EVHF500A-20-P-00A

100V_{AC}/60Hz to 265V_{AC}/50Hz, 12V/1.5A Output, 18W, AC/DC Power Supply Converter Evaluation Board

DESCRIPTION

The EVHF500A-20-P-00A is an evaluation board designed to demonstrate the capabilities of the HF500A-20 (a single-stage, isolated flyback power supply converter) in AC/DC power module and adapter applications.

The HF500A-20 is a fixed-frequency, current-mode regulator with built-in slope compensation. It combines a 700V MOSFET and a full-featured controller into one chip for a low-power, offline, flyback, switch-mode power supply. The device optimizes EMI performance, especially for radiated emission.

The HF500A-20 features a wide 100V_{AC} to 265V_{AC} input voltage (V_{IN}) range and a 12V/1.5A constant voltage output.

The HF500A-20 achieves low standby power consumption and high efficiency under full-load conditions. The HF500A-20 can pass EN55022/CISPR 22 Class B standards for both conducted emissions (CE) and radiated emissions (RE).

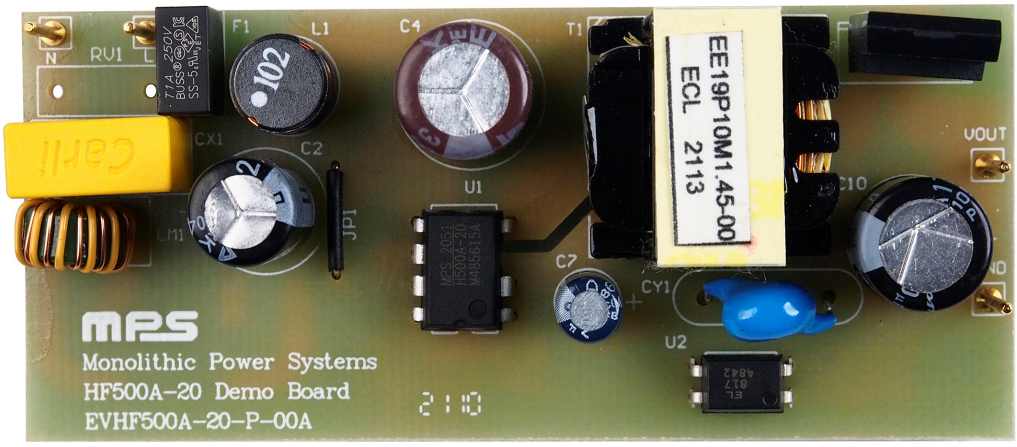
Full protection features include brownout (BO) protection, output short-circuit protection (SCP), overload protection (OLP), output over-voltage protection (OVP), and over-temperature protection (OTP).

PERFORMANCE SUMMARY

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

Parameters	Conditions	Value
Input voltage (V_{IN}) range		100V_{AC} to 265V_{AC}
Output voltage (V_{OUT})	V_{IN} = 100V_{AC} to 265V_{AC}, I_{OUT} = 0A to 1.5A	12V
Maximum output current (I_{OUT})	V_{IN} = 100V_{AC} to 265V_{AC}	1.5A
Typical efficiency	V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A	87.1%

EVALUATION BOARD



LxWxH (8mmx35mmx20mm)

DBoard Number	MPS IC Number
EVHF500A-20-P-00A	HF500A-20

QUICK START GUIDE

1. Preset the power supply input voltage (V_{IN}) between 100V_{AC} and 265V_{AC}.
2. Turn off the power supply.
3. Connect the power supply terminals to:
   a. Line terminal: L port
   b. Neutral terminal: N port
4. Connect the load terminals to:
   a. Positive (+): VOUT
   b. Negative (-): GND
5. After making the connections, turn on the power supply. The device should start up automatically.

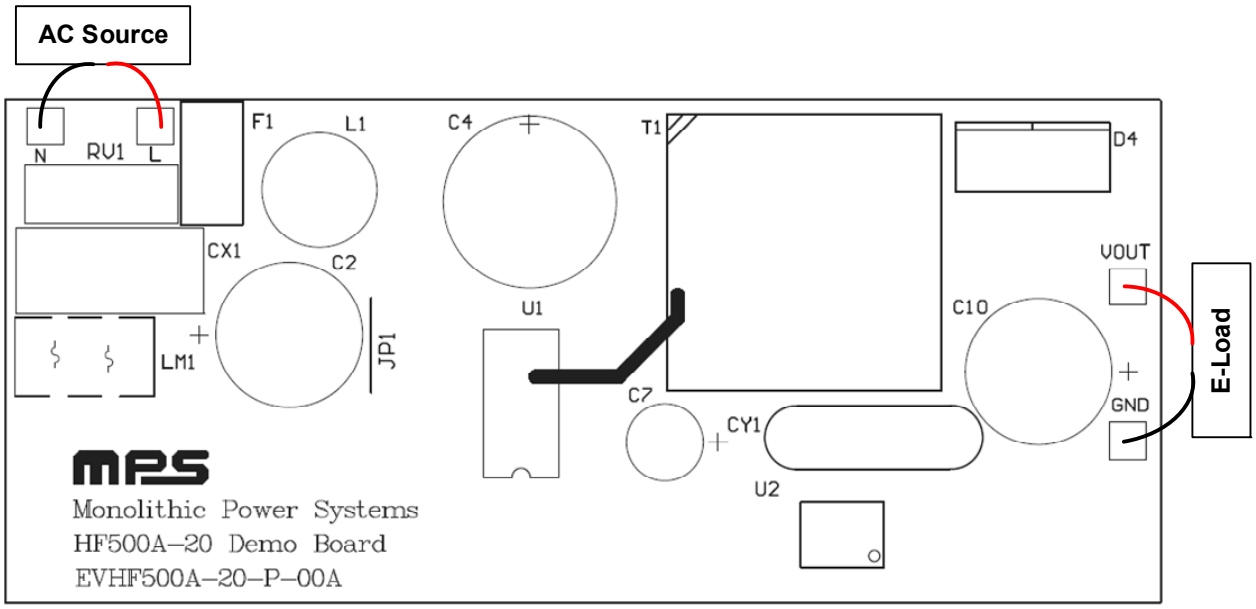


Figure 1: Measurement Equipment Set-Up

EVALUATION BOARD SCHEMATIC

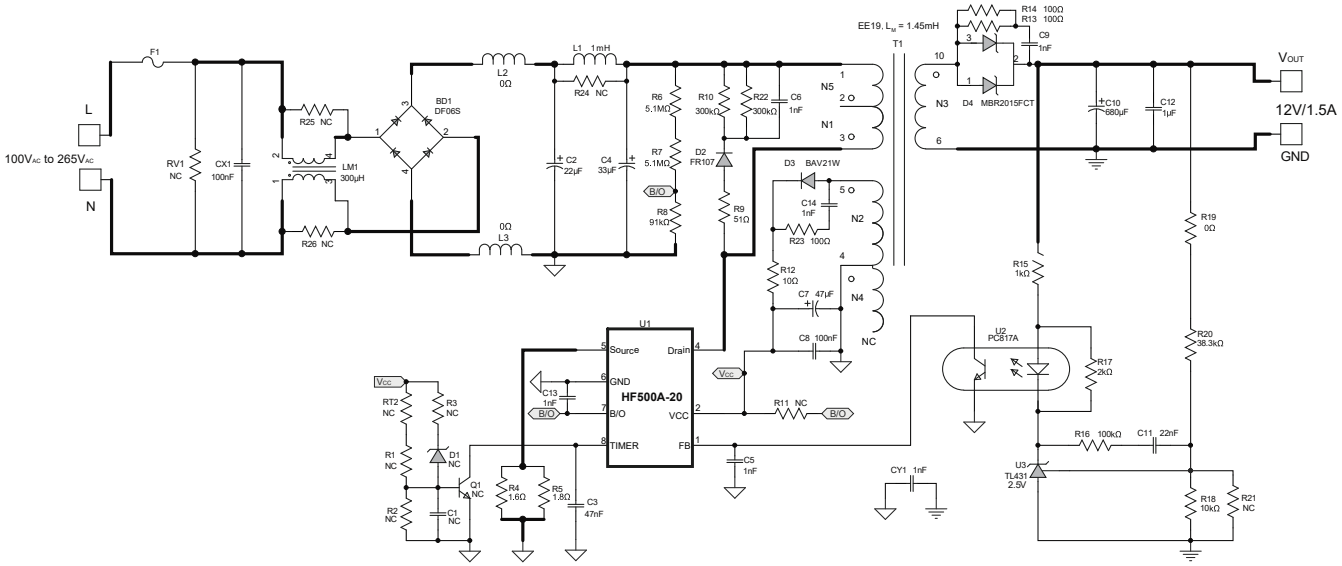


Figure 2: Evaluation Board Schematic

EVHF500A-20-P-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	BD1	600V	Bridge rectifier, 1A	SOIC-4	Fairchild	DF06S
1	C2	22µF	Electrolytic capacitor, 400V	DIP	Aihua	ERK2GM220F16OT
1	C4	33µF	Electrolytic capacitor, 400V	DIP	Yongming	KCX 400V 33uF 10*18
1	C3	47nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H473KA61D
1	C5	1nF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H102K
1	C6	1nF	Ceramic capacitor, 630V, U2J	1206	Murata	GRM31A7U2J102JW31D
1	C7	47µF	Electrolytic capacitor, 25V	DIP	Jianghai	CD286-25V47
1	C8	100nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
2	C9, C14	1nF	Ceramic capacitor, 250V, U2J	0805	Murata	GRM21A7U2E102JW31D
1	C10	680µF	Electrolytic capacitor, 25V	DIP	Rubycon	25ZLH680MEFC10*16
1	C11	22nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H223KA01D
1	C12	1µF	Ceramic capacitor, 25V, X5R	0603	TDK	C1608X7R1E105K
1	C13	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H102KA01D
1	CX1	100nF	X-capacitor, 275V_{AC}	DIP	Carli	PX104K3IC39L270D9R
1	CY1	1nF	Y-capacitor, 250V_{AC}	DIP	Hongke	JNK09E102MY02N
1	D2	1000V	Diode, 1A	SOD-123	MSV	FR107
1	D3	200V	Diode, 0.2A	SOD-123	Diodes	BAV21W-7-F
1	D4	150V	Diode, 20A	TO-220AB	Xutong	MBR20150FCT
1	F1	250V	Fuse,1A	DIP	Cooper	SS-5-1A
1	L1	1mH	Inductor, 0.5A	DIP	Wurth	768772102
1	LM1	300µH	Common chock	DIP	Emei	TP4U300-00
1	R4	1.6Ω	Film resistor, 1%	1206	Yageo	RC1206FR-071R6L
1	R5	1.8Ω	Film resistor, 1%	1206	Yageo	RC1206FR-071R8L
2	R6, R7	5.1MΩ	Film resistor, 1%	1206	Yageo	RC1206FR-075M1L
1	R8	91kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0791KL
1	R9	51Ω	Film resistor, 1%	1206	Yageo	RC1206FR-0751RL
2	R10, R22	300kΩ	Film resistor, 1%	1206	Yageo	RC1206FR-07300KL
1	R12	10Ω	Film resistor, 1%	1206	Yageo	RC1206FR-0710RL
2	R13, R14	100Ω	Film resistor, 5%	1206	Yageo	RC1206JR-07100RL
1	R15	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
1	R16	100kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R17	2kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-072KL
1	R18	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R19	0Ω	Film resistor, 5%	0603	Yageo	RC0603JR-070RL
1	R20	38.3kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0738K3L
1	R23	100Ω	Film resistor, 1%	0805	Yageo	RC0805FR-07100RL
1	JP1	9mm	Jumper	9mm	Any	
1	JR1	0Ω	Film resistor, 1%	0805	Yageo	RC0805FR-070RL

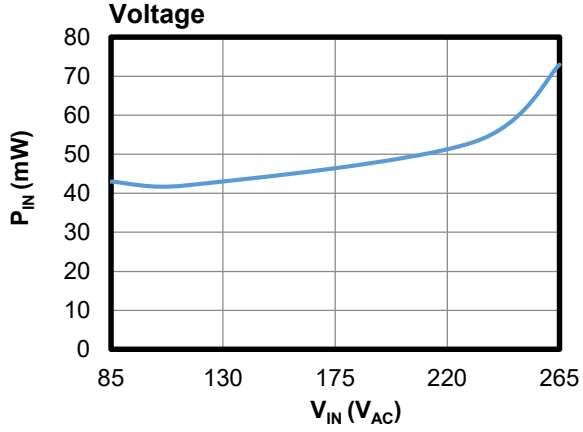
EVHF500A-20-P-00A BILL OF MATERIALS *(continued)*

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
3	JR2, L2, L3	0Ω	Film resistor, 1%	1206	Yageo	RC1206FR-070RL
1	T1	1.45mH	Transformer	Broaden EE19	Emei	FX0610
1	U2	PC817A	Photocoupler	DIP	Taiwan Yiguang	PC817A
1	U3	CJ431	Shunt regulator	SOT23	Changdian	CJ431
1	U1	HF500A-20	Single-stage, isolated flyback regulator	PDIP8-7B	MPS	HF500AGP-20

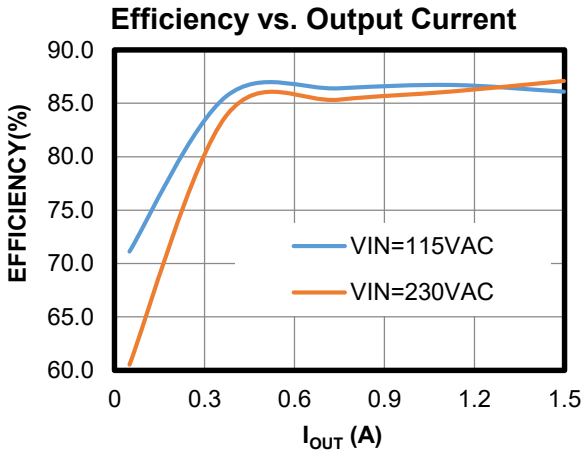
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A, T_A = 25°C, unless otherwise noted.

Input Power with No Load vs. Input Voltage



Efficiency vs. Output Current

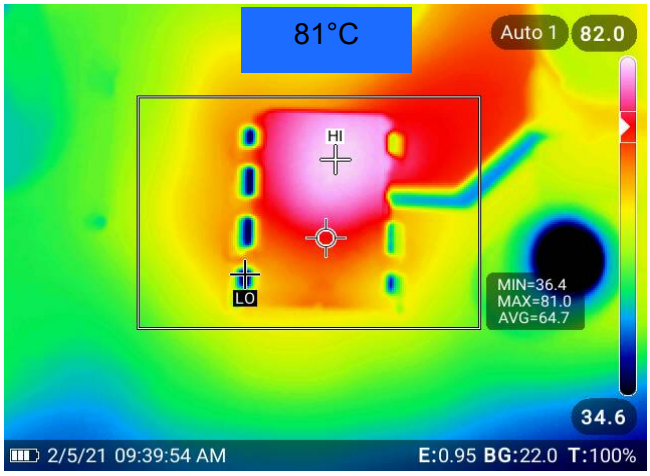


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A, T_A = 25°C, unless otherwise noted.

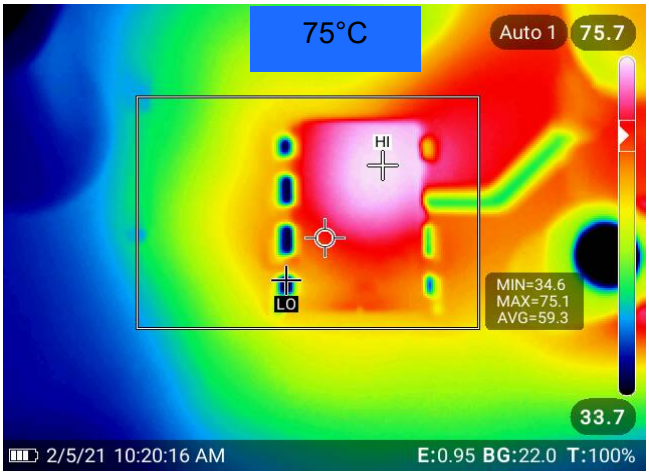
Thermal Performance

V_{IN} = 100V_{AC}



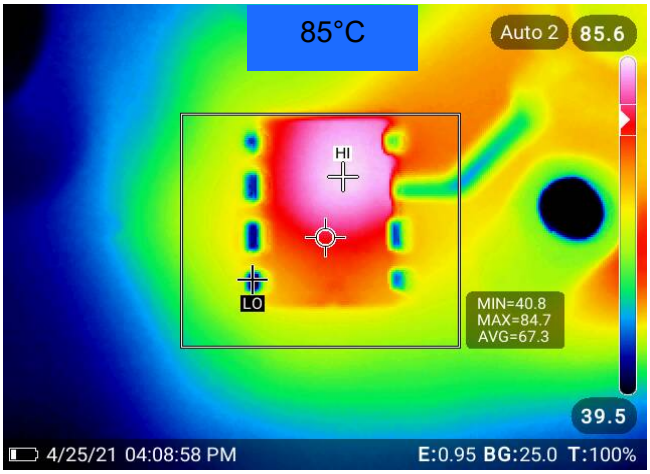
Thermal Performance

V_{IN} = 265V_{AC}, I_{OUT} = 1.5A



Thermal Performance

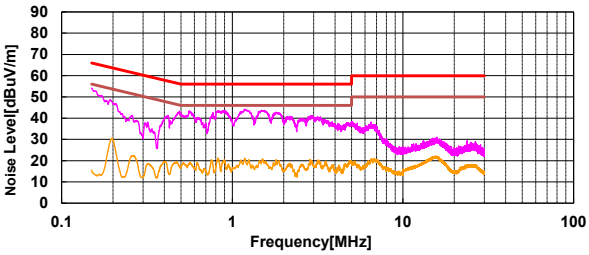
V_{IN} = 265V_{AC}, I_{OUT} = 1.3A, V_{DS} turns on at its peak value (worst case)



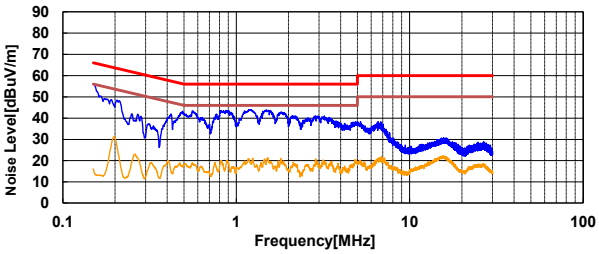
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A, T_A = 25°C, unless otherwise noted.

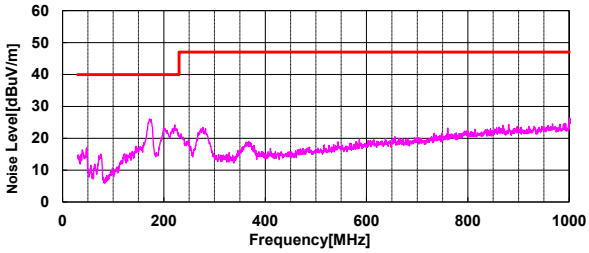
Conducted EMI
L line



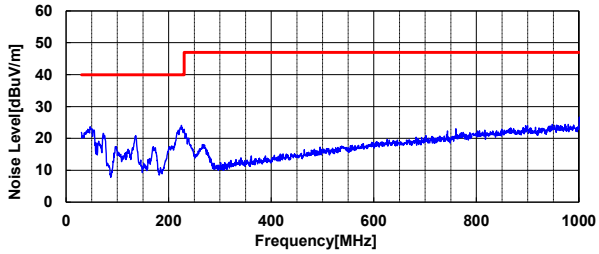
Conducted EMI
N Line



Radiated EMI
Horizontal



Radiated EMI
Vertical

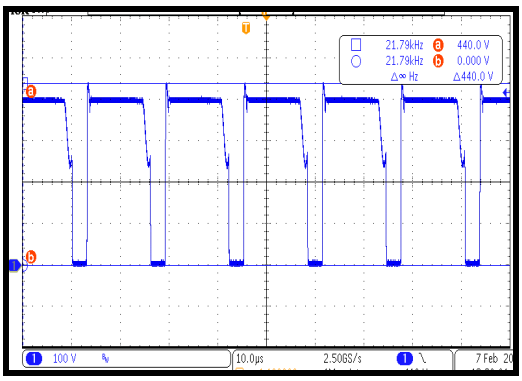


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A, T_A = 25°C, unless otherwise noted.

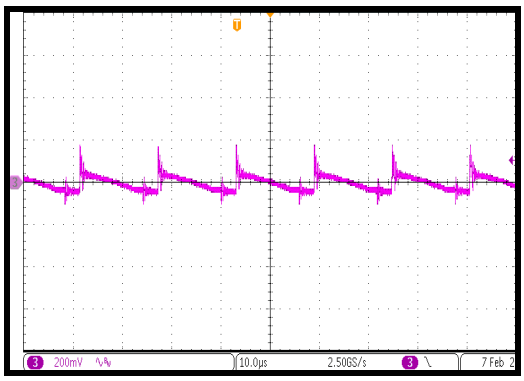
Stress

CH1: V_{DS} 100V/div



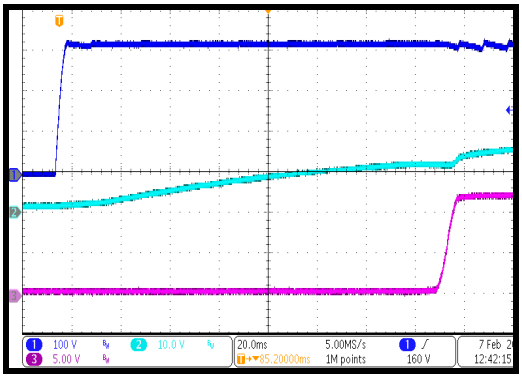
Output Ripple

CH1: V_{OUT_AC} 200mV/div



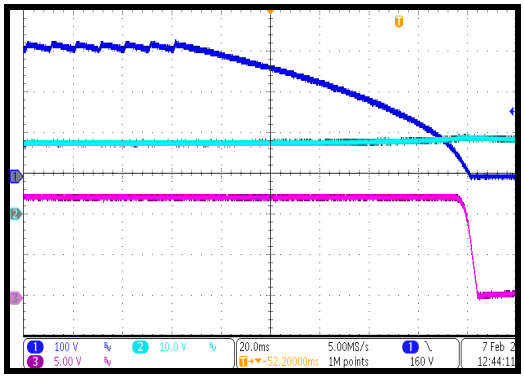
Start-Up

CH1: V_{BUS} 100V/div
CH2: V_{CC} 10V/div
CH3: V_{OUT} 5V/div



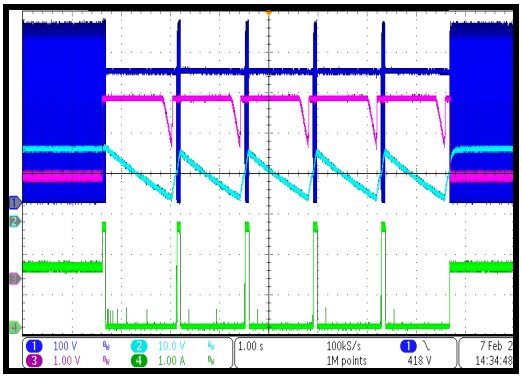
Shutdown

CH1: V_{BUS} 100V/div
CH2: V_{CC} 10V/div
CH3: V_{OUT} 5V/div



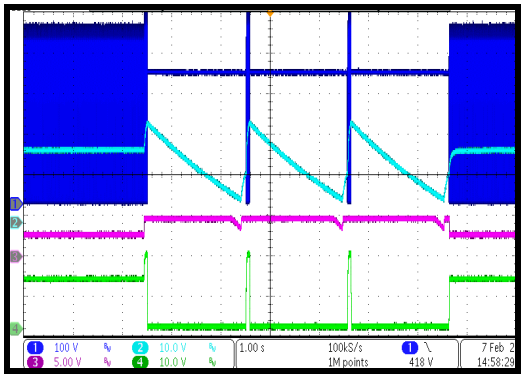
OLP Entry and Recovery

CH1: V_{DS} 100V/div
CH2: V_{CC} 10V/div
CH3: V_{FB} 1V/div
CH4: I_{OUT} 1A/div



OVP Entry and Recovery

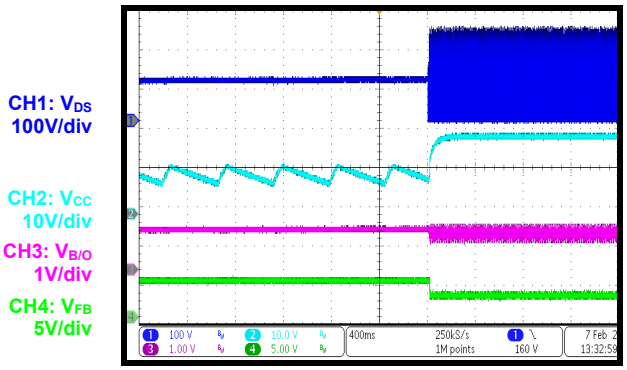
CH1: V_{DS} 100V/div
CH2: V_{CC} 10V/div
CH3: V_{FB} 5V/div
CH4: V_{OUT} 10V/div



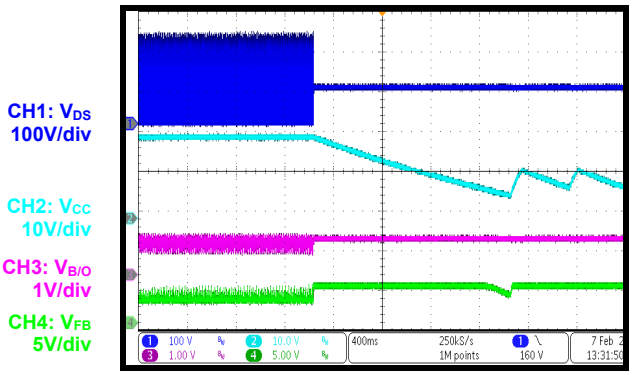
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board. V_{IN} = 230V_{AC}, V_{OUT} = 12V, I_{OUT} = 1.5A, T_A = 25°C, unless otherwise noted.

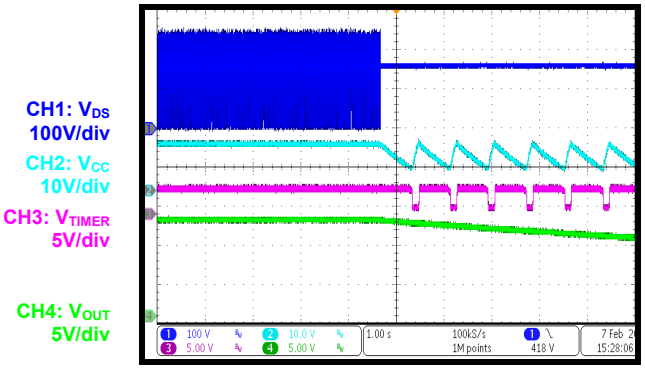
V_{IN} Increases until Brown-In



V_{IN} Decreases until Brownout



OTP Entry during Normal Operation



TRANSFORMER SPECIFICATIONS

Basic Characteristics

Table 1: Basic Characteristics

Parameter	Value
Core	Broadened EE19
Bobbin	Broadened EE19 vertical, 5 + 5 pin
Primary inductance	1.45mH
Core material	PC40 or equivalent
Turn ratio	N_P:N_S:N_{P_AUX} = 77:11:13

Electrical Diagram

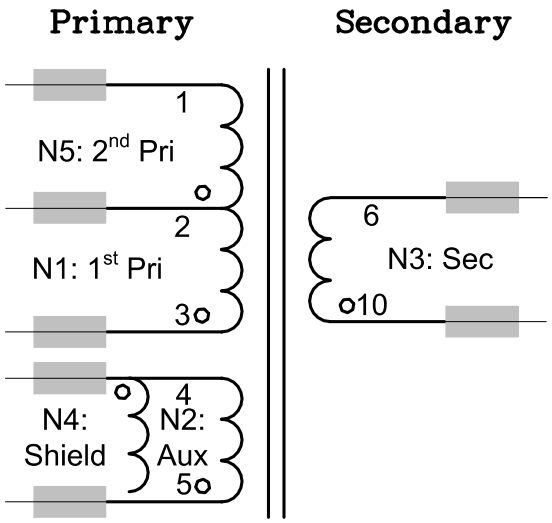


Figure 3: Transformer Electrical Diagram

Winding Diagram

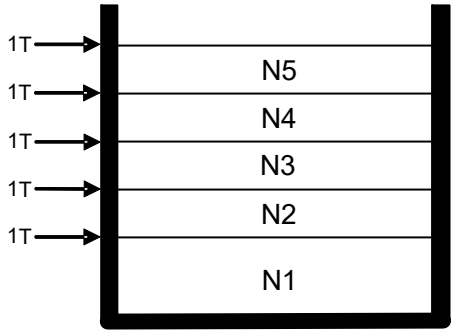


Figure 4: Winding Diagram

Winding Order

Table 2: Winding Order

Tapes (T)	Winding	Start and End	Wire Diameter (Ø)	Turns (T)
0	N1	3 to 2	0.25mm x 1	52
1	N2	5 to 4	0.15mm x 1	13
1	N3	10 to 6	0.45mm x 2 TIW	11
1	N4	4 to NC	0.25mm x 1	25
1	N5	2 to 1	0.25mm x 1	25

Electrical Specifications

Table 3: Electrical Specifications

Electrical Strength	60s, 60Hz, from PRI to SEC	3500 V_{AC}
	60s, 60Hz, from PRI to CORE	1500 V_{AC}
	60s, 60Hz, from SEC to CORE	1500 V_{AC}
	60s, 60Hz, from N1 to N2	500V_{AC}
Primary Inductance	Pin 3 to pin 1, all other windings are open, measured at 60kHz, 0.1V_{RMS}	1.45mH ± 10%

CIRCUIT DESCRIPTION

The EVHF500A-20-P-00A is configured with the HF500A-20 for 12V/1.5A flyback applications, and uses secondary side control to achieve a precise voltage output.

The fuse (F1) protects the system from component failures due to excessive short events.

The NTC thermistor (RV1) limits the inrush current during start-up.

To meet EN5502 standards, the X-capacitor (CX1) and common chock (LM1) are implemented to filter EMI noise. The Y-capacitor (CY1) also reduces conducted EMI.

C2 and C4 are input bulk capacitors that rectify the AC sinusoidal curve.

A primary-side snubber (R10, R22, C6, and D2) suppresses the voltage spike on the MOSFET by absorbing the leakage inductance when the MOSFET turns off.

Place resistors R6, R7, and R8 in series to form a resistor divider connected to B/O to sense the input voltage (V_{IN}) for input brown-in (BI) protection, brownout (BO) protection, and over-voltage protection (OVP). If the BO function is not required, do not use a resistor divider, and instead connect the B/O and VCC pins using a large-value resistor (R11) so that the B/O voltage exceeds 6V during normal operation.

To improve efficiency, it is recommended that the output diode (D4) be a Schottky diode due to its fast switching speed and low forward-voltage drop.

R13, R14 and C9 form a secondary-side snubber to suppress the voltage spike on D4.

The photocoupler (U2), shunt regulator (U3), and the components around them (R15, R16, R17, R18, R20, and C11) form the feedback circuit. C11 and R16 form the compensation network.

T1 is power transformer that should be designed to meet the application's power delivery requirements and reduce EMI.

C10 is a low-ESR electrolytic output capacitor that reduces the output voltage ripple and improve efficiency. C12 is a small ceramic capacitor that reduces high-frequency noise on the output.

PCB LAYOUT

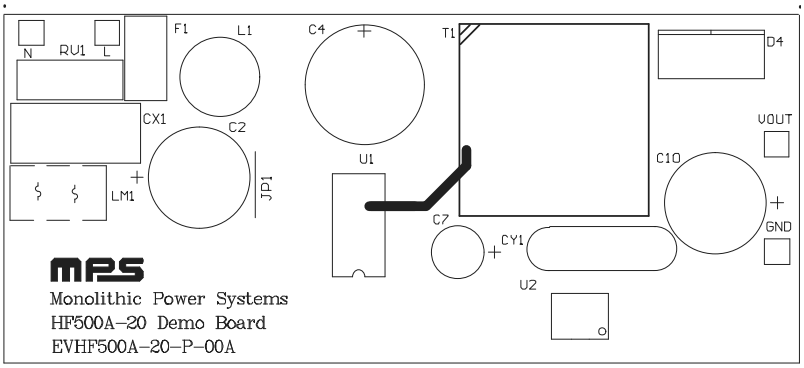


Figure 5: Top Layer

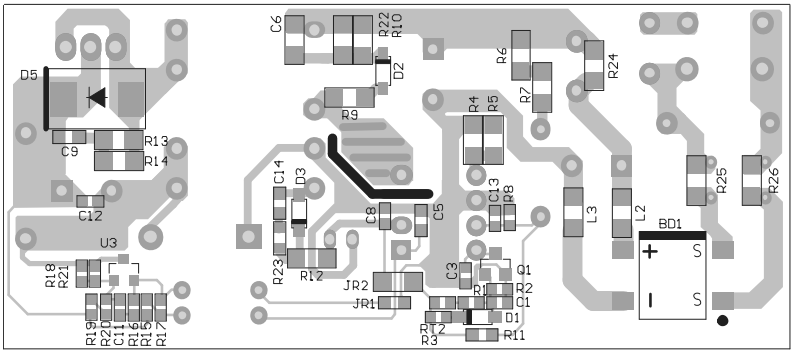


Figure 6: Bottom Layer

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	9/18/2023	Initial Release	-