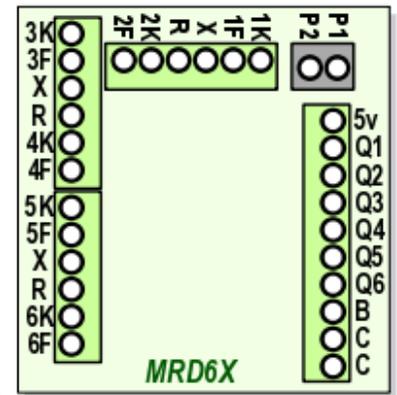


**What it is:** The MRD6T is a six-channel model train detector. It can detect model trains at up to six different locations on the layout and activate up to six LEDs or six 5-volt, low current electronic circuits. If the sensors are placed on a length of hidden track such as a tunnel, the MRD6T can control a signal to show if the track is clear.

**Kit contents:**

- ★ Circuit board
- ★ Infrared light-emitting diodes (IR LEDs) with orange & white (2 ft length) or red & white (6 ft length) wire leads
- ★ Infrared photo receivers with green & white (2 ft length) or blue & yellow (6 ft length) wire leads
- ★ Plastic mounting tubes. The tubes are for protection of the sensor leads and to provide mounting support. They are not essential for detector operation and may be shortened or removed entirely to best fit your situation. Just use caution to avoid damaging the leads.
- ★ Diode and 1,000-ohm ('1k') resistors for use with LED signals (pg. 4).



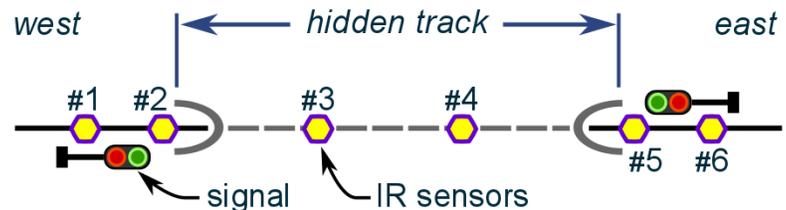
**How it works:** Trains are detected by infrared (IR) light, invisible to the human eye. There are two sensing elements at each track location - an IR LED light source paired with an IR photo receiver. Yellow LEDs on the MRD6T show the status of the detectors -- 'on' if the circuit is detecting an object, 'off' if no object is being detected. A red LED turns on when the MRD6T determines that a train is on the protected track section.

### Installation

There are four installation steps: Sensor installation, Power connection, Sensor adjustment, and Output connection.

**First, install the sensors:** Locate the IR sensor pairs as shown here. Spacing between sensors 1 & 2 should be slightly less than the length of the shortest locomotive. Similar spacing for sensors 5 & 6.

- Sensor 1**, west entrance, outer
- Sensor 2**, west entrance, inner
- Sensor 3**, inside west (optional)
- Sensor 4**, inside east (optional)
- Sensor 5**, east entrance, inner
- Sensor 6**, east entrance, outer

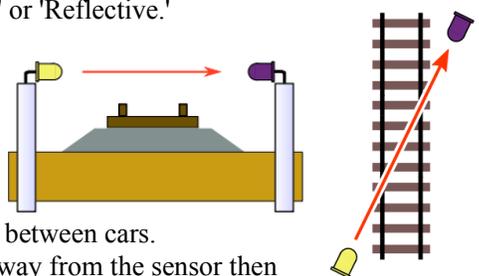


**An external LED** may be connected to each output terminal Q1 - Q6. Placing the LEDs on a control panel enables an operator to monitor a train's progress through the tunnel. LED connections are shown on page 4.

**LED track signals** or additional panel LEDs may be connected to output terminal B. This will show whether a train is anywhere on the protected track segment, even if it is between sensors. Connections are shown on page 4.

Each sensor pair may be installed in one of two different ways - 'Across the Track' or 'Reflective.'

**Across the Track sensing:** The IR LED is positioned horizontally on one side of the track(s), and the IR photo receiver is placed on the opposite side. A train is detected when it blocks the light path between the LED and photo receiver. The distance between the LED and photo receiver can be up to 18 in. (46cm), or more with careful alignment. Placing the sensors at an angle across the track(s) creates a longer detection zone and avoids possible detector flickering caused by the gaps between cars.

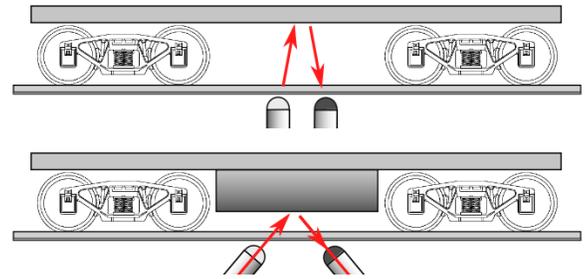


**Tip #1** - If mounting the sensors vertically as shown here, slide the plastic tubes away from the sensor then carefully bend the leads to a right angle. The leads are somewhat brittle, bending them more than two or three times may cause a break.

**Tip #2** - Locate the photo receiver so it faces away from bright lights or sunny windows. Use scenery or structures to conceal the sensors and shade them from bright light sources.

**Tip #3** - The detection zone of each detector can be expanded by adding a second IR LED/ photo receiver pair. Additional sensor pairs may be purchased from Azatrax, see the website [www.azatrax.com](http://www.azatrax.com) for details.

**Reflective sensing:** Trains are detected when light from the IR LED is reflected off a train and sensed by the IR photo receiver. Typically the sensors are mounted in two 3/16-inch (4.8mm) holes drilled in the roadbed as shown here. Vertical installation works for S and larger scales as long as there is no structure above the track such as a bridge. Angling the IR LED and photo receiver toward each other is best for N and HO scale where the trains are close to the rail head, and in places where an object above the track might otherwise cause false detections. Angle the IR LED and photo receiver so their centerlines intersect at the height of the bottom of your rolling stock.



**Tip #4** - You can ballast your track after sensors are installed. Cover each sensor with a bit of transparent tape. Apply ballast. When the glue has dried use a dental pick or similar tool to remove ballast from the sensors. An opening of just 1 or 2 mm is required.

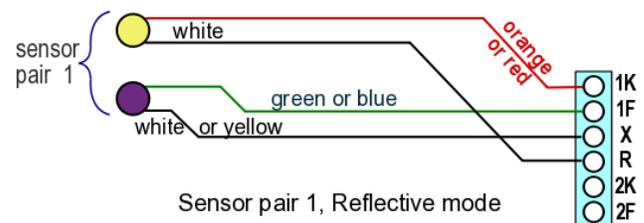
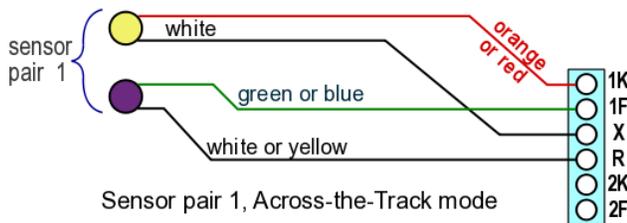
**Connecting wires to the terminal blocks:** The MRD6T has 'spring cage' terminal blocks.

To make a connection:

- ♣ Strip 3/8 inch (1 cm) of insulation off the end of the wire. You can measure with the strip gauge printed near the edge of the circuit board.
- ♣ Use a small screwdriver to push down (push, do not turn) the terminal's button. Push firmly.
- ♣ While the button is pushed in, hold the wire at a 45 degree angle to the terminal block and push it in. About 3/8 inch of wire should go into the terminal block.
- ♣ Release the button. Tug on the wire to make sure it is secure.

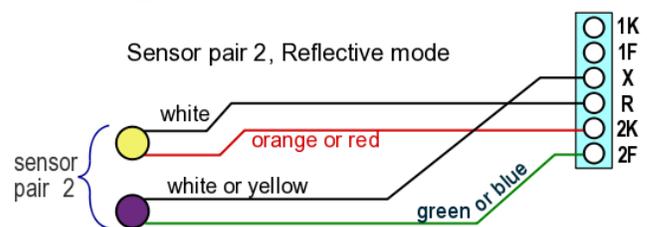
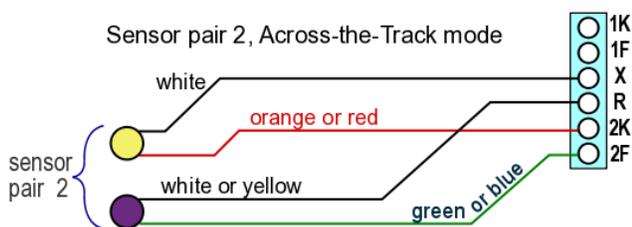


**Connect sensor pair 1:** Connect the orange (or red) wire from the IR LED to terminal 1K. Connect the green (or blue) wire from the IR photo receiver to terminal 1F. Now, how you connect the two white (or yellow) wires to the MRD6T will determine whether Detector 1 will operate in 'Across the Track' or 'Reflective' mode. See the diagrams below.



**Add connections for sensor pair 2:** Connect the orange (or red) wire from the IR LED to terminal 2K. Connect the green (or blue) wire from the IR receiver to terminal 2F. As with sensor pair 1, how you connect the two white (or yellow) wires will determine whether Detector 2 will operate in 'Across the Track' or 'Reflective' mode. Detector 2 can operate in the same mode as Detector 1, or in a different mode.

Note that when both sensor pairs are wired to the MRD6T, there will be two white (or yellow) wires in 'X' and two white (or yellow) wires in 'R.' For reliable results, twist the bare ends of these wires together.



Additional wire may be spliced to the sensor leads if needed. Use similar twisted pair wire for total length up to 25 ft (7.5m).

**➡ Pairing is important!** The IR LED that is connected to 1K must be paired on the layout with the IR photo receiver that is connected to 1F. And the IR LED that is connected to 2K must be paired on the layout with the IR photo receiver that is connected to 2F.

Test and adjust sensor pairs 1 & 2 as follows before connecting the rest of the sensors:

**Connect power to the MRD6T:** Connect an accessory power supply of 8 to 16 volts AC or DC to terminals P1 & P2. The red LED will briefly flash to show that power is on and the circuit is working.

#### Adjust the sensors:

With no trains in any of the detection zones, all of the yellow LEDs on the MRD6T module should be off. If any yellow LED is on, correct the false sensing condition.

#### **To fix false sensing for Across-the-Track mode:**

1. Verify that the sensor pair is wired correctly.
2. Make sure the IR LED and photo receiver are pointed at each other, and nothing is between them.
3. Shade the photo receiver from bright lights, and point it away from windows or other strong light sources.
4. Change the nearby room light from incandescent to a fluorescent bulb if possible.

#### **To fix false sensing for Reflective mode:**

1. Verify that the sensor pair is wired correctly.
2. Pull the IR LED and photo receiver a bit deeper into the roadbed.
3. Infrared light may be 'leaking' through the roadbed material from the IR LED to the photo receiver. Push a metal shim, such as the tip of a hobby knife blade, vertically into the roadbed between the IR LED and photo receiver.
4. Is there an object above the sensor, such as a bridge, or an upper layout level? Mount the IR LED and photo receiver at a shallower angle, or paint the object flat black. Or use across-the-track sensing.

Are all detectors now off? Now **test for train detection**. Place a locomotive or car in the detection zone of Detector 1. Yellow LED#1 should light. If yellow LED#2 also lights, re-adjust sensor pair 2 for false detection (see above). If LED#1 does not light, correct sensor pair 1 for a false clear condition.

#### **To fix a false clear indication for Across-the-track mode:**

1. Verify that the sensor pair is wired correctly.
2. Adjust the sensor height so the train is fully blocking the light path from the IR LED to the photo receiver.

#### **To fix a false clear indication for Reflective mode:**

1. Verify that the sensor pair is wired correctly.
2. Adjust the sensors higher or lower in the roadbed.
3. A bright light source above and to the side of the track may be saturating the IR photo receiver. Try pulling it deeper into the roadbed or create shade with scenery or a structure. Change the nearby light from incandescent to a fluorescent bulb.

Test with several types of rolling stock and adjust the sensors as needed.

Remove the train from Detector 1's detection zone, make sure LED#1 goes out.

Place a train in Detector 2's detection zone. The yellow LED#2 should light. If LED#1 also turns on, adjust sensor pair 1 for false detection (see above). If LED#2 does not light, adjust sensor pair 2 for a false clear condition (same process as above for sensor pair 1).

**Connect sensor pair 5:** Turn off the power. Connect the orange (or red) wire from the IR LED to terminal 5K. Connect the green (or blue) wire from the IR photo receiver to terminal 3F. Again, how you connect the two white (or yellow) wires to the MRD6T will determine whether Detector 3 will operate in 'Across the Track' or 'Reflective' mode.

**Connect sensor pair 6:** Connect the orange (or red) wire from the IR LED to terminal 6K. Connect the green (or blue) wire from the IR photo receiver to terminal 6F. As with the previous sensor pairs, how you connect the two white (or yellow) wires will determine whether Detector 6 will operate in 'Across the Track' or 'Reflective' mode.

Turn on power to test and adjust sensor pairs 5 & 6 the same way you tested sensor pairs 1 & 2.

If sensors 3 & 4 will be used, turn off power before connecting them.

#### **Sensor pair 3 (optional):**

IR LED orange (or red) wire to 3K. IR LED white wire to X (for across-the-track) or R (for reflective mode).

IR receiver green (or blue) wire to 3F. IR receiver white (or yellow) to R (across-the-track) or X (reflective).

#### **Sensor pair 4 (optional):**

IR LED orange (or red) wire to 4K. IR LED white wire to X (for across-the-track) or R (for reflective mode).

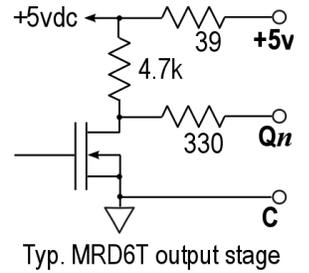
IR receiver green (or blue) wire to 4F. IR receiver white (or yellow) to R (across-the-track) or X (reflective).

Turn on power.

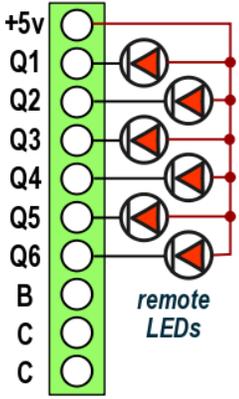
Test and adjust sensor pairs 3 & 4. All of your sensors should now be connected and working.

**Output connection**

Terminals **Q1 - Q6** and **B** are the output connections. **C** is a 'common' connection to all of the circuits on the MRD6T (the two C terminals are electrically connected). Outputs Q1 - Q6 provide a logic 'low' signal (near 0 volts) when their respective detectors are sensing an object, and provide a logic 'high' (+5 volts) when their respective detector is not sensing an object.



Typ. MRD6T output stage



**Remote LEDs**

LED panel indicators or signals may be connected to the MRD6T as shown on the left. Connect the positive side of all LEDs to the '+5v' terminal of the MRD6T. Connect the negative side of each LED to its own output terminal Q1 - Q6. Separate resistors are not required, as resistors are already on the MRD6T circuit board.

**Solid State Relays**

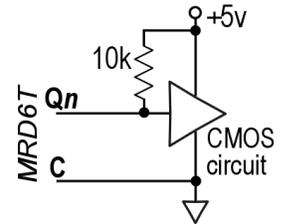
To switch higher currents or to achieve electrical isolation between the MRD6T and the controlled circuits, use a solid state relay. The input of the solid state relay connects to the MRD6T in the same way as a remote LED. Azatrax SSR6, Avago ASSR-1228 or similar relays will work well.

**+5 Volt Digital Circuits**

The schematic at right shows an MRD6T output connected to the input of a typical digital circuit.

Keep the following points in mind when choosing circuit components:

- Power the digital circuit with +5 volts only
- Use a minimum of 4.7k ohm pull up resistor, 10k is better
- Use CMOS logic components (4000 series or 74HC series) rather than TTL. 74LS TTL circuits usually work, but will be much more sensitive to interference.



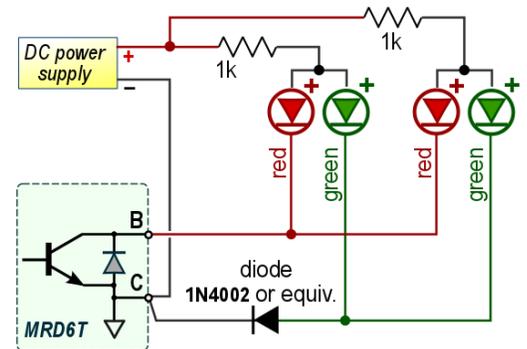
*Each output Q1 - Q6 may be connected to an LED, a solid state relay or to a digital electronic circuit -- but only to one at the same time.*

**Connecting Signals to Output 'B'**

The DC power supply for the signals may also power the MRD6T. Connect it to terminals P1 & P2 (+/- polarity at P1 & P2 does not matter).

Single LED or incandescent bulbs may be connected to the 'B' terminal, up to a max current of 0.25 amp.

Green / red common anode (+) LED signals can be controlled by connecting the red signal leads to 'B', and the green signal leads through a series diode as shown. Note the resistor is in the 'common' lead of each signal, not in the red and green leads. Remove any resistors in the red or green leads.



Switching red / green common anode (+) LEDs.

Green / red common cathode (-) LED signals and two-bulb incandescent signals must be controlled via a relay.

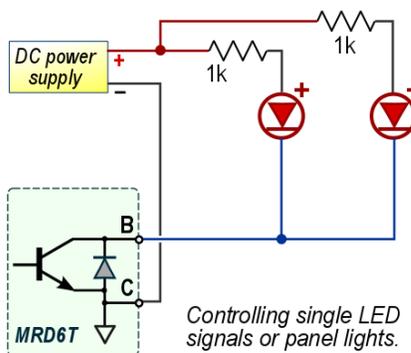
Connect the relay to 'B' as shown.

**Operation**

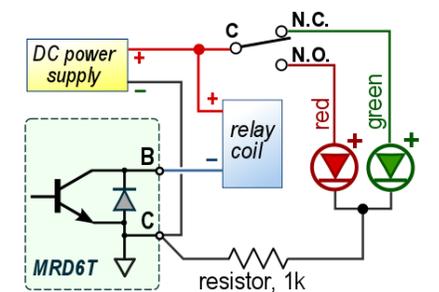
**Red on - Occupied** - At least one sensor is sensing a train, or the last train to pass through a portal was heading into the tunnel.

**Red off - Clear** - All sensors are clear, and the last train to pass through a portal was exiting the tunnel.

**Flashing red/green** - After power-up, if all sensors are clear but no train has yet passed completely through the tunnel, it is not certain if the tunnel is clear. A train may be between sensors. Make a visual inspection or proceed with caution. After the first train makes a *complete pass*, the signals will show a steady 'clear' or 'occupied' indication.



Controlling single LED signals or panel lights.



Switching incandescent bulbs or common cathode (-) LEDs with a relay.