RR-CirKits
Specializing in Affordable Electronics for Model Railroads

LNCP
LocoNet Control Point

Multi I/O to LocoNet® Interface
Firmware Revision 1.0

User's Guide

Contact Information

RR-CirKits, Inc.
7918 Royal Ct.
Waxhaw, NC USA 28173

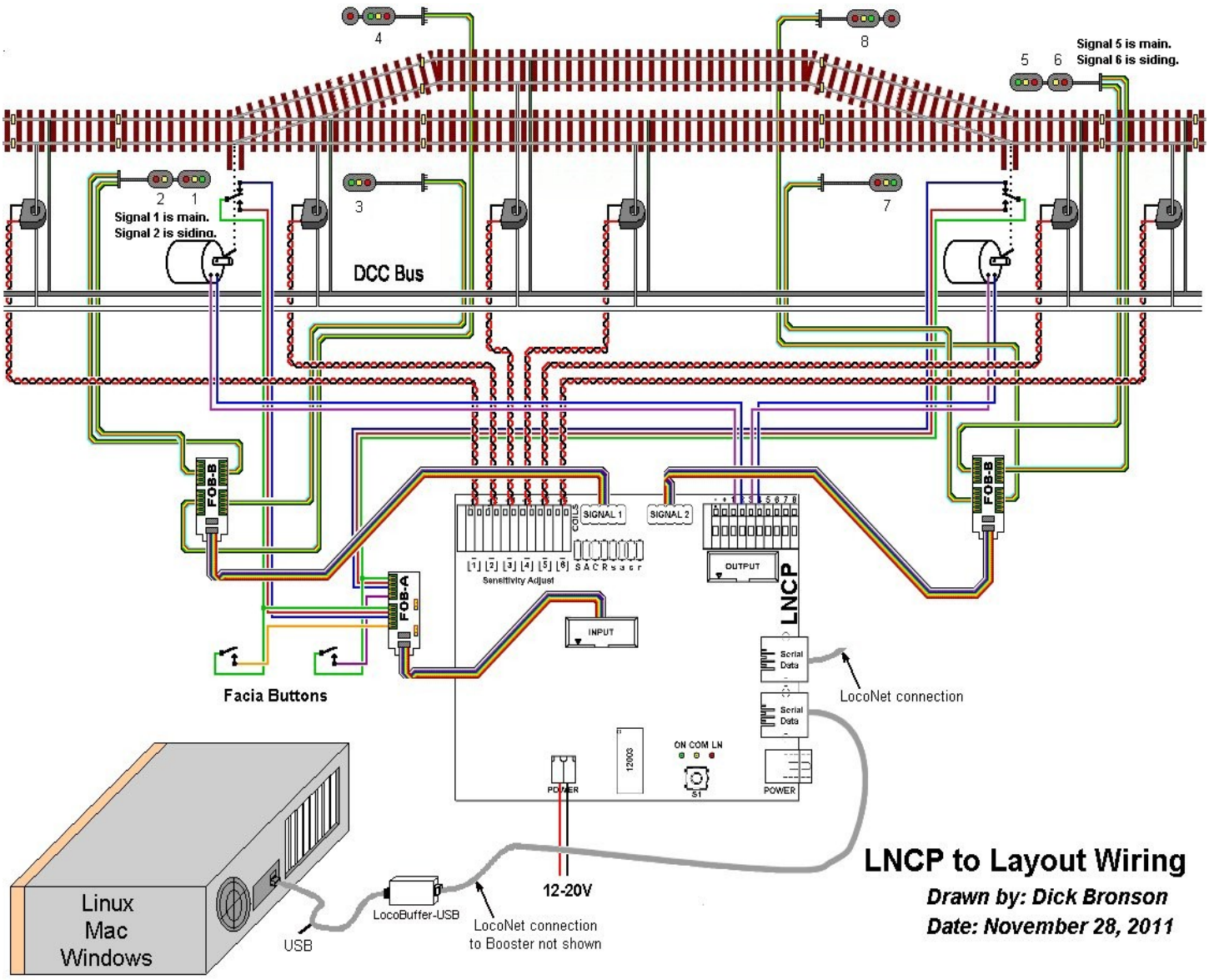
http://www.rr-cirkits.com
sales@rr-cirkits.com
service@rr-cirkits.com
1-704-843-3769
Fax: 1-704-243-4310

LocoNet® is a trademark of Digitrax Inc. (http://www.digitrax.com/)

WARNING: This product contains a chemical known to the state of California to cause cancer, birth defects or other reproductive harm.

Overview

The LNCP Multi I/O LocoNet® interface provides a simple and easy way to connect between the Digitrax LocoNet® bus and the layout. It may be connected at any convenient point on the LocoNet®.



1.0 Features

- All necessary hardware for a complete passing siding.
- Includes:
  - 6 Block Detectors.
  - Drive for up to 32 signal LEDs.
  - 8 inputs for local contacts.
  - 8 outputs with low power drivers.
- Internal Logic Blocks with up to 64 conditional statements.
- Communicates over the LocoNet® compatible serial interface.
- CV controlled programming via Software. (e.g. JMRI DecoderPro 2.14 or later.) Both reading and writing of CV values is supported in OPs mode.
- Each input and output line is individually addressed.
- Signal masts may be configured with up to 4 lamps per aspect.
- Automatically saves status during power down. (optionally)
- Boot Loader allows firmware upgrades over LocoNet® connection
- External power input accepts 12V-20V wide range without overheating. Dual Internal switching regulators provide up to ½ amp at 5VDC and 10VDC total power to ports for optional I/O modules and output drivers.
- 10VDC drive for LEDs and Stall Motor machines. Allows driving multiple LEDs in series.

2.0 Quick Start

We suggest that you use a computer program such as the JMRI DecoderPro (2.13 or later) to setup the LNCP. The "point and click" interface will save you much time and frustration while setting the many possible options that you will need to configure.

- **OPS Mode Address:** Each LNCP has a single address that is used for OPS mode programming on the layout. Each individual LNCP on your layout must have its own address. Your LNCP comes pre-programmed with an address that is 12xxx where 12xxx is the digits of the serial number. E.g. device serial number 12015a would have a programming address of 12015.
- This Ops mode address is only used to configure the LNCP. It has nothing to do with the addresses that each input/output line will use to communicate information with the LocoNet® system.
- This address **must not** conflict with that of any Locomotives or other devices in use on the layout, as no distinction is made between mobile and fixed decoders in OPS mode. If you need to modify the address for any reason it must be a long address in the range of 0001-16383. We suggest that you choose a 5 digit address to avoid potential conflicts.
- **Prior to connecting** your LNCP you should make a DecoderPro roster entry for it. Open the '**Service Mode Programmer '** and select RR-CirKits LNCP as the decoder type. Click 'Open Programmer', then go to the 'Basic' tab, check '4 digit addressing' and enter your unit's **5 digit** address in the 'Long Address' box. Go to the 'Roster Entry' tab, enter an ID (e.g. LNCP 12015) and then click on the 'Save' button.
- Connect and power up the LNCP. The green power ON status indicator should illuminate.
- Once the LNCP is operating, all actual configuration, other than any changes to the address, must be done with the **'Operations Mode Programmer'**.
- The LNCP decoder file is very large. You must use JMRI version 2.14 or later. (2.13.4 test or later) You also must not attempt to open two different programming windows at the same time. This will exceed the JMRI internal memory allocations.
- Connect the unit's LocoNet® jack to any point on your system's LocoNet®. The red status indicator should now indicate all LocoNet®activity. The yellow command indicator will light each time the LNCP initiates or responds to a LocoNet® command.
- You should now be able to interface to your Railroad from your software.

3.0 Power and Serial Connections

The LNCP (LocoNet Control Point) has ten connectors and three status indicators. Four of these are for connections to the system. The rest are connections to the layout devices. This section covers the system connections consisting of the serial port connectors, power connections and Status indicators.

3.1 LocoNet® Compatible Serial Port Connector

The serial port connection is made to the LNCP via the provided serial cable connected to either of the two RJ-12 (6 pin) modular jacks. Serial data cables are normally wired straight through, not reversed like phone cables. Either serial port may be used for connections because the wiring passes straight through both connectors.

Pin outs for the RJ-12 serial data connector:

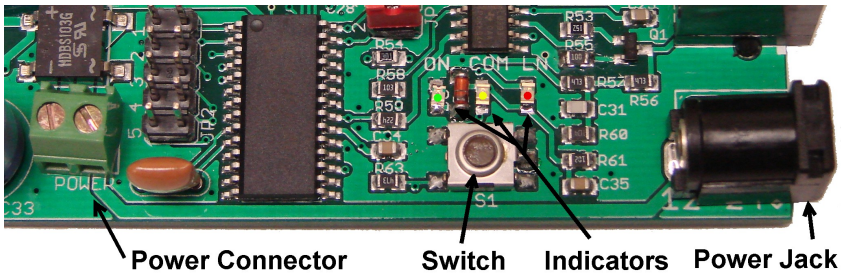
Pin	Description	Color
1	Rail_Sync-	white
2	Signal Ground	black
3	Serial-	red
4	Serial+	green
5	Signal Ground	yellow
6	Rail_Sync+	blue

Serial port pins 2 and 5, and pins 3 and 4 are connected together internally. (there is no distinction between Serial + and Serial -)

3.2 Power Connections

The LNCP requires an external power source of between 12 and 25 volts DC or 9-18VAC and should provide 8VA or more. Multiply the output voltage times the rated current to get VA. For example a 12V 800ma. supply would provide 9.6VA and be a good choice. A 9V 300ma, supply would only provide 2.7VA and severely limit the output drive capability of the LNCP. A voltage of less than 12VDC but at least 9V DC will reduce the LED and Tortoise drive voltage from its normal 10VDC, but otherwise not affect proper operation.

There are two power connectors on the LNCP. One is a standard 5.5mm coaxial power jack that is compatible with many wall plug power supplies. The other is a two position screw connector labeled 'POWER'. The connections are in parallel with each other and either or both may be used. For example a wall plug power supply may be connected to one LNCP unit via the power jack, and a two wire jumper from the power connector connected to other LNCP units in order to share the power.



3.3 Status Indicators

The LNCP has three status indicators located near to the coaxial power connector. The green ON status indicator shows the power status of the LNCP itself. The yellow COM (command) indicator normally shows all data activity addressed to, or coming from, this specific LNCP, and also any activity/error status during a boot loader firmware upgrade. (see section 8.0) The red (LN) indicator shows all serial port (LocoNet®) activity. Commands not acted upon by the LNCP will blink the red Activity indicator but not the yellow Command indicator.

4.0 Input/Output Connections

The LNCP Layout Input and Output cables are connected via two 10 pin polarized headers, Each header is know as a "Port". They are labeled 'INPUT' and 'OUTPUT'. Each port is configured individually with its own CV values. Each line has its own individual address. The number of addresses used by each port will be either 4 or 8 depending on its configuration and use. Multiple ports on different LNCP units may be assigned to the same and/or to different addresses.

We suggest that the user take advantage of JMRI DecoderPro or a similar program to set the values, rather than attempting to use a hand held controller due to the large number of items to set. Current versions of DP have the capability of setting groups of values with one selection.

4.1 Port connections

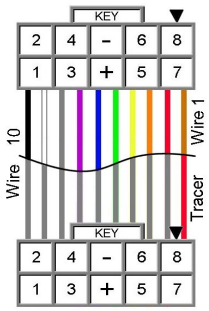
Each port connector contains 8 I/O data lines and two power connections, +5VDC and Ground. The +5VDC power available from either port should be limited to 200ma. (power connections plus lines)

4.1.1 Port Electrical

The maximum current draw by user devices such as LEDs should not exceed 15ma. at 5VDC per output line. The maximum current draw from any individual port, including data lines and the 5V supply line is 200ma. The total current per LNCP is limited to 960ma. The LNCP includes an internal 1A switching power supply and an internal auto reset fuse to protect against long term overloads that exceed these values. If you need to drive more voltage and/or current, then you will need to use an external I/O module powered from its own source.

4.1.2 Connector Pin Identification

Wire/Pin number	*I/O line number*
Brown 1 Tracer	Line 8 (h)
Red 2 Gray	Line 7 (g)
Orange 3 Gray	Line 6 (f)
Yellow 4 Gray	Line 5 (e)
Green 5 Gray	Ground
Blue 6 Gray	+5VDC
Violet 7 Gray	Line 4 (d)
Gray 8 Gray	Line 3 (c)
White 9 Gray	Line 2 (b)
Black 10 Gray	Line 1 (a)



Note: I/O line 1 is wire #10, I/O line 8 is wire #1. 10 position IDC connector

4.1.3 Detector Configuration

The LNCP includes the electronics for 6 CT (Current Transformer) based block detectors. The separately mounted CT coils are placed directly on one side of each block by running one of the track feeders through the center of a CT coil before it attaches to the DCC bus. It is recommended that all CT coils be placed on either Rail A or Rail B of your DCC layout. However when detecting reversing loops or “Y” tracks this is not necessary. The coil may be placed on either rail. Also because the detection draws no power from the tracks it is possible to construct overlapping detection districts simply by routing the track feeders through multiple CT coils as required. This will often be the case when a highway grade crossing is located in a way that does not match up with the signaling blocks. Simply cut gaps for each section and run feeders through each set of CT coils as appropriate.

To configure the detector inputs using DecoderPro, open the OPs mode programmer using the OPs mode address of the LNCP that you are configuring. Select the 'Detectors' tab and then select the type of input messages that you want each line to generate.

Detectors can generate up to three separate messages. Each message may have its own event number, and be any of three types, 'Sensor Messages', 'Switch Feedback' messages, or 'Switch Request' commands.

Each of the three messages may be sent when a train enters the block, when it leaves the block, as it both arrives in and leaves a block, or disabled for no message at all. For example one message could be sent on arrival, and a different message sent as it leaves.

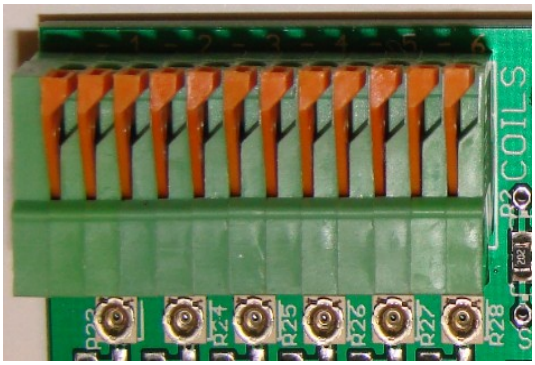
The detector inputs have a built in turn-on and turn-off delays. About ¼ second to activate and 4-5 seconds to release. This prevents dirty track from causing false readings.

When detectors are configured as 'Sensor Message' then each line uses 1 system addresses to create 2 inputs. To prevent the user from having to calculate these confusing addresses, the LNCP uses the actual detector event number desired and does these calculations internally. For example entering 'Sensor Message' event #4 will send LS4 as the message. In like manner, 'Switch Request' messages are stored as the actual event number and the LNCP calculates the required value to send.

Change the desired message polarity if required. 'Send normal' will send 'Lo' ('Closed') when a train is detected and 'Hi' ('Thrown') when the block is vacant. 'Send inverted' will send a 'Hi' ('Thrown') when the block is occupied and a 'Lo' ('Closed') when it is vacant.

Coil connections. The LNCP uses the same small CT (Current Transformer) detection coils as the BOD-8. Lengths of CAT5 cable are the usual way to run the low voltage signals back to the LNCP connector. Run a CAT5 pair through the center hole in the CT coil for strain relief, then connect the CAT5 pair to the two pins of the CT coil. The CT coil is then placed directly onto one of the two track feeders to each block by feeding the block feed wire through the center of the coil next to the CAT5 pair.

If your block is long enough to contain several feeders, combine them all into a sub bus and run that wire through the CT coil before attaching it to the main power bus. Note: the current and voltage from the CT coils is very weak and noise sensitive. Each coil must be connected to the LNCP using its own high quality twisted pair connection. Do not attempt to wire several CT coils to the LNCP using a single common wire. The readily available CAT3, CAT5, or other network cable works very well. Each CAT5 cable can be used to connect up to 4 CT coils without interference between their signals.



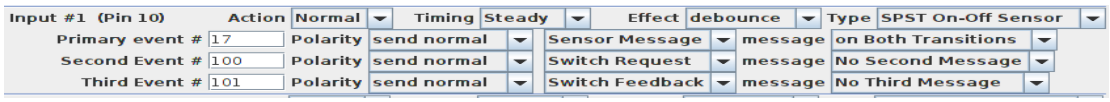
The opposite end of each CAT5 pair is connected to the compression connector labeled 'COILS' shown here. Strip the insulation from the wires for about 1/4”-3/8” before inserting them into the connector. Each of the six pairs connects to its own two compression points, numbered from left to right. (-1 -2 -3 -4 -5 -6) To make it easier to insert the wires or remove them simply press the orange quick release tabs toward the center of the connector using your finger nail or a small screwdriver.

The use of CT coils means that there are no track voltage losses associated with the detectors. Normal detection levels are 1ma. for 10K resistors but may be adjusted to higher or lower levels with the on-board trim pots. (R23 – R28) Use a small insulated flat blade screw driver if possible. A conductive jeweler's screwdriver will also work, but your body capacitance may trigger the detector because the adjustment rotor is conductive and the circuit is very sensitive.

Adjust the sensitivity by first centering the pots as shown above. (with the tabs facing the connector) To increase the sensitivity move the rotor in a small clockwise increment, then remove the screw driver and wait at least 5 seconds to detect any change in response. To reduce the sensitivity make the changes in a counterclockwise direction. The trim pot adjustments have no stops, so if you go past the minimum sensitivity position it will jump directly to the maximum sensitivity position. You may observe the sensor messages using the LocoNet traffic monitor or simply watch the yellow Command and red activity LEDs on the LNCP. The COM and LN LEDs will flash briefly when any detector is triggered and again 4-5 seconds later when it is cleared.

4.1.4 Input Port Configuration

To configure the input port using DecoderPro, open the OPs mode programmer with the OPs mode address of the LNCP you are configuring. Select the 'Input A' (1-4) or 'Input B' (5-8) tab as needed, then select the type of input message that you want each line to generate. (e.g. SPST On-Off Sensor) Note: The 'Type' is simply preset options for convenience. You may modify the individual settings as you require.



There are three 'default' input message types:

> **SPST On-Off Sensor** - One sensor event is sent when the contact closes, and a matching sensor event is sent when the contact is opened again. This is the normal input mode.
>
> **SPST Alt Output** - One switch event is sent the first time a contact closes, and a matching switch event is sent the next time the contact is closed. This mode is useful for local (fascia) turnout control. (this mode is shown in the wiring example)
>
> **Paired SPST Outputs** - One switch event is sent when the first contact of a pair is closed and a matching switch event is sent when the second contact of a pair is closed. This mode would be used when there are two separate buttons used to control a single turnout. This mode requires using two adjacent input lines. The first line's event number is used for both contacts. The second line's event number is ignored.

When inputs are configured as 'Sensor Message' then each port uses 4 addresses to create 8 inputs. To prevent the user from having to calculate these confusing addresses, the LNCP uses the actual contact number desired and does the calculations internally. For example entering event #4 will send LS4 as the message. In like manner, 'Switch Request' messages are stored as the actual event number and the LNCP calculates the required value to send.

The default 'Effect' setting for the SPST On-Off sensor it 'debounce'. The default (Steady) debounce timing is a few milliseconds which is sufficient for most contacts. To increase this use the 'Timing' options. Note that the debounce option is only active in one direction. The opposite action is not delayed. You can change which edge by changing the 'Polarity' setting.

Change the desired message polarity if required. 'Send normal' will send 'Lo' ('Closed') when a contact is closed and 'Hi' ('Thrown') when it is opened. 'Send inverted' will send a 'Hi' ('Thrown') when the contact is closed and a 'Lo' ('Closed') when it is opened.

Input lines can generate up to three separate messages, and each message may be any of three types, 'Sensor Messages', 'Switch Feedback' messages, or 'Switch Request' commands.

A message may be sent when a contact is closed, when it is opened, at both closed and open transitions, or disabled for no message.

To drive an input you may use a contact, an open collector transistor, or a TTL logic level output. Tie one side of the contact, the emitter of an open collector transistor, or logic ground, to the LNCP ground (port pin 5) and the other side to one of the 8 input lines. The LNCP includes internal 4.7K pull up resistors on each input line to make this simple. Do not allow the input voltage to exceed 5V at any time. Use series diodes from higher voltages with the anode connected to the LNCP input line, and the cathode connected to the external logic.

When inputs are configured as type 'SPST Alt Output', they are automatically configured in pairs that send Switch Request messages. However you can manually change one or the other to another setting. If the Alt Button is being used to control switch machines, then the control lines should be addressed the same as the output lines controlling the switch machines.

When inputs are configured as 'Switch Feedback', then the Switch feedback ports should be addressed the same as the driver ports that they are intended to control.

4.1.5 Output Port Configuration

Each output line may be configured to respond to sensor messages or turnout commands.

When output ports respond to turnout Commands, (Switch Request) the event address is the responding line's address. For example a port with the event address of 8 will respond to the LT8 message.

As way of explanation: Normally outputs are configured to respond to Switch (turnout) Messages, and inputs send Sensor Messages. However, if your outputs were driving panel indicators indicating block occupancy, then you could simply use the sensor event number of your occupancy detectors as the output line configured to respond to the 'Sensor Message' event so it would respond directly to the sensor's messages.

There are six 'default' output message types:

Driver - One switch event turns on the output, and its matching switch event turns the output off again. This is the normal output mode.

Dual Coil - One switch event turns on the first of a paired output for 0.1 seconds, then off again. The matching switch event turns on the second of a paired output for 0.1 seconds, then off again. Dual coil machines will probably require an external high current output driver such as the SCSD-8 to drive dual coil machines. The first line's event number is used for both outputs. The second line's event number is ignored.

Dual Inverted - This is the same as Dual Coil but with inverted outputs.

Stall Motor - One switch event turns on the first of a paired output for 1 second, then off again. The matching switch event turns on the second of a paired output for 1 second, then off again. Stall motor machines will normally be connected to adjacent pairs of the Output compression connector. To apply steady current to the stall motor change the 'Timing' to 'Steady', or change the pulse timing as desired. The first line's event number is used for both outputs. The second line's event number is ignored.

Stall Inverted - This is the same as Stall Motor but with inverted outputs.

Signal - This mode is used for controlling an external signal driver board such as the 4ASD-4. The lines are paired and coded to output 4 aspects using each pair of lines. Special effects such as fade are not supported on an external signal driver card.

When outputs are configured as 'Driver' then the port uses 8 individual offset addresses to create the 8 outputs. To prevent the user from having to calculate these confusing offset addresses, the LNCP uses the actual output event number desired and does the offset calculations internally. For example entering event #4 will respond to the message LT4. In like manner, 'Sensor Message' values are stored as the actual event number and the LNCP calculates the required value to respond to.

When using the OUTPUT port in Signal mode, normally the 4th aspect will be set to 'Steady' and 'dark'. If a flashing mode is required the panel software will blink the signal by sending alternate 'dark' and 'color' commands. Select 'SE8c 4 Aspect' as the JMRI signal type for this port. It is also possible to allow the LNCP to directly flash the signals in the 4th aspect selection. The use of JMRI 2.13.4 or later and signal masts makes this easy to configure.

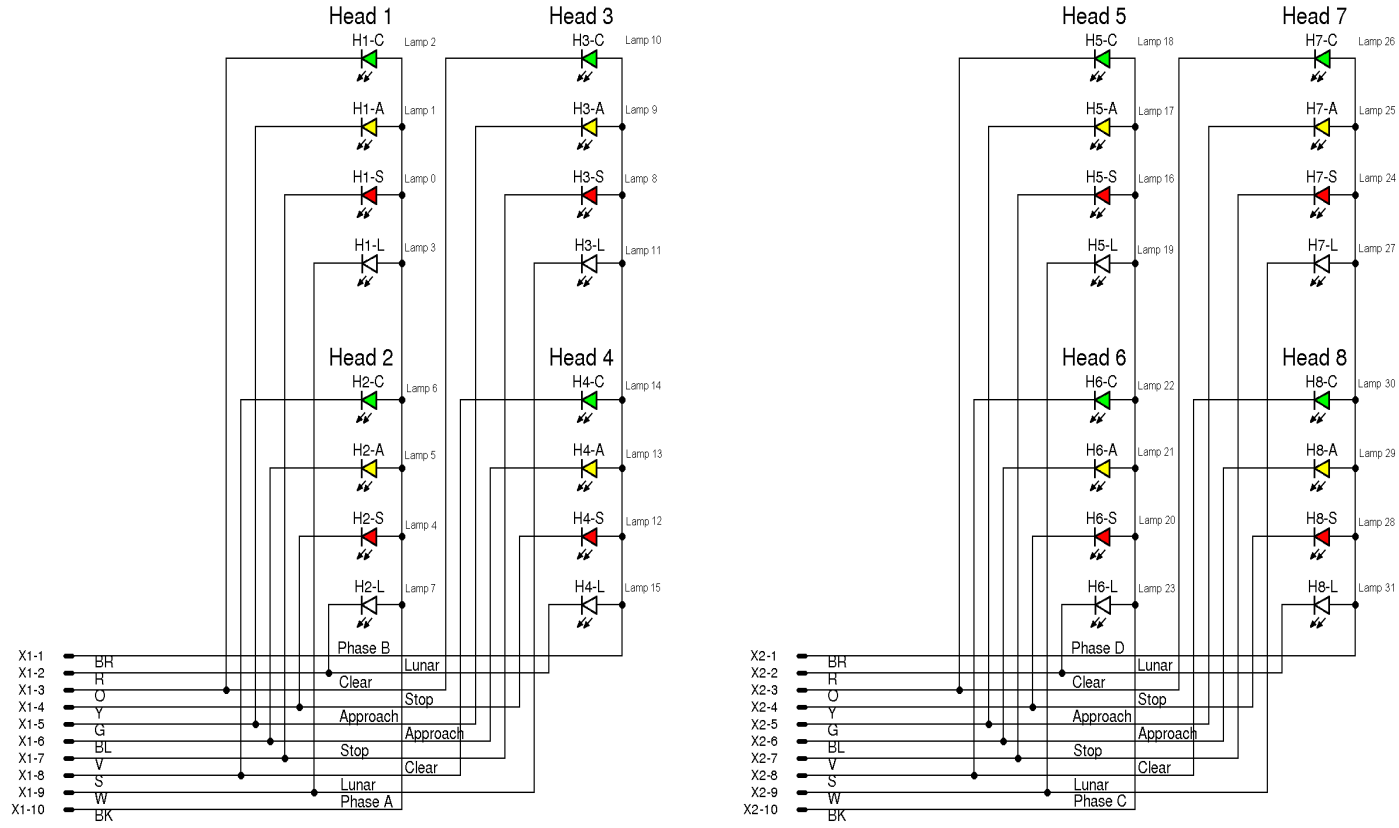
Note: The normal LNCP Signal output connections (below) are very different than using the OUTPUT port in Signal mode. You might use the OUTPUT port in Signal mode to drive a few additional heads or marker lamps at a complex interlocking, but no special effects are supported.

4.2 Signal Ports

The LNCP has two multiplexed signal output ports. 'SIGNAL1' and 'SIGNAL 2'. The LNCP signal drive is 8 lines and 4 multiplex commons for a total of 32 LEDs. Other than the requirement of maintaining the 4 commons as separate connections, any LED may be used with any signal mast. The LNCP signal port can supply up to 8V through current limiting resistors, so wiring several LEDs in series to each output is not a problem. For example, the easiest way to wire a PRR position light signal is to wire outer pairs of LEDs in series with the common center LED. This results in three yellow LEDs wired in series which requires at least 6V to drive. The LNCP can do this easily. Position Light, Color Position Light, and some European signals use multiple lamps for each aspect. In these cases each series LED set only counts as a single LNCP lamp.

To maintain backward compatibility with older software you may also configure each 'mast' to be the same as a single signal head and let other software such as JMRI combine them into masts. However the LNCP is designed to operate on a mast basis with a single DCC or LocoNet message being used to set each different aspect.

Each aspect may consist of up to 4 LEDs chosen from among the 32 possible for each aspect. Note: if any single aspect requires more than 4 lighted lamps, simply define additional masts using the same aspect control messages. The same LED may appear in any number of different aspects. The lamp special effects may be applied differently for each aspect. E.g. a single yellow LED may be held steady in one aspect and be flashing in another aspect.



4.2.1 Signal Port Connections

The default signal wiring for the LNCP is shown above.

The head names and lamp numbering are just for reference to the table entries. The actual lamp colors and head numbers may be changed to match your specific prototype requirements. For example a user modeling the B&O railroad's CPL signals might use the first three lamps of Head 1 for the central aspect's color position lights. (two LEDs wired in series or parallel for each aspect color) The fourth lamp plus the 4 lamps of Head 2 could then be used to control up to 5 of the six possible B&O marker lamps.

Another B&O mast might require all 4 lamps of Head 1 for the central aspect by adding a lunar for Caution. Four markers could then use the 4 lamps from Head 2. Yet another mast might only need 4 lamps, 3 for the CPL aspect and one used as a single marker. Both the central aspect and markers may all come from one head because there are no restrictions against lighting more than one lamp at a time on the same 'head' or 'mast'. In truth the 'Head' designations are simply a wiring convention carried over from earlier generations of hardware.

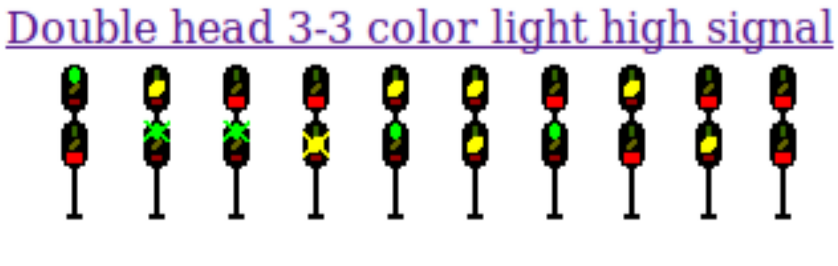
The **FOB-B** fanout board may be useful when wiring multiplexed signals, especially when connecting to the very small gauge wires that are found on many modern signals.

4.2.2 Signal Port Lamp Table Configuration

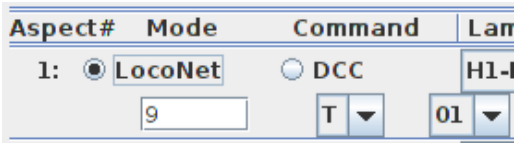
Each LNCP lamp control table supports up to 32 masts and 32 aspects. These may be distributed in any way required for your signaling system. To configure your masts select one of the 'Masts' tabs in DecoderPro. (version 2.13.4 or later) Any mast may continue from one tab to the next.

Any time a mast's aspect is changed, all the entries for that same mast number are first set to 'false' and all lamps associated with the changed aspects are turned off. Any secondary messages associated with 'false' or 'change' are sent. Then the new aspect is set to 'true' for all table entries that match it. Finally, all lights associated with the new aspect/s are turned on, and any secondary message associated with 'true' or 'change' is sent. Lamp 'phase' is only related to flashing lamps. If a phase A lamp is 'off' and a phase B lamp is 'off' they are both extinguished. If they are 'on' they are both lit. Only when they are flashing do they alternate between phase A and phase B.

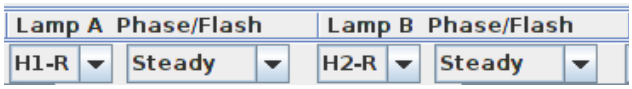
Here are the possible aspects for an example signal taken from CSX-1998 rules.



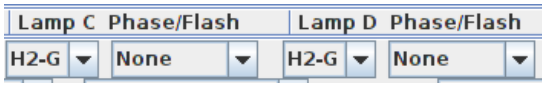
In this example we see the following settings for Aspect #1. ('Stop' which is Red over Red)



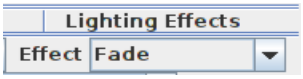
The mode is set to respond to LocoNet commands.
The command we used for 'Stop' is LT9 Thrown.
The mast number is '01'.



Lamp A is set to light LED H1-R steadily.
Lamp B is set to light LED H2-R steadily.



Lamp C and Lamp D are set to 'none'. Their lamp entries are ignored.



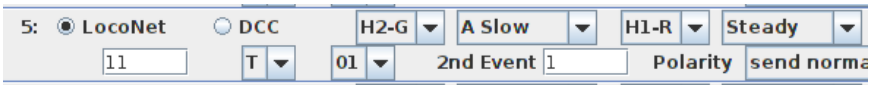
The lamp effect is set to 'Fade' to simulate the slow reaction of tungsten filament lamps.

The next aspect is 'Approach'. (Yellow over Red) All settings are the same as above except as indicated.

This command for 'Approach' is LT10 Thrown.

Lamp A is set to light LED H1-Y steadily.

Another required aspect is 'Limited Clear'. (Red over Flashing Green) All settings are the same as above except as indicated.



This command for Limited Clear is LT11 Thrown.

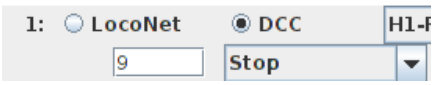
Lamp A is set to light LED H2-G.

Lamp A is set to 'A Slow'. The phase ('A Slow' or 'B Slow') does not matter unless you need alternating lamps.

Lamp B is set to H1-R, and lighted Steady.

Note: it does not matter which LED is LAMP A, and which is LAMP B. It also does not matter in what order the aspects are listed as long as the same mast number is used for each one.

In these examples there is no second message being sent. However a second message could be sent if desired, for example to activate a 'Stop' relay when the Stop aspect is sent, and to release the 'Stop' relay when any other aspect is sent. Another option could be to send locking commands to another signal.



NMRA DCC mode - If 'DCC' mode commands are selected, then the LNCP DecoderPro options change to mast number and aspect. The 'aspect' options offered are just default names and may not exactly match what your signaling system requires. For example the CSX rules for our example mast call for 'Medium Approach' but the default name in the lamp table is 'Medium-Stop' Both names actually mean the same thing, 'Medium' speed through this interlocking, and 'Stop' before arriving at the next signal. There are no preconceived rules based on the particular names being used. Using JMRI aspect based signals will give you the option of selecting the aspect names desired for each rule when configuring the masts. The use of default names in place of random numbers makes it much easier to match up your lamp table entries with the desired aspects in JMRI.

Effects – There are 4 possible effects during lamp changes.

1. **None**. The LEDs change immediately from one color to another.
2. **Fade**. The LEDs fade slowly from on to off and from off to on. The two lamps will actually cross fade as in the prototype signals. During a cross fade both lamps are lit at the same time. One is dimming as the other is brightening. The relays that control the prototype signal lamps switch quickly. The fade in brightness up and down is due to thermal lag in the lamp filaments.
3. **Tumble Down**. Due to the internal relay logic in some signals they pass through yellow when changing from green to red. This is seen on CPL signals and may be meant to simulate a dropping semaphore arm, or it may be an accident of the logic. To configure the effect first select the 'Tumble Down' option. Next choose the final color lamp using LAMP A. Finally choose the yellow intermediate lamp using LAMP B.
4. **H2 Flicker**. Due to the internal mechanism used in the classic US&S searchlight signals, the red color filter is located in the center position between the green and yellow filters. This means that when a searchlight changes between green and yellow there is a brief flicker of red as the filter passes from one side to the other. To configure this effect first select the 'H2 Flicker' option. Then choose the final color lamp using LAMP A. Finally choose the intermediate red lamp using LAMP B.

To prevent unwanted effect interactions on multi headed masts it is probably best to use the tumble down and H2 Flicker options on single heads and allow JMRI to send separate commands to each.

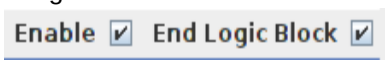
5.0 LNCP Logic Statements.

In addition to the light table, the LNCP contains 64 logic statements. Each statement may be used to control a mast and its aspect. Of course the logic blocks may also be used for other purposes because they are not tied to specific lamps or aspects. One example would be to control crossing gates and flashers.

5.1 Logic Blocks

A logic 'block' consists of several statements all related to a single mast. To calculate this logic, each logic block is treated as a group of statements independent of any other groups. The logic in any group will only be evaluated when some variable contained in that block changes state. This logic is event driven, not state driven. The logic blocks are used to do the signaling logic or other animations such as controlling grade crossings. Each statement of this table consists of an aspect identifier and two memory locations that remember the last command given for any items they are 'watching'. These memory locations remember the event information from the last seen commands to allow decision making. Any changes to these memory locations that cause a block to become 'true' will generate a new evaluation of the logic block, possibly switching to a new aspect.

Mast-Aspect logic block statements are required to be grouped together from the most restrictive aspect to the least restrictive aspect. The last entry of every block is marked by checking the 'End Logic Block' check box. Each entry that is to be evaluated must have its 'Enable' box checked. Each individual block evaluation is done from top down in the list, and all evaluation for that block is terminated with the first matching statement or when the “End Logic Block” check box is reached. If no enabled Mast-Aspect evaluates to 'true' then no Mast-Aspect message is sent, and evaluation ceases until some watched variable in that block changes again.



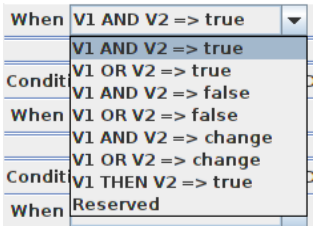
5.2 Variables

Each statement contains up to two variables for identifying the required sensor, turnout, and following signal's aspect information in order to do simple signal interlocking. Any logic statement evaluates to true only if its function and variables are true. A blank variable entry is considered to be true. A blank entry at the end of a logic block will cause a default aspect to be sent if no previous statement with the same mast number has evaluated to 'true'.

The state of all variables is remembered internally in order to compare them. A change in either variable's state will trigger a new comparison. The dual variable capability makes it easy to calculate the signal aspect based on turnout position and occupancy.

5.3 Functions

The 'Function' column has options for AND, and OR statements. The 'When' selection entry expands this capability. Especially note the 'V1 THEN V2' option. This allows you to only trigger on V2 if V1 was already true. This makes it easy to determine train direction simply using two occupancy sensors.

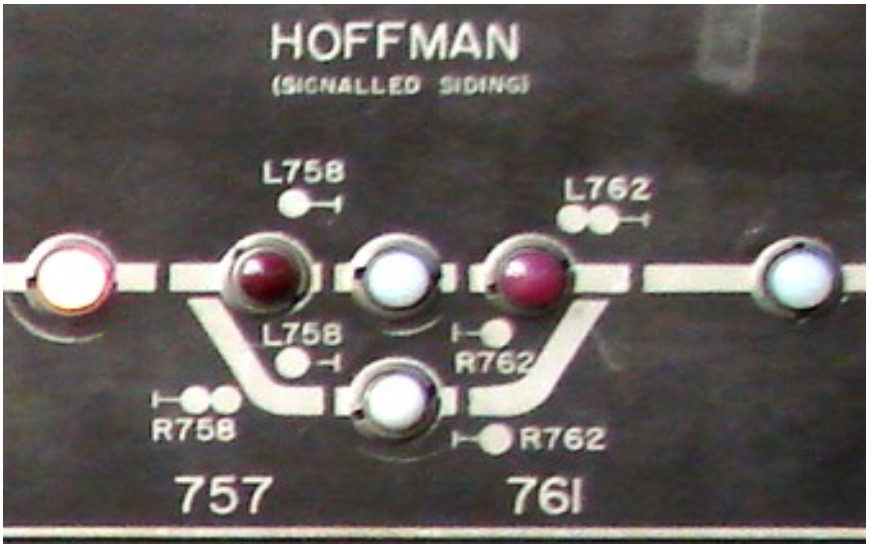


A statement may optionally send an event when true. To send an event define the event to be sent and check the 'Enable' check box. Events sent may be LocoNet sensor, switch, or switch feedback messages. Events may also be NMRA DCC Signal Mast commands. (mast number plus aspect)

5.4 ABS Signal example

The following is an example of ABS (Automatic Block Signaling) based CTC (Centralized Traffic Control).

Here is a sample file that does the complete logic required at Hoffman siding. We will number the occupancy sensors LS757 (South single track), LS758 (South OS), LS759 (main), LS761 (passing), LS762 (North OS), and LS763 (North single track). The CTC machine interacts with either sensors or turnouts and are indicated here as 'LT756 Closed', 'LT758 Closed', 'LT762 Closed', 'LT764 Closed'. The South intermediate signal is L756 and the North intermediate signal is R764.



Portion of a former Seaboard Air Line CTC panel, Hoffman, NC. This panel is now located at the NC Transportation Museum, Spencer, NC.

The masts are numbered as on the image, but with 'm' or 's' appended to distinguish the main signals from the siding signals. I have used the Aspect names currently in use by the CSX and many US railroads for this example.

Comment	Asp-I/O	Mast-Aspect	Asp-I/O	Variable 1	Funct	Asp-I/O	Variable 2
CTC R758 Signals Normal or OS occupied	Asp	R758 - Stop	I/O	LT758 Closed	OR	I/O	LS758 - Active
Siding occupied	Asp	R758 - Stop	I/O	LT757-Thrown	AND	I/O	LS761 - Active
Main occupied	Asp	R758 - Stop	I/O	LT757-Closed	AND	I/O	LS759 - Active
Next siding signal - stop	Asp	R758 - Medium Approach	I/O	LT757-Thrown	AND	Asp	R762s - Stop
Next main signal - stop	Asp	R758 - Approach	I/O	LT757-Closed	AND	Asp	R762 m - Stop
Next siding signal - approach	Asp	R758 - Medium Advanced Approach	I/O	LT757-Thrown	AND	Asp	R762 s- Medium Approach
Next main signal - approach	Asp	R758 - Advanced Approach	I/O	LT757-Closed	AND	Asp	R762m - Approach
Next siding signal - clear	Asp	R758 - Approach Medium	I/O	LT757-Thrown	AND	Asp	R762 s- Medium Clear
Next main signal - clear	Asp	R758 - Clear	I/O	LT757-Closed	AND	Asp	R762m - Clear
Default	Asp	R758 - Stop		--	AND		--
L758s Signals Normal	Asp	L758s - Stop	I/O	LT756 Closed	AND		--
OS occupied or Turnout opposed	Asp	L758s - Stop	I/O	LS758 - Active	OR	I/O	LT757 - Closed
Single track South - occupied	Asp	L758s - Stop	I/O	LS757 - Active			--
Single track South - approach	Asp	L758s - Medium Approach	I/O	LT757 - Thrown	AND	Asp	L756 - Stop
Single track South - Advanced	Asp	R758s - Medium Advanced Approach	I/O	LT757 - Thrown	AND	Asp	R756 - Approach
Single track South - clear	Asp	L758s - Medium Clear	I/O	LT757 - Thrown	AND	Asp	L756 - Clear
Default	Asp	L758s - Stop		--	AND		--
L758m Signals Normal	Asp	L758m - Stop	I/O	LT756 Closed	AND		--
OS occupied or Turnout opposed	Asp	L758m - Stop	I/O	LS758 - Active	OR	I/O	LT757 - Thrown
Single track South - occupied	Asp	L758m - Stop	I/O	LS757 - Active	AND		--
Single track South - Approach	Asp	L758m - Approach	I/O	LT757 - Closed	AND	Asp	L756 - Stop
Single track South - Advanced	Asp	L758m - Advanced Approach	I/O	LT757 - Closed	AND	Asp	L756 - Approach
Single track South - clear	Asp	L758m - Clear	I/O	LT757 - Closed	AND	I/O	L756 - Clear
Default	Asp	L758m - Stop		--	AND		--
L762 Signals Normal or OS occupied	Asp	L762 - Stop	I/O	LT762 Closed	OR	I/O	LS762 - Active

Siding occupied	Asp	L762 - Stop	I/O	LT761-Thrown	AND	I/O	LS761 - Active
Main occupied	Asp	L762 - Stop	I/O	LT761-Closed	AND	I/O	LS759 - Active
Next siding signal - stop	Asp	L762 - Medium Approach	I/O	LT761-Thrown	AND	Asp	L758s - Stop
Next main signal - stop	Asp	L762 - Approach	I/O	LT761-Closed	AND	Asp	L758 m - Stop
Next siding signal - approach	Asp	L762 - Medium Advanced Approach	I/O	LT761-Thrown	AND	Asp	L758s- Medium Approach
Next main signal - approach	Asp	L762 - Advanced Approach	I/O	LT761-Closed	AND	Asp	L758m - Approach
Next siding signal - clear	Asp	L762 - Approach Medium	I/O	LT761-Thrown	AND	Asp	L758s- Medium Clear
Next main signal - clear	Asp	L762 - Clear	I/O	LT761-Closed	AND	Asp	L758m - Clear
Default	Asp	L762 - Stop		--	AND		--
R762s Signals Normal or OS occupied	Asp	R762s - Stop	I/O	LT764 Closed	OR	I/O	LS762 - Active
Turnout opposed	Asp	R762s - Stop	I/O	LT761 - Closed	AND		--
Single track North - occupied	Asp	R762s - Stop	I/O	LS757 - Active	AND		--
Single track North - Approach	Asp	R762s - Medium Approach	I/O	LT761 - Thrown	AND	Asp	R764 - Stop
Single track North - Advanced	Asp	R762s - Medium Advanced Approach	I/O	LT761 - Thrown	AND	Asp	R764 - Approach
Single track North - clear	Asp	R762s - Medium Clear	I/O	LT761 - Thrown	AND	Asp	R764 - Clear
Default	Asp	R762s - Stop		--	AND		--
R762m Signals Normal or OS occupied	Asp	R762m - Stop	I/O	LT764 Closed	OR	I/O	LS762 - Active
Turnout opposed	Asp	R762m - Stop	I/O	LT761 - Thrown	AND		--
Single track North - occupied	Asp	R762m - Stop	I/O	LS757 - Active	AND		--
Single track North - approach	Asp	R762m - Approach	I/O	LT761 - Closed	AND	Asp	R764 - Stop
Single track North - Advanced	Asp	R762m - Advanced Approach	I/O	LT761 - Closed	AND	Asp	R764 - Approach
Single track North - clear	Asp	R762m - Clear	I/O	LT761 - Closed	AND	Asp	R764 - Clear
Default	Asp	R762m - Stop		--	AND		--

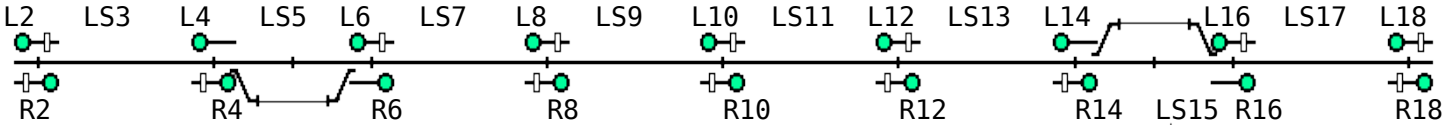
5.5 APB Signal example

The following is an example of APB (Absolute Permissive Block). I have used the Aspect names currently in use by the CSX and many US railroads for this example.

If the train is proceeding from East to West on the main line and reaches LS15; signal R14 Clear goes to Stop-Proceed, which sets R12 Clear to Stop-Proceed, which sets R10 Clear to Stop-Proceed, which sets R8 Clear to Stop-Proceed, which sets R6 (head block) Clear to Stop.

If 'L14 - Clear' and 'LS15 - Active', then set 'R14 - Stop-Proceed'.
If 'L12 - Clear' and 'R14 - Stop-Proceed', then set 'R12 - Stop-Proceed'.
If 'L10 - Clear' and 'R12 - Stop-Proceed', then set 'R10 - Stop-Proceed'.
If 'L8 - Clear' and 'R10 - Stop-Proceed', then set 'R8 - Stop-Proceed'.
If 'R8 - Stop-Proceed', then set 'R6 - Stop'.
When R6 (head block) is changed to Stop, then end.

If 'LS15 - Inactive' set 'R14 - Clear or Approach'.
If LS13 is unoccupied and R14 then unstick R12.
If LS11 becomes unoccupied then unstick R10.
If LS9 becomes unoccupied then unstick R8.
If LS7 becomes unoccupied then unstick R6.



Comment	Asp-I/O	Mast-Aspect	Asp-I/O	Variable 1	Funct	Asp-I/O	Variable 2
Left - Starts tumbledown	Asp	R14 - Stop-Proceed	I/O	LS15 - Active	AND	I/O	LS13 - Inactive
Left - Starts tumbledown	Asp	R14 - Stop-Proceed	I/O	LT14 - Thrown	AND	I/O	LS13 - Inactive
Right - Block 15 occupied or Turnout thrown	Asp	R14 - Stop	I/O	LS15 - Active	OR	I/O	LT14 - Thrown
Right - Block 17 occupied	Asp	R14 - Stop	I/O	LS17 - Active	AND		--
Right - R14 Approach	Asp	R14 - Approach	Asp	R16 - Stop	AND		--

Right - R14 Clear	Asp	R14 - Clear		--	AND		--
Right - L14 Stick	Asp	L14 - Stop-Proceed	Asp	L12 - Stop-Proceed	AND		--
Left - Block 13 occupied	Asp	L14 - Stop	I/O	LS13 - Active	AND		--
Left - L14 Approach	Asp	L14 - Approach	Asp	L12 - Stop	AND		--
Left - L14 Clear	Asp	L14 - Clear		--			--
Left - R12 Stick	Asp	R12 - Stop-Proceed	Asp	R14 - Stop-Proceed	AND		--
Right - Block 13 occupied	Asp	R12 - Stop	I/O	LS13 - Active	AND		--
Right - R12 Approach	Asp	R12 - Approach	Asp	R14 - Stop	AND		--
Right - R12 Approach Medium	Asp	R12 - Approach Medium	Asp	R14 - Approach	AND		--
Right - R12 Clear	Asp	R12 - Clear		--	AND		--
Right - L12 Stick	Asp	L12 - Stop-Proceed	Asp	L10 - Stop-Proceed	AND		--
Left - Block 11 occupied	Asp	L12 - Stop	I/O	LS11 - Active	AND		--
Left - L12 Approach	Asp	L12 - Approach	Asp	L10 - Stop	AND		--
Left - L12 Clear	Asp	L12 - Clear		--	AND		--
Left - R10 Stick	Asp	R10 - Stop-Proceed	Asp	R12 - Stop-Proceed	AND		--
Right - Block 11 occupied	Asp	R10 - Stop	I/O	LS11 - Active	AND		--
Right - R10 Approach	Asp	R10 - Approach	Asp	R12 - Stop	AND		--
Right - R10 Clear	Asp	R10 - Clear		--	AND		--
Right - L10 Stick	Asp	L10- Stop-Proceed	Asp	L8 - Stop-Proceed	AND		--
Left - Block 9 occupied	Asp	L10 - Stop	I/O	LS9 - Active	AND		--
Left - L10 Approach	Asp	L10 - Approach	Asp	L8- Stop	AND		--
Left - L10 Clear	Asp	L10 - Clear		--	AND		--
Left - R8 Stick	Asp	R8 - Stop-Proceed	Asp	R10 - Stop-Proceed	AND		--
Right - Block 9 occupied	Asp	R8 - Stop	I/O	LS9 - Active	AND		--
Right - R8 Approach	Asp	R8 - Approach	Asp	R10 - Stop	AND		--
Right - R8 Clear	Asp	R8 - Clear		--	AND		--
Right - L8 Stick	Asp	L8- Stop-Proceed	Asp	--	AND		L6 - Stick
Left - Block 7 occupied	Asp	L8 - Stop	I/O	LS7 - Active	AND		--
Left - L8 Approach	Asp	L8 - Approach	Asp	--	AND		L6- Stop
Left - L8 Approach Medium	Asp	L8 - Approach Medium	Asp	--	AND		L6- Approach
Left - L8 Clear	Asp	L8 - Clear		--	AND		--
Left - R6 Stick	Asp	R6 - Stop	Asp	--	AND		R8 - Stop-Proceed
Right - Block 7 occupied	Asp	R6 - Stop	I/O	LS7 - Active	AND		--
Right - R6 Approach	Asp	R6 - Approach	Asp	--	AND		R8 - Stop
Right - R6 Clear	Asp	R6 - Clear		--	AND		--
Right - Start Tumbledown	Asp	L6 - Stop-Proceed	I/O	LS5 - Active	AND	I/O	LS7 - inactive
Right - Start Tumbledown	Asp	L6 - Stop-Proceed	I/O	LT6 - Thrown	AND	I/O	LS7 - inactive
Left - Block 5 or 3 occupied	Asp	L6 - Stop	I/O	LS5 - Active	OR	I/O	LS3 - Active
Left - Turnout thrown	Asp	L6 - Stop	I/O	LT6 - Thrown	AND		--
Left - L6 Approach	Asp	L6 - Approach	Asp	L4- Stop	AND		--
Left - L6 Clear	Asp	L6 - Clear		--	AND		--
Crossing active	Asp	Cross buck - flashing	I/O	LS approach - Active	AND	Asp	Cross buck - clear
Crossing active	Asp	Cross buck - flashing	I/O	LS island - Active	AND	Asp	Cross buck - clear
Crossing inactive	Asp	Cross buck - clear	I/O	LS island - Inactive	AND		--
Crossing inactive	Asp	Cross buck - clear	I/O	LS approach - Inactive	AND	I/O	LS island - Inactive

6.0 Input/Output Cards

The RR-CirKits LNCP and any additional I/O cards are designed to be clipped into Tyco 3-1/4" Snap-Track® mounted to the bench work and connected with short ribbon cables. (Snap-Track® is a plastic channel designed to mount PC cards to a chassis, not something to run trains on.) Each I/O module card is equipped with two connectors to facilitate these connection options. A single LNCP fits into the 3TK2-2 (dual) mounting track. To add an optional I/O module use the 3TK2-3 mounting track. (or 3TK2-4 for dual I/O modules)

BOD-8 (DCC Block Occupancy Detector - 8 block) Use this board to add an additional 8 blocks of detection to the LNCP. The BOD-8 uses the same small CT (Current Transformer) detection coils as the LNCP. These are placed directly on the track feeders. Simple lengths of Cat-5 cable are the usual way to run the signals back to the detector boards. The use of CT coils means that there are no track voltage losses associated with the detectors. Normal detection levels are 1ma. but may be adjusted to higher levels with on board pots.

During a DCC bus power failure the Power-Lok input of the BOD-8 instantly locks the current state of each block detector. I.e. the state of the layout does NOT change during a DCC power outage, neither to all occupied, nor to all vacant. It just suspends sending any occupancy changes until after power is restored and things have stabilized again. If you do not want the feature there is a jumper switch to disable it. Currently the LNCP does not include this feature.

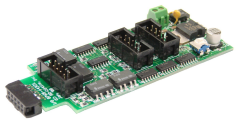
The BOD-8 outputs are low during detection so the LNCP input port should be configured as "Detector". This inverts the input lines to match most types of block detector outputs.

OIB-8 (Opto Isolator Board - 8 input) This 8 input board is used when a non-isolated source of voltage needs to be monitored and input to the LNCP. One example would be to monitor the DCC voltage on a set of points to determine the position of a turnout without using auxiliary contacts. Another example would be the detection of trains on a three rail or overhead wired layout using isolated rail sections.

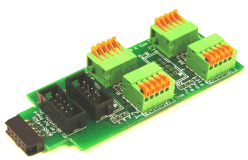
This board may be configured to monitor the absence or presence of an AC or DC signal. It may also be configured to monitor the polarity of a DC signal. This board requires 10ma. for reliable operation and includes pads for customer supplied dropping resistors.

SCSD-8 (Single Coil Solenoid Driver) The SCSD-8 Output Module is designed to drive individual solenoid coils or other high voltage high power devices. Normally the input voltage should not exceed 35VDC. The SCSD-8 board is optically isolated from the driving circuitry to protect the LNCP or other control device from the high power outputs.

By using the proper options on the LNCP the SCSD-8 may also be used to control dual coil momentary switch machines. Setting the Port 'Direction' to 'Output' and the Port 'Toggle' bit to 'Alt Action' places the port into paired mode. Each line of a pair normally responds to either 'Closed' or 'Thrown' with the output action selected for each line. This action will normally be a 0.1 second pulse when driving solenoids. Dual coil operation should not be attempted if the switch machine power supply is not of the capacitive discharge type that will limit the long term current to a low value. **Failure to observe this precaution may result in destruction of equipment and be a fire hazard!**



SMD-8 (Stall Motor Driver – 8 line) The SMD-8 board contains 8 individual, optically isolated, H-Bridge drivers. This allows the board to be powered from any supply between 9 Volts and 18 Volts. It is primarily designed to drive stall motor turnout machines such as those found in Tortoise® and Switchcraft® machines . Do not exceed 15VAC or 24VDC at the power input. This board includes an adjustable regulator to allow you to control the speed of your switch machine motors. This regulator will draw 100ma. plus your load current, and the board normally runs warm even with no load. When used with the LNCP it provides control for 8 stall motors, but you can not use both the SMD-8 and the internal LNCP drivers, as they use the same addresses. When using the SMD-8 the LNCP output port should be configured as 'Driver'. (not 'Stall Motor' as when using the internal drivers)



FOB-8 (Fan Out Board) This board is a convenient way to convert from the LNCP 10 pin ribbon cable signal outputs to compression terminals at the signal masts themselves. The manually operated quick release connectors will accept wire sizes down to the small #36 AWG magnet wire found in some signals.

The FOB-8 also does the complex splitting required when using multiplexed signal wiring. The compression connectors each terminate to a single 3 or 4 light head.

7.0 Trouble shooting

7.1 Sanity Test

To perform a very basic LNCP sanity test perform the following steps:

1. Power up the LNCP by plugging it into the power supply.
2. The green power LED should come on.
3. Plug in the LocoNet® cable. The red Activity LED should light briefly.
4. Unplug the LocoNet® cable. The red activity light should again blink briefly as the cable is removed.
5. Press the "Program" switch S1 located under the LEDs for 3 seconds. The yellow "Command" LED should begin to flash indicating that the LNCP has entered Service Mode and is waiting for an address change. Press the switch again briefly and the service mode LED should extinguish again.

If the green power LED does not light, be sure that the power supply is connected and provides at least 9V to the LNCP.

If the activity LED does not blink when you plug and unplug the LocoNet® cable, be sure that your DCC command station is powered up, then check your LocoNet® wiring.

7.2 Activity Test

The LNCP's input circuit and code sends directly to the unit's LocoNet® jack, so if you send any command it should immediately be seen on the input line. This test uses the free software available from the JMRI project to watch the test commands. (www.jmri.org)

Steps:

1. Open the JMRI LocoNet® Monitor window. Using any block detector or input line on the LNCP input jack send a command. The command should appear in the LocoNet® monitor window and both the LNCP command (Y) and activity (R) LEDs should blink.
2. Using JMRI to send a command (e.g. switch commands) addressed to an output located on this LNCP.
3. The commands should appear in the LocoNet® monitor window and the LNCP command and activity LEDs should blink. The connected output should respond.

If there is activity at the interface, but no activity light at the LNCP when switch commands are sent, check the LocoNet® wiring. If the command is seen in the activity light, but not in the command light, be sure that the command you are sending is addressed to respond on this LNCP. If there is no activity shown in the LocoNet® monitor window, check that you have the correct interface selected in the JMRI preferences, and that you have the correct COM port selected.

7.3 Factory Reset

If the LNCP settings get lost, the unit may be returned to its factory default settings by sending a value of 170 (hex AA) to CV21 using JMRI DecoderPro in 'Service Mode'. (Note: This is the only LNCP use of Service Mode other than initial address setting) The factory default Ops address is 12000.

Steps: **Note**: Do NOT use 'Reset to Defaults' found in the Roster tab.

1. Press the "Program" switch S1 located under the LEDs for 3 seconds. The yellow "Command" LED should begin to flash indicating that the LNCP is in Service Mode.
2. Open DecoderPro (2.13.4 or later) and select 'Service Mode'. Be sure that there are no locomotives on your program track. Select RR-CirKits – LNCP as the decoder. On the tool bar Choose 'Reset' - 'Factory Reset'. The flashing yellow light on the LNCP should flicker as the 'reset' command is sent to the unit.
3. Restore the proper address (the LNCP serial number) for this unit in the “Basic” tab, then switch to the “CVs” tab and write just CV17 and CV18. (red error is OK)
4. Press the “Program” switch again to return the LNCP back to its normal operating mode.

8.0 Boot Loader

If an update to your LNCP firmware is needed, a program such as "Download Firmware" in JMRI version 2.4 or later is required. Do Not use JMRI version 2.2 it contains a bug related to 'Download Firmware'.

To enter Boot loader mode, depress the switch 'S1' for 10 seconds, until the Command light first starts to blink, then lights steadily, and then release it. The yellow led will continue to light steadily indicating that the boot loader is now ready to

accept messages from the JMRI Down loader. Start JMRI and select "LocoNet" then "Download Firmware". Select the latest LNCP upgrade and click "Read file" then "Download". The red activity led will blink each time it receives a data packet from the JMRI down loader. When programming is successful, the yellow led will extinguish automatically, and normal operation will resume automatically.

Error codes:
During boot loading, several possible error codes are shown by the yellow led:
- 1 blink: manufacturer code or product code mismatch;
- 2 blinks: hardware version mismatch;
- 3 blinks: hex file software version equal or lower;
- 4 blinks: unused (no LocoNet® data);
- 5 blinks: internal programming error detected.

Each of the above errors will halt the boot loader process. To recover from the first three error types, just cycle power to restart the device, correct the error, and then re-run the JMRI program. Nothing has been overwritten.
To recover from the last error type, it must be assumed that the firmware is in an undefined state, most probably damaged or incomplete. If the process is interrupted for any reason you will also end up with corrupted firmware.
To recover from a corrupted upgrade you must first unplug the power to the LNCP, then, while holding the program switch depressed, plug in the power again. This will place the unit directly into program mode and allow you to resend the upgrade. (the yellow command light will light steadily) The boot loader code itself is protected against being written over.

9.0 Grounding and Isolation

Unlike the LocoBuffer-USB and the Tower Controller, the LNCP is not optically isolated from the LocoNet®. This allows for possible ground loop problems between the LocoNet® and your layout power supplies. Be sure that your system is installed in a properly grounded manner. Connect the booster ground to power ground, and either use grounded power supplies for accessories, or else completely isolated the power equipment. This provides a proper ground path from the local power supplies to the LocoNet® and then to the booster, or else prevents any power from traveling on the LocoNet® ground lines.

Normally all LNCP connections originate on the LNCP board itself, so there is no danger of ground loops. If you are controlling high current devices then be sure that their supplies are separated from the LNCP outputs by optical, relay, or transformer isolation devices. If your inputs come from powered equipment such as track contacts or indicator lamps, then use the OIB-8 isolation board to protect the LNCP inputs.

Properly ground your boosters, your power supplies, and your desktop computer through a 3 wire cable, and isolate them from each other via isolated equipment where necessary.

10.0 Warranty Information

We offer a one year warranty on the LNCP. This device contains no user serviceable parts. If a defect occurs, please contact RR-CirKits at:
service@rr-cirkits.com for a replacement.

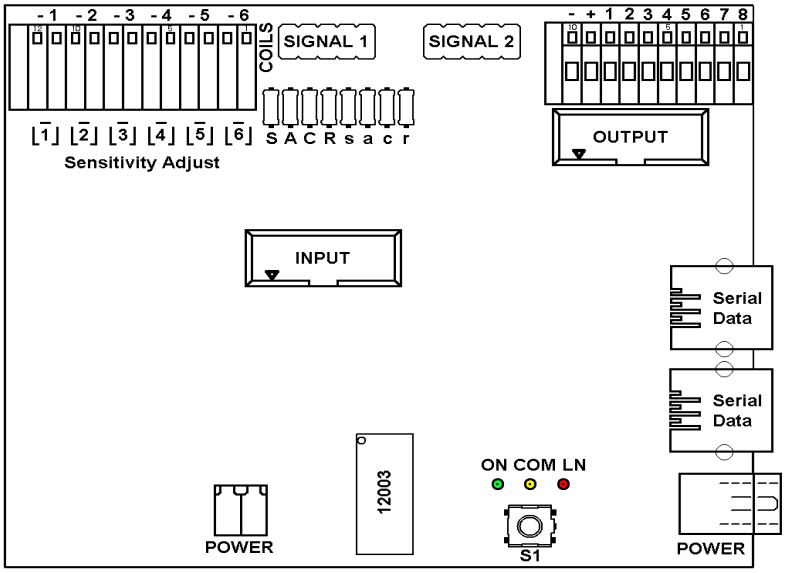
11.0 FCC Information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
--Reorient or relocate the receiving antenna.
--Increase the separation between the equipment and receiver.
--Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
--Consult the dealer or an experienced radio/TV technician for help.

Any modifications to this device voids the user's authority to operate under and be in compliance with these regulations. The actual measured radiation from the LNCP is much lower than the maximum that is permitted by the FCC Rules, so it is unlikely that this device will cause any RFI problems.



RR-CirKits, Inc.
7918 Royal Ct.
Waxhaw, NC USA 28173

http://www.rr-cirkits.com
sales@rr-cirkits.com
704-843-3769
Fax: 704-243-4310