

Northern California Free-mo

HO Scale Free-Form Modular Model Railroading

Standards and Guidelines

1.0 Overview

The main purpose of this modular group is to provide a place to operate finely detailed HO scale standard gauge models in a realistic fashion. Operating trains is the important aspect of meets, so the layout setup does not follow the traditional "endless circle" format of modular layouts. Instead it follows a "free-form" configuration that does not readily lend itself to continuous running; trains originate from one point on the layout, traverse it, and then terminate at the other end (or back at the starting point). This format results in modules that are viewed from both sides, and that are designed to be reversible (rotated 180 degrees).

This type of operation requires end points, typically in the form of stub end yards or reverse loops. A layout may then take on the form of an "out-and-back" or a "point-to-point". Other more complex formats are possible if "junction" modules are built; for example a wye module could allow a branch line operation.

Between the end points of the layout are modules which carry the single track main line from one end to the other. Large modules may be assembled from small, easily transportable "sections" to create a large layout feature; for example a passing siding long enough for a full-length freight train could be created as a multi-section module.

2.0 Definitions

MODULE:

Any layout component (or group of "sections") meant to be operated as a single unit in a fixed configuration. A module can have any number of sections. Both ends of a module comply with the Free-mo physical and electrical standards defined within this document.

SECTION:

A part of a larger module, complete with bench work, track, scenery, etc. Except where otherwise noted, standards for module end interfaces do not apply to inter-section interfaces, as these are considered to be internal to the module.

ENDPLATE:

The standardized end surface of a module that joins with an adjacent module in a Free-mo layout. The physical aspects of the endplate are defined in the Frame Work description, below.

FITTER RAILS:

The 2" long removable rails and joiners used to bridge the joints between adjacent modules or sections. Must be Code 83.

TRACK (POWER) BUS:

The continuous two wire bus feeding power and DCC commands to the track.

ACCESSORY (POWER) BUS:

The continuous two wire bus powering electrical accessories such as turnout motors, structure lighting, animation, etc.

LOCONET (DCC) BUS:

The continuous six-wire bus carrying DCC information among the Digitrax system components such as throttles, boosters, radio receivers, etc.

PIGTAIL:

Common name of any of the connector/wire assemblies used to connect the electrical busses together between modules.

3.0 Frame Work

"Frame work" refers to a module's structural frame including endplates, interior supports, legs, and braces. There are no requirements to use specific materials or construction methods; however, the basic trade-off is sturdiness versus weight. To date, frames have been built from dimensional lumber, high-quality plywood such as birch, and medium-density fiberboard (MDF). Other more exotic materials are possible but have not yet been used by NorCalF (wood/foam sandwich, aluminum, honeycomb structures, etc.).

Generally, dimensional lumber is discouraged due to warping issues.

HEIGHT:

The nominal module height measured from **floor to top of rail** shall be **50"**, adjustable from 49" to 51" above floor.

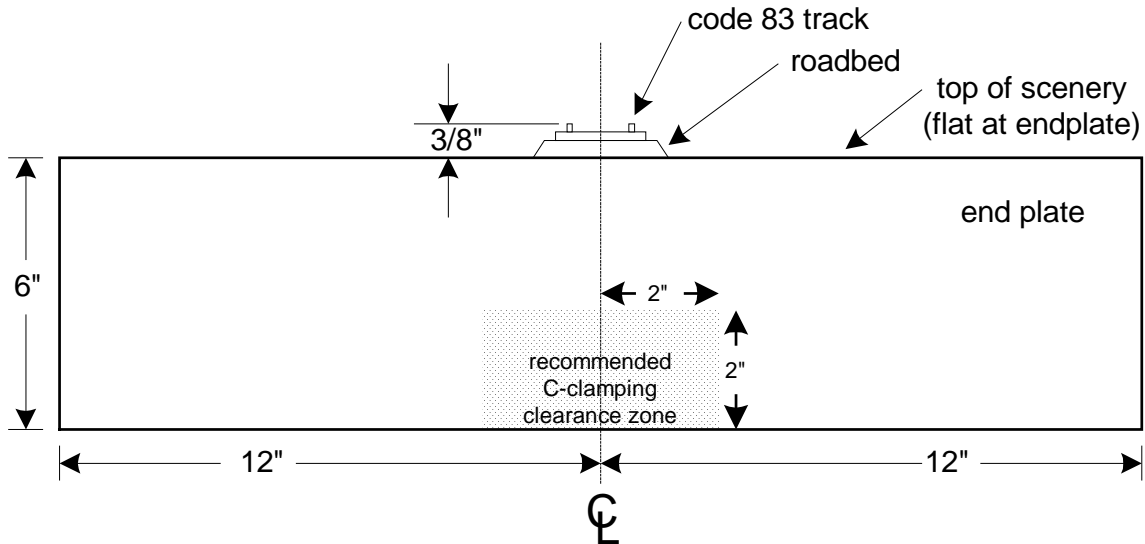
Suggestion: the height adjustment range of 2" is a minimum; a larger range is acceptable and recommended.

WIDTH, LENGTH, SHAPE:

See Endplate specifications (below); otherwise free.

Suggestion: modules over 6' long are difficult to move and transport.

ENDPLATES (SINGLE TRACK):



24" wide, 6" tall from bottom to scenery top surface; roadbed and track adds 3/8" to top of rail.

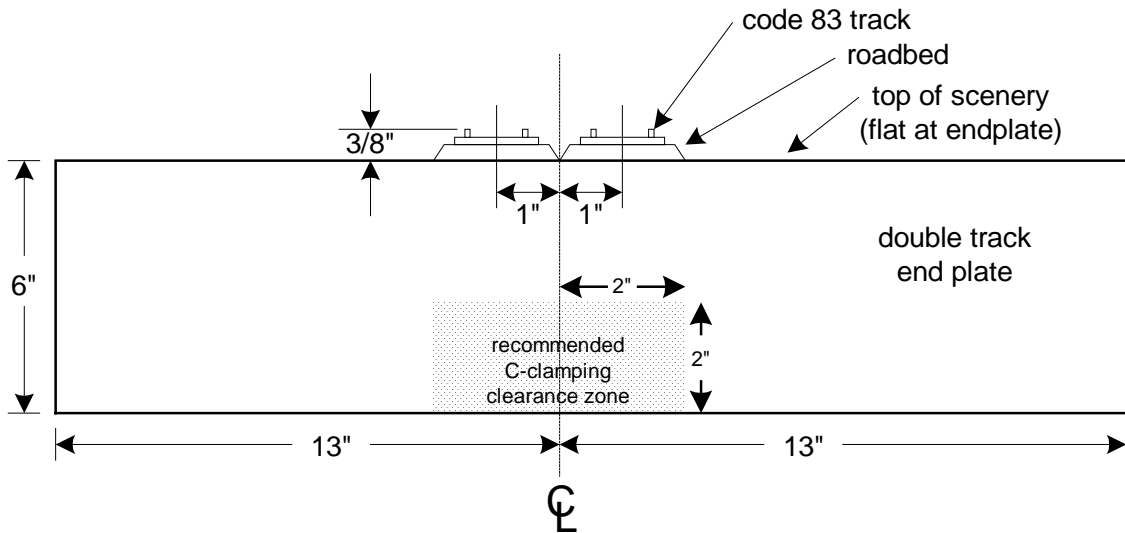
Endplates **MUST** be parallel to each other, and perpendicular to track both vertically and horizontally. They must be as flat as possible (e.g. not bowed, twisted, etc.). Material must be solid and sturdy for C-clamping to adjoining modules.

Suggestions:

- Make endplates from 3/4" plywood or equivalent stable material to maintain flatness. Dimensional pine lumber is not recommended as it often warps over time.
- To allow room for C-clamps, keep inner surface of endplate clear of obstructions (electrical terminal blocks, LocoNet connectors, etc.). Recommended clearance area is 2" high by 4" wide, centered at bottom edge of endplate inner surface.
- Cut handholds into endplates to assist transporting and positioning the module.
- Paint endplates Glidden "Great Desert" beige. Use "flat" to prevent modules sticking together.

Note: Mating 24"-wide single track and 26"-wide double track modules results in small fascia offsets.

ENDPLATES (DOUBLE TRACK):



Double track endplates are 26" wide; the two tracks are centered 2" apart, each centered 1" from endplate centerline. Rail tops of both tracks are at the same height, 3/8" above the scenery top surface.

Endplates **MUST** be parallel to each other, and perpendicular to track both vertically and horizontally. They must be as flat as possible (e.g. not bowed, twisted, etc.). Material must be solid and sturdy for C-clamping to adjoining modules.

See Single Track Endplate, above, for construction suggestions.

Notes:

- Track spacing may deviate from 2" centers within a module (e.g. broader through curves). See NMRA standards for spacing specifications.
- Some legacy modules have more than one track at a 24"-wide endplate. Mating them with 26"-wide double track modules results in small fascia offsets.
- Mating 24"-wide single track and 26"-wide double track modules results in small fascia offsets.

LEGS AND LONGITUDINAL BRACING:

Each module must have legs that support the module free-standing. A module must stand secure and level independent of other modules. Each leg must include vertical adjustment of plus and minus 1" minimum to compensate for uneven floors (e.g. rail top height above floor must be adjustable minimum of 49" to 51"). Painting legs is optional.

Suggestions:

- Design and construct legs as part of the frame, making them an integral part of a module structure.
- Install cross- and angle-bracing on legs for added stability.
- Permanently attach legs to module frame and have them fold up for transport. This method allows speedy setup/teardown, simplifies transport and storage, and eliminates loose hardware, etc.
- Add angled longitudinal braces to prevent module from swaying parallel to the track. This stabilizes the module for fine adjustments during setups, and when working on the module during construction.
- Use T-nuts and machine bolts in bottom of legs for height adjustment. Install rubber or nylon caps on bottom bolt heads to prevent damaging floor surfaces.

Note: NorCalF has a stock of 1/4" T-nuts for general distribution to module builders.

SIDES AND FASCIA:

Fascias must be smooth and made of a solid, sturdy material (plywood, hard board, Masonite, etc.). Color must be Glidden "Great Desert" beige.

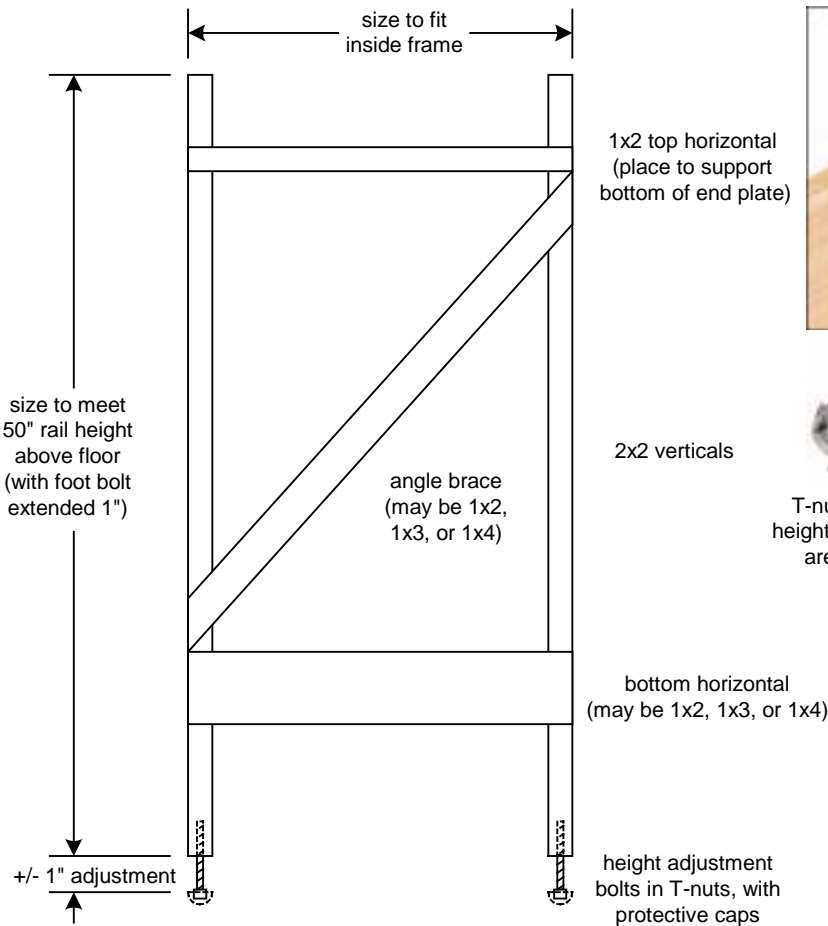
Suggestions:

- Use "semi-gloss" Great Desert to permit easier clean-up of fingerprints and the like.
- Avoid protruding items like toggle switches to prevent accidental damage or injury to operators; recess these items into cutouts in the fascia.
- Label both module sides with name of module. Chartpak Dry Transfer Lettering "Franklin Gothic" 36 point (#00220) is recommended.
- Label electrical switches and other operational items. Chartpak Dry Transfer Lettering "Franklin Gothic" 18 point (#00200) is recommended.

MODULE-TO-MODULE ATTACHMENT:

C-clamps are used at the endplates, positioned near the endplate center (directly below the tracks).

Suggestion: Use "deep-throat" C-clamps to apply pressure closer to module top and draw track ends together.



One possible leg design using dimensional lumber. T-nuts are mounted in the bottom for the height-adjustment bolts.



Visit Lee Valley Hardware at www.leevalley.com/hardware/

Folding brackets like these from Lee Valley (#00T16.01) can be used to build permanently attached fold-up legs. They lock into position both open and closed.



T-nuts like these may be used in the bottom of legs to hold height-adjustment bolts. Lee Valley #00N23.01 (item H above) are 1/4" Propell Nuts designed for end-grain installment.



Another option for height-adjustment hardware. Lee Valley #01S04.05 bracket and #01S06.03 (3" tall) or #01S06.04 (4" tall) leveler feet. These can be adjusted with a screwdriver from above, avoiding crawling around on the floor during setups.

4.0 Track Work

GENERAL:

All NMRA standards must be met.

SUB-ROADBED:

Sub-roadbed construction and materials are free, but must be built to prevent sagging or flexing, and must be installed to comply with the endplate requirements (see section 3.0 "Frame Work"). Track **MUST** be perpendicular to the endplate both horizontally and vertically!

Suggestions:

- To date NorCalF modules have used plywood, Homasote, and foam insulation board. The main trade-off is rigidity/stability versus weight.
- If foam board is used, run interior wood track supports parallel to the track to provide maximum support for the foam, resulting in a flat track profile.

ROADBED:

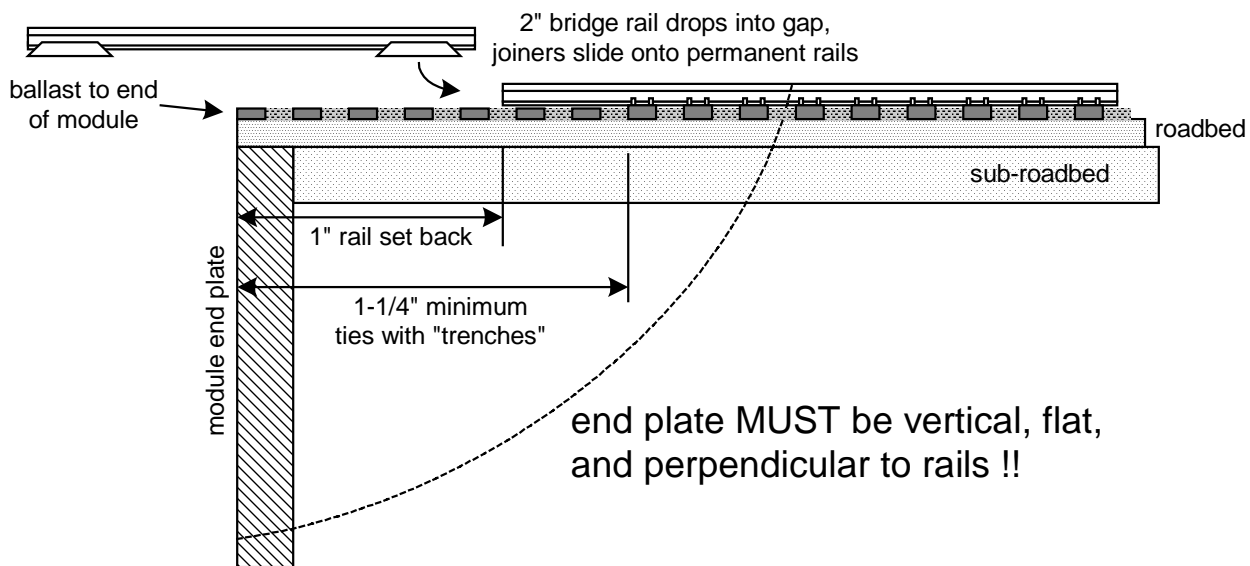
Material is free, but must comply with the 3/8" standard for top-of-scenery to rail-top dimension. See section 3.0.

Suggestion: Standard HO scale cork roadbed used under flex track meets the 3/8" requirement.

MAINLINE LOCATION:

The mainline must cross the module end plate centered on the 24" width; it **MUST** be perpendicular to the endplates both horizontally and vertically! The mainline must run straight and level for at least 6" from each endplate. Otherwise its location is free (within limits of standards for curves and turnouts). This guideline ensures there is at least 12" of straight track between reverse curves.

JOINING TRACK BETWEEN MODULES:



Rails end 1" from end of module (outer surface of the endplates). Ties and ballast continue to end of module. The ties within 1.25" (minimum) must accommodate installation of fitter rails with accompanying rail joiners, which are slid onto the module's fixed rail ends (typically these ties have a small "trench" where the spikes normally are found). Modules are connected with 2" fitter rails and rail joiners, which are dropped into the rail gaps and joined to the module rail ends.

Suggestions:

- Use Atlas code 83/100 joiners on fitter rails (their profile provides a surface for pushing into place).
- Use weathered code 83 rail for fitters.

RAIL:

All track must be nickel-silver commercial or hand laid. Mainline track must be Code 83. Other track may be smaller (e.g. Code 70 or 55), but must permit reliable travel by rolling stock with NMRA RP25 flanges. All active rails must be clean and flangeways clear.

Suggestion: clean rails and clear flangeways before each operating event.

CURVES:

Minimum radius is 42" for mainline, 30" for branch and industrial trackage. There must be at least 12" of straight track between reverse curves. All mainline curves should include easements; an article for creating easements can be found on the internet at <http://www.trains.com/Content/Dynamic/Articles/000/000/001/647dsuww.asp>

Suggestion: Use radii of 48" or more whenever possible. The 42" radius is the mainline minimum but larger radius looks and operates better!

Note: older versions of Free-mo standards call out a 36" mainline radius; modules built to this standard may still be used for branchline operations.

DOUBLE TRACK:

Double tracks at a 26" double track endplate must be centered 2" apart, with each track centered at 1" from the endplate centerline (see sketch in Section 3.0). Additional tracks must be centered at 2" increments from either of the two main tracks. Rail tops of all tracks must be at the same height, extending a minimum of 6" from the endplate.

MULTIPLE TRACKS (LEGACY MODULES):

Some legacy module designs have more than one track at a 24"-wide endplate. In this case the single main line track must be centered on the endplate. Additional tracks must be centered at 2" increments from the main track. Rail tops of all tracks must be at the same height, extending a minimum of 6" from the endplate.

SUPER-ELEVATION AND GRADES:

Super-elevation of mainline curves, vertical track curves, and grades are permitted, appropriate for mainline operation of contemporary long cars (90' cars must be able to negotiate these track profiles without derailling or uncoupling from adjacent cars). The maximum mainline grade is two percent (1/4" rise per foot of run). Track must be level for at least six inches from each end of module.

Suggestion: when constructing track that includes vertical curves as described above, use a straight edge of at least 12" laid on top of the rail to measure the rate of change of the rail height. Measure each rail separately. The space between rail top and straight edge should not exceed 1/16" within 12" of horizontal run.

Note: grades are possible within a large module, as long as nominal rail-top height is 50" from floor at both endplates of the module. US Free-mo has a provision for grades across multiple modules, but for simplicity NorCalF presently does not allow this until further notice.

TURNOUTS:

Minimum #6 for mainline, minimum #5 for branch and industrial trackage. All mainline turnout are controlled locally or through DCC. Point throw must reliably and completely close the point rails against the stock rails. Method of throw (powered or manual) is free. Frogs must be power routed from stock rails (relying on the contact between point and stock rails to conduct power through points into the frog is to be avoided).

Note: DCC accessory decoders are allowed for turnout control as long as there is at least one other method available to throw the turnout (fascia buttons, hand throw, etc.). DCC decoder addresses must be registered on the NorCalF Address List to avoid duplications.

CLEARANCES:

All clearances (curves, tunnels, structures, etc.) must meet NMRA standards.

Note: potentially every type of rolling stock will run over all modules; clearances must accommodate the tallest double stack, longest piggyback flat, etc.

5.0 Electrical

Three simple electrical "busses" run through each module and connect them together. Power to the track is routed over the Track Power bus, layout control is routed over the DCC LocoNet bus, and power for accessories is routed over the Accessory bus. Each bus uses a unique connector style to prevent accidental cross-wiring from one module to the next.

Suggestions:

- Tie all wiring to module frame to prevent damage during transport and setup, especially near endplates where C-clamping occurs.
- Construct wiring to be "modular" for easy debugging and repair; i.e. use terminal blocks, connectors, etc. wherever possible.

TRACK POWER BUS

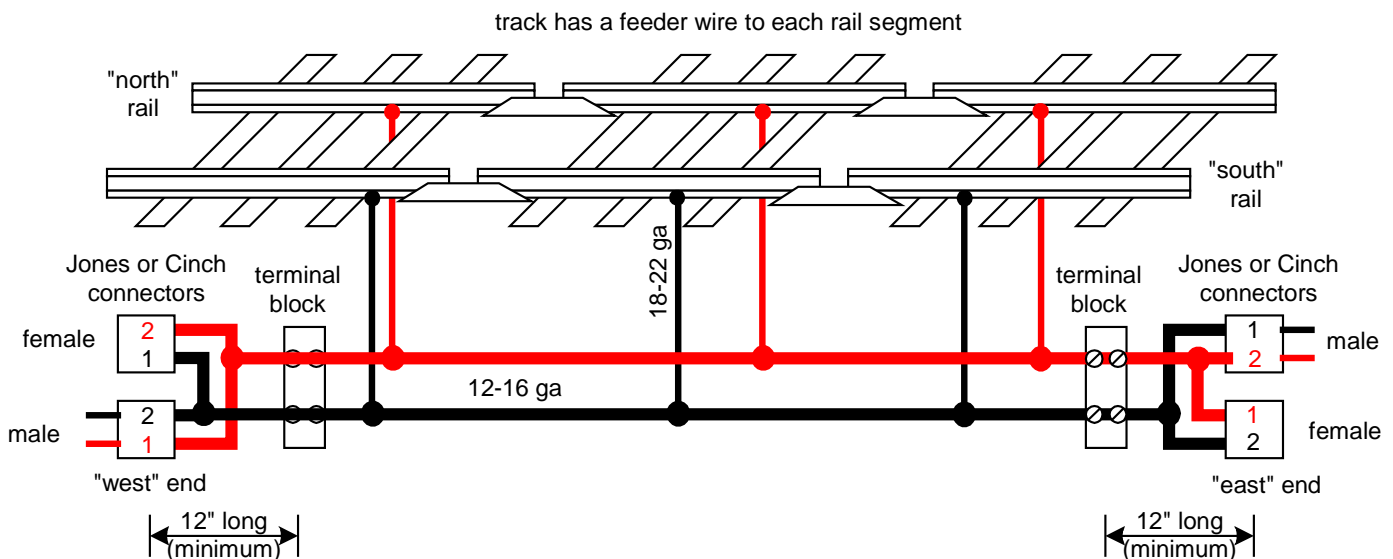
The track bus is a two wire track power daisy-chain bus that jumpers the mainline track power from one module to the next. It has two "jones" or "cinch" connectors at each end of each module. The two connectors are a male and female pair, cross-wired to allow a module to be rotated (reversed) and still maintain correct track polarity; these pairs are commonly called "pigtailed". These connectors are left disconnected where an electrical gap between blocks is desired (insulated rail joiners must also be used at one end of the 2" fitter rails to avoid shorting one block to the next).

These connectors are available at Radio Shack: 274-201A Male Jones Connector
274-202 Female Jones Connector

The "pigtailed" must be 12" long minimum and terminate within 6" of module endplates.

See the sketch below. Note the male and female connectors are wired differently at either end of the module. It is recommended to define "directions" for a module, i.e. North/East/South/West, to use as orientation keys during wiring. And a good way to verify the pigtailed are correct is: when facing the module endplate the male connector's pin 1 (the large blade) and the female connector's pin 2 (small receptacle) must both connect to the left-hand rail.

It is also recommended to install a continuous, 12-16 gauge (i.e. house wire) track bus wire pair between the two connector pigtailed, and connect these to each segment of track rail with 18-22 gauge feeder wires. This method allows the bus to carry high currents throughout the layout without voltage drop, and avoids relying on rail joiners to carry power from one rail segment to the next. It is good practice to install a terminal block at each end of the module; tie the internal track bus wires to one side and the connector pigtailed to the other side.



DIGITRAX DCC AND LOCONET BUS

NMRA compatible digital command control (DCC) is used for layout control providing maximum operational flexibility and realism with a minimum of inter-module wiring. The Digitrax system has been chosen due to its relatively low cost, rich feature set and simple, robust LocoNet system.

Both tethered and wireless walk around throttle operations are allowed. All NMRA-compatible DCC decoders are allowed.

For maximum flexibility in both operations and DCC system configuration, the Digitrax LocoNet is wired through all modules. The LocoNet is a 6-wire network that carries control commands among the various Digitrax DCC system components (command station, radio receivers, tethered throttles, remote boosters, etc.).

Each module must have a single 6-wire "RJ12" jack mounted on the underside, within 6" of each endplate, used to interconnect the LocoNet between modules forming a continuous network throughout the layout setup.

Note: To date, NorCalF has used both wall-mount style phone panels and female-female RJ12 couplers (straight-through wiring variety). Home Depot has Leviton brand single wall-mount panels, 832-C2675-W or 831-C2675-I; these require installing individual wires onto screw terminals. Fry's Electronics has female-female couplers; these allow fully modular LocoNet wiring (e.g. clip-plugs crimped on RJ12 cable).

Modules four feet or longer must have a single or dual 6-wire "RJ12" jack mounted on each side of the module for operators to plug in their walk around hand-held DCC throttles; DCC throttles use the RJ12 phone clip-plug style connector. Single jack panels are acceptable on modules with simple track arrangements (i.e. single main line with one spur). However it is strongly recommended to provide dual jack panels on modules with more complex track arrangements (i.e. passing sidings, yards, multi-track spurs) since more operators will be in those areas at any given time.

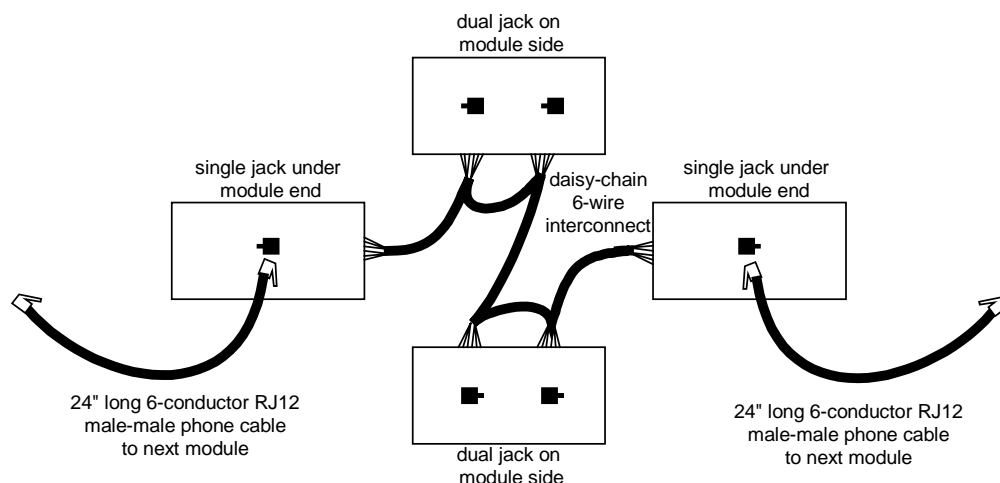
NOTE: To date, NorCalF has used both commercially available wall-mount style phone panels and DCC-specific throttle panels. Home Depot has Leviton brand dual panels, 832-C2676-W or 831-C2676-I; these require installing individual wires onto screw terminals. Digitrax and Tony's Train Exchange make DCC-specific throttle panels; these allow fully modular LocoNet wiring (e.g. clip-plugs crimped on RJ12 cable).

Wire all RJ12 jacks in a series "daisy-chain" fashion to minimize branches in the LocoNet network (see sketch below). Wire together each corresponding pin position of all the phone jacks (i.e. all pin 1's are connected, all pin 2's are connected, etc.).

Suggestions:

- Use color-coded wire matching the wire colors present in the RJ12 cable (white/green/yellow/black/red/blue is most common).
- Use minimum 26 gauge solid core wire for sturdy connection to phone jack screw terminals.
- Add strain relief to the wires near their connections to the phone jacks.
- Spend a bit more money and make everything modular for easier debug and repair.

Interconnection of modules is made with 24" lengths of "RJ12" 6-conductor jacketed phone cable with 6-position clip-plugs installed at both ends. Install the clip-plugs so all wires run "straight through", i.e. pin 1 to pin 1, pin 2 to pin 2, etc. These connect the underside mounted single jacks on adjacent modules.



ACCESSORY POWER BUS

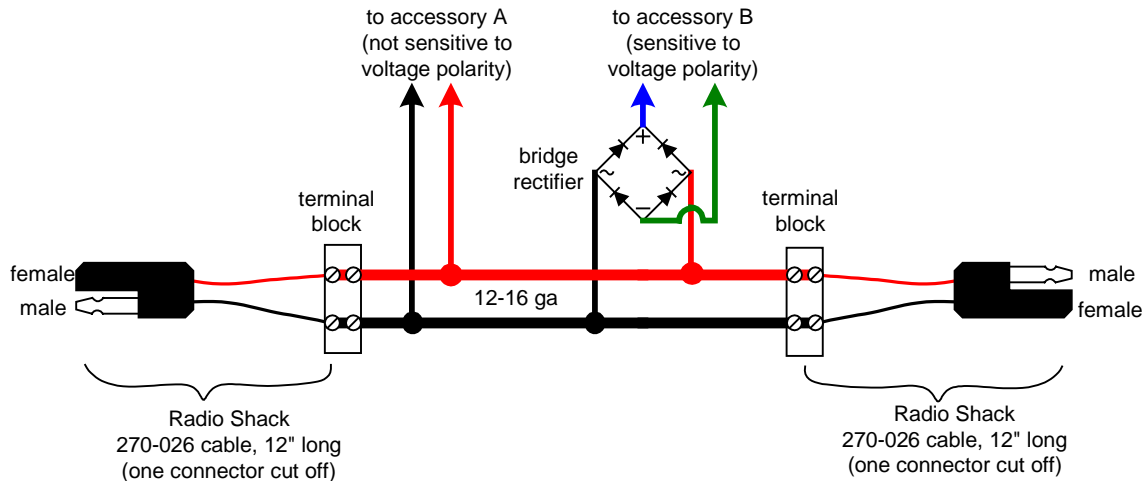
This two wire bus is used to power turnout motors that control track switches (i.e. Circuitron Tortoises), and it also may be used to power other accessories on modules such as structure lighting, signals, animation, and the like. It normally carries a DCC signal similar to that found on the Track Power bus (a separate booster is recommended to avoid robbing power from trains); however it may carry 16V AC as an alternate, lower cost implementation (but less flexible). Electrical accessories within modules can use the DCC power directly (e.g. to control and power stationary decoders), or rectify and regulate it to DC (e.g. to power lights or electronics). If 16V AC is on this bus it may be used directly or may be rectified and regulated to DC as well. One solution is to use a bridge rectifier like Radio Shack's 276-1146.

This bus must be installed in every module similar to the track power bus with a 12-16 gauge 2-wire bus running the length of each module, and connector pigtails on each end to connect to adjacent modules. However, the connector type and arrangement is different from the Track Power bus. Instead the Accessory bus uses "automotive DC accessory cable" connectors.

These connectors are available as pre-assembled cables from Radio Shack, part number 270-026 (2-conductor automotive DC accessory cable). This cable has two wires, one red and one black, with connectors at both ends, each of which has one male pin and one female pin.

The "pigtails" must be 12" long minimum and terminate within 6" of module endplates. Two cables must be used to obtain the 12" length for each pig-tail. One connector must be cut off each cable; the loose wires are then attached to the module's bus.

It is recommended to use terminal blocks at the module ends; connect the internal 2-wire bus on one side and the pigtail connector on the other side, just as is recommended for the Track Power bus (see above). The red wires on the two pigtails must be connected together, and the black wires must be connected together. There must not be a "cross wire" that shorts the red and black wires between the two pigtails on a module. This arrangement allows modules to be reversed without concern about shorting out the Accessory bus.



A typical pig-tail for Track and Accessory busses.

6.0 Scenery

SCENERY STYLE, MATERIALS, TECHNIQUES:

Scenery must depict realistic, commonly found rail-oriented scenes, with prototype locations preferred. Scenery must allow hand-cleaning of all tracks using a "track eraser" type cleaner. Materials and techniques are free.

Suggestion: use a generic "California" scenic theme so NorCalF layouts look more continuous and integrated.

MAINLINE BALLAST:

Ballast size must be "fine" – use Arizona Rock & Mineral 130-2 "Northern Pacific Medium Gray Granite HO Fine", or Woodland Scenics B1393 "Gray Blend Fine (shaker bottle)". Modules 12 feet or longer may use other ballast colors (to match a prototype locale, for example), but must transition to the standard ballast at module ends.

END PROFILE AND LANDSCAPE:

A flat horizontal scenery profile is used at module ends. Scenic "ground level" at module ends is nominal 3/8" below top of rails (see sketch in Section 3.0). Landscaping along the module ends must be designed to smoothly flow into adjacent modules - avoid features such as roads, lakes, and so forth from running against the module ends (see INTER-MODULE JOINT TREATMENT, below).

Suggestion: Using HO cork roadbed under mainline track to meet the 3/8" ground level guideline.

Note: scenic contours within a module between the flat end profiles are free (i.e. entire module does not have to be flat; in fact table-top flat modules are discouraged).

INTER-MODULE JOINT TREATMENT:

Polyfiber covered with fine ground foam (i.e. Woodland Scenics "turf" material) to simulate undergrowth "thickets" is temporarily placed over joints during a NorCalF setup, in random patterns, shapes, and colors. This technique hides the joints and transitions scenery from module to module. Polyfiber thickets must be placed clear of the track right-of-way.

BACKDROP:

No backdrop is allowed as modules are viewed from either side and are also meant to be reversible.

7.0 Public Displays

SKIRTING:

Both sides of all modules must have a skirt for use at public displays. Embossed vinyl sheeting, 54" size, brown color, flame treated with Antimony Oxide to meet NFPA 701 (Rev. 1989) and California Fire Marshall test. Each end of skirt extends 2" past the module endplate to ensure adequate coverage and no "gaps" at module joints. Bottom edge of skirt is even with bottom of leg vertical member (i.e. at the level of the T-nut) to prevent dragging on the floor regardless of the module height setting. Skirt attaches to underside edge of module's fascias with Velcro (the extra height of the 54" skirting material is folded inward at top of skirt to be hidden behind skirt face).

A tutorial on skirting is found on the internet at <http://www.imagestation.com/album/?id=4292221857>

Note: NorCalF has a large supply of this skirting material for general distribution to module owners.

CROWD CONTROL BARRIER SYSTEM:

Each module that is 5' or longer must provide two barrier stands for every 5' of length. Barrier stands consist of bases and uprights designed for simple construction and setup, and which may be separated for more efficient storage and transport. 1/4" yellow nylon style ropes (available at any hardware store) are threaded through the stands as a barrier.

Stand bases are 12" square made from 1.5" plywood (or equivalent multiple plywood layers). Painting is optional. A hole is centered in the base to accommodate a 1/2" white PVC pipe end cap, firmly wedged into the hole and used to receive the stand upright. Stand uprights press-fit into the base and are 36" tall 1/2" white PVC pipe with a PVC "T-junction" mounted on top, through which the nylon rope is threaded. Painting is not allowed – leave uprights white.

PLEXIGLAS SHIELDS:

Free, but should be easily removable for access to track for cleaning, uncoupling cars, etc.

8.0 Locomotives and Rolling Stock

WHEELS:

- Metal
- Clean
- Back-to-back spacing meets NMRA gauge
- Gauge meets NMRA gauge
- Flange contours are RP-25 or have equivalent flange depth
- Semi-scale (.088") wheel treads are allowed

ROLLING QUALITY:

- Cars roll freely down a 3% grade

TRUCKS:

- Pivot freely
- Slight lateral rock on at least one end (three-point mount)
- Able to negotiate a #5 turnout
- Able to negotiate a 30" radius curve
- Able to negotiate vertical rail curves as specified in Section 4.0 TRACK WORK standards

COUPLERS:

- Kadee #5 or #58; no substitute brands allowed as they all have one problem or another
- Match to center of Kadee coupler height gauge or NMRA Standards Gauge, plus or minus 1/32"
- Knuckle and centering springs work freely
- Free of flash
- Metal couplers are insulated from the rail
- Trip pins clear Kadee coupler height gauge or equivalent
- OPTIONAL: coupler trip pins may be cut off at the bottom of the coupler body

WEIGHT:

- Weighted to within +10%, -5% of NMRA specification (1 oz + ½ oz for each inch of car length:

car length (scale ft)	NMRA weight (oz)
30	3.1
35	3.4
40	3.8
45	4.1
50	4.4
55	4.8
60	5.1
65	5.5
70	5.8
75	6.2
80	6.5
85	6.9
90	7.2

ELECTRONICS:

- locomotives equipped with DCC decoders compatible with NMRA DCC compliant systems
- locomotives use 4-digit address—address is locomotive road number
- register decoder addresses (rolling stock and stationary) on the NorCalF Address List to avoid duplications

9.0 Setup Checklist

REQUIRED ITEMS:

In addition to the obvious items to bring to a Free-mo setup such as modules, legs, and rolling stock, the following items are required for each module:

- ❑ Minimum of two 2" fitter rails with joiners at both ends to join main line across module joints. Additional fitter rails are always welcome. Bring additional fitter rails and joiners to connect any additional tracks that cross module joints (i.e. yard extension modules). Atlas makes a joiner that fits both code 83 and code 100 rail; these seem to work well for fitter rails as they can be pushed easily onto the module's permanent rail ends with a small screwdriver.
- ❑ Minimum of one large C clamp to hold module ends together. Deep-throated clamps are best.
- ❑ Minimum of one 24" six conductor phone cable with RJ12 clip plugs on both ends, wired straight through, to connect the Digitrax DCC LocoNet across module joints.
- ❑ Minimum of one set of polyfiber/ground foam "thickets" to cover one inter-module joint on both sides of main line.

SUGGESTED ITEMS:

Other items suggested to bring, but not required:

- ❑ AC power extension cords and outlet expanders or strips to extend wall power throughout the layout.
- ❑ Digitrax DCC throttles - the more throttles available, the more people can run trains at once.
- ❑ Digitrax DCC boosters – for multiple power blocks or emergency backup should one fail.
- ❑ FRS 14-channel radios – handy for operations in noisy show environments.
- ❑ Tools including rail cutters, files, wood glue, levels, wrenches, screwdrivers, tape measures, pliers, wire cutters and strippers, multi-meter, soldering iron, track gauge, track cleaner, etc. These help resolve problems that may crop up, and to repair minor damage that may occur while transporting modules.
- ❑ Model tools including coupler height gauge, wheel gauge, small screwdrivers, ACC and styrene glues, tweezers, files, etc. These help repair or adjust rolling stock and track to keep things running smoothly.
- ❑ Folding chair or stool.

Revised 6/02: added double track standards, general update reflecting current construction methods.

Revised 12/00: added skirting and barrier requirements, general update, converted to PDF for web viewing/printing

Revised 8/29/00: added rolling stock section; clarified vertical curves, general update

Revised 8/7/00: updated sketches, tightened up spec of endplates, leg heights, track; added more suggestions for reliability

Revised 7/7/00: changed group name to Northern California Free-mo, minor text improvements

Revised 6/7/00: Added fascia labeling guidelines, revised Accessory bus to allow DCC, corrected fonts

Revised 11/10/99: improved sketches, minor text changes

Revised 5/2/99: added Accessory Power bus; updated DCC info; enlarged min radius to 42"; replaced Timescape paint with Great Desert

Revised 10/6/98: added DCC and setup guidelines

Revised 9/30/98: general update; added scenery guidelines; changed sketches to Visio

Revised 5/4/98: general update