

Note that this wire must have nothing soldered/connected (i.e., hardwired) to it except the Powerpole connectors at each end; use of this wire is by means of additional Powerpole connectors plugged in at the module end(s).

Standard — 120VAC Wiring

Refer to document "Recommended Practice for 120VAC NTRAK Layout Wiring." Built-in wiring of any kind is no longer acceptable on NTRAK modules.

Where to Purchase 12-Gauge Wire

12-gauge stranded copper zip wire is available at Lowe's and The Home Depot, plus some electronics supply stores and some hardware stores. Outdoor low-voltage lighting wire is the most readily available. The electronic suppliers listed below also offer 12-gauge two-color zip wire (red/black). 12-gauge stranded speaker wire can also be used. 12-gauge non-zip stranded copper wire is allowable, but not recommended due to its stiffness.

Where to Purchase Powerpole Connectors

The standard connector for NTRAK is the Anderson Power Products PP30 series 30 Amp Powerpole. This connector is genderless, significantly lower cost than Cinch-Jones connectors and exhibits lower voltage drop at the higher currents common in DCC applications

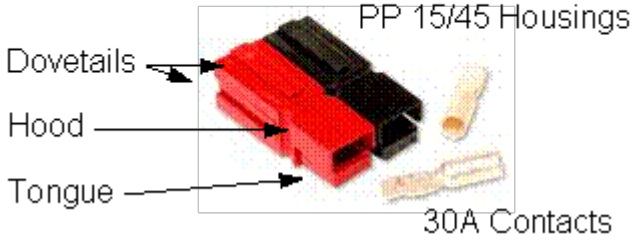
The Anderson part numbers for the PP30 series 30A Powerpole are provided in the table on the next page.

For NTRAK purposes you may choose to purchase red and black connectors only, and then apply colored tape as is currently done with the Cinch-Jones connectors, or you may purchase housing colors matched to the track colors.

Powerpole red/black and color connector pairs are available through the NTRAK Model Railroading Society's business office at www.ntrak.org/order_form.htm. An online Order Form and pricing is available at. All sets include an instruction sheet.

- Set "Red/Black" has 10 Red/Black housing pairs and two extra contacts.
- Set "NTRAK Colors" has housings with molded in colors for Red, Yellow, Blue and White. Black is used as the other color pair. Two extra contacts are included in the set.
- Two pair sets are available for the Mountain Division track (Green/Black); Front passing track (Orange/Black); Alternate Branch Line (Blue/Yellow). These sets include an extra contact.
- Other custom color sets will be made up on request at the two pair price.

Anderson Part Numbers for the PP30 Series 30A Powerpole Copnnectors



Housing Color	Complete PP30 Connector (Housing & Contact)	15–45A Housing Only
Black	1330G4	1327G6
Orange	1330G13	1327G17
Red	1330	1327
Yellow	1330G11	1327G16
Blue	1330G12	1327G8
Green	1330G2	1327G5
White	1330G5	1327G7
Purple	1330G17	1327G23
Gray	1330G14	1327G18
Brown	1330G15	1327G21
Pink	1330G16	1327G22
All connectors use #1331 30 Amp contacts.		

NTRAK pricing includes shipping cost and there is no minimum order amount.

Some other sources are the following mail-order electronic supply firms:

- Powerwerx at www.powerwerx.com
- Cablexperts at www.cablexperts.com/cfdocs/cat.cfm?ItemGroup=9&itmsub=0&bskt=0&USA_ship=1&c=0
- Quicksilver Radio Products at www.qsradio.com/DCpower.htm
- Hometek at www.cheapham.com/page10.html

- Connex Electronics at www.connex-electronics.com/?url=/html/products/anderson/powerpole/pp_main.html
- Rosspar Ltd. (Canada) at www.rosspar.com

Powerpoles are also carried by major industrial electronics distributors, including Newark InOne (www.newark.com) and Allied Electronics (www.alliedelec.com).

Since the 30A Powerpoles are also standard in the R/C model aircraft hobby these connectors are available at many hobby shops that carry R/C model aircraft. They may be known as SB connectors or Sermos connectors in these shops.

1974 NTRAK Standard for Module Wiring

General Information

The original 1974 NTRAK Electrical Standard remains in effect ("Grandfathered") for modules constructed using these standards prior to 2011. As stated above, newly constructed modules and re-furbished modules must comply with the 2011 standards described above.

Module wiring is essentially identical for each of the tracks, and is totally independent from one track to another — common rail wiring is prohibited. Where there is a crossover from one track to another, both rails must be gapped.

Module wiring consists of the following components:

- the track on the module
- the connecting tracks to the adjoining modules and their rail joiners
- the electrical bus underneath the module and its connectors that join to other modules
- the feeder wire that runs between the track and the electrical bus.

1974 Standard — Electrical Bus

Each track must have an electrical bus running the length of the module, located on the bottom of the module beneath the track to which it is connected. The bus must be 20-gauge stranded wire or 18-gauge "zip" cord" (Radio Shack Cat. No. 278-864); do *NOT* use telephone wire. This zip cord is ordinary 18-gauge lamp cord that has a thin section between the two wires and can be "zipped" apart. One side of the covering has a rib molded all along and/or one of the conductors is silver colored. Connect the ribbed/silver wire to the wide pin of the connector that will be attached to each end of the bus.

The length of the bus wire is the length of the module plus 6" at the left end and 18" at the right end (looking from the front of the module).

Two-pin connectors are soldered to the bus wires at each end to interconnect to the next module. Use the connectors as follows:

Left End	Right End
 TRW-Cinch #S-302-AB Chassis Socket or TRW-Cinch #S-302-CCT	 TRW-Cinch #P-302-CCT

Notes:

1. In all cases the #1 connector pin (wide pin) goes to the rail closest to the front of the module.
2. Use paint or colored tape to color code connectors to match track color.
3. The socket/plugs should be located in the center 12" of the depth of the module.
4. "Left" and "right" are defined looking at the front of the module.

Since Anderson Powerpole connectors are the NTRAK Electrical Standard, adapters from Cinch-Jones connectors to Powerpole connectors must be provided by Cinch-Jones module owners at each end for modules or module sets wired with Cinch-Jones connectors. Such adapters are illustrated at the extreme left and right in the Powerpole diagrams above, and described in the table at right:

16-gauge wire minimum should be used for the Cinch-Jones-to-Powerpole adapters with a maximum length of six (6) inches. 16-

Module End	Powerpole Connector		Cinch-Jones Connector
	Stacking	Configuration	
Right	Vertical	Black over Red	Plug (P-302-CCT) Ribbed/Red to Wide Pin Plain/Black to Narrow Pin
Left	Vertical	Red over Black	Socket (S-302-CCT) Ribbed/Red to Wide Pin Plain/Black to Narrow Pin

gauge wire minimum should be used for the Cinch-Jones-to-Powerpole adapters with a maximum length of six (6) inches. When using 16-gauge or larger wire in Cinch-Jones connectors at least one of the connections to the wire-terminals should be insulated using electrical tape or heat-shrink tubing to ensure no stray wires inside the shell can touch and cause a short.

Color-coding should be applied to the adapter cables per the Table earlier.

1974 Standard — Track Feeders

The track and electrical bus must be interconnected by either 22-gauge or 24-gauge solid wire soldered to the outside of the rails and to solder-type terminal strips (Radio Shack Cat. No. 274-688) mounted where the feeders go through the modules surface. The appropriate bus wire must be cut and soldered to the terminal strip. Feeder wires should be kept as short as possible. Use as many feeders per track as needed, but always at least one pair.

1974 Standard — Private Tracks

Private tracks on modules can be powered in different ways:

- A simple on/off DPST switch between the private track and the connecting NTRAK track, both rails.
- For independent operation with a separate throttle use a DPDT, center-off switch. This is, in effect, two cab wiring with the connecting NTRAK track as one cab and the separate throttle as the other.

If the module has a separate control panel the same color codes should be used for the NTRAK tracks as for the connectors. Since others may need to operate the tracks on the module the controls should be easy to use and clearly marked so turnouts can be worked and tracks powered with a minimum of confusion.

1974 Standard—White Wire

The White Wire is used to supply 12V DC power to the DC throttles developed for NTRAK. This wiring is 16-gauge stranded "zip cord" with the normal connectors on each end. Pin #1 (wide pin) is connected to +DC. Note that this wire must have nothing soldered/connected (i.e., hardwired) to it except the Cinch connectors at each end; use of this wire is by means of additional Cinch connectors plugged in at the module end(s).

1974 Standard — 120VAC Wiring

Refer to document "Recommended Practice for 120VAC NTRAK Layout Wiring." Built-in wiring of any kind is no longer acceptable on NTRAK modules.

Where to Purchase Wire

18-gauge stranded copper zip wire can be purchased in a number of colors at stores such as Radio Shack, Lowe's, The Home Depot, electronics supply stores and most hardware stores. This wire is the standard for the wiring of electric table lamps and similar items. 18-gauge stranded speaker wire can also be used.

Where to Purchase Cinch-Jones Connectors

The connector is the Jones connector made by Cinch, which is a TRW company. The connector is the 300 Series with Hood and 180° Cable Clamp (CCT). The chassis socket (AB) can also be used. The part numbers are:

Connector	Part No.
Plug Connector	P-302-CCT
Socket Connector	S-302-CCT
Chassis Socket	S-302-AB

These connectors are available through the NTRAK Model Railroading Society's business office. An online Order Form and pricing is available at www.ntrak.org/order_form.htm. Note that the S-302-AB chassis sockets will no longer be carried by NTRAK once the current stock is sold out.

Some other sources are the following mail-order electronic supply firms:

- Action Electronics at www.action-electronics.com/cinch.htm
- Digikey Corporation at www.digikey.com
- Mouser Electronics at www.mouser.com
- Newark in One at www.newark.com

Other electronics parts dealers may also carry the Cinch-Jones connectors. Note they are no longer available from Radio Shack.

References

NTRAK Publications

- NTRAK Module Manual
- The NTRAK Manual "How To" Book

Powerpole Proposal

- Introduction at http://home.comcast.net/~dstuard/powerpoles/NtrakPowerpole.htm
- The Proposal at http://home.comcast.net/~dstuard/powerpoles/PPproposal.htm
- The Quick Reference Guide at http://home.comcast.net/~dstuard/powerpoles/PPquickRef.htm
- The FAQs at http://home.comcast.net/~dstuard/powerpoles/PPfaq.htm
- Crimp Tool Evaluation at http://home.comcast.net/~dstuard/powerpoles/PPcrimp.htm

On the Internet

- Assembling Powerpole Connectors at www.wakeares.org/powerpole/index2.html
- Crimping at www.andersonpower.com/products/tooling/use.html
- History of the Connector at www.electronicstalk.com/news/ars/ars107.html
- Installation Instructions at www.w5fc.org/pse_docs/KNOWLEDGE/anderson_powerpole_instructions.htm
- Preventive Maintenance at www.andersonpower.com/products/tooling/maintenance.html
- Standard ARES Power Connector at http://www.rtpnet.org/wakeares/powerpole/index.html
- Using Anderson Powerpole Connectors — Fly RC Magazine articles:
  http://www.flyrc.com/articles/using_powerpole_1.shtml
  http://www.flyrc.com/articles/using_powerpole_2.shtml