SY20623D

High Efficiency, 3 A , 2.5V- 6V Input Synchronous Step Down DC/DC converter

General Description

The SY20623D is a step-down module converter with built-in power MOSFETs and inductor. The SY20623D achieves 3A of continuous output current from a 2.5V to 6V input voltage with excellent load and line regulation. It provides accurate regulation for a variety of loads over Tj= -40°C to 125°C. The output voltage can be regulated as low as 0.6V. Only input capacitors, output capacitor and FB resistor divider are needed to complete the design.

The SY20623D adopts the instant PWM architecture to achieve fast transient responses for high step down applications. The device is also equipped with cycle-by-cycle current limit, hiccup over current protection and thermal shutdown protection.

Features

- Wide Input Voltage Range: 2.5V to 6V
- Capable of 3A constant output current
- High Output Voltage Accuracy Over Temperature Range (Ta -40°C to 105°C)
- Instant PWM architecture to achieve fast transient response
- FCCM under all Io Range
- Pseudo 2.4MHz switching frequency
- Internal Soft-start Limits the Inrush Current
- Reliable Protection Mode:
  Auto-retry Mode for UVP, UVLO and OTP.
  Hiccup Mode for OCP
- Power good indicator
- 100% dropout operation
- RoHS Compliant and Halogen Free
- Compact Package: 2.5×2×1.3 mm

Applications

- Smart Phone
- Telecom Applications
- Light Module

Typical Applications

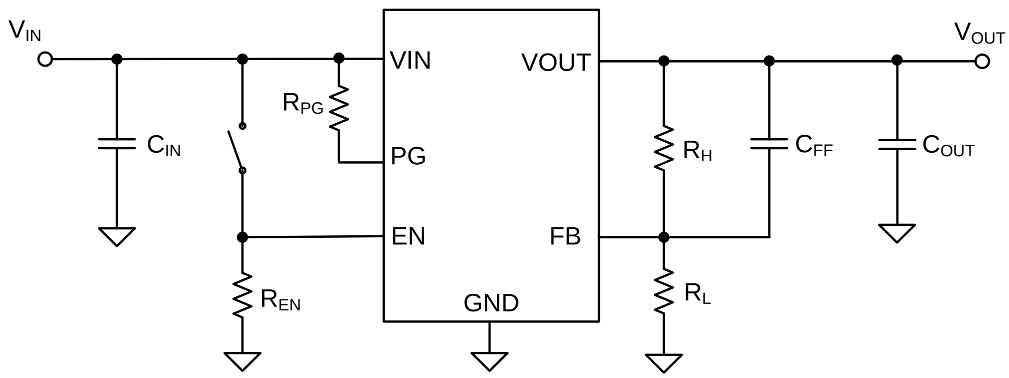


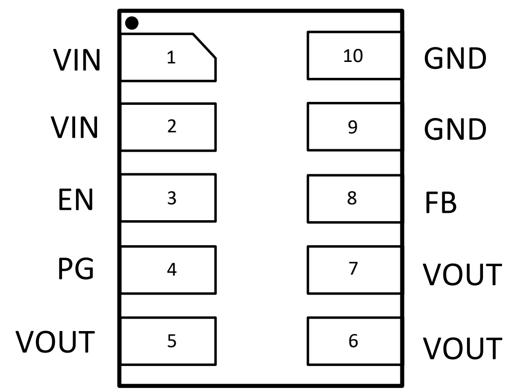
Figure 1. Schematic Diagram

Ordering Information

Ordering Part Number	Package type	Top Mark
SY20623DAFM	MDFN2.5×2-10 RoHS Compliant and Halogen Free	**a9***xyz*

***x*=year code, *y*=week code, *z*= lot number code**

Pinout (top view)



Pin Name	Pin Number	Pin Description
VIN	1,2	Input pin. Decouple this pin to GND pin with at least 20μF ceramic capacitor.
EN	3	Enable pin. Pull high to enable the device. Pull low to disable the device.
PG	4	Power good open drain output pin.
VOUT	5,6,7	Output voltage pin. Decouple this pin to GND pin with at least a 30μF ceramic capacitor.
FB	8	Output Feedback Pin. Connect this pin to the center point of the output resistor divider to program the output voltage: $V_{OUT}=0.6\times(1+R_H/R_L)$.
GND	9,10	Ground pin.

Block Diagram

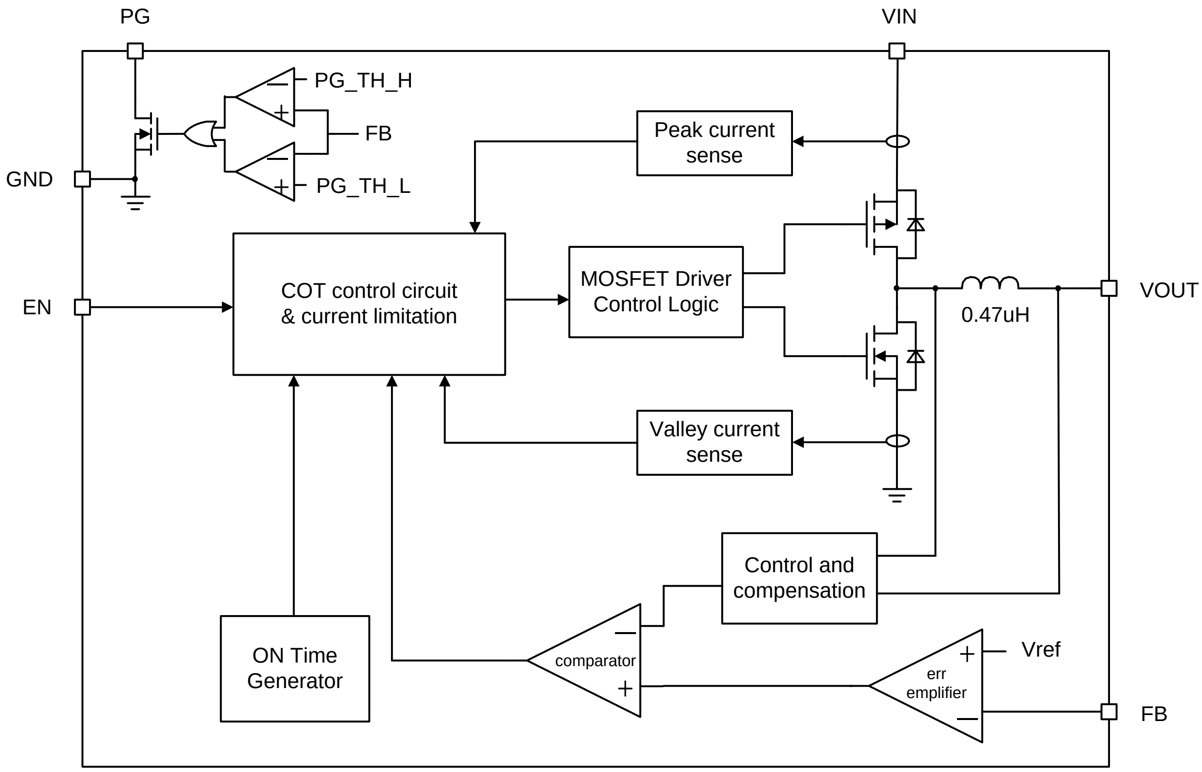


Figure 2. Block Diagram

Absolute Maximum Ratings(Note1)	**Min**	**Max**	**Unit**
IN	0.3	7	V
All Other Pins	-0.3	IN + 0.3	
Lead Temperature (Soldering, 10 sec.)		260	°C
Storage Temperature Range	-55	125	
Junction Temperature, Operating	−40	125	

Thermal Information (Note 2)	**Min**	**Max**	**Unit**
Package Thermal Resistance (Note 2)			
θ_{JA}		27	°C/W
Ψ_{JB}		18	
Power Dissipation ,P_D @T_A=25°C,MDFN		3. 7	W

Recommended Operating Conditions (Note 3)	**Min**	**Max**	**Unit**
IN	−0. 3	6	V
Output Voltage	0. 6	Vin	
Output Current Range	0	3	A
Junction Temperature Range	-40	125	°C

Electrical Characteristics

Electrical Characteristics V_{IN} = 3.3V, V_O =1.8V, I_O = 3A, C_O = 3*10μF, T_A = 25°C, FB divider resistor accuracy = 0.5%, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Specifications						
Input Voltage Range	V_{IN}		2.5		6	V
Input UVLO Threshold (falling)	$V_{UVLO,FALLING}$	EN=V_{IN}	2.1	2.2	2.3	V
Input UVLO Hysteresis	V_{HYS}			200		mV
Input Current with No Load	I_{IN}	I_O=0A	10	16	30	mA
Shutdown Current	I_{SHDN}			0.1	0.5	μA
Output Specifications						
Feedback Reference Voltage	V_{REF}	T_J=-40°C-125°C	0.594	0.6	0.606	V
Load Regulation	ΔV_{LDR}	T_A=25°C, I_O=0 to 3A			±1	%
Line Regulation	ΔV_{LNR}	V_{IN}=2.5-6V ,Io=3A			±0.5	%
Temperature Regulation	ΔT	T_A=-40°C to 105°C, I_O=3A			±2	%
Bottom FET Valley Current Limit	$I_{LIM,BOT}$			5		A
Rise Time	t_{RISE}	From EN high to 95% of VOUT nominal	0	0.3	1	ms
General Specifications						
Switching Frequency	f_{SW}		1.92	2.4	2.88	MHz
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis	T_{HYS}			20		°C
Maximum Duty Cycle (Note 4)	D_{MAX}		100			%
Min On Time	$t_{ON,MIN}$			50		ns
Signal Specifications						
EN Pin Logic High Threshold (rising)	V_{EN}		1.0			V
EN Hysteresis	$V_{EN,HYS}$			0.6		V
EN Pull-down Resistance	R_{EN}	EN Low	300	400	500	kΩ
Power Good Asserts Threshold	$V_{PG,ASSERTS}$	VOUT rising	93.5	95	97.5	%
		VOUT falling	86	88	91	%

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.

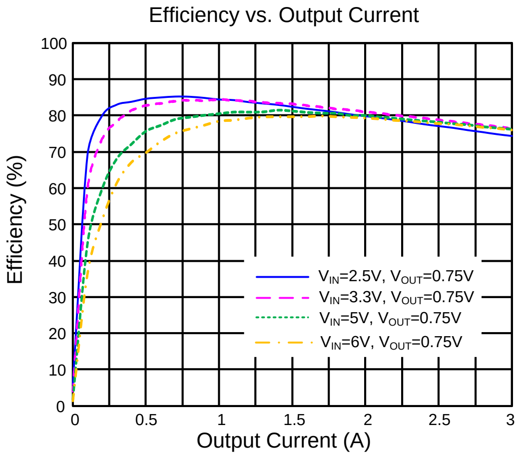
Note 2:θ_{JA} and Ψ_{JB} are based on a four-layer Silergy Evaluation Board in the natural convection at TA = 25°C. Board temperature refers to the PCB point to the hottest IC pin with a 1mm distance on the same PCB surface layer.

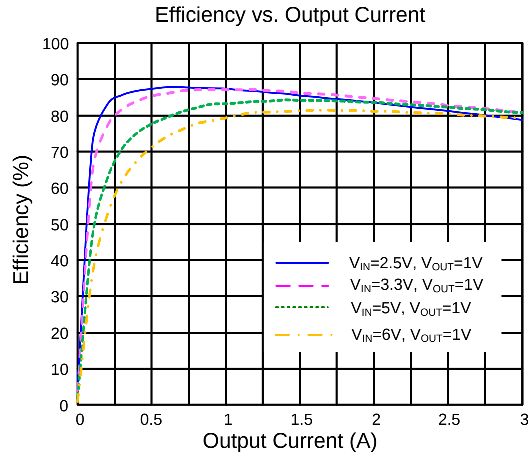
Note 3: The device is not guaranteed to function outside its operating conditions.

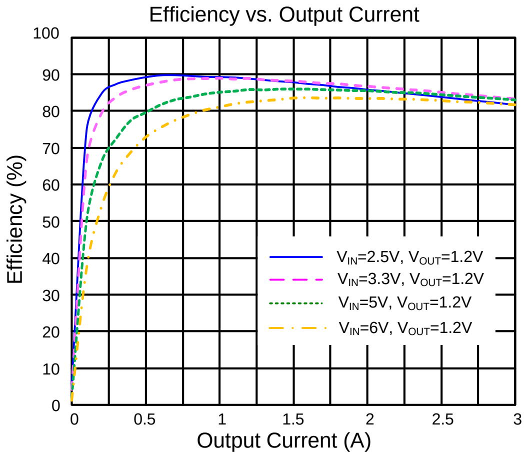
Note 4: The values are guaranteed by design.

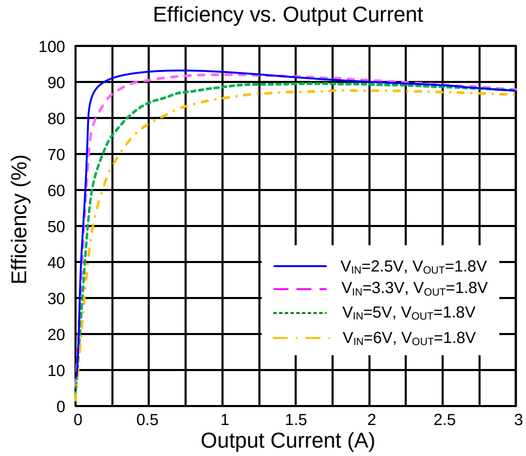
Typical Performance Characteristics

(C_{OUT} = 3×10μF, T_A = 25°C, resistor tolerance is ±1%, unless otherwise specified.)

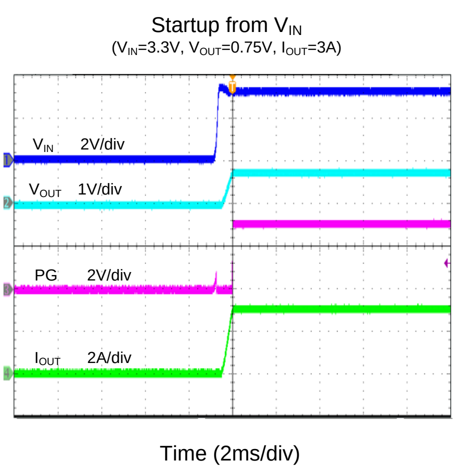


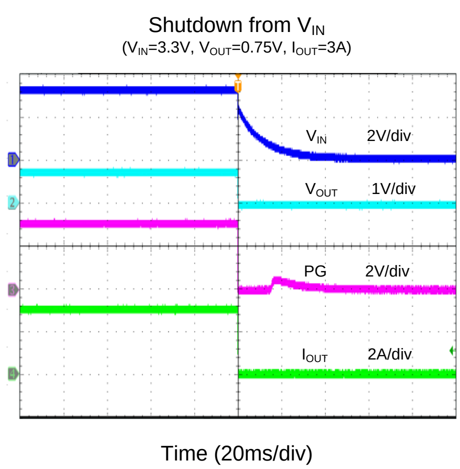






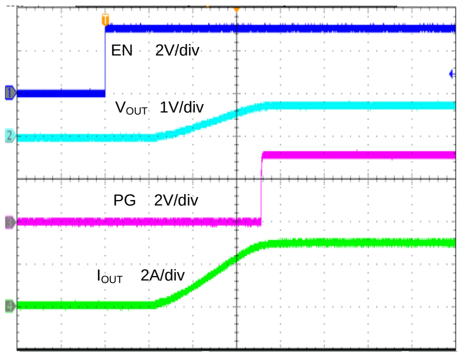
V_{OUT}=0.75V





Startup from EN

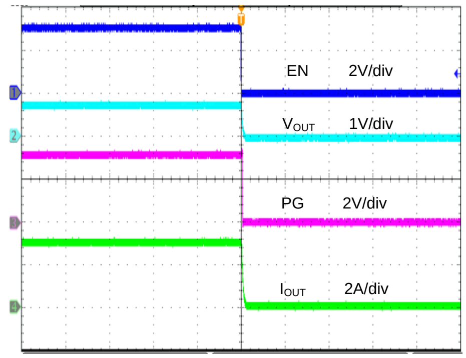
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=3A)



Time (200μs/div)

Shutdown from EN

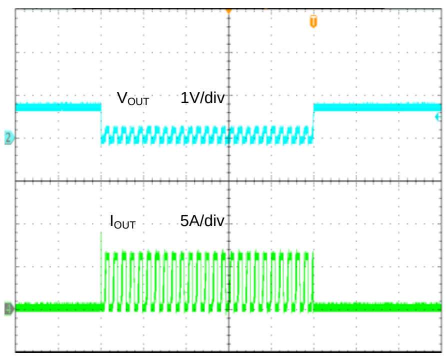
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=3A)



Time (200μs/div)

Short Circuit Protection

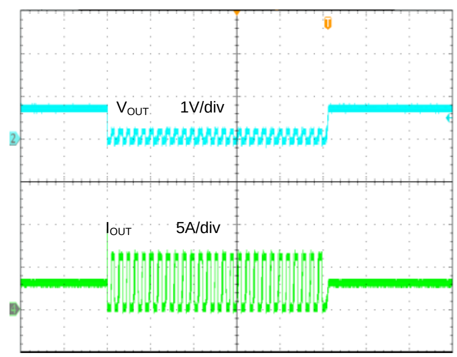
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=0A-Short)



Time (10ms/div)

Short Circuit Protection

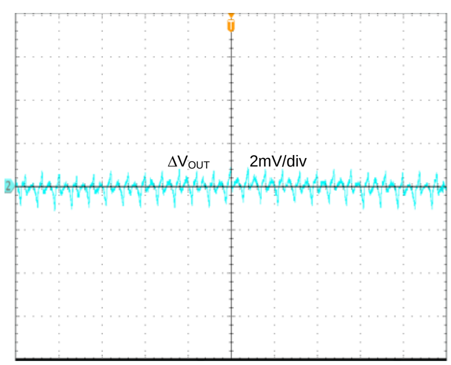
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=3A-Short)



Time (10ms/div)

Output Ripple

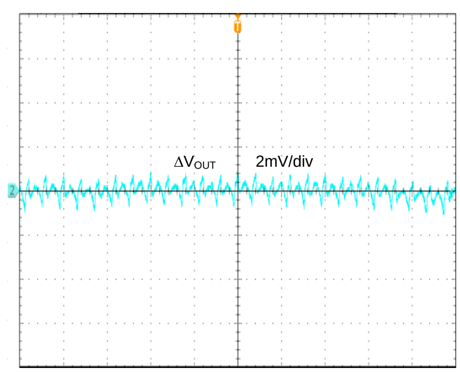
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=3A)



Time (1μs/div)

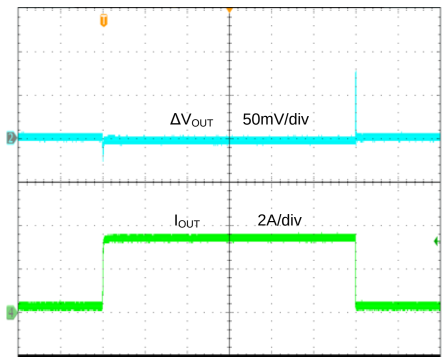
Output Ripple

(V_{IN}=3.3V, V_{OUT}=0.75V, I_{OUT}=0A)



Time (1μs/div)

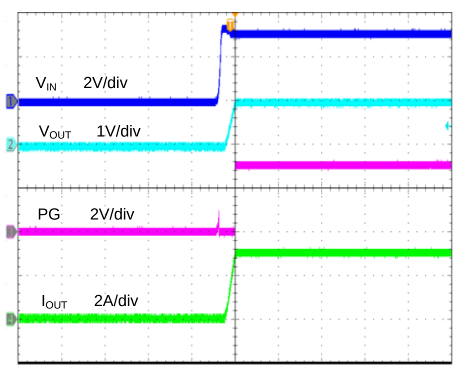
Load Transient
(V_{IN}=3.3V, V_{OUT}=0.75V, I_{LOAD}=0.3A~3A)



Time (400μs/div)

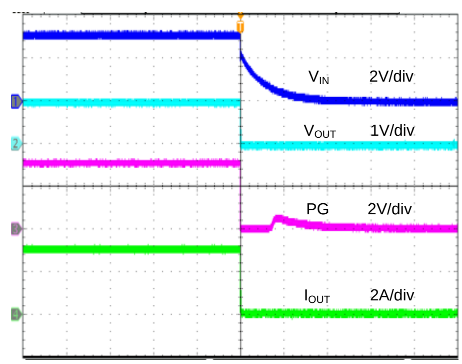
V_{OUT}=1V

Startup from V_{IN}
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A)



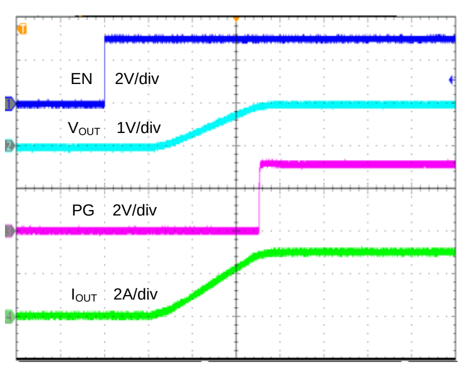
Time (2ms/div)

Shutdown from V_{IN}
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A)



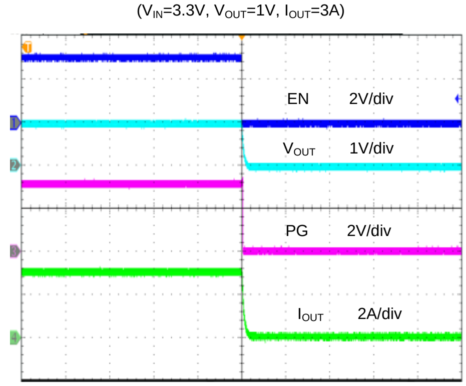
Time (20ms/div)

Startup from EN
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A)



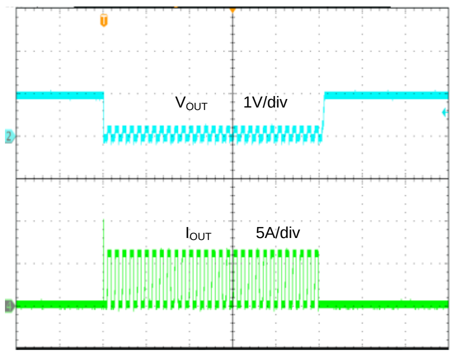
Time (200μs/div)

Shutdown from EN
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A)



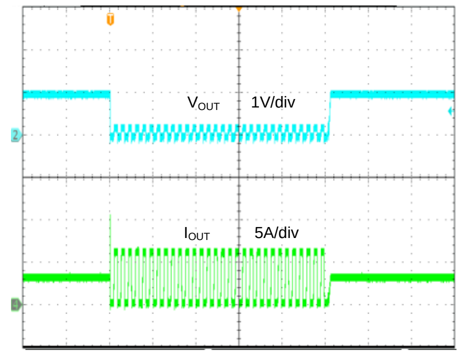
Time (200μs/div)

Short Circuit Protection
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=0A-Short)



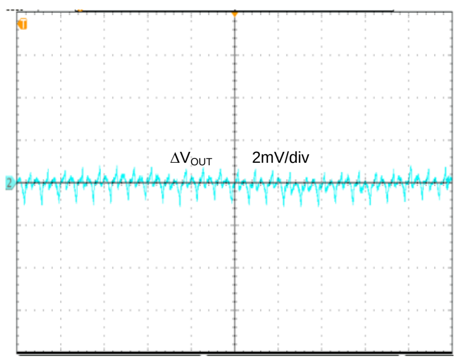
Time (10ms/div)

Short Circuit Protection
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A-Short)



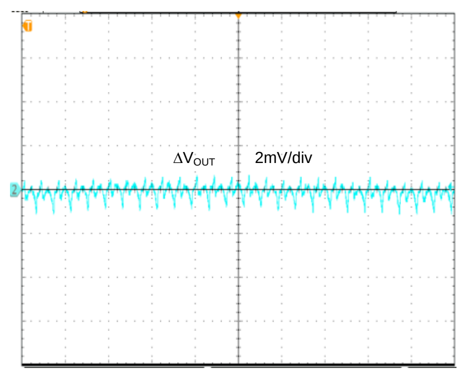
Time (10ms/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=3A)



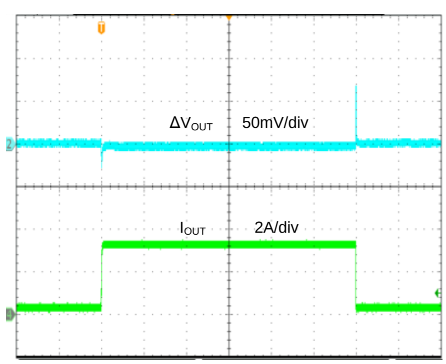
Time (1μs/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=0A)



Time (1μs/div)

Load Transient
(V_{IN}=3.3V, V_{OUT}=1V, I_{OUT}=0.3A~3A)

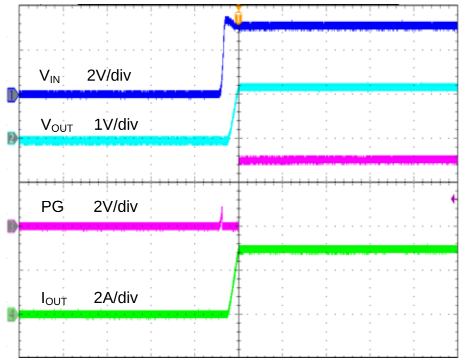


Time (400μs/div)

V_{OUT}=1.2V

Startup from V_{IN}

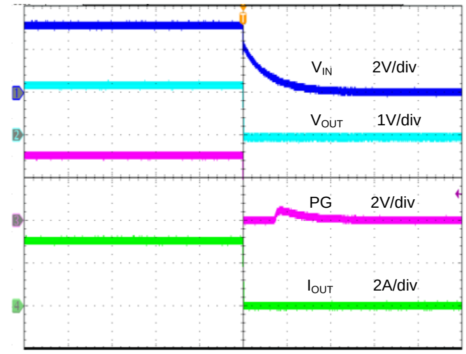
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A)



Time (2ms/div)

Shutdown from V_{IN}

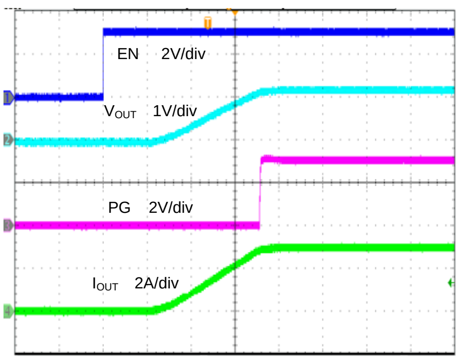
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A)



Time (20ms/div)

Startup from EN

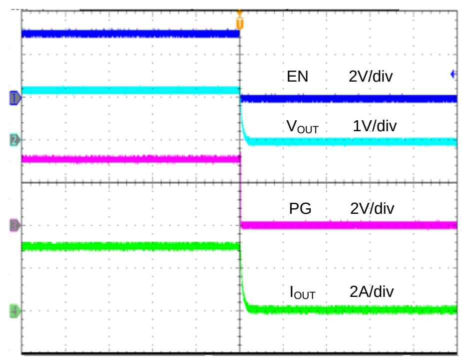
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A)



Time (200μs/div)

Shutdown from EN

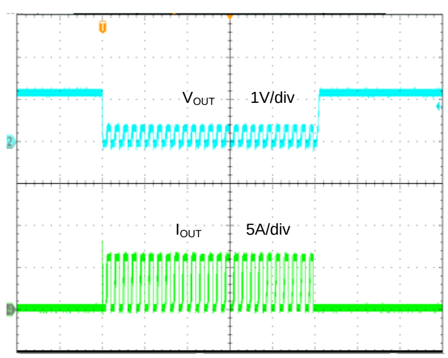
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A)



Time (200μs/div)

Short Circuit Protection

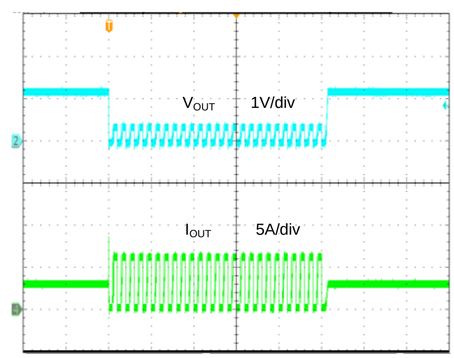
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=0A-Short)



Time (10ms/div)

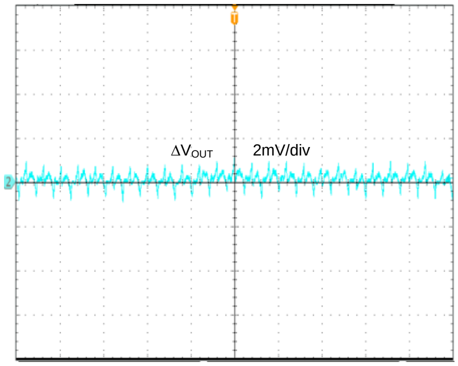
Short Circuit Protection

(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A-Short)



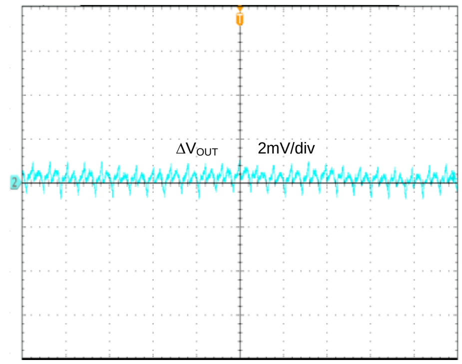
Time (10ms/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=3A)



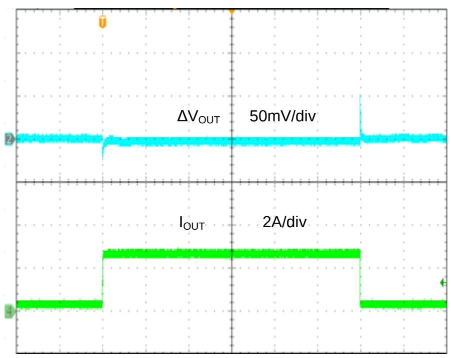
Time (1μs/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=0A)



Time (1μs/div)

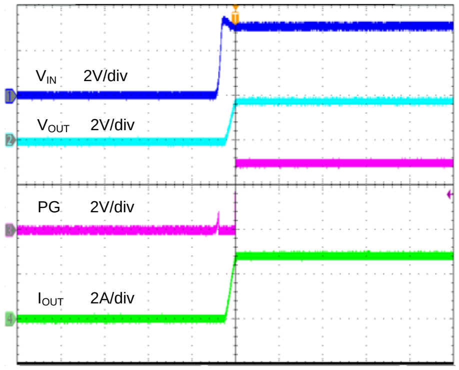
Load Transient
(V_{IN}=3.3V, V_{OUT}=1.2V, I_{LOAD}=0.3A~3A)



Time (400μs/div)

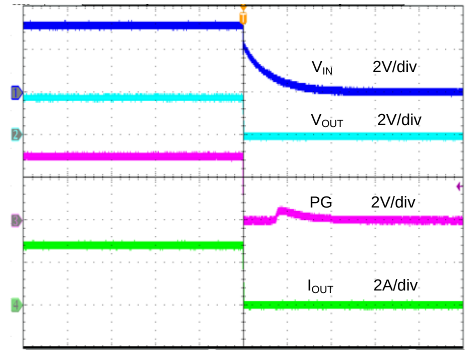
V_{OUT}=1.8V

Startup from V_{IN}
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A)



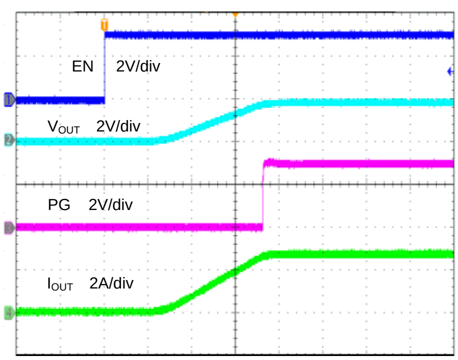
Time (2ms/div)

Shutdown from V_{IN}
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A)



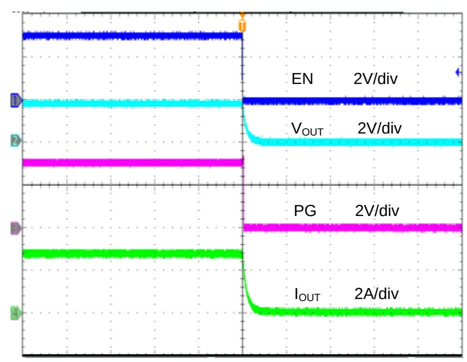
Time (20ms/div)

Startup from EN
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A)



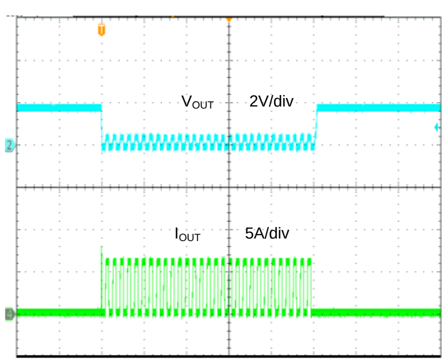
Time (200μs/div)

Shutdown from EN
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A)



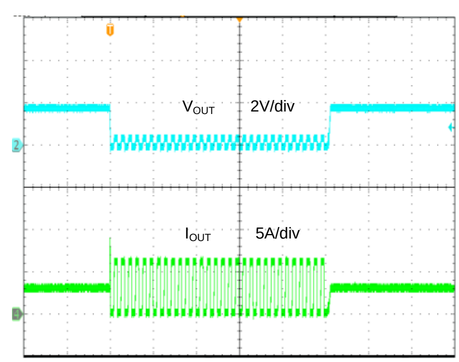
Time (200μs/div)

Short Circuit Protection
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=0A-Short)



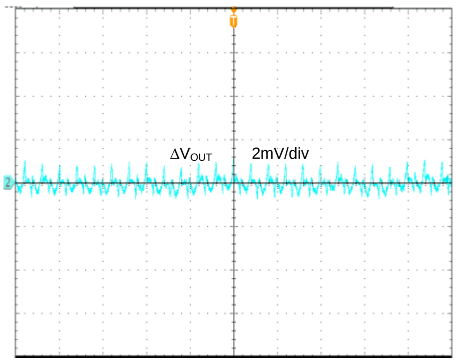
Time (10ms/div)

Short Circuit Protection
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A-Short)



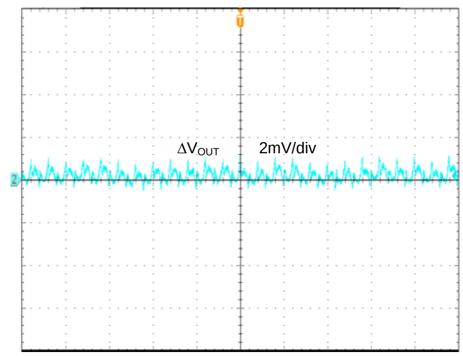
Time (10ms/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=3A)



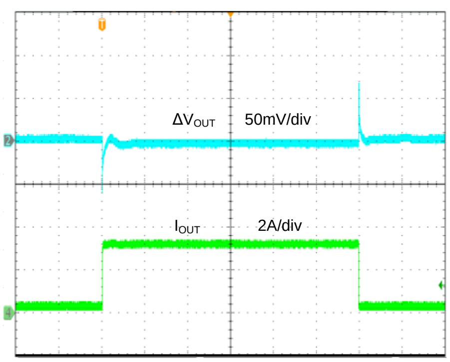
Time (1µs/div)

Output Ripple
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=0A)



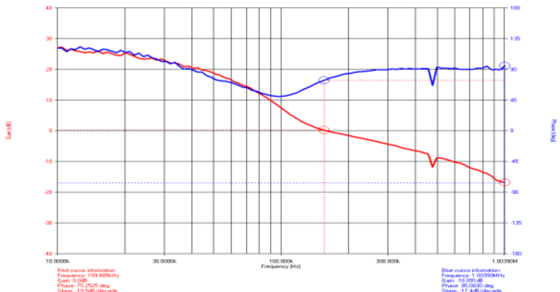
Time (1µs/div)

Load Transient
(V_{IN}=3.3V, V_{OUT}=1.8V, I_{LOAD}=0.3A~3A)

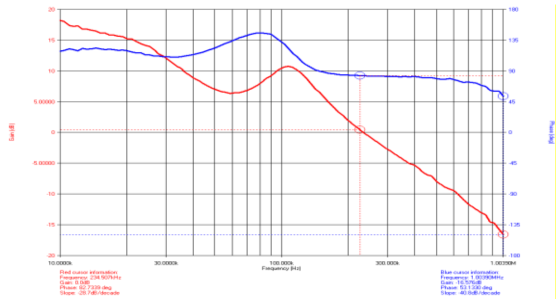


Time (400µs/div)

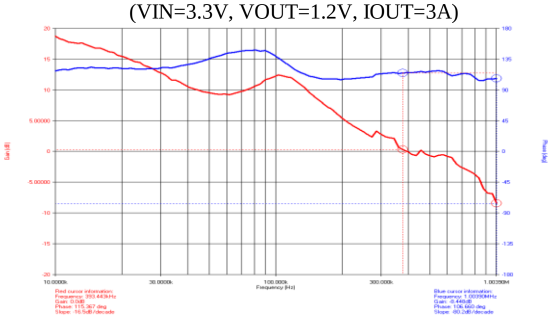
Bode Plot
(VIN=3.3V, VOUT=0.75V, IOUT=3A)



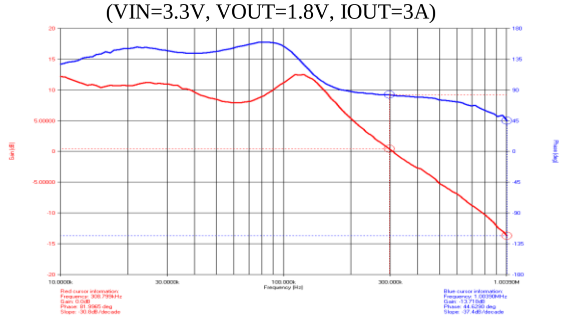
Bode Plot
(VIN=3.3V, VOUT=1V, IOUT=3A)

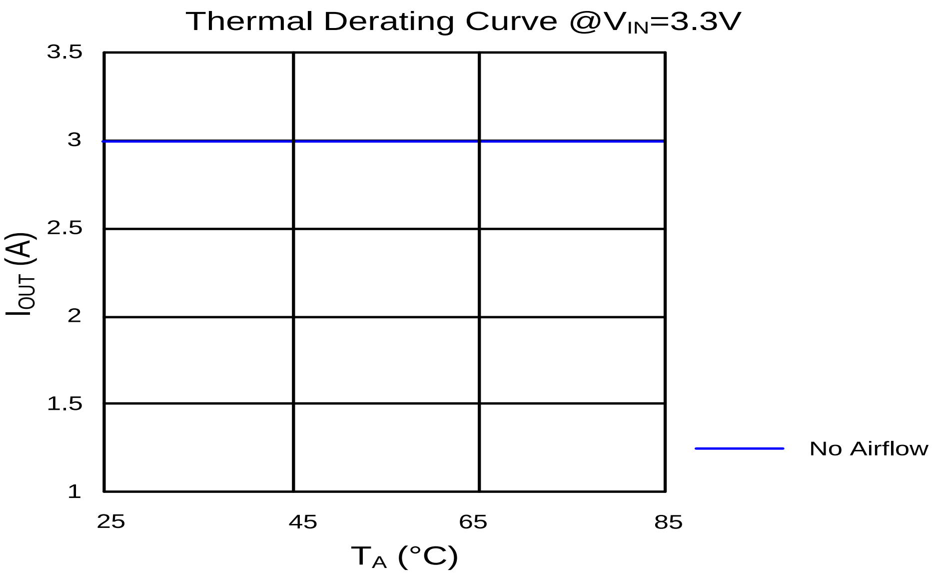


Bode Plot
(VIN=3.3V, VOUT=1.2V, IOUT=3A)



Bode Plot
(VIN=3.3V, VOUT=1.8V, IOUT=3A)





Notes:

1) T_A: Air temperature, 0.5 inch above IC.
2) Based on a four-layer Silergy Evaluation Board in the natural convection.
3) The inductor temperature is not beyond 115℃ under this TD curve.
4) For customer's specific application, the recommended inductor temperature limitation is 115℃.

Operation General Description

The SY20623D is a high efficiency 2.4MHz synchronous step-down DC/DC regulator which is capable of delivering up to 3A 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 2.4MHz switching frequency.

Applications Information

Because of the high integration in the SY20623D, the application circuit based on this regulator is rather simple. Only the input capacitor C_{IN}, the output capacitor C_{OUT}, 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 between 10kΩ and 1MΩ is highly recommended for both resistors. If R_H =100kΩ is chosen, then R_L can be calculated to be:

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

Input Capacitor C_{IN}

To minimize the potential noise problem, place a typical X7R or better grade ceramic capacitor with higher than 10V rating and greater than 20μF capacitance, Place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by the CIN, and the IN/GND pins.

External Capacitor Recommendation

	Description	Vendor	PN
CIN	10μF/10V/X7R, 0603	Murata	GRM188D71A106KA73#

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 higher than 6.3V rating and greater than 30μF capacitance. Place this ceramic capacitor really close to the OUT and GND pins to minimize the loop area formed by the COUT, and the OUT/GND pins.

External Capacitor Recommendation

	Description	Vendor	PN
COUT	10μF/6.3V/X7T, 0603	Murata	GRM188D70J106MA73D

If the output capacitance is larger than 100μF or other type of capacitor (polymer, tantalum…) is used, please contact Silergy supporting team to get more assessment.

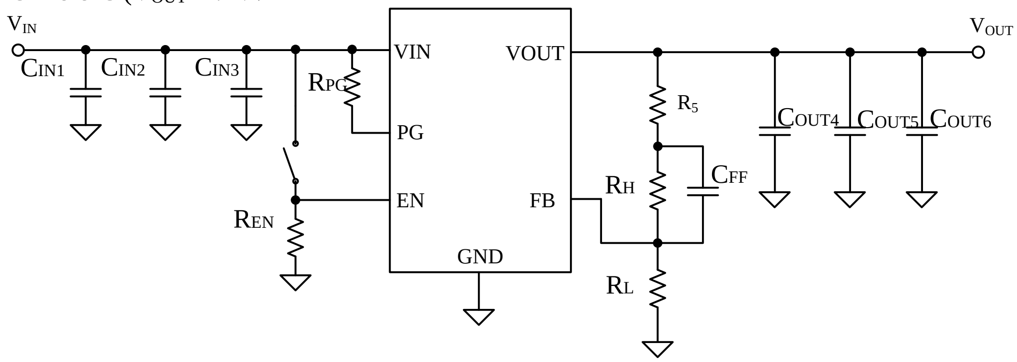
Over Current Protection

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.

Thermal Shutdown Protection

If the junction temperature of SY20623D 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.

Application Schematic (V_{OUT}=1.2V）



BOM List

Reference Designator	Description	Part Number	Manufacturer
C_{IN1}	47µF/25V Electrolytic Cap		
C_{IN2},C_{IN3}	10uF/10V/X7R,0603	GRM188D71A106KA73#	murata
C_{OUT4},C_{OUT5},C_{OUT6}	10uF/6.3V/X7T,0603	GRM188D70J106MA73D	murata
R_H ,R_{PG}	100kΩ,1%,0603		
R_L	100kΩ,1%,0603(VOUT=1.2V)		
R_{EN}	1MΩ,1%,0603		
R5	0Ω,1%,0603		
C_{FF}	120pF/100V/C0G,0603	GCM1885C2A121JA16#	murata

Recommend Table for Typical Applications

V_{OUT}(V)	R_2(KΩ)	R_1(KΩ)	C_7(pF)
0.6	0	100	120
1.2	100	100	120
1.8	50	100	120
3.3	22.1	100	120

Layout Design

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

1) C_{IN} must be close to the pins IN and GND. The loop area formed by C_{IN} and GND must be minimized.

2) C_{OUT} must be close to the pins OUT and GND. The loop area formed by C_{OUT} and GND must be minimized.

3) Place the FB components (R_H, R_L) as close to the FB pin as possible. Avoid routing the FB trace near LX as it is noise sensitive.

4) It is desirable to maximize the PCB copper area connecting to the GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

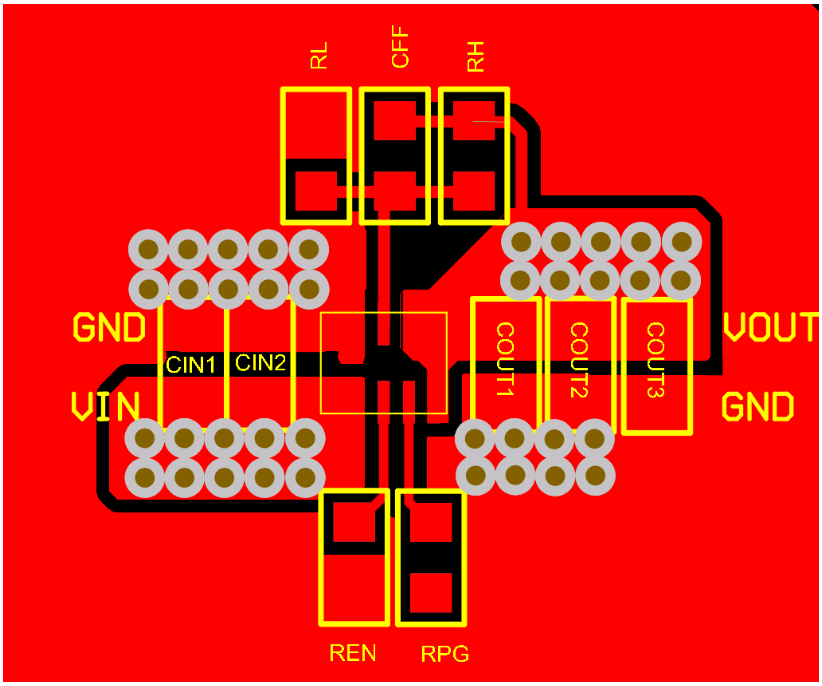
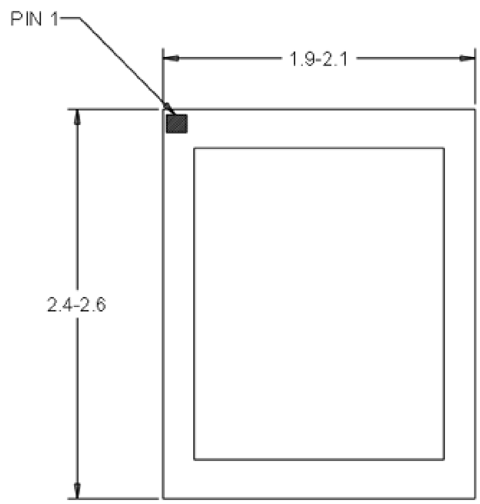
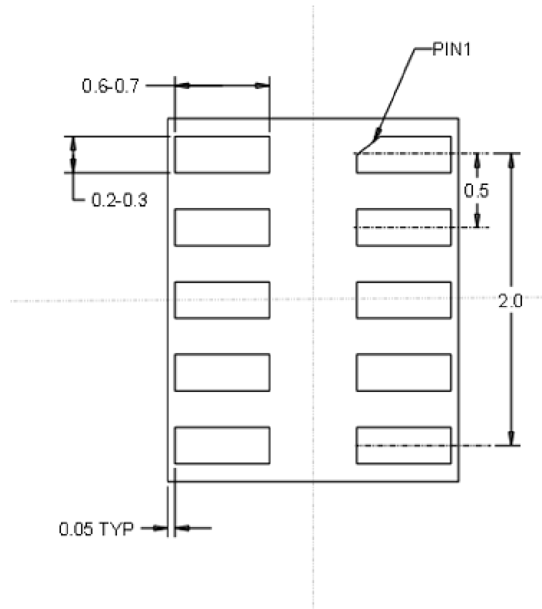


Figure 3. PCB Layout Suggestion

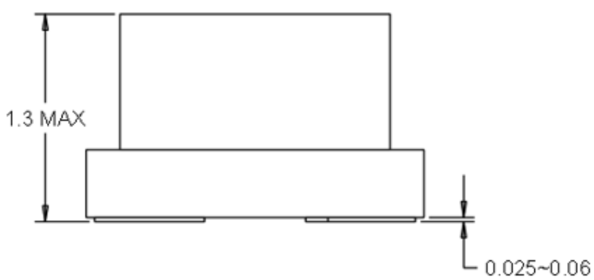
MDFN2.5×2-10 Package Outline Drawing



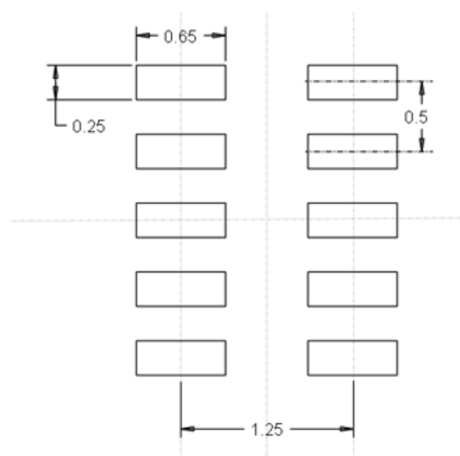
Top View



Bottom View



Side View

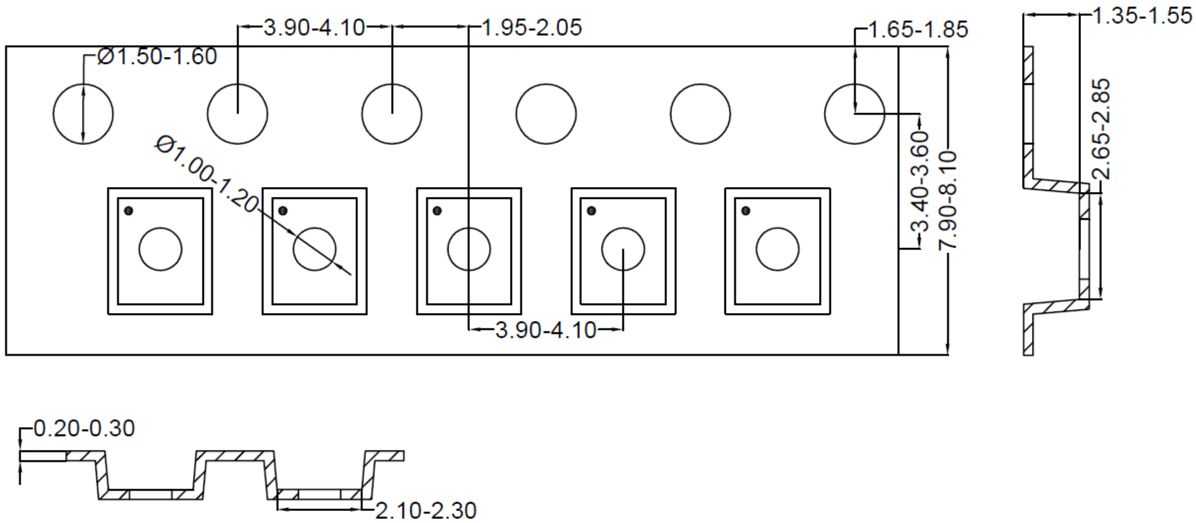


Recommended PCB layout (Reference Only)

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

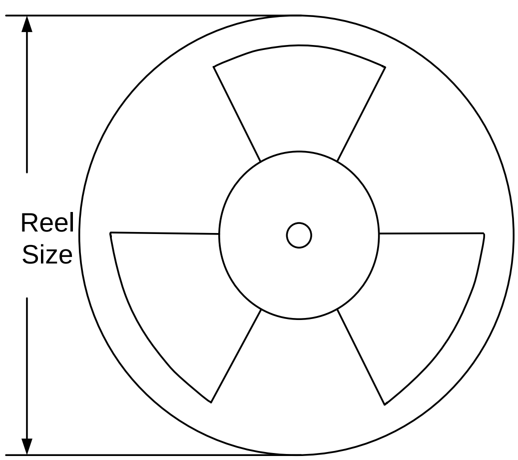
Taping & Reel Specification

1. MDFN2.5×2 taping orientation



Feeding direction →

2. Carrier Tape & Reel specification for packages



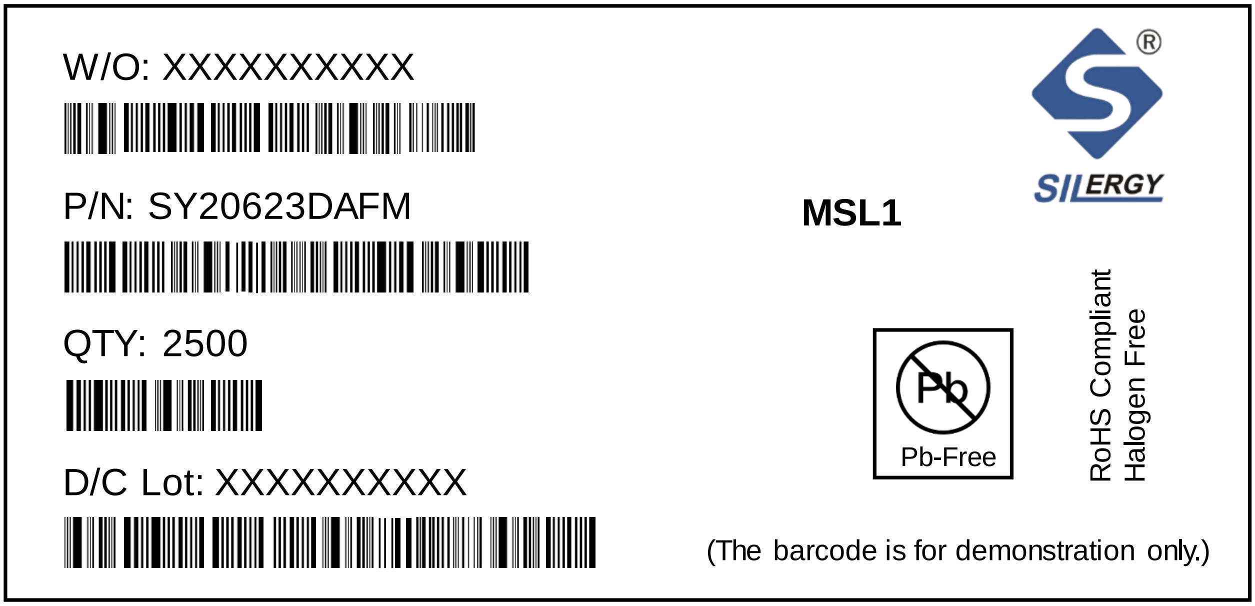
Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel
MDFN2.5×2	8	4	7"	400	160	2500

3. Others: NA

Packaging Information\

Device Marking: **a9**

Label Information



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