Regulated 5V Charge Pump In SOT-23

FEATURES

- Regulated ±4% Output Voltage
- Output Current: 100mA at V_{IN} =3.1V
- Input Range: 2.7V to 4.5V
- No Inductors Required
- Very Low Shutdown Current: <1μA
- 1.8MHz Switching Frequency
- Short-Circuit and Over Temperature Protection
- Low Profile Package: SOT-23-6

APPLICATIONS

- White LEDs Backlighting
- SIM Interface Supplies for Cellular Telephones
- Li-Ion Battery Backup Supplies
- Local 3V to 5V Conversion
- Smart Card Readers
- PCMCIA Local 5V Supplies

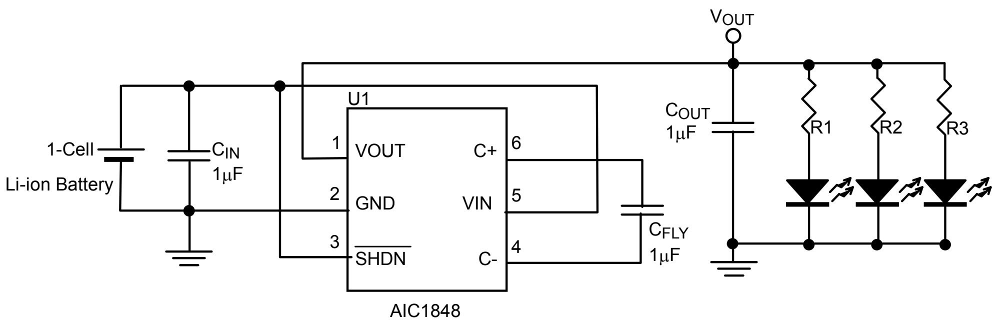
DESCRIPTION

The AIC1848 charge pump is a micropower charge pump DC/DC converter that produces a regulated output voltage from 2.7V to 4.5V input voltage. Low external-part count (one flying capacitor and two small bypass capacitors) makes the AIC1848 ideal for small, battery-powered applications.

The AIC1848 operates as a constant frequency mode switched capacitor voltage doubler to produce a regulated output and features with thermal shutdown capability and short circuit protection.

The AIC1848 is available in a space-saving SOT-23-6 package.

TYPICAL APPLICATION CIRCUIT



Regulated 5V Output from 2.7V to 4.5V Input

WLED series number: NSPW310BS, V_F=3.6V, I_F=20mA

$$R = \frac{V_{OUT} - V_F}{I_F}$$

C_{IN}, C_{FLY}, C_{OUT}: JMK107BJ105KA, TAIYO YUDEN

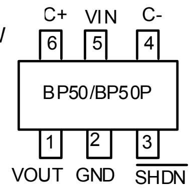
ORDERING INFORMATION

AIC1848XXXX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  G: SOT-23-6
- C: COMMERCIAL
  P: LEAD FREE COMMERCIAL
  G: GREEN PACKAGE

PIN CONFIGURATION

SOT-23-6
TOP VIEW



Note: Pin1 is determined by orienting the package marking as shown.

Example: AIC1848CGTR
→ in SOT-23-6 Package & Taping & Reel Packing Type
AIC1848PGTR
→ in Lead Free SOT-23-6 Package & Taping & Reel Packing Type

- **SOT-23-6 Marking**

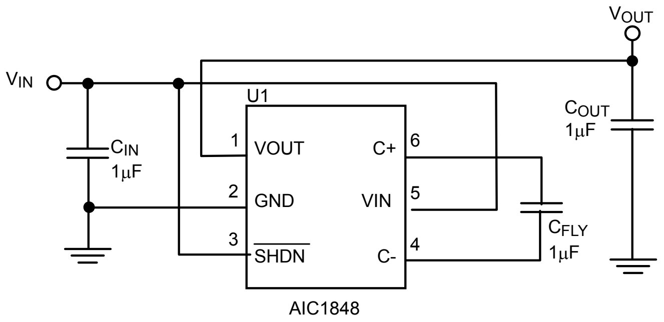
Part No.	Marking
AIC1848CG	BP50
AIC1848PG	BP50P
AIC1848GG	BP50G

ABSOLUATE MAXIMUM RATINGS

VIN to GND 6V
VOUT to GND 6V
All Other Pins to GND 6V
VOUT Short-Circuit Duration .... Continuous
Operating Temperature Range .... -40°C to 85 °C
Maximum Junction Temperature .... 125°C
Storage Temperature Range .... -65°C to 150 °C
Lead Temperature (Soldering 10 Sec.) .... 260°C
Thermal Resistance Junction to Case .... 130°C/W
Thermal Resistance Junction to Ambient .... 220°C/W
(Assume no Ambient Airflow, no Heatsink)

Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

TEST CIRCUIT



ELECTRICAL CHARACTERISTICS

(T_A=25°C, C_{FLY}=1μF, C_{IN}=1μF, C_{OUT}=1μF, unless otherwise specified.) (Note 1)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Input Voltage		V_{IN}	2.7		4.5	V
Output Voltage	2.7V≤ V_{IN}< 4.5V, I_{OUT}≤ 40mA	V_{OUT}	4.8	5	5.2	V
	3.1V≤ V_{IN}≤ 4.5V, I_{OUT}≤ 100mA		4.8	5	5.2	
Supply Current	2.7V≤ V_{IN}≤ 5.0V, I_{OUT}=0 , $\overline{SHDN}$ =V_{IN}	I_{CC}	1	3	5	mA
Shutdown Current	2.7V≤ V_{IN}≤ 5.0V, I_{OUT}=0 , $\overline{SHDN}$ =0V	$I_{\overline{SHDN}}$		0.01	1.0	μA
Efficiency	V_{IN} =2.7V , I_{OUT}=30mA	η		85		%
Switching Frequency	Oscillator Free Running	f_{OSC}		1.8		MHz
Output Ripple	V_{IN} =3.7V, Iout= 60mA, Cout = 2.2uF			30		mV
	V_{IN} =3.7V, Iout= 60mA, Cout = 1uF			40		
Shutdown Input Threshold	High	V_{IH}	1.4			V
	Low	V_{IL}			0.3	V
Shutdown Input Current	$\overline{SHDN}$ =V_{IN}	I_{IH}	-1		1	μA
	$\overline{SHDN}$ = 0V	I_{IL}	-1		1	μA
Vout Turn On Time	V_{IN} =3V, I_{OUT} = 1mA	t_{ON}		50		μS
Output Short Circuit Current	V_{IN}=3V, V_{OUT}= 0V, $\overline{SHDN}$ = V_{IN}	I_{SC}		300		mA

Note 1: Specifications are production tested at T_A=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

TYPICAL PERFORMANCE CHARACTERISTICS

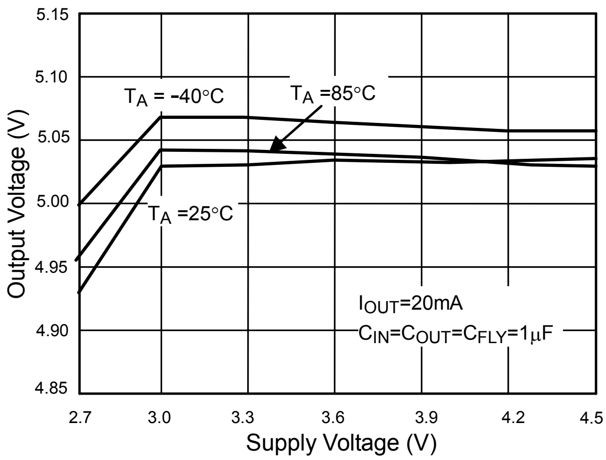


Fig. 1 Output Voltage vs. Supply Voltage

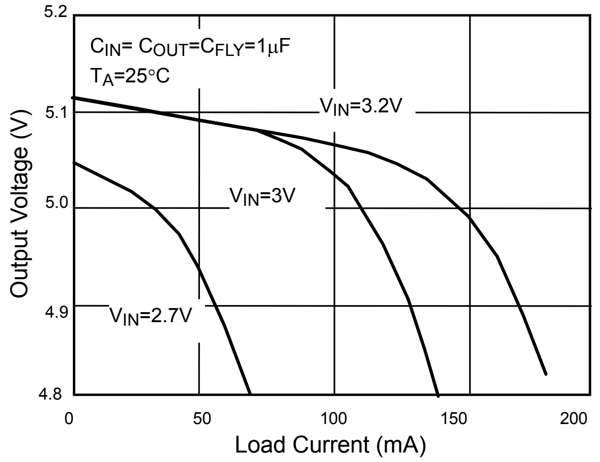


Fig. 2 Output Voltage vs. Load Current

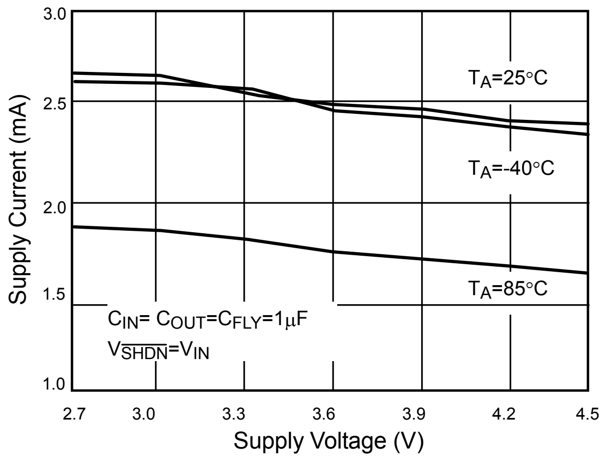


Fig. 3 No Load Supply Current vs. Supply Voltage

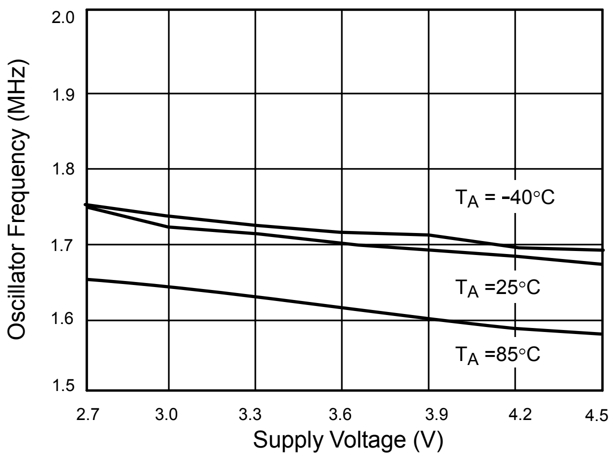


Fig. 4 Oscillator Frequency vs. Supply Voltage

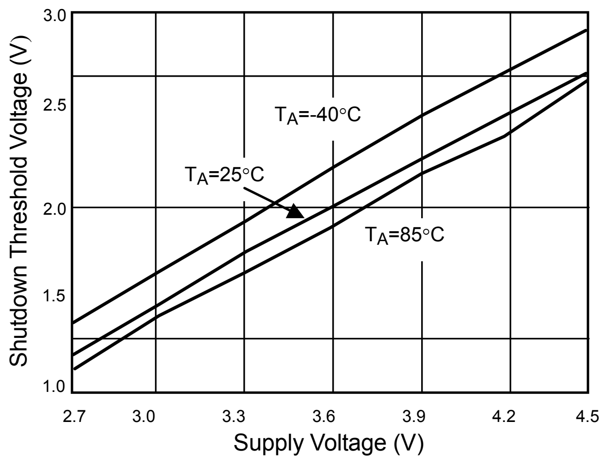


Fig. 5 $V_{\overline{SHDN}}$ Threshold Voltage vs. Supply Voltage

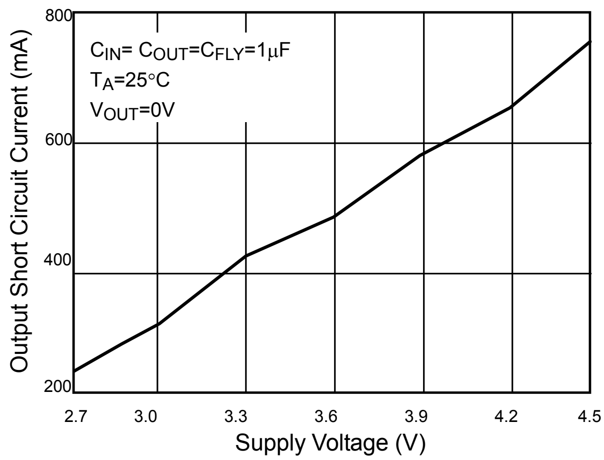


Fig. 6 Short Circuit Current vs. Supply Voltage

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

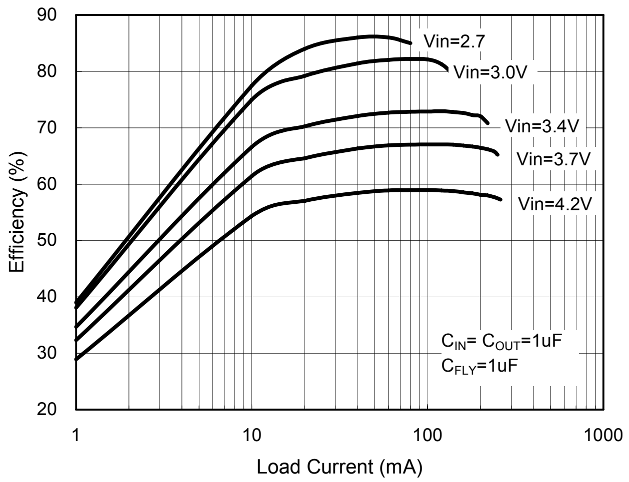


Fig.7 Efficiency vs. Load Current

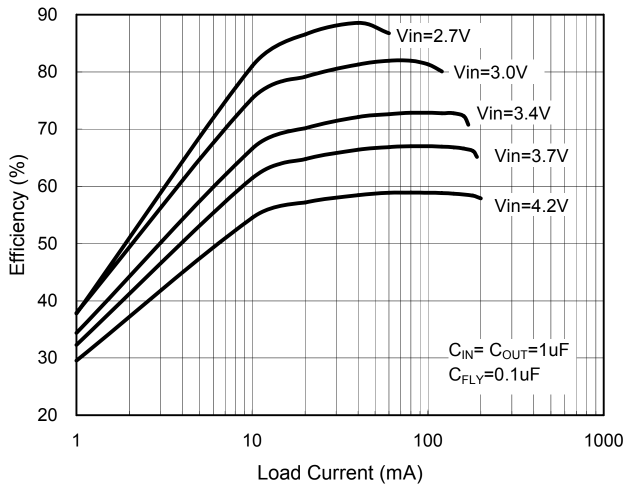


Fig.8 Efficiency vs. Load Current

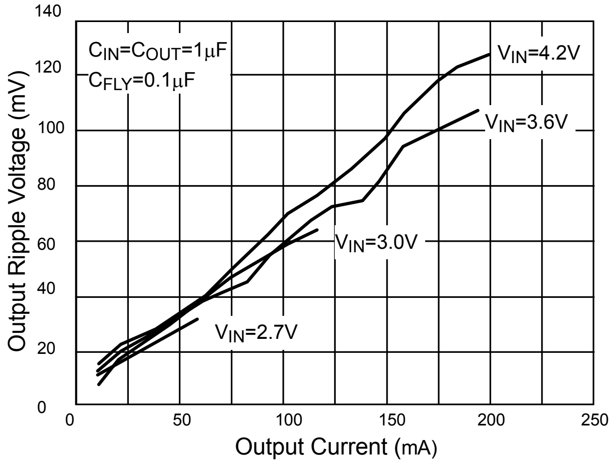


Fig. 9 Output Ripple Voltage vs. Output Current

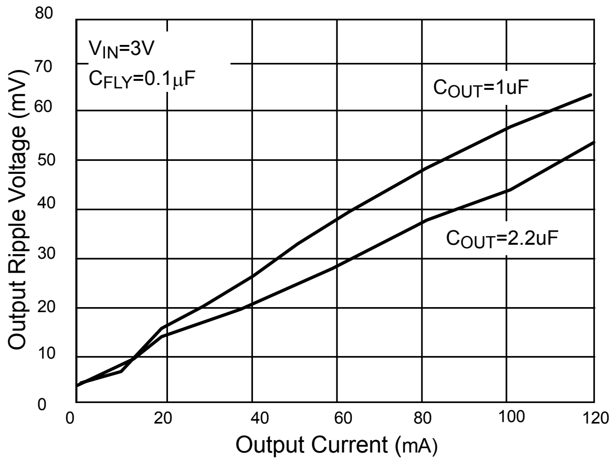
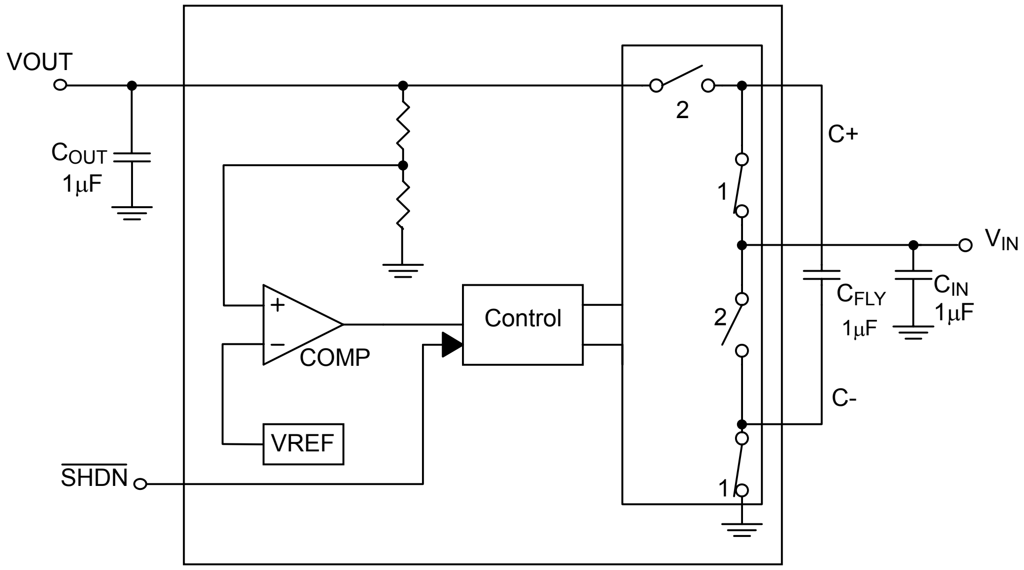


Fig. 10 Output Ripple Voltage vs. Output Current

BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN 1:VOUT - Regulated output voltage. For the best performance, V_{OUT} should be bypassed a 1μF (min.) low ESR capacitor with the shortest distance in between.

PIN 2: GND - Ground. Should be tied to ground plane direct for best performance.

PIN 3: $\overline{\text{SHDN}}$ - Active low shutdown input. Tie to higher than 1.4V to enable device, 0.3V or less to disable device. $\overline{\text{SHDN}}$ pin is not allowed to float.

PIN 4: C- - Flying capacitor negative terminal.

PIN 5: VIN - Input supply voltage. V_{IN} should be bypassed a 1μF (min.) low ESR capacitor with the shortest distance in between.

PIN 6: C+ - Flying capacitor positive terminal.

APPLICATION INFORMATION

Introduction

AIC1848 is a micropower charge pump DC/DC converter that produces a regulated 5V output with an input voltage range from 2.7V to 4.5V. It utilizes the charge pump topology to boost V_{IN} to a regulated output voltage. Regulation is obtained by sensing the output voltage through an internal resistor divider. A switched doubling circuit enables the charge pump when the feedback voltage is lower than the internal comparator point, and vice versa. When the charge pump is enabled, a two-phase non-overlapping clock activates the charge pump switches.

Operation

This kind of converter uses capacitors to store and transfer energy. Since the capacitors can't change to the voltage level abruptly, the voltage ratio of V_{OUT} to V_{IN} is limited. Capacitive voltage conversion is obtained by switching a capacitor periodically. Refer to Fig. 11, during the on state of internal clock, Q_1 and Q_4 are closed, which charges C_{FLY} to V_{IN} level. During the off state, Q_3 and Q_2 are closed. The output voltage is V_{IN} plus

V_{CFLY}, that is, $2V_{IN}$.

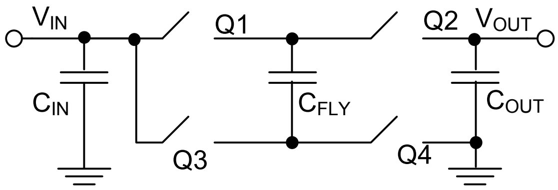


Fig. 11 The circuit of charge pump

Short Circuit/Thermal Protection

AIC1848 obtains built-in short circuit current limiting and over temperature protection. During the short circuit condition, the output current is automatically constrained at approximately 300mA. Continued current limit will cause internal IC junction temperature increased. When the temperature of device exceeds 150°C, the thermal protection will shut the switching down and the temperature will reduce afterwards. Once the temperature drops below 135°C, the charge pump switching circuit will re-start. If the fault doesn't eliminate, the above protecting operation will repeat again and again. It allows AIC1848 to continuously work at short circuit condition without damaging the device.

Shutdown

In shutdown mode, the output is disconnected from input. The input current gets extremely low since most of the circuitry is turned off. Due to high impedance, shutdown pin can't be floated.

Efficiency

Refer to Fig. 12 and Fig. 13, they shows the circuit of charge pump at different operation states.

$R_{DS\text{-}ON}$ is the resistance of the switching element at conduction.

ESR is the equivalent series resistance of the flying capacitor C_{FLY}.

$I_{ON\text{-}AVE}$ and $I_{OFF\text{-}AVE}$ are the average current during on state and off state, respectively.

D is the duty cycle, which means the proportion the on state takes.

Let's take advantage of conversation of charge for capacitor C_{FLY}. Assume that the capacitor C_{FLY} has reached its steady state. The amount of charge flowing into C_{FLY} during on state is equal to that flowing out of C_{FLY} at off state.

$$I_{ON-AVE} \times DT = I_{OFF-AVE} \times (1-D)T \quad \text{..........(1)}$$

$$I_{ON\text{-}AVE} \times D = I_{OFF\text{-}AVE} \times (1-D) \quad \text{................(2)}$$

$$\begin{aligned} I_{IN} &= I_{ON\text{-}AVE} \times D + I_{OFF\text{-}AVE} \times (1-D) \\ &= 2 \times I_{ON\text{-}AVE} \times D \quad \text{..........(3)} \\ &= 2 \times I_{OFF\text{-}AVE} \times (1\text{-}D) \end{aligned}$$

$$I_{OUT} = I_{OFF\text{-}AVE} \times (1-D)$$

$$I_{IN} = 2 \times I_{OUT} \quad \text{....................................(4)}$$

For AIC1848, the controller takes the PWM (Pulse Width Modulation) control strategy. When the duty cycle is limited to 0.5, there will be:

$$I_{ON\text{-}AVE} \times 0.5 \times T = I_{OFF\text{-}AVE} \times (1-0.5) \times T$$

$$I_{ON\text{-}AVE} = I_{OFF\text{-}AVE}$$

According to the equation (4), we know that as long as the flying capacitor C_{FLY} is at steady state, input current is double of output current. The efficiency of charge pump is given below:

$$\eta = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times 2I_{OUT}} = \frac{V_{OUT}}{2V_{IN}}$$

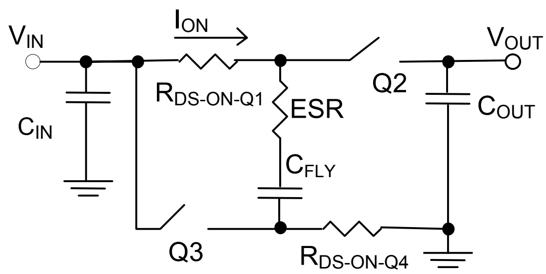


Fig. 12 The on state of charge pump circuit

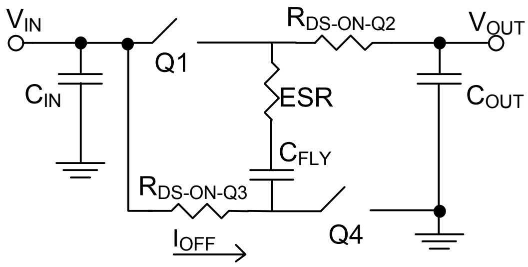


Fig. 13 The off state of charge pump circuit

External Capacitor Selection

Three external capacitors, C_{IN}, C_{OUT} and C_{FLY}, determine AIC1848 performances. Optimum performance can be obtained by using low ESR ceramic capacitors. Due to high ESR, tantalum and aluminum capacitors are not recommended for charge pump application.

To reduce noise and ripple, low ESR ceramic capacitor is recommended for C_{IN} and C_{OUT}. The value of C_{OUT} determines the amount of output ripple voltage. An output capacitor with larger value results in smaller ripple.

C_{FLY} is critical for the charge pump. The larger C_{FLY} is, the larger output current and smaller ripple voltage obtain. However, large C_{IN} and C_{OUT} are required when large C_{FLY} applies. The ratio of C_{IN} (as well as C_{OUT}) to C_{FLY} should be approximately 10:1.

Layout Considerations

Due to the switching frequency and high transient current of AIC1848, careful consideration of PCB layout is necessary. To achieve the best performance of AIC1848, minimize the distance between every two components and also minimize every connection length with a maximum trace width. Make sure each device connects to immediate ground plane. Fig. 14 to Fig. 16 show the recommended layout.

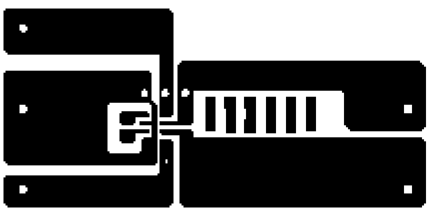


Fig. 14 Top layer

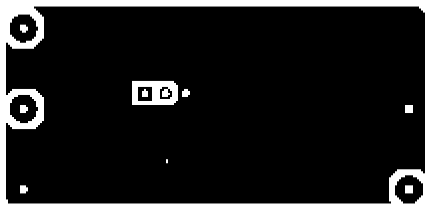


Fig. 15 Bottom layer

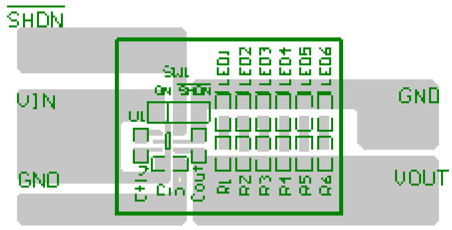


Fig. 16 Top-over layer

APPLICATION EXAMPLES

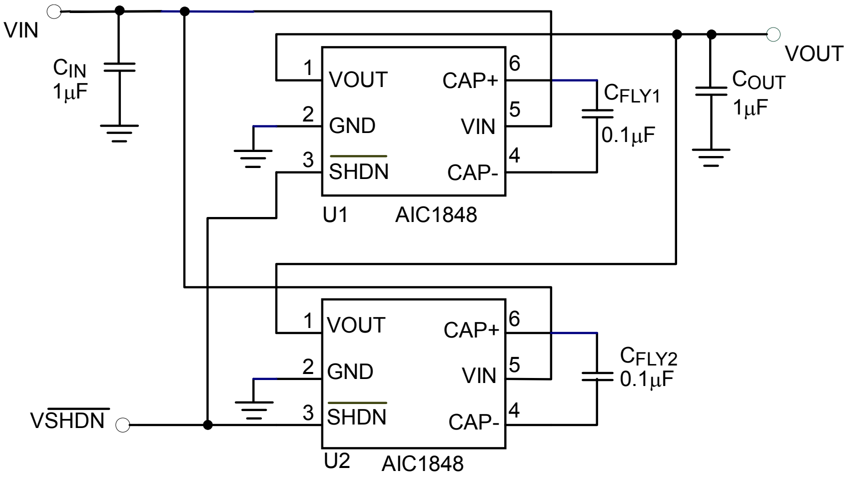


Fig. 17 Parallel Two AIC1848 to Obtain the Regulated 5V Output with large output current.

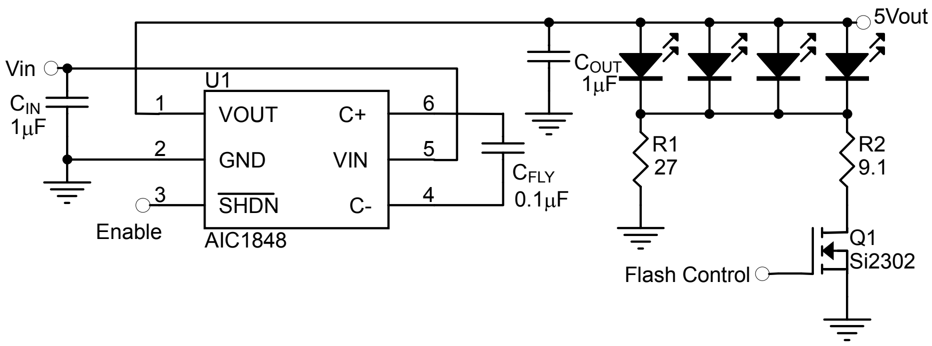


Fig. 18 Flash WLED Application

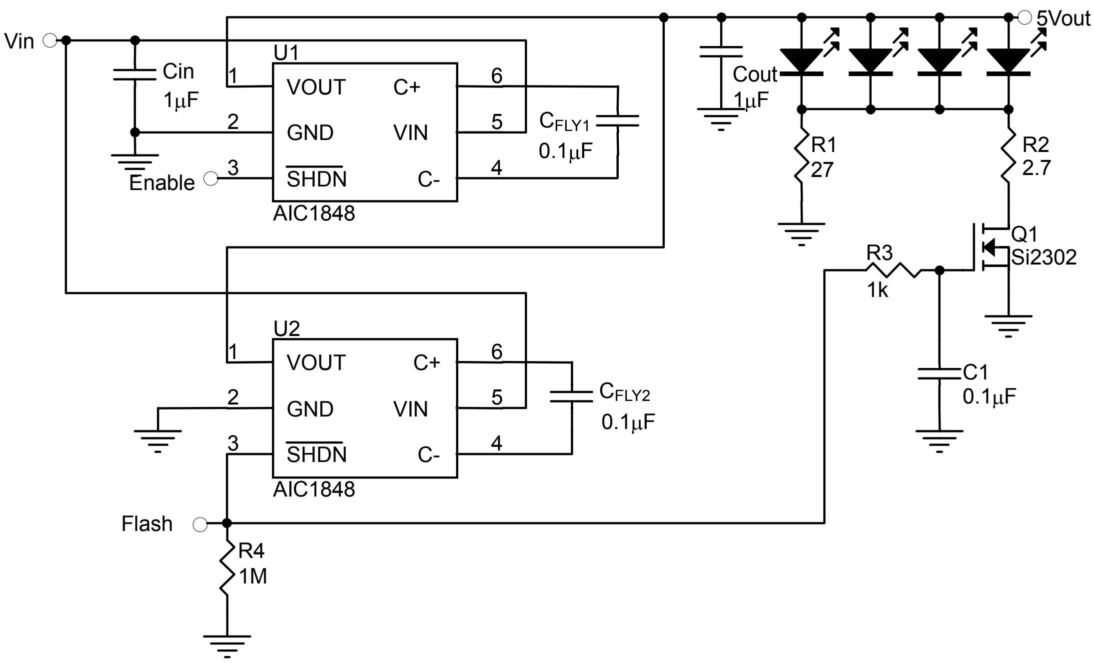
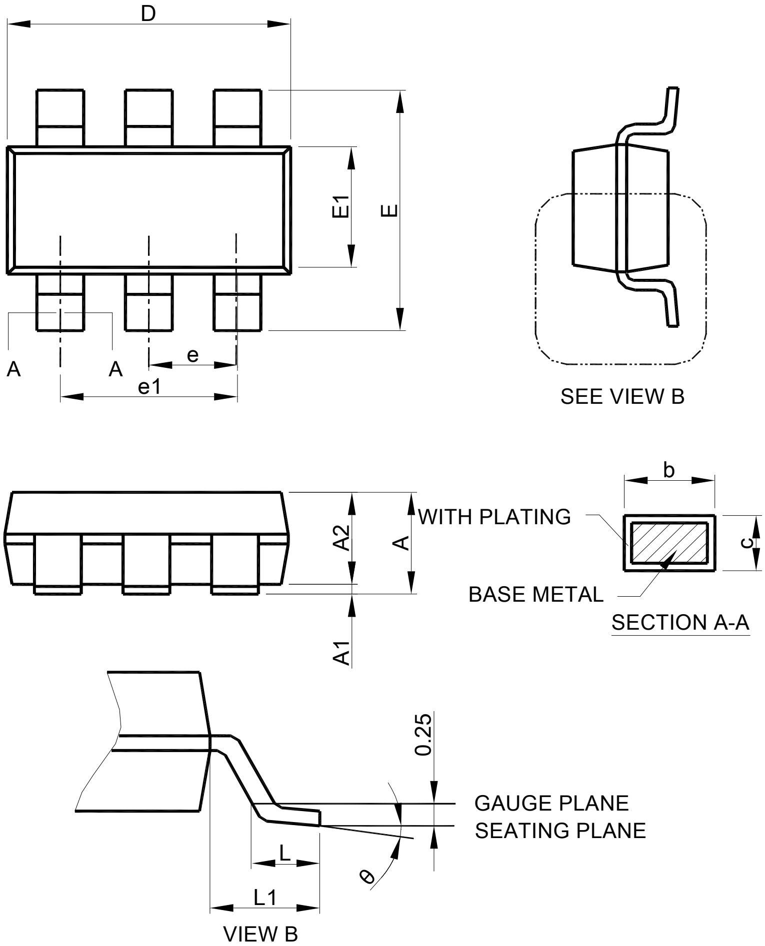


Fig. 19 Flash WLED Application with Parallel Two AIC1848

■ PHYSICAL DIMENSIONS (unit: mm)

- **SOT-23-6**



SYMBOL	SOT-23-6	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.05	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.42 REF	
θ	0°	8°

Note : 1. Refer to JEDEC MO-178AB.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.
3. Dimension "E1" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

Note: