SY20906

High Efficiency, 1.0MHz, 6A Synchronous Step Down Regulator

General Description

The SY20906 is a high efficiency 1.0MHz synchronous step down DC/DC regulator which is capable of delivering up to 6A output current. It can operate over a wide input voltage range from 2.5V to 6V and integrate main switch and synchronous switch with very low $R_{DS\ (ON)}$ to minimize the conduction loss.

Ordering Information

SY20906 □(□□)□
└ Temperature Code
Package Code
Optional Spec Code

Ordering Number	Package type	Note
SY20906SYC	DFN2×2-7	--

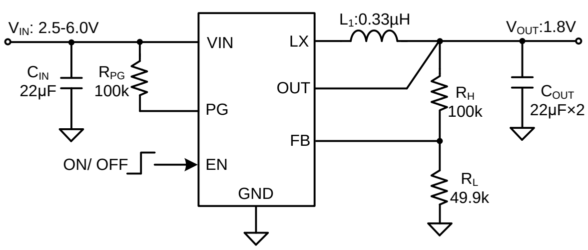
Features

- 2.5~6.0V Input Voltage Range
- 23μA Low Quiescent Current
- Low $R_{DS(ON)}$ for Internal Switches (Top/Bottom) 22mΩ /12mΩ
- Instant PWM Control Achieve Ultra Fast Dynamic Response
- 1.0MHz Switching Frequency Minimizes the External Components
- Internal Soft-start Limits the Inrush Current
- 100% Drop Out Operation
- Output Auto Discharge Function
- Hic-cup Mode for Short Circuit Protection
- RoHS Compliant and Halogen Free
- Compact Package: DFN2×2-7

Applications

- Set Top Box
- USB Dongle
- Media Player
- Smart Phone

Typical Applications



Inductor and C_{OUT} Selection Table

V_{OUT} [V]	L [μH]	C_{OUT} [μF]		
		22	22×2	22×3
1.2	0.33		☆	√
1.8	0.33		☆	√
3.3	0.47		☆	√

Note: '☆' means recommended for most applications.

Figure1. Schematic Diagram

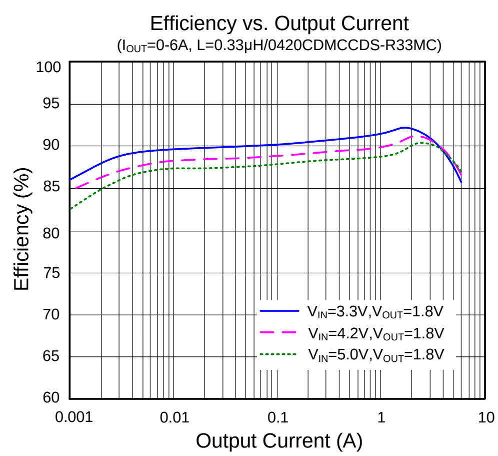
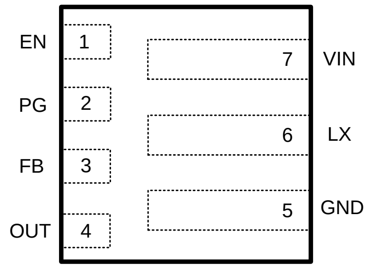


Figure2. Efficiency vs. Output Current

Pinout (Top View)



(DFN2×2-7)

Top Mark: Y9*xyz* (device code: Y9, ***x=year code, y=week code, z= lot number code)***

Pin Name	Pin Number	Pin Description
EN	1	Enable control. Pull high to turn on.
PG	2	Power good indicator.
FB	3	Output feedback pin. Connect this pin to the center point of the output resistor divider (as shown in Figure 1) to program the output voltage: $V_{OUT}=0.6\times(1+R_H/R_L)$.
OUT	4	Output voltage feedback pin, connect to the output capacitor side.
GND	5	Ground pin.
LX	6	Inductor pin. Connect this pin to the switching node of the inductor.
IN	7	Input pin. Decouple this pin to the GND pin with at least a 22µF ceramic capacitor.

Absolute Maximum Ratings (Note 1)

Supply Input Voltage -- -0.3V to 7.0V
EN, PG, FB, OUT-- -0.3V to V_{IN} + 0.3V
LX Voltage-- -0.3V (*1) to 6.5V (*2)
Power Discipation, P_D @ T_A = 25°C,
DFN2×2-7 -- 2.86W
Package Thermal Resistance (Note 2)
θ_{JA} -- 35°C/W
θ_{JC} -- 10°C/W
Junction Temperature Range --- -40°C~150°C
Lead Temperature (Soldering, 10 sec.) -- 260°C
Storage Temperature Range -- -65°C to 150°C

(*1) LX Voltage Tested Down to -3V <20ns
(*2) LX Voltage Tested Up to +7.5V <20ns

Recommended Operating Conditions (Note 3)

Supply Input Voltage -- 2.5V to 6.0V
Junction Temperature Range -- -40°C to 125°C
Ambient Temperature Range --- -40°C to 85°C

Electrical Characteristics

(V_{IN} = 3.6V, V_{OUT}=1.8V, L=0.33µH, C_{OUT}=22µF×2, T_A=25°C, I_{OUT}=1A, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		6.0	V
Input UVLO Falling Threshold	$V_{UVLO, FALLING}$		2.1	2.2	2.3	V
Input UVLO Hysteresis	V_{HYS}			200		mV
Quiescent Current	I_Q	V_{FB}=105%×V_{REF}		23	35	µA
Shutdown Current	I_{SHDN}	V_{EN}=0		0.1	1	µA
Feedback Reference Voltage	V_{REF}	I_{OUT}=1A, CCM, T_J=-40°C ~125°C	0.591	0.6	0.609	V
Output Discharge Resistor	R_{DIS}			10		Ω
Top FET R_{ON}	$R_{DS(ON)1}$			22		mΩ
Bottom FET R_{ON}	$R_{DS(ON)2}$			12		mΩ
EN Input Voltage High	$V_{EN,H}$		1.0			V
EN Input Voltage Low	$V_{EN,L}$				0.4	V
EN Pull Down Resistance	R_{EN}			400		kΩ
Power Good Threshold	V_{PG}	V_{FB} falling, PG from high to low	85	88	91	%V_{REF}
		V_{FB} rising, PG from low to high	92	95	98	
Min ON Time	$t_{ON,MIN}$			50		ns
Maximum Duty Cycle	D_{MAX}		100			%
Soft-start Time	t_{SS}	From EN high to 95% of V_{OUT} nominal		0.8		ms
Switching Frequency	f_{SW}			1.0		MHz
Top FET Current Limit	$I_{LIM,TOP}$		7.5			A
Bottom FET Current Limit	$I_{LIM,BOT}$		6			A
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			20		°C

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

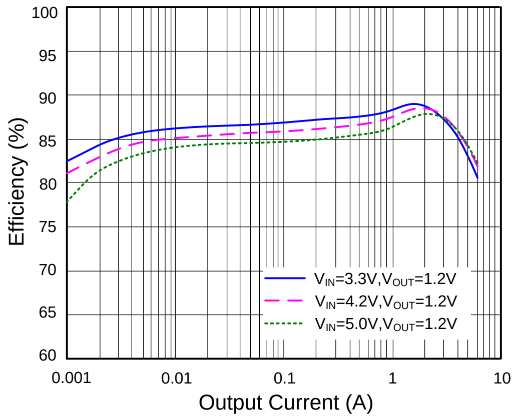
Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

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

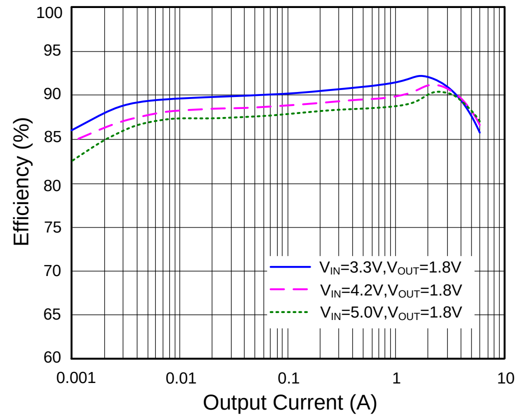
Typical Performance Characteristics

(T_A=25°C, V_{IN} = 5.0V, L=0.33µH, C_{OUT}=22µF×2, unless otherwise specified.)

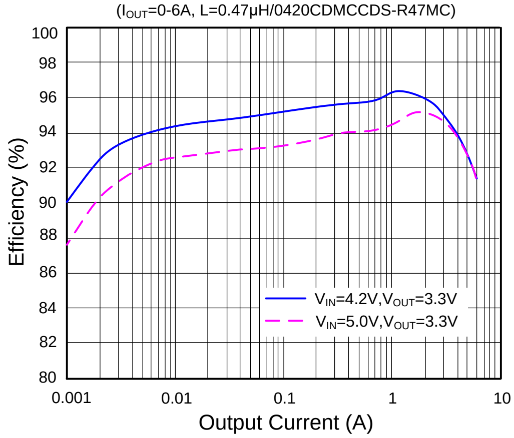
Efficiency vs. Output Current
(I_{OUT}=0-6A, L=0.33µH/0420CDMCCDS-R33MC)



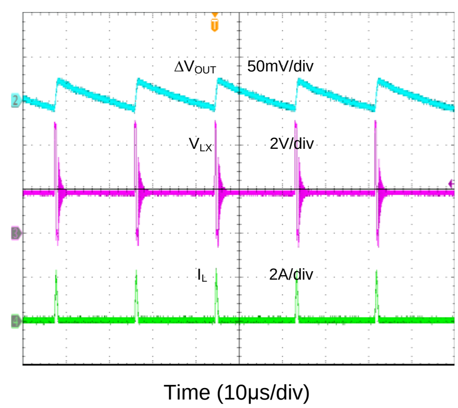
Efficiency vs. Output Current
(I_{OUT}=0-6A, L=0.33µH/0420CDMCCDS-R33MC)



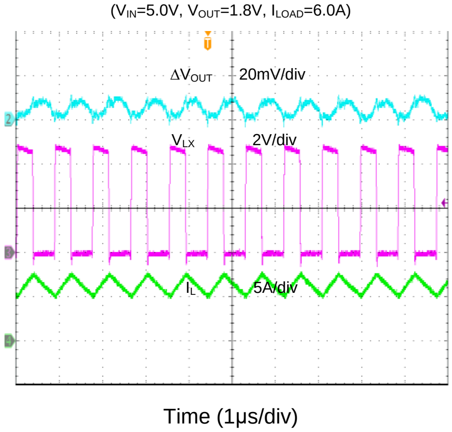
Efficiency vs. Output Current
(I_{OUT}=0-6A, L=0.47µH/0420CDMCCDS-R47MC)



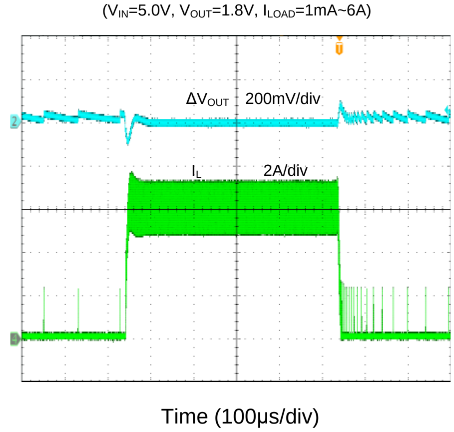
Output Ripple
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=50mA)



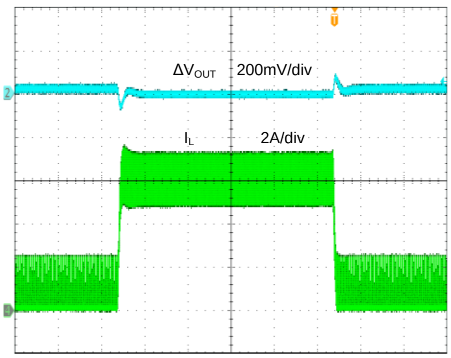
Output Ripple
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A)



Load Transient
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=1mA~6A)

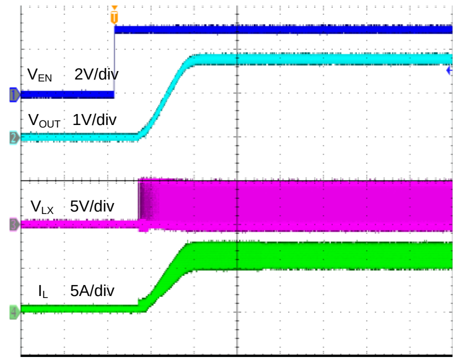


Load Transient
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=0.6A~6A)



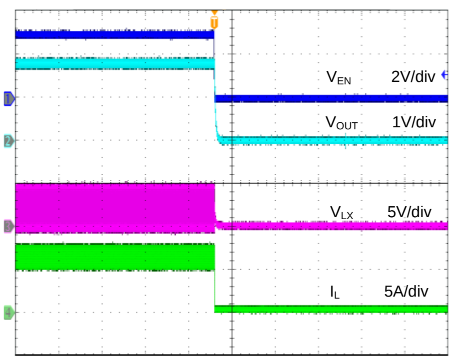
Time (100μs/div)

Startup from Enable
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A)



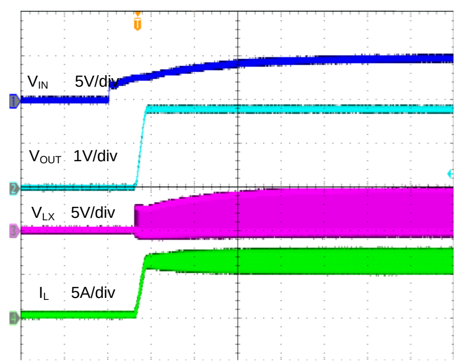
Time (400μs/div)

Shutdown from Enable
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A)



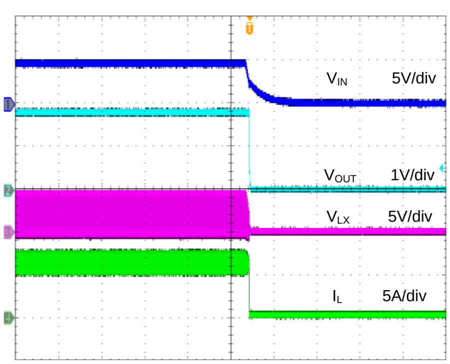
Time (400μs/div)

Startup from V_{IN}
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A)



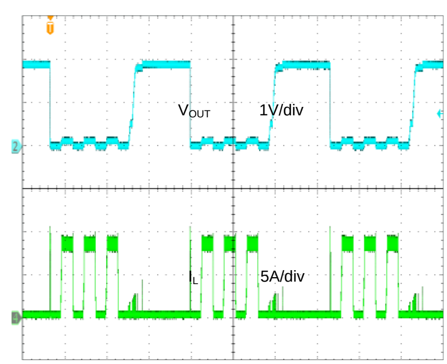
Time (2ms/div)

Shutdown from V_{IN}
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A)



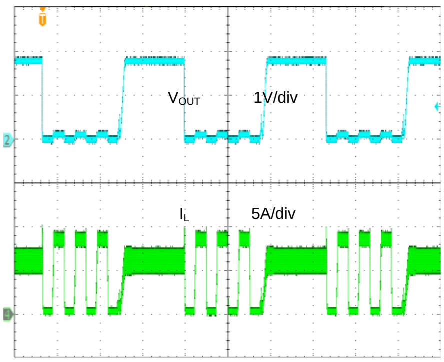
Time (2ms/div)

Short Circuit Protection
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=0A~Short)



Time (4ms/div)

Short Circuit Protection
(V_{IN}=5.0V, V_{OUT}=1.8V, I_{LOAD}=6.0A~Short)



Time (4ms/div)

Operation

The SY20906 is a high efficiency 1.0MHz synchronous step down DC/DC regulator which is capable of delivering up to 6A output currents. It can operate over a wide input voltage range from 2.5V to 6V and integrate main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss.

Low output voltage ripple, small external inductor and capacitor sizes are achieved with 1.0MHz switching frequency.

Applications Information

Because of the high integration in the SY20906, the application circuit based on this regulator is rather simple. Only the input capacitor C_{IN}, the output capacitor C_{OUT}, the output inductor L and the feedback resistors (R_H and R_L) need to be selected for the targeted application specifications.

Feedback Resistor Dividers R_H and R_L

Choose R_H and R_L 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_H and R_L. A value of between 10kΩ and 1MΩ is highly recommended for both resistors. If R_L =120kΩ is chosen, then R_H can be calculated to be:

$$R_H = \frac{(V_{OUT} - 0.6V) \times R_L}{0.6V}$$

Input Capacitor C_{IN}

A typical X5R or better grade ceramic capacitor with 10V rating and no less than 10uF capacitance is recommended. To minimize the potential noise problem, we place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by C_{IN}, and IN/GND pins.

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 f_{SW} is the switching frequency and I_{OUT}, max is the maximum load current.

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

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

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<25mΩ to achieve a good overall efficiency.

Minimum Duty Cycle and Maximum Duty Cycle

In the COT architecture, there is no limitation for small duty cycles, since even at very low duty cycles, the switching frequency can be reduced as needed once the on-time is close to the minimum on time, to always ensure a proper operation.

The device can support 100% maximum duty cycle operation under -40℃ ~ 125℃ condition.

In PFM light load operation, when the duty cycle is up to maximum duty cycle limitation, the device will enter into CCM operation even though the load current is null.

Over Current Protection

With load current increasing, as soon as the high side power FET current gets higher than peak current limit threshold, the high side power FET will turn off and the low side power FET will keep turning on until low side power FET current decrease below the valley current limit threshold. If the load current continues to increase, the output voltage will drop.

Over Voltage Protection

If the DC output voltage is about 3% over the regulation level, both high side power FET and low side power FET will turn off and enter into stand-by mode.

Thermal Shutdown Protection

If the junction temperature of SY20906 is higher than the thermal shutdown temperature (typical 150℃), the IC will turn off both high side power FET and low side power FET, and then enters thermal shutdown protection mode. It will remain in this state until the junction temperature decreases below 130℃. After exiting this state, the IC auto retries to normal operation.

Layout Design

To achieve a higher efficiency and better noise immunity, following components should be placed close to the IC: C_{IN}, L and C_{OUT}.

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

2) The decoupling capacitor of V_{IN} must be placed close enough to the pins. The loop area formed by the capacitors and GND must be minimized.

3) The PCB copper area associated with the LX pin must be minimized to improve the noise immunity.

4) The resistor RFB should be placed near the FB pin.

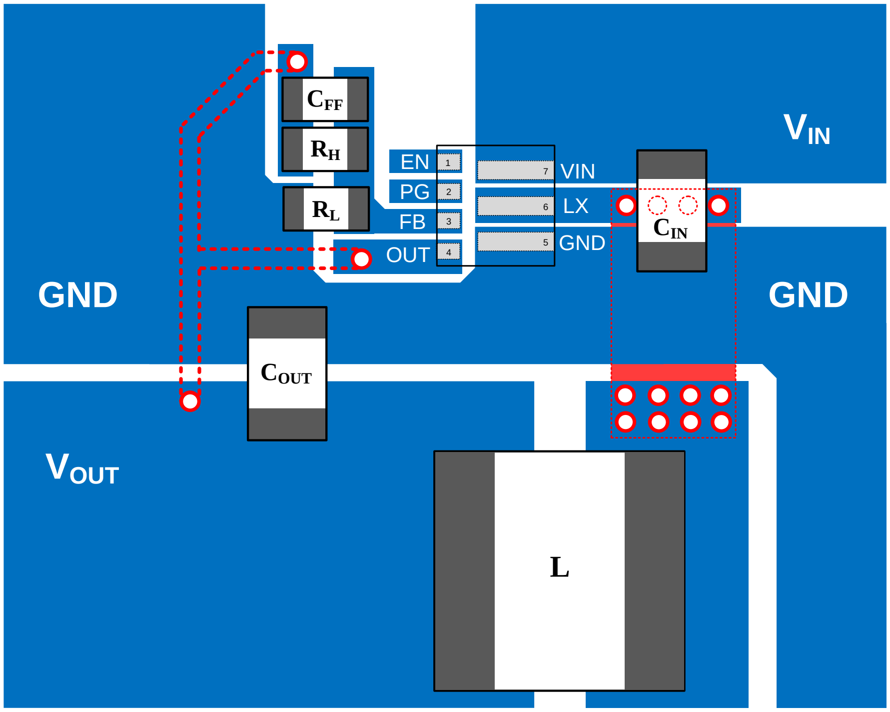
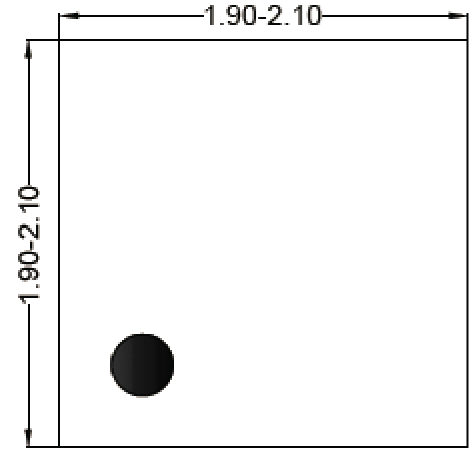
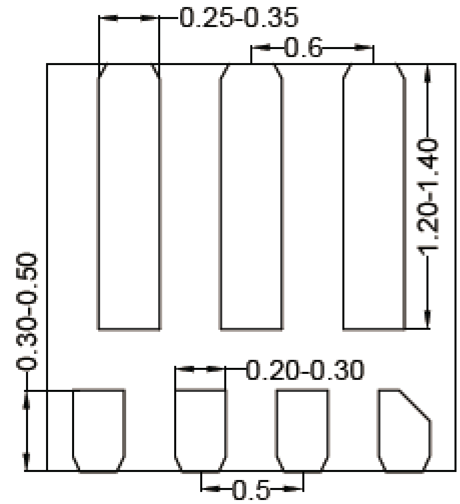


Figure3. PCB Layout Suggestion

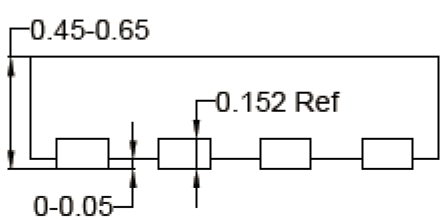
DFN2×2-7 Package Outline Drawing



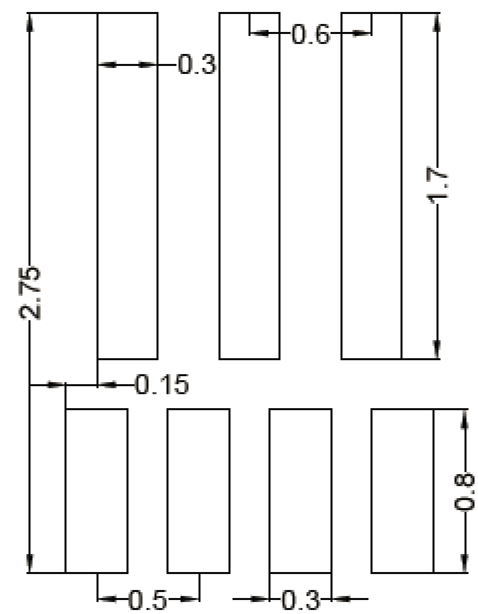
Top view



Bottom view



Front view

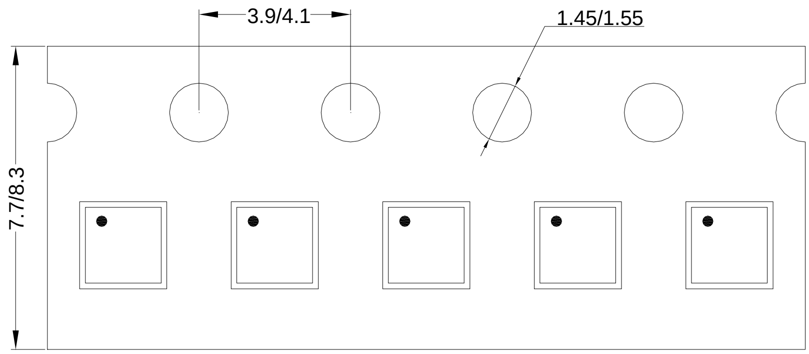


Recommended PCB layout (Reference only)

Notes: 1, All dimension in millimeter and exclude mold flash & metal burr;

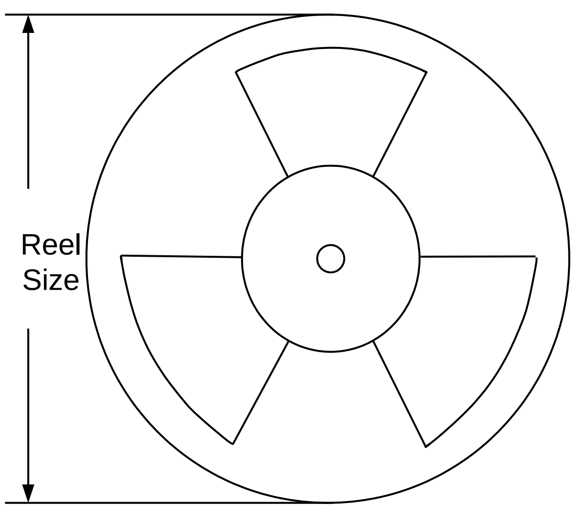
Taping & Reel Specification

1. DFN2×2



Feeding direction →

2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel
DFN2×2	8	4	7"	400	160	3000

3. Others: NA

Revision History

The revision history provided is for informational purpose only and is believed to be accurate, however, not warranted. Please make sure that you have the latest revision.

Date	Revision	Change
Dec.29, 2020	Revision 0.9	Initial Release

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