



Using LEDs With Drop-In Decoders

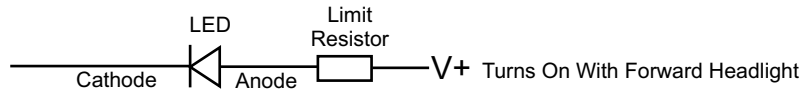
With the exception of the SD70MAC, all of the Drop-In decoders for USA-Trains locomotives are designed to drive incandescent lamps. This guide shows how to hookup LEDs in place of the high current lamps. Eliminating the high current lamps means your batteries last longer. Although you can use the existing wiring and lamp boards as a starting point, this is not a simple swap of lamps for LEDs. In most cases, you will be rewiring the lamps attached to the locomotive's light boards. This guide shows the appropriate connection point on the decoder along with the recommend connection for power. The other purpose of this guide is to show the various lighting sockets and the controlling functions.

Recommended Wire Size

Small wire is perfect for the wiring job. LEDs are such low current that #30 stranded wire works perfect. Use different colors and be sure to create a wiring diagram since you won't remember how you wired the locomotive a year from now.

Matching Plugs and Pigtails

CVP offers some, but not all matching plugs with attached wires. If we don't have the matching plug, your only source will be USA-Trains. Contact them if you need to purchase matching plugs for your locomotive.



Current Limit Resistors

All LEDs require a current limit resistor. Failure to use one, or failure to use the right value will destroy the LED and possibly damage the Drop-in decoder. Follow the guidelines below to select the proper resistor value. It does not have to be exact, but should be reasonably close. In all cases, lower resistance mean higher brightness and more current.

Step 1: Determine the voltage source driving the LED. The illustrations will show either V+ which is the battery voltage or VCC which is about 4.6 volts.

Step 2: Determine the forward voltage drop of the LED (called vf). In most cases you can use 2.5V for a white LED. Colored LEDs will be around 1 volt.

Step 3: use the formula below to calculate the resistance value

$$R \text{ (ohms)} = (\text{Source voltage}) - v_f - \text{driver voltage} / \text{LED current (usually 0.01 Amps)}$$

Example: White LED at 0.01A, $v_f=2.2V$, Source = VCC, driver voltage = 1.5V

$$R = 4.6V - 1.5 - 2.2 / 0.01$$

$R = 90 \text{ ohms}$, round to nearest 5% resistor which will be 91 ohms.

LEDs Are Polarity Sensitive

The anode of the LED must connect to a positive voltage to work. Some of the Drop-In circuit boards offer a source of voltage when turned on so the anode connects to the board. Other Drop-In circuit boards offer a switch to ground. In that case, the LED anode connects to the external positive power source (usually the large filter capacitor positive lead).

Controlling Functions

Next to each of the LEDs is a comment regarding what function turns on the lights. In most cases, the headlight function is turned on by F0 with the forward/reverse activation controlled by the direction switch. The CAB control is by default F11 but can be moved to other functions. See the Drop-In Decoder User's Guide for details.

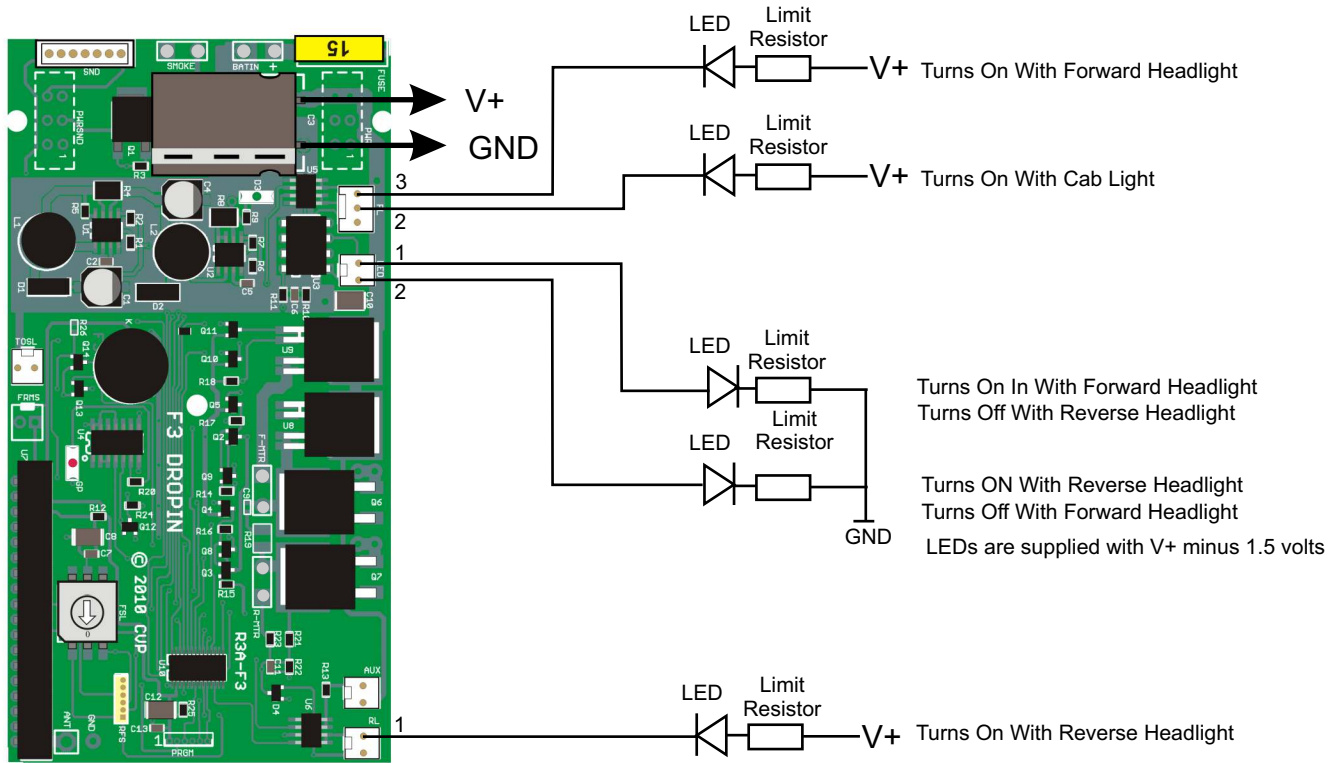
SD70MAC Drop-In Special Note

The SD70MAC is not shown since it already uses LEDs for all lights except one. The one hold out is the cab interior light. If you wish to replace the incandescent bulb, use a white LED along with a 150 ohm resistor and put the LED in place of the cab light. Increase the resistance to dim the LED.

AirWire F3A/B Drop-In Decoder

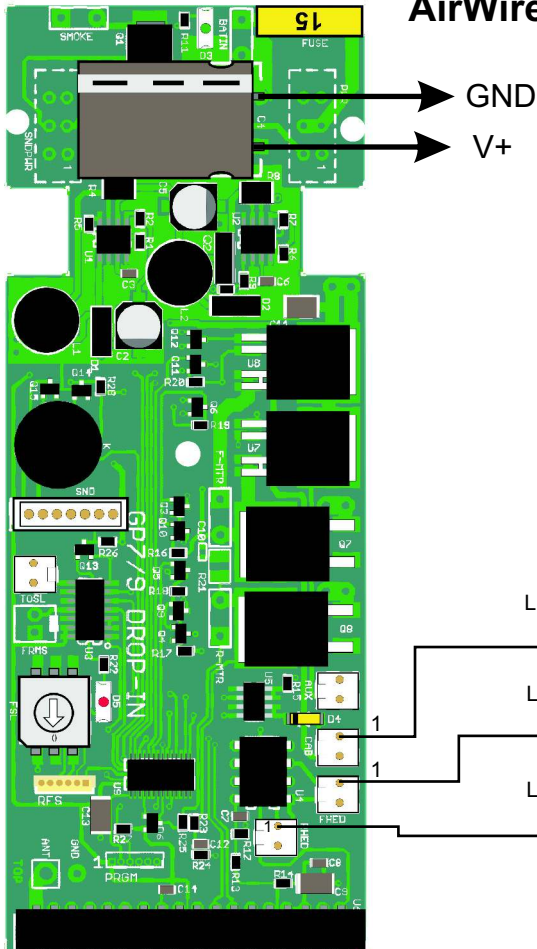
V+ wire is power supply for LEDs. It connects to plus lead of big capacitor, C3 and power supply voltage is equal to battery voltage.

GND wire is the negative lead of the big capacitor, C3. It is ground, or zero volts relative to V+.



Note: Matching plugs with 12 inches of attached wire are available for LED and RL connectors only

AirWire GP7/9 Drop-In Decoder



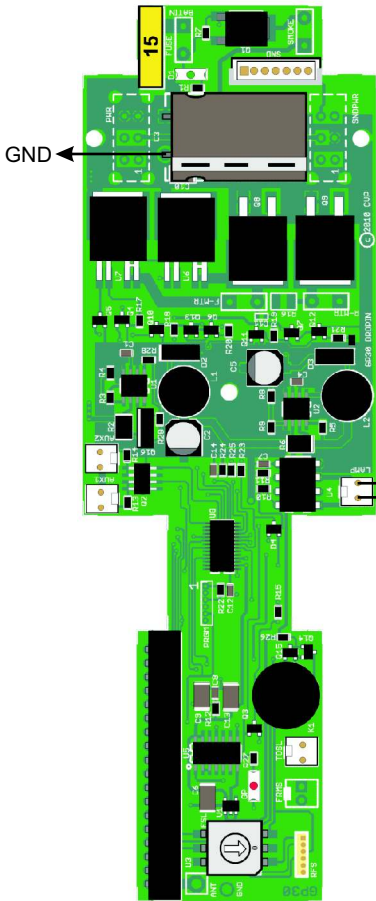
V+ wire is power supply for LEDs. It connects to plus lead of big capacitor, C3 and power supply voltage is equal to battery voltage.

GND wire is the negative lead of the big capacitor, C3. It is ground, or zero volts relative to V+.

Beware that the forward and reverse headlight drivers are low voltage sources of about 4.6 volts.

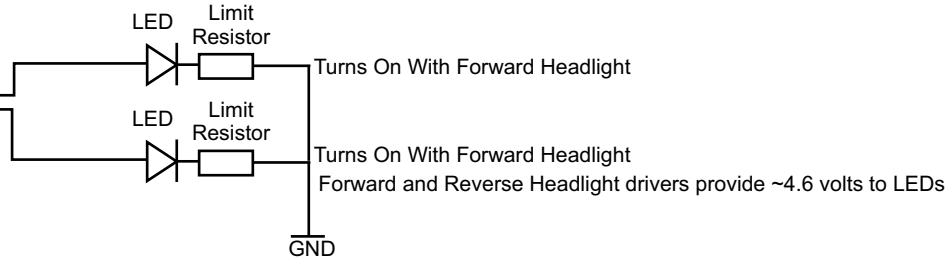
Note: Matching plugs with 12 inches of attached wire are available for CAB, RHED, FHED connectors

AirWire GP30 Drop-In Decoder



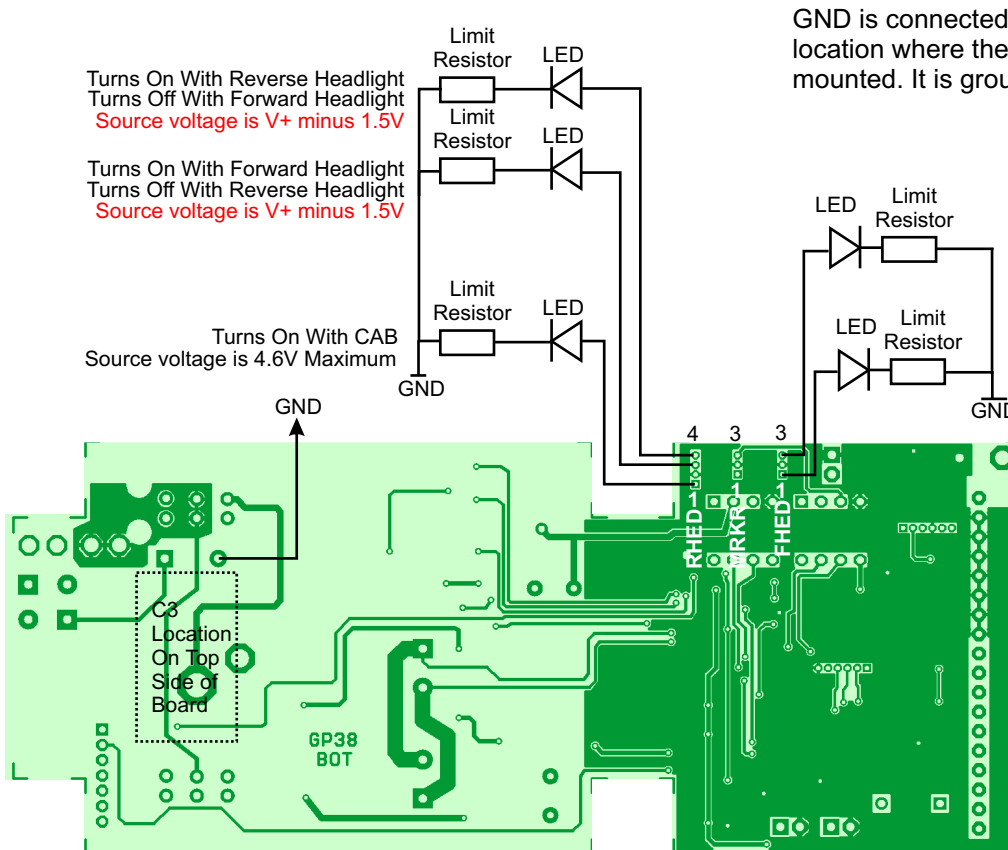
GND wire is the negative lead of the big capacitor, C3. It is ground, or zero volts relative to V+.

Beware that the forward and reverse headlight drivers are low voltage sources of about 4.6 volts.



Note: Matching plug with 12 inches of attached wire is available for LAMP connector.

AirWire GP38-2 Drop-In Decoder



GND is connected to the back side of the circuit board at the location where the negative lead of the big capacitor, C3 is mounted. It is ground, or zero volts relative to V+.

Back side of circuit board shown

Note: Matching plugs are not available - contact USA-Trains if you do not have the matching plugs