

HO Module  
Standards  
&  
Recommended Practices

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Virginia Piedmont & Central  
HO Model Railroaders

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## Introduction

The Standards, Recommended Practices, and other information in this manual are based on years of experience, both from members of the VP&C and other sources<sup>1</sup>. Then too, they are still in a state of change as experience of the club members shows what works well and what does not.

From the NMRA standards<sup>2</sup>...

A module is a portable section of table type structure which is but one part of a large group of like tables which when all assembled together form a large and fully operating model railroad. They are built by individuals as part of a home layout or specifically for use interfacing with others in a large setup. All are built to a set of standards that allow each unit to interface exactly with other units anywhere in the overall system. A module may be a single table or a group of tables which must be capable of interface at each end but may deviate between these ends so long as the type of operation is not compromised or restricted. By being portable, they may be disassembled for transporting to conventions or public displays. Many clubs are formed for the specific purpose of building module layouts as space for a permanent layout is hard to find and is very expensive when available

Standards and Recommended Practices differ as follows:

- A Standard is a figure, relationship, or dimension that is mandatory, it is “cut in stone” so to speak and must be followed. A Standard may be changed but only by a vote of the Club after the membership has been informed.
- A Recommended Practice is a figure, relationship, or dimension that the Standards Committee has established. These are not required to be voted on except when included in this document. A Recommended Practice covers a less critical matter than a Requirement.

NMRA Standards and Recommended Practices differ from Free-mo<sup>\*</sup> as follows

- The way that one views a module:
  - The viewing of the NMRA module is relative to one, public-viewing side. Therefore, the terminology of *front*, *rear*, *left*, and *right* is used based on the public’s viewing side.
  - The viewing of the Free-mo module may be from either side. Therefore, the terminology of *left* and *right* is based on viewing the endplate (that part of the module that connects to other modules and usually not seen by the viewing public).
- Track requirement is different for the two standards. Free-mo uses lighter track and larger radii than NMRA.

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<sup>\*</sup> At the time of publication of this document there were no “official” Free-mo standards published by the NMRA. Thus, we differentiate between the two by designating them as the “NMRA” and the “Free-mo” standards<sup>3</sup> in this document.

Input to this publication is welcomed. We will be happy to discuss your ideas.

## **Record of Changes**

1. October 15, 2004, Revision 1.0

## **Possible Future Changes**

1. More graphics and diagrams- to show construction details and wiring.
2. A more eye-appealing document cover.

# 1. General Standards and Recommended Practices

## 1.1. Introduction

The two standards, NMRA and Free-mo, contained in this document are organized in the same manner so they may be compared more easily.

## 1.2. Frame and Legs

- 1.2.1. Basically, the module frames and legs are constructed the same in each standard. The frame of the module is usually 3/4" plywood cut 3-1/2" wide. Some module makers suggest 5-1/2" wide side frames for 8'-0" modules. The legs are 1-1/2" x 1-1/2" wood, ripped from standard 2 x 4's and cut to the appropriate length. The exact requirements are spelled out in the appropriate section.
- 1.2.2. Legs shall have continuous adjustment of plus or minus 1 inch. (Any type of screw device is acceptable as long as the floor will not be damaged, e.g. rubber tipped leg, 5" eye bolt, or carriage bolt).

## 1.3. Track

- 1.3.1. Either Flex or handlaid track is allowed.
- 1.3.2. Insulating material shall be used to fill rail gaps. No air gaps are allowed. Crossovers between mainlines and tracks leading from mainlines to other trackage on the module shall have both rails gapped (insulated). All tracks gapped for block control shall have both rails gapped (insulated).

## 1.4. Wiring

### 1.4.1. Summary of Wire Gauges

AC Power (120V)	14 ga
Power Bus <sup>4</sup>	18 ga solid minimum
Track Lead	24 ga solid minimum
LocoNet Power	18 ga stranded minimum
LocoNet	Flat 6-conductor telephone cable or 6-conductor communications cable (CAT3 minimum)

### 1.4.2. Required Wiring Practices

- 1.4.2.1. Install a 2-row terminal barrier block at each end of the module. The number of positions on the barrier block depends on the number of circuits used by the module or the number of circuits that the module is passing through.

1.4.2.2. Run any wiring through holes in intermediate cross-member rather than under the member to avoid damage to the wire in transportation.

1.4.2.3. Turnouts should not rely on the points to power the frog.

1.4.2.4. Module wiring consists of a minimum of 2 or 3 pairs of bus wires:

- 1 or 2 pair for track power (one pair per mainline track). Modules are connected by jumper wires with plugs which vary by the standard.
- 1 pair for accessory power (18V AC). Power is converted from this source as required by the accessory. Modules are connected with 2-conductor trailer plugs, each with a 12" lead.

and

- Surface mount RJ12 box on inside of endplate for 6-conductor LocoNet. Modules are connected with a 2-foot jumper wire with a RJ12 plug on each end.
- Surface mount phono jack on inside of endplate for LocoNet power. The center pin of the jack is connected to LocoNet power. Modules are connected with a 2-foot jumper wire (18 ga stranded minimum) with a phono plug on each end. The wire is connected to the center pin of the plug.
- Flush mount dual 6-conductor RJ12 faceplate mounted on the exposed side of the module. Which side(s) are used vary by the standard.

## **1.5. Control**

1.5.1. Control will be with DC or DCC (LocoNet compliant) for locomotives. Mainlines will be insulated from each other (double gapped) so DC and DCC controlled trains can be run on the layout at the same time.

1.5.2. There are no standards for the control of track and scenery accessories.

## **1.6. Scenery**

1.6.1. All bench work shall be hidden by some form of scenery.

## **1.7. Recommended Practices**

1.7.1. Frame and Legs

1.7.1.1. Avoid dimensional lumber for your frame work. It has a tendency to warp and “cup”, with age, throwing off track alignment, at least. Plywood, particularly birch, works well as frame work. It has also

been found that plywood warps and twists less than dimension lumber (3/4 inch pine board). Pine lumber has a tendency to bend, warp and twist. Plywood tends to stay straighter over time. The use of Plywood over dimensional lumber will help keep you module flat, straight and true.

1.7.2. Wiring

1.7.2.1. Wire gauges are recommended to be larger than the requirements:

Power Bus	10 ga solid
Track Lead	20 ga solid

1.7.2.2. Recommended Wiring Practices

1.7.2.2.1. Track power bus wires should generally run parallel to each other. Slightly twisting the wires together will virtually eliminate radio interference. Avoid non-parallel wiring when running wire through and around obstacles. (Page 38 of the DCC Guide)

1.7.2.2.2. Connect the bus wires to the terminal blocks with ring connectors.

1.7.2.2.3. Connect the cinch/trailer connector leads to the terminal block with spade connectors.

1.7.2.2.4. Track and/or accessory leads should be run from the bus wires.

1.7.2.3. Typical track leads or other track related wiring (DC or DCC) usually use these combinations of colors. As a good practice, all color codes should be marked on the underside of the module. Some commonly used pairs of colors are shown in the table below:

Wire Type	Rail A (or +)	Rail B (or -)
Single	white	brown
Single	white	black
Single	yellow	green
Single	red	black
zip cord (pair)	ribbed	smooth
speaker wire (pair)	color coded	plain

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## 2. NMRA Specific Standards and Recommended Practices

### 2.1. Introduction

2.1.1. The reader is referred to the NMRA Standards MS-1 for the NMRA details.

### 2.2. Frame and Legs

#### 2.2.1. Module Sizes

Length:	multiples of 2'-0" Minimum: 2'-0" Maximum: 8'-0"
Width:	multiples of 6" Minimum: 24" Maximum: 36"

#### 2.2.2. Reference Points

Front of Module	edge of module closest to the viewing public
Rear of Module	edge of module furthest from the viewing public ("pit" side)
Left End of Module	end of module to the left of the viewing public
Right End of Module	end of module to the right of the viewing public

## 2.3. Track

### 2.3.1. Summary Table

Mainline Rail Code	100
Track Clearances	
Horizontal	1-1/32"
Vertical	3"
Track Centers	
Straight	2"
Curves	2-1/2"
Track Curves	
Minimum Mainline	32"
Minimum Industrial	24"
Track setback from end of Module	4-1/2"
Minimum Parallel Tangent Track Length	3"
Mainline track centerlines from module front	
Red line	5"
Yellow Line	7"
Maximum Mainline Grade	3%
Minimum Mainline Turnout	#6

### 2.3.2. Track Color Coded Names

#### Mainline

Red Line

Yellow Line

Green Line (Mountain Division): No standards are in this document. However, a recommended elevation is 5-13/16" above zero elevation<sup>5</sup>. A 5" centerline distance from the rear of the module is recommended.

#### Industrial

Blue Line

## 2.4. Wiring

### 2.4.1. Summary of Pin Connector Colors

2.4.1.1. Sockets (female cinch connector or auto end of trailer connector) will be at left end of module. The wire length for the lead is 6", 16 gauge stranded.

2.4.1.2. Plugs (male cinch connector or trailer end of trailer connector) will be at right end of module. The wire length for the lead is 18", 16 gauge stranded.

<b>Line</b>	<b>Connector</b>
Front Main Line	Red
Second Main Line	Yellow
AC Supply (18V)	Brown

#### 2.4.2. Pin Connections

2.4.2.1. The front rail is the "A" rail. Connect it to the wide blade of the Cinch connector (pin 1).

2.4.2.2. The rear rail is the "B" rail. Connect it to the narrow blade of the Cinch connector (pin 2).

2.4.2.3. For 4-conductor trailer plugs (to be used by all VP&C modules), connect them in the order of the rails:

Red Line	A Rail	Index Plug, White Lead
Red Line	B Rail	Brown Lead
Yellow Line	A Rail	Yellow Lead
Yellow Line	B Rail	Green Lead

2.4.3. Flush mount dual 6-conductor RJ12 faceplate mounted on the front side of the module, for throttles.

### 2.5. Control

See Section 1.5.

### 2.6. Scenery

See Section 1.6.

## 2.7. Recommended Practices

### 2.7.1. Cinch Connector Color Coding

<b>Line</b>	<b>Connector</b>
Mountain Division	Green
DC Supply (12V)	White
DCC (Sidings, Industrial Yards)	Blue
DCC (Other)	Violet
DCC (Other)	Orange
DCC (Other)	Gray

### **3. Free-mo Specific Standards and Recommended Practices**

#### **3.1. Introduction**

- 3.1.1. A Free-mo module is a free form module that conforms to the Free-mo Standards as outlined below. A Free-mo module can be any length and the endplates can be at any angle to each other. A Free-mo module can be one section or a set of two or more sections that form a module. The Free-mo standards govern the ends of the module and basic track requirements. Most Free-mo modules have two ends, but modules can have one, two, three or more ends. (If you build a loop module it will only have one end, a wye module will have three ends.
- 3.1.2. Unlike NMRA modules, Free-mo modules may be reversed in a layout.
- 3.1.3. Free-mo modules fall into three basic categories:
  - 3.1.3.1. Mainline – Mainline modules represent Mainline right of ways. Mainline modules are designed with large radius curves and minimal grades.
  - 3.1.3.2. Branchline – Branchline modules represent Branchline right of ways. Branchline modules can have smaller radius curves and steeper grades than a mainline module.
  - 3.1.3.3. Mini-mo – Mini-mo's have endplates that are narrower than the standard width endplates. With this in mind a Mini-mo can be Mainline or Branchline module, single track or double track.

#### **3.2. Frame and Legs**

- 3.2.1. General Frame and Legs
  - 3.2.1.1. Endplates shall be ¾" plywood or equivalent to provide sufficient strength for C-clamping to adjacent modules.
  - 3.2.1.2. Single track endplates shall be 24 inches wide by 6 inches tall (not including the module top).
  - 3.2.1.3. Double track endplates shall be 26 inches wide by 6 inches tall (not including the module top).
  - 3.2.1.4. Roadbed shall be ¼ inch cork or equivalent on ½ inch plywood or equivalent. Foam is acceptable if braced to prevent sagging or flexing.

- 3.2.1.5. The module (set) shall have at least four legs and stand on its own.
- 3.2.1.6. Nominal and Minimum height of railhead from floor is 50 inches. 40 inches is allowed only if the Free-mo module connects with modules that follow a 40" height standard.
- 3.2.1.7. On modules with grades, the elevation of the high end shall be some multiple of  $\frac{3}{4}$  inch above low end.
- 3.2.1.8. Maximum height of railhead from the floor is 12 inches above minimum railhead height. (See Section 3.2.1.6.)
- 3.2.1.9. Modules may be used with spectators on either or both sides. The module HAS to be viewable from both sides and look "realistic" from both sides. Back drops are not allowed on Free-mo modules. This precludes the use of sky-boards on a Free-mo module. (Since sky-boards are usually placed on a non-viewing side, by being visible from both sides, a Free-mo module shouldn't have a sky-board.) A module may have a center board to divide the module into two scenes.

### 3.2.2. Mainline Modules

There are no special Frame and Legs Standards for Mainline Modules.

### 3.2.3. Branchline Modules

There are no special Frame and Legs Standards for Branchline Modules.

### 3.2.4. Mini-mo Modules

- 3.2.4.1. Mini-mo endplates are recommended to be 12 inches wide; however, they can be as small as 8 inches provided there is minimum 4 inch spacing from the track center line to the edge of the module. (A single track Mini-mo can be 8 inches wide but, a double track Mini-mo can not be less than 10 inches wide.)
- 3.2.4.2. Mini-mo's may have legs for adjustment but do not need to stand on their own. (A Mini-mo might have one leg at each end).

### 3.3. Track

#### 3.3.1. Summary Table

Mainline Rail Code	83
Branchline Rail Code	83 or 70
Track Clearances	
Horizontal	1-1/32"
Vertical	3"
Track Centers	
Straight	2"
Curves	2-1/2"
Track Curves	
Minimum Mainline	42"
Minimum Branchline	36"
Rail setback from end of Module	1"
Straight and level from end of module	6"
Minimum Parallel Tangent Track Length (Reverse Curves)	12"
Track centerlines from module end plate centers	
Double track	-2" & +2"
Single track	0"
Maximum Mainline Grade	2%
Maximum Branchline Grade	4%
Minimum Mainline Turnout	#6

#### 3.3.2. General Track

- 3.3.2.1. Track must be perpendicular to the endplate for 6 inches from each end of the module.
- 3.3.2.2. Track must be straight and level for 6 inches from each end of the module (does not apply for sections of a module).
- 3.3.2.3. The centerline of all tracks shall be 4 inches or more from the edge of the module at all times. (This is for two reasons. 1) to protect models, if something was to happen and a train derails, we do not want cars or engines to fall to the ground. It will be bad enough to have them on their sides. 2) For scenic looks. It looks better if there is scenery between the track and the edge of the module.)
- 3.3.2.4. There shall be a minimum of 12 inches of straight track between reverse curves.
- 3.3.2.5. Turnouts shall be at least #6.

- 3.3.2.6. On a single track module, the track shall be centered on the 24-inch endplate.
- 3.3.2.7. On double track modules, the two track centerlines shall be spaced 2 inches apart and centered on the 26-inch end.
- 3.3.2.8. Rail (not ties) shall be cut off 1 inch away from module end.

### 3.3.3. Mainline Modules

- 3.3.3.1. Track on the through route shall be code-83 nickel-silver rail.
- 3.3.3.2. Sidings, spurs and other track may be less than code 83 but shall be no less than code 40.
- 3.3.3.3. Mainline maximum grade is 2.0%.
- 3.3.3.4. Vertical curves shall be appropriate for mainline operation of contemporary long cars, see NMRA Standards S-7 Clearances, the NMRA Gage, and NMRA Recommended Practices RP-11 Curvature and Rolling Stock.
- 3.3.3.5. Minimum radius is 42 inches; a 48 inch radius is preferred.
- 3.3.3.6. Spacing between track on curves shall allow long cars to operate without fouling each other, observe NMRA Standards S-8 Track Centers for "Class 1a" equipment.

### 3.3.4. Branchline Modules

- 3.3.4.1. Track on the through route may be less than code 83 but shall be no less than code 70. The module owner shall supply transition solution to code 83 rail at the Free-mo compliant ends if needed.
- 3.3.4.2. Siding, spurs and other track may be less than code 70 but shall be no less than code 40.
- 3.3.4.3. Branchline maximum grade is 4%.
- 3.3.4.4. Vertical curves shall be appropriate for Branchline operation of contemporary long cars.
- 3.3.4.5. The minimum curve radius on the through route may be less than 42 inches but shall be no less than 36 inches.

3.3.4.6. Spacing between tracks on curves shall allow for long cars to operate without fouling each other.

3.3.5. Mini-mo Modules

3.3.5.1. Mini-mo's shall be built to either Mainline or Branchline specifications.

**3.4. Wiring**

3.4.1. Double Track Module (looking at the end plate of the module):

<b>Track</b>		<b>Cinch Blades</b>		
Left Track	Left Rail	Female	2	Narrow
Left Track	Right Rail	Female	1	Wide
Right Track	Left Rail	Male	1	Wide
Right Track	Right Rail	Male	2	Narrow

3.4.2. Single track Module (looking at the end plate of the module):

3.4.2.1. In contrast to other published Free-mo standards, the wiring of the rails of the two main lines shall not be connected. There shall be a cinch plug arrangement the same as the double track module and the wiring shall be straight through.

3.4.2.2. On the underside of the module there shall be a switch arrangement where the single track power can be selected from only one of the two tracks. It shall be wired in a fail safe manner (i.e., to preclude human error). The same track selection shall follow for adjacent single track modules (here, human error in the one-track-to-chose selection process may, but should not, occur).

3.4.2.3. Each track shall be marked with a milepost, near the endplate, painted to correspond to the color of the NMRA wired track (red or yellow) to identify the electrical connection.

3.4.3. Flush mount dual 6-conductor RJ12 faceplate mounted on each exposed side of the module, for throttles.

**3.5. Control**

See Section 1.5.

### **3.6. Scenery**

- 3.6.1. General module fascia color shall complement scenery and not draw attention from the scene (black fascia is not recommended, although black legs are recommended).
- 3.6.2. Mainline shall be ballasted Woodland Scenics Fine Light Gray or equivalent.
- 3.6.3. Standard Mainline rail color is Floquil/Polly-S Roof Brown or equivalent.
- 3.6.4. Scenery at the Free-mo Standard end(s) shall have a flat profile roughly 3/8" below the top of the mainline rail.

### **3.7. Recommended Practices**

- 3.7.1. Mini-mo type modules are intended to be a Free-mo subset and not to replace or exclude an equivalent length standard module. Full width modules are generally more stable and should be used wherever possible.

## Glossary

**Vertical Curve**

Superelevation.

**Zero Elevation**

The distance measured from the top of the mainline rail (rail head) to the floor. The distance is usually measured at the end of the module before any grade.

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## Parts Sources

Possible sources for parts are:

- www.digikey.com
- www.mouser.com
- www.radioshack.com

Some Radio Shack parts:

Wire Gauge	Spade-Tongue	Ring-Tongue	Color
16	64-3127	64-3117	Blue
18	64-3124	64-3114	Red

Cinch Connectors

Male Plug	P-302-CCT
Female Socket	S-302-CCT

Terminal Blocks

Terminal blocks are specified by the number of positions that correspond to the number of possible wires. Therefore, a 12-position block has 12 pair of terminal screws (12 wires in and 12 wires out).

Color Coding Electrical Tape (available in 9 fade resistant colors, 5 year shelf life)

Color (Alphabetical)	Scotch™ 35 Vinyl Electrical Color Coding Tape
Blue	054007-10836
Brown	054007-10885
Gray	054007-00072
Green	054007-10851
Orange	054007-10869
Red	054007-10810
Violet	054007-11271
White	054007-10828
Yellow	054007-10844

and there is also...

Black	054007-06143
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## References

1. The NTRAK Module 'How-to' Book, NTRAK Modular Railroading Society, Inc.
2. NMRA INFOPAK, Volume I, A Digital Reference Source for Model Railroaders, National Model Railroad Association, Inc., 2000.
3. Free-mo standards that are available are at [www.Free-mo.org](http://www.Free-mo.org).
4. Ames, Stan; Friberg, Rutger; Loizeaux, Ed; Digital Command Control – the comprehensive guide to DCC; Allt om Hobby AB; 1998.
5. FitzGerald, J.; personal correspondence: *The Sun N Sand club in Phoenix originated the Mountain Division track in the early days of NTRAK. At that time it was expected that the US would join the rest of the world and convert to the Metric System. The height of 80 mm was chosen and that converts into 3.1496". 3-1/8" is the closest 1/16" to that. Just another example of "Seat of the Pants" design!*

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