Regulated 5V Charge Pump In SOT-23

FEATURES

- Ultralow Power: I_{IN} = 13µA
- Regulated 5V ±4% Output Voltage
- Output Current: 100mA (V_{IN} =3.3V)
  130mA (V_{IN} =3.6V)
- Input Range: 2.7V to 5.0V
- No Inductors Needed
- Very Low Shutdown Current: <1µA
- Internal Oscillator: 650KHz
- Short-Circuit and Overtemperature Protected
- 6-Pin SOT-23 Package

APPLICATIONS

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

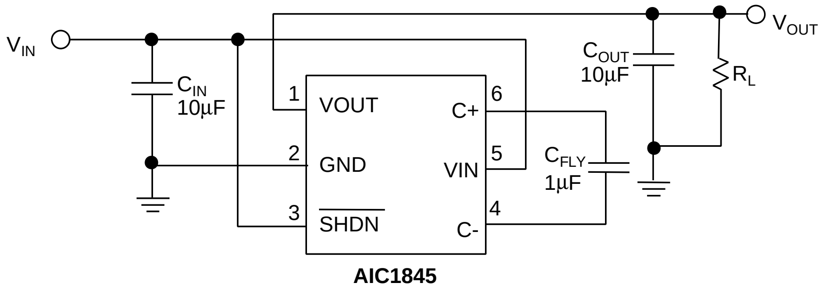
DESCRIPTION

The AIC1845 is a micropower charge pump DC/DC converter that produces a regulated 5V output. The input voltage range is 2.7V to 5.0V. Extremely low operating current (13µA typical with no load) and a low external parts count (one 1µF flying capacitor and two small bypass capacitors at V_{IN} and V_{OUT}) make the AIC1845 ideally suited for small, battery-powered applications.

The AIC1845 operates as a burst mode switched capacitor voltage doubler to produce a regulated output. It has thermal shutdown capability and can survive a continuous short circuit from V_{OUT} to GND.

The AIC1845 is available in a 6-pin SOT-23 package.

TYPICAL APPLICATION CIRCUIT



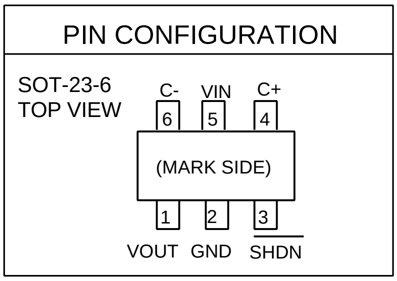
Regulated 5V Output from 2.7V to 5.0V Input

(10µF Ceramic Capacitors are recommended for C_{IN} and C_{OUT})

■ ORDERING INFORMATION

AIC1845CXXX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  G: SOT-23-6



Example: AIC1845CGTR
→ in SOT-23-6 Package & Taping & Reel
Packing Type

- **SOT-23-6 Marking**

Part No.	Marking
AIC1845	BO50

■ ABSOLUATE MAXIMUM RATINGS

VIN to GND 6V
VOUT to GND 6V
All Other Pins to GND 6V
VOUT Short-Circuit Duration .... Continuous
Maximum Operation Junction Temperature .... 150°C
Operating Temperature Range .... -40°C to 85 °C
Storage Temperature Range .... -65°C to 150 °C
Lead Temperature (Sordering 10 Sec.) .... 260°C

■ ELECTRICAL CHARACTERISTICS **(T_A=25°C, C_{FLY}=1μF, C_{IN}=10μF, C_{OUT}=10μF, unless otherwise specified.)**

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Input Voltage		V_{IN}	2.7		5.0	V
Output Voltage	2.7V≤ V_{IN}< 3.3V, I_{OUT}≤ 30mA 3.3V≤ V_{IN}≤ 5.0V, I_{OUT}≤ 60mA	V_{OUT}	4.8 4.8	5.0 5.0	5.2 5.2	V
Continuous Output Current	V_{IN}=3V, V_{OUT}=5V $\overline{SHDN}$ =V_{IN}		60			mA

ELECTRICAL CHARACTERISTICS (Continued)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Current	$2.7V \leq V_{IN} \leq 5.0V$, $I_{OUT}=0$, $\overline{SHDN}=V_{IN}$	I_{CC}		13	30	µA
Shutdown Current	$2.7V \leq V_{IN} \leq 5.0V$, $I_{OUT}=0$, $\overline{SHDN}=0V$	$I_{\overline{SHDN}}$		0.01	1.0	µA
Output Ripple	$V_{IN}=3V$, $I_{OUT}=50mA$	V_R		50		mV
Efficiency	$V_{IN}=2.7V$, $I_{OUT}=30mA$	η		83		%
Switching Frequency	Oscillator Free Running	f_{OSC}		650		KHz
Shutdown Input Threshold (High)		V_{IH}	1.4			V
Shutdown Input Threshold (Low)		V_{IL}			0.3	V
Shutdown Input Current (High)	$\overline{SHDN}=V_{IN}$	I_{IH}	-1		1	µA
Shutdown Input Current (Low)	$\overline{SHDN}=0V$	I_{IL}	-1		1	µA
Vout Turn On Time	$V_{IN}=3V$, $I_{OUT}=0mA$	t_{ON}		0.5		mS
Output Short Circuit Current	$V_{IN}=3V$, $V_{OUT}=0V$, $\overline{SHDN}=V_{IN}$	I_{SC}		170		mA

TYPICAL PERFORMANCE CHARACTERISTICS

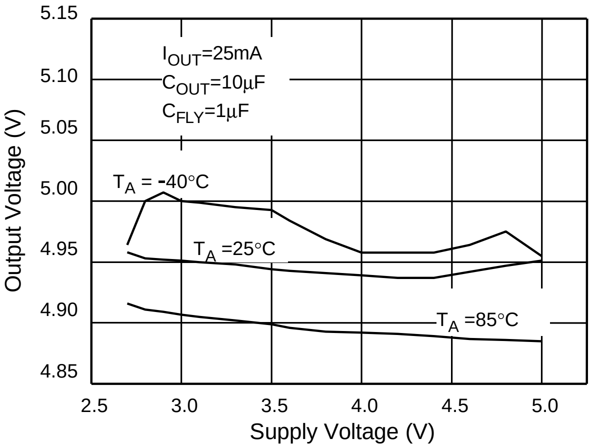


Fig. 1 Output Voltage vs. Supply Voltage

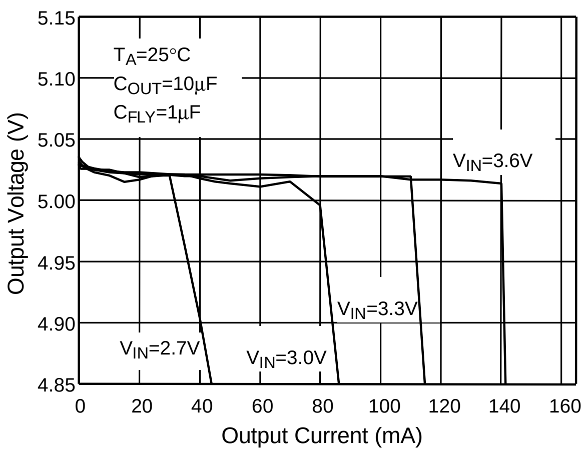


Fig. 2 Output Voltage vs. Output Current

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

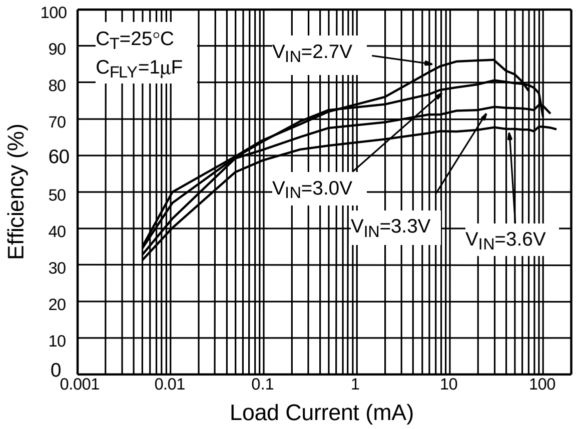


Fig. 3 Efficiency vs. Load Current

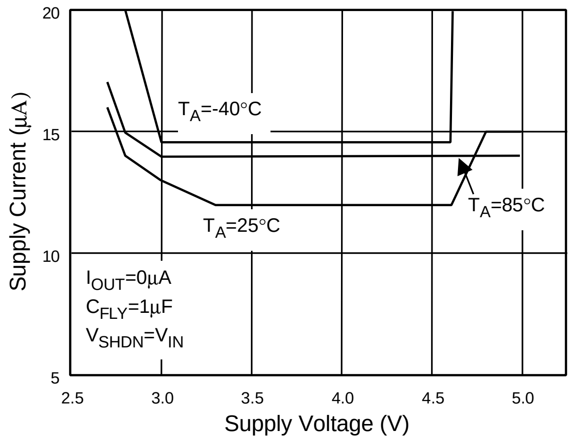


Fig. 4 No Load Supply Current vs. Supply Voltage

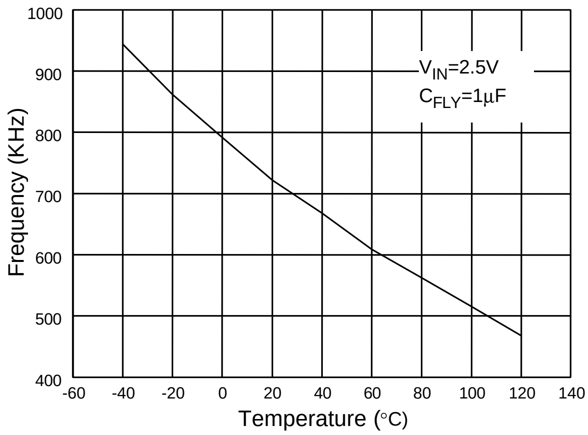


Fig. 5 Frequency vs. Temperature

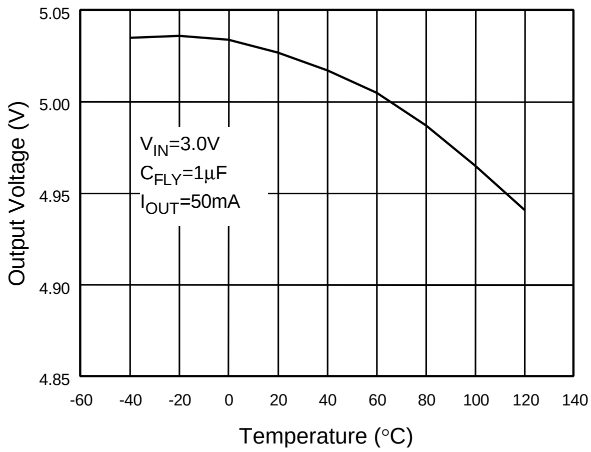


Fig. 6 Output Voltage vs. Temperature

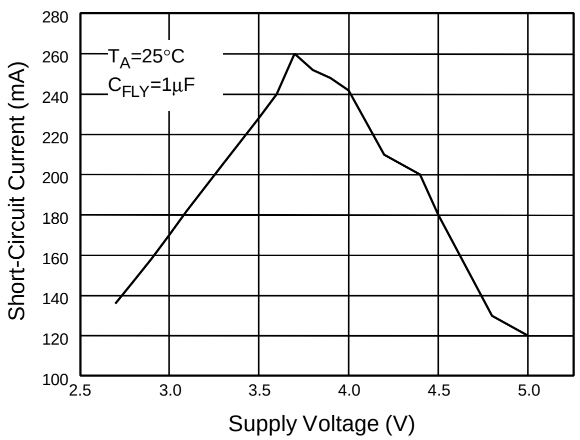


Fig. 7 Short-Circuit Current vs. Supply Voltage

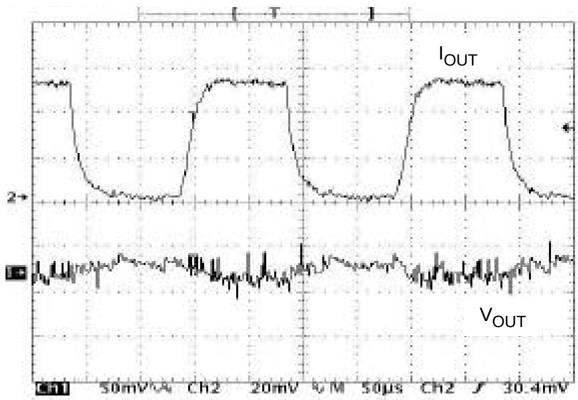


Fig. 8 Load Transient Response
I_{OUT}=0mA~50mA, C_{FLY}=1μF, V_{IN}=3.0V

■ TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

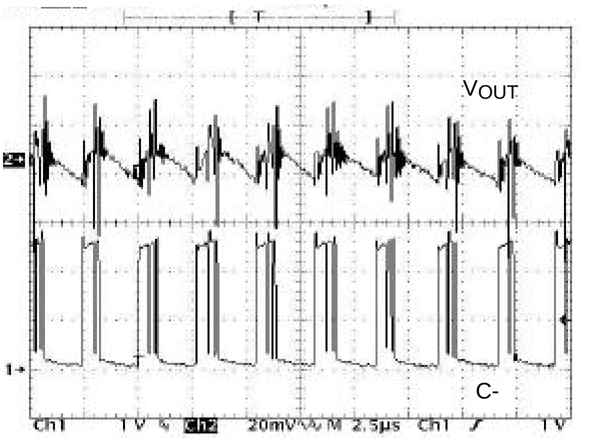


Fig. 9 Output Ripple,
I_{OUT}=50mA, C_{OUT}=10µF, V_{IN}=3.0V

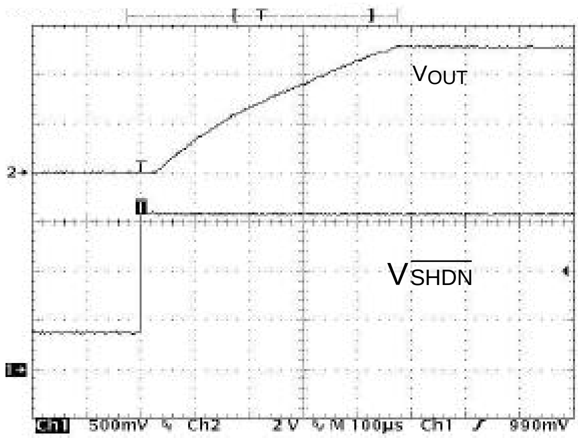
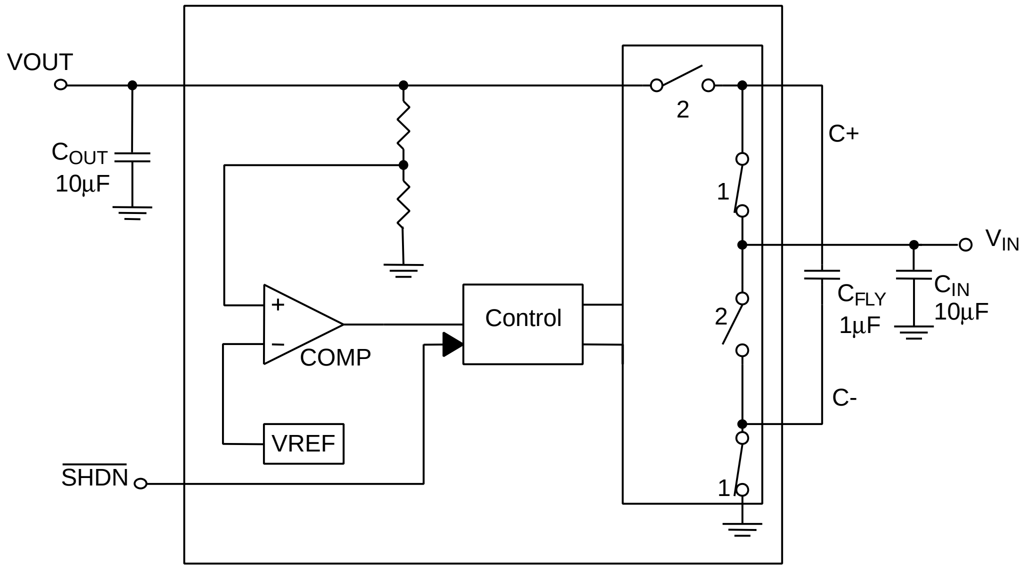


Fig. 10 Start-Up Time
I_{OUT}=0A, C_{OUT}=10µF, V_{IN}=3.0V

■ BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN 1:VOUT - Regulated output voltage. For best performance, V_{OUT} should be by-passed with a 6.8μF (min) low ESR capacitor as close as possible to the pin.

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

PIN 3: $\overline{SHDN}$ - Active low shutdown input. A low on $\overline{SHDN}$ disables the AIC1845. $\overline{SHDN}$ must not be allowed to float.

PIN 4: C- - Flying capacitor negative terminal.

PIN 5: VIN - Input supply voltage. V_{IN} should be bypassed with a 6.8μF (min) low ESR capacitor.

PIN 6: C+ - Flying capacitor positive terminal.

APPLICATION INFORMATION

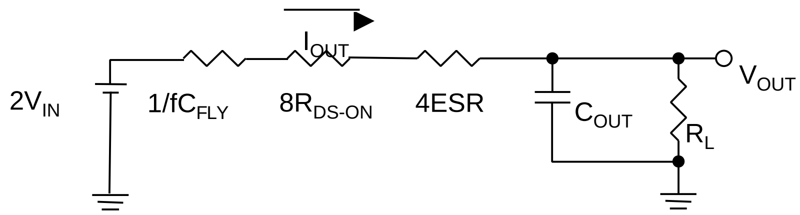


Fig.11 The euqivalent circuit of charge pump

Since AIC1845 needs 3 external capacitors, this section focuses on the selection of capacitors. In Fig.11, it shows the equivalent circuit of the charge pump. It is obvious that we have to make all the equivalent resistors ($1/fC_{FLY}$, $8R_{DS-ON}$, and 4ESR) as small as possible to achieve the maximum output current with the regulated output voltage. However, since the R_{DS-ON} is manufactured inside the IC, the only choice is to select the appropriate flying capacitor C_{FLY}. Generally, the ESR of the ceramic capacitor is inversely proportional to its capacitance and is also a function of frequency. The lower the capacitance, the larger the equivalent resistance($1/fC_{FLY}$ + 4ESR). And due to the thermal characteristic of the insulator, the capacitance varies with respect to the ambient temperature. Therefore it is necessary to consider the effect of the shrink of capacitance at different operation temperature. Make sure the enough capacitance to less the equivalent resistance. The X5R series will be the good choice for a wide operation condition. The maximum output current for the small capacitors is less than that of large capacitors. Fig. 12 shows the results. It is also noticable that the R_{DS-ON} will play the dominate role in the total resistance when C_{FLY} is large enough. 10μF Ceramic capacitors are suggested for C_{IN} and C_{OUT}.

Table 1 the contribution of total resistance from each item (T_A=25°C)

C_{FLY}(mF)	1/fC_{FLY} (W)	8R_{DS-ON} (W)	4ESR (W)	Total Resistance(W)
0.01	156	11.2	1.6	168.8
0.1	15.6	11.2	0.48	27.28
1	1.56	11.2	0.116	12.88
10	0.156	11.2	0.08	11.44

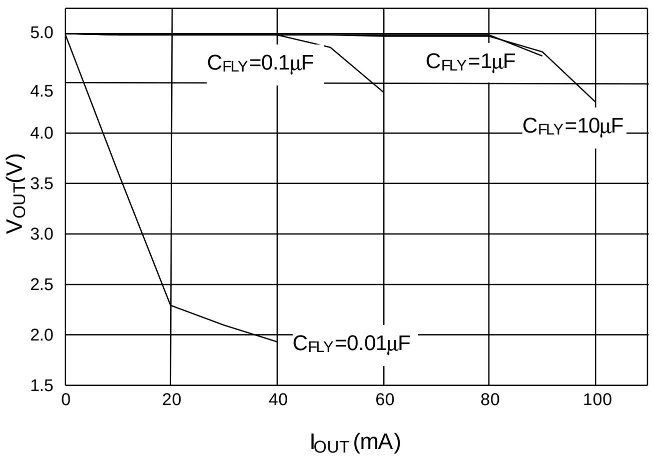


Fig. 12 The load regulation with different C_{FLY} (V_{IN}=3V)

Layout Considerations

Due to the high switching frequency and large transient current, the layout is recommended to have a ground plane and short connections to each capacitor. Fig. 13 is the typical application circuit. Fig 14 is the recommended placement for components. Tabel 2 is the recommended Bill of Material for Fig. 13.

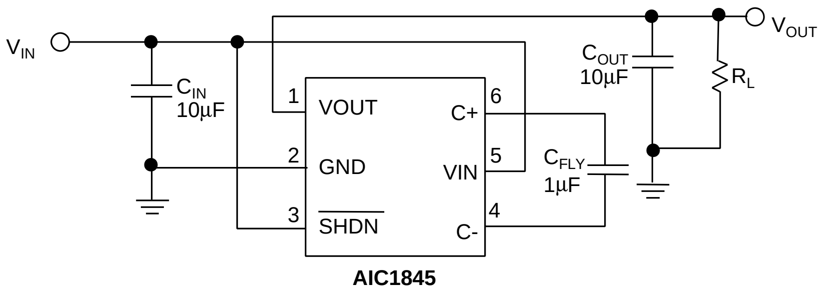


Fig 13.The typical application circuit

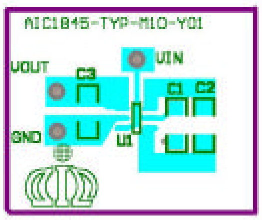


Fig 14.The recommended placement and routing of AIC1845.

Table 2 Bill of Material

Designator	Part Type	Description	Vendor
C1	10μ	GRM42-6X5R106K	Murata
C2	1μ	CC0805MBX7R6BN105	YAGEO
C3	10μ	GRM42-6X5R106K	Murata
U1	AIC1845	Regulated 5V Charge Pump	AIC

■ APPLICATION EXAMPLES

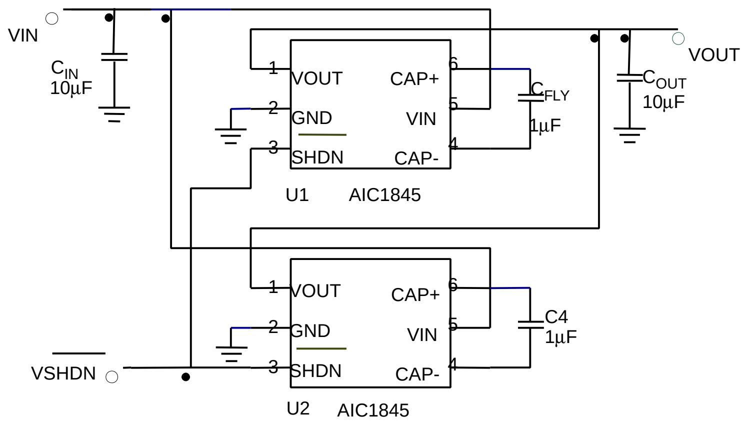


Fig. 15 Parallel two AIC1845 to obtain the regulated 5V output with 100mA.

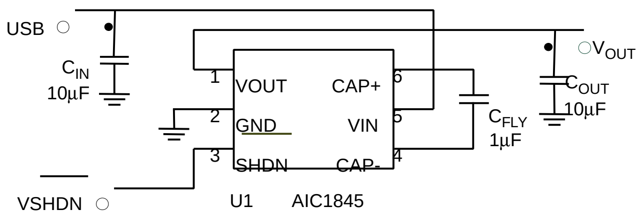
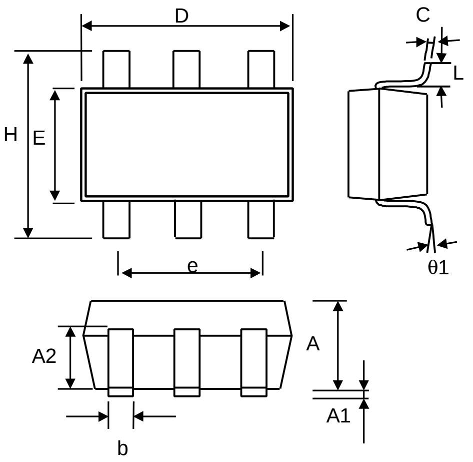


Fig. 16 Regulated 5V from USB

■ PHYSICAL DIMENSIONS

- **SOT-23-6 (unit: mm)**



SYMBOL	MIN	MAX
A	1.00	1.30
A1	—	0.10
A2	0.70	0.90
b	0.35	0.50
C	0.10	0.25
D	2.70	3.10
E	1.40	1.80
e	1.90 (TYP)	
H	2.60	3.00
L	0.37	—
θ1	1°	9°