LCC®/OpenLCB™ Starter Kit

SPROG DCC Ltd

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December 2023	1	Created
March 2024	1.1	Clarify jumper settings, fix typos

Unless otherwise notes references in this document to LCC apply equally to OpenLCB, and vice-versa.

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OpenLCB™ is a trademark of the OpenLCB Group

Contents

1 Introduction

Layout Command Control (LCC) is the new standard Layout Control Bus (LCB) for model railways. LCC is the name for standards adopted by the National Model railroad Association (NMRA) from the open-source Open Layout Control Bus (OpenLCB) standards developed by the OpenLCB Group www.openlcb.org.

You should refer to the LCC and/or OpenLCB standards and technical Notes and other related standards for more in-depth details of LCC and how it operates. This document should allow you to get started with the LCC Starter Kit.

A basic understanding of the concepts and terminology behind LCC is assumed, e.g., the difference between producer and consumer events. See the introductory document https://www.sprog-dcc.co.uk/downloads/lcc/lcc-basics-v1.pdf on our website.

Some familiarity with the Java Model Railroad Interface (JMRI) software is assumed.

An understanding of computer notation of bits, bytes and hexadecimal notation will be useful.

2 Starter Kit Contents

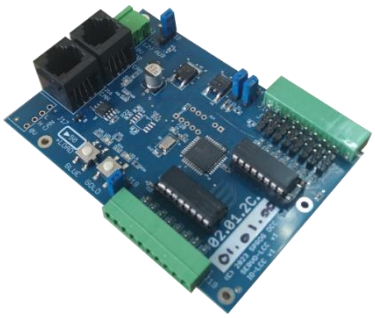
You should refer to our individual product documentation for more in-depth details of the products included in the starter kit. Also refer to the on-line documentation in the LCC configuration tool, when configuring a node.

To keep down the cost of the starter kit, only one I/O node is included. A feature of the USB-LCC allows communication between nodes to be demonstrated.

2.1 SERVOIO-LCC

A sixteen-channel configurable I/O with the following features (not all features supported at the same time)

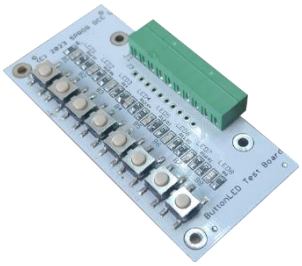
- Up to sixteen inputs in two banks
- Up to sixteen outputs in two banks
- Eight servo control outputs (bank A only)
- Logic level (5V) inputs
- Logic level (5V, 10 mA) outputs
- High voltage, high current outputs with optional driver IC(s).
- Six producer events per channel
- Six consumer events per channel
- Servo start-, mid- and end-point producer events



2.2 Terminators

Two CANBUS Terminators to be placed at the ends of the network. These should be plugged into the spare RJ45 sockets on the nodes at the end of the network. These ends of the network must never be connected together to form a ring.

2.3 ButtonLED Test Boards



A test boards for injecting and monitoring events during testing and setting up of the network.

The ButtonLED has eight Pushbuttons and eight LEDs. The pushbuttons can be used to simulate inputs into the CANSERVOIO to produce events on the LCC network. The LEDs may be driven by outputs from the CANSERVOIO to monitor consumed events.

The ButtonLED may also be used for the setting of servo endpoints.

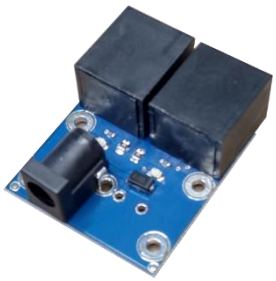
The ButtonLED is intended purely as a test and diagnostics aid whilst setting up an LCC network. In a real network the node inputs would be driven from control panels, block detectors, etc., and the outputs would be used to drive servos, LEDs, etc.

2.4 USB-LCC

One USB-LCC interface node for connecting to a computer.

The USB-LCC is directly supported by JMRI from version 5.5.7. To use with earlier JMRI versions, select the LCC Buffer-USB and set the baud rate, in the additional setting, to 460,800.

2.5 POWER-LCC and Power supply (PSU)



One POWER-LCC node for connection of power to the network.

The two LCC sockets can each supply up to 500 mA to connected nodes.

A 12V switch mode PSU is included.

2.6 RJ-45 Cables

Two RJ45 cables for connecting the nodes.

Nodes should be daisy-chained using the two RJ45 connectors.

2.7 Not included

Cables to connect ButtonLED test boards to the SERVOIO-LCC. Normal single or multi-strand hook-up wire or ribbon cable will suffice.

Tools.

Auxiliary PSU for use with servos controlled by the SERVOIO-LCC.

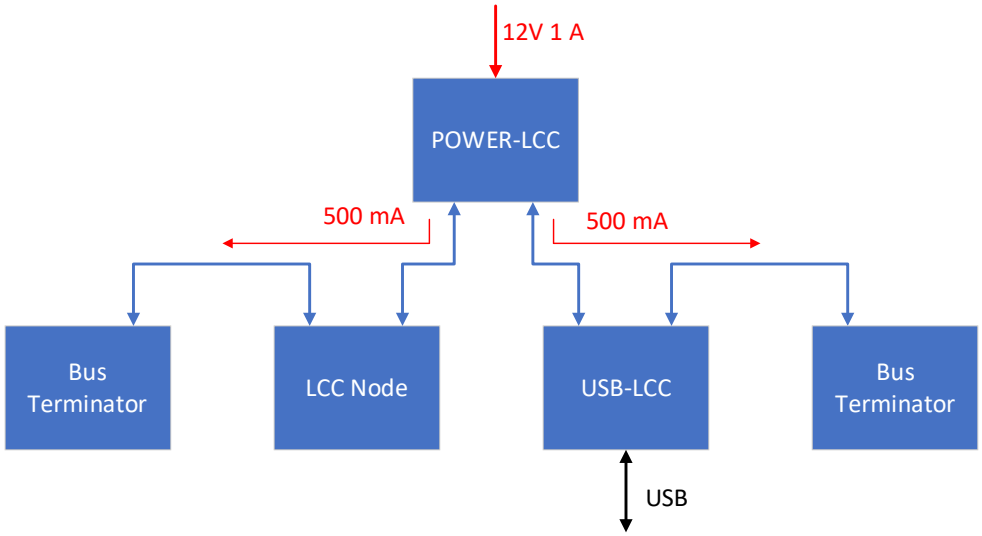
I/O modules or servos to connect to the SERVOIO-LCC

3 Hardware Setup

The LCC nodes should be connected using the supplied, or equivalent, cables. Suitable cables are often known as “Ethernet cables”. The cables must be CAT3 or better.

The LCC network should be created as a linear or “daisy-chain” connection between all nodes with terminators in the empty sockets at the two ends of the network.

It does not matter in which order the two sockets on a node are connected to neighbouring nodes, nor in which order the nodes are connected. The POWER-LCC should be connected near the middle of the network as it provides independently fused power on each connector.

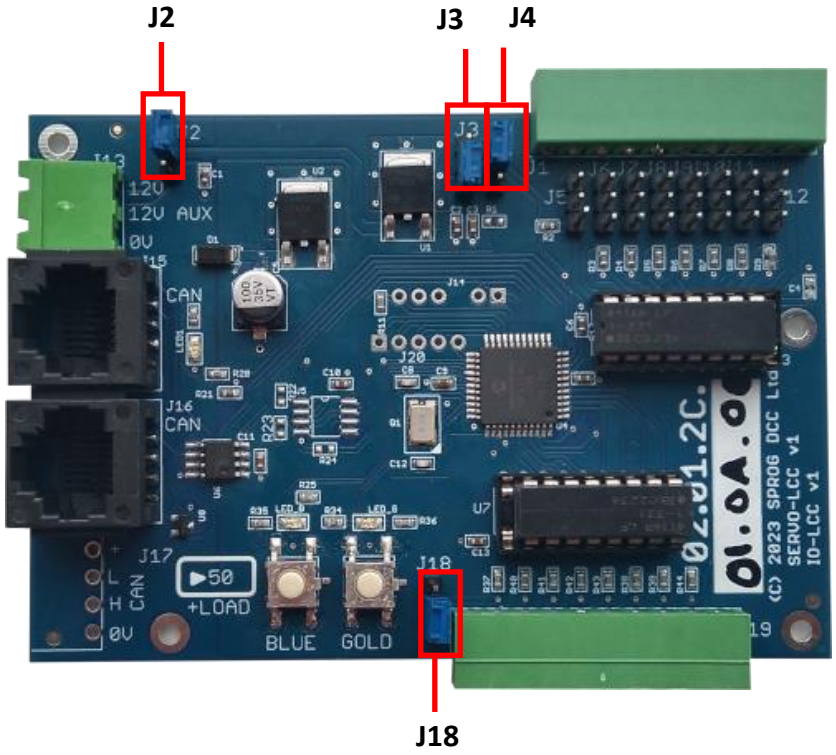


3.1 Setting Jumpers on the SERVOIO-LCC

Following sections will specify how the SERVOIO-LCC should be set up. The jumpers are listed here, and shown, for reference.

Jumper	Function	1-2	2-3	Comment
J2	VP select	J13 Aux	CAN	Voltage source for servo 5V regulator and I/O
J3	I/O Voltage	VP	VServo	Voltage source for I/O drivers (if fitted) and pull-ups
J4	Bank A	Pull-up	Pull-down	Select I/O pull-up or pull-down for Bank A (J1 and J5 – J7 servos)
J18	Bank B	Pull-up	Pull-down	Select I/O pull-up or pull-down for Ban B (J19)

NOTE: Pin 1 of each jumper is annotated by the square pad on the underside of the circuit board.



To follow the examples in this document, the jumpers should initially be fitted as shown in the picture, above, and in the table, below. The “Position” refers to the previous picture: up nearest the top of the picture, down nearest the bottom of the picture.

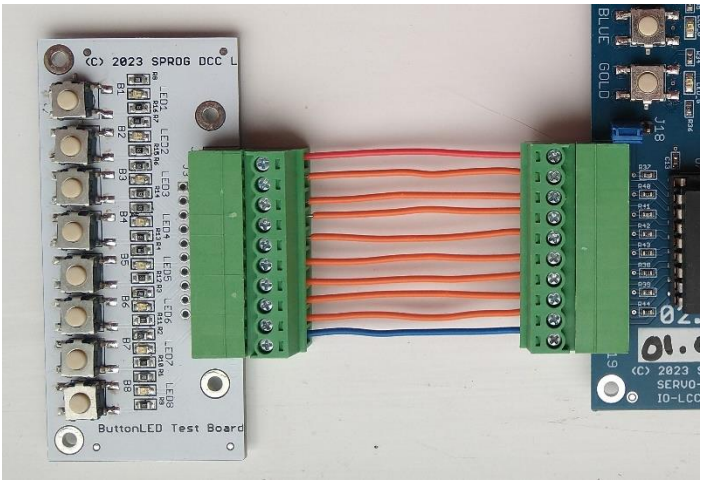
Jumper	Pins	Position	Function
J2	2 - 3	Up	Use CAN power
J3	2 - 3	Down	Use regulated 5 V
J4	1 - 2	Up	Pull-up
J18	1 - 2	Down	Pull-up

3.2 Connecting the ButtonLED

The SERVOIO-LCC has a number of actions and consumed/produced events enabled by default. Bank B is configured as inputs (for producing events) and bank A as outputs (for consumed events) in a new node, or after a factory reset.

NOTE: Nodes may be both producers and consumers. They may even consume their own produced events.

Connect a ButtonLED to bank A on the SERVOIO-LCC as shown in the picture. You can, e.g., use ribbon cable, solid or stranded hook-up wire. No appreciable current will flow so wires as thin as 7/0.1 or 30 AWG will be suitable.

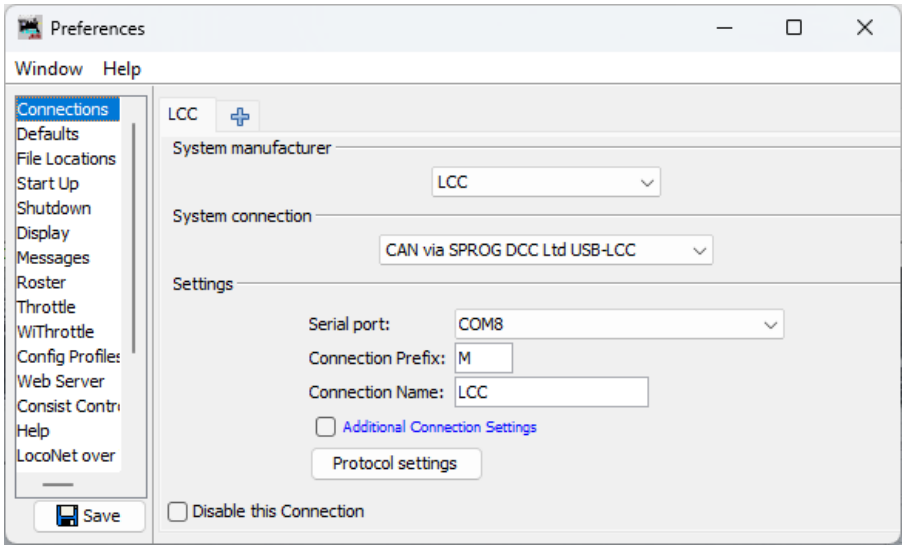


Complete all the connections and set the jumpers in the SERVOIO-LCC before turning on the power to the POWER-LCC.

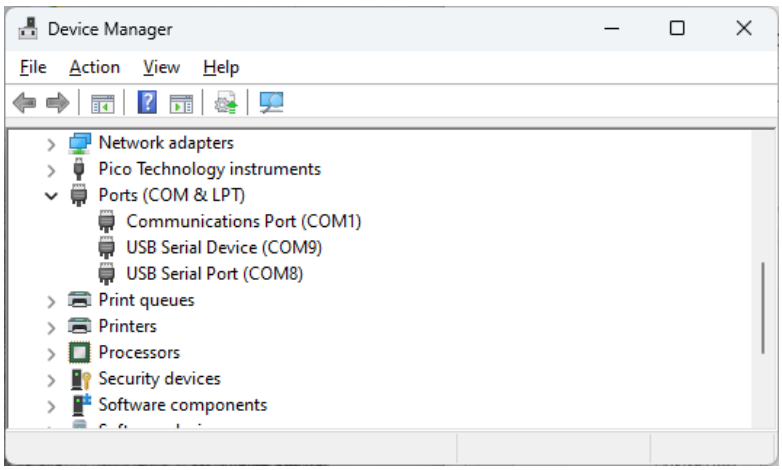
4 Software Setup

JMRI software is required for configuration of the LCC nodes, www.jmri.org. Download and install version 5.6, or later, for use with the LCC starter kit. Once an LCC network is created and configured it may be operated without the use of a computer.

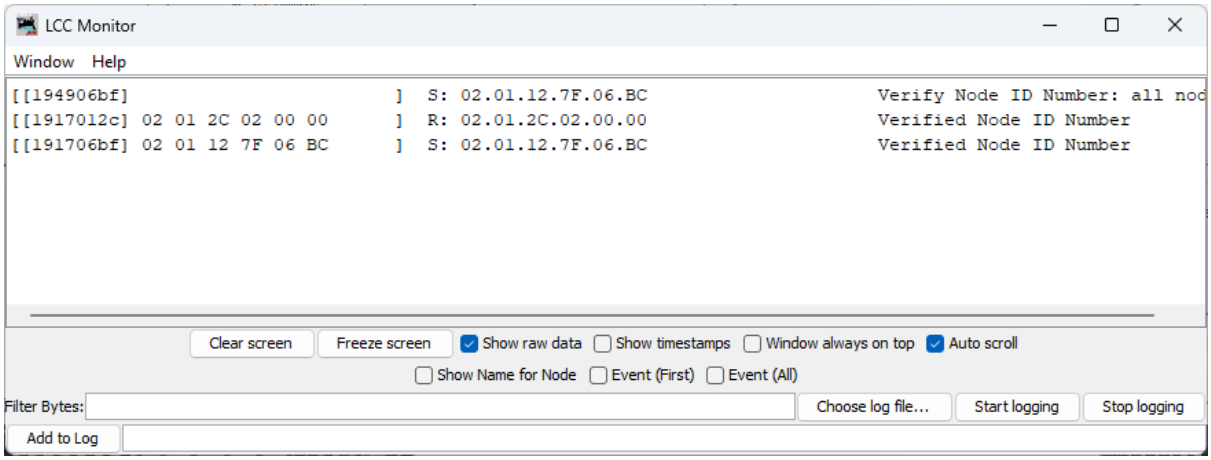
Start JMRI and set the connection preference for OpenLCB using CAN via SPROG DCC Ltd USB-LCC. It is possible to use CAN or LCC adapters from other manufacturers with sprog DCC Ltd products, but such products are beyond the scope of this document and will not allow some of the examples in this document to be implemented.

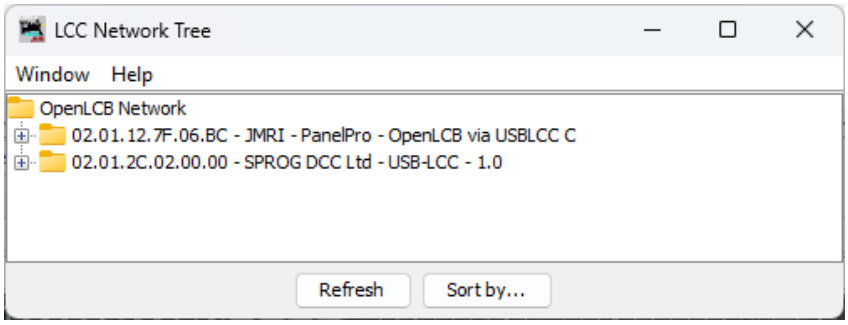


The serial port setting will depend on your individual setup. On Windows computers, check the Device Manager for the COM port assigned to the USB-LCC.



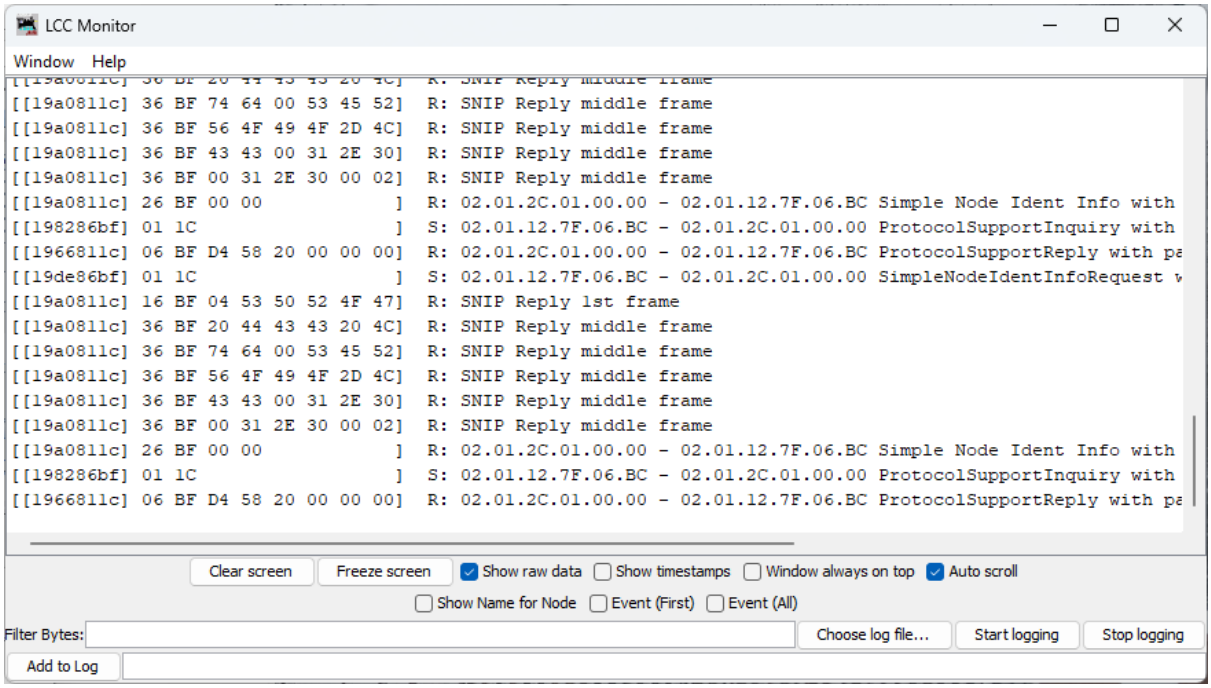
When JMRI is running, open the OpenLCB Traffic Monitor window followed by the Configure Nodes dialog. The Traffic Monitor will show a few messages and the Configure Nodes dialog will show the JMR node and the USB-LCC.

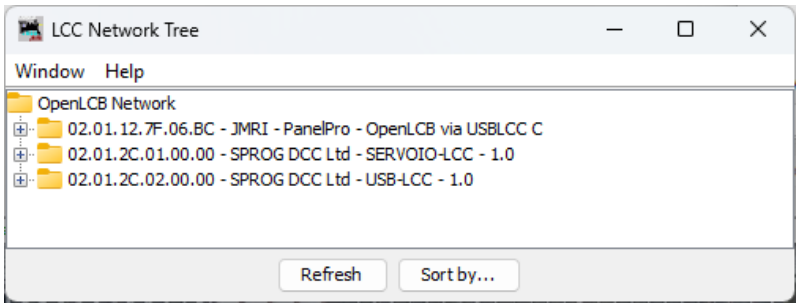




Turn on the power to the network.

The Traffic monitor will display quite a number of messages as nodes initialise and identify themselves to JMRI. The SERVOIO-LCC node will be added to the Configure Nodes dialog showing the Node ID, manufacturer and node type.





Hint: You can get on-line help for the JMRI tools from the Help > Window Help menu in each tool.

5 Node Configuration

Node configuration is the process of using a program to tailor a node's operation to the specific application of the node. Unlike programming DCC decoders, no extra data is required for use by the configuration software. All configuration is stored in the node, and will always be current for the node.

Configuration includes:

- Giving the node a user-friendly name and description (optional)
- Give events user friendly names (optional)
- Define the events to be produced by the node and when they are produced
- Define the events to be consumed and what the node does in response
- Other, node-specific, configuration

Once all nodes are configured, a computer is not mandatory, but may be useful, for LCC operation.

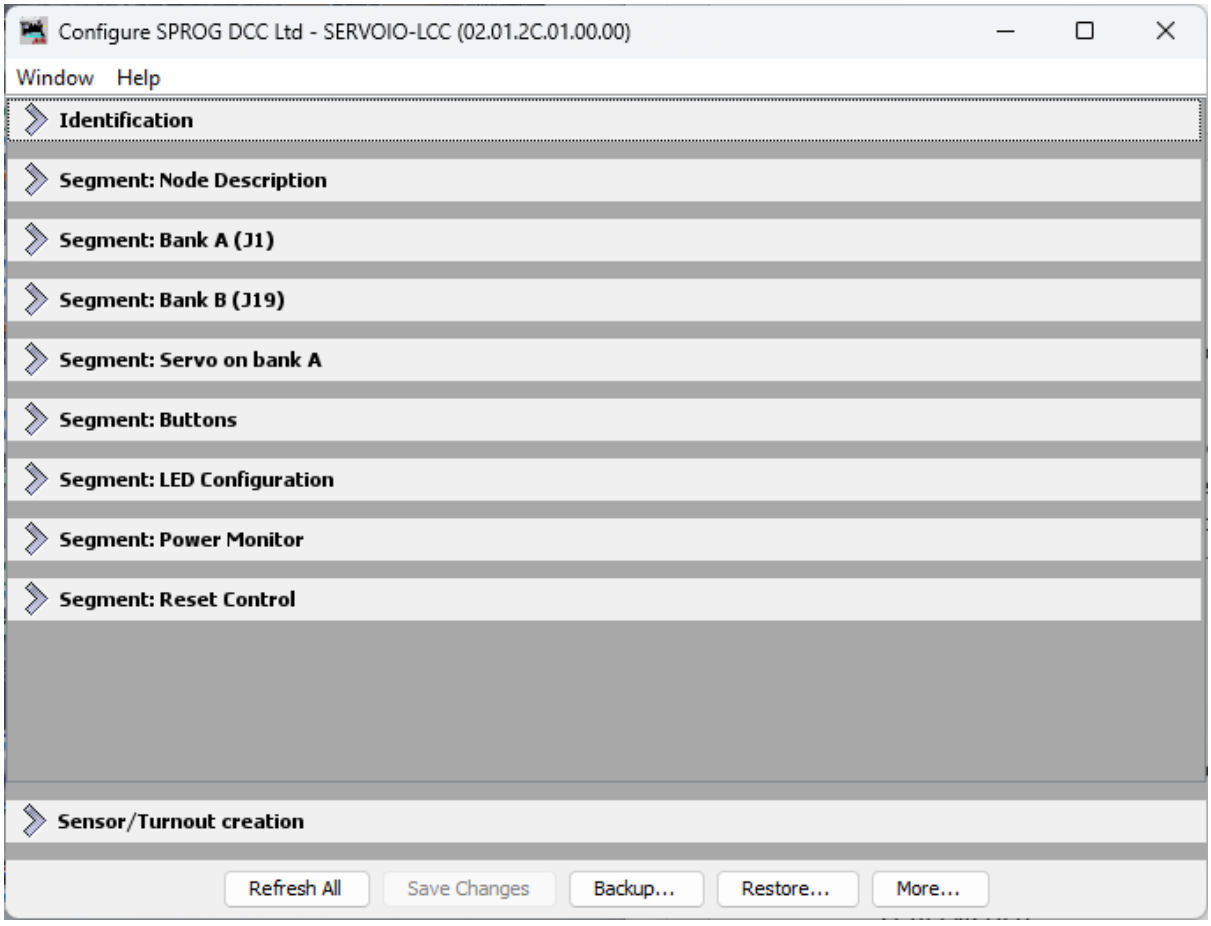
5.1 Tying or Teaching Events

We'll start by changing a bank A channel to an input and tying a producer event from this channel to a consumer event on the USB-LCC. This process is also referred to as "teaching", i.e., we must teach the consumer which produced events it should consume.

5.1.1 Creating Producer Events

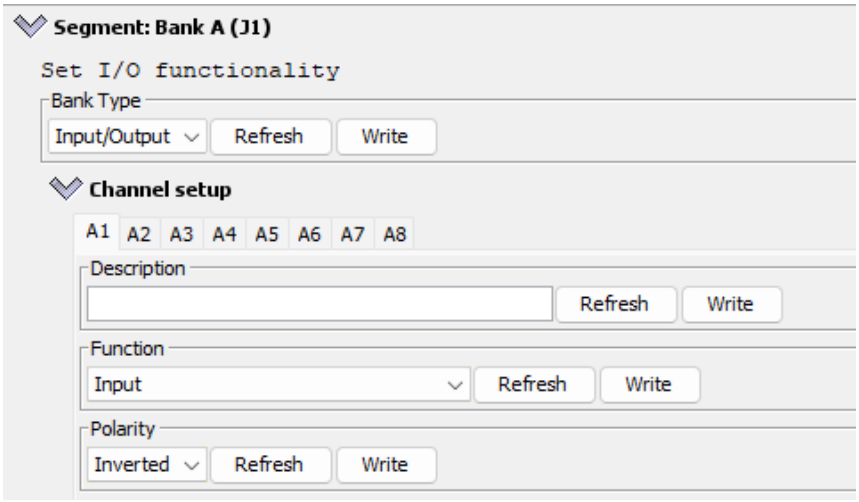
Choose the SERVOIO-LCC node in the JMRI Configure Nodes dialog and expand it's tree by clicking the '+'.

Double click on the leaf node that says "Open Configuration Dialog" to read the configuration from the node. A lot of messages will be displayed in the Traffic Monitor window. A new Configure node window will open with an inceremnting count as the data is read from the node. When the process is complete the window should look like the following screenshot.



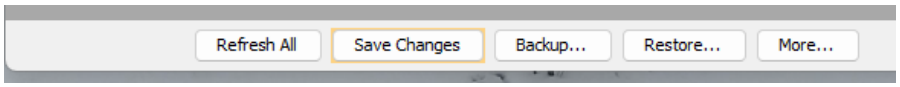
The configuration is broken down into segments, each of which may be expanded to show more detail.

Expand Bank A, select A1, and use the Function drop-down box to select Input and change the Polarity to inverted.

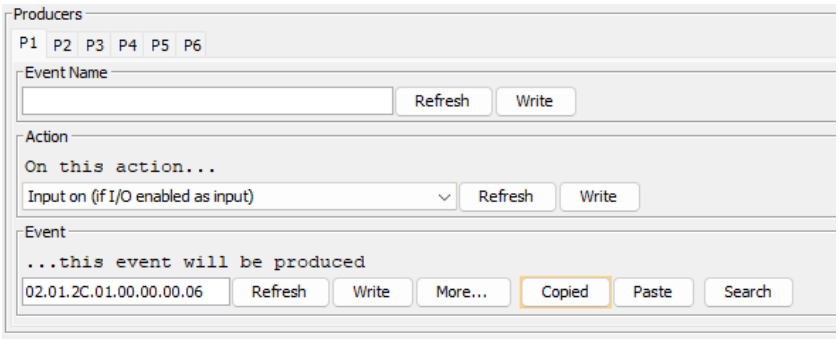


We change the polarity as the pushbuttons on the ButtonLED are active low, that is they connect a low voltage when pressed. Normally a low voltage could be thought of as off, and a high voltage as on. We want to treat the low voltage when the button is pressed as the on condition.

The Save Changes button at the bottom of the configuration window will be highlighted. Ignore this for the time being.



Scroll down to A1's producers, select P1 and use the Action drop-down to select "Input on" then click the Copy button for the event. The button will change to "Copied".



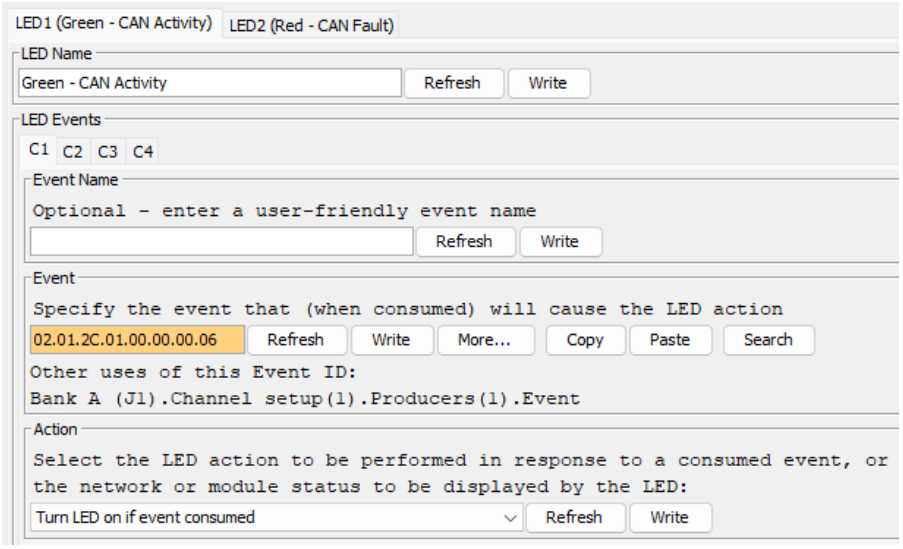
5.1.2 Creating Consumer Events

Next, Open the configuration dialog for the USB-LCC. You do not need to close the SERVOIO-LCC dialog.

Expand the LED Configuration segment.

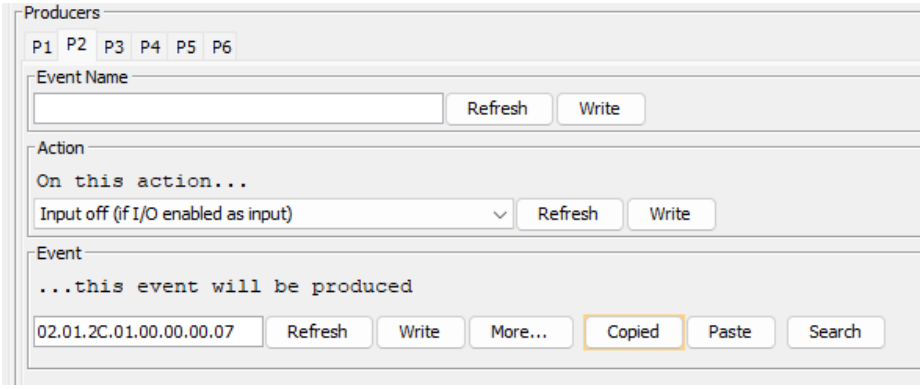
Select LED1 and event C1 and click the Paste button to past the producer event from the CANSERVOIO-LCC in place of the default event. The pasted event will be highlighted.

Use the Action drop-down to select “Turn LED On”.

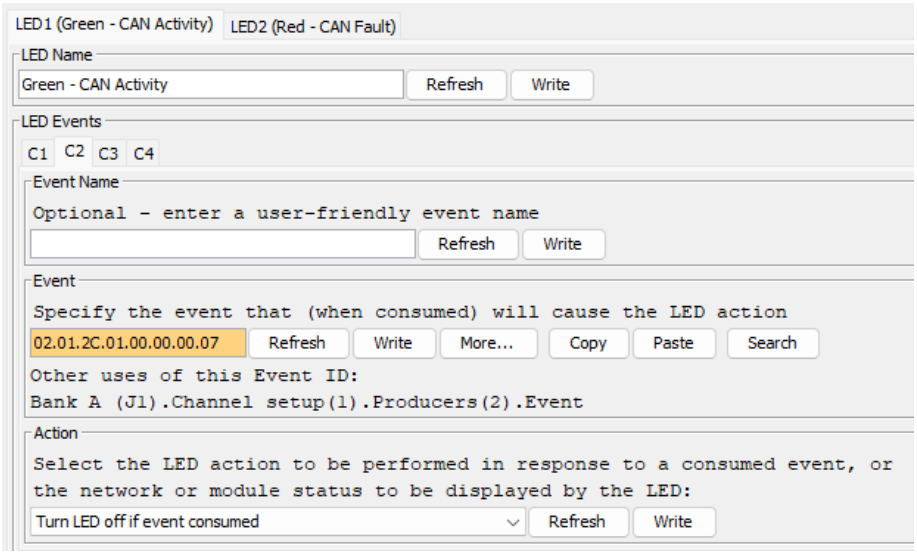


5.1.3 More Events

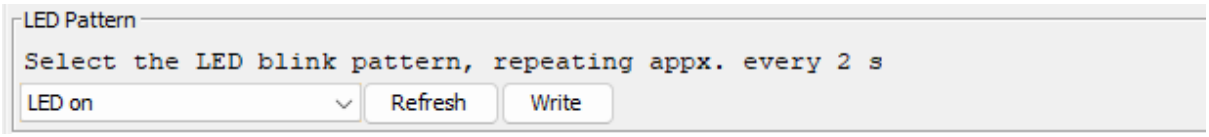
Follow a similar procedure to configure a second SERVOIO-LCC producer event (select P2 Producer) for Input Off and click Copy to copy the event. The button will highlight and the text will change to “Copied” to show that the event has been copied.



On the USB-LCC select LED1 C2 and Paste the event. If you prefer to use keyboard shortcuts then you can select the existing event and use CTRL+V to paste. Set the Action to turn the LED off.



Set the LED pattern to on



Various LED patterns are available, but there is only one pattern per LED, not one pattern for each consumer. When the LED output is on, the pattern is applied, when the LED output is off, the LED is completely dark. We selected the LED on pattern which means the LED is on solidly, with no actual pattern when the LED output is on. In other words, in our example, consumer event C1 will turn the LED on and consumer event C2 will turn the LED off.

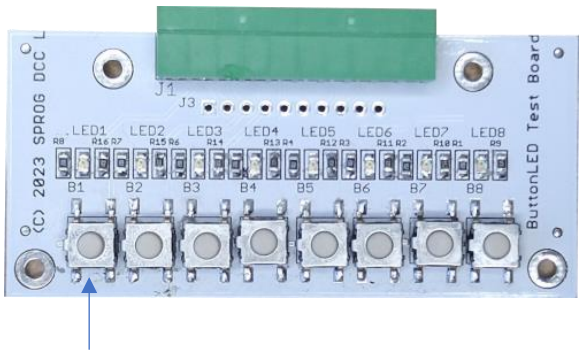
In each of the configure dialogs, click the Save Changes button, at the bottom. The LCC Monitor will show the messages used to write the changes.

We now need to re-initialise each node to make the new configuration become the active one. In each of the configure dialogs, click the More… button and click Update Complete.

IMPORTANT: When you are done with configuring a node click More… Update Complete. The node will reset and apply the new configuration.

You have now taught the producer (SERVOIO-LCC) to produce events when channel A1 input changes to on or off and taught the consumer (USB-LCC) turn LED1 on or off when it consumes those events.

Try it. Hold the button B1 down on the ButtonLed and watch the LED on the USB-LCC. Watch the event messages in the traffic monitor. Release the button and the LED will extinguish.



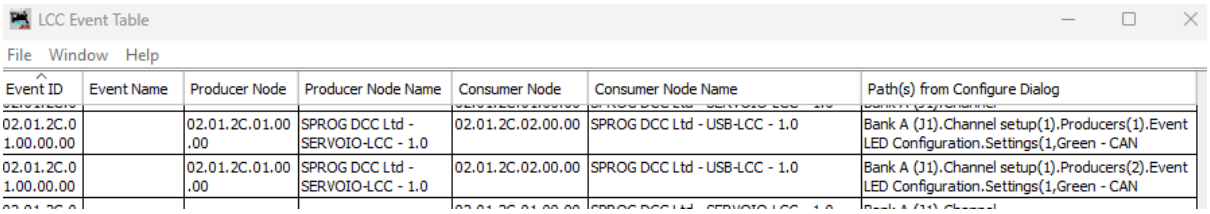
Button B1

Note: Ordinarily the USB-LCC LEDs would not form part of a layout control scheme. They are used here as a convenience to demonstrate the operation of LCC within the limitations of the hardware included in the starter kit.

Note: Whilst the ButtonLed is primarily intended as an aid in setting up and testing an LCC network, it can be used as a simple interface for interaction with a layout. The design could be copied and adapted to put the switches and LEDs on a track diagram to control a very simple layout, for example.

5.2 Examine the Events in the Event Table

Open the LCC Event Table and click to update from the network. The extract below shows the events just configured between the producer and consumer for each event.



The Path(s)… column shows the newly created event connections:

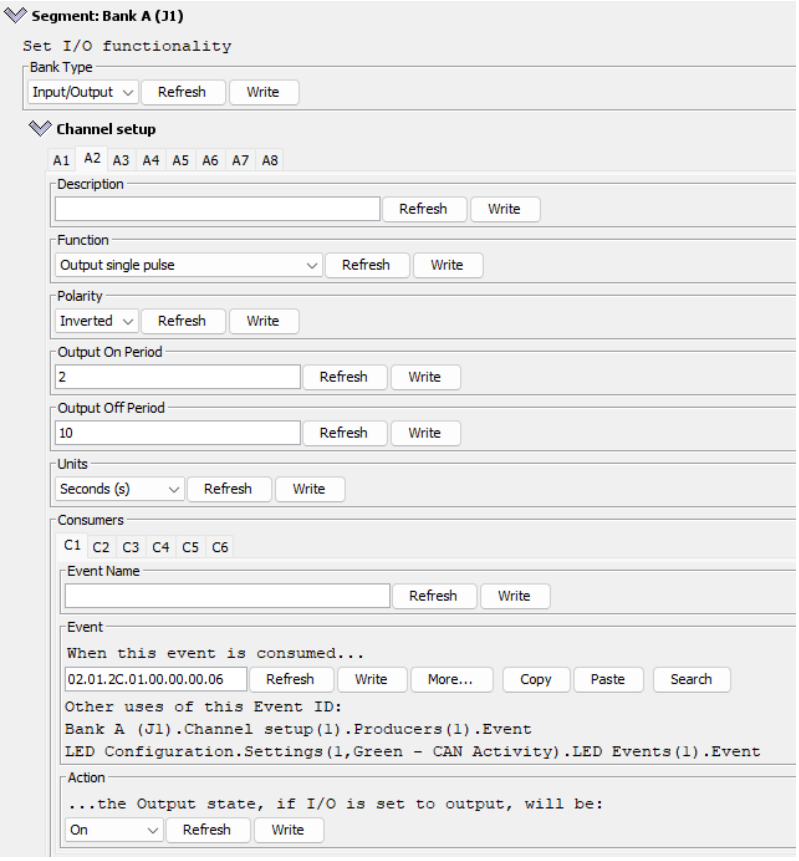
- From the SERVOIO-LCC (producer node) Bank A, channel 1, producer 1 to the USB-LCC (consumer node) LED 1
- From the SERVOIO-LCC (producer node) Bank A, channel 1, producer 2 to the USB-LCC (consumer node) LED 1

5.3 Node Consuming its Own Event

A basic principle of LCC is that all events are presented to the network and a node will see the events that it produces. This allows for events to cause things to happen on the same node, as well as remote nodes across the network.

Starting from the configuration we created in the earlier section, Copy the event from A1P1, select channel A2, configure it as an output with a single pulse, polarity inverted, change the Output On Period to 2 and the Units to Seconds, paste the event into C1 and set the action to on.

Save changes and click More>Update Complete



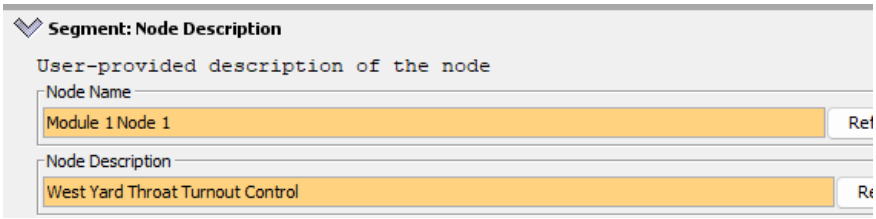
Now press B1 on the ButtonLed and you should see LED2 on the ButtonLed illuminate for 2 seconds.

This demonstrates the node consuming the on event that it produced fron the button press to control a different I/O channel. You will also see the on and off events from the button in the LCC monitor, just as before.

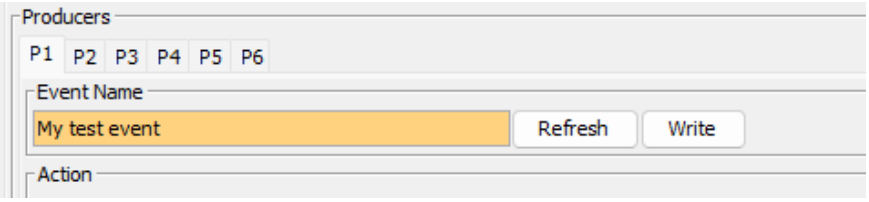
5.4 Naming Things

As mentioned, it's possible to use the Node Configuration to name nodes and events.

The Node Description segment of the SERVOIO-LCC allows a user-friendly name to be applied to the node, e.g.:



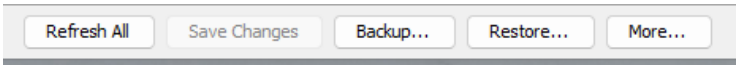
Producer and Consumer events may also be named:



Remember to write the changes to the node and, when you are done changing things, click More… Update Complete. The node will reset and apply the new configuration.

5.5 Saving the Node Configuration

You can save a node's configuration to a file on your computer using the Backup function in the node's configuration window.



You will be prompted for a file name to save to.

The restore function is used to restore the node configuration from a file.

5.6 Node Reset

If you feel you have messed things up and want to start again, you can reset a node to its factory default state by clicking More…Factory Reset. You have the option to create a backup first, and then reset the node. You should then click the Refresh All button to reload the nodes configuration into the configuration window.

6 Next Steps

This has been a very basic introduction to setting up and using an LCC network using LCC nodes from SPROG DCC Ltd. Now you can go ahead and experiment more with the configuration of the nodes in the starter kit. Remember you can easily revert a node to its factory settings if something goes wrong.

Expand your network by connecting more nodes from ourselves or other manufacturers.

Connect up some real I/O hardware such as servos and occupancy detectors or LEDS and relays.

Explore the features of JMRI for generating events, e.g., create a control panel and use this to control turnouts via LCC.

Consult the individual nodes' documentation for full details of how to configure them for your application.

Look out for updates on our website and YouTube channel.

More information can be found using the links in the next section.

7 Links

SPROG DCC Ltd website https://www.sprog-dcc.co.uk For all our products and support.

SPROG DCC Ltd Official YouTube Channel https://www.youtube.com/@sprogdcc

OpenLCB group https://openlcb.org The group behind the OpenLCB/LCC standards.

NMRA LCC standards page https://www.nmra.org/lcc The LCC standards adopted by the NMRA.

OpenLCB discussion group https://groups.io/g/openlcb/topics Discussion of OpenLCB topics, more developer focussed.

The NMRA's LCC user group https://groups.io/g/layoutcommandcontrol/topics a good starting point for asking questions of other LCC users.

JMRI users https://groups.io/g/jmriusers/topics JMRI software topics.

JMRI website https://www.jmri.org Download the latest JMRI releases and access support pages.

Book: Introduction to Layout Command Control https://www.amazon.co.uk/Introduction-Layout-Command-Control-Practical/dp/0988825902 focussed on RR-Cirkits products but the concepts are applicable to any LCC hardware.