# Application Report

**90W Single stage PFC-flyback using L6562A for LED driver**

## Introduction:

In these years, power LEDs for lighting is quite hot application. For the reasons: their life of LED is significantly longer at 100,000 to 15,000 full-power hours (11+ years) to half brightness, the cost of power LEDs is rapidly coming down, and it's easy to find different sources from the market recently.

We are always using the words to talk about LED lighting: high efficiency (light out per watt in), long life… but if we look back to the power supply solution for LED lighting, it's hard to find the benefit of the long life. The E-caps using in the switching mode power supply solution are limiting the total solution's lifetime. And for several tens watt application, it's hard to find suitable solution to meet the regulator requirement: Power Factor or Harmonic Current requirement, but with low costing also.

In this file, introduces the solution without E-cap, using traditional TM PFC controllor L6562A to control the flyback topology, combining the functions of PFC(Power Factor correction) and flyback topology (AC-DC converter), to meet the requirements: Long lifetime to match the LED Lighting's feature, PF or Harmonic Current for regulator, and also low costing for commerce. In this application, there are big advantages as talked above, but also a little drawback maybe somebody don't like: double line frequency ripple voltage on output, and also cause the same frequency ripple current on LEDs. It's possible to decrease the value of ripple voltage by adding e-caps at output side as adaptors, but it's impossible to get the same small ripple voltage as adaptors do.

## Main characteristics and brief circuit description

### The main characteristics of the design are listed below:

- Wide range input voltage (90Vac/60Hz ~ 264Vac/50Hz);
- Vout is set at 35V max, and able to low to 24Vdc with CV loading;
- Iout is set at 5A maximum current limitation;
- EN61000-3-2 is implemented;
- Capable of FCC Class B conducted EMI;
- Isolated output, "safe" voltage;

### Brief circuit description:

In this application, I'm using L6562A at Primary side for PFC - PWM control, and TSM1014 at secondary side for CC/CV control.

**At primary side:**

L6562A as a TM PFC control, I add FOT (fixed off-time) technical here, to change the TM mode to CCM mode control. The five components: D3, C10, C11, R15, R16 implement this change function. Using this FOT technical, we can limited the peak current at primary side for several tens power application and the peak voltage stress with primary MOSFET at starting up stage. A voltage regulator combines with C6, C7, R6, ZD1 and Q2, to supply L6562A a safety VCC voltage. To meet the requirement of different output voltage to cover the tolerance of LED forward voltage drop, the voltage supplies from aux. winding is always a little higher than the max. value of IC VCC pin at normal output conditions, so this regulator is added here. Resistor R7 is added to give a preliminary voltage on Pin1 to start up the IC. The value of Resistor R7, R9, R12 should be calculated to insure the voltage on Pin2 can be high to 6V and low to 0V, when the voltage on R11 is changing.

The practical value of R14, C9 on Multi pin of IC L6562A and the current sensing resistor R19A,B,C,D, are using to maximize the PF value, minimize the THD and harmonic current.

**At secondary side:**

Transformer secondary winding is split to two equal parts, the VCC of TSM1014 is regulated from the half point of the secondary winding, to drop to VCC value to the permitted range of this CC/CV controller. The capacitance of filter C-cap on Vref pin should not carefully select to avoid any oscillation of the reference voltage, the recommended value in this board is 10nF.

All the caps value are tried to minimized and replace by ceramic type, thanks to Murata for their advantage cap's technical.

And also for the transformer, thanks to TDK for low core loss materials.

Figure 1: Schematic

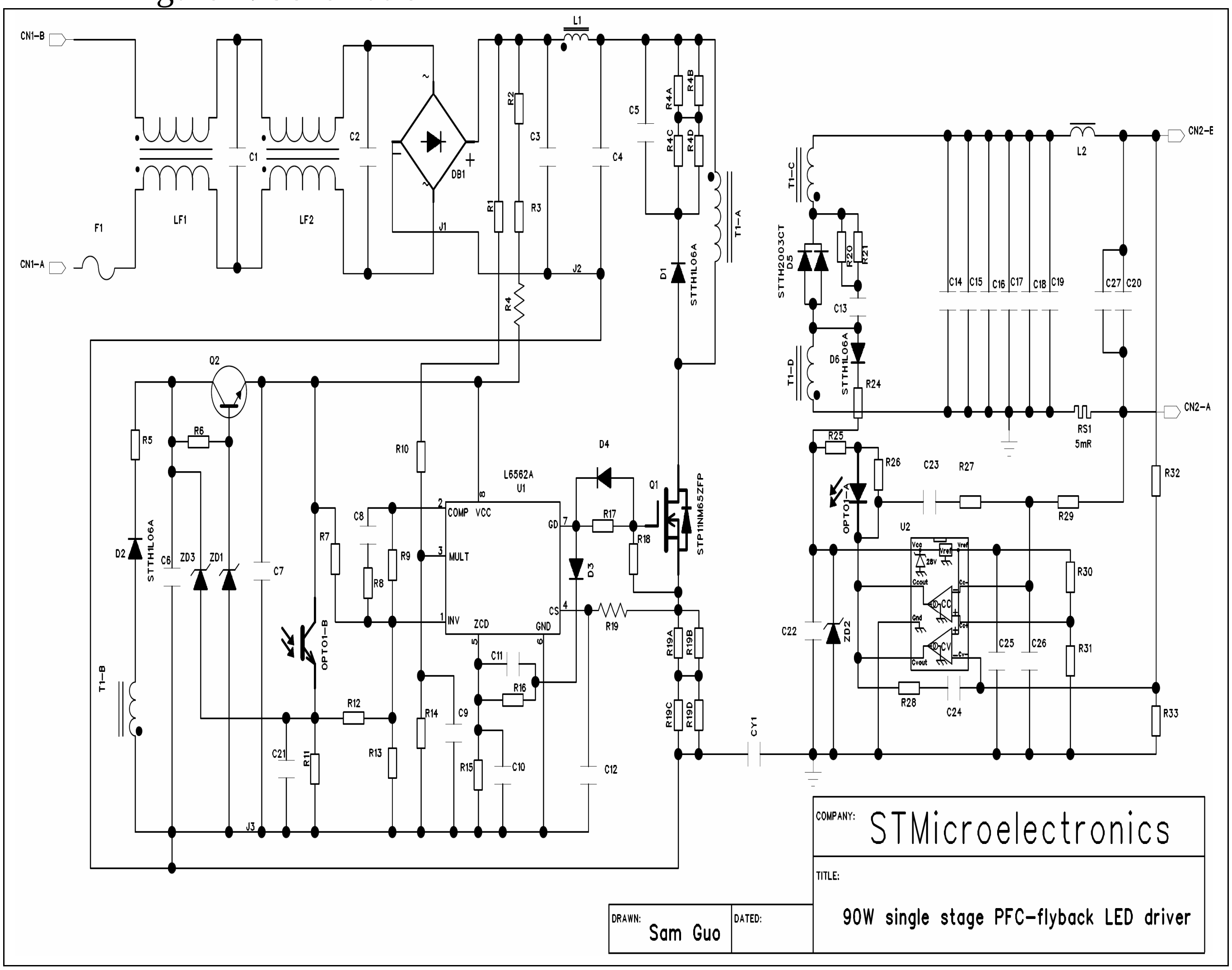


Table 1: Bill of Materials-1

| Des. | Part Type/ Part Value | Description | Supplier | CASE STYLE /PACKAGE |
|---|---|---|---|---|
| C1 | 100nF | X2 - SAFETY CAP. | | 6X18mm P=15mm |
| C2 | 100nF | X2 - SAFETY CAP. | | 6X18mm P=15mm |
| C3 | 1.0uF | 450V - MATEL FILM CAPACITOR | | 6X16mm P=15mm |
| C4 | 1.0uF | 450V - MATEL FILM CAPACITOR | | 6X16mm P=15mm |
| C5 | 4.7nF | 630V CERCAP - GRM31BR72J472KW01L | MURATA | 1206 |
| C6 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C7 | 47uF | 16V CERCAP - GRM32ER61C476KE15L | MURATA | 1210 |
| C8 | 1uF | 16V CERCAP - GRM39X5R105K16D52K | MURATA | 0603 |
| C9 | 1nF | 16V CERCAP - GERNERAL PURPOSE | MURATA | 0603 |
| C10 | N68 | 16V CERCAP - NPO | MURATA | 0603 |
| C11 | N39 | 16V CERCAP - NPO | MURATA | 0603 |
| C12 | N33 | 25V CERCAP - GERNERAL PURPOSE | MURATA | 0603 |
| C13 | 2.2nF | 630V CERCAP - GRM31BR72J222KW01L | MURATA | 1206 |
| C14 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C15 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C16 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C17 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C18 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C19 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C20 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C21 | 100nF | 16V CERCAP - GERNERAL PURPOSE | MURATA | 0603 |
| C22 | 2.2uF | 50V CERCAP - GRM31CR71H225KA12L | MURATA | 1206 |
| C23 | 0.47uF | 50V CERCAP - GERNERAL PURPOSE | MURATA | 0805 |
| C24 | 0.47uF | 50V CERCAP - GERNERAL PURPOSE | MURATA | 0805 |
| C25 | 10nF | 50V CERCAP - GERNERAL PURPOSE | MURATA | 0603 |
| C26 | 10nF | 50V CERCAP - GERNERAL PURPOSE | MURATA | 0603 |
| C27 | 4.7uF | 50V CERCAP - GRM31CR71H475KA12L | MURATA | 1206 |
| C28 | | | | |
| C29 | | | | |
| C30 | | | | |
| CN1 | AC INLET | 2PINAC GERNERAL PROPOSE WITH SAFETY | | PTH |
| CN2 | INLET | 2PINAC GERNERAL PROPOSE WITH SAFETY | | PTH |
| CY1 | 2N2 | Y1 - SAEFETY CAP. DE1E3KX222M | MURATA | PTH |
| DB1 | D4KB60 | 4A/600V GERNERAL PURPOSE BRIDGE RECTIFIER | | |
| D1 | STTH1L06A | 1A/600V ULTRAFAST HIGH VOLTAGE RECTIFIER | ST | SMA |
| D2 | STTH1L06A | 1A/600V ULTRAFAST HIGH VOLTAGE RECTIFIER | ST | SMA |
| D3 | LL4148 | FAST SWITCHING DIODE | | MINIMELF SOD-80 |
| D4 | LL4148 | FAST SWITCHING DIODE | | MINIMELF SOD-80 |
| D5 | STTH2003CFP | 20A/300V HIGHT FREQUENCY SECONDARY RECTIFIE | ST | TO-220FPAB |
| D6 | STTH1L06A | 1A/600V ULTRAFAST HIGH VOLTAGE RECTIFIER | ST | SMA |
| F1 | FUSE - 3.15A | FUSE T3.15A/250V - TIME DELAY | | PTH |
| L1 | CHOKE-L | 15uH T6.3, OD15.5, ID8.5 1.0MM WIRE | | PTH |
| L2 | Jump | Jump wire: D=1.0mm | | PTH |
| LF1 | COM-CHOKE | 2mH T7.2, OD14, ID7 0.6MM WIRE | | T14-7-7 |
| LF2 | COM-CHOKE | 14mH T8.6, OD16, ID9 0.6MM WIRE | | T16-9-9 |

Table 2: Bill of Materials-2

| Des. | Part Type/ Part Value | Description | Supplier | CASE STYLE /PACKAGE |
|---|---|---|---|---|
| J1-2 | Jump | Jump wire: D=0.8mm | | PTH |
| J3 | Jump | Jump wire: D=0.6mm | | PTH |
| J4 | 0Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| OPTO1 | PC817A | OPTOCOUPLER | SHARP | DIP-4 - 10.16MM |
| Q1 | STF11NM65N | 12A/650V 0.33Ω N-CHANNEL SECOND GENERATION M | ST | TO-220FP |
| Q2 | MMBT3904 | NPN SMALL SIGNAL BJT MMBT3904LT1 | | SOT23 |
| R1 | 1MΩ | SMD STANDARD FILM RES - 1/4W - 1% - 100ppm/℃ | | 1206 |
| R2 | 330KΩ | SMD STANDARD FILM RES - 1/4W - 1% - 100ppm/℃ | | 1206 |
| R3 | 330KΩ | SMD STANDARD FILM RES - 1/4W - 1% - 100ppm/℃ | | 1206 |
| R4 | 330KΩ | AXIAL STAND. M-FILM RES. - 0.166W - 1% | | PTH |
| R4A | 47KΩ | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R4B | 47KΩ | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R4C | 47KΩ | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R4D | 47KΩ | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R5 | 4.7Ω | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0805 |
| R6 | 2.2KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0805 |
| R7 | 680KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R8 | 10KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R9 | 100KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R10 | 1MΩ | SMD STANDARD FILM RES - 1/4W - 1% - 100ppm/℃ | | 1206 |
| R11 | 1.0KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R12 | 39KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R13 | | | | |
| R14 | 10KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R15 | 7.5KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R16 | 3.9KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R17 | 4.7Ω | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0805 |
| R18 | 20KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R19 | 1KΩ | AXIAL STAND. M-FILM RES. - 0.166W - 5% | | PTH |
| R19A | 0.18Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R19B | 0.18Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R19C | 0.18Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R19D | 0.18Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R20 | 24Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R21 | 24Ω | SMD STANDARD FILM RES - 1/4W - 5% - 250ppm/℃ | | 1206 |
| R24 | 10Ω | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0805 |
| R25 | 1.5KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0805 |
| R26 | | | | |
| R27 | 1KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R28 | 4.7KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R29 | 1KΩ | SMD STANDARD FILM RES - 0.1W - 5% - 250ppm/℃ | | 0603 |
| R30 | 100KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R31 | 2.2KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R32 | 27KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| R33 | 1KΩ | SMD STANDARD FILM RES - 0.1W - 1% - 100ppm/℃ | | 0603 |
| RS1 | 5mΩ | Resistor wire D=1.0mm | | PTH |

Table 3: Bill of Materials-3

| Des. | Part Type/ Part Value | Description | Supplier | CASE STYLE /PACKAGE |
|---|---|---|---|---|
| T1 | TRANSFORMER | PQ3220-PC47/PC95 TDK | | DWG |
| U1 | L6562A | TRANSITION-MODE PFC CONTROLLER | ST | SO-8 |
| U2 | TSM1014 | LOW CONSUMPTION VOLTAGE AND CURRENT CONT | ST | SO-8 |
| ZD1 | 15V/0.5W | ZENER DIODE | | MINIMELF SOD-80 |
| ZD2 | 22V/0.5W | ZENER DIODE | | MINIMELF SOD-80 |
| ZD3 | | | | |

# Electrical Testing Results:

## Efficiency

The unit's efficiency is tested at different input voltage and different output loading on CV mode. Because the output voltage and current are combined with a large AC component, the output power is no longer able to simply calculate by the average or RMS value of Voltage and Current time each other. Below results are basing on the electrical loading constant voltage mode (CV), to simplify the testing structure, if compare to the actual characteristics using LEDs, the waveforms and performances are very similar.

Table 4:

Testing conditions: CV loading 33V

| Vin | Iin (mA) | Pin (W) | PF | Vo (V)_rms | Po (W) | Eff. (%) |
|---|---|---|---|---|---|---|
| 90Vac/60Hz | 1028.1 | 91.56 | 0.99 | 33.24 | 74.36 | 81.21 |
| 100Vac/60Hz | 949.4 | 93.84 | 0.99 | 33.26 | 78.09 | 83.22 |
| 115Vac/60Hz | 856.0 | 96.50 | 0.98 | 33.27 | 81.68 | 84.64 |
| 120Vac/60Hz | 813.9 | 96.00 | 0.98 | 33.27 | 81.92 | 85.33 |
| 220Vac/50Hz | 503.6 | 103.32 | 0.92 | 33.30 | 90.94 | 88.02 |
| 230Vac/50Hz | 485.8 | 103.15 | 0.92 | 33.30 | 91.00 | 88.22 |
| 240Vac/50Hz | 467.7 | 102.51 | 0.91 | 33.30 | 90.24 | 88.03 |
| 264Vac/50Hz | 439.4 | 102.91 | 0.88 | 33.30 | 90.25 | 87.70 |

Testing conditions: CV loading 30V

| Vin | Iin (mA) | Pin (W) | PF | Vo (V)_rms | Po (W) | Eff. (%) |
|---|---|---|---|---|---|---|
| 90Vac/60Hz | 1086.6 | 96.92 | 0.99 | 30.28 | 78.69 | 81.19 |
| 100Vac/60Hz | 1124.8 | 111.38 | 0.99 | 30.33 | 92.05 | 82.64 |
| 115Vac/60Hz | 965.1 | 109.40 | 0.98 | 30.33 | 92.73 | 84.76 |
| 120Vac/60Hz | 923.3 | 109.11 | 0.99 | 30.33 | 92.79 | 85.04 |
| 220Vac/50Hz | 488.6 | 100.16 | 0.92 | 30.32 | 87.73 | 87.59 |
| 230Vac/50Hz | 471.5 | 99.91 | 0.92 | 30.32 | 87.48 | 87.56 |
| 240Vac/50Hz | 456.0 | 99.63 | 0.91 | 30.32 | 87.30 | 87.62 |
| 264Vac/50Hz | 426.5 | 99.34 | 0.88 | 30.32 | 86.92 | 87.50 |

# Table 5:

Testing conditions: CV loading 27V

| Vin | Iin (mA) | Pin (W) | PF | Vo (V)_rms | Po (W) | Eff. (%) |
|---|---|---|---|---|---|---|
| 90Vac/60Hz | 1064.6 | 94.83 | 0.99 | 27.31 | 77.49 | 81.71 |
| 100Vac/60Hz | 947.6 | 93.63 | 0.99 | 27.31 | 78.30 | 83.63 |
| 115Vac/60Hz | 826.2 | 93.49 | 0.98 | 27.31 | 79.58 | 85.12 |
| 120Vac/60Hz | 793.3 | 93.51 | 0.98 | 27.32 | 79.84 | 85.38 |
| 220Vac/50Hz | 445.0 | 89.59 | 0.92 | 27.31 | 78.22 | 87.31 |
| 230Vac/50Hz | 430.0 | 89.40 | 0.90 | 27.31 | 77.94 | 87.18 |
| 240Vac/50Hz | 417.3 | 89.39 | 0.89 | 27.31 | 78.04 | 87.30 |
| 264Vac/50Hz | 392.8 | 89.31 | 0.86 | 27.31 | 77.91 | 87.24 |

No load input power

| Vin | Pin (mW) | Vo (V) |
|---|---|---|
| 90Vac/60Hz | 708 | 34.94 |
| 100Vac/60Hz | 872 | 34.94 |
| 115Vac/60Hz | 917 | 34.94 |
| 230Vac/50Hz | 771 | 34.96 |
| 240Vac/50Hz | 781 | 34.96 |
| 264Vac/50Hz | 846 | 34.96 |

# Harmonic Current

This unit is also designed to follow the requirement per. EN6100-3-2 class C (lighting).

# Table 6:

| | | | | | | |
|---|---|---|---|---|---|---|
| Vin=115Vac/60Hz | Pin: | 95.7 | W | Iin: | 0.844 | A |
| Vin=230Vac/50Hz | Pin: | 100.24 | W | Iin: | 0.4743 | A |
| | PF: | 0.987 | | | | |
| | PF: | 0.908 | | | | |

| Set CV loading = 30V | | | | | |
|---|---|---|---|---|---|
| Limits for class C equipment (light >25W) | | | | | |
| Harmonic order | Maximum permissible har | | Testing Result | | Pass/Fail |
| | % | | % | | |
| | 115Vac/60Hz | 230Vac/50Hz | 115Vac/60Hz | 230Vac/50Hz | |
| 2 | 2 | 2 | 0.03 | 0.07 | |
| 3 | 29.61 | 27.24 | 8.73 | 17.32 | |
| 5 | 10 | 10 | 0.79 | 5.39 | |
| 7 | 7 | 7 | 0.20 | 3.37 | |
| 9 | 5 | 5 | 0.42 | 2.82 | |
| 11≤ n ≤ 39 | 3 | 3 | | | |
| 11 | 3 | 3 | 0.63 | 2.35 | |
| 13 | 3 | 3 | 0.60 | 2.22 | |
| 15 | 3 | 3 | 0.48 | 2.07 | |
| 17 | 3 | 3 | 0.34 | 1.82 | |
| 19 | 3 | 3 | 0.33 | 1.58 | |
| 21 | 3 | 3 | 0.26 | 1.53 | |
| 23 | 3 | 3 | 0.31 | 1.41 | |
| 25 | 3 | 3 | 0.45 | 1.27 | |
| 27 | 3 | 3 | 0.51 | 1.14 | |
| 29 | 3 | 3 | 0.34 | 0.96 | |
| 31 | 3 | 3 | 0.22 | 0.86 | |
| 33 | 3 | 3 | 0.04 | 0.82 | |
| 35 | 3 | 3 | 0.16 | 0.86 | |
| 37 | 3 | 3 | 0.30 | 0.80 | |
| 39 | 3 | 3 | 0.35 | 0.72 | |
| Result | | | | | Pass |

(=30*PF)

# Waveforms and Protection

## Normal operating waveforms:

In below section, will try to add some waveform to show the unit's performance when it works in steady states.

Vin=115Vac/60Hz, Loading CV=33V

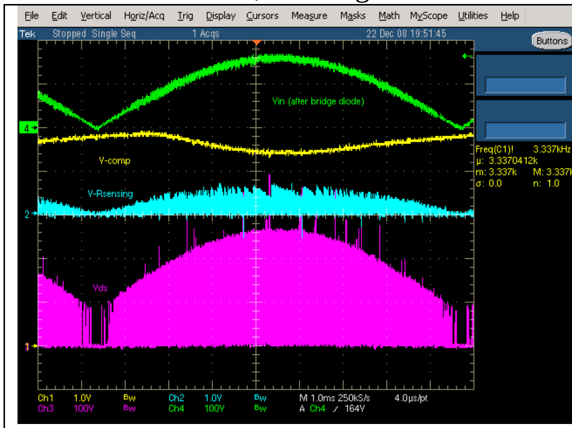



Figure 2

Vin=230Vac/50Hz Loading CV=33V

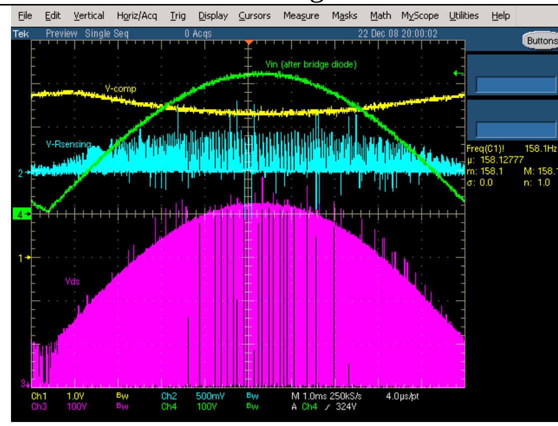



Figure 3

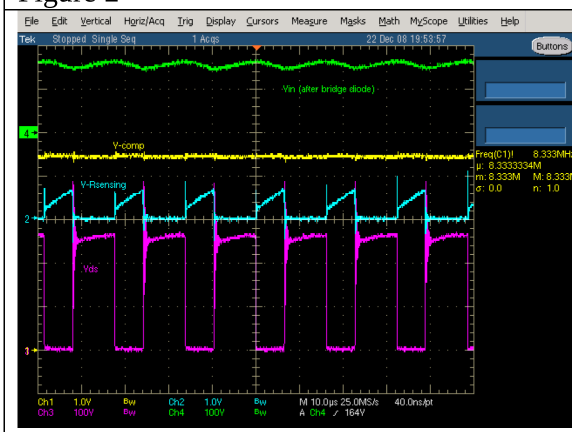



Figure 4

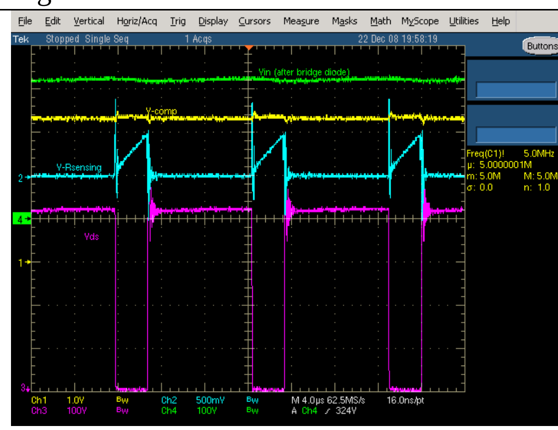



Figure 5

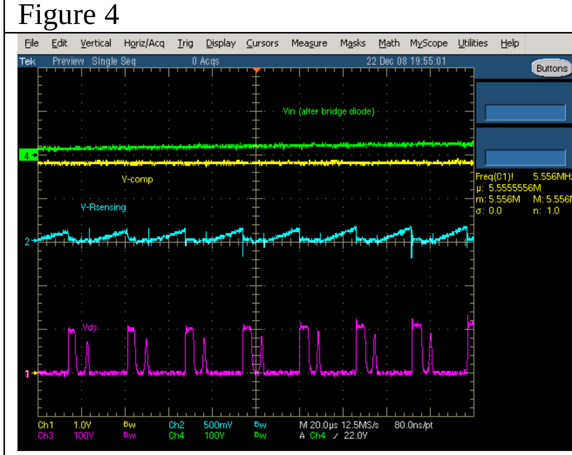



Figure 6

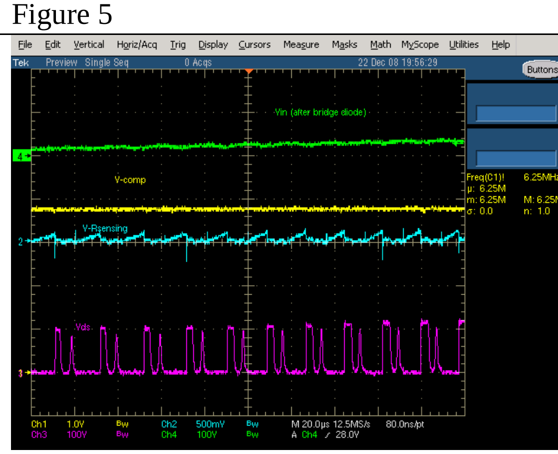



Figure 7

Above record the waveforms at primary side at nominal conditions. Figure 4,5 record the extension waveform of figure 2,3 when input voltage at the top of the sine waveform. And figure 6,7 record the extension waveform of figure 2,3 when input voltage at the bottom of the sine waveform.

From these waveforms we can find: the unit works in the mode of “fix-off-time”, means the turn off time of the MOSFET does not change when the input is waving. And the switching frequency doesn’t change so much when the input voltage change from low to high.

The waveform in figure 2 and 3, look like some click, but it causes by the display of the oscilloscope and the actual waveform is smooth.

Vin=115Vac/60Hz, Loading CV=33V

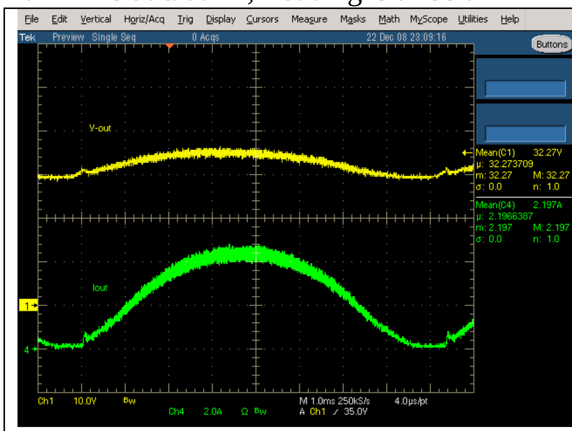



Figure 8

Vin=230Vac/50Hz Loading CV=33V

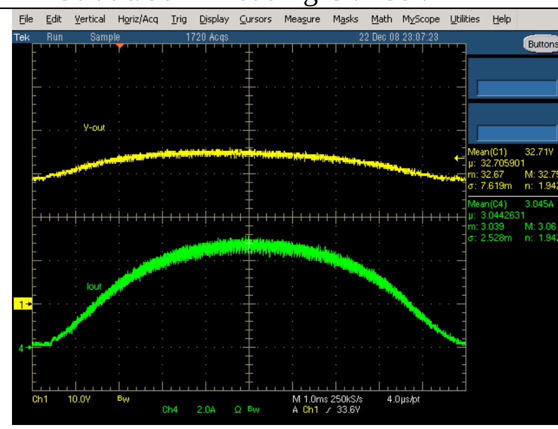



Figure 9

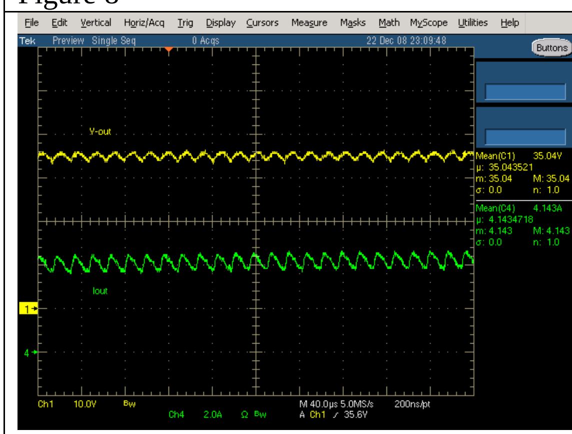



Figure 10

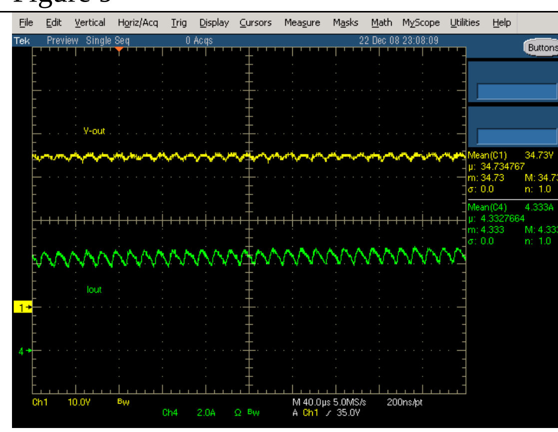



Figure 11

From above, shows the waveforms of output current and output voltage.

Because small value of ceramic capacitors (total is 8*4.7uF for 90W output) is used at the secondary output section, we can find large low frequency and high frequency ripple voltage and ripple current. It’s possible to decrease these ripple by increasing the capacitance of caps if you like. The high frequency can be very small (like peak to peak smaller than 1% of nominal (average value) output voltage), but for the line frequency ripple, same as the words at the beginning of this document, it’s almost impossible to do a large improvement.

# Starting-up waveforms:

In below, will show the waveforms at the unit's starting-up stage.

Vin=90Vac/60Hz, Loading CV=33V     Vin=264Vac/50Hz Loading CV=33V

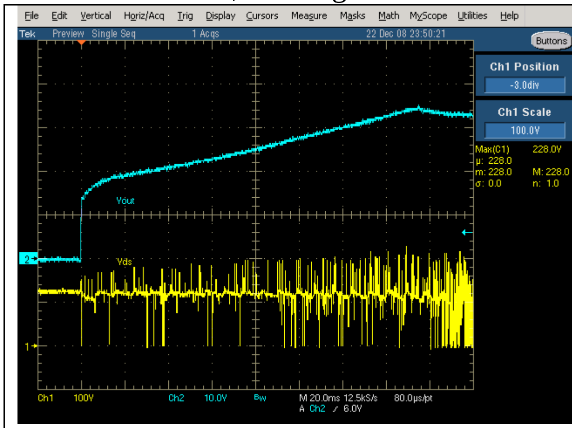



Figure 12

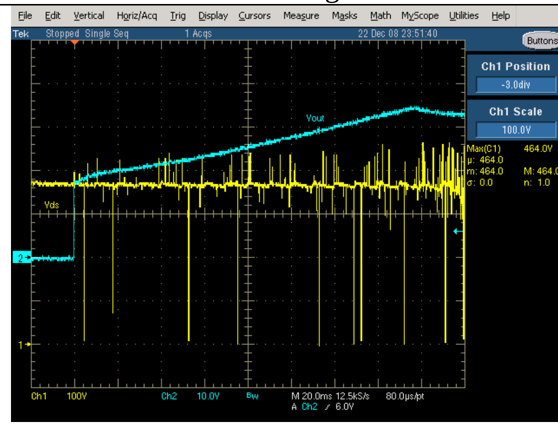



Figure 13

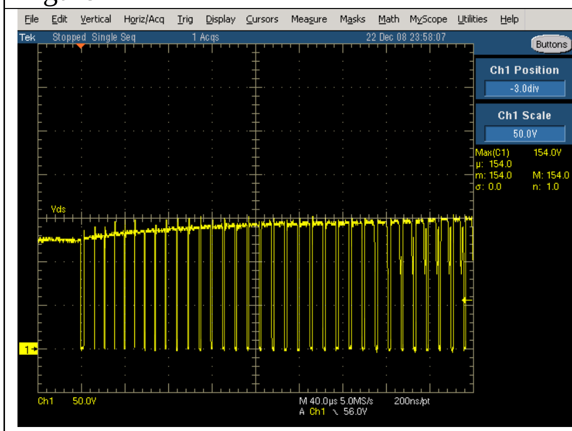



Figure 14

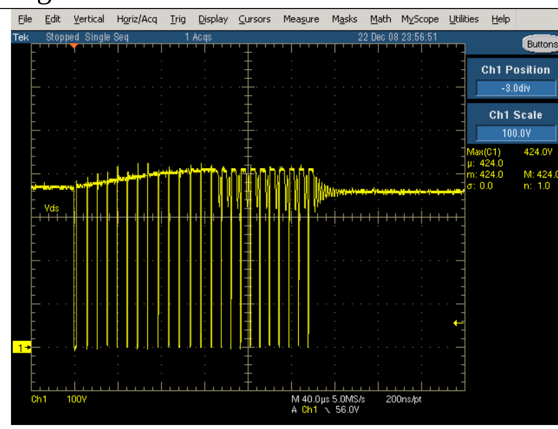



Figure 15

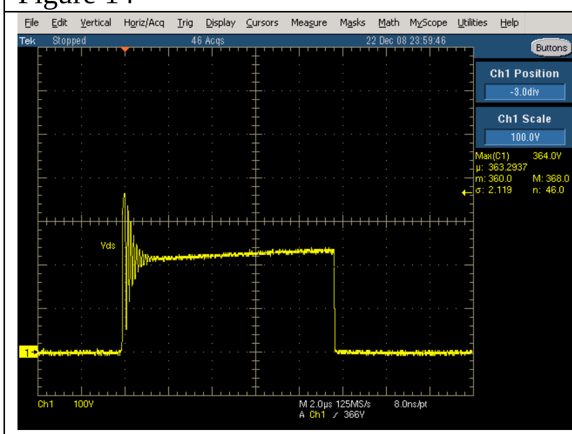



Figure 16

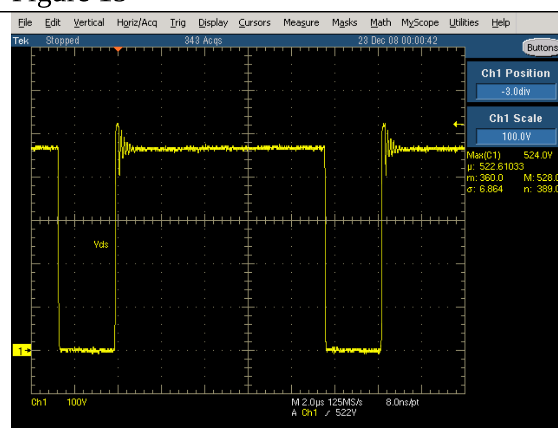



Figure 17

Figure 12,13 are long time starting-up stage waveforms, Ch1 is Vds voltage waveform of primary switching power MOSFET, Ch2 is output voltage. Figure 14,15 are the Vds voltage waveform of the same FET which trigger at the instantaneous starting switch second. Figure 16, 17 are the waveforms at normal operating condition.

From these waveforms, we can find the switching power MOSFET has enough margin of voltage stress at starting-up stage. Actually the voltage stress at starting-up stage is smaller than the value at normal operating condition.

## Protection:

The unit has implemented output short circuit protection. And output over voltage protect by primary sensing from aux winding.

For short circuit protection, the transformer is been specially handled. The primary aux. winding for Vcc supply is been put between secondary windings. This structure is used to minimize the effect of the leakage inductance of the aux. winding.

Vin=90Vac/60Hz, Loading CV=33V before short

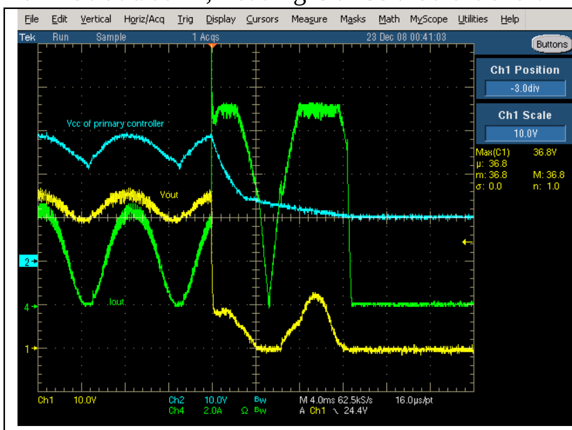


Figure 18

Vin=264Vac/50Hz Loading CV=33V before short

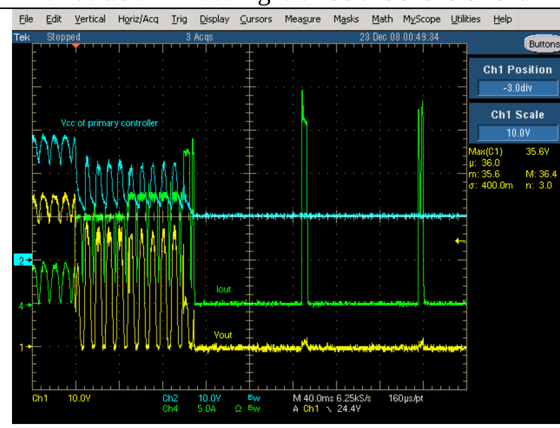


Figure 19

# References:

[1]. AN1895 APPLICATION NOTE EVAL6562-375W, 375W FOT-CONTROLLED PFC, STMicroelectronics

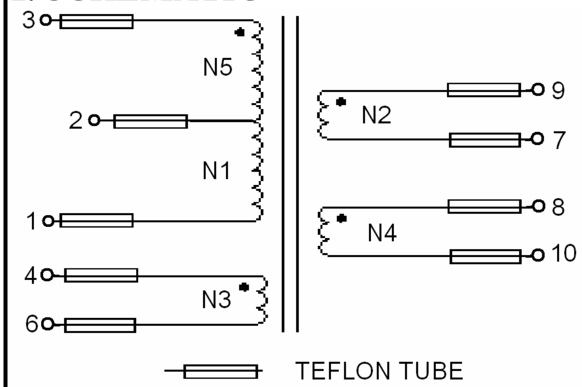
[2]. AN1792 APPLICATION NOTE DESIGN OF FIXED-OFF-TIME-CONTROLLED PFC PRE-REGULATORS WITH THE L6562, BY CLAUDIO ADRAGNA

[3]. AN1059 APPLICATION NOTES DESIGN EQUATIONS OF HIGH-POWER-FACTOR FLYBACK CONVERTERS BASED ON THE L6561, BY CLAUDIO ADRAGNA

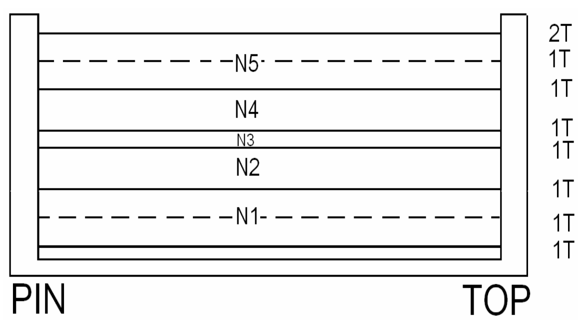
# Appendix 1:

# Transformer Specification

**1. SCHEMATIC**




**2. WINDING**




**3. WINDING TABLE**

| Tape Layer | Pin | Wire | | Turns | Margin Tape | Tape Layer | Winding Method | Remark |
|---|---|---|---|---|---|---|---|---|
| | | Diameter | Type | | | | | |
| N1 | 1—2 | ∮0.65*1 | 2UEW | 22Ts | / | 9mm*1Ts | One layer one wire, insulate between layers | Total 2 layers, 11T for each layer |
| N2 | 7—9 | ∮0.7*1 | TRW(B) | 8Ts | / | 9mm*1Ts | One layer one wire | |
| N3 | 6—4 | ∮0.15*1 | 2UEW | 13Ts | / | 9mm*1Ts | One layer one wire | Equally rounding |
| N4 | 10—8 | ∮0.7*1 | TRW(B) | 8Ts | / | 9mm*1Ts | One layer one wire | |
| N5 | 2—3 | ∮0.65*1 | 2UEW | 22Ts | / | 9mm*1Ts | One layer one wire | Total 2 layers, 11T for each layer |
| WINDING | | PIN | TURNS | INDUCTANECE | | TOLERANCE | DCR mΩMAX | Q MIN |
| LP | | 1→3 | 44Ts | 400 u H | | ±10% | 100 | 50 |

**NOTE**

1. **TEST CONDITION : 50KHz 0.1V**
2. **Pull out PIN 5,** Cut short PIN2 to let it’ s height does not exceed the BOBBIN。