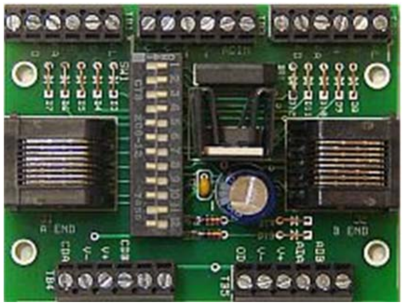
Occupancy Bus Utility Board 3



The Occupancy Bus Utility Board 3 (OBUB-3) is designed for use with the V2.0 Modular Signal System (MSS), the latest incarnation of the signal animation system first described in the February 2005 Rail Model Journal. For complete information about the MSS, visit www.modularsignalsystem.info.

The OBUB-3 offers the following benefits and features when implementing the MSS in a layout or module:
- implements the MSS Occupancy Bus wiring patterns for MSS Crossover and Cascade Nodes;
- DIP switches for quick configuration as either an MSS Crossover or MSS Cascade Node;
- RJ45 jacks for direct plug-in of MSS Occupancy Bus cables;
- screw terminals for wire connections to external detectors and signal drivers (not included);
- inputs for monitoring detected track turnout positions;
- supports the MSS V2.0 features for Approach Diverging (RJ45 pin 8) and alternate function (RJ45 pin 7);
- optional diodes to electrically isolate occupancy wires;
- optional 12-volt, 1-amp DC regulator for powering MSS electronics from an AC or DCC power source.

IMPORTANT !!!
The OBUB-3 differs from the earlier OBUB-2 and OBUB in several ways.
Follow only this Instruction Document for the OBUB-3 !!!

The OBUB-3 improves upon its predecessors, OBUB-2 and OBUB, as follows:
- rearranges the DIP switches into functional groups (MSS Crossover versus MSS Cascade Node);
- revises the signal driver connection positions to match trackside signal orientation;
- supports Approach Diverging feature (RJ45 pin 8, added in the V2.0 MSS);
- supports alternate function feature (RJ45 pin 7, added in the V2.0 MSS);
- adds a heat-sink for the 12-volt DC regulator.

How to Use this Instruction Document

First, follow the General Instructions (this page) that apply for all applications of the OBUB-3.

Then, follow either the MSS Cascade Instructions (pages 2-3) or the MSS Crossover Instructions (pages 4-5), depending on how the OBUB-3 will be applied in your Modular Signal System implementation. Page 6 describes applications, including monitoring turnout positions.
A MSS Cascade Node is located at the boundary between two signal blocks and has trackside signals (this includes MSS Complex Cascade Nodes such as junctions, single-to-double detected track transitions, etc.).
A MSS Crossover Node is located within a signal block and does not have trackside signals.

GENERAL INSTRUCTIONS

General Assembly Instructions

Refer to the board diagram, right. Each component position is labeled with a reference designator to guide you in installing the components. Install all components on the side of the board shown.

The on-board 12-volt DC regulator is optional. If you are not using this option, the components C1, C2, BR1, and VR1 will not be installed. Instead you will need to power external MSS elements such as detectors and signal drivers in some other way (e.g. with an external 12VDC power supply), and you MUST tie the external power supply ground to the MSS Ground at TB3 pin 3 or 4 (marked V-) to ensure proper system grounding.

When orienting and installing diodes, refer to Figure 1 below.
(note: be sure to read "A Note About Diodes" in the applicable section of this Instruction Document to determine which positions require diodes).

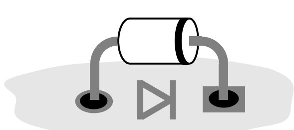
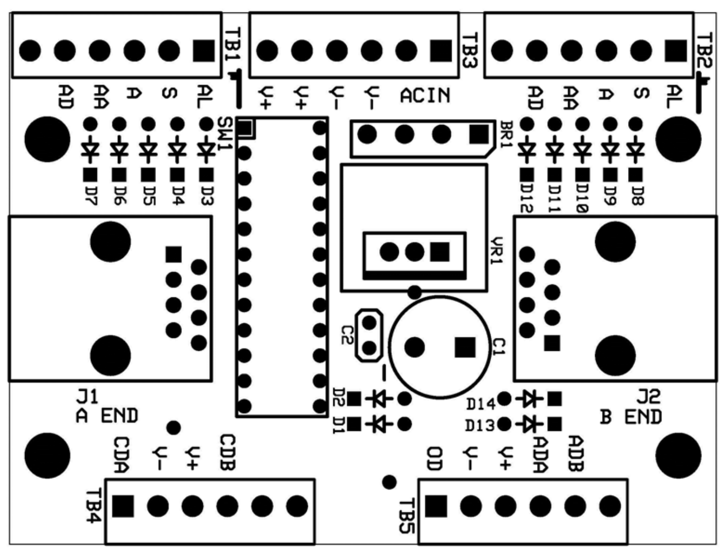


Figure 1
1. Form diode leads into a "⋂".
2. Insert in board oriented as shown.
3. Solder and clip leads.

Solder the component leads to the opposite side of the board using a "no clean" or "water soluble" type flux solder. Trim excess lead length with wire cutters after soldering. Remove excess solder flux as needed.



OBUB-3 Component Side with Component Reference Designators

Mounting Instructions

Locate the OBUB-3 where ambient air can flow to cool the VR1 voltage regulator and heat-sink.
The OBUB-3 has four large corner holes for mounting on standoffs with screws (not included).

Occupancy Bus Utility Board 3

MSS CASCADE INSTRUCTIONS

Before You Begin – A Note About Diodes

Locations D1 and D2 require 1N4148 diodes for MSS Cascade applications. Do not use solid-core wire at these positions.
These diodes ensure electrical isolation between MSS Occupancy Bus lines driven by the optical detector (which is required in MSS Cascade Nodes).

For locations D3 through D14, install short lengths of solid-core wire (instead of actual diodes) for simple applications such as an intermediate block boundary where there is just one signal facing in each direction and no track turnouts are involved. 26 AWG wire works well.
However, actual 1N4148 diodes must be installed if the MSS Cascade Node’s signal wiring will cause direct shorts between pins on TB1, TB2, and/or TB5. An example is when a signal driver input receives status from more than one source, such as both the MSS Occupancy Bus (i.e. status output from TB1 or TB2) and a local turnout position (i.e. status from a turnout controller that is input to TB5). The diodes isolate the multiple status sources from each other to ensure they do not inadvertently affect each other.

Be aware that diodes cause voltage drops between MSS detectors and signal drivers. For example when a MSS occupancy line is active (logic low), isolation diodes on the OBUB-3 will cause a higher voltage to be presented at the signal drivers monitoring it. The more diodes in the path, the worse this effect becomes. If the total diode voltage drop is large enough, the behavior of signal drivers (and their trackside signals) can become erratic. In summary, only use diodes at positions D3 through D14 when absolutely necessary. Otherwise, install short lengths of solid-core wire.

MSS Cascade Assembly

The table below lists the necessary components with their Digi-Key stock numbers (www.digikey.com) and corresponding OBUB-3 locations.
The parts are listed in the suggested order of installation, with shorter components installed first and tallest installed last. See page 1 for the board diagram.
Pay attention to the Instructions column! Most components must be oriented correctly to avoid damage when power is applied!

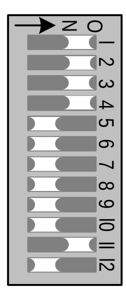
OBUB-3 Location	Component Type	Digikey Stock Number	Quantity	Instructions
D1 and D2	Isolation diodes	1N4148TACT-ND	2	Required. Orient per Figure 1 on page 1.
D3 to D14	Solid wire or diodes	1N4148TACT-ND (if diodes are needed)	12 max.	See diode note, above. When diodes are needed, orient per Figure 1 on page 1.
C2	filter capacitor, 0.1uF	399-4151-ND	1	Optional - install only if the 12V regulator is desired. Can be oriented either way around.
SW1	DIP switch, 12 position	CT20812-ND	1	Required. Orient switch number 1 toward TB3.
TB1 to TB5	screw terminal blocks	ED2744-ND	5	Required. Face terminal openings outward.
BR1	bridge rectifier	KBP2005GDI-ND	1	Optional - install only if the 12V regulator is desired. Orient beveled edge toward D12.
C1	filter capacitor, 330uF	P5167-ND	1	Optional - install only if the 12V regulator is desired. Orient negative lead toward C2.
J1 and J2	RJ45 jacks	A31407-ND	2	Required. Carefully align 8 leads in holes, snap plastic lugs into board, solder all 8 leads.
VR1	voltage regulator, 12V, 1A	LM2940CT-12/NOPB-ND	1	Optional - install only if the 12V regulator is desired. Orient metal tab side toward C1.
VR1 heatsink	TO220, 1.5W at 40C	HS121-ND	1	Optional - install only if the 12V regulator is desired. Slide onto VR1 voltage regulator.

MSS Cascade DIP Switch Configuration

IMPORTANT !!!
The OBUB-3 DIP switch configuration differs from the earlier OBUB-2 and OBUB.
Follow only this Instruction Document when configuring the OBUB-3 switches !!!

SW1 Switches 1 through 10

To configure the OBUB-3 as an MSS Cascade:
Set SW1 switches 1-4 to “ON”
Set SW1 switches 5-10 to “OFF”



SW1 Switch 11

SW1 switch 11 is set to “ON” by default to connect the MSS Occupancy Bus pin 7 to MSS Ground.
Only set switch 11 to “OFF” if your system needs to use MSS Occupancy Bus pin 7 for an alternate function (i.e. something other than MSS Ground). Setting switch 11 to “OFF” disconnects the RJ45 connectors J1 and J2 pin 7 from MSS Ground, leaving only MSS Occupancy Bus pin 5 connected to MSS Ground on the OBUB-3. When switch 11 is “OFF”, J1 pin 7 remains connected to J2 pin 7 such that alternate functions on pin 7 pass through the OBUB-3 unaffected.

SW1 Switch 12

SW1 switch 12 is not connected to anything on the OBUB-3 and is available to use however you wish. Fine-gauge wire (no larger than 26 AWG) may be soldered to the SW1 switch 12 through-hole pins (DIP pins 12 and 13). Take care to avoid solder-bridge shorts to adjacent pins.

MSS CASCADE INSTRUCTIONS, continued

IMPORTANT !!!
The OBUB-3 connector arrangement differs from the earlier OBUB-2 and OBUB.
Follow only this Instruction Document when connecting wires to the OBUB-3 !!!

MSS Cascade Installation and Connections, Intermediate Block Boundary

Figure 2 shows typical OBUB-3 connections for a simple “intermediate” block boundary. On TB1 through TB5, the square copper pad denotes pin 1.

If you have installed the on-board 12VDC regulator option (components BR1, C1, C2, and VR1), connect either DCC or AC input voltage (14.5VAC minimum, 26VAC maximum) to the TB3 pins 1 and 2 ACIN terminals. TB3 also outputs the regulated 12VDC power (V- on TB3 pins 3 and 4, V+ on TB3 pins 5 and 6). This power output may be used for a limited number of loads, up to the 1.0 Amp maximum current limit of the 12V regulator.

If you have not installed the 12VDC regulator option, then connect your external 12VDC power supply’s positive output to TB3 pin 5 or 6 (V+), and its negative (ground) output to TB3 pin 3 or 4 (V-). All of the OBUB-3's V+ terminals are connected together internally, and all V- terminals are connected internally, and can be used to distribute power and ground to detectors and signal drivers connected to the OBUB-3.

Note that V- is the MSS Ground – all MSS electronics must be referenced to this ground, including an external 12VDC power supply when present.

TB1 and TB2 output MSS occupancy status for connection to signal drivers (not included) for indications of Approach Diverging (AD, pin 5), Advance Approach (AA, pin 4), Approach (A, pin 3), Stop (S, pin 2), and Approach Light (AL, pin 1). ***Note these significant differences from the earlier OBUB-2 and OBUB:*** the signal protecting Block A connects to TB2; the signal protecting block B connects to TB1. DC power for signal drivers is available at TB3 pins 5 and 6 (V+). The MSS Ground is available at TB3 pins 3 and 4 (V-).

TB4 receives the outputs from two current detectors (not included) on pin 1 CDA for signal block A, and pin 4 CDB for signal block B. DC power for detectors is available at TB4 V+ pin 3. The MSS Ground is available at TB4 V- pin 2.

TB5 receives the output from the optical detector (not included) on pin 1 OD. TB5 can also receive status from auxiliary detectors such as turnout positions on pin 4 ADA for signal block A, and pin 5 ADB for signal block B. DC power is available for detectors at TB5 V+ pin 3. The MSS Ground is available at TB5 V- pin 2 for use by auxiliary detectors, since detection status inputs must be “active low” in the Modular Signal System. See application notes in this Instruction.

J1 and J2 receive straight-through (patch) RJ45 cables to extend the MSS Occupancy Bus to RJ45 couplers at the module endplates.

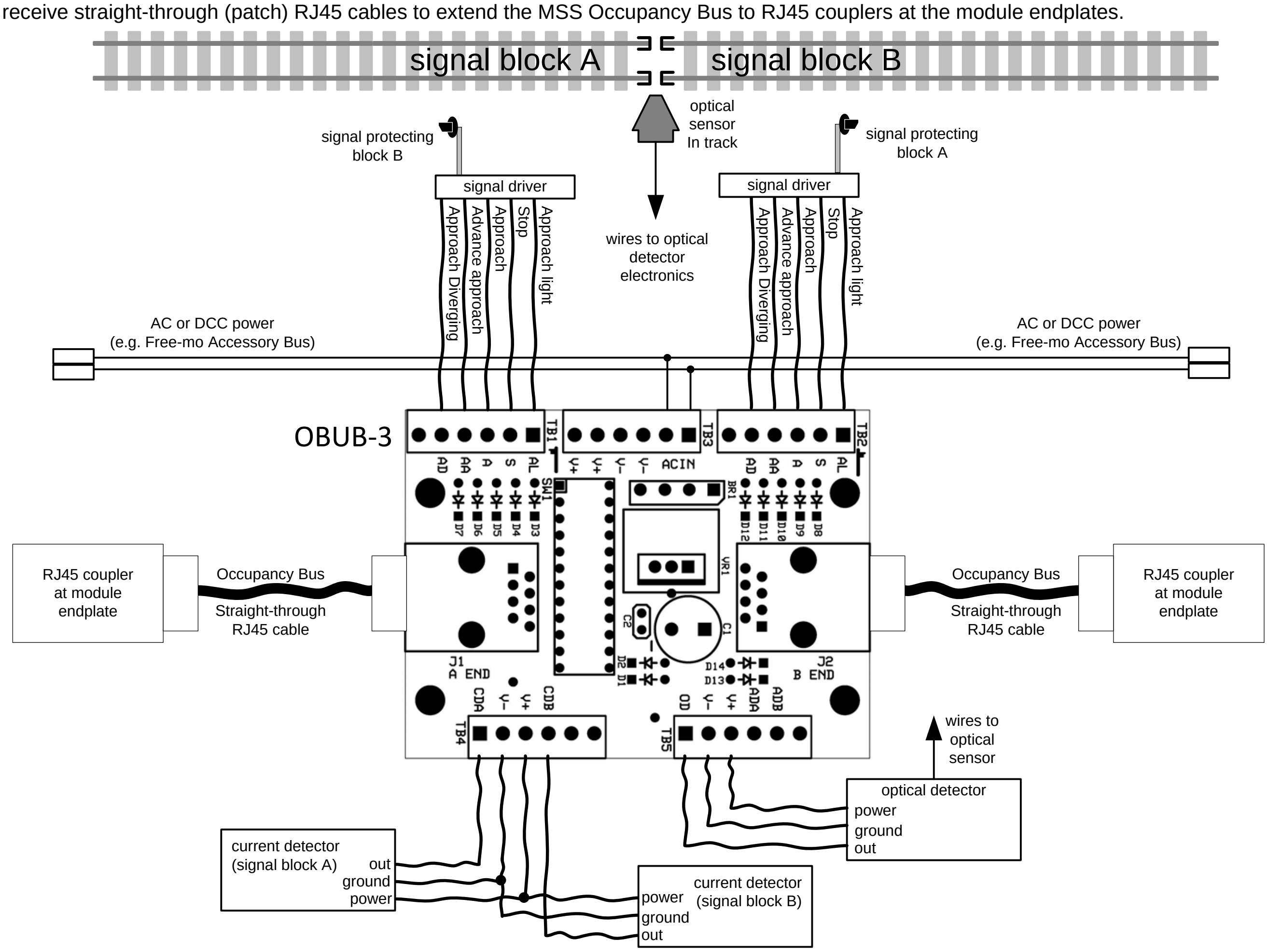


Figure 2

Note: Spare terminals at TB1 pin 6, TB2 pin 6, TB4 pins 5 and 6, and TB5 pin 6 are not connected to anything in the OBUB-3, and are available to use however you wish. Fine-gauge wire (no larger than 26 AWG) may be soldered to the through-hole pins. Take care to avoid solder-bridge shorts to adjacent pins.

MSS CROSSOVER INSTRUCTIONS

Before You Begin – A Note About Diodes

For MSS Crossover applications, no isolation diodes are required. However, if you plan to convert the OBUB-3 into an MSS Cascade in the future, consider the information about diodes in the MSS Cascade section of this Instruction (page 2). It may be simpler to install now any diodes that will be required by the future MSS Cascade application, even though they aren't necessary for an MSS Crossover application.

For locations D1 and D2, install solid-core wire jumpers only if an optional optical detector will be connected to TB5 pin 1 OD. 26 AWG wire works well. Otherwise, these locations may be left empty. Optical detection is not required for MSS Crossover Nodes.

Leave locations D3 through D12 empty. These are not used for MSS Crossover applications, since there are no signal drivers or trackside signals present.

For locations D13 and D14, install solid-core wire jumpers only if auxiliary detectors (e.g. turnout position) will be connected to TB5 pin 4 ADA or pin 5 ADB. Otherwise, these locations may be left empty.

MSS Crossover Assembly

The table below lists the necessary components with their Digi-Key stock numbers (www.digikey.com) and corresponding OBUB-3 locations.
The parts are listed in the suggested order of installation, with shorter components installed first and tallest installed last. See page 1 for the board diagram.
Pay attention to the Instructions column! Most components must be oriented correctly to avoid damage when power is applied!

OBUB-3 Location	Component Type	Digikey Stock Number	Quantity	Instructions
D1 and D2	Solid wire			Optional – see diode note, above.
D13 and D14	Solid wire			Optional – see diode note, above.
C2	filter capacitor, 0.1uF	399-4151-ND	1	Optional - install only if the 12V regulator is desired. Can be oriented either way around.
SW1	DIP switch, 12 position	CT20812-ND	1	Required. Orient switch number 1 toward TB3.
TB3, TB4	screw terminal blocks	ED2744-ND	2	Required. Face terminal openings outward.
TB5	screw terminal block	ED2744-ND	1	Optional – see diode note, above. Face terminal openings outward.
BR1	bridge rectifier	KBP2005GDI-ND	1	Optional - install only if the 12V regulator is desired. Orient beveled edge toward D12.
C1	filter capacitor, 330uF	P5167-ND	1	Optional - install only if the 12V regulator is desired. Orient negative lead toward C2.
J1 and J2	RJ45 jacks	A31407-ND	2	Required. Carefully align 8 leads in holes, snap plastic lugs into board, solder all 8 leads.
VR1	voltage regulator, 12V, 1A	LM2940CT-12/NOPB-ND	1	Optional - install only if the 12V regulator is desired. Orient metal tab side toward C1.
VR1 heatsink	TO220, 1.5W at 40C	HS121-ND	1	Optional - install only if the 12V regulator is desired. Slide onto VR1 voltage regulator.

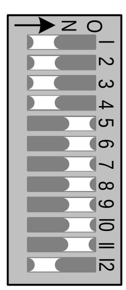
MSS Crossover DIP Switch Configuration

IMPORTANT !!!
The OBUB-3 DIP switch configuration differs from the earlier OBUB-2 and OBUB.
Follow only this Instruction Document when configuring the OBUB-3 switches !!!

SW1 Switches 1 through 10

To configure the OBUB-3 as an MSS Crossover:
- set SW1 switches 1-4 to "OFF"
- set SW1 switches 5-10 to "ON"

Switches 1-4 "OFF"



Switches 5-10 "ON"

SW1 Switch 11

SW1 switch 11 is set to "ON" by default to connect the MSS Occupancy Bus pin 7 to MSS Ground.
Only set switch 11 to "OFF" if your system needs to use MSS Occupancy Bus pin 7 for an alternate function (i.e. something other than MSS Ground). Setting switch 11 to "OFF" disconnects the RJ45 connectors J1 and J2 pin 7 from MSS Ground, leaving only MSS Occupancy Bus pin 5 connected to MSS Ground on the OBUB-3. When switch 11 is "OFF", J1 pin 7 remains connected to J2 pin 7 such that alternate functions on pin 7 pass through the OBUB-3 unaffected.

SW1 Switch 12

SW1 switch 12 is not connected to anything on the OBUB-3 and is available to use however you wish. Fine-gauge wire (no larger than 26 AWG) may be soldered to the SW1 switch 12 through-hole pins (DIP pins 12 and 13). Take care to avoid solder-bridge shorts to adjacent pins.

MSS CROSSOVER INSTRUCTIONS, continued

IMPORTANT !!!
The OBUB-3 connector arrangement differs from the earlier OBUB-2 and OBUB.
Follow only this Instruction Document when connecting wires to the OBUB-3 !!!

MSS Crossover Installation and Connections

Figure 3 shows typical OBUB-3 connections for a MSS Crossover Node, including current detector, Occupancy Bus cables, and power input.

If you have installed the on-board 12VDC regulator option (components BR1, C1, C2, and VR1), connect either DCC or AC input voltage (14.5VAC minimum, 26VAC maximum) to the TB3 pins 1 and 2 ACIN terminals. TB3 also outputs the regulated 12VDC power (V- on TB3 pins 3 and 4, V+ on TB3 pins 5 and 6). This power output may be used for a limited number of loads, up to the 1.0 Amp maximum current limit of the 12V regulator.

If you have not installed the 12VDC regulator option, then connect your external 12VDC power supply's positive output to TB3 pin 5 or 6 (V+), and its negative (ground) output to TB3 pin 3 or 4 (V-). All of the OBUB-3's V+ terminals are connected together internally, and all V- terminals are connected internally, and can be used to distribute power and ground to detectors and signal drivers connected to the OBUB-3.

Note that V- is the MSS Ground – all MSS electronics must be referenced to this ground, including an external 12VDC power supply when present.

TB1 and TB2 are not used for a MSS Crossover Node.

TB4 receives the output from the current detector (not included) on either pin 1 CDA or pin 4 CDB. DC power for detectors is available at TB4 pin 3 (V+) . The MSS Ground is available at TB4 pin 2 (V-).

TB5 can receive status from auxiliary detectors such as turnout positions on pin 4 ADA and pin 5 ADB. Also if an optional optical detector is used (not included), connect its output to pin 1 OD (make sure jumper wires are installed at locations D1 and D2). DC power is available for detectors at TB5 pin 3 (V+). The MSS Ground is available at TB5 pin 2 (V-) for use by auxiliary detectors, since detection status inputs must be "active low" in the Modular Signal System. See application notes in this Instruction.

J1 and J2 receive straight-through (patch) RJ45 cables to extend the Occupancy Bus to the RJ45 couplers at the module endplates. The OBUB-3 acts as a single MSS Crossover element, which satisfies the MSS requirement for an odd number of MSS Crossovers between module endplates.

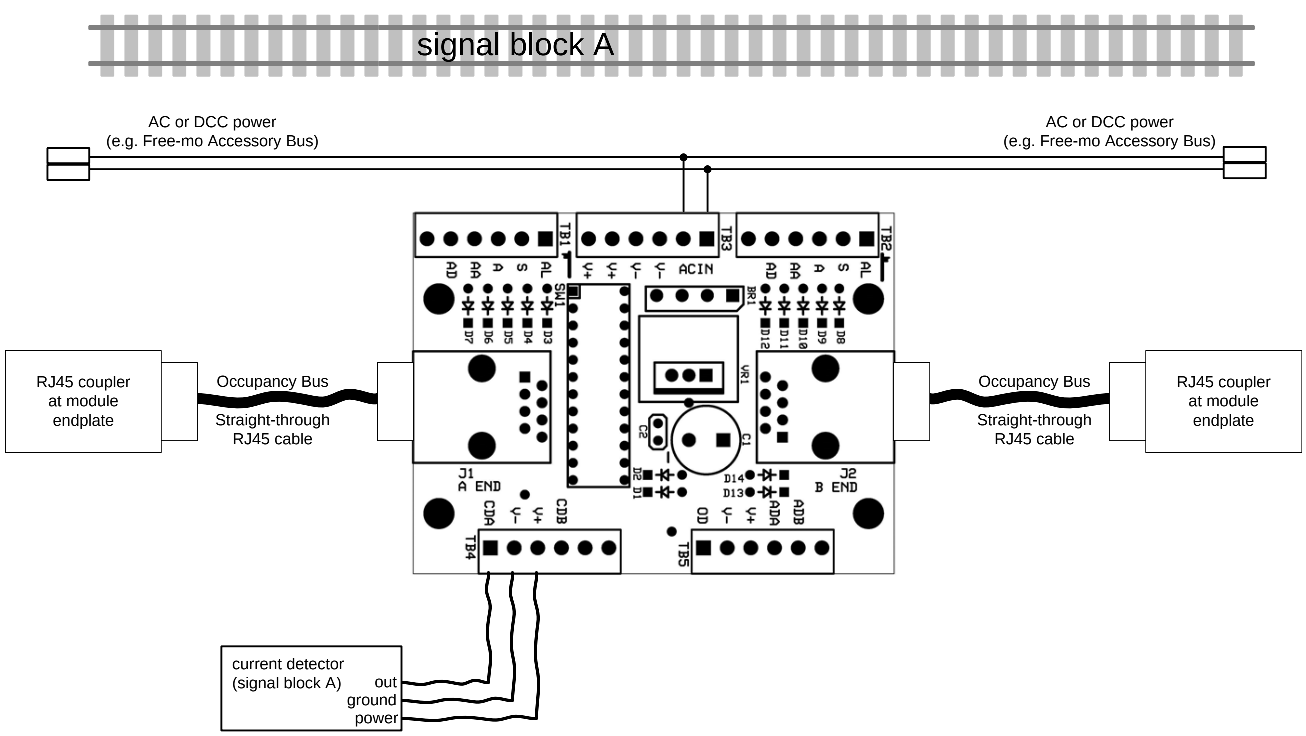


Figure 3

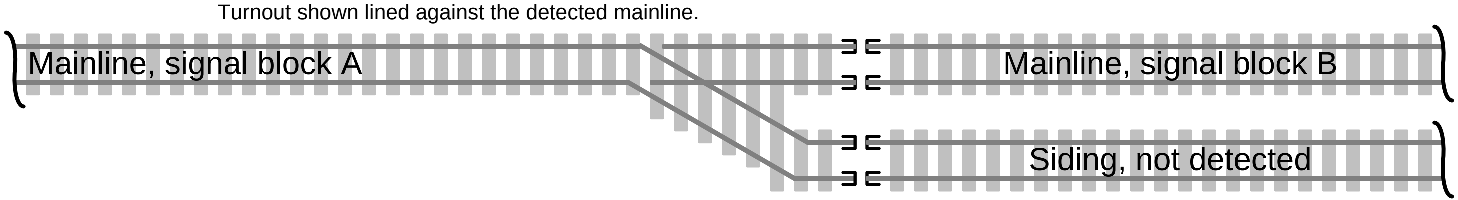
APPLICATION NOTES

Detecting Turnout Position

The MSS requires turnouts (track switches) on detected tracks to affect signal aspects. For example, when a turnout is lined against the detected track as shown below, the surrounding signals protecting that section of track must display “occupied”. The diagram below show how to connect auxiliary contacts on a Circuitron-brand Tortoise turnout motor to the OBUB-3 Auxiliary Detection inputs on TB5 to cause this behavior.

Situation 1:

Turnout near signal block boundary and MSS Cascade Node at end of a non-detected passing siding.
Turnout shown lined against the detected mainline.

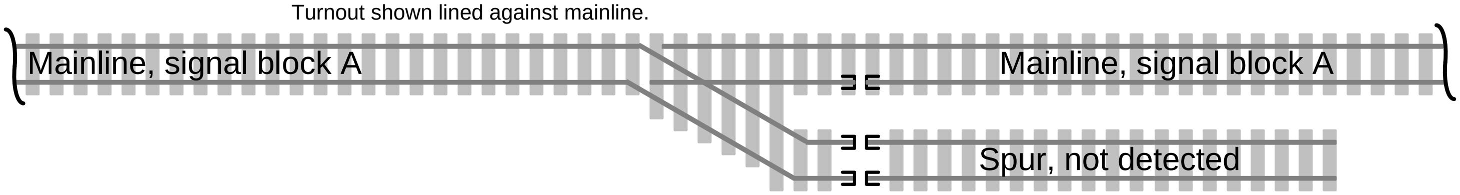


Both rails of mainline are gapped to ensure current detectors for blocks A and B are fully isolated.

Both rails to the non-detected siding are gapped to ensure trains in siding do not affect mainline current detectors.

Situation 2:

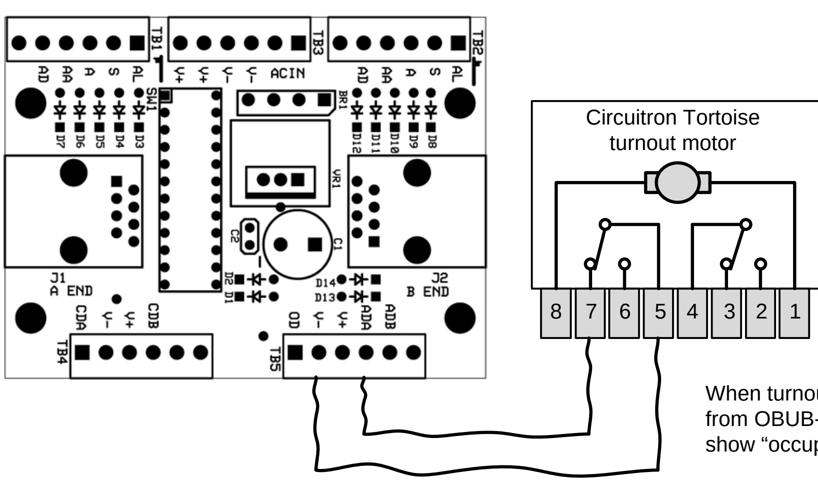
Turnout in middle of signal block to a non-detected industry spur, e.g. at a MSS Crossover Node.
Turnout shown lined against mainline.



Only the “frog” rail of the mainline is gapped to avoid shorting rails together (standard practice for powered frogs).

Both rails to the non-detected spur are gapped to ensure trains in the spur do not affect mainline current detectors.

OBUB-3



When turnout is lined against mainline, Tortoise contacts connect MSS Ground from OBUB-3 V- on TB5 to the ADA input on TB5, causing signal block A to show “occupied” status. OBUB-3 location D13 requires solid core wire installed.