

LED's and how to get the best from them

LEDs are used everywhere in the hobby - from control panel lights to signals, as overload warnings, as flashers, for loco and carriage lighting, building lights and in many other places.

They work in all scales and can be big enough to light the layout room or small enough to fit into a hole less than 1mm diameter... They can be bright enough for a locomotive headlight or dim enough to use for a steam era oil-powered loco lamp... or they can pulse gently or even flash like a welding machine arc.

Yet there is very little help or information that is made available for the modeller... We hope that this bulletin will give you the confidence to experiment with LEDs and "brighten" your hobby experience!

About this LED article:

Sometimes we need pictures not words... and we are sure that if we presented you with Ohms law and a lot of complex descriptions, the idea of having fun with LEDs would soon leave... so we've kept most of the reading to page 1 and 2 - the rest is mostly diagrams, separated into sections and spread over several pages to reduce confusion. We've also given you a really easy "tester" to make, so you don't ever need to calculate anything!

Do read page 1 & 2 though, so that you understand the basics before picking up a soldering Iron.

Key things to understand about LED's.

- LEDs are semiconductors (from the same family as transistors and microchips really). They are nothing like incandescent lamps, so how you power & protect them makes a big difference to their performance and life.
- The D in LED stands for diode, so like diodes, they will work only when power flows in the correct direction. (anode to cathode). Additionally, they will prevent power flowing in the reverse direction.
- Reverse voltage tolerance of an LED is very limited, so it will be helpful to protect a diode in an AC circuit by using a diode placed across it in "reverse parallel" as shown a little later on. (If you use DCC power, use a higher speed type such as IN4148 or similar, not a standard low cost rectifier diode)
- + and - can also be called anode and cathode. Being a "consumer of power" the anode is positive, the cathode negative. (for a battery, which is an energy producer, the terminology is reversed)
- Used properly, the reliability of LEDs is exceptional, but if you aren't careful, failure will be immediate.
- LEDs are "current driven" and have no specific voltage at all. "12v" LEDs simply have a resistor built in.

Providing the correct value of resistor is chosen any led can work well with any DC voltage providing it is higher than the forward voltage drop of the LED (typically about 1.5v for red, 2~2.5v for yellow and green and 3~3.5v for blue and white).

- Within the hobby, using a minimum resistor value of 1000 ohms as a "safe baseline" and assuming an average current consumption of 10mA for colours and 20mA for white LEDs will allow us to work with LEDs with confidence between 6 and 18v DC. As long as we use more than 1k ohm our LEDs will always be safe.
- Illumination brightness is not linear in proportion to the LED current consumption that will be set by choosing a combination of voltage and resistance - for example to significantly dim an led that is being used at 12v with a 1000 ohm resistor, you might need to increase resistance to perhaps 5000 ohms or more.

We could just tell you to use "ohms law" to calculate a value but that won't show you the real world brightness at all. It's better to see than guess - and a simple "experimental circuit" that lets you see an actual result will make it much easier for you to choose the right resistor value for the light level you want - so we have drawn it up for you on p3).

- Each led type/colour has different efficiency, so combining two differing LEDs in one circuit needs to allow for that. It usually means that to balance the circuit so both will work, each will need to have its own resistor. We cover that information later on in this article.

Page1 - A little about LEDs
Page 3,4 - Some more LED uses

Page 2,3 - How to use a meter, an LED tester & the basics
Page 5,6 - Using LED with Cobalt point motors & switches.



LEDs are low in cost and fantastically versatile
To see the DCCconcepts range, click on the image



LED's and how to get the best from them

A multimeter can be a useful tool, but many modellers just cannot understand how to use one.

Here are the basics - Because they are quite low cost, it is easy for us to assume that you have a digital multimeter. If you don't own one, you should, but please don't go too cheap... you get what you pay for!

By the way - digital multimeters need power to work... so it may be time for you to change the battery!

Using a multi-meter to measure resistance:

- (1) Turn the meter on (is the battery still ok?)
- (2) Red probe into the socket marked V and Ω
- (3) Black probe into the common socket
- (4) Set selector to "Ohms" or " Ω " setting
- (5) If available, set range to "auto"
- (6) Place the tips of red and black probes either End of the resistor or item being measured.
- (7) Read the meter. Look for any scale indicator Such as R (individual ohms) K (thousands) or M (millions) and interpret the result.

Examples:

1.5 with the letter K on the screen would be 1,500 ohms (1.5k ohms)

1.5 with the letter M On the screen would be 150,000 ohms.(150k ohms)

Using a multi-meter to measure voltage:

- (1) Steps 1/2/3 are as per measuring resistance
- (2) Set selector to "DC Volts" if measuring DC Or "AC" if measuring AC or DCC volts
- (3) Set the range to "auto" or V and not MV (MV is only for small fractions of a volt)
- (3) Place the red probe tip on what you think is the positive or + wire and the black on the negative or - wire. Read the meter.
- (4) If you see a "-" at the left side you have it backwards so swap the probes over to correct the polarity.
- (5) Read the meter.

At the voltages we use for model trains it should be clear...

12.25 will mean exactly that many volts!

Using a multi-meter to measure current draw (amps):

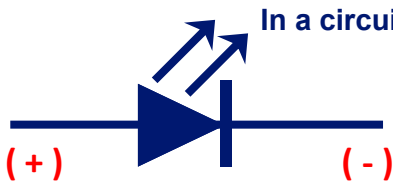
The circuit needs to be under power to measure current draw. We are measuring the power that passes THROUGH a device so the meter probes therefore need to go IN SERIES with one power wire, between the power wire supply source and the circuit or item being measured.

- (1) Turn the meter on (Did you remember to change the battery if you've had it more than a year?)
- (2) Put the RED probe into the meter socket marked 10A (10 amps) unless you KNOW the current draw, mA if you are certain it is less than one amp, μ A if you are sure its less than 0.1 amp.
- (3) Put the BLACK probe into the meters common socket.
- (4) Set selector to 10Amp range (or μ A or mA if you are sure that it is going to be less than one amp).
- (5) If the option is available, set the meters ranging option to "auto".
- (6) Disconnect one wire between the power supply and the item or circuit being tested.
- (7) Connect the RED probe to the + output of the power supply if DC, either if it is AC or DCC.
- (8) Connect the BLACK probe to the power input wire on the item/circuit you just disconnected
- (9) Read the display. 1.1 will mean 1.1 amps. 0.15 will mean 150milliamps or 15/1000'ths of an amp. 0.01 will mean 1/100th or 10/1000ths of an amp.

What do all coloured bands on resistors mean?

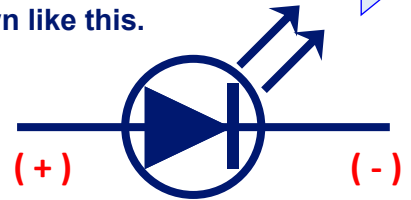
Type "**resistor colour codes**" into google or your favourite web search engine and you will find the answer in detail. There may also be a resistance colour band calculator available there to play with!

LED's and how to get the best from them



In a circuit diagram light emitting diodes can be shown like this.

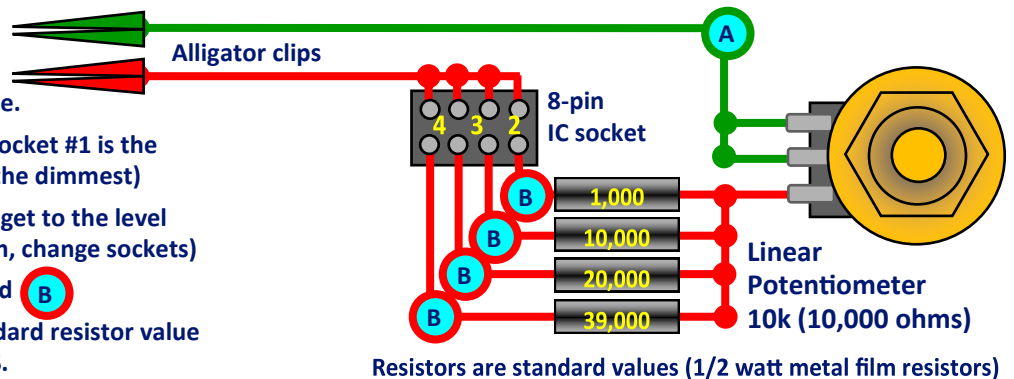
Note the polarity indicators. If power is connected correctly, the LED will light
But if polarity is reversed, power will not flow and the LED will not work



The simple-to-make LED resistor value selector

Using the resistor selector:

- (1) Connect the alligator clips to The power source that you will use.
- (1) Put LED into sockets 1, 2, 3 or 4 (socket #1 is the brightest possibility, socket #4 is the dimmest)
- (2) Turn the potentiometer until you get to the level you want. (If still too bright or dim, change sockets)
- (3) Measure between points **A** and **B**
- (4) Use the nearest appropriate standard resistor value when you are installing your LEDs.

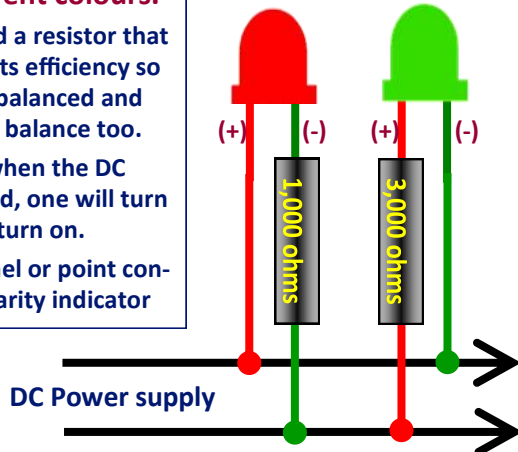


Two LED, different colours.

Each LED will need a resistor that is appropriate to its efficiency so that the circuit is balanced and light levels stay in balance too.

In this example, when the DC polarity is reversed, one will turn off and the other turn on.

Uses - control panel or point control indicator, polarity indicator

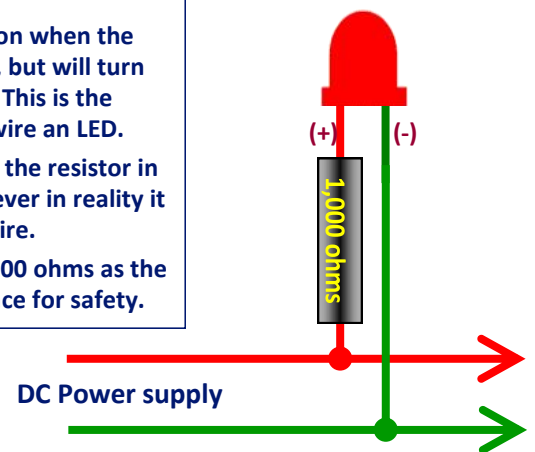


One LED

The LED will turn on when the polarity is correct, but will turn off when it is not. This is the standard way to wire an LED.

Best practice puts the resistor in the (+) wire, however in reality it can be in either wire.

Standardise on 1000 ohms as the minimum resistance for safety.

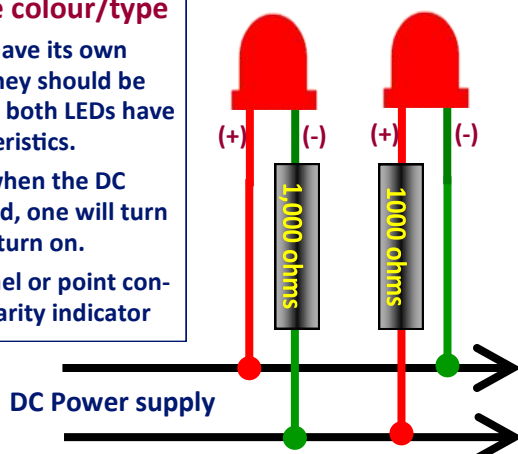


Two LED, Same colour/type

Each LED should have its own resistor ideally. They should be the same value as both LEDs have the same characteristics.

In this example, when the DC polarity is reversed, one will turn off and the other turn on.

Uses - control panel or point control indicator, polarity indicator

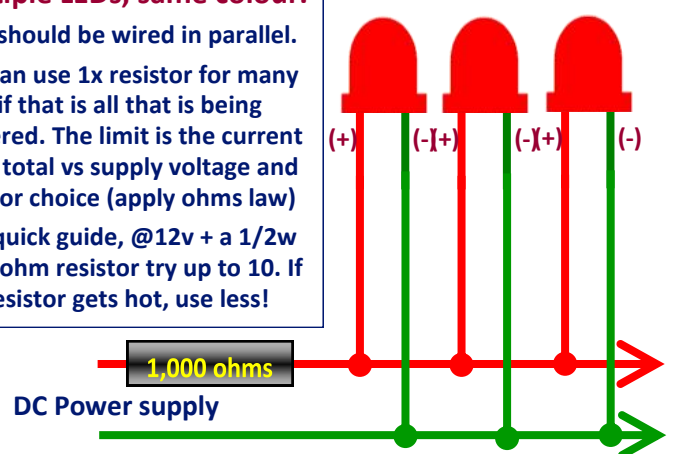


Multiple LEDs, same colour.

LEDs should be wired in parallel.

You can use 1x resistor for many LEDs if that is all that is being powered. The limit is the current draw total vs supply voltage and resistor choice (apply ohms law)

As a quick guide, @12v + a 1/2w 1000 ohm resistor try up to 10. If the resistor gets hot, use less!



LED's and how to get the best from them

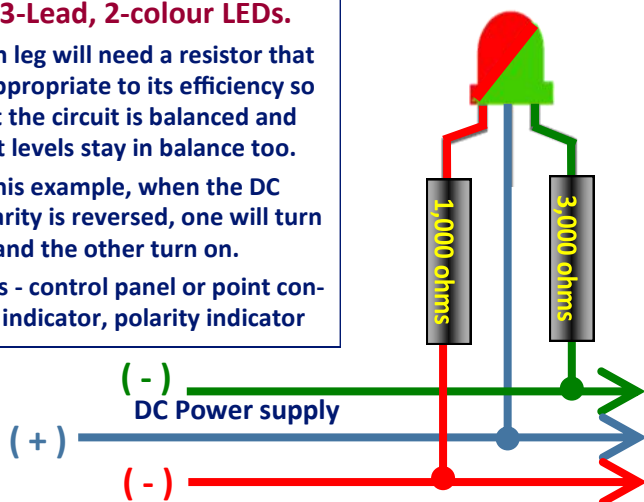
More basic LED applications... most of which are usable in control panel creation as indicators for turnout position etc. However - before you commit to "red/green control panels, consider how it might look with a whole complex track area done this way. Are you SURE it might not be better to stay with ONE colour, and only the tracks that are active lit up?

(e) 3-Lead, 2-colour LEDs.

Each leg will need a resistor that is appropriate to its efficiency so that the circuit is balanced and light levels stay in balance too.

In this example, when the DC polarity is reversed, one will turn off and the other turn on.

Uses - control panel or point control indicator, polarity indicator

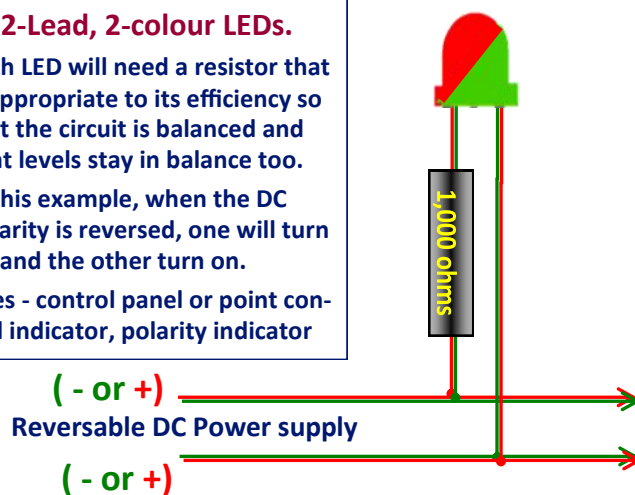


(f) 2-Lead, 2-colour LEDs.

Each LED will need a resistor that is appropriate to its efficiency so that the circuit is balanced and light levels stay in balance too.

In this example, when the DC polarity is reversed, one will turn off and the other turn on.

Uses - control panel or point control indicator, polarity indicator

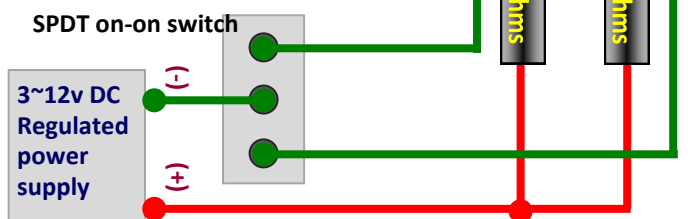
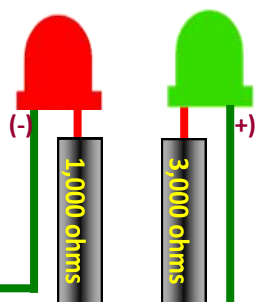


(g) Simple LED switching circuit (one led off, other LED on)

For those who have not wired LEDs before, here is a typical bit of wiring for an application that turns off one LED while turning on another.

Examples would be indicator lights on a control panel or simple colour light signal switching

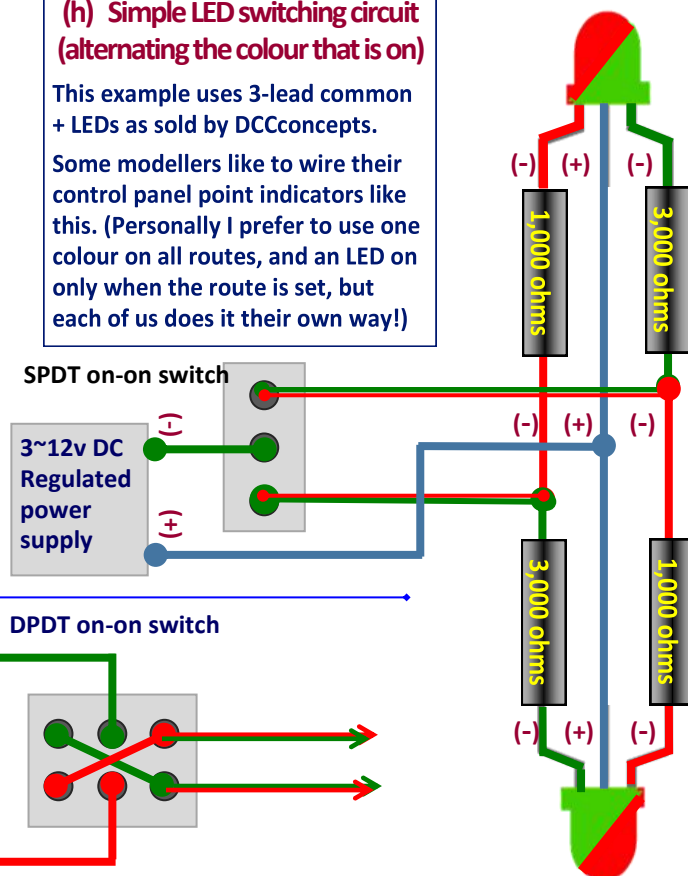
*All red/green Examples use
3-lead common Positive
LEDs sold by DCCconcepts.*



(h) Simple LED switching circuit (alternating the colour that is on)

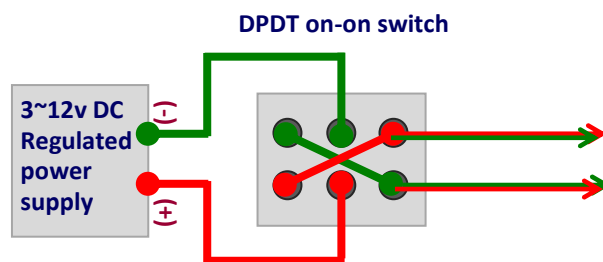
This example uses 3-lead common + LEDs as sold by DCCconcepts.

Some modellers like to wire their control panel point indicators like this. (Personally I prefer to use one colour on all routes, and an LED on only when the route is set, but each of us does it their own way!)



How to wire a... Double pole Double throw on-on (changeover) switch

Wire a dpdt switch like this to reverse the polarity of a DC power supply - useful for reversing a DC train/motor or for connecting LED circuits such as those in (a), (c) and (f) in these pages.



Change the switch and the output polarity will change.

We hope that you have found this article useful. It is one of many advice-type documents that we've made available on our website at www.dccconcepts.com. If you need more, email questions@dccconcepts.com

LED's and how to get the best from them

Adding LEDs to Cobalt Turnout motors:

Electronically, stall motor types do vary, and there are actually three different types of Cobalt motor. Each type needs a different approach to adding LEDs. Cobalt motors have lots of built-in switching too, so they also allow you more than one way to add control panel LEDs. How you choose to do it is up to you, but be sure you use the method that specifically suits your motors!

Standard DC powered Cobalt Motors

This includes original **Cobalt Classic** and the new **Cobalt Ω (Omega)** turnout motors.

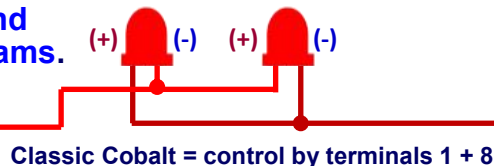
The motor drive in these types has constant DC power, with the polarity reversing to change the turnout.

The combination of the motors own internal resistance plus any resistances within the drive circuit inside the motor provide enough resistance, so you can connect LEDs directly in-line with a motor lead without the need to add a resistor, providing you are using DCCconcepts recommended drive voltage range of 9~12v DC or utilising a DCCconcepts AD series accessory decoder.

Adding panel LEDs is simple and can be done as per these diagrams.

- (1) Two LEDs put back-to-back in one lead from the DC Power supply

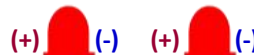
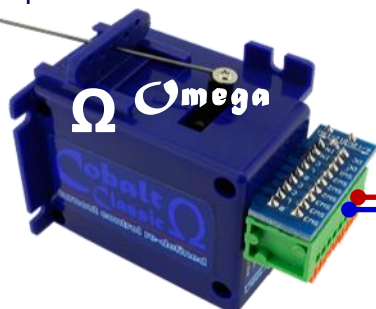
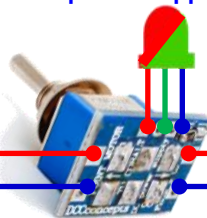
12v DC Power Supply
(regulated)



NOTE: if you use green or blue LEDs, please use a 12 volt DC power supply as they drop 2~3 volts

- (2) Bi-Colour LED and switches that are in the DCCconcepts switch packs

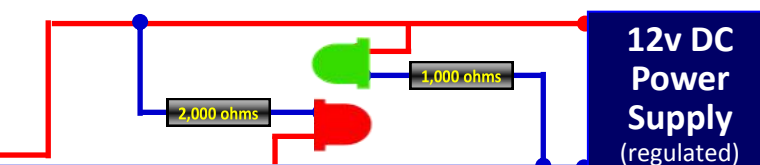
12v DC Power Supply
(regulated)



Cobalt Ω (Omega) = control by terminals 1 + 2.

12v DC Power Supply
(regulated)

IF YOU ARE NOT USING OUR SWITCHES, WE THINK THIS IS THE BEST WAY TO DO IT



Placing the LEDs across the power supply wires is the BEST way.
This is also a better way if you're using red & green as you can vary the resistor values to match the light output levels of the two LED colours.

LED's and how to get the best from them

Continued...

Adding LEDs to Cobalt iP Analog turnout motors:

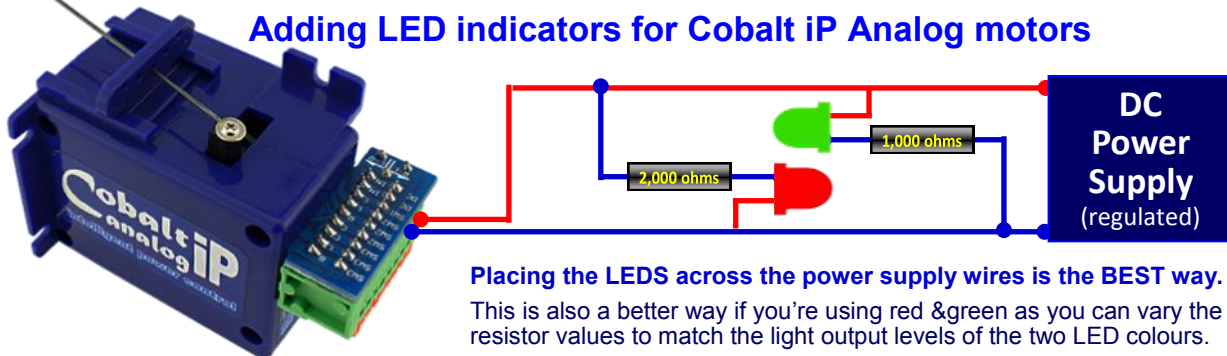
Cobalt "Intelligent power" motors such as Cobalt iP Analog and Cobalt iP Digital manage their power use quite differently to the Cobalt classic and the Cobalt Ω Omega, and this means we cannot use the same methods for adding LED indicators to our control panels

This is because the current draw varies during the throw cycle. While Cobalt iP motors typically draw less than 4 mA while static and waiting to be thrown, the current draw rises and falls as they change, with peaks at between 40 and 60mA for less than a second at the mid point of the throw.

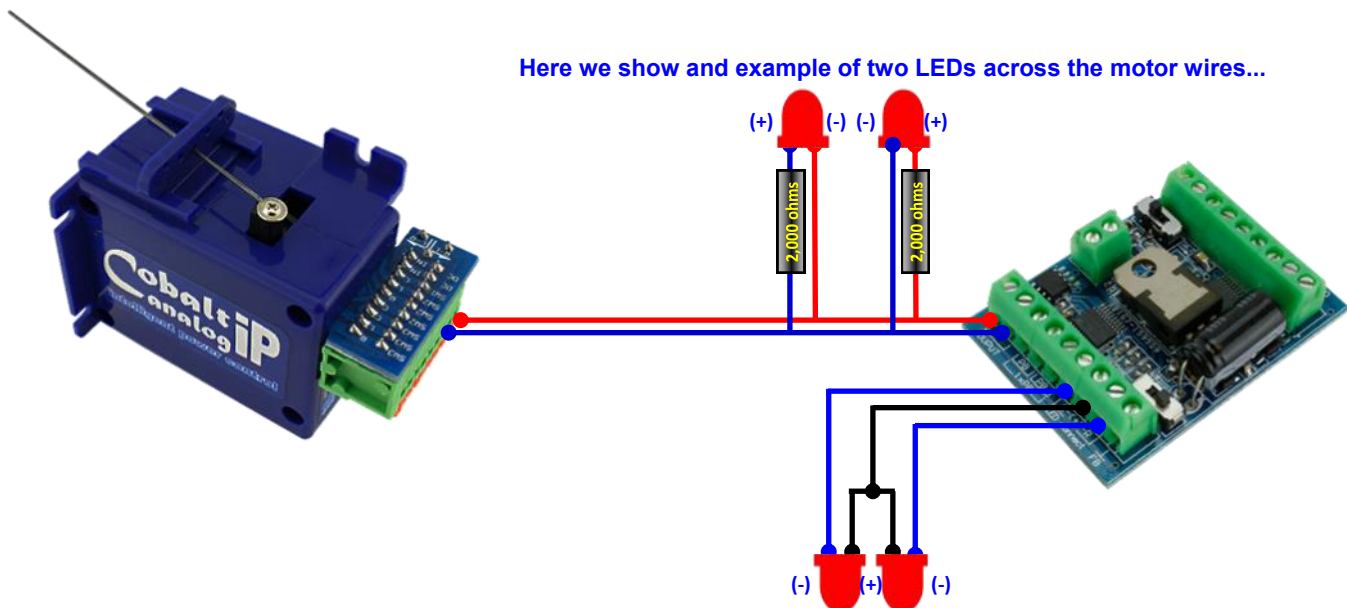
It is therefore not possible to use an LED inserted into the power supply lead. Doing that would simply destroy the LED and leave an open circuit so that the motor would no longer work.

Fortunately Cobalt iP Analog and Cobalt iP Digital offer several other ways to add Panel LEDs that are equally easy AND in some ways better, as they have the advantage that the illumination level will not vary as the motor moves (Inline LEDs DO dim and vary in brightness as the motors change).

Adding LED indicators for Cobalt iP Analog motors



Here we show an example of two LEDs across the motor wires...



Of course, if you use DCCconcepts AD-2fx or AD-8fx decoders... With **EITHER** Cobalt iP Analog or Cobalt Ω Omega - you have the choice of adding the LEDS to the decoder (or you can use decoder outputs for other things like computer I.O. or light-signal control)

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LED's and how to get the best from them

Continued...

Adding LEDs to Cobalt iP Digital turnout motors:

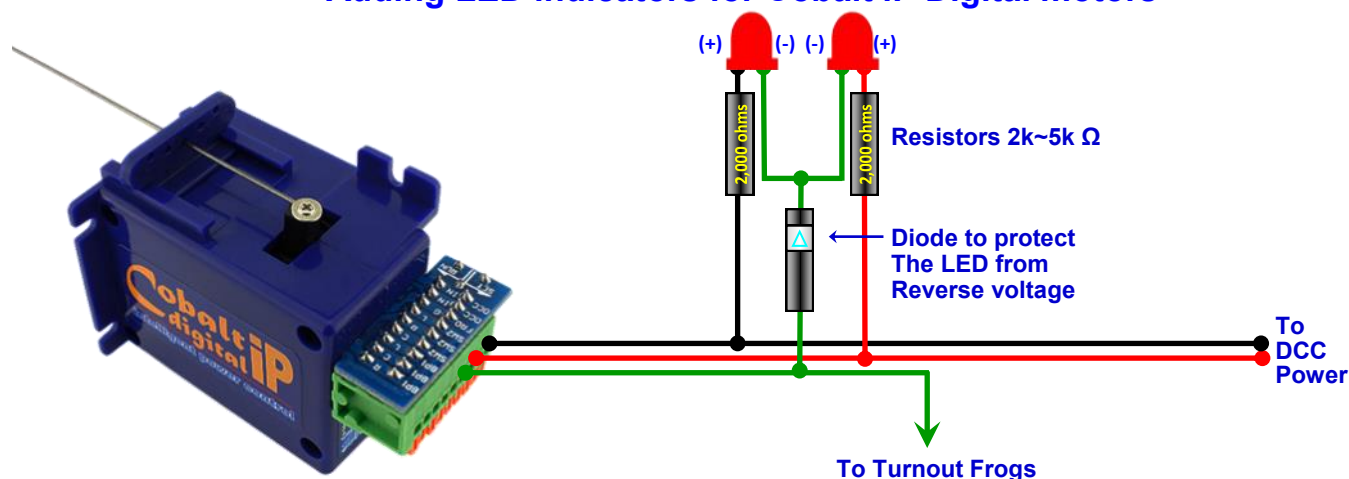
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Fortunately Cobalt iP Digital offers other ways to add Panel LEDs that are equally easy AND in some ways better, as they have the advantage that the illumination level will not vary as the motor moves (Inline LEDs DO dim and vary in brightness as the motors change).

Adding LED indicators for Cobalt iP Digital motors



Cobalt iP Digital can also control LEDs via the SPDT changeover switch that is built in, however you may wish to reserve this for other things...

Therefore DCCconcepts have decided to introduce a neat new pack of control panel LED + switch combinations early 2015.

This will have switches with integrated LEDs that can add manual control for your Cobalt iP digital at the control panel.

They will also feature on-board memory so they remember all of the turnout positions even after power has been turned off!

The part numbers of these switches will be as follows

DCP-DMG - Digital Switch pack, **Green** TACT switches

DCP-DMR - Digital Switch pack, **Red** TACT switches

DCP-DMB - Digital Switch pack, **Blue** TACT switches

Delivery of all three types is expected March/April 2015

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