



MODULE STANDARDS, THIRD REVISION, WINTER 2004

This manual is the product of six years of effort, education and enjoyment of Z Scale modules built for use at home and at shows. We hope you will find the concept one that you would like to construct for yourself.

We subscribe to the concept that model railroads are just more fun at home if they have a purpose - the prototypical pickup and delivery of goods and people from one point on a layout to another point. We strongly encourage operational sidings and branch tracks to serve industries and train stations for the simple pleasure of prototypical drop off and pickup of rolling stock.

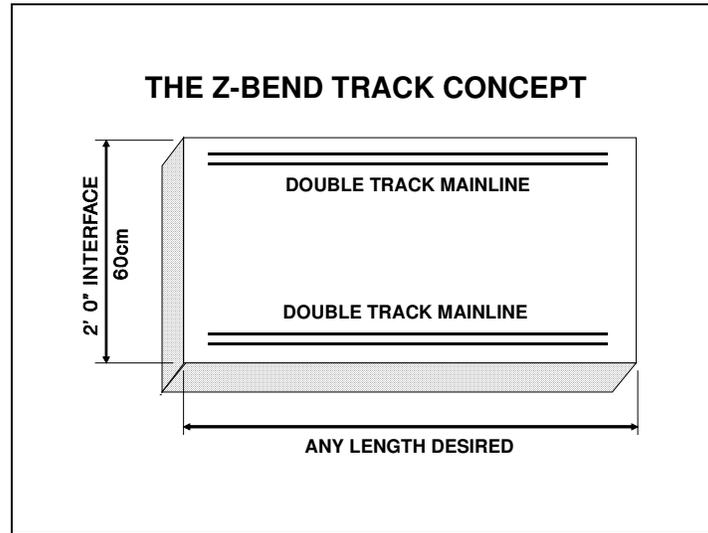
When we assemble these modules together as a group, we take great delight in running long trains our individual home layouts can not. Prototypically long trains of 50 to 100 cars are a delight to watch, and a real attention grabber at public shows. Obviously, such modules must be built to some form of a "standard" to allow sections built by any modeler's to be mated with those of another modular.

The **Z-Bend Track** concept supply supports both North American and European designs powered by either (or both) DC and DCC with (our without) centenary built using all known commercial track products. The concept only contains minimums (radius, height, etc.) with no upper limits imposed on modelers.

Let's examine how all this is possible.

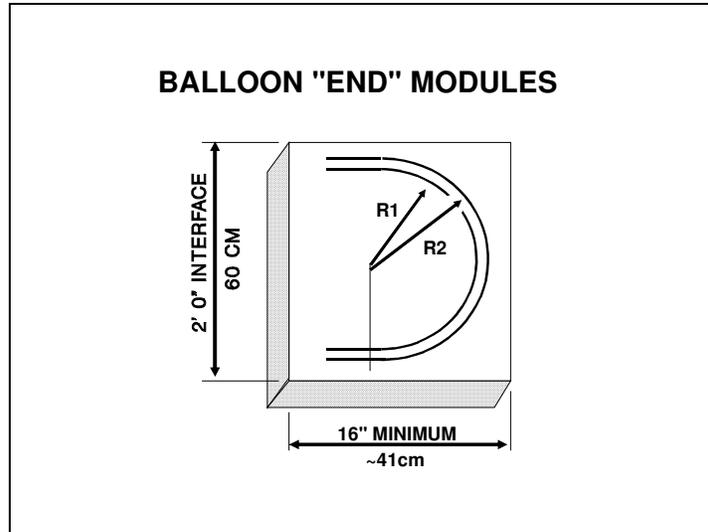
## BASIC CONCEPT:

The concept is simple. **Z-Bend Track** uses a double track mainline running down both sides of a module. Modules can be of any length, or width in the middle and any overall shape you desire. The "standard" called **Z-Bend Track** only applies to the last five inches (12.7 cm) of the module's interface to other modules, the electrical interface and the module height. There are very, very few "rules" for the rest of the module.

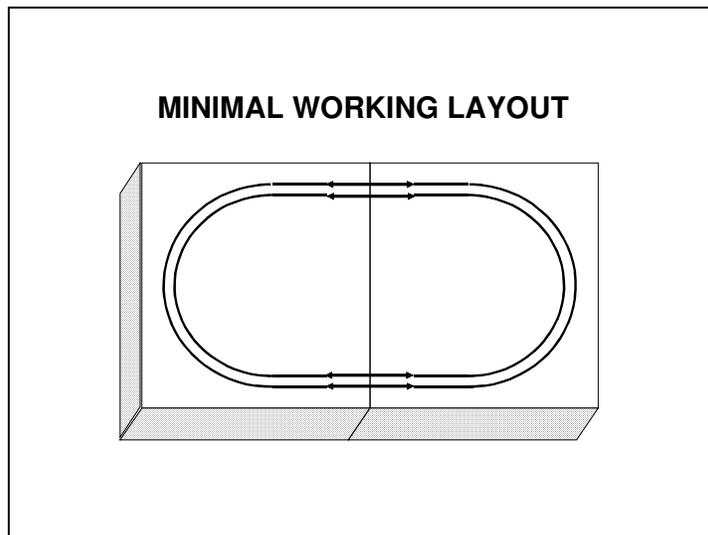


In order to "turn the train around" and send it back the other way, a simple to build "balloon" module accomplishes that task. We call such balloon modules simply "end" modules. Turning a train in Z scale (and in larger scales as well) is not prototypical on sharp radius track. This is particularly true in Z scale. A 90-foot passenger car, or an E8 locomotive, looks almost toy-like going around a radius that would be impossible in prototype railroads. The centerline of these long cars and locomotives would be well inside the centerline of the track, even on medium radius curves.

We encourage end modules to utilize the concepts of "view blocks." View blocks use buildings, tall grain elevators, trees, geology or other scenery to "hide" the train while it is in the turn. Even though our "logical" minds tell us the train is simply going behind an object, the train that reappears from hiding is somehow a "different" train than the one that disappeared a second before.

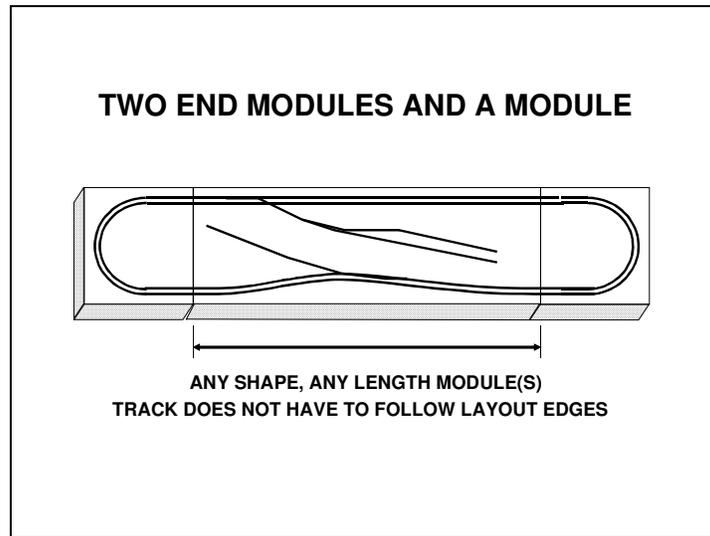


But end modules caps can be much more. For someone with very limited space, two end modules can be a complete layout. However, the owner can take them to group setups, and display their skills in module building right along with the rest of the participants.



If a modeler has more room, then the construction of one, or more, modules can go between the end modules to create a larger layout to fill the available layout space at home. The extra space is just waiting for lots of interesting turnouts and sidings to serve all manners of passenger and freight traffic.

Don't get the idea that modules have to be rectangles, limited to 2 feet wide. They can be constructed to any shape to fit in "that corner" of the room, or "miss the furnace in the basement" or simply have the room you need for a particular scene.

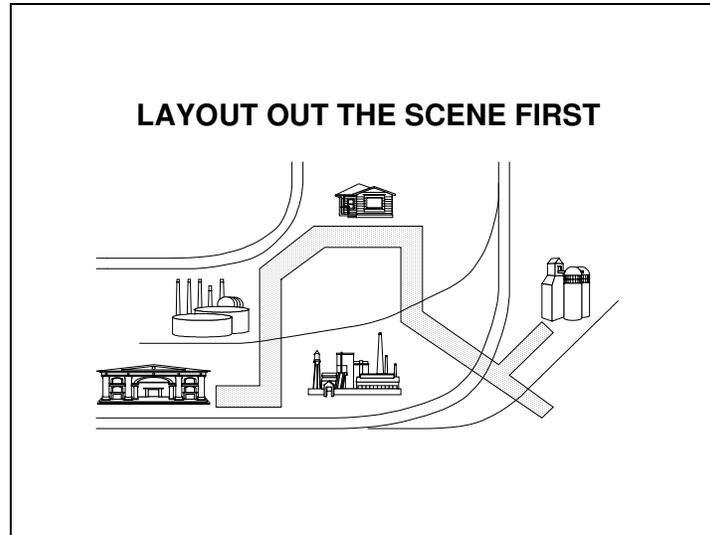


To date, **Z-Bend Track** Modules have been built in the shapes of the letters "X" (with four interfaces), "S," "L," and modules with "fat" middles in lengths from 48" to 90" (120 to 225 cm).

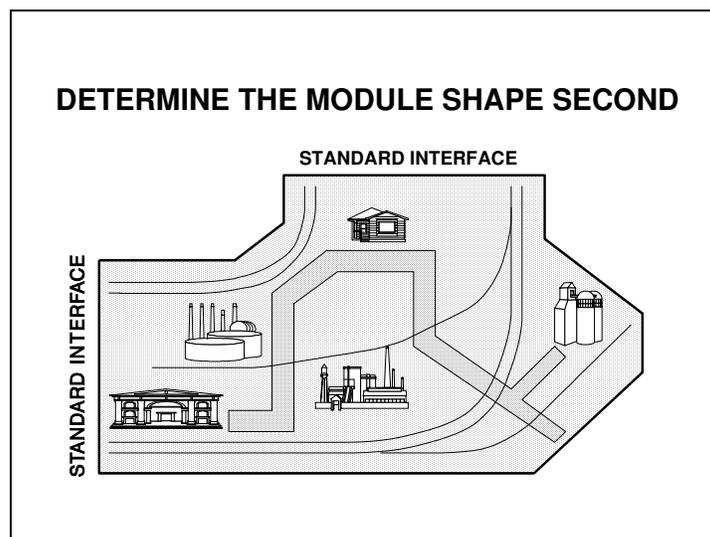
## MODULE PLANNING CONCEPTS

That brings us to one of the most important concepts of **Z-Bend Track**. Absolute freedom to build the scene you wish, without excessive forced compression, or leaving out part of the scene or distorting a prototypical scene you wish to model.

We strongly suggest that you layout the scene first, without showing any wooded "borders" around the edge of the scene. Don't confine your thinking to a particular rectangle of wood, unless your available space requires it:

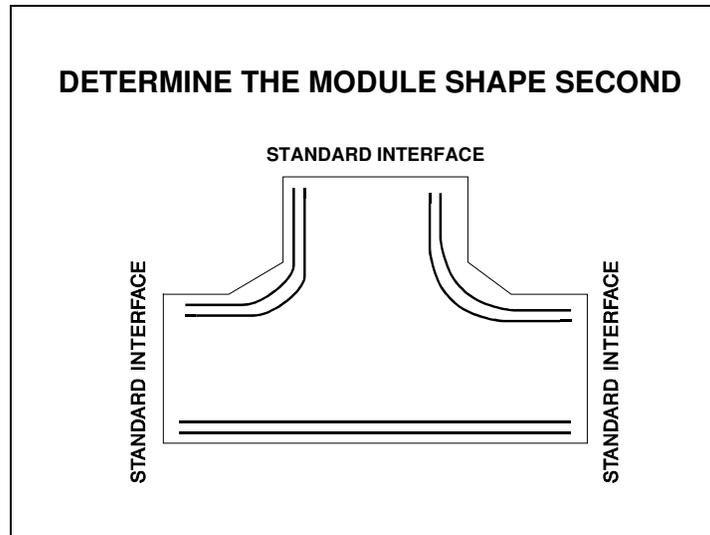


Once you have the scene completely drawn out (or on the computer screen) only then add wooden "borders" around the scene to determine what the woodworking project will be to construct the module. If the module frame is too complex, then you can make adjustments to the scene to simplify the module frame construction.

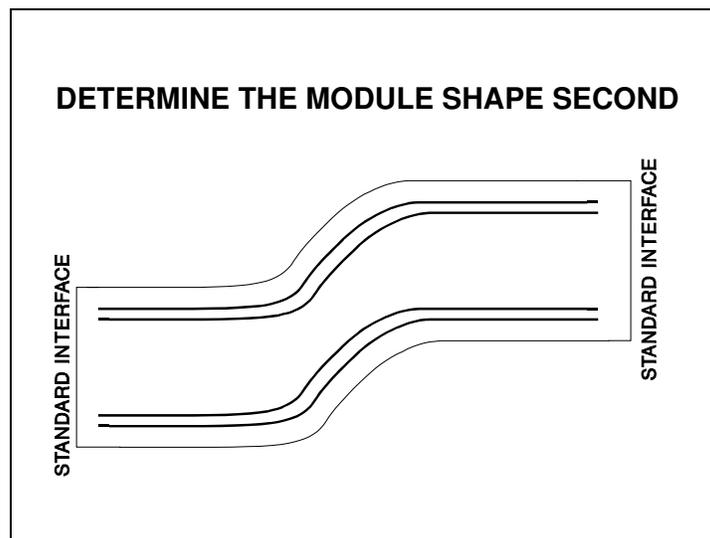


Nor do you have to restrict yourself to a design with one "in" and one "out" approach. Many modelers like to have "islands" that allows part of the layout to be in the center of the room, while much of the layout follows the wall. These extra module interfaces to not have to be 90 degrees relative to other interfaces either. Modules with odd angles between interfaces (i.e., 15, 22.5, 35 degrees, etc.) tend to break up long straight runs of track, and make a layout look more prototypical. Nor does track need to be parallel to the edge of the module. Consider having the track placed at a few degrees out of parallel with the edge for improved appearance. Also, consider gently curving the tracks as we all commonly see in prototype settings.

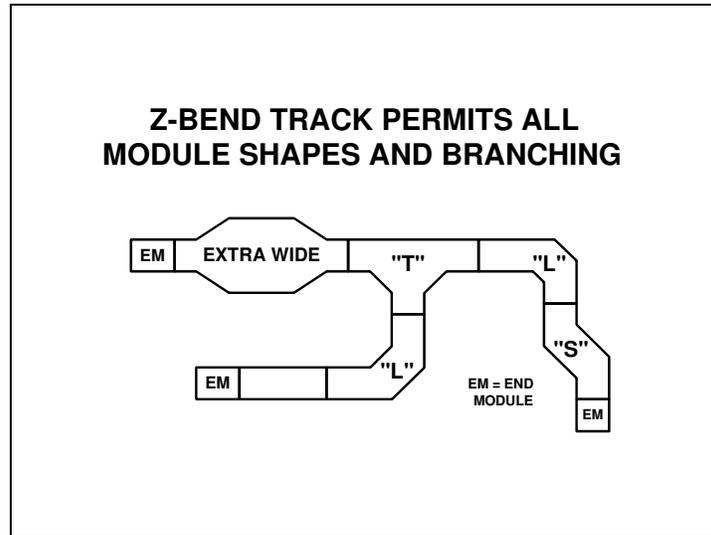
Everything you build will mate up with the work of others at group setups and shows.



Constructing a wooden frame is really not difficult, even when its shape is not rectangular. If you have a column in your layout area, simply go around it with your module design. Or model that famous curved river scene you have always wanted. One of the web references at the end of this manual will show you how really simple curved module sides can be.



How do all these interesting shapes work out when they are transported out of the home for public displays? Absolutely! Actually, we find they make for the most interesting layout you can imagine. The combination of shapes adds a lot of visual interest to the assembled layout, with trains twisting and turning just like we see them in real life.

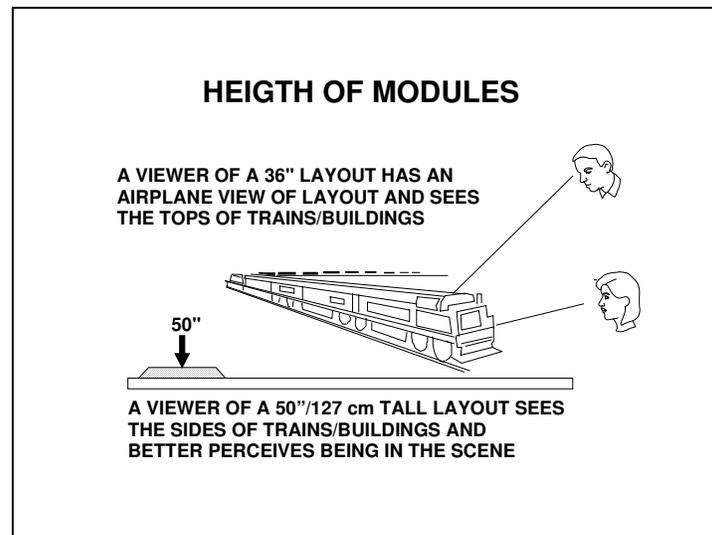


At public shows, the area set aside for displays may not be the perfect shape for setting up a layout. By using the wonderful module shapes the owner's built, the layout can be configured to go around existing doors, columns or other obstructions. This frequently occurs, and the assembled layout almost looks like it was build specifically for this particular show area.

## MODULE HEIGHT

Module height always requires a bit of explanation. During the research that led up to the **Z-Bend Track** concept, we collectively searched all available references on module height: Marklin Insider Magazine, other modular standards and the popular model railroad publications. It was interesting to find that although many module standards are in the 30 to 40 inch ranges, all the articles on the "best viewing height" recommended 50 inches (127cm) at the top of the railhead. Marklin recommends that height as the best viewing height for Z scale layouts in the Insider magazine. The layout in the March 2004 issue of Model Railroader magazine is also at 50 inches. After experimenting, we agreed that for public displays, this was the correct height. At home, the modeler has the freedom to display his efforts at any height that suits the owner's tastes.

We continue to feel that the wonderful details found on Z scale locomotives and cars would be lost if we had chosen an "airplane" view and could only see the roofs of the locomotives, rolling stock and structures. That's not how we look at the prototype world around us.



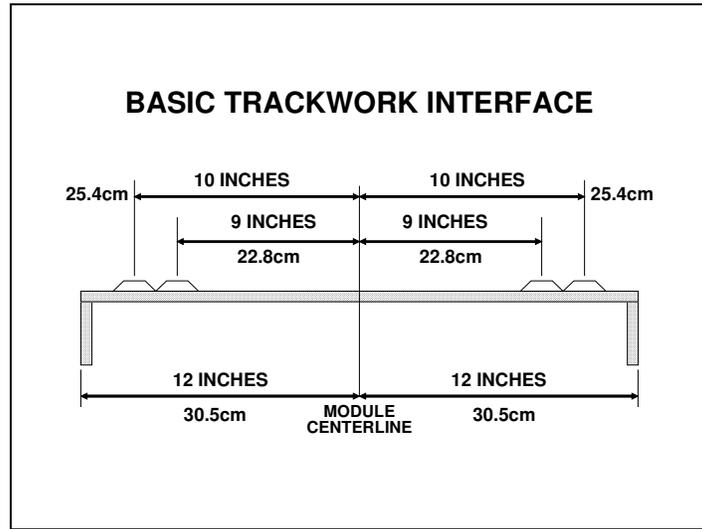
## MAINLINE TRACK STANDARDS

**Z-Bend Track** has only two mainlines we refer to as simply the Outer Track and the Inner Track. The Outer Track is the mainline farther from the center of the bench work and the Inner Track is the mainline closer to the center.

To position the mainlines at each end of a module, you first find the center of the 2 foot (61cm) wide interface, then measure out both directions 9 inches (22.8cm) and 10 inches (25.4cm) inches from the center line. This should leave approximately 2 inches (5cm) from the center of the Outer Track to the side of the module – an important safety distance in the event of a derailment. If you are using Marklin track products, this 1 inch (2.54 cm) spacing of the mainline tracks is required by the geometry of their turnouts.

PLEASE RESIST THE TEMPTATION to measure 2" (5cm) and 3" (7.6cm) from the outside edge of the module inward to locate the track centerlines. We have found the chance for error in alignment of mainlines from one module to another is greatly reduced by measuring out from the centerline of the module.

This is because the centerline, as a common point to align all mainlines from, prevents slight module width variations from becoming mainline alignment errors. One module's centerline will match another module's centerline even if the width of the two modules varies slightly. If this seems to be making a mountain out of a molehill, please realize that you can't slide a module sideways to improve track alignment on one side without creating a misalignment on the other side. Just a little care in the track laying stage will prevent any significant jogs in the track as a train crosses from one module to the next.



### TRACK CODE

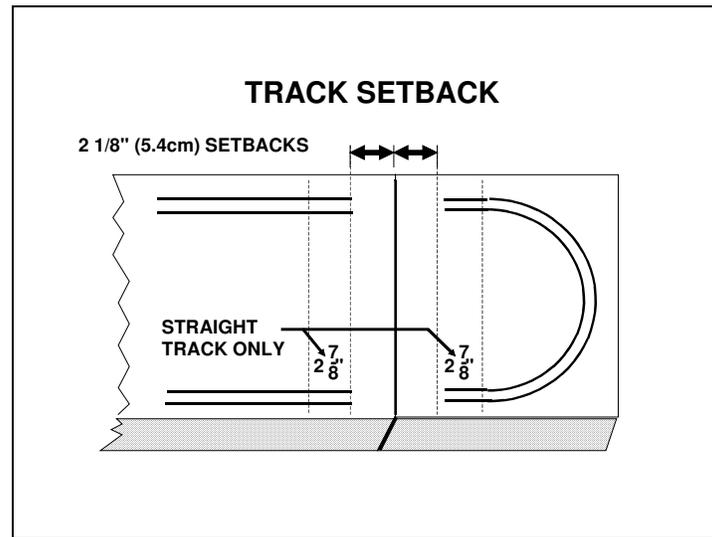
Both mainlines may use any combination of Marklin (sectional or flexible), Peco or MicroTrains track. Hand-laid track can be used if the owner's skill permits and the owner can demonstrate to others that the track gauge and flange clearances are correct prior to public displays.

### MAINLINE SPACING AND CLEARANCE

A 1" (2.54cm) track-to-track-centerline matches the geometry of all Marklin track and turnout products. However, the spacing between the two mainlines may be wider than that within the confines of the module to accommodate terrain or scenic needs. However, it should not go below this minimum spacing in order to insure proper clearance between equipment anywhere on the module.

There should be 1 and 3/8-inch (35 cm) (25 foot prototype) vertical clearance above the tops of the rails for high clearance rolling stock. Additional height may be required for any catenary structures over the rails. If tunnels, bridges or any structures extending over the mainline are to be used, make sure that there is easy access in order to retrieve any derailment that might occur.

## TRACK SETBACK ON MODULES



The last 5 inches (12.7cm) of roadbed at the edge of any module shall be set aside for perfectly straight track. This is done to insure good operation of trains in the interface zone and where there is some opportunity for misalignment due to measurement errors between modules.

Measure back from the end of the module 2 1/8-inch (5.4cm) and draw a line. None of the four tracks should go beyond this line. Bridge tracks will connect the tracks on this module to the next module starting at this setback point. More on bridge tracks later in the manual.

After positioning the module's mainlines at the setback point, secure straight track in place for at least 2 7/8 inches (7.3cm) before any curvature of track begins. This helps to avoid sudden changes in direction and derailments as trains go from one module to another.

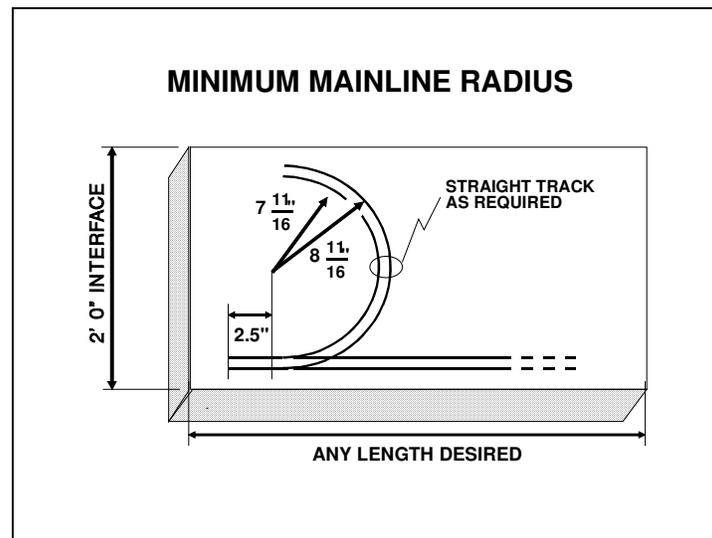
ALL RAILS at the point of interface shall have rail joiners installed (both rails, all tracks). Hard-learned experience has proved this to be the best solution to connecting modules with bridge tracks. Again, more on this later.

This interface zone will be a highly stressed area with frequent connections, disconnection and unexpected module shifts during assembly. It WILL get bumped frequently during the positioning of the modules.

Use extra glue, nails, or whatever your track/roadbed fastening techniques may be in this area. We find white glue to work well. If damage does occur, the white glue can be softened with water for repair operations. You may want to use a short piece of sectional track (i.e., Marklin 8503) such that it can easily be replaced without disturbing the rest of the track on the module.

A small drop of one-minute-cement (CA) where the rails fasten to the last few ties also helps to secure the rails from being damaged during module handling.

## MAINLINE RADIUS



Track radius of either mainline shall not be less than  $7 \frac{11}{16}$ " (19.5cm) anywhere. This is also a Marklin sectional track standard. The corresponding outer track would be  $8 \frac{11}{16}$ " (220 mm), again a Marklin sectional track standard, and maintains the required 1-inch (2.54cm) track centers. Please note that there is no maximum radius.

While these radii are standard for Marklin sectional track, our group of non-converted Metric users simply used 8" and 9" on our modules for the ease of laying flexible track. It does not matter if your ruler reads in cm or inches if you measure carefully the concept will work, trains will run, and modules will connect.

## MAINLINE ROADBED

The use of roadbed is strongly recommended throughout the module, but not required. However, roadbed can significantly improve the prototypical appearance of the module and offer some sound deadening opportunity, depending on the material used. Use of roadbed depends on the prototype road you are modeling and your personal preferences.

We have been successful in using very affordable and thin N-Scale cork with each "half section" cut down to 0.5 inches in width, which leaves a small prototypical "drainage ditch" in between tracks. Our use of ground foam for scenery tends to raise the "terrain level" up the sides of the cork thereby creating a prototypical drainage ditch on either side of the mainline, and helping to visually lower the thickness of the cork.

## MAINLINE TURNOUTS

Mainline turnout are strongly encouraged, both manual and remote. Remote control turnout must have some method of manual operation if electrical circuits fail, or fail in the "through" direction. Marklin turnout in good operating order are recommended.

If hand laid turnout are used, they shall be restricted to the "straight" direction on the mainline, unless the module owner has demonstrated the operation, proper gauge and that other geometry are correct prior to public displays.

## MAINLINE CROSSOVERS

Crossovers (Back to back turnout) made with standard turnout are allowed, and even encouraged. Marklin crossovers in good operating order are recommended. Hand laid turnout are allowed, subject to the owner's demonstration of operation, gauge and other track geometry at shows are correct prior to public displays.

### Mainline "X" Crossovers

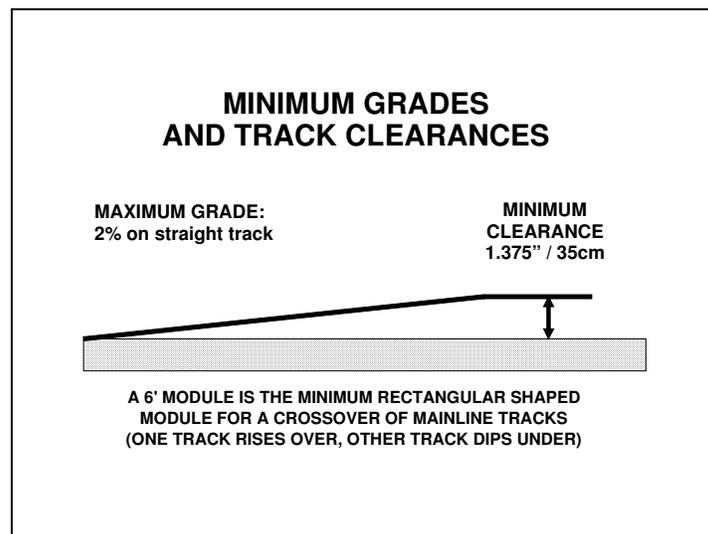
Are allowed on mainlines, but strongly NOT recommended. In addition to serious electrical power considerations, 11-degree "X" crossovers seem to be difficult to maintain in proper operation over time. Trains may "bounce" going over them, even if they do not derail. There is no time at shows to be adjusting them. Any use of "X" crossovers must have the prior approval of all other module owners before module assembly begins. Modules with poorly operating crossovers will be removed from the layout immediately.

### Mainline Double Slip Switches

Are NOT allowed. In addition to serious electrical power considerations, double slip switches seem to be difficult to maintain in proper operation over time. Trains may "bounce" going over them, even if they do not derail. There is no time at shows to be adjusting them.

## MAINLINE GRADES

Mainlines may have grades, but absolutely not over 2%. Remember that grades on a curve put a good deal of extra drag on a train. Curved grades should not exceed 1.5% at most.



Our purpose is to run trains of near prototypical length. Grades of greater than 2% severely impacts the number of cars that can negotiate the layout with most unmodified Z-Scale locomotives (no extra internal weight added). Slight grades may make the layout more interesting, but can shorten train lengths to near nothing. Test your proposed grade and track plan with loose track on an inclined surface before committing your ideas to a module.

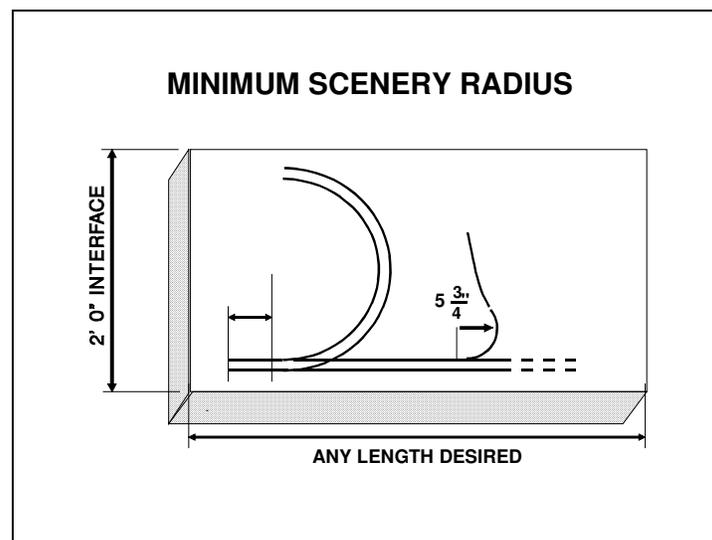
## SOLDERING OF RAILS

While we normally solder all rail connections, and solder track power feeder wires at these same points, it is clearly understood that many modelers do not possess the skills to solder track or perform some electrical wiring issues.

Any method of positive, reliable, long-term mechanical and electrical connections to the track that the owner is capable of is acceptable. However, if non-solder connections are used, a full electrical checkout and repair(s) of the module by the owner is strongly recommended before the day of group assembly time. Rail joiners have a bad habit of electrically failing without notice.

Modules which do not fully function (mechanical or electrical) at assembly time should be taken out of the layout and set aside for maintenance on another day.

## SCENERY TRACKS



Scenery tracks are defined as any track other than mainline tracks, such as industrial spurs or yards. Scenery tracks are EXTREMELY important for a number of reasons:

1. They give the layout a purpose. Real railroads do not run trains in circles; rather they move passengers and freight from one place to another. Make your modules look real by giving them realistic sidings serving these needs.
2. Scenery tracks, if properly arranged, allow for fascinating operational opportunities for the owner, allowing many, many hours of resolving switching operations at home as well as public shows.

While many viewers are attracted to the continuously running of trains on the mainlines, the attention of many viewers can be further captured by switching operations on the scenic tracks, regardless of the coupler system used (Marklin or MT).

### **SCENERY TRACK**

Scenery tracks may be any type of commercial track that is available. They may also be hand laid, if so inclined, without prior inspection or approval of other module owners.

### **SCENERY RADIUS**

There are no radius restrictions on scenery tracks. However radii smaller than Marklin's smallest sectional track is not recommended (5 3/4 / 145mm).

### **SCENERY GRADES**

There are no grade restrictions on scenery tracks.

### **SCENERY TURNOUTS**

Turnouts can be any type of commercial or hand laid, and may have any radius.

### **SCENERY ROADBED**

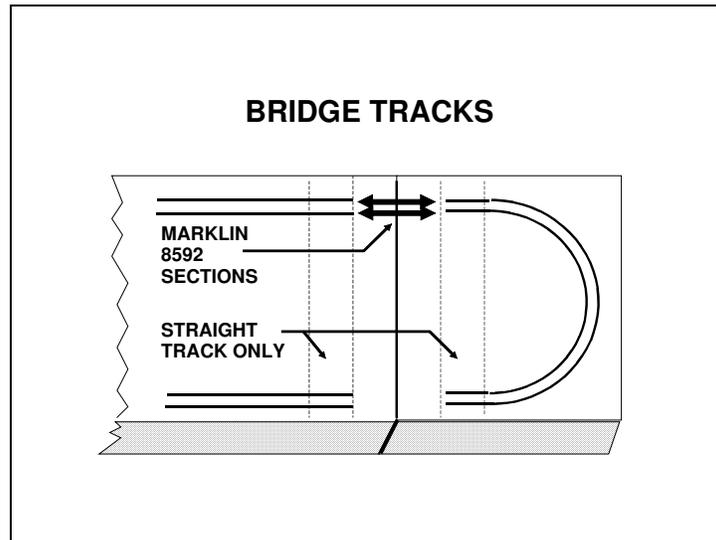
There are no restrictions or requirements for roadbed.

### **SCENERY ELECTRICAL**

While there are no electrical requirements for scenery tracks, owners are **STRONGLY** encouraged to power these tracks for operational reasons, previously stated.

## BRIDGE TRACKS

Since the mainline tracks end 2 1/8 inches (5.4 cm) from the edge of the modules, a short section of track is required to connect the rails of one module to the next. Further, there shall be a minimum of 2 7/8" (7.3 cm) of straight track preceding the bridge track to insure truck (boogie) alignment heading into the bridge track section.



Before you ask, yes, we did try using cut pieces of track for this module-to-module bridge connection. Was it ever a nightmare. No two modules ever turned out to be exactly the same track distance apart, and dozens of odd-length pieces of track had to be custom cut each assembly time. But the real killer was the rail joiners. No Z scale rail joiner was ever made that will "slide" back on the track rails like they do in N and HO scales. We constantly destroyed rail joiners and sometimes ran out of joiners at the worst of times. We even destroyed module tracks at group assemblies.

The Marklin #8592 is a delightful piece of German engineering. It's a telescoping rail-inside-a-rail section of track that can expand or contract to become any length between 3 15/16 inch and 4 3/4 inch (100-120 cm). It fits into the 4.25-inch (10.8-cm) gap between module tracks just perfectly and with a very slight compression. If the modules shift slightly, it simply expands or contracts to maintain a perfect mechanical and electrical bridge between modules.

We were delighted to spend the extra cost of the Expansion Tracks and end the chamber of horrors cut pieces of rail provided us. Yes, they cost about \$6usd each (MSRP). But countless feet of track cut up into odd length bridge tracks cost about the same. Not to mention countless numbers of destroyed rail joiners, or worse, module track damage.

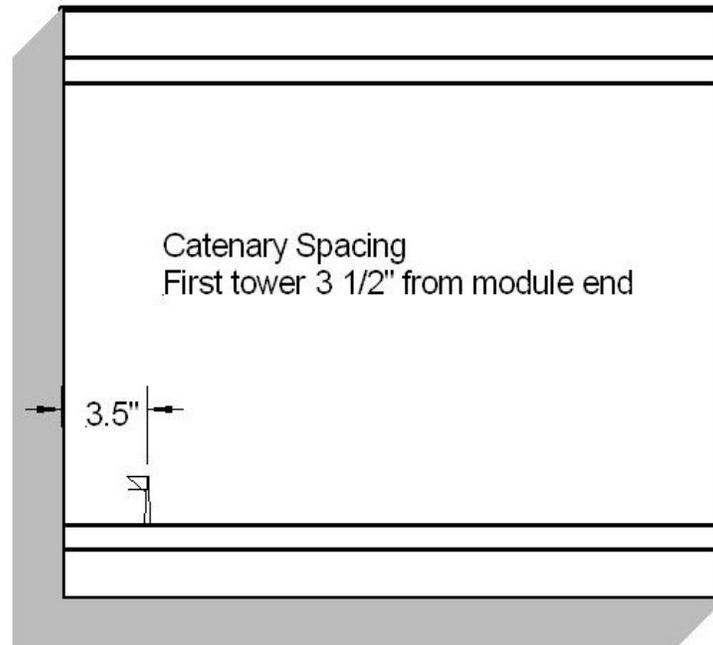
Module owners need to plan to purchase at least 4 pieces of Marklin #8592 Expansion track per module for this purpose. The Expansion tracks should have all rail joiners removed. In addition, the last tie/sleeper at each end should be removed. This allows all four pieces of rail to move independently to adapt to slightly mis-cut rail lengths on the modules. All module rail ends should be equipped with rail joiners.

Note: the 8592's rails are a few thousandths of an inch narrower than standard rails, and its rails will easily side into rail joiners attached to the module's rails. All standard rails will positively grip the rail joiners and hold them from being withdrawn when the expansion track is removed.

## CATENARY

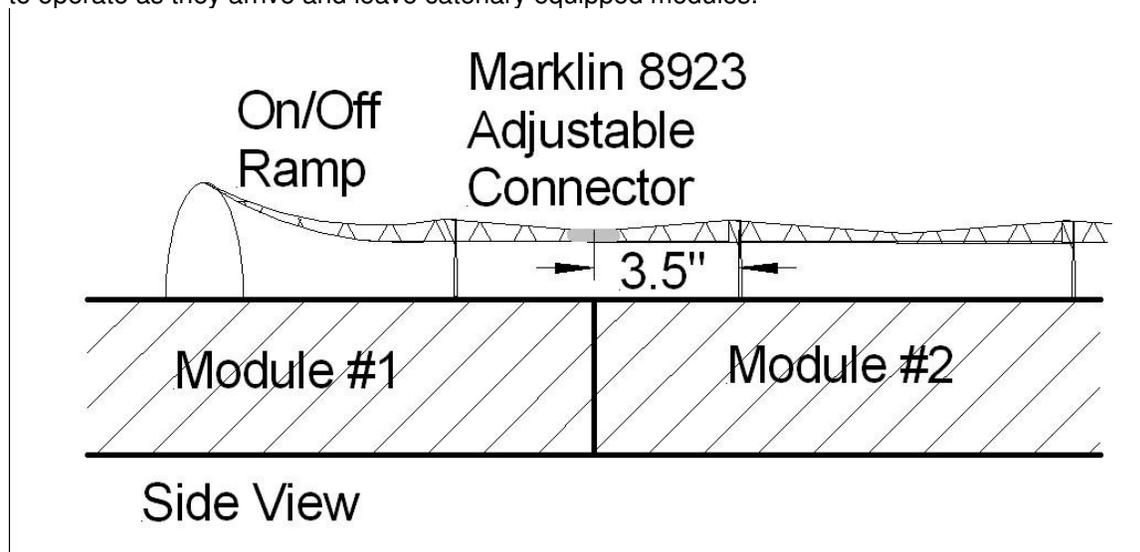
Catenary is allowed, but not required. Catenary can be either powered or unpowered, but should be mechanically functional (the pantograph makes contact with the catenary wires). Any brand of powered or unpowered catenary is allowed, so long as it is interoperable with Marklin pantograph equipped locomotives.

Purely decorative catenary that does not support Marklin pantographs in the up position is not allowed without consent of the other module operators.



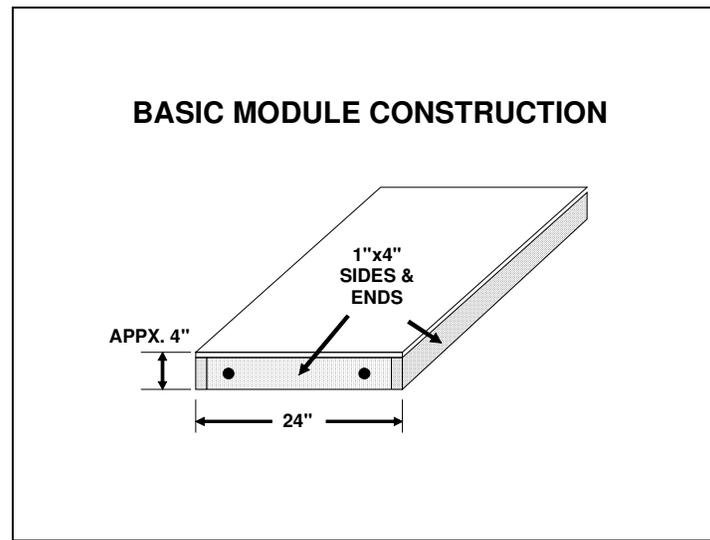
The first catenary mast is placed 3 ½ inches from the end of the module. Marklin 8923 expandable catenary sections are used to connect catenary between two catenary equipped modules. This is the same concept as the connections of the tracks. The Marklin 8923 adjustable catenary wire is 7" long at its mid adjustment point. By setting the first catenary mast 3.5" from the edge of the module, the adjustable wire can easily connect the catenary between two modules.

If the next module does NOT have catenary installed, then a catenary "ramp" should be used. This can be constructed in any manner, but it should allow extended pantograph arms to be ramped down under the catenary. This will permit pantograph-equipped locomotives to continue to operate as they arrive and leave catenary equipped modules.

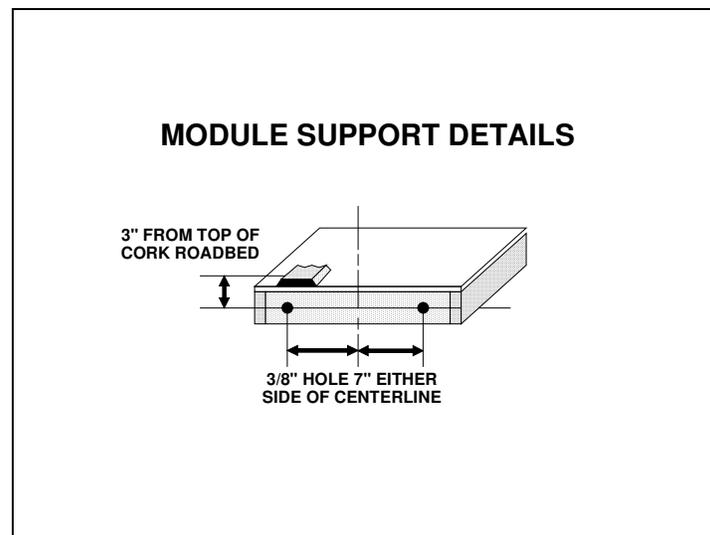


Powered catenary is allowed, but provisions should be taken to prevent power from transferring through the catenary to your neighbor's module just in case he or she does not use powered catenary! There are no other established standards for catenary power.

## BASIC WOOD WORKING



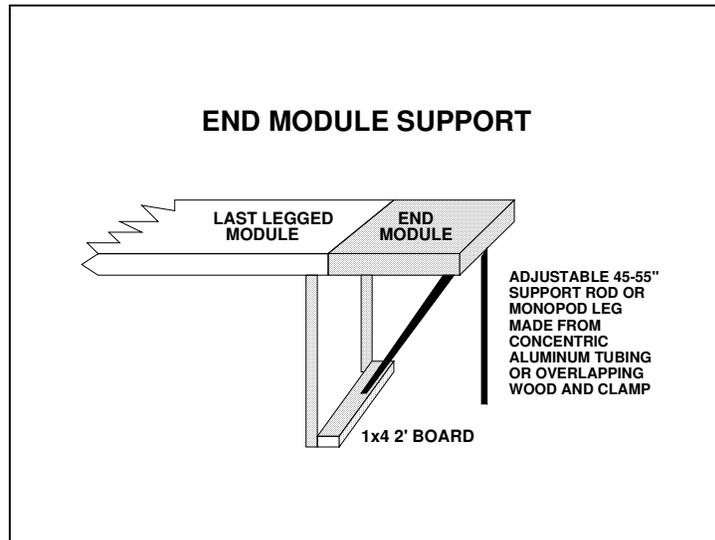
**Z-Bend Track** modules are no different in construction than any other modular standard. A simple, lightweight and strong frame is key to any module, no matter its length or shape. Pine 1x4 lumber is quite sufficient our experience has shown. Please note that the sidepieces go the entire length of the module and the end pieces go between them. This helps to have an attractive, continuous and smooth side to the module, which is what the public sees.



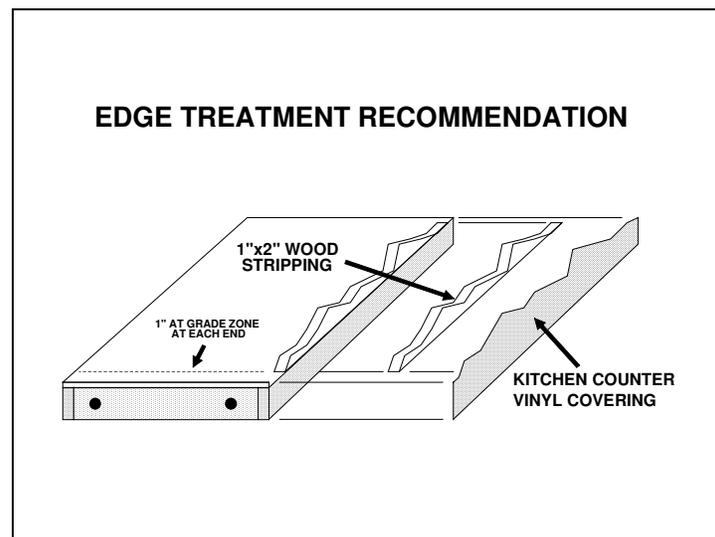
End modules present a special case. Since they are typically without legs, a simple "C" clamp is not sufficient to maintain the module's alignment at the end of a row of modules. We have found that people (even ourselves) tend to use the end module as an armrest, which can result in the 1x4 lumber on the end shattering under the "C" clamp. We drill 3/8" (~1 cm) holes in the ends of ALL modules for the purpose of using 1/4" (~6.4mm) bolt and wingnut hardware to fasten the balloons on the end of ANY module. These extra bolts stabilize the module from slipping down on one side of another.

These holes are also used during transport to protect modules. Two modules can be fastened together with scenery sides facing each other, and a 2x2-foot piece of 3/8<sup>th</sup> plywood fastened to each end of the pair, using the same module-to-module 1/4" bolt and wingnut hardware that was used during the operational setup.

### End Module support



We have also starting using monopod legs on end modules to protect them from "armrest" violations.

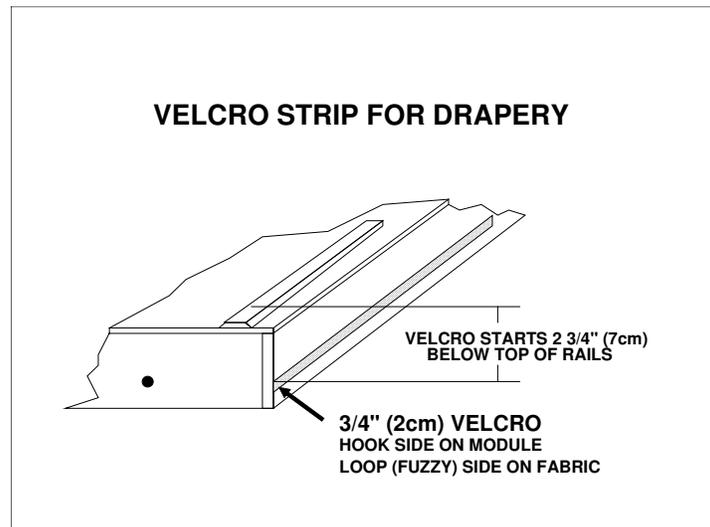


Please remember that there are no straight lines in nature. Consider using a strip of wood on the edges of your module to represent the continuation of the terrain you are modeling. It looks much better than forcing all your nice geology down to a straight line at the edge of a module. Wood is much more durable than whatever material you choose to make your scenery out of.

Lastly, we tend to use thin wood-grain vinyl countertop material to cover both the 1x4 lumber and the thin strip of wood terrain material on the sides that visitors will see. It cuts with a sharp knife or scissors and glues on nicely with standard contact cements. In addition to the visual benefit, it provides for a scratch free durable side on your module at shows. Although we treat modules very tenderly, inevitably, a module will be slid along a rough concrete floor, sooner or later. Painted edges scratch badly during transport while durable counter top material does not.

Kitchen replacement countertop material is available in a wide range of solid colors and wood grains to suit your color preferences. It cuts with scissors or a sharp knife and can be filed or sanded to irregular shapes on the side edge of your module.

### **Drapes:**



While a layout may be sceniced to perfection, looking at it standing on a bunch of exposed legs and toolboxes and crates stacked underneath will not help the overall visual image to viewers. It really looks nice to provide for some form of drapery around the modules to hide all that. In order to make all the drapes across (and mate with) all modules, a 3/4 inch (2cm) Velcro Hook tape should be fastened across the entire length of a modules side. The "hook" component of the Velcro tape should be fastened 2 3/4 inches (7cm) below the height of the rails. The loop (fuzzy) side of the Velcro tape should be fastened to the draperies.

## ELECTRICAL (BACKGROUND)

For transmitting power from module to module, we settled on the DB-25 series connector that is common available throughout the world. It's the same gold plated connector type that you find on the back of Personal Computers (printer port, serial port, video, etc.). Not only is the connector under one dollar USD, but it is extremely reliable, as any PC owner will acknowledge. It can accept multiconductor 26-awg wiring as well as 18-awg lamp cord, sometimes called "zip cord" for the power circuits. The resulting bundle of wiring is small, even with the added functions.

The power rating on DB series pins is 7 amps per pin for machined pins, and around 1 amp on quality crimp pins. We use three pins together to insure sufficient current capacity not only for normal operations, but also for catastrophic short conditions. The connector will still function normally if a single pin is accidentally broken during transport.

This solution has withstood the test of time in the field for six years, and the skills of a wide variety of module builders. Because of its wide spread use, crimp type connectors and crimp tools are commonly available at computer outlets for those that do not wish to solder wires.

When considering a wiring plan that can support 100 feet of modules, special consideration was paid to voltage drops in the backbone cable. No one wants to have to constantly twist a throttle back and forth to compensate for "slow trains" at the far end and "fast trains" close to the throttle. Our planning was to have no more than a 10% voltage drop 100 feet from the throttle with three locomotives pulling a 100-car train. Our super large layouts at the National Train Shows have proven that design goal has been achieved.

Additionally, when layouts become very large, the throttle operator may not be in visual contact with their train for periods of time. There are special problems the **Z-Bend Track** wiring plan considers:

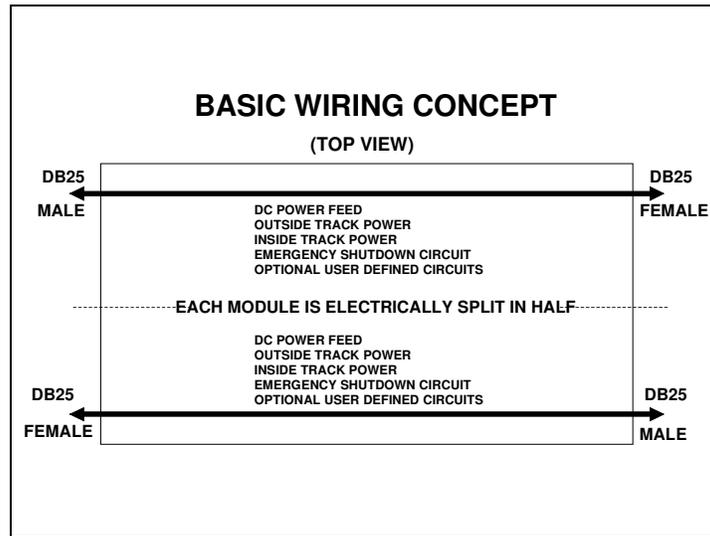
1. **The Z-Bend Track wiring is both DC and DCC compliant.** Users can even switch back and forth between the two power sources, or have one mainline on DC and the other on DCC. It offers the owner the flexibility to run one mode at home and another at shows.
2. Since derailments in Z are not uncommon, we felt it was important that the wiring carry sufficient current to insure a power pack's circuit breaker would trip when locomotives derail, and before the locomotive's trucks melt down from excessive short circuit currents (yes, that can happen at turnouts). This is especially true when working from DCC power sources.
3. Crowd noise frequently prevents effective communications between train operators and assisting observers. When a multi-engine consist derails, frequently the locomotives still on the track work to push the derailed locomotive in the lead off the edge of the table. We have added a circuit that enables simple pushbuttons to be placed around the layout which, when pressed, will completely shut down power to all tracks on the layout. If it's YOUR locomotive that's headed for the edge of the module, you will appreciate this safety feature much more.
4. In the original wiring plan, several non-power conductors (pins 22-25) were set aside for wired communications circuits (i.e., headsets) to overcome crowd noise when operating the layout. However, the extremely affordable 2-way personal radios (i.e., FRS/GMRS) made these considerations unnecessary. These circuits are **no longer required** by the standard.

However, these lines are now set aside for "user defined" conductors for electrical service between a given builder's module set. If you use these circuits, **you must**

**provide some method of disconnecting (or isolating) these conductors from other modules** you may connect up to. Remember that 24-awg wiring and a single DB-25 pin do not carry much current either. In-line glass fuses are recommended in these circuit paths.

## ELECTRICAL SPECIFICATIONS

Each half of the module is electrically totally independent from the other half. Each half of the module has a cable that furnishes a number of power connections to that half of the module, while other circuits just pass through. All power circuit and accessory power circuit wiring in the backbone must be at least 18 awg. Non-power circuits may be 24 awg.

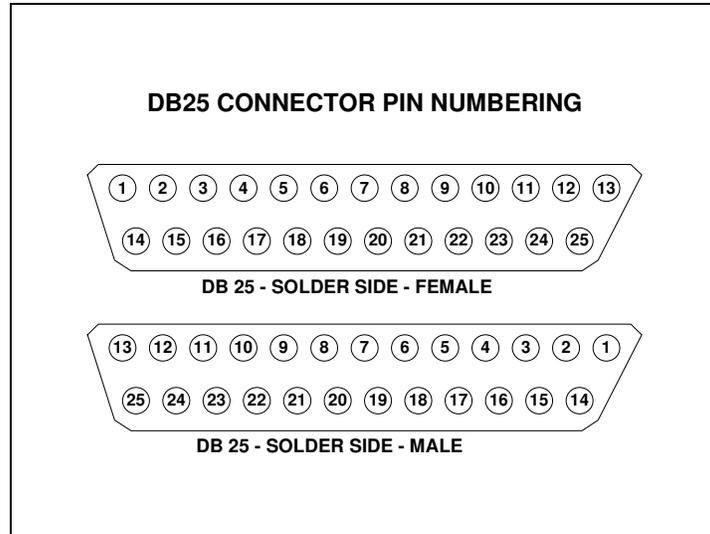


Each half of the module has a cable furnishes a number of power connections to the module half, while other circuits just pass through. In addition to track power, each module is furnished with a scenery power circuit for lights and animation uses (up to 1/3 amp per module). If you use scenery power, you are expected to provide a glass fuse (not a mechanical circuit breaker) to insure that if you develop a short circuit, the fuse will blow and the rest of the modules will not be affected. In addition, some method (i.e., an on/off switch) should be provided to disable the scenery power should an electrical malfunction occur in the module during a show.

**DO NOT USE** pre-made computer cables (printers, serial modems, etc.). While very inexpensive, they use extremely tiny wiring, which is absolutely not sufficient for power conductor service over great distances. Some pre-made computer cables have special internal wiring that will short out other **Z-Bend Track** modules with correct "standard" wiring.

## DB-25 CONNECTORS

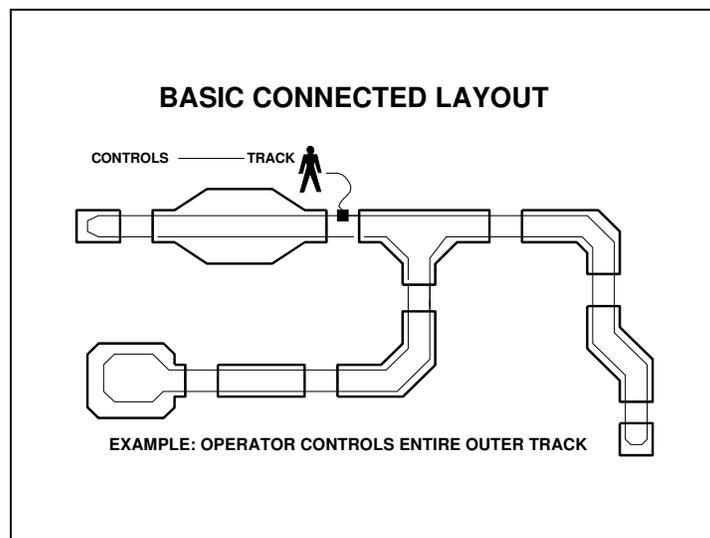
This is what a DB-25 connector looks like when you start to add wires to it. Note the method of counting pins when viewed from the back of the connector (solder side).



\*

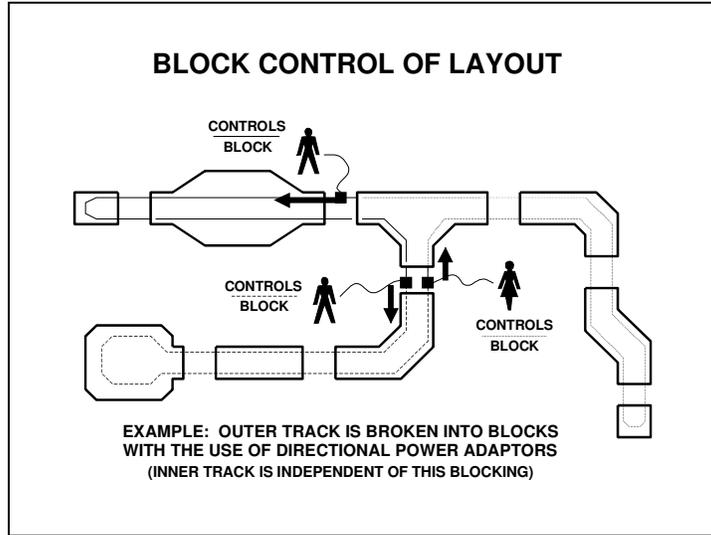
## POWERING UP MODULES

Since all modules have the same identical wiring plan, there must be a provision for applying power to modules. This is done without modification to any module by simply by plugging in an adapter in-between any two modules. In the illustration below, one of the mainline tracks is powered across all modules by a single throttle feed at an adapter that is inserted between the cables of two modules. The throttle would work equally well if it was moved anywhere around the layout shown.



By using insulated rail joiners on one end of bridge tracks and a special one-way power feed adapters, you can electrically break up the layout into several electrical "blocks" each with its own

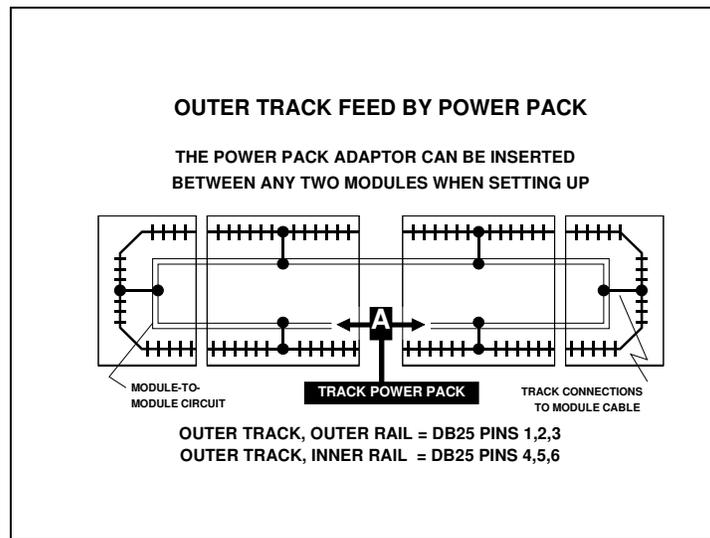
throttle and operator. One operator can "hand off" a train to another operator's control as it passes over insulated rail joiners and begins taking power from the new operator's power pack. Think for a second, isn't this exactly how prototype trains work, with the train passing from one control section to another and with coordination between from both dispatchers? Why not has fun with this in models as well?



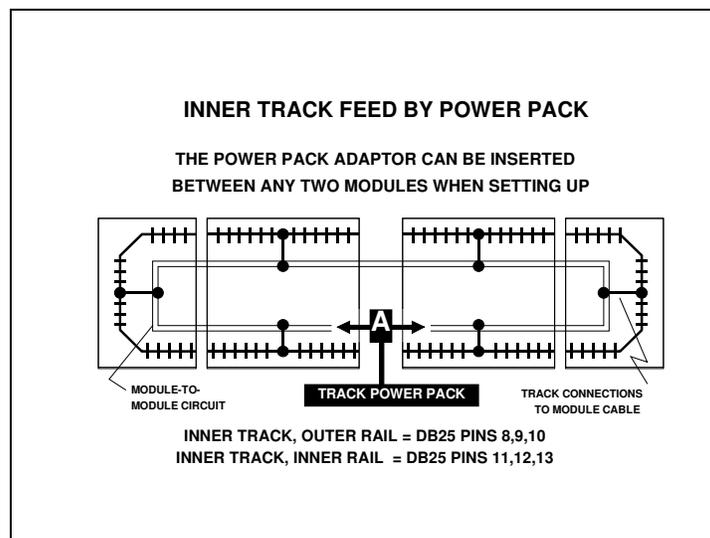
## DETAILS OF WIRING

The "outer" track gets its power from the indicated pins shown in the drawing below. Note that the under the table wiring follows the track all around the layout, large or small. Track power from the backbone 18 awg conductors to track rails on this module should be at least 22-awg. This is sufficient for the short wiring distances involved within a module. But it is not sufficient for moving current over 100 feet, which is why the backbone wiring it is attached to is always 18 awg.

If you solder 26 awg wires to the track, please keep those feeders down to a few inches/cm, and slice in 22 awg wiring as soon as practical. You don't want to own the module "where the train always slows down."



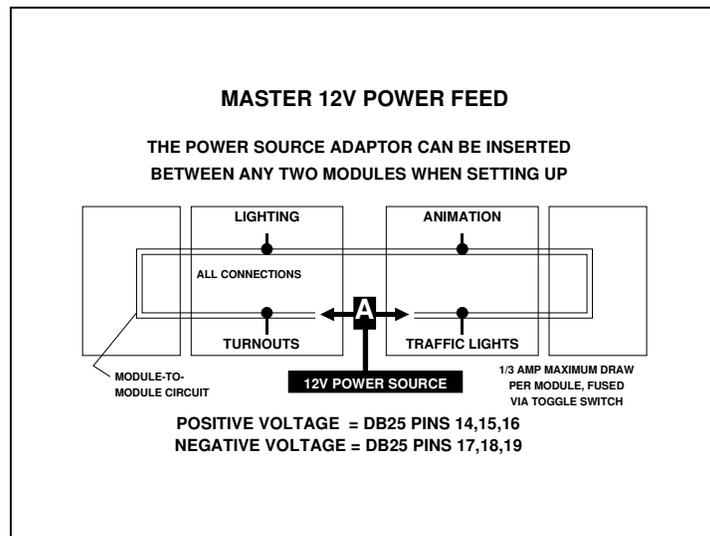
The "inner" track gets its power in an identical fashion, but from different pins in the connector, as shown below.



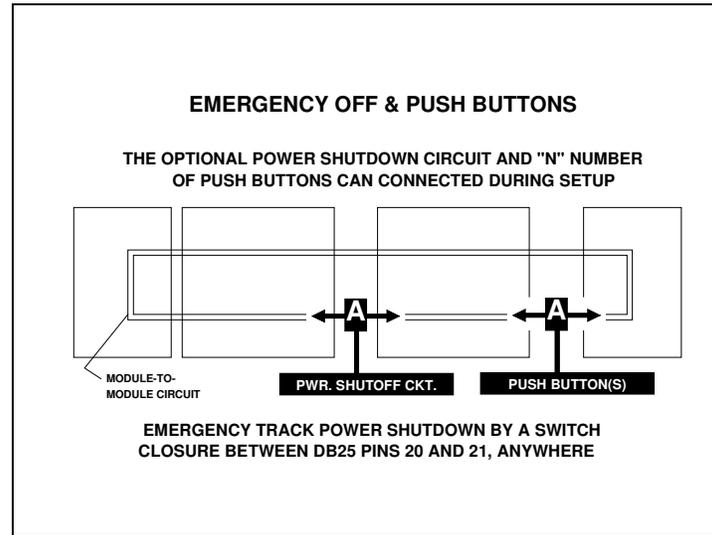
The 12vdc scenery power feed is also an 18-awg circuit that is available to all modules. No module should draw more than 1/3 amp from this pair of wires and should provide for both an on/off switch and a glass fuse to protect the rest of the layout in the event of a short.

This power feed should **NEVER** be connected to any track circuit. 12vdc is far too much voltage to apply to any Z scale motor. The standard requires a regulated, self-protected (i.e., shorts) power source. There shall be a “booster” power supply located every 9<sup>th</sup> module that draws power from this line to prevent more than 3 amps (average) current flow in the backbone circuit.

If your module contains any electronic circuit(s) that may be damaged by an accident polarity reversal during setup, you should plan to install a 3-amp diode in the positive lead you attach to the backbone wiring. This will protect all of your circuits until the power supply error is corrected.



There are several pass-through circuits in the cable. One is an emergency shut down circuit. At shows, crowd noise often prevents good communications between operators. In order to provide an emergency shutdown function for trains from various points around the layout, a low voltage is applied between these two leads. Push button switches are periodically added between modules by way of adapters between modules. If any of the push buttons are pressed, the closure across these wires will trigger the complete shutdown of all track power supplies. Power will be restored by a central push button. Wiring should be 22-awg wire. The detector circuit will be published in an Appendix to this manual.



There are also 4 wires reserved for user defined circuits (pins 22, 23, 24 and 25). If you provide wiring on these pins, you must provide for some method of isolating your wiring from adjacent modules (i.e., adapter, switch, etc.) which may use these conductors for an entirely different function.

As example, Rob Allbritton has utilized these extra circuits for enhanced DCC train detection within his set of Gotthard Line modules. His uses are shown below:

<b>Pin #</b>	<b>DCC Use</b>
7	DCC Ground
20	Loop to Pin 21
21	Loop to Pin 20
22	Digitrax BDL-16 Power (A) 12VAC
23	Digitrax BDL-16 Power (B) 12VAC
24	DCC Signal (A) 12VAC
25	DCC Signal (B) 12VAC

*Pin 7 and 22 through 25 are used for specific DCC purposes:  
DCC Ground and BDL-16 Power are needed for Digitrax electronic train detection  
DCC Signal is a "cleaner" way for the turnout DCC decoders to receive instructions*

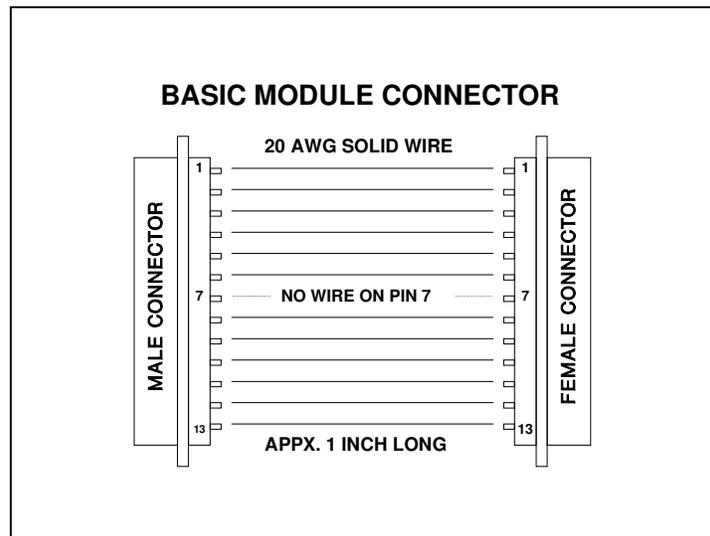
*If a DCC module is plugged into an analog module by mistake, then looping Pins 20 and 21 will trigger the automatic shutdown of the analog modules for their own protection. Normally, a DCC to Analog converter adapter (DB25) will separate out pins 7 and 20 through 25.*

## ADAPTER CONSTRUCTION

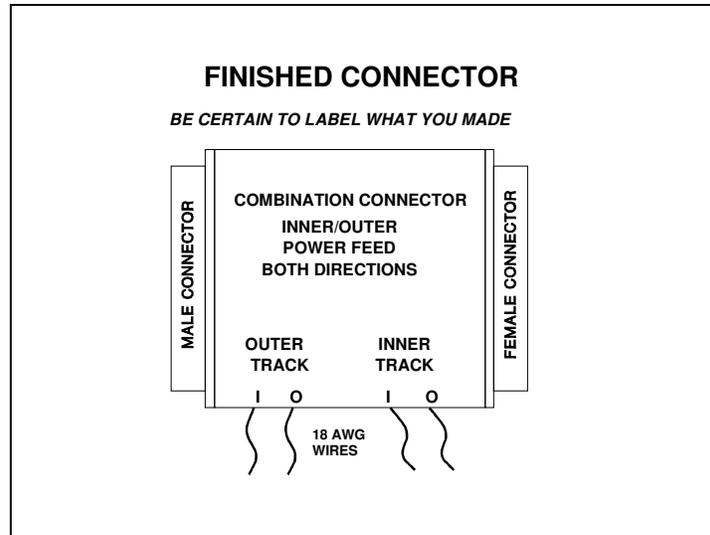
Since all modules have identical internal wiring, the method of connection to the layout is through adapters. Currently, the basic adapter involves a male and female connectors and 24 identically cut pieces of pre-tinned 20-awg wire.

Plan to stiffen the wire by "drawing" it. Like many metals, soft copper wire can be made very, very stiff by stretching it. Clamp 10 feet of wire in a vice, then use pliers to stretch it to almost 11 feet in length. Not only will the wire become straight as a laser beam, but also as stiff as piano wire in the process. Use a home make jig to cut 24 identical pieces of wire about 1.5" long.

Solder the first four wires to pins 1, 13, 14 and 25. This will perfectly align the two connectors, and make the insertion and soldering of the remaining 20 wires extremely easy.



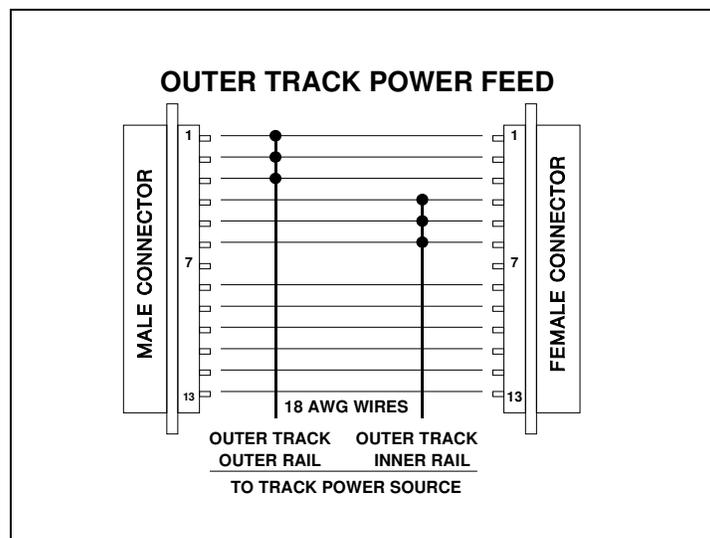
After adding wires which to power packs, scenery power supplies, shut down circuits and communications devices, we currently "pot" or encapsulate these adapters in Hydrocal plaster. Since all the voltages in these connectors are very low voltages, plaster is an excellent insulator and protects all 24 conductors from shorts.



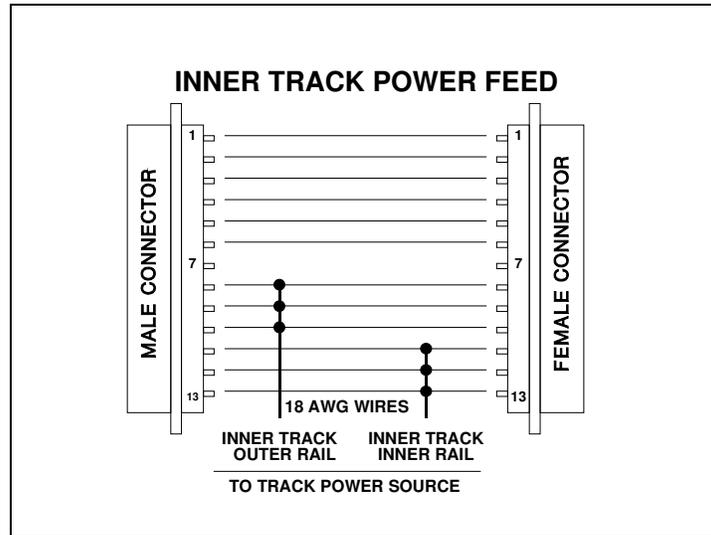
We recognize that a better long-term solution is required. The Houston group of **Z-Bend Trackers** is working to release a printed circuit board to make these 25 connections much simpler by use of a printed circuit board and plastic covers. Check our website for developments on these PC boards and other electrical products. Our products will never be a "for profit" venture.

### BASIC ADAPTORS

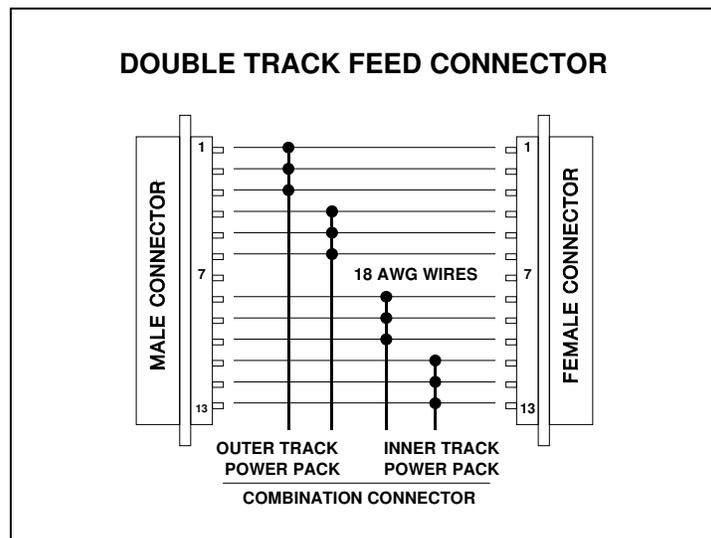
This adapter will feed the voltage from a power pack in both directions to the outer track.



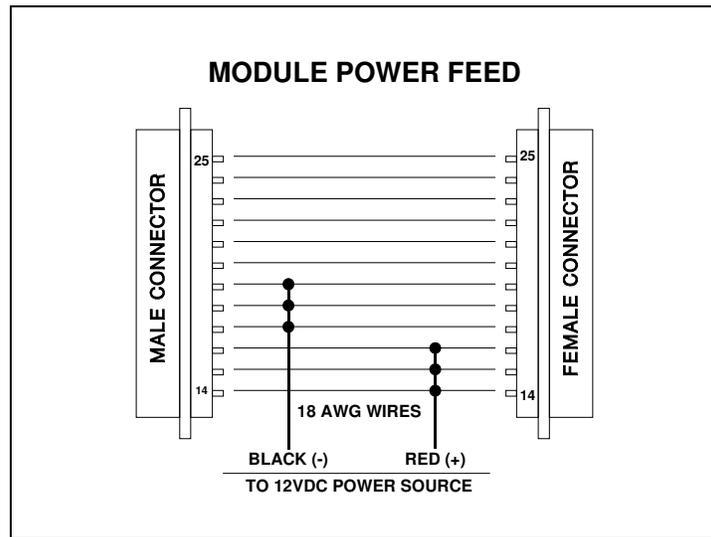
This adapter will feed power from a power pack in both directions to the inner track. Note that the Outer and Inner power packs do not have to be at the same location on the layout. They can be located between any two modules. This is very helpful when you have a small group of modelers and a large layout with limited operator vision. The two operators could "see" the entire layout much better if their power supply stations are in different locations around the layout.



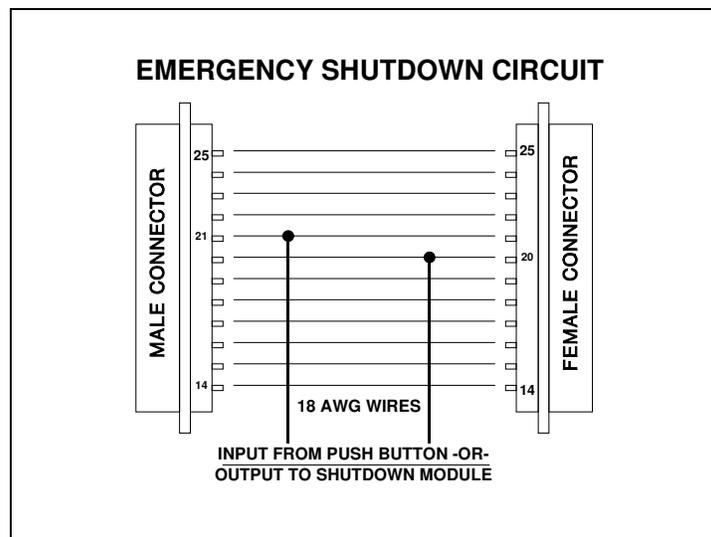
This adapter will feed the power from two power packs to both the Outer and Inner tracks at a single location.



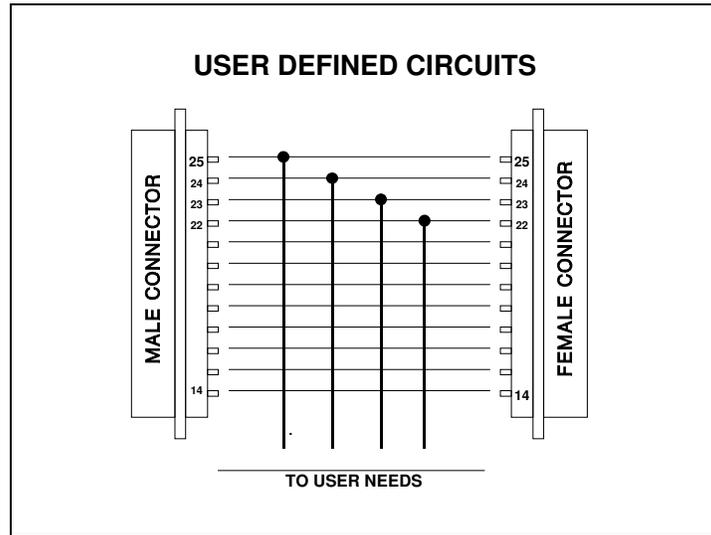
This adapter is used to inject 12vdc power into the Power Feed circuit in both directions. Modules that have illumination or animation can use this power.



When a layout is equipped for emergency shutdown circuits, simple pushbuttons placed around the layout connect up to the backbone with this simple adapter. The sensor itself also uses the same adapter to sense the depression of any pushbutton and shut down the layout power.

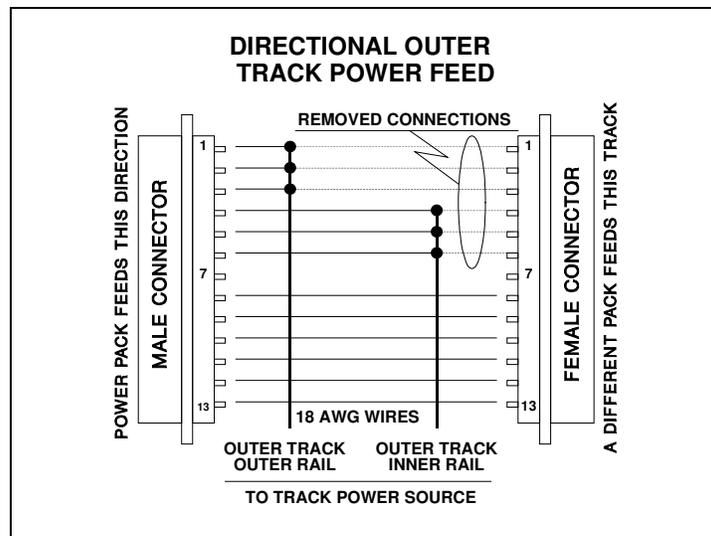


This adapter is used to access the user-defined circuits. The adapter should consider whether or not the feed through wires need to be connected in both directions.



All manners of directional power feeds can be set up for multi-block operations. In this example, the power is transmitted to the left hand module, but not to the right. Insulated rail joiners on the right side of the expansion track complete the isolation of the two blocks.

### SPECIAL ADAPTORS



## DC OPERATIONS

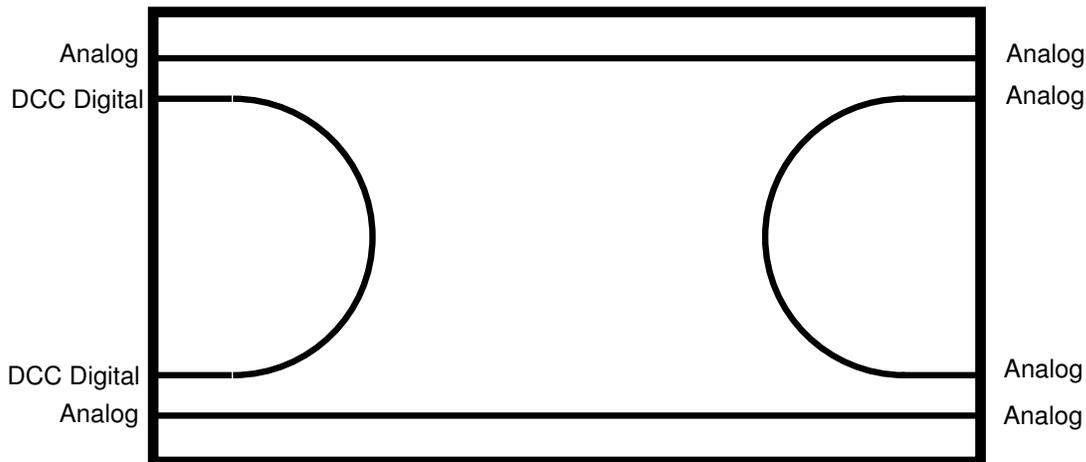
While the source of track power in a home environment is strictly up to the owner, in a group setting there will be some sensitivity to power sources due to a very wide range of motive power and internal train accessories that may be placed on the track. At public shows almost all of the Operations will be in the form of continuous running. Rather than place locomotives, user built solid state accessories and exotic motors at unknown compatibility risks with unknown power sources, only pure DC power packs should power the mainlines. Voltages shall not exceed 8 volts. Train speeds should be prototypical at all times. All devices including electrostatic generators or pulse power should not be applied to the rails. No one wants to accidentally damage someone's special lighting circuit or expensive motor.

## DCC OPERATIONS

**Z-Bend Track** fully supports DCC operation. No special wiring is required to the modules for DCC operation. The DCC encoded power is sent to the modules via the standard track power feed adapters. From an electrical standpoint, the DCC encoded power is sent into the modules the way any other throttle works, but during operating sessions DCC power **must** be isolated from analog power, unless you enjoy pyrotechnics!

The DCC booster **must** have short circuit protection. We strongly recommend use of a power management unit, such as a Digitrax PM4. It has superior DCC short circuit protection, and will provide protection for both locomotives, as well as inadvertent connection between DCC and Analog powered modules.

The best way to implement DCC in a mixed analog / digital layout is to designate the outer track as Analog and the inner track as DCC, or vice versa. Another wonderful way to share digital and analog is to have a special interface module that allows the outer tracks to go through, but loops the inner tracks back on themselves:



This solution allows some of the modules to have a DCC digital inner track, but allows the outer track to be available for all through running trains. The Washington and Houston groups did this at two NMRA National Train Shows with absolutely no problems. The Washington DC modules also pass Digitrax Loconet from module to module in a daisy chain fashion using RJ45 connectors not covered by this standard. Contact Rob Allbritton at [Robert@potomacnet.com](mailto:Robert@potomacnet.com) for more information if you would like to make your **Z-Bend Track** modules compatible with the Washington DC modules.

Prior to placement of locomotives and rolling stock on the track, the owner of the DCC equipment powering the rails shall advise the equipment owner of the maximum voltage that the DCC equipment will be applying to the rails. The owner of the DCC power source should make all possible attempts to maintain a track waveform that is reasonable and safe for the widest range of decoders, lighting accessories and user built circuits.

## APPENDIX 1

### **Acknowledgment of Intellectual Property:**

The concept of **Z-Bend Track** borrows heavily from the original work of Allen Heimsoth and Jim Hoover, the creators of N Scale's "Bend Track." With their knowledge and generous support and permission, **Z-Bend Track** was born.

Our **Z-Bend Track** logo reflects the N Scale "Bend Track " logo as a sign of our appreciation. The N Scale "Bend Track" website is an excellent reference, and can be found at the URL:

<http://www.alltel.net/~ah50902/>

The **Z-Bend Track** website can be found at:

[www.zbendtrack.com](http://www.zbendtrack.com)

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