Installation Instructions

Azatrax Dual Infrared Model Train Detector MRD2-U, USB only

What it is: The MRD2-U is a two-channel model train detector. It can detect model trains at two different locations and send information to a computer via USB interface.

Kit contents:
★ Circuit board
★ Two infrared light-emitting diodes (IR LEDs) with orange & white (2 ft length) or red & white (6 ft length) wire leads
★ Two infrared phototransistors (light receivers) with green & white (2 ft length) or blue & white (6 ft length) wire leads
★ Four 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 not to damage the leads.
★ Mounting screws

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 phototransistor (the receiver). Green and red LEDs on the MRD2 show the status of the detectors. Detector status and timing information is reported to the host computer via the USB connection. Installation

There are three installation steps: Sensor installation, USB connection and Sensor adjustment

First, install the sensors: Each sensor pair may be installed in one of two different ways - 'Across the Track' or 'Reflective.' Choose locations according to how you will use the detector. The sensors can be placed on two different tracks to report whether trains are present at those two locations and which one arrived first. Or the sensors can be placed on the same track, in which case the host computer's software can use the timing information from the detector to determine a train's speed and direction. Note that it is up to the computer's software to make these calculations and display the results. Azatrax only supplies the detector hardware, not the software.

Across the Track sensing: The IR LED is positioned horizontally on one side of the track(s), and the IR phototransistor is placed on the opposite side. A train is detected when it blocks the light path between the LED and phototransistor. The distance between the LED and phototransistor can be up to 18 in. (45cm), 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 phototransistor (receiver) so it faces away from bright lights or sunny windows. Use scenery or structures to conceal the sensors and shade them from room lighting.
Tip #3 - The detection zone of each detector can be expanded by adding a second IR LED/phototransistor pair. Additional sensor pairs may be purchased from Azatrax, see the website 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 phototransistor. Typically the sensors are mounted in two 3/16-inch (4.8mm) holes drilled in the roadbed as shown here. Vertical installation works for HO and larger scales as long as there is no structure above the track such as a bridge. Angling the IR LED and phototransistor toward each other is best for N 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 phototransistor 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 only 1 or 2 mm is required.

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Connect sensor pair 1: How you connect the IR LED and phototransistor to the MRD2 module determines whether Detector 1 will operate in 'Across the Track' or 'Reflective' mode.

Add connections for sensor pair 2: 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 MRD2, there will be two white wires in 'X' and two white wires in 'R.'

Additional wire may be spliced to the sensor leads if needed. Use similar twisted pair wire for total length up to 20 ft (6m).

Connect the MRD2-U detector to a live USB port: The MRD2-U is powered directly from the USB bus. It can be plugged directly into a USB port on a computer, or to a port on a USB hub.

Things to remember about the USB bus configuration --

» One USB host adapter (the port on your computer) may have up to 126 USB devices connected to it. There are two kinds of USB devices:
  - **Function** - Sometimes called a 'peripheral,' this is a device that does something useful for you. It may be a printer, keyboard, scanner, reading light or an Azatrax infrared train detector, to name a few. A USB function device has one USB port (connection) and it faces upstream (toward the computer).
  - **Hub** - It has one USB port that faces upstream, and multiple USB ports facing downstream. A hub allows one USB port on the computer to fan out to many USB functions. Typical hubs have four to seven downstream-facing ports. When counting the number of devices connected to your computer's USB port, total the number of hubs and functions. Note that while your Azatrax module contains two infrared train detectors, it counts as just one USB function.

Q - "What about my keyboard, it has one upstream connector plus a couple of downstream connectors like a hub, but it also does something useful like a function. What kind of device is it?"
A - This is an example of a **compound device**. Enclosed within your keyboard is a hub and a function. This would count as two devices on your USB bus.

» The illustration at right shows a USB bus with five 'tiers.' Tier 1 is the host computer. The bottom tier only has function devices. The tiers in between have hubs and may also have functions. A USB bus may have a maximum of seven tiers.

» Therefore, there may be a maximum of five hubs and six cables between the computer and any function device.

» The maximum length of any USB cable is 5 meters (16 ft). So the maximum distance from the computer to any function is 30 meters (96 ft).

» Hubs may be 'bus-powered' (no external power supply) or 'self-powered' (has an external power brick). Consider the computer's USB port to be a self-powered hub. If the function devices get their power from the USB hub (that is, if the function devices are not plugged in to an external power source), a general rule of thumb is that starting at the computer's USB port, two bus-powered hubs should not be chained together. Two bus-powered hubs should be separated by at least one self-powered hub. On the next page is an example bus configuration.
In this example there are 16 devices connected to the computer's upper USB port: 1 keyboard, 1 hub inside the keyboard, 1 mouse, 4 external hubs and 9 detectors. Even though there are five hubs (including the one in the keyboard), there are at most three hubs between any non-hub device and the host computer. The max allowed by the USB specification is five hubs between any device and the computer.

While our rule of thumb allows every other hub to be bus-powered, there are exceptions. If a hub needs to supply power to a high-current device, the hub will need to be self-powered. In our previous example, suppose the user attached a reading light or coffee cup warmer to one of the keyboard's USB outlets. The power for this accessory would have to come from Hub #1, so in this case Hub #1 would have to be self-powered.

For best system performance, USB devices that transfer large data files (printers, scanners, external drives, etc.) should be plugged into a different USB port on the host computer.

Adjust the sensors: The green and red on-board LEDs illuminate when the detectors are sensing an object. The green LED corresponds to detector #1, the red LED corresponds to detector #2.

With no trains in either detection zone, the green and red LEDs on the MRD2 module should be off. If either 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 LR LED and phototransistor are pointed at each other, and nothing is between them.
3. Shade the phototransistor 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 phototransistor a bit deeper into the roadbed.
3. Infrared light may be 'leaking' through the roadbed material from the IR LED to the phototransistor. Push a metal shim, such as the tip of a hobby knife blade, vertically into the roadbed to create a light-proof wall between the IR LED and phototransistor.
4. Is there an object above the sensor, such as a bridge, or an upper layout level? Mount the IR LED and phototransistor at a shallower angle, or paint the object flat black. Or use across-the-track sensing.

Both detectors now off? Good, now test for train detection. Place a locomotive or car in the detection zone of Detector 1. The MRD2's green LED should light. If the red LED also lights, re-adjust sensor pair 2 for false detection (see above). If the green LED 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 phototransistor.

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 phototransistor. 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 the green LED goes out.
Place a train in Detector 2’s detection zone. The MRD2’s red LED should light. If the green LED also turns on, adjust sensor pair 1 for false detection (see above). If the red LED does not light, adjust sensor pair 2 for a false clear condition (same as above for sensor pair 1).

Optional external LED connection
External LEDs, such as panel indicators or a trackside signal, may be connected to the L1 and L2 solder terminals near the Mode switch. Connect the LED anode (usually the longer lead) to the '+1' terminal, and the LED cathode (short lead) to the '+2' terminals. The external LEDs will give the same indication as the two on-board LEDs. A current limiting resistor is on the circuit board, the external LEDs can be connected directly to L1 and L2, no other resistors are needed.

USB Programming Information
Technical details required for writing software to operate the MRD2-U are available at the Azatrax website, www.azatrax.com/usb