DX3360

High Power Factor,Constant Current Controlling, Floating BUCK Offline LED Controller

DESCRIPTION

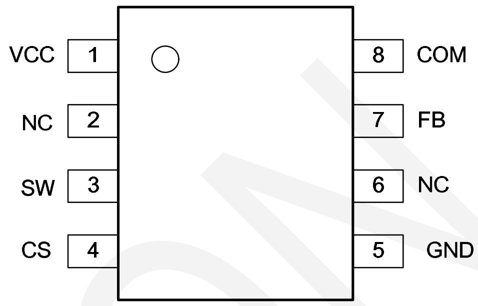
The DX3360 is a single-stage power factor (PF) corrected and low Total Harmonic distortion of current (THDi) AC/DC controller designed for off-line non-dimmable LED lighting applications.The DX3360 is a controller with high precise LED current controlling that it is intended for high power and non-isolated Buck applications.

The DX3360 implements the patented LED current controlling algorithm to maintain accurate output current regulation.The DX3360 operates in Boundary Conduction Mode(BCM) with the valley switching to get easy Electromagnetic Interference(EMI) .

The DX3360 built-in multiple protections: Soft start-up,OCP,UVLO, high temperature foldback, OVP and Output short-circuit protection.

PIN ASSIGNMENTS

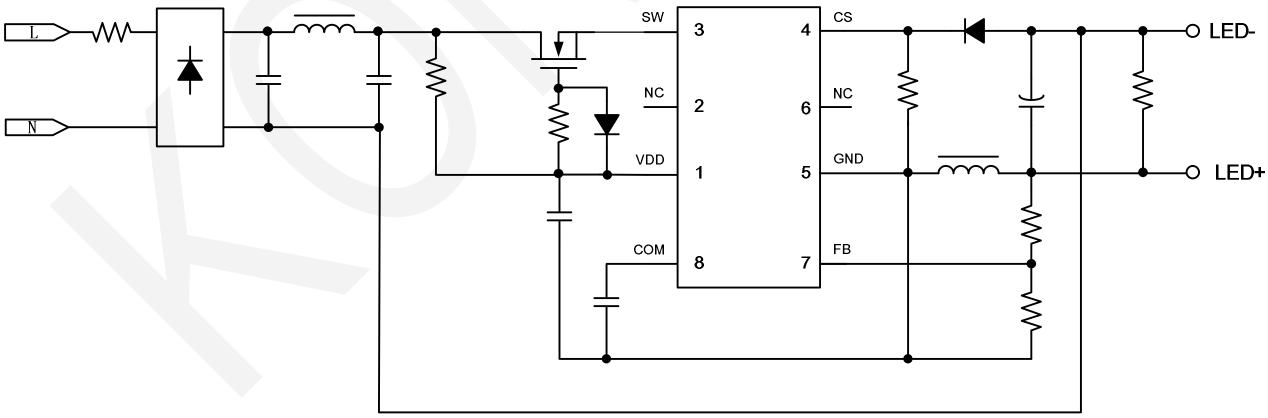
SOIC-8



APPLICATIONS

- Universal input voltage non-dimmable LED lighting
- Residential and Commercial lighting
- Retrofit A19,Tube,PAR and BR lamps
- Down lighting

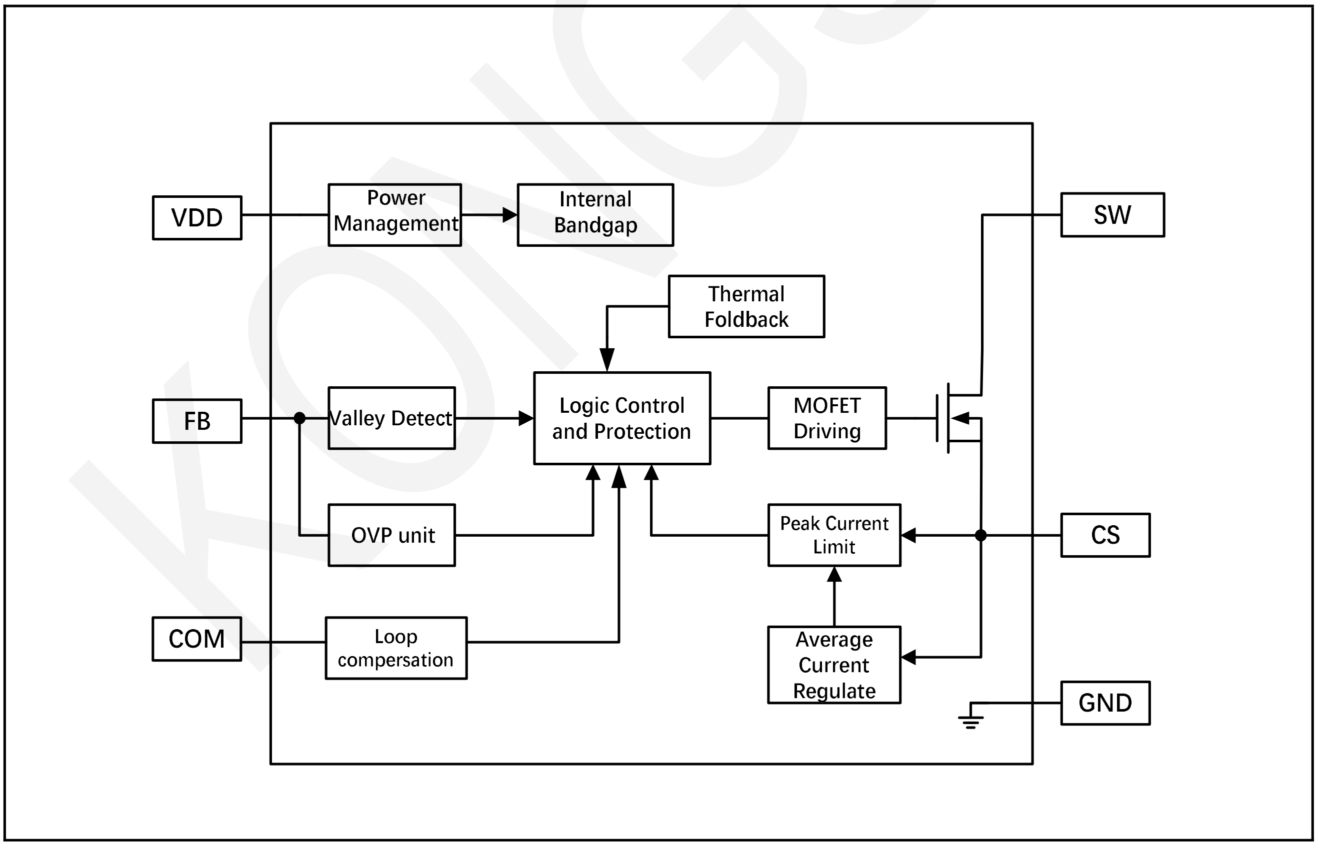
TYPICAL APPLICATION



FEATURES

- Design for BUCK topology
- Universal input voltage range(90~264VAC)
- High Power Factor Correction(PF>0.95)
- Low Harmonic Distortion(THD<20%)
- Precision current regulation(<±3% line & load regulation)
- True low system BOM cost with floating Buck converter solution
- Lowest start up current(<100uA)
- Valley switching technology
- Available in SOIC-8/DIP8 package
- Protections
  - Built-in over thermal foldback and protection
  - Built-in LED string over current protection
  - Built-in LED string open protection
  - Built-in LED string short protection
  - Soft start-up for reduced voltage & current stress

FUNCTION DIAGRAM



PIN FUNCTIONS

Pin#	Name	Description
1	VDD	Power supply. Supplies power for the controller.Connect VDD to an external capacitor.
2	NC	Not connect
3	SW	Drain pin of the internal LV MOSFET
4	CS	Current sense of the internal power MOSFET. Connect a resistor form CS to GND to cycle by cycle sense the current through the inductor.
5	GND	Ground. GND is the virtual ground of the IC.
6	NC	Not connect
7	FB	Valley switching detection. Connect to the tap of a resistor divider from the winding to GND and generates the internal MOSFET's turn-on signal. The LED open-circuit condition is detected from FB pin.
8	COM	Close loop compensation.

ABSOLUTE MAXIMUM RATINGS(@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Min.	Max.	Unit
V_{DD}	Supply voltage	-0.3	20	V
I_{VDD}	Input current at VDD pin	-	10	mA
V_{com}	Input voltage at V_{com} pin	-0.3	7	V
V_{FB}	Input voltage at FB pin	-0.3	7	V
V_{CS}	Input voltage at CS pin	-0.3	7	V
V_{SW}	Input voltage at SW pin	-0.3	20	V
ESD	Human Body Model	-	2000	V
	Machine Model	-	200	V
θ_{JA}	Thermal Resistance(Junction to Ambient)	-	158	℃/W
T_J	Operation Junction Temperature	-40	150	℃
T_{STG}	Storage Temperature	-55	150	℃

Notes:

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Functional operation above the Recommended Operating Conditions is not implied.Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.
2. All voltage values.except differential voltages.are given with respect to GND pin.

ELECTRICAL CHARACTERICS

(T_A=25˚C and VDD=16V unless otherwise specified.)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
Supply voltage (VDD)						
V_{DD_ON}	Start up voltage		-	15	-	V
V_{DD_CLAMP}	VDD clamp voltage	I_{VDD}=5mA		17		V
I_{VDD}	Operation current		-	300	-	uA
V_{DD_UVLO}	Under voltage lockout threshold		-	9.5	-	V
I_{VDD_START}	Startup current	V_{VDD}=6V	-	65	-	uA
V_{VREF}	VREF operation voltage		-	5.6	-	V
Current Sensing (CS)						
V_{CS_LIMIT}	Peak current limit		0.9	1.0	1.1	V
V_{CS_SET}	CS set voltage		190	200	210	mV
I_{CS_PUSH}	CS push current	V_{CS}=1V	--	2.0	--	uA
t_{LEB}	Leading-Edge Blanking Time		-	300	-	ns
Valley& OVP Detector (FB)						
V_{FB_OVP}	Over voltage threshold		--	1.9	-	V
$V_{FB\_CLAMP\_LOW}$	V_{FB} lower clamp voltage	I_{pull}=1mA	-	-0.1	-	V
$V_{FB\_CLAMP\_HIGH}$	V_{FB} upper clamp voltage	I_{push}=1mA	-	3.5	-	V
t_{OFF_LEB}	t_{OFF} blanking time		-	1.2	-	us
Over-Temperature Foldback						
T_{OTP_FB}	Foldback threshold temperature		130	140	150	˚C
T_{OTP_SD}	Protection threshold temperature		150	160	170	˚C
T_{OTP_RST}	IC restart up lever temperature		90	100	110	˚C

Notes:
Production testing of the device is performed at 25˚C. Functional operation of the device and parameters are guaranteed by design,characterization and process control.

FUNCTION DESCRIPTION

DX3360 operates in Boundary Conduction Mode(BCM) ,which operates in non-isolated buck configuration,to provide a constant output current to the LED string. It contains patented technology to achieving high Power Factor and low input current (THD).The DX3360 build-in multiple protections: OCP,UVLO,high temperature foldback,Output Short-circuit Protection and output open-circuit protection etc.

Start-up and Power Supply

The DX3360 is started up with the lowest start-up current (I_{VDD_START}) which using the startup resistor from the rectified mains voltage to charge V_{DD} capacitor,until the V_{DD} capacitor is charged to the desired start-up voltage(V_{DD_ON}),The DX3360 starts switching and provide the sufficient VDD supply.

The DX3360 built-in soft start-up feature to gradually ramp up the LED current, it minimums the inrush current stress and the audible noise during the start-up period.

When a fault conditions occurs,such as OTP, the DX3360 stops working until VDD voltage drops below V_{UVLO}, then DX3360 tries to restart-up.

Power Factor Correction

High power factor,low total harmonic distortion,high efficiency and simple system circuit are key parameters for LED drivers in the retro-fit dimmable market. Power factor is broadly defined as:

$$PF = \frac{P_{in\_avg}}{V_{rms} \times I_{in\_rms}}$$

Ideally, high power factor is accomplished by controlling the input current be directly proportional to the voltage.

The DX3360 implements the adaptive on time controlling to make the average current of the inductor as like as sinusoidal shape which it is dramatically achieving the high power factor and low input current THD performance.

Constant Current Regulator

The DX3360 contains a highly accurate current regulator. It senses the inductor current at every stocking and demagnetizing cycle to achieve constant LED current regulation.

The DX3360 senses the average current on CS resistor through the CS pin, the turn on time of the internal MOSFET is modulated exactly according to the desired LED output current.the following equation shows the LED current calculation in Buck Boost configuration.

$$I_{LED} = \frac{V_{CS\_SET}}{R_{CS}} = \frac{0.2V}{R_{CS}}$$

Leading Edge Blanking

The DX3360 build-in an internal Leading Edge Blanking(LEB) to prevent false detection of spike current on CS pin.because the parasitic capacitor in the circuit can causes high current spike during the turn-on of the internal MOSFET.During the blanking time,current comparator is disable and blocked from turning off the internal MOSFET. Figure1 shows the leading edge blanking.

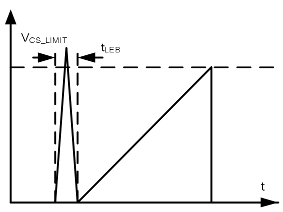


Figure 1: Leading Edge Blanking(LEB)

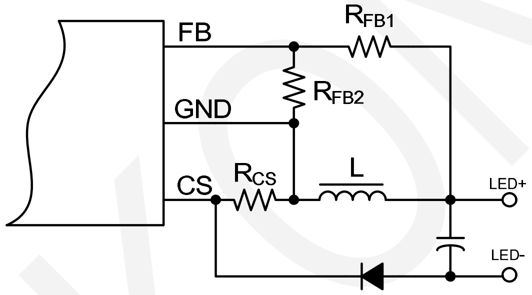
Short Circuit Protection(SCP)

When the LED short circuit occurs,the switching off time extends to an uncertainly time. Which mainly determined by the magnetization status of the inductor. Then the output power at this condition is limited at a safe range. The DX3360 resumes work at normal operation once the short circuit removes.

Over Voltage Protection(OVP)

The DX3360 built-in an exact Over Voltage Protection(OVP), it prevents the components from LED open damage,once the voltage at FB pin exceeds V_{FB} threshold,the OVP signal is triggered,as a result,the internal MOSFET is turned off, when V_{DD} drops below V_{DD_UVLO}, the DX3360 tries to restart up and then initiates a new soft-start cycle.

To avoid the false OVP detection because of the switch-off spike on the FB pin,the DX3360 has a blanking period (t_{OFF_LEB}) as figure 2 shown.The output OVP set point is calculated as bellow equation:



$$V_{LED\_OVP} = (1 + \frac{R_{FB1}}{R_{FB2}}) \times V_{FB\_OVP}$$

Figure 2: OVP Detecting Circuit

Thermal Foldback

The DX3360 integrates high temperature foldback function to limit the power dissipation while an abnormal condition occurring. When IC junction temperature exceeds T_{OTP_FB}, the LED output current decreases linearly with the preset curve as figure 3 shown, thus the total power dissipation in the application reduces and the further temperature increasing is slowed down.When the IC junction temperature reach to the maximum protection threshold(T_{OTP_SD}),the DX3360 turns off the switching cycle,once the temperature drops to below T_{OTP_RST}, IC resumes normal operation.

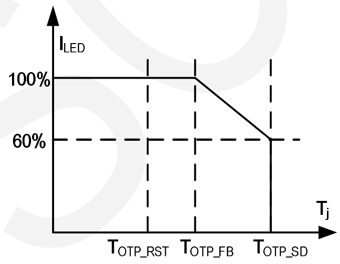


Figure 3: Thermal Foldback Curve

Inductor Selection

For high power factor application,the inductance range is defined by peak current of inductor and maximum and minimum value of switching on time and off time. The minimum switching frequency should be considered with EMI results and inductor dimension, below equation shows the Buck inductance calculation:

$$L = \frac{(\sqrt{2} \cdot V_{in} - V_{out}) \cdot V_O}{I_{PK} \cdot (\sqrt{2} \cdot V_{in}) \cdot f_{\min}}$$

When finish the inductance calculation, the minimum turn number of winding can be obtained by below equation:

$$N_{\min} = \frac{L \cdot I_{PK}}{A_e \cdot B_m}$$

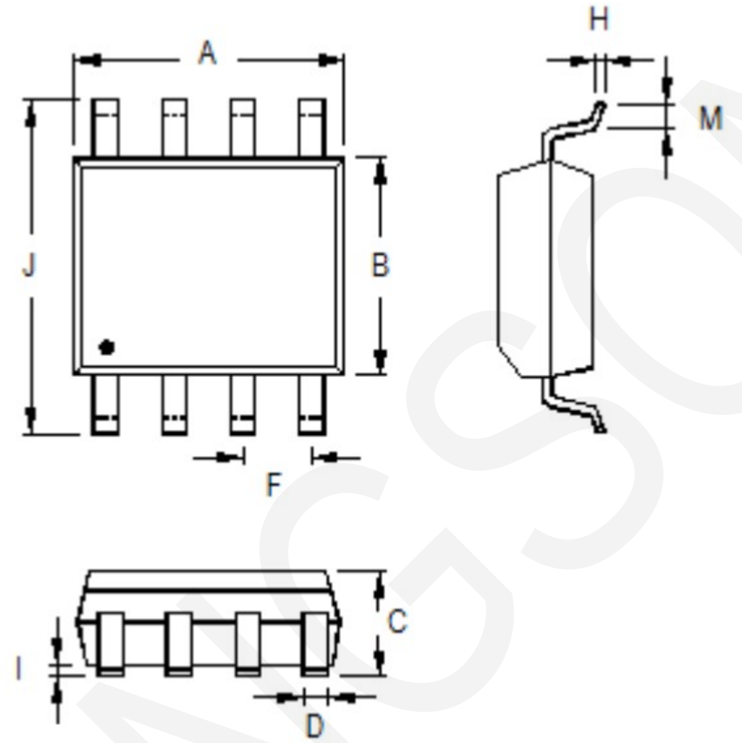
PCB Layout Guidelines

For best performance of the DX3360, like as the good EMI and good thermal performance in compact size LED application,the following layout guidelines should be strictly followed.

- The power supply capacitor must be placed as close as possible to the VDD pin.
- The IC CS pin are high frequency switching nodes. The traces must be as wide and short as possible.
- Keep the main trance with switching current(the rectified mains voltage→ DX3360 Drain pin→CS pin→IC_GND→ inductor→ LED+→ LED-→Rectified GND) as short as possible for better EMI.
- Put the AC input trace far away from the DC trace and the switching nodes to minimum the noise coupling.

PACKAGE INFORMATION

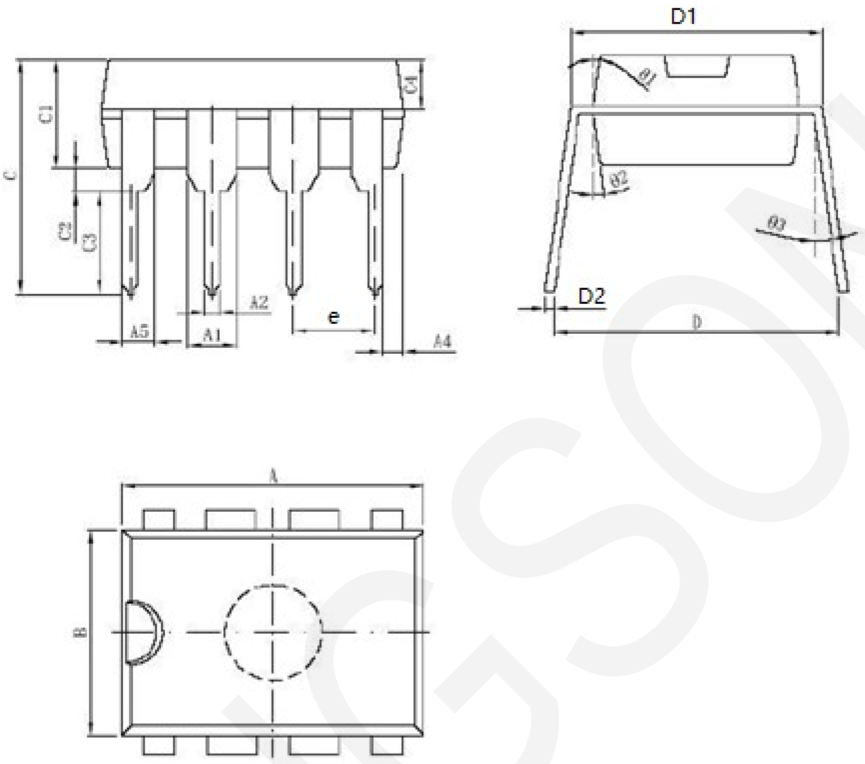
SOIC-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.170	0.254	0.007	0.010
I	0.050	0.254	0.002	0.010
J	5.791	6.200	0.228	0.244
M	0.400	1.270	0.016	0.050

PACKAGE INFORMATION

DIP-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Minimum	Maximum	Minimum	Maximum
A	9.0	9.4	0.146	0.17
A1	1.524		0.06	
A2	0.38	0.57	0.015	0.022
B	6.2	6.6	0.244	0.26
C1	3.2	3.6	0.126	0.142
C2	0.51		0.02	
D	8.4	9	0.331	0.354
D1	7.32	7.92	0.288	0.312
e	2.54		0.1	