JW5061TC/JW5061TF

18V/3A

Sync. Step-Down Converter

Preliminary Specifications Subject to Change without Notice

DESCRIPTION

The JW®5061TC and JW®5061TF are monolithic buck switching regulators based on I2 architecture for fast transient response. Operating with an input range of 4.5V~18V, JW5061TC and JW5061TF deliver 3A 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, JW5061TC operates in low frequency to maintain high efficiency.

JW5061TC and JW5061TF guarantees robustness with output short protection, thermal protection, current run-away protection and input under voltage lockout.

JW5061TC and JW5061TF are available in SOT23-6 package, which provide a compact solution with minimal external components.

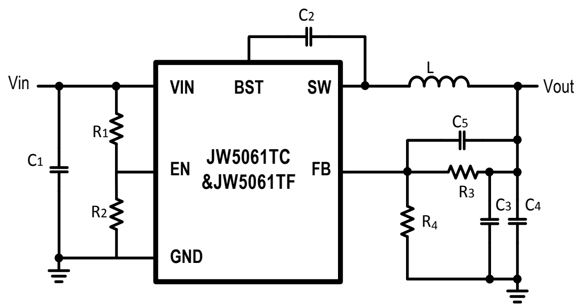
FEATURES

- 4.5V to 18V operating input range
  3A output current
- Up to 95% efficiency
- FCCM at light load (JW5061TF)
- PFM at light load (JW5061TC)
- 600kHz switching frequency
- Internal soft-start
- Input under voltage lockout
- Current run-away protection
- Output short protection
- Thermal protection
- Available in SOT23-6 packages

APPLICATIONS

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

TYPICAL APPLICATION



ORDER INFORMATION

DEVICE[1]	PACKAGE	TOP MARKING[2]
JW5061TCSOTB#TRPBF	SOT23-6	JWKH□ YW□□□
JW5061TFSOTB#TRPBF	SOT23-6	JWDD□ YW□□□

Notes：

1) JW□ □# TRPBF
- PB Free
- Tape and Reel(If” TR” is not shown, it means tube)
- Package Code
- Part No.

2) Line1: JW□□□
- Internal control code
- Product code
- Joulwatt LOGO

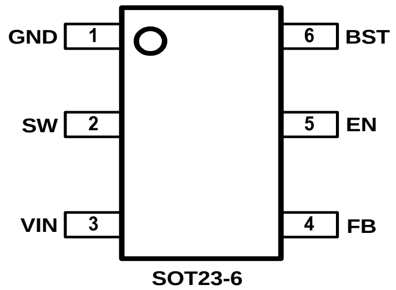
Line2: YW□□□
- Lot number
- Week code
- Year code

DEVICE INFORMATION

DEVICE	Operation Mode at light load	Function	Package
JW5061TCSOTB#TRPBF	PFM	-	SOT23-6
JW5061TFSOTB#TRPBF	FCCM	-	SOT23-6

PIN CONFIGURATION

TOP VIEW



ABSOLUTE MAXIMUM RATING[1)]

VIN, EN Pin……….. -0.3V to 20V
SW Pin……………………………………………………….-0.3V(-5V for 10ns) to 20V(22V for 10ns)
BST Pin.. SW-0.3V to SW+6V
All other Pins .... -0.3V to 6V
Junction Temperature[2)] 150ºC
Lead Temperature 260ºC
Storage Temperature ....-65ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Input Voltage V_{IN} ....4.5V to 18V
Output Voltage V_{OUT} ....0.765V to VIN*Dmax

THERMAL PERFORMANCE θ_{JA} θ_{Jc}

SOT23-6[3)]..220....130ºC/W
SOT23-6[4)]..140....75ºC/W

Note：

1) 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.

2) The JW5061TC and JW5061TF include 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.

3) Measured on JESD51-7, 4-layer PCB.

4) Measured on a two-layer JW5061TC/JW5061TF Evaluation Board at T_A=25℃.

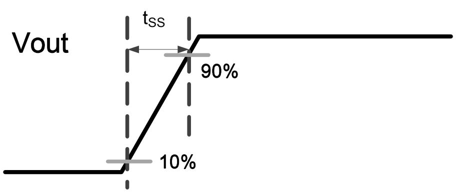
ELECTRICAL CHARACTERISTICS

VIN=12V, T_A=25℃, Unless otherwise stated。

Item	Symbol	Conditions[6]	Min.	Typ.	Max.	Unit
V_{IN} Under Voltage Lock-out Threshold	V_{IN_MIN}	V_{IN} rising	4.0	4.2	4.5	V
V_{IN} Under voltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$			350		mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V			1	μA
Supply Current	I_Q	V_{EN}=5V, V_{FB}=1.2V		150	220	μA
Feedback Voltage	V_{FB}	T_j=25 ºC	757	765	773	mV
		T_j=-40 ºC~125 ºC	750	765	780	mV
Top Switch Resistance	$R_{DS(ON)T}$			80		mΩ
Bottom Switch Resistance	$R_{DS(ON)B}$			45		mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=18V, V_{EN}=0V, V_{SW}=0V			1	μA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}=18, V_{EN}=0V, V_{SW}=18V			1	μA
Bottom Switch Current Limit	I_{LIM_BOT}		3	3.5		A
Negative Current Limit	I_{LIM_Neg}	(JW5061TF)		-1.5		A
Minimum On Time[5]	T_{ON_MIN}			120		ns
Minimum Off Time	T_{OFF_MIN}	V_{FB}=0.4V		150		ns
EN Rising Threshold	V_{EN_H}	V_{EN} rising	1.1	1.2	1.3	V
EN Falling Threshold	V_{EN_L}	V_{EN} falling	0.98	1.05	1.12	V
Soft-Start Period[6]	t_{SS}		0.6	0.8	1.0	ms
Thermal Shutdown[5]	T_{TSD}			160		°C
Thermal Shutdown Hysteresis[6]	T_{TSD_HYST}			20		°C

Note:

5) Guaranteed by design.
6) Soft-Start Period is tested from 10% to 90% of the steady state output voltage.

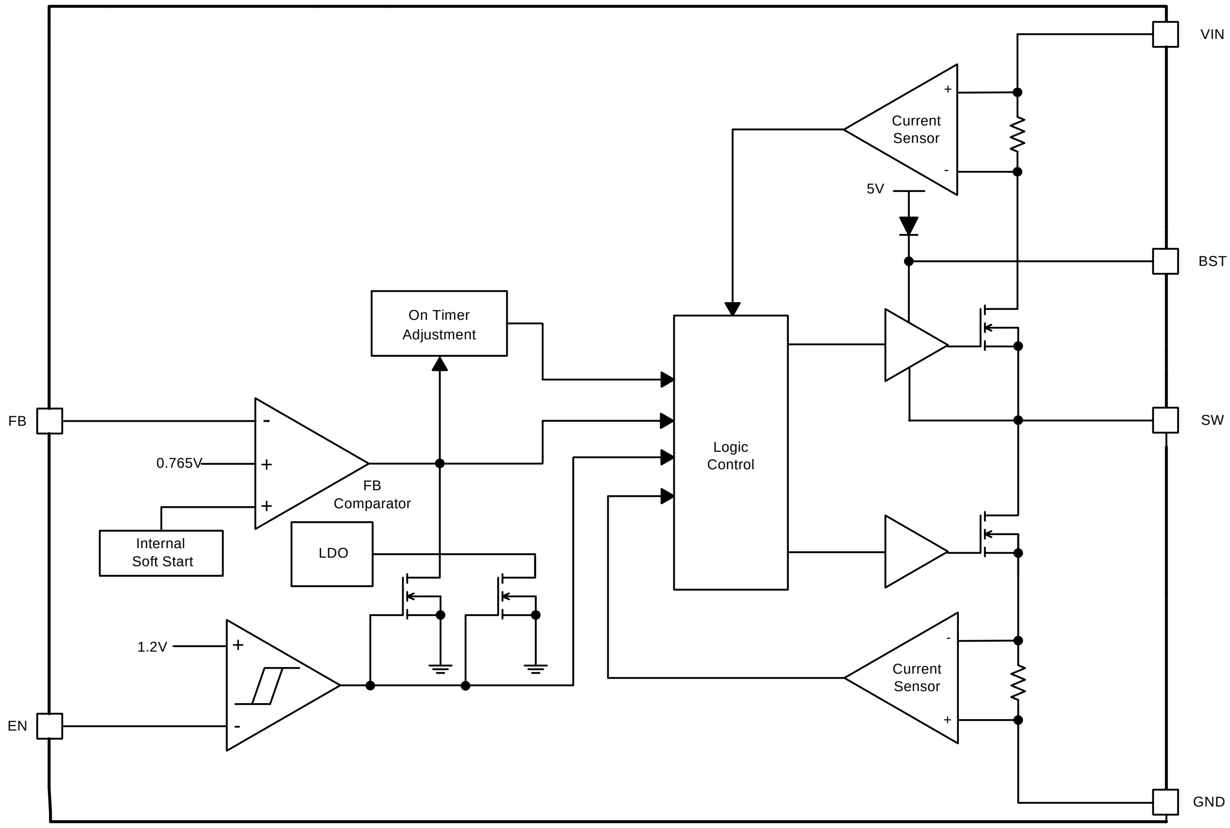


t_{SS} Waveform

PIN DESCRIPTION

SOT23-6	Name	Description
1	GND	Ground pin.
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 18V 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 0.765V. 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	Connect a 0.1µF capacitor between BST and SW pin to supply current for the top switch driver.

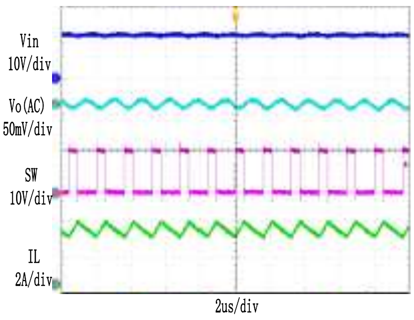
BLOCK DIAGRAM



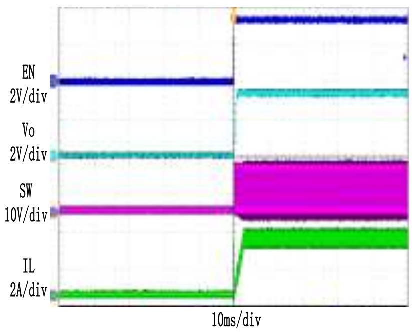
TYPICAL PERFORMANCE CHARACTERISTICS (JW5061TC)

Vin =12V, Vout = 3.3V, L = 4.7μH, Cout = 44μF, TA = +25°C, unless otherwise noted

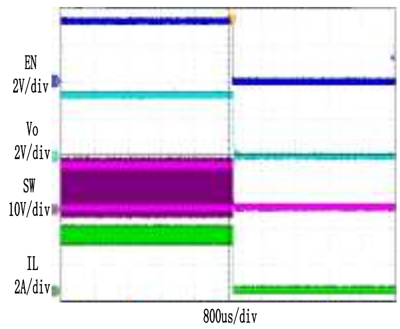
Steady State Test
VIN=12V, Vout=3.3V
Iout=3A



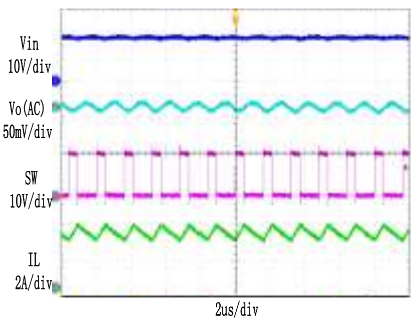
Startup through Enable
VIN=12V, Vout=3.3V
Iout=3A (Resistive load)



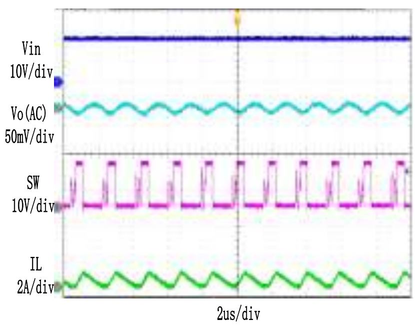
Shutdown through Enable
VIN=12V, Vout=3.3V
Iout=3A (Resistive load)



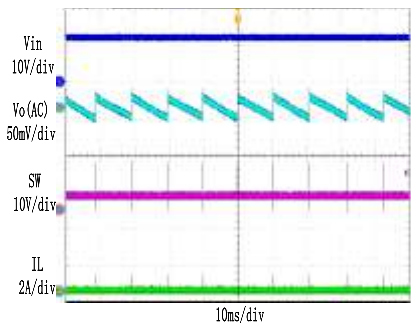
Heavy Load Operation
3A LOAD



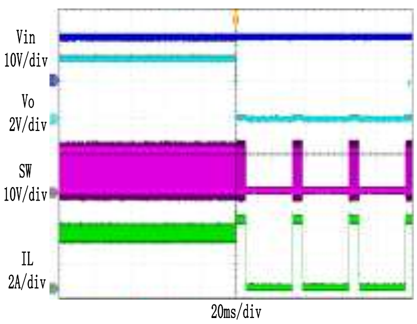
Medium Load Operation
0.3A LOAD



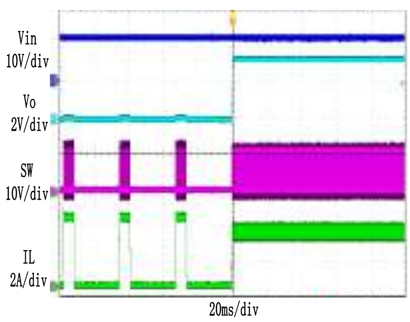
Light Load Operation
0 A LOAD



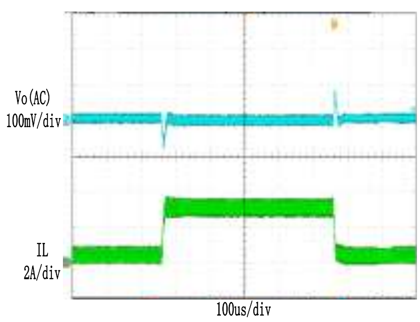
Short Circuit Protection
VIN=12V, Vout=3.3V
Iout=3A- Short



Short Circuit Recovery
VIN=12V, Vout=3.3V
Iout= Short-3A



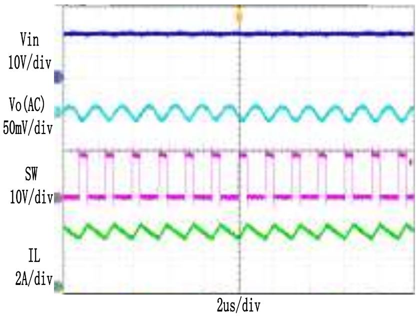
Load Transient
C4=51pF
0.3A LOAD → 3A LOAD → 0.3A LOAD



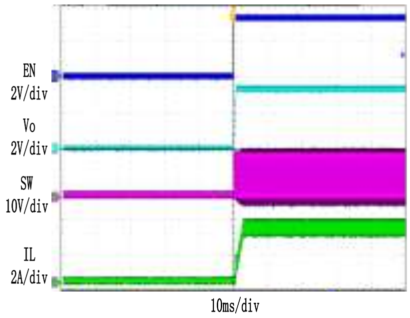
TYPICAL PERFORMANCE CHARACTERISTICS (JW5061TF)

Vin =12V, Vout = 3.3V, L = 4.7μH, Cout = 44μF, TA = +25°C, unless otherwise noted

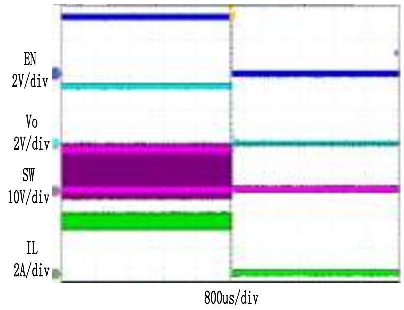
Steady State Test
VIN=12V, Vout=3.3V
Iout=3A



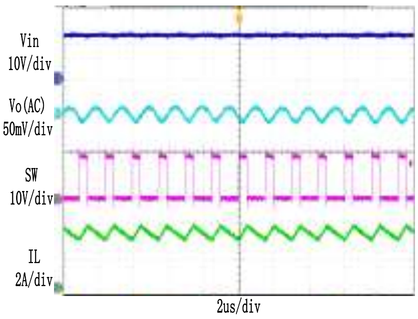
Startup through Enable
VIN=12V, Vout=3.3V
Iout=3A (Resistive load)



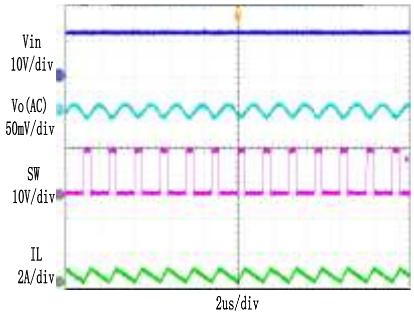
Shutdown through Enable
VIN=12V, Vout=3.3V
Iout=3A (Resistive load)



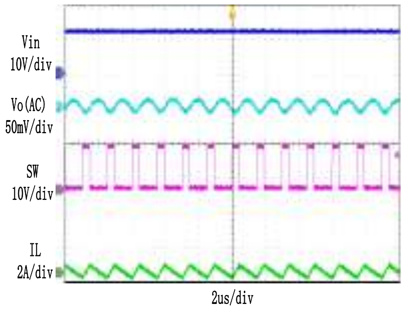
Heavy Load Operation
3A LOAD



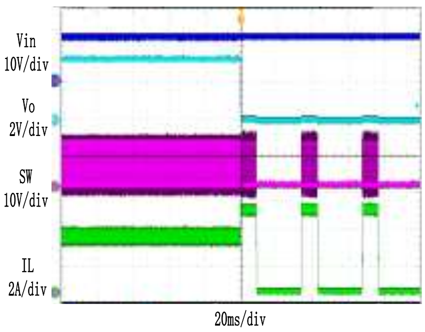
Medium Load Operation
0.3A LOAD



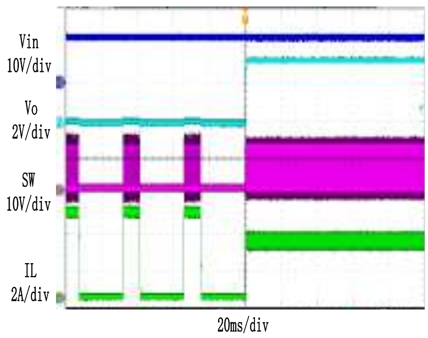
Light Load Operation
0 A LOAD



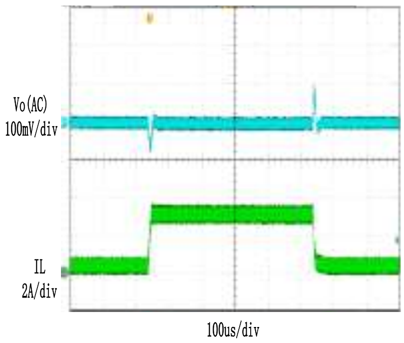
Short Circuit Protection
VIN=12V, Vout=3.3V
Iout=3A- Short



Short Circuit Recovery
VIN=12V, Vout=3.3V
Iout= Short-3A



Load Transient
C4=51pF
0.3A LOAD → 3A LOAD → 0.3A LOAD



TYPICAL PERFORMANCE CHARACTERISTICS (JW5061TC)

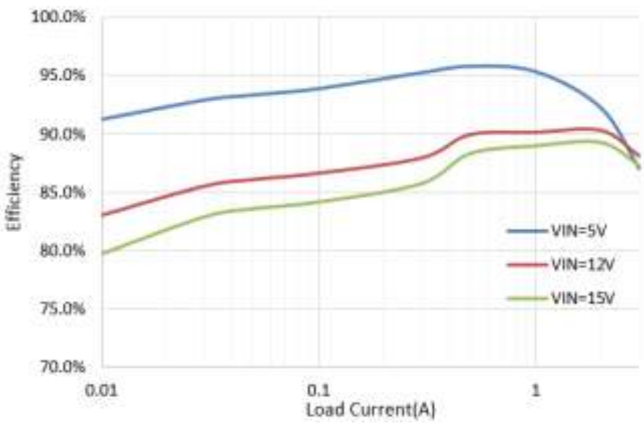


Figure 1. Efficiency vs Load Current

(Vout=3.3V, L=4.7µH)

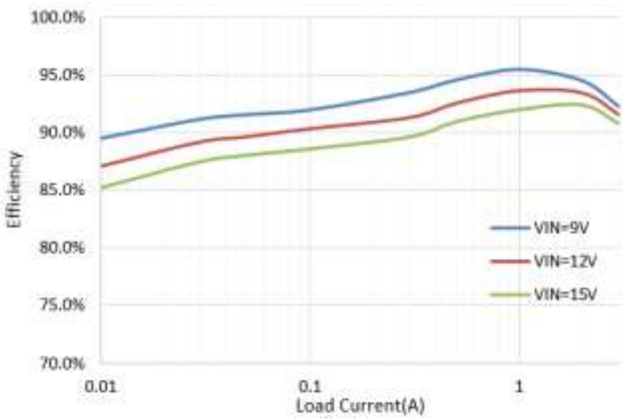


Figure 2. Efficiency vs Load Current

(Vout=5V, L=4.7µH)

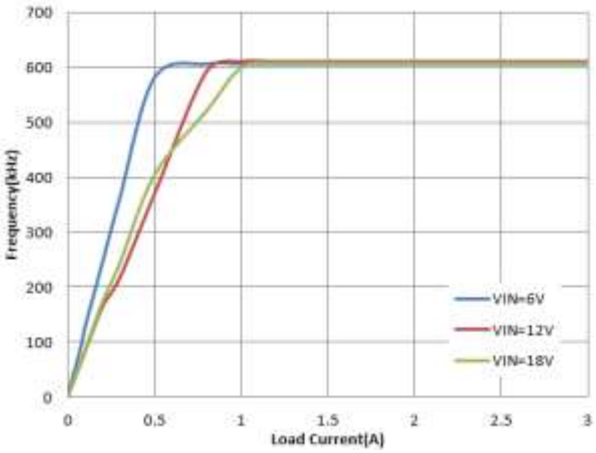


Figure 3. Frequency vs Load Current

(Vout=3.3V, L=4.7µH)

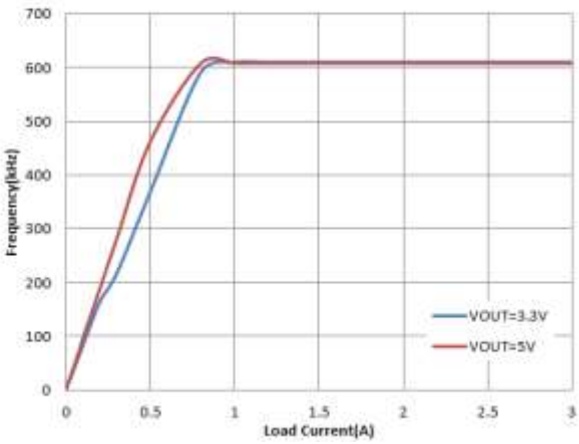


Figure 4. Frequency vs Load Current

(Vin=12V)

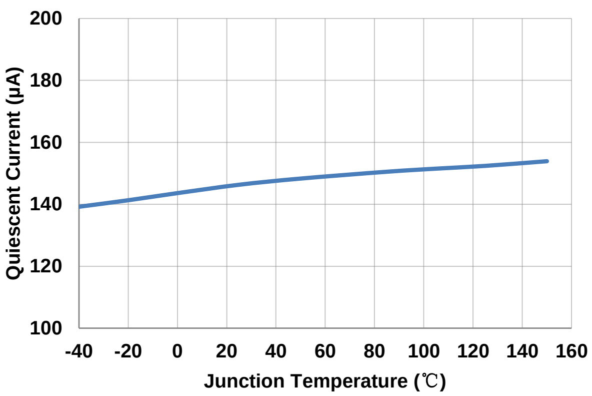


Figure 5. Supply Current vs Junction Temperature

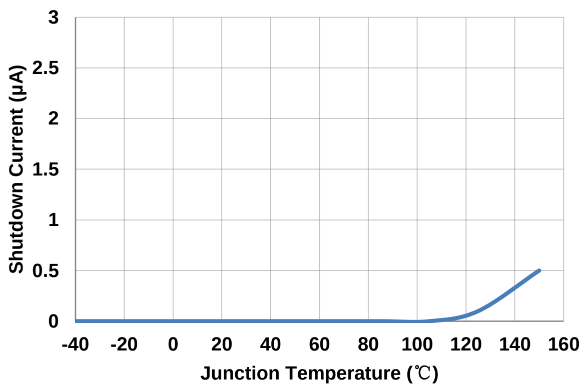


Figure 6. Shutdown Current vs Junction Temperature

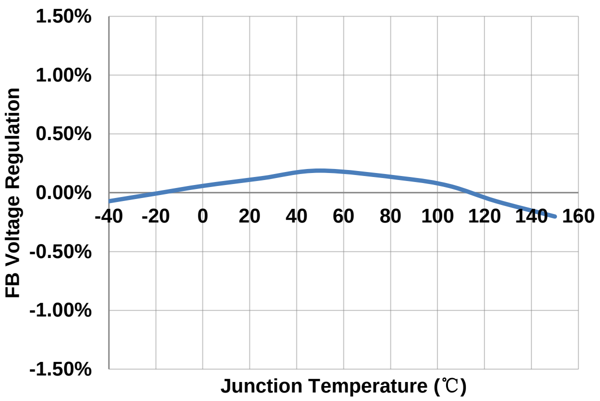


Figure 7. FB Voltage Regulaion vs Junction Temperature

TYPICAL PERFORMANCE CHARACTERISTICS (JW5061TF)

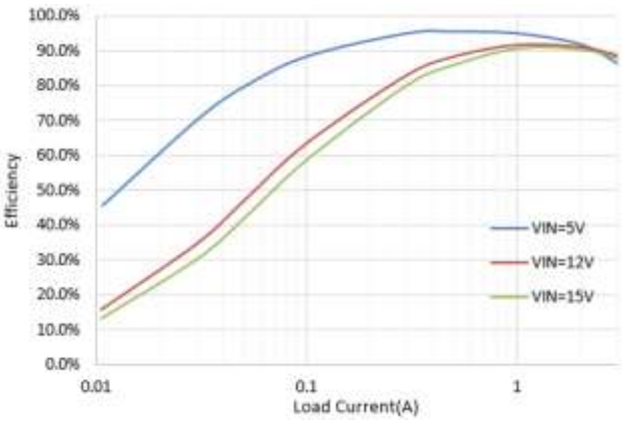


Figure 1. Efficiency vs Load Current

(Vout=3.3V, L=4.7µH)

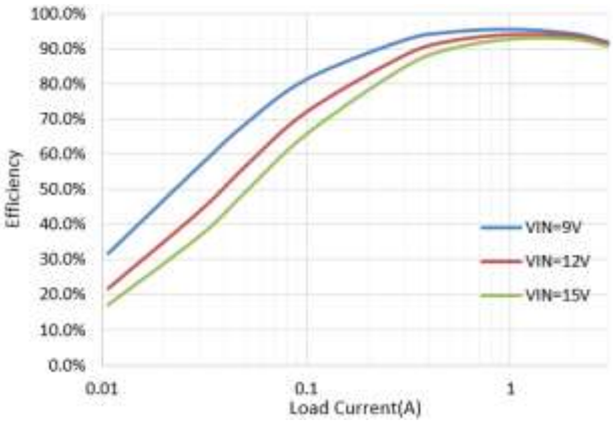


Figure 2. Efficiency vs Load Current

(Vout=5V, L=4.7µH)

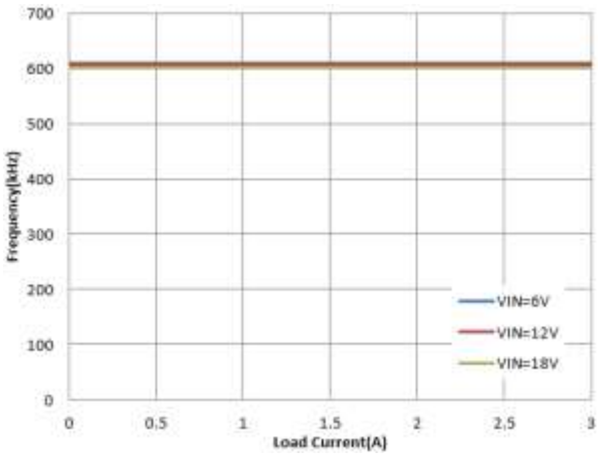


Figure 3. Frequency vs Load Current

(Vout=3.3V, L=4.7µH)

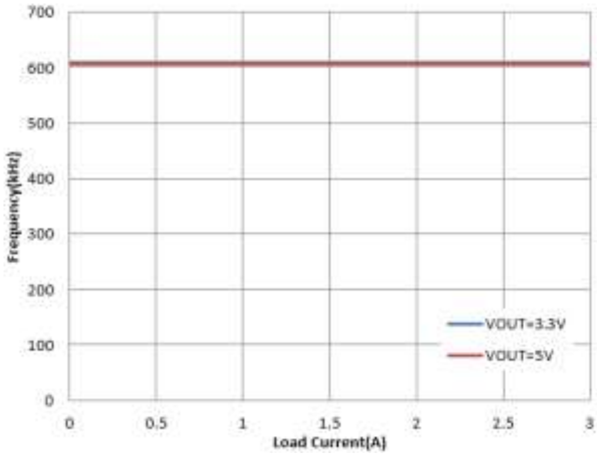


Figure 4. Frequency vs Load Current

(Vin=12V)

FUNCTIONAL DESCRIPTION

JW5061TC and JW5061TF are synchronous step-down regulators based on I2 control architecture. It regulates input voltages from 4.5V to 18V down to an output voltage as low as 0.765V, and is capable of supplying up to 3A of load current.

Shut-Down Mode

The regulator shuts down when voltage at EN pin is driven below 0.4V. The entire regulator is off and the supply current consumed by the regulator drops below 1μA.

Power Switch

N-Channel MOSFET switches are integrated on the JW5061TC and JW5061TF to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage great 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 5V 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 1.05V 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 inductor can be easily built up, resulting in a large start-up output current. A valley current limit is designed in JW5061TC and JW5061TF 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.

Output Short Protection

When the output is shorted to ground, the regulator is allowed to switch for 2048 cycles. If the short condition is cleared within this period, then the regulator resumes normal operation. If the short condition is still present after 2048 switching cycles, then no switching is allowed and the regulator enters hiccup mode for 6144 cycles. After the 6144 hiccup cycles, the regulator will try to start-up again. If the short condition still exists after 2048 cycles of switching, the regulator enters hiccup mode. This process of start-up and hiccup iterate itself until the short condition is removed.

Thermal Protection

When the temperature of the regulator rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 140°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:

$$V_{FB} = V_{OUT} \cdot \frac{R_4}{R_4 + R_3}$$

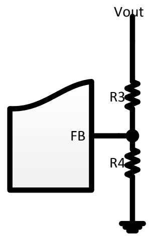
where V_{FB} is the feedback voltage and V_{OUT} is the output voltage.

Choose R_4 around 15kΩ, and then R_3 can be calculated by:

$$R_3 = R_4 \cdot \left(\frac{V_{OUT}}{0.765} - 1\right)$$

The following table lists the recommended values.

VOUT(V)	R4(kΩ)	R3(kΩ)
1	13.3	4.02
1.2	28	16
1.5	16	15.4
2.5	20.5	46.4
3.3	16	53.1
5	16	88.7



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 voltage.

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

A 22μF/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:

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

where C2 is the output capacitance value and RESR 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 44μF~66μF 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 40% 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, f_S is the switching frequency, and $\triangle I_L$ is the peak-to-peak inductor ripple current.

External Bootstrap Capacitor

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

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 JW5061TC or JW5061TF (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.

SOT23-6:

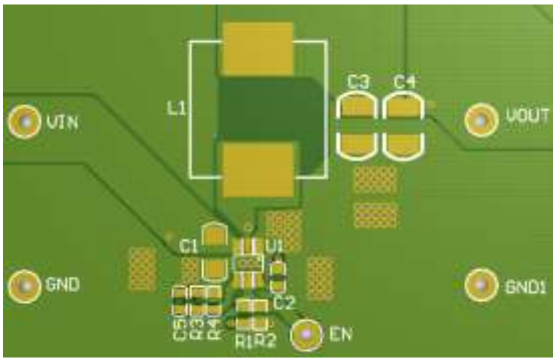
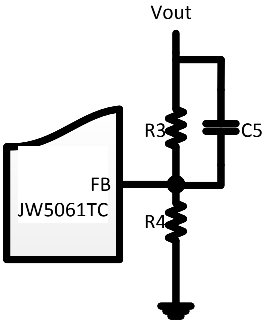


Figure 1. PCB Layout Recommendation

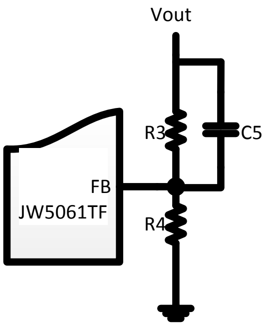
External Components Suggestion (JW5061TC):

VOUT(V)	R4 (kΩ)	R3 (kΩ)	C5 (pF)	L (μH)	Cout (μF)
1	13.3	4.02	0~470	1.5~2.2	54~66
1.2	28	16	0~470	1.5~2.2	54~66
1.5	16	15.4	0~470	2.2~3.3	54~66
2.5	20.5	46.4	0~330	2.2~4.7	44~66
3.3	16	53.1	0~220	2.2~4.7	44~66
5	16	88.7	0~120	3.3~6.8	44~66



External Components Suggestion (JW5061TF):

VOUT(V)	R4 (kΩ)	R3 (kΩ)	C5 (pF)	L(μH)	Cout(μF)
1	13.3	4.02	0~470	1.5~2.2	54~66
1.2	28	16	0~470	1.5~2.2	54~66
1.5	16	15.4	0~470	2.2~3.3	54~66
2.5	20.5	46.4	0~330	3.3~4.7	44~66
3.3	16	53.1	0~220	4.7~6.8	44~66
5	16	88.7	0~120	4.7~6.8	44~66



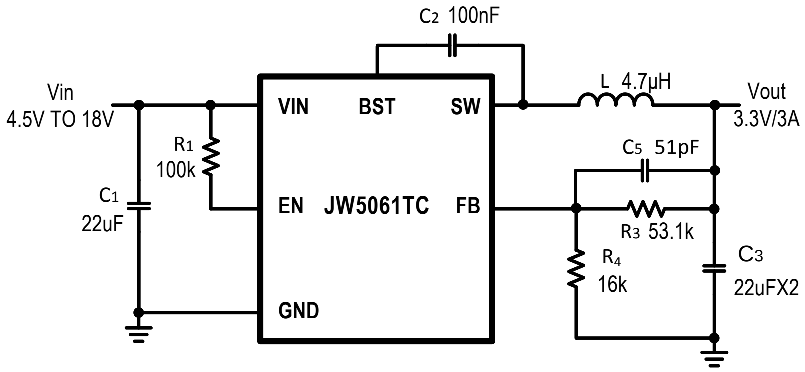
REFERENCE DESIGN

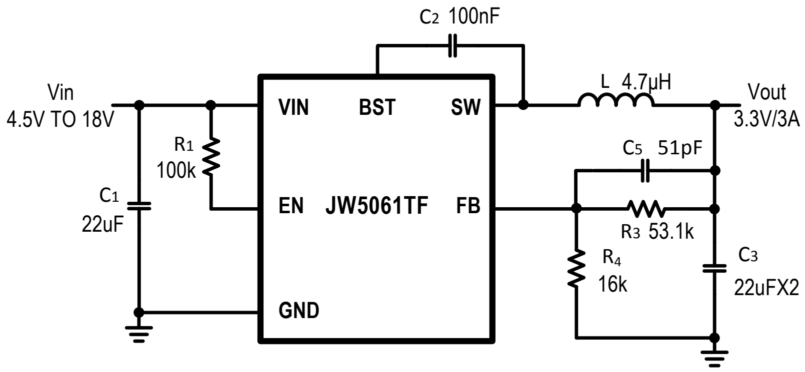
Reference 1:

Vin: 4.5V~18V

Vout: 3.3V

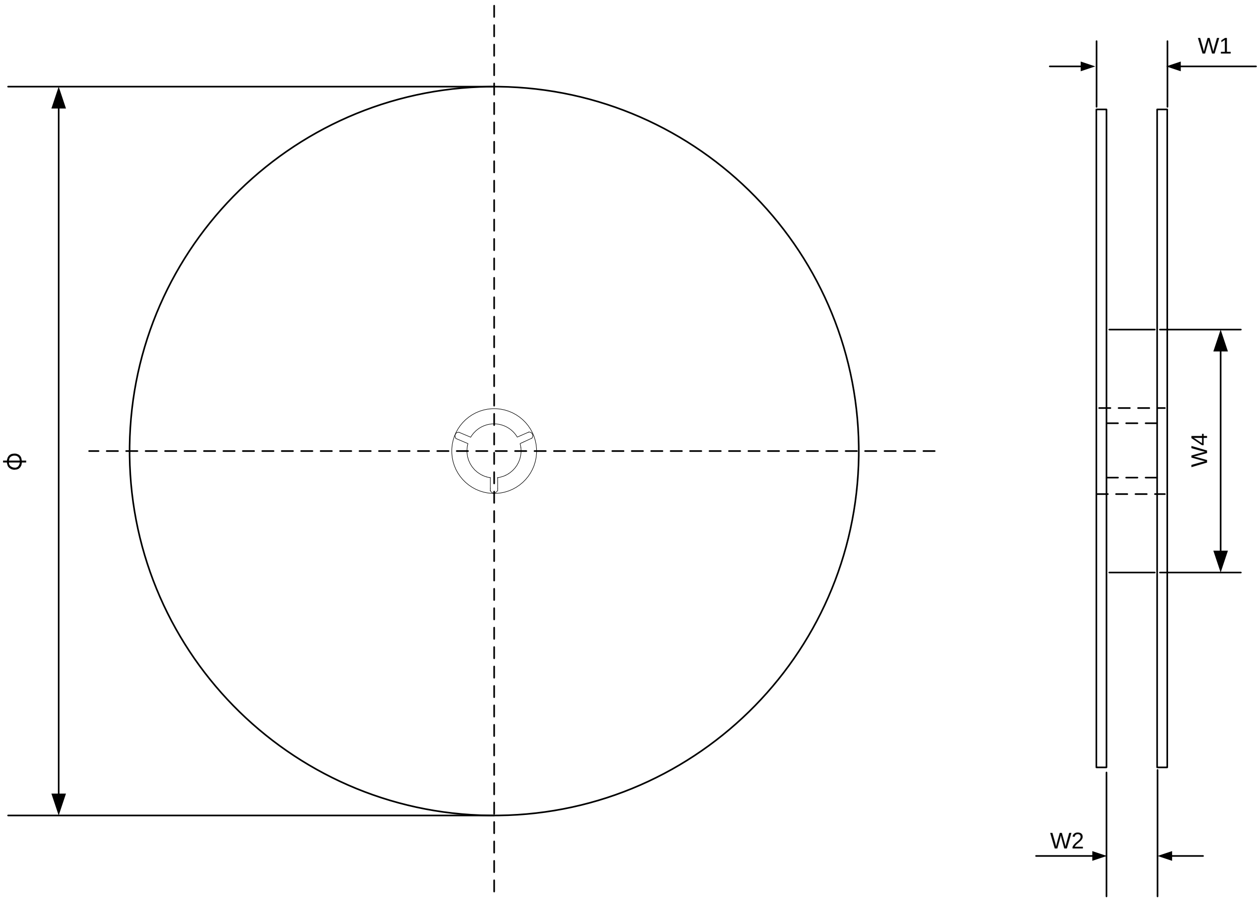
Iout: 0~3A





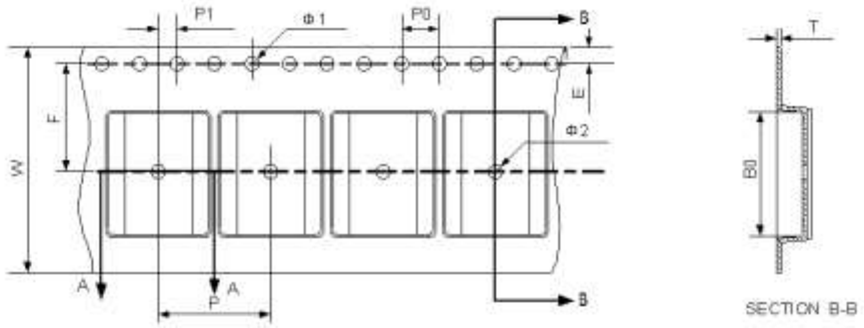
TAPE AND REEL INFORMATION

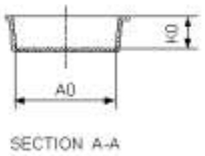
Reel UNIT: mm



Package	Diameter Φ	Thickness W1	Width W2	W4
SOT23-6	178±2	12.30±2	9.5±2	60±2

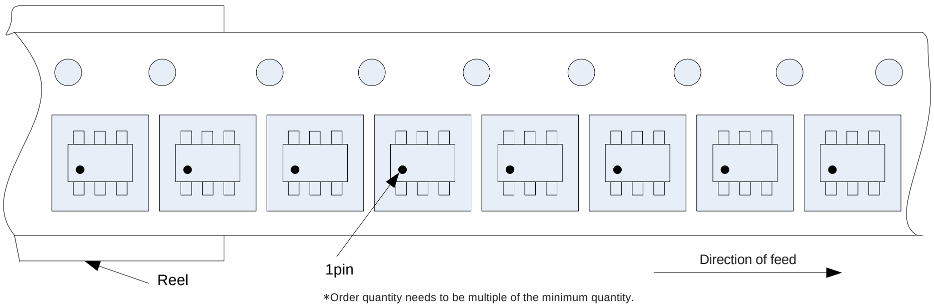
Carrier Tape UNIT: mm





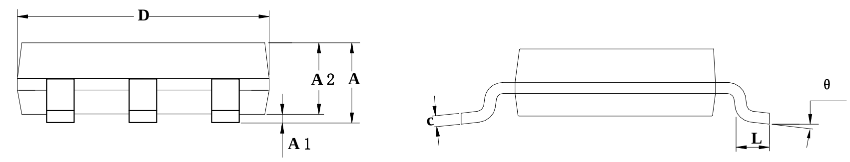
Package	P0	P1	P	A0	B0	W	T0	K0	Φ1	Φ2	E	F
SOT23-6	4.0±0.1	2.0±0.1	4.0±0.1	3.23±0.2	3.17±0.2	8.0±0.3	0.25±0.2	1.37±0.2	1.55±0.10	1.00min	1.75±0.1	3.50±0.1

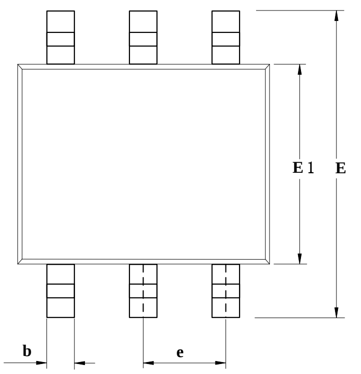
SOT23-6:

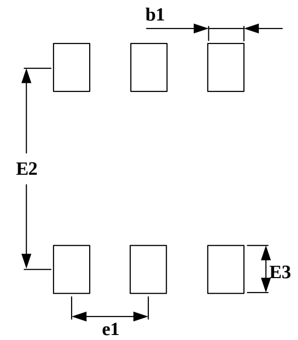


PACKAGE OUTLINE

SOT23-6 UNIT: mm







Recommended Pad Layout

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.05	1.15	1.25
A1	0	0.05	0.15
A2	0.95	1.10	1.20
b	0.20	0.40	0.60
b1	0.60		
c	0.05	—	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
E2	2.40		
E3	0.80		
e	0.95（BSC)		
e1	0.95（TYP)		
L	0.30	0.45	0.60
θ	0°	—	8°

IMPORTANT NOTICE

- **Joulwatt Technology Inc. reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein.**
- **Any unauthorized redistribution or copy of this document for any purpose is strictly forbidden.**
- **Joulwatt Technology Inc. does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.**