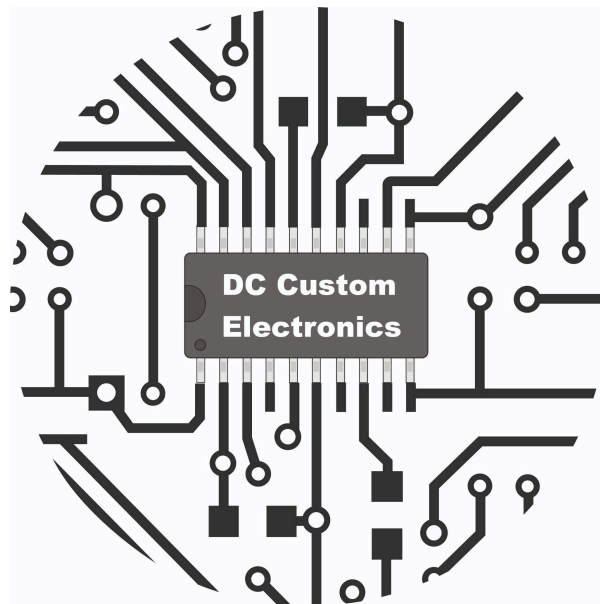# DC Custom Electronics
Intelligent Locomotion Controller (ILC)
V6-RC

General Use Instructions and wiring diagrams

DcCustomElectronics.com
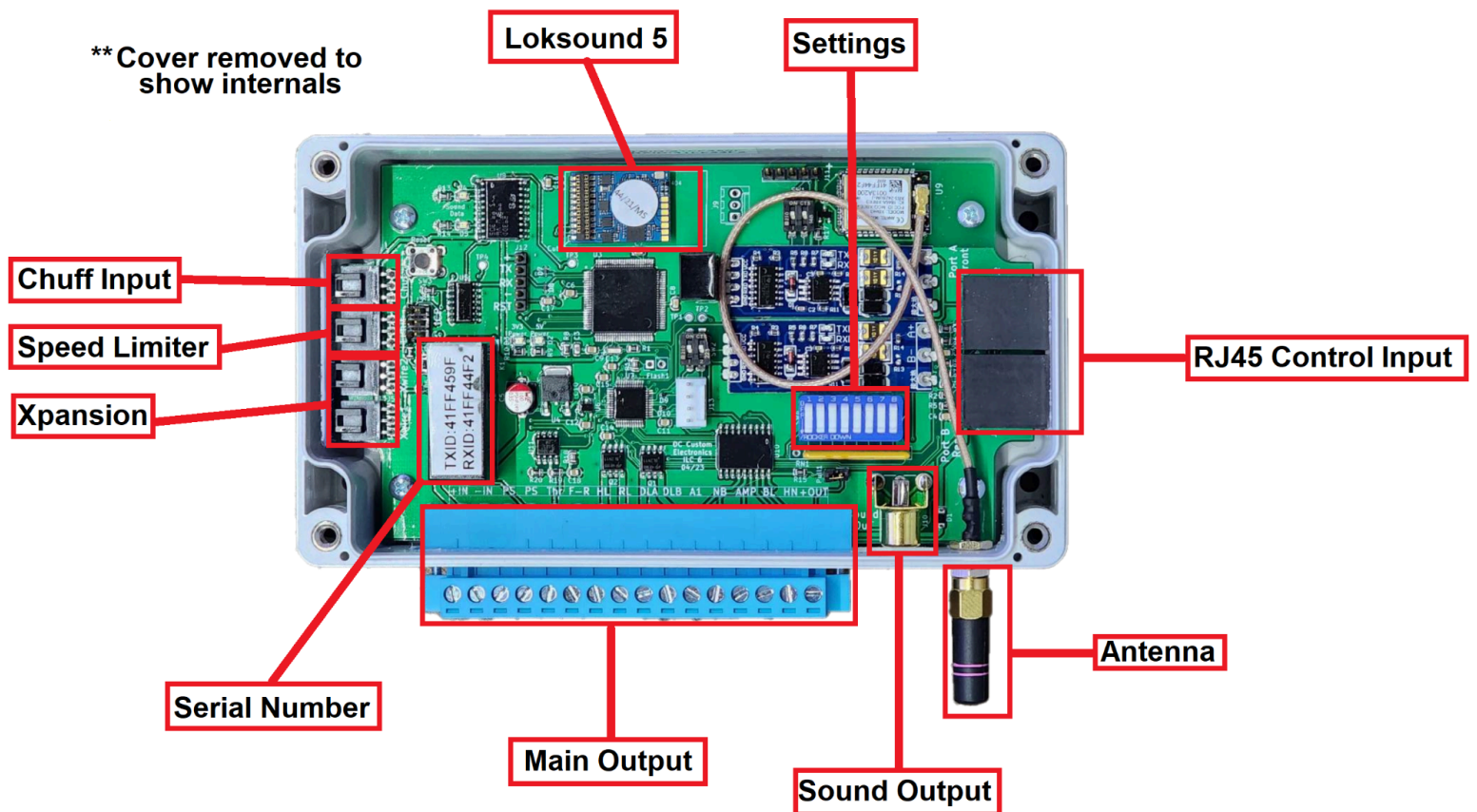**DcCustomElectronics@gmail.com**
+1 (623) 256 2021

Table of Contents

1. Introduction:

1.1.   The ILC is an advanced piggyback controller for large scale ride on locomotives. It features intelligent direction control sensing and multi unit capability intended to give the ability to easily connect multiple independent locomotives together. With a few easy to configure settings the ILC can adapt to most needs for large scale locomotives.

**Cover removed to show internals

Loksound 5

Settings

Chuff Input

Speed Limiter

Xpansion

RJ45 Control Input

Serial Number

Main Output

Sound Output

Antenna

2. *Mounting:*

2.1. There are a few things to take into consideration for mounting the receiver. The overall footprint is 6.3 inches long by 3.5 inches wide by 1.8 inches tall. Mounting holes in the corners beneath the case lid allow for mounting using a #8 screw. Special attention should be made to the direction of the wiring connections. You will need access to at least 2 sides of the controller for wiring with the 3rd side optional depending on the use of some add on features. See the following diagram for box dimensions and mounting.
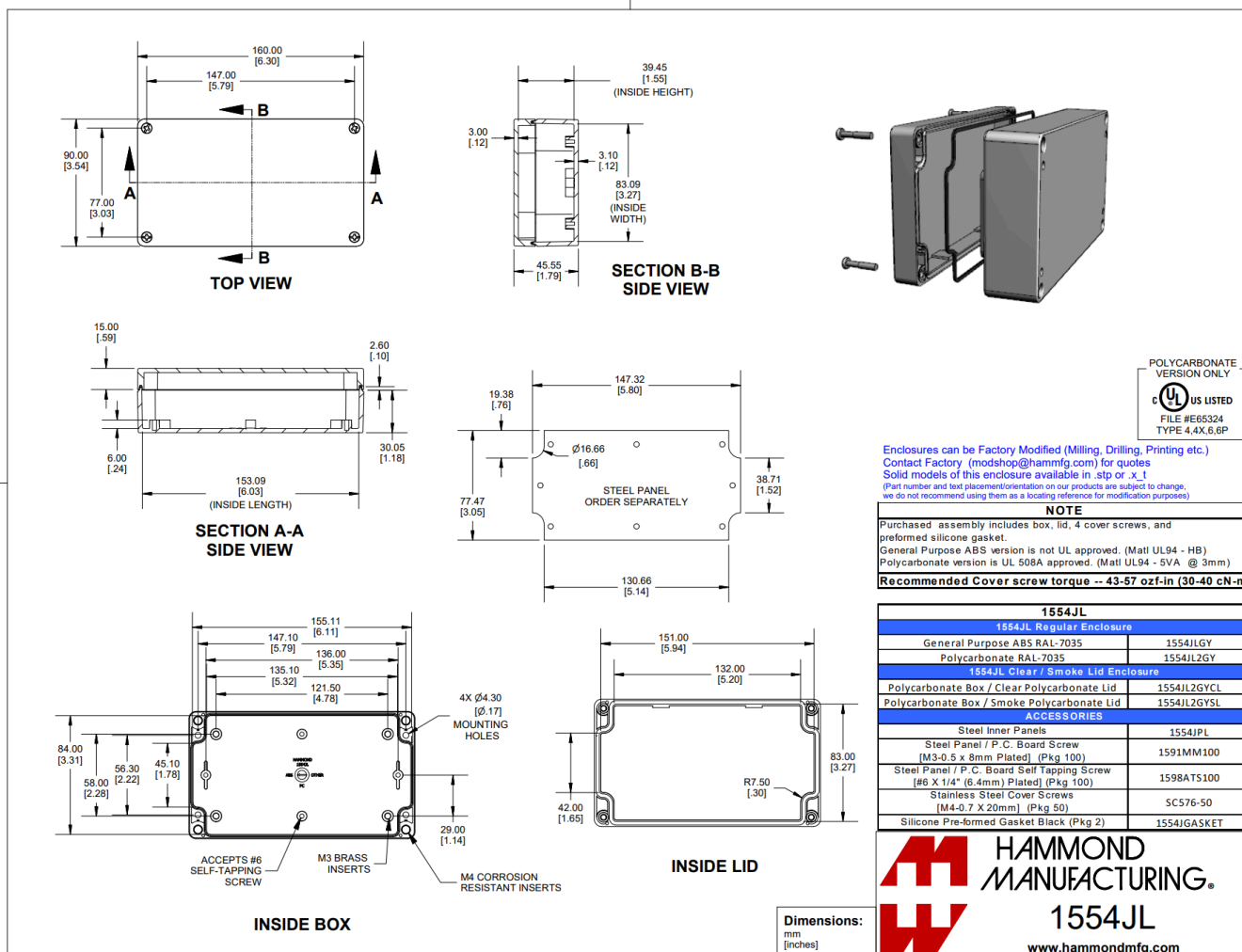
3. *Technical Specification:*

3.1.   Maximum operating voltage :   15V DC
3.2.   Total Maximum current (all outputs loaded) :   20A DC

3.3.   Maximum current sink/supply per output:
    3.3.1.   THR: 50mA 0-5V
    3.3.2.   F-R: 500mA up to 24V
    3.3.3.   HL: 5A up to 24V
    3.3.4.   RL: 5A up to 24V
    3.3.5.   DLA: 5A up to 24V
    3.3.6.   DLB: 5A up to 24V
    3.3.7.   A1:   500mA up to 24V
    3.3.8.   NB: 500mA up to 24V
    3.3.9.   Amp: 500mA up to 24V
    3.3.10.   BL: 500mA up to 24V
    3.3.11.   HN: 500mA up to 24V
    3.3.12.   +OUT: 15A

3.4.   Data protocol (wired):   RS485
3.5.   Data Protocol (wireless):   2.4GHz DSSS
3.6.   X-Pansion max load: 1A@12Vdc
3.7.   Maximum control cable length: 100 meters
3.8.   Maximum range (wireless):   >50 meters (LOS)
3.9.   Antenna type: RPSMA 2.4GHz
3.10.   Hand held battery type: 4x AA
3.11.   IP rating: IP54 Water resistant
3.12.   Maximum Operating temperature: 85C (185F)
3.13.   Minimum Operating temperature: -40C (-40F)

4.   *Power input:*

4.1.   The ILC requires a 12VDC supply. This can be a battery directly or a voltage converter capable of supplying a minimum 15A at 12V. Power should be connected to the removable screw terminal on the long side of the controller. Connections are labeled
"+ IN" and "- IN" respectively.

ILC v6-RC Reciever (locomotive)
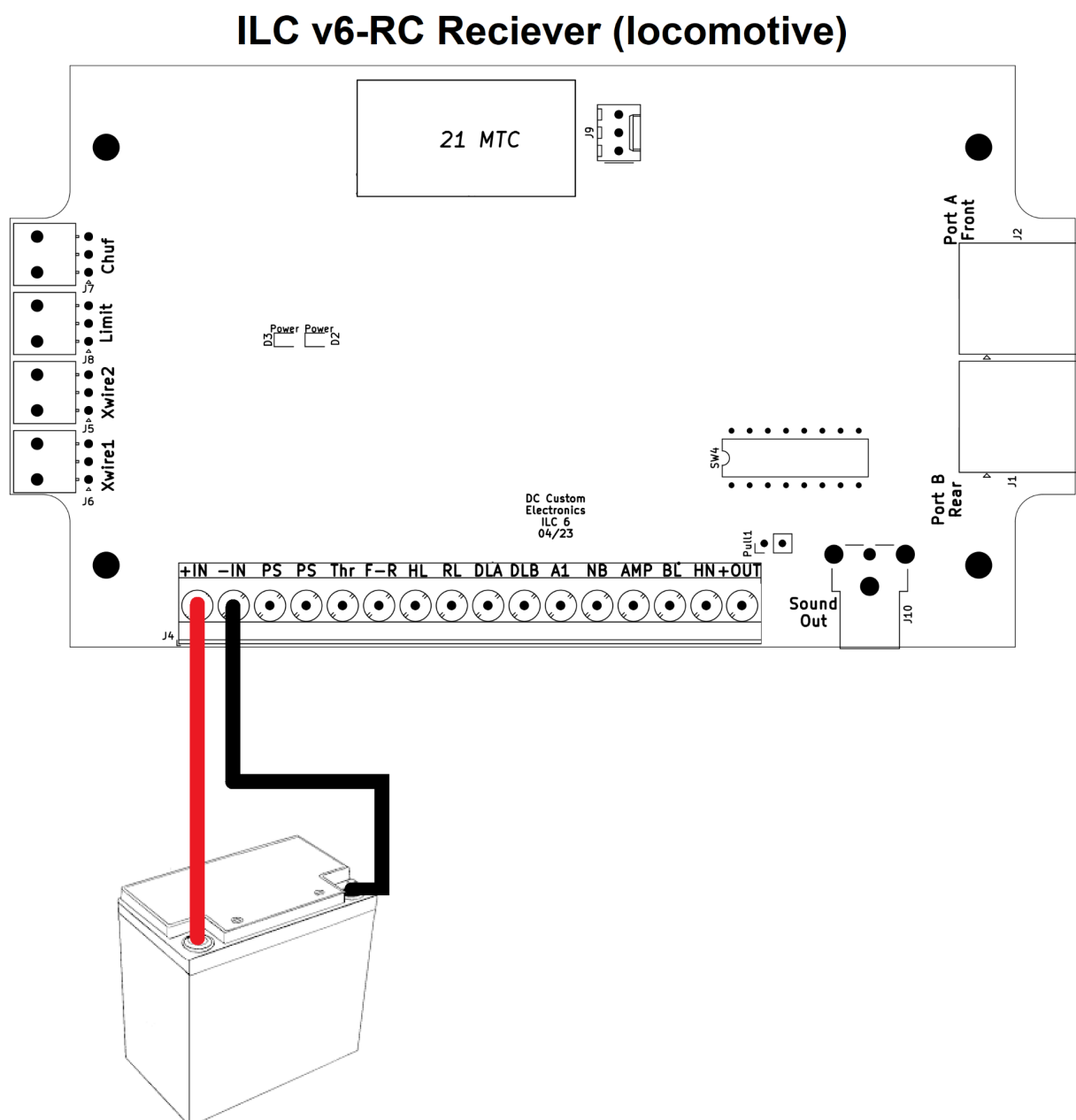
5. *Control Connections:*

5.1.   There are various connections in the ILC. You may use all of them or only some depending on your specific needs. There are also some settings that can change how these outputs act in regards to functions (see "Settings").

Located on the left of the receiver is in order top to bottom:

5.2.   Chuff sensor input
        Used only for steam outline engines

5.3.   Speed limiter
        Connecting a 5K pot to this input will allow you to set the maximum speed allowed by the controller. This is useful when MU-ing locomotives from different manufacturers or with different motors.

5.4.   Expansion
        This is used with our expansion add ons such as our air brake module

ILC v6-RC Reciever (locomotive)
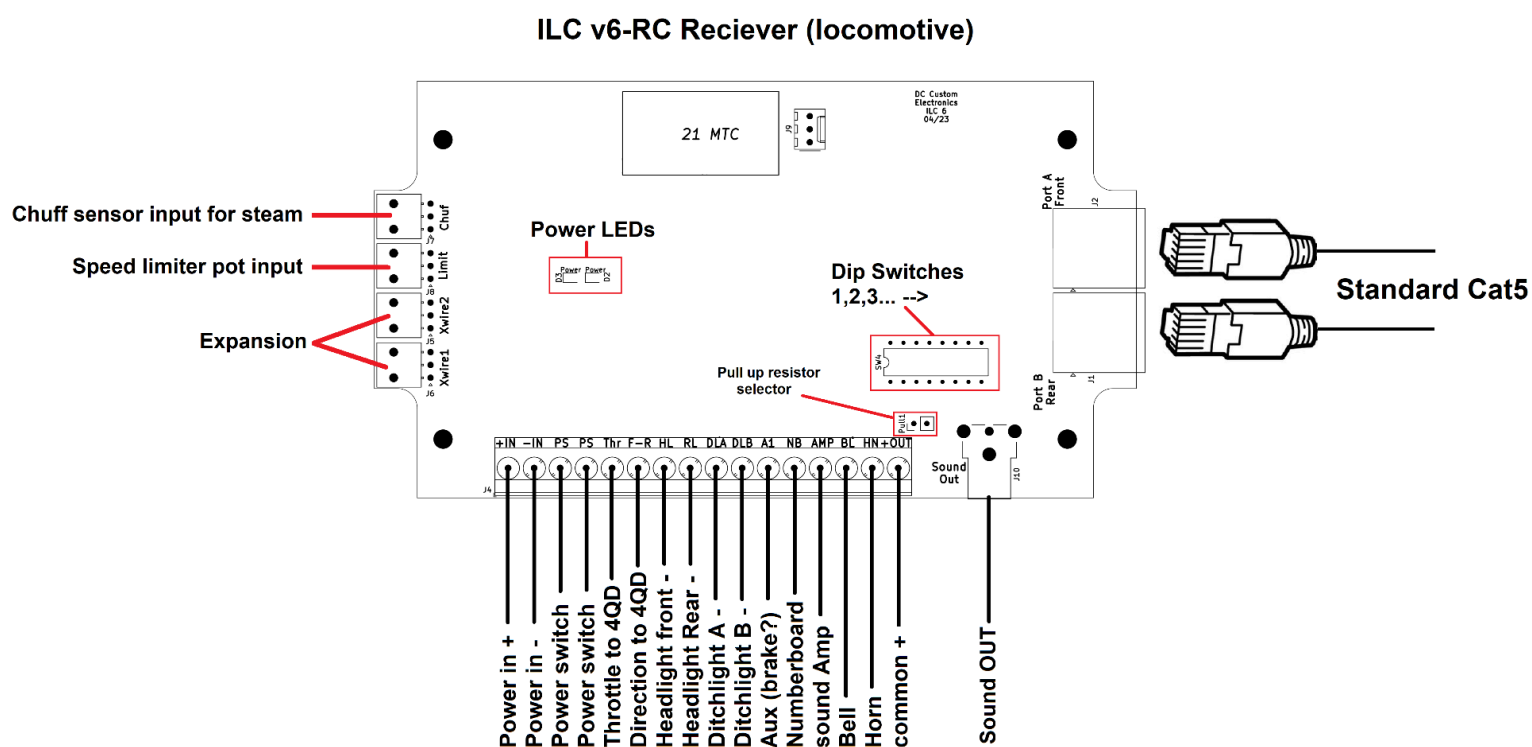
5.5. Located on the right side of the receiver is the control cable connections. These are RJ45 connectors and will accept any standard Cat5 (or the like) cable of lengths up to 100 meters. Additionally, Provided with the system is a special MU cable. This cable has a crossover built in to ensure the proper operation when MUing multiple locomotives. This cable should ONLY be used when MUing.

5.6. Also provided are 3x 5 foot cat5 cables and 2x RJ45 pass through couplers. These couplers should be placed at either end on the locomotive in an accessible place. Couple these to the controllers front and rear ports using 2 of the 3 provided cat5 cables. The leftover cable will be your control cable for when the need to run tethered may arise.

5.7. Lastly the lead unit dongle provided should always be placed in the front port of the forward most locomotive. This is how the system knows what locomotive is in front! If you lose this connector the information on how to make a replacement, as well as replacement MU cables, will be in the section: "RJ45 wiring" (section7)
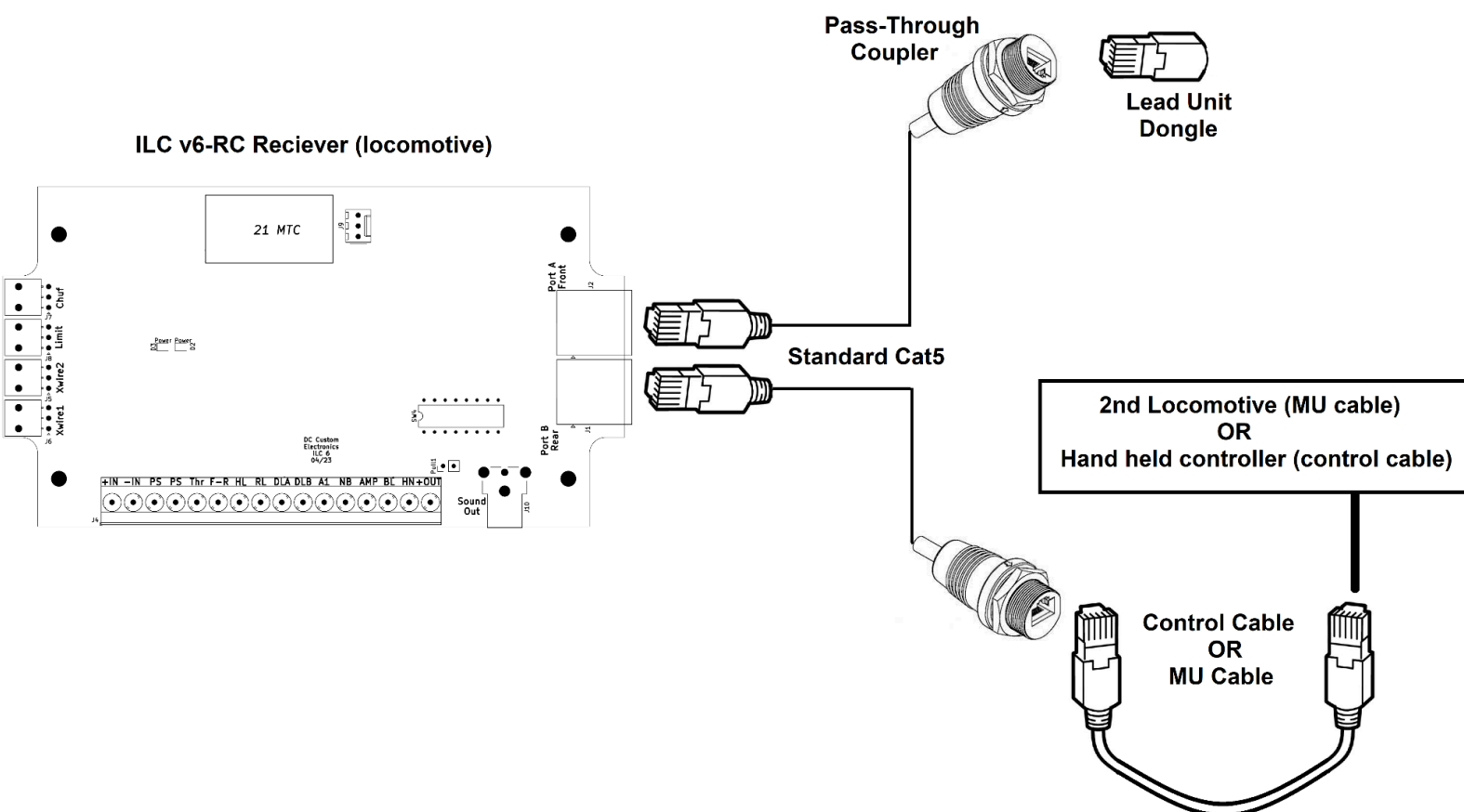
6.   *Main Outputs:*

6.1.   With the exception of "Thr" (throttle output) all outputs are current sinking, meaning that they are essentially grounding whatever is connected to them. This means that they can accept almost any voltage needed up to 28VDC. In order to wire a device to the ILC you will need to have its positive connection connected to 12V or 24V (or whatever voltage is required for the device i.e. 3V for LEDs). The negative side of the device should be connected to the respective output on the ILC. See the below example for connecting a horn using a relay.

ILC v6-RC Reciever (locomotive)

Horn example
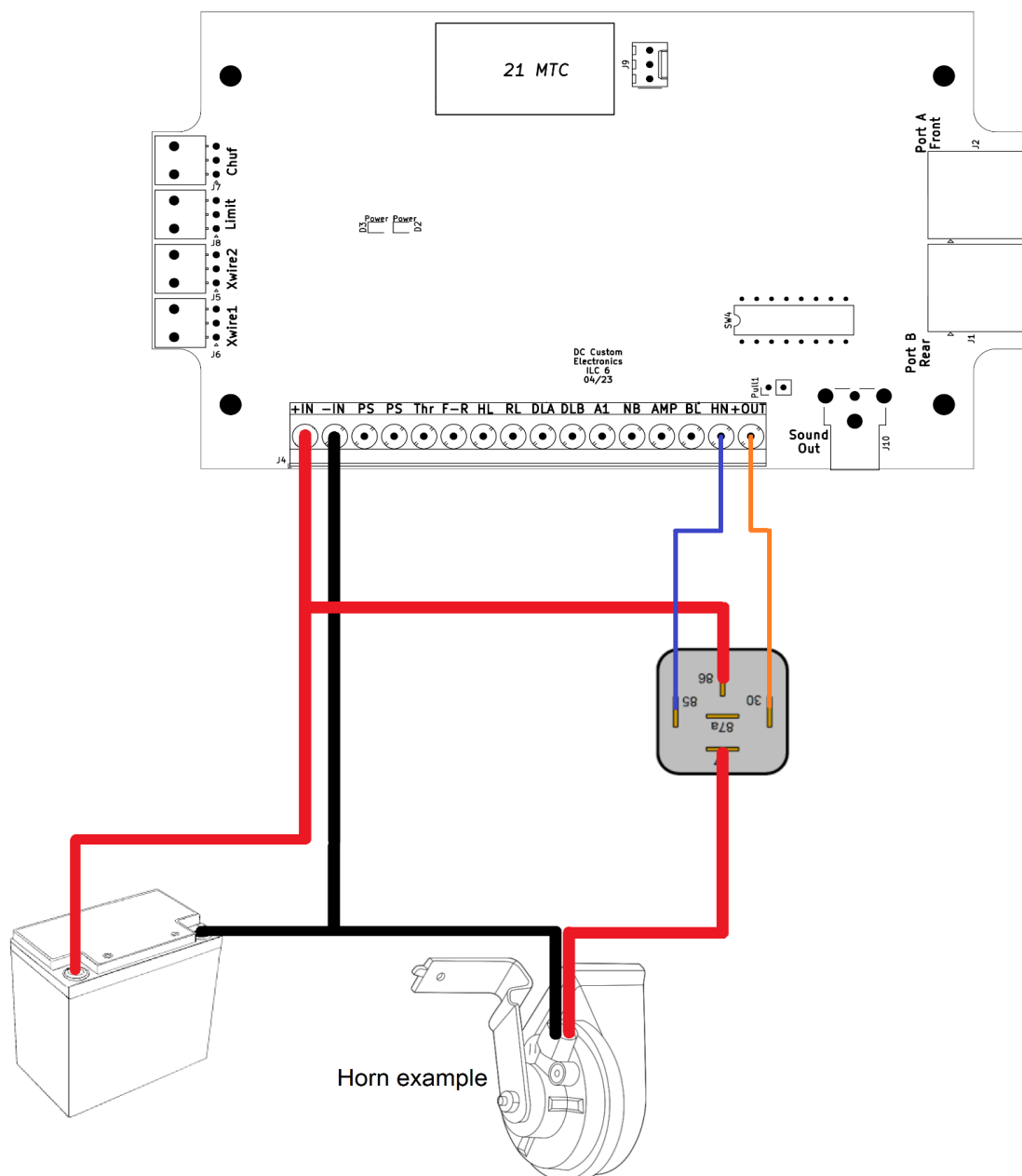
6.2. The relay - (minus) side is connected to the horn output. The relays + side is connected to +out on the ILC. This connection can be used for all relay + connections. This includes the relays for Bell, Amp, Number boards, Auxiliary, and Light reverser.

6.3. All Lighting outputs are capable of driving a 5A load directly through the board. Headlight, Reverse light (when in the correct mode) and Ditch Lights are all capable of this. To wire lights refer to the diagram below for an example how to wire a typical 20W halogen.

ILC v6-RC Reciever (locomotive)
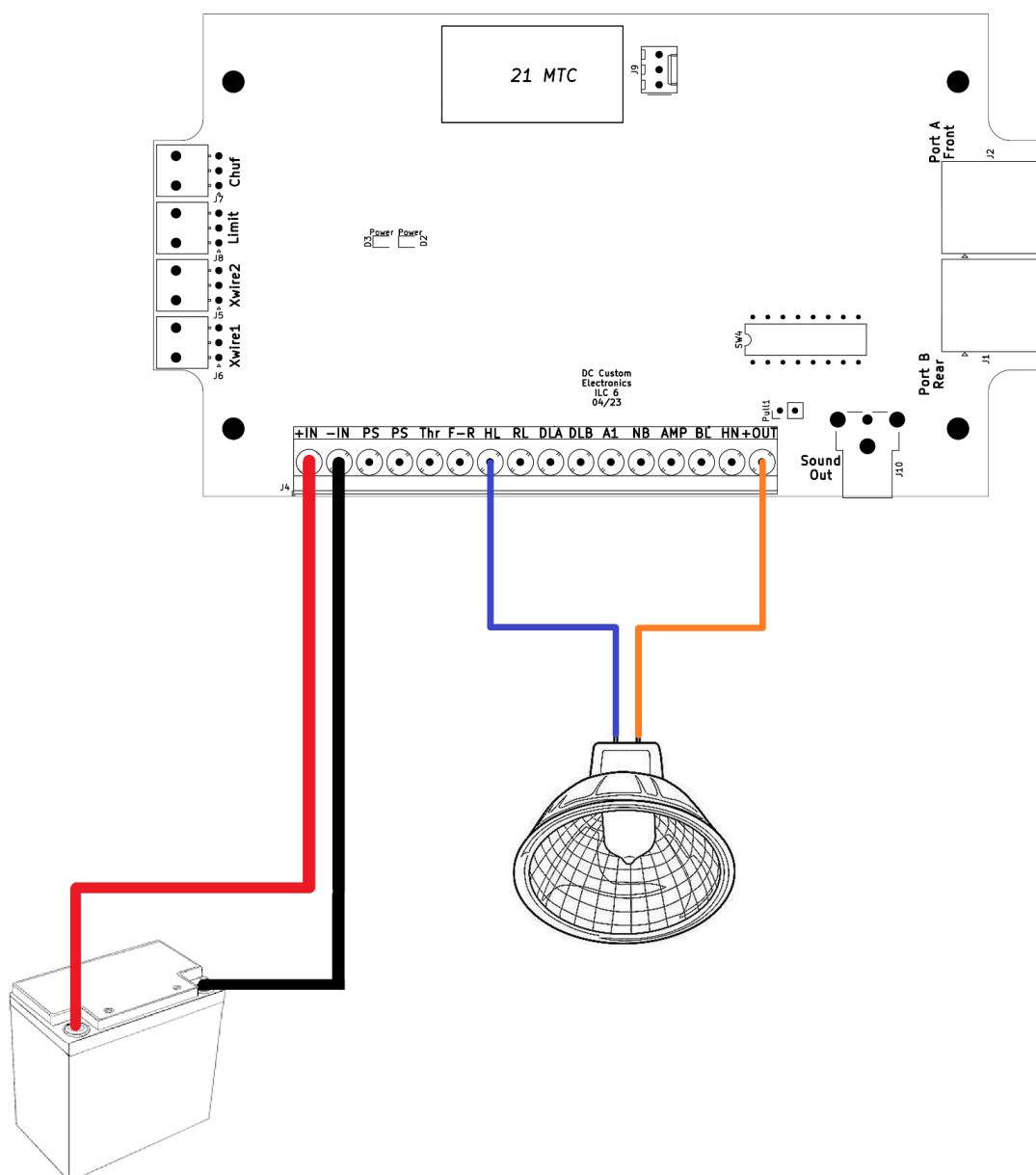
6.4. Alternatively the + side of the light may be directly connected to the battery power (up to 28V) as shown below.

6.5. All lighting outputs are PWM capable. This means they can pulse the lights on and off very fast to give a different brightness. This Is the default method for the headlight dim mode. If a solid and separate output is needed for low beam the reverse light output can be programmed to instead act as low beam (see settings)

ILC v6-RC Reciever (locomotive)
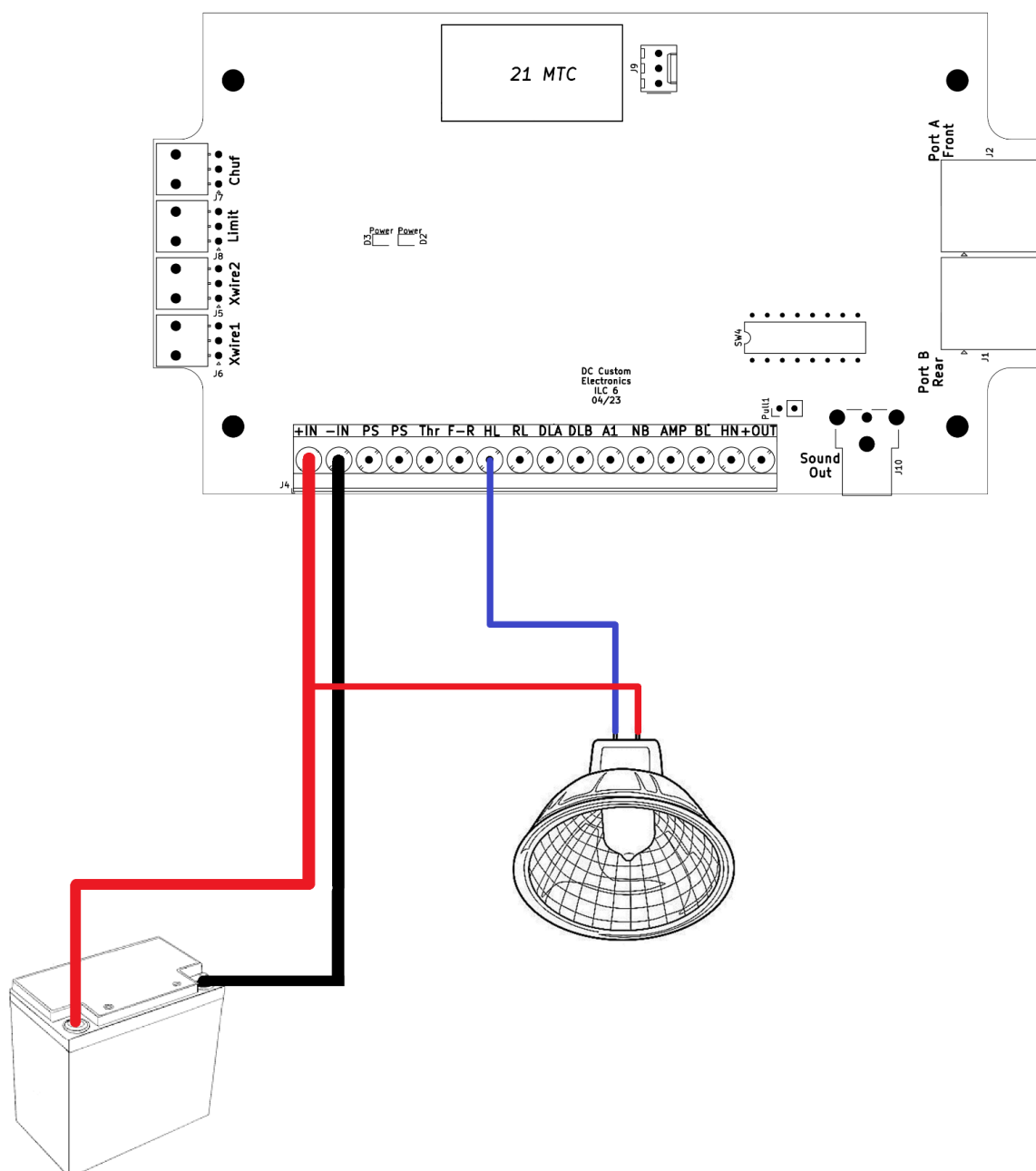
7. *Wiring to your motor controller*

7.1. Here let's take a look at the throttle and direction control outputs specifically and how that will interface with your motor controller. Currently the ILC is only officially compatible with 4QD and Syren 50 controllers.

7.2. The recommended controller for use with the ILC is the 4QD Pro series controllers. This is what we will focus on in the following information. Below is a diagram pulled from the official 4QD controller manual for the Pro 160. This will be the same for the Pro 360 with the exception of power and battery connections. Please refer to your 4QD user manual for information regarding the controller you have.
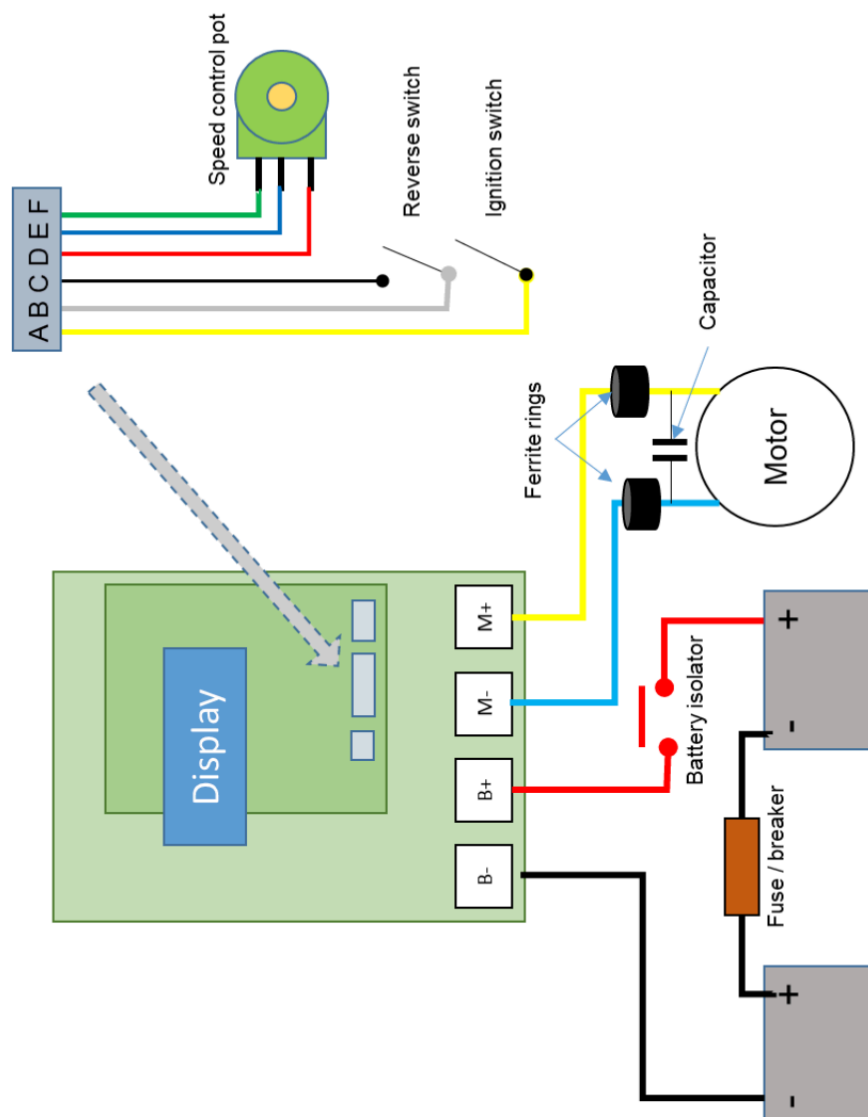
7.3.   Below is a diagram to show the proper connections between the ILC and 4QD controllers. Please reference your 4QD user manual to ensure the proper connector is used. Note you WILL need to jump the "Pull" jumper for direction control to work correctly. This pulls the direction line high to 12V via a 10K resistor
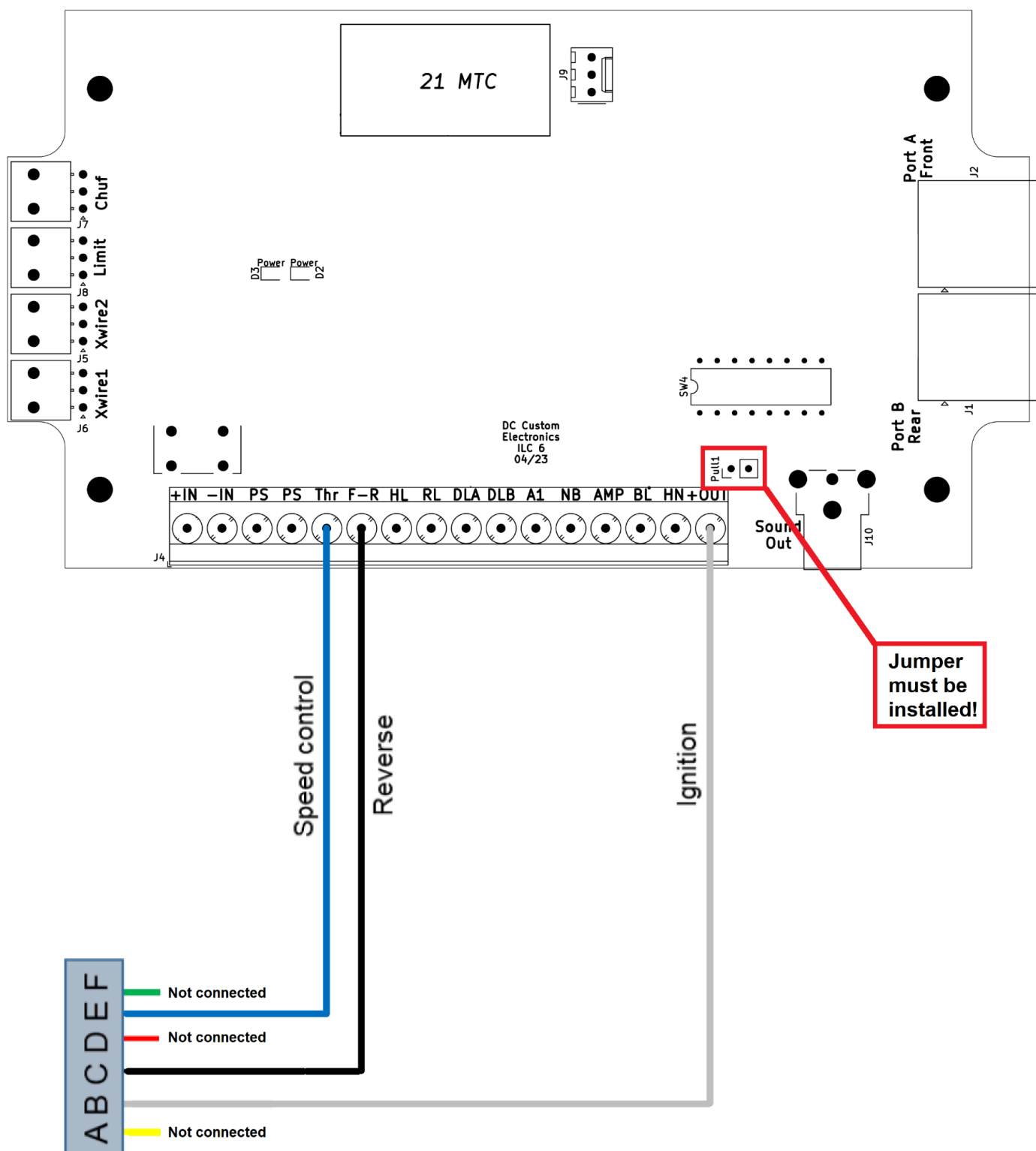
7.4. Once you have your 4QD Pro controller wired to the ILC you will need to program it. Follow these steps in order to ensure all settings are programmed properly. The four buttons on the controllers keypad will be needed for programming and are represented: [back] [up] [down] [select].

7.4.1. Select profile 3
7.4.1.1. Hold [select] while powering on the 4QD, -> Press [select], -> Press [down] until you see "P03 large loco" -> Press [select]

7.4.2. Edit profile
7.4.2.1. After the previous step: Press [down] until you see "edit profile" -> Press [select]

7.4.3. Set forward accel ramp to desired value [recommend this set to 1]
7.4.3.1. After the previous step: Press [up] or [down] until you see "Fwd settings", -> Press [select] -> Press [select] to enter "ACC RAMP", -> Press [up] or [down] to set to desired value, -> Press [select] to lock in value.

7.4.4. Set forward Decel ramp to desired value [recommend this set to 1]
7.4.4.1. After the previous step: Press [down] until you see "DECEL RAMP" -> Press [select], -> Use [up] or [down] to select desired value, -> Press [select] to lock in value.

7.4.5. Set forward Max PWM to 100% [or desired maximum speed]
7.4.5.1. After the previous step: Press [down] until you see "MAX PWM %" -> Press [select] -> Use [up] or [down] to select desired value, -> Press [select] to lock in value. Press [back] to go back to the main menu.

7.4.6. Set reverse accel ramp to desired value [recommend this set to 1]
7.4.6.1. After the previous step: Press [down] until you see "Rev Settings" -> Press [select] -> Press [select] to enter "ACC RAMP", -> Press [up] or [down] to set to desired value, -> Press [select] to lock in value.

7.4.7. Set reverse Decel ramp to desired value [recommend this set to 1]
7.4.7.1. After the previous step: Press [down] until you see "DECEL RAMP" -> Press [select], -> Use [up] or [down] to select

desired value, -> Press [select] to lock in value.

7.4.8.   Set reverse Max PWM to 100% [or desired maximum speed]
    7.4.8.1.   After the previous step: Press [down] until you see "MAX PWM %" -> Press [select] -> Use [up] or [down] to select desired value, -> Press [select] to lock in value. Press [back] to go back to the main menu.

7.4.9.   Navigate to throttle settings
    7.4.9.1.   After the previous step: Press [down] until you see "throttle" -> Press [select] to enter throttle settings

7.4.10.   Set input mode to "VOLT"
    7.4.10.1.   After the previous step: Press [up] or [down] until you see "INPUT MODE XX" -> Press [select] -> Press [up] or [down] until you see "VOLT" -> Press [select]

7.4.11.   Set Deadband to between 5 and 10
    7.4.11.1.   After the previous step: Press [up] or [down] until you see "DEAD BAND" -> Press [select] -> Press [up] or [down] to set desired value -> Press [select] to lock in value.

7.4.12.   Set "Pot learn" to "Active"
    7.4.12.1.   After the previous step: Press [up] or [down] until you see "POT Learn" -> Press [select] -> Press [select] again -> Press [up] until you see "YES" -> Press select.

7.4.13.   ***** You will need to power on the transmitter and receiver of the ILC and have the wiring from ILC to 4QD connected for the next steps*****

7.4.14.   Set zero
    7.4.14.1.   After the previous step: Press [up] or [down] until you see " "ZERO 0" -> Press [select]. -> Turn throttle on the transmitter to 0, you should see a low number on screen (somewhere around 25-35) -> Press [select]

7.4.15.   Set max Forward

    7.4.15.1.   After the previous step: Press [up] or [down] until you see " "MAX FWD" -> Press [select]. -> Turn throttle on the transmitter to 100%, you should see a high number on screen (somewhere around 400-500) -> Press [select]

7.4.16.   Set max reverse

    7.4.16.1.   After the previous step: Press [up] or [down] until you see " "MAX REV" -> Press [select]. -> Turn throttle on the transmitter to 100%, you should see a high number on screen (somewhere around 400-500) -> Press [select]

7.4.17.   ** Note after capturing max forward and reverse, value shown should be approximately 450 - 499

7.4.18.   SAVE ALL SETTINGS

    7.4.18.1.   Press [Back] Until you see "Profile 03" at top of screen -> Press [down] Until you see "Save Changes" -> Press [select] to save all changes. Note Controller will reset and begin startup. Make sure the throttle is set to 0 when performing this step.

7.5.   Wiring to Syren 50 is similar to wiring to a 4QD. However the Syren does not have an internal power down state so a properly sized relay or solenoid should be used to remove power from the syren when the ILC is turned off. See below diagram for wiring to Syren 50 controllers:
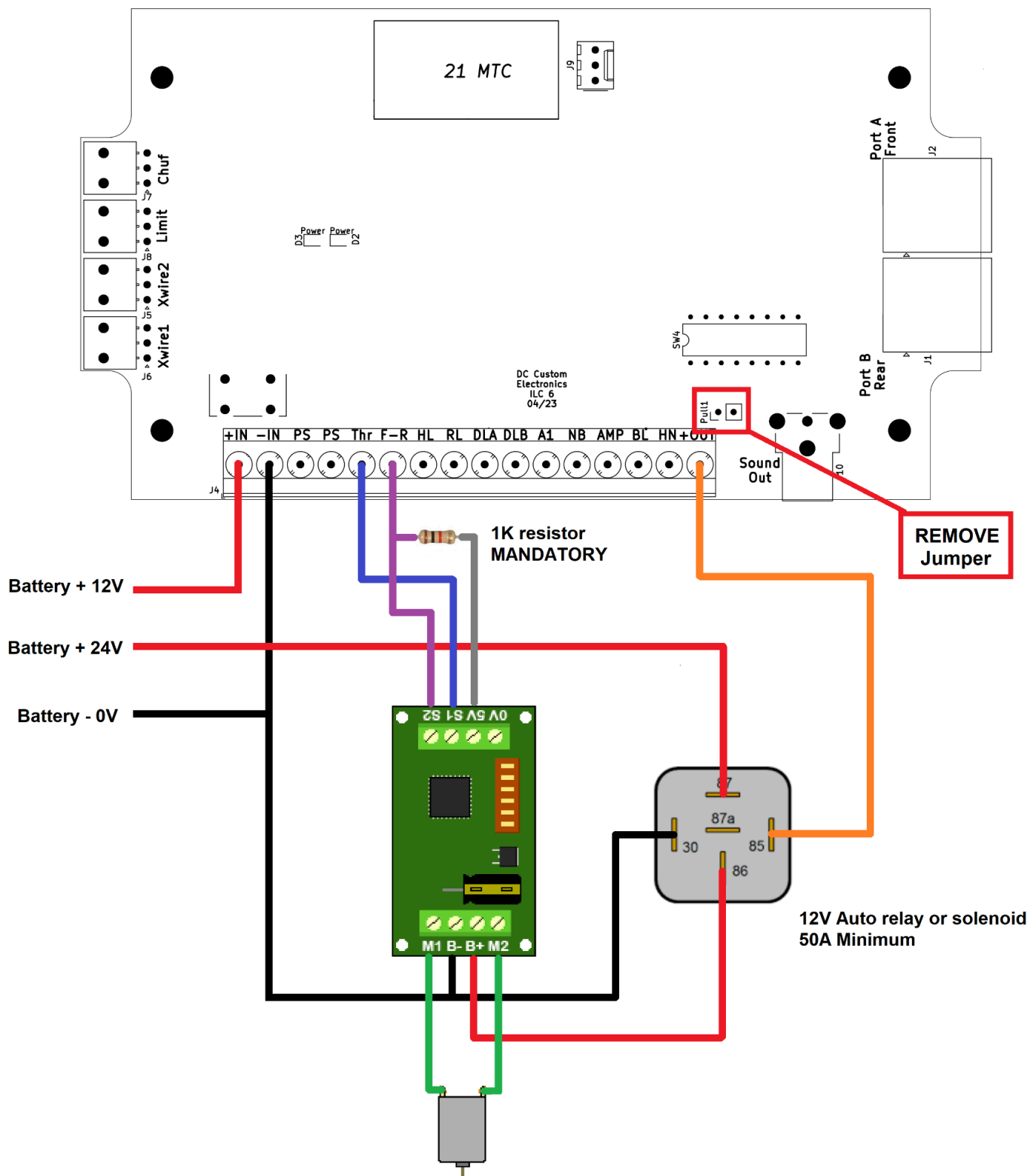
7.6.   Syren 50 dip switches

    7.6.1.   Reference your syren 50 documentation to confirm any settings before testing!

    7.6.2.   See below image for the proper Dip switch settings for Option 3 "Analog One-direction with forward/reverse select on S2" on Syren 50 controllers only.
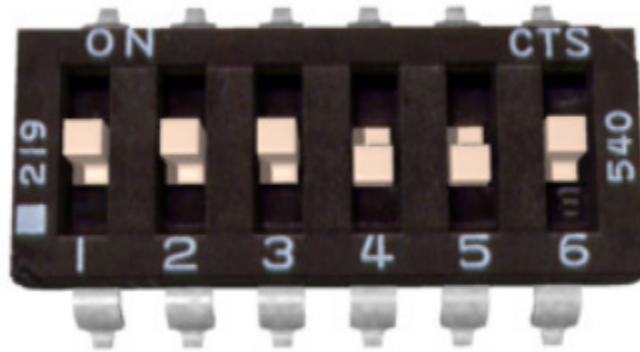
    7.6.3.   It is up to the user to ensure the proper connection and programming of the motor controller in use.

7.7.   The Throttle and reverser output can be used with other controllers. Some important details needed in order to property interface with other motor controller are:

7.7.1.   Throttle is represented by a voltage signal from 0 to 5V DC

7.7.2.   Reverser output can either be a high / low (12v / 0V) OR can operate like the other function outputs to drive a relay.

7.7.3.   Remove the "Pull" Jumper to use the reverser output for a relay. You can then use this relay to open or close whatever connections are needed for 3rd party controllers

See below diagram for wiring a relay to the reverser output:
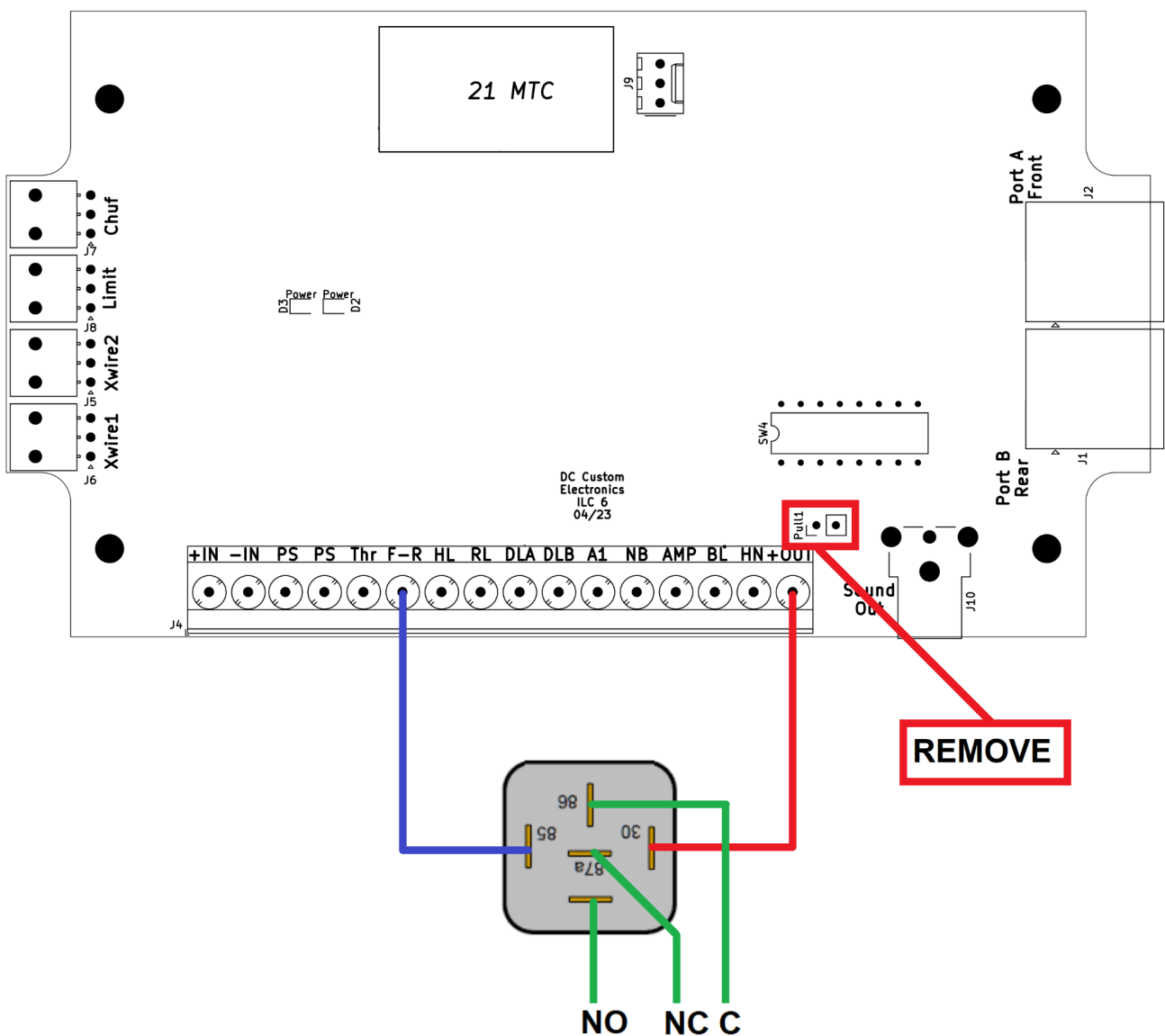
8. *Functionality:*

The following will explain how each of the outputs will act during normal use.

8.1. PS - These connections (2) should be wired to a normally open switch of your choosing. This will be used to power up the locomotive in RC mode ONLY. Place this switch accessible to you from the outside of the locomotive.

8.2. Thr - This output is the throttle. Throttle will be a 0-5V signal dependent on the throttle pot on the hand held controller and the speed limiter pot. Throttle will NOT output unless a direction has been selected on the direction control switch on the hand held controller. In the event of a hand held controller disconnecting the throttle will go to 0V.

8.3. F-R - This output is the direction control output. There is a pull up resistor selectable by jumping the "pull" jumper located near the sound jack. Use this pull up resistor when wiring directly to 4QD controllers. This output will be either off (forward by default) or on (reverse by default) and stay in the last known selected state. I.e there is no neutral. This output can be used to trigger a 12V relay.

8.4. HL - HeadLight output for the normally forward direction headlight. This output will be at full output when in forward with the headlight on high. When on low this output will be at 25% PWM, or 25% output UNLESS Dip4 is set to on. With Dip4 set to on this output will be off when the headlight switch is in low.

8.5. RL - Reverse Light output for the normally reverse direction. Only if Dip3 is in the on position, this output will be at full output when in reverse with the headlight switch set to high. When the headlight switch is in low this output will be at 25% PWM, or 25% output. Alternatively if Dip4 is set to on this output will act as the forward low output and be at 100% only when the headlight switch is in the low position. Note that you can not have reverse light AND use separate High/Low outputs.

8.6. DLA/DLB - These TWO outputs are for ditch lights. When the ditch light switch is on these outputs will be on 100% output. IF Dip8 is in the on

position these outputs, when on, will alternatingly flash in a fade in - fade out pattern during and for 30 seconds after the horn button has been pressed. Additionally they will flash this pattern for as long as the bell switch is in the on position provided that the ditch light switch is also on.

8.7. A1 - This output responds directly to the Aux switch.

8.8. NB - This output will by default turn on any time the headlight switch is in the high OR low position. This is intended for number boards, Marker lights, or any additional lighting. Alternatively with Dip1 in the on position this output can be used for a parking brake. When the direction switch is in the center neutral position this output will turn on to enable a parking brake and turn off when the direction switch is in forward or reverse.

8.9. AMP - this output is intended for use to enable or power an amplifier for the sound system. It will turn on only when the sound switch is in the on position and will remain on 20 seconds after turning off the sound switch to allow the sound system to play a shutdown sequence.

8.10. BL - Bell output for mechanical bell. Depending on the state of Dip7 this output will turn on when the sound switch is off and the bell switch is on. Use Dip2 to enable a 1 sec automatic pulse to right bells with no pulse circuit built in. If dip2 is in the on position this output will continue to operate with the sound switch in the on position and the sound system bell will be disabled.

8.11. HN - This output responds directly to the horn button. Subject to the same conditions as BL but instead using Dip6 the horn may be selected to play in place of the sound system horn.

8.12. +OUT - switched +12V out contingent on the power switch. Use this for all relay commons or LED headlight + supply.

9. *RJ45 Wiring:*

9.1. Shown below is the internal wiring of the control ports on the ILC6. This information is provided in order for users to make their own replacement MU cables and leed unit dongles in the event they are lost or damaged.

9.2. ***Do not attempt to interface with, adapt, or otherwise modify this connection, doing so will void any warranty and may damage the device. We are not responsible for damage to property due to improper use. If you are unsure and need help making a replacement cable contact us for free replacement, just pay shipping.***

MU Cable Crossover

DC Custom Electronics RJ45 Pinout for ILC versions 5.0 and up.

1: Direction sense Line 1 (grounded in remote)
2: 12V power from loco
3: Power switch OUT from remote
4: Data B
5: Port sense
6: Data A
7: Power Ground
8: Direction sense Line 2

RJ45 Pinout
T-568B

Lead unit Dongle Pinout
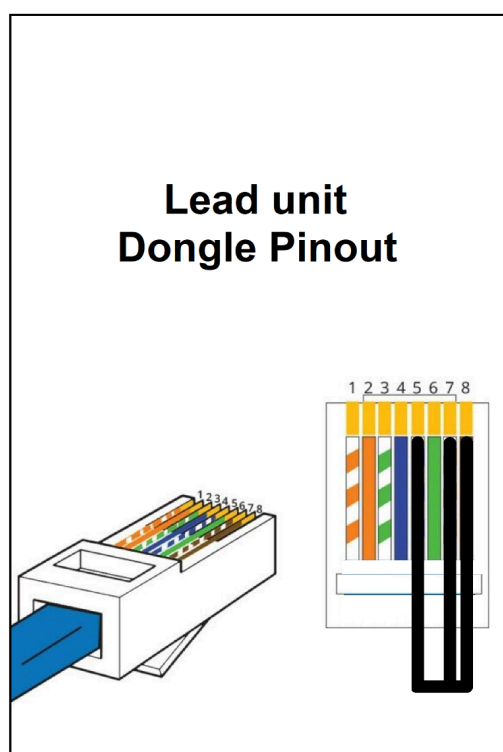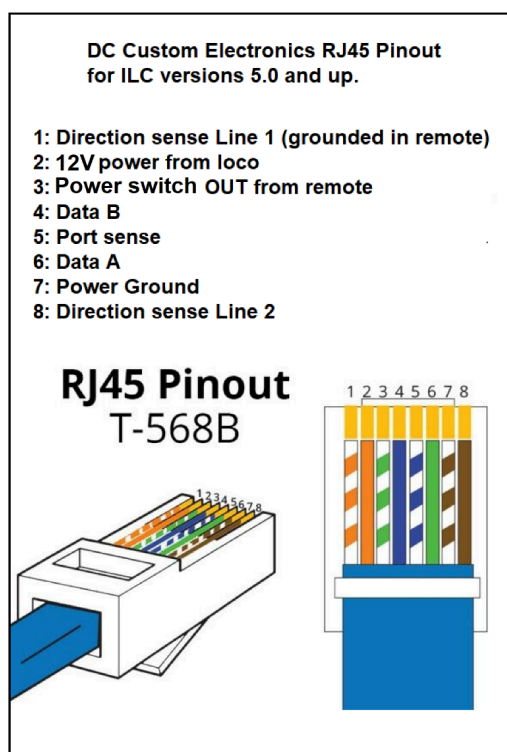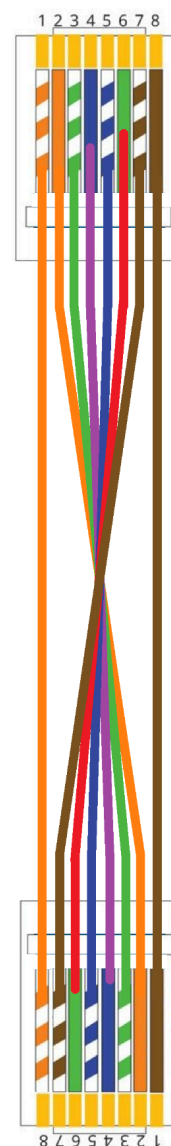
10. Antenna:

10.1. All Wireless systems must have an antenna. The ILC uses an industrial grade 2.4 GHz encrypted 2 way radio. Located on the control box in the locomotive is an RPSMA connector. You may choose to place the provided 2.4GHz antenna directly onto this connector OR use the provided 3 foot extension cable to mount the antenna in a better suited position.

10.2. **Antenna placement:** When choosing where to place your receiver antenna there are a few things to keep in mind. If your locomotive body is made of any conductive material, i.e. aluminum or steel, you may want to place your antenna externally. Make sure your antenna is secure and the connection is accessible if the need arises to remove your locomotive body.

Alternatively if the locomotive body is made of fiberglass or a similar non conductive material, you may be able to place the antenna inside or even directly on the receiver box. Not that this should not have any effect on range however every scenario is different so take appropriate steps to ensure nothing is blocking your antenna from receiving control input.

11. Sound:

11.1. Some ILC systems come with sound built in! If your system came with sound you are all set! Connect your amplifier of choice to the RCA sound output located next to the main function outputs and you are ready to rumble the rails!

11.2. If your system did not come with a loksound card installed or you wish to make changes to the sound profiles, you will need to access the main receiver in the locomotive. (see 9.4)

11.3. At this time ILC6 does not support Tsunami cards unless specially requested. All other systems except loksound 5 full decoders and loksound 5 FX sound only decoders.

11.4.   To install your decoder locate and remove the 4 screws securing the cover to the ILC6 receiver. Locate the 21MTC connector on the receiver circuit board. Insert your loksound decoder to align with the outline on the circuit board. Make sure that the black plug on the loksound decoder is facing UP away from the circuit board. You should gently press on the connector until you feel a slight pop and the decoder is fully seated.

11.5.   **For E-Steamers** It is important to install the hall effect chuff sensor! Some soldering is required. Located to the right of the 21 pin decoder socket is a 3 pin connector. You will need to solder the 3 wires from the loksound to these 3 pins in order to utilize the chuff sensor connection on the left expansion plugs.
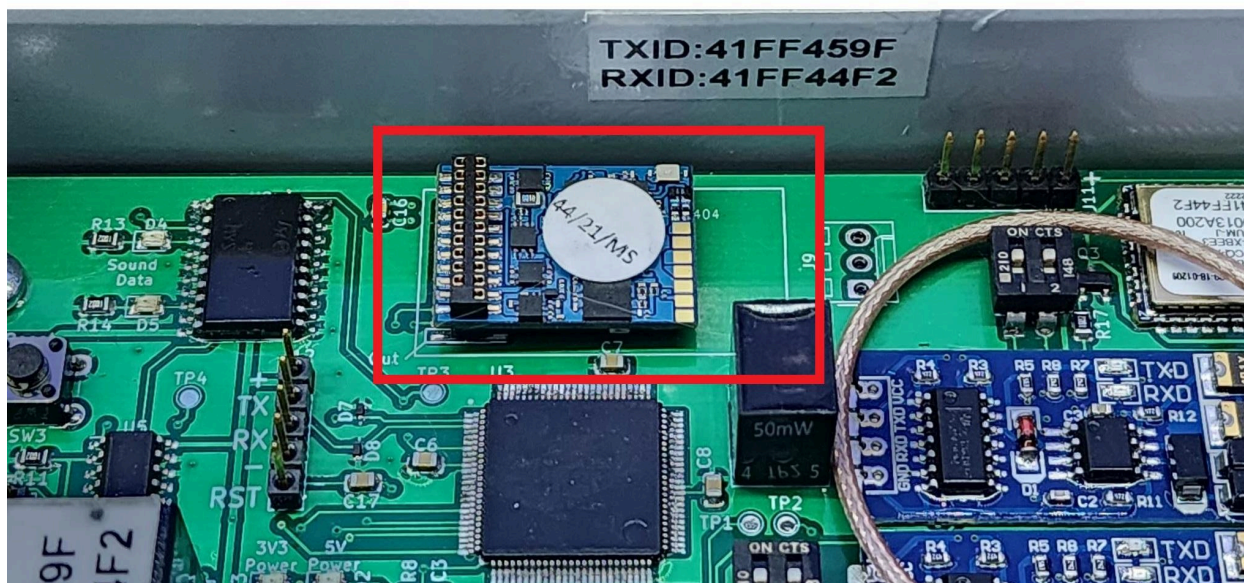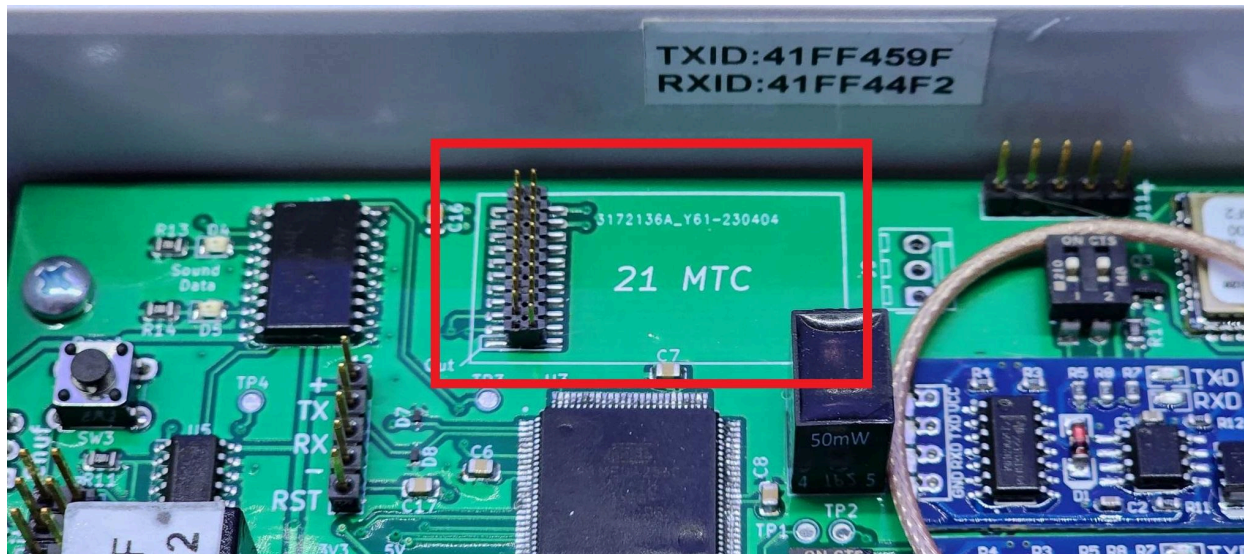
12. *Hand held controller:*

12.1. Your hand held controller has a few key features to be aware of. Here we will go over each of the controls and what you need to know about them.

12.2.   Shown above is the ILC6 remote control. Your controller should look similar to this but may be missing one or more of the controls shown depending on the options of your unit. Lets go over the controls:

12.2.1.   Power switch

The power switch is dual function. This is because it acts as the power switch for both the locomotive and the remote depending on the circumstances. When plugged into the locomotive, this is how you will power on the entire system. When in RC mode i.e not plugged in, this switch will only turn on the remote. You will need to power on the locomotive separately using the switch connected to "PS".

12.2.2.   Direction

This is your direction selector switch. You will need to first use this switch to select either forward or reverse before the system will enable the throttle. This switch is protected against accidental changes. This means if the switch is changed while in motion the system will hold until the throttle is set back to 0% before making the change.

12.2.3.   Throttle

This is the main throttle to make the locomotive move. This is represented as a % (percent) of full throttle by the markings around the knob. This value is then divided by the value of the (optional) speed limiter pot connected to the receiver. Throttle is disabled if a direction has not been chosen. The throttle will also be disabled at start up if not set to 0 when powering on the controller. Set the throttle to 0 to unlock.

12.2.4.   Horn

The horn button directly influences the horn output or sound system horn depending on the settings selected using the setting dip switches (see section 14)

12.2.5.   Light

This is the main headlight switch. Actual headlight behavior will be determined by the settings (see section 14). High will put the headlight into high beam mode. Low will put the

headlight into low beam mode. Center will turn off the headlight. Paired to this switch is the number board output unless otherwise changed using the settings. If the switch is in a position other than off the number board output will turn on. (see section 14 for setting on number board output).

12.2.6. Bell

This switch directly influences the bell output or sound system bell depending on the settings selected using the settings dip switches (see section 14)

12.2.7. Ditch light

This switch directly influences the ditch light output (DLA + DLB). Depending on the settings selected using the settings dip switches (see section 14) this output may be made to flash when the bell is on or when the horn is pressed.

12.2.8. Sound

This switch will power on the sound system starting up the prime mover (if off). The AMP output will turn on approximately 2 seconds before prime mover startup. If the throttle is not set to 0 when powering on then all sounds will start immediately. When this switch is turned off the sound system will play a shutdown sequence with a 20 second delay before turning off the AMP output. If the throttle is NOT set to 0 and prime mover sounds at idle when sound is powered off then all sounds will be immediately muted.

12.2.9. Volume

This switch is a center off momentary switch. Pushing this switch up and down will increment the sound system's 20 volume settings respectively. This volume will be saved to permanent memory 10 seconds after the last change. This means after powering off the system, it will remember the last saved volume setting for the sound system. This switch is a "one at a time" meaning you must press and release each time in order to increment the volume.

12.2.10.   Aux

This switch directly influences the AUX output. There are no special conditions for this switch. on is on and off is off.

12.2.11.   Train brake

This dial is optional. If you have the optional air brake controller expansion installed in your locomotive this dial will directly actuate the air pressure feed to the brake line. There are no special conditions to this dial. Pay special mind that brakes are not applied when adding throttle to avoid unnecessary battery use and strain on the motors and controller.

12.2.12.   Battery status

This indicator shows the battery status of the remote *ONLY*. When wired to the locomotive this indicator should be solid green. When in RC mode the indicator will start out green with fresh batteries at ~6.2V. Over time as the batteries deplete it will slowly change to red. Once the light is fully red the 4 AA batteries are at ~4.5V. At ~4V the red light will begin to blink. At this point it is recommended to change the batteries or have a spare set nearby. The transmitter can run all the way down to ~2.7V. To replace the batteries, open the battery door on the rear of the remote. Batteries are a standard AA. Make sure to use all the same brand of battery for best performance.

13. Power up/down procedure:

13.1.

14. Normal running

14.1.

15. MU-ing multiple locomotives

15.1.

16.   *Plug and play add-ons*

Xwire ports (1 and 2)

16.1.   Air brakes:
Wiring your air brake controller is as easy as 1-2-3!

1) Located on the top of your air brake valve is a 3 pin plug. Find your air brake control cable (3 wire cable) and plug one end into this plug and the other end into the ILC's "Xwire" port (one of 2 available ports, doesn't matter what one).

2) Now plumb a ¼ NPT fitting of your choice to supply air from your compressor tank to port one (1) on the brake valve.

3) Port two (2) should be plumbed out to your brake cylinders and/or train line.

That's it! You're all done!

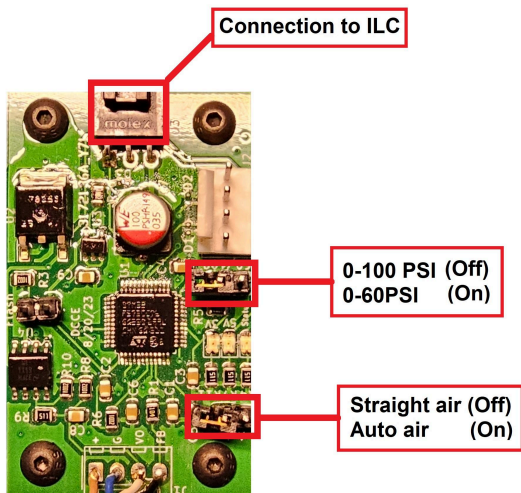For additional modes use the jumpers located on the valves control board. (see below)
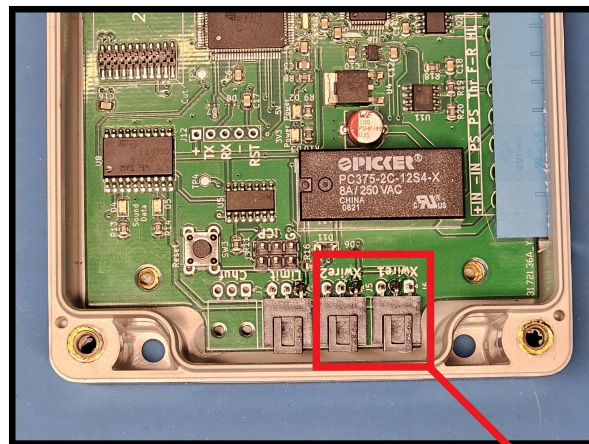
Port 1:
Air input not
to exceed
100PSI

Port 3: Relieving port

Port 2:
Regulated air output

Connection to ILC

0-100 PSI (Off)
0-60PSI   (On)

Straight air (Off)
Auto air   (On)

Top of brake valve

17.   Settings:

17.1.   There are some programmable settings on the locomotive circuit board. Locate the 8 dip switches labeled "SW4". They are as follows:

17.1.1.   Dip1   Swap number board output for parking brake

17.1.2.   Dip2   Bell ring mode (on= pulse, off= steady)

17.1.3.   Dip3   Enable reverse light
(DIP 4 MUST BE OFF If Dip 3 Is on!)

17.1.4.   Dip4   Headlight PWM dim (default) / Hi-low (using RL)
(DIP 3 MUST BE OFF If Dip 4 Is on!)

17.1.5.   Dip5   Ditch lights LED / Halogen

17.1.6.   Dip6   Disable sound horn and only use mechanical horn

17.1.7.   Dip7   Disable sound bell and only use mechanical Bell

17.1.8.   Dip8   Ditch lights flash (on horn or bell)

18. *Troubleshooting:*

18.1.