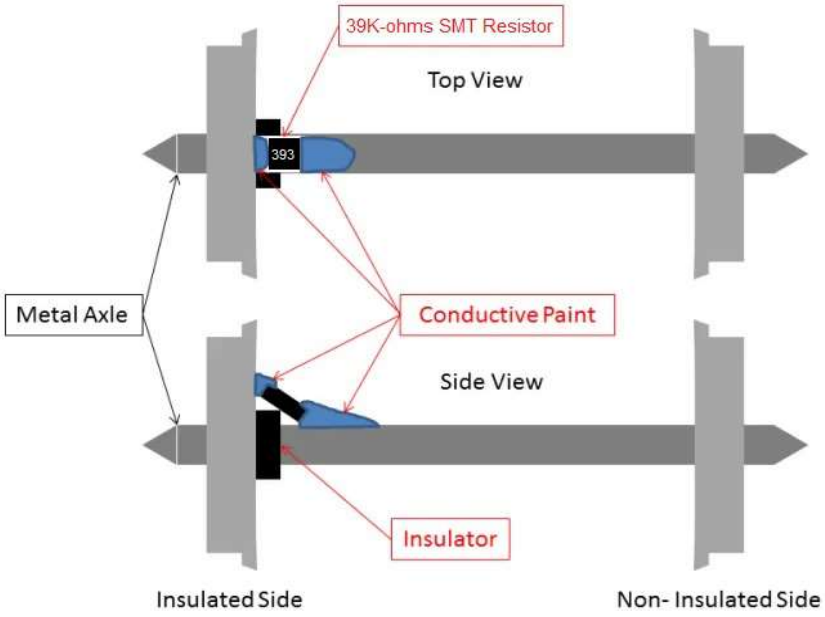
Thank you for your purchase of my Current-Sensing Block Occupancy Detector.

Introduction

The purpose of this unit is to provide the layout with a sense of realism in the operation of signals and controls. In real-world signaling, the presence of rail equipment on the track is detected by wayside electronics which send electric current through the rail, shunted by the wheels and axle, and the return of that current is sent back through the other rail to actuate a pickup coil on a relay at the wayside control. In modern signaling, an electric signal is sent down one rail from a transmitter and is shunted and carried over to the other rail, which is then picked up by a receiver. When a train or other rail equipment enters the designated block, the shunt is carried over into the equipment by it's wheels and axles, and the receiver will detect a change in frequency and phase of the signal using the Doppler effect. On the railroad, each car's wheels are conducting that shunt from one rail to the other, making it easy to detect the presence of equipment on a track.

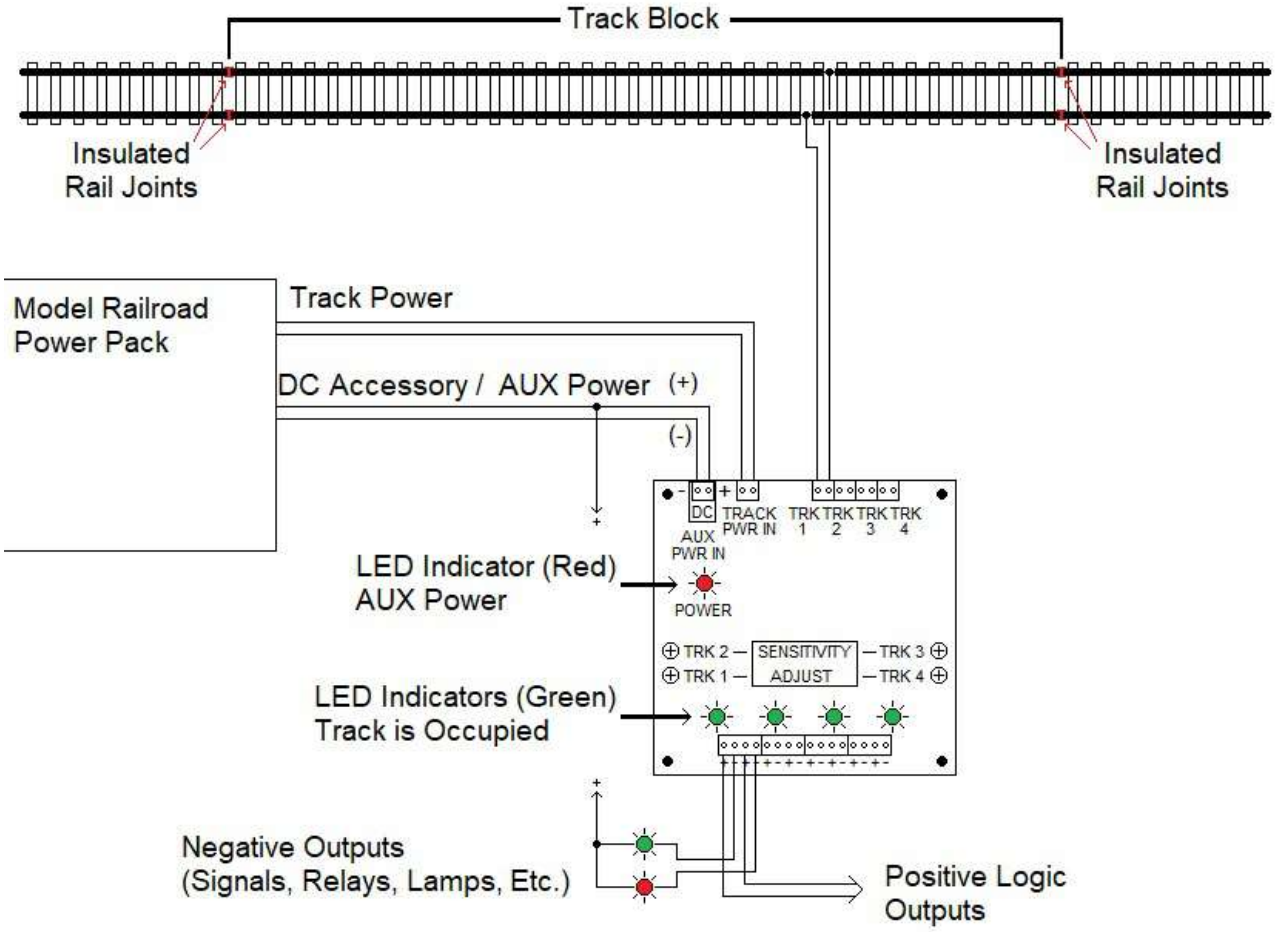
This Detector unit operates on a similar principle. On a model railroad layout, electric current is applied to the rails to provide power to the locomotive so that the train can move. With DCC, signals are even transmitted to the locomotive's controller unit through the same method. The detector unit is designed to precisely detect when such equipment is present within that block. The only difference is that most model train cars are manufactured with insulated wheels. So while the locomotive will trigger the Detector, the cars will not. It is advised to either install a resistor in the outer axle of each car, or replace the axles with those designed specifically to work as signaling shunts, but having resistive axles. It is recommended to use a resistance of no less than 4,000 ohms but no more than 40,000 ohms per axle. You can install the resistors yourself if you follow this example.



Connecting your Detector Unit

The detector unit is designed to run in-line with the track power, between your power pack and the track circuit in your layout. Near the top-left corner of the detector board is a 2-pole terminal labeled "TRACK PWR IN" and can be connected in any polarity to the power supply. Opposite of the board near the top-right corner is an 8-pole terminal block labeled "TRK 1 TRK 2 TRK 3 TRK4" which goes to the track. Be sure to insert your wire into each terminal and gently tighten the terminal lug with a small flat head screwdriver to finger-tightness only. DO NOT OVERTIGHTEN! For best results, it is recommended that you apply a solder tin to your wire before insertion. Alternately, you may also choose to crimp on insertion lugs at the ends of your wires.

The terminals or DC Power Jack immediately to the Left the Track Power terminals are labeled "AUX PWR IN" This is where the power source shall be connected to the unit to provide it with power to operate. This cannot be the same power source as the track power, as it will not function. The power in to AUX power must be at least 6 volts DC but no more than 18 volts DC. Recommended power supply is a 12-volt DC supply. The terminal on the Aux Power closest to the Track power terminals is the Positive lead. Connecting the polarity in reverse will cause the unit to not function at all.

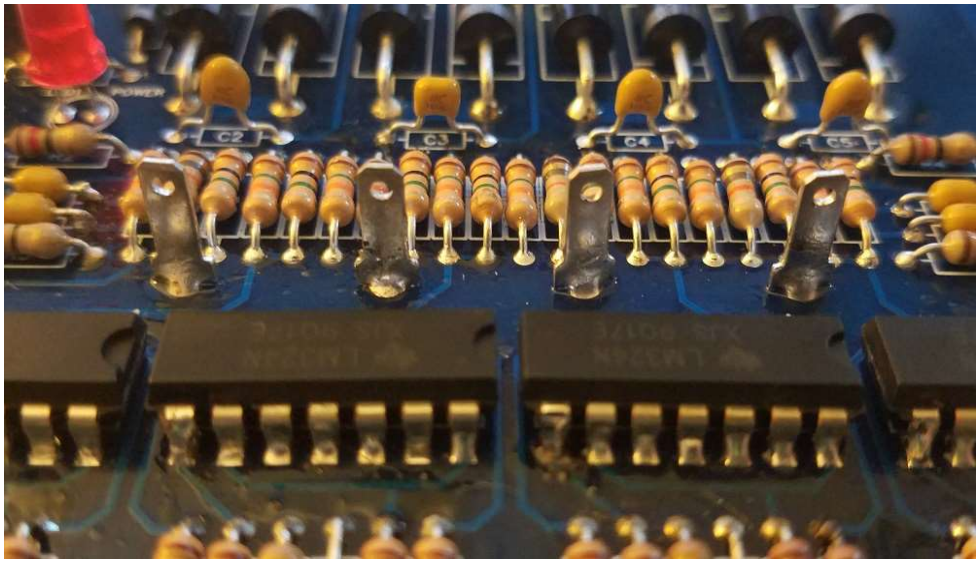


Connecting your Detector Unit, Cont'd

The outputs are located at the bottom of the board with 4 sets of 4-pole terminals and are labeled “CLEAR” and “OCC'D” with a (+) and – for each. The positive output for each is only intended to drive logic inputs such as an Arduino, or other Controller device. It is not advised to use this output to drive lights or motors as it may overload the unit and cause considerable damage.
The negative output for each is designated for driving lights, motors and relays, where the device(s) are connected with a Common Anode. (+) If you are using a DC power source, you can tap into the Positive terminal of the supply for your positive connection. If however you are using AC, you will need to install a small rectifier diode in series with your device to get your positive source. The unit is capable of switching up to 600mA on the Negative outputs, which is more than ample for small motors, relays and several lamps.

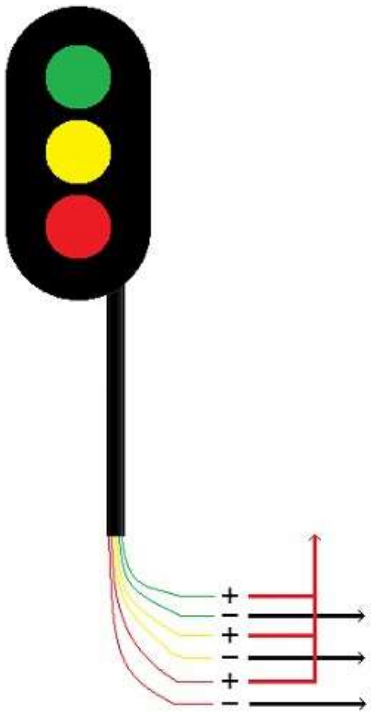
Once you have connected your unit to a Power supply and to the track power, turn on both power units. Then place a train car equipped with resistive axles in the designated block. Using a small phillips or flat head screwdriver, adjust the trimmer pot near the center edges of the board. Turn the pot clockwise until the indicator on the unit goes out, and then turn it back slowly just until the indicator illuminates again. You can always re-adjust the sensitivity later, but for now this should work fine. Turn off your power sources and connect your unit to the intended output devices as you desire.

The unit is equipped with an override function. There is a single terminal for each track located about mid-center of the board. The purpose of this terminal is so that you can interrupt any latching circuits in your logic without needing to wait for a train to enter the block. It's also a means of testing the logic outputs without the sensor being activated. One example for this feature is when you have a switch or turnout inside the block that is lined against the main track, say an industrial spur or customer track. While it is lined against the main track, you can have the block remain occupied without the presence of a train in the electric block. This terminal is a 0.110” male spade. You can either crimp a female spade of the same size onto a wire and snap it onto the terminal, or you can solder your wire to the terminal. Bridge your toggle or field switch between this terminal and Ground to achieve the desired effect.



Connecting your Detector Unit, Cont'd

If you are connecting a signal to the unit, please check first and be sure that the signal is either separate elements or common anode. (+) The detector unit will switch the lights from the negative side.



If using LEDs (Common) this is referred to as the Cathode. (-) When using LEDs, it is required to have a resistor in series with each of the anodes to bring the voltage down to the level that the LED will be able to function with. The following table is the method for calculating the value of your resistors.

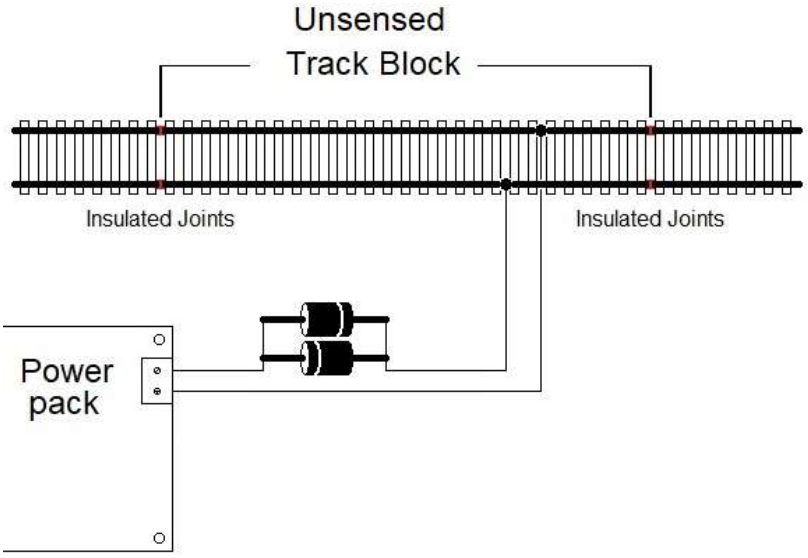
$$R = \frac{V_{in} - V_f}{I_f}$$

Where V_{in} is your DC power supply voltage, V_f is the LED's forward voltage rating and I_f is the LED's forward current rating.

Typically LEDs have a forward voltage of 3 to 4 volts and a forward current of 20mA or 0.02 Amps. So if you are using a 12-volt supply, subtract 3 volts which gives you 9. Then divide by 0.02 and you should have 450 which is R. The industry standard value is 470 ohms and that's the value you should be using for a 12-volt application on LEDs. Failure to use a current-limiting resistor in series with an LED will cause your LED to overcurrent and will destroy the LED. LEDs are just diodes, meaning they are intended to conduct current just like a wire, yet LEDs are only able to conduct a small amount of current. Exceeding the current in your LED is like putting 20 amps through your 1 amp fuse, it will blow!

******IMPORTANT NOTE*****

The detector will cause a remarkable difference in track power from a block that is not equipped with a detector. In other words you may observe the locomotive become slightly sluggish in the detector-sensed block compared to a block that's not equipped, and then it will lurch back to full speed once it returns to a non-sensed block. For continuity sake, it is recommended that you place a pair of rectifier diodes in line with your track power for each block that is not equipped with a detector, in reverse-parallel to each other. The recommended diodes are 3-amp Rectifier Diodes, such as the 1N5404.



Mounting your Detector Unit

Each unit is designed with 3/16th inch (3.175mm) mounting stud holes in all four corners. These stud holes are grounded for safety purposes, so that you can fasten them via mounting standoffs or studs to a metal panel. However the one concern is made regarding the grounding bond in that the Track power and Aux power are both bonded to ground on the Detector Unit. If for any reason this could create a short-circuit, it is imperative that you test your power connections after mounting but before energizing, to ensure that you are not connecting them to a short-circuit because you grounded the board. You can do this with a simple multimeter set on ohms or continuity. If you feel there may be an issue or you find an issue with grounding the board, it is recommended then that you fasten the detector unit to your panel using nylon standoffs or insulated wafers.

The detector unit is capable of stacking with more detector units, sandwich-style but require a 1-inch standoff or longer between them to separate the components.

Any other form of mounting or fastening of these units is neither supported nor recommended.

Support for your Detector Unit

Any and all questions regarding installation, testing and troubleshooting can be directed to me personally at JasonTurcyn@yahoo.com and I will be happy to help out as I am able. Please refer to these instructions first and if you are stuck on an issue, I will be here to assist you.

How to use your Block Occupancy Detector Unit

The applications for a Block Occupancy detector are many, in fact there is no way to explain all the available uses so I will simply give some examples where it might be used.

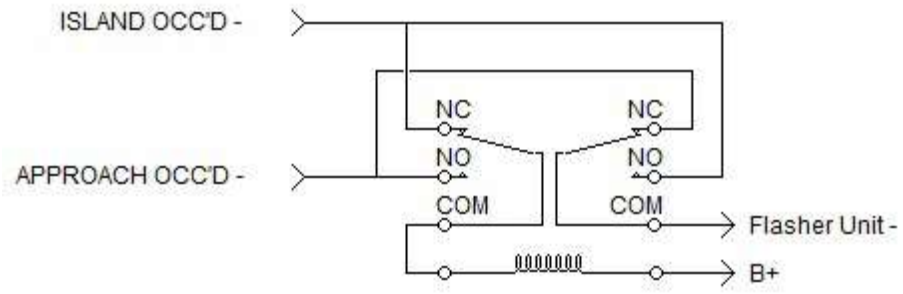
A Tunnel or Bridge location

If you have a tunnel that permits bi-directional traffic, you may want to regulate it with a signal in order to keep your trains from meeting in the middle suddenly. Using the Block Occupancy Detector you can set your signals on either side of the tunnel. If the block is clear, your signals can show a Green Light. But if your train has entered the tunnel block, the signals will drop to Red, alerting any train on the other side know the tunnel is in use.

Similarly with a draw bridge or long span bridge, you can warn traffic when the spam is in use or occupied. Or if you are using the draw bridge section and the bridge is open, you can connect the switch on the bridge to the "INT" terminal on the detector unit to override the block, showing a Red light regardless of the block condition.

A Highway At-Grade Crossing with flashers

Whenever your train nears the highway you wish to offer protection to, have the "OCC'D -" connect to a relay that activates a flasher and bell at your crossing warning motorists of the present danger ahead. If you can use two Detectors, establish an Island block for your crossing which is short and only includes a span as long as your highway is wide*. Then set up the approach circuit(s) on either side to allow for enough warning.



Using a Double-Pole Double-Throw relay, you can allow your crossing warning to activate when your train enters the approach circuit but deactivate once it clears the island circuit and resets when it clears the approach.

*Note – As with the prototype, you must also consider the length of your railcars in the island circuit. If you have a 40 ft. island but 80 ft. train cars, it's possible you could miss the island circuit when a train car straddles it electrically.

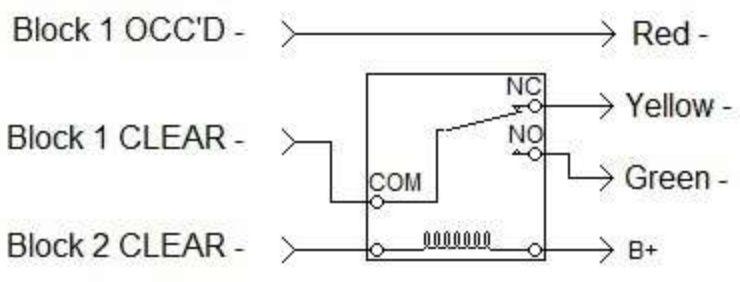
Automatic Block Signals

Before the technology of fiber optics and satellite communications enabled our railroads to communicate from a control office directly with every wayside controller and allow them to respond with telemetry back to the office, much of the railroad signaling was done using Automatic Blocks, meaning signals were autonomous and relied on Block detection to establish traffic speed and frequency.

How to use your Block Occupancy Detector Unit, Cont'd

Autonomous or Automatic Block Signals used a series of blocks with detectors to key in a signal or other wayside aspect. For most, the use of Red, Yellow and Green in a 2-block system was sufficient for any service that ran an autonomous section or subdivision. In cases where there were sidings or double track, switches would automatically line the train for the track to the right and signals were there to indicate the position and conditions of track ahead. The common aspects for these blocks were Stop, Approach and Clear.

Where you use a 2-block system you will need to connect a Relay for each signal, one on each end of the block as the following diagram shows:



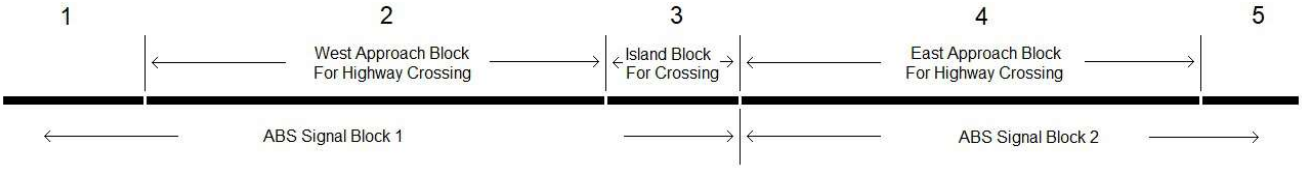
This circuit requires the adjacent detector's CLEAR – to connect to the coil on the relay in order to apply advance warning about the conditions of the block ahead. The relay will toggle the signal between an Approach Aspect, (Yellow) or a Clear aspect. (Green) However if Block 1 should become occupied, then the status of the Relay is null because Block 1 OCC'D will now illuminate the Red light giving you a Stop aspect. If you have reached the end of your Automatic Blocks, then simply omit the relay and use the Block 1 CLEAR – to go directly to your green light, unless you would prefer to use something different. In some cases, railroads would indicate the train is leaving signaled territory with a Lunar (Bluish-White) aspect meaning Restricting. This is generally preceded with an approach signal, because while the signal is Restricting, it's possible that you may have to stop soon anyway so the signal preceding it, Approach, means being prepared to stop at the next signal.

There are plenty of variables with the signal configuration utilizing a 2-block system, most which involve a switch into a Branch Line, Siding or Crossover. Or perhaps a Railroad At-Grade Crossing. If it involves more than one track and there's a Great possibility of more than one train at a time at this location, you will need an Interlocking device to control it. Interlocking refers to the mechanical, electrical and/or electromechanical devices that permits an action, while prohibiting further actions that conflict with the first one until it has been reset. Contrary to popular opinion, an Interlocking is not always an At Grade Railroad Crossing, though every signaled Railroad Crossing has an Interlocking mechanism present. Interlockings are also used at locations such as Siding Switches, Crossovers, Drawbridges and Control Points. There are two types of interlockings: Automatic and Manual. An automatic interlocking operates autonomously, using block detectors to position the interlocking to permit traffic to pass through. Manual interlockings require the input from a person such as a dispatcher before they will permit traffic to pass through. In any case, Interlocking devices can be as

simple as a series of relays interconnected with each other., or as complicated as a Computer Network with programming software designed to regulate the train traffic as the dispatcher sees fit to do so. How you set it up on your Model Layout is completely up to you.

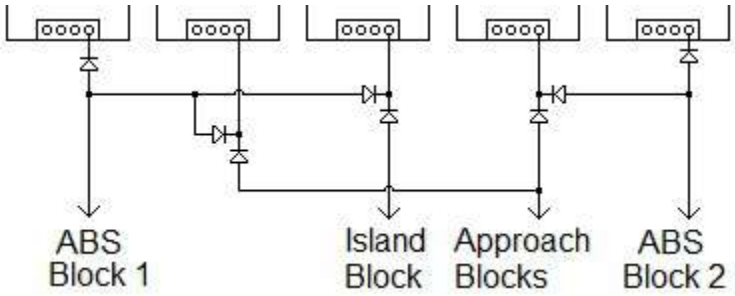
Overlapping your Blocks

It is possible to overlap blocks, however this means using more than one block detector for the single intended block in order to accomplish your goal. The best example that I can use is the example of the grade crossing above where there is an approach circuit and an island circuit in order to operate the crossing signals. But let's assume that the crossing is also on the edge of an ABS or CTC block and you can put the East approach and Island blocks on one ABS block, but the West Approach is on the adjacent ABS block.



In the illustration above, ABS Signal Block 1 has 3 detectors within the designated limits of this block. Each detector will have a small switching diode such as a 1N4148 to provide isolation between each other, and still provide the signal equipment with the proper readout. Meanwhile ABS Signal Block 2 has 2 detectors within its designated limits and also shares the signal from the detectors with a diode to isolate them.

The crossing circuit on the other hand will have the West and East Approaches connected with a diode to isolate them, but to link appropriately whenever a train enters the approaches to active the crossing signal.



Of course this is merely an example of how to overlap your blocks. You should survey your layout and decide what your blocks are going to be and how many blocks you are using before you begin wiring and mounting detectors. Among the most common applications of overlapping blocks is in a zone with interlocking controls such as a switch or crossover. The center of the interlocking is the short block where the switch(es) are located and within the clearance points of said switches. In the instance where you are using signals at a siding or junction, the interlocking center and the adjacent block will govern the authorization for movement.