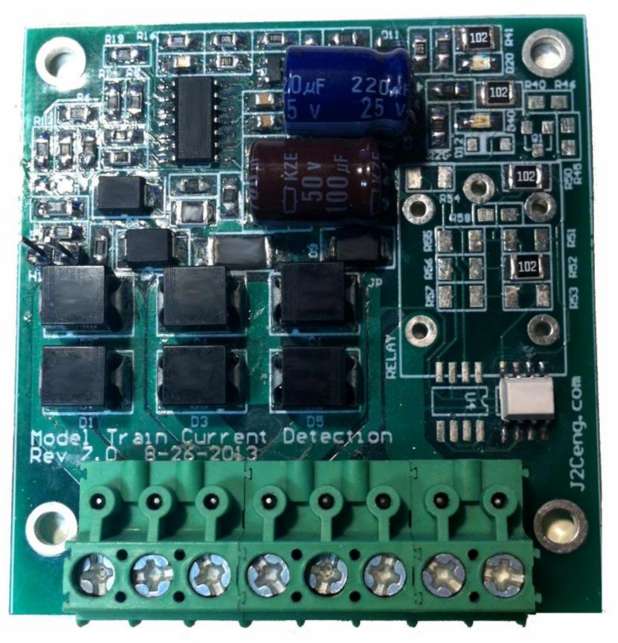
Train Current Detection Manual

Designed by: J2C Engineering
J2Ceng.com



J2C Current Detection Circuit Board

Train Current Detection Features:

- Can be used with either DCC or DC
- Up to 8 Amps can be put through the board. (200 Amps Surge)
- Works with reverse blocks.
- While under DC or DCC operation a bias voltage is supplied so detection will work when power is off.
- Automatically adjusts sensitivity while under DC or DCC operation (This prevents ghost trains from wire cross talk)
- Low sensitivity (needs about 10K ohms or under to trip) (This again prevents ghost trains from wire cross talk)
- If power supply or another block is shorted detection is still valid
- Detection is valid when the train spans detected blocks.
- Interface can be Opto or Relay controlled
- If detection power supply fails or gets unplugged the connected signals drop to the red indication or occupied status.

Introduction:

To successfully install a prototype signal system or a complex CTC (centralized traffic control) on a model train layout, a very reliable and accurate train detection circuit is necessary.

The J2C detection circuit uses current sense to detect a train. The detection circuit is wired in series with the track, so if a section of track called a block has something in it that uses electricity from the track such as a DCC decoder, motor, lighted car, or resister wheel set; the board will see this block as occupied. **To sense rolling stock that does not draw any track power, resister wheels are necessary.** This system will sense a load of 10K ohms or under.

The J2C detection circuit has been designed for very accurate train detection. The circuit overcomes several short comings that causes other detection circuits to fail.

It can withstands 8 amps of continues track power and 200 amps of surge. So if a fault occurs on the track, the breaker in the power supply will trip first and not damage the detection circuit.

The J2C detection circuit uses an advanced diode sensing circuit, while some other detection circuits use a transformer for sensing trains. The diode drop sensing circuit has the advantage of being more sensitive, and it allows the J2C detection circuit to detect DC controlled trains as well as DCC trains. This detection circuit can even detect trains when the power to the track is removed! Having this increased sensitivity allows the detection circuit to work properly when a train spans multiple blocks, where as a less sensitive detection circuits will show clear every time 2 blocks are spanned. The J2C detection circuit is not too sensitive to cause false occupancies because of cross talk between the wires. The J2C detection circuit will auto-adjusts the sensitivity based on the voltages being supplied to the track.

The J2C detection circuit is available in several types of output configurations, from relay type to multiple versions of opto-coupled configurations, this will allow the circuit to be interfaced with any signaling and CTC systems. Some output configurations will even allow the J2C detection circuit to be “Fail Safe”, meaning if the detection card is unplugged or looses power, the block will show occupied, therefore dropping the affected signals to red.

We, at J2C engineering, are as frustrated as you are with the currently available signaling systems being marketed today. Right now, we are working on making a fully computerized CTC and signal system that will solve the major problems associated with prototype modeling. Details for this will be available at www.j2eng.com website as the design becomes complete. Refer to section 3.3 of this manual for a block diagram of this. In the meantime, this detection circuit will be fully compatible with our signaling system to be introduced later this summer.

This manual assumes that the user has a basic understanding of model railroading DCC and/or DC block wiring. The manual is broken down into several sections:

Section 1 gives an overview of the pin out of the J2C detection circuit.

Section 2 shows how to power and connect the detection circuit to the track for both DCC and DC.

Section 3 shows how the different output options and some basic signal circuits.

Section 4 shows a couple of modifications that can be done to locomotives and rolling stock to make the detection even more accurate.

As hard as we try, this manual does not cover every possibility for model railroad track and signal wiring. If you don't see your desired application in this manual, contact J2C engineering at j2ceng.com for a custom wiring solution...we are always happy to help fellow enthusiasts.

Section 1- Detection Circuit Overview

Board Jumper, Pin Out and Indicator Lights

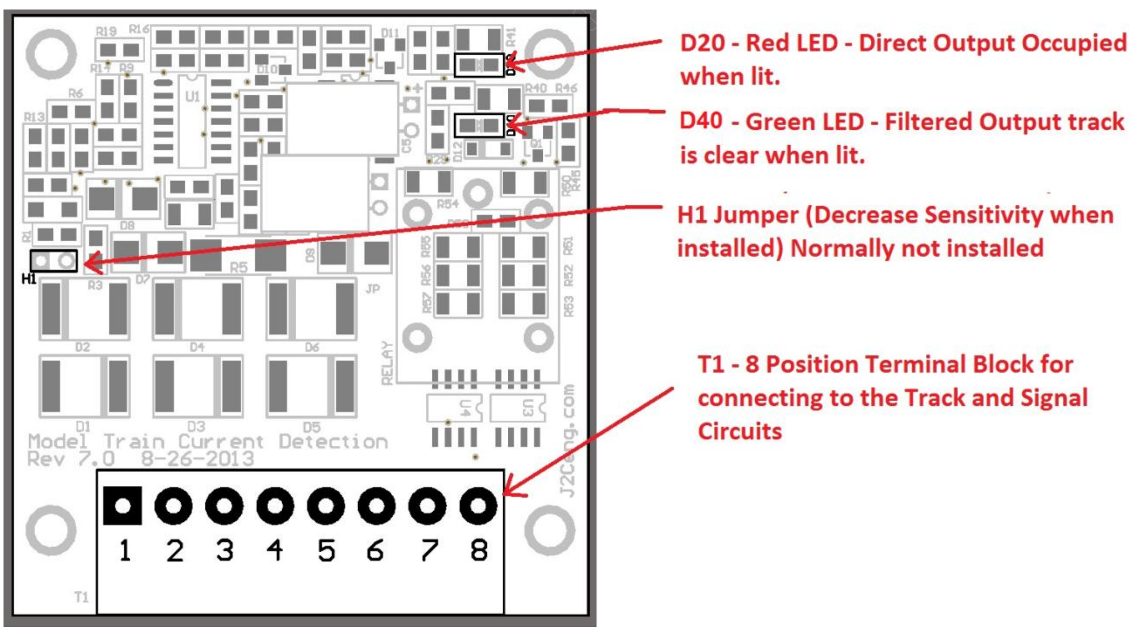


Figure 1: PCB pin out locations

D40 - Indicator Light (Green)

When illumined, this means the block is clear. This is filtered out of the detection circuit. When off this means the board is showing occupied or the detection power supply is off.

D20 - Indicator Light (Red)

When illumined, this means the block is occupied. This is the direct non filtered output of the detection circuit. If this light is flickering while a train is passing through the block this indicates dirty wheels.

H1 - Jumper: (Normal Position Not Installed) (Wet Track Override)

This jumper is not installed for normal operation. When installed, this Jumper will decrease the sensitivity of the detection card making it only sense large loads such as motors and lighted cars; it ignores small loads in this mode. This mode is used for wetted track from ballasting, scenery, or track adjustments. This allows the signals or an interlock plant connected to the affected detection card to function again without waiting for the track to dry. The jumper needs to be removed when the track dries in order to accurately sense the small loads again.

T1 - Pinout and Function Table

Pin #	Function	Circuit Connected To
1	Track Ground Power and Detection Power Supply Negative	Track Circuits and Detection Power
2	"To Track" Ground	
3	From Power Supply Track Hot	
4	"To Track" Hot	
5	Detection Power Supply Positive 9V to 12Volts DC	
6	Common	Signal System Interface
7	Out 1	
8	Out 2	

Pinout Notes:

Pins 1 to 5 are for connecting the track circuit and power for the detection board.

Pins 6-8 are for interfacing to the signal system. The outputs can be either relay or opto coupled outputs. The outputs are electronically isolated from the track and detection power. Having this isolation is important for Reverse, X-section, and DCC Blocks.

J2C Detection Circuit Electrical Specs

Isolated Supply Voltage	9 - 14 Volts
Power Supply Max Current Draw	80mA at 12 Volts
Track Power Type	DCC, DC, AC, Pulse
Max Track Voltage	24 Volts Peak
Max Continues Track Current	8 Amps
Max Surge Track Current	200 Amps 4mS
Resistor Wheel Value	5.1K – 10K ohms
Minimum Resistor Sense Value	10K ohms

Table 1

Section 2.1 - Detection Circuit Power and Track Connections (Pins 1-5) – Basic Wiring

WARNING: An isolated power supply is needed for the detection power. The power supply must be on a separate power transformer from the track power. If this is not followed, the circuit will not work and possible damage or short circuits will occur to the detection card, the DCC system, and/or power supplies. The negative and positive of the detection supply MUST BE isolated from Earth Ground as well.

At a minimum the DC power supply needs to be at least full wave rectified. A regulated supply is ideal. ***Do Not Use a half wave supply to run the board.*** The detection board draws about 40mA at 12 volts.

DC 9 to 12 volt "wall wart type" transformers work well for powering the detection cards.

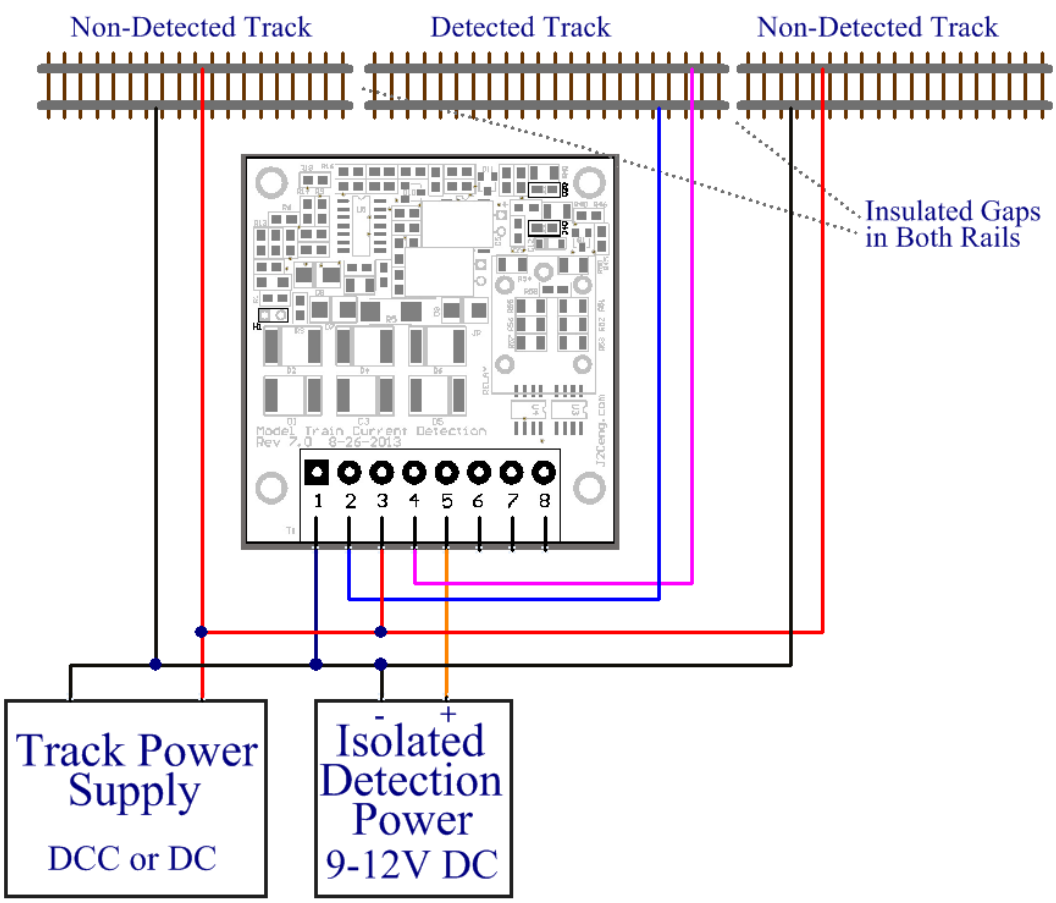


Figure 2: Simple one block detection wiring

Figure 2, shows how to connect one detection circuit. Notice that both rails need to be gaped for the J2C detection circuit. This is needed so the circuit can detect trains when the track power off or shorted. This also allows the auto adjust to work properly. The gaps do not need to be directly across from each other they can be offset by a couple of inches...the gap offset should not be more than 6 inches though. This offset is sometimes necessary for the mechanics of laying track in curves.

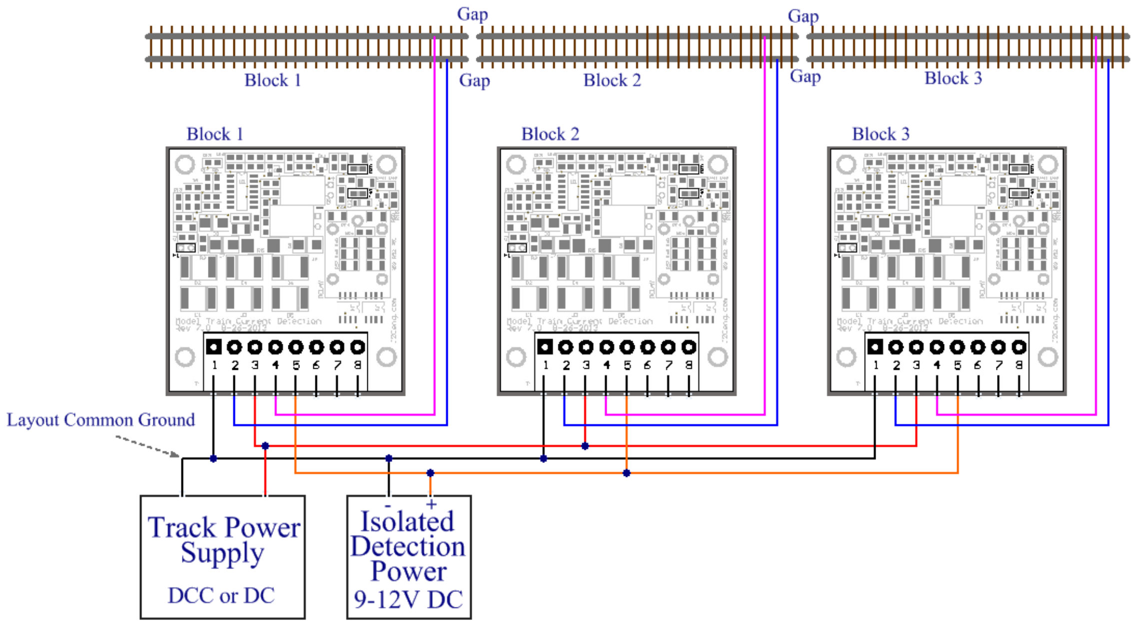


Figure 3: Three block detection circuit wiring

Figure 3, shows how to connect a three block detection circuit. Additional blocks can be added and powered from the same isolated power supply. Remember that each detection circuit takes about 80mA, so if 10 detection circuits are connected, the current draw on the detection power supply will be 800mA. If 20 boards are connected then current would be 1.6 Amps. Make sure that the power supplies are big enough to handle all the power that is needed for the number of detection circuits you require. Power supplies can also be split up, as long as long as the same common ground is shared for each isolated supply. Detection power can also be split for convenience of the location of the detection card. For large layouts it is best to group the detection circuits nearest to the location of the sense track. It is not recommend placing all of the detection circuits in one place on a large layout. Placing the detection circuits in groups on large layouts saves wire and helps avoid risks of cross talking between blocks.

Section 2.2 - Detection Circuit Power and Track Connections (Pins 1-5) – Adding Track Power Switches.

A common thing done on DCC and DC layout wiring, is adding block power switches. These control panel switches allows track power to be turned off to a certain section of track, and this is quite common for yard and storage tracks. In order for the detection circuit to work while the track power is switched off, the hot side of the track power needs to be broken before the detection circuit. Refer to figure 4 for a wiring diagram.

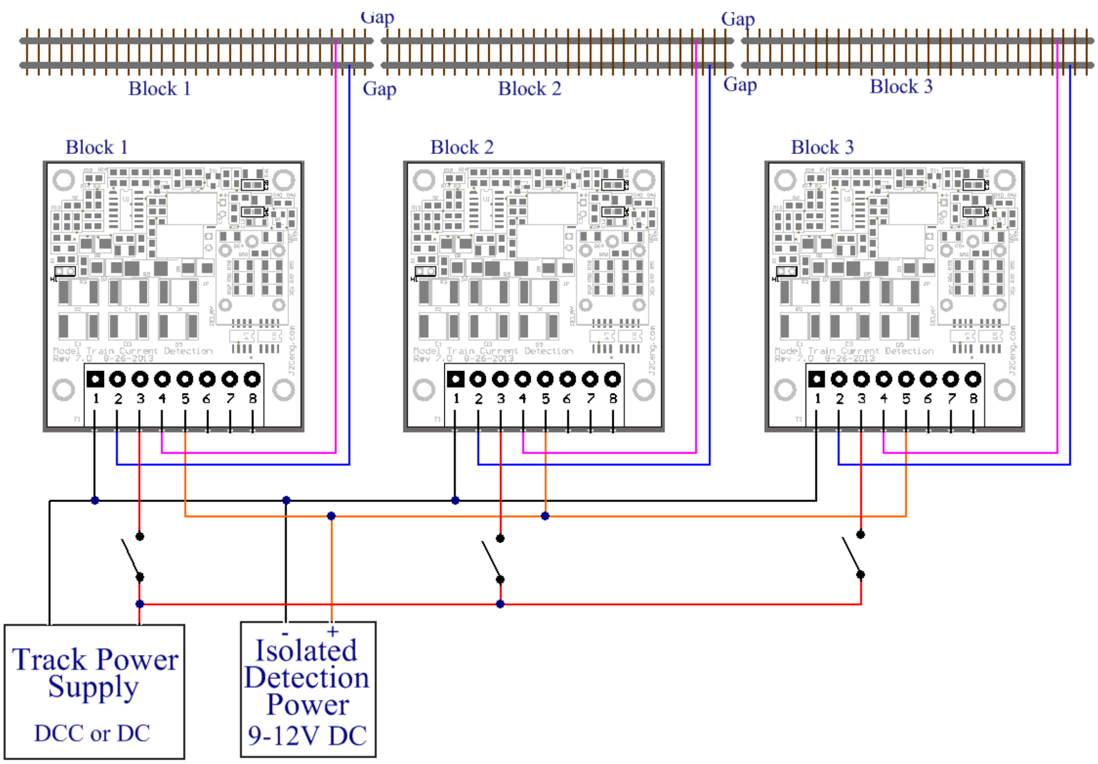


Figure 4: Three block detection circuit wiring with track power switches.

Section 2.3 - Detection Circuit Power and Track Connections (Pins 1-5) – DC and DCC Block Wiring

Several layouts are wired for DC block operation. The DC power blocks are connected to different cabs, as the different trains pass from block to block. Usually is it setup one cab for each train. It is possible to replace one of the DC cabs with a DCC system. Doing this allows DC and DCC trains to be run at the same time. Figure 5 shows that one of the DC cabs was replaced with a DCC system along with the wiring of detection circuits for this type of system. Note, each cab, DCC system, and detection circuits need to on their own isolated power supplies.

Figure 5 shows that this track split into power blocks and three detected blocks. Block 1 is a power block with one detection block. Block 2 is a power block with two sub detection blocks giving it block 2.0 and block 2.1.

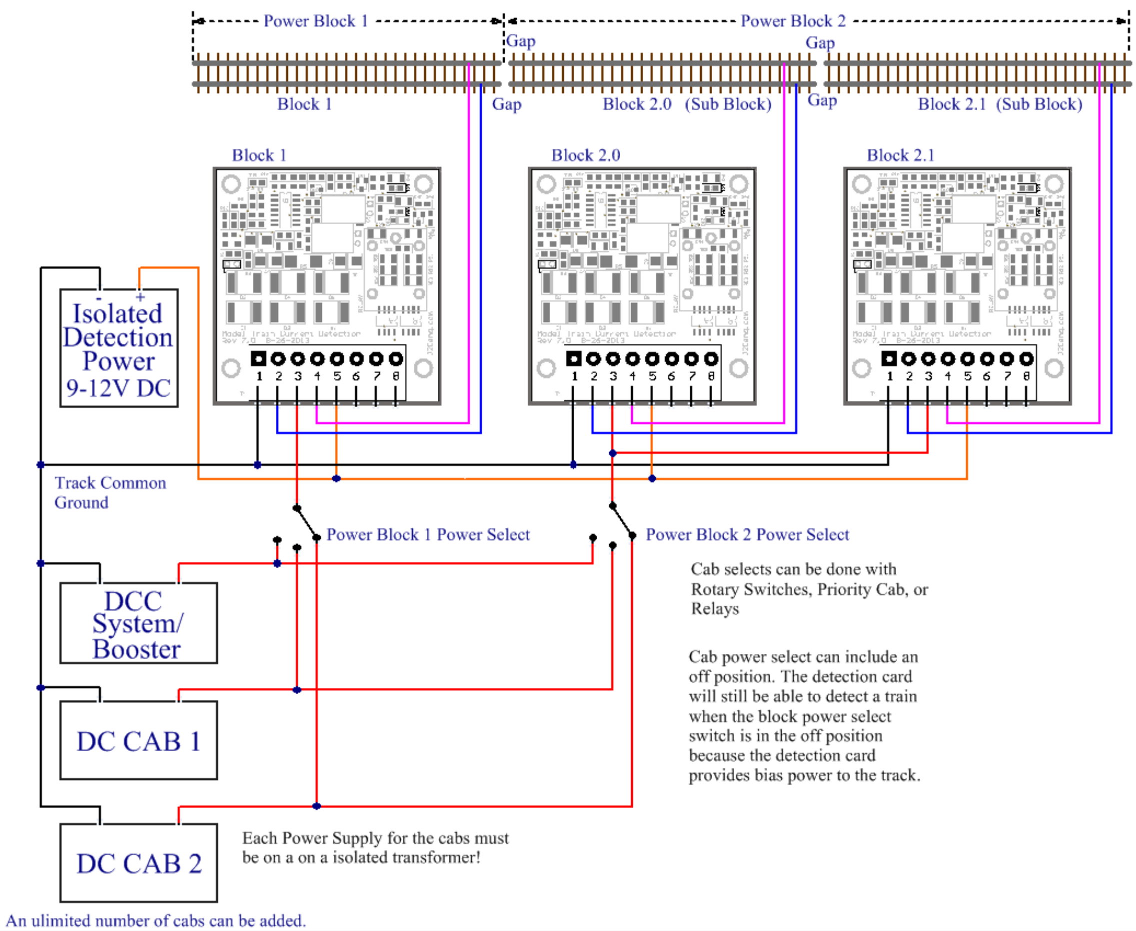


Figure 5: Detection with mixed DCC and DC power and with sub blocks

Section 2.4 - Detection Circuit Power and Track Connections (Pins 1-5) – DCC and DC Reverse Blocks

Reverse blocks in DCC require a reverse module. Figure 6 shows the wiring for detection circuit with DCC reverse modules. Two isolated power supplies are needed for separate isolated powering of the detection cards when using a reverse loop block. One Detection power supply is for the non-reverse blocks and the other power supply is used for the reverse blocks. Figure 7, shows DCC reverse blocks, adding sub blocks for more than one detection block within the reverse block. Figure 8 shows DCC and DC with reverse block wiring.

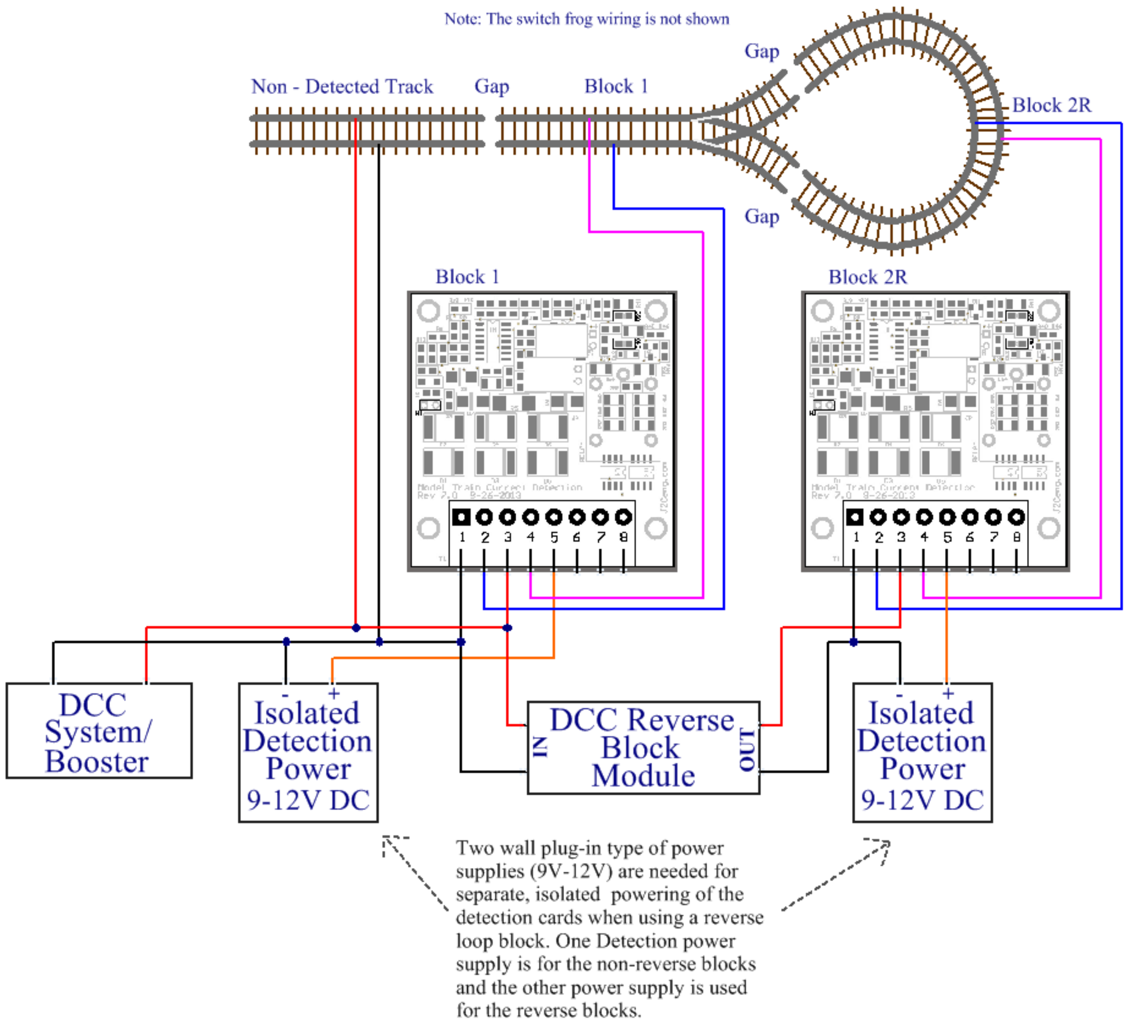


Figure 6: Detection with a DCC reverse block

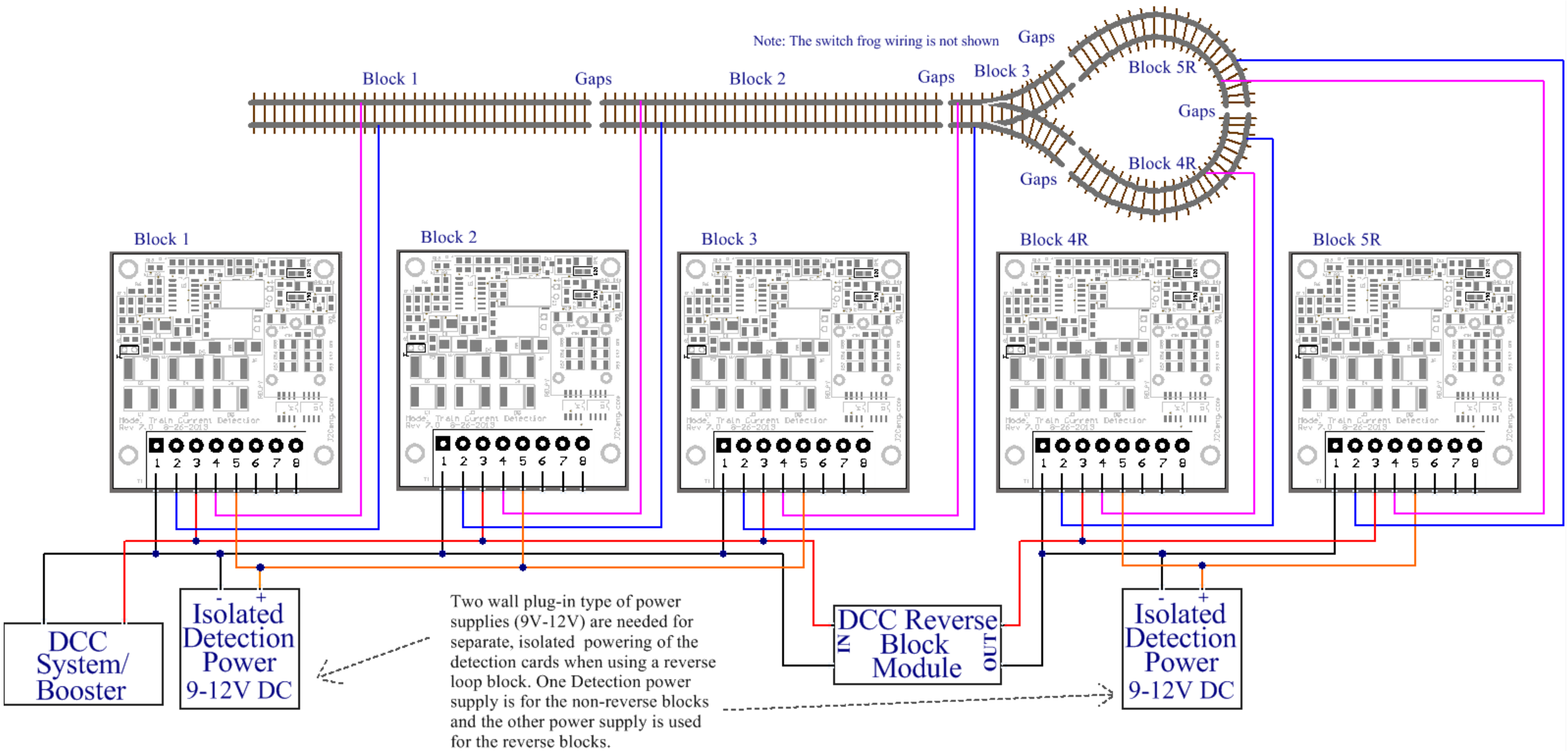


Figure 7: Detection with a DCC Reverse Block and Sub Blocks

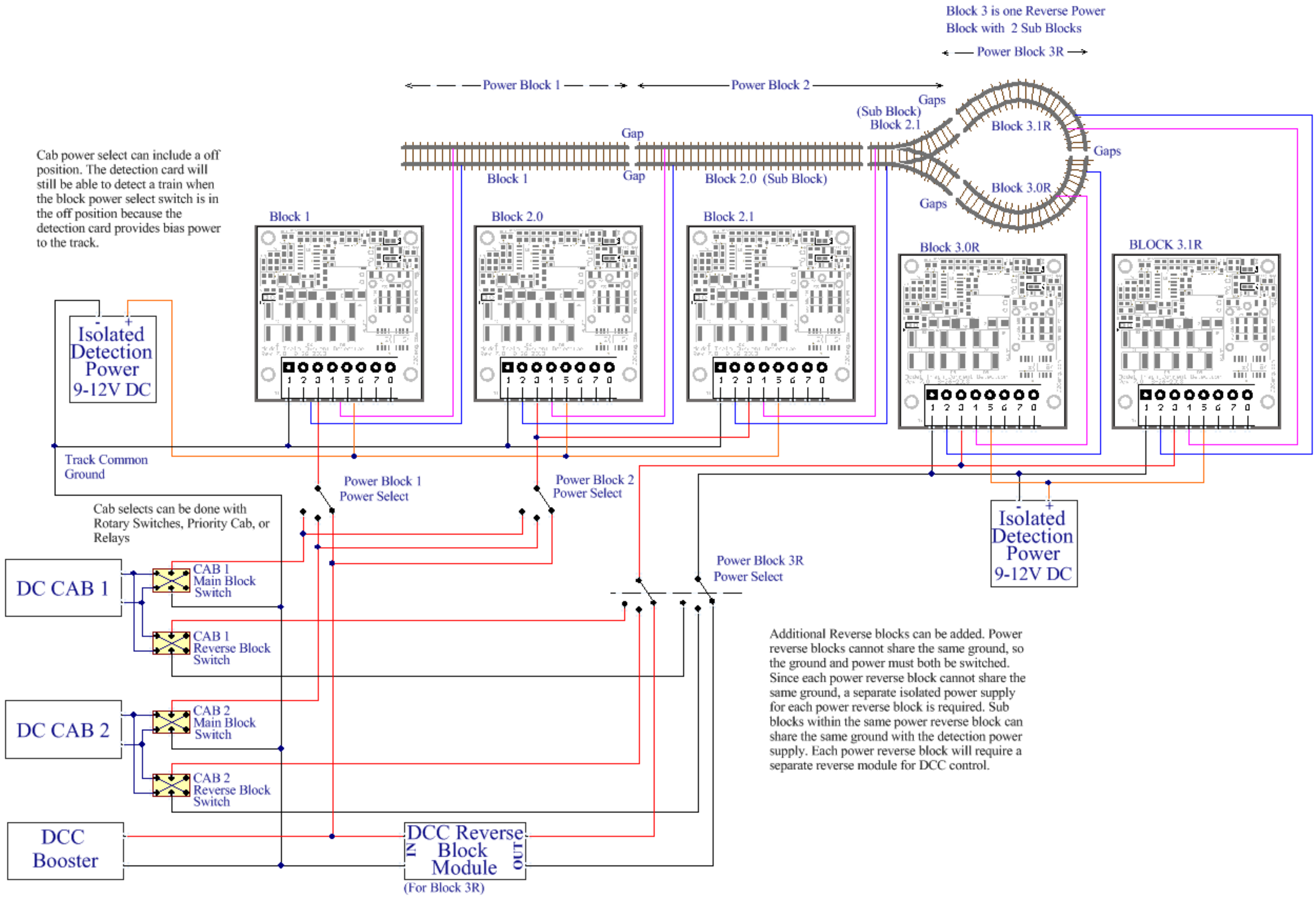


Figure 8: Detection with DCC and DC Blocks with Reverse and Sub Blocks

Section 2.5 - Multiple DCC Boosters with Common Ground System

Since the J2C detection circuit is best wired with a common ground system, it is very important to wire the DCC boosters properly. DCC Boosters should not have a common connection on the input and output of a booster. Each Booster needs to have an isolated transformer and the common ground that is connected at the output of the boosters. ***If this is not followed, by having a common connection at the input and output of the boosters, damage to the boosters will occur.*** The wrong way of wiring boosters is shown in Figure 9**.** The correct way is shown in figure 10. The following diagrams show Boosters that accept AC power in from a transformer. Some boosters require DC power supply make sure to check with the manufacture of your DCC booster to determine the proper power supply. Also when wiring the DCC boosters make sure they are in phase so when a train passes between booster zones on the layout a short does not occur between the boosters.

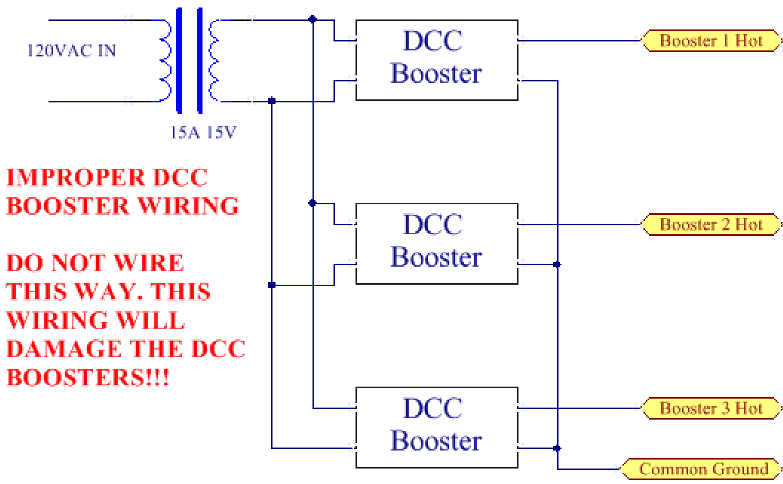


Figure 9**: Wrong DCC Booster wiring. This will damage the boosters.**

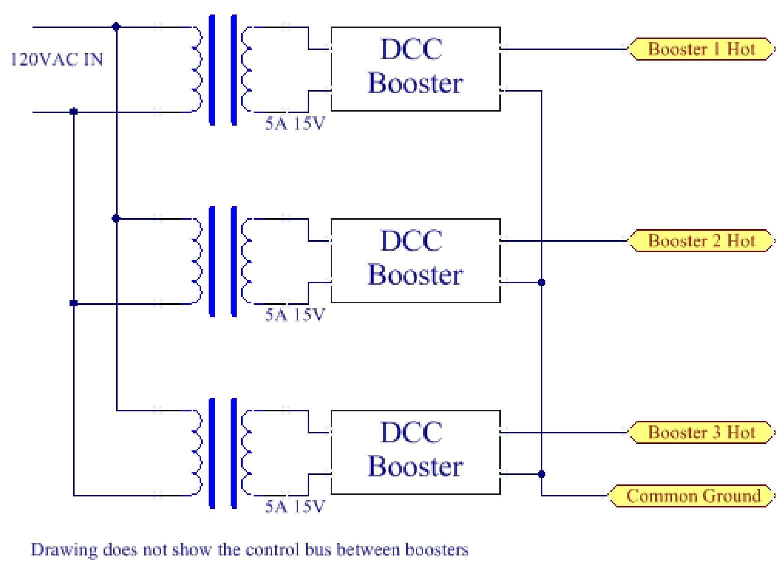


Figure 10: Recommended, correct DCC Booster wiring

Section 3.0 – Wiring the output of the Detection Circuit (Pins 6-8) – Output Option types

The J2C Detection Circuit provides several output options, so it can be interfaced with any type of signal system. Several output modes are "fail safe" meaning when the detection circuit looses power or gets unplugged, the connected blocks will show occupied and the effected signals drop red. Table 2 shows the details of the output options.

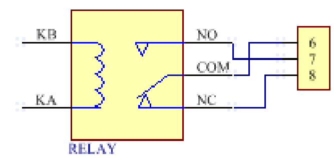
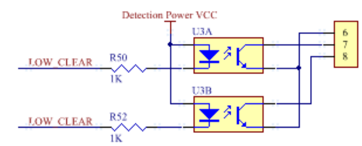
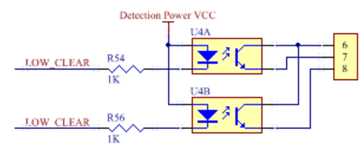
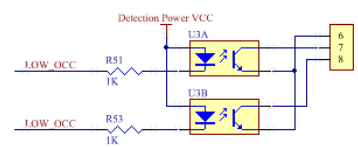
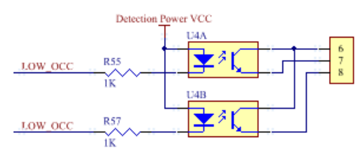
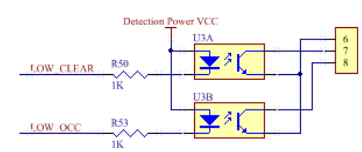
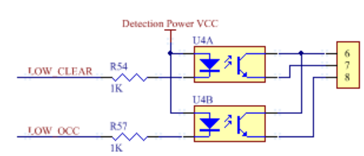
Output Option	Output Type	Pin Function		Power Loss Fail Safe	Output Schematic
1	Relay Output (Note: Relay is energized when clear)	6	Common	-	
		7	Closed When Clear	Yes	
		8	Closed When Occupied	Yes	
2	Two Opto Outputs, Sinking when Clear	6	Common Negative	-	
		7	Sink Out 1 when Clear	Yes	
		8	Sink Out 2 when Clear	Yes	
		****** Option 2 is used by the J2C Signal and CTC System******			
3	Two Opto Outputs, Sourcing when Clear	6	Common Positive	-	
		7	Source Out 1 when Clear	Yes	
		8	Source Out 2 when Clear	Yes	
4	Two Opto Outputs, Sinking when Occupied	6	Common Negative	-	
		7	Sink Out 1 when Occupied	No	
		8	Sink Out 2 when Occupied	No	
5	Two Opto Outputs, Sourcing when Occupied	6	Common Positive	-	
		7	Source Out 1 when Occupied	No	
		8	Source Out 2 when Occupied	No	
6	Opto Outputs, one sinking when clear and the other sinking when occupied	6	Common Negative	-	
		7	Sink Out when Clear	Yes	
		8	Sink Out when Occupied	No	
7	Opto Outputs, one sourcing when clear and the other sourcing when occupied	6	Common Positive	-	
		7	Source Out when Clear	Yes	
		8	Source Out when Occupied	No	

Table 2 Detection Circuit Output Options (Continued on Next Page)

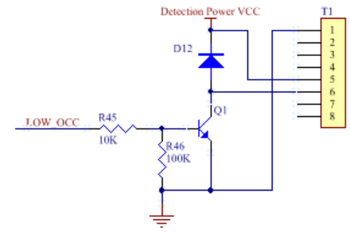
Output Option	**Output Type**	**Pin Function**		**Power Loss Fail Safe**	**Output Schematic**
8	External Relay (Note: Relay is energized when clear)	5	Relay Positive (Shared with detection positive)	-	
		6	Relay Negative Open Collector Transistor Output. Protection Diode is built into board. Output is rated at 50mA Max current. ***WARNING: This is a non-isolated 12V output and Must be connected to a relay to isolate signal power from track and detection power.***	Yes	
		7	No Connect	-	
		8	No Connect	-	

Table 2 Continued

When purchasing a J2C detection circuit, please note what type of output that you need for interfacing with your signal system. If you find that you need a different output on the boards you already purchased. J2C Engineering can exchange the parts and change the output option on the detection circuit and send it back to you, you just pay the shipping. There are couple more output options that could be done with this circuit not shown in the previous table. Figure 10 shows a complete schematic of the output circuit. If you find that you need a different configuration that is not listed in the chart, contact J2C Engineering to discuss your custom output option.

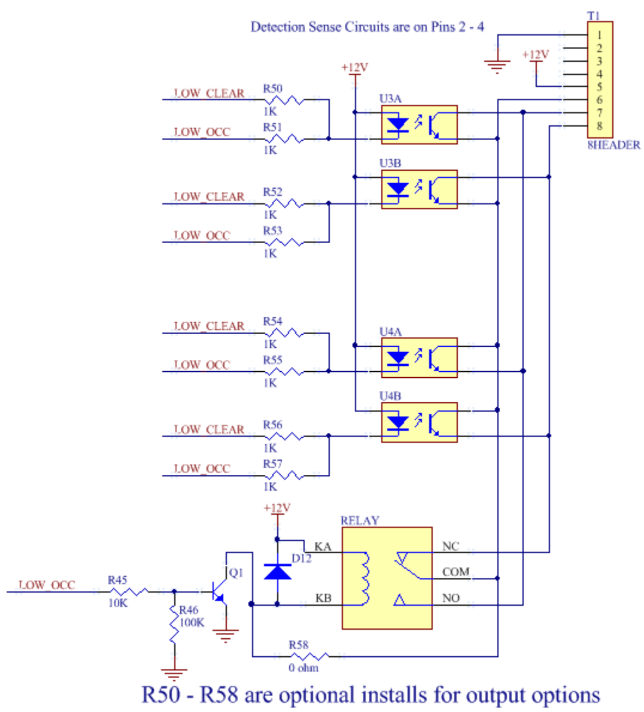


Figure 10 – Output Schematic

Section 3.1 – Wiring the output of the Detection Circuit (Pins 6-8) – Simple ABS Relay Signals

When a train passes a signal, the signal will change to red. The signal is red so the next train does not enter the block and run into the train that is ahead of it. ABS (Automatic Block Signaling) is for trains running in one direction and is setup to provide proper spacing between trains. This section of the manual will show simple signaling circuits and will only show the connections of pins 6-8. Refer to the track wiring section for detail of pins 1-5. This manual only shows circuits for ABS signaling. The wiring for adding switch indications, APB (Automatic Permissive Block), and CTC (Centralized Traffic Control) gets very complex. J2C Engineering is designing a system that will handle this complex logic using a programmable circuit. Refer to section 3.3 for information about the J2C programmable signal circuit. It is recommended that the power supply for running the signals is separate from the detection power. This separation is especially necessary when using reverse blocks, having signaling running at a different voltage, or having complex signal wiring.

Red / Green Signal (Output Type 1 Relay Output) **(Shown with track wiring)**

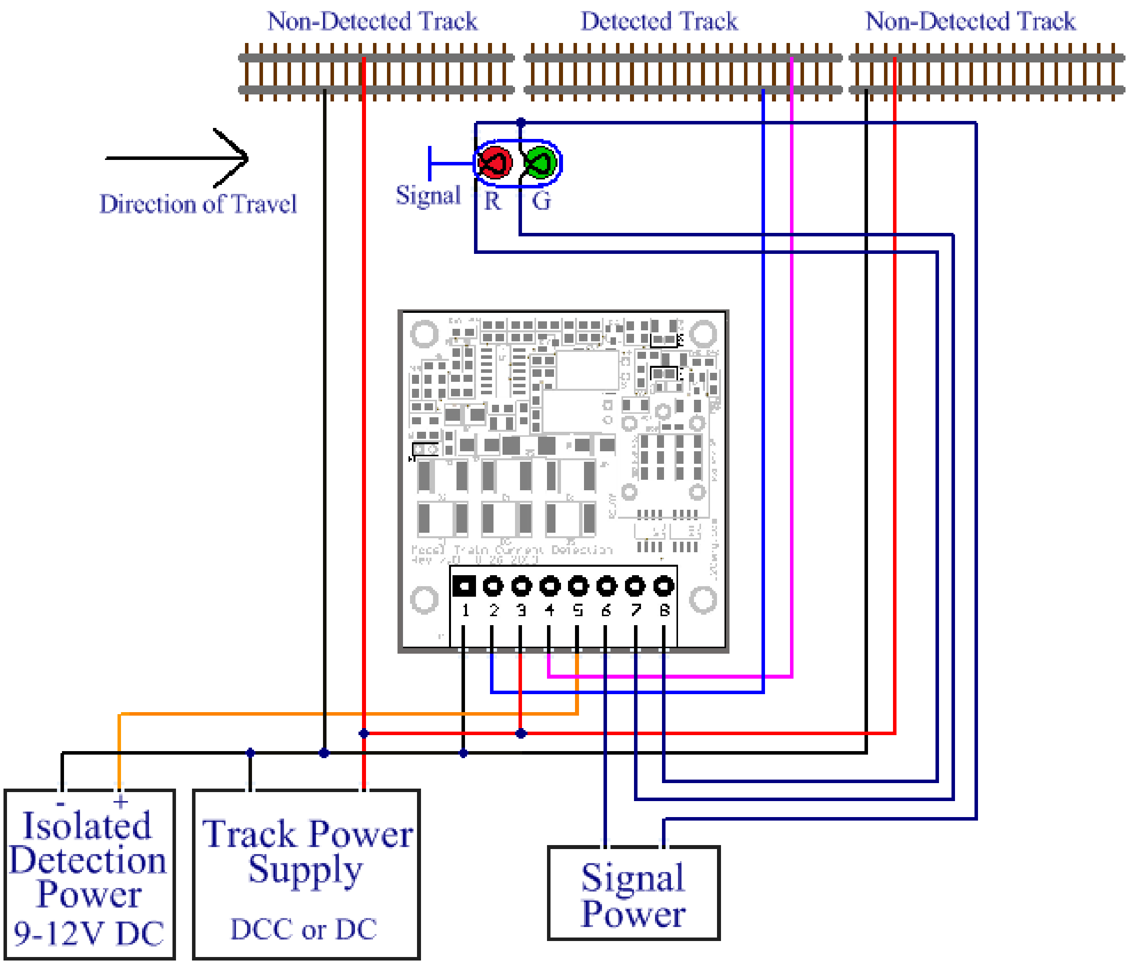


Figure 12 – Red / Green Signal (Output Type 1)

One Red / Yellow / Green Signal (Output Type 1 Relay Output)

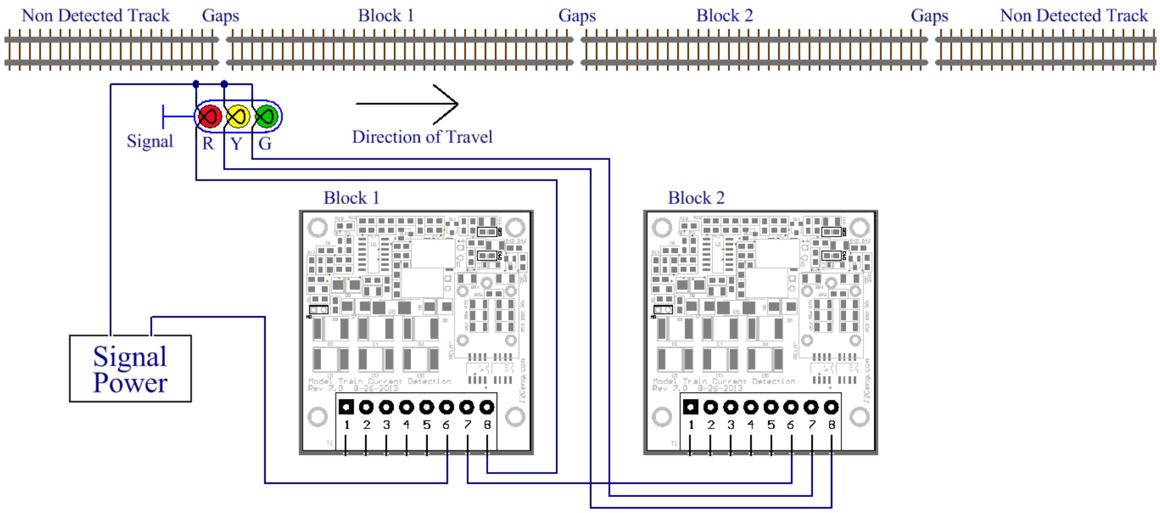


Figure 13 – Red Yellow Green Signal (Output Type 1)

Multiple Signals Red / Yellow / Green (Output Type 1 Relay Output)

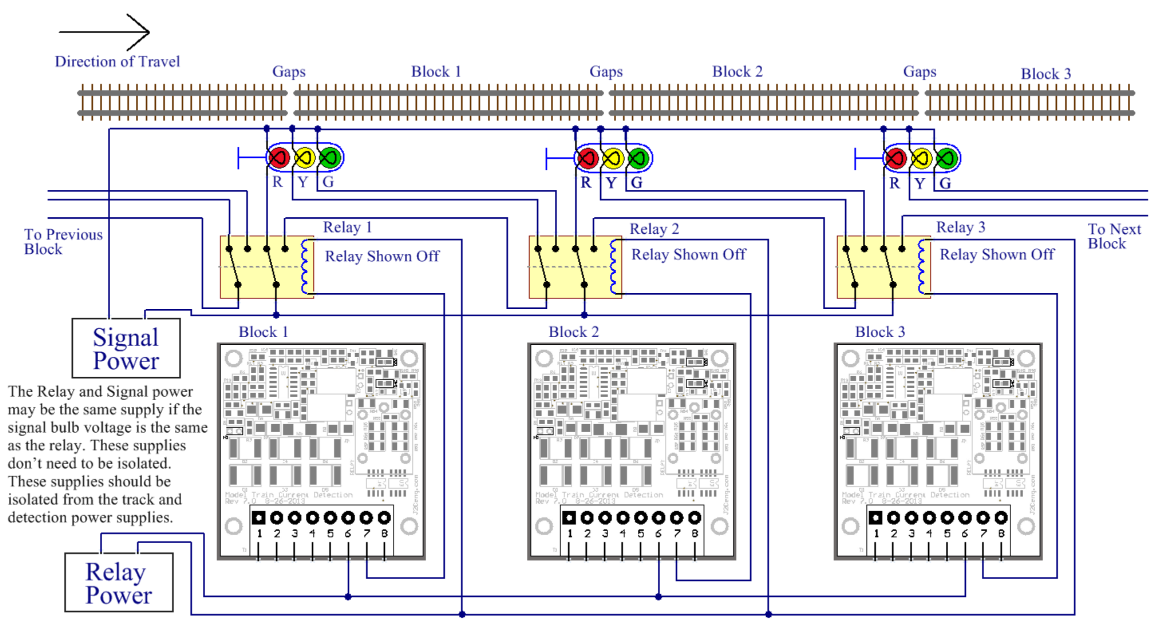


Figure 14 – Multiple Signals Red Yellow Green Signal (Output Type 1)

Multiple Signals Red / Yellow / Green (Output Type 8 Relay Output)

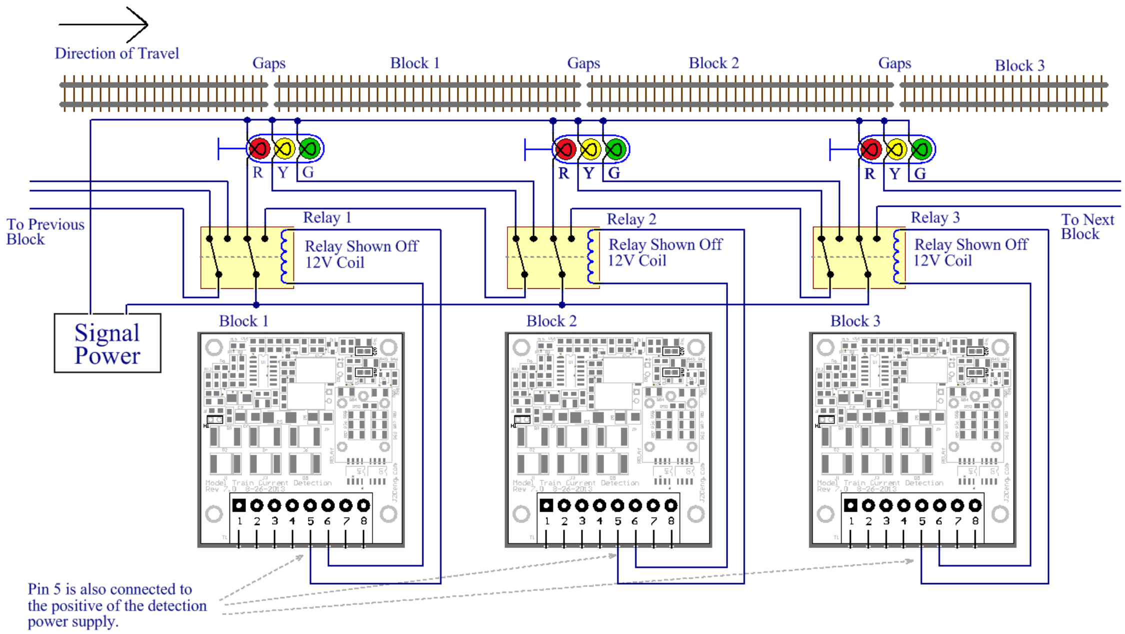


Figure 15 – Multiple Signals Red / Yellow / Green (Output Type 8 Relay Output)

Section 3.2 – Wiring the output of the Detection Circuit (Pins 6-8) Solid State Signal ABS Signals

The next circuit, Figure 16 shows an example using the opto output mode 2 (two sinking outputs) to control solid state signal circuits. The signals for this example are LEDs. Lamps could be used, provided the proper driver circuit was provided. This circuit shows using NAND gates to generate the needed logic for ABS signaling. Note: that the schematic does not show all of the power connections and other parts needed for NAND gates to work. The NAND gates can also be programmed into a PLD (Programmable Logic Device)

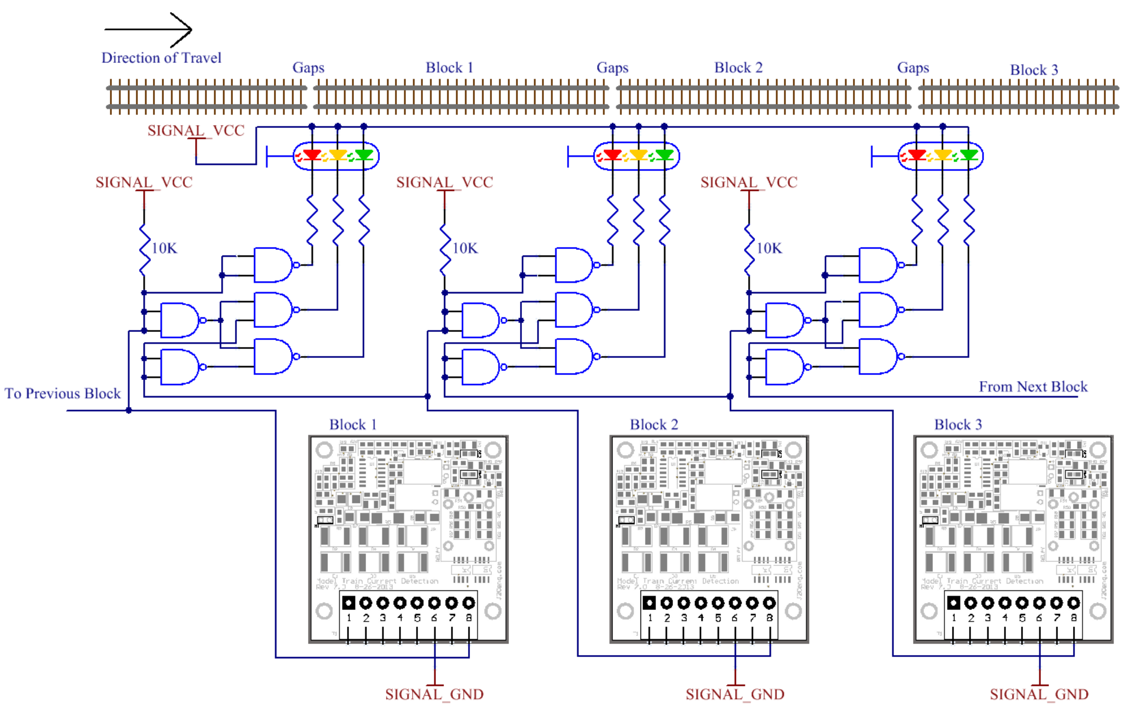


Figure 16 – Multiple Signals Red / Yellow / Green (Output Type 2, Two Opto Outputs Sink when block is clear)

Section 3.3 – Interfacing the Detection Circuit to the J2C signal board for ABS, APB, and CTC signaling

Though the experiences of building and using these signal circuits, it has become clear that to do anything more than ABS signaling with the circuits in the previous sections, the circuits become very complex and very costly. Programmable Logic Devices can simplify some of it but it still has its limits. This manual does not show these complex circuits since it would take a whole manual for each circuit. To get ABS, APB, and CTC signaling working all at the same time for the lowest and least amount of wiring, a new system needed to be developed. At the time this manual was written, J2C Engineering was busy developing a completely programmable microprocessor based system for doing signal and CTC logic. The new system will be able to run all of these different methods of signaling, and it will also provide control of switch motors and other accessories on a layout. The user will be able to draw their layout, with convenient track icons, on the computer display, and the system will compute all of the logic needed for switches and signals. More details will be posted at www.j2ceng.com, as the system gets further developed. Figure 16 show a simple block diagram of the system.

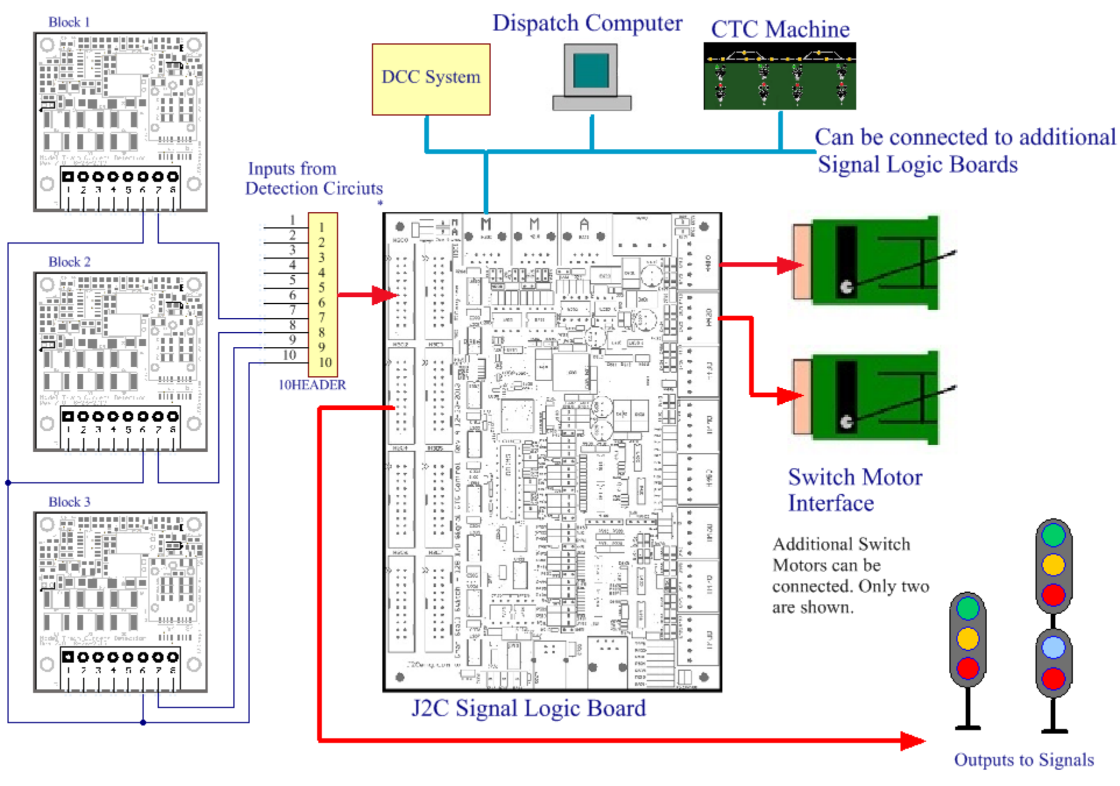


Figure 17 – Detection Circuits (output option 2) interfaced to the J2C signal system. At the time the manual was written; the J2C signal system was under development. More details about the system will be posted at www.j2ceng.com

Section 4.0 – Resistor Wheel Value

This detection board is designed to detect any resistance less than 10K ohms. It will ignore resistances greater than 100K. The resister wheel set value needed to trip this board is 5.1K – 10K ohms. Resistor Wheels sets should be installed on every car. There are some opinions that doing this will draw too much current from the track. If the track voltage is 15 volts, a car with a 10K ohm resistor it will draw 1.5mA. So a 100 car train will draw 0.150A.

V = Track Voltage
R = Resistor Wheel Value
N = Number of Resistor Wheels
A = Total Current Draw of the resistor wheels

(V / R) * N = A

15 / 10,000 * 100 = 0.150Amps (100 resistor wheels)
15 / 10,000 * 1000 = 1.5Amps (1000 resistor wheels)

If current draw is a problem on your layout, then it would be recommended add more sections using more DCC boosters or having bigger DC power supplies. For HO it is recommended to limit the current to the track at 5 Amps.

It is also not recommend going lower than 5.1K ohms for resistor wheels, since the wattage will become too great and cause too much heating of the resister. To check your wattage, use the following equation. The resistor selected should be at least double of the calculated wattage.

V = Maximum Track Voltage
R = Resistance of the Wheel
W = Wattage

(V^2) / R = W

(20^2) / 5100 = 0.078 Watts (5.1K ohm will dissipate 0.078 Watts at 20Volts so the minimum wattage resister that should be used is 1/16 Watt.

Section 4.1 – Improving Detection Reliability

Depending on how circuits for DCC decoders and DC lighting are designed, it can present a problem with detecting when track power is off. This happens because these circuits have diodes for direction lighting and to convert AC to DC. This diode drop masks the diode drop of the detection board, so the detection circuit can possibly show a false clear when track power is off. The fix for this problem is installing a 5.1K to 10K ohm resistor across the track power pickups.

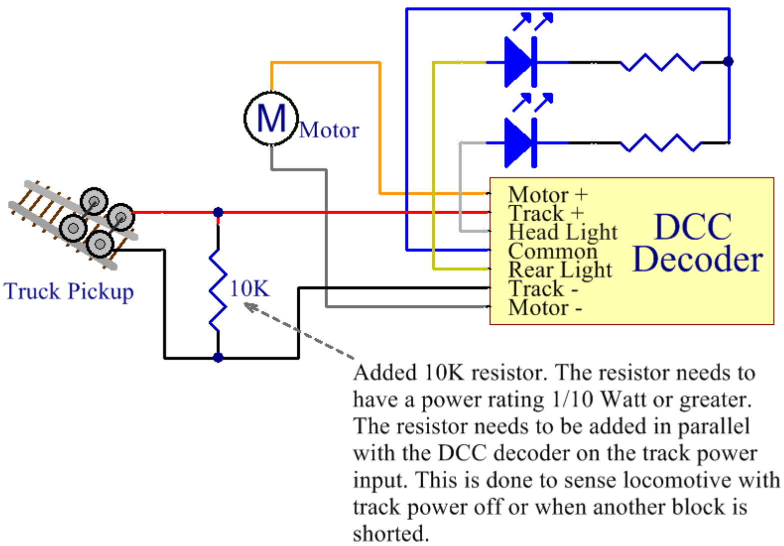


Figure 18 - Added 10K resistor in parallel with a DCC Decoder

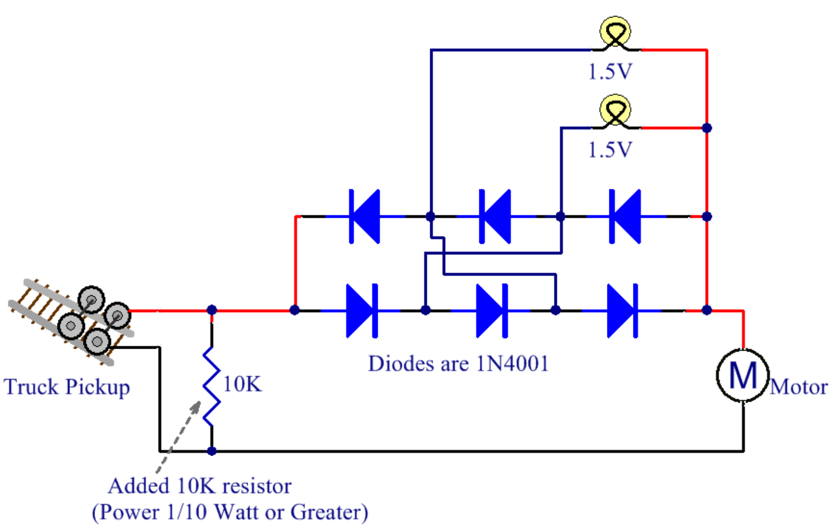


Figure 19 - Added 10K resistor in parallel with a DC Constant Lighting Circuit

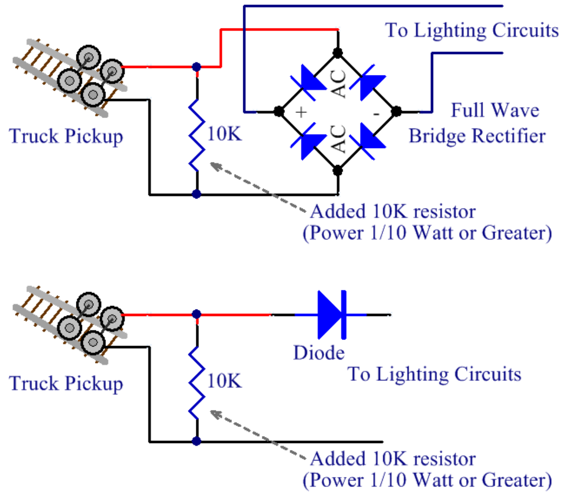


Figure 20 – 10K resistor should be used with these types of diode circuits

Sometimes a track powered FRED (Flashing Read End Device) will cause the detection to occupy only when the light is illumined. Since the light is flashing it will cause the signal to telegraph between aspects. This problem can again be fixed by placing a 10K resistor in parallel with the flasher FRED circuit. See figure 21.

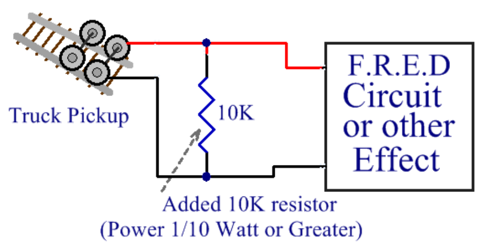


Figure 21 – 10K resistor in parallel with a FRED circuit