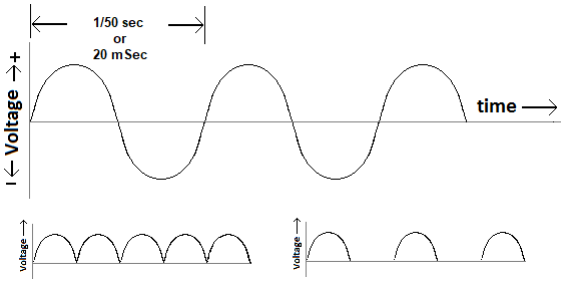
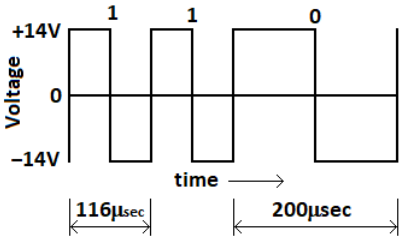
When is DC "not DC"?

by David Crosby. October, 2018.

All sorts of electronic accessories are used these days on model railway layouts. Most of these run off a DC supply. Direct Current – DC – is a supply of electricity, ideally at a constant voltage. A battery supplies such a constant voltage. However, supply often comes from a source that was originally alternating current, or AC. The mains supply that is the usual source of this varies from zero to plus 338 volts to zero to minis 338 volts and back to zero 50 times per second. This gives an effective overall voltage of 240. (See first waveform below.) One wire of the supply is ***alternately*** positive and negative with respect to the other wire.



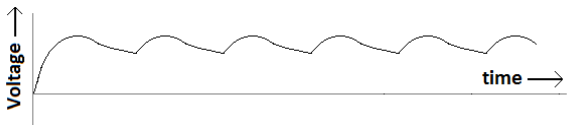
This can be "rectified" resulting in either the second waveform (full wave rectified) or the third waveform (half wave rectified.)In both cases, one wire is always positive with respect to the other, so it is classified as DC. However, it is a varying DC waveform, and has instants when it is zero, which can be seen especially in the half wave rectified form. This is the form of "DC" produced by early train controllers. It was only used to power locomotives, and the varying nature of the waveform did not affect the motors, since their mechanical inertia smoothed out the variations.



DCC control uses a form of alternating current, at a much higher frequency than mains AC. It must still be rectified to be used as DC to power electronic devices, and although the "DC" produced has much less variation than that provided from mains sourced AC, it still has instances when it drops to zero.

It is these times when the voltage is zero that causes problems to electronics. They do not work during that period, and many of them will restart from their beginning after the voltage rises to a usable level again.

To overcome this, we must use a capacitor, which stores up electrical charge during the higher voltage part of the cycle, and releases it during the low part. This result is a waveform that looks like the diagram at right for a mains AC derived supply. The variation in voltage between the minimum and maximum value is called the "ripple" voltage.



Supplies derived from DCC need much smaller capacitors, but still need something to avoid the times of zero voltage.

Modellers using old controllers to supply DC accessories can get caught out by this problem if they do not provide some capacitance to smooth out the waveform. Their "DC" supply is strictly speaking still DC, but it is unsuitable for use as a DC source for electronic devices without some smoothing capacitance. A rough estimate of the size of the capacitor needed is

10 times the current needed in milliamps, divided by the acceptable variation in voltage. This should have a voltage rating at least 50% greater than the supply voltage. If a 12 volt supply is being used to provide 150mA. and a ripple variation of 2 volts in the output is acceptable, the capacitor needed is 10 X 150 / 2 which is 750uF, at a voltage of at least 18 volts. Practically one would use 1000uF at 25 volts.

DC supplied by a switched mode power supply (SMPS – the usual form of a modern plug pack) is usually already a much purer form of DC, with no further need of treatment.

Your DC may be DC, but is it a suitable form of DC?