Applications Note: AN_SY20306/SY20306H

High Efficiency 1.5MHz, Dual 1A/1.5A Synchronous Step Down Regulator

General Description

The SY20306 and SY20306H are dual-output, high-efficiency 1.5MHz synchronous step-down DC-DC regulator ICs capable of delivering up to 1A and 1.5A output current per output respectively. The SY20306 /H operates over a wide input voltage range from 2.5V to 5.5V and integrate main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss.

Low output voltage ripple and small external inductor and capacitor sizes are achieved with 1.5MHz switching frequency.

Features

- Low $R_{DS(ON)}$ for internal switches (top/bottom):
  - SY20306:200/150m Ω,1A
  - SY20306H:180/120m Ω,1.5A
- 2.5-5.5V input voltage range
- 1.5MHz switching frequency minimizes the external components
- Internal softstart limits the inrush current
- 100% dropout operation
- RoHS Compliant and Halogen Free
- Compact and thermally enhanced package: DFN3x3-12

Ordering Information

SY20306□(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package type	Note
SY20306DCC	DFN3x3-12	1A
SY20306HDCC	DFN3x3-12	1.5A

Applications

- WiFi Card
- LCD TV
- GPS
- Access Point Router
- Smart Phone

Typical Applications

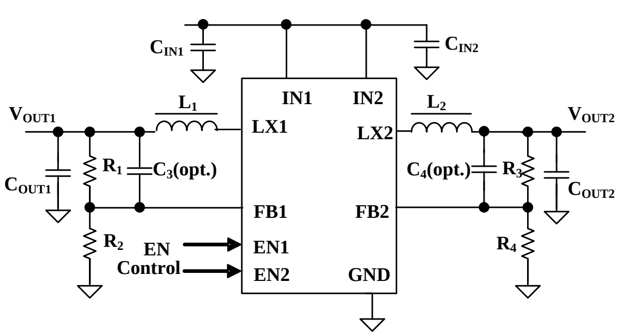


Figure 1. Schematic diagram

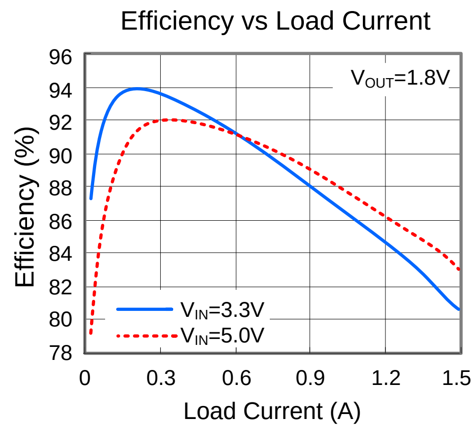
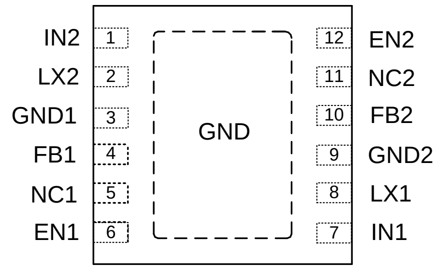


Figure2. Efficiency vs Load Current

Pinout (Top View)



Top Mark: **GA*xyz*** for SY20306, **CK*xyz*** for SY20306H

(Device code: GA for SY20306, CK for SY20306H; ***x=year code, y=week code, z= lot number code*****)**

Pin Name	DFN3x3-12	Pin Description
EN1,2	6,12	Enable controls.. Pull high to turn on. Do not float.
GND1,2	3,9	Ground pins.
LX1,2	8,2	Inductor pins. Connect this pin to the switching node of inductor
IN1,2	7,1	Input pins. Decouple IN1 to GND paddle with at least 10uF ceramic cap. Decouple IN2 to GND paddle with at least 10uF ceramic cap.
FB1,2	4,10	Output Feedback Pins. Connect this pin to the center point of the output resistor divider (as shown in Figure 1) to program the output voltage: Vout1=0.6*(1+R1/R2), Vout2=0.6*(1+R3/R4). Add optional C_3(10p-47pF), C_4(10p-47pF) to speed up transient response.
NC1,2	5,11	No connection.

Absolute Maximum Ratings (Note 1)

Supply Input Voltage -- 6V
All Other Pins -- V_{IN} + 0.6V
Power Dissipation, P_D @ T_A = 25℃ DFN3x3 --1.6 W
Package Thermal Resistance (Note 2)

DFN3x3, θ_{JA} --- 60℃/W

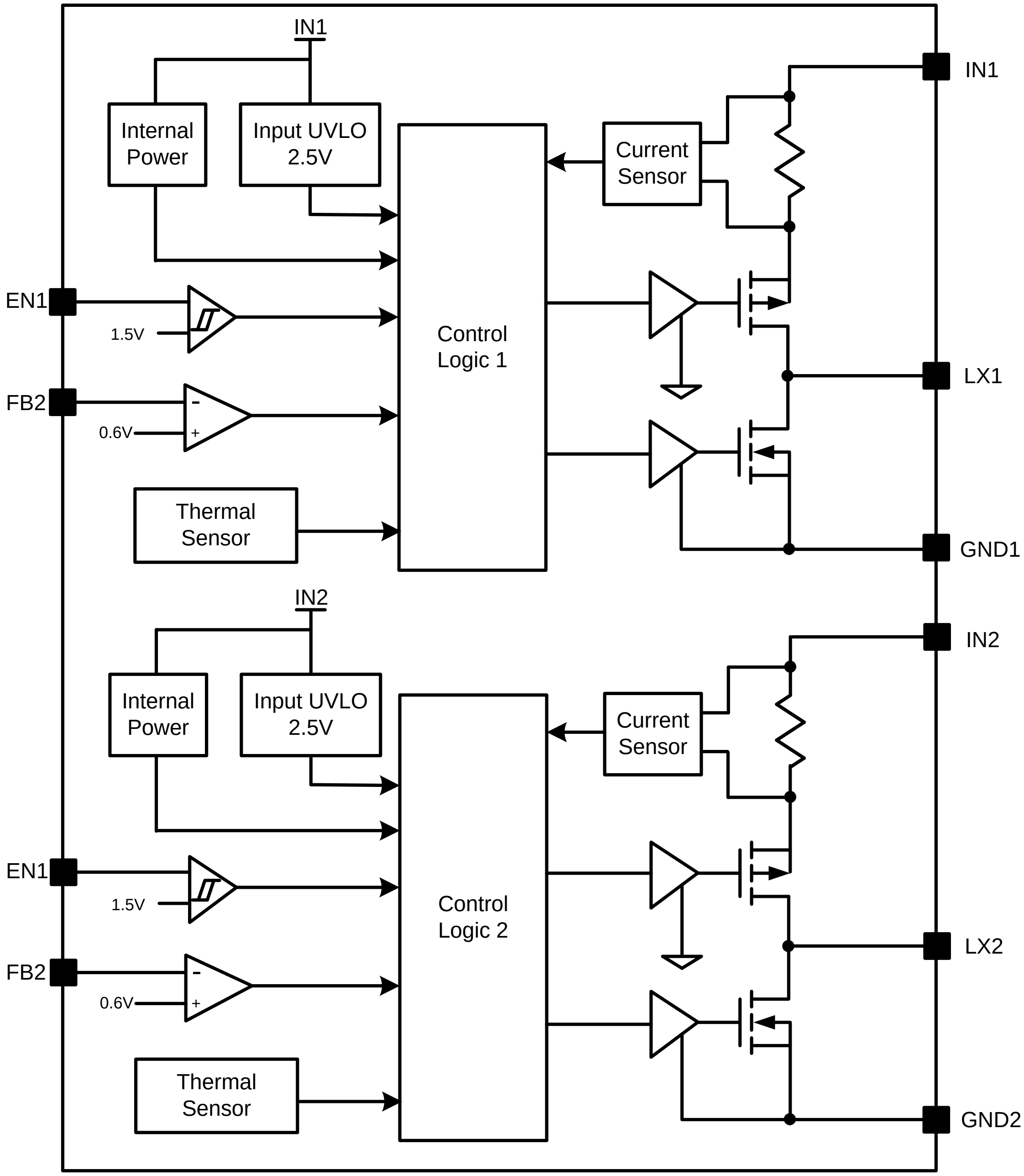
DFN3x3, θ_{JC} --- 8℃/W

Junction Temperature Range -- 150℃
Lead Temperature (Soldering, 10 sec.) -- 260℃
Storage Temperature Range --- -65℃ to 150℃
Dynamic LX voltage in 50ns duration -- IN+3V to GND-4V

Recommended Operating Conditions (Note 3)

EN, IN, MODE, FB pins -- 2.5V to 5.5V
LX pin --- 2.5V to 6V
Junction Temperature Range -- -40℃ to 125℃
Ambient Temperature Range -- -40℃ to 85℃

Block Diagram



Electrical Characteristics

(V_{IN} = 3.6V, V_{OUT} = 2.5V, L = 2.2uH, C_{OUT} = 10uF, T_A = 25 ℃, I_{MAX} = 1A unless otherwise specified)

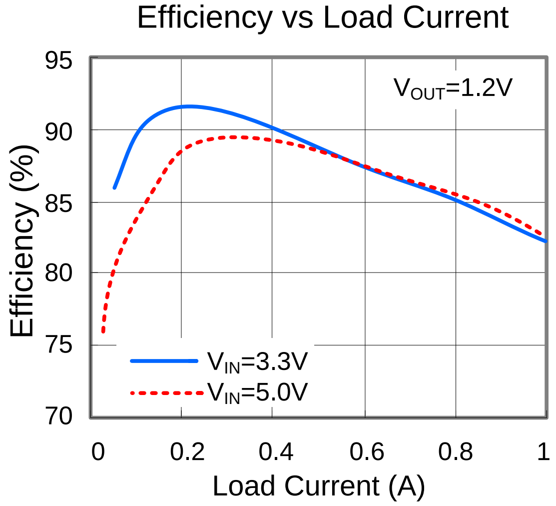
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		5.5	V
Quiescent Current	I_Q	I_{OUT}=0, V_{FB}=V_{REF} × 105%		50		μA
Shutdown Current	I_{SHDN}	EN=0		0.1	1	μA
Feedback Reference Voltage	V_{REF}		0.591	0.6	0.609	V
FB Input Current	I_{FB}	V_{FB}=V_{IN}	-50		50	nA
PFET RON	$R_{DS(ON),P}$	SY20306		200		mΩ
		SY20306H		180		mΩ
NFET RON	$R_{DS(ON),N}$	SY20306		150		mΩ
		SY20306H		120		mΩ
PFET Current Limit	I_{SW}	SY20306	1.4			A
		SY20306H	2			A
EN Rising Threshold	V_{ENH}		1.5			V
EN Falling Threshold	V_{ENL}				0.4	V
Input UVLO Threshold	V_{UVLO}				2.5	V
UVLO Hysteresis	V_{HYS}			0.1		V
Oscillator Frequency	F_{OSC}	I_{OUT}=100mA		1.5		MHz
Min ON Time				50		ns
Max Duty Cycle			100			%
Thermal Shutdown Temperature	T_{SD}			150		℃

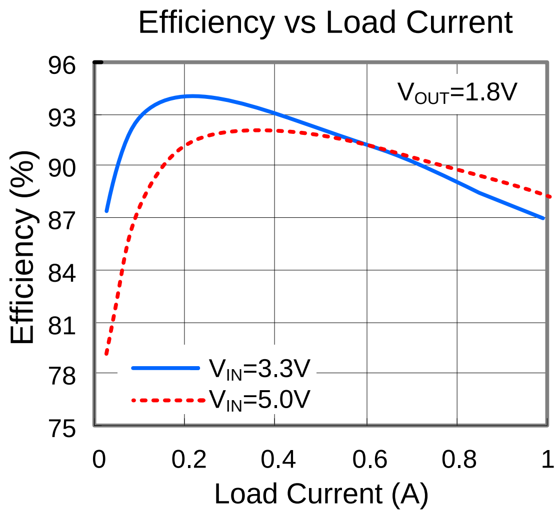
Note 1: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

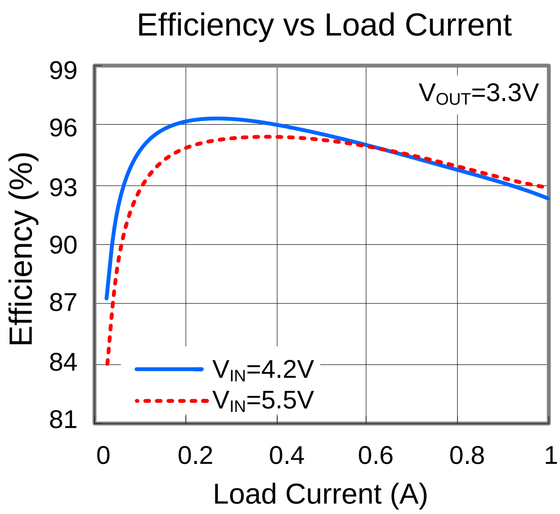
Note 2: θJA is measured in the natural convection at TA = 25 ℃ on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Paddle of DFN3x3-12 package is the case position for qJC measurement.

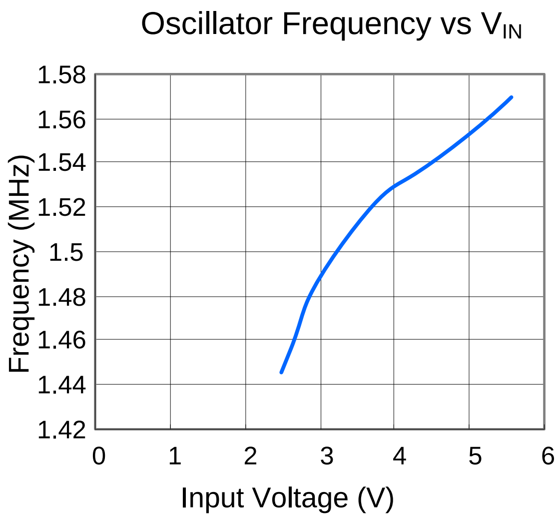
Note 3: The device is not guaranteed to function outside its operating conditions

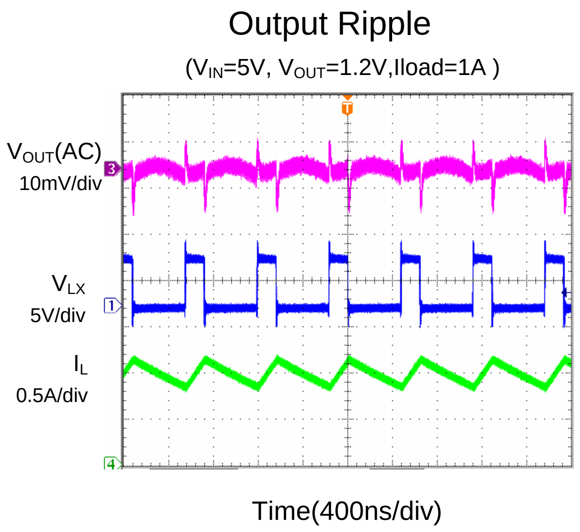
Typical Performance Characteristics（SY20306）

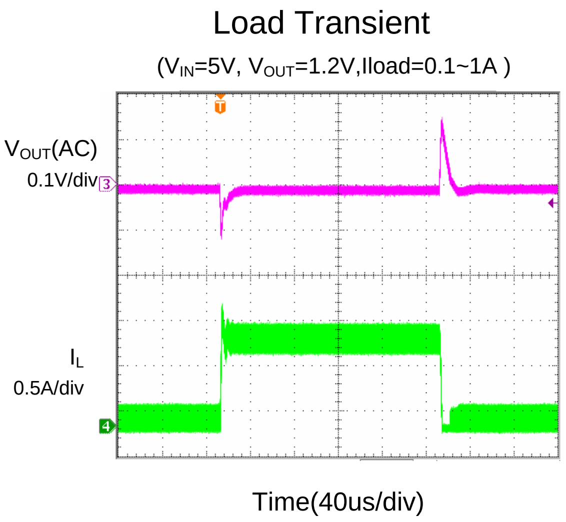






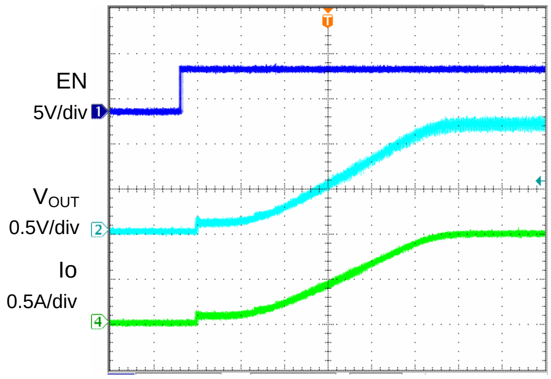






Startup

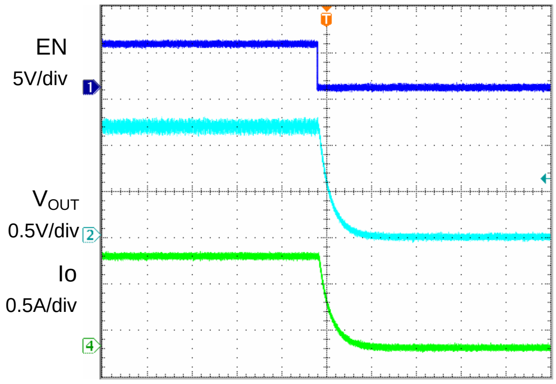
(V_{IN}=5V, V_{OUT}=1.2V,Iload=1A)



Time(200us/div)

Shutdown

(V_{IN}=5V, V_{OUT}=1.2V,Iload=1A)



Time(40us/div)

Operation

SY20306 is a synchronous buck regulator IC that integrates the PWM control, top and bottom switches on the same die to minimize the switching transition loss and conduction loss. With ultra low Rdson power switches and proprietary PWM control, this regulator IC can achieve the highest efficiency and the highest switch frequency simultaneously to minimize the external inductor and capacitor size, and thus achieving the minimum solution footprint.

Applications Information

Because of the high integration in the SY20306 IC, the application circuit based on this regulator IC is rather simple. Only input capacitor CIN, output capacitor COUT, output inductor L and feedback resistors (R1 and R2) need to be selected for the targeted applications specifications.

Feedback resistor dividers R1 and R2:

Choose R1 and R2 to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both R1 and R2. A value of between 100k and 1M is highly recommended for both resistors. If R2=120k is chosen, then R2 can be calculated to be:

$$R1 = \frac{(V_{OUT} - 0.6V)\cdot(R2)}{0.6V}$$

Input capacitor CIN:

SY20306 is a co-package IC integrated with two dies. It is strongly recommended to decouple IN1 to GND paddle with at least 10uF ceramic cap and decouple IN2 to GND paddle with at least 10uF ceramic cap. Place these ceramic capacitors really close to IN1 and GND pins, IN2 to GND pins to minimize the potential noise problem. Care should be taken to minimize the loop area formed by CIN, and IN/GND pins.

Output capacitor COUT:

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. For the best performance, it is recommended to use X7R or better grade ceramic capacitor with 6V rating and greater than 4.7uF capacitance.

Output inductor L:

There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{F_{SW} \times I_{OUT,MAX} \times 40\%}$$

where Fsw is the switching frequency and Iout,max is the maximum load current.

The SY20306 regulator IC is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{2 \cdot F_{SW} \cdot L}$$

3) The DCR of the inductor and the core loss at the switching frequency must be low enough to achieve the desired efficiency requirement. It is desirable to choose an inductor with DCR<50mohm to achieve a good overall efficiency.

Load Transient Considerations:

The SY20306 regulator IC integrates the compensation components to achieve good stability and fast transient responses. In some applications, adding a 22pF ceramic cap in parallel with R1 may further speed up the load transient responses and is thus recommended for applications with large load transient step requirements.

Layout Design:

The layout design of SY20306 regulator is relatively simple. For the best efficiency and minimum noise problems, we should place the following components close to the IC: CIN, L, R_H and R_L.

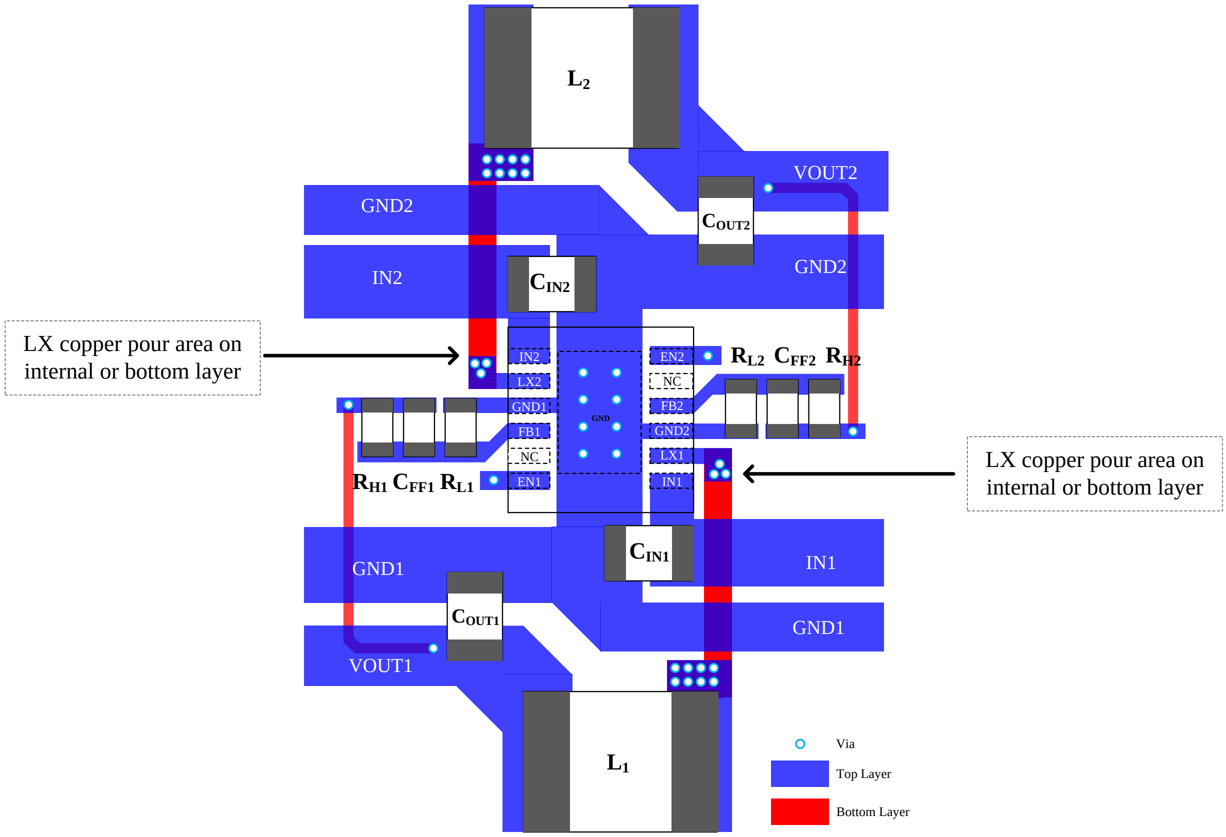
1) It is desirable to maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable. Reasonable vias are suggested to be placed underneath the ground pad to enhance the soldering quality and thermal performance.

2) It is strongly recommended to decouple IN1 to GND paddle with at least 10uF ceramic cap and decouple IN2 to GND paddle with at least 10uF ceramic cap. Place this ceramic capacitor really close to IN1 and GND pins, IN2 to GND pins to minimize the potential noise problem. The loop area formed by CIN and GND must be minimized.

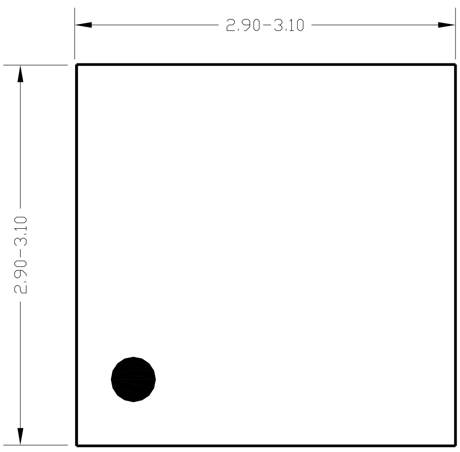
3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem. For the smallest loop area of CIN, IN and GND, LX pin copper can pour area on internal or bottom layer.

4) The components R_H and R_L, and the trace connecting to the FB pin must NOT be adjacent to the LX net on the PCB layout to avoid the noise problem.

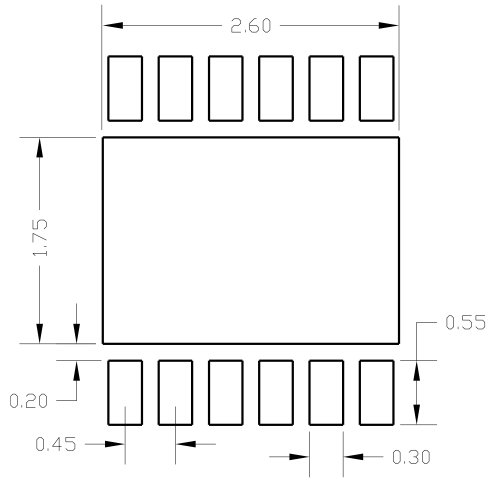
5) If the system chip interfacing with the EN pin has a high impedance state at shutdown mode and the IN pin is connected directly to a power source such as a LiIon battery, it is desirable to add a pull down 1Mohm resistor between the EN and GND pins to prevent the noise from falsely turning on the regulator at shutdown mode.



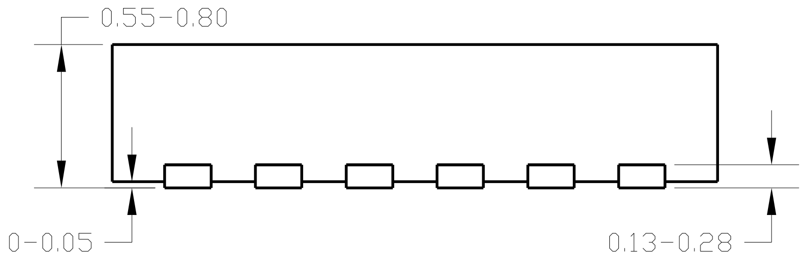
DFN3x3-12 Package outline



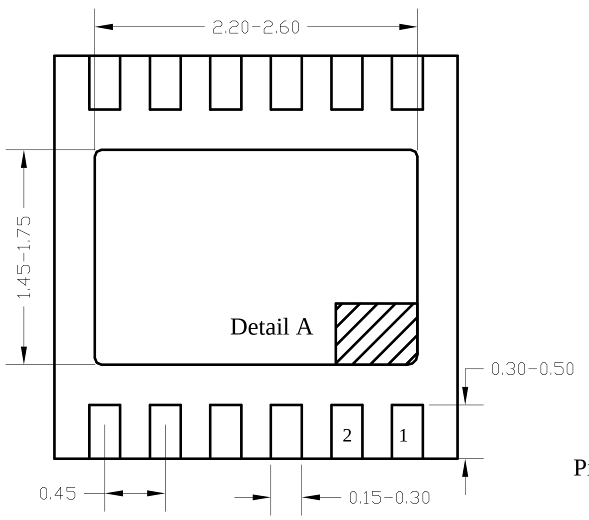
Top View

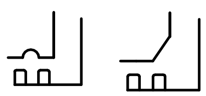


PCB layout (Recommended)



Side View





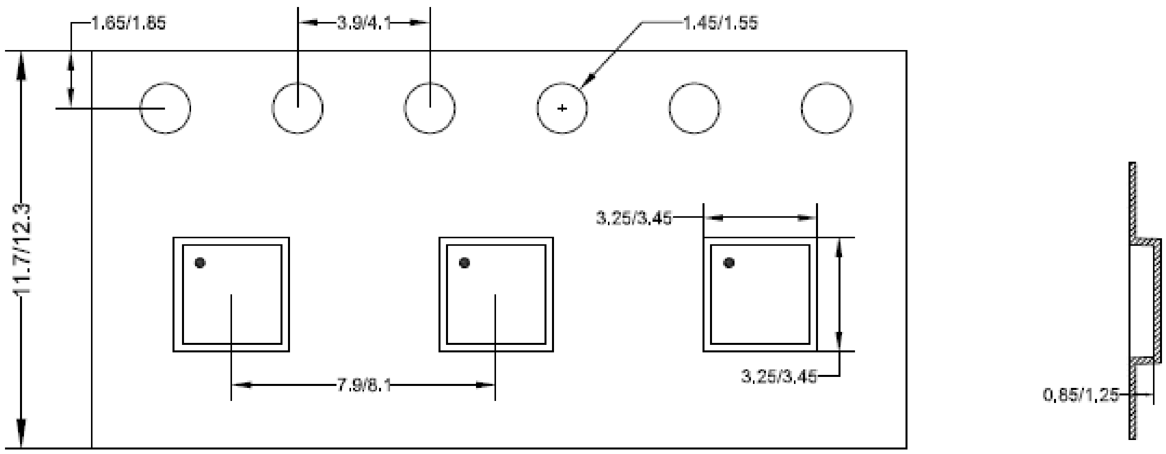
Detail A
Pin1 identifier: two options

Bottom View

Notes: All dimensions are in millimeters and exclude mold flash & metal burr.

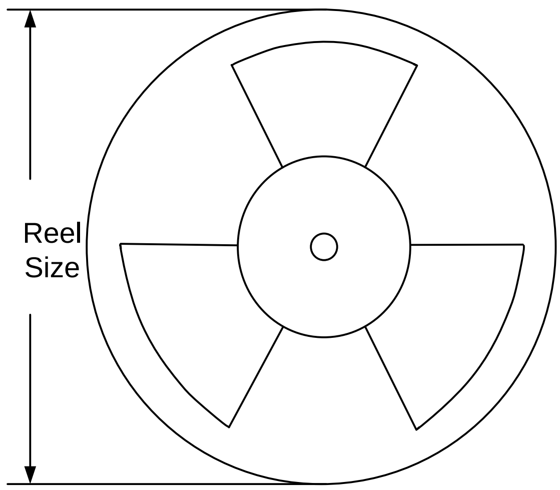
Taping & Reel Specification

1. DFN3x3 taping orientation



Feeding direction →

2. Carrier Tape & Reel specification for packages



Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel (pcs)
DFN3x3	12	8	13"	400	400	5000

3. Others: NA

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