2A,1.0MHZ Synchronous Step-Up DC/DC Converter

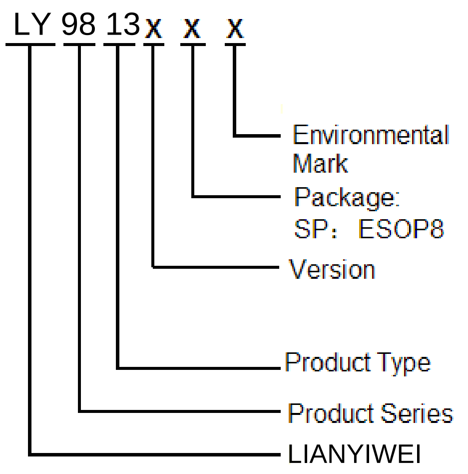
General Description

The LY9813 is synchronous, 2A, 1.0MHZ step-up DC-DC Converter, which mainly consists of a reference voltage source, an oscillation circuit, an error amplifier, a phase compensation circuit, a PWM / PFM switching control circuit and an adjustable output current limit circuit. With an internal low-ON-resistance N-ch Power MOS and P-ch Power MOS. This product is ideal for applications requiring high efficiency and a high output current.

Features

- High efficiency.(up to 93%)
- Up to 90% Efficiency at I_{OUT}=2A V_{OUT} = 5V from 3.3V Input.
- Guaranteed 2.5A Output Current at V_{OUT} = 5V from 3.3V Input
- Synchronous and internal P-ch Power MOSFET and N-ch power MOSFET ,No Schottky Diode Required
- Oscillator frequency：1.0MHz
- Reference voltage : 1.25V（±2%）
- Input voltage range: 2.3 V to 5.5 V
- Continuous output current: 2.0A typ. (V_{IN}=3V, V_{OUT}=5.0V)
- Soft start function
- Shutdown function:1.0μA max.
- UVLO (under-voltage lockout) function
- Current Limit: adjustable by the Rcs using different valve
- Thermal Shutdown Preotection:156℃
- Package：ESOP8

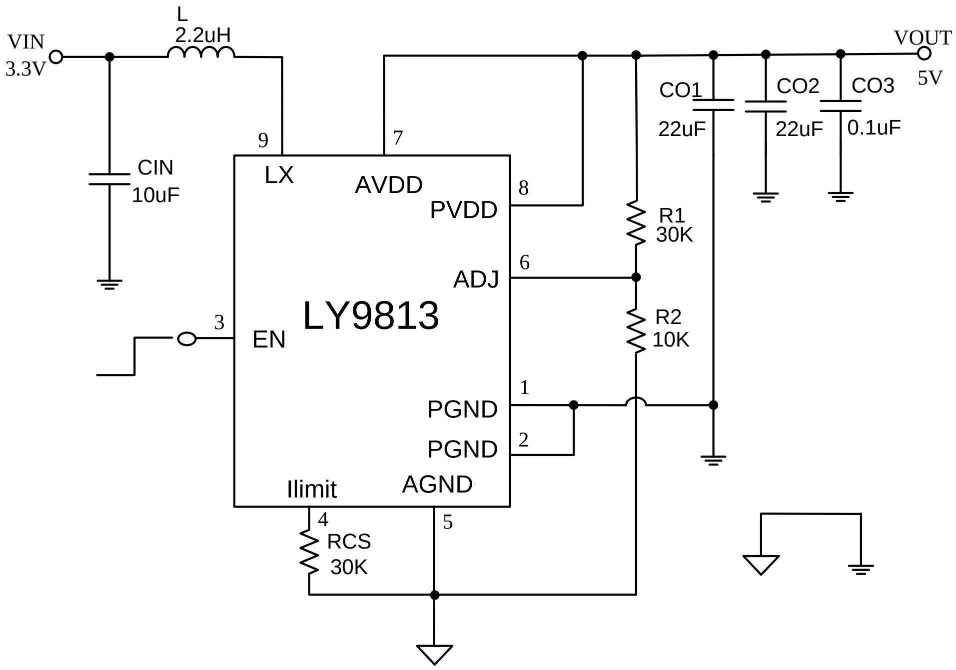
Selection Guide



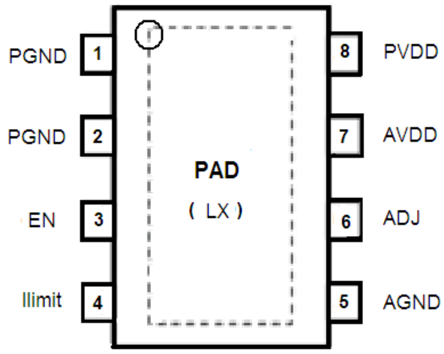
Typical Application

- Portable charger, mobile power.
- Digital cameras, GPS, wireless transceiver
- IPad-like computers, smart phones and portable handheld devices

Typical Application Circuit



Pin Configuration

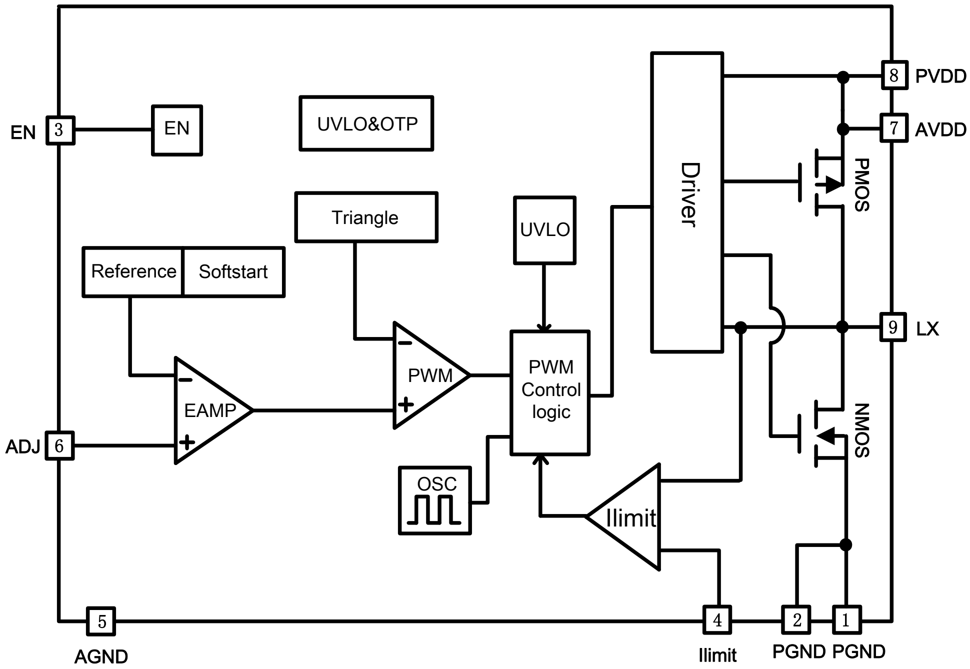


ESOP8

Pin information

Pin Number	Pin Name	Function
1	PGND	Power Ground
2	PGND	Power Ground
3	EN	Power-enable "H" : Power-on (normal operation) "L" : Power-off (standby)
4	Ilimit	Current limit External transistor
5	AGND	Analog Ground
6	ADJ	Feed Back voltage pin
7	AVDD	IC Analog power supply pin
8	PVDD	IC power supply pin
9	LX	Power switching pin

Block Diagram



Absolute Maximum Rang

PARAMETER	SYMBOL	RATING	UNIT
VDD Pin Voltage	AVDD, PVDD	-0.3～6.0	V
LX Pin Voltage	V_{LX}	-0.3～VDD+0.3	V
ADJ Pin Voltage	V_{ADJ}	-0.3～VDD+0.3	V
EN Pin Voltage	V_{EN}	-0.3～VDD+0.3	V
Power Dissipation (ESOP8)	Pd	2000	mW
Operating Temperature Range	T_{Opr}	-40~+85	℃
Storage Temperature Range	T_{stg}	-40~+125	℃

External Parts List When Measuring Electrical Characteristics

Element Name	SYMBOL	VALUE	UNIT
Inductor	L	≤2.2	uH
Input capacitor	CIN	10	uF
Output capacitor	Co1, Co2	22	uF
Output capacitor	Co3	0.1	uF
ADJ Resistance	R1,R2	30K,10K	Ω

Electrical Characteristics

Measuring conditions：V_{IN}=V_{EN}= 3.3V, V_{OUT}=5.0V,Ta=25℃。Unless otherwise specified。

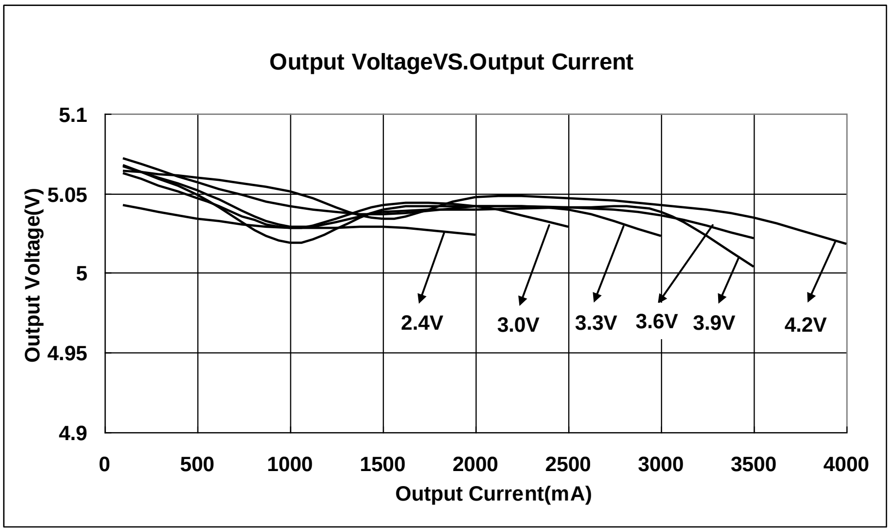
Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Feedback voltage	V_{ADJ}		1.225	1.250	1.275	V
Input voltage	V_{IN}		2.3	-	5.5	V
Current consumption 1	I_{SS1}	At switching operation, no external components ,AVDD=PVDD=V_{EN}=3.3V,V_{ADJ}=V_{ADJ}(S)× 0.95,	-	4	6	mA
Current consumption 2	I_{SS2}	At switching stop, no external components, AVDD=PVDD=V_{EN}=3.3V V_{ADJ}=V_{ADJ}(S)+ 0.5V,	-	150	300	μA
Current consumption during shutdown	I_{SSS}	AVDD=PVDD= 3.3V, V_{EN}=0V, no external components	-	-	1	μA
Oscillation frequency	Fosc		0.8	1.0	1.2	MHz
Max. duty ratio	MAXDUTY	V_{IN}=V_{EN}= 0.9V, no load	-	81	-	%
PWM/PFM switching duty ratio	PFMDUTY	V_{IN}=V_{EN}= 3.3V,no load	-	18	-	%
High level input voltage	V_{SH}	V_{IN}= 2.3V to 5.5 V, EN pin	0.9	-	-	V
Low level input voltage	V_{SL}	V_{IN}=2.3V to 5.5 V, EN pin	-	-	0.2	V
ADJ pin input current	I_{ADJ}	AVDD= PVDD= V_{EN} =2.3 V to 5.5 V, ADJ pin	-0.1	0	0.1	μA
UVLO release voltage	V_{UVLO+}		-	-	2.4	V
UVLO hysteresis width	$V_{UVLOHYS}$		-	0.4	-	V
Soft start time	t_{ss}	-	-	3	-	mS
Thermal Shutdown Protection	Tsd		-	156	-	℃

Note:

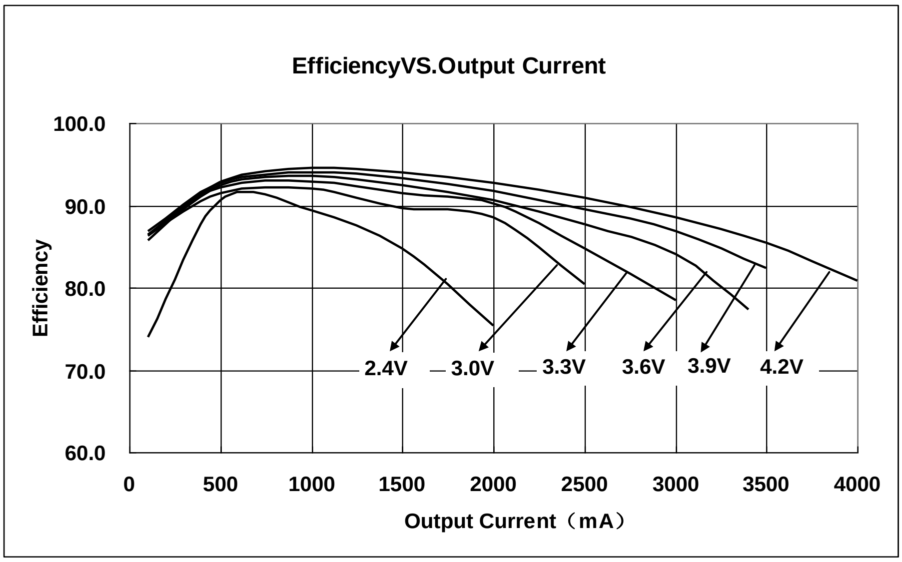
- Set the input voltage as to 2.3 V≤V_{IN}≤5.5V for stabilizing the output voltage and oscillation frequency.
- V_{ADJ}(S) is a setting value for ADJ voltage.

Typical Performance Characteristics

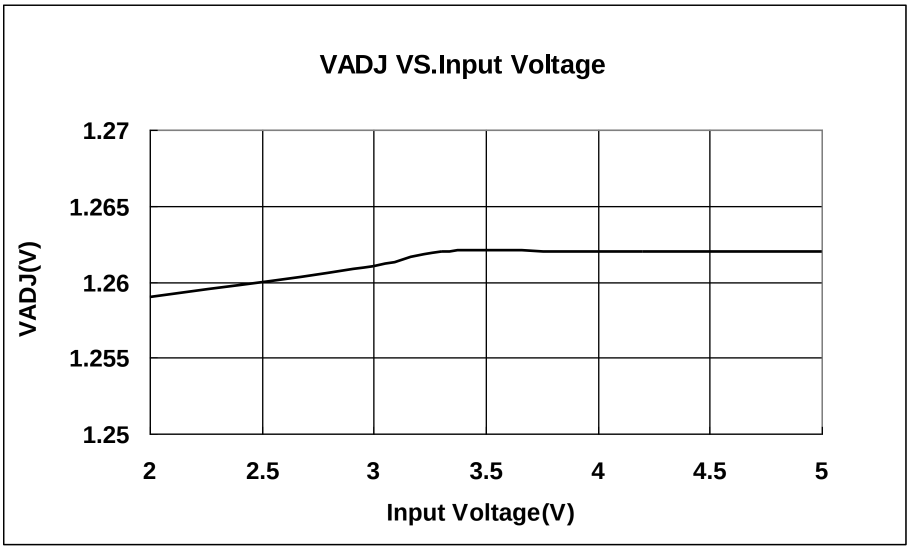
1、Output Voltage VS. Output Current（V_{OUT} =5.0V）



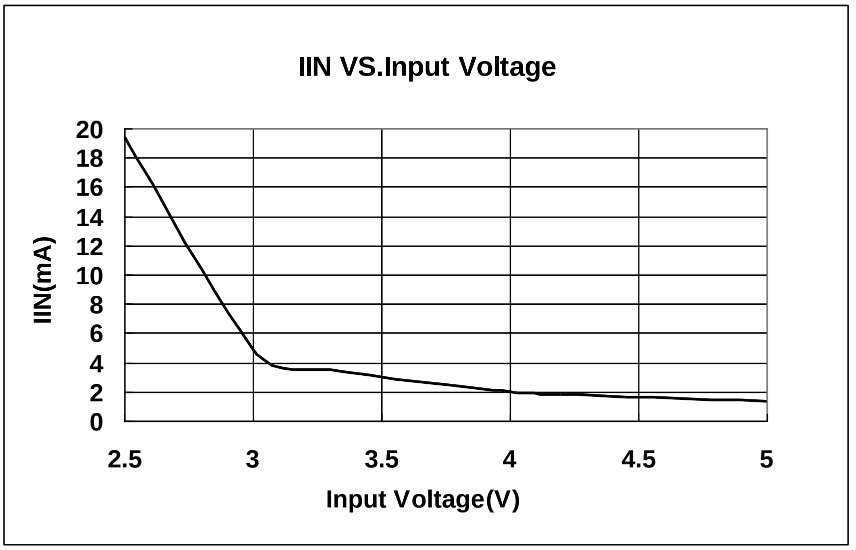
2、Efficiency VS. Output Current（V_{OUT} =5.0V）



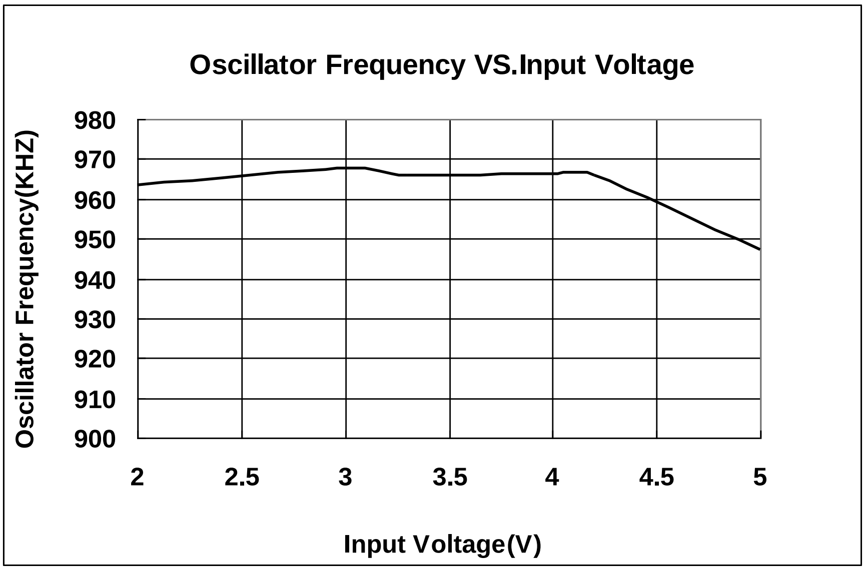
3、V_{ADJ} VS. Input Voltage （I_{OUT}=10mA）



4、IIN VS. Input Voltage（system testing，No load）



5、Oscillator Frequency VS. Input Voltage (V_{IN}=3.3V,I_{OUT}=500mA)



PWM / PFM switching control

The LY9813 switching regulator controller automatically switches between the pulse width modulation method (PWM) and pulse frequency modulation method (PFM) according to the load current. A low ripple power can be supplied by operating on PWM control for which the pulse width changes from 15% to 85% in the range where the output load current is large. The LY9813 operates on PFM control when the output load current is small and the fixed pulses which have the width of 15% are skipped according to the load current amount. Therefore, the oscillation circuit intermittently oscillates, reducing the self-current consumption. This avoids decreased efficiency when the output load current is small. The point at which PWM control switches to PFM control varies depending on the external element (inductor, diode, etc.), input voltage value, and output voltage value.

Soft-start function

The LY9813 has a soft-start circuit. The output voltage (V_{OUT}) gradually rises after power-on or startup when the EN pin is set to high, suppressing rush current and overshooting the output voltage. The soft-start time (tss) for the LY9813 is defined as the time from startup until V_{OUT} reaches 90% of the output set voltage value (V_{OUT}(S)). A reference voltage adjustment method is used as the soft-start method and the reference voltage gradually rises from 0 V after soft-start.

UVLO function

The LY9813 has a UVLO (under voltage lockout) circuit for avoiding IC malfunctions due to power supply voltage drops. The LY9813 stops switching operation upon UVLO detection and retains the external transistor in the off state. After entering the UVLO detection status once, the soft-start function is reset.

Note, however, that the other internal circuits operate normally and that the status differs from the power-off status.

CURRENT LIMIT DESIGNING

The LY9813 has a cycle-by-cycle current limit to maximum inductor peak current (I_{PK}) ,adjust inductor peak current limit ($I_{pklimit}$)by the Rcs with calculating the value for RCS as

$$R_{CS} \approx \frac{5}{I_{pklimit} \times R_{DSON}}$$

The R_{DSON} is the ON-resistance of Nch Power MOS and the value of R_{DSON} is about 40mΩ in this product.. When an over current condition is detected, the device reduces the output voltage accordingly.

When Output Current（IOUT）increases The inductor peak current (Ipk) increases, as The inductor peak current up to $I_{pklimit}$,, the Output Current is the I_{OLIMIT}

L=2.2uH , Co1,Co2=22uF ,CIN=10Uf,VOUT=5V

Table 1. Common R_{CS} Resistor Selections

VIN=3.3V	
R_{CS}	$I_{pklimit}$
60K	2.15A
30K	4.30A
25K	5.16A
20K	6.45A

NOTE: When selecting an R_{CS} .be careful about the influence of temperature at the R_{DSON} and other devices , select an R_{CS} inductor such that that $I_{pklimit}$ does not exceed the allowable current

External parts selection for DC/DC converter

- **Inductor**

The recommended L value of LY9813 is 2.2μH or less for 1.0 MHz products. Note the following when changing the inductance. The inductance (L) has a strong influence on the maximum output current (I_{OUT}) and efficiency (η). The inductor peak current (Ipk) increases when L is decreased, which improves the circuit stability and increases the I_{OUT} users can obtain. If L is decreased further, the ability of the external transistor to drive the current becomes insufficient, reducing the efficiency and decreasing I_{OUT}.

The loss due to the Ipk of the switching transistor is decreased by increasing L and the efficiency maximizes at a certain L value. If L is increased further, the loss due to the serial resistance of the inductor increases, lowering the efficiency.

Caution: When selecting an inductor, be careful about its allowable current. If a current exceeding the allowable current flows through the inductor, magnetic saturation occurs, substantially lowering the efficiency and destroying ICs due to large current. Therefore, select an inductor such that Ipk does not exceed the allowable current. The following equations express Ipk in the ideal statuses in the discontinuous and continuous modes :

$$Ipk = \sqrt{\frac{2 * Iout * (Vout + VD - VIN)}{f_{OSC} * L}} (A) \quad \text{(Discontinuous mode)}$$

$$Ipk = \frac{Vout + VD}{VIN} * Iout + \frac{(Vout + VD - VIN) * VIN}{2 * (Vout + VD) * f_{OSC} * L} (A) \quad \text{(Continuous mode)}$$

F_{OSC} is oscillation frequency, VD is the forward voltage of a diode. The reference value is 0.4 V. However, current exceeding the above equation flows because conditions are practically not ideal. Perform sufficient evaluation with actual application.

2. Capacitor (C_{IN}, C_{O1}, C_{O2})

To improve efficiency, an input capacitor (CIN) lowers the power supply impedance and averages the input current. Select CIN according to the impedance of the power supply used. The recommended capacitance is 10μF for LY9813 . An output capacitor (C_O), which is used to smooth the output voltage, requires a capacitance larger than that of the step-down type because the current is intermittently supplied from the input to the output side in the step-up type. A 22μF ceramic capacitor is recommended for LY9813 . However, a higher capacitance is recommended if the output voltage is high or the load current is large. If the output voltage or load current is low, another 22μF can be used without problems.

Select C_O after sufficient evaluation with actual application.

A ceramic capacitor can be used for both the input and output.

3.Output voltage setting resistors (R1 , R2)

For LY9813 , V_{OUT} can be set to any value by using external divider resistors. Connect the divider resistors between the V_{OUT} and V_{SS} pins. Because V_{ADJ} = 1.25 V typ., V_{OUT} can be calculated by using the following equation : $V_{OUT}=\left(\frac{R1+R2}{R2}\right)\times 1.25(V)$

Connect divider resistors R1 and R2 as close to the IC as possible to minimize the effects of noise.

The typical constants based on our evaluation are shown in the next Table:

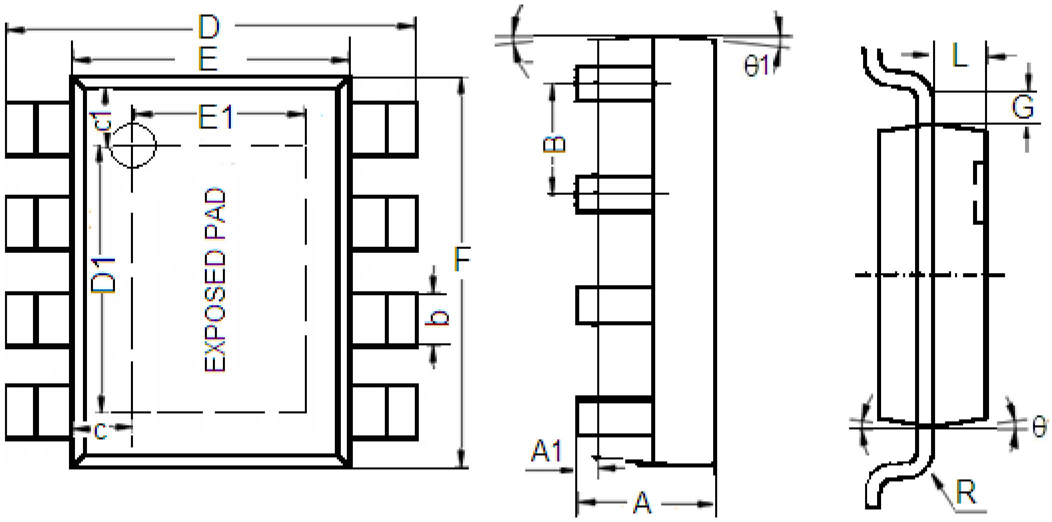
V_{OUT}(S) (V)	VIN (V)	R1 (KΩ)	R2 (KΩ)	L (μH)	Co1,Co2 (μF)
3.3	2.4	16.4	10	2.2	22
5	3.3	30	10	2.2	22

5. Precautions

- Mount external capacitors, a diode, and a coil as close as possible to the IC.
- Characteristics ripple voltage and spike noise occur in IC containing switching regulators. Moreover rush current flows at the time of a power supply injection. Because these largely depend on the inductor, the capacitor and impedance of power supply used, fully check them using an actually mounted model.
- The 0.1 μF capacitor connected between the VIN and GND pins is a bypass capacitor. It stabilizes the power supply in the IC when application is used with a heavy load, and thus effectively works for stable switching regulator operation. Allocate the bypass capacitor as close to the IC as possible, prioritized over other parts.
- Although the IC contains a static electricity protection circuit, static electricity or voltage that exceeds the limit of the protection circuit should not be applied.
- The power dissipation of the IC greatly varies depending on the size and material of the board to be connected. Perform sufficient evaluation using an actual application before designing.

Package Dimension

Packaging Type: SOP8-PP



Character	Dimension (mm)		Dimension (Inches)	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.1	0.3	0.004	0.012
B	1.27(Typ.)		0.05(Typ.)	
b	0.330	0.510	0.013	0.020
c	0.9(Typ.)		0.035(Typ.)	
c1	1.0(Typ.)		0.039(Typ.)	
D	5.8	6.2	0.228	0.244
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	2.313	2.513	0.091	0.099
F	4.7	5.1	0.185	0.201
L	0.675	0.725	0.027	0.029
G	0.32(Typ.)		0.013(Typ.)	
R	0.15(Typ.)		0.006(Typ.)	
θ1	7°		7°	
θ	8°		8°	

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