4MHz 6A Synchronous Step Down Converter

Features

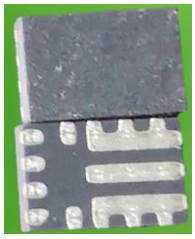
- 6A Output Current
- 4MHz Switching Frequency
- PFM Light Load Operation
- 25uA Quiescent Current
- 98% Peak Efficiency
- 2.3V to 6.5V Input Voltage Range
- 0.5V to 4V Adjustable Output Voltage
- Fast Load Transient Response
- 100% Duty Cycle
- Logic Enable Input
- Soft-Start
- Input Under-Voltage Lockout
- Over Current Protection
- Thermal Shutdown
- Active Output Discharge
- EU RoHS Compliant, Pb Free

Applications

- Optical modules
- Cellular Phones
- Tablets
- Wireless Data Cards
- Embedded Power supply
- Wearables and IoT
- Security and Surveillance

Package

DFN3X2

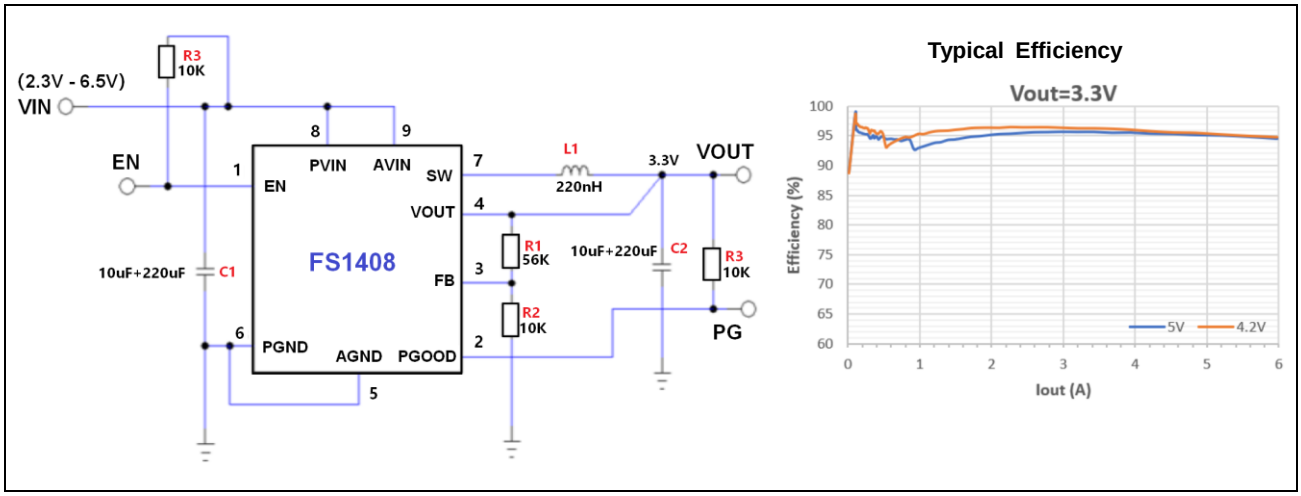


General Description

FS1408 is very efficient, high-frequency DC-DC voltage regulator. Operating with a switching frequency of 4MHz, it allows the use of small external components in both value and footprint. The output voltage is adjustable from 0.5V to 4.0V, delivered from an input voltage supply of 2.3V to 6.5V.

A low quiescent current of only 25uA enables high efficiency even with very light load. At light current load, the regulator automatically enters Pulse Frequency Modulation (PFM) operation mode for best possible efficiency over the entire range of load currents.The uPoL comes in a compact 9-pin DFN package with 0.5mm pin pitch and a 3mm x 2mm x 0.75mm size.

Typical Application Circuit



- **Absolute Maximum Ratings** （Operation of the device outside of these parameters may cause permanent damage.）

Parameter	Min	Max	Units
DC Supply Voltage, VIN	-0.3	+8.0	V
SW	-0.3	VIN	V
SW (10ns transient)	-4.0	+8.0	V
Voltage on other pins, FB, EN, PG	-0.3	VIN	V
Storage Temperature Range	-40	+150	°C
Junction Temperature	-40	+150	°C
Electrostatic Discharge (HBM)	-2000	+2000	V
Electrostatic Discharge (CDM)	-500	+500	V

- **Operating Conditions**

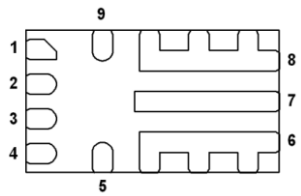
Parameter	Symbol	Min	Typ	Max	Units
Supply Voltage	V_{IN}	2.3		6.5	V
Output Current	I_{OUT}	0		6	A
Output Inductor	L	100	220		nH
Input Capacitor	C_{IN}	47	220		µF
Output Capacitor	C_{OUT}	47	220		µF
Operating Temperature, Junction	T_{OJ}	-40		+125	°C

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}	30.45	°C/W
Junction-to-Case Thermal Resistance	θ_{JC}	16.68	°C/W

- **PIN Configuration and Description**

Top View



Pin	Name	Description
1	EN	Enable. Part is active when VEN > 1.2V. Part is disabled when VEN < 0.5V.
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.

- **Electrical Specifications**

  Maximum and minimum values are: V_{IN} = EN = 2.3V to 6.5V, T_J = -40 to +125˚C

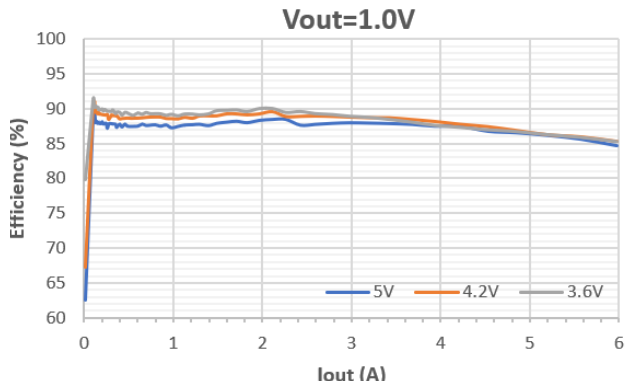
  Typical values unless otherwise noted: V_{IN} = 3.6V, V_{OUT} = 1.8V, Temp = +25°C

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
DC Characteristics						
Supply Voltage	V_{IN}		2.3		6.5	V
Quiescent Current	I_Q	PFM Mode		1		mA
		No Load, Not Switching		25		μA
Shutdown Current	I_{SHDN}	EN = GND		0.1	1	μA
Under-Voltage Lockout Threshold	V_{UVLO}	Rising V_{IN}		2.1	2.2	V
Under-Voltage Lockout Hysteresis	$V_{UVLOHYST}$			200		mV
Thermal Shutdown	T_{TSD}			155		°C
Thermal Shutdown Hysteresis	T_{HYST}			30		°C
Output Characteristics						
Switching Frequency	F_{SW}			4		MHz
Feedback Voltage	V_{FB}		-1%	0.5	+1%	V
Soft-Start Time	T_{SS}			3		ms
Enable Turn-on Delay	T_{EN}			100		μs
PMOS On Resistance	R_{DSONP}	V_{IN} = V_{GS} = 3.6V		12		mΩ
NMOS On Resistance	R_{DSONN}	V_{IN} = V_{GS} = 3.6V		7.5		mΩ
PMOS Peak Current Limit	I_{LIM}	V_{IN} = 3.6V, Open Loop		9		A
Output Discharge Resistance	R_{DIS}	EN = 0V		17		Ω
Power Good Threshold VOUT Rising	V_{PGR}			96%		
Power Good Threshold VOUT Falling	V_{PGF}			92%		
Power Good Low Voltage	V_{PGL}				100	mV
Power Good Leakage Current	I_{PG}				1	μA
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}				1	μA
Logic Input Hysteresis	V_{LHYST}			200		mV

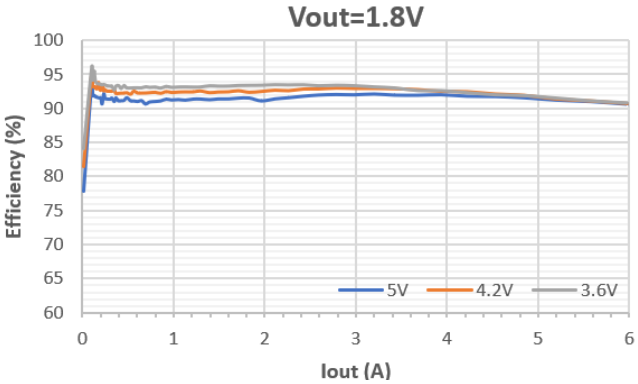
Typical Application Circuit unless otherwise noted.

- **Typical Performance and Operating Characteristics**

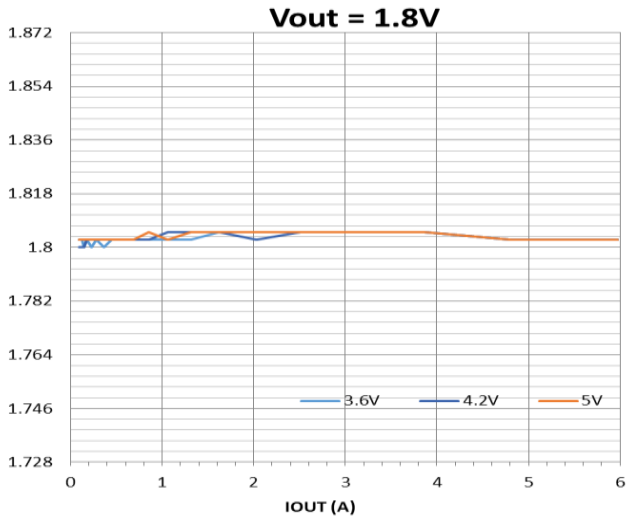
Typical test conditions unless otherwise noted: VIN = 3.6V, VOUT = 1.8V, Temp = +25°C.



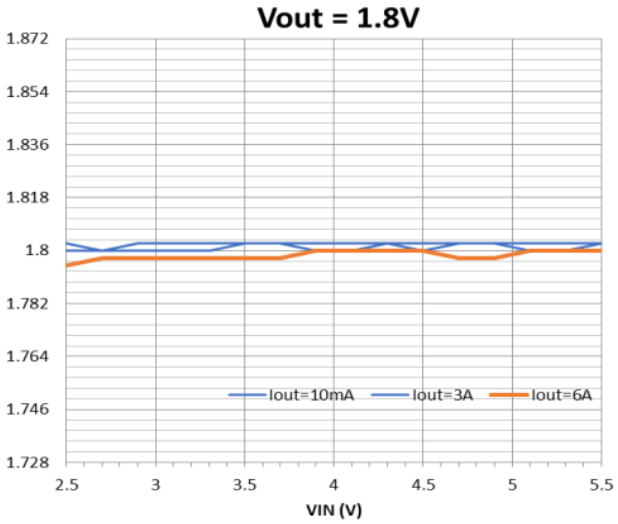
Efficiency, V_{OUT} = 1.0V



Efficiency, V_{OUT} = 1.8V

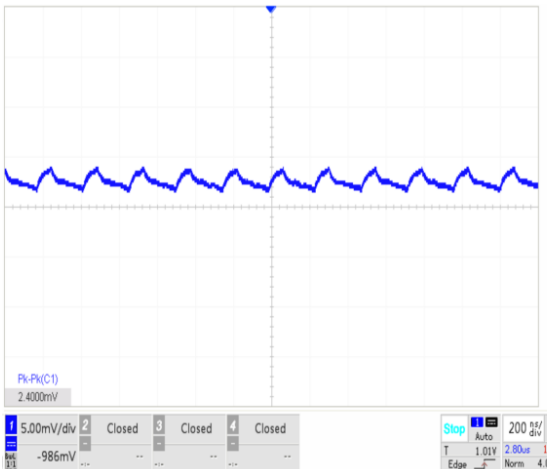


Load regulation, V_{OUT} = 1.8V

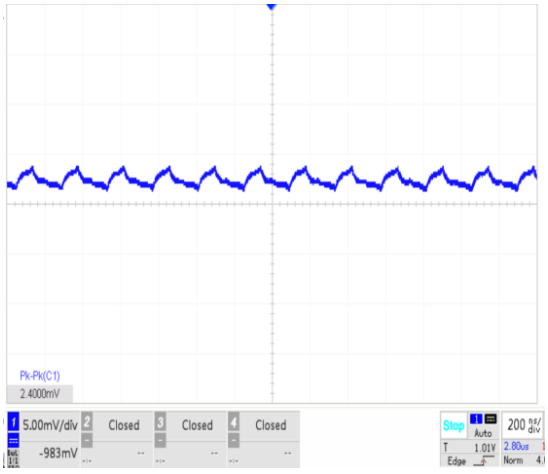


Line regulation, V_{OUT} = 1.8V

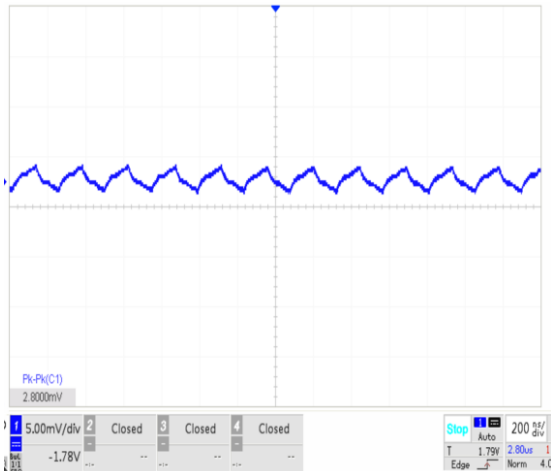
Typical Performance and Operating Characteristics



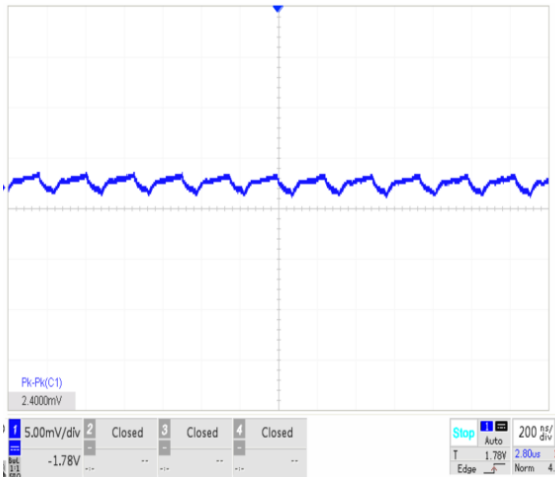
Output voltage ripple, V_{OUT} = 1.0V, IOUT=3A



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

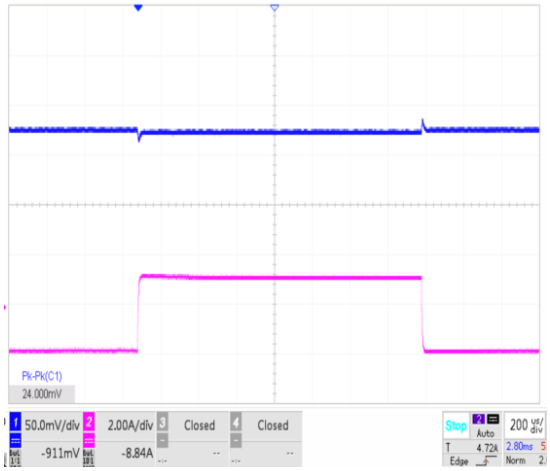


Output voltage ripple, V_{OUT} = 1.8V, IOUT=3A

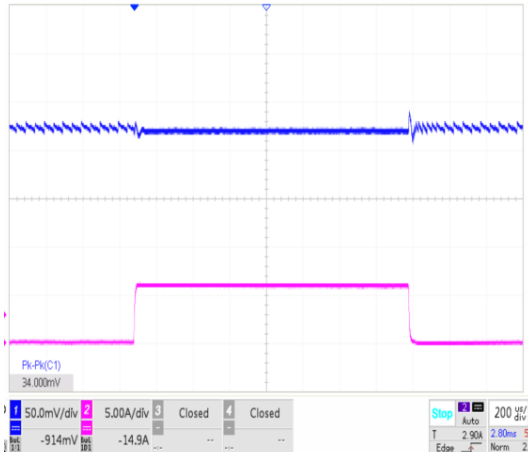


Output voltage ripple, V_{OUT} = 1.8V, IOUT=6A

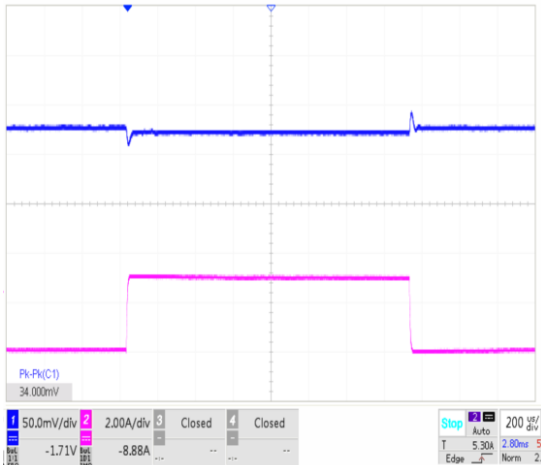
Typical Performance and Operating Characteristics



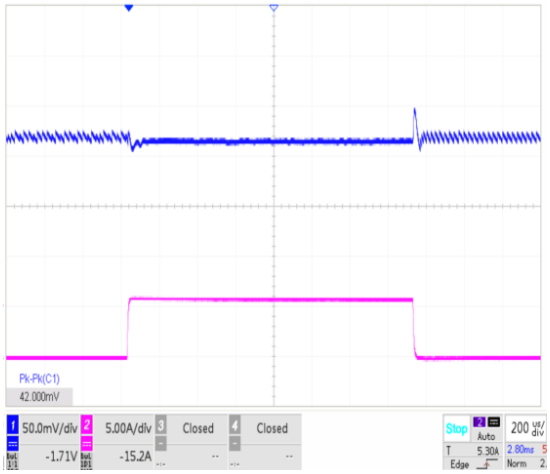
Transient Response, V_{OUT} = 1V, I_{LOAD} = 3A to 6A Step



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

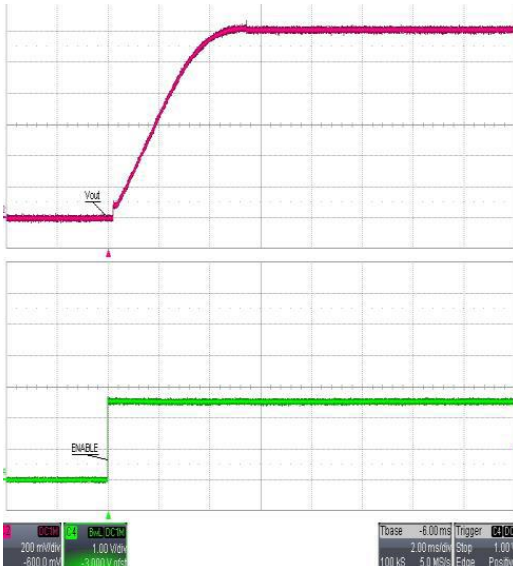


Transient Response, V_{OUT} = 1.8V, I_{LOAD} = 3A to 6A Step

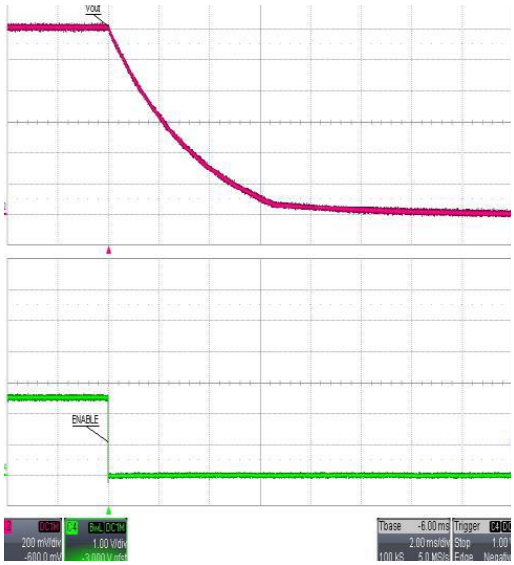


Transient Response, V_{OUT} = 1.8V, I_{LOAD} = 0A to 6A Step

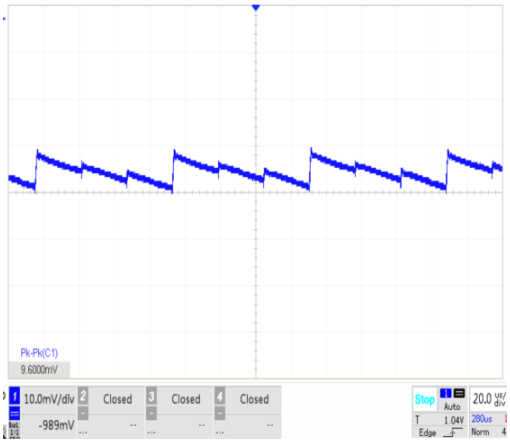
Typical Performance and Operating Characteristics



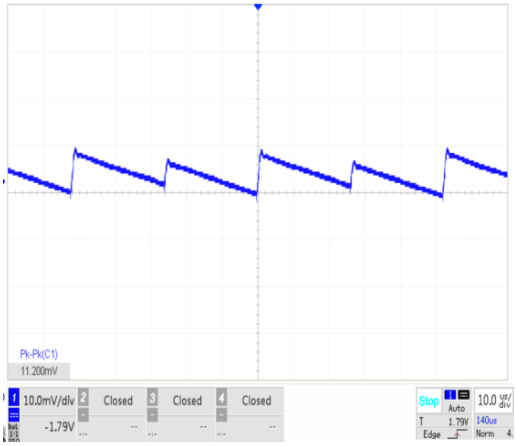
Start-Up



Shutdown

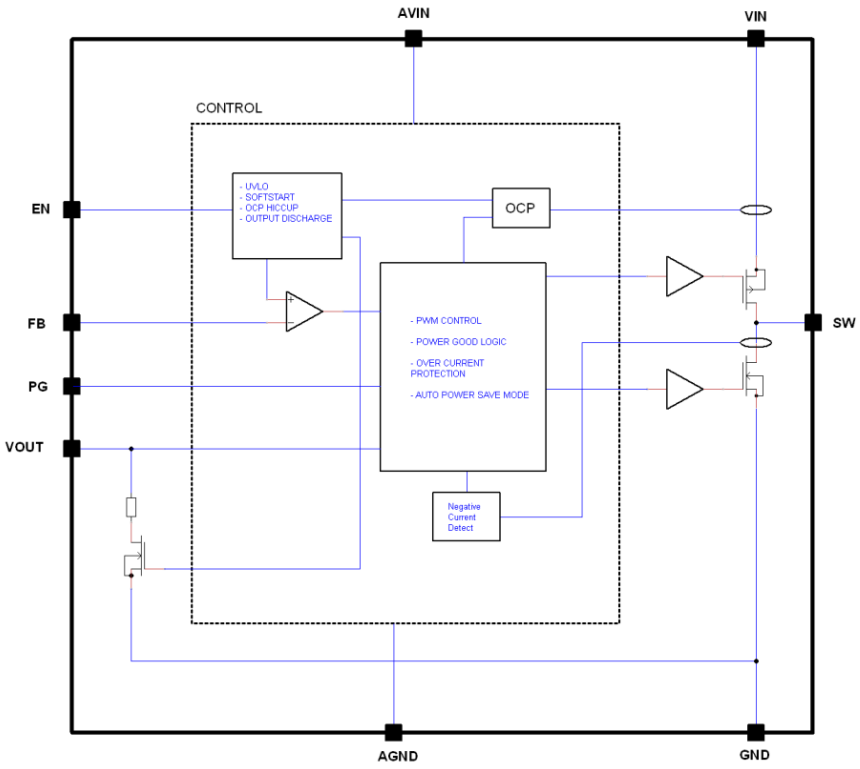


Output voltage ripple, V_{OUT} = 1.0V, I_{OUT}=0A



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

- **Functional Description**



FS1408 Block Diagram

The FS1408 is a synchronous DC/DC voltage regulator available with typical switching frequency of 4MHz. Operating from an input voltage between 2.3V and 6.5V, 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 1μA of current and the output is pulled to ground through a resistive load. V_{OUT} starts to ramp up after 100μs 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. 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 1.9V.

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

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.

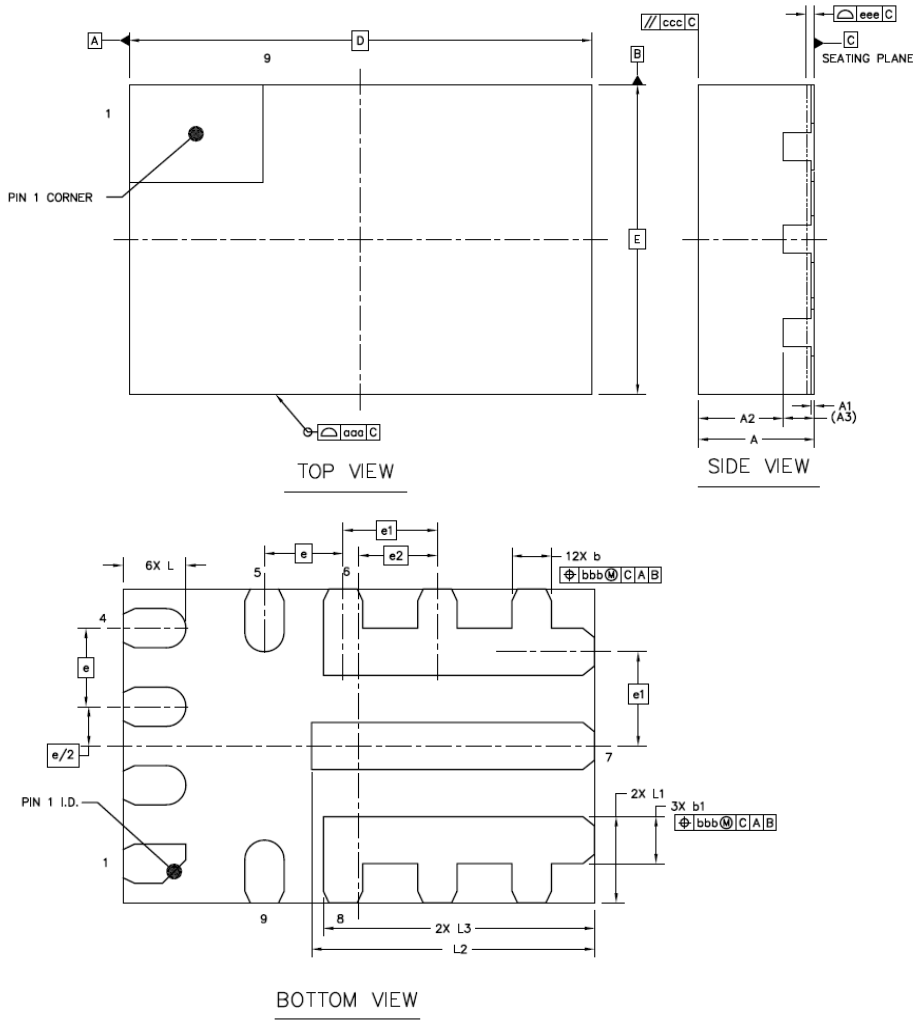
Overcurrent Protection

The device has overcurrent protection to prevent damage to the device and inductor during overcurrent conditions. Peak current protection occurs at 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.

- **Package 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		

Symbol	Dimensions in mm		
	Min	Nom	Max
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	