



## 10W LED Driver Module Using USL2500G

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Subject

**USL2500G Non-Isolated LED Driver\_10W\_0.15A\_Demo Board**

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**Key features:**

- AC Input Range 176Vac~264Vac
  - High Efficiency(90.91%@220Vac,full load)
  - Excellent line voltage regulation and load regulation(<math>< \pm 3\%</math>)
  - Multiple protection functions and high reliability
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**Revision History**

| Revise Date | Version | Reason/Issue |
|-------------|---------|--------------|
| 2018/1/9    | A       | First Issue  |

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## 1. LED Demo Board Specification

### 1.1. Input Characteristics

- AC input voltage rating 220Vac ~ 240Vac
- AC input frequency range 176Vac~264Vac
- AC input frequency range 47Hz ~ 63Hz

### 1.2. Output Characteristics

- Output Voltage 30Vdc~60Vdc
- Typical output current 150mA

### 1.3. Performance Specifications

- Maximum Output Power 9W

### 1.4. Protection Function

- Short Circuit Protection Shut down and auto recovery
- VCC OVP&UVLO Shut down and auto recovery
- OTP Reduce the output current till shutdown

### 1.5. Environment

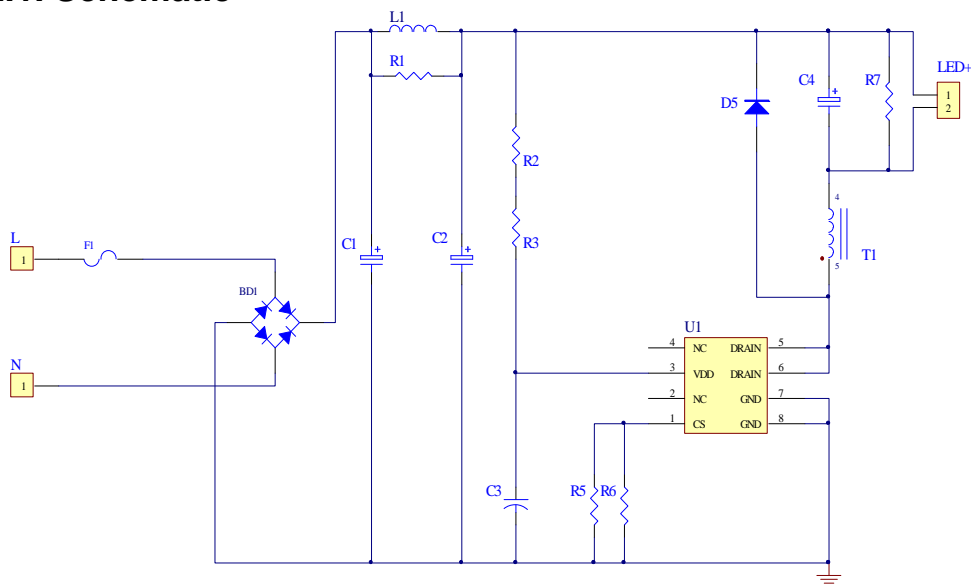
- Operation Temperature 0°C to 40 °C
- Operation Humidity 20% to 90% R.H
- Storage Temperature -40°C to 60 °C
- Storage Humidity 0% to 90% R.H



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## 2. LED Demo Board Information

### 2.1. Schematic



### 2.2. BOM

| No. | Position | Description                                 | Quantity |
|-----|----------|---|----------|
| 1   | F1       | Winding Fuse Resistor, 10R 1W               | 1        |
| 2   | L1       | Color Ring Inductor, 0.47mH                 | 1        |
| 3   | R1       | Resistor chip, 5.1K/1206, 1/4W, ±5%         | 1        |
| 4   | R2, R3   | Resistor chip, 300K/1206, 1/4W, ±5%         | 2        |
| 5   | R5, R6   | Resistor chip, 3.3R/1206, 1/4W, ±1%         | 2        |
| 6   | R7       | Resistor chip, 100K/1206, 1/4W, ±5%         | 1        |
| 7   | C1, C2   | Capacitor aluminum electrolytic, 3.3uF/400V | 2        |
| 8   | C3       | Capacitor aluminum electrolytic, 10uF/50V   | 1        |
| 9   | C4       | Capacitor aluminum electrolytic, 2.2uF/100V | 1        |
| 10  | BD1      | MB6S  | 1        |
| 11  | D5       | Diode, ES1J, 1A/600V                        | 1        |
| 12  | T1       | EE10, 3.0mH, φ 0.18*245T                    | 1        |
| 13  | U1       | UTC USL2500G SOP-8                          | 1        |



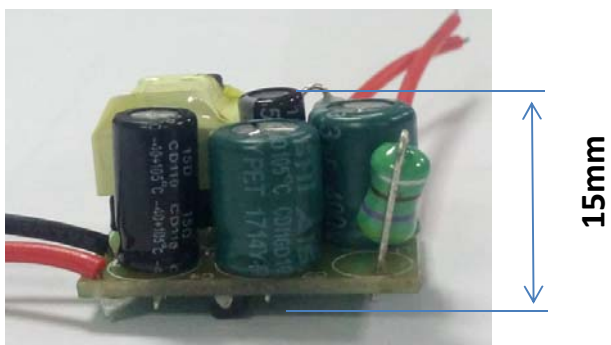
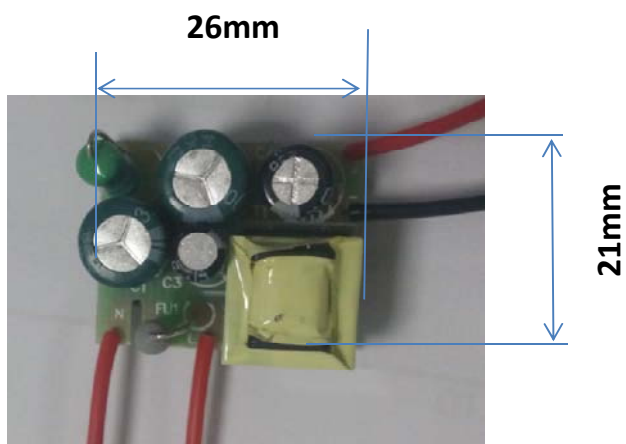
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## 2.3. TR Design

- 1) Bobbin: EE10 4+4
- 2) Core material: PC40(TDK or equivalent)
- 3) Lp 2-1: 3.0mH  $\pm 5\%$  (10KHz/1.0V)

| 层数   | 脚位    | 线径                                | 匝数   |
|------|-------|-----------------------------------|------|
| N1   | 1脚-8脚 | $\varnothing 0.18\text{mm}$ 顺时针密绕 | 245T |
| 绝缘胶带 |       | Tape                              | 2T   |

## 2.4. Demo Board Snapshot



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## 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                   | 220Vac ~ 240Vac |
| Input Current (@Vin=176Vac, full load) | 103mA           |
| <b>2. Output characteristics</b>       |                 |
| Maximum Output Power                   | 9W              |
| Output Typical Voltage                 | 30Vdc~60Vdc     |
| Output Typical Current                 | 150mA           |
| <b>3. Protection</b>                   |                 |
| Short Circuit 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&PF @Full Load

| Input Voltage | Irms (mA) | PF    | RESULT |
|---------------|-----------|-------|--------|
| 176Vac/50Hz   | 103       | 0.538 | N/A    |
| 200Vac/50Hz   | 96        | 0.518 |        |
| 240Vac/50Hz   | 87        | 0.484 |        |
| 264Vac/50Hz   | 82        | 0.476 |        |

### 3.2 Efficiency @Full Load

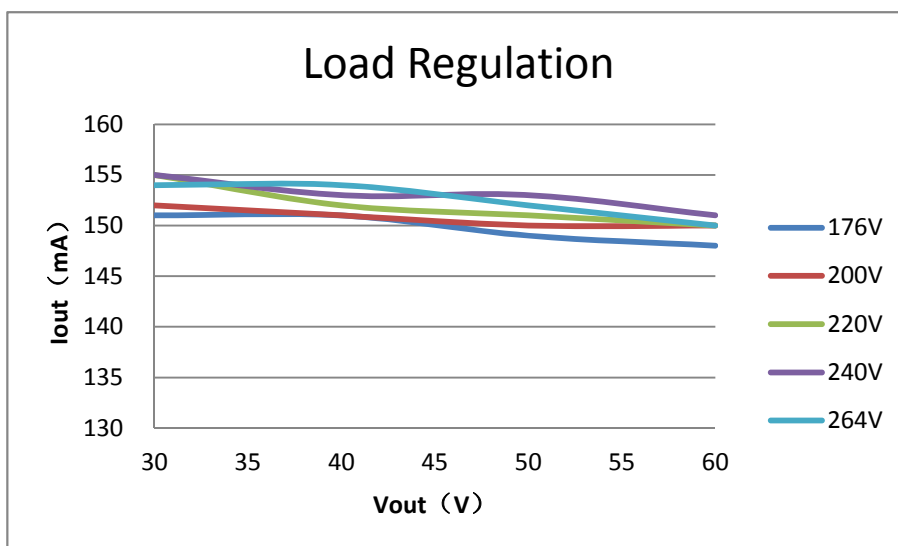
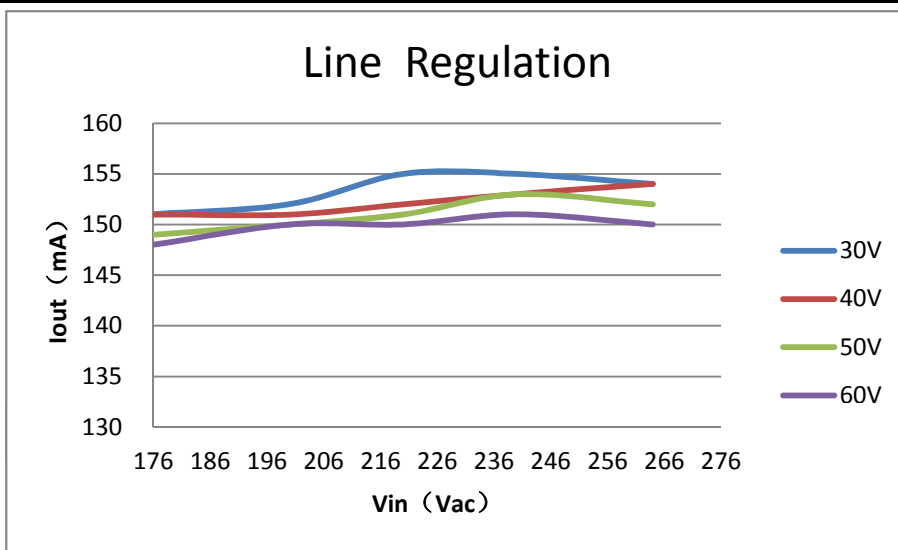
| Input Voltage(Vac) | Efficiency(%) |
|--------------------|---------------|
| 176                | 90.34%        |
| 200                | 90.54%        |
| 220                | 90.91%        |
| 240                | 90.06%        |
| 264                | 89.02%        |



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## 3.3 Line Regulation & Load Regulation

| Vout (V) \ Vin (Vac) | Pin(W) & Iout (mA) |     |        |     |        |     |        |     | Load Regulation |
|----------------------|--------------------|-----|--------|-----|--------|-----|--------|-----|-----------------|
|                      | 30                 |     | 40     |     | 50     |     | 60     |     |                 |
| 176                  | 5.22               | 151 | 6.83   | 151 | 8.38   | 149 | 9.83   | 148 | ±1.00%          |
| 200                  | 5.29               | 152 | 6.87   | 151 | 8.54   | 150 | 9.94   | 150 | ±0.67%          |
| 220                  | 5.44               | 155 | 6.96   | 152 | 8.52   | 151 | 9.90   | 150 | ±1.67%          |
| 240                  | 5.47               | 155 | 7.06   | 153 | 8.68   | 153 | 10.06  | 151 | ±1.33%          |
| 264                  | 5.51               | 154 | 7.16   | 154 | 8.74   | 152 | 10.11  | 150 | ±1.33%          |
| Line Regulation (%)  | ±1.33%             |     | ±1.00% |     | ±1.33% |     | ±1.00% |     | \               |



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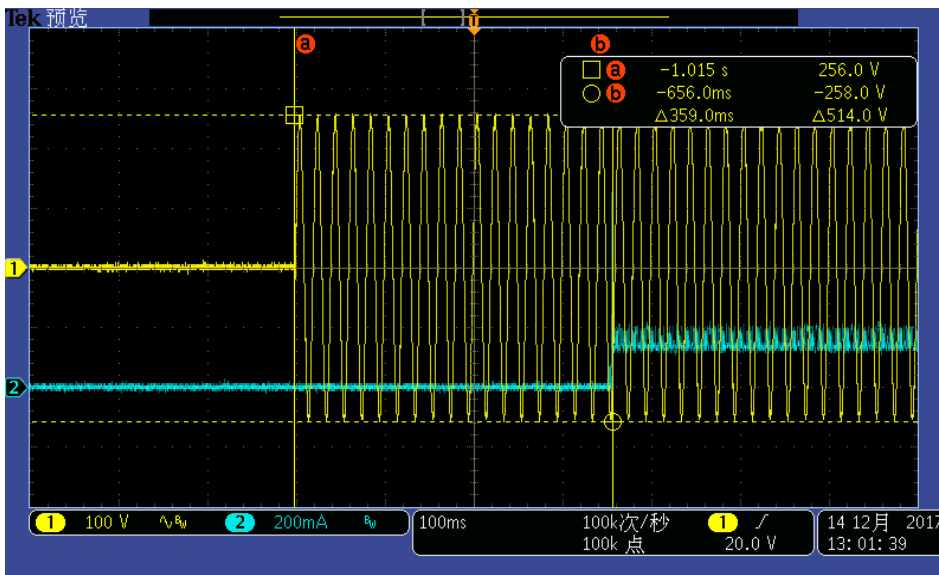
## 3.4 Temperature

Test@FULL LOAD      Ambient 16°C

| input voltage | 176Vac | 264Vac |
|---------------|--------|--------|
| IC1(USL2500)  | 55.7   | 57.2   |
| TR Core       | 54.0   | 60.7   |
| TR Wire       | 49.0   | 54.5   |
| Diode(ES1J)   | 50.5   | 53.6   |

## 3.5 Start-up Time

| Input Voltage (Vac) | Start-Up Time (s) |
|---------------------|-------------------|
| 176                 | 0.36              |



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## 4 Waveforms

### 4.1 Vds&Vcs waveform

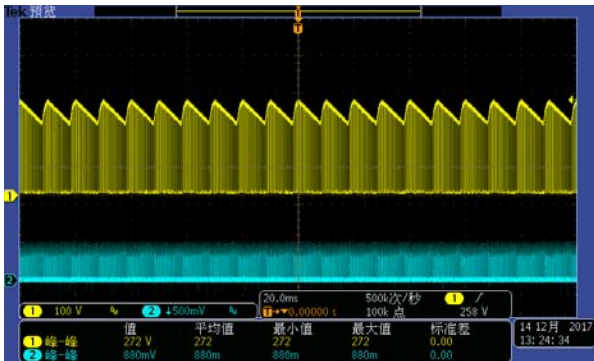


Fig.1 Vds&Vcs @Vin=176Vac Vout=60V

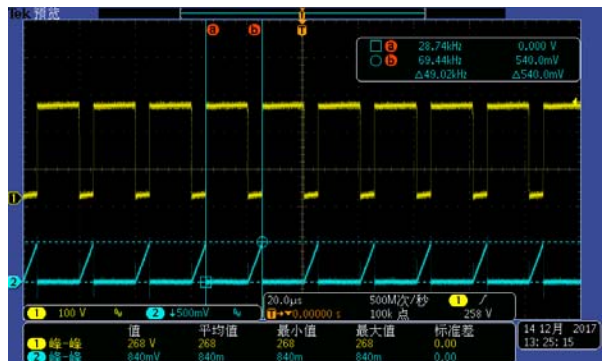


Fig.2 Spread Vds&Vcs @Vin=176Vac Vout=60V  
Vds=138V Vcs=540mV f=49.02KHz

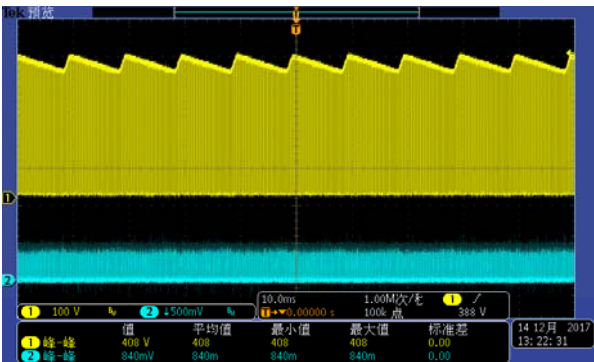


Fig.3 Vds&Vcs @Vin=264Vac Vout=60V

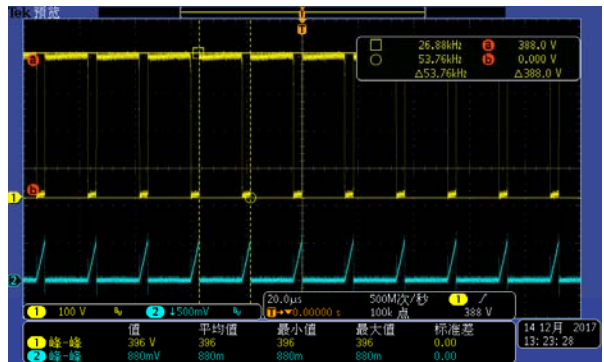


Fig.4 Spread Vds&Vcs @Vin=264Vac Vout=60V  
Vds=388V f=53.76KHz

### 4.2 VT1 waveform

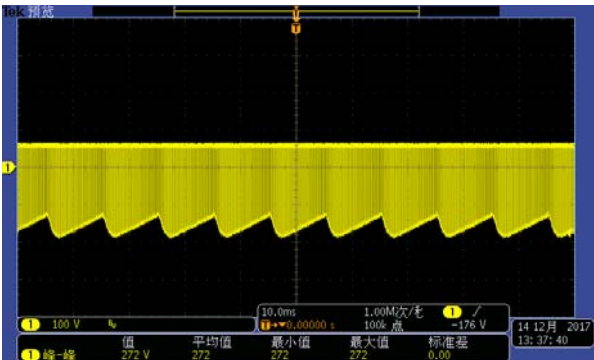


Fig.5 VT1 @Vin=176Vac Vout=60V

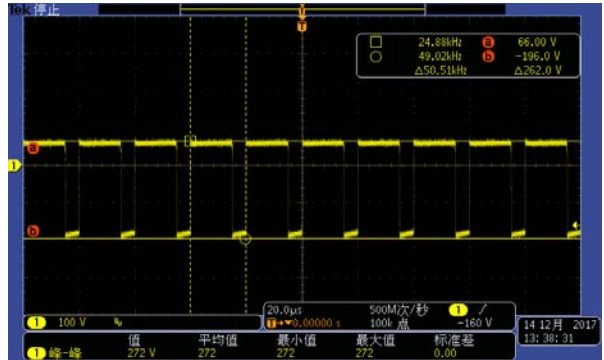


Fig.6 Spread VT1 @Vin=176Vac Vout=60V  
VD5=262V f=50.51KHz



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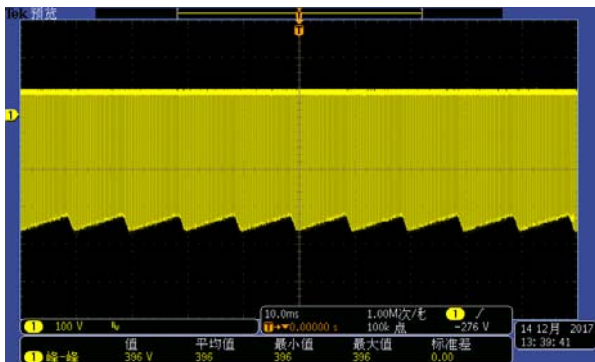


Fig.7 VT1 @Vin=264Vac Vout=60V

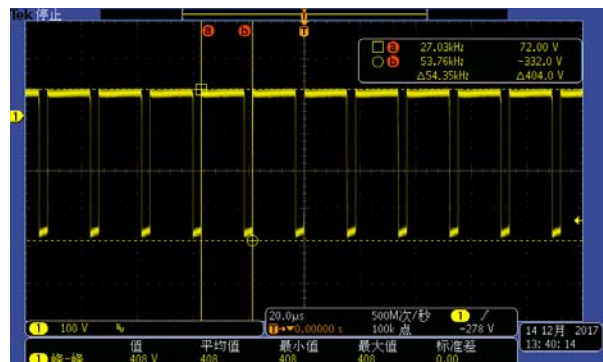


Fig.8 Spread VD5 @Vin=264Vac Vout=60V  
VT1=404V f=54.35KHz

## 4.3 VCC waveform

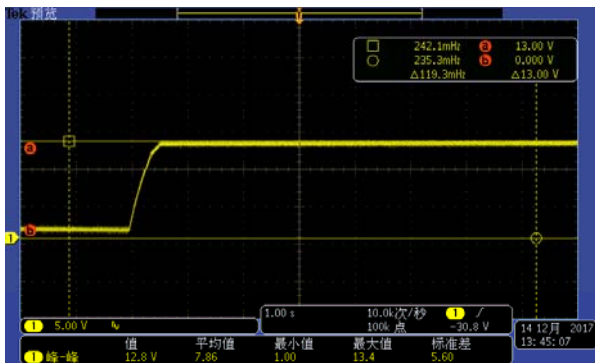


Fig.9 VCC waveform@Vin=176Vac Vout=60V  
Start-up VCC=13.0V

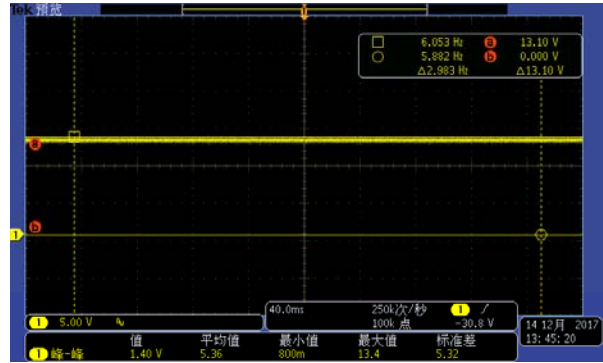


Fig.10 VCC waveform@Vin=176Vac Vout=60V  
VCC=13.1V

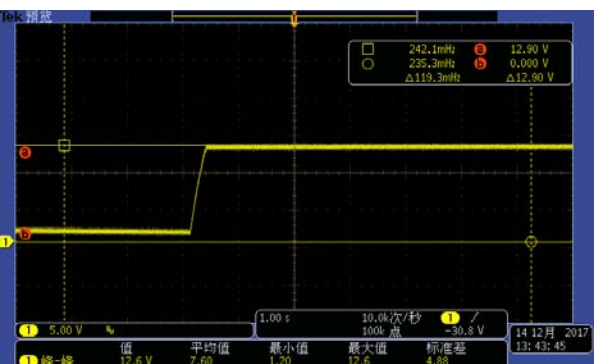


Fig.11 VCC waveform@Vin=264Vac Vout=60V  
Start-up VCC=12.90V

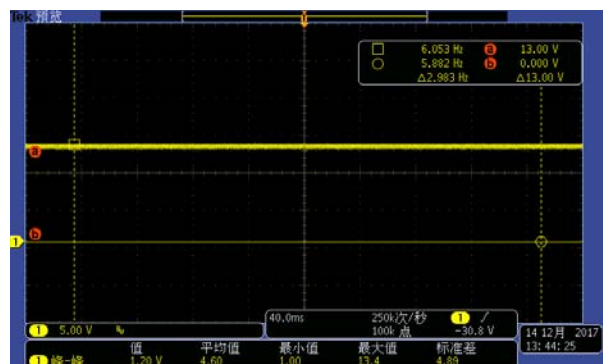


Fig.12 VCC waveform@Vin=264Vac Vout=60V  
VCC=13.0V

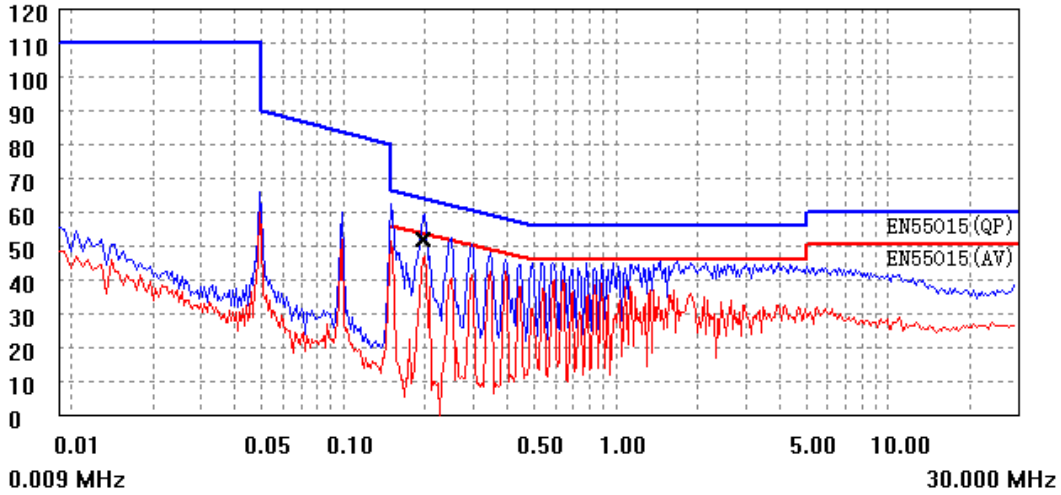


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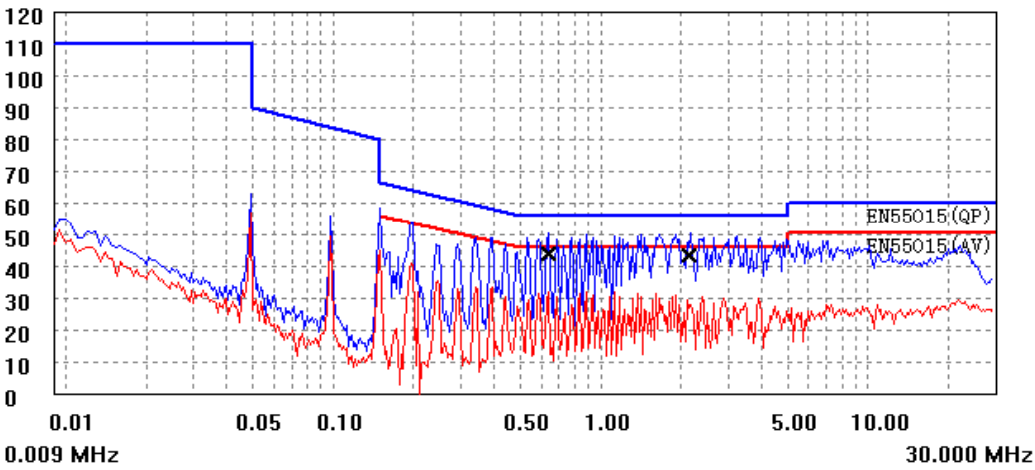
## 5 EMI

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

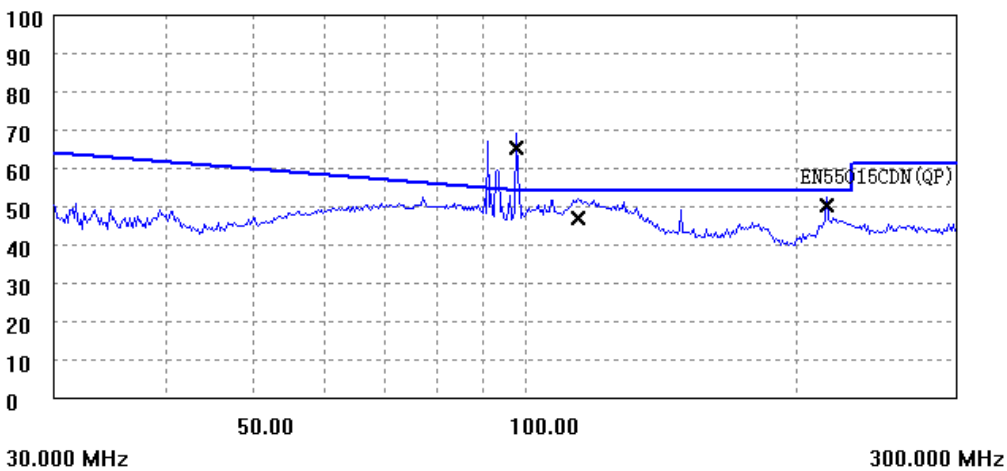
### 5.1 Live Conduction



### 5.2 Netural Conduction



### 5.3 Vertical Radiated



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