DESCRIPTION

The A7508 is synchronous, fixed frequency, step-up DC/DC converters with true cutoff output, delivering high efficiency in a compact SOT-26 package. Capable of supplying 3.6V at 180mA from 1.5V input, the A7508 contains an internal NMOS switch and PMOS synchronous rectifier. A switching frequency of 1.2MHz minimizes solution footprint by allowing the use of tiny, low profile inductors and ceramic capacitors. The A7508 can enter power saving mode at light loads.

The A7508 has true cutoff function, when EN pin input logic low level, the device can disconnect output from input completely, realizing the low shutdown current of under 0.1μA typical from V_{IN} pin.

The A7508 is available in SOT-26 package.

ORDERING INFORMATION

Package Type	Part Number	
SOT-26 SPQ: 3,000psc/Reel	E6	A7508E6R
		A7508E6VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

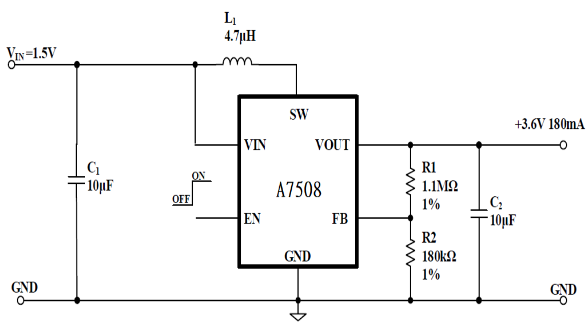
FEATURES

- Input voltage rang is 1.1V~5.5V
- Start-up voltage with load is 1V (Typical, when V_{OUT}=3.6V, I_{OUT}=1mA)
- Feedback voltage is 500mV
- Max load current is 180mA (when V_{OUT}=3.6V ， V_{IN}=1.5V)
- High efficiency: Up to 92%
- 1.2MHz Constant switching frequency
- True cutoff function: Completely disconnect output from input when EN shutdown device
- 0.1μA Shutdown current (Typical)
- Protection function: UVLO, OCP, SCP, OTP

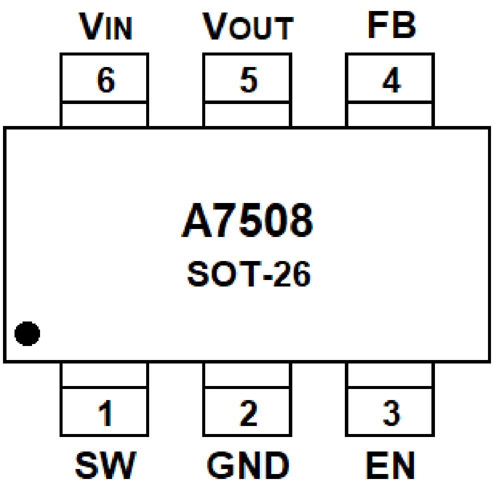
APPLICATION

- Cellular and Smart Phones
- Microprocessors and DSP Core Supplies
- Wireless and DSL Modems
- Portable Instruments
- Electronic Tag

TYPICAL APPLICATION



PIN DESCRIPTION



SOT-26, E6

Top View

Pin #	Symbol	Function
1	SW	Power Switch Pin. It is the switch node connection to Inductor.
2	GND	Ground Pin.
3	EN	Chip Shutdown Signal Input. Logic high is normal operation mode. Logic Low is shutdown mode and the device let output disconnect from input completely.
4	FB	Feedback Input Pin. Connect FB to the center point of the external resistor divider. The feedback threshold voltage is 500mV.
5	VOUT	Power Output Pin. V_{OUT} is disconnect from V_{IN} in shutdown.
6	VIN	Power Supply Input. Must be closely decoupled to GND, with a 10μF or greater ceramic capacitor.

ABSOLUTE MAXIMUM RATINGS (1)

T_A = 25°C, unless otherwise specified.

Parameter	Value	Unit
Input Supply Voltage	-0.3 to 6	V
SW Voltage	-0.3 to 6	V
FB, EN Voltage	-0.3 to 6	V
VOUT Voltage	-0.3 to 6	V
ESD Rating (Human Body Model) (2)	±2	kV
Thermal Resistance		
ϴJA (3)	160	°C/W
ϴJC (4)	40	°C/W
Operating Temperature Range	-40 to 85	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 10s)	260	°C

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) All voltages refer to GND pin unless otherwise noted; Stresses exceed those ratings may damage the device.
(2) Tested and classified as Class 3A per ESDA/JEDEC JDS-001-2017.
(3) Soldered to 100 mm2 , 1oz copper clad.
(4) Measured on pin 1(SW) Close to plastic interface.

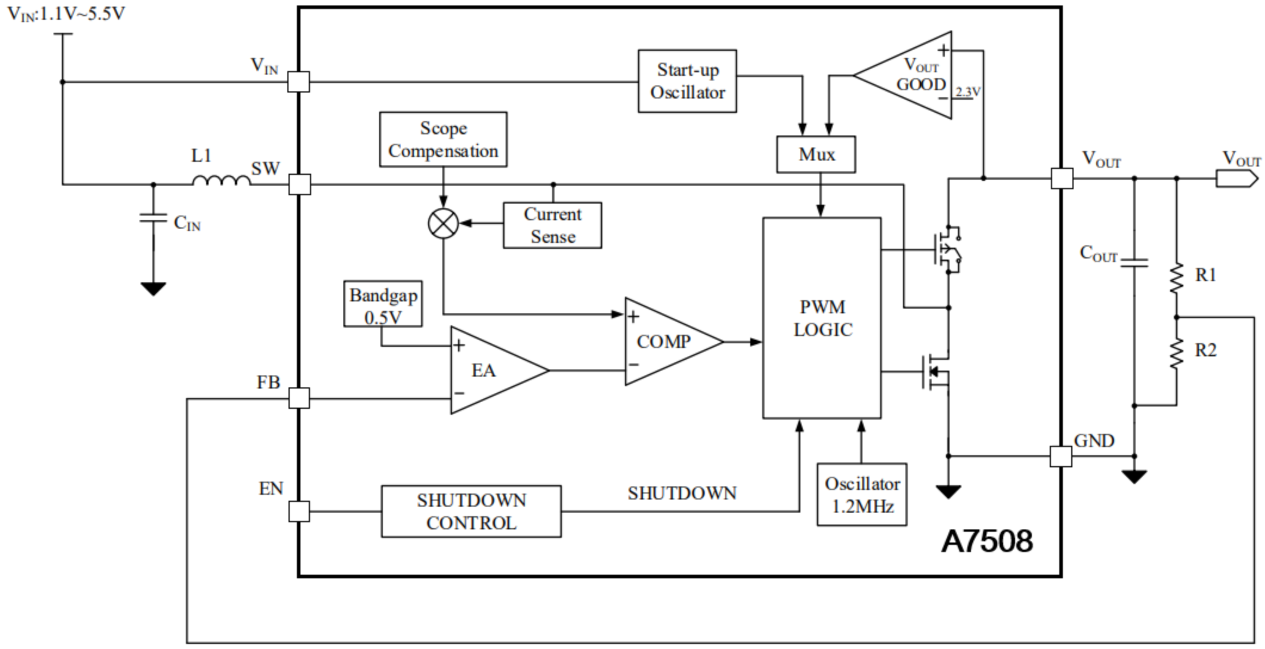
ELECTRICAL CHARACTERISTICS (1)

V_{IN}=5V, T_A=25°C, R_{LOAD}=20, unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input voltage range			1.1		5.5	V
Minimum Start-Up Voltage	I_{OUT}	I_{OUT}=1mA		1	1.1	V
Minimum Operating Voltage	V_{EN}	V_{EN} = V_{IN}		0.75		V
Output Voltage Range			2.5		5.5	V
Feedback Voltage			490	500	510	mV
Feedback input current	V_{FB}	V_{FB} = 0.5V		0.01		μA
Quiescent Current (Shutdown)	V_{EN}	V_{EN} = 0V		0.01	1	μA
Quiescent Current (Active)	IC enabled, NO load, NO switching, Measured on V_{IN}			1	3	μA
	IC enabled, NO load, NO switching, Measured on V_{OUT}			30	50	μA
Leakage current into V_{OUT}	V_{EN}	V_{EN} = 0V		1		μA
NMOS Switch Leakage	V_{SW}	V_{SW} = 5V		0.1	5	μA
PMOS Switch Leakage	V_{SW}	V_{SW} = 0V		0.1	5	μA
NMOS Switch ON Resistance	V_{OUT}	V_{OUT} = 3.3V		0.40		Ω
	V_{OUT}	V_{OUT} = 5V		0.35		Ω
PMOS Switch ON Resistance	V_{OUT}	V_{OUT} = 3.3V		0.70		Ω
	V_{OUT}	V_{OUT} = 5V		0.60		Ω
Line Regulation	V_{IN} = 1.1V to 3.0V, I_{OUT} = 10mA			1		%/V
Load Regulation	I_{OUT}	I_{OUT} = 1mA to 20mA		0.02		%/mA
NMOS Current Limit				850		mA
Current Limit Delay to Output (2)				40		ns
Max Duty Cycle	V_{FB}	V_{FB} = 0.5V	80	85		%
Switching Frequency				1.2		MHz
Soft start				1		ms
EN Input Threshold			1.2			V
EN Input Current	V_{EN}	V_{EN} = 5.5V		0.01	1	μA
Overtemperature Protection				160		°C
Overtemperature Hysteresis				20		°C

(1) Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.
(2) Guaranteed by design.

BLOCK DIAGRAM



TYPICAL PERFORMANCE CHARACTERISTICS

All curves taken at V_{IN} = 2.4V, V_{OUT} = 3.6V with configuration in Typical Application Circuit shown in this datasheet. T_A = 25°C, unless otherwise specified.

Fig 1. Efficiency vs. Load Current, V_{OUT} = 3.6V

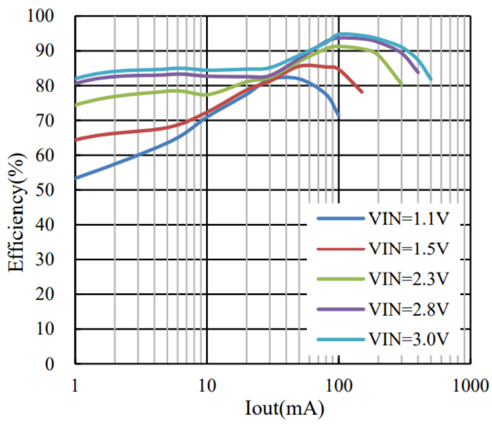


Fig 2. Efficiency vs. Load Current, V_{OUT} = 5V

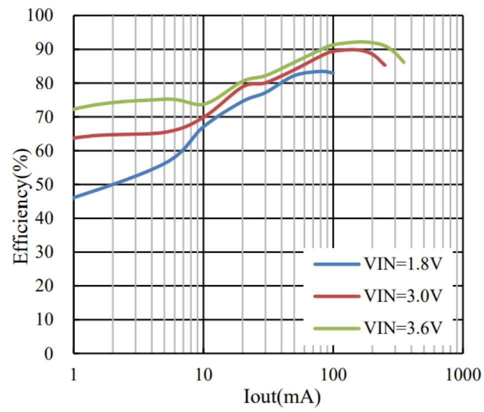


Fig 3. Max. Output current vs. Input voltage

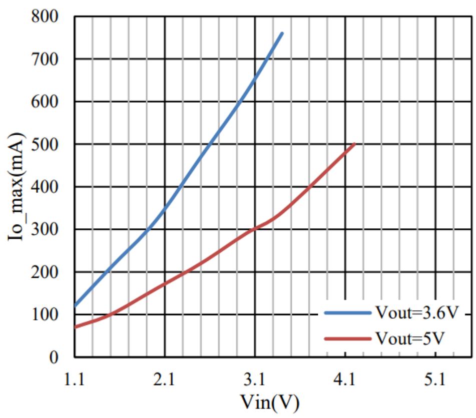


Fig 4. Output voltage vs. Load Current

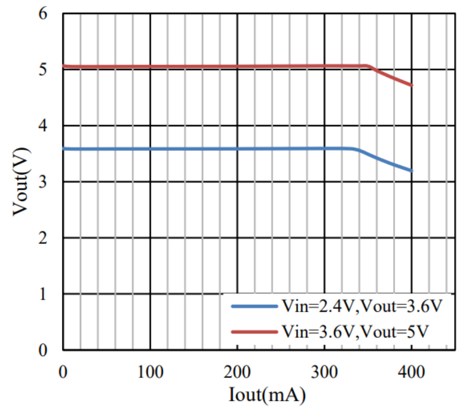


Fig 5. Startup Waveforms

Vin=2.4V, V_{OUT}=3.6V, RL=36Ω

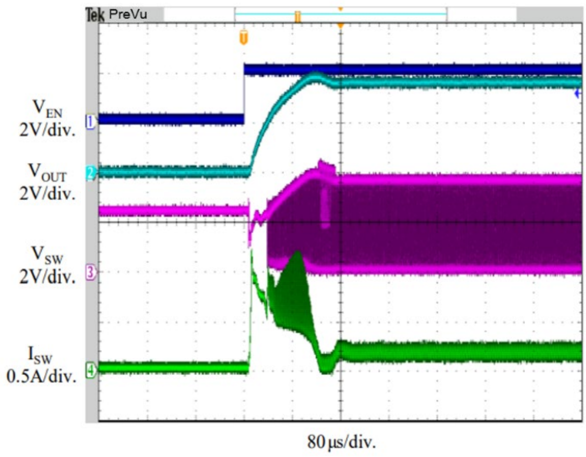
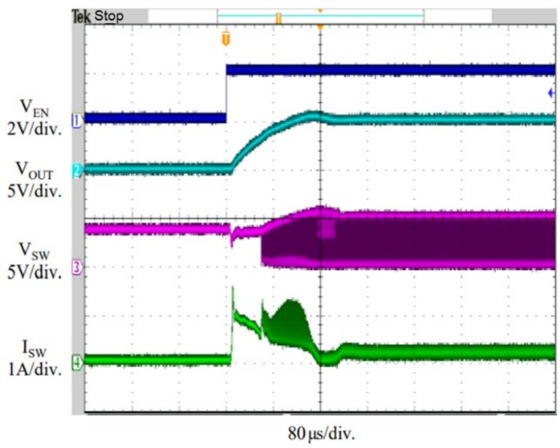


Fig 6. Startup Waveforms

Vin=3.6V, V_{OUT}=5V, RL=51Ω



All curves taken at V_{IN} = 2.4V, V_{OUT} = 3.6V with configuration in Typical Application Circuit shown in this datasheet. T_A = 25°C, unless otherwise specified.

Fig 7. Output Ripple Waveforms

Vin=2.4V, V_{OUT}=3.6V, I_{OUT}=10mA

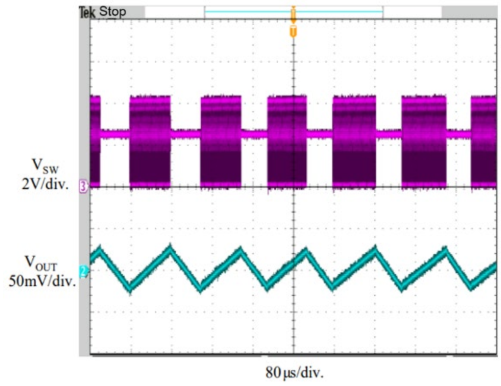


Fig 8. Output Ripple Waveforms

Vin=2.4V, V_{OUT}=3.6V, I_{OUT}=100mA

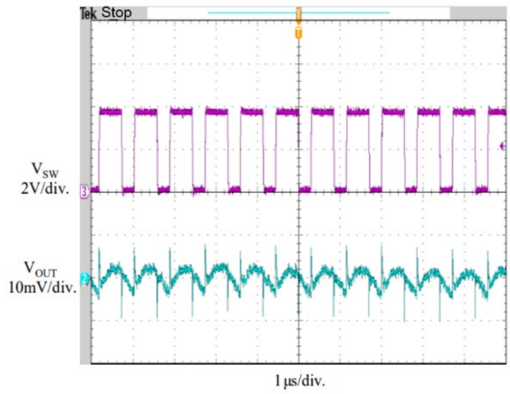


Fig 9. Output Ripple Waveforms

Vin=3.6V, V_{OUT}=5V, I_{OUT}=10mA

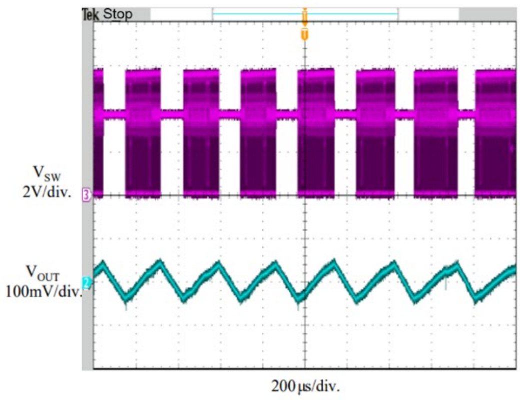


Fig 10. Output Ripple Waveforms

Vin=3.6V, V_{OUT}=5V, I_{OUT}=200mA

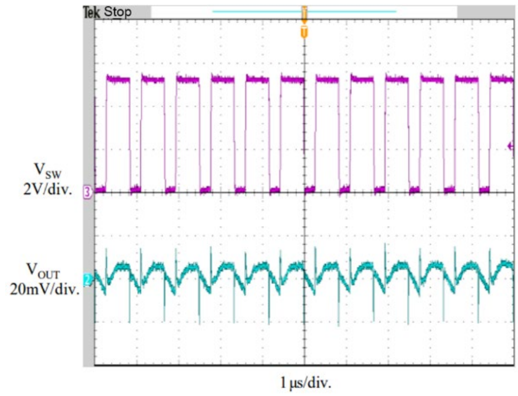


Fig11. Load Transient,

Vin=2.4V, V_{OUT} =3.6V, I_{OUT} =20mA-80mA

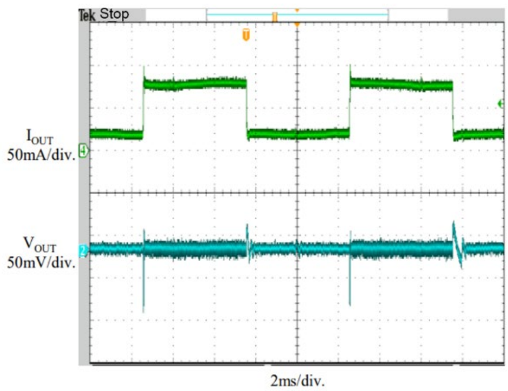
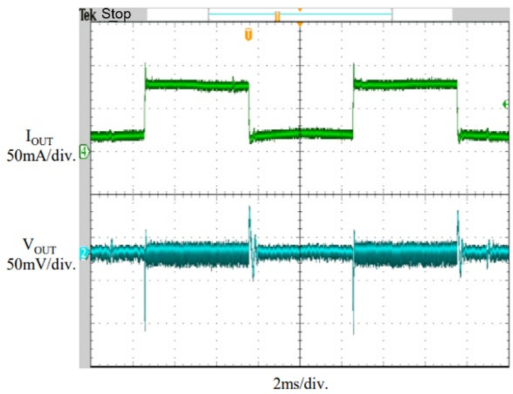


Fig 12. Load Transient,

Vin=3.6V, V_{OUT}=5V, I_{OUT} =20mA-80mA



DETAILED INFORMATION

The A7508 is 1.2MHz, synchronous boost converter housed in a 6-lead SOT package. Able to operate from an input voltage below 1.1V, the device features fixed frequency, current mode PWM control for exceptional line and load regulation. With its low $R_{DS(ON)}$ and gate charge internal MOSFET switches, the device maintains high efficiency over a wide range of load current. Detailed descriptions of the operating modes follow.

The A7508 has true cutoff function, when EN pin input logic low level, the device can disconnect output from input completely, realizing the low shutdown current of under 0.1μA typical from VIN pin.

Synchronous Rectification

The A7508 integrates a synchronous rectifier to improve efficiency as well as to eliminate the external Schottky diode. The synchronous rectifier is used to reduce the conduction loss contributed by the forward voltage of Schottky diode. The synchronous rectifier is realized by a P-ch MOSFET with gate control circuitry that incorporates relatively complicated timing concerns.

Low Voltage Start-Up

The A7508 will start up at a typical VIN voltage of 1V or higher. The low voltage start-up circuitry controls the internal NMOS switch up to a maximum peak inductor current of 850mA (typical), with an approximate 1.5us off time during start-up, allowing the devices to start up into an output load. Once VOUT exceeds 2.3V, the start-up circuitry is disabled and normal fixed frequency PWM operation is initiated. In this mode, the A7508 operate independent of VIN, allowing extended operating time as the battery can droop to several tenths of a volt without affecting output voltage regulation. The limiting factor for the application becomes the ability of the battery to supply sufficient energy to the output.

Low Noise Fixed Frequency Operation

Oscillator: The frequency of operation is internally set to 1.2MHz.
Error Amp: The error amplifier is an internally compensated trans conductance type (current output) with a trans conductance (gm) = 33 micro-siemens. The internal 0.5V reference voltage is compared to the voltage at the FB pin to generate an error signal at the output of the error amplifier. A voltage divider from V_{OUT} to ground programs the output voltage via FB from 2.5V to 5.5V.

Current Sensing: A signal representing NMOS switch current is summed with the slope compensator. The summed signal is compared to the error amplifier output to provide a peak current control command for the PWM. Peak switch current is limited to approximately 850mA independent of input or output voltage. The current signal is blanked for 40ns to enhance noise rejection.

Zero Current Comparator: The zero current comparator monitors the inductor current to the output and shuts off the synchronous rectifier once this current reduces to approximately 20mA. This prevents the inductor current from reversing in polarity improving efficiency at light loads.

Pulse Skipping Mode

At very light load, the A7508 automatically switches into Pulse Skipping Mode to improve efficiency. During this mode, the PWM control will skip some pulses to maintain regulation. If the load increases and the output voltage drop, the device will automatically switch back to normal PWM mode and maintain regulation.

Device Shutdown

When EN is set logic high, the A7508 is put into operation. If EN is set logic low, the device is put into shutdown mode and consumes lower than 1µA current. In shutdown mode, the device stops switching, all internal control circuitry is switched off, and the load is isolated from the input. This also means that the device can disconnect output from input completely, realizing the low shutdown current of under 0.1µA typical from VIN pin. After start-up timing, the internal circuitry is supplied by VOUT, however, if shutdown mode is enabled, the internal circuitry will be supplied by battery again.

Thermal Shutdown

A thermal shutdown is implemented to prevent the damage due to excessive heat and power dissipation. Typically, the thermal shutdown happens at the junction temperature of 160°C. When the thermal shutdown is triggered, the device stops switching until the junction temperature drops the hysteresis temperature lower than thermal shutdown threshold, then the device starts switching again.

APPLICATION INFORMATION

Setting the Output Voltage

The A7508 feedback voltage is regulated at 0.5V and the output voltage is programed by the feedback divider R1 and R2, where R1 form the upper feedback resistor and R2 is the lower feedback resistor. The output voltage can be calculated using the following Equation 1.

$\boldsymbol{VOUT} = \boldsymbol{VFB} \times (\boldsymbol{1} + \frac{\boldsymbol{R1}}{\boldsymbol{R2}})$=0.5V× $(\boldsymbol{1} + \frac{\boldsymbol{R1}}{\boldsymbol{R2}})$ (1)

Inductor

The high switching frequency of 1.2MHz allows for small surface mount inductors. For most designs, the A7508 operates with inductors of 2.2μH to 4.7μH.

Larger inductors mean less inductor current ripple and usually less output voltage ripple. Larger inductors also mean more load power can be delivered. But large inductors are also with large profile and costly. The inductor ripple current is typically set for 20% to 40% of the maximum inductor current. When selecting an inductor, the DC current rating must be high enough to avoid saturation at peak current. For optimum load transient and efficiency, the low DCR should be selected. Equation 2 can estimate inductance current:

$I_L = \frac{I_{OUT} \times V_{OUT}}{V_{IN} \times 0.8}$ (2)

Where

- V_{OUT} is the output voltage.
- V_{IN} is the input voltage.
- I_L is the maximum inductance current.

Equation 3 can calculate the inductance value: $L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{\Delta I_L \times F \times V_{IN}}$ (3)

Where

- ΔI_L is the inductor peak-to-peak ripple current.
- V_{OUT} is the output voltage.
- V_{IN} is the input voltage.
- F is the switching frequency.
- L is the inductor value.

Input Capacitor

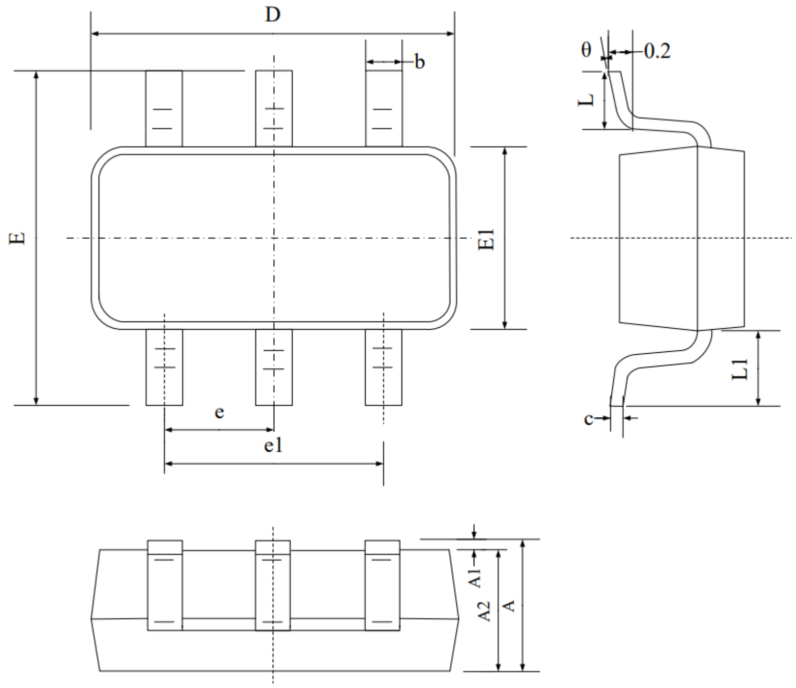
The input capacitor reduces the surge current drawn from the input and the switching noise from the converter. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Multilayer Ceramic Capacitor (MLCC) with X5R or X7R dielectric is highly recommended because of their low ESR, low temperature coefficients and compact size characteristics. A 10μF MLCC capacitor is sufficient for most applications.

Output Capacitor

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. MLCC with X5R or X7R dielectric is recommended due to their low ESR, low temperature coefficients and compact size characteristics.

PACKAGE INFORMATION

Dimension in SOT-26 (Unit: mm)



Symbol	Min.	Max.
A	1.050	1.450
A1	0.000	0.150
A2	0.900	1.300
b	0.300	0.500
c	0.080	0.220
D	2.820	3.050
E1	1.500	1.700
E	2.600	3.000
e	0.95	
e1	1.800	2.000
L	0.300	0.600
L1	0.6	
θ	0°	8°

IMPORTANT NOTICE