Low Cost DCC (LC-DCC) 2.0

Software Users Guide

8th April 2019

Summary

Provided in this document is a software user's guide for the LC-DCC Windows and Android software and M3/M4 processor programming details.

Software that resides in the ARM processors that control the DCC track lines and associated Windows and Android software is purchased from eBay.

Disclaimer

The designers accept no responsibility for any damage to any train or accessory decoder connected to this DCC system through incorrect assembly or use of the hardware design.

Please read s-9.1_electrical_standards_2006.pdf NMRA standard before purchasing and using a power supply. Also note some cheap power supplies can give over voltage output.

License / Usage Terms

All the software components are protected by license. When you buy the software from eBay, you are entitled to one free license which will be provided by Email.

Existing users of the 1.X design

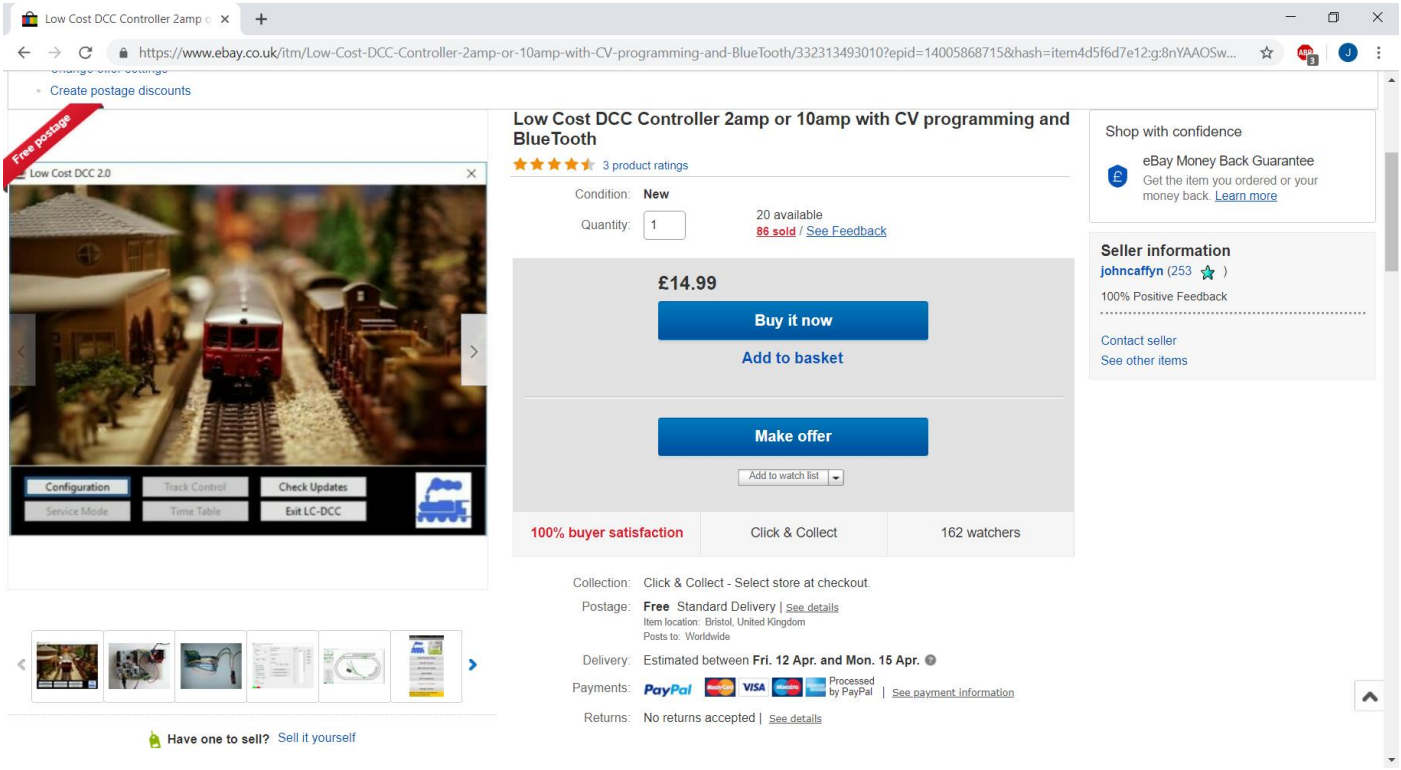
Existing users will need to obtain a license key, this will be provided free if you have purchased via my eBay account. Users creating their own software who want to upgrade will also need to contact us to obtain an "unlock code" for their M3 or M4 processor. Also, the M3/M4 pins A6/A7/C0/C1/B0/B1 functions have changed so this document should be consulted.

LC-DCC Forum

A low cost DCC forum can be found at http://low-cost-dcc.freeforums.net, this was created in March 2019.

Buying On EBay

Please note that there are a number of false adverts on EBay that cannot provide support or valid updates for this project and may not even provide anything for your money. The idea of Low Cost DCC is to make available a quality product at a price that everyone can afford. Only buy from the designer and developer of this project. To ensure you are buying from the only official EBay listing check the seller information is as displayed below (seller: johncaffyn, location: Bristol). Any other listing is false.



Contents

Introduction

This book describes installation and use of the various software items that make up the LC-DCC system.

This includes programming the M3/M4 micro controllers, installing and using the Android application and installing and using Windows application.

All software components can be downloaded free of charge from www.swws.co.uk/dcc_files.html. The software requires a license to use which is purchased on EBay.

M3/M4 Programming File

The M3 and M4 binary programming files are contained in .zip files that can be downloaded from www.swws.co.uk/lc-dcc-files.html. Within the .zip file there are four programming files, these files are for different current configurations. The INA219 can be configured to measure 3.2 amps maximum (default) or 6.4 amps, 9.6 amps or 12.8 amps by adding extra shunt resistors. The programming files are setup for each of these current limits and the correct one should be chosen for your configuration. If no INA219 is connected then you can program any binary file into the M3 or M4 processor.

Programming STM32F411RE Nucleo Boards

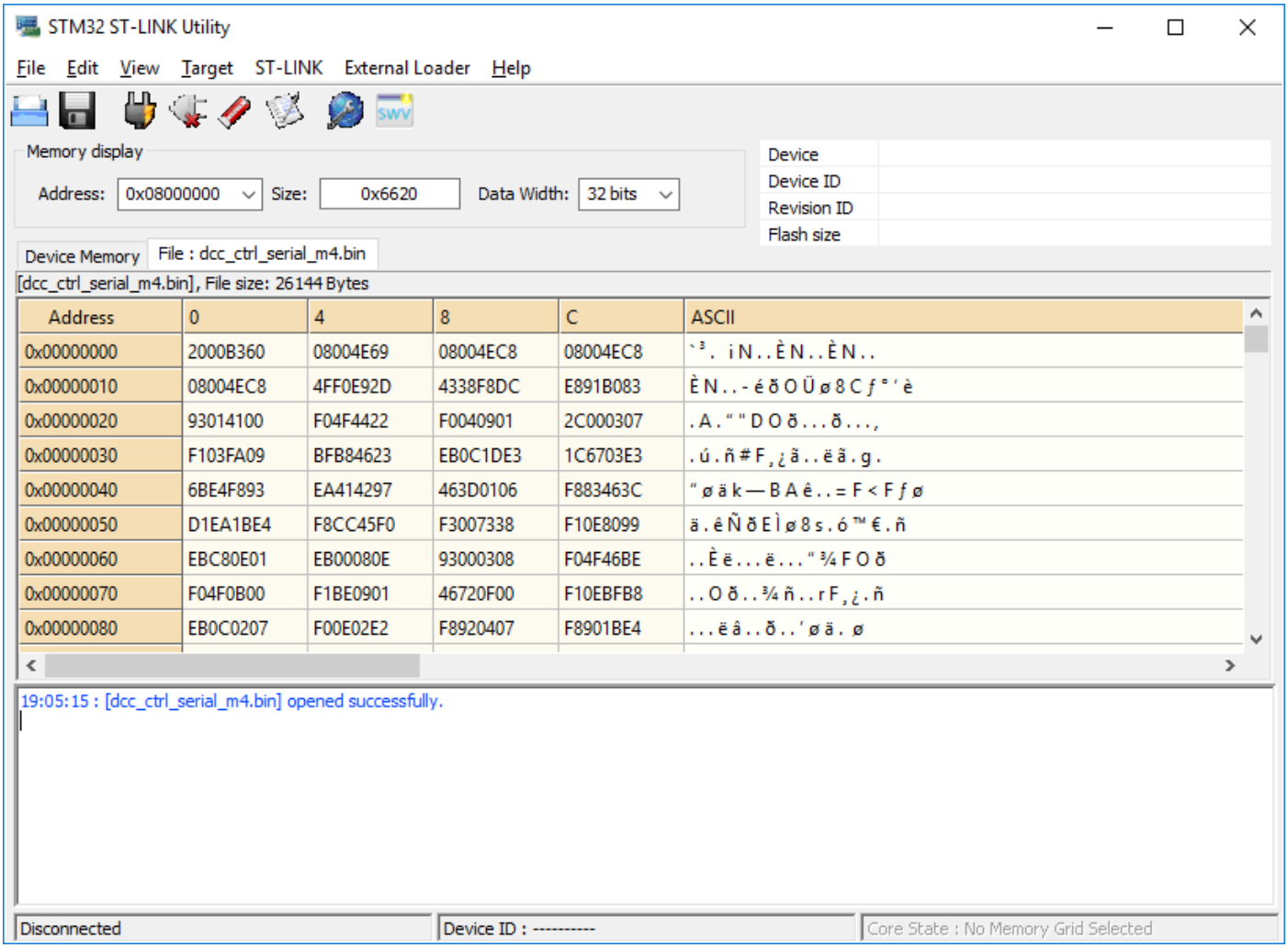
To program STM32F411RE boards you must download from the STM website the **STM32 ST-Link Utility** Windows application and associated USB drivers.

The board is then programmed using the STM32 ST-LINK Utility as follows:

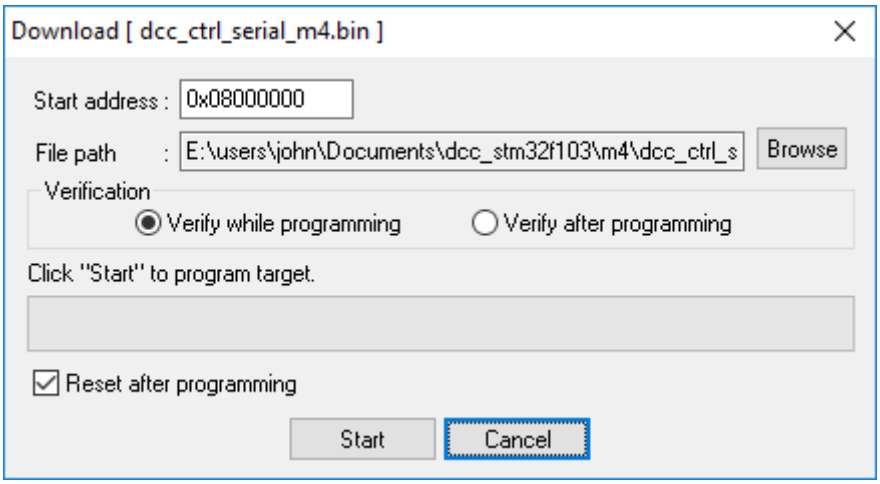
Install the STM V2 Link software, this can be downloaded for free from: http://www.st.com/en/embedded-software/stsw-link004.html.

Connect the F411RE board to a PC using a USB cable.

Use the file menu and open the binary file you require to load. This may be **bt_terminal_m4.bin** if you need to configure a Bluetooth module or any LC-DCC controller file such as **lc_dcc_serial_m4_3p2.bin**, **lc_dcc_serial_m4_6p4_wadc.bin** etc.

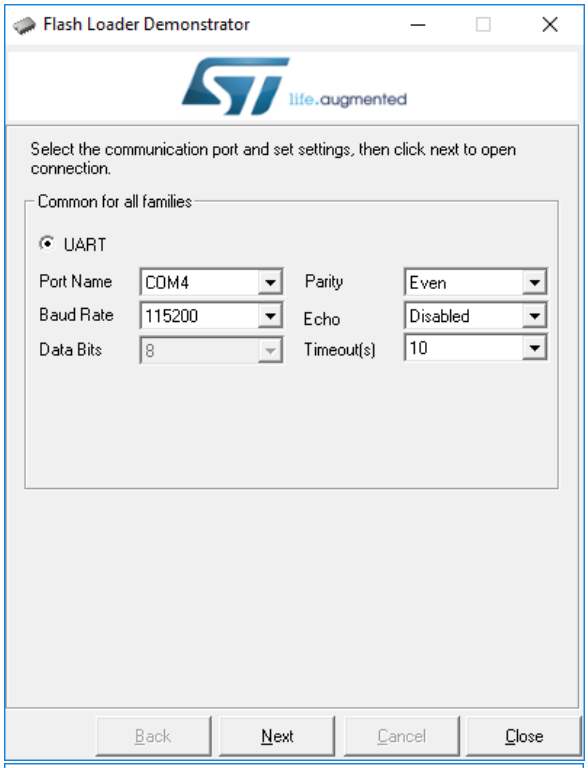


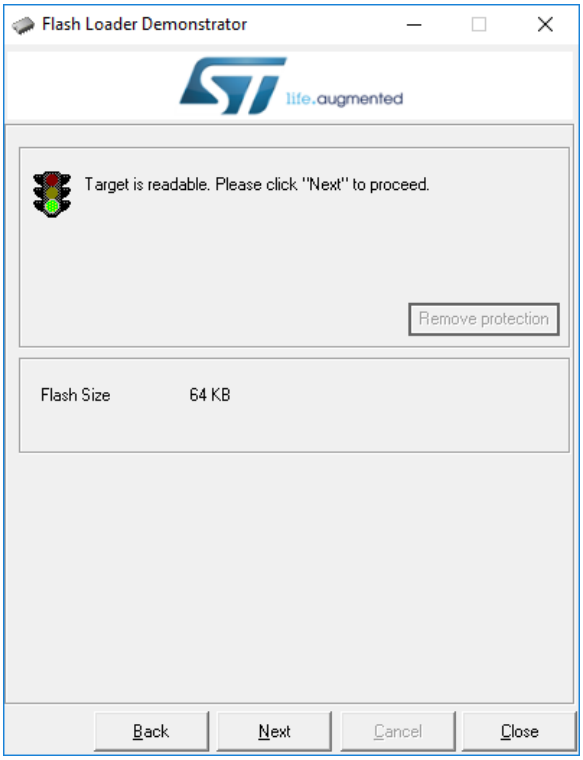
Use the target menu then program and verify (CTRL+P) to program to F411RE flash memory:

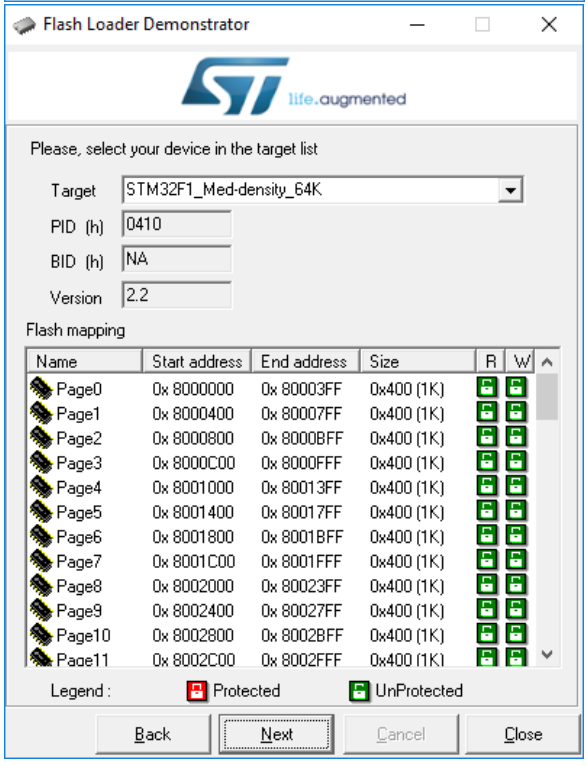


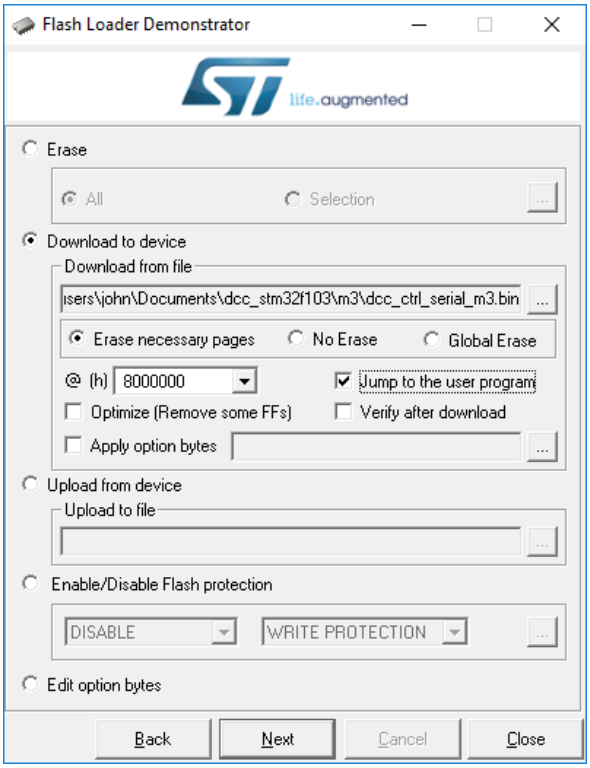
Programming SMT32F103 Arduino Boards

To program STM32F103 boards there are two options, either via the serial interface of USART1 or by using the debug connector and an STM ST-LINK V2 USB adapter. If using the STM ST-LINK V2 USB adapter follow the instructions in the previous section for the STM32F411RE processor. For the serial USART1 option you must download from the STM website the **Flash Loader Demonstrator** Windows application. The programming screens appear as follows:

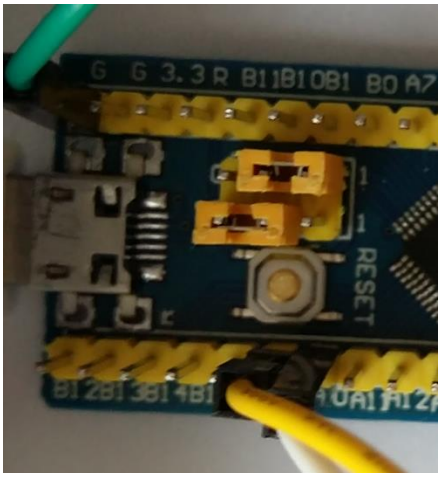








To program the STM32F103 make sure the two boot jumpers near the USB connector are set as shown below:



Connect a FTDI 232 USB serial adapter as shown above on the right to A9 and A10 pins on the STM32F103. Power the STM32F103 from either the FTDI module or from a USB cable connected between a PC and the STM32F103 USB connector. **Note if using the FTDI to power the STM32F103 ensure the correct voltage (jumper on FTDI) is selected and connected to the correct pin on the STM32F103.**

Run the flash loader software on the PC, select the correct COM port for the FTDI USB module. Select the next button three times assuming all is ok (as per the previous page screens).

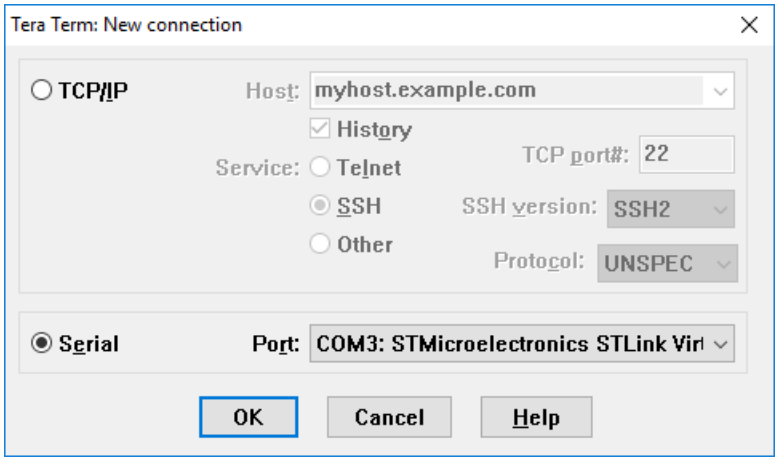
Select **Download to device** and choose which binary file to program. The binary files are different for the blue and black pill and have blue or black in their names: **lc_dcc_serial_m3_black_3p2.bin**, **lc_dcc_serial_m3_blue_3p2_wadc.bin** for example. Once the programming is complete change the boot jumpers so both jumpers are near the USB connector.

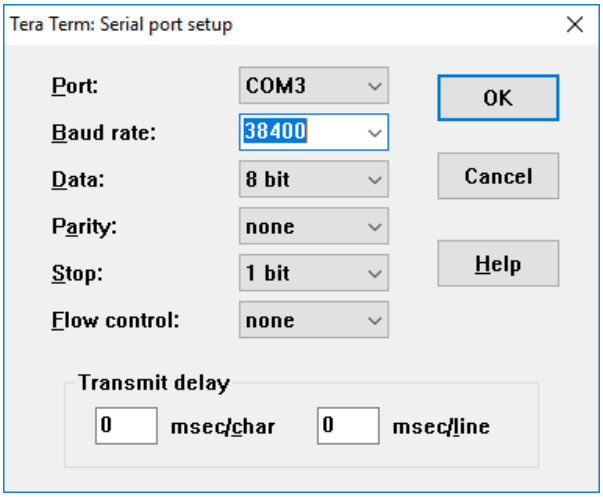
Cycle power on the STM32F103 board and then follow the programming verification section.

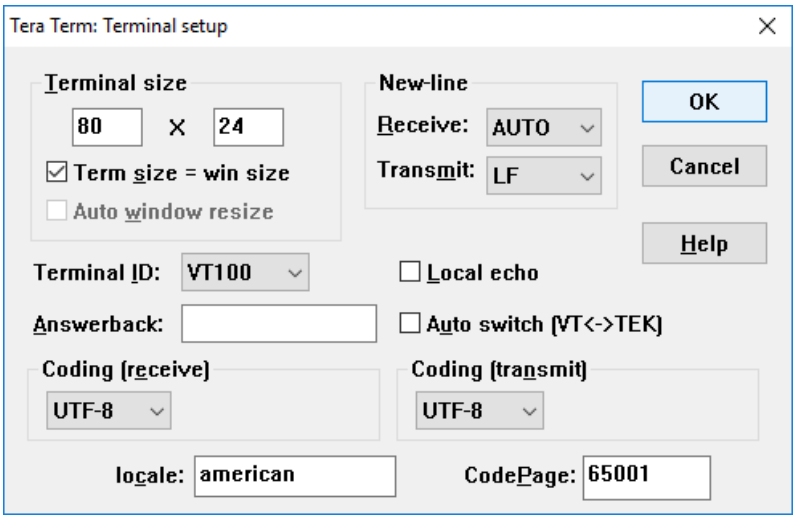
If you want to configure a Bluetooth module then program the **bt_terminal_m3.bin** file which works for both blue and black pill boards.

Programming Verification

Once the board has been programmed and if required the boot jumpers changed (STM32F103) the board LED should flash once a second. To further verify the board has programmed use Tera Term or any other terminal emulator program and connect to the board USB connector using a USB cable. Set Tera Term up as follows:



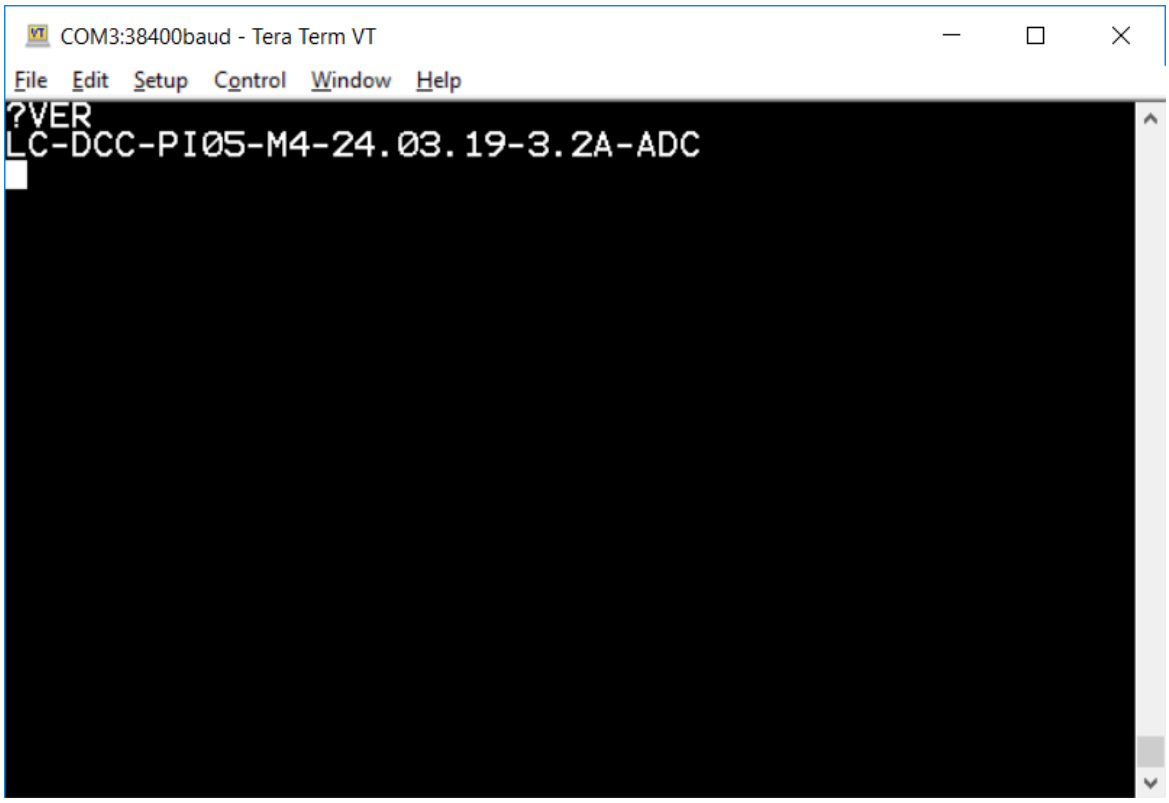




To verify correct operation of the software, use the following instructions on the terminal:

Enter **?VER** to display the software version number

The output should appear as follows on the Tera Term display for an STM32F411RE board with potentiometer control attached:



Similar outputs will appear for the SM32F103 boards. The software build date is indicated by 24.03.19 in the above screen shot. These dates are the same dates as used on the LC-DCC website, it is recommended to always use the latest software.

Windows Application

The Windows application can be downloaded from the website specified at the start of this document. This application does not need to be installed it can be copied and placed on any of the PC drives. The Windows application allows for CV programming (service mode), train/points control and a time table driven mode for trains and points.

The following sections explain the different screens.

Start Screen

When the Windows application is executed the screen appears as follows:

This screen provides the user with buttons to configure the DCC control system, check for software updates on the internet, exit the application and run the different operating modes of the DCC control software.

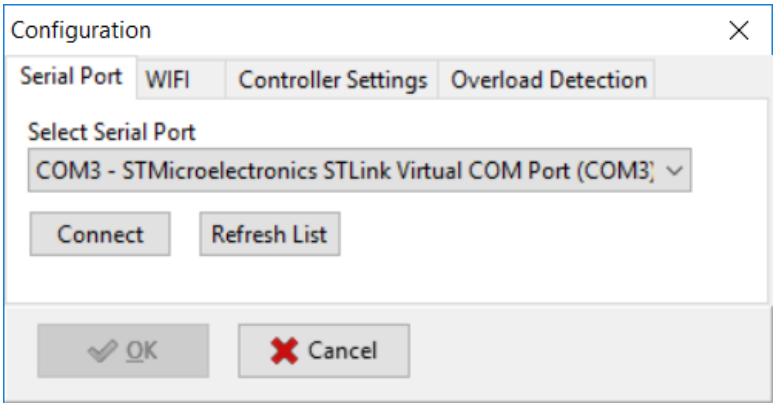
The check updates button will interrogate the www.swws.co.uk website to establish if there is a newer version of the software available. If there is a newer version the user will be informed of the download URL link and the new version number and release date.

The exit button closes the Windows application.

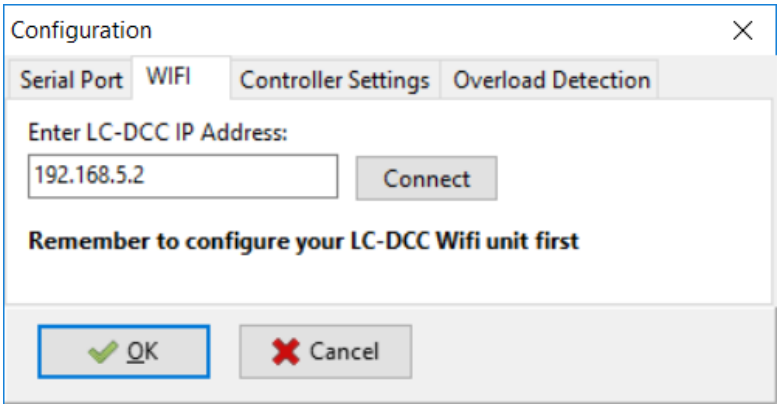
The configuration button displays a configuration window which is explained in the next section.

Configuration Window

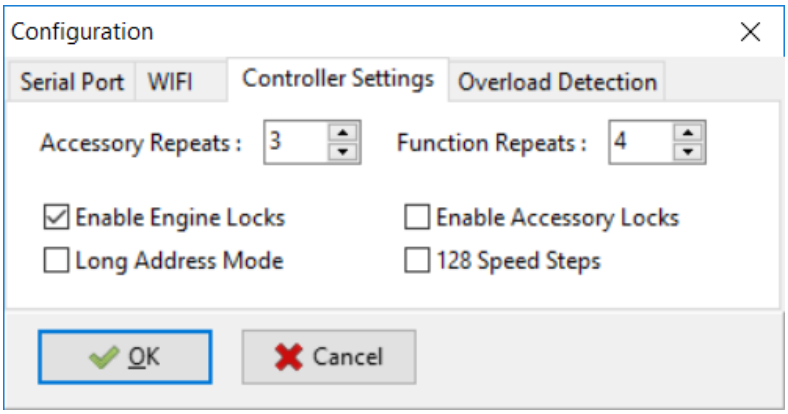
The configuration screen has four pages. The first page allows the user to choose a serial port that is used to communicate commands to the LD-DCC controller:



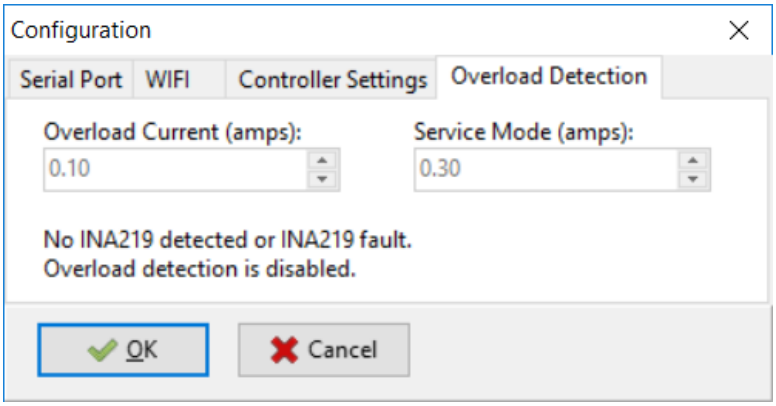
The second page allows the user to connect to an LC-DCC system that supports WIFI connection.



The third page allows for a number of LC-DCC controller configuration options:



The fourth page allows the overload detection configuration:



The controller settings page has the following configuration options:

Accessory Repeats

As DCC is unreliable due mainly to the mechanical pickup on the track and dirt on the track the user can configure the number of times an accessory packet is sent to the decoder. The maximum number of accessory packets that can be sent is 8. The default value is shown above.

Function Repeats

This controls the number of times a function packet is sent to a train decoder. A function repeat value of 255 means that the function command is sent all the time (after the engine speed packet) to the decoder. The default value is shown above.

Enable Engine Locks

This option enables engine locking. This means no two serial interface controls can manage the same engine. If there are multiple users controlling trains then this should be enabled. If you are using a second serial interface for Bluetooth walk about control then you probably want this not enabled.

Enable Accessory Locks

This option enables accessory locking. This means no two serial interface controls can manage the same accessory address. If there are multiple users controlling points or accessories then this should be enabled. If you are using a second serial interface for Bluetooth walk about control then you probably want this not enabled.

Long Address Mode

Long address mode enables 14-bit engine addresses in the LC-DCC controller and all addresses generated by the controller will be 14-bit addresses.

128 Speed Steps

This option sets the LC-DCC controller default speed steps to 128. The speed steps for any engine can be changed from the track control screen to either 28 or 128.

The overload detection page settings are as follows:

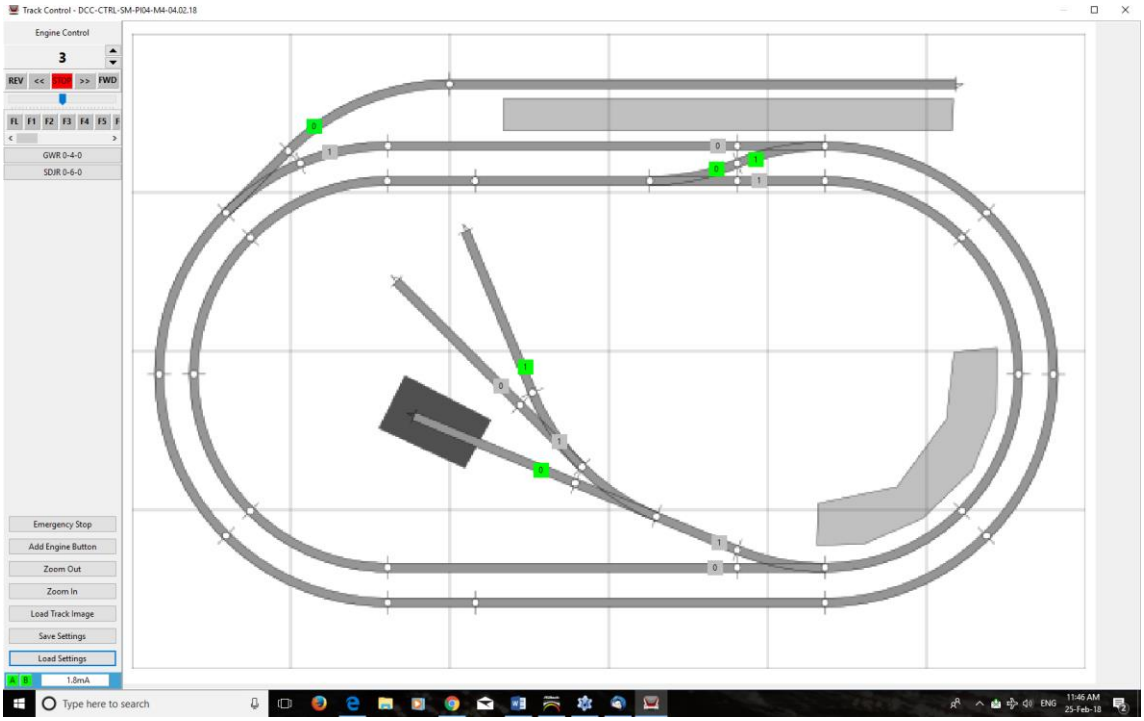
Overload Current

This is the overload detection maximum current allowed during normal train operation. If a current larger than this is detected the LC-DCC controller will remove power from both tracks A and B.

Service Mode Current

This is the overload detection maximum current allowed during service mode operation. If a current larger than this is detected the LC-DCC controller will remove power from both tracks A and B.

Track Control Window



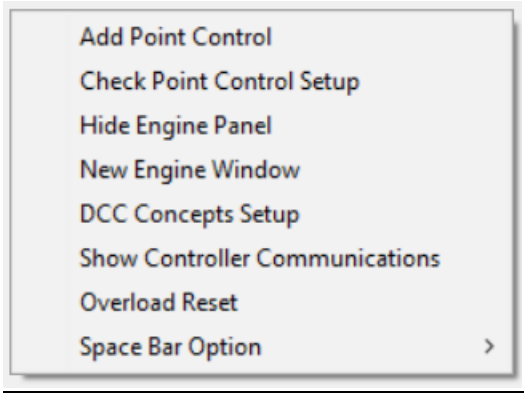
The track control screen allows control of both trains and point/accessory decoders. Each point can have two buttons allocated to it to control point direction. Engine buttons can be added to simplify engine control. Decoder function buttons can be labelled by the user for each engine address and the button on colour for each button can be defined. All configuration values can be saved and reloaded using the save/load settings buttons.

The status of track A and B power is monitored continuously along with the current being used by the layout.

To use this screen an image of the track layout must be loaded using the **Load Track Image** button. This can be in any of the common image formats like .png, .jpg etc.

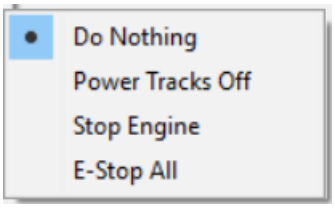
Popup Menu

The popup menu on the layout display allows addition of point control, engine windows, overload reset, space bar configuration and other miscellaneous features such as: hide the left-hand engine panel to maximize the track display, check their point configuration and setup DCC Concepts learning accessories.



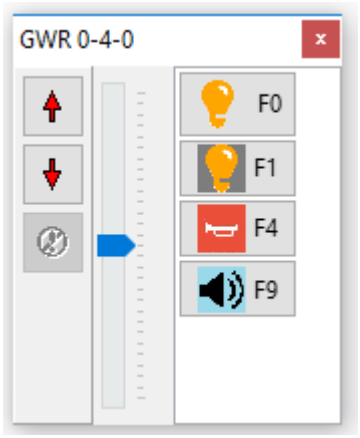
Space Bar Option

The space bar option allows the following action to be performed when the space bar is pressed:

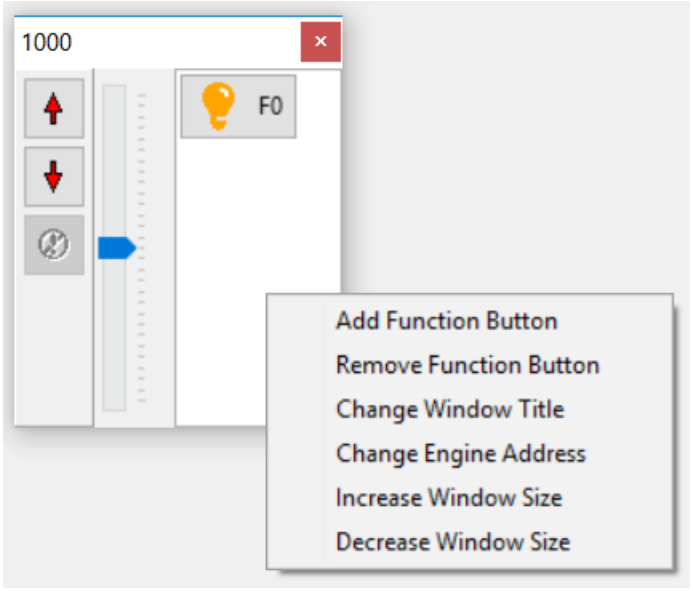


Adding Engine Windows

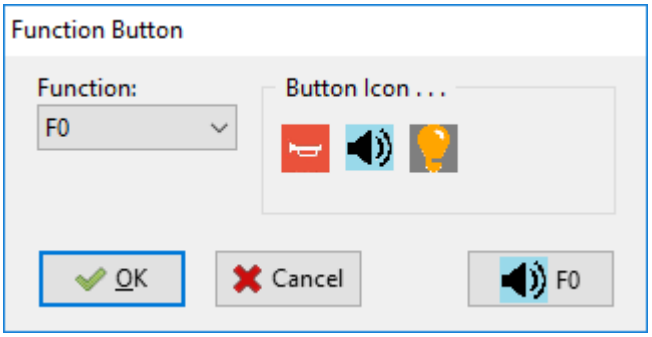
Engine windows can be added using popup menus from either the main track display or via engine buttons from the left-hand panel. An engine form appears as:



New function buttons can be added by using the popup menu accessed via the right mouse click.



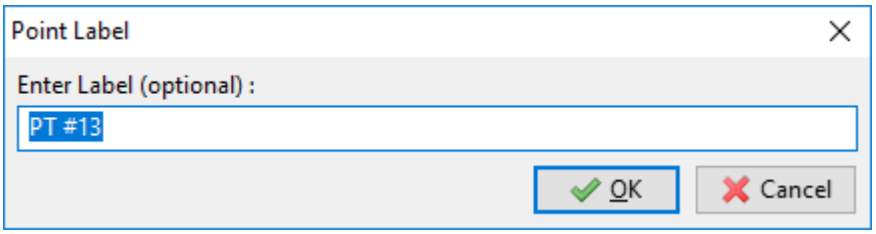
The engine address, window title and window size can also be changed via the popup window. New function buttons are added via the following window:

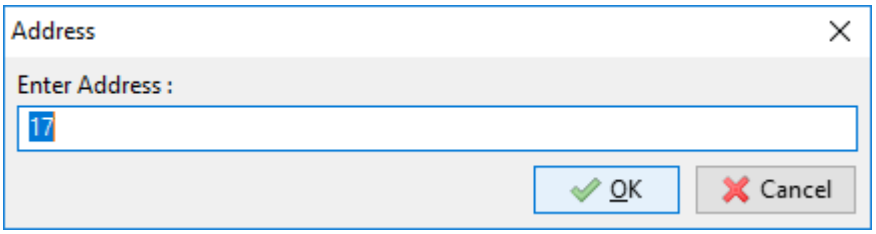


The function F0-F28 are selected from the drop down list and an icon for the new function button is chosen from those displayed. An example of the new button is displayed in the bottom right corner of the window.

Adding Point Direction Buttons

To add point direction buttons, use the right mouse button on the track image and then the popup menu **Add Point Control**, enter a label for the point and an address:





The point control setup can be checked by right clicking on the track image and selecting the **Check Point Control Setup** menu option. This will check addresses are not duplicated and direction values (0 or 1) are not duplicated. Any problems are highlighted red and yellow.

Once a point button has been added it can managed by using the popup menu for the point direction button. This is accessed using a right mouse click on the point direction button.

The popup menu has the following options:

Change Value (Direction)

This option allows the accessory value sent to the DCC unit to be changed, valid values are 0 to 7 inclusive. This value along with the address is used to switch a DCC point decoder when the button is clicked.

Change Address

This allows the DCC address used for the point direction button to be changed. When the point direction button is clicked this address along with the direction value 0 to 7 will be sent to the DCC control unit to control the point decoder.

Move

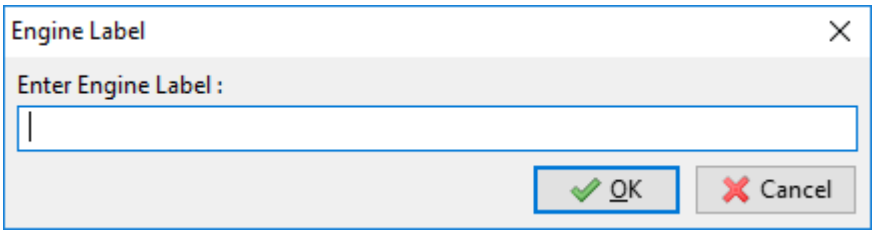
This option will move the point direction button with the mouse until the user clicks on the button or track image with the left mouse button.

Delete

This option allows the point direction button to be deleted.

Adding Engine Buttons

Engine buttons can be added using the **Add Engine** button. The button must have a label:

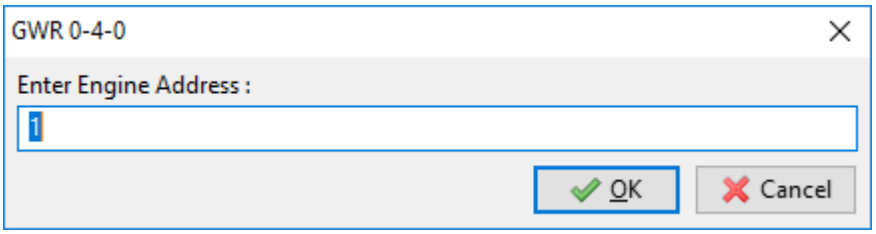


Each engine button has a popup menu accessed by using the right mouse click on the engine button.

The popup menu has the following options:

Change Address

The engine address can be changed using the following dialogue window:



Delete

The engine button can be deleted with this option.

Stop Engine

This option will send a DCC stop command for the engine address.

Engine Control

Apart from the engine buttons there is an engine address field that can be used to select engine address.

Below the engine address field are buttons to control engine speed + or -, engine direction >> or << for forward or reverse and an engine stop button.

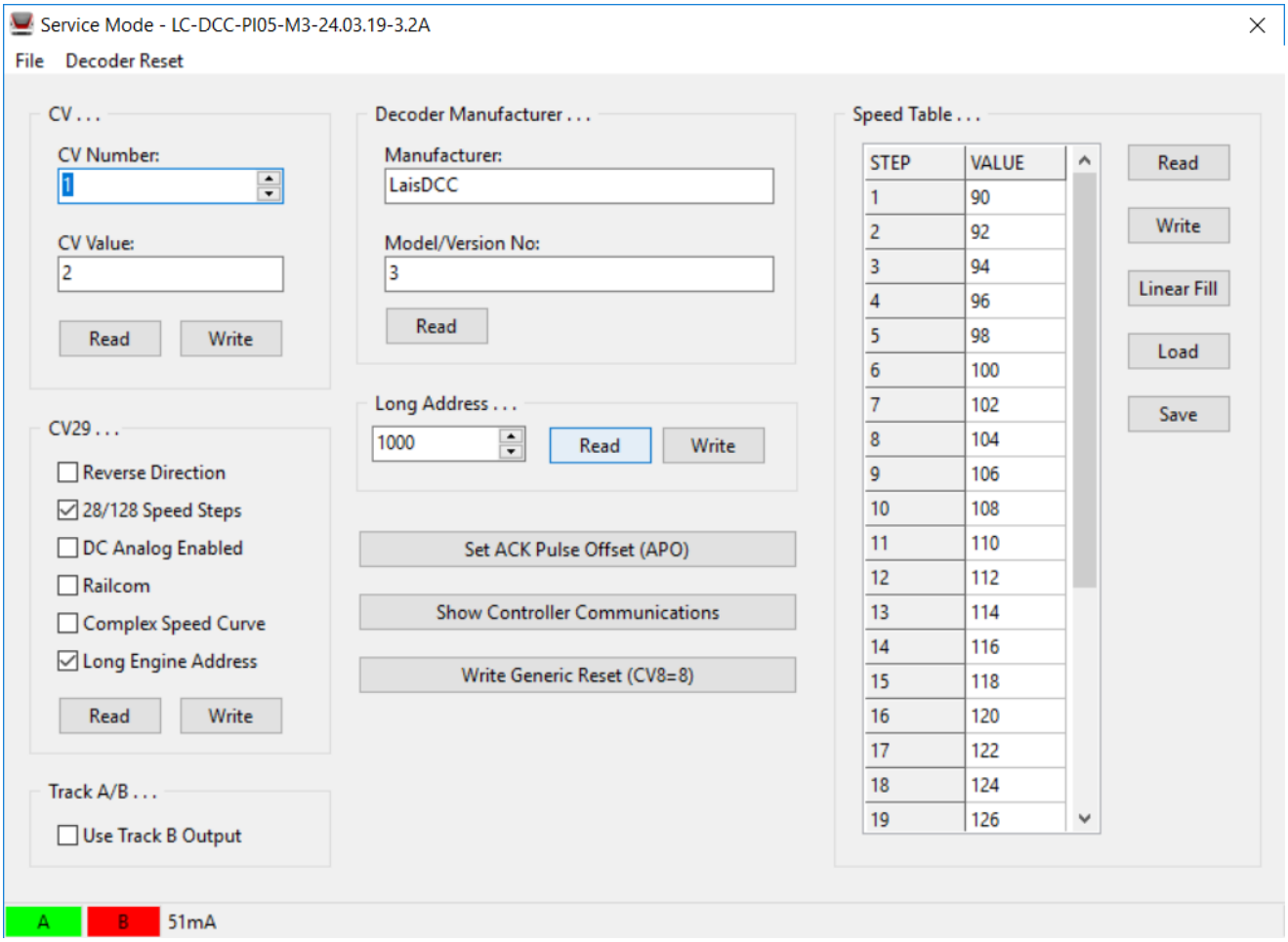
Below these buttons is a scroll bar that can also be used to set engine speed.

Below the speed scroll bar are buttons that allow engine functions to be turned on or off. The buttons currently support the NMRA DCC function group 1 functions F1..F4 and FL (light).

Function Buttons

Each function button has a popup menu accessed by using the right hand mouse button. The popup menu allows the function “on” colour to be changed and the button label to be changed for each engine address. All changes can be saved in the settings file.

Service Mode Window



This screen allows decoder service mode programming of all CVs from 1 to 1024. For special CVs such as CV29, 14-bit engine addresses (long address) or the speed table there are special controls to simplify programming. For all other CVs there is a simple control to read or write individual CV values.

Complete CV settings can be saved and restored using the **File** menu options **Save All CVs To File** and **Load All CVs From File** to store and recall CV settings to/from a file.

The DCC NMRA decoder ACK pulse is detected using the INA219 current monitor. The peak current before any service read is made and recorded and the peak current during the read is recorded. If the peak current increases this is considered to be a decoder acknowledge.

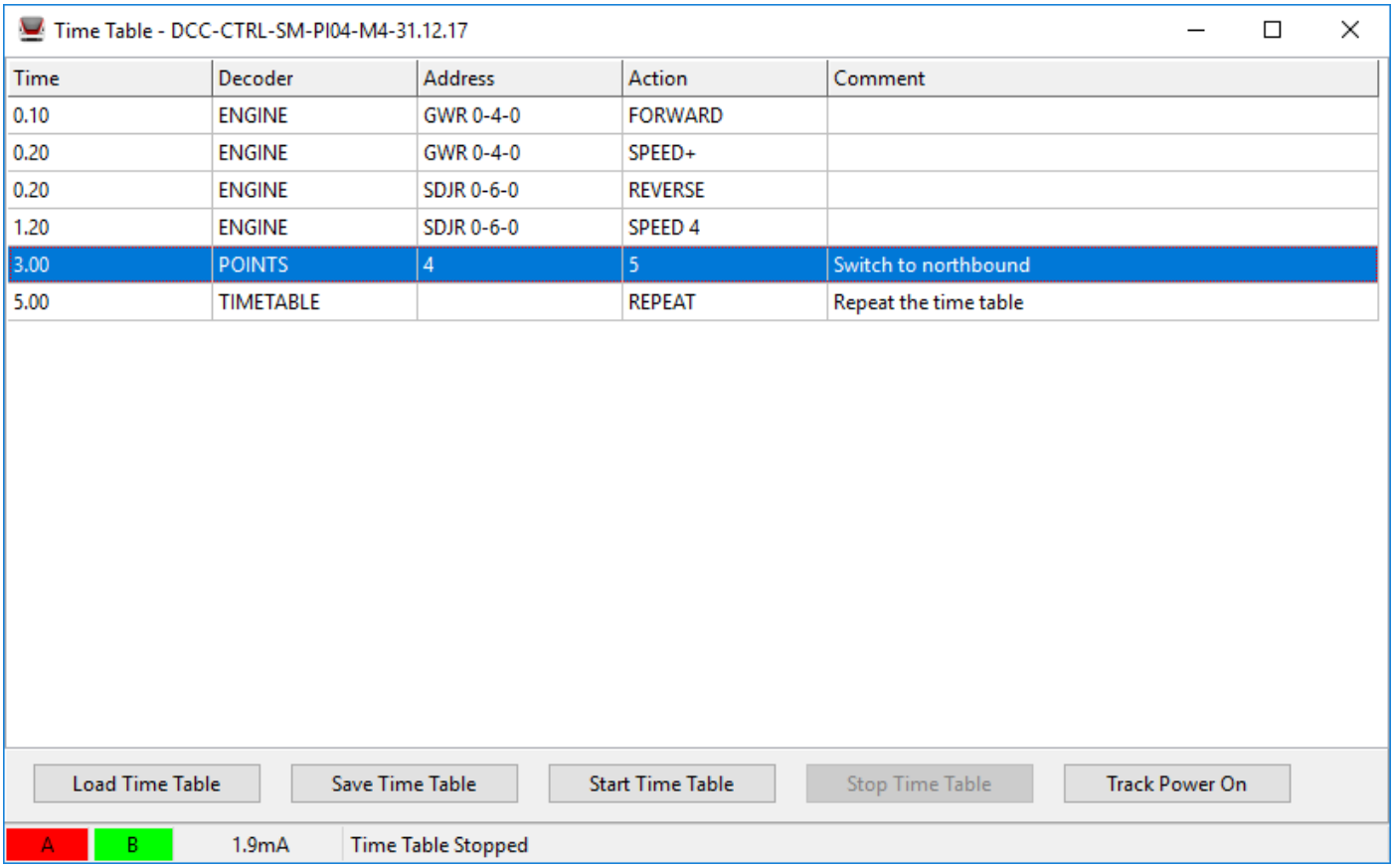
To overcome differences in decoders and noise on the current measurements the increase in current for an acknowledgment may be modified using the APO setting. This adjusts the acknowledgment pulse threshold from 20mA to 80mA (the default is 44mA).

There is also a **Decoder Reset** menu which contains resets for various DCC decoders. A reset can however be achieved by using the CV write facility and following the decoder manufacturers reset instructions.

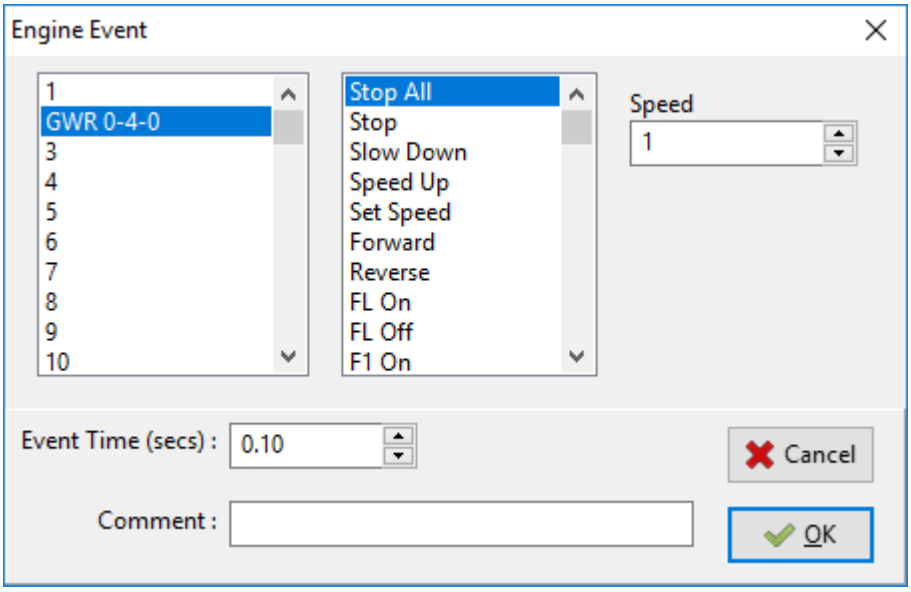
Track power can be turned on and off using the **File** menu options **Track Power Off** and **Track Power On**. A green or red background in the **Track A/B** display shows track power status. To change from using track A or B simply click the **Use Track B Output** checkbox.

Time Table Window

The time table window allows train function and accessory operations to be run from a time table. Engine speed and functions can be set as well as accessory on/off commands. The following is an example screen display of a running time table:

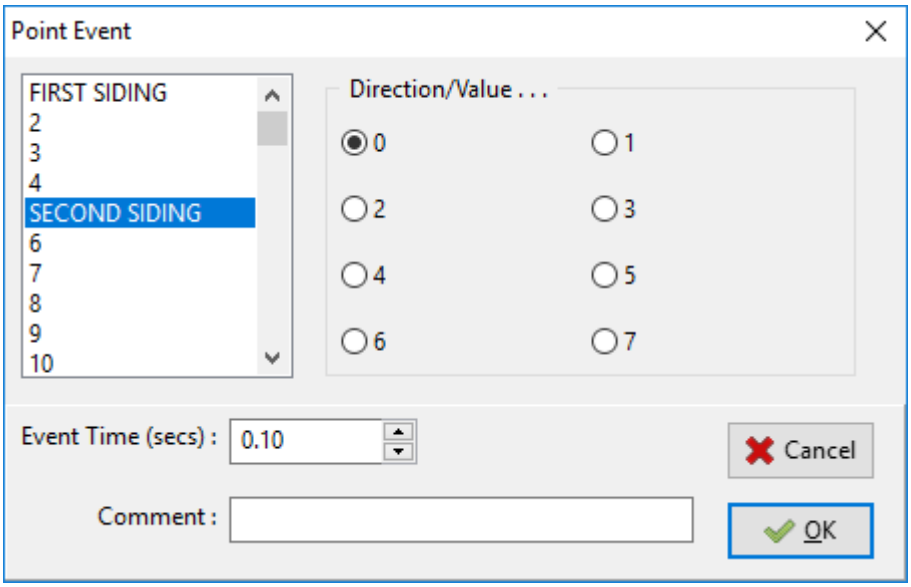


Using the right mouse button, a menu can be accessed that allows adding, editing and deleting of time table events. The engine event form appears as below:



This form can be used to add or edit engine time table events. Engine addresses can be changed to engine names using the right mouse button to access a popup menu.

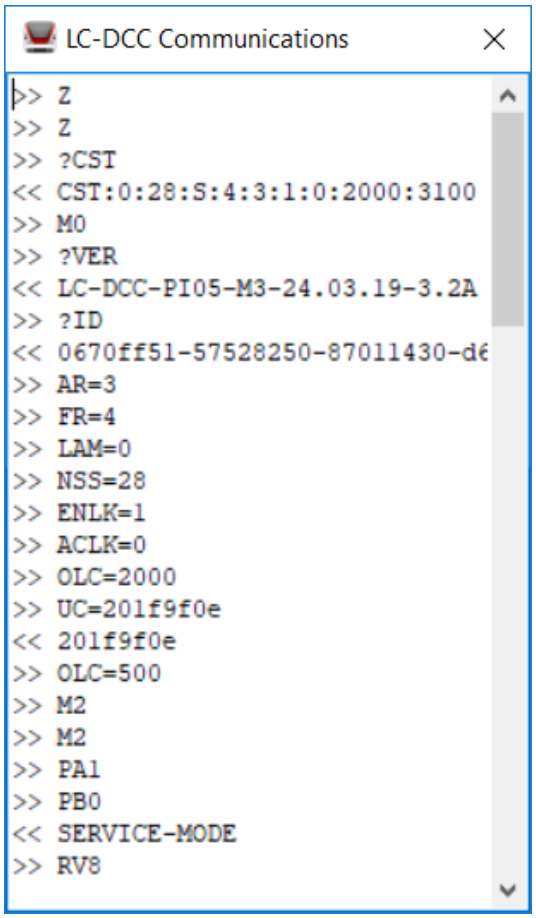
The accessory event form appears as below:



This form can be used to add or edit accessory (point) control events. Accessory addresses can be changed to meaningful names using the right mouse button to access a popup menu. Note any accessory value from 0 to 7 can be selected to be sent to the decoder. This supports all possible accessory modes available under NMRA DCC control.

LC-DCC Controller Communications Window

From most screens the LC-DCC controller communication window can be displayed. It appears as follows:



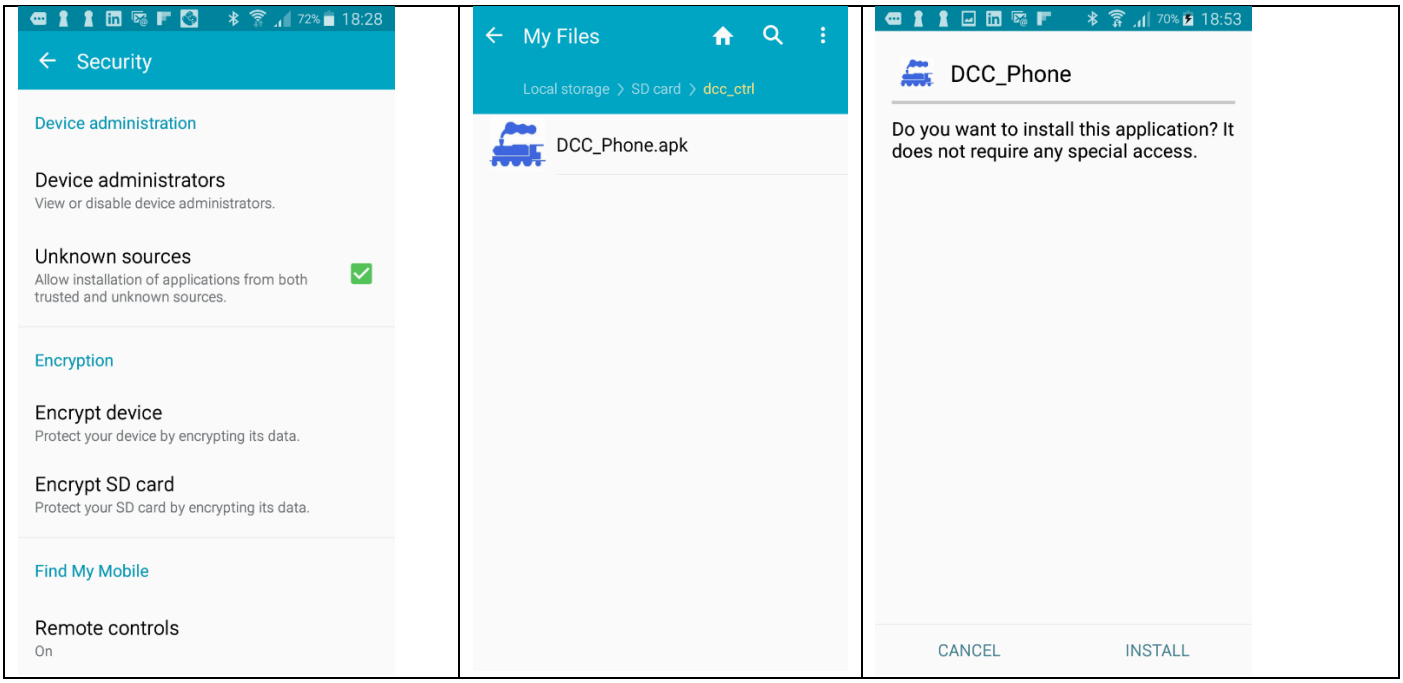
It contains the latest communication commands and responses to and from the LC-DCC controller. If you experience problems with your LC_DCC controller we may ask you to copy this output and Email it to us so we can determine your problem. The output can be copied by using the popup menu accessed by clicking the right mouse button.

Android Application

The Android application is stored in the .zip file as dcc_phone.apk. The application is installed onto the Android device using the following instructions:

Installing Android Application

To allow the software to be installed on the phone, the security setting “unknown sources” must be enabled, see below. The file dcc_phone.apk is then copied to the Android device either by using USB or some other mechanism. The software is installed by running the “My Files” application, locating the dcc_phone.apk file copied to the phone and selecting it then choosing install.

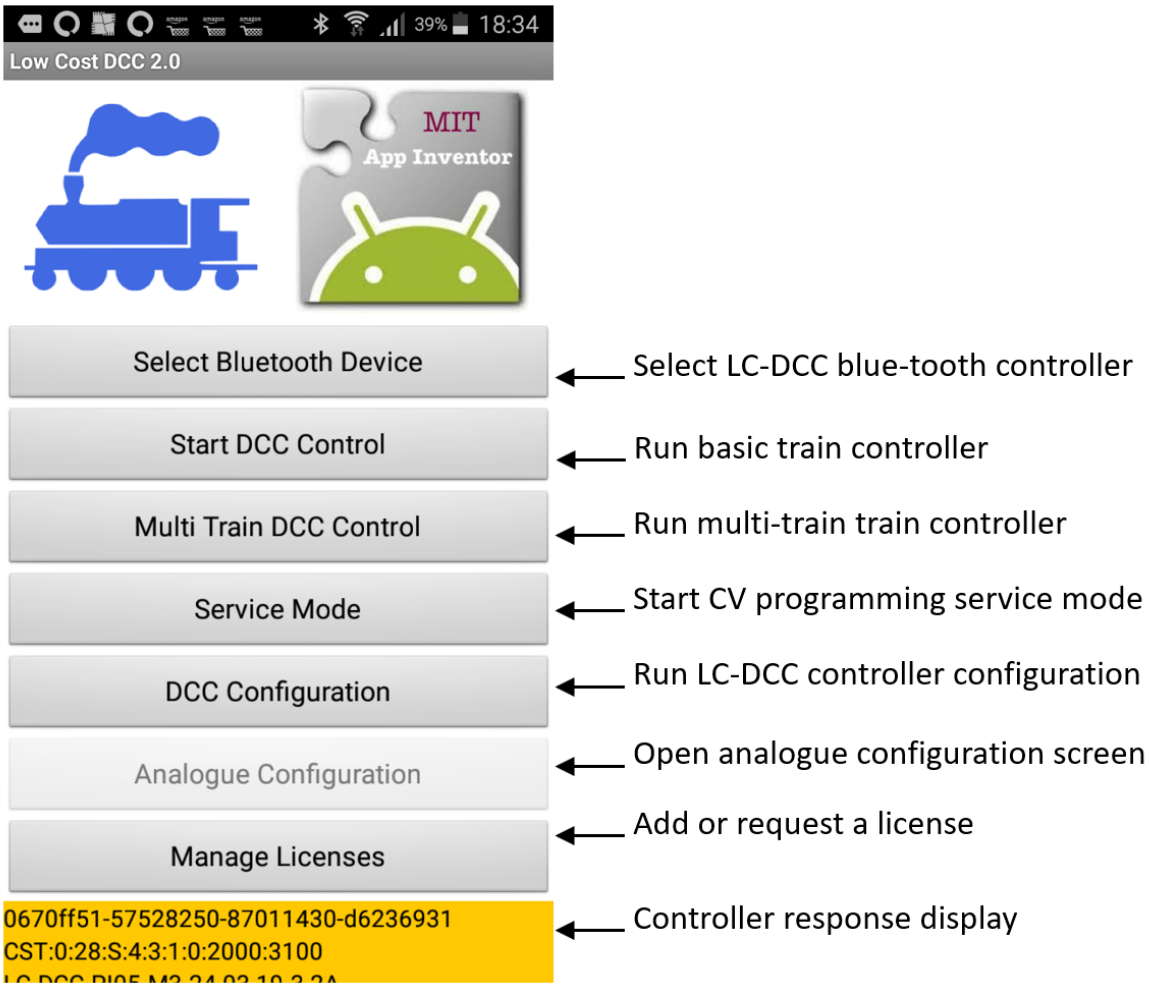


Startup Screen

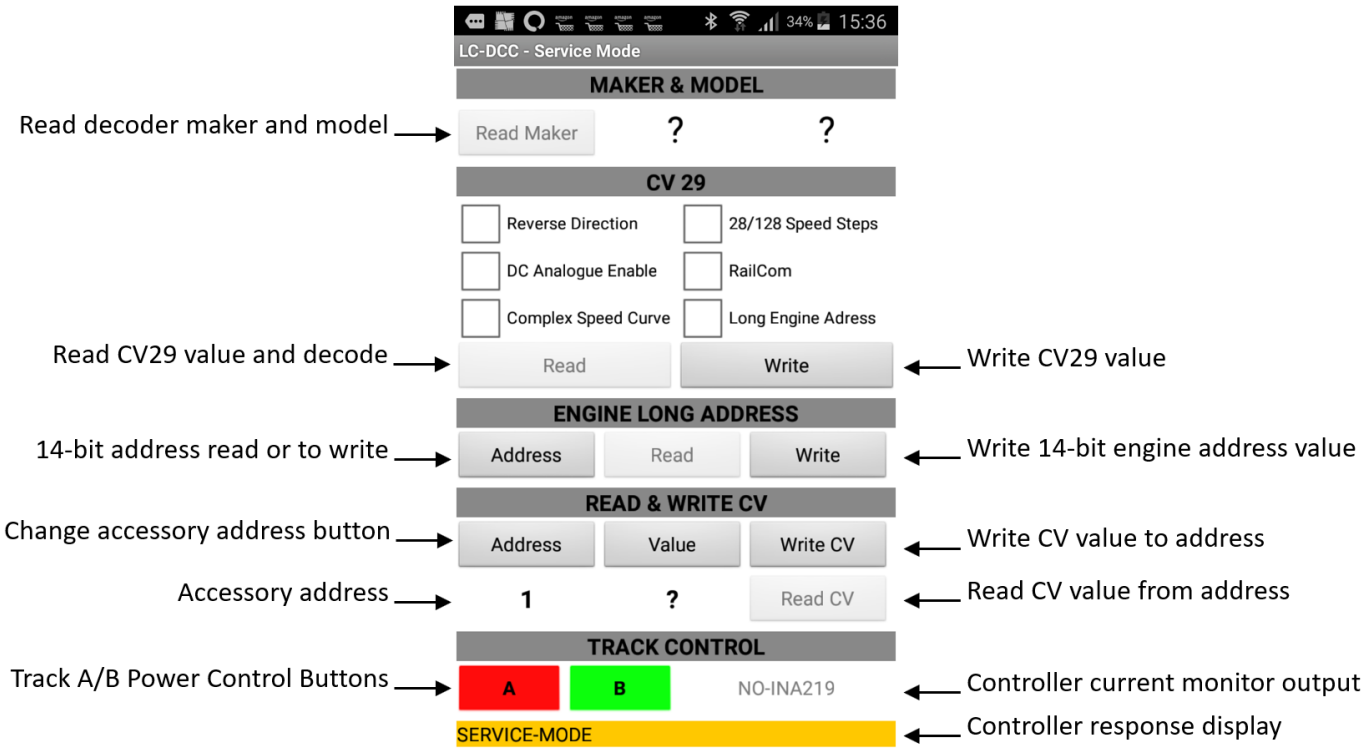
When the Android application is launched the screen shown below is displayed. The user must select a Bluetooth connection by clicking the **Select Bluetooth Device** button and choosing a Bluetooth connection. Once a connection has been chosen the other buttons become enabled and the user can select from the main options:

- Start DCC Control
- Multi Train DCC Control
- Service Mode
- DCC Controller Configuration
- Analogue Control Configuration
- License Configuration/Request

These different screens are explained in the following sections.



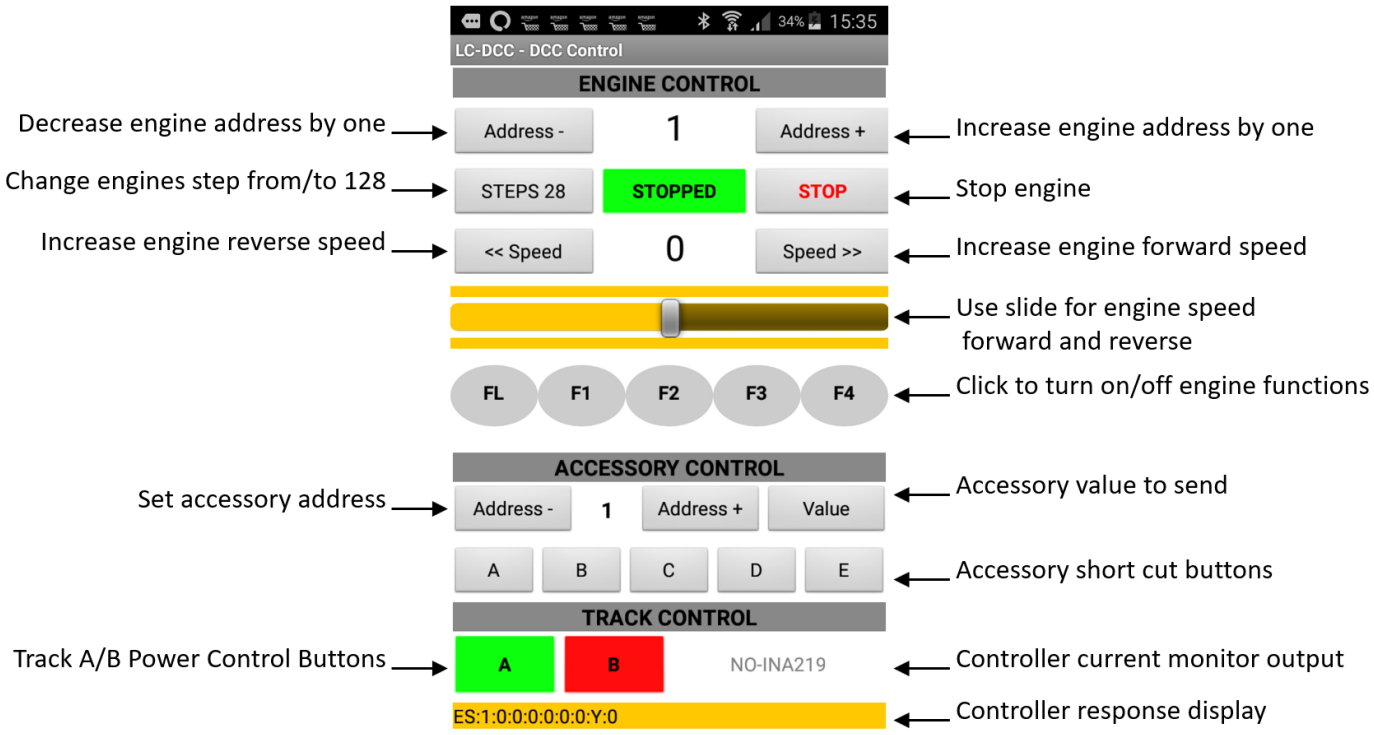
Service Mode Screen



The service mode screen allows programming of decoder CV values. To read the decoder make and model click the **Read Maker** button. To program the CV29 value use the check boxes to set: reverse direction, 28/128 speed steps, analogue enable, railcom, complex speed curve and long engine addresses then click **Write**. To read CV29 click the **Read** button in the CV29 section of the screen. You can also use the **Read CV** and **Write CV** buttons for CV29 by entering the CV address as 29. To change between track A and track B perform a *long button press* on either button **A** or **B**. To read any CV address, select the address by clicking the **Address** button and then click **Read CV**. To Write any CV address, select the address in the address box, select the value by clicking the Value button and then click **Write**. A 14-bit engine address can be read or written by using the **Address** button in the **Engine Long Address** section to set the 14-bit address. The **Read** and **Write** buttons can be used to read or write the 14-bit address to or from CVs 17 and 18.

A *long button press* is when the button is pressed and "held down" for a short period.

DCC Control Screen



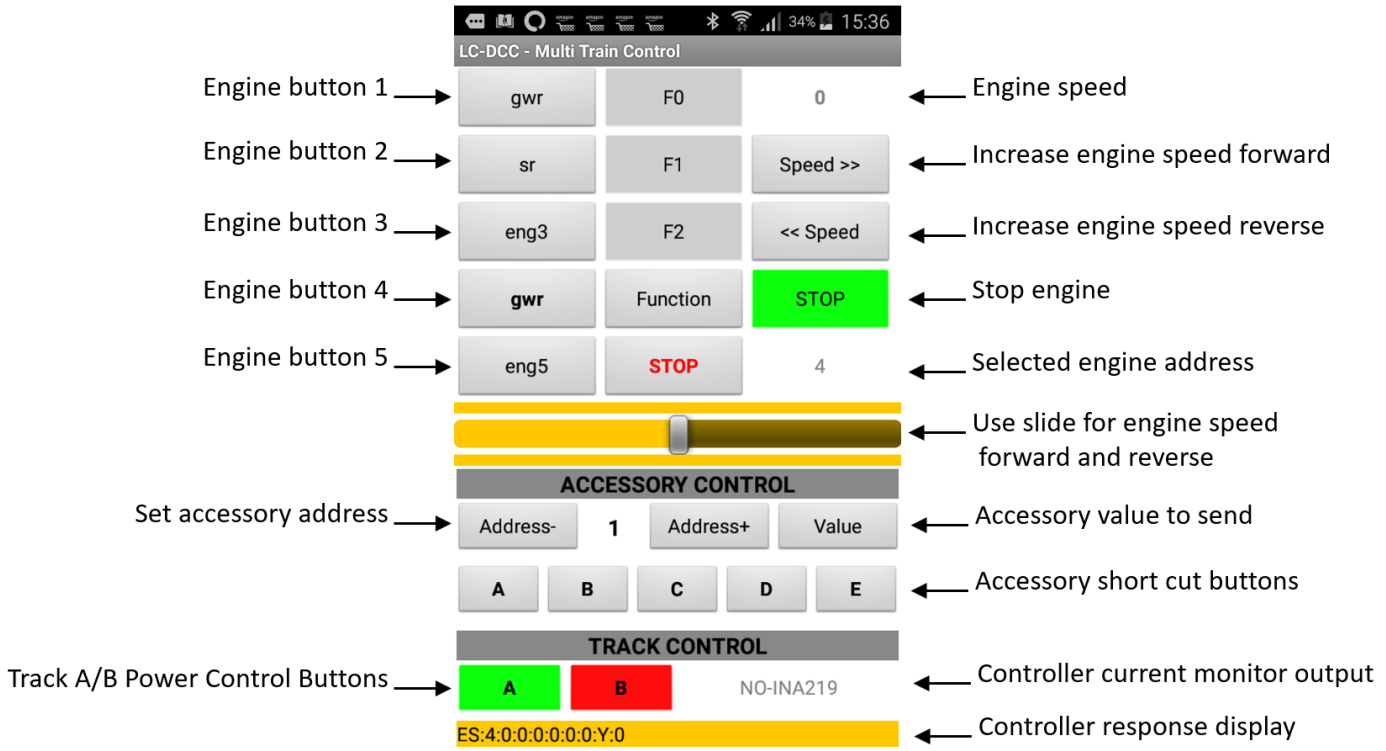
The DCC control screen allows the control of engine decoders and accessory decoders. Use **Address +** and **Address –** buttons to select an engine address. An **X** displayed in the engine speed display indicates that the engine is locked by another user. Once an unlocked engine address is chosen the engine speed will be displayed and the engine control buttons **Forward**, **Reverse**, **Stop**, **Speed >>** and **<< Speed** will become enabled, the engine speed slider will also become enabled. Use the FL (F0) to F28 buttons for the engine decoder functions. These buttons are highlighted light green when a decoder function is activated.

The accessory decoders can be turned on or off by using the **Address –** and **Address +** buttons to select an accessory address and then using the value button to send the accessory value 0 to 7. The address can also be selected by holding down either address button for a few seconds. There are also five accessory buttons **A**, **B**, **C**, **D** and **E**. These can used to set an accessory address and on/off value. Once an address has been set the button displays the address number and pressing the button will turn on/off the accessory at the chosen address. To change an accessory address once set hold the button down for a couple of seconds.

Tracks A and B can be turned on or off by holding down either the **A** or **B** buttons.

If an INA219 is present in the LC-DCC controller then the current in milli-amps being used by the controller will be displayed next to the **B** button.

Multi Train DCC Control Screen



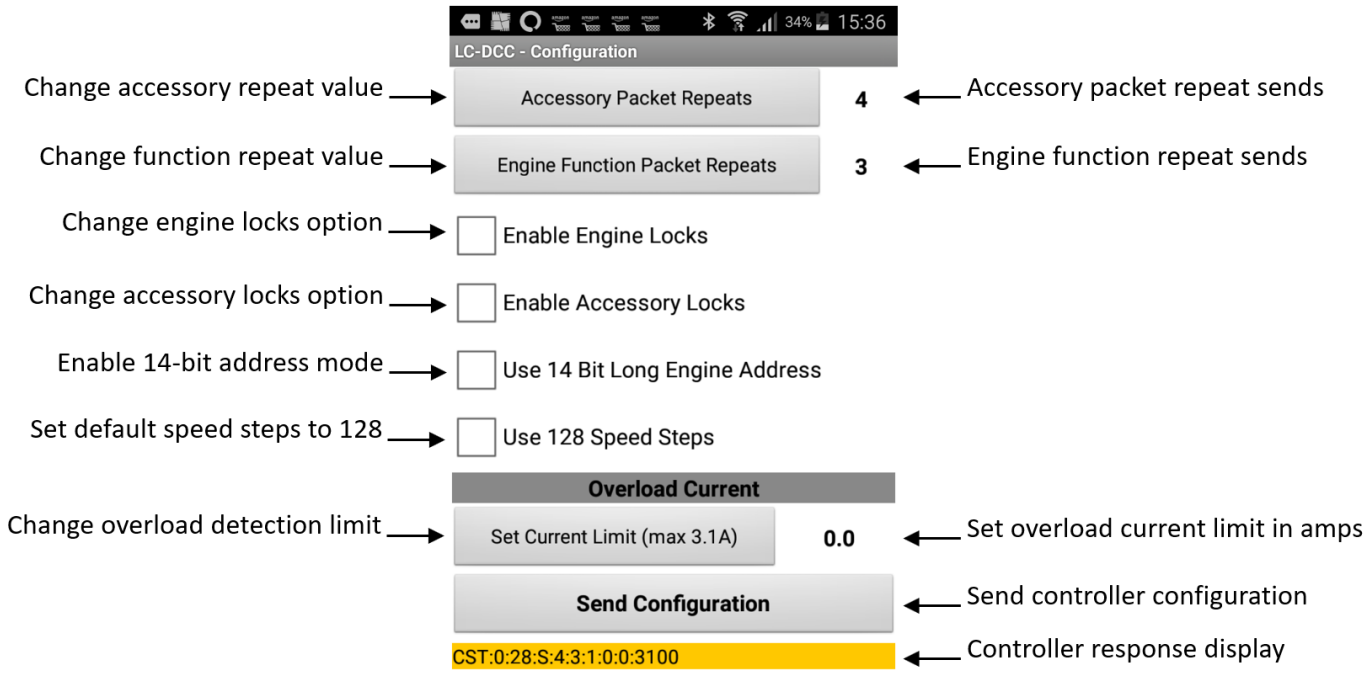
The multi train control screen allows the user to control up to five engines using engine buttons on the screen. Each engine address and button text are set by long clicking the engine button. When the engine button is clicked the engine address for that button will be selected in the LC-DCC controller and the address will also be displayed on the screen.

If an engine is already in use by another user then the engine speed display will show an **X** and no buttons will be enabled.

The accessory decoders can be programmed by using the **Address –** and **Address +** buttons to select an accessory address and then using the **Value** button to select a value to send to the decoder. There are also five accessory buttons **A**, **B**, **C**, **D** and **E**. These can be used to set an accessory address and value. Once an address has been set pressing the button will turn on/off (send accessory value 0/1 or 2/3 or 4/5 or 6/7) the accessory at the chosen address. To change an accessory address once set hold the button down for a couple of seconds.

The track power can be controlled by using long clicks on the track **A** and track **B** buttons. The current being used is also displayed under the track control section if an INA219 is present in the LC-DCC controller.

Configuration Screen



The configuration screen is used to configure:

Accessory Packet Repeats – The number of times an accessory packet is sent to an accessory decoder

Engine Function Packet Repeats – The number of times a function packet is sent to an engine (255=continuous)

Enable Engine Locks – When there are multiple users, lock an engine to a user

Enable Accessory Locks – When there are multiple users, lock and accessory to a user

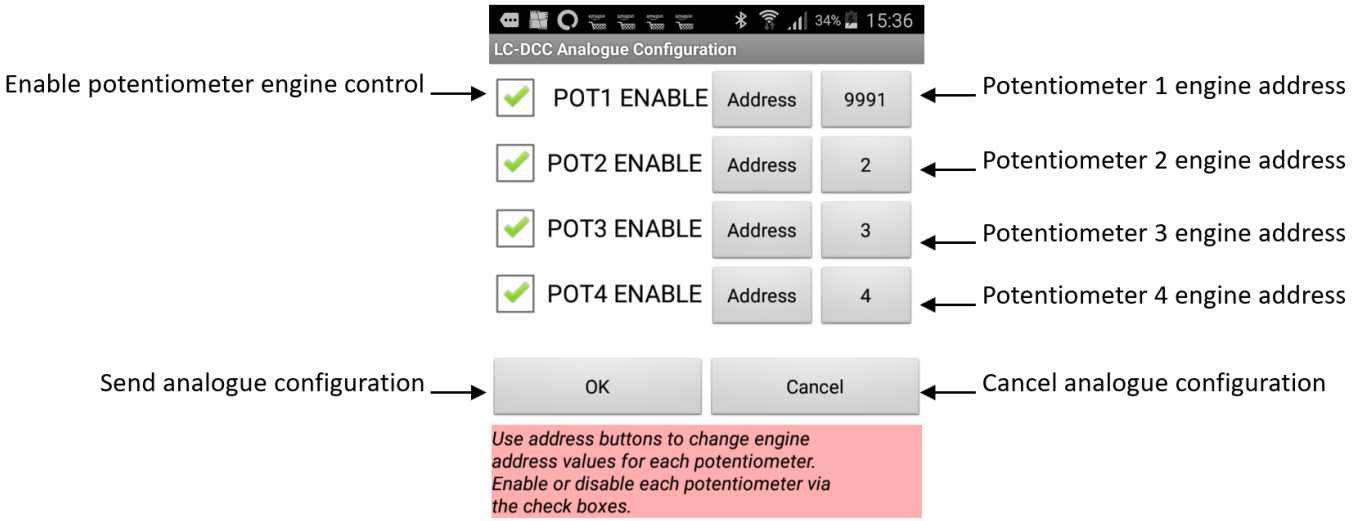
Use 14 Bit Long Engine Address – This enables use of long engine addresses from 1 to 9999

Use 128 Speed Steps – This sets the default engine speed steps to 128 if checked otherwise 28

Set Current Limit – Allows the user to change the default current overload detection limit

Once the settings have been configured use the **Send Configuration** button to send the settings to the LC-DCC controller.

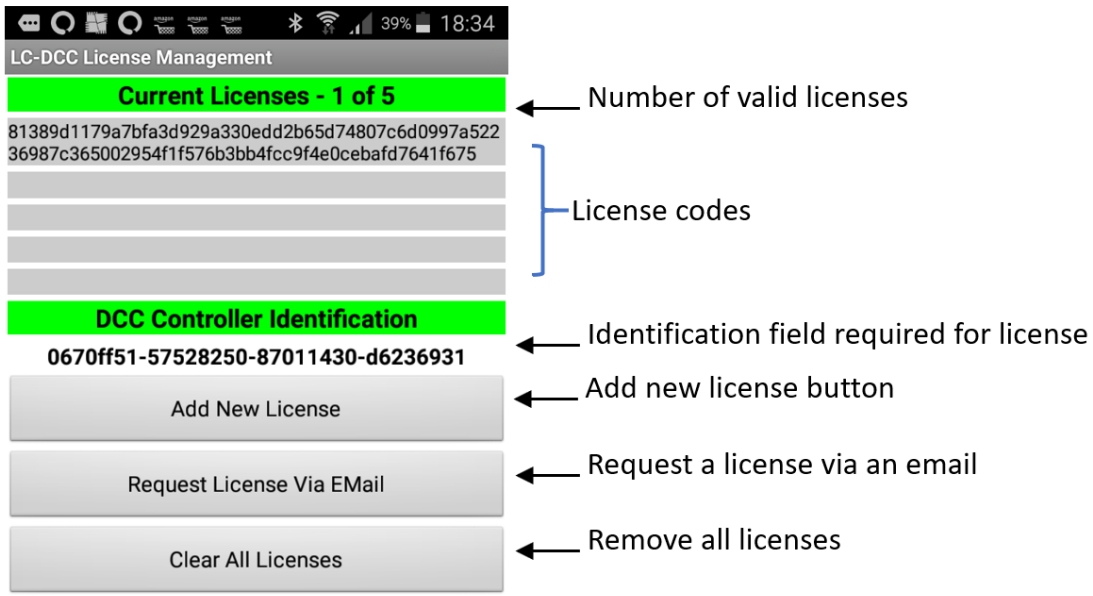
Analogue Configuration Screen



This screen allows the user to configure the four potentiometers used for analogue control if an ADC card if fitted to the LC-DCC controller. Each potentiometer can be enabled or disabled using the **ENABLE** check box. The engine address controlled by each potentiometer can be assigned by clicking the **address** buttons. The analogue configuration is sent to the LC-DCC controller once the **OK** button is clicked.

License Management Screen

The license management screen below allows for the configuration of licenses to use with the LC-DCC controller. Each LC-DCC controller needs a different license. If you require multiple licenses contact sales@swws.co.uk for bulk discount.



The LC-DCC controller identification is displayed in the middle of the screen. This must be supplied to support@swws.co.uk to obtain a license code. Up to five license codes are currently support in the Android application which allows connection to up to five different LC-DCC controllers. The license can be emailed to support@swws.co.uk by clicking the **Request License Via Email** button.

Version Change History

April 2019

Initial version.