THE FUTURE OF ANALOG IC TECHNOLOGY®







LED LIGHTING SOLUTIONS SELECTOR GUIDE

Monolithic Power Systems, Inc.

Monolithic Power Systems, Inc.



Corporate Headquarters, San Jose, CA USA

Monolithic Power Systems (MPS) is a high-performance analog semiconductor company headquartered in San Jose, California. Formed in 1997, the company has three core strengths; deep system-level and applications knowledge, strong analog design expertise, and an innovative proprietary process technology. These combined advantages enable MPS to deliver highly integrated monolithic products that offer energy efficient, cost-effective solutions.

MPS' systems and applications expertise stems from a team of industry veterans who possess a combination of highly-technical electronics knowledge, sophisticated system and IC level design capabilities and extensive customer application experience. This allows the company to work closely with customers to identify new product opportunities, reduce time-to-market and effectively support its applications. In addition, MPS has developed a portfolio of intellectual property and proprietary wafer fabrication processes that enhance its products and market share. MPS design teams hail from distinguished analog semiconductor companies and top universities with extensive experience per designer. The teams have brought many innovative product suites to market and helped increase the company's annual revenue by an average of 28% between 2004 and 2009. These talented individuals, coupled with MPS' technology advantages, have created an emerging leader in the future of analog technology.



MPS Chengdu, China

MPS' proprietary BCD Plus™ process technology is the key to its competitive advantage. Many conventional analog technologies are handicapped by an inability to support the integration of power devices at high power levels. This results in unacceptably large semiconductors and/or significant levels of power loss. High power loss results in significant heat dissipation. This must be managed to avoid damaging or reducing the overall performance and efficiency of the system.

Other analog semiconductor vendors rely on multiple chip solutions to avoid these issues. In contrast, MPS' BCD Plus process technology resolves each of these issues. Implemented at standard CMOS foundries, this unique process integrates BiCMOS signal transistors with a highly efficient DMOS power transistor. This allows MPS to design and deliver smaller, single-chip power management ICs that are highly efficient and accurate. In addition, MPS' single process technology simplifies the design process, and is applicable across a wide range of analog applications. The result is higher productivity and significant cost advantages for any MPS customer. MPS' product families include:

- DC/DC Converter ICs, including AEC-Q100 qualified, Modules, PMICs, and PMUs that provides the supply voltage to a variety of electronic devices and automotive applications
- Multiphase Converters up to 200A for computing and telecom markets
- POL Regulators with extremely low Iq to support longer battery life of mobile applications
- Efuses, Load Switches, and USB Current-Limit Switches for enterprise and consumer markets
- AC/DC Controller and Converter ICs for consumer and industrial markets
- Battery Chargers and Protection Devices for mobile and portable applications
- Power over Ethernet (PoE) PD Solutions for various applications, including IP phones, network cameras, and WLAN access points
- LED Driver ICs used in general illumination for residential and professional end markets
- Backlight Driver and Panel Bias ICs used in LCD displays, such as those found in smart phones, tablet PCs, notebook PCs, flat-panel displays, and televisions
- Stepper Motor, Brushless DC Motor, and Brushed DC Motor Drivers for consumer and industrial applications
- Class-D Audio Amplifier ICs that are well-suited for consumer electronic devices
- Linear ICs including operational and current-sense amplifiers

MPS is a fabless semiconductor company, working with third party foundries. However, in contrast to many other fabless companies that use standard process technologies, MPS works with its foundry partners to install its own proprietary process technology in their facilities for use solely by MPS. MPS has over 1,000 employees worldwide, located in the United States, China, Taiwan, Korea, Japan, Singapore and across Europe.

Table of Contents

MPS Offline Lighting Solutions.....3

MPS Offline Lighting Solutions Family (Complete BOM).....4

MP4021A: Isolated Offline LED Controller for High-Power Factor LED Driver.....5
Reference Design: MP4021A – 7.5W Flyback High-Power Factor LED Bulb.....6

MP4026: High-Performance Isolated Offline High-Power Factor LED Controller.....8
Reference Design: MP4026 – 7W PSR Flyback High-Power Factor LED Driver.....9

MP4027: High-Performance Isolated Offline High-Power Factor LED Controller with NTC and PWM Dimming.....10
Reference Design: MP4027 – 7W PSR Flyback High-Power Factor LED Driver.....11

MP4030A: Enhanced Isolated TRIAC Dimmable Offline LED Controller with High-Power Factor.....12
Reference Design: MP4030A – 7.5W Flyback High-Power Factor Dimmable LED Bulb.....13
Reference Design: MP4030A – 16W Flyback High-Power Factor Dimmable LED Bulb.....15

MP4031: Isolated TRIAC and Analog Dimmable, Primary-Side Controlled Offline LED Controller with Active PFC.....18
Reference Design: MP4031 – 16W PSR Flyback with PFC TRIAC and Analog Dimming.....19

MP4032-1: Isolated 500V Integrated MOSFET, High-Power Factor, Dimmable Offline LED Driver.....21
Reference Design: MP4032-1 – 6.5W Flyback High-Power Factor LED Bulb.....22

NEW **MP4033: TRIAC Dimmable, Primary-Side Control Offline LED Controller with Active PFC.....23**
Reference Design: MP4033 – 8.4W, 108V to 132V Low-Line 24
Reference Design: MP4033 – 10W, 198V to 265V High-Line.....26

MP4034: Isolated Primary-Side Regulator with Integrated 700V MOSFET.....29
Reference Design: MP4034 – 5.2W Flyback LED Application.....30

MP44010+HR1000A Isolated Boundary Mode PFC and Resonant Half-Bridge Controller.....31
Reference Design: MP44010+HR1000A – 90W LED Driver.....33

MP4000: Non-Isolated Offline LED Controller.....36
Reference Design: MP4000 – 3.5W to 14W Universal Input WLED Driver with PFC.....37

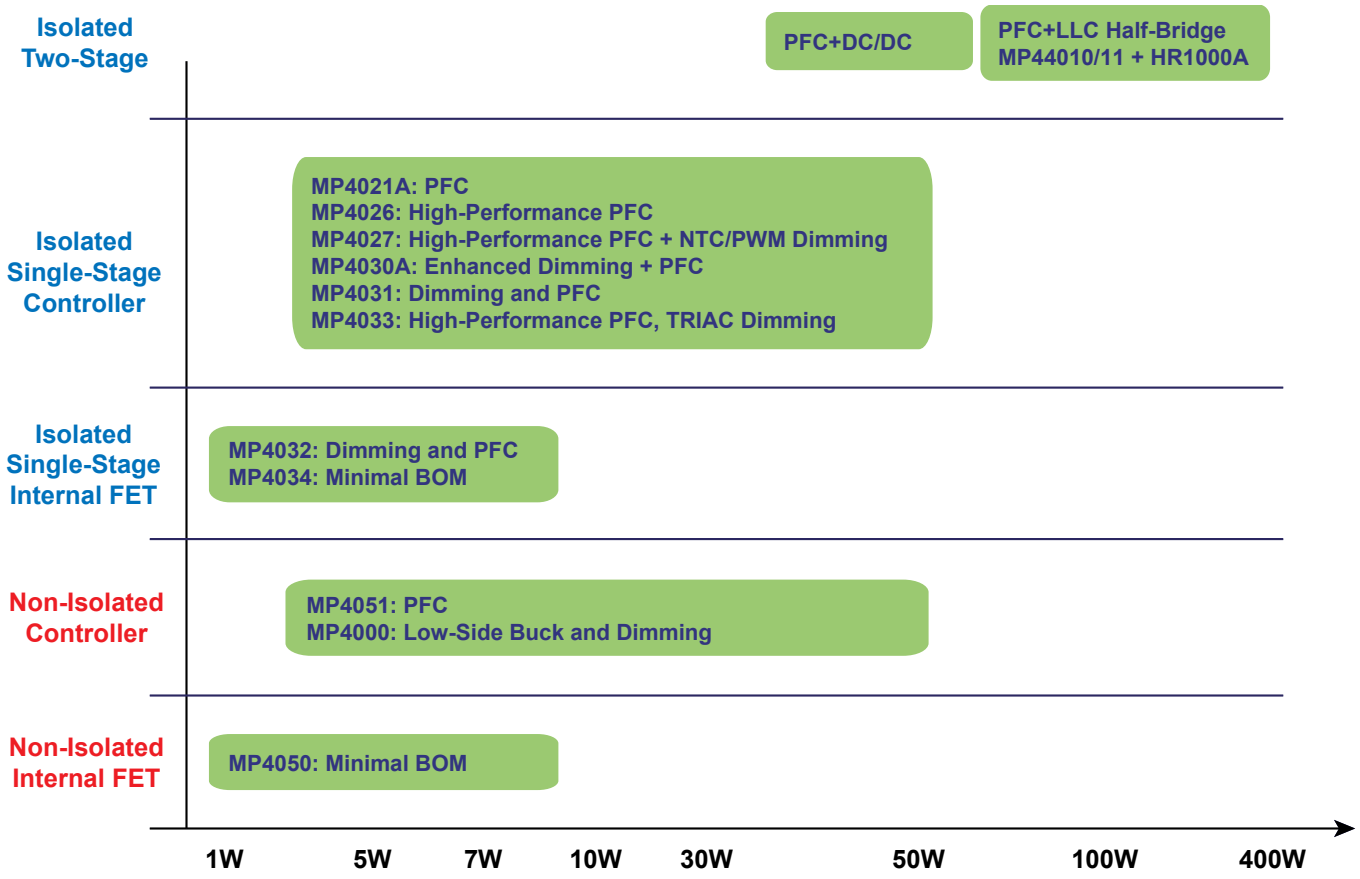
MP4050: Non-Isolated 500V Integrated MOSFET, High Brightness LED Driver.....38
Reference Design: MP4050 – 4.6W Universal Input Non-Isolated LED Driver.....39

MP4051: Non-Isolated Offline LED Controller for High-Power Factor LED Driver.....40
Reference Design: MP4051 – 4W High-Side Buck-Boost PFC LED Driver.....41
Reference Design: MP4051 – 6W Low-Side Buck-Boost PFC LED Driver.....42
Reference Design: MP4051 – 22.5W High-Side Buck-Boost PFC LED Driver.....43

MPS DC Lighting Products.....44
Reference Design: Many variants with and without PFC flyback. Please contact factory.

All Parts Patents Protected. All Rights Reserved.

MPS Offline Lighting Solutions







MPS Offline Lighting Solutions Family (Complete BOM)

Product	Power (W)	Application	Driver Type	Package	Reference Design							See Page
					Output Power P_{OUT} (W)	AC Input (VAC)	V_{OUT} (V) I_{OUT} (mA)	Efficiency	PF	Topology	Isolation	
MP4021A	3 to 50	LED Lighting (Non-Dimmable, PFC)	External FET	SOIC-8	7.5	85-265	21/350	>84%	>0.9	Flyback	Yes	6
					15	85-265	30/500	>86%	>0.9	Flyback	Yes	*
					30	85-265	43/700	>82%	>0.9	Flyback	Yes	
MP4026	3 to 50	LED Lighting (Non-Dimmable, PFC)	External FET	SOT23-5	7	90-265	20/350	>84%	>0.9	Flyback	Yes	9
					18	90-265	36/350	>84%	>0.9	Flyback	Yes	*
					20	90-265	40/500	>87%	>0.9	Flyback	Yes	
MP4027	3 to 50	LED Lighting (NTC/PWM Dimming)	External FET	FCTSOT-8	7	90-265	20/350	>84%	>0.9	Flyback	Yes	11
					10	90 to 265	72/140	>90%	>0.92	Flyback	Yes	*
MP4030A	3 to 50	LED Lighting (TRIAC Dimming, PFC)	External FET	SOIC-8	7.5	108-132	21/350	>83%	>0.95	Flyback	Yes	13
					16	198-265	30/530	>84%	>0.9	Flyback	Yes	15
MP4031	3 to 50	LED Lighting (TRIAC and Analog Dimming, PFC)	External FET	SOIC-8	16	108-305	30/530	>82%	>0.9	Flyback	Yes	19
MP4032-1	1 to 7.5	LED Lighting (TRIAC Dimming, PFC)	Internal 500V FET	SOIC-8	6.5	105-135	18/350	>82%	>0.95	Flyback	Yes	22
MP4033	3 to 50	LED Lighting (TRIAC Dimming, PFC)	External FET	SOIC-8 MSOP-10 SOIC-14	8.4	108-132	24/350	>82%	>0.95	Flyback	Yes	24
					10	198-265	24/420	>84%	>0.85	Flyback	Yes	26
MP4034	1 to 5	LED Lighting (Non-Dimmable, Non PFC)	Internal 700V FET	SOIC8-7	3.5	85-265	10/350	>80%	Non-PFC	PSR Flyback	Yes	*
					5.2	85-265	28/130	>80%	Non-PFC	PSR Flyback	Yes	30
MP44010 + HR1000A	70 to 250	High Power Outdoor LED Lighting (0-10V Dimming)	External FETs	SOIC-8 + SOIC-16	90	100-305	30-45/2100	>89%	>0.9	PFC+LLC	Yes	33
					100	90-305	24/4160	>90%	>0.9	PFC+LLC	Yes	*
					150	8-305	70/2100	>90%	>0.9	PFC+LLC	Yes	
MP4000	3 to 30	LED Lighting (PWM Dimming, Non PFC, Non-Isolated)	External FET	SOIC-8	3.5-14	90-265	10-40/350	>66%	>0.7 Valley Fill	Buck	No	37
					3.5-14	90-140	10-40/350	>70%	Non-PFC	Buck	No	*
					3.5-14	180-260	10-40/350	>66%	Non-PFC	Buck	No	
MP4050	1 to 7	LED Lighting (Non-Dimmable, Non-Isolated)	Internal 500V FET	TSOT23-5 SOIC-8	4.6	85-265	40/115	>85%	Non-PFC	Buck	No	39
MP4051	3 to 50	LED Lighting (Non-Dimmable, PFC, Non-Isolated)	External FET	SOIC-8	4	85-265	100/40	>85%	>0.9	Buck-Boost	No	41
					6	85-265	23/260	>83%	>0.9	Buck-Boost	No	42
					7	85-265	20/350	>82%	>0.9	Buck	No	*
					22.5	198-264	225/100	>91%	>0.9	Buck-Boost	No	43

* Contact Factory

MP4021A – Isolated Offline LED Controller for High-Power Factor LED Driver

Overview

The MP4021A is a primary-side controlled, offline, LED lighting controller that achieves a high power factor and accurate LED current for isolated, single-power-stage lighting applications in a single SOIC8 package. The proprietary real-current-control method accurately controls LED current using primary-side information. This method eliminates the need for secondary-side feedback components and the optocoupler to significantly simplify LED-lighting-system design.

The MP4021A integrates power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses. The extremely low start-up and quiescent currents reduce the total power consumption and provide a high-efficiency solution for lighting applications.

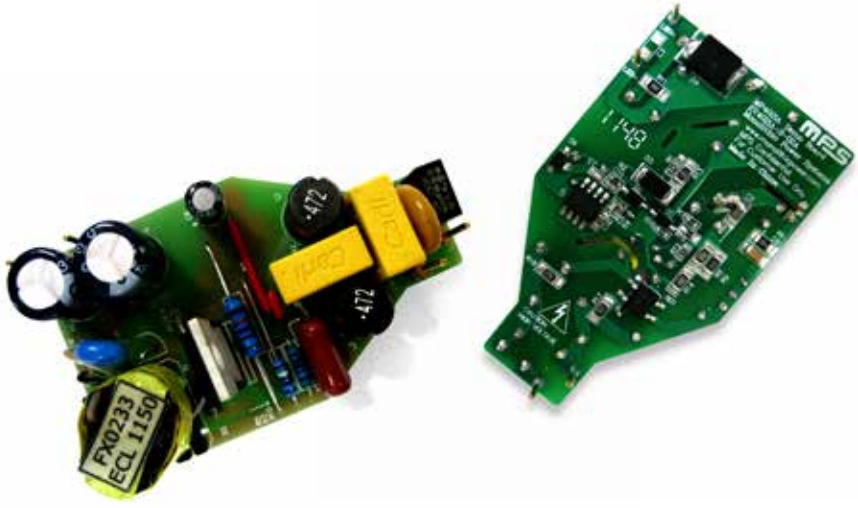
The multiple protection features greatly enhance system reliability and safety. The MP4021A features over-voltage protection, short-circuit protection, cycle-by-cycle current limiting, VCC UVLO, and auto-restart over-temperature protection.

Features

High-Performance
- Primary-Side Control
- High-Power Factor
- Good Line Regulation
- Good Current Accuracy

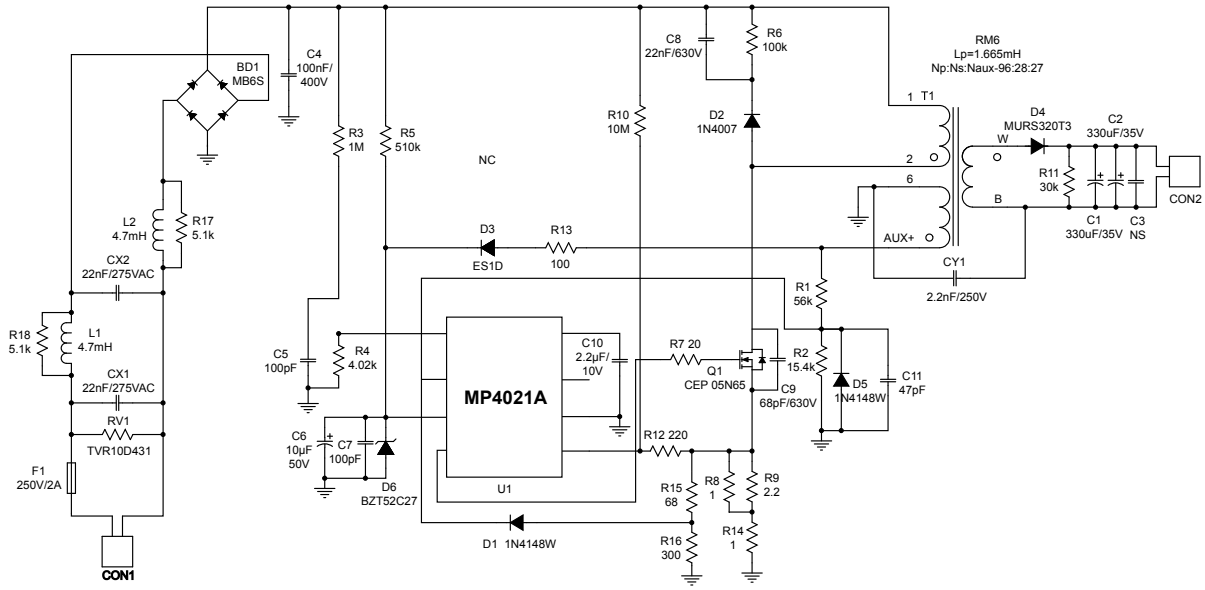
Low-Cost
- Primary-Side Control Eliminates Secondary-Side Feedback Components and the Optocoupler

Rich Protection
- Cycle-by-Cycle Current-Limit
- Programmable Primary-Side Over-Current Protection
- Over-Voltage Protection
- Short-Circuit Protection
- Over-Temperature Protection



Reference Design:
MP4021A – 7.5W Flyback High-Power Factor LED Bulb

Schematic: V_{IN} = 85V_{AC} to 265V_{AC} / V_{OUT} = 21V / I_{OUT} = 350mA



Constant Current, Efficiency and High-Power Factor

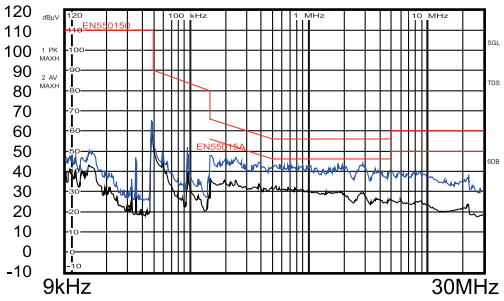
f (Hz)	V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
60	85	8.84	21.83	342.3	7.47	84.5%	0.993	11.0
	90	8.80	21.83	342.7	7.48	85.0%	0.992	11.4
	100	8.71	21.83	342.4	7.47	85.8%	0.991	12.1
	110	8.65	21.82	342.1	7.46	86.3%	0.988	12.6
	120	8.60	21.82	341.5	7.45	86.7%	0.986	13.4
	132	8.58	21.81	341.4	7.45	86.8%	0.984	13.9
	135	8.57	21.81	341.4	7.44	86.9%	0.982	14.0
f (Hz)	**V_{IN} (V_{AC})**	**P_{IN} (W)**	**V_{OUT} (V)**	**I_{OUT} (mA)**	**P_{OUT} (W)**	**Efficiency (%)**	**PF**	**THD (%)**
50	185	8.59	21.86	341.0	7.45	86.8%	0.966	16.6
	190	8.61	21.86	341.3	7.46	86.7%	0.964	16.7
	200	8.63	21.86	341.5	7.47	86.5%	0.958	16.8
	210	8.67	21.86	341.9	7.47	86.2%	0.953	16.8
	220	8.70	21.86	342.4	7.48	86.0%	0.947	16.9
	230	8.75	21.86	342.9	7.50	85.7%	0.940	16.9
	240	8.80	21.86	343.5	7.51	85.3%	0.933	17.0
	250	8.85	21.87	344.2	7.53	85.1%	0.925	17.0
	260	8.91	21.87	345.0	7.55	84.7%	0.914	17.1
	265	8.94	21.87	345.3	7.55	84.5%	0.913	17.1

Reference Design

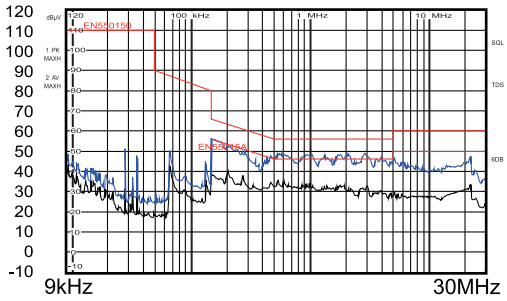
Reference Design:
MP4021A – 7.5W Flyback High-Power Factor LED Bulb

Conducted EMI and Line Regulation

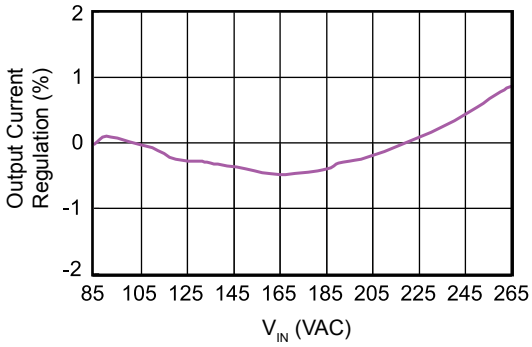
Conducted EMI
V_{IN} = 115V_{AC}, Full Load, RBW = 9kHz, MT = 20ms



Conducted EMI
V_{IN} = 230V_{AC}, Full Load, RBW = 9kHz, MT = 20ms



Line Regulation
Full Load



Electric Strength Test

Primary-to-secondary circuit electric-strength testing was complete according to IEC61347-1 and IEC61347-2-13. Input and output were shorted respectively. 3750VAC/50Hz sine wave applied between input and output for one minute and verified the operation.

Surge Test

Line-to-Line 500V and Line-to-Power-Earth 1kV surge testing were completed according to IEC61547. Input voltage was set at 230VAC/50Hz. Output was loaded at full load and operation was verified following each surge event.

Surge Level (V)	Input Voltage (V_{AC})	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
500	230	L to N	90	Pass
-500	230	L to N	270	Pass
1000	230	L to PE	90	Pass
-1000	230	L to PE	270	Pass
1000	230	N to PE	90	Pass
-1000	230	N to PE	270	Pass

Reference Design

MP4026 – High-Performance Isolated Offline High-Power Factor LED Controller

Overview

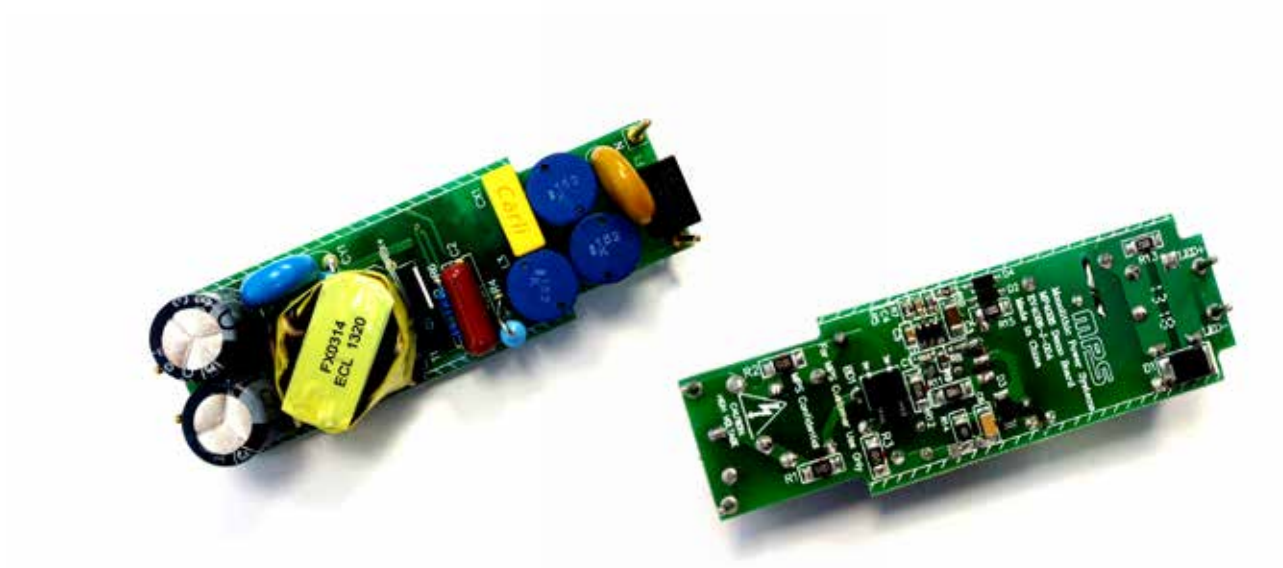
The MP4026 is a primary-side control, offline LED controller that achieves high-power factor and accurate LED current for isolated, single-power-stage lighting applications in an FCTSOT package. It is the next generation of the successful MP4021A. The proprietary real-current-control method accurately controls LED current from primary-side information with good line and load regulation. The primary-side-control eliminates the secondary-side feedback components and the optocoupler to significantly simplify LED-lighting-system design. The MP4026 integrates power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses. The MP4026's multiple protection features greatly enhance system reliability and safety. These features include over-voltage protection, short-circuit protection, primary-side over-current protection, brown out protection, cycle-by-cycle current limiting, VCC under-voltage lockout, and auto-restart over-temperature protection.

Features

- Real-Current Control without Secondary-Feedback Circuit
- <2% Line/Load Regulation
- High-Power Factor (≥0.9) Over Universal Input Voltage
- Boundary Conduction Mode for Improved Efficiency
- Brown-Out Protection
- Over-Voltage Protection
- Short-Circuit Protection
- Over-Temperature Protection
- Primary-Side Over-Current Protection
- Cycle-by-Cycle Current Limit
- Input UVLO
- Available in FCTSOT-6

Applications

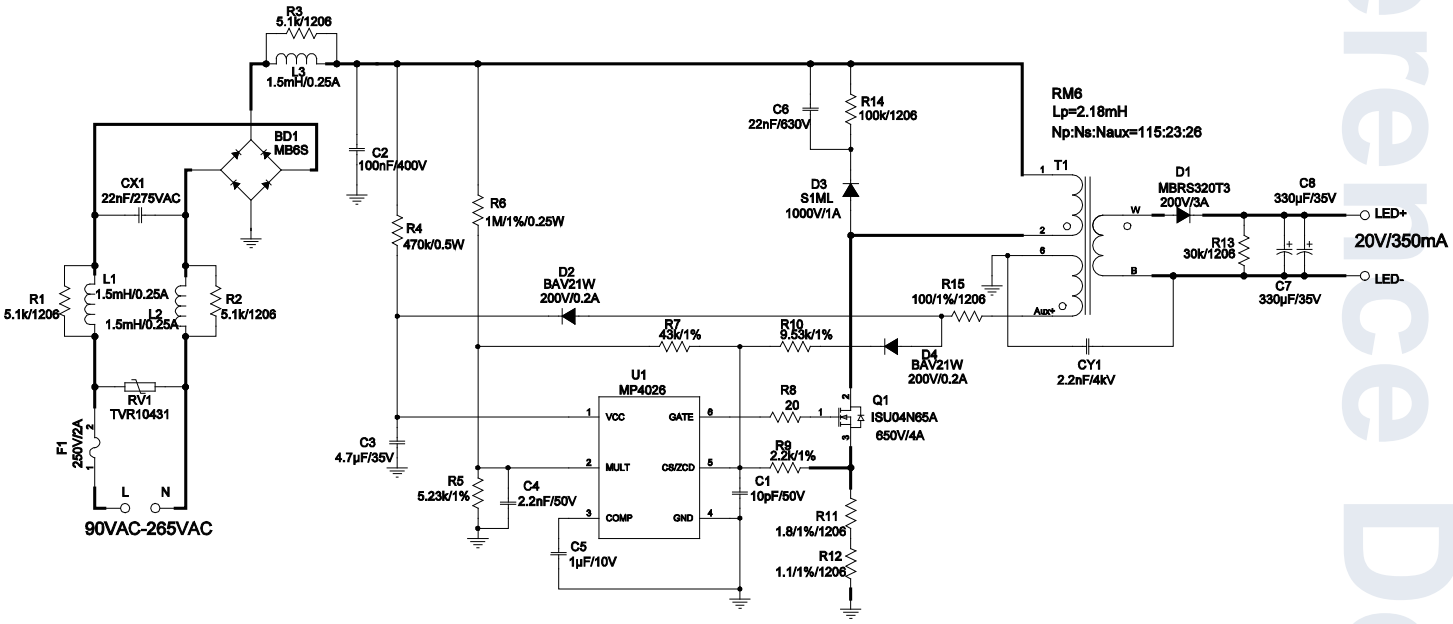
- Industrial and Commercial Lighting
- Residential Lighting



Reference Design

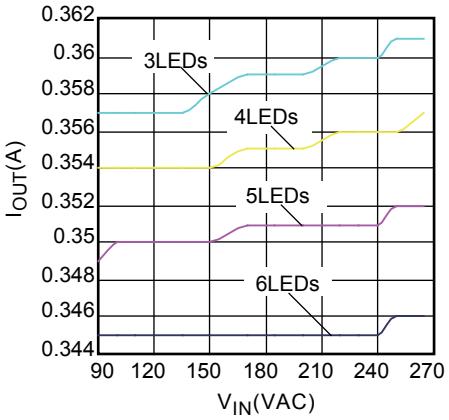
Reference Design:
MP4026 – 7W PSR Flyback High-Power Factor LED Driver

Schematic: V_{IN} = 90V_{AC} to 265V_{AC} / V_{OUT} = 20V / I_{OUT} = 350mA

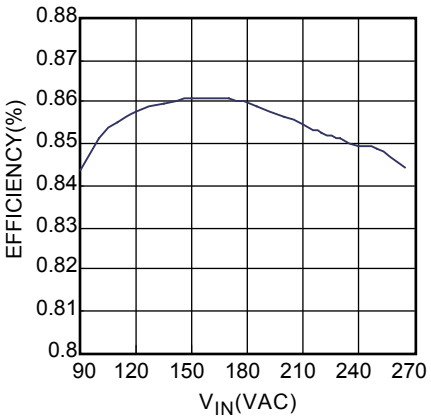


Good Line/Load Regulation, Good Efficiency and High-Power Factor

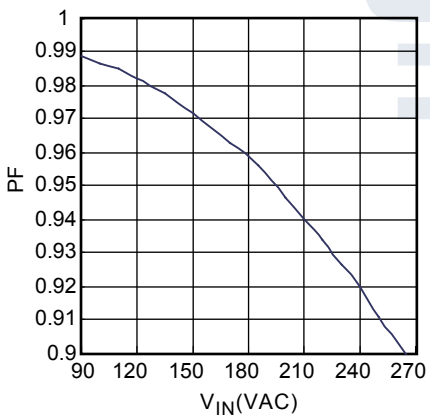
Line/Load Regulation



Efficiency



PF @Full Load



MP4027 – High-Performance Isolated Offline High-Power Factor LED Controller with NTC and PWM Dimming

Overview

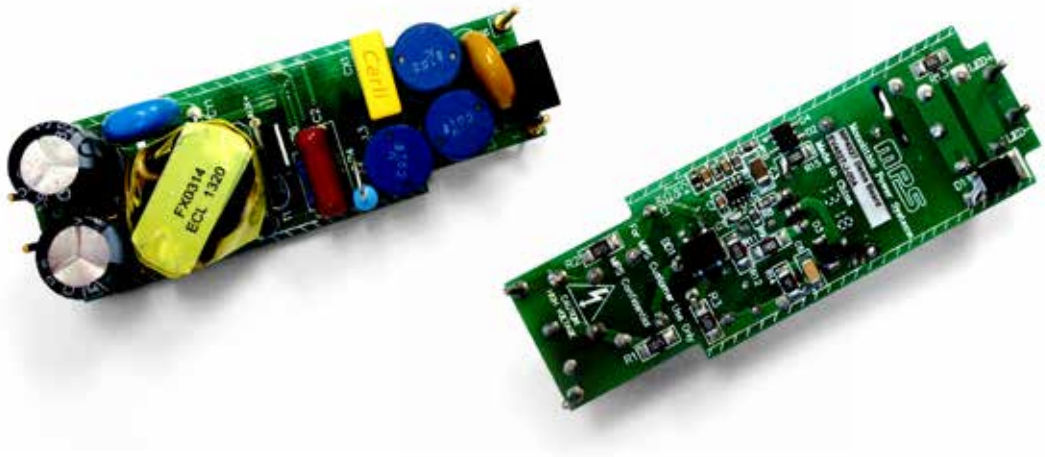
The MP4027 is a primary-side-control, offline LED controller that achieves high-power factor and accurate LED current for isolated, single-power-stage lighting applications in an FCTSOT package. The proprietary real-current-control method accurately controls LED current from primary-side information with good line and load regulation. The primary-side-control eliminates the secondary-side feedback components and the optocoupler to significantly simplify LED-lighting-system design. The MP4027 integrates power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses. The MP4027 has NTC function and allows PWM dimming. The MP4027's multiple protection features greatly enhance system reliability and safety. These features include over-voltage protection, short-circuit protection, primary-side over-current protection, brown out protection, cycle-by-cycle current limiting, VCC under-voltage lockout, and auto-restart over-temperature protection.

Features

- Real-Current Control without Secondary-Feedback Circuit
- <2% Line/Load Regulation
- Current Fold Back for Over Temperature (NTC)
- PWM Dimming Available
- High-Power Factor (≥0.9) Over Universal Input Voltage
- Boundary Conduction Mode for Improved Efficiency
- Brown-Out Protection
- Over-Voltage Protection
- Short-Circuit Protection
- Over-Temperature Protection
- Primary-Side Over-Current Protection
- Cycle-by-Cycle Current Limit
- Input UVLO
- Available in FCTSOT-8 Package

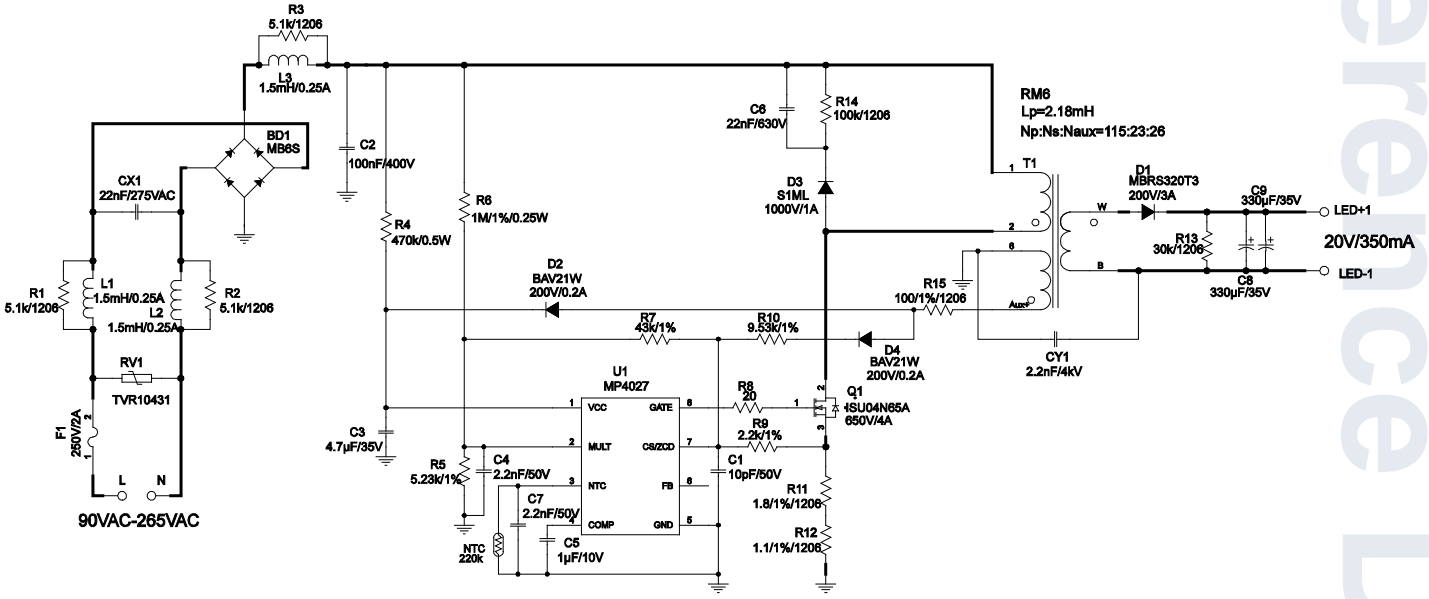
Applications

- Industrial and Commercial Lighting
- Residential Lighting



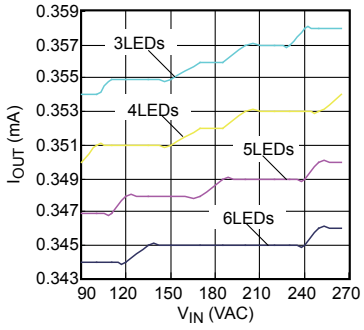
Reference Design:
MP4027 – Reference Design for 7W PSR Flyback High-Power Factor LED Driver

Schematic: V_{IN} = 90V_{AC} to 265V_{AC} / V_{OUT} = 20V / I_{OUT} = 350mA

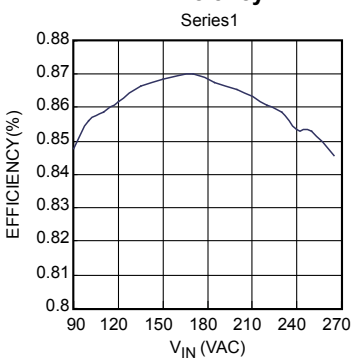


Good Line/Load Regulation, Good Efficiency and High-Power Factor

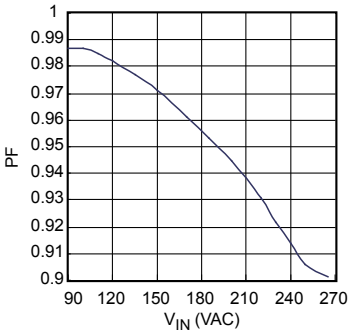
Line/Load Regulation



Efficiency

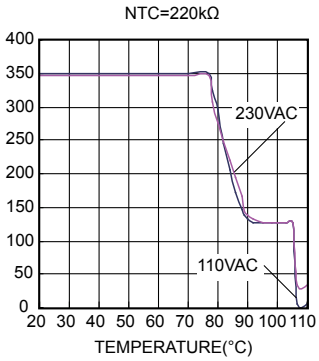


PF @ Full Load



NTC Performance

NTC Curve



MP4030A – Enhanced Isolated TRIAC Dimmable Offline LED Controller with High-Power Factor

Overview

The MP4030A is a TRIAC-dimmable, primary-side-control, offline LED lighting controller with active PFC. It can output an accurate LED current for an isolated lighting application with a single-stage converter. The proprietary real-current-control method can accurately control the LED current using primary-side information. It can significantly simplify LED lighting system design by eliminating secondary-side feedback components and the optocoupler.

The MP4030A implements power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses.

The MP4030A has an integrated charging circuit at the supply pin for fast start-up without a perceptible delay. The proprietary dimming control expands the TRIAC-based dimming range.

The MP4030A features multiple protections including over-voltage protection (OVP), short-circuit protection (SCP), primary-side over-current protection (OCP), supply-pin under-voltage lockout (UVLO), and over temperature protection (OTP). All of which not only simplifies circuit design but also enhances system reliability and safety greatly. All fault protections feature auto-restart.

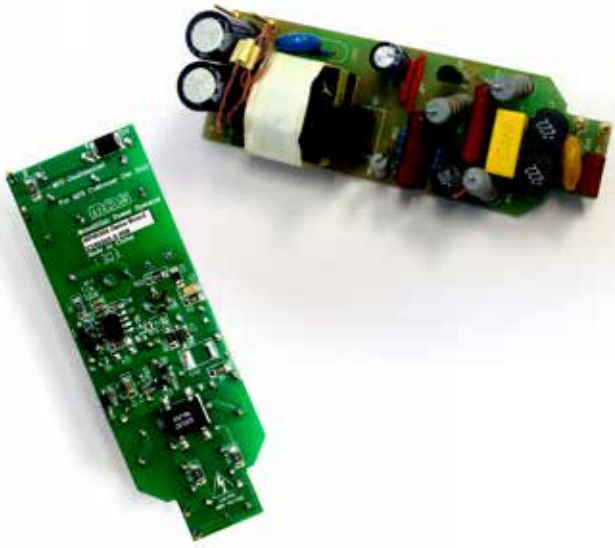
Features

- Phase-Controlled TRIAC Dimming with Expanded Dimming Range
- Primary-Side-Control without Requiring a Secondary-Side Feedback Circuit
- Internal Charging Circuit at the Supply Pin for Fast Start-Up
- Accurate Line & Load Regulation
- High Power Factor and Improved THD
- Operates in Boundary Conduction Mode
- Cycle-by-Cycle Current Limit
- Primary-Side, Over-Current Protection
- Over-Voltage Protection
- Short-Circuit Protection
- Over-Temperature Protection
- Available in an 8-Pin SOIC Package

Applications

- Solid-State Lighting, including:
- Industrial and Commercial Lighting
- Residential Lighting

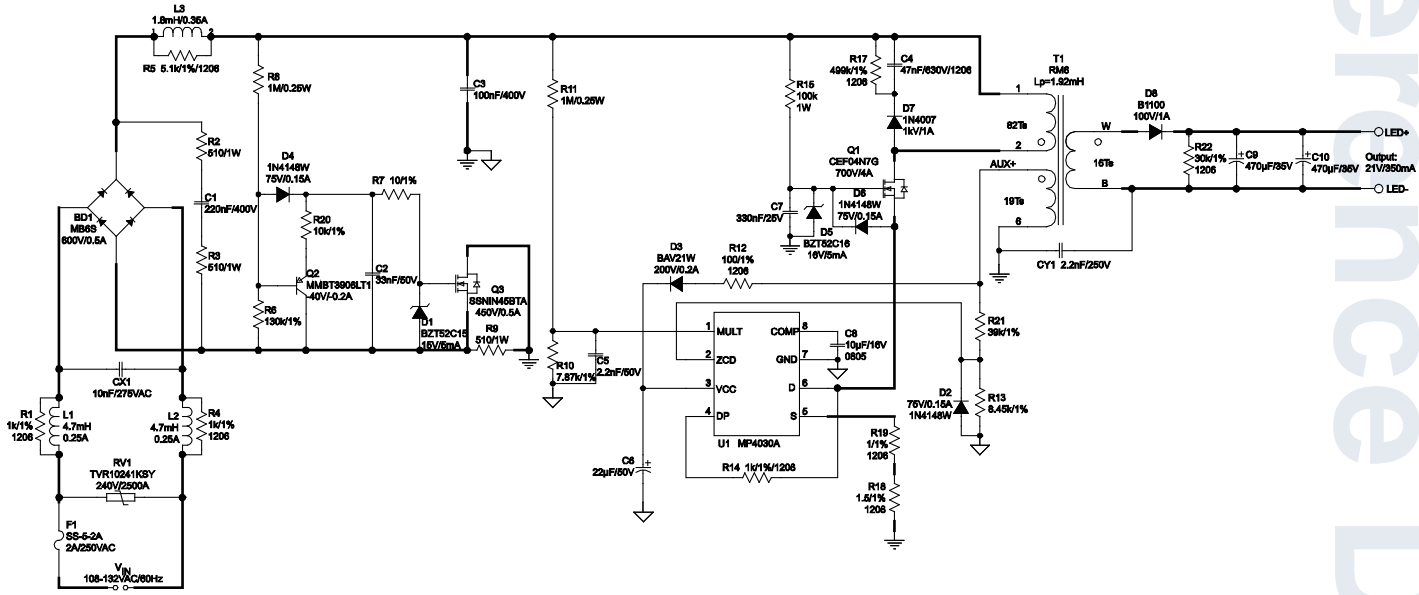




Reference Design

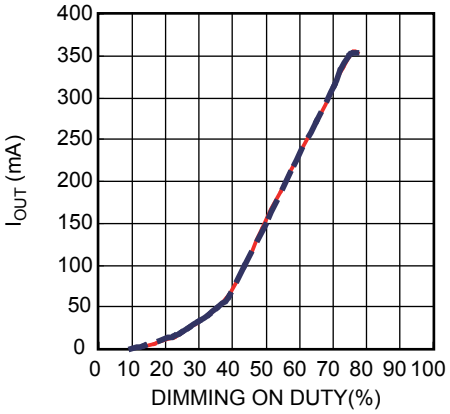
Reference Design: MP4030A – 7.5W Flyback High-Power Factor Dimmable LED Bulb

Schematic: V_{IN} = 108V_{AC} to 132V_{AC} / V_{OUT} = 21V / I_{OUT} = 350mA



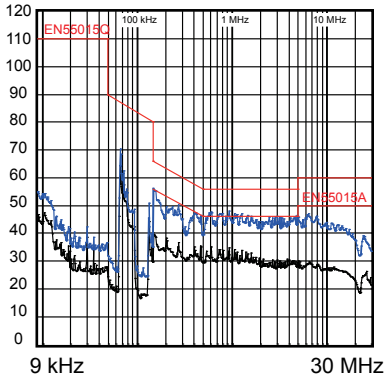
Conducted EMI and Dimming Curve

Dimming Curve



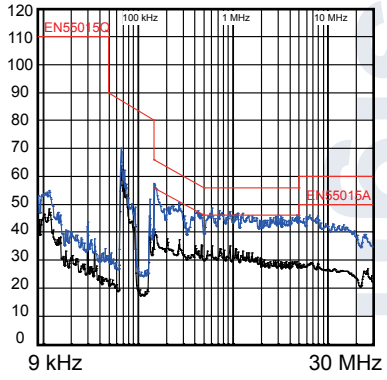
Conducted EMI

Based on Line L



Conducted EMI

Based on Line N



Performance Data Efficiency, PF and THD

f (Hz)	V_{IN} (VAC)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
60	108	8.88	20.88	353.1	7.37	83.00%	0.991	9.70%
	110	8.86	20.87	353.2	7.37	83.20%	0.99	9.90%
	120	8.81	20.87	354	7.39	84.90%	0.983	11.00%
	130	8.78	20.87	354.5	7.4	84.30%	0.976	12.20%
	132	8.78	20.86	354.6	7.4	84.20%	0.975	12.40%

Reference Design: MP4030A – 7.5W Flyback High-Power Factor Dimmable LED Bulb

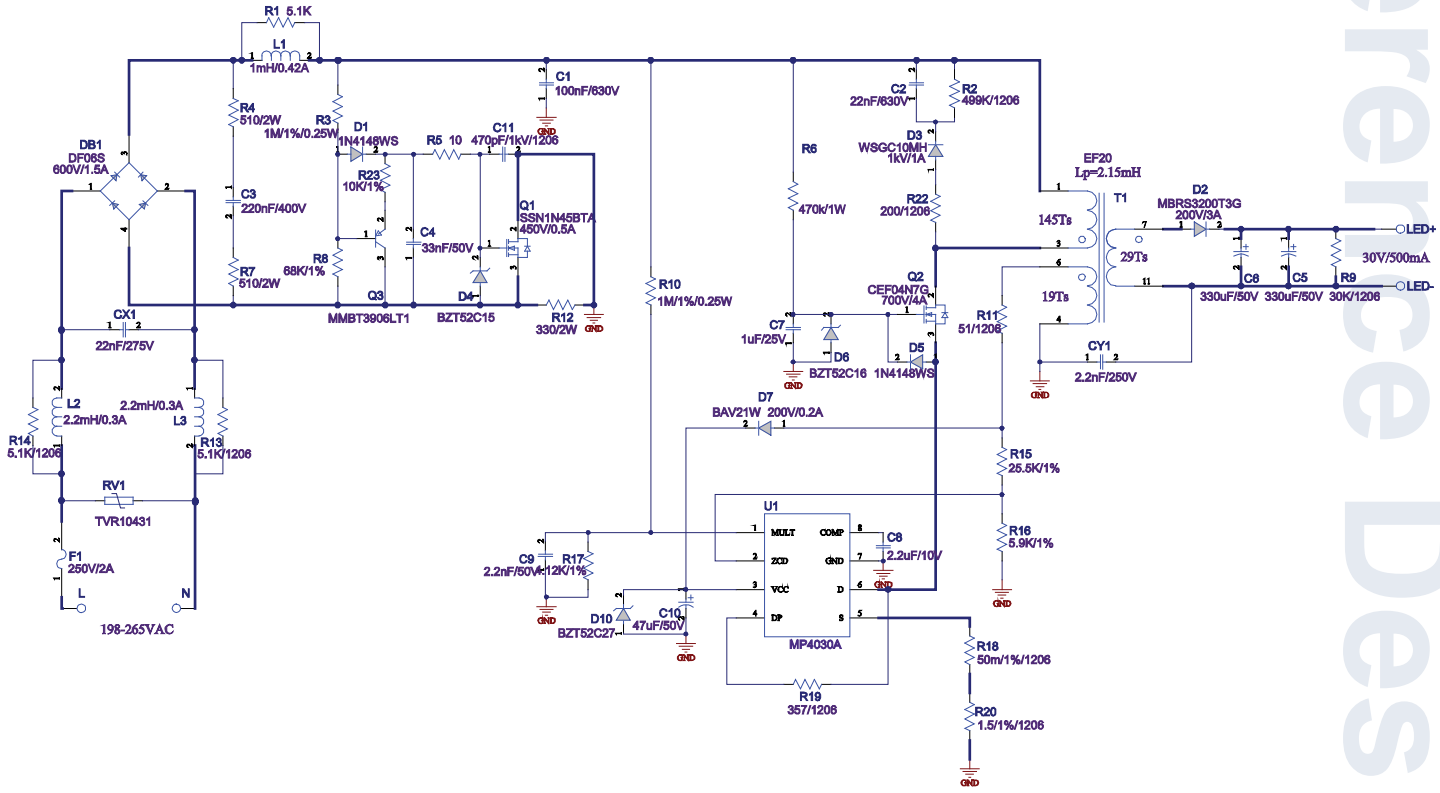
Dimmer Compatibility (No Flicker with These 32 Different Dimmers)

Manufacturer	Part Number	Power Stage	Imax (mA)	Imin (mA)	Dimming Ratio
LUTRON	Q-600P-IV	600W	335	9	2.69%
LUTRON	CN-600P	600W	321	3	1.06%
LUTRON	AY-600P	600W	302	7	2.22%
LUTRON	LG-600P	600W	323	3	0.80%
LUTRON	6B38-Q-600P	600W	325	8	2.40%
LUTRON	GL-600H-DK	600W	353	1	0.31%
LEVITON	1G40O5	600W	332	0	0.00%
LEVITON	6633-P	600W	354	0	0.00%
LUTRON	6B38-S-600P	600W	320	0	0.08%
LUTRON	6B38-S-603PG	600W	233	1	0.30%
LUTRON	6B38-DV-600P	600W	315	1	0.25%
LUTRON	6B38-DVLV-600P	600W	318	5	1.63%
LEVITON	1L10O5	600W	337	0	0.00%
LUTRON	DV-600P-BR	600W	318	2	0.53%
LEVITON	6613-PL	600W	354	0	0.00%
LEVITON	C20-6684-IW	600W	354	0	0.00%
LUTRON	AY-600P-LA	600W	337	13	3.76%
LUTRON	TG-600PH-WH	600W	319	9	2.70%
LUTRON	TG-603GH-WH	600W	207	7	3.58%
LUTRON	MAW-600H-WH	600W	310	12	3.81%
LUTRON	S-600	600W	354	0	0.06%
LUTRON	DVPDC-203P-WH	200W	354	41	11.48%
LUTRON	S-600P	600W	317	0	0.00%
LUTRON	6B38-DV-603PG	600W	227	4	1.72%
LUTRON	DNG-603PH-WH	400W	299	0	0.00%
LEVITON	6633-P-1G10O5	600W	354	0	0.00%
LUTRON	NTLV-600-AL	600W	354	4	1.24%
LEVITON	6615-P0W	300W	353	45	12.62%
LUTRON	DVELV-303P-WH	300W	300	6	1.84%
LUTRON	DVELV-300P-WH	300W	295	6	2.00%
LUTRON	MAELV-60-WH	600W	295	6	2.00%
LUTRON	TT-300H-WH	300W	355	0	0.00%
LUTRON	TT-300	300W	355	0	0.00%
LEVITON	1C1002	300W	355	0	0.00%

Reference Design

Reference Design: MP4030A – 16W Flyback High-Power Factor Dimmable LED Bulb

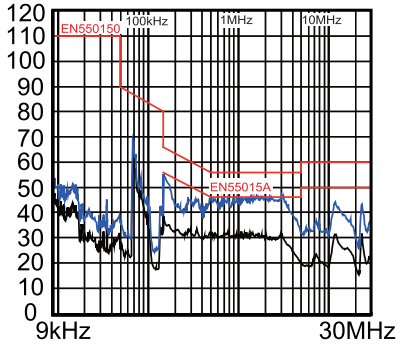
Schematic: V_{IN} = 198V_{AC} to 265V_{AC} / V_{OUT} = 30V / I_{OUT} = 530mA



Conducted EMI, Dimming Curve, and Line Regulation

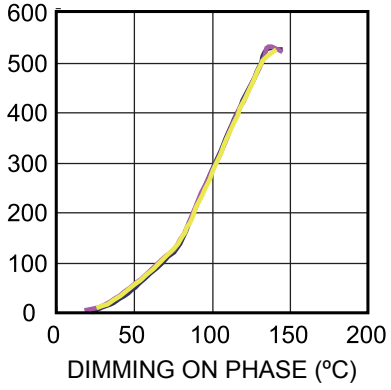
Conducted EMI

V_{IN}=220V_{AC}/50Hz, Full Load,
RBW=9kHz, MT=20ms



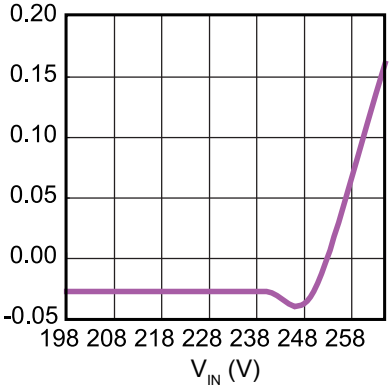
Dimming Curve

V_{IN}=220V_{AC}/50Hz, Full Load
with Different Dimmers



Line Regulation

Full Load



Reference Design: MP4030A – 16W Flyback High-Power Factor Dimmable LED Bulb

Constant Current, Efficiency, and High-Power Factor Without Dimmer

f (Hz)	V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
50	198	18.71	29.98	531	15.92	85.1%	0.97	13.0
	210	18.69	29.96	531	15.91	85.1%	0.97	13.8
	220	18.67	29.94	531	15.90	85.2%	0.96	14.0
	230	18.66	29.93	531	15.89	85.2%	0.95	14.2
	240	18.67	29.92	531	15.89	85.1%	0.94	14.3
	250	18.69	29.90	531	15.88	84.9%	0.94	14.6
	265	18.77	29.90	532	15.91	84.7%	0.92	14.8

Dimmer Compatibility (No Flicker on these Dimmers)

Manufacturer	Part Number	Power Stage	V_{IN} (V_{AC})	Dimming Type	I_{OUT} (Max) (mA)	I_{OUT} (Min) (mA)
BUSCH	2210..-510	60-400W	230	Leading	521	33
SCHNEIDER	SD300	300W	230	Leading	525	0
BUSCH	2250 U	600W	230	Leading	529	12
MIKA	434	60-400W	230	Leading	504	31
MIKA	433/4	60-400W	230	Leading	529	74
MIKA	EIM-672	20-400W	230/240	Leading	529	0
BUSCH	2247U	500W/VA	230	Leading	527	31
BUSCH	2200..	60-400W	230	Leading	523	31
GIRA	030200/I01	60-600W	230/240	Leading	526	25
JUNG	225 NVDE	20-500W	230/240	Leading	528	11
BERKER	283010	60-400W	230/240	Leading	526	31
BERKER	286610	20-500W	230/240	Leading	529	18
MIKA	433 HAB	20-315W	230	Trailing	531	54
MIKA	EIM-673	20-300W	230/240	Trailing	463	0.53
MIKA	433HAB	20-315W	230	Trailing	462	58
GIRA	0307 00	20-520W	230	Trailing	531	50
BUSCH	6513 U-102	420W/VA	230	Trailing	530	62

Reference Design

Reference Design: MP4030A – 15W Flyback High-Power Factor Dimmable LED Bulb

Electric Strength Test

Primary-to-secondary circuit electric-strength testing was complete according to IEC61347-1 and IEC61347-2-13. Input and output were shorted respectively. 3750V_{AC} / 50Hz sine wave applied between input and output for one minute and verified the operation.

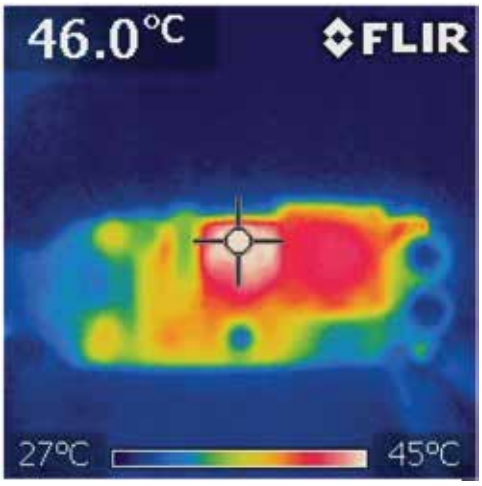
Surge Test

Line-to-Line 500V and Line-to-Power-Earth 1kV surge testing were completed according to IEC61547. Input voltage was set at 230V_{AC} / 50Hz. Output was loaded at full load and operation was verified following each surge event.

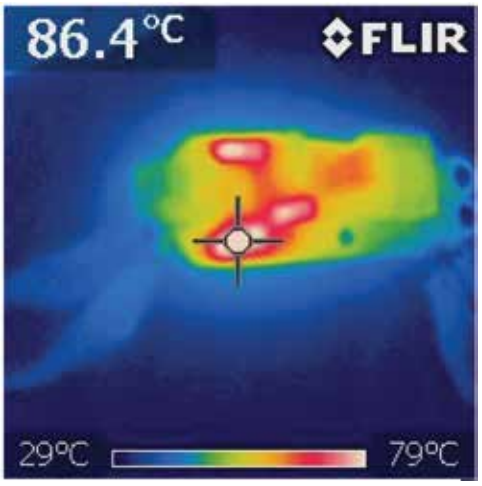
Surge Level (V)	Input Voltage (V_{AC})	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
500	230	L to N	90	Pass
-500	230	L to N	270	Pass
1000	230	L to PE	90	Pass
-1000	230	L to PE	270	Pass
1000	230	N to PE	90	Pass
-1000	230	N to PE	270	Pass

Thermal Test

Test without dimmer and with dimmer at 90% dimming on phase.



Without Dimmer



With Dimmer at 90% Dimming on Phase

Reference Design

MP4031 – Isolated TRIAC and Analog Dimmable, Primary-Side Controlled Offline LED Controller with Active PFC

Overview

The MP4031 is a TRIAC and analog dimmable, primary-side–controlled, offline LED lighting controller with active PFC. It can output an accurate LED current for an isolated lighting application with a single-stage converter. The proprietary real-current–control method can accurately control the LED current using primary-side information. It can significantly simplify LED lighting system design by eliminating secondary-side feedback components and the optocoupler.

The MP4031 implements power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses.

The MP4031 has an integrated charging circuit at the supply pin for fast start-up without a perceptible delay. The proprietary dimming control expands the TRIAC-based dimming range.

The special current sense structure can implement analog dimming.

The MP4031 has multiple protections that greatly enhance system reliability and safety, including over-voltage protection, overload protection, supply-pin under-voltage lockout, and over-temperature protection. All fault protections feature auto-restart.

Features

- Primary-Side-Control without Secondary-Side Feedback
- Internal Charging Circuit at the Supply Pin for Fast Start-Up
- Accurate Line Regulation
- High-Power Factor
- Operates in Boundary Conduction Mode
- Phase-Controlled TRIAC Dimming with Expanded Dimming Range
- Analog-Dimming Compatible
- Cycle-by-Cycle Current-Limit
- Over-Voltage Protection
- Over-Load Protection
- Over-Temperature Protection
- Available in an 8-Pin SOIC Package

Applications

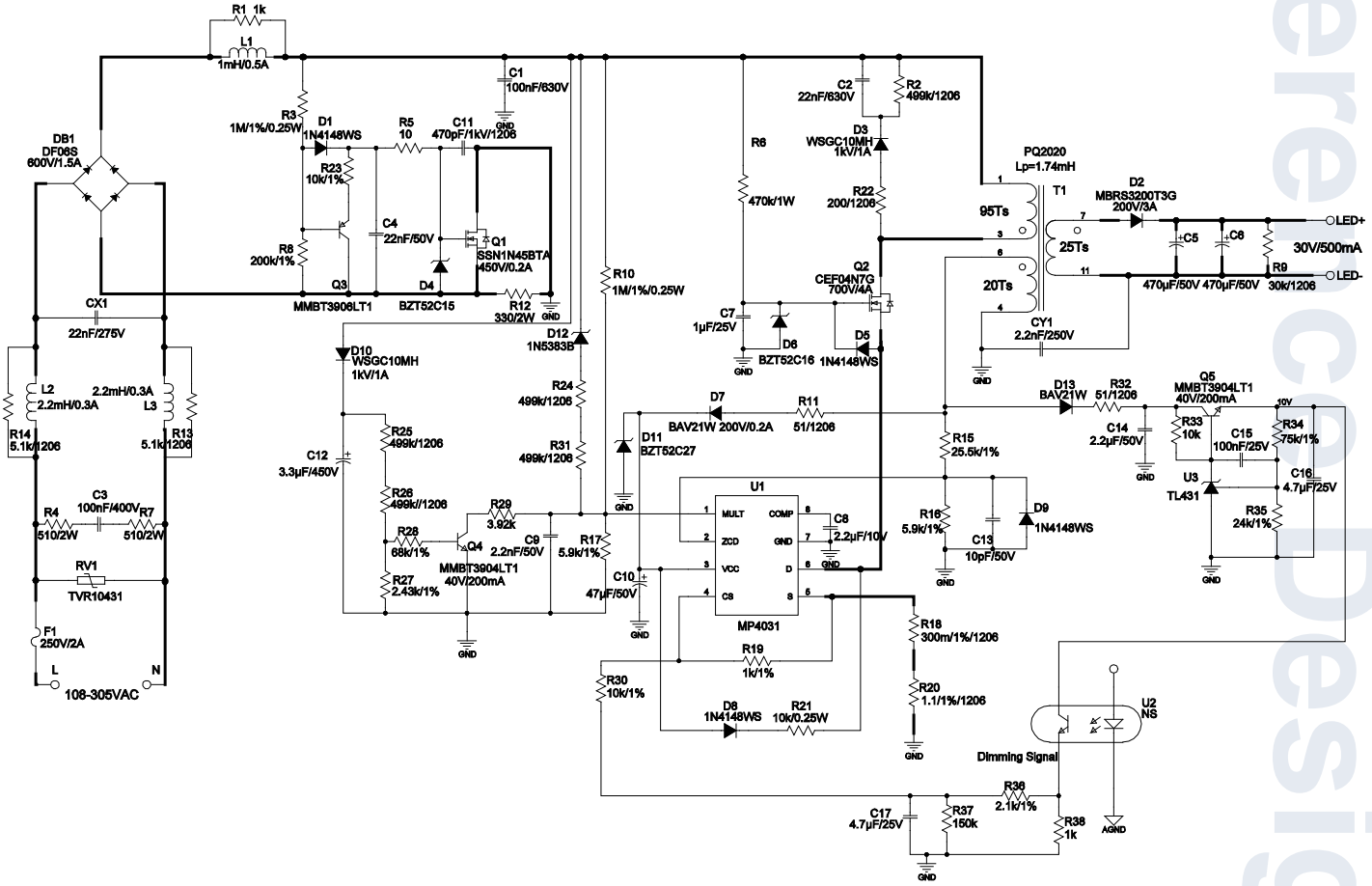
- Solid-State Lighting, including:
- Industrial and Commercial Lighting
- Residential Lighting



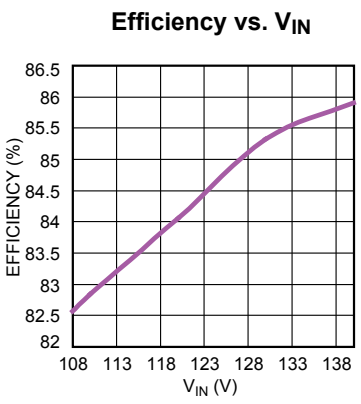


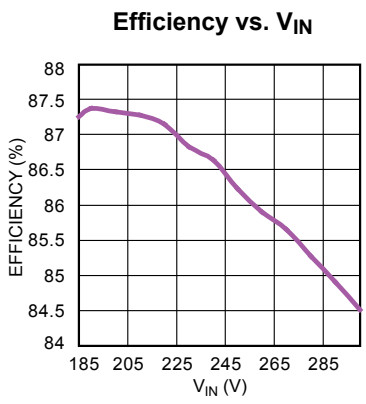
Reference Design:
MP4031 – 16W PSR Flyback with PFC TRIAC and Analog Dimming

Schematic: V_{IN} = 108V_{AC} to 305V_{AC} / V_{OUT} = 30V / I_{OUT} = 530mA

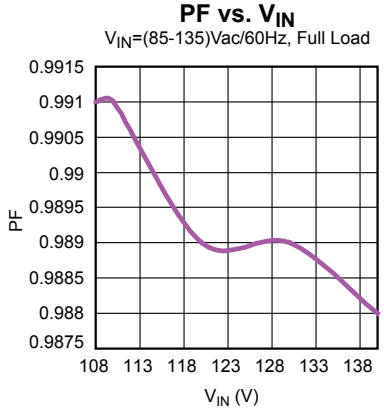


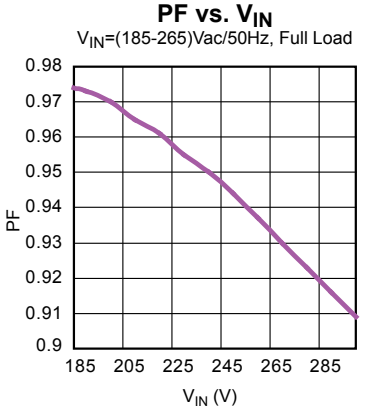
Efficiency vs VIN





PF vs VIN



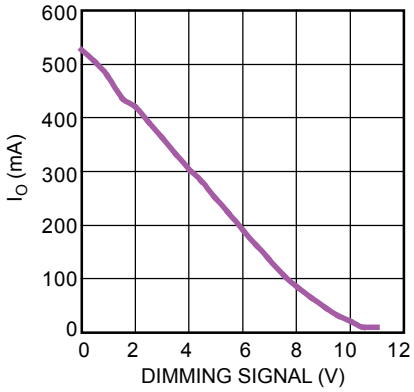


Reference Design

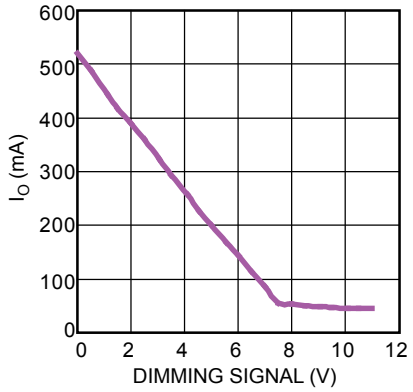
Reference Design

Analog Dimming

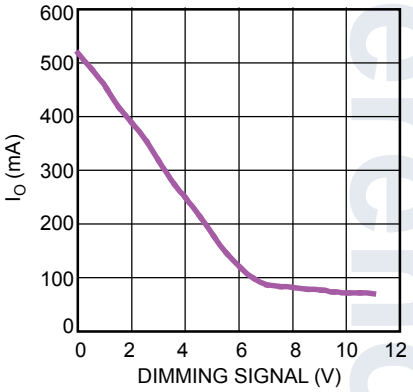
Analog Dimming Curve @ 110 Vac



Analog Dimming Curve @ 220 Vac



Analog Dimming Curve @ 265 Vac



Efficiency, PF and THD

f (Hz)	Vin(V)	Pin(W)	Vout(V)	Iout(mA)	Pout(W)	Efficiency(%)	PF	THD(%)
60	108	19.11	29.83	529	15.78007	82.6	0.991	11.6
	110	19.05	29.83	529	15.78007	82.8	0.991	11.7
	120	18.69	29.81	527	15.70987	84.1	0.989	12.4
	130	18.37	29.8	526	15.6748	85.3	0.989	12.8
	140	18.17	29.79	524	15.60996	85.9	0.988	13
f (Hz)	**Vin(V)**	**Pin(W)**	**Vo(V)**	**Io(mA)**	**Po(W)**	**Efficiency(%)**	**PF**	**THD(%)**
50	185	17.81	29.77	522	15.53994	87.3	0.974	15.3
	190	17.78	29.76	522	15.53472	87.4	0.973	15.4
	200	17.79	29.76	522	15.53472	87.3	0.97	15.6
	210	17.8	29.76	522	15.53472	87.3	0.965	15.8
	220	17.82	29.75	522	15.5295	87.1	0.961	16.4
	230	17.88	29.74	522	15.52428	86.8	0.955	16.8
	240	17.92	29.74	522	15.52428	86.6	0.95	17.9
	250	18.01	29.75	522	15.5295	86.2	0.944	18.1
	260	18.08	29.75	522	15.5295	85.9	0.937	18.6
	270	18.16	29.74	523	15.55402	85.6	0.93	18.7
	280	18.24	29.74	523	15.55402	85.3	0.923	18.8
	290	18.32	29.74	523	15.55402	84.9	0.916	18.9
	300	18.44	29.74	524	15.58376	84.5	0.909	19

MP4032-1 – Isolated 500V Integrated MOSFET, High-Power Factor, Dimmable Offline LED Driver

Overview

The MP4032-1 is a TRIAC-dimmable, primary-side controlled, offline, LED lighting driver. It has an integrated 500V MOSFET. It can achieve a high power factor and accurate LED-current control for lighting applications in a single-stage converter. The proprietary real-current-control method can control the secondary-side LED current accurately using primary-side information. It can significantly simplify LED-lighting-system designs and increase efficiency by removing the secondary-feedback components and the current-sensing resistor.

The MP4032-1 integrates power-factor correction and works in boundary-conduction mode to reduce power loss. The internal charging circuit can take supply current from the DRAIN pin for fast start-up without a perceptible delay. The proprietary dimming control extends the TRIAC-based dimming range. The multiple protection functions greatly enhance system reliability and safety, and include VCC UVLO, LED over-voltage/over-current protection, short-circuit protection, and over-temperature protection.

Features

High-Performance

- Integrated 500V MOSFET
- 500V Fast Start-Up
- TRIAC Dimmable–Dimming Curve Meets Standard SSL6
- Wide Dimming Range
- High-Power Factor
- Good Line Regulation, Good Current Accuracy

Low-Cost

- Primary-Side Control Eliminates Secondary-Side Feedback Components and the Optocoupler
- Integrated MOSFET with SOIC8-7 Package

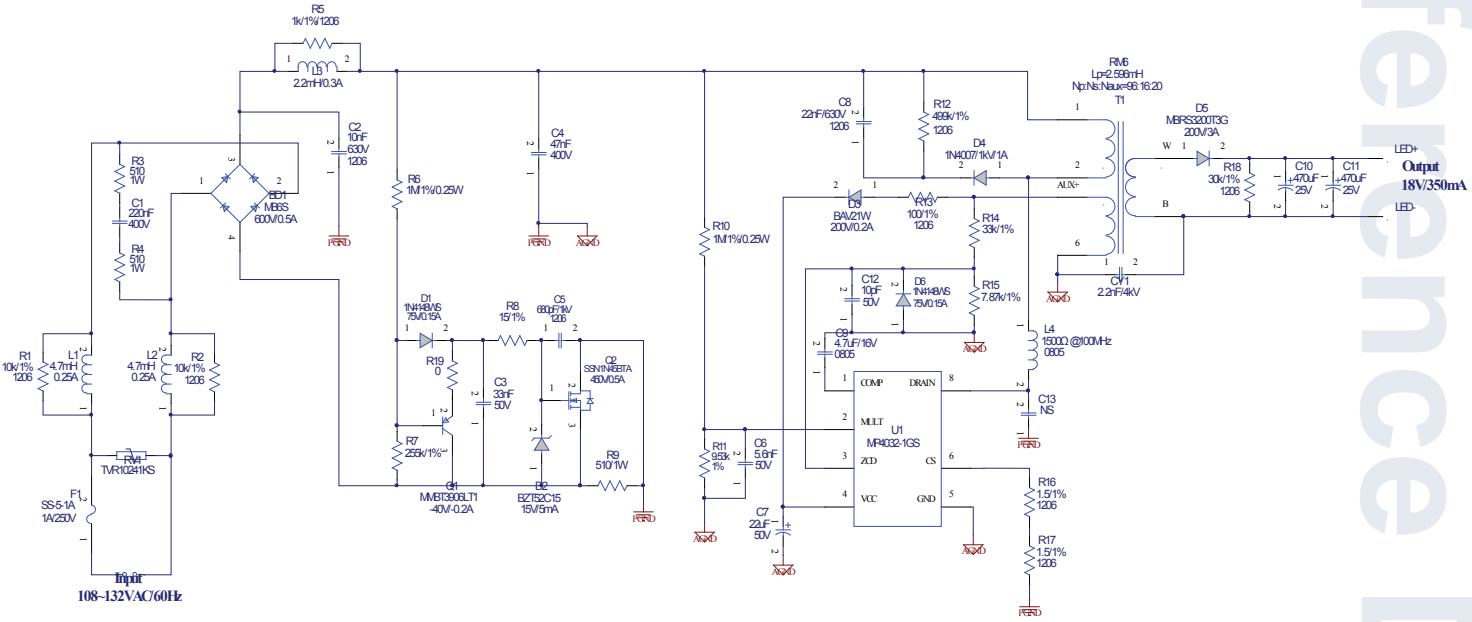
Rich Protection

- Cycle-by-Cycle Current-Limit
- Programmable Primary-Side Over-Current Protection
- Over-Voltage Protection
- Short-Circuit Protection



Reference Design:
MP4032-1 – 6.5W Flyback High-Power Factor LED Bulb

Schematic: V_{IN} = 105V_{AC} to 135V_{AC} / V_{OUT} = 18V / I_{OUT} = 350mA



Performance Data Efficiency, PF, and THD

f (Hz)	V_{IN} (V_{AC})	I_{IN} (mA)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
60	108	74	7.97	18.46	354.5	6.544	82.11	0.991	8.9
	110	72	7.92	18.44	353.6	6.52	82.33	0.99	8.9
	115	69	7.86	18.43	353.3	6.511	82.84	0.987	9
	120	66	7.81	18.42	353.3	6.508	83.33	0.984	9.1
	125	63	7.79	18.42	353.4	6.51	83.56	0.981	9.2
	130	61	7.76	18.41	353.4	6.506	83.84	0.977	9.2
	132	60	7.75	18.41	353.3	6.504	83.93	0.975	9.2

Dimming Compatibility

Manufacturer	Part Number	Power Stage	I_{MAX} (mA)	I_{MIN} (mA)	Dimming Ratio	Min Start Current (mA)
LUTRON	6B38-DVLV-600P	600W	333	6	1.80%	6
LUTRON	6B38-DV-603PG	600W	241	5	2.07%	5
LUTRON	6B38-S-600P	600W	330	1	0.30%	1
LUTRON	6B38-S-603PG	600W	246	2	0.81%	2
LUTRON	S-600	600W	357	1	0.28%	1
LUTRON	SLV-600P	600W	341	6	1.76%	6
LUTRON	6B38-GL-600-IV	600W	356	8	2.25%	8
LUTRON	NTLV-600-AL	600W	355	6	1.69%	6

Reference Design

MP4033 – TRIAC Dimmable, Primary-Side Control Offline LED Controller with Active PFC

NEW

Overview

The MP4033 is a single-stage LED controller that enables high-performance, TRIAC dimmable, and low-cost incandescent replacement LED lamps. The MP4033 is suitable for both isolated solution (Flyback) and non-isolated solution (Low-Side Buck-Boost). When used in isolated applications, the MP4033 precisely regulates LED current based on primary-side information of the transformer, thereby achieving cost savings by eliminating secondary-side feedback components and the opto-coupler.

The MP4033 implements active power-factor correction. In order to reduce MOSFET switching loss, the controller works in boundary conduction mode. The MP4033 employs adaptive dimmer type detection and proprietary dimming control to achieve good dimmer compatibility and deep-dimming range.

In addition to MP4033's rich LED protection features, the controller also includes an integrated charging circuit at the supply pin for fast start-up without a perceptible delay. It also provides an additional PWM dimming interface which can be utilized to achieve advanced dimming such as color temperature control.



Features

High-Performance

- Good Dimmer Compatibility and Deep-Dimming Range with Optional PWM Dimming.
- High-Power Factor
- Accurate Line & Load Regulation
- Fast Start-Up Without Perceptible Delay
- Programmable Current Fold-Back to Prolong the LED Lifetime (NTC)

Low-Cost

- Primary-Side Control Without Requiring a Secondary-Side Feedback Circuit
- Minimal External Components Required to Achieve Good TRIAC Dimming Performance

Rich Protection

- Cycle-by-Cycle Current-Limit
- Winding Short-Circuit Protection
- Output Over-Voltage Protection
- Output Short-Circuit Protection
- ZCD Pin Short-Circuit Protection
- Over-Temperature Protection

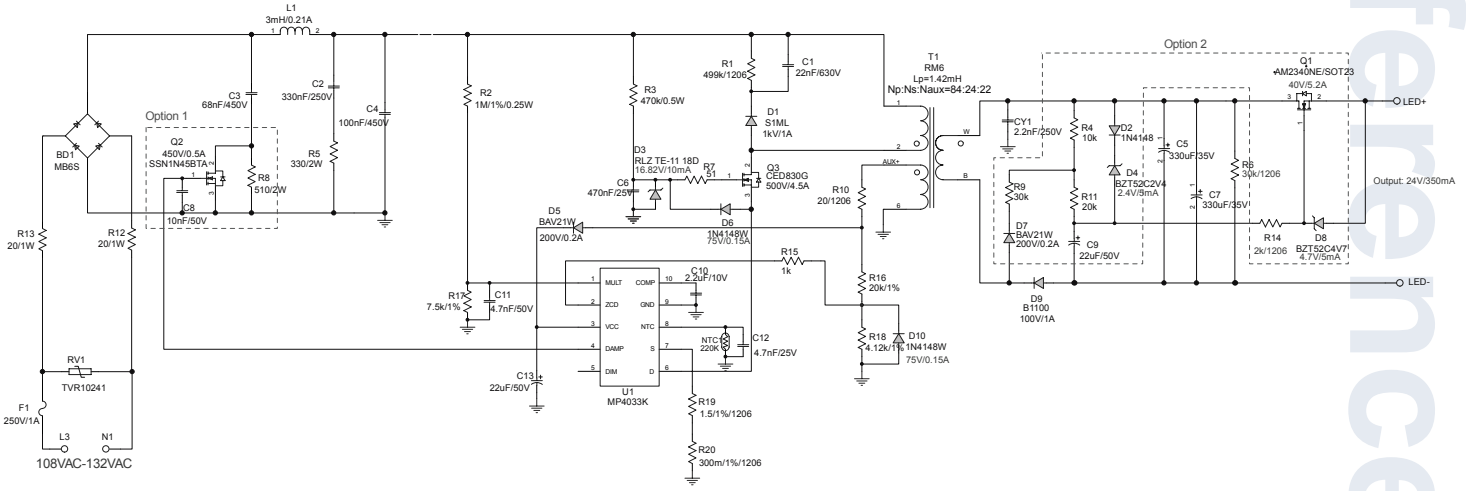
Applications

- Solid-State Lighting
- Industrial and Commercial Lighting
- Residential Lighting



Reference Design:
MP4033 – 8.4W, 108V to 132V Low-Line

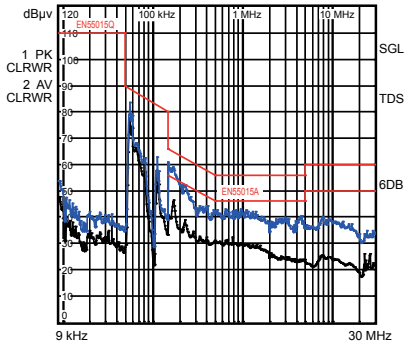
Schematic: V_{IN} = 108$_{VAC}$ to 132V_{AC} / 60Hz V_{OUT} = 24V / I_{OUT} = 350mA



Performance Data

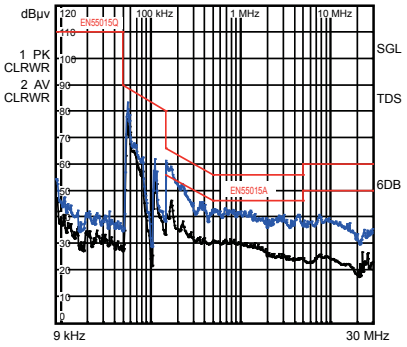
Conducted EMI L-Line

V_{IN} = 120V_{AC}/60Hz, Full Load,
RBW = 9kHz, MT = 20ms



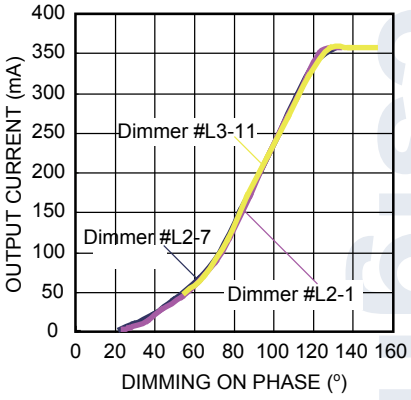
Conducted EMI N-Line

V_{IN} = 120V_{AC}/60Hz, Full Load,
RBW = 9kHz, MT = 20ms



Dimming Curve

V_{IN}=120V_{AC}/60Hz, Full Load,
with Different Dimmers



Efficiency, PF, and THD

f (Hz)	V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
60	90	10.24	23.62	353	8.34	81.42	0.985	12.1
	100	10.1	23.62	354	8.36	82.79	0.978	13.7
	110	10	23.62	355	8.39	83.85	0.97	14.6
	120	9.98	23.62	356	8.41	84.26	0.96	16
	132	9.96	23.62	357	8.43	84.66	0.945	17.5
	130	7.76	18.41	353.4	6.506	83.84	0.977	9.2

Reference Design

Reference Design:
MP4033 – 8.4W, 108V to 132V Low-Line

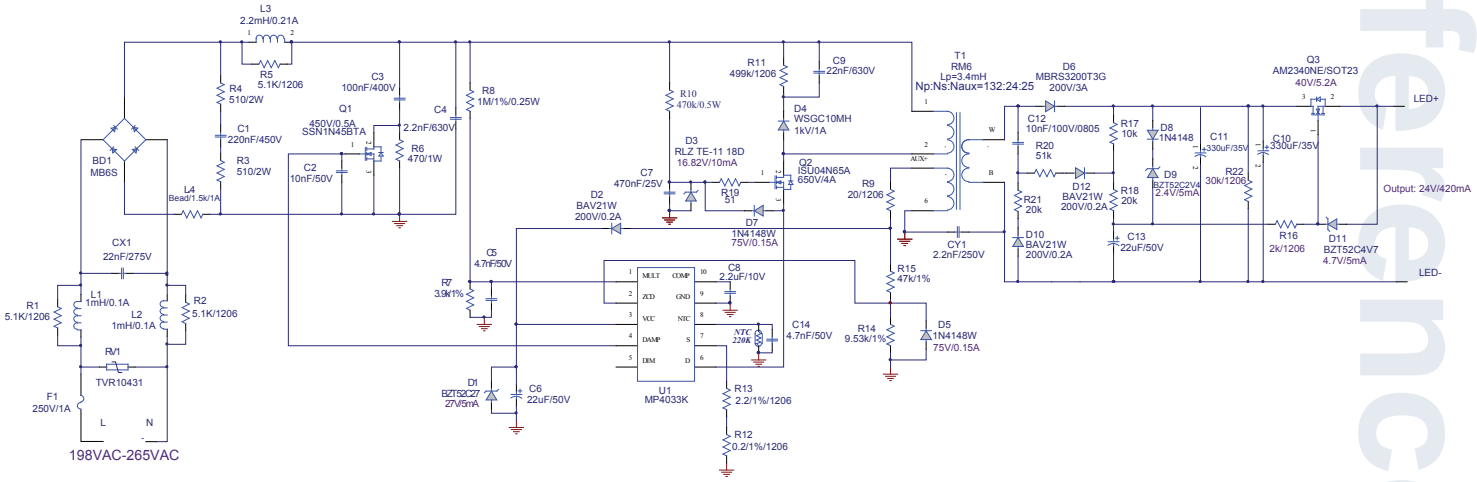
Dimming Compatibility

Manufacturer	Part Number	Power Stage	I_{MAX} (mA)	I_{MIN} (mA)	Dimming Ratio
LUTRON	Q-600P-IV	600W	357	22	6.16%
LUTRON	CN-600P	600W	357	11	3.08%
LUTRON	AY-600P	600W	356	17	4.78%
LUTRON	SLV-600P	600W	356	13	3.65%
LUTRON	LG-600P	600W	356	9	2.53%
LUTRON	6B38-Q-600P	600W	355	19	5.35%
LUTRON	GL-600H-DK	600W	358	5	1.40%
LEVITON	1G40O5	600W	358	0	0.00%
LEVITON	1I20O5	600W	357	0	0.00%
LUTRON	GLV02-F06392	600W	358	0	0.00%
LEVITON	6633-P	600W	357	0	0.00%
LUTRON	6B38-S-600P	600W	358	3	0.84%
LUTRON	CT-600P	600W	354	4	1.13%
LUTRON	6B38-S-603PG	600W	297	5	1.68%
LUTRON	6B38-DV-600P	600W	354	4	1.13%
LUTRON	DVCL-153P	600W	357	42	11.76%
LUTRON	6B38-DVLV-600P	600W	354	13	3.67%
LEVITON	1L10O5	600W	357	0	0.00%
LUTRON	GLS01-C06570	600W	302	0	0.00%
LUTRON	DV-600P-BR	600W	354	7	1.98%
LEVITON	6613-PL	600W	357	0	0.00%
LEVITON	C20-6684-IW	600W	356	0	0.00%
LUTRON	AY-600P-LA	600W	355	27	7.61%
LUTRON	TG-600PH-WH	600W	354	21	5.93%
LUTRON	TG-603GH-WH	600W	261	18	6.90%
LUTRON	S-600	600W	357	6	1.68%
LUTRON	DVPDC-203P-WH	200W	357	63	17.65%
LUTRON	S-600P	600W	357	3	0.84%
LUTRON	6B38-DV-603PG	600W	284	12	4.23%
LUTRON	DNG-603PH-WH	400W	357	0	0.00%
COOPER	6B28	600W	357	0	0.00%
LEVITON	6633-P-1G10O5	600W	357	2	0.56%

Reference Design

Reference Design:
MP4033 – 10W, 198V to 265V High-Line

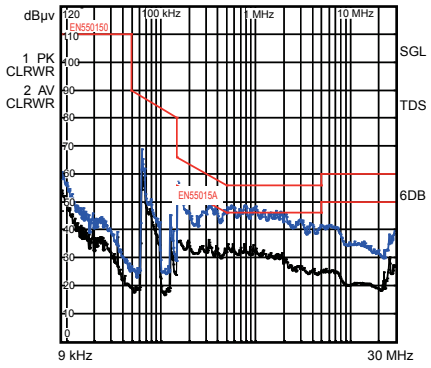
Schematic: V_{IN} = 198V_{AC} to 265V_{AC} / 50Hz V_{OUT} = 24V / I_{OUT} = 420mA



Performance Data

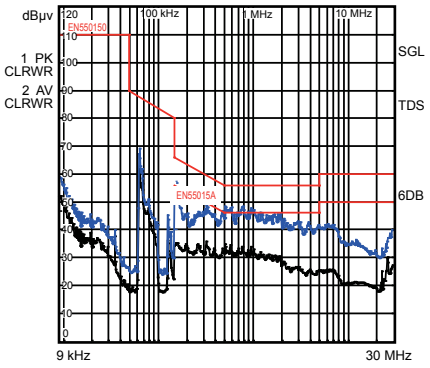
Conducted EMI L-Line

V_{IN} = 230V_{AC}/50Hz, Full Load,
RBW = 9kHz, MT = 20ms



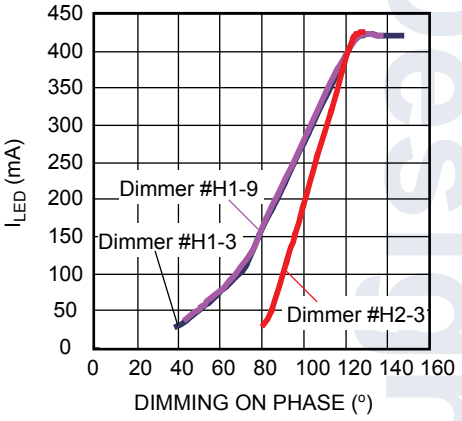
Conducted EMI N-Line

V_{IN} = 230V_{AC}/50Hz, Full Load,
RBW = 9kHz, MT = 20ms



Dimming Curve

V_{IN}=120V_{AC}/60Hz, Full Load,
with Different Dimmers



Efficiency, PF, and THD

f (Hz)	V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
50	198	11.53	23.24	419	9.74	84.45	0.938	17
	210	11.55	23.24	420	9.76	84.51	0.925	19
	220	11.57	23.23	421	9.78	84.53	0.914	20.1
	230	11.61	23.23	422	9.8	84.44	0.902	21.1
	240	11.65	23.23	422	9.8	84.15	0.89	22.6
	250	11.7	23.23	423	9.83	83.99	0.877	23.4
	260	11.75	23.23	424	9.85	83.83	0.864	24.8
	265	11.78	23.23	424	9.85	83.61	0.857	25.5

Reference Design

Reference Design:
MP4033 – 10W, 198V to 265V High-Line

Dimming Compatibility

Manufacturer	Part Number	Power Stage	Dimming Type	I_{MAX} (mA)	I_{MIN} (mA)	Dimming Ratio
GIRA	0302 00/I01	60-600W	Leading	533	30	5.63%
MIKA	433/4	60-400W	Leading	531	91	17.14%
Berker	283010	60-400W	Leading	531	43	8.10%
JUNG	225 NV DE	20-500W/VA	Leading	531	22	4.14%
JUNG	225 NV DE	20-500W/VA	Leading	532	105	19.74%
Berker	286610	20-500W	Leading	531	40	7.53%
JUNG	266 GDE	60-600W	Leading	527	33	6.26%
EMC	PROP400U	40-400W	Leading	531	28	5.27%
Busch	2247U	500W/VA	Leading	531	50	9.42%
Busch	2200..	60-400W	Leading	530	54	10.19%
Busch	6513 U-102	420W/VA	Trailing	531	50	9.42%
Grundtyp	ET1_53850	25~300W	Trailing	445	40	8.99%
MIKA	433 HAB	20-315W	Trailing	406	46	11.33%
MIKA?	EIM-585	20-300W	Trailing	458	1	0.22%
Busch	6591U-101	420W/VA	Trailing	462	39	8.44%
Busch	6519U	550W/VA	Trailing	527	50	9.49%
JUNG	225 TDE	20-525W	Trailing	504	44	8.73%
SIEMENS	5TC8 284	20-600W	Trailing	481	30	6.24%
LICHTREGLER	T46s	20~315W	Trailing	514	61	11.87%
JUNG	254 UDIE 1	50-420W/VA	Trailing	527	71	13.47%
Berker	286110	50-420W	Trailing	526	72	13.69%

Reference Design

Reference Design:
MP4033 – 10W, 198V to 265V High-Line

Electric Strength Test

Primary circuit to secondary circuit electric strength testing was completed according to IEC61347-1 and IEC61347-2-13. The input and output was shorted respectively. The 3750V_{AC}/50Hz sine wave applied between input and output for 1 min, and operation was verified.

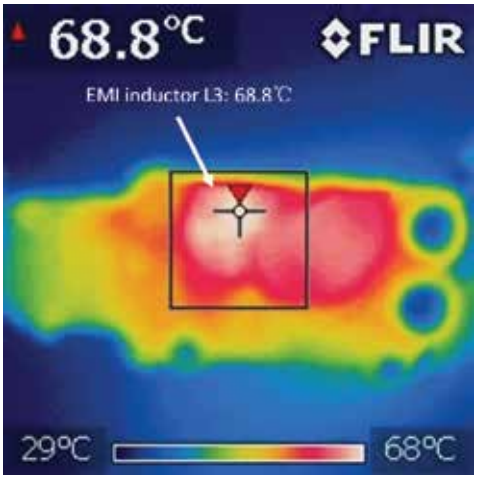
Surge Test

Line-to-Line 500V and Line-to-Power Earth 1kV surge testing was completed according to IEC61547. The input voltage was set at 230V_{AC}/50Hz. The output was loaded at full-load and operation was verified following each surge event.

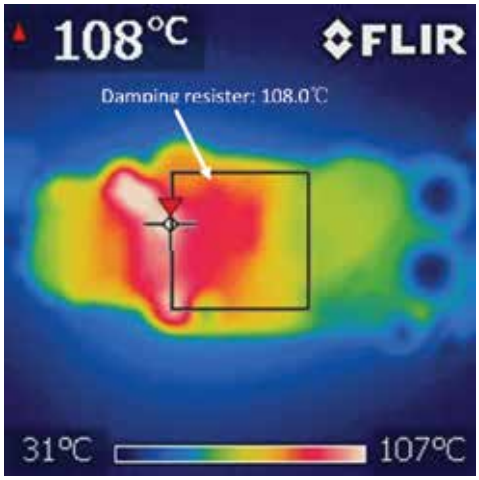
Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
500	230	L to N	90	Pass
-500	230	L to N	270	Pass
1000	230	L to PE	90	Pass
-1000	230	L to PE	270	Pass
1000	230	N to PE	90	Pass
-1000	230	N to PE	270	Pass

Thermal Test

Test without dimmer and with dimmer at 90% dimming on phase.



Without Dimmer



With Dimmer at 90% Dimming on Phase

Reference Design

MP4034 – Isolated Primary-Side Regulator with Integrated 700V MOSFET

Overview

The MP4034 is an offline regulator that provides accurate constant-current regulation. The LED driver circuit design is simplified by removing the optocoupler and the secondary feedback components.

The MP4034 has an integrated 700V MOSFET. Its variable off-time control allows a flyback converter to operate in discontinuous conduction mode (DCM). The MP4034 also features complete protection functions such as VCC under-voltage lockout, over-voltage protection, over-temperature protection, and open-loop protection.

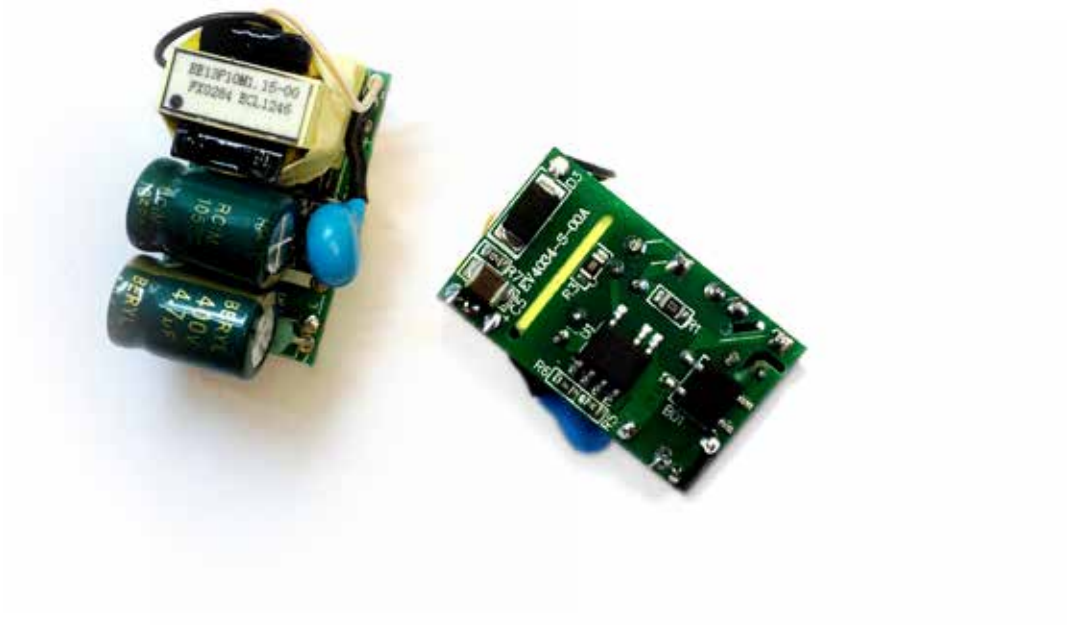
The MP4034's variable switching frequency provides natural spectrum shaping to smooth the EMI signature, which can reduce the EMI filter's size and cost.

Features

High-Performance
- Precise Constant-Current Control (CC) 6%
- Variable Off-Time Peak-Current Control
- 600μA High-Voltage Current Sense
- Natural Frequency Dithering for Improved EMI Signature
- Programmable Cable Compensation

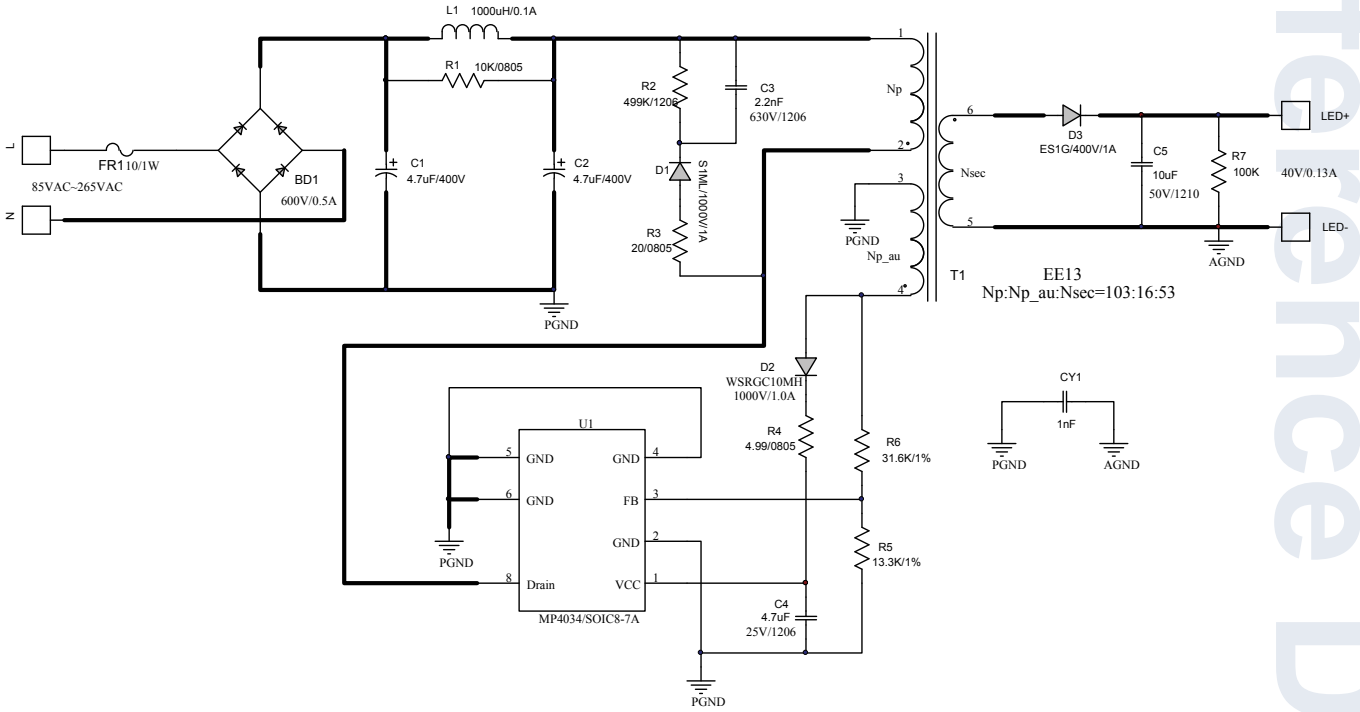
Low-Cost
- Primary-Side Control Elimination Secondary-Side Feedback Components and Optocoupler
- Integrated 700V MOSFET with Minimal External Components
- SOIC-7 and TSOT23-5 Packages

Rich Protection
- Over-Voltage Protection
- Open-Loop Protection
- Short-Circuit Protection
- Over-Temperature Protection



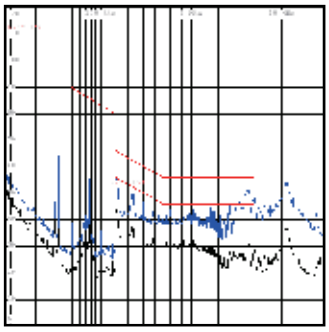
Reference Design:
MP4034 – 5.2W Flyback LED Application

Schematic: V_{IN} = 85V_{AC} to 265V_{AC} / V_{OUT} = 28V / I_{OUT} = 130mA

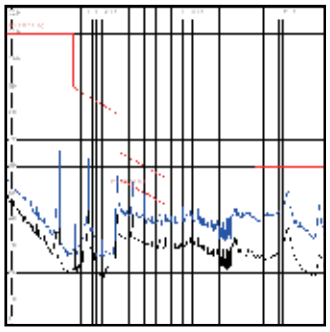


Conducted EMI Test

Conducted EMI Test
230Vac, 50Hz, Maximum Load, L Line, EN55015 Limits



Conducted EMI Test
115Vac, 60Hz, Maximum Load, L Line, EN55015 Limits



Conducted EMI Test

f (Hz)	V_{IN} (VAC)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)
50	85	6.27	38.9	131	5.11	81.4
	115	6.21	38.9	133	5.17	83.2
	150	6.16	38.9	135	5.24	85.1
60	180	6.26	38.9	136	5.29	84.5
	210	6.44	38.9	138	5.36	83.2
	230	6.43	38.9	136	5.3	82.4
	265	6.53	38.9	136	5.3	81.1

Reference Design

Product Overview

MP44010+HR1000A – Isolated Boundary Mode PFC and Resonant Half-Bridge Controller

MP44010 – Isolated Boundary Mode PFC Controller

Overview

The MP44010 is a boundary conduction mode PFC controller which can provide simple and high performance active power factor correction using minimum external components.

The output voltage is accurately regulated by a high performance voltage mode amplifier with an accurate internal voltage reference.

The precise adjustable output over-voltage protection greatly enhances the system reliability.

The on-chip R/C filter on the current sense pin can eliminate the external R/C filter.

The extremely low start-up current, quiescent current and the disable function can reduce the power consumption and result in excellent efficiency performance.

Features

- Boundary Conduction Mode PFC Controller for Pre-Regulator
- Zero-crossing Compensation to Minimum THD of AC Input Current
- Precise Adjustable Output Over-voltage Protection
- Ultra-low (15μA) Start-up Current
- Low (0.46mA) Quiescent Current
- On-chip Filter on Current Sense Pin
- Disable Function
- -600/+800mA Peak Gate Drive Current
- Available in SOIC8 and DIP-8 Packages

Applications

- Offline Adaptor
- Electronic Ballast
- LLC Front End
- Other PFC Pre-Regulators

MP44010+HR1000A – Isolated Boundary Mode PFC and Resonant Half-Bridge Controller

MPHR1000A – Resonant Half-Bridge Controller

Overview

The HR1000A is a controller designed specifically for the resonant half-bridge topology. It provides two drive-signal channels that output complementary signals at a 50% duty cycle. An internal fixed dead-time of 350ns between the two complementary gate signals guarantees zero-voltage switching during the transient and enables high-frequency operation.

The integrated bootstrap diode simplifies the external driving circuit for the high-side switch. It can withstand up to 600V with immunity against high dv/dt noise.

Modulating the switching frequency regulates the topology output voltage. A programmable oscillator can set both the maximum and minimum switching frequencies. The IC starts up at the programmed maximum switching frequency and gradually slows until the control loop takes over to prevent excessive inrush current.

The IC can be forced to enter a controlled burst-mode operation at light-load to minimize the power consumption and tighten output regulation.

Protections features—including latched shutdown, auto-recovery, brown-out protection, and over-temperature protection—improve converter design safety without engendering additional circuit complexity.

The IC provide 1.5A/2A source/sink capability for both high-side and low-side gate drivers.

Features

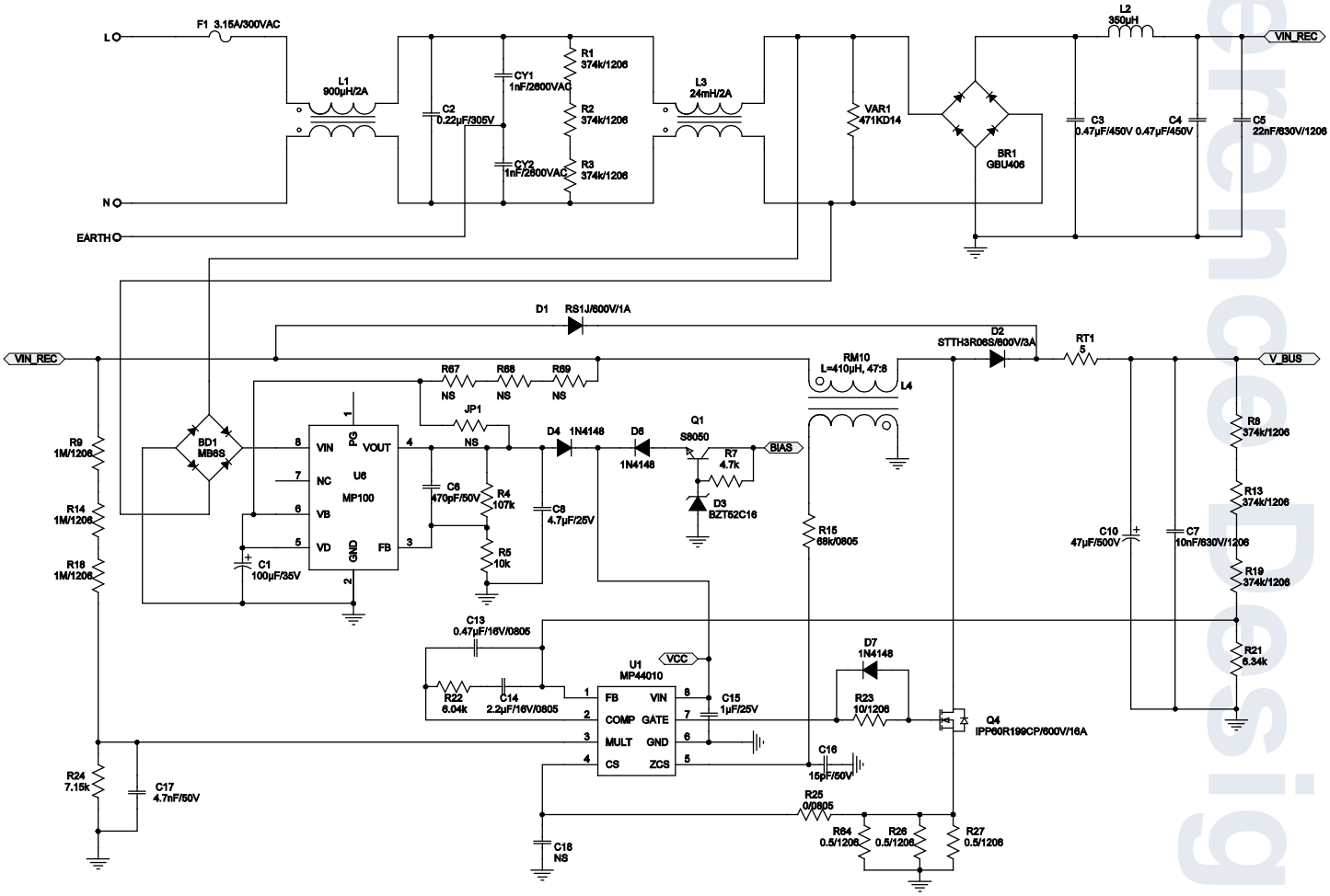
- 50% Duty Cycle, Variable Frequency Controller Resonant Half-Bridge Converter
- 600V High-Side Gate Driver with Integrated Bootstrap Diode and High dv/dt Immunity
- 1.5A/2A Source/Sink Capability for Both High-Side and Low-Side Gate Drivers
- High-Accuracy Oscillator
- Operates at up to 600kHz
- Two-Level Over-Current Protection: Frequency-Shift and Latched Shutdown with Programmable Duration Time
- Remote ON/OFF Control and Brown-Out Protection through the BO Pin
- Latched-Disable Input for Easy Protections Implementation
- Interfaces with PFC Controller
- Programmable Burst-Mode Operation at Light-Load
- Non-Linear Soft-Start for Monotonic Output Voltage Rise
- SO-16 package

Applications

- LCD and PDP TVs
- Desktop PCs and Servers
- Telecom SMPS
- AC/DC Adapter, Open-Frame SMPS
- Video Game Consoles
- Electronic Lighting Ballast

Reference Design:
MP44010+HR1000A – 90W LED Driver

PF Stage

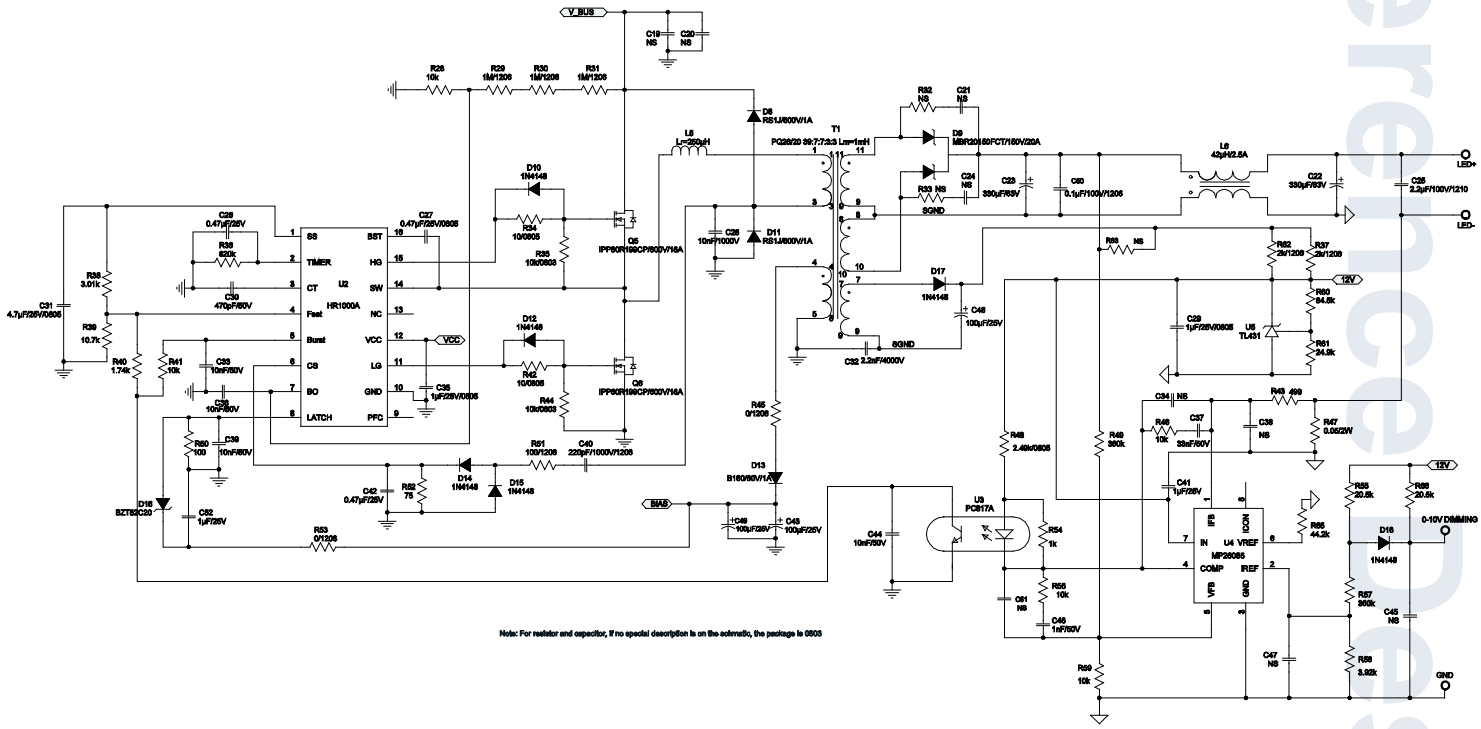


Note: For resistor and capacitor, if no special description is on the schmatic, the package is 0603

Reference Design

Reference Design:
MP44010+HR1000A – 90W LED Driver

LLC Stage



Reference Design

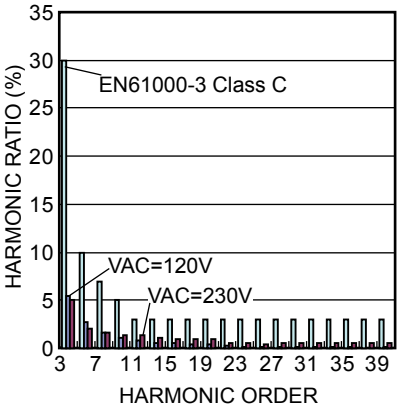
Reference Design: MP44010+HR1000A – 90W LED Driver

Performance Waveforms are Tested on the Evaluation Board

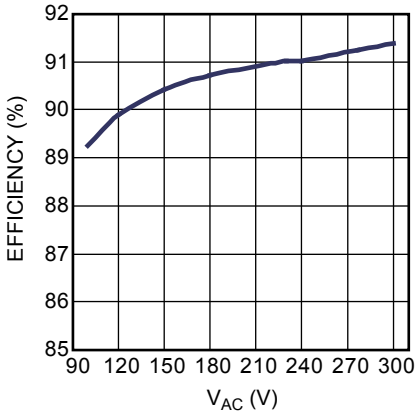
V_{AC} = 100V to 305V / I_{OUT} = 2.1A / P_{OUT} = 90W

Harmonic

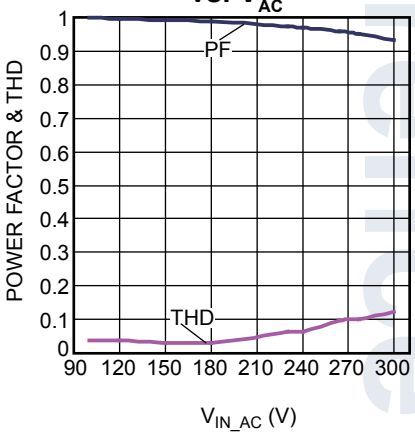
V_{AC}=120V & 230V, full load



Efficiency vs. V_{IN}

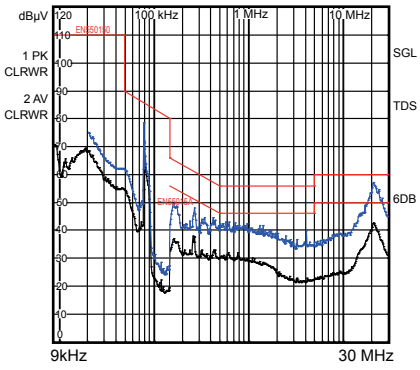


Power Factor & THD vs. V_{AC}



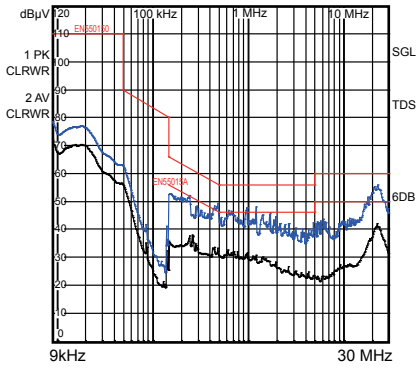
Conducted EMI

V_{AC}=115V, full load

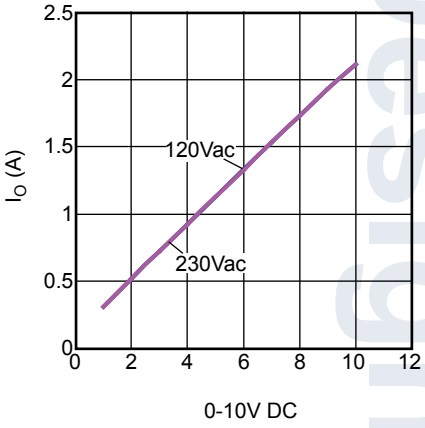


Conducted EMI

V_{AC}=230V, full load



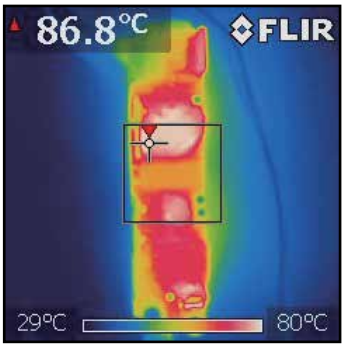
I_O vs. 0-10V DC (0-10V Dimming)



Thermal Figure

V_{AC}=100V, Full Load, T_A=28ºC

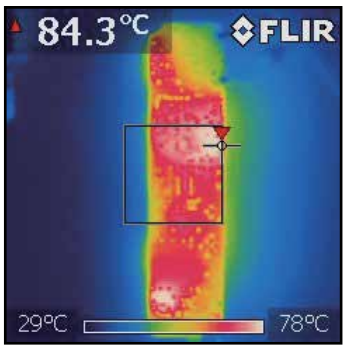
Top view



Thermal Figure

V_{AC}=100V, Full Load, T_A=28ºC

Bottom view



Reference Design

MP4000 – Non-Isolated Offline LED Controller

Overview

The MP4000 is a high-efficiency, step-down converter that drives high-brightness LEDs. The MP4000 drives an external MOSFET in the floating-buck-converter structure. The inductor current is regulated in boundary-conduction mode, which features no reverse-recovery loss in the freewheeling diode and soft turn-on for the power MOSFET. This operation mode can achieve very high efficiency while minimizing the inductor value and size. The MOSFET peak current can regulate the LED current, which is sensed through an external resistor. Its low 300mV feedback voltage reduces power loss and improves efficiency.

The MP4000 can accept an external PWM or a DC signal for the burst-dimming control.

The MP4000 features output-short protection, a maximum-switching-frequency limit, UVLO, and thermal shutdown.

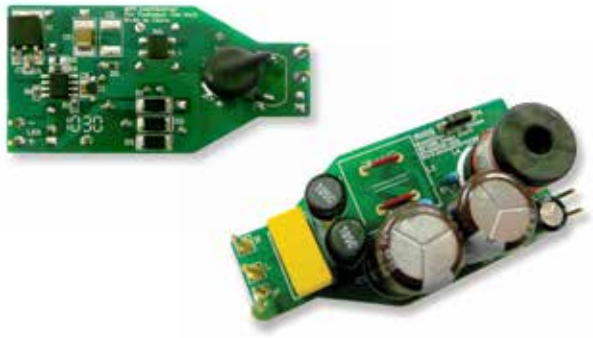
Features

- Constant-Current LED Driver
- Power MOSFET Zero-Current Turn-On
- No Freewheeling-Diode Reverse-Recovery Issues
- High-Efficiency and Reliability in Boundary Conduction Mode
- Low 0.9mA Operating Current
- PWM or DC Input-Burst Dimming Control
- Hiccup Short-Circuit Protection, UVLO, Thermal Shutdown
- Maximum Frequency Limited to 100kHz
- Available in a SOIC8 Package

Applications

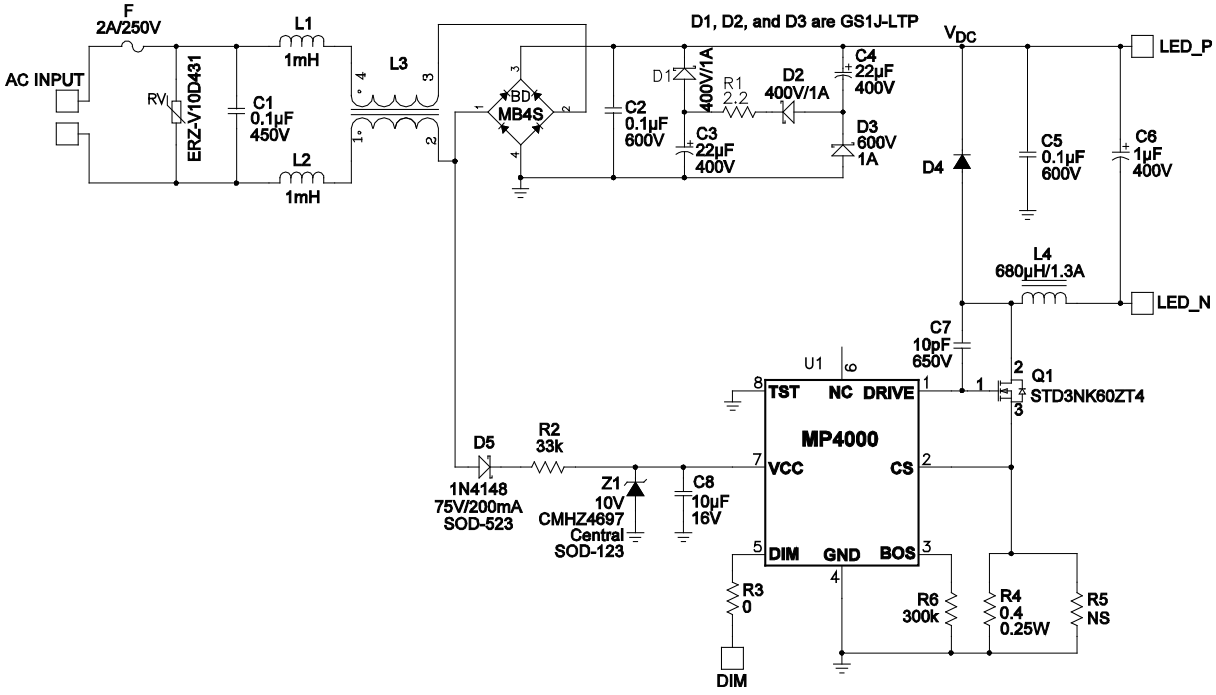
- DC/DC or AC/DC LED Driver Applications
- General Illumination
- Industrial Lighting
- Automotive/Decorative LED Lighting



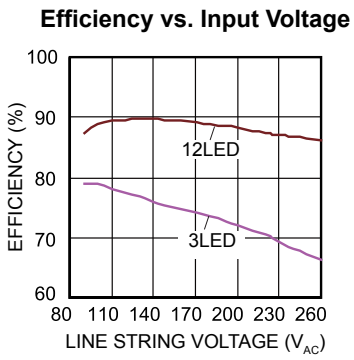


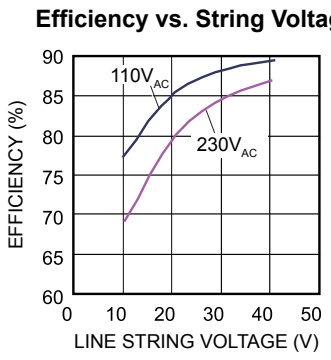
Reference Design:
MP4000 – 3.5W to 14W Universal Input WLED Driver with PFC

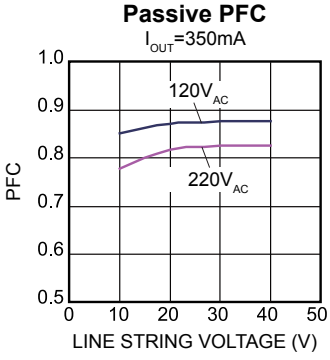
Schematic: V_{IN} = 90V to 265V_{AC} / V_{OUT} = 10V to 40V / I_{OUT} = 350mA



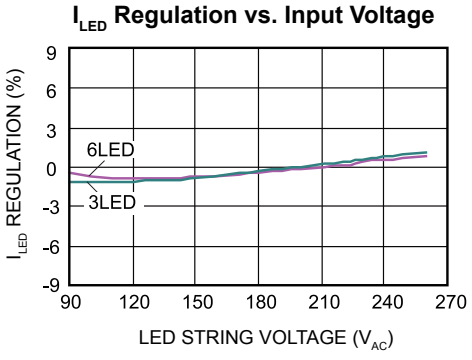
Efficiency and High PF vs. Input Voltage and Load

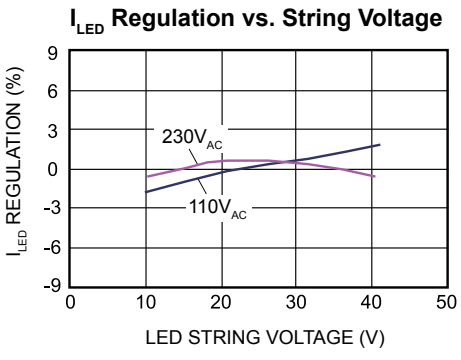






LED Current Regulation vs. Input Voltage and Load





MP4050 – Non-Isolated 500V Integrated MOSFET, High Brightness LED Driver

Overview

The MP4050 is a constant current LED driver integrated with an internal 500V MOSFET. It is specifically designed for energy efficient and low cost LED bulk replacement applications.

MP4050 is designed to drive high-brightness LEDs from an 85VAC to 265VAC line. It is also usable under DC input voltage. The accurate output LED current is achieved by an averaging internal current feedback loop. Constant LED current is delivered quietly by switching the internal MOSFET at a frequency regulated above 22kHz.

MP4050 can be directly powered by the high input voltage. An internal high voltage current source regulates supply voltage without external circuitry. MP4050 features various protections like Thermal Shutdown (TSD), VCC Under Voltage Lockout (UVLO), Open Lamp Protection and Short Lamp Protection. All of there features make MP4050 an ideal solution for simple, off-line and non-isolated LED applications.

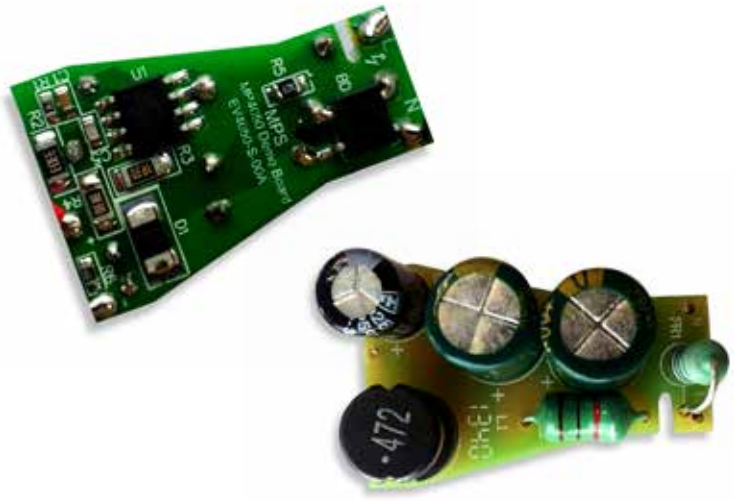
MP4050 is available in the TSOT23-5 and SOIC8 packages.

Features

- Constant Current LED Driver
- 500V/7.2Ω MOSFET integrated
- Low Vcc Operating Current
- Maximum frequency limit
- Audible noise restrain
- Internal High Voltage Current Source
- Internal 200ns Leading Edge Blanking
- Thermal Shutdown (auto restart with Hysteresis)
- VCC Under Voltage Lockout with Hysteresis (UVLO)
- Open Lamp Protection
- Short Lamp Protection

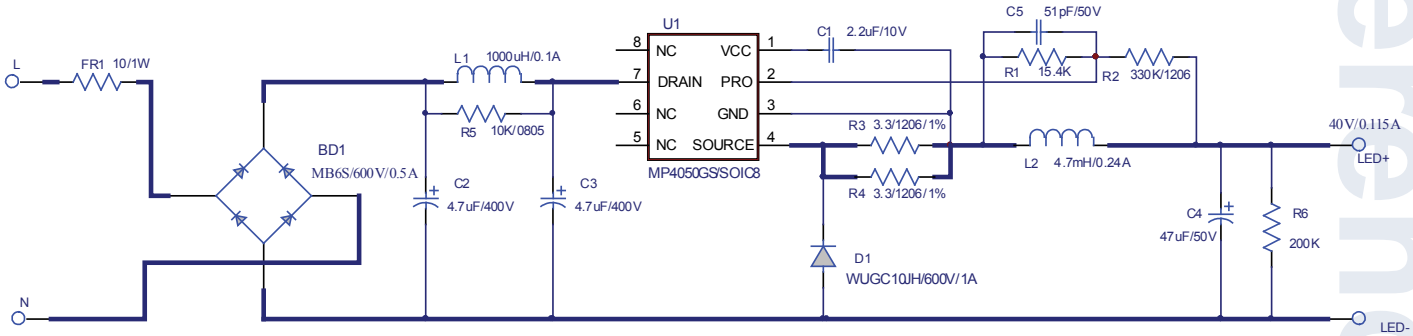
Applications

- AC/DC or DC/DC LED driver application
- General Illumination
- Industrial Lighting
- Automotive/Decorative LED Lighting



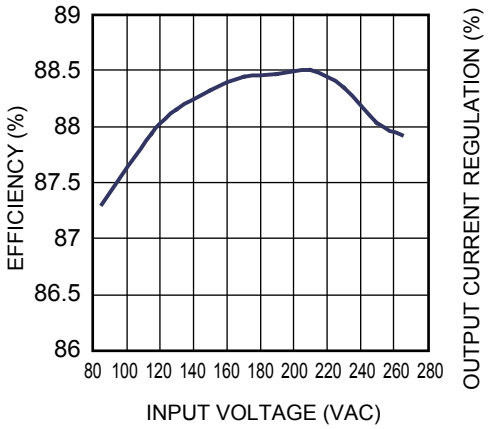
Reference Design:
MP4050 – 4.6W Universal Input Non-Isolated LED Driver

Schematic: V_{IN} = 85V_{AC} to 265V_{AC} / V_{OUT} = 40V / I_{OUT} = 115mA

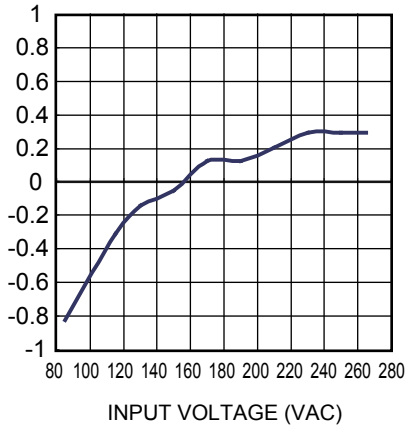


Efficiency and Output Current Regulation

Efficiency

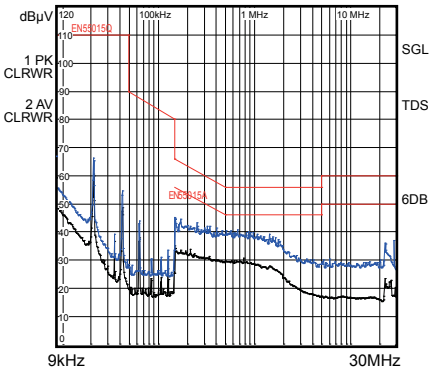


Output Current Regulation

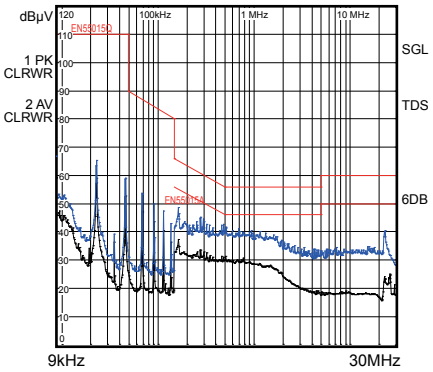


Conducted EMI

Conducted EMI
115V_{AC}/60Hz, Line Wire



Conducted EMI
230V_{AC}/50Hz, Line Wire



MP4051 – Non-Isolated Offline LED Controller for High-Power Factor LED Driver

Overview

The MP4051 is a non-isolated, offline, LED lighting controller that achieves a high power factor and accurate LED current for single-stage PFC lighting applications in a single SOIC8 package.

The MP4051 integrates power-factor correction and works in boundary-conduction mode to reduce MOSFET switching losses. The extremely low start-up current and quiescent current reduce the total power consumption and provides a highly-efficient solution for non-isolated lighting applications. The multiple protection features greatly enhance system reliability and safety, and include over-voltage protection, short-circuit protection, cycle-by-cycle current limiting, VCC UVLO, and auto-restart over-temperature protection.

Features

High-Performance

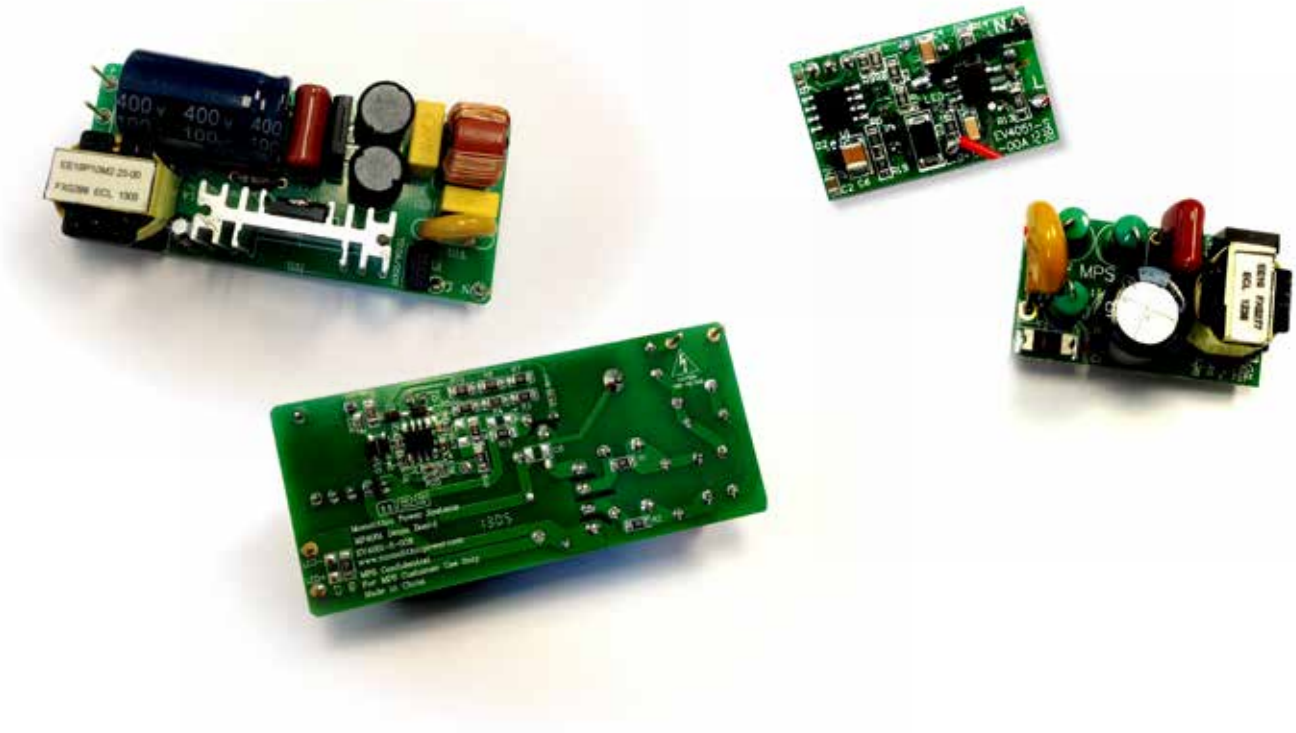
- High-Power Factor
- Good Line Regulation
- Good Current Accuracy

Low-Cost

- Non-Isolation Solution with Simple Circuit

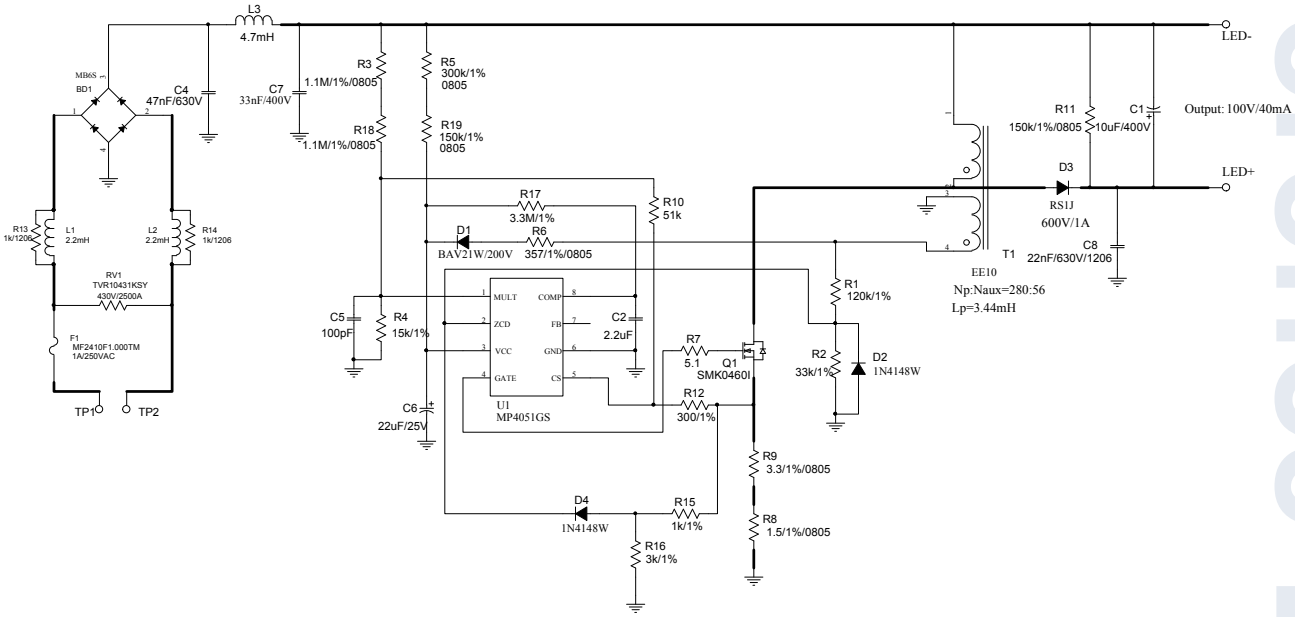
Rich Protection

- Cycle-by-Cycle Current-Limit
- Programmable Primary-Side Over-Current Protection
- Over-Voltage Protection



Reference Design:
MP4051 – 4W High-Side Buck-Boost PFC LED Driver

Schematic: V_{IN} = 85V_{AC} to 265V_{AC} / V_{OUT} = 100V / I_{OUT} = 40mA



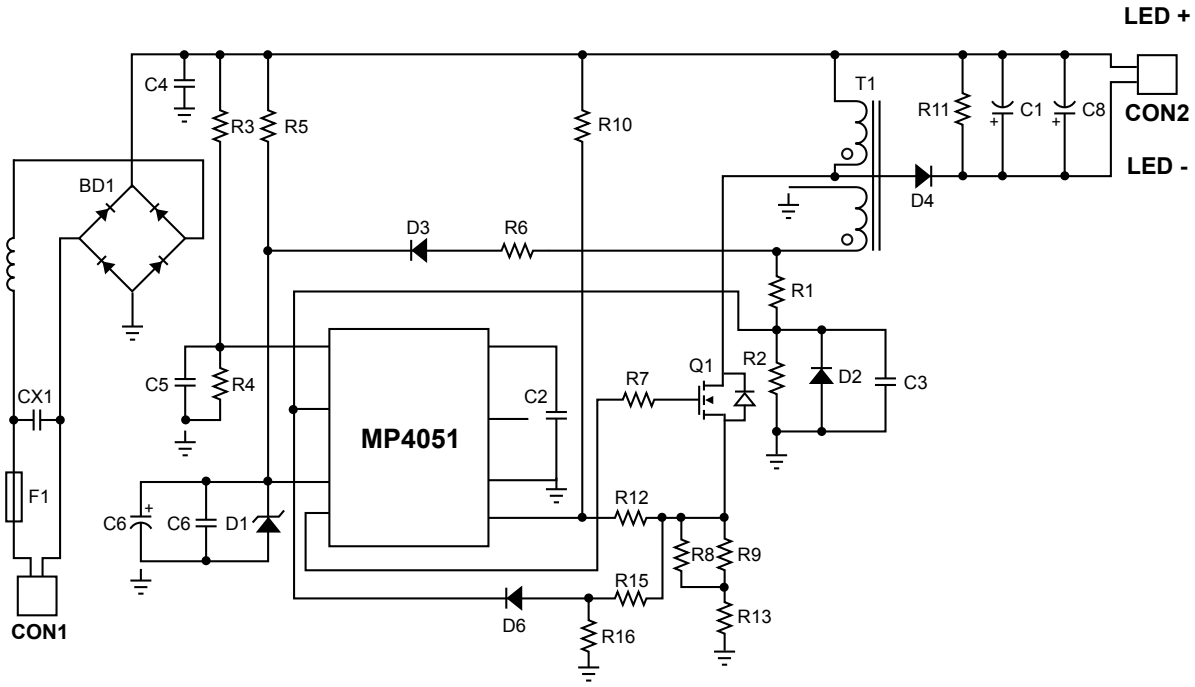
Performance Data

f (Hz)	V_{IN} (VAC)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
60	85	4.843	101.2	40.8	4.129	85.26	0.983	16.4
	95	4.802	101.2	40.9	4.139	86.19	0.984	15.3
	105	4.777	101.2	41.1	4.159	87.07	0.983	14.8
	115	4.765	101.2	41.2	4.169	87.5	0.982	14.5
	125	4.762	101.2	41.4	4.19	88	0.98	14
	135	4.771	101.2	41.5	4.2	88.03	0.978	14
	145	4.785	101.2	41.7	4.22	88.2	0.976	13.7
	155	4.798	101.2	41.8	4.23	88.16	0.974	13.9
	165	4.82	101.2	42	4.25	88.15	0.971	14.1
f (Hz)	V_{IN} (VAC)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF	THD (%)
50	175	4.841	101.2	42.1	4.26	88	0.968	14.3
	185	4.87	101.2	42.3	4.281	87.9	0.965	14.2
	195	4.899	101.2	42.5	4.301	87.79	0.962	14.2
	205	4.922	101.1	42.6	4.306	87.5	0.958	14.2
	215	4.954	101.1	42.7	4.316	87.14	0.954	14.3
	225	4.99	101.1	42.9	4.337	86.92	0.951	14.4
	235	5.028	101.1	43.1	4.357	86.66	0.946	14.5
	245	5.065	101.1	43.2	4.368	86.23	0.942	14.6
	255	5.106	101.1	43.4	4.388	85.93	0.938	14.6
	265	5.144	101.1	43.5	4.398	85.49	0.934	14.8

Reference Design

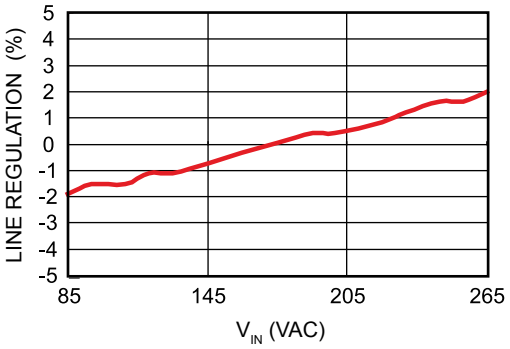
Reference Design:
MP4051 – 6W Low-Side Buck-Boost PFC LED Driver

Schematic: V_{IN} = 85V_{AC} to 265V_{AC} / V_{OUT} = 23V / I_{OUT} = 260mA

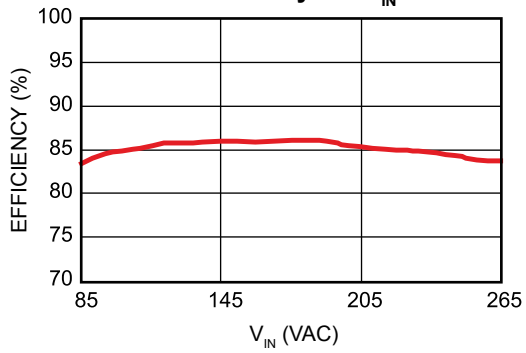


Constant Current, Efficiency and High-Power Factor

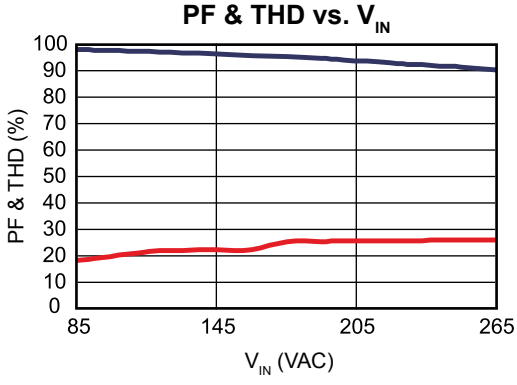
Line Regulation



Efficiency vs. V_{IN}

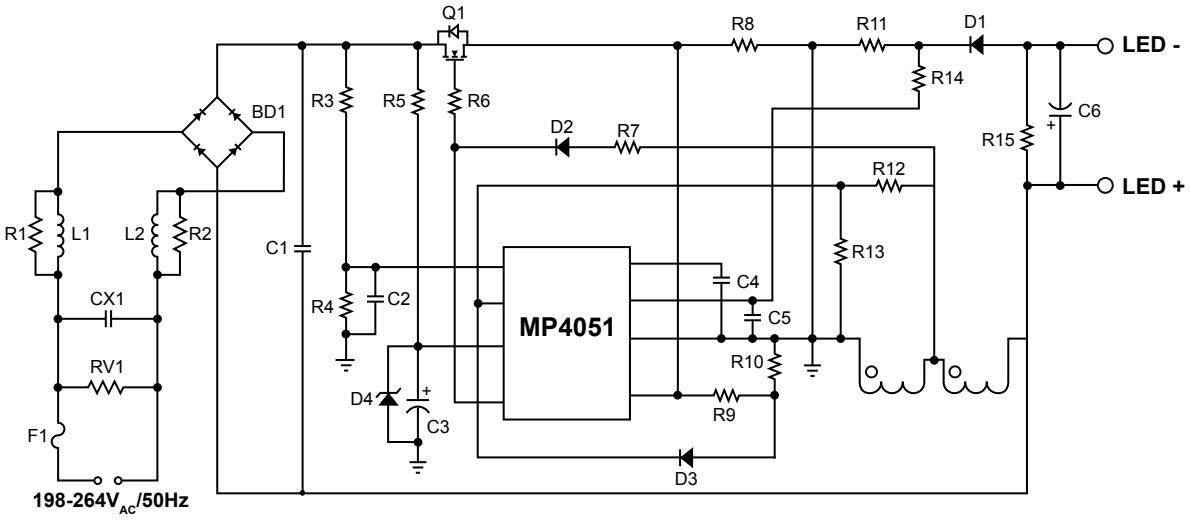


PF & THD vs. V_{IN}



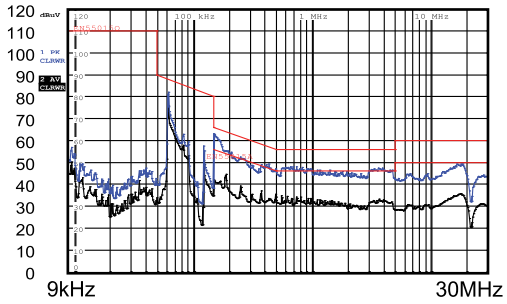
Reference Design:
MP4051 – 22.5W High-Side Buck-Boost PFC LED Driver

Schematic: V_{IN} = 198V_{AC} to 264V_{AC} / V_{OUT} = 225V / I_{OUT} = 100mA

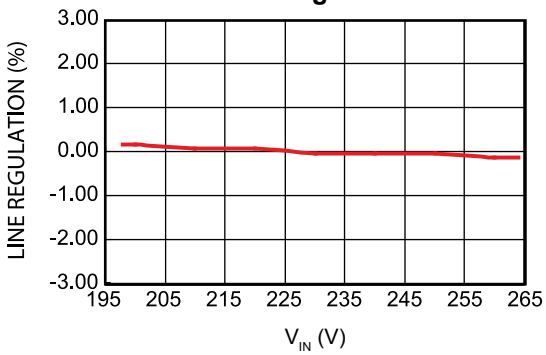


Conducted EMI (V_{IN} = 230V) and Line Regulation

Conducted EMI



Line Regulation



Constant Current, Efficiency and High-Power Factor

V_{IN} (V)	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	Efficiency (%)	PF
198	24.57	223.8	99.8	22.34	90.90%	0.977
200	24.54	223.7	99.8	22.33	90.97%	0.976
210	24.51	223.7	99.7	22.30	91.00%	0.972
220	24.48	223.6	99.7	22.29	91.07%	0.967
230	24.47	233.6	99.6	23.27	95.08%	0.961
240	24.46	223.6	99.6	22.27	91.05%	0.955
250	24.45	223.5	99.6	22.26	91.05%	0.948
260	24.45	223.4	99.5	22.23	90.91%	0.941
264	24.45	223.4	99.5	22.23	90.91%	0.938

MPS DC LED Driver Products

Monolithic Power Systems offers a wide range of DC LED driver products featuring Buck, Boost, and Buck-Boost topologies, high-input voltage operation (up to 100V), and advanced packaging. Fast switching frequencies help reduce the size and cost of the driver solution. Selected parts offer MPS's Adaptive Hysteretic Control for high output current accuracy.

MPS DC LED drivers can be used with PFC flyback MP44010/11 for a lowest ripple solution. Used with MP44010/11 also enables easy access to analog and PWM dimming on secondary side.

Features

- Buck, Boost, and Buck-Boost Topologies
- Analog and PWM Dimming
- Wide Operating Voltage Range
- High-Efficiency Designs up to 97.5%
- Low Reference Voltage Feedback
- Open Load and Short Circuit Protection
- Internal MOSFETs

Applications

- General Lighting
- Automotive
- Industrial
- LCD Backlighting
- Portable/Battery

Part Number	Input Voltage (VDC)	Current Limit (A)	F_{SW} (kHz)	Type	Feature	Package
MP3412	0.8 to 4.4	-	1000	Boost	1.1A Peak Switch Current, Output Disconnect	TSOT23-6
MP2480	5 to 36	4.3	Up to 2000	Buck	3A Output, 3% Current Accuracy, Hysteretic Control	SOIC8E
MP2481	4.5 to 36	2	1400	Buck-Boost	Open LED Production, Halogen Replacement	MSOP8
MP2489	6 to 60	1	300 to 600	Low-Side Buck	Hysteretic Control, Fast Transient Response	QFN6 TSOT23-5 SOIC8E
MP24892	4.5 to 45	1	200 to 600	Low-Side Buck	PWM and Analog Dimming	TSOT23-5
MP24893	6 to 36	1	200 to 600	Low-Side Buck	PWM and Analog Dimming	TSOT23-5 QFN6
MP24894	6 to 60	1	Up to 1000	Buck, Buck-Boost	PWM and Analog Dimming	TSOT6
MP2483	4.5 to 55	3	1350 Prog	Buck, Buck-Boost	DC/PWM Dimming	QFN10 SOIC14
MPQ2483	4.5 to 55	3	1350 Prog	Buck	Industrial Grade DC/PWM Dimming	QFN10
MP24183	4.5 to 55	2	1350 Prog	Buck	DC/PWM Dimming	QFN10
MP2488	4.5 to 55	3.2	200 Prog	Buck	Up to 97.5% Efficiency, 220mΩ Internal MOSFET	QFN10 SOIC8
MP2487	4.5 to 55	1.5	200 Prog	Buck	Up to 97.5% Efficiency, 220mΩ Internal MOSFET	SOIC8E
MP4688	4.5 to 75	3.2	2000	Buck	MPS Adaptive Hysteretic for High Output Current Accuracy	SOIC8E
MP4689	4.5 to 100	3.2	2000	Buck	MPS Adaptive Hysteretic for High Output Current Accuracy	SOIC8E
MP4012	8 to 55	Prog	115 to 580	Boost, Buck, Buck-Boost, and SEPIC	HV9912 Pin Compatible, Backlighting and High-Power Lighting	SOIC16

Reference Design – Many variants with and without PFC flyback. Please contact factory.



MPS US Corporate Headquarters





San Jose, CA USA





- Production, Test, QA, and R&D Center
- 250K Ft^2 (>23K m^2) Facility
- ISO9001:2000 Certified
- MPS Ship Capacity
  - >200M+ Units/Month in 2011



MPS Chengdu, China

Worldwide Offices

Corporate Headquarters
79 Great Oaks Blvd.
San Jose, CA 95119
USA
Tel: +1 408-826-0600
usinfo@monolithicpower.com

MPS China
Chengdu
#8 Kexin Road,
West Park of Export Processing Zone,
West High-Tech Zone,
Chengdu, Sichuan, China 611731
Tel: +86 28-8730-3000
china-cd@monolithicpower.com

Hangzhou
No. 3 Xidoumen Road,
The Paradise Software Park-D-Floor 15,16,
Zhejiang Province,
Hangzhou, 310012 P.R.C.
Tel: +86 571-8981-8588
china-hz@monolithicpower.com

Shanghai
Room 06, 30 Floor,
International Corporate City,
No. 3000 Zhongshan North Road,
Shanghai, 200063 P.R.C.
Tel: +86 21-5240-1212
china-sh@monolithicpower.com

Shenzhen
Room 1501, 1513,
Coastal City (West Tower) Hai De San Dao,
Nanshan District,
Shenzhen, 518054 P.R.C.
Tel: +86 755-3308-7732
china-sz@monolithicpower.com

MPS Korea
B-604, Pangyo InnoValley
621 Sampyeong-dong,
Bundang-Gu,Seongnam-City,
Gyeonggi-Do, 463-400, Korea
Tel: +82 2-598-2307
koreainfo@monolithicpower.com

MPS Taiwan
8F, No. 77,
Nan-King East Rd., Sec. 3,
Taipei 104, Taiwan, R.O.C.
Tel: +886 2-2504-0656
taiwaninfo@monolithicpower.com

MPS Japan
Tokyo
Shinjukugyoen-mae Bldg., 6F,
Shinjuku 1-34-8, Shinjuku-ku,
Tokyo, 160-0022, Japan
Tel: +81 3-5360-1361
japaninfo@monolithicpower.com

Osaka
Hirano-Machi Yachiyo Building 10F-D,
1-8-13, Hirano-Machi, Chuoh-ku
Osaka-shi, Osaka, Japan
Tel: +81-6-4708-8005
japaninfo@monolithicpower.com

MPS Europe
Centre d'Affaires Concorde,
1080 Chemin de la Croix Verte,
38330 Montbonnot,
Saint Martin, France
Tel: +33 684-138-570
europeinfo@monolithicpower.com

ISO9001:2001 Certified

RoHS COMPLIANT

Monolithic Power Systems
www.monolithicpower.com

© 2014 Monolithic Power Systems, Inc. Patents Protected. All Rights Reserved.