Loco Controller 'Quick Start' guide

Introduction

This guide gives a quick overview of choosing a battery, installation of the Loco Controller in Dapol and non Dapol models and the operation of the default firmware. There is more detail in the User Notes and other documentation.

> Please read Appendix 1 of the User Notes for more information on battery care and safety.

Battery Selection

Since the choice of battery is dependent on the particulars of the installation a battery is not provided with the unit.
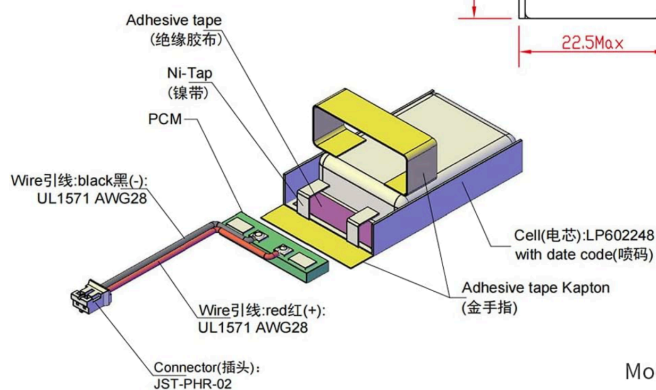
The controller is designed to work only with a 1S Lithium-Polymer (Li-Po) cell with a 2 mm JST-style connector.

> "WARNING – Battery fire or injury. If the battery cannot supply 1 A continuous or lacks internal protection, it can overheat, ignite, or fail. Use a protected 1S Li-Po rated ≥1 A continuous from a reputable manufacturer."
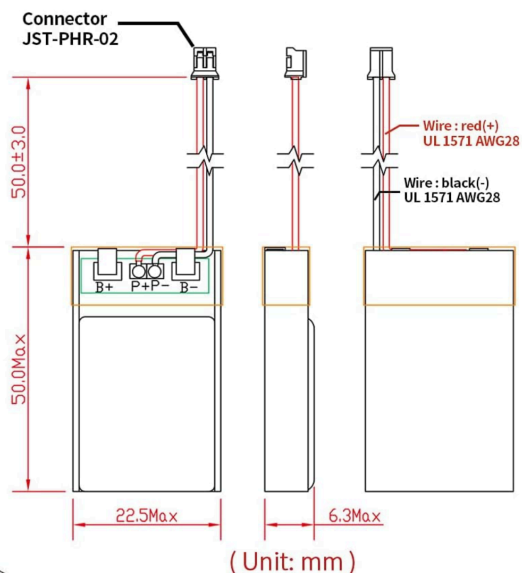
An example of a suitable battery is the LP602248 from EEMB.

LP602248

UL 1642 for Cell · UN38.3

- Typical Capacity: 620 mAh
- Nominal Voltage: 3.7 V
- Weight: 12g
- BMS Overcharge Voltage: 4.28±0.05 V
- BMS Overdischarge Voltage: 3.0±0.1 V
- Max Charge Current: 620 mA
- Max Loading Current (peak value): 2A
- Max Loading Current (constant): 1A
- Charge Temperature: 0 ~ 45 ℃
- Discharge Temperature: -20 ~ +60 ℃
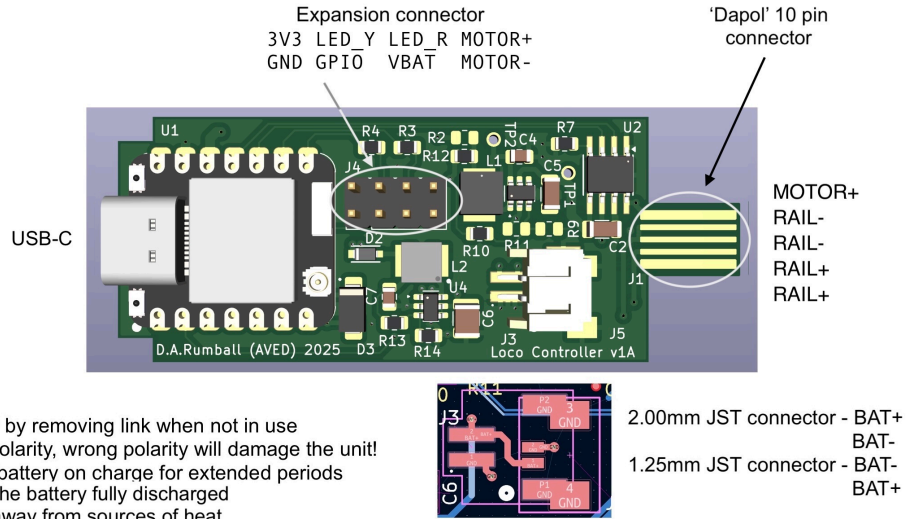- Battery Protection Circuit （PCM）included

Connector JST-PHR-02

50.0±3.0

50.0Max

22.5Max

6.3Max

(Unit: mm)

Wire : red(+) UL 1571 AWG28
Wire : black(-) UL 1571 AWG28

B+ P+P– B–

Adhesive tape (绝缘胶布)
Ni-Tap (镍带)
PCM
Wire引线:black黑(-): UL1571 AWG28
Wire引线:red红(+): UL1571 AWG28
Connector(插头): JST-PHR-02
Cell(电芯):LP602248 with date code(喷码)
Adhesive tape Kapton (金手指)
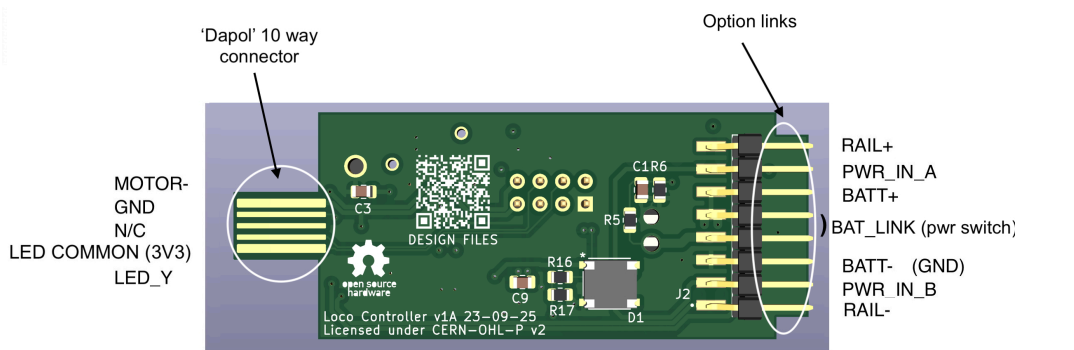
Model#:A21371-LP602248-PCM-LD-

Connections

The PCB has five main connectors, a USB-C socket that can be used for charging and loading firmware, the Li-Po battery connector, an 'edge' style connector that plugs into a Dapol locomotive's 10 pin internal socket, a set of 2.54 mm header pins under the front of the PCB with options for powering the device and a 2.54 mm header auxiliary connector that provides access to internal power, motor, LED and servo drive in models that don't use the Dapol connector.
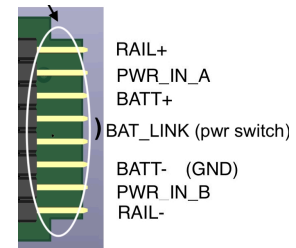

Expansion connector
3V3 LED_Y LED_R MOTOR+
GND GPIO VBAT MOTOR-

'Dapol' 10 pin connector

USB-C

MOTOR+
RAIL-
RAIL-
RAIL+
RAIL+

Notes:
• Isolate battery by removing link when not in use
• Note battery polarity, wrong polarity will damage the unit!
• Avoid leaving battery on charge for extended periods
• Avoid leaving the battery fully discharged
• Keep battery away from sources of heat

2.00mm JST connector - BAT+
BAT-
1.25mm JST connector - BAT-
BAT+

The battery is connected via a standard JST-style 2mm connector.

> CAUTION — Equipment damage. The PCB has no reverse-polarity protection. Confirm battery polarity before you connect the battery.

The battery negative is connected to GND on the PCB and the connection diagram above shows the polarity of the battery connector.

'Dapol' 10 way connector

Option links

MOTOR-
GND
N/C
LED COMMON (3V3)
LED_Y

RAIL+
PWR_IN_A
BATT+
BAT_LINK (pwr switch)
BATT- (GND)
PWR_IN_B
RAIL-

RAIL+
PWR_IN_A
BATT+
BAT_LINK (pwr switch)
BATT- (GND)
PWR_IN_B
RAIL-

The links at the front of the PCB allow for the isolation of the battery which can be used as a power switch (or alternatively used for connecting an external switch) and provide for the isolation of external track power by removing the two outer links. When these links are removed the battery can still be charged via the USB-C connector and external power can be supplied through the front header pins.

Status LEDs

There are two LEDs on the ESP32 module which are visible from the front if the smokebox door is open. Viewed from the front on the left hand side is a yellow flashing LED that indicates normal operation of the firmware and on the right hand side is a red LED that indicates charging status :-

- When no battery is connected:

    - The red light turns on when the Type-C cable is connected and turns off after 30 seconds.

- When a battery is connected and the Type-C cable is plugged in for charging:

    - The red light flashes.

- When the battery is fully charged via the Type-C connection:

    - The red light turns off.

Battery Charging

The controller has an on board charger which provides a maximum battery charge current of approximately 100 mA, a limit set for thermal dissipation reasons in the charger and to provide safe charging for low capacity cells. The charger is designed for Li-Po cells with high-precision linear constant-current and constant-voltage charging. It can automatically complete the processes of pre-charge, fast-charge, trickle floating charge, voltage fold-back holding, resistive voltage drop compensation and recharge. For more information please see the SGM40567 data sheet included as part of the documentation.

The supply for the charger can be either via the USB-C connector (500 mA @ 5 V) or via the connections for external power. External power can be between 12 V and 50 VDC, is protected from inductive spikes above 54 V and is insensitive to polarity. The current draw will depend on the applied voltage. The buck regulator used in the power conditioning stage has a maximum input voltage of 70 V which is well above the TVS clipping voltage of approx 55 V.

The controller can switch seamlessly between internal battery power and external charging without operator intervention. Do not apply external power and USB power at the same time.

With the current firmware the firebox LEDs of the 58XX and B4 locomotives will illuminate if external charging power is detected providing an easy way to check on charging status from outside the locomotive. Additionally the User Interface (UI) will show a 'charging' indicator although note that this is an indicator of external power rather than the actual charging status. However the battery voltage can be used to estimate the actual state of charge.

Battery Care

Please read Appendix 1 of the User Notes for more information on battery care and safety.

For long life, do not store Li-Po batteries fully charged or fully discharged. Store at about 50% state of charge (3.8 V)." Always isolate the battery after use either with an external power switch or by the battery link at the front of the PCB to avoid the Microcontroller Unit (MCU) completely draining the battery.

Although in normal operation the battery should not itself get hot, care should be taken in the location of the battery to keep it away from any heat sources. On the controller PCB these are located on the top side but as heat sinking is provided by the inner layers of the PCB the controller can become warm with use.

Care should also be taken to avoid compressing or bending the battery during installation as this will damage the cell.

Check your batteries regularly for any signs of damage, leakage or swelling of the cell. If you notice any issues then the battery should be disposed of safely. Do not dispose in your normal waste but rather take it to a recycling centre for safe disposal.

Installation in Dapol models with the internal 10 pin connector

   This installation method has been tested with the current versions of the Dapol 14/58XX and B4 models which are fitted with a 10 way card edge connector. There may be other compatible models in the future but you should check that the connector pin out is the same before installation.

   The installation process itself is simple. First open the smokebox door and remove the factory fitted DCC decoder carrier PCB then replace this with the loco controller and battery. Check that the PCB slides in without any force required, the battery is a loose fit and clear of the underneath of the controller PCB and the battery or it's connecting wire aren't fouling any parts of the locomotive. Check that the links are set as desired and the 'alive' yellow LED is flashing.

That's it! You can now connect to the controller's WiFi access point as described in the 'Operation' section below.

Installation in other models

   As the installation in other locomotives will be varied it's not possible to give exact instructions but instead here are some general hints and tips:-

- If not using the 'Dapol' connector insulate it with a wrap of tape or heat shrink.

- All the required signals and power for a typical installation should be available on the link and expansion header pins.

- ALWAYS arrange for the battery to be isolated via a power switch connected to the battery link pins.

- If there are metal parts in the vicinity of the controller it may be necessary to insulate the bottom of the PCB.

- The controller should not get hot during normal operation but air should be allowed to circulate around the PCB to remove any generated heat.

- Take great care with positioning and installation of the battery, it should not be exposed to any sources of heat or subjected to mechanical bending or pressure.

Operation

       The default firmware that is shipped with the controller gives a semi realistic set of controls implementing a very simple (and not quite correct) 'physics' model that simulates the characteristics of a steam locomotive including momentum and friction etc.

       The firmware instantiates a 2.4 GHz Wi-Fi access point capable of supporting four simultaneous connections together with a simple Web server appearing on port 80. This server provides a page defined by files stored in the ESP32's flash based file system.

       To use the controller connect your device's Wi-Fi to the locomotives AP, which defaults to 'LocoController'. Once connected open a browser and navigate to the IP address 192.168.4.1 then a page of controls will appear in the browser

       The current interface offers three sliders which provide a simple emulation of a steam locomotive's controls. To startup set the Reverser to 50% and with the brake off advance the regulator to about 33% and after a short delay the locomotive should move. The firmware implements a very simple 'physics' model that takes account of momentum and friction such that if the regulator is shut off the locomotive will coast, gradually slowing down. Applying the brake will increase friction thus increasing the rate of slowing. To reverse repeat the above but set the reverser to -50%

       To emulate a traditional 'direct' controller first set the regulator to 100% after which the reverser will act as an analogue control directly setting the locomotive speed.

As an aid to judging the charge state of the battery the battery voltage is displayed. Empty corresponds to approx 3.5 V and full 4.1 V. When track power is detected then the battery voltage will be prepended with a 'charging' message. Note that this is a proxy for the battery charging state as it isn't directly possible to sense charging.