



Highly Integrated Low Standby Power CV Converter

Description

The LKS620 is an ultra-low standby power non-isolated buck converter for constant output voltage application. The device is suitable for 20Vdc*~265Vac universal input non-isolated auxiliary power supply.

* Limited by D_{max} , when $V_{in} < 30V_{dc}$, V_o may be below 15V.

When $V_{in} = 20V_{dc}$, V_o typical value: about 13V, V_o minimum value: about 10V.

The LKS620 integrates a 500V high voltage power MOSFET and a free wheel diode. With the proprietary output voltage and current control technique, it can get excellent CV regulation. The chip integrates smart high voltage startup and power supply circuit, so the auxiliary winding can be eliminated.

The LKS620 utilizes PWM & PFM multiple mode control, from the output voltage through the internal power supply diode to power the VCC, which contribute to very low standby power, high efficiency and reduced audible noise.

The LKS620 is available in a SOP-8 package.



SOP-8 package

Features

- Standby power <20mW at 120Vac and 230Vac
- Fixed 15V output voltage
- Internal 500 V Power MOSFET
- Integrated HV startup
- Reduced audible noise
- Jittering techniques to improve EMI
- $\pm 5\%$ output CV accuracy
- Integrated soft startup function
- Protective function
 - Overload protection
 - Output short protection
 - Overtemperature protection
 - Cycle-by-cycle current limiting

Applications

- Auxiliary power

Applications

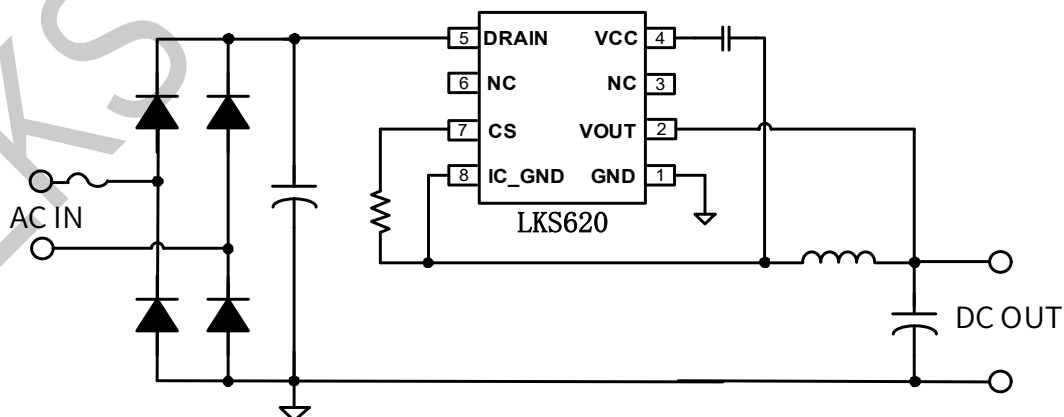


Figure 1 Typical application of LKS620



LKS620

Highly Integrated Low Standby Power CV Converter

Ordering Information

Part Number	Package	Packing Method	Marking
LKS620	SOP-8	Tape 4,000pcs/reel	LKS LKS620 YYWW

Pin Configuration and Marking Information

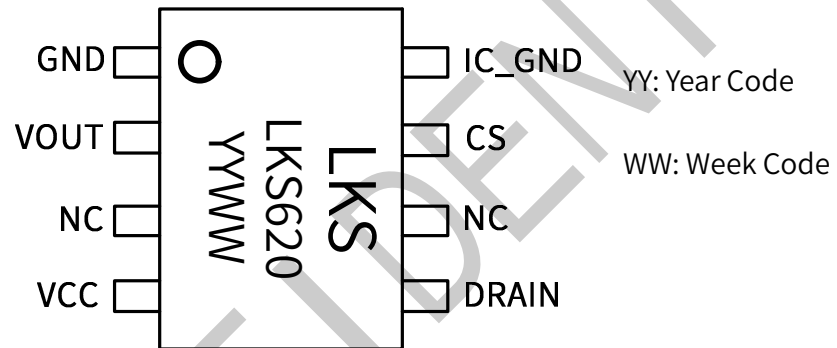


Figure 2. Pin configuration

Pin Functions

Pin NO.	Pin Name	Descriptive
1	GND	Output Voltage Reference Ground
2	VOUT	Output Voltage Pin
3,6	NC	Not Connect
4	VCC	Power Supply Pin
5	DRAIN	Drain of the integrated HV MOSFET
7	CS	Current Sense Pin. Connect a resistor to GND to sense the MOS current.
8	IC_GND	Chip Reference Ground



Highly Integrated Low Standby Power CV Converter

Absolute Maximum Ratings (Note 1) ($T_A=25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameters	Range	Unit
V_{DS}	Internal HV MOSFET drain to source voltage	-0.3~500	V
VCC	VCC Voltage limitation	-0.3~28	V
I_{CC_MAX}	Vcc pin sink current limitation	5	mA
CS	CS pin voltage limitation	0.3~6	V
GND	Output voltage reference ground (relative to IC_GND)	-650~+0.3	V
VOUT	Output voltage pin (relative to GND)	-0.3~28	V
P_{DMAX}	Power dissipation (note 2)	0.45	W
θ_{JA}	Thermal resistance of PN junction to Ambient	145	$^{\circ}\text{C/W}$
T_J	Operating junction temperature range	-40 to 150	$^{\circ}\text{C}$
T_{STG}	Storage temperature range	-55 to 150	$^{\circ}\text{C}$

Note 1: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. Unless otherwise noted, voltage values are referenced to IC_GND. The electrical characteristics table defines the operation range of the device, the electrical characteristics is assured on DC and AC voltage by test program. For the parameters without minimum and maximum value in the EC table, the typical value defines the operation range, the accuracy is not guaranteed by spec.

Note 2: The maximum power dissipation decrease if temperature rise, it is decided by T_{JMAX} , θ_{JA} , and environment temperature (T_A). The maximum power dissipation is the lower one between $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ and the number listed in the maximum table.

Max Output Current Capability

Output Current	Test conditions	Range	Unit
Continuous Output Current	Input Voltage: 85Vac-265Vac	240	mA
Pulse Output Current	Pulse current: duration < 60s, duty cycle < 10%	350	mA
IC Peak Current	Internal MOSFET limits maximum current	750	mA

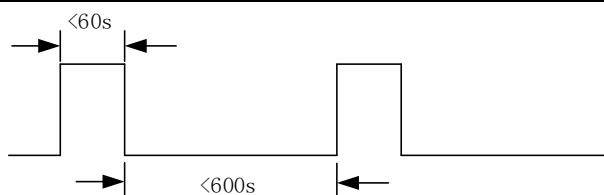


Figure. 3 Pulse current waveform



Highly Integrated Low Standby Power CV Converter

Electrical Characteristics (Notes 3, 4) (Unless otherwise specified, $T_A=25^{\circ}\text{C}$)

Symbol	Parameter	Condition	Min	Typ	Max	Units
Supply voltage						
V_{CC}	VCC Voltage		14.5	15	15.5	V
V_{CC_ON}	VCC Turn On voltage	Rising		11		V
V_{CC_OFF}	VCC Turn Off voltage	Falling		7.5		V
V_{CC_HYS}	VCC Voltage Hysteresis			3.5		V
V_{CC_CHRG}	JFET Charge On Voltage	Falling		8		V
V_{CLAMP}	VCC Clamp Voltage	$I_{CLAMP}=2\text{mA}$		27		V
V_{CC_OLP}	VCC Over Load Protection voltage			12		V
I_{OP}	VCC Operating Current	$V_{DRAIN}=40\text{V}$		200	300	μA
I_{CC}	VCC Startup Current			2		mA
Oscillator						
F_{OSC_MAX}	Maximum Switching Frequency		54	60	66	kHz
D_{MAX}	Maximum Duty Cycle			64		%
Current Sensing						
V_{CS_TH}	Current Sense Threshold			200		mV
T_{LEB}	Lead Edge Blanking Time			250		ns
T_{ILD}	Switch Off Delay Time			100		ns
Power MOSFET						
R_{DS_ON}	On-State Resistance	$V_{out}=15\text{V}/I_{DS}=50\text{mA}$		9		Ω
I_{DSS}	MOSFET Turn Off Drain Leakage Current	$V_{CC}=15\text{V}/V_{DS}=500\text{V}$			30	μA
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS}=0\text{V}/I_{DS}=250\mu\text{A}$	500			V
V_{DS_SUP}	Drain Supply Voltage		20			V
Free Wheel Diode						
V_{BR1}	Diode Breakdown Voltage	$I_R=5\mu\text{A}$	600			V
V_{F1}	Forward Voltage Drop	$I_F=300\text{mA}$			1.7	V
$I_{F_{AV1}}$	Maximum Average On-State Current		300			mA
T_{RR}	Reverse Recovery Time	$I_F=300\text{mA}/I_R=600\text{mA}$ $I_{RR}=150\text{mA}$			35	ns
VCC Power Supply Diode						
V_{BR2}	Diode Breakdown Voltage	$I_R=5\mu\text{A}$	600			V
V_{F2}	Forward Voltage Drop	$I_F=100\text{mA}$			1.7	V
$I_{F_{AV2}}$	Maximum Average On-State Current		100			mA
Thermal Shutdown						
T_{SD}	Thermal shutdown temperature			150		$^{\circ}\text{C}$
T_{SD_HYS}	Thermal shutdown Hysteresis			40		$^{\circ}\text{C}$

Note 3: production testing of the chip is performed at 25°C .

Note 4: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis



Highly Integrated Low Standby Power CV Converter

Internal Structure Block Diagram

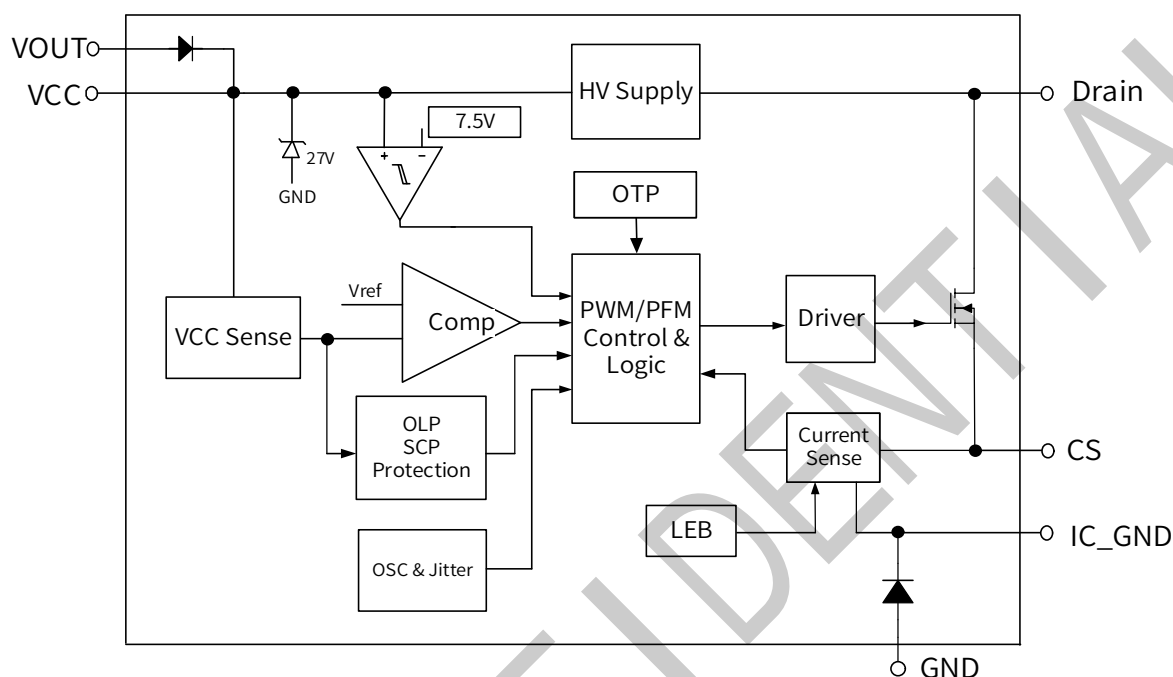


Figure 4. LKS620 internal block diagram

Application Information

The LKS620 is an ultra-low standby power non-isolated Buck converter for CV application. The LKS620 works in multiple control mode providing high accurate constant voltage control. The device integrates a 500V High Voltage power MOSFET, an output voltage sampling resistor, and a free wheel diode, so the BOM of the application is very simple. It is suitable for small auxiliary power application.

Start Up

After system is powered on, the VCC capacitor is charged up by the internal HV startup circuit directly. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The LKS620 integrates a 27V Zener diode inside to clamp the VCC voltage. At

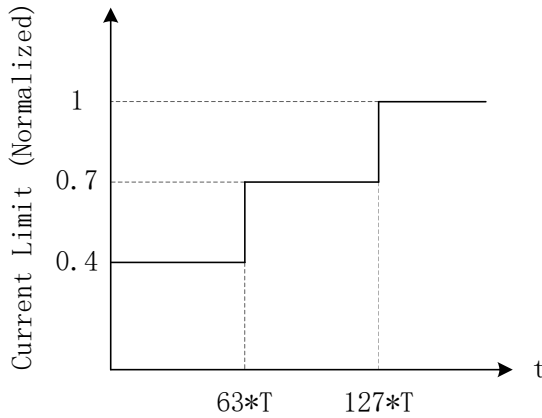
normal operation, the VCC is powered directly from output voltage. So the standby power is very low, and the auxiliary winding is not needed to supply the IC.

Soft Start

The LKS620 integrates a soft-start function. During the soft-start mode, the peak current of the power MOSFET increases to I_{limit} step by step, which can decrease the stress of switching MOSFET, and the soft-start function occurs at each startup period.



Highly Integrated Low Standby Power CV Converter



Inductor Selection

LKS620 can work in kinds of modes such as Continuous Conduction Mode (CCM) or Discontinuous Conduction Mode (DCM), some parameters of inductor should be considered such as inductance, peak current, and average current. It is determined finally by the price, the size, and the system efficiency. Normally, choosing the smaller inductance can achieve better price, smaller size, and better dynamic response. However, it will cause larger peak current and lower system efficiency. Oppositely, larger inductance can cause higher system efficiency, smaller output ripple and worse dynamic response, it also needs larger size inductor. As overall consideration, suggesting to use CCM mode for this case, using the current ripple coefficient r no less than 25%, due to input and output voltage, system frequency, full load current, and ΔI_L , The inductance can be calculated as:

$$L = \frac{V_{out} \times (V_{IN} - V_{out})}{V_{IN} \times F \times \Delta I_L}$$

Where,

$$\Delta I_L = I_{out} * r$$

Peak Current

According to current ripple coefficient r , peak current can be calculated as:

$$I_{L_PEAK} = I_{O_MAX} + \frac{\Delta I_L}{2}$$

$$I_{L_VALLY} = I_{O_MAX} - \frac{\Delta I_L}{2}$$

Where, I_{L_peak} is the peak current of the inductor. The max load current is also calculated by I_{limit} .

Sense Resistor Selection

LKS620 can setting the peak induction current by sense resistor. Different MOSFET has different peak current limitation. The value of R_{CS} also needs to consider the load current and its ripple, and leave some margin.

The R_{CS} can be calculated by:

$$R_{CS} = \frac{220 \text{ (mV)}}{I_{limit} \text{ (mA)}}$$

Please note the CS voltage limit is a little higher than 200mV threshold due to the comparator delay.

Bus CAP

The Bulk cap is used as a filter. As the input current is discontinuous, it needs Bulk cap to absorb the input AC current and provide a stable input voltage. Meanwhile, the bulk cap needs to sustain enough current ripple. The RMS of input current is calculated as:

$$I_{IN_RMS} = I_{O_MAX} \times \sqrt{D \times (1 - D)}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

To decrease the input noise, suggesting that the input

Bulk cap uses low ESR electrolytic cap.

Output CAP

Output cap is used as a filter for output voltage, it also supplies current to the output load. If the output current is stable, the output ripple is mainly caused by the ESR and capacitance:

$$V_{RIPPLE} = V_{RIPPLE_ESR} + V_{RIPPLE_C}$$



Highly Integrated Low Standby Power CV Converter

When the output cap is used with ceramic cap, the output ripple is mainly caused by capacitance. Ignoring ESR, the output ripple calculation can be simplified as:

$$V_{RIPPLE_C} = \frac{\Delta I_L}{8 \times C_{OUT} \times f_{SW}}$$

When the output cap is used with Tantalum cap or electrolytic cap, the output ripple is mainly caused by ESR. The output ripple calculation can be simplified as:

$$V_{RIPPLE_ESR} = \Delta I_L \times ESR$$

Dummy Load Selection

The dummy load in the system is to prevent the output voltage from drifting high at no load or light load. Dummy load resistance value is too large will lead to no-load output voltage drift high, while the resistance value is too small will affect the actual load carrying capacity, but also will increase the standby power of the system. Therefore, it is necessary to reasonably set dummy load resistance value, which is recommended to be 22kΩ.

Multi-Mode Control

The LKS620 utilizes multiple mode control of PWM & PFM, which contribute to high efficiency at light load and full load, speedup the dynamic response and reduce audible noise.

Over-Load and Short-Circuit Protection

In the event of a fault condition such as output overload, output short-circuit, the LKS620 enters into auto-restart operation. When the VCC voltage is lower than the setting threshold over about 160ms, the over-load/short protection occurs. During the protection station, the internal oscillator counts a 2s fixed time, if the error is

removed, the system will work normally again; If not, the fault mode keeps on.

Other Protection Functions

LKS620 also integrates several other protection functions, such as over temperature protection and cycle by cycle current limitation.

PCB Design

The following rules should be followed in LKS620 PCB layout:

Bypass Capacitor

The bypass capacitor for VCC needs to be immediately adjacent to the chip VCC and IC_GND pins.

Increase the alignment width of the IC_GND and GND pins to improve chip heat dissipation.

The alignment between the IC_GND output inductors of the chip should be short and thick to prevent the formation of a transmitting antenna affecting EMI radiation.

Area of the Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the bus capacitor, the IC Drain, Rcs and GND, the inductor and the output cap loop; And the inductor, the output cap and the output diode loop.

DRAIN

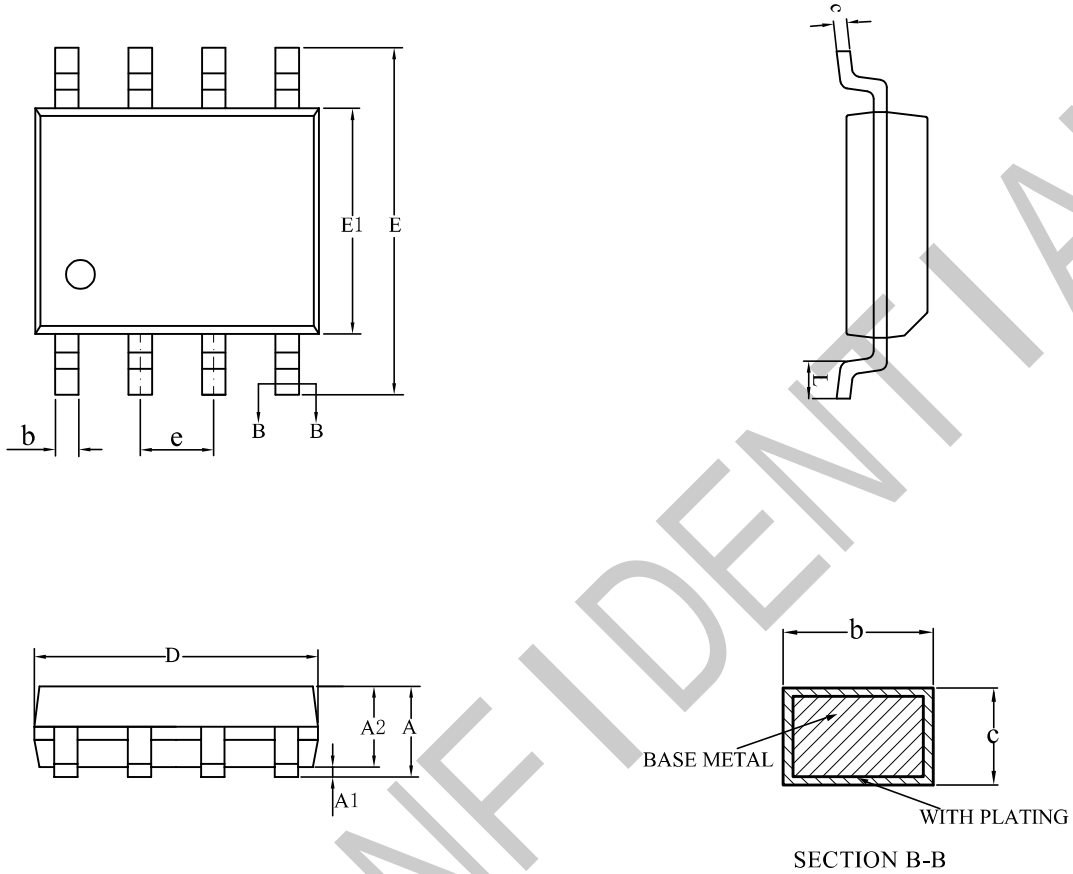
To increase the copper area of DRAIN pin for better thermal dissipation.



LKS620

Highly Integrated Low Standby Power CV Converter

Package Information



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.30	—	1.80
A1	0.05	—	0.25
A2	1.25	1.40	1.65
b	0.33	—	0.51
c	0.17	—	0.25
D	4.70	4.90	5.10
E	5.80	6.00	6.30
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.40	—	1.00

Version Information



LKS620

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Revision	Date	Notes

LKS CONFIDENTIAL



Highly Integrated Low Standby Power CV Converter

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Electronic device scrap description

After the end of its life cycle, the product is processed by the customer in accordance with the scrap process of general electronic products.

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