SY20334

High Efficiency 1.5MHz, Dual 3A Synchronous Step Down Regulator

General Description

The SY20334 is a dual-output, high-efficiency 1.5MHz synchronous step-down DC-DC IC capable of delivering up to 3A output current per output respectively. The SY20334 operates over a wide input voltage range from 2.7V to 5.5V and integrates 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): 105/85mΩ
- 2.7-5.5V input voltage range
- 1.5MHz switching frequency minimizes the external components
- Internal soft-start limits the inrush current
- 100% dropout operation
- RoHS Compliant and Halogen Free
- Compact and thermally enhanced package: DFN3x3-12

Ordering Information

SY20334□(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package type	Note
SY20334DCC	DFN3x3-12	3A

Applications

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

Typical Applications

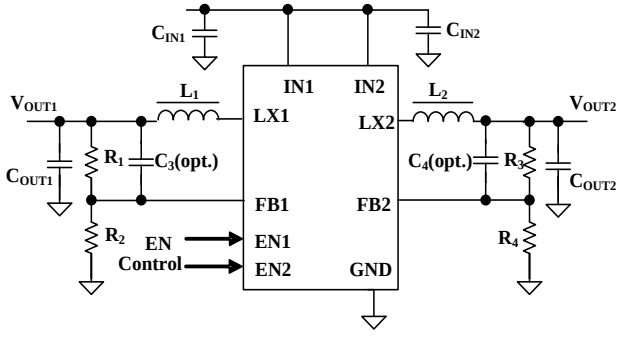


Figure 1. Schematic diagram

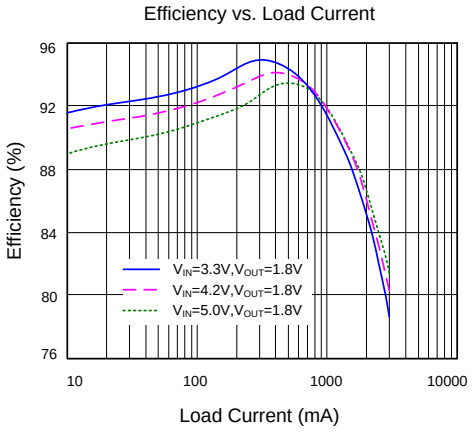
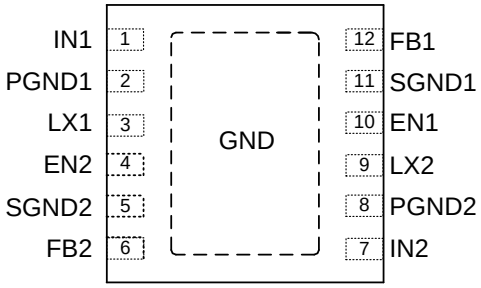


Figure2. Efficiency vs. Load Current

Pinout (Top View)



Top Mark: **TZ*xyz*** **(**Device code: **TZ**; ***x=year code, y=week code, z= lot number code***)

Pin Name	DFN3x3-12	Pin Description
EN1,2	10,4	Enable controls. Pull high to turn on. Do not float.
PGND1,2	2,8, exposed paddle	Power ground pins.
LX1,2	3,9	Inductor pins. Connect this pin to the switching node of inductor
IN1,2	1,7	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	12,6	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.
SGND1,2	11,5	Signal ground pins.

Absolute Maximum Ratings (Note 1)

Supply Input Voltage ---------- 6V
All Other Pins ---------- V_{IN} + 0.6V
Power Dissipation, P_D @ T_A = 25°C, DFN3x3 ----------1.6 W
Package Thermal Resistance (Note 2)
DFN3x3, θ_{JA} ---------- 60° C/W
DFN3x3, θ_{JC} ---------- 8° C/W
Junction Temperature Range ---------- 150°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C to 150°C

Recommended Operating Conditions (Note 3)

EN, IN, MODE, FB pins ----------2.7V to 5.5V
LX pin ----------2.5V to 6V
Junction Temperature Range ---------- -40°C to 125°C
Ambient Temperature Range ----------40°C to 85°C

Electrical Characteristics

(V_{IN} = 3.6V, V_{OUT} = 2.5V, L = 2.2uH, C_{OUT} = 10uF, T_A = 25°C, I_{MAX} = 3A unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.7		5.5	V
Quiescent Current	I_Q	I_{OUT}=0, V_{FB}=V_{REF}×105%		55		μA
Shutdown Current	I_{SHDN}	EN=0		0.1	1	μA
Feedback Reference Voltage	V_{REF}		0.588	0.6	0.612	V
PFET RON	$R_{DS(ON),P}$			105		mΩ
NFET RON	$R_{DS(ON),N}$			85		mΩ
PFET Current Limit	I_{SW}		3.5			A
EN Rising Threshold	V_{ENH}		1.5			V
EN Falling Threshold	V_{ENL}				0.4	V
Input UVLO threshold	V_{UVLO}				2.65	V
UVLO Hysteresis	V_{HYS}			0.2		V
Oscillator Frequency	F_{OSC}	I_{OUT}=100mA		1.5		MHz
Min ON Time				75		ns
Max Duty Cycle			100			%
Output Discharge Switch On Resistance	R_{DISCH}			50		Ω
Soft start time	T_{SS}			1		ms
Thermal Shutdown Temperature	T_{SD}			150		°C

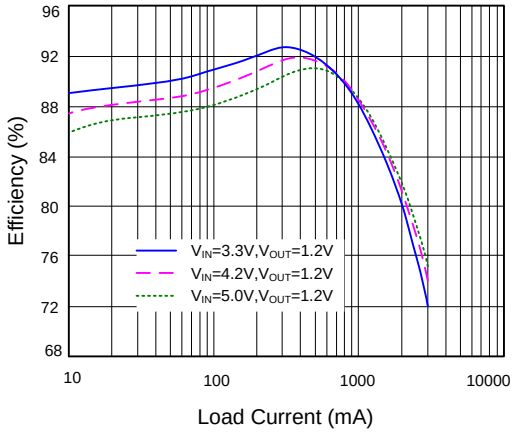
Note 1: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute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

Note 2: θJA is measured in the natural convection at TA = 25°C 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.

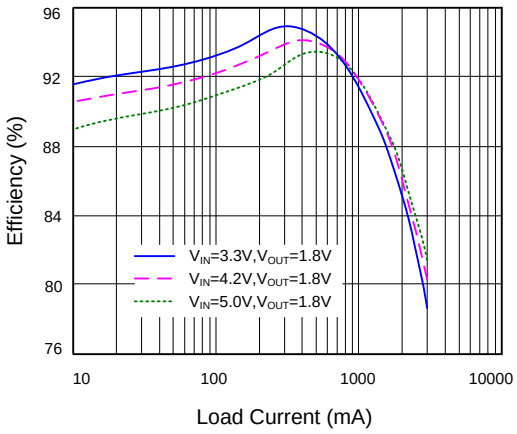
Note 3. The device is not guaranteed to function outside its operating conditions

Typical Performance Characteristics

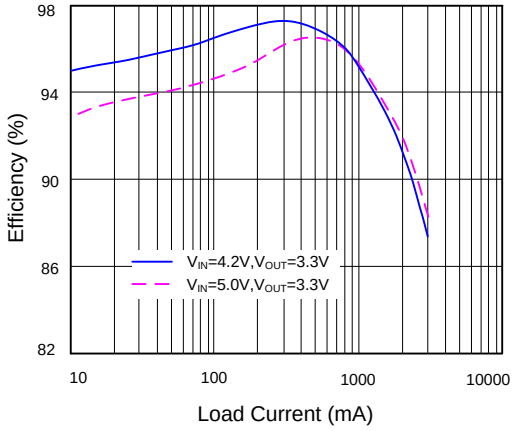
Efficiency vs. Load Current



Efficiency vs. Load Current

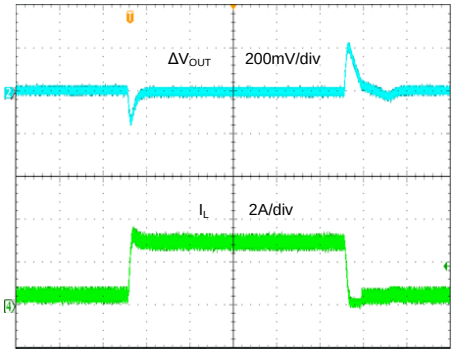


Efficiency vs. Load Current



Load Transient

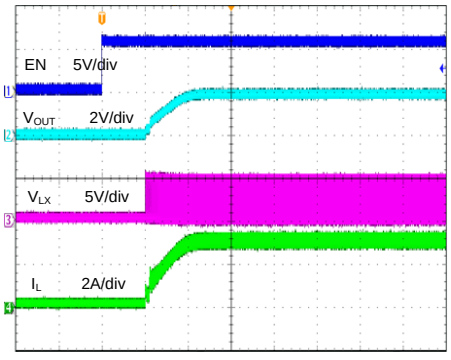
(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=0.3 ~ 3.0A)



Time (40μs/div)

Startup from Enable

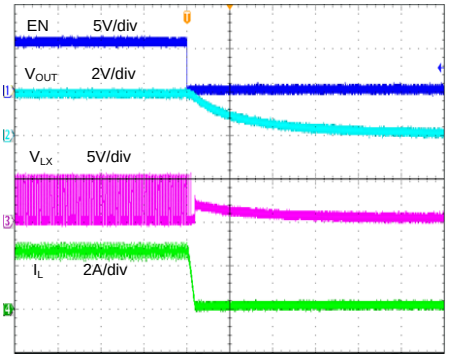
(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=3.0A)



Time (800μs/div)

Shutdown from Enable

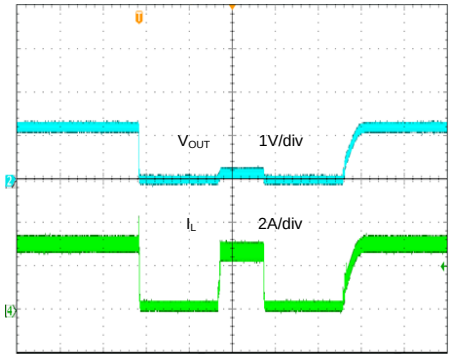
(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=3.0A)



Time (20μs/div)

Short Circuit Protection

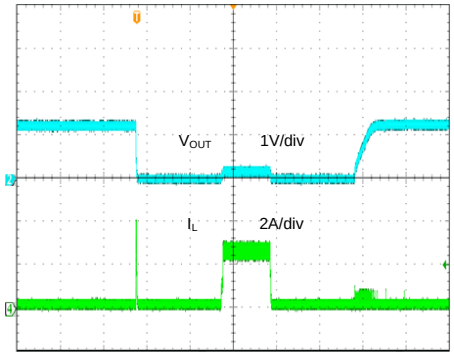
(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=3.0A ~ short)



Time (2ms/div)

Short Circuit Protection

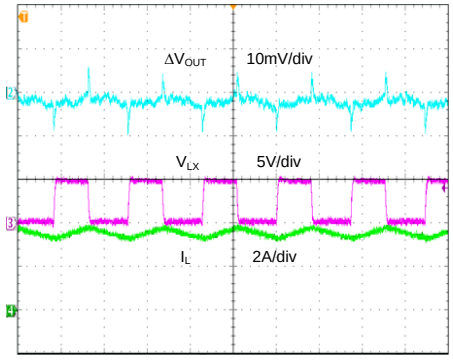
(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=0A ~ short)



Time (2ms/div)

Output Ripple

(V_{IN}=5.0V, V_{OUT}=1.8V, I_O=3.0A)



Time (400ns/div)

Operation

SY20334 is a synchronous buck regulator IC that integrates the PWM control, top and bottom switches on the same die to minimize the switching loss and conduction loss. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the highest efficiency and the highest switching 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 SY20334 IC, the application circuit based on this regulator IC is simple. Only input capacitor C_{IN}, output capacitor C_{OUT}, output inductor L and feedback resistors (R_1 and R_2) need to be selected for the targeted applications specifications.

Short Circuit Protection

After the soft start is over, if the output voltage falls below 40% of the regulation level. The frequency is folded back to about 30% of the nominal frequency and the current limit is folded back to 3.0A to prevent the inductor current from runaway and to reduce the power dissipation of the IC under short circuit conditions.

Feedback resistor dividers R_1 and R_2:

Choose R_1 and R_2 to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both R_1 and R_2. A value of between 10k and 1M is recommended for both resistors. If R_2=120kΩ is chosen, then R_1 can be calculated to be:

$$R_1 = \frac{(V_{OUT} - 0.6V) \times R_2}{0.6V}$$

Input capacitor C_{IN}:

The ripple current through input capacitor is calculated as:

$$I_{CIN\_RMS} = I_{OUT} \cdot \sqrt{D(1-D)}$$

SY20334 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 C_{IN}, and IN/GND pins.

Output capacitor C_{OUT}:

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 greater than 40uF 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 $I_{OUT,MAX}$ is the maximum load current.

The SY20334 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<20mΩ to achieve a good overall efficiency.

Load Transient Considerations:

The SY20334 regulator IC integrates the compensation components to achieve good stability and fast transient responses. In some applications, adding a 22pF~100pF ceramic capacitor in parallel with R_1 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 SY20334 regulator is relatively simple. For the best efficiency and minimum noise problems, we should place the following components close to the IC: C_{IN}, 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.

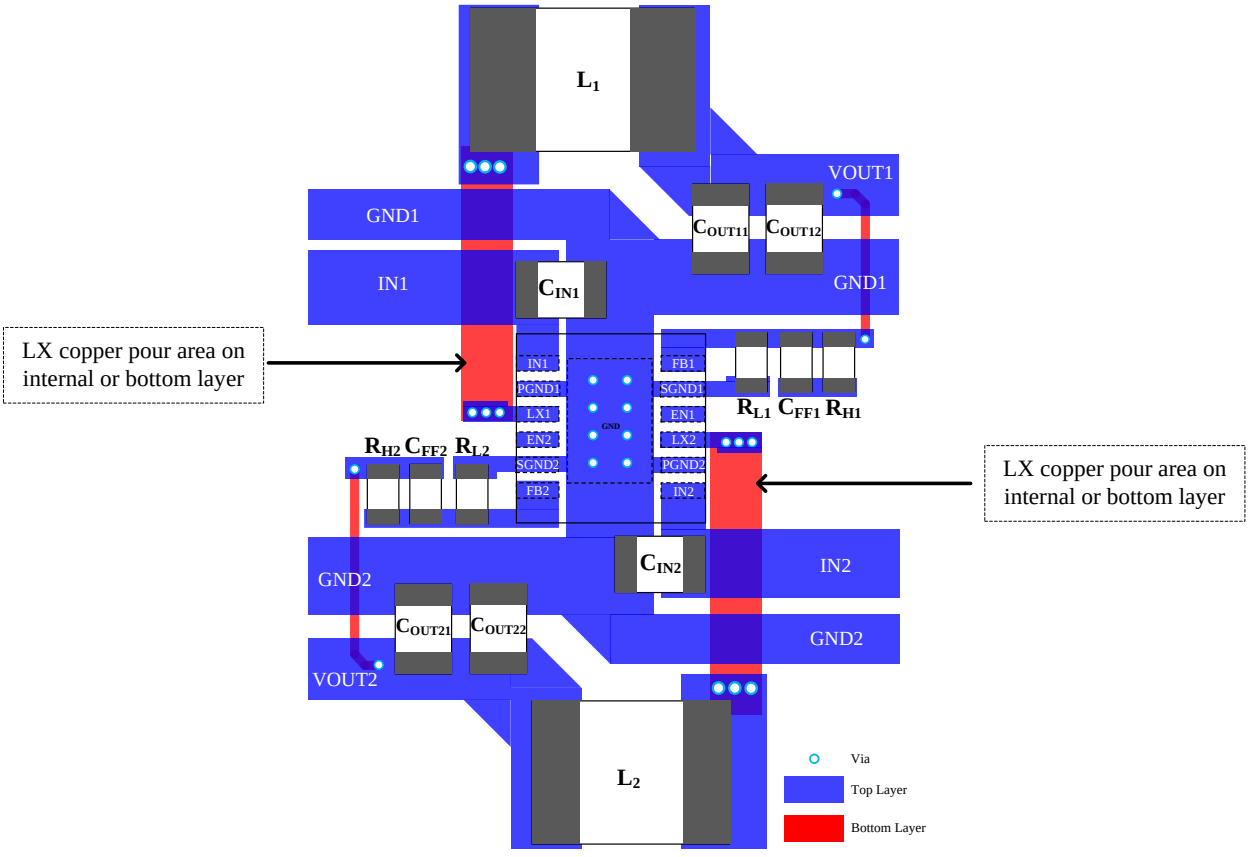
2) It is strongly recommended to decouple IN1 to GND paddle with at least 10uF ceramic cap and decouple IN2 to GND paddle with at least 10uF ceramic cap. Place these ceramic capacitors really close to IN1 and GND pins, IN2 to GND pins to minimize the potential noise problem. The loop area formed by CIN 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 C_{IN}, IN and GND, LX pin copper can pour area on internal or bottom layer.

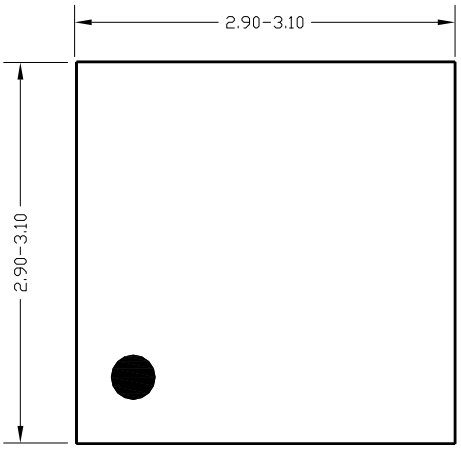
4) The components R_H and R_L, and the trace connecting to the FB pin must NOT be adjacent to the LX net on the PCB layout to avoid the noise problem.

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.

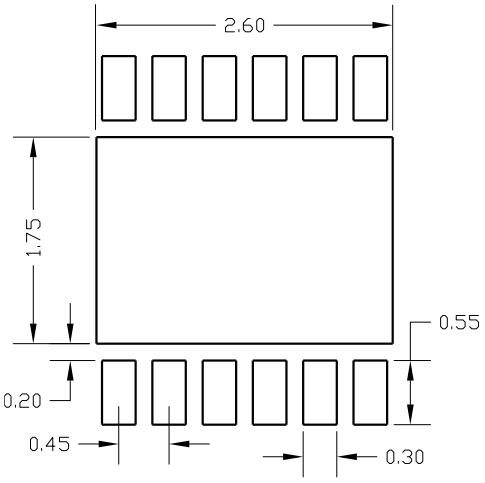
PCB Layout Suggestion



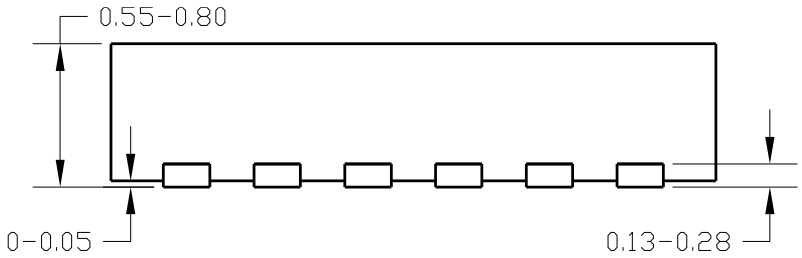
DFN3x3-12 Package outline



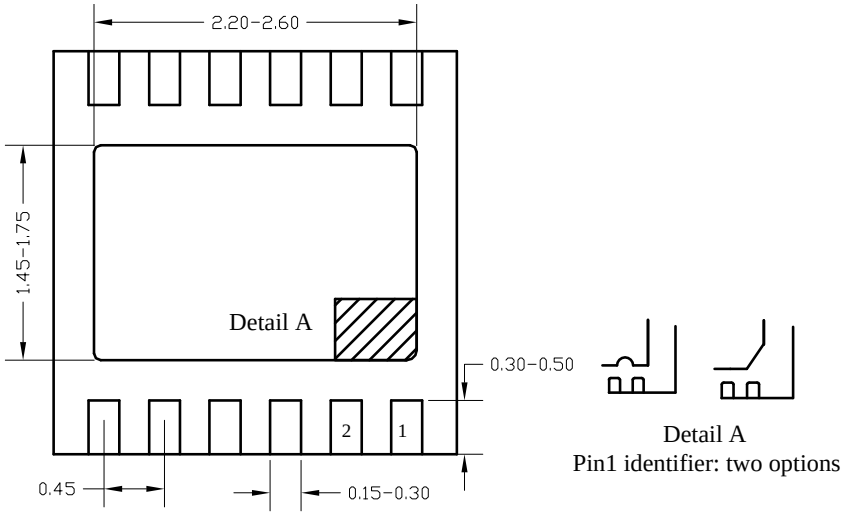
Top View



PCB layout (Recommended)



Side View



Bottom View

Detail A
Pin1 identifier: two options

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

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