



The Future of Analog IC Technology®

# MPQ2128

2.5V-to-6V Input, 3MHz, 1A  
Synchronous, Step-Down Converter  
Available in AEC-Q100

## DESCRIPTION

The MPQ2128 is a 3MHz, constant-frequency, current-mode, PWM, step-down converter. It has an integrated main switch and synchronous rectifier that make it ideal for low-voltage conversions.

The MPQ2128 can supply up to 1A load current from a 2.5V-to-6V input voltage. The output voltage can go as low as 0.6V.

Additional features include <math><1\mu\text{A}</math> shutdown current, internal soft-start, cycle-by-cycle over-current protection, short-circuit protection, and thermal shutdown.

The MPQ2128 is available in a 2mmx2mm 8-pin QFN package.

## FEATURES

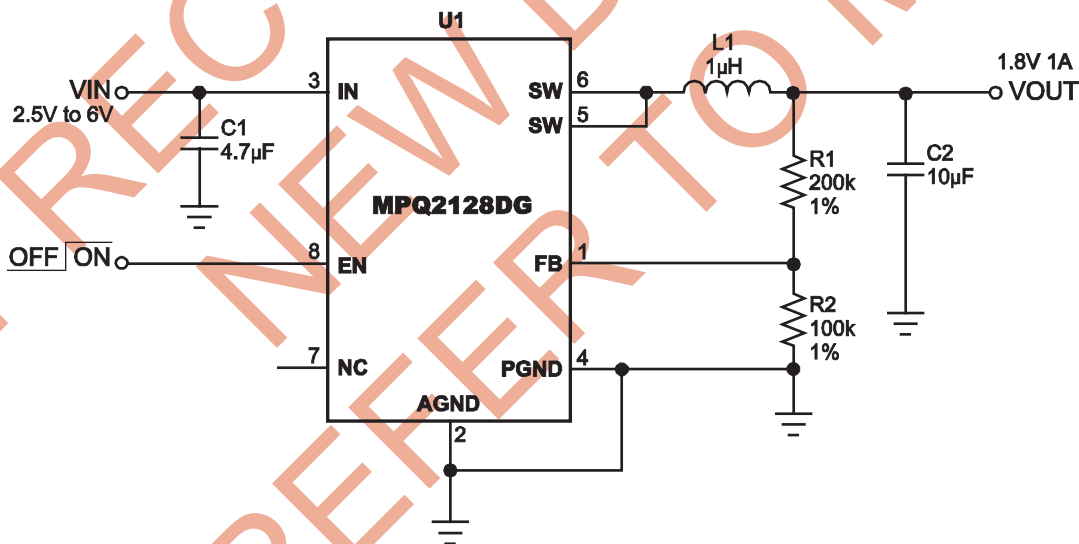
- Meets Automotive Requirements
- Highly Efficient: Up to 95%
- 3MHz Constant-Switching Frequency
- 1A Available Load Current
- 2.5V-to-6V Input Voltage Range
- Output Voltage as Low as 0.6V
- Current-Mode Control
- Cycle-by-Cycle Over-Current Protection
- Short-Circuit Protection
- Thermal Shutdown
- <math><1\mu\text{A}</math> Shutdown Current
- Internal Soft-Start
- QFN8 (2mmx2mm) Package
- AEC-Q100 Qualified

## APPLICATIONS

- Industrial/Automotive

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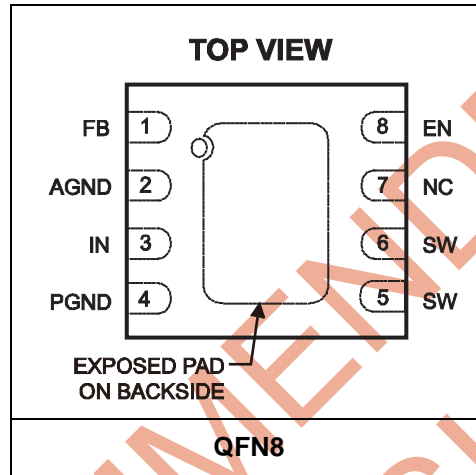
## TYPICAL APPLICATION



**ORDERING INFORMATION**

Part Number*	Package	Top Marking
MPQ2128DG	QFN8 (2mmx2mm)	AY
MPQ2128DG-AEC1*	QFN8 (2mmx2mm)	AY

\* For Tape & Reel, add suffix -Z (eg. MPQ2128DG-Z).  
 For RoHS compliant packaging, add suffix -LF (e.g. MPQ2128DG-LF-Z)

**PACKAGE REFERENCE**

**ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>**

IN to GND .....	-0.3V to +6.5V
SW to GND.....	-0.3V to $V_{IN} + 0.3V$
FB, EN to GND.....	-0.3V to +6.5V
Continuous Power Dissipation. ( $T_A = +25^{\circ}C$ ) <sup>(2)</sup>	
QFN8 (2mmx2mm).....	2.5W
Junction Temperature.....	150°C
Lead Temperature .....	260°C
Storage Temperature.....	-65°C to +150°C

**Recommended Operating Conditions <sup>(3)</sup>**

Supply Voltage $V_{IN}$ .....	2.5V to 6V
Output Voltage $V_{OUT}$ .....	0.6V to 6V
Operating Junction Temp.....	-40°C to +125°C

Thermal Resistance <sup>(4)</sup>	$\theta_{JA}$	$\theta_{JC}$
QFN8 (2mmx2mm).....	50	12 ... °C/W

**Notes:**

- Exceeding these ratings may damage the device.
- The maximum allowable power dissipation is a function of the maximum junction temperature  $T_J$  (MAX), the junction-to-ambient thermal resistance  $\theta_{JA}$ , and the ambient temperature  $T_A$ . The maximum allowable continuous power dissipation at any ambient temperature is calculated by  $P_D$  (MAX) =  $(T_J$  (MAX) -  $T_A$ ) /  $\theta_{JA}$ . Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
- The device is not guaranteed to function outside of its operating conditions.
- Measured on JESD51-7, 4-layer PCB.

**ELECTRICAL CHARACTERISTICS <sup>(5)</sup>**
 $V_{IN} = V_{EN} = 3.6V$ ,  $T_j = -40^{\circ}C$  to  $125^{\circ}C$ , unless otherwise noted. Typical values are at  $T_j = 25^{\circ}C$ .

Parameters	Condition	Min	Typ	Max	Units
Supply Current	$V_{EN} = V_{IN}$ , $V_{FB} = 0.65V$		350	750	$\mu A$
Shutdown Current	$V_{EN} = 0V$ , $V_{IN} = 6V$		0.01	1.2	$\mu A$
IN Under Voltage Lockout Threshold	Rising Edge	1.75	2.1	2.3	V
IN Under Voltage Lockout Hysteresis			250		mV
Regulated FB Voltage	$T_j = +25^{\circ}C$	0.582	0.594	0.606	V
	$-40^{\circ}C \leq T_j \leq 125^{\circ}C$	0.574	0.594	0.614	V
FB Input Bias Current	$V_{FB} = 0.65V$	-200		200	nA
PFET Current Limit	Duty Cycle $\leq 40\%$	$T_j = 25^{\circ}C$	1.8		A
		$-40^{\circ}C \leq T_j \leq 125^{\circ}C$	1.2		
PFET On-Resistance	$I_{SW} = 100mA$		200		m $\Omega$
NFET On-Resistance	$I_{SW} = -100mA$		150		m $\Omega$
SW Leakage Current	$V_{EN} = 0V$ ; $V_{IN} = 6V$ $V_{SW} = 0V$ or $6V$	-3		3	$\mu A$
EN High Threshold	$-40^{\circ}C \leq T_j \leq 125^{\circ}C$	1.6			V
EN Low Threshold	$-40^{\circ}C \leq T_j \leq 125^{\circ}C$			0.4	V
Internal Soft-Start Time			100		$\mu s$
Oscillator Frequency		2.2	2.8	3.4	MHz
Thermal Shutdown Threshold	Hysteresis= $20^{\circ}C$		150		$^{\circ}C$

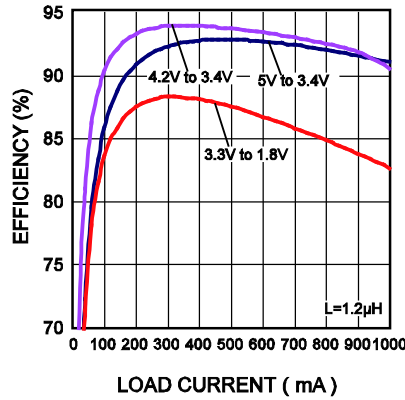
**Note:**

 5) Production test at  $+25^{\circ}C$ . Specifications over the temperature range are guaranteed by design and characterization.

## TYPICAL PERFORMANCE CHARACTERISTICS

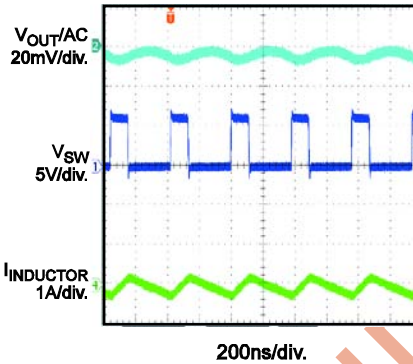
$V_{IN}=6V$ ,  $V_{OUT}=1.8V$ ,  $L=1.2\mu H$ ,  $C2=10\mu F$ ,  $T_A=25^\circ C$ , unless otherwise noted.

### Efficiency vs. Load Current



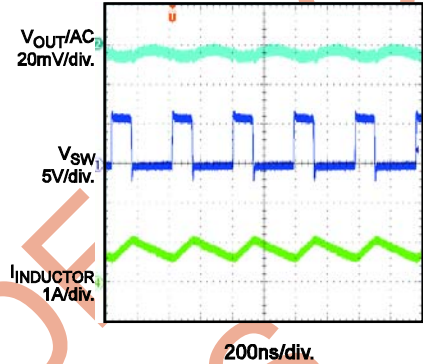
### Steady State Operation

$I_{OUT}=0A$



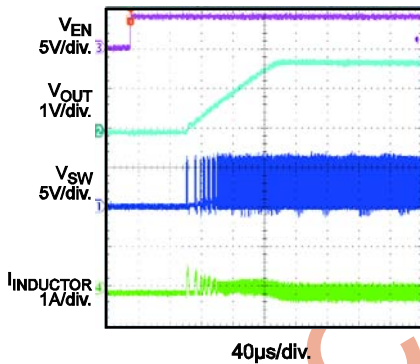
### Steady State Operation

$I_{OUT}=1A$



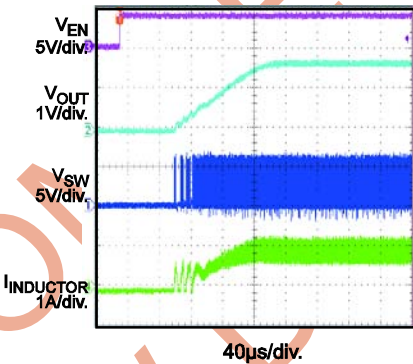
### Start-up Through Enable

$I_{OUT}=0A$



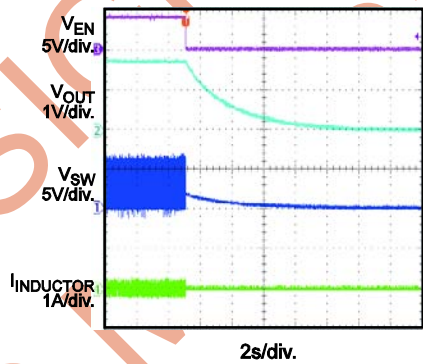
### Start-up Through Enable

$I_{OUT}=1A$



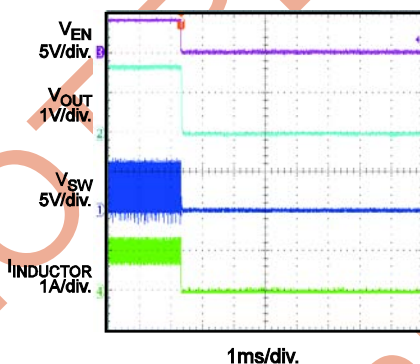
### Power-down Through Enable

$I_{OUT}=0A$



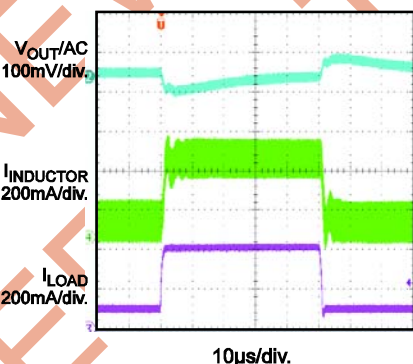
### Power-down Through Enable

$I_{OUT}=1A$



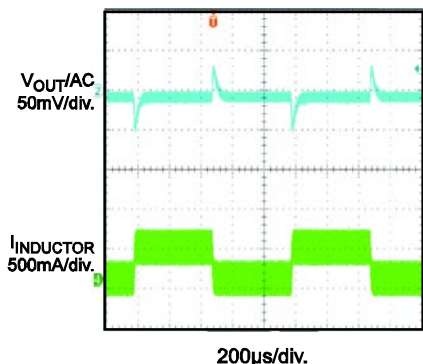
### Load Transient

Load Step: 100mA-400mA,  
 $V_{IN}=4.2V$ ,  $V_{OUT}=3.4V$



### Load Transient

Load Step: 100mA-400mA,  
Slew Rate: 250mA/µs



## PIN FUNCTIONS

QFN Pin #	Name	Description
8	EN	Enable. Drive EN above 1.6V to turn on the part. Drive EN below 0.4V to turn it off.
2,4	GND	Ground.
5,6	SW	Power Switch Output. Connect an inductor to the drains of the internal PFET and NFET switches.
3	IN	Supply. Bypass to GND with a $\geq 4.7\mu\text{F}$ ceramic capacitor.
1	FB	Feedback. Connect to the tap of the external resistor divider. The regulated feedback voltage is 0.6V.
Exposed Pad		

## BLOCK DIAGRAM

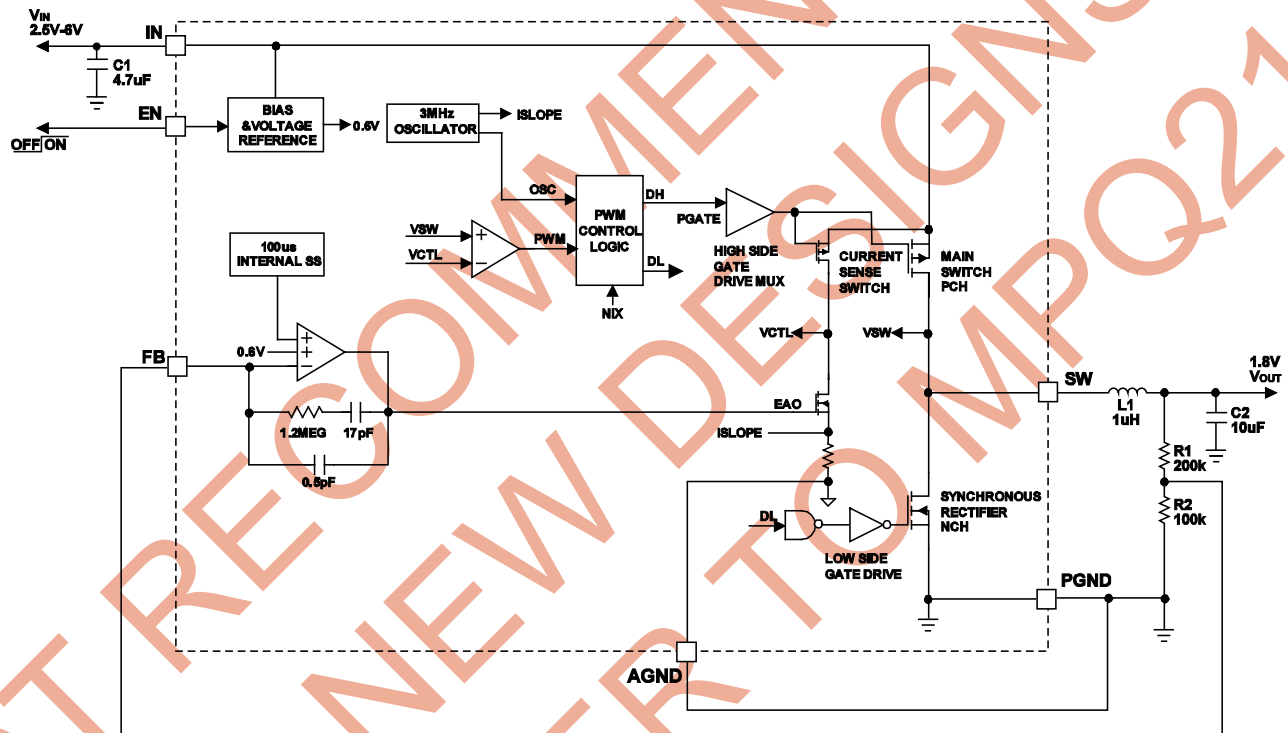


Figure 1: Functional Block Diagram

## FUNCTIONAL DESCRIPTION

MPQ2128 is a 3MHz, constant frequency, current-mode, PWM, step-down converter. The device integrates both a main switch and a synchronous rectifier, which provides high efficiency and eliminates the need for an external Schottky diode. It is ideal for powering portable equipment that runs from a single Li-Ion or Li-Polymer battery.

The MPQ2128 can achieve 100% duty cycle. The duty cycle, D, of the step-down converter is defined as:

$$D = t_{ON} \times f_{OSC} \times 100\% \approx \frac{V_{OUT}}{V_{IN}} \times 100\%$$

Where,

$t_{ON}$ : Main Switch ON time

$f_{OSC}$ : Switching frequency (3MHz)

$V_{OUT}$ : Output voltage

$V_{IN}$ : Input voltage

### Peak-Current –Mode PWM Control

Slope-compensated, current-mode, PWM control provides stable switching and cycle-by-cycle current limiting for superior load and line response, and protects the internal main switch and synchronous rectifier. The MPQ2128 switches at a constant frequency (3MHz) and regulates the output voltage. During each cycle the PWM comparator modulates the power transferred to the load by changing the inductor peak current based on the feedback error voltage.

During normal operation, the main switch turns on to ramp-up the inductor current with each rising edge of the internal oscillator, and switches off when the peak inductor current rises above the error voltage.

When the main switch is off, the synchronous rectifier turns on immediately and remains on until the next cycle starts.

### Dropout Operation

The MPQ2128 allows the main switch to remain on for more than one switching cycle and increases the duty cycle while the input voltage drops down to the output voltage. When the duty cycle reaches 100%, the main switch is held ON to deliver current to the output up to the PFET

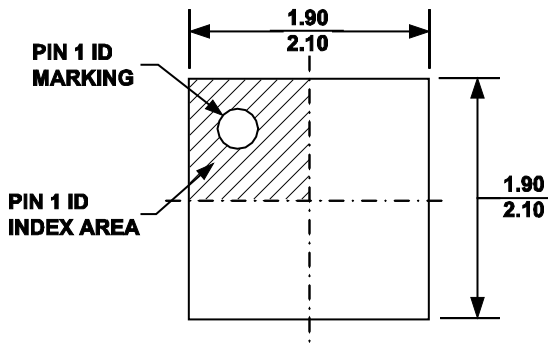
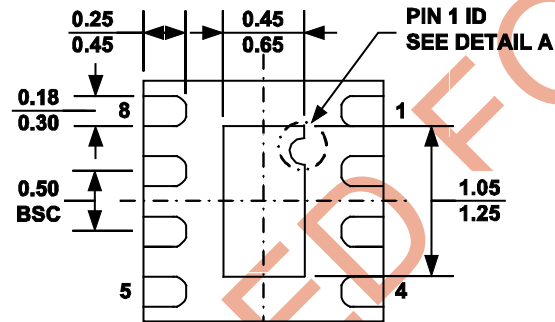
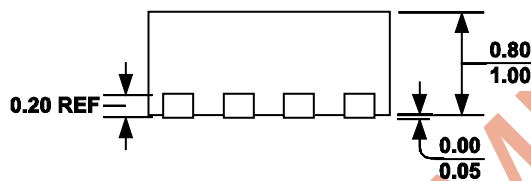
current limit. The output voltage is then the difference between the input voltage and the voltage drop across the main switch and the inductor.

### Short-Circuit Protection

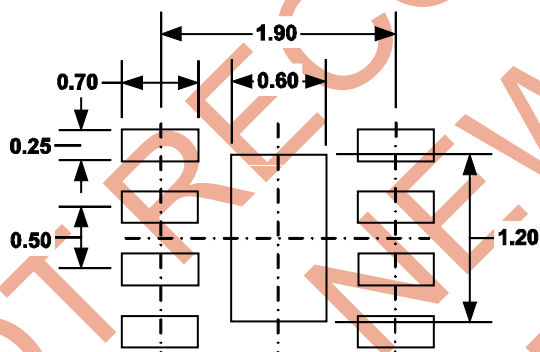
The MPQ2128 has short-circuit protection. When the output is shorted to ground, the oscillator frequency reduces to prevent the inductor current from increasing beyond the PFET current limit. The PFET current limit also drops to lower the short-circuit current. The frequency and current limit return to their normal values once the short circuit condition is removed and the feedback voltage reaches 0.6V.

### Maximum Load Current

The MPQ2128 can operate at an input voltage as low as 2.5V. However the maximum load current decreases with the lower input due to a large voltage drop across the main switch and synchronous rectifier. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%. Conversely the current limit increases as the duty cycle decreases.

**PACKAGE INFORMATION**
**QFN8 (2mm×2mm)**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**
**PIN 1 ID OPTION A**  
 R0.20 TYP.

**PIN 1 ID OPTION B**  
 R0.20 TYP.

**DETAIL A**

**RECOMMENDED LAND PATTERN**
**NOTE:**

- 1) ALL DIMENSIONS ARE IN MILLIMETERS.
- 2) EXPOSED PADDLE SIZE DOES NOT INCLUDE MOLD FLASH.
- 3) LEAD COPLANARITY SHALL BE 0.10 MILLIMETER MAX.
- 4) DRAWING CONFORMS TO JEDEC MO-229, VARIATION VCCD-3.
- 5) DRAWING IS NOT TO SCALE.

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