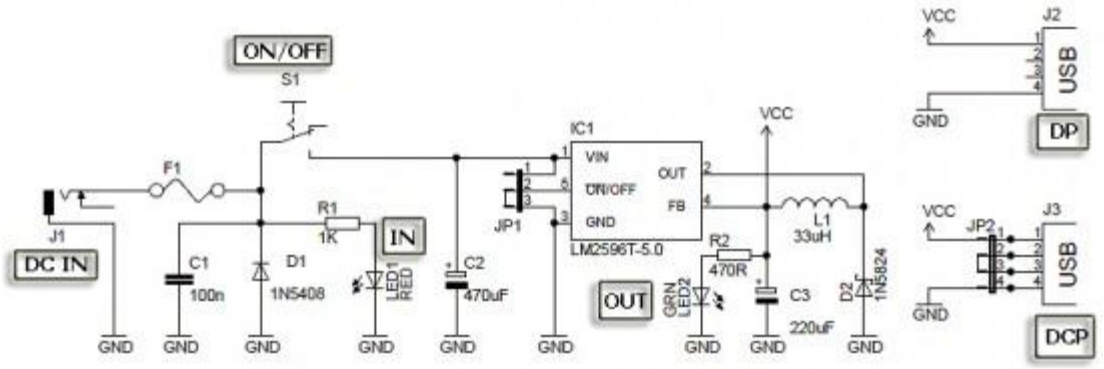
USB Car Charger

This usb car charger was designed with the aim of providing an onboard usb power outlet for charging/running portable usb devices. This circuit is an improved version of the usb power socket circuit published years ago in Electronics For You. At the time, this was designed around a step-down linear regulator chip. The aim of the present design, based on a step-down switching regulator chip, is to create a usb power outlet that has more efficiency which can cope with higher current requirements, so that it also becomes suitable for more powerful standard usb devices and non-standard usb decorations. A switching voltage regulator is a handy weapon in the battle to reduce heat dissipation in circuits. The buck-converter chip in this circuit can handle input voltage up to 40 V, and can deliver an output current of up to 3 A. Note that the circuit is principally designed for use with an in-dash cigar lighter socket, because this mode of operation is particularly practical in automobiles.

Schematic of the USB Car Charger Circuit



Circuit Description

The DC voltage delivered by the car battery is routed to the input socket (J1) of the circuit through the indash cigar lighter power socket. The fuse (F1) and diode (D1) are wrong polarity/overcurrent circuit protection components and the capacitor (C1) is a smoothing element. When on/off switch (S1) is turned to its on position, this input supply is extended to the rest of the circuit, and the power input indicator (LED1) lights up.

The switching regulator (buck converter) circuit is built around the LM2596,and is mostly based on the design given in the device's datasheet. The LM2596 series of regulators are precision monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3A load with excellent line and load regulation. These regulators operates at a switching frequency of 150 kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators.

Here, the 5V fixed output version LM2596T-5.0 (IC1) is used as the switching regulator. Note that the output available is highly dependent on the quality of inductor (L1) and output capacitor (C3). For the inductor, the dc current and resistance ratings are critical in addition to its inductance. For the capacitor, a low ESR is essential. The green LED

(LED2) is the power output indicator. Stable 5V dc output from IC1 is branched into two usb outputs, named DP (Decoration Port) and DCP (Dedicated Charging Port). DP port can be used to run non-standard usb gizmos like usb reading lamp, heater, fridge, etc. The DCP is reserved only for charging standard usb devices including smart phones and tablets. The jumpers JP1 and JP2 are reserved for circuit enhancements. By default, pins 2&3 of JP1 and JP2 are bridged independently for standard operation. Infact, jumper JP1 can be used to add special features like under-voltage lock out (UVL), and JP2 can be used to carry out some usb trickery!

Components List

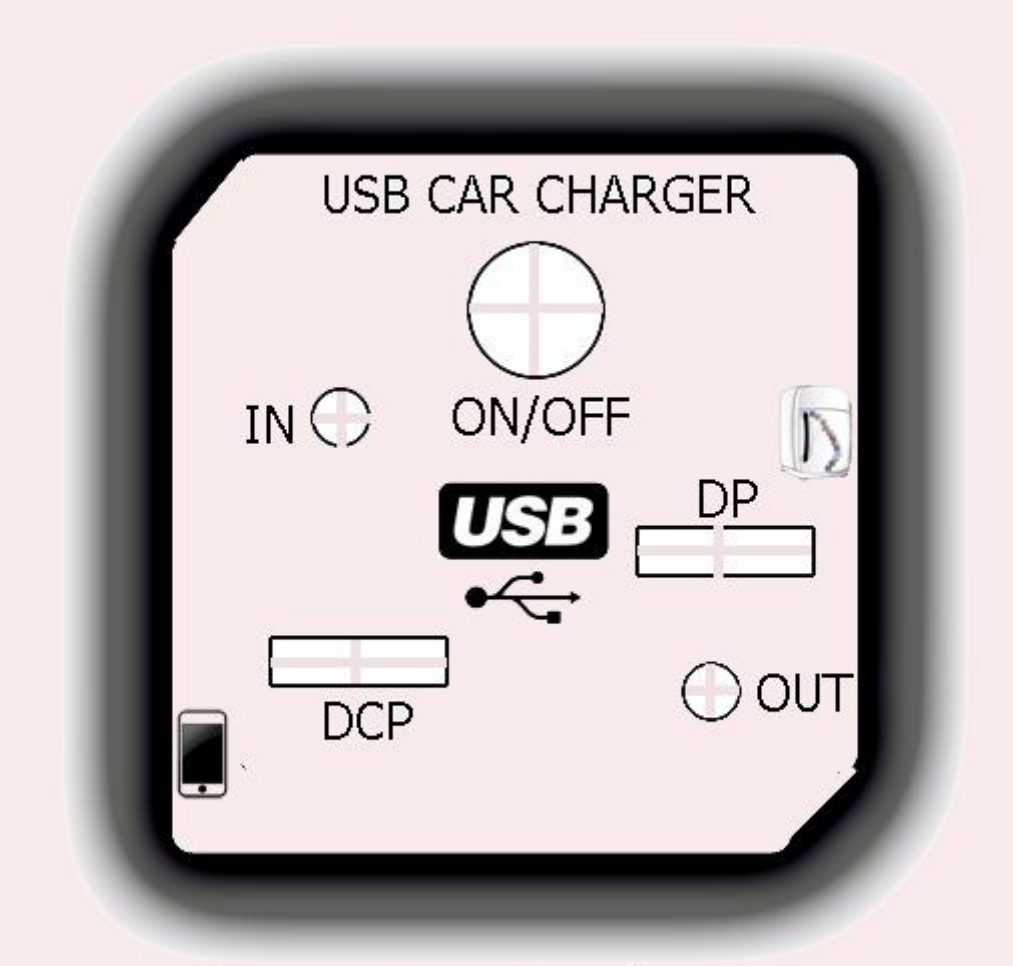
- IC1: LM2596T-5.0*
- D1: 1N5408
- D2: 1N5824*
- LED1: 5mm Red
- LED2: 5mm Green
- L1: 33uH/3Amp* – Designed for National's 150KHz Simple Switcher
- C1: 100nF
- C2: 470uF/25V* – Low ESR Aluminium Electrolytic Capacitor
- C3: 220uF/25V* – Low ESR Aluminium Electrolytic Capacitor
- R1: 1K ¼ w
- R2: 470R ¼ w
- S1: SPST on/off switch
- J1: DC socket
- J2-J3: USB (A) sockets
- F1: 4Amp Fuse (test selected)

* crucial components

USB Charging

According to the USB Battery Charging Specification, a device plugged into a USB port to charge may find itself connected to a source that is capable of data transfer as well as power, or it may be connected to a source that provides power only. If the source supports data, the device is expected to do a trickle charge only, but if the source does not support data, the device may draw more current because the source is likely to be an ac adapter. So if you want to charge your smart phone as fast as possible with the USB car charger, it may become necessary to join the usb data pins together, which is the spec-compliant way to indicate that the usb power source does not support data (more details available on Wikipedia).

Construction



SUGGESTED FRONT PANEL/ENCLOSURE

Building up the usb car charger should not present undue difficulties if you follow the components list and (ofcourse) the datasheets of crucial components used. It is recommened to build the system on a small circuit board. Having verified the circuit works properly, you are ready to fit the wired circuit board in a suitable enclosure with the suggested front panel. The enclosure may be finished to individual taste.