1.0MHz Current-Mode Step-Up DC/DC Converter

FEATURES

- Fixed Frequency 1.0MHz Current-Mode PWM Operation.
- Adjustable Output Voltage up to 24V.
- 2.5V to 5.5V Input Range.
- Maximum 0.1µA Shutdown Current.
- Programmable Soft-Start.
- Tiny Inductor and Capacitors are allowed.
- Space-Saving TSOT-23-6 and SOT-23-6 Package.

APPLICATIONS

- OLED Driver for MP3 Player
- White LED Backlight

DESCRIPTION

The current-mode pulse-width modulation, AIC1899, step up converter is designed for MP3 player. The built-in high voltage N-channel MOSFET allows AIC1899 for step-up applications with up to 24V output voltage, and other low-side switching DC/DC converter.

The high switching frequency allows the use of small external components. The Soft-Start function is programmable with an external capacitor, which sets the input current ramp rate.

The AIC1899 is available in a space-saving TSOT-23-6 and SOT-23-6 package.

TYPICAL APPLICATION CIRCUIT

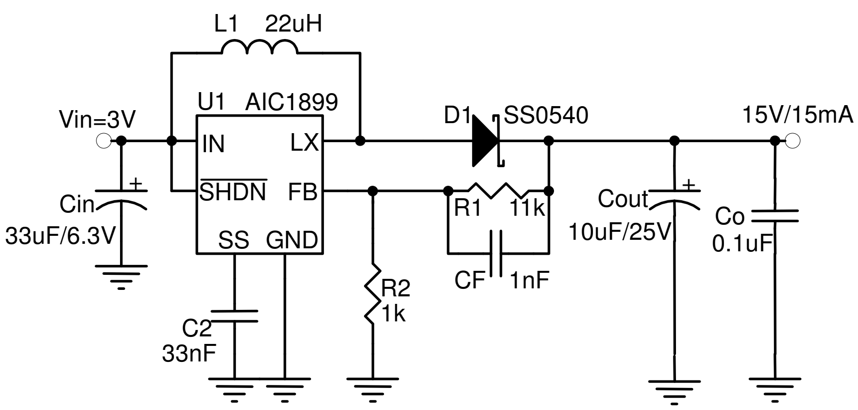


Fig. 1 Typical Step up Application Circuit

ORDERING INFORMATION

AIC1899XXXX

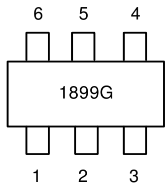
- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  G: SOT-23-6
  K: TSOT-23-6
- P: LEAD FREE COMMERCIAL
  G: GREEN PACKAGE

Example: AIC1899PGTR
→ in Lead Free SOT-23-6 Package & Tape & Reel Packing Type

AIC1899PKTR
→ in Lead Free TSOT-23-6 Package & Tape & Reel Packing Type

PIN CONFIGURATION

SOT-23-6 / TSOT-23-6
FRONT VIEW
1: LX
2: GND
3: FB
4: $\overline{SHDN}$
5: SS
6: IN



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

- **TSOT-23-6 Marking**

Part No.	Marking	Part No.	Marking
AIC1899PK	899PK	AIC1899GK	899GK

- **SOT-23-6 Marking**

Part No.	Marking	Part No.	Marking
AIC1899PG	1899P	AIC1899GG	1899G

ABSOLUTE MAXIMUM RATINGS

IN, $\overline{SHDN}$, FB, SS to GND .... -0.3V to +6V
LX to GND .... -0.3V to +27V
LX Pin RMS Current 0.14A
Operating Temperature Range .... -40°C to 85°C
Junction Temperature .... 125°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (soldering, 10s) .... 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.

■ ELECTRICAL CHARACTERISTICS

(V_{IN}=$V_{\overline{SHDN}}$ =3V, FB=GND, SS=Open, T_A=25°C, unless otherwise specified) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply Range	V_{IN}		2.5		5.5	V
Output Voltage Adjust Range	V_{OUT}				24	V
V_{IN} Undervoltage Lockout	UVLO	V_{IN} rising, 50mV hysteresis		2.2		V
Quiescent Current	I_{IN}	V_{FB} = 1.3V, not switching		0.1	0.2	mA
		V_{FB} = 1.0V, switching		1	5	
Output Current	Iout	V_{in} = 3V, Vout = 15V		15		mA
		V_{in} = 3.3V, Vout = 15V		17		
Shutdown Supply Current		$V_{\overline{SHDN}}$ = 0, T_A = +25°C		0.01	0.5	µA
		$V_{\overline{SHDN}}$ = 0		0.01	10	µA
ERROR AMPLIFIER						
Feedback Regulation Set Point	V_{FB}		1.205	1.23	1.255	V
FB Input Bias Current	I_{FB}	V_{FB} = 1.24V		21	80	nA
Line Regulation		2.6V < V_{IN} < 5.5V		0.05	0.20	%/V
OSCILLATOR						
Frequency	f_{OSC}		800	1000	1700	KHz
Maximum Duty Cycle	DC		80	82		%
POWER SWITCH						
On-Resistance	$R_{DS(ON)}$	Vin = 5V		1.2	1.6	Ω
Leakage Current	$I_{LX(OFF)}$	V_{LX} = 24V, T_A = +25°C		0.1	1	µA
		V_{LX} = 24V			10	
SOFT-START						
Reset Switch Resistance		Guaranteed By Design			100	Ω
Charge Current		V_{SS} = 1.2V	1.5	4	7.0	µA
CONTROL INPUT						
Input Low Voltage	V_{IL}	$V_{\overline{SHDN}}$, V_{IN} = 2.5V to 5.5V			0.3	V
Input High Voltage	V_{IH}	$V_{\overline{SHDN}}$, V_{IN} = 2.5V to 5.5V	1.0			V
$\overline{SHDN}$ Input Current	$I_{\overline{SHDN}}$	$V_{\overline{SHDN}}$ = 1.8V		25	50	µA
		$V_{\overline{SHDN}}$ = 0		0.01	0.1	

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

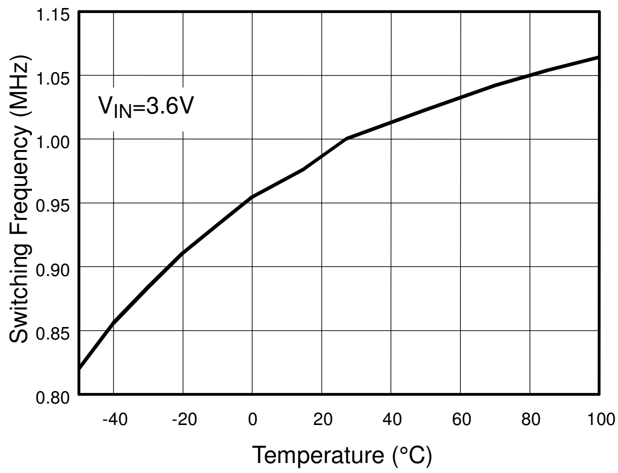


Fig. 2 Switching Frequency vs. Temperature

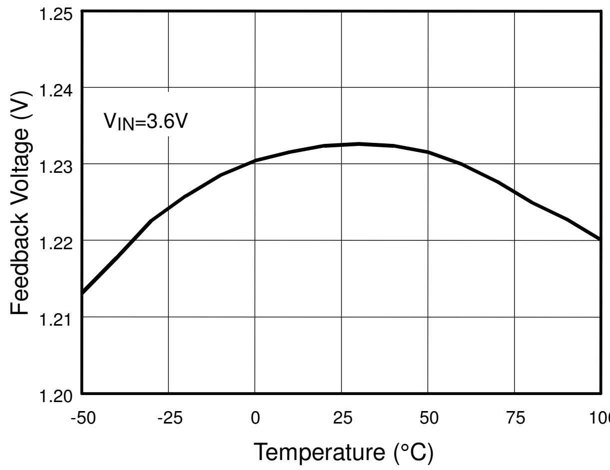


Fig. 3 Feedback Pin Voltage

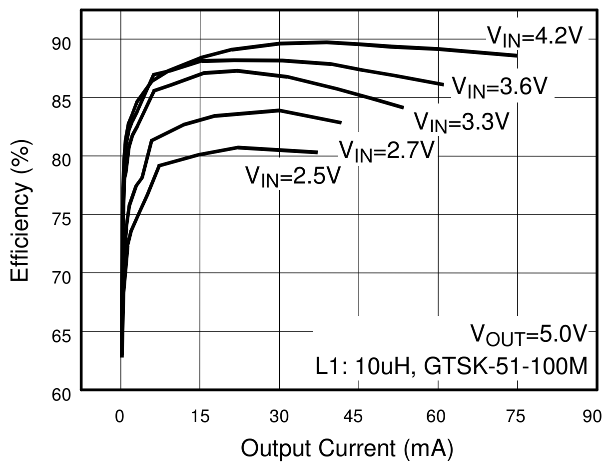


Fig. 4 Efficiency vs. Output Current

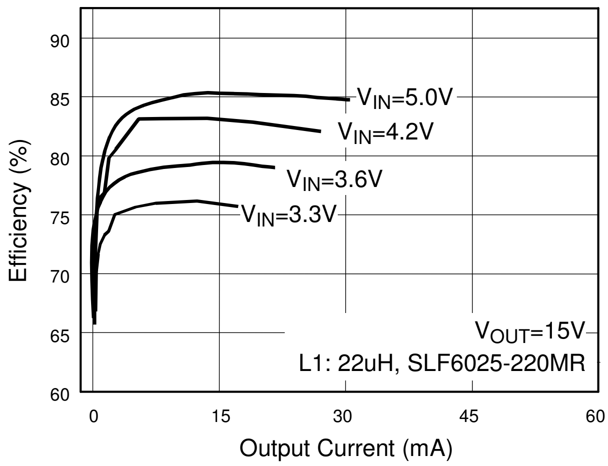


Fig. 5 Efficiency vs. output current

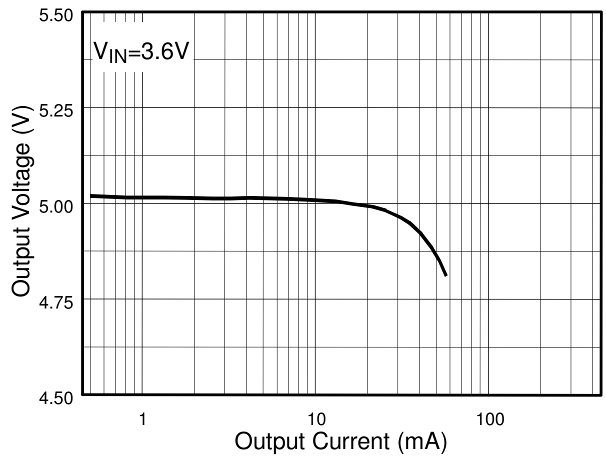


Fig. 6 Load Regulation (L1=10 μH)

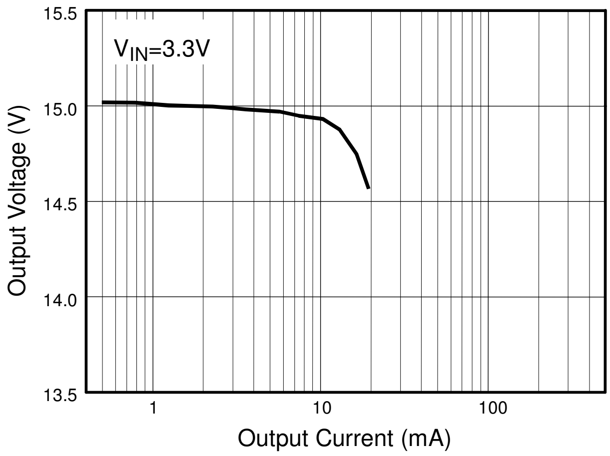


Fig. 7 Load Regulation (L1=22 μH)

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

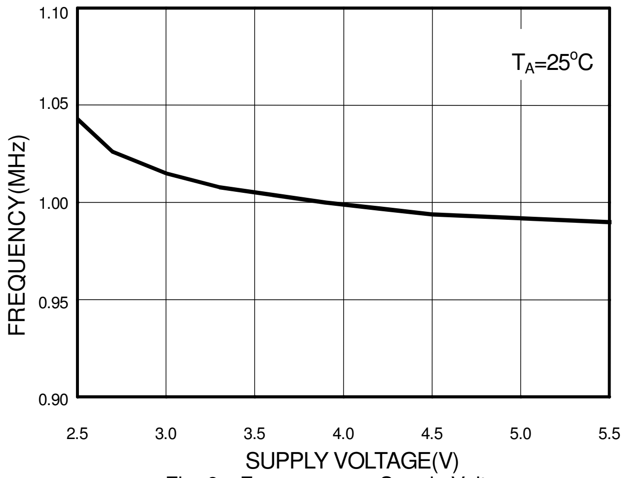


Fig. 8 Frequency vs. Supply Voltage

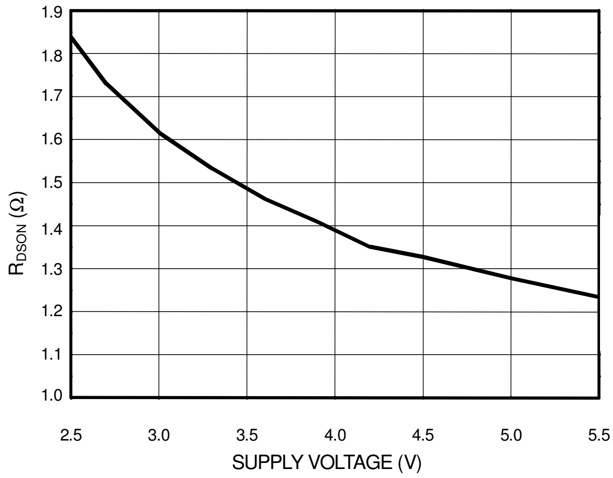


Fig. 9 R_{DS-ON} vs. Supply Voltage

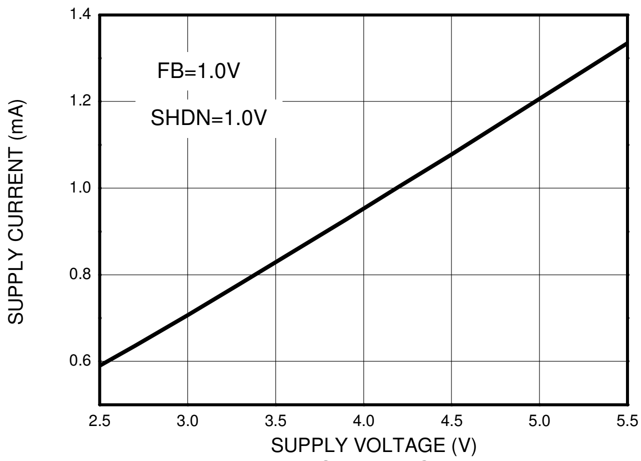


Fig. 10 Switching Current

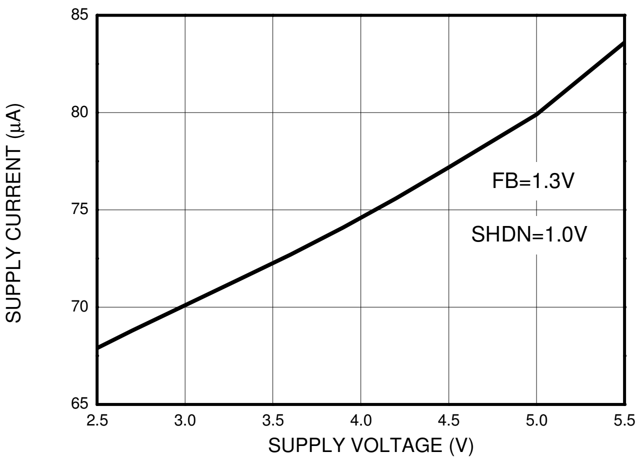


Fig. 11 Non-Switching Current

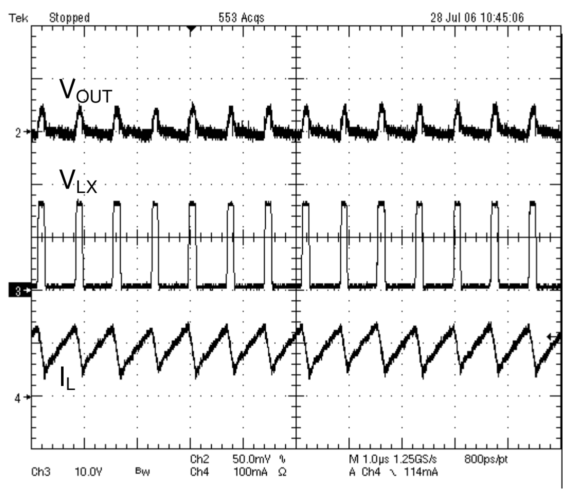


Fig. 12 Operation Waveform

(V_{IN}=3V; V_{OUT}=15V, I_{OUT}=15mA, Test circuit as Fig.1)

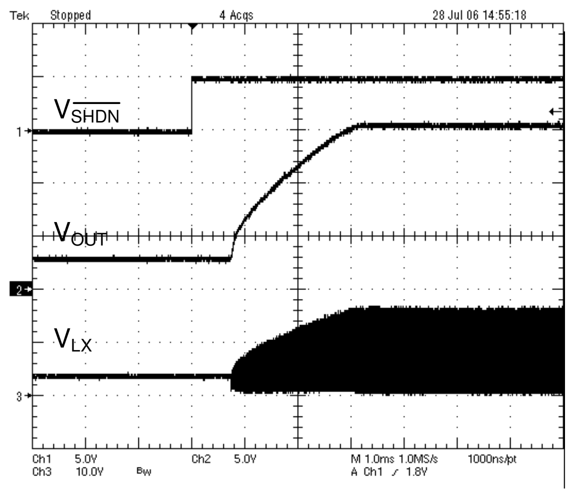
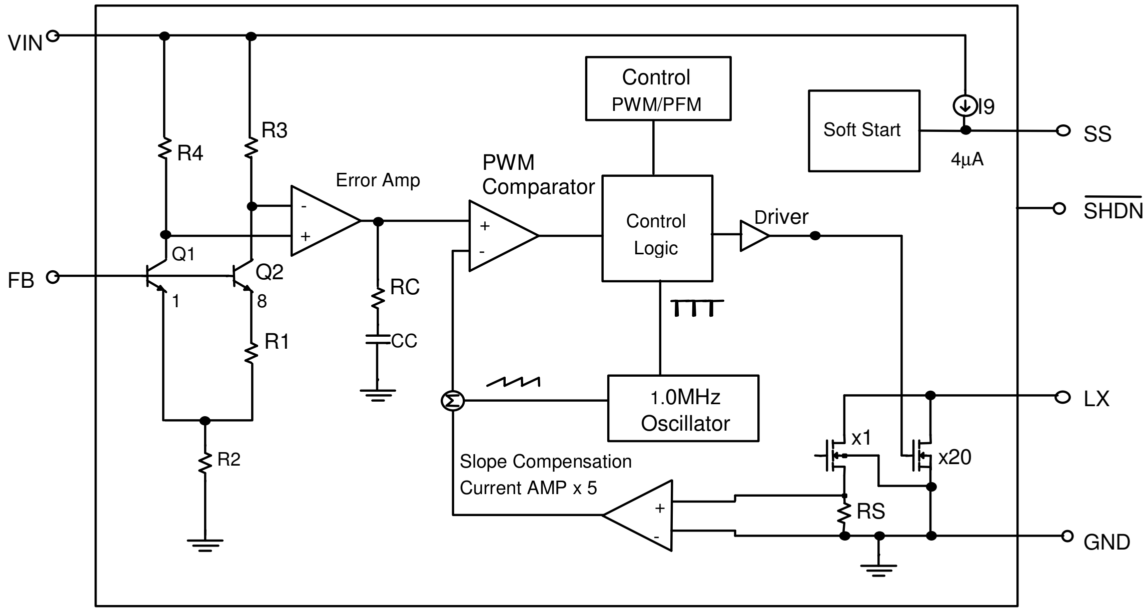


Fig. 13 Start-up Waveform

(V_{IN}=3V; V_{OUT}=15V, I_{OUT}=15mA, Test circuit as Fig.1)

BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN 1: LX - Power Switching Connection. Connect LX to inductor and output rectifier. Keep the distance between the components as close to LX as possible.

PIN 2: GND - Ground.

PIN 3: FB - Feedback Input. Connect a resistive voltage-divider from the output to FB to set the output voltage.

PIN 4: $\overline{\text{SHDN}}$ - Shutdown Input. Drive $\overline{\text{SHDN}}$ low to turn off the converter. To automatically start the converter, connect $\overline{\text{SHDN}}$ to IN. Drive $\overline{\text{SHDN}}$ with a slew rate of 0.1V/µs or greater. Do not leave $\overline{\text{SHDN}}$ unconnected. $\overline{\text{SHDN}}$ draws up to 50µA.

PIN 5: SS - Soft-Start Input. Connect a soft-start capacitor from SS to GND in order to soft-start the converter. Leave SS open to disable the soft-start function.

PIN 6: IN - Internal Bias Voltage Input. Connect IN to the input voltage source. Bypass IN to GND with a capacitor sitting as close to IN as possible.

APPLICATION INFORMATION

The AIC1899 operates well with a variety of external components. The components in Figure 1 are suitable for most applications. See the following sections to optimize external components for a particular application.

Inductor Selection

A 22µH inductor is recommended for most AIC1899 applications. Although small size and high efficiency are major concerns, the inductor should have low core losses at 1.0MHz and low DCR (copper wire resistance).

Inductor selection depends on input voltage, output voltage, maximum current, size, and availability of inductor values. Other factors can include efficiency and ripple voltage. Inductors are specified by their inductance (L), peak current ($I_{L(PK)}$), and resistance (DCR). The following step-up circuit equations are useful in choosing the inductor values based on the application. They allow the trading of peak current and inductor value while considering component availability and cost.

The equation used here assumes a constant K, which is the ratio of the inductor peak-to-peak AC current to average DC inductor current. A good compromise between the size of the inductor versus loss and output ripple is to choose a K of 0.3 to 0.5. The peak inductor current is then given by:

$$i_{L(pk)} = \frac{I_{o(\max)} \cdot V_o}{\eta \cdot V_{i(\min)}} \cdot \left(1 + \frac{K}{2}\right)$$

where:

$I_{O(max)}$: Maximum output current, (A)

$V_{i(min)}$: Minimum input voltage, (V)

η : Conversion efficiency, 0.8

$K = \frac{\Delta i_L}{I_L}$: Ratio of the inductor peak-to-peak AC current to average DC inductor current

The inductance value is then given by:

$$L = \frac{{V_{i(\min)}}^2 \cdot \eta \cdot D}{K \cdot f \cdot V_o \cdot I_{o(\max)}}$$

where:

$$D = Duty\ \ cycle = \frac{V_{i(\min)} - (V_f + V_o)}{I_{i(\max)} \cdot R_{ds(on)} - (V_f + V_o)}$$

V_f : Catch diode forward drop

f : Switching frequency

Capacitor Selection

The AIC1899 operates with both tantalum and ceramic output capacitors. When using tantalum capacitors, the zero caused by the ESR of the tantalum is used to ensure stability. When using ceramic capacitors, the zero due to the ESR will be at too high a frequency to be useful in stabilizing the control loop. When using ceramic capacitors, add a feedforward capacitor to increase the phase margin, improving the control-loop stability.

Diode Selection

Schottky diodes, with their low forward voltage drop and fast reverse recovery, are the ideal choices for AIC1899 applications. The forward voltage drop of an Schottky diode represents the conduction losses in the diode, while the diode capacitance (CT or CD) represents the switching losses. For diode selection, both forward voltage drop and diode capacitance need to be considered. Schottky diodes with higher current ratings usually have lower forward voltage drop and larger diode capacitance, which can cause significant switching losses at the 1.0MHz switching frequency of AIC1899.

Setting the Output Voltage

The AIC1899 operates with an adjustable output from Vin to 24V. Connect a resistive voltage divider from the output to FB (see Fig.1). Calculate R_1 and R_2 using the equation:

$$\frac{R_1}{R_2} = \left(\frac{V_o}{V_{FB}} - 1\right)$$

where V_{FB}, the step-up regulator feedback set point, is 1.23V. Connect the resistive-divider as close to the IC as possible.

■ APPLICATION EXAMPLES

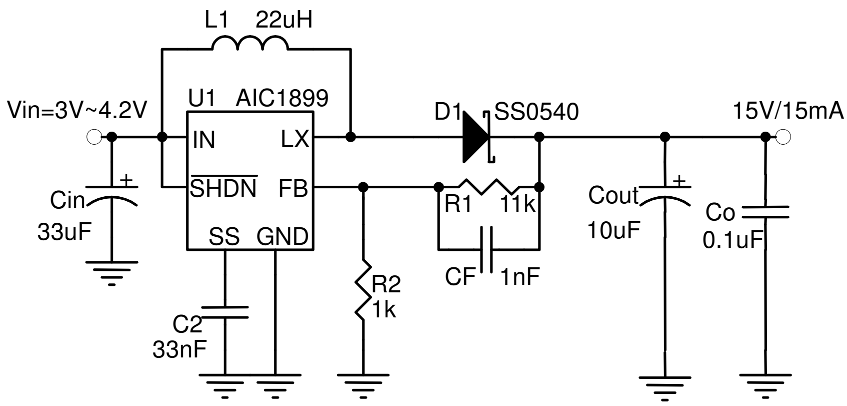
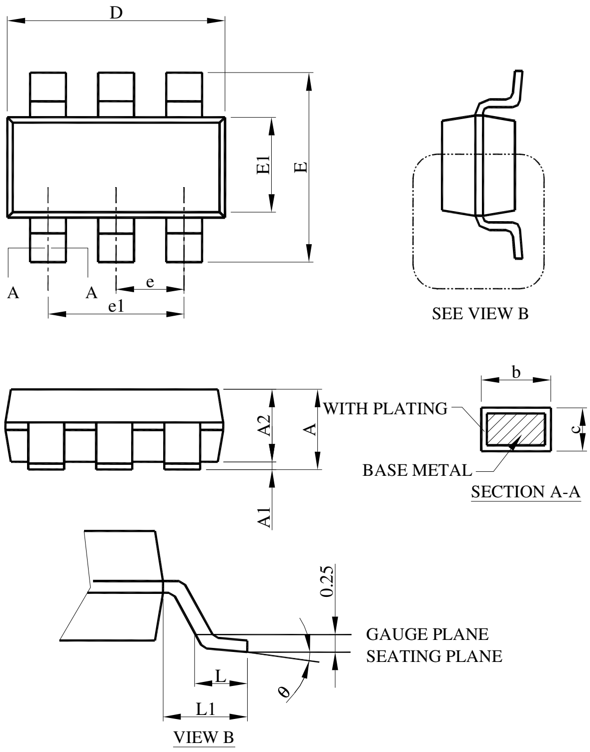


Fig. 14 1-Cell Li-Ion boost converter for OLED Application

PHYSICAL DIMENSIONS (unit: mm)

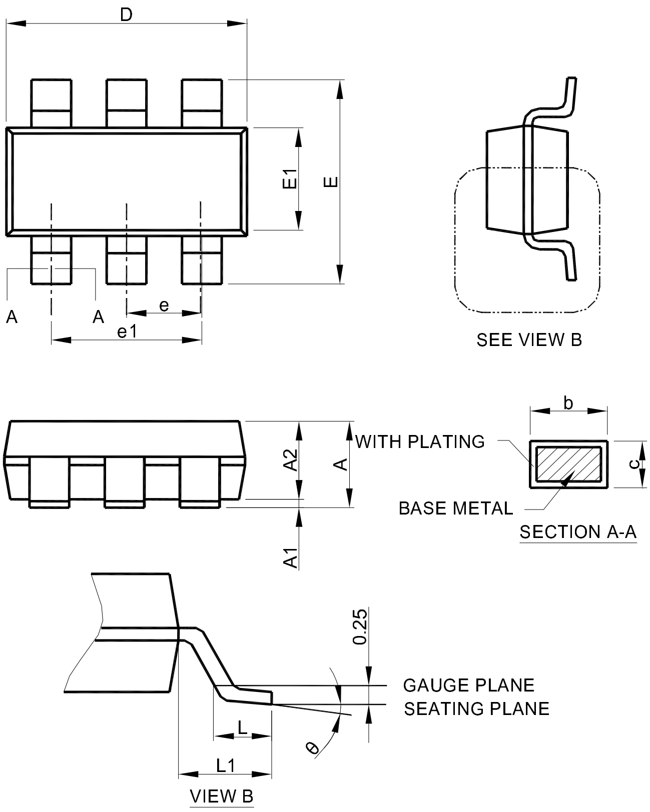
- **TSOT-23-6**



SYMBOL	TSOT-23-6	
	MILLIMETERS	
	MIN.	MAX.
A	-	1.00
A1	0	0.10
A2	0.70	0.90
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	0.60 REF	
θ	0°	8°

Note : 1. Refer to JEDEC MO-193AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 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.

- **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.