



FEATURES

- ## DESCRIPTION

The XPC0136 comes in a compact 9-pin 2mm x 3mm DFN package, offering the highest power density solution.

APPLICATIONS

- ## TYPICAL APPLICATION

 $V_{in}=3.6V$ 

REVISION HISTORY

Release	Rev	Changes	Date
Preliminary	0.9	First revision	12/2/2021
Updates	0.96	Fine tune EC table based on char results	3/23/2023
Updates	0.98	Update marking rules	5/30/2023

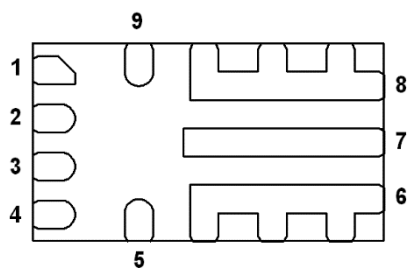
ORDERING INFORMATION

Part Number	Output Current (A)	VOUT (V)	Top Marking	MPQ
XPC0136XA	6	Adjustable	0136XA	5,000

MPQ = Minimum Package Quantity.

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

PIN CONFIGURATION AND DESCRIPTION



Top View

Pin Configuration

Pin	Name	Description
1	EN	Enable. Part is active when $V_{EN} > 1.2V$. Part is disabled when $V_{EN} < 0.4V$.
2	PG	Power good. Connect to VOUT thru resistor.
3	FB	Feedback. Connect to the mid-point of external resistor divider to set the desired Vout.
4	VOUT	Output voltage sensing pin.
5	AGND	Analog Ground.
6	PGND	Power Ground. Low-side switch source terminal.
7	SW	Switching node. Connect to the output inductor.
8	PVIN	Power supply input. Connect to power source with a minimum 10uF ceramic capacitor.
9	AVIN	Power supply for Control section. Connect to PVIN.

ABSOLUTE MAXIMUM RATINGS

Parameter	Min	Max	Units
DC Supply Voltage, VIN	-0.3	+7.0	V
SW	-0.3	VIN + 0.3	V
SW (10ns transient)	-4.0	+8.0	V
Voltage on other pins, FB, EN, PG, VOUT	-0.3	VIN + 0.3	V
Storage Temperature Range	-40	+150	°C
Junction Temperature	-40	+150	°C
Electrostatic Discharge (HBM)	-4000	+4000	V
Electrostatic Discharge (CDM)	-2000	+2000	V

⁽¹⁾ Operation of the device outside of these parameters may cause permanent damage.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Typ	Max	Units
Supply Voltage	VIN	2.3		5.5	V
Output Current	IOUT	0		6	A
Output Inductor	L		220		nH
Input Capacitor	CIN		2 x 10		μF
Output Capacitor	COUT		3 x 22		μF
Operating Temperature, Junction	TOJ	-40		+125	°C

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 with JEDEC standard JESD51 on natural convection.

Parameter	Symbol	Typ	Units
Junction-to-Ambient Thermal Resistance	θJA	30.45	°C/W
Junction-to-Case Thermal Resistance	θJC	16.68	°C/W

ELECTRICAL SPECIFICATIONS

Typical values unless otherwise noted: $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, Ambient Temperature = $+25^{\circ}C$.

Maximum and minimum values are: $V_{IN} = V_{EN} = 2.3V$ to $5.5V$, $T_J = -40$ to $+125^{\circ}C$.

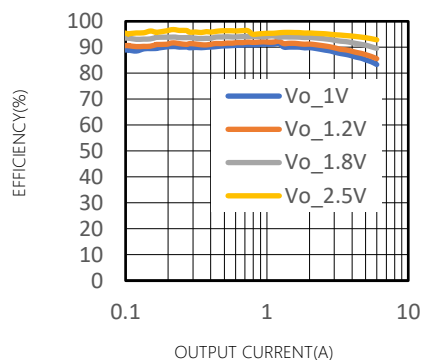
Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Supply Voltage	V_{IN}		2.3		5.5	V
Quiescent Current	I_Q	PFM Mode		1		mA
		No Load, Not switching	25	35	50	μA
Shutdown Current	I_{SHDN}	EN = GND		0.1	3.5	μA
Under-Voltage Lockout Threshold	V_{UVLO}	Rising V_{IN}		2.1	2.2	V
Under-Voltage Lockout Hysteresis	$V_{UVLOHYS}$			220	250	mV
Thermal Shutdown	T_{SD}			155		$^{\circ}C$
Thermal Shutdown Hysteresis	T_{HYS}			30		$^{\circ}C$
Logic input: EN						
Logic High Voltage	V_{IH}		1.2			V
Logic Low Voltage	V_{IL}				0.4	V
Logic Pin Leakage Current	I_{LPIN}			2.5		μA
Logic Input Hysteresis	V_{LHYS}			220		mV
Output Characteristics						
Switching Frequency	F_{SW}		3.6	4	4.4	MHz
Feedback Voltage (PFM mode)	V_{FB}		0.490	0.5	0.510	V
Feedback Voltage (PWM mode)			0.495	0.5	0.505	
Input Leakage Current into FB Pin	$I_{FB,LKG}$				0.1	μA
Soft-Start Time	T_{SS}			3		ms
Enable Turn-on Delay	T_{EN}			100		μs
Power Switches						
PMOS On Resistance	$R_{DS(ON)P}$	$V_{IN} = V_{GS} = 3.6V$	9.5	11.5	15	m Ω
NMOS On Resistance	$R_{DS(ON)N}$	$V_{IN} = V_{GS} = 3.6V$	5	6.5	8	m Ω
PMOS Peak Current Limit	I_{LIM}	$V_{IN} = 3.6V$, Open Loop		8		A
Output Discharge Resistance	R_{DIS}	EN = GND		16		Ω
Power Good						
PG Threshold V_{OUT} Rising	V_{PGR}			98		%
PG Threshold V_{OUT} Falling	V_{PGF}			94		%
Power Good Low Voltage	V_{PGL}	Sink Current = 1mA			100	mV
Input Leakage Current into PG Pin	$I_{PG,LKG}$				0.1	μA

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and $Temp = +25^{\circ}C$.

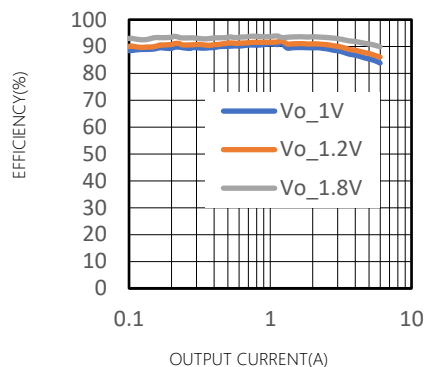
Efficiency

$V_{in}=3.3V$



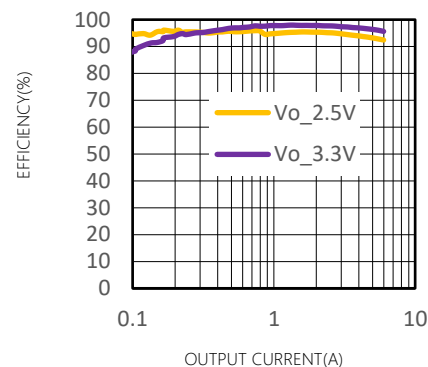
Efficiency

$V_{in}=3.6V$



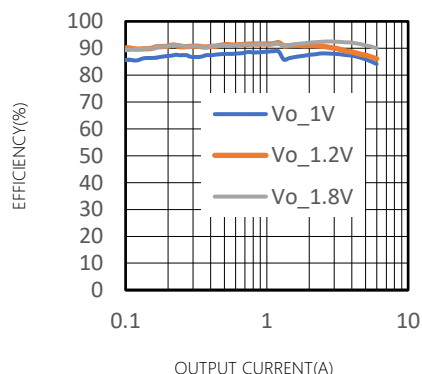
Efficiency

$V_{in}=3.6V$



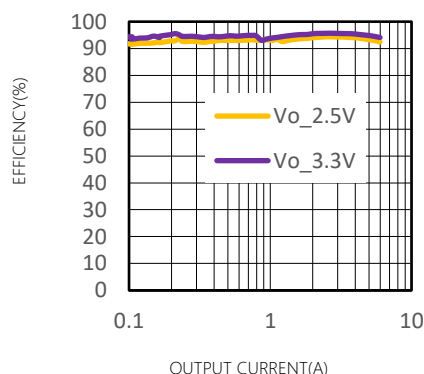
Efficiency

$V_{in}=5V$



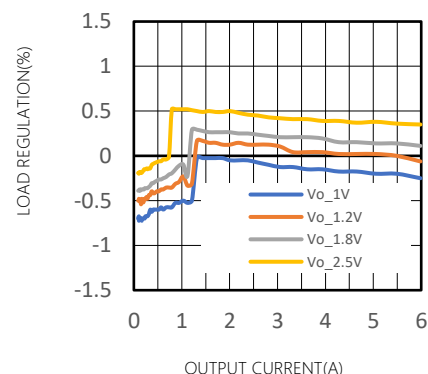
Efficiency

$V_{in}=5V$



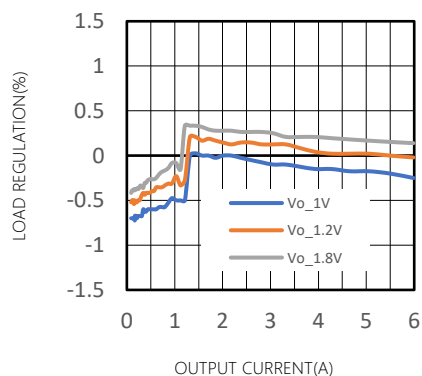
Load Regulation

$V_{in}=3.3V$



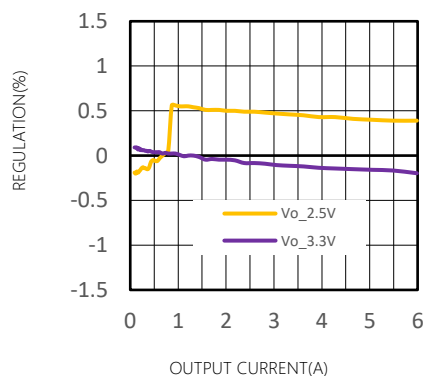
Load Regulation

$V_{in}=3.6V$



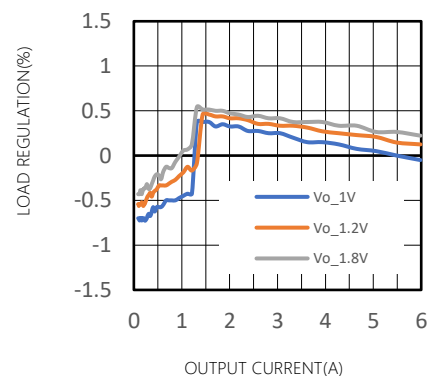
Load Regulation

$V_{in}=3.6V$



Load Regulation

$V_{in}=5V$

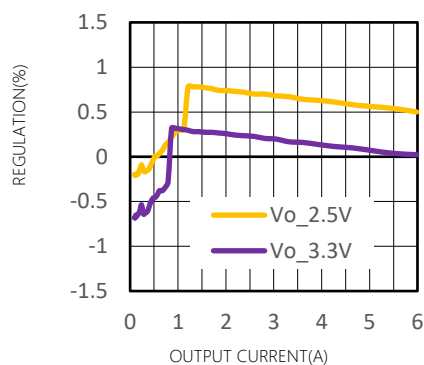


TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and Temp = +25°C. (continued)

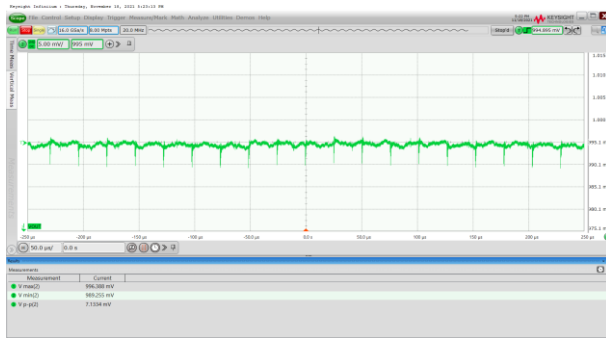
Load Regulation

$V_{in}=5V$

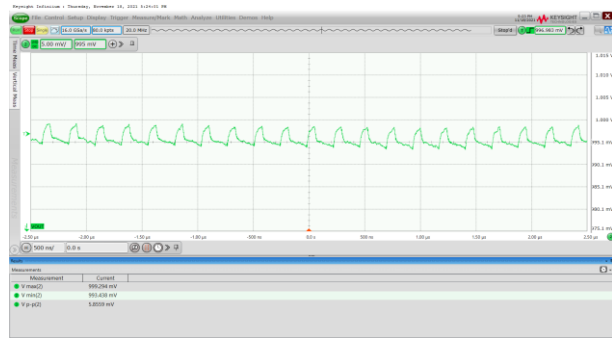


TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

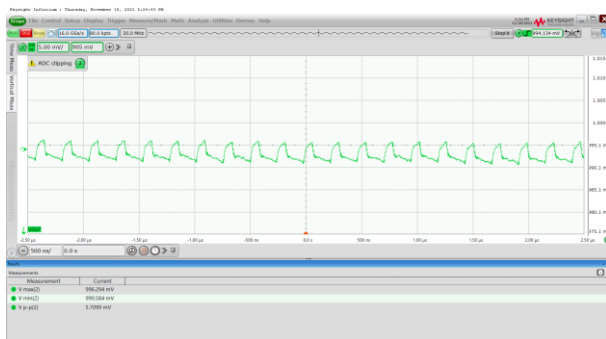
Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and Temp = +25°C. (continued)



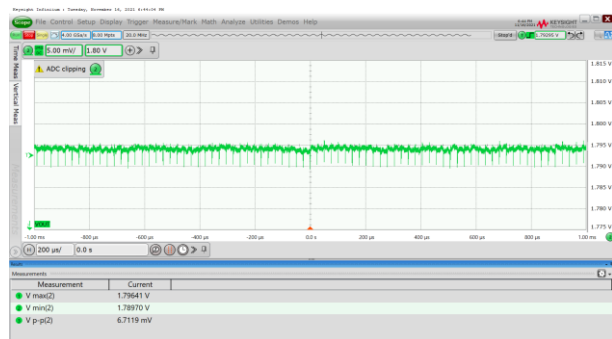
Output voltage ripple, $V_{OUT} = 1.0V$, $I_{OUT} = 0A$



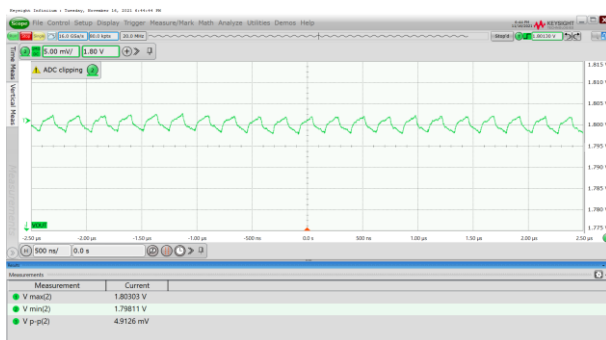
Output voltage ripple, $V_{OUT} = 1.0V$, $I_{OUT} = 3A$



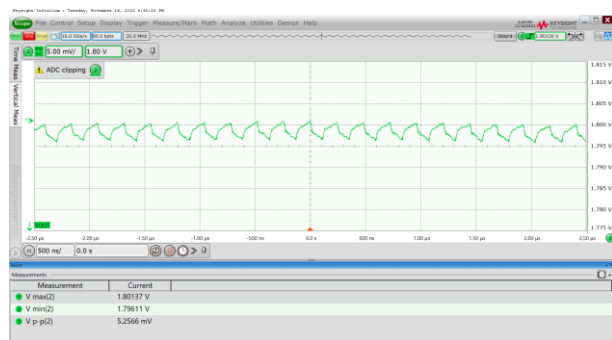
Output voltage ripple, $V_{OUT} = 1.0V$, $I_{OUT} = 6A$



Output voltage ripple, $V_{OUT} = 1.8V$, $I_{OUT} = 0A$



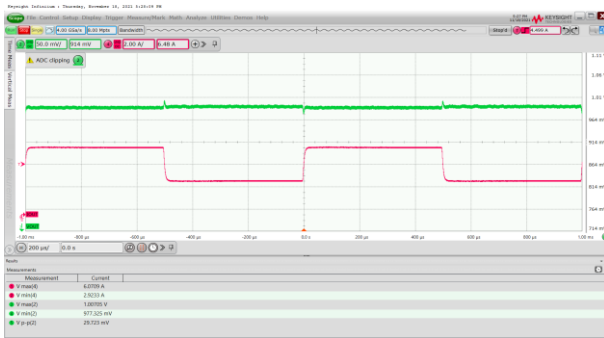
Output voltage ripple, $V_{OUT} = 1.8V$, $I_{OUT} = 3A$



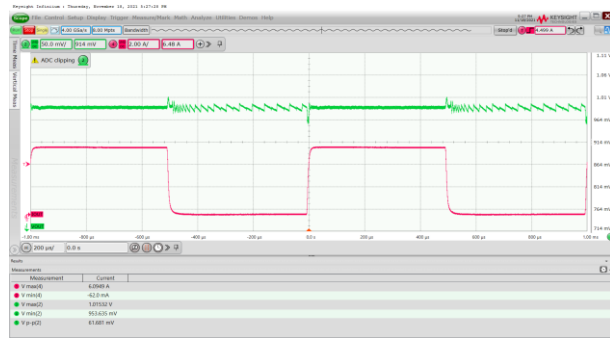
Output voltage ripple, $V_{OUT} = 1.8V$, $I_{OUT} = 6A$

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

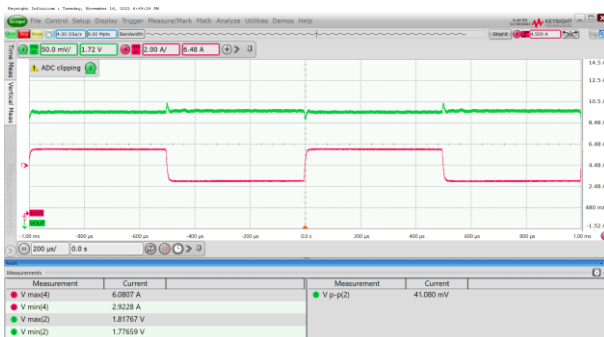
Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and Temp = +25°C. (continued)



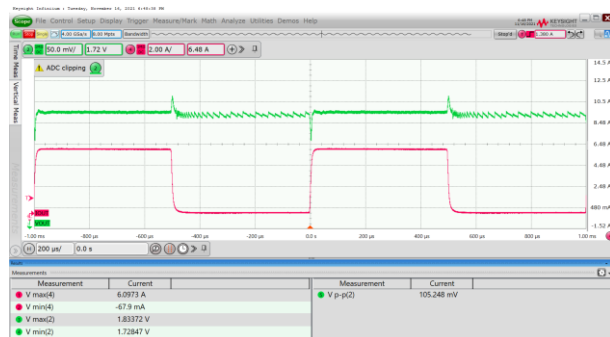
Transient Response, $V_{OUT} = 1V$, $I_{LOAD} = 3A$ to $6A$ Step



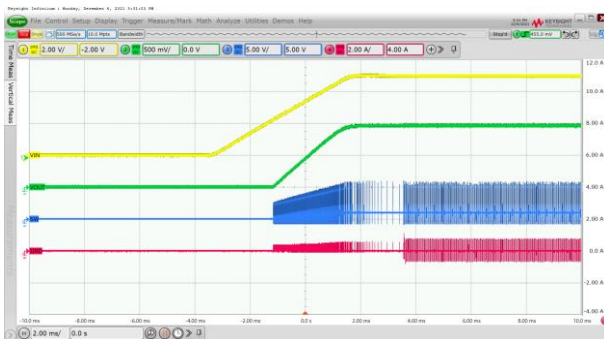
Transient Response, $V_{OUT} = 1V$, $I_{LOAD} = 0A$ to $6A$ Step



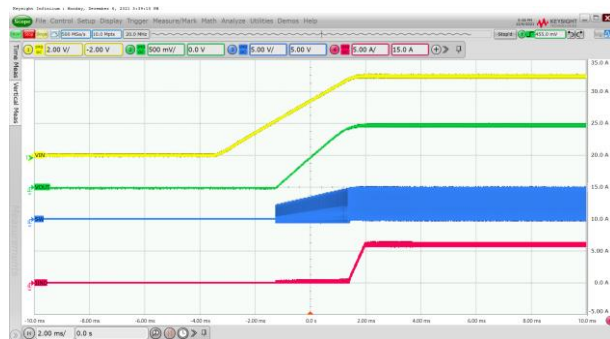
Transient Response, $V_{OUT} = 1.8V$, $I_{LOAD} = 3A$ to $6A$ Step



Transient Response, $V_{OUT} = 1.8V$, $I_{LOAD} = 0A$ to $6A$ Step



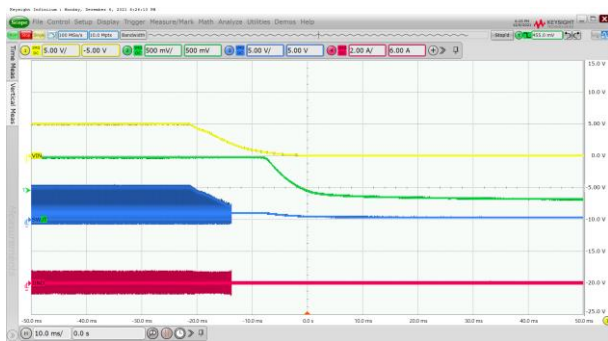
Start-Up, $V_{OUT} = 1.0V$, $I_{OUT} = 0A$



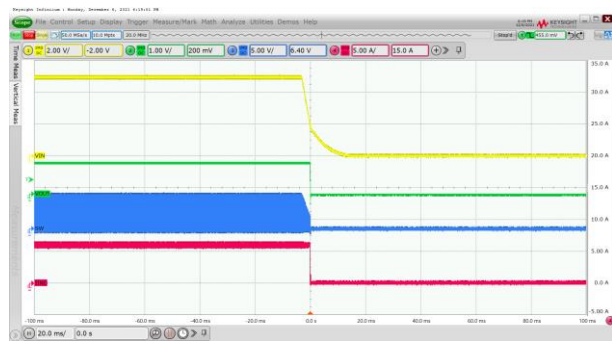
Start-Up, $V_{OUT} = 1.0V$, $I_{OUT} = 6A$

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

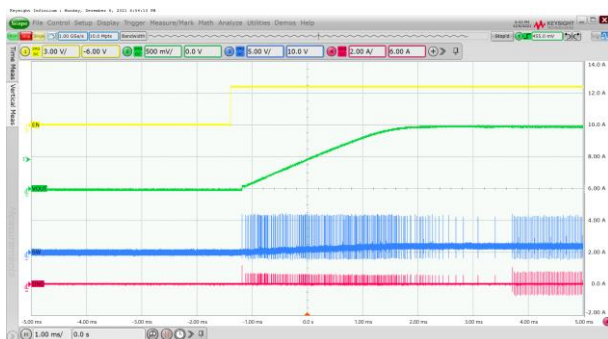
Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and Temp = +25°C. (continued)



Shut down, $V_{OUT}=1.0V, I_{OUT}=0A$



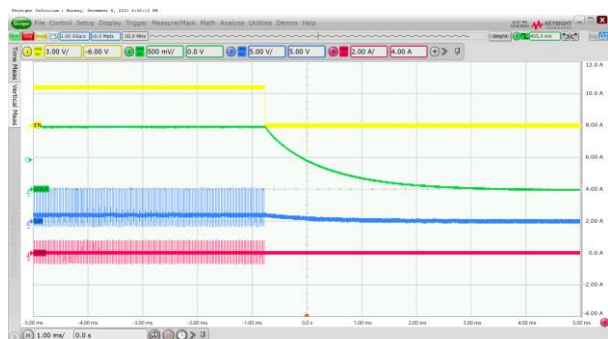
Shut down, $V_{OUT}=1.0V, I_{OUT}=6A$



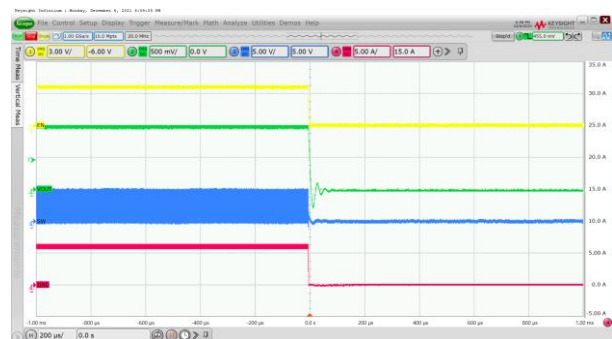
Enable on, $V_{OUT}=1.0V, I_{OUT}=0A$



Enable on, $V_{OUT}=1.0V, I_{OUT}=6A$



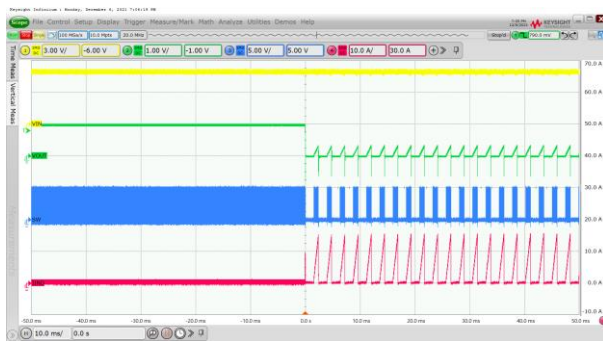
Enable off, $V_{OUT}=1.0V, I_{OUT}=0A$



Enable off, $V_{OUT}=1.0V, I_{OUT}=6A$

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

Test conditions unless otherwise noted: Typical Application, $V_{IN} = 3.6V$, $V_{OUT} = 1.8V$, $L = 220nH$, $C_{IN} = 2 \times 10\mu F$, $C_{OUT} = 3 \times 22\mu F$ and Temp = +25°C. (continued)



Hiccup With Output short, $V_{IN}=5V, V_{OUT}=1.0V$, Entry

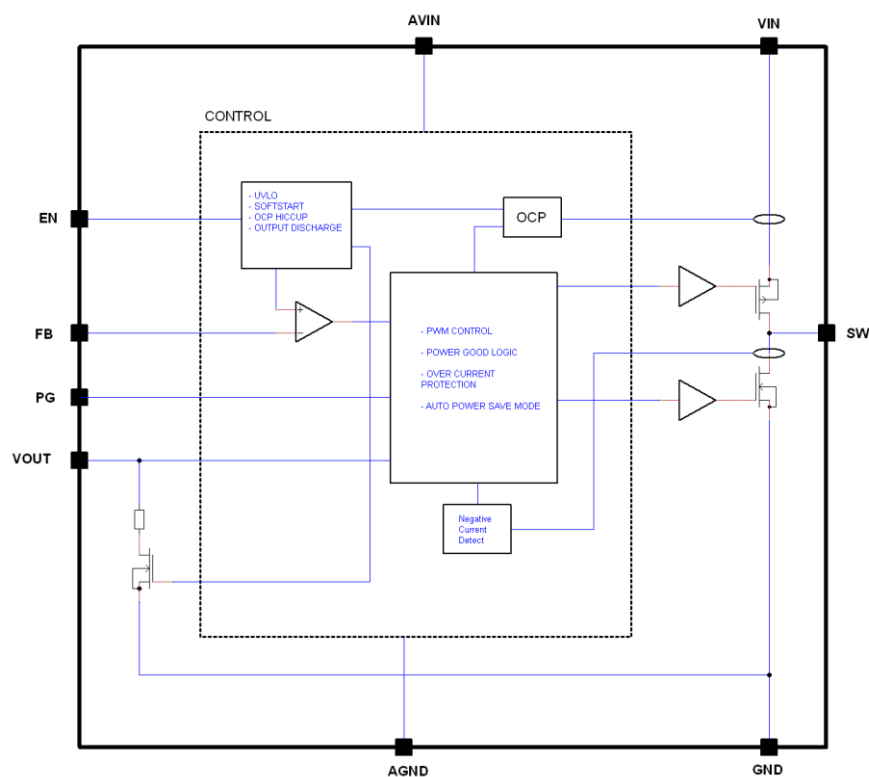


Hiccup With Output short, $V_{IN}=5V, V_{OUT}=1.0V$, Steady



Hiccup With Output short, $V_{IN}=5V, V_{OUT}=1.0V$, Recovery

FUNCTIONAL DESCRIPTION



Block Diagram

Overview

The XPC0136 is a synchronous step-down DC-DC voltage regulator available with switching frequency of 4MHZ. Operating from an input voltage between 2.3V and 5.5V, the regulator can deliver up to 6A of load current.

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 1 μ A (typical) of current and the output is pulled to ground through a resistive load. V_{OUT} starts to ramp up after 100 μ s delay.

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 2.1V (typical). 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 220mV of hysteresis and the device will turn off if V_{IN} drops below 1.9V (typical).

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 16 Ohm resistor (R_{DIS}).

Modes of Operation

The converter automatically switches to pulse frequency modulation (PFM) operation at light current loads. In PFM mode the frequency of pulses is varied to deliver the best possible efficiency. The device switches between PFM and PWM as the load current changes and thus optimizes performance.

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 155°C. Once the temperature drops below 125°C, the device will be re-enabled, and a new soft-start cycle will begin.

Overcurrent Protection

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

Peak current protection occurs at 8A. 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 94% of the nominal internal reference voltage and resumes when FB voltages is greater than 98% of the nominal internal reference voltage.

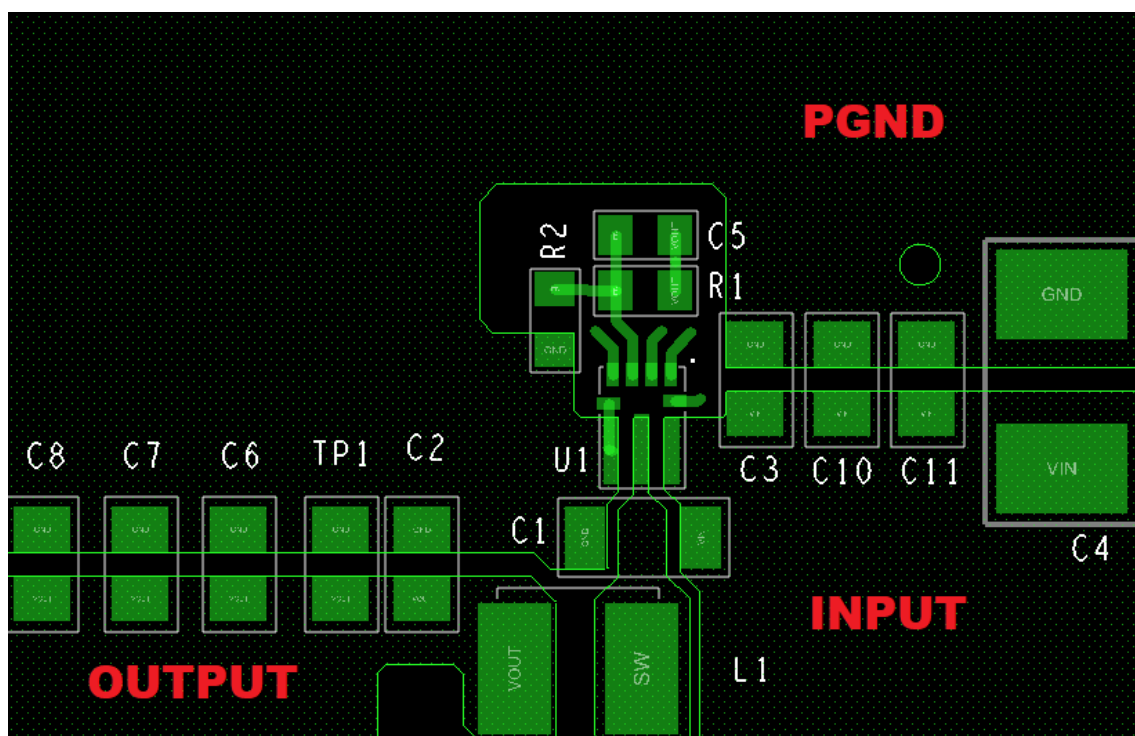
LAYOUT GUIDELINES AND EXAMPLE

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:

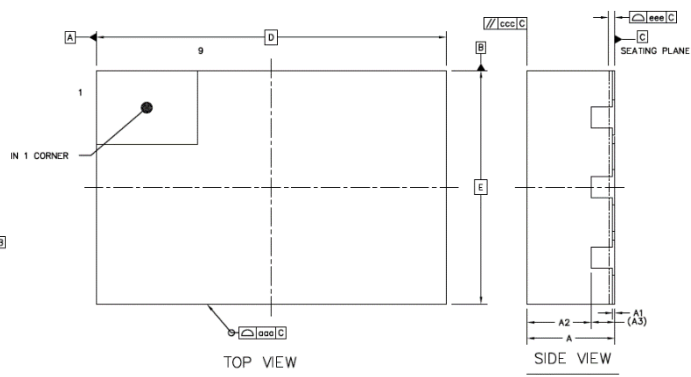
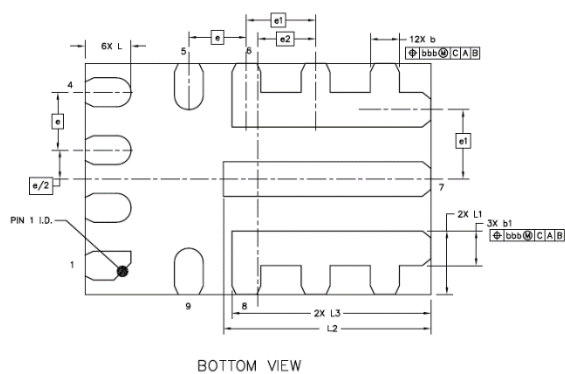
- 1) Keep components placement as compact as possible.
- 2) Place a low-ESR input capacitor as close to VIN and GND as possible.
- 3) Minimize the area between SW pin trace and inductor to limit high frequency radiation.
- 4) Keep FB trace away from noisy components and traces (e.g., SW and inductor).
- 5) Use wide and short traces for the main current paths.
- 6) Ground pins of regulator must be strongly connected to PCB ground with low inductance and impedance.
- 7) Place common and unbroken ground for CIN and COUT.
- 8) Reduce excessive thermal relief vias and keep them away from SW and inductor.



PHYSICAL DIMENSIONS

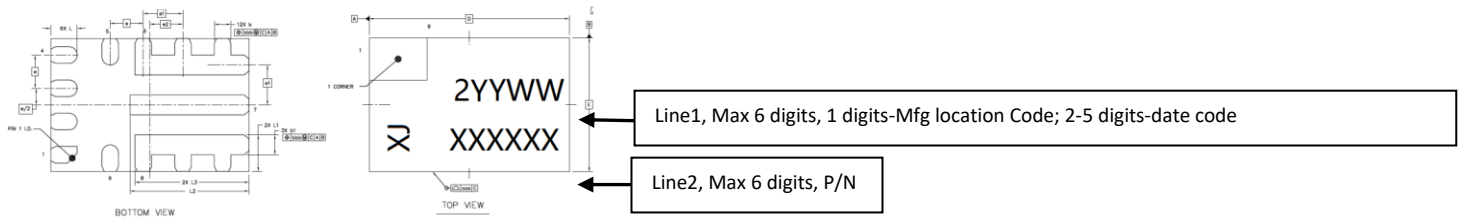
Table: Chip Dimensions

Symbol	Dimensions in mm		
	Min	Nom	Max
A	0.7	0.75	0.8
A1	0	0.02	0.05
A2	-	0.55	-
A3	0.203 REF		
b	0.2	0.25	0.3
b1	0.25	0.3	0.35
D	3 BSC		
E	2 BSC		
e	0.5 BSC		
e1	0.6 BSC		
e2	0.5 BSC		
L	0.3	0.4	0.5
L1	0.5	0.55	0.6
L2	1.75	1.8	1.85
L3	1.675	1.725	1.775
aaa		0.1	
ccc		0.1	
eee		0.05	
bbb		0.1	



TOP MARKING

Format:



Pin 1 located in Q1 direction in T&R

