

TAM VALLEY DEPOT

QuadLN_S User Manual

Firmware v2.0

**N3IX Engineering
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Contents

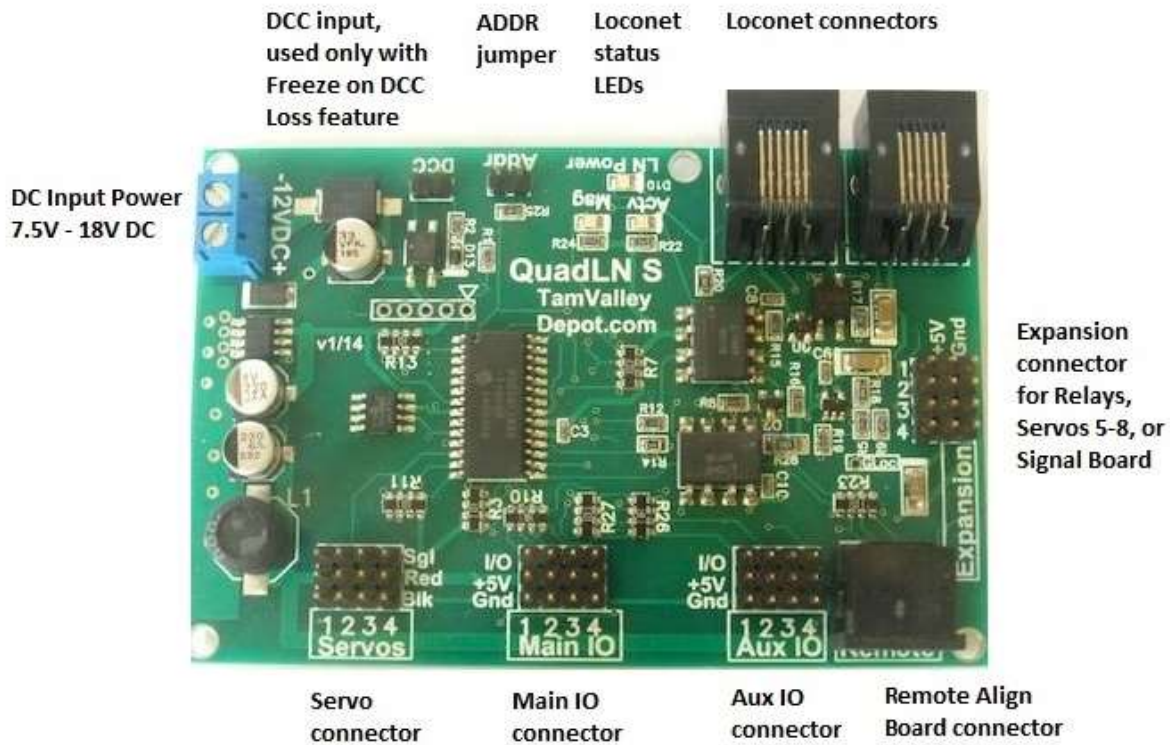
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1 Basics



1.1 Overview

The **QuadLN_S** is a stationary decoder that can drive up to 8 servos for controlling turnouts. The servos can be actuated using pushbutton or toggle switch inputs. A single input can control one servo or multiple servos. The **QuadLN_S** has 3 configurations:

- 4 servos, 8 IO plus 4 remote relay outputs (Relay Mode)
- 8 servos, 8 IO (Octo Mode)
- 4 servos, 8 IO plus 24 LEDs using the optional Signal Board

The **QuadLN_S** can display the servo state on a Tam Valley Depot Fascia Controller or drive user control panel LEDs. Besides showing whether a turnout is Closed or Thrown, the **QuadLN_S** can indicate when a servo is in motion (without requiring Turnout Position Feedback sensors!) and when it is Locked.

The **QuadLN_S** provides realistic signaling effects for Searchlight and Color Position Light signals and for Crossing signals using the optional Signal Board. Both Signal Head/Mast addressing and Turnout addressing for signals are available.

The **QuadLN_S** supports up to 4 current sense detectors using the optional Detector board.

The **QuadLN_S** is a Loconet device. Servos can be controlled via Loconet Switch commands. Turnout position can be reported to software such as JMRI. The **QuadLN_S** even provides local control Locking capability so that local pushbutton or toggle switch servo control can be disabled on an individual servo basis whenever desired by just sending a Loconet Switch command.

QuadLN_S inputs can be wired to external detectors and then report block occupancy using Loconet General Sensor messages. Almost any device with a contact closure or 5V logic-level signal output can be wired to an available **QuadLN_S** input and then reported via Loconet.

The **QuadLN_S** also includes Cascade and programmable Routes/ Selectors features that take advantage of the Loconet to implement layout control functions such as yard ladder control and track selection. Although setting up these features is more complex than just configuring a single turnout, using the **QuadLN_S** template in JMRI greatly simplifies things.

1.2 Servos

The **QuadLN_S** drives up to 8 R/C airplane servos for controlling turnouts or performing other layout animation tasks. Independent control over the travel and speed for each servo, plus a RapidStart feature, make turnout movement more realistic.

1.3 External Power Supply

The **QuadLN_S** requires an external DC power supply between +7.5V and +18V. Do not exceed +18V DC. Typical current is 100-200 mA from a 12V supply, but heavy servos mechanical loads can increase the current beyond that range. See Section 2.1 for connection details.

1.4 Onboard LED Indicators

There are 3 LEDs on the **QuadLN_S**.

1.4.1 LN POWER LED

The LN POWER LED indicates that Loconet Rail Sync is present and the opto-isolated Loconet interface is powered. This LED should be ON when a Loconet cable is plugged into the **QuadLN_S**.

1.4.2 LN MESSAGE LED

The MSG LED is normally lit. The LED blinks once when any Loconet message traffic is seen, other than messages sent by the **QuadLN_S**. If this LED never blinks then there is probably a Loconet connection issue.

1.4.3 LN ACTIVE LED

The ACTV LED is normally lit. The LED blinks once when any Loconet message is sent by the **QuadLN_S** or when the **QuadLN_S** acts upon any incoming Loconet message. This LED also blinks once when the DCC state changes.

1.5 Frog Power

The QuadLN_S can drive four Tam Valley Depot 5 volt remote relay boards for powering turnout frogs and other uses. The relay state changes at the servo travel midpoint to reduce problems with electrical shorts during movement with certain types of turnouts.

1.6 Inputs

The QuadLN_S provides 4 “Main” Inputs and 4 “Aux” Inputs. All inputs are fully configurable, including what action to take and what type of input change should trigger the action. Possible actions on an input change include controlling the onboard servos, sending Switch commands to other decoders or to trigger routes, and generating general sensor messages that report the input change to any interested Loconet device.

The QuadLN_S has special features that allow the input lines to also drive LED indicators or other devices. Since each “input” also has an “output” capability, each connection is called an “IO” line in this manual (IO = Input / Output).

1.7 Addresses

1.7.1 Device Address

The QuadLN_S requires a Device Address so its features can be configured via Loconet [Ops Mode](#) programming. This address is just for device programming, and is independent from the Servo and Sensor addresses which are described in Sections 1.7.2 and 1.7.3 below. The valid range for the Device Address is 0-16383 and it must be unique.

Typically a 5 digit extended address is used for the Device Address. This avoids conflict with locomotives and other devices when doing [Ops Mode](#) programming. The default Device Address is 11000. When first installing QuadLN_S's remember to connect just one unprogrammed unit at a time to Loconet and change the Device Address to a unique address following the procedure in 2.2.3. or 2.3.2.

1.7.2 Servo Start Address

The QuadLN_S Servos respond to Loconet Switch commands at addresses starting at the Servo Start Address. The QuadLN_S Servos use 4 or 8 consecutive switch addresses depending on the configuration. The Servo Start Address can be from 1 to 2045. Avoid using addresses 1017-1020 for any Servo if possible (those addresses are also used by a special interrogation command).

1.7.3 Lock Start Address

The QuadLN_S Locks respond to Loconet Switch commands at addresses starting at the Lock Start Address. The QuadLN_S Locks use 4 or 8 consecutive switch addresses depending on the configuration. The Lock Start Address can be from 1 to 2045. Avoid using addresses 1017-1020 for any Lock if possible (those addresses are also used by a special interrogation command). If the Servo and Lock address ranges overlap, any Lock with the same address as a Servo will not be accessible using Loconet Switch commands.

1.7.4 Main IO Start Address

The QuadLN_S reports the status of its Main inputs using Loconet Sensor addresses starting at the Main IO Start Address. The QuadLN_S uses 4 consecutive sensor addresses for Main IO1 – Main IO4. The Main IO Start Address can be from 1 to 4093. In general the Main IO address range should not overlap the Aux IO address range.

1.7.5 Aux IO Start Address

The QuadLN_S reports the status of its Aux inputs using Loconet Sensor addresses starting at the Aux IO Start Address. The QuadLN_S uses 4 consecutive sensor addresses for Aux IO1 – Aux IO4. The Aux IO Start Address can be from 1 to 4093. In general the Main IO address range should not overlap the Aux IO address range.

1.8 Groups

The QuadLN_S has 4 functional Groups when in **Relay** or **Signaling** mode. Each Group consists of a Servo, Main IO line and Aux IO line. As shipped, the IO lines in each Group are configured for a momentary pushbutton and change the state of the Servo on each button press.

The QuadLN_S has 8 functional Groups when in **Octo** mode. Each Group consists of a Servo and *either* a Main IO line or an Aux IO line. As shipped, the IO line in each Group is configured for a momentary pushbutton and changes the state of the Servo on each button press.

Any Input can be configured to control any Servo. In fact any input can control as many of the QuadLN_S Servos as desired, or it can serve other functions and not control any QuadLN_S servo. There are some QuadLN_S features (for example LED indication) that only work when an Input is used with the Servo in the same Group, so it is best to start with that arrangement when learning about the QuadLN_S.

1.8.1 Panel Indicators

The QuadLN_S can drive panel indicator LEDs connected to the Main IO and Aux IO lines. The panel indication shown on any specific IO line reflects the state of the Servo in the same group. Thus when using panel indicators such as the Tam Valley Depot Fascia Controller, it is best to use an IO line in the same Group as the Servo being controlled so that the position, movement and lock indications are meaningful.

2 Quick Start

2.1 Connecting Power

The QuadLN_S requires an external DC power supply between +7.5V and +18V. Do not exceed +18V DC. Typical current is 100-200 mA, but heavy servos mechanical loads can increase the current beyond that range. The power input is via the connector with two screw terminals near the upper left corner

of the board. Connect the power supply **minus** lead to the **upper** terminal (the one closest to the corner of the board) and connect the power supply **plus** lead to the **lower** terminal (the one furthest from the corner of the board). If the leads are connected backwards, the QuadLN_S will not function but will not be damaged.

2.2 Setup without JMRI

All device behavior is controlled via CV values so it is possible to fully configure the device manually. Generally this requires deciphering the CV tables in Chapter 8 below and manually calculating the proper values, however the following steps will get your QuadLN_S up and running controlling turnouts.

2.2.1 Servo Start Address

Set the Servo Start Address first to prevent conflicts with other stationary decoders. (Skip this step if your device is not connected to Loconet).

- Install the **ADDR** jumper. The **ACTV** and **MSG** LEDs on the board should start alternately flashing.
- Using your throttle issue a Switch command for the desired Servo Start Address. When the command is received, the Servo Start Address is set and the LEDs stop flashing.
- Remove the **ADDR** jumper.

The Servos are now set to 4 consecutive addresses starting with the address sent with the Switch Command. Avoid using addresses 1017-1020 for any Servo if possible (those addresses are also used by a special interrogation command).

2.2.2 Manual Alignment of Travel and Speed

The travel endpoints and speed for each servo can be set manually using the **Select**, **Up** and **Down** buttons on the Remote Alignment Board. Here is the adjustment procedure.

Connect the remote alignment board to the QuadLN_S. Remove the QuadLN_S **ADDR** jumper if it is installed.

1. Hold the Select button down until a Servo selection LED turns on (about 1 second), indicating that you are in Servo Selection mode and that indicated Servo is selected. (The initial Servo selection will be the same as the one selected the last time alignment was performed.)
2. Use the Up and Down buttons to select the desired Servo, then press the Select button briefly.
3. The Closed LED is now flashing to indicate that the Closed Position is being adjusted. Use the Up and Down buttons to move the Servo to the desired Closed Position. When satisfied with the Closed Position, press the Select button briefly.
4. The Thrown LED is now flashing to indicate that the Thrown Position is being adjusted. Use the Up and Down buttons to move the Servo to the desired Thrown Position. When satisfied with the Thrown Position, press the Select button briefly.
5. The Speed LED is now flashing to indicate that the Speed is being adjusted. Use the Up and Down buttons to change the speed. The Servo will change position to demonstrate the new

Speed. You can continue to adjust the speed while the Servo is moving if desired. When satisfied with the Speed, press the Select button briefly.

6. To readjust any of the parameters, press the Select button briefly to return to step 4.

To exit the Adjustment process at any point, hold the Select button until the remote align board LEDs turn off (about 1 second). The new settings are now saved and in use.

2.2.3 Device Address

The Device Address can be changed using [Service Mode/Programming-Track](#) programming messages that are received by the QuadLN_S over Loconet. (No connection between the QuadLN_S and the programming track is required.) Choose a unique address between 1 and 16383. See Section 1.7.1 for information about Device Addresses. The CV format is shown in Table 8-2 – note the upper 2 bits in CV17 must be 1. A unique 5-digit address is recommended to avoid conflicts.

- Remove all locomotives from the programming track.
- Install the **ADDR** jumper. The **ACTV** and **MSG** LEDs should start flashing alternately.
- Enter Programming mode and select Paged mode.
- Write the high byte (upper 8 bits) of the desired address to CV17.
- Write the low byte (lower 8 bits) of the desired address to CV18.
- Remove the **ADDR** jumper.

2.3 Setup with JMRI

The QuadLN_S template in JMRI provides the easiest and quickest way to configure the overall device. This section covers the basics needed to get the decoder up and running. Later sections dive into the details.

2.3.1 Minimum JMRI Version

The QuadLN_S template uses features introduced in JMRI version 3.8. If you are running an earlier version of JMRI, please update to the latest version before proceeding.

2.3.2 Create roster entry and set the Device Address

Each decoder needs its own Roster entry so that there is a place to store the configuration settings that are unique to that decoder. In this step we will create the Roster entry for the decoder. We will also assign a unique Device Address to the decoder using the [Service-Mode/ Programming-Track](#) Programmer so that we can later alter its configuration whenever required without affecting any other devices. When setting all other parameters of the QuadLN_S we will always use [Ops-Mode / Programming On Main](#). The [Service-Mode/Programming-Track](#) Programmer is only used in this step and when performing a Factory Reset.

The Device Address can be set using [Service Mode/Programming-Track](#) programming messages that are received by the QuadLN_S over Loconet. (No connection between the QuadLN_S and the programming track is required.)

- Remove all locomotives from the programming track.
- In DecoderPro or PanelPro click the **Service-Mode** Programmer button or go to **Tools / Programmers** and select **Service-Mode** Programmer. In DecoderPro3 select the **Programming Track** option and then click the “+ New Loco” button.
- Scroll down the decoder list to **Tam Valley Depot**, expand it, select the **Quad-LN_S** family and expand it, select **Quad-LN_S_v1** decoder and then click **Open Programmer**. (see the note below if the entry is missing)
- On the **Roster Entry** tab, enter an ID for the device such as QLNnnnnn (where nnnnn is the 5-digit address for this device) or other unique identifier.
- Go to the **Basic** tab.
- Enter the desired Device Address in the **Long Address** field. Choose a unique address between 1 and 16383. See Section 1.7.1 for information about Device Addresses. A unique 5-digit address is recommended to avoid conflicts. (Do **NOT** click on any of the buttons at the bottom.)
- Click **Save** on the **File** menu to save the new roster entry.
- Go to the **CVs** tab.
- Install the **ADDR** jumper. The **ACTV** and **MSG** LEDs should start flashing alternately.
- **Write** CV17 and then **Write** CV18. (Ignore the “Programmer error” message, this is normal.)
- Remove the **ADDR** jumper.
- In DecoderPro or PanelPro **Close** the **Service-Mode** Programmer. In DP3 select the **Program on Main** option.

Note: If the **Tam Valley Depot / Quad-LN_S** family or **Quad-LN_S_v1** decoder entry is missing, please follow these steps to download and install the necessary template file.

- Download the latest QuadLN_S templates from the /Decoder files/Tam Valley Depot/ folder in the files area of the Yahoo JMRI Users Group. Place the decoder file in the decoders subfolder under the User File Location specified in your JMRI Preferences File Locations. Place the TVD folder in the xml/decoders subfolder under the User File Location specified in your JMRI Preferences File Locations. (Create this folder if it doesn’t already exist.)
- **Close** the **Service-Mode** Programmer if it is still open.
- Select **Recreate Decoder Index** on the **Debug** menu.
- When that step is complete, go back to the first step in this section.

2.3.3 Servo Start Address, Lock Start Address, Main and Aux IO Start Addresses

Now we are ready to enter all other parameters of the QuadLN_S. To do this in JMRI we use **Ops-Mode / Programming On Main**.

- In DecoderPro or PanelPro click the **Ops-Mode/Main-Track** Programmer button or go to **Tools / Programmers** and select **Ops-Mode/Main-Track** Programmer. In DecoderPro3 select the **Programming On Main** option.
- Select the QuadLN_S entry you created above from the roster and Open it.
- Go to the **QuadLN_S** tab.

- Enter the desired servo start address in the **Desired Servo Start Address** field.
- (optional) Enter the desired lock start address in the **Desired Lock Start Address** field.
- (optional) Enter the desired Main IO start address in the **Desired Main IO Start Address** field.
- (optional) Enter the desired Aux IO start address in the **Desired Aux IO Start Address** field.
- Click **Write changes on sheet** to update the QuadLN_S.
- (optional) Click **Read full sheet** to read back the address values and confirm the settings.
- Click **Save** on the **File** menu to update the roster entry.

2.3.4 Travel and Speed

You can follow the procedure in Section 2.2.2 above or at any time just [use Ops-Mode / Programming On Main](#) in JMRI by clicking on one of the Group tabs and begin exploring using the information starting in Chapter 3.

2.4 Factory Reset

The QuadLN_S settings can always be restored to their factory defaults. Factory Reset is performed by writing a special value to CV 8 (Manufacturer ID) using [Service Mode](#) programming messages that are received by the QuadLN_S over Loconet. (No connection between the QuadLN_S and the programming track is required.) Menu choices have been provided in the JMRI **QuadLN_S** template file to make this easy to do using the JMRI [Service-Mode/Programming-Track Programmer](#). Alternate manual methods that do not require JMRI are also described below.

2.4.1 Restore Selective Parameters to Factory Defaults using JMRI

- Remove all locomotives from the programming track.
- Go to **Programmers** on the **Tools** tab and open the [Service-Mode Programmer](#). (In DP3 just select the [Programming Track](#) option.)
- Select any **QuadLN_S** roster entry and open it.
- Select the **Reset** menu and then click **Factory Reset...**
- Select **Restore All CVs...**, **Restore Addresses...** or **Restore Servo and Input CVs...** to specify which parameters to restore.
- Install the **ADDR** jumper. The **ACTV** and **MSG** LEDs should start flashing alternately.
- Click **OK** to perform the reset.
- Remove the **ADDR** jumper.
- **Close** the [Service-Mode Programmer](#).
- If you chose "Restore Addresses..." above, cycle power to the QuadLN_S so the changes can take effect.

2.4.2 Restore All Parameters to Factory Defaults using the Remote Align Board

- Remove power from the **QuadLN_S**.
- Install the **ADDR** jumper.
- Connect the remote alignment board to the QuadLN_S.
- Press and hold both the Up and Down buttons.
- Reapply power to the **QuadLN_S**.

- Continue holding both the Up and Down buttons until the **ACTV** and **MSG** LEDs flash alternately for 1 second and then stop flashing.
- Release the buttons.
- Remove the **ADDR** jumper.

2.4.3 Restore Selective Parameters to Factory Defaults without using JMRI

- Remove all locomotives from the programming track.
- Install the **ADDR** jumper. The **ACTV** and **MSG** LEDs should start flashing alternately.
- Enter Program Mode on your throttle.
- Write one of the following values to CV8 to specify which parameters to restore.
 - 8 to restore all configuration, address, servo and input parameters to their factory default values.
 - 9 to restore all configuration and address parameters to their factory default values.
 - 10 to restore all servo and input parameters to their factory default values.
- Remove the **ADDR** jumper.
- Exit Program Mode on your throttle.
- If you wrote 9 to CV8 above to restore only the addresses, cycle power to the QuadLN_S so the changes can take effect.

3 Servo Control

To access the following parameters in JMRI always use [Ops-Mode / Programming On Main](#).

3.1 Travel

The Travel parameters allow the Servo Closed and Thrown Position endpoints, Speed, and RapidStart feature to be set for each Servo.

3.1.1 Closed Position

The Closed Position endpoint can be set from 0 to 2400, where 0 is fully counter-clockwise and 2400 is fully clockwise.

3.1.2 Thrown Position

The Thrown Position endpoint can be set from 0 to 2400, where 0 is fully counter-clockwise and 2400 is fully clockwise.

3.1.3 Speed

The Speed can be set from 0 to 63, where 0 is very slow and 63 is very fast. A typical Speed setting is 4. When you reduce the speed of other types of slow motion switch machines by lowering the drive voltage, this also reduces the applied force (torque). With servos the position is controlled continually during movement so full torque is available. This makes movement smooth even at very slow speed settings.

3.1.4 RapidStart

With any slow motion turnout motor there is generally some amount of over-travel to ensure that the throwbar is tensioned and the point rail is locked against the stock rail. When the motor is reversed, no movement of the points occurs until the over-travel is “unwound” and the motor begins to drive the throwbar in the opposite direction. The time it takes to unwind the over-travel is noticeable at slow motor speeds and detracts from the realistic movement that slow motion motors are intended to create. In some cases this effect creates the impression that the turnout action requested by the operator failed to occur, and results in operators re-actuating turnout control buttons and toggles.

The RapidStart feature is designed to minimize the over-travel delay and provide more realistic throwbar motion. When RapidStart is enabled and a servo is reversed, the QuadLN_S moves the servo through the first part of the range of motion at high speed and then switches to the speed set by the Speed parameter for the remainder of the motion. The initial movement at high speed quickly unwinds the over-travel so that the throwbar begins moving much sooner, while the final movement at low speed creates the desired slow motion effect.

The RapidStart parameter allows you to set the fraction of the movement that occurs at high speed. The available RapidStart settings are **none**, **one-eighth travel**, **one-quarter travel**, and **three-eighths travel**.

3.1.5 Directional Speed

Normally the QuadLN_S drives a servo at the same speed whether the servo is moving towards the Closed position or towards the Thrown position. The QuadLN_S also allows each servo to have independent Speed (and RapidStart) settings for each direction of movement. This feature might be useful when using a servo to drive a semaphore blade or an animation function like a pile driver, where the speed in one direction is different than the other.

The Directional Speed parameter allows you to set independent Speed and RapidStart values for each direction of travel. The available Directional Speed settings are **Disable** and **Enable**. When Directional Speed is set to **Enable**, the JMRI template will display two additional settings: “Thrown Speed” and “Thrown RapidStart”.

3.1.6 Thrown Speed

When Directional Speed is enabled, the Thrown Speed parameter sets the speed when moving in the Thrown direction. The Speed parameter in Section 3.1.3 always sets the speed when moving in the Closed direction.

3.1.7 Thrown RapidStart

When Directional Speed is enabled, the Thrown RapidStart parameter sets the RapidStart behavior in the Thrown direction. The RapidStart parameter in Section 3.1.4 always sets the behavior in the Closed direction.

3.2 Lock Mode

The QuadLN_S has two optional Lock modes, **Local Lockout** and **Midpoint**, which are described below. The Loconet Switches at addresses **Lock Start Address** to **Lock Start Address + 3** control the locks on Servo 1 to Servo 4 respectively. When a Lock Switch is Thrown, the selected Lock Mode for the corresponding Servo is activated, and when the Lock Switch is Closed, the Lock Mode for the corresponding Servo is deactivated.

The available Lock Mode settings for each Servo are **None**, **Local Lockout** and **Midpoint**. When set to **None**, the Loconet Switch at the Lock Address has no effect. When set to **Local Lockout**, the local controls for the turnout will be disabled (locked) when the Lock Control Switch is set to Thrown. When set to **Midpoint**, the Servo will move to the mid-travel position when the Lock Control Switch is set to Thrown and will return to the last commanded position when the Lock Control is set to Closed.

3.2.1 Local Lockout

In systems like CTC, some turnouts are controlled remotely by the dispatcher. These remotely control turnouts are normally “locked”, that is they cannot be operated by a local train crew member. When a train crew wishes to operate one of these controlled turnouts such as during local switch moves, they are required to first obtain permission from the dispatcher before the turnout is “unlocked” and then operated locally.

Besides supporting realistic operation under CTC, the ability to lock a turnout is useful just to prevent it from changing inadvertently. For example, if running a train continuously during an Open House it is desirable to lock the mainline route so that someone bumping into a fascia control doesn't cause a derailment or worse.

The QuadLN_S **Local Lockout** feature permits local control of a turnout to be disabled (locked out). It also has the ability to provide a local indication of the state of the turnout lock. Locking a QuadLN_S Servo means that local control actions via the Main and Aux IO lines (i.e. buttons, toggles and secondary triggers) can no longer directly change the Servo position. The Servo still responds normally to Loconet Switch commands at its address, including commands originated by secondary messages or by routes.

Example 1. Servo 1 Lock Mode is set to **Local Lockout** and the QuadLN_S Lock Start Address is set to 13. This means the Lock Control Switch for Servo 1 is at Loconet Switch address 13. When Switch 13 is Thrown, local control of Servo 1 is locked, and when Switch 13 is Closed local control of Servo 1 is unlocked.

Example 2. Servo 1 Lock Mode is set to **None** and the QuadLN_S Lock Start Address is set to 13. Changing Switch 13 to Thrown or Closed has no effect on local control of Servo 1.

The QuadLN_S Lock mechanism supports unlocking either by the local crew or by the Dispatcher as desired. The local crew could control the lock by sending the appropriate Switch command to the Lock Control Switch using a handheld throttle. A more interesting approach might be for the local crew to control the lock via a keyswitch or other special electrical interlock device that is connected to a

QuadLN_S input pin. There is an example in Section 4.5.5 showing how to accomplish this. Having the local crew control the lock in this manner is similar to prototype practice but requires hardware like a keyswitch for every turnout to be unlocked.

An alternative approach is to have the Dispatcher control the lock by sending the appropriate Loconet Switch command, which could be done via a control panel lever for instance. This approach doesn't require extra hardware and the Tam Valley Fascia Controller can indicate the state of the Lock to the local crew to avoid confusion (see Section 4.3.1).

To lock specific turnouts to protect a continuously running train during an open house, the Lock Control Switch for any turnout can be set using a handheld throttle. Lock Control Switches can be part of a Route, making it possible to lock or unlock a series of turnouts with just a single action. The Lock or Unlock Routes could even be fired by a pushbutton or toggle switch connected to one of the QuadLN_S inputs, making the process of locking or unlocking key fascia turnout controls very simple. There is an example in Section 4.5.5 showing how to configure a pushbutton press to fire a Route. Tam Valley Fascia Controllers can display the state of the Lock so it is easy to see that the layout is secured (see Section 4.3.1).

3.2.2 Midpoint

When **Midpoint** mode is selected, setting the Lock Control Switch to Thrown causes the servo to move midway between the Closed and Thrown setpoints. The servo will return to the last commanded position when the Lock Control Switch is Closed. This mode may be useful for control of 3 position semaphores, 3-way stub turnouts, and special animation effects.

Both LEDs on a Tam Valley Depot Fascia Controller will be lit when the corresponding servo is at the midpoint position. If using bicolor LEDs, the Red and Green elements are switched on and off rapidly so that each is on half the time, producing a shade of Yellow. The switch rate is faster than the eye can detect so no flicker is visible. If using a custom circuit to drive an indicator, the Yellow shade can be varied by changing the Red and Green LED current levels (often more Red current / less Green current is required).

3.2.3 Midpoint Example - Semaphore Mast

Suppose that a semaphore is controlled by Servo turnout LT140 and the associated Lock turnout is LT148. To set up the QuadLN_S, enable **Midpoint** mode for Servo LT140 as described above. Now whenever LT148 is THROWN the servo goes to the Midpoint regardless of the state of LT140. When LT148 is CLOSED the servo will follow the state of LT140.

To enable control of the Semaphore in JMRI, create a new Signal Mast in JMRI and set the **Mast Driver** to **Output Matrix Mast**. Next set the **Number of logic outputs** to **2** and configure the rest of the mast as shown in the following screenshot.

Add/Edit Signal Mast

Window Help

User Name:

Signal System: B&O-Semaphore ▼

Mast Type: B&O single arm semaphore ▼

Mast Driver: Output Matrix Mast ▼

This Mast can be unlit: ☐

Outputs for Unlit ☐ ☐

Number of logic outputs: 2 ▼

Output 1 ☒ Use Existing ☐ Create new
Semaphore 12 Servo - LT140 ▼

Output 2 ☒ Use Existing ☐ Create new
Semaphore 12 Lock - LT148 ▼

For each enabled Aspect, check a unique combination of Outputs 1 to 2:

Clear ☐ Disable Aspect ☒ ☒

Approach ☐ Disable Aspect ☐ ☐

Restricted Proceed ☐ Disable Aspect ☐ ☒

Unlit ☒ Disable Aspect ☐ ☐

☐ Reset previous Aspect

Copy Aspect Matrix from Mast: ▼

Cancel Create

There are 2 checkboxes in each Aspect: the first is for LT140 (Output 1) and the second is for LT148 (Output 2). When one of these boxes is checked JMRI sets associated turnout to CLOSED for that Aspect, and when the box is not checked JMRI sets the associated turnout to THROWN for that Aspect. The key is the second checkbox, which controls Lock turnout LT148. Only the Approach Aspect sets LT148 to THROWN since that forces the servo to the Midpoint. Both the Clear and Stop Aspects set LT148 to CLOSED, which allows LT140 to govern the servo position per the first checkbox.

3.3 Output Message - Servo Position Feedback without sensors

The QuadLN_S sends continuous position commands to each servo, so it always knows the servo position. As a result the QuadLN_S can provide Turnout Position Feedback messages based on the servo position. This feature is a very effective way to provide visual indication of the turnout state on your dispatcher panel without any sensors!

The available Output Message choices are **No Output Feedback** and **Exact feedback (sim)**. If you are using software such as JMRI to create control panels, **Exact feedback (sim)** will allow you to incorporate field device feedback into those panels. If you are not using software that monitors turnout position feedback or you just don't require turnout position feedback for your layout, then select **No Output Feedback** to eliminate the unneeded Loconet messages.

3.3.1 Exact feedback (sim)

Exact feedback normally utilizes two limit switches that are mounted on the turnout: one limit switch turns on when the turnout reaches the Closed position and the other limit switch turns on when the turnout reaches the Thrown position. Feedback messages are sent when either limit switch changes state. In Exact feedback (sim) mode, the QuadLN_S sends the same feedback messages but bases them on the current servo position. When the Servo first starts to move the limit switch corresponding to the initial position is reported as Low and when the Servo reaches its endpoint the limit switch corresponding to the final position is report as High.

3.4 Cascade

Cascade action refers to a condition where command to one turnout also triggers a command to a second turnout. If the second turnout triggers a command to a third turnout, etc, the command is said to "Cascade" down. Cascade action provides a very handy way to align a route through a yard ladder or crossover by sending only one Loconet Switch command.

The details of the Cascade settings are shown below, followed by examples to illustrate the basics.

3.4.1 Trigger

The Trigger is the specific Switch command that initiates the Cascade event. When the Trigger command is received, the Cascade Switch command is sent.

The available Cascade Trigger settings for each Servo are **None**, **Closed**, **Thrown** and **Closed or Thrown**. When set to **Closed**, the Cascade action is triggered whenever the Servo receives a Closed Switch command. When set to **Thrown**, the Cascade action is triggered whenever the Servo receives a Thrown Switch command. When set to **Closed or Thrown**, the Cascade action is triggered whenever the Servo receives any Switch command.

3.4.2 Action

The Action is the type of Switch command that is sent to the Cascade turnout when the Trigger condition is met.

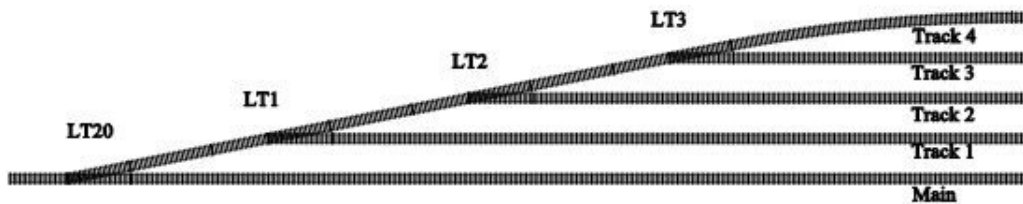
The available Cascade Action settings for each Servo are **Closed**, **Thrown**, **Follow** and **Invert**. When set to **Closed**, a Closed Switch command is sent. When set to **Thrown**, a Thrown Switch command is sent. When set to **Follow**, a Switch command matching the state of the Servo is sent. When set to **Invert**, a Switch command opposite to the state of the Servo is sent

3.4.3 Turnout

The Turnout is the Switch number for the turnout that is to receive the Cascade Switch command.

3.4.4 Cascade Examples

Yard ladder alignment. We have a number of yard tracks accessed via a simple ladder.



The entry to the yard from the main is controlled by Switch 20: Closed for the main and Thrown for the ladder. Switches on the yard ladder are Closed for the ladder and Thrown to select their specific track, so Switch 1 is Thrown for track 1, Switch 2 is Thrown for track 2, etc. Suppose we wish to fully line the route from the main to any yard track by only issuing one Switch command.

First set Switch 1 Cascade Trigger to **Closed or Thrown**, Cascade Action to **Thrown**, and Cascade Turnout to **20**. Now whenever Switch 1 receives any command, it will send a message to Switch 20 to move to the Thrown position. To line a train into Track 1, all we need to do is set Switch 1 to Thrown: Switch 20 will get Thrown by the Cascade action.

Next set Switch 2 Cascade Trigger to **Closed or Thrown**, Cascade Action to **Closed**, and Cascade Turnout to **1**. Now whenever Switch 2 receives any command, it will send a message to Switch 1 to move to the Closed position. Switch 1 will in turn send a command to Switch 20 to move to the Thrown position. To line a train into Track 2, all we need to do is set Switch 2 to Thrown: Switch 1 will get Closed and Switch 20 will get Thrown by the Cascade action.

Repeat this process for each of the remaining tracks. The key is that any change to the turnout that directly selects the track sends a Cascade message to the preceding turnout that aligns it as required.

Crossover. We have a crossover is controlled by two turnouts at addresses 6 and 15.



For the normal routes, both 6 and 15 are Closed. For the crossover route, both 6 and 15 are Thrown. Now suppose we want to just send Switch 6 Closed and Switch 6 Thrown to select the routes.

One simple way for this to happen is if Switch 6 sends a Cascade message to Switch 15 to Follow it anytime Switch 6 is commanded to a position. Set Switch 6 Cascade Trigger to **Closed or Thrown**, Cascade Action to **Follow**, and Cascade Turnout to **15**. Now whenever Switch 6 receives a command, it will send a message to Switch 15 to move to the same position.

4 Main and Aux IO lines

There are 8 digital Input / Output (IO) lines: 4 Main IO lines and 4 Aux IO lines. Each IO line can be used as an Input, an Output, or both. Simple uses of the input capability of an IO line include reporting input state over Loconet or controlling an associate Servo. More complex actions are also possible, for instance a single IO line can control all of the QuadLN_S servos. The output capability of an IO line is typically used to drive an LED panel indicator but can even be used to drive a Tam Valley Depot relay board.

The specific behavior of each IO line is configured using the parameters described in this section. To access the IO parameters in JMRI always use [Ops-Mode / Programming On Main](#).

4.1 Assignment of IO lines to Servos

The assignment of the 8 IO lines to Servos depends on the Expansion Port mode that is in use.

4.1.1 IO line assignment in Relay Mode and Signaling Mode

In Relay mode and Signaling mode, each QuadLN_S Servo has both an associated Main IO line and an associated Aux IO line.

Main IO 1 and Aux IO 1 for Servo 1
Main IO 2 and Aux IO 2 for Servo 2
Main IO 3 and Aux IO 3 for Servo 3
Main IO 4 and Aux IO 4 for Servo 4

4.1.2 IO line assignment in Servos 5-8 Mode (Octo Mode)

In Servos 5-8 mode (Octo mode), each Servo has just one associated IO line. In Octo mode, each Servo has just one associated IO line:

| | |
|----------------------|-----------------------|
| Aux IO 1 for Servo 1 | Main IO 1 for Servo 5 |
| Aux IO 2 for Servo 2 | Main IO 2 for Servo 6 |
| Aux IO 3 for Servo 3 | Main IO 3 for Servo 7 |
| Aux IO 4 for Servo 4 | Main IO 4 for Servo 8 |

4.2 Input Response

When an IO line is used as an input, the QuadLN_S samples the line 50 times per second and debounces (filters) input changes to suppress electrical noise. This helps to prevent multiple actions from single button pushes or multiple events caused by detector chattering.

4.2.1 Type – Aux Inputs

The available Input Types for each Aux Input are **General** and **Detector**. For **General** inputs, a debounce time of 100 milliseconds is used for both Positive and Negative edges. Trigger and Indication options are available. Typical devices connected to **General** inputs are pushbuttons, contact closures, and open collector outputs.

For **Detector** inputs, Trigger is always set to **Both Edges** and Trigger options are not available. The debounce time for positive edges is extended to 2 seconds to ensure that the occupied (low) indication is maintained during momentary loss of contact (current detector) or momentary change in light level (optical detector). Indication options are available.

4.2.2 Type – Main Inputs

The available Input Types for each Main Input are **General** and **TVD Detector**. For **General** inputs, a debounce time of 100 milliseconds is used for both Positive and Negative edges. Trigger and Indication options are available. Typical devices connected to **General** inputs are pushbuttons, contact closures, and open collector outputs.

The **TVD Detector** input is used when connected to a Tam Valley Depot detector board. For **TVD Detector** inputs, Trigger is always set to **Both Edges** and the debounce time for positive edges is extended to 2 seconds to ensure that the occupied (low) indication is maintained during momentary loss of contact (current detector) or momentary change in light level (future optical detector). Detector Type, Range and Sensitivity options are available for **TVD Detector** inputs, while Trigger and Indication options are not available.

4.2.3 Detector Type (Main IO pins only)

When using a Tam Valley Depot detector board, Current Transformer (CT) or Infrared (IR) detection can be individually assigned to each Main Input pin.

4.2.4 Detector Range (Main IO pins only)

When using a Tam Valley Depot current detector board the **Range** may be set for either **Low Current** or **High Current**. The **Low Current** range allows the sensitivity to be adjusted between approximately 0.3mA and 4mA. The **High Current** range allows the sensitivity to be adjusted between approximately 4mA and 20mA.

4.2.5 Sensitivity (Main IO pins only)

When a Main IO pin is set for **TVD Detector**, the input is processed using the Sensitivity value to determine if the signal represents the Occupied or Unoccupied state. The Occupied state is reported as a 0 and the Unoccupied state is reported as a 1. The higher the Sensitivity value, the more sensitive the input and the lower the signal value required for detection. Set the Sensitivity value just high enough to ensure reliable detection. If false detection occurs, decrease the Sensitivity value.

4.2.6 Trigger

Input actions are initiated only when an input change occurs that matches the Trigger condition.

For **General** inputs the available Input Trigger settings for each Input are **None**, **Positive Edge**, **Negative Edge** and **Both Edges**. When set to **Positive Edge**, the input action is triggered whenever the Input changes from the Low level to the High level. When set to **Negative Edge**, the input action is triggered whenever the Input changes from the High level to the Low level. When set to **Both Edges**, the input action is triggered whenever any Input change occurs. When set to **None**, no action is triggered by the input and the input line is not sampled.

For **Detector** inputs the Input Trigger is fixed at **Both Edges** and the Trigger selection is not available.

When a sampled input line changes state and then remains stable for the debounce time, a Loconet Sensor message is generated.

4.2.7 DCC Freeze

Some input devices give false indications when DCC is not present. For example, a short in a DCC power district may cause all block occupancy detectors in that district to indicate that their blocks are vacant whether or not trains are present. The QuadLN_S has the ability to monitor the DCC signal and to freeze an input at its previous level when the DCC signal is lost, thus preventing false reports from detectors during short circuit conditions.

The available settings are **Always Live** and **Freeze on DCC loss**. When set to **Always Live**, input action follows the Trigger setting independent of the DCC state. This is generally the appropriate setting when the input is used for Servo control. When set to **Freeze on DCC lost**, input action is disabled when no DCC signal is present on the DCC input pins. This is generally the appropriate setting when the input is used for a block occupancy detector.

4.3 Indication

When the Input line is not being sampled, the QuadLN_S has the capability to treat the line as an Output and can drive an LED indicator to display the state of the Servo. Since the input sampling takes place very quickly and at a rate higher than the eye can detect, the LED indicator will appear to be on continuously with no discernible flicker. (If using input devices other than Tam Valley Depot Fascia Controllers, please see the general Quad datasheet for information on simultaneously wiring switches and LEDs to the Input lines.)

For **TVD Detector** inputs the LED Indication feature is not available.

4.3.1 LED Mode

When the LED indicator is enabled, the steady LED indication shows whether the Servo is Closed or Thrown. The LED can be set to blink rapidly while the Servo is moving, thus providing feedback that travel is complete when the indicator again becomes steady. When the associated Servo is Lockable, the LED can be set to blink slowly to provide feedback on the whether local control of the Servo is Locked or Unlocked. (The global Lock Indicator setting determines whether blinking indicates the Locked or the Unlocked state – see Section 6.9.)

For **TVD Detector** inputs the LED Mode feature is not available.

The available LED Mode settings for each Input are **Disable – Input only**, **Steady Drive**, **Blink on Move**, **Blink on Move or Lock**, **Blink on Lock**, **Lock State**, **Position** and **Blink on Thrown**. When set to **Steady Drive**, the output indication shows the Servo position. If the Servo is in motion the output indication changes when the Servo passes the midpoint. Choose this mode when the IO pin is driving a Tam Valley Depot 5 Volt relay board for frog power. When set to **Blink on Move**, the output indication shows the commanded Servo position and blinks rapidly while the Servo is moving. When set to **Blink on Move or Lock**, the output indication shows the commanded Servo position, blinks rapidly while the Servo is moving and blinks slowly when the Servo is **Lockable** and the state of the lock matches the Lock Indicator setting. When set to **Blink on Lock**, the output indication shows the commanded Servo position and blinks slowly when the Servo is **Lockable** and the state of the lock matches the Lock Indicator setting. When set to **Lock State**, the output indication shows the commanded Lock position instead of the commanded Servo position. When set to **Position**, the output indication shows the actual Servo position instead of the commanded position, and only changes when the servo reaches the commanded position and stops. When set to **Blink on Thrown**, the output indication blinks when the Servo is commanded to the Thrown position. In this mode the Main and Aux IO indications blink on opposite phases, which allows them to be used to animate grade crossing flashers when the Servo is controlling a crossing gate. When set to **Disable – Input only**, no output drive is provided and the line is always left as an input. This is appropriate when the input device is a detector for example.

Except in the **Steady** and **Position** modes, the LED output changes gradually (fades) from one state to another to simulate the appearance of an incandescent panel lamp turning on or off. In the **Steady** and **Position** modes the output changes abruptly in one step, so that the output signal can more easily be used to trigger other types of devices if desired.

4.3.2 LED Drive

If the LED panel wiring results in the opposite indication from what is desired, the QuadLN_S can simply invert the output drive to the LED. This eliminates the need to rewire the LED indicators or remount the Fascia Controller.

For **TVD Detector** inputs the LED Drive feature is not available.

The available LED Sense settings for each Input are **Normal** and **Inverted**. When set to **Normal**, the LED output drive is High when the Servo is Closed and Low when Thrown. When set to **Inverted**, the LED output drive is Low when the Servo is Closed and High when Thrown.

4.4 Action

Each QuadLN_S input can control any or all of the Servos. This allows inputs to trigger routes without requiring a Loconet connection. The local action of any input on each of the QuadLN_S Servos can be set independently. (The local action on a Servo is only performed if that Servo is not locked.)

The available Servo action settings for each Input are **None, Toggle, Follow, Invert, Closed, Thrown, Lock Toggle, Lock Follow, Lock Invert, Lock Closed and Lock Thrown**. When set to **None**, the state of the corresponding Servo is unaffected by the input. When set to **Toggle**, the state of the corresponding Servo is set to the opposite of its current state. When set to **Follow**, the state of the corresponding Servo is set to Closed if the Input is High and set to Thrown if the Input is Low. When set to **Invert**, the state of the corresponding Servo is set to Closed if the Input is Low and set to Thrown if the Input is High. When set to **Closed**, the state of the corresponding Servo is set to Closed. When set to **Thrown**, the state of the corresponding Servo is set to Thrown. When one of the **Lock** settings is selected, the state of the corresponding Lock is set accordingly.

4.5 Secondary Message

Each Input can receive or send a Secondary message. This can be used to implement more complex logic for yards, panels or other functions. If set to send a Secondary message, when the Input Trigger condition set in Section 4.2.1 is met the Secondary message is sent. If set to receive a Secondary message, a Loconet sensor or turnout message that matches the Secondary Trigger fires the Servo Actions that are configured for the Input.

4.5.1 Type

The available Secondary Type settings for each Input are **Trigger on this message** and **Send this message**. When set to **Trigger on this message**, the specified Servo Actions for the input are executed when the Condition below is met. When set to **Send this message**, the Secondary message is sent when the Input Trigger condition is met, and the message content is determined by the Condition below.

4.5.2 Device

The available Secondary Device settings for each Input are **Turnout** and **Sensor**. When set to **Turnout**, the Secondary message is a Switch command message. When set to **Sensor**, the Secondary message is a General Sensor message.

4.5.3 Condition

The available Secondary Condition settings for each Input are **None, Hi / Closed, Lo / Thrown** and **Both / Follow**.

If Type is **Trigger on this message**: When set to **Hi / Closed**, the trigger condition is a Sensor Hi or Switch Closed message. When set to **Lo / Closed**, the trigger condition is a Sensor Lo or Switch Thrown

message. When set to **Both / Follow**, the trigger condition is a Sensor or Switch message in either state. When set to **None**, the Secondary message function is disabled.

If Type is **Send this message**: When set to **Hi / Closed**, the message sent is a Sensor Hi or Switch Closed message. When set to **Lo / Closed**, the message sent is a Sensor Lo or Switch Thrown message. When set to **Both / Follow**, the message sent is a Sensor or Switch message with the state matching the Input state. When set to **None**, the Secondary message function is disabled.

4.5.4 Number

The Switch or Sensor number for the Secondary message.

4.5.5 Secondary Message Examples

All Mainline Turnouts to Closed. Suppose we have many mainline turnouts controlled by QuadLN_S boards. Each turnout is controlled by a pushbutton on its Main IO line. We would like to be able to set all the turnouts to their Closed position with a single Switch command, say Switch 200 Closed. For each Servo Main IO line, set the Secondary Message Type to **Trigger on this message**, the Device to **Turnout**, the Condition to **Hi / Closed**, and the Number to **200**. Now sending a single Switch command lines all the turnouts to the Closed position.

All Mainline Turnouts to Closed with a single button press. Same as the previous example, except we want to press a pushbutton to line the turnouts instead of sending a Switch command with a throttle. Do the setup as in the previous example. Wire the pushbutton to an available Aux IO line on a QuadLN_S board, then adjust the settings for the Aux IO line as follows: Trigger to **Positive Edge**; Action to **None** for each Servo; Secondary Message Type to **Send this message**, Device to **Turnout**, Condition to **Hi/Closed** and Number to **200**. Now pressing the button sends a Switch 200 Closed command, which in turn causes all the mainline turnouts to move to the Closed position.

Unlock a Mainline Turnout using a keyswitch. We have a local fascia pushbutton set up for control of Switch 17, but wish to lock (disable) the pushbutton unless a keyswitch is actuated. Suppose we have also set the Lock Base Address to 21. Wire the keyswitch to an available IO line on a QuadLN_S board, then adjust the settings for the IO line as follows: Trigger to **Both Edges**; Action to **None** for each Servo; Secondary Message Type to **Send this message**, Device to **Turnout**, Condition to **Both/Follow** and Number to 21 (21 is the Lock Control Switch for Switch 17 – see Section 3.2). Now opening the keyswitch sends a Switch 21 Closed command which unlocks Switch 17, and closing the keyswitch sends a Switch 21 Thrown command which locks Switch 17. A suitable indicator on the Dispatcher panel could monitor Switch 21 and provide an indication when Switch 17 is unlocked.

5 Routes

Routes are arbitrary sequences of Switch and Sensor messages that are sent when a trigger condition is met. The QuadLN_S has 8 routes, each containing up to 4 entries consisting of Switch commands, Sensor state messages or Signal aspects. Routes can be set to Expand the prior route, so it is possible to have a single route with as many as 32 entries. This makes it easy to do things like create an

arbitrary track alignment by sending a single command. To access the following parameters in JMRI always use [Ops-Mode / Programming On Main](#).

5.1 Type

The available Route Types are **None**, **Normal Route**, **Selector** and **Expand (Prior) Route**. A **Normal Route** is only triggered by the first entry and always sends the remaining entries exactly as entered. A **Selector Route** is triggered by any of the entries and sends the remaining entries in the opposite state from that entered. This action implements a “1-of-n” selection. An **Expanded Route** simply adds its entries to the prior route.

5.2 Entries

Each Route entry consists of an Address and Device Type / Action. For Switch messages the available Actions are **Closed** and **Thrown** and for Sensor messages the available Actions are **Sensor Hi** and **Sensor Lo**. For these messages, the Address is the Loconet device number. For Signals the available action is **Aspect**, and the Address represents the number of an Aspect on this QuadLN_S.

5.3 Route Examples

Align a Route when a button is pressed. We would like to be able to line a route that involves many turnouts by pressing a pushbutton. Wire the pushbutton to an available Aux IO line on a QuadLN_S board, then adjust the settings for the Aux IO line so that the Input Type is set to **General**. Set the Action to **None** for each Servo. Pick a Route in any QuadLN_S and set the Type to **Normal Route**, set the first entry to the **Aux IO address** and **Sensor Hi**, and then enter the **Switch address** and **Closed** or **Thrown** in the following entries for each turnout in the route. Use Expanded Routes as needed. Now pressing the button lines the entire route.

Lock All Mainline Turnouts. We have many mainline turnouts controlled by QuadLN_S boards. Each turnout is controlled by a pushbutton on its Main IO line. We would like to be able to lock out all the pushbuttons (for continuous running during an Open House for example) by sending a single Switch command, say Switch 200 Closed. Pick a Route in any QuadLN_S and set the Type to **Normal Route**, set the first entry to **200 Closed**, and then enter the **Lock address** and **Thrown** in the following entries for each mainline turnout lock. Use Expanded Routes as needed. Now sending a single Switch command locks all the mainline turnouts.

Panel track selection indicator. We have a yard panel with an LED for each track. The LEDs are controlled via a stationary decoder(s) using Switch commands. Setting a particular Switch address to Closed turns an LED on, and setting it to Thrown turns the LED off. We would like to be able to send a single Switch command to light the LED for the selected track and have all the other LEDs go out. Pick a Route in any QuadLN_S, set the Type to **Selector** and then enter the **Switch address** and **Closed** in the route entries for each Switch address that controls an LED. Use Expanded Routes as needed. Now sending a single Switch command turns on the LED for the selected track and turns off the LEDs for the non-selected tracks.

Set signals for a turnout. We have a number of signals protecting Switch 200 and would like to set their Aspects just based on the position of a turnout. Pick a Route in the QuadLN_S that controls the signals and set the Type to **Normal Route**, set the first entry to **200 Closed**, and then enter the desired **Aspect Number** for each signal and **Aspect** in the following entries in the route. Use Expanded Routes as needed. Next repeat these steps for another **Normal Route**, this time with **200 Thrown** as the first entry and the desired Aspect Number in each of the following entries. Now sending any command to Switch 200 will cause each of the signals to display the appropriate Aspect.

6 The QuadLN_S Pane

The QuadLN_S has a number of address settings and special configuration settings. Most users will only need to set the Servo Start Address, Main IO Start Address and Aux IO Start Address here (the Long Address is shown for information only and will have already been set if required). The remaining special configuration settings can generally be left at their default values. To access the following parameters in JMRI always [use Ops-Mode / Programming On Main](#).

6.1 Addresses

6.1.1 Long Address

The Long Address is the address used when programming the device in [Ops Mode](#). This address is also shown on the Basic pane. See Section 1.7.1 for more info. A special procedure is required to change the device address, and this procedure is described in Section 2.2.3. This procedure is intended to prevent inadvertent device address changes.

6.1.2 Servo Start Address

The Switch addresses for the QuadLN_S Servos are set using this field. The QuadLN_S uses 4 consecutive Switch addresses for Servo control. Avoid using addresses 1017-1020 for any Servo if possible (those addresses are also used by a special interrogation command). The address for each Servo is displayed on its Group tab. See Section 1.7.2 for more info on the Servo Start Address.

6.1.3 Lock Start Address

The Switch addresses for the QuadLN_S Locks are set using this field. The QuadLN_S uses 4 consecutive Switch addresses for Lock control. Avoid using addresses 1017-1020 for any Lock if possible (those addresses are also used by a special interrogation command). The address for each Lock is displayed on its Group tab. See Section 1.7.3 for more info on the Lock Start Address. If the Servo and Lock address ranges overlap, any Lock with the same address as a Servo will not be accessible via a Loconet Switch command.

6.1.4 Main IO Start Address

The Main IO addresses for the QuadLN_S Servos are set using this field. The QuadLN_S uses 4 consecutive Sensor addresses for the Main IO. See Section 1.7.4 for more info on the Main IO Start Address.

6.1.5 Aux IO Start Address

The Aux IO addresses for the QuadLN_S Servos are set using this field. The QuadLN_S uses 4 consecutive Sensor addresses for the Aux IO. See Section 1.7.5 for more info on the Aux IO Start Address.

6.2 Expansion Port

The Expansion Port may be used to directly drive 4 Tam Valley Depot 5 Volt Relay Boards, 4 additional Servos, or 24 LEDs using the Tam Valley Depot Signal board. This setting determines which signals are supplied to the expansion port. When set to **Relays 1-4**, relay board drive signals are supplied that change state when the servo is at mid travel. When set to **Signaling**, LED drive signals are supplied to control 24 LEDs using the Tam Valley Depot Signal Board. When set to **Servos 5-8**, servo drive signals are supplied for 4 additional servos.

Note: After writing a new Expansion Port setting to the QuadLN_S, it is a good idea to **Read** each of the Group tabs. This will ensure that the JMRI template you are viewing reflects the values in your QuadLN_S.

6.2.1 Route Delay

Each action in a local route can occur immediately after the route is triggered or it can occur after a fixed delay. The length of the delay is controlled by this setting. The available **Route Delay** settings are **1 Sec**, **2 Sec**, **4 Sec** and **8 Sec**. The default is **1 Sec**.

6.3 Servo OFF When Stopped

This setting permits the drive signal to a servo to be turned off when the servo is not moving. In cases where little force is required to hold the turnout at the desired position, such as when over-center spring force holds the turnout in position, turning off the drive will prevent a problem servo from buzzing. The default value is **Unchecked** meaning **Always On**. **Check** the box to enable the **Servo OFF When Stopped** feature.

6.4 Servo State Memory

This setting controls whether the QuadLN_S records the Servo positions when they change and then restores all Servos to their last known position at power-up. By default the box is **Checked** meaning that the state of each Servo will be **Restored on Power-up**. If the box is **Unchecked** then each Servo will be set to **Closed at Power-up**.

6.5 Signal State Memory

This setting controls whether the QuadLN_S records the Signal aspects when they change and then restores all Signals to their last known aspect at power-up. By default the box is **Unchecked** meaning

all Signal outputs will be **Off at Power-up**. If the box is **Checked** then the state of each Signal output will be **Restored on Power-up**.

6.6 Retry on DCC Busy

This setting controls whether the QuadLN_S attempts to retry Switch Requests when the Command Station reports that the DCC bus is busy. The default value is **Checked** meaning **Retry Switch Requests** when required.

Note: This section is somewhat technical. Users that don't need any Switch Request sent by the QuadLN_S to reach DCC-only stationary decoders can simply ignore this section. The information below is included so that those users with complex configurations that include DCC-only stationary decoders can better understand the system performance tradeoffs.

When the QuadLN_S sends a Switch Request on Loconet as part of a Cascade, Secondary Message or Route, the Command Station attempts to send the command over the DCC bus. This is done so that DCC-only stationary decoders will also receive the command. However due to the difference in bandwidths, Loconet Switch Requests can arrive at the Command Station faster than the Command Station can send them out over DCC. When this happens the Command Station internally buffers the Switch Requests in order to give the DCC bus a chance to catch up. When the Command Station receives a Switch Request and its internal buffer is already full (or with some Command Stations if track power is turned off so that DCC commands cannot be sent), the Command Station responds with a special Loconet message to indicate that the Switch Request did not make it to the DCC bus.

When a Switch Request does not get to the DCC bus, the QuadLN_S has two options: ignore the failure or send the Switch Request again. Sending the Switch Request again usually works out fine, but if there are a large number of Switch Requests being generated on Loconet (from one or more devices) then the retries can start to pile up. When this happens performance degrades until the Command Station is able to get the DCC side caught up, and under most circumstances things get resolved without any noticeable impact.

If you need the QuadLN_S to be able to send Switch Requests to DCC-only stationary decoders then **Check** this option and the QuadLN_S will **Retry Switch Requests** when required. If you have not set up the QuadLN_S to send Switch Requests to DCC-only stationary decoders, then **Uncheck** this option since in this case it doesn't matter whether a command sent by the QuadLN_S makes it to the DCC bus and thus there is no reason to create additional Loconet traffic by resending Switch Requests.

Finally, if you are using a DCS100 and have no DCC-only stationary decoders at all, you can set OPSW 27 to Closed. Closing OPSW 27 tells the DCS100 not to send any Switch Requests over the DCC bus. This eliminates the entire DCC backlog issue and allows Switch Requests to be sent at full Loconet speed under all conditions.

6.7 Output Off Switch Request

This setting controls whether the QuadLN_S sends the Output Off form of the Switch Request after sending the Output On form of the Switch Request. The default value is **Checked** meaning **Send Output Off** form of the Switch Request.

Note: As with the preceding section, this section is somewhat technical and most users can just ignore it.

When the QuadLN_S sends a Switch Request on Loconet as part of a Cascade, Secondary Message or Route, two Loconet messages are generated. The first message is an Output On Switch Request and the second is an Output Off Switch Request. By convention these two messages are sent because some stationary decoders turn their output drive on when they receive an Output On Switch Request and turn the drive off when they receive an Output Off Switch Request. The QuadLN_S inserts a delay of about 100 milliseconds between the two messages.

When receiving Switch Requests, the QuadLN_S ignores the Output Off Switch Requests and leaves the output drive on all the time. Many stall motor decoders act this way. Although sending the Output Off messages doesn't affect the decoders it does double the amount of Loconet traffic and doubles the amount of **DCC** traffic (see Section 6.5) for each Switch Request. This can reduce performance briefly during intense bursts of Switch Request activity, such as when sending a long Route. If all your stationary decoders ignore the Output Off Switch Request then **Uncheck** this option to eliminate the unnecessary Loconet messages.

6.8 No Command Station

This setting is applicable to standalone **LocoNet** installations where no command station is present. The QuadLN_S can expand the responses to certain programming messages to also provide the replies normally sent by a Command Station. When no Command Station is present, these responses will suppress error messages in JMRI or other software that expects to see the command station replies. The default value is **Unchecked** meaning that a Command Station is present. **Check** this option if **No Command Station** is present on **LocoNet**.

6.9 Input Invert

This setting allows the Sensor Input Polarity to be inverted for use with certain layout control programs that require Active Low inputs to be reported as High. The default value is **Unchecked** meaning inputs are not inverted. When **Checked** the signal level is **Inverted** at the pin prior to any other processing. Note that input settings may need to be adjusted whenever this option is changed.

6.10 Blink Indicates Unlock

This setting determines whether the IO line LED indicators configured to display their Servo Lock status will blink when the Servo is in the Locked state or when it is in the Unlocked state. The default value is **Unchecked** and a blinking LED indicates the Locked state. When **Checked** a blinking LED indicates the **Unlocked** state.

6.11 Broadcast Local Actions

This setting controls whether the QuadLN_S makes local Servo and Lock actions visible on Loconet. The default value is **Checked** meaning **Local Actions are Broadcast**.

The QuadLN_S can perform the local Servo or Lock actions that are triggered by input changes (see Section 4.4 for information on local actions) in two slightly different ways. In the first approach the QuadLN_S directly changes the Servos and Locks to the new values. In the second approach the QuadLN_S generates Loconet Switch Request commands just as would happen if some other Loconet device were sending the commands. The second approach is used by default and provides Loconet visibility to the state changes caused by the local actions the same as with any Loconet Switch Request. The second approach also allows the QuadLN_S input changes to trigger routes. If Loconet visibility is not needed and local routes are not in use, then you can **Uncheck** option and eliminate the unnecessary Loconet message traffic. Regardless of which setting you choose, the local actions will be performed whether or not the Loconet is connected.

6.12 Switch State Request

(Advanced) This setting controls whether the QuadLN_S responds to Loconet Switch State Requests. The default value is **Unchecked** meaning **Switch State Requests are ignored**.

It is possible for a PC monitoring the Loconet to get out of sync with the state of the physical Turnouts or Sensors. There is a standard method provided by Loconet for obtaining device status called "Interrogation". Interrogation queries the entire layout at once and on large systems many devices will attempt to respond at the same time. This can result in one or more responses getting lost. The QuadLN_S provides an alternative approach that allows individual devices to be queried one-by-one. When this feature is enabled and the QuadLN_S sees a Switch State Request addressed to one of its Servo Addresses, the board will respond with a Turnout feedback report for the specified Servo, a Turnout feedback report for the associate Lock turnout, and a Sensor Report for one of the Sensor inputs. By polling each Turnout Address, one at a time, using Switch State Requests a PC can reliably collect the state of all Turnouts and Sensors.

For most systems the Interrogation method works acceptably and this option can be left **Unchecked**. If your system is large and the PC sometimes is not in sync with your layout, **Check** this option and then you can use a script to query all your Turnouts or just those missed during Interrogation.

6.13 Disable Interrogate

(Advanced) This setting controls whether the QuadLN_S responds normally to Loconet Stationary Interrogate messages or ignores those messages. The default value is **Unchecked** meaning that the board provides **Normal Interrogate Responses**.

JMRI queries the Loconet using the Stationary Interrogation method when it starts, and Command Stations do it every time layout power is turned on. Interrogation can generate a great deal of Loconet traffic on large systems, resulting in slow response and missed messages. The **Disable Interrogate**

option can speed system response on large systems when used in concert with the **Switch State Response** options discussed previously in Section 6.12. When this option is enabled the QuadLN_S will ignore Stationary Interrogate messages, reducing the Loconet traffic during Interrogation.

For most systems the Interrogation method works acceptably and this option should be left **Unchecked**. If your system is large and you have decided to implement a manual query using the Switch State Response feature, then you may wish to **Check** this option to **Disable Interrogate Responses**.

6.14 Device Information

This section contains information mainly useful for debugging problems and performing updates.

6.14.1 Manufacturer ID

The Manufacturer ID for Tam Valley Depot is 59. Writing special values to this parameter when in **Service Mode** can reset the device – see Section 2.4.

6.14.2 Product ID

This value identifies the product and helps prevent installing incorrect firmware updates. The Product ID for the QuadLN_S is 6.

6.14.3 Hardware Version

This value identifies the product hardware revision and helps prevent installing incorrect firmware updates.

6.14.4 Software Version

This value identifies the product software revision and helps prevent installing incorrect firmware updates.

6.14.5 Build Number

This value is an additional software identifier and enables better factory support.

7 Updating the Firmware

7.1 Performing the Update

The QuadLN_S design incorporates a bootloader that permits the firmware to be updated in the field using JMRI. The bootloader portion of the firmware is protected and cannot be accidentally overwritten during the update process. Normally the QuadLN_S user settings are not affected by the firmware update process. However it is always best to ensure your QuadLN_S decoder file is up to date before performing a firmware update so that your settings can be easily restored later if required.

To perform a firmware update, follow the steps below.

1. Download the new firmware from TamValleyDepot.com and place the file in your JMRI Preferences folder.
2. Select **Download Firmware** from the JMRI **LocoNet** menu.
3. For older versions of JMRI, the **File format** must be manually set by clicking the **16 bit** File format button if it isn't already selected. If you have a newer version of JMRI and the **File format** buttons are not selectable, just proceed to the next step.
4. Click the **Select** button and then open the firmware file you downloaded in Step 1.
5. For older versions of JMRI there will be a **Read file** button. If that button is present, click it to load the file into the downloader. If you have a newer version of JMRI and there is no **Read file** button, just proceed to the next step.
6. Connect the Remote Alignment Board to the QuadLN_S.
7. Simultaneously press and hold down all three buttons on the Remote Alignment Board.
8. After about 2 seconds when the **MSG LED** dims, release the buttons and the **MSG LED** should go dark. The QuadLN_S is now in bootloader mode.
9. In JMRI, click **Download** to begin downloading the file to the QuadLN_S. The **MSG LED** will toggle as each message is received. The **ACTV LED** will flash briefly as each block of memory is written.
10. If the download completes successfully, the QuadLN_S will resume normal operation.
11. If an error occurs, the **ACTV LED** will flash continuously about once/second. The **MSG LED** will indicate the error code.
 - **MSG LED** On = communication error - bad message received.
 - **MSG LED** Off = configuration error. This can be one of the following:
 - firmware file error - wrong manufacturer code or wrong product code. The file you are attempting to download is not for this product.
 - hardware version error – the firmware is not for this version of the board.
Obtain the proper firmware file for the hardware version of your board.
 - **MSG LED** Flashing once/second = software version error – the firmware isn't newer than the existing firmware. The current firmware is as new or newer than the firmware you are attempting to download. If the download is still desired, select **Don't check software version** in the JMRI Firmware Downloader, cycle power to the board and repeat the process starting with step 7 above.

Notes:

The QuadLN_S software is overwritten as the download progresses. Once the download starts, if it is interrupted or if a communication error occurs then the QuadLN_S software will probably be corrupted. However the bootloader will be intact, so just click **Abort**, remove power to the board, press and hold the Select button then reapply power to the board. The **ACTV LED** should be lit and the **MSG LED** should be dark. Now repeat the download process starting with step 9 above.

In cases where there is a great deal of other Loconet traffic, try increasing the **Delay (msec)** value to 200. This will slow the download process but will make it more tolerant of Loconet collisions.

If a configuration error occurs, the QuadLN_S did not accept the download and the previous software is intact. If you still want to perform the update, resolve the issue and then repeat the download process. When errors occur repeatedly you may want to try increasing the **Delay** value as described in the previous paragraph.

7.2 Updating the Decoder Template

If the firmware update contains new features, you will need the latest JMRI decoder template file to take advantage of those features. The latest version of JMRI should contain the latest decoder template. If you are not running the latest version of JMRI and a QuadLN_S feature appears to be missing when you open a roster entry, please follow these steps to download and install the new decoder template files.

- Download the latest templates from the /Decoder files/Tam Valley Depot/ folder in the files area of the Yahoo JMRI Users Group.
- Copy the decoder xml file to the “decoders” subfolder under the User File Location specified in your JMRI Preferences File Locations.
- Copy the decoder xsl file to the “xml/decoders” subfolder under the User File Location specified in your JMRI Preferences File Locations.
- Copy the tvd folder to the “xml/decoders” subfolder under the User File Location specified in your JMRI Preferences File Locations.
- Select **Recreate Decoder Index** on the JMRI **Debug** menu.

8 CV Tables

8.1 Full CV Table

| CV # | Description | Range | Default |
|---------|---------------------------|--------------------------|------------------|
| 1 | Reserved | | |
| 3,2 | Servo Start Address | 0-2044 | 0 (0,0) |
| 4 | Software Version | 0-255 | - |
| 5 | Software Build Number | 0-255 | - |
| 6 | Hardware Revision | 0-255 | - |
| 7 | Product ID | 6 | 6 |
| 8 | Manufacturer ID | 59 | 59 |
| 10,9 | Main IO Start Address | 0-4092 | 0 (0,0) |
| 11 | Configuration | Table 8-3 | 180 |
| 12 | Configuration2 | Table 8-4 | 0 |
| 14,13 | Lock Start Address | 0-2044 | 101 (0,101) |
| 16,15 | Aux IO Start Address | 0-4092 | 4 (0,4) |
| 17,18 | Long Address | Table 8-2 | 11000 (234, 248) |
| 19-58 | Reserved | | |
| 59-250 | Signal Aspect 1-48 | Table 8-14 | |
| 251-256 | Reserved | | |
| 257-264 | Servo 1-8 Speed | Table 8-5 | 4 |
| 265-272 | Servo 1-8 Speed Thrown | Table 8-5 | 4 |
| 273-288 | Servo 1-8 Closed Position | Table 8-6 | 1260 (4,236) |
| 289-304 | Servo 1-8 Thrown Position | 0-2400 | 1140 (4,116) |
| 305-320 | Servo 1-8 Cascade Address | Table 8-7 | 0 (0,0) |
| 321-324 | Aux IO 1-4 Option | Table 8-8 | 13 |
| 325-328 | Main IO 1-4 Option | Table 8-8 | 13 |
| 329-332 | Main IO 1-4 Detector | Table 8-9 | 16 |
| 333-340 | Aux IO 1-4 Secondary | Table 8-10 | 0 (0,0) |
| 341-348 | Main IO 1-4 Secondary | Table 8-10 | 0 (0,0) |
| 349-364 | Aux IO 1-4 Action | Table 8-11 | Table 8-11 |
| 365-380 | Main IO 1-4 Action | Table 8-11 | Table 8-11 |
| 381-512 | Reserved | | |
| 513-536 | Signal Lamp 1-24 | Table 8-18 | 160 |
| 537-632 | Signal Address 1-48 | Table 8-16 Table 8-17 | 0 |
| 633-656 | Signal LED 1-24 | Table 8-19 | 159 |
| 657-704 | Signal Aspect Config 1-48 | Table 8-15 | 0 |
| 705-768 | Reserved | | |
| 769-776 | Route 1 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 777-784 | Route 2 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 785-792 | Route 3 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 793-800 | Route 4 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 801-808 | Route 5 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 809-816 | Route 6 Entry 1-4 | Table 8-12 | 0 (0,0) |

| CV # | Description | Range | Default |
|---------|-------------------|------------|---------|
| 817-824 | Route 7 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 825-832 | Route 8 Entry 1-4 | Table 8-12 | 0 (0,0) |
| 833-896 | Reserved | | |
| 897-904 | Route 1-8 Control | Table 8-13 | 0 |
| 905- | Reserved | | |

For address entries, the associated Loconet device number is (address + 1).

Table 8-1 Full CV Table

8.2 Long Address CV Format

| CV | 17 | | | | | | | | 18 | | | | | | | |
|---------|----|---|---|---|---|---|---|---|----|---|---|---|---|---|---|---|
| Bit | 1 | 1 | h | h | h | h | h | h | l | l | l | l | l | l | l | l |
| Default | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |

h = High address bits

l = Low address bits

Table 8-2 Long Address CV Format

8.3 Configuration CV Format

| CV | 11 | | | | | | | |
|---------|----|----|---|---|----|----|---|---|
| Bit | b | lb | l | o | si | se | e | e |
| Default | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |

b = Busy retry: 0 = Disabled, 1 = Enabled

lb = Lock blink state: 0 = Locked, 1 = Unlocked

l = Local Action: 0 = Internal, 1 = Visible on Loconet

o = Output Off switch request: 0 = don't send, 1 = send

si = Signal State Memory: 0 = Off, 1 = On

se = Servo State Memory: 0 = Off, 1 = On

e = Expansion Port: 0 = Relay Drive, 1 = Signal Drive, 2 = Servo Drive (Octo Mode), 3 = Reserved

Table 8-3 Configuration CV Format

8.4 Configuration2 CV Format

| CV | 12 | | | | | | | |
|---------|----|---|----|----|---|---|---|---|
| Bit | s | i | rd | rd | r | c | d | p |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

s = Switch State request: 0 = Ignore, 1 = Respond

i = Interrogate request: 0 = Normal response, 1 = Ignore

rd = Route Delay: 0 = 1 Sec, 1 = 2 Sec, 2 = 4 Sec, 3 = 8 Sec

c = No Command Station: 0 = Disable, 1 = Enable

d = Servo Drive: 0 = Always on, 1 = Off when stopped

p = Invert Input: 0 = Normal, 1 = Inverted

Table 8-4 Configuration2 CV Format

8.5 Servo Speed CV Format

| CV | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|
| Bit | r | r | s | s | s | s | s | s |
| Default | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

r = RapidStart mode: 0 = None, 1 = one-eighth, 2 = one-quarter, 3 = three-eighths

s = Speed: 0 = slowest, 63 = fastest

Table 8-5 Servo Speed CV Format

8.6 Servo Closed Position CV Format

| CV | | | | | | | | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | d | l | l | m | h | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |

d = Directional Speed: 0 = Disabled, 1 = Enabled

l = Lock mode: 0 = None, 1 = Local Lockout, 2 = Midpoint, 3 = Reserved

m = Message: 0 = None, 1 = Exact Feedback

h = High position bits

l = Low position bits

Table 8-6 Servo Output Option CV Format

8.7 Servo Cascade Address CV Format

| CV | | | | | | | | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | t | t | a | a | x | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = Trigger: 0 = None, 1 = Closed, 2 = Thrown, 3 = Closed or Thrown

a = Action: 0 = Closed, 1 = Thrown, 2 = Follow, 3 = Invert

h = High address bits

l = Low address bits

Table 8-7 Servo Cascade Address CV Format

8.8 IO Option CV Format

| CV | | | | | | | | |
|---------|---|----|---|---|---|---|----|----|
| Bit | f | ty | s | l | l | l | tr | tr |
| Default | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

f = DCC Freeze: 0 = Always live, 1 = Freeze on DCC loss

ty = Input Type: 0 = General, 1 = Detector

s = LED Sense: 0 = Normal, 1 = Inverted

l = LED Mode: 0 = Disable, 1 = Steady, 2 = Blink on Move, 3 = Blink on Move or Lock, 4 = Blink on Lock, 5 = Lock State, 6 = Position, 7 = Blink on Thrown

tr = Trigger: 0 = None, 1 = Positive Edge, 2 = Negative Edge, 3 = Both Edges

Table 8-8 IO Option CV Format

8.9 Main IO Detector Option CV Format – Detector Input

| CV | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|
| Bit | t | r | g | s | s | s | s | s |
| Default | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |

t = Input Type: 0 = CT, 1 = IR

r = Reserved

g = range: 0 = Low, 1 = High

s = Sensitivity: 0-31

Table 8-9 Main IO Option CV Format – Detector Input

8.10 IO Secondary CV Format

| CV | | | | | | | | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | t | d | c | c | h | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = Type: 0 = Trigger on this message, 1 = Send this message

d = Device: 0 = Turnout, 1 = Sensor

c = Condition: 0 = None, 1 = Hi/Closed, 2 = Lo/Thrown, 3 = Both/Follow

h = high address bits

l = low address bits

Table 8-10 IO Secondary CV Format

8.11 IO Action CV Format

| CV | | | | | | | | | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | h | h | h | h | g | g | g | g | f | f | f | f | e | e | e | e |
| Default | H | H | H | H | G | G | G | G | F | F | F | F | E | E | E | E |
| CV | | | | | | | | | | | | | | | | |
| Bit | d | d | d | d | c | c | c | c | b | b | b | b | a | a | a | a |
| Default | D | D | D | D | C | C | C | C | B | B | B | B | A | A | A | A |

h = Servo 8 (Octo Mode only)

g = Servo 7 (Octo Mode only)

f = Servo 6 (Octo Mode only)

e = Servo 5 (Octo Mode only)

d = Servo 4

c = Servo 3

b = Servo 2

a = Servo 1

0 = None, 1 = Toggle, 2 = Follow, 3 = Invert, 4 = Closed, 5 = Thrown, 9 = Lock Toggle, 10 = Lock Follow, 11 = Lock Invert, 12 = Lock Closed, 13 = Lock Thrown

Default: For the Servo in the same group, Default = 1; for all other Servos, Default = 0.

Table 8-11 IO Action CV Format

8.12 Route Entry CV Format

| CV | (even) | | | | | | | | (odd) | | | | | | | |
|---------|--------|---|---|---|---|---|---|---|-------|---|---|---|---|---|---|---|
| Bit | r | a | a | a | h | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

r = Reserved

a = Action: 0= None, 1 = Closed Turnout, 2 = Thrown Turnout, 3 = Hi Sensor, 4 = Lo Sensor

h = high address bits

l = low address bits

Table 8-12 Route Entry CV Format

8.13 Route Control CV Format

| CV | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|
| Bit | r | r | r | r | r | r | t | t |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

r = Reserved

t = Type: 0 = None, 1 = Basic, 2 = Selector, 3 = Expand

Type = 3 is not used on Route 1.

Table 8-13 Route Control CV Format

8.14 Signal Aspect CV Format

| CV | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|
| Bit | b | m | m | p | p | p | p | p |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

b = Bicolor: 0 = No, 1 = Yes

mm = Mode: 0 = None, 1 = Steady, 2 = Flash Phase A, 3 = Flash Phase B

ppppp = Pin: 0-31

i = In Use: 0 = No, 1 = Yes

a = Address Mode: 0 = Signal Mode, 1 = Turnout Mode

r = Reserved

Table 8-14 Signal Aspect CV Format

8.15 Signal Aspect Config CV Format

| CV | | | | | | | | |
|---------|---|---|----|---|---|---|---|---|
| Bit | i | m | tS | r | r | r | r | r |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

i = In Use: 0 = No, 1 = Yes

a = Address Mode: 0 = Signal Mode, 1 = Turnout/Turnout Mode

tS = Turnout/Sensor Selector: 0 = Turnout, 1 = Sensor

r = Reserved

Table 8-15 Signal Aspect Config CV Format

8.16 Signal Aspect Address CV Format – Signal Mode

| CV | (even) | | | | | | | | (odd) | | | | | | | |
|---------|--------|---|---|---|---|---|---|---|-------|---|---|---|---|---|---|---|
| Bit | a | a | a | a | a | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

a = Aspect: 0-31

h = Mast high address bits

l = Mast low address bits

Table 8-16 Signal Aspect Address CV Format – Signal Mode

8.17 Signal Aspect Address CV Format – Turnout Mode

| CV | (even) | | | | | | | | (odd) | | | | | | | |
|---------|--------|---|---|---|---|---|---|---|-------|---|---|---|---|---|---|---|
| Bit | m | m | m | m | s | h | h | h | l | l | l | l | l | l | l | l |
| Default | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

a = Mast: 0-15

s = Turnout Sense: 0 = Thrown, 1 = Closed

h = Turnout high address bits

l = Turnout low address bits

Table 8-17 Signal Aspect Address CV Format – Turnout Mode

8.18 Signal Lamp CV Format

| CV | | | | | | | | |
|---------|---|----|---|---|---|---|---|---|
| Bit | f | fr | t | r | r | r | r | r |
| Default | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

r = Reserved

t = Type: 0 = Non-Searchlight, 1 = Searchlight

fr = Flash Rate: 0 = Signal, 1 = Crossing

f = Fade: 0 = No, 1 = Yes

Table 8-18 Signal Lamp CV Format

8.19 Signal LED CV Format

| CV | | | | | | | | |
|---------|---|---|---|---|---|---|---|---|
| Bit | g | e | e | b | b | b | b | b |
| Default | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |

g = Group Start: 0 = No, 1 = Yes

e = Effect: 0 = Off, 1 = On, 2 = Bicolor, 3 = Reserved

b = Brightness: 0-31

Table 8-19 Signal LED CV Format