

DESCRIPTION

The EVHR1200-M-02A is a general-purpose evaluation board for the HR1200 for 240W PC adapters and gaming power applications.

The HR1200 integrates a digital PFC controller and a half-bridge resonant controller into a single chip. It uses very low power at no load or ultra-light load, making it compliant with Energy Using Product Directive (EuP) Lot 6 and Code of Conduct Version 5 Tier 2 specifications.

The PFC of the HR1200 employs a patented average current control scheme, which can operate in continuous conduction mode (CCM) and discontinuous conduction mode (DCM) according to the instantaneous condition of the input voltage and output load. The IC exhibits excellent efficiency and a high power factor (PF) at light load.

The half-bridge LLC converter achieves high efficiency with zero-voltage switching (ZVS). The HR1200 implements an adaptive dead-time adjustment (ADTA) function so the LLC converter can easily achieve ZVS from heavy load to light load. Additionally, the HR1200 can prevent the LLC converter from operating in capacitive mode, making it more robust and easier to design.

Typically, the EVHR1200-M-02A is designed for PC adapters and gaming power applications with a 12V, 20A constant voltage output and 240W rated power from 90V_{AC} to 265V_{AC} and 50Hz/60Hz.

The EVHR1200-M-02A has excellent efficiency and a high power factor for the entire load range. Full protection features include overload protection, short-circuit protection (SCP), over-voltage protection (OVP), and anti-capacitive mode protection. The EVHR1200-M-02A also meets the Class C standard of IEC61000-3-2 and EN55022 standard.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input AC voltage	V _{IN_AC}	90 to 265	V
Output current	I _{OUT}	20	A
Output voltage	V _{OUT}	12	V
Output power	P _{OUT}	240	W

FEATURES

- Wide Operating Input Range (from 90V to 265V)
- 240W Rated Power and Constant Voltage Output
- High Efficiency up to 93%
- Meets EuP Lot 6 and COC Version 5 Tier 2 Specifications
- Meets Class C Standard of IEC61000-3-2
- Meets EN55022 Standard
- Meets EN61000-4-5 Level 4 for Surge Immunity (4kV)
- High Power Factor (PF)
- Overload Protection (Auto-Restart Mode)
- Short-Circuit Protection (SCP) (Auto-Restart Mode)
- Over-Voltage Protection (OVP)
- Anti-Capacitive Mode Protection

APPLICATIONS

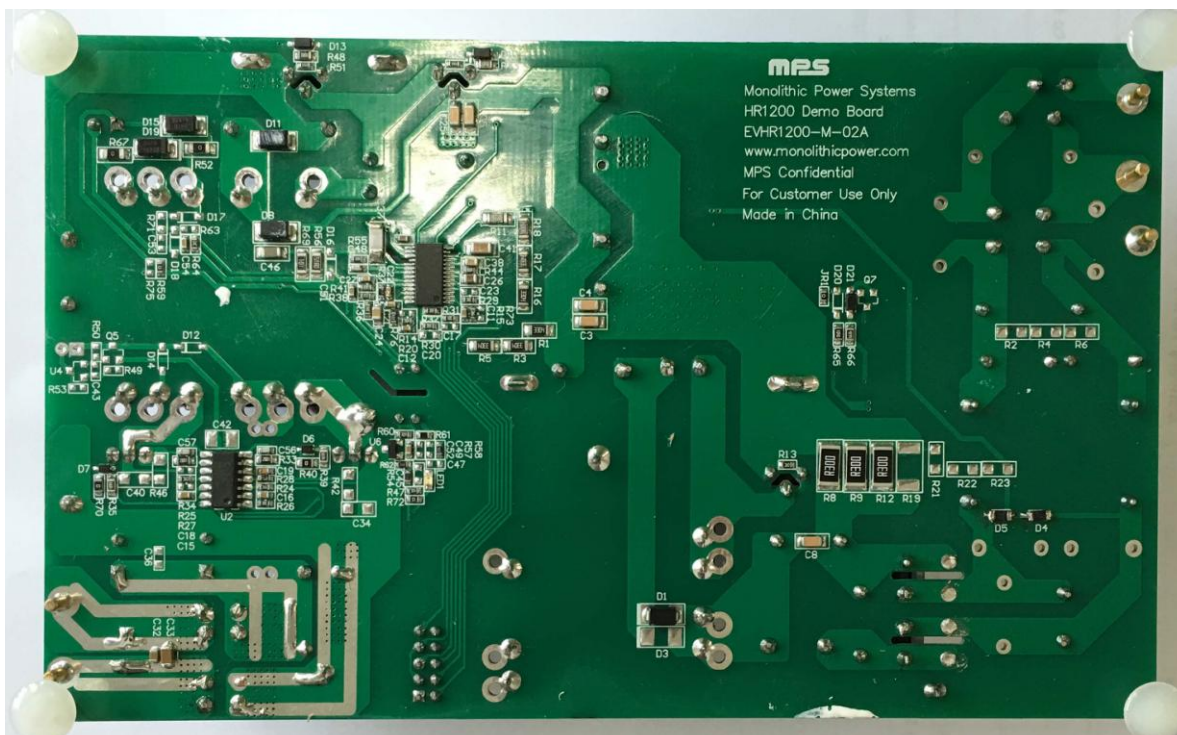
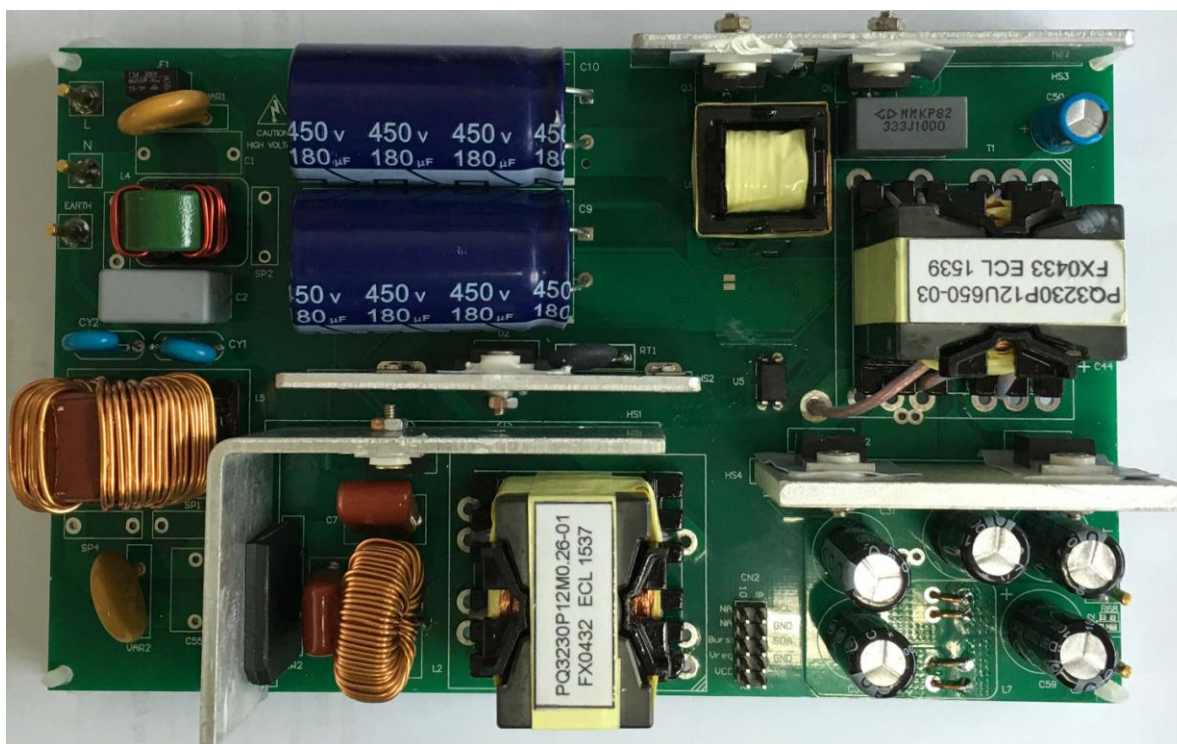
- Gaming Power Supplies
- PC Adapters Applications

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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 AC input to the prototype board.

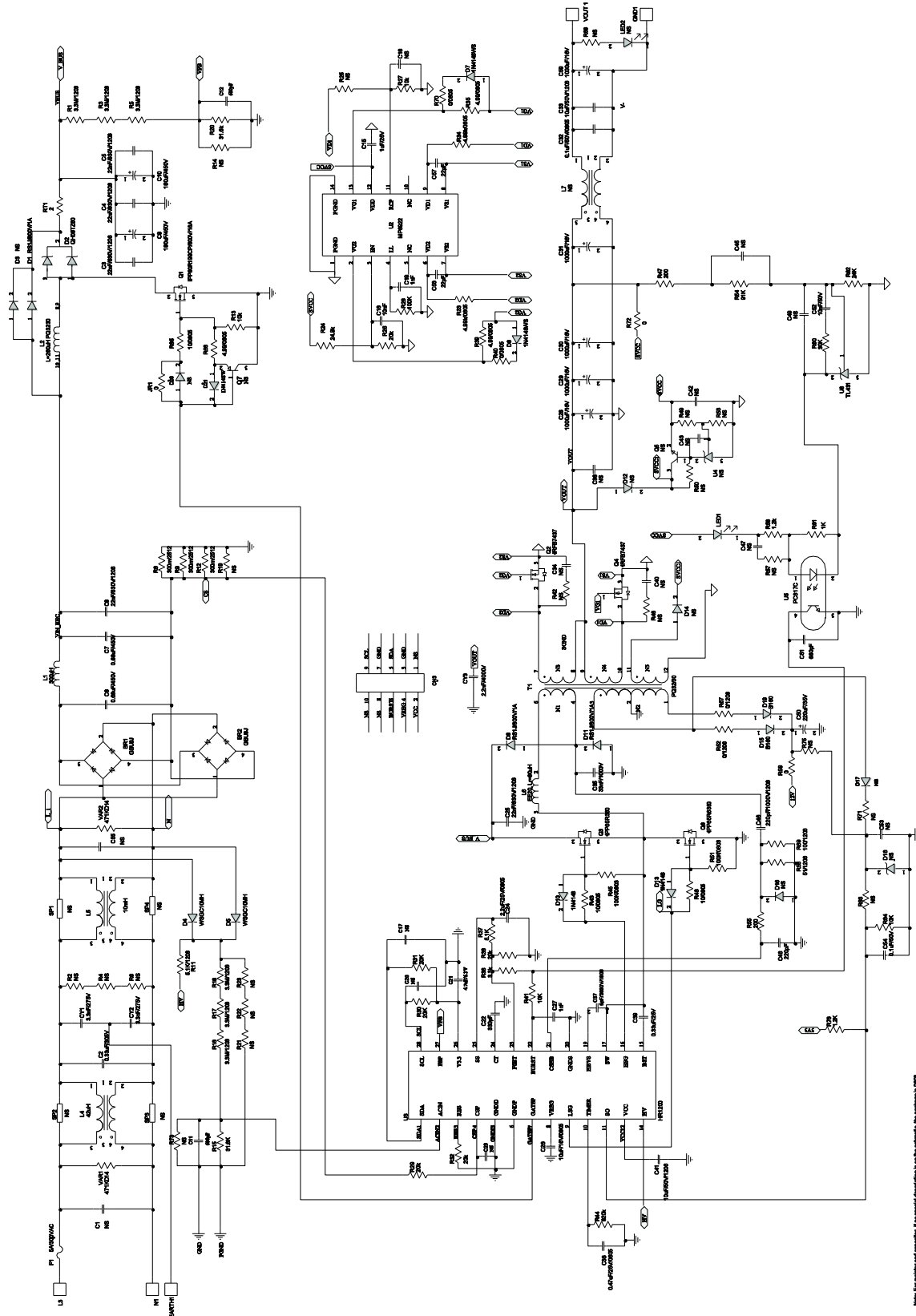
EVHR1200-M-02A EVALUATION BOARD



(L x W x H) (17.4cm x 10.55cm x 3.5cm)

Board Number	MPS IC Number
EVHR1200-M-02A	HR1200GM
	MP6922DS

EVALUATION BOARD SCHEMATIC



Note: For number and location, if repeated description is not the same, the page is 1000

EVHR1200-M-02A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
2	CY1, CY2	3.3nF	Y-capacitor, 2600V, 20%	DIP	HongKe	JYK10F332MY72N
1	CY3	2.2nF	Y-capacitor, 4000V, 20%	DIP	HongKe	JNK12E222MY02N
5	C28, C29, C30, C31, C59	1000µF	Electrolytic capacitor, 16V	DIP	JIANGHAI	C287-16V1000
1	C2	0.33µF	X-capacitor, 310V	DIP	VISHAY	BFC233920334
2	C6, C7	0.68µF	Capacitor, 450V, CBB	DIP	CARLI	TF684K2Y10BL270D9R
5	C3, C4, C5, C8, C25	22nF	Ceramic capacitor, 630V, X7R	1206	TDK	C3216X7R2J223K
1	C15	1µF	Ceramic capacitor, 25V, X7R	0603	Murata	GRM188R71E105KA12D
2	C9, C10	180µF	Electrolytic capacitor, 450V	DIP	JIANGHAI	CD263-450V180
3	C11, C12, C51	680pF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H681KA01D
0	C1, C17, C18, C20, C23, C34, C40, C55, C45, C42, C43, C44, C47, C49, C36, C53	NS				
2	C19, C27	1nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H102KA01D
1	C54	0.1µF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D
1	C39	0.33µF	Ceramic capacitor, 25V, X5R	0603	TDK	C1608X5R1E334K
1	C22	330pF	Ceramic capacitor, 50V, COG	0603	TDK	C1608COG1H331D
1	C48	220pF	Ceramic capacitor, 50V, COG	0603	Murata	GMR1885C1H221JA01D
1	C37	5pF	Ceramic capacitor, 3000V, NP0	1808	HHEC	C1808N5R0J302T
2	C16, C52	10nF	Ceramic capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
1	C21	4.7µF	Ceramic capacitor 6.3V, X5R	0603	TDK	C1608X5R0J475K
1	C32	0.1µF	Ceramic capacitor, 50V, X7R	0805	TDK	C2012X7R1H104K
1	C35	33nF	Capacitor, 1000V	DIP	FaLa	MMKP82-1000V-333P15JA
1	C38	0.47µF	Ceramic capacitor, 25V, X7R	0805	Murata	GMR21BR71E474KA01L
2	C33, C41	10µF	Ceramic capacitor, 50V, X5R	1206	Murata	GRM31CR61H106KA12L

EVHR1200-M-02A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
1	C26	10μF	Ceramic capacitor, 16V, X7R	0805	Murata	GMR21BR61C106KE15
1	C46	220pF	Ceramic capacitor, 1000V, U2J	1206	Murata	GMR31A7U3A221JW31D
1	C50	220μF	Electrolytic capacitor, 35V	DIP	JIANGHAI	CD110-35V220
1	C24	2.2μF	Ceramic capacitor, 25V, X7R	0805	Murata	GRM21BR71E225KA73L
2	C56,C57	22pF	Ceramic capacitor, 50V, COG	0603	TDK	C1608COG1H220J
0	R2, R4, R6, R14, R19, R21, R22, R23, R25, R42, R46, R49, R50, R53, R57, R63, R68, R71, R73, R75	NS				
3	R35, R39, R66	4.99	Film resistor, 1%	0805	Yageo	RC0805FR-074R99L
6	R26, R29, R30, R31, R32, R36	20K	Film resistor, 1%;	0603	Yageo	RC0603FR-0720KL
6	R1, R3, R5, R16, R17, R18	3.3M	Film resistor, 1%	1206	Yageo	RC1206FR-073M3L
1	R11	5.1K	Film resistor, 1%	1206	Yageo	RC1206FR-075K1L
2	R33, R34	4.99K	Film resistor, 1%	0805	Yageo	RC0805FR-074K99L
2	R58, R76	1.2K	Film resistor, 1%	0603	Yageo	RC0603FR-071K2L
3	R28, R45, R51	100K	Film resistor, 1%	0603	Yageo	RC0603FR-07100KL
1	R24	24.9K	Film resistor, 1%	0603	Yageo	RC0603FR-0724K9L
3	R43, R48, R65	10	Film resistor, 1%	0805	Yageo	RC0805FR-0710RL
1	R60	30k	Film resistor, 1%	0603	Yageo	RC0603FR-0730KL
3	R8, R9, R12	0.3	Film resistor, 1%	2512	Yageo	RL2512FK-070R3L
1	R37	5.1K	Film resistor, 1%	0603	Yageo	RC0603FR-075K1L
4	R13, R27, R41, R64	10K	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
2	R15, R20	31.6K	Film resistor, 1%	0603	Yageo	RC0603FR-0731K6L
1	R44	820K	Film resistor, 1%	0603	Yageo	RC0603FR-07820KL
1	R61	1K	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
2	R47, R55	200	Film resistor, 1%	0603	Yageo	RC0603FR-07200RL
1	R38	3.3K	Film resistor, 1%	0603	Yageo	RC0603FR-073K3L
2	R52, R67	0	Film resistor, 5%	1206	Yageo	RC1206JR-070RL
3	R59, R72, JR1	0	Film resistor, 5%	0603	Yageo	RC0603JR-070RL

EVHR1200-M-02A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
2	R40, R70	0	Film resistor, 5%	0805	Yageo	RC0805JR-070RL
1	R54	91K	Film resistor, 1%	0603	Yageo	RC0603FR-0791KL
1	R56	51	Film resistor, 1%	1206	Yageo	RC1206FR-0751RL
1	R69	100	Film resistor, 1%	1206	Yageo	RC1206FR-07100RL
1	R62	24K	Film resistor, 1%	0603	Yageo	RC0603FR-0724KL
1	RT1	2	Thermal resistor	DIP	Semitec	2D2-10
2	VAR1, VAR2	471KD14	MOV	DIP	TKS	TVR14471KS42Y
2	BR1, BR2	GBU8J	Bridge rectifier, 600V, 8A	DIP	Diodes	GBU8J
3	D1, D8, D11	RS1J	Diode, 600V, 1A	SMA	Diodes	RS1J
1	D2	QH08TZ60	Diode, 600V, 8A	TO-220	PI	QH08TZ60
2	D4, D5	WSGC10MH	Diode, 1000V, 1A	1206	ZOWIE	WSGC10MH
2	D6, D7	1N4148WS	Diode, 75V, 0.15A	SOD-323	Diodes	1N4148WS
3	D10, D13, D21	1N4148W	Diode, 75V, 0.15A	SOD-123	Diodes	1N4148W
0	D3, D12, D14, D16, D17, D18, D20	NS				
2	D15, D19	B160	Schottky diode, 60V, 1A	SMA	Diodes	B160
1	F1	5A/300VAC	FUSE-SS-5H	DIP	COOPER BUSSMANN	SS-5H-5N-APH
1	L4	42μH	Common choke, 42μH, 6.5A	DIP	Würth	744842742
1	L1	300μH	Filter inductor, 300μH, 3A	DIP	Würth	7447065
1	L5	10mH	Common choke, 10mH, 5A	DIP	Würth	744825510
1	L2	260μH	PFC inductor, L = 260μH, PQ3230	DIP	Emei	FX0432
1	L6	80μH	Resonant inductor, EE20	DIP	Emei	FX0430
0	L7	NS	Jumper wire instead	DIP		
1	Q1	IPP60R199CP	N-channel MOSFET, 650V, 16A	TO220	Infineon	IPP60R199CP
2	Q3, Q6	IPP65R380E	N-channel MOSFET, 700V, 29A	TO220	Infineon	IPP65R380E6
2	Q2, Q4	IRFB7437	N-channel MOSFET, to 220	TO220	IR	IRFB7437
0	Q5, Q7	NS				
0	SP1, SP2, SP3, SP4	NS				
1	T1	0.65mH	Transformer, Lp = 0.65mH N1:N2:N3:N4:N5 = 48:5:5:3:3, PQ3230	DIP	Emei	FX0433

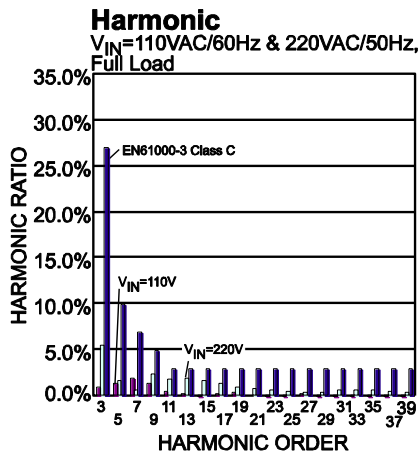
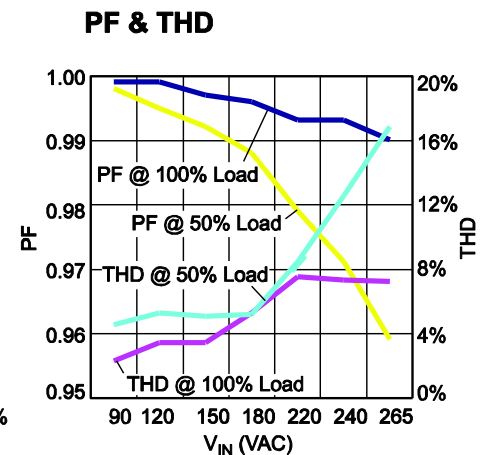
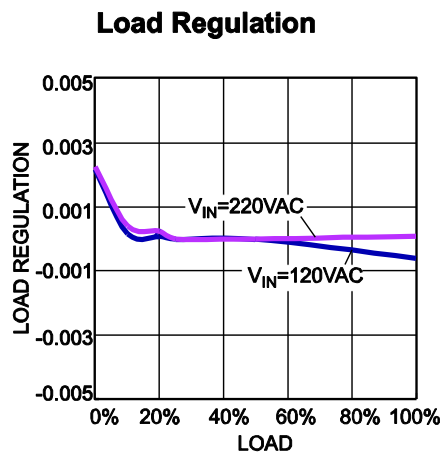
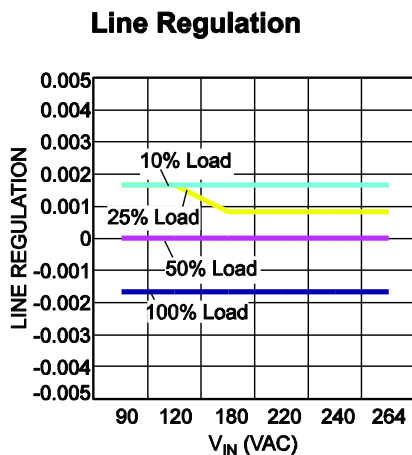
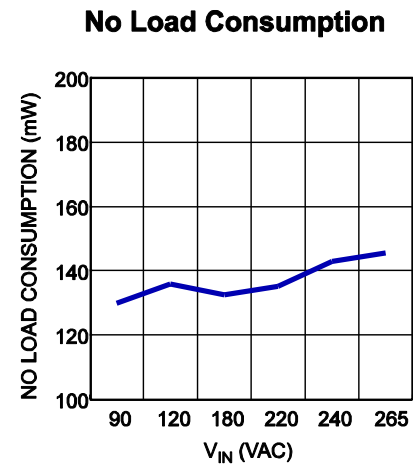
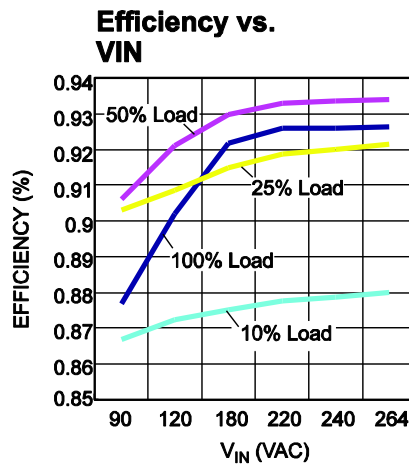
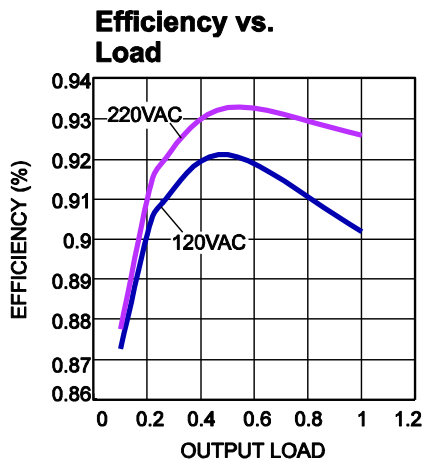
EVHR1200-M-02A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer P/N
1	U3	HR1200	PFC + LLC combo controller		MPS	HR1200
1	U6	TL431	Shunt regulator, $V_{REF} = 2.5V$	SOT-23	Changjiang Electronics	TL431
1	U5	PC817C	Photocoupler, 1-channel	DIP	SHARP	PC817C
0	U4	NS				
1	U2	MP6922	SR controller	SOIC8	MPS	MP6922DS-LF-Z
1	LED1	HL-PSC-2012H203BC	LED, blue	0805	BRIGHT LED	HL-PSC-2012H203BC
0	LED2	NS				
5	VOUT, GND, L, N, Earth		2mm connector pin			
1	HS1		Heatsink for bridge and PFC MOSFET			
1	HS2		Heatsink for PFC rectifier			
1	HS3		Heatsink for LLC primary MOSFETs			
1	HS4		Heatsink for SR MOSFETs			
1	CN2		2x5 pin connector			

EVB TEST RESULTS

Performance waveforms are tested on the evaluation board.

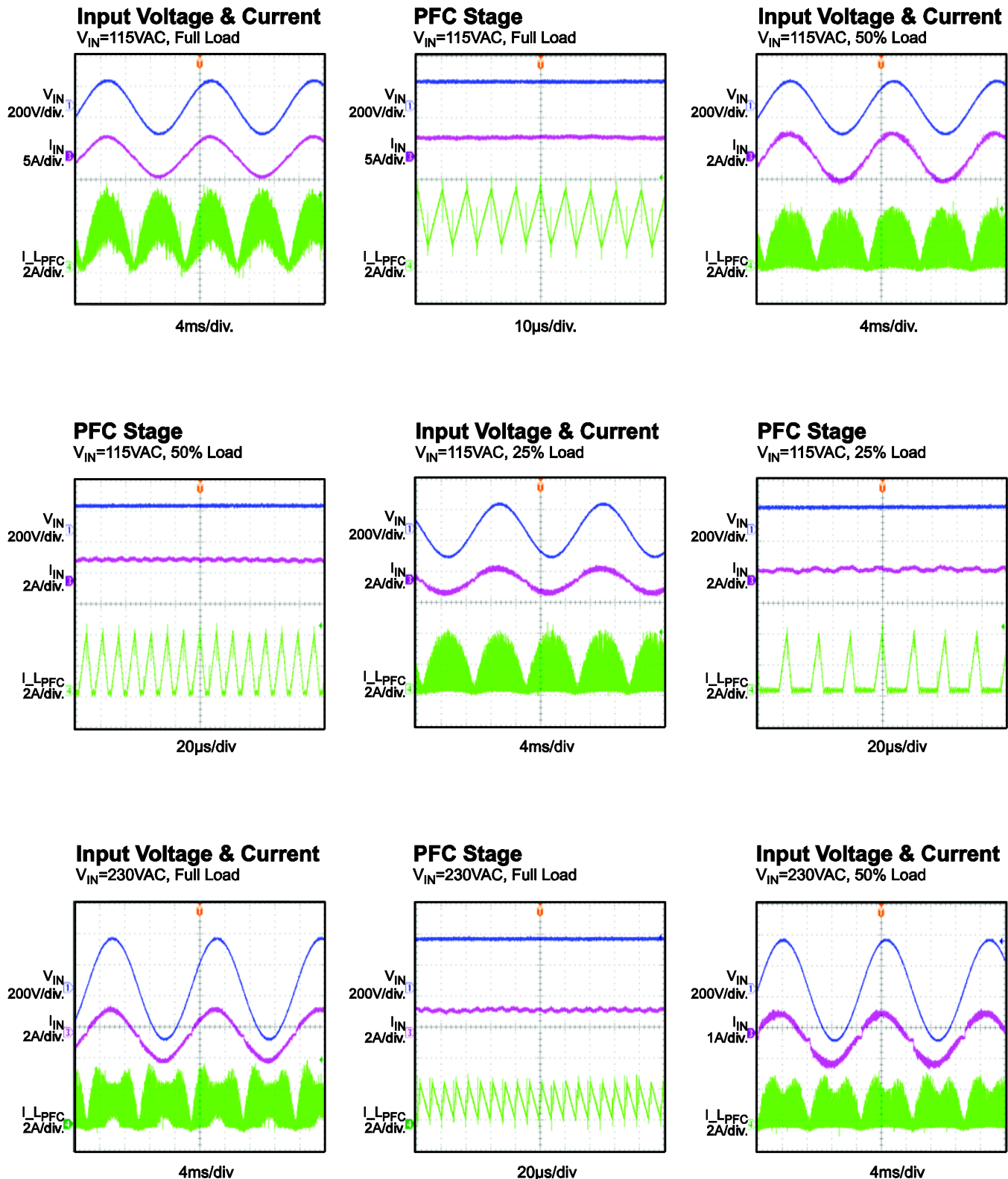
$V_{IN_AC} = 90V \text{ to } 265V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $P_{OUT} = 240W$



EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.

$V_{IN_AC} = 90V$ to $265V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $P_{OUT} = 240W$



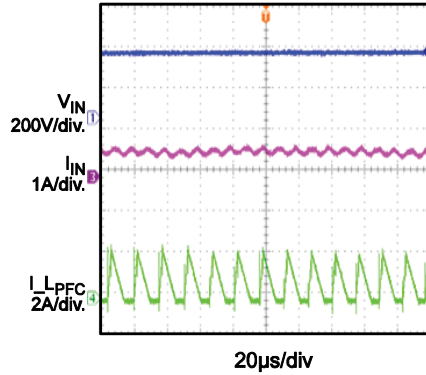
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.

$V_{IN_AC} = 90V$ to $265V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $P_{OUT} = 240W$

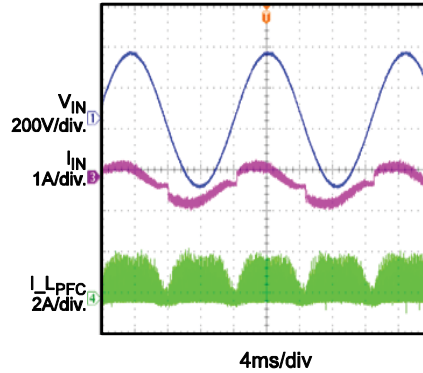
PFC Stage

$V_{IN}=230VAC$, 50% Load



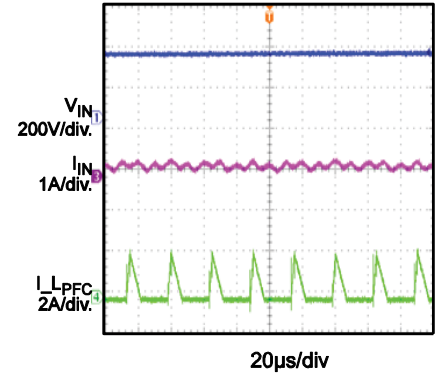
Input Voltage & Current

$V_{IN}=230VAC$, 25% Load

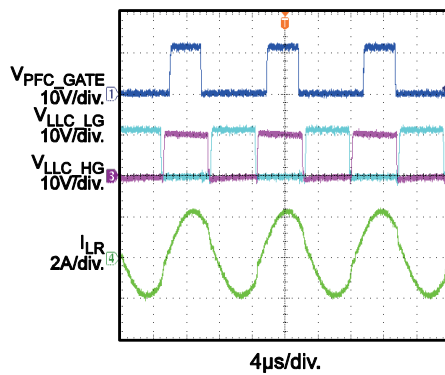


PFC Stage

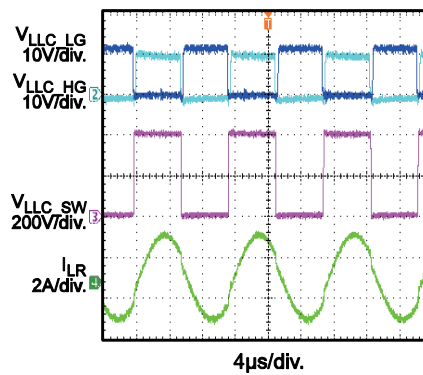
$V_{IN}=230VAC$, 25% Load



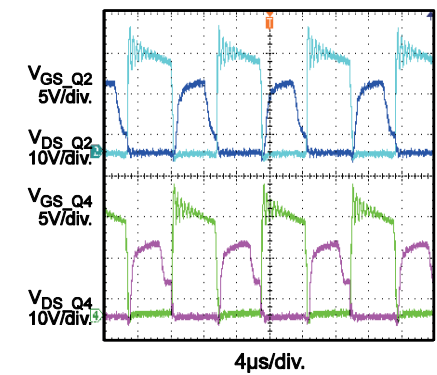
Steady State



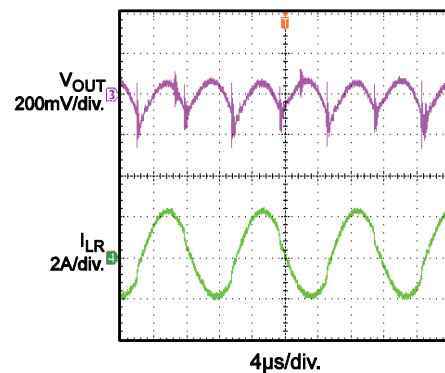
LLC Stage



SR Operation



Output Ripple



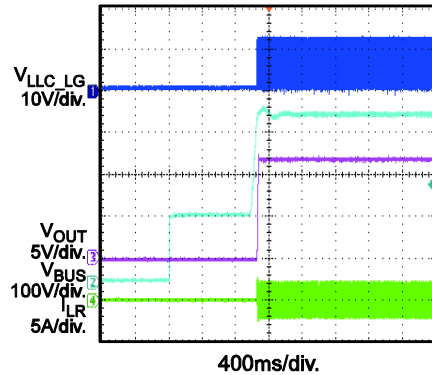
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.

$V_{IN_AC} = 90V$ to $265V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $P_{OUT} = 240W$

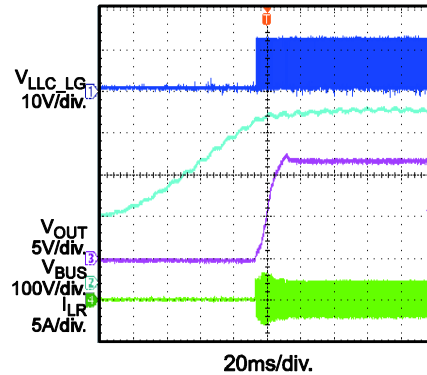
Start-Up

$V_{IN} = 115VAC$



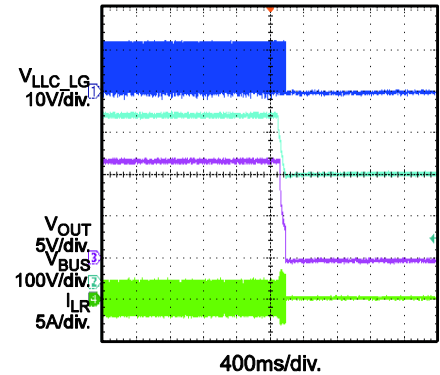
Output Rise Time

$V_{IN} = 115VAC$



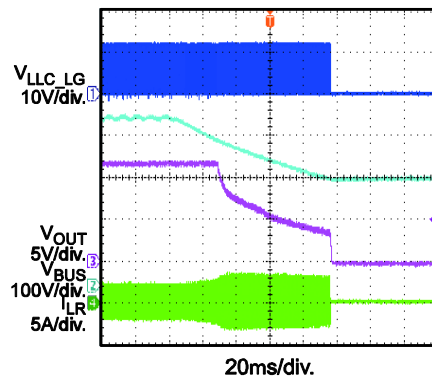
Shutdown

$V_{IN} = 115VAC$



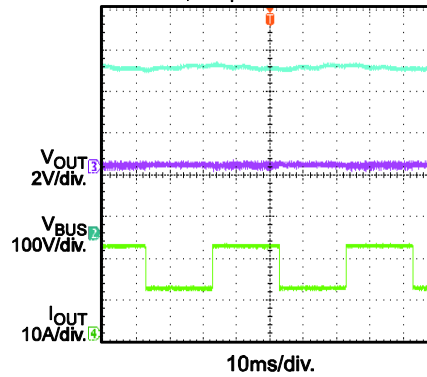
Hold Up Time

$V_{IN} = 115VAC$



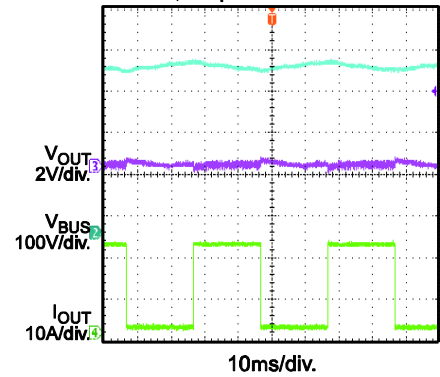
Load Transient

$V_{IN} = 115VAC$,
 $10A-20A$, $1A/\mu s$



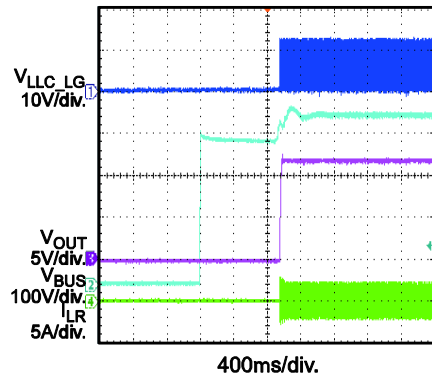
Load Transient

$V_{IN} = 115VAC$,
 $0A-20A$, $1A/\mu s$



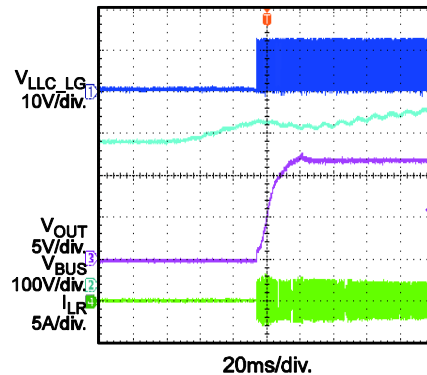
Start-Up

$V_{IN} = 230VAC$



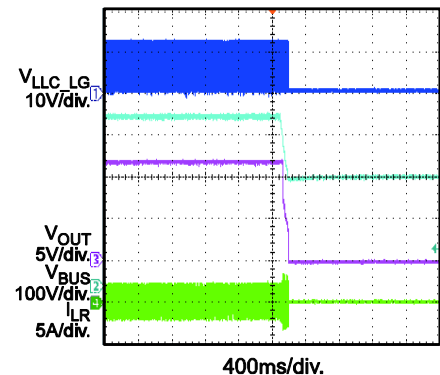
Output Rise Time

$V_{IN} = 230VAC$



Shutdown

$V_{IN} = 230VAC$



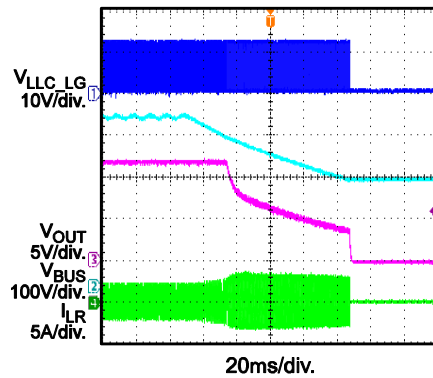
EVB TEST RESULTS (continued)

Performance waveforms are tested on the evaluation board.

$V_{IN_AC} = 90V$ to $265V$, $V_{OUT} = 12V$, $I_{OUT} = 20A$, $P_{OUT} = 240W$

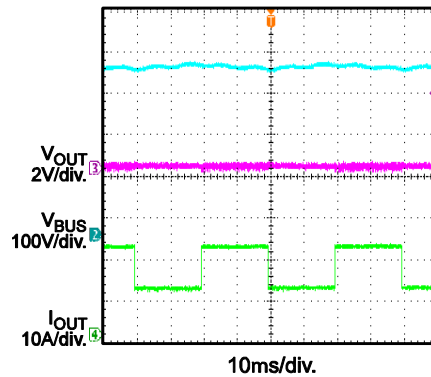
Hold Up Time

$V_{IN} = 230VAC$



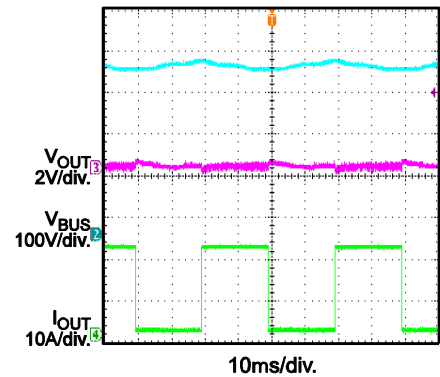
Load Transient

$V_{IN} = 230VAC$,
10A-20A, 1A/ μ s

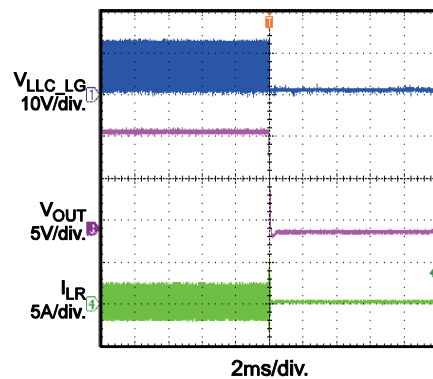


Load Transient

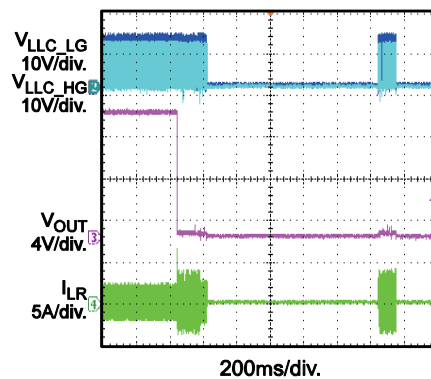
$V_{IN} = 230VAC$,
0A-20A, 1A/ μ s



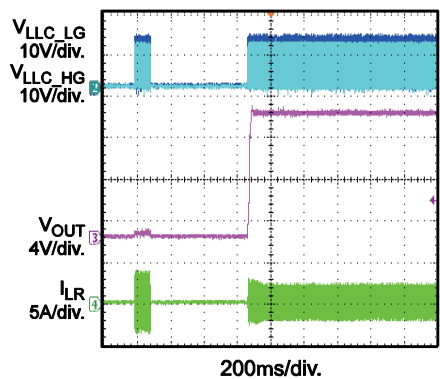
SCP Latch



OCP Enter



OCP Recovery



PRINTED CIRCUIT BOARD LAYOUT

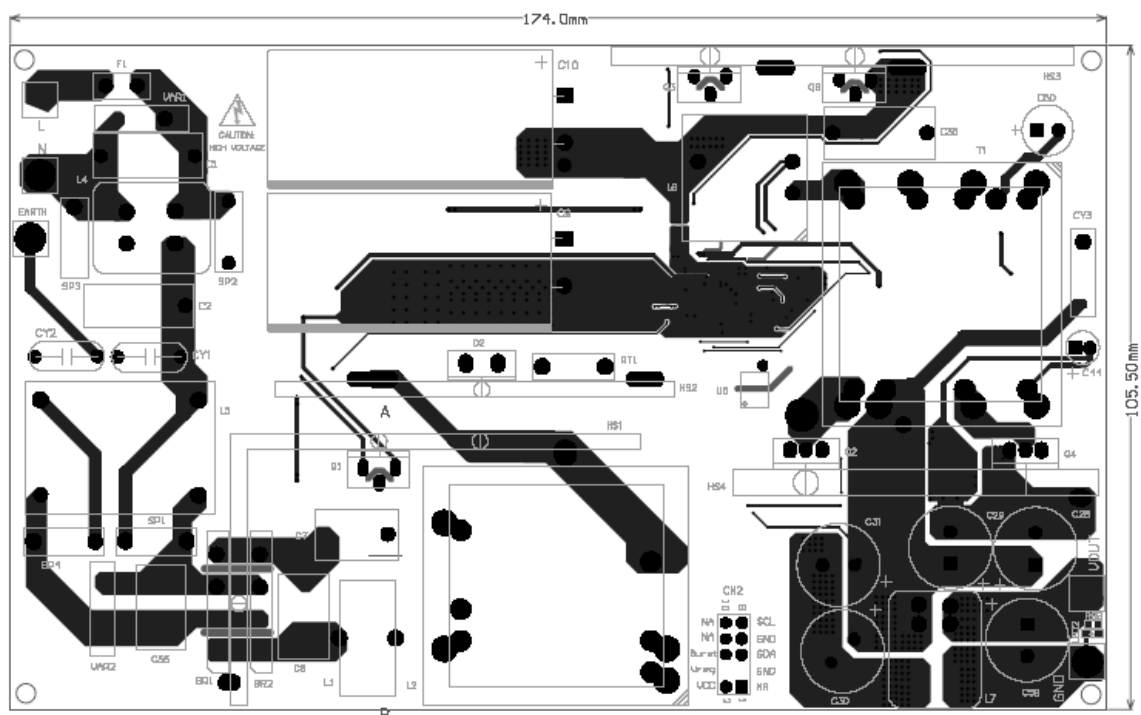


Figure 1: Top Layer

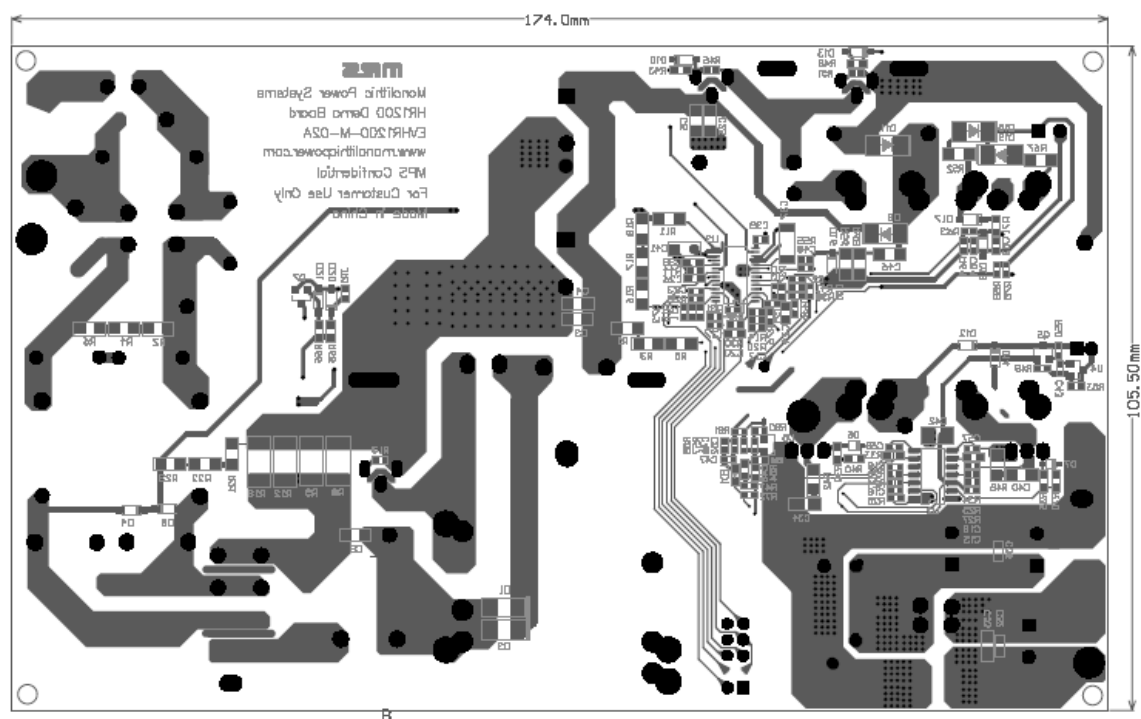


Figure 2: Bottom Layer

SURGE TEST

Line-to-line 4kV and line-to-power earth 4kV surge testing was completed according to EN61000-4-5 Level 4.

The input voltage was set at 220V_{AC}/50Hz. The output was loaded at full load, and operation was verified following each surge event (see Table 1).

Table 1: Surge Test Results

Surge Level (V)	Input Voltage (V _{AC})	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
4000	220	L to N	90	Pass
-4000	220	L to N	270	Pass
4000	220	L to PE	90	Pass
-4000	220	L to PE	270	Pass
4000	220	N to PE	90	Pass
-4000	220	N to PE	270	Pass

CONDUCTED EMI TEST

Figure 3 shows the test with a 115V_{AC} input and full-load condition.

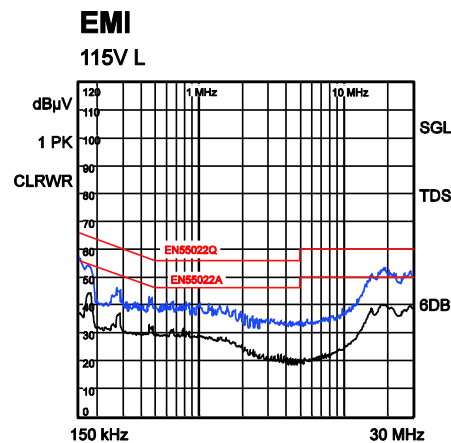


Figure 3: 115V_{AC}, 60Hz, Maximum Load, EN55022 Limits

Figure 4 shows the test with a 230V_{AC} input and full-load condition.

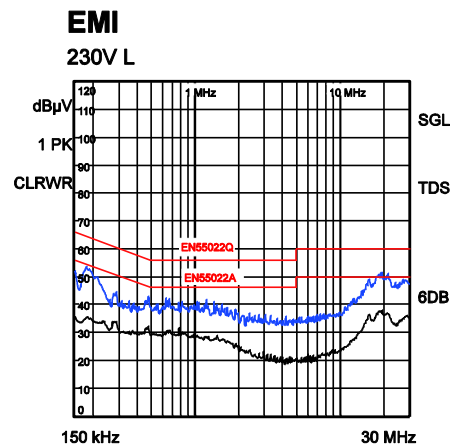


Figure 4: 230V_{AC}, 50Hz, Maximum Load, EN55022 Limits

THERMAL TEST

Figure 5 shows the test with 90V_{AC} input and full-load condition. The PCB layout is with 2oz copper. The ambient temperature is 33°C without air flow.

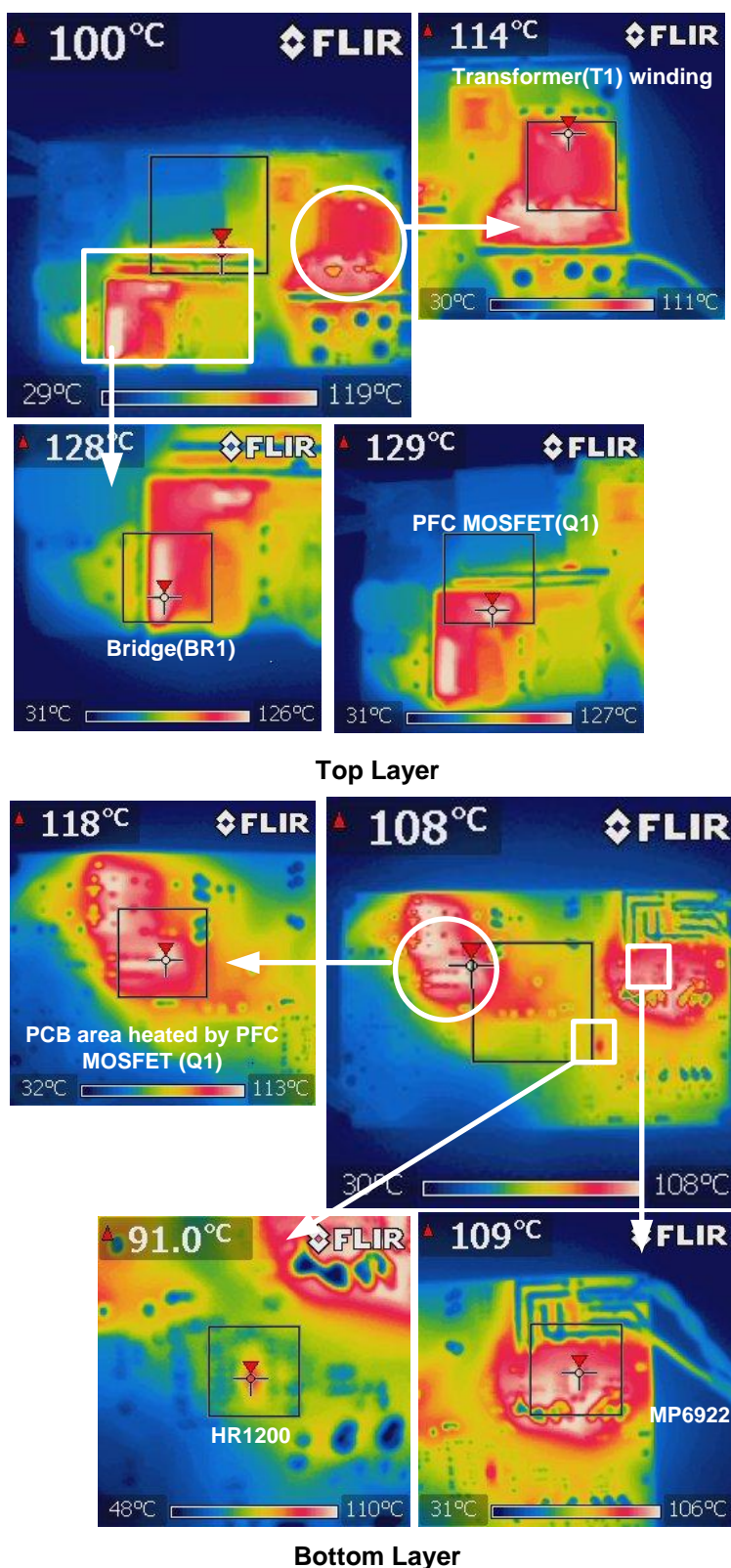


Figure 5: Temperature Chamber Test

QUICK START GUIDE

To quick start the EVB, follow the steps below.

1. Pre-set the power supply to $90V_{AC} \leq V_{IN} \leq 265V_{AC}$.
2. Turn the power supply off.
3. Connect the line and neutral terminals of the power supply output to the L and N ports. For three-wire input applications, connect the earth terminal to the earth port.
4. Connect the positive (+) load to VOUT.
5. Connect the negative (–) load to GND.
6. Turn the power supply on after making the connections.

CONTACT INFORMATION

To request this evaluation board, please refer to your local sales office:

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

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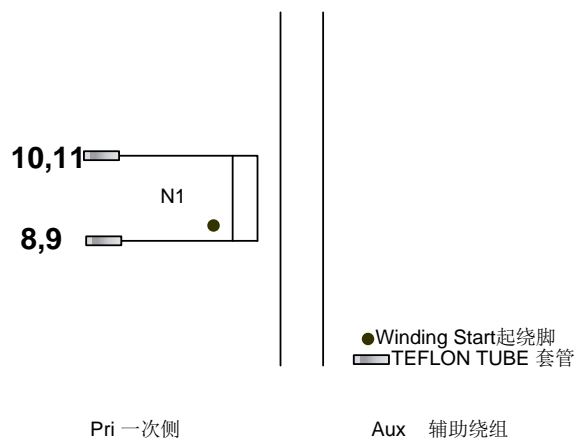
MPS semiconductors are typically used in power supplies in which high voltages are present during operation. High-voltage safety precautions should be observed in design and operation to minimize the chance of injury.

REVISION HISTORY

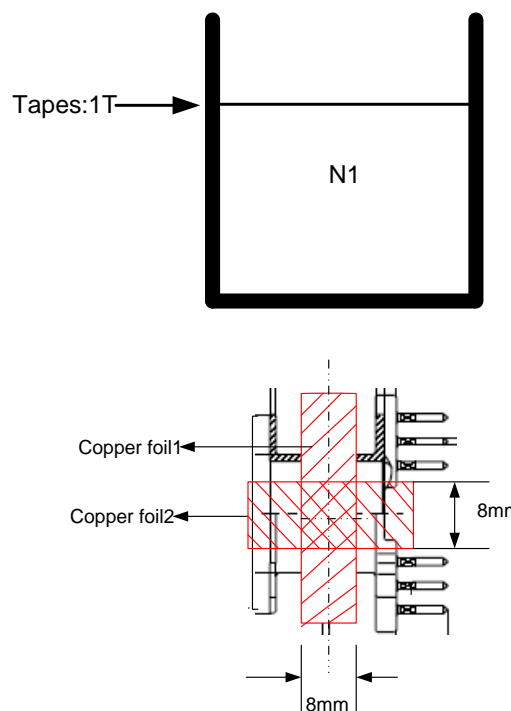
Date	Author	Revision	Description & Changes	Reviewed

APPENDIX 1: PFC INDUCTOR SPECIFICATION

Electrical Diagram



Winding Diagram



Pin Definition of Bobbin

Pin out

1	12
2	11
3	10
4	9
5	8
6	7

View from the top

Note: Core is wrapped with copper foils, as shown above. Connect the foils to pin 4 of the bobbin with wires.

Table 2: Electrical Characteristic

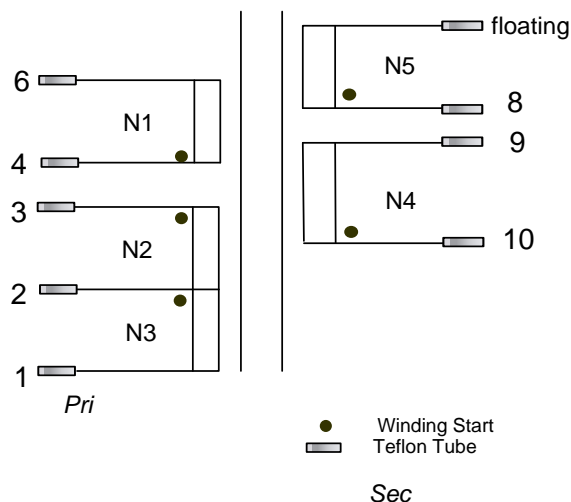
Parameter	Condition	Value
Primary inductance	L (8, 9-10, 11)	260 μ H \pm 10%
Core		PQ3230
Bobbin		PQ3230
Core material		DMR40 or equivalent
Turn ratio	N1	

Table 3: Winding Specification

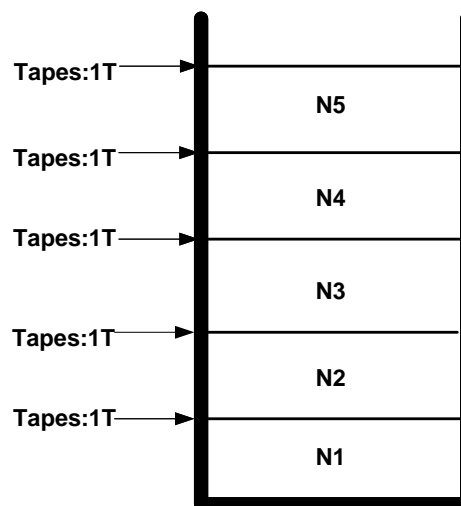
Tape Turns	Winding No.	Margin Tapes	Start and End	Wire Diameter (mm)	Turns
1	N1		8, 9→10, 11	0.1x100	30

APPENDIX 2: LLC TRANSFORMER SPECIFICATION

Electrical Diagram



Winding Diagram



Pin Definition of Bobbin

Pin out	
1	12
2	11
3	10
4	9
5	8
6	7

View from the top

Table 4: Electrical Characteristic

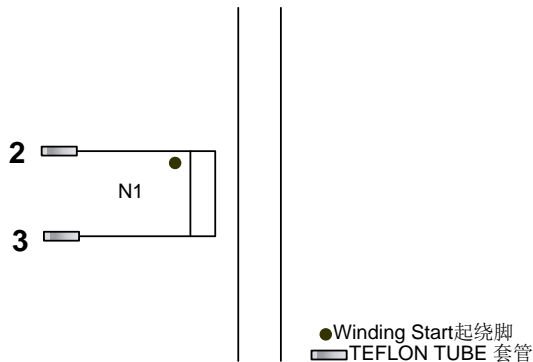
Parameter	Condition	Value
Primary inductance	L _p (4-6)	0.55mH ±5%
Core		PQ3230
Bobbin		PQ3230
Core material		DMR44 or equivalent
Turn ratio	N1:N2:N3:N4:N5	48:5:5:3:3

Table 5: Winding Specification

Tape Turns	Winding No.	Margin Tapes	Start and End	Wire Diameter (mm)	Turns
1	N1		4→6	0.1x30	48
1	N2		3→2	0.2x3	5
1	N3		2→1	0.2x3	5
1	N4		8→floating	0.1x100	3
1	N5		10→9	0.1x100	3

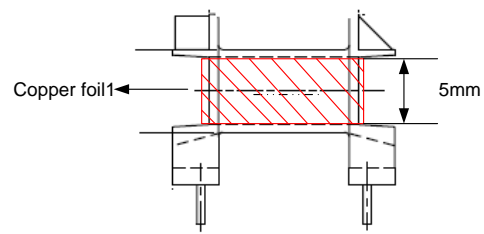
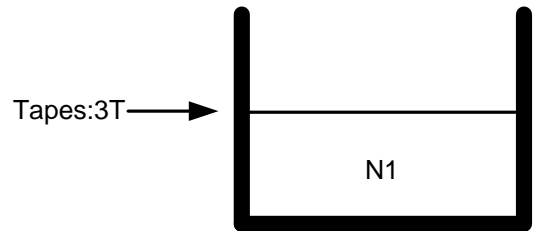
APPENDIX 3: LLC RESONANT INDUCTOR SPECIFICATION

Electrical Diagram



Pri 一次侧

Winding Diagram



Pin Definition of Bobbin

Pin out

1	8
2	7
3	6
4	5

View from the top

Note: Core is wrapped with copper foil, as shown above. Connect the foils to pin 6 of the bobbin with wires.

Table 6: Electrical Characteristic

Parameter	Condition	Value
Primary inductance	L (2-3)	80μH ±5%
Core		EE20/10/6
Bobbin		EE20/10/6
Core material		DMR40 or equivalent
Turn ratio	N1	40

Table 7: Winding Specification

Tape Turns	Winding No.	Margin Tapes	Start and End	Wire Diameter (mm)	Turns
3	N1		2→3	0.1x30	40

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