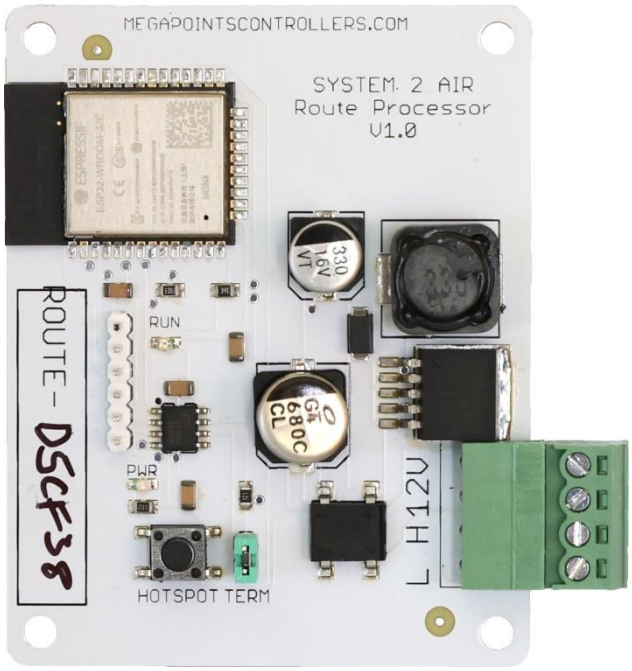
System2
Route Processor
User Reference
by MegaPoints Controllers

A route processor capable of complex route setting across a System2 installation from a single button press.

Supports CAN wired network interface only.



User Reference and Guide

Revision 2 November 2024 Status: Pre Release Draft

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Table of contents

How to use this document

Treat this guide as a reference. All settings are documented and examples given where appropriate. It is designed to accompany the appropriate product introduction that will demonstrate all the functions and use cases. The video is available from the same product page as this document.

System2 Route Processor

Introduction

The System2 route processor can set up pre-configured routes across your model railway for all System2 motor types. This includes turnouts, signals, gates, barriers doors and other animations.

The System2 Route Processor is simple to hook-up; requiring only 12 volt power and optionally two CAN network cables. All configuration and operation is performed over a web browser interface or the network itself.

The System2 Route Processor has the following common System2 features:

- Common 12 Volt power supply to all other System2 components.
- Control via two wire CAN bus.
- Intuitive web interface for route development.
- Addressable via vPorts for both command and feedback.
- Software updateable as new features are developed.
- Board location entry to remind you where you placed the device.
- Tooltips to explain what each field does as you mouse over.

This is a 12 Volt device and should be connected to a minimum of a ½ Amp regulated power supply.

MegaPoints Controllers use static sensitive components that must be handled with care.

Avoid touching any components or the circuit printed on the bottom of the board.

Avoid placing the board on any metallic surfaces including track.

DO NOT connect any part of this device directly to your track bus.

The route Processor is very powerful and offers the following routing features:

- Up to 100 routes per device (install as many as you need).
- Up to 16 elements (vPorts) per route entry.
- Multiple route entries per route:
  - For example routes 3, 45 and 67 can be triggered as a single operation.
- Large route number display and name so you know which route you are working on.
- Routes can be triggered by:
  - Pushbutton.
  - Toggle switch.
  - Block occupancy.
  - Points position.
  - DCC accessory command.
- RFID tag (16 tags per route entry), multiple route entries can be combined to provide multiples of 16 RFID tags per route.

    - Manually via web interface.
- Active routes are monitored and will trigger an alarm if broken by another device that interferes with an active route device (flashes the route LEDs).
- Routes can be programmed by:
    - Learning from listening to the network (with listen range vPort filtering).
    - Manually entered by vPort.
- Built in route editor.
    - Change the order of route elements.
    - Delete individual route elements.
    - Change the delay between firing elements.
    - Clear all route elements for current route.
- Route naming per route.
- Optional feedback on route status.
- With having so many routes (up to 100) you can:
    - Search for routes by name or partial name.
    - Search for routes that contain a specific vPort.
    - Summary report on all configured routes.
- Other management features include:
    - The option to edit and change routes without saving (this allows for testing before committing changes).
    - Backup and restore routes to your PC, tablet or Apple Mac.
    - Clean memory (delete's all routes).
    - Copy routes with easy one button inverting to create an 'opposite' route.
- Animation features:
    - Circular routes that call themselves repeatedly.
    - Device specific time delay (up to 60 sec between device slots).
    - Started when route is triggered.

Not supported

The following System2 features are not currently supported by this device:

- JMRI
- MQTT (Wi-Fi for control messages).

Additional Requirements

You may also need:

- 12 Volt DC regulated power supply.
  - ½ Amp minimum
- Network cable (twisted pair).
  - Telephone cable
  - Alarm cable
  - Such as CW1109B/Y supplied by CPC/Farnell. See website for cable links. Non twisted pair cable is OK for testing purposes, not for installation.

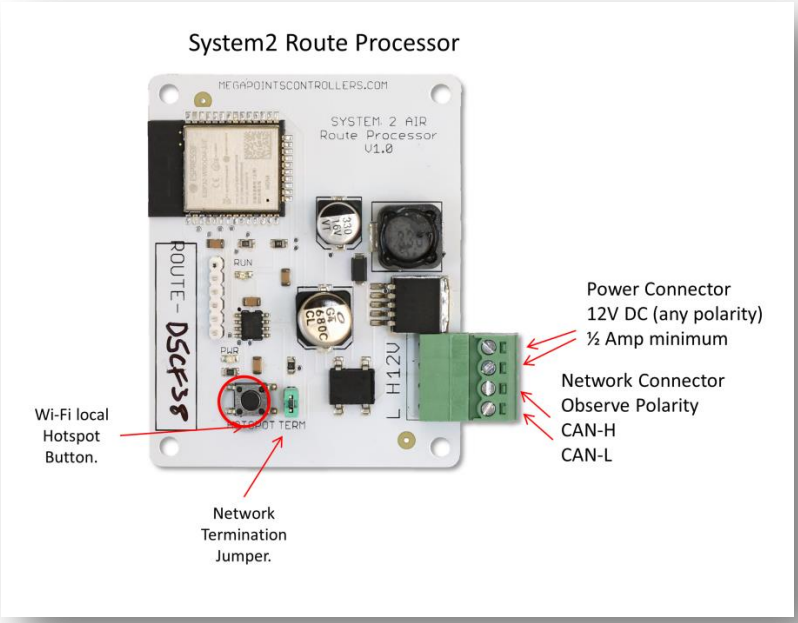
To use the network features of this board you will require:

- A Wi-Fi Router that is configured for:
  - DHCP (default enabled on most routers)
  - An active internet connection (only required for software updates).
- A current browser that supports HTML5 or later.

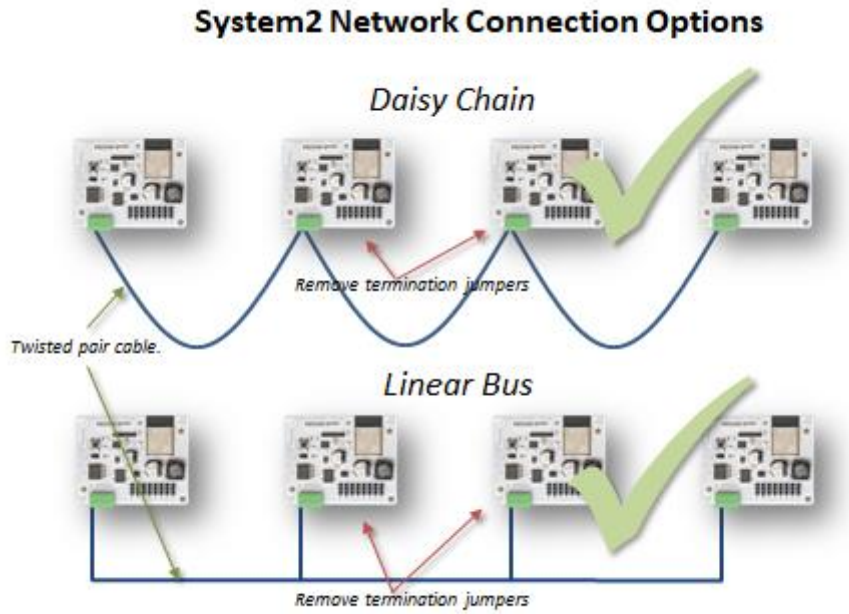
First use

WARNING: Ensure this board is kept in a well ventilated area. Do not affix within a sealed or unventilated enclosure. Ensure the rear of the circuit board does not come into contact with any conductive material. Suggest you consider our PCB Mounts for mounting the device.

See the connection diagram below for details.



Network cabling



See the above diagram for network cabling. All cables should be a twisted pair signal cable. Fit any termination jumpers (supplied as part of a starter kit) to the boards at the ends of the network for a maximum of two jumpers per network.

You can use droppers to a main bus much like DCC or connect boards to each other in daisy chain fashion. Ensure the CAN-H and CAN-L connects to the same terminal in all cases.

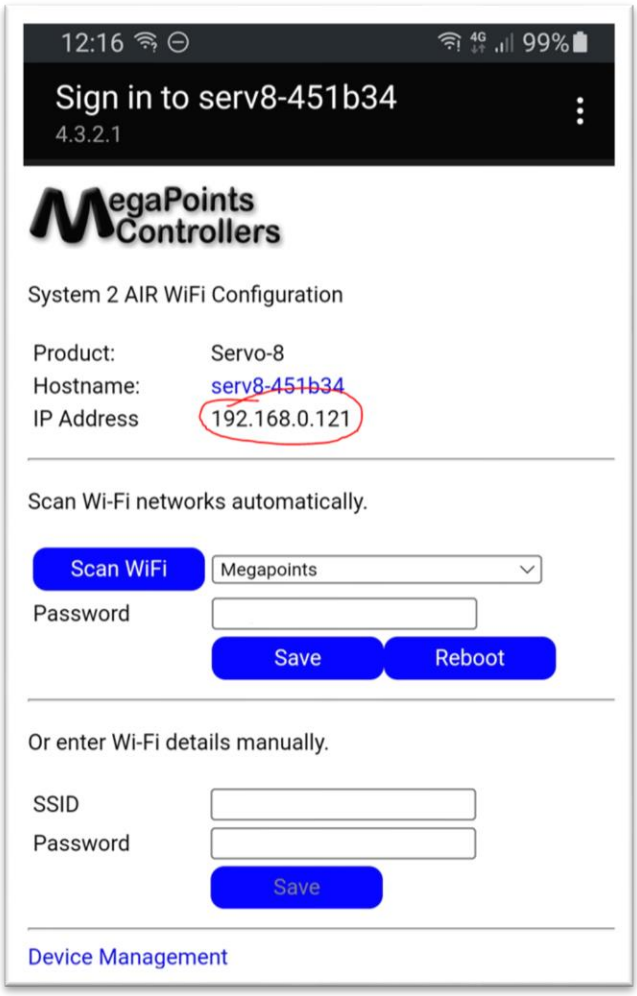
Getting your first board on your local Wi-Fi network

There's a dedicated YouTube video demonstrating this. Follow this link to view: `https://youtu.be/G3ajZazycP4`. It will probably be easier than going through the following text.

With your updated software the procedure here overrides that in the Starter Kit Quick Start Guide. It has changed slightly making it more intuitive and easier. The very first board on from your System-2 Air should be configured for your Wi-Fi. This will allow you to connect and adjust the board settings such as servo movement type, speed or range adjustment as well as download future software updates and change port addresses. We suggest using the Panel Controller for this example.

Broadly speaking, here's how to connect to your Wi-Fi:

- Apply 12 DC regulated power to the device.
- Observe the RUN LED flashing about once per second (may take up to 30 seconds on first time boot.
- Hold the HOTSPOT button for 1 second; observe the RUN LED flash rate increase to double.
- From your phone, tablet or other Wi-Fi device scan for Wi-Fi networks and locate the hotspot network for the panel controller (it will be the device name/serial number on the sticker) such as "panel-xxxxxx" or "serv8-xxxxxx". The name is dependent on the device you are connecting to.
- Connect to this network hotspot network. You may receive a warning stating this network does not connect to the Internet. This is OK.
- If your device states "sign-in required", select this option and go to the sign-in page.
- If your device does not offer a sign-in page, navigate your browser to "4.3.2.1/admin" (Apple).
- Enter the SSID and password for your local network. Note case sensitivity (screenshot below).
- Press the "Scan WiFi" button. After a few seconds the adjacent text box will populate with scanned networks. Select the appropriate network (strongest signals towards the top).
- Enter a password (case sensitive) and press the save button.



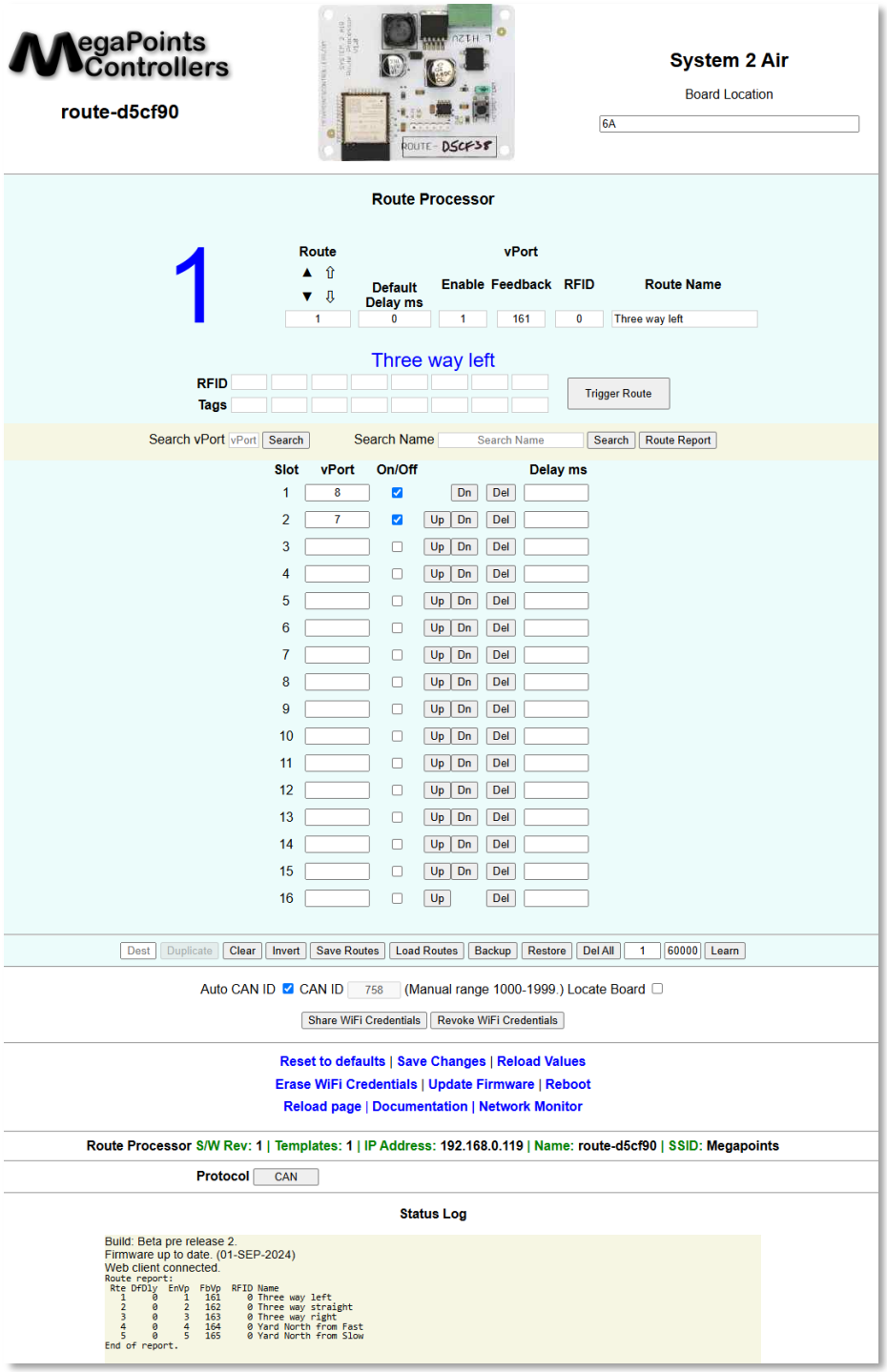
- Your devices IP address will now be displayed near the top (red band). Make a note of this.
- Press the reboot button when ready and access the device via your usual network using the IP address obtained previously.

Refer to the website for how to videos and full documentation (megapointscontrollers.com/system2).

Admin Interface

The admin web page is shown on the below. On this page you will change any settings for the driver board. Each board on the System2 network has its own management web page.

The upper and lower white background areas relate to the board itself. The light blue background relates to the selected route shown in a large blue number at the top right.



Below is a description of all the fields on the main admin page:

Upper header (white background):

- Device name and serial number (`route-d5cf90`).
- A photo of the device.
- A location description field. Use this to enter meaningful information such as baseboard number, IE: “B12C7 Tunnel entrance”.

Middle light blue (route specific):

Field/Button	Description
Large “1”	Shows current selected route.
Up and Down black triangles.	Moves to next or previous route.
Up and down arrows.	Moves 10 routes higher or lower.
Small “1” under “Route”	Route number. Enter specific route number to go to.
Default delay ms	Sets the default delay as each slot is executed in milliseconds. Internally the minimum is 50ms irrespective of what is entered. The maximum is 60,000 (60 seconds).
Enable	Vport address to trigger this route.
Feedback	Feedback Vport address to indicate route is active.
RFID	RFID vport address to listen for RFID tag data.
Route Name	24 char route description.
“No route name”	Big letter representation of the route name.
RFID TAGS	Lists of up to 16 RFID tags that will trigger this route. The monitored tags must also match the RFID vport address set above.
Trigger Route	Manually trigger this route.
Search vPort	Enter a vPort address and click search. Any matching routes will be displayed in the Status Log at the page footer.
Search Name	Enter a character string and click search. Returns a list of route numbers that match displayed in the Status Log at the page footer.
Route Report	Generates a summary report of all used routes in the status log.
Slot	Up to 16 slot entries per route.
vPort	The vPorts that will be fired when the route is active.
On/Off	Whether the vPort is thrown or not as part of the route.
Up	Moves the line up one (swapping with the line above).
Dn	Moves the line down one (swapping with the live below).
Del	Deletes the line.
Delay ms	Sets the delay in milliseconds after the vPort has fired.

Lower blue background:

Field/Button	Description
Dest	Destination route number to duplicate this route to.
Duplicate	Duplicates the route to the “Dest” above. WARNING: Will overwrite the destination route.
Clear	Clears all values for this route and sets default delay to 50 ms.
Invert	Inverts the On/Off selection for any slot containing a valid vPort.
Save Routes	Saves all route data to the internal non-volatile memory so it will survive a reboot.
Load Routes	Reloads all routes from non-volatile memory, undoing all changes that were not saved.
Backup	Backs up all routes to local PC storage. File will be stored in your browsers default download location. File name is in the format “route-d5cf90-31-10-2024” where: route – prefix d5cf90- route serial number 31-Date within month 10-Month number 2024-Year While route backups are text data, if you edit the file and strange things happen, it’s on you.
Restore	Prompts a file explorer style dialogue to select a file to restore. This button also displays the route number as it’s being restored.
Del All	Deletes all routes. Thankfully you made a backup didn’t you?!?!
1	Lower vPort limit for route learning by sniffing the network.
60000	Upper vPort limit for route learning by sniffing the network.
Learn	Button that fires off route learning. Press again to stop learning and refresh the page.

In addition when appropriate a button may change its background to yellow highlighting prompting the user to perform an action. For example if route data is changed, you may be prompted to save the route.

While learn mode is active its background is highlighted to show that it is listening for data from the network. Press the button again to stop listening and replace the route slots with what was observed.

Lower footer (white background):

- Auto CAN ID. You can override the CAN ID if required.
- Locate Board: Will cause the LED on the selected board to flash fast helping you to locate the board if you have many. This will also bring up a list of discovered boards in the Status Log.
- Share and revoke Wi-Fi credentials with all boards on the CAN network.
- Control buttons (shown in blue text) to:
    - Reset the board
    - Save changes you've made
    - Reload changes (resyncs the web page with board)
    - Erase this boards Wi-Fi credentials (will immediately leave the network)
    - Select the firmware update (requires internet connection)
    - Reboot the board (throws out any unsaved changes if you made a mess)
    - Reload the web page
    - Link to online documentation and support videos
    - A CAN network monitor (for those who prefer watching network packets to trains).
- The next line shows:
    - Product name (Route Processor)
    - Software version
    - Templates version (should match the software version)
    - The local IP address
    - The device network name (includes serial number)
    - The Wi-Fi name you are connected to

- The last item is a status log (light yellow background). This provides a real time status such as up to date software, or boards joining the network, whether you saved (or should) save your changes etc. Also shows the result of any searches.

Board Location

The board location field (top right) should be used to enter meaningful information to help you locate a specific board. We are planning an update for this feature in a future release that will display the first few characters as part of a report when you request all boards to report in (covered later in this document).

We therefore suggest you begin the text with the most meaningful information such as a baseboard number or location for example:

Suggested entry types	B2 Fiddle Yard 12 Station throat A3 Scenic
Avoid	Baseboard B2 Main approach on the left

Example use cases

Manual route creation

This example assumes a servo driver is configured as EasyConfig board 1A with vPorts 1-8 driving motors 1-8.

A Panel Controller configured as EasyConfig range 1-16 is also assumed.

In this procedure we'll:

- Create a new route in route #1.
- Set up some sensible defaults for the route.
- Configure the trigger and feedback vPorts so we can see when it's active.
- Give the route a name.
- Add devices and output stated to each.
- Trigger the route.

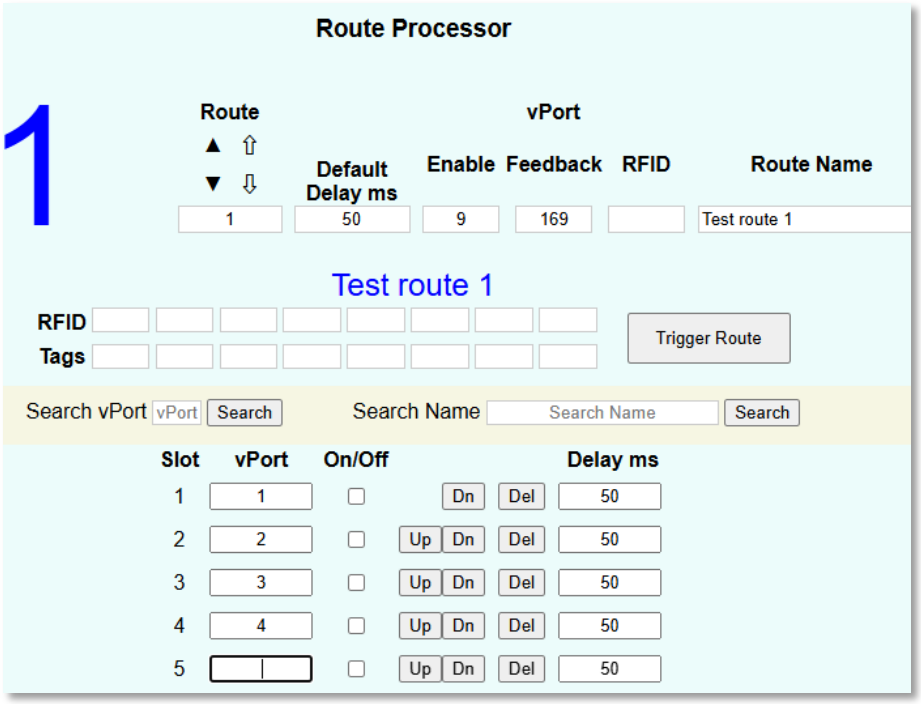
As this is our first use of the Route processor, press the "Del All" button to erase and reset to default all routes.

You will observe the "Save Routes" button is highlighted; this is to remind you to save any changes.

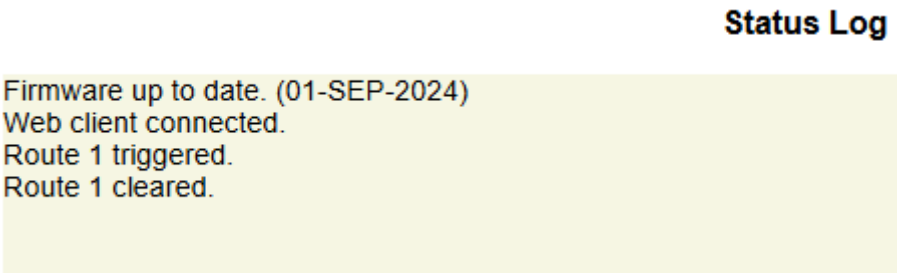
Set the following:

Route	1
Default Delay	50
Enable	9
Feedback	169
Route Name	Test route 1
Slot1-4 vPorts	1, 2, 3, 4
On/Off	Not ticked

The router admin screen should look like this:



If you press the pushbutton on the Panel Controller twice you will observe the route is triggered and cleared as shown in the Route Processor status monitor (below):



If your point motors are moved to one direction (On/Off = not ticked) you'll be able to move them in one direction only. Follow the next step to create an opposite route.

Creating the opposite route

This procedure builds from the previous step.

We could just enter the new route details again, but where's the fun in that? The route processor can duplicate routes and invert the vPort states without the faff of entering it all again. All you have to do is set it up on different trigger and feedback vPorts.

In this procedure we'll:

- Duplicate route #1 to route #2.
- Alter its trigger and feedback vPorts.
- Invert the On/Off flags.
- Test the route.
- Save the routes.

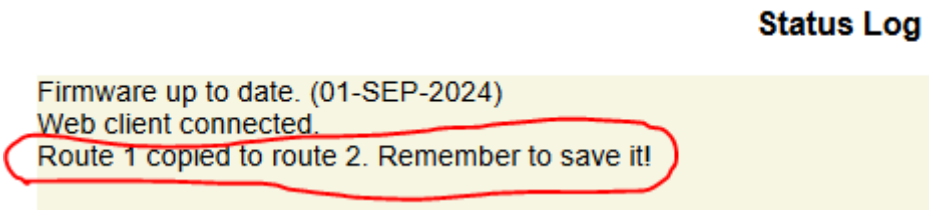
Before starting ensure you are still looking at route #1 (big blue 1).

Let's duplicate this route to route #2.

At the footer of the light blue section you'll see a box to the left of a greyed out "Duplicate" button. Enter 2 into this (the route copy destination).

The Duplicate button is now enabled. Click it once.

The status log should now confirm the route has been copied:



Press the upward pointing solid triangle to select the next route. When you see a big blue "2" you're looking at the new route. It should also have a default name applied to it "Copied from 1" so you know the origins of this route.

We need to change the trigger and feedback vPorts else the ON and OFF versions of this route will trigger together and that's no use to anyone.

Set the following:

Enable	10
Feedback	170

Let's invert the outputs. Click the "Invert" button once (located at the bottom line of the light blue are).

The first four slot rows should have ticks in the On/Off column.

Clicking the "Invert" button again reverses this.

Notice that only slots that have a valid vPort entry are affected. If you had all sixteen vPorts entered, you would be inverting all.

Make sure you have four ticks before continuing.

The router admin screen should look like this:

Saving Routes

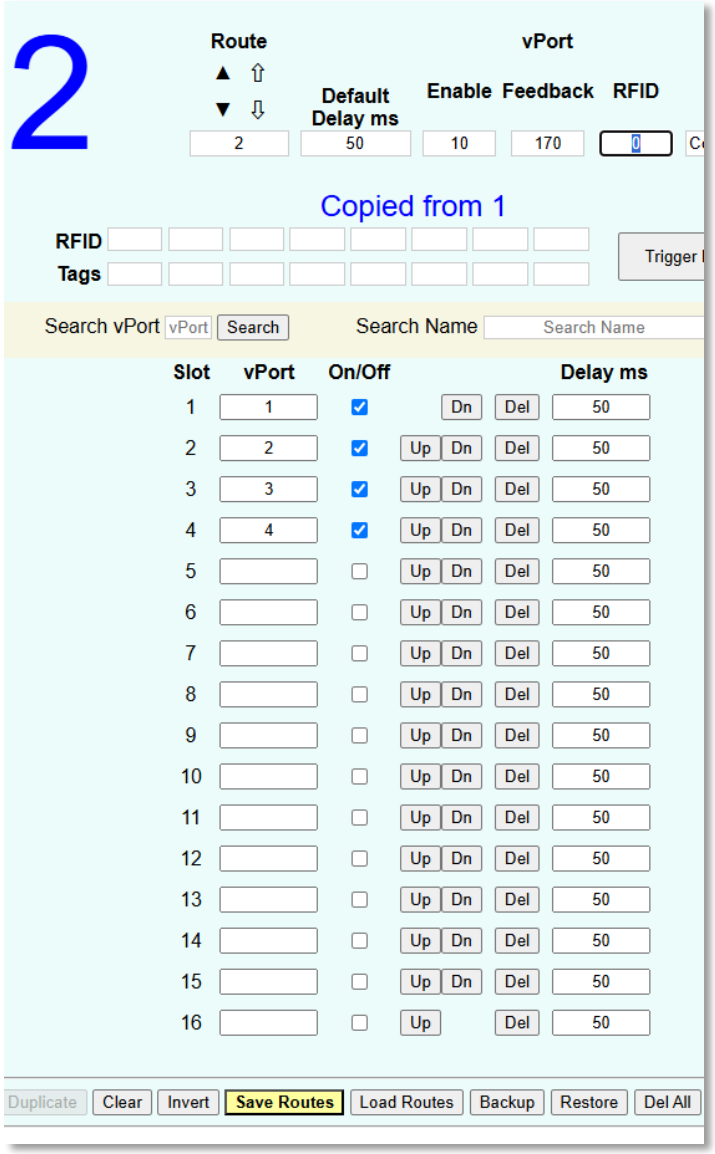
At this point it's time to stop that yellow glowing button labelled "Save Routes". It is yellow because it's shouting that you made a change to a route that's not saved.

This feature allows you to try out changes and bin them if you don't like what you see.

If you wanted to revert your changes back to how they were before then ***DON'T DO THIS*** (unless you want to type it all again) then press the "Load Routes" button. It will replace what's in memory with what was saved, just like a reboot would.

If you want to save the current routes (and we do), click the yellow "Save Routes" button and end its misery. It will momentarily confirm with a "Saved" message before reverting to its initial message.

If the Route Processor is rebooted or powered off, these routes will automatically be restored.



We now have route #1 with vPorts 1-4 all off and route #2 with vPorts 1-4 all on. You can use the black triangles to navigate through routes up and down one at a time.

Let's test it.

On the Panel Controller:

Press the button connected to input 9.

Press the button connected to input 10.

As you press the buttons you'll observe the turnout motors move from one side to the other. If you used the defaults suggested above you'll also observe the feedback on the Panel Controller on LEDs connected to outputs 1-4. If it's a slow motor, the outputs will flash while the turnout motor moves and settle on the opposite LED when movement is complete.

You will also observe which route is enabled on Panel Controller LED outputs 9 & 10.

You have correctly created a route, duplicated and inverted it.

Route editing and adding delay

We'll swap the movement of the second and fourth point motors and add some delay.

Select route #1 (solid down triangle if you're still on route #2).

Remove ticks from slots 1 and 3.

Select route #2.

Remove ticks from slots 2 and 4.

Use the up and down triangles to switch routes. You should observe the ticks on alternate lines between routes.

This will cause two of the turnout motors to move in the opposite direction as the other two.

Test by pressing the buttons on the panel controller for inputs 9 and 10.

Let's add a delay between turnout motor moves.

Select route 1.

Change the default delay (top row near the big number "1") to 1000 and tab out or select another field. You will observe this has now been populated to all slots.

Select route 2.

Do the same as above setting Default Delay to 1000.

Fire route #1 and observe the delay between each turnout motor being fired.

NOTE: If you are using slow acting turnout motors the delay may not be noticeable, change the delay to 4000 on both routes and observe.

Changing the order

Select route #1.

The "Up" and "Dn" buttons allow you to move slots up or down.

Press the "Up" button for slot 4. You'll see vPort 4 swap positions with vPort 3. Follow it up pressing the "Up" button until it is at the top in slot 1.

Level Crossing (example)

If you had a single line level crossing controlled by two or four servos you can see how to configure routes for barriers up/open and down/closed. You could even add a little delay to subsequent barriers to make the opening and closing more prototypical.

If a block detector we placed a suitable distance before the crossing it could automatically trigger the gates. A subsequent block detector can open the gates with an 'opposite' route.

So that's your gates sorted, what shall we do with the remaining 98 routes?

Backing up and restoring

Background

Usually System2 boards save their configuration to an area of memory that is not affected when updating software via the usual update process. The System2 Route Processor uses this memory where possible for the board configuration. It's not large enough to store all the route data as there's a lot of it.

We've moved the route data store to the internal file system. This provides a much larger space as it coexists with the web pages, images and other internal files necessary to make the board work.

Complexity and mitigation

This adds a complexity that we've mitigated for.

When the any System2 software is updated, the entire contents of the file system are replaced. If the penny's dropped, then you'll understand that your routes also won't survive a software update.

Enter the backup and restore options.

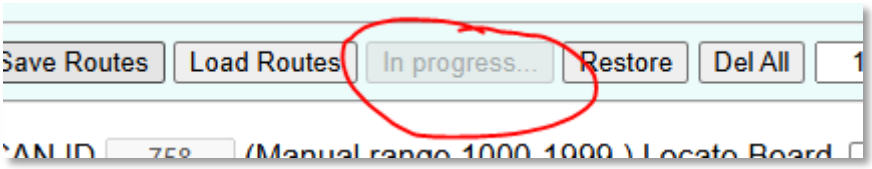
The System2 Route Processor has the built in option to save route data to your PC, Mac or tablet.

To save routes first commit any unsaved changes by pressing the "Save Routes" button if it's background is yellow.

Initiating a backup

Press the "Backup" button.

Notice the button changes to a greyed out "in progress" message (see below):



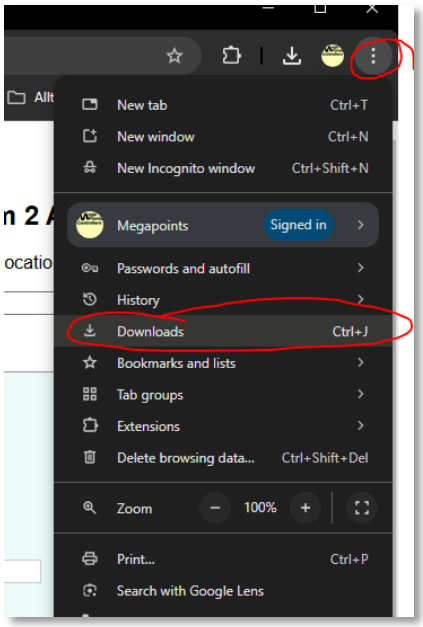
After a few seconds the button returns to the default "Backup" option.

Where's my backup?

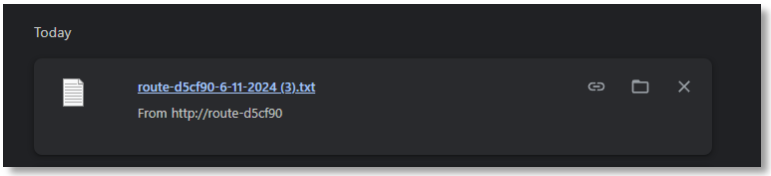
Where is it I hear you ask?

It's been downloaded to your default download folder that's defined by your web browser (not us).

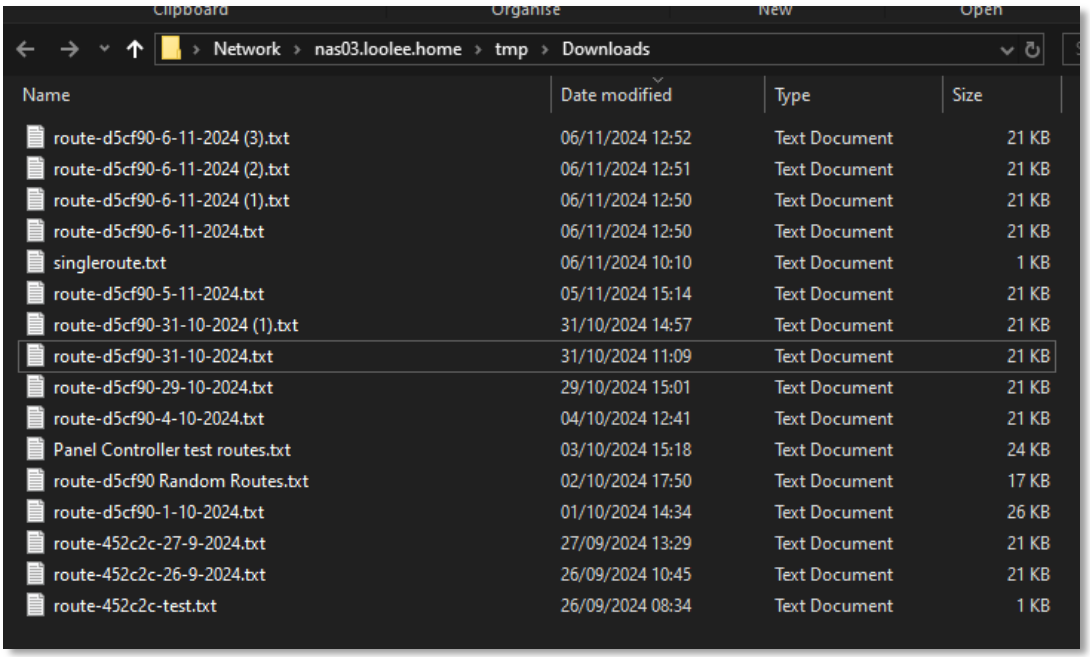
I'm testing on Chrome browser, so to see the file I go to the following browser from the three dots menu:



The top entry shows the file and the name of the router that created it:



Clicking on the folder icon will open the download folder:



The backup naming convention is:

```
route-{serial}-{day of month}-{month}-{year}.txt
```

Restoring a backup

Let's do the unthinkable and erase all our routes in the Route Processor. This is not a necessary step, we'll use it to illustrate and prove the restore.

Assuming you made a backup up the routes, proceed with erasing all routes:

- Press the "Del All" button at the bottom of the light blue area.
- Press the now yellow "Save Routes" button to commit the deletion to non-volatile memory.
- Using the triangles, switch between routes #2 and #2. Observe there's no longer any route data present.

You've now reset the route configurations – congratulations!

Let's restore…

- Click the "Restore" button. This changes the button background to yellow with the test "In Progress". A dialogue box will pop up.
- Navigate to the folder where your route backup file is located and select it.
- Double click or select "open" within the dialogue window.
- Observe the "Restoring" button with an incrementing counter. This is counting each route as it is restored into memory.
- Toggle between routes #1 and #2. You should observe your routes are now restored.
- Press the "Save Routes" button to save the routes from memory to non-volatile disk.

You've now backed up, deleted and restored your routes.

Before performing a software update, back up your routes. They will be erased from the internal storage as part of the update process.

Active route monitoring

Setting up the test

With the two routes created in the first two test cases we can see active route monitoring taking place.

To speed up the process, ensure all delays are set to 50 by setting the default delay on routes 1 & 2 to 50 and saving.

Press the pushbutton on Panel Controller input #9 and observe the LED on output #9 toggle.

Press it again to observe it toggle the opposite way (I'm assuming you are using a pair of LEDs for testing, normally I would expect a single ON/OFF type LED for routes).

See how with each press it toggles the state of the LED as the same route is activated and then disabled.

NOTE: If you are doing this correctly you'll see the LEDs on output #9 toggle, but your turnout motors won't move (were only pressing one route).

Observe when switching the route off, the LED immediately comes off.

Breaking the route

Now, switch the route back on.

Using the button on input #10 to turn route #2 on whilst route #1 is active will result in route #1 being broken while it is active. You'll see the LEDs for route #1 flash for 1.5 seconds indicating the route has been broken.

This is normal behaviour and nothings really broken.

If you intentionally turn off a route the LED extinguishes.

If you clash with a route its disabled and the assigned LEDs flash for a period just to remind you that the route is no longer active. Think of it as another way to turn off a route.

Route learning

Background

On the off chance that you don't keep up to date documentation on all the vPort assignments on your layout we've a route programming option just for you.

Instead of knowing the vPort addresses why not just listen for and learn from them?

Selective deafness

If we were to monitor the network for a Panel Controller button push and record the route within the Route Processor we could get into a mess. If you have the default configuration as described at the beginning of these use cases then the following network events are quite possible after button #1 is pressed:

1. vPort 1 packet instructs servo 1 to move.
2. Servo 1 sends feedback to vPort 161 indicating that it is in motion.
3. At the centre point the servo sends feedback to vPort 321 to throw the frog relay.
4. When the servo arrives at the opposite side, vPort 161 receives conformation that the servo completed its movement.

You can see the network packets in the "Network Monitor" on all System2 boards:

Seq	Min SS mSS uSS	CanId	D0	D1	D2	D3	D4	D5	D6	D7	V-Port
0081	19.50.758.687	717	1	0	1	2	0	0	0	0	1
0082	19.50.764.901	397	1	0	161	3	0	0	0	0	161
0083	19.51.404.989	397	1	1	65	0	0	0	0	0	321
0084	19.52.029.653	397	1	0	161	0	0	0	0	0	161

Sending an instruction on vPort 1 also produced network traffic to vPort 321 and 161 twice. That's a lot of information that out router doesn't care about.

We can tell the router when it's learning a route to only listen for vPort addresses within a range. If you are using our EasyConfig we've already thought this through for the first 160 devices. You are free to change to any numbering scheme that works for you. Just be logical.

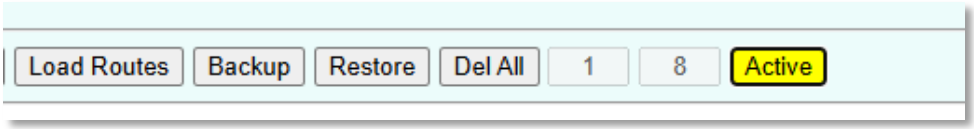
Setting up

In the input box under the arrows and triangles enter 10 and press enter. This will take you immediately to route #10. We just learnt a new fast way to navigate to a specific route by entering its number in the box.

To the left of the “Learn” button at the bottom of the light blue area you’ll see two boxes one with the number “1” and the other with the number “60000”. These are the lower and upper vPort range limits. VPorts within this range will be collected.

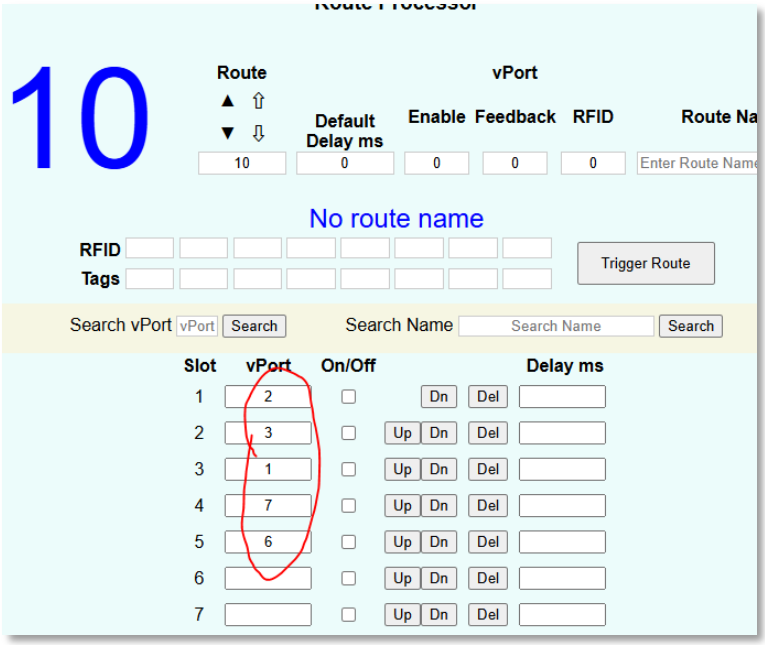
Let’s capture a route.

- Leave the lower vPort range at “1”, adjust the upper vPort range to “8” and press the “Learn” button.

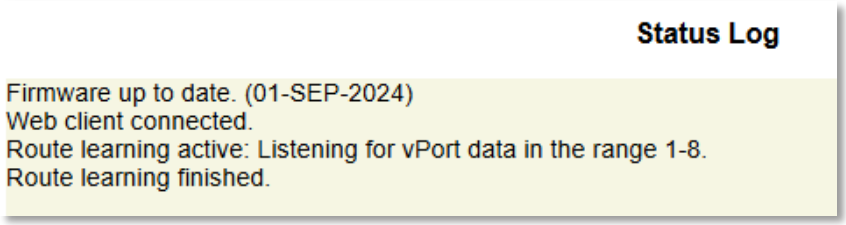


- The learn button will change to “Active” with a yellow background.
- On the Panel Controller press buttons in this sequence: 2,3,1,7,6.
- Press the “Active” button and it will return to “Learn”.

If you look at the route data above you’ll observe the buttons presses (vPorts) have been captured:



Observe the following in the Status Log:



The turnout is pointing the wrong way!

Now that you have your captured route you can change the direction of the vPorts by toggling the “On/Off” column.

The above method allows you to capture a range of vPorts. When in “Learn” mode you operate your turnout motors in the usual manner and the route processor will build up the route for you. After 26

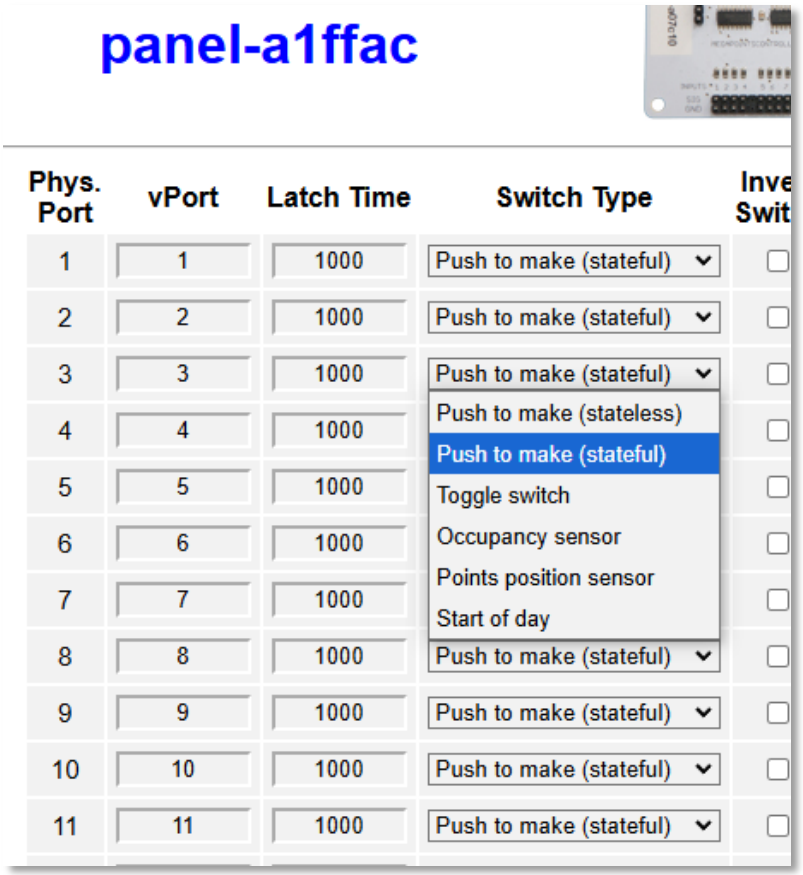
But wait. There’s more!

Its necessary do dive in a little deeper.

By default the Panel Controller will have been configured for “stateless” switch type. This means the state machine is delegated to the motor driver. The Panel Controller will send a status of ‘3’ every time it is pressed and it is the receiving device that has to work out where the next position is.

When the Route Processor listens for a route it doesn’t understand a state of ‘3’ as it does not have access to the internal state machine in whatever the motor driver or device it is driving. The next best thing it can do is record the vPort and let the user tweak the direction later.

The Panel Controller can also support a ‘stateful’ mode where the panel controller is the state machine. In this mode the Panel Controller will instruct a device to move to the ON or OFF positions absolutely. This can be set by changing the switch type as shown below:



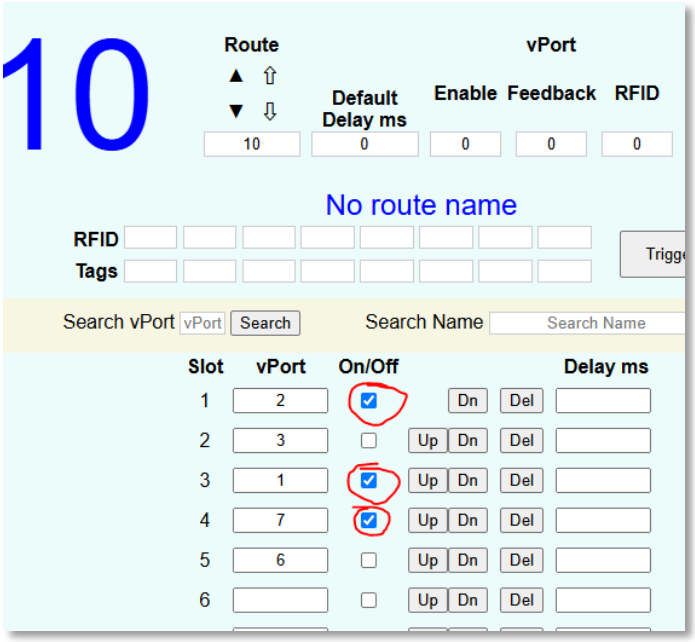
When state information is transmitted the Route Processor can also track and set the states appropriately.

Learning done properly

Let’s repeat the route learning process with inputs 1-8 on the Panel Controller set to stateful.

With the learning range set for 1-8, press the Learn button again and press the buttons in the following sequence: 2,3,1,7,6,6,7 (yes 6 and 7 are pressed twice).

Stop learning and observe your route:



Notice this time some are Off and some are On. Your results will differ from mine depending on how the points were thrown.

This means that you can set route learning on and operate the track as you would like it and the Route Processor memorises the positions without having to later edit them.

The best of both worlds

I'm not suggesting this is a better way to operate or configure your layout. There are advantages and disadvantages to both methods. One might be suited for single panel operation, whereas if you use several remote mimic panels to operate the same turnouts you may achieve better results with stateless modes.

Rather than offer one solution, we've included both options and on a switch by switch basis so you are free to decide based on your circumstances and preferences.

Route searching

With so many routes you can search for routes that contain a specific vPort or test in the route name.

Let's set up a test.

- Select route #1.
- Duplicate the route to route 50:
- Enter 50 in the "Dest" box.
- Click the "Duplicate" button.
- Enter 60 in the "Dest" box.
- Click the "Duplicate" button.
- Enter 70 in the "Dest" box.

- Click the “Duplicate“ button.

You will see status log messages confirming the route has been copied to destinations 50, 60 and 70.

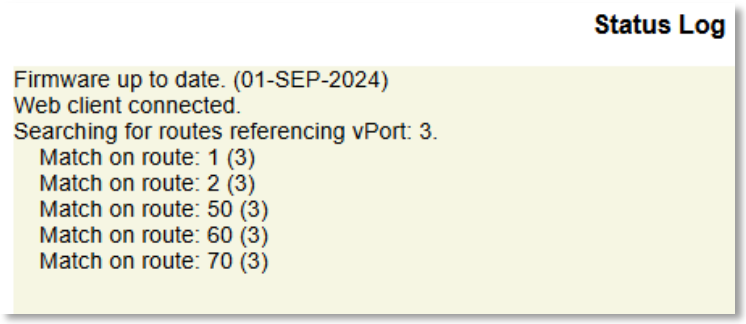
- Navigate to route 50.
- Change the route name to “three way left”.
- Navigate to route 60.
- Change the route name to “three way straight”.
- Navigate to route 70.
- Change the route name to “three way right”.

Select route #1 again.

Searching by vPort

In the yellow banded vPort box enter vPort ‘3’ and press the “Search” button next to it.

In the status Log area you will see your search results:



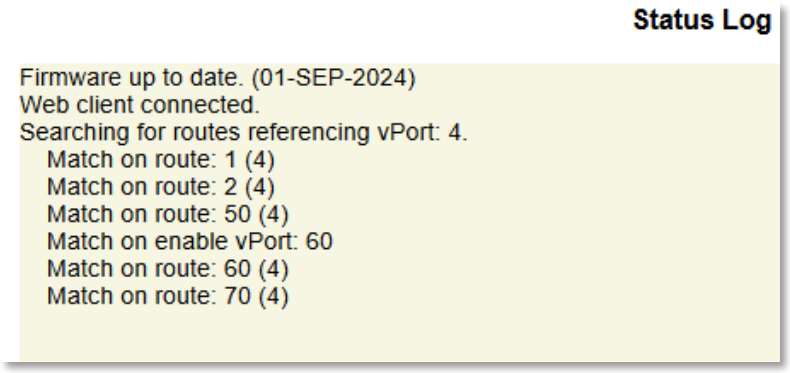
Every route that contains a reference to vPort 3 is listed. The number within the brackets refers to the slot location of the vPort.

The header vPorts are also searched. Let’s tweak some data to show this.

Select route 60.

Change the “Enable” vPort to 4.

Search again, this time searching for vPort 4. You will see results like:



Notice the enable vPort is listed in the results.

Searching by name

Somewhere in the Route Processor we have three routes pertaining to a three way point.

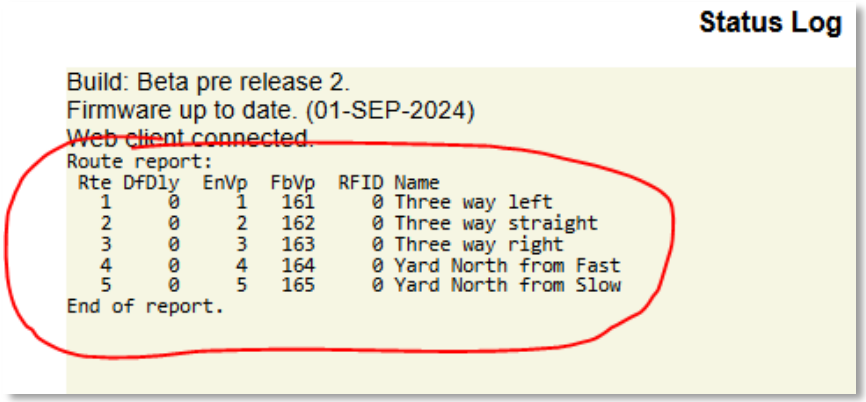
Enter “way” in the “Search Name” box located within the yellow search bar and press the “Search” button next to it. You will observe the following in the Status Log:

This makes finding routes by name or vPort easy.

Route Report

The route report will produce a summary report of all routes that have at least one vPort assigned within a slot. Routes with no vPorts assigned to a slot are considered unused.

The report will display in the status log area of the screen:



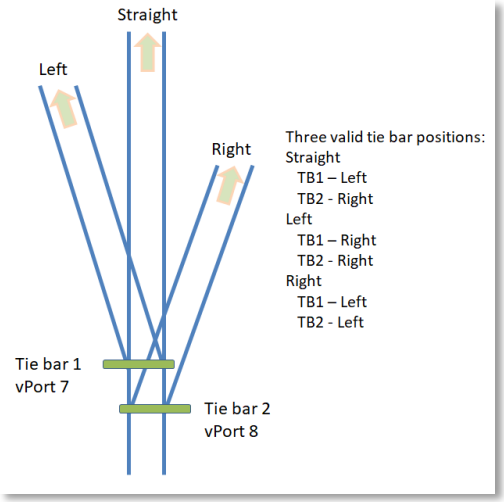
Building routes for three way point logic

Background

Three way points allow three directions of travel from two tie bars. This means there’s three legal combinations and one illegal combination of tie bar movement.

Under regular (route less) control you would have one button controlling each tie bar and you’ll have to remember the combinations to set the correct road.

With the System2 Route Processor you can set up routes to provide the three way logic. This means you simply set an output direction and the tie bars will move to the correct positions for the left, straight ahead and right roads.



We'll use the above diagram as the basis for the following example.

NOTE: Different manufacturers of track use different methods of tie bar configuration. Some three way points will lock up if moved out of sequence while others are more simplistic in operation. The basic operation is the same for all, though differences may be observed with the combinations presented here. The idea is to present a complete solution that allows the reader to further develop as needs require.

Setting up

Let's clear out all routes.

Navigate to route #1 and press the "Del All" button. Then extinguish the "Save Routes" button. You now have 100 empty routes.

On the Panel Controller admin screen do the following:

- Reset to defaults.
- EasyConfig range selector set to vPort range 1-16.
- Set the first 8 switch types to "stateful" (1-8).
- Save changes.

Connect your tie bars to servo driver ports 7 and 8 as per the above illustration.

Operating the switches 7 and 8 on the Panel Controller should show the three way point tie bars moving.

Range or limit adjustment is not covered in this document. See the motor driver documentation for specifics regarding servo range adjustment.

Programming the routes

Route 1

- On route 1, enter the route name “Three way left”.
- Set the enable vPort to 1 and feedback vPort to 161.
- Set the route learning range to 1 and 10 and press the “Learn” button.
- On the Panel controller move both tie bars until the left road is set in the three way points. If it happens to be correct when you start, toggle each tie bar at least once.
- Cancel learning.

Route 2

- Navigate to route #2.
- Enter the text “Three way straight”.
- Set the enable vPort to 2 and the feedback vPort to 162.
- Press the “Learn button”.
- Repeat the button pushes on the Panel Controller until you have straight ahead set up on the three way points.
- Cancel learning.

Route 3

- Navigate to route #3.
- Enter the text “Three way right”.
- Set the enable vPort to 3 and the feedback vPort to 163.
- Press the “Learn button”.
- Repeat the button pushes on the Panel Controller until you have the right set up on the three way points.
- Cancel learning.

On the Panel Controller switch ports 1 – 3, change the switch type back to “stateless”.

Why the change back to stateless?

If you leave the pushbutton on “stateful” subsequent button pushes turn the vPort ON and OFF. If you turn the route on button 1 on and subsequently break the route by pressing button 2 the state machine will turn the route off next time you press button 1. By switching back to stateless we just select a road without having to press the button twice. Don’t be alarmed, we haven’t got to this bit yet so it hasn’t been fully covered.

Testing the routes

Press button 1 on the Panel Controller. This should turn the LED#1 ON. If you have indicators feeding positions of the tie bars these will show the positions. Your three way points should be set to the left route.

Press button 2 on the Panel Controller. The LED on #1 will blink and extinguish (you just broke its route) and LED #2 will illuminate to show straight ahead is selected.

Press button 3 on the Panel Controller. LED #2 flashes and gives up and LED #3 illuminates indicating road 3 (right) has been set.

Sub routes

With the System2 Route Processor it's a simple set up to configure sub routes. These are normal routes that are also called by other routes.

Background

In the previous example we set up a three way point. In this section we'll build on that and incorporate the three way points into another route. When we set the new route, if the three way points are part of it, they will automatically be configured without the need to reprogram the points every time.

Configuration

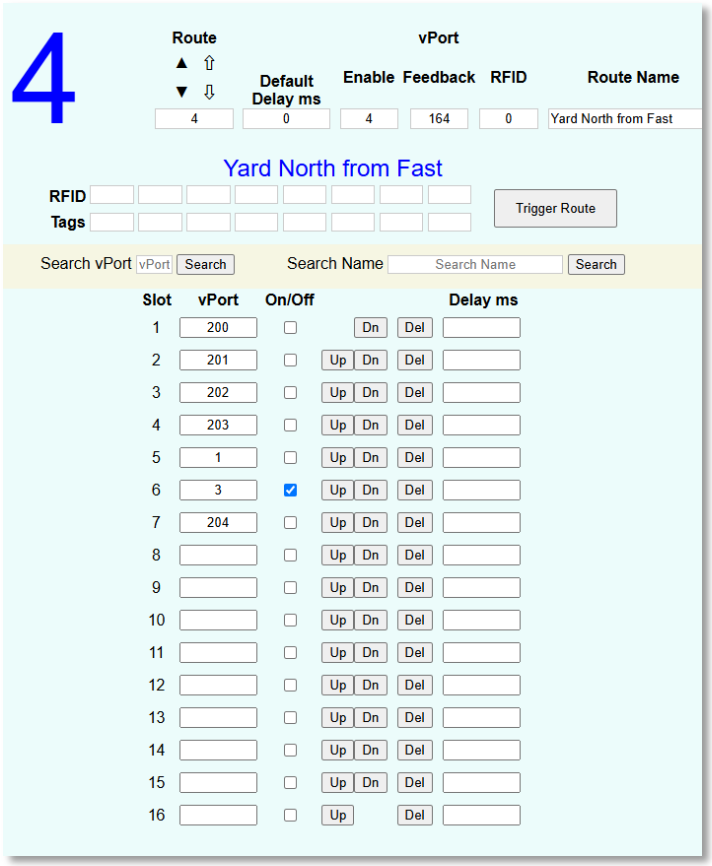
On the Panel Controller we've used vPorts 1, 2 and 3 for the three way routes. vPorts 7 and 8 are used by the tie bars.

Let's configure a route 4 that uses ghost vPorts (they aren't actually connected to anything, were just illustrating the sub route feature).

Main yard entrance North Bound from the fast line.

- Navigate to route #4 on the Route Processor.
- Enable set to 4, feedback set to 164.
- Name set to "Yard North from Fast"
- Manually set the following vPorts: 200, 201, 202, 203, 1, 3, 204.
- Ensure the vPort 3 on slot 6 is ticked ON.
- Ensure the vPort 1 on slot 5 is not ticked.

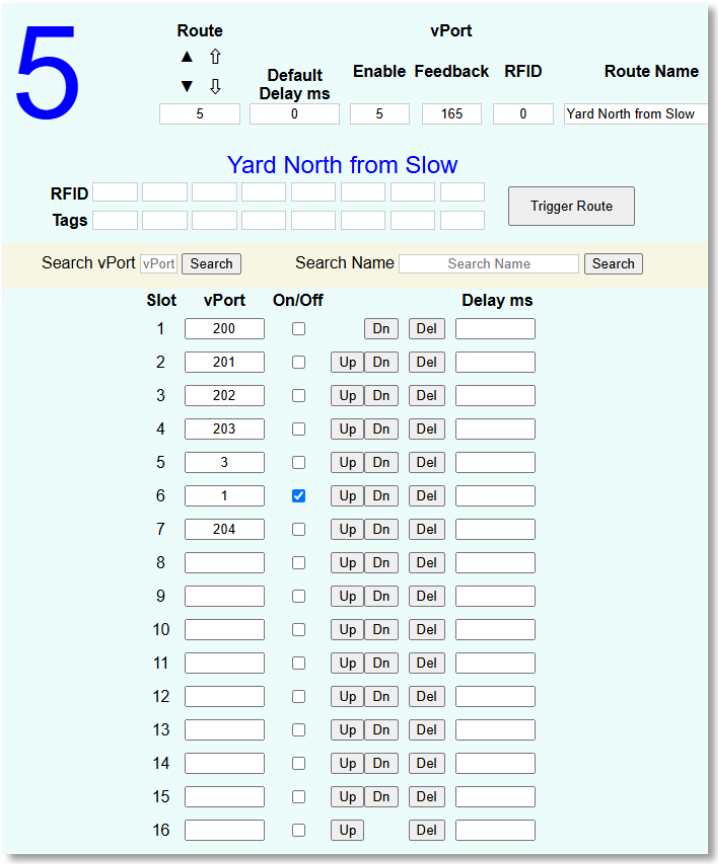
See below.



Main yard entrance North Bound from the slow line.

- Navigate to route #5 on the Route Processor.
- Enable set to 5, feedback set to 165.
- Name set to “Yard North from Slow”
- Manually set the following vPorts: 200, 201, 202, 203, 3, 1, 204.
- Ensure the vPort 1 on slot 6 is ticked ON.
- Ensure the vPort 3 on slot 5 is not ticked.

See below.



Proving the solution

Subsequent presses of button #4 and #5 on the Panel Controller will switch your main route and also switch the three way point that's been included as a sub route.

This may make setting up easier of the three way points are defined once and then called upon as needed. Alternatively you can choose to directly add them to the route as required.

What is System2 Air?

System2 is our new generation of model railway accessory bus products that feature our V-Port protocol (virtual port) and can address up to 60,000 devices. You can scale an installation from a single Servo-8 Controller (8 V-ports) right up to a huge layout as your needs grow. Flexibility is baked in and as we announce new modules that will work right alongside other System2 modules.

The “Air” in System2 refers to how you configure the system. It’s done wirelessly using Wi-Fi. This means you can configure a device using your PC, tablet or phone and replaces the need for buttons, flashing lights and extension cables to reach under baseboard locations.

We use Wi-Fi for configuration and a CAN network for data. This offers high speed, low latency and above all else reliability. You can even shut down the Wi-Fi network when your configuration is complete making your system secure and robust. It’s not required for operation at all.

Software for all System2 Air modules can be updated over the air if your network allows Internet access. A single button push is all that’s needed to download and install the latest version. This means as new ideas and features are introduced everyone gets to benefit from them. You can even see the changes that have been introduced since your last update and choose whether to install or not. You won’t get nagging reminders to update. It’s flexible and entirely up to you when or if you decide to do it.

System2 has been real world tested on some of the largest exhibition model railway layouts in the UK for over a year before launching, so you can be confident it’s fit for your needs and fit for purpose.

Each of our System2 boards has the administrative core baked in. You can connect to any board’s admin web page and from there manage your entire network. There’s no central point of control (or failure) as they are all peers in their own right.

We use standard web protocols for configuration so that your browser can connect and perform all administrative tasks without requiring any special apps and app permissions. This leaves you in control of your network.

System2 Air, for the smallest to the largest layouts and everything in between.

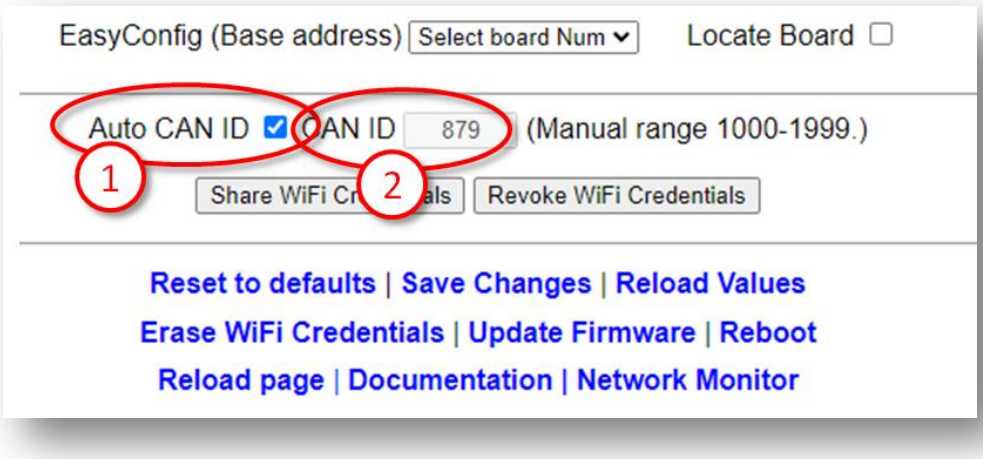
In order to use System2 you’ll need a Wi-Fi router configured for DHCP with optional Internet access. This is the standard router configuration as supplied by your Internet Service Provider.

Designed and manufactured in Cheshire, England.

Reference section

CAN ID management

The next area down on the main configuration page concerns network parameters. Refer to the screenshot below and explanation text for details.

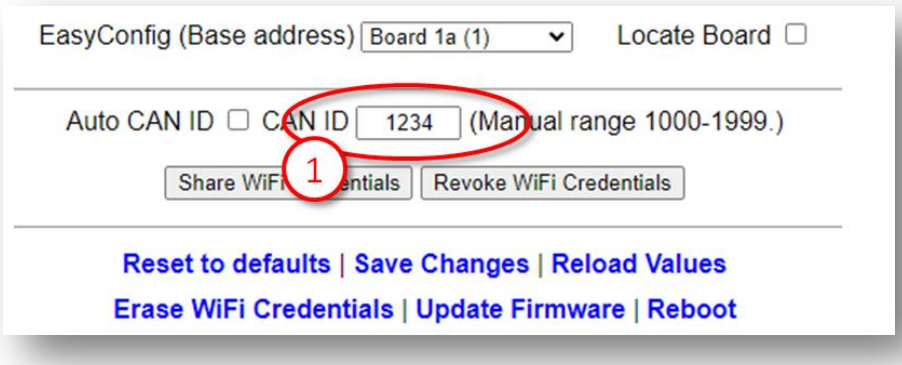


1 Auto CAN ID – Normally left selected (default). This will allow the board to automatically assign its CAN address and if a duplicate is detected may automatically reassign to a vacant address.

2 The current boards CAN ID. Showed greyed out if auto enabled (default).

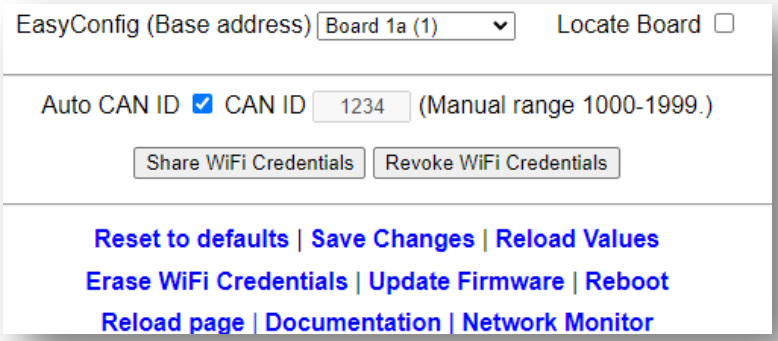
Automatic range: The automatic range for the CAN ID is 1 – 9999. If a duplicate is detected and Auto CAN ID is enabled either this or the other board with a duplicate ID will seek out a vacant CAN ID and update its configuration. When Auto CAN ID is selected do not expect CAN IDs to be persistent as they can change without notice. System2 is designed with this in mind and the board CAN ID is not relevant to operation.

The CAN specification requires all boards to have a unique CAN ID as part of the collision detection mechanism. Forcing duplicates is a bad idea and will lead to data errors.

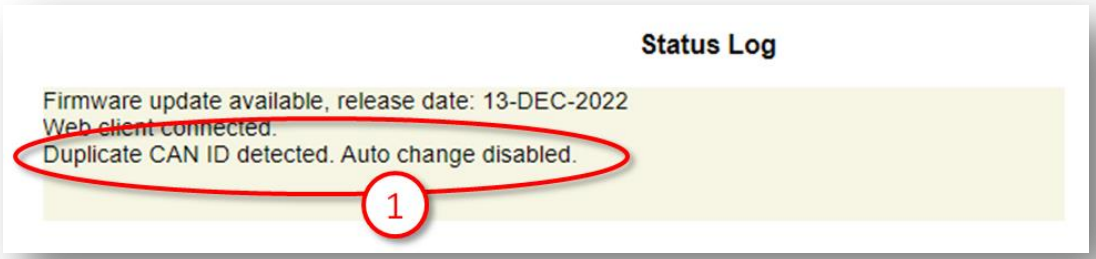


Manual CAN ID selection: We must ask why? There's no possible benefit we can think of, so it's included for edge use cases. Not recommended to change this. Manual range is 1000 – 1999.

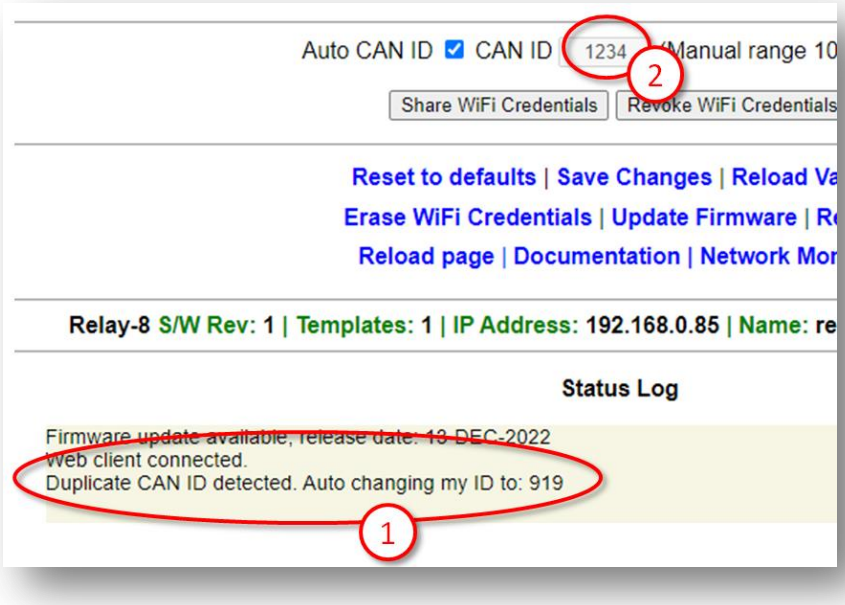
When reselecting Auto CAN ID, the current setting will remain until a collision is detected; whereupon the software will automatically reassign the ID (see below).



If a duplicate ID is detected and the address manually configured you will observe a message in the Status Log (example below) warning of the duplicate address and that auto change is disabled You need to manually reconfigure this.



With Auto CAN ID enabled the message is slightly different (see below):



The CAN ID was automatically changed to an unused ID. When the board is rebooted or the web page refreshed the CAN ID field will update to the new value.

Wi-Fi credential sharing

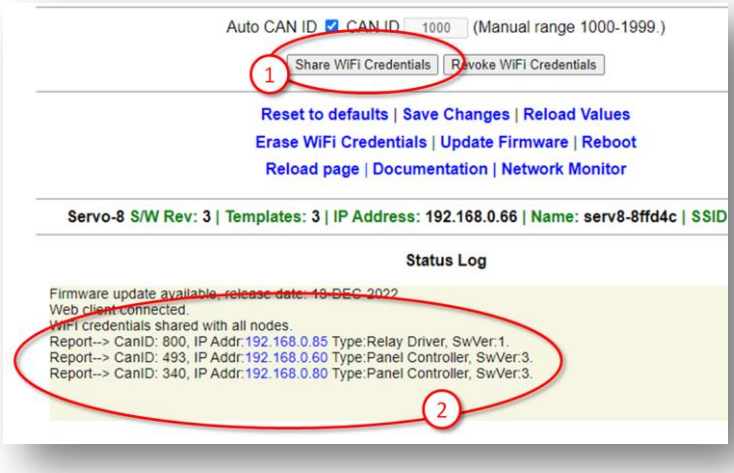
You may recall the procedure to connect the first board to your Wi-Fi network using your phone or tablet to connect to the boards local hotspot? You'll be pleased to know that you don't ever have to go through this again. In this section we'll cover how to share the Wi-Fi configuration with all boards on your CAN bus.

Connect to a System2 board using your browser. Obviously you'll only be able to connect to a board that is connected to your local Wi-Fi.

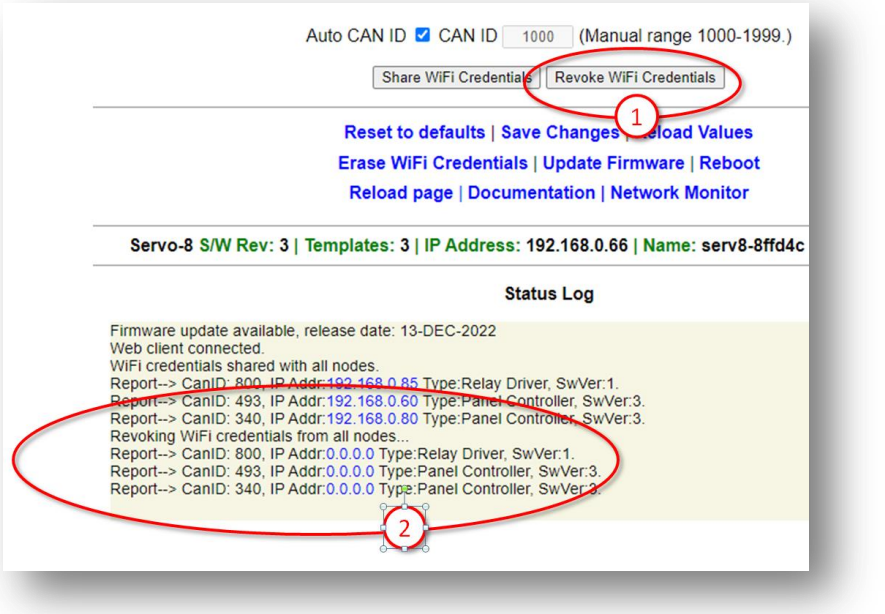
See the diagram below.

Click the "Share WiFi Credentials" button (1).

You will observe all boards on the CAN bus reporting in (Status Log) (2) with an IP address. These boards will now be accessible via a web browser from the same Wi-Fi network.



To revoke Wi-Fi access for all connected boards click the “Revoke WiFi Credentials” (1) button (see below):

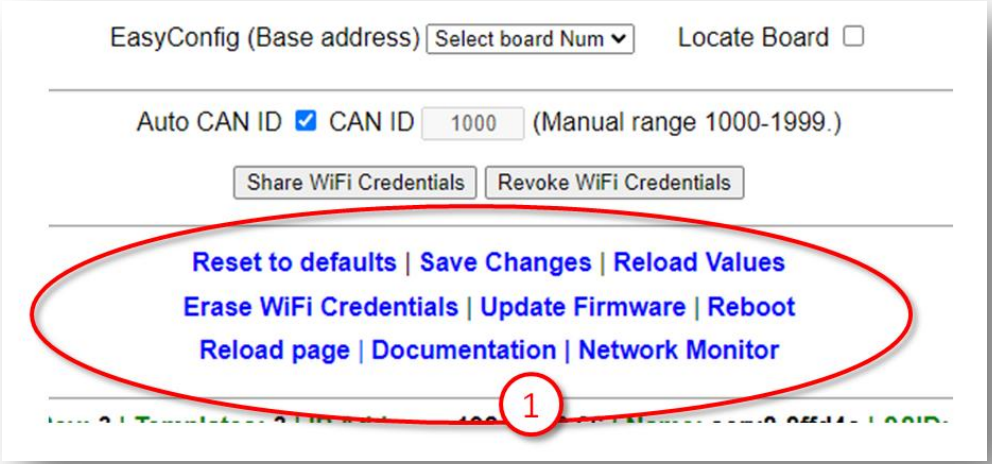


You will observe in the Status Log revocation messages. Each board will restart and show an IP address of “0.0.0.0” showing that it is not connected to any Wi-Fi network.

The board you are issuing the commands from is not affected by this and will remain connected to Wi-Fi until specifically revoked. This is covered later in this guide.

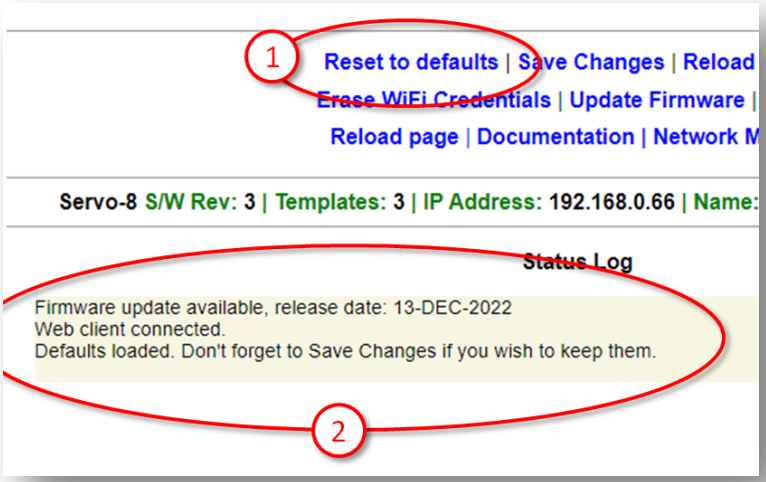
Actions

The action area (1 below) contains blue text that behaves just like buttons. This section covers each in turn.



Reset to defaults

This will reset most of the board values to defaults. Observe the message in the Status Log (2). You have reset to defaults and the default values are live, however will revert back to previous settings upon a reboot unless specifically saved. Particularly useful for testing and reverting.



Resetting to defaults changes the following:

- EasyConfig 1a is selected.
- V-Ports including trigger and feedback set for 1a (above).
- Reversed checkbox cleared.

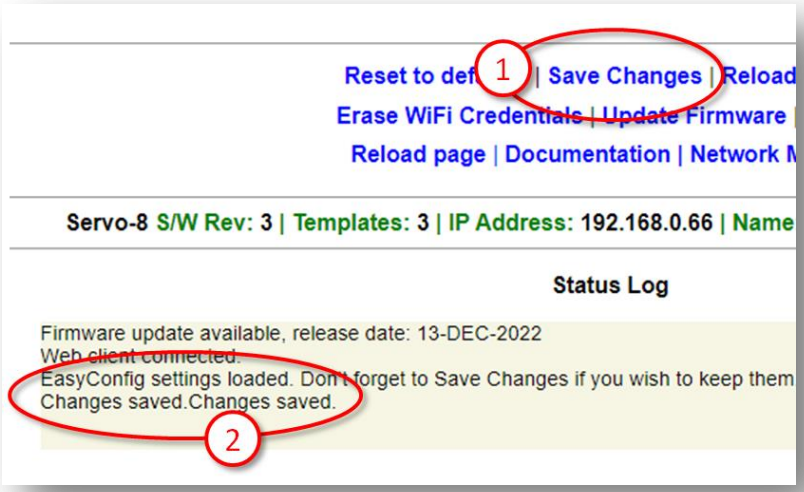
The following are not changed:

- Board location description (upper left of page).
- CAN ID
- IP Address
- Wi-Fi configuration
- Speed

Save Changes

As suggested by the description, this will save all uncommitted changes to non-volatile memory and be retained after reboots.

After saving you'll see the confirmation message (2) in the Status Log below.



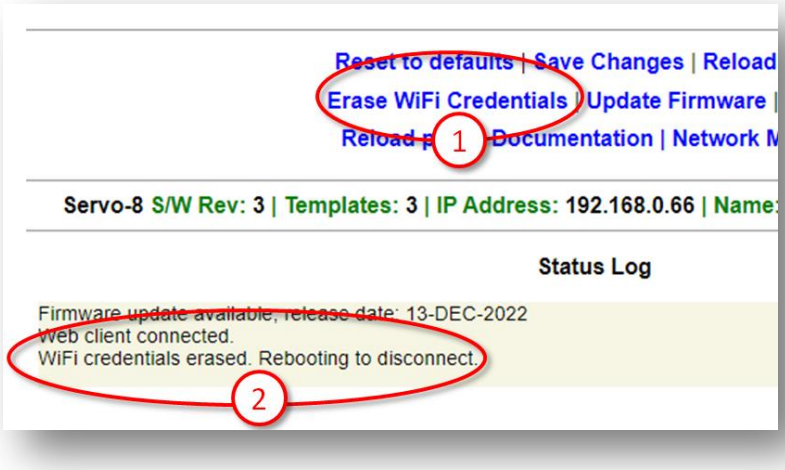
Reload Values

The Reload Values button will reset the parameters to the saved version. This will unto any changes that have not been saved. The browser page will refresh as part of the process.

Erase WiFi Credentials

Erasing the WiFi Credentials will remove the Wi-Fi details and reboot the board you are connected to. This action applies to the board you are connected to only. Other networked boards are unaffected.

If you wish to remove all boards from Wi-Fi see the Wi-Fi Credential Sharing section.

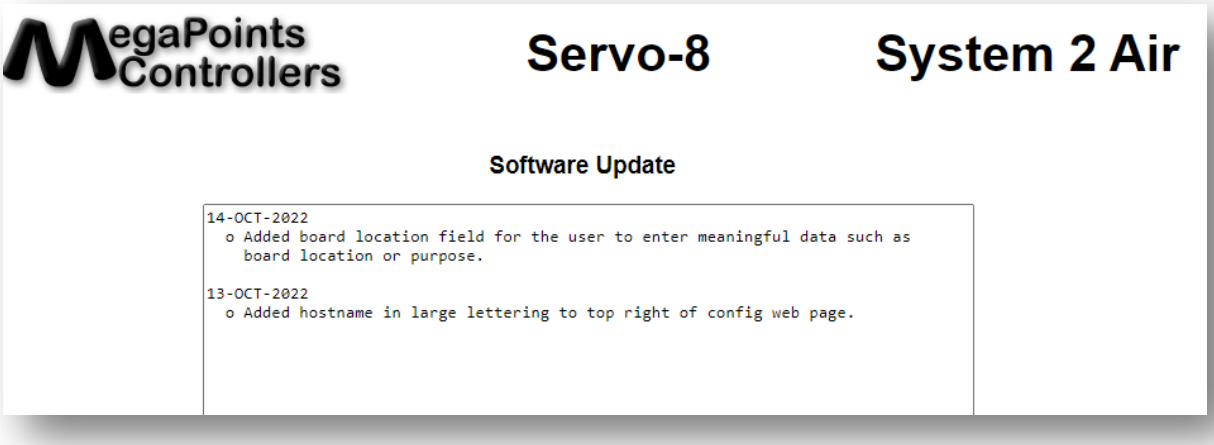


Update Firmware

If your board is connected to your Local Wi-Fi and that Wi-Fi has access to the Internet then you can update firmware. If a new firmware is available a message will be presented in the Status Log area:

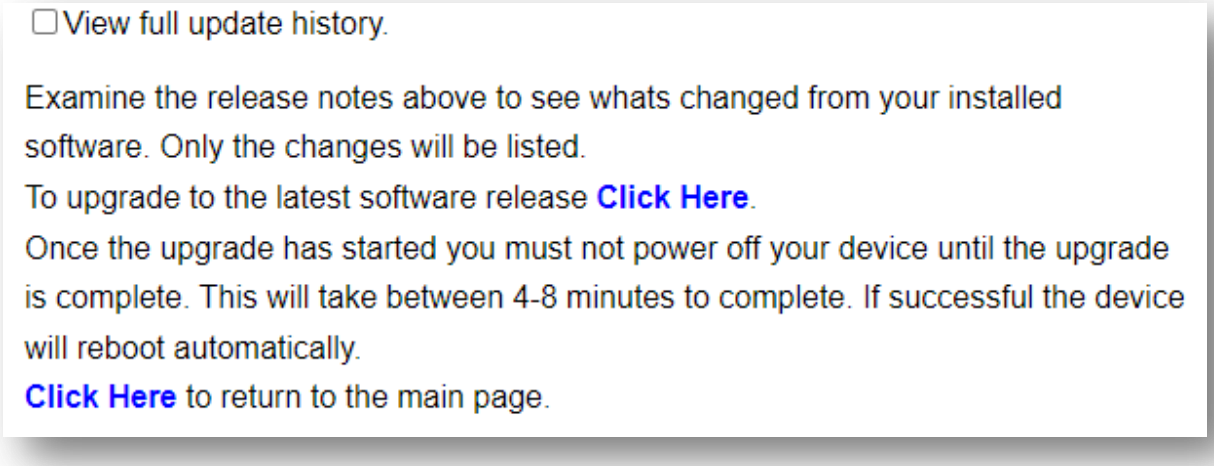
Click on the Update Firmware to begin the dialogue. You will be taken to a new page.

Any changes that are available since your last update will automatically be listed in the Software Update section along with the dates they were released.



You can see the release dates and what's in each release. If you select to update you'll get all the changes right up to the latest version. The update is not mandatory. Installation is up to you.

In this example were going to select the firmware update. It should complete within 10 minutes. During the update you'll see progress on the web page and the on board LED will flash erratically showing data transfer.



Below is an example log displayed during the software update process:

```
Update initiated.
Beginning firmware update. Two downloads will be processed.
  Onboard LED will flash erratically indicating data transfer.
  The update will take between 4-8 minutes to complete.
  An active internet connection is required for success.
  Please wait, do not reboot! Update in progress...
  Download (1/2). Connecting to update server.
    Received 926816 bytes from the update server.
    Written only: 0/926816. Please Retry.
    Received 926816 bytes from the update server.
     Wrote: 926816 bytes successfully.
      File (1/2) has been updated.
    File (1/2) download complete.
  Download (2/2). Connecting to update server.
    Received 1507328 bytes from the update server.
     Wrote: 1507328 bytes successfully.
      File (2/2) has been updated.
    Rebooting. Please return to the main web page.
```

When complete the board will automatically reboot and re-join the network.

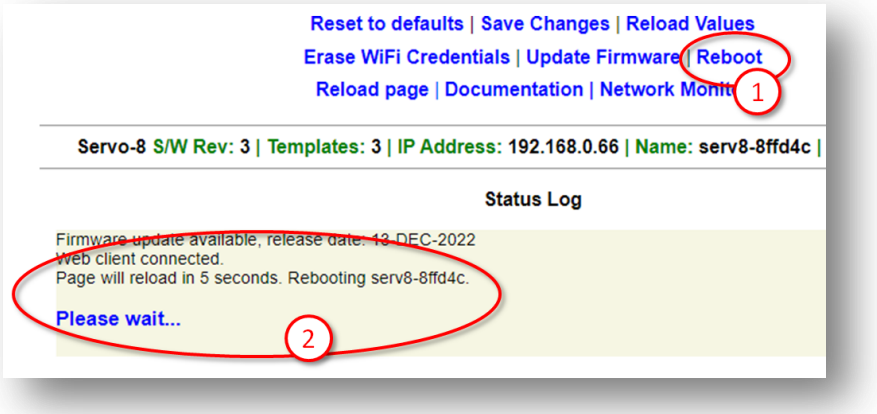
All your configuration data remains unchanged and is preserved across updates.

The update will fail safe. This means that if you interrupt the connection or power off during an update you can return to the update screen and begin the process again though it's not recommended to interrupt the update process.

Select the "Click Here" on the bottom line to return to the main configuration page and not perform any update.

Reboot

Clicking the reboot text will cause the board to immediately restart. You will observe a message in the Status Log that the page will reload automatically after a few seconds along with a "Please wait …" in blue.



Reload Page

This option reloads the web page and resets the Status Log area. Useful for clearing garbage from the log and confirming you are connected to the board.

Documentation

Clicking the Documentation link will open a new window in your browser and take you to the product page for the board you clicked from. On the product page you'll find links to the relevant documentation and video guides for this product along with recommended accessories.

This option requires an Internet connection.

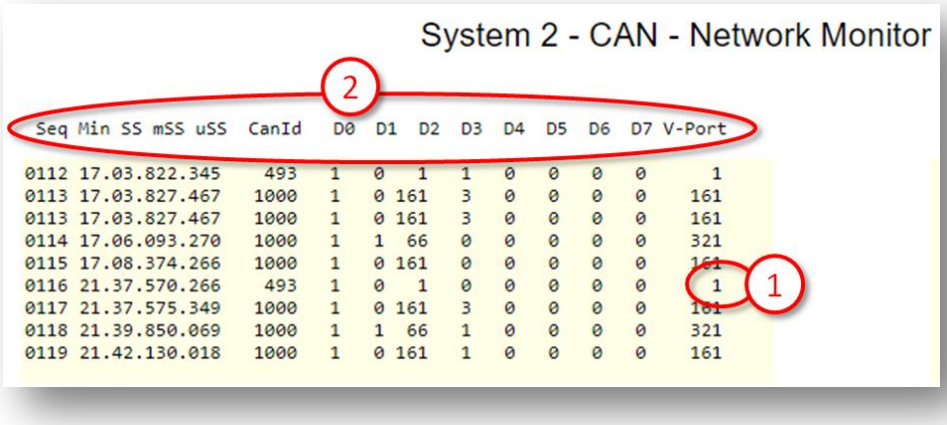
Network Monitor

WARNING! This section may send you to sleep and is not required reading.

The Network Monitor option takes you to a CAN bus network monitor.

The Network Monitor should be considered experimental, though we relied on it heavily during development.

The Network Monitor will provide a real time display of the traffic on your CAN bus.



The V-Port the packet is intended for is decoded n the right column (1).

The headers (2) contain the following details:

Header	Description
Seq	Packet sequence as observed by the board the Network Monitor is running on.
Min	Number of minutes since starting. Rolls over at 99.
SS	Seconds within the previous minute.
mSS	Millisecond within the previous second.
uSS	Microsecond within the previous millisecond.
CanId	The CAN ID that created the packet.
D 0-7	Data field of the packed (D0 – D7).

V-Port	Decoded V-Port the message is intended for.

The Network Monitor will only display packets created by remote boards. It will not display packets that are locally transmitted.

The local board that is running the packet monitor remains fully operational while the packet monitor is running. It will respond to events in its usual manner.

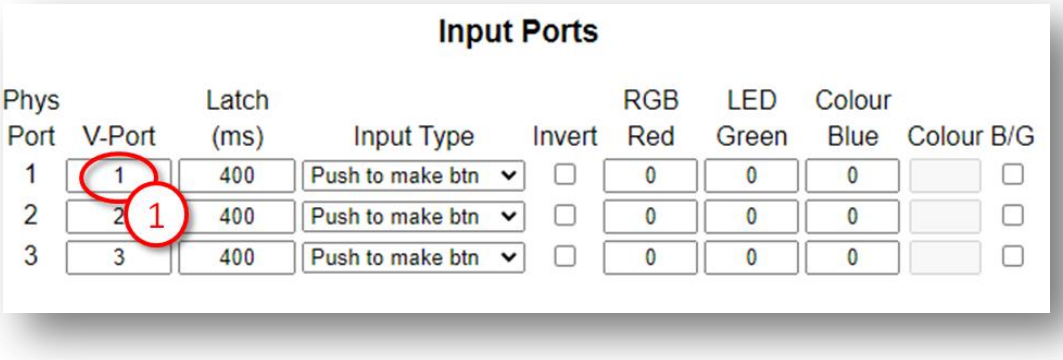
The data fields (D0-7) will be covered in separate documentation and are data type dependent.

In the above screen shot you can see network packets that were triggered by a button being pushed twice, once to turn on and again to turn off.

Under the V-Port column observe the following events that occurred at minute 17:

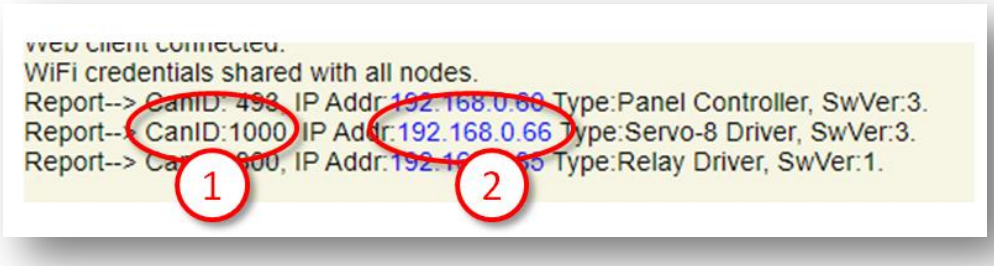
Header	Description
1	An event addressed to V-Port 1 is initiated from CAN ID 493.
161	An event is addressed to V-Port 161 from CAN ID 1000 (packet duplicated).
321	An event is addressed to V-Port 321 from CAN ID 1000.
161	An event is addressed to V-Port 161 from CAN ID 1000 (packet duplicated).

CAN ID 493 is a Panel Controller and looking at its configuration we observe V-Port 1 is a push button attached to physical port 1:



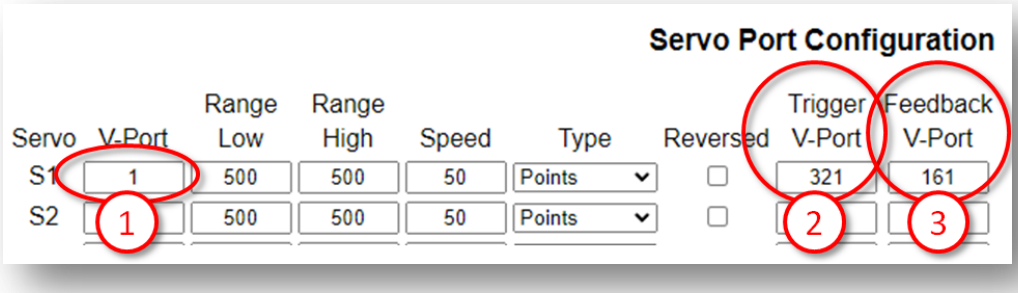
So we know what created the packet, a button on physical port 1.

The next packet was created by Can ID 1000. Looking at the Status Log (below) we can see (1) this is a Servo-8 board:



We are also presented with the IP address of the board (2), so clicking on the blue IP address takes us to the Servo-8 management portal.

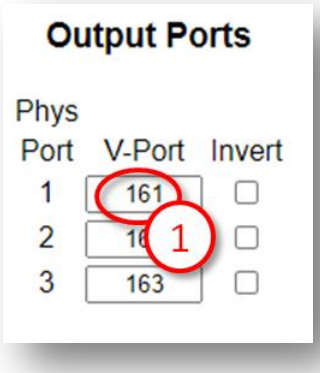
The Servo-8 port configuration is reported as:



The V-Port (1) is 1 meaning channel S1 (servo 1) is listening for this address (V-Port).

Remember this board has a CAN ID of 1000, and it generated a packet to V-Port 161. This is the configured Feedback V-Port at the marker (3).

If we look at the packet under column D3 you'll observe a "3" in the data byte. Where is this going?

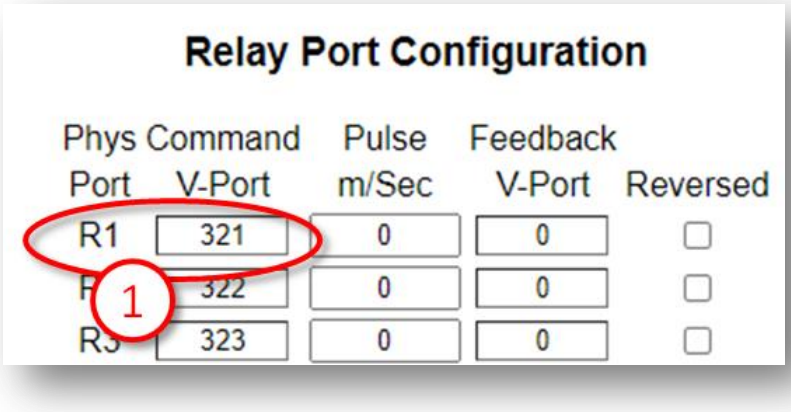


The Output Ports section of the Panel Controller (1 left) matches the Feedback V-Port of the Servo-8. It is this port that is listening for the event.

The data value of "3" indicates to flash. This will cause the panel Controller to flash the LEDs on physical port 1 and is used to indicate a motor in motion.

When the centre of motion for the servo has been reached another event is triggered to V-Port 321. Look at the Servo Port Configuration above. See the Trigger V-Port is configured for 321. The trigger fires when the servo is at its centre position. Particularly useful for firing a frog when the point blades are dead centre.

Looking at the relay driver port configuration (below) we observe:

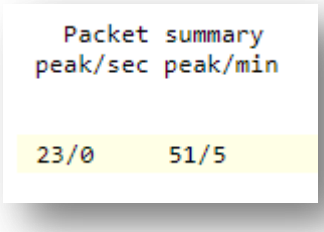


Relay R1 is configured for events on V-Port 321 and ill trigger when the Servo-8 is halfway.

This can be freely changed to respond to the same ports as the push button or any other device. It can also provide feedback data of its own, however setting the Feedback V-Port to "0" disables feedback from the relay.

Finally on the Network Monitor we observe the last packet at minute 17. It's addressed to V-Port 161 and this time contains a 0 in the D3 column. This tells the Panel Controller to stop flashing as the servo has reached its final position.

Skipping ahead to the last packet on the report you can see its to V-Port 161 and contains a 1 under the D3 column. This is the polar opposite of the previous paragraph and indicates the servo has reached the opposite end of motion and sets the Panel Controller indicator appropriately.



At the bottom of the network monitor page are some packet statistics. The leftmost column indicates the peak and current number of packets per second. The right most column shows the sae data over a one minute interval.

Status area

The status area shows information at the board level and is display only.

Board Type (1)

This tells you what the board is. In this case a servo-8.

SW Rev (2)

The current software version loaded.

Templates (3)

Displays the current version of loaded templates. Normally this will match the software version above.

IP Address (4)

The current IP address of the board as allocated from your Wi-Fi.

Board Name and serial (5)

The board serial number. Each is unique and is a combination of the board type and last 3 hexadecimal digits of the MAC address.

SSID(6)

The network name of the configured Wi-Fi network.

In conclusion

We hope you'll agree, System2 Air is a powerful, flexible model railway control system. Future updating is baked in through a trivial firmware update process and new boards are under development to expand the capabilities of the range.

If you've made it this far through the user reference then you'll understand just how much this board is capable of.

Happy railroading!

Contacting us

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If you have any product improvement suggestions we'd be very pleased to hear from you.

NOTE: We operate on a policy of continuous improvement. Colours, specifications and even the placement of components may vary from time to time.