Dying GASP Storage and Release Controller

FEATURES

- Wide input voltage: 5V~18V
- Up to 2A Release Current From Storage to VIN
- 300mA Charge Current Limit
- Open Drain Dying GASP Flag Indicator
- Programmable Storage and Release Voltage
- SOP8 Package

APPLICATIONS

- Gateway, AP Networks
- DSL/PON/Cable Modems

GGENERAL DESCRIPTION

The TMI5111 is a dying gasp storage and release controller IC with internal power MOSFET and Diode. It offers a very compact solution to reduce the storage capacitor and keep the same release time when input is power off. During normal power on, it boosts input voltage and charges storage capacitor with a limited current about 300mA. When the charge voltage reaches the selected voltage set by FB1, the charge is stopped and the voltage is maintained until the low input voltage is detected, which is set by FB2. The TMI5111 release charge form storage capacitor to input capacitor with a limited current about 2A. The storage and release voltage can be programmed by user different external divided resistors of FB1 pin and FB2 pin.

The TMI5111 requires a minimal number of readily-available, standard, external components and is available in a SOP8 package.

TYPICAL APPILCATION

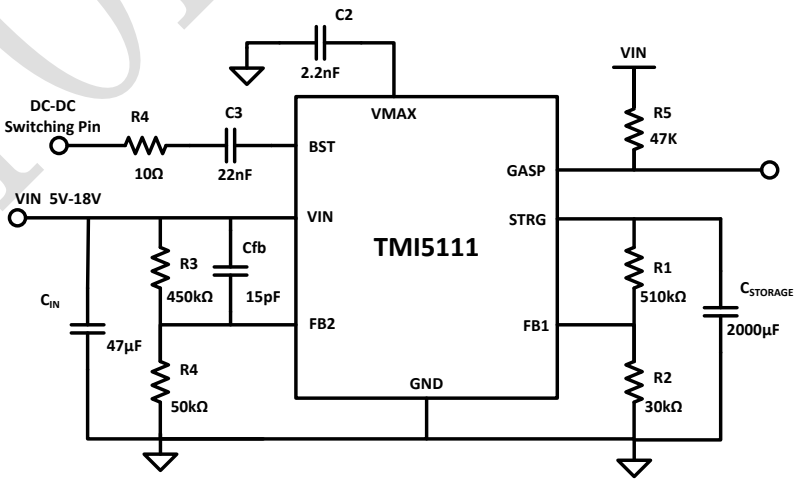


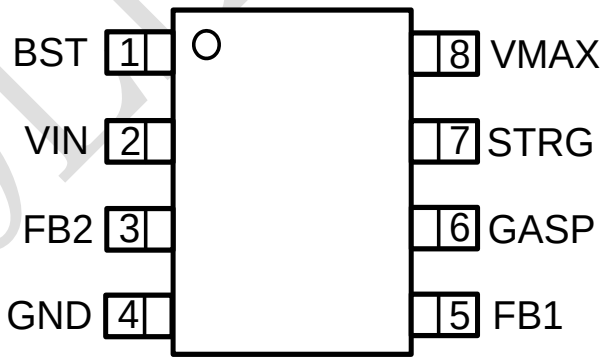
Figure 1. Basic Application Circuit

ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Unit
VIN Voltage Range	-0.3~20	V
BST, VMAX Voltage Range	-0.3~40	V
BST to VIN, VMAX to VIN Voltage Range	-0.3~25	V
STRG Voltage Range	-0.3~32	V
ALL other pins Voltage Range	-0.3~6	V
Junction Temperature	-40~150	°C
Storage Temperature	-65~150	°C
Junction-to-ambient Thermal Resistance	90	°C/W
Junction-to-case Thermal Resistance	46	°C/W
Package Dissipation	1.2	W

Over operating free-air temperature range (unless otherwise noted)

PACKAGE/ORDER INFORMATION



SOP8

Top Mark: T5111 XXXXX (T5111: Device Code, XXXXX: Inside Code)

Part Number	Package	Top mark	Quantity/ Reel
TMI5111	SOP8	T5111XXXXX	3000

PIN FUNCTIONS

Pin	Name	Function
1	BST	Boost pin, connect a RC in series to DC-DC switching pin
2	VIN	Power Input pin
3	FB2	Feedback pin to set release voltage
4	GND	Ground
5	FB1	Feedback pin to set storage voltage
6	GASP	Dying GASP indicate pin
7	STRG	Storage pin, connect a charge capacitor
8	VMAX	Internal high voltage bias pin, connect a ceramic capacitor for decoupling

ESD RATING

Items	Description	Value	Unit
V_{ESD}	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
V_{IN}	Input Voltage Range	5	18	V
T_A	Operating Temperature Range	-40	85	°C

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ELECTRICAL CHARACTERISTICS

(V_{IN}=12V, T_A = 25°C, unless otherwise noted.)

Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range		5		18	V
Input Quiescent Current	V_{FB1} =1.1V		220		μA
Under Voltage Lockout	V_{IN} rising		4.0		V
UVLO Hysteresis			550		mV
Feedback Threshold Voltage	V_{FB1} and V_{FB2}	0.95	1	1.05	V
Storage Refresh High Threshold Voltage			1.025		V
Storage Refresh Low Threshold Voltage			0.975		V
FB Pin input current	V_{FB1} and V_{FB2}=1V	-50		50	nA
GASP high Threshold voltage			1.05		V
GASP low Threshold voltage			1		V
GASP Rising Delay			10		μs
GASP Falling Delay			1.3		μs
Storage Charge limit current	V_{IN}=12V		300		mA
Release limit current			2.0		A
Thermal Shutdown Threshold			150		°C
Thermal Shutdown Hysteresis			30		°C

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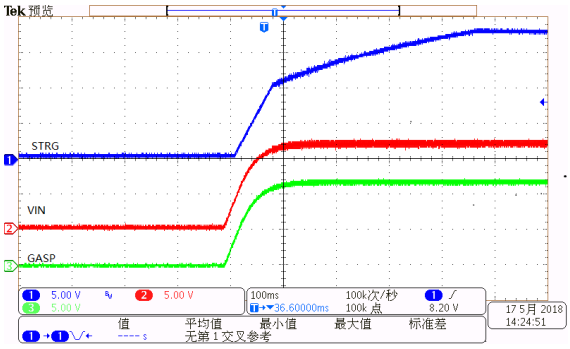
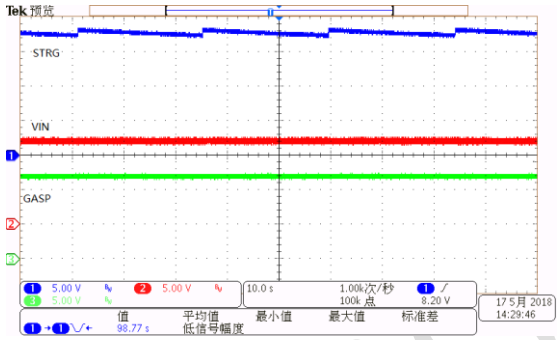
TYPICAL PERFORMANCE CHARACTERISTICS

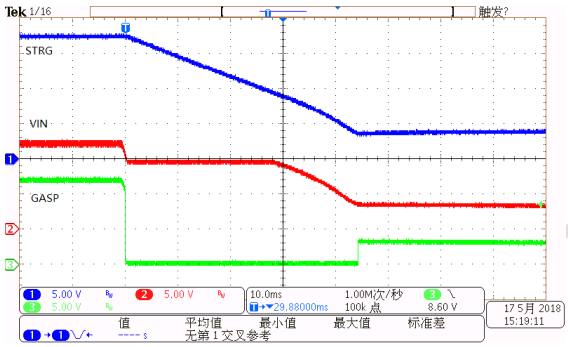
(V_{IN}=12V, V_{STRG}=18V, T_A = 25°C, unless otherwise noted.)



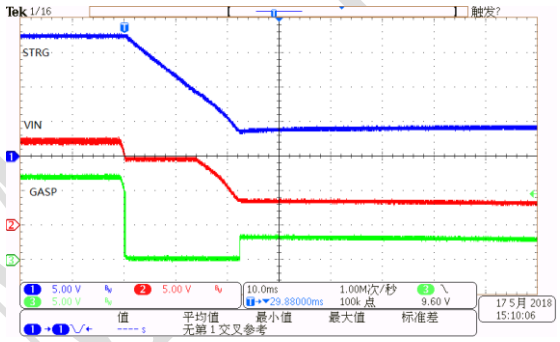
Charge Up (C_{STRG}=2000μF)



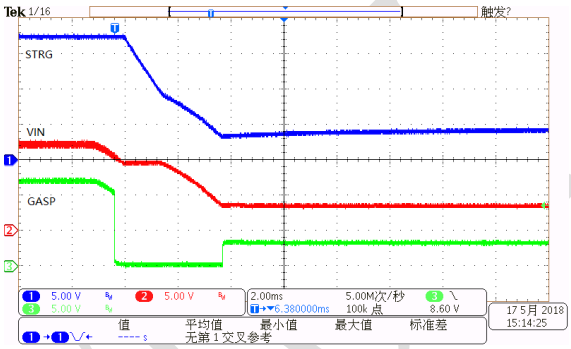
Stand by (C_{STRG}=2000μF)



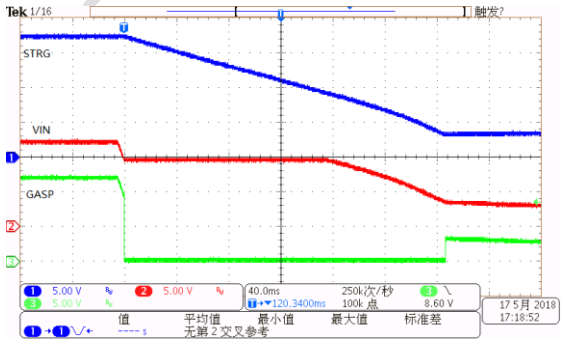
STRG Release (C_{STRG}=2000μF, PD=5W)



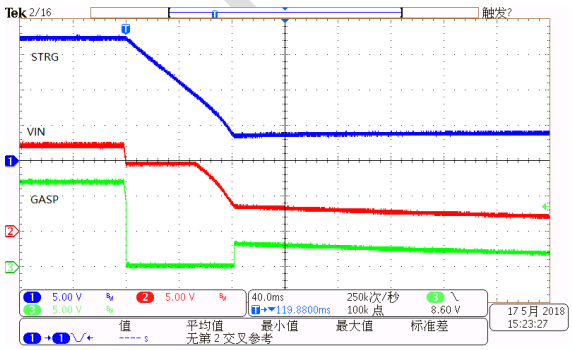
STRG Release (C_{STRG}=1000μF,PD=5W)



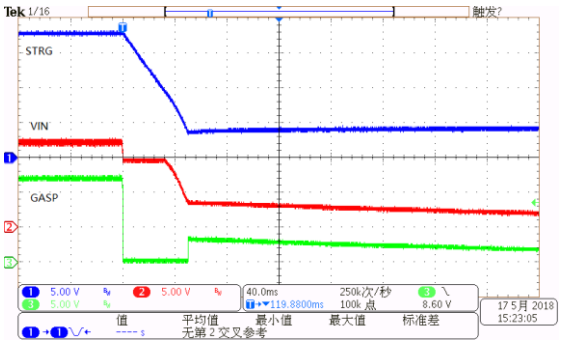
STRG Release (C_{STRG}=100μF, PD=5W)



STRG Release (C_{STRG}=2200μF, PD=1W)

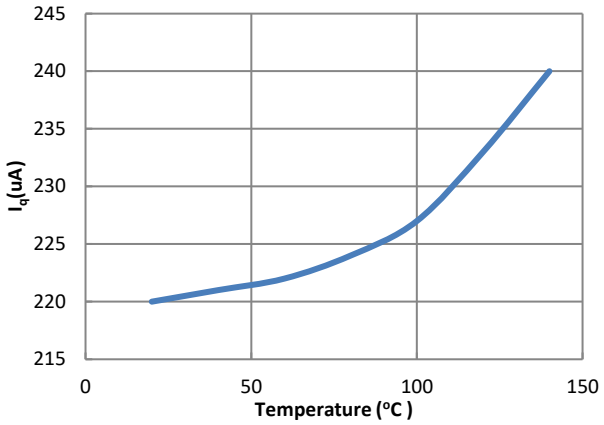


STRG Release (C_{STRG}=2200μF, PD=3W)

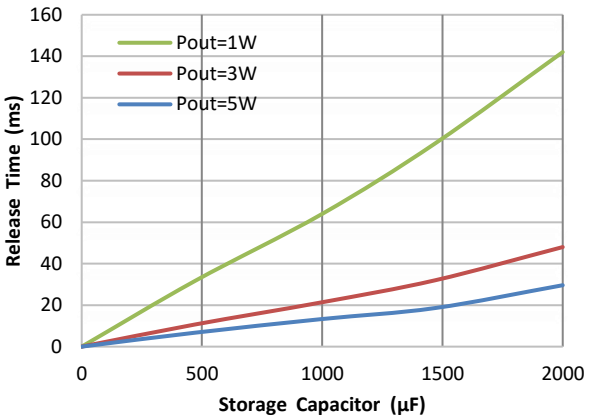


STRG Release (C_{STRG}=2200μF, PD=5W)

TYPICAL PERFORMANCE CHARACTERISTICS



I_q vs Temperature



Release Time vs Storage Cap

OPERATION DESCRIPTION

The TMI5111 is a dying gasp storage and release controller IC with internal power MOSFET and Diode. It offers a very compact solution to reduce the storage capacitor and keep the same release time when input is power off. During normal power on, it boosts input voltage and charges storage capacitor with a limited current about 300mA. When the charge voltage reaches the selected voltage set by FB1, the capacitor voltage is maintained until the low input voltage is detected, which is set by FB2. The TMI5111 release charge form storage capacitor to input capacitor with a limited current about 2A. The storage and release voltage can be programmed by user different external divided resistors of FB1 pin and FB2 pin.

Power on and Charge Storage Capacitor

During the system input voltage powers on, there are two periods to charge the storage capacitors. In the first period, the TMI5111 pre-charges the large storage capacitors from 0 to nearly VIN with built-in inrush current limit 300mA typically. The BST pin of TMI5111 should be connected to the system DC/DC switch node with RC components. After the DC/DC converter is enabled, the TMI5111 begins boosting $V_{STORAGE}$ voltage to the target value which is set by divider resistors on FB1 pin.

Power off and Release Storage Capacitor

During the normal operation, TMI5111 keeps monitoring the input voltage. Once the input voltage powers off and is lower than voltage set by divider resistor on FB2 pin, TMI5111 releases the charge from high voltage of storage capacitor to low input voltage capacitor. The maximum release current from storage to Vin can be as high as 2A typically. If the release current reaches the release current limit, release circuits will be disabled. When the storage capacitor voltage drops down to near the input voltage, the input voltage loses its regulation and drops further.

GASP Indicator

GASP is an open drain output pin. When the FB2 voltage is higher than 1.05 x V_{FB2}, the GASP pin will be pulled high. Connect a resistor across VIN and GASP can drive GASP high. When the FB voltage is lower than

1.0 x V_{FB2}, the GASP voltage will be internally pulled low. GASP voltage could be used as communication indicator signal which states input power availability.

APPLICATION INFORMATION

Set Storage Voltage

The storage voltage can be set by choosing appropriate external feedback divider resistors R1 and R2 on FB1 pin which is shown in Figure 2.

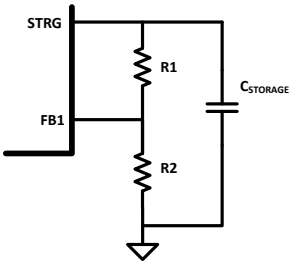


Figure 2. Feedback Divider Circuit for Storage Voltage

The storage capacitor voltage can be determined by the below equation:

$$V_{STORAGE} = (1 + \frac{R1}{R2}) \times V_{FB1}$$

Here is the example, if the storage voltage is set to be 18V, choose R2 to be 30kΩ, R1 will be:

$$R1 = \frac{30k\Omega \times (18 - V_{FB1})}{V_{FB1}} = 510k\Omega$$

Select Release Voltage and Input Capacitors

The release voltage can be set by appropriate external feedback divider resistors R3 and R4 on FB2 pin.

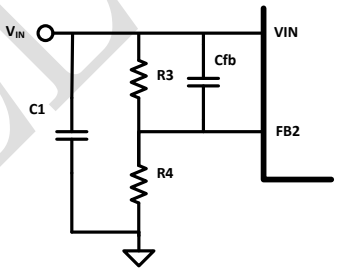


Figure 3. Feedback Divider Circuit for Release Voltage

As shown in Figure 3, the release voltage is set by:

$$V_{RELEASE} = (1 + \frac{R3}{R4}) \times V_{FB2}$$

However, the selection of R3 and R4 not only determines the release voltage, but impacts the stability. Generally, choosing R3 to be 300kΩ~500kΩ is recommended for a stable performance with 22uF or 47μF C_{IN}. A 15pF feedforward capacitor Cfb paralleling with R3 is helpful for stability of the release circuits.

Select Storage Capacitor

The Storage Capacitor is for energy storage during normal operation and the energy will be released to VIN in case of losing input power. Typically, a general purpose electrolytic capacitor is recommended. The

voltage rating of storage capacitor needs to be higher than the targeted storage voltage. The voltage rating of storage capacitor can be fully utilized since the voltage on storage capacitor is very stable during normal operation. There will be less ripple current/voltage for most of the time during normal operation. The ripple current rating of storage cap can be less consideration. The needed capacitance is dependent on how long the dying gasp time based on typically application. Assume the input release current is IRELEASE when input voltage is regulated at $V_{RELEASE}$ for the DC/DC converter. The storage voltage of TMI5111 is VSTORAGE, and the required dying gasp time is T_{DASP}. The necessary storage capacitance can be calculated as following equation:

$$C_{STRG} = \frac{I_{RELEASE} \times T_{DASP}}{V_{STORAGE} - V_{RELEASE}}$$

For example, If $I_{RELEASE}$=1A, T_D=20ms, $V_{STORAGE}$=18V, $V_{RELEASE}$=10V, the needed storage capacitance is about 2000μF. Generally, the storage capacitance should be chosen a little bit large to avoid capacitance reduction at high voltage offset. In typical xDSL applications using a 12V input supply, it is recommended to set the storage voltage higher than 20V to fully utilize the high voltage energy and minimize storage capacitance requirements. Generally, a 25V rated electrolytic capacitor can be used. The lifetime of electrolytic capacitors can be severely impacted by both environmental and electrical factors. One of the most critical electrical factors is the AC RMS ripple current through the capacitor which leads to increased capacitor core temperatures. Normally, for typical industrial uses, it is recommended to de-rate the capacitor voltage rating by as much as 70%-80%. For example, a 25V rated electrolytic capacitor would be used for a 16V to 20V application. However, since the TMI5111 tightly regulates the storage voltage, the storage capacitor almost has no AC ripple current going through it. The resulting refresh rate of the TMI5111 is very low which allows customers to safely use a 90% capacitor derating. For example, a 25V electrolytic capacitor, can safely handle a storage voltage of up to 22V. Table 3 is some recommended storage electrolytic capacitors which can be used in typical xDSL application.

PCB Layout Guide

PCB layout is very important to achieve stable operation. Please follow these guidelines and take the DEMO board layout for references.

1) Connect the BST pin as close as possible to the SW node of DCDC converter through a resistor and a small ceramic capacitor. Try to avoid interconnect the feedback path.

2) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.

3) Keep the connection of the storage capacitors and STRG pin as short and wide as possible.

TYPICAL APPLICATION CIRCUITS

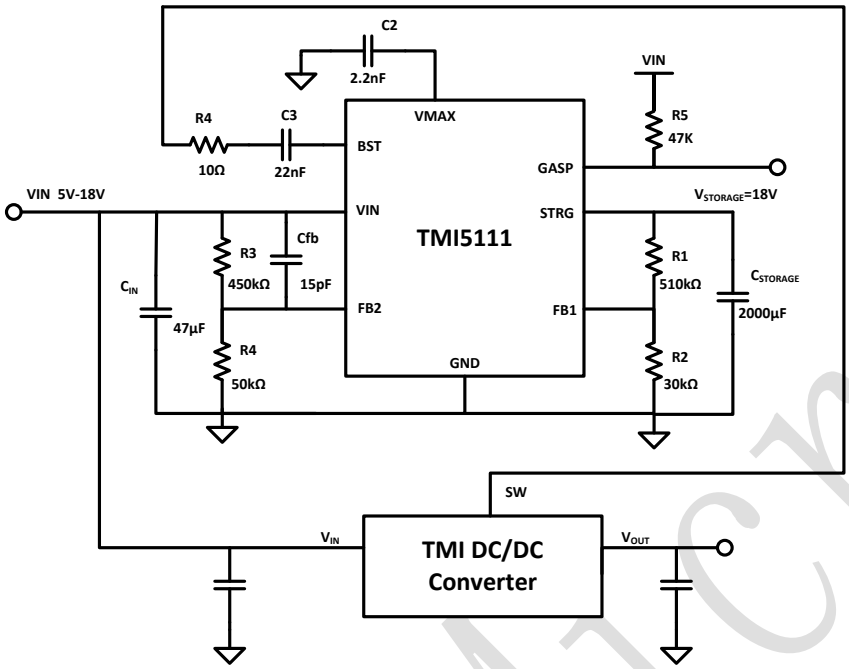


Figure 4. TMI5111 Typical Application Circuit

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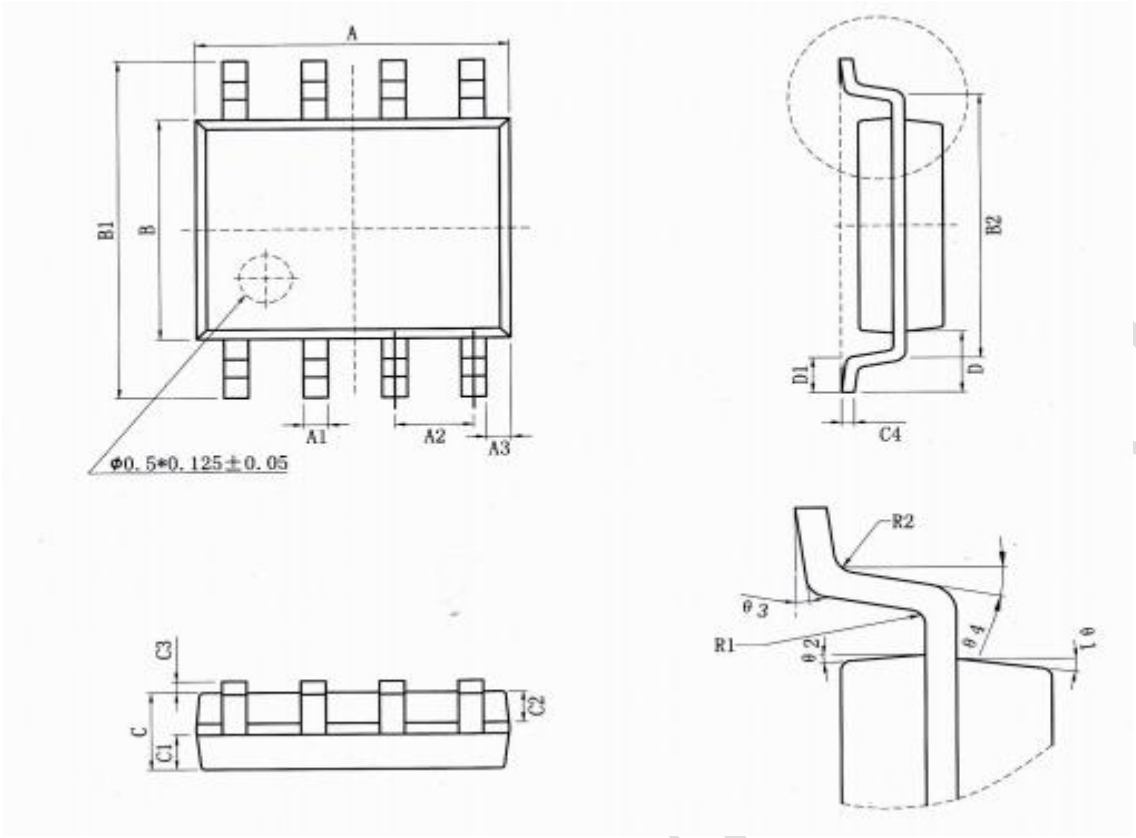
PACKAGE INFORMATION



DIMENSION / SYMBOL	MIN (mm)	MAX (mm)	DIMENSION / SYMBOL	MIN (mm)	MAX (mm)
A	4.80	5.00	C3	0.05	0.20
A1	0.356	0.456	C4	0.203	0.233
A2	1.27TYP		D	1.05TYP	
A3	0.345TYP		D1	0.40	0.60
B	3.80	4.00	R1	0.20TYP	
B1	5.80	6.20	R2	0.20TYP	
B2	5.00TYP		θ1	17° TYP4	
C	1.30	1.55	θ2	13° TYP4	
C1	0.55	0.65	θ3	0° ~ 8°	
C2	0.55	0.65	θ4	4° ~ 12°	

SOP8

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