AC/DC·HVBUCK·Power·Switch IC

1. Feature

- Designed for HVBUCK™ high voltage step-down conversion
- Built-in patented ZeroFlux™ control technology
- Built-in smartEnergy™ energy efficiency control technology
- Internal integrated 800 V high voltage power switch
- Peak switch current can be adjusted externally
- Reliable fast peak current limiting mode of operation
- Short circuit, overload and overheat protection
- Very low standby power and extremely high conversion efficiency
- Standby power is less than 0.1 W
- Meet Energy Star energy efficiency requirements
- Available in SOP6/DIP7 high isolation package with minimal peripherals
- Rated output current capability up to 250 mA

2. Applications

- Household Appliance Controller Board Power Supply
- Air conditioner controller power supply
- Electrical Controller Power Supply
- Other Non-isolated High Voltage Step-down Power Supply Applications

3. Description

The LN8K06 is a high performance current mode intelligent power switching controller IC designed for non-isolated offline and DC to DC switching buck converters such as small appliance control board power supplies. It integrates a complete PWM/PFM hybrid control circuit, a power switch circuit with up to 800 V withstand voltage, fault detection and protection circuit, clock and delay control circuit, etc., which can be provided up to 250 mA maximum output current capability under the ultra-wide grid voltage of 85-380 Vac. Complete internal circuit design minimizes the number of external components, and requires only a few devices to implement a typical BUCK topology switching power supply design. The well-functioning multiple fault protection circuit further simplify the design of the power supply and reduce the system cost.

The built-in patented ZeroFlux™ intelligent magnetic pass zero control technology, the switch and each switching cycle turn on when the core flux is released to zero, ensuring that the core operates in a safe hysteresis loop area, thus completely eliminating the current overshoot phenomenon, greatly improving the safety of the system work.

The maximum output current capability can be easily set by the current setting pin. The circuit operates in the switching mode of the current discontinuous mode, and has extremely high conversion efficiency. According to the different requirements of the output characteristics, the circuit can be flexibly operated in different connection structures. In order to conveniently achieve a positive or negative voltage output to accommodate the different needs of driving relays or thyristor circuits.

The chip integrates a clock generation circuit with maximum time limit function, cycle-by-cycle current limit circuit with leading edge blanking, thermal shutdown circuit with hysteresis, output short circuit and overload protection and restart circuit.

Built-in new generation smartEnergy™ energy efficiency control technology, standby power as low as 0.1 W, conversion efficiency can meet ErP2013 standard, so that the whole machine can easily meet the national energy efficiency standards.

Standard green packaging for SOP6/DIP7 is available.

4. Functional Block Diagram

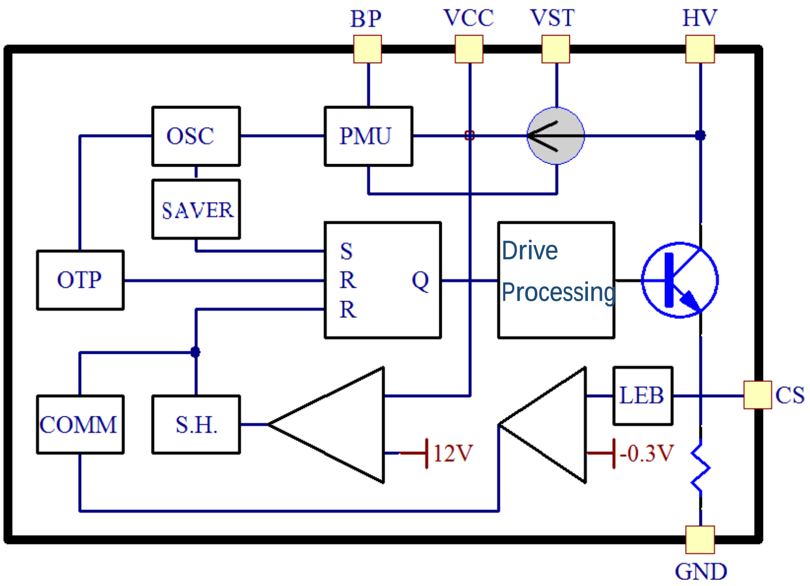

Fig1. Internal functional block diagram

5. Pin Definitions

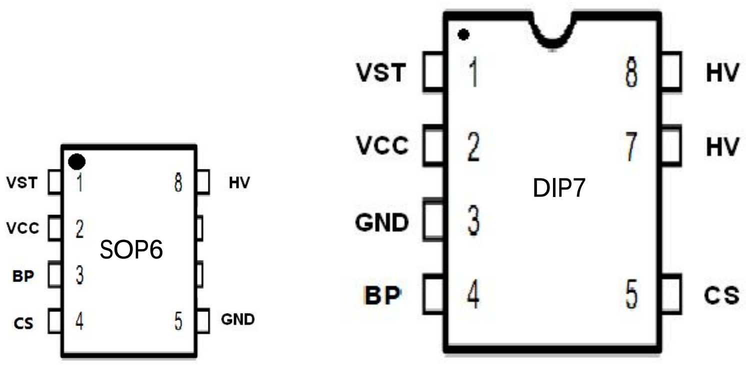

Fig2. Pin Definitions

6. Pin Function Description

PIN		Symbol	Function
DIP7	SOP6		
1	1	VST	Start trigger pin, external start resistor to input DC voltage positive
2	2	VCC	Power supply pin
3	5	GND	Ground pin
4	3	BP	Bypass capacitor pin, external bypass capacitor
5	4	CS	Extended current setting, external current limiting resistor
7,8	7,8	HV	High voltage switch pin, connected to input DC high voltage positive

7. Typical Simplified Schematic

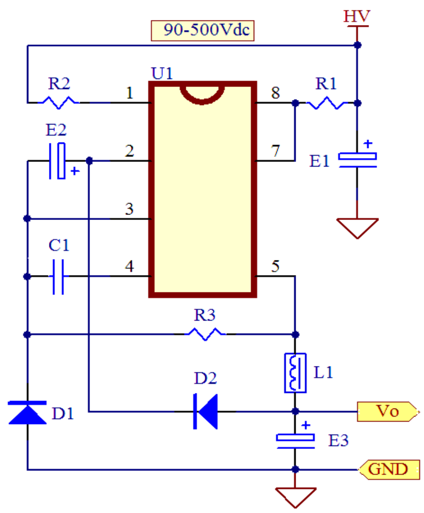

Fig3. Typical Simplified Schematic

8. Absolute Maximum Ratings

Parameter		Rating	Units
VCC pin Voltage		18	V
Other Pin Input Voltage (except HV)		-0.3 to $VCC^{+0.3}$	V
HV Pin Voltage		-0.3 to +800	V
Peak Switch Current		750	mA
PD		1200	mW
Min/Max Operating Junction Temperature T_J		-20 to +150	℃
Min/Max Storage Temperature Tstg		-55 to +150	℃
Recommended Soldering Conditions		+260 ℃,10 S	
ESD	HBM	2500	V
	MM	250	V

9. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
V_{IN}	Input DC Voltage	100	-	550	Vdc
I_{PEAK}	Peak Switching Current	-	-	600	mA
TA	Operating Ambient Temperature	-20	-	+85	℃

10. Electrical Characteristics(Ta = 25 ℃, Vcc=12 V, Rst=2.4 MΩ, C_{VCC}=22 uF, if not otherwise noted)

Power Switch Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
BV_{HV}	Max. Switching pin Voltage	V_{CC}=0 V, I_{HV}=1 mA	800	850	-	V
I_{HV}	Switch Leakage Current	HV=800 V	-	-	100	uA
V_{HVON}	Switch Forward Voltage	I_{HV}=400 mA	-	4.5	-	V
Ton	Switch on Delay	I_{HV}=400 mA	-	30	-	nS
Toff	Switch off Delay	I_{HV}=400 mA	-	300	-	nS

OSC Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
F_{OSC}	Switching Frequency		-	55	-	kHz
ΔF_{OSC}_T	F_{OSC} VS Ta	T_J=0-100	-3	-	+3	%
ΔF_{OSC}_V	F_{OSC} VS VCC	I_{HV}=0.2-0.4 A	-3	-	+3	%

PWM Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
D_{MIN}	Min. Turn-on Duty Cycle		-	1	-	%
T_{ONMAX}	Max. Turn-on Time		-	10	-	uS
T_{OFFMAX}	Min. Turn-off Time		-	16	-	uS
Gain	PWM Gain		-	3.5	-	V/V

Current Limit Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{TH}	Current Limit Threshold Voltage		285	300	315	mV
I_{LIMIT}	Peak Current Limit	R_{CS}=0.75	380	400	420	mA
T_{LEB}	Leading Edge Blanking Time		-	300	-	nS
T_{ILD}	Current Limit Delay	L=1000 uH	-	300	-	nS

Over Temperature Protection Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
t_{OTPON}	Over Temperature Protection On		130	140	150	℃
T_{OPT}	Over Temperature Protection Delay		-	500	-	nS

Power Supply Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
I_{ST}	Starting Current	VCC<8.7 V	-	15	50	UA
V_{ST}	Starting Voltage		-	8.9	-	V
V_{OFF}	VCC Undervoltage Shutdown Voltage		-	5.5	-	V
V_{OVP}	Shutdown Enable Threshold Voltage		11.4	12	12.6	V

Thermal Data

Symbol	Parameter	Rating		Unit
		SOP6	DIP7	
θ_{JA}[1]	Thermal Resistance Junction-Ambient	80	70	℃/W
θ_{JC}[2]	Thermal Resistance Junction-Case	30	20	℃/W

Notes: 1. All leads are soldered on a 200 mm^2 copper foil with 2 oz thick to measuring. 2. Measured on the surface of the package near pin 7.

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12. Application and Implementation

12.1 Start-up Section

At startup, the RST resistor triggers the internal high-voltage current source to charge the VCC capacitor. When the VCC voltage rises to 8.9 V, the power management circuit starts to work, turns on the internal reference voltage, the switching pulse triggers the power switch to turn on and the high voltage current source turns off. After normal operation, it is external (the output) supplies the required energy to VCC. Before the circuit works stable, ensure that the VCC voltage does not fall to the VCC undervoltage protection point, otherwise the circuit will enter the fault protection mode and try to start again after a certain time.

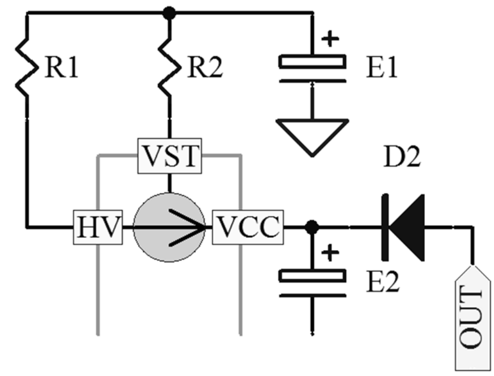


Fig4. Start-up Circuit diagram

12.2 PMW and VCC Feedback Control

The control circuit operates in current mode, and the power switch is turned on at the leading edge of each clock in the non-fault state. When the voltage generated by the peak inductor current through current limiting resistor reaches the internal current comparator threshold voltage, the switch is turned off, and the peak current is controlled by the condition for each switching cycle, thereby achieving a fixed output current. By feeding back the output voltage to VCC and comparing it to the internal reference on the VCC voltage comparator inside the chip, the current cycle is terminated when the VCC voltage reaches the voltage limit point, and the internal feedback control circuit thus establishes and maintains an error signal, which is constantly adjusted according to the error signal-like turn-off time, thereby maintaining the output voltage stable under specified load conditions. If the VCC feedback loop is disconnected, the system will continue to enter a restart state to protect the chip from damage.

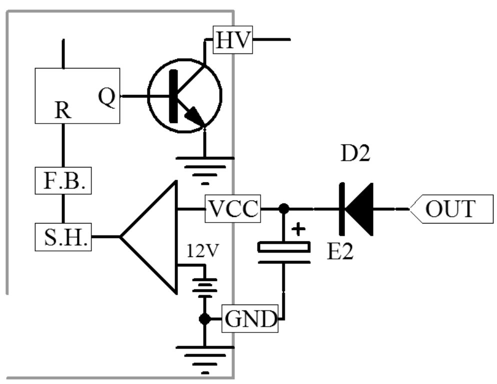


Fig5. Feedback Circuit diagram

12.3 Cycle-by-cycle Current Limit

During each turn-on cycle, the voltage developed by the sampled inductor current is compared to the internal reference voltage. If the specified value is reached, the current cycle is immediately aborted and the output shutdown state is locked until the next switching pulse comes, thereby achieving cycle-by-cycle current limiting, which is limited by the internal circuit for the maximum current during overload. The leading edge blanking circuit automatically masks the sampling circuit for 300 nS time at the beginning of each current signal to eliminate the influence of the turn-on current spike caused by the transformer turn-to-turn capacitance and the output diode reverse recovery time on the switching action detection.

12.4 VCC Undervoltage Protection

When the circuit starts, the output is automatically locked in the off state before the VCC voltage reaches 8.9 V. After the VCC reaches 8.9 V, the reference voltage is established to make the internal circuit fully work. If the VCC voltage drops to 5.5 V during operation, the undervoltage comparator operates. The output is reset to the shutdown state and the trigger circuit enters the restart mode; if the VCC voltage reaches the overvoltage comparator threshold, the current cycle is turned off and latched until the next clock pulse switch is turned back on.

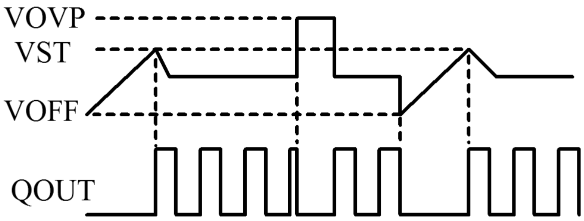


Fig6. UVLO Waveform diagram

12.5 Smart Energy Efficiency Processing

After the output load drops to a certain value, the system energy-efficiency processing circuit automatically switches the working mode to the light-load mode to improve the light load efficiency. When the output is completely empty, a small number of switching times and switching current are kept so that the system consumes only very little power.

12.6 No Noise Mode

At no-load and light-load conditions, the system operates in an advanced pulse output state, locking the output pulse train out of the human audible audio range in real time, thereby avoiding audible noise.

12.7 Over Temperature Protection

When the circuit works normally, the internal temperature detection circuit detects the core temperature of the chip in real time. If the temperature reaches the set over temperature protection threshold, the output will be turned off and locked until the VCC voltage drops below 5.5 V, and the system enters the restart mode. A typical over temperature protection threshold is 140 °C.

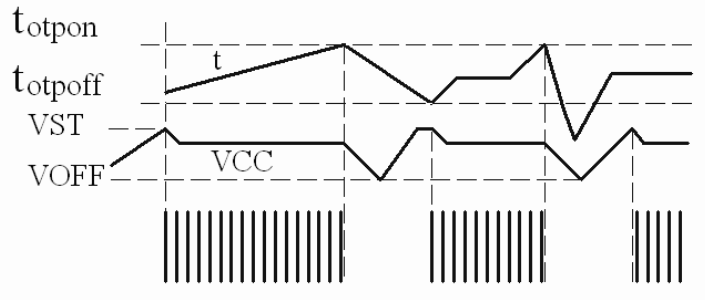


Fig7. OTP Waveform diagram

12.8 Output Overload and Short Circuit Protection

In the normal output of the system, the switch current is set by the current limiting resistor. When the output power continues to increase and tries to exceed the maximum design limit current of the system, the output voltage will start to decrease rapidly with the further increase of the output current until the VCC voltage drops to 5.5 V. The circuit enters the restart mode; when the output is shorted, it will directly cause the VCC voltage to drop rapidly to 5.5 V, and the circuit enters the restart mode.

13. Layout Guidelines

13.1 Principles of high-frequency layout

Minimize area of switched current loops. In a buck regulator there are two loops where currents are switched very fast. The first loop starts from the input capacitor, to the regulator HV pin, to the regulator VCC pin, to the inductor then out to the output capacitor and load. The second loop starts from the output capacitor ground, to the regulator GND pins, to the in ductor and then out to the load (see Fig.8).

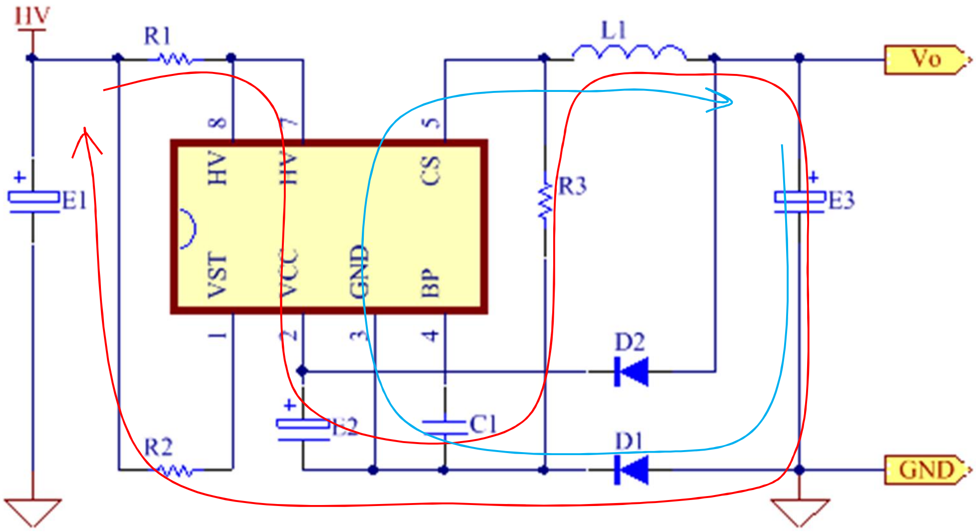


Fig8. Typical current loop diagram

13.2 Typical layout reference

An example of a typical PCB layout is shown below.

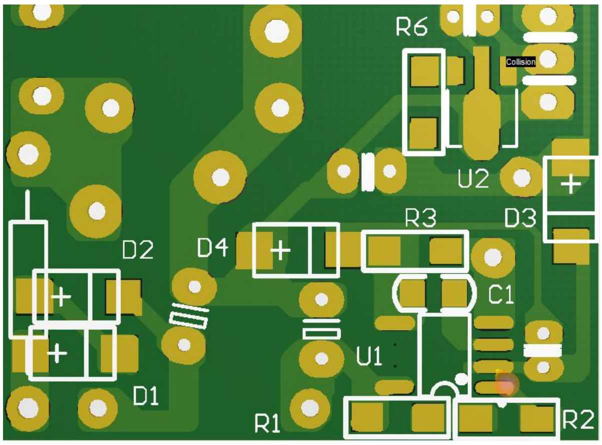


Fig9. Typical layout reference (bottom view)

14. Typical Application Circuit Schematic (input : 90~265 Vac)

Schematic 1 (SOP6)

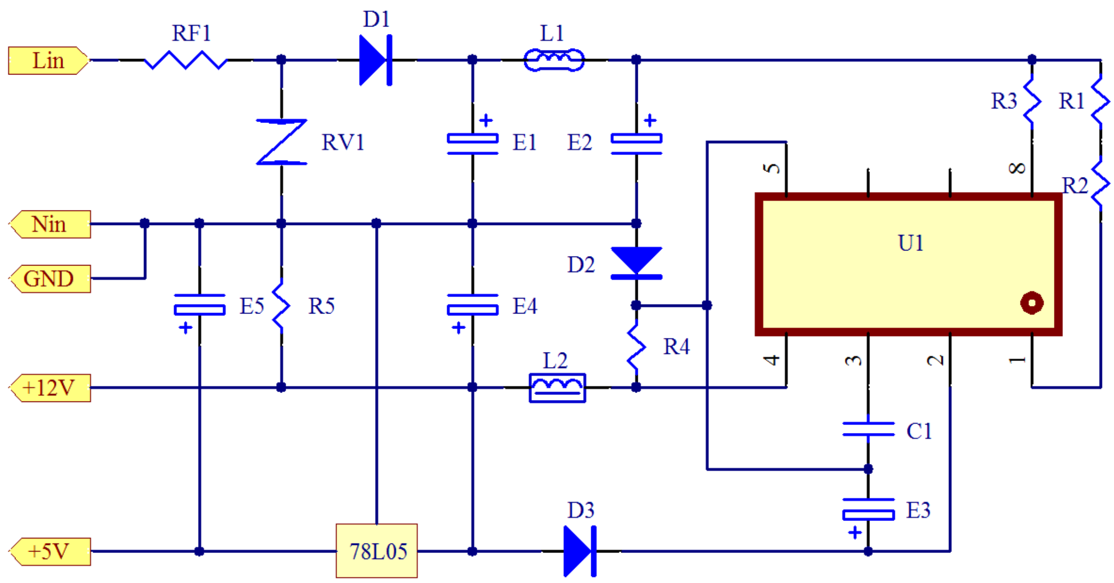


Fig10. Positive voltage output application diagram1

Schematic 2 (SOP6)

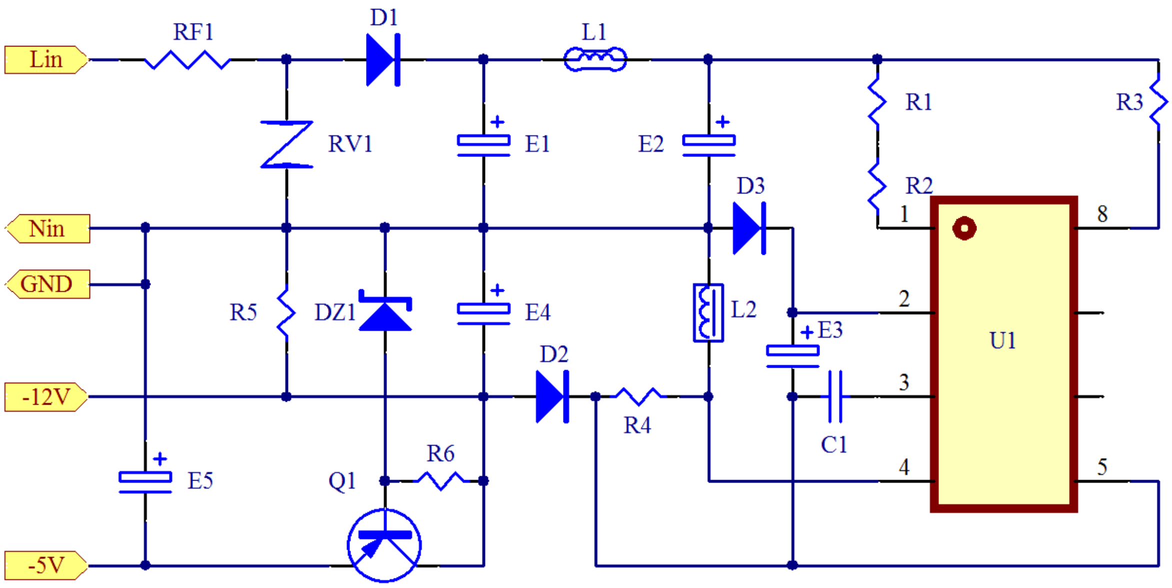
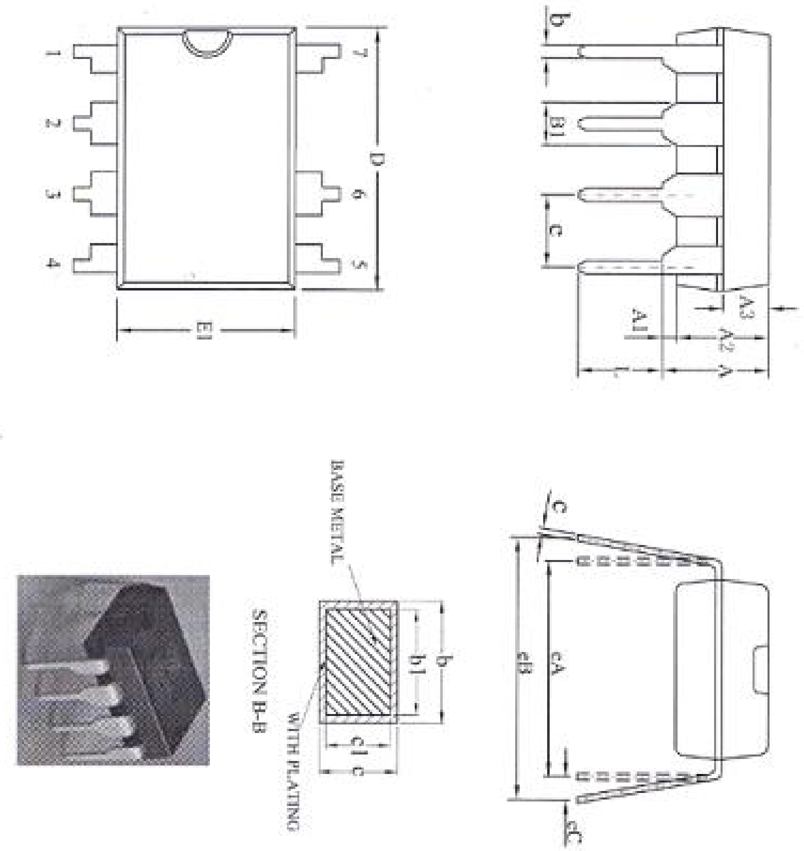


Fig11. Negative voltage output application diagram2

15. Mechanical and Packaging

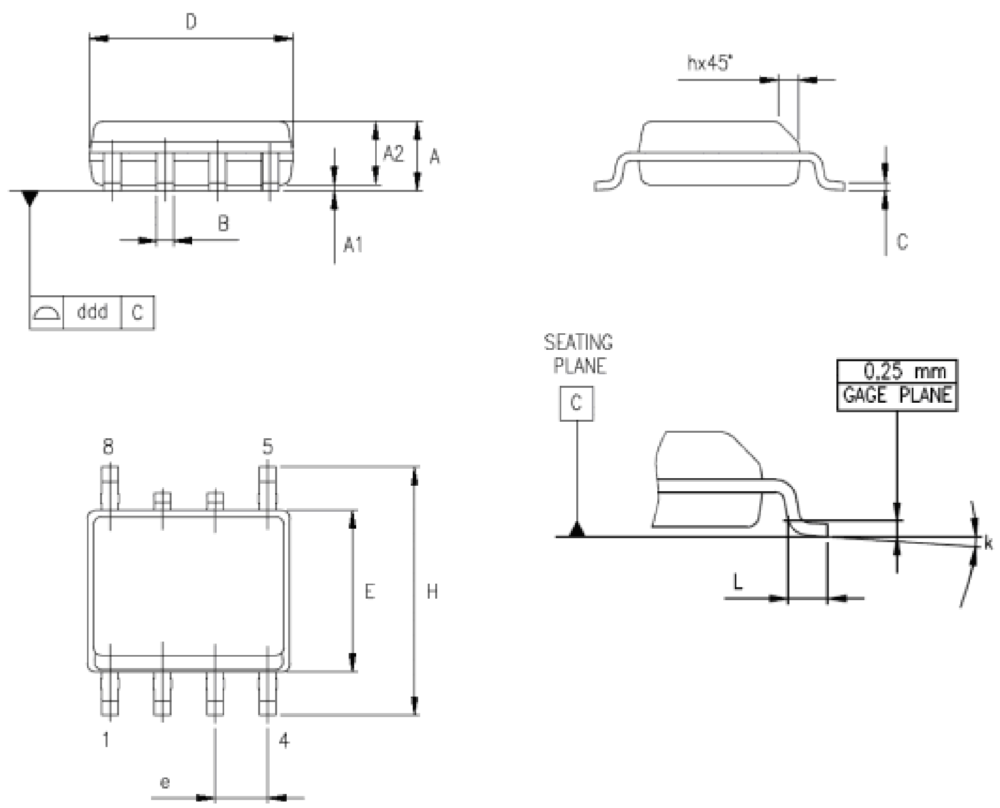
DIP7



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	3.60	3.80	4.00
A1	0.51	—	—
A2	3.20	3.30	3.40
A3	1.55	1.60	1.65
b	0.44	—	0.52
b1	0.43	0.46	0.49
B1	1.52REF		
c	0.25	—	0.29
c1	0.24	0.25	0.26
D	9.15	9.25	9.35
E1	6.25	6.35	6.45
e	2.54BSC		
eA	7.62REF		
eB	7.62	—	9.30
eC	0	—	0.84
L	3.00	—	—

Fig14. Mechanical Dimensional Drawings 1(mm)

SOP6L



Dimensions			
Ref.	Databook (mm.		
	Nom.	Min.	Max.
A	1.35		1.75
A1	0.10		0.25
A2	1.10		1.65
B	0.33		0.51
C	0.19		0.25
D	4.80		5.00
E	3.80		4.00
e		1.27	
H	5.80		6.20
h	0.25		0.50
L	0.40		1.27
k	8° (max.)		
ddd			0.1

Fig15. Mechanical Dimensional Drawings 2(mm)

16. Orderable Information

Part Number	Marking	package	Quantity per Tube
LN8K06	LN8K06 YYWWZ	DIP7	50 PCS/TUBE
LN8K06M	LN8K06 YYWWZ	SOP6	100 PCS/TUBE

17. Important Notice

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