

## Wiring Your Layout with LocoNet By Bruce DeMaeyer

There are no real restrictions on LocoNet wiring with respect to wire pairs. Most Digitrax customers choose to use 6 wire Telco type flat ribbon cables because they are cost effective, simple to wire and give superior network performance.

Digitrax engineered LocoNet to use 6 wires because of several advantages outlined below.

LocoNet can support a total cable length of up to 1,200 feet. No two devices should be connected by more than 600 feet of cable. This allows for the network to be split & branched in a free form style with no stringent connection rules for network transmission. You can "tree" or branch out network stubs wherever it is convenient for the layout and debugging or servicing. The single network termination needed is provided by the Command Station. ***We do not recommend ever looping the network back on itself.***

You can purchase ready made 6 pin male RJ12 to RJ12 jumper cables of various lengths from many sources. *Be sure to use 6 conductor and not 4 conductor plugs and wires.* Alternately, you can crimp your own jumper cables. LocoNet cables should be wired pin 1 to pin 1. When you hold the plug with the tab up and investigate the end of the connector, you will see, from left to right, white-black-red-green-yellow-blue wires. This arrangement is called a "reversing" cable in the telecom industry. The UP5 is "reversing" in that all pin 1s of the RJ12 jacks connect to one another.

- 1) In a 6-wire flat configuration, as crimped onto a RJ12 6 pin style plug, the left 3 wires are effectively a "mirror" image of the right 3 wires. This allows you to "daisy-chain" outlets without worrying about whether the cables are "reversing" or "non-reversing."
- 2) There are 2 ground and 2 LocoNet data connections, so the effective "loop resistance" is lower due to paralleled wires. This makes it possible to run LocoNet over greater distances than other command control systems.
- 3) If a ground or signal connection is broken or intermittent the network can still maintain a reliable connection. These types of faults are the greatest nightmare to locate and fix!
- 4) The two outside wires, typically Blue and White in a 6 conductor Telco ribbon, carry opposite phase copies of the master system rail packets, this is called RAIL SYNC. Because these are broadcast differentially in a single cable, we can accurately and reliably tap a remote Track booster anywhere along a LocoNet cable run. We can do this many thousands of feet from the Master Packet generator (Command station) with very good

signal fidelity, even in the presence of a lot of noise and interference! Also, this signal can support several low current draw modules that can tap on anywhere in the network.

- 5) The balanced nature of the cable and the way the signal currents propagate in this "RF Quad" configuration allow the lowest possible RFI radiation outwards, and EMC susceptibility or inward interference pickup. This is a good thing. This is part of the reason Digitrax's LocoNet handily passed the FCC Class B radiation Certification requirements.
- 6) The LocoNet philosophy and architecture were carefully crafted to allow "free-form" wiring with no termination or "linear-bus" restrictions. You can "star", "tee" into, branch or expand the network any way that is convenient for you. If you do choose to "loop" the wiring back on itself (like a snake biting its tail) be sure that the outside 2 Railsync wires have a matched polarity! The center 4 pins of the RJ12 can be plugged in either orientation.

These are the reasons we would recommend the loop around the layout be a 6-conductor ribbon type wire. The wire gauge in the range of 22AWG to 28AWG is OK. Telco uses typically 26AWG. If you don't mind the extra work, you could use round 3 pair cables. It is best to stay with a fixed color to pin number in the jacks throughout the layout to prevent later problems debugging!

We find it best to break up this "backbone" wiring into sections. Each section will be a run of cable connected by male-male 6 conductor cords with RJ12 plugs on each end. This allows the network to be quickly disconnected and isolated for fault-finding or expansion.

The Digitrax Universal Panels (UP1, UP2, UP3 & UP5) and Digitrax Universal Receivers (UR91 & UR92) are connection panels that are very convenient for quick layout hook up. They come in a variety of configurations to suit the needs of most layouts. You just plug in your cables, and you are ready to play. Obviously, it is cheaper to use 6 conductor dual wall plates and wire them in parallel around the layout. This will take you a little more time but will save money. The main downside to this is that if any of the cables are disturbed or yanked on, it is very time-consuming to try to repair a "bird nest" of small wires under the layout! The choice is up to the you!

Your LocoNet wiring scheme is very flexible and easy to wire. It was designed to be "plug & play" because we know you would rather spend your time running your trains instead of troubleshooting the wiring. The primary concern really boils down to having a physically secure and maintainable wiring strategy and discipline.

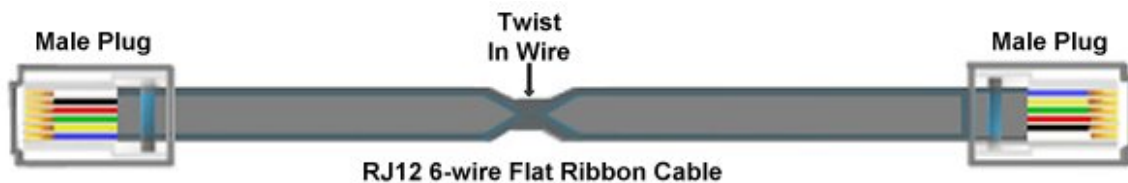
It remains very important that every cable on your layout should be labeled with its name (on both ends)

The "glow" of low-price wire and fixtures quickly fades, as you become the poor individual who has to trouble-shoot a maze of "spaghetti" that was disturbed by someone who tripped over "some wires" under the layout!!

## The Digitrax RJ12 LocoNet Wiring Standard

Somewhere in the instruction manual, it says that "The RJ12 is the 6-pin version of the RJ11 connector with all pins loaded with conductors. This is the connector that Digitrax uses for LocoNet." At which point, your eyes start to glaze over, and you go off into a trance.

Now before you go into a coma, let's back up a bit. You're familiar with your telephone set and the cables and plugs that go into the telephone set. On the previous page, we've shown you some of the Digitrax components that use these components. The LocoNet consists of the same type of wires and connectors - used in your telephone system - with one very important difference. Your telephone cables may have 2 or 4 small wires covered by that grey, black or white plastic insulation. The Digitrax LocoNet uses components that use 6 wires. Here's what this type of cable looks like. It's not much different from the cable that goes into your telephone set.



The telephone/data communications industry calls this an "RJ12 6-wire standard". RJ12 components consist of 6-wire telephone cable, 6-wire male plugs and 6-wire female jacks. You can have many different combinations of these components:

- Male plug to flat cable to male plug.
- Male plug to flat cable to female jack.
- Male plug to two female jacks - all in one plastic assembly.
- Female jack to female jack - all in one plastic assembly (module railroad clubs call this a gender bender).
- Female jack in a wallplate or two female jacks in a wallplate
- Male plug to flat cable to two female jacks (I call this a double-female extension cord)

This is what some of these components look like.



Two RJ12 Female Jacks in a Wallplate



RJ12 Male Plug to Flat Cable



RJ12 Double-Female Extension Cord



RJ12 Female-Female Gender Bender

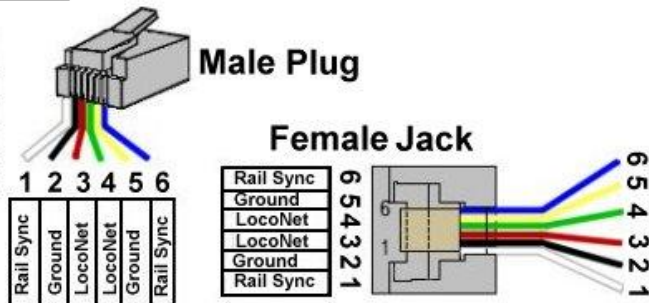
If you have a Digitrax system, 6 wires are very important. Anything less and it won't work.

Here are the wiring standards, wire colors, functions, and pinouts for the Digitrax RJ12 6-wire LocoNet.

## Digitrax Wiring Standards

Pin No	Colour	Function	Voltage
1	White	Rail Sync-B	7 vdc
2	Black	Ground	—
3	Red	LocoNet	14.5 vdc
4	Green	LocoNet	14.5 vdc
5	Yellow	Ground	—
6	Blue	Rail Sync-A	7 vdc

All components are RJ12 6-wire  
Do not use RJ11 4-wire.



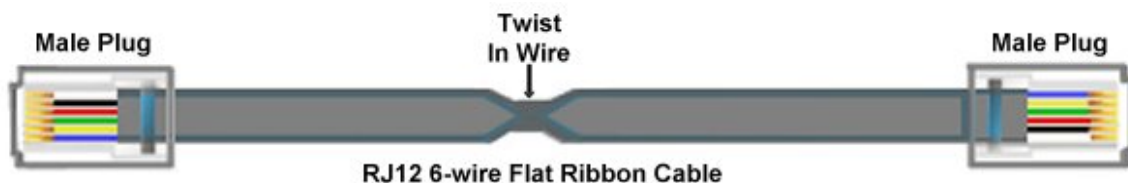
Note the relationship between the Pin Number, the color of the wire inside the cable, the function, and the voltage. If you look at the front of the male plug, you'll see that the White wire (Pin 1) is on the left, and the Blue wire (Pin 6) is on the right. If you look at the front of the female jack, you'll see that the White wire (Pin 1) is on the right, and the Blue wire (Pin 6) is on the left.

If you visually connect the male plug to the female jack, you'll see that the white wire of the male plug connects to the white wire of the female jack, the black wire connects to the black wire, the red to the red, the green to the green, the yellow to the yellow, the blue to the blue. This is sometimes referred to "Pin 1 to Pin 1, Pin 2 to Pin 2, Pin 3 to Pin 3, Pin 4 to Pin 4, Pin 5 to Pin 5, Pin 6 to Pin 6" wiring - or "Pin 1 to Pin 1" wiring to keep it short. It will help in troubleshooting if you always make sure that each colored wire connects to its own color.

Also note that

- The blue wire has the same function as the white wire - Rail Sync
- The yellow wire has the same function as the black wire - Ground
- The green wire has the same function as the red wire - LocoNet

So, if you happen to crimp a male plug onto the end of a cable the wrong way, it won't affect the operation of the LocoNet because the corresponding wire at the other end (blue - white, yellow - black, green - red) both have the same function. (It's not necessary to understand what Rail Sync, Ground, or LocoNet functions are.) However, we highly recommend that you make sure that Pin 1 is connected to Pin 1..... Pin 6 is connected to Pin 6.



Here's that cable we showed you at the top of the page. You'll note that, to keep the Pin 1 to Pin 1 orientation, we must put a twist in the cable.

What we do is crimp one of the male plugs with the tab on top of the cable and crimp the other male plug with the tab on the bottom of the cable. The Digitrax manual shows it something like this.



We'll show you a little trick to help you keep that orientation when it comes to crimping on those male plugs.

RJ Information for Those "Pickers of Nits"  
(Skip this part if you aren't one of *these people*)

*RJ stands for Registered Jack* - as in telephone jack - as in registered with the Federal Communications Commission (FCC) by the telephone industry when plastic modular components were developed in the 1950s/60s. Later, as data communications technology developed, the telecommunications industry added to these standards. The RJ standards don't refer to the physical size of the male plugs or the female jack. They refer to the way the jack is to be wired and what all this wiring is to be used for.

To confuse things even more, the RJ standards specify the number of cables (wires) going into the plug or jack and the number of positions available in the plug or jack to anchor these wires to. **For example, the RJ12 LocoNet plugs and jacks we use are specified as RJ12 6p6c.** That is, 6 positions are available to anchor the wires (the 6p). And 6 cables (wires) can be wired into the plug or jack (the 6c). And all this wiring is to be used for a Local Area Network (LAN) - which we call the LocoNet.

### **Powering the devices comprising your LocoNet Network.**

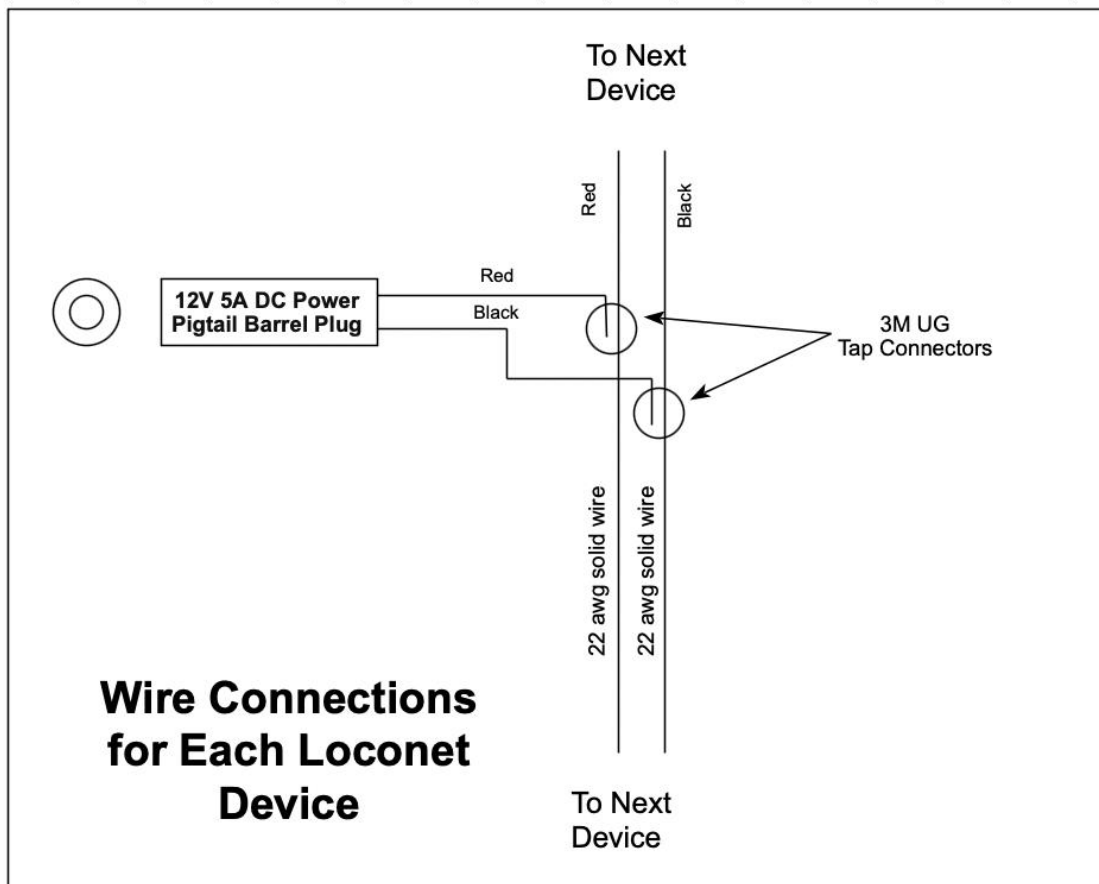
To work properly, the many devices that comprise your LocoNet needs to be supplied with 12v power, usually into a barrel type plug on each of the devices. You can use Digitrax PS14 wall "warts" for this task but the larger LocoNet layouts can also be powered by a dedicated 12v network. Digitrax suggests each device will consume about 100 milliamps of 12v DC Power.

So, multiply the number of devices on the network (in my case 20 devices) and then double the number (in my case watts) and this will give you the 12v power needs for your network (in my case 24 watts).

My layout has an auxiliary power supply (for non-rail) requirements and can easily supply this need for power. The individual devices can be connected using a Pigtail Barrel Plug Connector wired as described below. Use Red and Black solid 22 Gauge wire for your LocoNet power wiring. Connecting the wires with Corning K5/UG Tap Connectors ( available at Amazon).

Slide the connector into the through channel of the connector and insert the clean-cut end of the barrel connector (color to color) into the closed channel of the connector and squeeze the green top with a slip joint pliers.

Careful application of these ideas should result in a very stable LocoNet.



Standard	Use	Positions/Cable	Authority	Plug Width	Jack Width
RJH	Telephone Phone Headset	4p4c	FCC	0.299 "	0.355 "
RJ11	Telephone Phone Single Line	6p2c	FCC	0.375 "	0.383 "
RJ14	Telephone Phone Two Line	6p4c	FCC	0.375 "	0.383 "
RJ12	LAN/Printer network	6p6c	Industry	0.375 "	0.383 "
RJ25	Same as RJ12 but for stranded cable	6p6c	Industry	0.375 "	0.383 "
RJ45	LAN/Data network	8p8c	Industry	0.492 "	0.459 "

The columns for "Plug Width" and "Jack Width" aren't part of the standards. To remove some confusion, I took my digital caliper and measured these plugs. RJ11 RJ14, RJ12, and RJ25 have the same Plug and Jack Widths. But only RJ12 and RJ25 have the number of cables/positions we need for our LocoNet.

#### The Bottom Line

So, what does all this mean to you and me and our Digitrax LocoNet system?

We must make sure that we use a plug/jack that is about 0.375"/0.383" wide and has a 6p6c configuration – i.e., it takes 6-wires.

The only jacks/ plugs/ components that fit the bill are the RJ12 and RJ25.

Because the LocoNet wiring is so critical to the success of the Digitrax Layout, I decided to buy the best cable tools available.

I decided on the Klein Tools VDV2266-011



### **Ratcheting Modular Crimper/Stripper**

The all-in-one Ratcheting Modular Crimper/Stripper cuts, strips and crimps paired-conductor cables (round STP/UTP and flat-satin phone cables). Durably made from steel and finished in black oxide for high performance, it provides fast, reliable modular-crimp connector installation for voice- and data applications. Crimps 4, 6, and 8 position modular connectors (RJ22, RJ11/RJ12, and RJ45).

- Fast, reliable modular-crimp connector installation for voice and data applications.
- All-In-One Tool, cuts, strips and crimps paired-conductor cables (round STP/UTP and flat-satin phone cable).
- Crimps 4, 6, and 8 position modular connectors (RJ22, RJ11/RJ12, and RJ45).
- Steel body with black-oxide finish for excellent performance and durability.
- Crimping dies are precision ground from high-carbon steel.
- Designed for Western Electric (WE)/Stewart Stamping (SS)-type modular connectors.

- Ratchet safety-release and a blade-guard on cutting and stripping knives reduce risk of injury.
- Full-cycle ratchet mechanism prevents the release of the connector prior to full compression.

**Crimps 4, 6, and 8 position modular connectors (RJ22, RJ11/RJ12 and RJ45)**

**KLEIN TOOLS**

Since 1857

**Cuts, strips and crimps paired-conductor cables (round STP/UTP and flat-satin phone cable)**

**Fast, reliable modular-crimp connector installation for voice and data applications**



Several years ago, when building my Lexington Layout, I bought a large spool of 6 Pair Flat Telephone cable suitable for use on the Digitrax LocoNet.

For those of you without this benefit, you can still order **Flat Modular Cable Cord, 6 Conductor, Stranded Copper 26 AWG, 100' FT Bulk Cable Roll RJ12 Gray Telephone Wire Silver Satin 6C RJ-12 Phone Wire** from Amazon. Do not use round CAT 5 internet cable.

I also had several RJ12 Plugs available in my wiring supplies, but if you need to order them you can still get them on Amazon, be sure to specify RJ12, 6P6C Modular Plugs.

There are also a couple of YouTube DIY videos that can easily show you how to use the Klein Crimper.

Hope this helps you create a flawless LocoNet for your layout.