Azatrax Product Description
MRD2 two-channel infrared proximity sensor with USB.

22-Dec-2011 Initial release.

Nomenclature:
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'Channel' - one of two proximity detector circuits.
'Sensors' - the infrared LED and phototransistor that connect to each detector
circuit and are mounted where an object is to be detected.
'Active' - a detector that is sensing the presence of an object.
'Clear' - a detector that is not sensing an object.
Hexadecimal numbers are prefixed by 0x. All other numbers are decimal or
binary.

Overview
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The MRD2 is a two channel infrared proximity detector. Each channel generates
active infrared light signals and senses its reflected infrared light to
determine if an object is present within its field of view.

The MRD2 is available in three versions:
version: relays: USB:
MRD2-R 2 no
MRD2-S 2 yes
MRD2-U 0 yes

For model MRD2-U, the two channels, 1 & 2, operate as independent detectors.
Each channel has an on-board LED that lights when an object is sensed.

MRD2-R and MRD2-S have four operating modes, selectable by the user via a DIP
switch. The user may change the setting on the fly. The selected mode does
not change USB behavior, other than the reporting of the selected mode.

The four operating modes are:
1. NonTurnout, Separate -
Each channel acts independently. Relay and LED for each channel are on when
an object is sensed (active), and off when an object is not sensed (clear).

2. Non-Turnout, Block Signal -
The sensors for channel 1 are placed at the entrance to a track block, and the
sensors for channel 2 are placed at the exit. Relays 1 & 2 connect to a block
signal at the block entrance to provide green/yellow/red indications.

3. Turnout, Solenoid type -
When a channel goes active, it operates its relay for 0.5 sec to actuate a
twin-coil type switch machine. If one channel is active, the other channel's
relay is locked out until the first channel has been clear for 4 sec.

4. Turnout, Motor type (Tortoise, SwitchMaster, etc.) -
When a channel is triggered, it latches its relay on to drive a slow motion
motor type switch machine. If one channel is active, the other channel's
relay is locked out until the first channel has been clear for 4 sec.

State change by external intervention
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In either turnout mode (3 & 4 above), the user has an option of manually changing the turnout position. External push buttons are required. If an external trigger is received, the ExternallyChanged status bit will be set, even if the position did not actually change (i.e., the user selected the position that the turnout was already in). This status bit will stay set until cleared by USB command.

Externally-commanded state changes are enabled at power-up. They can be disabled and re-enabled by USB commands.

The turnout position can also be changed by USB commands. Changes by USB are always enabled, even if the external buttons have been disabled. Changes by USB command do not affect the ExternallyChanged status bit.

Stopwatch
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A stopwatch function measures the time difference between the arrival of an object at one sensor and the subsequent arrival of an object at the other sensor. Resolution is 10 millisec (0.01 sec). The stopwatch only starts if both sensors initially are clear. The stopwatch will not measure time intervals greater than 255 hours. When the stopwatch reaches 255 hours, it will stop.

If sensors are located a known distance apart on the same track, stopwatch time can be used to calculate the train’s speed.

USB
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MRD2-S and MRD2-U have a USB interface. Connection is via standard type-B jack.

The software interface consists of one control endpoint (Endpoint_00) and one interrupt endpoint (Endpoint_01). The software application program uses Endpoint_01 to send commands to the MRD2 and to read data from it.

The MRD2 is of the Vendor Specific class (identifier 0xFF).

Each MRD2 has a unique 9-digit serial number (all numeric characters). MRD2-U serial numbers are '01xxxxxxx' where each 'x' is a digit from 0-9. MRD2-S serial numbers are '02xxxxxxx'.

Enumeration data is shown in a separate document.
USB Commands
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The following 1-byte commands are recognized by the MRD2. Commands are written to Endpoint_01.

Hex  Command
0x31  Sets relays and status bits as if a train activated channel 1 (-S, turnout mode only).
0x32  Sets relays and status bits as if a train activated channel 2 (-S, turnout mode only).
0x34  Clear 'ExternallyChanged' status bit (data packet byte 2)
0x37  Disable external changes of turnout state (-S only)
0x38  Enable external changes of turnout state (-S only)
0x50  Restore LED Function - On-board LEDs return to their normal function of indicating status of sensors 1 & 2.
0x51  Identify 1 - Flashes sensor 1's LED.
0x52  Identify 2 - Flashes sensor 2's LED.
0x53  Identify 1 & 2 - Flashes sensor 1 & 2 LEDs.
0x54  ResetStopwatch - Stops the stopwatch and resets time to 0.
0x57  GetStateData - Causes MRD2 to return a 16-byte data packet, and automatically sets ResetStatus bit.

The 'Identify' LED commands may be used in initial program debugging, and also as an installation aid to assist users in identifying individual detectors on the layout.

USB Data Packet (returned to host in response to GetStateData cmd)

<table>
<thead>
<tr>
<th>Byte</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0x57 - Echo of the GetStateData cmd byte.</td>
</tr>
<tr>
<td>1</td>
<td>Endpoint_01 received packets counter, 0-255. Rolls over from 255 to 0. This counter increments each time a packet is received by Endpoint_01. Intended as a software debugging aid.</td>
</tr>
<tr>
<td>2</td>
<td>Status bits:</td>
</tr>
<tr>
<td></td>
<td>7 (MSB) - 0, reserved</td>
</tr>
<tr>
<td></td>
<td>6 - 1, reserved</td>
</tr>
<tr>
<td></td>
<td>5 - 0, reserved</td>
</tr>
<tr>
<td></td>
<td>4 - Module type, 0 if no relays (MRD2-U), 1 if relays (MRD2-S)</td>
</tr>
<tr>
<td></td>
<td>3 - Latch_2 (see below)</td>
</tr>
<tr>
<td></td>
<td>2 - Latch_1 (see below)</td>
</tr>
<tr>
<td></td>
<td>1 - Sense_2, 1 if sensor 2 is active</td>
</tr>
<tr>
<td></td>
<td>0 (LSB) - Sense_1, 1 if sensor 1 is active</td>
</tr>
<tr>
<td>3</td>
<td>Status bits:</td>
</tr>
<tr>
<td></td>
<td>7 (MSB) - 0, reserved</td>
</tr>
<tr>
<td></td>
<td>6 - 1, reserved</td>
</tr>
<tr>
<td></td>
<td>5 - 1, reserved</td>
</tr>
<tr>
<td></td>
<td>4 - 0, reserved</td>
</tr>
<tr>
<td></td>
<td>3 - AllowExternalChanges, 0 = disabled, 1 = enabled (default)</td>
</tr>
<tr>
<td></td>
<td>2 - ExternallyChanged, 1 if turnout state was changed by an external source (always 0 for MRD2-U)</td>
</tr>
<tr>
<td></td>
<td>1 - StopwatchTicking, 1 if stopwatch is running</td>
</tr>
<tr>
<td></td>
<td>0 (LSB) - ResetStatus, 0 at power-up, set to 1 after 1st USB read status.</td>
</tr>
</tbody>
</table>
4  Stopwatch fraction, 1/100ths of a sec. (00 - 99)
5  Stopwatch whole seconds (00 - 59)
6  Stopwatch whole minutes (00 - 59)
7  Stopwatch whole hours (00 - 255)
    Timing stops if hours reaches 255.
8  Operating mode, user selected
    0x31 - NonTurnout, Separate ( -U always reports this)
    0x32 - NonTurnout, Direction Sensing
    0x34 - Turnout, Solenoid (momentary action)
    0x37 - Turnout, Motor (sustained action)
9  0x63 - end of data
10-15 reserved

Latch bits (data packet byte 2, bits 2 & 3)
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At power-up, if neither sensor 1 nor 2 detect an object, Latch_1 and Latch_2 will both be 0. This is the only steady-state condition where both Latch bits are the same. Once either channel goes active, Latch_1 and Latch_2 will have opposite states.

Latch_1 and Latch_2 indicate which channel went active first (if channels 1 & 2 are both active), or which one was the last to be cleared (if channels 1 & 2 are both clear). Can be used to determine direction of travel if sensors are on the same track.

Truth table:
Latch_2  Latch_1  Sense_2  Sense_1  Meaning
  0    1    0    0    ch 1 cleared after ch 2
  1    0    0    0    ch 2 cleared after ch 1
  0    1    1    1    ch 1 went active before ch 2
  1    0    1    1    ch 2 went active before ch 1
  0    1    0    1    When sensors are in opposite
    states, latch bits equal
    sense bits.

Power Source
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MRD2-S may be powered by either an external power supply (9 to 15 volts AC or DC), or it can be powered by the USB bus power. Current required is 80mA.

MRD2-U is powered only by the USB bus power. Current required is 26mA.