

Recommended Practices for 120VAC Layout Wiring

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Introduction

NTRAK and T-TRAK layouts use standard 120VAC electrical power for various purposes: the power supplies that power throttles and DCC equipment, on-module accessories, module lighting, signs and other miscellaneous uses such as soldering irons, power tools and vacuum cleaners. The 120VAC wiring to and around modules must meet certain standards defined in the current issues of the National Electric Code (NEC), the Uniform Fire Code (UFC) and the International Fire Code (IFC). In addition, states and/or local municipalities may impose their own variations on these codes, which are generally more restrictive than the codes themselves; local codes may take precedence over the national codes. Layout coordinators should consult local fire and building codes prior to set up. Any questions should be directed to the local authorities.

Standards for the components used for 120VAC wiring (power strips, extension cords, etc.) are defined by Underwriters Laboratories (UL), specifically Standard UL-817 (Cord Sets and Power Supply Cords) and UL-1363 (Relocatable Power Taps).

Background

Early on the NTRAK Modular Railroading Society, Inc. (NTRAK) recognized the need to safely distribute 120VAC power around our layouts. Initially a standard electrical outlet box with receptacle and cover permanently fastened to the bottom of the NTRAK module was recommended. A cord with a plug on the end was permanently secured to the box and ran from this box, attached to the bottom of the module, to the other end of the module where it could be plugged into the box on the next module.

In 1988, in recognition of possible safety issues with such "homebrew" approaches and based on input from the National Model Railroad Association (NMRA) Technical Department the recommendation was changed to use commercial, UL-approved power strips with each NTRAK module, suspended from the module by cup hooks. While not permanently mounted to the modules, these would be plugged together to extend 120VAC power down the layout as needed.

In July 2004, the Fire Codes were amended concerning the use of such power strips ("Relocatable Power Taps" in NEC parlance), stating that "A cord-connected Relocatable Power Tap is not intended to be connected to another cord-connected Relocatable Power Tap". This technically put the typical NTRAK module AC power configuration (daisy-chained power strips) at odds with the code, even though our power usage was low and presented little danger of the overloads the NEC revision was designed to address.

With the temporary nature of most of our setups, this has not previously been an issue; however some NTRAK layouts were flagged by local Fire Marshalls for the use of "daisy-chained" power strips, and although they were allowed to continue the show, they were informed that future setups must be code-compliant. Safety inspectors elsewhere around the country have become more rigorous in their enforcement of this provision as well, and this trend is likely to continue.

As a result of the recent code change, and possible increased enforcement of this provision, the NTRAK Modular Railroading Society, Inc. is no longer recommending the use of power strips in a daisy-chain configuration. Accordingly, and after a review of other applicable codes, NTRAK's recommendations for AC power distribution to layouts and modules have been revised. These are presented in this document.

NTRAK's recommendations are intended to insure the successful interconnection and interoperation of modules. How modules are hooked up to venue power is outside of NTRAK's control and individuals and/or clubs can do anything they wish, realizing that other codes and standards may apply. NTRAK, Inc. will not knowingly advocate anything that is against code. The recommendations in this document offer an approach that, to the best of NTRAK's knowledge, will be code compliant in the great majority of cases. Whether or not an individual and/or group decides to implement these recommendations is up to them.

The Rules According to the NEC, UFC and IFC

After a review of the applicable codes and other codes and standards, the following is a summary of what these rules mean for NTRAK and T-TRAK layouts:

What We Are NOT ALLOWED to Do

The following are not permitted:

- A power strip (RPT) cannot be plugged into another power strip or into an extension cord.
- An extension cord cannot be plugged into another extension cord.
- Multiplug adapters are not permitted.

What We Are REQUIRED to Do

We must comply with the following:

- Any power strips (RPTs) used must be UL approved 3-wire (i.e. with ground), rated for 15 Amps and must include a 15 Amp resettable circuit breaker.
- Ground-Fault Circuit Interrupter (GFCI) outlets are required in areas where electricity and water may come into contact or where a "massive ground" environment which would present a safety hazard is encountered.
- Extension cords must be UL approved 3-wire rated for 15 Amps either with outlets along their length, a single female outlet at the end, three female outlets at the end, or permanently fixed into a reel with two or four outlets.

What We Are ALLOWED to Do

We are permitted to do the following:

- A power strip (RPT) can only be plugged into an approved receptacle (i.e. wall outlet, floor outlet or permanently wired power drop).
- Extension cords with one or more outlets, either at the end or along their length, can be plugged into this power strip or into an approved receptacle.
- A single electrical device can be plugged into each such extension cord outlet, being careful to ensure the total current load of all devices is within the rated capacity of the overall circuit.
- We are also allowed connections involving Uninterruptible Power Supplies (UPS) as follows:
 - Approved receptacle to UPS to extension cord to device.
 - Approved receptacle to power strip to UPS to device(s).
 - Approved receptacle to UPS to device(s).

- Approved receptacle to UPS to power strip to device(s).

NTRAK, Inc. Recommended Practice

The following recommendations are made to ensure that NTRAK and T-TRAK modules and layouts are as compliant as possible to current electrical and fire codes.

Modules

NTRAK Modules NOT NEEDING 120VAC should have the Power Strip or the older outlet box/receptacle with wire and plug removed.

NTRAK Modules that need power ONLY when used at home should have any Power Strips removed before taking the module to a show layout.

Lighting effects and animations on modules should be powered by low voltage wherever possible. Power supplies for these effects should be UL listed devices. Such power supplies should not be mounted to modules but mounted on a shelf mounted on a module with quick connect plugs on the low voltage side. Additional recommendations for low voltage power will be made in a separate Recommended Practice.

Layout Coordinators

Club layout coordinators are responsible to ensure the layout meets the requirements of the electrical and fire codes in force in the location of the layout. Coordinators need to work out plans to suit layout sizes and track power needs:

- Purchase Commercial grade Power Strips with 15' cords (as defined above) as necessary. The 15' cord could let a power strip be placed across an aisle, when needed.
- Purchase an assortment of extension cords (25', 50' and 100') that meet code specs.

Extension cords must be UL approved, 3-wire rated for 15 Amps either with outlets along their length, a single female receptacle at the end, three female receptacles at the end, or permanently fixed in a reel with two or four outlets. For extension cords of 50 ft length or less, this means 14/3-gauge wire. For extension cords greater than 50 ft up to 100 ft this means 12/3-gauge wire.

Household, small thin type extension cords; spliced cords; or homemade receptacles are not permitted. Extension cords with broken wires or damaged insulation must be discarded; splicing or taping is not allowed.

- Power strip cords and extensions cords subjected to foot or equipment traffic must be protected from damage as follows:
 - Cords 3/8" or less in diameter must be covered with hard plastic "office cord covers" or an approved alternate method.
 - Cords larger than 3/8" in diameter must use a plywood ramp style cover, or an approved alternate method.
 - All cord covers must be secured in place using tape, nails or other methods.
- Purchase Ground-Fault Circuit Interrupter (GFCI) units as required; the use of GFCI units for all applications is strongly recommended.

Although GFCI circuit protection is not required on all layouts, it is a good practice and highly recommended to always use GFCI protection. The GFCI protection device should be the first device connected to the building outlet (approved receptacle).

- The use of multiplug adapters is prohibited.

Layout coordinators also need to pay attention to workmanship and the neatness of the 120VAC wiring; workmanship is what catches the inspector's eyes first. Wherever possible the 120VAC wiring should be

suspended from NTRAK modules using Velcro, twist wraps, tie wraps or cup hooks. If any 120VAC wiring must be on the floor it should be routed under the NTRAK modules or T-TRAK tables where it cannot be damaged, unless protected by a cover as defined above.

Options for module low voltage power requirements for animation, lighting, local track power, etc., are the subject of a separate Recommended Practice.

Purchasing Code Compliant Wiring Devices

There are many UL-listed compliant devices that can be used with NTRAK and T-TRAK modules and layouts. Those listed below are a sample of the available devices. A summary of the requirements for each device is included.

These devices can be purchased at many different locations, including hardware stores, home centers, electrical supply stores, etc.

Purchasing Extension Cords

Extension cords must be UL approved and rated for 15 Amps with either outlets along their length, a single female receptacle at the end, three female receptacles at the end, or permanently fixed in a reel with two or four outlets. Extension cords must be three-conductor (grounded) and polarized. They must be rated "Heavy Duty" or "Extra-Heavy Duty" and must be a continuous length. Cords classified as SO, ST and SJ meet this requirement. For extension cords up to 50 ft length, this means 14/3-gauge wire. For extension cords 50 ft and up to 100 ft this means 12/3-gauge wire.

Extension Cords with End Outlets

- Tradesman Model 832462 25 Foot 14/3 Cord with Powerlite Power Block
- Woods Model 8819 50 Foot 12/3 SJTW 2-Outlet Power Block
- Woods Model 8820 100 Foot 12/3 SJTW 3-Outlet Power Block
- Yellow Jacket Model 82827 50 Foot 12/3 Power Block

Extension Cords with Multiple Outlets Along Their Length

ElectraTrac Multi Outlet Extension Cords. Available in 25 (12 and 14 gauge) and 50 foot (12 gauge) lengths with lighted outlets every 8 feet.

Nexstep Model 50101 Multi-Outlet Extension Cord, 25', 14/3 STW, 15A/125V, 3 outlets spaced at 8-foot intervals.

Nexstep Model 50112 Multi-Outlet Extension Cord, 50', 12/3 STW, 15A/125V, 6 lighted outlets at 10-foot intervals.

Hard plastic "office cord covers" can be purchased at Best Buy, Circuit City, Office Depot, Office Max, Staples and most hardware, computer and building supply stores.

Purchasing Ground-Fault Circuit Interrupter (GFCI) Units

A GFCI instantly interrupts the circuit to the load (i.e. disconnects) when a fault to ground exceeds a predetermined value that is less than that required to operate the over-current protective device of the supply circuit. FCI devices must be used outdoors, within six feet of a water source, in damp/wet locations and in any area where a person may be in direct contact with a solidly grounded conductive object (UL 943).

As the "first line of defense", GFCIs may be incorporated into an approved power strip, via a wall plug adapter or in-line adapter.

Power-Strip with GFCI and Overcurrent Protection

Stanley/Belkin Model STB102 Combo Pack with Model STP280 Power Strip and Model STA143 GFCI Protector

Tripp Lite Model PS-615-HGULTRA 6-Outlet Power Strip with 15ft power cord, built-in circuit breaker and built-in GFCI protection. (www.tripplite.com)

Wall Plug GFCI Adapter

Grainger Model 5YL43

In-Line GFCI Adapter

Stanley/Belkin Model STA143

Technology Research Corporation Model 14880-4-001

Purchasing Power Strips

A “power strip” is called a “Relocatable Power Tap (RPT)” in electrical code parlance. It is different from an extension cord in that it has 3 or more female outlets and includes overcurrent protection. A “Cord-connected Relocatable Power Tap” has a cord with a male plug on it. For NTRAK applications a Power Strip with a 15 ft. cord is recommended.

Power Strip with GFCI & Overcurrent Protection

Stanley/Belkin Model STB102 Combo Pack with Model STP280 Power Strip and Model STA143 GFCI Protector

Tripp Lite Model PS-615-HGULTRA 6-Outlet Power Strip with 15ft power cord, built-in circuit breaker and built-in GFCI protection. (www.tripplite.com)

Power Strips with 15Ft Cord, On/Off Switch & Overcurrent Protection

Hammond Model 1584H6B1, 6 Outlets

Hammond Model 1584H8B1, 8 Outlets

Stanley/Belkin Model STP280, 8 Outlets

Waber by Tripp Lite, Model 6SPDX-15, 6 Outlets

Wiremold Model UL207BD, 6 Outlets

Wiremold Model UL210BD, 10 Outlets

Wiremold Model UL218BD, 8 Outlets

References

NTRAK Publications

- NTRAK Module Manual
- The NTRAK Manual “How To” Book

Standards Publications

- National Fire Protection Association (www.nfpa.org)
 - NFPA publishes the National Electric Code (NEC), publication NFPA 70..
 - NFPA publishes the Uniform Fire Code, publication NFPA 1.
- International Fire Code Institute, a division of the International Code Council (www.iccsafe.org), publishes the International Fire Code.
- Underwriters Laboratories (www.ul.com). Relevant UL standards at ulstandardsinfontet.ul.com

Other Publications

- Extension Cords, University of Houston Department of Public Safety, Fire Marshall’s Office.
- Extension Cord Safety, Thomas Jefferson National Accelerator Facility, November 2004.
- Fire Safety Requirements for Eugene Outdoor and Indoor Events Involving: Assemblies, Carnivals, Fairs, Exhibitions and Tents, Eugene Fire & EMS Fire Prevention Section, Eugene, OR, September 2005.
- Ground-Fault Circuit Interrupters, US Consumer Product Safety Commission, August 2004.
- Self-Fire Inspection Checklist, City of Medford, OR.
- Temporary Wiring & Extension Cord Use for Permitted Events, Office of the Fire Marshall, Eugene, OR 9/1/2005.
- Use of Extension Cords and Multiplug Adapters, City of Houston Fire Department

Source

This TipsNTechniques originated with the North Raleigh Model Railroad Club and has been used and modified with their permission.