DESCRIPTION

The A7121A is a high efficiency synchronous step-down DC-DC converter. Its input voltage range is from 2.7V to 6V and provides an adjustable regulated output voltage from 0.6V to 3.4V while delivering up to 2A of output current.

The current mode architecture of A7121A operation with internal compensation allows the transient response to be optimized over a wide range of loads and output capacitors.

The very low supply current with no load is 60uA and even drops to <1uA in shutdown. The 2.7V to 6.0V input voltage range makes the A7121A ideally designed for single Li-Ion, two to four AA battery-powered applications. It's 100% duty cycle provides low dropout operation to extend battery life in portable systems.

The PWM pulse skipping mode of A7121A, 1MHz internal switching frequency, allows very small inductors and capacitors and provides very low output ripple voltage for noise sensitive applications.

The A7121A is available in SOT-25 and SOT-26 packages.

FEATURES

- High Efficiency: Up to 97%
- Vin Range from 2.7V to 6V
- Output Voltage as Low as 0.6V, V_{REF}=0.6V
- 1MHz Constant Switching Frequency
- 2.0A Output Current at V_{IN}=3V
- Quiescent Current: 60µA (input < 4.2V)
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Robust protection features, OCP, SCP, TSD
- 100% Duty Cycle in Dropout
- Shutdown Current <1uA
- Internal Soft start Circuitry
- Available in SOT-25 and SOT-26 packages

APPLICATION

- Set Top Box, Cable Modem, xDSL Platforms
- LCD TV Power Supply & Metering Platforms
- General Purpose Point of Load (POL)
- Portable Instruments, Notebook Computer
- Battery Powered Equipment
- Wireless Access Point Router
- Microprocessors and DSP Core Supplies
- Digital Still and Video Cameras

ORDERING INFORMATION

Package Type	Part Number	
SOT-25 SPQ: 3,000pcs/Reel	E5	A7121AE5R
		A7121AE5VR
SOT-26 SPQ: 3,000pcs/Reel	E6	A7121AE6R
		A7121AE6VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

TYPICAL APPLICATION

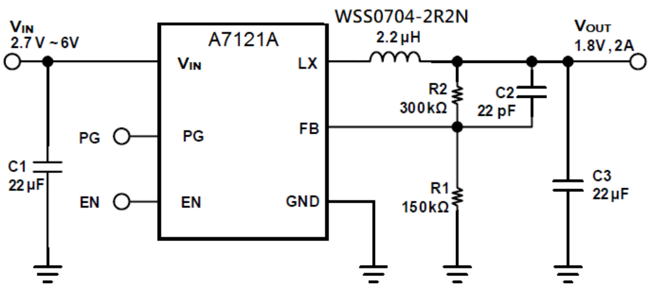
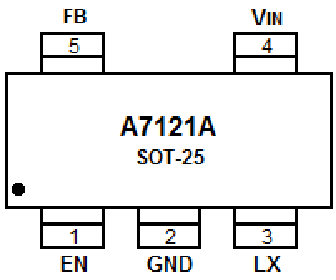
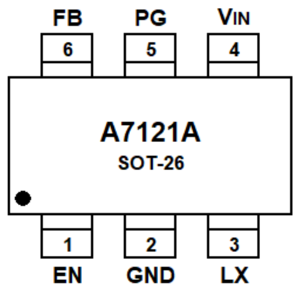


Figure 1. Typical Application Circuit

PIN DESCRIPTION



Top View



Top View

Pin #		Symbol	Function
SOT-25	SOT-26		
1	1	EN	Regulator Enable control input. Drive EN above 1.1V to turn on the part. Drive EN below 0.6V to turn it off. In shutdown, all functions are disabled drawing <1μA supply current. Do not leave EN floating.
2	2	GND	Ground
3	3	LX	Power Switch Output. It is the Switch note connection to inductor. This pin connects to the drains of the internal P-CH and N-CH MOSFET switches.
4	4	V_{IN}	Power supply input pin. Must be closely decoupled to GND with a 22μF or greater ceramic capacitor.
-	5	PG	Power Good Indicator. This pin is an open drain logic output. Connect PG to an external pull-up resistor and get a high level output. PG is pulled to ground when the output voltage is less than 91.5% of the target output voltage. Let PG float or connect to ground when don't use PG function.
5	6	FB	Feedback Input Pin. Connect FB to the center point of the external resistor divider. The feedback threshold voltage is 0.6V.

ABSOLUTE MAXIMUM RATINGS

V_{IN}, Input Supply Voltage	-0.3V ~ +7V
EN, FB V_{FB} Voltages	-0.3V ~ V_{IN}+0.3V
SW Voltages	-0.3V ~ V_{IN}+0.3V
ESD Ratings Human Body Model	±4 kV
Package Thermal Resistance NOTE1	
θ_{JA}, SOT-25, SOT-26	220°C/W
θ_{JC}, SOT-25, SOT-26	55°C/W
Operating Temperature Range	-40°C ~ 85°C
Junction Temperature NOTE2	Internal Limit
Storage Temperature Range	-65°C ~ 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.

ELECTRICAL CHARACTERISTICS[NOTE3]

V_{IN} =V_{EN}= 3.6V, T_A = 25°C, unless otherwise noted.

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range		2.7		6.0	V
Input DC Supply Current					
Active Mode	V_{FB}=0.5V or V_{OUT}=90%		60	300	μA
Shutdown Mode	V_{FB}=0V, V_{IN}=4.2V		0.1	1	μA
Regulated Feedback Voltage	T_A = +25°C	0.5880	0.6000	0.6120	V
	0°C ≤ T_A ≤ 85°C	0.5865	0.6000	0.6135	V
	-40°C ≤ T_A ≤ 85°C	0.5820	0.6000	0.6180	V
Feedback Input Bias Current	V_{FB} = 0.65V		±30		nA
Reference Voltage Line Regulation	V_{IN} = 2.7V to 5.5V, I_{OUT}=300mA		0.5	0.60	%/V
Output Voltage Line Regulation	V_{IN} = 2.7V to 5.5V I_{OUT}=300mA		0.5	0.60	%/V
Output Voltage Load Regulation	I_{OUT}=300 to 2000mA		0.25		%/A
Peak Inductor Current	V_{IN}=3V, V_{FB}=0.5V or V_{OUT}=90%, Duty Cycle <35%		4.5		A
Oscillator Frequency	V_{FB}=0.6V or V_{OUT}=100%	0.8	1.0	1.2	MHz
$R_{DS(ON)}$ of P-CH MOSFET	I_{LX} = 300mA		110		mΩ
$R_{DS(ON)}$ of N-CH MOSFET	I_{LX} = -300mA		80		mΩ
LX Leakage	V_{EN} = 0V, V_{LX} = 0V or 5V, V_{IN} = 5V		±0.01	±1	μA
Soft start			1		ms
UVLO	V_{IN} Rising	2.3	2.5	2.7	V
	V_{IN} Falling	2	2.2	2.4	V
EN Threshold Low	-40°C ≤ T_A ≤ 85°C			0.6	V
EN Threshold High		1.1			V
EN Leakage Current			±0.01	±1	μA
Thermal Shutdown [NOTE 4]			155		℃
PG	Measured at FB pin with respect to V_{REF}	85	91.5		%

NOTE 1: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

NOTE 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula:
A7121A: $T_J = T_A + (P_D)x(220°C/W)$

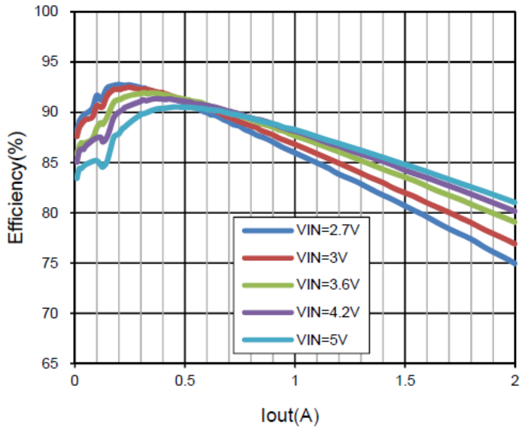
NOTE 3: Specifications over the temperature range are guaranteed by design and characterization.

NOTE 4: Guaranteed by design and characterization only.

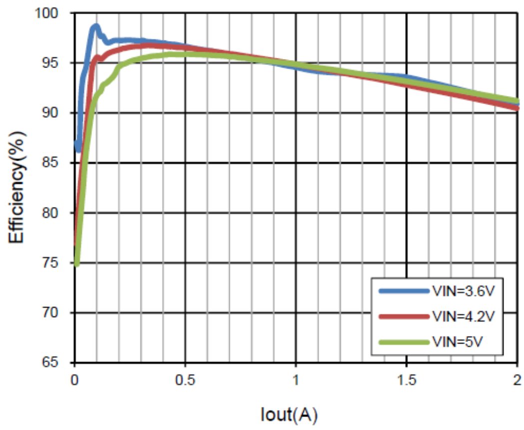
TYPICAL OPERATING CHARACTERISTICS

Test Figure 1 above unless otherwise specified

1. Efficiency vs. I_{OUT} @V_{OUT}=1.2V

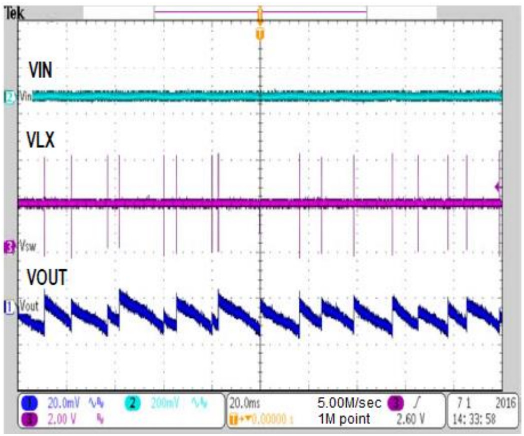


2. Efficiency vs. I_{OUT} @V_{OUT}=3.3V

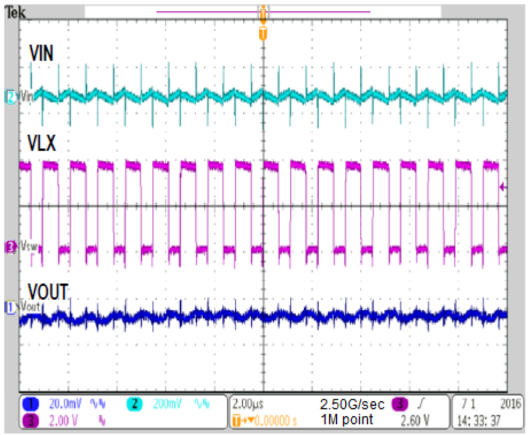


V_{OUT} Ripple

3. V_{IN}=3.6V,V_{OUT}=1.8V,I_{OUT}=0

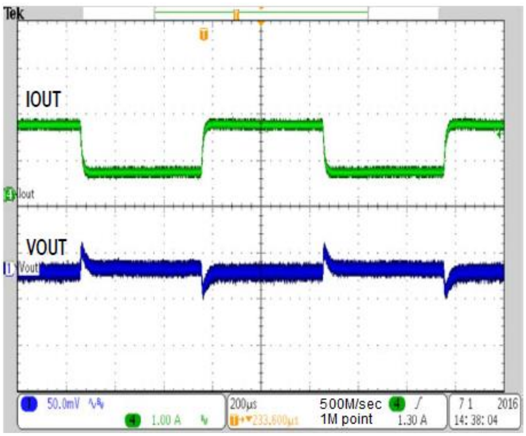


4. V_{IN}=3.6V,V_{OUT}=1.8V,I_{OUT}=2.0A

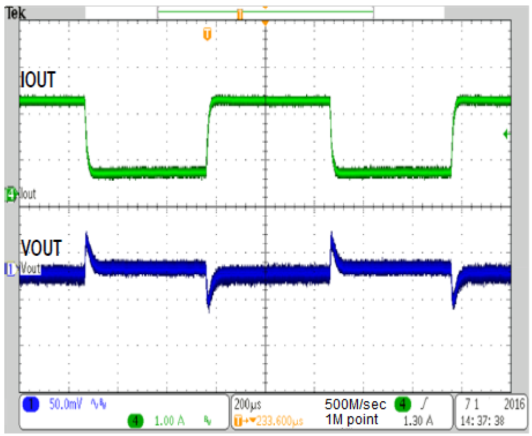


Load Transient

5. V_{IN}=5V,V_{OUT}=1.2V,I_{OUT}=0.5-1.5A

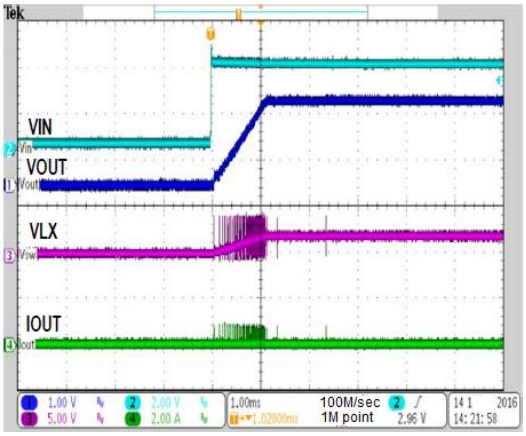


6. V_{IN}=5V,V_{OUT}=1.2V,I_{OUT}=0.5-2A

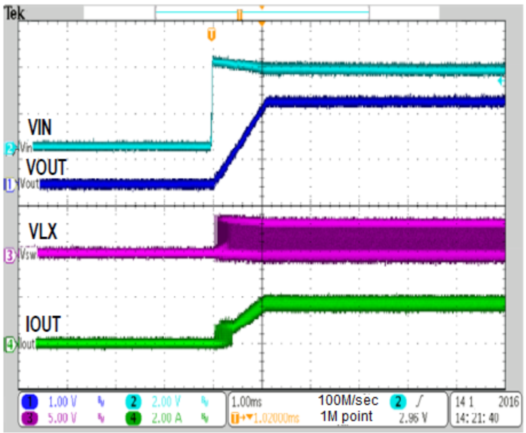


Soft-start

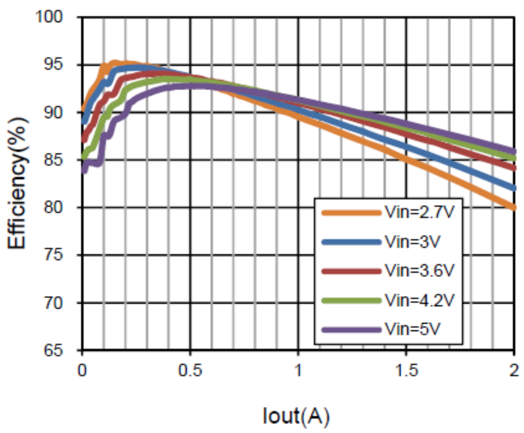
7. V_{IN}=3.6V,V_{OUT}=1.8V,I_{OUT}=0



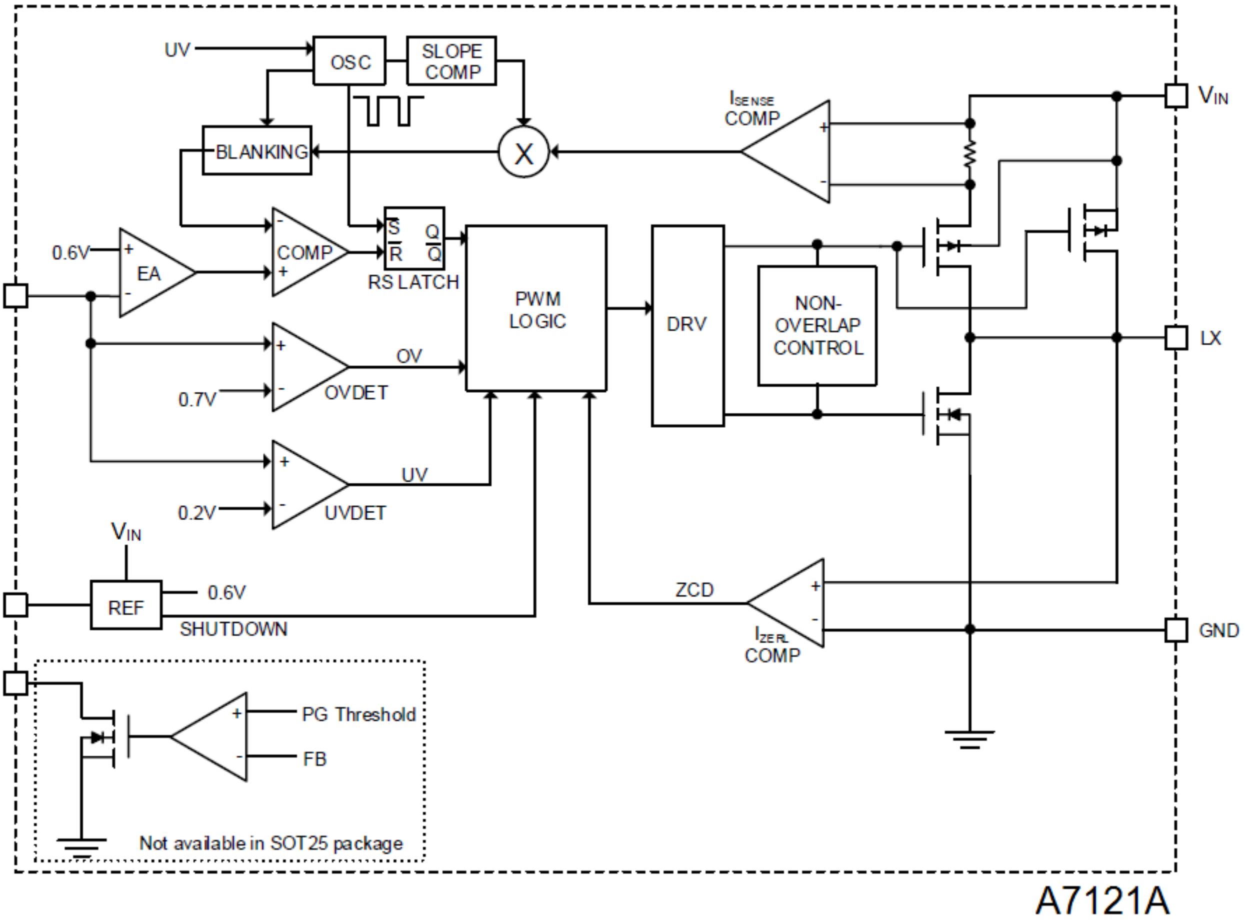
8. V_{IN}=3.6V,V_{OUT}=1.8V,I_{OUT}=2A



9. Efficiency vs. I_{OUT} @V_{OUT}=1.8V



BLOCK DIAGRAM



DETAILED INFORMATION

Operation

A7121A is a monolithic switching mode Step-Down DC-DC converter. It utilizes internal MOSFETs to achieve high efficiency and can generate very low output voltage by using internal reference at 0.6V. It operates at a fixed switching frequency, and uses the slope compensated current mode architecture. This Step-Down DC-DC Converter supplies 2.0A output current at V_{OUT} = 1.8V with input voltage range from 2.7V to 6.0V.

Current Mode PWM Control

Slope compensated current mode PWM control provides stable switching and cycle-by-cycle current limit for excellent load and line responses and protection of the internal main switch (P- CH MOSFET) and synchronous rectifier (N-CH MOSFET). During normal operation, the internal P- CH MOSFET is turned on for a certain time to ramp the inductor current at each rising edge of the internal oscillator, and switched off when the peak inductor current is above the error voltage. The current comparator, I_{COMP}, limits the peak inductor current. When the main switch is off, the synchronous rectifier will be turned on immediately and stay on until either the inductor current starts to reverse, as indicated by the current reversal comparator, I_{ZERO}, or the beginning of the next clock cycle.

Idle Mode Operation

At very light loads, the A7121A automatically enters pulse skipping Mode. In the pulse skipping Mode, the inductor current may reach zero or reverse on each pulse. The PWM control loop will automatically skip pulses to maintain output regulation. The bottom MOSFET is turned off by the current reversal comparator, I_{ZERO}, and the switch voltage will ring. This is discontinuous mode operation, and is normal behavior for the switching regulator.

Power Good Output (PG)

PGOOD is an open-drain type output and requires a pull up resistor. PGOOD is actively held low in soft-start, standby, and shutdown. It is released when the output voltage rises above 91.5% of nominal regulation point. The PGOOD signal goes low if the output is turned off or falls below 91.5% of nominal regulation point.

Dropout Operation

When the input voltage decreases toward the value of the output voltage, the A7121A allows the main switch to remain on for more than one switching cycle and increases the duty cycle [NOTE5] until it reaches 100%. The output voltage then is the input voltage minus the voltage drop across the main switch and the inductor. At low input supply voltage, the $R_{DS(ON)}$ of the P-Channel MOSFET increases, and the efficiency of the converter decreases. Caution must be exercised to ensure the heat dissipated not to exceed the maximum junction temperature of the IC.

NOTE 5: The duty cycle D of a step-down converter is defined as:

$$D = t_{ON} \times f_{OSC} \times 100\% \approx \frac{V_{OUT}}{V_{IN}} \times 100\%$$

Where t_{ON} is the main switch on time and f_{OSC} is the oscillator frequency (1MHz).

Maximum Load Current

The A7121A will operate with input supply voltage as low as 2.7V, however, the maximum load current decreases at lower input due to large I-R drop on the main switch and synchronous rectifier. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%. Conversely the current limit increases as the duty cycle decreases.

Layout Guidance

When laying out the PCB board, the following suggestions should be taken to ensure proper operation of the A7121A. These items are also illustrated graphically in Figure 2.

1. The power traces, including the GND trace, the LX trace and the V_{IN} trace should be kept short, direct and wide.
2. The V_{FB} pin should be connected directly to the feedback resistor. The resistive divider R1/R2 must be connected between the (+) plate of C3 and ground.
3. Connect the (+) plate of C1 to the V_{IN} pin as closely as possible. This capacitor provides the AC current to internal power MOSFET.
4. Keep the switching node, LX, away from the sensitive V_{FB} node.
5. Keep the (-) plates of C1 and C3 as close as possible.

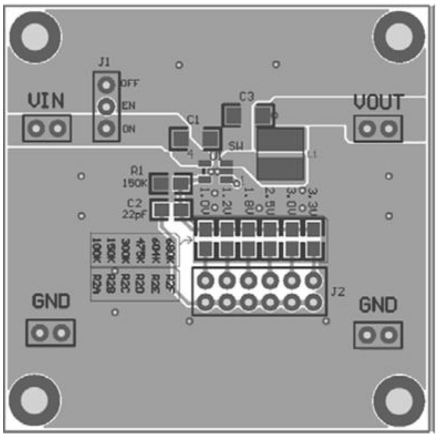


Figure 2. A7121A Suggested Layout

Application Information

Setting the Output Voltage

Figure 1 above shows the basic application circuit with A7121A. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.6V \times \left(1 + \frac{R2}{R1}\right)$$

R1=150kΩ for all outputs; R2= 100kΩ for V_{OUT}=1.0V, R2=150kΩ for V_{OUT} =1.2V, R2=300kΩ for V_{OUT} =1.8V, R2=475kΩ for V_{OUT} =2.5V, R2=604kΩ for V_{OUT} =3.0V, and R2=680kΩ for V_{OUT} =3.3V. (Use 1% tolerance resistor)

Inductor Selection

For most designs, the A7121A operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

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

WhereΔI_L is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 35% of the maximum load current 2000mA, or ΔI_L=700mA.

For output voltages above 2.0V, when light-load efficiency is important, the minimum recommended inductor is 2.2μH. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range. For higher efficiency at heavy loads (above 500mA), or minimal load regulation (but some transient overshoot), the resistance should be kept below 100mΩ. The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation. Table 1 lists some typical surface mount inductors that meet target applications for the A7121A.

Brand	P/N	L(μH)	DCR(Ω)	I_{RATED}(A)	I_{SAT}(A)	Size(L*W*H), (mm)
AiT	WSS0704-2R2N	2.2	0.02	5	4.5	7.0 x 7.0 x 4.0

Table 1 Recommended Inductors

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 shall 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 22μF ceramic capacitor for most applications is sufficient.

Output Capacitor Selection

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. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current. The output ripple ΔV_{OUT} is determined by:

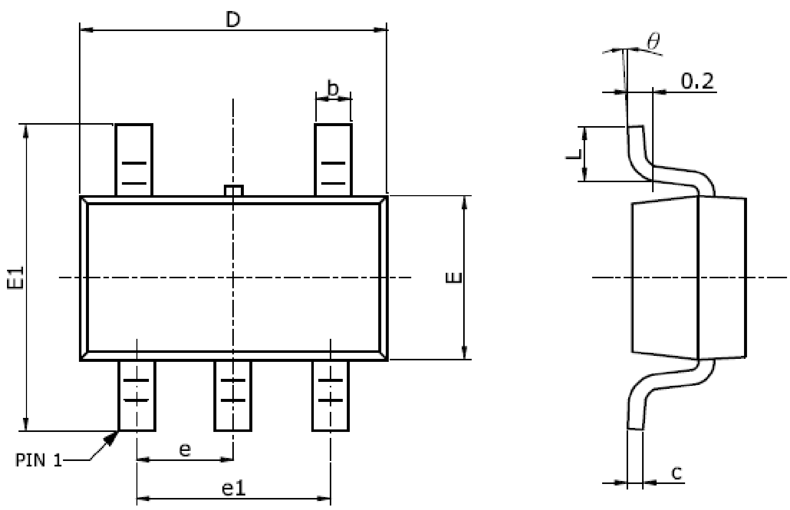
$$\Delta V_{OUT} \le \frac{V_{OUT} \times (V_{IN}-V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(ESR+\frac{1}{8 \times f_{OSC} \times C3}\right)$$

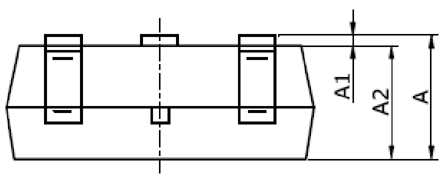
V_{OUT}	R1(kΩ)	R2(kΩ)	L1(μH)	C2(pF)	C1(μF)	C3(μF)
3.3V	150	680	2.2	22	22	22
3.0V	150	604	2.2	22	22	22
2.5V	150	475	2.2	22	22	22
1.8V	150	300	2.2	22	22	22
1.2V	150	150	2.2	22	22	22
1.0V	150	100	2.2	22	22	22

Table 2 Recommended Component Values for Figure 1 Typical Application Circuit

PACKAGE INFORMATION

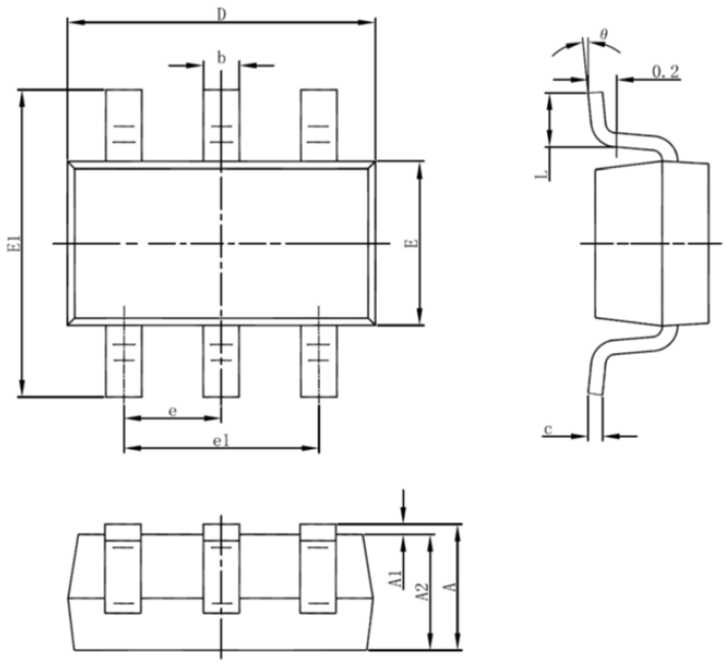
Dimension in SOT-25 (Unit: mm)





Symbol	Millimeters		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
E	1.500	1.700	0.059	0.067
E1	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°

Dimension in SOT-26 (Unit: mm)



Symbol	Millimeters		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
E	1.500	1.700	0.059	0.067
E1	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°

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