

## PI5USB266 Car Charger design with PI5USB266 by Noyes Mok

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### 1. Introduction

Pericom's PI5USB266 is USB charge controller IC which suitable for the dual USB port charger design in different application, for example automotive and home appliance. PI5USB266 supports most of the charging protocols for the portable device and the USB device can be drawn the current efficiently to charge itself.

This application note describes how to use PI5USB266 to design a dual USB port charger for automotive application (USB car charger). This design is fulfill the Battery charger specification BC1.1 / BC1.2 and YD/T-1591 Chinese Telecom Standard. It also supports the non-standard protocol such as Apple 2.1A charging mode.

## 2. Overview

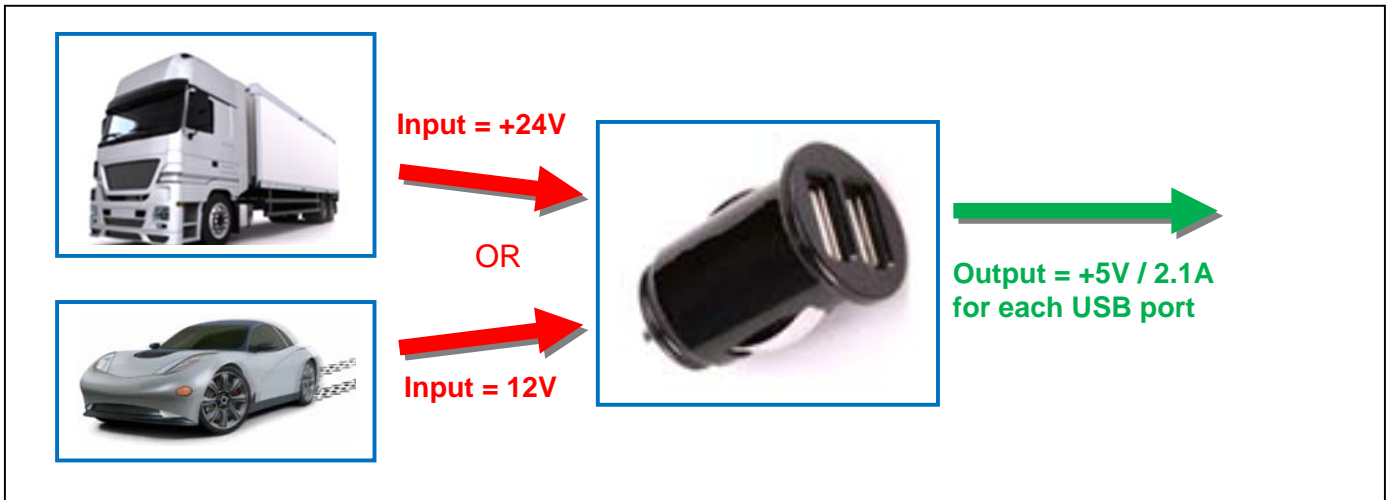


Figure 1, Block diagram for car charger application

### Input voltage

The typical output voltage of the cigarette lighter socket is 12V (car) or 24V (truck), therefore the input voltage supply for the car charger should be support up to at least 36V.

### Output voltage

According to the USB organization, the VBUS output voltage of USB port should be 5V (nominal) with tolerance of  $\pm 5\%$  (4.75V to 5.25V), therefore, the output voltage of the car charger should be followed this requirement.

### Output current

PI5USB266 can support Apple 2.1A charging mode, therefore the maximum output current for each port on car charger should support 2.1A which means the total current should be about 4.2A.

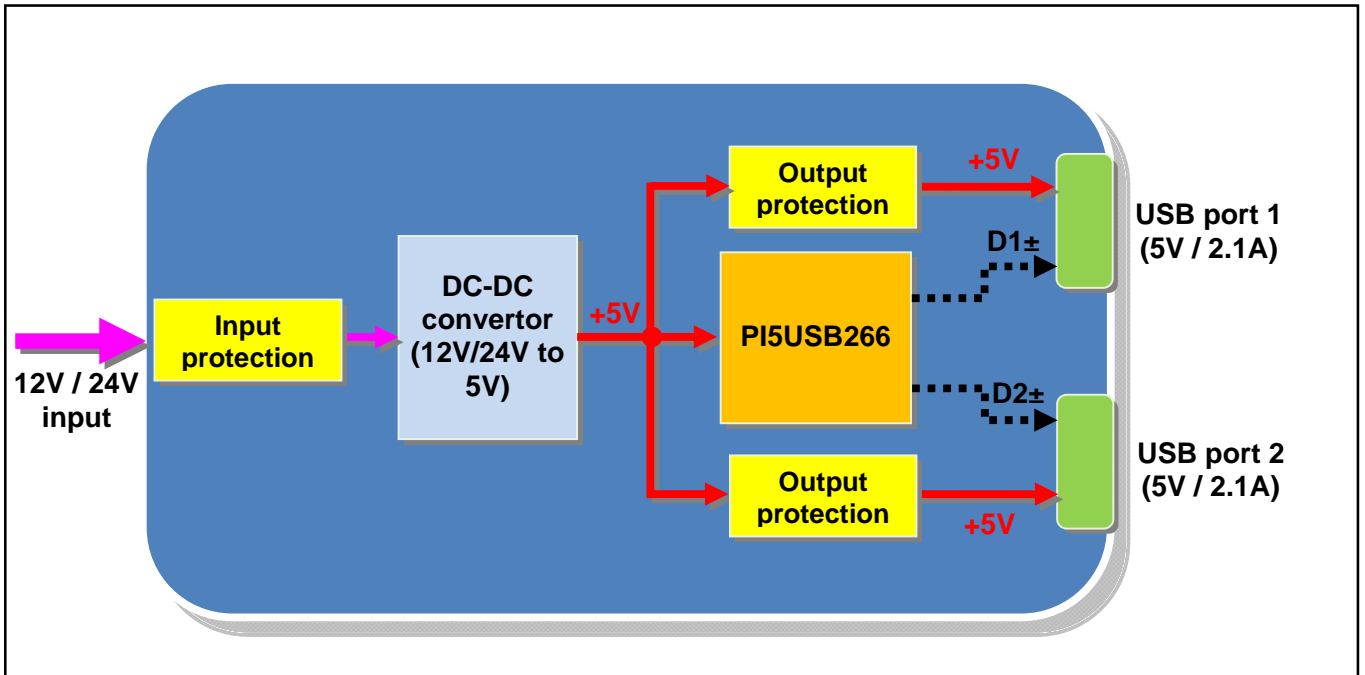


Figure 2, Block diagram of the PI5USB266 dual USB port car charger

The car charger should be divided to few parts:

- a) PI5USB266 – charging mode detection
- b) Input Protection: Over voltage Protection
- c) DC- DC convertor
- d) Output Protection: over current protection / Thermal protection / UVLO

## 2.1 PI5USB266 – charging mode detection

PI5USB266 is an intelligent charging IC which is detecting the USB data line voltage of the mobile device and providing the suitable charging mode to let the mobile charge in efficient way.

PI5USB266 requires  $+5V \pm 10\%$  input supply voltage on Vdd pin (Pin 12 & Pin 16) and 0.1uF or greater value decoupling capacitor should be mounted as close to each Vdd pin.

D1+ (Pin 3), D1- (Pin 4) and D2+ (Pin 7), D2- (Pin 8) are connected to the D+ and D- pins of the USB receptacle connectors. The D1± and D2± are performed as Apple 2.1A charger after power up. Once the mobile device plug into the USB port, PI5USB266 will check the D± voltage then identifies the attached mobile device type and provides the correct charging mode. When the mobile device recognized the correct charging mode from D± pin of the USB port, mobile device will draw the current that it required. D1± & D2± can do the mode detection separately.

S1 (Pin 5) and S2 (Pin 9) are the control pin of PI5USB266 and both pins should tie to ground for normal operation.

For details, please refer to below schematic for PI5USB266 session

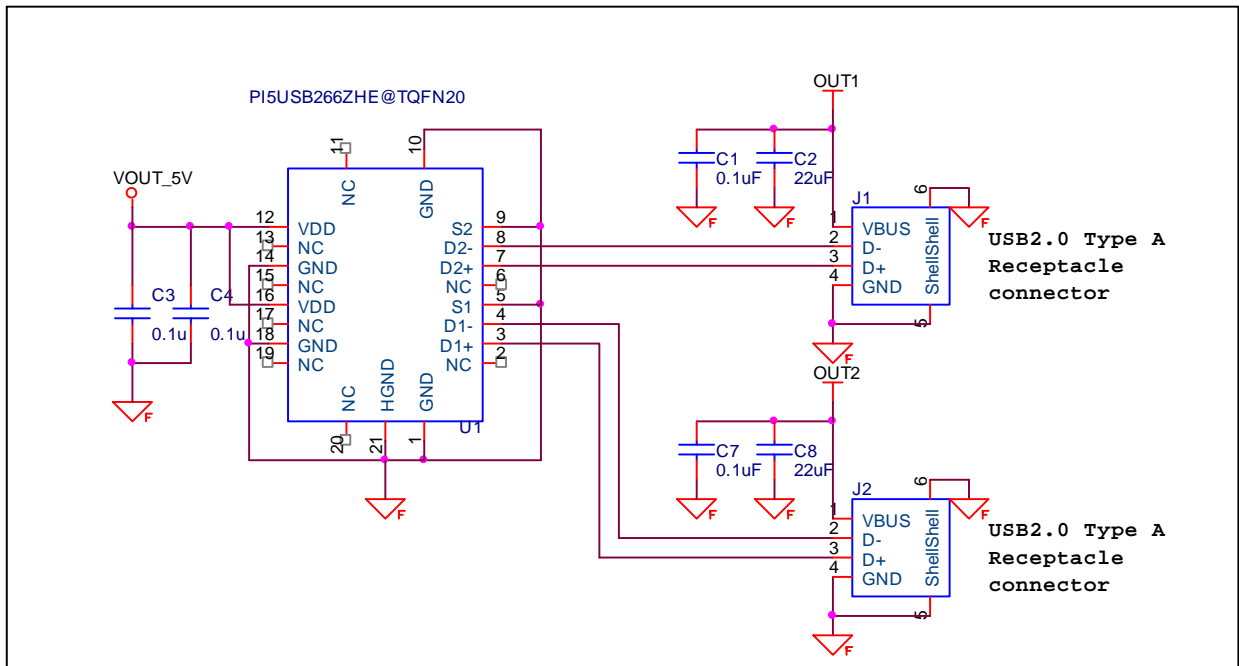


Figure 3, Schematic of PI5USB266 with USB connectors

## 2.2 Input Protection

The instant pulse / surges voltage level may burn the car charger. The lowest cost solution is adding a 5A fuse implemented between the input of the DC-DC convertor and the output signal of the cigarette lighter socket as protection.

An additional protection way is adding the unidirectional transient-voltage-suppression (TVS) diode. TVS diode presents high impedance to the protected circuit. The TVS diode junction avalanches providing a low impedance path for the transient current when the voltage is exceeded the normal operating voltage.

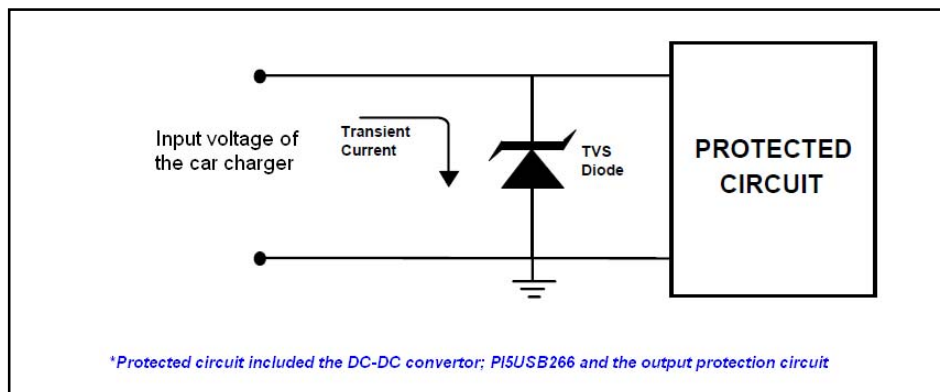


Figure 4, TVS connection diagram

## 2.3 DC-DC convertor

PI5USB266 can let the portable device charge up to 2.1A for each USB port. In this dual USB car charger mode design, the DC-DC convertor need to convert the output voltage of the car / truck cigarette socket 12V / 24V to 5V (4.75V to 5.25V) with output current  $\geq 4.2A$  high current output DC-DC converters can be found from Linear Technology and AXElite Technology Co. Ltd.

## 2.4 Output Protection

If the DC-DC convertor part didn't have the under-voltage lockout (UVLO), short circuit protection and thermal protection, external output protection circuit on VBUS pin is required. This circuit is not only protecting the car charger itself but also protecting the mobile device not to be burned.

One of the suggestions is using the Vbus power switch at Vbus pin for each USB port. Pericom's PI5PD2068 (EN pin = active Low) and PI5PD2069 (EN pin = active high) are the power switch which limited the current draw up to 2.85A (typ.). Once the short-circuit situation is presented, PI5PD2068 / PI5PD2069 will limit the output current by switching into a constant-current mode and enable the over-current pin (OC# pin).

The heavy overloads / short-circuits will increase the power dissipation in the switch which causing the junction temperature rising ( $> 135^{\circ}C$ ), then the thermal protection circuit in PI5PD2068/PI5PD2069 will turn off the switch to prevent damage. PI5PD2068 / PI5PD2069 will remain off until the junction temperature cools down to approximate  $125^{\circ}C$  and the switch will recover automatically.

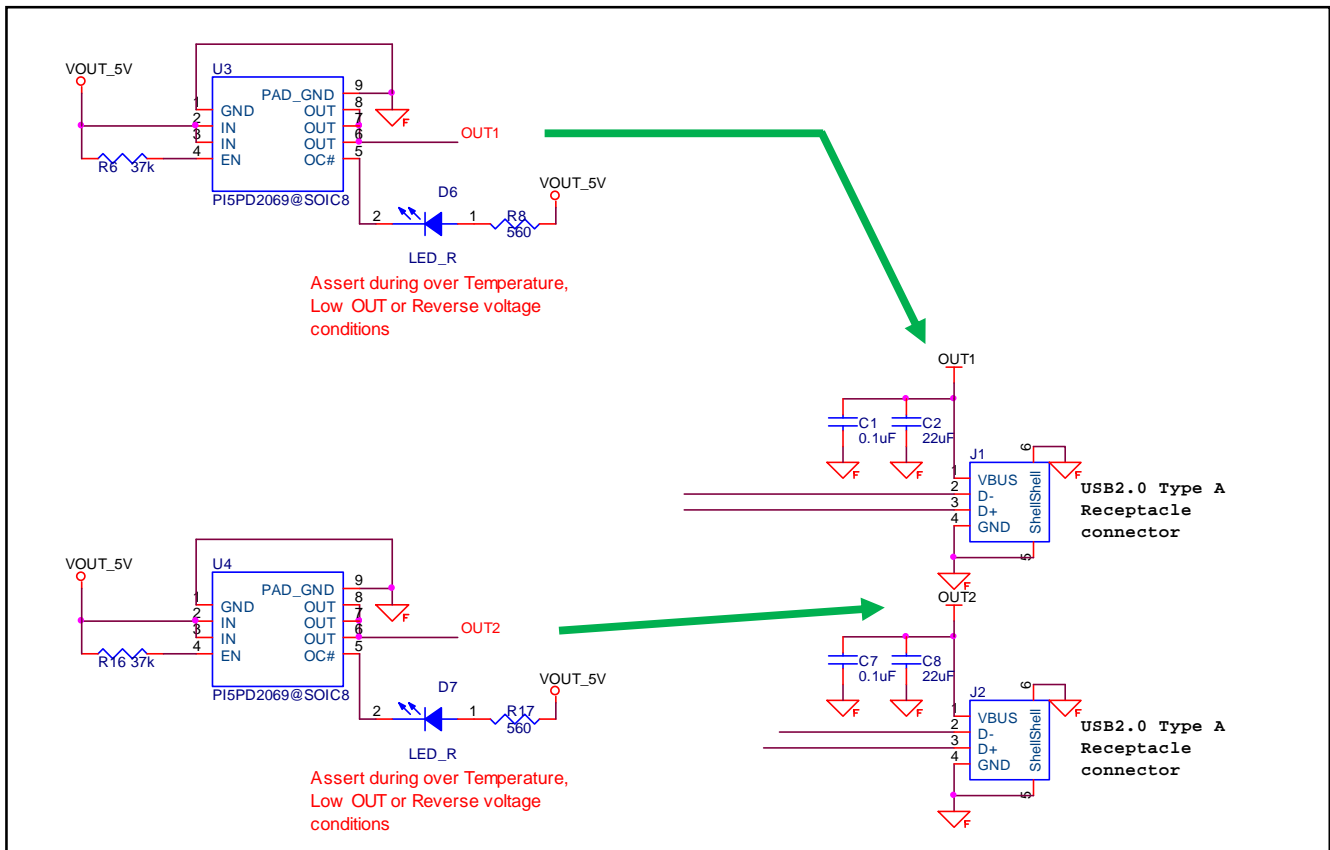


Figure 5, Schematic of Power switch (PI5PD2069) with USB connectors

### 3. Typical Schematic for Dual USB port car charger

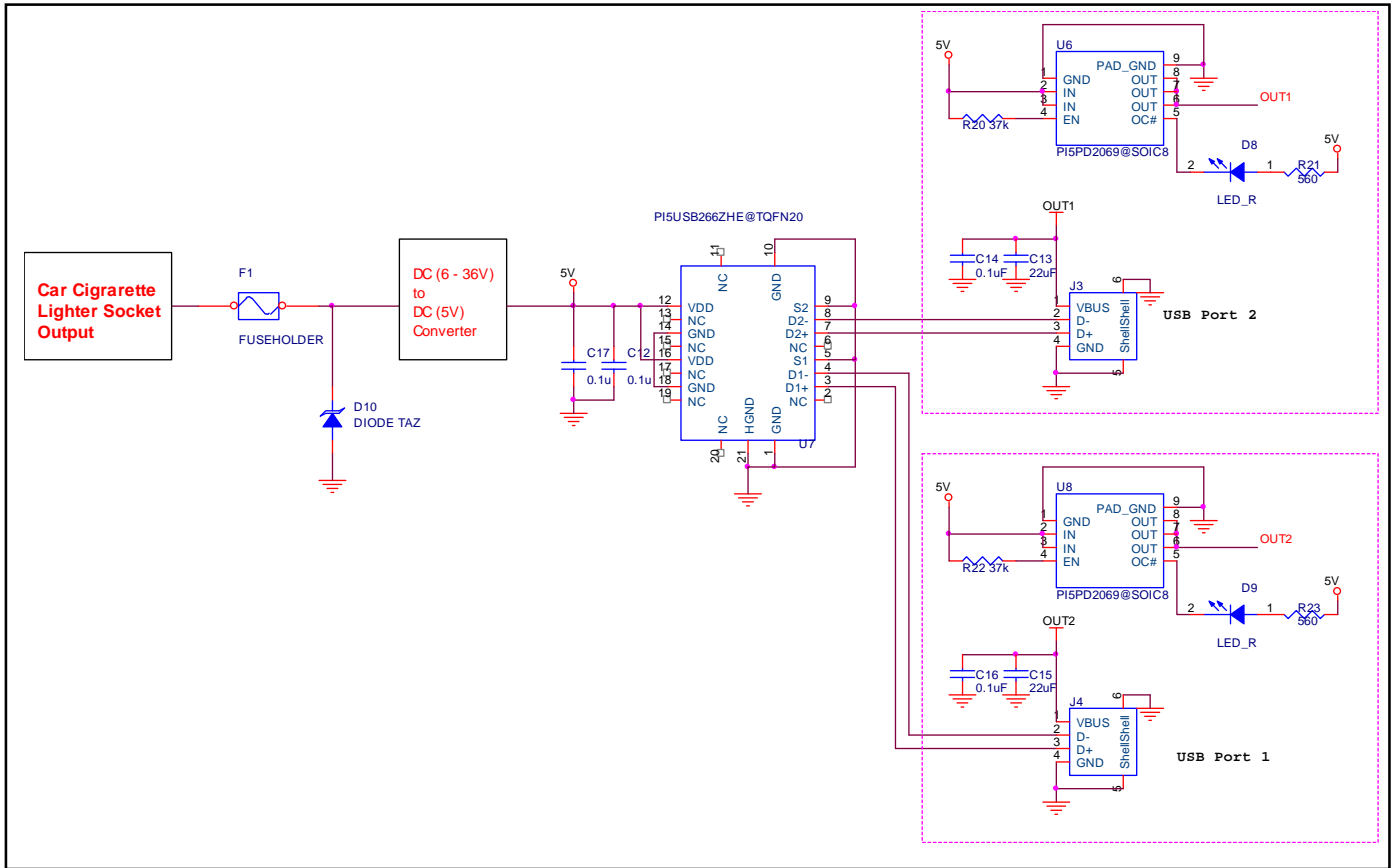


Figure 6, Application Diagram of PI5USB266 Dual USB port Car charger

### 4. References

- 1) Battery Charging Specification Revision 1.2 (December 7, 2010)
- 2) YD/T 1591-2009 Technical Requirements and test method for power adapter and charging /data of mobile telecommunication terminal Equipment
- 3) Pericom PI5PD2068 / 2069 datasheet