XPC1136

2.7V to 5.5V Supply Voltage, 1% Accuracy
Synchronous 6A Point-of-Load Step Down Regulator
in 3mm x 3mm QFN Package

FEATURES

- 15mΩ and 8.5mΩ internal power MOSFETs
- 200kHz to 2MHz switching frequency
- 0.6-V ±1% voltage reference over temperature
- Monotonic start-up into pre-biased voltage
- Power good indicator
- Adjustable soft-start and sequencing
- Cycle by cycle current limit and hiccup current protection
- Adjustable input voltage UVLO
- Over temperature protection
- Overvoltage transient protection
- Thermally enhanced 16-pin 3mm*3mm QFN package
- EU RoHS compliance, Pb free

APPLICATIONS

- High-performance DSPs, FPGAs, ASICs and MCUs
- Broadband, networking and optical
- Cellular Phones
- Communications infrastructure
- Gaming, DTV and set-top boxes

DESCRIPTION

The XPC1136 Micro-Point-of-Load (µPOL) is a full-featured 6-A synchronous step-down current-mode regulator with integrated power MOSFETs.

Operating with up to 2MHz switching frequency, it allows the use of small external components in both value and form factor, reducing solution size.

The XPC1136 provides accurate regulation for varieties of loads with an accurate ±1% voltage reference over temperature.

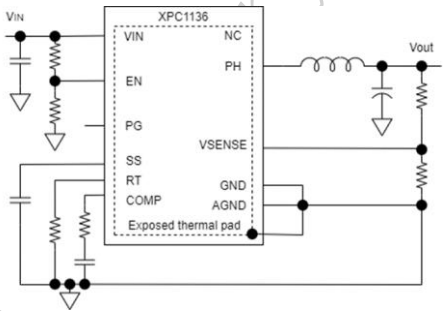
The output voltage is adjustable from 0.6V to 3.6V with soft-start (SS) controlled monotonic start-up ramp.

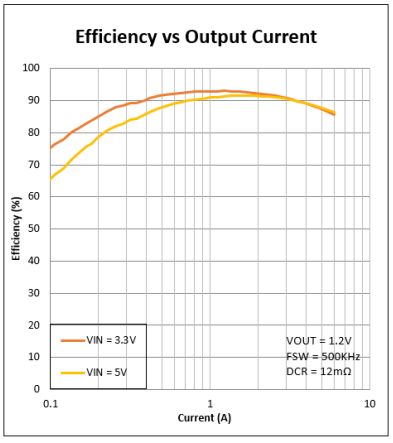
Under-voltage lockout threshold can be adjusted by adding a resistor divider on the enable pin.

An open-drain power good signal indicates the output is within 93% to 105% of its nominal voltage.

Cycle-by-cycle current limitation, hiccup overcurrent protection and thermal shutdown protect the device during an overcurrent condition.

TYPICAL APPLICATION





REVISION HISTORY

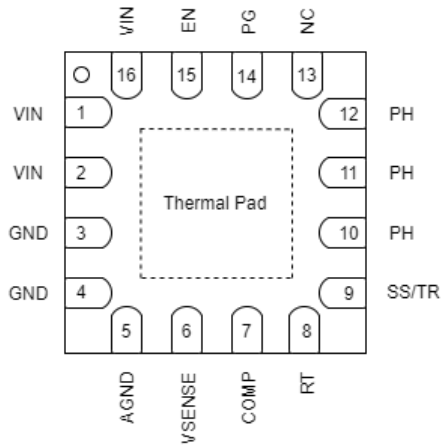
Release	Rev	Changes	Date
Preliminary	0.4	First revision	4/15/2023

ORDERING INFORMATION

Part Number	Output Current (A)	VOUT (V)	Top Marking	MOQ
XPC1136XA	6	Adjustable	1136XA	3,000

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 2 16	VIN	Input power supply, 2.7V to 5.5V.
3 4	GND	Power ground. Connect this pin directly to thermal pad under the device.
5	AGND	Analog ground should be electrically connected to GND close to the device.
6	VSENSE	Inverting node of the trans-conductance (gm) error amplifier.
7	COMP	Error amplifier output, and input to the output switch current comparator. Connect frequency compensation components to this pin.
8	RT	Resistor Timing.
9	SS/TR	Soft-start and Tracking. An external capacitor connected to this pin sets the output voltage rise time. This pin can also be used for tracking.
10 11 12	PH	The source of the internal high-side power MOSFET and drain of the internal low-side (synchronous) rectifier MOSFET.
13	NC	Dummy pin.
14	PG	An open-drain output asserts low if output voltage is low due to thermal shutdown, overvoltage, under-voltage, or EN shut down.
15	EN	Enable pin, internal pull-up current source. Pull below 1.2 V to disable. Float to enable. Can be used to set the on/off threshold (adjust UVLO) with two additional resistors.

Thermal pad	GND pin should be connected to the exposed thermal pad for proper operation. This thermal pad should be connected to any internal PCB ground plane using multiple vias for good thermal performance.

ABSOLUTE MAXIMUM RATINGS(1)

Parameter	Min	Max	Units
DC Supply Voltage, VIN	-0.3	+7.0	V
PH	-0.3	V_{IN} + 0.3	V
PH (10ns transient)	-4.0	+8.0	V
COMP	-0.3	+3.0	V
Voltage on other pins, VSENSE, EN, PG, RT, SS	-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)	-1000	+1000	V

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

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min	Max	Units
Supply Voltage	V_{IN}	2.7	5.5	V
Operating Temperature, Junction	T_{OJ}	-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	θ_{JA}	19.82	°C/W
Junction-to-Case Thermal Resistance	θ_{JC}	8.99	°C/W

ELECTRICAL SPECIFICATIONS

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

Maximum and minimum values are: V_{IN} = V_{EN} = 2.7V to 5.5V, TJ = -40 to +125˚C.

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Supply Voltage	V_{IN}		2.7		5.5	V
Quiescent Current	I_Q	No Load, Not switching		600		µA
Shutdown Current	I_{SHDN}	EN = GND		0.7		µA
Under-Voltage Lockout Threshold	V_{UVLO}	Rising V_{IN}		2.5		V
Under-Voltage Lockout Hysteresis	$V_{UVLOHYST}$			250		mV
Thermal Shutdown	T_{TSD}			170		°C
Thermal Shutdown Hysteresis	T_{HYST}			15		°C
Logic Input: EN						
Logic High Voltage	V_{IH}			1.3		V
Logic Low Voltage	V_{IL}			1.18		V
Input Current		EN threshold +50mV		-3.5		µA
Input Current		EN threshold -50mV		-0.7		µA
Output Characteristics						
Switching Frequency	F_{SW}		200		2000	kHz
Feedback Voltage	V_{FB}		594	600	606	mV
Enable Turn-on Delay	T_{EN}			250		µs
Power Switches						
PMOS On Resistance	R_{DSONP}	V_{IN} = V_{GS} = 3.6V		15		mΩ
NMOS On Resistance	R_{DSONN}	V_{IN} = V_{GS} = 3.6V		8.5		mΩ
Minimum ON-time	Ton_min	Measured at 50% points on PH. IOUT=3A		60		ns
		Measured at 50% points on PH. IOUT=0A		80		ns
Error Amplifier						
Error amplifier transconductance	gm	-2uA<I(comp)<2uA, V(comp)=1V		220		umhos
Error amplifier transconductance during soft start		-2uA<I(comp)<2uA, V(comp)=1V V(vsense)=0.4V		90		umhos
Error amplifier source and sink		Error amplifier source and sink		-20/+10		µA
COMP to Iswitch gm				36		A/V
Current Limit						
High side current limit threshold	I_{LIM}	Fs=500kHz	9.5	10.5	11.5	A
Cycles before entering hiccup during overcurrent				512		cycles
Hiccup cycles				16384		cycles

Typical values unless otherwise noted: V_{IN} = 3.6V, V_{OUT} = 1.8V, Ambient Temperature = +25°C.
Maximum and minimum values are: V_{IN} = V_{EN} = 2.7V to 5.5V, TJ = -40 to +125˚C.

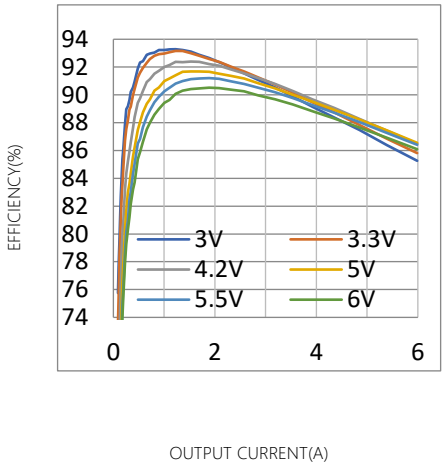
Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Low side sourcing current threshold			7	8.5	10.5	A
Low side reverse current protection				4		A
Soft Start and Tracking						
Charge current		V(SS/TR)<0.15V		40		µA
		V(SS/TR)>0.15V		2		µA
SS to VSENSE matching		V_{IN} = 3.3 V		55		mV
SS/TR to reference crossover		98% nominal		0.8		V
SS/TR discharge voltage (overload)		VSENSE = 0 V; V(SS/TR) = 4 V		150		mV
SS/TR discharge current (overload)		VIN = 3 V; V(SS/TR) = 4 V		90		uA
SS/TR discharge current (UVLO, EN, thermal fault)		VIN = 3 V; V(SS/TR) = 4 V		1000		uA
Power Good						
Powe good threshold		VSENSE falling (Fault)		91		%V_{REF}
		VSENSE rising (Good)		93		%V_{REF}
		VSENSE rising (Fault)		105		%V_{REF}
		VSENSE falling (Good)		103		%V_{REF}
Power Good Low Voltage	V_{PGL}	$I_{(PWRGD)}$=2.5mA		0.15	0.3	V
Power Good Leakage Current	I_{PG}	VSENSE= V_{REF}, $V_{(PWRGD)}$ =5.5V		2		nA
Minimum VIN for valid output		$V_{(PWRGD)}$ <0.5V at 100µA		0.8	1.2	V

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

Test conditions unless otherwise noted: Typical Application, V_{IN} = 3.6V, V_{OUT} = 1.8V, Fsw = 500kHz, L = 1.2uH, C_{IN} = 3 x 47uF, C_{OUT} = 5 x 47uF and Temp = +25°C.

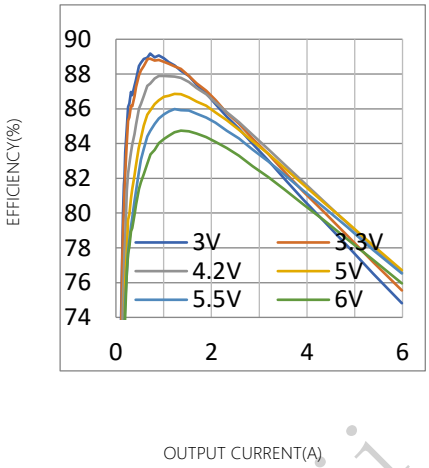
Efficiency

Vo=1.2V



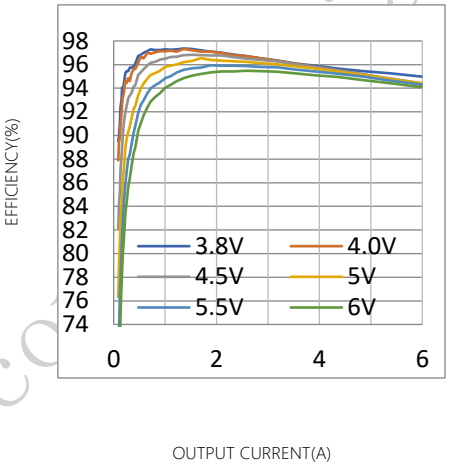
Efficiency

Vo=0.6V



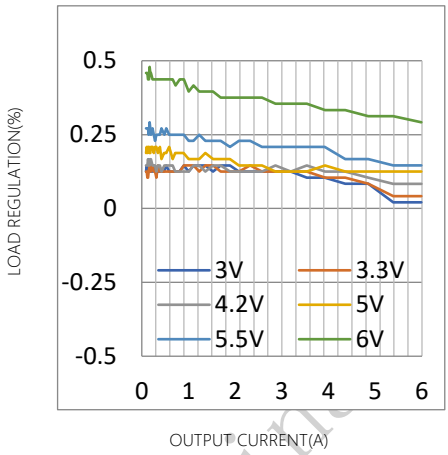
Efficiency

Vo=3.6V



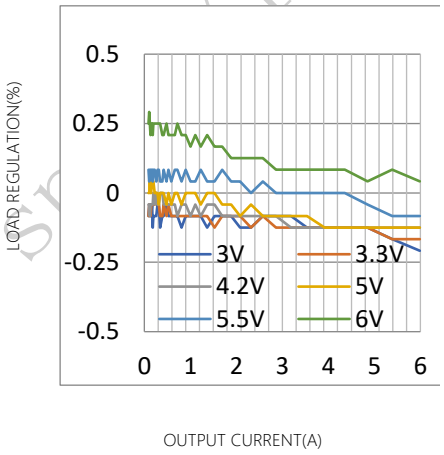
Load Regulation

Vo=1.2V



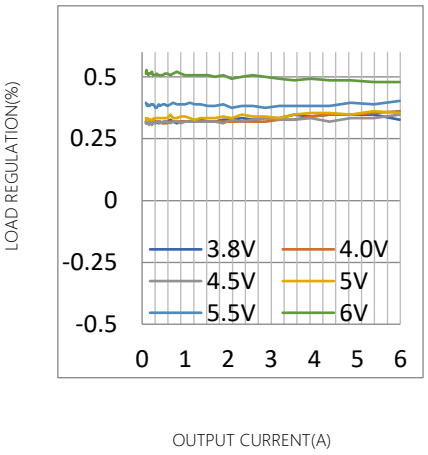
Load Regulation

Vo=0.6V



Load Regulation

Vo=3.6V

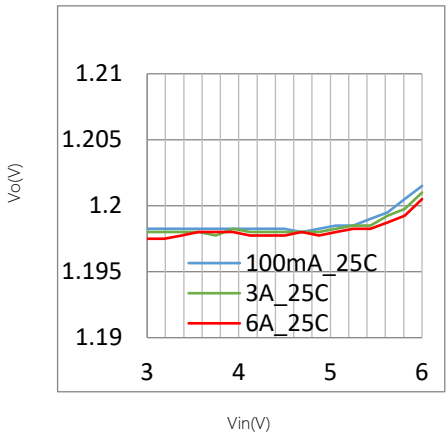


TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

Test conditions unless otherwise noted: Typical Application, V_{IN} = 3.6V, V_{OUT} = 1.8V, Fsw = 500kHz, L = 1.2uH, C_{IN} = 3 x 47uF, C_{OUT} = 5 x 47uF and Temp = +25°C.（continued）

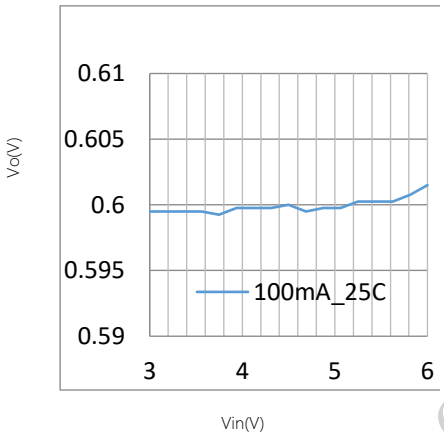
Line Regulation

Vo=1.2V



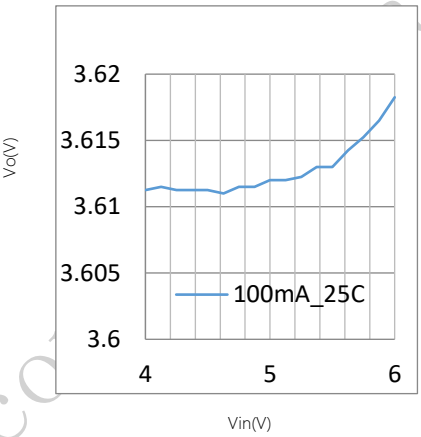
Line Regulation

Vo=0.6V



Line Regulation

Vo=3.6V



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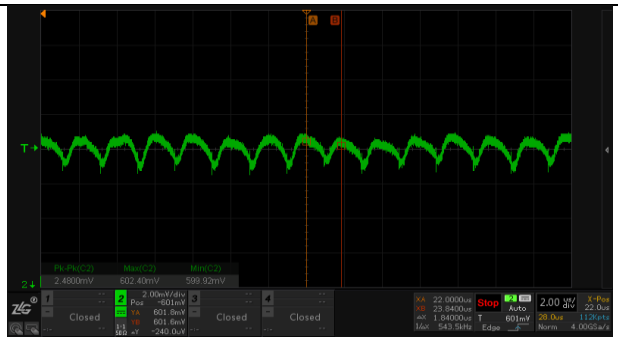
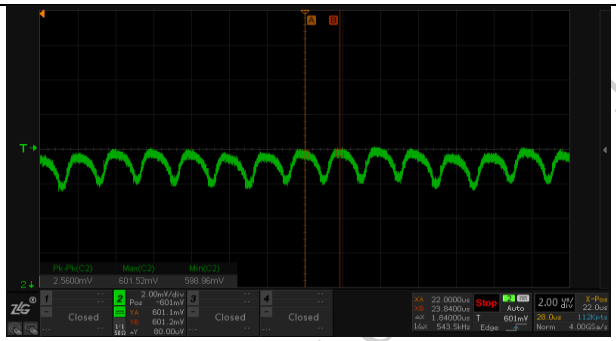
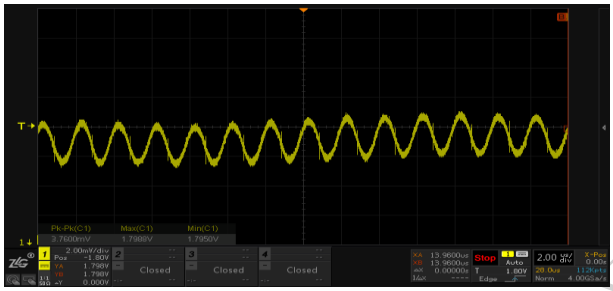


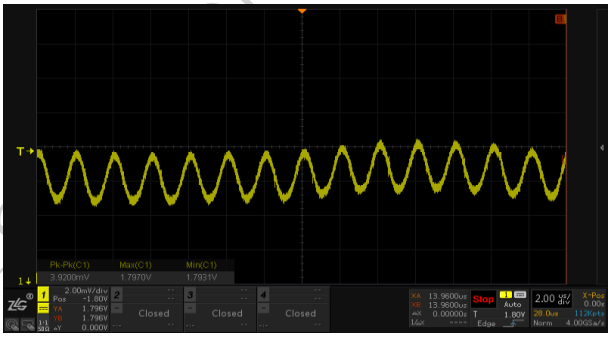
Output voltage ripple, V_{OUT} = 0.6V, I_{OUT}=0A



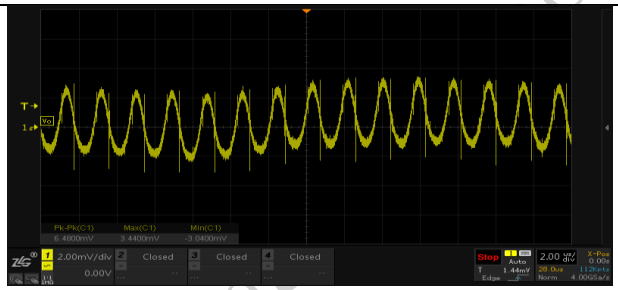
Output voltage ripple, V_{OUT} = 0.6V, I_{OUT}=6A



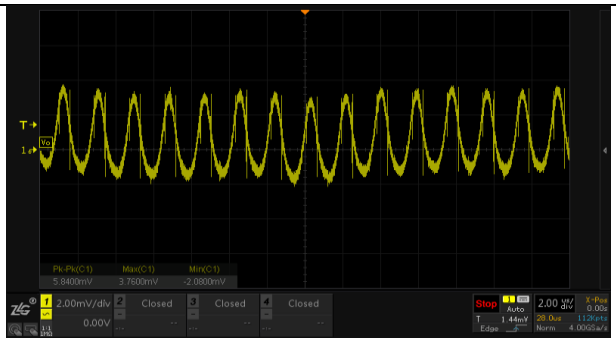
Output voltage ripple, V_{OUT} = 1.8V, I_{OUT}=0A



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



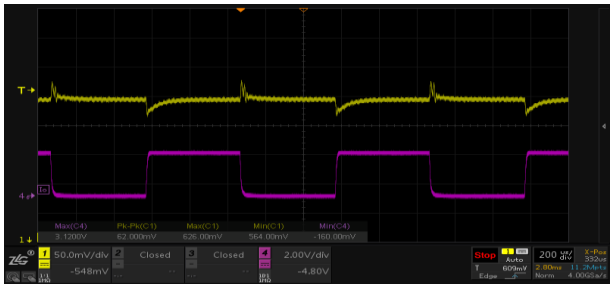
Output voltage ripple, V_{OUT} = 3.6V, I_{OUT} = 0A



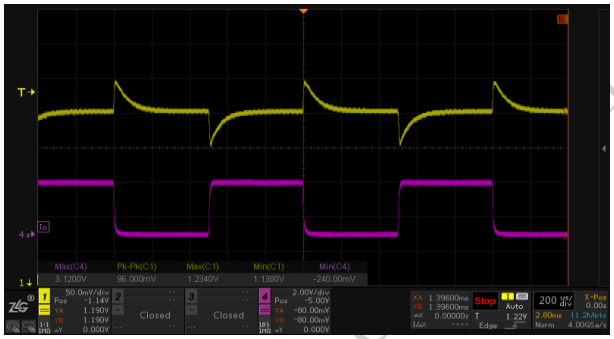
Output voltage ripple, V_{OUT} = 3.6V, I_{OUT} = 6A

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

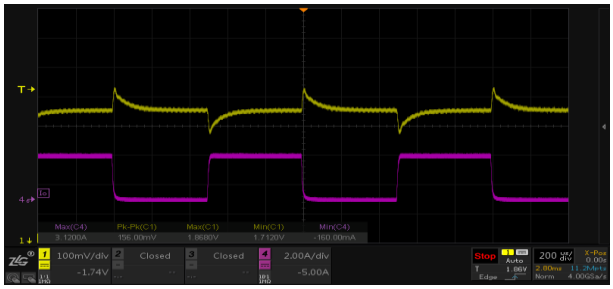
Test conditions unless otherwise noted: Typical Application, V_{IN} = 3.6V, V_{OUT} = 1.8V, Fsw = 500kHz, L = 1.2uH, C_{IN} = 3 x 47uF, C_{OUT} = 5 x 47uF and Temp = +25°C.（continued）



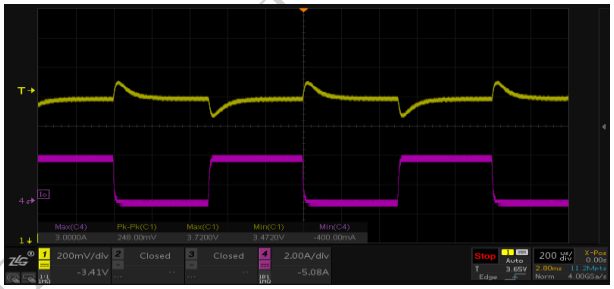
Transient Response, V_{OUT} = 0.6V, I_{LOAD} = 0A to 3A Step



Transient Response, V_{OUT} = 1.2V, I_{LOAD} = 0A to 3A Step



Transient Response, V_{OUT}=1.8V, I_{LOAD} = 0A to 3A Step



Transient Response, V_{OUT} = 3.6V, I_{LOAD} = 0A to 3A Step

TYPICAL PERFORMANCE AND OPERATING CHARACTERISTICS

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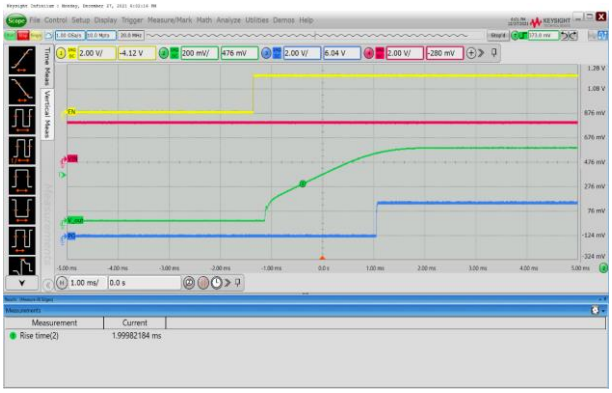
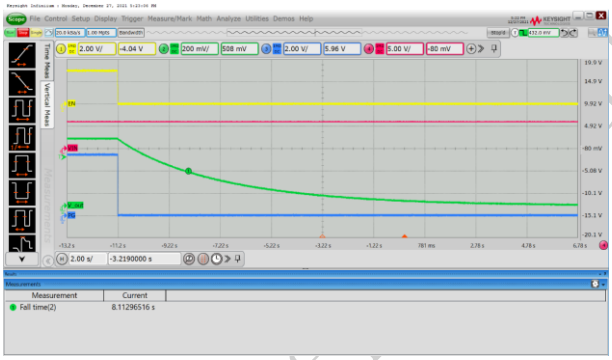
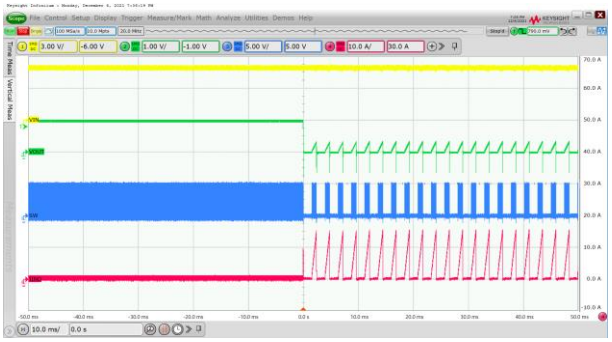


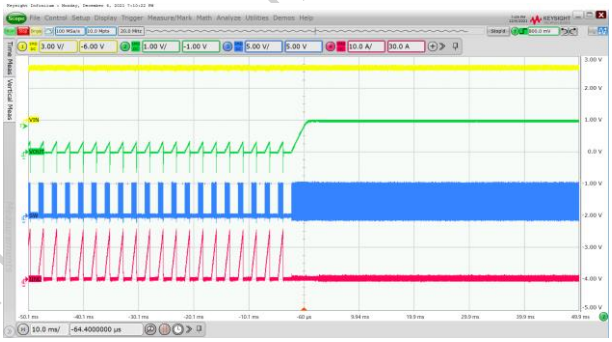
Enable on, V_{OUT}=0.6V, I_{OUT}=0A



Enable off, V_{OUT}=0.6V, I_{OUT}=0A

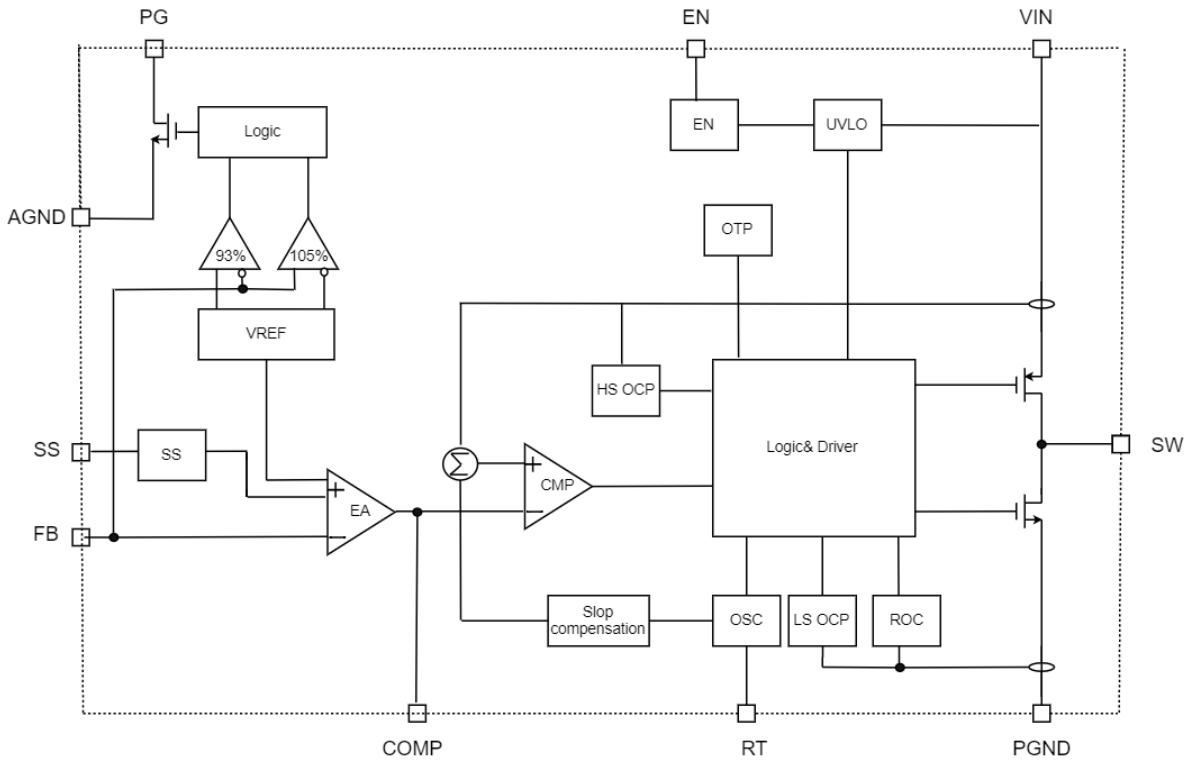


Hiccup with output short, V_{IN}=5V,V_{OUT}=1.0V,Entry



Hiccup with output short, V_{IN}=5V, V_{OUT}=1.0V, Recovery

FUNCTIONAL DESCRIPTION



Block diagram

Overview

The XPC1136 is a synchronous DC/DC voltage regulator available with switching frequency of up to 2MHz. Operating from an input voltage between 2.7V and 5.5V, the regulator can deliver up to 6A of load current.

Enable

Setting the EN pin to logic High or floating enables the device. Alternatively, the device is disabled when the EN voltage is set to logic Low. In this state the IC stops switching and draws less than 1μA of current.
If an application requires controlling the EN pin, use open drain or open collector output logic to interface with the pin.
EN pin can be used to set up input under-voltage lockout (UVLO) by adding a resistor divider from VIN to GND.

Soft start

XPC1136 effectively uses the lower voltage of the internal voltage reference or the SS/TR pin voltage as the reference voltage of the power supply and regulates the output accordingly.
A capacitor on the SS/TR pin to ground will implement a slow-start time.

$$Css(nF) = 3*Tss(ms)$$

Adjusting output voltage

The output voltage is set with a resistor divider from the output node to VSENSE pin. It is recommended to use 1% tolerance or better divider resistors to yield better regulation accuracy.

Switching frequency setting

The switching frequency of the XPC1136 is adjustable over a wide range from 200 kHz to 2MHz by placing a maximum of 210kohm and minimum of 18kohm, respectively, on the RT pin.

The voltage on RT is typically 0.5 V. To determine the timing resistance for a given switching frequency, use the curve in Figure TBD.

$$R_T \text{ (kohm)} = 56183/(Fsw(kHz))^{1.052}$$

Power good

The PWRGD pin is an open-drain output and pulls the PWRGD pin low when the VSENSE voltage is less than 91% or greater than 105% of the nominal internal reference voltage.

Thermal shut-down

The device thermal shutdown protection is enabled if the chip temperature exceeds 170°C. Once the temperature drops below 155°C, the device will be re-enabled, and a new soft-start cycle will begin.

Safe startup into pre-biased output

The XPC1136 allows monotonic start-up into pre-biased output.

Overcurrent protection

The XPC1136 implements current mode control which uses the COMP pin voltage to turn off the high-side MOSFET and turn on the low-side MOSFET on a cycle-by-cycle basis. Each cycle the switch current and the COMP pin voltage are compared, when the peak switch current intersects the COMP voltage the high-side switch is turned off.

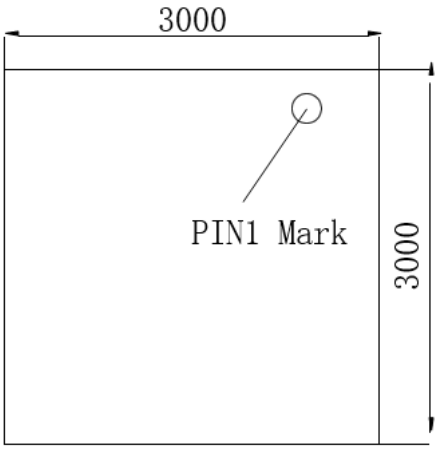
Over voltage protection

XPC1136 incorporates an overvoltage transient protection (OVTP) circuit to minimize voltage overshoot when recovering from output fault conditions or strong unload transients.
The OVTP feature minimizes the output overshoot by implementing a circuit to compare the VSENSE pin voltage to OVTP threshold which is 105% of the internal voltage reference.
If the VSENSE pin voltage is greater than the OVTP threshold, the high-side MOSFET is disabled preventing current from flowing to the output and minimizing output overshoot. When the VSENSE voltage drops lower than the OVTP threshold the high-side MOSFET can turn on the next clock cycle.

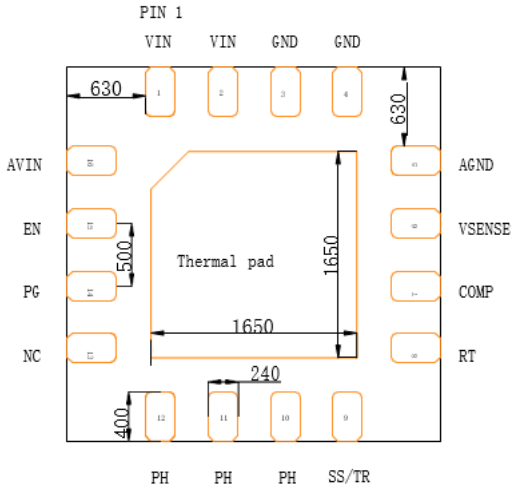
PHYSICAL DIMENSIONS

Units: um

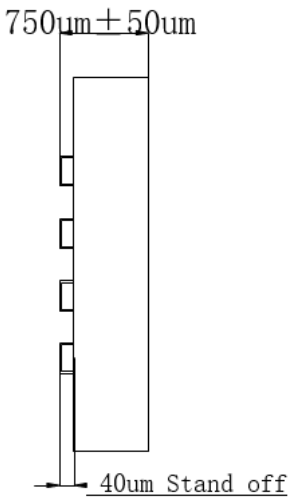
Top view



Bottom view

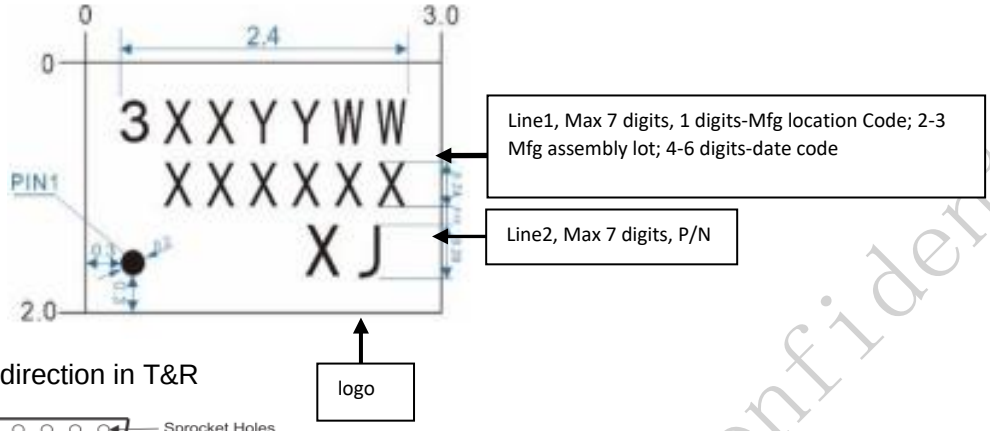


Side view



TOP MARKING

Format:



Pin 1 located in Q1 direction in T&R