



EVHR1211-Y-00A

HR1211 digital controller evaluation board

With universal input and 12V/34A output

DESCRIPTION

The EVHR1211-Y-00A Evaluation Board is designed to demonstrate the capabilities of MPS' HR1211.

The HR1211 is a high performance multi-mode PFC and current mode LLC combo digital controller. Its parameters are programmable through UART Interface, which provides great convenience for customization. The power saving technology of HR1211 helps the power supply design to achieve overall optimized efficiency.

The PFC controller in HR1211 employs patented digital average current control scheme to achieve hybrid CCM and DCM operation.

HR1211 implements current mode control in the LLC stage, so it can easily achieve good stability and fast response at the same time. In addition, three different operation modes are implemented based on the different load conditions, i.e. steady state mode, skip mode and burst mode. In this way, efficiency in different load conditions can be optimized independently.

HR1211 features variable protections to make the system safe in case of any system faults. Such as thermal Shutdown (TSD), PFC Open Loop Protection (OLP), Over voltage Protection (OVP), Over Current Limit (OCL) and LLC Over Current Protection (OCP), SO pin protection, Over Power Protection (OPP).

HR1211 is available in SOIC20 and TSSOP20.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V_{IN}	90 to 265	VAC
Output Voltage	V_{OUT}	12	V
Output Current	I_{OUT}	34	A
Output Power	P_{OUT}	408	W

FEATURES

General System Features

- HV Current Source for Start Up
- Smart X-cap Discharge when AC Dropout, Approved by IEC62368 and IEC60950
- UART interface for Parameter Programming
- User-Friendly GUI

PFC Controller

- CCM/DCM Multi mode PFC control
- Operate Up to 250kHz
- High PF due to Input Cap Current Compensation
- Programmable Frequency Jittering
- Programmable Soft Start-up
- Programmable AC input Brown In/Out
- Cycle-by-cycle Current Limit
- OLP, OVP Protection

LLC Controller

- 600V High-Side Gate Driver with Integrated Bootstrap Diode and High dV/dt Immunity
- Current Mode Control
- Operate up to 500kHz at Steady State Mode
- Adaptive dead time adjustment with minimum and maximum limit
- Burst/Skip mode switching at light load
- Programmable Soft-Start
- Programmable DC input Brown In/Out
- Capacitive Mode Protection
- OCP, OPP Protection with auto-restart or latch
- Programmable protection on SO pin

APPLICATIONS

- Desktop PC and ATX Power Supply
- All-in-one and Gaming Power Supply.
- Notebook Adapter
- LCD TV and OLED TV Power Supply
- Power Tools Power Supply
- LED Driver

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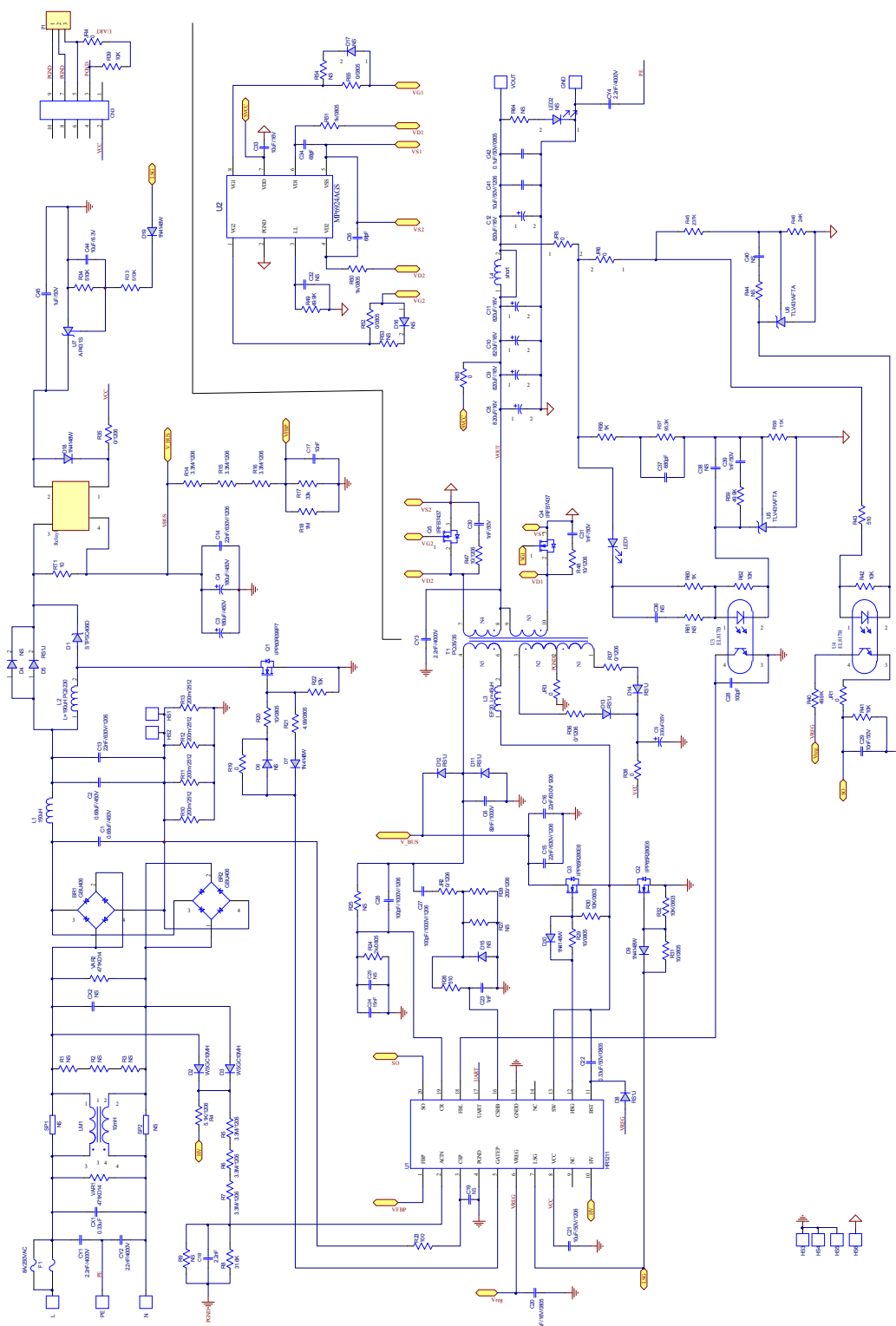
EVHR1211-Y-00A EVALUATION BOARD



(L × W × H) 13.2cm x 14.5cm x 4.5cm

Board Number	MPS IC Number
EVHR1211-Y-00A	HR1211

EVALUATION BOARD SCHEMATIC



EVHR1211-Y-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
2	BR1, BR2	GBU406	600V; 4A	DIP	Diodes	GBU406
2	C1, C2	680nF	450V; CBB	DIP	CARLI	TF684K2Y10BL270D9R
2	C3, C4	180μF	450V; Electrolytic	DIP	Jianghai	CD263 450V180uF
1	C5	330μF	35V; Electrolytic	DIP	Jianghai	CD263-35V330
1	C6	82nF	1000V	DIP	Panasonic	ECWH10823HV
5	C8, C9, C10, C11, C12	820μF	16V; solid capacitor	DIP	NIPPON CHEMI-CON	APSG160ELL821MJB5S
4	C13, C14, C15, C16	22nF	630V; X7R	1206	TDK	C3216X7R2J223K
3	C17, C29, C39	10nF	50V; X7R	0603	muRata	GRM188R71H103KA01D
4	C23, C30, C31, C39	1nF	50V; C0G	0603	muRata	GRM1885C1H102JA01D
1	C18	2.2nF	50V; C0G	0603	muRata	GRM1885C1H222JA01D
0	C19, C32, C36, C38	NC				
1	C20	10μF	16V; X7R	0805	muRata	GRM21BR61C106KE15
2	C21, C41	10μF	50V; X5R	1206	muRata	GRM31CR61H106KA12L
1	C22	330nF	50V; X7R	0805	TDK	C2012X7R1H334K
1	C24	15nF	50V; C0G	0805	TDK	C2012C0G2A153J085AC
0	C25	NC				
2	C26, C27	100pF	1000V; C0G	1206	TDK	C3216C0G3A101JT00N
1	C28	100pF	50V; NP0	0603	Wurth	885012006057
1	C33	10μF	16V; X5R	0603	muRata	GRM188R61C106KAALD
2	C34, C35	68pF	50V; C0G	0603	TDK	C1608C0G1H680J
1	C37	680pF	50V; X7R	0603	muRata	GRM188R71H681KA01D
1	C42	100nF	50V; X7R	0603	muRata	GRM188R71H104KA93D
1	C44	10μF	6.3V; X5R	0603	muRata	GRM188R60J106ME47D
1	C45	1μF	50V; X5R	0603	muRata	GRM188R61H105KAAL
1	CN3	690157000872	2*5 2.54mm socket	DIP	Wurth	690157000872
1	CX1	0.33μF	330nF; 275V; 10%	DIP	Carli	PX334K3ID49L270D9R
3	CY1, CY2, CY3	2.2nF	250V; 20%	DIP	Hongke	JN12E222MY02N
1	D1	STPSC406D	600V; 4A	TO-220	ST	STPSC406D
2	D2, D3	SRGC10MH	1000V; 1A	1206	Maxmega	SRGC10MH
0	D4	NC				
6	D5, D8, D11, D12, D13, D14	RS1J	600V; 1A	SMA	Diodes	RS1J-13-F
0	D6, D15	NC				
5	D7, D9, D10, D18, D19	1N4148W	75V; 0.15A	SOD-123	Diodes	1N4148W

EVHR1211-Y-00A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
0	D16, D17	NC				
5	GROUND, L, N, VOUT, GND,		2mm	DIP	Any	Any
1	F1	0216008. MXEP	8A; 250V;	DIP	Littlefuse	0216008.MXEP
1	L1	150μH	42mΩ; 5.4A	DIP	Würth	7447055
1	L2	190μH	PQ3230, 45 turns	DIP	Emei	FX0551
1	L3	45μH	EF20, 30 turns	DIP	Emei	FX0548
1	LM1	10mH	10mH; 55mΩ; 5A;	DIP	Würth	744825510
1	LED1	HL-PSC- 2012H203BC	blue light;	0805	BRIGHT LED	HL-PSC-2012H203BC
0	LED2	NC				
1	P1	3 Pin header	2.54mm	DIP	Any	
1	Q1	IPP60R099C7 XKSA1	650V; 0.099/10V	TO-220	INFINEON	IPP60R099C7XKSA1
2	Q2, Q3	IPP65R280E6	700V; 0.340/10V	TO-220	INFINEON	IPP65R280E6
2	Q4, Q5	IRFB7437	40V; 2mΩ; 225nC; 250A	TO220	IR	IRFB7437PBF
0	R1, R2, R3, R25, R27	NC				
1	R4	5.1K	Film resistor; 5%	1206	Yageo	RC1206JR-075K1L
6	R5, R6, R7, R14, R15, R16	3.3M	Film resistor; 1%	1206	Yageo	RC1206FR-073M3L
7	R22, R30, R32, R39, R41, R42, R62	10K	Film resistor; 1%	0603	Yageo	RC0603FR-0710KL
1	R8	31.6K	Film resistor; 1%	0603	Yageo	RC0603FR-0731K6L
0	R9, R18, R44, R61, R64	NC				
4	R10, R11, R12, R13	200m	Film resistor; 1%	2512	TA-I	RLP25FEER200
1	R17	33K	Film resistor; 1%	0603	Yageo	RC0603FR-0733KL
1	R18	1M	Film resistor; 1%	0603	Yageo	RC0603FR-071ML
2	R19, R38	0	Film resistor; 1%	0603	Yageo	RC0603FR-070RL
3	R20, R29, R31	10	Film resistor; 1%	0805	Yageo	RC0805FR-0710RL
1	R21	4.99	Film resistor; 1%	0805	Yageo	RC0805FR-074R99L
1	R23	100	Film resistor; 1%	0603	Yageo	RC0603FR-07100RL
1	R24	1K	Film resistor; 1%	0805	Yageo	RC0805FR-071KL
2	R26, R43	510	Film resistor; 1%	0603	Yageo	RC0603FR-07510RL
1	R28	200	Film resistor; 1%	1206	Yageo	RC1206FR-07200RL
2	R33, R34	510K	Film resistor; 1%	0603	Yageo	RC0603FR-07510KL

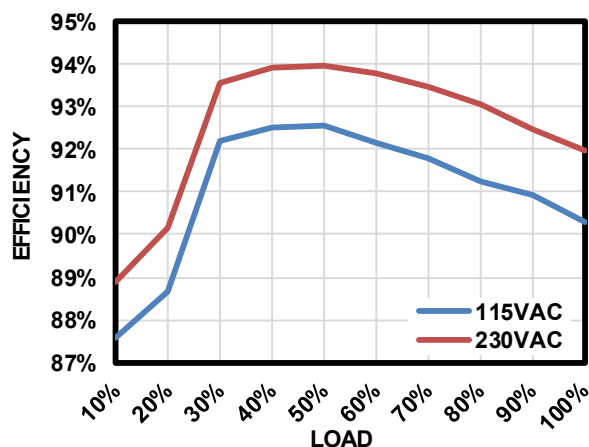
EVHR1211-Y-00A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
7	R35, R36, R37, R63, JR1, JR2, JR3	0	Film resistor; 1%	1206	Yageo	RC1206FR-070RL
3	R40, R49, R59	49.9K	Film resistor; 1%	0603	Yageo	RC0603FR-0749K9L
1	R45	237K	Film resistor; 1%	0603	Yageo	RC0603FR-07237KL
1	R46	24K	Film resistor; 1%	0603	Yageo	RC0603FR-0724KL
2	R47, R48	10	Film resistor; 1%	1206	Yageo	RC1206FR-0710RL
2	R50, R51	1K	Film resistor; 1%	0805	Yageo	RC0805FR-071KL
5	R52, R55, JR4, JR5, JR6	0	Film resistor; 5%	0805	Yageo	RC0805JR-070RL
0	R53, R54	NC				
2	R56, R60	1K	Film resistor; 1%	0603	Yageo	RC0603FR-071KL
1	R57	95.3K	Film resistor; 1%	0603	Yageo	RC0603FR-0795K3K
1	R58	11K	Film resistor; 1%	0603	Yageo	RC0603FR-0711KL
1	Relay1	307HN-1AH-S 24V	24V relay	DIP	SONG CHUAN	307HN-1AH-S 24V
1	RT1	10	NTC	DIP	Shunxing	10D2-10
1	T1	400μH	PQ3535	DIP	Emei	FX0561
1	U1	HR1211	Digital PFC and LLC controller	SOIC20	MPS	HR1211GY
1	U2	MP6924AGS-Z	SR controller	SOIC8	MPS	MP6924AGS-Z
2	U3, U4	EL817B	1-Channel;	DIP	Everlight	EL817B
2	U5, U6	TLV431AFTA	1.24V voltage reference	SOT-23	Diodes	TLV431AFTA
1	U7	AP431SANTR- G1	2.5V voltage reference	SOT-23	Diodes	AP431SANTR-G1
2	VAR1, VAR2	TVR14471KS42Y	Disk varistor	DIP	TKS	TVR14471KS42Y
2	HS1, HS2	60mm*30mm* 3mm(hole pitch 22mm)	Installed on BR1, BR2			
2	HS3, HS4	60mm*30mm* 3mm(hole pitch 25mm)	Installed on Q1, D1			
2	HS5, HS6	60mm*30mm* 3mm(hole pitch 22mm)	Installed on Q2, Q3, Q4, Q5			
3	JP1, JP2, JP12	12.5mm				
2	JP3, JP8	48mm				
7	JP4, JP5, JP7, JP10, JP11, JP 13, JP14	17.5mm				
2	JP6	41mm				
2	JP9, JP15	34mm				
1	JP16		Copper bar			

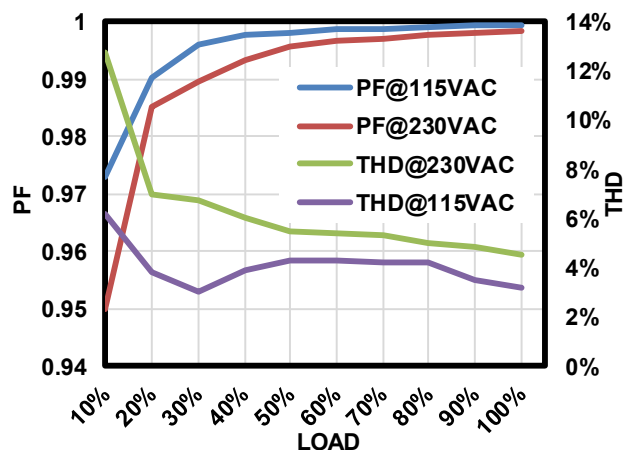
EVH TEST RESULT

V_{IN_AC} = 90 to 265 V, V_{OUT} = 12 V, I_{OUT} = 34 A, unless otherwise noted.

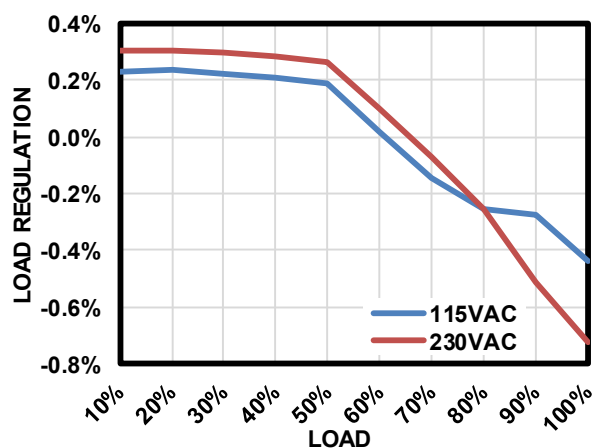
Efficiency vs. Load



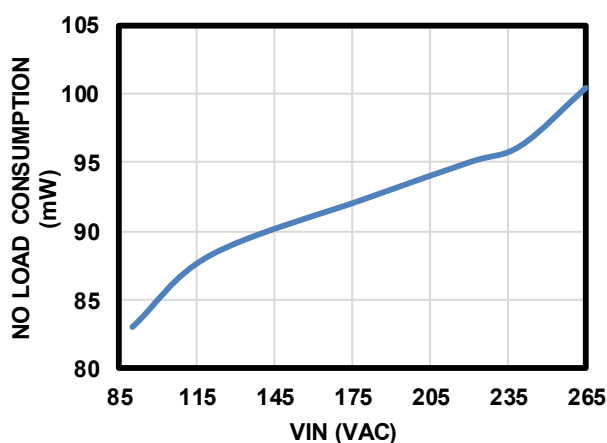
PF&THD



Load Regulation vs. Load



No Load Consumption

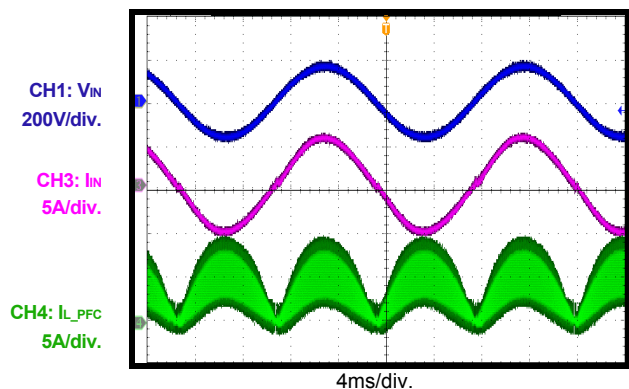


EVB TEST RESULT *(continued)*

$V_{IN_AC} = 90$ to 265 V, $V_{OUT} = 12$ V, $I_{OUT} = 34$ A, unless otherwise noted.

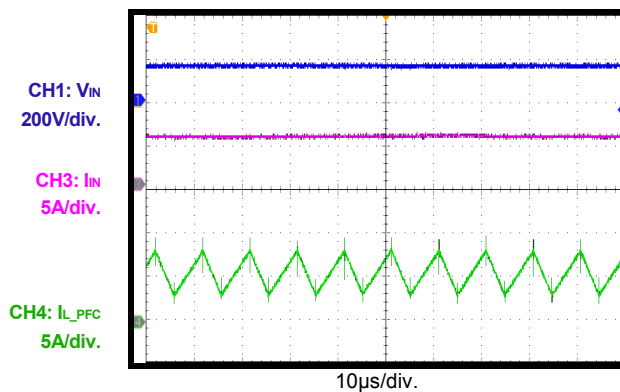
Input Voltage & Current

$V_{IN}=115$ VAC, Full Load



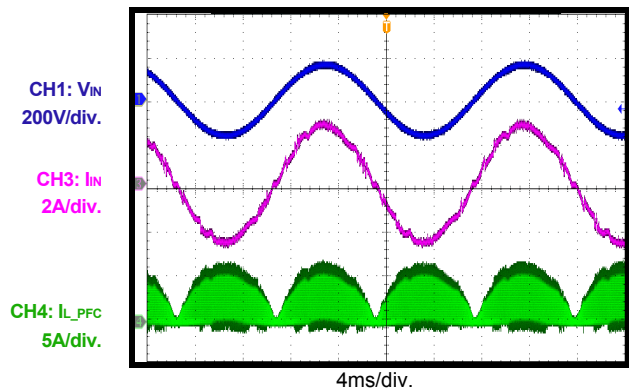
Input Voltage & Current

$V_{IN}=115$ VAC, Full Load



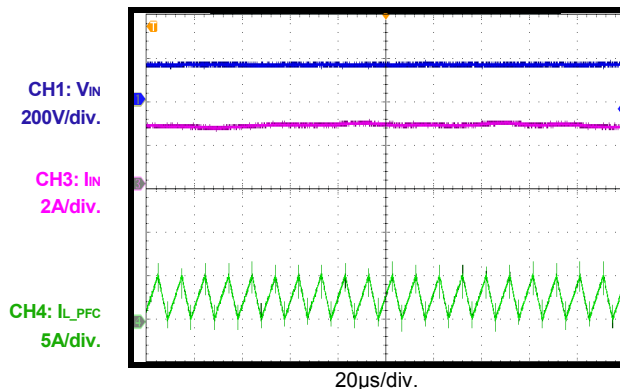
Input Voltage & Current

$V_{IN}=115$ VAC, 50% Load



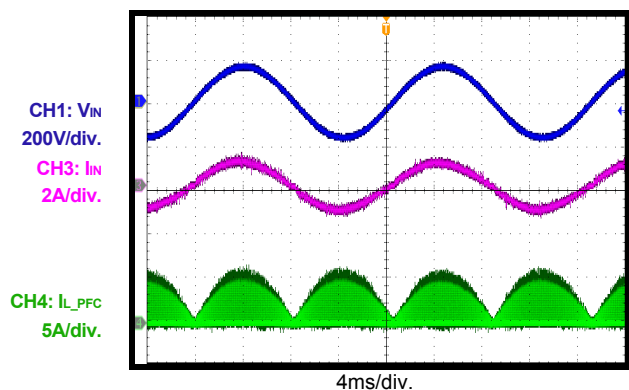
Input Voltage & Current

$V_{IN}=115$ VAC, 50% Load



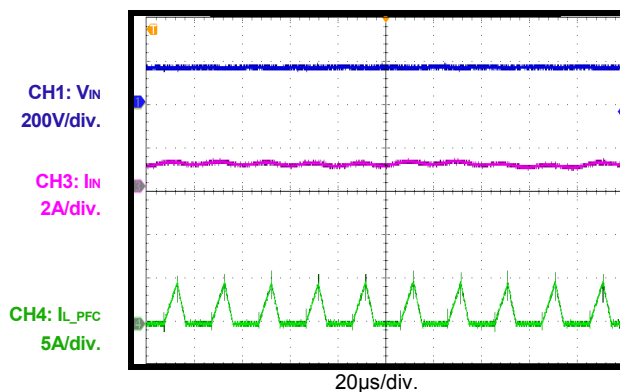
Input Voltage & Current

$V_{IN}=115$ VAC, 25% Load



Input Voltage & Current

$V_{IN}=115$ VAC, 25% Load

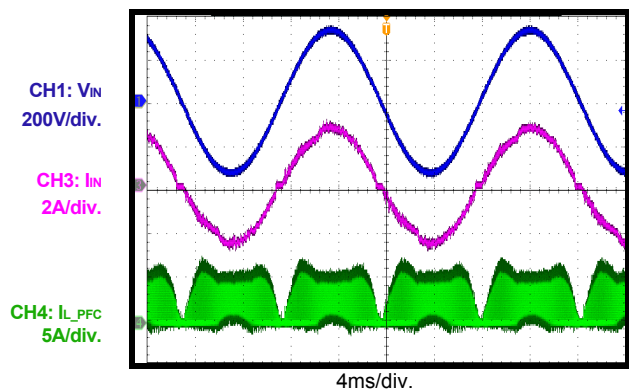


EVB TEST RESULT *(continued)*

$V_{IN_AC} = 90$ to 265 V, $V_{OUT} = 12$ V, $I_{OUT} = 34$ A, unless otherwise noted.

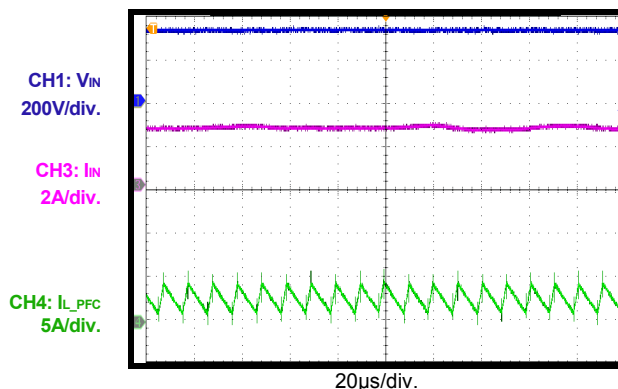
Input Voltage & Current

$V_{IN}=230$ VAC, Full Load



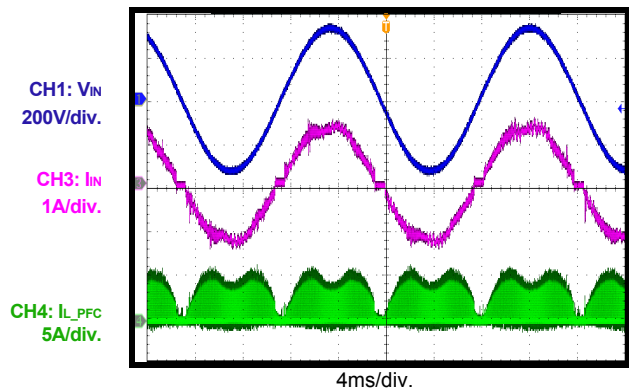
Input Voltage & Current

$V_{IN}=230$ VAC, Full Load



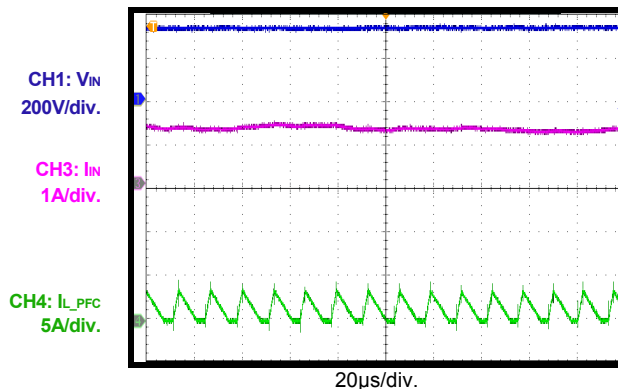
Input Voltage & Current

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



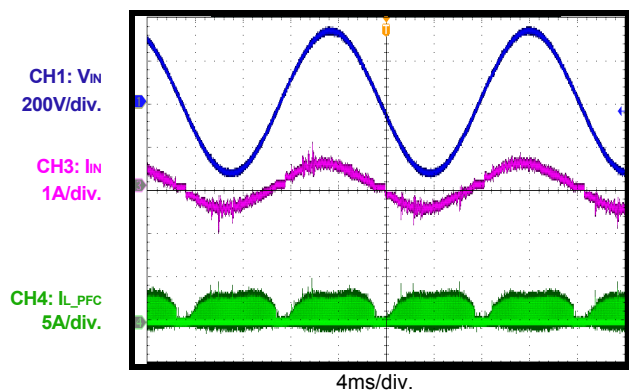
Input Voltage & Current

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



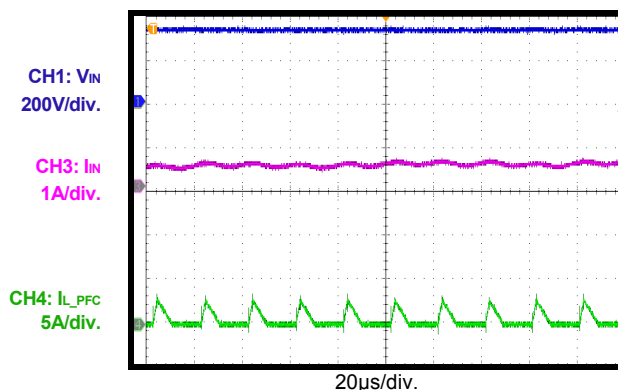
Input Voltage & Current

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



Input Voltage & Current

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

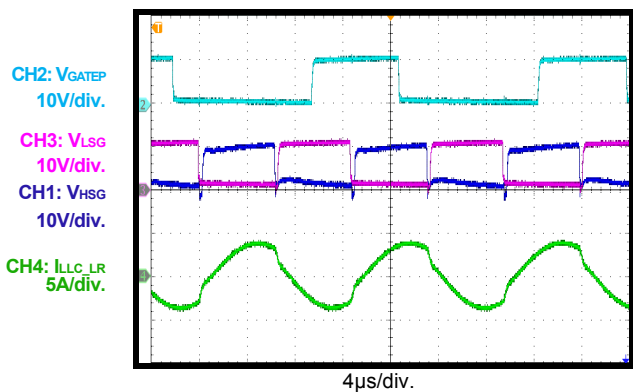


EVB TEST RESULT (continued)

$V_{IN_AC} = 90$ to 265 V, $V_{OUT} = 12$ V, $I_{OUT} = 34$ A, unless otherwise noted.

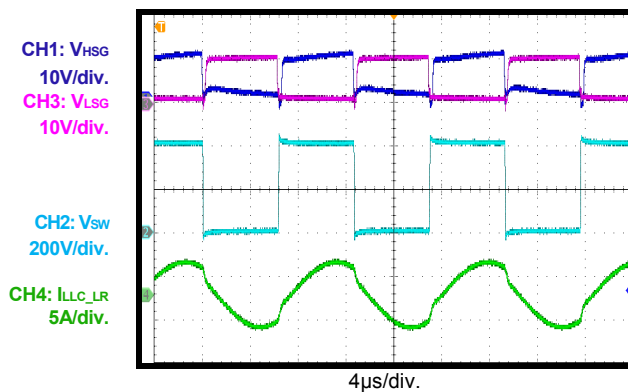
LLC Steady State

Full Load



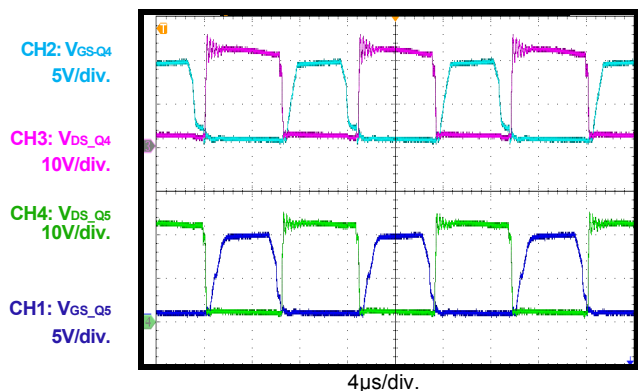
LLC Steady State

Full Load



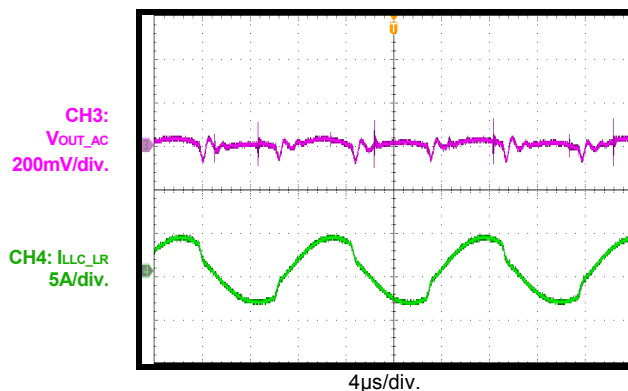
SR Operation

Full Load



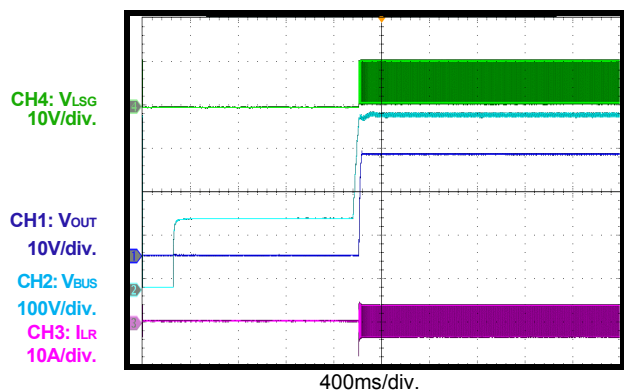
Output Ripple

Full Load



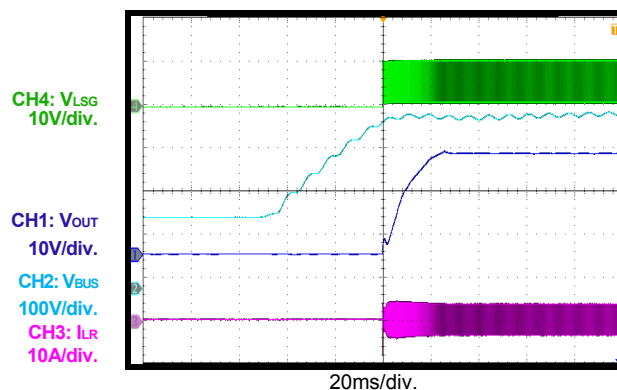
Start-up

$V_{IN}=115$ VAC, Full Load



Output Rise Time

$V_{IN}=115$ VAC, Full Load

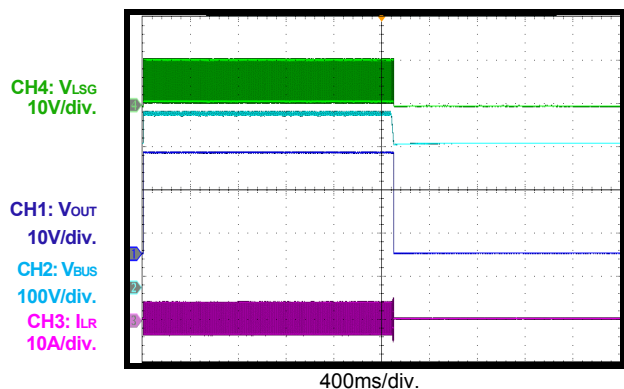


EVB TEST RESULT (continued)

$V_{IN_AC} = 90$ to 265 V, $V_{OUT} = 12$ V, $I_{OUT} = 34$ A, unless otherwise noted.

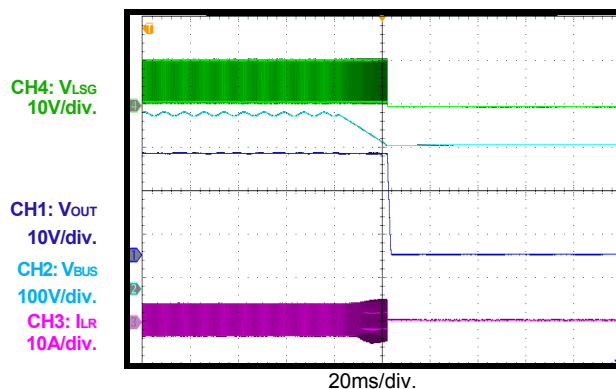
Shutdown

$V_{IN}=115$ VAC, Full Load



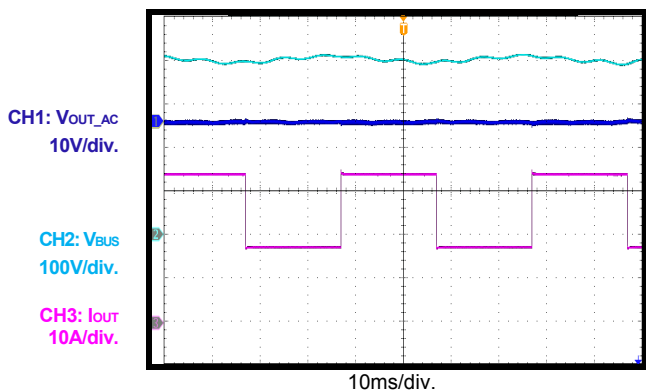
Hold Up Time

$V_{IN}=115$ VAC, Full Load



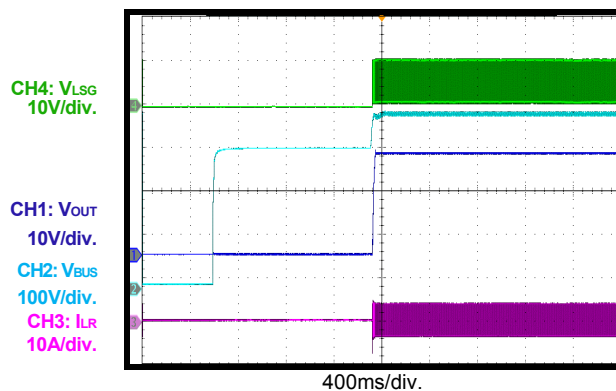
Load Transient

$V_{IN}=115$ VAC, 1A/ μ s



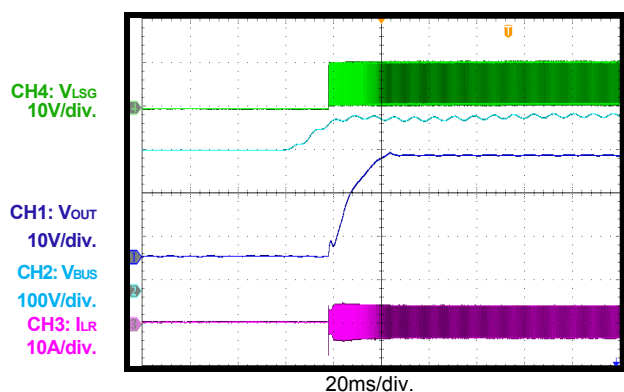
Start-up

$V_{IN}=115$ VAC, Full Load



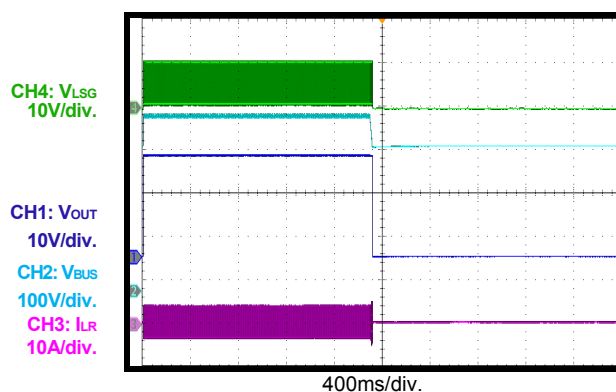
Output Rise Time

Full Load



Shutdown

Full Load

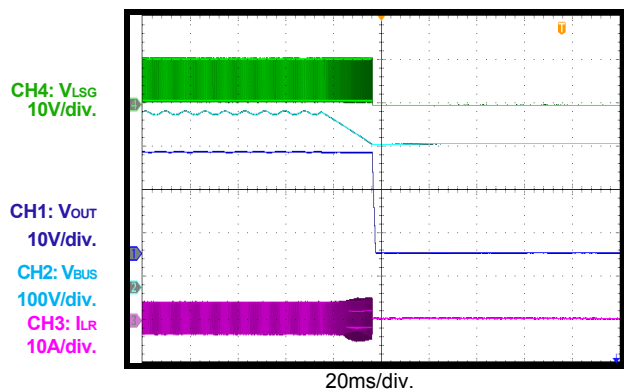


EVB TEST RESULT (continued)

$V_{IN_AC} = 90$ to 265 V, $V_{OUT} = 12$ V, $I_{OUT} = 34$ A, unless otherwise noted.

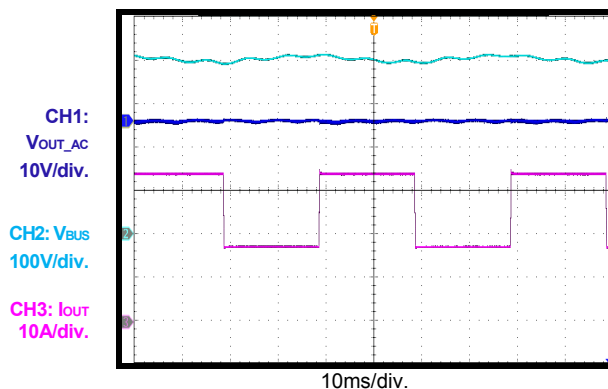
Hold Up Time

$V_{IN}=230$ VAC, Full Load



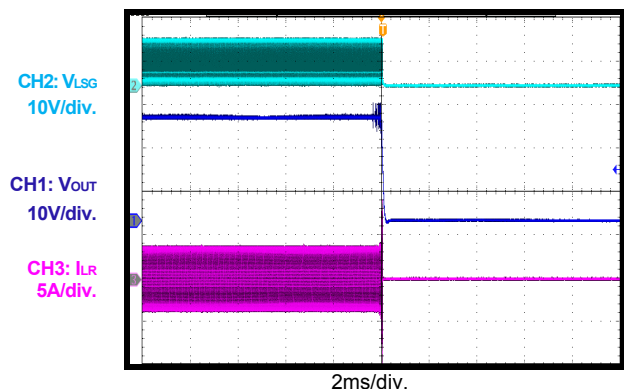
Load Transient

$V_{IN}=230$ VAC, 1A/ μ s



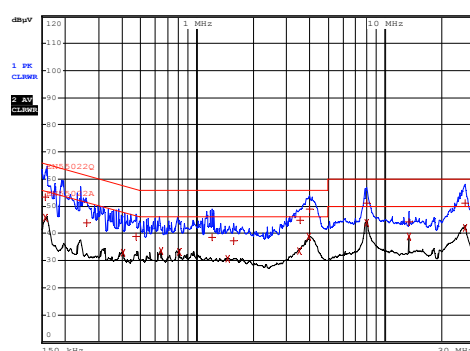
SCP Latch

Full Load



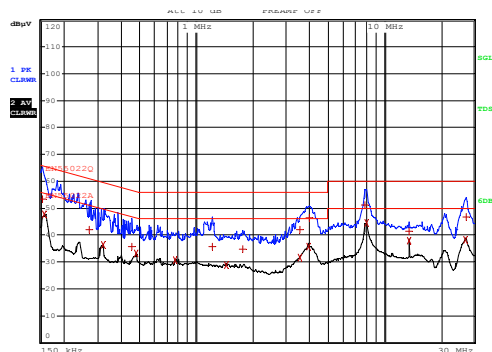
EMI test

230V AC, L wire



EMI test

230V AC, N wire



PRINTED CIRCUIT BOARD LAYOUT

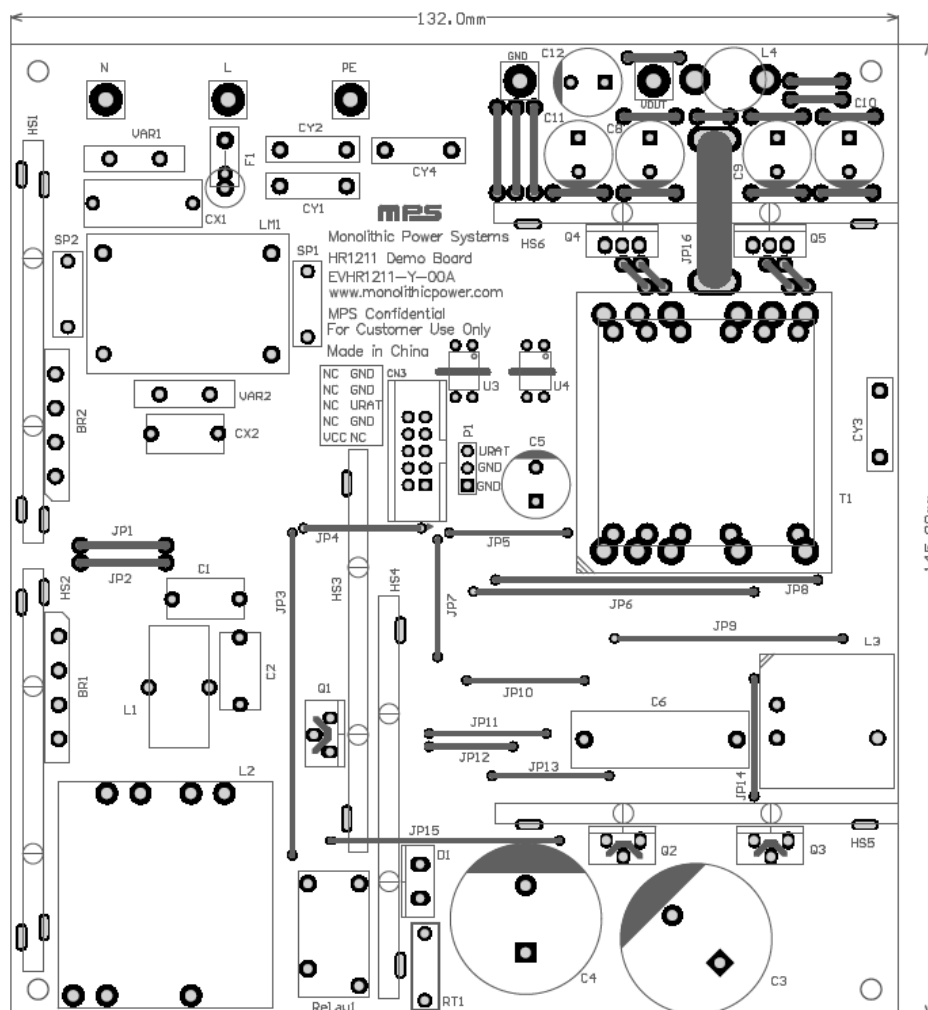


Figure 1: Top Silkscreen and Top Layer

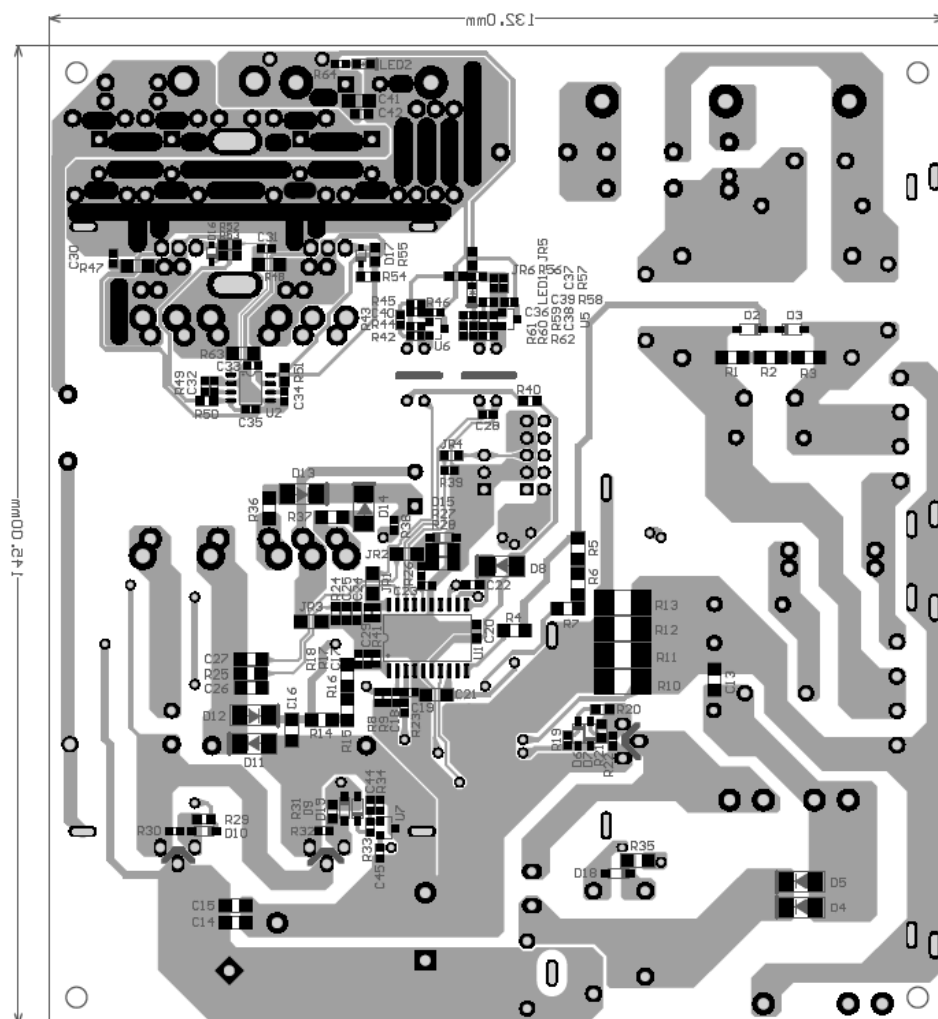


Figure 2: Bottom Silkscreen and Bottom Layer

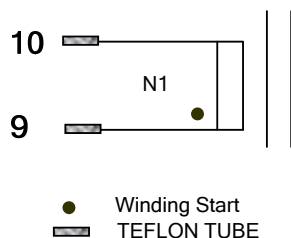
QUICK START GUIDE

1. Preset power supply to $90\text{VAC} \leq V_{\text{IN}} \leq 265\text{VAC}$.
2. Turn power supply off.
3. Connect AC power supply terminals to L and N:
4. Connect load to:
 - a. Positive (+): VOUT
 - b. Negative (–): GND
5. Turn power supply on after making connections.
6. **Please remove the UART to GND short cap on P1 when programming and re-install it after programming.**

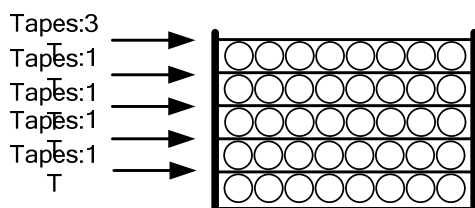
Notice: Avoid touching C3 and C4 even after power off, because there is high voltage on them. Make sure these two capacitors are full discharged after testing.

APPENDIX 1: PFC INDUCTOR SPECIFICATION (PQ3230)

1. Electrical diagram



2. Winding diagram



3. Winding specification

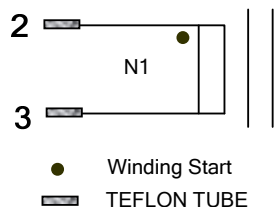
Winding No.	Start & end	Wire diameter(mm)	Turns	Tube
N1	9→10	0.1mm*100	45	Match wire

4. Electrical characteristic

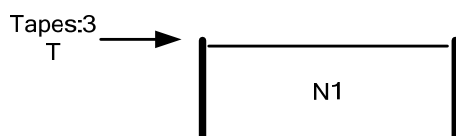
No.	parameter	Test Pin	Condition	Value
1	Inductance	9 to 10	100kHz	0.19mH±5%
2	Electrical strength	9 to Core	60Hz, <5mA	AC 500V

APPENDIX 2: LLC RESONANT INDUCTOR SPECIFICATION (EF20)

1. Electrical diagram



2. Winding diagram



3. Winding specification

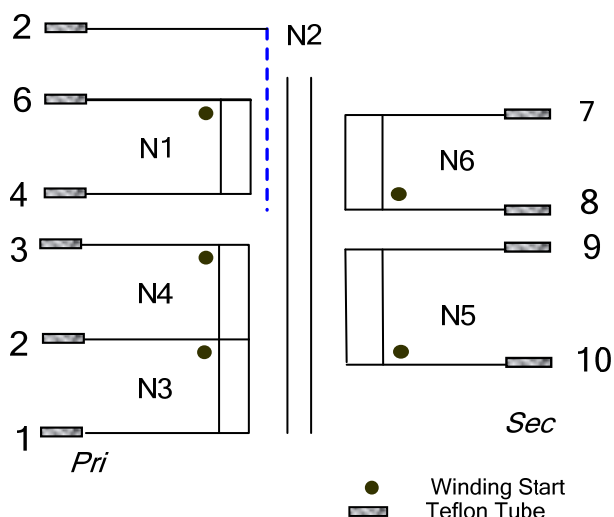
Winding No.	Start & end	Wire diameter(mm)	Turns	Tube
N1	2→3	0.1mm*50	30	Match wire

4. Electrical characteristic

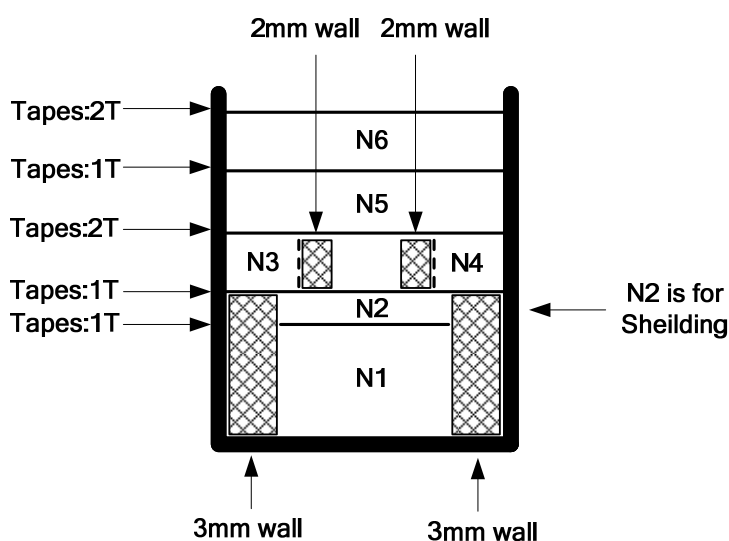
NO.	parameter	Test Pin	Condition	Value
1	Inductance	2 to 3	100kHz	45μH±5%
2	Electrical strength	2 to Core	60Hz, <5mA	AC 500V

APPENDIX 3: LLC TRANSFORMER SPECIFICATION (PQ3535)

1. Electrical diagram



2. Winding diagram



3. Winding specification

Tape	Wall	Winding No.	Start & end	Wire diameter(mm)	Turns	Tube
1	3mm each side	N1	6→4	0.1mm*50	32	Match wire
2	3mm each side	N2	2→NC	15mm copper tape	1	Match wire
1		N3	2→1	0.3mm T.I.W	4	Match wire
1		N4	3→2	0.3mm T.I.W	4	Match wire
1		N5	10→9	0.3mm*20mm copper	2	Match wire
1		N6	8→7	0.3mm*20mm copper	2	Match wire

4. Electrical characteristic

NO.	parameter	Test Pin	Value	Condition
1	Inductance	4 to 6	400μH±5%	100kHz
2	Electrical strength	2/4 to 8/9	AC 3500V	60Hz, <5mA
		4 to core	AC 500V	
		8/9 to core	AC 3500V	

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