RX4 Transponder Detector Installation Manual

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1.0 Introduction

The RX4 is 4 Zone Transponder Detector for use with the Digitrax BDL16/BDL162 Occupancy Detector and Digitrax transponders. The addition of an RX4 allows the BDL16/BDL162 to track and inform LocoNet of the layout location and identification of rolling stock equipped with transponders. Digitrax transponders are available as stand alone units which can be used to retrofit existing DCC decoder installations or can be installed separately in rolling stock that is not decoder equipped. Many Digitrax premium decoders come transponder equipped so that no retrofit is necessary.

Digitrax transponding is an area detection technology that works something like this:

1. Transponders (either included in a decoder or a separate transponder like a TD1 or TL1) installed in locos and rolling stock create small current pulses.
2. Transponder detectors (BDL16/BDL162/BDL168 with RX4s) installed on the layout use advanced digital signal processing, DSP, to determine which transponder is located in which transponding zone.
3. When a transponder equipped piece of rolling stock is located in a zone equipped with a transponder detector, information about the unit's address and zone location is reported to LocoNet and can be displayed on a detection panel or computer screen, displayed in DT400 throttles, used for layout automation, etc.

Each transponder is programmed with a unique address that lets the transponder detector keep track of many different transponders at the same time, even when they are located in the same transponding zone.

Transponding can be used with most DCC compatible boosters and decoder installations. To make this work, just set up LocoNet wiring and hook up the BDL16/BDL162/BDL168s and RX4's. Transponding can also be adapted for use on almost any model railroad control method!

Transponding detection technology works with current pulses that are so low that there is no danger of interference with decoders or track control signals.

Transponding can be combined with other means of occupancy detection to set up a customized feedback system for your layout at a very reasonable cost.

2.0 Terminology

The following list of terms will be helpful as you learn more about Digitrax detection and transponding.

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/BDL162 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 PM42. Power sub-districts are double gapped on both ends.

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

Zone common is the common return used to implement zone transponding. Zone common connections to the booster should be as short as possible and relatively heavy gauge since they are common to all four detection sections in each zone.

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 transponder zone 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/BDL168 and upgrade 4 detection zones of the BDL16 to be transponder detection zones. In this case, each transponding zone encompasses 4 detection zones.

Transponder zone is an area of track that may be single gapped on one rail or double gapped on both ends and equipped with a transponder detector. Up to four detection sections can be included in a transponder zone.

3.0 Plan Your Feedback System

Before you begin installing BDL16/BDL162's & RX4's you should carefully analyze your layout and what you want to achieve with your feedback system. The best choice is usually a combination of detection sections and transponding zones. To use transponding effectively, you do not need to set up transponding on every section of track. By using transponding and other types of detection technologies in tandem, you will be able to get excellent performance and results at the lowest possible cost.

3.1 Basic Transponding

This manual presents basic transponding & detection wiring. The zone transponding example presented here will show you how to set up 4 transponding zones each with 4 detection sections using one BDL16/BDL162 & one RX4. For most layouts, this set up will be just what is needed. If your plan calls for other capabilities, instructions for more advanced options are also available.

Before you begin planning and wiring your layout for transponding, you may want to set up a test transponder as described in Section 8.6 of this manual. This will help you become familiar with the concepts involved in setting up transponding and will be a useful de-bug tool as you proceed with the actual installation on your layout.

3.2 Advanced Transponding

The combination of BDL16/BDL168 & RX4 and the addition of other LocoNet components like the PM42 offer many additional possibilities for detection & transponding that are not be presented in this manual. Please visit our web site www.digitrax.com Application Notes and Technical Information page to print out additional ideas and examples for advanced transponding & detection. If you are not able to find these documents on the web site, our tech support staff will be happy to mail or fax copies to you upon request.

4.0 BDL16 Installation

The BDL16/BDL162 is used to host your RX4. It provides the LocoNet connection and wiring connections you will need to set up the layout for feedback. Before installing your RX4, you will need to have a BDL16/BDL168 installed. The manual that came with your BDL16/BDL168 will guide you through how to do this and how to troubleshoot problems with the BDL16/BDL168.

5.0 The RX4

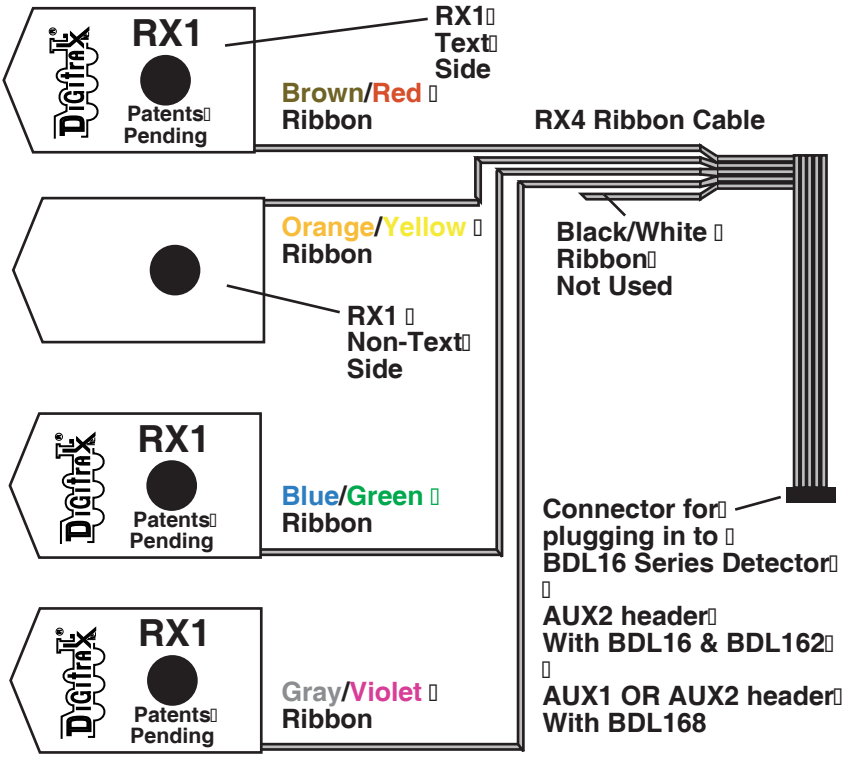
Each RX4 is made up of 4 RX1 sensors, a ribbon cable and a connector that let's you plug the unit into a BDL16/BDL162. The RX1's are very sensitive to current. The detection level is sensitive enough that reliable detection & transponding can be achieved with transponding current levels of only 1-2% of the zone current. In most cases, a level of 20-30 milliamps is enough for dependable operation. For example, on a N-scale board decoder, the 470ohm dropping resistor that comes installed on the board is enough current for a zone of 2-3 amps. See Section 7.0 for more information about enabling your transponder equipped decoders for transponding.

Because of the high sensitivity level of the RX1's their placement relative to the zone common wires is important to avoid interference among the RX1's

installed on the layout. Follow the spacing instructions carefully to be sure you have the best operation possible.

In your installation, you will pass the zone common wire from the booster to the track through the RX1 sensor. The direction in which you do this is important. To make this easy, each RX1 has text on one side and is blank on the other. The instructions that follow will indicate which direction you should use to achieve the desired results.

Digitrax RX4 Diagram



Each RX4 is made up of 4 RX1's

Wire Color	Detection Zone
Brown & Red	Zone A
Orange & Yellow	Zone B
Green & Blue	Zone C
Violet & Gray	Zone D

The black and white wires in the RX4 cable are not used or connected.

6.0 RX4 Installation

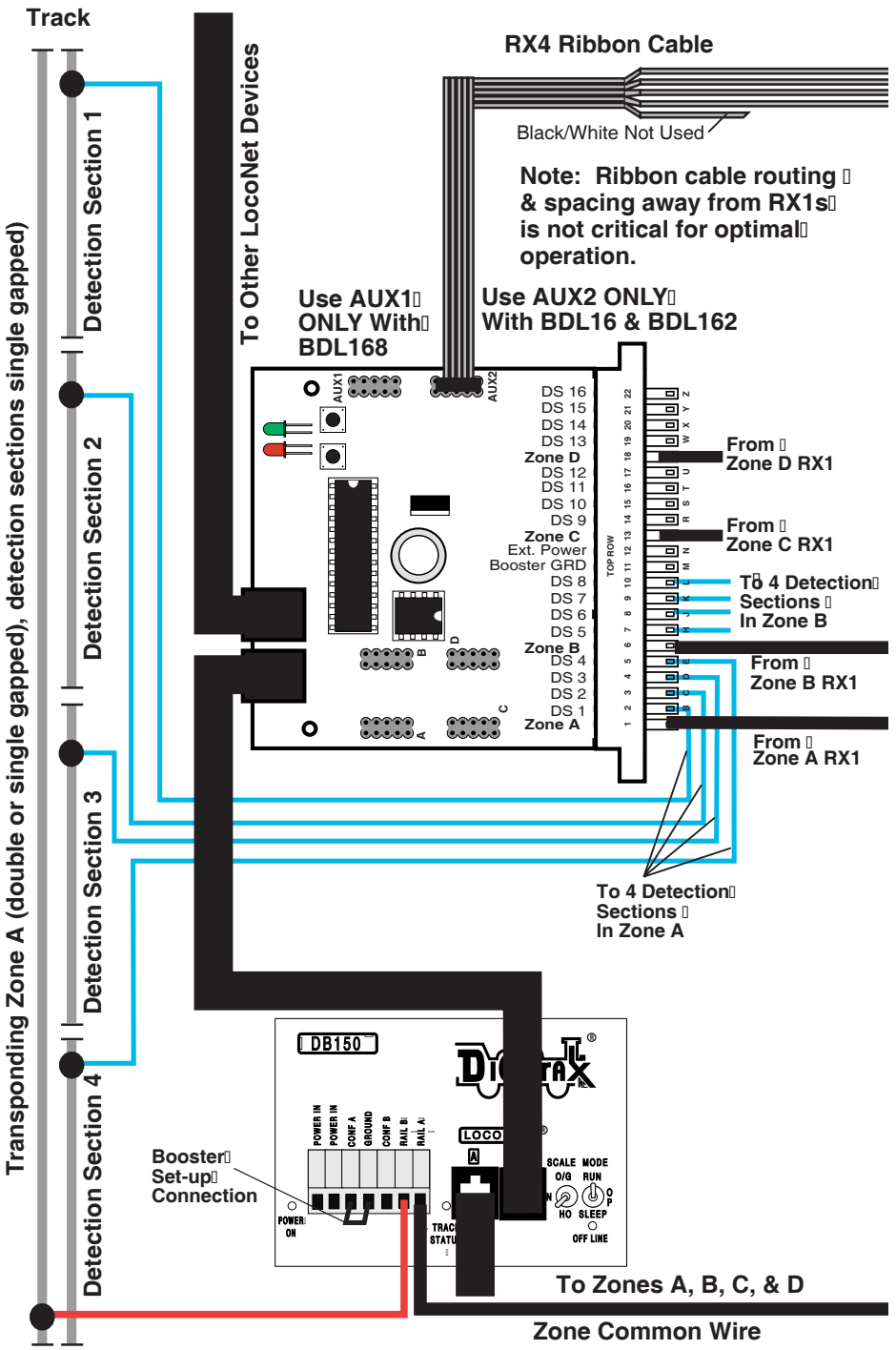
First time RX4 users may want to set up the test transponder described in Section 8.6 before beginning the first RX4 installation.

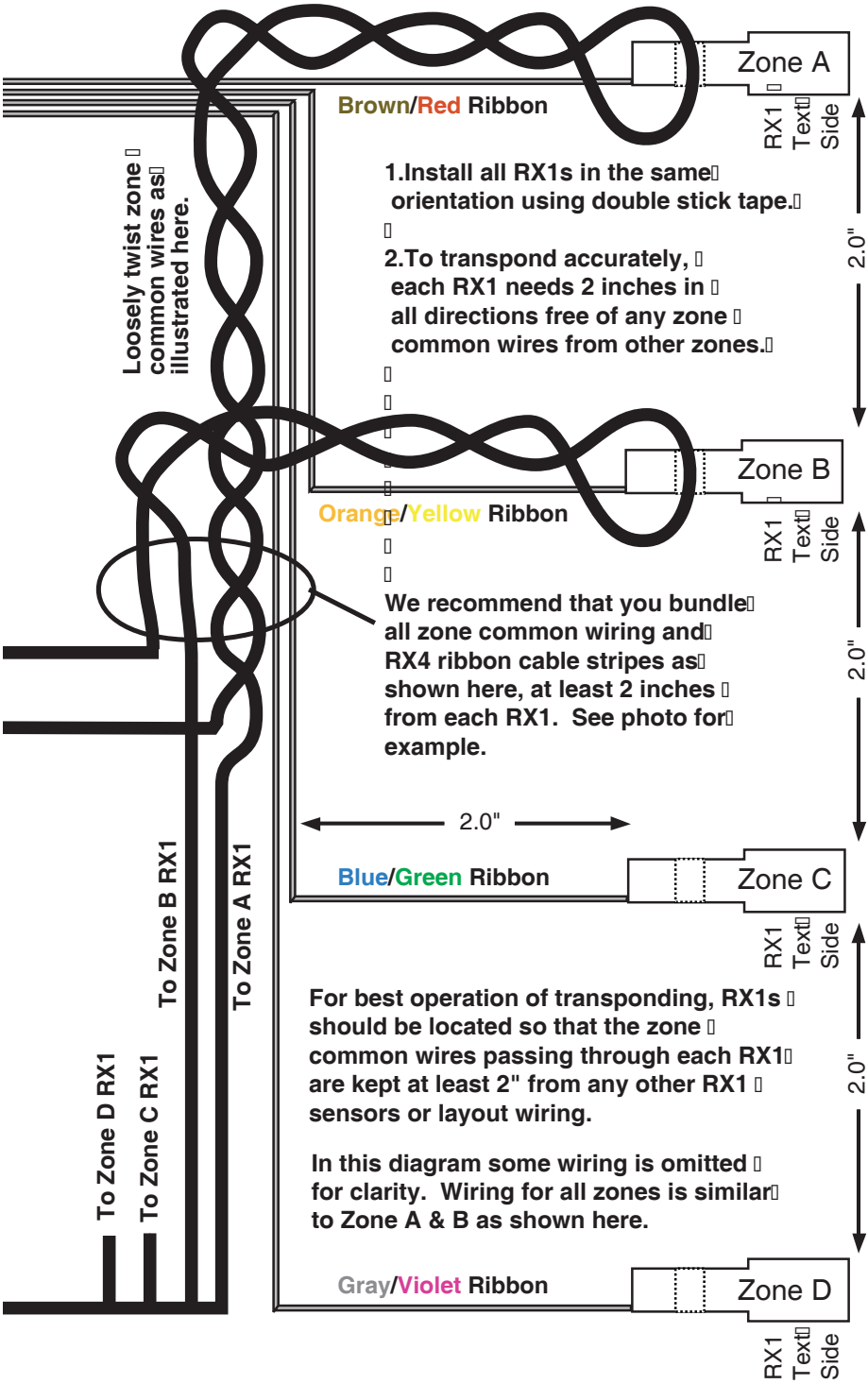
1. Plug the connector on the end of the ribbon cable connecting the four RX1 sensors that make up the RX4 into the AUX2 socket on the BDL16/BDL162. Do not use the AUX1 socket for this connection. The black stripe on the cable should be plugged in towards the board edge connector side of the BDL16 board.
2. For each transponding zone you want to set up,
   a. Pass the zone common wire from the DCC booster's Rail A (or B) terminal through the center hole of an RX1 from the "non-text" side and exit from the "text" side of the RX1 sensor
   b. Loosely twist the zone common wire together as you route it away from the RX1. Be sure you route the zone common wires at least 2" away from all other RX1's.
   c. Connect the zone common wire to the appropriate pin on the BDL16/BDL168's board edge connector.

6.1 RX1 Sensitivity

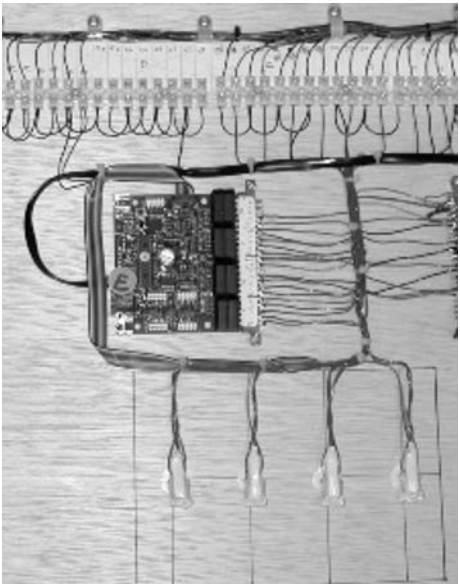
RX1 sensors are extremely sensitive to current, for best results:

1. The zone common wires that pass through each RX1 should be kept at least 2 inches from any other RX1 sensors.
2. Form these high current leads in a bundle away from the mounted RX1's.
3. The ribbon cables on the RX4 can pass close to the RX1's with no effect.
4. Transponding related option switches on the BDL16/BDL162 should be set up. The factory setting for LocoNet Railsync polarity for a cable connecting the BDL16/BDL162 to a DCS100 or DB150 is such that the default board polarity of the BDL16/BDL162 is correct with the factory defaults. Option Switch 3 can be used to swap the board Railsync polarity
5. The presence of any active transponder in a transponding zone will cause that related zone power indicator LED to blink. When there is no transponder in a transponding zone, the LED will be on steady. It is useful to make up four of the 5 LED test cables as detailed in the BDL16/BDL162 Manual. These will let you see the occupancy status of each of the 16 detection sections and also show zone power and transponding status, for simplified debug. Transponder capable software, a LocoNet message monitor and other transponder capable LocoNet devices can display the unique transponder messages, confirm those messages and use those messages to automate tasks on


Track
Transponding Zone A (double or single gapped), detection sections single gapped)
Detection Section 1
Detection Section 2
Detection Section 3
Detection Section 4
To Other LocoNet Devices
RX4 Ribbon Cable
Black/White Not Used
Note: Ribbon cable routing & spacing away from RX1s is not critical for optimal operation.
Use AUX1 ONLY With BDL168
Use AUX2 ONLY With BDL16 & BDL162
AUX1
AUX2
DS 16
DS 15
DS 14
DS 13
Zone D
DS 12
DS 11
DS 10
DS 9
Zone C
Ext. Power
Booster GRD
DS 8
DS 7
DS 6
DS 5
Zone B
DS 4
DS 3
DS 2
DS 1
Zone A
TOP ROW
From Zone D RX1
From Zone C RX1
To 4 Detection Sections In Zone B
From Zone B RX1
From Zone A RX1
To 4 Detection Sections In Zone A
DB150
POWER IN
POWER IN
CONF A
GROUND
CONF B
RAIL B
RAIL A
LOCO
SCALE
O/G
MODE
RUN
HO
SLEEP
OFF LINE
POWER ON
Booster Set-up Connection
To Zones A, B, C, & D
Zone Common Wire


Zone A
RX1 Text Side
Brown/Red Ribbon
1.Install all RX1s in the same orientation using double stick tape.
2.To transpond accurately, each RX1 needs 2 inches in all directions free of any zone common wires from other zones.
2.0"
Loosely twist zone common wires as illustrated here.
Zone B
RX1 Text Side
Orange/Yellow Ribbon
We recommend that you bundle all zone common wiring and RX4 ribbon cable stripes as shown here, at least 2 inches from each RX1. See photo for example.
2.0"
2.0"
Blue/Green Ribbon
Zone C
RX1 Text Side
For best operation of transponding, RX1s should be located so that the zone common wires passing through each RX1 are kept at least 2" from any other RX1 sensors or layout wiring.
2.0"
In this diagram some wiring is omitted for clarity. Wiring for all zones is similar to Zone A & B as shown here.
Gray/Violet Ribbon
Zone D
RX1 Text Side
To Zone D RX1
To Zone C RX1
To Zone B RX1
To Zone A RX1

the layout.



This photo shows an example of how to set up a wiring panel for your BDL16/BDL168 & RX4's.

Notice that the RX1's are spaced apart by 2 inches on all sides so that the zone common wires can be routed to avoid interference between RX1 sensors.

Notice that the BDL16/BDL168 is located near the RX1's.

In this example, wiring from the power supply and the booster are routed through a terminal strip at the top of the photo.

6.2 Option Switches for BDL16/BDL168 that affect transponding

The default settings for the BDL16/BDL168's option switches are indicated in bold type in the table below.

	t=thrown	**c=closed**
OpSw 01	**Direct Home-Digitrax compatible**	Common rail DCC logic
OpSw 03	**Normal BDL16 LocoNet Railsync cable polarity.** Affects detection and changes timing edge to be used for transponder detection.	Reverse BDL16 LocoNet Railsync cable polarity. Affects detection and changes timing edge to be used for transponder detection.
OpSw 05	Disable Transponding	**Enable Transponding**
OpSw 06	**RX4 connected** OPSW6 and 7 MUST be "t" when RX4 connected.	
OpSw 07	**RX4 connected** OPSW6 and 7 MUST be "t" when RX4 connected.	

The BDL16 is sensitive to the Rail Sync polarity, OpSw 03 lets you change the BDL16/BDL168's setting to agree with what it sees when it is plugged in to LocoNet. If you have wired your LocoNet with all LocoNet cables in the same orientation, all BDL16's will see the same Rail Sync polarity everywhere on the layout. If your LocoNet has any cables that are wired in different orientations, you may need to use OpSw 03 to compensate for this by changing the expected Rail Sync polarity for each BDL16/BDL168.

7.0 Setting Up Locos & Other Rolling Stock for Transponding

1. Your locomotive or other rolling stock that you want to use for transponding must be equipped with either a transponder device or a decoder with transponder included. Transponder devices such as the TD1 & TL1 can be added to non-transponding decoder installations. These devices are very small and easy to install. If you have not put decoders in your locos, it is easy to use a transponder equipped decoder and then you won't have to add a second board inside the loco. For example, the Digitrax DN163K2 N scale Kato SD40 transponder equipped "plug and play" decoder is factory ready to transpond on most layouts with no additional modifications required to the decoder, locomotive or associated DCC boosters.
2. When you install a wired transponder equipped decoder, you should also install a load resistor of between 270 ohms & 470 ohms between the blue and white decoder leads. If you are using a board decoder, like Digitrax DN163K2, the resistor may already be installed on the decoder. Digitrax transponder current pulse generation uses the F0 decoder function lead that is also used for the forward light function. Transponding will not affect the operation of the forward light but you may see a slight glow when the light is turned off because of the way transponding works. If you are running zones where the average current draw is more than 3 amps, you can connect an additional 100 ohm 1/8 watt resistor in series with a 0.1uF ceramic capacitor across the white and blue decoder leads.

Note: If the resistor is not connected between the blue & white leads, then the locomotive will transpond in only one orientation on the track.

Note: If you are using TD-1 or TL-1 to equip your loco or rolling stock for transponding, you won't need to install the resistor because it is included on the board.

3. Enable transponding in the transponder equipped decoder by programming CV61 to a value of 02.

4. Place the loco on the track, select it and run it back & forth. Verify that transponding is working in that orientation. If transponding is not working, be certain that the resistor described in step 2 above is installed properly between the white and blue leads of the decoder.
5. Pick up the loco and turn it around on the track, select it and run it back and forth again. Verify that transponding is working in that orientation. If transponding is not working, be certain that the resistor described in step 2 above is installed properly between the white and blue leads of the decoder.

NOTE: Locos must be selected in the system for transponding to work.

8.0 RX4/BDL16/BDL162 Troubleshooting: Checklist

When troubleshooting the BDL16/RX4 installation, begin with the BDL16 since it must be working properly for the RX4 to work.

8.1 Packet Reception-BDL16/BDL162

Be sure the BDL16/BDL168's green ID LED is mainly on and briefly "winking" off approximately every 2 seconds. This means that correctly formatted DCC packets are being received. For DCC detection the same DCC packet signal that drives the Booster must be connected to the RJ12 socket left most pin. If this green led is not lit ever, check the external power connections.

8.2 Mode Indication-BDL16/BDL162

The winking on the BDL16's green ID LED indicates the primary BDL16/BDL168 mode. A single wink every 2 secs 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.

8.3 Occupancy Debug-BDL16/BDL162

Each BDL16 comes with an LT5 that will help you with layout wiring and troubleshooting for transponding & detection with Digitrax BDL16/BDL168 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. See your BDL16 manual for information about how to use the LT5.

8.4 LocoNet Debug-BDL16/BDL162

If you are using LocoNet for reporting, be sure that the configuration is correct for your usage. In normal operations the BDL16/BDL168's red OPTION LED will blink on briefly when valid LocoNet messages are seen confirming a good network connection.

8.5 Transponder Debug-RX4/Decoder or other transponder

Be sure the BDL16 is functioning correctly as an occupancy detector. This shows correct power and LocoNet connections are present

1. Be sure that the zone you wish to test for transponding has a correctly wired RX1.
2. Be sure that the zone common wire from the DCC booster passes through the RX1 in the correct orientation and that it is connected to correct pin on the BDL16's connector.
3. Be sure that the decoder in the test zone is transponder capable or that you have a transponder device installed.
4. Be sure there is a load resistor of 270 ohms to 470 ohm value between the blue and white leads of the decoder.
5. Be sure that transponding is enabled in the decoder by programming CV61 to a value of 02.
6. Even when the forward light/F0 is off, you may still see a slight glow in the lamp or LED because of the transponder current pulses being generated. Whether the F0/white lead or light is on or off does not affect transponding.
7. Be sure that there is power to the decoder.
8. Be sure the decoder is selected on a throttle and it responds to speed and direction commands.
9. Be sure the associated occupancy detection section gives an occupied reading.
10. If no occupancy is indicated by the associated zone indicator LED blinking, try reversing the BDL16 Railsync polarity by changing the state of OpSw 03. OpSw 03 only needs to be set up once during the initial installation.
11. If transponding is working when the loco is placed on the track in one orientation but is not working when the loco is picked up and placed back on the track in the opposite orientation, check to be sure that the load resistor is properly installed between the white and blue leads of the decoder.

8.6 Using a Test Transponder for de-bugging

I am just learning about transponding and I am completely confused about how to do this. OR Nothing worked so what now???

You can use a Test Transponder as follows:

1. Use a DH163 or other transponder capable decoder set up with a 470 ohm resistor between the blue and white leads. This removes any lamp issues from initial transponding tests. The motor leads can be left unconnected/insulated and all other leads except the red/black track connections should be insulated. Set CV61 to a value of 02 to enable transponding.
2. Power up the BDL16 connected to a piece of flex track.

3. Use the first RX1 sensor (RX1 unit with brown/red leads in ribbon cable connected to AUX2 connector) and one leg of the track through the RX1. Connect the test transponder and select the address of this decoder/ Test transponder on a throttle.
4. If the Railsync polarity is correct, the zone power LED will blink steadily about 2 times a second indicating that a valid transponder with that address is being detected in that transponding zone. If the zone indicator does not blink either (1) reverse the feed wire through the center of the RX1 or (2) change the setting of OpSw 03 for the BDL16/BDL162.

9.0 Warranty and Repair Information

Digitrax gives a one year “No Worries" Warranty against manufacturing defects and accidental customer damage on all Digitrax products.

That's it! A simple, straightforward warranty with no tricky language!

Limitation of Warranty (The Legalese)

All warranties on Digitrax products are limited to repair or replacement of Digitrax products at the discretion of Digitrax.

Except to the extent expressly stated, there are no warranties, express or implied, including but not limited to any warranties of merchantability or fitness for a particular purpose.

Non-Warranty Repairs

For items that are no longer covered under warranty, whenever possible we will make repairs to units at fair and reasonable rates.

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.

10.0 Using RX4 With BDL168

Each RX4 requires a BDL series detector as a host. BDL16 & BDL162 allowed only one RX4 to be used per BDL. The instructions contained in this manual explain how to use a single RX4 with ANY BDL series detector (BDL16, BDL162 & BDL168).

BDL16 & BDL162 boards are labeled with AUX1 & AUX2. Only the AUX2 connection should be used for an RX4.

BDL168 is labeled with RX4-A (corresponds to AUX2) and RX4-B (corresponds with AUX1). Both RX4-A and RX4-B can host an RX4.

Using 2 RX4s with your BDL168

1. Plug two RX4s on to the RX4-B & RX4-A connections of the BDL168. Follow the instructions in this manual for spacing and mounting your RX4s. The same cautions regarding spacing around the RX1s must be followed for accurate operation.

2. Your BDL168 supports 16 detection sections 1-16. You can set up transponding for the detection sections in any way you choose. You can run one or more DS wires through any of the RX1s. For example, you might have 8 transponding zones and 8 detection sections. Many combinations are possible to accomplish your goals.

Each BDL168 detection section (or a combination of detection sections) can be set up for transponding by:

1. Running one or more wires from the detection section connection(s) on the BDL168;
2. Keeping the wires loosely twisted as instructed in this manual;
2. Through any one of the RX1s mounted as shown in this manual entering on the non-text side of the RX1 and exiting on the text side of the RX1;
3. To the gapped piece of track on your layout that you are setting up as a transponding zone.
4. Zone common wires from BDL168's Zone A, B, C, & D connections should be connected together and wired directly to the booster Rail A or B terminal. Use the RAIL A terminal when Rail A is gapped for detection and RAIL B terminal when rail B is gapped for detection.

RX4-A Supports Zones A,B,C, & D.
Your DT400 will display Zone 00, 02, 04, 06.

RX4-B Supports Zones E,F, G, & H.
Your DT400 will display Zone 08, 10, 12, 14.

New Option Swich Settings Available with BDL168

Option switch settings detailed in this manual for BDL162 are available on BDL168. In addition the following new features that will affect your transponding operations have been added to the BDL168:

Option Switch 39 Transponder Tracking Mode

thrown=Sequential Mode (Factory Default Setting)
This allows the system to track a transponder only in the first instance in any zone. For example as a transponder moves from one transponding zone into another, it will briefly occupy both transponder zones. In sequential mode, the system will report the transponder in only one of the zones. This is how BDL16 & BDL162 handled transponder tracking.
closed=Verbose Mode
This allows the system to track all transponders in all zones. For example as a transponder moves from one transponding zone into another, it will briefly occupy both transponder zones. In verbose mode, the system will report the transponder in both zones simultaneously.

Note that you can use BDL16, BDL162 & BDL168 on the same layout but if OpSw 39 is set to closed you will see a difference in reporting from the different BDLs

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Option Switch 43 Anti-chatter filtering

This feature improves transponding operation on dirty track by filtering the transponder release time.

thrown=Anti-chatter filter enabled (Factory Default Setting)

closed=Anti-chatter filter disabled

Option Switch 44 Anti-chatter filter sensitivity

Active only when Option Switch 43 is enabled. This feature allows you to adjuts the amount of anti-chatter filtering (transponder release time filtering) that is implemented to improves transponding operation on dirty track.

thrown=Maximize anti-chatter filter (Factory Default Setting)

closed=Standard anti-chatter filter