1. Description

The XPM6136 is a fully integrated, high-frequency, synchronous, rectified, step-down, power module with internal inductor.

It offers a very compact solution to achieve 6A of continuous output current over a wide input range, with excellent load and line regulation.

Advanced Constant-on-time (COT) control operation provides very fast transient response and easy loop design, as well as very tight output regulation.

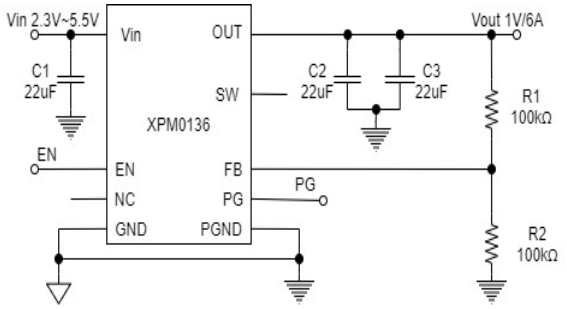
Comprehensive protection features include short-circuit protection (SCP), over-current protection (OCP) and thermal shutdown.

The XPM6136 requires a minimal number of readily available, standard external components, and is available in a space-saving LGA-24 (4mmx6mm) package.

2. Applications

- FPGA Power Systems
- Optical Modules
- Telecom
- Networking
- Industrial Equipment

Figure 1. Typical Application Circuit

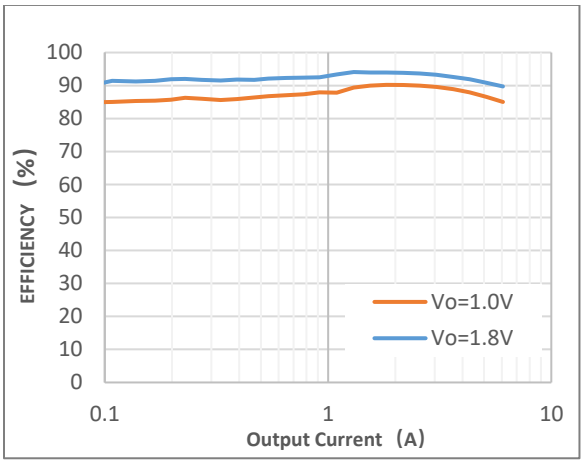


3. Features

- Wide 2.3V to 5.5V Input Range
- 6A Output Current
- Internal Power MOSFETs
- Output Adjustable from 0.5V
- Pre-Biased Start-Up
- Forced CCM Mode for Low Vout ripple
- Fixed 3MHz Switching Frequency
- Soft-Start
- EN and Power Good for Power Sequencing
- Over-Current Protection and Hiccup Mode
- Thermal Shutdown
- 100% Duty Cycle
- Active Output Discharge
- Available in an LGA-24 (4mmx6mmx1.6mm) Package
- EU RoHS Compliant, halogen and Pb Free

Figure 2. Typical Efficiency

Vin=3.6V



4. Revision History

TABLE 1. REVISION HISTORY

Release	Rev	Changes	Date
Updates	0.5	Updates	9/19/23

5. Ordering Information

TABLE 2. LIST OF PARTS

Part Number	Output Current (A)	VOUT (V)	Top Marking	MPQ
XPM6136XA	6	Adjustable	M6136	2500

MPQ = Minimum Packaging Quantity. For production orders greater than MPQ, the order must be a multiple of MPQ per package size above.

6. PIN Configuration and Description

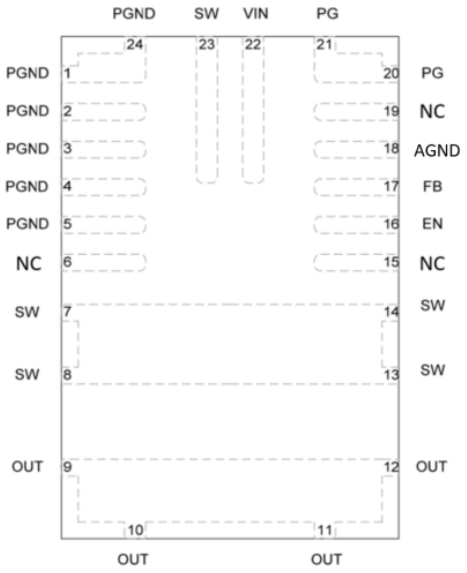


Figure 3. Top View

Table 3. Pin Definition

Pin	Name	Description
1,2,3,4,5,24	PGND	**System Ground.** This pin is the reference ground of the regulated output voltage.
6	NC	**Dummy Pin.**
7,8,13,14,23	SW	**Switch Output.** This pin can be left floating.
9,10,11,12,	OUT	**Output Pin.** Connect this pin to C_{OUT}.
15	NC	**Dummy Pin.**
16	EN	**Enable.** Pull EN high to enable the part. When floating, EN is pulled down to GND by internal 2MΩ resistor and is disabled.
17	FB	**Feedback.** Sets the output voltage when connected to the tap of an external resistor divider that is connected between output and GND.
18	AGND	**Signal Ground.** AGND is not internally connected to PGND, so ensure that AGND is connected to PGND in the PCB layout.
19	NC	**Dummy Pin.**
20,21	PG	**Power-Good Output.** The output of this pin is an open-drain output. Its state changes if UVP, OCP, or OTP occurs.
22	VIN	**Supply Voltage.** The part operates from a 2.3V to 5.5V input rail. C1 is necessary to decouple the input rail. Use a wide PCB trace to make the connection.

7. Absolute Maximum Ratings

TABLE 4. ABSOLUTE MAXIMUM RATINGS[1]

Parameter	Min	Max	Units
DC Supply Voltage, VIN	-0.3	7	V
Voltage on other pins, PG, SW, FB, EN, OUT	-0.3	V_{IN} + 0.3	V
Storage Temperature Range	-40	+150	°C
Junction Temperature	-40	+150	°C
Electrostatic Discharge (HBM)	-2000	2000	V
Electrostatic Discharge (CDM)	-2000	2000	V

8. Recommended Operating Conditions

TABLE 5. OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Units
Supply Voltage	V_{IN}	2.3		5.5[2]	V
Output Current	I_{OUT}	0		6.0	A
Input Capacitor	C_{IN}	10	2*10		µF
Output Capacitor	C_{OUT}	22	3*22		µF
Operating Temperature, Junction	T_{OJ}	-40		+125	°C

TABLE 6. THERMAL INFORMATION

Junction to ambient thermal resistance is a function of board layout and ambient air flow condition. This data is based on four layers PCB (30mm x 30mm; 70µm Cu top signal layer) in still air box in accordance to JEDEC standard JESD51 on natural convection.

Parameter	Symbol	Typ	Units
Junction-to-Ambient Thermal Resistance	θ_{JA}	TBD	°C/W
Junction-to-Board Thermal Resistance	θ_{JB}	TBD	°C/W

[1] Operation of the device outside of these parameters may cause permanent damage.
[2] Vin above 5.5V over extended periods may affect device reliability.

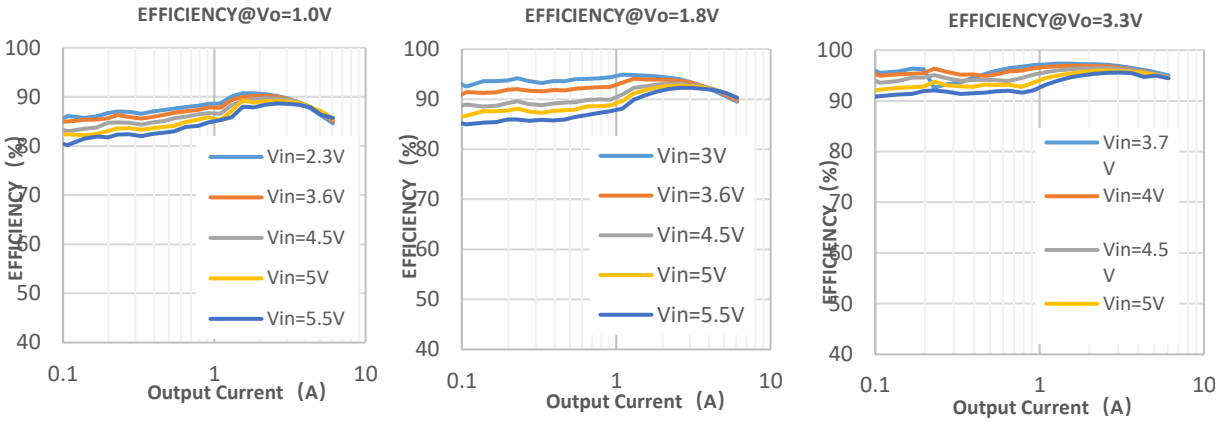
9. Electrical Specifications

Typical values unless otherwise noted: V_{IN} = 3.3V, V_{OUT} = 1.8V, Temp = +25°C
Maximum and minimum values are: V_{IN} = EN = 2.3V to 5.5V, T_J = -40 to +125˚C
Circuit of **Figure 1** unless otherwise noted.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Supply Voltage	V_{IN}		2.3		5.5	V
Quiescent Current		No Load, Not Switching		40		µA
Shutdown Current	I_{SHDN}	EN = GND		3		µA
Under-Voltage Lockout Threshold	V_{UVLO}	Rising V_{IN}		2.0	2.2	V
Under-Voltage Lockout Hysteresis	$V_{UVLOHYST}$			200		mV
Thermal Shutdown	T_{TSD}			150		°C
Thermal Shutdown Hysteresis	T_{HYST}			20		°C
Output Characteristics						
Switching Frequency	F_{SW}			3		MHz
Feedback Voltage	V_{FB}		-1%	0.5	+1%	
Feedback Input Leakage Current	$I_{lkg(FB)}$	V_{FB} = 0.6V		5		nA
Soft-Start Time	T_{SS}			3		ms
Enable Turn-on Delay	T_{EN}			100		µs
PMOS On Resistance	R_{DSONP}	V_{IN} = V_{GS} = 3.3V		12		mΩ
NMOS On Resistance	R_{DSONN}	V_{IN} = V_{GS} = 3.3V		7.5		mΩ
Dropout Resistance	R_{DP}	100% mode, Vin = 2.7V		22		mΩ
PMOS Peak Current Limit	I_{LIM}	V_{IN} = 3.3V, Open Loop		9		A
Output Discharge Resistance	R_{DIS}	EN = 0V		17		Ω
Power Good Threshold V_{OUT} Rising	V_{PGR}	V_{FB} referenced to V_{FB} nominal		96.5%		
Power Good Threshold V_{OUT} Falling	V_{PGF}	V_{FB} referenced to V_{FB} nominal		92.5%		
Power Good Low Voltage	V_{PGL}				100	mV
Power Good Leakage Current	I_{PG}			3		nA
Logic input: EN						
Logic High Voltage	V_{IH}		1.2			V
Logic Low Voltage	V_{IL}				0.5	V
Logic Pin Leakage Current	I_{LPIN}			2.5		µA
Logic Input Hysteresis	V_{LHYST}			250		mV

10. Typical Performance and Operating Characteristics

Typical test conditions unless otherwise noted: V_{IN} = 3.3V, V_{OUT} = 1.8V, Cin=2*10uF, COUT = 3*22uF, f_{SW} = 3MHz, and Temp = +25°C.



11. Functional Descriptions

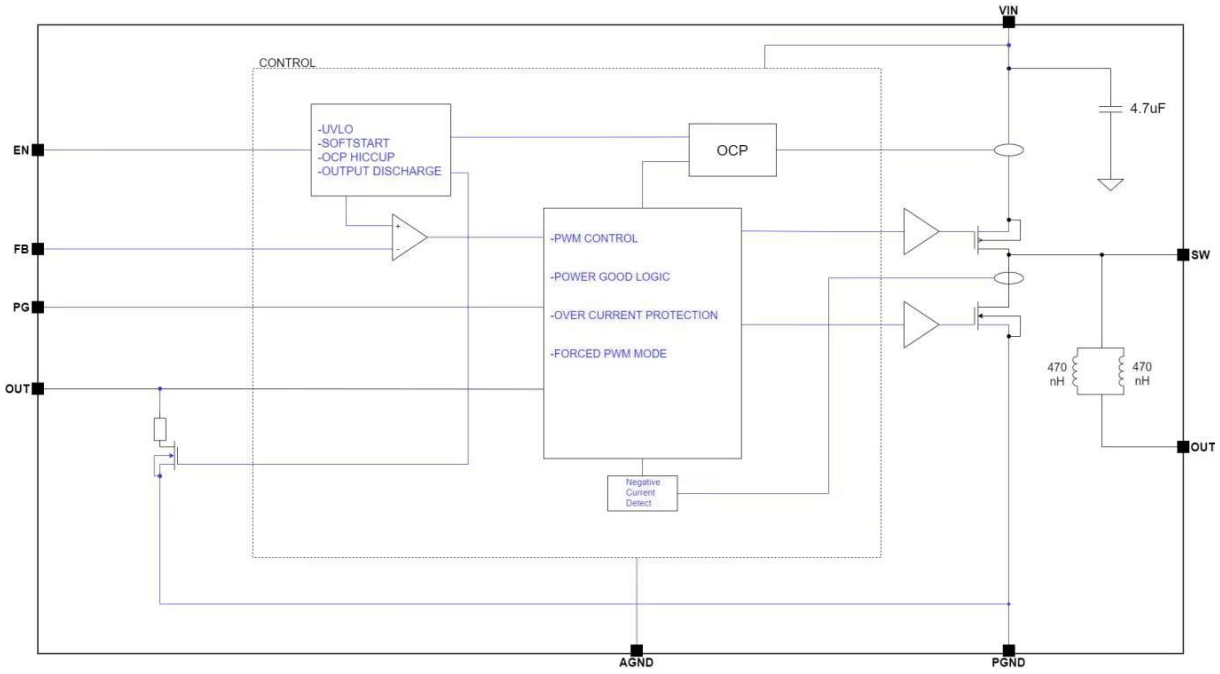


Figure 4. Functional Block Diagram

The XPM6136 is a synchronous DC/DC power module integrated with power inductor. Operating from an input voltage between 2.3V and 5.5V, the power module can deliver up to 6A of load current. With 3MHz typical switching frequency and Advance Constant-on-time (ACOT), it provides fast load transient response performance and excellent DC voltage regulation.

Enable

Setting the EN pin to logic High enables the device. Alternatively, the device is disabled when the EN voltage is set to logic Low. In this state the IC draws less than 3µA of current and the output is pulled to ground through a resistive load. V_{OUT} starts to ramp up after 100µs delay.

When floating, EN is pulled down to GND by an internal 2MΩ resistor.

Soft-Start

When the device is enabled, internal soft-start circuitry causes V_{OUT} to ramp up over a period of 3ms to limit inrush current. This feature protects a high impedance source from being pulled to a lower voltage as the device turns on.

Under voltage Lockout (UVLO)

The under-voltage lockout feature prevents the device from turning on if V_{IN} is below the UVLO level of 2.0V. If the device is enabled under UVLO conditions, the circuitry will not turn on until the input voltage

is increased. Once active, the UVLO circuit has 200mV of hysteresis and the device will turn off if V_{IN} drops below 1.8V.

Active Output Discharge

When the device is disabled through the EN pin, a discharge path for the output capacitor is created between V_{OUT} and ground through a 17 Ohm resistor (R_{DIS}).

Modes of Operation

XPM6136 employs advance constant-on-time control, its switching frequency is nearly constant at 3MHz at high current loads.

If the input voltage ever gets too close to the target output voltage, such that regulation can no longer be maintained, the regulator will enter 100% duty cycle mode. In this mode the high side switch is ON, connecting the input and output together to deliver a voltage as close to the target as possible.

Thermal Shutdown

The device thermal shutdown protection is enabled if the chip temperature exceeds 150°C. Once the temperature drops below 130°C, the device will be re-enabled, and a new soft-start cycle will begin.

Over current Protection

The device has over current protection to prevent damage to the device and inductor during over current conditions.

Peak current protection occurs at 9A. After hitting 16 consecutive cycles of peak current limit, the output will be disabled. After being disabled for 1.5ms, the device will be re-enabled, and a new soft-start cycle will begin.

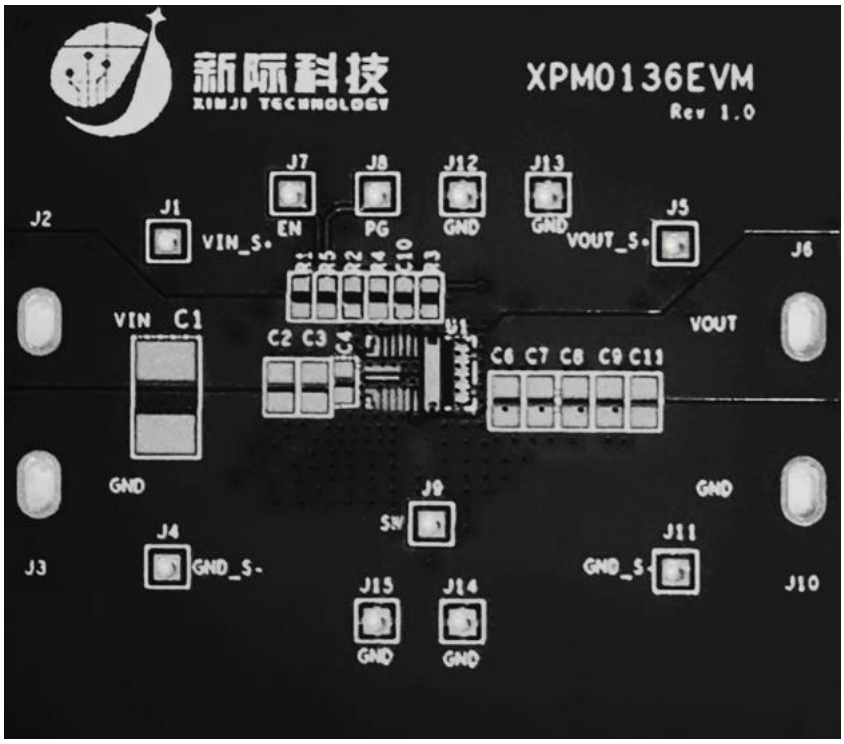
Power Good Indicator

The PG pin is an open-drain output and pulls the PG pin low when the FB voltage is less than 92% of the nominal internal reference voltage and resumes when FB voltages is greater than 96% of the nominal internal reference voltage.

12. Layout Guidelines and Example

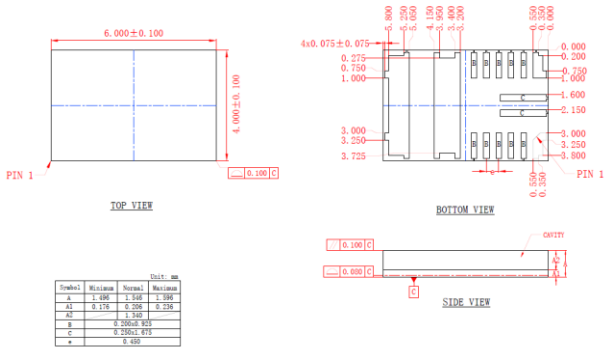
A well-designed and manufactured PCB is important for all switching power supplies, especially for those operate at high switching frequency.
If the layout is not fulfilled carefully, not only regulator performance could be degraded but also stability or EMI issue may be introduced. Hence, care must be taken in board layout to achieve the specified performance.
Please use the following guidelines when designing PCBs:
1) Keep components placement as compact as possible.
2) Place a low-ESR input capacitor as close to VIN and GND as possible.
3) Keep FB trace away from noisy components and traces (e.g., SW and inductor).
4) Use wide and short traces for the main current paths.

5) Ground pins of regulator must be strongly connected to PCB ground with low inductance and impedance.
6) Place common and unbroken ground for CIN and COUT.
7) Reduce excessive thermal relief vias and keep them away from SW and inductor.



13. Physical Dimensions

LGA-24 (4mm*6mm*1.6mm)



14. Tape and Reel Information

Pin 1 located in Q1 direction in T&R