

*Preliminary Specifications Subject to Change without Notice*

## DESCRIPTION

The JW<sup>®</sup>5071 is a current mode monolithic buck voltage converter. Operating with an input range of 4.5V-28V, the JW5071 delivers 2A of continuous output current with two integrated N-Channel MOSFETs. At light loads, regulators operate in low frequency to maintain high efficiency.

The JW5071 guarantees robustness with short circuit protection, thermal protection, current run-away protection, and input under voltage lockout.

The JW5071 is available in a 6-pin SOT23-6 package, which provides a compact solution with minimal external components.

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## FEATURES

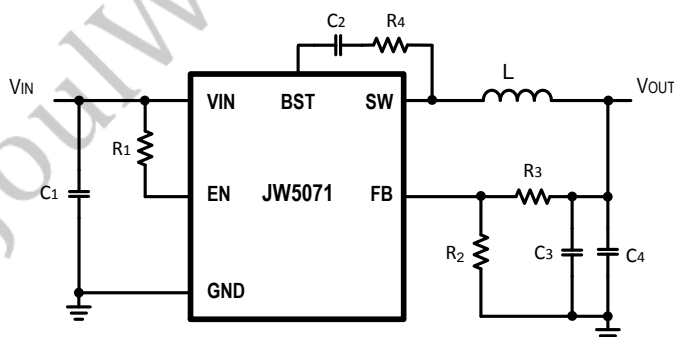
- 4.5V to 28V operating input range
- 2A output current
- Up to 93% efficiency
- High efficiency at light load
- 600kHz switching frequency
- Input under voltage lockout
- Start-up current run-away protection
- Over current protection and hiccup
- Thermal protection
- Available in SOT23-6 package

## APPLICATIONS

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

## TYPICAL APPLICATION

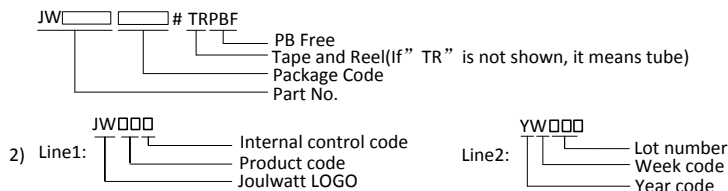
### 2A Step Down Regulator



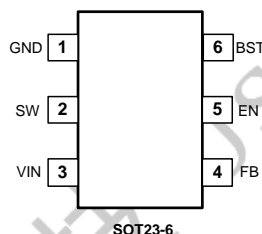
## ORDER INFORMATION

DEVICE <sup>1)</sup>	PACKAGE	TOP MARKING <sup>2)</sup>
JW5071SOTB#TRPBF	SOT23-6	JWDY□ YW□□□

## Notes:



## PIN CONFIGURATION

ABSOLUTE MAXIMUM RATING<sup>1)</sup>

VIN, EN Pin .....	-0.3V to 30V
SW.....	-0.3V(-5V for 20ns) to 30V(32V for 20ns)
BST Pin.....	SW-0.3V to SW+5.5V
All Other Pins .....	-0.3V to 6V
Junction Temperature <sup>2)</sup> .....	150°C
Lead Temperature .....	260°C
Storage Temperature.....	-65 °C to +150 °C

RECOMMENDED OPERATING CONDITIONS<sup>3)</sup>

Input Voltage V <sub>IN</sub> .....	4.5V to 28V
Output Voltage V <sub>OUT</sub> .....	0.6V to V <sub>IN</sub> *Dmax
Operating Junction Temperature.....	-40 °C to +125 °C

THERMAL PERFORMANCE<sup>4)</sup> $\theta_{JA}$   $\theta_{JC}$ 

SOT23-6.....	220...130°C/W
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## Note:

- Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.
- The JW5071 includes thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.
- The device is not guaranteed to function outside of its operating conditions.
- Measured on JESD51-7, 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

$V_{IN}=12V$ , $T_A=25^{\circ}C$ , unless otherwise stated.						
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
$V_{IN}$ Under Voltage Lock-out Threshold	$V_{IN\_MIN}$	$V_{IN}$ rising	3.95	4.2	4.45	V
$V_{IN}$ Under Voltage Lock-out Hysteresis	$V_{IN\_MIN\_HYST}$			400		mV
Shutdown Supply Current	$I_{SD}$	$V_{EN}=0V$			3	$\mu A$
Supply Current	$I_Q$	$V_{EN}=5V$ , $V_{FB}=1.2V$		110	130	$\mu A$
Feedback Voltage	$V_{FB}$	$-40^{\circ}C \leq T_J \leq 125^{\circ}C$	588	600	612	mV
Top Switch Resistance	$R_{DS(ON)T}$			90		m $\Omega$
Bottom Switch Resistance	$R_{DS(ON)B}$			78		m $\Omega$
Top Switch Leakage Current	$I_{LEAK\_TOP}$	$V_{IN}=28V$ , $V_{EN}=0V$ , $V_{SW}=0V$		0.1	1	$\mu A$
Bottom Switch Leakage Current	$I_{LEAK\_BOT}$	$V_{IN}=28V$ , $V_{EN}=0V$ , $V_{SW}=28V$		0.1	1	$\mu A$
Top Switch Current Limit	$I_{LIM\_TOP}$	Minimum Duty Cycle	3	4	5	A
Switching Frequency	$F_{SW}$		450	600	750	kHz
Minimum On Time <sup>5)</sup>	$T_{ON\_MIN}$			100		ns
Minimum Off Time	$T_{OFF\_MIN}$	$V_{FB}=0.4V$		120		ns
EN Rising Threshold	$V_{EN\_H}$	$V_{EN}$ rising		1.2	1.35	V
EN Falling Threshold	$V_{EN\_L}$	$V_{EN}$ falling	1.0	1.1		V
EN Hysteresis	$V_{EN\_HYST}$			100		mV
Soft-Start Time <sup>5)</sup>	$t_{SS}$			1		ms
Thermal Shutdown <sup>5)</sup>	$T_{TSD}$			150		$^{\circ}C$
Thermal Shutdown Hysteresis <sup>5)</sup>	$T_{TSD\_HYST}$			20		$^{\circ}C$

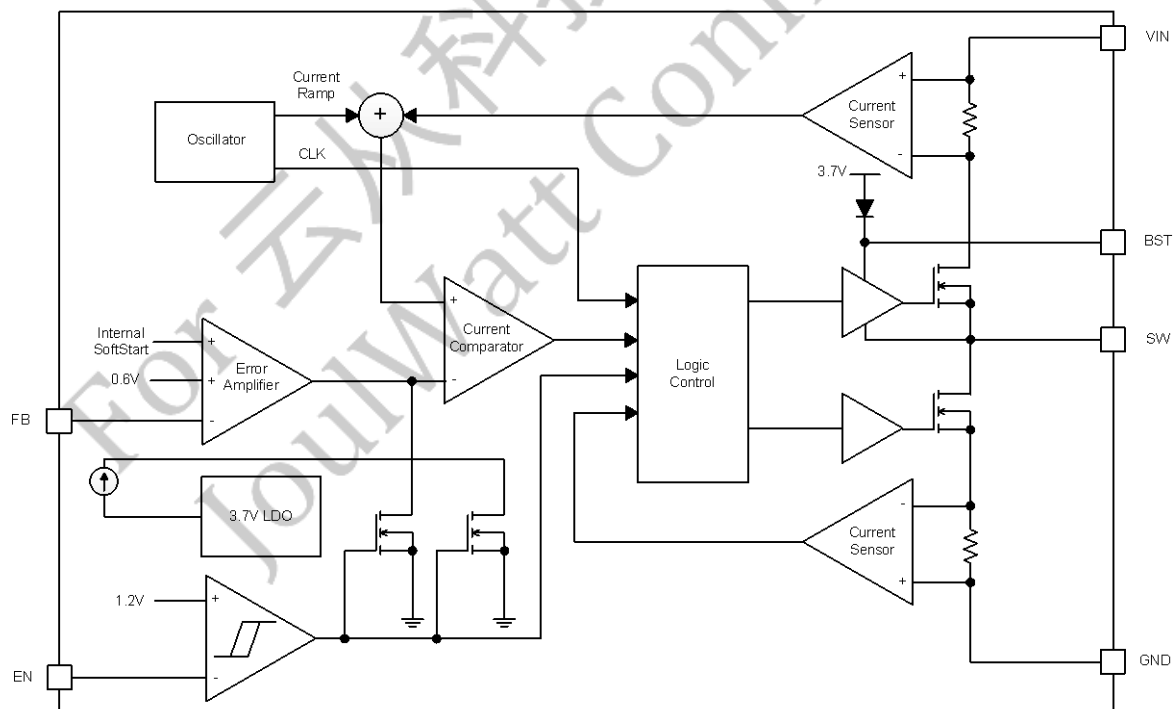
**Note:**

5) Guaranteed by design.

## PIN DESCRIPTION

SOT23-6 Pin	Name	Description
1	GND	Ground.
2	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
3	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.5V to 28V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
4	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.6V. Connect a resistive divider at FB.
5	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
6	BST	Bootstrap pin for top switch. A 0.1uF or larger capacitor and a 10Ω resistor should be connected between this pin and the SW pin to supply current to the top switch and top switch driver.

## BLOCK DIAGRAM

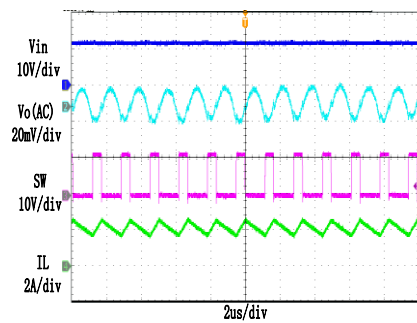


## TYPICAL PERFORMANCE CHARACTERISTICS

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$ ,  $L = 4.7\mu H$ ,  $C_{OUT} = 22\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted

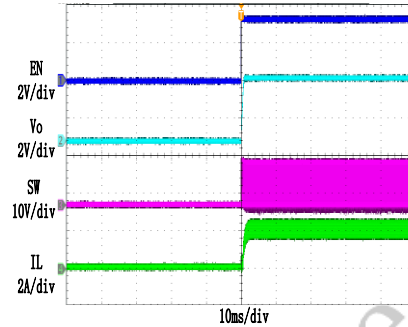
### Steady State Test

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$   
 $I_{OUT} = 2A$



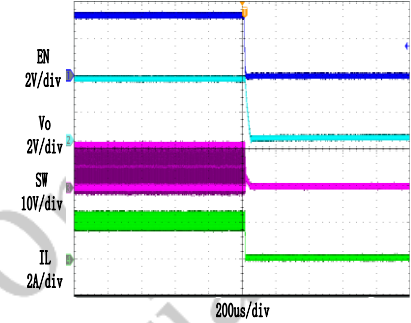
### Startup through Enable

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$   
 $I_{OUT} = 2A$  (Resistive load)



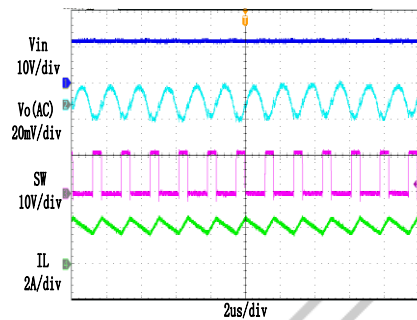
### Shutdown through Enable

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$   
 $I_{OUT} = 2A$  (Resistive load)



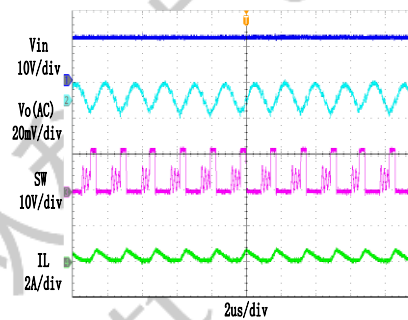
### Heavy Load Operation

2A LOAD



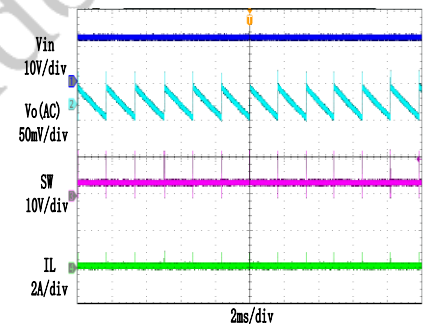
### Medium Load Operation

0.2A LOAD



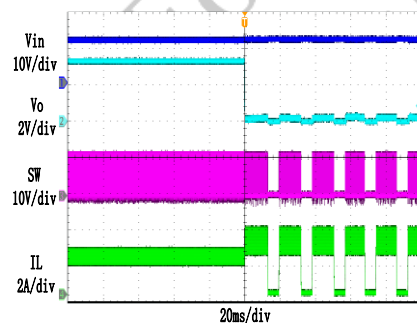
### Light Load Operation

0 A LOAD



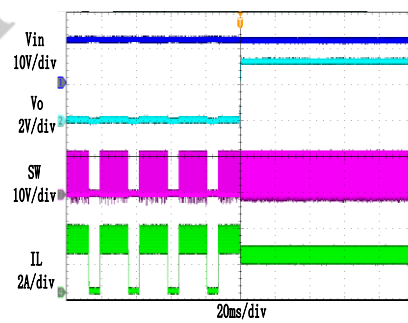
### Short Circuit Protection

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$   
 $I_{OUT} = 2A$  - Short



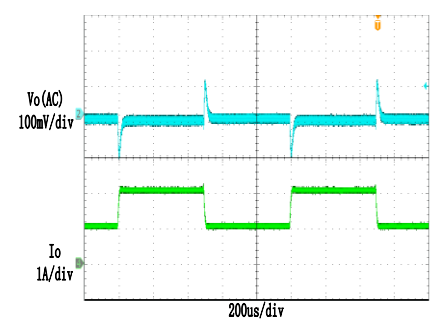
### Short Circuit Recovery

$V_{IN} = 12V$ ,  $V_{OUT} = 3.3V$   
 $I_{OUT} = \text{Short} - 2A$



### Load Transient

1A LOAD  $\rightarrow$  2A LOAD  $\rightarrow$  1A LOAD



## TYPICAL PERFORMANCE CHARACTERISTICS

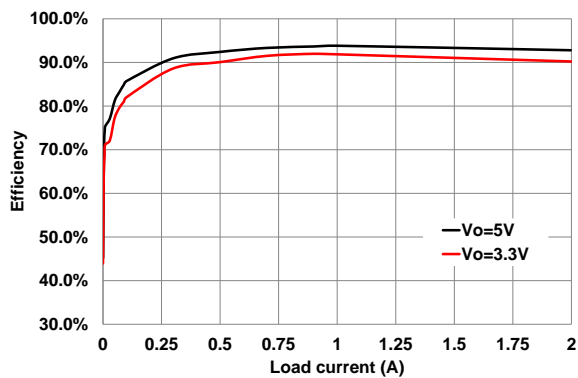


Figure 1. Efficiency vs Load Current  
( $V_{in}=12V$ ,  $L=4.7\mu H$ )

## FUNCTIONAL DESCRIPTION

The JW5071 is a synchronous, current-mode, step-down regulator. It regulates input voltages from 4.5V to 28V down to an output voltage as low as 0.6V, and is capable of supplying up to 2A of load current.

### Current-Mode Control

The JW5071 utilizes current-mode control to regulate the FB voltage. Voltage at the FB pin is regulated at 0.6V so that by connecting an appropriate resistive divider between  $V_{OUT}$  and GND, designed output voltage can be achieved.

### PFM Mode

The JW5071 operates in PFM mode at light load. In PFM mode, switch frequency decreases when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency increases when load current rises, minimizing output voltage ripples.

### Internal Soft-Start

Soft-Start makes output voltage rising smoothly follow an internal SS voltage until SS voltage is higher than the internal reference voltage. It can prevent overshoot of output voltage when startup.

### Power Switch

N-Channel MOSFET switches are integrated on the JW5071 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 3.7V rail when SW is low.

### $V_{IN}$ Under-Voltage Protection

A resistive divider can be connected between  $V_{IN}$  and GND, with the central tap connected to EN, so that when  $V_{IN}$  drops to the pre-set value, EN drops below 1.1V 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 JW5071 so that only when output current drops below the valley current limit can the top power switch be turned on. By such control mechanism, the output current at start-up is well controlled.

### Over Current Protection and Hiccup

JW5071 has a cycle-by-cycle current limit. When the inductor current triggers current limit, JW5071 enters hiccup mode and periodically restart the chip.

JW5071 will exit hiccup mode while not triggering current limit.

### Thermal Protection

When the temperature of the JW5071 rises above 150°C, it is forced into thermal shut-down.

Only when core temperature drops below 130°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:

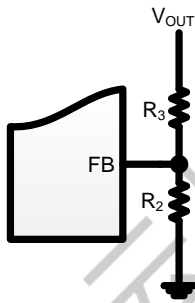
$$V_{FB} = V_{OUT} \cdot \frac{R_2}{R_2 + R_3}$$

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

If  $R_2$  is determined, and then  $R_3$  can be calculated by:

$$R_3 = R_2 \cdot \left( \frac{V_{OUT}}{0.6} - 1 \right)$$

For better noise immunity, when input voltage is high (e.g. above 18V), the value of low side divider resistor  $R_2$  is strongly recommended to be no larger than 3k $\Omega$ .



### 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,  $\Delta V_{IN}$  is the input ripple voltage.

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

A 22 $\mu$ F/25V 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:

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

where  $C_{OUT}$  ( $C_3/C_4$ ) 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 22 $\mu$ F~44 $\mu$ F ceramic capacitor is recommended in typical application.

### Inductor

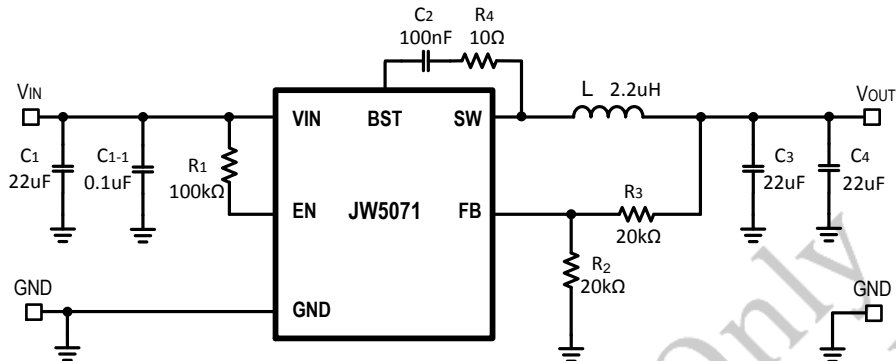
The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the



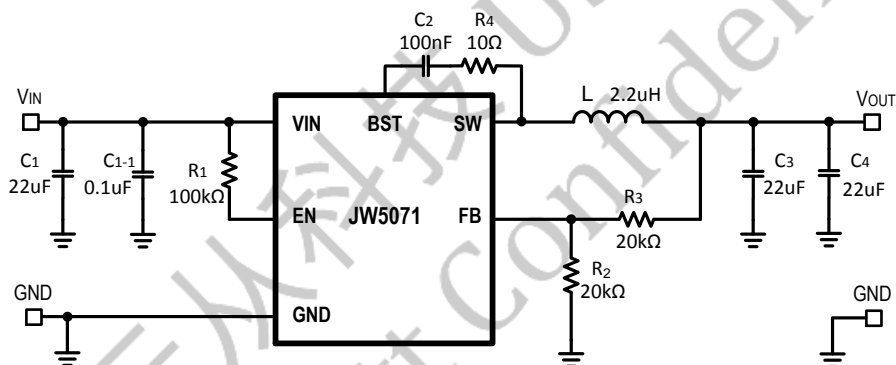


## REFERENCE DESIGN

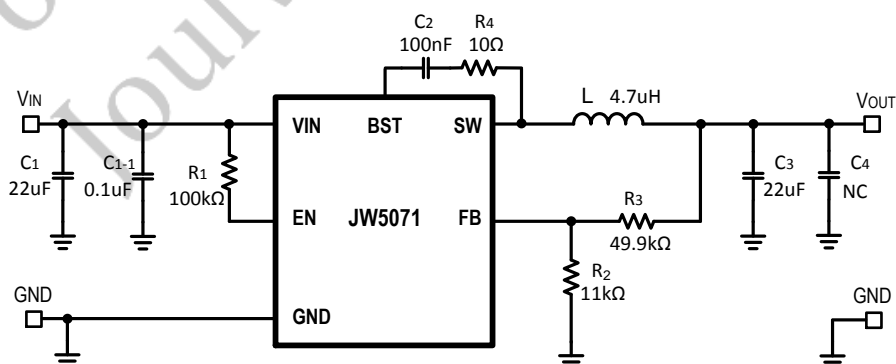
## Reference 1:

Figure 3:  $V_{IN}=5V$ ,  $V_{OUT}=1.2V/2A$ 

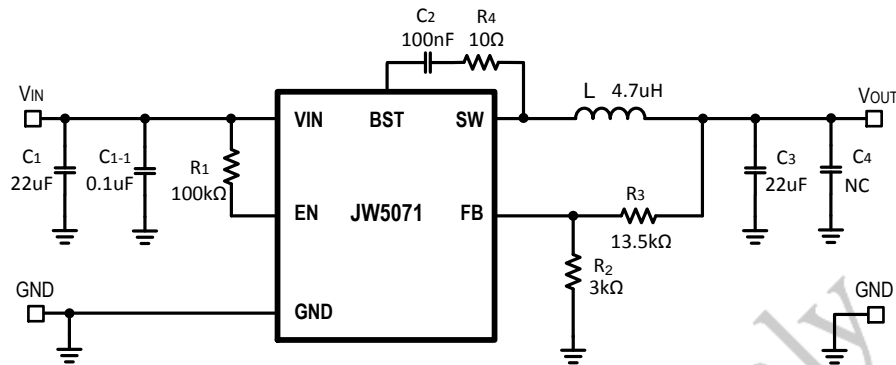
## Reference 2:

Figure 4:  $V_{IN}=12V$ ,  $V_{OUT}=1.2V/2A$ 

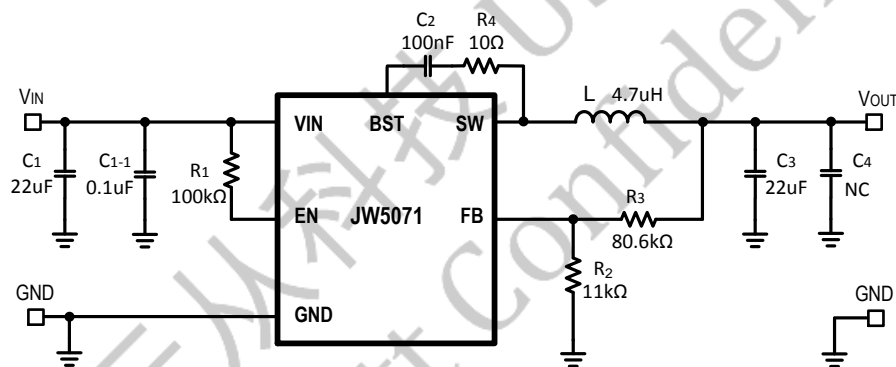
## Reference 3:

Figure 5:  $V_{IN}=12V$ ,  $V_{OUT}=3.3V/2A$

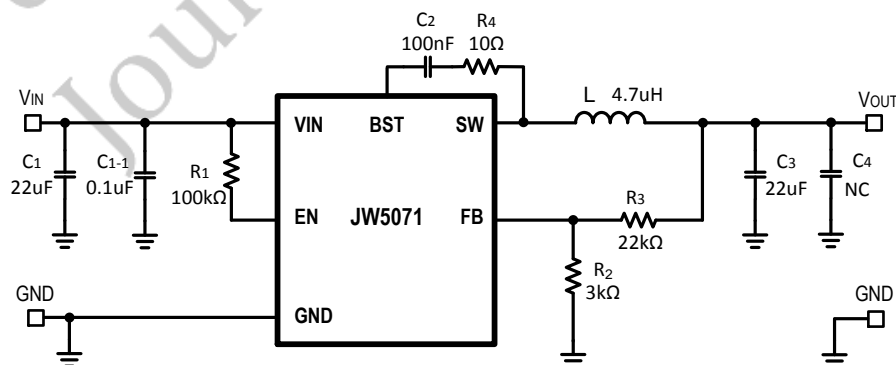
## Reference 4:



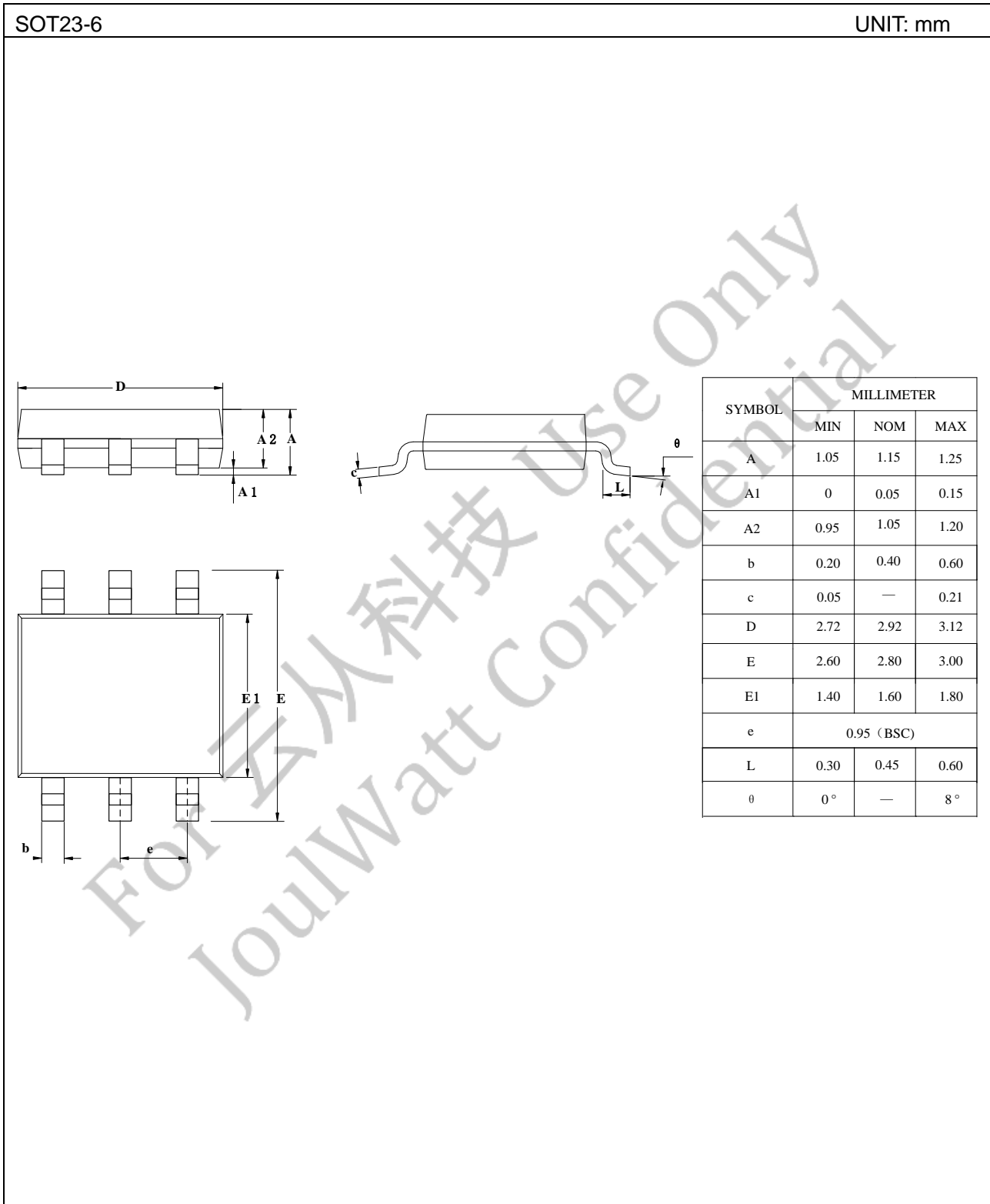
## Reference 5:



## Reference 6:



PACKAGE OUTLINE



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