Evaluation Board Report

5V 5W ACDC power supply

Design Specs	Value	Unit
Input Voltage	85-265	VAC
Output Voltage	5	VDC
Output Current	1	A
Isolation	YES	
MPS IC	MP020-5GS	
Application	• Cell Phone Chargers • Adapters for Handheld Electronics • Stand-By and Auxiliary Power Supplies • Small Appliances	

Document Number	EBXXX
Author	Application Engineering Department
Date	Nov, 2014
Revision	1.0

Design Summary

EV020-5-S-00A evaluation board provides a reference design for a universal offline power supply with 5V, 1A output. It contains the complete specification of the power supply, a detailed circuit diagram, the entire bill of materials required to build the power supply, drawing of the power inductors and transformers, and test data of the most important performance.

DESCRIPTION

The EV020-5-S-00A Evaluation Board is designed to demonstrate the capabilities of MP020-5. The MP020-5 is a primary-side-control regulator which can eliminates secondary feedback components.

The EV020-5-S-00A is typically designed for cell phone which output 5V, 1A load from 85VAC to 265VAC, 50HZ/60HZ.

The EV020-5-S-00A has an excellent efficiency and meets IEC61000-4-5 surge immunity and EN55022 conducted EMI requirements. It has multi-protection function as open circuit protection, short-circuit protection, cycle by cycle current limit and over-temperature protection, etc.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V_{IN}	85 to 265	VAC
Output Voltage	V_{OUT}	5	V
Output Current	I_{OUT}	1	A
Output Power	P_{OUT}	5	W
Efficiency (full load)	η	>70	%

FEATURES

- Primary-Side–Control without Opto-Coupler or Secondary Feedback Circuit
- Precise Constant Current and Constant Voltage Control (CC/CV)
- Integrated 700V MOSFET with Minimal External Components
- Variable, Off-Time, Peak-Current Control
- 550μA High-Voltage Current Source
- 30mW No-Load Power Consumption
- Programmable Cable Compensation
- Multiple Protections: OVP, OCP, OCkP, OTP, and VCC UVLO
- Natural Spectrum Shaping for Improved EMI Signature
- Low Cost and Simple External circuit

Warning: Although this board is designed to satisfy safety requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.

EV020-5-S-00A EVALUATION BOARD

TOP VIEW

BOTTOM VIEW

(L x W x H) 47mm x 30mm x 18mm

Board Number	MPS IC Number
EV020-5-S-00A	MP020-5GS

EVALUATION BOARD SCHEMATIC

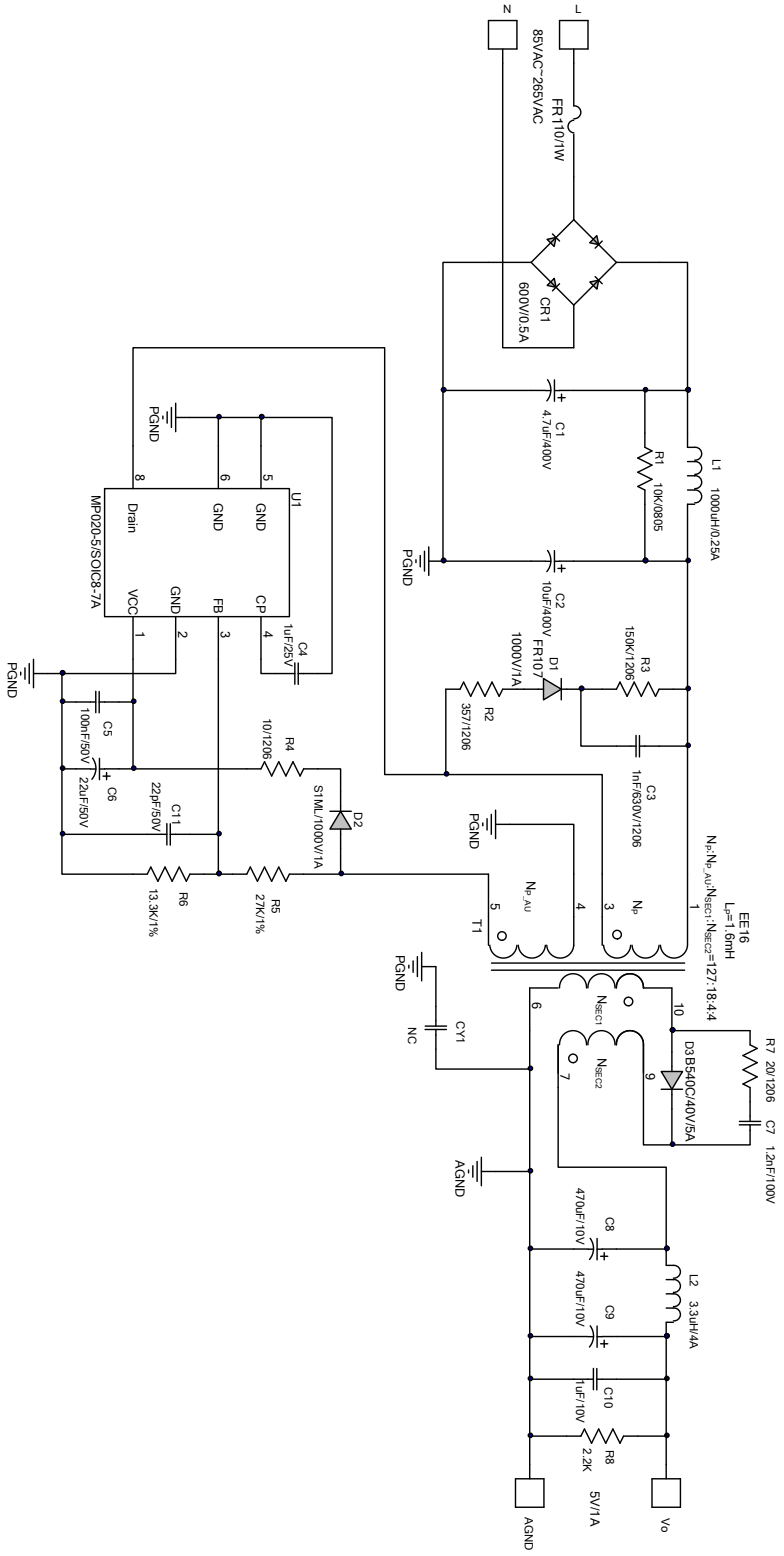


Figure 1—Schematic

PCB LAYOUT (SINGLE-SIDED)

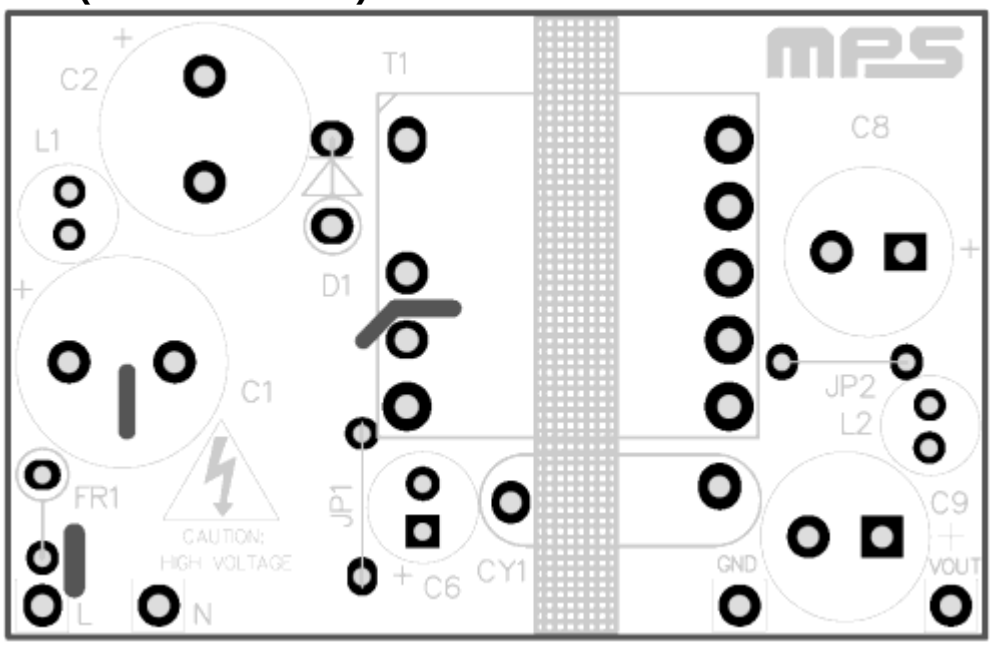


Figure 2—Top Layer

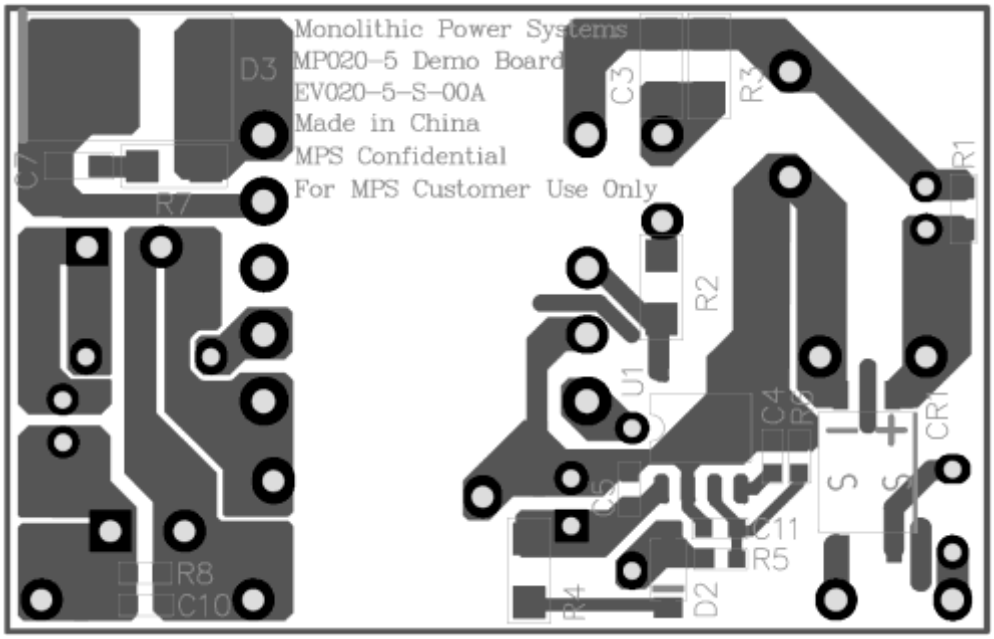


Figure 3—Bottom Layer

CIRCUIT DESCRIPTION

The EV020-5-S-00A is configured in a single-stage Flyback topology, it uses primary-side-control which can mostly simplify the schematic and get a cost effective BOM. It can also achieve accurate constant voltage and constant current.

FR1 and CR1 compose the input stage. FR1 is used to protect for the component failure or some excessive short events, also it can restrain the inrush current.

C1, L1 and C2 compose π filter to guarantee the conducted EMI meet standard EN55022. R2, R3, D1 and C3 compose the snubber circuit to reduce drain-source voltage spike.

R4, C5, C6 and D2 are used as Vcc power supply.

R5 and R6 are resistor divider for detecting output voltage by sampling voltage on primary auxiliary winding.

CY1 is Y capacitor lowering common mode noise to make sure there is enough EMI margin. T1 is power transformer, the structure of which is also very important to pass EMI test.

D3, C8, C9, C10, L2 and R8 compose output circuit. D3 is schottky diode for better efficiency. C10 is ceramic capacitor for lower output voltage ripple and R8 is dummy load, which is used for good regulation. C8, L2 and C9 compose π filter to restrain the output ripple.

R7 and C7 are used to depress the spike of schottky.

EV020-5-S-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer_P/N
1	C1	4.7μF	Capacitor;400V;20%	DIP	Nichicon	UVY2G4R7MPD
1	C2	10μF	Capacitor;400V;20%	DIP	Ltec	TY 10uF/400V
1	C3	1nF	Ceramic Capacitor;630V;X7R	1206	Murata	GRM31A7U2J102JW31D
1	C4	1μF	Ceramic Capacitor;25V;X7R;	0603	Murata	GRM188R71E105KA12D
1	C5	100nF	Ceramic Capacitor;50V;X7R;	0603	Murata	GCJ188R71H104KA12D
1	C6	22μF	Electrolytic Capacitor;50V	DIP	Jianghai	CD281L-50V22
1	C7	1.2nF	Ceramic Capacitor;100V;X7R	0603	muRata	GRM188R72A122KA01D
2	C8,C9	470μF	Electrolytic Capacitor;10V,Low ESR	DIP	Nippon Chemi-con	EKZE100ELL471MHB5D
1	C10	1μF	Ceramic Capacitor;10V;X7R	0603	Murata	GRM188R71A105KA61D
1	C11	22pF	Ceramic Capacitor;50V;C0G;	0603	Murata	GRM1885C1H220JA01D
1	CY1	NC				
1	CR1	MB6F	Diode;600V;0.5A	SOP-4	Diodes	MB6F
1	D1	FR107	Diode;1000V;1A	DO-41	Diodes	FR107
1	D2	S1ML	Diode;1000V;1A;	SMA	Taiwan Semiconductor	S1ML
1	D3	B540C	Schottky Diode;40V;5A	SMC	Diodes	B540C
1	FR1	10Ω	Fusible Resistor, 1 W, 5%	Yageo	DIP	FKN1WSJT-52-10R
1	L1	1000μH	Inductor;1000uH;6 Ohm;0.25A	DIP	Wurth	7447462102
1	L2	3.3μH	Inductor;3.3uH;0.025Ohm;4A	DIP	Wurth	7447462033
1	R1	10kΩ	Film Resistor;5%	0805	Yageo	RC0805JR-0710KL
1	R2	357Ω	Film Resistor; 1%;1/4W	1206	Yageo	RC1206FR-07357RL
1	R3	150kΩ	Film Resistor; 1%,1/4W	1206	Panasonic	ERJ8ENF1503V
1	R4	10Ω	Film Resistor;5%;1/4W	1206	Yageo	RC1206JR-0710R
1	R5	27kΩ	Film Resistor;1%;	0603	Yageo	RC0603FR-0727KL
1	R6	13.3kΩ	Film Resistor;1%	0603	Yageo	RC0603FR-0713K3L
1	R7	20Ω	Film Resistor;5%;1/4W	1206	Royalohm	1206J0200T5E
1	R8	2.2kΩ	Film Resistor;5%;	0603	LIZ	RC0603JA0222G
1	R9	510Ω	Film Resistor;5%;	0805	LIZ	RC0805JA0510
1	U1		Primary side regulator R3	SOIC8-7A	MPS	MP020-5GS
1	T1		Transformer;1.6mH; N_P:N_{P_AU}:N_{SEC1}:N_{SEC2}=127:18:4:4	EE16	Wurth(1)	7508110157
Notes:		(1) Wurth transformer sample request please login on website: www.we-online.com				

TRANSFORMER SPECIFICATION

Electrical Diagram

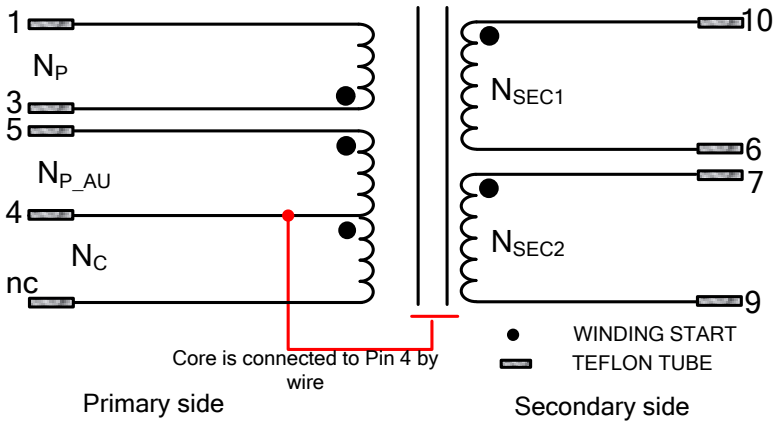


Figure 4—Transformer Electrical Diagram

Notes:
1. N_{SEC1} and N_{SEC2} are coiled at one layer.
2. Core is connected to Pin 4 with naked wire.
3. N_{SEC1} and N_{SEC2} are with Triple Insulation Wire.

Winding Diagram

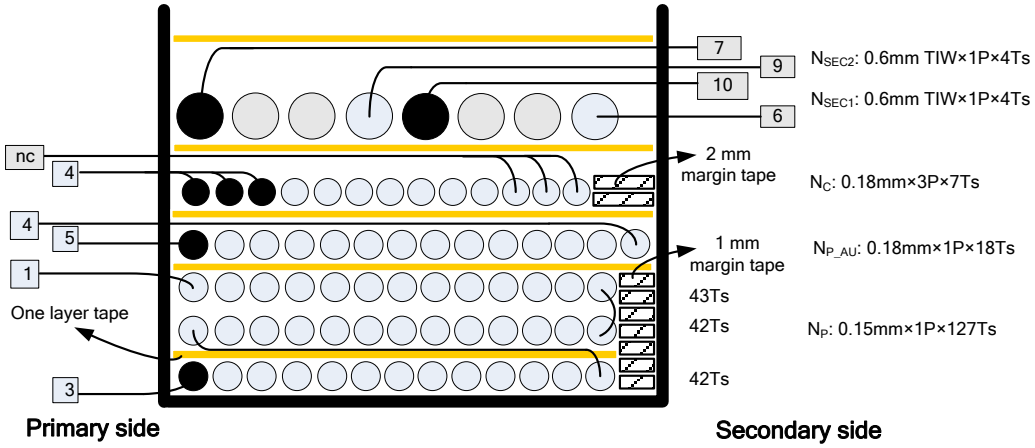


Figure 5—Winding Diagram

Winding Order

Winding No.	Tape Layer Number	Start & End	Magnet WireΦ(mm)	Turns
N_P	1	3→1	0.15mm * 1	127
N_{P_AU}	1	5→4	0.18mm * 1	18
N_C	1	4→nc	0.18mm * 3	7
N_{SEC1}	1	10→6	0.6mm * 1 TIW	4
N_{SEC2}	1	7→9	0.6mm * 1 TIW	4

Electrical Specifications

Electrical Strength	60 second, 60Hz, from PRI. to SEC.	3000VAC
	60 second, 60Hz, from PRI. to CORE.	500VAC
	60 second, 60Hz, from SEC. to CORE.	3000VAC
Primary Inductance	Pins 1 - 3, all other windings open, measured at 60kHz, 0.1 VRMS	1.6mH±10%
Primary Leakage Inductance	Pins 1 - 3 with all other pins shorted, measured at 60kHz. 0.1 VRMS	50μH±10%

Materials

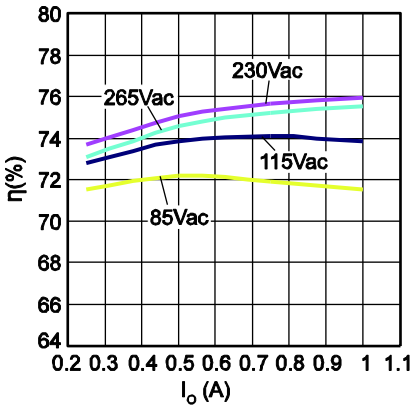
Item	Description
1	Core: EE16, UI=2300±25%, AL=73.2.4nH/N^2±3% GAPPED, or equivalent
2	Bobbin: EE16, 5+5PIN 1 SECT TH, UL94V-0
3	Wire:Φ0.15mm,, 2UEW, Class B
4	Wire:Φ0.18mm,, 2UEW, Class B
5	Triple Insulation Wire: Φ0.60mm TIW
6	Tape: 8.0mm(W)×0.06mm(TH)
7	Varnish: JOHN C. DOLPH CO, BC-346A or equivalent
8	Solder Bar: CHEN NAN: SN99.5/Cu0.5 or equivalent

EVB TEST RESULTS

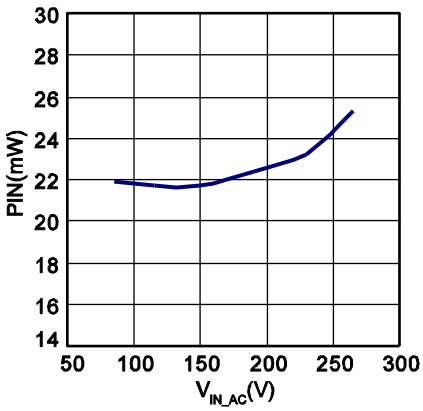
Performance Data

T_A=25℃, unless otherwise noted.

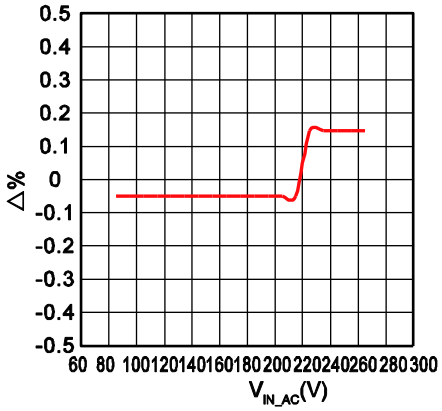
Efficiency



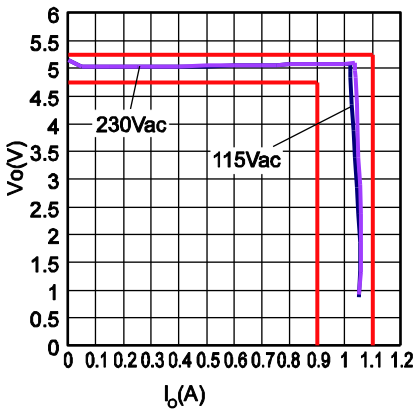
No Load Consumption



Line Regulation



CV/CC



Electric Strength Test

Primary circuit to secondary circuit electric strength testing was completed according to IEC61000-4-2.

Input and output was shorted respectively. 3000VAC/50Hz sine wave applied between input and output for 1min, and operation was verified.

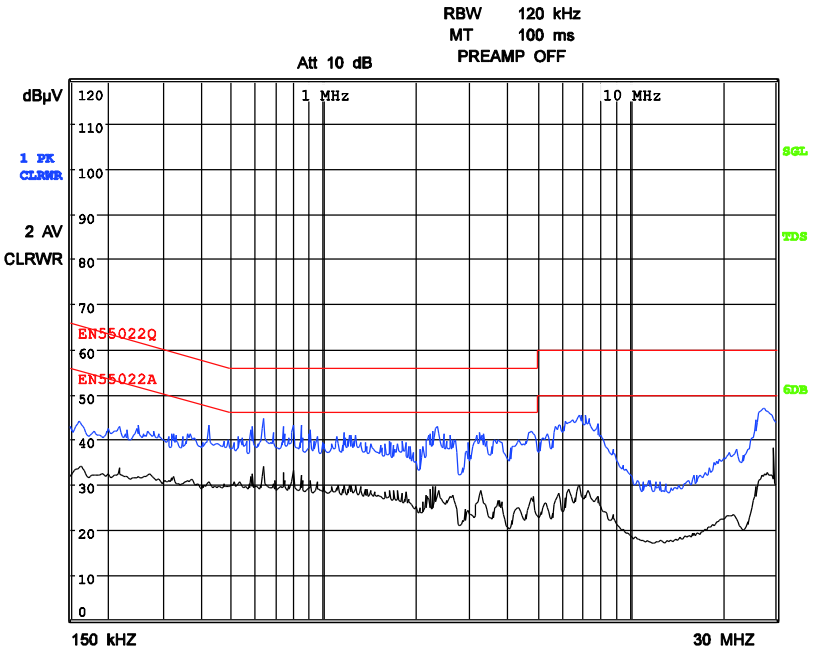
Surge Test

Line to Line 1kV and Line to Power Earth 1kV surge testing was completed according to IEC61000-4-5. Input voltage was set at 220VAC/50Hz. Output was loaded at full load and operation was verified following each surge event.

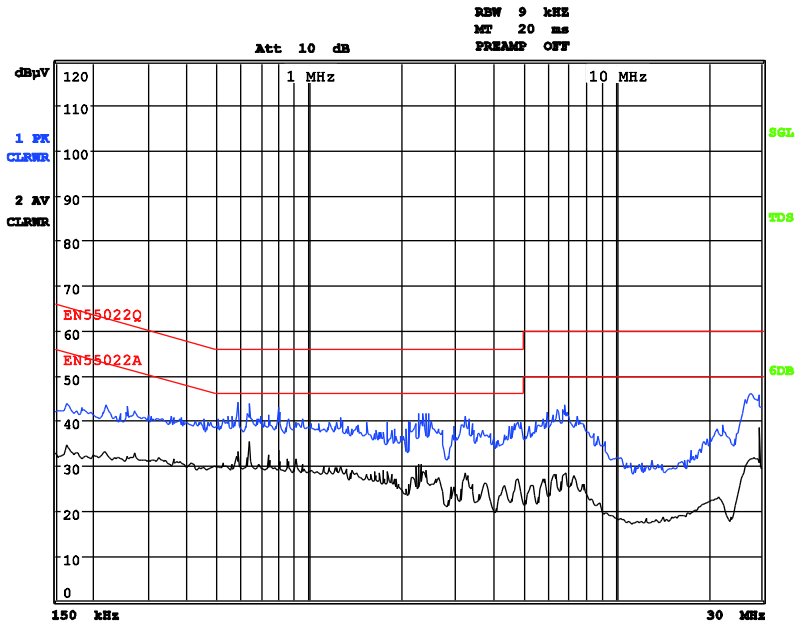
Surge Level (V)	Input Voltage (VAC)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
1000	220	L to N	90	Pass
-1000	220	L to N	270	Pass
1000	220	L to PE	90	Pass
-1000	220	L to PE	270	Pass
1000	220	N to PE	90	Pass
-1000	220	N to PE	270	Pass

Conducted EMI Test

Test with 230Vac input and full load condition

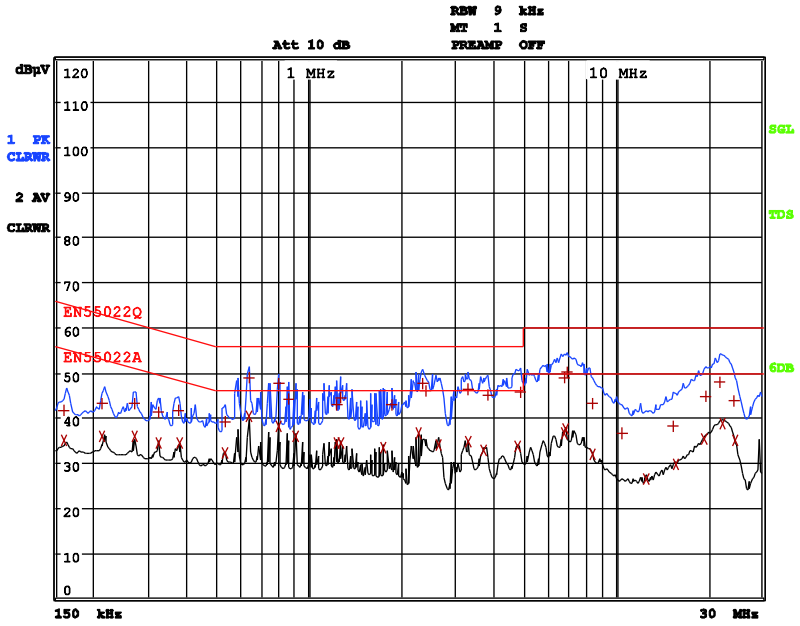


230Vac, 50Hz, Maximum Load, L Line, Output GND floats, EN55022 Limits

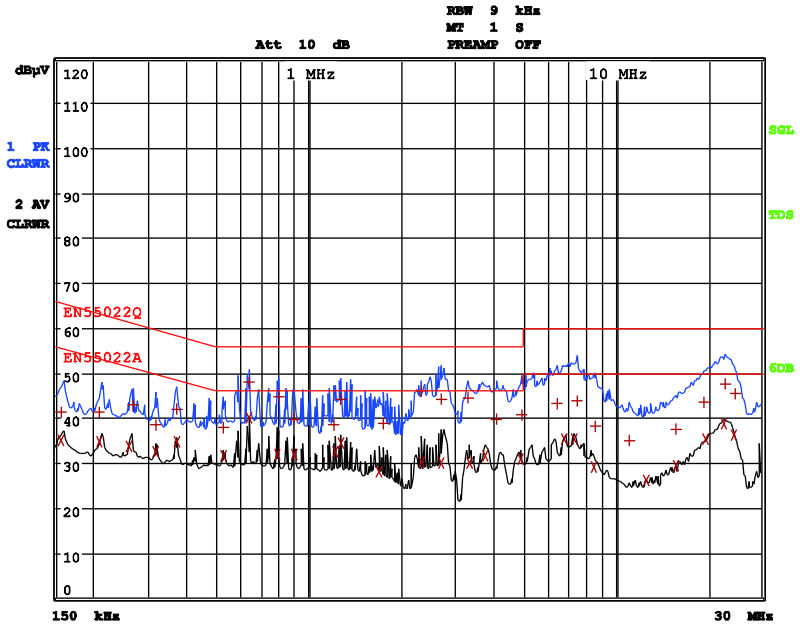


230Vac, 50Hz, Maximum Load, N Line, Output GND floats, EN55022 Limits

Conducted EMI Test *(continued)*



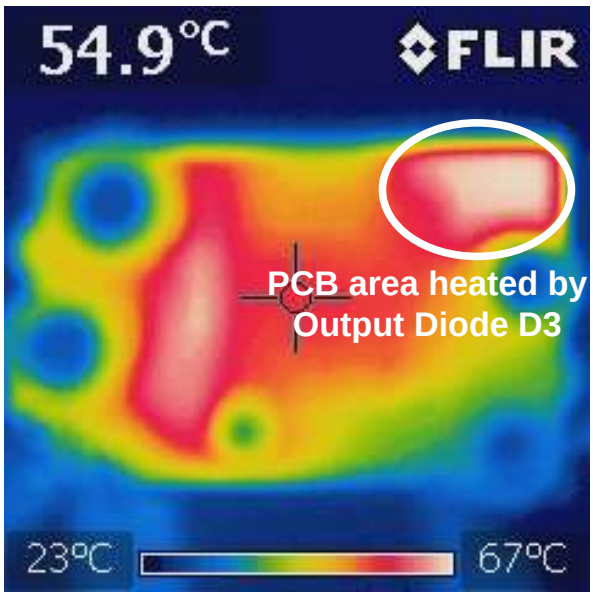
230Vac, 50Hz, Maximum Load, L Line, Output GND connects to Earth, EN55022 Limits



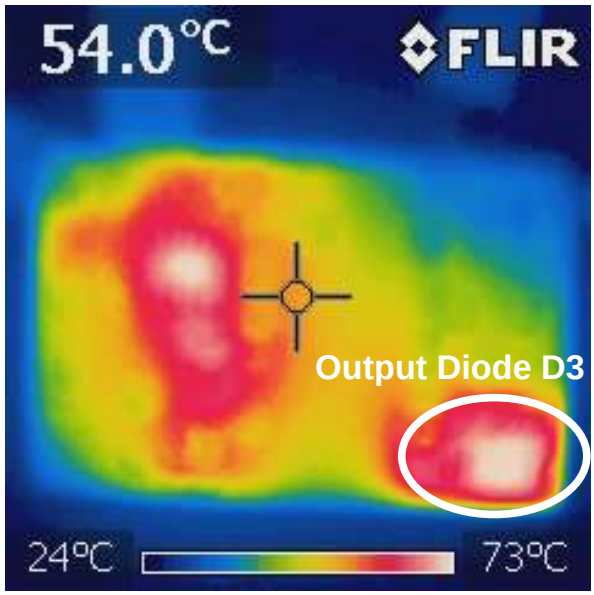
230Vac, 50Hz, Maximum Load, N Line, Output GND connects to Earth, EN55022 Limits

Thermal Test

Test with 85Vac input and full load condition. PCB layout is with 1Oz copper. Ambient temperature is 25°C.



Top Layer



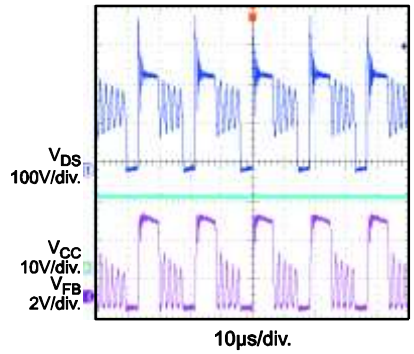
Bottom Layer

EVB TEST RESULTS

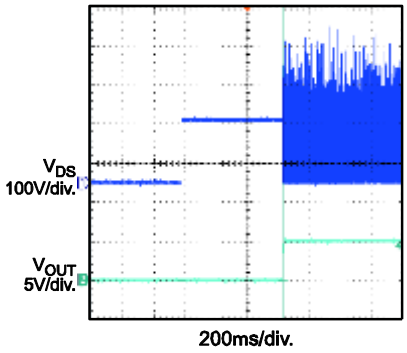
Performance waveforms are tested on the evaluation board.

V_{IN}=115VAC/60Hz, V_{OUT}=5V, I_{OUT}=1A, L_P=1.6mH, N_P:N_{P_AU}:N_{SEC1}:N_{SEC2}=127:18:4:4, T_A=25℃, unless otherwise noted.

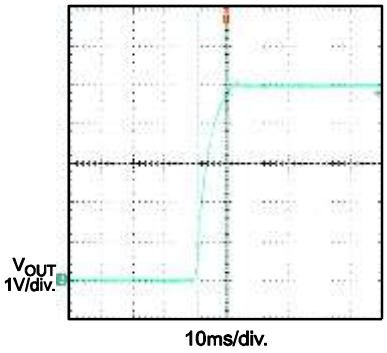
Steady State



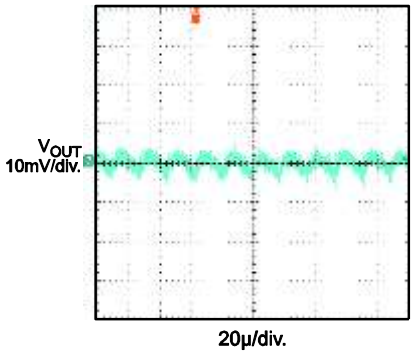
Turn On Delay



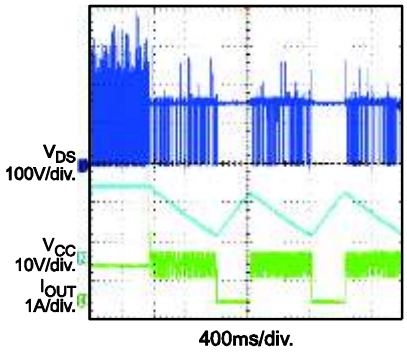
Output Rise Time



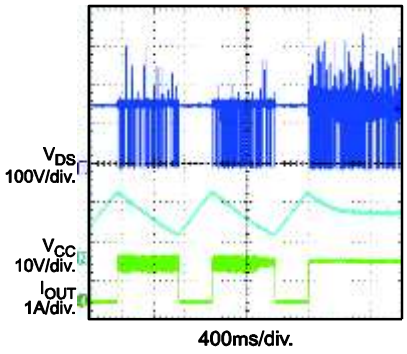
Output Ripple



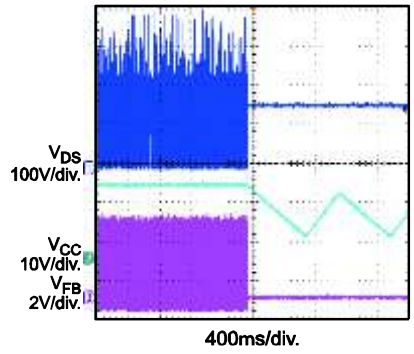
SCP Enter



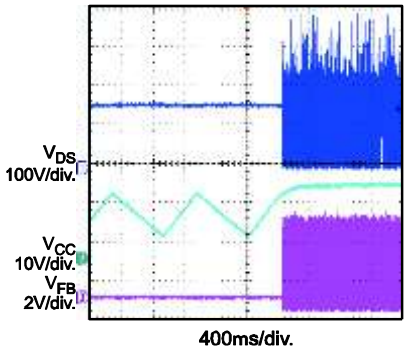
SCP Recovery



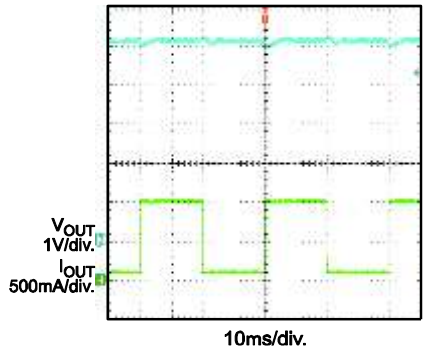
OCkP Enter



OCkP Recovery



Load Transient

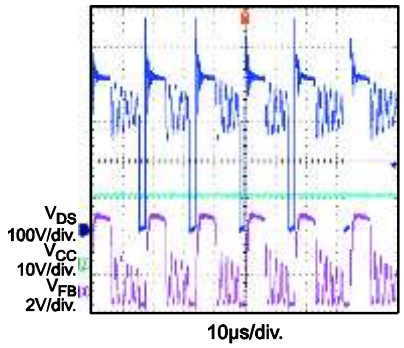


EVB TEST RESULTS *(continued)*

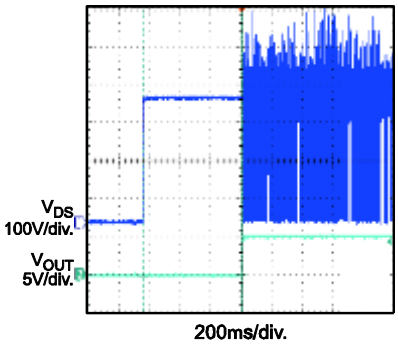
Performance waveforms are tested on the evaluation board.

V_{IN}=230VAC/50Hz, V_{OUT}=5V, I_{OUT}=1A, L_P=1.6mH, N_P:N_{P_AU}:N_{SEC1}:N_{SEC2}=127:18:4:4, T_A=25℃, unless otherwise noted.

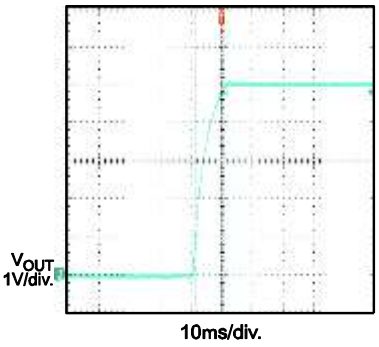
Steady State



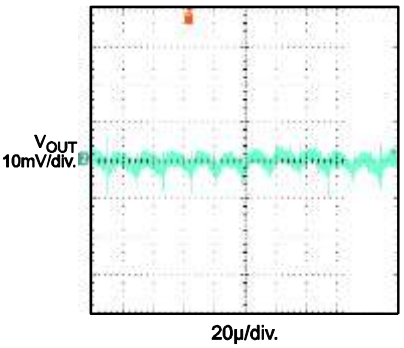
Turn On Delay



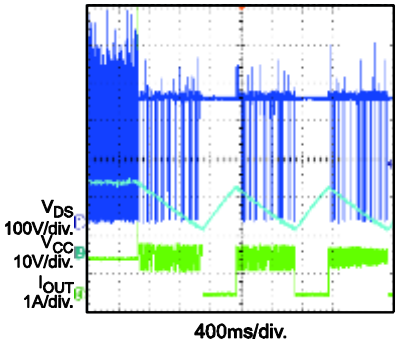
Output Rise Time



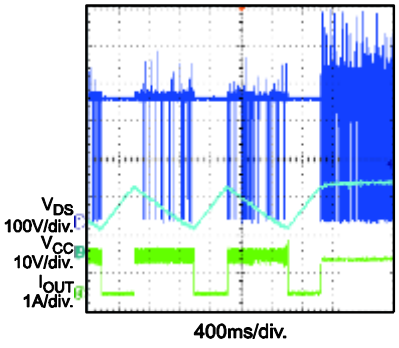
Output Ripple



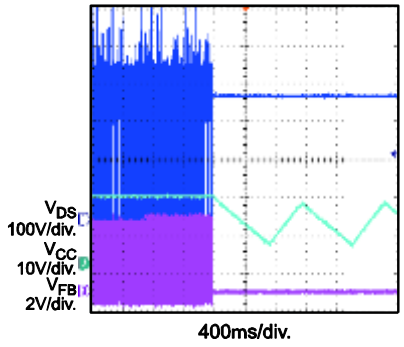
SCP Enter



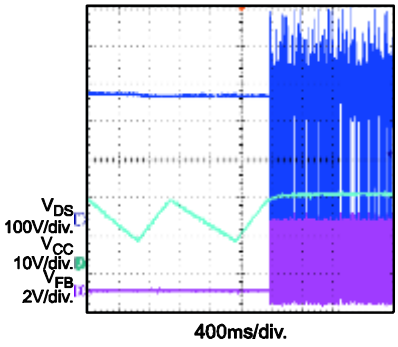
SCP Recovery



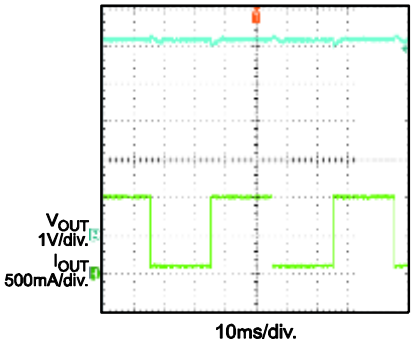
OCkP Enter



OCkP Recovery



Load Transient



QUICK START GUIDE

1. Preset Power Supply to 85VAC ≤ V_{IN} ≤ 265VAC.
2. Turn Power Supply off.
3. Connect the Line and Neutral terminals of the power supply output to L and N port. For three-wire input application, make OUTPUT GND connected to Earth.
4. Connect Load to:
    a. Positive (+): VOUT
    b. Negative (–): GND
5. Turn Power Supply on after making connections.

Contact Information

To request this evaluation board, please refer to your local sales offices which can be found from:

http://www.monolithicpower.com/Company/Contact-Us

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MPS PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE‐SUPPORT APPLICATIONS, DEVICES OR SYSTEMS, OR OTHER CRITICALAPPLICATIONS.

Inclusion of MPS products in critical applications is understood to be fully at the risk of the customer. Questions concerning potential risk applications should be directed to MPS.

MPS semiconductors are typically used in power supplies in which high voltages are present during operation. High voltage safety precautions should be observed in design and operation to minimize the chance of injury.