Digital Command Control

Design & Operational Considerations for NTS 2005 NTRAK Layout

Final Version
June 17, 2005

by
John M. Wallis

As modified from the original by
2005 NTS DCC Committee

Table of Contents

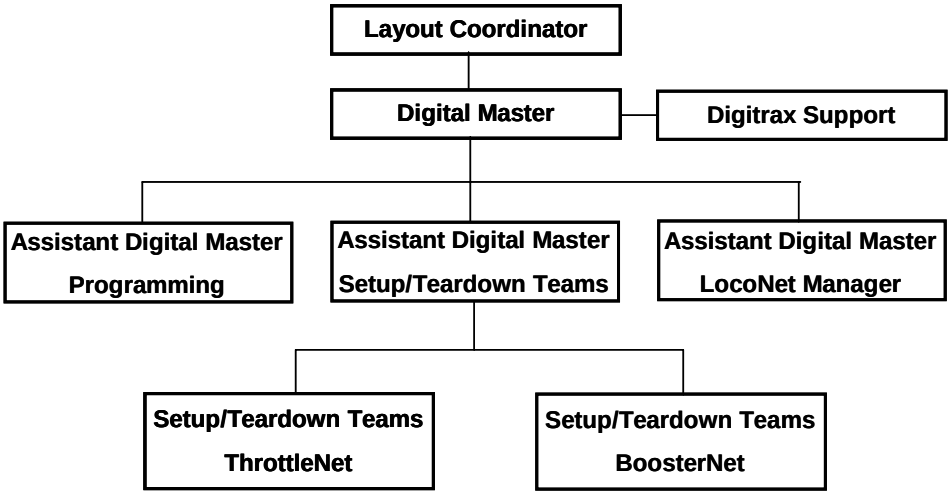
1. Introduction

The NTS 2005 Convention will feature an NTRAK layout with 117 modules, of which about two thirds of the layout will be DCC-controlled. The intent of this document is to specify in detail the DCC system for NTS 2005 such that railroad operations are successful, continuous and reliable throughout the show.

A conservative approach is being taken to ensure a "more than enough" design. The premise is that over-design is preferred to under-design.

2. Digital Staff

A dedicated digital staff will be required to setup, operate and tear down the DCC portion of the NTS 2005 layout. All members of the Digital Staff must be knowledgeable with the details of this document for their area of responsibility. The following diagram shows the organizational structure:



The Digital Master and/or one of the three Assistant Digital Masters will be present during all hours the NTS 2005 NTRAK layout is operating.

People requirements are 8 to 12 people of which 4 will be needed for the entire time and 4 to 8 needed for setup and teardown, as follows:

2.1 Digital Master

The Ntrak organizing committee will appoint a Digital Master who will be responsible for the design, setup, operation, reliability, monitoring and troubleshooting of the DCC part of the NTS 2005 NTRAK layout. The Digital Master will be responsible for appointing Assistant Digital Masters and other digital staff.

No changes will be made to the design, implementation or operational aspects of the DCC layout without the agreement of the Digital Master.

The Digital Master will be responsible to the overall Layout Coordinator.

2.2 Assistant Digital Masters

Three (3) Assistant Digital Masters will be appointed to work with and support the Digital Master so there is always an Assistant Digital Master present during all hours the layout is in operation.

2.3 LocoNet® Manager

One of the Assistant Digital Masters will be assigned the task of LocoNet Manager. The LocoNet Manager will be responsible for coordinating with the Convention layout coordinator to ensure the layout is using it's own radio ID.

2.4 Programming Manager

One of the Assistant Digital Masters will be assigned the task of Programming Manager. The Programming Manager will be responsible for operation and staffing of the programming station(s) that will be set up at the layout.

2.5 Setup/Teardown Teams

One of the Assistant Digital Masters will be assigned the task of managing the Setup/Teardown Teams. A minimum of two (2), but preferably four (4) two-person teams will be required for the installation and test of the DCC system (Boosters, Radio Receivers, Universal Panels, LocoNet cables, etc.). One or two teams will be responsible for the installation and test of ThrottleNet while the other team(s) will be responsible for the installation and test of BoosterNet (see Section 3).

2.6 Technical Support

Support for DCC operations will be provided by Digitrax. In the provision of this support, Digitrax will work with the Digital Master.

2.7 Digital Staff Meeting

There will be an informal meeting of the Digital Staff on the evening of Wednesday, July 6, at a location to be determined. The purpose is to meet each other, socialize, and have a Q&A session. Attendees will also review diagrams showing where all blocks, gaps, Command Stations, Boosters, etc. would be in the layout so these diagrams and others could be given and explained to others during setup, especially other Digital Staff and the clubs responsible for setting up the loops.

A second meeting of the Digital Staff will take place at the layout site at 8:00am as setup begins. This will finalize configurations and ensure the required DCC equipment and materials are in place. A walk around of the layout space will follow.

3. System

The DCC system to be used for NTS 2005 is the Digitrax Digital Command Control system, specifically the Digitrax Chief. The track voltage switch on the Command Station and all Boosters will be set to the "N" Scale position (nominal 12 volts).

A set of printed Digitrax manuals for all Digitrax equipment in use at NTS 2005 will be prepared and located at the Command Station throughout the Convention. Alternatively, a CD-ROM containing copies of all Digitrax manuals in PDF format will be burned and transferred to computers located at the Command Station and Programming Stations all of which will have Adobe Acrobat Reader 7.0 installed.

Except as specified in this document, components from other manufacturer's DCC systems require a specific exception from the DCC master to be connected to the layout. may be permitted connection to the layout. A specific exception is given for decoders, throttle panels, and power managers from other manufacturers provided they conform to all appropriate standards.

Interconnection between most components of the Digitrax system utilizes LocoNet®, a proprietary Digitrax communications network especially designed for this purpose. For most applications a single LocoNet daisy-chained from component-to-component provides the optimum method of interconnection.

Because of the size of the layout at NTS 2005, the electrically noisy environment of the Convention Center and the prime objective of continuous, reliable running of trains the LocoNet at NTS 2005 will be split into separate LocoNets for throttles (called ThrottleNet) and Boosters (called BoosterNet). Universal panels, PM4/PM42 Power Managers and radio receivers will be part of ThrottleNet.

Splitting the LocoNet will reduce potential data corruption when a problem is encountered. For example, a faulty connection on a throttle is plugged into ThrottleNet creating data corruption. BoosterNet will not be affected.

4. Command Station

There will be a total of three dedicated DCS100 and/or DCS200 Command Stations present during the Convention, as shown in the diagram below. In addition to the Active and Backup Command Stations described following, the third can be used for programming, but its main purpose is to provide a second backup should either the Active or Backup Command Station fail or develop problems. Each of these Command Stations must have its own dedicated power supply, and each will be equipped with new internal batteries (CR2032 Lithium Coin Cell) just prior to the start of the Convention.

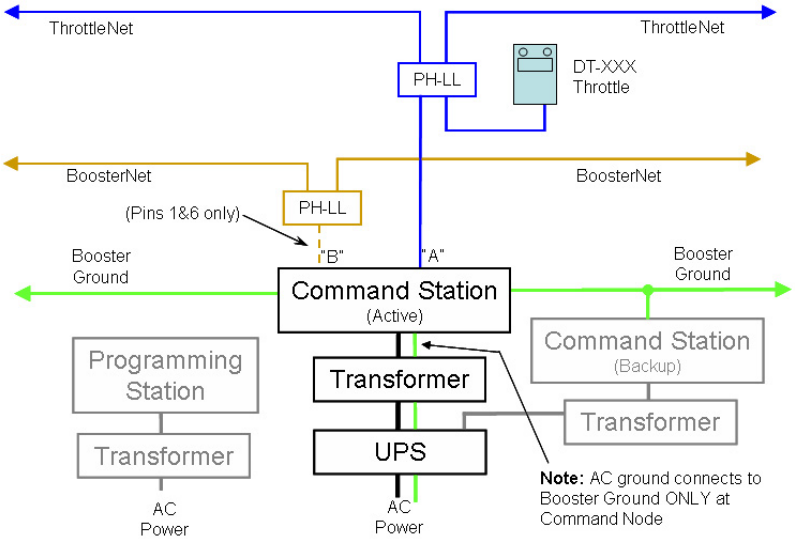
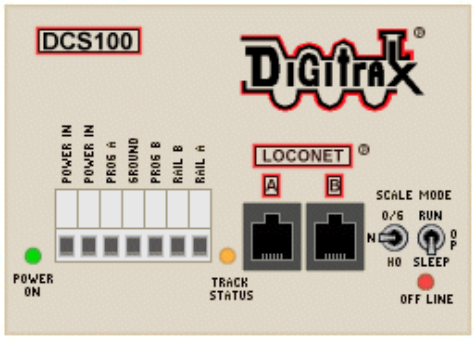


Diagram courtesy of Doug Stuard, NVNTrak

4.1 Active Command Station

KSONS will provide a DCS100 or DCS200 as the Command Station for the DCC system, since 120 addresses are accommodated by these Command Stations. This DCS100 or DCS200 will operate ***only*** as the Command Station. Its Booster section ***will not*** be connected to the track, nor will this Command Station be used for programming. The Command Station will be powered through an Uninterruptible Power Supply (UPS) to isolate it from any noise and interference in the 120VAC electrical power supply.



Digitrax Chief Command Station (DCS100 or DCS200)

Digitrax DT100 Throttle

A dedicated DTxxx throttle with an installed known good 9V battery will be connected to the active Command Station at all times for monitoring and control purposes.

The Command Station LocoNet jacks will be connected to the layout as follows:

Jack A: Split for the dedicated DTxxx throttle and the Throttle Network (ThrottleNet)
Jack B: Booster Network (BoosterNet)

The Command Station Ground terminal will be connected to the electrical ground at its power supply. The Command Station will also be grounded to each Booster through its Ground terminal.

4.2 Backup Command Station

A second DCS100 or DCS200 will be kept in reserve to use as a spare should any problems develop with the active Command Station, or should it be necessary to divide the layout into two sections for troubleshooting problems. This Command Station will be located next to the active Command Station, connected to the UPS, OPSW's set identical to the active Command Station, and maintained in Sleep mode with power on.

4.3 Programming Command Station

A third DCS100 or DCS200 that could be used for minor locomotive decoder programming (see section on Programming) will serve as a second backup Command Station for the layout.

5. Boosters and Power Management

The preferred method of powering the track is through a Power Manager such as the PM42 between the Booster and the track, as shown in the diagram below. The PM42 short circuit trip current will be set as low as practical based on the length of the powered electrical district and the traffic density expected.

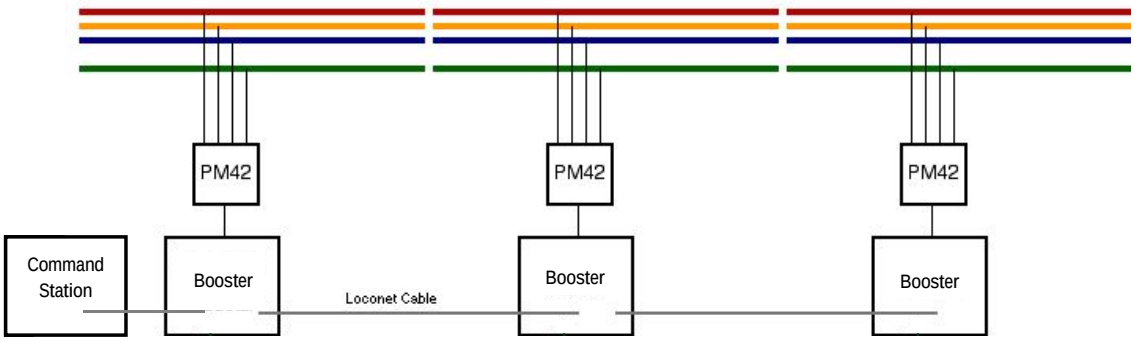
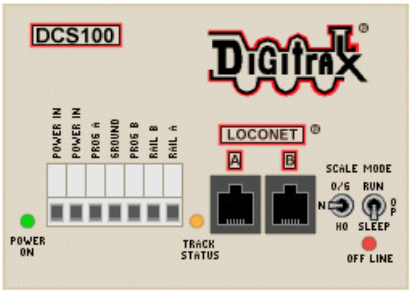


Diagram courtesy of Dayton NTRAK

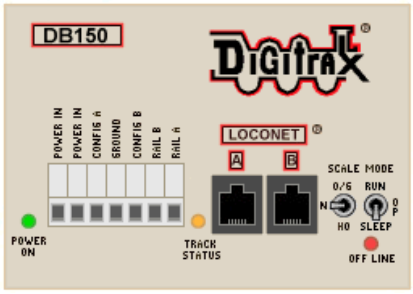
5.1 Boosters

Digitrax Boosters, including the DCS100, DCS200, DB100, DB150 and DB200 are preferred for use on the NTS 2005 NTRAK layout. The Booster track voltage switch will be set to the "N" Scale position (nominal 12 volts).

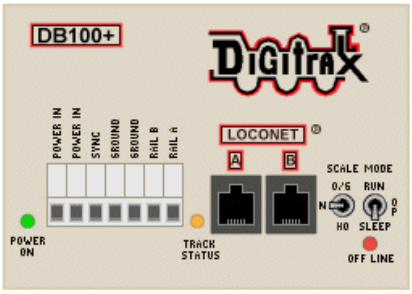
Other boosters may be permitted on a case by case basis.



DCS100 or DCS200



DB150



DB100 or DB200

DCS100 and DCS200 Command Station/Boosters used as a Booster must have new internal batteries (CR2032 Lithium Coin Cell) installed prior to the Convention, and must have the setting of their CVs checked by the Digital Master before installation.

A DCS50 (Zephyr) Command Station, set as a Booster only, may be used to power industrial complexes and/or yards where these are a separate electrical district. Note that the Zephyr throttle will not be usable since the Zephyr will be connected to BoosterNet, which does not have the throttle data lines connected.

A DB150 used as a Booster only must have a wired jumper in place between Config A and Ground.

5.2 Power Management

Insertion of a Power Management device between the output of the Booster and the track is highly recommended for all Boosters and mandatory for DCS200 and DB200 Boosters. The intent is to limit the current to each track block to the maximum extent possible in order to minimize potential incidents of meltdown of locomotives and/or trucks. While the Digitrax PM4/PM42 is the preferred Power Manager, power management devices from Tony's Train Exchange are also permitted.

Based on tests carried out a number of train shows to determine the optimum PM42 setting for the electrical block lengths that will be found at NTS 2005, the PM42 short circuit trip current will be set at 3A.

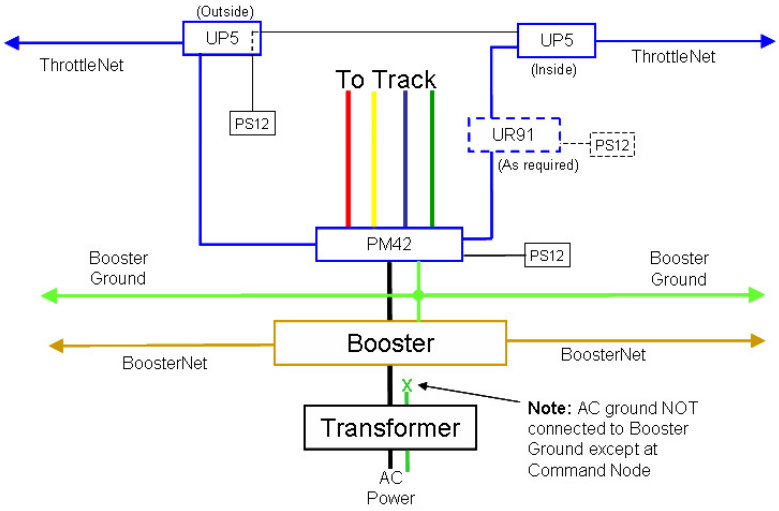


Diagram courtesy of Doug Stuard, NVNTrak

The preferred method of powering, as shown above, is an 8A Booster (DB200) feeding a PM42 with each section set up as short circuit protection. Each section of the PM42 then feeds one NTRAK track (Red, Yellow, Blue, and Green) in the electrical district powered by that Booster. Each PM4/PM42 requires a PS12 power supply.

Each PM4/PM42 Power Manager will be assigned an address and connected to ThrottleNet so its trip current and timing can be remotely programmed at setup and during the Convention as necessary. See also Section 9.

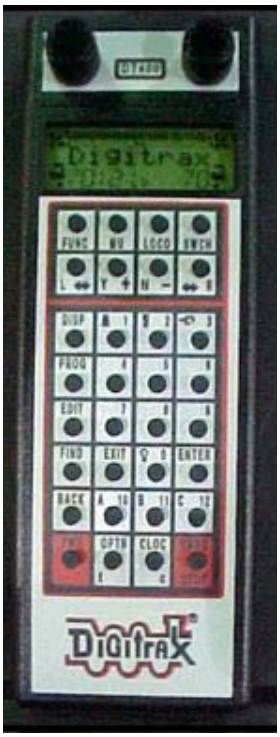
DB100 Boosters and DCS100/DB150 Command Station/Boosters may be used to power individual tracks, with (preferred) or without a Power Manager. Direct track powering with no power manager using a DB200 Booster is not permitted at NTS 2005.

6. Throttles

Acceptable throttles for use on DCC trackage at NTS 2005 are the Digitrax family of wireless radio throttles. These include the UT4R, DT100R, DT300R and DT400R, as shown below. Information on the use of DTx00 throttles is provided in Appendix M and in a separate handout for convention attendees.

DT100R Throttle

DT300R Throttle



DT400R Throttle

UT4R Throttle

Digitrax wired throttles such as the DT100, DT200, DT300, DT400, UT1, UT2, and UT4 may be used for local industrial switching, but not for mainline running. Any such DTxxx and UT4 throttles **must** have a battery installed. UT1 and UT2 throttles must be plugged in only at Digitrax UP3/UP5 Universal Panels that have auxiliary power connected.

All throttles in use on the NTS 2005 layout, except those used by the Digital staff, will have Global Emergency Stop disabled and Local Emergency Stop enabled. Refer to Appendix D for instructions.

7. Programming

The active and backup DCC Command Stations operating the NTS 2005 layout will not be used for the programming of decoder addresses or other CVs. Separate programming systems will be available at the layout for decoder programming. Programming details are provided in Appendix D.

7.1 Address Assignments

Addresses will be carefully managed by the Digital Staff to ensure unique assignments and provide for slot management in the Command Station.

7.1.1 Four-Digit Addresses

Engineers wishing to operate trains on the NTS 2005 Layout will be able to use the 4-digit addresses already programmed into their locomotives if the address(es) are not already in use on the layout. As each engineer marks up for running a train his locomotive addresses will be checked against addresses already in use on the layout. If there is a conflict the locomotive(s) will be re-programmed to vacant address(es).

Using this method of address assignment it is very important that engineers mark off when they complete their run and dispatch their locomotive(s) from the DCC system.

7.1.2 Two-Digit Addresses

Two-digit addresses will be assigned **only** at a NTS 2005 Programming Station by the Digital Staff. Two-digit addresses will be available only to locomotives with decoders not capable of 4-digit addresses, and as Consist Addresses (see Section 7.3).

7.2 Programming Stations

At least one, preferably two, Programming Stations will be provided at NTS 2005 for programming decoders. There are three configurations that may be used for the Programming Stations:

1) A programming track and mainline (operating) track section connected to a DCS100 Command Station and a DTxxx throttle.
2) A programming track and mainline (operating) track section connected to a DCS100 Command Station, in turn connected to a computer running JMRI DecoderPro.
3) A programming track connected to Digitrax PR1 hardware, which is plugged into a computer running PR1 software.

Configurations 2 and/or 3 are preferred for the Programming Stations at NTS 2005. Details are provided in Appendix D. Other DCC systems, if available, can also be used for programming.

7.3 Consisting

Consisting is the combining of two or more locomotive units together so a single throttle can control them. There are three types of consisting possible with the Digitrax system and decoders of recent design (less than 5 years old). As defined elsewhere, slot management of the system is important with up to 50 simultaneous operators expected. Two of the three types of consisting make more efficient use of slots than the third method, which, unfortunately, is the most commonly used.

- This most common method is **Command Station Assisted Consisting (CSAC),** called **UniVersal Consisting** by Digitrax, in which the Command Station sends a packet addressed to each locomotive in the consist for speed and direction as specified in the NMRA standards. Since each locomotive in the consist uses one memory slot in the Command Station, sending these packets adds to data congestion on the rails, and can contribute to lag time between the throttle and the locomotive. CSAC is carried out on the mainline.

- A more effective method is **Basic Consisting** where all locomotives in the consist are programmed to the same address, thus using only a single memory slot. The main disadvantage is the loss of individual control of locomotive functions. Basic Consisting can only be carried out on a programming track.
- The third type of consisting is **Decoder Assisted Consisting (DAC)**, called Advanced Consisting by Digitrax, if supported by the decoders involved, where a 2-digit consist address is programmed into CV19 of the decoder in each locomotive in the consist. DAC can be set up on either the programming track or the mainline.

  Only Digitrax decoders with EPF can be used with DAC; these include all DNxxFX, DN14x, DN16x and DZ143 decoders. Decoders from Lenz, TCS, NCE and others that support DAC may be used. Decoders without EPF functions must use Basic Consisting.

  With DAC either the decoder must be Status Edited so the status number ends in 4 or 7, or the Command Station OPSW #21, 22 and 23 must be set to default to a status number of 7. At NTS 2005 the Command Station OPSWs will be set to default to this status.

In order to conserve memory slots in the Command Station CSAC (Command Station Assisted Consisting) will NOT be used at NTS 2005. Registrants will have the choice of Basic Consisting or Decoder Assisted Consisting (DAC) for the locomotives they will operate on the layout, since either requires only a single memory slot per consist.

7.4 Operations Mode Programming

Operations Mode Programming allows the programming of CV's in locomotives equipped with Extended Packet Format decoders while they are on the main line. ***Because of the ability for one operator to accidentally program a different locomotive than intended, and thus create potential problems with the continuous reliable operation of the DCC tracks, Operations Mode Programming is prohibited at NTS 2005.***

7.5 Throttle Emergency Stop

When operators come to the Programming Stations at NTS 2005 to have their locomotive addresses checked/programmed, their throttles will also be checked and set so that Local Emergency Stop only is enabled. Refer to Appendix D.

8. Track Power Distribution

The tracks of DCC-powered NTRAK layouts can be wired using two different methods of power distribution — Centralized and Distributed. Distributed Power Distribution is more flexible for differing layout configurations than Centralized Power Distribution. Both types of power distribution will be used at NTS 2005.

In either method it is mandatory that the Rail A output from the Booster/PM42 be connected to the wide pin of the Cinch-Jones connectors, which in turn is connected to the front rail of each track, per NTRAK electrical standards.

8.1 Centralized Power Distribution

With Centralized Power Distribution, there is normally a power case/cabinet that is centrally located in the layout loop, containing a Command Station (which will be used as a Booster at NTS 2005) and Boosters. The output of the Boosters are connected to the NTRAK tracks by an "octopus" of 12-gauge or larger power cables feeding the various modules in that loop. The Boosters are connected back to the Command Station by BoosterNet.

8.2 Distributed Power Distribution

With Distributed Power Distribution, several Boosters are located around the layout to define a number of electrical districts of length such that the voltage drop at the end of the district is not more than 0.5 volts. In all cases the Booster will be located in the geographic center of the electrical district. The Boosters are connected back to the Command Station by BoosterNet, daisy chained through the various Boosters.

The length of the electrical districts within a layout loop will be equalized as much as possible; however, no electrical district can be longer than 80 feet.

The output of the Booster/PM4 will be connected to the track bus via 12-gauge (14-gauge minimum) wire with dual Cinch-Jones connectors.

9. Throttle LocoNet Network and Universal Panels

The Throttle LocoNet Network (called ThottleNet) connects the Command Station to all Universal Panels, UR91 Radio Receivers, other throttle plug-in points and other devices requiring LocoNet connections (such as PM4/PM42 Power Managers), except Boosters. Boosters will not be connected to ThrottleNet (see next section). ThrottleNet will be daisy-chained through the various Universal Panels and UR91 Receivers. As required 4-way LocoNet connectors (such as Loy's Toys PH-LL LocoNetLink Connector) may be used along the spine of the layout and as needed throughout ThrottleNet to split the ThrottleNet for more efficient wiring. This is shown below graphically.

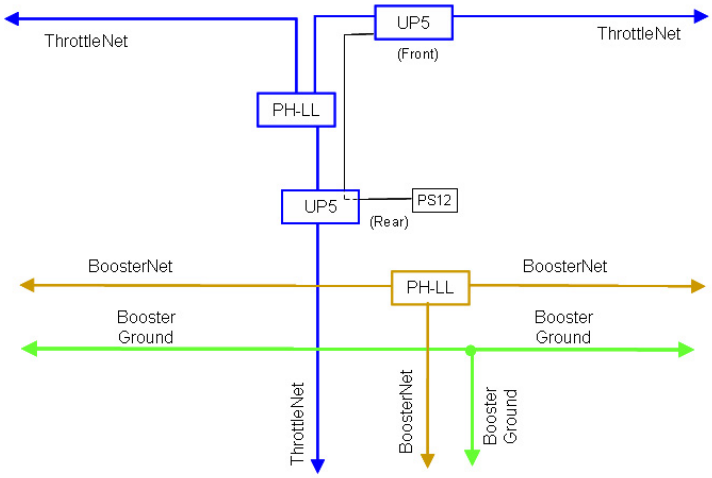


Diagram courtesy of Doug Stuard, NVNTrak

Universal Panels with/without connected wall-wart power supplies will be provisioned throughout the layout as follows:

- Universal Panels will be mounted in the center of the diagonal on all corner modules, both inside and outside the layout.
- Universal Panels will be mounted along the outside and inside of the layout at approximately 20-foot intervals. For narrow loops where the interior is 8' or less wide, UPs need only be located along the inside of one side of the loop.
- Modules equipped with throttle plug-in devices will be included in ThrottleNet and in the distance calculations, once tested for proper operation of the network in the module. Such plug-ins will be covered over with tape and bypassed if they do not test fully operational. Throttle plug-in devices need not be panels manufactured by Digitrax.

The 6-wire cabling for ThrottleNet will be suspended from the module as it is run throughout the layout. ThrottleNet cable must not be allowed to hang down where it may be damaged by activity under the modules (such as box storage, entry/exit from the layout, etc.), especially in the vicinity of the RJ plugs.

Should the ThrottleNet need to be run on the floor, it must be securely fastened to the floor with suitable tape and not be twisted underneath the tape.

The 6-wire cable for ThrottleNet will be **white** or **silver**, or have white tape applied at each RJ12 plug.

The specific location and quantities of Universal Panels and ThrottleNet routing will be detailed on the final layout drawings available at the Convention.

Special Note for Digitrax UP3/UP5 Universal Panels
Digitrax UP3 and UP5 Universal Panels serve multiple purposes but they ***do not*** add power to the LocoNet, only to the front panel (and side panel in the UP5) RJ jacks for whatever is plugged into them. Thus they will help reduce the load on the LocoNet when batteryless throttles are used and for battery throttles when the battery voltage is low. They have 3 possible power sources for the UP3/UP5 and they can be used singly, or all together.

First there is the LocoNet power. If the UP3/UP5 is connected only to the LocoNet, then it will only have available LocoNet power. As such a UP3/UP5 is the same as any other dual RJ connector, and all power drawn will be from LocoNet.

Second there are also track power connectors. When these are connected to local track power they provide power to the front jacks (and side jack on the UP5). There is also a bi-colored LED on the UP3/UP5 that will now show the status of the local track power. This way as long as there is track power, any throttle connected to either of the front jacks (or the side jack on the UP5), will use the track power instead of LocoNet power.

Third, there is a 2mm DC power jack. Connect a 12–15VDC power source here; a Digitrax PS12 or other 12VDC 300mA wall wart works very well for this. Also located in the rear back center is a solder hole. These solder holes can be connected together from one UP3/UP5 to another, and this will allow the 12VDC to power up to a total of 10 UP3/UP5 panels in a daisy chain fashion. Only this single conductor for the daisy chain is needed because the LocoNet common will supply the return path. If the 12VDC power is connected and always on, even with the systems powered down, the UP3/UP5 can be used as a battery saver for battery throttles as long as they are plugged into the UP3/UP5. At NTS 2005 only the wall wart supplies will be used, except where permanently installed UP3/UP5s on modules are wired together.

10. Booster LocoNet Network and Grounding

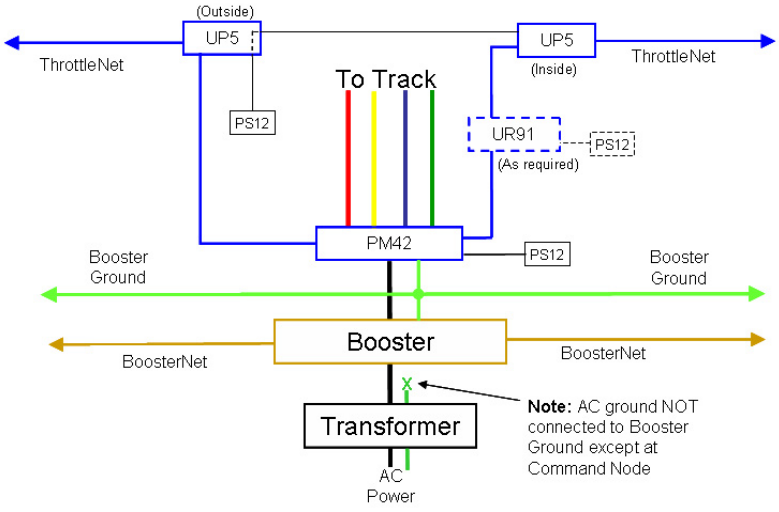
The Booster LocoNet Network (called BoosterNet) connects the Command Station to all Boosters and Command Stations that are configured as Boosters, as shown on the next page. Throttles, Radio receivers, Universal Panels, Power Managers or other devices will not be connected to BoosterNet. BoosterNet will be daisy-chained through the various Boosters. As required 4-way LocoNet connectors (such as Loy's Toys PH-LL LocoNetLink Connector) may be used along the spine of the layout and as needed throughout BoosterNet to split the BoosterNet for more efficient wiring.

The 6-wire cabling for BoosterNet will be suspended from the module as it is run throughout the layout. BoosterNet cable must not be allowed to hang down where it may be damaged by activity under the modules (such as box storage, entry/exit from the layout, etc.), especially in the vicinity of the RJ plugs. This is shown graphically above.

Should the BoosterNet need to be run on the floor, it must be securely fastened to the floor with suitable tape and not be twisted underneath the tape.

The 6-wire cabling for BoosterNet will be **black** in color, or have black tape applied at each RJ12 plug.

The specific location and quantities of Boosters and BoosterNet routing will be detailed on the final layout drawings available at the Convention.



In addition to the 6-wire BoosterNet cabling, Boosters will be interconnected via a 12-gauge (preferable, 14-gauge minimum) ground wire connected to the Ground terminal on each Booster and to the Ground terminal on the Command Station. Boosters will not be connected to electrical ground at their own power supply; any such connections will be removed.

11. Radio Receivers

Digitrax UR91 Radio receivers will be used to receive transmissions from Digitrax wireless throttles. All UR91 receivers will be mounted on a “radio tower” at least 3 feet above the top of the layout’s skyboards. All UR91 receivers will be powered by PS12 or equivalent 12V wall-wart power supplies. Powering of the UR91s by track power will not be permitted, as a shutdown of track power for any reason will remove power from the UR91. UR91 radio receivers will be connected to ThrottleNet.

A minimum of one UR91 radio receiver, tower mounted, will be placed at a central location in each layout loop in the DCC portion of the layout.

The specific location and quantities of Radio Receivers will be detailed on the final layout drawings available at the Convention.

12. Other LocoNet DCC Devices

A variety of products have been developed to work with the Digitrax system LocoNet. These include stationary decoders, signals, detection units and fast clocks. Use of any of these systems MUST be pre-approved by the Digital Master. Such approval will only be given if the use of the product(s) is verified to not cause any interference with the prime objective of the Convention layout — the continuous and reliable operation of trains.

12.1 Stationary Decoders

Some modules that will be in the NTS 2005 layout will include Stationary Decoders, such as the Digitrax DS54, for the control of turnouts. Multiple groups using DS54s, etc., must coordinate addresses with the Digital Master.

12.2 Signals

Digitrax has recently released the SE8C Signal Decoder, which requires the use of a computer and compatible software for full feature operation. Digitrax might bring modules featuring a working signaling system to NTS 2005 for demonstration purposes.

Pending further study of the SE8C system, only the Digitrax modules will be permitted in the layout.

12.3 Detection Units

The Digital Staff will verify that the use of any detection units, whether Digitrax or other manufacturer, does not interfere with normal layout operations. Detection units found to create problems will be bypassed.

12.4 Other Devices

Except for devices covered in Sections 12.1 and 12.2 for which connection to the system is authorized, no other devices may be connected to ThrottleNet.

13. Setup and Test

A major challenge will be to install, complete and test the various DCC components, cables, etc., that will make up the DCC system, and to do this in the time available after the layout is sufficiently assembled and before operations are scheduled to start.

Setting up the Command Station, Boosters, Radio Receivers, Universal Panels and LocoNets will require close coordination and communications among several people. The Digital Team members involved will be equipped with Family Radio Service (FRS) radios set to a unique channel assigned for this purpose.

Except for locomotives used by the Digital Staff for testing purposes, there should be no locomotives on any of the DCC-powered tracks until setup has been completed and the system activated. No DCC trains should be run until the whole system is complete, except for track cleaning or other trains as authorized by the Digital Master. Locomotives used by the Digital Staff for testing purposes are exempt from any address programming restrictions of Section 6, but must be programmed to 4-digit addresses greater than 8,000.

As soon as the layout spine is set up, wired and tested for DCC, the DCC system will be activated. Each layout loop can then be activated as it is completed, wired and tested.

13.1 Setup

The Red and Blue line will be DCC all the time. The Yellow line will be DC and will be divided into no more than 32 blocks and will use a control panel and a dispatcher. The Mountain line will be either DCC or DC depending on the use of said line and that will be controlled at the Nashville Ntrak Trainmaster Panel. Switching from DCC to DC and vice versa will only be done by one of the DCC crew.

13.1.1 Setup Proceedings

We need to lock down the specific times and locations for the below information. The first step of module set up will be for NVNTrak to place marks on the floor for the whole layout. NVNTrak will do this the day before layout setup (August 4, 2004), if possible. At 8:00am on Thursday, August 5, 2004 setup of the spine modules will begin. Individual loop setup will begin as modules become available and inspected.

13.1.2 Module Inspection

All modules destined for the NTRAK layout at NTS 2005 must meet the NTRAK Specifications, as a minimum. It will be the responsibility of Clubs with recognized Certification procedures to inspect and certify the modules their Members are bringing to NTS 2005. Will we do the following? NVNTrak has developed certification requirements and a checklist, and "Module Certified" stickers obtained for this purpose. All other modules will receive a cursory visual inspection on arrival, and before they are assembled into the layout. The procedure for this module inspection is defined in Appendix A.

Any deficiencies found will be documented for a more detailed inspection once the problem(s) is remedied by the owner and installed in the layout, but before operations begin. If the module clearly does not meet basic NTRAK, Bend Track, TwinTrak or oNeTRAK standards it will not be permitted in the layout.

13.1.3 Section Isolation

Electrical district boundaries will be marked on layout module diagrams that will be provided to all clubs showing where the block gaps should be located. The Digital Staff will also check to ensure these block gaps are installed at the specified locations.

13.1.4 LocoNet Management

LocoNet Management in the assignment of ID numbers will be assigned by the NTS staff.

13.2 Command Station Setup

If the Command Station internal battery has not been replaced within the week previous to the Convention, begin by replacing this battery (Type CR2032 Lithium Coin Cell).

The active and backup Command Stations will be set on a table located at a central location on the spine of the DCC layout. The power supplies of both Command Stations will be plugged into an Uninterruptible Power Supply (UPS), which in turn will be connected to the 120VAC supply to the layout. A DT100-type throttle, with a known good 9V battery installed, will be connected to each Command Station at all times for monitoring and control purposes. The computer used to monitor the Command Station will also be located on this table and plugged into the UPS.

Once the Command Stations are installed, they will be powered up and a total system reset (CV39=c) carried out. The procedure for a total system reset is provided in Appendix C, Section C.1. After the total system reset is complete, the Command Station will be programmed with the various CVs specified for normal operations as defined in Appendix C, Section C.2.

13.3 Manufacturing and Testing LocoNet Cables

LocoNet is a proprietary Digitrax communications network especially designed for model railroad operation to provide rapid response even when many throttles and other devices are connected to the network — the communications bus. LocoNet is a peer-to-peer Local Area Network (LAN) and is based on the Ethernet CSMA/CD (Carrier Sense Multiple Access with Collision Detection) Local Area Network protocol, the most universal worldwide hookup standard for computer networks. LocoNet has been optimized for use with Digitrax systems to allow 100% traffic capacity with less than 0.33% collision rate.

LocoNet is the method of interconnecting all parts of a Digitrax DCC system, such as the Command Station, Boosters, Radio and I/R Receivers, Throttles, Universal Panels, and Detectors. It does not connect to Mobile or Stationary Decoders, which are "connected" via the track.

The LocoNet design allows very simple free form wiring, which makes adding extra devices and features simple.

LocoNet cables utilize 6-wire telephone/data-type flat or round wire with RJ12 plugs on each end. Using flat cable they can be easily manufactured to meet the specific needs of the NTS 2005 layout. The actual wiring of the LocoNet is a balanced RF Quad configuration, which is what allows the free-form non-terminated architecture.

This information needed to manufacture, operate, maintain and repair LocoNet cables is provided in Appendix E.

Note: The use of standard Ethernet cable for LocoNet applications is prohibited. The voltages do not match, the pinout does not match, the cabling is different, the RJ plug is different, and the protocols are different.

13.4 ThrottleNet Setup

ThrottleNet will consist of two main branches, each extending outwards in opposite directions from the Command Station. Each branch will be subdivided and daisy-chained throughout the layout to efficiently connect to all Universal Panels, other throttle connection jacks and UR91 radio receivers.

A specific ThrottleNet routing plan will be detailed on the final layout drawings.

Existing white/silver LocoNet cabling can be used where the length matches what is needed. Otherwise new cable will be constructed using a spool of white/silver 6-wire flat cable, an appropriate crimping tool(s) and RJ12 plugs. In either case, each cable will be checked for integrity using a network cable tester.

Refer to Appendix F for ThrottleNet details and setup procedures.

13.5 BoosterNet Setup

BoosterNet will consist of two main branches, each extending outwards in opposite directions from the Command Station. Each branch will be subdivided and daisy-chained throughout the layout to efficiently connect to all Boosters.

A specific BoosterNet routing plan will be detailed on the final layout drawings.

Existing black LocoNet cabling can be used where the length matches what is needed. Otherwise new cable will be constructed using a spool of black 6-wire flat cable, an appropriate crimping tool(s) and RJ12 plugs. In either case, each cable will be checked for integrity using a network cable tester.

Refer to Appendix G for BoosterNet details and setup procedures.

14. Operations

Once set up is complete the layout enters operational mode, which must be sustained until the Convention is over and tear down begins.

14.1 Power-Up Sequence

To ensure proper operation, the power up sequence is to power the Command Station before any of the Boosters. Refer to Appendix I for the Power Up procedure.

14.2 Layout Operations

Like a prototype railroad, certain activities must be carried out on a model railroad to ensure continuous reliable and safe operation. These include activities relating to the track structure, rolling stock and locomotives, and the control equipment.

14.2.1 Track and Wheel Cleaning

Clean track, clean turnout points and clean wheels are fundamental to reliable operation. Refer to Appendix J.

14.2.2 Command Station

It is very important that analog locomotive operations be turned off (OPSW#20 = c) and the speed of address 00 set to 00 during normal layout operations. The stretched pulses generated when using analog address 00 consume system bandwidth rapidly as the speed of address 00 is increased.

The pulse width of normal DCC pulses (OPSW#20 = c, address 00 speed=00) is 95μS. Analog operations allow this 95μS to be stretched up to 12000μS, which means that fewer packets can be sent per second, thus cutting bandwidth and slowing response to throttle commands.

14.2.3 Radio Throttles

By design radio throttles act slightly different from normal tethered throttles. They do not send commands until the throttle is inactive. This means that when the engineer is changing speed, direction or setting functions, etc., the throttle does not transmit the commands to the radio receiver until the engineer stops making changes. This gives the effects of delays, but what it is doing is keeping radio data to a minimum to allow maximum bandwidth over the airwaves.

User education is necessary here. If the user learns to not be constantly changing throttle speed, etc. but do it either in small steps, or all at once to reach a relax state on the throttles he will hardly notice this effect. On the other hand, the more active the user is with the throttle, the more pronounced it becomes. Also, the human body can act as a shield to the radio signals. Thus the user should keep the throttle about 10 inches out from his/her body and try not to get his/her body between the throttle and a radio receiver.

Additional radio bandwidth can be obtained, if necessary, by turning off ballistic tracking on all throttles and using the Up and Down buttons to change speed instead of the throttle knobs.

14.2.4 LocoNet Bus Speed

The LocoNet used in the Digitrax system is similar to Ethernet in a computer system, but its speed is 16.6Kbps. With LocoNet, even if all memory slots are active, every known LocoNet device connected and every LocoNet message in use, the actual LocoNet would be at less than 30% capacity. With 100% traffic, there should only be about a 1 in 300 collision rate. The capacity of the LocoNet bus should not be an issue for the NTS 2005 layout.

14.3 System Reset

In the event major control problems are encountered such as an all slots full condition or other corruption of the Command Station slot memory, and the releasing of slots using the JMRI LocoTools Slot Monitor does not clear the problem, it may be necessary to perform a partial or full system reset. This process should only take about one minute, but it requires shutting down the DCC tracks. After the reset is performed all locomotive addresses including any UniVersal consists may need to be reprogrammed into the system. The on-duty Digital Master will advise all operators prior to a system reset, and then advise operators what actions they need to take (re-establish UniVersal consists, etc.) after the reset is complete. See Appendix I for the process.

14.4 System Shut Down

System Shut Down is a controlled process to prevent runaways or other conditions with trains on the DCC-controlled tracks. Refer to Appendix I for the Shut Down Process.

15. Monitoring, Measuring and Troubleshooting

To ensure the continuous and reliable operation of trains, the DCC system will be monitored on a continuous basis throughout the Convention. A computer with appropriate software located next to the Command Station will be connected to the system and used for this purpose. Also, there may be occasion where it will be necessary to measure voltage and/or current on the tracks and track power wiring. This requires a true RMS AC meter.

In addition, should something go wrong, procedures need to be in place to handle any problems and ensure a speedy resolution.

15.1 System Monitoring

JMRI: A Java Model Railroad Interface will be used to monitor and control the Digitrax DCC system being utilized for NTS 2005. As well as the DecoderPro tool for programming decoders (see Section 7 above), JMRI has developed a library of LocoNet-specific tools (LocoTools) that interface to specific hardware of the DCC system. These will be used to monitor the Digitrax Chief Command Station slots. Refer to Appendix K for details.

The computer to be used will be a Windows-based laptop computer running Windows 98, ME, 2000 or XP. Interface to LocoNet will be via the Digitrax MS-100 interface or the LocoBuffer interface. LocoBuffer is the preferred interface.

15.2 Measuring and Monitoring Voltage and Current

Since the DCC waveform is square-wave alternating current, and not DC or sine-wave AC, a true RMS meter is required to accurately read DCC voltage and current. The meter to be used at NTS 2005 for this purpose is the RRampMeter, designed by Tony's Train Exchange. The RRampMeter will be used for measuring voltage drop and loss, and for monitoring voltage and current as necessary on the layout track and track power wiring. Refer to Appendix K for details.

15.3 Troubleshooting

In the event problems are encountered during the Convention, procedures must be in place to test the problem and related equipment, then rectify the problem and/or replace the faulty equipment. Details are provided in Appendix L.

Problems should be reported to the on-duty Digital Master, who will either resolve or assign Digital Team staff to resolve.

16. Tear Down

When NTS 2005 ends at 4:00pm on Sunday, July 10, 2005, operations on the layout must be shut down and the layout disassembled, and modules packed up and removed from the site.

At 4:00 pm track power will be turned off at the Command Station, but the Command Station will remain powered until all Boosters are powered off. The DCC Setup/Teardown teams will act expeditiously to disconnect all components of the DCC system — Boosters, PM4s, UPs, UR91s, PS12s, ThrottleNet and BoosterNet cabling, and associated hardware — and remove them from the layout.

As DCC components are disconnected and removed from the layout they will be taken to a central marshalling point. Once all components have been collected they will be sorted by owner. When this is complete owners may claim their property.

17. Equipment and Material List

The following is a list of equipment and supplies that must be on hand for NTS 2005 2004 by the start of setup. The DCC committee will be responsible for ensuring the provision of these items, but not necessarily for providing them.

The DCC committee will provide a secure marshalling point at the layout site for the assembly of equipment, material and tools. Only the Digital Staff will have access to this equipment.

17.1 Equipment

The following DCC equipment will be needed during NTS 2005. Specific quantities will be specified as soon as possible in a separate document.

Digitrax Chief Command Stations — Qty 3 (Active/Backup/Programming) — DCS100 or DCS200

Digitrax Boosters — the following are acceptable:

- DCS100 (in Booster only mode)
- DCS200 (in Booster only mode)
- DB100
- DB150 (in Booster only mode)
- DB200
- DCS50 (in Booster only mode)

Uninterruptible Power Supply (UPS)

Digitrax Radio Receivers — UR91 + PS12 wall-wart supply
Digitrax Power Managers — PM4/PM42 + PS12 wall-wart supply
Digitrax Universal Panels + Power — UP3/UP5 + PS12 wall-wart supply

Loy's Toys PH-LL – LocoNet 4-way Connector
Loy's Toys PH-UP – LocoNet Universal Panel
Digitrax LocoNet Tester — LT1
Digitrax PR1 Programmer
Digitrax MS100 Computer Interface
6-wire Cable Tester
All DCC equipment listed above should be clearly marked with the name of its owner, so it can be returned to the correct party at the end of the Convention.

Personal Computers (two or three) running Windows Operating System
LocoBuffer Computer Interface
JMRI DecoderPro and LocoTools software
Digitrax PR1 Programming Software and Power Supply

17.2 Material

1,000 Feet 6-wire Flat Telephone Cable, Color 1 (ThrottleNet) — white/silver
1,000 Feet 6-wire Flat Telephone Cable, Color 2 (BoosterNet) — black
White and/or black tape to ID cables if only one color 6-wire cable purchased
200 RJ12 Plugs for above cable
Polarity Change Cables
Ties to fasten LocoNet cables under modules. Suitable ties are:
- Plastic wire tires
- Twist Ties (e.g. for sandwich bags, garbage bags)
- Plastic twist ties

Cinch-Jones Connectors
200 Feet 12-gauge zip wire (outdoor low-voltage wire)
200 Feet 16-gauge zip wire
Radio Towers
Power Strips
CR2032 Lithium Coin Cells (Qty 5)
No. 4 x ½" round-head wood screws for fastening Universal Panels to modules. *(Module owners will be consulted prior to affixing of Universal Panels, and alternate methods will be made available on a case-by-case basis.)*
Elastic Bands
Red Map Tacks
Tags for attaching to Cinch-Jones connectors.
Atlas or Peco Insulated Rail Joiners
Clear Nail Polish
Duct Tape

17.3 Miscellaneous Tools

Diagonal Wire Cutters
Wire Stripper
Long-Nosed Pliers
Screwdrivers — Flat and Phillips — Miscellaneous Sizes
Soldering Irons (15W, 25W) and solder
Network Cable Tester
6-Wire Crimping Tool

Appendix A
Module Inspection

Since the same problems with modules and larger layouts that cause bottlenecks and train backups appear to surface year after year, all modules destined for the NTRAK layout at NTS 2005 must meet the NTRAK Mechanical and Electrical Specifications, as a minimum. It will be the responsibility of Clubs with recognized Certification procedures to inspect and certify the modules their Members are bringing to NTS 2005.

Modules pre-certified will have a Certification Sticker applied before coming to NTS. Modules without the Certification Sticker will receive a cursory visual inspection on arrival, and before they are assembled into the layout. Any deficiencies found will be documented for a more detailed inspection once the problem(s) is remedied by the owner and installed in the layout, but before operations begin. If the module clearly does not meet basic NTRAK, Bend Track or oNeTRAK standards it may be relegated to a branch section off the main layout depending on the inspectors' recommendation.

The objective of certification and inspection of modules is to increase reliability of the entire layout and improve enjoyment for spectators and crews alike.

A.1 Pre-Certification Inspection

Clubs with recognized Certification procedures should carry out the following checks on all modules that will be in the NTS 2005 NTRAK layout:

A.1.1 Track Inspection

Any shortcomings found should be correct prior to applying the certification sticker.

Inspection Train — Run a short inspection train with the following consist:

- 2 or more long 6-axle locomotives (SD90) coupled together with body-mounted couplers
- a PA-1 locomotive (long 6-axle wheelbase truck)
- several long (86') cars coupled together

Ensure these locomotives and cars track easily without derailing around all 18" (blue) and 24" curves, reverse curves and crossovers. Pay particular attention to "S" curves that need at least an 8" straight section between the curves for a smooth transition.

Car Clearance — Include in the inspection train an 86' "clearance car" with a profile form 1.75" above the rail to test clearances to NTRAK standards as well as to clear all possible double stack loads. The profile form should also have appropriate side profiles to simulate the wide low pressure cylinders on a Y6b articulated locomotive.

Flange Clearance — Include in the inspection train some cars with Micro-Trains standard (pizza cutter) wheels and some with Micro-trains lo-profile wheels. Watch for cars bouncing that may indicate track out of gauge, ballast on the track or in flangeways, attempts to pick turnouts or that derail.

Turnouts — Check that crossovers between Red–Yellow-Blue are Peco long turnouts. Check that all turnouts have positive operating controls. Repair, replace or spike turnouts as necessary. Restrictions on long locomotive and cars may be needed where the curved part of medium or short turnouts are used, particularly in crossovers.

Track — All track must be Code 80 at the ends of the module. Sections of Micro-Engineering or Peco Code 55 track are acceptable, but Atlas Code 55 *is prohibited* due to interference of the spikes with wheels. There should be no damaged or kinky rails.

Track Alignment — Ensure the rails at the end of modules are level and bent up due to warped roadbed or plywood. Ensure the module ends are flat and square with no overhanging plywood top. Check that track spacing is 1.5" ± 1/16".

A.1.2 Electrical Inspection

Any shortcomings found should be correct prior to applying the certification sticker.

Continuity — To check track continuity quickly operate a singe 4-axle diesel locomotive without a flywheel along all tracks and crossovers, and check for dead sections in turnouts and connector tracks, and dirty track. This locomotive should run slowly over turnouts and suspect areas.

Wire Size — Ensure all Red-Yellow-Blue bus wires are 18 gauge or heavier from one Cinch Jones connector to the Cinch Jones connector at the other end of the module. Ensure the presence of the White Wire and that it is 16 gauge or heavier. Ensure presence of the 120VAC power strip.

Junctions and Inside Corners — Check that all wiring and connectors are properly reversed where required. Improper plug wiring can damage train controls.

Yard Controls — Ensure the train controls in yards have the capability to disconnect from the power of the Red-Yellow-Blue community tracks.

Isolation of Rails — Ensure all connectors and rails are isolated from all other rails; this can be checked using an ohmmeter.

Cinch Jones Connectors — Ensure all Cinch Jones connectors are properly color coded and the contacts are clean. To clean apply Conducta-Lube or CRC Contact Cleaner to the contacts and push plugs in and out several times.

Voltage Drop — Observe trains carefully to see if they slow in one or more areas on the module. Use a digital meter (RRampMeter) to measure voltage and check for loose connections by wiggling the Cinch Jones connectors and track feeder wires. Repair or replace as necessary.

Test Under Load — For troubleshooting low voltage conditions use a RRampMeter with a No. 1156 automotive bulb connected to the output and a DCC input to the module. The No. 1156 draws 2.5A, which will allow determining accurate voltage, drop across a module. Target voltage drop per module is 0.1 volt or less.

A.2 On Site Inspection

Modules without a certification sticker will be tested on arrival at the Convention. Following are the items to be checked during this initial module inspection:

- Check for bent or damaged rails of community tracks, especially at the module ends. Make note of any damage for repair by owner.
- Check for proper wire size (#18 or larger) with the male Cinch-Jones plugs on the right end. Modules with telephone-type wiring will not be permitted in the layout, except for short rail feeders.
- Check for correct color-coding on the Cinch-Jones connectors. Apply correct colored tape where required.
- Check the connector pins on the Cinch-Jones plugs for cleanliness. Wire brush as necessary and apply Conducta-Lube or TV-Tuner Cleaner.
- If the module has chassis-mount female Cinch-Jones sockets check solder connections to them closely when moving wires around. Check for wear and looseness of the contact pins. If one or both feel loose add a tag and conduct a simple voltage drop test using a MRC 501 and a 10-ohm resistor. Replace socket or jump socket as necessary.
- Check terminal blocks for loose or disconnected wires.
- Check for presence of the White line (if we decide to require it) and the 120VAC line.

An “OK” sticker will be applied to modules passing all the above items or notes made of defects on a 3” x 5” card for later follow-up.

Appendix B
LocoNet Management

There will be several layouts using the Digitrax DCC system to operate at NTS 2005. Each of these layouts must be assigned a separate LocoNet ID so they will not interfere with each other. A maximum of eight (8) LocoNet IDs are available with ID=0 being the default.

The LocoNet Manager will assign LocoNet IDs to the various layouts either before the Convention or as the layouts "report in." The Main NTRAK Layout will be assigned LocoNet ID=7. Other layouts will be assigned LocoNet IDs in descending order, with ID=0 being the last assigned.

LocoNet ID	Layout
7	Main NTRAK Layout
6	
5	
4	
3	
2	
1	
0	

In the event there are more than 8 Digitrax-operated layouts at the Convention, LocoNet IDs may need to be shared. This will be done based on size (small can be shared) and geographic diversity (distance between nearest UR91s).

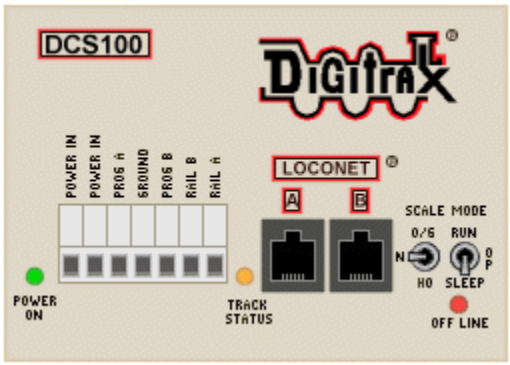
Following is the procedure to set the LocoNet ID:

DT100/DT100R Throttle	DT300/DT300R Throttle	DT400/DT400R Throttle
1. Disconnect the DT100/R from LocoNet. 2. Press and hold MODE/DISP on the DT100/R and plug back into LocoNet. Release MODE/DISP after plugging in the throttle. 3. The DT100/R will display current LocoNet ID "lr:0n" or "rA:0n," where "n" is current LocoNet ID. Use R throttle knob to change the ID, which can be 0 to 7. 4. Press SEL/SET to set the system to new LocoNet ID. 5. The DT100/R used to change the ID will automatically log on to new LocoNet ID.	1. Disconnect the DT300/R from LocoNet. 2. Press and hold MODE on the DT300/R and plug back into LocoNet. Release MODE after plugging in the throttle. 3. The DT300/R will display current LocoNet ID "lr:0n" or "rA:0n," where "n" is current LocoNet ID. Use either throttle knob to change the ID, which can be 0 to 7. 4. Press SEL to set the system to the new LocoNet ID. 5. The DT300/R used to change the ID will automatically log on to new LocoNet ID.	1. Disconnect DT400/R from LocoNet. 2. Press and hold EDIT on the DT400/R and plug back into LocoNet. Release EDIT after plugging in the throttle. 3. The DT400/R will display E1 in Mode Indicator and current LocoNet ID "lr:0n" or "rA:0n," where "n" is the current LocoNet ID. Use R throttle knob to change the ID, which can be 0 to 7. 4. Press ENTER to set the system to the new LocoNet ID. 5. The DT400/R used to change the ID will automatically log on to new LocoNet ID.
Unplug and reconnect any other DT series throttles that will be used on this system so they can log on to the new LocoNet ID number and be able to operate on the system. If a new UR91 is added to the system the IDs must be re-synchronized in all the UR91s using this procedure.		

From time-to-time during the Convention, the LocoNet Manager will monitor each layout to ensure they are actually using the ID assigned. This is done by plugging in a DTxxxR throttle and reading the number in the right side of the display.

Appendix C
Command Station Configuration and Operation

The Command Station complex is described in Section 4. This section describes the electrical configuration and operation for the Command Station. The Digitrax DCS100 will be used as the Command Station, both active and backup, for NTS 2005.



The Digital Master will confirm that a new battery (CR2032 Lithium Coin Cell) has been recently installed in both the active and backup Command Stations. If this cannot be determined with certainty the Digital Master will install a new battery prior to initial power up of the Command Station.

The Digital Master will also verify all power connections through the UPS to the 120VAC supply and ensure the 120VAC supply is on.

C.1 Total System Reset

Once the Command Stations are initially installed, they will be powered up and a total system reset (CV39=c) carried out. This total system reset may also be required from time-to-time should the Command Station slots become full or should the Command Station slot memory become corrupted. Following is the procedure for the total reset:

Procedure to Set OPSW #39 for Total System Reset		
DT100/DT100R Throttles	DT300/DT300R Throttles	DT400/DT400R Throttles
1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT100/R to LocoNet port. 3. Press MODE/DISP to enter Switch mode. 4. Use throttle knobs to dial up OPSW #39. 39 will appear in display left side and "t" in display right side. 5. To change state of OPSW #39 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT300/R to LocoNet port. 3. Press MODE to enter Switch (Sw) mode. 4. Use throttle knobs to dial up OPSW #39. 39 will appear in display left side and "t" in display right side. 5. To change state of OPSW #39 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT400/R to LocoNet port. 3. Press SWCH to enter switch mode. 4. Use numeric keypad to enter OpSw number (39). "39" is displayed on text line along with "t." 5. Press CLOC c to move it to "closed" position. 6. Move Command Station mode switch to RUN, and press EXIT or FUNC on throttle.

C.2 Command Station Parameter Configuration

The scale switch on the DCS100 will be set to the "N" position.

The following table provides the normal operating configuration for the Command Stations (CS):

OPSW#	Purpose	Setting	Effect for NTS 2005
2	Disable Command Station Function	t	Ensures CS is Command Station
3	Booster is Auto-Reverse	t	n/a
5	Command Station is Command Station	c	Ensures CS is Command Station
13	Address purge time extended to 600 seconds	c	Sets purge time at 600 seconds
15	Purging forces a locomotive to speed 00	c	Purged locomotive is stopped
18	Extend short circuit shutdown from 1/8 to ½ second	c	Short circuit shutdown is ½ second
20	Disable address 00	c	See note below.
25	Disable aliasing	c	Aliasing not permitted at Convention
26	Enable Routes	c	Enables routes if needed, otherwise "t"
44	Expand system capacity to 120 slots	c	System has 120 slots
Note: For setup and testing of BoosterNet, including phasing the Boosters, OPSW#20 should be set to "t". At all other times, and especially during operations, OPSW#20 must be set to "c" to disable analog address 00.			

Since Decoder Assisted Consisting will be used at NTS 2005 (Section 6), the following OPSWs will also be programmed:

OPSW#	Purpose	Setting	Effect for NTS 2005
21	Global System Default for NEW Loco Selection	t	t t t =Normal 128 step mode
22	Global System Default for NEW Loco Selection	t	
23	Global System Default for NEW Loco Selection	c	t t c = FX 128 step mode for DAC

Leave all other OPSWs at their default setting. Following is the procedure to set the OPSWs in a DCS100 or DCS200:

Procedure to Set OPSW Switches		
DT100/DT100R Throttles	DT300/DT300R Throttles	DT400/DT400R Throttles
1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT100/R to LocoNet port. 3. Press MODE/DISP to enter Switch mode. 4. Use throttle knobs to dial up desired option switch. OpSw # will appear in display left side and either "c" or "t" in display right side. 5. To change state of OPSW press L Reverse key for thrown (t) or R Reverse key for closed (c). 6. Repeat steps 4 and 5 until all desired OPSW have been set. 7. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT300/R to LocoNet port. 3. Press MODE to enter Switch (Sw) mode. 4. Use throttle knobs to dial up desired option switch. OpSw # will appear in display left side and either "c" or "t" in display right side. 5. To change state of OPSW press L Reverse key for thrown (t) or R Reverse key for closed (c). 6. Repeat steps 4 and 5 until all desired OPSW have been set. 7. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT400/R to LocoNet port. 3. Press SWCH to enter switch mode. 4. Use numeric keypad to enter desired OpSw number. The OpSw number is displayed on text line along with "c" or "t." 5. Press OPTN t to move OpSw to "thrown" position or CLOC c to move it to "closed" position. 6. Repeat steps 4 and 5 until all desired OPSW have been set 7. Move Command Station mode switch to RUN, and press EXIT or FUNC on throttle.

Special note on Purging (OPSW #13, 14, 15):

The Command Station is configured above to permit Purging, extend the Purging time to 600 seconds (10 minutes) and to force Purged locomotives/consists to 00 speed. These settings are a compromise that allows improved slot management while also allowing for delays in train operation

when waiting for clear track ahead or for trains running at a constant speed without throttle intervention for a lengthy time.

During normal usage throttles (tethered or radio) will ping the Command Station to keep the purge countdown timer from reaching "0". The countdown timer is reset to 600 seconds with each ping. The ping only occurs after periods of time with no throttle actions. When a battery operated radio throttle goes into the Power Saver mode (r-PS), the throttle will wake up into normal function mode approximately every 60 seconds and ping the Command Station to reset the purge countdown timer

The alternative to Purging as specified above is to disable Purging then do a complete System Reset when the slots become full or train response becomes sluggish. This is not an acceptable approach for NTS 2005 given our objective of the continuous reliable running of trains. The JMRI LocoTools Slot Monitor permits releasing throttles individually, and is the preferred method of solving problems of this type.

C.3 Command Station Audible Sounds

The DCS100/200 will emits several beeps and clicks that provide information on its status and which can be helpful in troubleshooting any problems.

Sound	DCS100/200 Meaning
1 Beep	DCS powered on successfully or sent programming command.
3 Beeps	Loco address has been "purged" due to non-use.
4 Beeps	Route nesting error or too many entries cascaded
5 Beeps	Booster short circuit shutdown. Fault alarm
6 Beeps	Command Station already present in system
7 Beeps	CMOS battery low condition
8 Beeps	Memory ECC/checksum fail. Auto reset (no action)
9 Beeps	DCS transmit failure. LocoNet fault
16 Beeps	Software timeout failure. Auto reset (no action)
Continuous soft clicks	Low input supply voltage (<9.5VDC or <8VAC)

C.4 DCS100 or DCS200 Command Stations Used as Booster Only

The following table provides the operating configuration for a DCS100 or DCS200 Command Station to be configured as a Booster:

OPSW#	Purpose	Setting	Effect for NTS 2005
2	Disable Command Station Function	c	Ensures CS is Booster only
3	Booster is Auto-Reverse	t	Ensures Booster is Non-Reversing
5	Command Station is Command Station	t	Ensures CS is Booster only
Notes: If auto-reversing if required for a Command Station operating as a Booster set OPSW#3 to "c". All other OPSW settings can be ignored.			

C.5 DCS50 Command Station Used as Booster Only

The following table provides the operating configuration for a DCS50 Command Station to be configured as a Booster:

OPSW#	Purpose	Setting	Effect for NTS 2005
2	Disable Command Station Function	c	Ensures CS is Booster only
3	Booster is Auto-Reverse	t	Ensures Booster is Non-Reversing
Note: If auto-reversing if required for a Command Station operating as a Booster set OPSW#3 to "c".			

Following is the procedure to effect this change to Booster only:

- Press the **PROG** key followed by the **SWITCH** key. The **Switch Indicator Dot** blinks to indicate the system is in Option Switch Mode.
- Use the numeric keypad to enter the number of the Option Switch to be changed.
- Press the **c/-** or **t/+** key to set the OPSW to the setting desired.
- Press **EXIT** when finished. The DCS50 display will show **–CS–** to indicate Command Station mode or **–br–** to indicate Booster only mode.

C.6 DB150 Command Station Used as Booster Only

To set a DB100 as a Booster only, connect a jumper wire between the Config A and Gnd terminals. For auto-reversing also connect a jumper between Config B and Gnd.

It should be noted that the DB150 Power LED will flash at a 1 second rate when the DB150 is configured as a Booster.

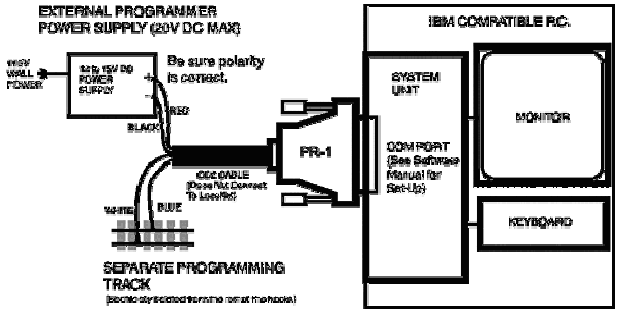
Appendix D
Decoder Programming and Consisting

Two programming stations will be set up near the NTRAK layout at NTS 2005 for programming locomotive and consist addresses, and to ensure analog operation is turned on in the decoder. Either the Digitrax PR1 programmer or the JMRI DecoderPro software program can be used. Details of these programmers follow.

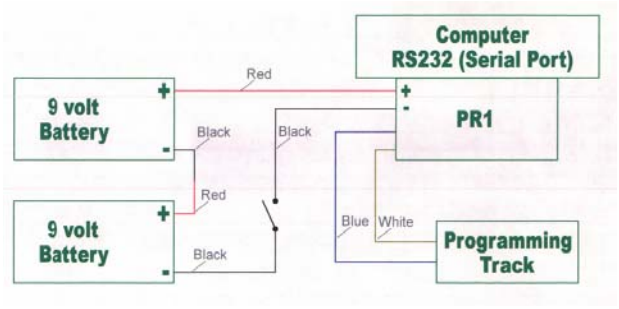
D.1 Digitrax PR1 Programmer

The Digitrax PR1 programmer is an offline programmer that is not connected to the DCC system. It requires an IBM-compatible computer, power source, a programming track, PR1 software and the PR1 hardware. The PR1 reads and writes all the decoder Configuration Variables (CVs) and their values directly on the computer screen. A number of other features make programming simple.

The PR1 Programmer is very fussy about its power supply. It requires a very "clean" or well-filtered source of power (it is sensitive to AC voltage ripples over 0.1 volt), and the closer to 18 volts DC the better, with at least 16 volts required to successfully program and read decoder Configuration Variable (CV) values. There are two options:



Wall-Wart Supply with 1000µF, 35V Filter Capacitor Added



Two 9-Volt Batteries in Series

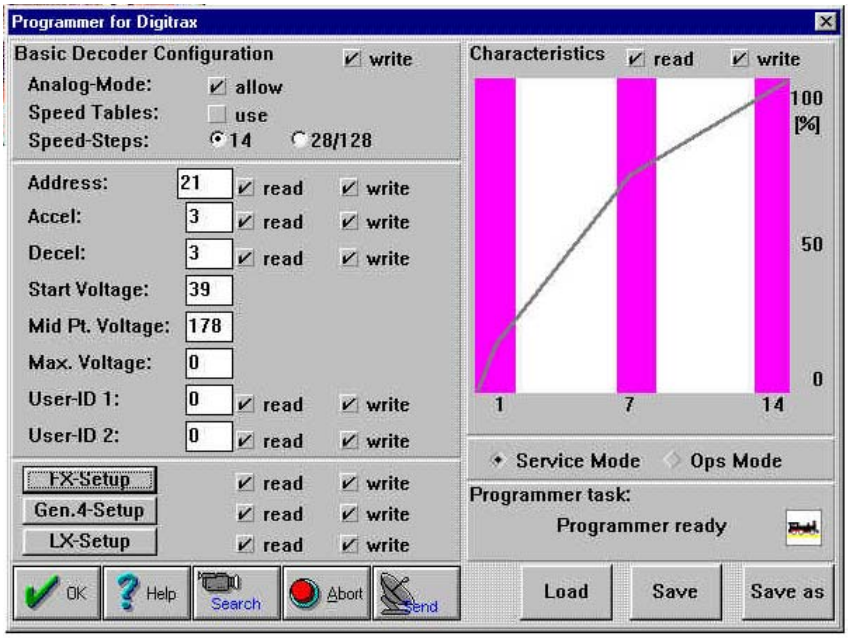
Detailed instructions for programming the PR1 are available in the Digitrax Decoder Manual. The following are some hints to ensure your programming will be successful or to make it easier to program decoders installed in locomotives.

- **Track, Wheels and Pickup Wipers Must be Clean**. It is very important to have a good contact between the rails of the programming track and the wheels of the decoder-equipped locomotive since the voltage applied to the track is current limited to protect the decoder and keep the locomotive from running off the track during programming. Be sure to clean the programming track and clean the wheels of the locomotive prior to programming. If the locomotive uses a wiper contact to collect power from the wheels, make sure it is clean and making as good a contact as possible.
- **Other Devices**. Since the PR1 is current limited to protect the decoder during programming, ensure there is no other device (lamps, LEDs, another decoder, etc.) in parallel with the red and black wires of the decoder being programmed. Such other devices may prevent the PR1 from seeing the decoder's acknowledge pulses and/or reliably, if at all, reading decoder CV values, although the PR1 may still be able to write to the decoder.
- **Decoder Functions**. Before programming a decoder with the PR1, make sure all the decoder functions (headlights, etc.) are turned OFF. This must be done from a normal DCC-powered track using a Command Station/Power Booster and throttle. The Windows version of the PR1

software requires that CV29 be set correctly for 4-digit addressing before the PR1 will read back the 4-digit address.

- **Listen/Watch**. During programming listen and watch for any motor movement. This indicates that the decoder is generating an Acknowledge (ACK) pulse for the PR1 as confirmation of an exchange of messages between the PR1 and the decoder.

A view of the PR1 computer screen is shown below:



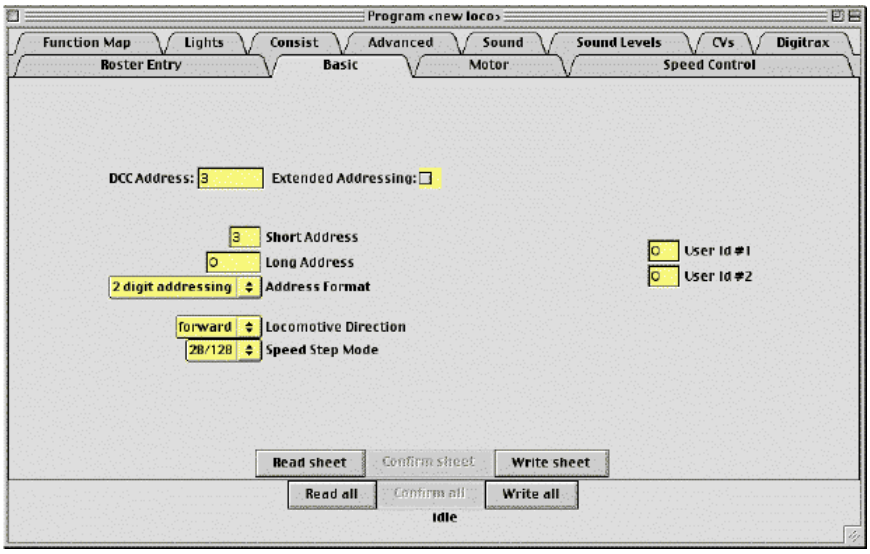
A copy of the Digitrax Decoder Manual (either hard copy or CD-ROM), which contains the PR1 Manual, will be kept both at the Programming Table and the Command Station.

D.2 JMRI DecoderPro

The DecoderPro symbolic programmer provides a friendly interface to program decoders, using a computer running any version of Windows and Java, and the DCC Command Station. It simplifies the job of configuring complicated DCC decoders by providing screens on which you can select the various options and values you want. These screens show the exact contents of each specific decoder type. Both the programming screens and decoder information are stored in text files, so you can make up new ones as desired. DecoderPro talks to the decoders using the JMRI programming interface. The connection from the computer to the Command Station can be via the Digitrax MS100 or the LocoBuffer; LocoBuffer is preferred.

When the program starts the following opening screen is seen:

The following screen is used during actual programming of decoder addresses:



A copy of the Manual for DecoderPro (either hard copy or on CD-ROM) will be kept both at the Programming Table, and in the master book of DCC Documentation kept at the Command Station.

Operating of DecoderPro for checking and assigning addresses is summarized as follows:

- DecoderPro will be launched in the “NMRA Standard CV Definitions” mode.
- To check a locomotive, sit it on the programming track and let DecoderPro “read sheet” while on the “Basic” tab.
- To change the address write the changes on the Basic sheet.

Using DecoderPro’s Basic programmer instead of the comprehensive programmer will restrict the programming screen to just the “Roster Entry” and “Basic” tabs.

D.3 Decoder-Assisted Consisting (DAC)

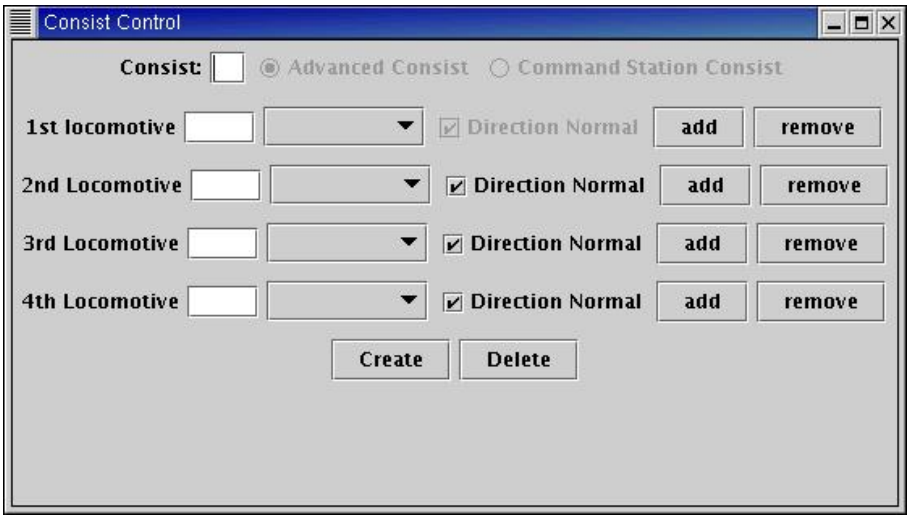
Decoder Assisted (Advanced) Consisting is similar to Command Station Assisted (UniVersal) Consisting except the consist address is programmed into the decoder to permanently MU locomotives together, even if removed from the layout and taken to another layout. (Care must be taken when such locomotives are removed from the layout to put them back in the EXACT arrangement in which they were originally consisted together.)

The top address (the one assigned to the right throttle) in a DAC must be a two-digit (short) address. This does not mean that a locomotive with a two-digit address actually has to be in the consist. If the locomotives to be consisted only have four-digit addresses, select a two-digit address that does not actually exist on the layout and assign it to the right throttle — this 2-digit address will be assigned at the Programming Table. Then MU all four-digit addresses to the two-digit address.

MU'ing the locomotives to be consisted is then performed in the same manner as with Command Station Assisted (UniVersal) Consisting. When the consisting takes place, the DCS100 will automatically assign the consist address to CV19 in the decoders being consisted. When locomotives are removed from the consist, CV19 is automatically changed back to '00'.

The easiest way to consist locomotives using DAC is with DecoderPro, and can be done at the Programming Stations at NTS 2005. DecoderPro performs consisting using Ops Mode Programming

so the locomotive must be placed on the mainline track during consisting. Following is the programming screen from DecoderPro.



The following details are provided to assist in manual programming of Decoder Assisted Consisting.

CV19 contains the DAC address. CV19 also contains data for the direction in which the consist will operate. The table below can be used to determine what value to program into CV19.

CV19 Value	Effect on DAC Address	Normal Direction of Travel
000/x00	DAC Addressing Disabled	N/A
001/x01 to 127/x7F	DAC Addressing Enabled	Forward
129/x81 to 255/xFF	DAC Addressing Enabled	Reverse

When CV19 is active the various function within the advanced consist are individually controlled at their regular addresses. However, CV21 and CV22 allow placing specific functions under the control of the advanced consist address.

To determine the hex value to program into CVs 21 and 22, add up the hex values of the functions to be controlled in the advanced consist and program that value into the CVs — see the following table. To make all CVs be controlled by the advanced consist address, program a value of 255/xFF to both CV21 and CV22.

CV21 Values		CV22 Values	
F0	x00	F0	x01
F1	x01		
F2	x02		
F3	x04		
F4	x08		
F5	x16	F9	x16
F6	x32	F10	x32
F7	x64	F11	x64
F8	x128	F12	x128

For example, for F0 to be controlled by the advanced consist address program Cv21 to x00 and Cv22 to x01. For F0, F1 and F5 controlled by the advanced consist address, program Cv21 to x17 and CV22 to x01. All other functions will be controlled by the decoder's regular address.

It must be noted that some decoders block an Ops Mode write to CVs 1, 17, 18 and 19. Locomotives with such decoders must be programmed manually on the programming track.

D.4 UniVersal Consisting

The normal method of consisting with Digitrax systems is with UniVersal Consisting where the Command Station keeps track of all consists, and each locomotive in a consist uses one memory slot. **Due to the large number of operators expected at NTS 2005 and the need for strict slot management, UniVersal Consisting requires the prior approval of the on-duty Digital Master.**

For completeness, following is the procedure to add locomotives to and remove locomotives from a consist.

Adding a Locomotive to a Consist		
DT100R Throttle	**DT300R Throttle**	**DT400R Throttle**
1. Select the 2-digit consist address on the R throttle knob. 2. Select the address of the locomotive to be consisted to the Top locomotive on the L throttle knob. 3. Move locomotive into position, making sure that both are traveling in the same physical direction. 4. Press MODE/DISP key twice until MU mode indicator is lit, then UP/ADD key to add locomotive's address to consist. 5. Repeat steps 2–4 for each additional locomotive to be added to the consist.	1. Select the 2-digit consist address on the R throttle knob. 2. Select the address of the locomotive to be consisted to the Top locomotive on the L throttle knob. 3. Move locomotives into position, making sure that both are traveling in the same physical direction. 4. Press MODE key twice until MU mode indicator is lit, then press Y+ key to add the locomotive's address to the consist. 5. Repeat steps 2–4 for each additional locomotive to be added to the consist.	1. Select the 2-digit consist address on the R throttle knob. 2. Select the address of the locomotive to be consisted to the Top locomotive on the L throttle knob. 3. Move locomotives into position, making sure that both are traveling in the same physical direction. 4. Press the MU key then the Y+ key to add the locomotive's address to the consist. 5. Repeat steps 2–4 for each additional locomotive to be added to the consist.
Removing a Locomotive from a Consist		
1. Select the locomotive address to be removed from the consist on the L throttle knob. 2. Press MODE/DISP key twice until MU mode indicator is lit, then press DOWN/DELETE key. The L throttle becomes active with locomotive just removed from the consist.	1. Select the locomotive address to be removed from the consist on the L throttle knob. 2. Press MODE key twice until MU mode indicator is lit, then press N- key. The L throttle becomes active with locomotive just removed from the consist.	1. Select the locomotive address to be removed from the consist on the L throttle knob. 2. Press the MU key, then press the N- key. The L throttle becomes active with the locomotive just removed from the consist.

D.5 Releasing/Dispatching Locomotives from the Throttle

To assist in slot management in the Command Station all locomotives must be released/dispatched from their throttle when operation on the layout is complete. This allows for reuse of addresses, particularly the 2-digit addresses for consisting.

Radio throttles must be plugged into ThrottleNet to release an address from the throttle.

Following is the procedure:

Releasing an Address from a Throttle			
DT100R Throttles	**DT300R Throttles**	**DT400R Throttles**	**UT4R Throttles**
1. Set the locomotive speed to 00. 2. Press SEL/SET key then MODE/DISP key. DT100 LCD will show SEL.	1. Set the locomotive speed to 00. 2. Press SEL key then press MODE key. The DT300 LCD will show SEL.	1. Set the locomotive speed to 00. 2. Press LOCO key then press DISP key. The DT400 LCD will show SEL.	1. Turn throttle knob completely to left. 2. Hold down F4/DISP key while inserting plug into UP3/5. 3. Release F4/DISP key when LED turns red. 4. Unplug when LED turns green.

D.6 Throttle Emergency Stop Setting

At the time of checking and programming decoder addresses and consist, operator throttles will be check and set to ensure they are set for **Local Emergency Stop** (which is the default setting) rather than Global Emergency Stop. This is done to prevent the accidental stoppage of all DCC trains on the layout due to an operator inadvertently (or on purpose) pressing the Emergency Stop button on the throttle.

Throttles used by the Digital Staff will be exempt from this requirement.

The correct throttle options for DCC train operators at NTS 2005 are:

Option	Setting	Meaning
#1	x01	Ballistic Tracking & Typematic Keys, Key and Knob Clicks, Local Run/Stop
#2	x23	DT100R — 128 step decoder, Radio only enabled
	x43	DT300R/DT400R — 128 step decoder, Radio only enabled

Following is the procedure to set throttle options.

Procedure to Set Throttle Options

DT100R Throttles	DT300R Throttles	DT400R Throttles
1. Unplug the DT100R from LocoNet. Press/hold SEL/SET key while plugging DT100R back into LocoNet. The display will show "oP:0x"., where "x" is the current setting. 2. Use R or L throttle knob to change setting to "oP:01". 3. Press SEL/SET key to save setting & advance to next option. The display will show "oS:xx". 4. Use R or L throttle knobs to change the setting to "oS:23". 5. Press SEL/SET to save setting then press SEL/SET two more times to complete the process.	1. Unplug the DT300R from LocoNet. Press/hold SEL key while plugging DT300R back into LocoNet. The display will show OP#1=??? where ??? is current setting. 2. Use R or L throttle knob to change setting to x01. 3. Press SEL key to set OP#1 and advance to OP#2. 4. Use R or L throttle knob to change the setting to x43. 5. Press SEL key to set OP#2 and advance to OP#3. 6. Since no change required in OP#3–6 press SEL four more times to step through these options.	1. Press the OPTN t key. The right side of the display will show the current value for OP#1 2. Use R or L throttle knob to change the setting to x01. 3. Press ENTER key to set OP#1 to the selected value &advance to OP#2. 4. Use R or L throttle knob to change the setting to x43. 5. Press ENTER key to set OP#2 to the selected value & advance to OP#3. 6. Since no change is required in OP#3–6 press ENTER key four more times to step through these options.

Note: DT100R and DT300R throttles will time out and return to RUN mode in 5 or 6 seconds if no action is taken following each step above.

It is strongly recommended that all locomotives assigned to the throttle (both throttle knobs) are released (i.e. dispatched) before any throttle options are changed.

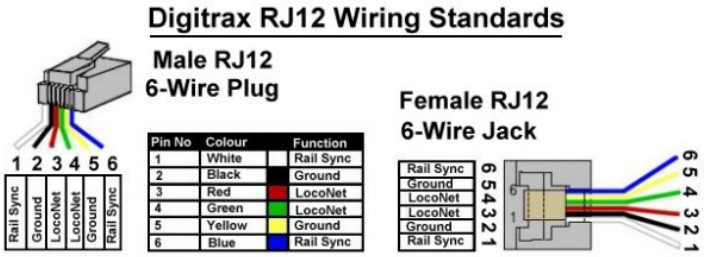
Appendix E
Manufacturing and Testing LocoNet Cables

E.1 Manufacturing LocoNet Cables

LocoNet cables utilize 6-wire telephone/data-type cable with RJ12 plugs on each end. For our model railroad purposes, flat cable is much easier to work with.

The 6-wire cable is configured as follows:

Pin	Color	Function
1	White	Rail-Sync B
2	Black	Common
3	Red	Data
4	Green	Data
5	Yellow	Common
6	Blue	Rail-Sync A
Note: Colors may vary with different cable manufacturers		



Telephone-type cable and data-type cable are essentially the same cable. What is different is how the RJ12 plugs are positioned on the cable — normal or reversed. Data-type cable is preferred for LocoNet.

If you take a Telco-type or modular phone cable and lay it out flat, the connectors on each end are in the same orientation. That is, both face up or down in relation to the locking tab. This causes the cable to reverse the polarity of the cable. That is, pin 1 connects to 6, 2 to 5, 3 to 4 on the opposite end. This is a normal or straight phone cable.

On a data-type cable, laid out flat, the connectors are of the opposite orientation on each end. That is, one end faces up and the other faces down. See photo below. This causes the cable to keep the same polarity. That is, pin 1 connects to 1, 2 to 2, 3 to 3, 4 to 4, 5 to 5 and 6 to 6 on the opposite end. This is a reversed or skewed cable. Even though it is called reversed, this is only in relation to the connectors; the wires are always straight and pin 1 is always connected to pin 1 on the other end.

Note: Flat 6-wire cable has a tiny, single rib down the middle of one side. When making cables be sure to have rib side up for one RJ plug and rib side down for the other.

The following material is needed to manufacture a LocoNet cable:

6-Wire Flat Line Cord
RJ12 (6p6c) Plugs
Professional Crimping Tool for 6-wire or 8-wire cable

To make the cable, do the following:

- Using diagonal wire cutters (or the crimping tool blade that will cut through the cable, if your tool has that blade) cut the 6-wire flat cable to the desired length. Be sure the cut is at right angles to the cable and the end is smooth where the cut was made.
- Insert one end of the cable into the cable jacket-stripping blade of the crimping tool. Squeeze the handle and then carefully pull out the 6-wire cable from the tool. This operation removes the cable jacket exposing the 6 conductors. Be sure the ends of the wires are even; if necessary, make them even using the diagonal wire cutters. Spread the wires apart just slightly to ensure they will fit properly into the RJ12 plug.
- Slide the RJ12 connector onto the wires, making sure the wires stay lined up. The connector has six slots, one for each wire. Try to make each wire reach the end of its slot. The cable jacket/insulation should reach just beyond the end of the crimp point. If the insulation doesn't reach far enough inside the connector, cut the wires off just a bit more. If the cable jacket/insulation reaches too far past the crimp point or if the wires don't reach the end of their slots, simply trim off a little more jacket/insulation.

  For the RJ12 connector to be very reliable it is very important to ensure the cable jacket is inserted into the clear body of the connector. This is the only strain relief these frail wires will receive. If you fail to do this, the connector will, sooner or later, fail and get you into trouble.

  Whether the blue wire or the white goes is on the left doesn't matter. What you must be is consistent. If you always have the same color cable on the left at both ends of the cable you are constructing a data-type cable, the preferred type. If you have one color on the left at one end of the cable and the other color on the left at the other end of the cable, you will construct a telco-type cable. You can also use the molded rib as a guide as explained in the note under the diagram above.
- Again verify that all is in order and insert the connector into the crimping tool. Crimp it. This requires a little bit of strength, and you may need to use two hands.
- Repeat the previous step for the other end of the cable.
- Test the cable to make sure it works properly (see next section).

E.2 Testing a LocoNet Cable

If using a Digitrax LT1 tester, plug one end of the cable into either the LocoNet A or B jack on the nearest Booster, and plug the other end into the LT1. The LEDs on the LT1 should light. Refer to Section E.3 for the correct interpretation of the LT1 LEDs.

If using a data cable tester plug both ends of the cable into the tester. If all LEDs light green the cable is a good data-type cable. If no LEDs light or they light in any other combination the cable is faulty. Wiggle the cable at each connector to be sure there is not an intermittent crimp. Try to determine which RJ12 connection is incorrect, cut it off and replace with a new RJ12 plug.

E.3 Testing a LocoNet Cable Using the Digitrax LT-1 Tester

The Digitrax LT1 LocoNet Cable Tester will be used to check the integrity of the throttle network (ThrottleNet). A short length of known good LocoNet cable with RJ12 plugs on each end will be plugged in at one end to the LT1. The other end will be plugged into LocoNet jacks around the layout to check the integrity of the ThrottleNet. The following procedure will be used:

- A Digitrax throttle should be plugged into the ThrottleNet near the Command Station.
- Connect the free end of the LocoNet cable to ThrottleNet jacks beginning at the Command Station and working successively out to the layout extremities.

- All four LEDs on the LT1 will light if the cables and jacks are good to the point tested. LEDs may not all be the same brightness; this is normal. (Note: if a Digitrax throttle is not plugged in only 3 LEDs will light.)
- If any of the LEDs fail to light then check the cabling back to the point of the last successful test. This could involve re-crimping the connectors, replacing a connector or replacing the cable.
- The following are the meaning of the various possible indications on the LT1:
- All 4 LEDS reference to LocoNet common, which is Pins 2 and 5 on the LocoNet cable. If both LEDs on one side or the other of the LT1 are off, then there is a problem with that side of the LocoNet common. If both sides (all LEDs) are out, then that would indicate no power on LocoNet at that location or an open common on both sides.
- Both outside LEDs are RailSyncs, the low current mirrors of the track signal and used for LocoNet limited power. If both these LEDs are out, either there is an open in both Pins 1 and 6 or the system has track power off. If one or the other LED is off there is an open at this location or a Command Station problem.
- Both inside LEDs are the LocoNet data lines. If both LEDs are off the system is either in sleep mode or there is an open or short taking the LocoNet voltage down (throttles will go to idle). Note that if there are no LocoNet devices such as a throttle plugged in then only one of these LEDs will light; at least one throttle should be plugged into LocoNet close to the Command Station for LT1 testing.

The following are nominal LocoNet voltages, measured to LocoNet common (Pins 2 and 5), at the N Scale setting:

- LED #1, RailSync +, White Wire = 6.2VDC
- LED #2, LocoNet Data 1, Red Wire = 14.5VDC
- LED #3, LocoNet Data 2, Green Wire = 14.5VDC
- LED #4, RailSync -, Blue Wire = 6.2VDC

Note that the LED #1 and #4 voltage is dependent on the track voltage setting (figures shown reflect the “N” scale setting on the Booster).

E.4 Warning re Use of LT-1 Tester During Layout Operations

The use of the LT-1 Tester to check LocoNet during normal railroad operations must be avoided. The LT-1 is not a LocoNet device, it is a tool, a tester as the name implies. With a normal load of throttles on the LocoNet, plugging in an LT-1 can cause problems. Plugging in two LT-1’s will definitely cause problems, probably causing LocoNet to stop functioning.

Appendix F
ThrottleNet Wiring and Testing

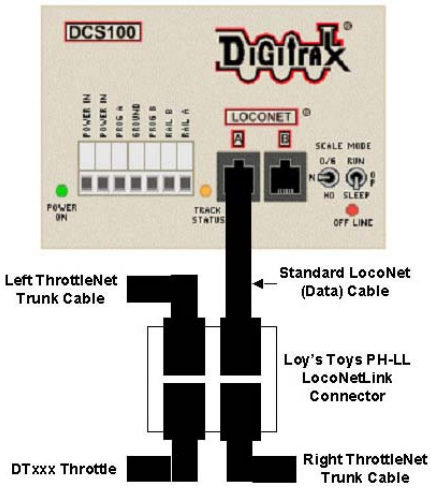
ThrottleNet will consist of two main branches, each extending outwards in opposite directions from the Command Station. Each branch will be subdivided and daisy-chained throughout the layout to efficiently connect to all Universal Panels, other throttle connection jacks and UR91 radio receivers.

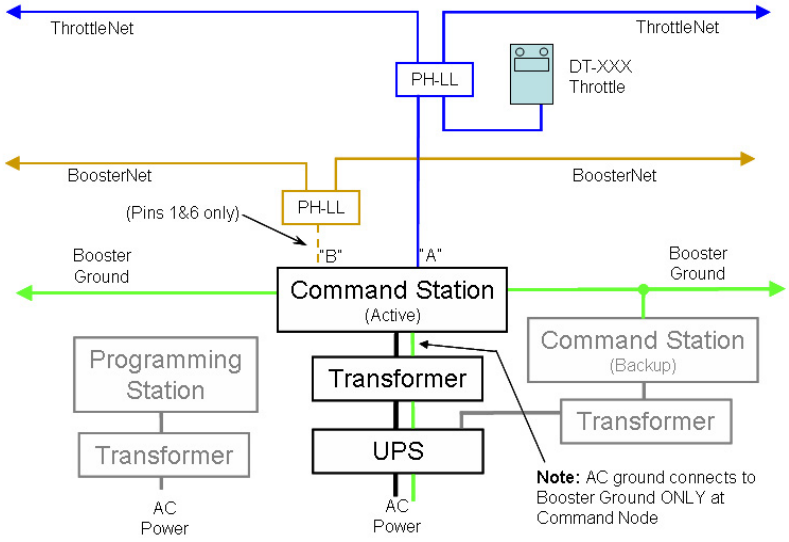
Once the layout plans firm up, a ThrottleNet routing plan will be developed.

Existing white/silver LocoNet cabling can be used where the length matches what is needed. Otherwise new cable will be constructed using a spool of white/silver 6-wire flat cable (or marked with white tape at each RJ12), an appropriate crimping tool(s) and RJ12 plugs. In either case, each cable will be checked for integrity using a network cable tester.

F.1 ThrottleNet Wiring at Command Center

A short length of white/silver 6-wire flat cable will be connected between Jack A on the Command Station and a Loy's Toys PH-LL 4-way LocoNetLink Connector. The two main trunk ThrottleNet cables will be plugged into two of the 4-jacks on the PH-LL, and a DTxxx throttle will be plugged into the fourth connector. See the diagram at left below. This is a sub-part of the overall connections at the Command Station, as shown at right below.





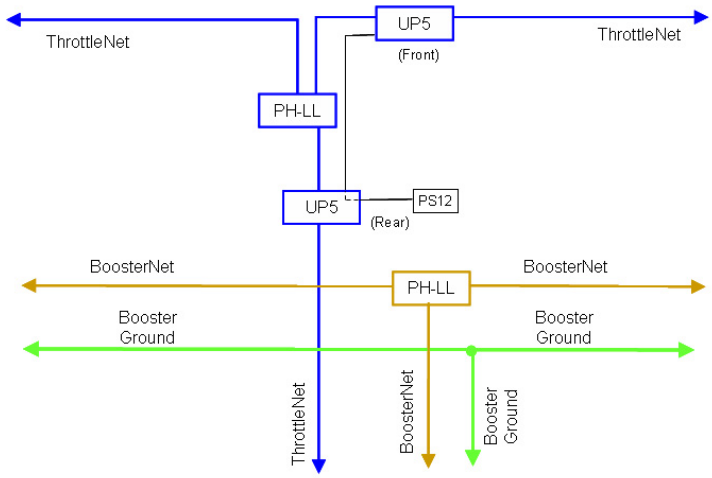
F.2 Extending ThrottleNet Along the Layout Spine

When layout setup begins at 8:00am on August 5, 2004, the layout spine will be the first to be built. Once the spine is complete Command Station setup and installation of the ThrottleNet trunk cables along the spine can begin. Installation consists of installing Universal Panels, ThrottleNet cabling and inserting Loy's Toys PH-LL 4-way LocoNetLink Connectors at the locations where ThrottleNet will be extended to the individual layout loops. See the diagram at the top of the next page.

All ThrottleNet cables must be suspended from the modules and not allowed to be routed on the floor or hang down excessively from the modules. Twist ties or other suitable fasteners are to be used for this purpose. Any extra length of cable must be coiled and fastened with twist ties.

The procedure follows:

- Locate the necessary Universal Panels on modules at roughly the desired distances (20 feet on the outside of the spine), using either built-in panels or installing panels as necessary.



- Use either existing LocoNet cables of the correct length or manufacture LocoNet cables to the needed length, as appropriate, and connect the various Universal Panels together moving along the spine. Be sure to insert Loy's Toys PH-LL 4-way connectors at each junction module where ThrottleNet will be extended to the layout loops. Suspend the cable from the underside of the modules using twist ties or other secure mounting. As each connection to a Universal Panel or PH-LL is made test the connection using the LT-1 tester. Resolve any problems found before continuing to the next link.

  All modules with yard or significant switching capabilities should have Digitrax UP panels and the wall-wart supply should be connected and plugged into the 120VAC line.

  Also connect a ThrottleNet cable to each PM4/PM42 board encountered during ThrottleNet installation.

- For modules with built-in Universal Panels and module LocoNet wiring, connect a LocoNet cable to the module then test the Universal Panels with the LT-1. If the test passes the built-in panels may be used. If the test fails tape over the built-in panels and install Digitrax UP or Loy's Toys PH-UP Universal Panels.
- Attach a red ribbon to each UP to make them more visible to engineers walking around the layout.
- Continue the above process until ThrottleNet for the entire spine is complete, tested and operational.

F.3 Extending ThrottleNet Around the Layout Loops

As layout loops are completed, the setup teams will then begin to install Universal Panels and connect ThrottleNet cabling around the layout loops, following the ThrottleNet routing plan, and testing each cable as they go with a network cable tester and testing each Universal Panel and/or UR91 as they are connected into LocoNet. See the diagram at the top of the next page. Test procedures using the Digitrax LT1 tester are provided in Appendix E, Section E.3.

All ThrottleNet cables must be suspended from the modules and not allowed to be routed on the floor or hang down excessively from the modules. Twist ties or other suitable fasteners are to be used for this purpose. Any extra length of cable must be coiled and fastened with twist ties.

If it is necessary to run a ThrottleNet cable on the floor, care must be used to ensure it is flat (not twisted) and secured with appropriate duct or similar tape.

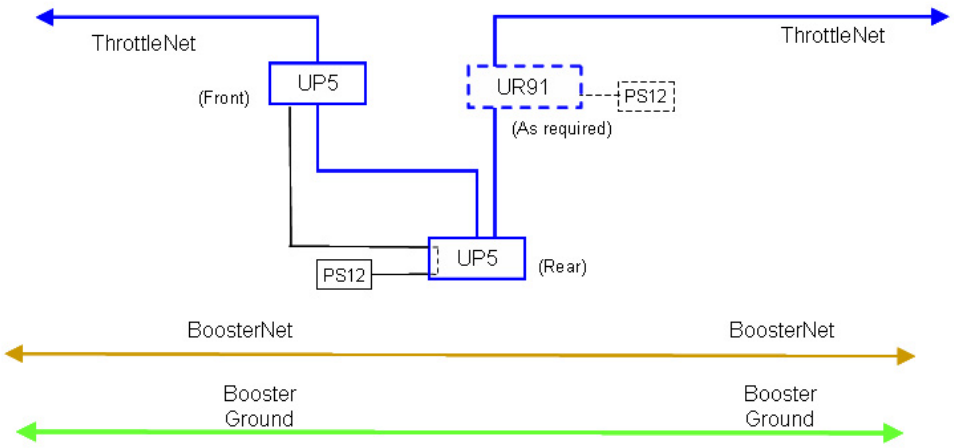


Diagram courtesy of Doug Stuard, NVNTrak

The procedure follows:

- Locate the necessary Universal Panels on modules at roughly the desired distances (20 feet outside and inside the modules), using either built-in panels or installing panels as necessary. Do this for all panels on a sub-loop of the layout.

  All modules with yard or significant switching capabilities should have Digitrax UP panels and the wall-wart supply should be connected and plugged into the 120VAC line.

  Also connect a ThrottleNet cable to each PM4/PM42 board encountered during ThrottleNet installation.

- Locate and install the UR91 radio receivers and PS12 power supplies as defined in the wiring plan, using radio towers. Ensure the UR91 antennas are straight, vertical and spread about 20 degrees apart.

- Use either existing LocoNet cables of the correct length or manufacture LocoNet cables to the needed length, as appropriate, and connect the various Universal Panels and radio receivers together moving around the loop. Suspend the cable from the underside of the modules using twist ties or other secure mounting. As each connection to a Universal Panel or radio receiver is made test the connection using the LT-1 tester. Resolve any problems found before continuing to the next link.

  LocoNet cables from UR91 radio Receivers can be plugged into the side jack on Digitrax UP5 Universal Panels, where present.

- For modules with built-in Universal Panels and module LocoNet wiring, connect a LocoNet cable to the module then test the Universal Panels with the LT-1. If the test passes the built-in panels may be used. If the test fails tape over the built-in panels and install Digitrax UP or Loy's Toys PH-UP Universal Panels.

- Attach a red ribbon to each UP to make them more visible to engineers walking around the layout.

- Continue the above process until ThrottleNet for the entire DCC portion of the layout is complete, tested and operational.

F.4 Extending ThrottleNet to DCC Tracks on DC Loops

Since predominantly DC-operated loops will not be contiguous to the DCC-wired portion of the spine, ThrottleNet must be extended to the DCC-controlled tracks from the closest DCC wiring on the spine.

Once ThrottleNet is extended to the loop, the procedure of Section F.3 above will be followed.

Appendix G
BoosterNet Wiring and Testing

BoosterNet will consist of two main branches, each extending outwards in opposite directions from the Command Station. Each branch will be subdivided and daisy-chained throughout the layout to efficiently connect to all Boosters.

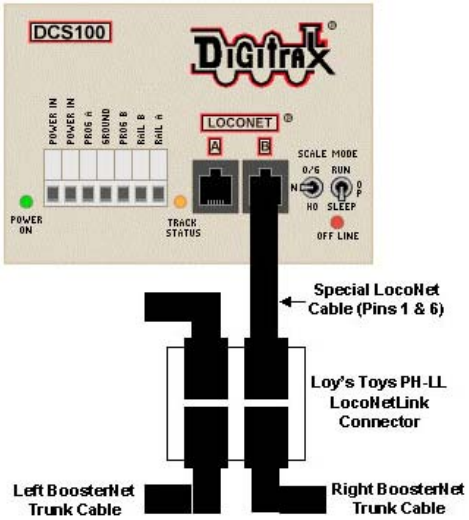
Once the layout plans firm up, a BoosterNet routing plan will be developed.

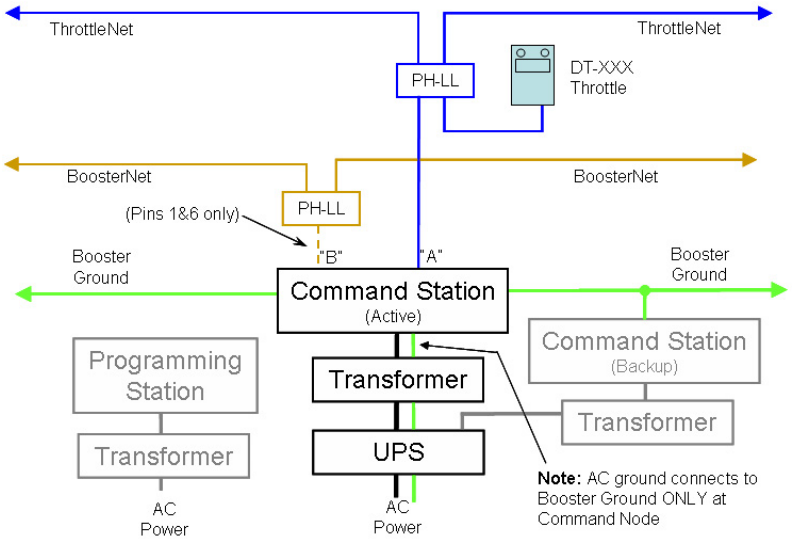
Existing black LocoNet cabling can be used where the length matches what is needed. Otherwise new cable will be constructed using a spool of black 6-wire flat cable (or black tape at each RJ12), an appropriate crimping tool(s) and RJ12 plugs. In either case, each cable will be checked for integrity using a network cable tester.

G.1 BoosterNet Wiring at Command Station

A short length of specially constructed black 6-wire flat cable will be connected between Jack B on the Command Station and a Loy's Toys PH-LL 4-way LocoNetLink Connector. The two main trunk BoosterNet cables will be plugged into two of the 4-jacks on the PH-LL. The fourth connector on the PH-LL will not be used.

The cable between Jack B of the Command Station and the PH-LL will be specially constructed, and will have only pins 1 and 6 (RailSyncs) connected in the RJ12 plug at the end plugged into the Command Station. See the diagram at left below. This is a sub-part of the overall connections at the Command Station, as shown at right below.

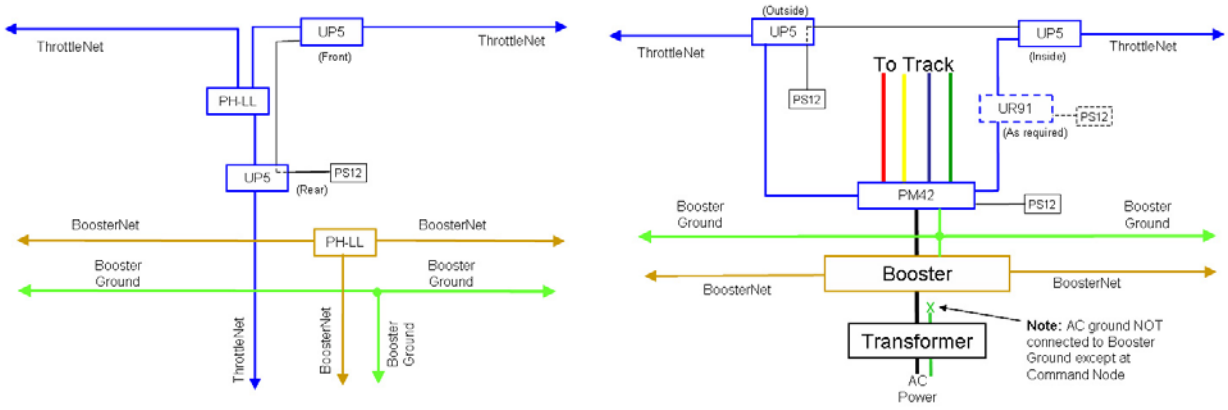




G.2 Extending BoosterNet Along the Layout Spine

When layout setup begins at 8:00am on August 5, 2004, the layout spine will be the first to be built. Once the spine is complete Command Station setup and installation of the BoosterNet trunk cables along the spine can begin. Installation consists of installing Boosters and PM4s, BoosterNet cabling and inserting Loy's Toys PH-LL 4-way LocoNetLink Connectors at the locations where BoosterNet will be extended to the individual layout loops. See the diagram at the top of the next page.

All BoosterNet cables must be suspended from the modules and not allowed to be routed on the floor or hang down excessively from the modules. Twist ties or other suitable fasteners are to be used for this purpose. Any extra length of cable must be coiled and fastened with twist ties.



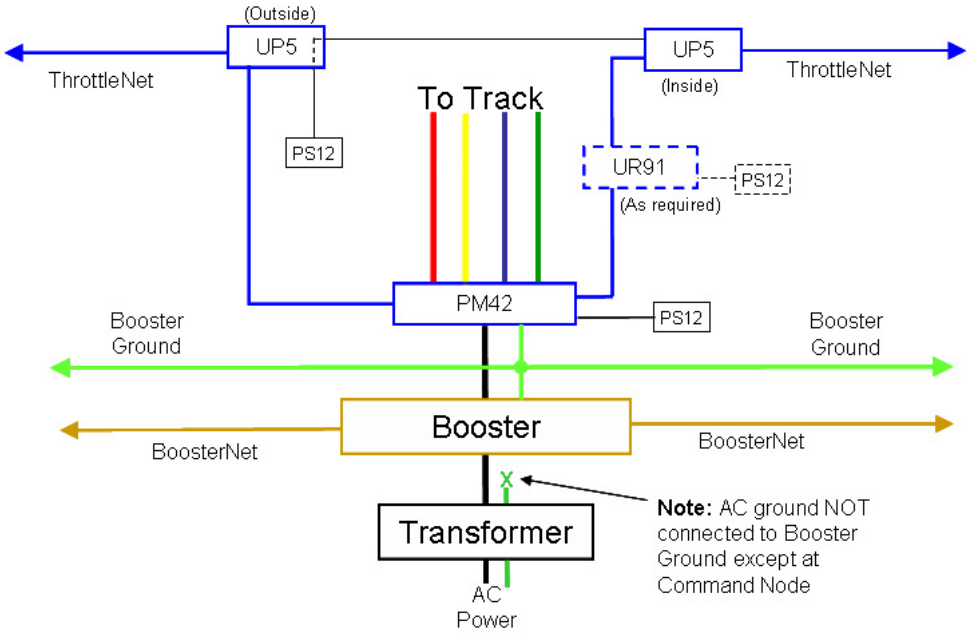
Boosters and PM4s should be located on the floor beneath the geographical center of the electric block, as shown on the routing plan.

The procedure follows:

- Locate Boosters/PM4s on the floor under the module at roughly the geographic center of each electrical district, as shown on the BoosterNet plan. Booster power supplies should be plugged into the 120VAC line; any extra line cord length should be coiled and fastened with a twist tie. Do this for all Boosters on the spine of the layout. Be sure the Scale Switch on each Booster is set to the "N" position.
- At the electrical district boundaries ensure insulated rail joiners are installed and that the bus cables beneath the module are unplugged. Fasten a tag to those cables indicating they should not be connected.
- Use either existing black LocoNet cables of the correct length or manufacture LocoNet cables to the needed length, as appropriate, and connect the various Boosters together moving along the spine. Be sure to insert Loy's Toys PH-LL 4-way connectors at each junction module where BoosterNet will be extended to the layout loops. Suspend the cable from the underside of the modules using twist ties or other secure mounting, and provide a direct vertical drop to the Booster, leaving a little slack in the vertical drop. As each connection to a Booster is complete phase the input to the Booster (Appendix H, Section H.1). Connect the Booster output to the track and ensure the track polarity is correct (see Appendix H, Section H.2). Resolve any problems found before continuing to the next Booster.
- Continue the above process until BoosterNet for the entire spine is complete, tested and operational.

G.3 Extending BoosterNet Around the Layout

Each setup team will then begin to install Boosters and PM4s, and connect BoosterNet cabling around the layout, following the BoosterNet routing plan. See the following diagram.



All BoosterNet cables must be suspended from the modules and not allowed to be routed on the floor or hang down excessively from the modules. Twist ties or other suitable fasteners are to be used for this purpose. Any extra length of cable must be coiled and fastened with twist ties.

If it is necessary to run a BoosterNet cable on the floor, care must be used to ensure it is flat (not twisted) and secured with appropriate duct or similar tape.

Boosters and PM4s should be located on the floor beneath the geographical center of the electric block, as shown on the routing plan.

The procedure follows:

- Locate Boosters/PM4s on the floor under the module at roughly the geographic center of the electrical district, as shown on the BoosterNet plan. Booster power supplies should be plugged into the 120VAC line; any extra line cord length should be coiled and fastened with a twist tie. Do this for all Boosters on a sub-loop of the layout. Be sure the Scale Switch is set to the “N” position.
- At the electrical district boundaries ensure insulated rail joiners are installed and that the bus cables beneath the module are unplugged. Fasten a tag to those cables indicating they should not be connected.
- Use either existing black LocoNet cables of the correct length or manufacture LocoNet cables to the needed length, as appropriate, and connect the various Boosters together moving around the loop. Suspend the cable from the underside of the modules using twist ties or other secure mounting, and provide a direct vertical drop to the Booster, leaving a little slack in the vertical drop. As each connection to a Booster is complete phase the input to the Booster (see Appendix H Sections H.1 and H.2). Connect the Booster output to the track and ensure the track polarity is correct (see Appendix H Section H.3). Resolve any problems found before continuing to the next Booster.
- For layout sub-loops with centralized power distribution, connect a LocoNet cable to the central cabinet using a route that will expose the shortest distance of LocoNet cable on the floor. Cover the floor portion of the cable with tape from the drop point under modules to the central panel. Check Booster phasing (Appendix H Sections H.1 and H.2) and track polarity (Appendix H Section H.3) at the central cabinet. Resolve any problems before continuing.

- Continue the above process until BoosterNet for the entire DCC portion of the layout is complete, tested and operational.

G.4 BoosterNet Testing

During setup, a cable with all 6-wires connected will be used to connect BoosterNet to the Command Station. This will enable verifying of all BoosterNet wires. Once setup is complete the jumper cable between the Command Station and the PH-LL will be replaced with the 1-6 wire only cable.

The Digitrax LT-1 LocoNet Cable Tester can be used for BoosterNet testing, however only the two outer LEDs will light on a properly working connection.

Simply connecting the cable to the Booster and observing the LEDs on the Booster can also test BoosterNet. If the Booster goes online and the Track Status LED glows red or green then the BoosterNet cable is OK.

G.5 Extending BoosterNet to DCC tracks on DC Loops

Since predominantly DC-operated loops will not be contiguous to the DCC-wired portion of the spine, BoosterNet and Booster Ground must be extended to the DCC-controlled tracks from the closest DCC wiring on the spine.

Once BoosterNet and Booster Ground are extended to the loop, the procedure of Section G.3 above will be followed.

Appendix H
Booster Phasing and Grounding, Track Polarity and Coin Test

The Boosters in use on the Red Line Route and most other DCC-operated tracks will be set as non-reversing Boosters, and thus must be phased at setup. Phasing should also be checked at least once per day, plus whenever the layout is powered up. The Boosters must be phased first at the input (LocoNet) side and then at the output (track power) side.

The Track Status LED in the Command Station and Boosters is a bi-polar LED, which means it lights orange with DCC packets, and with analog pulse stretching either red or green depending on the polarity of the DC component. When properly phased all Boosters plus the Command Station will have their Track Status LED either red or green at the same time, when analog pulse stretching is at maximum. The color depends on the setting of the direction button.

When the Boosters are properly phased a locomotive should be able to run from any electrical district into the adjoining electrical district without encountering a polarity change (short circuit). This assumes that the track wires are connected properly — Rail A to Cinch-Jones wide pin to front rail on module.

Booster phasing is not required for any Boosters set up for auto-reverse. They will take care of themselves.

H.1 Booster Phasing — Input

Following is the process for phasing the Boosters at their input from BoosterNet:

- With the Command Station powered up and in the “Run” state, using the throttle at the Command Station set address 00 active at speed 99 during Booster phasing.
- When the Booster is powered up, check the Track Status LED to verify it is the same color as the Track Status LED on the Command Station.
- If the color of the LED is different, set the Booster to the Auto-Reverse mode and then short the track to switch polarity. Then take the Booster out of the Auto-Reverse mode. Alternately, a crossover LocoNet cable can be used in the connection towards the next Booster towards the Command Station.
- Follow up by making sure the track polarity is correct for each track that is DCC powered, as instructed in the next Section.

Continue the process until BoosterNet is complete and all Boosters are installed, phased and track polarity correct.

H.2 Booster Phasing — Output

The requirement for Booster phasing on the output side is that the Rail A terminal of the Booster ends up being connected to the wide pin of the Cinch-Jones connectors at the module, and thus the outside (front) rail. Any PM4/PM42 in the circuit must be included in this check and corrected as necessary.

The tool for checking polarity is a bi-polar LED. This LED, with a 1,000 ohm series resistor and red and black alligator clips, is connected to each track across the district boundary to check polarity.

If the LED is placed across the Rail A and Rail B terminals on the Booster the LED should light with the same color as the Track Status light on the Booster. If not reverse the LED connection. Then,

ensuring the same alligator clip that connected to Rail A is connected to the wide pin of the Cinch Jones plug on the track feeder cable, check that the LED still lights with the same color. If not reverse the track power connections at the Rail A and Rail B terminals, and check again with the bi-polar LED.

H.3 Checking Track Polarity

Theoretically, with all Boosters phased and the Rail A output of the Boosters/PM4s connected to the wide pin of the Cinch-Jones connectors and thus the outside rail, track polarity at electrical district boundaries should be automatically correct. In practice this is not a sure thing. Thus it is necessary to check track polarity at the district boundaries.

The tool for checking polarity is a bi-polar LED. This LED, with a 1,000 ohm series resistor and red and black alligator clips, is connected to each track across the district boundary to check polarity.

If the LED is placed across the two rails in the electrical district the LED should light with the same color as the Track Status light on the Booster. If not reverse the Rail A and B leads at the Booster or PM4; a 6-inch polarity changing cable with Cinch-Jones connectors on each end suffices.

If the LED lights when the clips are placed on like rails (either both outside rails or both inside rails) on either side of the boundary then the track polarity is wrong. If the LED remains dark the track polarity is correct.

Track polarity will be checked and fixed by the BoosterNet crew as BoosterNet is connected around the layout.

H.4 The Coin Test

Once the Booster is phased and Track Polarity correct, the team must take a coin (25¢) and go over every section of the track(s) in the electrical district. Place the coin across the track and verify the Booster shuts down virtually instantaneously.

If there is a PM4/PM42 Power Manager between the Booster and track, verify that the PM4/PM42 shuts down before the Booster, and that the Booster does not trip.

If you can count to one before the Booster trips, the track wiring is marginal, but acceptable. If you can count to two before the Booster trips, the track wiring must be augmented — either by re-wiring or doubling up on the wire. If the Booster does not trip at all the module wiring must be doubled or the module must be carefully examined for removal from the layout.

H.5 Booster Grounding

Coincident with extending BoosterNet around the layout, the BoosterNet team will also install Booster ground wires. The ground wires will be routed following the same path as BoosterNet wiring and connected to the Ground terminal of each Booster.

When connecting the ground wire to each Booster any existing ground from the Booster to any other source such as the metal case of the local power supply will be removed.

Appendix I
Power Up, System Reset and Shut Down Sequences

I.1 Power Up Sequence

To ensure proper operation, the power up sequence is to power the Command Station before any of the Boosters.

I.1.1 Command Station

Before any Boosters are powered, the Command Station must be powered up and stabilized, so it is generating proper DCC packets, especially the RailSyncs, even with Track Power off. This process should take approximately 2 – 3 seconds after the Mode Switch is placed in the Run position.

If the Boosters are powered up before the Command Station is generating packets, the results are anything from jumping locomotives to runaways.

Once the Command Station is power up in Run mode, address 00 will be selected and the speed set to 99. This will be the operating mode until all Boosters are installed and phased.

I.1.2 Boosters

Once the Command Station is powered up individual Boosters can be powered up. When all Boosters are powered up Track Power will be turned on at the Command Station. Address 00 will be selected at the Command Station and the speed set to 99. Booster phasing should then be verified. If any Boosters are determined to be out-of phase they should be re-phased and the track polarity verified at each electrical district boundary served by that Booster.

Once this process is complete, the speed of address 00 will be set to 00 and address 00 dispatched from the Command Station. Analog operation will be turned off by setting OPSW #20 at the Command Station to “c”.

I.2 System Reset

In the event major control problems are encountered such as an all slots full condition, corruption of the Command Station slot memory or other problems, and releasing slots via the JMRI LocoTools Slot Monitor does not resolve the problem, it may be necessary to perform a system reset. This process should only take about one minute, but it requires shutting down power to the DCC tracks. After the reset is performed all locomotive addresses including and UniVersal consists must be reprogrammed into the system.

Depending on the problem encountered there are two degrees of System Reset to be followed. For an all slots full or corruption of slot memory the Command Station must be reset using OPSW #36. For any other problem reset the system using the more inclusive OPSW #39.

Special Note: An OPSW #39 reset will be carried out at the start of operations each day.

I.2.1 OPSW #36 Reset

This reset clears all locomotive and consist information from the Command Station, idling all slots. The following is the process:

- At the Command Station, turn Track Power off.
- Carry out the following procedure to set OPSW #36.

Procedure to Set OPSW #36 to Clear Locomotive and Consist Information		
DT100/DT100R Throttles	DT300/DT300R Throttles	DT400/DT400R Throttles
1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT100/R to LocoNet port. 3. Press MODE/DISP to enter Switch mode. 4. Use throttle knobs to dial up OPSW #36. 36 will appear in display left side and "t" in display right side. 5. To change state of OPSW #36 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT300/R to LocoNet port. 3. Press MODE to enter Switch (Sw) mode. 4. Use throttle knobs to dial up OPSW #36. 36 will appear in display left side and "t" in display right side. 5. To change state of OPSW #36 press R reverse key for closed (c). 5. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT400/R to LocoNet port. 3. Press SWCH to enter switch mode. 4. Use numeric keypad to enter OpSw number (36). "36" is displayed on text line along with "t." 5. Press CLOC c to move it to "closed" position. 6. Move Command Station mode switch to RUN, and press EXIT or FUNC on throttle.

1.2.2 OPSW #39 Reset

This reset clears all internal memory states in the Command Station. The following is the process:

- At the Command Station, turn Track Power off.
- Carry out the following procedure to set OPSW #39.

Procedure to Set OPSW #39 for Total System Reset		
DT100/DT100R Throttles	DT300/DT300R Throttles	DT400/DT400R Throttles
1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT100/R to LocoNet port. 3. Press MODE/DISP to enter Switch mode. 4. Use throttle knobs to dial up OPSW #39. 39 will appear in display left side and "t" in display right side. 5. To change state of OPSW #39 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT300/R to LocoNet port. 3. Press MODE to enter Switch (Sw) mode. 4. Use throttle knobs to dial up OPSW #39. 39 will appear in display left side and "t" in display right side. 5. To change state of OPSW #39 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT400/R to LocoNet port. 3. Press SWCH to enter switch mode. 4. Use numeric keypad to enter OpSw number (39). "39" is displayed on text line along with "t." 5. Press CLOC c to move it to "closed" position. 6. Move Command Station mode switch to RUN, and press EXIT or FUNC on throttle.

- Reset all Command Station internal OPSW's to the state described in Appendix C, Section C.2.
- At the Command Station turn track power on.
- Inform train engineers they can re-program their locomotives and consists into the system and resume operations.

I.3 Shut Down Process

Whenever necessary to cease operations or at the time of tear down of the layout after the Convention ends the following process to shut down the DCC system will be followed:

- At the Command Station, turn Track Power off.
- Remove power from the Boosters.
- Set the Command Station mode switch to the Sleep position.
- Remove power from the Command Station

At the end of the Convention continue with disassembly of the total layout as described in Section 16.

Appendix J
Track and Wheel Cleaning

Clean track, clean turnout points and clean wheels are fundamental to reliable operation whether DC or DCC. All should be cleaned before the start of operations and again during operations as necessary to ensure continuous reliable operation. Peco turnout points provide a special cleaning need to ensure conductivity, especially with electrofrog turnouts.

J.1 Cleaning Track

Track cleaning removes oxides and dirt, both of which interfere with electrical pickup. There are at several ways to clean track, all of which will be used at NTS 2005. These include:

- An abrasive rubbing pad, such as a Bright Boy.

  Be careful with abrasives. Coarser grits scratch rails and minute ruts collect dirt. Finer grits polish railheads reducing traction.

- Track cleaning cars such as Aztec (liquid and abrasive) or Roco (abrasive).

  Be especially careful with car-mounted abrasive blocks since the polishing of the railheads is longitudinal in the same direction as tractive force.

- Centerline track cleaning cars, two used in tandem. The cloth on the front roller should be wet and the cloth on the rear roller should be dry.

- Atlas/Tomix motorized track-cleaning car.

  This car offers both liquid and abrasive cleaning as well as a vacuum effect to clean debris; only one effect can be used at a time.

- Wipe the track with a wet rag followed by a dry rag.

Suitable cleaning fluids are 409 Detergent, Fantastik or Isopropyl Alcohol, and electronic solvents (contact cleaners and degreasers, but be sure they are styrene compatible). Other cleaning fluids such as Goo Gone and lighter fluid are prohibited at NTS 2005 (Goo-Gone leaves a film on the track and lighter fluid is flammable).

It is important to be sure the track has dried from any liquid track cleaner and that any residue has been removed. If trains are run while the track is still wet, then the train will spread any dirt that is coming off wheels or the residue of the cleaner all over the layout.

Liquid track cleaning cars should be run only in special track cleaning trains. Abrasive track cleaning cars can be included in any train.

J.2 Cleaning Peco Turnouts

To clean Peco turnout points to improve electrical conductivity through the turnout, do the following:

- Fold a one-half inch by 4-inch slice of BLACK 320-grit wet/dry emery paper in half lengthwise.
- Place it between the stock and point rails. Hold the other point rail so the wet/dry paper is for sure going to contact both surfaces. Slowly move the paper back and forth; a few times is all that is needed.
- Repeat for the opposite stock/point rail.

- Place a drop or two of Atlas Conducta Lube & Cleaner on both stock/point rail pairs. This will improve the electrical contact of the points.

J.3 Cleaning Wheels

All attendees will be requested to clean the wheels on all of the locomotives and rolling stock that they will use on the Convention layout. The following procedure will be provided to attendees:

- Use a section of track approximately 12 – 18 inches long.
- Take a sheet of single thickness kitchen-type paper towel and place it over the track section.
- *Saturate* the towel with cleaning fluid (see below).
- Take one car at a time and roll it with left and right pressure to clean the flanges about 3 to 4 times. Check the wheels. If not clean repeat until clean.
- For locomotives connect the track section to an appropriate power source. Place one truck of the locomotive on the towel and the other on the track. Loosely hold the locomotive in place and turn on the power so the wheels turn. Continue until the wheels on that truck are clean. Turn the locomotive end-for-end and repeat for the other truck.

  The Minitrix No. 66623 Track Cleaning Fixture may also be used for cleaning locomotive wheels.

As the wheels become clean the paper towel will blacken. From time-to-time move the towel slightly so the wheels roll on a clean section. Be sure to keep the towel saturated by rewetting it from time-to-time.

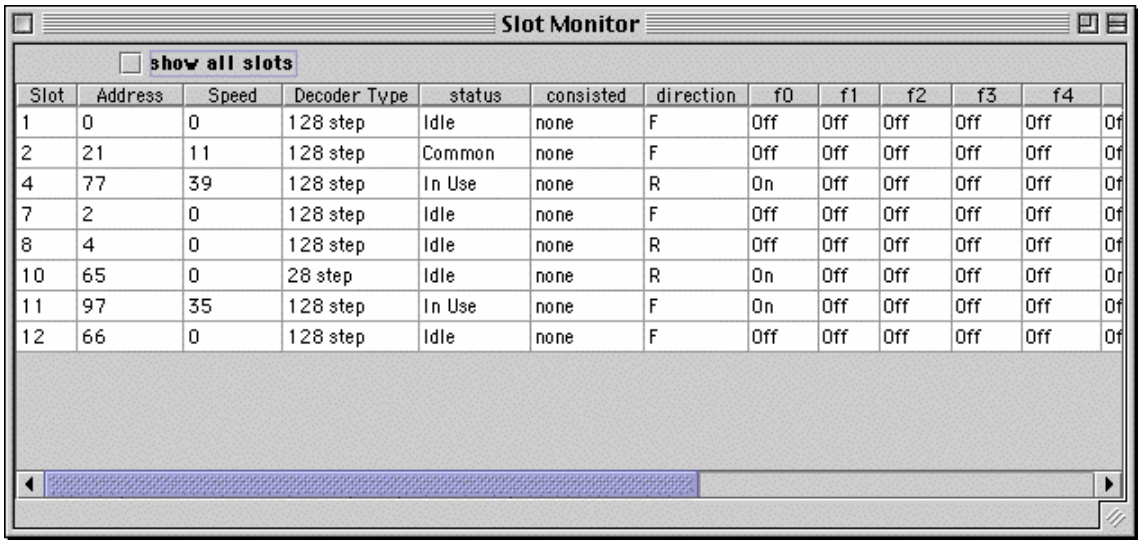
Suitable cleaning fluids are 409 Detergent, Fantastik, Isopropyl Alcohol, and electronic solvents (contact cleaners and degreasers, but be sure they are styrene compatible). The use of Goo Gone and lighter fluid will not be permitted at the Convention.

At least two wheel-cleaning stations will be provided at NTS 2005, one for the DCC layout and one for the DC layout.

Appendix K
System Monitoring and Measuring

K.1 Command Station Slot Monitoring

The Slot Monitor LocoNet Tool displays a table of the “command station slots” content. Slots are used to control individual locomotives and consists. The display includes the decoder’s speed step format, current speed and function settings, consist information and status. The tool can display all slots or only the slots being actively used. A sample display follows:



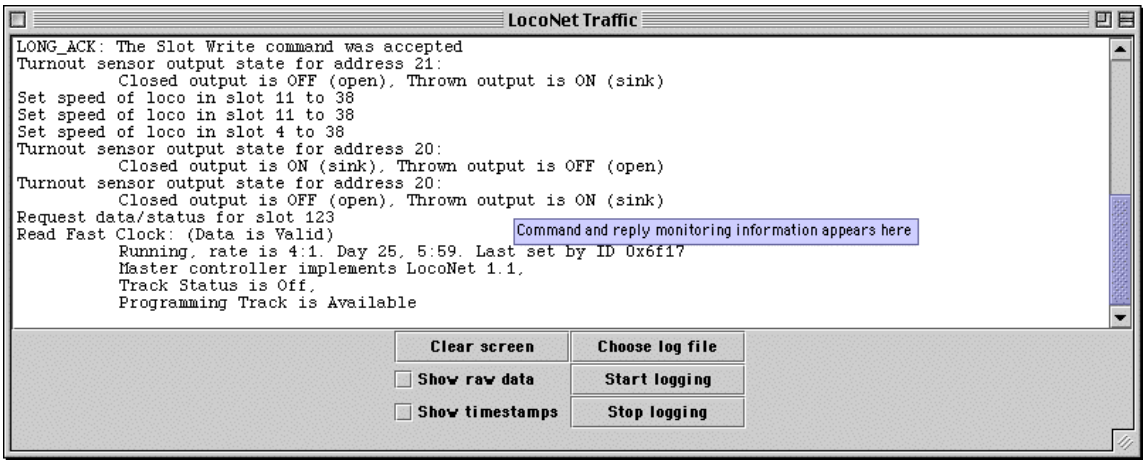
Slot	Address	Speed	Decoder Type	status	consisted	direction	f0	f1	f2	f3	f4	
1	0	0	128 step	Idle	none	F	Off	Off	Off	Off	Off	Of
2	21	11	128 step	Common	none	F	Off	Off	Off	Off	Off	Of
4	77	39	128 step	In Use	none	R	On	Off	Off	Off	Off	Of
7	2	0	128 step	Idle	none	F	Off	Off	Off	Off	Off	Of
8	4	0	128 step	Idle	none	R	Off	Off	Off	Off	Off	Of
10	65	0	28 step	Idle	none	R	On	Off	Off	Off	Off	Or
11	97	35	128 step	In Use	none	F	On	Off	Off	Off	Off	Of
12	66	0	128 step	Idle	none	F	Off	Off	Off	Off	Off	Of

The address display allows the Digital Team to determine if unauthorized locomotive addresses are being used.

The Slot Monitor LocoNet tool allows the individual release of slots, which should significantly reduce the instances when a full system reset might be required.

K.2 LocoNet Monitor

The LocoNet Monitor tool displays LocoNet traffic in a human-readable form. The last 20 messages are available in a scrolling window. Optionally, the time the message was received and/or the raw packet bytes can be included. The log information can be stored in a text file. A sample display follows:



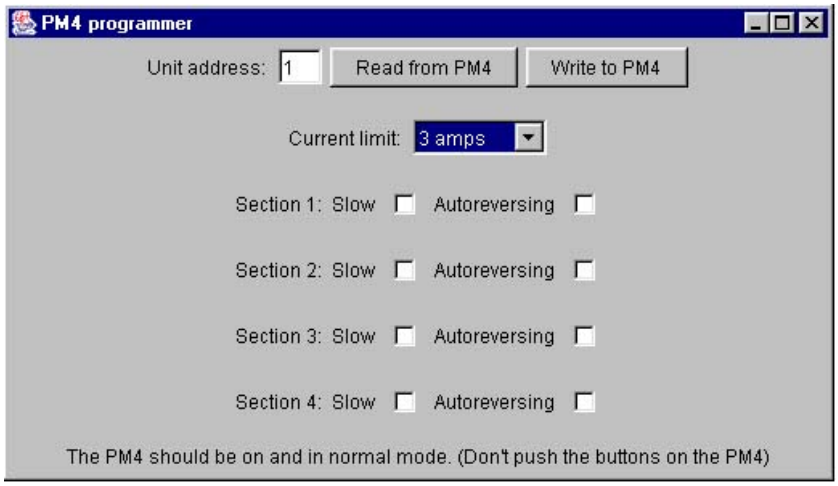
K.3 Programming the PM4 Power Manager

The PM4 Programmer provides a simple graphic interface for configuring Digitrax power management boards, once the PM4/PM42 has been assigned an address. Each section is shown as a checkbox on the screen. The current contents can be read from the board, and changes written to the board. There is no need to remove the board from the layout, or climb underneath the layout to push buttons as all programming is done via their LocoNet connections.

For dynamic configuration of PM4/PM42 boards they must be connected to ThrottleNet since they require access to the data lines. PM4/PM42 boards should ***NOT*** be connected to BoosterNet.

Addresses will be assigned to all PM4/PM42 boards in the layout by the BoosterNet setup team. A piece of tape will be attached to the PM4/PM42 board indicating its assigned address, and that address will be marked on the overall layout configuration diagram. The ThrottleNet setup team will ensure a ThrottleNet connect to each PM4/PM42 board.

As the screen display shows it is only necessary to enter the PM4's address then its current settings can be read and/or new settings created.



To set the PM4/PM42 board address do the following:

- Connect a DT-type throttle to the LocoNet port on the PM4/PM42.
- If the PM4/PM42 is not connected to a working LocoNet position the LocoNet termination jumper, located behind the RJ12 sockets, across both pins. This is not necessary if the PM4/PM42 is connected to a working LocoNet.
- Press and hold the "ID" button behind the green LED for about 1 second. The green "ID" LED will blink when the button is released. This indicates the PM4/PM42 is in board address setting mode.
- At NTS 2005, PM4/PM42 boards will be assigned addresses in the 100–200 range.
- Enter the Switch control mode on the throttle. Select the switch address that corresponds to the desired PM4/PM42 board address, then press the "c" button to issue a "closed" command. This sets the board address. The green "ID" LED changes to a steady green indicating PM4/PM42 power ON and that the board address setting mode is complete.
- Remove the LocoNet termination jumper, if it was used earlier.

Note that the PM4/PM42 response time should be set fast enough that a short circuit trips the PM4/PM42 before the associated Booster trips.

Following are the PM4/PM42 OPSW settings, if necessary to do manual programming with a DT-type throttle:

Short Circuit Trip Current (PM4 and PM42)				
OpSw	**Section 1**	**Section 2**	**Section 3**	**Section 4**
01	t	c	t	c
02	t	t	c	c
Trip Current	3A	6A	9A	12A

1. Trip current can be reduced by 1.5A from values above by setting OPSW 09 to "c."
2. The default value for all PM4/PM42 OPSWs is "t" (thrown).
3. OPSW 01 and 02 determine the trip current threshold for all 4 sections of the PM4/PM42. Default = 3A.

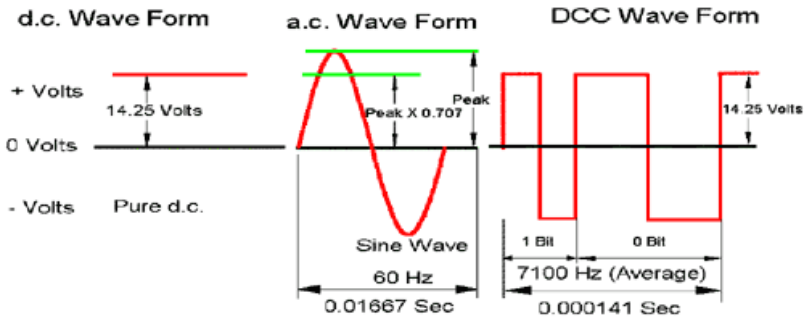
Short Circuit Current Sensitivity (PM42)			
Section 1	OPSW 03	OPSW 05	Sensitivity
	t	c	Slow
	t	t	Standard (Default)
	c	c	Faster
	c	t	Fastest
Section 2	OPSW 11	OPSW 13	Sensitivity per Section 1
Section 3	OPSW 19	OPSW21	Sensitivity per Section 1
Section 4	OPSW 27	OPSW 27	Sensitivity per Section 1

To change OpSw's using a DTxxx throttle instead of the PM4 Programmer, do the following:

- Enter Option Switch mode — press **OPTION** (left) button for 1 second and release. The Green **ID** LED and red **OPTION** LED will flash alternatively.
- Connect a DT series throttle to the PM4/PM42 LocoNet connector. If the PM4/PM42 is not connected to a working LocoNet, position the LocoNet termination jumper across both pins.
- Enter switch control mode on the throttle. Select the switch address for the desired **OpSw**. Press "c" or "t" as appropriate.
- When finished, press the **OPTION** button. The PM4/PM42 will exit **OPTION** mode. Open the LocoNet jumper.

K.4 Voltage and Current Measurements

The DCC waveform is neither DC nor sine wave AC. It is square-wave AC, as shown in the following diagram. Most common meters can read both DC and sine wave AC, but cannot accurately read DCC. In order to accurately read DCC power a true RMS meter is required. The true RMS meter to be used for voltage and current measurements at NTS 2005 is the RRampMeter, shown below, designed by Tony's Train Exchange.



Voltage is read by connecting the two terminals on the left side of the meter. The end of the circuit board has an area that permits putting the meter directly on the rails to measure the voltage, or a set of test clips can be plugged into a jack just behind the left-hand terminals. To measure current, the current must flow through the meter by connecting the two terminals on the right side of the meter. Again, a set of test clips can be plugged into a jack behind the right-hand terminals.

K.4.1 Measuring Voltage Drop and Loss

There are many places in the path from the Booster to the decoder where voltage can be lost, and the amount of loss generally increases with the amount of current drawn. All components in the path including the rails, rail joiners, wiring, connectors, etc., contribute to the voltage loss.

To determine voltage loss the voltage must be measured when current is flowing. Without a current flow there is little to no voltage loss. It is difficult to get a good stable voltage reading using a train running as a current load. Some type of steady load is required. An automotive lamp provides a steady load, and they are cheap and readily available. The following lamps are useful:

Lamp	Current
912	1A
1141	1.5A
1156	2.25A

Solder a couple of pieces of wire to the lamp terminals. Fasten alligator clips to the other ends of the wires, and then clip to the right side of the meter, as shown below.

To check voltage loss, proceed as follows:

- Measure the no load voltage of the Booster at a point as close to the Booster as possible.
- Leaving the RRampMeter connected near the Booster, connect the load (lamp) to the rails. The difference between the two readings provides the voltage loss of the Booster at the lamp current.
- Measure the no load voltage at the rails.
- Measure the voltage at the rails with the lamp clipped to the right side of the meter. Make additional measurements at other points within the electrical district as necessary.

By taking readings at specific points it is possible using this method to measure the voltage loss across many types of components, such as connectors, rail joiners, wiring, etc.

K.4.2 Monitoring Voltage and Current

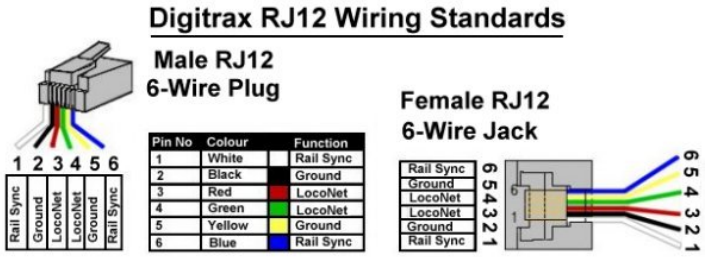
Using special cables with Cinch-Jones connectors on one end and the RRampMeter banana-type plug on the other it is possible to monitor voltage and current of an electrical district during layout operations. For example, the RRampMeter could be place in the track power feed between the Booster/PM4 and the cable connecting to the track plugs.

Appendix L
Troubleshooting

L.1 Replacing a Broken RJ12 Plug

RJ12 plugs on throttles and LocoNet cables occasionally break and must be replaced. The most common problem is the locking tab breaks off. Another problem is excessive strain on the wires inside the RJ12 plug causes one to break or become intermittent. Replacing the plug is easy and quick. Just do the following:

- Note the proper wire color as oriented to the existing plug. Looking at the RJ12 plug on a Digitrax throttle, with the locking tab up and away from you, as shown in the diagram below, the white wire is on the left.



- Cut off the damaged or failed plug as close to the plug as possible. Use diagonal wire cutters.
- Be sure the end of the cable is cut square and smooth. Use the jig built into the crimping tool to cut and remove the cable sheath back the proper distance.
- Insert one end of the cable into the cable jacket stripping blade of the crimping tool. Squeeze the handle and then carefully pull out the 6-wire cable from the tool. This operation removes the cable jacket exposing the 6 conductors. Be sure the ends of the wires are even; if necessary, make them even using the diagonal wire cutters. Spread the wires apart just slightly to ensure they will fit properly into the RJ12 plug.
- Slide the RJ12 connector onto the wires, making sure the wires stay lined up and the xx wire goes to the correct pin on the plug. The connector has six slots, one for each wire. Try to make each wire reach the end of its slot. The cable jacket/insulation should reach just beyond the end of the crimp point. If the insulation doesn't reach far enough inside the connector, cut the wires off just a bit more. If the cable jacket/insulation reaches too far past the crimp point or if the wires don't reach the end of their slot, simply trim off a little more jacket/insulation.

  For the RJ12 connector to be very reliable it is very important to ensure the cable jacket is inserted into the clear body of the connector. This is the only strain relief these frail wires will receive. If you fail to do this, the connector will, sooner or later, fail and cause trouble.
- Again verify that all is in order and insert the connector into the crimping tool. Crimp it. This requires a little bit of strength, and you may need to use two hands.
- Test the cable to make sure it works properly (Appendix E, Section E.2).

L.2 LocoNet Problems and Troubleshooting

The NET indicator on the DCS100/DCS200 Command Station is a red LED that displays information about what the Command Station sees on LocoNet. When the LocoNet is wired correctly and is operating properly, the NET indicator will be on and it will flicker off any time a good LocoNet

message is detected by the Command Station. The following table explains the various patterns for this indicator:

NET LED Indication	Meaning
Solid Red	LocoNet OK
ON, Blink Off	Command Station detects a valid LocoNet message
Off	Command Station detects a short circuit on LocoNet
Off, Blink Every 0.5 Second	Command Station is in Option Set Up Mode

L.2.1 Troubleshooting LocoNet

If an installed and working LocoNet starts causing or problems or stops working, testing each part of the LocoNet will be necessary to isolate the problem cable or components. The only tool necessary to do this is the Digitrax LT1 tester. Some faults can be better checked with a multimeter and test probes, but for expediency it is easier to replace any suspect cable or component.

The starting point for testing is at the Command Station and its LocoNet distribution PH-LL LocoLink 4-Way Connectors. For all tests be sure there is a Digitrax DTxxx throttle plugged into either the Command Station directly or the PH-LL. Following is the procedure:

- Starting at the appropriate PH-LL remove one main branch of the LocoNet and plug in the LT1. All 4 LEDs should light. If less than 4 LEDs or none light the problem is in the LocoNet leg still connected to the PH-LL. If all 4 LEDs light then the problem is in the LocoNet branch disconnected.
- Move out the affected branch to the end of the first cable, disconnect it and plug in the LT1 there. If less than 4 LEDs or none light then replace that cable.
- Continue outwards from the Command Station PH-LL. At each PH-LL splitting LocoNet into the various loops disconnect the loop LocoNet cable and test with the LT1 at the PH-LL.
- Continue along the spine or down the loop until the LT1 fails to light or less than 4 LEDs light, and replace the bad cable. If a PH-LL or other Universal Panel is determined to be the problem replace it.

Types of LocoNet problems to check for are:

- Plugs that aren't fully inserted into the jacks (insert the plug, then pull it back just a bit so that it "clicks" into place).
- Male plugs that haven't been properly crimped.
- Loose or broken wires on RJ12 telco jacks.
- Using 4-wire components (cables and plugs)
- Using Ethernet RJ45 components (jacks, plugs, Cat 5 cables)

L.3 Lost Control of Trains

Perhaps the most common problem encountered is lost control of trains, especially with wireless throttles. Most of these problems tend to be operator caused, not a system problem. The following items should be checked when operators report losing control of their trains.

L.3.1 Analog Address 00 is Active

While analog operation should be disabled and address 00 set to speed 00, it may be that this has not been reset when after being used for phasing or checking the phase of Boosters. Check to be sure address 00 is set to speed 00 and analog operation (OPSW #20=c) is

disabled in the Command Station. The "zero stretching" can cause various anomalies on the LocoNet, especially when a lot of locomotives are in use.

L.3.2 Locomotive Address Purging

Allowing the command stations slots to fill up often slows down throttle response. For this reason purging is enabled (OPSW #14=t), and set to force a purged address to stop (OPSW #15=c). The purge time is extended to 600 seconds (from 200 seconds) (OPSW #13=c) so that locomotives will not be purged during any delay less than 10 minutes on the layout.

L.3.3 Clear Command Station Locomotive and Consist Information

Consists made using Universal Consisting do not purge. As necessary and at least once each day, perform an OPSW #36=c to clear out all locomotive and consist information. Advise all operators before doing this reset, then let them know when it is complete and what they must do to resume operation.

Following is the procedure to clear locomotive and consist information:

Procedure to Set OPSW #36 to Clear Locomotive and Consist Information		
DT100/DT100R Throttles	DT300/DT300R Throttles	DT400/DT400R Throttles
1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT100/R to LocoNet port. 3. Press MODE/DISP to enter Switch mode. 4. Use throttle knobs to dial up OPSW #36. 36 will appear in display left side and "t" in display right side. 5. To change state of OPSW #36 press R reverse key for closed (c). 6. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT300/R to LocoNet port. 3. Press MODE to enter Switch (Sw) mode. 4. Use throttle knobs to dial up OPSW #36. 36 will appear in display left side and "t" in display right side. 5. To change state of OPSW #36 press R reverse key for closed (c). 5. Move Command Station mode switch to RUN.	1. Move right toggle switch on front of Command Station to OP position. 2. Disconnect LocoNet from Command Station and connect DT400/R to LocoNet port. 3. Press SWCH to enter switch mode. 4. Use numeric keypad to enter OpSw number (36). "36" is displayed on text line along with "t." 5. Press CLOC c to move it to "closed" position. 6. Move Command Station mode switch to RUN, and press EXIT or FUNC on throttle.

L.3.4 Throttle Power

Since all Digitrax UP3/UP5 Universal Panels will be powered by a wall-wart supply, this should only apply to throttles that are plugged-in, and to throttle-plug-ins that are not powered. The issue is the LocoNet voltage may be dragged down to the level where LocoNet becomes unstable.

Modules with built-in, non-UP throttle plug-ins need to be observed from time-to-time to ensure any wired throttles have batteries in them, and that no UT-type throttles are in use.

L.3.5 Throttle Settings

Wireless throttles can be set for wired operation only, radio only, or radio and IR operation. IR does not work very well in large open spaces such as the NTS 2005 layout so check the throttle is in radio mode.

If the throttle operates correctly when connected to LocoNet but not when untethered, even after ensuring correct battery polarity and confirming the battery is good, the problem may be that radio transmission has been turned off. Reset the throttle to normal radio mode. Be sure to release all addresses from the throttle knobs before doing this.
Check that when you first plug in the throttle to LocoNet, the display says rA:0n when n is a number. This indicates the UR91 is operating correctly.

The throttles should be set to the following options;

Option	Setting	Meaning
#1	x01	Ballistic Tracking & Typematic Keys, Key and Knob Clicks, Local Run/Stop
#2	x23	DT100R — 128 step decoder, Radio only enabled
	x43	DT300R/DT400R — 128 step decoder, Radio only enabled

Following is the procedure to set throttle options.

Procedure to Set Throttle Options		
DT100R Throttles	**DT300R Throttles**	**DT400R Throttles**
6. Unplug the DT100R from LocoNet. Press/hold SEL/SET key while plugging DT100R back into LocoNet. The display will show "oP:0x"., where "x" is the current setting. 7. Use R or L throttle knob to change setting to "oP:01". 8. Press SEL/SET key to save setting & advance to next option. The display will show "oS:xx". 9. Use R or L throttle knobs to change the setting to "oS:43". 10. Press SEL/SET to save setting then press SEL/SET two more times to complete the process.	7. Unplug the DT300R from LocoNet. Press/hold SEL key while plugging DT300R back into LocoNet. The display will show OP#1=??? where ??? is current setting. 8. Use R or L throttle knob to change setting to x01. 9. Press SEL key to set OP#1 and advance to OP#2. 10. Use R or L throttle knob to change the setting to x43. 11. Press SEL key to set OP#2 and advance to OP#3. 12. Since no change required in OP#3–6 press SEL four more times to step through these options.	7. Press the OPTN t key. The right side of the display will show the current value for OP#1 8. Use R or L throttle knob to change the setting to x01. 9. Press ENTER key to set OP#1 to the selected value &advance to OP#2. 10. Use R or L throttle knob to change the setting to x43. 11. Press ENTER key to set OP#2 to the selected value & advance to OP#3. 12. Since no change is required in OP#3–6 press ENTER key four more times to step through these options.
Note: DT100R and DT300R throttles will time out and return to RUN mode in 5 or 6 seconds if no action is taken following each step above. It is strongly recommended that all locomotives assigned to the throttle (both throttle knobs) are released (i.e. dispatched) before any throttle options are changed.		

L.3.6 Throttle Battery

If lost train control appears to be isolated to a single throttle and the throttle's settings are OK, check the throttle's battery. If this does not solve the problem remove the throttle from operation on the layout.

First be sure the battery is inserted in the throttle with the correct polarity. This condition should be suspect if the throttle display goes blank when the throttle is unplugged from ThrottleNet.

A good battery is key to successful operation in the radio (tetherless) mode. A battery is not needed when the throttle is plugged into LocoNet. Whatever may appear to be wrong with a throttle, the first thing to suspect is the battery. Replace the 9V battery with a new or known good battery. Try two or three batteries before deciding there is a fault with the throttle. Examples of problems caused by weak or dying batteries include:

- The throttle operates correctly when plugged into LocoNet, but you cannot control the train after it is unplugged.
- The throttle loses control of a train after a period of time.
- The throttle makes beeping noises.

Don't assume that a newly purchased battery will always be a good battery. A new battery can have a high internal resistance that prevents it from putting out sufficient voltage and/or current to operate the throttle. Always purchase batteries from a store that sells lots of

batteries and therefore always has fresh batteries on hand. Batteries have a "shelf life" as they will deteriorate even if not used.

L.3.7 UR-91 Radio Receivers

The number of UR91 receivers that will be used at NTS 2005, mounted on radio towers, should provide reliable operation. When there are complaints about radio reception, the wall-wart power supply to the UR91 should be checked that it is plugged into 120VAC.

L.3.8 Radio Deadspots

Several UR91 radio receivers will be strategically located around the DCC portion of the layout to minimize any problems with radio reception. However, radio dead spots may still be encountered. In most cases simply moving a foot or two should correct the problem.

In normal operation the best orientation is to hold the throttle from about horizontal to about 30 degrees upward in a natural hand position, about 12” out from the body.

L.3.9 Command Station Reset

If lost control issues cannot be resolved by application of the recommendations above, then a Command Station reset (OPSW #39) should be carried out.

L.4 Failing UP3 or UP5 Universal Panels

The following can happen to a Digitrax UP3 or UP5 Universal Panel only if it is connected to Track Power (via the rail screw terminals on the back) and a throttle with a damaged RJ12 connector is plugged in. The resulting damage is to blow one of the 500mA diodes in series with the external power connections to the UP3.

The problem throttle can have a damaged RJ12 plug, a bad crimp or a loose wire inside such that this throttle causes a short between one of the track terminals on the rear and the Booster via LocoNet. This is caused by the throttle shorting two of the pins in the UP throttle receptacle together either at the connector or in the throttle. The current path would pass the Booster’s power through the diode thus damaging it. Normally these diodes see very little current.

This may not always damage the diode and the throttle in question may appear to operate properly. Also, enough load may be presented that the Booster does not see a short. So this throttle may be used for a while until another diode blows. The UP3/UP5s may fail anywhere on the layout, in any electrical district, into which this throttle plugs.

The only way to detect the problem throttle is by plugging an LT-1 LocoNet Tester into one of the front receptacles on the UP3/UP5. When the bad throttle is plugged into the other front port, one of the two outside LEDs on the LT-1 will dim noticeably while this current path is in action.

Putting 100 ohm, 2-watt resistors in series with both rail connections will prevent damage to the diode(s) by limiting the current while still allowing the track to provide power for the UP3/UP5’s throttles.

At NTS 2005 failed UP3/UP5 Universal Panels will be replaced with a like UP, or with a Loy’s Toys PH-UP.

L.5 Short Circuits at Insulated Rail Frogs

This problem is encountered with insulfrog turnouts and crossings. The problem does not exist with electrofrog turnouts.

At insulated frogs the two rails in the frog are separated by a thin section of plastic. It is possible for the wheels treads of locomotives, lighted cars and any cars with metal wheels to momentarily bridge the insulation gap and contact both rails at the same time as the train passes through the frog, causing a short circuit.

With DC (analog) power, most power packs take a finite amount of time to detect the short circuit and shut down. By the time this occurs the locomotive/car has usually moved on and no longer bridges the gap. The train continues to run.

With DCC (digital) power, detection of the short circuit and shut down of the Booster/PM42 is much faster, sometimes instantaneous. The effect on the train will depend on its speed and whether the locomotive(s) have flywheels. A train traveling faster and/or having flywheels will probably continue past the frog thus ending the short circuit. There may be a noticeable jerk in speed, however. This scenario will repeat as each wheel set in the locomotives and cars pass the frog. It will also cause jerkiness in the speed of all trains in the same power district.

A train traveling slower and/or not having flywheels will probably jerk to a stop as a result of the short circuit. The train will probably have to be pulled through the frog to clear the short circuit. All trains in the same power district are affected.

The solution is to modify the frog to prevent the short circuit from happening. There are at least three (3) ways of doing this:

1) Brush a thin coat of clear nail polish on the end of the frog where the short occurs. This is the fastest solution, but the frog must be recoated from time-to-time as the nail polish wears off due to train traffic through the frog.

2) Glue thin paper or plastic to the frog to cover the area where a short may occur. If using plastic, file down the frog slightly so the top surface including the plastic overlay is flat. Also file the shape of the plastic to match the frog.

3) Using a Dremel tool, make the rail V-shaped, with the apex of the “V” the inside of the rails, where the flange contacts the rail.

Method 3 is preferred as it is permanent, but Method 1 is acceptable at NTS 2005 for expediency.

L.6 Advanced Consist Related Problems

These potential problems relate to Advanced Consisting.

L.6.1 Single Locomotive Does Not Run at Its Address

If a single locomotive will not run at its assigned two-digit or 4-digit address check and make sure that CV19 is set to 0.

L.6.2 Advanced Consist Does Not Run

If an advanced consist does not run, be sure the throttle is using the two-digit consist address, not the address of one of the locomotives.

L.6.3 Headlights/Functions Don’t Work on Lead Locomotive

If the headlight or other functions don’t work on the lead locomotive of an advanced consist, do one of the following:

- Pull up the lead locomotive on a throttle and use that throttle to control lights and functions. Speed and direction are controlled by the consist address..

- Put the locomotive on the programming track and make sure CVs 21 and 22 are set to allow the lead unit's headlights and functions to respond to commands sent out to the consist address.

L.7 Command Station/Booster Problems

If a Command Station/Booster and/or Booster is not performing properly on the layout, check the following items. If these do not bring the Command Station and/or Booster back to proper operation the unit should be sent to Digitrax for repair.

Before sending a DCS100 or DCS200 Command Station for repair, replace the CR2032 battery with a new battery and test again. Sometimes a low or dead CR2032 battery can create various problems.

L.7.1 Command Station Audible Sounds

The DCS100/200 emits several beeps and clicks that provide information on its status and which can be helpful in troubleshooting any problems.

Sound	DCS100/200 Meaning
1 Beep	DCS powered on successfully or sent programming command.
3 Beeps	Loco address has been "purged" due to non-use.
4 Beeps	Route nesting error or too many entries cascaded
5 Beeps	Booster short circuit shutdown. Fault alarm
6 Beeps	Command Station already present in system
7 Beeps	CMOS battery low condition
8 Beeps	Memory ECC/checksum fail. Auto reset (no action)
9 Beeps	DCS transmit failure. LocoNet fault
16 Beeps	Software timeout failure. Auto reset (no action)
Continuous soft clicks	Low input supply voltage (<9.5VDC or <8VAC)

L.7.2 Nothing is Responding

L.7.2.1 No LEDs lit on Front Panel of the Command Station/Booster.

Check the following:

- Check the power supply to ensure the 120VAC plug is firmly inserted in the outlet, and there is power to the outlet.
- Check any fuses and/or circuit breakers on the power supply to ensure they have not blown or tripped. Replace with the same rated fuse. Apply power. If the fuse blows again disconnect the wires from the Command Station/Booster and try another fuse. If it still blows then replace the power supply.
- Once the power supply is verified as producing power, check the connections from the power supply to the Power In connections on the front of the Command Station/Booster. Ensure they are firmly attached.
- Swap out the power supply if there are still no lights on the Command Station/Booster.
- If the above does not correct the problem, replace the Command Station/Booster and send the faulty Command Station/Booster to Digitrax for repair.

L.7.2.2 Some LEDs Lit on Front Panel of the Command/Station/Booster

Check the following:

- Check the throttle's **Track Status Indicator** to see if track power is turned off at a throttle. If the Track Status LED or Dot is not on, turn track power on at a throttle.
- To turn track power on with a DT100 or DT300 press the STOP and Y/+ buttons together. To turn Track Power on with a DT400 press the POWER and then the Y/+ buttons.

L.7.3 No Power or Intermittent Operation

The majority of intermittent operation problems result from bad connections on the layout, dirty track or dirty wheels and power pickups on locomotives. Do the following:

- Clean the track and locomotive wheels and power pickups.
- Check for adequate track power everywhere in the electrical district using the quarter test. Take a quarter and move along the track in the electrical district from boundary to boundary creating short circuits every 4 feet or so. The Booster should beep and shut down virtually instantaneously as each short is detected. When the coin is removed the Booster should return to normal operations. If this does not happen or the Booster takes more than 1 second to shut down check wiring to ensure minimal voltage drop in the feeder wires. Add more feeders as necessary.

  If there is a Power Manager between the Booster and track it should trip before the Booster.
- Check LocoNet cables with the LT1 tester to ensure the cables are sound.
- Check locomotives for problems with their mechanical drive train and make sure there is free movement of the locomotive wheel sets. This is a particular issue with inexpensive locomotives.

L.7.4 Troubleshooting Command Station/Booster Shutdowns

If the Command Station/Booster and/or Booster shuts down when not planned or shuts down frequently do the following:

- Ensure the Command Station/Booster heat sink has a flow of cool air.
- Place the Command Station/Booster out of direct radiant heat such as sunshine or other heater.
- Use a small fan to blow air onto the heat sink. If this is a recurring problem consider mounting a cooling fan directly to the fins of the heat sink.
- Lower the track load current by running fewer locomotives or making the electrical district smaller.
- Reduce the input voltage from the power supply. For operation at the N scale setting the recommended input voltage from the power supply is 14V.

L.7.5 Layout Wiring Issues

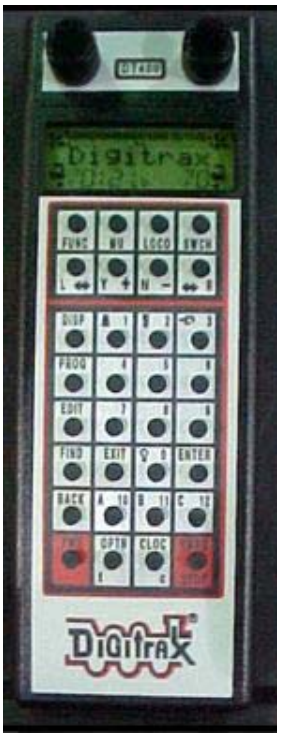
Sometimes problems with layout wiring can create what appears to be a Command Station/Booster problem. The way to verify whether the Command Station/Booster or the layout wiring is the problem is to disconnect the Command Station/Booster from the layout and test it on a small section of track (that is not connected to the layout). If the Command Station/Booster works OK in this configuration the problem lies in the layout. If the Command Station/Booster still does not work it should be sent to Digitrax fro repair.

Appendix M
Summary Throttle Operating Instructions

This Appendix provides summary operating instructions and helpful hints for the Digitrax DT100R, DT300R and DT400R throttles that will be used on the DCC portion of the layout at NTS 2005. Operation of DT100, DT200, DT300 and DT400 tethered throttles is similar. Refer to this Appendix as needed for help.

DT100R Throttle

DT300R Throttle



DT400R Throttle

M.1 General Information

The following general information on the use of Digitrax DTxxxR throttles will provide improved performance and radio signal reception.

M.1.1 Throttle Knob Movements

When operating in radio mode, throttle knob tracking will feel slightly different than when connected to LocoNet. I***n radio mode, slow movement of the throttle knob will result in improved response.*** It will also provide less congestion to the radio receivers and LocoNet.

M.1.2 Throttle Orientation

The optimum orientation to hold the DTxxxR in normal usage is from horizontal to 30º upward in a natural hand position about 12" out from your body. This gives the best radio coverage. Although there are several radio receivers located in and about the layout, occasionally wiring, metal plumbing, HVAC ducting and other items may cause small areas of poor radio reception. **Moving about 6" – 24" in any direction or varying the orientation of the DTxxxR will typically overcome any dropouts.**

M.1.3 Display Power Down

If an untethered DTxxxR throttle detects no user throttle activity for about 3 minutes, it will enter Power Saver Mode and display r-PS on the display until a throttle or button action restores normal activity and displays. If the DTxxxR has a locomotive assigned to it and is in

Power Saver Mode, it will continue to "check in" with the system every 60 seconds telling the system "I'm still here." This keeps the system from releasing the locomotive back to "common." **The easiest and fastest way to signal the DTxxxR to exit from Power Saver Mode is to hold down either the + or – button.**

M.2 Throttle Operations

M.2.1 Select Locomotive to Drive

DT100R Throttle	DT300R Throttle	DT400R Throttle
• DT100R must be connected to LocoNet. • Turn desired throttle knob at least ¼ turn in either direction until display shows SE:L-. • To select 2-Digit Address, press SEL/SET. Display shows 00:03 with "00" flashing. Turn either throttle knob until desired locomotive address appears on display. Press SEL/SET to set address active. • To select 4-Digit Address, press and hold SEL/SET then turn one throttle knob. DT100R enters 4-digit address range & RED EXP indicator lights. Select 4-digit address (left knob changes in hundreds, right in units). Press SEL/SET to set address active.	• DT300R must be connected to LocoNet. • Turn desired throttle knob at least ¼ turn in either direction or press down on knob. • Press SEL/SET; Loco icon flashes. • To select 2-Digit Address turn left throttle knob so "00" appears in display, then use right knob to dial up desired address. Press SEL/SET to set address active. • To select 4-Digit Address use left throttle knob to dial up first 2 digits (1000's & 100's) &right knob to dial up last two digits (10's & 1's). Press SEL/SET to set address active.	• DT400R must be connected to LocoNet. • Turn desired throttle knob at least ¼ turn in either direction. • Press LOCO. Display shows SEL under activated knob. • Use the numeric keypad to enter the desired address (either 2-digit or 4-digit) • Press LOCO to select the address. The loco icon associated with the throttle knob shows a direction arrow and blinking smoke. The blinking smoke indicates which throttle knob is associated with the top line of the display.

M.2.2 Controlling Lights and Functions

DT100R Throttle	DT300R Throttle	DT400R Throttle
• Press FUNC/F0 to get to Light/Function mode for display active throttle. Display shows Fn:00 with n flashing to indicate the function number of desired function needs to be selected. • Use one of five BLUE buttons to choose desired function. FUNC/F0 controls lights. Pressing FUNC/FO toggles light from off (F0:of) to on (F0:on) to off, etc. • Operation is the same for other functions F1, F2, F3, F4. • To access functions F5–F7 press & hold FUNC/F0 while pressing the BLUE F5, F6, F7 or F8 buttons to toggle between on & off. • Adjust either throttle to return to Loco mode.	• Press FUNC/F0 button to get to Light/Function mode for display active throttle. Display shows Fn:00 with n flashing to indicate the function number of desired function needs to be selected. • Use one of five BLUE buttons to choose desired function. FUNC/F0 controls lights. Pressing FUNC/FO toggles light from off (F0:of) to on (F0:on) to off, etc. • Operation is the same for other functions F1, F2, F3, F4. • To access functions F5–F7 press & hold FUNC/F0 while pressing the BLUE F5, F6, F7 or F8 buttons to toggle between on & off. • Adjust either throttle to return to Loco mode.	• Ensure the throttle knob to be used is in normal function mode, as it is during normal locomotive operations. If not sure press FUNC. • For the light function (F0) press the LAMP 0 button to toggle F0 on and off. • For functions 1–12 press the button on the numeric keypad that corresponds with the desired function to be turned on/off. Note that F2 is a non-latching function and only is on as long as button 2 is held down. To latch F2 hold down button 2 then press the PWR button then release both simultaneously.

M.2.3 Locomotive Speed and Direction Control

DT100R Throttle	DT300R Throttle	DT400R Throttle
• Turn throttle knob for locomotive whose speed is to be changed. UP/+ & DOWN/- can also be used. • With 2-digit address speed is shown on right side of display. • With 4-digit address speed flashes up as SP:XX. Display will return to 4-digit address. • To change direction press c/R for right throttle knob or L/t for left throttle knob. Direction indicator changes color (to RED for reverse or GREEN for forward.)	• Turn throttle knob for locomotive whose speed is to be changed. Y+ & N- buttons can also be used. • % of full speed will be displayed in text line of display on the L or R side depending on throttle knob that is controlling locomotive. % of full speed is also displayed on bar graph above the text area in the display. • To change direction double click the Throttle Knob controlling locomotive or press the L or R Reverse button.	• Turn throttle knob for locomotive whose speed is to be changed. The Y+ and N- buttons can also be used. • % of full speed will be displayed in text line of display on the L or R side depending on throttle knob that is controlling locomotive. % of full speed is also displayed on bar graph above the text area in the display. • To change direction double click the Throttle Knob controlling locomotive or press the L or R Reverse button.

M.2.4 Dispatching/Releasing an Address from a Throttle

DT100R Throttle	DT300R Throttle	DT400R Throttle
• DT100R must be connected to LocoNet. • Ensure the locomotive speed is 00. • Press SEL/SET then MODE/DISP. DT100 LCD will show SEL.	• DT300R must be connected to LocoNet. • Ensure the locomotive speed is 00. • Press SEL then press MODE. The DT300 LCD will show SEL.	• DT400R must be connected to LocoNet. • Ensure the locomotive speed is 00. • Press LOCO then press DISP. The DT400 LCD will show SEL.
Note: if the throttle is not plugged onto LocoNet when this step is carried out the address will be released from the throttle, but will not be dispatched from the system.		

M.2.5 Stealing a Locomotive/Slot Following

DT100R Throttle	DT300R Throttle	DT400R Throttle
• DT100R must be connected to LocoNet. • Press SEL/SET to enter selection mode. • Dial up address to be stolen. • Press SEL/SET. • Disconnect DT100R from LocoNet. Display should go to idle. • Press and hold Direction Arrow button for throttle knob used above and plug DT100R back into LocoNet. • After DT100R beeps release direction button. Slot following mode is active.	• DT300R must be connected to LocoNet. • Press SEL/SET to enter selection mode. • Dial up address to be stolen • Press SEL/SET. • If address can be stolen, DT300 will display Steal?=Y in text area. • Press Y+ to steal or N- to not steal. • Slot following mode is active	• DT400R must be connected to LocoNet. • Press LOCO to enter selection mode. • Dial address to be stolen & press LOCO again. • If address can be stolen, DT400 will display Steal?=Y in text area. • Press Y+ to steal or N- to not steal. • Slot following mode is active.

M.2.6 Status Editing a Decoder

DT100R Throttle	DT300R Throttle	DT400R Throttle
• DT100R must be connected to LocoNet. • Press SEL/SET to enter selection mode. Be sure desired address is displayed. • Press FUNC to enter status edit mode. Current status code xy at right of test area flashes. • Use either throttle knob to change status code value. • Once desired code is displayed press SEL/SET to change status code and select address to run.	• DT300R must be connected to LocoNet. • Press SEL/SET to enter selection mode. Be sure desired address is displayed. • Press FN F0 to enter status edit mode. Lo changes to SE and current status code displayed in text area. • Use either throttle knob or Y+ or N- buttons to change status code value. • Once desired code is displayed press SEL/SET to change status code and select address to run.	• DT400R must be connected to LocoNet. • Press LOCO to enter selection mode. • To display current status turn throttle knob up one address & back to original. • Press EDIT. Lo changes to SE & current status code displayed. • Use throttle knob or press EDIT to scroll through status codes. • Once desired code is displayed press ENTER to change status code & select address to run.

M.3 Consisting

The preferred method of consisting at NTS 2005 is either **Basic** or **Advanced** (Decoder Assisted) Consisting, which only use one memory slot per consist. **UniVersal** Consisting is ***discouraged*** due to the requirement for a memory slot in the Command Station per locomotive. Basic or Advanced Consisting can be set up prior to the Convention or at the Programming Stations.

M.3.1 Basic Consisting

With Basic Consisting all locomotives in the consist are programmed to the same address. For locomotives moving in the forward physical direction program CV29 to 06/x06 for 2-digit address or 38/x26 for 4-digit address. For locomotive(s) moving in the reverse physical direction program CV29 to 07/x07 for 2-digit address or 39/x27 for 4-digit address. (Note: the first figure is the decimal value and the second figure, with the x, is the hexadecimal value.) The DT100R and DT300R program in hexadecimal. The DT400R programs in either format. For non-Digitrax decoders these values may be different; check the decoder manual.

M.3.2 Advanced (Decoder Assisted) Consisting

Not all decoders are capable of Advanced Consisting. Digitrax FX decoders (DNxxFX, DN14x, DN16x and DZ143) can be used with Advanced Consisting. For compatibility of

other manufacturer's decoders with Advanced Consisting check your decoder manual. Programming of Advanced Consists will be carried out at the Programming Station.

M.4 Programming Decoders

Throttle directions for programming decoders are not provided here since staffed Programming Stations are available at NTS 2005. The programming staff is fully qualified to provide assistance as needed in programming decoders.

Operations Mode Programming on the layout tracks is prohibited at NTS 2005. It is too easy to make an unintentional error with Operations Mode Programming that could cause problems for another locomotive or the entire layout.

M.5 Throttle Problems and Maintenance

If problems with a throttle are encountered during the Convention check the following items. If these do not solve the problem the throttle should be taken to the on-duty Digital Master, who will check it out.

M.5.1 Battery

Be sure the battery is installed with the correct polarity. Check this especially if the throttle display goes blank when unplugged from ThrottleNet.

A good battery is key to successful operation in the radio (tetherless) mode. A battery is not needed when the throttle is plugged into LocoNet. Whatever may appear to be wrong with a throttle, the first thing to suspect is the battery. Replace the 9V battery with a new or known good battery. Try two or three batteries before deciding there is a fault with the throttle. Examples of problems caused by weak or dying batteries include:

- The throttle operates correctly when plugged into LocoNet, but you cannot control the train after it is unplugged.
- The throttle loses control of a train after a period of time.
- The throttle makes beeping noises.

Don't assume that a newly purchased battery will always be a good battery. A new battery can have a high internal resistance that prevents it from putting out sufficient voltage and/or current to operate the throttle. Always purchase batteries from a store that sells lots of batteries and therefore always has fresh batteries on hand. Batteries have a "shelf life" as they will deteriorate even if not used.

M.5.2 No Radio Operation

If the throttle operates correctly when connected to LocoNet but not when untethered, even after ensuring the battery is good, the problem may be that radio transmission has been turned off. Bring the throttle to the on-duty Digital Master who will check it out and make sure radio transmission is turned on.

M.5.3 Loose Throttle Knobs

The throttle knobs are held in place by two 0.050" screws, which can work loose over time. The screws require a 0.050" Allen wrench to tighten them. When tightening the screws, be careful not to put too much sideways pressure on the knob, as the encoder shaft can be damaged. If the throttle knob(s) gets loose bring the throttle to the on-duty Digital Master, who will have the required Allen wrench.

M.5.4 RJ12 Plug

There are 3 potential problems relating to the RJ12 plug on the end of the stubby LocoNet cable:

- The locking tab breaks off,
- The contacts on the plug are bent or otherwise damaged (rare), or
- The wires are not making a good connection with the contacts in the plug.

The solution to any of these problems is to replace the RJ12 plug. The on-duty Digital Master is equipped to replace your damaged RJ connector.