AXPM28285

100V CC LED Driver with Analog and Digital Dimming, and 5V Buck Regulator Controller

Preliminary Datasheet ─ Dec 2021

Description

The AXPM28285 consists of an integrated grounding Buck Regulator and 100V power MOSFET, specifically designed for a high performance non-isolated converter with minimal external components targeting at LED lighting applications. It also has an integrated Buck regulator controller for 5V which can supply 200mA Iload current for the application usage. If only lower current of 10mA is needed, it can be configured into a LDO without the need for an external inductor.

It drives the Buck converter with ultra-low RDS(ON) power switch to achieve higher efficiency with dual dimming control methods for enhanced resolutions. Dimming can be achieved digitally by controlling, enabling, and disabling of the PWM using the DDIM pin. Analog dimming control is also possible via an ADIM pin voltage reference input, setting the PWM current threshold.

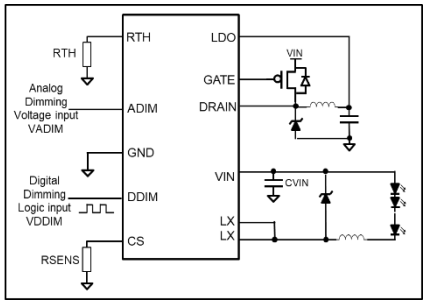
Features

- Internal 100V Power MOSFET
- Common-anode design for simplified wiring and low system cost
- Wide input range: 8-100V
- 400kHz switching frequency
- 200mΩ low RDS(ON) MOSFET for maximum 2.5A LED current output
- Support Digital dimming (1-100% duty cycle)
- Support Analog dimming (0.2-1.2V)
- Buck regulator controller 5V 200mA current output or internal 5V LDO 10mA. Selection by RTH pin
- Multiple protection features:
  - LED open protection
  - LED short protection
  - Over Current protection
  - Under Voltage Lockout protection
  - Thermal protection
- Compact package: eTSSOP14

Applications

- High power LED lighting
- Dimming IoT lighting
- Stage lamp
- Landscape lighting
- E-bike lighting

Figure 1 Simplified Schematic



Order information

Table 1 Device Summary

Order code	Package	Packing
AXPM28285	eTSSOP14	Reel

eTSSOP14 5.0mm x 4.4mm

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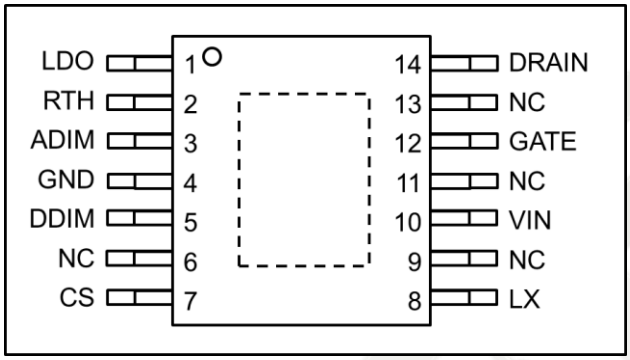
1 Pin Description

1.1 Pin Names

Figure 2 Pin Configuration



1.2 Pin Functions

Table 2 Pin Functions

Pin Name	Pin Number	Pin Type	Description
LDO	1	Power	5V feedback pin for Buck regulator mode. 5V LDO output when device in LDO mode
RTH	2	Input	RTH resistor to set the current switching threshold for the 5V Buck regulator. When unconnected it selects 5V LDO mode. Resistor to ground selects Buck Regulator mode.
ADIM	3	Input	Analog Dimming Voltage Control. 1.2 to 5V => PWM current threshold = 0.2/RSENS 1.2 to 0.2V => PWM current threshold = (V_{ADIM}/6)/RSENS <0.2V => PWM Off
GND	4	GND	Device Ground
DDIM	5	Input	Digital Dimming Logic Control 1 = Enable switching PWM, 0 = Disable switching PWM
NC	6, 9, 11, 13		Not Connected
CS	7	Output	Current Sense. Connect R_{SENS} for sensing PWM current
LX	8	Output	Power Mosfet Drain Output. Connect LED Buck inductor.
VIN	10	Power	Device Power Supply
GATE	12	Output	Gate drive for 5V Buck regulator PMosfet
DRAIN	14	Input	Drain voltage of 5V Buck regulator PMosfet
PAD	-	GND	Thermal pad. Connect to ground.

2. Electrical Specifications

2.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)(1)

Table 3 Absolute Maximum Ratings

Symbol	Min	Max	Unit
LX, VIN, GATE, DRAIN	-0.3	105	V
LDO, ADIM, DDIM, RTH	-0.3	5.5	V
CS	-0.5	1	V
Operating junction temperature, Tj	-40	150	°C
Storage temperature, Tstg	-65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

2.2 Thermal Data

Table 4 Thermal Data

Symbol	Parameter	Value	Unit
Rth j-amb	Junction-to-ambient thermal resistance	45	°C/W
Rth j-case	Junction-to-case thermal resistance	10	°C/W

2.3 ESD and Latch Up

Table 5 ESD and Latch Up

Symbol	Parameter	Value	Unit
All pins	ESD HBM	±2,000	V
All pins	ESD CDM	±500	V
All pins	Latch Up JESD78, Class A	≥ 100	mA

2.4 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

Table 6 Recommended Operating Ratings

Symbol	Min	Max	Unit
Power supply voltage (VIN)	8	100	V
DDIM, V5, ADIM	0	5.5	V
CS	0	1.0	V
Peak output current	0	2.5	A
Operating ambient temperature(1)	-40	125	°C

(1) Power dissipation and thermal limits must be observed.

2.5 Electrical Characteristics

T_A = 25°C, over recommended operating conditions (unless otherwise noted)

Table 7 Electrical Characteristics

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
VIN	VIN Operating voltage		8		100	V
I_{DN}	Shutdown Current	ADIM=0		220		μA
I_{OP}	Quiescent Current	Enabled with ADIM and DDIM		10		mA
R_{DSON}	Power MOSFET ON Resistance			200		mΩ
I_{LIMIT}	Power MOSFET Current Limit			2.5		A
F_{SW}	Switching Frequency			400		kHz
V_{CS}	Current Sense Limit		196	200	204	mV
V_{DDIM}	Logic ON Threshold		1.28			V
V_{ENL}	Logic OFF Threshold				0.56	V
VIN_{ON}	VIN UVLO turn-on threshold			7.4		V
VIN_{OFF}	VIN UVLO turn-off threshold			6.8		V
V_{ADIM}	Analog Dimming Range	I_{LED}=16.7%		0.2		V
		I_{LED}=100%		1.2	5	V
LDO	Internal 5V	RTH unconnected I_{LDO} = 10mA		5		V

Freq	5V Buck maximum switching Frequency				1	MHz
R_{GATE}	GATE driver turn off resistance			6		Ω
I_{RTH}	5V buck regulator current threshold	Resistor from RTH to ground		20		μA
T_{SD}	Thermal Shutdown Temperature			150		°C
T_{HYST}	Thermal Hysteresis			30		°C

3 Functional Description

3.1 Overview

The AXPM28285 consists of an integrated grounding Buck Regulator and 100V power MOSFET, specifically designed for a high performance non-isolated converter with minimal external components targeting at LED lighting applications.

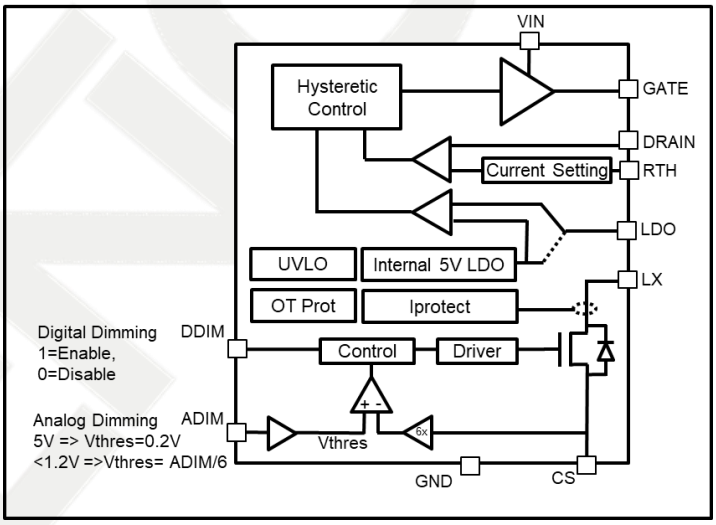
The AXPM28285 drives the Buck converter base on a fixed frequency switching with cycle by cycle sensing of the output current. Switching frequency is fixed at 400kHz with a minimum off time of 100ns. Current sensed voltage through an external R_{SENS} resistor is amplified with a 6x gain and compared with V_{ADIN} for setting current threshold.

The AXPM28285 drives the Buck converter with ultra low RDS(ON) power switch to achieve higher efficiency and keeps the Buck converter connecting PWM signal by connecting Analog signal with ADIM pin to achieve dimming control.

The AXPM28285 has an internal 5V LDO and a hysteretic 5V Buck controller. By not connecting the RTH pin, it allows the user to select to use 5V LDO which has a limited current drive of 10mA. If the hysteretic Buck with a higher current output of 200mA is needed instead, this can be achieved by connecting the RTH through a resistor to ground. The resistor will also set the current limit of the 5V Buck regulator. These regulators are independent of the LED Buck function and remain operational even when there is a shutdown by ADIM=0 or an autoshutdown due to inactivity of DDIM.

3.2 Functional Block Diagram

Figure 3 Functional Block Diagram



3.3 Feature Description

3.3.1 Operation

Start Up

After DC supply is powered on, the capacitor CVIN across VIN and GND pin is charged up by VIN voltage. Once VIN rises up to VIN_{ON}, the UVLO is lifted, internal blocks start to work and PWM output is enabled.

Shut Down

After DC supply is powered off, the energy stored in the VIN capacitor CVIN will be discharged. When the VIN capacitor CVIN can't supply enough energy to VIN pin, VIN will drop down. Once VIN is below VIN_{OFF}, the device will stop working.

Only input capacitor C_{VIN}, output capacitor C_{OUT}, output inductor L and current sense resistor R_{SENS} need to be selected for the targeted applications specifications.

Current sense resistor RCS

R_{SENS} to program the proper output Current:

$$I_{LED}(A) = \frac{0.2(V)}{R_{SENS}(\Omega)}$$

Input capacitor CVIN

The ripple current through input capacitor is calculated as:

$$I_{CINRMS} = I_{OUT} \times \sqrt{D(1-D)}$$

A typical X7R or better grade ceramic capacitor with suitable capacitance should be chosen to handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor really close to the VIN and GND pins. Care should be taken to minimize the loop area formed by C_{VIN}, and VIN/GND pins.

Output inductor L

There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}\ (1 - V_{OUT}/V_{INMAX})}{F_{SW}\ \times I_{OUTMAX}\ \times 40\%}$$

Where FSW is the switching frequency and I_{OUTMAX} is the LED current.

2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SATMIN} > I_{OUTMAX} + \frac{V_{OUT}\ (1 - V_{OUT}/V_{INMIN})}{2\ \times F_{SW}\ \times L}$$

Short Circuit Protection

The device is designed with 2 protection safeguards. The first is the cycle by cycle PWM current limit set by ADIM voltage. In the event of a short circuit across LED+ and LED-, high current will develop on PWM turn ON, across R_{SENS}. This will be limited by the ADIM threshold. A current sensing independent of R_{SENS} is also available. On CS pin being short to ground, the protection circuit will switch off the device on detecting short circuit current greater than 2.5A going through the power Mosfet.

Auto shutdown

When DDIM is set to logic 0 for disabling the switching for more than 16ms, the device will automatically enter into a shutdown low current mode. All switching will be disabled. The internal LDO 5V and Hysteretic Buck 5V regulator controller will continue operation.

3.3.2 Dimming Operation

Digital Dimming

Applying a varying duty cycle signal of larger than 20kHz to DDIM, the current can be modulated to provide dimming capability to the LED. This enables switching from 0% to 100% duty cycle of ADIM current set.

ANALOG Dimming

The ADIN pin provides for an analog reference voltage input to control the PWM current threshold for dimming purposes.

V_{ADIN} >1.2V,	$V_{threshold}$ = 1.2V,	$I_{LED} = V_{CS}/R_{SENS}$ A (100% setting)
1.2V>V_{ADIN} >0.2V,	$V_{threshold} = V_{ADIM}$	$I_{LED} = (V_{CS}/6) / R_{SENS}$ A (min 16.7% setting)
0.2V>V_{ADIM}>0V,	$V_{threshold}$ = 0V	I_{LED} = 0A, Device is turned off

Digital and Analog dimming can be used in combination to tune to desired dimming performance.

3.3.3 5V Generation

AXPM provides for either a 5V LDO output or is able to provide the hysteretic control for a 5V Buck regulator. RTH pin not connected and floating selects the 5V LDO mode, while a resistor connected from RTH to ground selects the 5V Buck regulator mode. The 5V generation starts to work upon Vin greater than UVLO.

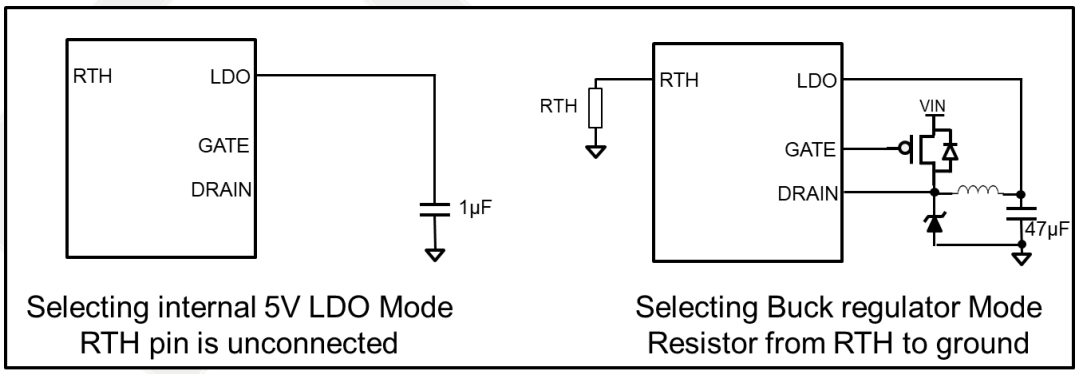
5V LDO

For applications that do not require a robust 5V voltage supply, AXPM28285 provides for an internally generated 5V LDO output with limited current drive of 10mA.

Hysteretic 5V Buck Controller

For applications that require a 5V supply that is able to provide up to 200mA current, AXPM28285 allows for the control of a hysteretic Buck regulator using external PMosfet and Schottky diode. The pin RTH has a current source of 20uA. Connecting a resistor from RTH to ground sets the threshold voltage for the sensing of current across the external PMosfet.

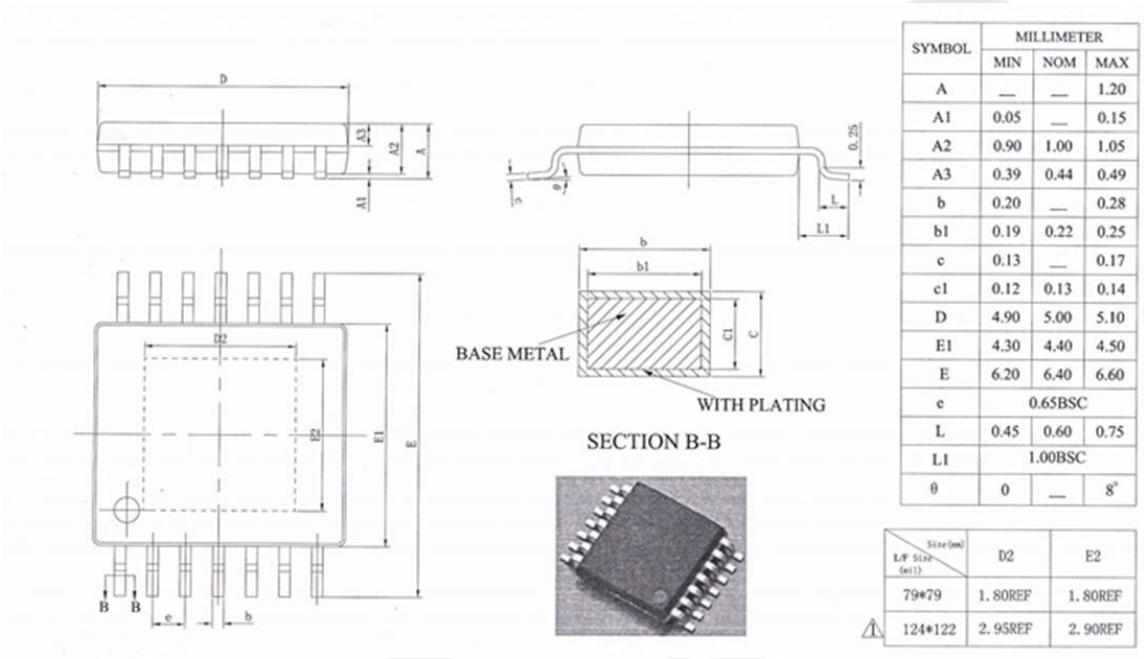
Figure 4 5V Generation Selection



4 Package Information

4.1 Package Dimensions

Figure 5 eTSSOP14 Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°

Size(mm) / L/F Size (mil)	D2	E2
79*79	1.80REF	1.80REF
124*122	2.95REF	2.90REF

4.2 Device Marking Information

5 Packing Information

6 Revision History

Table 8 Document Revision History

Date	Version	Description
Dec 2021	Draft	Preliminary Version