BDL16 LocoNet Occupancy Detector
with RX4 Installation Information
Manual

1.0 Introduction

The BDL16 uses digital signal processing (DSP) to give you occupancy detection for 16 detection sections on your layout. The BDL16 can also host transponder detectors to let you implement Digitrax transponding. The BDL16 reports detection section occupancy and transponder location information to the system via its LocoNet connection. You can also install LEDs in an occupancy display panel to report detection section occupancy and transponder location.

The BDL16 is split into 4 zones, A through D, each with 4 detection sections, for a total of 16 detection sections. Each BDL16 zone can be run from a different booster.

On your Digitrax system, the BDL16 automatically detects the LocoNet configuration it finds and initializes itself accordingly. This automatic detection also lets BDL16's be used for occupancy detection on DCC systems without a Digitrax compatible LocoNet command station.

The BDL16 can operate with no connection to LocoNet, using only the RailSync DCC signal from any Digitrax compatible DCC system, and reporting detection information via optional LED outputs.

2.0 Terminology
Following are some terms you might find useful as you work with the BDL16.

Direct home wiring is a layout wiring method where each power district and its booster is electrically isolated. The track within each power district uses a "common return" wiring method for occupancy detection and/or power management. Direct home wiring is the wiring method recommended by Digitrax for safety reasons & also because it makes detection work more prototypically.

Power district is the power wiring, components and equipment attached to that wiring, driven by a single properly isolated booster. Power districts are double gapped on both ends. BDL16 is used to set up detection sections within one or more power districts.

Power sub-district is the wiring, components and equipment that are controlled from both power bus wires by their own power management device, for example a reversing section controlled by an automated reversing device like the PM4. Power sub-districts are gapped on both ends.

Detection common is the common return used within a properly electrically isolated power district for implementing occupancy detection.

Security element is the plant, including track, associated with any reporting, interlocking and/or signaling for that track section.

Whole layout common rail is a method of wiring layouts where power districts and their boosters are connected electrically by a common rail or common power bus return wire. This method is traditionally used for conventionally controlled layouts. The track feeds for one rail are connected together to one output of the power pack. The other rail is gapped and the track feeds are connected to the power pack through block control switches. Whole layout common rail wiring has a disadvantage when it comes to detection systems because detectors are not able to independently monitor whether zone power is on or off. There is no way to tell whether occupancy detection is actually working in any given detection section.

Detection Section is a section of track gapped on one or both rails and connected to an occupancy detector so that the detector can sense the presence of a loco (or other specially equipped cars) in that section of track.

Occupancy detector is a device that senses the presence of a locomotive (or other specially equipped cars) in a section of track that is set up for occupancy detection. Occupancy detectors also provide feedback to indicate occupancy. This feedback may be in the form of a lamp on a control panel or it may be a feedback message sent to the system that can be used by other layout devices. Also called a block occupancy detector on conventional layouts. Detectors are not covered by the DCC Standards or Recommended Practices.

Transponder is an electronic device with a transponder address that is installed in rolling stock. Transponders provide information to transponder detectors installed on the layout. This lets the system determine in which detection section the transponder is currently located. Transponders are included in many Digitrax premium decoders. TD1 (transponder) & TL1 (transponder with light output) are available as separate units that can be added to locos with existing decoders or to other rolling stock without decoders if you want to use them for transponding only and don't need motor control.

Transponder detector is an electronic device installed in a detection section on the layout that receives the information broadcast from a transponder. The transponder detector sends feedback to the system that lets it determine the detection section location of any given transponder at any time. RX4 Transponder detectors are hosted by the BDL16 and upgrade 4 detection zones of the BDL16 to be transponder detection zones. In this case, each transponding zone encompasses 4 detection zones.

The BDL16 is divided into four **Zones.** Each Zone supports 4 detection sections and each zone can be run from a different booster.

3.0 Track Wiring for Detection with BDL16

BDL16 comes from the factory set up for DCC operation on layouts that use direct home wiring. Direct home wiring is the wiring method recommended by Digitrax. With direct home wiring, each power district and its booster is electrically isolated. This method of wiring has safety advantages and makes detection work more prototypically. The track within each power district can use "common rail" wiring for detection or power management. In most cases, the BDL16 will work as it comes from the factory with direct home wiring when its 44 pin socket is wired to the layout and connections are made to a 12V AC power supply (100mA minimum), booster power and ground. *Figure 1: Typical Direct Home Wiring*, shows the typical usage of a BDL16 operating all 4 zones from a single booster, i.e. in a single power district. A single BDL16 can be operated by up to four different boosters.

With direct home wiring, the BDL16 can determine & indicate whether any of its 4 zones is powered or not (possibly short-circuited) even when there is nothing on the rails in the detection sections. The BDL16 default logic causes the detection sections to show "occupied" if the associated zone's power is off (because in this case, detection is not possible). This default matches prototype detection safety practices.

Whole layout common rail is a method of wiring layouts where power districts and their boosters are electrically connected using a common rail or common power bus return wire. Whole layout common rail wiring is at a disadvantage when it comes to detection systems since detectors cannot independently monitor whether zone power is on or off so they can't tell whether occupancy detection is working or not in any given detection section. To get around this limitation, the BDL16 uses option switch 10 to set up detection section 16 to be used as a zone power detector for detection sections 1 through 15. Wire a 10K resistor from detection section 16 (not connected to tracks) to the detection common return for the whole BDL16. Then detection section 16 on the BDL16 will be active when the BDL16 sees track power and you will be able to tell whether detection is actually available in detection sections 1 through 15.

4.0 BDL16 Installation

TABLE I shows the pin-out for the BDL16's 44 pin connector. Be sure to wire the BDL16 ground wire to the Digitrax Booster ground, common (or case) of the boosters. Wire the track outputs to the appropriate detection section following the example in *Figure 1*. The Zone common connections to the booster should be as short as possible and relatively heavy gauge, since they are common to all four detectors in the zone. For example, a 12awg zone connection to the booster should be less than 10 feet for best performance. For whole layout

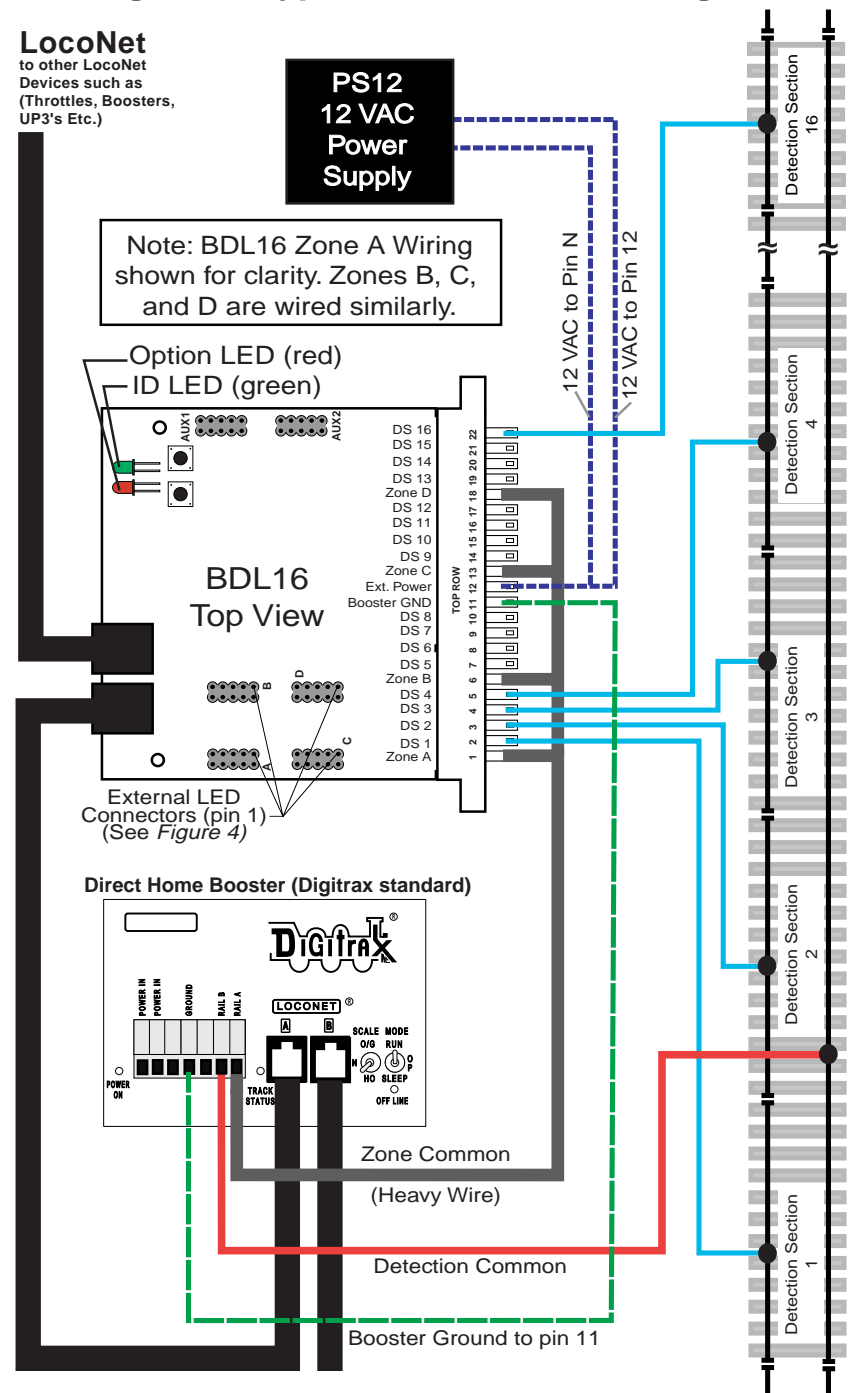## Figure 1: Typical Direct Home Wiring

TABLE I: BDL 16 Connector Printed Circuit Bboard Component Side

Pin #	Name	Connect To
1	Zone A	Connection to booster for Zone A
2	Detection Section 1 (DS 1)	Isolated track section for Detection Section 1
3	DS 2	Isolated track section for Detection Section 2
4	DS 3	Isolated track section for Detection Section 3
5	DS 4	Isolated track section for Detection Section 4
6	Zone B	Connection to booster for Zone B
7	DS 5	Isolated track section for Detection Section 5
8	DS 6	Isolated track section for Detection Section 6
9	DS 7	Isolated track section for Detection Sectio n 7
10	DS 8	Isolated track section for Detection Section 8
11	Ground**	LocoNet/BDL16 ground to Booster case/common ground
12	AC Power 1*	Power input to BDL16 : AC 12V to 15V, or +DC 12V to 15V
13	Zone C	Connection to booster for Zone C
14	DS 9	Isolated track section for Detection Section 9
15	DS 10	Isolated track section for Detection Section 10
16	DS 11	Isolated track section for Detection Section 11
17	DS 12	Isolated track section for Detection Section 12
18	Zone D	Connection to booster for Zone D
19	DS 13	Isolated track section for Detection Section 13
20	DS 14	Isolated track section for Detection Section 14
21	DS 15	Isolated track section for Detection Section 15
22	DS 16	Isolated track section for Detection Section 16

Note that all connector pins except 11/M and 12/N are paired top (component side) and bottom(solder side) of the PCB(printed circuit board). For 6A current rating with 3A connector pins, track/zone wires must be connected to both pin pairs: e.g., Zone A = pins 1 & A.

TABLE I: BDL 16 Connector Printed Circuit Board Solder Side

Pin #	Name	Connect To
A	Zone A	Connection to booster for Zone A
B	Detection Section 1	Isolated track section for Detection Section 1
C	DS 2	Isolated track section for Detection Section 2
D	DS 3	Isolated track section for Detection Section 3
E	DS 4	Isolated track section for Detection Section 4
F	Zone B	Connection to booster for Zone B
H	DS 5	Isolated track section for Detection Section 5
J	DS 6	Isolated track section for Detection Section 6
K	DS 7	Isolated track section for Detection Section 7
L	DS 8	Isolated track section for Detection Section 8
M	LocoNet	LocoNet network, connect to RED/GREEN wires if not using RJ12 jacks
N	AC Power 2*	Power input to BDL16: AC 12V to 15V, or DC 12V to 15V return
P	Zone C	Connection to booster for Zone C
R	DS 9	Isolated track section for Detection Section 9
S	DS 10	Isolated track section for Detection Section 10
T	DS 11	Isolated track section for Detection Section 11
U	DS 12	Isolated track section for Detection Section 12
V	Zone D	Connection to booster for Z one D
W	DS 13	Isolated track section for Detection Section 13
X	DS 14	Isolated track section for Detection Section 14
Y	DS 15	Isolated track section for Detection Section 15
Z	DS 16	Isolated track section for Detection Section 16

Note some letters are not used on connector.

*These AC1/AC2 power connections should be made to supply only used by BDL16(s).

**The Ground connection must be made to booster for correct BDL16 operation.

common rail wiring, refer to *Figure 2:Common Rail Wiring* and be sure to change option switch 10 to "closed".

If you are using a Digitrax system, connect LocoNet via one of the BDL16's LocoNet jacks. If you are using another DCC system, connect the leftmost pin of the RJ12 socket (called the RailSync pin) to a reliable source of the DCC signal that matches the DCC signal being sent by the booster to the detection sections handled by the BDL16. It is best if this signal stays active even when the booster output is shorted or disconnected from the BDL16 zone inputs, for example by a PM4 Power Manager.

Connect a 12VAC power supply to the AC1 and AC2 terminals of the BDL16's 44 pin connector. This powers the BDL16(s). Multiple BDL16 units can be supplied by a single shared supply as long as you provide at least 100mA for each BDL16. This supply should not power or be shared by any devices other than BDL16's.

Set up the BDL16 to operate on your layout: The BDL16's option switches are set at the factory for default values that will work for most direct home wired layouts. You can fine-tune the BDL16's characteristics using its option switches. The BDL16's option switches can be set using a Digitrax compatible throttle or a PC with LocoNet compatible software that can control turnouts. See "Customizing your BDL16 By Setting Up Option Switches below".

## 5.0 Set up for Non-Digitrax layouts

To make set up simpler and to make it easier for non-Digitrax layouts to use the BDL16, there are two quick configuration buttons that let you set up your unit to work with either direct home or whole layout common rail without using a Digitrax throttle or computer.

If the "ID" switch behind the green ID LED is held down when AC power is first applied, the BDL16 will operate on direct home layouts(the default as shipped from factory). When DCC packets are supplied to the RJ12 connector the ID LED will be lit and "wink" off once every 2 seconds to indicate direct home operation is selected.

If the "OPTION" switch behind the red option LED is held down when AC power is first applied, the BDL16 will operate on whole layout common rail layouts. When DCC packets are supplied to the RJ12 connector the ID LED will be lit and "wink" off twice every 2 seconds to indicate whole layout common rail operation is selected.

If either switch is pressed when the BDL16 is first powered up, the BDL16 will be re-configured.

Figure 2: Common Rail Wiring
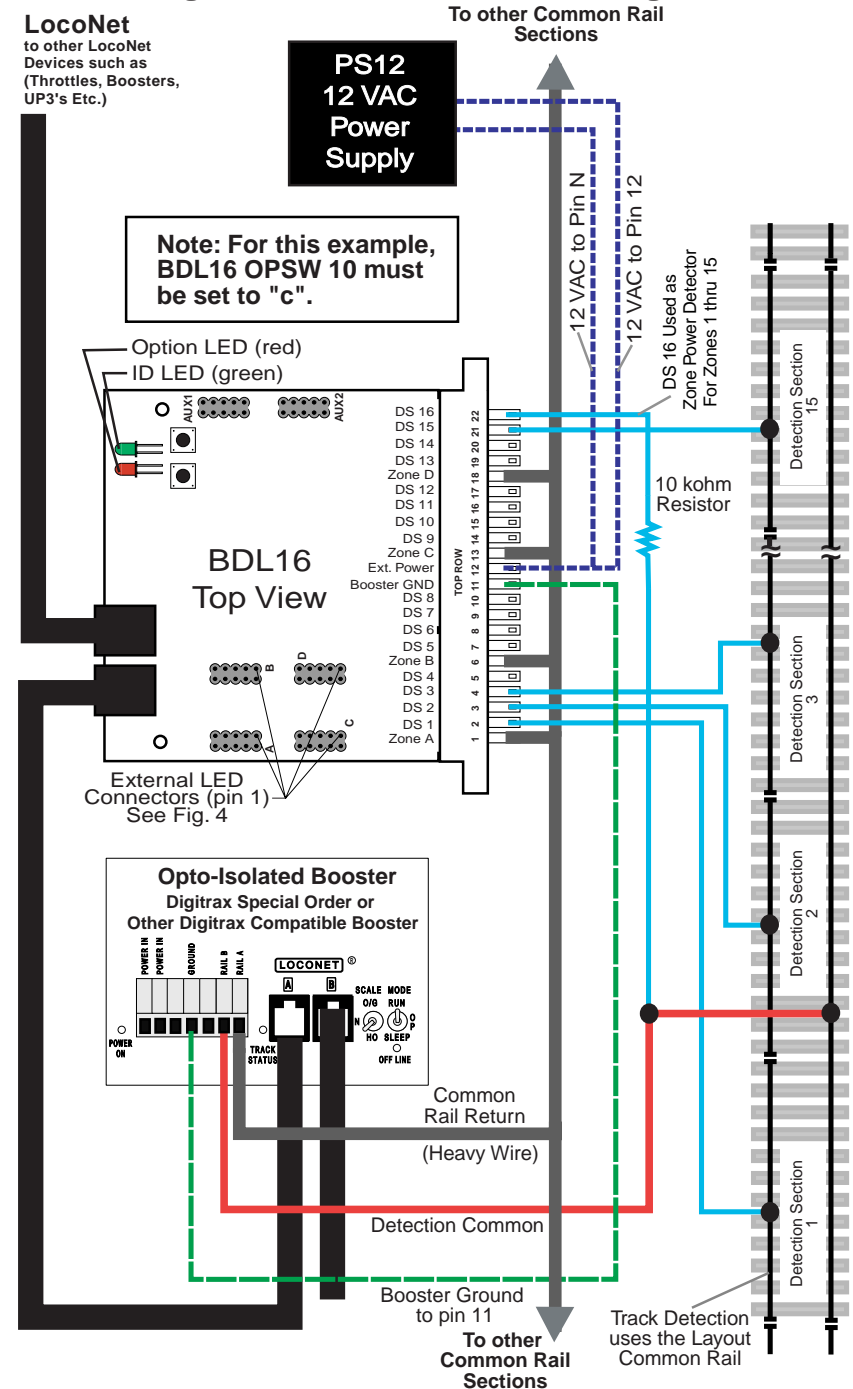
6.0 Customizing Your BDL16 By Setting Up Option Switches

TABLE II, below, details the option switches & settings you can use to customize your BDL16. These option switches are set up using your Digitrax throttle's SWITCH commands. SWITCH mode is normally used for operating turnouts by issuing closed ("c") or thrown ("t") commands. In the case of your BDL16, each switch address is a BDL16 option switch.

6.1 How to read back and change BDL16 Option Switches:

1. Power up your BDL16.
2. Press the switch behind the red option LED for about 1 second, then release it. The red option and green ID LEDs will flash alternately to let you know that you are in option switch setup mode.
3. Connect a DT or UT series Digitrax throttle to the BDL16's LocoNet connector.
4. Go into SWITCH mode. Dial up the switch number that corresponds to the OPSW you want to change and issue a closed "c" or thrown "t" command to set the OPSW to the desired setting. The OPSW is changed as soon as you issue the SWITCH command. See below for instructions for specific Digitrax throttles.
5. When BDL16 OPSWs are set up as desired, press the switch behind the red option LED for about 1 second and release it, the BDL16 will exit option switch set up mode. You can also exit option switch set up mode by turning off the power to the BDL16 and then turning it back on.

DT100 or DT200 series throttle, press "MODE/DISP" on the throttle to enter SWITCH mode. Use the throttle to read back each OPSW in TABLE II by dialing it up on the throttle and looking at it's setting (c or t). If you need to make a change to the OPSW simply press c or t to make the change you want. Once you are finished reading back and changing settings, simply wait 6 seconds for the throttle to time out and return to LOCO mode. Be sure to complete step 5 above when finished setting OPSWs.

UT series throttle, press RUN/STOP and DISP/OPSW at the same time to enter SWITCH mode. With a UT throttle, you won't be able to read back the BDL16 OPSW settings but you can change them by dialing up the OPSW number you want to modify and pressing the c key. When the LED under the c key is on the OPSW is set to closed, when it is off, the OPSW is set to thrown (the factory default setting). When you are finished setting up BDL16 OPSWs, return to LOCO mode by pressing RUN/STOP and DISP/OPSW at the same time to exit SWITCH mode. Be sure to complete step 5 above when finished setting OPSWs.

TABLE II: BDL16 Option Switches (OPSWs)

BDL16 option switches (OPSWs) have a default of "t" or thrown. The following table shows what each OPSW is used for when it is set for thrown or closed.
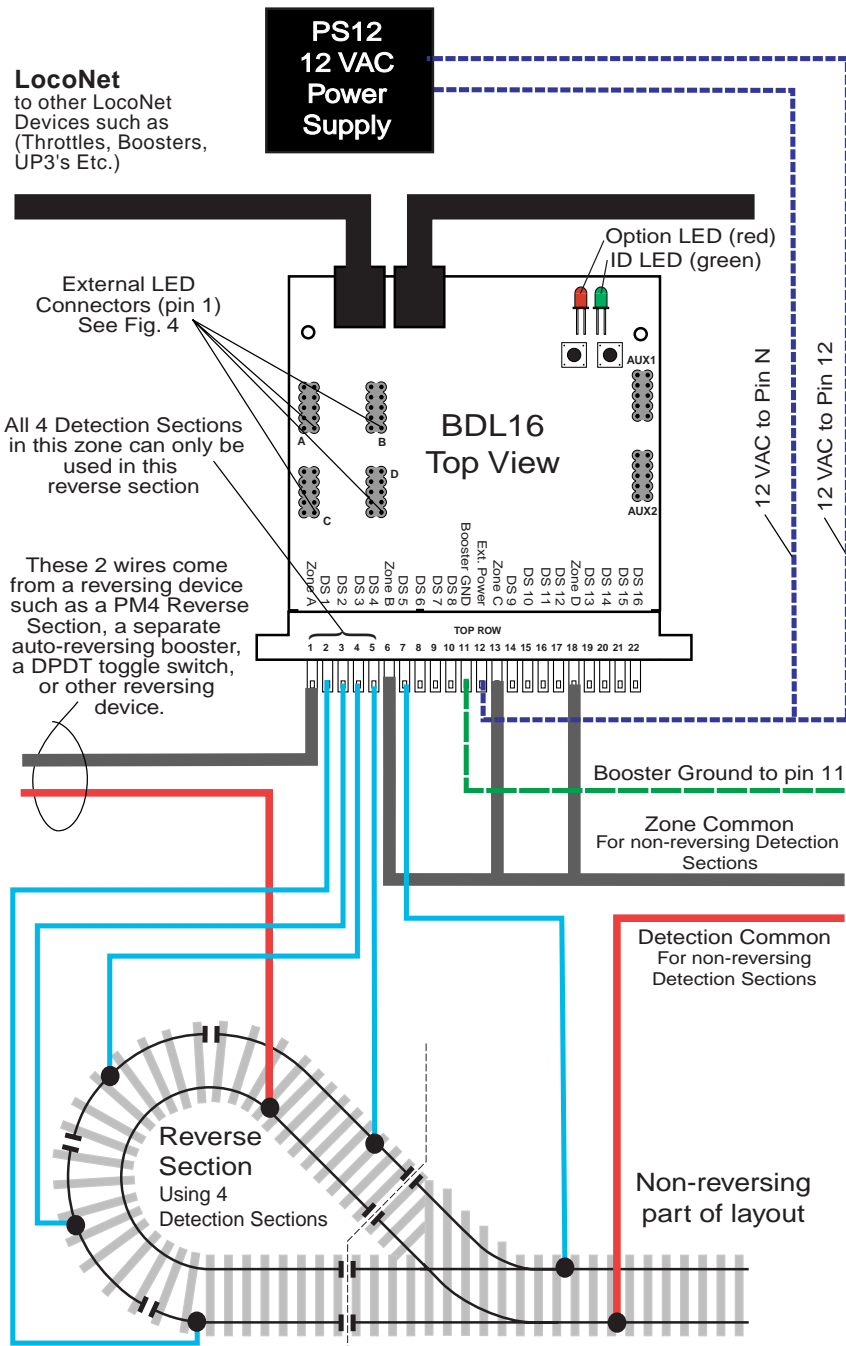
OPSW	t=thrown (factory default)	c=closed
01	Set up for operation with direct home wired layouts (Digitrax recommended wiring)	Set up for whole layout common rail wired layouts
09	Detection sections show occupied when zone power is off	no forced occupie d detection when zone power is off
10	Use detection section 16 as a normal detection section.	Use detection section 16 as zone power ON qualifier for whole layout common rail wiring
11	Allow this BDL16 to be the master.	Do not allow this BDL16 to be master
12	Allow this BDL16 to terminate LocoNet	Do not allow this BDL16 to terminate LocoNet
13	Power up delay 5 seconds for DB150 compatibility	Power up delay 1/2 second
19	Use regular threshold sense DCC occupancy. (approx 22 kohms minimum)	Use high thres hold sense DCC occupancy (approx 10 kohms minimum)
25	16 LEDs show occupancy	Drive 16 occupancy LEDs from SWITCH commands (not occupancy)
26	Occupancy LEDs decoded from track DCC switch commands	Occupancy LEDs decoded from LocoNet SWITCH commands
40	Direct home wiring compatible	Make all option switches factory default

7.0 Power Management

The BDL16 is designed to operate "downstream" of the Digitrax boosters and power management devices. The BDL16 is the "last" device in the chain from booster to power manager to BDL16. It is connected directly to the track detection section. There should be no other connections to any detection section that will draw track power or the detection section will always show occupied.

If a device is used to switch off power feeding the BDL16 and the track it is connected to, for example, a PM4 Power Manager, it should break the track power to both the zone and detection common rail. If a device only switches off a single leg, then it must be placed in the detection common rail wiring.

Figure 3: Reverse Section Wiring

LocoNet
to other LocoNet Devices such as (Throttles, Boosters, UP3's Etc.)

External LED Connectors (pin 1) See Fig. 4

All 4 Detection Sections in this zone can only be used in this reverse section

These 2 wires come from a reversing device such as a PM4 Reverse Section, a separate auto-reversing booster, a DPDT toggle switch, or other reversing device.

PS12 12 VAC Power Supply

Option LED (red)
ID LED (green)

BDL16 Top View

12 VAC to Pin N

12 VAC to Pin 12

Booster Ground to pin 11

Zone Common
For non-reversing Detection Sections

Detection Common
For non-reversing Detection Sections

Reverse Section
Using 4 Detection Sections
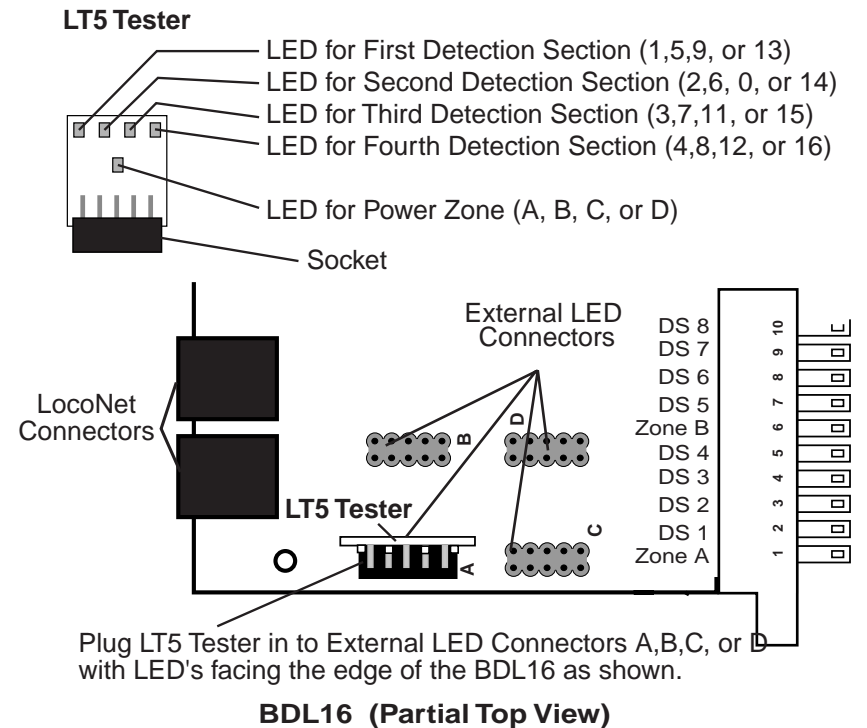
Non-reversing part of layout

8.0 Auto-Reversing

Note that an auto-reverse section can only use detection sections that are contained in a BDL16 zone that is correctly set up for auto-reversing , see *Figure 3: Reverse Section Wiring* for a wiring example.

9.0 LED Occupancy Indicators

9.1 LT5 Tester

Each BDL16 comes with an LT5 that will help you with layout wiring and troubleshooting for transponding & detection with Digitrax BDL16 LocoNet Occupancy Detector. The LT5 plugs onto the LED Connections of BDL16 and the LEDS on the LT5 light when detection sections are occupied. The status of power to each zone is also shown.

LT5 Tester

LED for First Detection Section (1,5,9, or 13)
LED for Second Detection Section (2,6, 0, or 14)
LED for Third Detection Section (3,7,11, or 15)
LED for Fourth Detection Section (4,8,12, or 16)

LED for Power Zone (A, B, C, or D)

Socket

External LED Connectors

LocoNet Connectors

LT5 Tester

Plug LT5 Tester in to External LED Connectors A,B,C, or D with LED's facing the edge of the BDL16 as shown.

**BDL16 (Partial Top View)**

9.2 Panel Indicator Wiring

For a front panel display of status with user supplied LED's, connect to the four 0.1" 2x5 headers, and wire up LEDs as shown in *Figure 4: LED Panel Indicators Wiring*. DigiKey (1-800-DigiKey) part number M1AXA-1036R-ND is a convenient plug and cable assembly that you can use to wire LED indicators. Header "A" includes the 4 detection indicators for detection sections 1 to 4 and the zone power indicator for zone A that includes these four

detection sections.

The BDL16 incorporates current setting resistors to set the LED current typically about 3mA. If you use higher LED drive currents you can external transistors etc to amplify the LED current.

The LED drive from the BDL16 is active high at about +5 volts above the BDL16 ground pin, via a 1 kilo-ohm resistor. Note that the ribbon cable includes separate ground return conductors for each LED that allow a 10 conductor ribbon cable to be split into 5 pairs to conveniently route to individual LEDS. Be sure to connect the +ve active output leads to the LED anodes.

Figure 4: LED Panel Indicators Wiring
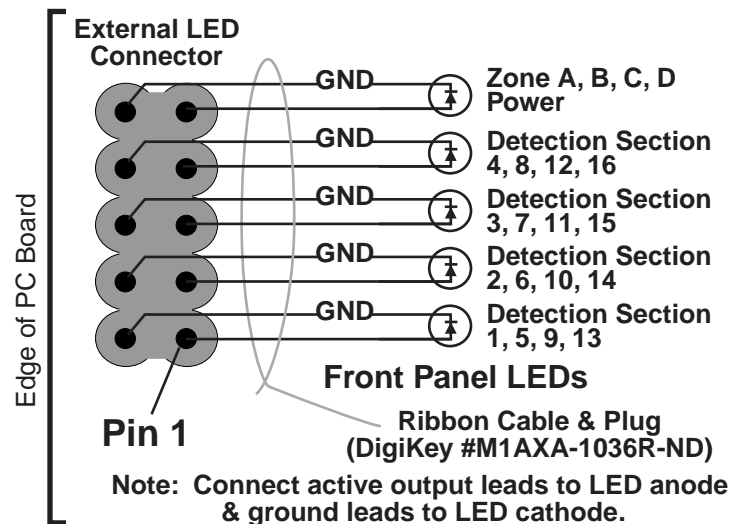
10.0 BDL16 Board Address

When the BDL16 is connected to LocoNet, it will communicate coded detection information to the system. If you wish to report BDL16 status to LocoNet and attached devices or computers that can interpret these messages, you will probably want to set up a unique board address for each BDL16.

10.1 To set up the board address

1. Power up your BDL16.
2. Press the switch behind the green ID LED for about 1 second, then release it. The green ID LED will blink. The red option LED will not light. This let's you know that you are in board address set up mode.
3. Connect a DT or UT series Digitrax throttle to the BDL16's LocoNet connector.
4. Go into SWITCH mode. Dial up the switch number that corresponds to the board address you want to set and issue a closed "c" command to set the board

address. The board address is changed as soon as you issue the SWITCH command. See below for instructions for specific Digitrax throttles.

DT100 or DT200 series throttle, press "MODE/DISP" on the throttle to enter SWITCH mode. Use the throttle dial up the board address you would like to assign to the BDL16. When the address is in the display, press "c" to issue a closed command. This will set the board address for the BDL16. The green LED will then go steady green to indicate BDL16 Power on.

UT series throttle, press RUN/STOP and DISP/OPSW at the same time to enter SWITCH mode. With a UT throttle, dial up the board address you would like to assign to the BDL16. Press the "c" key until the corresponding LED is lit. This will set the board address for the BDL16. The green LED will then go steady green to indicate BDL16 Power ON. When you are finished setting up BDL16's board address, return to LOCO mode by pressing RUN/STOP and DISP/OPSW at the same time to exit SWITCH mode.

11.0 Troubleshooting: Checklist

11.1 Packet Reception
Be sure the green ID LED is ON & is "winking" off about every 2 seconds. This means that correctly formatted DCC packets are being decoded from the left most (Railsync) pin of the RJ12 LocoNet socket. For DCC detection, the same DCC packet signal that drives the booster must be connected to the RJ12 socket's leftmost pin. If you are using LocoNet, and you do not see the green LED blinking pattern described, check to be sure that the system is powered up and that your LocoNet cable connections are good. You can use your LT-1 to test the LocoNet cables if you suspect there is a problem with them. If the green LED on the BDL16 is not lit, check the external power connections.

11.2 Mode Indication
The winking on the green ID LED indicates the primary BDL16 mode. A single wink indicates standard Digitrax compatible Direct Home track wiring and detection logic will be used, a double wink indicates Common Rail wiring and detection logic is to be used. For Common Rail, all 4 BDL16 zone connections must be made to the System Common ground point. Be sure the BDL16 configuration is appropriate for your usage.

11.3 Occupancy Debug
Use the LT5 provided with your BDL16 as described in Section 9.1. You can also build a simple LED display debugger as follows. Use a 10 pin plug and cable such as DigiKey (1-800-DigiKey) part number M1AXA-1036R-ND that will plug into one of the 4 occupancy LED headers on the BDL16 and solder LEDs to the wires to create an array of LEDs. By plugging this display array

into one of the 4 occupancy LED headers, you can see the state of the zone and occupancies for that header. This allows you to easily check the zone sensitivity (typically 22K ohms to give detection). This also aids in the determination of detection number and activity for a track detection section. Many detection problems are related to wiring problems or poor connections to the detection section rather than to the actual BDL16. By using the display array, you can eliminate the wiring issues from the equation and be sure that the BDL 16 is set up correctly.

Remember, if the zone power is OFF, the occupancy LEDs should be set up so that they will be on to be sure that signaling systems or a CTC/dispatcher will see the detection section in its most restricted aspect.

11.4 LocoNet Debug
If you are using LocoNet for reporting, be sure that the configuration is correct for your usage. In normal operations the red "option" LED will blink ON briefly when valid LocoNet messages are seen confirming a good LocoNet network connection.

11.5 Analog Locomotives
The motor inductance of analog locomotives may in some installations cause cross talk among the BDL16 detection sections. The addition of a 220ohm 3watt power wire wound resistor between the booster track terminals (Rail A and Rail B on Digitrax boosters) will typically reduce the effect of this cross talk. Simply use a leaded resistor as a jumper between the booster's two track terminals.

12.0 Warranty and Repair Information
 Digitrax guarantees the BDL16 to be free from manufacturing defects for five years from the date of purchase. These units are not user serviceable. If a defect occurs, return the unit to Digitrax for service. Digitrax will repair or replace BDL16s at our discretion at no charge to you for one year from purchase date. This warranty excludes damage due to abuse, such as failure to properly protect against input over current with a fuse or circuit breaker or applying excessive input voltage to the unit.
 Digitrax will make non-warranty repairs needed because of physical damage or electrical abuse at fair and reasonable rates.
 All warranties on Digitrax products are limited to refund of purchase price or repair or replacement of Digitrax products at the sole discretion of Digitrax.
 In the event that Digitrax products are not installed or used in accor-

dance with the manufacturer's specifications, any and all warranties either expressed or implied are void. Except to the extent expressly stated in this section, there are no warranties, express or implied, including but not limited to any warranties of merchantability or fitness for a particular purpose.
 Digitrax, Inc. reserves the right to make changes in design and specifications and/or to make additions or improvements in its products without imposing any obligations upon itself to install these changes, additions or improvements on products previously manufactured.

13.0 FCC Information

Radio or TV Interference: (this information is MANDATED by the FCC) This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
  -Reorient or relocate the receiving antenna.
  -Increase the separation between the equipment and the receiver.
  -Connect the equipment into an outlet on a circuit different form that
   to which the receiver is connected.
  -Consult the dealer or an experienced radio/TV technician for help.
Note that any modifications to the equipment not expressly approved by Digitrax voids the user's authority to operate under and be in compliance with CFR 47 rules, as administered by the Federal Communication Commission. Digitrax believes any conscientiously installed equipment following guidelines in this manual would be unlikely to experience RFI problems.