Figure 1. Physical Photos of AT8028

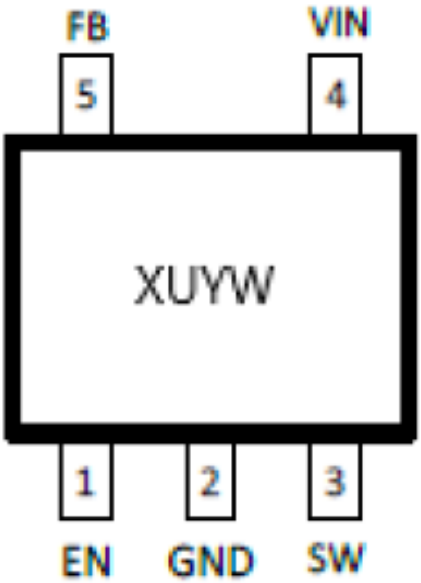


Figure 2. Pin Configurations

ORDERING GUIDE

Online Stores		Commission Fee	Unit Price (June 2024)	Buy Now
AS	shop.analogtechnologies **Our own online store**	Zero sale commission	$0.30/100PCs	*
SZ	SMTZone **Our own online store**	Zero sale commission	$0.30/100PCs	*
K	Digikey	≈40% sale commission	$0.42/100PCs	*

FEATURES

- High Efficiency: up to 97%
- Up to 1.5A Max Output Current
- 2MHz Switching Frequency
- Low Dropout 100% Duty Operation
- Internal Compensation and Soft-start
- Current Mode Control
- Reference 0.6V
- Logic Control Shutdown (IQ<1uA)
- Thermal Shutdown, UVLO
- Available in SOT23-5

APPLICATIONS

- Cellular Phones
- Digital Cameras
- MP3 and MP4 Players
- Set Top Boxes
- Wireless and DSL Modems
- USB Supplied Devices in Notebooks
- Portable Devices

DESCRIPTION

The AT8028 is a high-efficiency, DC to DC step-down switching regulators, capable of delivering up to 1.5A of output current. The device operates from an input voltage range of 2.6V to 5.5V and provides an output voltage from 0.6V to VIN. Working at a fixed frequency of 2MHz allows the use of small external components, such as ceramic input and output caps,

as well as small inductors, while still providing low output ripples. This low noise output along with its excellent efficiency achieved by the internal synchronous rectifier, making AT8028 an ideal replacement for large power consuming linear regulators. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal shutdown protection improves design reliability. The AT8028 is available in SOT23-5 package.

TYPICAL APPLICATION

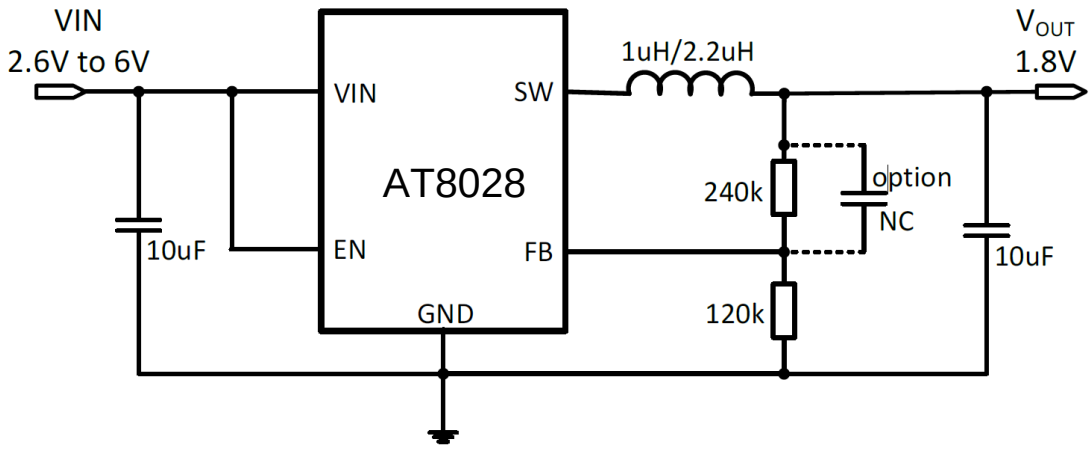


Figure 3. Typical Application Circuit

ABSOLUTE MAXIMUM RATING

Table 1.

Parameter	Value
Max Input Voltage	8V
Max Operating Junction Temperature(T_J)	125°C
Operating Ambient Temperature(T_A)	−40°C to +125°C
Maximum Power Dissipation	400mW
Storage Temperature(T_S)	−40°C to +150°C
Lead Temperature & Time	260°C, 10s
ESD (HBM)	>2000V

Note: Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect device reliability.

PIN DESCRIPTION

Table 2.

NO.	NAME	DESCRIPTION
1	EN	Enable pin for the IC. Drive the pin to high to enable the part, and low to disable.

NO.	NAME	DESCRIPTION
2	GND	Ground
3	SW	Inductor connection. Connect an inductor between SW and the regulator output.
4	VIN	Power supply voltage.
5	FB	Feedback input. Connect an external resistor divider from the output to FB and GND to set the output to a voltage between 0.6V and VIN.

ELECTRICAL CHARACTERISTICS

(At T_A = +25°C, V_{IN} =5V, unless otherwise noted.)

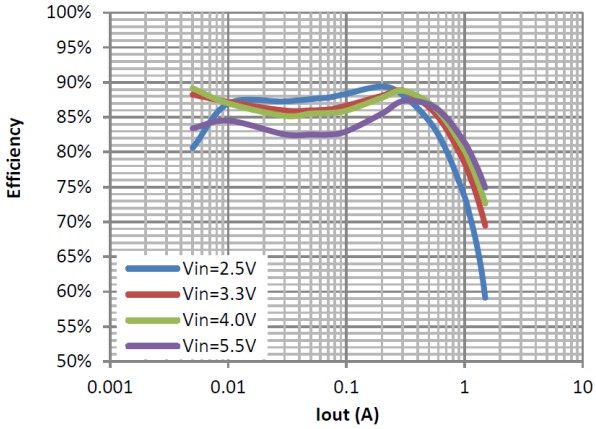
Table 3.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		2.6		5.5	V
Input Overvoltage Threshold	V_{OVP}			6.1		V
Feedback Voltage	V_{REF}	V_{IN} = 5V	0.588	0.6	0.612	V
Feedback Leakage Current	I_{FB}			0.1	1	μA
Quiescent Current	I_Q	Active, VFB=0.65, No Switching		80		μA
Shutdown Input Current	$I_{SHUTDOWN}$	EN = 0V			1	μA
Line Regulation	LNR	V_{IN} = 2.6V to 5.5V		0.1	0.2	%/V
Load Regulation	LDR	I_{OUT} = 0.01 to 1A		0.1	0.2	%/A
Switching Frequency	F_{SOC}			2		MHz
PMOS Rdson	R_{DSON_P}			250	350	mΩ
NMOS Rdson	R_{DSON_N}			150	250	mΩ
Under Voltage Lockout	V_{UVLO}		1.9	2.1	2.3	V
UVLO hysteresis	V_{UVLO_HY}			100		mV
Peak Current Limit	I_{LIMIT}			2.3		A
	I_{NOLOAD}	V_{IN} = 5V, V_{OUT} = 3.3V, I_{OUT} = 0A		80		μA
SW Leakage Current	I_{SWLK}	V_{IN} = 6V, V_{SW} = 0 or 6V, I_{OUT} = 0A			1	μA
EN Leakage Current	I_{ENLK}				1	μA
EN Input High Voltage	I_{H_EN}		1.2			V
EN Input Low Voltage	I_{L_EN}				0.5	V
Thermal Shutdown Temperature	T_{SD}			160		°C
Thermal Shutdown Hysteresis	T_{SH}			15		°C

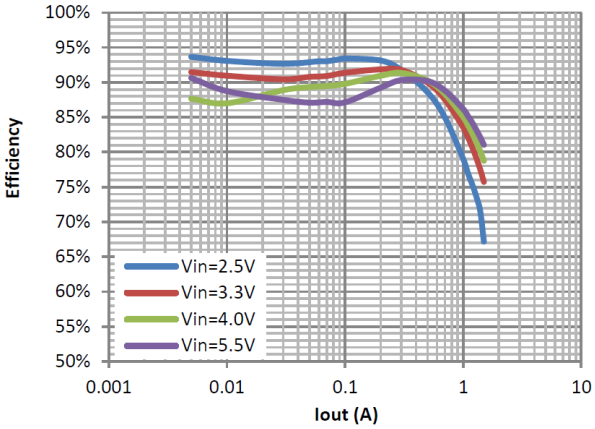
TYPICAL CHARACTERISTICS

(At T_A = +25°C, V_{IN} =5V, unless otherwise noted.)

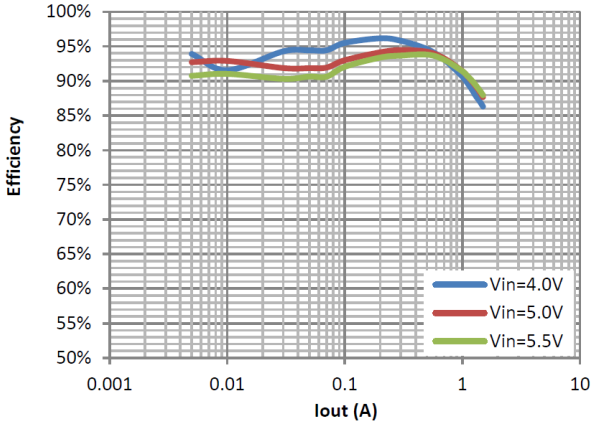
Efficiency vs. Output Current
(Vout=1.2V)



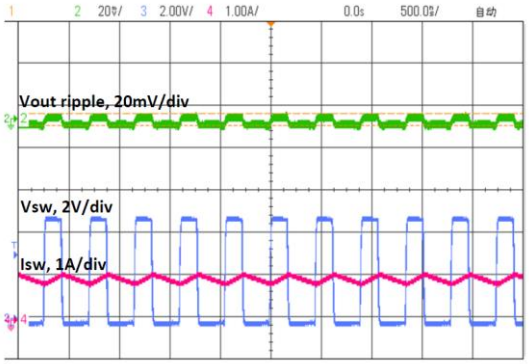
Efficiency vs. Output Current
(Vout=1.8V)



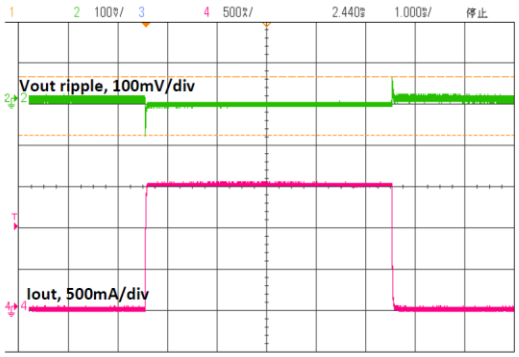
Efficiency vs. Output Current
(Vout=3.3V)



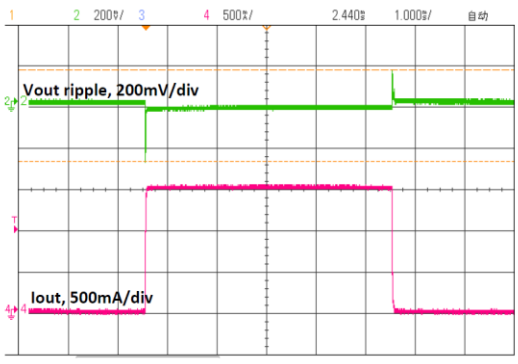
Output Ripple and SW at 1A load
Vin=5V / Vout=1.8V
Ch2—Vout ripple, Ch3—Vsw, Ch4—Isw



Load Transient
Vin=5V / Vout=1.2V / Iout=0.01~1.5A
Ch2—Vout ripple, Ch4—Iout



Load Transient
Vin=5V / Vout=3.3V / Iout=0.01~1.5A
Ch2—Vout ripple, Ch4—Iout



BLOCK DIAGRAM

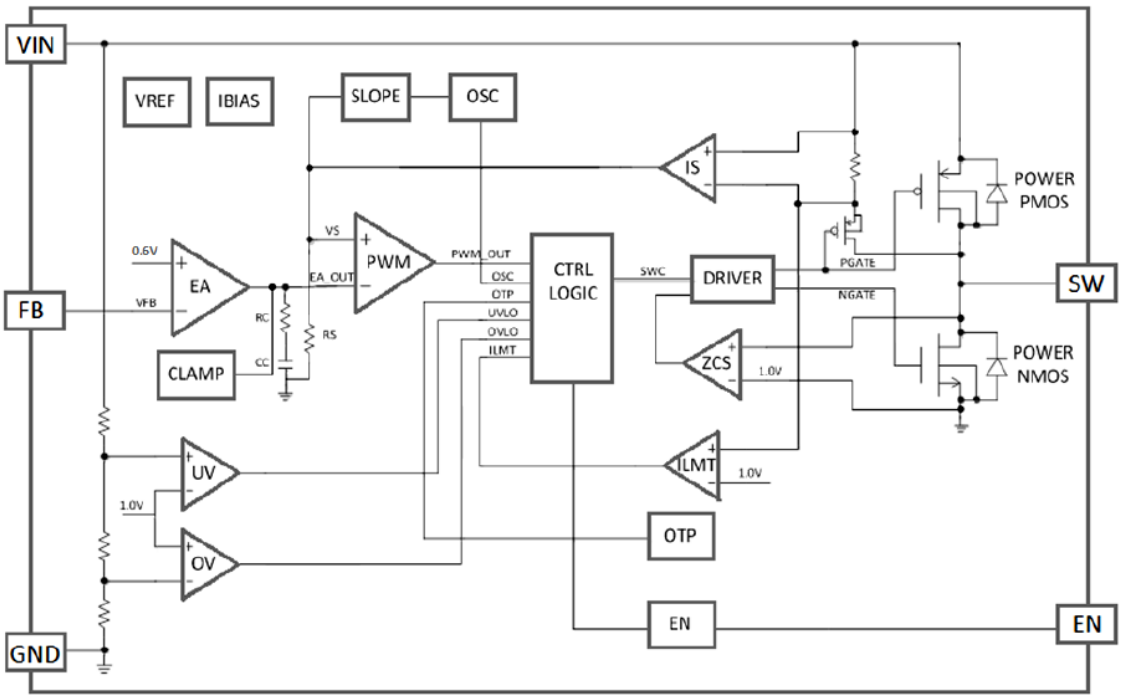


Figure 4. Block Diagram

DETAILED DESCRIPTION

The AT8028 high-efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1.5A of output current. The device operates in pulse-width modulation (PWM) at 2MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to VIN, making the AT8028 ideal for on-board post regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

Loop Operation

AT8028 uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal highside P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

Current limit

There is a cycle-by-cycle current limit on the ighside MOSFET of 2.3A(typ). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. AT8028 utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 100mV, limiting the current to 2.3A(typ) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-start

AT8028 has an internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal shutdown event, the soft-start circuitry slowly ramps up current available at SW.

UVLO

If VIN drops below 2.1V, the UVLO circuit inhibits switching. Once VIN rises above 2.2V, the UVLO clears, and the soft-start sequence activates.

Thermal shutdown

Thermal shutdown protection limits total power dissipation in the device. When the junction temperature exceeds T_J= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 15°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

DESIGN PROCEDURE

Setting output voltages

Output voltages are set by external resistors. The FB threshold is 0.6V.

$$R_{TOP} = R_{BOTTOM} \times \left(\frac{V_{OUT}}{0.6} - 1\right)$$

Input capacitor selection

The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

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

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_S^2 \times L \times C_{OUT}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

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

LAYOUT GUIDE

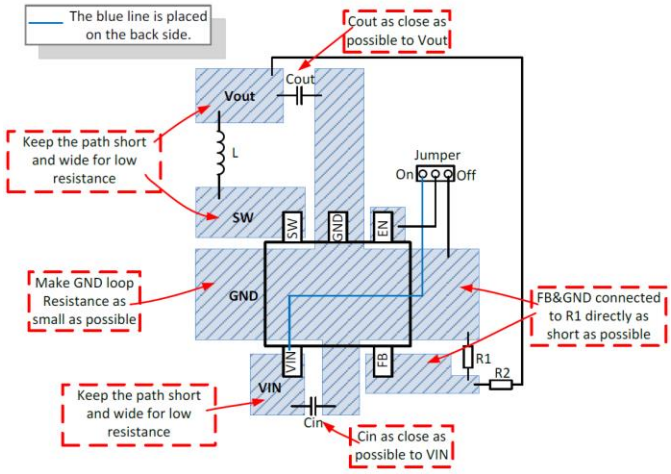


Figure 5. Layout Guide

OUTLINE DIMENSIONS

SOT23-5

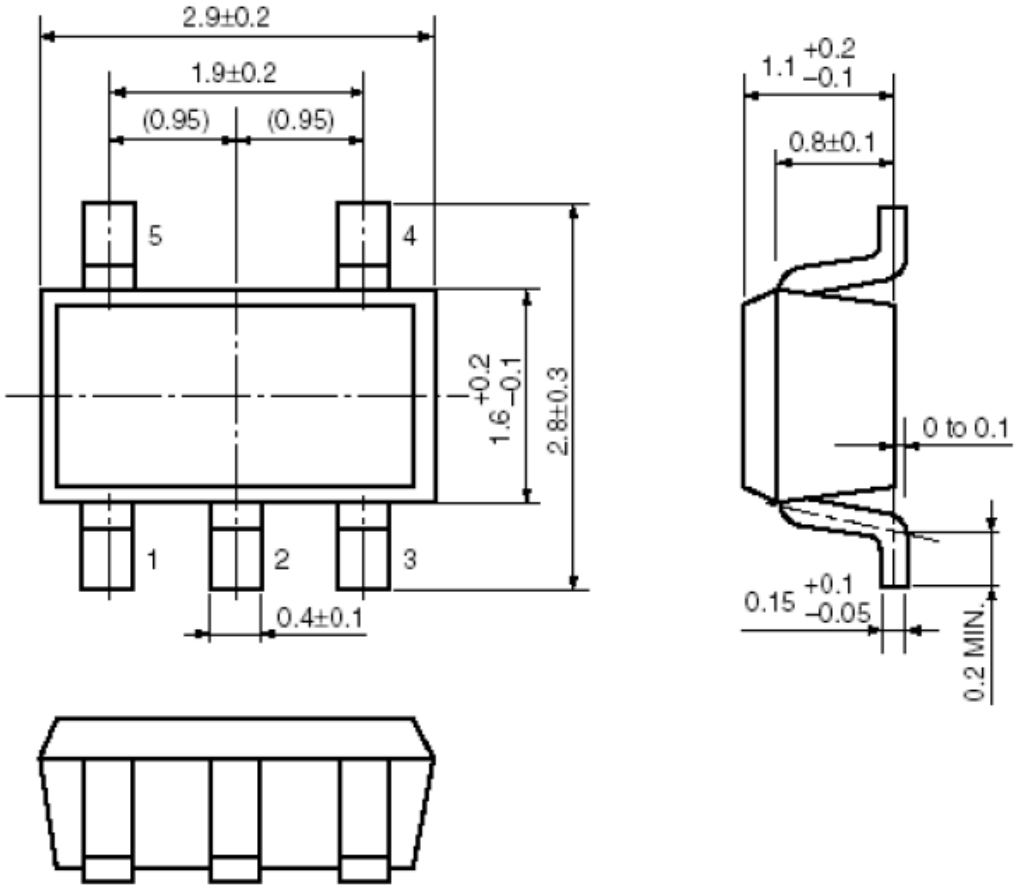


Figure 6. Outline Dimensions

ORDERING INFORMATION

Table 4. Ordering Information

Part Number	Buy Now
AT8028	* *

*: both and are our online store icons. Our products can be ordered from either one of them with the same pricing and delivery time.

NOTICE

1. It is important to carefully read and follow the warnings, cautions, and product-specific notes provided with electronic components. These instructions are designed to ensure the safe and proper use of the component and to prevent damage to the component or surrounding equipment. Failure to follow these instructions could result in malfunction or failure of the component, damage to surrounding equipment, or even injury or harm to individuals. Always take the necessary precautions and seek professional assistance if unsure about proper use or handling of electronic components.

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