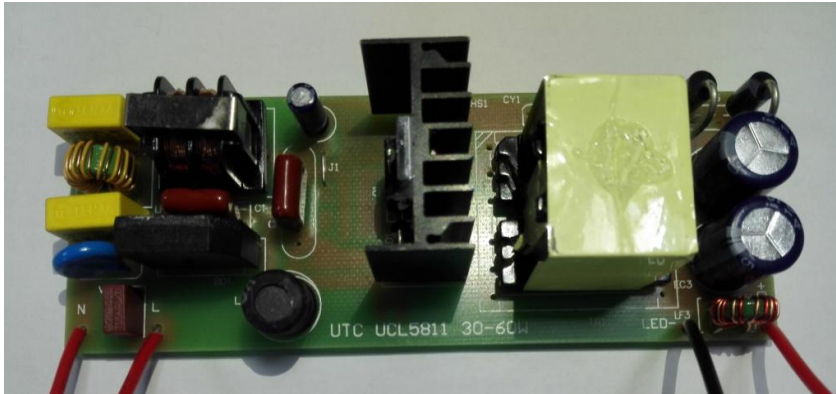




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## 60W LED Driver Module Using UCL5811

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### Subject

### UCL5811 Isolated LED Driver\_60W\_1.25A\_Demo Board Manual

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#### Key features:

- AC Input Range 90Vac~264Vac
  - High Efficiency(90%@230Vac,full load)
  - High PF(0.951@230Vac,full load)
  - Excellent line voltage regulation and load regulation(<±3%)
  - Multiple protection functions and high reliability
- 

#### Revision History

| Revise Date | Version | Reason/Issue |
|-------------|---------|--------------|
| 2016/12/28  | A       | First Issue  |



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# 60W LED Driver Module Using UCL5811

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## 1. LED Demo Board Specification

### 1.1. Input Characteristics

- AC input voltage rating 100Vac ~ 240Vac
- AC input frequency range 90Vac~264Vac
- AC input frequency range 47Hz ~ 63Hz

### 1.2. Output Characteristics

- Output Voltage 36Vdc~48Vdc
- Typical output current 1.25A

### 1.3. Performance Specifications

- Maximum Output Power 60W

### 1.4. Protection Function

- Short Circuit Protection Shut down and auto recovery
- Open Loop Protection Shut down and auto recovery
- OTP Shut down and auto recovery

### 1.5. Environment

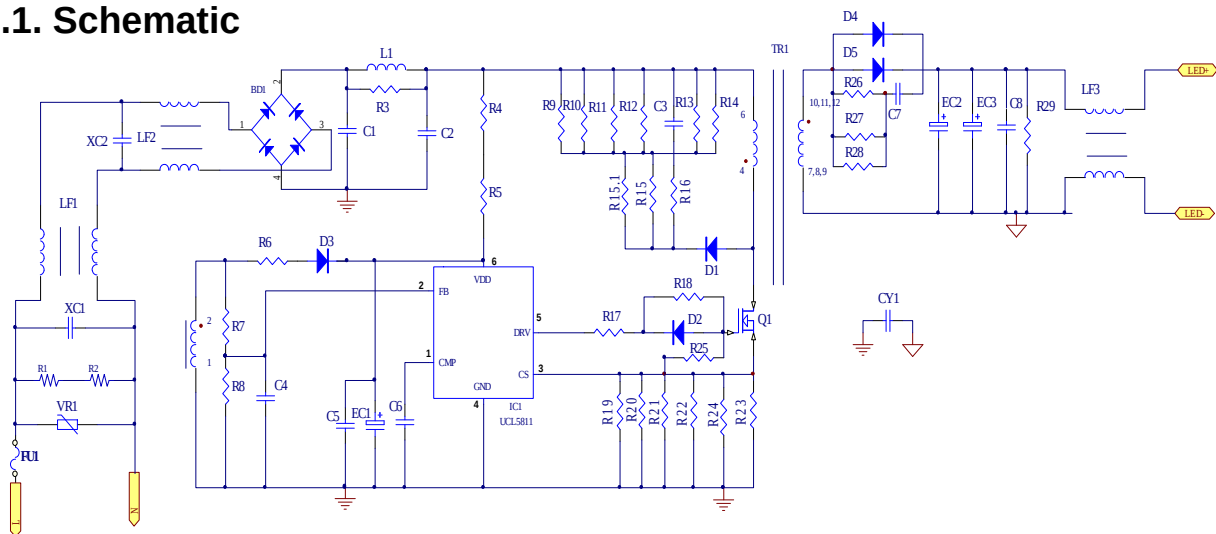
- Operation Temperature 0°C to 40 °C
- Operation Humidity 20% to 90% R.H
- Storage Temperature -40°C to 60 °C
- Storage Humidity 0% to 90% R.H



# 60W LED Driver Module Using UCL5811

## 2. LED Demo Board Information

### 2.1. Schematic



### 2.2. BOM

| No. | Position                   | Description                    | Quantity |
|-----|----------------------------|--------------------------------|----------|
| 1   | R1/R2                      | 820KR, 5%, 1206                | 2        |
| 2   | R3                         | 5.1KR, 5%, 0805                | 1        |
| 3   | R4/R5                      | 200KR, 5%, 1206                | 2        |
| 4   | R6                         | 4.7R, 5%, 0805                 | 1        |
| 5   | R7                         | 68KR, 1%, 0805                 | 1        |
| 6   | R8                         | 14.3KR, 1%, 0805               | 1        |
| 7   | R9/R10/R11/<br>R12/R13/R14 | 560KR, 5%, 1206                | 6        |
| 8   | R15/R16                    | 100R, 5%, 1206                 | 2        |
| 9   | R17                        | 27R, 5%, 0805                  | 1        |
| 10  | R18                        | 100R, 5%, 0805                 | 1        |
| 11  | R19/R20/R21/<br>R22/R23    | 0.75R, 1%, 1206                | 5        |
| 12  | R25                        | 10KR, 5%, 0805                 | 1        |
| 13  | R26/R27/R28                | 100R, 5%, 1206                 | 3        |
| 14  | R29                        | 100K, 5%, 1206                 | 1        |
| 15  | C3                         | 1nF, 1000V, 10%, 1206, X7R     | 1        |
| 16  | C6                         | 220nF, 50V, 10%, 0805, X7R     | 1        |
| 17  | C7                         | 330pF, 1000V, 10%, 1206, X7R   | 1        |
| 18  | C8                         | 100nF, 63V, 10%, 1206, X7R     | 1        |
| 19  | FU1                        | FUSE 3.15A, 250V               | 1        |
| 20  | EC1                        | 22uF, 50V, 5*11, 105°, 5000H   | 1        |
| 21  | EC2/EC3                    | 560uF, 50V, 10*16, 105°, 5000H | 2        |
| 22  | C1/C2                      | 0.22uF, 400V, F=10mm           | 2        |
| 23  | BD1                        | KBP406                         | 1        |
| 24  | VR1                        | 10D471K, P=7.5mm               | 1        |
| 25  | XC1, XC2                   | 0.22uF, 275V, P=10mm           | 2        |

## 60W LED Driver Module Using UCL5811

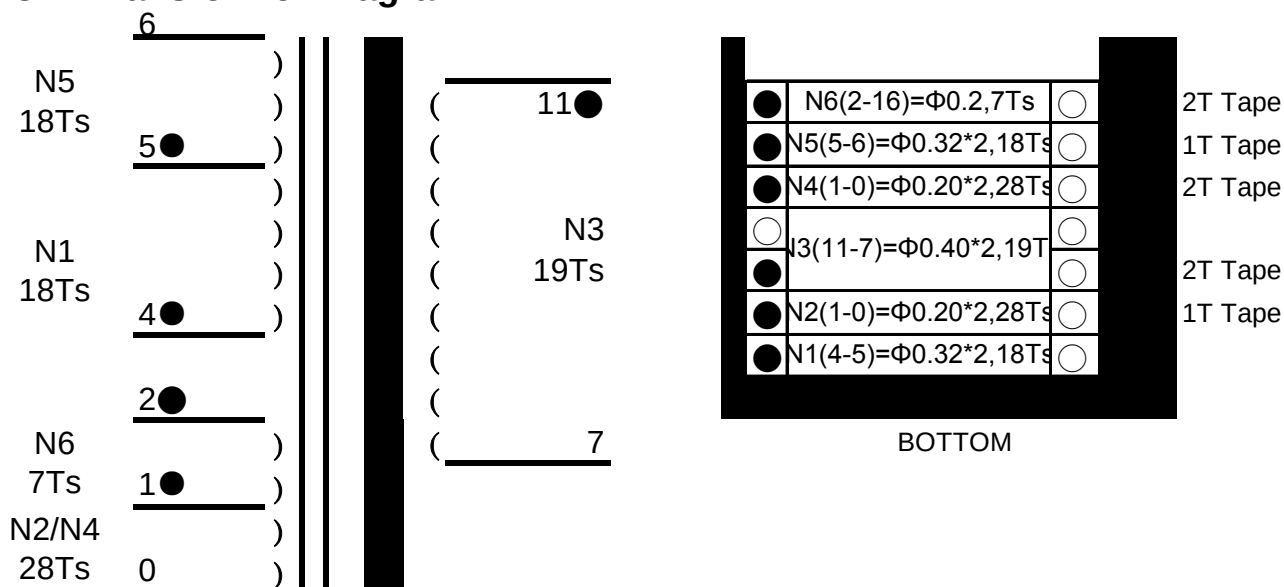
|    |       |                                        |   |
|----|-------|----------------------------------------|---|
| 26 | D1    | UTC FR207G, D0-41                      | 1 |
| 27 | D4/D5 | UTC SF56G (5A 400V), D0-201AD          | 2 |
| 28 | D2    | UTC 1N4148, SOD-323                    | 1 |
| 29 | D3    | UTC F7, SOD-123                        | 1 |
| 30 | IC1   | UTC UCL5811 SOP-8                      | 1 |
| 31 | Q1    | UTC 10N65KL-MT TO-220F1                | 1 |
| 32 | L1    | 1.0mH, 12*16, $\varphi=0.4\text{mm}$   | 1 |
| 33 | LF1   | 1.3mH, T10*6*5, $\varphi=0.4\text{mm}$ | 1 |
| 34 | LF2   | 20mH, UU10.5, $\varphi=0.35\text{mm}$  | 1 |
| 35 | LF3   | 300uH, T9*5*3, $\varphi=0.4\text{mm}$  | 1 |
| 36 | TR1   | UTR-PQ2625 0.24mH                      | 1 |
| 37 | CY1   | 2.2nF, 400VAC, $\pm 20\%$ , P=10mm     | 1 |
| 38 | HS1   | HEAT SINK                              | 1 |
| 39 | J1    | Jump Wire 0.6X7mm                      | 1 |
| 40 | SCREW | M3.0*5.0mm                             | 1 |

### 2.3. Transformer Design

#### 2.3.1. Transformer Specification

- 1) Bobbin: PQ2625 6+6
- 2) Core material: PC40(TDK or equivalent)
- 3)  $L_p$  4-6: 0.24mH  $\pm 5\%$  (10KHz/1.0V)

#### 2.3.2. Transformer Diagram

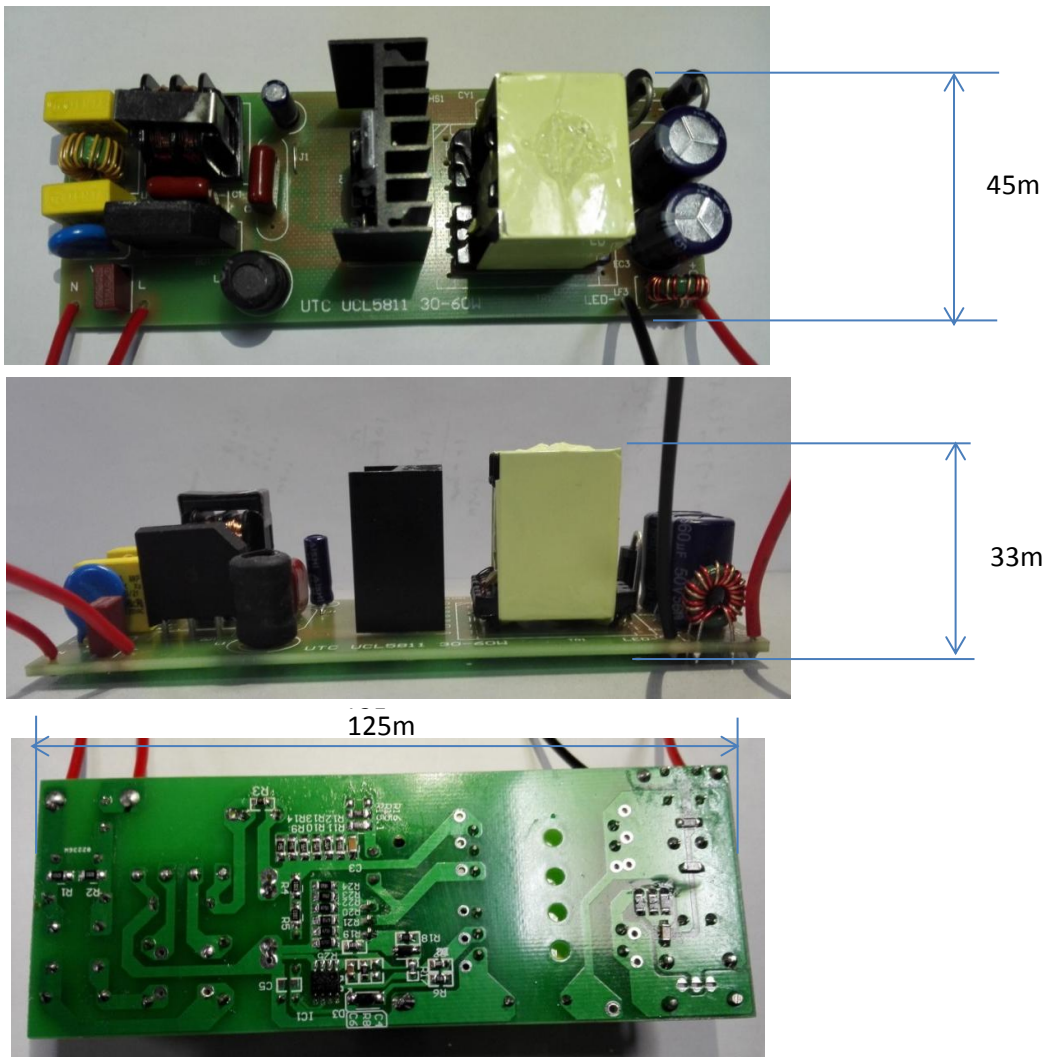


# 60W LED Driver Module Using UCL5811

Transformer Winding Data

| Layer No. | Winding | Material                       | Start | Turns | Finish |
|-----------|---------|--------------------------------|-------|-------|--------|
| 1         | N1      | 0.32Φ X 2 2 UEW                | 4     | 18    | 5      |
| 2         | Tape    | Tape                           |       | 1     |        |
| 3         | N2      | 0.2Φ X 2 2 UEW                 | 1     | 28    | 0      |
| 4         | Tape    | Tape                           |       | 2     |        |
| 5         | N3      | Triple Insulated Wire 0.40Φ X2 | 11    | 19    | 7      |
| 6         | Tape    | Tape                           |       | 2     |        |
| 7         | N4      | 0.2Φ X 2 2 UEW                 | 1     | 28    | 0      |
| 8         | Tape    | Tape                           |       | 1     |        |
| 9         | N5      | 0.32Φ X 2 2 UEW                | 5     | 18    | 6      |
| 10        | Tape    | Tape                           |       | 2     |        |
| 11        | N6      | 0.2Φ 2 UEW                     | 2     | 7     | 1      |
| 12        | Tape    | Tape                           |       | 2     |        |

## 2.4. Demo Board Snapshot



# 60W LED Driver Module Using UCL5811

## 3. Performance Evaluation

This document presented here is to describe the LED Driver Module performance.

The measuring data are tested at the PCB end, unless otherwise specified.

### The Summarized Result :

| Item                                  | Test result     |
|---------------------------------------|-----------------|
| <b>1. Input Characteristics</b>       |                 |
| Input Voltage rating                  | 100Vac ~ 240Vac |
| Input Current (@Vin=90Vac, full load) | 770mA           |
| <b>2. Output characteristics</b>      |                 |
| Maximum Output Power                  | 60W             |
| Output Typical Voltage                | 36Vdc~48Vdc     |
| Output Typical Current                | 1.25A           |
| <b>3. Protection</b>                  |                 |
| Short Circuit Protection              | Auto Recovery   |
| Open Loop Protection                  | Auto Recovery   |

### Test Equipment:

| Item                   | Vendor     | Model No: |
|------------------------|------------|-----------|
| 1.AC Source            | GW INSTEK  | APS-9501  |
| 2.Digital Power meter  | DECTECH    | 3330S     |
| 3.Electronic Load      | PRODIGIT   | 3302C     |
| 4.Digital Oscilloscope | Tektronics | DPO3012   |
| 5.Multi-meter          | Keithley   | 2000      |

### 3.1 Input Current(@FULL LOAD)

| Input Voltage | Irms (mA) | SPEC | RESULT |
|---------------|-----------|------|--------|
| 90Vac/60Hz    | 770       | N/A  | N/A    |
| 110Vac/60Hz   | 600       |      |        |
| 220Vac/50Hz   | 310       |      |        |
| 264Vac/50Hz   | 280       |      |        |

### 3.2 PF&THD(@FULL LOAD)

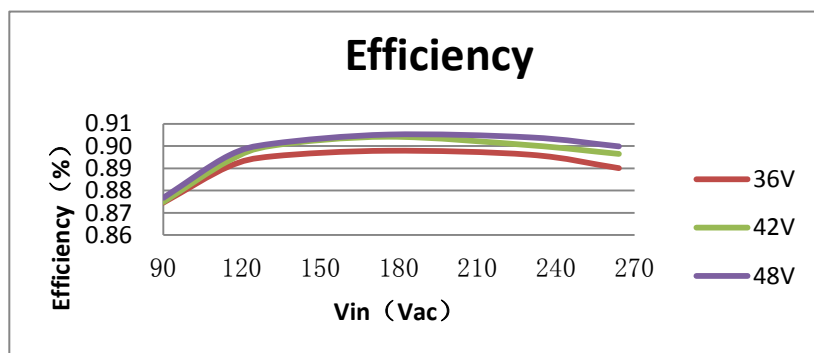
| VIN(Vac) | PF    | THD (%) | SPEC              | RESULT |
|----------|-------|---------|-------------------|--------|
| 90       | 0.994 | 8.4     | PF>0.9<br>THD<15% | OK     |
| 115      | 0.991 | 9.2     |                   |        |
| 230      | 0.951 | 9.9     |                   |        |
| 264      | 0.929 | 10.6    |                   |        |



# 60W LED Driver Module Using UCL5811

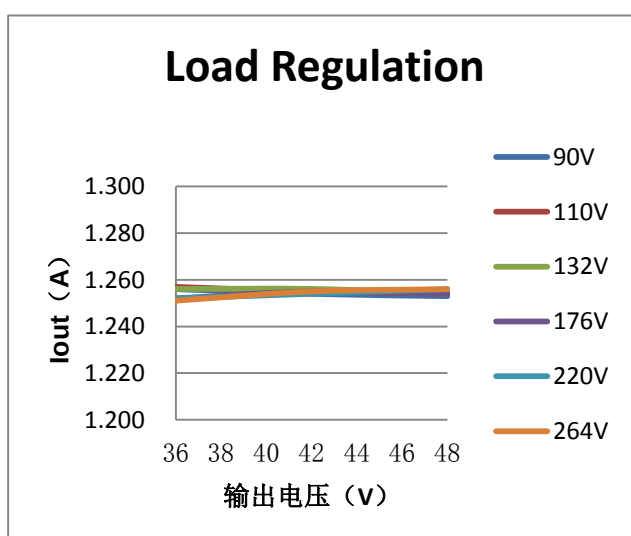
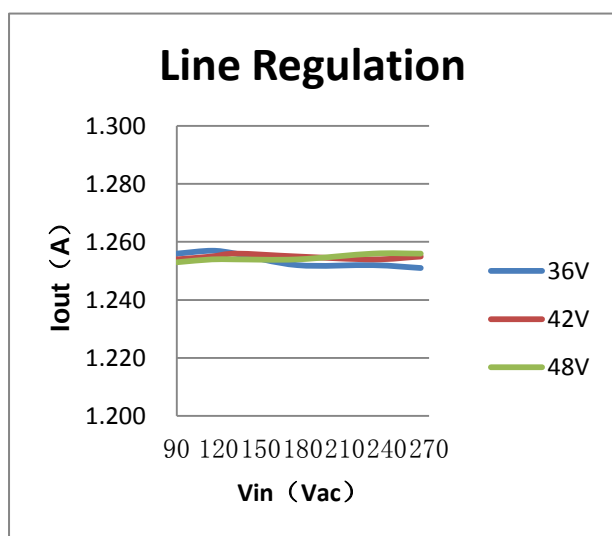
## 3.3 Efficiency

| load (V) \ Vin (Vac) | 90   | 115  | 132  | 176  | 230  | 264  |
|----------------------|------|------|------|------|------|------|
| 36                   | 0.87 | 0.89 | 0.90 | 0.90 | 0.90 | 0.89 |
| 42                   | 0.87 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 |
| 48                   | 0.88 | 0.90 | 0.90 | 0.91 | 0.90 | 0.90 |



## 3.4 Line Regulation & Load Regulation

| Input Voltage<br>(Vac) | Pin(W) & Iout (A) |       |          |       |          |       | Load<br>Regulation |
|------------------------|-------------------|-------|----------|-------|----------|-------|--------------------|
|                        | Vout=36V          |       | Vout=42V |       | Vout=48V |       |                    |
| 90                     | 51.7              | 1.256 | 60.2     | 1.254 | 68.6     | 1.253 | 0.12%              |
| 115                    | 50.8              | 1.257 | 59.0     | 1.255 | 67.2     | 1.254 | 0.12%              |
| 132                    | 50.5              | 1.256 | 58.6     | 1.256 | 66.8     | 1.254 | 0.08%              |
| 176                    | 50.2              | 1.252 | 58.3     | 1.255 | 66.5     | 1.254 | 0.12%              |
| 230                    | 50.3              | 1.252 | 58.5     | 1.254 | 66.7     | 1.256 | 0.16%              |
| 264                    | 50.6              | 1.251 | 58.8     | 1.255 | 67.0     | 1.256 | 0.20%              |
| Line                   | 0.24%             |       | 0.08%    |       | 0.12%    |       | \                  |





## 60W LED Driver Module Using UCL5811

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### 3.5 Thermal Testing

Test@FULL LOAD      Ambient 30℃

| input<br>voltage | 90Vac | 264Vac |
|------------------|-------|--------|
| IC1              | 61.4℃ | 52.1℃  |
| TR1 Wire         | 74.4℃ | 79.5℃  |
| TR1 Core         | 64.2℃ | 69.5℃  |
| D4(SF56)         | 79.5℃ | 84.1℃  |
| Q1(10N65)        | 74.2℃ | 58.7℃  |
| BD1              | 84.5℃ | 50.4℃  |
| EC2              | 50.2℃ | 56.2℃  |

### 3.6. Protection

#### 3.6.1. Open Loop Protection

When LED connection is opened , the Output will be limited to 60V.Once the condition is removed, and the power will be back to normal output Voltage .

| Input Voltage | Output Voltage (V) | Spec | Result |
|---------------|--------------------|------|--------|
| 90Vac/60Hz    | 53.4               | 60V  | OK     |
| 115Vac/60Hz   | 53.2               |      |        |
| 230Vac/50Hz   | 54.3               |      |        |
| 264Vac/50Hz   | 54.2               |      |        |

#### 3.6.2. Short Circuit Protection

When Short Circuit Protection condition is removed and restart the power,the power will recover

| Input Voltage | Pi(mW) | Remark |
|---------------|--------|--------|
| 90Vac/60Hz    | 0.24   | —      |
| 115Vac/60Hz   | 0.24   | —      |
| 230Vac/50Hz   | 0.24   | —      |
| 264Vac/50Hz   | 0.24   | —      |



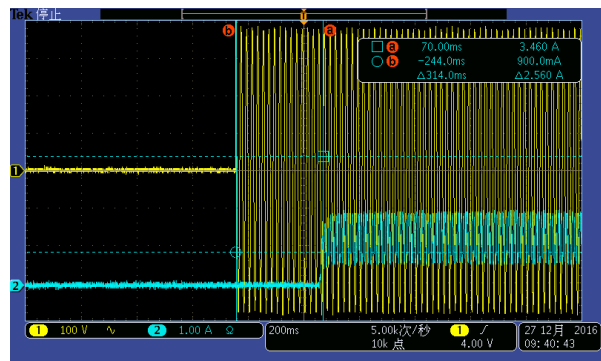
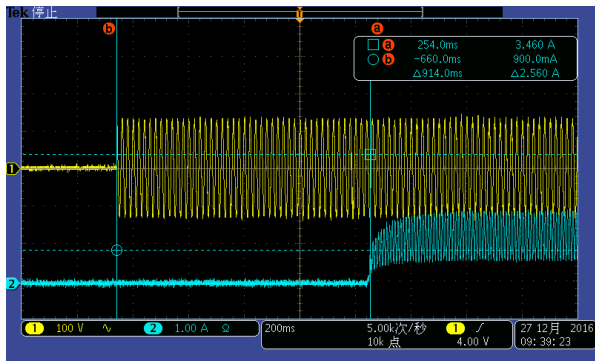
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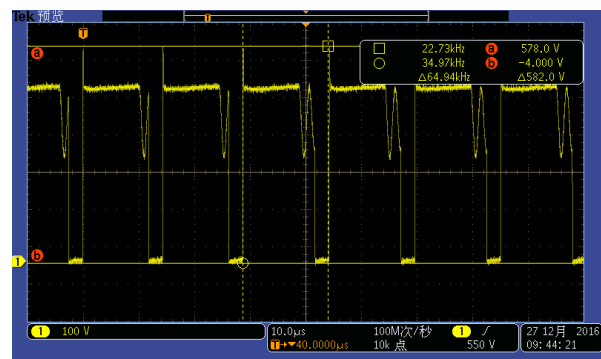
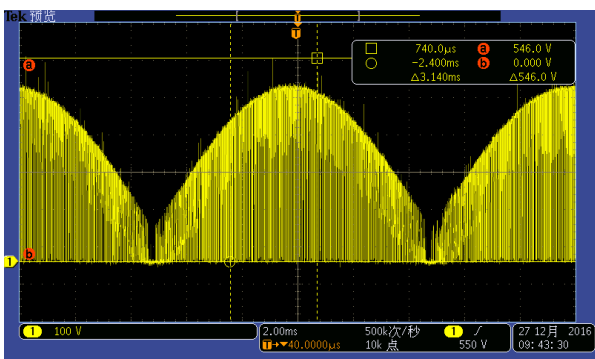
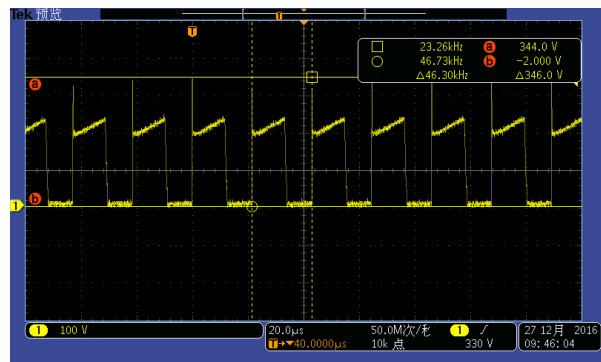
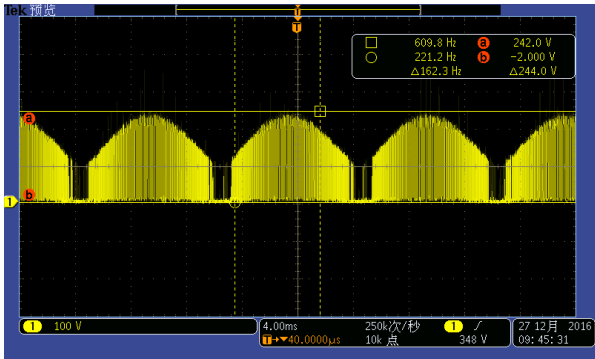
# 60W LED Driver Module Using UCL5811

## 4 Waveforms

### 4.1 VIN&IO startup waveform



### 4.2 VDS waveform



# 60W LED Driver Module Using UCL5811

## 4.3 VCS waveform

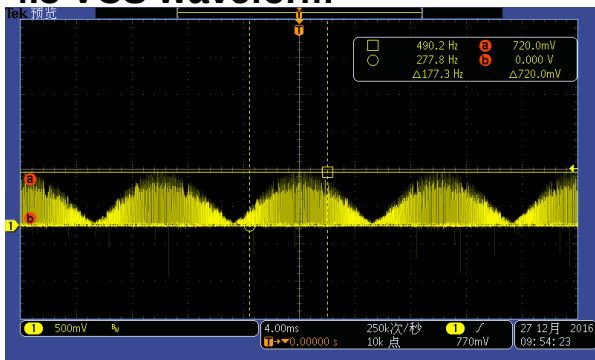


Fig7.VCS waveform@90Vac FULL LOAD

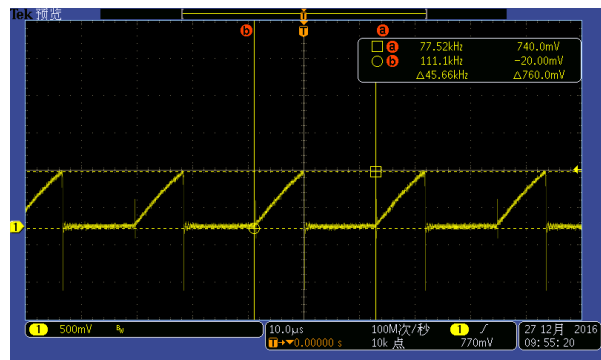


Fig8.Spread VCS waveform@90Vac FULL LOAD

CH1=Vcs, Vcs (P-P) =760mv, f=45.66KHz

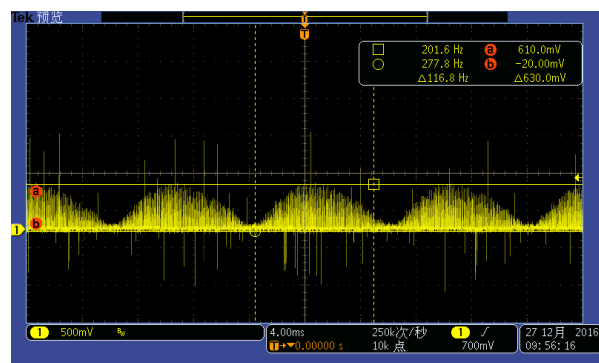


Fig9.VCS waveform@264Vac FULL LOAD

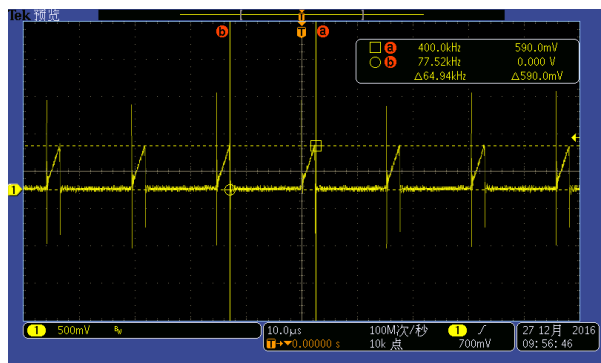


Fig10.Spread VCS waveform@264Vac FULL LOAD

CH1=Vcs, Vcs (P-P) =590mv, f=64.94KHz

## 4.4 VCC waveform

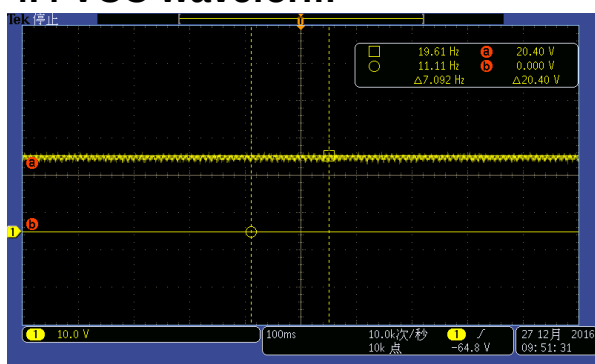


Fig11.VCC waveform@90Vac FULL LOAD

CH1=VCC, VCC (P-P) =20.4V

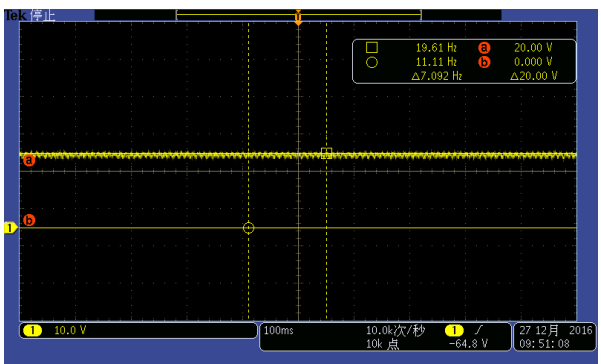


Fig12.VCC waveform@264Vac FULL LOAD

CH1=VCC, VCC (P-P) =20.00V

# 60W LED Driver Module Using UCL5811

## 4.5 VD4 waveform

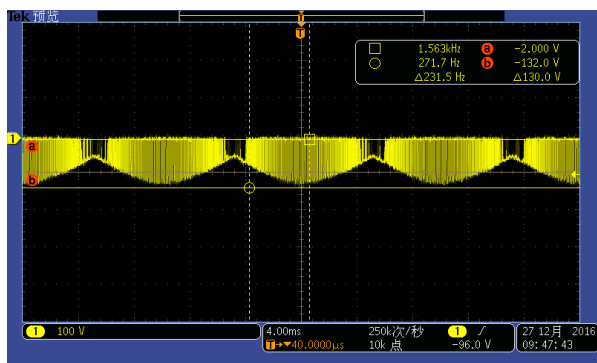


Fig13.VD4 waveform@90Vac FULL LOAD

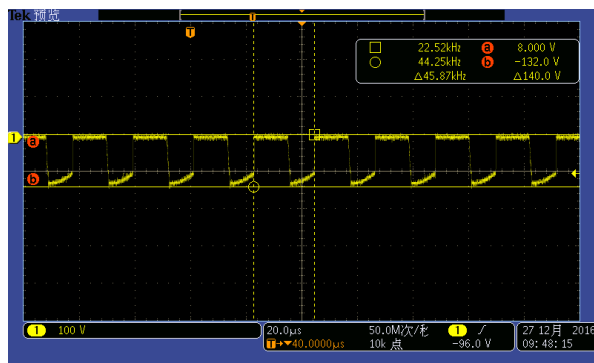


Fig14.Spread VD4 waveform@90Vac FULL LOAD  
CH1=VD4, VD4 (P-P) =140v, f=45.87KHz

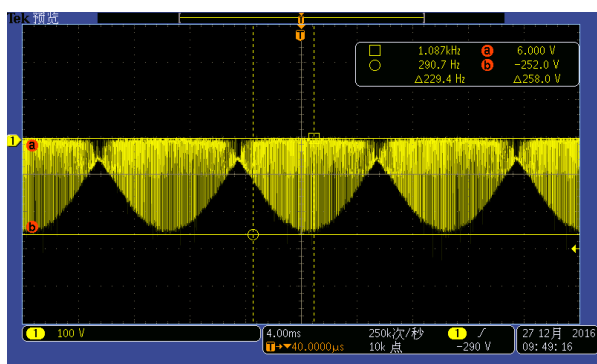


Fig15.VD4 waveform@264Vac FULL LOAD

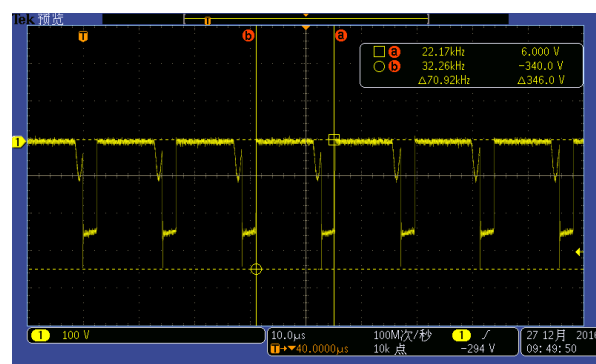


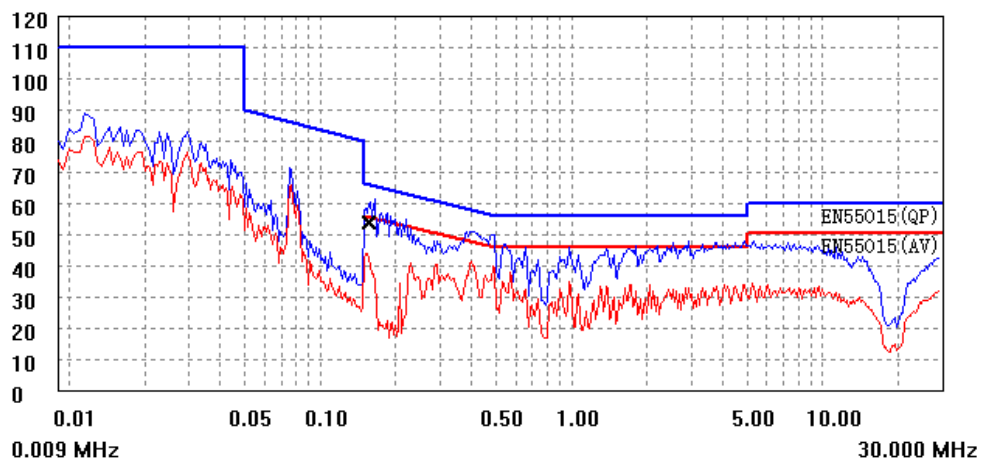
Fig16.Spread VD4 waveform@264Vac FULL LOAD  
CH1=VD4, VD4 (P-P) =346v, f=70.92KHz

# 60W LED Driver Module Using UCL5811

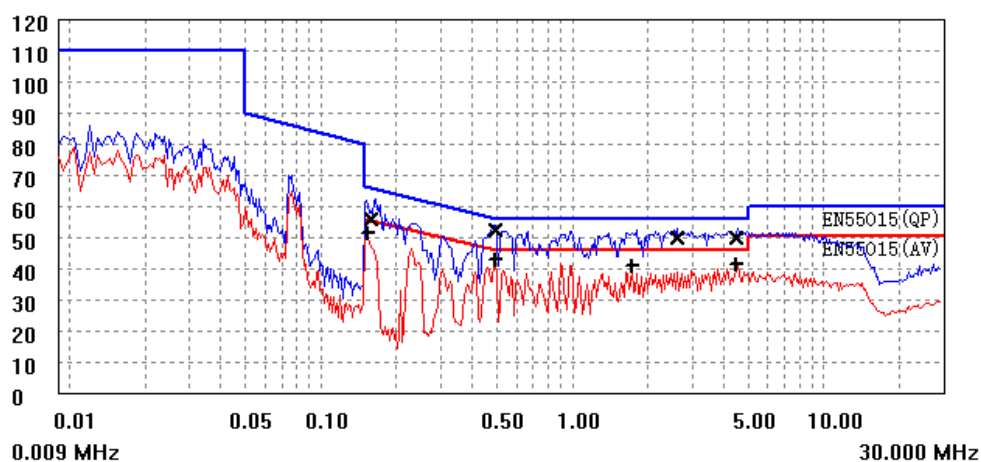
## 5 EMI

(Test @Vin=230Vac/50Hz, FULL Load)

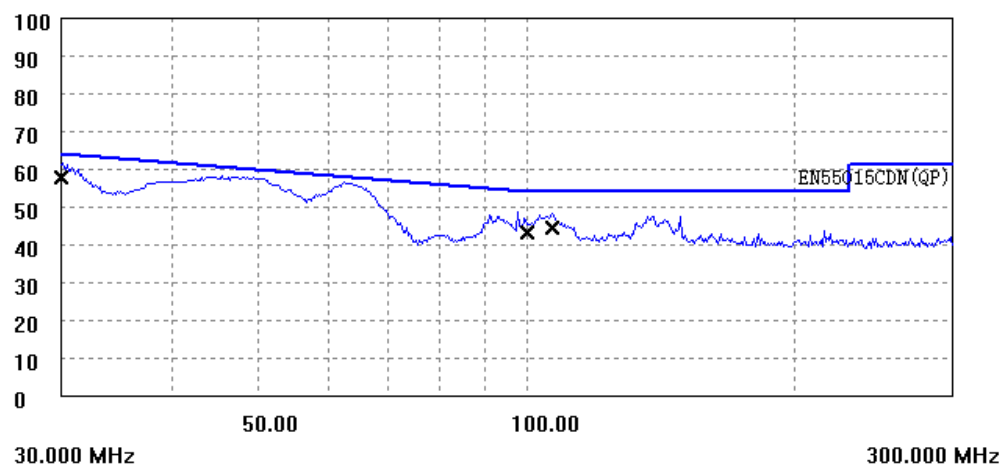
### 5.1 Live Conduction



### 5.2 Netural Conduction



### 5.2 Vertical Radiated



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