JW5211

1.2A, 6V, 1.5MHz, 40uA I_Q Synchronous Step-Down Converter

Parameters Subject to Change Without Notice

DESCRIPTION

The JW®5211 is a current mode monolithic buck switching regulator. Operating with an input range of 2.5V-6V, the JW5211 delivers 1.2A of continuous output current with integrated P-Channel and N-Channel MOSFETs. The internal synchronous power switches provide high efficiency. At light loads, the regulator operate in low frequency to maintain high efficiency and low output ripples. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The JW5211 guarantees robustness with hiccup output short-circuit protection, FB short-circuit protection, start-up current run-away protection, input under voltage lockout protection, hot-plug in protection, and thermal protection.

The JW5211 provides output power good indication which is only available in SOT23-6 package.

The JW5211 is available in 5-pin TSOT23-5、SOT23-5 or 6-pin SOT23-6 package, which provides a compact solution with minimal external components.

Company's Logo is Protected, "JW" and "JOULWATT" are Registered Trademarks of JoulWatt technology Inc.

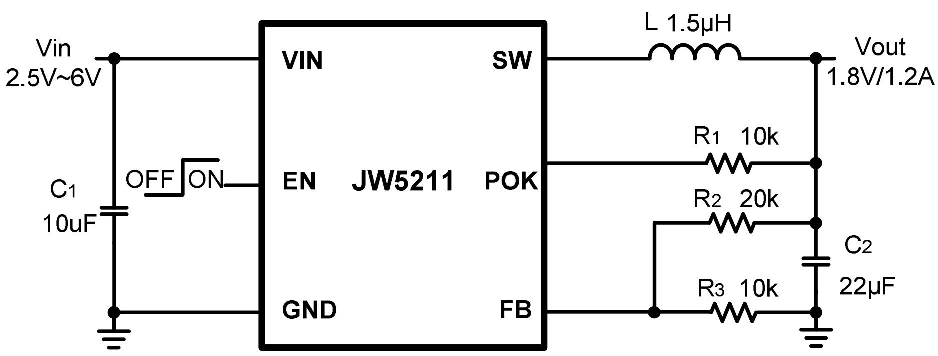
FEATURES

- 2.5V to 6V operating input range
- Up to 1.2A output current
- Up to 94% peak efficiency
- High efficiency (>85%) at light load
- Internal Soft-Start
- 1.5MHz switching frequency
- Input under voltage lockout
- Short circuit protection
- Thermal protection
- Hot-plug in protection
- Output POK indication (available in SOT23-6 package)
- Available in TSOT23-5/SOT23-5/SOT23-6 package

APPLICATIONS

- 5V or 3.3V Point of Load Conversion
- Set Top Boxes
- Telecom/Networking Systems
- Storage Equipment
- GPU/DDR Power Supply

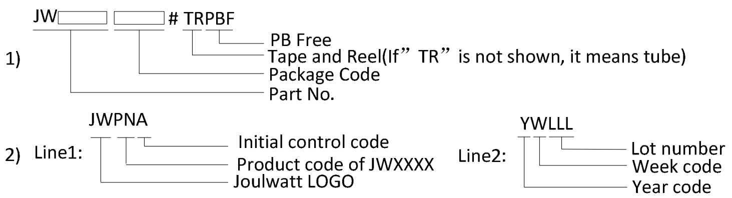
TYPICAL APPLICATION



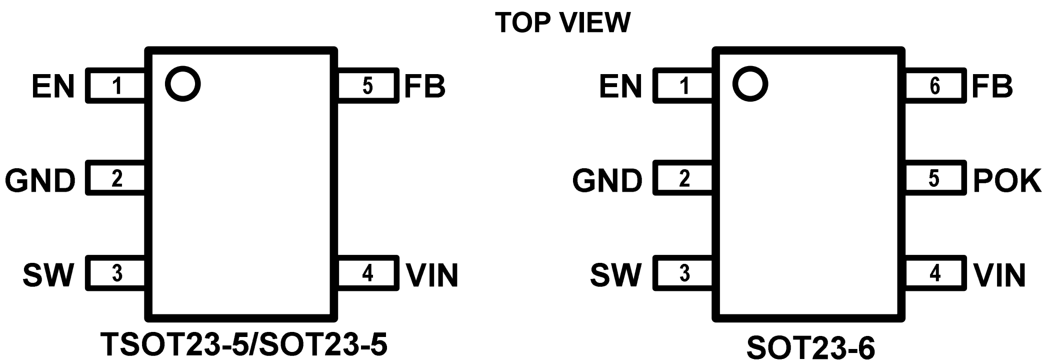
ORDER INFORMATION

DEVICE[1]	PACKAGE	TOP MARKING[2]
JW5211SOTA#TRPBF	SOT23-5	JWA5X YWLLL
JW5211SOTB#TRPBF	SOT23-6	JWA6X YWLLL
JW5211TSOTA#TRPBF	TSOT23-5	JWK4X YWLLL

Notes:



PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING[1]

EN, FB, POK Pins ....-0.3V to 7.0 V
Vin, SW Pins ....-0.3V(-1.7V for 20ns) to 7.0V(7.5V for 70ns)
Junction Temperature.[2] [3] 150ºC
Lead Temperature.. 260ºC
ESD Susceptibility (Human Body Model) 2kV

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN .... 2.5V to 6V
Output Voltage Vout... 0.6V to VIN
Operating Junction Temperature... -40ºC to 125ºC

THERMAL PERFORMANCE[4)]

SOT23-5/SOT23-6

Absolute Max Storage Temp.	Recommended Operating Junction Temp. Range	Recommended Max Case Temp. T_C (°C)	Abs. Max Junction Temp. T_j (°C)	Recommended Max Power Loss P_D@25°C (W)
-65ºC to 150ºC	-40ºC to 125ºC	122	150	0.45
$R_{\theta JC}$ (°C/W)	$R_{\theta JA}$ (°C/W)	$R_{\theta JB}$ (°C/W)	ψ_{JT} (°C/W)	ψ_{JB} (°C/W)
130	220	36.1	2.3	35.3

TSOT23-5

Absolute Max Storage Temp.	Recommended Operating Junction Temp. Range	Recommended Max Case Temp. T_C (°C)	Abs. Max Junction Temp. T_j (°C)	Recommended Max Power Loss P_D@25°C (W)
-65ºC to 150ºC	-40ºC to 125ºC	122	150	0.45
$R_{\theta JC}$ (°C/W)	$R_{\theta JA}$ (°C/W)	$R_{\theta JB}$ (°C/W)	ψ_{JT} (°C/W)	ψ_{JB} (°C/W)
110	200	36.1	2.3	35.3

Note：

1) Exceeding these ratings may damage the device.

2) The JW5211 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 JW5211 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 CHARACTERISTICS

VIN=5V, T_A=25℃, unless otherwise stated.

Item	Symbol	Condition	Min.	Typ.	Max.	Units
V_{IN} Under Voltage Lockout Threshold	V_{IN_UVLO}	V_{IN} rising	2.25	2.4	2.55	V
V_{IN} Under Voltage Lockout Hysteresis[5)]	$V_{IN\_UVLO\_HYST}$	V_{IN} falling		180		mV
V_{IN} Over Voltage Protection Threshold	V_{IN_OVP}	VIN rising	6.5	7	7.5	V
V_{IN} Over Voltage Protection Hysteresis[5)]	$V_{IN\_OVP\_HYST}$	VIN falling		400		mV
Shutdown Current	I_{SHDN}	V_{EN}=0V		0.1	1	μA
Quiescent Current	I_Q	V_{EN}=2V, V_{FB}=V_{REF}*105%		40	60	μA
Regulated Feedback Voltage	V_{FB}	2.5V<V_{IN}<6V	0.582	0.6	0.618	V
PFET On Resistance[5)]	R_{DSON_P}	VIN=3.6V, I_{SW}=200mA		230		mΩ
NFET On Resistance[5)]	R_{DSON_N}	VIN=3.6V, I_{SW}=-200mA		150		mΩ
PFET Leakage Current	I_{LEAK_P}	V_{IN}=5.5V, V_{EN}=0V, V_{SW}=0V			1	uA
NFET Leakage Current	I_{LEAK_N}	V_{IN}=5.5V, V_{EN}=0V, V_{SW}=5.5V			1	uA
PFET Current Limit[5)]	I_{LIM_TOP}	Duty Cycle=100%	1.4	1.6	1.85	A
Switch Frequency	F_{SW}	I_{OUT}=1.2A	1.2	1.5	1.8	MHz
Minimum On Time[5)]	T_{ON_MIN}			80		ns
Maximum Duty Cycle[5)]	D_{MAX}			100		%
EN Input Logic High Voltage	V_{EN_H}	V_{EN} rising, FB=0.4V	1.5			V
EN Input Logic Low Voltage	V_{EN_L}	V_{EN} falling, FB=0.4V			0.4	V
Thermal Shutdown Threshold[5)]	T_{SHDN}			150		℃
Temperature Hysteresis[5)]	T_{HYS}			15		ºC

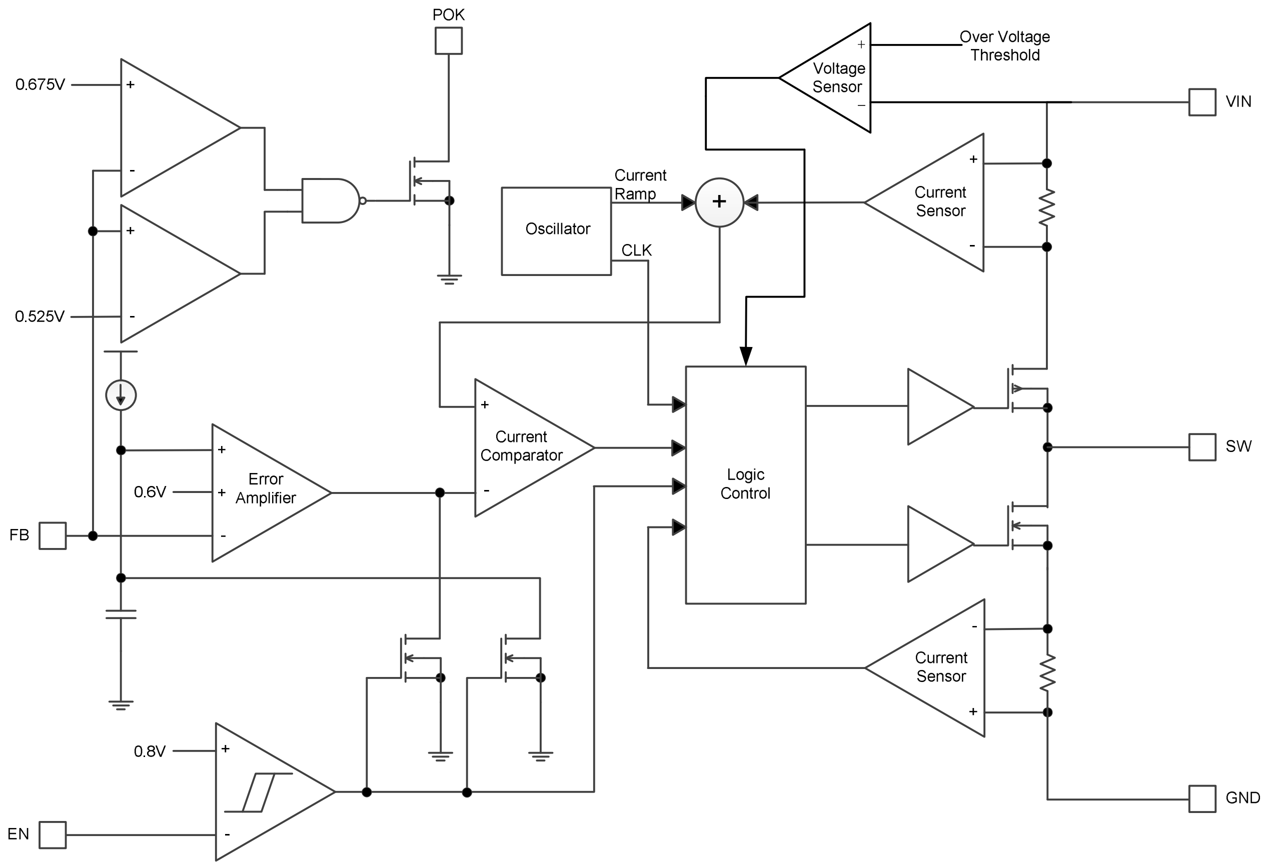
Note：

5) Guaranteed by design.

PIN DESCRIPTION

SOT23-5/ TSOT23-5 Pin	SOT23-6 Pin	Name	Description
1	1	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
2	2	GND	Ground pin.
3	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	4	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 2.5V to 6V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
-	5	POK	Open drain output. Connect a 10KΩ resistor from POK to output. POK is high when V_{FB} is within +/-12.5% of V_{REF}.
5	6	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.

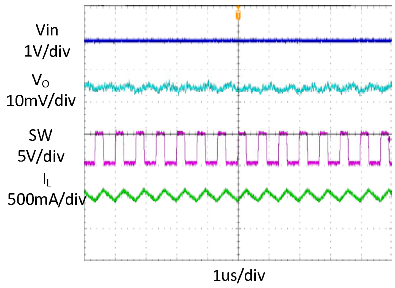
BLOCK DIAGRAM



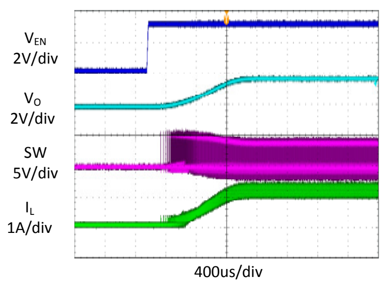
TYPICAL PERFORMANCE CHARACTERISTICS

Vin = 5V, Vout = 1.8V, L = 1.5μH, Cout = 22μF, TA = +25°C, unless otherwise noted

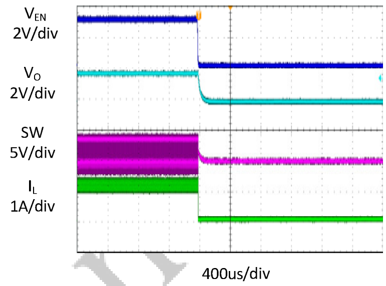
Steady State Test
VIN=5V, Vout=1.8V
Iout=1.2A



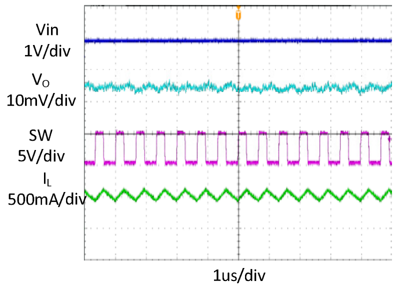
Startup through Enable
VIN=5V, Vout=1.8V
Iout=1.2A(Resistive load)



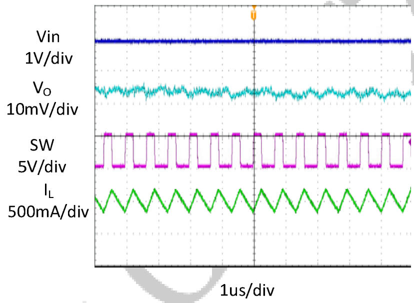
Shutdown through Enable
VIN=5V, Vout=1.8V
Iout=1.2A(Resistive load)



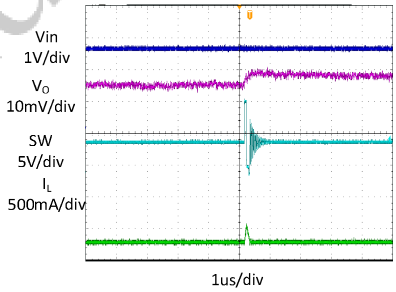
Heavy Load Operation
1.2A LOAD



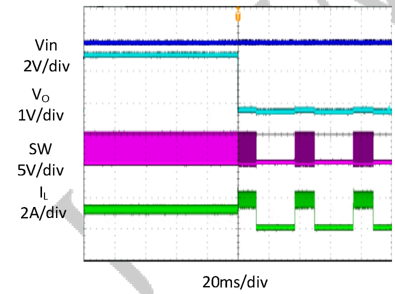
Medium Load Operation
0.6A LOAD



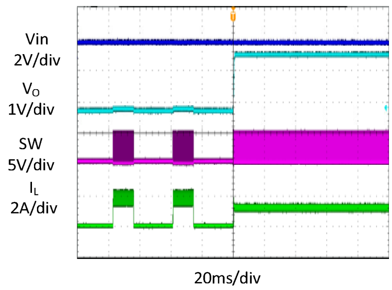
Light Load Operation
0 A LOAD



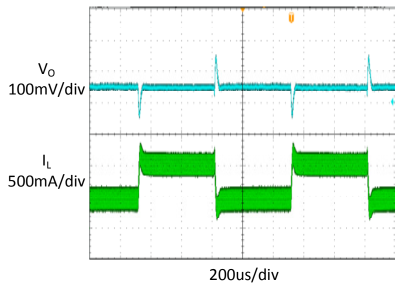
Short Circuit Protection
VIN=5V, Vout=1.8V
Iout=1.2A- Short



Short Circuit Protection
VIN=5V, Vout=1.8V
Iout= Short-1.2A



Load Transient
0.6A LOAD → 1.2A LOAD →0.6A LOAD

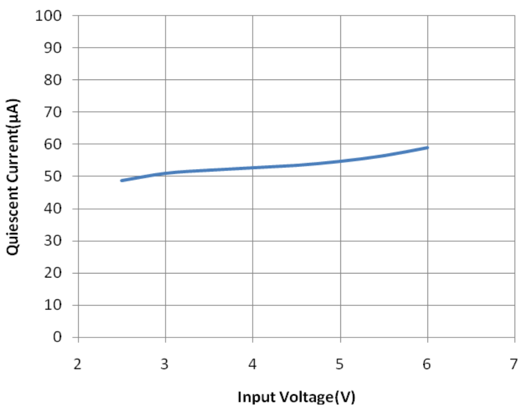


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

Vin = 5V, Vout = 1.8V, L = 2.2μH, Cout = 22μF, TA = +25°C, unless otherwise noted

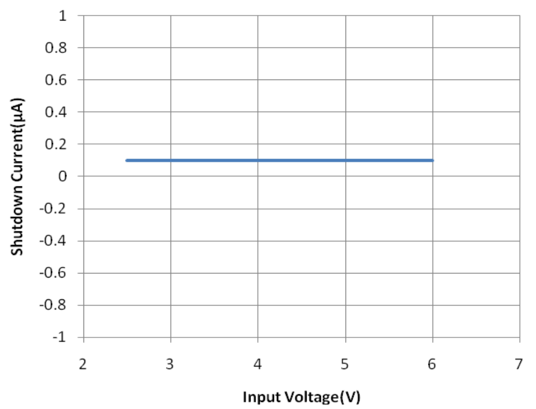
Quiescent Current Vs. Input Voltage

VIN=2.5V ~ 6.5V, VEN=2.5V, VFB=0.8V

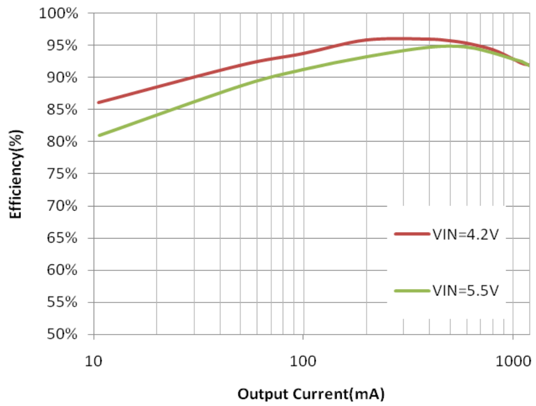


Shutdown Current Vs. Input Voltage

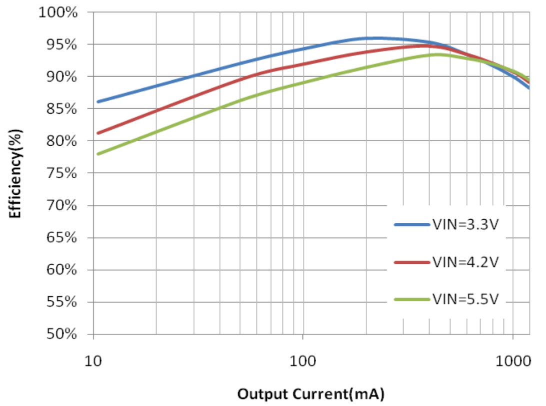
VIN=2.5V ~ 6.5V, VEN=0V, VFB=0.5V



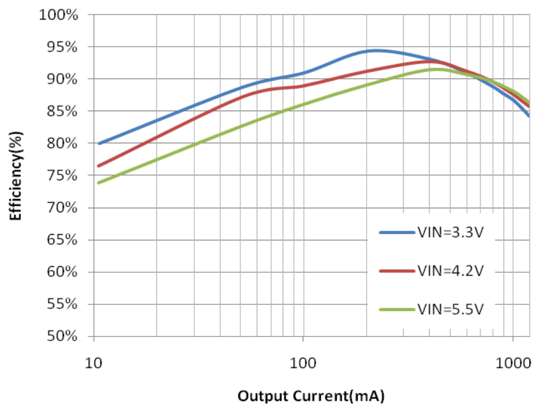
Efficiency @ Vout=3.3V



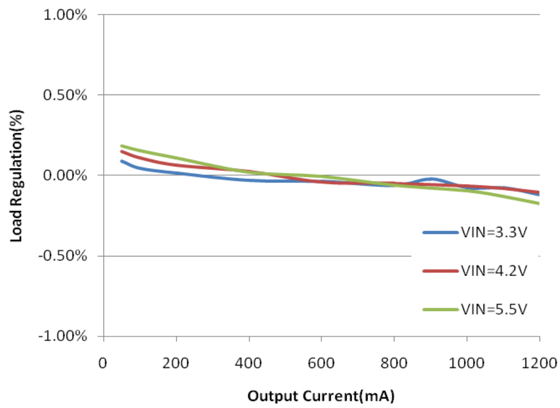
Efficiency @ Vout=2.5V

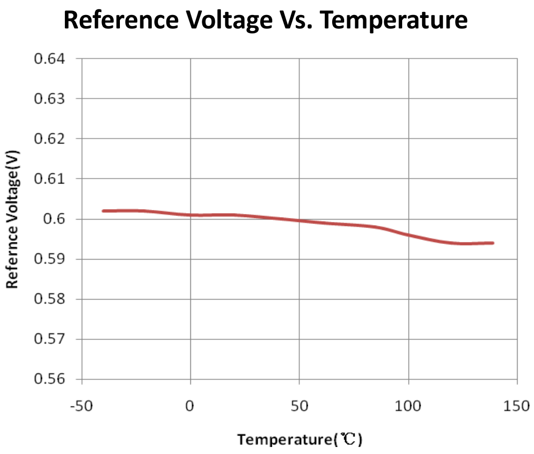


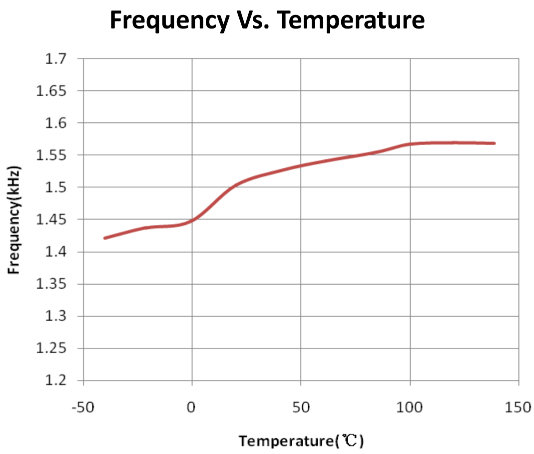
Efficiency @ Vout=1.8V

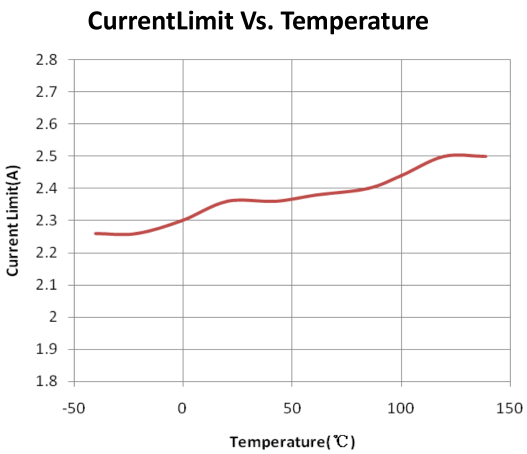


Load regulation @ Vout=1.8V




Reference Voltage Vs. Temperature
Refernce Voltage(V)
0.64
0.63
0.62
0.61
0.6
0.59
0.58
0.57
0.56
-50
0
50
100
150
Temperature(℃)


Frequency Vs. Temperature
Frequency(kHz)
1.7
1.65
1.6
1.55
1.5
1.45
1.4
1.35
1.3
1.25
1.2
-50
0
50
100
150
Temperature(℃)


CurrentLimit Vs. Temperature
Current Limit(A)
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
-50
0
50
100
150
Temperature(℃)

FUNCTIONAL DESCRIPTION

The JW5211 is a synchronous, current-mode, step-down regulator. It regulates input voltages from 2.5V~6V down to an output voltage as low as 0.6V, and is capable of supplying up to 1.2A of load current.

Current-Mode Control

The JW5211 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 JW5211 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 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.

Shut-Down Mode

The JW5211 operates in shut-down mode when voltage at EN pin is driven below 0.4V. In shut-down mode, the entire regulator is off and the supply current consumed by the JW5211 drops below 1uA.

Power Switches

P-channel and N-channel MOSFET switches are integrated on the JW5211 to down convert the input voltage to the regulated output voltage.

Hot-Plug In Protection

If the Vin voltage exceeds 6.85V, IC can turn off power switch, entering over-voltage protection. It can remain in this state until Vin voltage is less than 6.5V.

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 JW5211 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.

Short Circuit Protection

When output is shorted to ground, the switching frequency is reduced to prevent the inductor current from increasing beyond PFET current limit. If short circuit condition holds for more than 1024 cycles, both PFET and NFET are forced off and can be enabled again after 8ms. This procedure is repeated as long as short circuit condition is not removed.

FB Short Circuit Protection

When FB is shorted to ground and holds for more than 16 cycles, NFET could be turned off after inductor current drops to zero, and then both PFET and NFET are latched off. Only toggling EN or VIN UVLO/OVP can PFET and NFET be enabled again.

Thermal Protection

When the temperature of the JW5211 rises above 150°C, it is forced into thermal shut-down.

Only when core temperature drops below 135°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:

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

The following table lists the recommended values.

VOUT(V)	R2(KΩ)	R3(KΩ)
1.2	10	10
1.5	15	10
1.8	20	10
3.3	49.9	11

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 2uF 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:

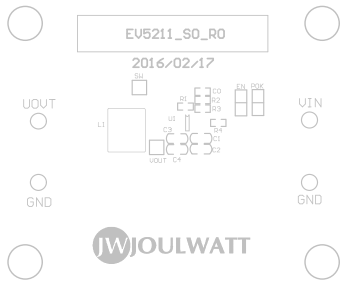
$$L = \frac{V_{OUT}}{f_S \cdot \Delta I_L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

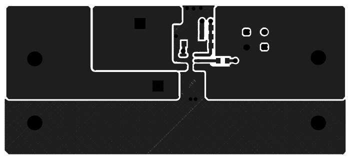
where V_{IN} is the input voltage, V_{OUT} is the output voltage, f_S is the switching frequency, and $\triangle I_L$ is the peak-to-peak inductor ripple current.

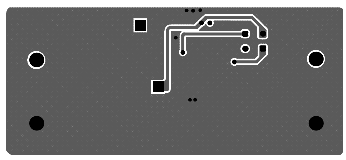
PCB Layout Note

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 JW5211 (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

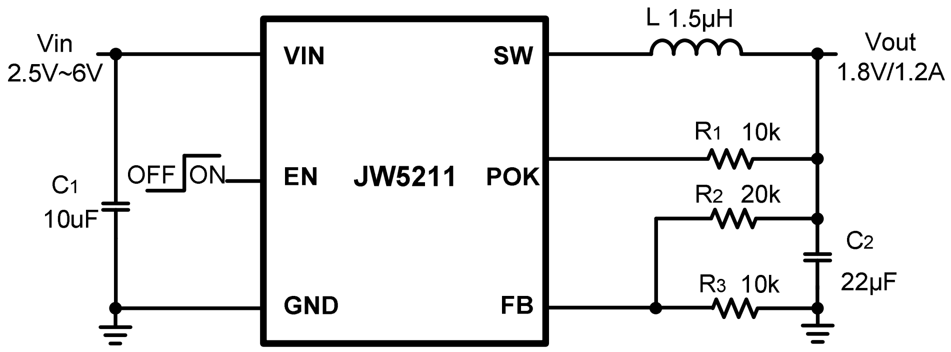
Reference 1:

V_{IN}: 2.5V ~ 6V

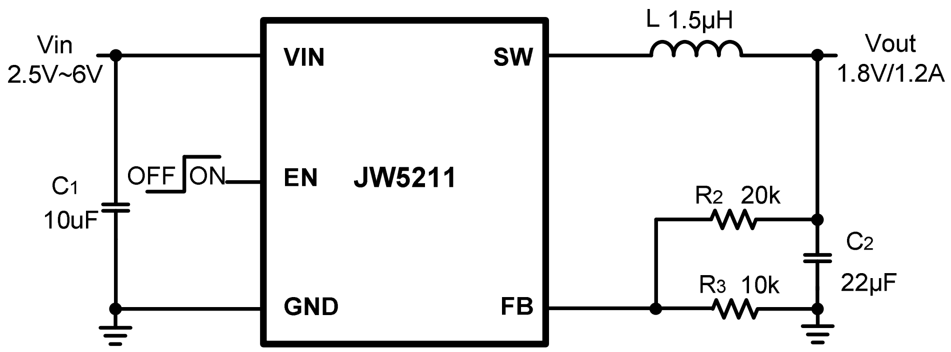
V_{OUT}: 1.8V

I_{OUT}: 0~1.2A

Package: SOT23-6



Package: SOT23-5/TSOT23-5



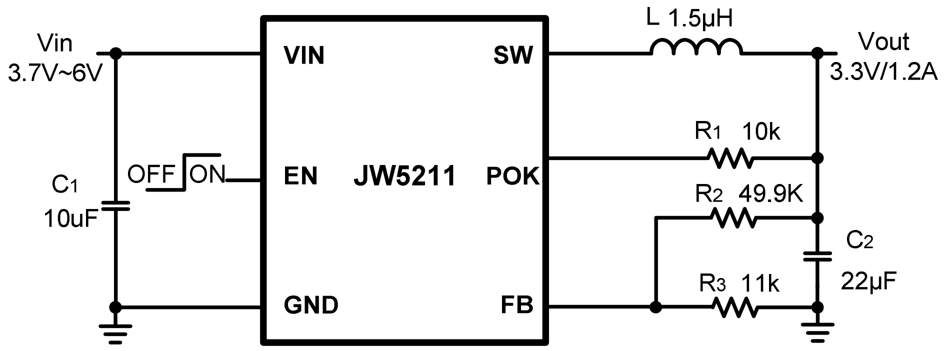
Reference 2:

V_{IN}: 3.7V ~ 6V

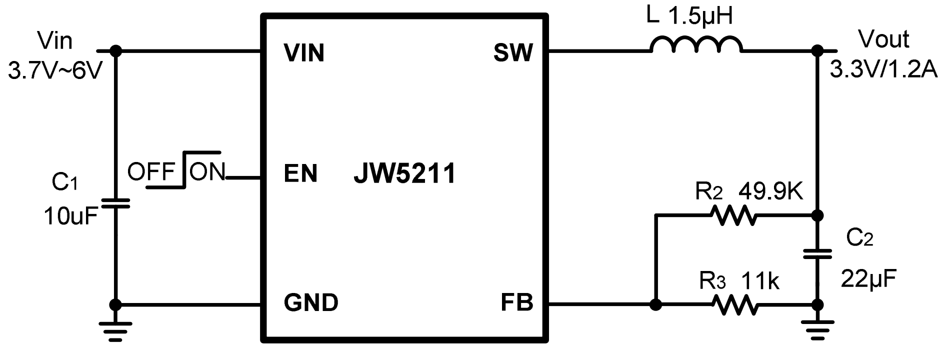
V_{OUT}: 3.3V

I_{OUT}: 0~1.2A

Package:SOT23-6

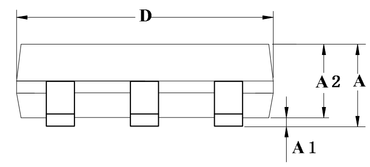


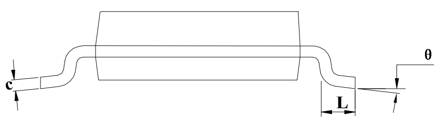
Package: SOT23-5/TSOT23-5



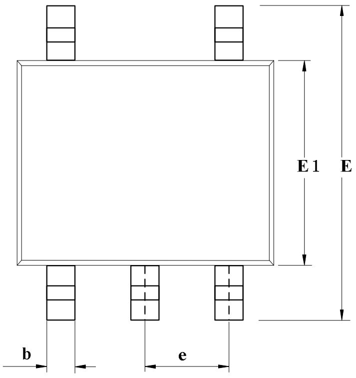
PACKAGE OUTLINE

SOT23-5 UNIT: mm

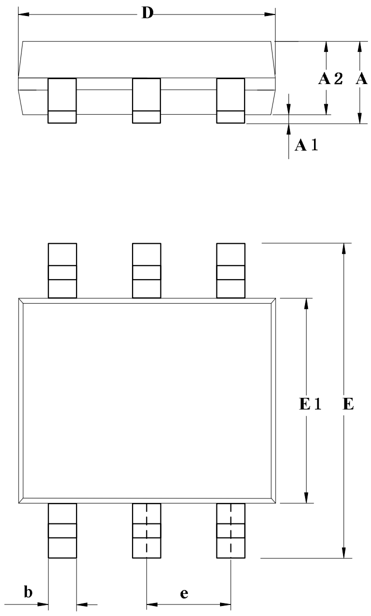


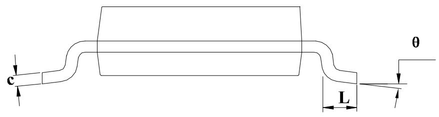


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.05	1.15	1.25
A1	0	0.05	0.15
A2	0.95	1.05	1.20
b	0.20	0.40	0.60
c	0.05	—	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95（BSC)		
L	0.30	0.45	0.60
θ	0°	—	8°



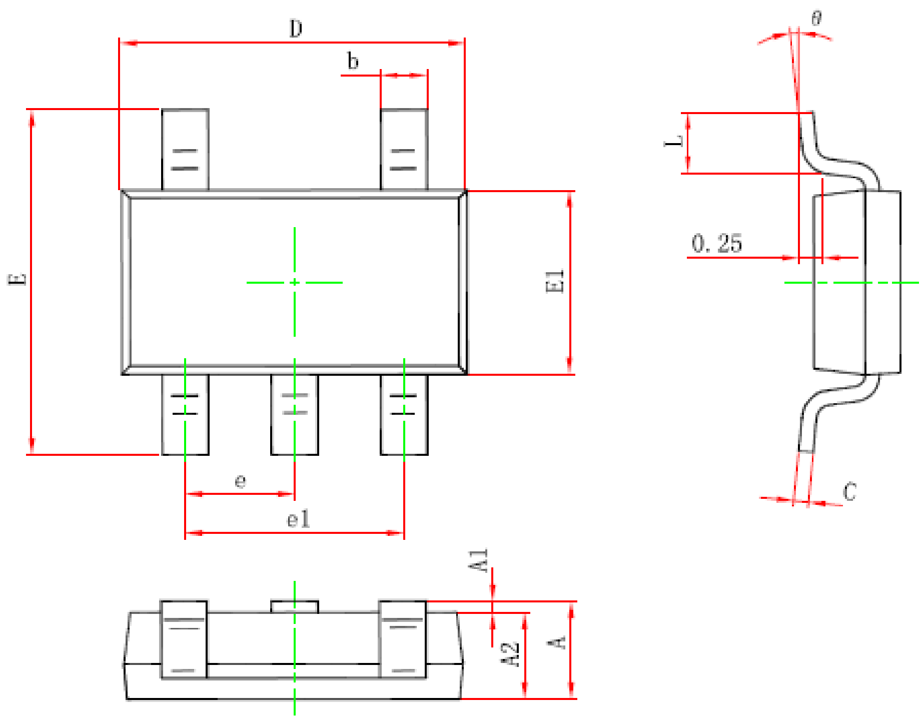
SOT23-6 UNIT: mm





SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.05	1.15	1.25
A1	0	0.05	0.15
A2	0.95	1.05	1.20
b	0.20	0.40	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
e	0.95（BSC)		
L	0.30	0.45	0.60
θ	0°	—	8°

TSOT23-5 UNIT: mm



NOTES:
ALL DIMENSIONS MEET JEDEC STANDARD MO-193 AB
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	---	0.900	---	0.035
A1	0.020	0.090	0.001	0.004
A2	0.700	0.800	0.028	0.031
b	0.350	0.500	0.014	0.020
c	0.080	0.200	0.003	0.008
D	2.820	3.020	0.111	0.119
E1	1.600	1.700	0.063	0.067
E	2.650	2.950	0.104	0.116
e	0.95（BSC）		0.037(BSC)	
e1	1.90（BSC）		0.075(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	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.**