AC/DC·HVBUCK·Power·Switch IC

1. Feature

Designed for HVBUCK™ high voltage step-down conversion

Direct feedback control 5 V output voltage

Accurate 5 V output with output voltage compensation

Internal integrated 800 V high voltage power switch

Built-in peak current limit function

Peak switch current can be extended externally

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

Available in a highly isolated SOP6/DIP7 package

Maximum output current capability up to 250 mA

2. Applications

Replaceable Capacitor Step-down to Achieve 0.5 W Standby

Household Appliance Controller Board Power Supply

Electrical Controller Power Supply

Other Non-isolated High Voltage Step-down Power Supply Applications

3. Description

The LN8K05 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 direct 5 V feedback control with output voltage compensation automatically compensates for changes in the output voltage generated by external devices when the load changes, so that the output voltage is accurately stabilized at 5 V, and the output voltage accuracy is better than 5 %.

The chip already has a built-in current limiting circuit that can be extended by an external resistor to increase the output current capability. When LN8K05 is used in an alternative RC circuit, it can eliminate the need to externally set the current. When more current is needed, the output current capability can be further extended by the external resistor. The maximum output current capability can be extended to 250 mA.

According to the different requirements of the output characteristics, the circuit can be flexibly operated in different connection structures, so that the positive voltage or the negative voltage output can be conveniently realized to meet the different requirements of driving the relay or the thyristor circuit.

The chip also has comprehensive fault protection functions such as output short circuit, overload, and overheating, which effectively improves the system security level.

The built-in proportional drive mode is combined with the energy efficiency control circuit, so that the standby power of the system can be as low as 0.1 W or less, meeting the latest energy efficiency standards of various countries.

Standard green packaging for SOP6 / DIP7 is available.

4. Functional Block Diagram

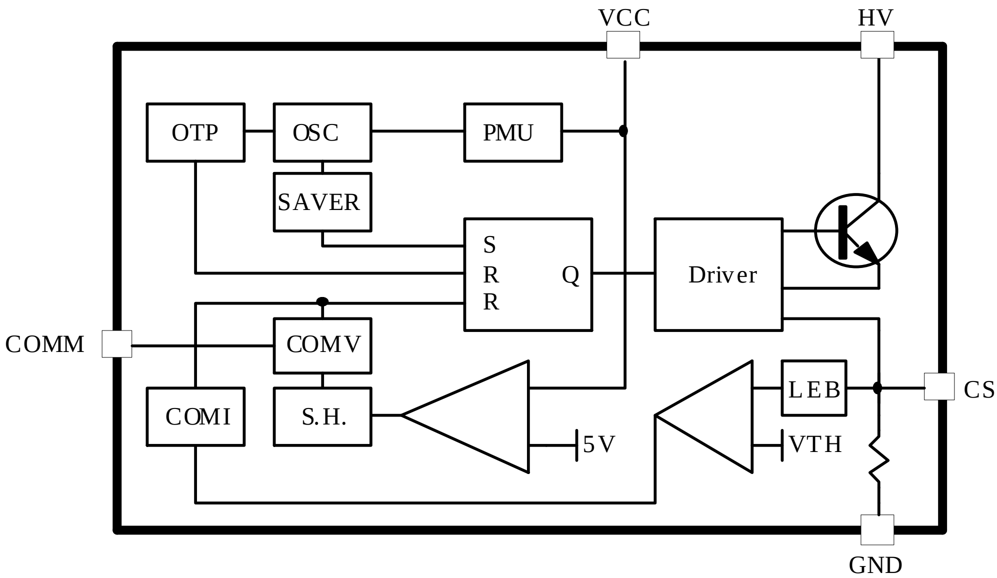

Fig1. Internal functional block diagram

5. Pin Definitions

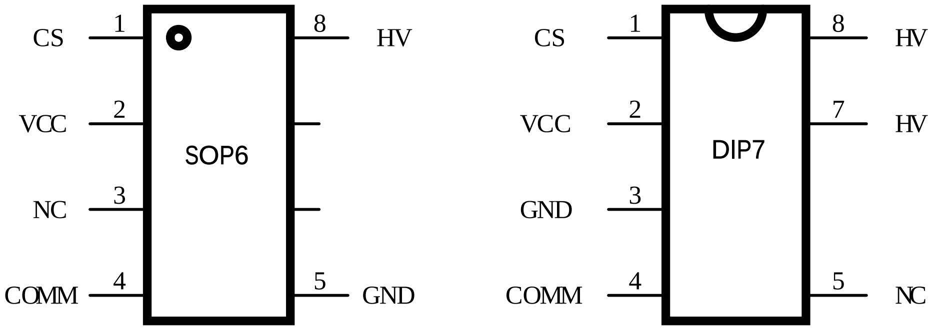

Fig2. Pin Definitions

6. Pin Function Description

PIN		Symbol	Function
DIP7	SOP6		
1	1	CS	Extended current setting, external current limiting resistor
2	2	VCC	Power supply pin
3	5	GND	Ground pin
4	4	COMM	Output voltage compensation pin, external compensation capacitor
5	3	NC	Unused, no internal connection
7,8	8	HV	High voltage switch pin, connected to input DC high voltage positive

7. Typical Simplified Schematic

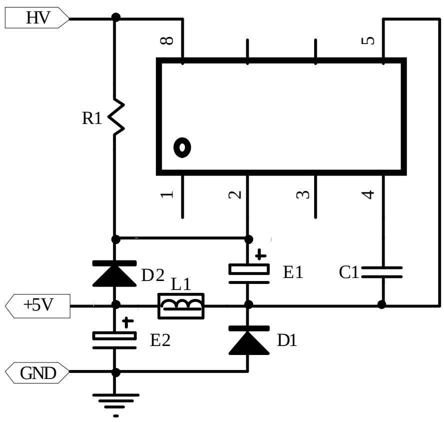

Fig3. Typical Simplified Schematic

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		600***	mA
PD		800(SOP6)/1200(DIP7)	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

Note***: Only 1 ms pulses with a period of not less than 1 s are allowed to pass.

9. Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
V_{IN}	Input DC Voltage	100	-	550	Vdc
I_{PEAK}	Peak Switching Current	-	-	400	mA
TA	Operating Ambient Temperature	-20	-	+85	℃

10. Electrical Characteristics(Ta = 25 ℃, C_{VCC}=22uF, 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}=300 mA	-	3	-	V
Ton	Switch on Delay	I_{HV}=300 mA	-	100	-	nS
Toff	Switch off Delay	I_{HV}=300 mA	-	300	-	nS

OSC Section

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
F_{OSC}	Switching Frequency		-	50	-	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
T_{ONMIN}	Min. Turn-on Time		-	1	-	uS
T_{ONMAX}	Max. Turn-on Time		-	10	-	uS
T_{OFFMAX}	Min. Turn-off Time		-	20	-	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		-	0.75	-	V
I_{CSI}	Internal Current Limit	Internal, CS=OPEN	-	200	-	mA
T_{LEB}	Leading Edge Blanking Time		-	250	-	nS
T_{ILD}	Current Limit Delay	L=800 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<6.5 V	-	5	50	UA
V_{ST}	Starting Voltage		-	7.5	-	V
I_{OP}	Operating Current	VCC=5 V, no switch	-	2	-	mA
V_{OFF}	VCC Undervoltage Shutdown Voltage		-	3.5	-	V
V_{OVP}	Shutdown Enable Threshold Voltage		4.5	5	5.5	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 internal high-voltage current source charges the VCC capacitor. When the VCC voltage rises to 7.5 V, the power management circuit starts to work, turns on the internal reference voltage, and pulse is triggered to turn the power switch on when the voltage drops to 5 V. 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.

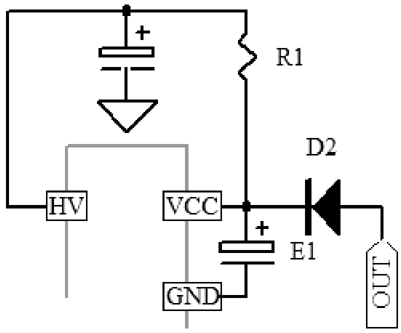


Fig4. Start-up Circuit diagram

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 (typical value is 5 V) 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.

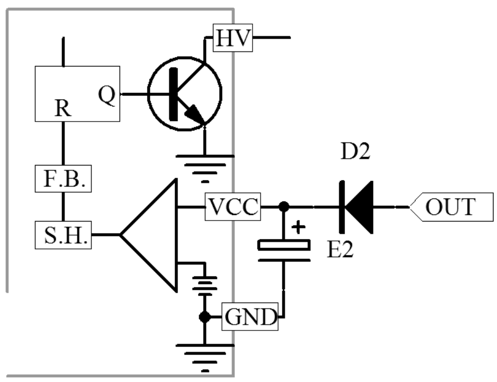


Fig5. Feedback Circuit diagram

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 Switch Current Regulation

The system switch current can be externally extended through the CS pin. Simply connect a resistor between the CS pin of the chip and the GND pin of the chip. The minimum external current-limiting resistor structure allowed to be used is 3.6 Ω.

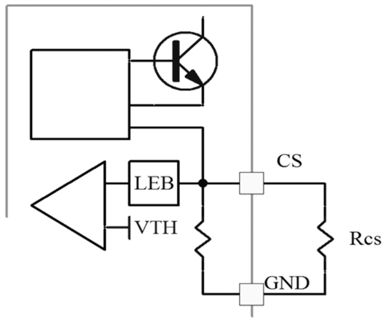


Fig6. Switch Current Regulation Circuit diagram

The relationship between the output current and the external limit resistor is:

$$I_{OUT} \approx (\frac{V_{TH}}{R_{CS}} + I_{CSI}) \div 2$$

V_{TH} is the current limit threshold, typically 0.75 V; I_{CSI} is the internal limiting current, typically 0.2 A.

12.5 VCC Undervoltage Protection

When the circuit starts, the output is automatically locked in the off state before the VCC voltage reaches 7.5 V. After the VCC reaches 7.5 V, the reference voltage is established to make the internal circuit fully work. If the VCC voltage drops to 3.5 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.

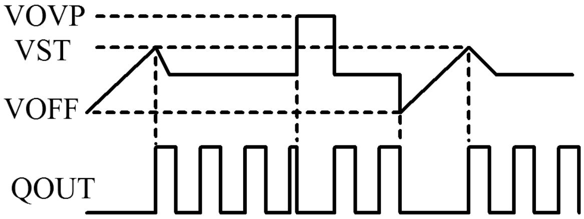


Fig7. UVLO Waveform diagram

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.

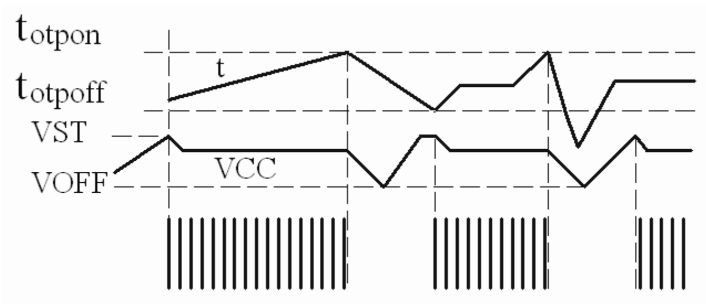


Fig8. OTP Waveform diagram

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 3.5 V. The circuit enters the restart mode; when the output is shorted, it will directly cause the VCC voltage to drop rapidly to 3.5 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.9).

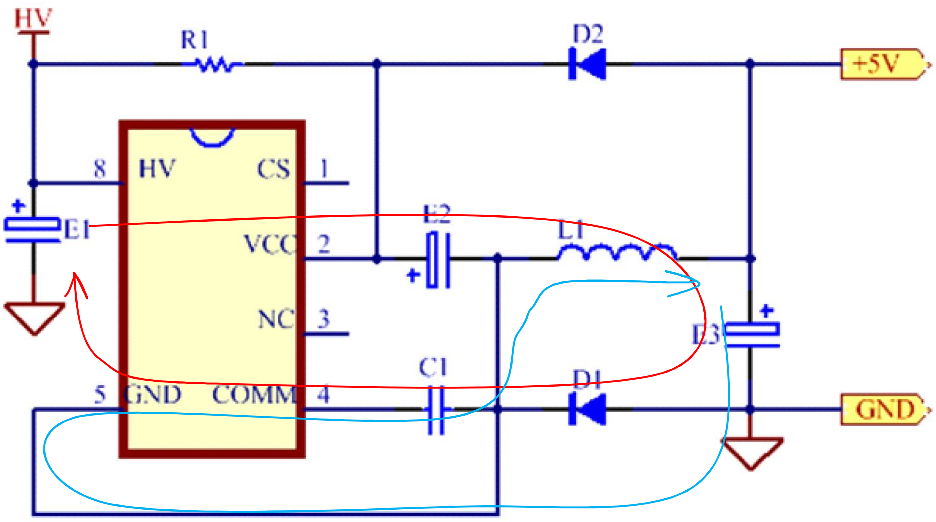


Fig9. Typical current loop diagram

13.2 Typical layout reference

An example of a typical PCB layout is shown below.

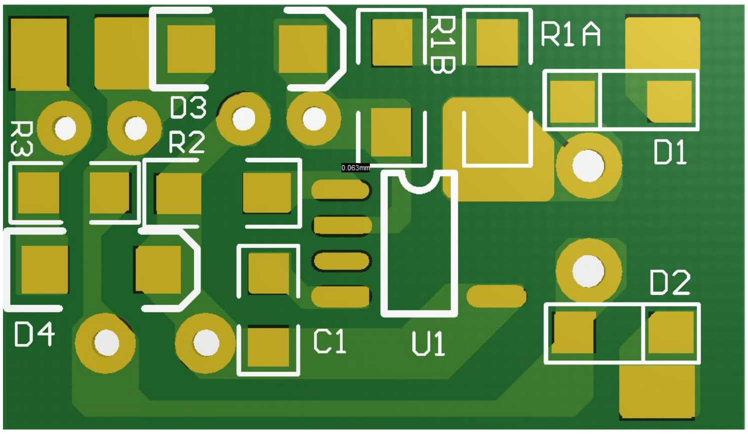


Fig10. Typical layout reference (bottom view)

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

Schematic 1 (SOP6)

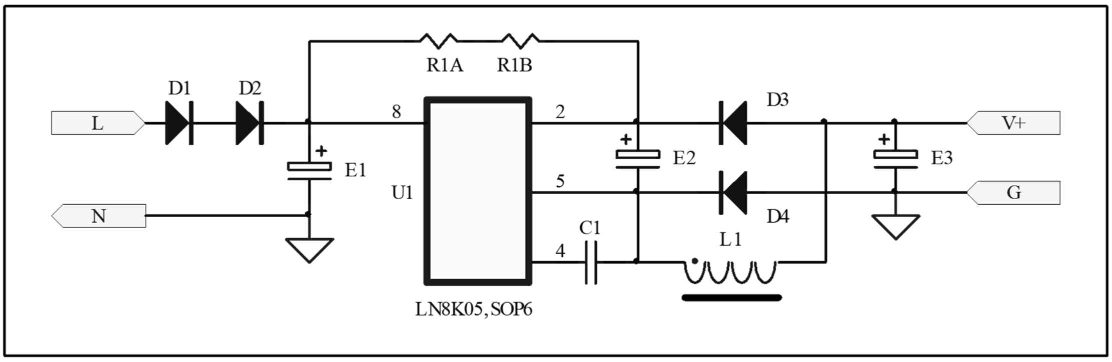


Fig11. Positive voltage output application diagram1

Schematic 2 (SOP6)

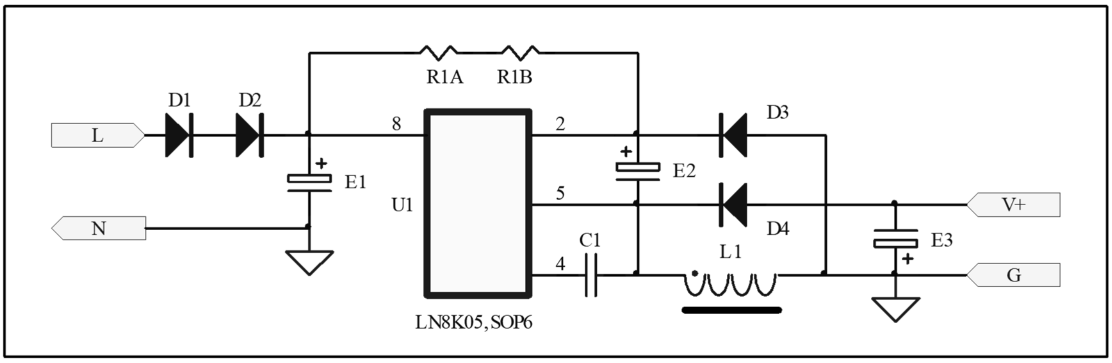


Fig12. Negative voltage output application diagram2

Schematic 3 (SOP6)

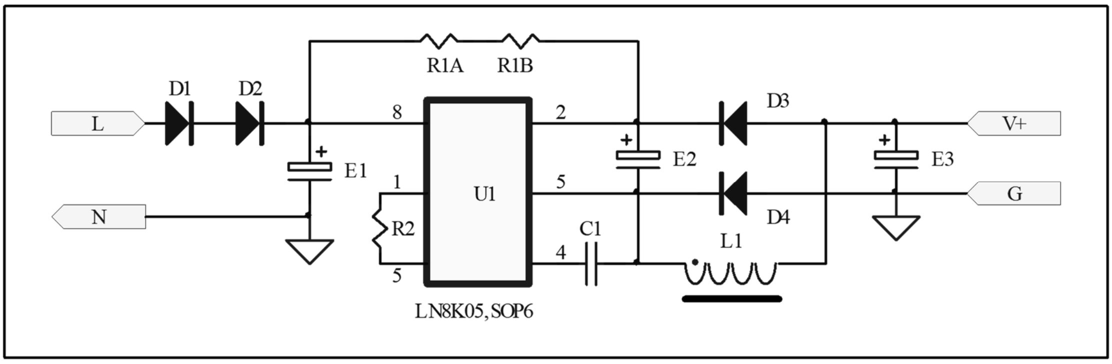
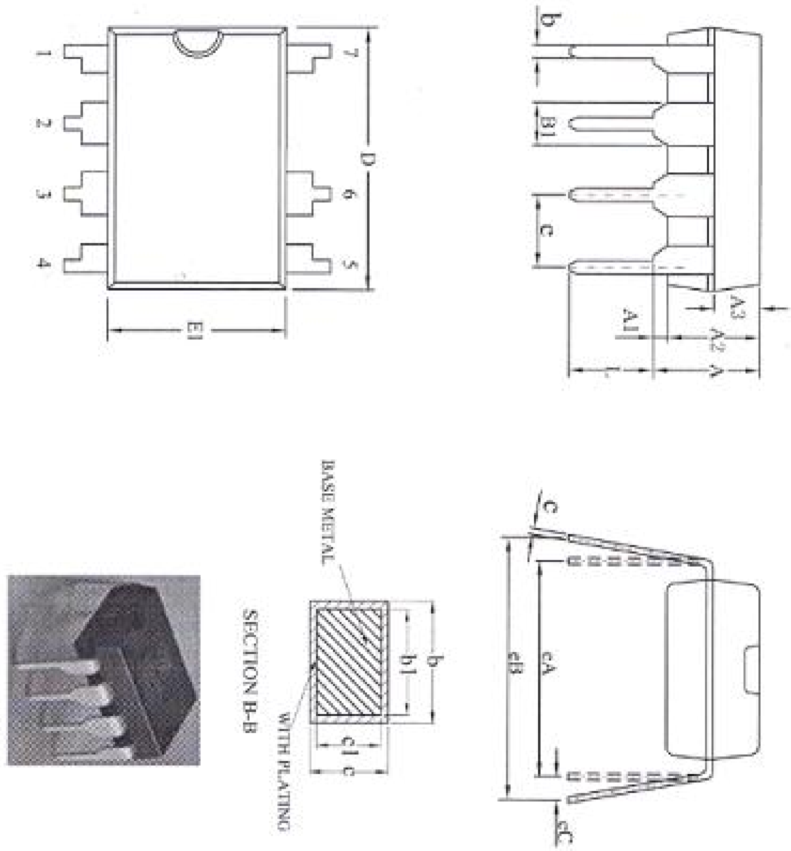


Fig13. Positive voltage output application diagram3

15. Mechanical and Packaging

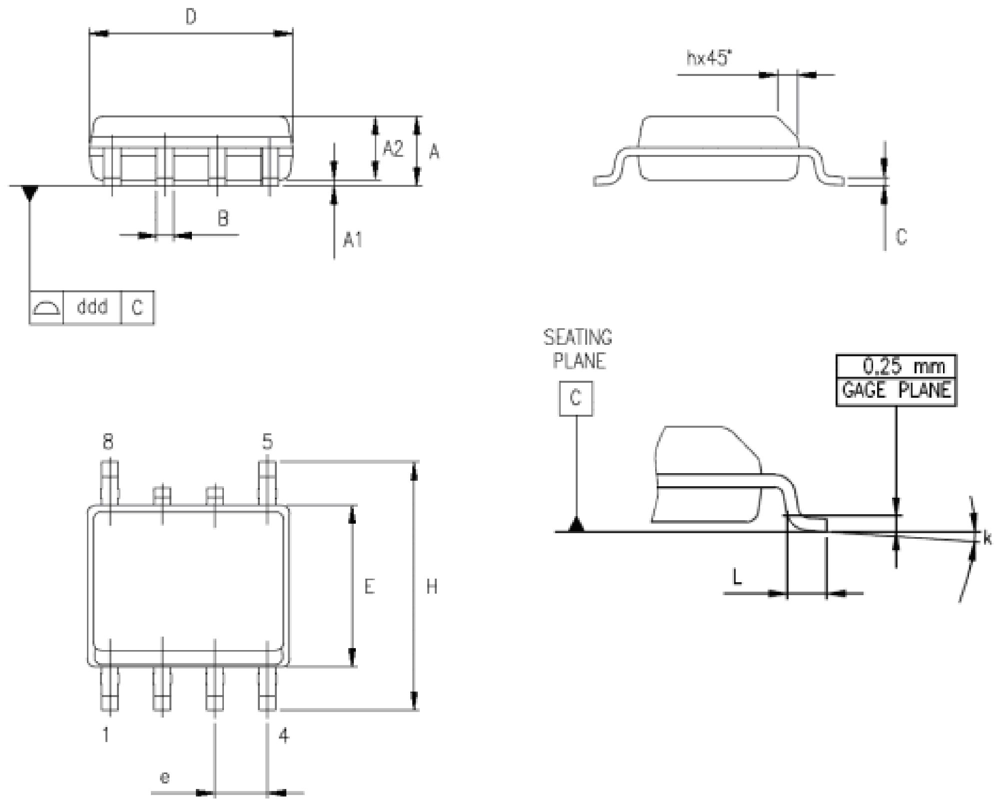
DIP7



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
LN8K05	LN8K05 YYWWZ	DIP7	50 PCS/TUBE
LN8K05M	LN8K05 YYWWZ	SOP6	100 PCS/TUBE

17. Important Notice

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