



MODULE MANUAL



NTRAK Modular Railroading Society, Inc.

This book describes the standards for modules that are used in NTRAK modular layouts. The original material and previous versions were edited by Jim FitzGerald, Founder and first President of NTRAK. This version was edited by Hans-Jochen Trost with contributions from the NTRAK Board and Advisory members.

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Introduction

In 1973 a group of enthusiastic model railroaders got together at an N scale meet in Signal Hill, California, and talked about what they could do to help interest people in N scale and to share information about N scale. The NTRAK project resulted from that meeting and the idea has spread throughout the model railroad hobby.

NTRAK modules are used to build large display layouts as well as home and club layouts. Modelers from all over the world can build modules, bring them to a show, connect to the next module, and become part of a giant N scale layout. To be sure that each module fits to the next one, a set of standards was worked out. This manual is the result of experience gained from building thousands of modules. They have been used for National Convention layouts since 1974 and for many regional and local layouts.

Over 100 clubs around the world are now using the modules for all or part of their club layouts. Some have semi-permanent quarters and others assemble the layout in space rented or borrowed for just that meeting. With careful attention to detail, quick assembly and reliable operation can be achieved. Some of their successful ideas are shown in this manual.

In 1996, NTRAK became a nonprofit corporation. Our purpose and objective are to encourage and promote model rail-roading in N scale. Besides this manual, we keep in touch with N scalers with a Newsletter and help coordinate NTRAK layouts for public showings. These shows and publications help inform people about model railroading.

NTRAK layouts combine beautifully detailed modules with long trains running on two main tracks. A third track, the branch line, may be used for picking up and setting out cars at the many industries along the way. Several modules can be combined to model a complex scene. You can contribute to this scene by building a module. The length of the module you build will be part of the early planning. The 4' modules fit inside most cars and allow enough room for industrial and city scenes. The 6' modules will fit in many SUVs and are large enough to model many scenes. The big problem with the 8' modules is transporting them. They should be protected from the wind and rain. This means a van or pickup with a shell or covered trailer.

Since the modules are moved about, construction is a bit different from home layouts. This manual gives many ideas, but in general remember that there will be great changes in humidity and temperature, as well as vibration. The framework should be assembled with glue and screws. Weight is a problem too, so consider plastic foam mountains instead of plaster. Structures should either be well glued in place or packed separately. The key to good operation is good trackwork. One bad piece of mainline will ruin operations for everyone. The Meet Coordinator may order repairs, or the module removed from the layout. Check your turnouts for gauge and that the flangeways are clear of ballast. Gently blowing a single Micro-Trains® truck through the track work will show any obstructions or tight spots.

For more copies of this manual, newsletter subscriptions, books and supplies visit the NTRAK website at http://www.ntrak.org/ntrak_store/default.html.

Modular Layout Ideas

The concept shown in Fig.1 is based on 4, 6 and 8-foot long modules, plus several styles of corner modules. Most of the types of modules built so far are shown in this plan. Of course, there are many possible combinations to fit the space available. 12' wide layouts give a good working space in the "Operating Pit". On 8' wide layouts the "Pit" is less than 4' wide and can get crowded.

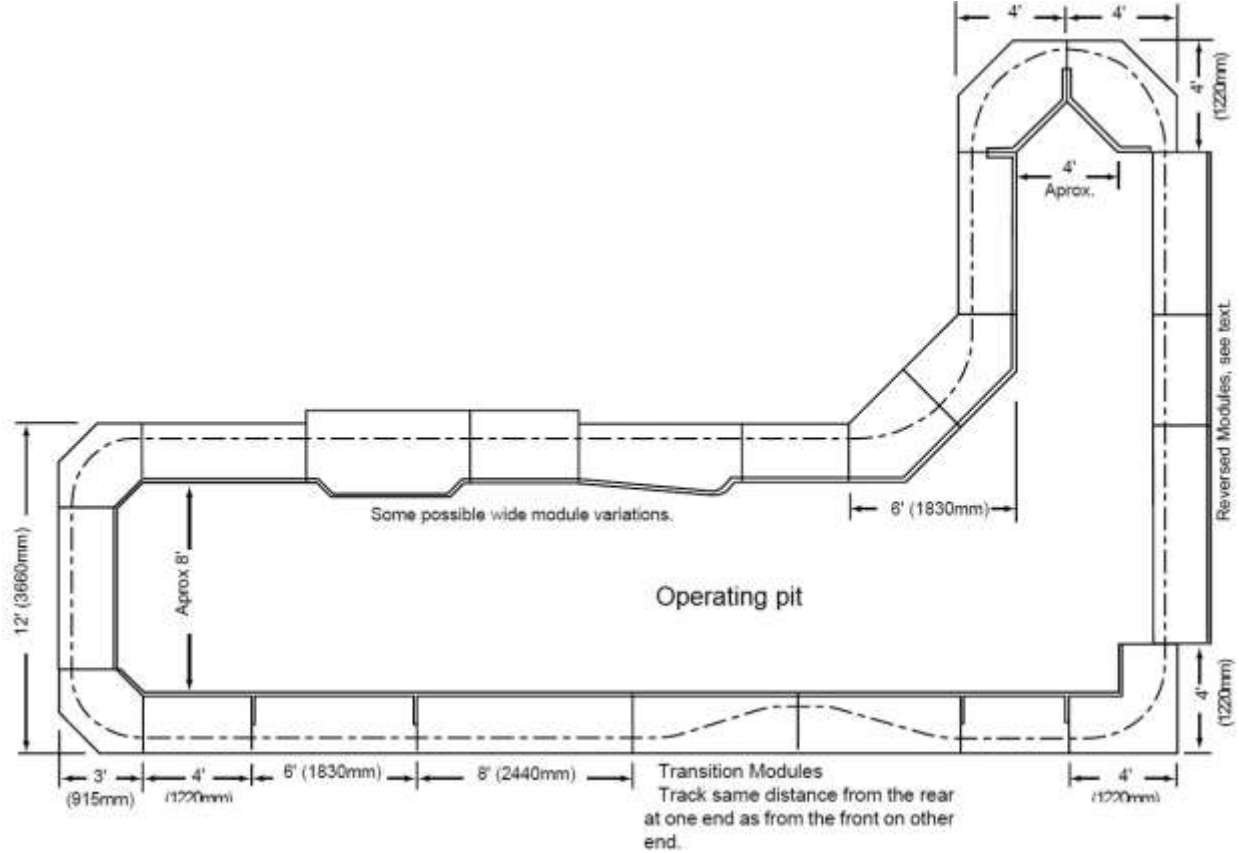


Figure 1: Example layout

The 4' and 3' corner modules with six sides have proved to be most useful and easy to transport. To get the maximum mainline radius for inside corners, either an extended version of the six-sided module is used, or "Transition Modules" are used to swing the tracks to the rear of the module so that the standard six-sided module can be reversed and used. As shown in this drawing, the "Transition Modules" can also be used in pairs as standard modules.

Wiring of reversed modules requires special attention and possibly special adapter cables. Details are in the NTRAK Module 'How-to' book. By reversing some modules, where space is limited, an aisle can be eliminated, as shown on the right in Figure 1.

The following track plans are among the over 100 plans, drawn to 1/2"=1' scale, shown in the Track Plan Set available from NTRAK. Plan S-9 (Fig.2) shows the branchline swinging away from the mainlines and has a simple siding that leaves ample room for scenery on the four-foot module. Plan S-7 (Fig.3) on the other hand puts a maximum of track on a four-foot module. Plan S-1 (Fig.4) gives room for several industries and interesting switching problems on a six-foot module.

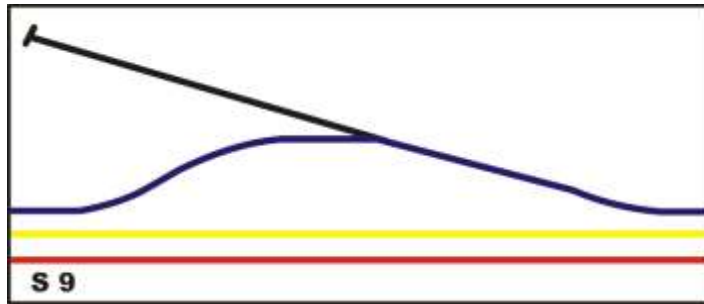


Figure 2: Module layout S-9

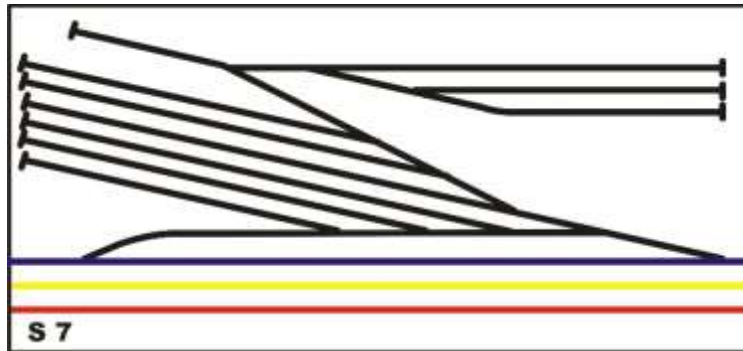


Figure 3: Module layout S-7

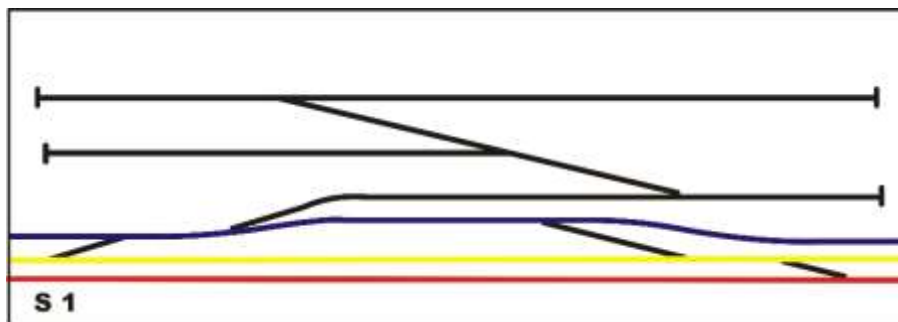


Figure 4: Module layout S-1

Two or more modules can be combined and always used together. With S-14 and C-11 (Fig.5) a corner and a four-foot module have been combined for a terminal facility. This makes an excellent end for a point to point home layout.

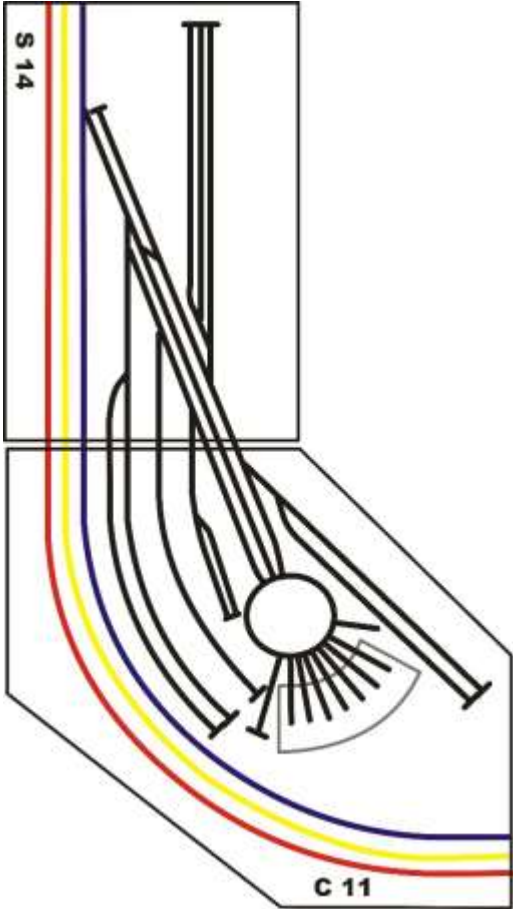


Figure 5: Module layouts S-14 and C-11

Figure 6 shows two modules combined for a through passenger terminal.



Figure 6: Passenger terminal

The following big layout (Fig.7) is 22'x41' and is also taken from the Track Plan Set; it would make an excellent club layout. Photos of many of the template modules are shown in the NTRAK Module 'How-to' Book.

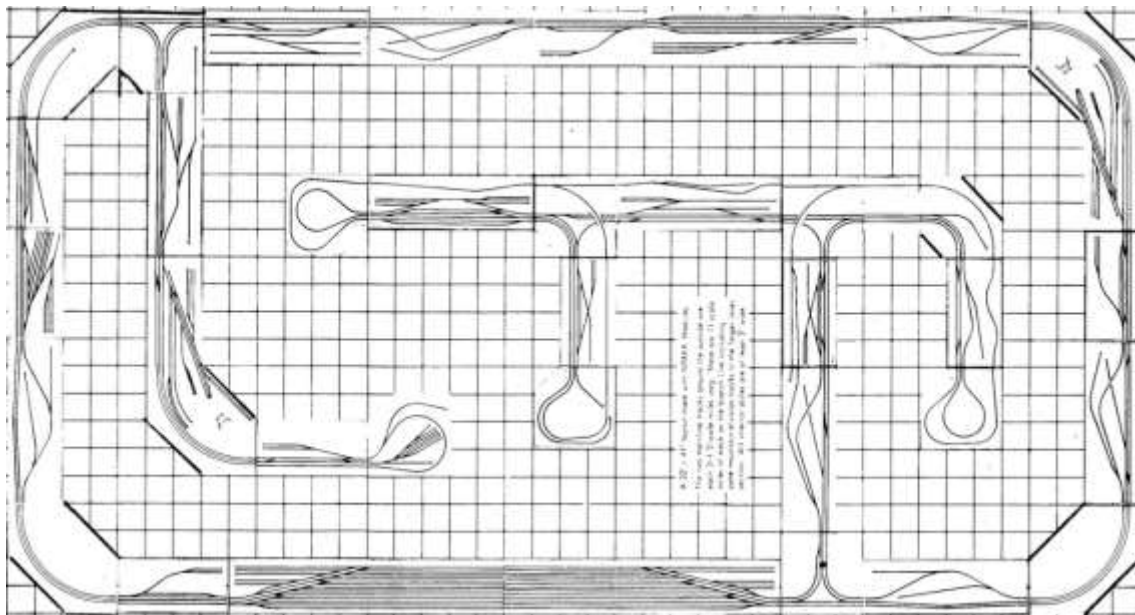


Figure 7: Large layout

The use of Junction and Balloon modules for individual branches allows for layouts without any enclosed pit. Figure 8 shows an example of such a layout.

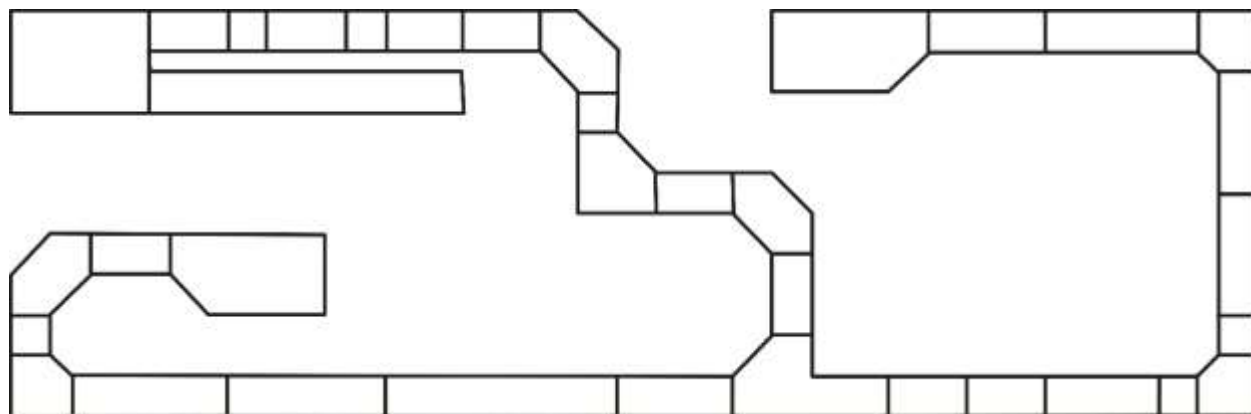


Figure 8: Open layout

Module Standard Short Overview

General layout of a module

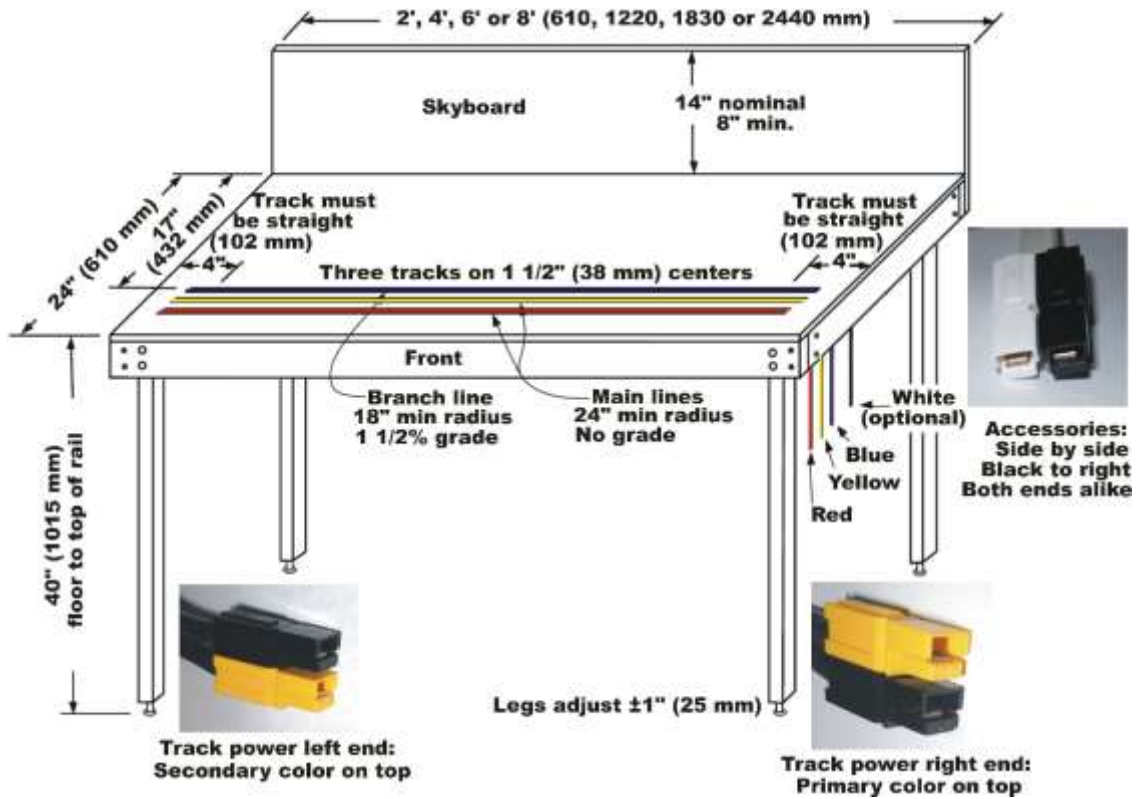


Figure 9: General layout of a module

Modules are joined by setting two “C” clamps and inserting a 5” connecting track (Fig.10). Remove ties from track ends as needed to allow rail joiners (Atlas, Peco) to slide fully on. The clearance from the clamp to the top of the rail is typically 4½”.

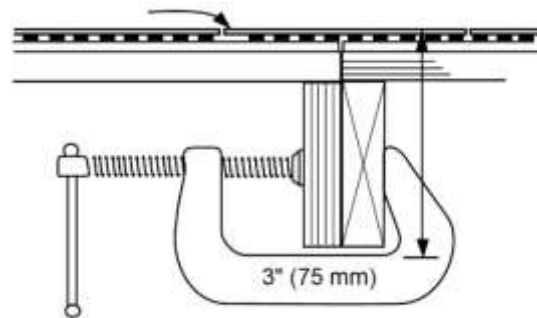


Figure 10: C-clamp joining modules

To obtain a square module, make the lengths L1 and L2 equal, the end depths E1 and E2 equal, and the diagonals D1 and D2 equal (Fig.11).

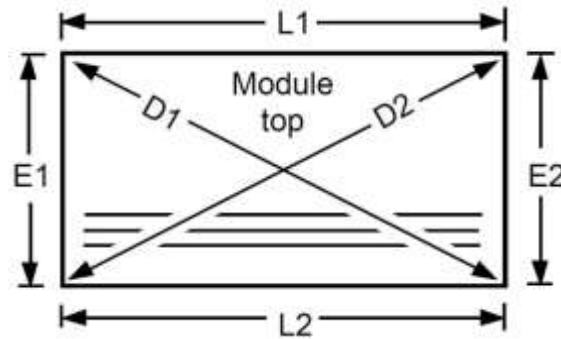


Figure 11: Squaring a module

Module table

Length:	multiple of 2' (610 mm)
Depth:	2' (610 mm)
Keyboard:	min. 8", nominal 14"

The most common length is 4'. Optionally, 6" depth can be added at the front and/or rear. Each module should have its own legs. Bridge and other special modules may be used with the approval of the layout coordinator. The module owner shall provide two "C" clamps per module, size at least 3".

Tracks

Three tracks are obligatory for all modules and are considered "community property". Placement of the track centers, measured from the rear of a 2' deep module, is at

20.0" (508 mm)	front main, "red",
18.5" (470 mm)	inner main, "yellow",
17.0" (432 mm)	branch line, "blue".

Track positions are defined at the ends of a module or module set. The first 4" from the edge of the module must be straight. Internally to a module (set), the minimum track separation is 1.25". A number of optional tracks have been defined, see the table below. The minimum distance from the front edge of the module to the center of the first track is 2".

Recommended track material is Atlas Code 80 flex track, Peco Code 80 or Peco Code 55 flex track, or Kato Unitrack. Modules are connected with 5" Atlas Snap track sections

(nominally 4.91") or Peco Code 80 or Peco Code 55 flex track cut to the same size. Community property tracks must be compatible with large wheel flanges and must accept the standard connecting track. The module owner shall provide connecting track sections as needed.

Crossovers between the three community tracks are suggested for long (6' and up) modules; turnout sizes of #6 or larger are recommended. Among other options, uncoupling ramps have to be electrical, and tunnels have to be easily accessible for track cleaning and rerailing of rolling stock.

Wiring

Track power and optional accessory power shall pass through underneath the module in 12 AWG stranded copper zip wire, extending 12" beyond either end of the module. Feeder wires for tracks and accessories can be attached with suitcase connectors (3M 567, brown) or by soldering them to the bus wires (soldering recommended). Connections between modules use Anderson Powerpole 30 A rated connectors. The community tracks and a number of established optional tracks have unique color codes assigned (see table below). The color codes are applied to the connectors by selecting proper colored shells or by wrapping them in colored tape (no black tape, other secondary colors are applied as thin stripes). For track power, the primary color shall mark the wire feeding the front rail of the track.

Do not use common rail wiring. There should be no connection between any of the rails of the three community tracks. Crossovers need to have insulating gaps in both rails.

Identification of tracks and wiring

<i>Track/Line</i>	<i>Color code</i>	<i>Position</i>	<i>Min Radius</i>	<i>Height</i>	<i>%Grade</i>	<i>Front / Rear Rail</i>	
Front Main	Red	20.0	24	40	0	Red	Black
Inner Main	Yellow	18.5	24	40	0	Yellow	Black
Branch	Blue	17.0	18	40	1.5	Blue	Black
Branch Option	Blue/Yellow	10.0	18	40	1.5	Blue	Yellow
Mountain Division	Green	4.0	12	43 1/8	3	Green	Black
Set-up Track	Green/Yellow	-1.5	18	40	0	Green	Yellow
Front Passing	Orange	21.5	24	40	0	Orange	Black
Nn3 Front Track	Red/Green	22.0	no std.	38	no std.	Red	Green
Nn3 Center Track	Yellow/Green	15.5	no std.	40	no std.	Yellow	Green
Nn3 Rear Track	Blue/Green	6.0	no std.	40	no std.	Blue	Green
NCat Front Track	no std.	15.0	10	40	no std.	Special Plugs	
NCat Rear Track	no std.	2.0	10	40	no std.	Special Plugs	
Booster output	Purple	n/a	n/a	n/a	n/a	Purple	Black
DC Supply 12 V	White	no track connection, white on pos. 12 V				White	Black
AC Supply 15 V	Brown	no track connection				Brown	Black

Notes:

1. Heights are given above floor level.
2. Positions are measured from the rear of a 2' deep module. The set-up track thus is mounted behind the module, usually hidden by the skyboard.
3. To help protect against confusion with the Nn3 Center track, connectors for the setup track should always be wrapped green with a narrow yellow strip over the middle.
4. For details on Nn3, NCat, see separate documentation.

Optional Features

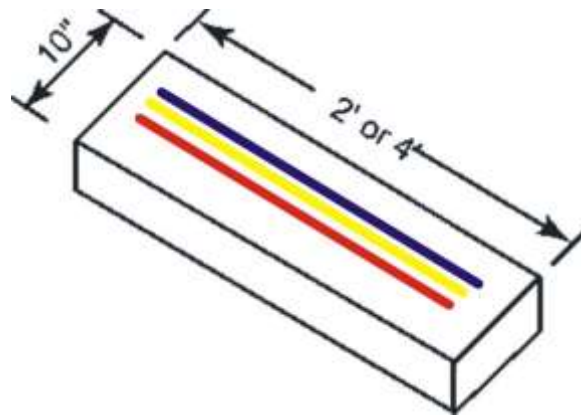


Figure 12: Bridge module

Bridge modules in 2' and 4' lengths are used to complete a layout with the available full-size modules (Fig.12). One-foot and three-foot lengths are also useful. They also serve as “duck under” spots for easier entrance to the layout. They are about 10" wide with the front main tracks back the normal 4". Skyboards are optional, and legs aren't used. Full wiring is needed.

Module depth: Up to 6" may be added to both the front and rear of modules to make room for scenery or track plans (Fig.13). If extra is added at the rear, the skyboard should still come forward in some manner to match the standard position.

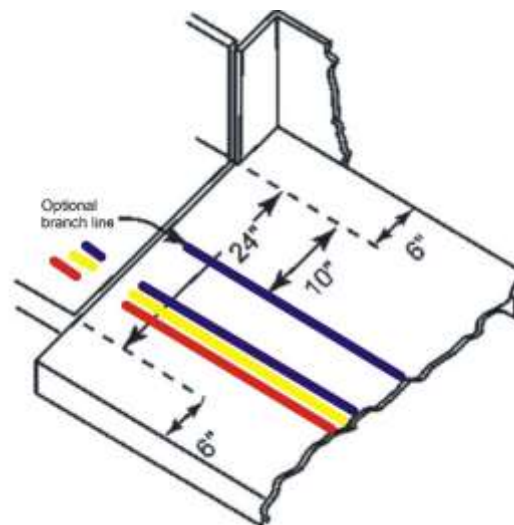


Figure 13: Module options

An **optional location for the branch line** is shown in Figure 13. It may be used within groups of modules but must go back to standard location at the outer ends of the module set.

Skyboards should be at least 8" high, and normally 14". Diorama dividers are optional and should stay within the dimensions indicated in the drawing (Fig.14).

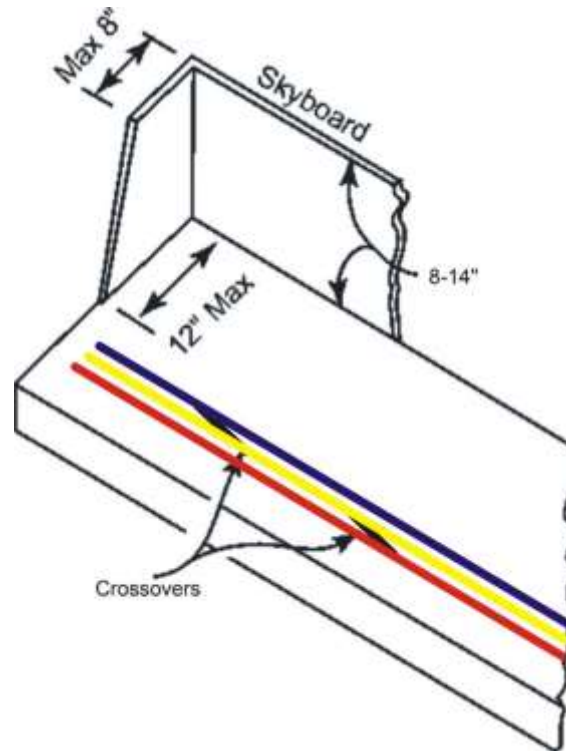


Figure 14: Skyboards and crossovers

An easy way of fastening skyboards is to provide "Tee" nuts in the rear fascia board and use 1/4" eyebolts with washers to screw the board on (Fig.15).

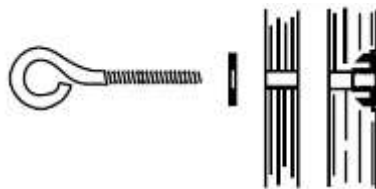


Figure 15: Skyboard fastening

Crossover tracks between the mainlines and branch line tracks are an option (Fig.14). A set of each hand is helpful in any layout to shift trains from one track to another. Builders of 6' and 8' modules are asked to include a set of either hand on their modules if they fit

with the track plan. Insulated gaps are needed in both rails of any crossover tracks. Peco or Atlas turnouts are preferred.

Canyon type modules require extra structural support. The concept is shown in Figure 16 for a 4-foot module; more details can be found in the NTRAK Module How-To Book.

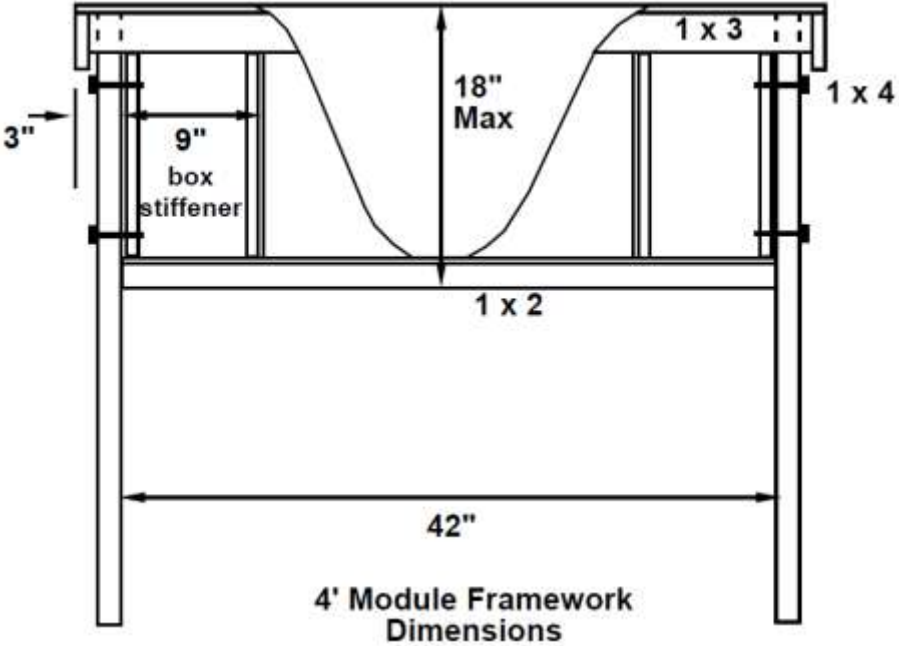


Figure 16: Canyon module

Additional Tracks

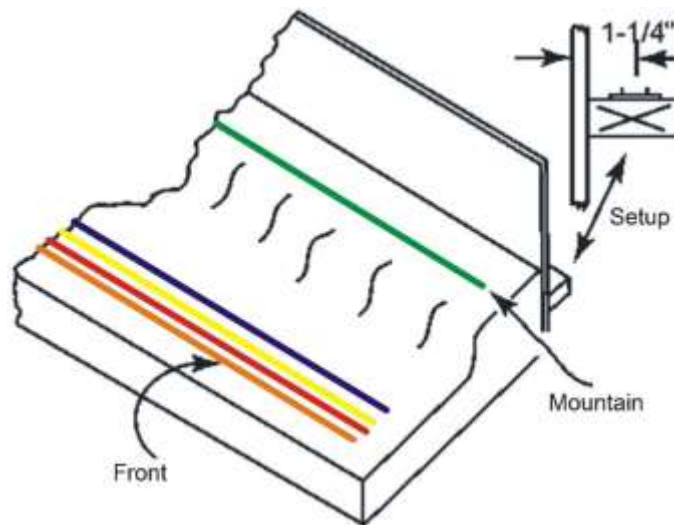


Figure 17: Additional tracks

A **setup track** behind the skyboard (Fig.17) can be used for behind the scenes removal and set-up of trains. It is used by some as a return loop track within the module or for a string of modules. Color code the connectors Green with a narrow Yellow center stripe.

A **mountain division track** runs at 3 1/8" above the normal level, 4" in front of the skyboard on a standard depth module (Figs.17, 18).

A **front or passing track** can be added 1.5" in front of the main lines (Fig.17).

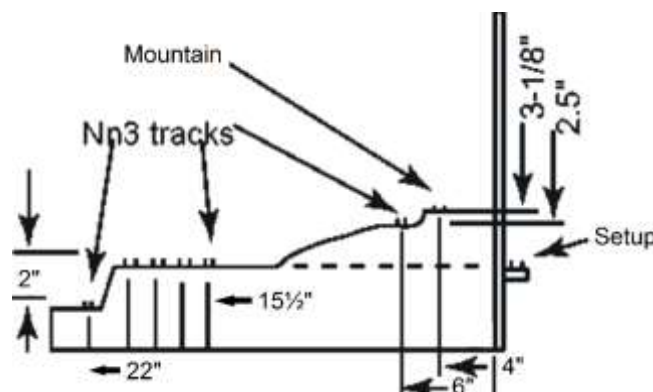


Figure 18: Narrow gauge tracks

Narrow gauge (Nn3) makes use of Z scale tracks (Fig.18). Track sections 110 mm long (Märklin #8500, Micro-Trains #990 40 902, Rokuhan #R001) or adjustable track (100-120

mm, keep it close to 110 mm; Märklin #8592, Rokuhan #R031) are used for connecting tracks between modules. The center and elevated rear tracks are required, and the front track is an option.

Catenary tracks: Electric type locomotives operating under live overhead wire are a feature of the NCat modules. Shown in Figures 19 and 20 are the required tracks for NCat modules. Additional tracks and sidings are the choice of the builder.

More information is available at <http://www.teamsavage.com/ncat/ncat.html> and the Yahoo group at <https://groups.yahoo.com/neo/groups/nscaletraction/info>.

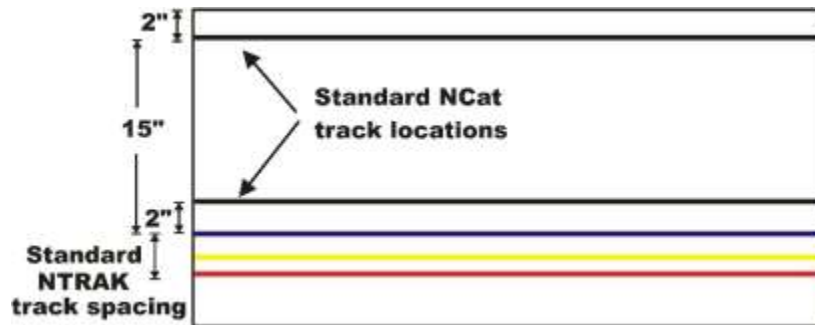


Figure 19: NCat tracks

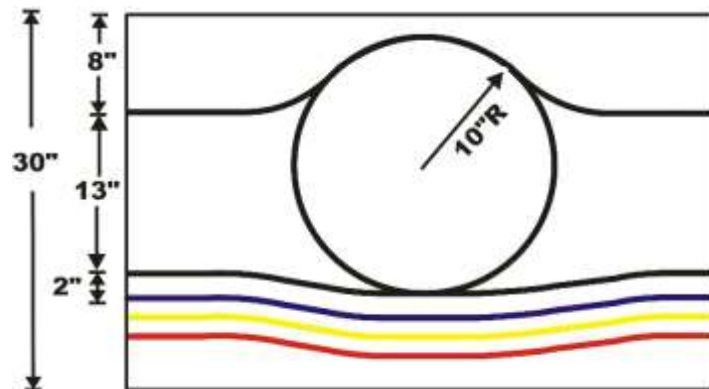


Figure 20: A NCat loop

Module Construction Odds and Ends

The following sketch (Fig.21) summarizes the mechanical dimensions of the core module and some optional features (diorama divider, canyon type design).

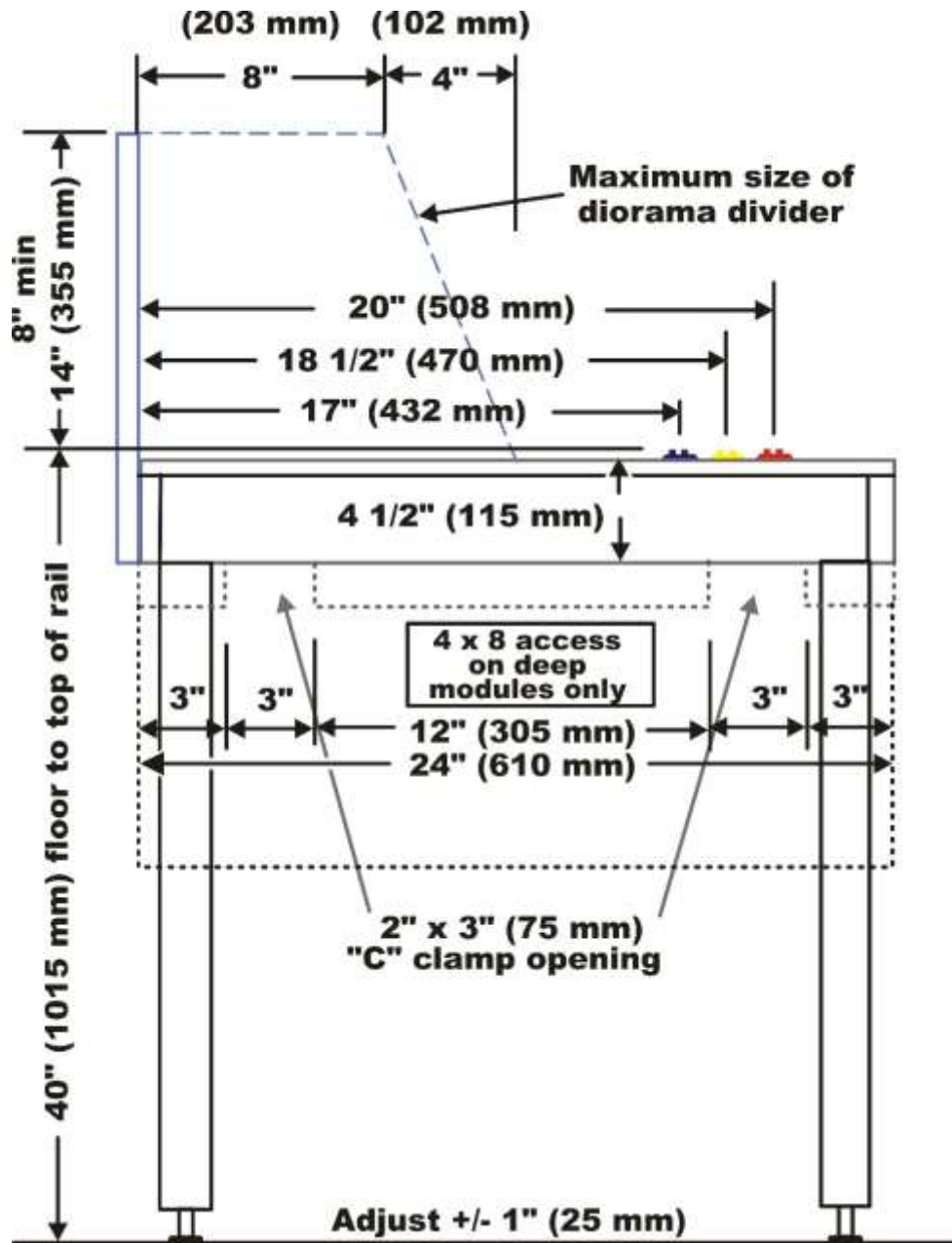


Figure 21: Module dimensions

Atlas “Snap Track” straight 5” sections (actually 4.910” long) are the traditional connecting track pieces, setting the basic length for this purpose. A handy way to get the proper set-back is to clamp a scrap of plywood to the end of the module and use a 1/2 section as a guide. (See Figure 22. Some Atlas track assortments have two 1/2 sections of slightly different length; use the longer one, 2.455”.) Lay track leaving a 1/64” gap. Repeat at the other end and cut rail to fit. Observe these dimensions even if you expect to use other options for connecting track (e.g., Peco flextrack).

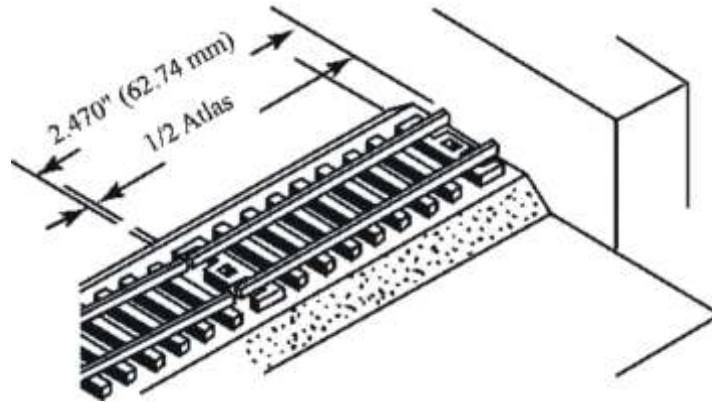


Figure 22: Space for connecting track

Clearances can be checked with a gauge. The dimensions listed in the table following Figure 23 are based on NMRA recommendations for N scale and adjusted to the prototype clearances for double-stack and other modern cars. These clearances are used for the three “community property tracks”; other tracks may have restricted clearances.

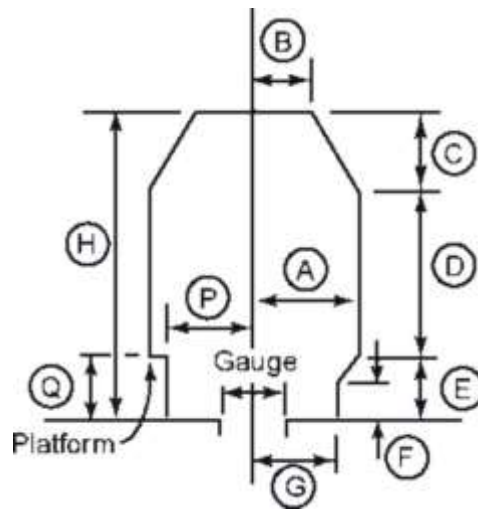


Figure 23: NMRA gauges

Clearance gauge dimensions

	Standard gauge		Narrow gauge	
	Prototype	N	Prototype	N
A	9'0"	11/16"	6'3"	0.469"
B	4'0"	5/16"	3'0"	0.225"
C	6'0"	7/16"	4'3"	0.319"
D	12'0"	29/32"	10'0"	0.750"
E	4'0"	5/16"	2'9"	0.206"
F	2'6"	3/16"	1'6"	0.112"
G	6'9"	15/32"	5'0"	0.375"
H	23'0"	1 23/32"	17'0"	1.275"
P	6'9"	15/32"	4'9"	0.356"
Q	4'0"	5/16"	2'9"	0.206"

A simplified gauge is available from NTRAK (Fig.24), more complete versions are available from NMRA and some retailers.

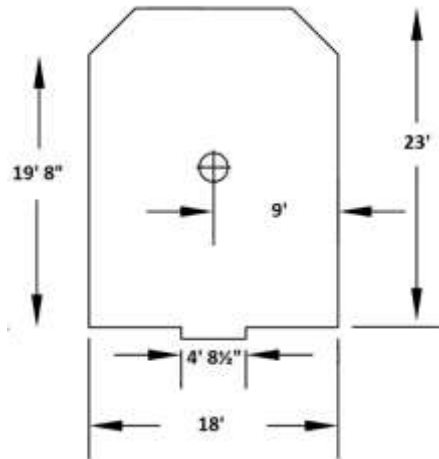


Figure 24: NTRAK gauge: A=9', H=23', C=3'4", B=5'8", rail gauge 4'8½".

NMRA Track Gauges:

https://www.nmra.org/sites/default/files/standards/sandrp/pdf/rp-2_2017.10.20_track_gages.pdf

NMRA gauge dimensions:

https://www.nmra.org/sites/default/files/standards/sandrp/pdf/rp-7.1_tangent_track_centers_and_clearance_diagrams_july_2017.pdf

Corner Modules

The six-sided NTRAK corner modules are basically a 4' or 3' square with two corners cut off. The 4' corners (Fig.25) are nearly 5'8" long and 34" wide, giving them room for a roundhouse or other larger scenes. A similar corner module based on a 3' square (Fig.26) is easier to store and transport. A layout can be assembled with a mixture of two 4' and two 3' corners. In addition, Figure 27 shows an option for laying out an inside corner.

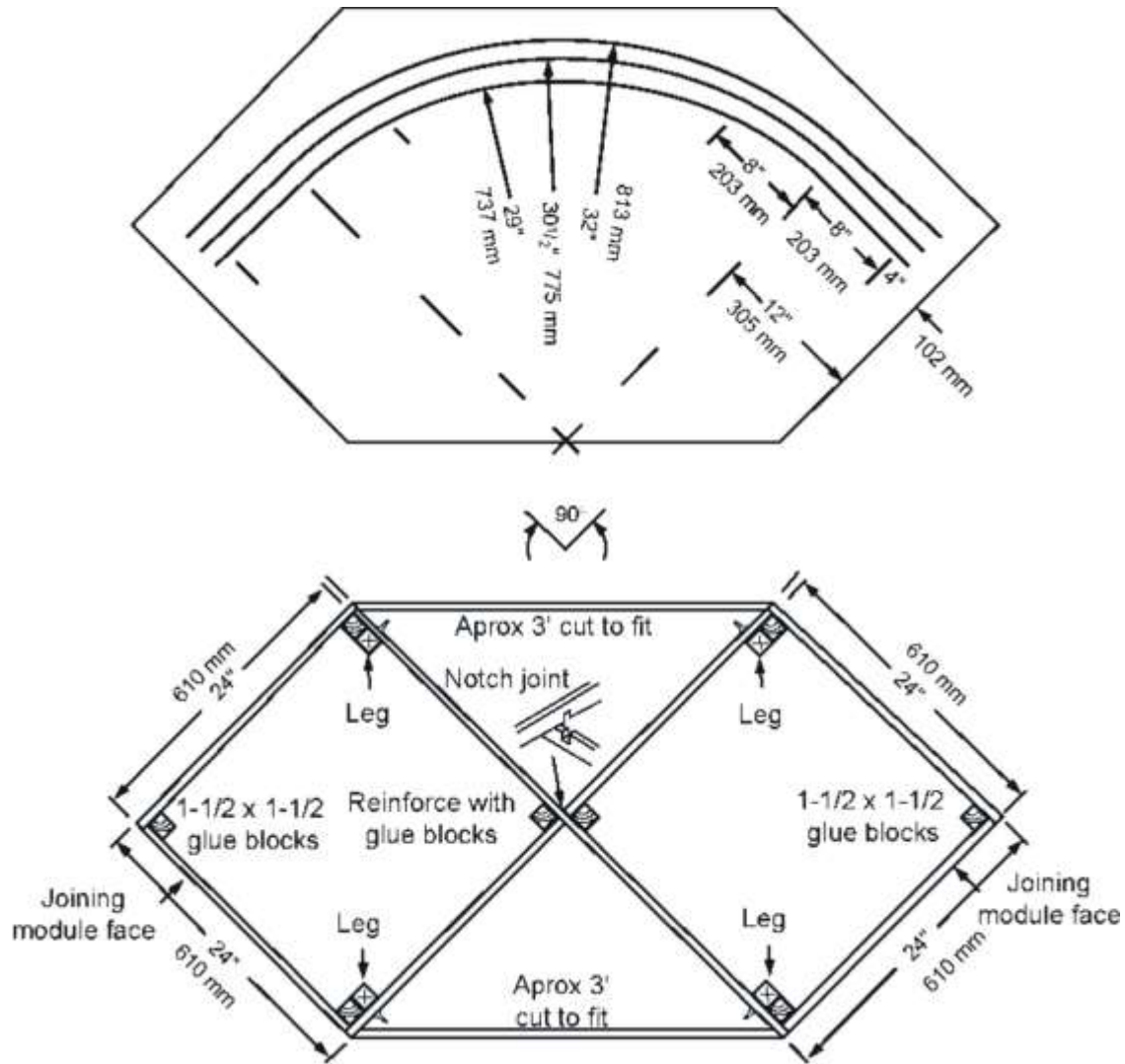


Figure 25: 4' corner

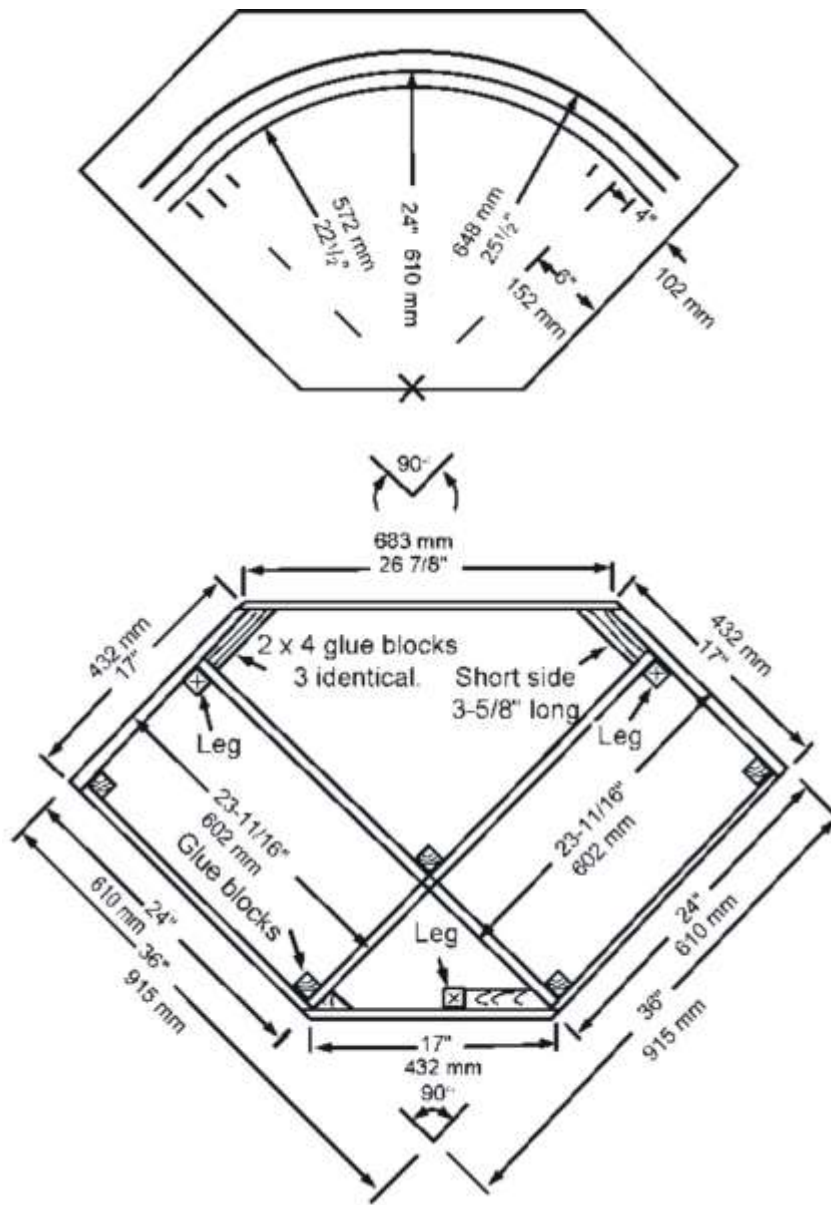


Figure 26: 3' corner

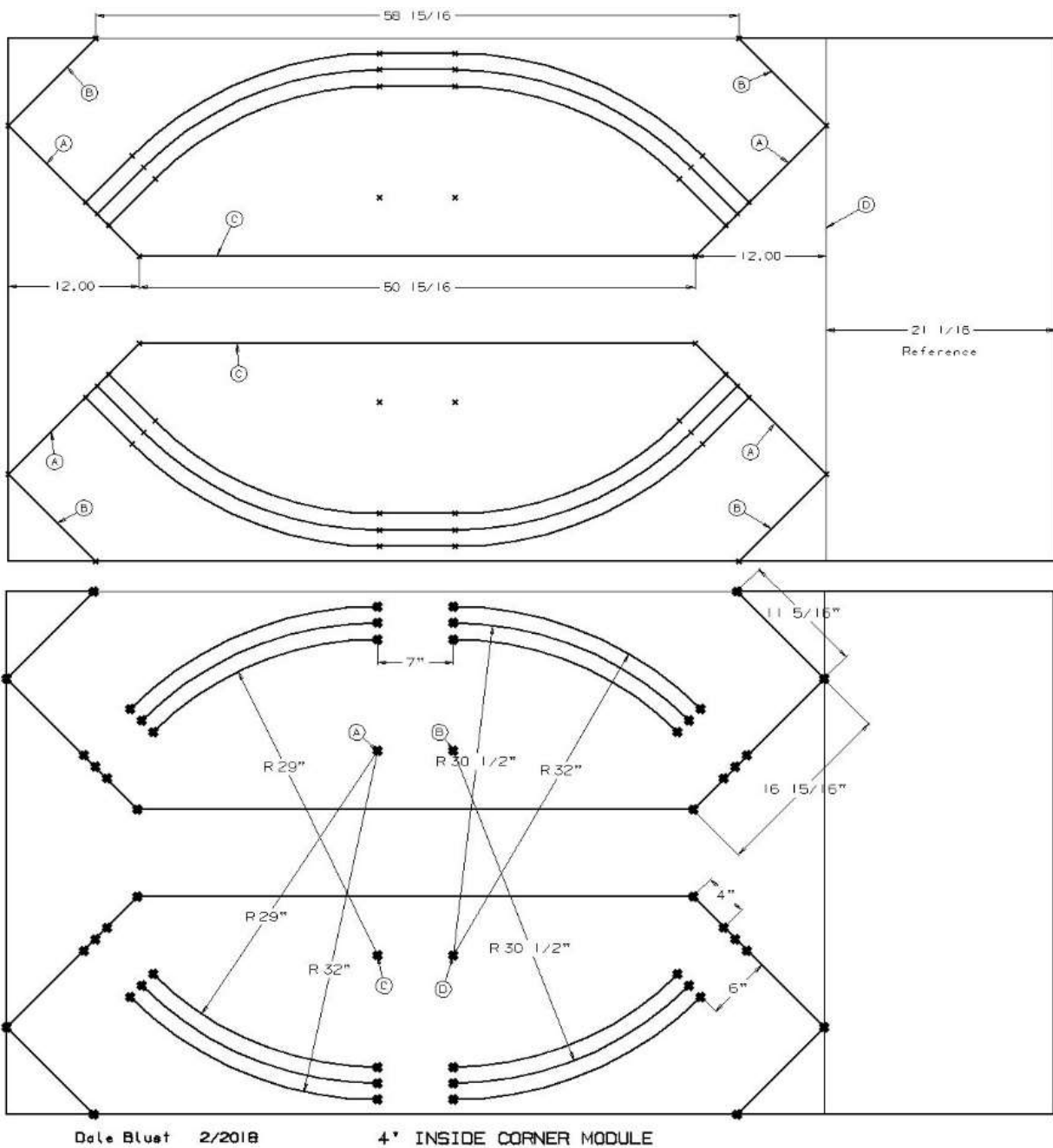


Figure 27: Inside corner

All key dimensions are given, but some dimensions are omitted since they are governed by the thickness of the materials used. Where the two braces cross, they could be notched to fit together, or one could be solid and the other in two pieces that butt against it. The use of screws, glue, and glue blocks will make a solid and long-lasting base for your track

and scenery. Typical materials used include 1/2" or 3/8" plywood for the top surface and 1x4 lumber or 1/2" plywood for the framing.

NOTE: It is most important that the two faces that mate with other modules be square with each other. If you use a plywood top, use a factory cut corner for these two faces. If you build an open grid version, the use of the corner of a plywood sheet as a square during assembly is suggested.

A transition curve is recommended where a curved length of track meets a tangent (straight) track. The transition will avoid the misalignment of the ends of longer cars as they pass from the curve to tangent track.

Super elevation (banked curves) are not recommended. Longer trains can be run with flat curves than can be run with super elevation.

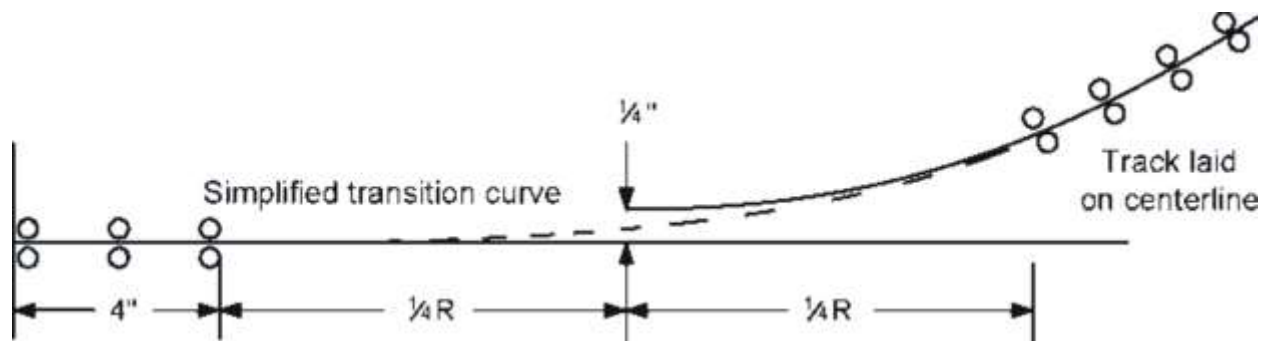


Figure 28: Transition curve

A smooth transition at the ends of a curve (Fig.28) can be laid out by eye by using flex track as a "bent stick", as shown here. The first 1 1/2" of track must be straight to meet NTRAK specs (4" in from end of module). It is suggested that track be extended to or beyond the module edge and then trimmed to length after the laying of the transition curve is completed. This will make it easier to keep the 1 1/2" length straight. The track is restrained by pins or nails at the points marked with small circles. Check it out by pushing several long passenger cars through the transition. If the ends of the long cars stay aligned coming out of the curve, without relative motion from side to side, then the transition is good. If not adjust the track and recheck. Avoid sharp kinks in the rails.

Where two pieces of track must be joined on a curve, solder the rail joiners in place with the track straight and then form the curve.

There isn't enough room for a full transition on the three-foot corner, but enough easing can be done to make problems with long cars minimal on these corners.

Junction Modules

To join several clubs into one big layout, the Junction Module was developed by Matt Schaefer and the Northern Virginia NTRAK Club. The design was inspired by the six sided "Diamond Mill" by Dave Savage and Paul Miller that was used for the huge '93 Valley Forge layout.

The dotted lines in Figure 29 show the concept of adding an extension to a corner module. The actual junction module frames are made just for their use and ignore the dotted line shown. A 3' size is shown. Some 4' versions are also used.

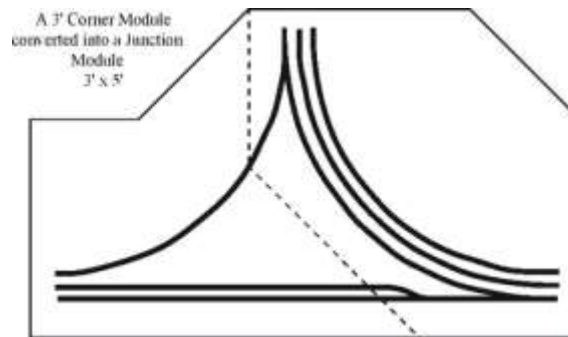


Figure 29: 3' junction layout

When the layout is in operation, the two inner tracks of each oval are traditional NTRAK ovals. The outside track, however, goes completely around the layout. It can be 30 to 40 scale miles around one of these big layouts. The operators follow their trains using radio throttles, either DCC or analog wireless throttles.

Junction modules are built in left- and right-hand versions and there are several track plans in use. You need three electrical gaps in the track (Fig.30) and double pole double throw switches to correct the polarity in the tracks connecting to the next loop.

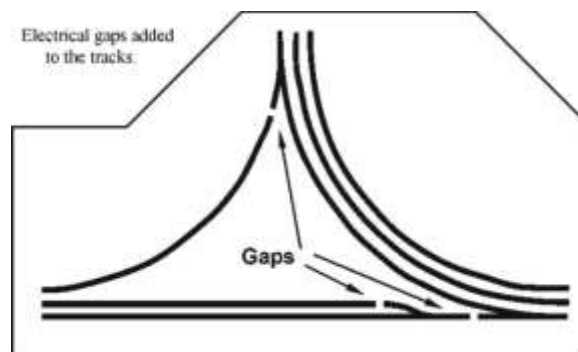


Figure 30: 3' junction electrical gaps

oNeTRAK Modules

Pioneered by the Northern Virginia NTRAK Club, the basic module is a one foot wide and four foot long unit with a single track anywhere in the middle 4" area of the module. They can be wider, they can have two or more tracks, they can have an offset "S" bend or just about any design that you feel would be workable. The idea is to come off of a regular NTRAK oval and get into a branchline, single track type layout (Fig.31) that can be used for switching operations and be free of the high-density traffic on the NTRAK main layout.

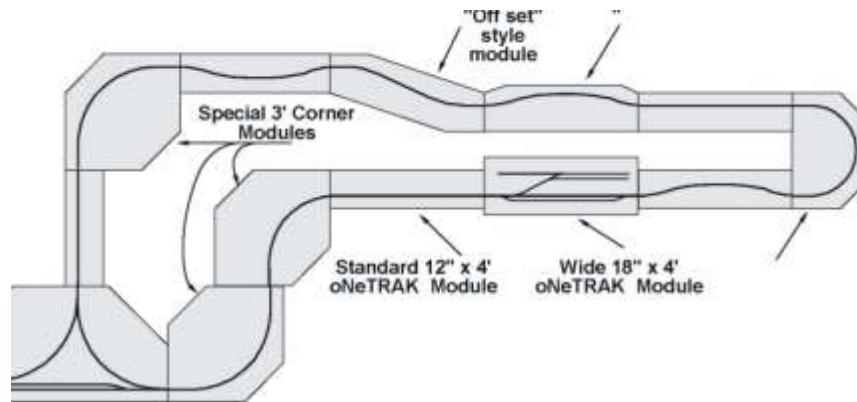


Figure 31: oNeTRAK example layout

The concept is proving popular with a number of clubs and individuals. The units can be used with, or as, a home layout. They are easily moved or taken to a big show. They can be used with or without a skyboard. The electrical wiring is the same as NTRAK and the height is the standard 40". For other heights, use a second set of legs. The narrower units are easy to transport or store.

At some of the big layouts, the oNeTRAK modules have made up a loop of their own within the big NTRAK layout. Grades may be used, if the group wishes it. Only shorter trains would be dispatched into this loop, leaving the main layout for the long trains.

The oNeTRAK Manual available from NTRAK gives more details.

Leg Details

Legs can be fastened with 1/4" hex bolts or machine screws (Fig.32). On the outside, they should be flush with the surface for a neat and safe assembly.

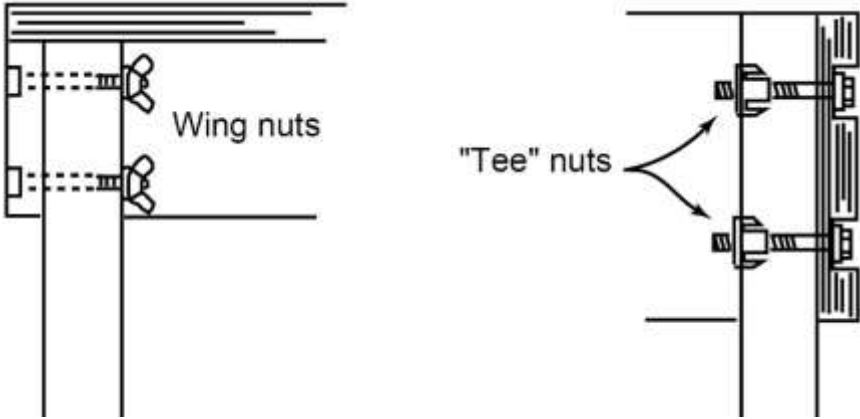


Figure 32: Leg fastening

Corner modules usually have glue blocks for reinforcement where otherwise legs could be located, so the legs have to be attached differently. Here are two options (Figs.33, 34).

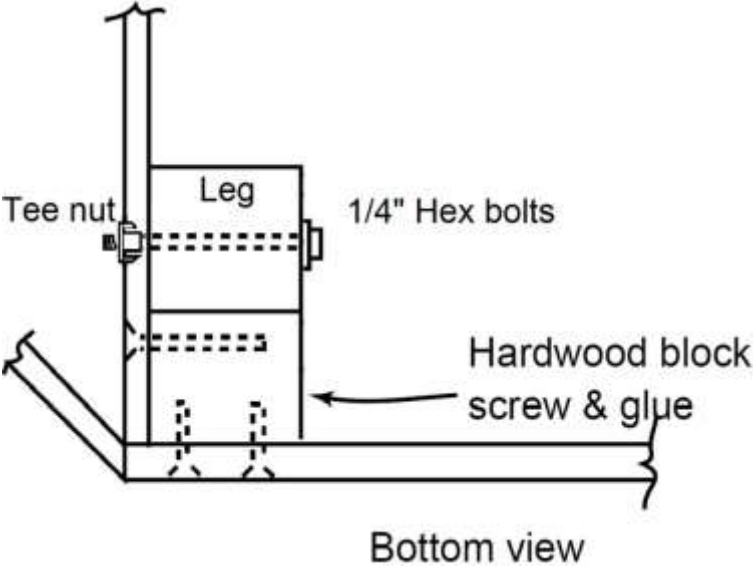


Figure 33: Leg at corner module

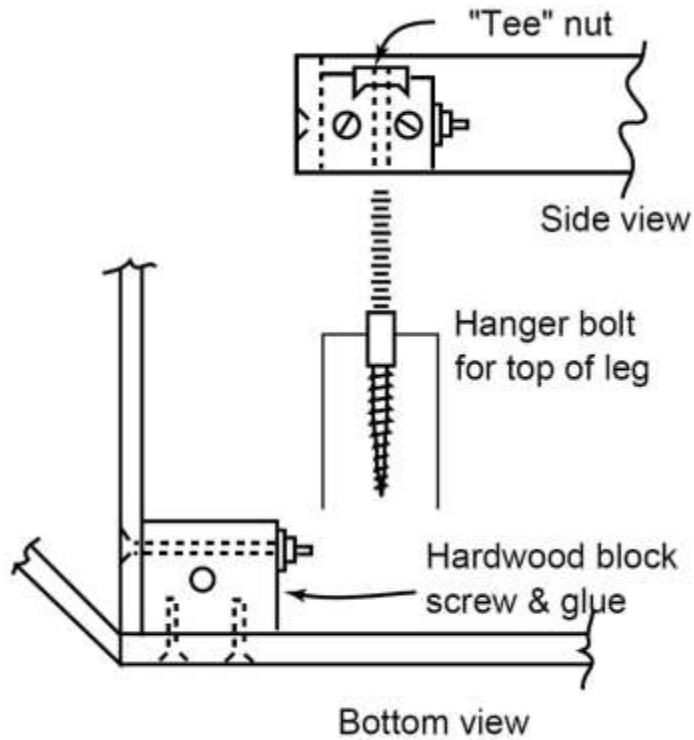


Figure 34: Leg at corner module, alternative

The height adjustment for modules can be achieved using hex bolts or carriage bolts screwed into "Tee" nuts or threaded inserts (preferred) in the bottom end of the legs (Fig.35). Lag screws are very difficult to adjust and are not recommended.

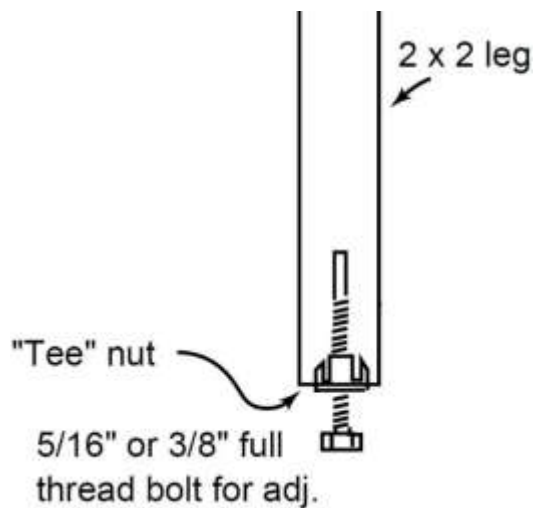


Figure 35: Height adjustment

It may help to drill a hole through the carriage bolt as shown here to allow for inserting a rod, with which the bolt can be turned (Fig.36).



Figure 36: Turning a carriage bolt

Folding legs may speed up assembly and breakdown of a layout. Bracing using “Tee” nuts can be fastened with thumb screws (Figs.37, 38).

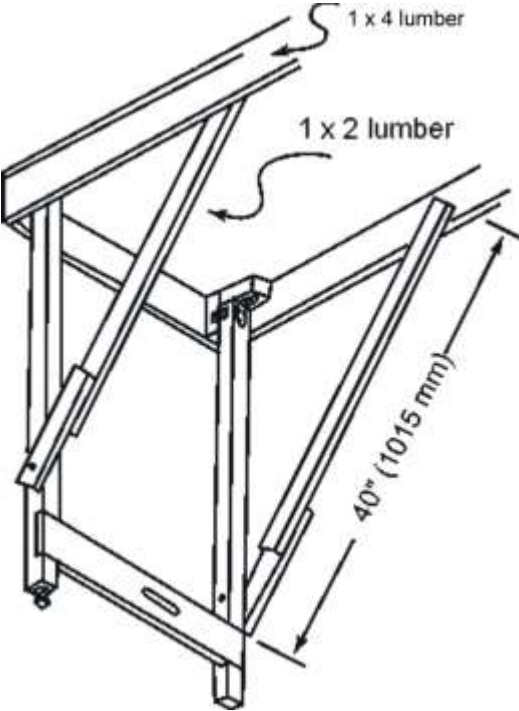


Figure 37: Folding legs

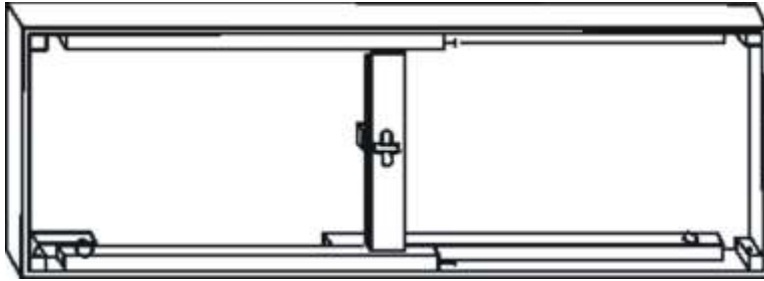


Figure 38: Module with folding legs

Electrical

Powering the layout

For small NTRAK layouts powered with DC, each main can be powered by a single throttle controlling a single train per loop. With layouts over about 24' long the three tracks can be broken into four or more “blocks” each and more trains can be run. You need two blocks per train for good control. Single block loops can be powered by regular power packs fitted with connectors matching the power bus line (Fig.39). In the larger layouts, electrical blocks are formed by using connecting tracks with gaps or insulated rail joiners and not plugging in the connectors at the block boundaries. Each loop can be divided into several blocks, each with its own throttle. Better performance can be had using the throttle developed for NTRAK. Plans for two versions are included in the NTRAK booklet “Transistor Throttles for NTRAK and Home Layouts”.

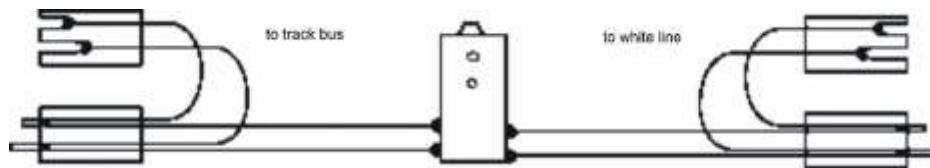


Figure 39: DC throttle connection

Many larger layouts are now powered with DCC. For very large NTRAK layouts with multi DCC zones, special precautions need to be taken. For detailed information, refer to the recently updated DCC Handbook from NTRAK available at Amazon.

Powering your module tracks

Track power and optional accessory power shall pass through underneath the module in 12 AWG stranded copper zip wire, extending 12” beyond either end of the module. Feeder wires for tracks and accessories can be attached with suitcase connectors (3M 567, brown, Fig.40) or by soldering them to the bus wires (preferred). Connections between modules use Anderson Powerpole 30 A rated connectors. The community tracks and a number of established optional tracks have unique color codes assigned. The color codes are applied to the connectors by selecting proper colored shells or by wrapping them in colored tape (no black tape, other second colors are applied as thin stripes). For track power, the primary color shall mark the wire feeding the front rail of the track. The two-conductor bus cables may have different colors for the conductors, or one of the two has a rib marking on it. Use the colored or ribbed conductor for the front rail.

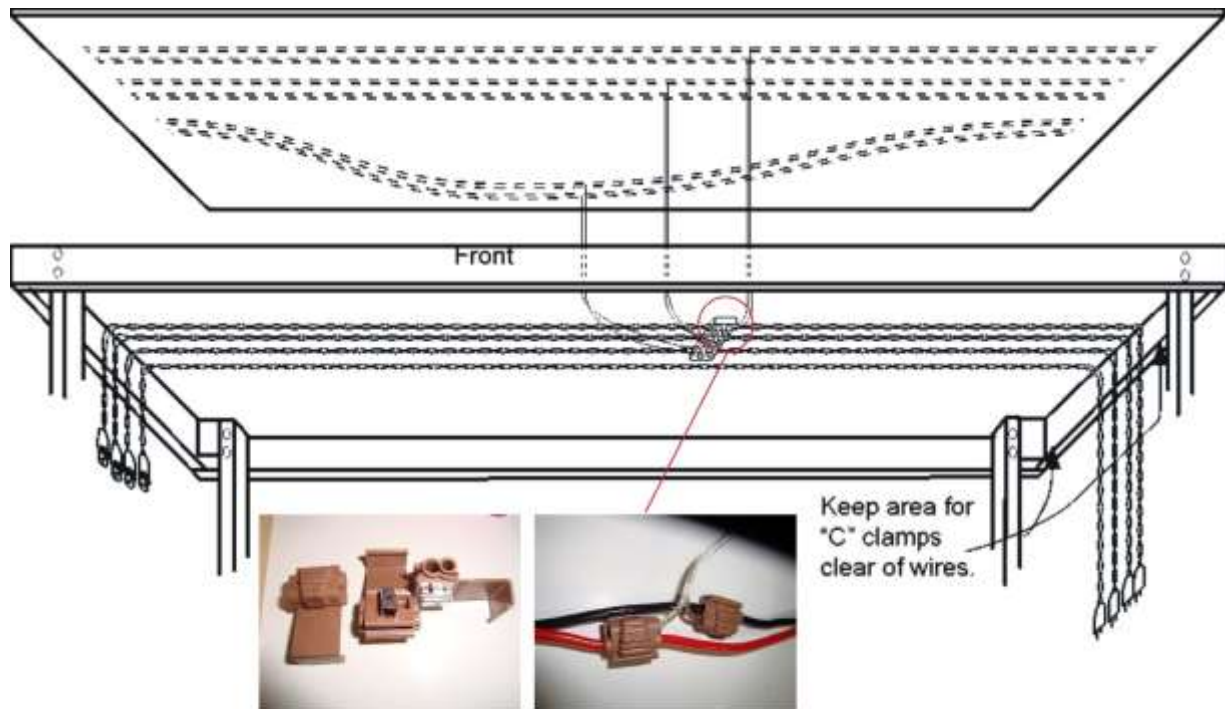


Figure 40: Track feeders

Do not use common rail wiring. There should be no connection between any of the rails of the three community tracks; this practice is recommended also for all optional tracks. Crossovers need to have insulating gaps in both rails.

The private tracks on your module that run into a through-line track, typically the branch line, can be powered several different ways. If you have only a siding or two and don't plan more than picking up and setting out cars, then just an on - off switch between your track and the through-line power is all that is needed (Fig.41). With the switch locomotives can be parked on your tracks by turning the switch off.

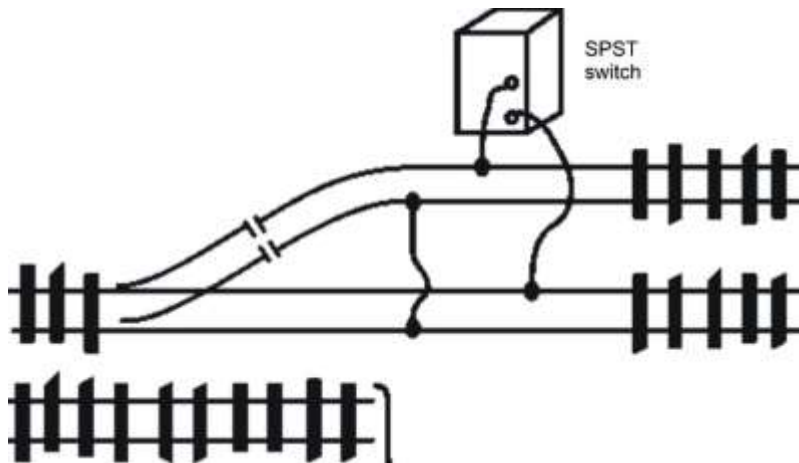


Figure 41: Powering a siding

With DC operation, if you plan more in the way of switching, then, so as not to tie up the through line throttle, you should furnish your own throttle and connect it in with a DPDT, center off switch (Fig.42). This would be "Two-Cab" wiring with the branch line (blue) as one cab and your throttle as the other.

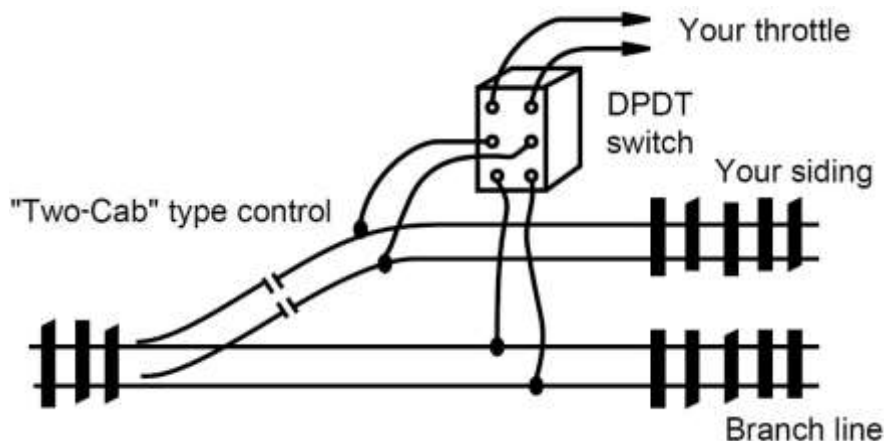


Figure 42: Two-Cab siding control

When operating with DCC control on both the through line and the private tracks, electrical separation is not necessary.

A control panel for your module should use the same color code for the mainline and branch line tracks as for the connectors. During a show, others may want to operate on your module and the controls should be easy to use and clearly marked. If you aren't there to guide them, another operator should be able to work the turnouts and power the tracks with a minimum of confusion. An NTRAK layout is very much a joint venture, and

everyone should be able to operate all parts of it. Complicated momentum throttles can cause much confusion for first time operators and are better saved for the home layout.

Checking module wiring

Checking for wiring errors can be accomplished with a multimeter set to measure resistances. Use the lowest range available on your unit. A length of cable (8-10" will do) with connectors on one end and alligator clips soldered to the other ends of the two conductors can help making reliable contacts with the probe tips of the multimeter. Test the multimeter first by touching the two probe tips against each other; the multimeter should show zero Ohm. Adjust the multimeter if necessary. Then test the bus cable and corresponding track: There should be zero Ohm between the colored/ribbed conductor and the front rail, and also between the black conductor and the rear rail. All other combinations of conductors and/or rails, including those between different tracks, should show infinite resistance. Performing these tests on both ends of a module helps ensure that the track bus cables have their connectors correctly attached (no swapping of colors). For the white and brown lines, you have to reach both ends of the bus cable to check that the colored connectors sit on the same conductor. Also check the rails on either side of any turnout, with the turnout thrown first in one, then the other direction. These tests will show if there is poor contact in a turnout or rail joiner, as well as connectors wired backwards or missing rail gaps in crossovers.

Powerpole connector assembly

Anderson Powerpole® connectors may be soldered and/or crimped. Crimping takes only a fraction of the time and, if properly done, provides an electrical connection that is superior to what can be achieved by the vast majority of modelers using solder.

PREPARATION

Strip the wire back 5/16 inch, just enough for the wire to fully fit into the contact barrel. Orient the contact on the wire so that it will not need to be twisted when inserted into the connector shell. Wire smaller than #14 may be doubled or tripled over to fill the contact opening.

CRIMPING

It is important to use the correct type of crimping tool. Although a full ratchet crimper will consistently give the best results, inexpensive pliers-type crimp tools can do an excellent job as well, although a little practice is required. Both types are available from a number of sources.

Place the contact in the appropriate crimper die, with the seam of the contact barrel against the concave portion of the die (Fig.43). Crimp down firmly, using not quite full force but not bottoming out the tool. You will notice that the barrel is now slightly wider than it was originally.



Figure 43: Initial crimp

After the initial crimp, the barrel may need to be re-formed to allow proper insertion into the housing. Rotate the barrel 90 degrees and place it in the contact-forming die (Fig.44). Squeeze it again, but not as firmly as before to restore the outline of the barrel so that the contact will insert easily into the connector shell. Repeat the first crimp if necessary, but with less pressure.

Note: In order to ensure full contact pressure, be sure that after crimping and reforming, the contact tip has not been bent down. The profile should be the same as a new contact.



Figure 44: Reforming crimp

SOLDERING

Use the proper soldering iron, (approximately 40 watts with a 1/8- to 1/4-inch tip) and good electronics grade solder. (Never use acid flux plumbing solder!) The iron should cause the solder to flow nicely into the joint within a few seconds. It is important to have the iron tip clean and shiny and tinned with a fresh coating of solder.

If possible, clamp the wire in a small bench vise with the stripped end up and the contact in place on the wire (Fig.45). Put the iron tip on the contact at the end of the wire and flow just enough solder between the iron tip and the contact to “wet” this junction. Once solder

starts to flow, add only enough additional solder so that it flows into the inside of the contact barrel and the core of the wire.



Figure 45: Soldering a contact

Too much solder can begin to flow down into the wire's insulation, reducing flexibility, which may cause the wire to break with repeated flexing. Inspect the completed joint - there should not be any solder on the outside of the contact (Fig.46). If there is, you may file or scrape it off. If there is solder on the contact-mating surface, redo the connection with a new contact.

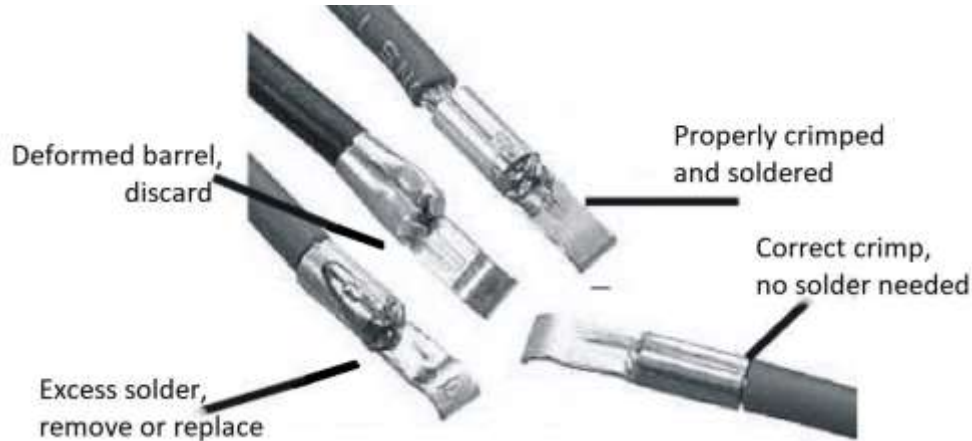


Figure 46: Good and bad contacts

CONNECTOR ASSEMBLY

Before inserting the wires, slide (do not snap) the connector shells together in the desired configuration using the molded in dovetails.

Insert the wires with attached contacts into the shells with the tips of the contacts arching down towards the stainless-steel springs. Push them in until they click (Fig.47).



Figure 47: Assembled Powerpole connector

If you have difficulty pushing a contact in, be sure that there is no excess solder on the contact tip or barrel, the contact is not bent, and that the contact is rotated properly with respect to the housing. Once you have properly assembled the connector, the wire and contact should “float” slightly inside the housing and cannot be pulled out. If the insulation of the zip wire is too thick to fit into the Powerpole housing, use an X-Acto knife to reduce the insulation until it fits.

If you need to remove a contact from its housing, a small jeweler’s screwdriver or X-Acto knife tip can be inserted under the contact tip to disengage it from the spring (Fig.48). The contact and wire may then be pulled out from the rear.



Figure 48: Releasing a contact in a Powerpole connector

To prevent slippage, it is recommended that the shells be secured together by wrapping the rear half of each pair with colored tape. Standard NTRAK color coding applies.

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. If both wires have the same color, then 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 primary 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 below.

The following table is a summary of the Powerpole configuration as shown in the diagram (Fig.49). (For telling the left side from the right side of a module, look at it from the front, i.e., where the red-line track is; the skyboard marks the back side.)

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 (Fig.49).

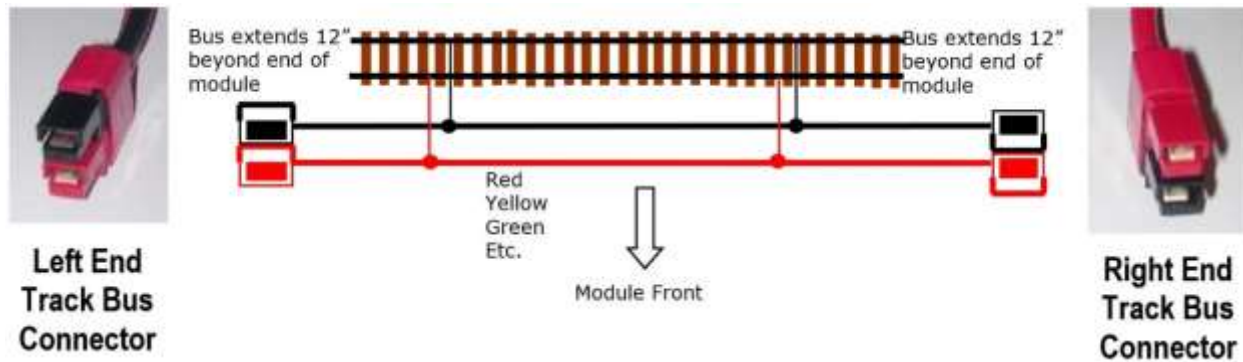


Figure 49: NTRAK Module Wiring Standard – Electrical Track Bus

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 primary 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	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 below.

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.

Standard — White Wire

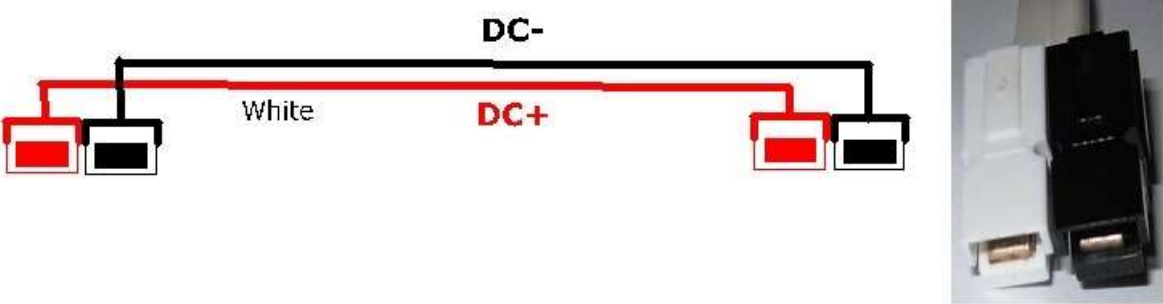


Figure 50: White wire

Note in the diagram (Fig.50) 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 or white on the left of the DC power bus and black on the right. (With a red connector, mark the red/black pair with white tape.)

The White Wire is NOT required for DCC operation and generally no longer obligatory; however, for compatibility with existing NTRAK modules the white wire should be included in the module wiring. The same 12-gauge wire used for the Electrical Bus is required. Note that the connectors are stacked horizontally rather than vertically, as shown in the table below and diagram above.

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

The use of the White Wire for 16VAC supply to DCC Boosters is not permitted, for safety reasons. Boosters must be powered with a dedicated 120V to 16VAC power supply for each Booster 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 White-Wire diagram above (Fig.50), the same connection scheme applies here. Note that the connectors are stacked horizontally rather than vertically, 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 DCC Boosters is not permitted, for safety reasons. Boosters must be powered with a dedicated 120V to 16VAC power supply for each Booster 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 “Recommended Practice for 120VAC NTRAK Layout Wiring”, contained in Chapter 10 of the 2018 edition of the NTRAK Module How-To Book. A summary is included further below. 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 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 connector (Fig.51). This connector is genderless, significantly lower cost than the former standard 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 connectors are provided in the table below Figure 51.

For NTRAK purposes you may choose to purchase red and black connectors only, and then apply colored tape, or you may purchase housing colors matched to the track colors. Powerpole red/black and other color connector pairs are available through the NTRAK Modular Railroading Society's business office. Online and printable order forms and pricing are available at www.ntrak.org/ntrak_store/default.html.

- Set “**10 Pair (Red/Black)**” has 10 Red/Black housing pairs and two extra contacts. A 10-pair set with colors red, yellow, blue, green and white is also available.
- Set “**8 Pair (R, Y, B & W)**” (NTRAK colors) has housings with molded in colors for Red, Yellow, Blue and White. Black is used as the other color in each pair. Two extra contacts are included in the set.
- Two pair sets are available for various primary colors plus black. These sets include an extra contact.
- Other custom color sets will be made up on request at the two pair price.

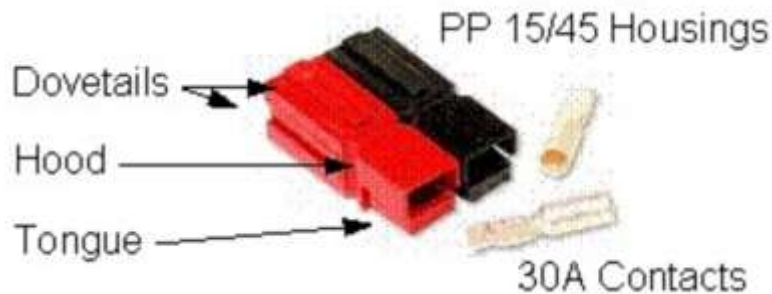


Figure 51: Anderson Powerpole® PP30 Connector

Anderson Part Numbers for the PP30 Series 30A Powerpole Connectors

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_shi p=1&c=0
- Quicksilver Radio Products at www.qsradio.com/DCpower.htm
- Hometek at www.cheapam.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.

Cinch-Jones connectors

Cinch-Jones connectors are no longer standard for electrical connections to and between modules. Replacing them with Powerpoles is strongly recommended. Many older fully operational modules still have CJ connectors, and some will continue to do so for some time to come. Thus, there is a need for adapter cables. Owners of modules with Cinch-Jones connectors, who are joining multi-club layouts, must prepare or acquire adapter cables for both ends of their modules. The color coding on Cinch-Jones connectors matches the tape-marking scheme listed further above for Powerpoles. The wires are routed such that the primary-color Powerpole for the front rail is connected to the broad blade of the Cinch-Jones connector. For the track power adapters, the cable with the CJ socket has its Powerpole connectors stacked with the primary color on top, and the cable with the CJ plug has the primary colored Powerpole at the bottom, see Figure 52.

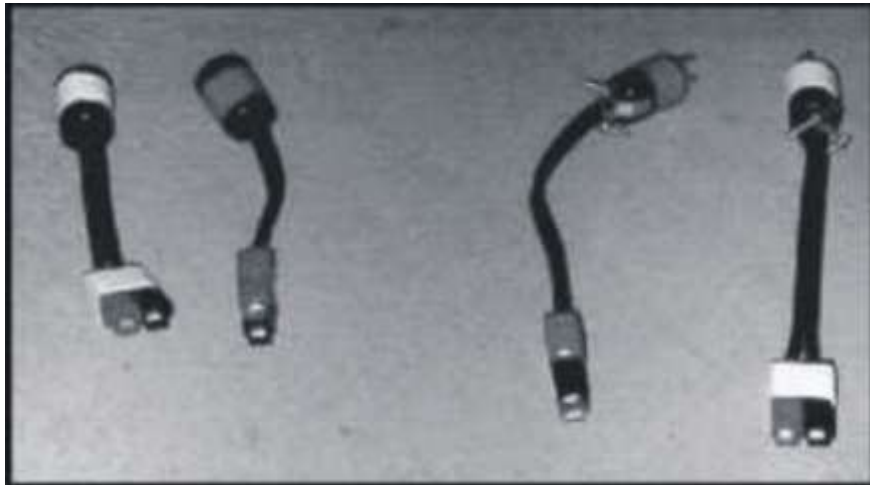


Figure 52: Cinch-Jones-to-Powerpole adapters

Recommended practices for 120VAC NTRAK layout wiring (abridged)

Note: The following is taken from Chapter 10 Layout Wiring of the thoroughly revised 2018 edition of The NTRAK Module How-To Book.

NTRAK layouts use standard 120VAC electrical power for various purposes: the power supplies that power throttles and DCC equipment, on-module accessories, module lighting, signs and other miscellaneous uses such as soldering irons, power tools and vacuum cleaners. The 120VAC wiring to and around NTRAK modules must meet certain standards as defined in the current issues of the National Electric Code (NEC), the Uniform Fire Code (UFC) and the International Fire Code (IFC). In addition, states and/or local municipalities may impose their own variations on these codes, which are generally more restrictive than the codes themselves; local codes may take precedence over the national codes. Layout coordinators should consult local fire and building codes prior to setup. Any questions should be directed to the local authorities.

Standards for the components used for 120VAC wiring (power strips, extension cords, etc.) are defined by Underwriters Laboratories (UL), specifically Standard UL-817 (Cord Sets and Power Supply Cords) and UL-1363 (Relocatable Power Taps).

The Rules According to the NEC, UFC and IFC

After a review of the applicable codes and other codes and standards, the following is a summary of what these rules mean for NTRAK layouts:

What We Are NOT ALLOWED to Do

The following are not permitted:

- A power strip (RPT) cannot be plugged into another power strip or into an extension cord.
- An extension cord cannot be plugged into another extension cord.

- Multiplug adapters are not permitted.

What We Are REQUIRED to Do

We **must** comply with the following:

- Any power strips (RPTs) used must be UL approved 3-wire (i.e., with ground), rated for 15 Amps and must include a 15 Amp resettable circuit breaker.
- Ground-Fault Circuit Interrupter (GFCI) outlets are required in areas where electricity and water may come into contact or where a "massive ground" environment which would present a safety hazard is encountered.
- Extension cords must be UL approved 3-wire rated for 15 Amps, either with outlets along their length, a single female outlet at the end, three female outlets at the end, or permanently fixed into a reel with two or four outlets.

What We Are ALLOWED to Do

We are permitted to do the following:

- A power strip (RPT) can only be plugged into an approved receptacle (i.e. wall outlet, floor outlet or permanently wired power drop).
- Extension cords with one or more outlets, either at the end or along their length, can be plugged into this power strip or into an approved receptacle.
- A single electrical device can be plugged into each such extension cord outlet, being careful to ensure the total current load of all devices is within the rated capacity of the overall circuit.
- We are also allowed connections involving Uninterruptible Power Supplies (UPS) as follows:
 - Approved receptacle to UPS to extension cord to device
 - Approved receptacle to power strip to UPS to device(s)
 - Approved receptacle to UPS to device(s)
 - Approved receptacle to UPS to power strip to device(s)

NTRAK Recommended Practice

The following recommendations are made to ensure that NTRAK modules and layouts are as compliant as possible to current electrical and fire codes.

Modules

- Modules so equipped **MUST** have the Power Strip or the older outlet box/receptacle with wire and plug removed.
- Modules that need 120 VAC power **ONLY** when used at home should have any Power Strips removed before taking the module to a show layout.
- Lighting effects and animations on modules should be powered by low voltage (Accessory Bus) wherever possible. Power supplies for these effects should be UL listed devices. Such power supplies should not be mounted to modules but mounted on a shelf mounted on a module with quick connect plugs on the low voltage side.

Layout Coordinators

Club layout coordinators are responsible to ensure the layout meets the requirements of the electrical and fire codes in force in the location of the layout. Coordinators need to work out plans to suit layout sizes and track power needs:

- Purchase Commercial Grade Power Strips with 15' cords (as defined above) as necessary. The 15' cord could let a power strip be placed across an aisle, when needed.
- Purchase an assortment of extension cords (25', 50' and 100') that meet code specs.

Extension cords must be UL approved, 3-wire rated for 15 Amps either with outlets along their length, a single female receptacle at the end, three female receptacles at the end, or permanently fixed in a reel with two or four outlets. For extension cords of 50 ft length or less, this means 14/3-gauge wire. For extension cords greater than 50 ft up to 100 ft this means 12/3-gauge wire.

Household, small thin type extension cords; spliced cords; or homemade receptacles are not permitted. Extension cords with broken wires or damaged insulation must be discarded; splicing or taping is not allowed.

- Power strip cords and extensions cords subjected to foot or equipment traffic must be protected from damage as follows:
- Cords 3/8" or less in diameter must be covered with hard plastic "office cord covers" or an approved alternate method.
- Cords larger than 3/8" in diameter must use a plywood ramp style cover, or an approved alternate method.
- All cord covers must be secured in place using tape, nails or other methods.
- Purchase Ground-Fault Circuit Interrupter (GFCI) units as required; the use of GFCI units for all applications is strongly recommended.

Although GFCI circuit protection is not required on all layouts, it is a good practice and highly recommended to always use GFCI protection. The GFCI protection device should be the first device connected to the building outlet (approved receptacle).

- The use of multiplug adapters is prohibited.

Layout coordinators also need to pay attention to workmanship and the neatness of the 120VAC wiring; workmanship is what catches the inspector's eyes first. Wherever possible the 120VAC wiring should be suspended from the modules using Velcro, twist wraps, tie wraps or cup hooks. If any 120VAC wiring must be on the floor it should be routed under the modules where it cannot be damaged, unless protected by a cover as defined above.

Layout Checklists

THINGS TO CHECK BEFORE YOU GO TO A MEET

1. Be sure that your module meets the current NTRAK specifications.
2. Have all flangeways clear of ballast and turnouts working properly.
3. Check wheel gauge and couplers. Try your engines and long cars to be sure everything operates and that you have the proper clearances.
4. Have your controls working, clearly marked, and color coded.
5. Your scenery should look so great that you don't have to apologize!

THINGS TO TAKE ALONG

1. For each module: two "C" clamps, four connecting tracks, one w/ insulating gaps. (Re-move one tie or undercut so that rail joiners go fully on at one end of all connecting track sections.)
2. Any tools needed for assembly and any tools, glues, paint, etc. for last minute repairs of the module. Have your name and contact information on everything!
3. Throttle and cords, if needed.
4. Cars and engines all marked for easy identification with your personal code. An inventory list can be a big help. Don't leave engines on the layout overnight or on a siding in easy reach during the show. Be very watchful of your things during tear down. Security is lax then, and, in the confusion, things can disappear.
5. If you plan to enter your module in a contest, it may have to be in the contest room for judging. If so, you should furnish a three track "bridge" so the layout can operate while your module is being judged.

IF YOU ARE COORDINATING A MEET

CONFIRM THE SPACE: Measure the space yourself or have someone do it for you. The hotel or exhibit hall drawings are often quite optimistic and/or incorrect. One room was about two feet smaller in both directions than advertised. While you are setting up is NOT the time to find out about this. Note locations of pillars that might interfere with the layout, visitors' entrance, the loading dock area, and parking.

ELECTRICAL: Check the location of electrical outlets. Avoid having cords across an aisle if possible. In some exhibit halls they can place outlets overhead to suit. Locate circuit breakers and light switches.

SET UP: Find out when you can start setting things up and the hours of the show. Start set up as early as possible so that the layout is running smoothly for the visitors.

TEAR DOWN: Be sure that everyone knows when layout tear down will start. One person can't pull his module out ahead of time and leave without advance warning and planning. The NTRAK layout should not be torn down while other exhibits are still open.

APPEARANCE: For a good appearance, the legs of the modules and the boxes of tools and junk should be hidden by a drape. These are often furnished by the convention, or tablecloths can be thumb tacked in place. Check ahead of time. For public shows a barrier about two feet out from the layout is a necessity. Note: Some convention hosts and/or fire marshals may insist that drapes and curtains are made of fire-retardant material.

LAYOUT PLAN: Have a layout plan made up ahead of time. Copies should go to all participants. The first persons to get to the set up should know where the layout will be and the arrangement of the modules.

ELECTRICAL: The modules should be checked electrically before they are connected together. Plans for a special checker are shown in the 'How-to' book.

LEVELING: If the floor is level, start with all modules at 40" height. Floor tiles or carpet patterns can be a big help in getting the layout square. A fishing line pulled taut can be used in leveling modules. An "eyeball" check for dips, humps, zigs and zags is also helpful. On very large layouts a transit or builders' level is useful, if you have people who know how to use them. Cumulative errors can make one side of the layout longer than the other. Two-foot lengths of 2x4, 1x4 or 1/2" plywood can be clamped between modules as needed to even things up and then fit with filler track as needed.

BRIDGE MODULES: A 2' and 4' three track "bridge" can be useful in case a module doesn't show, or if the module lengths that are available don't come out even. The bridge makes a good "duck under" entrance to the operating pit. If any of the modules are to be moved into the contest room for judging, then the builder should furnish a "bridge" while his module is out of the layout.

SET UP SEQUENCE

1. Get module legs in place and adjust so the roadbed is 40" above floor. (It is easier to measure to the roadbed.)
2. Make electrical check of each module before connecting to other modules.
3. Clamp modules together, level, and align.
4. Put gapped rail connector tracks at block boundaries.
5. Put in all other connector tracks.
6. Connect track wiring connectors between modules. (Don't connect track wiring at gapped rail tracks.) Prepare and connect AC supply.
7. Connect throttles.
8. Have fun!!!