



Digital Command Control (DCC) Troubleshooting

by

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**How to find and correct problems encountered
during layout operations.**

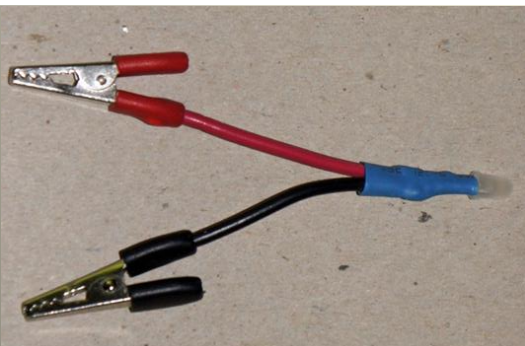
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Keeping It Running

Tools & Test Equipment Required

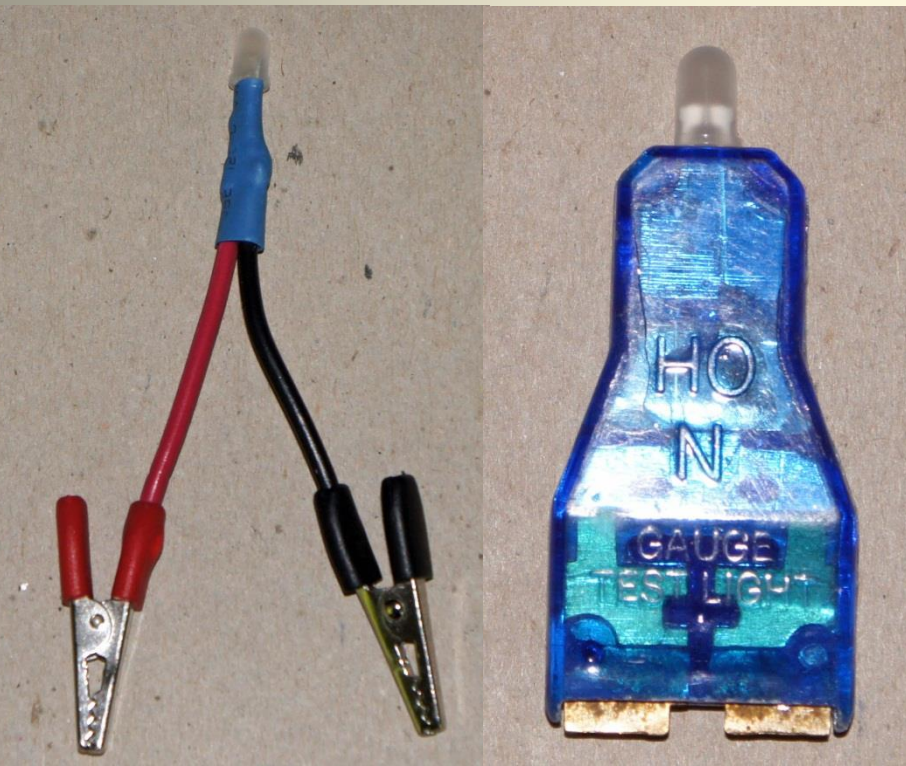
Tool/Test Equipment	Use
Quarter	Used for the “quarter test”.
LED Tester	Used to check track power, polarity and Booster phase
Digitrax LT-1 Tester	Used to check LocoNet cables and RJ plugs
Network Tester	Used to test newly made LocoNet cables
Digitrax DT4/5/6xx throttle	Used to check LocoNet voltage, turn track power on/off
RRampMeter	Indispensible for measuring DCC track voltage and current
VOM Multimeter	Indispensible for measuring voltage and resistance
Product Manuals	When all else fails, RTFM
Small hand tools	Same tools used for setting up the layout

LED Tester	LT-1 Tester	LocoNet Voltmeter
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LED Tester

Used to check track power, track polarity and
Booster phase



- 2-wire bi-color LED in series with 1,000 Ω resistor
- Placed across rails indicates if track is powered and whether DCC (orange) or DC red or green depending on polarity. (red/green)
- Placed on same rail across electrical district boundary indicates Booster phase
 - Lit indicates out-of-phase
 - Dark or very dim indicates in-phase

LT-1 Tester

Used to check LocoNet cables and RJ plugs

Tests the integrity of the installed LocoNet network.

- All four LT-1 LEDs will light if cables and jacks are good to the point tested. (Note: if a throttle is not plugged in only 3 LEDs may light.)
- If any LEDs fail to light, then check cabling back to the point of the last successful test.
 - Two outside LEDs reference Rail Sync lines.
 - Two inside LEDs reference LocoNet data lines.



Note: The LT-1 is not a LocoNet device. During normal layout operations do not leave the LT-1 plugged in longer than necessary to conduct the test. Two LT-1s at the same time will probably bring down LocoNet.

RRampMeter

Indispensible for measuring DCC track voltage and current, also DC voltage



- True RMS AC voltmeter
- Directly measure track voltage
- In series with track feeder measure track voltage and current.
- With known load (e.g. auto tail lamp) measure voltage drop as you move RRampMeter from power feed to district boundary.

Troubleshooting the Layout

First step — determine the affected section of the layout, e.g. electrical district

- If the layout is equipped with a LocoNet Repeater (LNRP) then a LocoNet problem can be detected by the LNRP diagnostic LEDs.
- If not a LocoNet problem, then check for a track short.
 - Look for a derailed locomotive/car or loco/car sitting on turnout or gap.
 - Check all track and turnouts — ensure gaps are still open.

As necessary check the various DCC devices in the layout, the track wiring and the LocoNet wiring.

Ensure spares of major components are on hand — Command Station, Boosters, URs, UPs, PMs, LNRPs, LocoNet cables, etc.



Electrical Districts & Track Bus

Gaps at power feed point allow quick determination of which direction a fault lies

- Unplug one power feeder. If problem goes away, then fault is in the direction of the feeder that was removed. If not, problem in other direction.

Ensure Power Manager trip current is set to carry the current load required, but must be less than the Booster capacity. Use JMRI Configure PM42 to read and set.

- Requires a LocoNet connection to PM42 and address set for PM42.
- Trip current can be reset during operations as necessary.

Use RRampMeter to measure current and voltage drop

- In series with power feed to measure current
- With known current load to measure voltage drop



LocoNet Problems

- LocoNet voltage measured between wires 3+4 (plus) and 2+5 (minus) with a DC voltmeter.
- LocoNet becomes unstable ~8V and/or stops working when voltage is ~7VDC.
- LocoNet voltage at Command Station with no other LocoNet cables connected should be 14 - 14.5VDC.
- As devices are plugged into LocoNet the voltage will drop. Anything above 9VDC allows normal operation.
- If low voltage detected begin troubleshooting the entire LocoNet network.
 - If multiple LocoNet branches, disconnect one at a time until voltage returns to normal.
 - Test from the Command Station outwards to the end of the branch, checking each device (cable, Booster, UP, UR, etc.) until faulty device is found. Replace.
- Note that a problem with one device can cause problem symptoms in other devices

Use LocoNet voltage tester & Digitrax LT-1 to determine faulty component.

LocoNet Testing



- ◀ Measure LocoNet voltage
 - Special cable + multimeter
 - Dedicated voltmeter
- ▶ Check LocoNet cable and RJ jacks
 - Digitrax LT-1



LocoNet problems can cause all kinds of bad things to happen.

LocoNet Rail Sync Problems

- **DCC requires Rail Sync signals from the Command Station to provide low-voltage DCC packets to Boosters and accessory decoders.**
- **If a booster is not operating correctly check for the Rail Sync signals using a LT-1 tester.**
 - **The two outer LEDs must be brightly and constantly lit.**
 - **If not, work back towards the Command Station until they are brightly and constantly lit, then identify and replace the offending cable or device.**
 - **For complete and proper operation of the booster all 4 LT-1 LEDs should be lit.**
- **This problem is not the same as a booster “out of phase” condition.**

Throttle Problems

- Make sure DT4xx/DT5xx/DT6xx throttles have the latest firmware updates installed.
- Always suspect the battery first when experiencing DT4xx/DT5xx throttle problems. Try several.
 - Throttles become unstable and stop working around 8 volts.
 - A fresh 9 volt alkaline battery is only 8.7 volts.
 - Duplex throttle current draw is much higher than simplex throttles.
 - Recommend Maha 9.6v Rechargeable Imedion (NiMH) batteries, especially for DT402D/DT500D duplex throttles.
- Make sure throttle options are correctly set, e.g. radio vs. IR.
 - For DT402D/500D throttles set display backlight to MIN to reduce current drain.
- DT602D duplex power 2x older throttles.
- Duplex throttles work well. Interference more of a concern.

Radios

UR91 Simplex Receiver & UR92/93 Duplex Transceivers

Mounting

- As high as possible above layout, on poles or “radio towers” for modular layouts
- Use multiple UR91/92/93 as required for full coverage of layout
- UR91 and UR92/93 can be co-located in close proximity

Power

- All UR91 and UR92/93 *MUST* be powered — use PS14 or equivalent.

Problems

- Ensure data-style only LocoNet cables between UR and Command Station
- Ensure UR green LED flashes as throttle knob is turned.
- Troubleshoot LocoNet cabling as required; replace UR with spare.

UR93

- Double the power of UR92. Still being evaluated. No longer a channel 26.

“Common” Wire Connecting CS with All BS

Keeps all CS/BS at same voltage reference, improves reliable operations.

- 14ga wire (green) connected between the Gnd terminal on the CS to all Boosters
- No connection between CS or BS to 120VAC electrical ground.
- However, in low humidity situations a single connection (at CS) in series with a 1 megohm resistor to 120VAC electrical ground is permitted to eliminate potential for static discharge

Provides protection for both human beings and electronic equipment through the “grounding” of all equipment. In other words our objective is to keep humans from electrocuting themselves and keep the trains running.

Provides smooth transition of locomotives across the double insulated gaps in the track that separate two Boosters, and prevents the possibility of voltage doubling between Boosters which can damage decoders. It also provides more stable operation of the Boosters.

Device Timing

Up to three devices can be involved in device timing:

- (Command Station) / Booster
- Power Manager (PM42, PSX)
- Auto-Reverser (AR1, PSX-AR)

Need the auto-reverser to activate before the PM or BS. Adjust detection timings as necessary for proper and reliable operation.

- (Command Station) / Booster — slowest (1/2 second setting)
- Auto-reverser — fastest
- Power Manager — in between (slower than auto-reverser, faster than BS)
 - PM42 detection timing adjustable — in real time via LocoNet connection
 - PSX timing not adjustable in real time.



Keep Firmware Up-to-Date

Several Digitrax devices are user upgradable:

- DT402, DT402D, DT402R, DT500, DT502D DT602D Throttles
- Duplex Radio Transceiver (UR92/UR93)
- LocoNet Repeater (LNRP)
- PR3, PR4
- Zephyr Extra/Express (DCS51/52)
- DCS210, DCS210+, DCS240 Advanced Command Stations
- LocoNet Wi-Fi Interface (LNWI)
- Other devices

Download from Digitrax Web Site “Downloads” page. Instructions on page.

Use either Digitrax software or JMRI to update devices.



Command Station

Be sure CR2032 battery is good in each DCS100 and DCS200 used in the layout, especially those set to be Boosters.

At start of show and each morning, clear consists and addresses (OpSw#36) or push Loco Reset button on DCS210/240

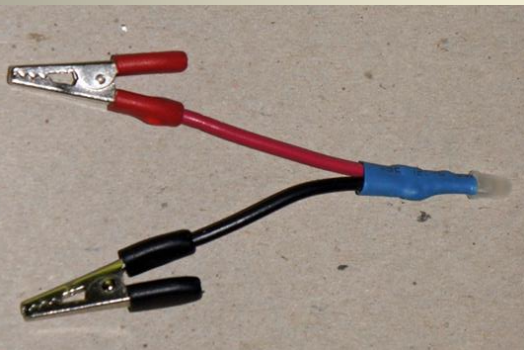
Do a reset (OpSw #39) whenever everything is/seems to be going wrong.

JMRI or LocoNet Checker can be used.

Issue when CS/BS powered with AC power supply connected in same LocoNet network with CS/BS powered by DC power supply.

Summary

- Know the design of the layout and the location of all DCC devices.
- Be sure to have the tools and test equipment needed for troubleshooting problems



- Monitor layout operations to ensure everything runs smoothly throughout the show or operating session.