JW5022

2A, 20V Synchronous Step-Down Converter

Parameters Subject to Change Without Notice

FEATURES

- 4.6V to 20V operating input range
  2A output current
- Up to 94% efficiency
- High efficiency (>85%) at light load
- Adjustable Soft-Start
- Fixed 340kHz Switching frequency
- Input under voltage lockout
- Available in SOP8 package
- Start-up current run-away protection
- Short circuit protection
- Thermal protection

APPLICATIONS

- Distributed Power Systems
- Networking Systems
- FPGA, DSP, ASIC Power Supplies
- Green Electronics/ Appliances
- Notebook Computers

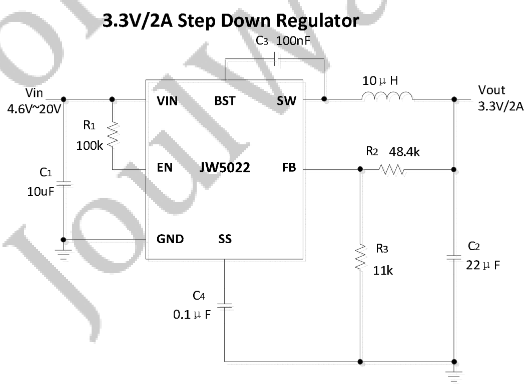
DESCRIPTION

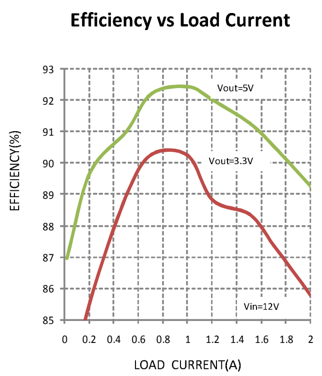
The JW5022 is a current mode monolithic buck switching regulator. Operating with an input range of 4.6V~20V, the JW5022 delivers 2A of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. At light loads, regulators operate in low frequency to maintain high efficiency and low output ripple. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The JW5022 guarantees robustness with short-circuit protection, thermal protection, start-up current run-away protection, and input under voltage lockout.

The JW5022 is available in an 8-pin SOP package, which provides a compact solution with minimal external components.

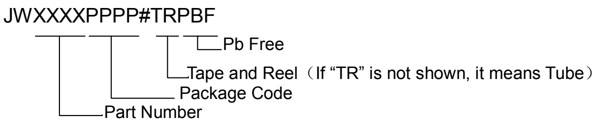
TYPICAL APPLICATION



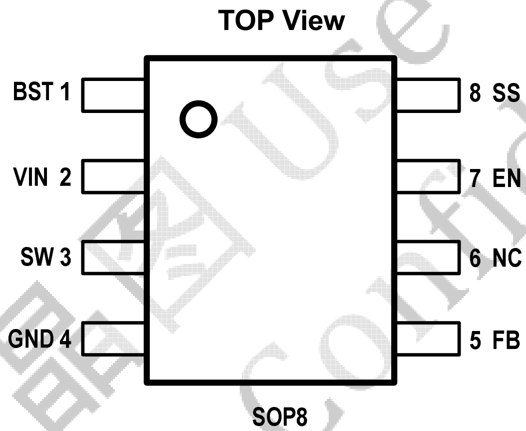


ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PACKAGE	TOP MARKING	JUNCTION TEMPERATURE RANGE
JW5022SOPB#PBF	JW5022SOPB#TRPBF	SOP8	JW5022	－40 °C to 150 °C



PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING[1)]

VIN, EN, SW Pin .... -0.3V to 22V
BST Pin .... SW-0.3V to SW+5V
All other Pins .... -0.3V to 6V
Junction Temperature[2) 3)] .... 150°C
Lead Temperature .... 260 °C
Storage Temperature .... −65 °C to +150 °C

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN .... 4.6V to 20V
Output Voltage Vout............... 0.8V to 17V
Operating Junction Temperature... -40°C to125°C

THERMAL RESISTANCE[4)]

	θ_{JA}	θ_{Jc}	
ESOP8	90....	45..	°C /W

Note:

1) Exceeding these ratings may damage the device.
2) The JW5022 guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.
3) The JW5022 includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.
4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARATERISTICS

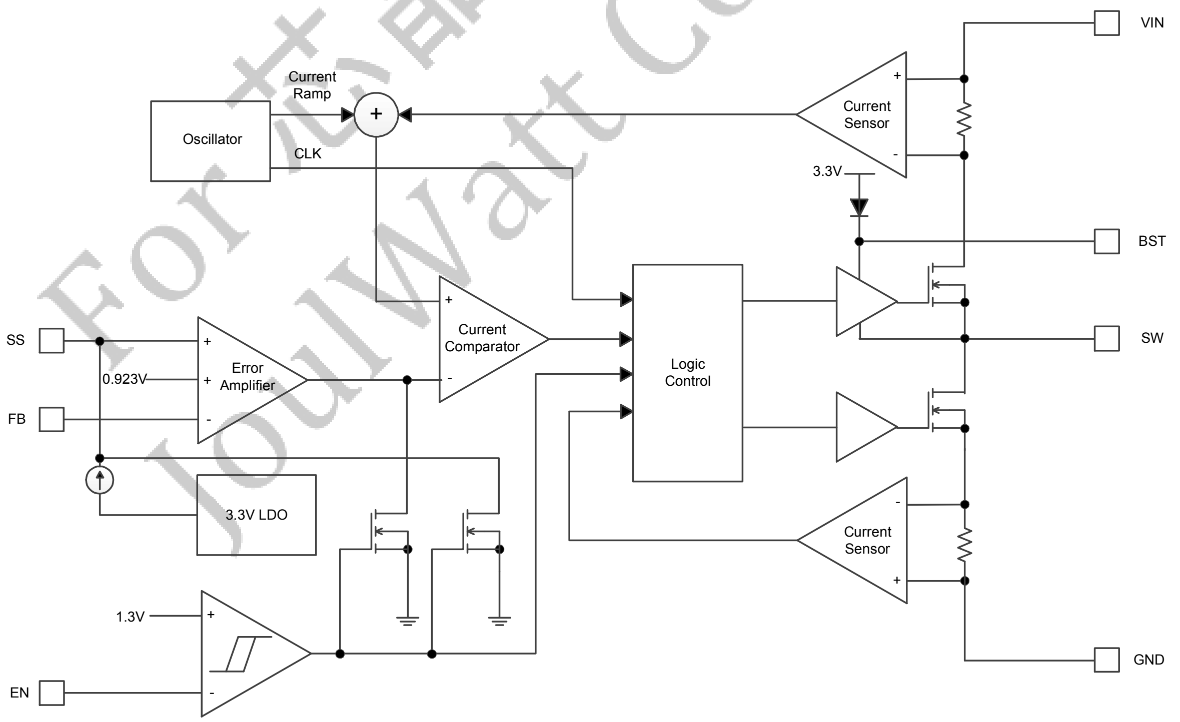
V_{IN} = 12V, T_A = 25ºC, unless otherwise stated.

Item	Symbol	Condition	Min.	Typ.	Max.	Units
V_{IN} Undervoltage Lockout Thershold	V_{IN_MIN}	V_{IN} falling		3.6		V
V_{IN} Undervoltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$	V_{IN} rising		650		mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V			1	μA
Supply Current	I_Q	V_{EN}=5V, V_{FB}=2V		55		μA
Feedback Voltage	V_{FB}	3.6V<V_{VIN}<20V		0.923		V
Top Switch Resistance	$R_{DS(ON)T}$			185		mΩ
Bottom Switch Resistance	$R_{DS(ON)B}$			100		mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=20V, V_{EN}=0V, V_{SW}=0V			0.5	uA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}= V_{SW} =20V, V_{EN}=0V,			0.5	uA
Top Switch Current Limit	I_{LIM_TOP}	Minimum Duty Cycle		2.9		A
Switch Frequency	f_{SW}			340		kHz
Minimum On Time	T_{ON_MIN}			120		ns
Minimum Off Time	T_{OFF_MIN}	V_{FB}=0V		120		ns
EN shut down threshold voltage	V_{EN_TH}	V_{EN} falling, FB=0V		1.2		V
EN shut down hysteresis	V_{EN_HYST}	V_{EN} rising, FB=0V		80		mV
Soft-Start Current	I_{SS}	SS=0V		9		μA
Thermal Shutdown	T_{TSD}			140		℃

PIN DESCRIPTION

SOP8 Pin	Name	Description
1	BST	Bootstrap pin for top switch. A 0. 1uF or larger capacitor should be connected between this pin and SW pin to supply current to the top switch and top switch driver.
2	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.6V to 20V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
3	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
4	PGND	Power ground pin.
5	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.923V. Connect a resistive divider at FB.
6	NC	No Connection.
7	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
8	SS	Soft-start pin. SS controls the rate at which the output voltage rises. Connect a capacitor at SS pin to ground to set the soft-start period.

BLOCK DIAGRAM



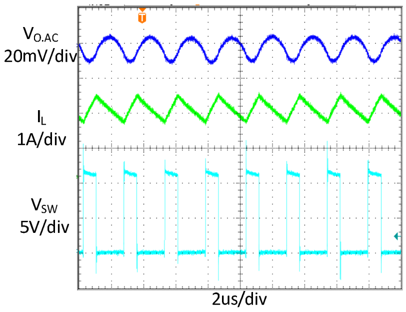
TYPICAL PERFORMANCE CHARACTERISTICS

Vin = 12V, Vo = 3.3V, L = 10μH, Cout = 47μF, TA = +25°C, unless otherwise noted

Steady State Test

VIN=12V, Vout=3.3V

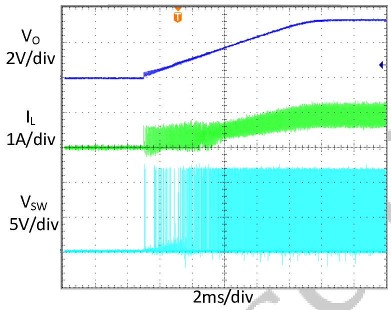
Iout=2A,I_{in}=0.65A



Startup through Enable

VIN=12V, Vout=3.3V

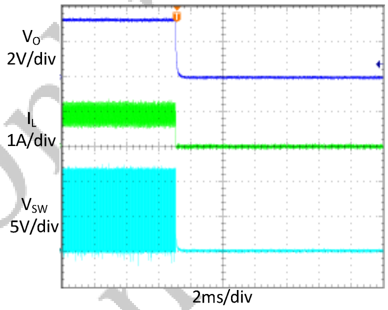
Iout=1A(Resistance load)



Shutdown through Enable

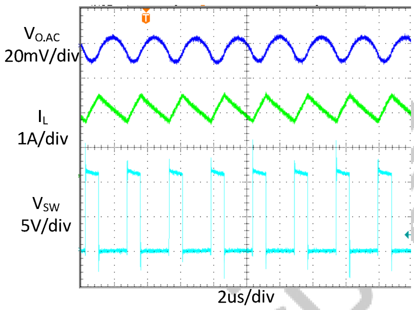
VIN=12V, Vout=3.3V

Iout=1A(Resistance load)



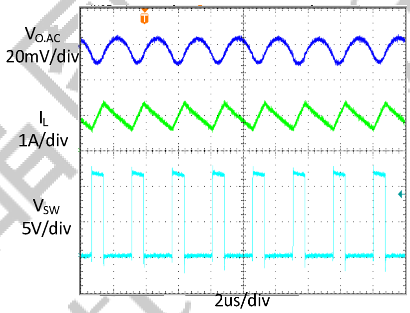
Heavy Load Operation

2A LOAD



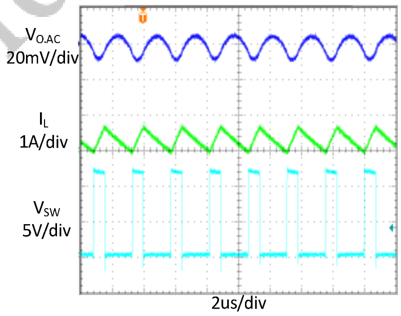
Medium Load Operation

1A LOAD

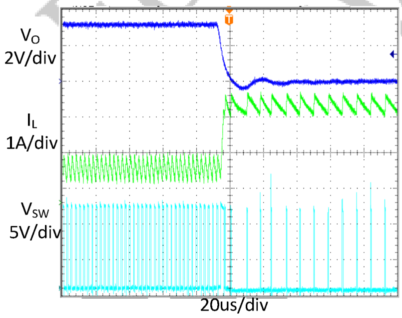


Light Load Operation

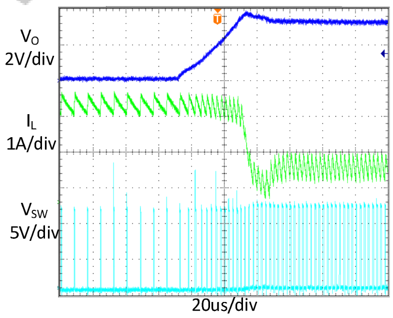
0.3A LOAD



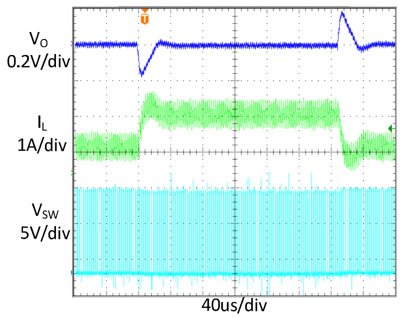
Short Circuit Protection



Short Circuit Recovery



Load Transient



FUNCTIONAL DESCRIPTION

The JW5022 is a synchronous, current-mode, step-down regulator. It regulates input voltage from 4.6V to 20V down to an output voltage as low as 0.923V, and is capable of supplying up to 2A of load current.

Current-Mode Control

The JW5022 utilizes current-mode control to regulate the output voltage. The output voltage is measured at the FB pin through a resistive voltage divider and the error is amplified by the internal transconductance error amplifier.
Output of the internal error amplifier is compared with the switch current measured internally to control the output current limit.

PFM Mode

The JW5022 operates in PFM mode at light load. In PFM mode, switch frequency is continuously controlled in proportion to the load current, i.e. switch frequency is decreased when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency is increased when load current rises, minimizing both load current and output voltage ripples.

Shut-Down Mode

The JW5022 operates in shut-down mode when voltage at EN pin is driven below 0.3V. In shut-down mode, the entire regulator is off and the supply current consumed by the JW5022 drops below 1uA.

Power Switch

N-Channel MOSFET switches are integrated on the JW5022 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.3V rail when SW is low.

Vin Under-Voltage Protection

A resistive divider can be connected between Vin and ground, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductance can be easily built up, resulting in a large start-up output current. A valley current limit is designed in the JW5022 so that only when output current drops below the valley current limit can the bottom power switch be turned off. By such control mechanism, the output current at start-up is well controlled.

Output Short Protection

When output is shorted to ground, output current rapidly reaches its peak current limit and the top power switch is turned off. Right after the top power switch is turned off, the bottom power switch is turned on and stay on until the output current falls below the valley current limit. When output current is below the valley current limit, the top power switch will be turned on again and if the output short is still present, the top power switch is turned off when the peak current limit is reached and the bottom power switch is turned on. This cycle goes on until the output short is removed and the regulator comes into normal operation again.

Thermal Protection

When the temperature of the JW5022 rises above 140°C, it is forced into thermal shut-down. Only when core temperature drops below 125°C can the regulator becomes active again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} \cdot \frac{R_3}{R_2 + R_3}$$

where V_{FB} is the feedback voltage and V_{OUT} is the output voltage.

Choose R_3 around 10kΩ, and then R_2 can be calculated by:

$$R_2 = R_3 \cdot \left(\frac{V_{OUT}}{0.923\,V} - 1\right)$$

The following table lists the recommended values.

VOUT(V)	R2(kΩ)	R3(kΩ)
2.5	10	17
3.3	10	26.1
5	11	48.4

Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The ripple current through the input capacitor can be calculated by:

$$I_{C1} = I_{LOAD} \cdot \sqrt{\frac{V_{OUT}}{V_{IN}} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

where I_{LOAD} is the load current, V_{OUT} is the output voltage, V_{IN} is the input voltage.

Thus the input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$C_1 = \frac{I_{LOAD}}{f_S \cdot \Delta V_{IN}} \cdot \frac{V_{OUT}}{V_{IN}} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where C_1 is the input capacitance value, f_S is the switching frequency, $\triangle V_{IN}$ is the input ripple current.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 10uF ceramic capacitor is recommended in typical application.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \cdot L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \cdot \left(R_{ESR} + \frac{1}{8 \cdot f_S \cdot C_2}\right)$$

where C_2 is the output capacitance value and R_{ESR} is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The output capacitors also affect the system stability and transient response, and a 22uF ceramic capacitor is recommended in typical application.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 30% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_S \cdot \Delta I_L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where V_{IN} is the input voltage, V_{OUT} is the output voltage, fs is the switching frequency, and △I_L is the peak-to-peak inductor ripple current.

External Boostrap Capacitor

A boostrap capacitor is required to supply voltage to the top switch driver. A 0.1uF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

External Soft-start Capacitor

A soft-start capacitor is required to set the soft-start period，which controls the rate of the output voltage rise. Take the startup current and voltage rise rate into consideration, a 0.1uF ceramic capacitor is recommended.

PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to JW5022 (VIN pin and PGND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the feedback trace as far away from the inductor and noisy power traces as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.

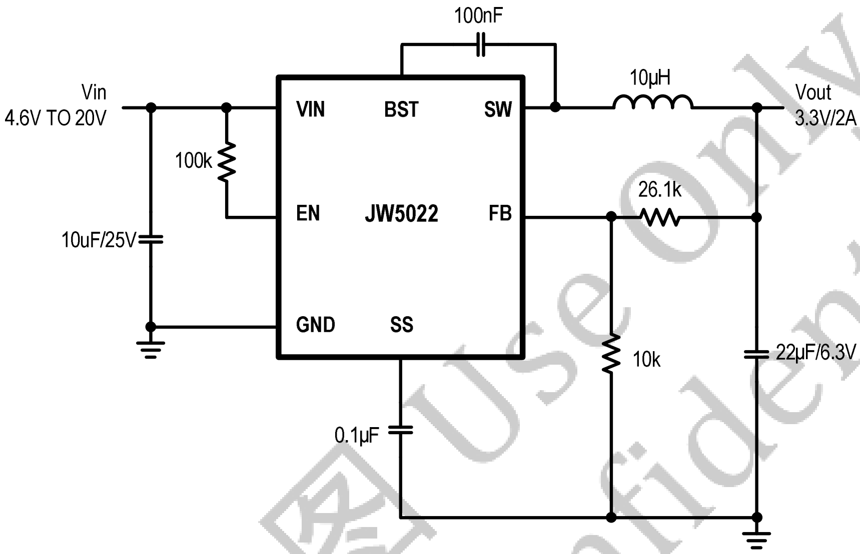
REFERENCE DESIGN

Reference 1:

V_{IN}: 4.6V ~ 20 V

V_{OUT}: 3.3V

I_{OUT}: 0~2A

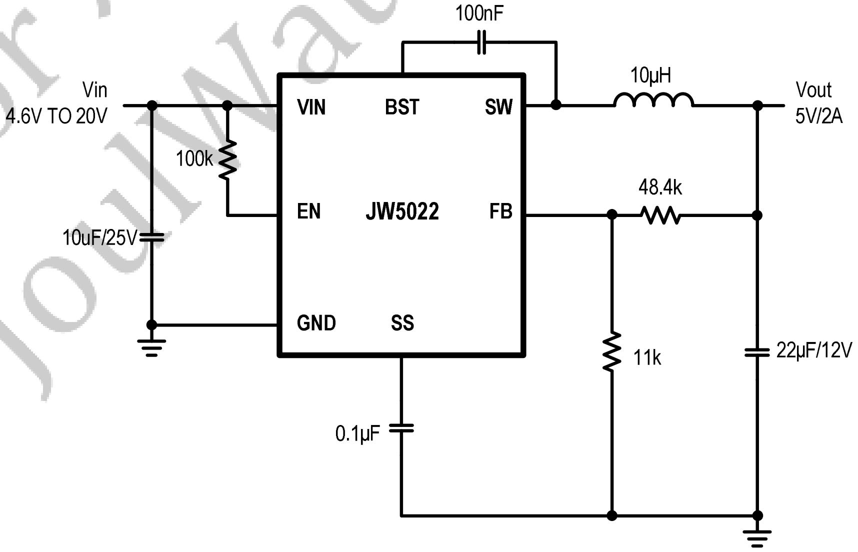


Reference 2:

V_{IN}: 4.6V ~ 20 V

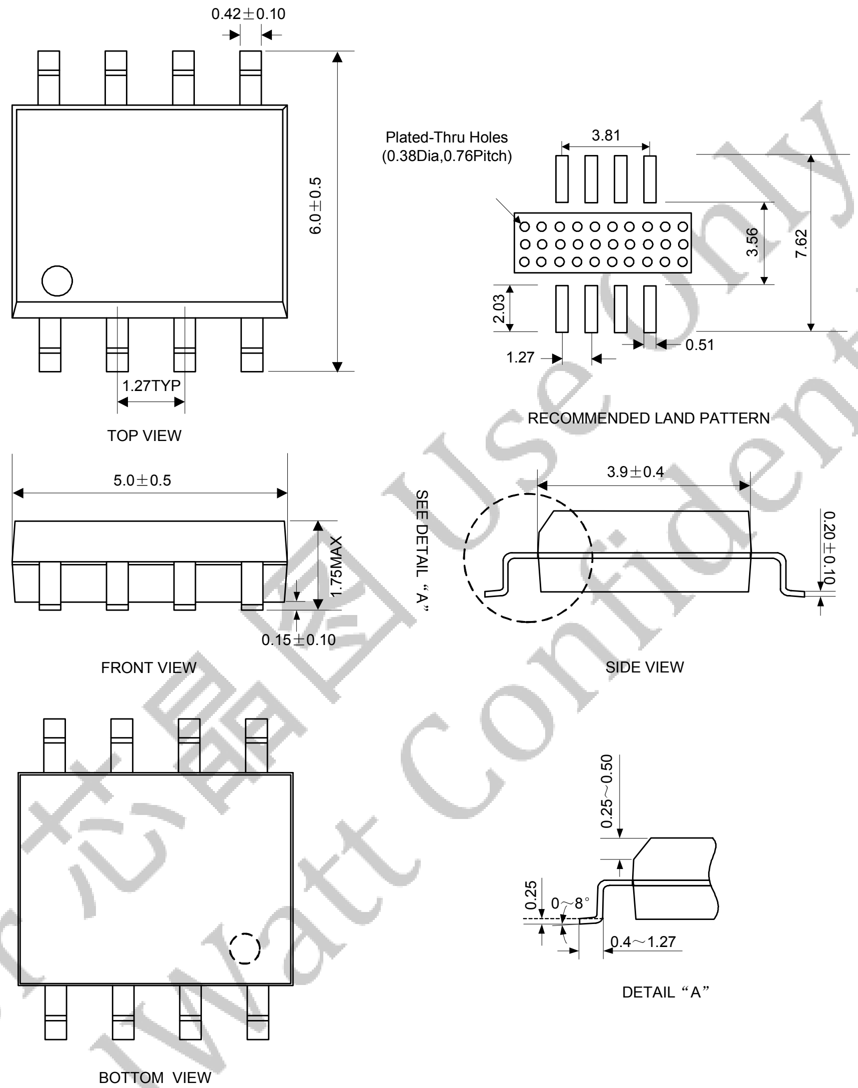
V_{OUT}: 5V

I_{OUT}: 0~2A



PACKAGE OUTLINE

SOP8	UNIT: mm



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