Isolated Primary Side Feedback Single-stage Active PFC LED Driver IC

Description

D80644 is a single-stage, with the active power factor correction, high-precision primary side feedback LED constant current control IC, which can be applied to 85Vac-265Vac universal input voltage flyback isolated or boost non-isolated LED constant current power. D80644 integrates active power factor correction circuit, which can achieve high power factor and low total harmonic distortion. Due to operating in inductor current critical continuous mode, power MOSFET is at zero current turn on condition, the switching loss can be reduced, while the utilization of transformer can be increased.

D80644 uses an advanced current sampling system, operating in the primary feedback mode, can achieve high precision output constant current control without secondary feedback circuit. D80644 integrate 600V power MOSFET, need only a few external devices, so it saves the cost and bulk, also improve the system reliability.

D80644 use the advanced line voltage and load compensation technology, which can achieve excellent line voltage regulation rate and load voltage regulation rate. Moreover, line voltage compensation factor can also be flexible adjust by the external device.

D80644 is built-in multi-protection functions, to increase the system reliability. It concludes LED open circuit protection, LED short circuit protection, chip power supply over voltage protection, under voltage protection, open circuit protection of current sampling resistor, by-cycle current limiting. All protection status has the automatic reboot function. In addition, D80644 has the function of intelligent temperature regulation, which can reduce the output current when the power driver is overheat, so as to improve the reliability of the system.

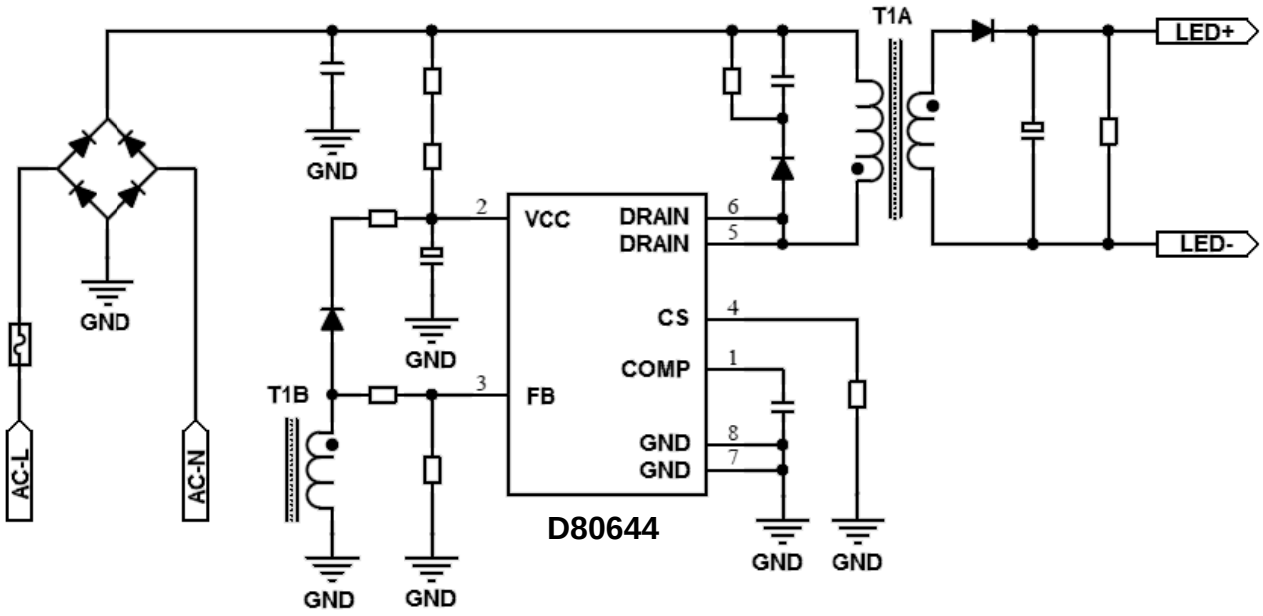
Feature

- Single stage, active power factor correction, high PF value, low THD
- Constant current control of primary side feedback, no secondary feedback circuit
- Built in 600V power MOSFET
- ±3% LED output current accuracy
- Excellent line voltage regulation rate and load regulation rate
- Inductance current critical continuous mode
- Ultra low (40uA) turn on current
- LED short / open circuit protection
- Current sampling resistor open circuit protection
- Primary side current limit cycle by cycle
- Chip power supply under voltage protection
- Intelligent temperature regulating function
- Auto reboot function
- Available in DIP-8 package

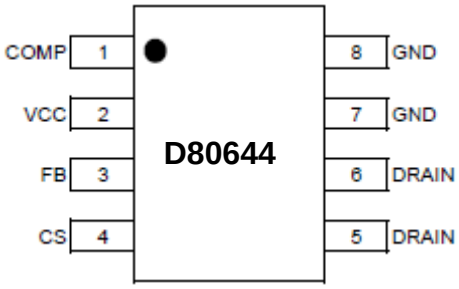
Application

- GU10 / E27 LED Bulb Lamp, spot lamp
- LED PAR30, PAR38 light
- LED Tube
- Other LED lighting

Typical applications



Pin package diagram



Pin Definition

Pin No.	Name	Description
1	COMP	Loop compensation Pin.
2	VCC	Chip power supply.
3	FB	Auxiliary winding feedback signal sampling Pin.
4	CS	Current sampling Pin, connect sampling resistor to ground.
5,6	DRAIN	Internal high voltage MOSFET Drain.
7,8	GND	Chip signal and power ground.

Absolute Maximum Ratings (Note1, Note2)

Symbol	Parameter	Range	Units
V_{DS}	Internal high voltage MOSFET drain to source peak voltage	-0.3 ~ 600	V
V_{CC}	Supply voltage	-0.3 ~ 25	V
I_{CC-MAX}	VCC Pin maximum supply current	10	mA
COMP	Loop compensation	-0.3 ~ 6	V
CS	Current sampling	-0.3 ~ 6	V
FB	Feedback of the auxiliary winding	-0.3 ~ 6	V
P_{DMAX}	Power dissipation (Note 2)	0.45	W
θ_{JA}	PN Junction to ambient thermal resistance	145	℃/W
T_J	Operating junction temperature range	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃
	ESD(Note 3)	2	KV

Note 1: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. Under “recommended operating conditions” the device operation is assured, but some particular parameter may not be achieved. 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 $P_{DMAX} = (T_{JMAX} - T_A)/\theta_{JA}$ or the minimum number in the absolute maximum ratings table.

Note 3: Human Body mode, 100pF capacitor discharge on 1.5KΩ resistor.

Recommended operating conditions

Symbol	Parameter	Range	Unit
V_{CC}	Supply voltage	8.5~20	V
P_{OUT1}	Output power(input voltage230±15%）	＜16	W
P_{OUT2}	Output power(input voltage85V~265V)	＜12	W

Electrical characteristic (Note 4, 5) （Unless otherwise specified, V_{CC} =16V, T_A =25 ℃）

Symbol	Parameter	Condition	Min.	Typ	Max.	Unit
Power Supply Voltage						
V_{CC_CLAMP}	V_{CC} Clamp voltage			23		V
V_{CC_ON}	V_{CC} turn on voltage	V_{CC} rise		17		V
V_{CC_UVLO}	V_{CC} under voltage protection threshold	V_{CC} drop		7.5		V
I_{CC_UVLO}	V_{CC} turn off current	V_{CC}=$V_{CC\text{-}ON}$-1V		40	60	uA
I_{OP}	V_{CC} operating current	F_{OP}=10KHZ		1	2	mA
Current sampling						
V_{CS_LIMIT}	CS peak voltage limit			1		V
T_{LEB}	Leading edge blanking time			350		nS
T_{DELAY}	Chip turn off delay			200		nS
FB Feedback						
V_{FB_FALL}	FB lower threshold voltage	FB drop		0.1		V
V_{FB_HYS}	FB hysteresis voltage	FB rise		0.08		V
V_{FB_OVP}	FB over voltage protection threshold			1.6		V
T_{ON_MAX}	Maximum turn on time			25		uS
T_{OFF_MIN}	Minimum demagnetization time			4.5		uS
T_{OFF_max}	Maximum demagnetization time			100		uS
Loop compensation						
V_{REF}	Internal reference voltage		0.194	0.2	0.206	V
V_{COMP_LO}	Under COMP voltage clamp			1.5		V
V_{COMP}	COMP Linear operating range		1.5		3.5	V
V_{COMP_HI}	COMP voltage clamp			3.6		V
Power MOSFET						

R_{OS_ON}	Power MOSFET conduction impedance	V_{GS}=10V,I_{DS}=2A			2.3	Ω
BV_{DSS}	Breakdown voltage of power MOSFET	V_{GS}=0V,I_{DS}=250uA	600			V
I_{DSS}	Power MOSFET leakage current	V_{GS}=0V,V_{DS}=600V			1.0	uA
Over temperature protection						
TSD	Over heat regulating temperature			140		℃

Note 4: The typical parameters values is tested under typical parameters, in 25 ℃.

Note 5: Specifications, the maximum / minimum specification range ensure by testing, typical value ensure by design, test and statistical analysis.

Application information

D80644 is an internal integrated 600V power MOSFET with primary side feedback single-stage active power factor correction LED constant current control chip, operating in the inductor current critical continuous mode, the chip can achieve a high power factor, low total harmonic distortion and high efficiency.

Start-up control

The start-up current of D80644 is very small, when VCC is charged and voltage is higher than the under voltage lockout turn off voltage, D80644 quick start-up, COMP voltage is quickly pulled up to 1.5V, and D80644 begin to output pulse signal. System has just started to operate at 10kHz switching frequency, and COMP voltages began to gradually rise from 1.5V, and inductor peak current increased too, so as to realize the soft start of the LED output current, prevent the overshoot of output current effectively, when the output voltage is established, the VCC voltage is power by the diode (the power diode must be fast recovery diode) of the auxiliary winding, so as to reduce the power dissipation of the system.

Constant current control, output current setting

D80644 adopts advanced current sampling mechanism, operates in the primary side feedback mode, and can achieve high precision output constant current control without secondary feedback circuit.

LED output current calculation method:

$$I_{OUT} \approx \frac{V_{REF}}{2 \times R_{CS}} \times \frac{N_P}{N_S}$$

V_{REF} is the internal reference voltage

R_{CS} is the value of the current sampling resistor resistance.

N_P is the number of turns of the transformer primary winding.

N_S is the number of turns of the secondary winding of the transformer.

Feedback network

D80644 detect the output current zero crossing state through FB, FB down threshold voltage is set at 0.1V, hysteresis voltage is 0.08V. FB pin can be used to detect output over-voltage protection (OVP), the threshold voltage is 1.6V. The upper and lower voltage divider resistor ratio of FB can be set to:

$$\frac{R_{FBL}}{R_{FBL}+R_{FBH}}=\frac{1.6V}{V_{OVP}}\times\frac{N_S}{N_A}$$

R_{FBL} is a feedback network lower divider resistor

R_{FBH} is a feedback network upper divider resistor

V_{OVP} is the output voltage over-voltage protection set point

N_S is the number of turns of the secondary winding of the transformer.

N_A is the number of turns of the auxiliary winding of the transformer.

Adjusting the size of the FB pin divider resistor can change the line voltage compensation tiny.

Intelligent temperature regulating function

D80644 is with intelligent temperature regulating function, when the driving power is overheat, reduce the output current gradually, so as to control the output power and temperature rise, so that keep the power temperature in the set value, in order to improve the reliability of the system. Chip internal control set the temperature point of 140℃.

Protection function

D80644 built in multiple protection functions to ensure the reliability of the system.

When the LED is open circuit, the output voltage increases gradually, and the FB pin can detect the output voltage when the power MOSFET is turned off. When the FB is raised to the OVP protection threshold, the protection logic will be triggered and the switch will be stopped.

When LED is short circuit, the system operates at 10KHZ low frequency. As the output voltage is very low, the auxiliary winding cannot be supplied to the VCC through the diode, so the VCC voltage is decreased gradually until the under voltage protection threshold.

After the System enters the protection state, the VCC voltage starts to drop, when the VCC reaches the under voltage protection threshold, the system will reboot. At the same time, the system will continue to detect the state of the system, if the fault is removed, the system will resume normal operate.

When the output short circuit or transformer saturation, CS peak voltage will be relatively high. When the CS voltage rises to the internal limit value (1V), the switching cycle stops immediately. This cycle by cycle function can protect the power MOSFET, power inductor and output fly-wheel diode.

Parameter of circuit design guide

Auxiliary power supply

Chip start-up to output voltage is established, the auxiliary winding supply power to the VCC voltage through the diode. As a result of the relatively high frequency of the circuit, the power diode must be a fast recovery diode. VCC voltage is proposed design at about 16V

when full load, the lower VCC can obtain better radiation characteristics. In the auxiliary winding power supply circuit, a resistor in series is proposed to reduce the VCC peak caused by switching noise. After the completion of the design, should pay attention to verify in full load start-up process, VCC voltage do not fall below 8V and should be left margin, do not happen to start two times.

COMP Pin design

COMP pin capacitance is recommended for the 1uF, to ensure the stability of the loop circuit, COMP pin capacitance value the greater the PF value is better, but it will reduce the response speed of the loop circuit, the size of the capacitor does not affect the start-up.

How to adjust the high and low voltage compensation

D80644 chip has input high and low voltage compensation function, can adjust the size of the high and low voltage compensation through the adjustment of the FB upper divided resistor of size. If the output current increases with the increasing of the input voltage, it shows that the high and low voltage compensation is not large enough, which can be enhanced compensation by reducing the FB upper divider resistor size. If the output current decreases with the increasing of the input voltage, it is means that the high and low voltage compensation is too large, which can reduce the compensation by increasing the FB upper divider resistor. It should be noted that, in the adjustment of high or low compensation, it need to increase the proportion of FB lower divider resistor, otherwise, it will change the output voltage OVP point. FB lower divider resistor value is recommended in the about 20K, too much resistance will make the FB more vulnerable to interference, it may cause to wrong trigger OVP protection. The normal operating voltage of FB is recommended to be set at around 1V, too small will lead the open circuit voltage too high.

Reflected voltage

Proposed to select the reflected voltage between 80V ~ 110V, in guarantee of the MOSFET, the output rectifier diode is in withstand voltage conditions, can be adapted to take a slightly larger reflection voltage to get better PF and THD, it's recommended that the duty ratio not greater than 0.5.

Maximum magnetic flux density

Need to focus on verification, to ensure that Bmax<0.3T, because there is a risk of saturation of the transformer, it need to recalculate the transformer. But in some extreme applications can be appropriate to increase the Bmax, in order to get a better price.

How to adjust the load regulation rate

D80644 chip has load compensation function, you can adjust the load regulation rate by changing the ratio of N_S/N_M. If the output current increases with the increasing of the output voltage, it shows that the load compensation is too large, can be reduced the compensation by increasing the proportion of N_S/N_M. If the output current decreases with the increasing of the output voltage, it shows that the load compensation is not enough, it can be enhanced by reducing the proportion of N_S/N_M, so as to achieve excellent load regulation rate.

System minimum frequency

Recommended to select the minimum frequency of 40KHz~50KHz (The lowest frequency with full load is at the peak of the minimum input voltage), too high operating frequency will make the PF value becomes worse, too low operating frequency need a

greater transformer or more circles of primary side to ensure transformer not saturated. In addition, ensure the maximum conduction time of the minimum input voltage should not exceed 20uS, the lower operating frequency can get better load regulation rate and line regulation rate.

PCB Design Guide

In PCB design, need notice the bellow item:

VCC bypass capacitors need to be close to the chip VCC and GND pins.

The power ground wire of the current sampling resistor is as thick as possible, and close to the ground (Pin 7 & 8) of the chip as possible, so as to ensure the accuracy of the current sampling, otherwise it may affect the regulation rate of the output current. In addition, the signal ground needs to be connected to the chip ground separate.

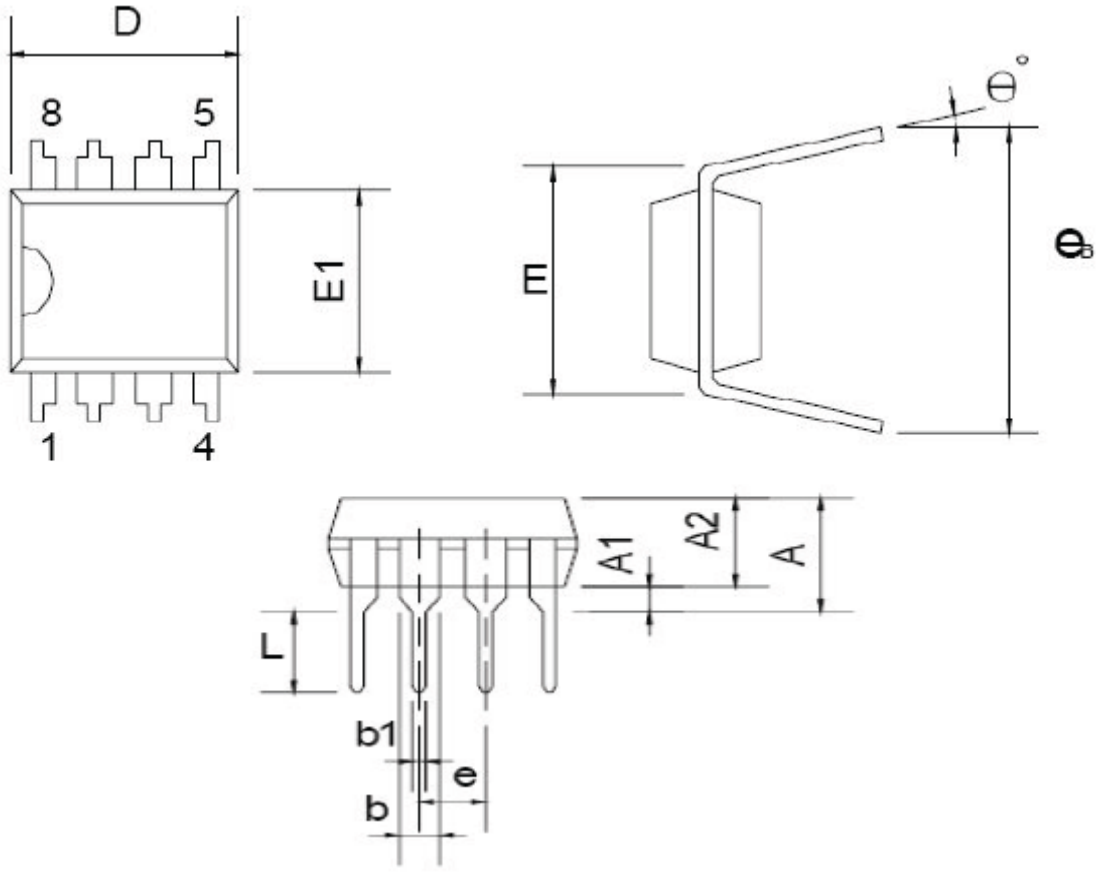
Reduce the area of the large current loop circuit, such as the loop circuit area of the transformer main stage, the power MOSFET and the absorption network, and the loop circuit area of the transformer secondary, the secondary diode and the output capacitor, to reduce the EMI radiation.

The FB divider resistor must be close to the FB pin, and the node must be far away from the transformer (DRAIN pin on the wire), otherwise the system noise will prone to false trigger OVP FB protection function.

Appropriately increase to lay the copper area of the DRAIN pin, in order to improve the chip heat dissipation.

Package information

DIP8



Symbol	Unit (mm)			Unit (inch)		
	Min.	Type	Max.	Min.	Type	Max.
A			5.334			0.210
A1	0.381			0.015		
A2	3.175	3.302	3.429	0.125	0.130	0.135
b		1.524			0.060	
b1		0.457			0.018	
D	9.017	9.271	10.160	0.355	0.365	0.400
E		7.620			0.300	
E1	6.223	6.350	6.477	0.245	0.250	0.255
e		2.540			0.100	
L	2.921	3.302	3.810	0.115	0.130	0.150
eB	8.509	9.017	9.525	0.335	0.355	0.375
θ°	0°	7°	15°	0°	7°	15°

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