ACL410D - Direct AC Line LED Driver

UP TO 10W OUTPUT

ACL410D-AN-V2.2 – JUNE 2021

Application Notes

MATURITY
In Production

1. FEATURES

ACL410D UP TO 10W 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% (typical),
- Low quiescent current: 350µA,
- High Efficiency: 85% typical,
- Ultra-Flexible LED Forward Voltage Configuration,
- Up to 4 LED stages capability,
- Low Flicker: according to applications (need to external components: see application note for more information),
- Percentage flicker : 25%,
- Flicker index : 10%,
- Over Temperature Power derating,
- Enable and Analog/PWM dimming functions 0-3.3V,
- Embedded 3.3V DC regulator for connected devices (up to 40mA DC current consumption),

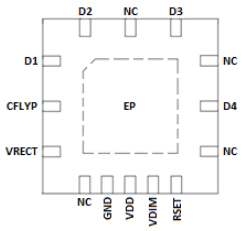
2. APPLICATIONS

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

3. DESCRIPTION

The ACL410D 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 VDIM pin of the ACL410D. The VDIM pin supports analog dimming or digital PWM.
The ACL410D embeds a linear DC/DC regulator delivering an output voltage of 3.3V to supply external devices such as low-power RF microcontroller.
Multiple ACL410D AC line drivers can be used in parallel to drive high power LED systems for industrial applications.

4. PIN CONNECTIONS



QFN 5x5mm with exposed pad (TOP VIEW)

5. TYPICAL APPLICATION: 230V_{AC} LOW-COST BULB

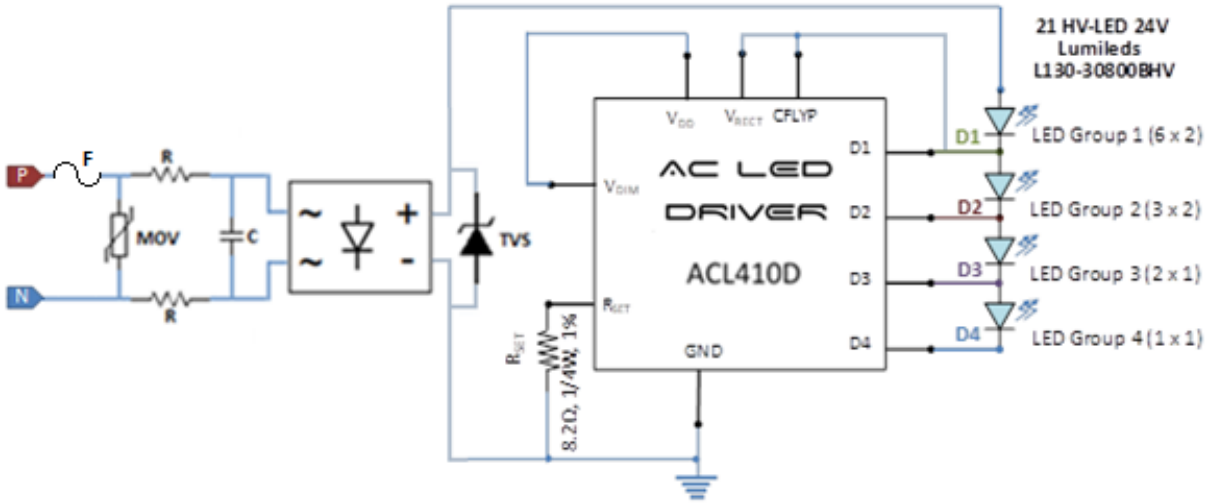


Figure 1: Low-cost application schematic for 230V_{AC}

LED Group (a x b) description:

A LED group is defined by a number "a" of LEDs in series and a number "b" of LEDs in parallel.

P_{sector} (W)	P_{LED} (W)	P_{LUM} (lumen)	PF	Efficiency (%)	Percentage flicker (%)	Flicker index (%)
11.6	10.3	1200	0.97	88	100	36

Table 1: Electrical characteristics for the bulb

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

- I_{D1} = (0.32*V_{DIM}-0.36)/(5.9+R_{SET})in A,
- I_{D2} = (0.32*V_{DIM}-0.3) /(5.9+R_{SET}) in A,
- I_{D3} = (0.32*V_{DIM}-0.22)/(5.9+R_{SET}) in A,
- I_{D4} = (0.32*V_{DIM}-0.05)/(5.9+R_{SET}) in A.

In this application, the LED current is summarized below:

R_{SET} (Ω)	condition	ID_1 (mA)	ID_2 (mA)	ID_3 (mA)	ID_4 (mA)
8.2	V_{DIM} = V_{DD}	50.3	54.5	60.2	72.3

Table 2: current in LED

It's compulsory to make the full tests and qualifications of this design before to place it in the market.

6. TYPICAL APPLICATION: 230V_{AC} LOW-COST RF LIGHTING CONTROL

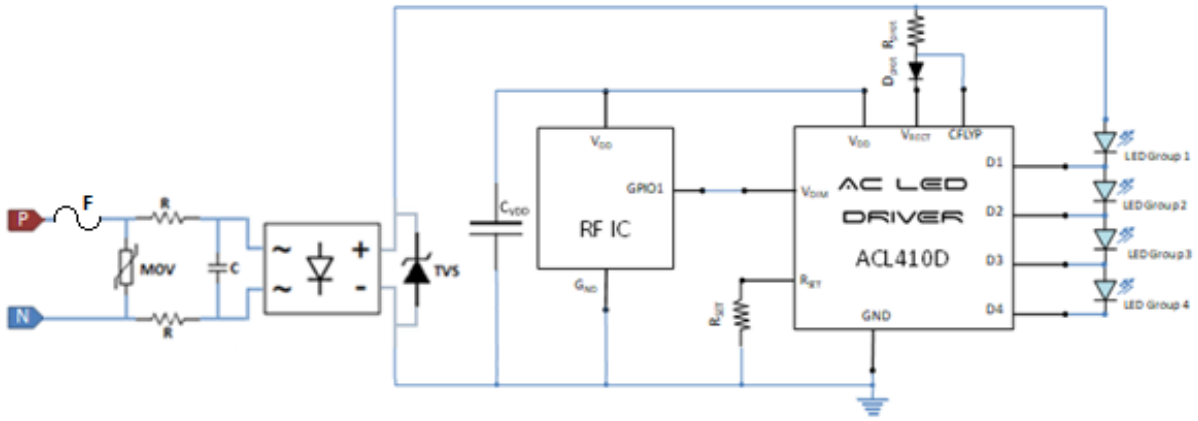


Figure 2: Low-cost application schematic for 230V_{AC} RF lighting control

HV LEDs are recommended for LED groups in order to get compact and efficient lighting solutions (see voltage difference D_{n-1}-D_n (2≤n≤4) in part "Operating conditions").

It's compulsory to make the full tests and qualifications of this design before to place it in the market.

7. TYPICAL APPLICATION: TWO ACL410D WITH RF LIGHTING CONTROL FOR TWO TYPES OF WHITE LED

Schematics:

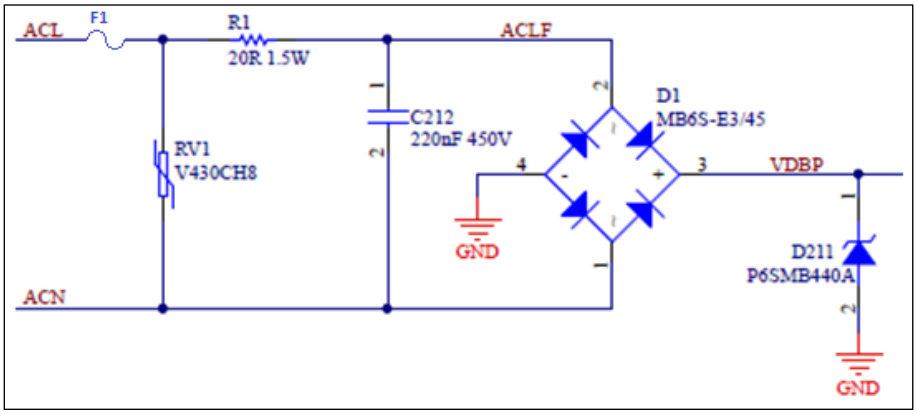


Figure 3: 230VAC Input with protections.

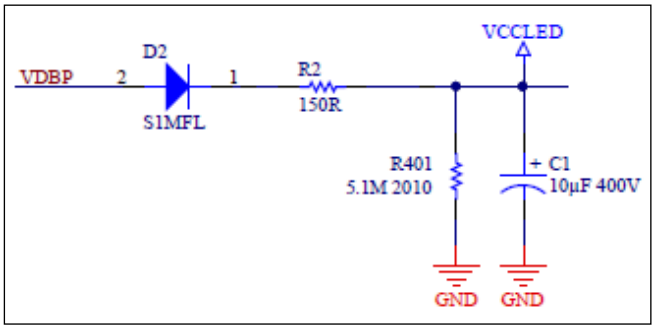


Figure 4: Power supply for the LED in Zero Flicker mode.

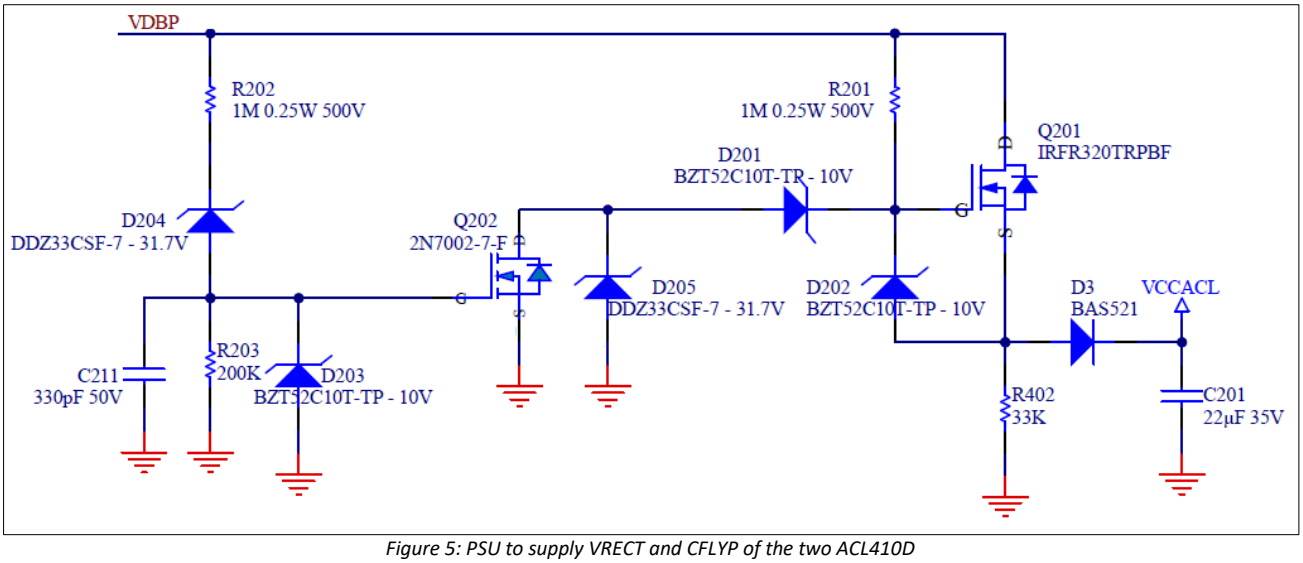


Figure 5: PSU to supply VRECT and CFLYP of the two ACL410D
This PSU reduce the power dissipation in the ACL410D to provide 8mA for the RF device.
To replace this PSU, it's possible to use the ACP2500. It's a cost and surface reduction with Zero Crossing detection.

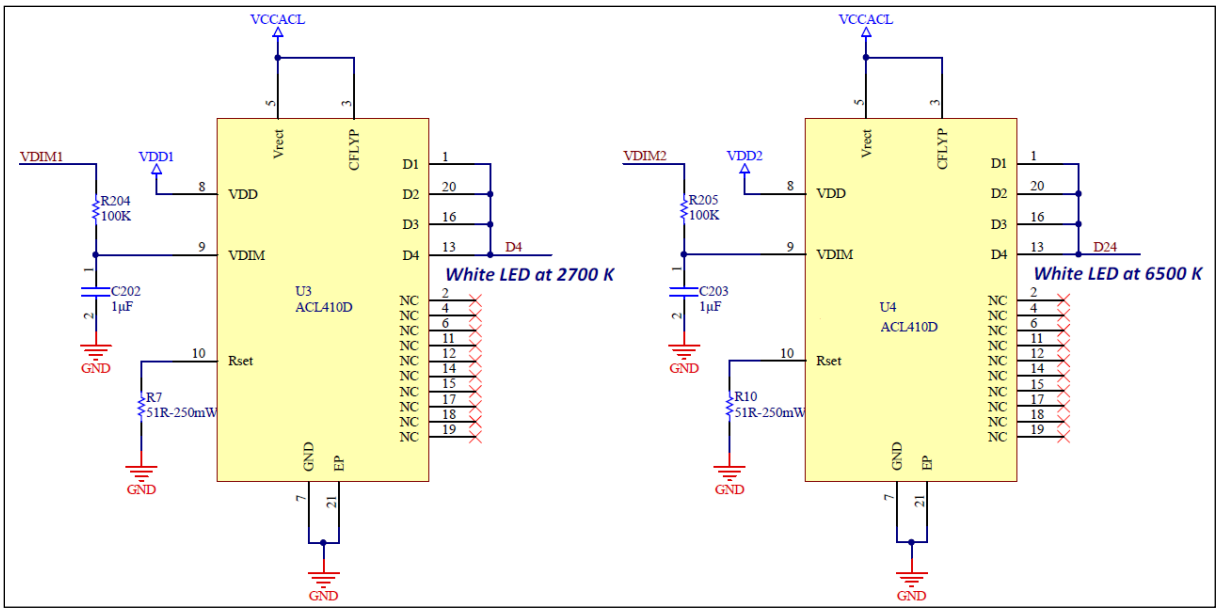


Figure 6: Two ACL410D to control 2 types of white LEDs

Zero Flicker design: D1, D2, D3 and D4 are connected. VDIM1 & VDIM2 are a PWM (from the RF part) to control the light intensity of the LED at 2700K and at 6500K.

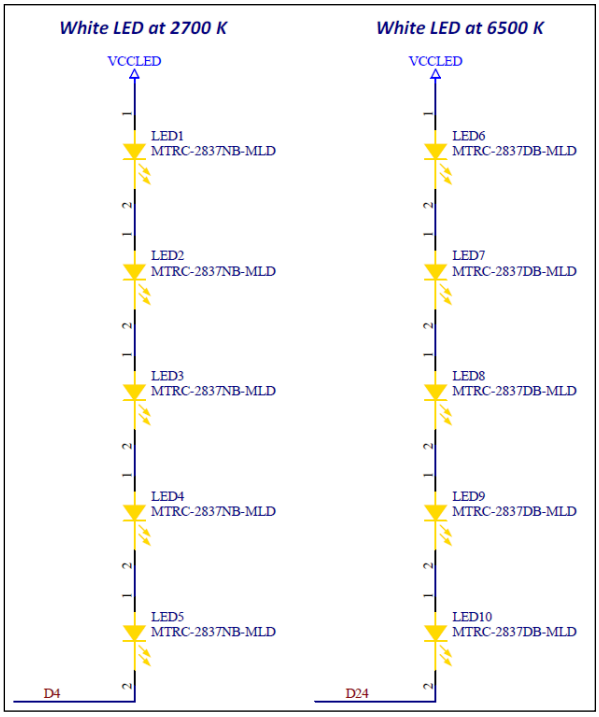


Figure 7: 2 types of white LEDs

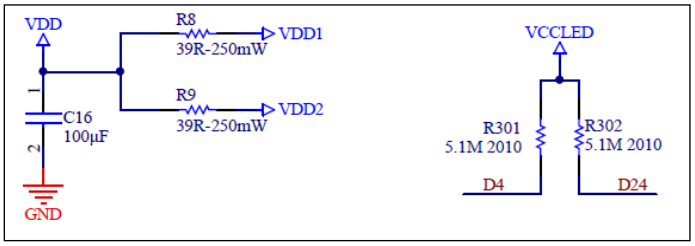


Figure 8: VDD is the power for the RF part. It's the merge of the LDO of the ACL410D to provide 8mA (2 x 4mA).
R301 and R302 are in parallels with the LED in the case of the LED have a very small conduction (and light) when VDIM1 and/or VDIM2 is at 0V to switch off the light with the RF microcontroller.

BOM:

Item	QTY	Designator	Comment	Description
1	1	C1	10µF400V	CAP ALUM 10µF 400V 20%
2	1	C16	100µF	Capacitor, Ceramic, 100µF, 6.3V, 20%, X5R, 1206
3	1	C201	22µF35V	CAP CER 22UF 35V X5R 1206
4	2	C202, C203	1µF	Capacitor, Ceramic, 1µF, 6.3V, 10%, X5R, 0402
5	1	C211	330pF	Capacitor, Ceramic, 330pF / 50V / X7R, 0402
6	1	C212	220nF450V	Capacitor MLCC 1210 450V 0.22uF X7T 20% T2mm
7	1	D1	MB6S-E3/45	Bridge Rectifier 500mA 600V SMD TO-269AA
8	1	D2	S1MFL	1 Amp Rectifier 1000 Volts
9	2	D3, D206	BAS521	Diode Standard 300V 250 mA (CC) SOD-523
10	3	D201, D202, D203	BZT52C10T-TP-10V	DIODE ZENER 10V 100mW SOD523
11	2	D204, D205	DDZ33CSF-7-31.7V	DIODE ZENER 31.7V 500mW SOD323F
12	1	D211	P6SMB440A	DIODE TVS 376V 602V DO214AA
13	1	F1	Fuse	250VAC
14	1	Q201	IRFR320TRPBF	MOSFET N-CH IRFR320TRPBF 400V 3.1A DPAK
15	1	Q202	2N7002-7-F	N Channel 60V / 115mA / 370mW / STO23-3
16	5	LED1 to LED5	MTRC-2837NB-MLD	LED 48V, 20mA, 2700K, BIN=2, 100Lm, code WA9,case 2835
17	5	LED6 to LED10	MTRC-2837DB-MLD	LED 48V, 20mA, 6500K, BIN=5, 120Lm, code 65M,case 2835
18	1	R1	20R 1.5W	Resistor 20R, 1%, 1.5W, 500V 2512
19	1	R2	150R	Resistor 150 Ohm 1% 1.25W 400V 2010 Thick Film
20	2	R7, R10	51R-250mW	RES SMD 51 OHM 1% 1/4W 0603
21	2	R8, R9	39R-250mW	RES SMD 39 OHM 5% 1/4W 0603
20	2	R201, R202	1M0.25W500V	RES SMD 1M OHM 5% 1/4W 500V 1206
21	1	R203	200K	Resistor, Thin Film, 200K, 1%, 1/16W, 0402
22	2	R204, R205	100K	RES SMD 100K OHM 5% 1/20W 0201
23	3	R301,R302, R401	5.1M2010	RES SMD 5.1M OHM 5% 3/4W 2010
24	1	R402	33K	RES SMD 33K OHM 5% 1/10W 0402
25	1	RV1	V430CH8	VARISTOR 430V 250A 2SMD
26	2	U3, U4	ACL410D	Direct AC Line LED Driver

Table 3: BOM dual ACL410D

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