Quad Occupancy Detector

This device provides current-sensing detection to four separate blocks or sections of track being powered by a single feeder. The device may be used with either DC or DCC systems.

The device may be used with or without common rail wiring as it is wired in-line with only one rail and requires no connection to the other rail. Output circuits are electrically isolated from track power to allow proper functioning whether or not the two have a common ground.

Trackside Electrical Specifications

Track current (maximum continuous per detector)	4 amperes
Track power connectors	Screw terminals: 2 for power feed 1 for each block
Track power terminal minimum wire gauge	22
Track power terminal maximum wire gauge	14
Track power terminal maximum current	16 amperes

Output Electrical Specifications

Output connectors	6-pin SIP Screw terminals: 2 for output power, 4 for outputs
Output drive	Open collector
Output maximum voltage	26 volts
Output maximum continuous current *	50 milliamperes

** Detector outputs can sink up to 190 mA, however sensitivity decreases as output current increases. It is recommended that output current be limited below 50 mA. Driving a digital input is well under this limit, and driving most relays are under this limit.*

Connecting the Detector to Track Wiring

Track power source may be connected to either screw terminal on the block labeled X1 in Figure 1. The second terminal may be used to daisy chain the power feed to another detector card.

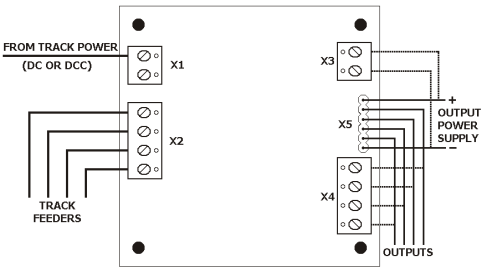


Figure 1

Feeders for each of four separately detectable track sections are connected to one of the four screw terminals on the block labeled X2. If one detector is to feed a block in more than one location (e.g.: provide a feed for each section of track in the block), it is recommended that a single heavier-gauge feed connect to the card and each track feeder branch off of the heavier feeder.

Once power and track feeders have been connected, track is ready for use. It is not necessary to have any outputs nor the output power supply connected in order for the detector to provide connection from the track power to the track feeders.

Connecting the Detector to Output Circuits

On the output terminals, it is necessary to connect the negative terminal of a power supply to either pin 6 of the output header, X5 on Figure 1, or to the terminal labeled "-" on X3 (the terminal closest to X5). This is the same power supply that is used to power the circuit that the detectors' outputs will drive, or may be a separate power supply with the same voltage used by that circuit. The detector circuit has been designed to operate with any power supply providing up to 26 volts.

Connecting the positive terminal of the same power supply to either pin 1 of X5 or the terminal labeled "+" on X3 will enable the indicator LEDs on the card to operate. LEDs glow brightly when occupancy is detected and are off or very dim when there is no occupancy.

Each detector output is found on either pins 2 through 5 of X5 or on the terminals of X4, in the same order as X5.

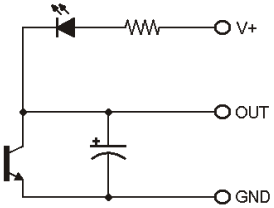


Figure 2

Each detector circuit provides an open collector output that conducts when the block is occupied (see Figure 2). If the detector is driving a digital circuit or computer interface, this makes the output *active low*. The capacitor on the output reduces occasional loss of occupancy detection due to intermittent contact as wheels roll.

If driving other devices directly, load current should be kept below 50 milliamperes to maintain maximum sensitivity of the detector. The output transistor is capable of sinking 200 mA, and the indicator LED can draw up to 10 mA, leaving an absolute maximum of 190 mA.

If the detector is driving an inductive load, such as a relay, a clamping diode must be used to prevent damage to the detector's output transistor, see Figure 3. A rectifier diode such as the 1N4000 is suitable for this purpose.

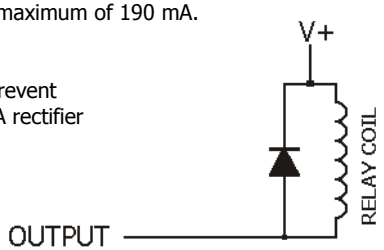


Figure 3

Warranty

A factory-assembled Quad Occupancy detector is tested and warranted against manufacturing defects for a period of 1 year from date of purchase. As the circumstances under which this detector card is installed cannot be controlled, failure of the detector card due to installation problems cannot be warranted. This includes misuse, miswiring, operation under loads beyond its specifications, or short circuits. The warranty is voided if the detector card is connected to an output supply voltage more than 26 volts, used for a load greater than 190 milliamperes, or used for track power exceeding 4 amperes per block, or 16 amperes in total, including daisy-chained feeds.

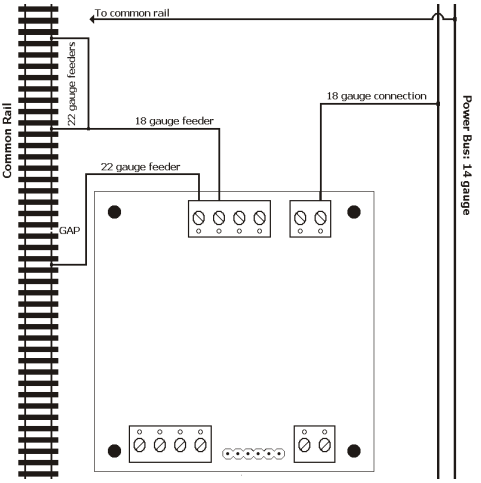
If the Quad Occupancy detector fails for non-warranted reasons, it can be replaced with no questions asked for the cost of $24 plus shipping (this fee subject to change).

Send an email to **circuits@daxack.ca** for information on warranty or non-warranty replacement.

This document is available in PDF format on our website.

Occupancy Detection Application Notes

In wiring a model railroad, generally longer runs, and runs intended to carry more current should use heavier gauge wire. Feeders that connect to track tend to be a lighter gauge, such as 22 gauge, but the length of such a light section of wire should be kept as short as possible.



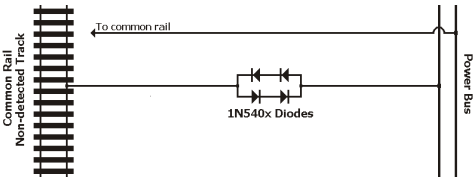
The diagram to the right shows one suggested method for wiring a DCC layout. In the diagram, the main power bus uses 14 gauge wire. The connection from the bus to the Quad Occupancy Detector card uses 18 gauge wire. Connections to the track use 22 gauge wire.

Where a single connection from the track to the Quad Occupancy Detector card is short (about 18" maximum), the 22 gauge feeder is connected directly to the card. Where there is more than one feeder from the track (e.g.: it is good practice to have a feeder for each section of track, even when track joints are soldered), or where the distance from the track connection to the card are longer, using an 18 gauge feeder from the card to a close location to the track is recommended.

Non-detected Track

The Quad Occupancy detector passes track current through two diodes, and this drops track voltage by about 1.4 volts.

If there are track sections where detection is not used (e.g.: in a yard), when a locomotive moves from detected to non-detected track, there will be a noticeable change in motor speed.



To avoid this change in speed, non-detected track should have its power pass through a pair of diodes that are in parallel with another pair with the opposite polarity. Diodes used should have suitable current carrying capabilities for the application.

Best practice would be to use diodes capable of carrying 4 amperes of current. If your track bus has a lower level of over-current protection, you may use diodes with that lower limit. For instance, if your over-current protection limits current to 3 amperes, you may use diodes in the the 1N540x family (e.g.: 1N5401, 1N5402, etc.).

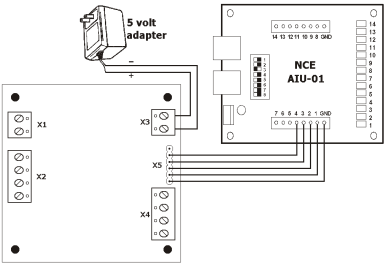
It is not necessary to have a separate set of diodes for each non-detected track feeder. A single set can be placed in line with a bus that provides power to all non-detected track sections.

Interfacing With Other Systems

Outputs of the Quad Occupancy detector provide an active low input to digital systems. This means that the output goes low to a digital "0" when a train is detected. In order for this to function electrically, a common ground must exist between the Quad Occupancy detector and the circuit it is driving.

It is not necessary to provide power on the output side of the Quad Occupancy detector, however without power, its indicators will not function. Ideally, the power supply should be the same power supply that is used for the circuit or system that receives the outputs. In some cases, it is not practical to obtain the same power supply. In that circumstance, your own power supply may be used but its output voltage should not be greater than the power supply of the circuit or system that received the detector's outputs. Many digital systems use a 5 volt supply, but you should confirm what is used by yours.

Your own power supply can be as simple as a DC wall adapter (a "wall wart", as they are sometimes called). Its current output should be capable of powering all the Quad Occupancy detectors it will supply. Each indicator can draw up to 10 mA (40 mA if all are on at the same time), though with a 5 volt supply, each will only draw less than 2 mA (8 mA for all).

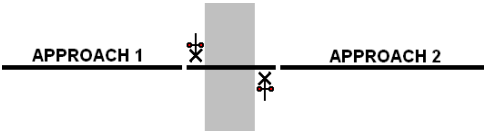


As an example, the AIU-01 Auxiliary Input Unit from NCE works well with the Quad Occupancy detector. A ground terminal is provided on the AIU-01, but no terminal for its 5 volt power supply exists, so using a separate power supply for the detector's indicators is needed. See the diagram to the right. Note that the adapter and the ground from the AIU-01 may be connected using either X3 or X5.

"High Definition" Detection

There are some situations where occupancy detection requires a higher resolution than simply knowing if a train is in a block or not. It is sometimes necessary to know what part of the block a train is in, and there are some track sections that are part of two blocks for signaling purposes.

One example of this is at a signaled level crossing. Simply detecting the occupancy of the entire block would mean that the crossing signals would flash anytime the train occupied the block. Anyone who has spent a little time near a crossing knows this is not how they operate. They operate for a minimum amount of time before the train arrives, and shut off just after the last car clears the crossing. The logic needed to operate grade crossing signals needs to know the occupancy of three sections of track: the approach sections on either side of the crossing plus the section of track over the crossing itself. See the figure to the right.



Level Crossing Figure

The basic operation will have the grade crossing start flashing when either approach section becomes occupied, and continue while either that section or the section over the crossing remains occupied. The occupancy of the other approach section of track, on the departure side of the crossing, is ignored if the crossing is already flashing when it becomes occupied. Assuming all of this is in the same block, the signals protecting that block consider the entire block as occupied when any one of these three sections of track are occupied. This block essentially has three "sub-blocks" and each must have its own detection circuits.

Another situation that requires additional detection is at a controlled location in CTC territory (sometimes called an "OS Section"). Refer to the figure to the right. For signaling, the section of track surrounding a turnout needs to have its occupancy detected separately from the surrounding blocks. When this section of track is occupied, the block at the points end (Block 3) will also considered to be occupied, and one of the frog-end blocks (either Block 1 or Block 2, depending on the switch alignment) will also be considered occupied. Occupancy of the controlled location should also prevent the operation of the turnout. This adds a detection circuit for each switch at a controlled location.

Controlled Location Figure