Concept Description of the S-MOD Modular Layout Electrical System

NOTE: This description should be read in conjunction with the S-MOD Electrical Standards.

I.. The S-MOD ELECTRICAL SYSTEM is a two level system that allows easy upgrading from the relatively simple "WIRE-TO-RAIL" subsystem to the sophisticated cab/block control system (the "RAIL-CAB" subsystem). Every piece of equipment used in the WIRE-TO-RAIL subsystem can be used in the RAIL-CAB subsystem so no money or effort will be wasted. The general design concept is to make it possible for the electrically unsophisticated modeler to build a module with simple wiring harnesses and leave the sophisticated control of the layout to the layout coordinator. PLEASE REFER to the S-MOD ELECTRICAL STANDARDS for the minimum electrical requirements.

Both subsystems allow for reversibility of modules. The ability to reverse a module by turning it 180 degrees maximizes layout design when operation-oriented layouts are constructed. As shown in Figure 1, both corner and straight modules (even straight modules with skyboards) can be placed in branch lines in a reversed configuration. Corner modules with skyboards would not be used in a reversed condition. The construction of skyboards on S-MOD modules is entirely up to the owner.

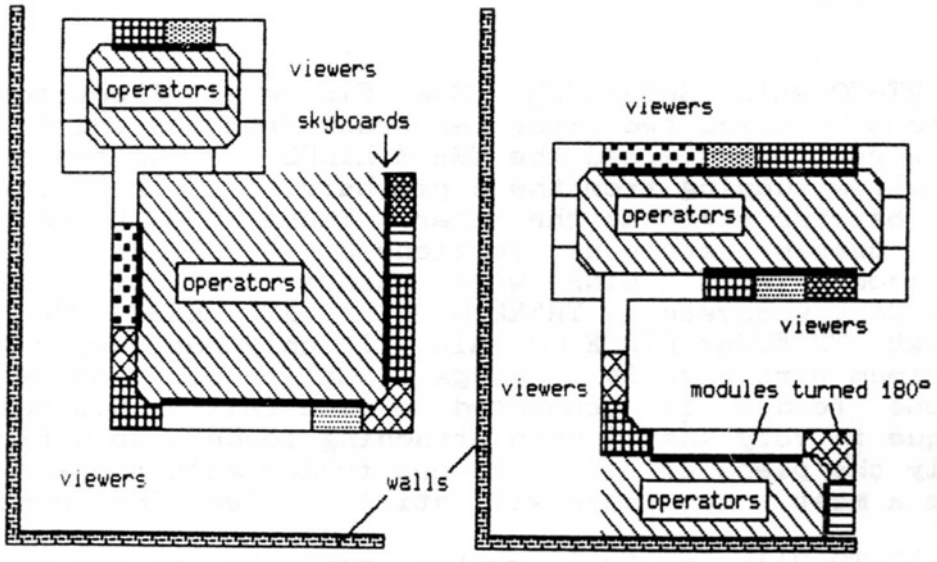


Figure 1.

In addition, both subsystems are built using one electrical feed per rail (with a suggestion of 2 wires sent to each piece of rail to ensure continued operability if one gets broken). In other words, COMMON-RAIL WIRING IS NOT USED so that reversibility of modules can be attained when needed and so that the greatest variety of control systems can be used to operate the trains.

All track-related wiring-connections between modules at the points where they interface .with.another module are done via 2-pin plugs and sockets such as Cinch P302-CCT & S 302-CCT or Radio Shack 274-201 & 274-202 . (See Figures E1-E3, Electrical Standards) Note that within EACH INTERFACE CONNECTOR there is a LARGE and SMALL PIN or SOCKET . LARGE PINS OR SOCKETS ALWAYS ARE CLOSEST TO THE OUTSIDE OF THE MODULE. SMALL PINS OR SOCKETS ARE ALWAYS CLOSEST TO THE CENTER LINE OF THE 8-POSITION BARRIER STRIP. ALL TRACK RELATED WIRING SHALL BE CONSTRUCTED USING A MINIMUM 16 GAUGE WIRE. All wires from these Interface Connectors should be about 10 inches long and are attached to an 8-position dual row safety barrier strip (such as RS 274-670). THESE RULES APPLY TO BOTH SUBSYSTEMS. Although a beginner may not wish to use all 8 positions, the cost is only 20 cents more for an 8 position barrier strip over the cost of a 4 position barrier strip, and the other positions may be used at a later time. The barrier strip should be attached to the bottom of the module

at least 6 inches from the Interface Board. (See Physical Standards for Interface Construction techniques.) It is also recommended that wires be attached to the barrier strip using soldered spade lugs.

For those who wish to build multi-section modules, it is recommended that you use plugs and sockets with the greatest number of pins that you can find to fill your needs to make your electrical connections between sections. Only the connectors at the ends of the multi- section module where it will interface with other modules need adhere to the 2-pin connector standard. Any of the 300-series CCT or AB connectors by Cinch are rated at 10 amps per contact and they are available in a myriad of configurations from 2 pins to 36. In addition, Radio Shack sells the 4 pin version (RS 274-204 & 274-205). You should not use connectors with smaller current-carrying capacity.

II. The WIRE-TO-RAIL SUBSYSTEM (See Figure El, Electrical Standards) consists of running two wires per track from one end to the other. These wires are called the TRACK LINES. A two track module would have 4 wires running from the 8 pin barrier strip on one end to the 8 pin barrier strip at the other. These TRACK LINES are connected to the barrier strip at positions 3-6. Feeds to each rail come from each TRACK LINE wire, hence the descriptive name of WIRE-TO-RAIL subsystem. THERE MUST BE AT LEAST ONE FEEDER WIRE CONNECTED TO EVERY PIECE OF RAIL. If only one feeder wire is used, the minimum wire size is 20 gauge. Smaller wire can be used if more than one feeder is connected to each rail. This multiple feeder technique is very useful when attaching feeders to a block made up of only one piece of rail. If one feeder gets broken in transit to or from a meet, then there will still be electrical continuity.

The WIRE-TO-RAIL control system consists of one throttle with an S-MOD interface per mainline track. The type of throttle.is .entirely up to the owner. The "Handheld Throttle" article by Don DeWitt[1] describes the construction of a sturdy, inexpensive and easy-to-repair throttle that has been found to be very effective in modular layouts where a variety of operators are involved. It does not have momentum, as beginner operators have difficulty in dealing with coasting trains.

The S-MOD Throttle Interface (shown in Figure E2, Electrical Standards) consists of a pair of 2-pin connectors and can be plugged into the TRACK lines between any two modules. Note that this type of interface allows the control point to be placed anywhere in the layout. In addition, the second throttle can be placed somewhere else in the layout between two other modules. Finally, when you bring your module to a convention, your module can be more easily utilized in the layout if it IS NOT a module with permanently attached throttles. Your throttles with their S-MOD interfaces could be positioned between other modules at the most useful place in terms of operation of the layout. Note also that these S-MOD Throttle Interfaces will not need to be changed if and when the throttle is used in the RAIL-CAB subsystem (See Figure E3, Electrical Standards). In addition to the flexibilty inherent in the S-MOD Throttle Interface, there is a significant reduction in the cost, and in the electrical construction difficulties associated with each module as it is built. This savings originates from the fact that no SPECIAL Throttle Interface is required with each module. The Interface Connectors have a dual role in that they are used to electrically connect adjacent modules but also can act as a place to interface a throttle.

In summary, the WIRE-TO-RAIL subsystem allows for two-track operation using different throttles permanently (at least for that day) assigned to each mainline. Many people and clubs will be very happy with this type of system. It is especially good for shows where trains are continuously run in a display manner. In addition, owners of WIRE-TO-RAIL modules will be able to bring their modules

[1] See listing of available S-Mod resouces.

to conventions and connect into a layout that is using the advanced RAIL-CAB subsystem. This connection can be accomplished in several possible manners:

1) The WIRE-TO-RAIL module can be placed in a section of the layout that would not have cab control, or at the end of a branch beyond where the cab selector panel accepts cab power and sends it to the tracks.

2) The owner of the WIRE-TO-RAIL module can bring TWO 2-wire bypass harnesses (16 gauge) that have a 2-pin plug and socket (Standard Interface Connectors) on opposite ends. The configuration of these connectors should be consistent with S-MOD Interface Connectors. One harness would be used to connect CAB LINES 1 & 2 (RED CAB) (See Figure E3, Electrical Standards) of adjacent modules on either side of the bypassed module. The second harness would connect CAB LINES 7 & 8 (YELLOW CAB) of adjacent modules on either side of the bypassed module.

3) The owner of the WIRE-TO-RAIL module could upgrade his or her module by running FOUR 16 gauge CAB LINES from end to end, add the appropriate 2-pin Interface Connectors to the barrier strip, and thus make the module a RAIL-CAB module.

III. The RAIL-CAB SUBSYSTEM

A. TWO-TRACK MAINLINE MODULES (See Figure E3, Electrical Standards)

1) One of the major differences between the WIRE-TO-RAIL and the RAIL-CAB subsystems is the addition of FOUR extra wires (CAB LINES) under each module which allows the throttle outputs to be carried throughout the layout across block boundaries.

   BLOCKS: A block can be defined as a region of track that is electrically isolated from adjacent areas of track and is capable of being used to operate a train independent of traffic in adjacent blocks . In the RAIL-CAB subsystem, a mainline block has the capability of being connected to any one of the following throttles: MAINLINE RED CAB, MAINLINE YELLOW CAB, LOCAL BLUE CAB, LOCAL WHITE CAB, OR LOCAL GREEN CAB. All blocks are minimimally required to be able to be connected to at least one local cab in addition to both of the mainline cabs. The second and third local cabs are optional. To move from one block to an adjacent one, both blocks are connected to the same MAINLINE CAB. If a layout is large, then several blocks are constructed to allow local switching as through trains move on to other blocks. Thus in a large layout, all blocks have access to the RED and YELLOW MAINLINE CABS and each block may also be connected to at least one, and optionally to a selection of, LOCAL CABS.

   Note that in the WIRE-TO-RAIL subsystem, each block requires its own MAINLINE throttle and the throttle of an adjacent block must be set to the same settings in order for smooth movement of a train from one block to the next. This is not a very enjoyable way to operate and thus these layouts generally are made up of just two blocks... one in each mainline track.

   DIVISONS: IN A VERY LARGE LAYOUT such as those at conventions, the layout can be further divided into DIVISIONS, where each division has its own RED AND

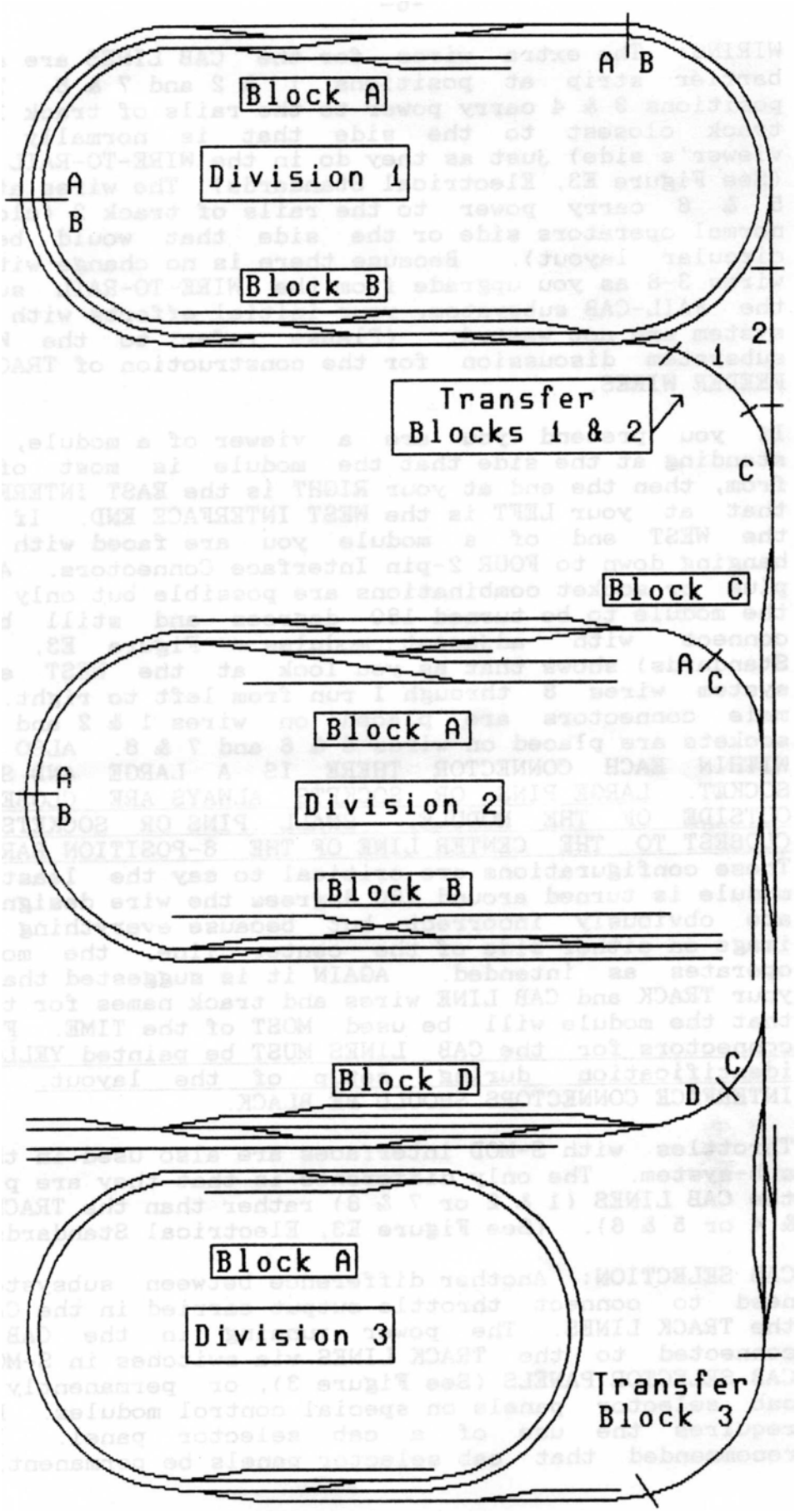

A
B
Block A
Division 1
A
B
Block B
2
1
Transfer
Blocks 1 & 2
C
Block C
A
C
Block A
Division 2
A
B
Block B
C
Block D
D
Block A
Division 3
Transfer
Block 3

Figure 2.

YELLOW MAINLINE CABS and associated LOCAL CABS. Each division can then be divided into as many blocks as deemed necessary. In the multi-division layout, special transfer blocks are used to move trains from one Division to the next. For instance, a Division One operator moves his train into the transfer block and stops it. He then switches the block over to control by the Divison 2 operator. The second operator then moves the train into the Division Two area. (See Figure 2 for a diagram of a layout that includes three divisions!!) The multi-division layout is very useful in S gauge as hi-rail modules that can operate American Flyer as well as scale trains can then be placed in a hi-rail division. Thus Flyer can be operated in this division and scale trains can operate everywhere. The multi-divsion approach maximizes the number of operators who can be involved with the layout.

2) WIRING: The extra wires for the CAB LINES are added to the barrier strip at positions 1 & 2 and 7 & 8. The wires at positions 3 & 4 carry power to the rails of track 1 (i.e., the track closest to the side that is normally used as the viewer's side) just as they do in the WIRE-TO-RAIL subsystem. (See Figure E3, Electrical Standards.) The wires at positions 5 & 6 carry power to the rails of track 2 (closest to the normal operator's side or the side that would be inside a circular layout). Because there is no change with regard to wires 3-6 as you upgrade from the WIRE-TO-RAIL subsystem to the RAIL-CAB subsystem, your initial efforts with the simpler system are not wasted. (Please refer to the WIRE-TO-RAIL subsystem discussion for the construction of TRACK LINES and FEEDER WIRES.

   If you pretend you are a viewer of a module, and you are standing at the side that the module is most often viewed from, then the end at your RIGHT is the EAST INTERFACE END and that at your LEFT is the WEST INTERFACE END. If you examine the WEST end of a module you are faced with EIGHT wires hanging down to FOUR 2-pin Interface Connectors. A myriad of plug or socket combinations are possible but only a few allow the module to be turned 180 degrees and still be able to connect with adjacent modules. Figure E3 (Electrical Standards) shows that as you look at the WEST end, module system wires 8 through 1 run from left to right. Note that male connectors are placed on wires 1 & 2 and 3 & 4 while sockets are placed on wires 5 & 6 and 7 & 8. ALSO NOTE THAT WITHIN EACH CONNECTOR THERE IS A LARGE AND SMALL PIN OR SOCKET. <u>LARGE PINS OR SOCKETS ALWAYS ARE CLOSEST TO THE OUTSIDE OF THE MODULE. SMALL PINS OR SOCKETS ARE ALWAYS CLOSEST TO THE CENTER LINE OF THE 8-POSITION BARRIER STRIP.</u> These configurations are critical to say the least!!! If a module is turned around 180 degrees the wire designations #l-8 are obviously incorrect but because everything is a mirror image on either side of the center line, the module still operates as intended. AGAIN it is suggested that you label your TRACK and CAB LINE wires and track names for the position that the module will be used MOST of the TIME. <u>Finally, all connectors for the CAB LINES MUST be painted YELLOW for easy identification during setup of the layout.</u> TRACK LINE INTERFACE CONNECTORS SHOULD BE BLACK.

   Throttles with S-MOD interfaces are also used in the RAIL-CAB sub-system. The only difference is that they are plugged into the CAB LINES (1 & 2 or 7 & 8) rather than the TRACK LINES (3 & 4 or 5 & 6). (See Figure E3, Electrical Standards.)

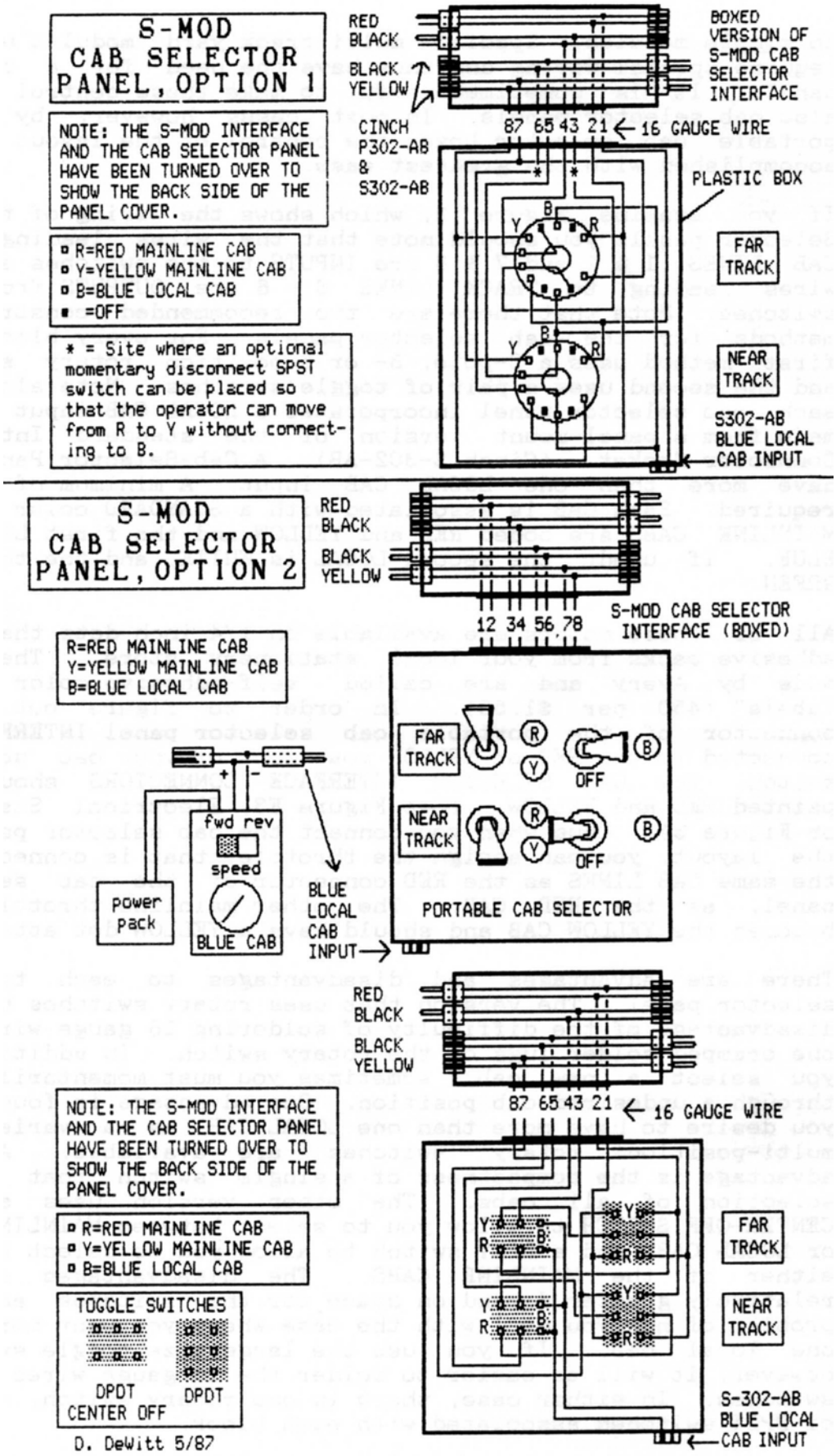

S-MOD
CAB SELECTOR
PANEL, OPTION 1
NOTE: THE S-MOD INTERFACE AND THE CAB SELECTOR PANEL HAVE BEEN TURNED OVER TO SHOW THE BACK SIDE OF THE PANEL COVER.
R=RED MAINLINE CAB
Y=YELLOW MAINLINE CAB
B=BLUE LOCAL CAB
=OFF
* = Site where an optional momentary disconnect SPST switch can be placed so that the operator can move from R to Y without connecting to B.
RED
BLACK
BLACK
YELLOW
CINCH
P302-AB
&
S302-AB
BOXED VERSION OF S-MOD CAB SELECTOR INTERFACE
87 65 43 21
16 GAUGE WIRE
PLASTIC BOX
FAR TRACK
NEAR TRACK
S302-AB
BLUE LOCAL
CAB INPUT
S-MOD
CAB SELECTOR
PANEL, OPTION 2
RED
BLACK
BLACK
YELLOW
12 34 56 78
S-MOD CAB SELECTOR INTERFACE (BOXED)
R=RED MAINLINE CAB
Y=YELLOW MAINLINE CAB
B=BLUE LOCAL CAB
FAR TRACK
NEAR TRACK
OFF
OFF
PORTABLE CAB SELECTOR
power pack
fwd rev
speed
BLUE CAB
BLUE LOCAL CAB INPUT
RED
BLACK
BLACK
YELLOW
87 65 43 21
16 GAUGE WIRE
NOTE: THE S-MOD INTERFACE AND THE CAB SELECTOR PANEL HAVE BEEN TURNED OVER TO SHOW THE BACK SIDE OF THE PANEL COVER.
R=RED MAINLINE CAB
Y=YELLOW MAINLINE CAB
B=BLUE LOCAL CAB
TOGGLE SWITCHES
DPDT
CENTER OFF
DPDT
FAR TRACK
NEAR TRACK
S-302-AB
BLUE LOCAL
CAB INPUT
D. DeWitt 5/87

Figure 3.

3) CAB SELECTION: Another difference between subsystems is the need to connect throttle output carried in the CAB LINES to the TRACK LINES. The power running in the CAB LINES is connected to the TRACK LINES via switches in S-MOD PORTABLE CAB SELECTOR PANELS (See Figure 3), or permanently installed cab selector panels on special control modules. EVERY BLOCK requires the use of a cab selector panel. It is not recommended that cab selector panels be permanently attached to simple modules. Special multi-track yard modules usually require special wiring and thus have the need for a control panel. It is sometimes useful to make these control panels also cab selector panels. In most cases ,however, by using portable cab selector boxes the control of the layout can be accomplished with the greatest ease.

   If you examine Figure 3, which shows the wiring of the Cab Selector panels, you should note that the wires leading from CAB LINES 1 & 2 and 7 & 8 are INPUTS to the switches, and the wires leading to TRACK LINES 3-6 are OUTPUTS from the switches. Note that there are two recommended construction methods for the cab selector panels. For every block, the first method uses a 2-pole, 5- or 6-position rotary switch, and the second uses a pair of toggle switches. Note also that each cab selector panel incorporates a LOCAL CAB input socket made from a panel-mount version of the standard Interface Connector Socket (Cinch S-302-AB). A Cab-Selector Panel may have more than one LOCAL CAB input. A minimum of one is required. Each CAB is associated with a STANDARD color code. MAINLINE CABS are coded RED and YELLOW and the first LOCAL is BLUE. If used, the second LOCAL is WHITE, and the third is GREEN.

   All of these colors are available on 1/4 inch dots that have adhesive backs from your local stationery store. They are made by Avery and are called "self-adhesive color coding labels" (450 per $1.50). In order to figure out which connector of the portable cab selector panel INTERFACE is connected to the RED or YELLOW positions of your cab selector switch, the CAB SELECTOR INTERFACE CONNECTORS should be painted RED and YELLOW. (See Figure E3, Electrical Standards or Figure 3.). Thus when you connect the cab selector panel to the layout, you can assign as the RED CAB the throttle that is connected to the same CAB LINES as the RED connector of the cab selector panel. The other mainline throttle then becomes the YELLOW CAB and should have a YELLOW dot attached.

   There are advantages and disadvantages to each type of selector panel. The version that uses rotary switches has the disadvantage of the difficulty of soldering 16 gauge wires to the cramped solder lugs of the rotary switch. In addition, as you select a new cab, sometimes you must momentarily pass through an undesired cab position. One advantage is found when you desire to have more than one LOCAL CAB, as a variety of multi-position rotary switches are available. Another advantage is the compactness of a single switch that allows selection of all cabs. The other version uses a DPDT, CENTER-OFF SWITCH to allow you to select between MAINLINE, OFF or LOCAL CAB; and a DPDT switch to allow you to select between either of the MAINLINE CABS. The disadvantages are the relatively greater demand on space for the switches and the problem of how you deal with the case where you want more than one local cab. However, if you use the large size toggle switches, it will be easier to solder the 16 gauge wires to the switches. In either case, there is one rotary switch, or one pair of DPDT switches associated with each block.

   WARNING: The first time you attempt to build a cab selector panel, you will most likely be met with crossed connections and either shorts and/or reversed polarities. The wiring connections must be adhered to EXACTLY in order for your cab selector panel to work correctly with other S-MOD cab selector panels in a layout.

4) BLOCK CREATION: When you use S-MOD cab selector panels, the size of its block is determined by placement of insulated rail joiners in BOTH rails of the track at each end of the block (usually between the permanently installed track and the bridge rails used to connect the rails to an adjacent module at the interface). IN ADDITION, you must disconnect the TRACK LINE INTERFACE CONNECTORS at the interfaces where the block boundary has been created. With this method, a mainline block can be as short as one module or as large as the entire layout. In contrast, if you are building a complex yard module where you wish to have small blocks, then your selector switch may operate a block that is permanent in its size on your module.

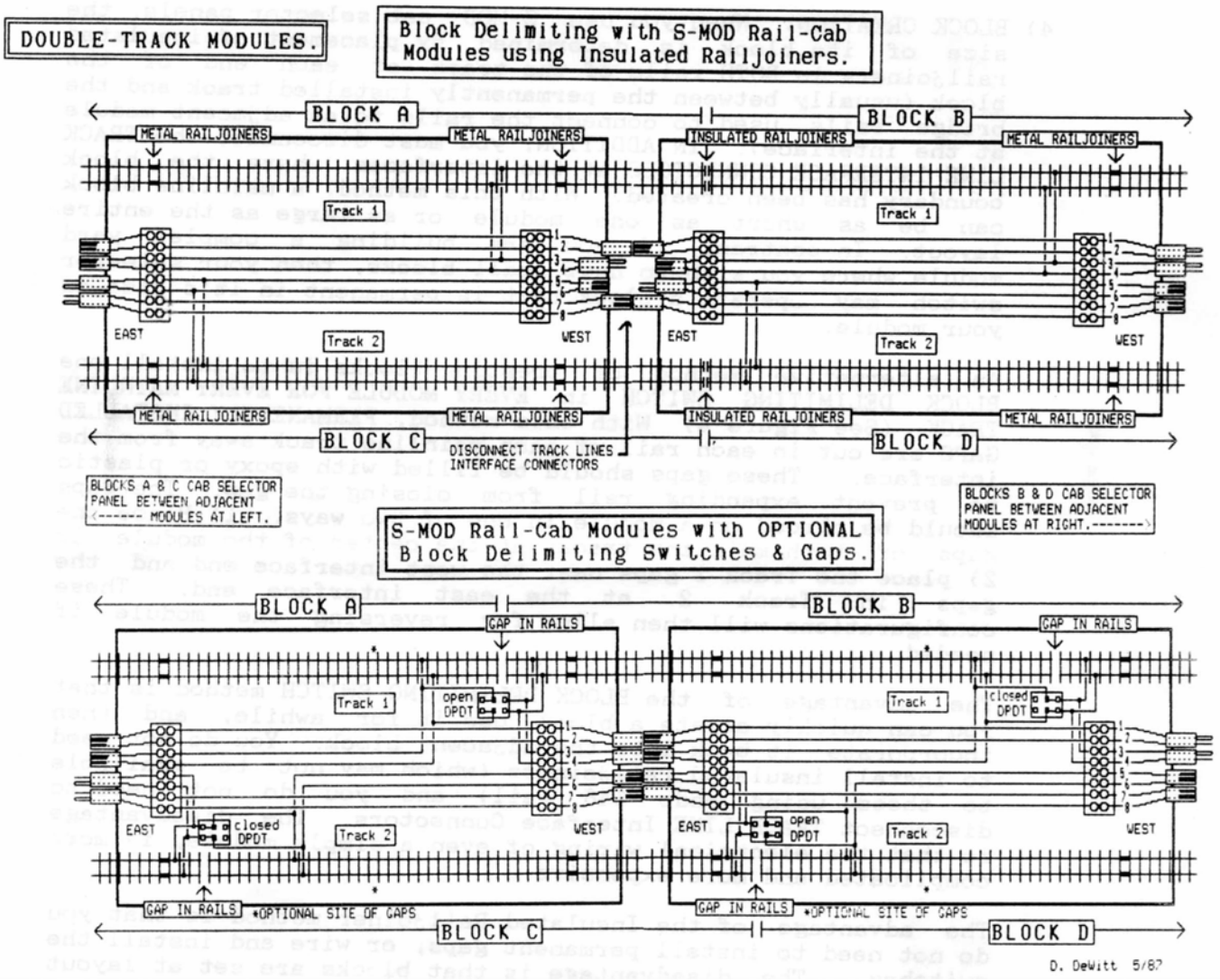


Figure 4.

An alternative method of creating blocks is to install one BLOCK DELIMITING SWITCH in EVERY MODULE FOR EVERY MAINLINE TRACK. (See Figure 4.) With this method, PERMANENTLY INSTALLED GAPS are cut in each rail of each mainline track away from the interface. These gaps should be filled with epoxy or plastic to prevent expanding rail from closing the gap. The gaps should be placed on a module in one of two ways. 1) Place the gaps of both mainline tracks at the center of the module, or 2) Place the Track 1 gaps near the west interface end and the gaps in Track 2 at the east interface end. These configurations will then allow for reversing the module if needed.

The advantage of the BLOCK DELIMITING SWITCH method is that you can quickly create a block, use it for a while, and then incorporate it back into the adjacent block. You do not need to install insulated railjoiners (which may not be available to those using code 148 rail) and you do not need to disconnect TRACK LINE Interface Connectors. The disadvantage is that the electrical wiring of even a simple module is more complicated and more expensive.

The advantage of the Insulated Rail Joiner method is that you do not need to install permanent gaps, or wire and install the switches. The disadvantage is that blocks are set at layout construction time and cannot be divided up thereafter, and you must use insulated rail joiners. If a layout coordinator anticipates a need for a temporary block, then he can place the insulated rail joiners at the time of the layout construction and leave the TRACK LINES connected until the small block is needed. With this method any two blocks can be made into one block by simply connecting the TRACK LINES connectors.

WITHIN A DIVISION, at NO TIME should the CAB LINES be disconnected.

Please note that the "insulated rail-joiner" and the "block-delimiting switch" methods are the only two recommended methods for use in the S-MOD system. The two methods are fully compatible with each other so that modules can be mixed together.

B. SINGLE-TRACK MODULES

Many model railroaders would rather model branch line operations that have only one mainline. Because most modules in the past have had two or more mainlines (e.g., NTRAK modules) many of these modelers have lost interest in modular layouts. The S-MOD system also includes a wiring system for single-track modules that can be operated under either electrical subsystem. Figures El & E3 of the Electrical Standards shows how the single-track modules should be wired. Note that each module carries six lines. Two are the TRACK LINES used to carry track power from either of the MAINLINE CABS or LOCAL(s), and four lines are the CAB LINES used to carry the RED and YELLOW CABS. In order to be able to reverse modules the wire assignments are:

	MOST OFTEN USED POSITION	**REVERSED POSITION**
Wire 1:	RED CAB, rail 1	YELLOW CAB, rail 1
Wire 2:	RED CAB, rail 2	YELLOW CAB, rail 2
Wire 3/5:	Track, rail 1	Track, rail 2
Wire 4/6:	Track, rail 2	Track, rail 1
Wire 7:	YELLOW CAB, rail 2	RED CAB, rail 2
Wire 8:	YELLOW CAB, rail 1	RED CAB, rail 1

Note that to be able to reverse modules, both a male and a female connector must be attached to the TRACK LINES and that is most easily done by using the usual 8 position barrier strip with the appropriate jumpers between positions 3 & 5 and 4 & 6. IN EITHER POSITION, ONLY ONE TRACK LINES INTERFACE CONNECTOR IS USED!!!!!

If the entire layout is made up of single-track modules or if a single-track branch line is very long, then the operators may wish to break the branch into blocks. This is done simply by disconnecting the TRACK connectors in between the modules adjacent to the block break, AND inserting insulated rail joiners in the rails (or opening block delimiting switches). Each block then requires its own cab selector panel. (See Figure 5.)

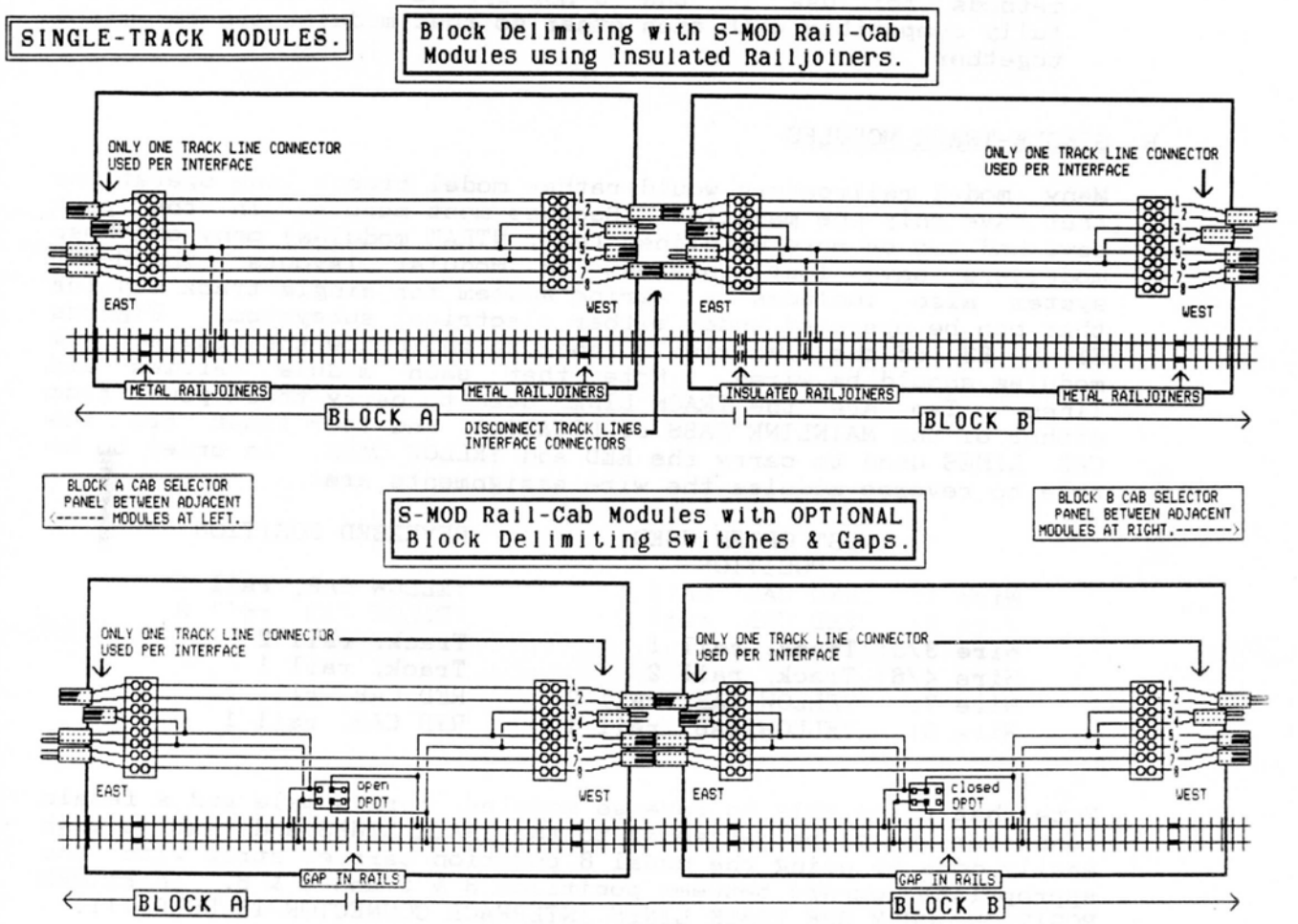


Figure 5.

IV. There are many other special situations that need to be explained. These topics include:

1) how to wire Transfer Block Controllers which are used to transfer train control between Divisions.
2) how to wire "Semi-Block" modules which allow an operator to switch his Semi-Block from local to main cabs but does not allow selection of mainline cabs. The block simply accepts whatever assignment has been made within the block that the semiblock resides.
3) how to insert RAIL-CAB modules into a WIRE-TO-RAIL layout.
4) how to connect single track modules to double track modules.
5) how to build an S-MOD Wiring Analyzer.
6) how to build gauntlet modules.
7) how to build yard modules.
8) how to build interchange modules.
9) how to connect branch lines to interchange modules.
10) etc., etc.

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