LP3316H
High Output Voltage Boost Converter

Features

- Input voltage range: 2.7V to 5.5V
- Output voltage up to 30V
- 1.1MHz Boost switching frequency
- Dedicated pin to support enable/disable
- Integrated 2Aswitch FET
- 1.24V reference voltage for V_{OUT} programming
- 90% high efficiency for 15V/80mA output
- 250uA quiescent current (V_{FB}=1.5V)
- Internal loop compensation
- Protections
  - Soft-start
  - Input under-voltage lockout (UVLO)
  - Boost cycle-by-cycle current-limit protection
  - 36V over-voltage protection
  - Thermal shutdown protection
- Packaging
  - SOT23-5L
  - RoHS compliant and halogen free
  - 100% lead (Pb) free

Applications

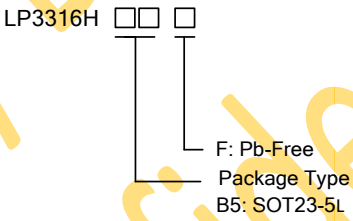
- Smart phones
- Portable devices with LED display
- Portable media players

General Description

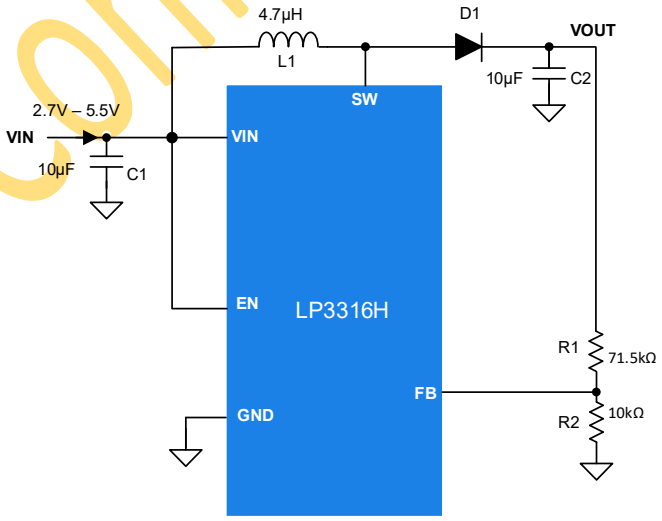
The LP3316H is a Boost converter that has programmable output voltage by feedback resistors. The device has a 2A N-channel MOSFET and the Boost converter switches at a constant switching frequency 1.1MHzallowing low-profile inductor and ceramic capacitors. The output voltage is programmed with two resistors connected from VOUT to GND and the middle point is connected to FB pin. The voltage at FB pin is regulated at 1.24V. The device can be enabled or disabled at EN pin.

LP3316H offers low noise, small size, high efficiency and robust protections. The protection features include under-voltage lockout (UVLO), internal soft-start, Boost cycle-by-cycle current limit, over voltage protection (OVP) as well as thermal shutdown. The LP3316His available in a SOT23-5L package.

Order Information



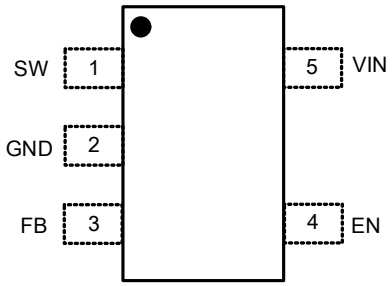
Typical Application Circuit



Device Information

Part Number	Top Marking	Package	Moisture Sensitivity Level	Shipping
LP3316HB5F	LPS FrYWX	SOT23-5L	MSL3	3K/REEL
Marking indication: Year code. W: Week code. X: Batch numbers.				

Pin Diagram



SOT23-5L (Top View)

Pin Description

Pin #	Name	Description
1	SW	Switching node. Connect this pin to a terminal of Boost input inductor.
2	GND	Ground.
3	FB	Output voltage feedback input. Connect VOUT to FB pin and GND with a resistor divider.
4	EN	Enable pin. Active High.
5	VIN	Supply input. Connect a 10μF ceramic capacitor from this pin to GND.

Absolute Maximum Ratings (Note)

VIN, FB, EN Voltage to GND ---------- -0.3V to 6V
SW Voltage to GND ---------- -0.3V to 38V
Maximum Junction Temperature (Tj) ---------- 150℃
Operation Ambient Temperature Range ---------- -40℃ to 85℃
Storage Temperature Range ---------- -60℃ to 150℃
Maximum Soldering Temperature (at leads, 10 sec) ---------- 260℃

Note: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD Ratings

HBM(Human Body Model) ---------- +/-2kV
MM(Machine Model) ---------- +/-200V
CDM (Charge Discharge Model) ---------- +/-500V

Thermal Information

θ_{JA}(Junction-to-Ambient Thermal Resistance) for SOT23-5L ---------- 120℃/W

Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
VIN	Input Voltage	2.7		5.5	V
IOUT	Output Current			300(1)	mA
VOUT	Output Voltage	VIN + 3V		30	V
TJ	Operating Junction Temperature Range (TJ)	-40		125	℃
TA	Ambient Temperature Range	-40		85	℃
L	Boost Inductance	3.3	4.7	12	μH
CIN	Input Capacitance (2)	3.0	10		μF
COUT	Input Capacitance (2)	3.0	10		μF

Notes:
(1) The actual output current is limited by the Boost input current limit and thermal performance depending on output voltage and input voltage
(2) The values recommended in the table are effective inductance and capacitance.

Electrical Characteristics

(The specifications are at V_{IN}=3.7Vand Tj=25 except otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT VOLTAGE AND CURRENT						
V_{IN}	Input Voltage Range		2.7		5.5	V
V_{IN_UVLO}	Under Voltage Lockout of V_{IN}	V_{IN}Rising	2.4	2.5	2.6	V
$V_{IN\_UVLO\_HYS}$	V_{UVLO} Hysteresis	V_{IN}Falling		230		mV
I_{SD}	Shutdown current	V_{EN} =0			1	μA
I_Q	Quiescent current	V_{FB} = 1.2V		250		μA
BOOST CONVERTER						
F_{SW}	Switching Frequency			1.1		MHz
I_{LIM}	Switch Current Limit			2		A
D_{MAX}	Maximum Duty Cycle			93.5		%
R_{DSON_LS}	Low-side MOSFET On-resistance			0.2		Ω
V_{OVP}	SW Over-voltage Protection			36		V
V_{FB_REF}	FB Reference Voltage		1215	1240	1265	mV
T_{SOFT_START}	Soft-start Time			3		ms

Electrical Characteristics (Continued)

(The specifications are at V_{IN}=3.7V and T_J = 25°C for typical values unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
EN CONTROL						
T_{OFF}	EN Shutdown Deglitch time	EN high to low	2.5			μs
V_{EN_HIGH}	EN Logic High	VIN=2.7V to 6.0V	1.4			V
V_{EN_LOW}	EN Logic LOW	VIN=2.7V to 6.0V			0.4	V
R_{EN}	EN Pull Down Resistor			600		kΩ
THERMAL SHUTDOWN PROTECTION						
T_{SHUT}	Thermal Shutdown	Temperature Rising		140		℃
T_{SHUT_HYST}	Thermal Shutdown Hysteresis	Temperature Falling		20		℃

Typical Characteristics

(V_{IN}=3.7V, L1=4.7μH at V_{OUT}=10V, L=10μH at V_{OUT}=20V and above, C1=10μF, C2=10μF and T_J = 25°Cunless otherwise noted andthe schematicsas shown in Figure 7)

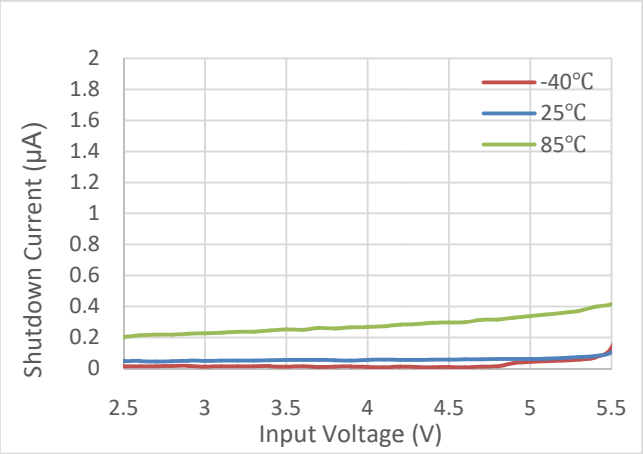


Figure 1. Shutdown Current vs. Input Voltage

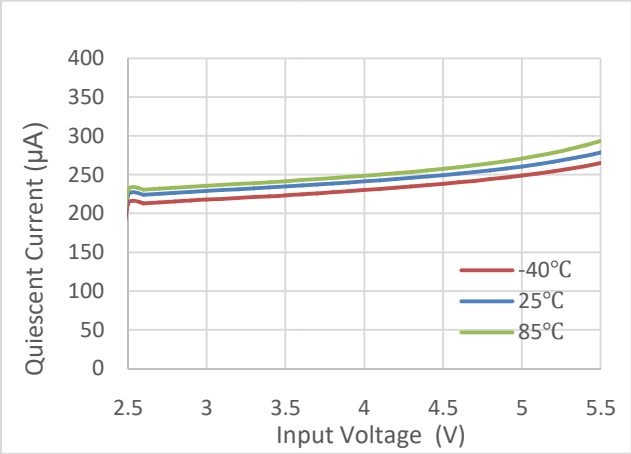


Figure 2. Quiescent Current vs. Input Voltage

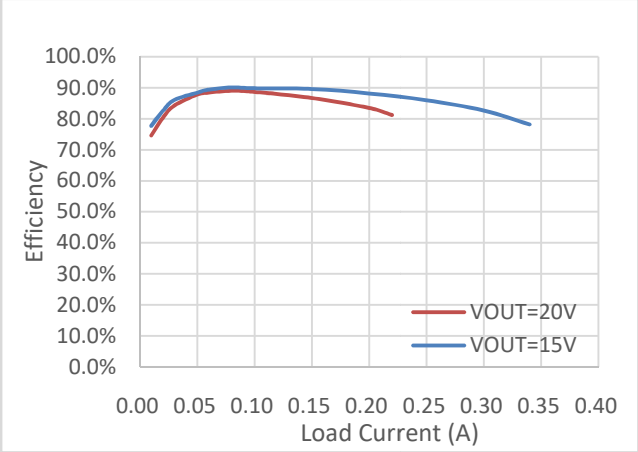


Figure 3. Efficiency vs. Load Current

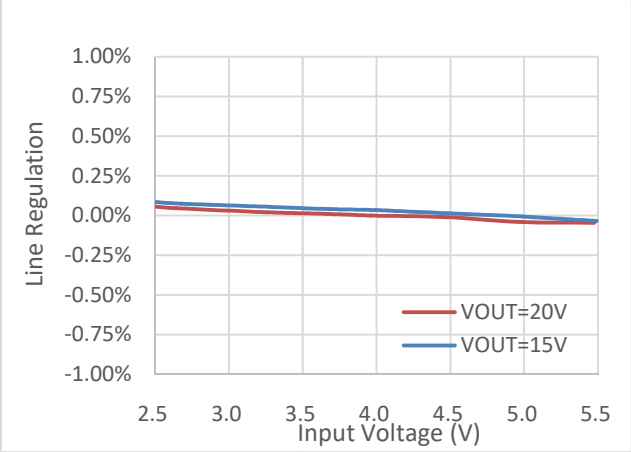


Figure 4. Line Regulation vs. Input Voltage (V_{IN}=3.7V, I_{OUT}=60mA)

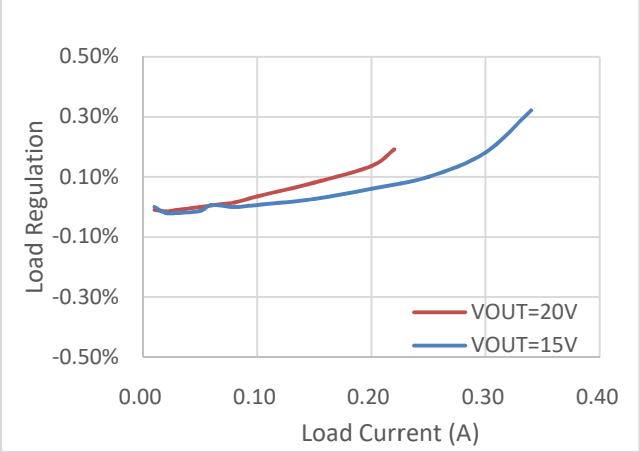


Figure 5. Load Regulation vs. Load Current

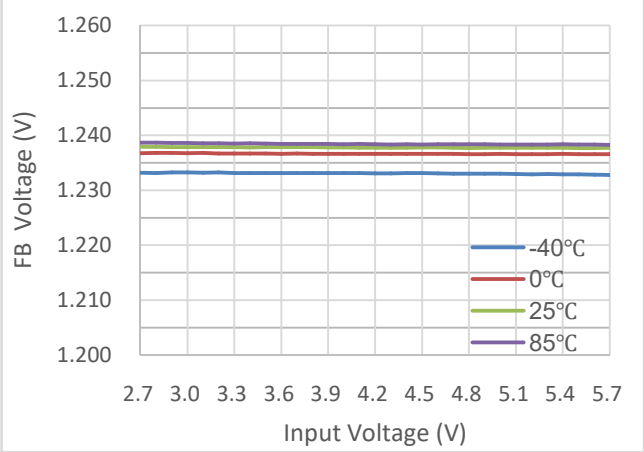
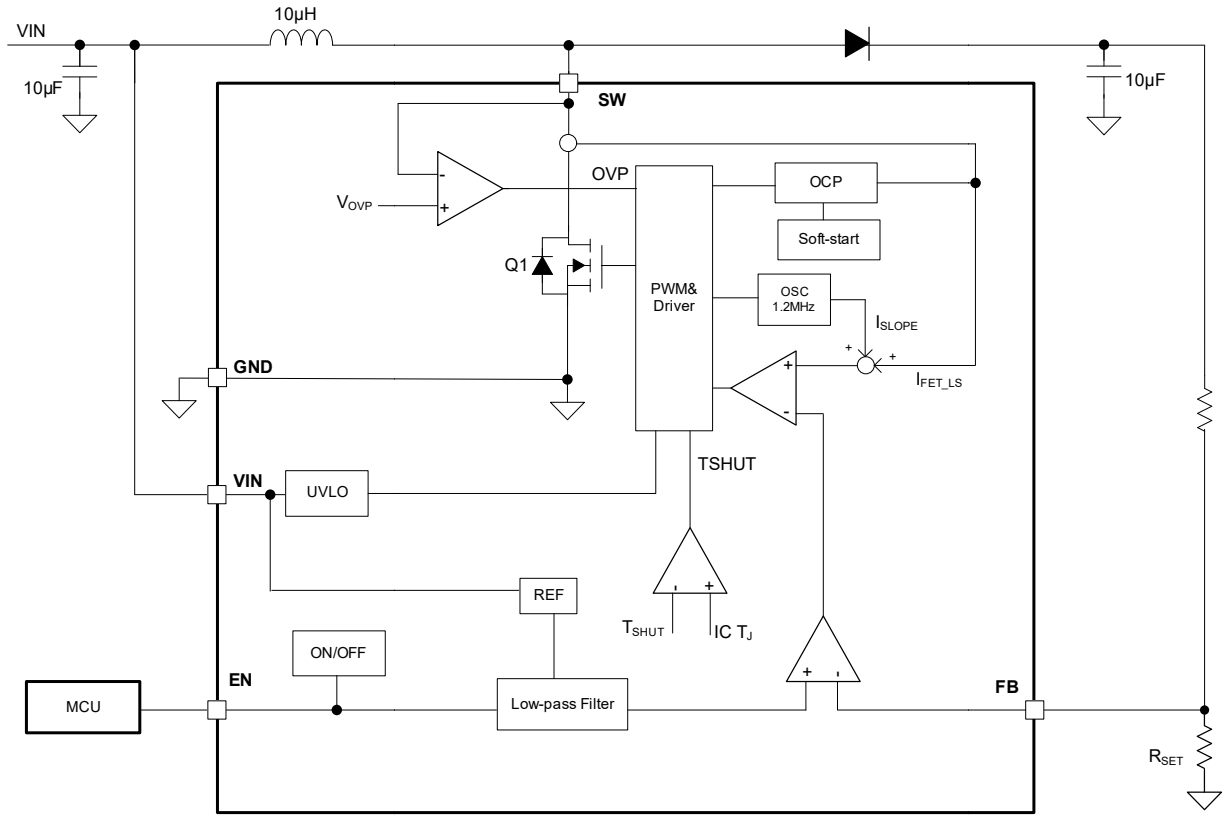


Figure 6. FB Voltage vs. Temperature and V_{IN}

Functional Block Diagram



Detailed Description

Overview

The LP3316H integrates a non-synchronous Boost converter operating with peak current mode control. Schottky diode is added externally from SW pin to an output capacitor. The output voltage is fed back to an error amplifier (E/A) by FB pin and the E/A output is sent to PWM modulation to determine the Boost duty cycle. Slope compensation is implemented to eliminate sub-harmonic oscillation at high duty cycle (D>0.5).

Under Voltage Lockout (UVLO)

The LP3316Hintegrates an under-voltage lockout block (UVLO) that enables the device after the voltage on the VIN pin exceeds the UVLO threshold. The device is disabled as soon as the VIN voltage falls below the UVLO falling threshold.

Soft Startup

When the device is enabled, the over current protection limit increases to full scale in a specific time, which prevents input rush current and output voltage from overshooting.

Over Current Protection

The LP3316H integrates a cycle-by-cycle over current protection. Once the inductor peak current hits the over current limit, the low-side MOSFET turns off immediately for the rest of the cycle. During the soft-start time, the cycle-by-cycle over current limit ramps up into full scale.

FB Pin Protection

When FB upper resister is open or FB pin is short to ground, the feedback voltage at FB pin falls to ground level causing output voltage of the E/A goes up and Boost duty cycle increase. As a result, the output voltage goes up until it hits the over voltage protection threshold. The output voltage is detected from SW pin when NFET switch is off. When the NFET turns on, the voltage at SW pin is pulled to ground, and inductor is charged by the input voltage. Once the NFET turns off, the inductor current is discharged to the output through the external schottky diode and the voltage at SW pin reflect the output voltage as $V_{SW}=V_{out}+V_F$. If the output voltage detected at SW pin is over the OVP threshold V_{OVP} for 4 times, the Boost converter latches off. The Boost converter is re-enabled under either of the two conditions:

- VIN is recycled
- EN pin is pulled low for > T_{OFF} and re-enabled

Shutdown

The EN pin is used for device enabling and shutdown. If EN pin voltage is from high to low for more than T_{OFF}, the device shuts down.

Thermal Shutdown Protection

The LP3316Hdevice enters over temperature protection and shuts down if its junction temperature exceeds T_{SHUT}. Once the junction temperature falls below the hysteresis threshold, the device restarts.

Application Information

The LP3316Hdevice can support up to 30V output voltage. Set the output voltage by selecting the resistor voltage divider ratio. The voltage divider from VOUT to GND is R1 and R2, where R1 is high-side resistor and R2 is low side resistor. Recommend R2=10kΩ, the output voltage can be calculated as in Equation 1:

VOUT = (R1/R2+ 1) × VFB (1)

Inductor Selection

4.7μH inductor is recommended for typical applications. If higher than 10V voltage is needed, 10μH inductor is recommended.

Capacitor Selection

A10μF or higher values of low ESR ceramic capacitors are recommended for Boost input capacitor, and 10μF or higher values of low ESR ceramic capacitors are recommended for Boost output capacitor as shown in the table of Recommended Operating Conditions.

Diode Selection

Shottky diode is a good choice for low forward drop voltage and fast switching time. The output diode rating should be able to handle the maximum output voltage, average power dissipation and the pulsating diode peak current.

Current Limiting

The internal power-MOS switch current is monitored cycle-by-cycle and is limited to the value not exceed 2A (Typ.). When the switch current reaches the limited value, the internal power-MOS is turned off immediately until the next cycle.

Application Schematic

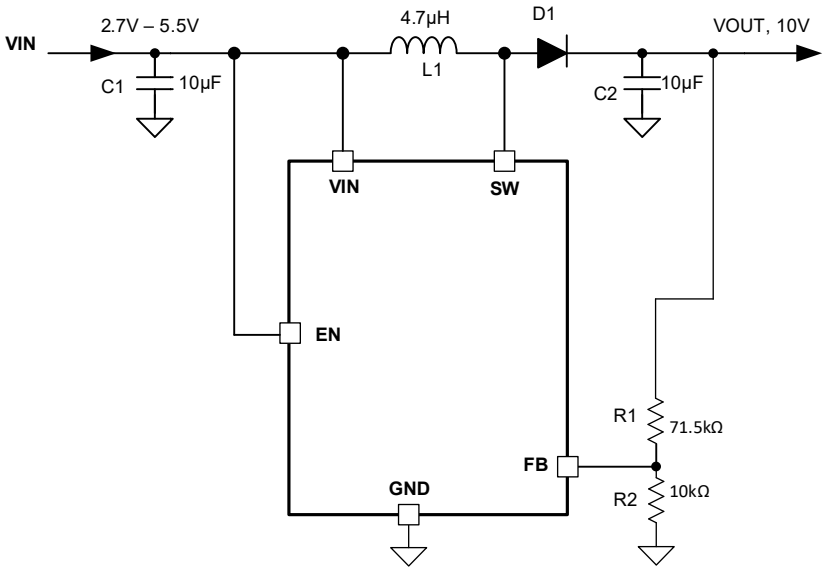


Figure 7.Typical10V output application

Application and Implementation

Application Curves

(L1=4.7μH at Vout=10V, L1=10μH at Vout=20V and above, C1=10μF, C2=10μF and T_J = 25°Cunless otherwise noted and the schematicis shown in Figure 7)

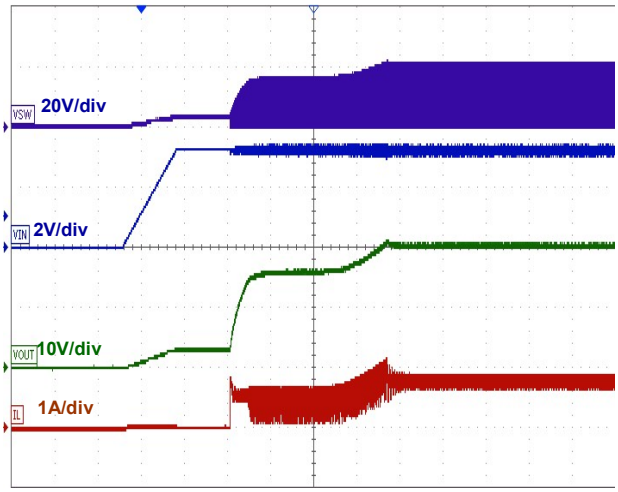


Figure 8. VIN Startup
(VIN=3.3V, VOUT=20V, IOUT=0.1A)

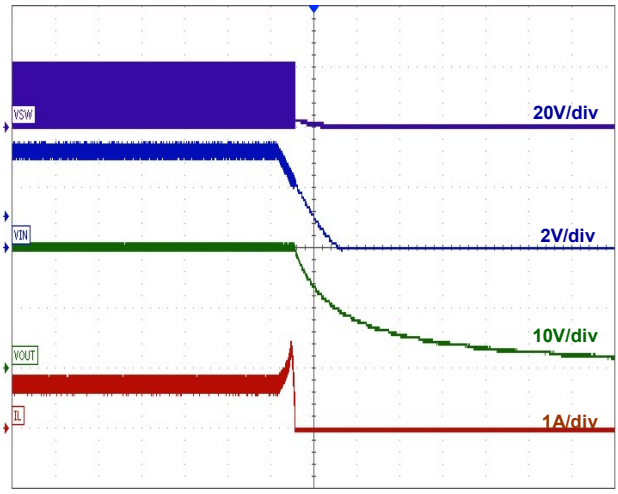


Figure 9. VIN Startup
(VIN=3.3V, VOUT=20V, IOUT=0.1A)

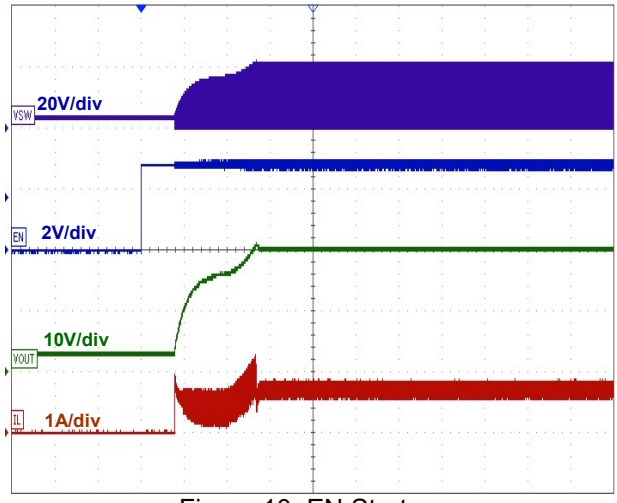


Figure 10. EN Startup
(VIN=3.3V,VOUT=20V, IOUT=0.1A)

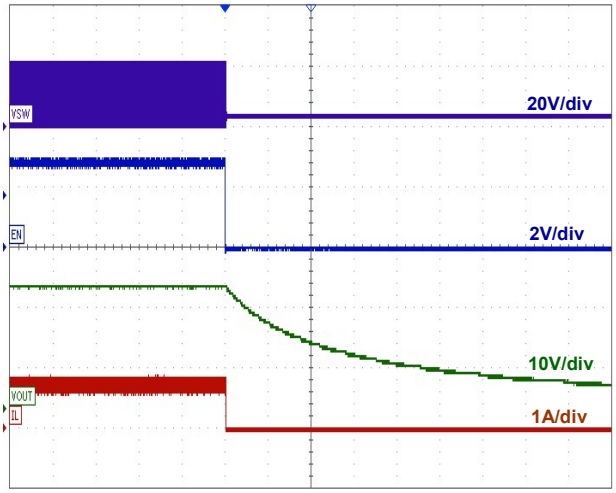


Figure 11. EN Shutdown
(VIN=3.3V, VOUT=20V, IOUT=0.1A)

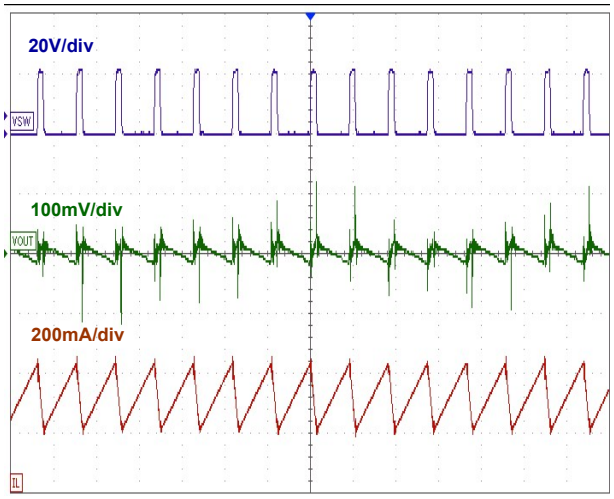


Figure 12. Steady State
(VIN=3.3V, VOUT=20V, IOUT=0. 1A)

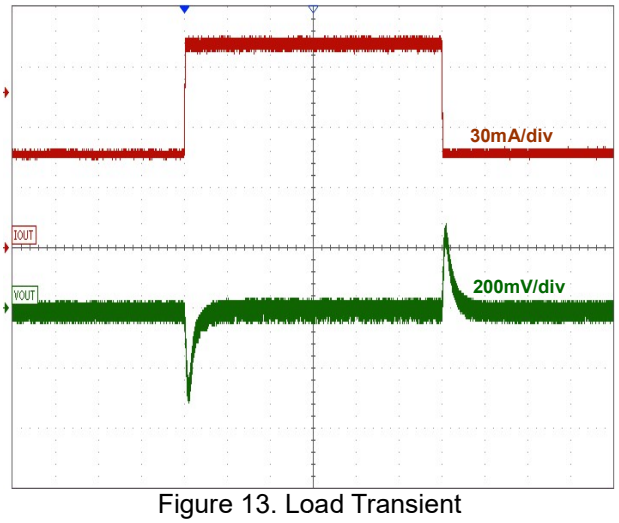


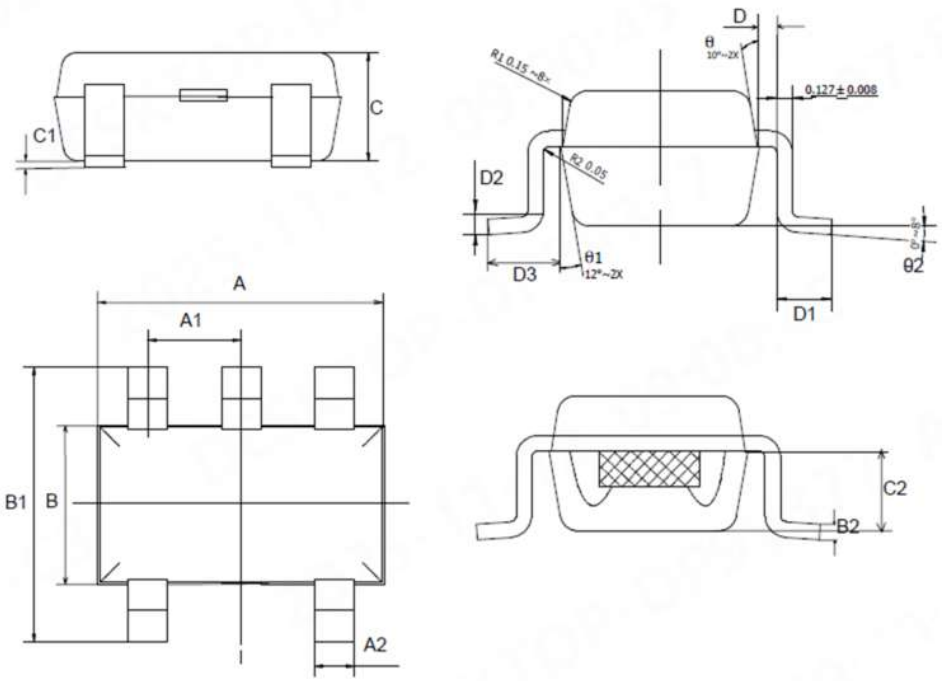
Figure 13. Load Transient
(VIN=3.3V, VOUT=20V, IOUT=0.05A→0.1A→0.05A)

PCB Layout Guideline

Appropriate PCB layout is important in the power supply design. Good PCB layout minimizes EMI and allows very good output voltage regulation. Ref to Figure 7, the following design considerations are recommended:

- Input and output capacitors are replaced closed to the IC and connected to ground plane on top layer to reduce noise coupling
- C2, D1, SW to GND loop shall be minimized to reduce switching voltage spikes and ringing.
- R1 and R2 shall be placed close to FB pin.
- Connect IC GND to the ground plane if available.

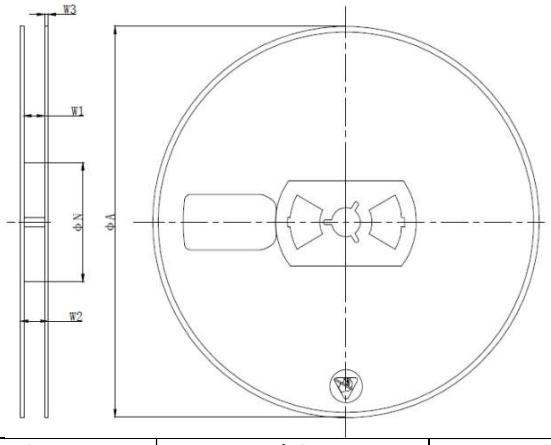
Package Information (SOT23-5L)



COMMON DIMENSIONS CUNITS MEASURE=MILLIMETER			
SYMBOL	MIN	MID	MAX
A	2.82	2.92	3.02
A1	0.90	0.95	1.0
A2	0.30	0.35	0.40
B	1.52	1.62	1.72
B1	2.80	2.90	3.0
B2	0.125	0.14	0.155
C	1.05	1.10	1.15
C1	0.03	0.08	0.13
C2	0.6	0.65	0.7
D	0.03	0.08	0.13
D1	0.4	0.45	0.5
D2	0.25TYP		
D3	0.6	0.65	0.7

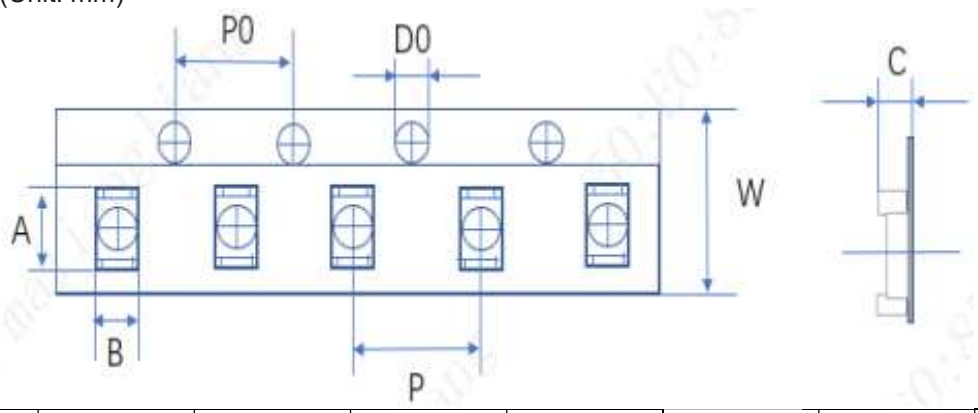
Carrier Information

Reel Dimensions (Unit: mm)



Device	ΦA	W2
LP3316HB5F	180±4	12±2

Tape Dimension (Unit: mm)



Device	A	B	P0	P	D0	W	C
LP3316HB5F	3.20±0.20	3.26±0.20	4.00±0.10	4.00±0.10	1.50±0.10	8.00±0.30	1.40±0.20

SOT23-5L