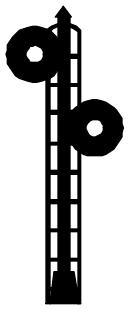
SearchlightMaster™



Installation Guide

Revision 1.3a
9/4/02

***LOGIC RAIL*™**
TECHNOLOGIES

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1.0 INTRODUCTION

Thank you for purchasing a ***Logic Rail Technologies*** product! Please read all instructions prior to installing this board. **CAUTION:** The *SearchlightMaster* contains circuits which can be sensitive to electrostatic discharge. Store the *SearchlightMaster* board in its static protective bag until you are ready to install it. Avoid a build-up of static electricity and handle the board by its edges to minimize potential damage.

1.1. Package Contents

The following items should be found in the *SearchlightMaster* packaging:

- *SearchlightMaster* board
- flat, ribbon cable assembly for connection to trackside signal heads
- flat, ribbon cable assembly for connection to signal controlling inputs (signaling circuit, computer interface, etc.)
- installation guide (what you're reading!)

1.2. Electrical & Mechanical Data

The *SearchlightMaster* has the following electrical and mechanical specifications:

Board size:	2.5" x 3"
Board height:	1"
Mounting holes:	0.125" (quantity 4)
Input Voltage:	6.3V - 16V AC or DC
Output Voltage:	DC, value depends upon input voltage
Power Consumption:	≤ 250mA when all LEDs are illuminated
Signal Head Cable Length:	2'
Control Input Cable Length:	2'

1.3. Locating the *SearchlightMaster*

The *SearchlightMaster* board is best located underneath your layout near the signals that it is controlling. You can use the holes on the *SearchlightMaster* board to mount it. Do **NOT** enlarge the holes. Irreparable damage may occur and you will certainly void the warranty! You should locate the *SearchlightMaster* board in an area where there is some ventilation. **CAUTION:** The voltage regulator on-board the *SearchlightMaster* can get hot so it is best to have some airflow around it. This is located in the upper left corner of the board and has a black finned heatsink attached to it. Try not to touch it - burnt fingers are not covered under the warranty!

2.0 THEORY OF OPERATION

The *SearchlightMaster* translates the green, yellow and red lines for a standard 3-color signal into the type of electrical signals required to control the bipolar LED used in searchlight signals. A bipolar LED consists of a red and a green element encased in a single housing. In order to generate a yellow indication the *SearchlightMaster* simply alternates the turning on of the red element and the green element. The result to the human eye is a blend of the two colors which is yellow! The *SearchlightMaster* has two modes of operation: multiplexed inputs and non-multiplexed inputs. Our *SignalMaster* product generates multiplexed signal control outputs. It is beyond the scope of this manual to describe multiplexed inputs. Most other signal control or train detection systems use non-multiplexed inputs. This simply means for a given bipolar LED there are two or three distinct inputs. The following tables illustrate the relationship between the inputs and the outputs for a bipolar LED.

signal control inputs			Bipolar LED Outputs	
Green	Yellow	Red	Green	Red
off	off	off	off	off
on	off	off	on	off
off	on	off	on/off	off/on
off	off	on	off	on

Table 1 - Non-multiplexed inputs (green, yellow, red)

signal control inputs		Bipolar LED Outputs	
Green	Red	Green	Red
off	off	off	off
on	off	on	off
off	on	off	on
on	on	on/off	off/on

Table 2 - Non-multiplexed inputs (green, red)

You can see from the above tables that there are two ways to provide non-multiplexed inputs to the *SearchlightMaster*. You can either provide individual green, yellow, and red signal inputs or you can provide just green and red signal inputs. In the latter case if both green and red inputs are “on” then it is interpreted as a yellow condition. Also notice that if none of the signal control inputs are “on” that neither of the bipolar LED outputs are “on.” In other words, the LED will be dark! This is done to support signal systems that perform approach lighting!

3.0 SWITCH AND JUMPER SETTINGS

There are two switches (labeled MAST and COMA) and one jumper (labeled E1) on the *SearchlightMaster* board. ALL switch and jumper settings should be made prior to applying power to the *SearchlightMaster* board. The locations of the switches and jumper are illustrated in Figure 1.

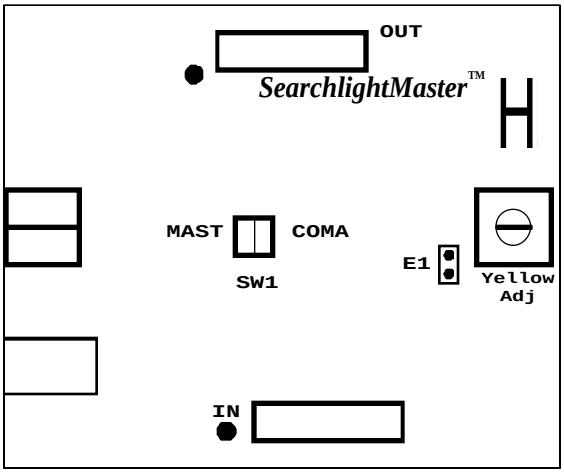

Figure 1

The switch settings are described in the following table:

Switch #	Description
1	Mast Select. When connecting to the ***SignalMaster*** this switch chooses which Mast Select outputs to use (ON/CLOSED = Mast Selects 1-4, OFF/OPEN = Mast Selects 5-8). When connecting to other signal control systems this switch will determine how many inputs are used per bipolar LED (ON/CLOSED = 2 inputs (G,R) per bipolar LED, OFF/OPEN = 3 inputs (G,Y,R) per bipolar LED)
2	Common Anode Signal Control Inputs. When connecting to the ***SignalMaster*** this switch should be in the same position as the corresponding one on the ***SignalMaster***. With other signal control systems this switch should will usually be ON/CLOSED. See the text below.

Table 3

Jumper E1 determines whether the *SignalMaster* is being used or not. The small white or black shorting block should only cover one pin on E1 when connecting to the *SignalMaster*. For all other applications the shorting block should cover both pins on E1. This is depicted below.

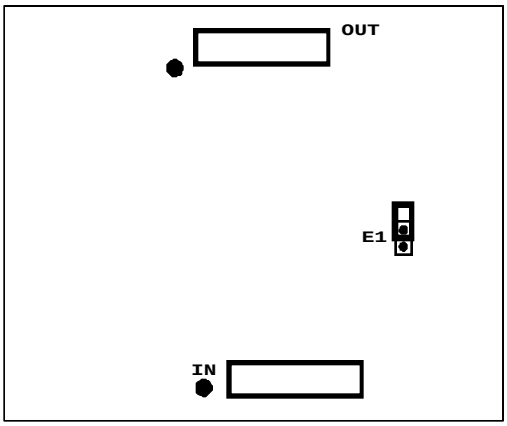

Figure 2 - Jumper position for ***SignalMaster***

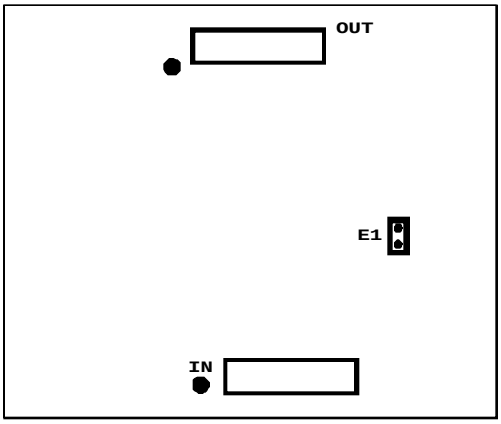

Figure 3 - Jumper position for other signal control systems

Care must be taken when using signal control systems other than the *SignalMaster*. In this application the COMA switch will be in the ON/CLOSED position indicating that the inputs are active when they are ≤ 0.8VDC; they are said to be "active low." However, some signal control systems have outputs that when active are at a high voltage level. In this situation it is still possible to use the *SearchlightMaster* provided the signal control inputs are never more than 5.0VDC. In this situation the COMA switch should be in the OFF/OPEN position and so an active input is one which is ≥ 2.4VDC.

4.0 *SearchlightMaster* POWER

There are several different ways to power the *SearchlightMaster*. Since the *SearchlightMaster* accepts AC or DC power at a minimum of 6.3V you can use a variety of power sources. The *SearchlightMaster* accepts AC or DC power through its power jack or DC power through its screw terminals. Wall transformers (available from places such as Radio Shack) provide a convenient and inexpensive means of providing power. The mating connector on the wall transformer should be a 2.1mm (I.D.) x 5.5mm (O.D.) female type. If you choose to use DC power via the screw terminals take great care in matching the polarity. Severe damage to the *SearchlightMaster* could result if power is applied incorrectly. The *SearchlightMaster's* current requirements vary based on the number of signal heads connected. Your power source can be shared among multiple *SearchlightMaster* boards if it can provide sufficient current for each *SearchlightMaster*. For example, a single AC power source can be connected to one *SearchlightMaster*. The DC connections on that *SearchlightMaster's* screw terminals can then be connected to the DC connections on other *SearchlightMaster* boards; this is depicted in Figure 4. However, do not power more than three additional *SearchlightMaster* boards from one *SearchlightMaster*. Do NOT "daisy-chain" the AC power between *SearchlightMaster* boards.

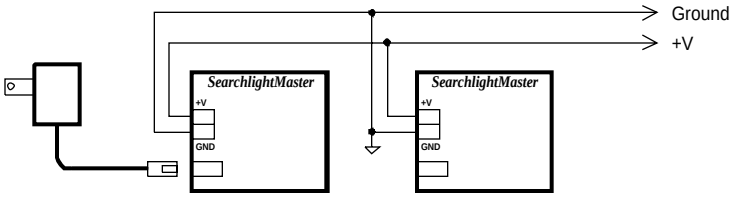

Figure 4

Alternatively, you can use a DC power source and daisy-chain it among *SearchlightMaster* boards as illustrated in Figure 5. In this case the limit to the number of boards powered together is dictated by the maximum output capacity of the DC power supply.

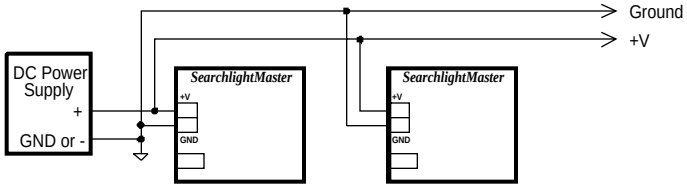

Figure 5

You can power the *SearchlightMaster* from the *SignalMaster*'s DC lines when using it for the signal controller. This is shown in Fig. 6.

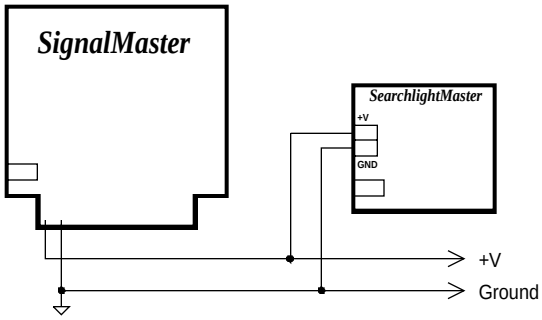

Figure 6

NOTE: When using command control you CANNOT daisy-chain *SearchlightMaster* boards used in different Power Districts. Consult your signal control system or command control system instruction guide for the definition of a Power District.

NOTE: No matter how you choose to power the *SearchlightMaster* you MUST have connect together the ground of the *SearchlightMaster* and the ground of the signal control system. This is shown in Figure 7.

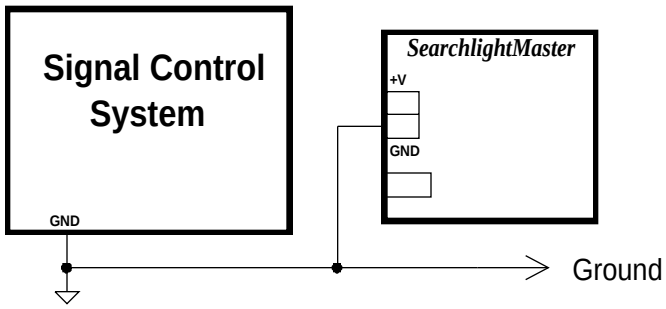

Figure 7

5.0 SIGNAL CONTROL INPUTS

There are 16 signal control inputs on the *SearchlightMaster*. The input mode you select will determine the maximum number of individual bipolar LEDs that are controlled by the *SearchlightMaster*.

5.1. Connecting to the *SignalMaster*

Nothing could be simpler! Just plug one of the sockets on the *SignalMaster's* signal head cable onto the connector labelled "IN" on the *SearchlightMaster* (refer to Figure 8 below). The *SignalMaster's* signal head cable is designed so that you can connect up to two *SearchlightMaster* boards to it and have up to sixteen searchlight signal heads. The standard 3-color signal control outputs of the *SignalMaster* are still available at the stripped-lead end of the cable!

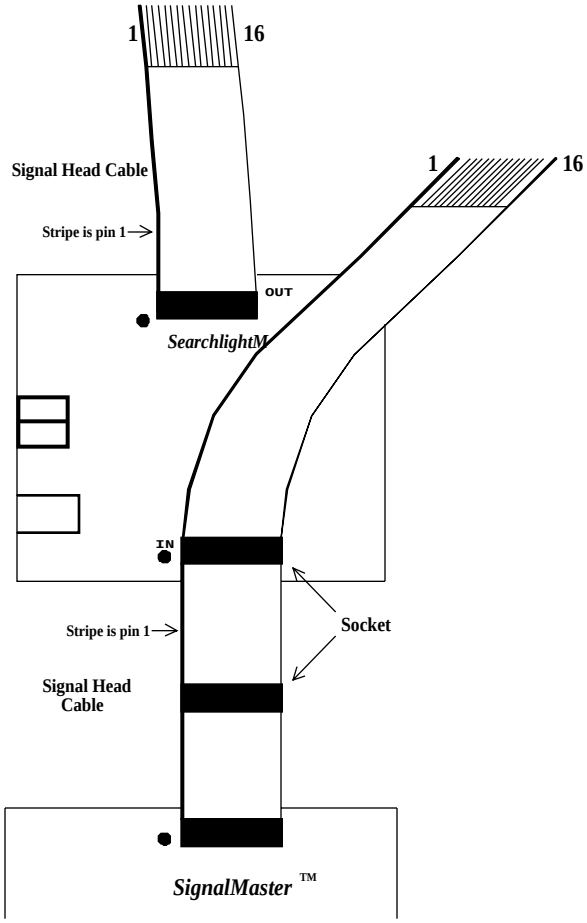

Figure 8

5.2. Connecting to other signal control systems

The simplest way to activate one of the *SearchlightMaster* signal control inputs is to connect it to ground. However, that input will thus always be considered active (i.e. it is a static signal). The more common way to control the signal inputs is with active components (diodes, transistors, relays). Most signal control and train detection systems use transistors to drive the signals (for example, Chubb's C/MRI). This section will focus on those systems which use active low logic. That means that an electrical signal will be at approximately 0 volts when it's considered "active" or "on." It is important to note that in this implementation an electrical signal which is "inactive" or "off" does NOT have a valid voltage level associated with it; the signal is said to be "floating." Most signal control and train detection systems use an open-collector transistor output which does exactly this. However, there are some systems which do have a distinct voltage level when the output is

"off." As long as this voltage does NOT exceed +5V then there is no problem in using it with the *SearchlightMaster*. Figure 9 illustrates how the signal control input cable is connected to the board. Carefully plug the black connector onto the mating gold pins on the *SearchlightMaster* board with the stripe along the lefthand side and near the large white dot on the board.

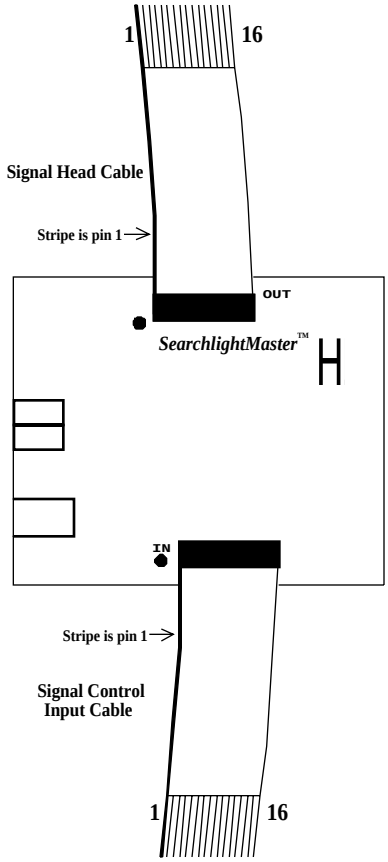

Figure 9

You must choose the appropriate non-multiplexed input mode that best fits the signal control system you're using. For example, if you are using a system which provides individual green, yellow and red signal controls then you should choose the "3-inputs per bipolar LED mode" (MAST switch OFF/OPEN). In this mode you may be limited to controlling a total of 5 individual bipolar LEDs (i.e. 5 searchlight signal heads); see section 5.2.1. If you are using a system which only provides individual green and red signal controls then choose the "2-inputs per bipolar LED mode." In this mode you can control up to 8 individual bipolar LEDs. NOTE: in this mode if your signal control system is UNABLE to activate both the red and green inputs simultaneously you will NOT be able to generate a yellow indication. For users of Chubb's C/MRI we recommend that you use this 2-input mode as it will support the greater number of bipolar LEDs. You can certainly write the software to turn on both the red and green lines when a yellow condition is desired. More on this subject in section 5.2.2. You can also control the inputs manually with switches. Figure 10 below illustrates the use of three individual SPST (single pole single throw) switches. To operate you would simply flip one of the switches to the "on" position. If none of the three switches are on then the LED will remain dark. In this example you must choose the "3-inputs per bipolar LED mode." You could duplicate the set of switches five times in order to control five separate searchlight signals. Alternatively you could add a few diodes to the switches as shown in Figure 11 and described in the next section. In this example you should choose the "2-inputs per bipolar LED mode." As such you would then be able to duplicate the "circuit" eight times in order to control eight separate searchlight signals.

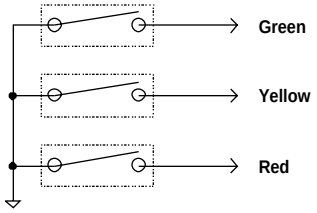

Figure 10

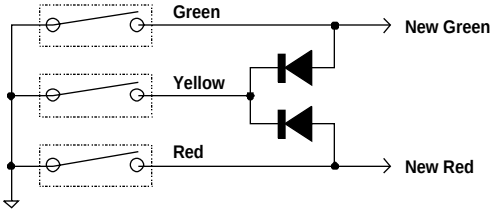

Figure 11

5.2.1. 3-inputs per bipolar LED mode

As previously described this mode may limit you to 5 bipolar LEDs (3 inputs per bipolar LED X 5 bipolar LEDs = 15 inputs). However, depending upon the electrical characteristics of your signal control system you MAY be able to "translate" the 3 inputs into 2 inputs. First, Table 4 shows the pinout of the signal control input cable when using 3-inputs per bipolar LED.

Pin #	Description
1	Grn, signal 1
2	Yel, signal 1
3	Red, signal 1
4	Grn, signal 2
5	Yel, signal 2
6	Red, signal 2
7	Grn, signal 3
8	Yel, signal 3
9	Red, signal 3
10	Grn, signal 4
11	Yel, signal 4
12	Red, signal 4
13	Grn, signal 5
14	Yel, signal 5
15	Red, signal 5
16	not used

Table 4

If your signal control system's outputs consist of open-collector transistors then chances are good that when these outputs are active they are at ≈0.2V. If so then you can use "diode logic" to "translate" the green, yellow, and red control lines into just green and red control lines. This will also work in the manual control example in Figure 11. As previously mentioned, in "2-inputs per bipolar LED mode" when both the green and red control lines are active the result will be a yellow indication. In this case then we'll need to activate the *SearchlightMaster's* green and red control inputs when the yellow control line is active. This "OR" function is easily done with inexpensive diodes. The symbol for a diode and its terminals are shown in Figure 12. The concept used here is *negative logic*. Consider the circuit in Figure 13. If either the green or yellow control lines are at a low voltage then line *new green* (*SearchlightMaster's* green control input) will be at a low voltage. Similarly if either the red or yellow control lines are at a low voltage then line *new red* (*SearchlightMaster's* red control input) will be at a low voltage. If either the green or red control lines are at a low voltage then only line *new green* or *new red*, respectively, will be at a low voltage.

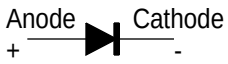

Figure 12

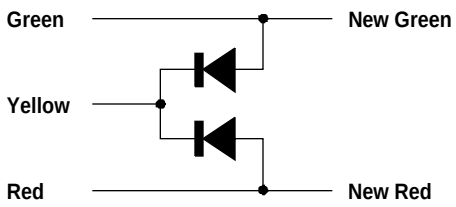

Figure 13

The diodes used are the popular 1N4001 (Radio Shack #276-1101). The band on the diode is the cathode (negative side). If your signal control system can operate in this manner or you're using manually operated switches as in Figure 11 then you should choose the "2-inputs per bipolar LED mode" and refer to section 5.2.2.

5.2.2. 2-inputs per bipolar LED mode

As described above in this mode there are 2-inputs per bipolar LED. That means that you can have up to 8 bipolar LEDs (2 inputs per bipolar LED X 8 bipolar LEDs = 16 inputs). The signal control input cable pinout is shown in Table 5.

Pin #	Description
1	Grn, signal 1
2	Red, signal 1
3	Grn,signal 2
4	Red, signal 2
5	Grn,signal 3
6	Red, signal 3
7	Grn,signal 4
8	Red, signal 4
9	Grn,signal 5
10	Red, signal 5
11	Grn,signal 6
12	Red, signal 6
13	Grn,signal 7
14	Red, signal 7
15	Grn, signal 8
16	Red, signal 8

Table 5

As mentioned previously, if you want to generate a yellow signal in this mode you'll need to activate both the green and red inputs simultaneously. With Chubb's C/MRI this is easy to do. Instead of using a single line from the output card for red and then running it through an inverter for green, you should use two separate lines from the output card thereby eliminating the inverter; see Figure 14 below. Your C/MRI software should then turn on the lines from the output card according to Table 2 in this document.

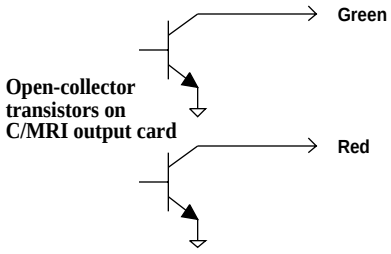

Figure 14

6.0 SIGNAL HEAD CONNECTIONS

The *SearchlightMaster* directly drives the bipolar LEDs found in searchlight signals. Remember to always use a current limiting resistor for each LED; we recommend a value of 150Ω (available from Radio Shack). Higher values will limit the current more and cause the LED to be dimmer. Figure 15 below illustrates the wiring for the two different types of bipolar LEDs. Figure 16 illustrates a different way to use current limiting resistors with a three-lead bipolar LED. In this case you can use a different resistor value for the two colors. In this way you can slightly adjust the brightness of each LED if necessary.

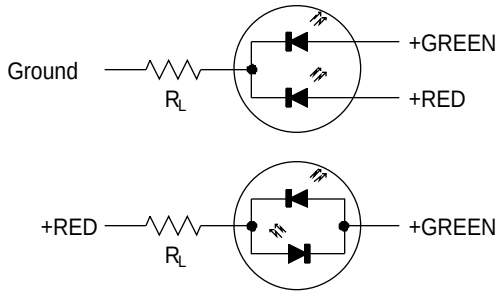

Figure 15

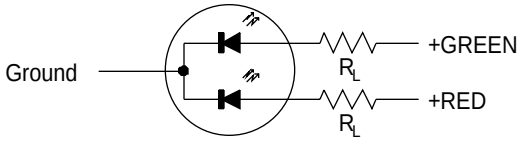

Figure 16

As shown in Figures 8 & 9 the signal head cable has a stripe on one side. Carefully plug the black connector onto the mating gold pins on the *SearchlightMaster* board with the stripe along the lefthand side and near the large white dot on the board. The following tables show the signal head cable pinout (pin 1 on the cable has the stripe). Choose the table based upon which configuration of the *SignalMaster* you're using. If you're not using the *SignalMaster* mode then choose the correct table based upon which of the other modes (3-inputs per bipolar LED or 2-inputs per bipolar LED) you're using.

SignalMaster **Track Configuration 1a - 1d**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1L	Red, Signal 5L
2	Green, Signal 1L	Green, Signal 5L
3	Red, Signal 1R	Red, Signal 5R
4	Green, Signal 1R	Green, Signal 5R
5	Red, Signal 2L	Red, Signal 6L
6	Green, Signal 2L	Green, Signal 6L
7	Red, Signal 2R	Red, Signal 6R
8	Green, Signal 2R	Green, Signal 6R
9	Red, Signal 3L	Red, Signal 7L
10	Green, Signal 3L	Green, Signal 7L
11	Red, Signal 3R	Red, Signal 7R
12	Green, Signal 3R	Green, Signal 7R
13	Red, Signal 4L	Red, Signal 8L
14	Green, Signal 4L	Green, Signal 8L
15	Red, Signal 4R	Red, Signal 8R
16	Green, Signal 4R	Green, Signal 8R

SignalMaster **Track Configuration 2a -2f**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1LM	Red, Signal 6L
2	Green, Signal 1LM	Green, Signal 6L
3	Red, Signal 1R	Red, Signal 6RM
4	Green, Signal 1R	Green, Signal 6RM
5	Red, Signal 1LS	not used
6	Green, Signal 1LS	not used
7	not used	Red, Signal 6RS
8	not used	Green, Signal 6RS
9	Red, Signal 3L	Red, Signal 7L
10	Green, Signal 3L	Green, Signal 7L
11	Red, Signal 4L	Red, Signal 7R
12	Green, Signal 4L	Green, Signal 7R
13	Red, Signal 3R	Red, Signal 8L
14	Green, Signal 3R	Green, Signal 8L
15	Red, Signal 4R	Red, Signal 8R
16	Green, Signal 4R	Green, Signal 8R

SignalMaster **Track Configuration 3a -3g**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1L	Red, Signal 5LM
2	Green, Signal 1L	Green, Signal 5LM
3	Red, Signal 2L	Red, Signal 5R
4	Green, Signal 2L	Green, Signal 5R
5	Red, Signal 1R	Red, Signal 5LS
6	Green, Signal 1R	Green, Signal 5LS
7	Red, Signal 2R	not used
8	Green, Signal 2R	not used
9	Red, Signal 4L	Red, Signal 7L
10	Green, Signal 4L	Green, Signal 7L
11	Red, Signal 4RM	Red, Signal 8L
12	Green, Signal 4RM	Green, Signal 8L
13	not used	Red, Signal 7R
14	not used	Green, Signal 7R
15	Red, Signal 4RS	Red, Signal 8R
16	Green, Signal 4RS	Green, Signal 8R

SignalMaster **Track Configuration 4**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1L	Red, Signal 6T
2	Green, Signal 1L	Green, Signal 6T
3	Red, Signal 1R	Red, Signal 6B
4	Green, Signal 1R	Green, Signal 6B
5	Red, Signal 2L	Red, Signal 7T
6	Green, Signal 2L	Green, Signal 7T
7	Red, Signal 2R	Red, Signal 7B
8	Green, Signal 2R	Green, Signal 7B
9	Red, Signal 4L	Red, Signal 8T
10	Green, Signal 4L	Green, Signal 8T
11	Red, Signal 4R	Red, Signal 8B
12	Green, Signal 4R	Green, Signal 8B
13	Red, Signal 5L	not used
14	Green, Signal 5L	not used
15	Red, Signal 5R	not used
16	Green, Signal 5R	not used

SignalMaster **Track Configuration 5a-5d**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1aL	Red, Signal 5aL
2	Green, Signal 1aL	Green, Signal 5aL
3	Red, Signal 1aR	Red, Signal 5aR
4	Green, Signal 1aR	Green, Signal 5aR
5	Red, Signal 2aL	Red, Signal 1bL
6	Green, Signal 2aL	Green, Signal 1bL
7	Red, Signal 2aR	Red, Signal 1bR
8	Green, Signal 2aR	Green, Signal 1bR
9	Red, Signal 3aL	Red, Signal 2bL
10	Green, Signal 3aL	Green, Signal 2bL
11	Red, Signal 3aR	Red, Signal 2bR
12	Green, Signal 3aR	Green, Signal 2bR
13	Red, Signal 4aL	not used
14	Green, Signal 4aL	not used
15	Red, Signal 4aR	not used
16	Green, Signal 4aR	not used

SignalMaster **Track Configuration 6a -6d**

Pin #	Description (MAST = ON/CLOSED)	Description (MAST = OFF/OPEN)
1	Red, Signal 1LM	Red, Signal 6L
2	Green, Signal 1LM	Green, Signal 6L
3	Red, Signal 3LS	not used
4	Green, Signal 3LS	not used
5	Red, Signal 1R	Red, Signal 6RM
6	Green, Signal 1R	Green, Signal 6RM
7	not used	Red, Signal 8RS
8	not used	Green, Signal 8RS
9	Red, Signal 3LM	Red, Signal 8L
10	Green, Signal 3LM	Green, Signal 8L
11	Red, Signal 1LS	not used
12	Green, Signal 1LS	not used
13	Red, Signal 3R	Red, Signal 8RM
14	Green, Signal 3R	Green, Signal 8RM
15	not used	Red, Signal 6RS
16	not used	Green, Signal 6RS

3-inputs per bipolar LED mode (non-*SignalMaster*)

Pin #	Description
1	Red, signal 1
2	Green, signal 1
3	Red, signal 2
4	Green, signal 2
5	Red, signal 3
6	Green, signal 3
7	Red, signal 4
8	Green, signal 4
9	Red, signal 5
10	Green, signal 5
11	not used
12	not used
13	not used
14	not used
15	not used
16	not used

2-inputs per bipolar LED mode (non-*SignalMaster*)

Pin #	Description
1	Red, signal 1
2	Green, signal 1
3	Red, signal 2
4	Green, signal 2
5	Red, signal 3
6	Green, signal 3
7	Red, signal 4
8	Green, signal 4
9	Red, signal 5
10	Green, signal 5
11	Red, signal 6
12	Green, signal 6
13	Red, signal 7
14	Green, signal 7
15	Red, signal 8
16	Green, signal 8

7.0 YELLOW HUE ADJUSTMENT

The mix of red and green when displaying yellow can be adjusted on the *SearchlightMaster* board. You may wish to adjust the "factory setting" depending upon the yellow hue achieved with your particular brand of searchlight signals. Using a small slotted screwdriver slowly turn the potentiometer labeled "Yellow Adj" clockwise for more red and less green. Turn it counter-clockwise for less red and more green. All LED outputs are affected equally. Obviously it helps to have a yellow indication displayed on the signal head(s) when making this adjustment!!!

8.0 TECHNICAL SUPPORT

Please direct any questions about the use of this product to ***Logic Rail Technologies.*** You can contact us as follows:

email: info@logicrailtech.com
phone/fax: (281) 251-5813
mail: 21175 Tomball Parkway
PMB # 287
Houston, TX 77070

Include as much detail as possible about your usage (e.g. voltage supply rating, signal controller type, signal head brand, etc.). Comments and suggestions are always welcome.

9.0 WARRANTY

This product is warranted to be free from defects in materials or workmanship for a period of one year from the date of purchase. ***Logic Rail Technologies*** reserves the right to repair or replace a defective product. The product must be returned to ***Logic Rail Technologies*** in satisfactory condition. This warranty covers all defects incurred during normal use of this product. This warranty is void under the following conditions:

1) If damage to the product results from mishandling or abuse.
2) If the product has been altered in any way (e.g. soldering).
3) If the current or voltage limitations of the product have been exceeded.

Requests for warranty service must include a dated proof of purchase, a written description of the problem, and return shipping and handling ($6.00 inside U.S./$8.00 outside U.S. - U.S. funds only). Except as written above, no other warranty or guarantee, either expressed or implied by any other person, firm or corporation, applies to this product.