CL8800
230 V_{AC} Offline LED Driver Evaluation Board
User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the CL8800 230 V_{AC} Offline LED Driver Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the CL8800 230 V_{AC} Offline LED Driver Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the CL8800 230 V_{AC} Offline LED Driver Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the CL8800 230 V_{AC} Offline LED Driver Evaluation Board and a detailed description of each function.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the CL8800 230 V_{AC} Offline LED Driver Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the CL8800 230 V_{AC} Offline LED Driver Evaluation Board.
- **Appendix C. "Plots and Waveforms"** – Describes the plots and waveforms for the CL8800 230 V_{AC} Offline LED Driver Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use the CL8800 230 V_{AC} Offline LED Driver Evaluation Board. The following Microchip document is available and recommended as supplemental reference resource:

- **CL8800 Data Sheet - *"Sequential Linear LED Driver"* (DS20005357)**

THE MICROCHIP WEB SITE

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- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (August 2018)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the CL8800 230 V_{AC} Offline LED Driver Evaluation Board and covers the following topics:

- CL8800 Short Overview
- CL8800 Key Features
- Overview of the CL8800 230 V_{AC} Offline LED Driver Evaluation Board
- Contents of the CL8800 230 V_{AC} Offline LED Driver Evaluation Board Kit

1.2 CL8800 SHORT OVERVIEW

The CL8800 is designed to drive a long string of low current LEDs directly from the AC mains.

Applications:

- Fluorescent tube retrofit
- Incandescent and CFL bulb replacement
- A19 bulb with a maximum power rating of about 8.5W at 230 V_{AC} (60W incandescent equivalent bulbs).

1.3 CL8800 KEY FEATURES

- Minimal Component Count, the Base Configuration: CL8800, Six Resistors and a Diode Bridge
- No Magnetics, No Capacitors
- Up to 7.5W Output (13W with Heat Sink)
- > 110 Lm/W Using Efficient LEDs
- 85% Typical Electrical Efficiency
- > 0.95 Power Factor
- < 20% Total Harmonic Distortion (THD) Line Current
- Low Conducted EMI Without Filters
- 85% LED Luminous Utilization
- Phase Dimmer Compatible with a Resistor-Capacitor (RC) Network

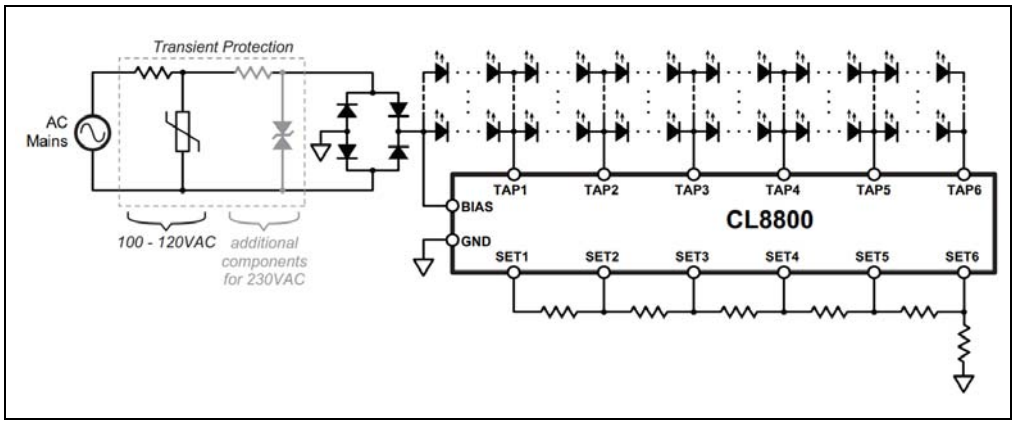


FIGURE 1-1: *Typical CL8800 230 V_{AC} Offline LED Driver Evaluation Board Circuit.*

1.4 OVERVIEW OF THE CL8800 230 V_{AC} OFFLINE LED DRIVER EVALUATION BOARD

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board (ADM00866) and a designated LED Load Board (ADM00861) represent a complete lighting solution, powered directly from the 230 V_{AC} line and based on Microchip Technology's CL8800 sequential linear LED driver. The application achieves efficient operation without using any magnetics or conventional switching techniques and is a flexible solution that allows users to design and test their own LED Load. The available LED Load is made with 12 LEDs. Since no high frequencies are present, it exhibits inherently low conducted and radiated EMI without needing input filters or shielding. Because the current through the LEDs follows the AC input voltage, Power Factor Correction (PFC) circuitry is not needed. With the addition of an RC network, the CL8800 is compatible with both leading-edge and trailing-edge dimmers.

The LED Load is provided on a double-layer 60 mm diameter FR4 (0.6 mm thick) PCB, ready to be mounted on a pin-fin heat sink. The kit includes a black anodized pin-fin heat sink and double-sided adhesive thermal tape to mount the LED Load on it. The LED Load is also developed to be used with other LED Driver boards from the CL88XXX series, so it is equipped with a selectable (by means of a jumper) NTC or PTC thermistor, making overtemperature protection (OTP) possible. For the current application, the selection activates the PTC by mounting the jumper between positions 1 and 2 of the J4 header.

The LED Driver PCB (ADM00866) is made on a 1.6 mm standard double-layer FR4. The kit includes a 10-wire flat cable to connect the LED Driver Board to the LED Load.

All circuitry and hardware is provided, along with transient protection and overtemperature protection. Plug into a 230 V_{AC} outlet (50 Hz or 60 Hz) to get started.

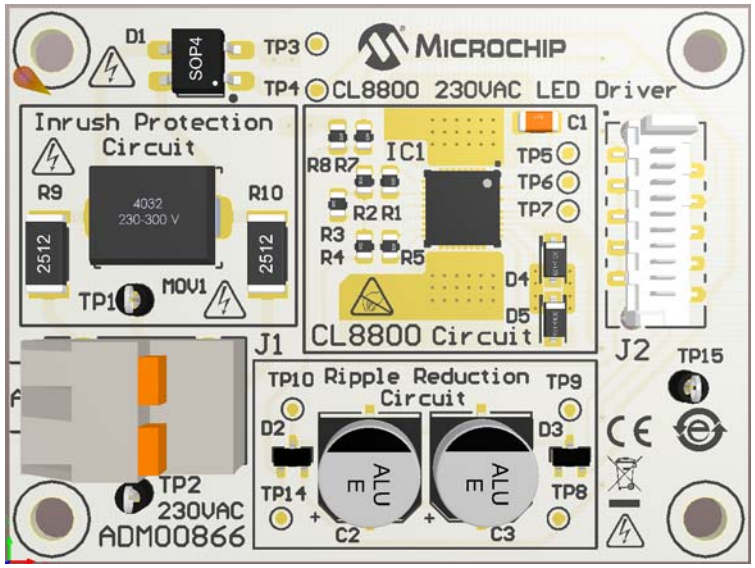


FIGURE 1-2: *CL8800 230 V_{AC} Offline LED Driver Evaluation Board (ADM00866) – Top View.*

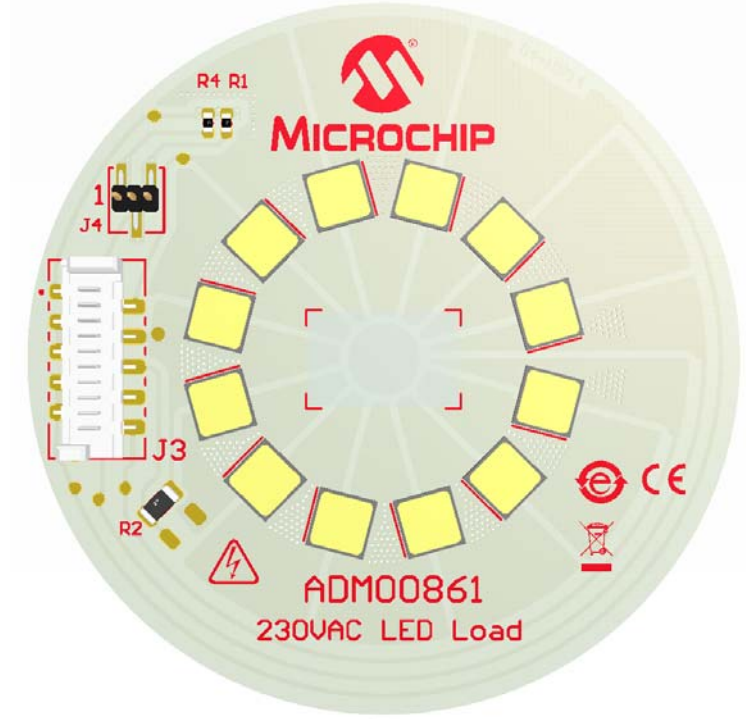


FIGURE 1-3: *CL8800 LED Load Board (ADM00861) – Top View.*

1.5 CONTENTS OF THE CL8800 230 V_{AC} OFFLINE LED DRIVER EVALUATION BOARD KIT

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board Kit includes:

- CL8800 230 V_{AC} Offline LED Driver Evaluation Board (ADM00866)
- 10-wire interconnection flat cable
- 4 nylon stand-offs with corresponding screws
- Important information sheet

The CL8800 LED Load Board (ADM00861) is available for purchase from www.microchipdirect.com. The CL8800 LED Load Board Kit includes:

- CL8800 LED Load Board (ADM00861)
- LED Load pin-fin heat sink
- Thermal double-sided adhesive tape
- Important information sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board is intended to drive a long string of low current LEDs directly from the 230V AC mains. A basic driver circuit consists of CL8800, six resistors and a bridge rectifier. Two to four additional components are optional for various levels of transient protection, also with a low-price PTC to assure remote OTP. No capacitors, EMI filters or power factor correction circuits are needed.

A string of series LEDs is tapped at four locations, the next two outputs being populated with Zener diodes from economic considerations (fewer taps reduce costs). It is economically inefficient to populate the last two taps with LEDs since they are lit for a very short time when the voltage is near the peak of the input voltage sinus wave. Regarding the application requirements, the user can have six taps populated with LEDs because higher taps increase the efficiency and lower the THD. Six linear current regulators sink current at each tap and are sequentially turned on and off, tracking the input sine wave voltage. Voltage across each regulator is minimized when conducting, providing high efficiency. Output current at each tap is individually resistor-adjustable. Cross-regulation, as the CL8800 switches from one regulator to another, provides smooth transitions. The current waveform can be tailored to optimize for input voltage range, line/load regulation, output power/current, efficiency, power factor, THD, dimmer compatibility and LED utilization. With the addition of a Resistor-Capacitor (RC) network, the driver is compatible with a wider range of phase-cut dimmers. The data sheet includes a description of how the driver operates, with design guidelines and examples.

2.1.1 Board Features

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board (ADM00866) has the following features:

- Input Voltage: 230 V_{AC} +/-15%, 50/60 Hz
- Typical Output Capability: up to 115 mA (TAP1 = 60 mA, TAP2 = 90 mA, TAP3-6 = 115 mA)
- Efficiency: Typical 85%
- Maximum Output Power: 7.5W (13W, it depends on the cooling provided)

The 12 series LED Load Board (ADM00861) has the following features:

- 12 Osram Duris® S8 Family LEDs (GW P9LR31.EM) Grouped in 4 Taps
- A 10-Wire Flat Cable Input Connector
- The Possibility to Select a PTC or an NTC Thermistor for OTP, by Using Jumper J4 As Follows:
  - Mounted on position 1-2 and a 3.3Ω PTC is active in circuit (R4). This selection should be made when the LED Load is used with the CL8800 230 V_{AC} Offline LED Driver Evaluation Board (ADM00866).
  - Mounted on position 2-3 and a 470k NTC is active in circuit (R1). This selection should be made when the LED Load is used with the CL88030 230 V_{AC} LED Driver Board (ADM00860).
  - By default, the J4 jumper is set between positions 2 and 3

- Two 0Ω Resistors (R2 and R3) to Select the First Tap Series LED Count. R2 is Present by Default.

2.2 GETTING STARTED

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board is fully tested to evaluate and demonstrate the CL8800 LED Driver.

WARNING

The CL8800 LED Driver Evaluation Board (ADM00866) and CL8800 LED Load Board (ADM00861) do NOT provide electrical isolation between the AC line and the lamp circuitry. Dangerous voltages are present when connected to the AC line. Exercise caution!

Take into account the following recommendations before starting the setup process:

- Place the CL8800 LED Driver Evaluation Board and the LED Load assembly on a non-conductive surface when connected to the AC line.
- Do not come into contact with any of the two demonstration unit boards while they are connected to the AC line.
- Disconnect the demonstration units from the AC line before performing any work on any of them.
- Do not connect instruments having earth-referenced inputs, such as most oscilloscopes (use isolation transformers).
- It is suggested that utility power for testing is provided from an AC source with a floating output, and that differential voltage probes are used.

Failure to adhere to these guidelines may result in damage to the demo unit, the test instruments, and/or can put the person conducting the tests in danger.

2.2.1 Prerequisites

Since the power of the application is about 10W, for a longer operation of the LED Load (more than 30s), attach the provided heat sink using the double-sided adhesive thermal tape by following these steps:

1. Before you start, be sure that the surface of the heat sink and of the PCB are dry and clean (use cotton-made smooth material to clean if needed).
2. Detach the protection foil on the thermal tape from one side.
3. Attach the open portion of the thermal tape to the base of the heat sink.
4. Detach the second protection foil from the thermal tape.
5. Attach the PCB to the heat sink.

Slowly press on the top of the PCB to be sure that the thermal contact will be made all over the board.

2.3 SETUP PROCEDURE

Powering the CL8800 230 V_{AC} Offline LED Driver Evaluation Board is easy. The only connections to be made are from the LED Driver Board to the LED Load assembled on a pin-fin heat sink, using the provided 10-wire flat cable, and from the LED Driver Board to the AC line via the power cord.

Follow these steps:

1. Read the above recommendations and precautions.
2. Set the jumper J4 on the LED Load Board between positions 1 and 2 to activate the PTC for the OTP (this is specific when using the LED Load with ADM00866).
3. Connect the CL8800 LED Driver Evaluation Board and the CL8800 LED Load Board by means of the provided 10-wire flat cable, between J2 and J3 connectors. It is recommended to exercise caution, as the connectors on the flat cable are protected from being connected incorrectly.
4. Connect the power cord on J1 on the LED Driver Board. The input connector J1 is placed on the left side of the LED Driver board, which is marked with the inscription: AC.
5. Use a colored plexiglass above the LED Load Board for eye protection against extreme light.
6. Plug the power cord into a 230 V_{AC} outlet and apply 230 V_{AC} ±15%, 50 Hz. While it is possible for the values to be below this range, it is recommended not to exceed 265 V_{AC}. In this case, the Transient Protection feature is automatically activated. Line frequency is not critical (50 Hz or 60 Hz).

A variable AC power supply is needed for testing and evaluation in the laboratory. The power supply requires an output capability of at least 20W and a voltage range from 0 V_{AC} to 270 V_{AC}. This can also be obtained from an autotransformer supplied from the mains or an electronic AC/AC power supply (for example, the Chroma ATE Inc. 61500 series).

Note:	Auto-transformers do not provide isolation from the utility mains.

Figure 2-1 illustrates the connection between ADM00866 and ADM00861.

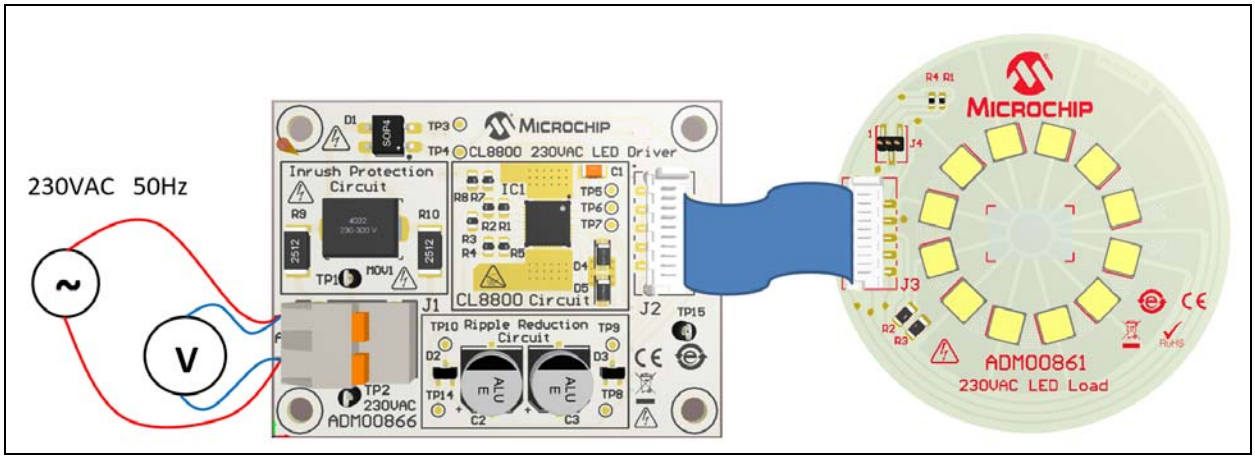


FIGURE 2-1: *Connection Diagram.*

2.4 HOW THE CL8800 230 V_{AC} OFFLINE LED DRIVER EVALUATION BOARD WORKS

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board is designed to control the current through the six taps, four with LEDs and two populated with Zener diodes, while maintaining high-input power factor (PF) and low THD.

Zener diodes may be substituted for LEDs for the upper taps of the string. The last one or two taps of the LED string contribute little to the light output – they are mainly present to offload the adjacent upstream regulator at high-line voltages to minimize losses. The advantages of Zener substitution include minimizing unlit LEDs at low line for better light uniformity, better line regulation at high line, fewer LEDs for lower cost and less PCB area, and fewer board-to-board connections. Disadvantages include slightly reduced efficiency at high line and additional heat load on the driver board.

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board includes a CL8800 IC, which is a sequential linear LED driver controlling six taps of an LED string. Tap sequencing assures the regulators are turned on and off at the proper times. Tap sequencing also controls the smooth transition from one regulator to the next, without generating EMI-causing glitches in input current. Two concepts are involved:

- Output current at each tap is individually resistor-adjustable.
- The second concept is called self-commutation. Using only the tap currents themselves, this technique inherently provides smooth transitions from one regulator to the next without relying on tap voltages or the rectified AC to coordinate the transitions. This avoids having to monitor high voltages and is more precise.

These two concepts work together to properly sequence the current regulators and to provide glitch-free operation and thus avoiding conducted EMI.

The CL8800 230 V_{AC} Offline LED Driver Evaluation Board contains all the circuitry necessary to perform, as well as OTP, and output light ripple reduction circuit.

The OTP is implemented using a single non-linear positive temperature coefficient resistor (PTC) in series with the current-setting resistors. This uses an inexpensive, external 2.2Ω to 3.3Ω standard PTC thermistor to remotely sense LED temperature. The thermistor is located on the LED Load Board, in close proximity to the LEDs, providing near-direct LED temperature monitoring. At a critical temperature (around 85°C), the resistance of the PTC rapidly increases manifold. At this point, the PTC resistance becomes significant compared to the current-setting resistor and begins reducing LED drive current. If a different critical temperature value is desired, simply replace the supplied PTC (R4 on the LED Load) with another low-resistance PTC with the desired thermal response. Paralleling the PTC with an ordinary resistor is another way to control thermal response.

The Ripple Reduction Circuit (RRC) providing low output ripple is achieved using a capacitor (C2, C3) and four diodes (D2, D3). The capacitor may consist of one or more paralleled ceramic/electrolytic capacitors. The CL8800 with RRC operates in four phases: recharge, hold-up, direct, and under certain conditions, idle. All active current paths include Segment 1 (TAP1), assuring uninterrupted light output on it during all phases of operation, excluding idle. That is why it is important to have a much greater number of LEDs on TAP1 (6 LEDs in this case) compared to the rest. This reduces overall ripple.

For more information, see the CL88020 data sheet.

The Mindi™ analog simulator of the CL8800 can be used to adjust tap resistors. To run the Mindi model for the CL8800, install the Mindi analog simulator tool from www.microchip.com.

Once you have installed MPLAB Mindi on your computer, you can open the "Sequential Linear LED Driver" application schematic from *Power Management > High-Voltage LED Drivers > CL8800*.

2.5 BOARD TESTING

To start testing the evaluation board, follow these steps:

1. Connect the input AC source and the output LED Load, as shown in Figure 2-1.
2. Use an eye protection filter to check that all the four taps light up on the LED Load Board.
3. Power the board at 230 V_{AC}, 50 Hz-60 Hz.
4. Verify each tap current through the LEDs. It should be within a range of 65 mA and 134 mA. It can be measured by separating each wire from the inter-connection 10-wire flat cable between the CL8800 LED Driver Board and the CL8800 LED Load Board.
5. If a variable AC source is available, set the input voltage to any value between 180 V_{AC} and 245 V_{AC}. The LED Load delivers nearly constant lumen power.
6. Power-down the AC source.

NOTES:

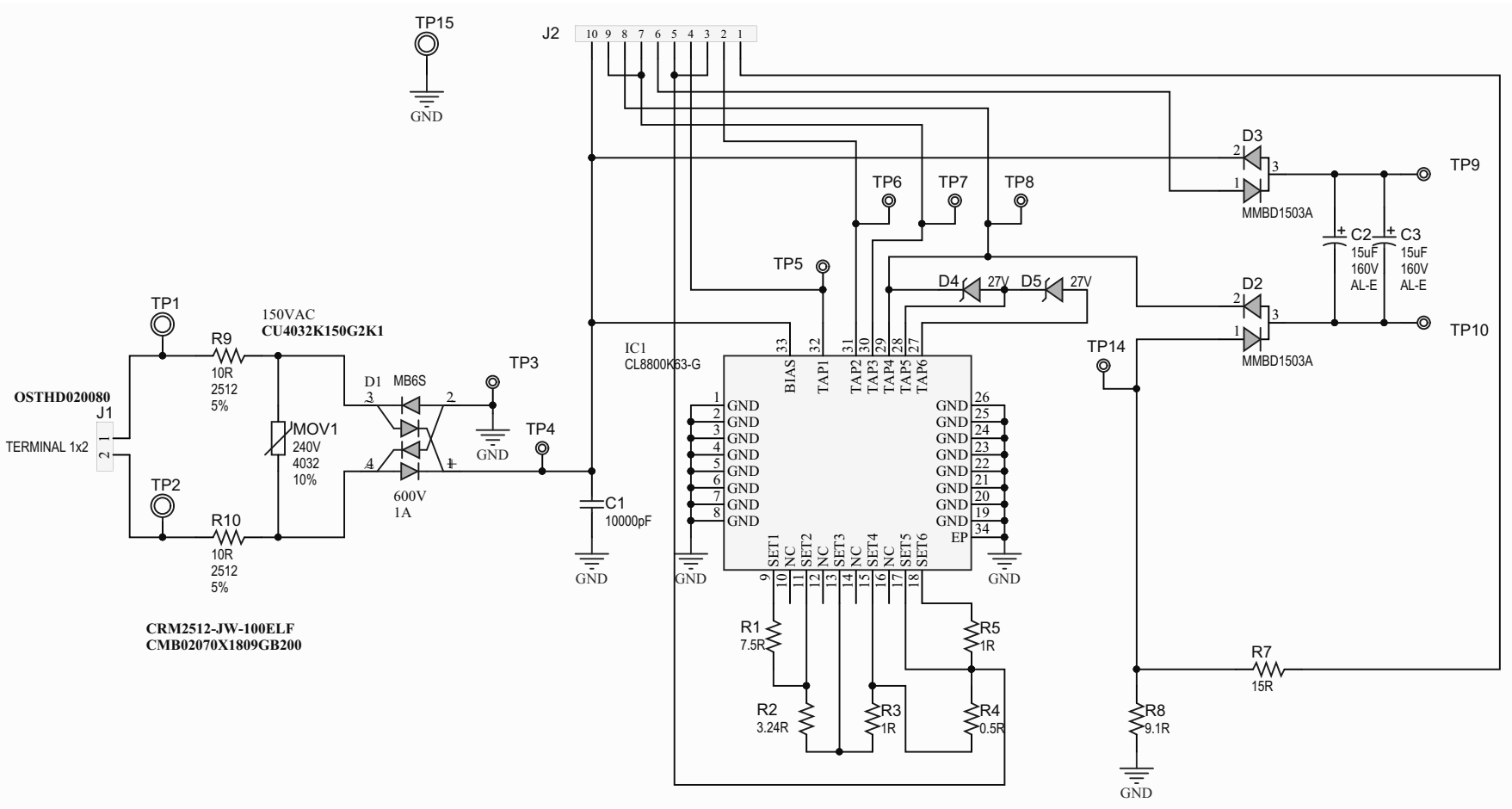
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

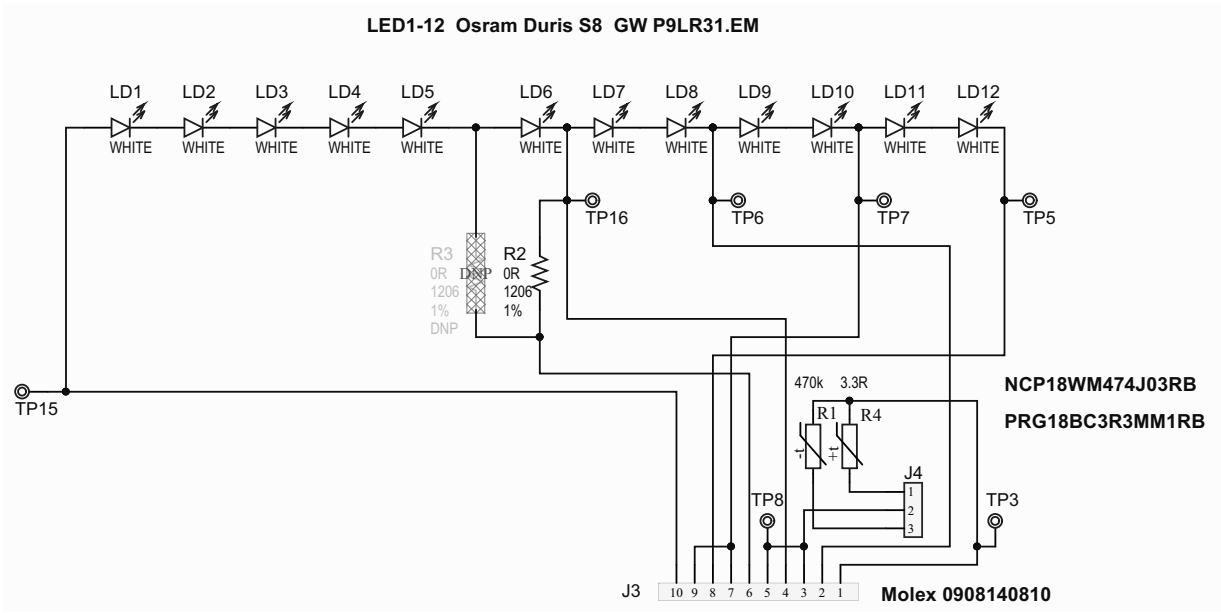
This appendix contains the following schematics and layouts for the CL8800 230 V_{AC} Offline LED Driver Evaluation Board and for the CL8800 LED Load Board:

- Board Schematic – ADM00866
- Board Schematic – ADM00861
- ADM00866:
  - ADM00866 – Top Silk
  - ADM00866 – Top Copper and Silk
  - ADM00866 – Top Copper
  - ADM00866 – Bottom Copper
  - ADM00866 – Bottom Copper and Silk
- ADM00861:
  - ADM00861 – Top Silk
  - AMD00861 – Top Copper and Silk
  - ADM00861 – Top Copper
  - ADM00861 – Bottom Copper

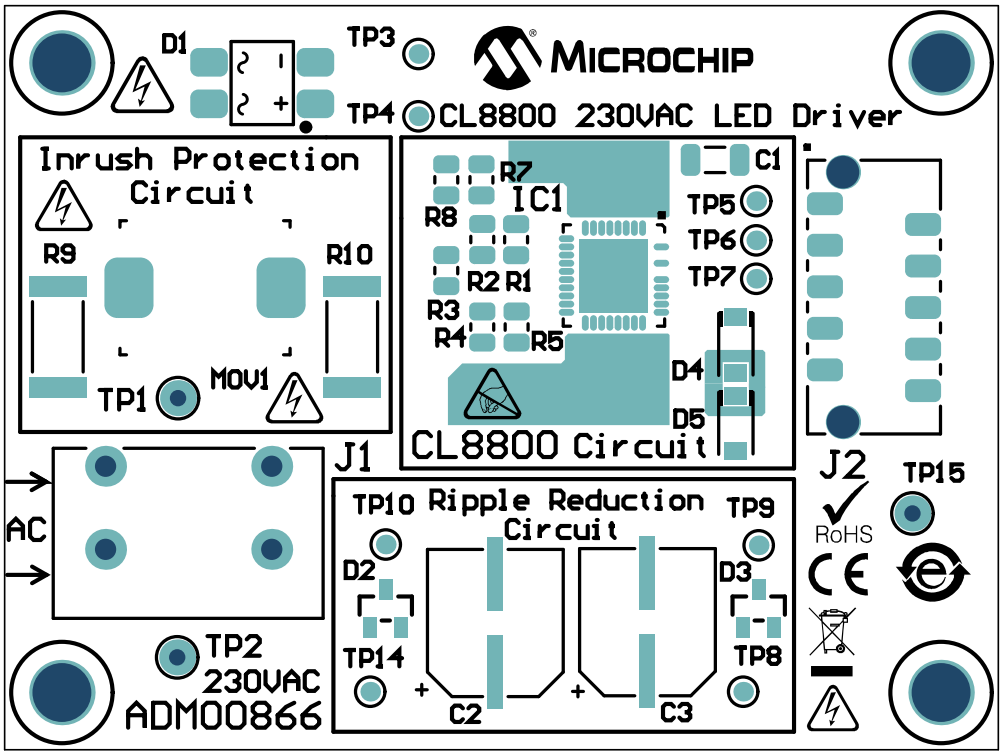
A.2 BOARD SCHEMATIC – ADM00866



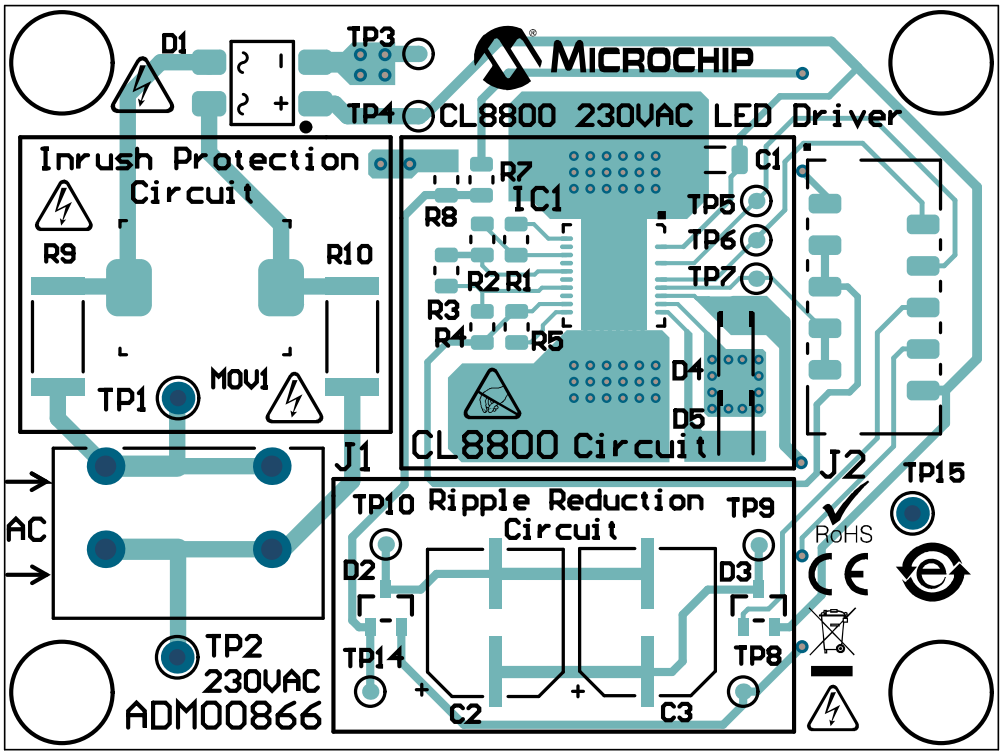
A.3 BOARD SCHEMATIC – ADM00861



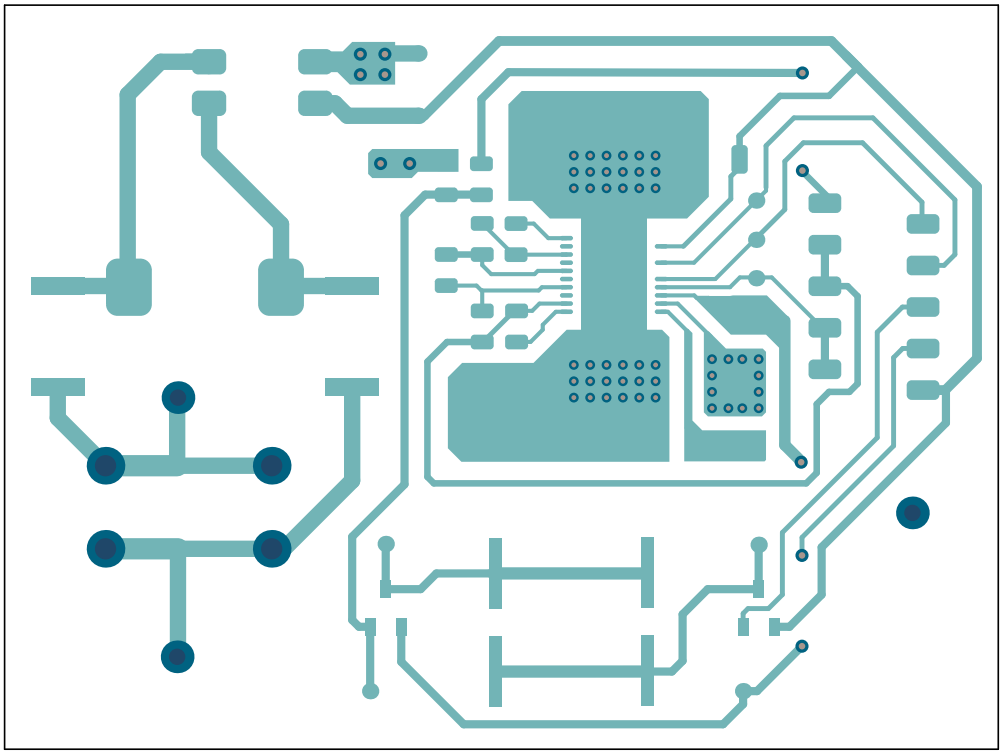
A.4 ADM00866 – TOP SILK



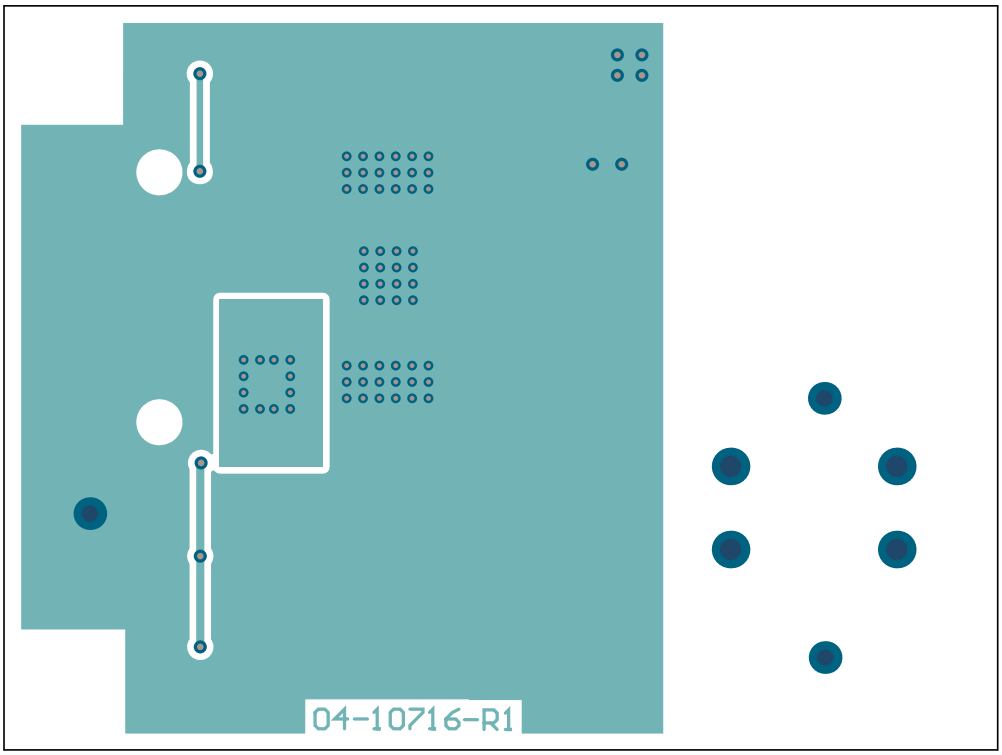
A.5 ADM00866 – TOP COPPER AND SILK



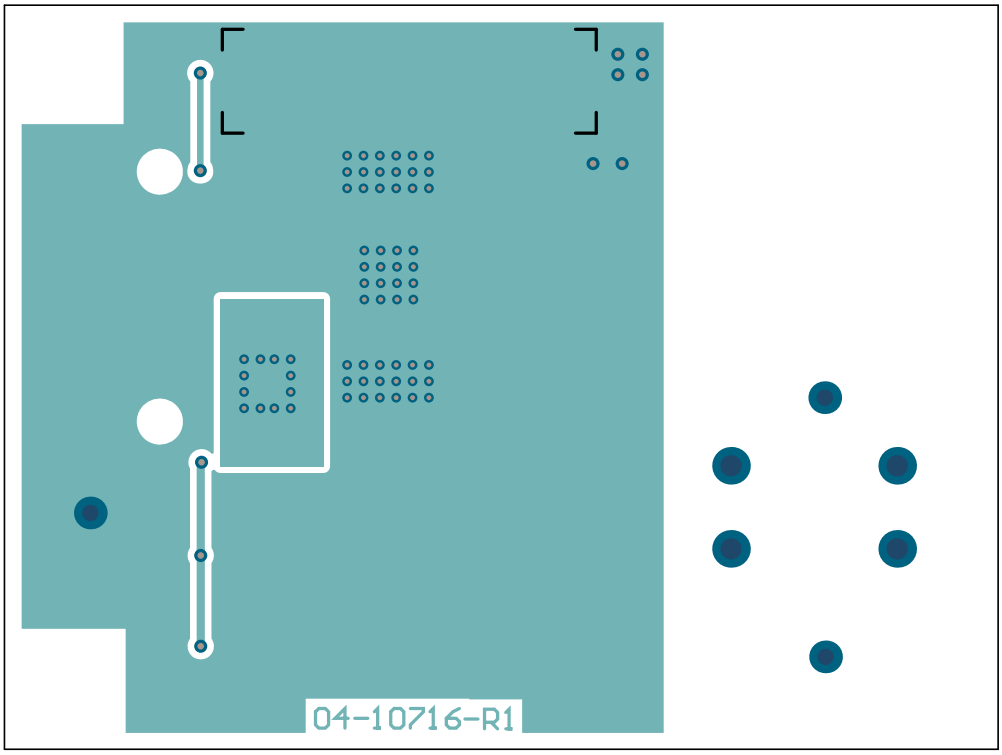
A.6 ADM00866 – TOP COPPER



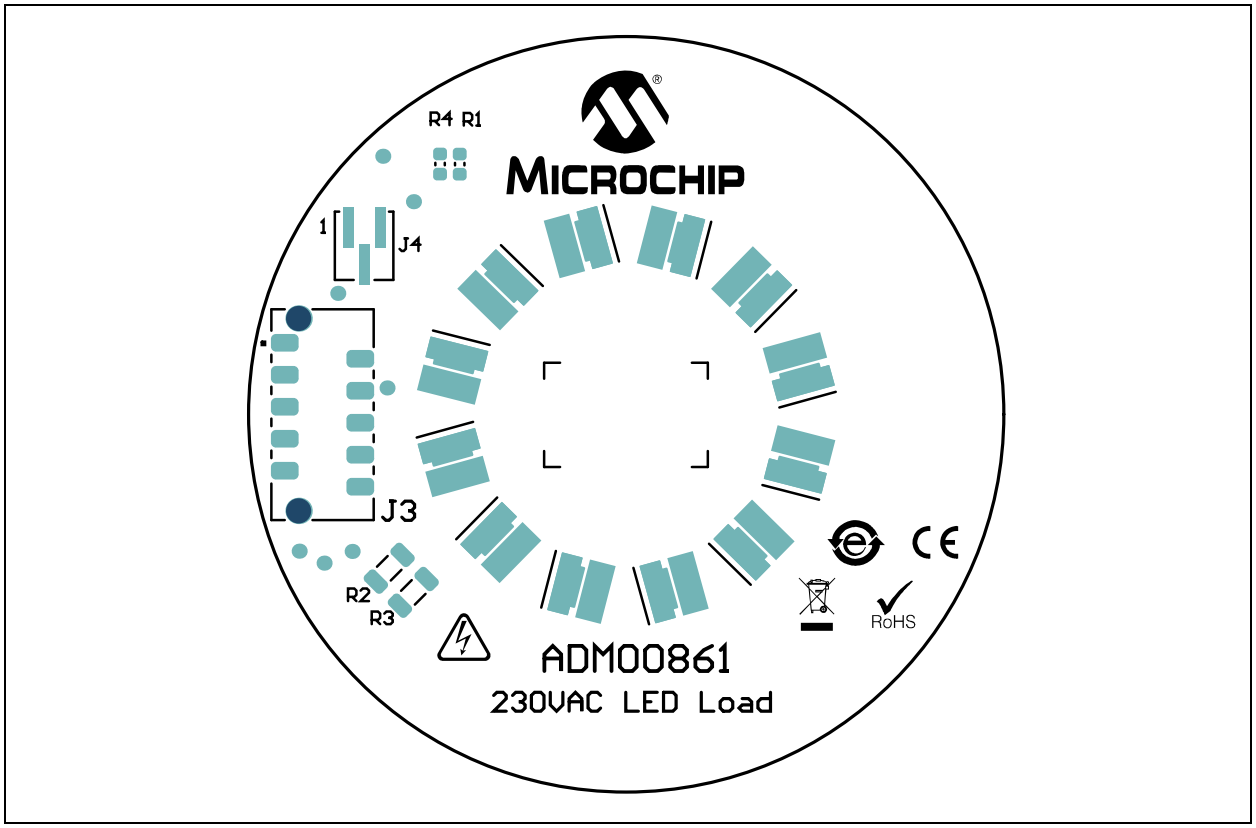
A.7 ADM00866 – BOTTOM COPPER



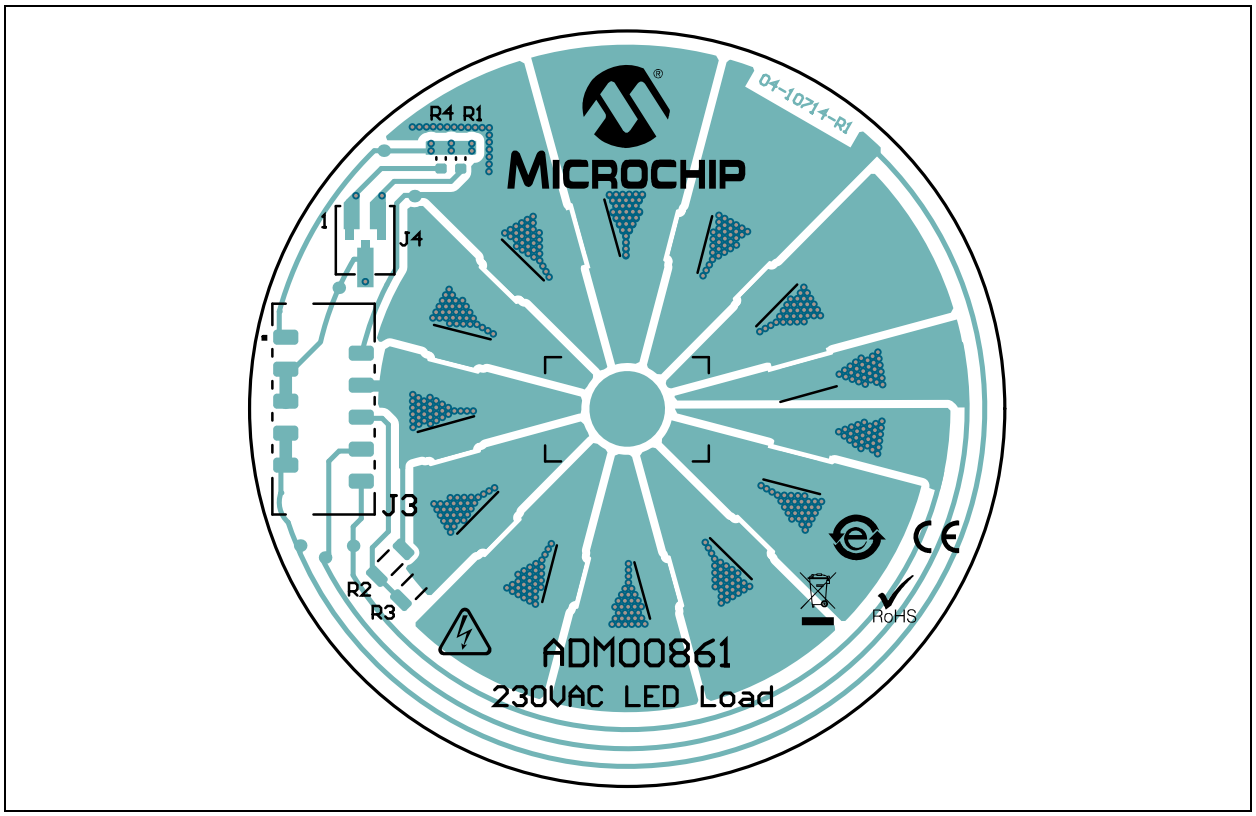
A.8 ADM00866 – BOTTOM COPPER AND SILK



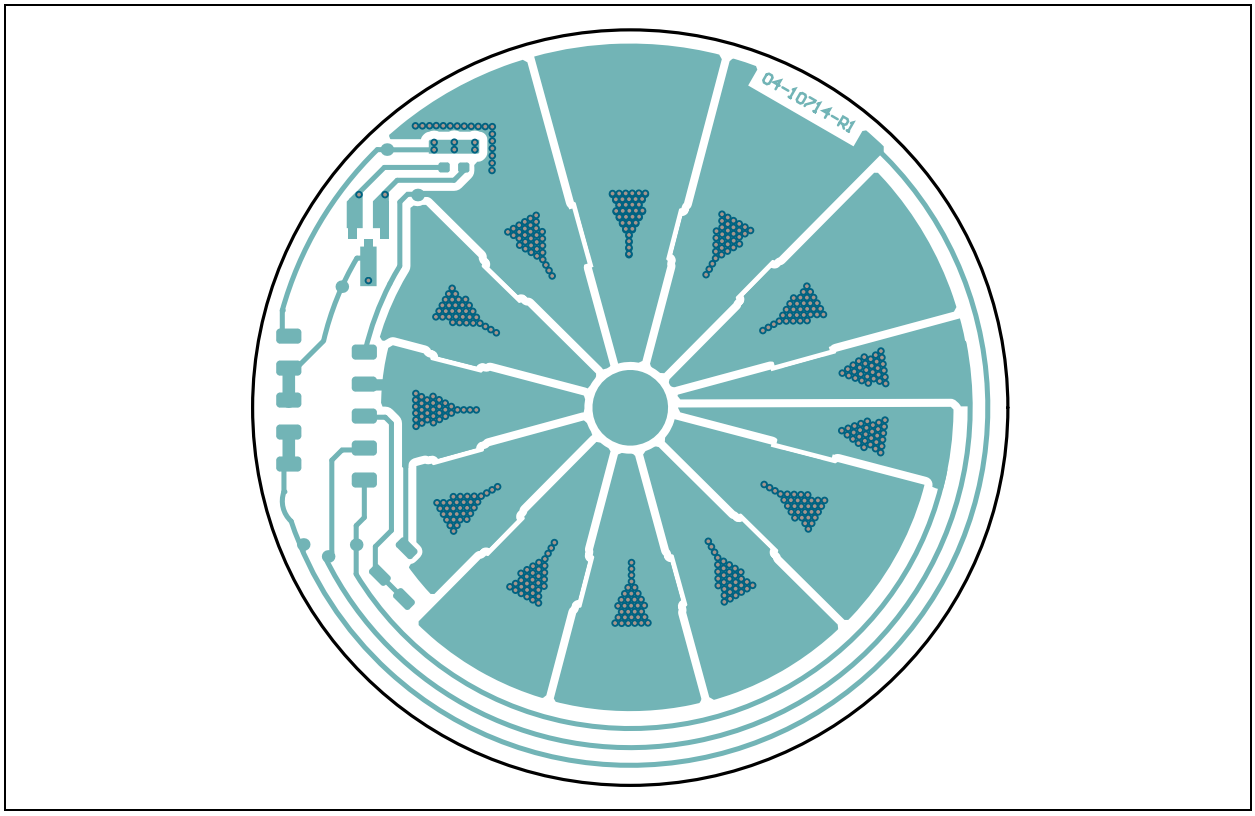
A.9 ADM00861 – TOP SILK



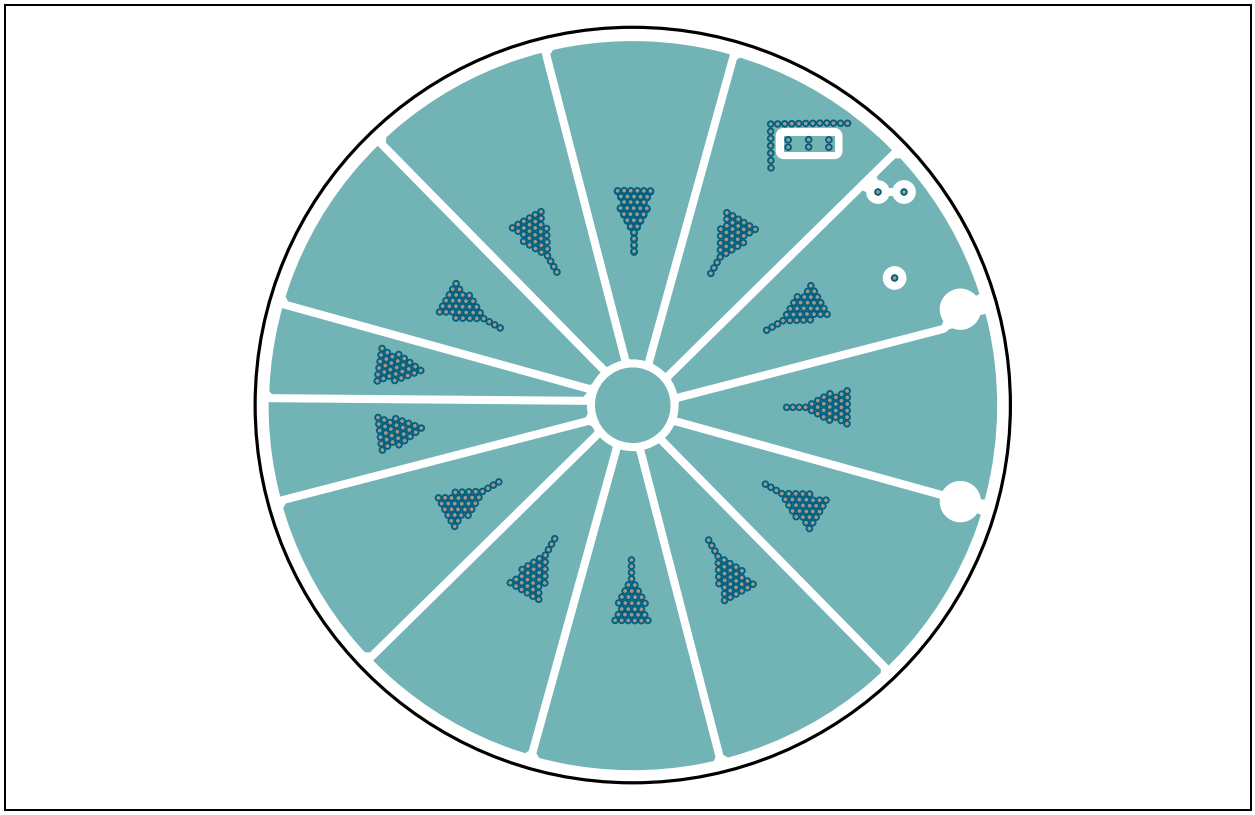
A.10 AMD00861 – TOP COPPER AND SILK



A.11 ADM00861 – TOP COPPER



A.12 ADM00861 – BOTTOM COPPER



NOTES:

Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM) FOR ADM00866

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor Ceramic, 10000 pF, 500V, 10%, X7R SMD, 1206	KEMET	C1206C103KCRACTU
2	C2, C3	Capacitor Aluminium, 15 µF, 160V, 20%, SMD E	Nichicon Corporation	ULT2C150MNL1GS
1	D1	Diode, Bridge Rectifier, MB6S, 1V, 0.5A, 600V, SMD, SOIC-4	Fairchild Semiconductor®	MB6S
2	D2, D3	Diode Array, MMBD1503A, 1.1V, 200 mA, 200V, SMD, SOT-23-3	Fairchild Semiconductor	MMBD1503A
2	D4, D5	Diode, Zener, BZT52C27, 27V, 500 mW, SOD-123	Diodes Incorporated®	BZT52C27-7-F
1	IC1	Microchip Analog CL8800K63-G LED Driver, QFN-33	Microchip Technology Inc.	**CL8800K63-G**
1	J1	Terminal Block, 5.08 mm, 1x2, Female, 16-22AWG,12A, TH, R/A	On-Shore Technology, Inc.	OSTHD020080
1	J2	Connector Header-1.27 Male, 1x10, Tin, SMD Vertical	Digi-Key® Electronics	WM19277-ND
1	MOV1	Varistor, 430V, 1.2 kA, SMD, 4032	EPCOS TDK	B72660M0271K093
1	PCB	CL8800 230 V_{AC} Offline LED Driver Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	**04-10716-R1**
1	R1	Resistor, TKF, 7.5R, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW08057R50FKEA
1	R2	Resistor, TKF, 3.24R, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW08053R24FKEA
2	R3, R5	Resistor, TKF, 1R, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW08051R00FKEA
1	R4	Resistor, TKF, 0.5R, 1%, 1/4W, SMD, 0805	Stackpole Electronics, Inc.	CSR0805FKR500
1	R7	Resistor, TKF, 15R, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW080515R0FKEA
1	R8	Resistor, TKF, 9.1R, 1%, 1/3W, SMD, 0805	Panasonic® – ECG	ERJ-6BQF9R1V
2	R9, R10	Resistor, TKF, 10R, 5%, 1W, SMD, 2512	Panasonic – ECG	ERJ-1TYJ100U
3	TP1, TP2, TP15	Miscellaneous, Test Points, Multi-Purpose, Miniature, Black	Keystone Electronics Corp.	5001

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-2: BILL OF MATERIALS (BOM) FOR ADM00866 - MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	CBL1	Mechanical HW Cable, Picoflex, IDT to IDT, 10-COND, 250 mm	Molex®	92315-1025
1	HS1	Mechanical HW Heat Sink, L8.5 mm x W6.35 mm x H4.8 mm, Black	Assmann Electronics Inc.	V5618A
1	LABEL1	Label Assembly, W/REV Level (Small Modules), PER MTS-0002		
4	SCR1, SCR2, SCR3, SCR4	Mechanical HW Screw, #6-32 x 1/4", PanHead, PHIL, Nylon	B&F™ Fasteners Supply	NY PMS 632 0025 PH
4	STANDOFF1, STANDOFF2, STANDOFF3, STANDOFF4	Mechanical HW Stand-Off, #6-32 x 3/8", F, HEX, Nylon	Keystone Electronics Corp.	1903B
1	TAPE1	Mechanical HW, Tape, Thermal Sheet, L254W254, a Fraction of 7 x 9 mm	Bergquist Company GmbH	BP100-0.008-00-1010

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

TABLE B-3: BILL OF MATERIALS (BOM) FOR ADM00861

Qty.	Reference	Description	Manufacturer	Part Number
1	HS2	Mechanical HW Heat Sink, D60 mm x H30 mm, 9.1W, Black	MechaTronix Kaohsiung Co., Ltd.	LPF60A30-5-B
1	J3	Connector Header, 1.27 mm, Male, 1x10, Tin, SMD, Vertical	Digi-Key Electronics	WM19277-ND
1	J4	Connector Header, Male, 1x3, 1.27 mm, AU, SMD	Harwin Plc.	M50-3630342
1	LABEL1	Label, AIPD Board Assembly		
12	LD1, LD2, LD3, LD4, LD5, LD6, LD7, LD8, LD9, LD10, LD11, LD12	Diode LED, White, 24.8V, 150 mA, 500 lm, 2700K, SMD, L5W5H0.7	OSRAM Opto Semiconductors GmbH	GW P9LR31.EM-PPPR-XX58-1-150-R18
1	PCB1	CL8800 LED Load Board – Printed Circuit Board	Microchip Technology Inc.	**04-10714-R1**
1	R1	Resistor Thermistor, 470k, 5%, 100 mW, 0603	Murata Electronics North America, Inc.	NCP18WM474J03RB
1	R2	Resistor, TKF, 0R, 1%, 1/4W, SMD, 1206	TT Electronics Plc.	WCR1206-R005JI
0	R3	**DO NOT POPULATE**	TT Electronics Plc.	WCR1206-R005JI
1	R4	Resistor, Fuse Resettable, 180 mA, 16V, PTC, SMD, 0603	Murata Electronics North America, Inc.	PRG18BC3R3MM1RB
1	SH4	Mechanical HW Jumper, 1.27 mm, 1x2, Gold	Sullins Connector Solutions	NPB02SVAN-RC
1	TAPE 1	Mechanical HW, Tape, Thermal Sheet, L254W254, a Fraction (circular 60 mm diameter) of 1/16 from the Sheet	Bergquist Company GmbH	BP100-0.008-00-1010

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

Appendix C. Plots and Waveforms

C.1 CL8800 230 V_{AC} OFFLINE LED DRIVER EVALUATION BOARD TYPICAL WAVEFORMS

C.1.1 Total Output Current at 230 V_{AC}, 255 V_{AC} RMS Input

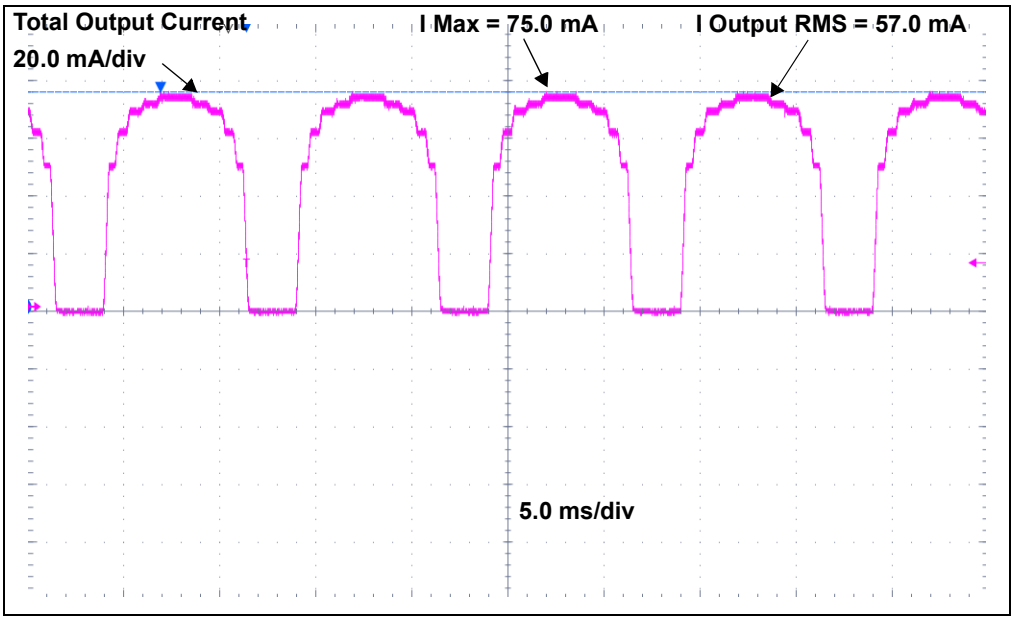


FIGURE C-1: *Total Output Current at 230 V_{AC} Input.*

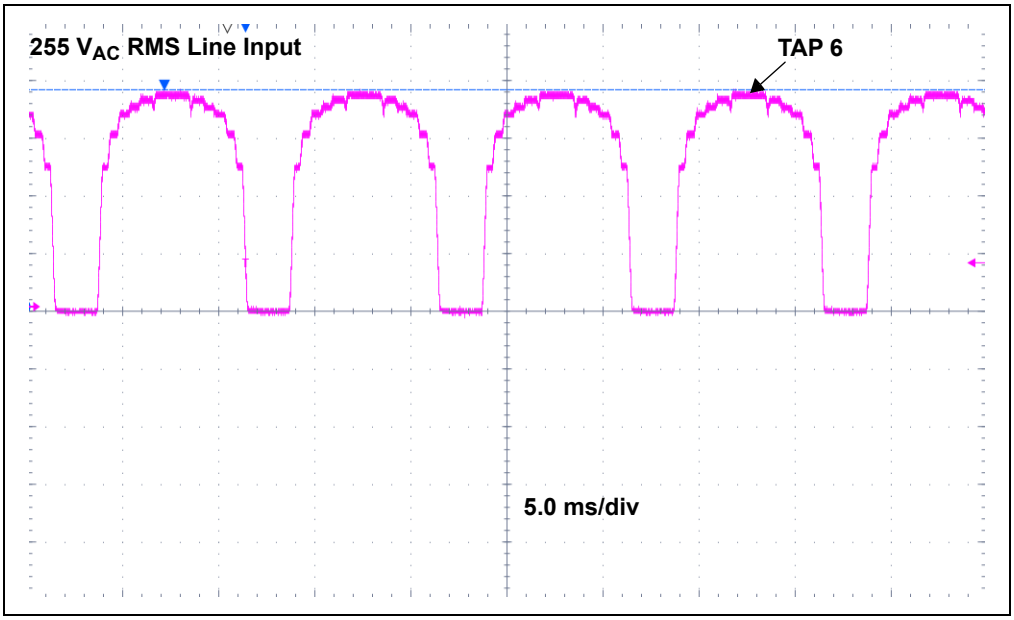


FIGURE C-2: *Total Output Current at 255 V_{AC} Input.*

C.1.2 TAPs 1, 2, 3, 4, 5 Currents at 230 V_{AC} RMS Input

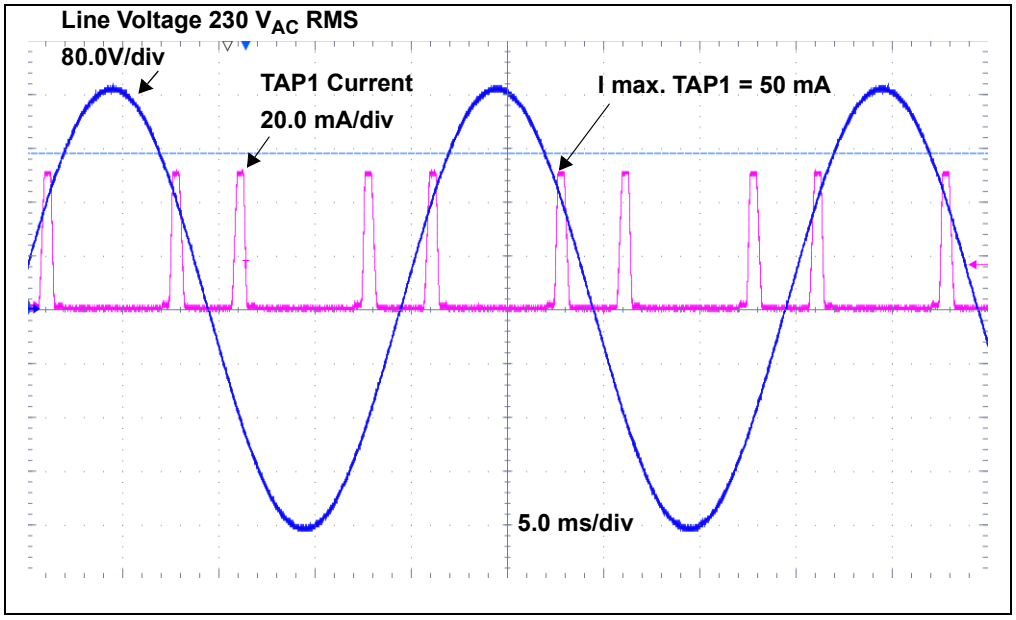


FIGURE C-3: *TAP1 Current and Input Line Voltage at 230 V_{AC} RMS.*

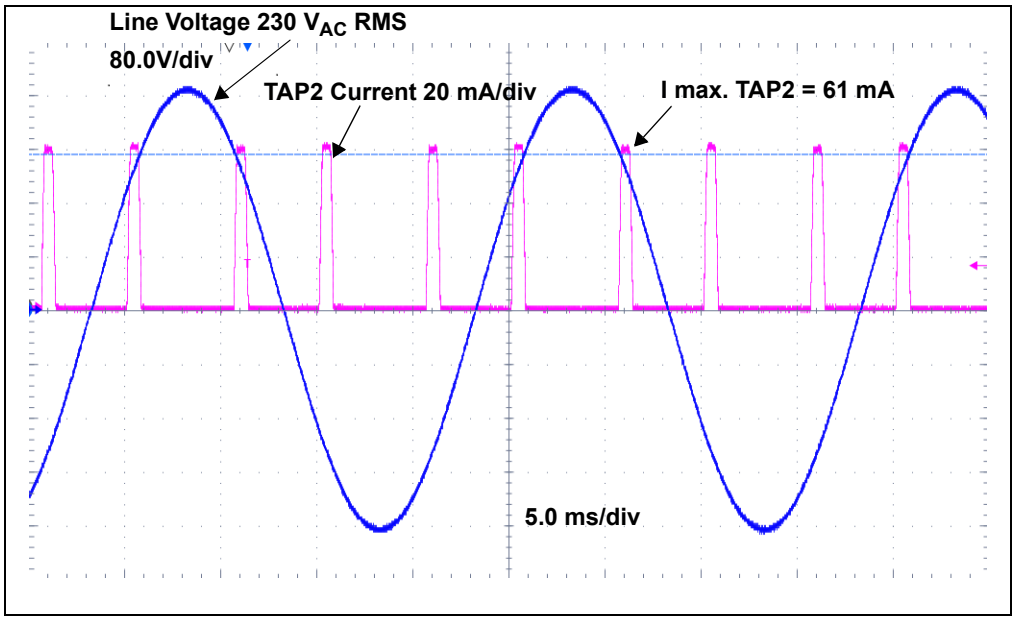


FIGURE C-4: *TAP2 Current and Input Line Voltage at 230 V_{AC} RMS.*

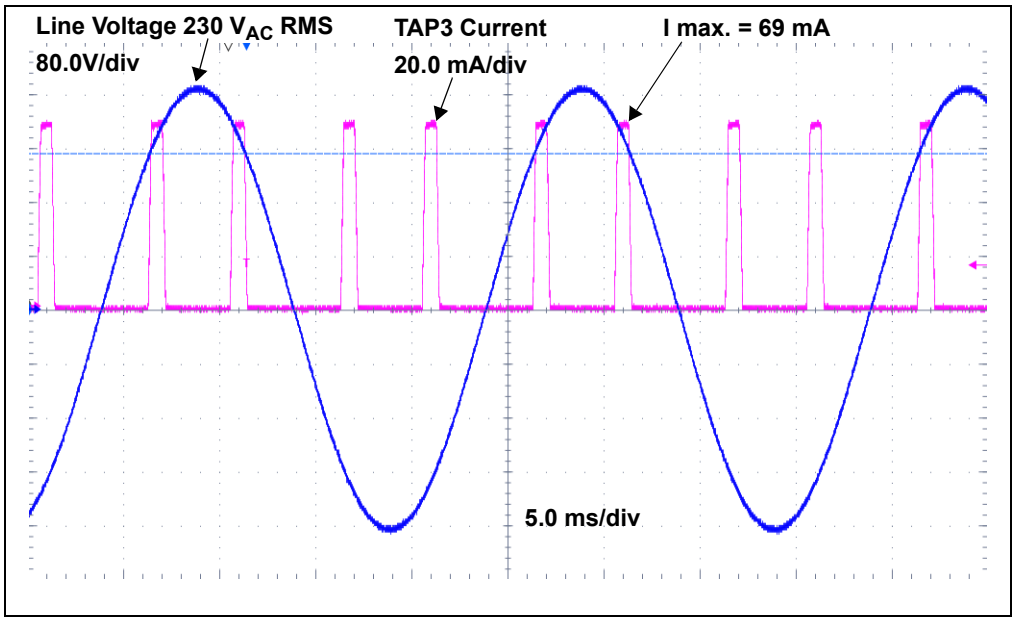


FIGURE C-5: *TAP3 Current and Input Line Voltage at 230 V_{AC} RMS.*

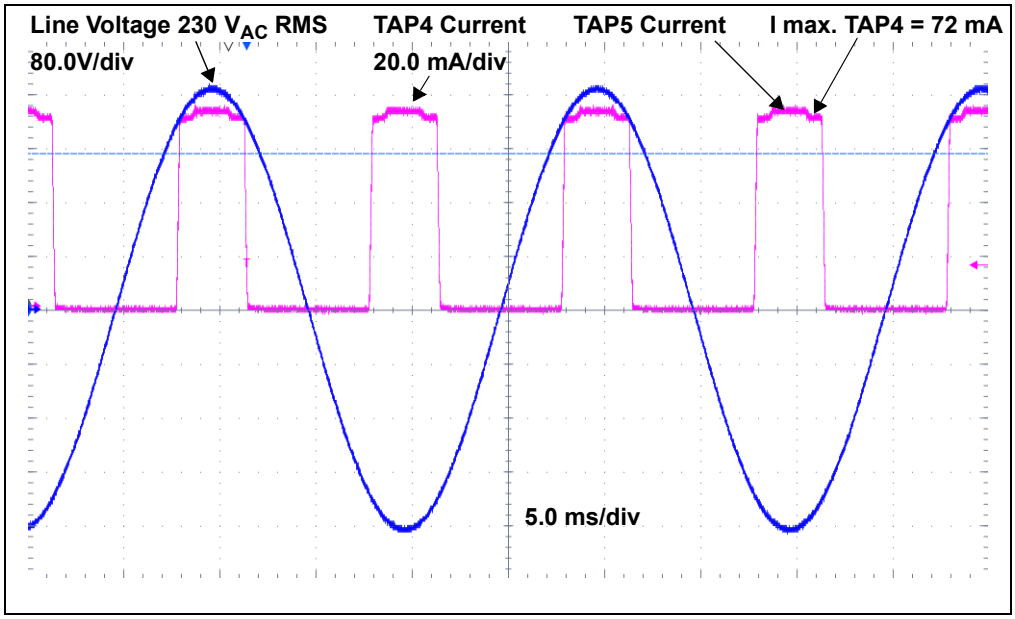


FIGURE C-6: *TAP4 and TAP5 Current and Input Line Voltage at 230 V_{AC} RMS.*

C.1.3 Output Current on Startup at 230 V_{AC} RMS Input Line Voltage

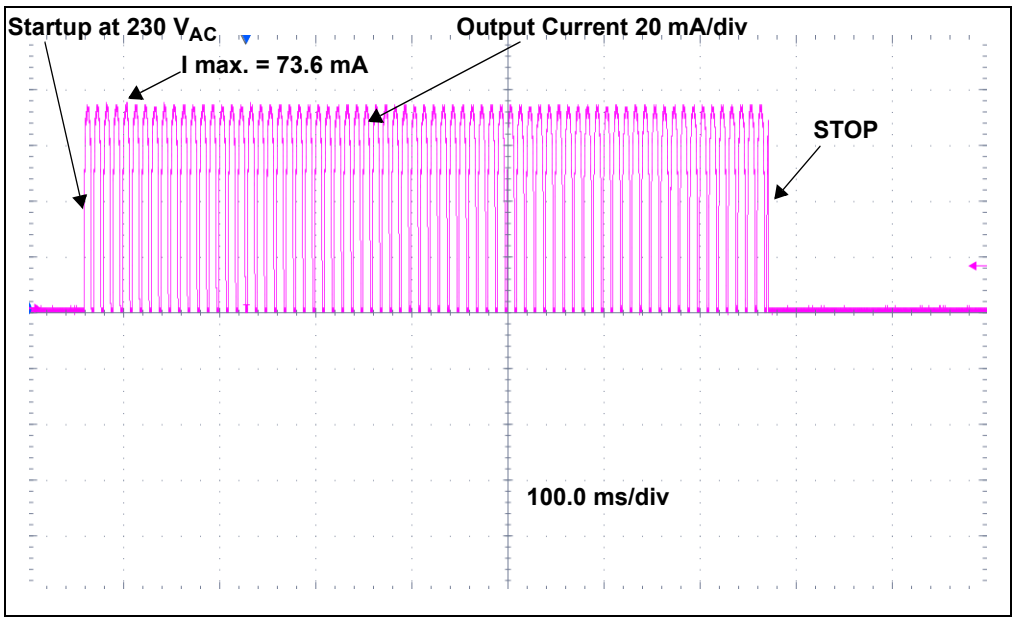


FIGURE C-7: *Output Current on Startup at 230 V_{AC} Line Input.*

C.1.4 Input Current and Input Voltage Waveforms

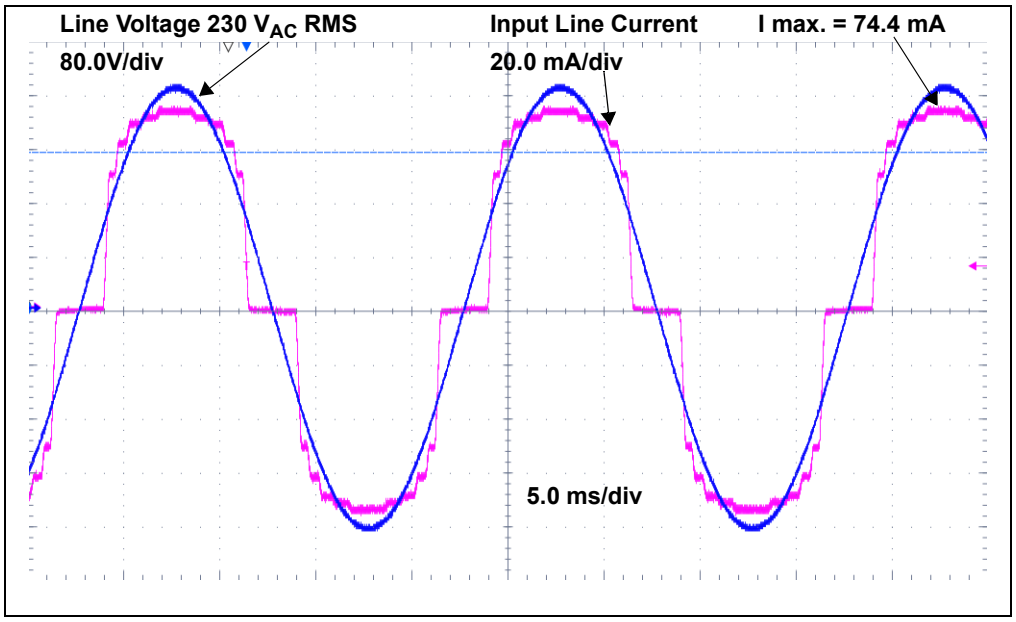


FIGURE C-8: *Input Current vs. Input Voltage Waveforms at 230 V_{AC} RMS Input.*

C.1.5 Input Current Waveforms, Detail at 230 V_{AC} Input Line Voltage

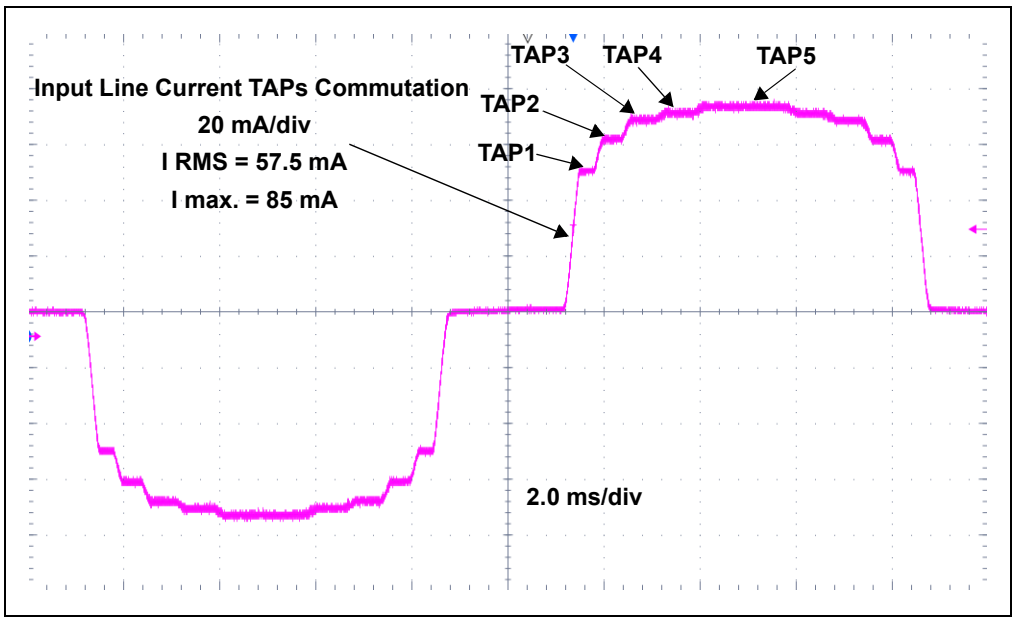


FIGURE C-9: *Input Current Waveform – TAPs 1-5 Commutation at 230 V_{AC} Line Input.*

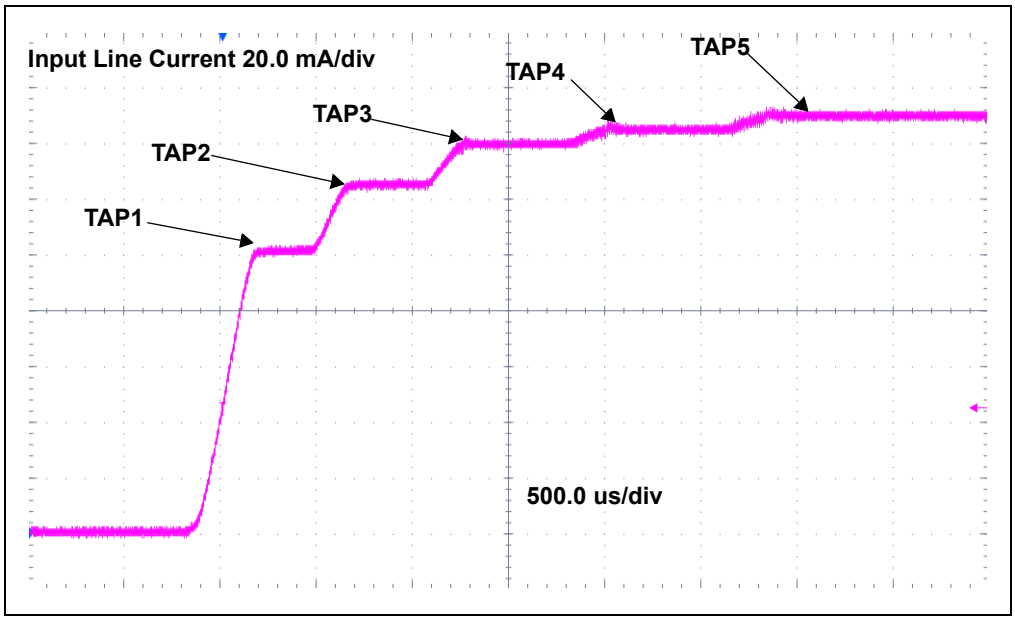


FIGURE C-10: *Input Current Waveform – TAPs 1-5 Commutation, Detail at 230 V_{AC} Line Input.*

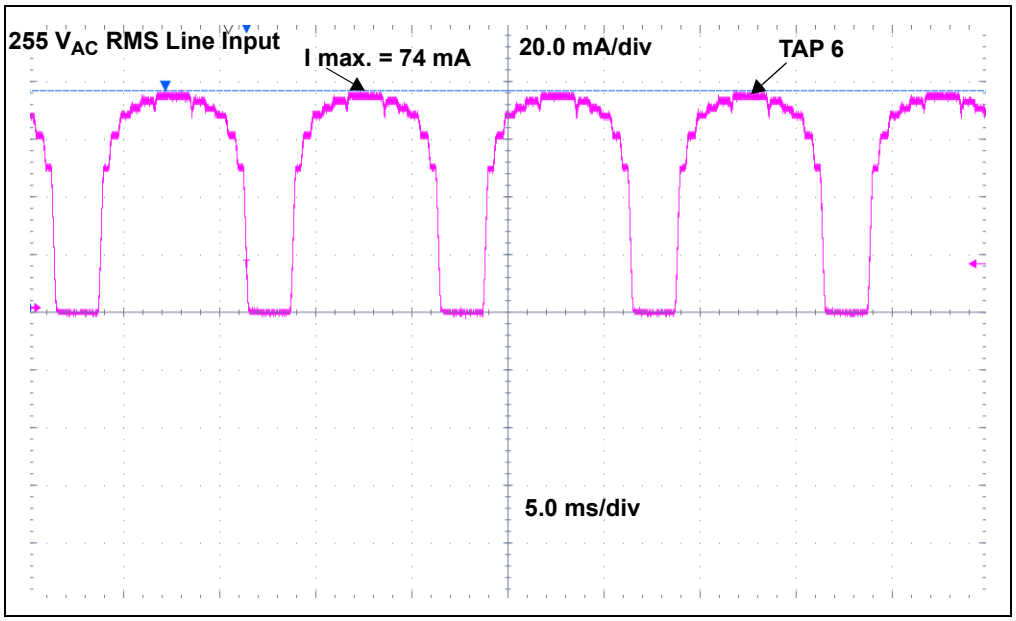


FIGURE C-11: *Output Current Waveform – TAP6 Commutation, Detail at 255 V_{AC} Line Input.*

C.1.6 Output Current with/without Ripple Reduction Circuit (RRC) at 230 V_{AC} Input

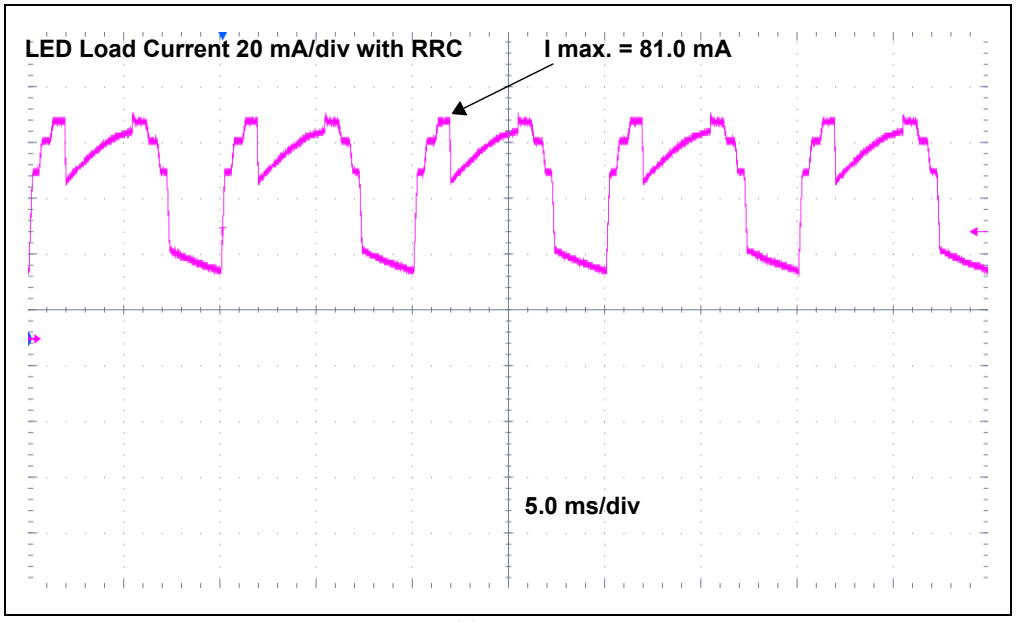


FIGURE C-12: *Output Current with RRC at 230 V_{AC} Input.*

C.2 CL8800 230 V_{AC} OFFLINE LED DRIVER EVALUATION BOARD TYPICAL MEASUREMENTS

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

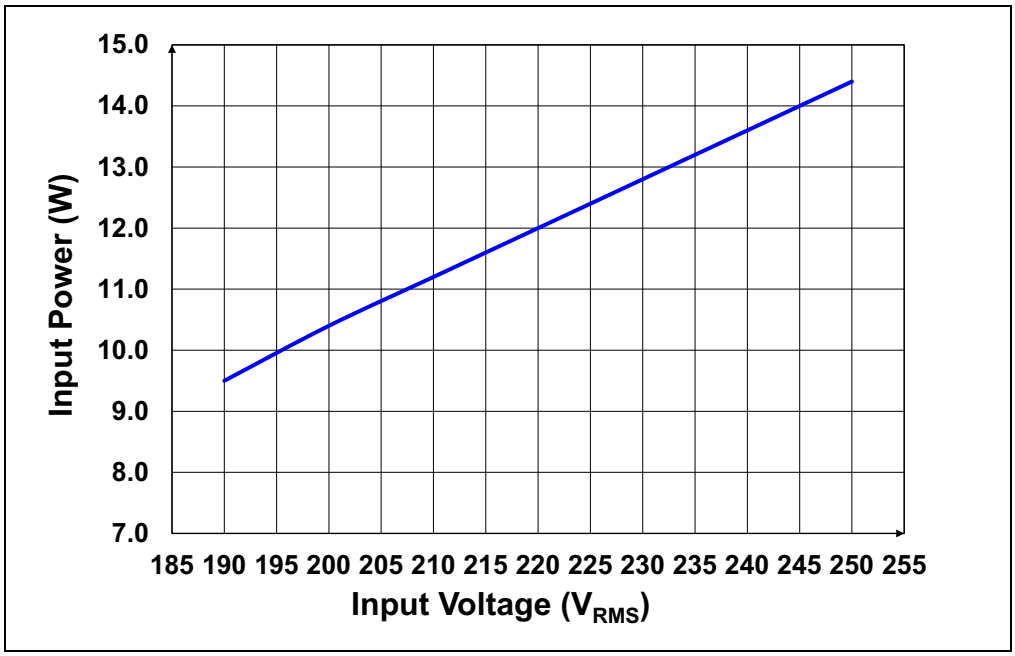


FIGURE C-13: *Input Power vs. Input Voltage.*

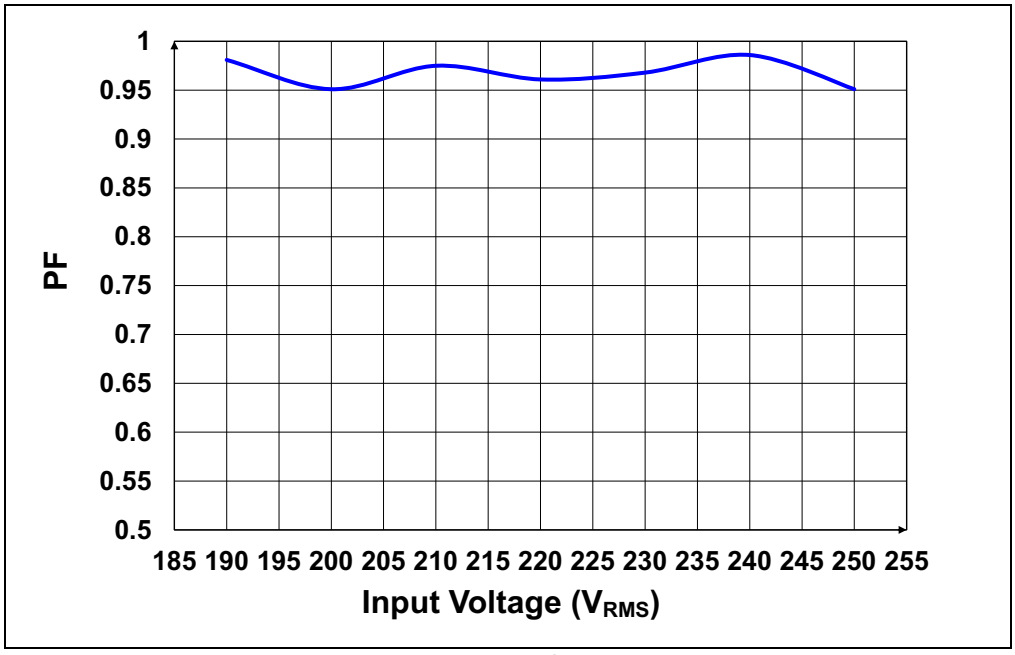


FIGURE C-14: *Power Factor vs. Input Voltage.*

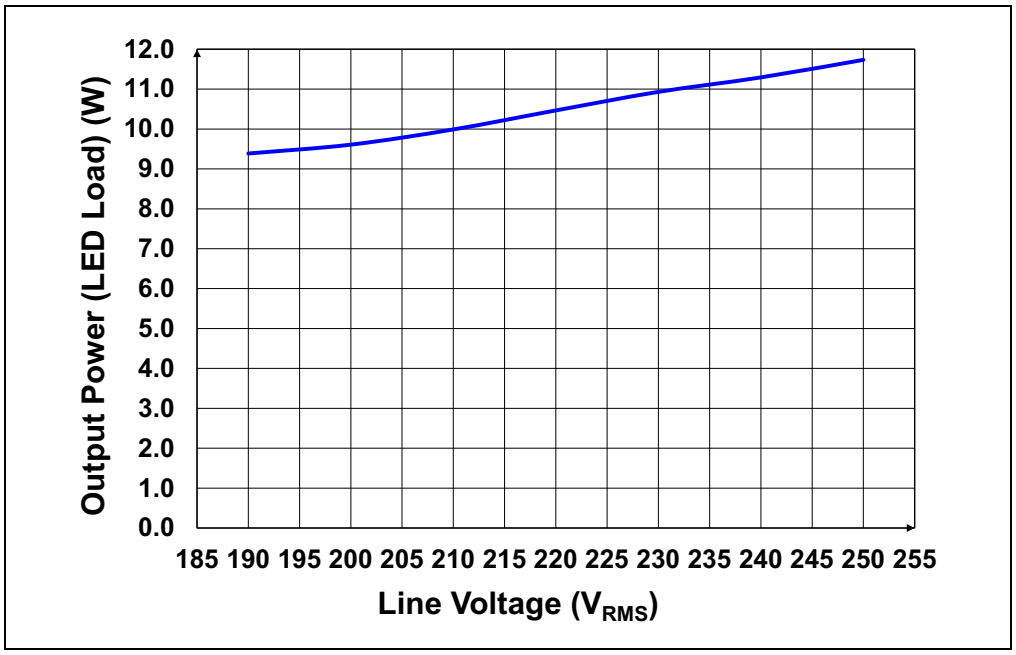


FIGURE C-15: *Output Power (LED Load) vs. Input Line Voltage.*

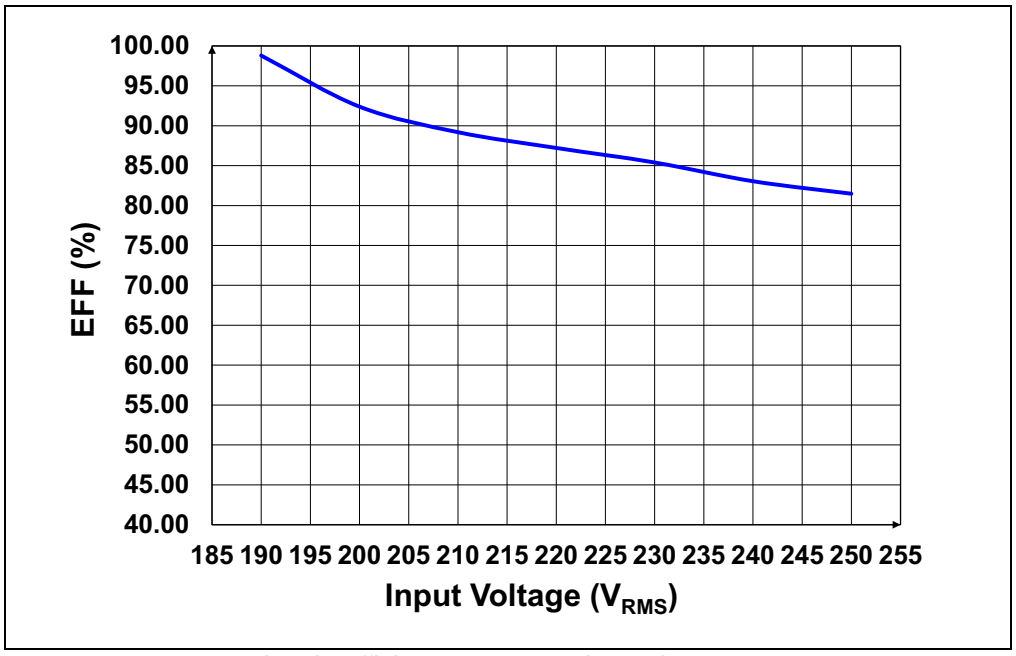


FIGURE C-16: *Electric Efficiency vs. Input Line Voltage.*

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