EVHFC0512-S-00A

130kHz, 12V, 20W, Fixed-Frequency Flyback Controller with Low Standby Power Consumption Evaluation Board

DESCRIPTION

The EVHFC0512-S-00A is an evaluation board designed to demonstrate the capabilities of the HFC0512. The HFC0512 is a fixed-frequency, current-mode controller with internal slope compensation. It is specifically designed for medium-power, offline, flyback, switch-mode power supplies.

The HFC0512 is a highly efficient green-mode controller. At light loads, the controller maintains the peak current and reduces its switching frequency (f_{SW}) down to 27kHz to achieve excellent light-load efficiency. At very light loads, the controller enters burst mode to achieve very low standby power consumption.

The HFC0512 offers frequency jittering to help dissipate energy generated by the conducted noise. The EVHFC0512-S-00A meets EN55022 conducted EMI requirements.

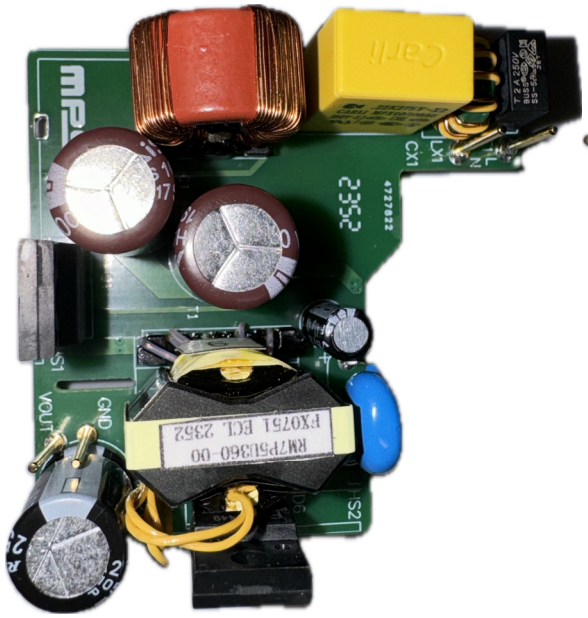
The HFC0512 employs an over-power compensation function, which narrows the over-power protection point differences between the low line and high line. In addition, the device features protections such as thermal shutdown, V_{CC} under-voltage lockout (UVLO), overload protection (OLP), over-voltage protection (OVP), and brownout protection.

PERFORMANCE SUMMARY (1)

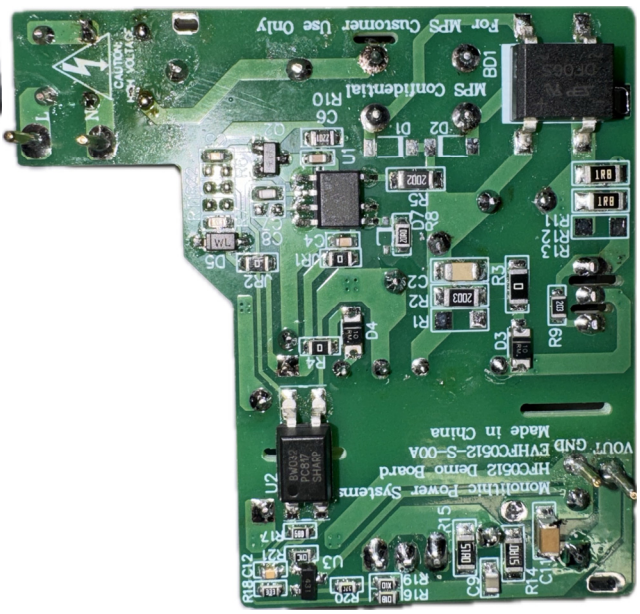
Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		85V_{AC} to 265V_{AC}
Output voltage (V_{OUT})	V_{IN} = 85V_{AC} to 265V_{AC}, I_{OUT} = 0A to 1.67A	V_{OUT} = 12V
Switching frequency (f_{SW})		130kHz

EVALUATION BOARD



Top View



Bottom View

LxWxH (54mmx53mmx22mm)

Board Number	MPS IC Number
EVHFC0512-S-00A	HFC0512GS

QUICK START GUIDE

1. Preset the power supply (V_{IN}) to be $85V_{AC} \leq V_{IN} \leq 265V_{AC}$.
2. Turn the power supply off.
3. Connect the line and neutral terminals of the power supply output to L port and N port, respectively.
4. Connect the load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND
5. Turn the power supply on after making the connections.

CIRCUIT DESCRIPTION

The EVHFC0512-S-00A is configured in flyback applications for the HFC0512. It uses secondary-side-control to achieve a precise voltage output.

F1 is a fuse that protects the circuit from component failure or some excessive short events.

LX1, CX1, and LX2 comprise a filter to guarantee that the conducted EMI meets the standard EN55022.

BD1 can be configured for the rectifier bridge to convert the AC voltage to a DC voltage.

R1, R2, and C2 comprise the primary-side snubber. This snubber absorbs the leakage inductance energy when the MOSFET turns off, which reduces the high spike from the MOSFET's drain to source.

R5 can suppress the HV pin's spike when VCC is charged by the HV pin during the start-up period.

D4, R4, and C3 are used as the VCC power supply after the IC begins to switch. The ceramic C4 is used in parallel with C3 to decouple the voltage noise; it should be positioned as close to the IC as possible.

C6 is used to set the jittering period and the clock for protections such as OLP.

R7, D5, C5, and Q2 comprise the latch-off timer circuit for over-voltage protection (OVP).

R11, R12, and R13 are the current-sense resistors with a 1% tolerance for the peak current set-up.

R10 and C8 comprise the RC filter for the CS pin's input.

T1 is the transformer that transfers power from the primary side to the secondary side. T1 is a key component for the entire circuit to operate normally with optimal performance. Therefore, T1 must be designed carefully.

CY1 is a safety Y-capacitor that lowers the common-mode noise to ensure a sufficient EMI margin.

D6 is the secondary rectifier for the output. R14, R15, and C9 are the snubber for D6 to suppress high-voltage spikes on the rectifier.

C10 is an output capacitor. It should be a low-ESR electrolytic capacitor for improved output voltage ripple and improved efficiency.

C11 is a small ceramic capacitor that bypasses the high-frequency noise on the output.

R20 and R21 are configured to set the output voltage.

The control loop comprised of U2, U3, R16, and R17 feeds the output voltage's instantaneous value back to the FB pin.

R18 and C12 are configured as the compensation network. To obtain excellent dynamic response and high system stability, carefully design the control loop.

EVALUATION BOARD SCHEMATIC

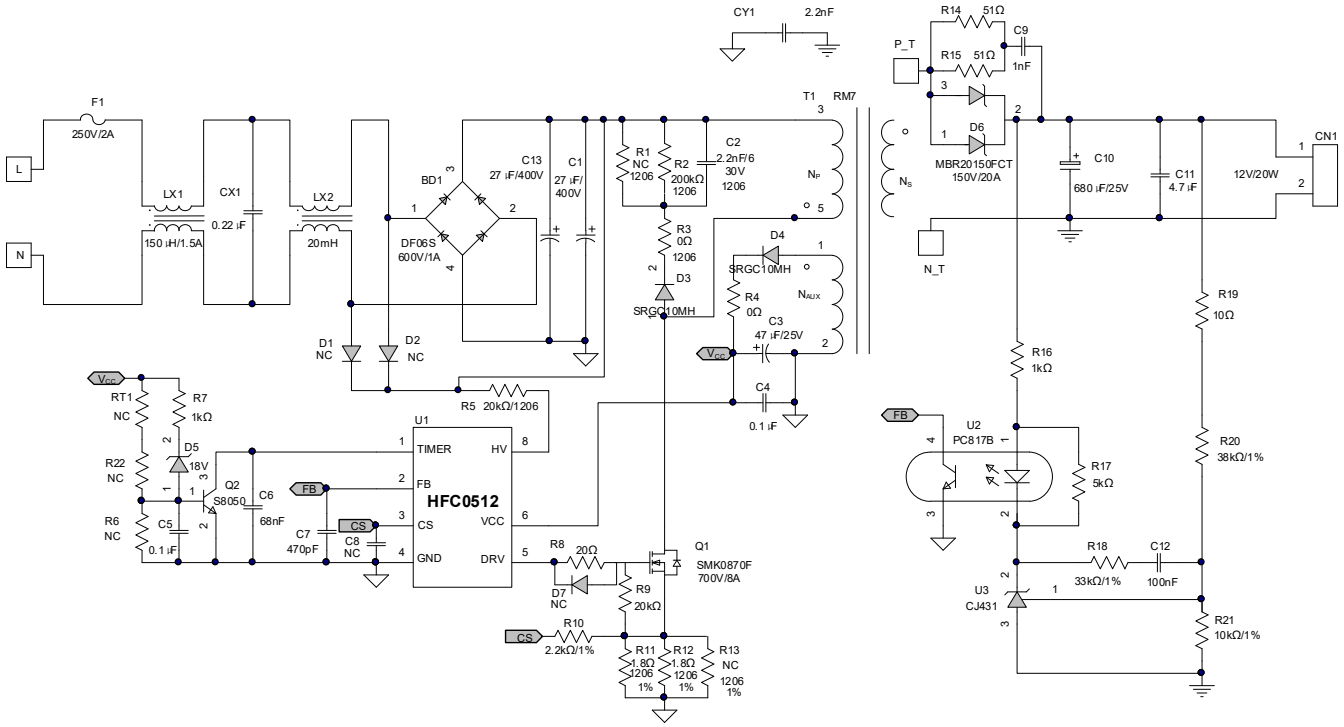


Figure 1: Evaluation Board Schematic

EVHFC0512-S-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	BD1	600V	Diode, 600V, 1A	SMD	Fairchild	DF06S
1	C1, C13	27μF	Electrolytic capacitor, 400V	DIP	Aishi	HS 400V 27μF 10*18
1	C2	2.2nF	Ceramic capacitor, 630V, X7R	1206	Murata	GRM31BR72J222KW01L
1	C3	47μF	Electrolytic capacitor, 25V	DIP	Jianghai	CD286-25V47μF
3	C4, C5, C12	0.1μF	Ceramic capacitor, 25V, X7R	0603	Murata	GCM188R91E104KA37D
1	C6	68nF	Ceramic capacitor, 50V, X7R;	0603	TDK	C1608X7R1H683K
1	C7	470pF	Ceramic capacitor, 50V, C0G	0603	Murata	GRM1885C1H471JA01D
1	C8	NC				
1	C9	1nF	Ceramic capacitor, 250V, X7R	0805	TDK	C2012X7R2E102K
1	C10	680μF	Electrolytic capacitor, 25V	DIP	Rubycon	25ZLH680MEFC10X16
1	C11	4.7μF	Ceramic capacitor, 25V, X7R	1206	Murata	GCM31CR71E475KA55L
1	CX1	0.22μF	Film capacitor, 275V, 10%	DIP	Carli	PX224K3IC59H200D9R
1	CY1	2.2nF	Capacitor, 4000V, 20%	DIP	Hongke	JNK12E222MY02N
2	D1, D2	NC				
2	D3, D4	1000V	Diode, 1000V, 1A	1206	Maxmega	SRGC10MH
1	D5	18V	Zener diode, 18V, 5mA/500mW	SOD-123	CJ	BZT52C18
1	D6	150V	Diode, 150V, 20A	TO-220AB	Xutong	MBR20150FCT
1	F1	250V	Fuse, 250V, 2A	DIP	Cooper Bussmann	SS-5-2A
1	LX1	150μH	Common inductor, 1.5A	DIP	Emei	TP4U150-00
1	LX2	20mH	Common inductor, 0.5A	DIP	Wurth	744822120
1	Q1	700V	MOSFET, 700V, 8A, 0.9Ω	TO-220F-3L	AUK	SMK0870F
1	Q2	25V	25V/0.5A	SOT-23	Changdian	S8050
1	R1	NC				
1	R2	200kΩ	Film resistor, 1%, 1/4W	1206	Yageo	RC1206FR-07200KL
1	R3	0Ω	Film resistor, 5%, 1/4W	1206	Yageo	RC1206JR-070RL
1	R4	0Ω	Film resistor, 5%	0805	Yageo	RC0805JR-070RL
1	R5	20kΩ	Film resistor, 5%, 1/4W	1206	Yageo	RC1206JR-0720KL

EVHFC0512-S-00A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
2	R7, R16	1kΩ	Film resistor, 5%	0603	Uniohm	0603SAJ0102T5E
1	R8	20Ω	Film resistor, 1%	0805	Yageo	RC0805FR-0720RL
1	R9	20kΩ	Film resistor, 5%	0805	Yageo	RC0805JR-0720KL
1	R10	2.2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072K2L
2	R11, R12	1.8Ω	Film resistor, 1%, 1/4W	1206	Yageo	RC1206FR-071R8L
1	R13	NC				
2	R14, R15	51Ω	Film resistor, 1%, 1/4W	1206	Yageo	RC1206FR-0751RL
1	R17	4.99kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-074K99L
1	R18	33kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0733KL
1	R19	10Ω	Film resistor, 1%	0603	Yageo	RC0603FR-0710RL
1	R20	38.3kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0738K3L
1	R21	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	JR1, JR2	0Ω	Film resistor, 5%	0805	Yageo	RC0805JR-070RL
1	T1	360μH	Transformer, RM7, PC40	RM7 5+0	Emei	RM7P5U360-00
1	U2	1-channel	Photocoupler, 1-channel	SMD	Sharp	PC817B
1	U3	2.5V	Shunt regulator, 2.5V	SOT-23	Changdian	CJ431
1	U1	HFC0512	PWM controller	SOIC8-7	MPS	HFC0512GS-Z

TRANSFORMER SPECIFICATIONS

Electrical Diagram

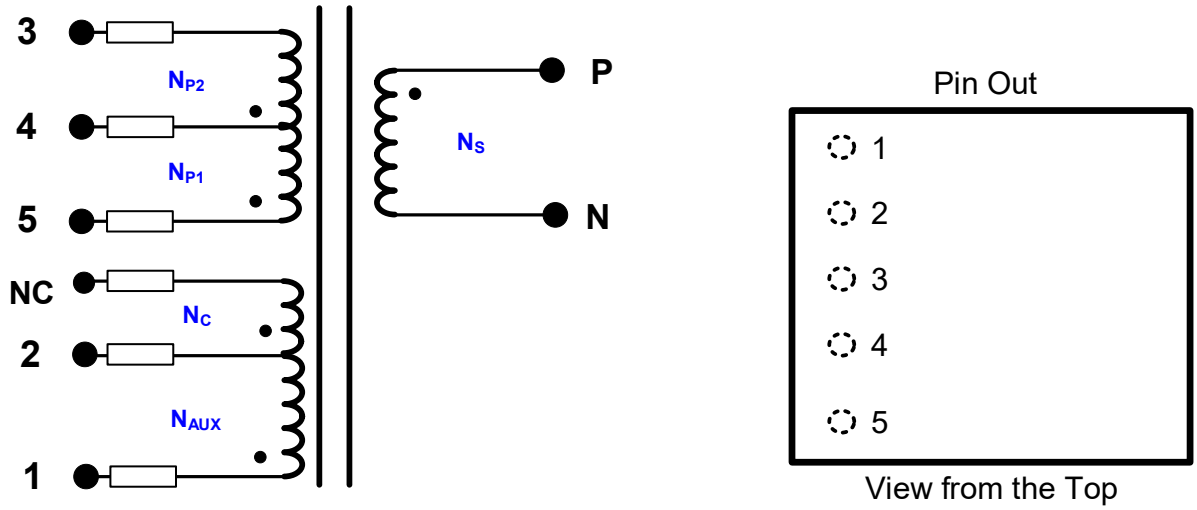


Figure 4: Transformer Electrical Diagram

Notes:

1) All the windings must be planar layers with uniform distribution.
2) N1, N2, N3, and N4 have double-stranded winding
3) P and N are flying wires.

WINDING DIAGRAM

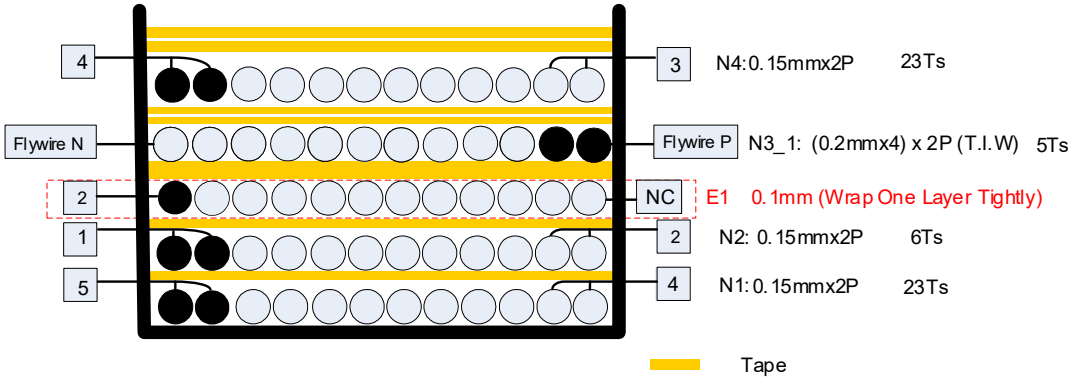


Figure 5: Winding Diagram

WINDING ORDER

Winding Order	Pin Number		Wire Type (Φ)	Number of Wires	Number of Turns
	Start	Finish			
N1	5	4	0.15	2	23
N2	1	2	0.15	2	6
E1	2	NC	0.1	1	One layer
N3	P	N	(0.2mm x 4) (T.I.W)	2	5
N4	4	3	0.15	2	23

ELECTRICAL SPECIFICATIONS

#	Item	Measuring Terminal	Value	Condition
1	Primary Inductance	L_P (5 to 3)	360μH ±5%	100kHz
2	Leakage Inductance	L_P (5 to 3), P short to N	15μH (Max)	100kHz
3	Turn Ratio	N1:N2:N3:N4	23:6:5:23	
4	Electrical Strength	Primary side to secondary side	AC: 3500V	1s, 1mA
		Primary side to core	AC: 1500V	
		Secondary side to core	AC: 1500V	

MATERIAL LIST

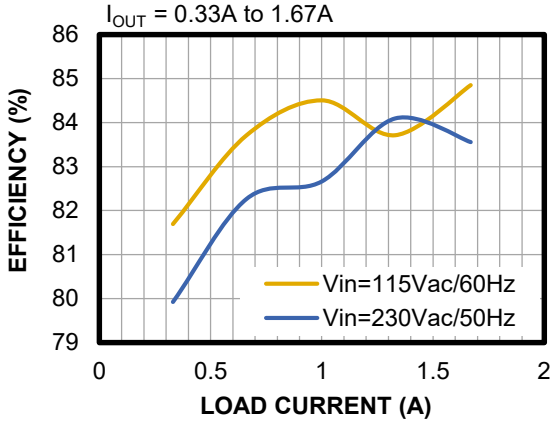
Item	Description
1	Core: RM7 PC40
2	Bobbin: RM7 Vertical, 5 + 0 PIN

EVALUATION BOARD TEST RESULTS

Performance waveforms are tested on the evaluation board. V_{IN} = 265V_{AC}, V_{OUT} = 12V, I_{OUT1} = 1.67A, T_A = 25°C, unless otherwise noted.

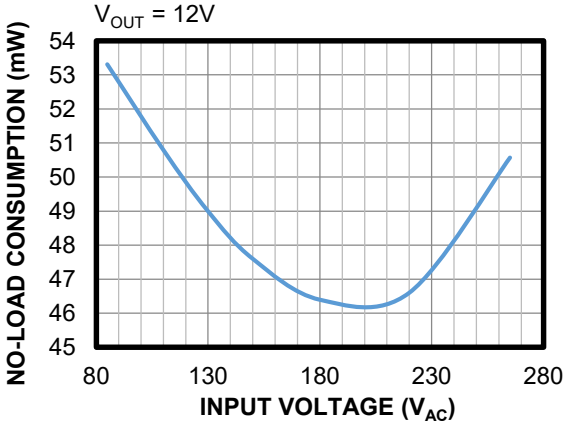
Efficiency vs. Load Current

I_{OUT} = 0.33A to 1.67A



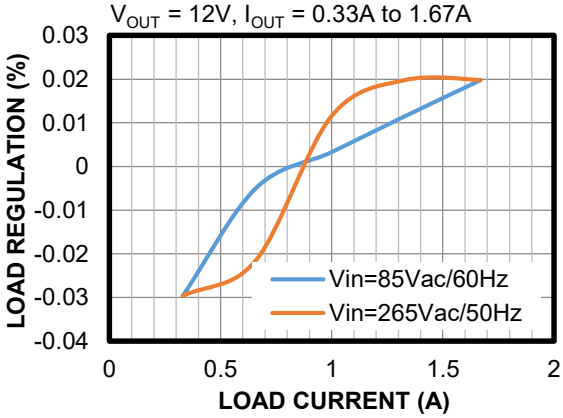
No-Load Consumption vs. Input Voltage

V_{OUT} = 12V



Load Regulation

V_{OUT} = 12V, I_{OUT} = 0.33A to 1.67A

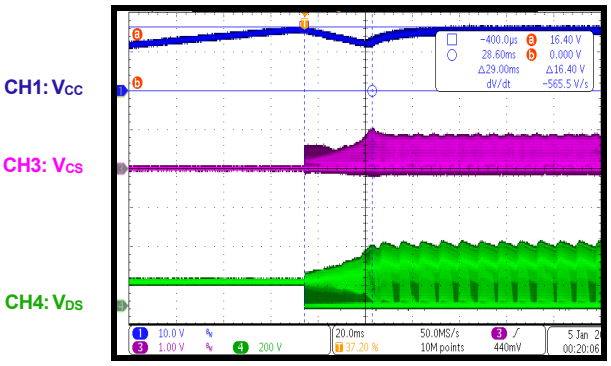


TYPICAL PERFORMANCE CHARACTERISICS

Performance waveforms are tested on the evaluation board. V_{IN} = 265V_{AC}, V_{OUT} = 12V, I_{OUT1} = 1.67A, T_A = 25°C, unless otherwise noted.

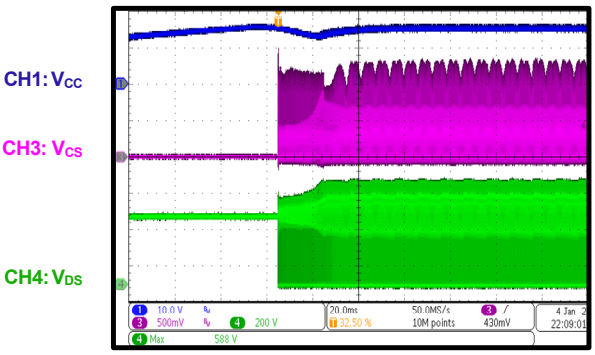
Start-Up

V_{IN} = 85V_{AC}



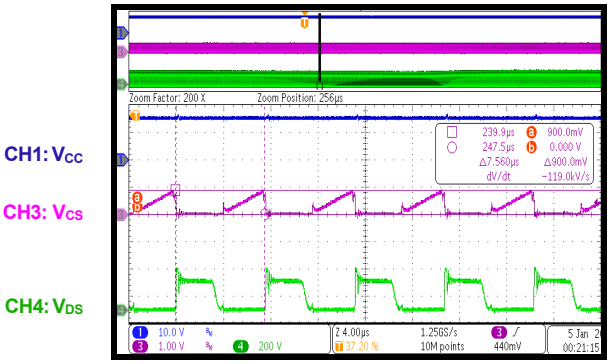
Start-Up

V_{IN} = 265V_{AC}



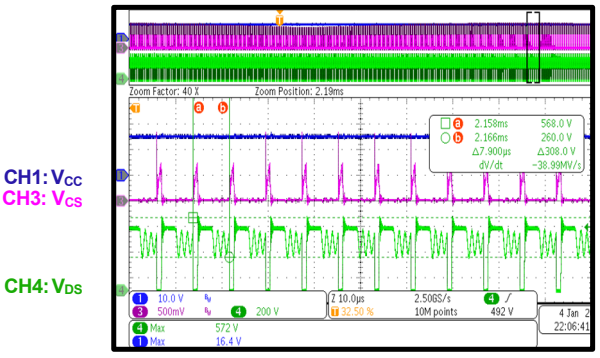
Steady State

V_{IN} = 85V_{AC}

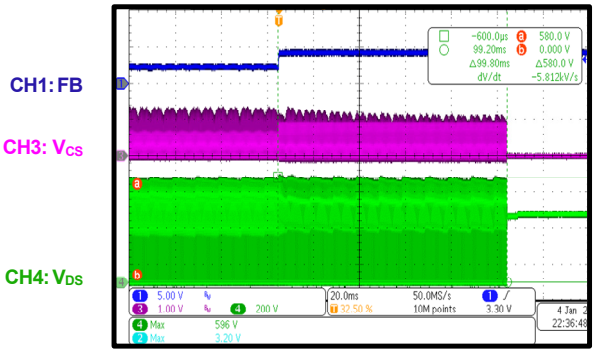


Steady State

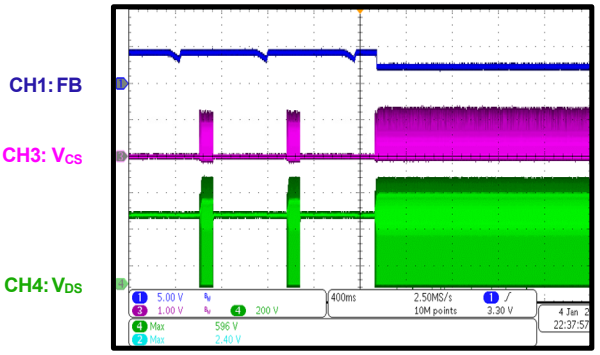
V_{IN} = 265V_{AC}



OLP Entry



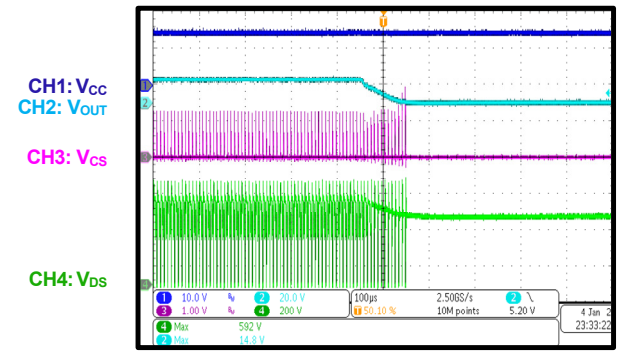
OLP Recovery



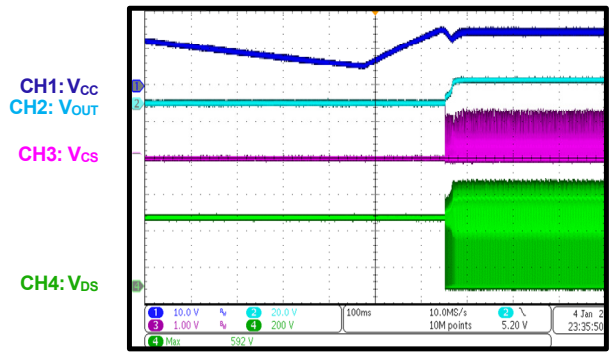
TYPICAL PERFORMANCE CHARACTERISICS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 265V_{AC}, V_{OUT} = 12V, I_{OUT1} = 1.67A, T_A = 25°C, unless otherwise noted.

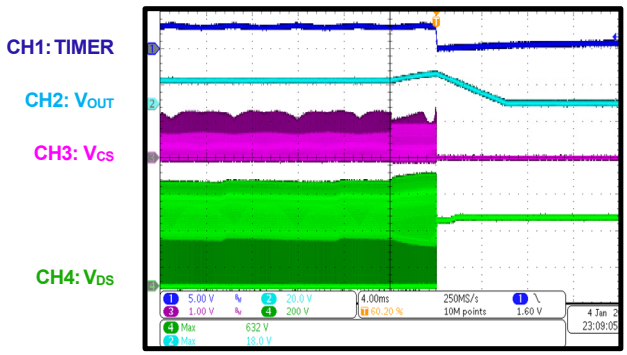
SCP Entry



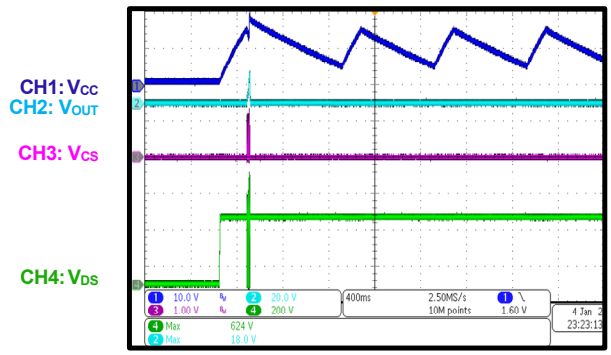
SCP Recovery



TIMER Latch-off Entry

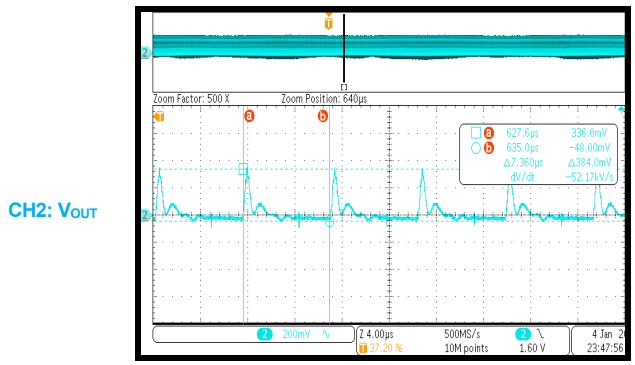


TIMER Latch-Off Start-Up



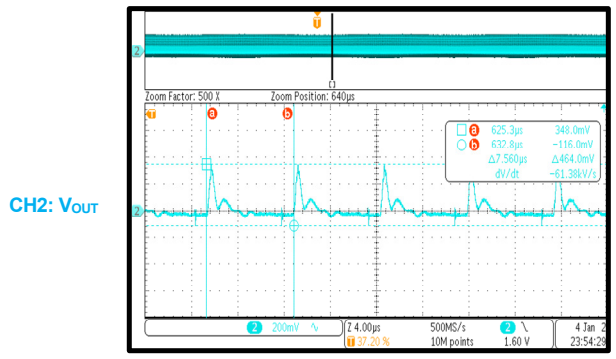
Output Voltage Ripple

V_{IN} = 115V_{AC}



Output Voltage Ripple

V_{IN} = 230V_{AC}

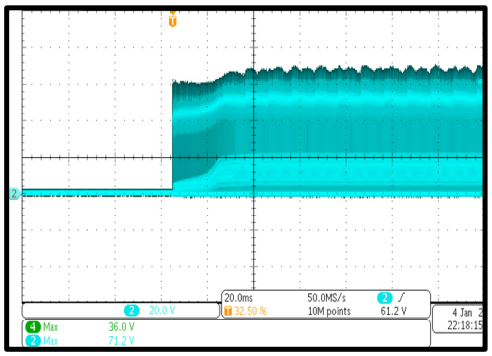


TYPICAL PERFORMANCE CHARACTERISICS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 265V_{AC}, V_{OUT} = 12V, I_{OUT1} = 1.67A, T_A = 25°C, unless otherwise noted.

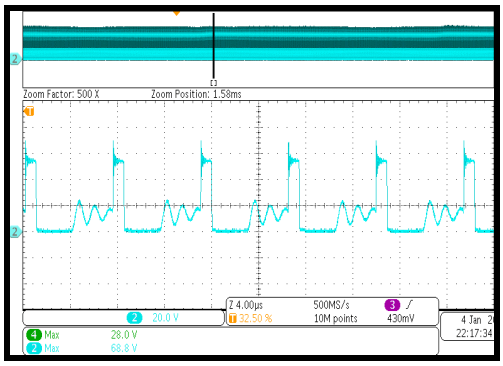
Secondary Diode Stress

CH2: V_{D6}



Secondary Diode Stress

CH2: V_{D6}

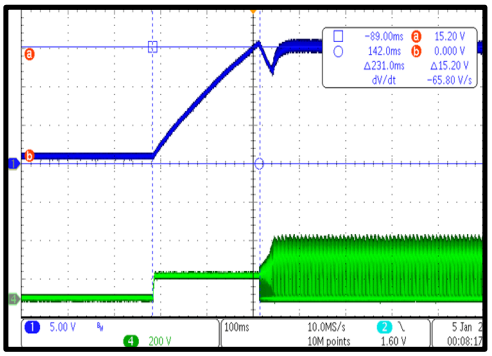


Turn-On Delay

V_{IN} = 85V_{AC}

CH1: V_{CC}

CH4: V_{DS}

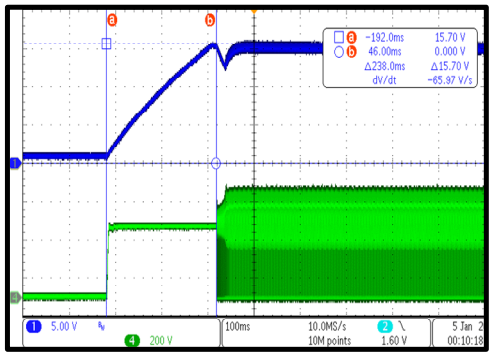


Turn-On Delay

V_{IN} = 265V_{AC}

CH1: V_{CC}

CH4: V_{DS}

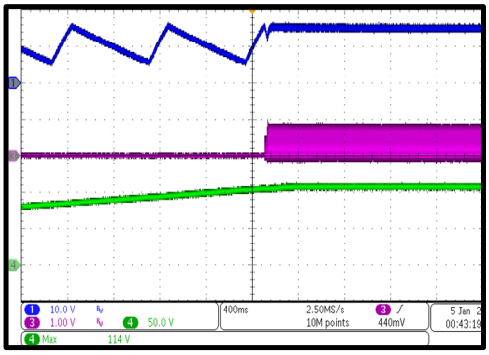


DC Brown-In

CH1: V_{CC}

CH3: V_{CS}

CH4: V_{BUS}

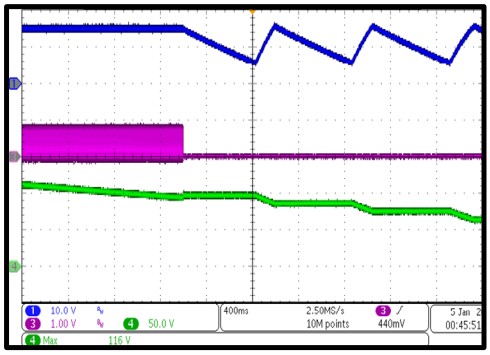


DC Brownout

CH1: V_{CC}

CH3: V_{CS}

CH4: V_{BUS}

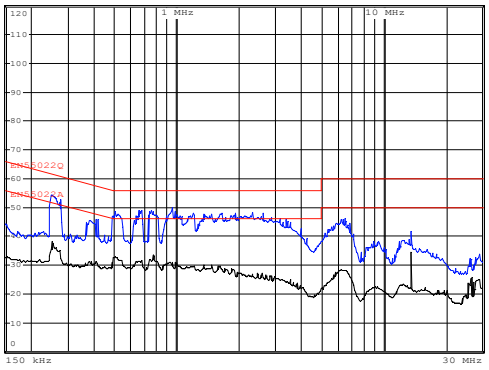


TYPICAL PERFORMANCE CHARACTERISICS *(continued)*

Performance waveforms are tested on the evaluation board. V_{IN} = 265V_{AC}, V_{OUT} = 12V, I_{OUT1} = 1.67A, T_A = 25°C, unless otherwise noted.

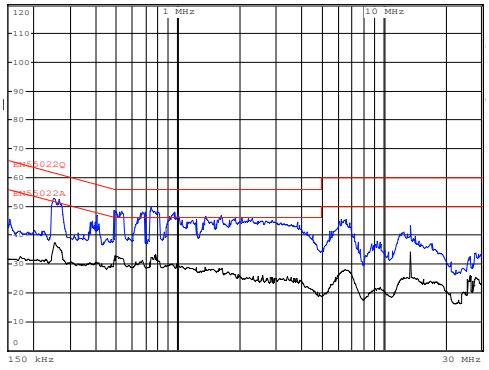
EMI

115V_{IN} live wire



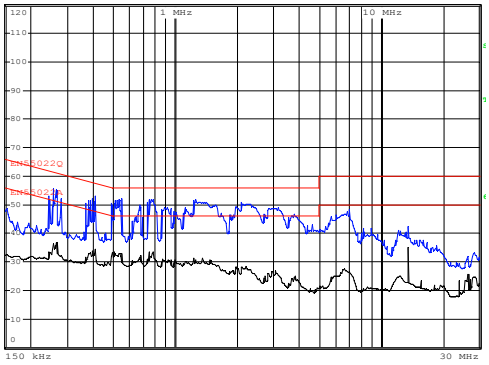
EMI

115V_{IN} neutral wire



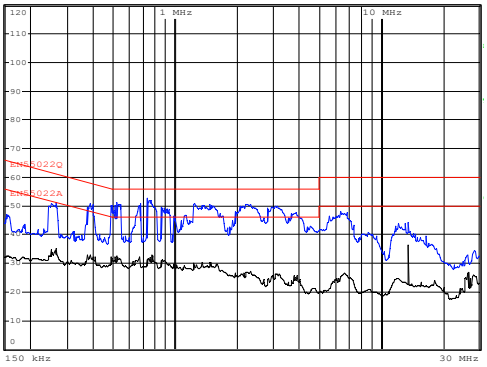
EMI

230V_{IN} live wire



EMI

230V_{IN} neutral wire



PCB LAYOUT

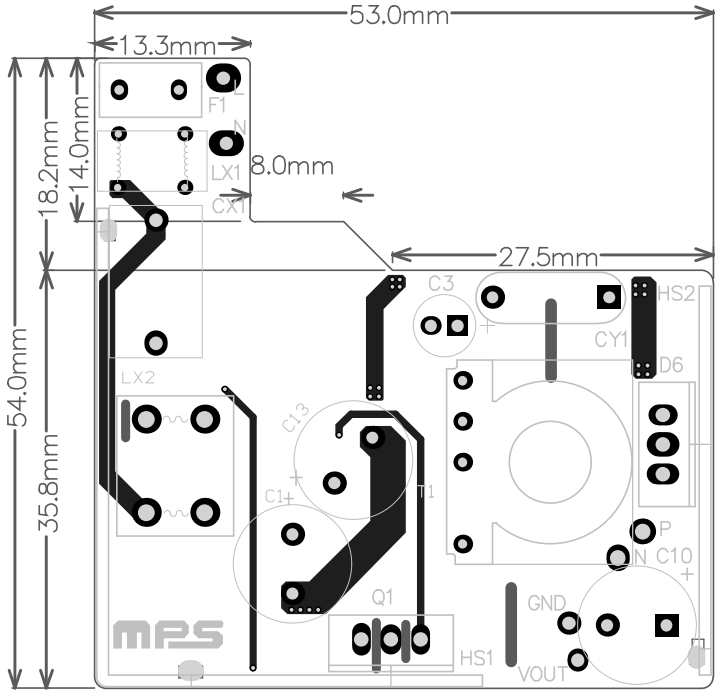


Figure 6: Top View

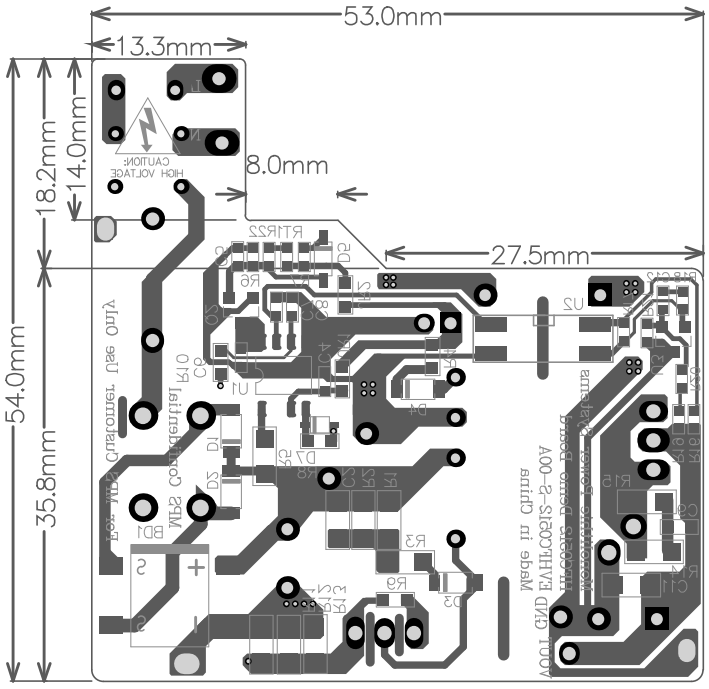


Figure 7: Bottom View

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	3/6/2024	Initial Release	-