Active-Semi

# Innovative High Power Solutions

# High Power (HP) DC-DC Product Selection Guide

**August 2012**

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# DC-DC Converters

**Applications**

- *Car Chargers for Smart Phones, iPad / iPhone / iPod, PND , and tablet PCs*
- *LCD-TV, Set-Top Box, ADSL, Monitor*
- *Data Storage*
- *Digital Video Recorder and Security Camera*
- *LED Lighting*

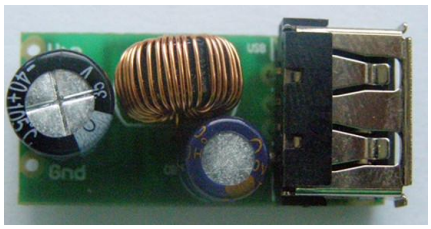
## DC-DC PRODUCT SELECTION GUIDE

| Part Number | Topology | Input Voltage (V) | Output Current (A) | Feedback Voltage (V) | Switching Frequency | Package | Applications |
|---|---|---|---|---|---|---|---|
| ACT4501 | Async Buck | 10 to 30 (40V surge) | 1.25 | 0.808 | 125KHz | SOP-8 | 5V/1.0A Car Charger |
| ACT4515 | Async Buck | 10 to 40 | 1.5 | 0.808 | 210kHz | SOP-8 | 5V/1-1.4A Car Charger |
| ACT4513 | Async Buck | 10 to 40 | 2.0 | 0.808 | 210kHz | SOP8-EP | 5V/1.2-1.8A Car Charger |
| ACT4523 | Async Buck | 10 to 40 | 3.0 | 0.808 | 225kHz | SOP8-EP | 5V/1.5-2.1A Car Charger |
| ACT4303 | Async Buck | 10 to 30 | 3.0 | 0.808 | 225kHz | SOP8-EP | USB Charger with AC adap-tors, LCD-TV |
| ACT4455 | Async Buck | 7.5 to 36 (40V surge) | 5.0 | 0.800 | 200kHz | SOP8-EP | 5V/2.1A+2.1A and 5V/2.1A+1.0A Dual-Output Car Chargers, LCD-TV, Automotive |
| ACT2102 | Sync Buck | 4.5 to 18 | 2.0 | 0.923 | 310kHZ | SOP-8 | LCD-TV, ADSL, Set-Top Box, Monitor |
| ACT2103 | Sync Buck | 4.5 to 18 | 3.0 | 0.923 | 310kHZ | SOP-8EP | LCD-TV, ADSL, Set-Top Box, Monitor |
| ACT2113 | Sync Buck | 4.5 to 18 | 3.0 | 0.923 | 510kHZ | SOP-8EP | LCD-TV, ADSL, Set-Top Box, Monitor |
| ACT4060B | Sync Buck | 4.5 to 18 | 2.0 | 0.923 | 350kHz | SOP8-EP | LCD-TV, ADSL, Set-Top Box, Monitor |
| ACT4065A | Async Buck | 6.0 to 30 | 2.0 | 0.808 | 210kHz | SOP-8 | Car Charger, Networking, Set-Top Box, Black box |
| ACT4070B | Async Buck | 6.5 to 30 | 3.0 | 0.808 | 300kHz | SOP-8EP | Car Charger, Networking, Set-Top Box, Black box |
| ACT4088 | Async Buck | 4.5 to 28 | 1.5 | 0.810 | 1.4MHz | SOT23-6 | ADSL, Set-Top Box |
| ACT111A | Async Buck | 4.5 to 30 | 1.5 | 0.100 | 1.4MHZ | SOT23-6 | LED Lighting, LED Display |

## Demo Board Introduction

# ACT4501 5V/1.0A Smart Phone Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency | Topology |
|---|---|---|---|---|---|
| 10-28V | ACT4501 | 60mW@12Vin | 5V@1.0A | 88%@1A , Vin=12V | Buck |



L=30.5mm
W=14.5mm
H=12.8mm

## Design Features

- Wide input voltage range from 10V to 28V
- Transparent input voltage surge 12V-40V-12V
- 1A-1.5A output current limit
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 125kHz switching frequency
- 88% efficiency at 12V input
- Least external components
- Low-cost single layer PCB with very good EMC performance

## Operation and Application

ACT4501 is a step-down DC-DC converter with wide input voltage range and high efficiency dedicated to 5V/1A smart phone micro car chargers. The ACT4501 is internally optimized for good EMC performance and it passed radiated EMI test even on low-cost single layer PCBs without adding any EMC components.

ACT4501 provides constant current (CC) output with patented Active-CC control technology that eliminate external sense resistors and the related efficiency loss.

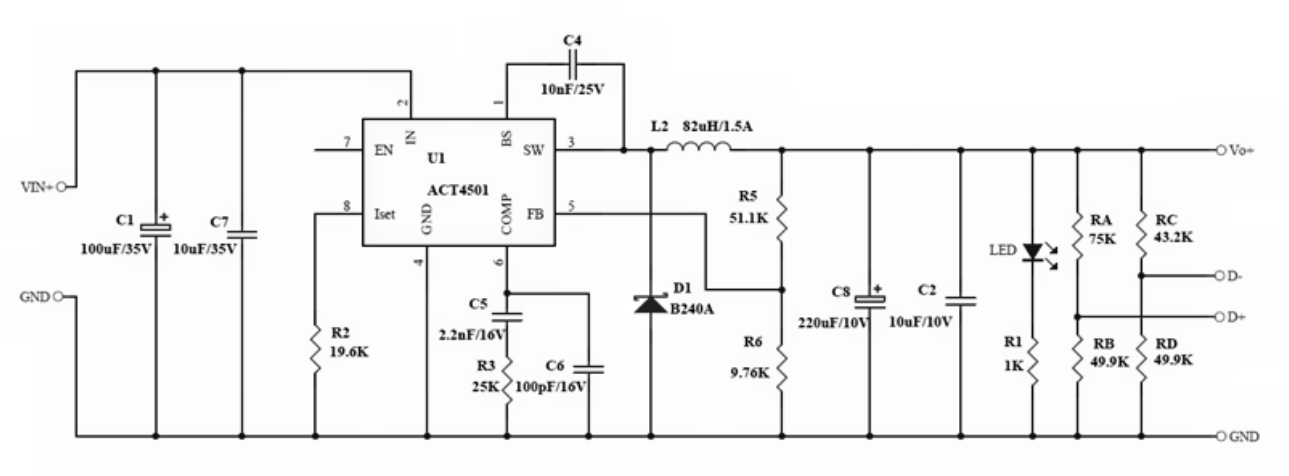
The ACT4501 operates at constant output voltage mode until it reaches the CC limit set by the ISET resistor. The devices are available in a SOP-8 package.

## Key Component Selection

Higher output inductance reduces the inductor peak-to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. Usually, the combination of low ESR capacitors and tantalum or electrolytic types are used. In this application, 220uF electrolytic capacitor is connected in parallel with a small 2.2μF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of Charger

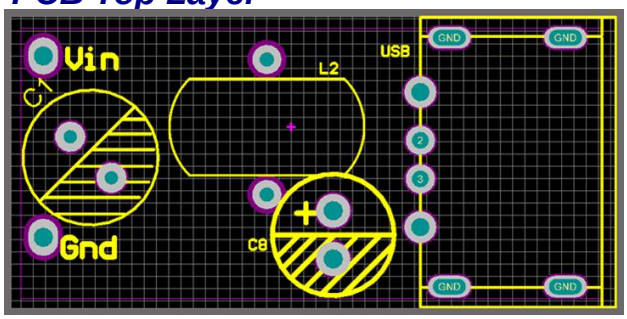


# ACT4501 5V/1.0A Smart Phone Car Charger

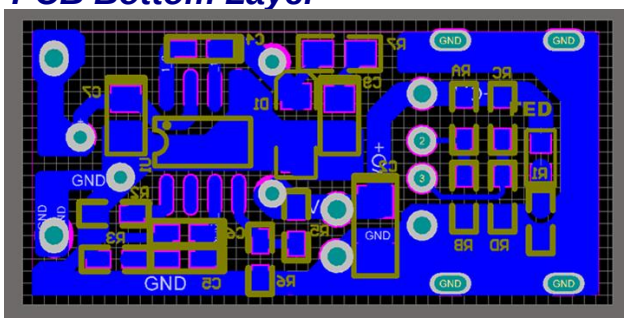
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| L1 | Choke Coil, ring core:8*4*5mm,Pi=0.35mm,L=82uH, dip | Haining Electronic-Magnetics |
| D1 | Schottky Diode, B240A,2A/40V, SMA | Diodes |
| C1 | Capacitor,Electrolytic,100uF/35V,Φ7x8mm,Dip | KSC |
| C2 | Ceramic capacitor,10uF/16V,X7R,0805 | Murata/TDK |
| C4 | Ceramic capacitor, 10nF/25V, X7R, 0603 | Murata/TDK |
| C5 | Ceramic capacitor, 2.2nF/25V, X7R, 0603 | Murata/TDK |
| C6 | Ceramic capacitor, 100pF/16V, X7R, 0603 | Murata/TDK |
| C7 | Ceramic capacitor, 10uF/35V, X7R, 0805 | Murata/TDK |
| C8 | Ceramic Electrolytic, 220uF/10V, Φ6.3x7mm,Dip | Murata/TDK |
| R1 | Chip Resistor, 1KΩ, 1/16W, 5%, 0603 | Murata/TDK |
| R2 | Chip Resistor, 19.6KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R3 | Chip Resistor, 25KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 51.1KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R6 | Chip Resistor, 9.76KΩ, 1/16W ,5%, 0603 | Murata/TDK |
| RA/RB | Chip Resistor, 49.9KΩ, 1/16W, 1%,0603 | Murata/TDK |
| RC | Chip Resistor, 43.2KΩ, 1/16W, 1%,0603 | Murata/TDK |
| RD | Chip Resistor, 75KΩ, 1/16W, 1%,0603 | Murata/TDK |
| U1 | IC, ACT4501 SOP-8 | Active semi |
| USB | 15mm*10mm*8mm | USB Manu |

## PCB Top Layer




## PCB Bottom Layer




## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

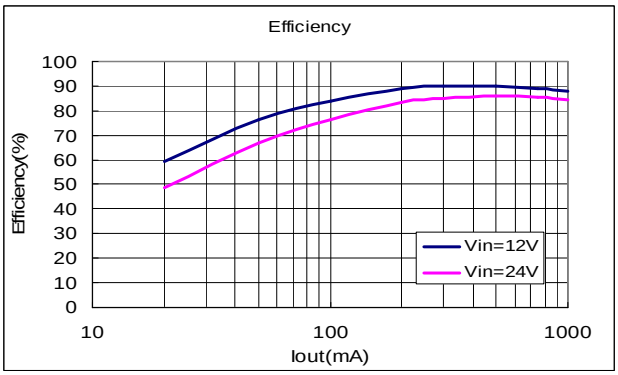
2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

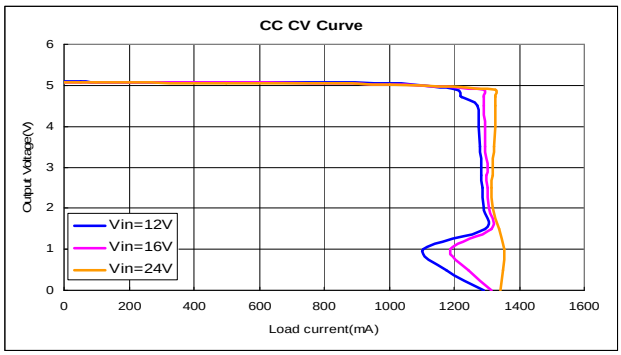
3) Place feedback resistor close to FB pin.

4) Use short trace connecting HSB-C4-SW loop.

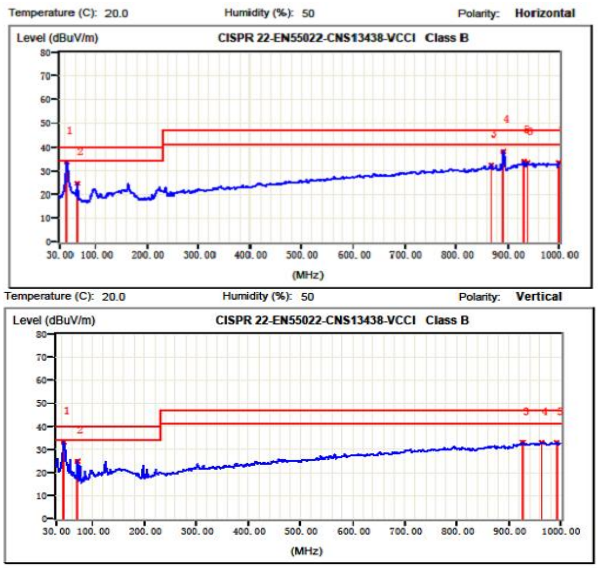
5) SW pad is a noisy node switching from Vin to GND. It

## Typical performance characteristics



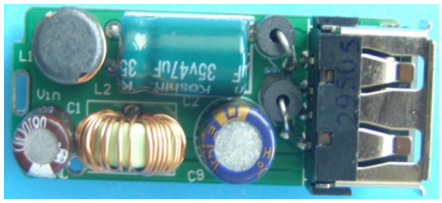

## Radiated EMI Test




| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4501-DMB-#1 | 10-28V | 4.75-5.25V | 1000mA |

# ACT4515 5V/1.2A Smart Phone Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency | Topology |
|---|---|---|---|---|---|
| 10-32V | ACT4515 | 60mW@12Vin | 5V@1.2A | 86%@1.2A Vin=12V | Buck |



L=36.5mm
W=16.7mm
H=12.8mm

## Design Features

- Wide input voltage range from 10V to 32V
- Transparent input voltage surge 12V-40V-12V
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 210kHz switching frequency
- Standby input current 5mA
- 1.2A ~1.4A accurate current limit
- Thermal shutdown protection
- Output cord compensation
- Over current protection
- Meet EN5502 EMC Standard

## Operation and Application

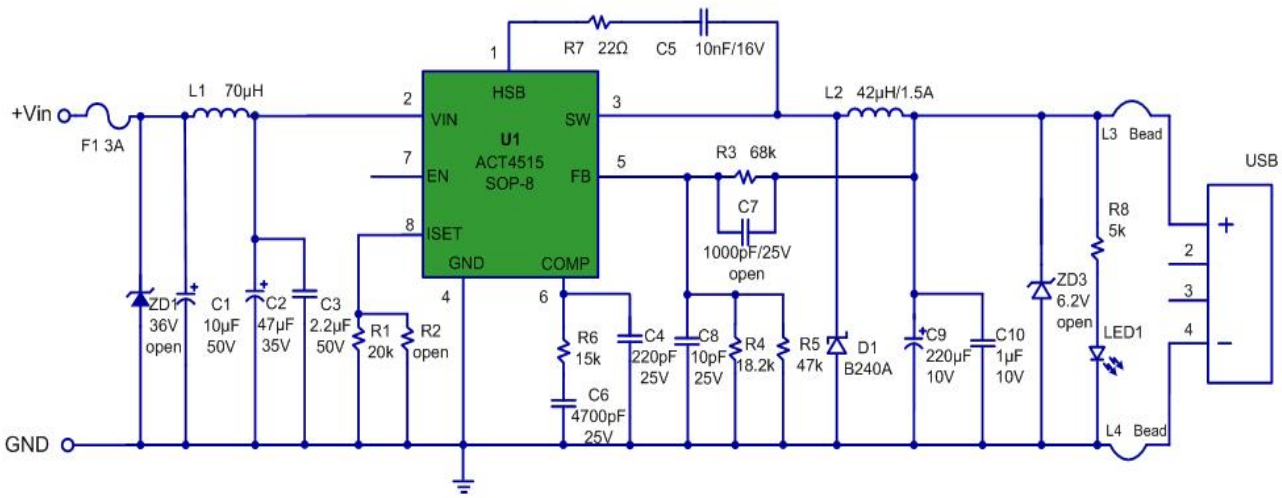
ACT4515 is a wide input voltage, high efficiency Active CC step-down DC-DC converter that operates in either CV (Constant Output Voltage) mode or CC (Constant Output Current) mode. ACT4515 provides up to 1.5A output current at 210kHz switching frequency. Active CC is a patent-pending control scheme to provide CC function accuracy by sensorless constant current control, which eliminates the expensive, high accuracy current sense resistor, making it ideal for battery charging applications. charging applications. The ACT4515 operates at constant output voltage mode until it reaches the CC limit set by the ISET resistor. The devices are available in a SOP-8 package.

## Key Component Selection

Higher output inductance reduces the inductor peak-to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. Usually, 22uFx2 ceramic capacitors are sufficient. In the case of tantalum or electrolytic types, 220uF capacitor is connected in parallel with a small 1μF-10uF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of Charger

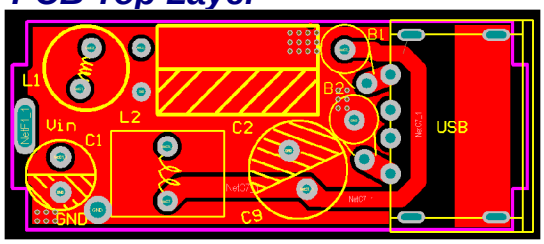


# ACT4515 5V/1.2A Smart Phone Car Charger

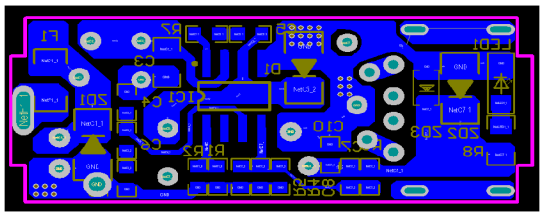
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| F1 | Fuse 3A,1206( Replaced by 0Ω 1206 chip resister) | Murata/TDK |
| L1 | Choke Coil,75uH,DR=6x8mm, 1A, dip | ACT |
| L2 | Choke Coil, ring core,42uH,8*4*4mm, 1.5A, dip | ACT |
| L3,4 | Bead,K5B,T3.5x3x1.2mm | KingCore |
| D1 | Schottky Diode, B240A, 40V/2A,SMB | Diodes |
| ZD1 | Open | |
| ZD3 | Open | |
| C1 | Capacitor,Electrolytic,33uF/50V,Φ5x7mm,Dip | KSC |
| C2 | Capacitor,Electrolytic,47uF/35V,Φ7.5x8mm,Dip | Koshin |
| C3 | Ceramic capacitor, 2.2uF/50V, X7R, 1206 | Murata/TDK |
| C4 | Ceramic capacitor, 220pF/25V, X7R, 0603 | Murata/TDK |
| C5 | Ceramic capacitor, 10nF/16V, X7R, 0603 | Murata/TDK |
| C6 | Ceramic capacitor, 4700pF/25V, X7R, 0603 | Murata/TDK |
| C7 | Ceramic capacitor,1000pF/25V, X7R, 0603 (Open) | Murata/TDK |
| C8 | Ceramic capacitor, 10pF/25, X7R, 0603 | Murata/TDK |
| C9 | Capacitor,Electrolytic,220uF/10V,Φ6.3x7.2mm,Dip | Micon |
| C10 | Ceramic capacitor, 1uF/10V, X7R, 0603 | Murata/TDK |
| R1 | Chip Resistor, 20KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R2 | Open | |
| R3 | Chip Resistor, 68KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R4 | Chip Resistor, 18.2KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 47KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R6 | Chip Resistor, 15KΩ, 1/16W ,5%, 0603 | Murata/TDK |
| R7 | Chip Resistor, 10Ω, 1/16W, 5%,0603 | Murata/TDK |
| R8 | Chip Resistor, 5KΩ, 1/16W, 5%,0805 | Murata/TDK |
| U1 | IC, ACT4515, SOP-8 | ACT |
| LED | LED ,Green,0805 | |
| USB | 15mm*10mm*8mm | |

## PCB Top Layer




## PCB Bottom Layer



## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

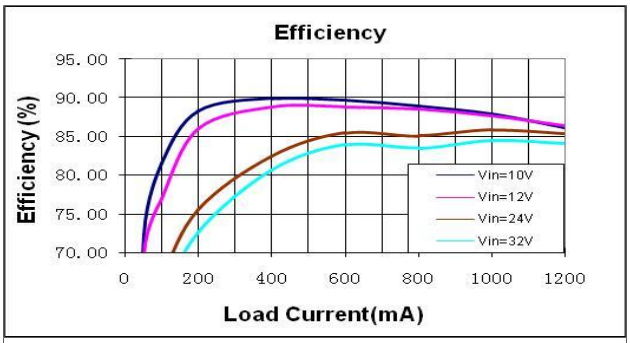
3) Use copper plane for power GND for best heat dissipation and noise immunity.

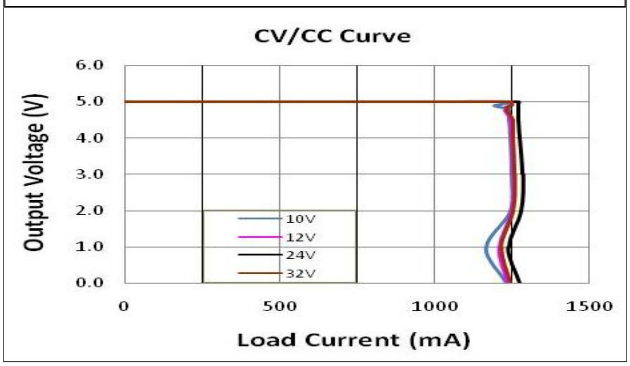
4) Place feedback resistor close to FB pin.

5) Use short trace connecting HSB-C5-SW loop.

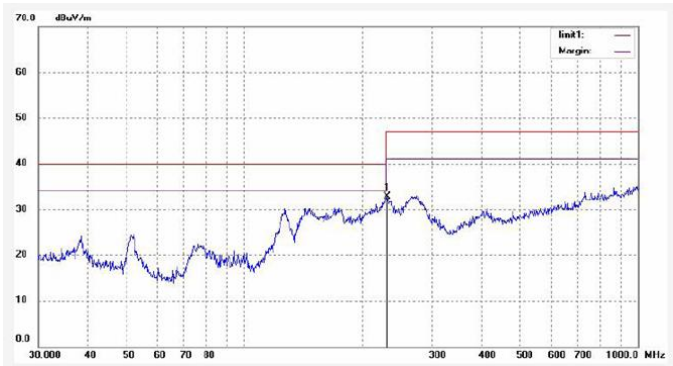
6) SW pad is a noisy node switching from Vin to GND. It should be isolated away from the rest of circuit for good EMI and low noise operation.

## Typical performance characteristics



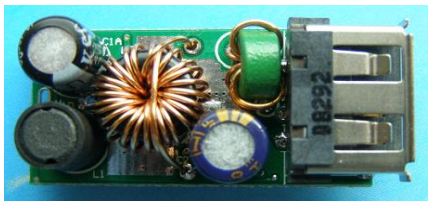

## Radiated EMI Test




| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4515-DMB-#1 | 10-32V | 4.75-5.25V | 1200mA |

# ACT4513 5V/2.0A Smart Phone Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency | Topology |
|---|---|---|---|---|---|
| 10-32V | ACT4513 | 36mW@12Vin | 5V@2.0A | 84.4%@2.0A Vin=12V | Buck |



L=32.7mm
W=15.1mm
H=12.8mm

## Design Features

- Wide input voltage range from 10V to 32V
- Transparent input voltage surge up 12V-40V-12V
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 210kHz switching frequency
- Standby input current 3mA
- 2.2A accurate current limit
- Shut down at output short circuit
- Thermal shutdown protection
- Output cord compensation
- Over current protection
- Pass radiated EMI test

## Operation and Application

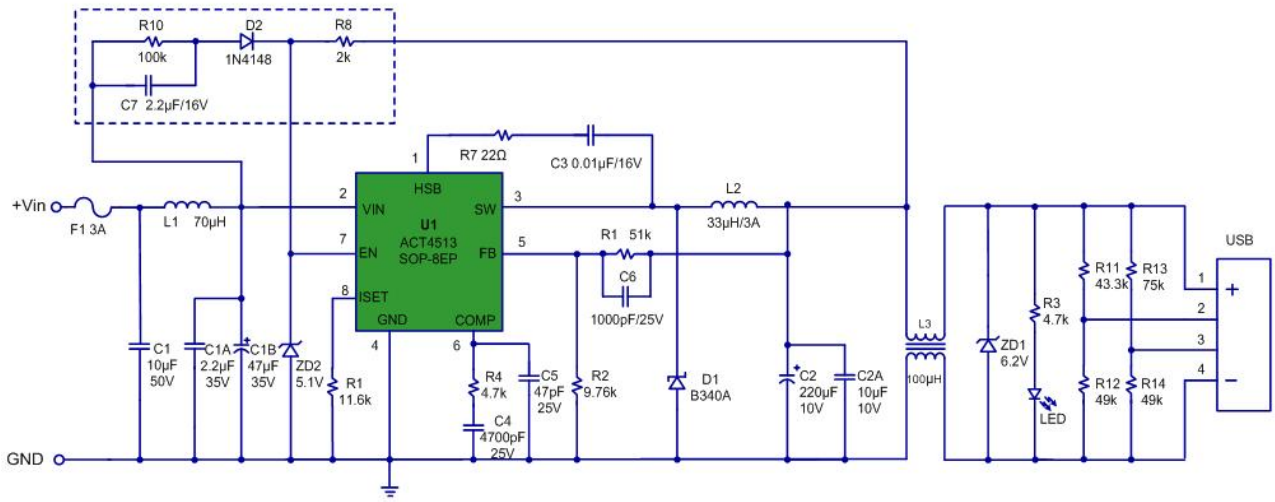
ACT4513 is a wide input voltage, high efficiency Active CC step-down DC-DC converter that operates in either CV (Constant Output Voltage) mode or CC (Constant Output Current) mode. ACT4513 provides up to 2.5A output current at 210kHz switching frequency. Active CC function accuracy by senseless constant current control, which eliminates the expensive, high accuracy current sense resistor, making it ideal for battery charging applications. charging applications. The ACT4513 operates at constant output voltage mode until it reaches the CC limit set by the ISET resistor. The devices are available in a SOP8-EP package.

## Key Component Selection

Higher output inductance reduces the inductor peak -to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. For this application, 22uFx2 ceramic capacitors are needed. In the case of tantalum or electrolytic types, 220uF capacitor is connected in parallel with a small 1μF-10uF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of Charger

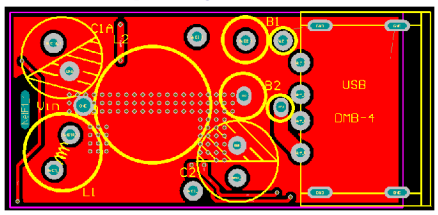


# ACT4513 5V/2.0A Smart Phone Car Charger

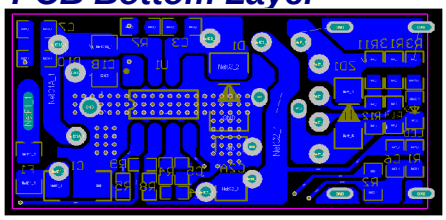
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| L1 | Choke Coil,Dip, 6*8mm, phi=0.35mm, L=70-75uH | ACT |
| L2 | Choke Coil,Dip,T8*4*4mm, phi=0.45mm, L=33uH | ACT |
| L3 | Common Mode Choke ,Dip,T6*4*3mm, phi=0.45mm, L=100uH | ACT |
| D1 | Schottky Diode, B340A,40V/3A, SMA | Diodes |
| D2 | Switch Diodes,1N4148WS, 0.2W, SOD323 | Diodes |
| ZD1 | Zener Diode,GMZJ6.2A,6.2V,0.5W,Mini-Melf (open) | Panjit |
| ZD2 | Zener Diode, BZT52C5V1S, 5.1V, 0.2W, SOD323 | Diodes |
| C1A | Ceramic capacitor, 2.2uF/35V, X7R,0805 | Murata/TDK |
| C1B | Electroytic capacitor,47uF/35V,6.3x7.8mm | Koshin |
| C1 | Ceramic capacitor, 10uF/35V. X7R, 0805 | Murata/TDK |
| C2 | Electroytic capacitor,220uF/10V,6.3x7mm | Koshin |
| C2A | Ceramic capacitor, 10uF/10V, X7R,0805 | Murata/TDK |
| C3 | Ceramic capacitor, 0.01uF/16V, X7R,0603 | Murata/TDK |
| C4 | Ceramic capacitor,4700pF/10V, X7R, 0603 | Murata/TDK |
| C5 | Ceramic capacitor, 47pF/25V, X7R, 0603 | Murata/TDK |
| C6 | Ceramic capacitor, 1000pF/25V, X7R, 0603 | Murata/TDK |
| C7 | Ceramic capacitor, 0.22uF/25V, X5R, 0603 | Murata/TDK |
| F1 | Fuse,3A,1206 ( Replaced by 0Ω 1206 chip resistor ) | Murata/TDK |
| R1 | Chip Resistor, 51KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R2 | Chip Resistor, 9.76KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R3,R4 | Chip Resistor, 4.7KΩ, 1/16W, 5%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 11.6KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R7 | Chip Resistor, 22Ω, 1/16W, 1%, 0603 | Murata/TDK |
| R8 | Chip Resistor, 2KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R10 | Chip Resistor, 100KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R11 | Chip Resistor, 75KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R13 | Chip Resistor, 43.2KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R12,R14 | Chip Resistor, 49.9KΩ, 1/16W ,5%,0603 | Murata/TDK |
| U1 | IC, ACT4513,SOP-8-EP | ACT |
| USB | USB Rev:A | |
| LED | LED ,White,Dip | |

## PCB Top Layer




## PCB Bottom Layer



## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

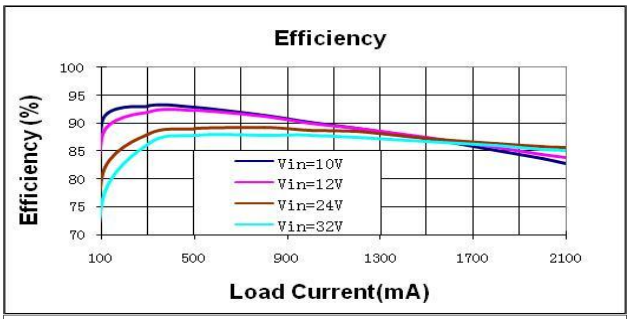
3) Use copper plane for power GND for best heat dissipation and noise immunity.

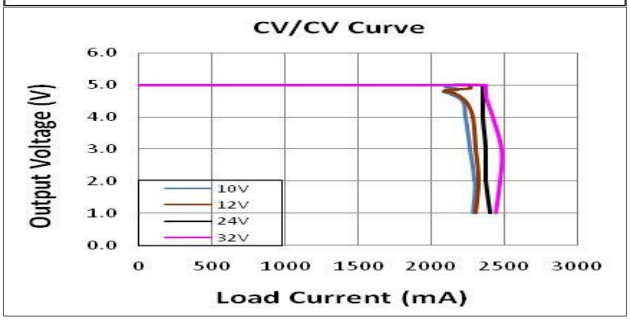
4) Place feedback resistor close to FB pin.

5) Use short trace connecting HSB-C3-SW loop. Thermal pad is connected to a large ground copper area.

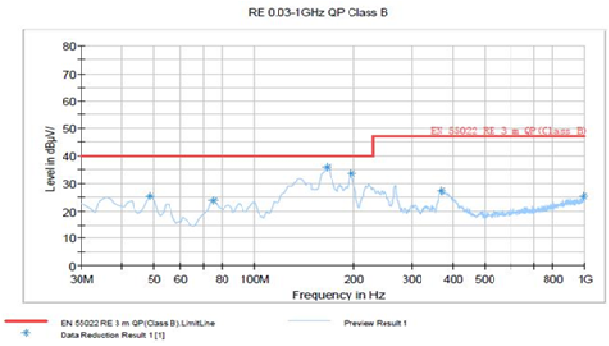
6) SW pad is a noisy node switching from Vin to GND. It should be isolated away from the rest of circuit for good

## Typical performance characteristics



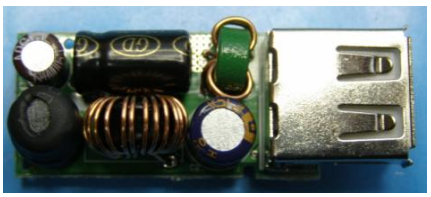

## Radiated EMI Test




| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4513-DMB-#1 | 10-32V | 4.75-5.25V | 2000mA |

# ACT4523 5V/2.1A iPAD Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency | Topology |
|---|---|---|---|---|---|
| 10-32V | ACT4523 | 39mW@12Vin | 5V@2.1A | 87%@2.1A Vin=12V | Buck |



L=39.8mm
W=14.9mm
H=12.6mm

## Design Features

- Wide input voltage range from 10V to 32V
- Transparent input voltage surge 12V-40V-12V
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 225kHz switching frequency
- Standby input current 3.2mA
- 2.35A accurate current limit
- Shut down at output short circuit
- Thermal shutdown protection
- Output cord compensation
- Over current protection
- Meet the EN55022 EMC standard

## Operation and Application

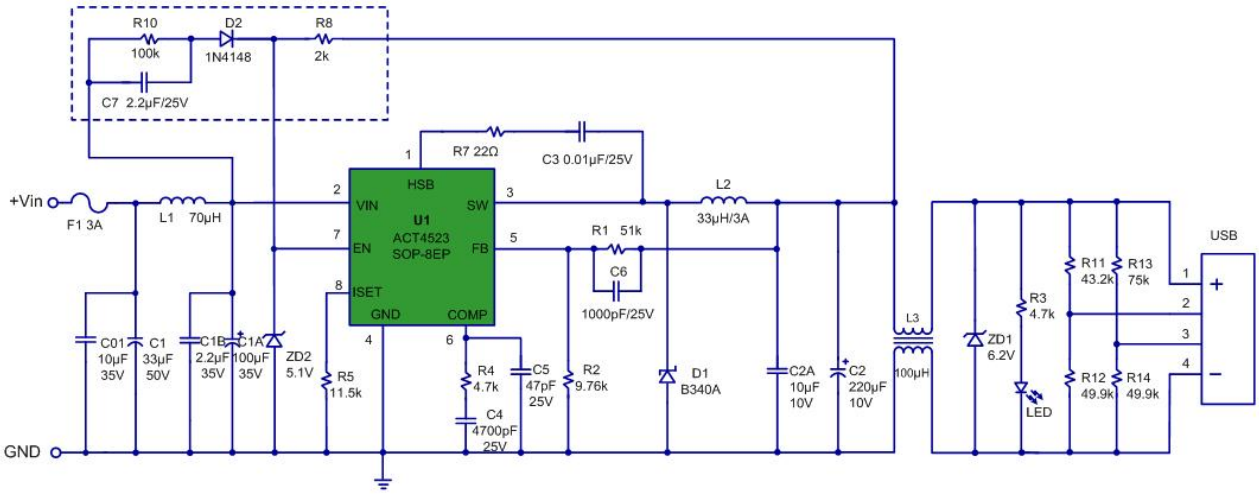
ACT4523 is a wide input voltage, high efficiency Active CC step-down DC-DC converter that operates in either CV (Constant Output Voltage) mode or CC (Constant Output Current) mode. ACT4523 provides up to 3.0A output current at 225kHz switching frequency. Active CC is a patent-pending control scheme to provide CC function accuracy by senseless constant current control, which eliminates the expensive, high accuracy current sense resistor, making it ideal for battery charging applications. charging applications. The ACT4523 operates at constant output voltage mode until it reaches the CC limit set by the ISET resistor. The devices are available in a SOP8-EP package.

## Key Component Selection

Higher output inductance reduces the inductor peak-to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. For this application, 22uFx2 ceramic capacitors are needed. In the case of tantalum or electrolytic types, 220uF capacitor is connected in parallel with a small 1μF-10uF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of Charger

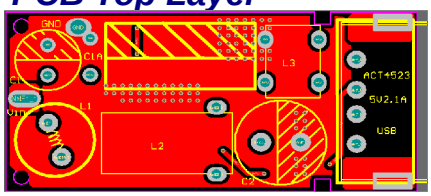


# ACT4523 5V/2.1A iPAD Car Charger

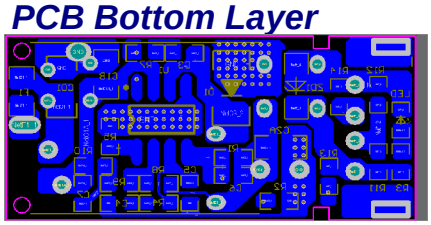
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| L1 | Choke Coil,Dip, 6*8mm, phi=0.35mm, L=70-75uH | ACT |
| L2 | Choke Coil,Dip,T8*5*4mm, phi=0.45mm, L=33uH | ACT |
| L3 | Common Mode Choke ,Dip,T6*3*3mm, phi=0.45mm, L=100uH | ACT |
| D1 | Schottky Diode, B340A,40V/3A, SMA | Diodes |
| D2 | Switch Diode,1N4148WS, 0.2W, SOD323 | Diodes |
| ZD1 | Zener Diode,GMZJ6.2A,6.2V,0.5W,Mini-Melf (open) | Panjit |
| ZD2 | Zener Diode,BZT52C5V1S, 5.1V, 0.2W, SOD323 | Diodes |
| C1A | Electroytic capacitor,100uF/35V,6.3x11.5mm | Koshin |
| C1B | Ceramic capacitor,2.2uF/50V,0805 | Murata/TDK |
| C1 | Electroytic capacitor,33uF/50V,5x7mm | Koshin |
| C2 | Electroytic capacitor,220uF/10V,6.3x7mm | Koshin |
| C2A | Ceramic capacitor, 10uF/10V, X7R,0805 | Murata/TDK |
| C01 | Ceramic capacitor, 10uF/35V, X7R,1206 | Murata/TDK |
| C3 | Ceramic capacitor, 0.01uF/25V, X7R,0603 | Murata/TDK |
| C4 | Ceramic capacitor,4700pF/10V, X7R, 0603 | Murata/TDK |
| C5 | Ceramic capacitor, 47pF/25V, X7R, 0603 | Murata/TDK |
| C6 | Ceramic capacitor, 1000pF/25V, X7R, 0603 | Murata/TDK |
| C7 | Ceramic capacitor, 2.2uF/25V, X5R, 0603 | Murata/TDK |
| F1 | Fuse,3A,1206 ( Replaced by 0Ω 1206 chip resistor ) | Murata/TDK |
| R1 | Chip Resistor, 51KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R2 | Chip Resistor, 9.76KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R3,R4 | Chip Resistor, 4.7KΩ, 1/16W, 5%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 11.5KΩ, 1/16W, 1%, 0603 | Murata/TDK |
| R7 | Chip Resistor, 22Ω, 1/16W, 1%, 0603 | Murata/TDK |
| R8 | Chip Resistor, 3KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R10 | Chip Resistor, 100KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R11 | Chip Resistor, 75KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R13 | Chip Resistor, 43.2KΩ, 1/16W ,5%,0603 | Murata/TDK |
| R12,R14 | Chip Resistor, 49.9KΩ, 1/16W ,5%,0603 | Murata/TDK |
| U1 | IC, ACT4523,SOP-8-EP | ACT |
| USB | USB Rev:A | |
| LED | LED ,White,Dip | |

## PCB Top Layer




## PCB Bottom Layer



## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

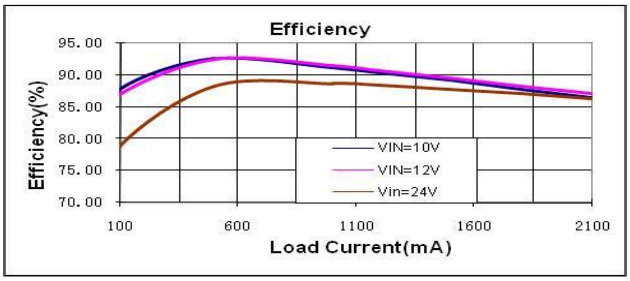
3) Use copper plane for power GND for best heat dissipation and noise immunity.

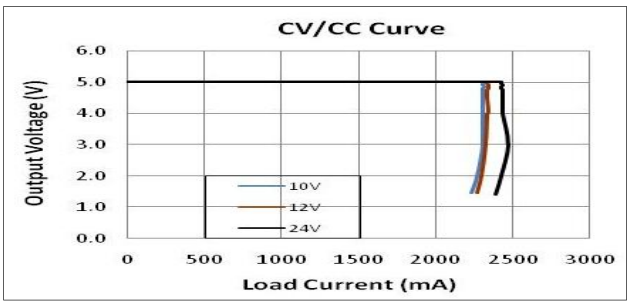
4) Place feedback resistor close to FB pin.

5) Use short trace connecting HSB-C3-R7-SW loop. Thermal pad is connected to a large ground copper area.

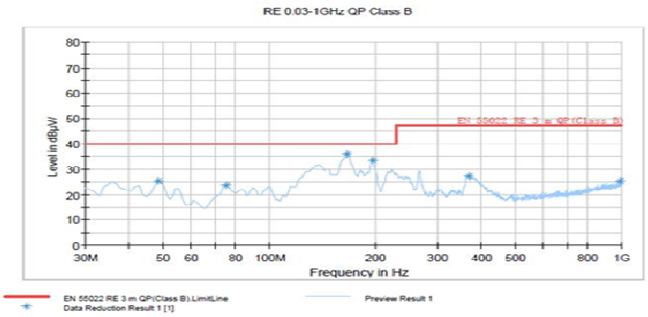
6) SW pad is a noisy node switching from Vin to GND. It should be isolated away from the rest of circuit for good EMI and low noise operation.

## Typical performance characteristics



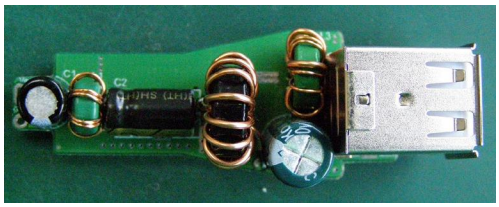

## Radiated EMI Test

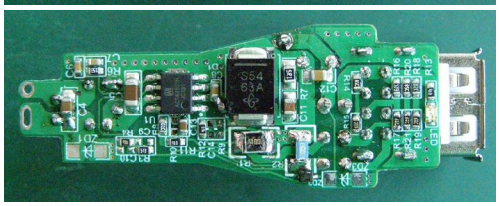



| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4523-DMB-#2 | 10-32V | 4.75-5.25V | 2100mA |

# ACT4455—5V/3.1A Dual-Output Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency |
|---|---|---|---|---|
| 7.5-33V | ACT4455 | 150mW@12Vin | 5V@2.1+1A | 90%@3.1A,Vin=12V |





L=59mm
W=20.2mm
H=18mm

## Design Features

- Wide input voltage range from 7.5V to 33V
- Transparent input voltage surge 12V-40V-12V
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 200kHz switching frequency
- Standby input current 10mA
- Programmable precise output current limit via sensing resistance
- 3ms internal soft startup time
- Cycle-by-cycle over current protection
- Thermal shutdown protection
- Output cord compensation
- Nearly zero power loss at over loading or output short
- Hiccup mode at output over voltage
- Auto recovery into full load after faults
- Meet EN5502 EMC standard

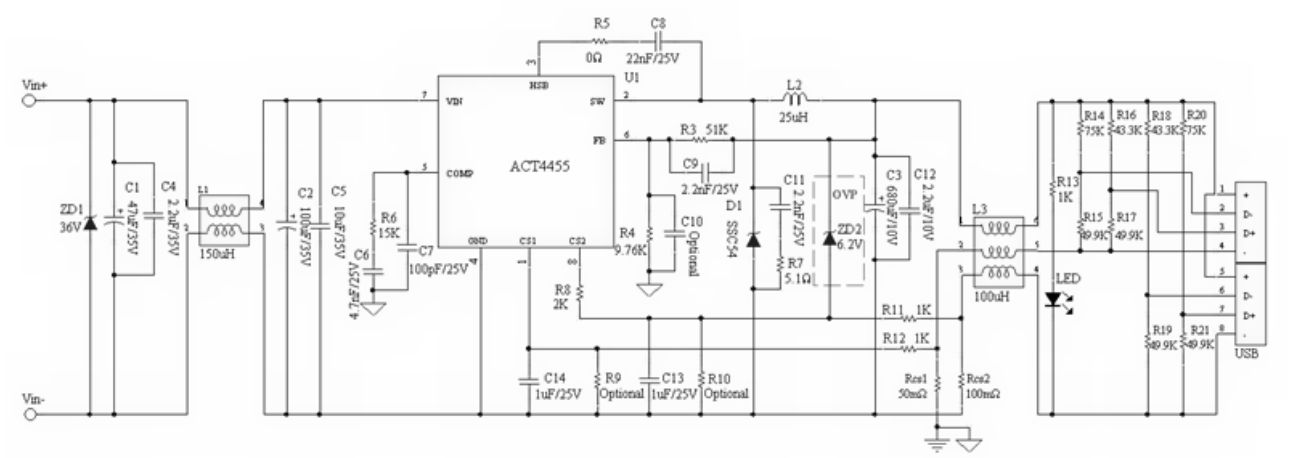
## Key Component Selection

Higher output inductance reduces the inductor peak-to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating.

higher than the maximum input voltage. Double schottky diodes could be added to achieve higher efficiency and pass single fault test. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. In the case of tantalum or electrolytic types, 680uF capacitor is connected in parallel with a small 1μF-10uF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of 5V/3.1A Dual-Output Car Charger

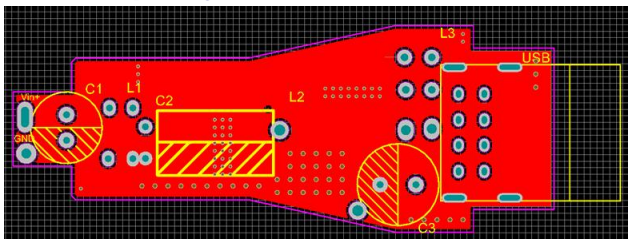


# ACT4455-5V/3.1A Dual-Output Car Charger

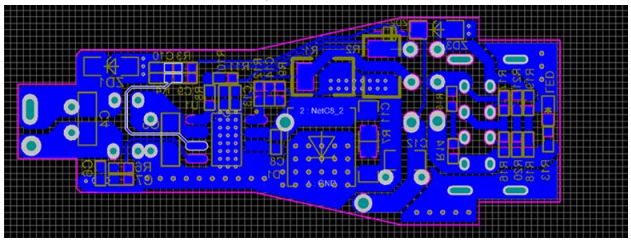
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| L1 | Choke Coil, 6*3*3mm L=150uH, dip | ACT |
| L2 | Choke Coil, ring core,25uH,11*6.5*4mm, 5A, dip | ACT |
| L3 | Choke Coil, 9*6*5mm L=100uH, dip | ACT |
| D1 | Schottky Diode, SSC54, 40V/5A, SMC | Vishay |
| ZD1 | Open | |
| ZD2 | Zener Diode, 6.1V/0.2W | Diodes |
| C1 | Capacitor,Electrolytic,47uF/35V,Φ6.3x8mm,105℃ | KSC |
| C2 | Capacitor,Electrolytic,100uF/35V,Φ6.3x11.5mm,105℃ | Koshin |
| C3 | capacitor, Electrolytic,680uF/10V, Φ8x11.5mm,105℃ | Koshin |
| C4 | Ceramic capacitor, 2.2uF/35V, X7R, 0805 | Murata/TDK |
| C5 | Ceramic capacitor, 10uF/35V, X7R, 1206 | Murata/TDK |
| C6 | Ceramic capacitor, 4.7nF/25V, X7R, 0402 | Murata/TDK |
| C7 | Ceramic capacitor,100pF/25V, X7R, 0402 | Murata/TDK |
| C8 | Ceramic capacitor, 22nF/25V, X7R, 0603 | Murata/TDK |
| C9 | Ceramic capacitor. 2.2nF/25V.X7R.0603 | Murata/TDK |
| C10 | Optional | Murata/TDK |
| C11 | Ceramic capacitor, 2.2nF/25V, X7R, 0805 | Murata/TDK |
| C12 | Ceramic capacitor, 2.2uF/10V, X7R, 0805 | Murata/TDK |
| C13,C14 | Ceramic capacitor, 1uF/16V, X7R, 0603 | Murata/TDK |
| Rcs1 | Chip Resistor, 50mΩ,1/2W, 1%, 1206 | ROHM |
| Rcs2 | Chip Resistor, 100mΩ,1W, 1%, 1210 | Vishay |
| R3 | Chip Resistor, 51KΩ,1/16W, 1%, 0603 | Murata/TDK |
| R4 | Chip Resistor, 9.76KΩ,1/16W, 1%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 0Ω,1/16W, 5%, 0603 | Murata/TDK |
| R6 | Chip Resistor, 15KΩ,1/16W ,5%, 0603 | Murata/TDK |
| R7 | Chip Resistor, 5.1Ω,1/4W, 5%,1206 | Murata/TDK |
| R8 | Chip Resistor, 2KΩ,1/10W, 1%,0603 | Murata/TDK |
| R9,R10 | Optional | |
| R11,R12 | Chip Resistor, 1KΩ,1/10W, 1%,0603 | Murata/TDK |
| R13 | Chip Resistor, 1KΩ,1/10W, 5%,0603 | Murata/TDK |
| R14,R20 | Chip Resistor, 75KΩ,1/10W, 1%,0603 | Murata/TDK |
| R15,R17,R19 ,R21 | Chip Resistor, 49.9KΩ,1/10W, 1%,0603 | Murata/TDK |
| R16,R18 | Chip Resistor, 43.2KΩ,1/10W, 1%,0603 | Murata/TDK |
| U1 | IC, ACT4455, SOP-8 EP | ACT |
| LED | LED ,Red,0805 | |
| USB | 17.5mm*14.5mm*15.7mm | |

## PCB Top Layer




## PCB Bottom Layer



## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

3) Use copper plane for power GND for best heat dissipation and noise immunity.

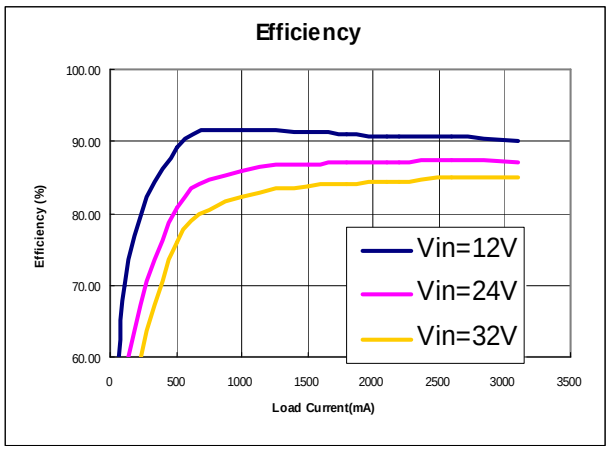
4) Place feedback resistor close to FB pin.

5) Use short trace connecting HSB-R5-C7-SW loop.

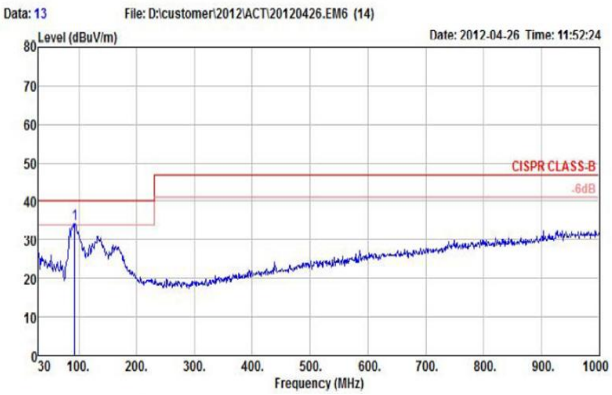
6) SW pad is a noisy node switching from Vin to GND. It should be isolated away from the rest of circuit for good EMI and low noise operation.

7) Thermal pad is connected to GND layer through at least 6 vias.

## Typical performance characteristics



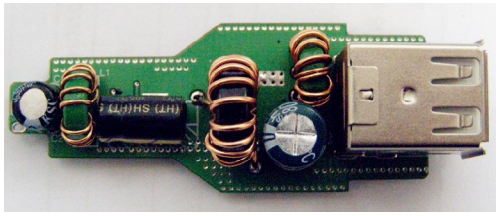

## Radiated EMI Test

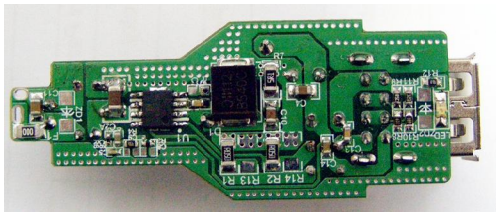



| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4455-DMB-#2 | 10-33V | 4.75-5.25V | 2.1A+1A |

# ACT4455—5V/4.2A Dual-Output Car Charger

| Input Voltage | Device | Standby Power | Output | Efficiency |
|---|---|---|---|---|
| 7.5-33V | ACT4455 | 150mW@12Vin | 5V@2.1+2.1A | 88%@4.2A Vin=12V |





L=63mm
W=23.5mm
H=18mm

## Design Features

- Wide input voltage range from 7.5V to 33V
- Transparent input voltage surge 12V-40V-12V
- 4.75V-5.25V during input and load transients
- 5% output voltage accuracy
- 200kHz switching frequency
- Standby input current 10mA
- Programmable precise output current limit via sensing resistors
- 3ms internal soft startup time
- Cycle-by-cycle over current protection
- Thermal shutdown protection
- Output cord compensation
- Nearly zero power loss at over loading or output short
- Hiccup mode at output over voltage
- Auto recovery into full load after faults
- Meet EN5502 EMC Standard

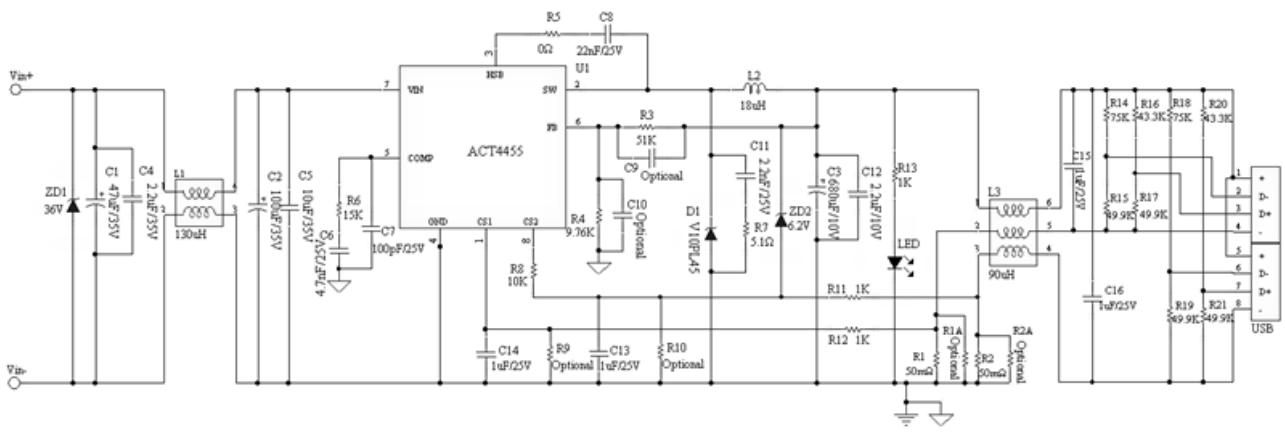
## Key Component Selection

Higher output inductance reduces the inductor peak-to-peak current at the expense of higher larger core size and inductance DCR value. Usually, an optimum inductance value is selected to make its peak-to-peak current 20%-40% of the maximum load current. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating.

higher than the maximum input voltage. Double schottky diodes could be added to achieve higher efficiency and pass single fault test. Output capacitor is selected to keep the peak-to-peak voltage ripple under required value and also meet the load transient requirements. In the case of tantalum or electrolytic types, 680uF capacitor is connected in parallel with a small 1μF-10uF ceramic capacitor to achieve small output voltage ripple and meet the requirements of input and load dynamic response.

**Figure 1:**

## Schematic of 5V/4.2A Dual-Output Car Charger

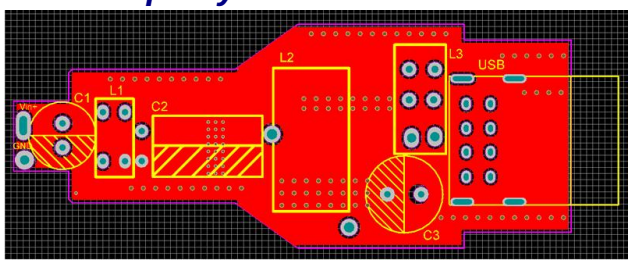


# ACT4455-5V/4.2A Dual-Output Car Charger

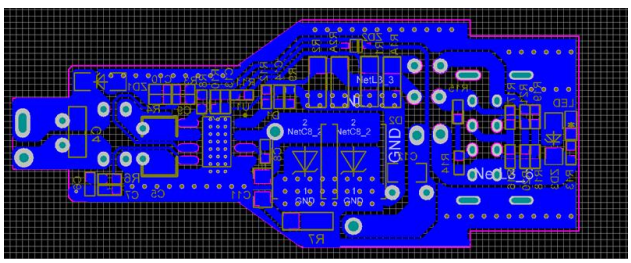
## Bill of Materials

| REF | DESCRIPTION | MFTR |
|---|---|---|
| L1 | Choke Coil, 6*3*3mm L=150uH, dip | ACT |
| L2 | Choke Coil, ring core,18uH,11*6.5*4mm, 5A, dip | ACT |
| L3 | Choke Coil, 9*6*5mm L=100uH, dip | ACT |
| D1 | Schottky Diode, V10PL45-EH 45V/10A, SMPC | Vishay |
| ZD1 | Open | |
| ZD2 | Zener Diode, 6.1V/0.2W | Diodes |
| C1 | Capacitor,Electrolytic,47uF/35V,Φ6.3x8mm,105℃ | KSC |
| C2 | Capacitor,Electrolytic,100uF/35V,Φ6.3x11.5mm,105℃ | Koshin |
| C3 | capacitor, Electrolytic,680uF/10V, Φ8x11.5mm,105℃ | Koshin |
| C4 | Ceramic capacitor, 2.2uF/35V, X7R, 0805 | Murata/TDK |
| C5 | Ceramic capacitor, 10uF/35V, X7R, 1206 | Murata/TDK |
| C6 | Ceramic capacitor, 4.7nF/25V, X7R, 0402 | Murata/TDK |
| C7 | Ceramic capacitor,100pF/25V, X7R, 0402 | Murata/TDK |
| C8 | Ceramic capacitor, 22nF/25V, X7R, 0603 | Murata/TDK |
| C9 | Ceramic capacitor. 2.2nF/25V.X7R. 0603 | Murata/TDK |
| C10 | Optional | Murata/TDK |
| C11 | Ceramic capacitor, 2.2nF/25V, X7R, 0805 | Murata/TDK |
| C12 | Ceramic capacitor, 2.2uF/10V, X7R, 0805 | Murata/TDK |
| C13,C14 | Ceramic capacitor, 1uF/16V, X7R, 0603 | Murata/TDK |
| Rcs1,Rcs2 | Chip Resistor, 50mΩ,1/2W, 1%, 1210 | ROHM |
| R1A,R2A | Optional | |
| R3 | Chip Resistor, 51KΩ,1/16W, 1%, 0603 | Murata/TDK |
| R4 | Chip Resistor, 9.76KΩ,1/16W, 1%, 0603 | Murata/TDK |
| R5 | Chip Resistor, 0Ω,1/16W, 5%, 0603 | Murata/TDK |
| R6 | Chip Resistor, 15KΩ,1/16W ,5%, 0603 | Murata/TDK |
| R7 | Chip Resistor, 5.1Ω,1/4W, 5%,1206 | Murata/TDK |
| R8 | Chip Resistor, 2KΩ,1/10W, 1%,0603 | Murata/TDK |
| R9,R10 | Optional | |
| R11,R12 | Chip Resistor, 1KΩ,1/10W, 1%,0603 | Murata/TDK |
| R13 | Chip Resistor, 1KΩ,1/10W, 5%,0603 | Murata/TDK |
| R14,R18 | Chip Resistor, 75KΩ,1/10W, 1%,0603 | Murata/TDK |
| R15,R17,R19 ,R21 | Chip Resistor, 49.9KΩ,1/10W, 1%,0603 | Murata/TDK |
| R16,R20 | Chip Resistor, 43.2KΩ,1/10W, 1%,0603 | Murata/TDK |
| U1 | IC, ACT4455, SOP-8 EP | ACT |
| LED | LED ,Red,0805 | |
| USB | 17.5mm*14.5mm*15.7mm | |

## PCB Top Layer




## PCB Bottom Layer



## PC Board Layout Guidance

1) Arrange the power components to reduce the AC loop size that consists of CIN, IN pin, SW pin the Schottky diode.

2) Place input decoupling ceramic capacitor CIN as close to IN pin as possible. CIN is connected power GND with vias or short and wide path.

3) Use copper plane for power GND for best heat dissipation and noise immunity.

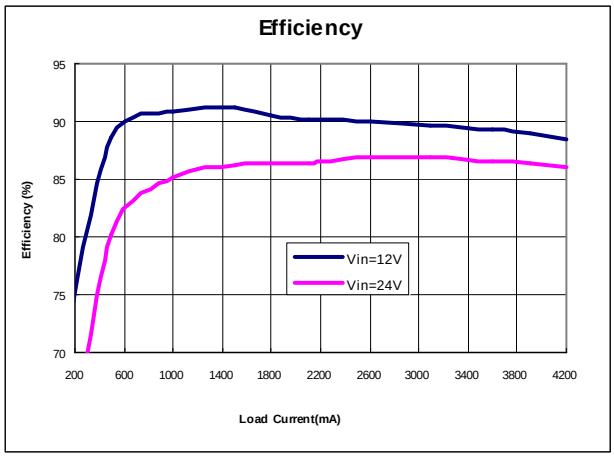
4) Place feedback resistor close to FB pin.

5) Use short trace connecting HSB-R5-C7-SW loop.

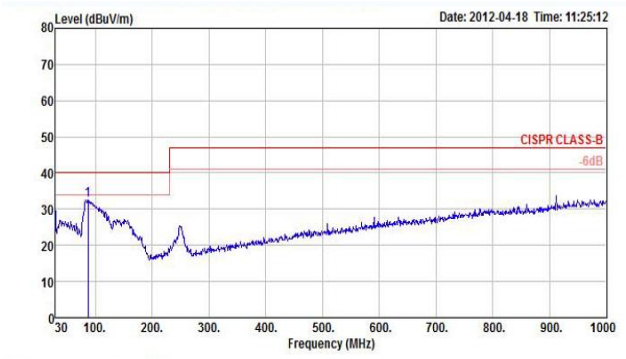
6) SW pad is a noisy node switching from Vin to GND. It should be isolated away from the rest of circuit for good EMI and low noise operation.

7) Thermal pad is connected to GND layer through at least 6 vias.

## Typical performance characteris-




## Radiated EMI Test



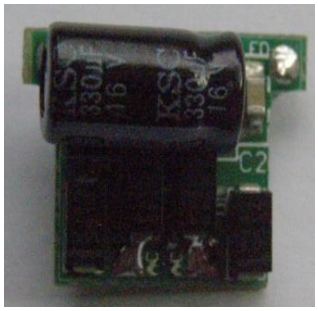

Site : chamber
Condition : CISPR CLASS-B 3m VULB9160 HORIZONTAL

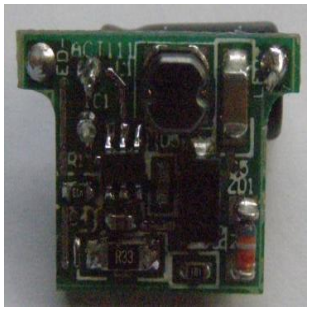
| EVALUATION KITS | Vin | Vo | Io |
|---|---|---|---|
| Car Charger ACT4455-DMB-#1 | 10-33V | 4.75-5.25V | 2.1A+2.1A |

# ACT111A High Efficiency, Low Cost HB LED Lighting

| Input Voltage | LED # | Output Current | $V_{FB}$ | Topology |
|---|---|---|---|---|
| 4.8 – 30VDC | 1-6 | 1.5A | 100mV | Buck |

***Circuit Bottom View*** ***Circuit Top View***





## Design Features

- 95% Efficiency
- 4.8V to 30V Input and up to 1.5A Output
- 1.4 MHz Switching & Small SOT23-6 Package
- PWM (0-100%, 0.1-10kHz) Dimming
- **Thermal Shutdown & Short Circuit Protection**

## Operation and Application

The bridge rectifier is for AC input only. The DC input is directly connected to IN and ground. The ACT111A has an under-voltage lockout (UVLO) at 4.0V with 250mV hysteresis. When input voltage falls below 4.0V, SW stops switching. The device is activated as input voltage goes higher than 4.2V.

The LED output current is sensed by a resistor in series with the LED. The ACT111A precisely regulates the LED current by the internal EA and 0.1V reference. The average LED current is determined by the equation: $\mathbf{I_{LED} = 0.1V / R_{SENSE}}$.

The ACT111A allows dimming with a PWM signal at the DIM pin. A signal level above 1.5V enables switching and turns LED on. To turn off the LED current, the signal level has to be below 1.52V. The dimming signal frequency range is from 100Hz to 10kHz.A 200kΩ resistor is needed to connect between FB pin $R_{SENSE}$. A 100pF capacitor is recommended to connect from the FB pin to ground.

## Key Component Selection

An inductor with RMS rating greater than load current and its saturation current at least 30% higher should be used. Inductance value is selected to make its ripple current 20-30% of the load current. A Schottky diode (D5) is usually used for better efficiency as long as the breakdown voltage can withstand the maximum output voltage. The forward current rating of the diode must be at least equal to the maximum LED current.

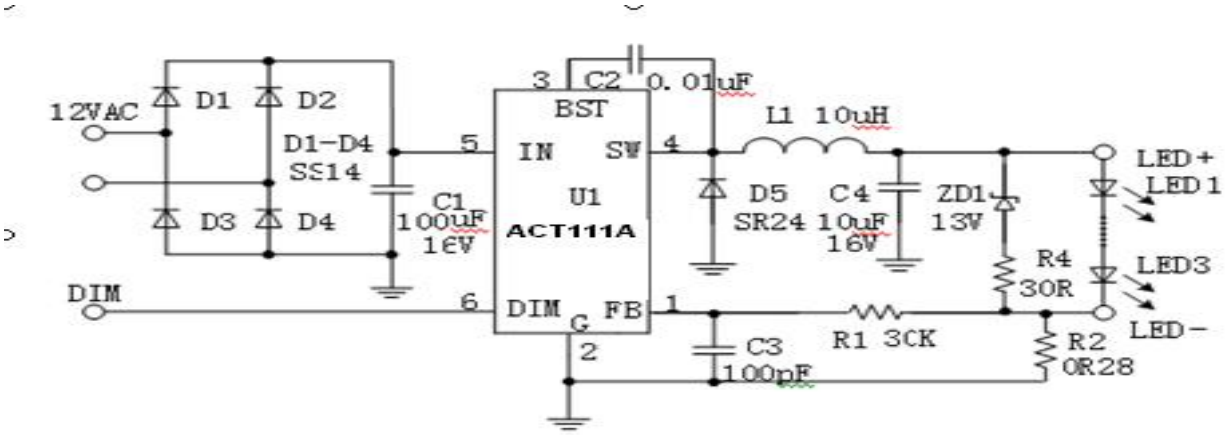
For AC input, if a conventional step-down line transformer is used, a low cost IN4001can be used for D1-D4. However, if a high frequency electronic transformer is used, a Schottky diode such as SS14 should be used for high efficiency operation. For input and output capacitors, small size and low ESR ceramic capacitor is preferred.

## PC Board Layout Guidance

Place input capacitor (C1) to IN pin, inductor (L1) and diode (D5) to SW pin as close as possible to reduce the voltage ringing at these pins. Place the current sense resistor (R2 ) close to FB pin. Minimize ground noise by connecting high current ground returns, the input capacitor ground lead, and the output filter ground lead to a single point (star ground configuration). There are two power loops in normal operation, one is formed when the SW is high and the high current flows through input capacitor (C1), internal MOSFET, inductor(L1), LEDs, $R_{SENSE}$(R2) to ground. The other loop is through inductor (L1), LEDs, $R_{SENSE}$(R2), ground to diode(D5). Make these loop areas as small as possible to minimize noise interaction.

# ACT111A High Efficiency, Low Cost HB LED Lighting

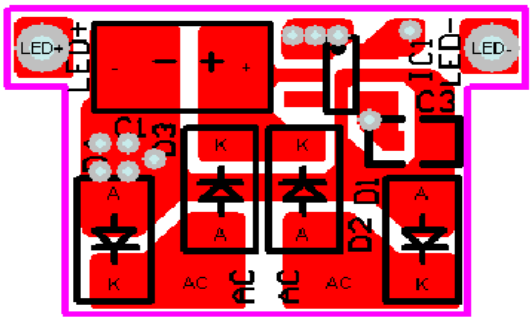
## Schematic ( VIN=12VDC or AC, 3x350mA LEDs )



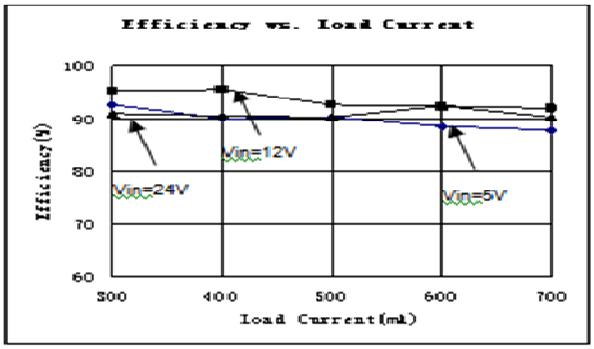

## Bill of Materials

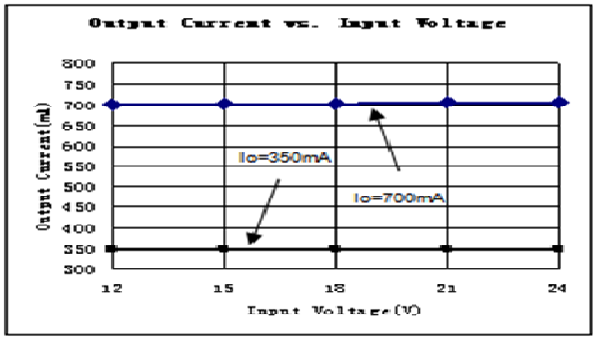
| Ref. | Description | Mftr |
|---|---|---|
| C1 | Capacitor Tantalum,100uF/16V, D Case | AVX |
| C2 | Capacitor, Ceramic,0.01uF/50V,0603 | POE |
| C3 | Capacitor, Ceramic,100pF/25V,0603 | POE |
| C4 | Capacitor Ceramic,10uF/16V,1206 | AVX |
| D1-D4 | Diode shottoky, 40V/1A, SS14, SMA | PANJIT |
| D5 | Schottky Barrier Rectifier,SR24,40V/2.0A,SMB | PANJIT |
| ZD1 | Diode Zener,GLZ13A,13V, 0.5W, MINI-MELF | PANJIT |
| R1 | Meter Film Resistor, 30KΩ,0603, 5% | TY-OHM |
| R2 | Meter Film Resistor, 0.28Ω,1206, 1% | TY-OHM |
| R4 | Meter Film Resistor, 510Ω,1206, 5% | TY-OHM |
| L1 | SMD Power Inductor,SR0604220ML,10uH,±20% | QianRu |
| U1 | IC,ACT111,SOT23-6 | Active |

## PCB Top Layer




## Typical performance characteristics




## PCB Bottom Layer