

DX3580 High Performance, TRIAC dimmable, Non-isolated Offline LED Controller

Features

- Design for BUCK/BUCK BOOST topology
- Compatible with 120VAC/230VAC phase-cut dimmers
- Deep dimming & 0~100% dimming range
- Built-in logarithm dimming curve
- Lowest start up current(<100uA)
- High Power Factor Correction(PF>0.9)
- Low Harmonic Distortion(THD<20%)
- Accurate current line & load regulation(<±3%)
- Quasi-Resonant switching mode
- Available in SOIC-8/DIP8 package
- Protections
 - ◆ Cycle-by-Cycle Current Limit
 - ◆ Over Current Protection
 - ◆ Output over voltage protection
 - ◆ Output short circuit protection
 - ◆ High Temperature foldback
 - ◆ Abnormal over current protect(AOCP)
 - ◆ Soft start-up for reduced voltage & current stress

Description

The DX3580 is a high performance, single-stage power factor (PF) corrected AC/DC controller designed for off-line TRIAC dimmable LED lighting applications. The DX3580 adopts high precise LED current controlling that it is intended for non-isolated Buck and Buck-Boost applications.

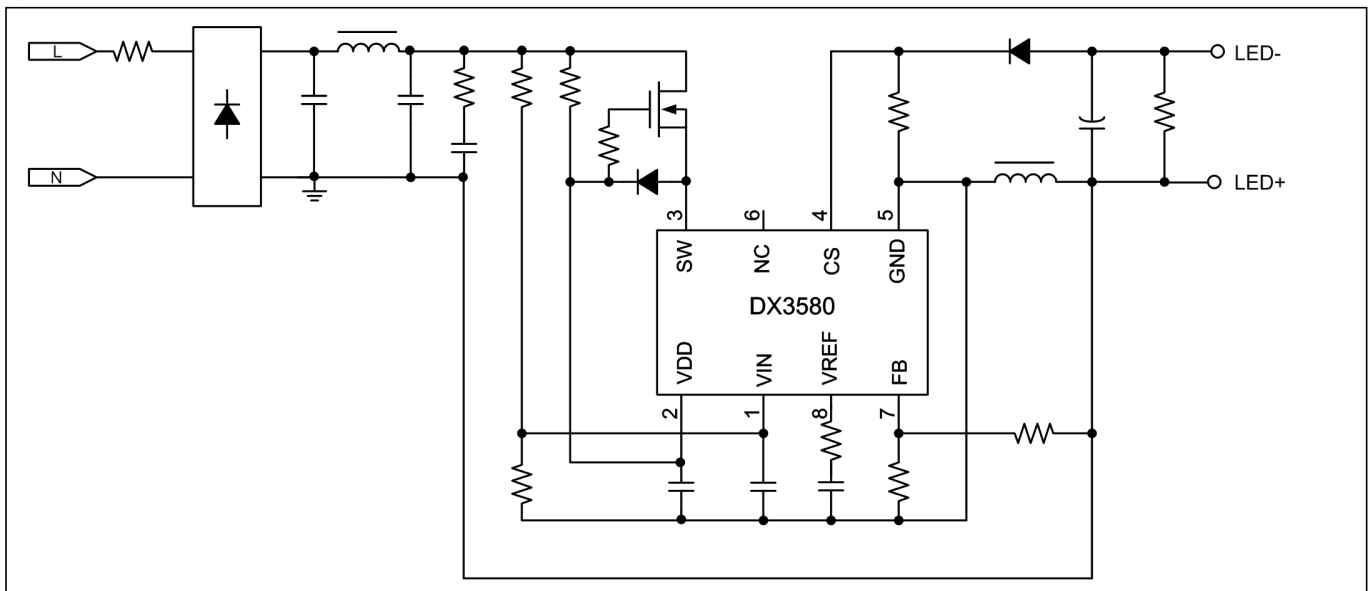
The DX3580 implements a unique LED current controlling algorithm to maintain accurate output current regulation. The DX3580 operates in Boundary Conduction Mode(BCM) with the valley switching and power factor correction features to get easy Electromagnetic Interference(EMI) and low total harmonic distortion.

The DX3580 built-in multiple protections: Soft start-up, OCP, UVLO, high temperature foldback, OVP and Output short-circuit protection.

Applications

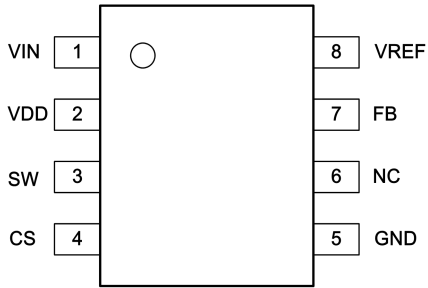
- 120VAC, 230VAC TRIAC dimmable LED lighting
- Residential and Commercial lighting
- Retrofit A19, PAR and BR lamps
- Down lighting

Typical Application



Pin Configuration and Marking Information

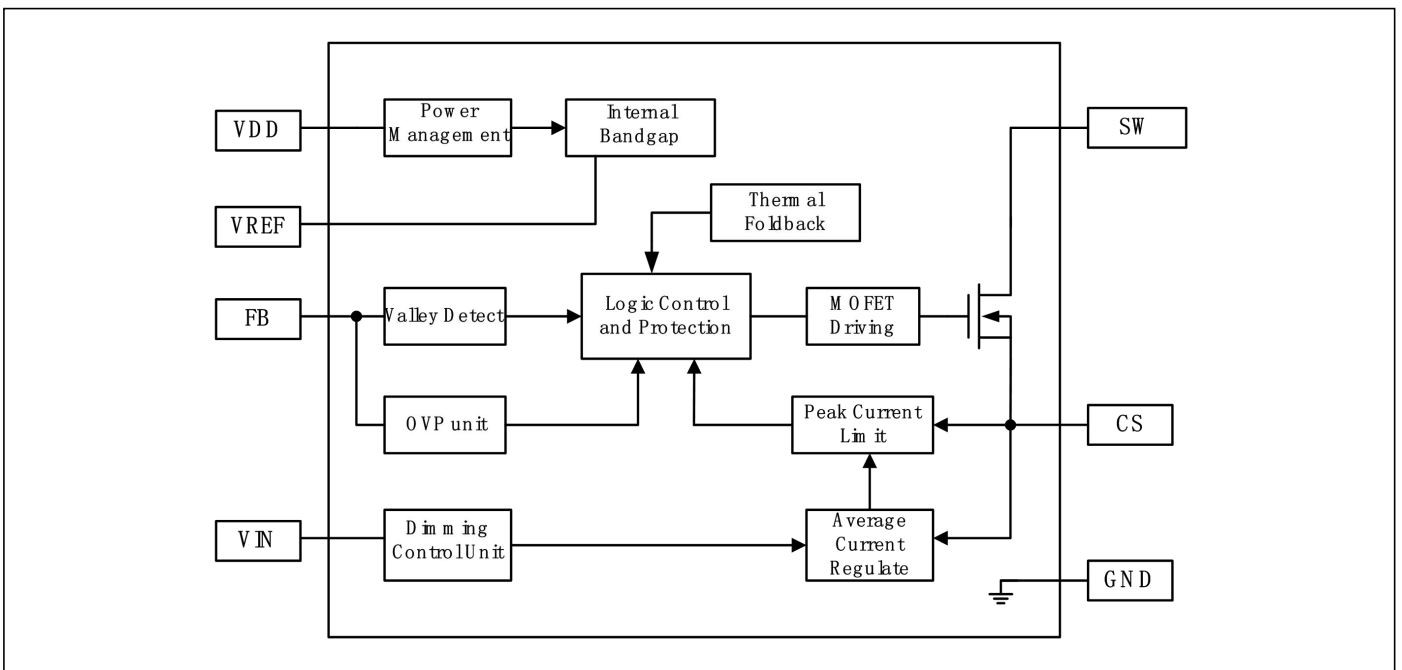
The DX3580 is available in SOIC-8/DIP-8 package



Pin Definition

Pin No.	Name	Description
1	VIN	Dimming controlling.It provides the programmable dimming algorithm to control the LED output current.
2	VDD	Power supply. Supplies power for the controller.Connect VDD to an external capacitor.
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	VREF	Internal reference voltage.Provides a precise voltage source.

Internal Block Diagram



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 _{VIN}	Input voltage at DIM pin	-0.3	7	V
V _{REF}	Reference voltage at VREF 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	°C/W
T _J	Operation Junction Temperature	-40	150	°C
T _{STG}	Storage Temperature	-55	150	°C

Notes:

- 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.
- All voltage values, except differential voltages, are given with respect to GND pin.

Electrical Characteristics (TA=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} P	VDD clamp voltage	I _{VDD} =5mA		17		V
I _{VDD}	Operation current		-	300	-	uA
V _{DD_UVL} O	Under voltage lockout threshold		-	9.5	-	V
I _{VDD_STAR} T	Startup current	V _{VDD} =6V	-	65	-	uA
V _{VREF}	VREF operation voltage		-	5.6	-	V
Dimming detector (VIN)						
V _{VIN_CLAMP}	VIN clamp voltage	I _{DIM} =500uA	-	3.8	-	V
I _{VIN_SINK}	Max. sink current		-	0.5	-	mA
V _{VIN_REF}	VIN control reference voltage		1.9	2.0	2.1	V
I _{VIN_PUSH}	VIN push current	V _{DIM} =0V	-	3.6	-	uA
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)						
$V_{FB_OV_P}$	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	T_j	-	140	-	°C
ΔV_{CS}	V_{CS} voltage drop every 10 °C	Temp> T_{OTP_FB}	-	30	-	mV

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.

Application Information

The DX3580 is a single-stage, high performance AC/DC offline power supply controller for the conventional TRIAC dimmable LED lighting applications. The DX3580 built-in the programmable dimming curve to achieve the good dimmer compatibility and deep dimming performance. It is very compatible with 120VAC and 230VAC phase-dimmable dimmers. The DX3580 uses patented current regulation technology to deliver excellent LED current accuracy under a specific AC line and LED load voltage range.

The DX3580 operates in Boundary Conduction Mode(BCM) and combines with the Power Factor Correction controlling to provide high system efficiency and low electro-magnetic interference(EMI).

The DX3580 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 DX3580 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 DX3580 starts switching and provide the sufficient VDD supply, if V_{DD} cannot provide enough power supply at the deep dimming angle, It's recommended to using LED+ output voltage to support the additional power supply.

The DX3580 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 DX3580 stops working until VDD voltage drops below V_{UVLO} , then DX3580 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 DX3580 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 THD performance.

Constant Current Regulator

The DX3580 contains a highly accurate current regulator. It senses the inductor current at every stocking and demagnetizing cycle to achieve constant LED current regulation.

The DX3580 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.

$$I_{LED} = \frac{V_{CS_SET}}{R_{CS}} \times (1-D) = \frac{0.2V}{R_{CS}} \times (1-D)$$

Leading Edge Blanking

The DX3580 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.

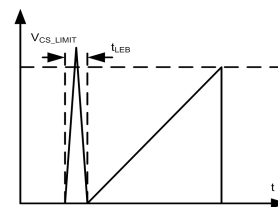


Figure 1: Leading Edge Blanking(LEB)

Dimming Function

The DX3580 provides a logarithmic dimming curve to performs a smoothly light output, it makes the pupil of human's eye getting good feeling when the light is dimmed.

The DX3580 built-in an unique dimming function to delivery 0~100% LED output current range when connects the different TRIAC dimmers. The maximum dimming lever is programmable by adjust the initial voltage at VIN pin.

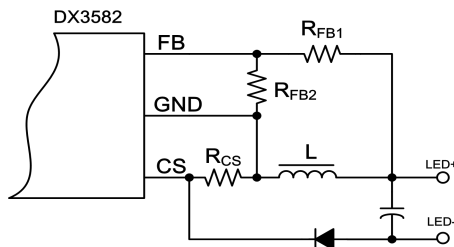
Short Circuit Protection(SCP)

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 DX3580 resumes work at normal operation once the short circuit removes.

Over Voltage Protection(OVP)

The DX3580 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 DX3580 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 DX3580 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 DX3582 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. The reliability of the whole lighting system be dramatically enhanced as well.

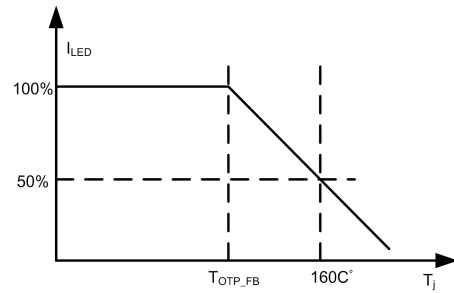


Figure 3: Thermal Foldback Curve

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 Boost inductance calculation:

$$L = \frac{\sqrt{2} \cdot V_{in} \cdot V_o}{I_{PK} \cdot (\sqrt{2} \cdot V_{in} + V_o) \cdot f_{min}}$$

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

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

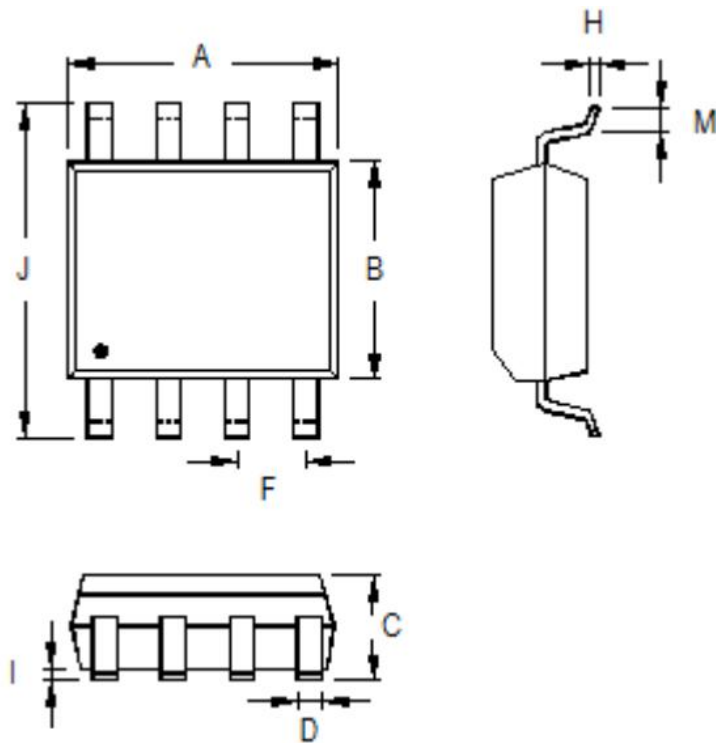
PCB Layout Guidelines

For best performance of the DX3580, 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→ MOSFET Drain pin→DX3580 SW pin→CS pin→IC_GND→ inductor→ LED+→ LED→Rectified GND) as short as possible for better EMI.
- Make sure a safety distance between the AC input traces and the rectified DC traces to minimum the noise coupling.

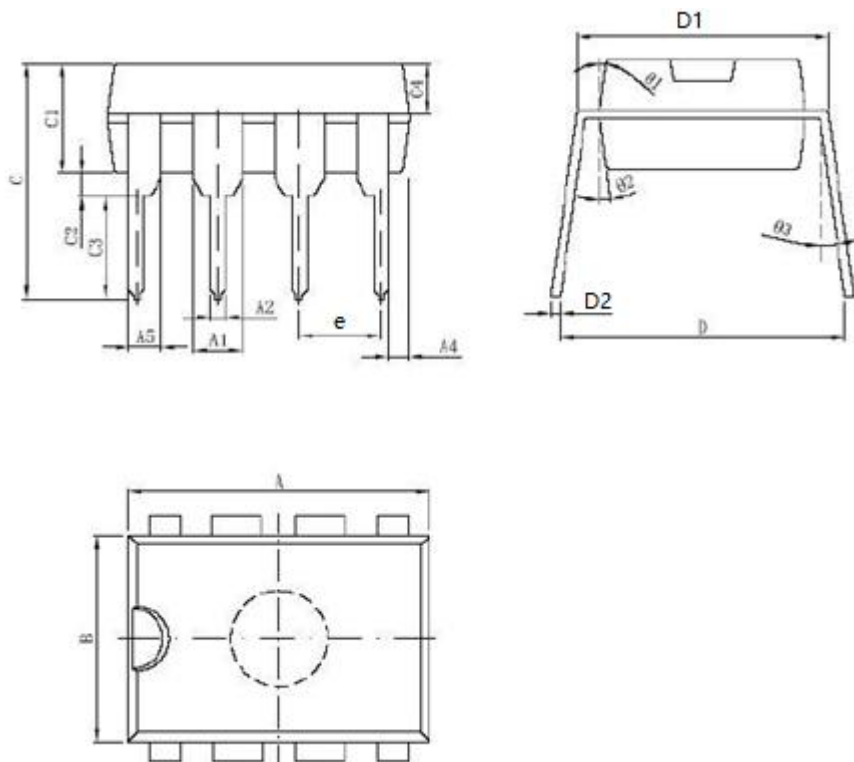
Package Information

SOIC8 Package Outline Dimensions



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

DIP8 Package Outline Dimensions



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	

NOTE:

- 1.We strongly recommend customers check carefully on the trademark when buying our product, if there is any question, please don't be hesitate to contact us.
- 2.Please do not exceed the absolute maximum ratings of the device when circuit designing.
- 3.Winsemi Microelectronics Co., Ltd reserved the right to make changes in this specification sheet and is subject to change without prior notice.

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