ACL410D - Direct AC Line LED Driver

UP TO 10W OUTPUT

ACL410D-DS-V1.2 – February 2022

Datasheet

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,
- 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

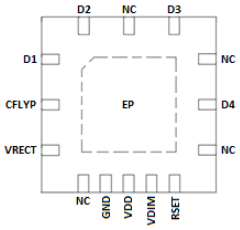

Figure 1: QFN 5x5mm with exposed pad (TOP VIEW)

5. TYPICAL APPLICATIONS

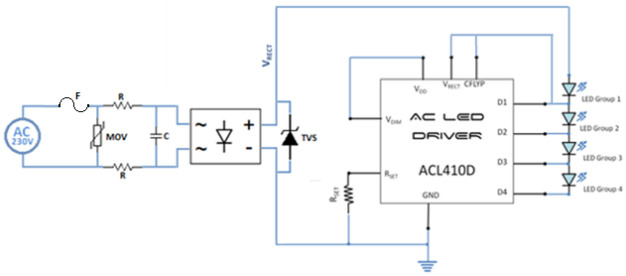

Figure 2: Low-cost application schematic for 230V_{AC}

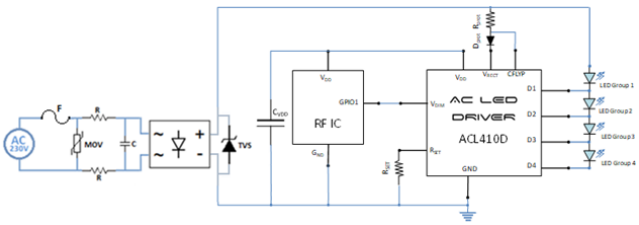

Figure 3: RF lightning control application schematic for 230VAC

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

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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
V_{RECT}	3	PWR	Power supply for 3.3V regulator
NC	4		
GND	5	GND	ground
V_{DD}	6	IO	Regulator output 3.3V
V_{DIM}	7	IO	Analog input for analog/PWM dimming
R_{SET}	8	IO	Resistor to set the max LED current
NC	9	NC	
D4	10	IO	Cathode LED group 4
NC	11		
D3	12	IO	Cathode LED group 3
NC	13		
D2	14	IO	Cathode LED group 2
EP	15	GND	Exposed Pad connected to the GND

Table 1: Pin description and functions

ACL410D Pin Mapping (QFN 5x5x0.85mm with exposed pad)

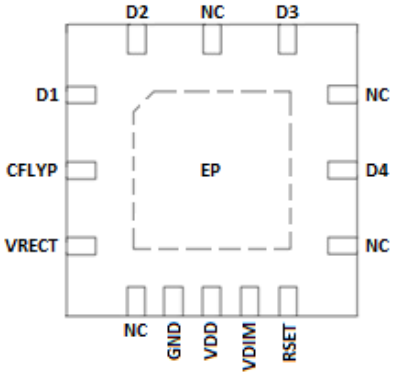


Figure 4: Pin mapping

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°C		175°C	°C
$T°_{storage}$	-55°C		150°C	°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 **ACL410D** 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 ACL410D 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 on V_{RECT} (V_{RECT} x $Iload_{VDD}$)*			1.15	W
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}	5.9		59	Ω
V_{DIM}	0		VDD	V
Load Current V_{DD} ($Iload_{VDD}$)*			40	mA
Load Capacitance V_{DD}**	47			µF
$T°_{junction}$	-40		125	°C

Table 3: Operating conditions

* Consider power dissipation of IC, thermal management of lighting system has to be carefully taken into account. VDD output power supply is provided by a linear DC regulator with VRECT input power supply.
** If external V_{DD} is used to supply another device.

Electrical Parameters

Parameter	Conditions	Min	Typ	Max	Units
$I_{QUIESCENT}$		243	347	451	µA
I_{CC}			$I_{QUIESCENT}$ + I_{VDD}		
P_{LED*}	V_{DIM} = V_{DD} (@25°C) V_{RECT} = 230VAC R_{SET}=12Ω	-10%	8.6	+10%	W
Input V_{DIM} current		0		4	µA
V_{DD} voltage		3	3.34	3.6	V
V_{DD} output load				40	mA
Power output derating** Curie point (P_T = $P_{25°C}$/2)			175		°C
Power output derating* from -40°C to 100°C			0.1		%/°C
Package Thermal Resistance Θ_{JA}*** (junction to air thermal resistance)			26		°C/W
Package Thermal Resistance Θ_{JC} (JESD15-3 norm)			2.5		°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 currents decrease with excessive IC temperature.
*** Warning: Junction-to-air thermal resistance highly depends on application and PCB layout. Thermal management of lighting system has to be carefully taken into account.

10. FONCTIONAL DESCRIPTION

LED Current Setting

For ACL410D the LED current is set by an external resistor R_{SET}. Each channel's current sink level is calculated as follows:

Parameter	Conditions	value	Units
ILED	@25°C	I_{D1} = (0.32*VDIM-0.36)/(5.9+RSET)	A
		I_{D2} = (0.32*VDIM-0.3) /(5.9+RSET)	
		I_{D3} = (0.32*VDIM-0.22)/(5.9+RSET)	
		I_{D4} = (0.32*VDIM-0.05)/(5.9+RSET)	

Table 5: LED current setting

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 D_{n-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.

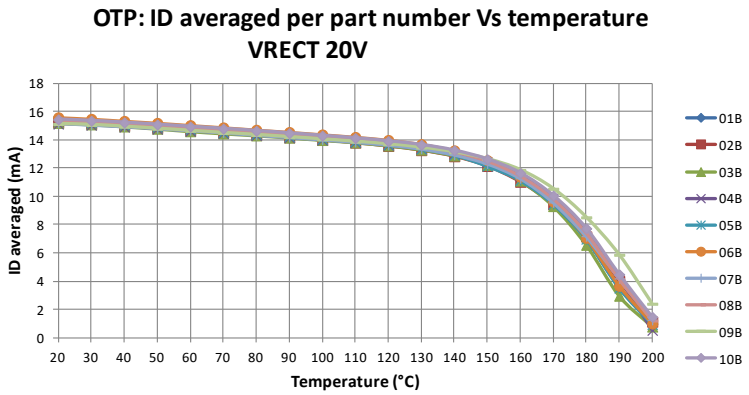


Figure 5: Output LED current derating vs temperature

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.

11. PACKAGE DESCRIPTION

QFN014 5x5x0.85mm with exposed pad

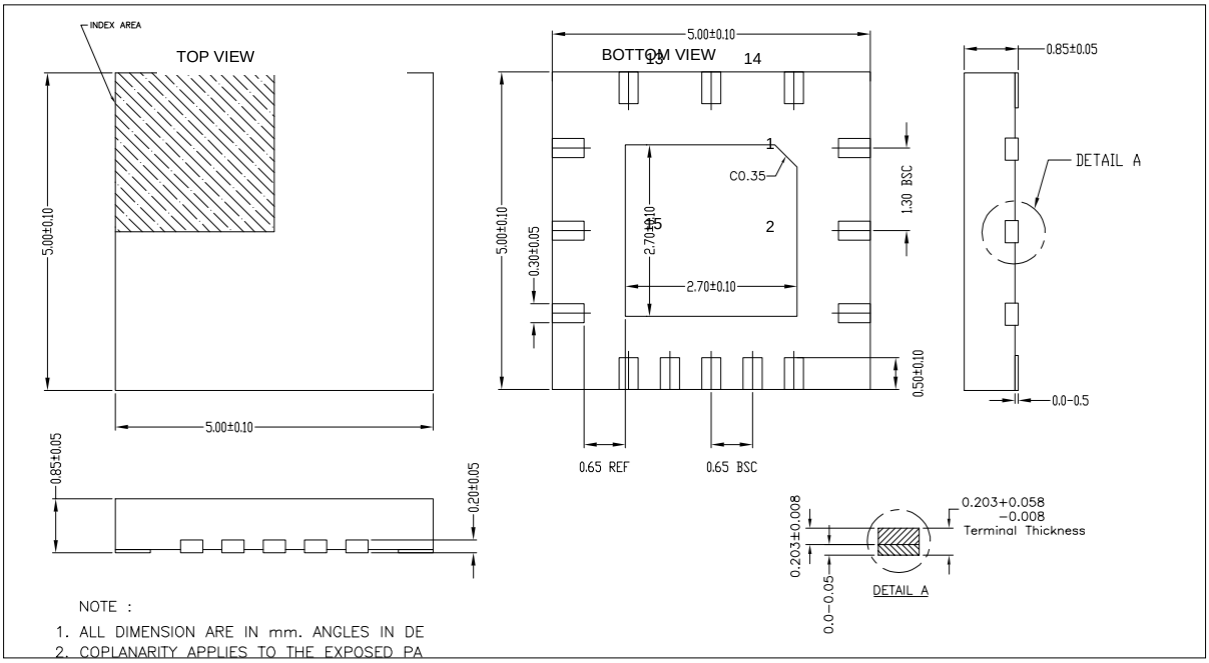
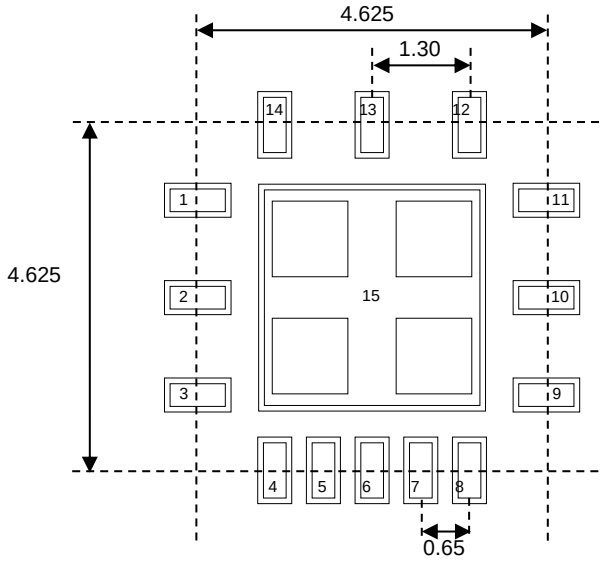


Figure 6: Package outline drawing

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)

12. ORDERING INFORMATION

Device	Package	Shipping*
ACL410D	QFN14 5x5mm	Tape & Reel

Table 6: Ordering reference

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

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

✉ : sales-IC@easii-ic.com
http://www.easii-ic.com