



Application Note: AN_SY6288

Low Loss Power Distribution Switch

General Description

SY6288 is an ultra-low $R_{DS(ON)}$ switch with current limiting function to protect the power source from over current and short circuit conditions.

Ordering Information

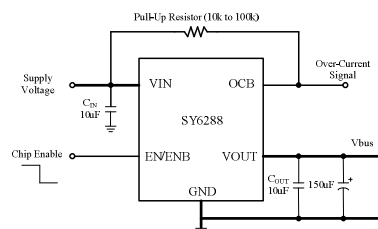
SY6288□(□□)□
 └─ Temperature Code
 └─ Package Code
 └─ Optional Spec Code

Ordering Number	Package Type	UL certified	TUV certified
SY6288AAAC	SOT23-5	YES	YES
SY6288ACAC	MSOP8	YES	YES
SY6288AFAC	SO8	YES	YES
SY6288A1AAC	SOT23-5		YES
SY6288BAAC	SOT23-5	YES	YES
SY6288BCAC	MSOP8	YES	YES
SY6288BFAC	SO8	YES	YES
SY6288CAAC	SOT23-5	YES	YES
SY6288C3AAC	SOT23-5	YES	YES
SY6288C30AAC	SOT23-5		YES
SY6288CFAC	SO8	YES	YES
SY6288CCAC	MSOP8	YES	YES
SY6288C1CAC	MSOP8	YES	YES
SY6288C2CAC	MSOP8	YES	YES
SY6288C4CAC	MSOP8	YES	YES
SY6288C5CAC	MSOP8	YES	
SY6288C30CAC	MSOP8	YES	YES
SY6288DAAC	SOT23-5	YES	YES
SY6288D1AAC	SOT23-5	YES	YES
SY6288D30AAC	SOT23-5		YES
SY6288DCAC	MSOP8	YES	YES
SY6288D1CAC	MSOP8	YES	YES
SY6288D2CAC	MSOP8	YES	YES
SY6288D5CAC	MSOP8	YES	
SY6288DFAC	SO8	YES	YES
SY6288D1FAC	SO8	YES	YES

Features

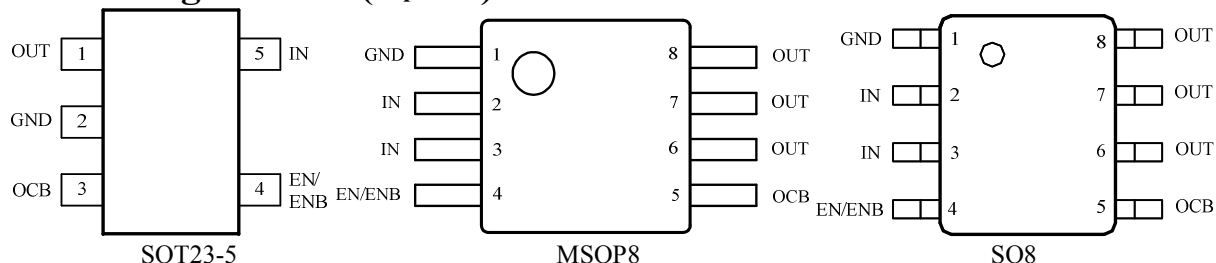
- Distribution voltages: 2.5V to 5.5V
- Over temperature shutdown and automatic retry
- Reverse blocking (no body diode)
- At shutdown, OUT can be forced higher than IN
- Fault flag (OCB) output if over current, thermal shut down, reverse blocking happens.
- Automatic output discharge at shutdown
 - SY6288A1: No output discharge function
 - Others: Auto output discharge function
- Built-in softstart
- 0.4ms rise time
- RoHS Compliant and Halogen Free
- Two Enable polarities and three current levels
 - SY6288A: Active High/0.6A
 - SY6288A1: Active High/0.6A
 - SY6288B: Active Low/0.6A
 - SY6288C: Active High/2A
 - SY6288C1: Active High/1.5A
 - SY6288C2: Active High/1.5A
 - SY6288C3: Active High/1.5A
 - SY6288C30: Active High/2A
 - SY6288C4: Active High/2A
 - SY6288C5: Active High/2.5A
 - SY6288D: Active Low/2A
 - SY6288D1: Active Low/1.5A
 - SY6288D2: Active Low/1.5A
 - SY6288D5: Active Low/2.5A
 - SY6288D30: Active Low/2A
- Compact packages minimize board space: SOT23-5, SO8, MSOP8
- UL certification NO. E333762
TUV certification NO. R 50188769

Typical Application Circuit



Note: A low-ESR 150uF aluminum electrolytic or tantalum between VOUT and GND is strongly recommended.

Pin Configurations (Top View)



Part Number	Package type	Top Mark ^①
SY6288AAAC	SOT23-5	CW _{xyz}
SY6288ACAC	MSOP8	ABT _{xyz}
SY6288AFAC	SO8	AAJ _{xyz}
SY6288A1AAC	SOT23-5	Fd _{xyz}
SY6288BAAC	SOT23-5	DB _{xyz}
SY6288BCAC	MSOP8	ABD _{xyz}
SY6288BFAC	SO8	AAJ _{xyz}
SY6288CAAC	SOT23-5	DF _{xyz}
SY6288C3AAC	SOT23-5	FP _{xyz}
SY6288C30AAC	SOT23-5	Br _{xyz}
SY6288CCAC	MSOP8	ABU _{xyz}
SY6288C1CAC	MSOP8	ADK _{xyz}
SY6288C2CAC	MSOP8	ADL _{xyz}
SY6288C4CAC	MSOP8	AEX _{xyz}
SY6288C5CAC	MSOP8	AZD _{xyz}
SY6288C30CAC	MSOP8	ARW _{xyz}
SY6288CFAC	SO8	AAM _{xyz}
SY6288DAAC	SOT23-5	Bu _{xyz}
SY6288D1AAC	SOT23-5	DS _{xyz}
SY6288D30AAC	SOT23-5	Bq _{xyz}
SY6288DCAC	MSOP8	ABE _{xyz}
SY6288D1CAC	MSOP8	ACK _{xyz}
SY6288D2CAC	MSOP8	AEH _{xyz}
SY6288D5CAC	MSOP8	AZE _{xyz}
SY6288DFAC	SO8	AAN _{xyz}
SY6288D1FAC	SO8	ACJ _{xyz}

Note ①: x=year code, y=week code, z=lot number code.

Functional Pin Description

Pin Name	Pin Number (SO8, MSOP8)	Pin number (SOT23-5)	Pin Description
IN	2,3	5	Input pin
GND	1	2	Ground pin
OUT	6,7,8	1	Output pin
EN- SY6288A/A1/C/C1/C2/C3/C30/C4/C5 ENB- SY6288B/D/D1/D2/D5/D30	4	4	ON/OFF control. Don't float. EN: high enable. ENB: low enable.
OCB	5	3	Open Drain Fault Flag

**Absolute Maximum Ratings** (Note 1)

All pins	6V
Power Dissipation, P_D @ $T_A = 25^\circ\text{C}$ SOT23-5/MSOP8/SO8	0.4/0.5/0.65W
Package Thermal Resistance (Note 2)	
SOT23-5/MSOP8/SO8, θ_{JA}	100/150/90°C/W
SOT23-5/MSOP8/SO8, θ_{JC}	30/ 65/ 45°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)

IN	2.5V to 5.5V
EN/ENB	-0.3V to $V_{IN}+0.3V$
All other pins	0-5.5V
Junction Temperature Range	-40°C to 125°C
Ambient Temperature Range	-40°C to 85°C

Electrical Characteristics

($V_{IN} = 5V$, $C_L = 1\mu F$, per channel, $T_A = 25^\circ C$ unless otherwise specified)

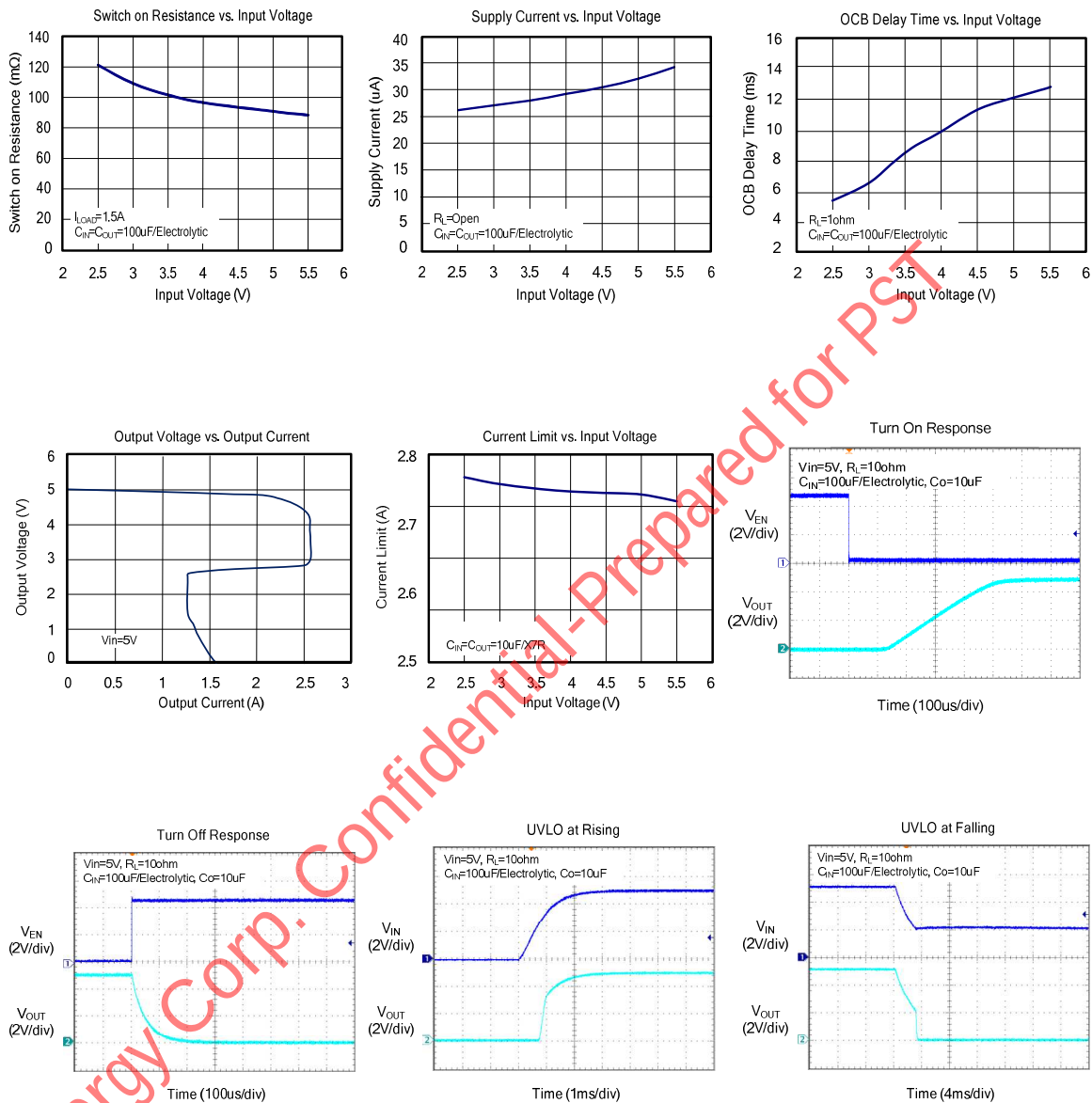
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		5.5	V
Shutdown Input Current	I_{SHDN}	Open load, switch off		0.1	1	μA
		Output grounded, switch off		0.1	1	μA
Quiescent Supply Current	I_Q	Open load, switch on		32		μA
FET RON	$R_{DS(ON)}$	SOT23-5 (SY6288A/A1/B/C/D/D1)	60	80	100	m Ω
		SOT23-5(SY6288C3/C30/D30)	50	70	90	m Ω
		MSOP8 (SY6288A/B/C/C1/C4)	60	80	100	m Ω
		MSOP8(SY6288C2/C5/D1/D2/D5)	50	70	90	m Ω
		MSOP8 (SY6288C30/D)	57	70	83	m Ω
		SO8(SY6288A/B/C/D/D1)	65	85	105	m Ω
Current Limit	I_{LIM}	SY6288A/A1/B	0.8	1.2	1.6	A
		SY6288C/C30/D/D30	2.1	2.9	3.7	A
		SY6288C1	1.6	2.4	3.2	A
		SY6288C2/C3/D2	1.5	1.75	2	A
		SY6288D1	1.6	2.5	3.7	A
		SY6288C4	2.5	2.9	3.7	A
		SY6288C5/D5	2.7	3.55	4.4	A
Short Circuit Output Current	I_{OS}	MSOP8 (SY6288D), OUT connected to GND device enabled.	1.2	1.8	2.4	A
		SOT23-5(SY6288C3)	0.7	1.05	1.4	A
EN/ $\overline{EN}$ Threshold	Logic-Low Voltage	V_{IL}			0.8	V
	Logic-High Voltage	V_{IH}	2			V
IN UVLO Threshold	$V_{IN,UVLO}$				2.4	V
IN UVLO Hysteresis	$V_{IN,HYS}$			0.1		V
Turn-ON Time	T_{ON}	$R_L = 5\Omega$, $C_L = 1\mu F$		400		μs
OCB Low Resistance	R_{OCB}			10		Ω
OCB Delay Time	T_{OCB_Delay}			10		ms
OUT Shutdown Discharge Resistance	R_{DIS}	Except for SY6288A1		10		Ω
Thermal Shutdown Temperature	T_{SD}			150		$^\circ C$
Thermal Shutdown Hysteresis				20		$^\circ C$

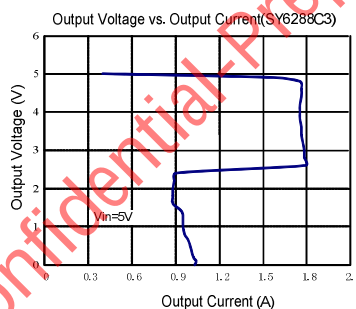
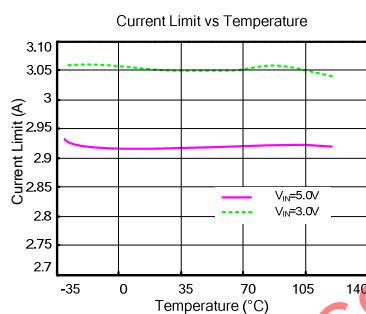
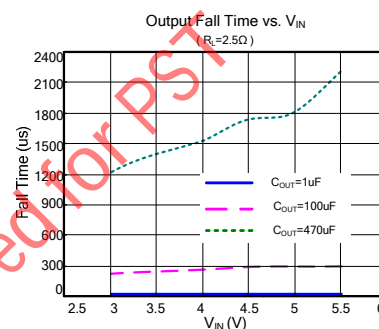
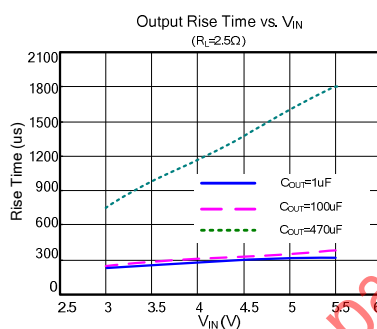
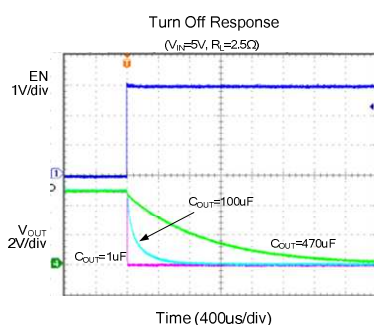
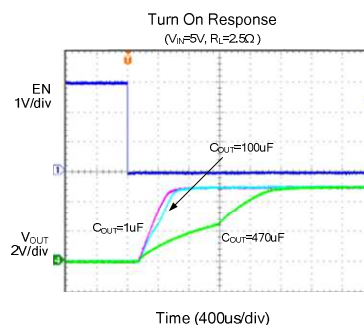
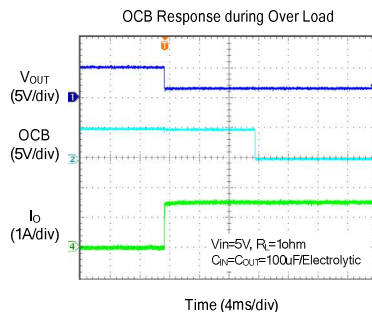
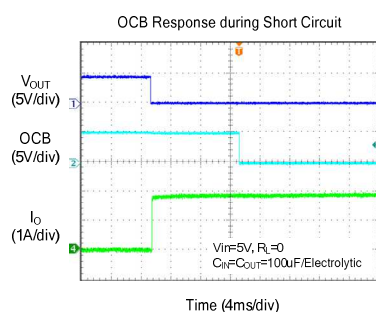
Note 1: Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute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

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

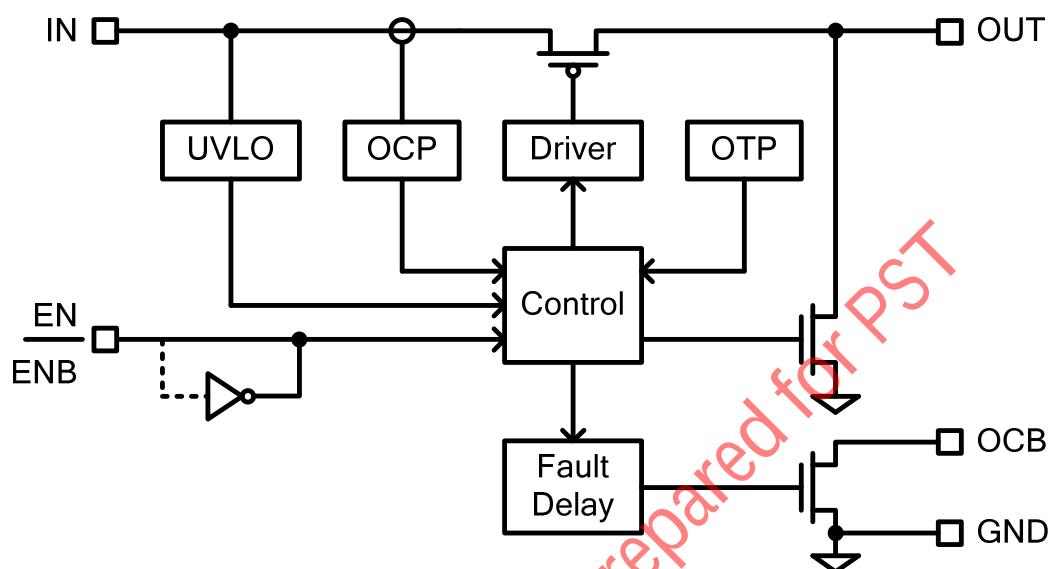
Note 3: The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics (SY6288DFAC)





Block diagram



Operation

The SY6288 is a current limited P-channel MOSFET power switch designed for high-side load-switching applications. There is no parasitic body diode between drain and source of the MOSFET, so the SY6288 prevents current flow from out to input when out being externally forced to a higher voltage than V_{IN} when chip is disabled.

Over-current protection

When the over-current condition is sensed, the gate of the pass switch is modulated to achieve constant output current. Under output short circuit conditions, the normal current limit folded back 50%. If the over current condition persists for a long enough time, the junction temperature may exceed 150°C , and over-temperature protection will shut down the part. Once the chip temperature drops to 130°C , the part will restart.

Fault Flag (OCB)

The OCB output is asserted (active low) when an over temperature shutdown condition is encountered. The OCB will also be pulled if over current or reverse blocking happens and persists for 10ms. The output remains asserted until the fault status is removed. Connecting a heavy capacitive load to an enabled device can cause a momentary over current condition; however, no false reporting on OCB occurs due to the 10-ms deglitch circuit. OCB is not deglitched when the

switch is turned OFF due to an over temperature shutdown.

Supply Filter Capacitor

In order to prevent the input voltage drooping during hot-plug events, a 10uF ceramic capacitor from V_{IN} to GND is strongly recommended. However, higher capacitor values could reduce the voltage droop on the input further. Furthermore, an output short will cause ringing on the input without the input capacitor. It could destroy the internal circuitry when the input transient exceeds 6V which is the absolute maximum supply voltage even for a short duration.

Output Filter Capacitor

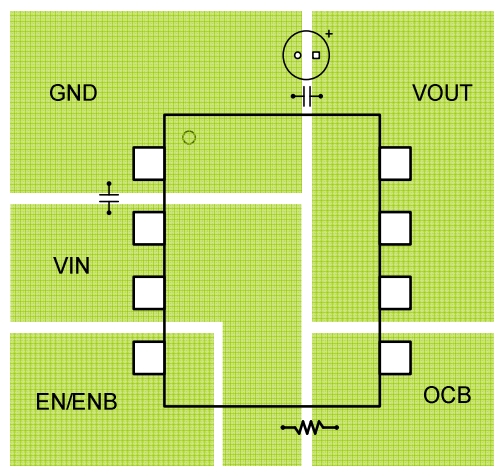
Between V_{OUT} and GND, a low-ESR 150uF aluminum electrolytic or tantalum capacitor is strongly recommended to meet the 330mV maximum droop requirement. Standard bypass methods should be used to minimize inductance and resistance between the bypass capacitor and the down stream connector. This will reduce EMI and improve the transient performance. If long cables are connected to the output terminals, an anti-parallel schottky diode such as BAT54 is suggested to be placed in parallel with the output terminals to absorb the negative ringing due to the cable inductance.

PCB Layout Guide

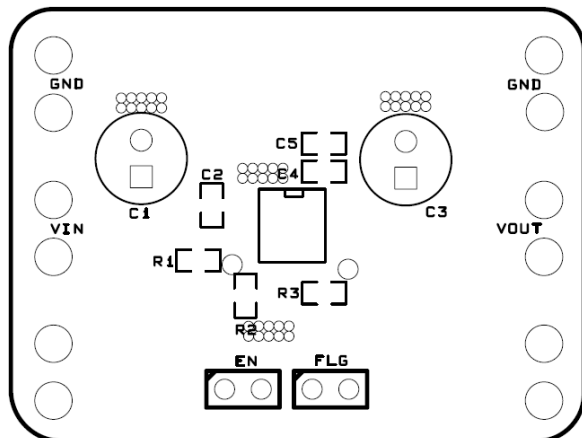
For best performance of the SY6288, the following guidelines must be strictly followed:

- Keep all V_{BUS} traces as short and wide as possible and use at least 2 ounce copper for all V_{BUS} traces.
- Place a ground plane under all circuitry to lower both resistance and inductance and improve DC and transient performance.
- A low-ESR 150uF aluminum electrolytic or tantalum capacitor between V_{OUT} and GND is strongly recommended.
- Locate the output capacitor as close to the connectors as possible to lower impedance (mainly inductance) between the port and the capacitor and improve transient performance.
- Input and output capacitors should be placed closed to the IC and connected to ground plane to reduce noise coupling.

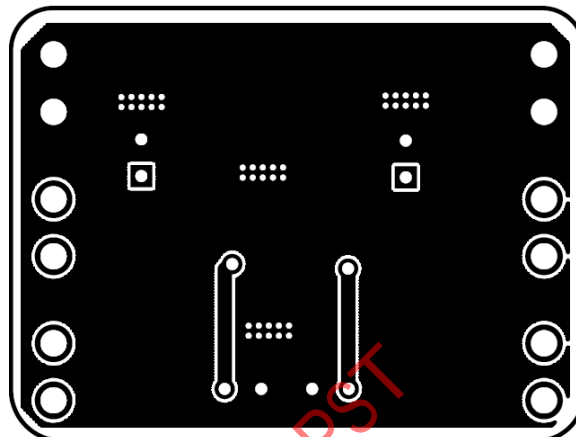
- Locate the ceramic bypass capacitors as close as possible to the V_{IN} pins and V_{OUT} pins of SY6288.



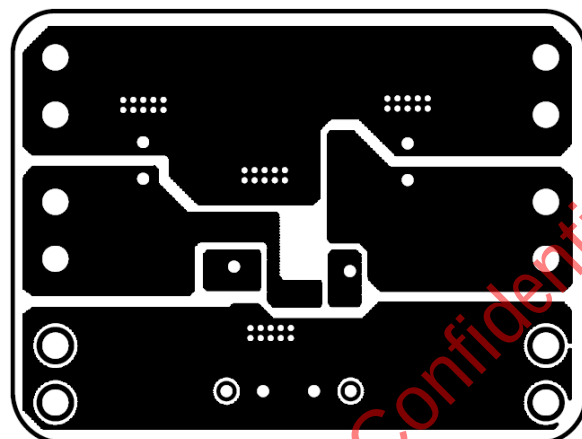
PCB Layout Guide (SO8)



PCB Top Over Layer (SO8)

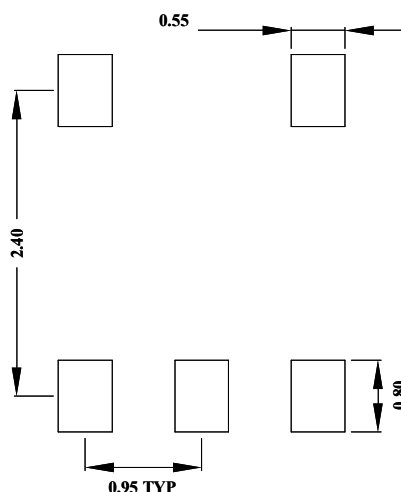


PCB Bottom Layer (SO8)

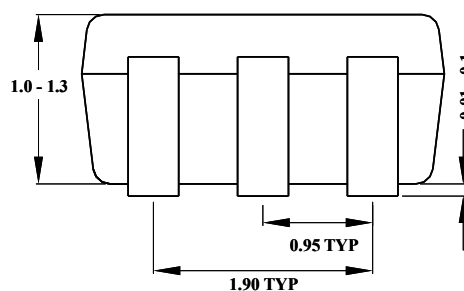
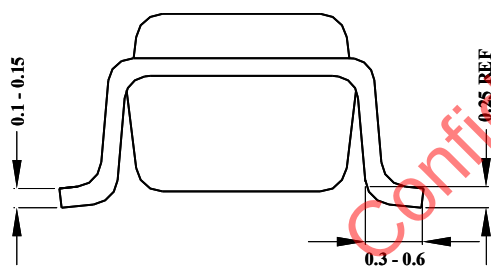
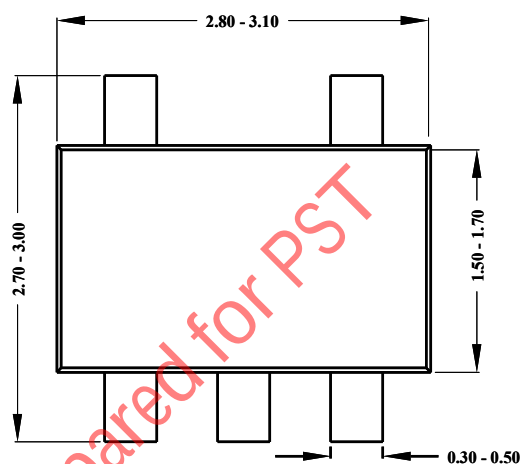


PCB Top Layer (SO8)

SOT23-5 Package outline & PCB layout design

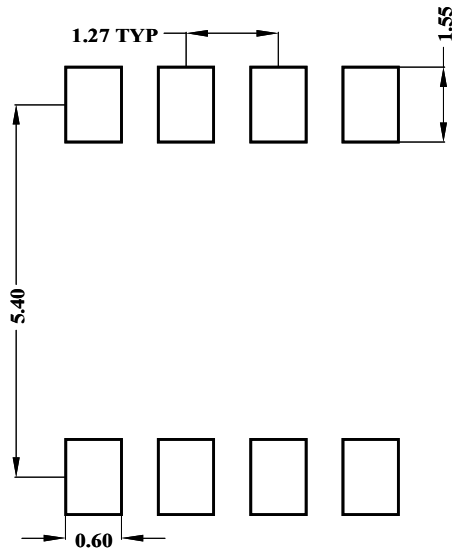


Recommended Pad Layout

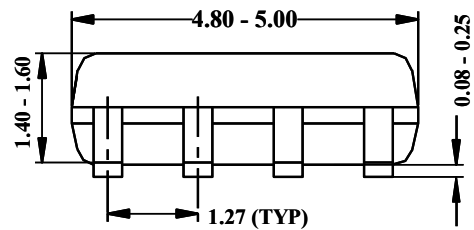
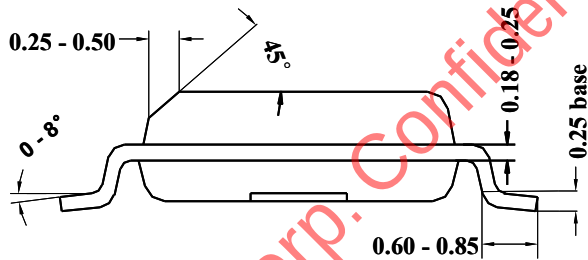
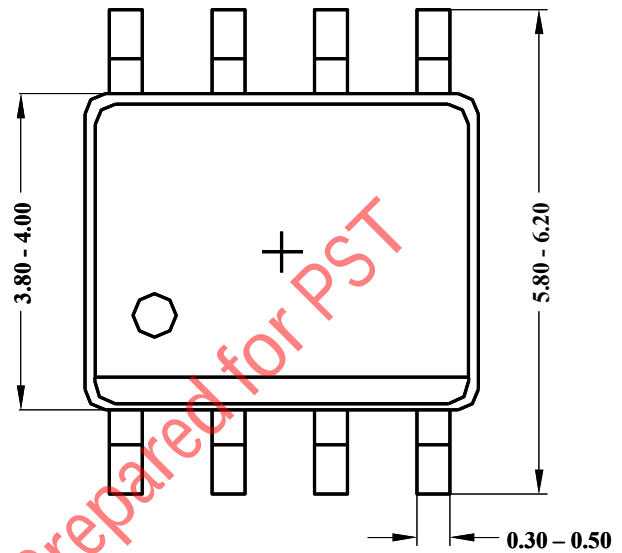


Notes: All dimensions are in millimeters.
All dimensions don't include mold flash & metal burr.

SO8 Package outline & PCB layout design

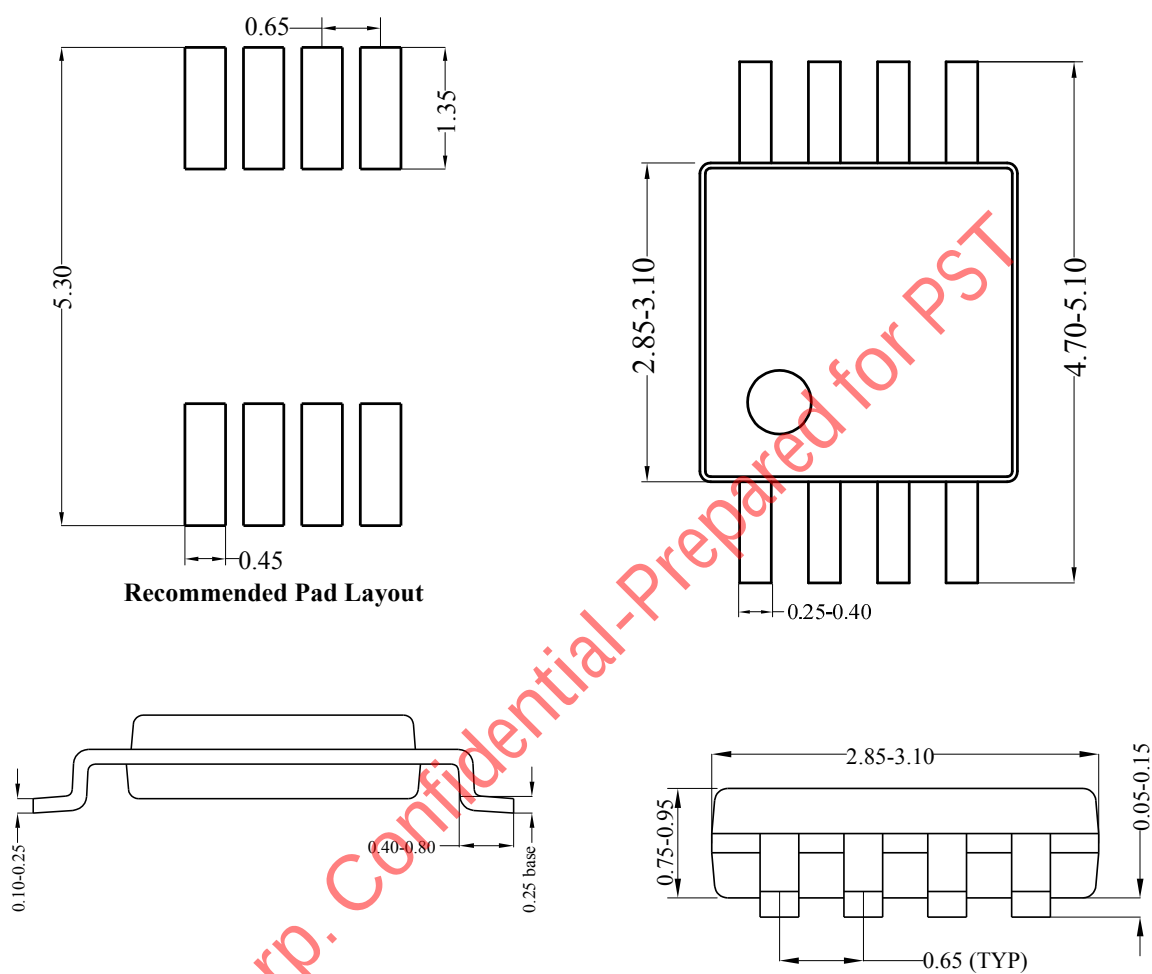


Recommended Pad Layout



Notes: All dimensions are in millimeters.
All dimensions don't include mold flash & metal burr.

MSOP8 Package outline & PCB layout design

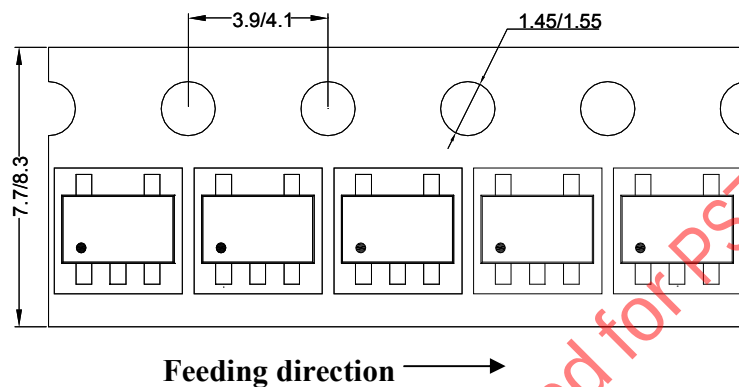


Notes: All dimensions are in millimeters.
All dimensions don't include mold flash & metal burr.

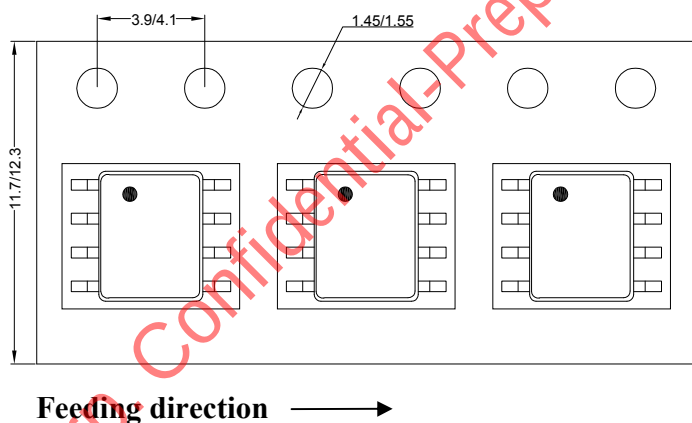
Taping & Reel Specification

1. Taping orientation

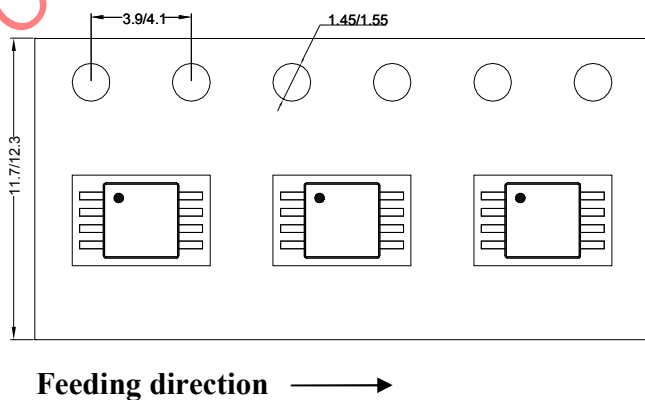
SOT23-5



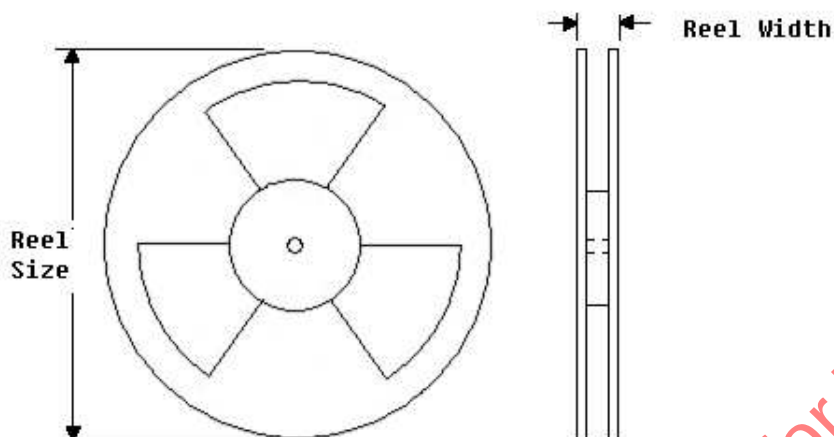
SOP8



MSOP8



2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Reel width(mm)	Trailer length(mm)	Leader length (mm)	Qty per reel
SOT23-5	8	4	7"	8.4	280	160	3000
SOP8	12	8	13"	12.4	400	400	2500
MSOP8	12	8	13"	12.4	400	400	3000

3. Others: NA