

RR-CirKits

Specializing in Affordable Electronics for Model Railroads

Installation Guide
Revision-d August 2013

SignalMan ***DCC or Simple Serial Bus*** ***Signal Head Driver***

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WARNING: This product contains a chemical known to the state of California to cause cancer, birth defects or other reproductive harm. Do not ingest.

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1.0 Features

- Direct drive for up to 16 LEDs.
- Includes drive for any combination of:
 - Up to 16 Common Anode or Common Cathode LEDs
 - Up to 8 dual color LEDs, bipolar or three wire.
 - Up to 8 stall motors.
- Internal Logic Blocks with up to 32 conditional statements.
- Communicates over the Simple Serial Bus which is a 3 wire LocoNet® compatible serial interface.
- Alternatively will connect directly to a DCC bus. (no internal logic available in DCC mode)
- CV controlled programming via Software. (e.g. JMRI DecoderPro 3.4 or later.) Both reading and writing of CV values is supported in OPs mode over the LocoNet® compatible Simple Serial Bus connection. OPs mode 'Write Only' over DCC.
- Signal masts may be configured with up to 4 lamps per aspect, with 32 total aspects available.
- Automatically saves signal states during power down.
- Boot Loader allows firmware upgrades over the LocoNet® compatible Simple Serial Bus connection.
- Power is supplied by either the Simple Serial Bus or the DCC connection.
- 10VDC or greater drive for LEDs and Stall Motor machines. Allows driving multiple LEDs in series and Stall Motors at reasonable speeds.

2.0 Getting Started

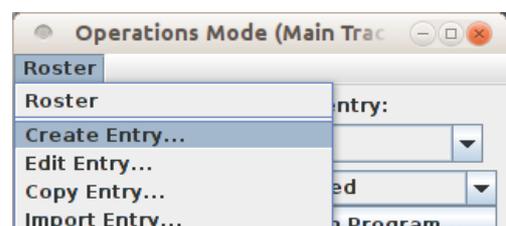
We suggest that you use a computer program such as the JMRI DecoderPro (3.4 or later) to setup the SignalMan. The "point and click" interface will save you much time and frustration while setting the many possible options that you will need to configure.

OPS Mode Address: Each SignalMan has a single address that is used for OPS mode programming on the layout. Each individual SignalMan on your layout may have its own address, (recommended) or each SignalMan may use the jumper selectable pre-programmed default address of 9999.

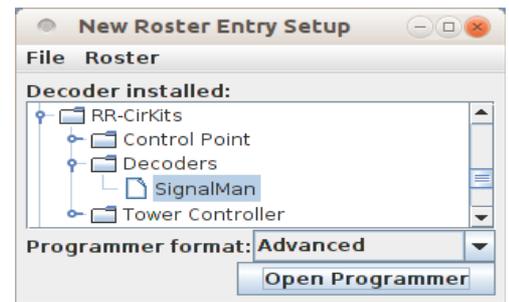
2.1 Create a Defult Roster Entry as a template

Follow the following steps:

- a) Open the '**OPs Mode Programmer**' and select 'Roster' - 'Create Entry'.



- b) Next Select 'RR-CirKits' - 'Decoders' - 'SignalMan' as the decoder type. Set the format: to 'Advanced' then Click 'Open Programmer'.



- c) Once the Decoder File opens, go to the 'Basic' tab, check '4 digit addressing' and enter an address of '9999' in the 'Long Address' box.

- d) Go to the 'SignalMan' tab.

- e) Set Master mode as follows:



- For use with a LocoNet® compatible command station select 'No'.
- For use with any other, or no command station, select 'Enabled'.

- f) Set OPs Mode Programming as follows:

- To only use the default address of 9999 with JP1 1-3 on all SignalMan select 'No'.
- For user defined individual addressing select 'Enable'. (recommended)

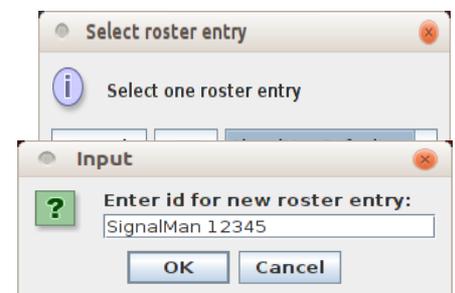
- g) Go to the 'Roster Entry' tab, enter an ID (e.g. 'SignalMan Default') and then click on the 'Save to Roster' button.

- h) Close the new default decoder file. (template)

2.2 Create a New Roster Entry for each SignalMan

Follow the following steps:

- Open the 'OPs Mode Programmer' and select 'Roster' - 'Copy Entry...'
- Select 'SignalMan Default' as the original.
- Enter a new roster id for each new SignalMan.
- Close each new entry by clicking on OK.



2.3 Edit the new Roster Entry

- This Ops mode address is only used to configure the SignalMan. It has nothing to do with the addresses that each aspect will use to respond to aspect commands.
- Connect the unit's LocoNet® compatible Simple Serial Bus to any point on your system's bus. The yellow command indicator will light each time the SignalMan initiates or responds to a LocoNet® command.
- Apply Power to the SignalMan. The green power ON status indicator should illuminate.
- Once the SignalMan is operating, all actual configuration, including any changes to the address, must be done with the JMRI 'Operations Mode Programmer'.

- e) When a SignalMan is powered up for the first time it will have a default address of 9999 to match the roster entry that you have just created from the 'SignalMan Default' template.
- f) If this SignalMan has an unknown address, Install the option select jumper JP1 at 1-3. The JP1 1-3 jumper will force the SignalMan into OPs mode and it will respond to both address 9999 and also what ever address was set by the CVs. This always allows you to take control of any SignalMan and correct any setup errors. The JP1 1-3 jumper also forces the SignalMan into Master Mode Enabled for use on a stand alone bus.



For use on a stand alone bus the Master Mode must be enabled by manually writing to CV 112 before removing the JP1 1-3 jumper.

Tip



Change to the 'CV' tab, check that the value is 155, then click on 'Write' to save the CV 112 value to the SignalMan.

- g) Any changed address will only take effect after the power is cycled on the SignalMan.
- h) The SignalMan decoder file is large. You must use JMRI version 3.4 or later. (3.3.6 test or later) You also must not attempt to open two different programming windows at the same time. This may exceed the JMRI internal memory allocations.
- i) It is recommended that you give the SignalMan a long address in the range of 10000-16383 to avoid potential conflicts with locos. This address must not conflict with that of any Locomotives or any other devices in use on the layout, as no distinction is made between mobile and fixed decoders in OPS mode.
- j) Change any other info you want to at this time, write all changes to the SignalMan, then save to the roster.
- k) Remove the JP1 1-3 jumper if used, then power cycle the SignalMan.
- l) You should now be able to interface to your Railroad from your software.

Tip

Remember, to modify, or restore an unknown address, you first power up the unit, then set the program option (JP1) to 1-3 and use the default 9999 address to re-program the unit. The unit will not power up with the jumper 1-3 in place. Always power it up first, then add the jumper.

3.0 Power and Serial Connections

The SignalMan (Signal Head Driver) has six connectors and two status indicators. Two of these are for connections to the system. The rest are connections to the signal heads. This section covers the system connections consisting of the serial port connectors, power connections and Status indicators.

3.1 LocoNet® Compatible Simple Serial Bus Connector

The serial port connection is made to the SignalMan via the Simple Serial Bus cable connected to either of the two screw terminals. (3 pin) Simple Serial Bus cables are normally wired straight through, but no harm comes from an accidental reversal. Either serial connector X1 or X2 may be used for daisy chain style connections because the wiring passes straight through both connectors.

Pin outs for the Simple Serial Bus data connector:

Pin	Description
1	DC or DCC
2	LocoNet® Serial line
3	DC or DCC

Simple Serial Bus power is supplied on Pin 1 and Pin 3. Power can be from +12V DC or DCC. Serial port Pin 2 is the LocoNet® compatible Simple Serial Bus signal line.

The Simple Serial Bus connectors will accept wire from 14 AWG to 22 AWG. For larger wire sizes simply attach a tail of smaller gauge wire to extend from the main bus wires to the SignalMan connectors. It may help to tin stranded conductors to prevent any stray strands from causing short circuits.

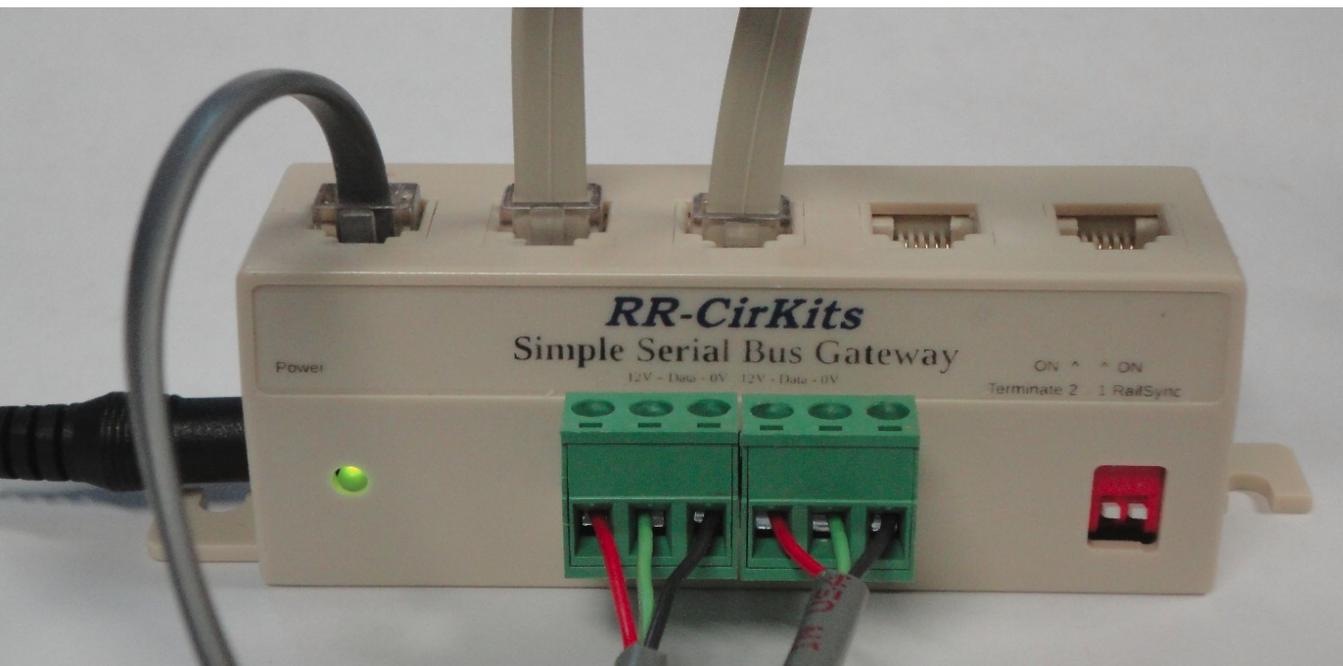
3.2 Power Connections

The SignalMan requires an external power source of between 12 and 15 volts DC or DCC supplied on the Simple Serial Bus. A voltage of less than 12VDC but at least 9V DC will reduce the LED and Tortoise drive voltage from its normal 10VDC, but otherwise not affect proper operation.

3.2.1 The Simple Serial Bus Gateway

The SSB Gateway unit is a convenient way to supply power to the SignalMan and other Simple Serial Bus boards over one or two 3 wire cables. It includes both a LocoNet® terminator and power to the RailSync lines as options for stand alone LocoNet® users. It also provides an easy point to connect up to 5 LocoNet® cables to compatible devices such as a LocoBuffer-USB computer interface.

For stand alone use you can supply both the power to the LocoNet RailSync lines and the LocoNet termination by flipping the selector switches to their on (up) positions. Do NOT turn on the SSB RailSync power switch if your SSB Gateway is connected to a Digitrax or other compatible command station. The outputs will conflict and prevent your system from working correctly.



Simple Serial Bus Gateway

3.3 Status Indicators

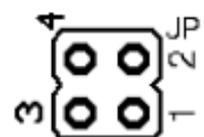
The SignalMan has two status indicators located near to the Simple Serial Bus connectors. The green ON status indicator shows the power status of the SignalMan itself. The yellow COM (command) indicator normally shows all data activity addressed to, or coming from, this specific SignalMan, and also any activity/error status during a boot loader firmware upgrade. (see section 8.0)

3.4 JP1 JP2, and JP3 Mode Selection jumpers

The SignalMan has two Mode Jumpers, JP1 and JP2. These select the electrical interface mode and options.

JP1 has 4 valid positions:

- a) **None** = Serial mode. (LocoNet® data) Simple Serial Bus mode. (use with JP2 1-2) Read only at power up.
- b) **2 - 4** = DCC mode. (DCC data) DCC accessory decoder mode. (use with JP2 2-3) Read only at power up.
- c) **1 - 3** = OPs Mode Programming. Read after power up.



Note This jumper is not allowed during power up. It causes a rapid flash error warning if it is in place at power up.

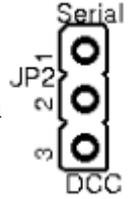
- d) **3 - 4** = Boot Loader mode. Serial Mode only. Read only at power up.

Warning

For proper Boot Loader error status reporting be sure to remove Boot Loader jumper **3 - 4** after power up. The Boot Loader status is maintained until power is cycled or the boot process has completed.

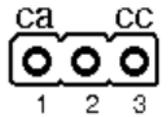
JP2 has 2 positions.

- a) Serial = Serial mode. (1 - 2) Simple Serial Bus mode. (use with JP1 = none)
- b) DCC = DCC mode. (2 - 3) DCC accessory decoder mode. (use with JP1 = 2 - 4)



JP3 has 2 positions. Read after changes are made.

- a) ca = Common Anode. (1 - 2) Signal common line is tied to SignalMan power (+12V)
- a) cc = Common Cathode. (2 - 3) Signal common line is tied to power common (Ground)



3.5 Lamp Brightness and Strobe control.

The SignalMan uses PWM control of its lamp outputs for creating special effects such as 'Fade'. This also allows us to set the brightness of individual lamps using control CVs. Each output has 48 brightness levels with a minimum of 1 and a maximum of 48. A lamp may only be 'Faded' through its available brightness values, so it should be obvious that a lamp with a brightness setting of '2' will only have 2 possible steps during its fade. (2 to 1, and then 1 to off) Higher values will allow smoother fade effects.

Each lamp has a brightness slider on the 'Brightness' pane. The value may be changed by using the slider thumb, or by directly entering the desired value in the box.



Strobe Length x 10ms

The 'Strobe Length' setting applies to every output with the

'Strobe' effect enabled. The strobe length may be set from a minimum of 10ms to a maximum of 2 seconds. (1-200) Each unit shown in the slider value box is 10ms. Changes to the strobe length between 10ms and 100ms will appear as brightness changes. Longer strobe lengths will appear as a blink of various lengths. The strobe activates when the lamp turns 'on'. If the lamp Phase/Flash is set to 'Steady' then the strobe will just flash once. If the lamp is set to some flash rate, then the strobe will flash every time the lamp lights. Tower beacons typically flash at a 30 per minute rate. Set the Phase/Flash to 'A Slow' or 'B Slow' for this rate.

4.0 Output Connections

We suggest that the user take advantage of JMRI DecoderPro or a similar program to set the values, rather than attempting to use a hand held controller due to the large number of items to set, and the inability of the hand held to access 5 digit

addresses. Current versions of DP also have the capability of setting groups of values with one selection.

4.1 Signal Ports

The SignalMan has two or four signal output ports depending on the version. The signal drive on the 10 pin output version SignalMan-P is two each of 8 lines and 2 commons, for a total of 16 LEDs. The compression connector version SignalMan-C has four each of 4 lines plus a single common, for a total of 16 LEDs.

Each of the 4 commons are connected to the ca/cc connection jumper and thereby to +12V or Ground. Any LED may be used with any signal mast on any SignalMan. The SignalMan signal ports can supply up to 10V through current limiting resistors, so wiring several LEDs in series to each output is not a problem. For example, the easiest way to wire a PRR position light signal is to wire its outer pairs of LEDs in series with the single center LED. This results in three yellow LEDs wired in series which requires at least 6V to drive. The SignalMan can do this easily. Position Light, Color Position Light, and some European signals also use multiple lamps for each aspect. In these cases each series LED string only counts as a single SignalMan lamp. To drive higher currents you may use multiple output lines in parallel connected to the same signal lamp.

To maintain backward compatibility with older software you may also configure each 'mast' to be the same as a single signal head and let other software such as JMRI combine them into masts. However the SignalMan is designed to operate on a mast basis with a single DCC or LocoNet® message being used to set each aspect.

Each aspect may consist of up to 4 LEDs chosen from among the 16 possible. Note: if any single aspect requires more than 4 lighted lamps, simply define additional masts using the same aspect control messages. The same LED may appear in any number of different aspects. The lamp special effects may be applied differently for each aspect. E.g. a single yellow LED may be held steady in one aspect and be flashing in another aspect.

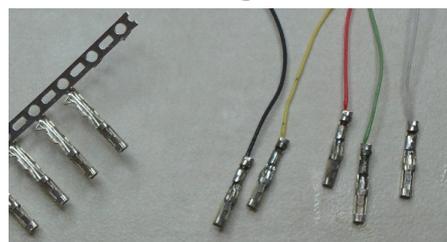
4.1.1 SignalMan-P Signal Wire Connections

The SignalMan-P version is designed with pin headers for easy push on female pin connections. We include pins and color coded shrink wrap. This signal has color coded wires, but many signals do not. The color coded shrink wrap makes it easy to know which wires are being connected under the layout. Apply the pins and shrink wrap at the bench and feed them down a small hole under the signal.



Shrink Wrap Insulation

The shrink wrap serves to prevent any short circuits when connecting to the pin headers. It also makes it easy to see which color lamps are being connected. These wires are for a B&O



Female pin connectors

Color Position signal with a single marker lamp. The black wire is the common and is soldered to the brass mast. On multi mast bridges the single common wiring of the SignalMan is easy to wire to multiple heads wired with a single common connection.

4.2 Signal Lamp Tables

Each SignalMan lamp control table supports up to 16 masts and a total of 32 aspects. These may be distributed in any way required for your signaling system. To configure your masts select one of the 'Masts' tabs ('Masts A', etc.) in DecoderPro. (version 3.4 or later) Any mast may continue from one tab to the next. There is no limitation between 'Masts A', etc. and any given signal connector. The different tabs simply exist to present the data one pane at a time. The same is true of 'Logic A', etc.

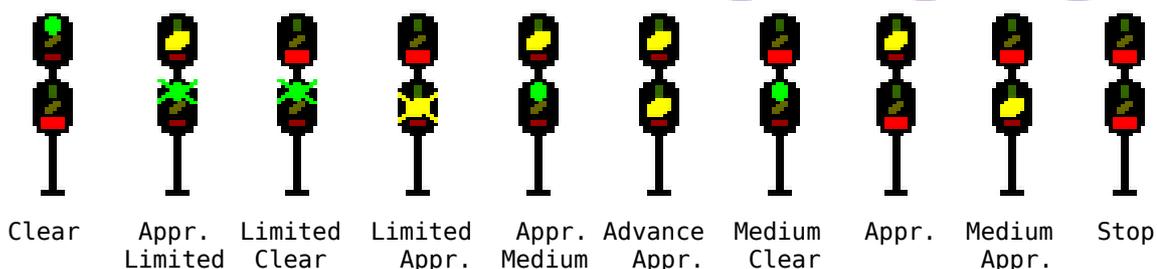
4.2.1 SignalMan Aspects

Any time a mast's aspect is changed, all the entries for that same mast number (or Group) are first set to 'false' and all lamps associated with the changed aspects are turned off. Any secondary messages associated with 'false' or 'change' are sent. Then the new aspect is set to 'true' for all table entries that match it. Finally, all lights associated with the new aspect/s are turned on, and any secondary message associated with 'true' or 'change' is sent. Lamp 'phase' is only related to flashing lamps. If a phase A lamp is 'off' and a phase B lamp is 'off' they are both extinguished. If they are 'on' they are both lit. Only when they are flashing do they alternate between phase A and phase B.

4.2.2 Aspect Examples

Here are the 10 possible aspects for an example signal taken from CSX-1998 rules.

Double head 3-3 color light high signal



In this example we see the following settings for Aspect #1. ('Stop' which is Red over Red)

- The mode is set to respond to Turnout commands.
- The command we used for 'Stop' is LT9 Thrown.
- The mast number is '01'.
- Lamp A is set to light LED H1-R steadily.

Aspect#	Mode	Command	Lamp A
1:	<input checked="" type="radio"/> Turnout <input type="radio"/> DCC	9	H1-R T 01

Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash
H1-R	Steady	BP <input type="checkbox"/>	H1-Y	Steady

- Lamp B is set to light LED H2-R steadily.
- This is not a Bi-Polar LED.
- Lamp C and Lamp D are set to 'none'. Their lamp entries are ignored.

Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash
H1-R	None	BP <input type="checkbox"/>	H1-R	None

Lighting Effects
Effect: Tumble Down

- The lamp effect is set to 'Fade' to simulate the slow reaction of tungsten filament lamps.

The next aspect is 'Approach'. (Yellow over Red) All settings are the same as above except as indicated.

10 T 01
H1-Y Steady

- This command for 'Approach' is LT10 Thrown.
- Lamp A is set to light LED H1-Y steadily.

Another required aspect is 'Limited Clear'. (Red over Flashing Green) All settings are the same as above except as indicated.

5: Turnout DCC H1-R Steady BP H1-G A Medium
11 T 02 2nd Event 1 Polarity send norm

- This command for Limited Clear is LT11 Thrown.
- Lamp A is set to light LED H1-R, and lighted Steadily.
- Lamp B is set to H2-G and 'A Medium'. The phase ('A Medium' or 'B Medium') does not matter unless you need alternating lamps.

Note

Railroad signals and crossing gate warning lights flash at approximately 45 flashes per minute. Select the 'A Medium' or 'B Medium' rates for this. Highway flashing lights flash at 60 flashes per minute. Choose 'A Fast' or 'B Fast' for this rate. Beacons flash at about 30 flashes per minute. Choose "A Slow" or 'B Slow' for this rate.

Note

It does not matter which LED is LAMP A, and which is LAMP B. It also does not matter in what order the aspects are listed as long as the same mast number is used for each one.

4.2.3 SignalMan Secondary Messages

In these examples there is no second message being sent. However a second message could be sent if desired, for example to activate a 'Stop' relay when the Stop aspect is sent, and to release the 'Stop' relay when any other aspect is sent. Another option could be to send locking commands to another signal.

4.2.4 Turnout Mode

1: Turnout DCC H1-R St
9 T 01

In 'Turnout' mode the decoders will respond to turnout commands on the LocoNet[®] compatible serial data line, or respond to turnout accessory commands read from the DCC connection. (based on the JP2 selection) These commands are described in the

SignalMan DecoderPro files as turnout number plus closed (C) or Thrown (T). Some DCC systems may refer to these states as Normal and Reverse, or simply 1 and 2.

To take advantage of the SignalMan's internal flashing capabilities use the JMRI signal head option LDT LS-DEC as shown here. This allows JMRI to send a single turnout command per aspect, even for flashing aspects that would otherwise require approximately two commands per second per flashing aspect. When there are many flashing aspects involved this extra traffic can quickly load down the command system. As shown here the 'Dark' aspect will actually light the Lunar lamp if one is connected.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	Turnout	DCC	H1-R	Steady	BP	H1-R	None	H1-R	None	BP	H1-R	None	Effect None
		9	T	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
2:	Turnout	DCC	H1-Y	Steady	BP	H1-Y	None	H1-Y	None	BP	H1-Y	None	Effect None
		10	T	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
3:	Turnout	DCC	H1-G	Steady	BP	H1-G	None	H1-G	None	BP	H1-G	None	Effect None
		9	C	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
4:	Turnout	DCC	H1-L	Steady	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect None
		10	C	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
5:	Turnout	DCC	H1-R	A Medium	BP	H1-R	None	H1-R	None	BP	H1-R	None	Effect None
		11	T	02		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
6:	Turnout	DCC	H1-Y	A Medium	BP	H1-Y	None	H1-Y	None	BP	H1-Y	None	Effect None
		12	T	02		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
7:	Turnout	DCC	H1-G	A Medium	BP	H1-G	None	H1-G	None	BP	H1-G	None	Effect None
		11	C	02		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
8:	Turnout	DCC	H1-L	A Medium	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect None
		12	C	02		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	

4.2.5 DCC Signal Decoder Mode

1: Turnout DCC H1-R Steady 9 0-Stop

In the NMRA DCC Signal Decoder mode, the SignalMan DecoderPro options will respond

to a NMRA DCC Signal Accessory mast number plus an aspect number. These commands will come from either the LocoNet[®] compatible serial data line, or else respond to NMRA Signal Accessory commands read from the DCC connection, based on the JP2 setting and the SignalMan connections.

Edit Signal

Window Help

DCC Signal Decoder

System Name: LH\$17 OffSet Address

User Name: H3

Aspect Numbering	
Dark	8
Red	0
Yellow	21
Green	29
Lunar	4
Flashing Red	3
Flashing Yellow	22
Flashing Green	30
Flashing Lunar	5

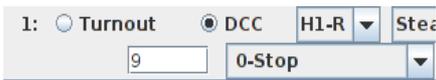
Cancel Update

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
17:	Turnout	DCC	H3-R	Steady	BP	H3-R	None	H3-R	None	BP	H3-R	None	Effect Fade
		17	0-Stop			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
18:	Turnout	DCC	H3-Y	Steady	BP	H3-Y	None	H3-Y	None	BP	H3-Y	None	Effect Fade
		17	21-Approach			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
19:	Turnout	DCC	H3-G	Steady	BP	H3-G	None	H3-G	None	BP	H3-G	None	Effect Fade
		17	29-Clear			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
20:	Turnout	DCC	H3-L	Steady	BP	H3-L	None	H3-L	None	BP	H3-L	None	Effect Fade
		17	4-Restricting			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
21:	Turnout	DCC	H3-R	A Medium	BP	H3-R	None	H3-R	None	BP	H3-R	None	Effect Fade
		17	3-Stop-Proceed			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
22:	Turnout	DCC	H3-Y	A Medium	BP	H3-Y	None	H3-Y	None	BP	H3-Y	None	Effect Fade
		17	22-Advance-Appr			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
23:	Turnout	DCC	H3-G	A Medium	BP	H3-G	None	H3-G	None	BP	H3-G	None	Effect Fade
		17	30-Cab-Speed			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
24:	Turnout	DCC	H3-L	A Medium	BP	H3-L	None	H3-L	None	BP	H3-L	None	Effect Fade
		17	5-Permissive			2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	

The matching SignalMan configuration is shown here. You may note that there is no 'Dark' entry. If it is required, then you could add this 9th item on the next 'Masts' pane, or simply replace an unneeded aspect in this list.

The only aspect number that is specified by the NMRA is the '0' for 'Stop'. The rest of the 'aspect' numbers are left up to the Manufacturer and/or user. This means that the options offered in the DecoderPro signal head file are simply default names and numbers. They may not exactly match what your signaling system requires. You simply make sure that JMRI sends the required aspect number for each aspect that you define. I have redefined these aspect numbers to more closely match the default aspect names in the SignalMan decoder file.

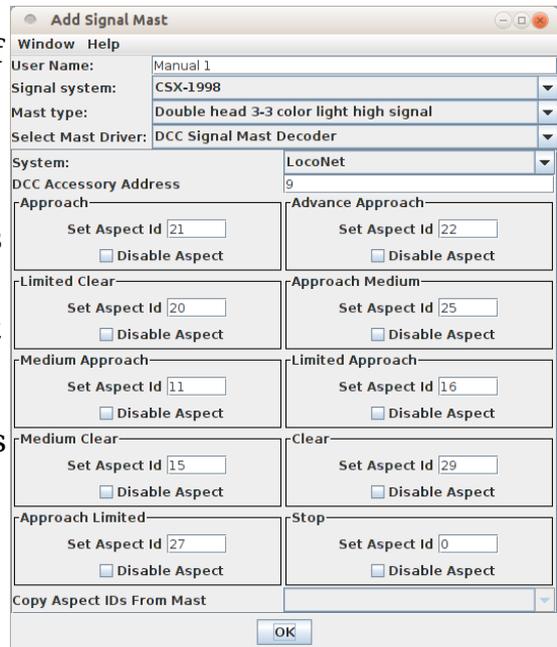
4.2.6 JMRI DCC Signal Mast Decoder Mode



Going back to our original example; one of the CSX rules for our mast called for 'Medium Approach'. The default name given in the lamp table is '11 Medium-Appr'. This means Medium speed through this interlocking, and Stop before arriving at the next signal.

Because this example requires two signal heads to display, we either need to use a combination of two heads in JMRI, or else we can use the JMRI Signal Mast option. Using the Signal Mast option has great advantages for signaling because the signal rules are already known to JMRI which greatly simplifies the setup. Also JMRI only sends a single command per each aspect change.

First we need to enter a Signal Mast in JMRI that knows how to talk to our head. Use the 'Add Signal Mast' option. There are no preconceived rules based on the particular names and numbers being used. Just be sure that the actual numbers match between what JMRI sends and the values that you are entering into the SignalMan tables. The Signal Mast will automatically know all the available aspects and their names, based on the Signal system and Mast type that you have selected.



Using JMRI aspect based signals will give you the option of selecting the aspect number desired for each rule when configuring the masts.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-G	Steady	BP	H2-R	Steady	H1-R	None	BP	H1-R	None	Effect Fade
		9 29-Clear				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
2:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP	H2-G	A Medium	H1-Y	None	BP	H1-Y	None	Effect Fade
		9 27-Appr-Limited				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
3:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP	H2-G	A Medium	H1-G	None	BP	H1-G	None	Effect Fade
		9 20-Limited-Clear				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
4:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP	H2-Y	A Medium	H1-L	None	BP	H1-L	None	Effect Fade
		9 16-Limited-Appr				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
5:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP	H2-G	Steady	H1-R	None	BP	H1-R	None	Effect Fade
		9 25-Appr-Medium				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
6:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP	H2-Y	Steady	H1-Y	None	BP	H1-Y	None	Effect Fade
		9 22-Advance-Appr				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
7:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP	H2-G	Steady	H1-G	None	BP	H1-G	None	Effect Fade
		9 15-Medium-Clr				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	
8:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP	H2-R	Steady	H1-L	None	BP	H1-L	None	Effect Fade
		9 21-Approach				2nd Event 1	Polarity send normal		Reserved (0x4X)		message	No Second Message	

10 aspects requires that we continue our mast info onto the next pane.

Aspect#	Mode	Command	Lamp A Phase/Flash	Bi-Polar	Lamp B Phase/Flash	Lamp C Phase/Flash	Bi-Polar	Lamp D Phase/Flash	Lighting Effects					
9:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-Y	Steady	H2-R	None	BP <input type="checkbox"/>	H2-R	None	Effect	Fade
		9	11-Medium-Appr	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message					
10:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-R	Steady	H2-Y	None	BP <input type="checkbox"/>	H2-Y	None	Effect	Fade
		9	0-Stop	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message					

The use of default names in place of randomly assigned numbers makes it much easier to match up your lamp table entries with the desired aspects in JMRI, but remember that you may not always have 100% agreement with the default names. Only the numbers are used in the DCC commands. You can see from this example that we use 'Lamp A' for the upper head and 'Lamp B' for the lower head. This is simply to make it easier to follow what is going on. Except for certain effects, any lamp may be placed in any position.

4.2.7 Effects

There are 5 possible effects available during aspect changes.

- 1) **None.** The LEDs change immediately from one color to another.
- 2) **Fade.** The LEDs fade slowly from on to off and from off to on. The two lamps will actually cross fade as happens in the prototype signals. During a cross fade both lamps are lit at the same time. One is dimming as the other is brightening. The relays that control the prototype signal lamps actually switch quickly. The fade in brightness up and down is due to thermal lag in the lamp filaments.
- 3) **Tumble Down.** Due to the internal relay logic in some signals they may pass through yellow when changing from green to red. This is seen on CPL signals and may be meant to simulate a dropping semaphore arm, or it may be an accident of the logic. To configure the effect first select the 'Tumble Down' option. Then choose the intermediate yellow lamp using LAMP B. Finally choose the final color lamp using LAMP A, C, or D. The 'Tumble Down' effect always includes 'Fade' automatically.
- 4) **H2 Flicker.** Due to the internal mechanism used in the classic US&S 'H' series searchlight signals, the red color filter is normally located in the center position between the green and yellow filters. This means that when a searchlight changes between green and yellow there is a brief flicker of red as the filter passes from one side to the other. To configure this effect first select the 'H2 Flicker' option. Then choose the intermediate red lamp using LAMP B. Finally choose the final color lamp using LAMP A, C, or D.
- 5) **Strobe.** The Strobe effect allows you to use any extra lamps for special effects such as radio tower strobe lights. Tower strobe lights usually flash at a 30 times per minute rate. Select 'A Slow' or 'B Slow' to get this rate. The strobe flash length may be set in the brightness pane.

To prevent unwanted effect interactions on multi headed signal masts it is probably best to use the tumble down and H2 Flicker options on single heads and allow your control system to send separate commands to each.

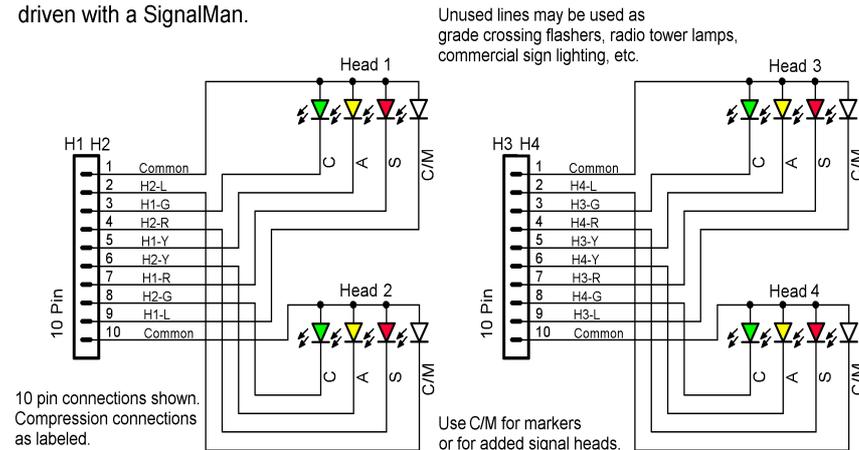
4.3 Signal Lamp Wiring

The following examples show how to wire the common signal types and give some simple example Lamp Table entries used to control them.

4.3.1 Color Light Signal Connections

For this example we are using turnout commands for aspect control. The default Color Light signal wiring for the SignalMan is shown here. The head names and lamp numbering are just for reference to the table entries. The actual lamp colors and head numbers may be changed to match your specific prototypes requirements.

Color Light Signals using LEDs driven with a SignalMan.



requirements.

For example, when using 3 color signals the SignalMan will actually control 5 heads by using the unused Lunar connections to drive the 5th head. Alternately these unused connections may be used for crossing gate flashers, radio tower strobes, advertising signs or other layout lighting effects.

SignalMan Signal Head Wiring for Color Light Signals.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	<input checked="" type="radio"/> Turnout	<input type="radio"/> DCC	H1-R	Steady	<input type="checkbox"/> BP	H1-R	None	H1-R	None	<input type="checkbox"/> BP	H1-R	None	Effect Fade
		9	T	01			send normal		Reserved (0x4X)		message	No Second Message	
2:	<input checked="" type="radio"/> Turnout	<input type="radio"/> DCC	H1-Y	Steady	<input type="checkbox"/> BP	H1-Y	None	H1-Y	None	<input type="checkbox"/> BP	H1-Y	None	Effect Fade
		10	T	01			send normal		Reserved (0x4X)		message	No Second Message	
3:	<input checked="" type="radio"/> Turnout	<input type="radio"/> DCC	H1-G	Steady	<input type="checkbox"/> BP	H2-G	None	H1-G	None	<input type="checkbox"/> BP	H1-G	None	Effect Fade
		9	C	01			send normal		Reserved (0x4X)		message	No Second Message	
4:	<input checked="" type="radio"/> Turnout	<input type="radio"/> DCC	H1-L	None	<input type="checkbox"/> BP	H1-L	None	H1-L	None	<input type="checkbox"/> BP	H1-L	None	Effect Fade
		10	C	01			send normal		Reserved (0x4X)		message	No Second Message	

Aspect #1 (9T Stop) sets 'Lamp A' to 'H1-R Steady' which is connected to the red LED. This incandescent prototype signal fades from one color to the next. The SignalMan automatically does this effect if 'Fade' is selected. The 3 unused lamp entries are set to 'None'.



Aspect #2 (10T Approach) sets 'Lamp A' to 'H1-Y' for the yellow indication. The 3 unused lamp entries are set to 'None' and 'Fade' is selected.



Aspect #3 (9C Clear) sets 'Lamp A' to 'H1-G' for the green indication. The 3 unused lamp entries are set to 'None' and 'Fade' is selected.

Aspect #4 (10C Dark) in this example, is dark so each of its 4 lamp entries are set to 'None'.

'Fade' is set for each effect to simulate the slow brightening and dimming of incandescent bulbs with ballast resistors.

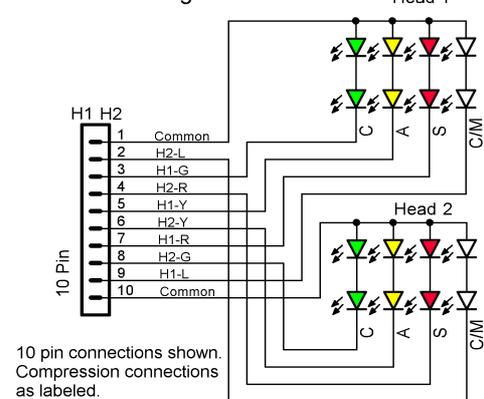
Tip

Remember, it requires less command traffic to add flashing aspects in the tables, than if you use 'Dark' and expect JMRI to turn the lamps on and off.

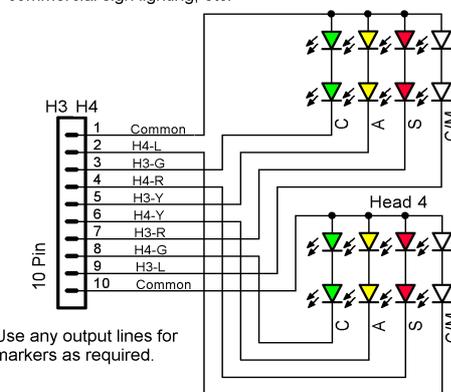
4.3.2 Color Position Light Signal Connections

For this example we are using turnout commands for aspect control. A user modeling the B&O railroad's CPL signals might use the first three lamps of Head H1 for the central aspect's color position lights. (two LEDs wired in series or parallel for each aspect color) The fourth lamp plus the 4 lamps of Head H2 could then be used to control up to 5 of the six possible B&O marker lamps.

Color Position Light Signals using LEDs driven with a SignalMan.



Unused lines may be used as grade crossing flashers, radio tower lamps, commercial sign lighting, etc.



10 pin connections shown. Compression connections as labeled.

Use any output lines for markers as required.

Another B&O mast might add a lunar for Caution and require all 4 lamps of Head H1 for the central aspect. Four markers could then use the 4 lamps from Head H2.

Yet another mast might only need 4 lamps, 3 for the CPL aspect and one used as a single marker. Both the central aspect and markers

SignalMan Signal Head Wiring for Color Position Lights

may all come from one 'head' because there are no restrictions against lighting more than one lamp at a time on the same 'head' or 'mast'. In truth the 'Head' designations are simply a wiring convention carried over from earlier generations of hardware that could only light one lamp per head at a time.

Note: These LEDs are connected 'ca' (Common Anode) to match the LEDs on the mast.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	Serial	DCC	H1-R	Steady	BP	H1-Y	Steady	H1-R	None	BP	H1-R	None	Effect Tumble Down
		9	T	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message			
2:	Serial	DCC	H1-Y	Steady	BP	H1-L	None	H1-L	Steady	BP	H1-Y	None	Effect Fade
		10	T	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message			
3:	Serial	DCC	H1-G	Steady	BP	H1-Y	Steady	H1-L	Steady	BP	H1-G	None	Effect Tumble Down
		9	C	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message			
4:	Serial	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect Fade
		10	C	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message			



Aspect #1 (9T Stop) lights 'H1-R Steady' which is connected to the Red LED. This B&O signal lights the approach aspect briefly when dropping from clear to stop. The SignalMan automatically does this effect if 'Tumble Down' is selected. First the lamp selected as 'Lamp B' is activated for 500ms, then it extinguishes and any lamps selected as 'Lamp A', 'Lamp C', and 'Lamp D' are

lighted. The 'Lamp B' position in this case is 'H1-Y'. The 2 unused lamp entries are set to 'None'.

 Aspect #2 (10T Approach) sets 'Lamp A' to 'H1-Y' for the yellow indication and 'Lamp C' to 'H1-L' for the upper center marker. The 2 unused lamp entries are set to 'None'.

 Aspect #3 (9C Clear) is similar to Aspect #1 in that it just blinks the yellow LED 'H1-Y Steady' in 'Lamp B' with the 'Tumble Down' effect, followed by lighting the green LED 'H1-G Steady' in 'Lamp A'. 'Lamp C' set to 'H1-L' for the upper center marker. The unused 'Lamp D' entry is set to 'None'.

Aspect #4 (10C Dark) in this example, is dark so each of its 4 lamp entries are set to 'None'.

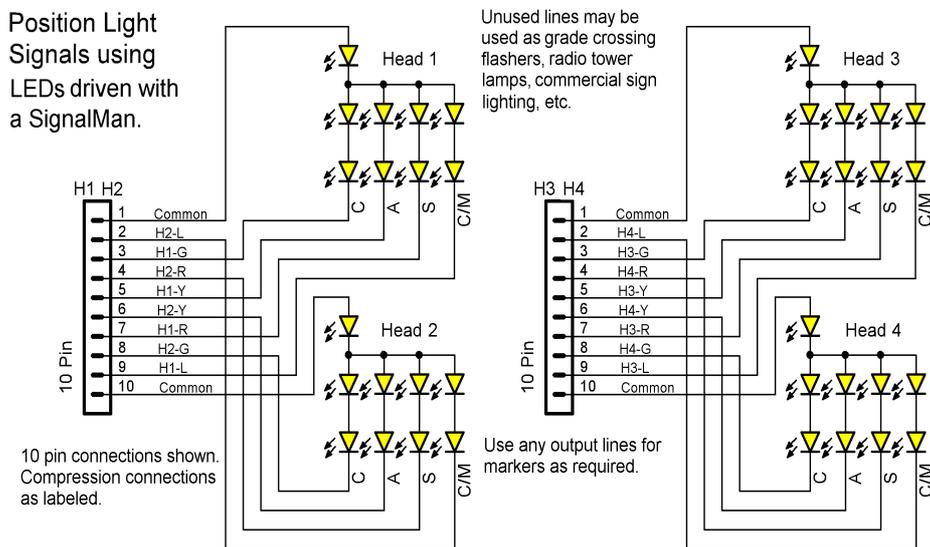
'Fade' is set for each effect to simulate the slow brightening and dimming of incandescent bulbs with ballast resistors. The 'Tumble Down' effect automatically fades its lamps.

Note

Do not allow a signal using the 'Tumble Down' effect to be flashed by software to show Cab Speed. It will blink the yellow before each green is displayed in an un-prototypical manner. Instead add an additional aspect for 'Cab Speed' that uses the SignalMan itself to flash the green lamp.

4.3.3 Position Light Signal Connections

For this example we are using NMRA DCC Aspect commands for aspect control.



This shows the simplest wiring option for position light signals. The advantage of serial connection is that all LEDs receive the same current and will show with equal brightness. LEDs are current, not voltage operated devices, and even units from the same batch will often show with different brightnesses when connected in parallel.

Tip

The wiring for the Conrail Amtrak version of these heads connects two horizontal red LEDs in place of the horizontal yellow LEDs in series on the upper head. (horizontal LEDs do not appear on the lower head) If the red LEDs are too bright simply dim them with the brightness control.

Unfortunately many commercial signal heads use parallel connections because some commonly available signal head drivers are low voltage devices that are

unable to drive a signal with 3 yellow LEDs in series. Driving such parallel LEDs is not a problem for the SignalMan, but it may require that you use different connection options. For example the center marker lamp may have its own connection.

Aspect#	Mode	Command	Lamp A Phase/Flash	Bi-Polar	Lamp B Phase/Flash	Lamp C Phase/Flash	Bi-Polar	Lamp D Phase/Flash	Lighting Effects					
17:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP <input type="checkbox"/>	H2-G	A Medium	H3-R	None	BP <input type="checkbox"/>	H3-R	None	Effect	Fade
		17	27-Appr-Limited		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
18:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-G	A Medium	H3-Y	None	BP <input type="checkbox"/>	H3-Y	None	Effect	Fade
		17	20-Limited-Clear		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
19:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP <input type="checkbox"/>	H2-G	Steady	H3-G	None	BP <input type="checkbox"/>	H3-G	None	Effect	Fade
		17	25-Appr-Medium		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
20:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-G	Steady	H3-L	None	BP <input type="checkbox"/>	H3-L	None	Effect	Fade
		17	15-Medium-Clr		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
21:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-Y	Steady	BP <input type="checkbox"/>	H2-Y	Steady	H3-R	None	BP <input type="checkbox"/>	H3-R	None	Effect	Fade
		17	23-Appr-Slow		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
22:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-Y	A Medium	H3-Y	None	BP <input type="checkbox"/>	H3-Y	None	Effect	Fade
		17	11-Medium-Appr		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
23:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-Y	Steady	H3-G	None	BP <input type="checkbox"/>	H3-G	None	Effect	Fade
		17	6-Slow-Appr		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
24:	<input type="radio"/> Turnout	<input checked="" type="radio"/> DCC	H1-R	Steady	BP <input type="checkbox"/>	H2-L	Steady	H3-L	None	BP <input type="checkbox"/>	H3-L	None	Effect	Fade
		17	4-Restricting		2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
Type DCC														

In the following examples we will use Head 1 as the upper head, and Head 2 as the lower head in a dual head mast. We will use Mast #17 in our example table.



Rule 281b Aspect #17 (27-Appr-Limited) lights 'H1-Y Steady' which is connected to the H1 45° LEDs, and 'H2-G A Medium' which is connected to the H2 vertical LEDs. It flashes the H2 LEDs.



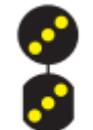
Rule 281c Aspect #18 (20-Limited-Clear) lights 'H1-R Steady' which is connected to the H1 horizontal LEDs, and 'H2-G A Medium' which is connected to the H2 vertical LEDs. It flashes the H2 LEDs.



Rule 282 Aspect #19 (25-Appr-Medium) lights 'H1-Y Steady' which is connected to the H1 45° LEDs, and 'H2-G Steady' which is connected to the H2 vertical LEDs.



Rule 283 Aspect #20 (15-Medium-Clear) lights 'H1-Y Steady' which is connected to the H1 45° LEDs, and 'H2-G Steady' which is connected to the H2 vertical LEDs.



Rule 284 Aspect #21 (23-Appr-Slow) lights 'H1-Y Steady' which is connected to the H1 45° LEDs, and 'H2-Y Steady' which is connected to the H2 45° LEDs.



Rule 286 Aspect #22 (11-Medium-Appr) lights 'H1-R Steady' which is connected to the H1 horizontal LEDs, and 'H2-Y A Medium' which is connected to the H2 45° LEDs. It flashes the H2 LEDs.

 Rule 288 Aspect #23 (6-Slow-Appr) lights 'H1-R Steady' which is connected to the H1 horizontal LEDs, and 'H2-Y Steady' which is connected to the H2 45° LEDs.

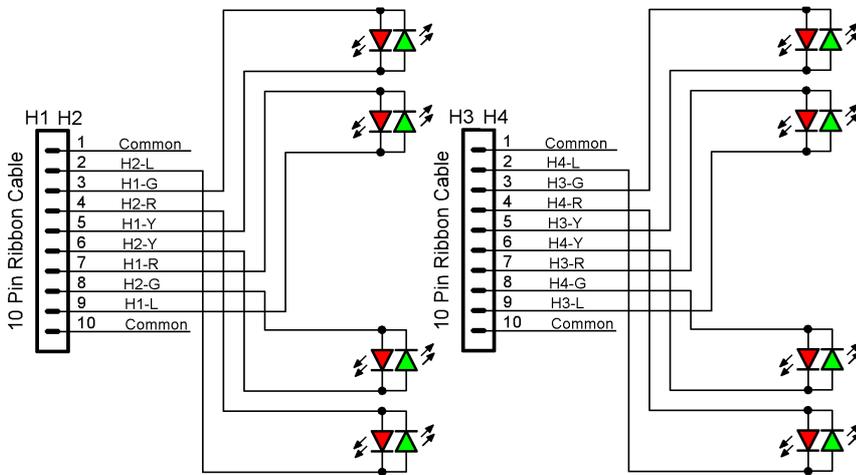
 Rule 290 Aspect #22 (4-Restricting) lights 'H1-R Steady' which is connected to the H1 horizontal LEDs, and 'H2-L Steady' which is connected to the H2 135° LEDs.

We can see from this example that the SignalMan can easily control all 8 possible aspects of the PRR dual head masts sent as 8 different NMRA DCC signal aspects for Mast number 17.

4.3.4 Searchlight Light Signal Connections (bi-polar)

For this example we are using turnout commands for aspect control. This DecoderPro file shows the settings required for driving bi-polar LEDs to show 3 colors plus the red flash seen when changing between yellow and green mechanical searchlight signals. In the SE8c setting of JMRI it outputs the following commands when using LT9 and LT10: 9T = Red, 10T = Yellow, 9C = Green, and 10T = Dark.

Searchlight Signals using bi-polar LEDs driven with a SignalMan.



You can see from this wiring diagram that H1-G and H1-Y connect to the first LED. When 'H1-Y' is low and 'H1-G' is high then the red LED lights. When 'H1-Y' is high and 'H1-G' is low then the green LED lights. To make a yellow indication both LEDs need to be lighted by rapidly alternating between the two polarities. If one

SignalMan Signal Head Wiring for bi-polar (R/G) LEDs

color or the other predominates, then use the SignalMan Brightness pane to adjust as required. You will need to resend the yellow aspect command after each brightness change to reload the PWM (pulse width modulation) registers to their new values.

Note: These LEDs are connected as if they are 'cc' (Common Cathode). Be sure to power cycle the board after changing the 'ca cc' jumper to 'cc'. Connecting as if 'ca' will reverse the red and green colors.

 Aspect #1 (9T Stop) lights 'H1-G Steady' which is connected to the Red half of the LED. The 3 unused lamp entries are set to 'None'.

Aspect#	Mode	Command	Lamp A Phase/Flash	Bi-Polar	Lamp B Phase/Flash	Lamp C Phase/Flash	Bi-Polar	Lamp D Phase/Flash	Lighting Effects					
1:	Serial	DCC	H1-G	Steady	BP	H1-G	None	H1-R	None	BP	H1-R	None	Effect	None
		9	T	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
2:	Serial	DCC	H1-G	None	BP	H1-G	Steady	H1-G	Steady	BP	H1-Y	Steady	Effect	H2 Flicker
		10	T	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
3:	Serial	DCC	H1-Y	Steady	BP	H1-G	Steady	H1-G	None	BP	H1-G	None	Effect	H2 Flicker
		9	C	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
4:	Serial	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect	None
		10	C	01	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
5:	Serial	DCC	H1-R	Steady	BP	H1-R	None	H1-R	None	BP	H1-R	None	Effect	None
		11	T	02	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
6:	Serial	DCC	H1-R	None	BP	H1-R	Steady	H1-R	Steady	BP	H1-L	Steady	Effect	H2 Flicker
		12	T	02	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
7:	Serial	DCC	H1-L	Steady	BP	H1-R	Steady	H1-R	None	BP	H1-G	None	Effect	H2 Flicker
		11	C	02	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				
8:	Serial	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect	None
		12	C	02	2nd Event 1	Polarity	send normal	Reserved (0x4X)	message	No Second Message				

Aspect #2 (10T Approach) is more complex due to the red flicker effect when a mechanical searchlight changes between green and yellow indications. The SignalMan automatically does this effect if the 'H2 Flicker' effect is selected. First the lamp selected as 'Lamp B' is activated for 100ms, then it extinguishes and any lamps selected as 'Lamp A', 'Lamp C', and 'Lamp D' are lighted. 'H1-G Steady' is connected to the red LED, so we enter it as 'Lamp B'. Then we select 'Lamp C' as 'H1-G Steady' and 'Lamp D' as 'H1-Y Steady' to light both the red and the green LEDs to yield yellow as the final color. We use 'Lamp C' and 'Lamp D' because we must also check a 'BP' (Bi-Polar) box for the pair to cause the required fast reversal to light them both. 'Lamp A' is set to 'None'.

Aspect #3 (9C Clear) is simpler in that it just flashes the red LED 'H1-G Steady' in 'Lamp B' followed by the green LED 'H1-Y Steady' in 'Lamp A'. The 2 unused lamp entries are set to 'None'.

Aspect #4 (10C Dark) in this example, is dark so each of its 4 lamp entries are set to 'None'. The 'Dark' aspect allows the control software to be able to 'Approach Control' the signal by extinguishing the lamp.

Note Do not allow a signal using the 'H2 Flicker' effect to be flashed by software to show Advance Approach. It will flicker the red before each yellow is displayed in an un-prototypical manner. Instead add an additional aspect for 'Advance Approach' that uses the SignalMan itself to flash the signal.

The second LED is controlled in a like manner using aspects #5 - #8. The difference being that the second LED is connected to 'H1-R' and 'H1-L', and output lines LT11 and LT12 are used to control the aspects.

Tip When using Bi-Polar LEDs it is difficult to get a good yellow signal. There are several reasons for this. First, because of the way that these LEDs are manufactured, the green and red dies are not close to one another. This permits both colors to be seen distinctly. Second, as the viewer changes position he will see more or less of each color due to the lens of the LED. To minimize this color shift be sure to locate the LED leads vertically to each other. Finally, neither the red nor the green colors are very close to an actual signal's colors. For best color fidelity consider using the RR-CirKits SS-RGY instead.

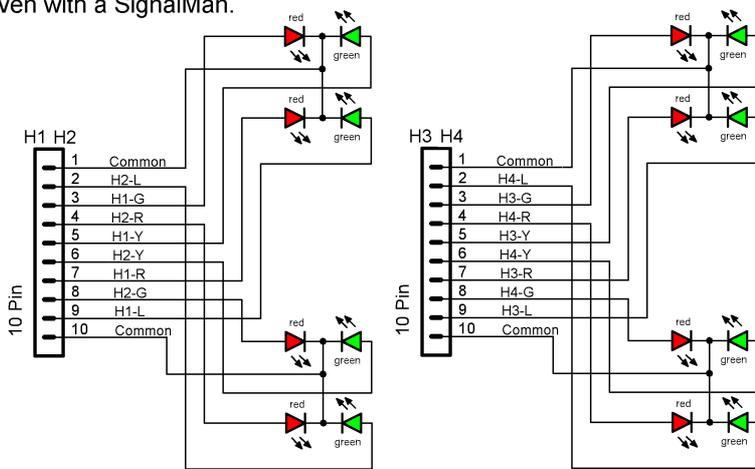
4.3.5 Searchlight Light Signal Connections (Dual Color)

Note: These LEDs are connected 'cc' (Common Cathode).

For this example we are using turnout commands for aspect control. The following DecoderPro file shows the settings required for driving dual color LEDs to show 3 colors plus the red flash seen when changing between yellow and green mechanical searchlight signals.

In the SE8c setting of JMRI it outputs the following commands when using LT9 and LT10: 9T = Red, 10T = Yellow, 9C = Green, and 10T = Dark. You can see from the wiring diagram that H1-G connects to the red side of the first LED, and H1-Y connects to the green side. To make a yellow indication both LEDs need to be lighted.

Searchlight Signals using two color LEDs driven with a SignalMan.



Aspect #1 (9T Stop) lights 'H1-G Steady' which is connected to the Red half of the LED. The 3 unused lamp entries are set to 'None'.

Aspect #2 (10T Approach) is more complex due to the red flicker effect when a mechanical searchlight changes between green and yellow indications. The SignalMan automatically does this effect if 'H2 Flicker' is selected.

SignalMan Signal Wiring for two color (3 lead R/G) LEDs

First the lamp selected as 'Lamp B' is activated for 100ms, then it extinguishes and any lamps selected as 'Lamp A', 'Lamp C', and 'Lamp D' are lighted. 'H1-G Steady' is connected to the red LED, so we enter it as 'Lamp B'. Then we select 'Lamp A' as 'H1-G Steady' and 'Lamp C' as 'H1-Y Steady' to light both the red and the green LEDs to yield yellow as the final color. 'Lamp D' is set to 'None'.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	Serial	DCC	H1-G	Steady	BP	H1-G	None	H1-R	None	BP	H1-R	None	Effect None
		9	T	01			Polarity send normal	Reserved (0x4X)			message	No Second Message	
2:	Serial	DCC	H1-G	Steady	BP	H1-G	Steady	H1-Y	Steady	BP	H1-Y	None	Effect H2 Flicker
		10	T	01			Polarity send normal	Reserved (0x4X)			message	No Second Message	
3:	Serial	DCC	H1-Y	Steady	BP	H1-G	Steady	H1-G	None	BP	H1-G	None	Effect H2 Flicker
		9	C	01			Polarity send normal	Reserved (0x4X)			message	No Second Message	
4:	Serial	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect None
		10	C	01			Polarity send normal	Reserved (0x4X)			message	No Second Message	
5:	Serial	DCC	H1-R	Steady	BP	H1-R	None	H1-R	None	BP	H1-R	None	Effect None
		11	T	02			Polarity send normal	Reserved (0x4X)			message	No Second Message	
6:	Serial	DCC	H1-R	Steady	BP	H1-R	Steady	H1-L	Steady	BP	H1-Y	None	Effect H2 Flicker
		12	T	02			Polarity send normal	Reserved (0x4X)			message	No Second Message	
7:	Serial	DCC	H1-L	Steady	BP	H1-R	Steady	H1-G	None	BP	H1-G	None	Effect H2 Flicker
		11	C	02			Polarity send normal	Reserved (0x4X)			message	No Second Message	
8:	Serial	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect None
		12	C	02			Polarity send normal	Reserved (0x4X)			message	No Second Message	

- Aspect #3 (9C Clear) is simpler in that it just flashes the red LED 'H1-G Steady' in 'Lamp B' followed by the green LED 'H1-Y Steady' in 'Lamp A'. The 2 unused lamp entries are set to 'None'.

Aspect #4 (10C Dark) in this example, is dark so each of its 4 lamp entries are set to 'None'.

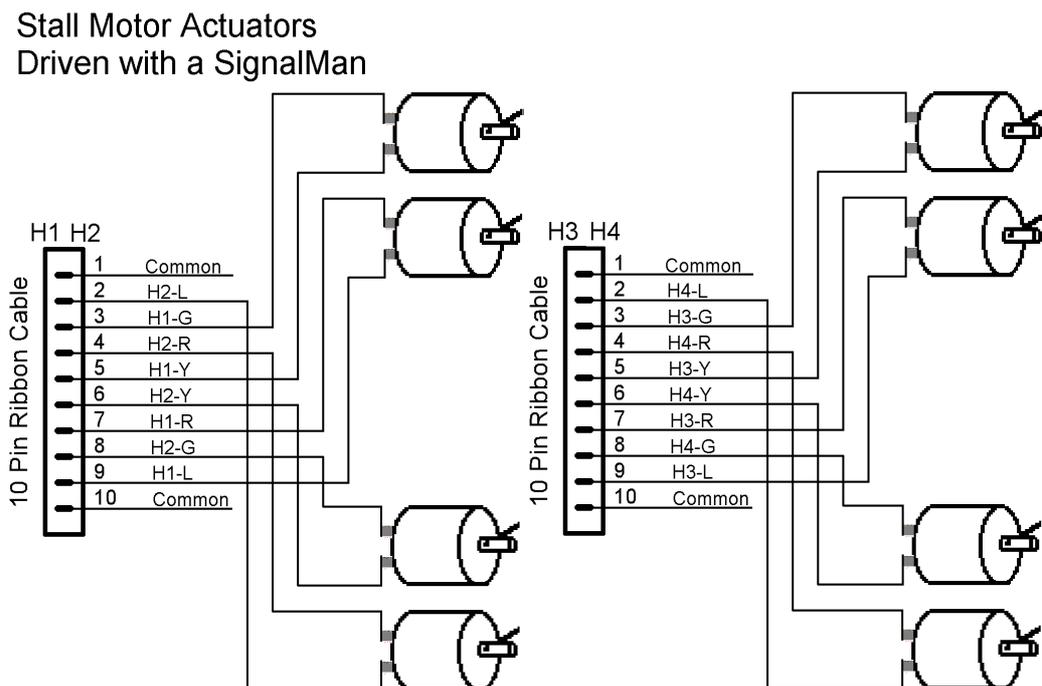
Note Do not allow a signal using the 'H2 Flicker' effect to be flashed by software to show Advance Approach. It will flicker the red before each yellow is displayed in an un-prototypical manner. Instead add an additional aspect for 'Advance Approach' that uses the SignalMan itself to flash the signal.

The second LED using aspects #5 - #8 is controlled in a like manner. The difference being that the second LED is connected to 'H1-R' and 'H1-L', and output lines LT11 and LT12 are used to control the aspects.

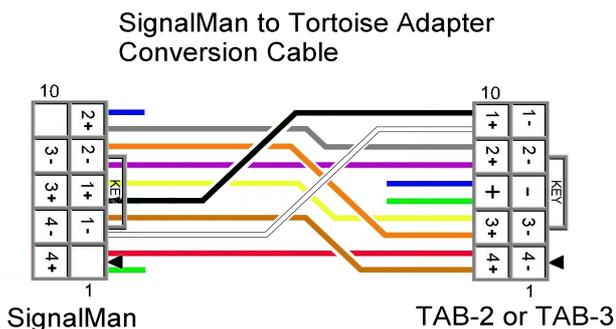
Tip When using dual color LEDs it is difficult to get a good yellow signal. The green and red dies are usually closer to each other than in a Bi-Polar LED. However both colors may still be seen distinctly. Second, as the viewer changes position he will see more or less of each color due to the lens of the LED. To minimize this color shift be sure to locate the LED leads horizontally to each other. Finally, neither the red nor the green colors are very close to an actual signal's colors. For best color fidelity consider using the RR-CirKits SS-RGY instead.

4.4 Stall Motor Machine Wiring

The following examples show how to wire low current Stall Motors such as Tortoise®, SwitchMaster® or other low current switch machines. The SignalMan outputs are rated for 20mA maximum. Most Stall Motor machines draw 10 to 20mA when running at a reasonable speed.



4.4.1 Switch Machine Connections



Switch machines represent the simplest possible control because they have just two positions, closed, and thrown, A switch machine is wired the same as a Bi-Polar LED would be, but with no need to show a 'yellow' signal.

RR-CirKits makes an adapter from the Stall Motor Driver board (SMD-8) to a Tortoise® machine. It is called the TAB-2. If you do this wire



conversion at the end of your cable it will allow the SignalMan to connect to the TAB-2 or TAB-3 boards for solderless plug connections to your Tortoise® machines. (the blue and green connections are optional for the TAB-2, but supply the lamp circuit on the TAB-3.)

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	Turnout	DCC	H1-G	Steady	BP	H1-R	None	H1-R	None	BP	H1-R	None	Effect None
		9	C	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
2:	Turnout	DCC	H1-Y	Steady	BP	H1-Y	None	H1-Y	None	BP	H1-Y	None	Effect None
		9	T	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	

This is the SignalMan Mast Table entry for a Stall Motor Turnout connected between the H1-G and H1-Y output lines and controlled by LT9.

Aspect #1 (9C) is easy. Just activate H1-G. The opposite wire will be correct.

Aspect #2 (9T) is just as easy. Activate H1-Y. The opposite wire will be correct.

Tip

When using the SignalMan to drive Stall Motors it may improve their operation to add 330 ohm resistors in parallel with the current limiter resistors to increase the output current available. You may also run the Simple Serial Bus at a higher voltage. For example, 15-18V may be required for proper traverse speeds on a 3 position Semaphore signal.

4.4.2 Semaphore Machine Connections

Semaphore machines using three position Tortoise® units require double outputs from the SignalMan to allow for three positions using the internal contacts in a Tortoise® actuator with a TAB-3 board. These can be controlled using just 4 aspects with each aspect controlling 4 output lines. The 4th aspect is 'Dark' and will extinguish the Semaphore lamp without moving the blade. Use the 'ca' polarity setting on the SignalMan.

Aspect#	Mode	Command	Lamp A	Phase/Flash	Bi-Polar	Lamp B	Phase/Flash	Lamp C	Phase/Flash	Bi-Polar	Lamp D	Phase/Flash	Lighting Effects
1:	Turnout	DCC	H1-Y	Steady	BP	H1-R	Steady	H1-R	None	BP	H1-R	None	Effect None
		9	T	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
2:	Turnout	DCC	H1-Y	Steady	BP	H1-L	Steady	H1-Y	None	BP	H1-Y	None	Effect None
		10	T	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
3:	Turnout	DCC	H1-G	Steady	BP	H1-L	Steady	H1-G	None	BP	H1-G	None	Effect None
		9	C	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	
4:	Turnout	DCC	H1-L	None	BP	H1-L	None	H1-L	None	BP	H1-L	None	Effect None
		10	C	01		2nd Event 1	Polarity	send normal		Reserved (0x4X)	message	No Second Message	



Aspect #1 (9T Stop) enables 'H1-Y Steady' and 'H1-R Steady' which moves the TAB-3 with Tortoise® controlled blade to the horizontal position. The 2 unused lamp entries are set to 'None'.



Aspect #2 (10T Approach) enables 'H1-Y Steady' and 'H1-L Steady' which moves the TAB-3 with Tortoise® controlled blade to the 45° position. The 2 unused lamp entries are set to 'None'.



Aspect #3 (9C Clear) enables 'H1-G Steady' and 'H1-L Steady' which moves the TAB-3 with Tortoise® controlled blade to the vertical position. The 2 unused lamp entries are set to 'None'.



Aspect #4 (10C Dark) is dark so each of its 4 entries are set to 'None'. This removes power from the TAB-3 board and the lamp extinguishes without moving the blade from its previous position.

5.0 SignalMan Logic Statements

In addition to the light table, the SignalMan contains 32 logic statements. Each statement may be used to control a mast and its aspect. Of course the logic blocks may also be used for other purposes because they are not tied to specific lamps or aspects. One example would be to control crossing gates and flashers.

5.1 Logic Blocks

A logic 'block' consists of several statements all related to a single mast. To calculate this logic, each logic block is treated as a group of statements independent of any other groups. The logic in any group will only be evaluated when some variable contained in that block changes state. This logic is event driven, not state driven. The logic blocks are used to do the signaling logic or other animations such as controlling grade crossings. Each statement of this table consists of an aspect identifier and two memory locations that remember the last command given for any items they are 'watching'. These memory locations remember the event information from the last seen commands to allow decision making. Any changes to these memory locations that cause a block to become 'true' will generate a new evaluation of the logic block, possibly switching to a new aspect.

Mast-Aspect logic block statements are required to be grouped together from the most restrictive aspect to the least restrictive aspect. The last entry of every block is marked by checking the 'End Logic Block' check box. Each entry that is to be evaluated must have its 'Enable' box checked. Each individual block evaluation is

Enable End Logic Block

done from top down in the list, and all evaluation for that block is terminated with the first matching statement or when the "End Logic Block" check box is reached. If no enabled Mast-Aspect evaluates to 'true' then no Mast-Aspect message is sent, and evaluation ceases until some watched variable in that block changes again.

5.2 Variables

Each statement contains zero to two variables for identifying the required sensor, turnout, and following signal's aspect information in order to do simple signal interlocking. Any logic statement evaluates to true only if its function and variables are true. A blank variable entry is considered to be true. A blank entry at the end of a logic block will cause a default aspect to be sent if no previous statement with the same mast number has evaluated to 'true'.

The state of all variables is remembered internally in order to compare them. A change in either variable's state will trigger a new comparison. The dual variable capability makes it easy to calculate the signal aspect based on turnout position and occupancy.

5.3 Functions

The 'Function' column has options for AND, and OR statements. The 'When' selection entry expands this capability. Especially note the 'V1 THEN V2' option. This allows you to only trigger on V2 if V1 was already true. This makes it easy to determine train direction simply by using two occupancy sensors.

When	V1 AND V2 => true
	V1 AND V2 => true
Condit	V1 OR V2 => true
	V1 AND V2 => false
When	V1 OR V2 => false
	V1 AND V2 => change
	V1 OR V2 => change
Condit	V1 THEN V2 => true
When	Reserved

A statement may optionally send an event when true. To send an event define the event to be sent and check the 'Enable' check box. Events sent may be LocoNet sensor, switch, or switch feedback messages. Events may also be NMRA DCC Signal Mast commands. (mast number plus aspect)

5.4 ABS Signal example

The following is an example of ABS (Automatic Block Signaling) based CTC (Centralized Traffic Control).

Portion of a former Seaboard Air Line CTC panel, Hoffman,



NC. This panel is now located at the NC Transportation Museum, Spencer, NC.

Here is a sample file that does the logic required at the left end of Hoffman siding. (the right end logic would be in the next SignalMan) We will number the occupancy sensors LS757 (South single track), LS758 (South OS), LS759 (main), LS761 (passing). The CTC machine interacts with either sensors or turnouts and are indicated here as 'LT756 Closed', 'LT758 Closed'. The South intermediate signal is L756.

The masts are numbered as on the image, but with 'm' or 's'

appended to distinguish the main signals from the siding signals. I have used the Aspect names currently in use by the CSX and many US railroads for this example.

Comment	Asp-I/O	Mast-Aspect	Asp-I/O	Variable 1	Funct	Asp-I/O	Variable 2
CTC R758 Signals Normal or OS occupied	Asp	R758 - Stop	I/O	LT758 Closed	OR	I/O	LS758 - Active
Siding occupied	Asp	R758 - Stop	I/O	LT757-Thrown	AND	I/O	LS761 - Active
Main occupied	Asp	R758 - Stop	I/O	LT757-Closed	AND	I/O	LS759 - Active
Next siding signal - stop	Asp	R758 - Medium Approach	I/O	LT757-Thrown	AND	Asp	R762s - Stop
Next main signal - stop	Asp	R758 - Approach	I/O	LT757-Closed	AND	Asp	R762 m - Stop
Next siding signal - approach	Asp	R758 - Medium Advanced Approach	I/O	LT757-Thrown	AND	Asp	R762 s- Medium Approach
Next main signal - approach	Asp	R758 - Advanced Approach	I/O	LT757-Closed	AND	Asp	R762m - Approach
Next siding signal - clear	Asp	R758 - Approach Medium	I/O	LT757-Thrown	AND	Asp	R762 s- Medium Clear
Next main signal - clear	Asp	R758 - Clear	I/O	LT757-Closed	AND	Asp	R762m - Clear
Default	Asp	R758 - Stop		--	AND		--
L758s Signals Normal	Asp	L758s - Stop	I/O	LT756 Closed	AND		--
OS occupied or Turnout opposed	Asp	L758s - Stop	I/O	LS758 - Active	OR	I/O	LT757 - Closed
Single track South - occupied	Asp	L758s - Stop	I/O	LS757 - Active			--
Single track South - approach	Asp	L758s - Medium Approach	I/O	LT757 - Thrown	AND	Asp	L756 - Stop
Single track South - Advanced	Asp	R758s - Medium Advanced Approach	I/O	LT757 - Thrown	AND	Asp	R756 - Approach
Single track South - clear	Asp	L758s - Medium Clear	I/O	LT757 - Thrown	AND	Asp	L756 - Clear
Default	Asp	L758s - Stop		--	AND		--
L758m Signals Normal	Asp	L758m - Stop	I/O	LT756 Closed	AND		--
OS occupied or Turnout opposed	Asp	L758m - Stop	I/O	LS758 - Active	OR	I/O	LT757 - Thrown
Single track South - occupied	Asp	L758m - Stop	I/O	LS757 - Active	AND		--
Single track South - Approach	Asp	L758m - Approach	I/O	LT757 - Closed	AND	Asp	L756 - Stop
Single track South - Advanced	Asp	L758m - Advanced Approach	I/O	LT757 - Closed	AND	Asp	L756 - Approach
Single track South - clear	Asp	L758m - Clear	I/O	LT757 - Closed	AND	I/O	L756 - Clear
Default	Asp	L758m - Stop		--	AND		--

5.5 APB Signal example

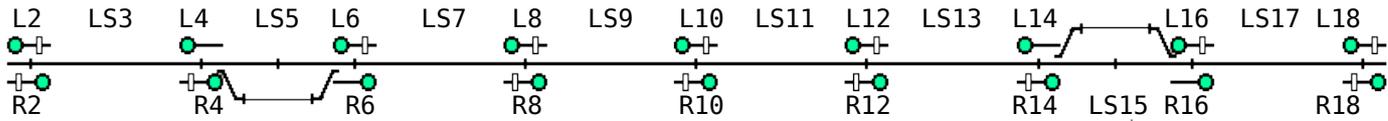
The following is an example of APB (Absolute Permissive Block). I have used the Aspect names currently in use by the CSX and many US railroads for this example.

If the train is proceeding from East to West on the main line and reaches LS15; signal R14 Clear goes to Stop-Proceed, which sets R12 Clear to Stop-Proceed,

which sets R10 Clear to Stop-Proceed, which sets R8 Clear to Stop-Proceed, which sets R6 (head block) Clear to Stop.

If 'L14 - Clear' and 'LS15 - Active', then set 'R14 - Stop-Proceed'.
 If 'L12 - Clear' and 'R14 - Stop-Proceed', then set 'R12 - Stop-Proceed'.
 If 'L10 - Clear' and 'R12 - Stop-Proceed', then set 'R10 - Stop-Proceed'.
 If 'L8 - Clear' and 'R10 - Stop-Proceed', then set 'R8 - Stop-Proceed'.
 If 'R8 - Stop-Proceed', then set 'R6 - Stop'.
 When R6 (head block) is changed to Stop, then end.

If 'LS15 - Inactive' set 'R14 - Clear or Approach'.
 If LS13 is unoccupied and R14 then unstick R12.
 If LS11 becomes unoccupied then unstick R10.
 If LS9 becomes unoccupied then unstick R8.
 If LS7 becomes unoccupied then unstick R6.



Comment	Asp-I/O	Mast-Aspect	Asp-I/O	Variable 1	Funct	Asp-I/O	Variable 2
Left - Starts tumbledown	Asp	R14 - Stop-Proceed	I/O	LS15 - Active	AND	I/O	LS13 - Inactive
Left - Starts tumbledown	Asp	R14 - Stop-Proceed	I/O	LT14 - Thrown	AND	I/O	LS13 - Inactive
Right - Block 15 occupied or Turnout thrown	Asp	R14 - Stop	I/O	LS15 - Active	OR	I/O	LT14 - Thrown
Right - Block 17 occupied	Asp	R14 - Stop	I/O	LS17 - Active	AND		--
Right - R14 Approach	Asp	R14 - Approach	Asp	R16 - Stop	AND		--
Right - R14 Clear	Asp	R14 - Clear		--	AND		--
Right - L14 Stick	Asp	L14 - Stop-Proceed	Asp	L12 - Stop-Proceed	AND		--
Left - Block 13 occupied	Asp	L14 - Stop	I/O	LS13 - Active	AND		--
Left - L14 Approach	Asp	L14 - Approach	Asp	L12 - Stop	AND		--
Left - L14 Clear	Asp	L14 - Clear		--			--
Left - R12 Stick	Asp	R12 - Stop-Proceed	Asp	R14 - Stop-Proceed	AND		--
Right - Block 13 occupied	Asp	R12 - Stop	I/O	LS13 - Active	AND		--
Right - R12 Approach	Asp	R12 - Approach	Asp	R14 - Stop	AND		--
Right - R12 Approach Medium	Asp	R12 - Approach Medium	Asp	R14 - Approach	AND		--
Right - R12 Clear	Asp	R12 - Clear		--	AND		--
Right - L12 Stick	Asp	L12 - Stop-Proceed	Asp	L10 - Stop-Proceed	AND		--
Left - Block 11 occupied	Asp	L12 - Stop	I/O	LS11 - Active	AND		--
Left - L12 Approach	Asp	L12 - Approach	Asp	L10 - Stop	AND		--
Left - L12 Clear	Asp	L12 - Clear		--	AND		--
Left - R10 Stick	Asp	R10 - Stop-Proceed	Asp	R12 - Stop-Proceed	AND		--
Right - Block 11 occupied	Asp	R10 - Stop	I/O	LS11 - Active	AND		--
Right - R10 Approach	Asp	R10 - Approach	Asp	R12 - Stop	AND		--
Right - R10 Clear	Asp	R10 - Clear		--	AND		--
Crossing active	Asp	Cross buck - flashing	I/O	LS approach - Active	AND	Asp	Cross buck - clear
Crossing active	Asp	Cross buck - flashing	I/O	LS island - Active	AND	Asp	Cross buck - clear
Crossing inactive	Asp	Cross buck - clear	I/O	LS island - Inactive	AND		--
Crossing inactive	Asp	Cross buck - clear	I/O	LS approach - Inactive	AND	I/O	LS island - Inactive

6.0 Input/Output Cards

The RR-CirKits SignalMan and other I/O cards are designed to be clipped into Tyco 3-1/4" Snap-Track® mounted to the bench work. (Snap-Track® is a plastic channel designed to mount PC cards to a chassis, not something to run trains on.) Each I/O module is equipped with two connectors to facilitate these connection options. A single SignalMan fits into the 3TK2-1 (single) mounting track.

7.0 Trouble shooting

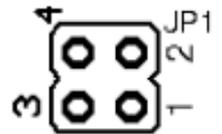
7.1 Sanity Test

To perform a very basic SignalMan sanity test perform the following steps:

- Power up the SignalMan by plugging it into the power supply.
- The green power LED should come on.
- The previous signal state should be automatically be restored.

Or

- Apply the JP1 1 - 3 option jumper.
- Power up the SignalMan by plugging it into the power supply.
- This causes an error and the COM LED should flash rapidly if the unit is operational.



If the green power LED does not light, be sure that a power supply is connected to the Simple Serial Bus, or the DCC track power is on, and provides at least 9V to the SignalMan.

7.2 Activity Test

The SignalMan's input circuit and code sends data directly to the unit's processor, so if you send any command to the unit it should immediately be seen on the command (COM) LED. This test uses the free software available from the JMRI project to watch the test commands. (www.jmri.org)

Steps:

- Open the JMRI LocoNet® Monitor window. Using the signal table send a command to any head on this SignalMan. The command should appear in the LocoNet® monitor window and the SignalMan command (Y) LED should blink.
- The connected output should respond.

If there is activity at the LocoBuffer-USB red LED, but no activity light at the SignalMan when switch or signal commands are sent, check the Simple Serial Bus wiring. If the command is seen in the LocoNet® monitor, but not in the command light, be sure that the command you are sending is addressed to respond on this SignalMan. If there is no activity shown in the LocoNet® monitor window, check

that you have the correct interface selected in the JMRI preferences, and that you have the correct COM port selected.

7.3 Factory Reset

If the SignalMan settings get lost restore the address as shown in section 2.0. The factory default address with JP1 1-3 in place is 9999. The SignalMan is also forced into Master Mode by the JP1 1-3 jumper, so it may be programmed on a stand alone bus.

Steps:

- 1) Power the unit.
- 2) Apply jumper at JP1 1-3
- 3) Use the SignalMan Default roster entry to restore the proper address for this unit in the "Basic" tab, then switch to the "CVs" tab and write just CV17 and CV18.
- 4) Remove the JP1 1-3 jumper
- 5) Remove then restore power to return the SignalMan back to its normal operating mode.

8.0 Boot Loader

If an update to your SignalMan firmware is needed, a program such as "Download Firmware" in JMRI version 2.4 or later is required.

To enter Boot loader mode:

- 1) Remove power from the SignalMan.
- 2) Add a jumper at JP1 3-4.
- 3) Apply power to the SignalMan. The yellow COM light should light.
- 4) Remove the JP1 3-4 jumper.
- 5) The yellow COM LED will continue to light steadily indicating that the boot loader is now ready to accept messages from the JMRI Downloader.
- 6) Start JMRI and select "LocoNet" then "Download Firmware".
- 7) Select the latest SignalMan upgrade and click "Read file" then "Download".
- 8) The COM LED will blink very faintly each time it receives a data packet from the JMRI down loader.
- 9) When programming is successful, the yellow COM LED will extinguish automatically, and normal operation will resume automatically.

Error codes:

During boot loading, several possible error codes are shown by the yellow LED:

- 1 blink: manufacturer code or product code mismatch; - Be sure that you have chosen the proper file to upload.
- 2 blinks: hardware version mismatch; - You may need to select "Accept later hardware versions".

- 3 blinks: hex file software version equal or lower; - You may need to select "Don't check software version".
- 4 blinks: unused (no LocoNet® data).
- 5 blinks: internal programming error detected. - The operation has failed, see below.

Each of the above errors will halt the boot loader process. To recover from these error types, remove power from the SignalMan, add the jumper at JP1 3-4, apply power again, then remove the jumper as before. Correct the error, and then re-run the JMRI program.

To recover from the last error type, it must be assumed that the firmware is in an undefined state, most probably damaged or incomplete. If the process is interrupted for any reason you will also end up with corrupted firmware which must be reloaded. The boot loader code itself is protected against being written over.

9.0 Grounding and Isolation

Unlike the LocoBuffer-USB and the Tower Controller, the SignalMan is not optically isolated from the Simple Serial Bus. This allows for possible ground loop problems between the LocoNet® and your layout power supplies, so be sure to keep the ground connection to the Terminator unit isolated, or else in common with your booster's power source.

Normally all SignalMan connections originate on the SignalMan board itself, so there is no danger of ground loops. If you are controlling multiple masts with common connections such as a signal bridge, then it is permissible to connect together the common lines from multiple SignalMan boards.

Properly ground your boosters, your power supplies, and your desktop computer through a 3 wire cable, and isolate them from each other via isolated equipment where necessary.

10.0 Warranty Information

We offer a one year warranty on the SignalMan. This device contains no user serviceable parts. If a defect occurs, please contact RR-CirKits at: service@rr-cirkits.com for a replacement.

11.0 FCC Information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any modifications to this device voids the user's authority to operate under and be in compliance with these regulations. The actual measured radiation from the SignalMan is much lower than the maximum that is permitted by the FCC Rules, so it is unlikely that this device will cause any RFI problems.

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