



ACL406B - Direct AC Line LED Driver

UP TO 6W OUTPUT

ACL406B-AN-V2.4 – February 2022

Application Notes



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 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 can be used in parallel to drive high power LED systems for industrial applications.

4. PIN CONNECTIONS

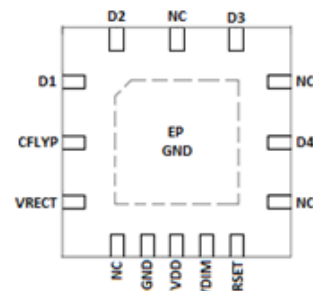


Figure 1: ACL406B QFN5x5 Pinout (TOP VIEW)

5. TYPICAL APPLICATION: 230V_{AC} BULB

Schematic:

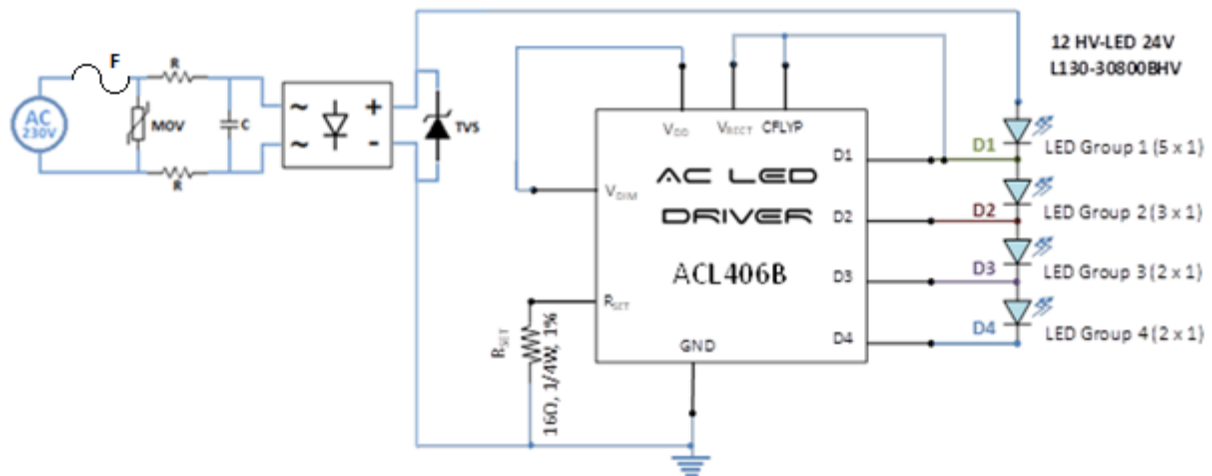


Figure 2: Recommended Low-cost application schematic for 230V_{AC}

Options :

1. $R_{SET} = 31.6 \Omega$, the light is at 502 Lm with 6 LED. In this design, only 7 components + 6 LEDs on the PCB.
2. $R_{SET} = 20 \Omega$, the light is at 696 Lm with 12 LED. In this design, only 7 components + 12 LEDs on the PCB.

Psector	PLED	PLUM	PF	Efficiency	Percentage flicker (%)	Flicker index (%)
7.0 W	6.1 W	720 Lm	0.98	87 %	100 %	33 %

Table 1: Characteristics of the bulb

Calculations of I_{LED} @25°C for each stage are:

- $I_{D1} = (0.32 * V_{DIM} - 0.34) / (9 + R_{SET})$
- $I_{D2} = (0.32 * V_{DIM} - 0.28) / (9 + R_{SET})$
- $I_{D3} = (0.32 * V_{DIM} - 0.20) / (9 + R_{SET})$
- $I_{D4} = (0.32 * V_{DIM} - 0.03) / (9 + R_{SET})$

The LED current is summarized below:

RSET	Conditions	I_{D1}	I_{D2}	I_{D3}	I_{D4}
16 Ω	@25°C - $V_{DIM} = V_{DD}$	29.2 mA	31.6 mA	34.8 mA	41.6 mA

Table 2: LED currents

6. TYPICAL APPLICATION: LIGHT EXAMPLE WITH TWO ACL406B UP TO 900 LUMENS

Schematic:

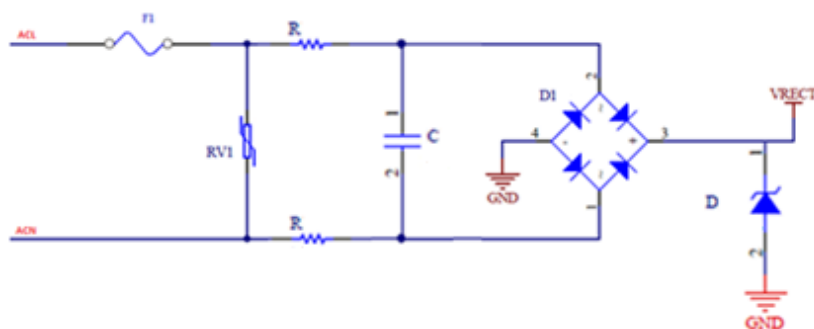


Figure 3: ACL406B AC line in.

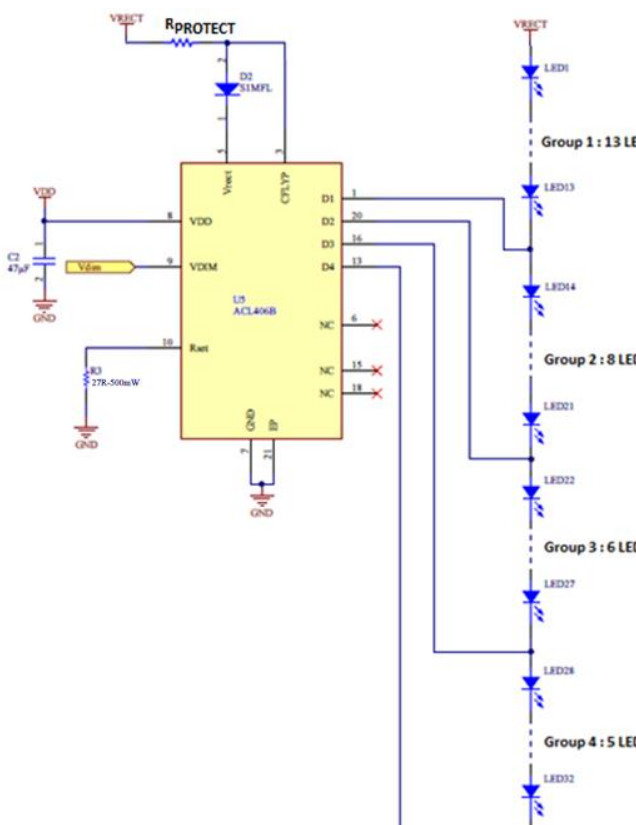


Figure 4: ACL406B #1 controlled by the RF IC on VDIM and 32 LED

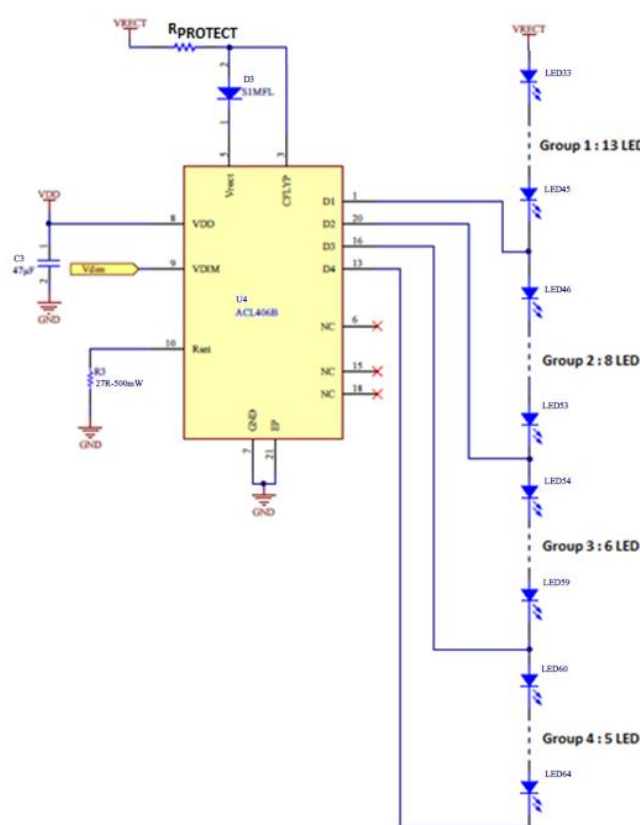


Figure 5: ACL406B #2 controlled by the RF IC on VDIM and 32 LED

The RF microcontroller can control the light with only 1 GPIO connected to the two VDIM on each ACL406B. In this application, it's only a RF switch ON-OFF. With a PWM on VDIM, it's possible to control the intensity of the light (need to add a RC filter). Motion sensor could be used to control VDIM input to switch on/off automatically the light.

For each ACL406B:

R _{SET}	ID ₁	ID ₂	ID ₃	ID ₄	V _{DD}	I _{VDD}
27 Ω	19.3 mA	21.0 mA	23.2 mA	27.9 mA	3.3 V	2.0 mA
P _{CORE}	P _{SWITCH1}	P _{SWITCH2}	P _{SWITCH3}	P _{SWITCH4}	P _{REGULATOR}	P _{IC_TOTAL}
0.07 W	0.14 W	0.11 W	0.13 W	0.16 W	0.45 W	1.07 W
Percentage FLICKER	FLICKER INDEX	Light Flux	Power LED			
100 %	32.8 %	465 lm	4.06 W			

Table 3: Electrical characteristics for one ACL406B

For this design with two ACL406B:

P _{SECT}	I _{SECT}	PF	EFF.	Light Flux	Light Power Σ P _{LED}
10.16 W	44.9 mA	0.98	79.9 %	900 lm	8.12 W
V _{DD}	I _{VDD}				
3.3 V	4.0 mA				

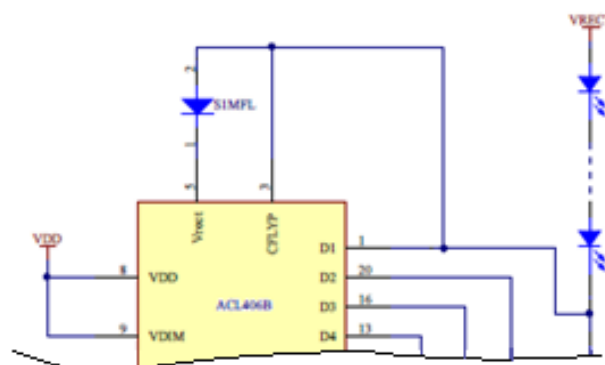
Table 4: Electrical characteristics for the bulb

BOM:

Item	QTY	Designator	Description
1	2	C2, C3	Capacitor Ceramic 47µF - 6.3V - X5R - 0805
2	1	C	Capacitor MLCC – 450V - X7T - 20% - 1210
3	1	D1	Bridge Rectifier MB6S - 500mA 600V SMD TO-269AA
4	1	D	DIODE TVS - 376V - 602V
5	2	D2, D3	1 Amp Rectifier 1000 V
6	1	F1	FUSE SMD - 250mA – Slow - 250VAC
7	64	LED1 to LED64	LED – White 4000K - VF=9.4V, IF=60mA, 113lm/W, 0.5W
8	2	R	Resistor SMD 5% 1.5W 250V
9	2	R6, R9	Resistor SMD 27 OHM 1% 1/2W 0805
10	2	R _{PROTECT}	Resistor 1k SMD
11	1	RV1	Varistor 275Vac 8.6 joules
12	2	U5, U4	Direct AC Line LED Driver ACL406B

Table 5: BOM for the bulb

Remark: to change this design without microcontroller, on each ACL406B the pin VDIM are connected with the pin VDD, the pin VRECT and the pin CFLYP are connected like this example:



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EASii IC France: 90, Avenue Leon Blum 38100 Grenoble – France

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✉ : sales-IC@easii-ic.com

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