

**DESCRIPTION**

The LX7172/72A are 1.4MHz fixed frequency, current-mode, synchronous PWM buck (step-down) DC-DC converters, capable of driving a 1.2A load with high efficiency, excellent line and load regulation. The devices integrate synchronous P-channel and N-channel power MOSFET switches with low on-resistance. They accept an input voltage range from 2.5V to 5.5V and will enter 100% duty cycle at dropout making them ideal for powering portable equipment that runs from a single Li-ion battery.

A standard series of inductors are available from several different manufacturers optimized for use with the LX7172/72A. This feature greatly simplifies the design of switch-mode power supplies.

The converters include standard safety features such as over-current, short-circuit and thermal shutdown protection. These devices are both available in the SOT23-5 package, the two versions providing alternative pin out configurations for maximum flexibility.

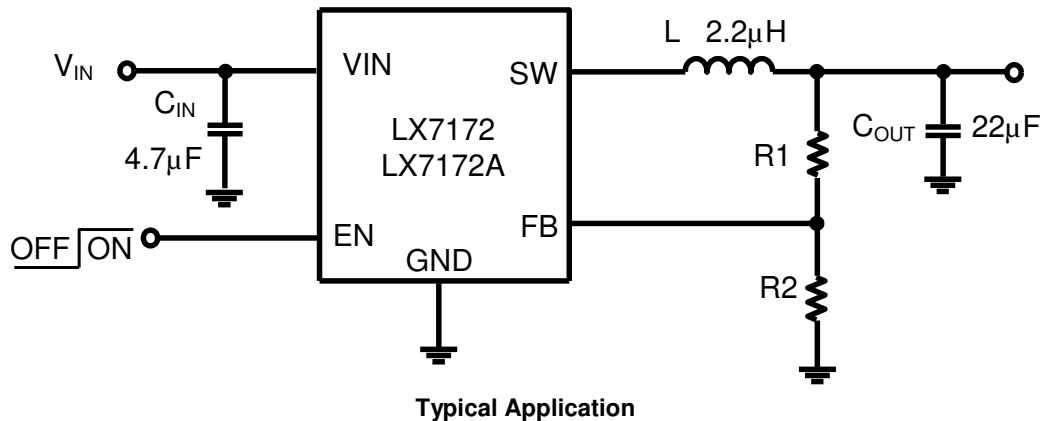
**KEY FEATURES**

- Input Supply Range: 2.5V to 5.5V
- Output Adjustable from 0.6V to  $\sim V_{IN}$
- 100% Duty Cycle in Dropout
- Integrated NMOS & PMOS Switches
- Current Mode Control
- 1.2A Maximum Output Current
- Fixed 1.4MHz Frequency
- High Efficiency: Up To 95%
- Built-in Soft-start
- Built-in UV & OT Protection
- Built-in Short Circuit Protection
- RoHS Compliant & Halogen Free

**APPLICATIONS**

- Datacom
- Portable Devices
- Smart Phone

**IMPORTANT:** For the most current data, consult MICROSEMI's website: <http://www.microsemi.com>

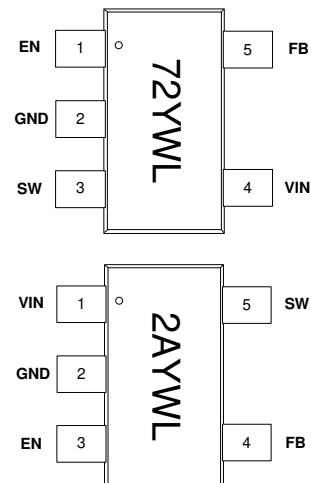
**PRODUCT HIGHLIGHT**

**PACKAGE ORDER INFO**
**THERMAL DATA**

$T_A$ (°C)	<b>SE</b>	Plastic SOT23-5	$\theta_{JA} = 265$ °C/W
		RoHS Compliant / Pb-free	THERMAL RESISTANCE-JUNCTION TO AMBIENT
-40 to +85		<b>LX7172ISE</b> <b>LX7172AISE</b>	Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$ . The $\theta_{JA}$ numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow. $\theta_{JA}$ number above is with 4-layer pcb board.
Note: Available in Tape & Reel. Append the letters "TR" to the part number. (i.e. LX7172ISE-TR)			

**ABSOLUTE MAXIMUM RATINGS**

VIN (Input Pin).....	-0.3V to 6V
EN (Enable Pin).....	-0.3V to VIN+0.3V
SW (Switch Pin).....	-0.3V to VIN+0.3V
FB (Feedback Pin).....	-0.3V to VIN+0.3V
Maximum Junction Temperature.....	150°C
Storage Temperature Range.....	-65°C to 150°C
Peak Package Solder Reflow Temperature (40 seconds maximum exposure).....	260°C
Lead Temperature. (Soldering 10 seconds).....	260°C

Notes: Exceeding these ratings could cause damage to the device. All voltages are with respect to GND. Currents are positive into, negative out of specified terminal. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" are not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

**PACKAGE PIN OUT**


**LX7172 = 72YWL**  
**LX7172A = 2AYWL**

**SE PACKAGE**

(Top View)

YWL = Year/Week/Lot Code  
 RoHS / Pb-free Matte Tin Pin Finish

**RECOMMENDED OPERATING CONDITIONS**

Parameters	Symbol	Min	Max	Units
Input Voltage	VIN	2.5	5.5	V
Output Voltage	VOUT	0.6	VIN-0.5V	V
Maximum Output Current	IOUT (MAX)	1.2		A
Operating Ambient Temperature	TA	-40	85	°C

**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, the following specifications apply at VIN = VEN = 3.3V. TA = 25°C.

Parameters	Symbol	Test Conditions/Comments	MIN	TYP	MAX	Units
<b>Operating Current</b>						
Quiescent Current	IQ	VFB = 0.65V		62	100	µA
Shutdown Supply Current	ISHDN	VEN = GND		0.1	1	µA
<b>VIN UVLO</b>						
Under Voltage Lockout	VUVLO	VIN Rising		2.3		V
UVLO Hysteresis	VHYS			200		mV
<b>Feedback Voltage</b>						
Feedback Voltage	VREF		0.588	0.6	0.612	V

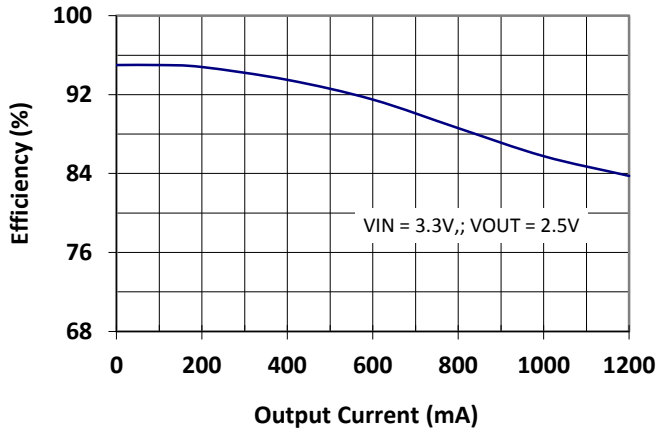
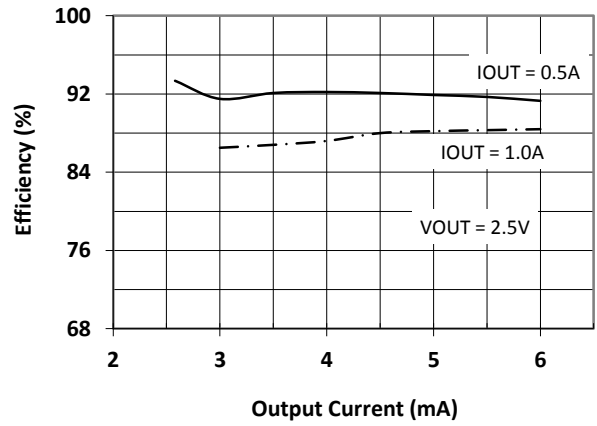
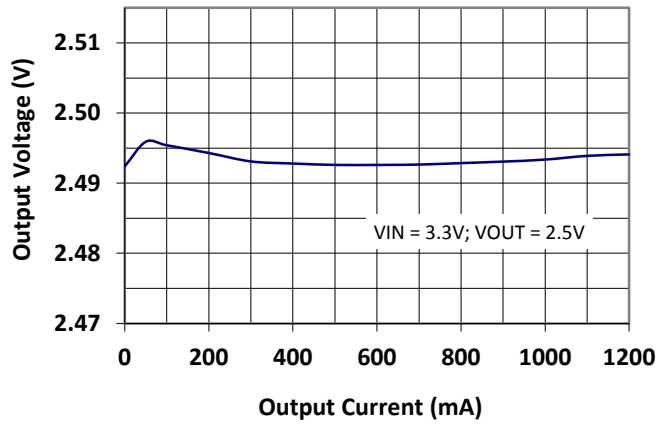
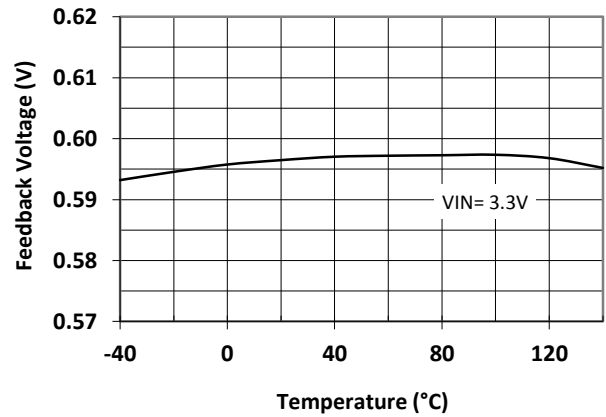
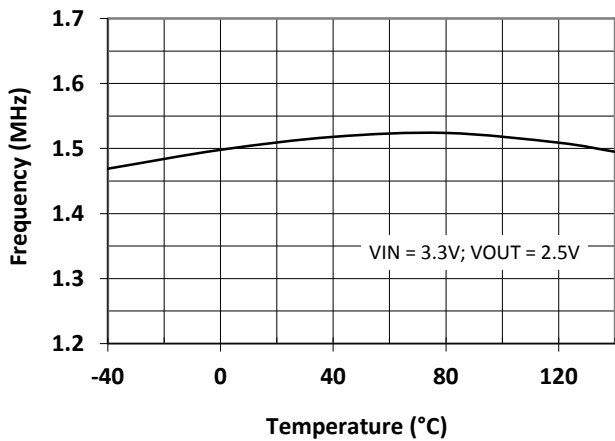
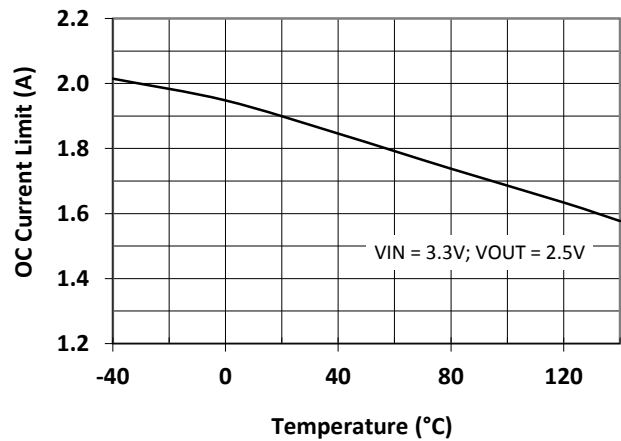
**ELECTRICAL CHARACTERISTICS**

 Unless otherwise specified, the following specifications apply at  $V_{IN} = V_{EN} = 3.3V$ .  $T_A = 25^{\circ}C$ .

Parameters	Symbol	Test Conditions/Comments	MIN	TYP	MAX	Units
FB Input Bias Current	$I_{FB}$	$V_{FB} = V_{IN}$	-100		100	nA
Output Voltage Accuracy	$\Delta V_{OUT}$		-2		2	%
<b>Output</b>						
PMOS Switch $R_{DSON}$	$R_{DSON\_P}$	$I_{SW} = 200mA$		0.28		$\Omega$
NMOS Switch $R_{DSON}$	$R_{DSON\_N}$	$I_{SW} = -200mA$		0.25		$\Omega$
NMOS Switch Leakage Current	$I_{LEAK}$	$V_{IN} = 3.3V, V_{SW} = 3.3V$		0.1		$\mu A$
Switch Current Limit	$I_{LIM}$	$V_{FB} = 0.55V$	1.5	2.0		A
Thermal Shutdown	$T_{OTSD}$			160		$^{\circ}C$
Thermal Shutdown Hysteresis	$T_{HYS}$			20		$^{\circ}C$
<b>Oscillator</b>						
Oscillator Frequency	$f_{OSC}$		1.12	1.40	1.68	MHz
Maximum Duty Cycle	$D_{MAX}$	$V_{FB} = 0V$	100			%
Minimum Duty Cycle	$D_{MIN}$	$V_{FB} = 0.65V$			0	%
<b>Soft Start</b>						
Soft Start Time	$T_{SS}$			1		ms
<b>EN Input</b>						
EN Pin Threshold	$V_{EN\_H}$		1.5			V
	$V_{EN\_L}$				0.4	

**FUNCTIONAL PIN DESCRIPTION**

Pin Number		Pin Name	Function
LX7172	LX7172A		
1	3	EN	Enable Input. Setting this pin above 1.5V enables the IC. Setting this pin below 0.4V shuts down the IC. When the IC is in shutdown mode, all functions are disabled to decrease the supply current below 1 $\mu A$ .
2	2	GND	Ground Pin
3	5	SW	Power Switch Output Pin. Inductor connection to drain of the internal PFET and NFET switches.
4	1	VIN	Supply Input Pin. A 4.7 $\mu F$ ceramic capacitor should be connected between the VIN pin and GND pin to bypass the supply.
5	4	FB	Feedback Pin. This pin is connected to an external resistor divider to program the system output voltage.

**TYPICAL PERFORMANCE CHARACTERISTICS**

**Figure 1 Efficiency vs. Output Current**

**Figure 2 Efficiency vs. Input Voltage**
**Fi**

**Figure 3 Output Voltage vs. Output Current**

**Figure 4 Feedback Voltage vs. Temperature**

**Figure 5 Frequency vs. Temperature**

**Figure 6 OCP Current Limit vs. Temperature**

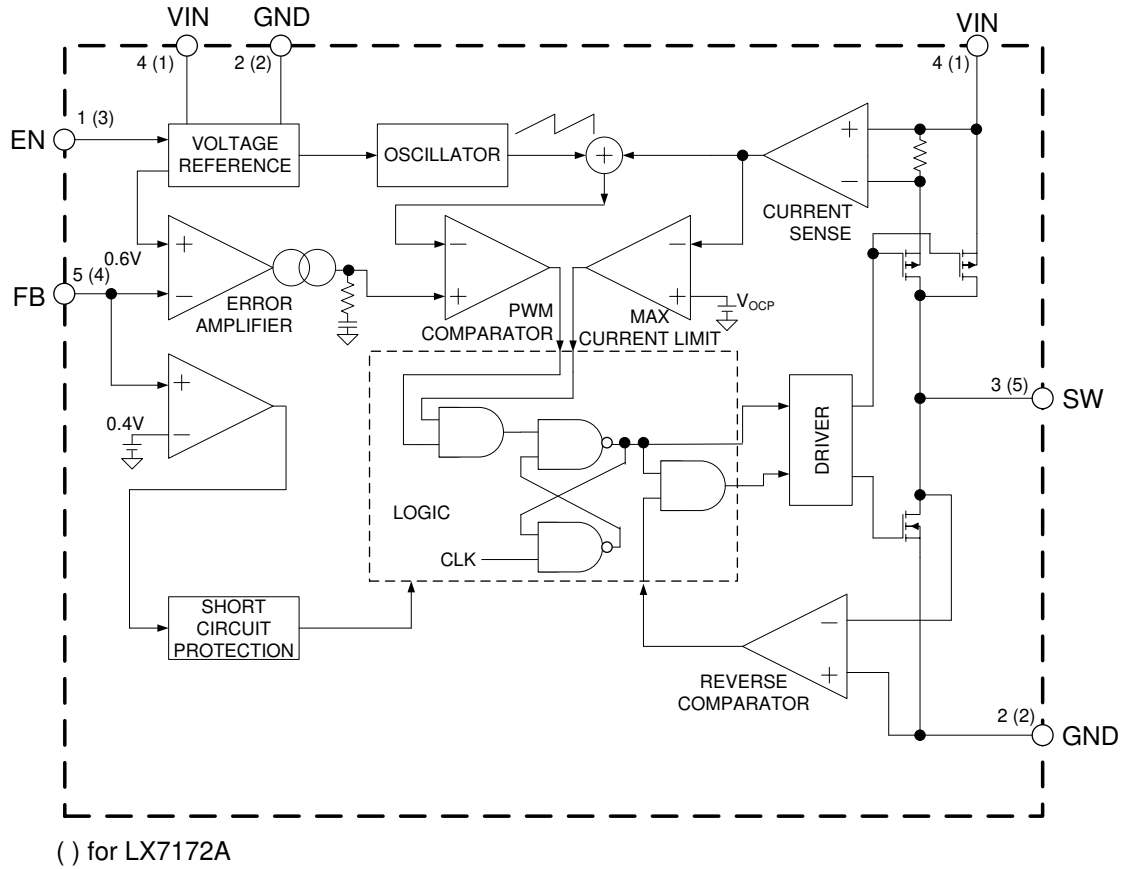
**FUNCTIONAL BLOCK DIAGRAM**


Figure 1. LX7172/LX7172A Functional Block Diagram.

**THEORY OF OPERATION / APPLICATION INFORMATION**
**OPERATION OVERVIEW**

The LX7172/A is a synchronous step-down converter operating with a typically 1.4MHz fixed frequency pulse width modulation (PWM) at moderate to heavy load currents and in power-saving mode (PSM) when operating at light load currents. It is capable of delivering a 1.2A output current over a wide input voltage range from 2.5 to 5.5V.

At the beginning of each cycle initiated by the clock signal (from the internal oscillator), the P-channel MOSFET switch is turned on, and the inductor current ramps up until the comparator trips and the control logic turns off the switch. The current limit comparator also turns off the switch in case the current limit of the P-channel MOSFET is exceeded. Then the N-channel synchronous switch is turned on and the inductor current ramps down. The next cycle is initiated by the clock signal again, turning off the N-channel synchronous switch and turning on the P-channel switch (See Figure 1).

Two operational modes are available: PSM and PWM. The internal synchronous rectifier with low  $R_{DS(ON)}$  dramatically reduces conduction loss at PWM mode. No external Schottky diode is required in practical application. The LX7172/A enters PSM at extremely light load condition. The equivalent switching frequency is reduced to increase the efficiency in PSM.

As the input supply voltage decreases to a value approaching the output voltage, the duty cycle increases to the maximum. Further reduction of the supply voltage forces the P-channel main switch to remain on for more than one cycle until it reaches 100% duty cycle. The output voltage will then be determined by the input voltage minus the voltage drop across the P-channel MOSFET and the inductor. This is particularly useful in battery powered applications to achieve longest operation time by taking full advantage of the whole battery voltage range.

**TYPICAL APPLICATION**

A general LX7172/A application circuit is shown in Figure 2. External component selection is driven by the load requirement, and begins with the selection of the inductor L. Once L is chosen,  $C_{IN}$  and  $C_{OUT}$  can be selected.

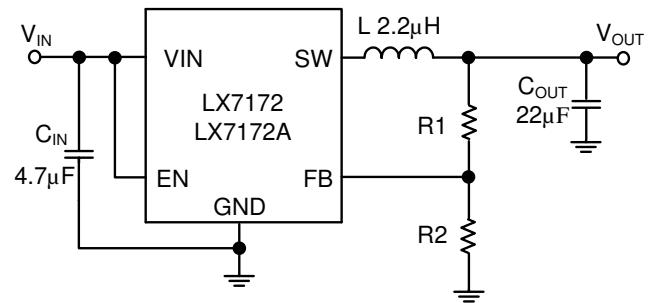


Figure 2 Typical Application

**COMPONENT SELECTION**
**Inductor Selection**

Although the inductor does not influence the operating frequency, the inductor value has a direct effect on ripple current. The inductor ripple current  $\Delta I_L$  decreases with higher inductance and increases with higher  $V_{IN}$  or  $V_{OUT}$ .

$$\Delta I_L = \frac{V_{OUT}}{f_{OSC} \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Accepting larger values of  $\Delta I_L$  allows the use of low inductances, but results in higher output voltage ripple, greater core losses, and lower output current capability. A typical  $\Delta I_L$  value is 20% to 40% of output current.

Another important parameter for the inductor is the current rating. Exceeding an inductor's maximum current rating may cause the inductor to saturate and overheat. Once the inductor value has been selected, the peak inductor current can be calculated as the following:

$$I_{PEAK} = I_{OUT} + V_{OUT} \times \frac{V_{IN} - V_{OUT}}{2 \times f_{OSC} \times V_{IN} \times L}$$

It should be ensured that the current rating of the selected inductor is 1.5 times of the  $I_{PEAK}$ .

**THEORY OF OPERATION - CONTINUED**
**Input Capacitor Selection**

Because the buck converter has a pulsating input current, a low ESR input capacitor is required. This results in the best input voltage filtering and minimizing the interference with other circuits caused by high input voltage spikes. Also the input capacitor must be sufficiently large to stabilize the input voltage during heavy load transients. Ceramic capacitors show a good performance because of the low ESR value, and they are less sensitive to voltage transients and spikes. Place the input capacitor as close as possible to the input pin of the device for best performance. The typical value is about 4.7μF. The X5R or X7R ceramic capacitors have the best temperature and voltage characteristics, which is good for the input capacitor.

**Output Capacitor Selection**

The output capacitor is the most critical component of a switching regulator, it is used for output filtering and keeping the loop stable. The selection of C<sub>OUT</sub> is driven by the required ESR to minimize voltage ripple and load step transients. Typically, once the ESR requirement is satisfied, the capacitance is adequate for filtering. The output ripple (ΔV<sub>OUT</sub>) is determined by:

$$\Delta V_{OUT} \approx \Delta I_L \left( ESR + \frac{1}{8 \times f_{OSC} \times C_{OUT}} \right)$$

The output ripple is highest at maximum input voltage since ΔI<sub>L</sub> increases with input voltage.

Once the ESR requirements for C<sub>OUT</sub> have been met, the RMS current rating generally far exceeds the I<sub>RIPPLE (P-P)</sub> requirement, except for an all ceramic solution. In most applications, a 22μF ceramic capacitor is usually enough for these conditions.

At light load currents, the device operates in PSM mode, and the output voltage ripple is independent of the output capacitor value. The output voltage ripple is set by the internal comparator thresholds. The typical output voltage ripple is 1% of the output voltage V<sub>OUT</sub>.

**Feedback Divider Resistors**

The LX7172/A develops a 0.6V reference voltage between the feedback pin, FB, and the signal ground as shown in Figure 1. The output voltage is set by a resistive divider according to the following formula:

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

Keeping the current small (<40μA) in these resistors maximizes efficiency, but making them too small (<20μA) may allow stray capacitance to cause noise problems and reduce the phase margin of the error amp loop.

The Output resistor divider values are recommended below.

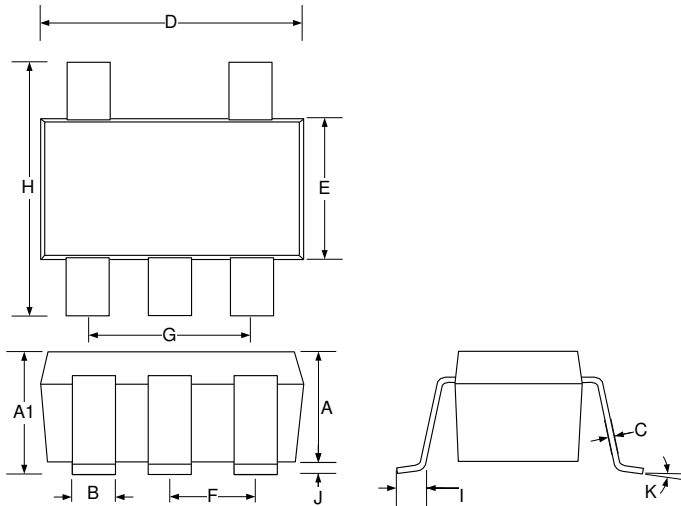
V <sub>OUT</sub>	R1	R2
0.9V	12.1k	24.3k
1.2V	24.3k	24.3k
1.8V	47.5k	24.3k
2.5V	76.8k	24.3k
3.0V	95.3k	24.3k
3.3V	107k	24.3k

**Layout Consideration**

PCB layout is very important to the performance of the LX7172/A. The traces where switching current flows should be kept as short as possible. The external components (especially C<sub>IN</sub>) should be placed as close to the IC as physically possible. Therefore use wide and short traces for the main current paths, as indicated in bold in Figure 3.

Try to route the feedback trace as far from the inductor and noisy power traces as possible. You should also make the feedback trace connection as direct as possible and of reasonable thickness. These two criteria sometimes involve a trade-off, but keeping the trace it away from the inductor and other noise sources is the more critical of the two. Locate the feedback divider resistor network near the feedback pin with short leads.

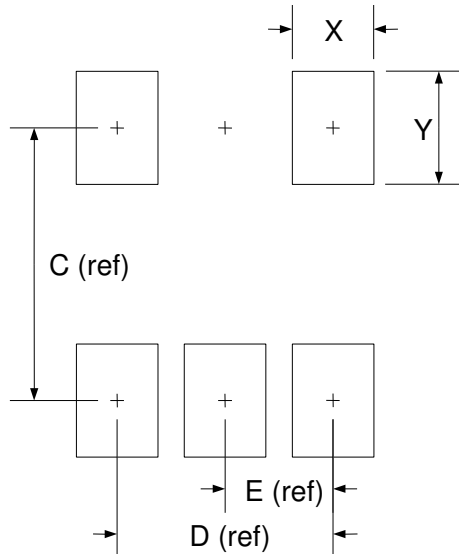
Flood all unused areas on all layers with copper. Flooding with copper will help to reduce the temperature rise of power components. These copper areas should be connected to one of the input supplies.

**PACKAGE DIMENSIONS**
**SE 5-Pin SOT-23 Package**


Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.90	1.30	0.035	0.051
A1	-	1.45	-	0.057
B	0.25	0.50	0.010	0.020
C	0.09	0.20	0.004	0.008
D	2.80	3.10	0.110	0.122
E	1.50	1.75	0.059	0.069
F	0.95 BSC		0.037 BSC	
G	1.90 BSC		0.075 BSC	
H	2.60	3.00	0.102	0.118
I	0.30	0.60	0.012	0.024
J	0.00	0.15	0.000	0.006
K	10° MAX		10° MAX	

**Note:**

- Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm(.006") on any side. Lead dimension shall not include solder coverage.

**Recommended Footprint**


Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
C	-	2.40	-	0.094
D	-	1.90	-	0.074
E	-	0.95	-	0.037
X	-	0.70	-	0.028
Y	-	1.00	-	0.039





LX7172/ LX7172A

1.4MHz 1.2A Synchronous Buck Converter

PRODUCTION DATASHEET

NOTES

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