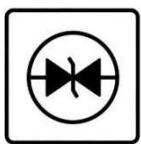




ESD



TVS



TSS



MOV



GDT



PLED

MS14010ADDCR

Product specification

GENERAL DESCRIPTION

MS14010ADDCR is a current mode monolithic buck switching regulator. Operating with an input range of 4.5V~40V, the MS14010ADDCR delivers 800mA of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripple. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The MS14010ADDCR guarantees robustness with short-circuit protection, thermal protection, current run-away protection, and input under voltage lockout.

The MS14010ADDCR is available in 6-pin SOT23-6 package, which provides a compact solution with minimal external components.

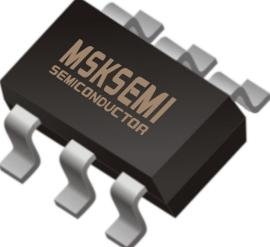
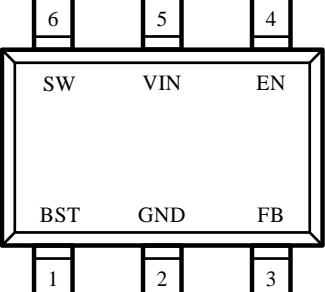
FEATURES

- 4.5V to 40V Input Voltage Range 800mA output current
- High Efficiency: Up to 95%
- No Schottky Diode Required
- 0.8V Reference
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response Integrated internal compensation
- Stable with Low ESR Ceramic Output Capacitors
- Input under voltage lockout
- Short circuit protection
- Thermal Shutdown
- Inrush Current Limit and Soft Start
- -40°C to +125°C Temperature Range

APPLICATIONS

- Distributed Power Systems
- Automotive Systems
- High Voltage Power Conversion
- Industrial Power Systems
- Battery Powered Systems

Reference News

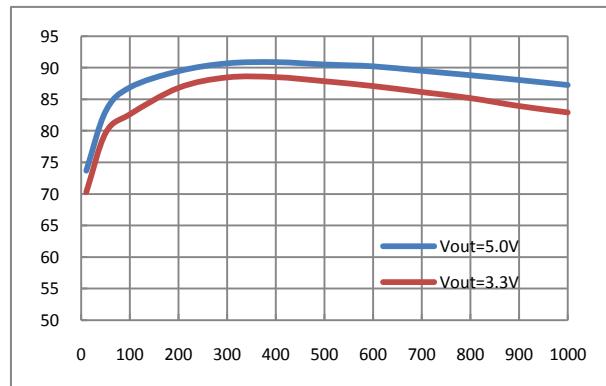
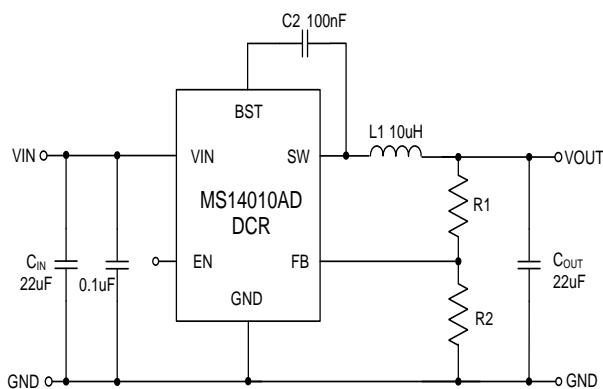
SOT-23-6	PIN CONFIGURATION	MARKING
	 PIN CONFIGURATION 1 GND 2 FB 3 BST 4 EN 5 VIN 6 SW	 8HM*

ORDER INFORMATION

P/N	PKG	QTY
MS14010ADDCR	SOT-23-6	3000

Typical Application Circuit

Efficiency@ $V_{IN}=12V$



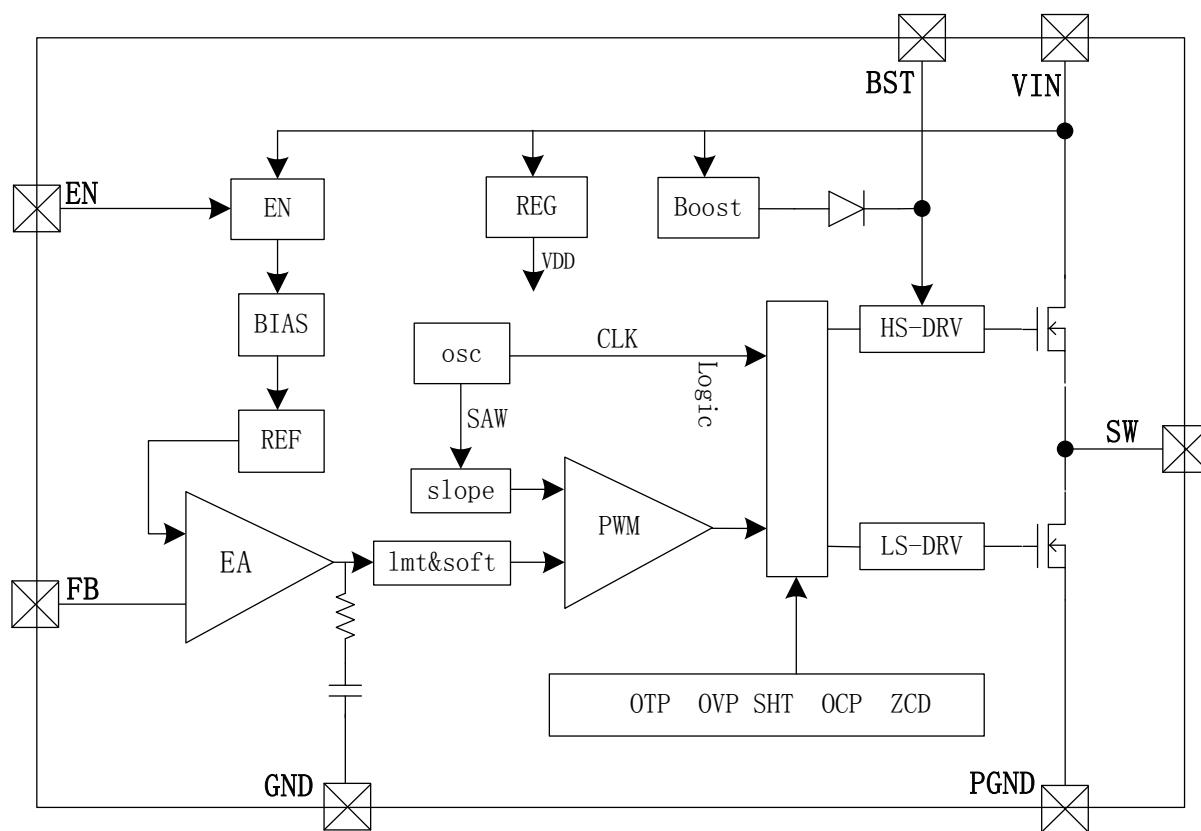
Pin Assignment

Pin Number	Pin Name	Function
SOT-23-6		
1	BST	Bootstrap pin. Connect a $100nF$ capacitor from this pin to SW .
2	GND	Ground.
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set VOUT .
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
5	VIN	Supply Voltage. Bypass with a $22\mu F$ ceramic capacitor to GND .
6	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.

Absolute Maximum Ratings

Parameter	Symbol	Maximum Rating		Unit	
Input Voltage	V_{IN}	$V_{SS}-0.3 \sim V_{SS}+45$		V	
SW Voltage		$V_{SS}-0.3 \sim V_{IN}+0.3$			
BST Voltage		$V_{SW}-0.3 \sim V_{SW}+6$			
FB Voltage		$V_{SS}-0.3 \sim V_{SS}+6$			
Power Dissipation	P_D	SOT-23-6L	600	mW	
Thermal Resistance θ_{JC}	θ_{JC}	130		$^{\circ}C/W$	
Thermal Resistance θ_{JA}	θ_{JA}	170		$^{\circ}C/W$	
Operating Ambient Temperature	T_{opr}	-40~125		$^{\circ}C$	
Storage Temperature	T_{stg}	-40~+150			
ESD HBM (Human Body Mode)		2		kV	

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Function Block Diagram


Electrical Characteristics

Note : VIN = 12V, VOUT = 5.0V, unless otherwise specified. Typical values are at TA = 25°C

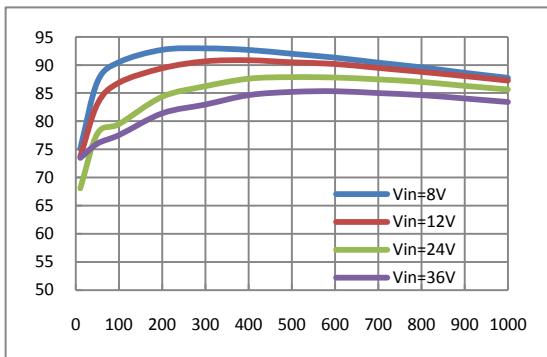
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage	V _{IN}		4.5		40	V
VIN Under Voltage Protect	V _{UV}			4.3		V
VIN Under Voltage Protect Hys.	V _{UV_hys}			0.2		V
Supply Current	I _{Q1}	V _{EN} =2V, V _{FB} =0.85V		40	60	µA
Supply Shutdown Current	I _{SD}		-1		1	µA
FB Voltage	V _{FB}	T _A =25°C, 4.5V≤V _{IN} ≤40V	0.776	0.8	0.824	V
Switching Frequency	F _{osc}			800		kHz
Minimum On Time	T _{ON_MIN}			200		ns
Maximum Duty Cycle	D _{MAX}			90		%
High Side Switch On Resistance	R _{DSON_H}			450		mΩ
Low Side Switch On Resistance	R _{DSON_L}			270		mΩ
High Side Current Limit	I _{LIM}			2		A
EN Rising Threshold	V _{ENH}			1.3		V
EN Falling Threshold	V _{ENL}			1.2		V
EN Input Current	I _{EN}	V _{EN} =5V		2		uA
Thermal Shutdown	T _{SHD}			160		°C
Thermal Shutdown Hys.	T _{SHD_Hys}			20		°C

Typical Performance Characteristics

Vin=12V, Vout=5.0V, L=10uF, Cout=10uF, TA=+25°C, unless otherwise noted.

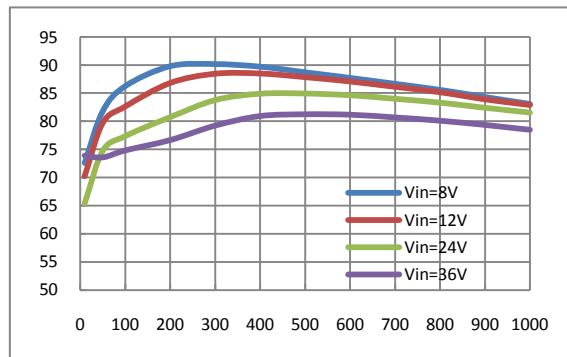
Efficient @Vout=5.0V

C_{VIN}=22uF, C_{OUT}=10uF, C_{BST}=0.1uF L_{IND}=10uH



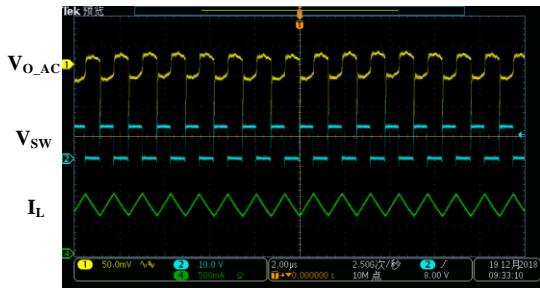
Efficient @Vout=3.3V

C_{VIN}=22uF, C_{OUT}=10uF, C_{BST}=0.1uF L_{IND}=10uH



Steady State Test

Vin=12V, Vout=5.0V, Lout=800mA



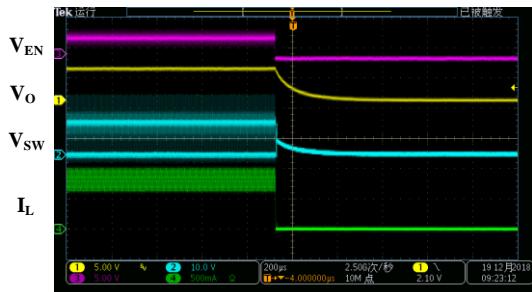
Medium Load Operation

Vin=12V, Vout=5.0V, Lout=400mA



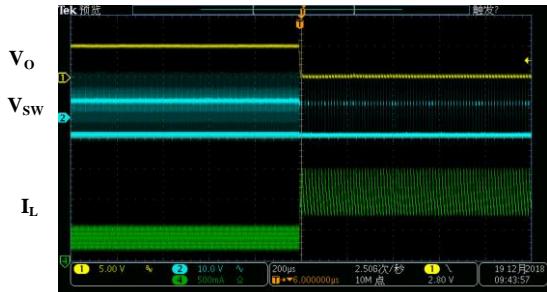
Shutdown through Enable

Vin=12V, Vout=5.0V, Lout=800mA (Resistive load)



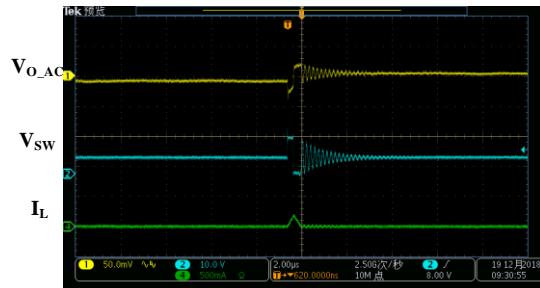
Short Circuit Protection

Vin=12V, Vout=5.0V, Lout=800mA - Short



Light Load Operation

Vin=12V, Vout=5.0V, Iout=0A



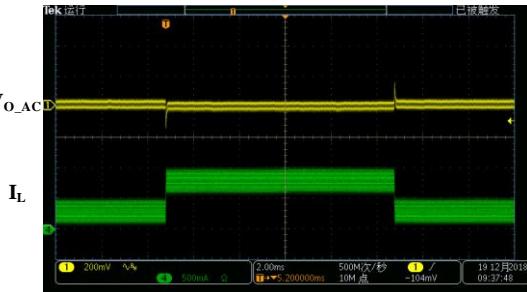
Startup through Enable

Vin=12V, Vout=5.0V, Lout=800mA (Resistive load)



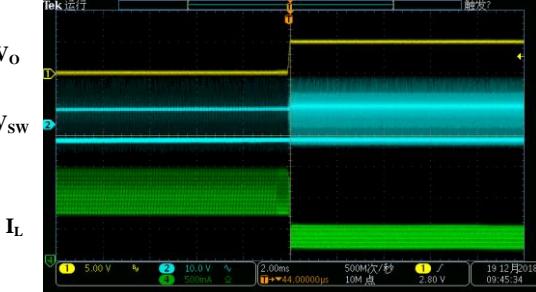
Load Transient

Load: 300mA ->800mA ->300mA



Short Circuit Protection

Vin=12V, Vout=5.0V, Lout= Short - 800mA



Functional Description

The MS14010ADDCR is a synchronous, current-mode, step-down regulator. It regulates input voltages from 4.5V to 40V, and is capable of supplying up to 800mA of load current.

Current-Mode Control

The MS14010ADDCR utilizes current-mode control to regulate the output voltage. The output voltage is measured at the FB pin through a resistive voltage divider and the error is amplified by the internal transconductance error amplifier. Output of the internal error amplifier is compared with the switch current measured internally to control the output current.

PFM Mode

The MS14010ADDCR operates in PFM mode at light load. In PFM mode, switch frequency decreases when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency increases when load current rises, minimizing output voltage ripples..

Shutdown Mode

The MS14010ADDCR shuts down when voltage at EN pin is below 0.3V. The entire regulator is off and the supply current consumed by the MS14010ADDCR drops below 0.1uA.

Power Switch

N-Channel MOSFET switches are integrated on the MS14010ADDCR to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 4.0V rail when SW is low.

Vin Under Voltage Protection

A resistive divider can be connected between Vin and ground, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Over-Current-Protection and Hiccup

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductance can be easily built up, resulting in a large start-up output current. In the MS14010ADDCR used current limit of low side power mosfet to control the output current at start-up.

Output Short Protection

When output is shorted to ground, output current rapidly reaches its peak current limit and the top power switch is turned off. And the bottom power switch is turned on and stay on until the output current falls below the current limit. When output current is below the current limit, the top power switch will be turned on again and if the output short is still present, the top power switch is turned off when the peak current limit is reached and the bottom power switch is turned on. This cycle goes on until the output short is removed and the regulator comes into normal operation again.

Thermal Protection

When the temperature of the MS14010ADDCR rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 140°C can the regulator becomes active again

Application Information

Setting the Output Voltage

The external resistor divider is used to set the output voltage. Choose R1 and R2 follow the next table or calculated by following equation, where the internal reference voltage $V_{REF}=0.8V$.

$$\frac{R1}{R2} = \frac{V_{OUT} - V_{REF}}{V_{REF}}$$

$V_{OUT}(V)$	$R2(k\Omega)$	$R1(k\Omega)$
2.5	24	51
3.3	24	75
5.0	24	126

Inductor Selection

A $4.7\mu H$ to $22\mu H$ inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor DC resistance should be less than $15m\Omega$. For most designs, the inductance value can be derived from the following equation.

$$L > \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is the inductor ripple current.

Choose ΔI_L to be approximately 30% of the maximum load current.

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Note: If the output voltage is less than 2.5V, it is recommended to use a larger inductance and add a small capacitance ($10nF$) parallel to R1.

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A $22\mu F$ ceramic capacitor for most applications is sufficient. Include a capacitor with a value of $0.1 \mu F$ for high-frequency filtering and place it as close as possible to the device pins.

Output Capacitor Selection

The output capacitor (C_{OUT}) is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(R_{ESR} + \frac{1}{8 \times f_{OSC} \times C_{OUT}} \right)$$

Where L is the inductor value and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The characteristics of the output capacitor also affect the stability of the regulation system, and a $10\mu F$ ceramic capacitor is recommended in typical application. The MS14010ADDCR can be optimized for a wide range of capacitance and ESR values.

Application Information

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to MS14010ADDCR (VIN pin and GND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.

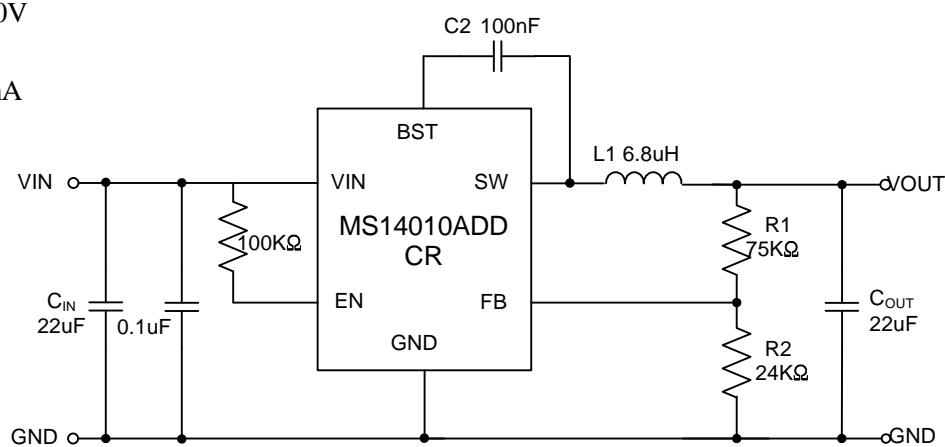
Reference Design

Reference 1:

V_{IN} : 5.0V~40V

V_{OUT} : 3.3V

I_{OUT} : 0~800mA

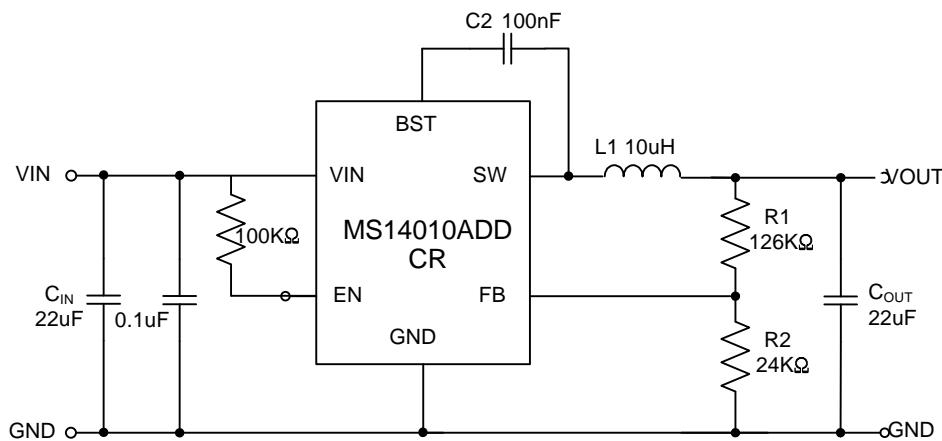


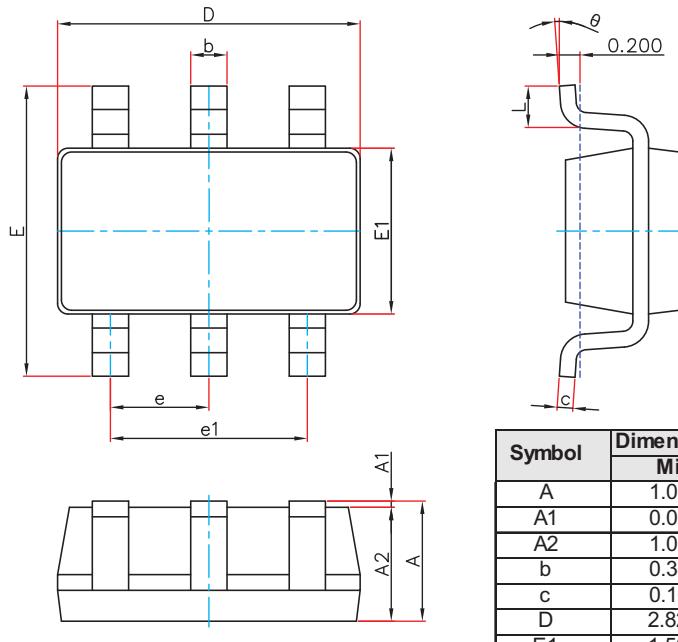
Reference 2:

V_{IN} : 6.5V~40V

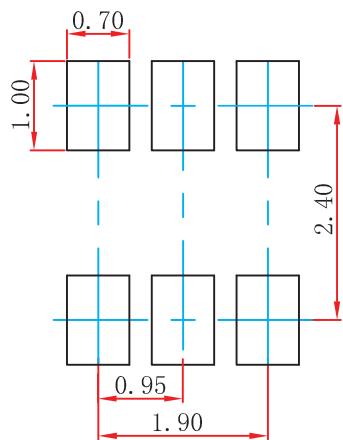
V_{OUT} : 5.0V

I_{OUT} : 0~800mA



SOT-23-6 Package Outline Dimensions


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOT-23-6 Suggested Pad Layout

Note:

1. Controlling dimension: in millimeters.
2. General tolerance: ± 0.05 mm.
3. The pad layout is for reference purposes only.

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