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Northern California Free-mo DCC Standards

Revised 9/8/2015

120VAC Power, General

Any quantity and location of 120VAC outlets may be used. The “only one outlet” rule is no longer required.

Outlets must have the safety earth-ground “third hole”.

Multi-outlet power strips and multi-outlet extension cords are allowed for distributing power around the layout and setup area, per the following rules modeled on national electrical safety codes:

- Power strips and extension cords must have the safety earth-ground “third prong”.
- Power strips and extension cords must be rated for 15 Amps minimum.
- Power strips must have built-in resettable overload protection.
- Power strips are allowed to plug into wall outlets only.
- Power strips are not allowed to plug into another power strip or into an extension cord.
- Extension cords are allowed to plug into wall outlets or into power strips.
- Extension cords are not allowed to plug into another extension cord.
- Stand-alone outlet expanders are not allowed.

DCC Units and Booster Farm

A DCC "unit" consists of, at a minimum:

- Either a Digitrax command station (e.g. DCS100) or booster (e.g. DB150);
- The power supply for the Digitrax unit;
- An 8-position terminal strip;
- One Track Power pigtail;
- Two DCC Commons pigtails.

The Booster Farm consists of, at a minimum:

- 120VAC power strip;
- One, and only one, command station DCC unit for overall control of the LocoNet bus;
- The NorCalF LocoNet Junction Box (including its 12VDC power supply) to distribute the LocoNet bus;
- At least one booster DCC unit to power the layout Track Bus, with additional booster DCC units as needed to power all track power districts in the layout;
- At least one booster DCC unit or AC power source to power the layout Accessory Bus, with additional booster DCC units or AC power sources as needed to power all accessory power districts in the layout;
- LocoNet cables to interconnect the DCC units via the LocoNet Junction Box;
- DCC Commons jumpers to interconnect the DCC units' Commons pigtails.

The Booster Farm is connected to the layout by group-owned Track Power Cables and a LocoNet cable.

Locate the Booster Farm central to the layout and near a 120VAC power outlet such that Track Power Cable run lengths are minimized.

Refer to Appendix B for a diagram of typical DCC Unit and Booster Farm interconnections.

Refer to Appendix D for images of a typical DCC Unit and Booster Farm setup.

DCC Unit AC Power Connection

All DCC units' 120VAC cords plug into the Booster Farm power strip that is plugged directly into a nearby AC outlet.

TBD: The command station DCC unit shall have an EMI filter on its power input.

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DCC Unit Power Supplies

The 120VAC power cord on DCC unit power supplies must have the AC safety earth-ground “third prong”.

Power supply exposed metal surfaces, such as enclosures, must be tied to the AC safety earth-ground.

TBD: Is a standard power supply output voltage required to ensure all boosters output the same track voltage?

DCC Unit Terminal Strip

Each DCC unit must have an owner-supplied 8-position screw-style terminal strip located within 6” of the Digitrax front panel connector. Owner-supplied 12-AWG wire must connect the seven Digitrax front-panel connector terminals to seven of the terminal strip screws, leaving open the eighth terminal position adjacent to the “Power” terminals. Refer to Appendix B for a diagram.

Note: For durability and ease of installation of the AC safety earth-ground, the barrier strip should have #8 screws and all ring and spade lugs sized to fit the #8 screws.

Note: In addition to providing a robust platform to connect power inputs, output pigtails, etc., the terminal strip also provides a more convenient platform to connect program tracks, configuration jumpers, etc.

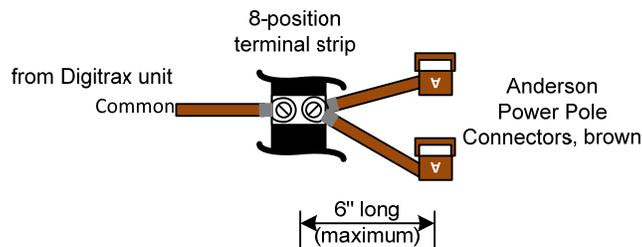
DCC Unit Commons Pigtails and Connections

Note: Digitrax DCS100 and DB150 units’ front panel connectors have one terminal labeled “ground”. This terminal is herein referred to as “Commons” to avoid confusion with the AC safety earth-ground.

Each DCC unit must have two “Commons Pigtails” attached to its terminal strip “Commons” position. Each Commons Pigtail is 6” long maximum, single-conductor, 14-AWG stranded brown wire, with one brown Anderson PowerPole connector installed on the free end and a ring lug on the terminal strip end.

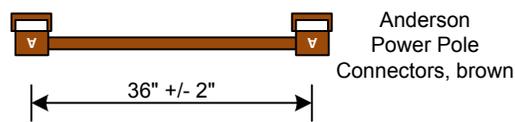
Note: PowerPole connector assembly requires a specialized crimper, such as:

<http://www.powerwerx.com/powerpole-accessories/tricrimp-crimping-powerpole-contacts.html>



DCC Unit Commons Pigtails

Each DCC unit must be accompanied by at least one owner-supplied standard “Commons Jumper”. The standard Commons Jumper is 36” +/- 2” long, single-conductor, 14-AWG stranded brown wire with one brown Anderson PowerPole connector installed at each end.



Commons Jumper

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Commons Jumpers longer than 36" may be assembled at setup time on an as-needed basis, but kept as short as possible. All other parameters must match the standard Commons Jumper.

At setup time, all DCC units' Commons Pigtails are linked together with standard Common Jumpers, connecting from one DCC unit to the next daisy-chain style. The Command Station is located at one end of the daisy-chain so that it has one Commons Pigtail available for the single AC safety-ground connection. Refer to Appendix B for a diagram.

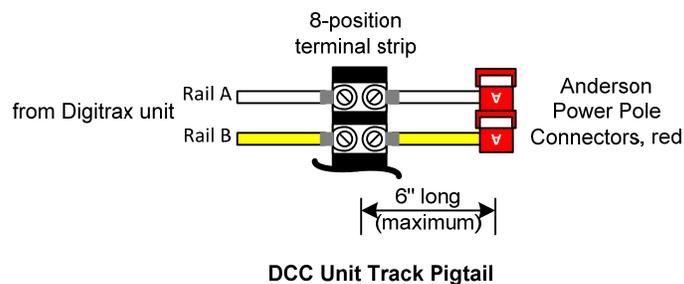
Note: When NorCalF DCC units are used in a distributed DCC system, two Commons Jumpers can be used to connect each unit's Commons Pigtails to the layout's DCC Booster Commons bus, daisy-chain style. However, this arrangement requires twice as many Commons Jumpers for a given layout.

DCC Unit Track Power Pigtails

Each DCC unit must have one user-supplied standard "Track Power Pigtail" installed on its 8-position terminal strip, at the "Rail A" and "Rail B" positions.

The standard Track Power Pigtail is 6" long maximum, two-conductor, 12-AWG stranded wire, with two vertically stacked Anderson PowerPole connectors installed on the free end, and ring lugs crimped on the terminal strip end.

The "Rail A" shall be white wire connected to the top red PowerPole. The "Rail B" shall be yellow wire connected to the bottom red PowerPole.



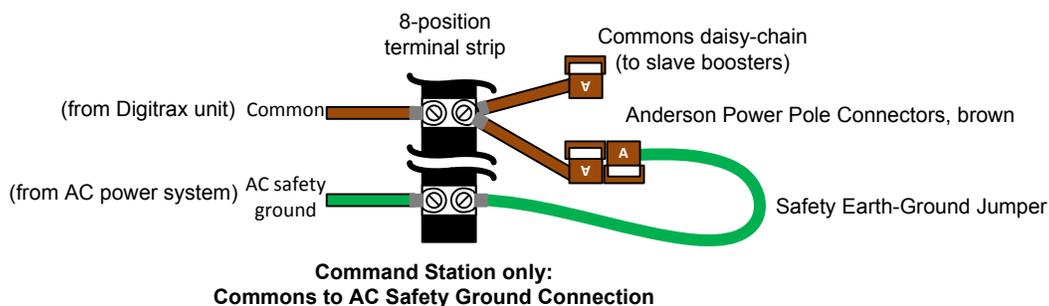
DCC Commons to Safety Earth-Ground Connection

Every Digitrax DCS100 DCC unit must include a connection of the AC safety earth-ground to the eighth terminal on the 8-position terminal strip (the end position, adjacent to the "Power" terminals).

At setup time, the DCC Commons daisy-chain must be connected to the AC safety earth-ground at one point, and only one point. This connection shall always be made at the single DCS100 DCC unit designated as the layout command station by installing a "Safety Earth-Ground Jumper" between its terminal strip's AC safety earth-ground terminal and one of its "Commons" pigtails.

The Safety Earth-Ground Jumper is single-conductor, 14-AWG (minimum) stranded green wire, with a spade or ring lug crimped on the terminal strip end and a brown PowerPole installed on the other end.

Note: DB150 units may support this connection for home use, though it will not be used at Free-mo setups.



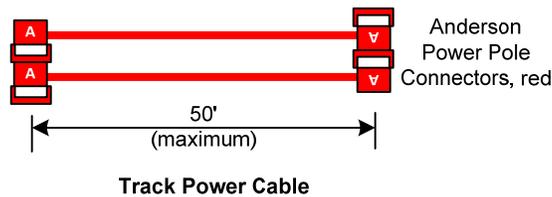
Track Power Connections and Distribution

The command station DCC unit shall not be used to provide Track Bus power to any portion of the layout.

Track Power Cables

Group-owned, standard "Track Power Cables" connect booster DCC units' Track Power Pigtails to their assigned track power districts on the layout.

The standard Track Power Cable is 50' long maximum, two-conductor, 12-AWG stranded wire, with two red Anderson PowerPole connectors installed on each end stacked vertically. These cables shall be "cross wired" from end to end, relative to the stacked PowerPole connectors (i.e. "top to bottom" and "bottom to top"). This allows them to be used in-line within a layout in addition to connecting the Booster Farm to the layout.



Track Power Cables shorter than 50' are acceptable. All other parameters must match the standard Track Power Cable.

Track Power Cable to Layout Connection

Track Power Cables connect to the layout's Track Power Bus by opening the Track Power Bus PowerPole pigtail connection between two modules where the track power district boundary is desired. The Track Power Cable is attached to one module's Track Power pigtail, thereby feeding power into the end of the district. The adjacent module's Track Power pigtail is left unconnected to isolate adjacent districts.

Note: Mid-district connection between two modules in the same power district is allowed, but requires a PowerPole "wye" adapter to mate the Track Power Cable to both modules' Track Bus pigtails. The module Track Bus pigtails at both ends of the district must be left unconnected for isolating the power districts.

A maximum of two Track Power Cables may be daisy-chained to lengthen a run.

Track Power Cable runs shall not exceed 100' each.

LocoNet Connections, Distribution, and Power

LocoNet Junction Box

The group-owned "LocoNet Junction Box" must be used to distribute LocoNet from the command station DCC unit to the booster DCC units and the layout. Refer to Appendix C for schematic.

The LocoNet Junction Box performs the following functions:

- Routes only RailSync signals to the boosters so they cannot interfere with the LocoNet signals.
- Reverses RailSync signals to each booster using slide switches to match phase among track power districts.
- Powers the layout's LocoNet bus using a dedicated 12VDC supply (instead of the RailSync signals), preventing the command station being affected by voltage sags from too many plugged-in throttles.
- Provides multiple RJ12 jacks for RailSync distribution to boosters ("booster bus").
- Provides one RJ12 jack for auxiliary LocoNet items, such as a computer.

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LocoNet Power

Providing power to the LocoNet from the Track Bus or Accessory Bus is NOT allowed.

A regulated 12VDC power supply connects to the LocoNet Junction Box power jack labelled "12V DC", and is considered part of the LocoNet Junction Box. This 12VDC powers the layout's LocoNet bus (a.k.a. "throttle bus") for powering plugged-in throttles. This supply is powered from the Booster Farm 120VAC power strip or any available 120VAC outlet.

Additional "remote" power for the layout LocoNet bus is allowed on an as-needed basis. This power shall be provided ONLY from dedicated 12VDC power supplies (e.g. "wall wart" units). These supplies may receive power from any available 120VAC power outlet.

Digitrax UR91/UR92 radio receiver units MUST be powered by dedicated "remote" power supplies.

All "remote" supplies must be approved by the layout DCC Chief or Run Chief before connecting to the layout.

Booster Farm LocoNet Interconnections

Refer to Appendix B for a diagram.

The LocoNet Junction Box RJ12 jack labeled "COMMAND STATION" connects to the command station DCC unit using a RJ12 cable no longer than 36". The shortest cable possible is preferred.

Note: the command station's second RJ12 jack is left open to plug in a throttle for setting Ops Switches, debugging the DCC system, or programming locomotives.

The LocoNet Junction Box RJ12 jacks labeled "BOOSTERS" connect to each booster DCC unit using RJ12 cables no longer than 36". The shortest cable possible is preferred. This results in a "star" configuration of RJ12 cables from the LocoNet Junction Box to the boosters (a.k.a. "booster bus"). These jacks have RailSync only.

Note: each booster's second RJ12 jack is left open to plug in a throttle for setting Ops Switches or debugging the DCC system.

The LocoNet Junction Box RJ12 jack labeled "COMPUTER" is available for optional connection of a computer via an appropriate adapter. This jack has both RailSync and LocoNet signals. One possible use is for monitoring LocoNet activity and command station address slot status.

LocoNet Layout Connections

The LocoNet Junction Box RJ12 jack labeled "LAYOUT" connects to the layout's LocoNet "throttle bus" using a RJ12 cable not to exceed 10 feet in length. The shortest cable possible is preferred.

Use of a RJ12 "splitter" device for making the layout connection is acceptable. Connecting to a RJ12 coupler mounted at a module endplate is acceptable. Connecting to a Digitrax UP5 or NCE UTP throttle panel is acceptable, but MUST be at a "rear" (inside) jack. Do not connect to the "front" (outside) or "side" jacks on such panels – these are for throttles only.

Digitrax UR91/UR92 radio receiver units' LocoNet connections shall use the shortest cable possible and may be made at any layout LocoNet RJ12 jack, including throttle jacks, though the preferred method is connection to a jack inside a module (e.g. throttle panel "rear" jack, an endplate coupler, etc.). Use of a RJ12 "splitter" device is acceptable.

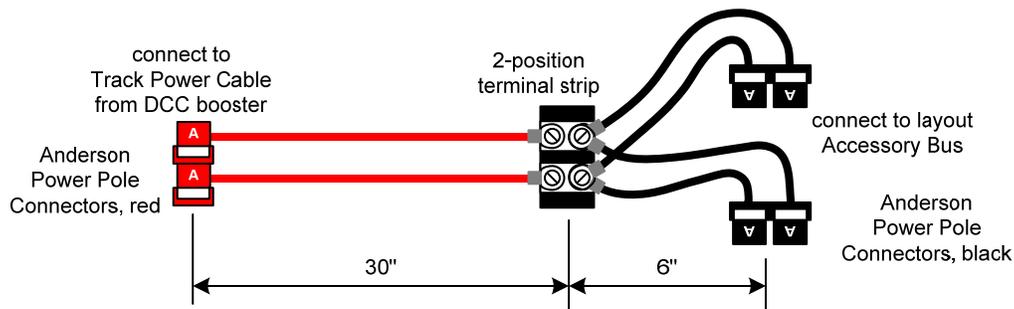
Accessory Power Connections and Distribution

Accessory Power Connections and Distribution (DCC)

The command station DCC unit shall not be used to provide power to any portion of the layout Accessory Power Bus.

Whenever possible, at least one slave booster DCC unit (typically a DB150) is designated to supply power to the layout Accessory Power Bus. A group-owned "Track-to-Accessory Power Wye" is used at the end of a standard Track Power Cable (connected to the designated booster DCC unit's Track Power Pigtail) to connect to the layout's Accessory Power Bus as close to the Booster Farm as possible.

The Track-to-Accessory Power Wye is 36" long overall, constructed in a "wye" pattern using two-conductor, 14-AWG wire and a two-position terminal strip. The "base" leg of the wye is 30" long with two vertically stacked red Anderson PowerPole connectors (for connection to the Track Power Cable). The two "branch" legs of the wye are each 6" long, each with two horizontally stacked black Anderson PowerPole connectors (for connection to the layout Accessory Power Bus, either end-connected or mid-connected). The wiring shall be "top red to left black" and "bottom red to right black" when viewing the PowerPole's mating ends with their "tongues" down. (Note: for clarity, the drawing below shows the red PowerPoles upside down with the "tongues" up).



Track-to-Accessory Power Wye

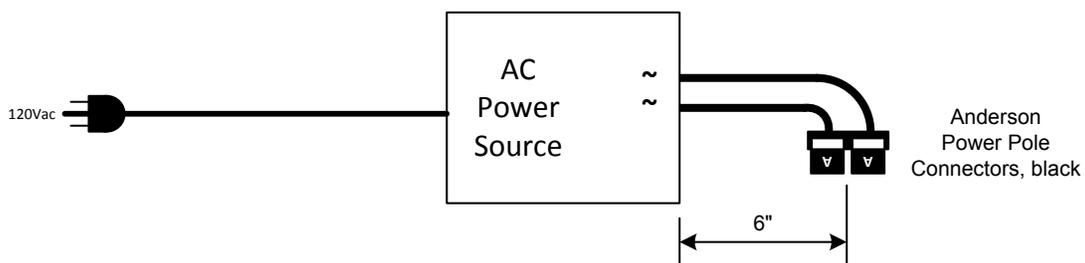
If the layout's Accessory Power Bus is divided into multiple power districts powered by multiple DCC boosters, follow the multi-booster connection system described for Track Power, and use additional Track-to-Accessory Power Wyes.

Accessory Power Connections and Distribution (AC)

When a booster DCC unit is not available to power the Accessory Power Bus, an AC power supply may be used instead. The AC output must be between 14.5VAC and 16VAC, and have a minimum 3 Amp current capacity.

Note: Most model railroad "power packs" cannot be used for this purpose, since their AC voltage output is usually too high (e.g. 18VAC) and their current capacity is usually too low (e.g. less than 1 Amp).

Such AC power sources shall have a 6" long (nominal), two-conductor, 14-AWG stranded wire "AC Power Source Pigtail" terminated with two horizontally stacked black Anderson PowerPoles.

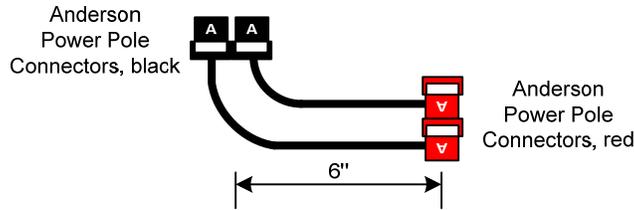


AC Power Source Pigtail

Northern California Free-mo DCC Standards

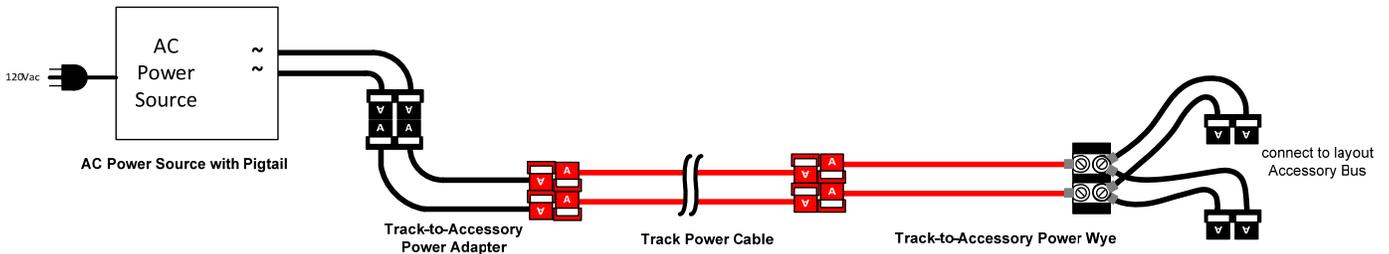
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The AC power source requires an owner-supplied "Track-to-Accessory Power Adapter" to adapt the AC power source's pigtail to a Track Power Cable's vertically stacked red PowerPoles. The wiring shall be "top red to left black" and "bottom red to right black" when viewing the PowerPole's mating ends with their "tongues" down. (Note: for clarity, the drawing below shows the black PowerPoles upside down with the "tongues" up).



Track-to-Accessory Power Adapter

Connect the AC power source to the Track-to-Accessory Power Adapter, then connect the Track Power Cable, and finally connect the group-owned Track-to-Accessory Power Wye to the layout's Accessory Power Bus.



AC Power Source Connection to Layout Accessory Bus

Settings and Configurations

Command Station and Booster Settings

The command station must be a Digitrax DCS100 unit.

The “Scale” toggle switch must be set to “HO” on all boosters.

The command station and booster Options Switch configuration is standardized as follows:

Op Sw	Command Station	Booster	Reverse Booster	Action
#39	close	close	close	“close” = clear all memory (addresses, consists, routes) move toggle to “SLEEP”, move toggle to “RUN”, then move toggle to “OP” (“t” will not show until next access)
#02	throw	close	close	“close” = normal booster only
#03	throw	throw	close	“close” = auto reversing booster only
#05	close	throw	throw	“close” = command station & booster
#15	close			“close” = force purged loco to stop
#20	close			“close” = disable address 00 and analog stretching
#25	close			“close” = disable aliasing
#44	close			“close” = expand to 120 address slots (DCS100 only)

The standard Options Switch configuration and the setting procedure must be posted on or near each DCC unit. Refer to Appendix A for a printable version designed to mount on the top of Digitrax enclosures.

At the start of each operating day, the command station must be completely cleared and reset, and its Options Switch configured to the standard settings.

Decoder Settings

All decoders shall have Analog Mode Conversion (i.e. DC operation) disabled to prevent inadvertent run-away. Set CV29 bit 2 to 0 (off or low). Most decoders default with this mode enabled – decoder owners must change it when programming the decoder. After a global reset to the decoder, remember to disable this mode again.

Note: this setting is subject to inspection and correction on any decoder at any time by the layout DCC Chief or Run Chief (the owner will be consulted first). Non-compliant units shall be removed from the layout until the correction is made.

DCC System Installation, Configuration, and Test Procedure

Refer to Appendix B for interconnections

CONNECT BOOSTER FARM

1. Select AC outlet near layout center and define Booster Farm area nearby; do not plug in Booster Farm power strip yet.
2. Collect Command Station DCC unit and all booster DCC units into Booster Farm area.
3. Assign a DCS100 unit as Command Station and label it as such.
4. Plug all units' AC cords into power strip. Plug LocoNet Junction Box 12VDC power supply into power strip, connect it to LocoNet Junction Box. Do not plug in Booster Farm power strip yet.
5. Install brown Commons Jumpers to daisy-chain together all units' Common terminals.
6. On Command Station only, install green Safety Earth-Ground Jumper to connect Commons daisy-chain to AC safety-ground.
7. Install Track Power Cables between each booster and its target layout power district as modules come online (including the booster assigned for Accessory Bus power, which requires wye and/or adapter cables for connection to layout Accessory Bus).
8. Label each booster with its assigned layout power district name.
9. At each track power district boundary, ensure track has insulated joiners on both rails and the Track Bus PowerPole connectors are open (not connected).

CONFIGURE COMMAND STATION

10. Toggle all units' "Mode" switches to SLEEP. Verify all units' "Scale" switches are set to HO.
11. Set power supply switches on all units to ON (for units that have power switches).
12. Now plug Booster Farm power strip into AC outlet. All units' "Power On" lamps should be lit.
13. Plug throttle into Command Station and configure its Op Switches (chart attached to unit):
 - a. toggle "Mode" switch to OP, close #39 Op Switch.
 - b. toggle "Mode" switch to SLEEP, then to RUN, and finally back to OP (this resets all Op Switches to 'thrown').
 - c. close various Op Switches 05 to 44 following chart column labeled "Command Station".
 - d. verify all other Op Switches are 'thrown' using the throttle to sequence up through OpSw 47.
14. Install a LocoNet cable between Command Station and LocoNet Junction Box jack labeled COMMAND STATION.
15. Install LocoNet cables into LocoNet Junction Box jacks labeled BOOSTER, one for each slave booster. Do not connect these cables to the boosters yet. Set all LocoNet Junction Box Phase slide switches to the same position.
16. Set Command Station's "Mode" switch to RUN. Verify its "Net" lamp is lit solid red; if not, there is a short in the LocoNet jumper cables or the LocoNet Junction Box. Locate and correct the problem as needed.
17. Set Command Station's "Mode" switch to SLEEP.

CONFIGURE SLAVE BOOSTERS

18. Move throttle from Command Station to a slave booster. Configure booster's Ops Switches (chart attached to unit):
 - a. toggle "Mode" switch to OP, close #39 Op Switch.
 - b. toggle "Mode" switch to SLEEP, then to RUN, and finally back to OP (this resets all Op Switches to 'thrown').
 - c. close Op Switch 02 for a normal booster, or close Op Switches 02 and 03 for a reversing booster, depending on how that unit is used in the layout.
 - d. verify all other Op Switches are 'thrown' using the throttle to sequence up through OpSw 47.
 - e. toggle "Mode" switch to RUN, then back to SLEEP.
19. Attach a LocoNet cable (installed at step 15) from LocoNet Junction Box to the booster.
20. Toggle the booster's "Mode" switch to RUN. Then toggle the Command Station's "Mode" switch to RUN.
21. If Command Station's "Track Status" lamp is dark, use throttle to turn on track power.
22. The booster's "Track Status" lamp should light unless there is a track short in the layout district connected to it (pending step 7 completion). Locate and correct the short as needed.
23. Repeat steps 18 - 22 for each slave booster unit.

TURN ON BOOSTER OUTPUT POWER

24. Toggle all units' "Mode" switches to SLEEP. Toggle all slave boosters' "Mode" switches to RUN. Then toggle Command Station's "Mode" switch to RUN. Verify "Track Status" lamp is lit on all units. Track power now should be on in all districts, though there may be phase reversals.
25. Use a multi-meter in AC-VOLTS mode to measure across rails in each district; the reading should be between 14 and 15 VAC. If not, locate and correct problems as needed. Also measure the Accessory Bus to verify its power is on.
26. Test for phase reversals at each track power district boundary. Measure across insulated joiner on one rail (i.e. not across the two rails); if the reading is more than 7 VAC, there is a phase reversal. Use the LocoNet Junction Box Phase slide switches to reverse booster phases as needed until all track power districts have the same phase.
27. Test each booster's short-circuit response by shorting rails with a coin in each power district. A slow booster shut down, or no reaction at all, indicates a high resistance somewhere in the track wiring for that district. Locate and correct problems as needed.

CONNECT LOCONET TO LAYOUT, TEST THROTTLE JACKS

28. Plug a LocoNet cable into LocoNet Junction Box jack labeled "LAYOUT". Plug a throttle into Command Station. Use a LocoNet Tester (Digitrax LT1) with a RJ12 coupler to test this cable. Replace or repair cable if all 4 LEDs do not light brightly.
29. Once the cable test succeeds, remove the LT1. Connect the LocoNet cable to the layout's LocoNet bus.
30. Plug a throttle into layout's LocoNet bus. Use LocoNet Tester LT1 to check each throttle jack on layout, progressing outward from where LocoNet Junction Box is attached. All four LEDs should light brightly; if not, correct module LocoNet wiring or repair throttle jack pins as needed.
31. Remove LocoNet Tester LT1 for operations.

DCC System Power-Down Procedure

AT END OF OPERATING DAY

1. Toggle Command Station "Mode" switch to SLEEP.
2. Toggle all slave booster's "Mode" switches to SLEEP.
3. Turn off or unplug the Booster Farm power strip so that AC power is cut off from all units.

DCC System Power-Up Procedure

AT START OF OPERATING DAY

1. Verify all booster's "Mode" switches are set to SLEEP.
2. Verify Command Station "Mode" switch is set to SLEEP.
3. Turn on or plug in the Booster Farm power strip so that AC power is applied to all units.
4. Plug a throttle into Command Station and reset it using its Op Switches (chart attached to unit):
 - a. toggle "Mode" switch to OP, close #39 Op Switch.
 - b. toggle "Mode" switch to SLEEP, then to RUN, and finally back to OP.
 - c. close various Op Switches 05 to 44 following chart column labeled "Command Station".
 - d. verify all other Op Switches are 'thrown' using the throttle to sequence up through OpSw 47.

Note – this will clear all consists, so operators must create consists again.

5. Toggle Command Station "Mode" switch to RUN, then back to SLEEP.
6. Toggle all slave boosters' "Mode" switches to RUN. Then toggle Command Station "Mode" switch to RUN.
7. Verify the Command Station "Net" lamp is lit solid red.
8. Verify that "Track Status" lamps are lit on all units. If not, use a plugged-in throttle to turn on track power. It may be necessary to cycle track power off and then on again.

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 Revised 9/8/2015

Appendix A: Options Switch (OpSw) Configuration

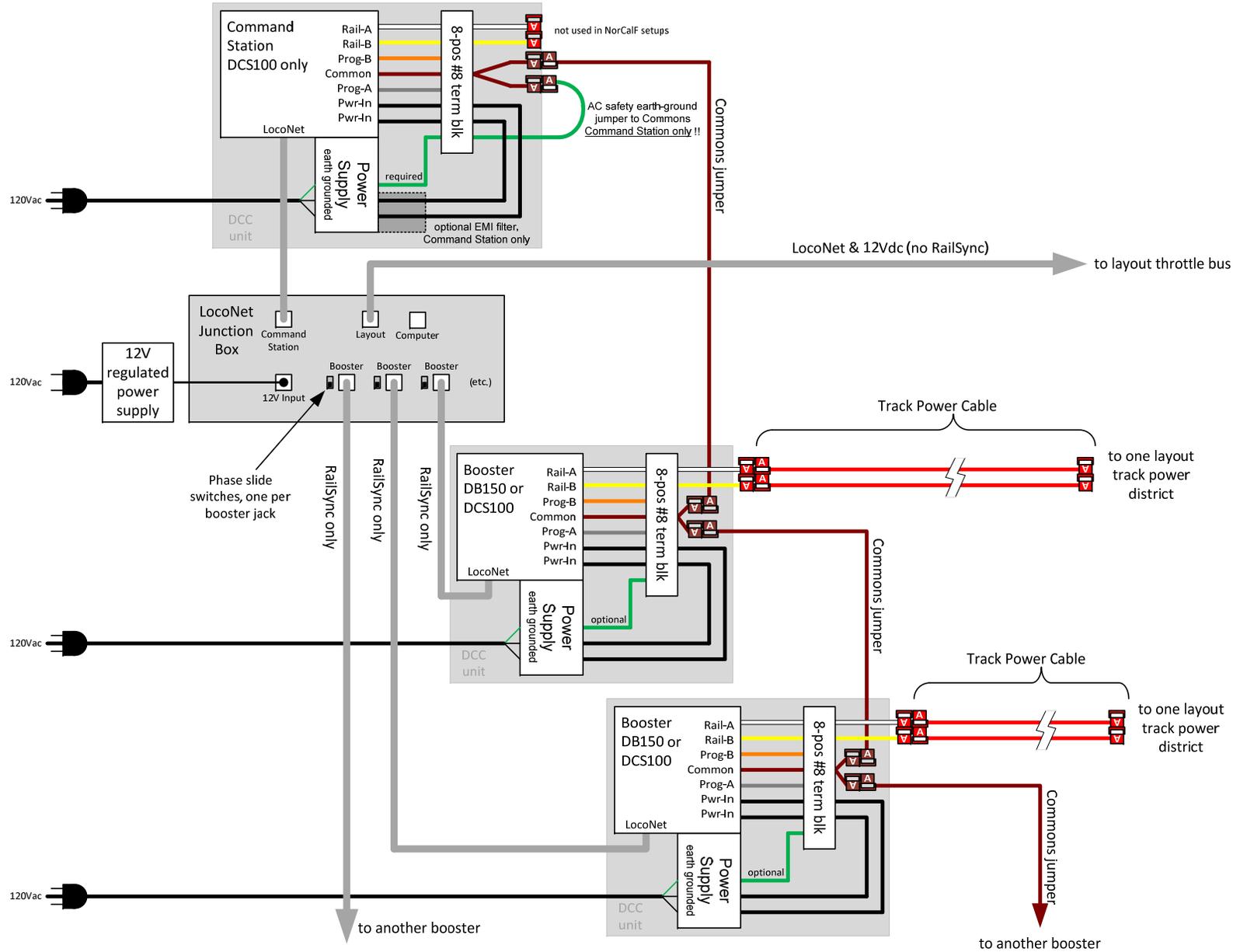
Print and attach on or near each Digitrax DCS100 and DB150 unit:

DCS100 / DB150 Options Switch Configuration				
1] Set unit's MODE switch to OP. Confirm SCALE switch is set to HO.				
2] Disconnect LocoNet cables, plug in throttle at either LocoNet port.				
3] Set throttle to "switch" mode [DT100: "MODE"] [DT400: "SWCH"] left display = OpSw number right display = current state				
4] Select OpSw number [DT100: right knob] [DT400: number keys]				
5] Set OpSw state [DT100: "c-R"=close, "L-t"=throw] [DT400: "CLOC c"=close, "OPTN t"=throw]				
6] When config completed, set unit's MODE switch to RUN.				
NOTE: All DCS100 ops-switches default to "t" after a #39 clear				
OpSw	Command Station	Booster	Reverse Booster	Action
#39	close	close	close	"close" = clear all memory move MODE to SLEEP, then RUN, then OP ("t" will not show until next access)
#02	throw	close	close	"close" = normal booster only
#03	throw	throw	close	"close" = auto reversing booster only
#05	close	throw	throw	"close" = command station & booster
#15	close			"close" = force purged loco to stop
#20	close			"close" = disable address 00
#25	close			"close" = disable aliasing
#44	close			"close" = expand to 120 address slots (DCS100)

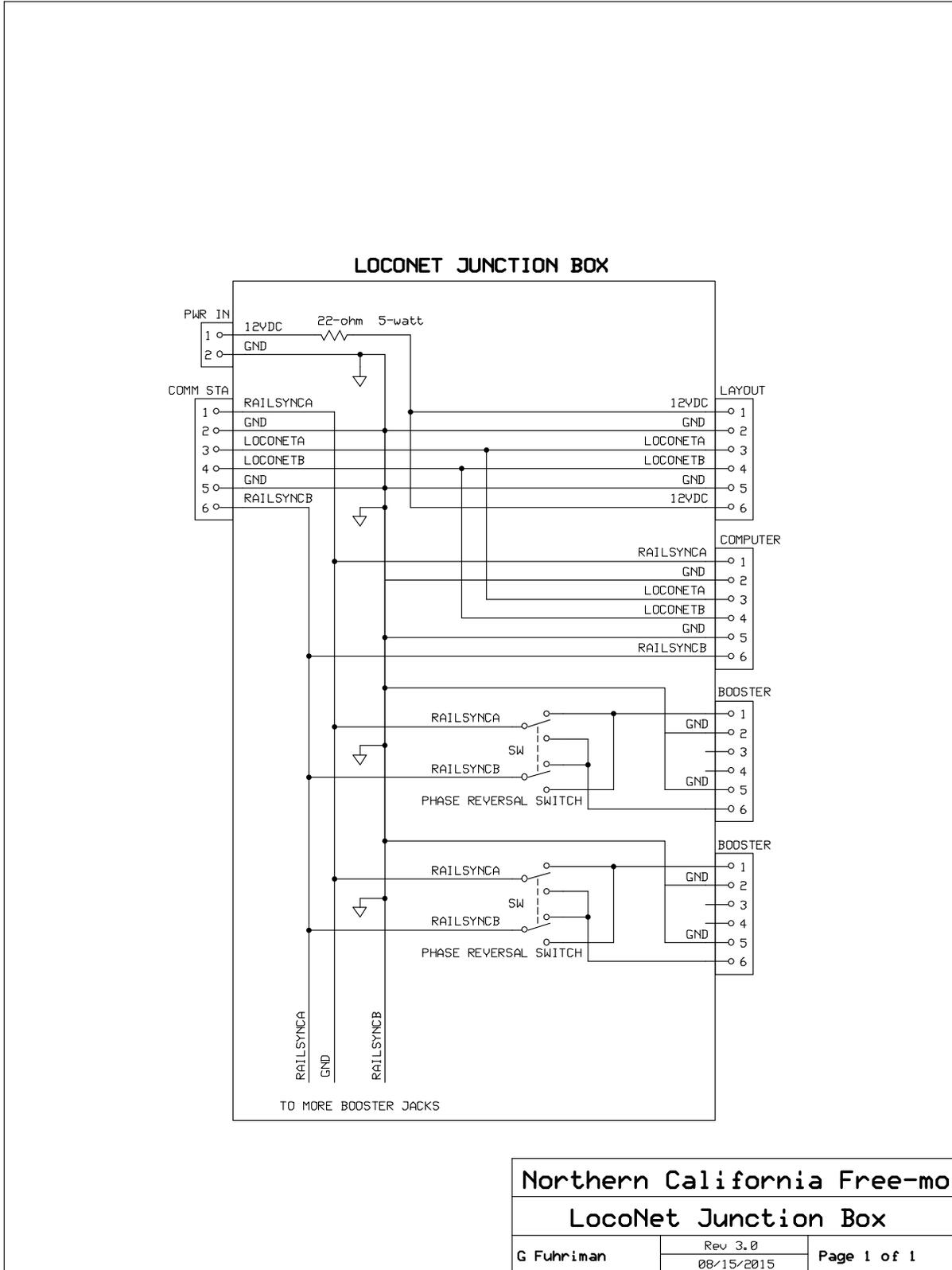
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Appendix B: NorCalF DCC System Overview



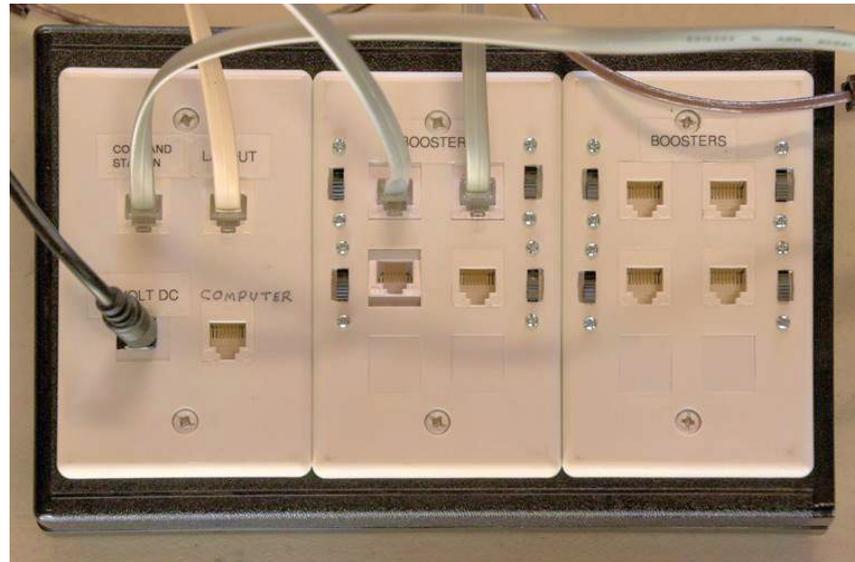
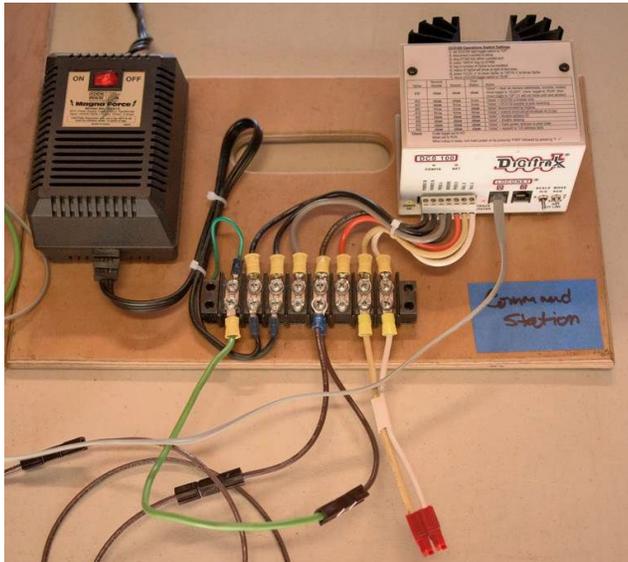
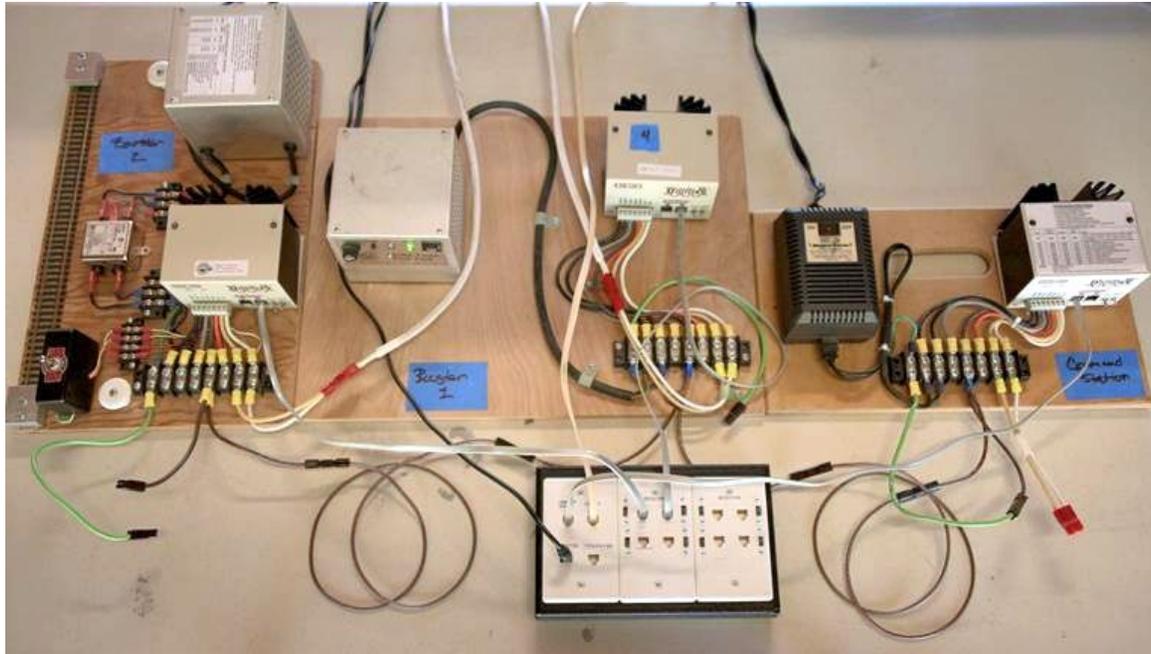
Appendix C: Loconet Junction Box Schematic



Northern California Free-mo DCC Standards

Revised 9/8/2015

Appendix D: Booster Farm Images



Northern California Free-mo DCC Standards
Revised 9/8/2015

Revision History

September, 2015	General update, replace Cinch-Jones with Anderson PowerPole connectors
January, 2009	Initial release