

Bremerton Northern Model Railroad

NTRAK Group

Digital Command Control Manual

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INTRODUCTON

The purpose of this manual is to provide the guidance needed to deploy the Digital Command Control (DCC) system to power and run a layout.

The Group typically uses the Digitrax brand DCC system, thus this document only addresses the Digitrax system. A DCC system simplifies layout wiring compared to a traditional DC system and allows any number of trains to run on the same track in the same direction or in opposite directions at the same time each with independent control.

Modules are built to our NTRAK standards so that the modules are compatible with any other module built to NTRAK standards.

The subject of decoder programming is not covered in this manual. Refer to the literature supplied with the DCC system and the decoder manual.

This manual is subject to review and modification as necessary based on revisions to the NTRAK standards, changes in technology, and lessons learned during use.

SYSTEM COMPONENTS

The Group's DCC system typically consists of the following equipment:

DCS200 Command Station

Tethered and Wireless Throttles

DB150 Booster

UR92 Receiver Panel

LNRP LocoNet Repeater(s)

DCC Specialties PSX electronic circuit breakers

DCC track power cabling

LocoNet cabling

LT1 LocoNet tester and test cable

Green 12 gauge wires long enough to connect between all boosters and the command station Commons. This wire prevents the formation of interference between the DCC equipment that can result in unreliable operation of the DCC system.

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Tools and supplies as necessary

The exact number and models of the components will vary over time due to needs and changes in technology.

DEFINITIONS

Booster: A separate device which requires instructions from a command station. It requires two inputs to function: a data signal from the command station and power from a power supply. The output is DCC track power connected to the track buss.

Command Station: The device that generates the commands that are sent to the boosters and decoders.

Decoder: Mobile decoders are typically installed in locomotives or other rolling stock that move along on the rails. This allows control of motors, lights, sound, and other functions. Stationary decoders are used to control fixed devices such as turnout motors/machines, grand crossing signals, etc.

Decoder Address: An identifying number programmed into a particular mobile or stationary decoder. The system uses the decoder address to send commands to the appropriate decoder.

Electronic Circuit Breaker: An electronic device used to interrupt DCC track power in the event of a short circuit on the track, such as when a locomotive overruns a misaligned turnout. Its ability to interrupt track power is superior to the short circuit protection built into the boosters. The Group uses the PSX-x units.

LocoNet: Digitrax's method of communication between LocoNet compatible devices on a model railroad layout. LocoNet is a peer-to-peer ethernet type of multiple access network. LocoNet is designed to run using flat, six-conductor telephone wire, and RJ12 6P6C connectors.

LocoNet Repeater (LNRP): Isolates and protects the LocoNet circuit, it allows for greater expansion of the circuit on large installations and provides troubleshooting capabilities.

Power District: When the layout is divided into separate DCC electrical sections, powered independently from each other, those sections are termed power districts. Thus a fault in one section will not affect the entire layout.

Throttle: Handheld input devices that tell the command station what you want the decoders to do. The number is determined by the capabilities of the command station in use. Smart phones can also be setup to run an app to function as a throttle using a WiFi system connected to the command station.

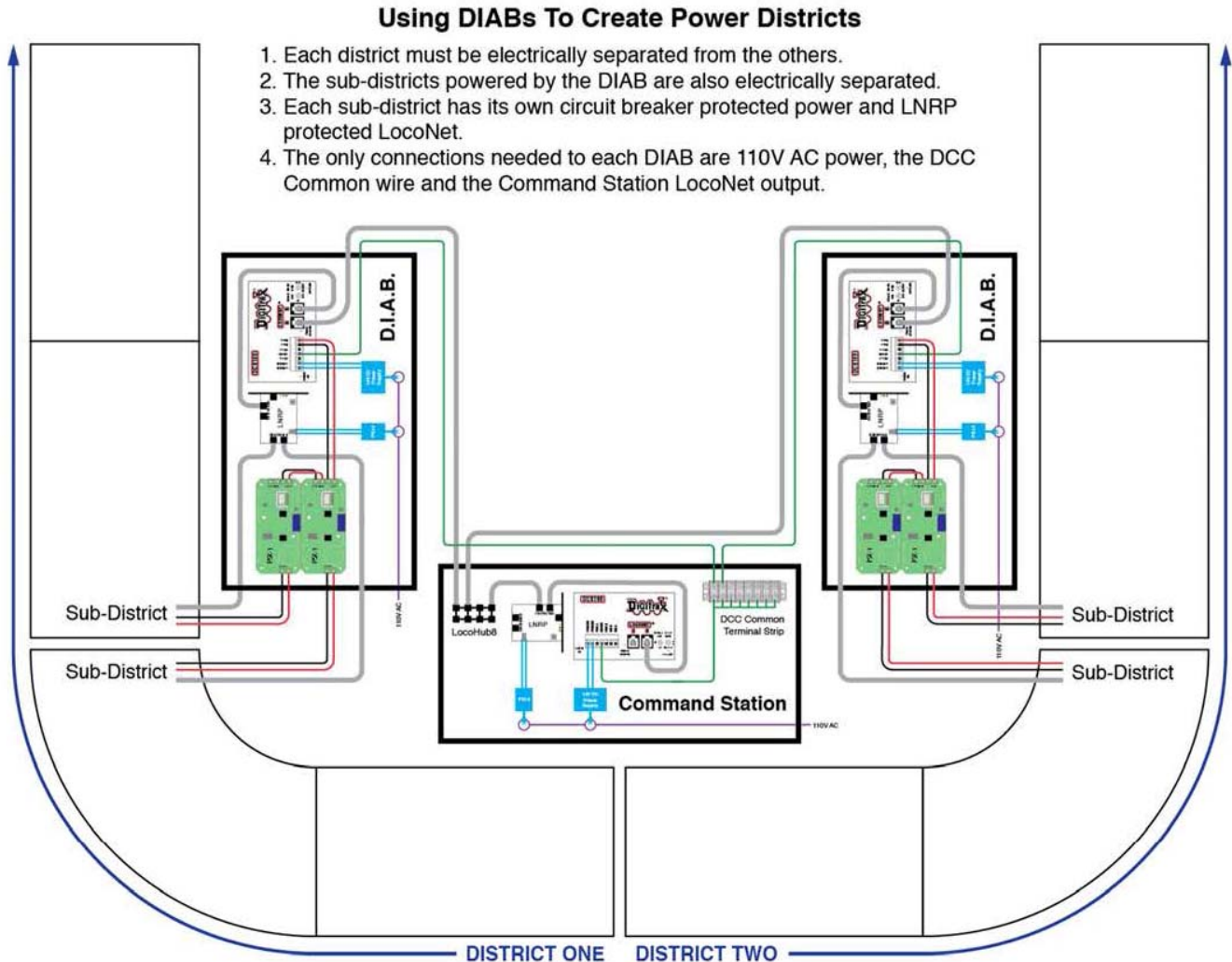
Universal Throttle Panel: Used to add more LocoNet connection points around the layout.

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DCC SYSTEM OVERVIEW

A basic DCC system is shown in this diagram:



THROTTLES:

Each member is expected to own and be responsible for their throttle(s). Smart phones with such apps as Engine Driver are allowed to be used when a WIFI system is in use.

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LOCONET:

Wiring Specifics:

- LocoNet supports a total cable length of up to about 2000 feet depending on actual wire type used and its capacitance.
- No two devices should be connected by more than 1000 feet of cable.
- LocoNet can be split & branched in any free form style.
- There should be only one Command Station connected to the layout.
- Do not loop LocoNet back on itself. Looping LocoNet back on itself causes RailSync (pins 1 and 6) to be shorted together and to be out of phase. This causes it to look like an overload.
- The recommended 6 wire flat telephone type ribbon cable is 26AWG.
- Plug and play design using 6 wire telephone type cables and RJ12 jacks makes setting up LocoNet quick and easy.
- Plug in your LocoNet Cables in the same pin orientation around the layout for best results.

LocoNet Cables:

LocoNet Cables must be reliable and well made, or you may see intermittent connectivity and spotty operation on the layout. If areas of the layout exhibit intermittent issues, bad cables may be the problem. Bad cables on your layout can be very frustrating and are completely avoidable by simply testing each cable before you install it on the layout.

Step by step instructions for making LocoNet cables:

- Use quality tools and materials!
- Measure the length of the cable needed and cut the flat telephone cable with the diagonal cutters.
- Using the crimping tool, strip the outside jacket from the telephone cable to expose the 6 individual wires inside the jacket.
- Verify the order of the wires matches this sequence: White, Black, Red, Green, Yellow and Blue.
- Hold the cable with the freshly stripped end pointing away from you. Orient the cable so the white wire is on the left side of the cable.
- Insert an RJ12 Connector on the cable. When inserting the connector, make sure the metal contacts are facing up and the tab is on the bottom.
- Visually inspect the wires through the plastic to make sure the wires are still in the proper order.
- Make sure the connector is inserted fully on the wire.
- Place the cable and the connector into the 'crimp' portion of the crimper.
- Compress the handles of the crimper to crimp the connector onto the cable.
- A properly crimped cable has all the wires fully inserted into the connector, the strain relief contacting the outer jacket of the cable and the metal contacts making a connection with the individual wires.
- Perform the same steps on the other end of the cable.

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Testing LocoNet Cables:

1. Use the LT1 for testing LocoNet cables.
2. Plug one end of the LocoNet cable being tested into the LT1
3. Plug the other end of the LocoNet cable being tested into LocoNet
4. Turn on Track Power using a throttle.
5. Make sure address 00, the analog loco address, is set to 0 speed.
6. Leave the throttle plugged in to Loco Net.
7. If the cable is good ALL 4 LEDs will glow.
 - a. LED 1 checks RailSync White & Black wires
 - b. LED 2 checks LocoNet Black & Red wires
 - c. LED 3 checks LocoNet Green & Yellow wires
 - d. LED 4 checks RailSync Yellow & Blue wires
8. If any of the LEDs fail to glow or are dim, cut the ends off the cable and crimp new connectors on the cable. Re-test the cable. If it still fails the test, there may be a problem with the cable itself and you should consider discarding it.
9. DO NOT leave the LT1 connected to a running layout, because it adds an extra unnecessary load Loco Net. It is meant to be used as a simple temporary diagnostic tool.

Shorted Contacts Inside a LocoNet Jack:

1. If the contacts inside a LocoNet jack are accidentally shorted, LocoNet may exhibit strange behavior or may stop working all together.
2. It's easy to see if these contacts are shorted by simply looking inside the jack.
3. If contacts are shorted inside the LocoNet Jack, simply straighten them so they are no longer touching.
4. If contact 3 or 4 is shorted to contact 2 or 5 (ground), the Command Station will not see LocoNet messages and LocoNet will appear unresponsive.
5. If contact 1 or 6 is shorted the Boosters may not make good track packets or power reductions to throttles and other devices may brown out and not operate properly.

LocoNet Jacks and Throttle Jacks:

1. LocoNet Cables are plugged into LocoNet Jacks located around the layout. LocoNet Jacks are available on all LocoNet compatible components.
2. LocoNet Jacks, like the ones on the back of all UTPs, are used for hooking up the LocoNet backbone. Additional LocoNet devices can be daisy chained from the rear LocoNet jacks.

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Command Stations and Boosters:

1. A layout must have only active ONE command station.
2. The command station must be powered up before any boosters are powered up.
3. A fresh battery should be placed in the Command Station before each show.
2. Multiple command stations on the layout will cause command station control confusion and loss of reliable layout control.
3. Power each Command Station and Booster with its own power supply that is properly rated for the device being powered.
4. If using a Command Station as a Booster by setting Option Switches be certain it is operating as booster by setting the OpSw after powering up the unit to avoid layout control problems.
5. Both track rails must be gapped between booster districts. All districts must receive power from only one booster and the phase between boosters must be correct.

LocoNet & RailSync Voltages:

If either LocoNet or RailSync voltage is too low, the layout may experience several different symptoms. It may have difficulty in turning on track power to additional Boosters. Throttles may not operate correctly or may have no display at all if they do not have a battery installed. Use a good quality Digital Voltmeter (DVM) to help diagnose:

1. The 2 LocoNet data lines (pins 3 & 4) should have voltage between 8V and 14V with no message traffic present. This confirms that the booster is outputting enough voltage.
2. If the RailSync lines (pins 1 & 6) are OK, then the two RailSync lines are driven as anti-phase copies of the track digital signal. These two lines should not be connected together, as this would cause excess current draw and low voltages.

How to Check for Low LocoNet Voltage:

1. Prepare a short LocoNet cable with one end stripped to expose the wires inside the jacket. The test cable supplied with the LT1 should be used for this test.
2. Strip the Red and Green wires and twist them together.
3. Strip the Black and Yellow wires and twist them together.
4. Plug this short LocoNet cable directly into one of your command station's LocoNet Ports.
5. Disconnect LocoNet from the layout at your Command Station so that you are measuring LocoNet voltage at the Command Station without the layout attached.
6. Use a good quality multimeter (in the 20 volt DC range) to measure the DC voltage between the red/green and black/yellow pairs.
 - a. Connect the red/green wires to the +ve lead of the DVM and the -ve DVM lead black/yellow wires and measure the voltage.
7. The voltage on the LocoNet data wires should be at least +8V DC. The highest voltage depends on the command station but is usually +12V to +14V.

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Check RailSync for Low Voltage:

1. Use the short LocoNet cable prepared for checking LocoNet voltage above.
2. Plug this short LocoNet cable directly into one of your command station's LocoNet Ports.
3. Disconnect LocoNet from the layout at your Command Station so that you are measuring RailSync voltage at the Command Station without any of the layout attached.
4. Measure the Unloaded RailSync voltage at the Command Station without the layout plugged in. Measure both RailSync voltages separately and add them to remove any analog zero stretching changes and to be sure both wires are carrying RailSync.
5. Use a DVM to measure from the white wire pin1 to black or the yellow ground (pin 2 or 5).
6. Use a DVM to measure from the blue wire pin 6 to the black or yellow ground (pin 2 or 5).
7. Add these two DC voltages, the total should be a voltage of +12V to +14V DC, with the command station unplugged from the layout. This is the unloaded RailSync measurement.
8. Measure the Loaded RailSync Voltage at the Command Station with the layout plugged back in to the Command Station.
9. Plug the LocoNet Cable from the layout in to the Command Station.
10. Again, use a DVM to measure from the white wire pin1 to the black or yellow ground (pin 2 or 5) on the short LocoNet Cable plugged in to the Command Station.
11. Use a DVM to measure from the blue wire pin 6 to the black or yellow ground (pin 2 or 5).
12. Add these two DC voltages, the total should be a voltage of +7 volts DC, with the command station plugged into the layout. This is the loaded RailSync measurement.
13. Compare the Unloaded and Loaded measurements for RailSync; this voltage difference is a measure of how much power the RailSync loads are drawing.
14. If voltage is below 8 volts, make sure all UR92s, UR91s, PM42s, etc. are powered using PS14 or similar power supplies as required.
15. If this does not bring the voltage above 8 volts, power all throttles with batteries and/or power UP5 and similar panels using PS14. Multiple UP panels can share a single power supply by daisy chaining them together as shown in their instruction sheets.

LocoNet Repeater:

1. Used to isolate LocoNet areas of the layout from each other.
2. Allows for troubleshooting with LocoNet fault indications.
3. Proper operation REQUIRES at least a 14VDC power supply.

THROTTLES

Each member is expected to own and be responsible for their throttle. Smart phones with an application such as Engine Driver are encouraged to be used when a WIFI system is in use.

Wireless throttles are encouraged to be used when a Digitrax UR92 radio unit is in use.

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DECODER ADDRESS PRACTICES

Each loco shall be equipped with a NMRA compliant decoder. Locomotive decoders must not use the default address (03) during shows. Decoder programming must ONLY be done on the dedicated programming track. Analog stretching is disabled in the command station; therefore, all decoders shall have CV29 configured with Analog Mode Conversion to OFF. Refer to the specific decoder manual for setting CV value details.

Locomotive decoder addresses are typically set to the locomotive's road number. In the event of duplicate address numbers at an operating session, one of the locomotives will be programmed to a new number, such as by selecting the 4th digit and adding or subtracting 1, i.e. 4449 would become 4448 or 4450. For use during joint shows with other NTRAK groups, an alternative method will need to be established with those other groups.

PRE-SHOW PREPARATIONS:

Inventory the DCC system equipment and inspect each device for damage. All available LocoNet cables should be tested using the LT-1 tester. Repairs should be made well before arriving at the show venue, if possible.

List of items to have on hand for DCC at the show:

- Quality Digital Multimeter
- Fresh 9v batteries for throttles
- Fresh Command Station and Booster batteries
- Quality RJ12 Crimping Tool
- Quality 6 Conductor Flat Telco Cable
- Spare RJ12 Connectors
- Spare Power Pole housings and contact inserts
- Tools – Screwdrivers, Wire Strippers, Needle Nose Pliers, Cutters, etc.
- 12 gauge green wire for Common Wire(s)
- Manuals and Instruction Sheets for each piece of equipment

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DCC SETUP SUMMARY:

When given the word to begin module setup, the modules are moved into place, the command station and booster(s) can be positioned as per the layout floor plan drawing. The 12 gauge green common wire must be routed between the command station and all boosters. Some form of tripping hazard prevention must be in-place over any wires on the floor.

The command station and booster(s) should be setup following the procedures in Appendix One. The command station and booster(s) must be checked for proper operation at this stage of the setup. If both are operating properly, the modules may be electrically connected and checked for proper operation.

120 vac power must be provided using the methods as detailed in the NTRAK standards to meet fire marshal safety requirements.

Track Polarity Check:

In the case of multiple power districts, the polarity must be checked across each power district track boundary. This is accomplished with all track power sources on. Use the digital multimeter to measure volt between corresponding rails and across opposite rails at each boundary.

Coin Test:

Once the track polarity is correct, the team must take a coin (25¢) and place it across the track and verify the PSX or PM4, as appropriate, shuts power off before the booster shuts down. If the booster shuts down first the trip setting of the PSX/PM-4 must be reset to trip at a lower setting. This check must be performed in each track power district.

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Appendix A

Digital Command Control System Setup Procedures

PART A: DCC System Setup Procedure at the Start of Show

Step A: Initial Condition Checks

- Each step (A-E) should be performed in the order given below.
- The Command Station should be powered up be any Boosters are powered up.
- Command Station and DIAB power supplies turned off.
- Command Station LNRP protected side plugged to the LocoNet Junction Hub.
- Layout LocoNet cables disconnected from LNRP monitored side (Rear RJ12 Jacks).
- LocoNet cable to DIAB disconnected from Command Station Cart Junction Hub.
- Green ground wires connected from Command Station Cart to DIAB ground wire connection.
- DCC power cables connected to layout and power district boundaries set.
- Refer to Appendix B for use of OpSw functions
- There should be two beeps each time an OpSw is closed
- If more than one DIAB is used, follow Step C for each DIAB.

Step B: Configure DCS200 COMMAND STATION for Show

1. Unplug LocoNet from front of DCS200.
2. Turn on the Command Station power supply.
3. Move the SCALE switch to 'N'.
4. Move the MODE switch to 'OP' position.
5. Connect DT402 to either Jack A or Jack B on the Command Station.
6. Press the DT402 **SWCH** key to enter 'Sw' mode.
7. Close **OpSw#39** by pressing the **Cloc/c** key to clear internal memory.
8. Listen for the Command Station to beep twice to confirm.
9. Move MODE switch to 'SLEEP' position.
10. Move MODE switch to 'RUN' position. Net light on steady.
11. Leave the DT402 connected.
12. Move MODE switch to "OP" position.
13. Press **SWCH** key to enter 'Sw' mode.
14. Close **OpSw#5** by pressing the Cloc/c key to set to command station mode.
15. Close **OpSw#15** by pressing the Cloc/c key to force purged locos to speed '00'.
16. Close **OpSw#20** by pressing the Cloc/c key to disable address 00.
17. Close **OpSw#25** by pressing the Cloc/c key to disable aliasing.
18. Close **OpSw#44** by pressing the Cloc/c key to expand slot area to 120 locos.
19. Move MODE switch to 'SLEEP' position. Net light blinks.

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Appendix A

Digital Command Control System Setup Procedures

Step C: Configure DIAB DB150 Booster for Show

1. Unplug LocoNet from front of the Booster.
2. Move the SCALE switch to 'N'.
3. Turn on the Booster power supply.
4. Ensure Booster MODE switch is set to 'SLEEP' position.
5. Move MODE switch to 'OP' position.
6. Connect DT402 to either Jack A or Jack B.
7. Press **SWCH** key to enter 'Sw' mode.
8. Close **OpSw#39** by pressing the **Cloc/c** key to clear internal memory.
9. Move MODE switch to 'SLEEP' position.
10. Move MODE switch to 'RUN' position. Hear eight beeps.
11. Move MODE switch to 'OP' position.
12. Leave DT402 connected.
13. Press **SWCH** key to enter 'Sw' mode.
14. Close **OpSw#18** – to extend short circuit time to ½ second.
15. Move MODE switch to 'SLEEP' position.
16. Remove DT402.
17. Turn Booster Power Off.
18. Connect Config A and Ground Terminal.

Step D: LocoNet Connections

1. Connect LocoNet between front of Command Station and LNRP protected side jack.
2. Turn power on to the Command Station and DIAB LNRPs.
3. Move Command Station MODE switch to 'RUN' position and check the 'NET' light is solid red. If not check for bad LocoNet cables and replace.
4. Move Command Station MODE switch to 'SLEEP' position. Net light blinks.
5. Connect LocoNet cables to layout from DIAB LNRP monitored side (Rear RJ12 Jacks).
6. Connect LocoNet from LocoNet Junction Hub to Booster front LocoNet Jack.
7. Move Command Station MODE switch to 'RUN' position. Net light is solid.
8. Move Command Station MODE switch to 'SLEEP' position. Net light blinks.

Step E: DCC System Activation Procedure for Start of Running

1. Ensure Booster MODE switch is in the 'SLEEP' position.
2. Move Command Station MODE switch to 'RUN' position. Net light is solid.
3. Turn on Booster Power.
4. Move Booster MODE switch to 'RUN' position. Hear five beeps.
5. Plug DT402 into the LocoNet and press the red 'PWR' button followed by the 'Y /+' button to turn on track power. Verify track power light on.
6. DCC track power should be checked at each power district boundary to verify phase is correct.
7. Power up and then connect the LNWI to the LocoNet.

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Appendix A

Digital Command Control System Setup Procedures

PART B: DCC System De-Activation Procedure for End of Running

1. Press the DT402 red 'PWR' button followed by the 'N /-' button to turn off track power. Verify track power light off – hear five beeps from Booster.
2. Move Booster MODE switch to 'SLEEP' position.
3. Turn off Booster power supply and DIAB power strip.
4. Move Command Station MODE switch to 'SLEEP' position.
5. Turn off Command Station power supply and Command Station Cart power strip.

PART C: Activation Procedure for Subsequent Show Days

1. Move Command Station and Booster MODE switches to 'SLEEP' position.
2. Turn on Command Station Cart power strip and then Command Station power supply.
3. *It is strongly suggested the **PART A** Steps A & B are executed to ensure a clean command station prior to a run session.*
4. Move MODE switch on Command Station to 'RUN' position.
5. Turn on DIAB power strip and then Booster power supply.
6. Move Booster MODE switch to 'RUN' position. Hear five beeps.
7. Plug DT402 into the LocoNet and press the red 'PWR' button followed by the 'Y /+' button to turn on track power. Verify track power light on.
8. Power up and then connect the LNWI to the LocoNet.

PART D: Configure a DCS50/51 to Function as a Booster and Throttle

When a DCS50/51 is added to an existing system, as a booster, an additional 2.5/3.0 amps of power and a stationary throttle are gained. This is ideal for use to power and operate a small yard or industrial area of a larger layout. These steps are accomplished on the DCS50 unit.

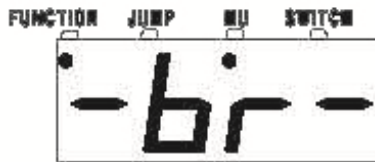
1. Press the prOg key. The display shows the last programming mode used by the DCS50/51.
2. Press the SwitCh key. The display shows the last switch used by the DCS50/51. The Switch Indicator Dot will start blinking to indicate you are in Option Switch Mode.
3. Use the keypad to enter 2. To let the DCS50/51 know you want to change Option Switch 02.

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Appendix A

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4. Press the c/- key to let the DCS50/51 know that you want to change Option Switch 02 to c and make the DCS50/51 a booster and throttle only. The display will show 002c with "L"s walking from left to right through the display. This means that you have set the DCS50/51 to run as a booster and throttle causing a loss of carrier signal. This is normal.
5. Press the exit key. The display will show -br- followed by the last address used by the DCS50/51 with the walking Ls through the display.



6. The DCS50/51 that is now running as a booster. Connect it to DCC track power and Loco Net wiring.

The DCS50/51 will now run as a combination booster/throttle.

To exit the booster configuration, change Option Switch 02 to the t position.

AutoReversing Note: DCS50/51 cannot be a command station AND be AutoReversing. First change it to function as a booster per the steps above. To make the DCS50 autoreversing: Press the prOg key, press the SwitCh key, use the keypad to enter 3, press the c/- key and press the exit key.

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Appendix B

How to Set an Option Switch (OpSw)

How to Set an Option Switch (OpSw)

1. Be sure the DCS-200 is powered up.
2. Find the two small silver toggle switches on the DCS-200 that are on the right side of the case.
3. The left toggle switch ("SCALE") should always be in the "N" position (middle).
4. Move the right toggle switch ("MODE") to the "OPS" position (middle).
5. Plug a DT-400 throttle into the DCS-200.
6. On the throttle, press red SWCH button.
7. Type the OpSw number into the keypad.
8. Press "CLOC / c" to close or "OPTN /t" to throw (in the throttle's bottom row)
9. To set more OpSw's, loop back to step 7
10. When done, move the silver "MODE" switch to "RUN"

Important! If you did a Command Station Reset (OpSw 39), move the "MODE" toggle switch down to "SLEEP" position and then all the way up to "RUN" position. This is not necessary when setting other OpSws.

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Appendix C

Power Pole Connectors for DCC Track Buss

Power Pole Assembly Instructions

Install the Metal Contact the Wire

These instructions cover the assembly of Power Pole connectors using a crimping tool specifically designed for this purpose. The tool is available from <http://www.westmountainradio.com> and <http://powerwerx.com>. The tool is also available from one or more group members.

1. Remove insulation so that approximately one-quarter inch of bare wire is exposed.
2. The crimper has 3 jaw openings: 15, 30, and 45. We only use the center one, marked 30.
3. It is recommended that you insert the wire into the contact prior to inserting contact into the tool. There is no need to tin the wire with solder.
4. With the flat side of the contact down, insert the contact tip into the center slot for crimping. Note that the contact's split portion of the wire barrel is facing squarely towards the upper die.
5. Squeeze the ratchet handle until the ratchet mechanism releases. Do not over crimp by squeezing the handles together until they touch, it is possible to break the die.

DO NOT SQUEEZE PAST THE POINT WHERE THE RATCHET RELEASES, doing this will make a poor and damaged connection. The ratchet release point assures that the crimp is fully compressed and makes the best connection.

Assemble the Power Pole Connector

The contacts go in the housings in only one way.

With the housing tongue down and hood up, insert the contacts with their curved part down against the flat spring that is in the housing.

The contact should slide in and click, or they are not fully seated.

When fully inserted, notice that the contact and its wire "floats" slightly inside its housing. If it feels tight it may not be snapped in fully or the contact may have been flattened out when crimped or soldered. Tug slightly on the assembled connector to make sure the contact is locked in place. If the contact does not lock into the housing, check to make sure the contact has not been widened or deformed.

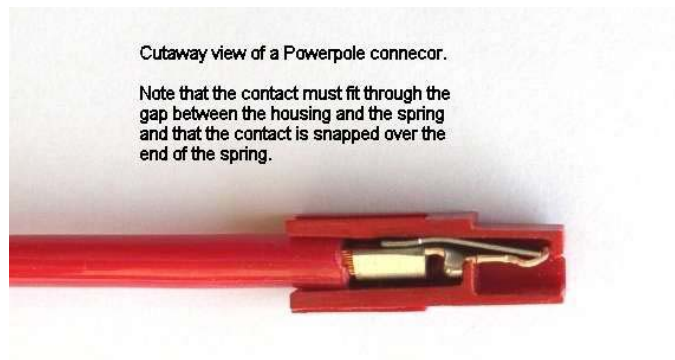
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Appendix C

Power Pole Connectors for DCC Track Bus

The plastic housings are held together with dovetail joints. Always slide these joints together! They will be damaged if you try to snap them together or apart. They ONLY slide together in one direction. This should be obvious by looking at them carefully.

This is a cutaway illustration of a properly inserted metal contact in the housing with the tongue up and the hood down. While not visible, the contact's split portion of the wire barrel is facing down.

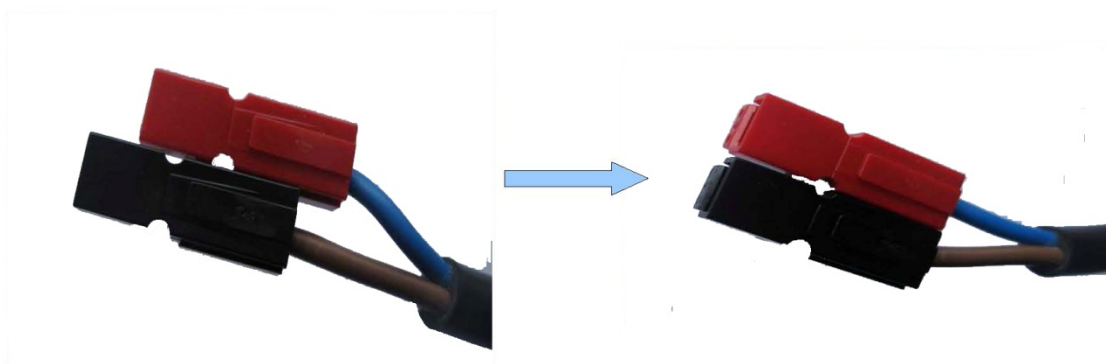


Referring to the above illustration, the metal contact can be removed from the housing by inserting a jeweler's screwdriver between the curved connect and the housing, then pushing the curved connect away from the flat spring to release it from the housing. Once the metal contact is free from the spring the contact and wire is pulled free from the housing out the back.

This illustration shows an internal cutaway view of two Power Pole connectors properly mated.



The illustration below demonstrates how to slide two Power Pole connectors together using the dovetail feature.

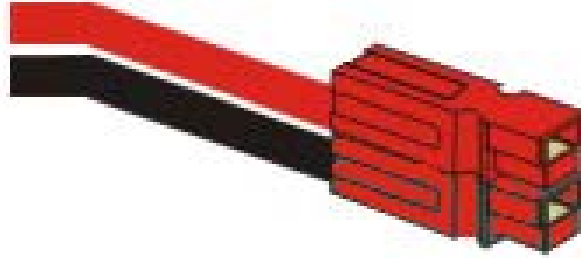


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Appendix C

Power Pole Connectors for DCC Track Bus

This illustration shows two Power Pole connectors stacked vertically with the hood up and tongue down.



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Appendix D

Loco Net Components and Use

OVERVIEW:

The following components are used to construct the throttle bus network (Loco Net) for PNW Free-mo N Group modules. If followed, these wiring diagrams will allow creation of a LocoNet that is completely compatible with the most popular DCC systems such as Digitrax, Lenz, or NCE.

It will not work with EasyDCC, which uses coaxial video cable for its throttle network.

This specification calls for readily available, inexpensive parts. While callouts are indicated for Tony's Train Exchange part numbers, an equivalent part from another source may be substituted, as long as it meets the same specifications as the listed part.

It should be noted that the wiring for each cable is identical - a relationship of Pin1-to-Pin1 is maintained throughout the bus. This allows any cable to be substituted for any other cable as needed. This same cable is also used for the throttle cables on NCE/SystemOne Cab Bus and Lenz ExpressNet based systems.

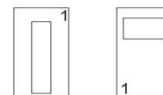
Digitrax throttles use this connector as a default.

COMPONENTS:

6-Conductor Flat Phone Cable
Tony's Train Exchange P/N M6C or equivalent



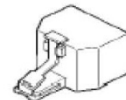
RJ11/12 6-Position Plugs -
Tony's Train Exchange P/N M PG



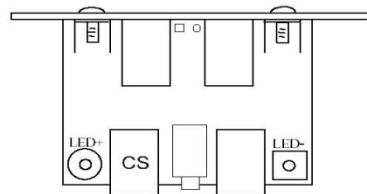
Female-to-Female Coupler -
Tony's Train Exchange P/N M FF



Two-way Splitter -
Tony's Train Exchange P/N M SP2
(1-RJ11 Plug-to-2 RJ11 Jack)



Universal Throttle Connector Panel -
Tony's Train Exchange P/N UTP/TTX



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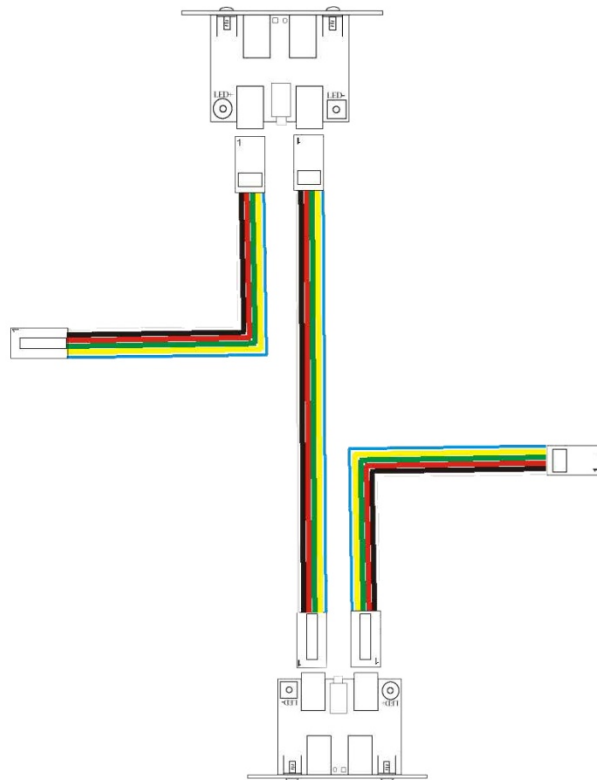
Appendix D

Loco Net Components and Use

This diagram illustrates the basic cable used in the network. It is a simple 6-wire data cable using 6P6C RJ11 connectors and 6-conductor flat telco/network cable. These cables can be ordered custom made to any length, or may be made by the modeler with relative ease. PNW members have the necessary tools to make the cables. This cable, along with a Female-to-Female coupler fulfills the minimum DCC pass-thru requirement for a module.



This diagram illustrates the placement and connections of two UTPs on a module.



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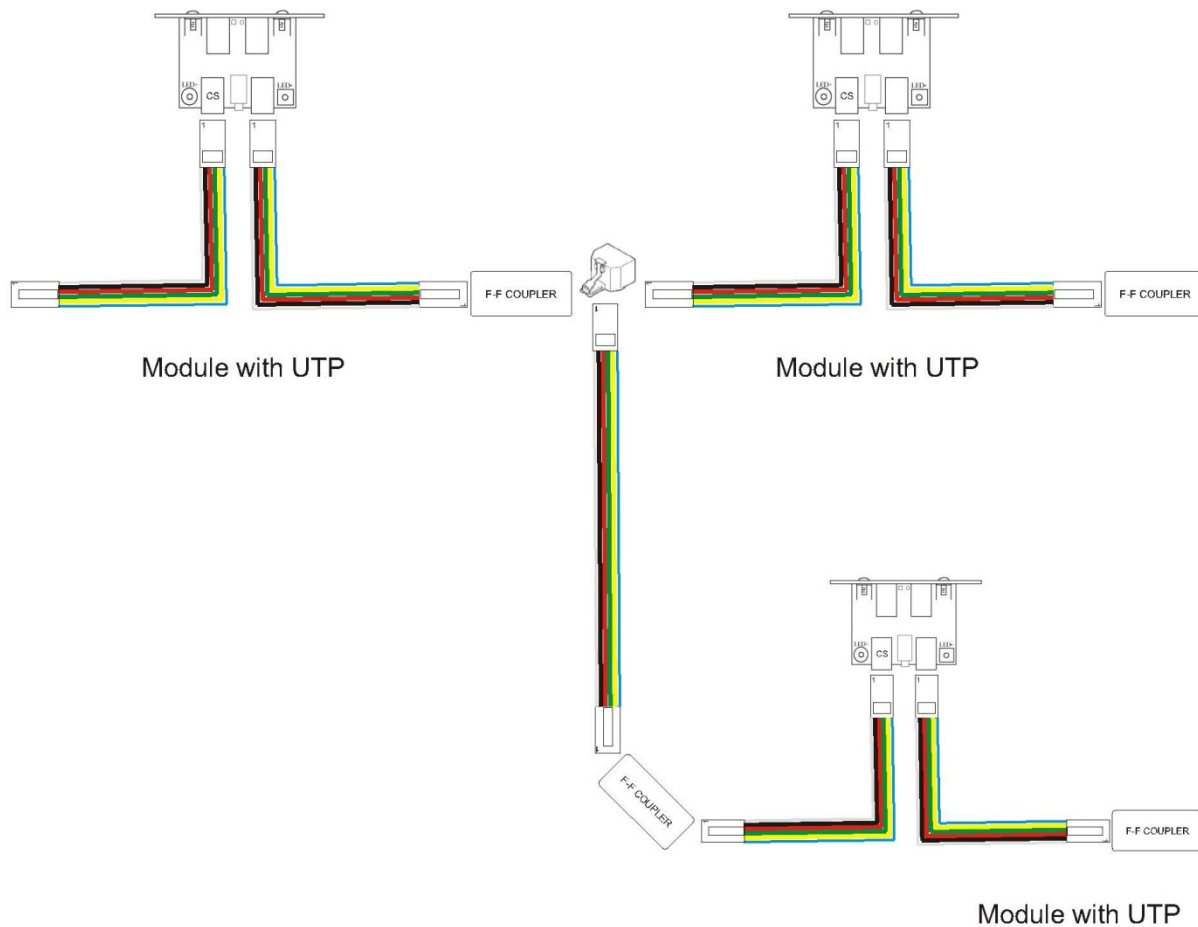
Appendix D

Loco Net Components and Use

In situations where there are branching modules, the DCC bus should branch as well. This illustrates how a two-way splitter plug can be used to accomplish this branching.

It is theoretically possible to branch as often as desired, up to the cumulative limits of the total system bus length. The maximum bus length between Loco Net components for Digitrax is approximately 1,000 feet.

In all cases, the Loco Net must NEVER form a closed loop. While there is little chance of component damage, operational problems may occur if a loop is formed.



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Appendix E

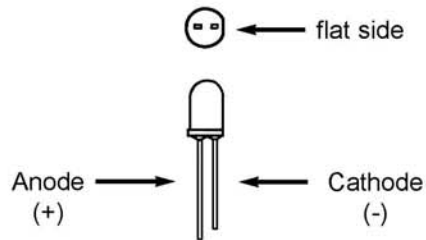
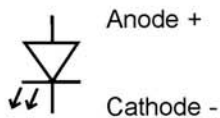
Using Light Emitting Diodes

USING LIGHT EMITTING DIODES (LEDS)

POLARITY

LEDs are polarized. If you hook them up backwards they won't work. To determine polarity: If the package is round, look for a flat spot on the edge of the device. The lead wire nearest the flat spot is probably the Cathode or negative lead. If the leads of the LED haven't been cut, the longest lead is usually the Anode or positive lead.

SCHEMATIC SYMBOL FOR LED



CURRENT LIMITING RESISTOR

LEDs can be operated on almost any voltage as long as they are used with the proper current limiting resistor. Most LEDs require a forward bias voltage of around 2 Volts and consume a current of about 20 mA. Using LEDs on voltages above 3 Volts without an appropriate resistor will probably cause them to burn out quickly, if not immediately. If you don't know the exact specs for the LED you are using, you can usually use 2 Volts @ 20 mA as a starting point for calculating the required resistor. Higher brightness LEDs and specialty LEDs may require higher voltages and currents. If the LED appears too dim, use a slightly lower resistance; if it's too bright raise the resistance. To calculate the resistance use Ohms Law

$$\text{Resistance} = \frac{\text{Supply Voltage} - \text{Voltage of the LED}}{\text{Current of LED}}$$

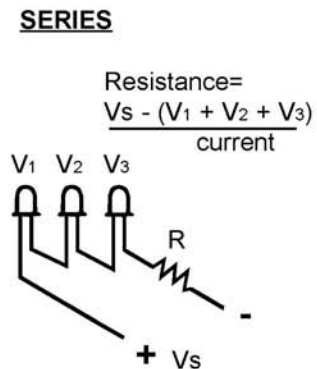
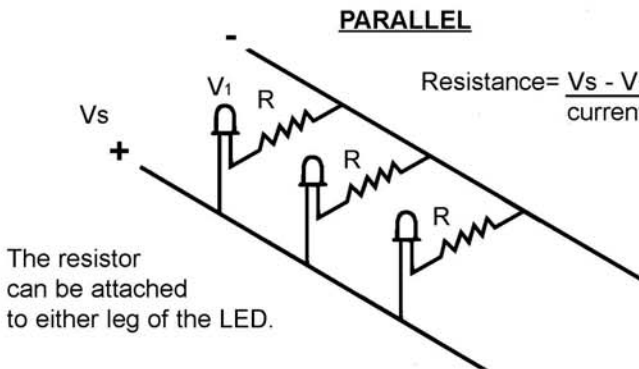
Eg. To operate a typical 2V LED at 20 mA

$$R = \frac{V_s - 2V}{0.02A}$$

for 6V use	200 Ohms
9V use	360 Ohms
12V use	510 Ohms
24V use	1100 Ohms

MULTIPLE LEDS

You can put LEDs in series with one resistor for the whole string. Add up the voltages of all the LEDs in the string. This should not exceed 80 percent of the supply voltage. To calculate the resistance required, the dropped voltage will be the supply voltage minus the total voltage of the LEDs in the string. Series strings can be paralleled if each string has its own dropping resistor.



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Appendix F

Accessory Buss Practices

Accessory Buss Practices

The Accessory Buss is optional on BNMR NTRAK modules. This appendix only applies if the buss is installed on a module.

AC SUPPLY:

The Accessory Buss can be powered from any number of low-voltage power supplies. Typical voltages range from 12-16 volts ac. One method is to use a DCC booster such as the Tam Valley Depot 3 amp model. This unit requires a separate 12-18 volt dc, 5 amp power supply.

DC SUPPLY:

In order to provide low voltage dc power to accessories such as switch machines, structure lighting, and animated devices the ac voltage must be rectified into dc power. This is accomplished by use of a full wave bridge rectifier such as the MDA990-3, part #25574 unit available from www.jameco.com.

A voltage regulator can be used to provide a constant regulated dc voltage if needed for a particular accessory. Numato Lab's (<https://numato.com>) voltage regulator breakout boards are made for just this purpose. Any of the following may be used depending upon needs:

- #7805 5v
- #7809 9v
- #7812 12v
- #LM317 variable voltage

Numato provides a quality product at a reasonable price with low shipping costs.