GS1008

120V-Input, Very High Voltage, Linear Regulator

GENERAL DESCRIPTION

The GS1008 device is a very high voltage-tolerant linear regulator that offers the benefits of a thermally-enhanced package (ESOP-8L), and is able to withstand continuous DC or transient input voltages of up to 100 V.

The GS1008 device is stable with any output capacitance greater than 4.7 μF and any input capacitance greater than 1 μF (over temperature and tolerance). Therefore, implementations of this device require minimal board space because of its miniaturized packaging (ESOP-8L) and a potentially small output capacitor. In addition, the VLO1050ESP device offers an enable pin (EN) compatible with standard CMOS logic to enable a low-current shutdown mode.

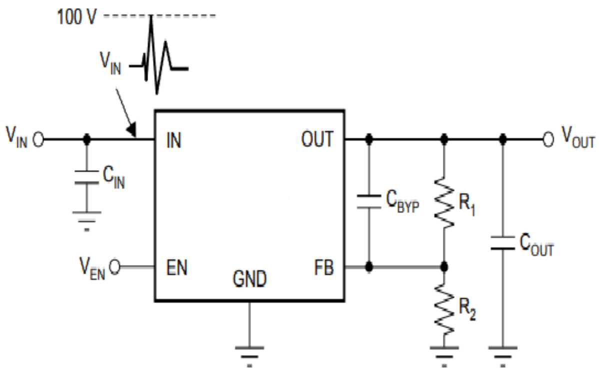
The GS1008 device has an internal thermal shutdown and current limiting to protect the system during fault conditions. The ESOP-8L packages has an operating temperature range of T_J = -40°C to 125°C.

In addition, the GS1008 device is ideal for generating a low-voltage supply from intermediate voltage rails in telecom and industrial applications; not only can it supply a well-regulated voltage rail, but it can also withstand and maintain regulation during very high and fast voltage transients. These features translate to simpler and more cost-effective electrical surge-protection circuitry for a wide range of applications, including PoE, bias supply, and LED lighting.

FEATURES

- Low Quiescent Current: 25μA
- Wide Input Voltage Range: 7V to 120V
- Output Current: 50mA
- Low Dropout Voltage: 290mV
- Adjustable Output Voltage from about 1.175 to 90 V
- Output Voltage Tolerance: ±2%
- Stable With Ceramic Capacitors:
  Input Capacitance: ⩾ 1 μF
  Output Capacitance: ⩾ 4.7 μF
- Built-In Current Limit & Thermal Shutdown Protection
- Operating Temperature Range: -40°C to 125° C
- LED Lighting Appliance
  Laptop, Palmtops, Notebook Computer

TYPICAL APPLICATION



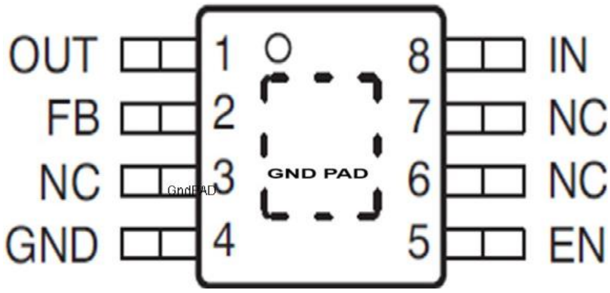
VLO1050ESP Typical Application Schematic

Design Parameters	Example Value
Input Voltage	7V - 120V
Output Voltage	1.175V - 90V
Maximum Output Current	Peak >50mA

APPLICATIONS

- Microcontrollers Powered by Industrial Busses with High Voltage Transients
- Industrial Automation
- Power over Ethernet (PoE)
- LED Lighting Appliance

PIN Description



Order Information

Pin	Name	Description
1	OUT	Regulator output. A capacitor > 4.7 µF must be tied from this pin to ground to assure stability.
2	FB	This pin is the input to the control-loop error amplifier. It is used to set the output voltage of the device.
3	NC	No Connection
4.	GND	Ground
5	EN	This pin turns the regulator on or off. If $V_{EN} \geq V_{EN\_HI}$ the regulator is enabled. If $V_{EN} \leq V_{EN\_LO}$, the regulator is disabled. If not used, the EN pin can be connected to IN. Make sure that $V_{EN} \leq V_{IN}$ at all times.
6	NC	No Connection
7	NC	No Connection
8	IN	Input supply
	GND PAD	Heat dissipation path of die. Electrically connection to GND pin. Must be connected to ground plane on PCB for proper operation and optimized thermal performance.

ORDERING INFORMATION:

Part Number	Package	Packing Option	Mark
GS1008HL-XXFR GS1008HL-ADJFR	DFN3X3-8	Tape and Real，5000	GS1008
GS1008HL-XXESR GS1008HL-ADJFSR	ESOP-8	Tape and Real，4000	GS1008

Note: (HL 代表高压 LDO; ADJ 代表可调)

ABSOLUTE MAXIMUM RATINGS ：

Symbol	Parameter	Min	Max	Unit
V_{IN}	IN to GND pin	-0.3	120	V
V_{OUT}	OUT to GND pin	-0.3	120	V
	OUT to IN pin	-120	0.3	
V_{EN}	EN to GND pin	-0.3	120	V
	EN to IN pin	-120	0.3	
V_{FB}	FB to GND	-0.3	2	V
	FB to IN pin	-120	0.3	
Current	Peak Output	Internally Limited		
T_J	Operating virtual junction	-40	125	℃
T_{STG}	Storage Junction Temperature	-65	150	℃
MSL	Moisture sensitivity level	3		
V_{HBM}	ESD, Human Body Model (HBM)		±2000	V
V_{CDM}	ESD, Charged Device Model (CDM)		±2000	V
I_{ESD}	Latch up current		±100	mA

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

RECOMMANDED OPERATING RANGE:

Parameter	Symbol	Min	Max	UNIT
Supply Voltage	V_{IN}	2.5	36	V
Output current	I_{OUT}	0	150	mA
Operating Temperature	T_{OPT}	-40	85	℃

Thermal Information

Thermal Metric	Symbol	Min	Max	UNIT
Junction-to-ambient thermal resistance	$R_{\theta JA}$	185.6	165	℃/W
Junction-to-case(top)thermal resistance	$R_{\theta JC(top)}$	104.3	88.5	℃/W
Junction-to-board thermal resistance	$R_{\theta JB}$	54.5	39.6	℃/W
Junction-to-top characterization parameter	ψ_{JT}	31	26.5	℃/W
Junction-to-board characterization parameter	ψ_{JB}	54.5	49.7	℃/W
Junction-to-case(bottom)thermal resistance	$R_{\theta JC(bot)}$	N/A	77.7	℃/W

ELECTRICAL CHARACTERISTICS (2.5V ≤ V_{CELL} ≤ 4.9V, T_A =25℃, unless otherwise specified.)

Parameter	Symbol	Test conditions	Min.	Typ.	Max.	Unit.
Input voltage	V_{IN}		7		120	V
Internal reference	V_{REF}	T_J = 25℃, V_{FB} = V_{REF}, V_{IN} = 9 V, I_{OUT} = 25mA	1.161	1.173	1.185	V
Output voltage range (1)	V_{OUT}	V_{IN} ≥ $V_{OUT(NOM)}$ + 2 V	V_{REF}		90	V
Nominal accuracy		T_J = 25℃， V_{EN}=5V,V_{IN} = 9 V, I_{OUT} = 25 mA	-1		+1	%V_{OUT}
Overall accuracy		$V_{OUT(NOM)}$ + 2 V ≤ V_{IN} ≤ 24 V(2) 100 µA ≤ I_{OUT} ≤ 50 mA	-2.5		+2.5	%V_{OUT}
Line regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \bullet V_{OUT(s)}}$	7 V ≤ V_{IN} ≤ 120 V, No Load		0.03		%V_{OUT}
Load regulation	Δ V_{OUT2}	100 µA ≤ I_{OUT} ≤ 50 mA		0.31		%V_{OUT}
Dropout voltage	V_{DO}	V_{IN} = 17 V, $V_{OUT(NOM)}$ = 18 V, I_{OUT} = 20 mA		290		mV
Feedback short voltage	$V_{FB（short）}$	V_{IN} = 17 V, $V_{OUT(NOM)}$ = 18 V, I_{OUT} = 50mA		0.78	1.3	V
Current limit	I_{LIM}	V_{OUT} = 90% $V_{OUT(NOM)}$, V_{IN} = 7 V, T_J ≤ 85℃	51	117	200	mA
		V_{OUT} = 90% $V_{OUT(NOM)}$, V_{IN} = 9 V	51	128	200	mA
Ground current	I_{GND}	7 V ≤ V_{IN} ≤ 120 V, I_{OUT} = 0 mA		25	65	µA
		I_{OUT} = 50 mA		25		µA
Shutdown supply current	I_{SHDN}	V_{EN} = 0.4 V	1	5	20	µA
Feedback current (3)	I_{FB}		-0.1	0.01	0.1	µA
Enable current	I_{EN}	7 V ≤ V_{IN} ≤ 120 V, V_{IN} = V_{EN}		0.02	1	µA
Enable high-level voltage	V_{EN_HI}		1.5		V_{IN}	V
Enable low- level voltage	V_{EN_LO}		0		0.4	V
Output noise voltage	V_{NOISE}	V_{IN} = 12 V, $V_{OUT(NOM)}$ = V_{REF}, C_{OUT} = 10 µF, BW = 10 Hz to 100 kHz		58		µV_{RMS}
		V_{IN} = 12 V, $V_{OUT(NOM)}$ = 5 V, C_{OUT} = 10 µF, C_{BY} (4) = 10 nF, BW = 10 Hz to 100 kHz		73		µV_{RMS}
Power-supply rejection ratio	PSRR	V_{IN} = 12 V, $V_{OUT(NOM)}$ = 5 V, C_{OUT} = 10 µF, C_{BY} (4) = 10 nF, f = 100 Hz		75		dB
Thermal shutdown temperature	T_{SD}	Shutdown, temperature increasing		170		℃
		Reset, temperature decreasing		150		℃
Operating junction temperature	T_J		-40		125	℃

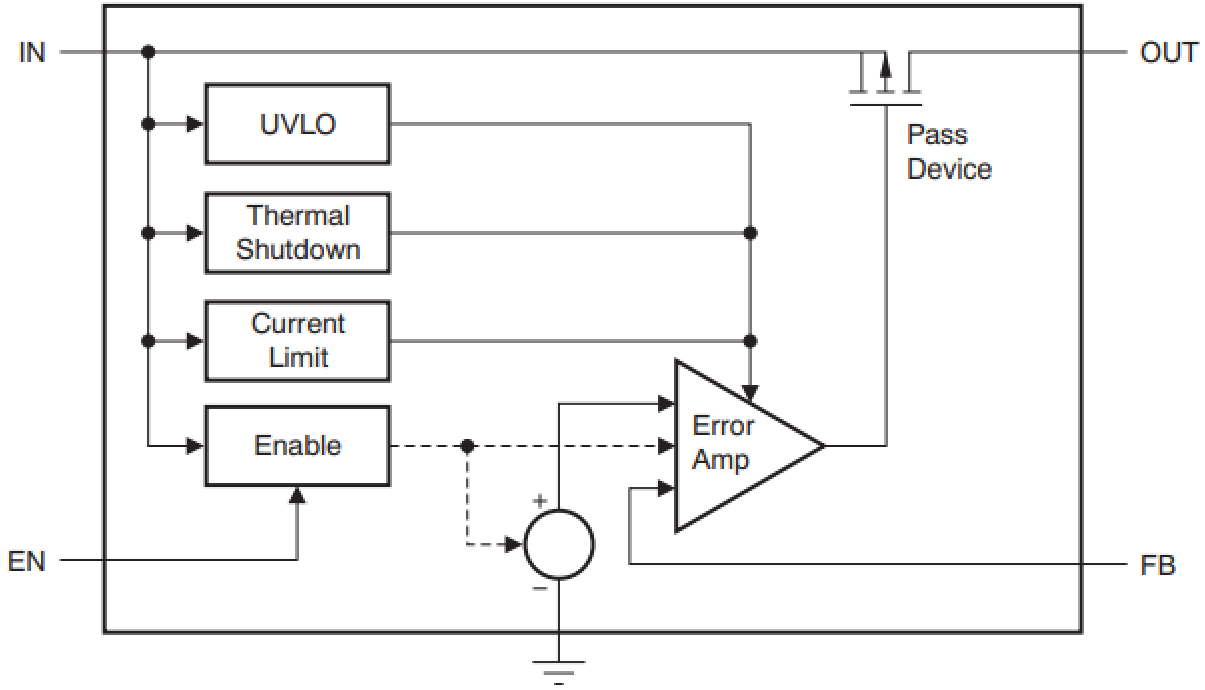
Note: (1) To ensure stability at no-load conditions, a current from the feedback resistive network greater than or equal to 10µA is required.

(2)Maximum input voltage is limited to 24V because of the package power dissipation limitations at full load (P ≈ (V_{IN} – V_{OUT}) × I_{OUT} = (24V – V_{REF}) × 50 mA ≈1.14 W). The device is capable of sourcing a maximum current of 50 mA at higher input voltages as long as the power dissipated is within the thermal limits of the package plus any external heatsinking.

(3) I_{FB} > 0 flows out of the device.

(4) C_{BYP} refers to a bypass capacitor connected to the FB and OUT pins

Functional Block Diagram



Applications Information

Overview

The GS1008 device belongs to a new generation of linear regulators that use an innovative BCD120V process technology to achieve very high maximum input and output voltages.

This process not only allows the GS1008 device to maintain regulation during very fast high- voltage transients up to over 100V, but it also allows the GS1008 device to regulate from a continuous high-voltage input rail. Unlike other regulators created using bipolar technology, the ground current of the GS1008 device is also constant over its output current range, resulting in increased efficiency and lower power consumption.

These features, combined with a high thermal performance ESOP-8L Ground-Pad package, make this device ideal for industrial and telecom applications.

Thermal Protection

Thermal protection disables the output when the junction temperature rises to approximately 170°C, allowing the device to cool. When the junction temperature cools to approximately 150°C, the output circuitry is enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits the dissipation of the regulator, protecting it from damage as a result of overheating. Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heatsink. For reliable operation, limit junction temperature to a maximum of 125°C. To estimate the margin of safety in a complete design (including heatsink), increase the ambient temperature until the thermal protection is triggered; use worst-case loads and signal conditions. For good reliability, trigger thermal protection at least 35°C above the maximum expected ambient condition of your particular application. This configuration produces a worst-case junction temperature of 125°C at the highest expected ambient temperature and worst-case load.

Current Limit Protection

The fixed internal current limit of the GS1008 device helps protect the regulator during fault conditions. The maximum amount of current the device can source is the current limit, and is largely independent of output voltage. For reliable operation, the device does not operate in current limit for extended periods of time.

Under Voltage Lock-Out

The GS1008 contains an Undervoltage Lockout comparator that ensures the error amplifier is disabled when the input voltage is below the required minimum operational voltage. The minimum recommended operational voltage is 7 V.

Enable Pin Operation

The GS1008 device provides an enable pin (EN) feature that turns on the regulator when $V_{EN} > V_{EN\_HI}$, and disables the regulator when $V_{EN} < V_{EN\_LO}$.

Normal Operation

The device regulates to the nominal output voltage under the following conditions:

- The input voltage is at least as high as V_{IN} (min).
- The input voltage is greater than the nominal output voltage added to the dropout voltage.
- The enable voltage has previously exceeded the enable rising threshold voltage and has not decreased below the enable falling threshold.
- The output current is less than the current limit.
- The device junction temperature is less than the maximum specified junction temperature.

Dropout Operation

If the input voltage is lower than the nominal output voltage plus the specified dropout voltage, but all other conditions are met for normal operation, the device operates in dropout mode. In this mode of operation, the output voltage is the same as the input voltage minus the dropout voltage. The transient performance of the device is significantly degraded because the pass device (as a bipolar junction transistor, or BJT) is in saturation and no longer controls the current through the LDO. Line or load transients in dropout can result in large output voltage deviations.

Disabled

The device is disabled under the following conditions:

- The enable voltage is less than the enable falling threshold voltage or has not yet exceeded the enable rising threshold.
- The device junction temperature is greater than the thermal shutdown temperature.

Table 1 lists the conditions that lead to the different modes of operation.

OPERATING MODE	PARAMETER			
	V_{IN}	V_{EN}	I_{OUT}	T_J
Normal mode	$V_{IN} > V_{OUT(nom)} + V_{DO}$ and $V_{IN} > V_{IN(min)}$	$V_{EN} > V_{EN\_HI}$	$I_{OUT} < I_{LIM}$	$T_J < 125°C$
Dropout mode	$V_{IN(min)} < V_{IN} < V_{OUT(nom)} + V_{DO}$	$V_{EN} > V_{EN\_HI}$	—	$T_J < 125°C$
Disabled mode (any true condition disables the device)	—	$V_{EN} < V_{EN\_LO}$	—	$T_J > 170°C$

Table 1. Device Functional Mode Comparison

Adjustable Operation

The GS1008 device has an output voltage range of about 1.175 to 90 V. The nominal output voltage of the device is set by two external resistors, as shown in Figure 1.

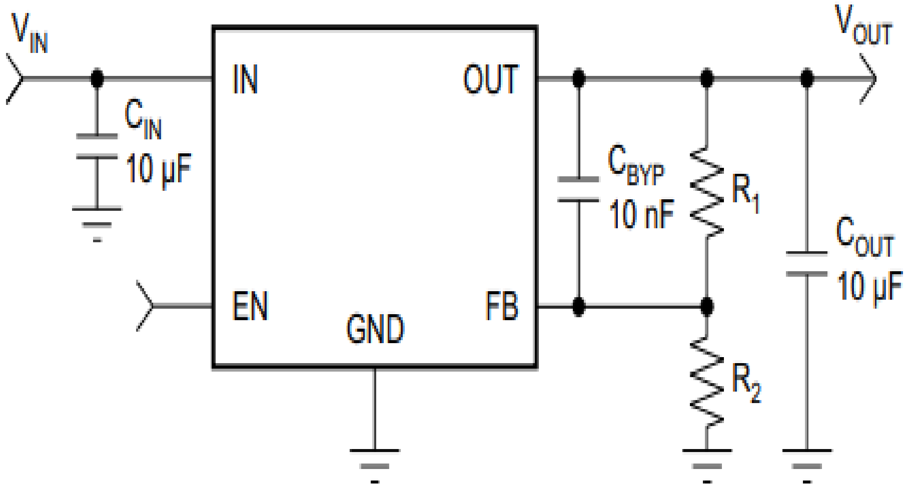


Figure 1. Adjustable Operation for Maximum AC Performance

If greater voltage accuracy is required, consider the output voltage offset contributions because of the feedback pin current and use 0.1% tolerance resistors. The maximum value of total feedback resistance can be calculated to be 500 kΩ. Equation (1) was used to calculate R1 and R2, and standard 1% resistors were selected to keep the accuracy within the 5% allocation. 10- uF ceramic input and output capacitors were selected, along with a 10-nF bypass capacitor for optimal AC performance.

Capacitor Recommendations

Low equivalent series resistance (ESR) capacitors should be used for the input, output, and bypass capacitors. Ceramic capacitors with X7R and X5R dielectrics are required. Ceramic X7R capacitors offer improved voltage and temperature coefficients, while ceramic X5R capacitors are the most cost-effective and are available in higher values.

Input and Output Capacitor Requirements

The GS1008 device high voltage linear regulator achieves stability with a minimum output capacitance of 4.7 μF and input capacitance of 1 μF; however, highly recommends to use 10 μF output and input capacitors to maximize AC performance.

Bypass Capacitor Requirements

Although a bypass capacitor (C_{BYP}) is not needed to achieve stability, highly recommends using a 10 nF bypass capacitor to maximize AC performance (including line transient, noise, and PSRR).

Transient Response

As with any regulator, increasing the size of the output capacitor reduces overshoot and undershoot magnitude but increases the duration of the transient response. The presence of the CBYP capacitor may greatly improve the line transient response of the GS1008 device.

Power Supply Recommendations

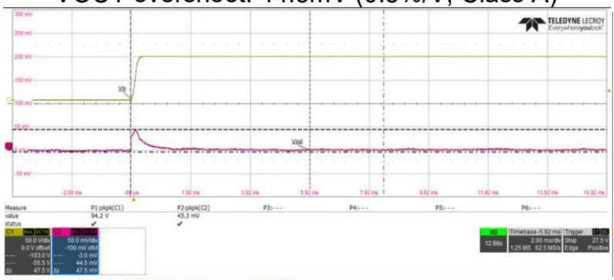
The input supply for the LDO should not exceed its recommended operating conditions (7 V to 100 V). The input voltage should provide adequate headroom for the device to have a regulated output. If the input supply is noisy, additional input capacitors with low ESR can help improve the output noise performance. The input and output supplies should also be bypassed with 10-μF capacitors located near the input and output pins. There should be no other components located between these capacitors and the pins.

Typical Device Performance

(At T_A = 25 °C)

#1. VIN L→H:

VOUT overshoot: 44.5mV (0.8%/V, Class A)



CH1: V_{IN} ; CH2: V_{OUT} (AC)

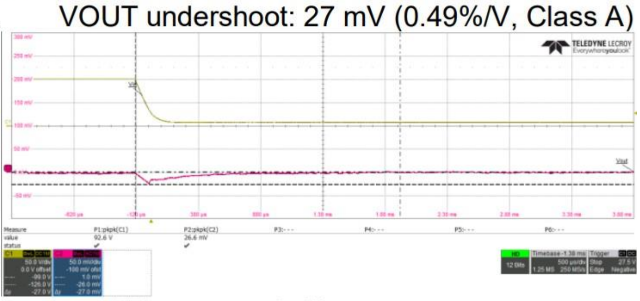
Fig1. Line Transient Response

Vin = 7 V to 100V, Rise Time = 10us

Vout = 7V, Load 1mA

#1. VIN H→L:

VOUT undershoot: 27 mV (0.49%/V, Class A)



CH1: V_{IN} ; CH2: V_{OUT} (AC)

Fig2. Line Transient Response

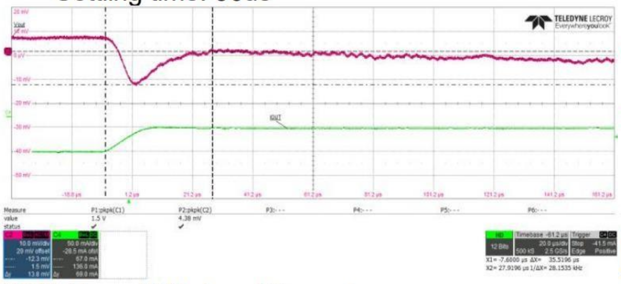
Vin = 100 V to 7V, Rise Time = 10us

Vout = 7V, Load 1mA

#1. Load L→H:

VOUT undershoot: 13.8 mV(0.25%/V, Class A)

Settling time: 36us



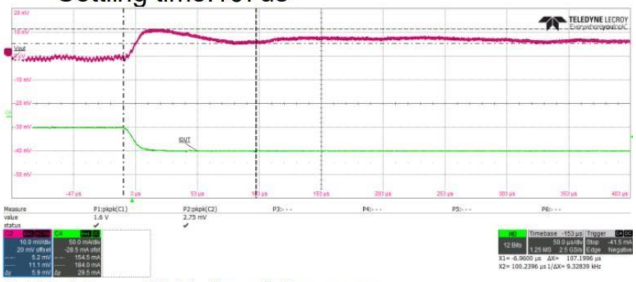
CH2: V_{OUT}; CH4: Load Current

Fig3. Load Transient Response Vin = 100V, Rise Time = 10us Vout = 7V, Load 1mA to 50mA

#1. Load H→L:

VOUT overshoot: 5.9 mV(0.1%/V, Class A)

Settling time:107us



CH2: V_{OUT}; CH4: Load Current

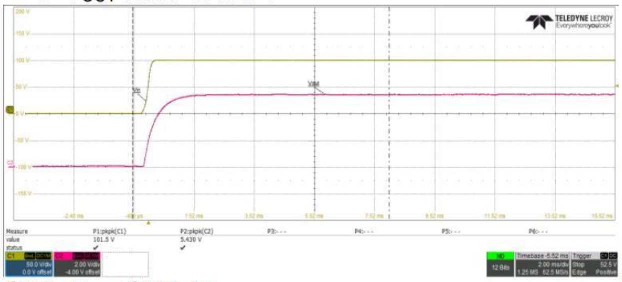
Fig4. Load Transient Response

Vin = 100V, Rise Time = 10us

Vout = 7V, Load 50mA to 1mA

#1 V_{IN}=100V, Rise Time=100us

→ V_{OUT} Max=5.430 V

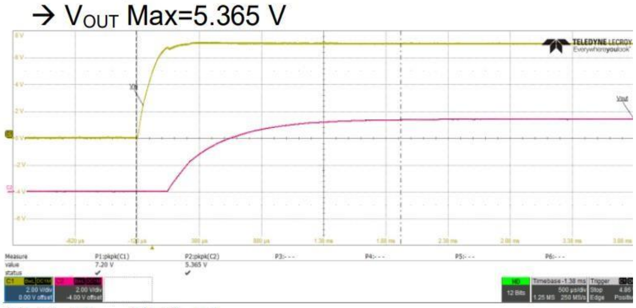


CH1: V_{IN} ; CH2: V_{OUT}

Fig5. V_{IN} Start up

#1 V_{IN}=7V, Rise Time=100us

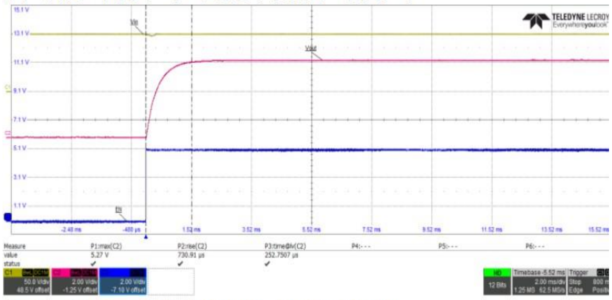
→ V_{OUT} Max=5.365 V



CH1: V_{IN} ; CH2: V_{OUT}

Fig6. V_{IN} Start up

#1 VIN=100V → VOUT max= 5.27 V

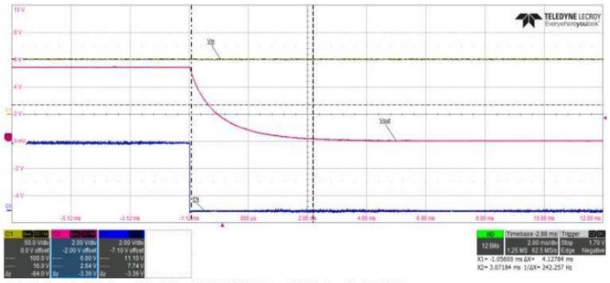


CH1: VIN; CH2: VOUT; CH3: VEN

Fig7. EN Power on

V_{IN} =100V, V_{EN}=0V → 5V (Rise Time=10us), Load =0A

#1 VIN=100V → VOUT falling time= 4.1ms



CH1: VIN; CH2: VOUT; CH3: VEN

Fig8. EN Power off

V_{IN} =100V, V_{EN}=0V → 5V (Rise Time=10us), Load =50mA

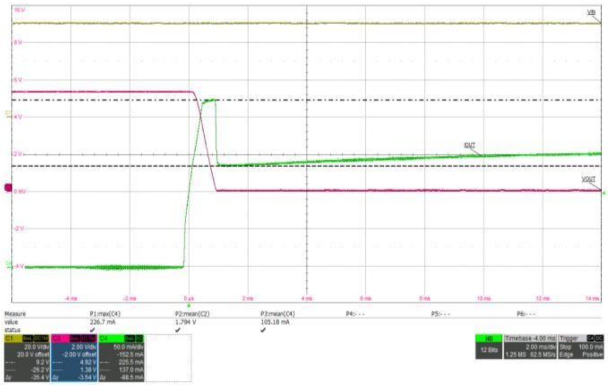


Fig9. Current Limit

Vin = 50 V, Peak current = 226mA

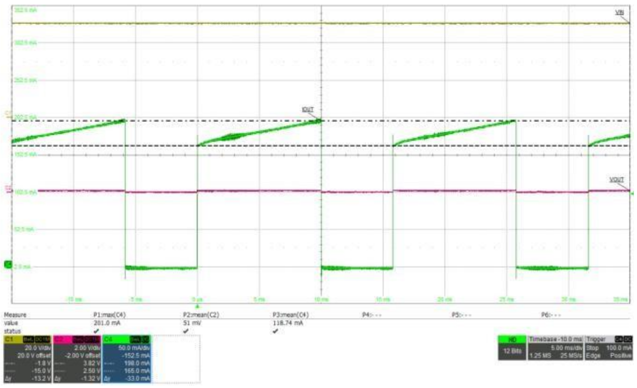
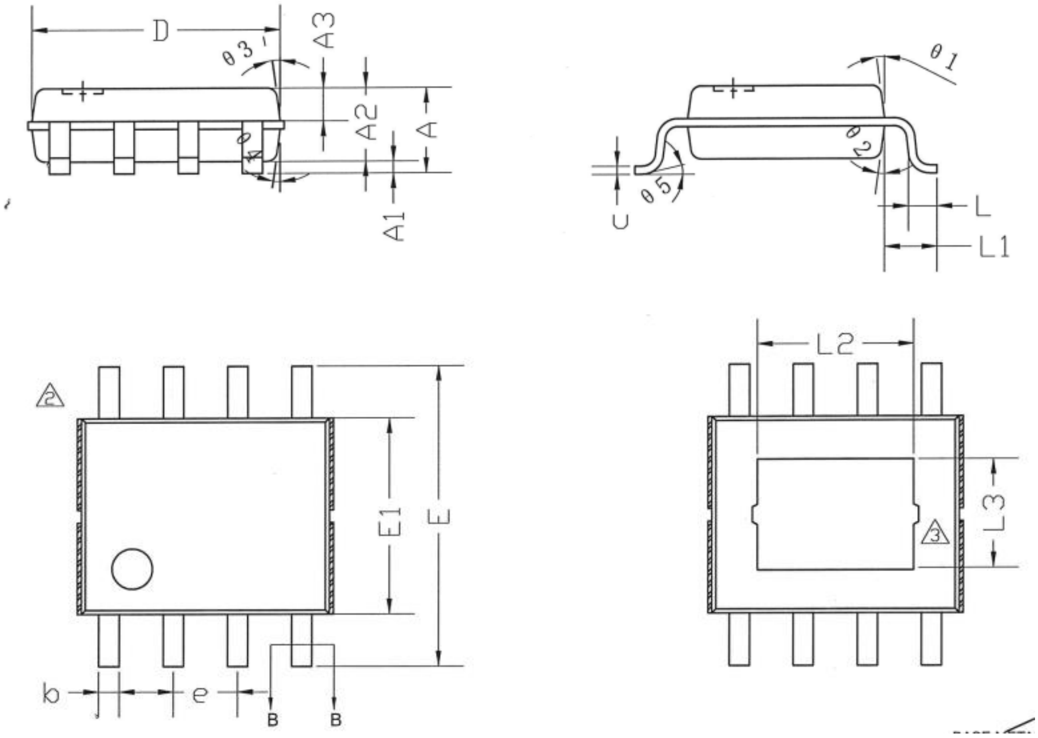


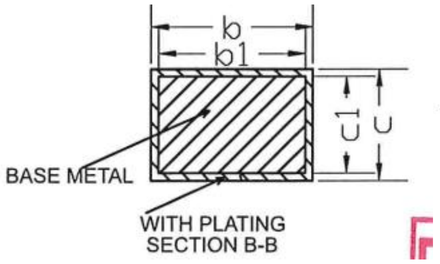
Fig10. Thermal Protection

Vin = 50 V, Peak current = 226mA, Current Limit

Package Dimensions

ESOP-8

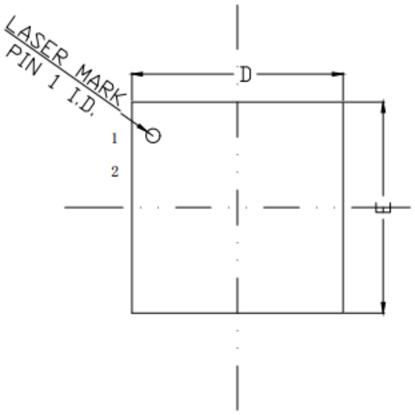




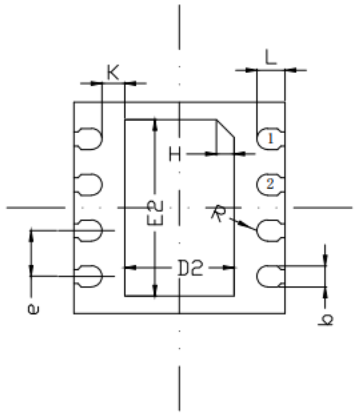
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.015	--	0.100
A2	1.40	1.42	1.50
A3	0.60	0.65	0.70
b	0.33	--	0.47
b1	0.32	0.41	0.44
c	0.20	--	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.90	6.00	6.20
E1	3.85	3.90	4.00
e	1.27(BSC)		
L	0.50	0.60	0.70
L1	1.05(BSC)		
L2	3.10(REF)		
L3	2.20(REF)		
θ1	6°	~	12°
θ2	6°	~	12°
θ3	5°	~	10°
θ4	5°	~	10°
θ5	0°	~	6°

Package Dimensions

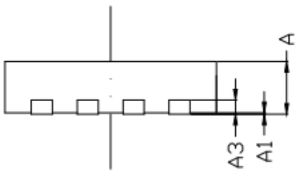
DFN3X3-8



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.20REF		
b	0.25	0.30	0.35
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.45	1.55	1.65
E2	2.40	2.50	2.60
e	0.55	0.65	0.65
H	0.25REF		
K	0.325	--	--
L	0.35	0.40	0.45
R	0.15	--	--