User Guide for

# FEBFL7734_L55H008A Evaluation Board

## 8.6 W LED Driver at High Line

## Featured Fairchild Product: FL7734MX

***Direct questions or comments about this evaluation board to: "Worldwide Direct Support"***

[Fairchild Semiconductor.com](http://www.fairchildsemi.com)

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This user guide supports the evaluation board for the FL7734MX. It should be used in conjunction with the FL7734MX datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

# 1. Introduction

This document describes a high performance phase-cut dimming LED driver solution with excellent dimmer compatibility. The input voltage range of the LED driver board is 198 $V_{RMS}$ ~ 264 $V_{RMS}$ and there is one DC output with a constant current of 360 mA at 24 V. Also in this document is a general description of the FL7734MX, the power supply solution specification, schematic, bill of materials, and typical operating characteristics.

## 1.1. General Description of FL7734MX

The FL7734 is a highly integrated PWM controller with advanced Primary-Side-Regulation (PSR) technique to minimize components in low power LED lighting solutions. Using the innovative TRUECURRENT® technology for tight constant current control, it enables design with Constant Current (CC) tolerance of less than ±1% over universal line voltage range to meet stringent LED brightness requirements. FL7734 operates with all types of phase cut dimmers. Phase cut dimming is managed smoothly by Fairchild's proprietary constant input current control, switching mode control and bleeding current control to achieve excellent dimmer compatibility without visible flicker. The controller can automatically detect when there is no dimmer connected. In non dimming mode, the operating mode is set to optimize Power Factor (PF) and Total Harmonic Discharge (THD) by enabling linear frequency control and voltage mode control with Discontinuous Conduction Mode (DCM) operation. An external bleeding MOSFET also acts as the high-voltage startup circuit to implement fast startup and high system efficiency. The FL7734 also provides powerful protections, such as LED open / short, sensing resistor shorted, and over-temperature for high system reliability.

## 1.2. Controller Features

### High Performance

- Excellent Dimmer Compatibility by Active Dimming Control
- Programmable Dimming Curve and Input Current Management
- Constant LED Current Regulation in Large Phase Angle Range
- Cost-Effective Solution without Input Bulk Capacitor and Feedback Circuitry
- Power Factor Correction in Non-Dimming Mode
- Excellent CC Tolerance:
  - <±0.14 % Over the range of ±10% Input Line Voltage Variation
- Fast Startup utilizing Bleeding Circuit
  - < 0.1 s at the Max. Dimmer Phase Angle
  - <0.5 s at the Min. Dimmer Phase Angle

### High Reliability

- LED Short / Open Protection
- Output Diode Short Protection
- Sensing Resistor Short / Open Protection
- $V_{DD}$ Over-Voltage Protection (OVP)
- $V_{DD}$ Under-Voltage Lockout (UVLO)
- Over-Temperature Protection (OTP)
- All Protections are Auto Restart
- Cycle-by-Cycle Current Limit

## 1.3. Controller Internal Block Diagram

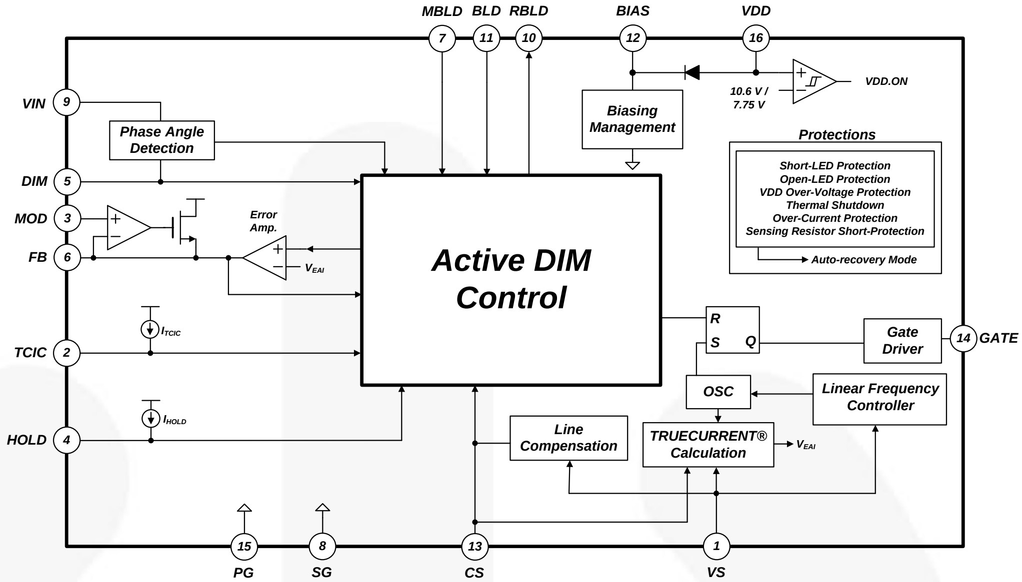


Figure 1. Block Diagram

# 2. Evaluation Board Specifications

**Table 1. Evaluation Board Specifications for LED Lighting Bulb**

| Description | | Symbol | Value | Comments |
|---|---|---|---|---|
| Input | Voltage | $V_{IN.MIN}$ | 198 $V_{AC}$ | Minimum AC Input Voltage |
| | | $V_{IN.MAX}$ | 230 $V_{AC}$ | Maximum AC Input Voltage |
| | | $V_{IN.NOMINAL}$ | 264 $V_{AC}$ | Nominal AC Input Voltage |
| | Frequency | $f_{IN}$ | 60 Hz / 50 Hz | Line Frequency |
| Output | Voltage | $V_{OUT.MIN}$ | 21 V | Minimum Output Voltage |
| | | $V_{OUT.MAX}$ | 27 V | Maximum Output Voltage |
| | | $V_{OUT.NOMINAL}$ | 24 V | Nominal Output Voltage |
| | Current | $I_{OUT.NOMINAL}$ | 360 mA | Nominal Output Current |
| | | CC Deviation | < ±0.14% | Line Input Voltage Change: 198~264 $V_{AC}$ |
| | | | < ±0.56% | Output Voltage Change: 21~27 V |
| Efficiency | | $Eff_{198VAC}$ | 83.7% | Efficiency at 198 $V_{AC}$ Input Voltage |
| | | $Eff_{230VAC}$ | 83.9% | Efficiency at 230 $V_{AC}$ Input Voltage |
| | | $Eff_{264VAC}$ | 83.4% | Efficiency at 264 $V_{AC}$ Input Voltage |
| PF/THD | | PF / $THD_{198VAC}$ | 0.97 / 9.9% | PF/THD at 198 $V_{AC}$ Input Voltage |
| | | PF / $THD_{230VAC}$ | 0.96 / 11.4% | PF/THD at 230 $V_{AC}$ Input Voltage |
| | | PF / $THD_{264VAC}$ | 0.95 / 13.7% | PF/THD at 264 $V_{AC}$ Input Voltage |
| Temperature | FL7734MX | $T_{FL7734MX}$ | 66.9°C | Open-Frame Condition ($T_A$ = 25°C) FL7734MX Temperature |
| | Primary MOSFET | $T_{MOSFET}$ | 63.1°C | Primary MOSFET Temperature |
| | Secondary Diode | $T_{DIODE}$ | 66.8°C | Secondary Diode Temperature |
| | Transformer | $T_{TRANSFORMER}$ | 66.1°C | Transformer Temperature |

# 3. Evaluation Board Photographs

Dimensions: 62.1 mm (L) x 28 mm (W) x 22 mm (H)

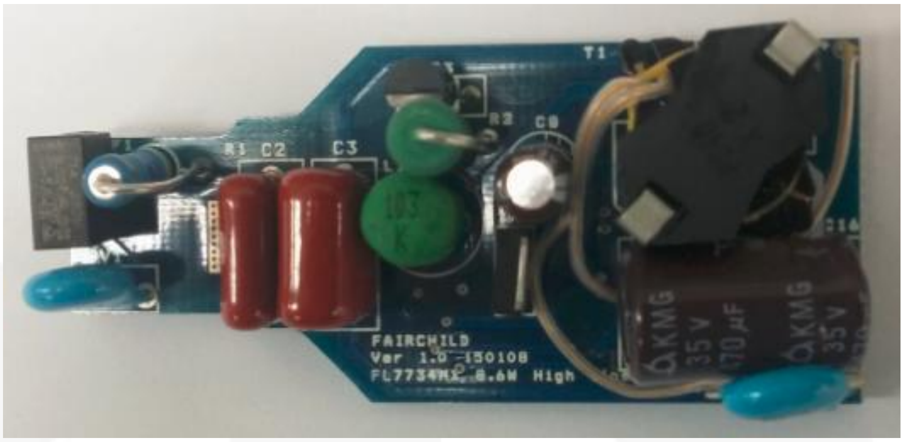


**Figure 2. Top View**

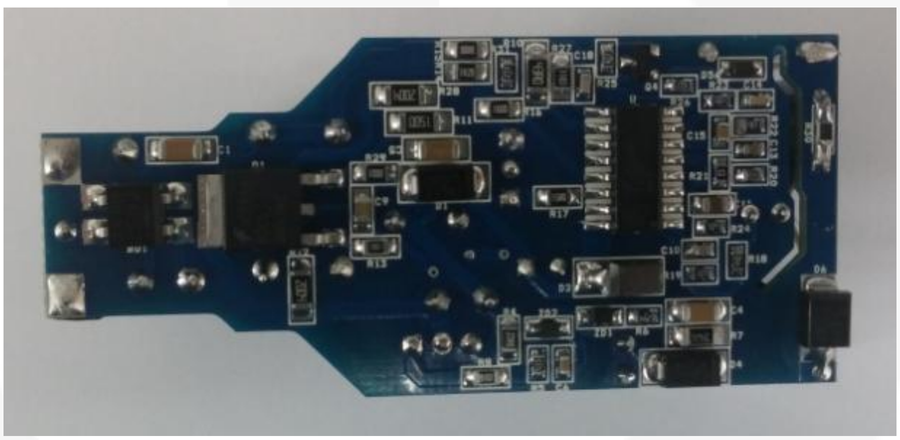

**Figure 3. Bottom View**

# 4. Evaluation Board Printed Circuit Board (PCB)

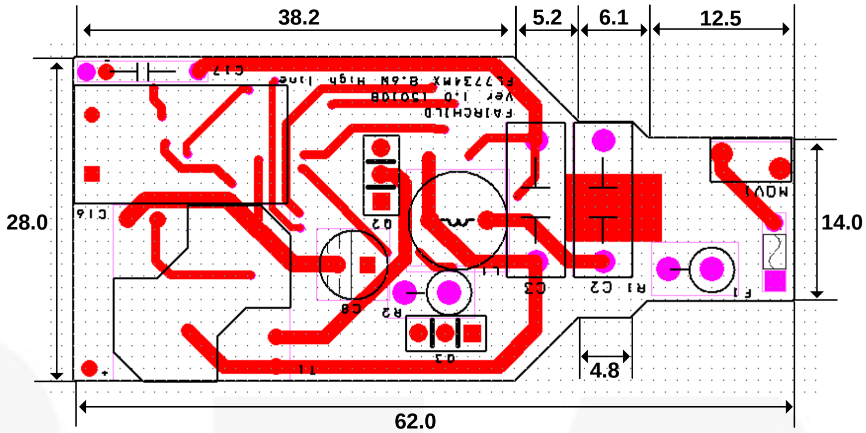


**Figure 4. Top Pattern (mm)**

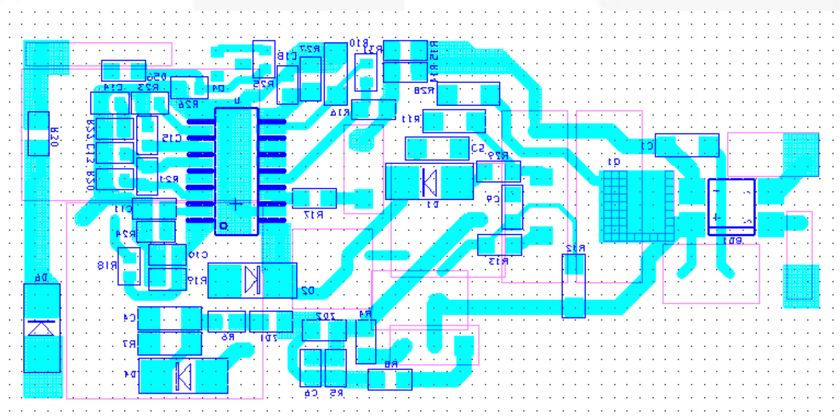

**Figure 5. Bottom Pattern (mm)**

# 5. Evaluation Board Schematic

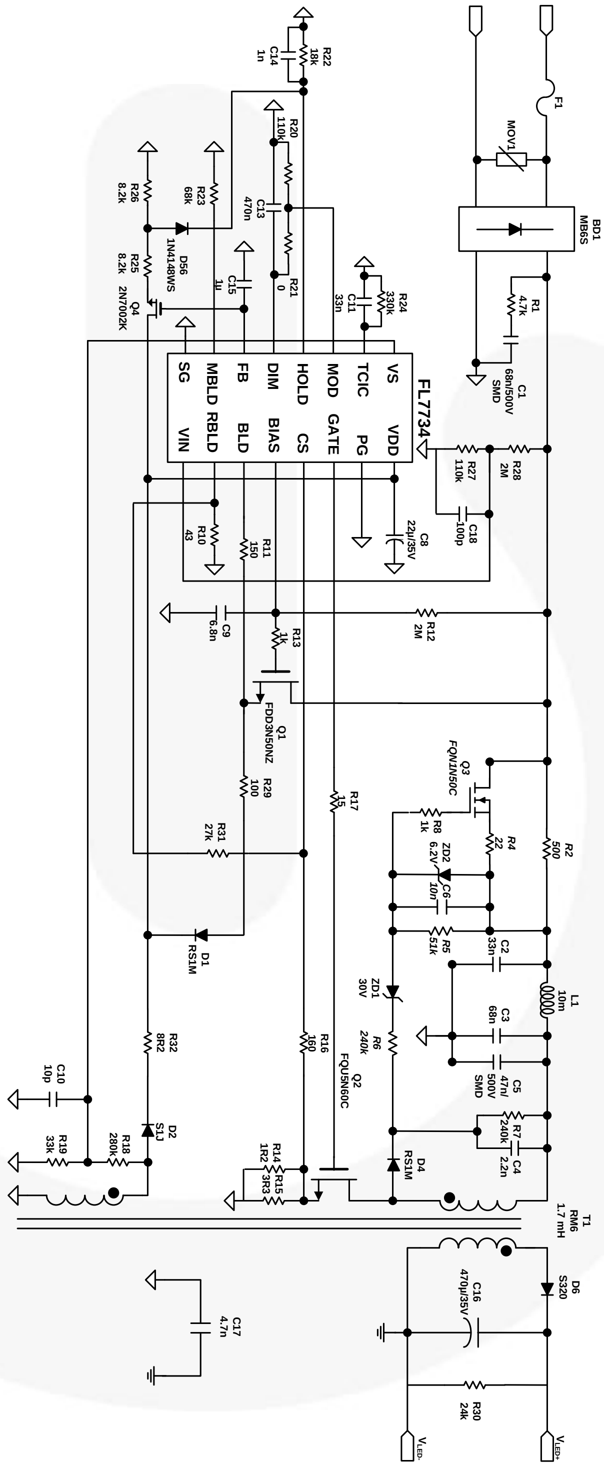


**Figure 6. Schematic**

# 6. Evaluation Board Bill of Materials (BOM)

| Item No. | Part Reference | Part Number | Description | Manufacturer |
|---|---|---|---|---|
| 1 | F1 | SS-5-1A | 1 A/250 V Fuse | Bussmann |
| 2 | MOV1 | SVC 471 D-07A | Metal Oxide Varistor | Samwha |
| 3 | BD1 | MB6S | 600 V/0.5 A SOIC-4 | Fairchild |
| 4 | R1 | MOR 1W TC 4.7K | Metal Oxide Film Resistor RSD Type J 4.7 kΩ/1 W R-Forming | ABC |
| 5 | R2 | MOR 2W TC 500R | Metal OxideFilm Resistor RSD Type J 500 Ω/2 W R-Forming | ABC |
| 6 | R4 | RC0805JR-0722RL | 22 Ω SMD Resistor 2012 F 1/4 W | Yageo |
| 7 | R5 | RC0603 JR-0751KL | 51kΩ SMD Resistor 1608 F 1/16 W | Yageo |
| 8 | R7 | RC1206 JR-07240KL | 240 kΩ SMD Resistor 3216 F 1/4 W | Yageo |
| 9 | R6 | RC0603 JR-07240KL | 240 kΩ SMD Resistor 1608 F 1/16 W | Yageo |
| 10 | R8 | RC0805 JR-071KL | 1 kΩ SMD Resistor 2012 F 1/8 W | Yageo |
| 11 | R10 | RC1206 JR-0743RL | 43 Ω SMD Resistor 3216 F 1/4 W | Yageo |
| 12 | R11 | RC1206 JR-07150RL | 150 Ω SMD Resistor 3216 F 1/4 W | Yageo |
| 13 | R12 | RC1206 JR-072ML | 2 MΩ SMD Resistor 3216 F 1/4 W | Yageo |
| 14 | R13 | RC0805 JR-071KL | 1 kΩ SMD Resistor 2012 F 1/8W | Yageo |
| 15 | R14 | RC0805 JR-071R2L | 1R2 SMD Resistor 2012 1/4 W F | Yageo |
| 16 | R15 | RC0805 JR-073R3L | 3R3 SMD Resistor 2012 1/4 W F | Yageo |
| 17 | R16 | RC0805 JR-07160RL | 160 Ω SMD Resistor 2012 F 1/4 W | Yageo |
| 18 | R17 | RC0805 JR-0715RL | 15 Ω SMD Resistor 2012 F 1/4 W | Yageo |
| 19 | R18 | RC0603 JR-07280KL | 280 k SMD Resistor 1608 F 1/16 W | Yageo |
| 20 | R19 | RC0603 JR-0733KL | 33 k SMD Resistor 1608 F 1/16 W | Yageo |
| 21 | R20 | RC0603 JR-07110KL | 110 kΩ SMD Resistor 1608 F 1/16 W | Yageo |
| 22 | R21 | RC0603 JR-070R0L | 0 Ω SMD Resistor 1608 F 1/16 W | Yageo |
| 23 | R22 | RC0603 JR-0718KL | 18 k SMD Resistor 1608 F 1/16 W | Yageo |
| 24 | R23 | RC0603 JR-0768KL | 68 kΩ SMD Resistor 1608 F 1/16 W | Yageo |
| 25 | R24 | RC0603 JR-07330KL | 330 kΩ SMD Resistor 1608 F 1/16 W | Yageo |
| 26 | R25 | RC0603 JR-078R2KL | 8.2 k SMD Resistor 1608 F 1/16 W | Yageo |
| 27 | R26 | RC0603 JR-078R2KL | 8.2 k SMD Resistor 1608 F 1/16 W | Yageo |
| 28 | R27 | RC0805 JR-07110KL | 110 kΩ SMD Resistor 2012 F 1/4 W | Yageo |
| 29 | R28 | RC1206 JR-072ML | 2M Ω SMD Resistor 3216 F 1/4 W | Yageo |
| 30 | R29 | RC0805 JR-07100RL | 100 Ω SMD Resistor 2012 1/4 W F | Yageo |
| 31 | R30 | RC0805 JR-0724KL | 24 k SMD Resistor 2012 F 1/4 W | Yageo |
| 32 | R31 | RC0603 JR-0727KL | 27 k SMD Resistor 1608 F 1/16 W | Yageo |
| 33 | R32 | RC0805 JR-078R2L | 8.2 Ω SMD Resistor 2012 F 1/4 W | Yageo |
| 34 | C1 | C1206V683KCRACTU | 68 nF/500 V SMD Capacitor 3216 X7R | Kemet |
| 35 | C2 | MPE 630V333 | MPE33 nF/630 V 12.5 x 10.0 x 5.0 mm | Sungho Electronics |
| 36 | C3 | MPE 630V683 | MPE 68 nF/630 V 12.5 x 10.0 x 5.0 mm | Sungho Electronics |
| 37 | C5 | C1206V473KCRACTU | 47 nF/500 V SMD Capacitor 3216 X7R | Kemet |
| 38 | C4 | C1206C222KDRACTU | 2.2 nF/1 kV SMD Capacitor 3216 | Kemet |

## BOM (Continued)

| Item No. | Part Reference | Part Number | Description | Manufacturer |
|---|---|---|---|---|
| 39 | C6 | GRM1885C1E103JA01# | 10 nF/16 V SMD Capacitor 1608 COG | Murata |
| 40 | C8 | KMG 22µF35V | KMG series 22 µF/35 V D5 X H11 105°C Electrolytic Capacitor | Samyoung |
| 41 | C9 | GRM2192C1H682JA01# | 6.8 nF/50 V SMD Capacitor 2012 CH | Murata |
| 42 | C10 | C0603C100K8GACTU | 10 pF/10 V SMD Capacitor 1608 NP0 | Kemet |
| 43 | C11 | GRM21A1X1H333JA39# | 33 nF/50 V SMD Capacitor 2012 SL | Murata |
| 44 | C13 | GRM188B11A474KA61# | 470 nF/10 V SMD Capacitor 1608 B | Murata |
| 45 | C14 | GRM1881X1E102JA01# | 1 nF/10 V SMD Capacitor 1608 SL | Murata |
| 46 | C15 | GRM185D71A105KE36# | 1 µF/10 V SMD Capacitor 1608 X7T | Murata |
| 47 | C16 | KMG 470µF35V | KMG Series 470 µF/35 V D10 X H12.5 105°C Electrolytic Capacitor | Samyoung |
| 48 | C17 | SCF2E472M14DW7 | Y Cap 4700 pF | Samwha Capacitor |
| 49 | C18 | GRM1882C1H101JA01# | SMD Capacitor CH 100 pF/50 V | |
| 50 | L1 | R06103KT00 | Radial inductor 10 mH size Φ6.5 mm X H7.5 mm Molding Color Green | Bosung |
| 51 | T1 | RM6 core | Core RM6 PC40 Bobbin BRM6-716CPFR | TDK |
| 52 | D1 | RS1M | 1000 V/1.0 A SMA Package Fast Recovery Diode | Fairchild |
| 53 | D2 | S1J | 600 V/1.0 A SMA Package General Purpose Diode | Fairchild |
| 54 | D4 | RS1M | 1000 V/1.0 A SMA Package Fast Recovery Diode | Fairchild |
| 55 | D56 | 1N4148WS | 100 V/0.3 A SOD-323 Package General Purpose Diode | Fairchild |
| 56 | D6 | S320 | 200 V/3.0 A SMB Package Schottky Rectifier | Fairchild |
| 57 | ZD1 | MM3Z30B | 30 V Zener Diode SOD-323 | Fairchild |
| 58 | ZD2 | MM3Z6V2B | 6.2 V Zener Diode SOD-323 | Fairchild |
| 59 | Q1 | FDD3N50NZ | N-ch Mosfet 500 V/3 A D-Pak | Fairchild |
| 60 | Q2 | FQU5N60C | N-ch Mosfet 600 V/5 A I-Pak | Fairchild |
| 61 | Q3 | FQN1N50C | N-ch Mosfet 500 V/0.38 A TO-92 | Fairchild |
| 62 | Q4 | 2N7002K | N-ch Mosfet 60 V/0.3 A SOT-23 | Fairchild |
| 63 | U1 | FL7734MX | Triac Dimmable LED Driver IC | Fairchild |

# 7. Transformer Design

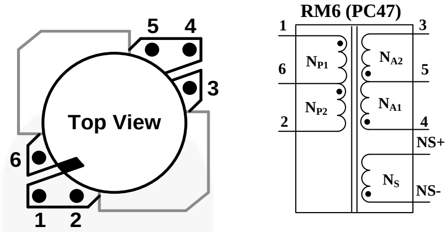


**Figure 7. Transformer Bobbin Structure and Pin Configuration**

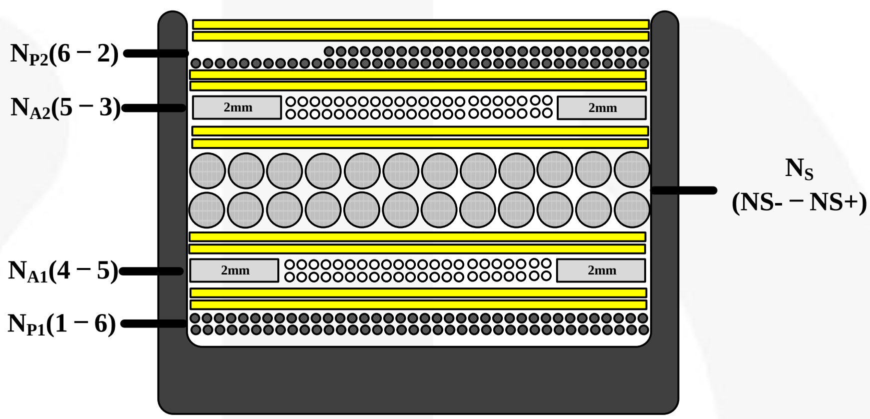


**Figure 8. Transformer Winding Structure**

**Table 2. Winding Specifications**

| No. | Winding | Pin (S → F) | Wire | Turns | Winding Method |
|---|---|---|---|---|---|
| 1 | $N_{P1}$ | 1→ 6 | 0.13φ | 73 Ts | Solenoid Winding |
| 2 | Insulation: Polyester Tape t = 0.025 mm, 2-Layer | | | | |
| 3 | $N_{A1}$ | 4→5 | 0.13φ | 20 Ts | Solenoid Winding |
| 4 | Insulation: Polyester Tape t = 0.025 mm, 2-Layer | | | | |
| 5 | $N_S$ | NS- → NS+ | 0.2φ (TIW) | 44 Ts | Solenoid Winding |
| 6 | Insulation: Polyester Tape t = 0.025 mm, 2-Layer | | | | |
| 7 | $N_{A2}$ | 5→ 3 | 0.13φ | 20 Ts | Solenoid Winding |
| 8 | Insulation: Polyester Tape t = 0.025 mm, 2-Layer | | | | |
| 9 | $N_{P2}$ | 6→2 | 0.13φ | 51 Ts | Solenoid winding |
| 10 | Insulation: Polyester Tape t = 0.025 mm, 2-Layer | | | | |

**Table 3. Electrical Characteristics**

| | Pins | Specifications | Remark |
|---|---|---|---|
| Inductance | 6 – 2 | 1.7 mH ±10% | 60 kHz, 1 V |
| Leakage | 6 – 2 | 30 µH | 60 kHz, 1 V, Short All Output Pins |

# 8. Evaluation Board Performance

**Table 4. Test Condition & Equipment List**

| **Ambient Temperature** | **$T_A$ = 25°C** |
|---|---|
| Test Equipment | AC Power Source: PCR500L by Kikusui<br>Power Analyzer: PZ4000000 by Yokogawa<br>Electronic Load: PLZ303WH by KIKUSUI<br>Multi Meter: 2002 by KEITHLEY, 45 by FLUKE<br>Oscilloscope: 104Xi by LeCroy<br>Thermometer: Thermal CAM SC640 by FLIR SYSTEMS<br>LED: EHP-AX08EL/GT01H-P03 (3 W) by Everlight |

## 8.1. Startup

Figure 9 shows the overall startup performance at rated output load when no dimmer is connected. The output load current starts flowing at least 0.06 s after the AC input power switch turns on for input voltage 230 $V_{AC}$ condition. CH1: $V_{IN}$ (100 V / div), CH2: $V_{DD}$ (10 V / div), CH3: $V_{CS}$ (500 mV / div), CH4: $I_{LED}$ (100 mA / div), Time Scale: (100 ms / div), Load: 8 series-connected LEDs.

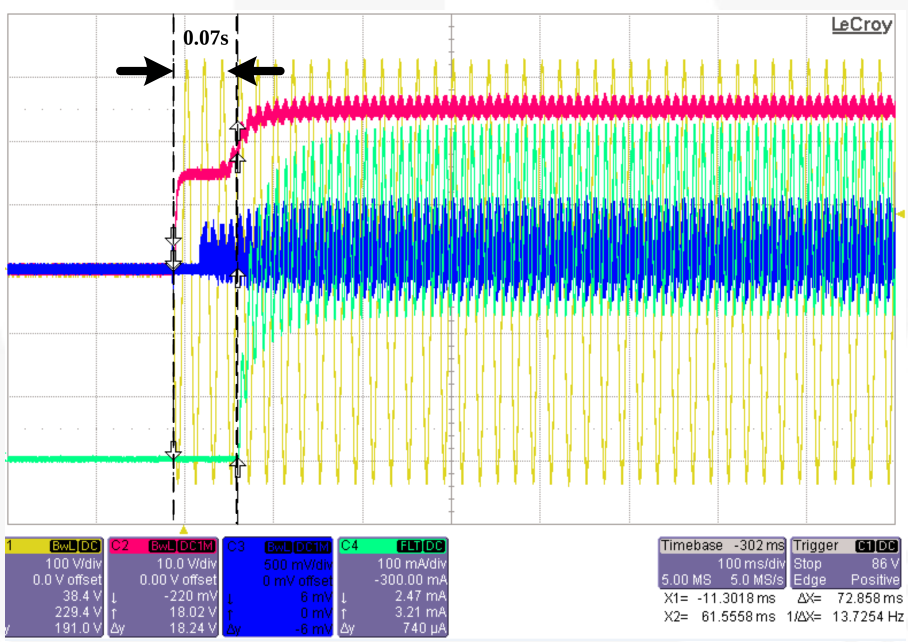


**Figure 9. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

## 8.2. Operation Waveforms

Figure 10 through Figure 12 show AC input and output waveforms at rated output load. CH1: $V_{IN}$ (100 V / div), CH2: $V_{CS}$ (500 mV / div), CH3: $I_{IN}$ (100 mA / div), CH4: $I_{LED}$ (200 mA / div), Time Scale: (5 ms / div), Load: 8 series-connected LEDs.

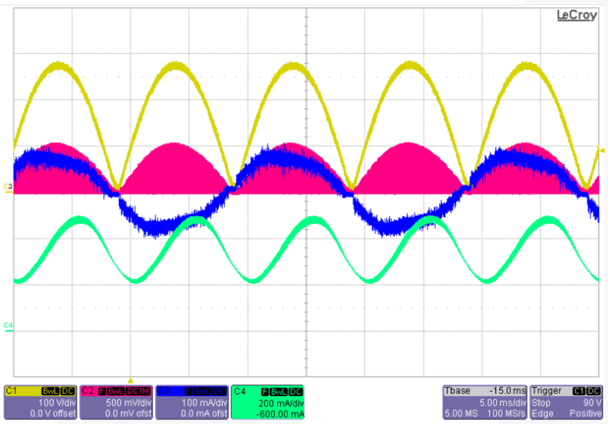


**Figure 10. $V_{IN}$ = 198 $V_{AC}$ / 50 Hz**

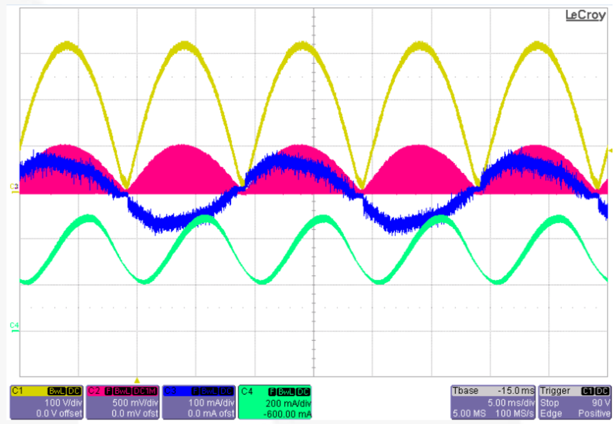


**Figure 11. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

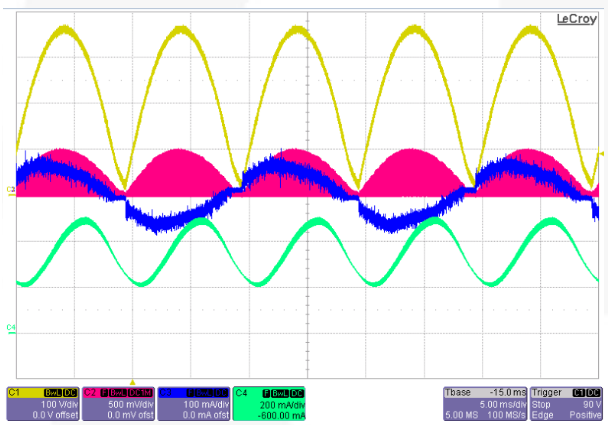


**Figure 12. $V_{IN}$ = 264 $V_{AC}$ / 50 Hz**

## 8.3. Constant-Current Regulation

Output current deviation over the output voltage ranges, from 21 V to 27 V, is less than ±0.56% at each line voltage. Line regulation at the rated output voltage (24 V) is less than ±0.14%. The results were measured with Electronic Load [CR Mode].

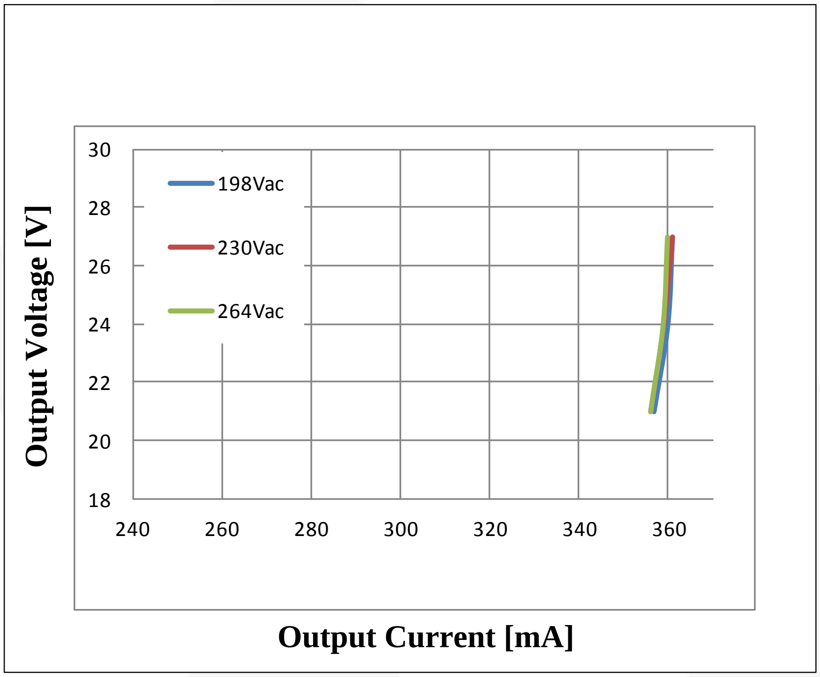


**Figure 13. Constant-Current Regulation**

**Table 5. Constant-Current Regulation by Output Voltage Change (21 ~ 27 V)**

| Input Voltage | Min. Current [mA] | Max. Current [mA] | Tolerance |
|---|---|---|---|
| 198 $V_{AC}$ [60 Hz] | 360 | 361 | ±0.14% |
| 230 $V_{AC}$ [60 Hz] | 357 | 361 | ±0.56% |
| 264 $V_{AC}$ [60 Hz] | 357 | 360 | ±0.42% |

**Table 6. Constant-Current Regulation by Line Voltage Change (198 ~ 264 $V_{AC}$)**

| Output Voltage | 198 $V_{AC}$ [50 Hz] | 230 $V_{AC}$ [50 Hz] | 264 $V_{AC}$ [50 Hz] | Tolerance |
|---|---|---|---|---|
| 27 V | 360 mA | 361 mA | 360 mA | ±0.14% |
| 24 V | 360 mA | 360 mA | 359 mA | ±0.14% |
| 21 V | 358 mA | 357 mA | 357 mA | ±0.14% |

## 8.4. Short- / Open-LED Protections

Figure 14 shows a waveform for the protection and AR operation when the LED is shorted. Once the LED short occurs, SLP is triggered and the controller then shuts down the switching MOSFET. After 4 s, the Startup sequence reinitiates. This behavior lasts until the fault condition is removed. Systems can restart automatically when normal condition resumes at least 4 seconds. CH1: $V_{IN}$ (100 V / div), CH3: $V_{GATE}$ (10 V / div), CH4: $V_{OUT}$ (5 V / div), Time Scale: (1 s / div), Load: 8 series-connected LEDs.

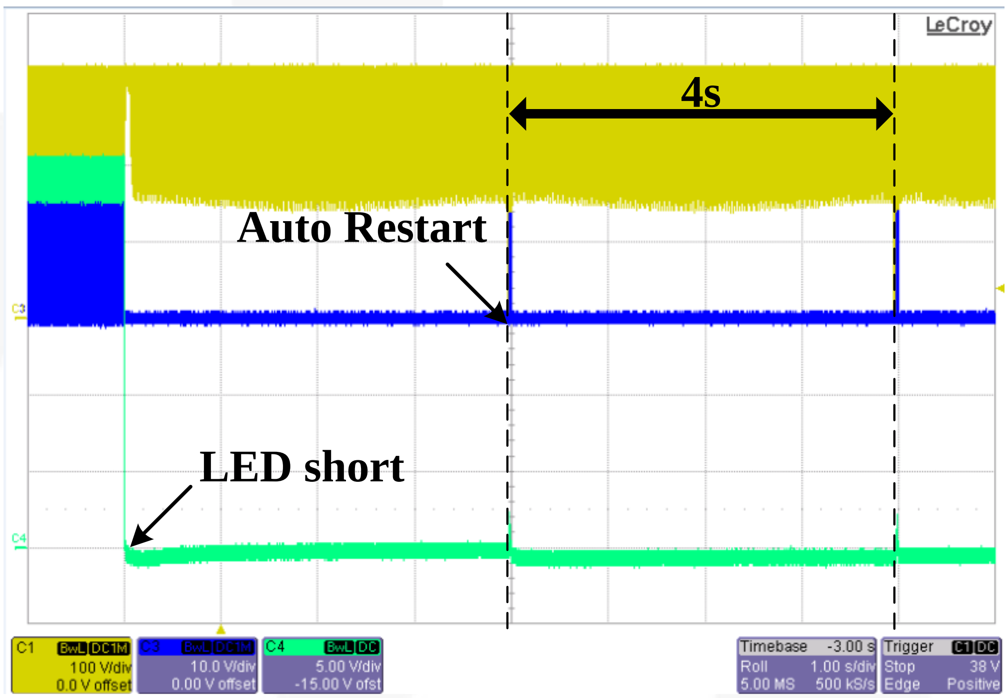


**Figure 14. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

Figure 15 shows a waveform for the protection and AR operation when the LED is opened. Once the LED load is disconnected, $V_S$ OVP or $V_{DD}$ OVP is triggered and the controller then shuts down the switching MOSFET. After 4 s, Startup sequence reinitiates. This behavior lasts until the fault condition is removed. Systems can restart automatically when normal condition resumes at least 4 seconds. CH1: $V_{IN}$ (100 V / div), CH3: $V_{GATE}$ (10 V / div), CH4: $V_{OUT}$ (5 V / div), Time Scale: (1 s / div), Load: 8 series-connected LEDs.

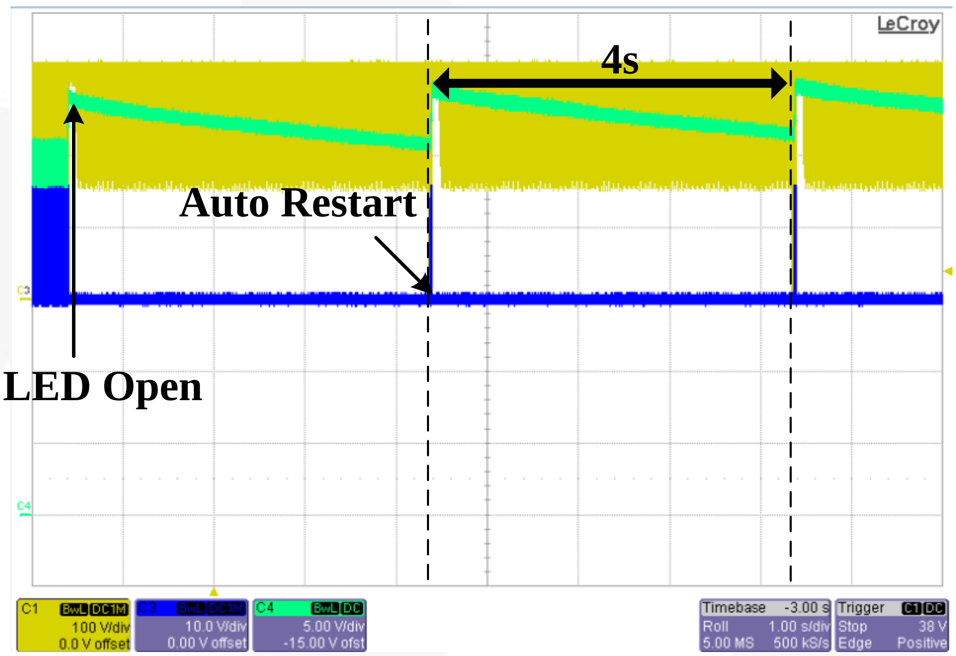


**Figure 15. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

If the LED load is re-connected after an open-LED condition, the output capacitor is quickly discharged through the LED load and the inrush current due to the discharge could destroy LED load.

## 8.5. Secondary Diode / Sensing Resistor Short Protection

Figure 16 shows a waveform for the protection operation when the secondary diode is shorted. $V_{CS}$ is monitored during the gate turn-on time to detect over-current except for LEB time. Once $V_{CS}$ goes higher than $V_{CS\text{-}OCP}$ (1.8 V) after the LEB time, OCP is triggered and the controller then shuts down the switching MOSFET. $I_{peak}$ amplitude can be adjusted by using different magnetizing inductance. CH1: $V_{IN}$ (100 V / div), CH2: $V_{CS}$ (500 mV / div), CH3: $V_{GATE}$ (10 V / div), Time Scale: (10 ms / div), Load: 8 series-connected LEDs.

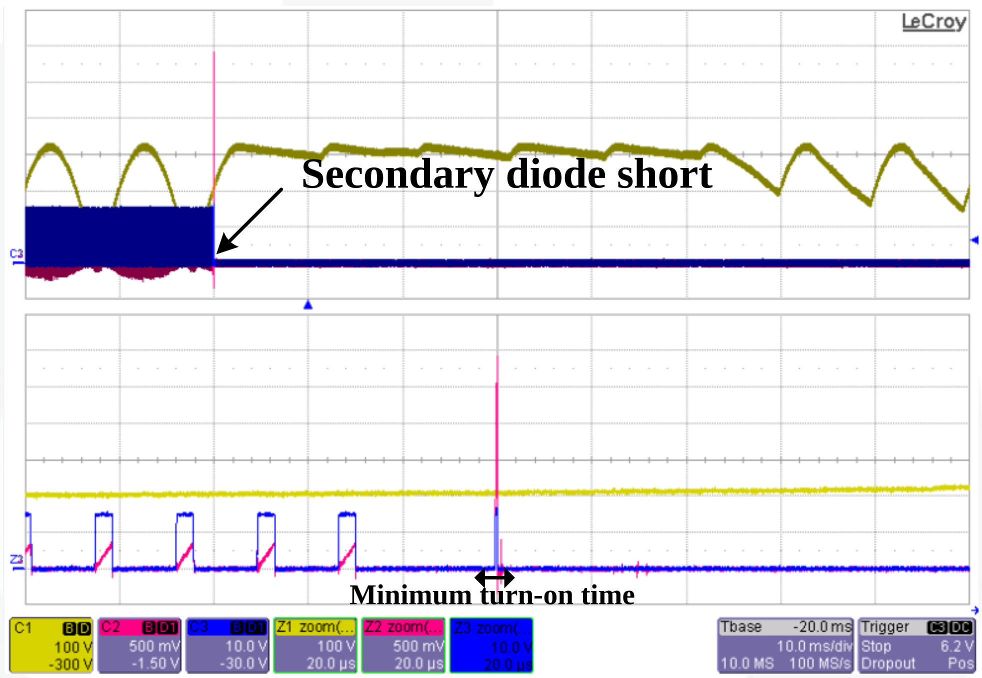


**Figure 16. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

After 4 s, startup operation starts again. This behavior lasts until the fault condition is removed. Systems can restart automatically when normal condition resumes at least 4 seconds.

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Figure 17 shows a waveform for the protection operation when the sensing resistor is shorted. If $V_{CS}$ doesn't reach $V_{CS\text{-}SRSP}$ (0.1 V) within the initial two switching operations during the Startup period, SRSP is triggered and the controller then shuts down the switching MOSFET. CH1: $V_{IN}$ (100 V / div), CH2: $V_{CS}$ (500 mV / div), CH3: $V_{GATE}$ (10 V / div), Time Scale: (10 ms / div), Load: 8 series-connected LEDs.

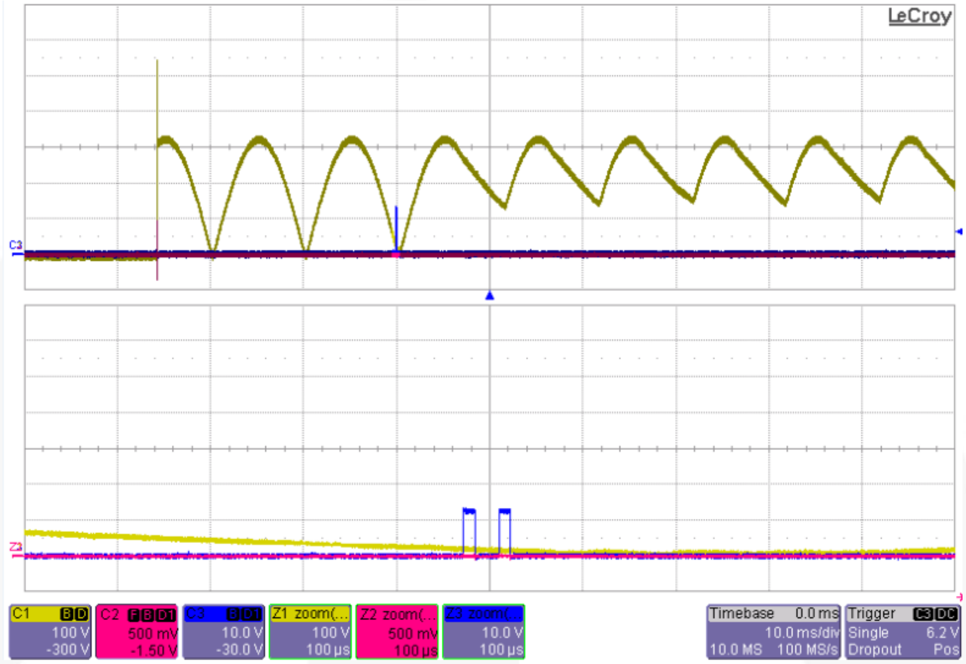


**Figure 17. $V_{IN}$ = 230 $V_{AC}$ / 50 Hz**

After 4 s, Startup operation starts again. This behavior lasts until the fault condition is removed. Systems can restart automatically when normal condition resumes at least 4 seconds.

## 8.6. Efficiency

System efficiency is over 83% from 198 ~ 264 $V_{AC}$. The results were measured using actual, rated LED loads 5 minutes after startup.

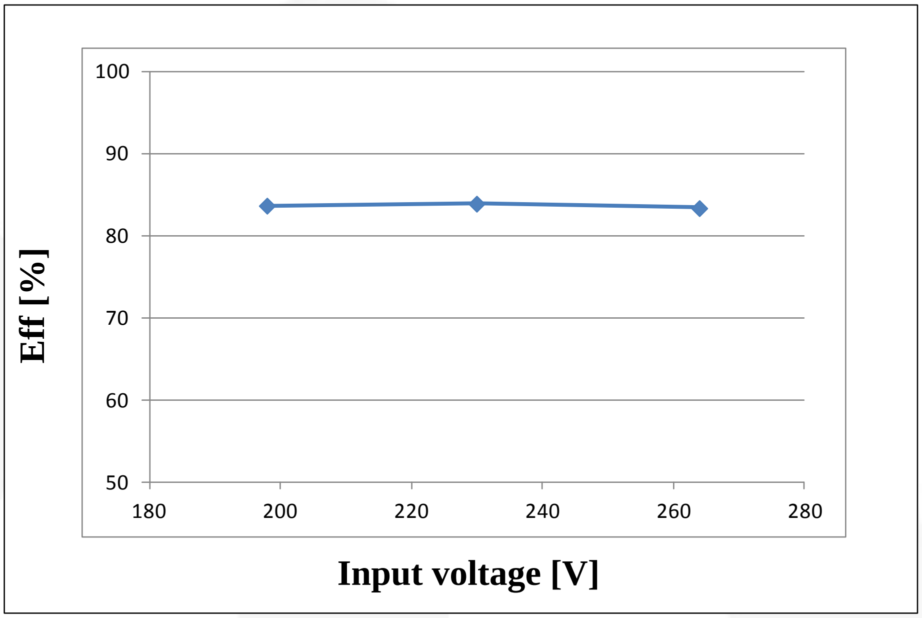


**Figure 18. System Efficiency**

**Table 7. System Efficiency**

| Input Voltage | Input Power | Output Current | Output Voltage | Output Power | Efficiency |
|---|---|---|---|---|---|
| 198 $V_{AC}$ [60 Hz] | 10.32 W | 0.360 A | 24 V | 8.640 W | 83.70% |
| 230 $V_{AC}$ [60 Hz] | 10.26 W | 0.359 A | 24 V | 8.616 W | 83.94% |
| 264 $V_{AC}$ [60 Hz] | 10.33 W | 0.359 A | 24 V | 8.616 W | 83.40% |

## 8.7. Power Factor (PF) & Total Harmonic Distortion (THD)

The FL7734MX evaluation board shows excellent THD performance, less than 13%. Power factor has enough margins from 0.9. The results were measured using actual, rated LED loads 5 minutes after startup.

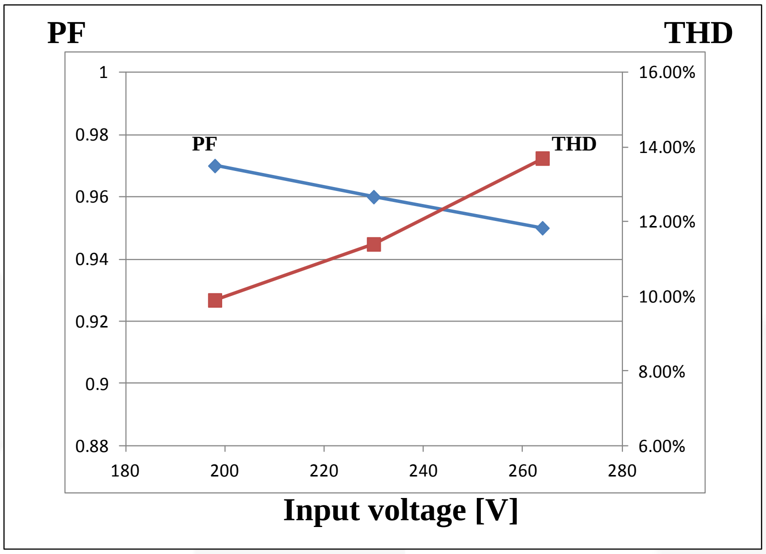


**Figure 19. Power Factor & Total Harmonic Distortion**

**Table 8. Power Factor & Total Harmonic Distortion**

| Input Voltage | Output Current | Output Voltage | Power Factor | THD |
|---|---|---|---|---|
| 198 $V_{AC}$ [60 Hz] | 0.360 A | 24 V | 0.97 | 9.9% |
| 230 $V_{AC}$ [60 Hz] | 0.359 A | 24 V | 0.96 | 11.4% |
| 264 $V_{AC}$ [60 Hz] | 0.359 A | 24 V | 0.95 | 13.7% |

## 8.8. Dimming Operation

Figure 20 to Figure 22 shows the overall startup performance with dimmer connected at the rated output load. The output load current starts flowing 0.36 s after the AC input power switch turns on at small dimmer phase angle for input voltage 230 $V_{AC}$ condition. CH1: $V_{IN}$ (100 V / div), CH2: $V_{DD}$ (10 V / div), CH4: $I_{LED}$ (100 mA / div), Time Scale: (100 ms / div), Load: 8 series-connected LEDs.

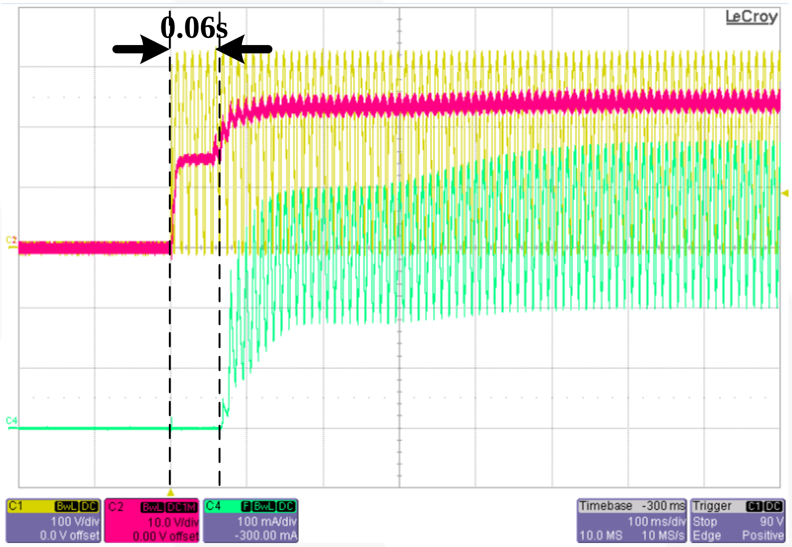


Figure 20. Max Phase Angle Dimming

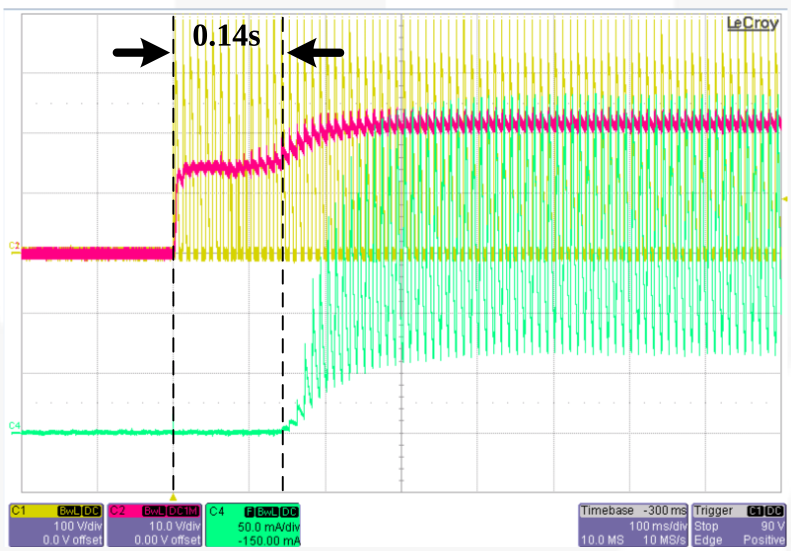


Figure 21. Half Phase Angle Dimming

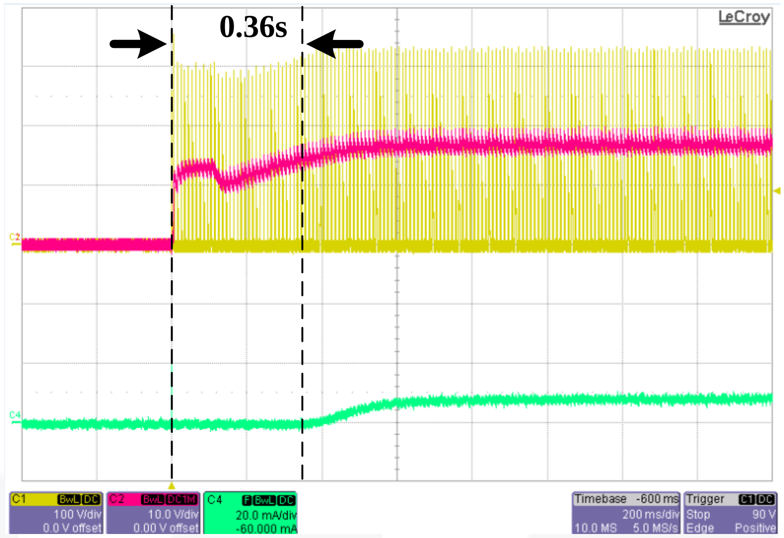


**Figure 22. Min Phase Angle Dimming**

Figure 23 demonstrates the dimming operation with a dimmer connected at the rated output load. Active DIM Control in FL7734MX provides stable dimmer operation and implements flicker-free dimming operation. CH1: $V_{IN}$ (100 V / div), CH2: CS (500 mV / div), CH4: $I_{LED}$ (100 mA / div), Time Scale: (100 ms / div), Load: 8 series-LEDs.

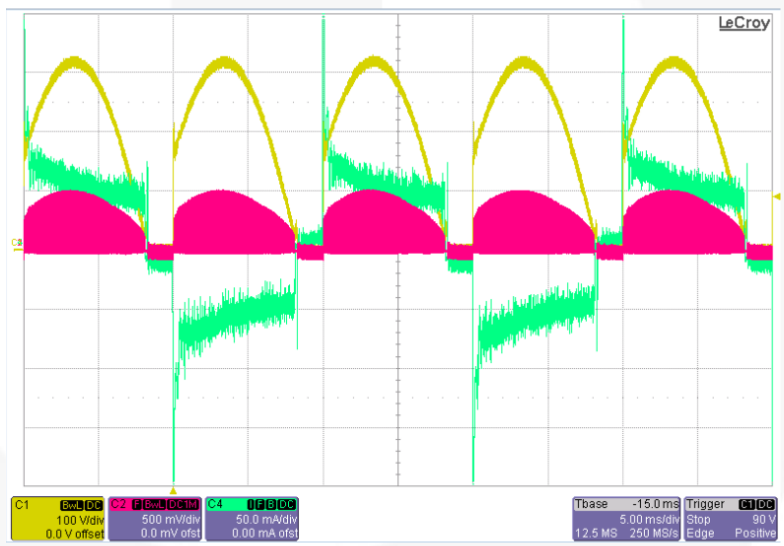


**Figure 23. Max. Phase Angle Dimming**

Figure 24 shows a dimming curve which is obtained by rotating the dimmer switch. Regardless of input line voltage ±10% variation, LED current is constantly regulated from 180 to 130° dimmer phase angle .When the phase angle is below 130°, LED current decreases linearly according to internal dimming reference modulation.

FL7734MX dimming control method can meet NEMA SSL-7A specification. Figure 25 indicates the maximum and minimum dimmed output range as specified by NEMA SSL-7A.

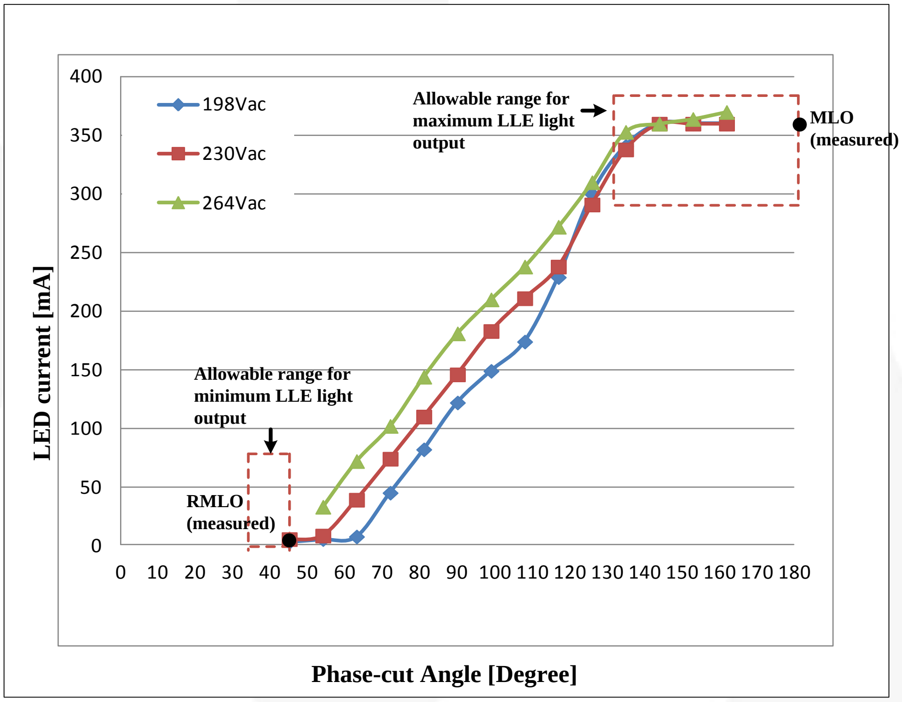


**Figure 24. Dimming Curve**

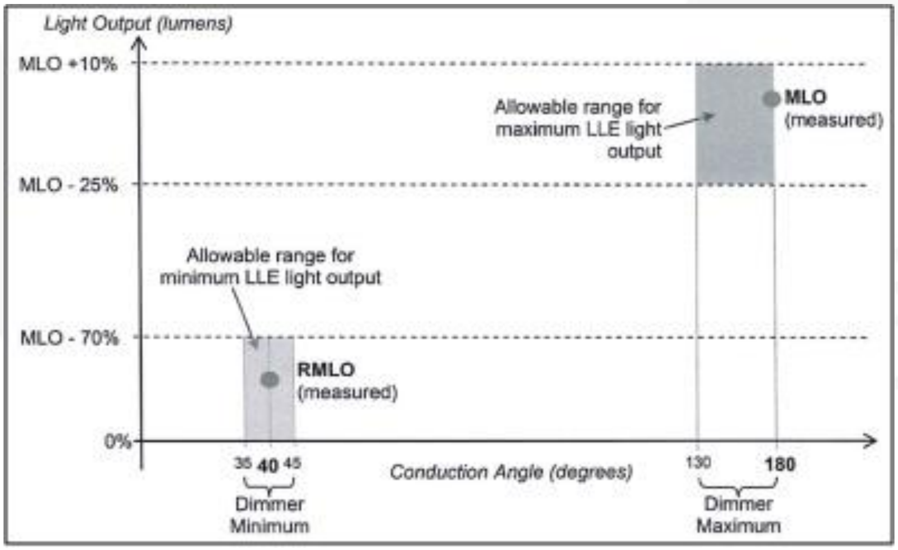


**Figure 25. NEMA SSL-7A Specification**

Table 9 demonstrates that FL7734MX evaluation board has excellent dimmer compatibility without flicker and the minimum output current can be less than 5% of the rated output current when evaluated with most dimmer. It also operates well with both forward phase dimmer and reverse phase dimmer.

**Table 9. Dimmer compatibility**

| Manufacturer | Dimmer S/N | Condition | Max. Current [mA] | Min. Current [mA] | Flicker |
|---|---|---|---|---|---|
| BUSCH | 2247U | 230 V/50 Hz | 361 | 11 | NO |
| BUSCH | 2250 | 230 V/50 Hz | 361 | 8.3 | NO |
| BUSCH | 2200 | 230 V/50 Hz | 360 | 13.6 | NO |
| GIRA | 226200 | 230 V/50 Hz | 359 | 7 | NO |
| JUNG | 225NVDE | 230 V/50 Hz | 361 | 7.5 | NO |
| JUNG | ST550 | 230 V/50 Hz | 361 | 0 | NO |
| JUNG | 266GDE | 230 V/50 Hz | 360 | 9.7 | NO |
| JUNG | 244EX | 230 V/50 Hz | 363 | 6.5 | NO |
| PEHA | 436 | 230 V/50 Hz | 362 | 10 | NO |
| GIRA | 2608 | 230 V/50 Hz | 360 | 10 | NO |
| Vossloh-Schwabe | 172774 | 230 V/50 Hz | 360 | 7.6 | NO |
| KOPP | 8033 | 230 V/50 Hz | 360 | 11.8 | NO |
| MERTEN | 572199 | 230 V/50 Hz | 359 | 4 | NO |
| JIN HEUNG | SA04003 | 220 V/60 Hz | 361 | 8.7 | NO |
| JIN HEUNG | SA04003-3004 | 220 V/60 Hz | 361 | 4 | NO |
| NANO | SKD-500 | 220 V/60 Hz | 360 | 4.5 | NO |
| Legrand | 0 488 69 | 100-240/50-60 Hz | 355 | 3.1 | NO |
| DAESUNG | SKD-500 | 220 V/60 Hz | 359 | 2.3 | NO |
| CLIPSAL | 32E450TM | 230 V/50 Hz | 361 | 43 | NO |
| MERTEN | 577129 | 230 V/50 Hz | 359 | 50 | NO |
| EVERFLORISH | EF700DC | 230 V/50 Hz | 359 | 46 | NO |
| GIRA | 4210 | 230 V/50 Hz | 360 | 46 | NO |

## 8.9. Operating Temperature

Temperatures on all components on this board are less than 72ºC. The results were measured using the rated LED loads after 60 minutes burn-in.

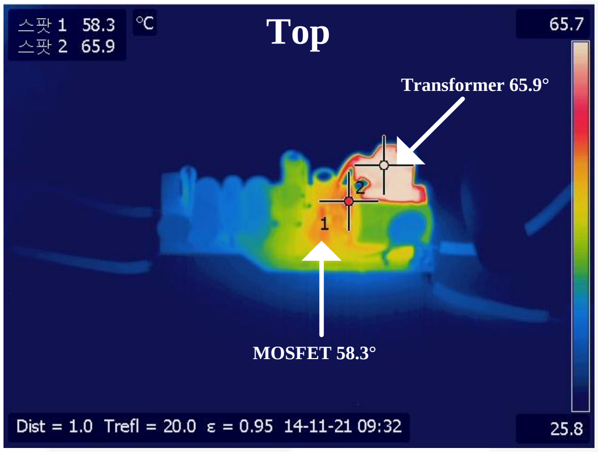


**Figure 26. Non-Dimming Mode $V_{IN}$=230 $V_{AC}$**

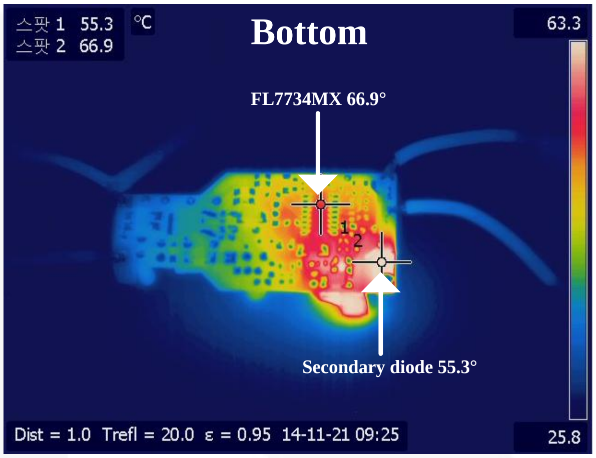


**Figure 27. Non-Dimming Mode $V_{IN}$=230 $V_{AC}$**

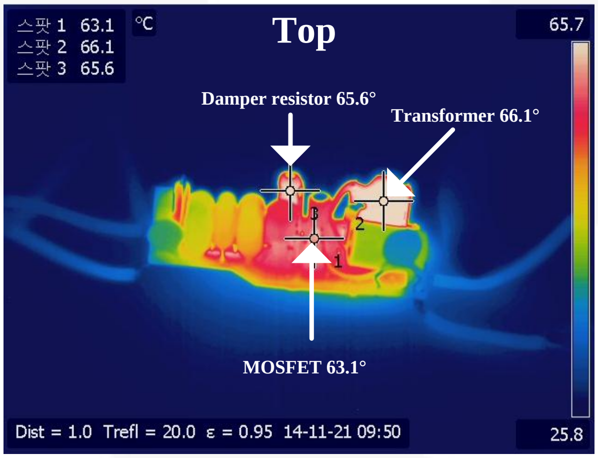


**Figure 28. Dimming Mode $V_{IN}$=230 $V_{AC}$**

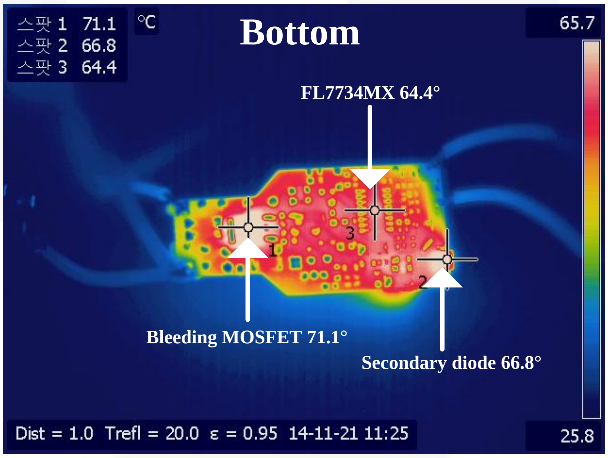


**Figure 29. Dimming Mode $V_{IN}$=230 $V_{AC}$**

## 8.10. Electromagnetic Interference (EMI)

All measurements were conducted in observance of EN55022 criteria. The results were measured using rated LED loads after 60 minutes burn-in.

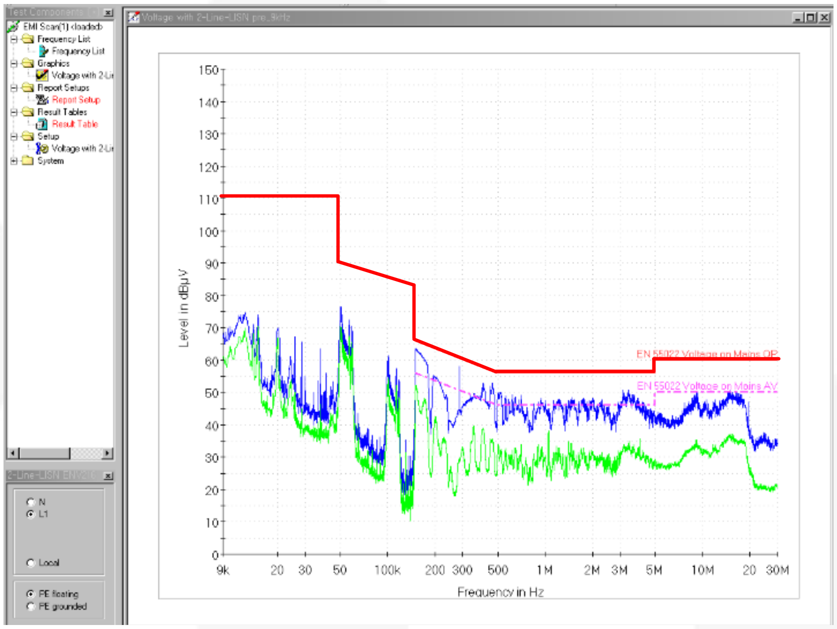


**Figure 30. $V_{IN}$ [230$V_{AC}$, Live]**

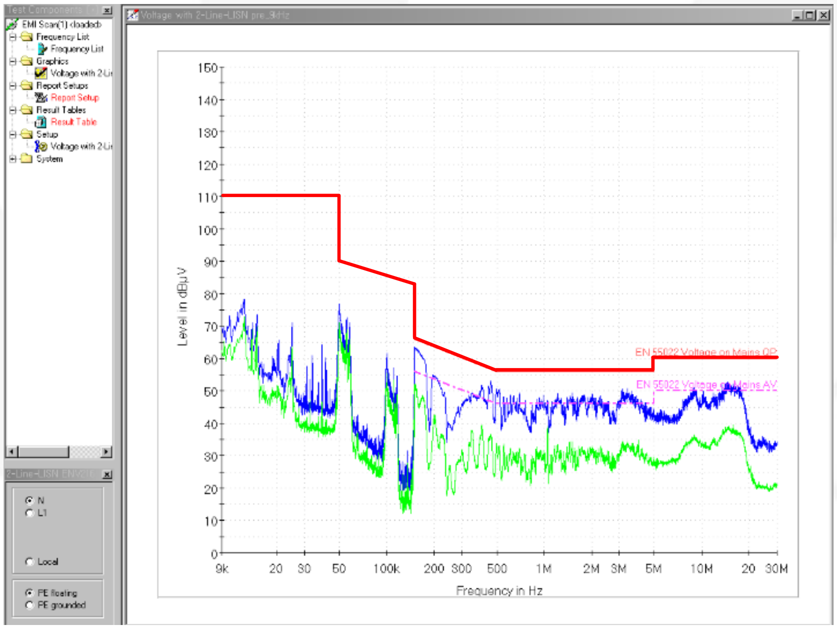


**Figure 31. $V_{IN}$ [230 $V_{AC}$, Neutral ]**

# 9. Revision History

| Rev. | Date | Description |
|---|---|---|
| 1.0.0 | Feb. 2015 | Initial Release |
| | | |
| | | |
| | | |
| | | |

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