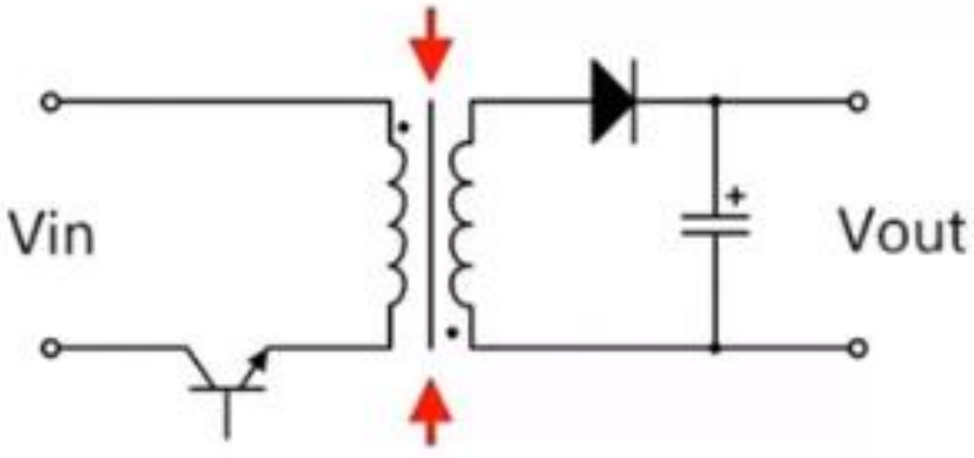
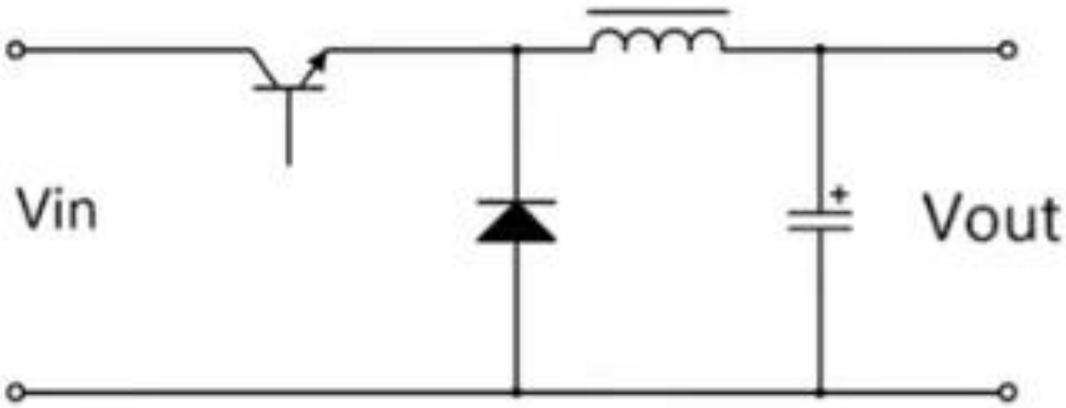
Fixture Design Instruction with Non-isolated Driver

LED Driver Design : Isolated vs. Non-Isolated Differences



Isolated LED Driver

There is no direct electrical connection between the input and output circuits of the power supply, and the input and output are in a high resistance state



Non-Isolated LED Driver

There is a direct connection between the input and output.

LED Driver Design : Isolated vs. Non-Isolated Differences

Lifud
Technology | Quality | Service

- **Efficiency**
  - Non-isolated drivers are 1-6% more efficient
  - can translate to higher overall system efficacy

- **Surge Protection**
  - Isolated drivers have better inherent surge protection
  - Non-isolated drivers compensate by using higher surge protection components

- **Dimming**
  - 0-10V dimming is always isolated in any LED driver design due to safety standards

- **Safety regulation**
  - Isolated drivers inherently meet safety regulations due to insulation disctances between input and output
  - Non-isolated drivers require additional protections to meet safety regulations

- **Size**

Non-isolated drivers can achieve smaller form factors for the same power
They also weigh less than their isolated counterparts

- **Cost**
  - Non-isolated drivers are more cost-effective compared to their isolated counterparts (cut down 30-40%)
  - Smaller form factor and weight also allows non-isolated driver design to save on packaging and shipping costs

Creepage Distance of Light Fixture’s Aluminum Substrate (between LED board’s layout and earth wire)

LiFud
Technology | Quality | Service

Design instruction

Firstly, Class I light fixtures need to be basically insulated.

e.g. LED driver LF-FAAxxx series [maximum output voltage: Uout310V (RMS)]

- **EU-Standard light fixtures:**

  According to the difference method: 310V is between 250V and 500V

  =3.1mm (basic insulation)

- **US-Standard light fixtures:**

  According to the minimum creepage distance: 310V is between 301V and 450V

  ≥0.0059*310V+2.09=3.919mm≈4.0mm

- **EU-Standard & US-Standard light fixtures:**

  ≥4.0mm (in accordance with US-Standard)

Thus, for example, if Lifud LED driver LF-FAAxxx is used, the creepage distance needs to be ≥4.0mm.

* When using a non-isolated LED driver, please pay attention that the creepage distance from aluminum substrate’s circuit to protective grounding wire (including radiators’ sectional materials and fixed metal screw caps) comply with the minimum requirement.

16.2.2 Minimum creepage distances for working voltages

Table 7 defines the minimum creepage distance values for working voltages.

Table 7 – Minimum creepage distances for working voltage

Distances mm		RMS working voltage not exceeding V					
		50	150	250	500	750	1 000
Creepage distances [a]							
– Basic or supplementary insulation PTI [b]	≥ 600	0,6	0,8	1,3	2,5	3,8	5,0
	< 600	1,2	1,6	2,5	5,0	7,6	10
– Reinforced insulation PTI [b]	≥ 600	–	1,6	2,6	5,0	7,6	10
	< 600	–	3,2	5,0	10	16	20

Linear interpolation between columns is allowed.

NOTE In Japan and North America, the values defined here are not applicable. Japan and North America require larger values.

[a] For creepage distances the equivalent d.c. voltage is equal to the r.m.s. value of the sinusoidal a.c. voltage.

[b] PTI (proof tracking index) in accordance with IEC 60112.

IEC/EN61347

Table 7.5
Spacings on printed wiring boards and for board-mounted components

Locations	Maximum voltage between parts, Vrms (Vpeak=1.4 Vrms) 0 – 50	51 – 150	151 – 300	301 – 450	451 – 600
	Minimum spacings in millimeters (inches) [through air/over surface distance]				
Parts potted or conformal coated	–/0.18[a] (–/0.007)	–/0.3[a] (–/0.012)	–/0.7 (–/0.028)	–/0.8 (–/0.030)	–/0.8 (–/0.030)
Live parts reliably positioned AND insulator with CTI ≥ 600 (PLC = 0)[b, e, f]	0.2/0.6 (0.008/0.025)	0.5/0.8 (0.020/0.030)	1.5/1.5 (0.060/0.060)	2.25/2.25 (0.090/0.090)	3.0/3.0 (0.120/0.120)
Live parts reliably positioned AND insulator with CTI ≥ 100 (PLC ≤ 4)[c, e, f]	0.2/1.2 (0.008/0.045)	0.5/1.6 (0.020/0.065)	1.5/3.0 (0.060/0.120)	2.25/4.5 (0.090/0.175)	3.0/6.1 (0.120/0.250)
1) Parts on a printed wiring board and Board mounted components that are soldered in place but can move in production prior to soldering to fixed parts[d, e] or 2) Uninsulated live parts on a printed wiring board (including the traces) to grounded or accessible dead metal that can deflect[d, e] or 3) Uninsulated live parts on board mounted components to grounded or accessible dead metal that can deflect[d, e]	3.0/– (0.120/–)	3.0/– (0.120/–)	3.9/– (0.155/–)	4.7/– (0.185/–)	5.6/– (0.220/–)
Live parts and dead conductive parts in a conventional magnetic device construction where the coil size can vary due to random wind OR where coil assembly placement can vary in production	(0				

NOTE: D = distance in millimeters, V = voltage in v

[a] Or as determined from the investigation of the cor

[b] Linear interpolation is permitted for over surface d

[c] Linear interpolation is permitted for over surface d

Table 7.5 Continued

Locations	Maximum voltage between parts, Vrms (Vpeak=1.4 Vrms) 0 – 50	51 – 150	151 – 300	301 – 450	451 – 600
	Minimum spacings in millimeters (inches) [through air/over surface distance]				

for V ≤ 160, **D = 0.004V + 1.0**
for V > 160, **D = 0.01V**

[a] Linear interpolation is permitted for through air distance to be calculated by the following formula:
for 150 < V < 600, **D = 0.0059V + 2.09**

[e] Deflection refers to reduction in spacings due the mechanical tests in 8.15. Compliance is determined after the sample has been tested per mechanical tests in 8.15.

[f] i.e., a) Adjacent PWB traces, b) Lead pins of board mounted components (e.g. semiconductor devices to their mounting surface(s) that cannot deflect, or c) PWB traces to adjacent grounded or accessible dead metal that cannot deflect.

UL8750Table7.5

Creepage Distance of Light Fixture's Aluminum Substrate (between the layouts on the LED board)

LiFud® Technology | Quality | Service

Design instruction

e.g. LED driver LF-FAAxxx (Uout: 310V)

According to the IPC-2221APCB standard (shown in the right figure), the creepage distance between the layouts on the LED board shall be

≥1.25mm (if available)

<1.25mm (in the low voltage area)

Table 6-1 Electrical Spacing of Leading Wire

Voltage Between Wires (peak value of AC or DC)	Minimum						
	Bare Board				Assembly Parts		
	B1	B2	B3	B4	A5	A6	A7
0-15	0.05mm [0.00197in]	0.1mm [0.0039in]	0.1mm [0.0039in]	0.05mm [0.00197in]	0.13mm [0.00512in]	0.13mm [0.00512in]	0.13mm [0.00512in]
16-30	0.05mm [0.00197in]	0.1mm [0.0039in]	0.1mm [0.0039in]	0.05mm [0.00197in]	0.13mm [0.00512in]	0.25mm [0.00984in]	0.13mm [0.00512in]
31-50	0.1mm [0.0039in]	0.6mm [0.024in]	0.6mm [0.024in]	0.13mm [0.00512in]	0.13mm [0.00512in]	0.4mm [0.016in]	0.13mm [0.00512in]
51-100	0.1mm [0.0039in]	0.6mm [0.024in]	1.5mm [0.0591in]	0.13mm [0.00512in]	0.13mm [0.00512in]	0.5mm [0.020in]	0.13mm [0.00512in]
101-150	0.2mm [0.0079in]	0.6mm [0.024in]	3.2mm [0.126in]	0.4mm [0.016in]	0.4mm [0.016in]	0.8mm [0.031in]	0.4mm [0.016in]
151-170	0.2mm [0.0079in]	1.25mm [0.0492in]	3.2mm [0.126in]	0.4mm [0.016in]	0.4mm [0.016in]	0.8mm [0.031in]	0.4mm [0.016in]
171-250	0.2mm [0.0079in]	1.25mm [0.0492in]	6.4mm [0.252in]	0.4mm [0.016in]	0.4mm [0.016in]	0.8mm [0.031in]	0.4mm [0.016in]
251-300	0.2mm [0.0079in]	1.25mm [0.0492in]	12.5mm [0.4921in]	0.4mm [0.016in]	0.4mm [0.016in]	0.8mm [0.031in]	0.8mm [0.031in]
301-500	0.25mm [0.00984in]	0.25mm [0.0984in]	12.5mm [0.4921in]	0.8mm [0.031in]	0.8mm [0.031in]	1.5mm [0.0591in]	0.8mm [0.031in]
>500	0.0025 mm/V	0.005 mm/V	0.025 mm/V	0.00305 mm/V	0.00305 mm/V	0.00305 mm/V	0.00305 mm/V

B1– Internal leading wire

B2– External leading wire without coating; sea level to 3050m [10, 007ft]

B3– External leading wire without coating; sea level exceeds to 3050mm [10, 007ft]

B4– External leading wire with permanent polymer coating (sea level is random)

A5– External leading wire with conformal coating on assembly parts (sea level is random)

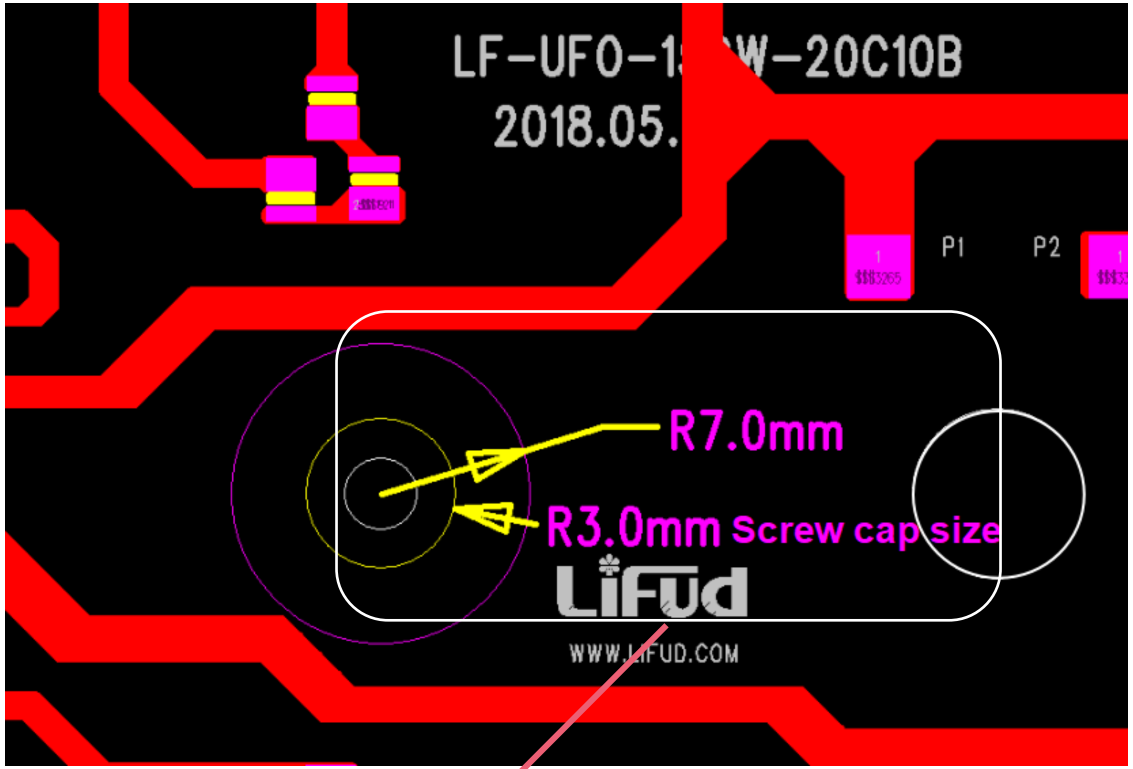
A6– Leading wire/butting of external assembly parts without coating; sea level to 3050m [10, 007ft]

A7– Leading wire and butting of external assembly parts with conformal coating (sea level is random)

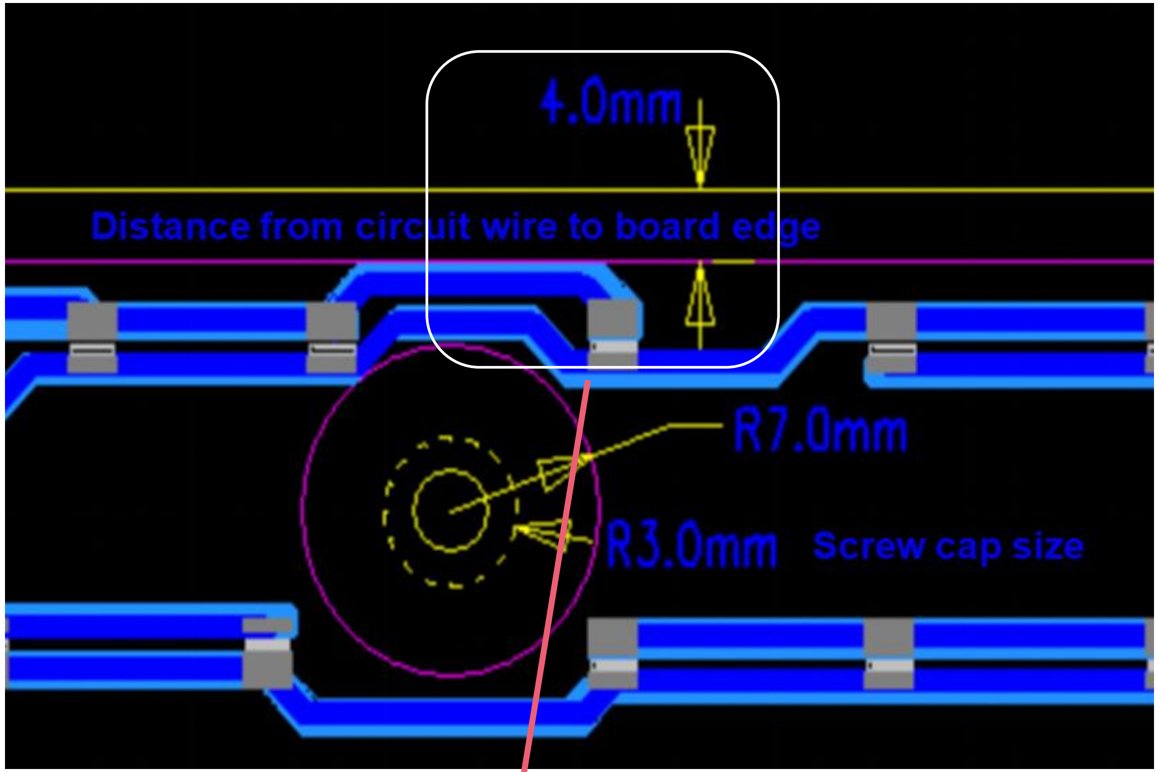
IPC-2221A
Generic Standard on Printed Board Design

Creepage Distance of Light Fixture's Aluminum Substrate (Examples)

Technology | Quality | Service



Safety standard of round aluminum substrate:
4.0mm (between screw cap margin and circuit wire)



Safety standard of linear aluminum substrate:
4.0mm (between circuit wire to board edge)

Withstanding Voltage of Light Fixture's Aluminum Substrate

How to avoid over-large leakage current in the design?

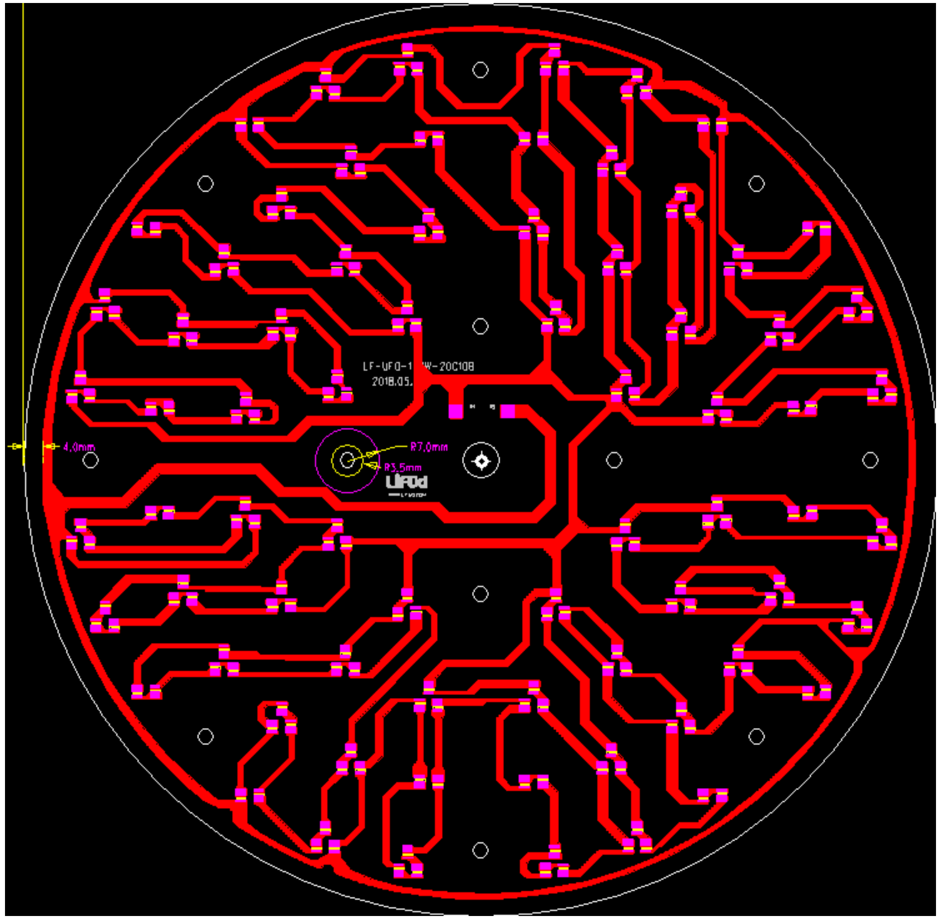
Cause: the aluminum substrate is extremely close to the copper foil, which makes the near-field effect obvious and almost equivalent to the capacitance generated by two planar conductive boards.

Thus, the larger the area of copper foil on the LED board, the larger the parasitic junction capacitance and the larger the leakage current.

Solution: the area of copper foil on the LED board should be as small as possible provided that it is suitable for the current. If it is too large, the parasitic junction capacitance of aluminum substrate will be increased, resulting in larger leakage current and even the failure of withstanding voltage test (as shown in the right figure).

Calculation formula of planar capacitance: C=ε*ε0*S/d
(main international system of units applied)
C: capacitance; unit: F;
ε : relative permittivity: 4.3;
ε0: vacuum permittivity: 8.86*10^ (-12); unit: F/m;
S: square; unit: m^2;
d: plate distance; unit: m;

* When using Lifud LED driver (driver's residual voltage <2kVac), please pay attention that the withstanding voltage of aluminum substrate be › 2kVac (AC) or 2.8kVdc (DC) and the leakage current be <3mA. In this way, the LED beads can be effectively protected during various applications.



Attentions During Light Fixture’s Production

1. It is recommended that manufacturer conduct insulation resistance test and grouding resistance test instead of Hi-pot test on light fixtures to protect LEDs as much as possible.

2. The withstanding voltage ability of aluminum substrate is of great importance. Thus, it is necessary for manufacturers to conduct Hi-pot test with fixtures on all the aluminum substrates so that the withstanding voltage ability of every aluminum substrate is qualified.

3. When conducting the burn-in test on the whole light fixtures, please connect them to the grounding wires to avoid defective products with electrical leakage aluminum substrates from being shipped to customers.