

## High Performance Low Cost Off-line PWM Power Switch

### FEATURES

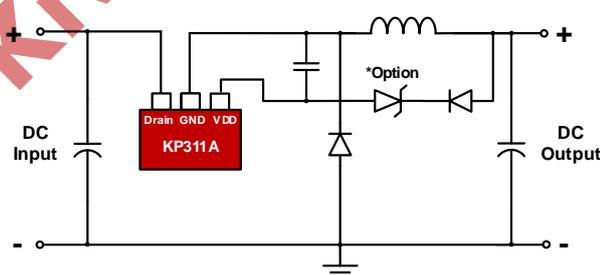
- High Precision 5V Default Output
- Integrated with 500V MOSFET and High Voltage Startup Circuit
- No External Rsense needed, Low BOM Cost
- Support Ultra-low Input Voltage (>12V)
- Support Buck and Buck / Boost Topology
- On/OFF Peak Current Mode Control
- Less than 50mW Standby Power
- Built-in 31kHz Oscillator with Frequency Shuffling
- Built-in Soft Start
- Very Low VDD Operation Current
- Build in Protections:
  - Over Load Protection (OLP)
  - On-Chip Thermal Shutdown (OTP)
  - Cycle-by-Cycle Current Limiting (OCP)
  - Abnormal Over Current Protection (AOCP)
  - Leading Edge Blanking (LEB)
  - VDD UVLO
- SOT23-3 Package Available

### APPLICATIONS

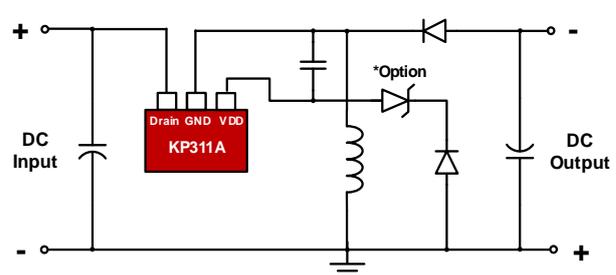
- Small Home Appliance
- Linear Regulator / RCC Replacement

### TYPICAL APPLICATION CIRCUIT

**Buck Converter**



**Buck/Boost Converter**



### GENERAL DESCRIPTION

KP311A is a low cost, highly integrated PWM power switch for non-isolated buck and buck-boost applications.

KP311A combines a 500V power MOSFET with the ON/OFF PWM controller in one chip. The IC can achieve high precision 5V default Output at universal AC input. In KP311A, Toff\_min is set to 32μs with frequency shuffling. The IC has built-in green mode control for light and zero loadings, which can achieve less than 50mW standby power.

KP311A integrates functions and protections of Under Voltage Lockout (UVLO), Cycle-by-cycle Current Limiting (OCP), On-chip Thermal Shutdown (OTP), Abnormal Over Current Protection (AOCP), Over Load Protection (OLP) Short Load Protection (SLP), etc.

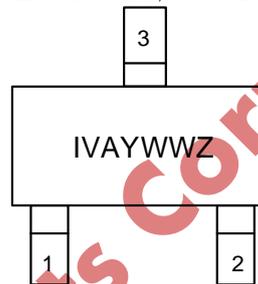
### Pin Configuration



SOT23-3

### Marking Information

Y: Year Code  
 WW: Week Code, 01-52  
 Z: Serial Number, 1-9 or A-Z



SOT23-3

### Typical Output Power Table

Package	Maximum Load Current @ 85-265 Vac,5V
SOT23-3	100mA

**Note:**

1. Default 5V Buck output
2. The practical output power is determined by the output voltage and thermal condition

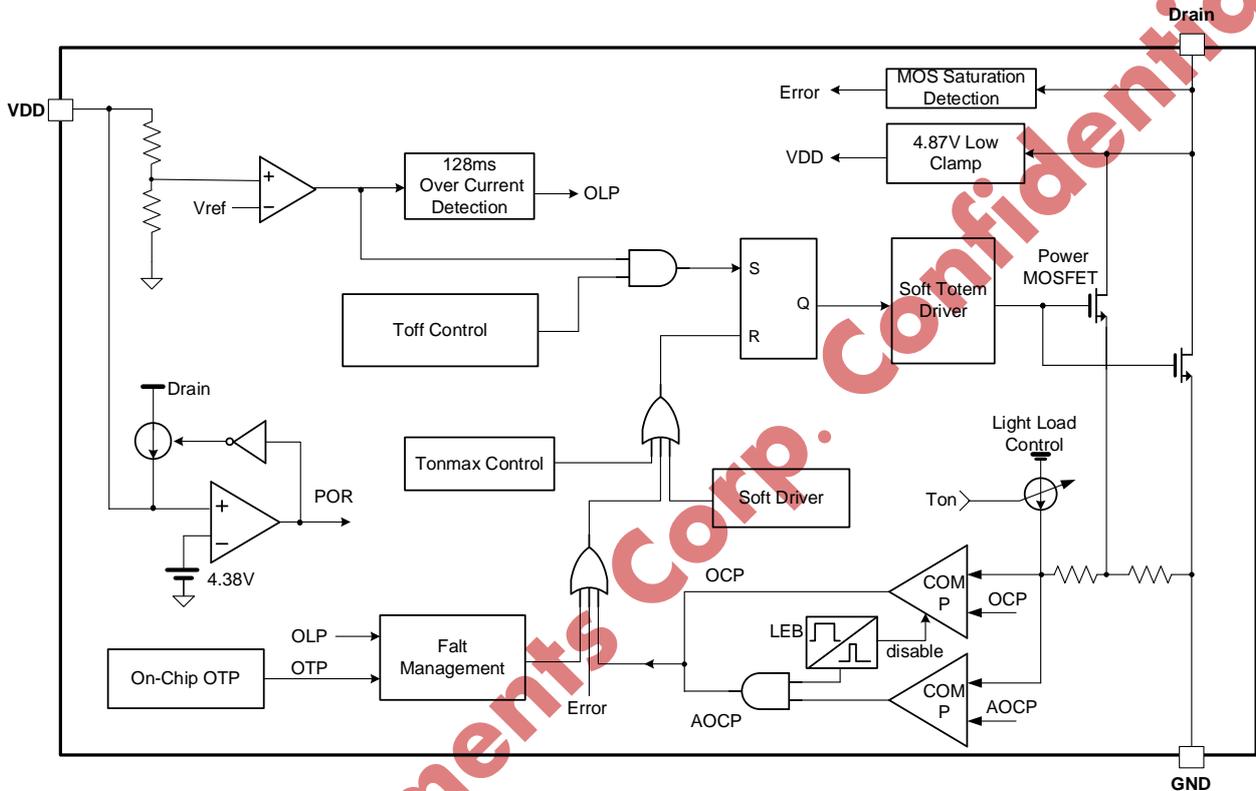
### Pin Description

Pin Number	Pin Name	I / O	Description
1	Drain	P	Internal power MOSFET drain
2	VDD	P	Power Supply Pin of the Chip, This pin is also used for output voltage feedback
3	GND	P	The Ground of the IC

### Ordering Information

Part Number	Description
KP311ALGA	SOT23-3, Halogen free in T&R, 3000 Pcs / Reel

### Block Diagram



**Absolute Maximum Ratings (Note 1)**

Parameter	Value	Unit
VDD – GND Voltage Range	-0.3 to 7	V
Drain – GND Voltage Range	-0.3 to 500	V
Package Thermal Resistance (SOT23-3)	260	°C / W
Maximum Junction Temperature	160	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 10sec.)	260	°C
ESD Capability, HBM (Human Body Model)	5	kV
ESD CDM	2	kV
Maximum Internal MOSFET DC Drain Current	0.4	A
Drain Maximum Pulse Current (Tpulse=100µs)	1.2	A

**Recommended Operation Conditions**

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	°C
Operation Switching Frequency	20 to 30	kHz

**Electrical Characteristics (Ta = 25°C, if not otherwise noted)**

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
<b>Power MOSFET Section (Drain Pin)</b>						
$I_{\text{Drain\_to\_VDD}}$	High Voltage VDD Charging Current Source	Drain=15V, VDD=2.5V	1.9	3	4.1	mA
$I_{\text{Drain\_to\_VDD1}}$	High Voltage VDD Charging Current Source1	Drain=40V, VDD=0V		2.7		mA
$I_{\text{Drain\_leakage}}$	Drain Leakage Current	Drain=500V, VDD=6V			80	µA
$V_{\text{Drain\_on}}$	Drain-On Voltage			8		V
$V_{\text{BR}}$	Power MOSFET Drain Source Breakdown Voltage		500			V
$R_{\text{dson}}$	Static Drain-Source On Resistance	I (Drain)=50mA		25		Ω

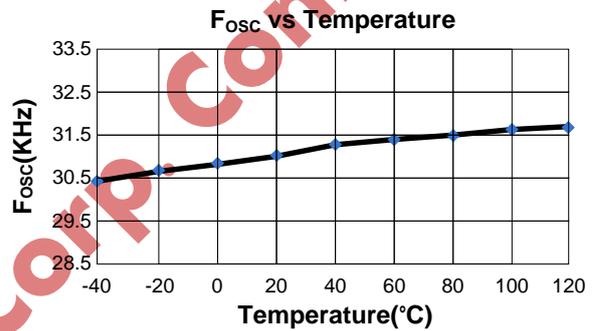
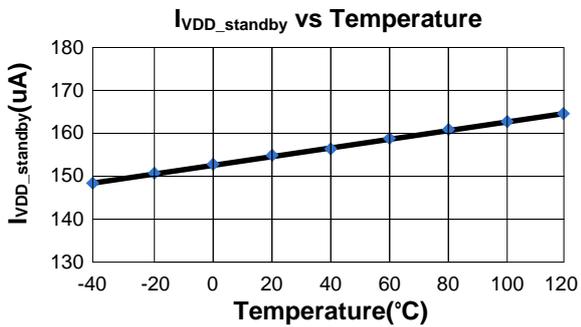
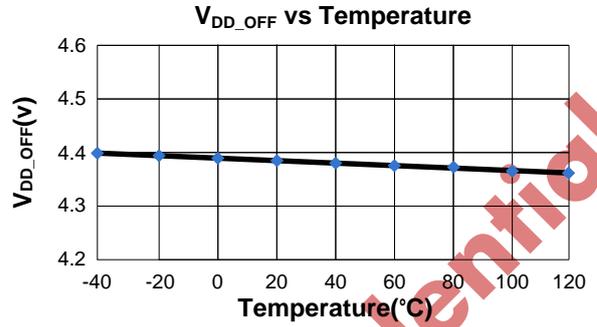
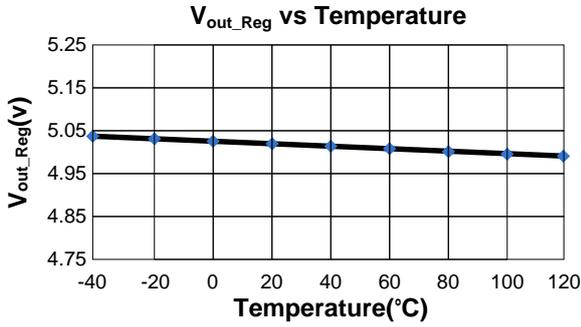
<b>Supply Voltage Section (VDD Pin)</b>						
$I_{VDD\_standby}$	Standby Operation Current	VDD=6V		120		$\mu A$
$V_{DD\_ON}$	VDD On Voltage			4.87		V
$V_{DD\_OFF}$	VDD Under Voltage Lockout Enter			4.38		V
$V_{DD\_Op}$	VDD Operation Voltage		5.32	5.46	5.55	V
<b>Oscillator Section</b>						
$T_{OFF\_MIN}$	Minimum Turn Off Time	VDD=5.46V	28	32	35	$\mu s$
$T_{ON\_MAX}$	Maximum Turn On Time	(Note 2)		60		$\mu s$
$T_{D\_OLP}$	Over Loading Debounce Time	VDD=4.9V		128		ms
<b>Internal Current Sense Input Section</b>						
$T_{LEB}$	CS Input Leading Edge Blanking Time			400		ns
$I_{peak\_limit}$	Peak Current Limit		200	210	220	mA
$I_{peak\_AOC}$	AOC Current Limit			250		mA
$T_{D\_OCP}$	Over Current Detection and Control Delay			200		ns
<b>Over Temperature Protection</b>						
$T_{SD}$	Thermal Shutdown Trigger Point	(Note 2)		155		$^{\circ}C$

**Note 1.** Stresses listed as the above "Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to maximum rating conditions for extended periods may remain possibility to affect device reliability.

**Note 2.** Guaranteed by design.

**Note 3.** Devices are ESD sensitive. Handling precaution is recommended.

Characterization Plots



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## Operation Description

KP311A combines a high voltage power MOSFET switch with power controller in one chip. It is optimized for off-line non-isolated buck or buck-boost applications for small home appliances and linear regulator replacement. The IC utilizes the ON/OFF current mode PWM control to regulate a 5V default output with high precision and lowest components count. Additionally, KP311A supports ultra-low input voltage (>12V) under normal load.

- **Very Low Operation Current**

The standby operating current in KP311A is as small as 150 $\mu$ A (typical). The small operating current results in higher efficiency and reduces the VDD hold-up capacitance requirement. Normally 0.1-1 $\mu$ F ceramic capacitor is recommended.

- **Oscillator with Frequency Shuffling**

Minimum Toff Time in KP311A is fixed to 32 $\mu$ s. To improve system EMI performance, KP311A operates the system with  $\pm$  5% frequency shuffling around setting frequency. The practical system switching frequency is determined by the load condition and the comparison of VDD voltage over output reference, which cause system works in the pulse-skipping mode.

- **Current Limit and Leading Edge Blanking**

The current limit circuit samples the differential voltage on the internal current sense resistor, as shown in "Block Diagram". When the sampled differential voltage exceeds the internal threshold, the power MOSFET is turned off for the remainder of that cycle. An internal leading edge blanking circuit is built in. During this blanking period (400ns, typical), the cycle-by-cycle current limiting comparator is disabled and cannot switch off the

GATE driver.

- **Green Mode Operation**

In light/zero load condition, the system usually works in DCM mode. Therefore, the main power dissipation is proportional to the square of peak current limit. In KP311A, the IC can automatically reduce the peak current limit under such load conditions, thus less than 50mW standby power can be achieved.

- **Soft Start**

KP311A features an internal 4ms (typical) soft start that slowly increases the threshold of cycle-by-cycle current limiting comparator during startup sequence. Every restart attempt is followed by the soft start activation.

- **Over Load Protection (OLP) / Short Load Protection (SLP)**

If over load or short load occurs, a fault is detected. If this fault is present for more than 128ms (typical), the protection will be triggered, the IC will experience an auto-restart mode protection as mentioned below.

- **Abnormal Over Current Protection (AOCP)**

When in heavy load or output short condition, the inductor current may be increased too large. To avoid system components damaged, there's a abnormal over current limit (typically 250mA). When the current sense voltage is larger than this threshold, the internal power MOSFET is turned off immediately and is to be turned on again after 2 cycles.

- **On Chip Thermal Shutdown (OTP)**

KP311A integrates thermal shutdown function. When the IC temperature is over 155 °C, the IC shuts down and enters into auto-restart mode as mentioned below.

- **Protections with Auto-Restart**

In the event of OTP or OLP, the IC enters into auto-restart and VDD oscillation mode begins, wherein the power MOSFET is disabled. In VDD oscillation mode, the VDD hold-up capacitor voltage will periodically ramp up and down

between 4.87V and 4.38V with a digital counter counting the oscillation cycle. When 511 cycles had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above mentioned process.

- **Soft Totem-Pole Gate Driver**

KP311A has a soft totem-pole gate driver with optimized EMI performance.

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### Typical Reference Design

- **Inductor Calculation**

In order to ensure stable system operation, KP311A is recommended to work under light CCM condition, which means inductor current ripple  $\Delta I$  is close to Max CS-PK (210mA). Detail calculation shows below:

$$L = (V_o + V_f) \cdot T_{off\_min} / \Delta I$$

$V_o$ : Output Voltage;

$V_f$ : Forward voltage on freewheeling diode;

$T_{off\_min}$ : Internal Toff-min,  $\sim 32\mu s$ ;

$\Delta I$ : inductor current ripple,  $2 \cdot (I_{o\_cp} - I_{o\_max})$  under CCM condition.

For example, take 5V-100mA as the output spec,  $I_{o\_max}$  is set to 1.2 times of the normal output current (120mA);

$$L = (5V + 0.7V) \cdot 32\mu s / (210 - 120) mA / 2 = 1.01 mH.$$

Choose  $L = 1mH$  &  $I_{saturation} > 210mA$  as the specific inductor parameter demand.

- **Output Capacitor and Dummy Load Selection**

Output Capacitor Selection: for 5V-100mA application, Output capacitor is choose between  $100\mu F - 220\mu F$  according to actual output voltage ripple.

Dummy Load Selection: heavy dummy load could suppress the output voltage from floating up, but too heavy dummy load would enlarge the standby power loss; take balance among load regulation and standby power loss.

1k-2k dummy load is recommended in KP311A system for good output regulation and low dummy load power loss (10-15mW).

### Typical Application Diagram

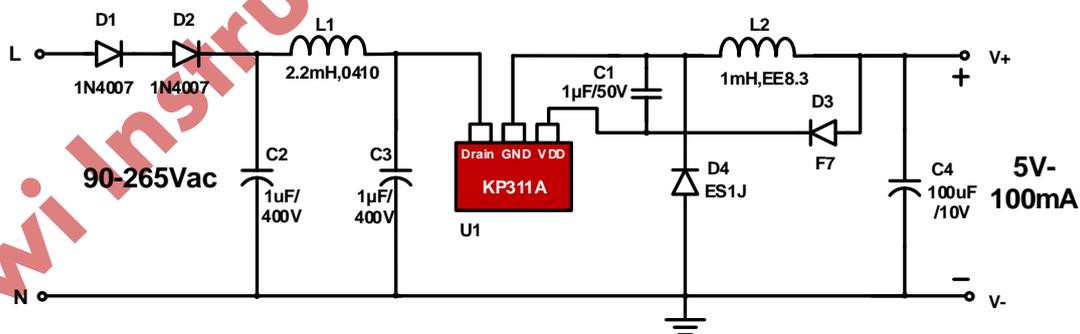
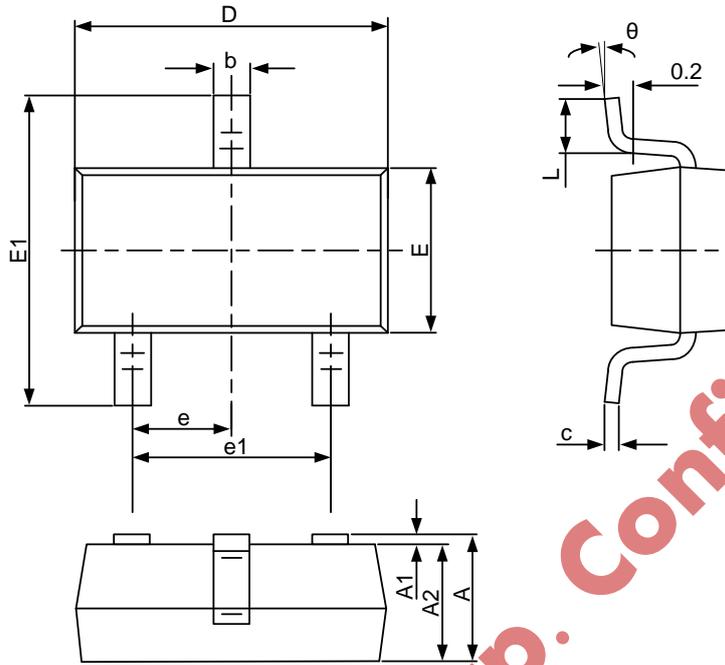


Fig. 1

Package Dimension

SOT23-3



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	-	1.350	-	0.053
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.300	0.500	0.012	0.020
c	0.100	0.220	0.004	0.009
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	3.000	0.102	0.118
e	0.950 BSC		0.037 BSC	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



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