ACL406B - Direct AC Line LED Driver

UP TO 6W OUTPUT

ACL406B-DS-V1.2 – February 2022

Datasheet

MATURITY
In Production

1. FEATURES

ACL406B UP TO 6W OUTPUT

- Direct AC Line LED Driver requiring few external components,
- Wide AC Input Range: 50 to 280V AC,
- High Power Factor: > 0.98 with optimized LED configuration,
- Low harmonic content : THD < 15% (typ.),
- Low quiescent current: 380µA,
- High Efficiency: 85% typical,
- Ultra-Flexible LED Forward Voltage Configuration,
- Up to 4 LED stages capability,
- Over Temperature Protection and LED Failure Protection: power derating.
- Enable and Analog/PWM dimming functions 0-3.3V,
- Embedded 3.3V DC regulator for connected devices (RF component).

2. APPLICATIONS

- General Solid State Lighting,
- Medium Power LED Lamp,
- Connected Medium Power Led Lamp,
- Industrial High power LED Lamp.

3. DESCRIPTION

The ACL406B is an AC direct LED driver requiring few external components: a diode bridge to rectify the AC voltage and a resistor to tune the LED current.
The LED current can be tuned and switched off thanks to the V_{DIM} pin of the ACL406B. The V_{DIM} pin supports analog dimming or digital PWM.
The ACL406B embeds a linear regulator delivering an output voltage of 3.3V to supply external devices such as low-power RF microcontroller.
Multiple ACL406B AC line drivers may be used in parallel to drive high power LED systems for industrial applications.

4. PIN CONNECTIONS

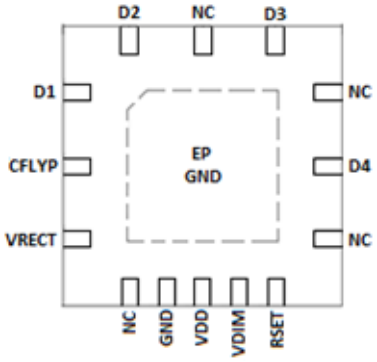

Figure 1:ACL406B QFN5x5 Pin-out (TOP VIEW)

5. TYPICAL APPLICATIONS

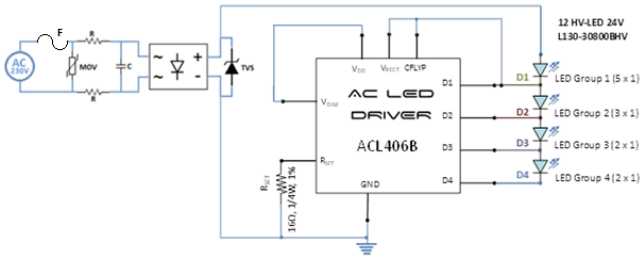

Figure 2: Low-cost application schematic for 230V_{AC}

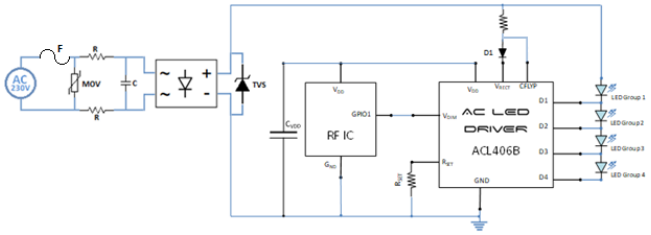

Figure 3: RF lightning control application schematic for 230VAC

In this case, the RF IC needs to be supplied all the time, so the VRECT can't be connected with the pin D1.

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6. REVISION HISTORY

Version	Date	Changes
1.0	21/06/2019	1st public release
1.1	22/06/2021	Updated figure label for chapter 5.
1.2	08/02/2022	Updated release

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

7. PIN CONFIGURATION

Pin descriptions and Functions

Symbol	Pin #	Type	Function
D1	1	IO	LED Cathode group 1
CFLYP	2	PWR	Power supply ACL406B
V_{RECT}	3	PWR	Power supply for 3.3V regulator
NC	4		Not Connected
GND	5	GND	ground
VDD	6	IO	Regulator Output 3.3V
VDIM	7	IO	Analog input for analog/PWM dimming
R_{SET}	8	IO	Resistor to set the LED current
NC	9	NC	Not Connected
D4	10	IO	Cathode LED group 4
NC	11		Not Connected
D3	12	IO	Cathode LED group 3
NC	13		Not Connected
D2	14	IO	Cathode LED group 2
EP	15	GND	Exposed Pad connected to the GND

Table 1: Pin description and functions

ACL406B Pin Mapping (QFN014 5x5 x 0.85mm with exposed pad)

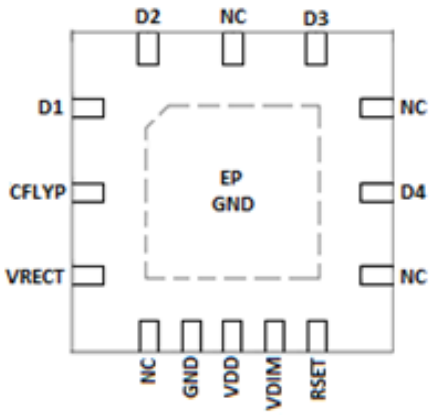


Figure 4: ACL406B QFN5x5 Pin out (TOP VIEW)

8. ABSOLUTE MAXIMUM RATINGS

Parameter	Min	Typ	Max	Units
Input power supply V_{RECT}	- 0.3		650	V
Input power supply CFLYP	- 0.3		650	V
Output R_{SET}	- 0.3		5	V
Output LED Voltage D1	- 0.3		650	V
Output LED Voltage D2	- 0.3		650	V
Output LED Voltage D3	- 0.3		650	V
Output LED Voltage D4	- 0.3		650	V
Input VDIM	- 0.3		5	V
Output VDD	- 0.3		5	V
$T°_{junction}$	-55		175	°C
$T°_{storage}$	-55		150	°C
ESD-HBM according to ANSI/ESDA/JEDEC JS-001-2014			1	kV
ESD-FCDM according to ANSI /ESDA /JEDEC JS-002-2014			500	V

Table 2: Absolute maximum ratings

Notes:

1. The **ACL406B** product type has been submitted to and conforms with HTOL, PCON/MSL1/TMCL, PCON/MSL1/UHAST and HTSL qualification tests. Stress tests have been completed without rejects and were performed according to the requirements of the test reference.
2. HTOL test reference is **JESD22-A108.** PCON/MSL1/TMCL test reference is according to the **JESD22-A113, JESD22-A104** standard**.** PCON/MSL1/UHAST test reference is according to the **JESD22-A113, JESD22-A118** standard**.** HTSL test reference is according to the **JESD22-A103** standard.
3. The ACL406B product withstands class I with immunity level A of latch-up **JESD78E** standard.

9. ELECTRICAL CHARACTERISTICS

Operating Conditions

Parameter	Min	Typ	Max	Units
Input power supply V_{RECT}			400	V
Input power supply CFLYP			400	V
dV/dt			10	$V.\mu s^{-1}$
V_{D1}	0		400	V
Voltage difference D_{n-1}-D_n (2≤n≤4)	0	75	100	V
V_{D4}	0	75	100	V
R_{SET}	10		100	Ω
VDIM	0		VDD	V
Load Current VDD			5	mA
Load Capacitance VDD*	22			µF
$T°_{junction}$	-40		125	°C

Table 3: Operating conditions

* If external V_{DD} is used to supply another device

Electrical Parameters

Parameter	Conditions	Min	Typ	Max	Units
$I_{QUIESCENT}$	ACL406B @VRECT=20V @25°C	259	380	481	µA
I_{CC}			IQUIESCENT + IVDD (ACL406B)		
P_{LED}*	ACL406B(@25°C), VDIM=VDD, V_{RECT} = 230VAC, R_{SET} = 12 Ω	-10%	7.42	+10%	W
Input VDIM current VDIM = VDD			2.3		µA
VDD voltage		3	3.34	3.6	V
VDD output load				5	mA
Output power derating** - from -40°C to 100°C			*0.1*		*%/°C*
Output power derating - Curie point ($P_T = P_{25°C}/2$)			*175*		*°C*
Package Thermal Resistance Θ_{JA}***			26		°C/W
Package Thermal Resistance Θ_{JC} (JESD15-3 norm)			3		°C/W

Table 4: Electrical parameters

* $P_{LED} = \frac{15.7*ID1*75+18.3*ID2*150+27*ID3*225+23*ID4*300}{100}$

** Power derating acts as a soft over temperature protection. LED current decreases with excessive IC temperature.

*** Warning: Junction-to-air thermal resistance depends greatly on user application and PCB layout. Thermal management of the lighting system has to be carefully managed and taken into account.

10. FONCTIONAL DESCRIPTION

LED Current Setting

For ACL406B the LED current is set by an external resistor R_{SET} and the value of V_{DIM}. Each channel's current sink level is calculated as follows, so ILED for ACL406B at 25°C is:

- $I_{D1}=(32\%*V_{DIM}-0.34)/(9+R_{SET})$ in A,
- $I_{D2}=(32\%*V_{DIM}-0.28)/(9+R_{SET})$ in A,
- $I_{D3}=(32\%*V_{DIM}-0.22)/(9+R_{SET})$ in A,
- $I_{D4}=(32\%*V_{DIM}-0.03)/(9+R_{SET})$ in A.

Over temperature and LED failure Protection.

- In case of excessive temperature in the IC, thermal regulation is managed by regulating the delivered power and the associated temperature. The implemented output power acts as soft temperature protection. The LED current is decreased to regulate the junction temperature until a safe state is found.
- In case of LED failure, the output power derating acts also as a protection. If the group of LED n is broken (open circuit), the LED current will flow in the previous pin Dn-1 of the IC. This will increase dissipated power and temperature too. The output power derating will activate to decrease temperature until a safe state is reached again.

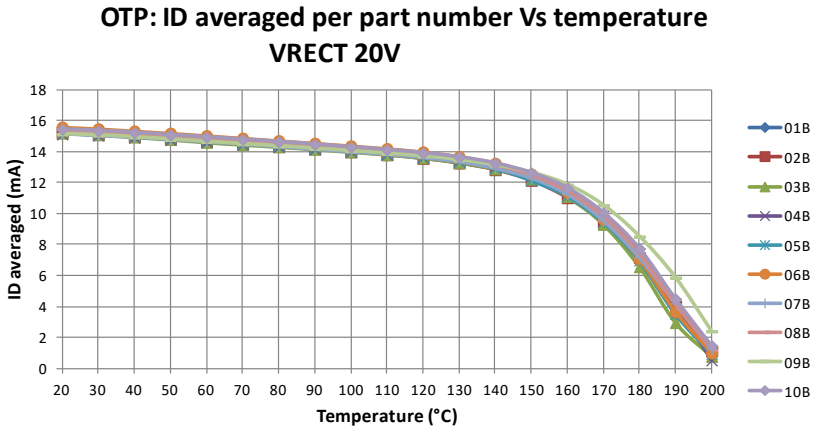


Figure 5: Output LED current derating vs temperature

R_{SET} open/short Protection.

When R_{SET} Pin is opened, the LED output current becomes zero.
When R_{SET} Pin is shorted to GND, a current limitation is enabled. It is set to a hundred of milliamperes and prevents damage to the IC.

VDD short Protection

When VDD Pin is shorted to GND, a current limitation starts up, set to around 25 mA preventing damage to the IC.

11. PACKAGE DESCRIPTION

QFN014 5x5x0.85mm with exposed pad

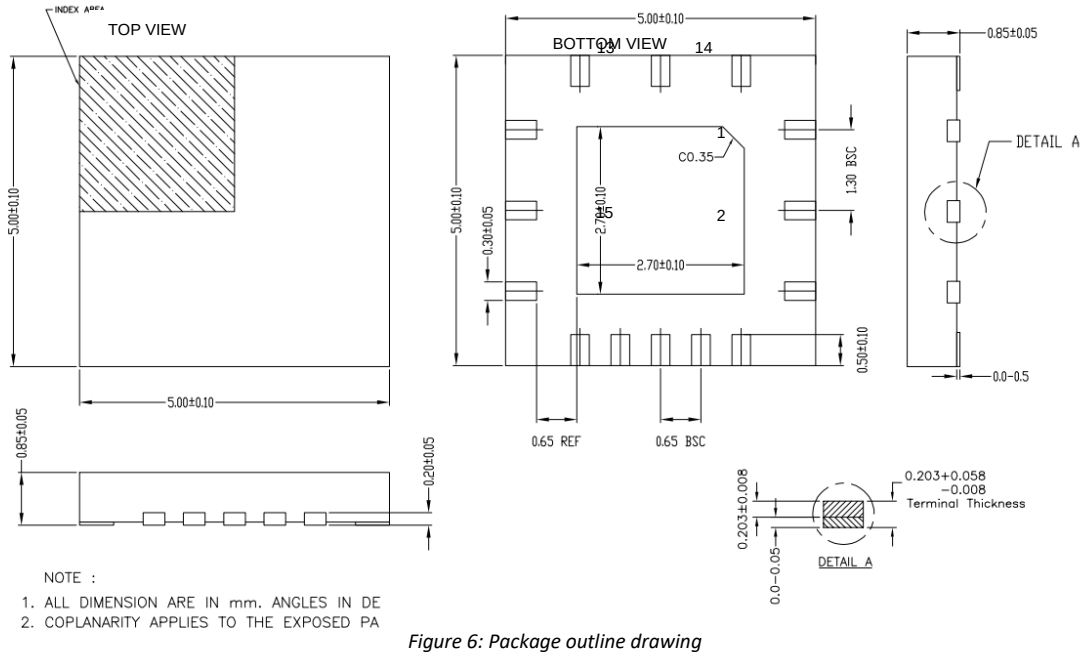
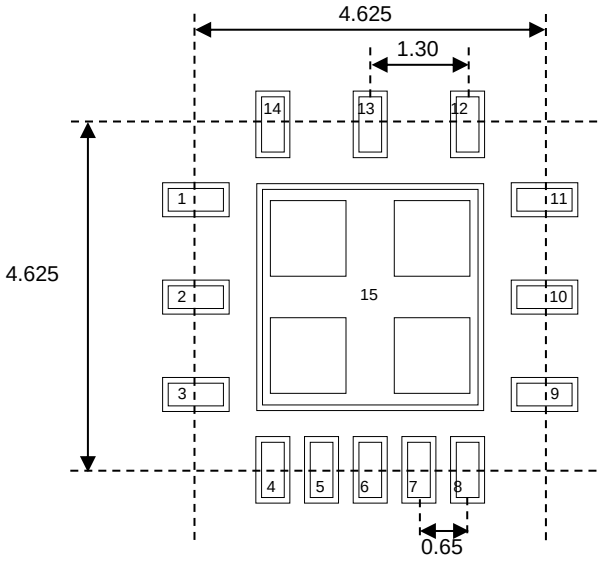


Figure 6: Package outline drawing

PCB Footprint



Pad Top Elec: 0.725 x 0.3 mm
Pad Top Paste: 0.725 x 0.3 mm
Pad Top Solder Resist: 0.875 x 0.45 mm

Thermal Pad Top Elec: 2.85 x 2.85 mm
Thermal Pad Top Paste: 1 x 1 mm (x4)
Thermal Pad Top Solder Resist: 3.0 x 3.0 mm

Figure 7: PCB footprint (TOP view). Size in mm.

12. ORDERING INFORMATION

Device	Package	Shipping*
ACL406B	QFN 5x5	Tape & Reel

Table 5: Ordering references

* Please, ask EASii IC for details of the quantity per reel with the part orientation.

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