



EVHR1211-Y-01A

12V, 34A, Digital Controller with Universal Input Evaluation Board

DESCRIPTION

The EVHR1211-Y-01A evaluation board is designed to demonstrate the capabilities of the HR1211, a high performance, multi-mode PFC and current mode LLC combo digital controller. The device's parameters are configurable through the UART interface, which provides convenient customization. Power saving technology helps the power supply design achieve optimized efficiency.

The PFC controller in the HR1211 employs a patented, digital average current control scheme to achieve hybrid continuous conduction mode (CCM) and discontinuous conduction mode (DCM).

The HR1211 implements current mode control in the LLC stage, so it can simultaneously achieve good stability and fast response. Three operation modes are implemented based on different load conditions: steady state mode, skip mode, and burst mode. This allows the device to maximize efficiency under different load conditions.

The HR1211 features protections to keep the system safe if a fault occurs, including 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, and over-power protection (OPP).

The HR1211 is available in SOIC-20 and TSSOP20 packages.

ELECTRICAL SPECIFICATIONS

Parameter	Symbol	Value	Units
Input voltage	V_{IN}	90 to 265	V_{AC}
Output voltage	V_{OUT}	12	V
Output current	I_{OUT}	34	A
Output power	P_{OUT}	408	W

FEATURES

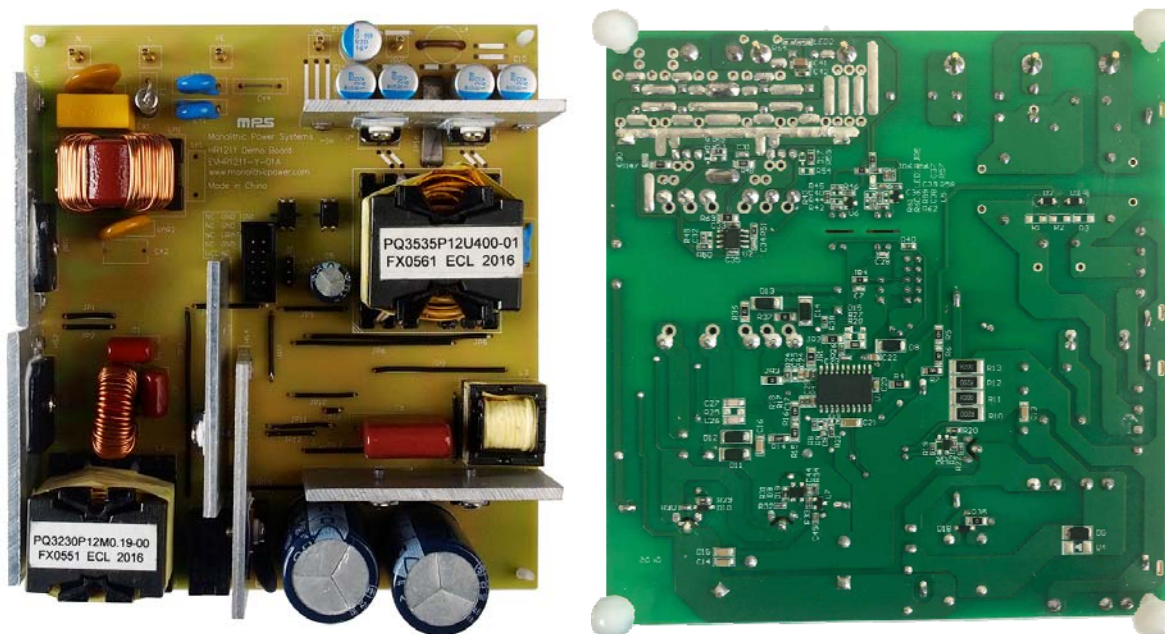
- General System Features:
 - Smart X-Capacitor Discharge during AC Dropout, Approved by IEC62368 and IEC60950
 - User-Friendly Parameter Configurations and GUI
- PFC Stage:
 - CCM/DCM Multi-Mode PFC Control
 - High PF Due to Input Capacitor Current Compensation
 - Better EMI Noise with Frequency Jitter Function Enabled
 - Soft Start
 - Configurable AC Input Brown-In/Out
 - Cycle-by-Cycle Current Limiting
 - OLP and OVP
- LLC Stage:
 - Current Mode Control
 - Adaptive Dead Time Adjustment with Minimum and Maximum Limit
 - Improved Efficiency at Light-Load with Burst/Skip Mode Switching
 - Soft Start
 - Capacitive Mode Protection
 - OCP, OPP with Automatic Restart or Latch-Off Mode
 - OVP through the SO Pin

APPLICATIONS

- Reference Design for Desktop PCs and Other 12V Output Power Supplies with the HR1211
- Evaluation Board for the HR1211:
 - Desktop PCs and ATX Power Supplies
 - All-in-One and Gaming Power Supplies
 - Notebook Adapters
 - LCD TVs and OLED TV Power Supplies
 - Power Tools Power Supplies
 - LED Drivers

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EVHR1211-Y-01A EVALUATION BOARD



LxWxH (13.2cmx14.5cmx4.5cm)

Board Number	MPS IC Number
EVHR1211-Y-01A	HR1211GY-0005-Z

QUICK START GUIDE

1. Preset the power supply (V_{IN}) to be between $90V_{AC}$ and $265V_{AC}$.
2. Turn the power supply off.
3. Connect the AC power supply terminals to the respective L and N terminals.
4. Connect the load terminals to:
 - a. Positive (+): VOUT
 - b. Negative (-): GND
5. Turn the power supply on after making the connections.
6. Remove the UART to GND short capacitor on P1 when configuring the device. Reinstall the capacitor on P1 after configurations are complete.

Due to high voltages, do not touch C3 or C4, even if the device is off. Ensure that these capacitors are fully discharged after testing.

EVALUATION BOARD SCHEMATIC

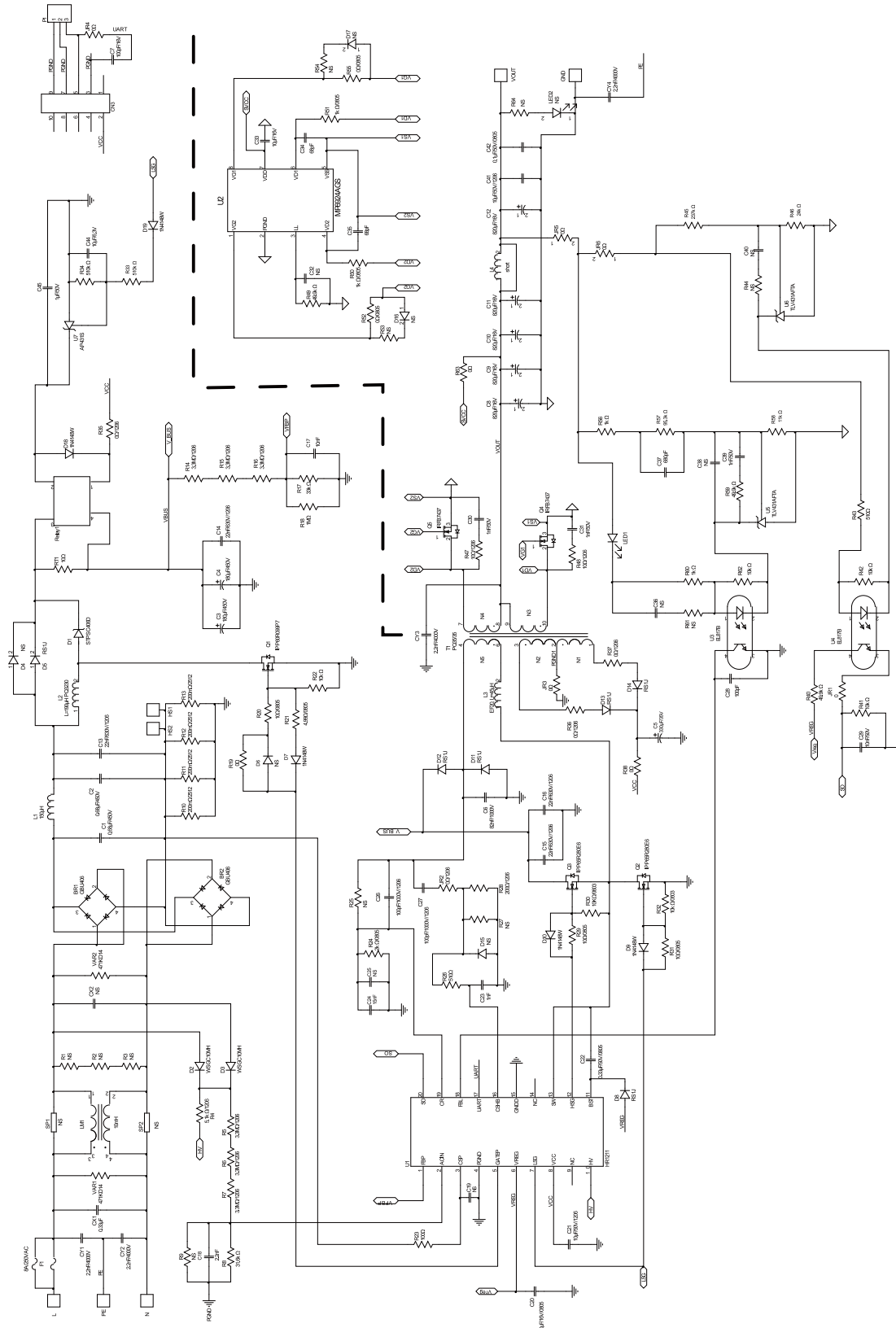


Figure 1: Evaluation Board Schematic

EVHR1211-Y-01A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
2	BR1, BR2	80pF	Capacitor, 600V, 4A	DIP	Diodes, Inc.	GBU406
2	C1, C2	680nF	Capacitor, 450V, CBB	DIP	Carli	TF684K2Y10BL270D9R
2	C3, C4	180μF	Electrolytic capacitor, 450V	DIP	Jianghai	CD263 450V180uF
1	C5	330μF	Electrolytic capacitor, 35V	DIP	Jianghai	CD263-35V330
1	C6	82nF	Capacitor, 1000V	DIP	Panasonic	ECWH10823HV
5	C8, C9, C10, C11, C12	820μF	16V, solid capacitor	DIP	Nippon Chemi-Con	APSG160ELL821MJB5S
4	C13, C14, C15, C16	6.8nF	Capacitor, 630V, X7R	1206	Murata	GRM31BR72J682KW01
3	C17, C29, C39	10nF	Capacitor, 50V, X7R	0603	Murata	GRM188R71H103KA01D
3	C23, C30, C31	1nF	Capacitor, 50V, C0G	0603	Murata	GRM1885C1H102JA01D
1	C18	2.2nF	Capacitor, 50V, C0G	0603	Murata	GRM1885C1H222JA01D
0	C19, C32, C36, C38	NC				
1	C20	10μF	Capacitor, 16V, X7R	0805	Murata	GRM21BR61C106KE15
2	C21, C41	10μF	Capacitor, 50V, X5R	1206	Murata	GRM31CR61H106KA12L
1	C22	330nF	Capacitor, 50V, X7R	0805	TDK	C2012X7R1H334K
1	C24	15nF	Capacitor, 50V, C0G	0805	TDK	C2012C0G2A153J085AC
0	C25	NC				
2	C26, C27	100pF	Capacitor, 1000V, C0G	1206	TDK	C3216C0G3A101JT00N
1	C7, C28	100pF	Capacitor, 50V, NP0	0603	Würth	885012006057
1	C33	10μF	Capacitor, 16V, X5R	0603	Murata	GRM188R61C106KAALD
2	C34, C35	68pF	Capacitor, 50V, C0G	0603	TDK	C1608C0G1H680J
1	C37	680pF	Capacitor, 50V, X7R	0603	Murata	GRM188R71H681KA01D
1	C42	100nF	Capacitor, 50V, X7R	0603	Murata	GRM188R71H104KA93D

EVHR1211-Y-01A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C44	10 μ F	Capacitor, 6.3V, X5R	0603	Murata	GRM188R60J106ME47D
1	C45	1 μ F	Capacitor, 50V, X5R	0603	Murata	GRM188R61H105KAAL
1	CN3	2.54mm	Connector, 2x5 pins, 2.54mm socket	DIP	Wurth	690157000872
1	CX1	0.33 μ F	X-capacitor, 330nF, 275V, 10%	DIP	Carli	PX334K3ID49L270D9R
3	CY1, CY2, CY3	2.2nF	Y-capacitor, 250V, 20%	DIP	Hongke	JN12E222MY02N
1	D1	600V, 4A	Diode	TO-220	ST	STPSC406D
2	D2, D3	1000V, 1A	Diode	1206	Maxmega	SRGC10MH
0	D4	NC				
6	D5, D8, D11, D12, D13, D14	600V, 1A	Diode	SMA	Diodes	RS1J-13-F
0	D6, D15	NC				
5	D7, D9, D10, D18, D19	75V, 0.15A	Diode	SOD-123	Diodes	1N4148W
0	D16, D17	NC				
5	GROUND, L, N, VOUT, GND,	2mm	Connector	DIP	Any	Any
1	F1	8A, 250V	Fuse	DIP	Littlefuse	0216008.MXEP
1	L1	150 μ H	Inductor, 42m Ω , 5.4A	DIP	Wurth	7447055
1	L2	190 μ H	Inductor, PQ3230, 45 turns	DIP	Emei	FX0551
1	L3	45 μ H	Inductor, EF20, 30 turns	DIP	Emei	FX0548
1	LM1	10mH	55m Ω , 5A	DIP	Wurth	744825510
1	LED1	Blue	Luminous diode	0805	Bright LED	HL-PSC-2012H203BC
0	LED2	NC				

EVHR1211-Y-01A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	P1	2.54mm	3 pins	DIP	Any	
1	Q1	650V, 99mΩ	MOSFET, 650V, 0.099Ω/10V	TO-220	Infineon	IPP60R099C7XKSA1
2	Q2, Q3	700V, 280mΩ	MOSFET, 700V, 0.340Ω/10V	TO-220	Infineon	IPP65R280E6
2	Q4, Q5	40V, 2mΩ	MOSFET, 40V, 2mΩ, 225nC, 250A	TO-220	Infineon	IRFB7437PBF
0	R1, R2, R3, R25, R27	NC				
1	R4	5.1kΩ	Film resistor, 5%	1206	Yageo	RC1206JR-075K1L
6	R5, R6, R7, R14, R15, R16	3.3MΩ	Film resistor, 1%	1206	Yageo	RC1206FR-073M3L
6	R22, R30, R32, R41, R42, R62	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
1	R8	31.6kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0731K6L
0	R9, R18, R44, R61, R64	NC				
4	R10, R11, R12, R13	200mΩ	Film resistor, 1%	2512	TA-I	RLP25FEER200
1	R17	33kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0733KL
1	R18	1MΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071ML
2	R19, R38	0Ω	Film resistor, 1%	0603	Yageo	RC0603FR-070RL
3	R20, R29, R31	10Ω	Film resistor, 1%	0805	Yageo	RC0805FR-0710RL
1	R21	4.99Ω	Film resistor, 1%	0805	Yageo	RC0805FR-074R99L
1	R24	2kΩ	Film resistor, 1%	0805	Yageo	RC0805FR-072KL
3	R23, R26, R43	510Ω	Film resistor, 1%	0603	Yageo	RC0603FR-07510RL

EVHR1211-Y-01A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	R28	200Ω	Film resistor, 1%	1206	Yageo	RC1206FR-07200RL
2	R33, R34	510kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07510KL
7	R35, R36, R37, R63, JR1, JR2, JR3	0Ω	Film resistor, 1%	1206	Yageo	RC1206FR-070RL
3	R40, R49, R59	49.9kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0749K9L
1	R45	237kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-07237KL
1	R46	24kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0724KL
2	R47, R48	10Ω	Film resistor, 1%	1206	Yageo	RC1206FR-0710RL
2	R50, R51	1kΩ	Film resistor, 1%	0805	Yageo	RC0805FR-071KL
5	R52, R55, JR4, JR5, JR6	0Ω	Film resistor, 5%	0805	Yageo	RC0805JR-070RL
0	R53, R54	NC				
1	R57	95.3kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0795K3K
1	R58	11kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0711KL
2	R56, R60	1kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-071KL
1	Relay1	24V	Relay	DIP	Song Chuan	307HN-1AH-S 24V
1	RT1	10Ω	NTC	DIP	Shunxing	10D2-10
1	T1	400μH	Transformer, PQ3535	DIP	Emei	FX0561
1	U1	HR1211	Digital PFC and LLC controller	SOIC-20	MPS	HR1211GY-0005-Z
1	U2	MP6924A	SR controller	SOIC-8	MPS	MP6924AGS-Z
2	U3, U4	35V	1-channel	DIP	Everlight	EL817B

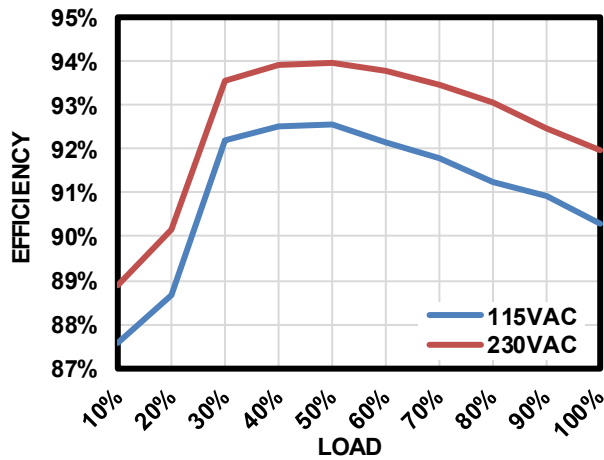
EVHR1211-Y-01A BILL OF MATERIALS (continued)

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
2	U5, U6	1.24V	Voltage reference	SOT-23	Diodes, Inc.	TLV431AFTA
1	U7	2.5V	Voltage reference	SOT-23	Diodes, Inc.	AP431SANTR-G1
2	VAR1, VAR2	470V	Disk varistor	DIP	TKS	TVR14471KS42Y
2	HS1, HS2	60mmx 30mmx 3mm	Installed to BR1, BR2	DIP	Any	
2	HS3, HS4	60mmx 30mmx 3mm	Installed to Q1, D1	DIP	Any	
2	HS5, HS6	60mmx 30mmx 3mm	Installed to Q2, Q3, Q4, and Q5	DIP	Any	

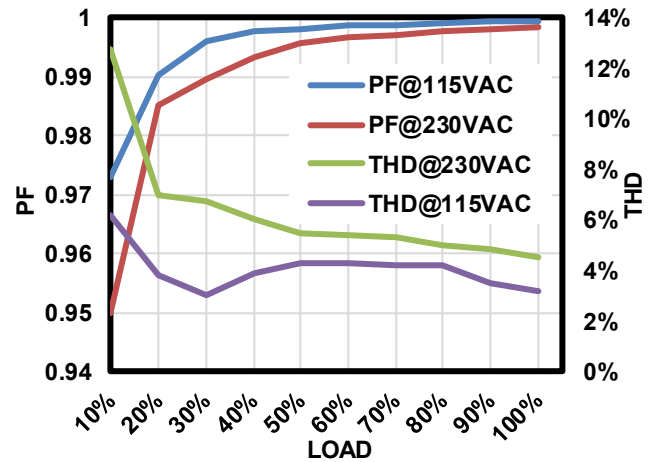
EVb TEST RESULTS

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

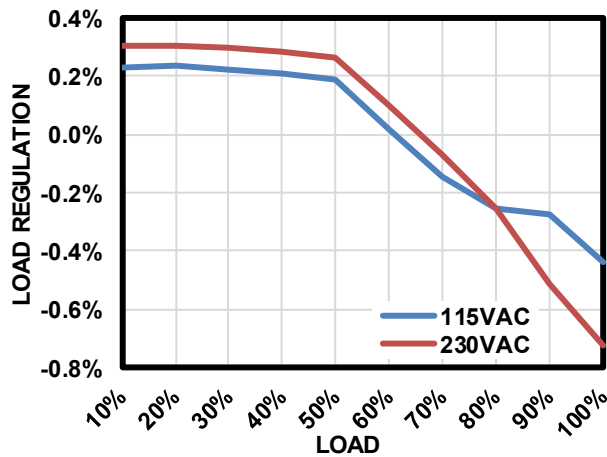
Efficiency vs. Load



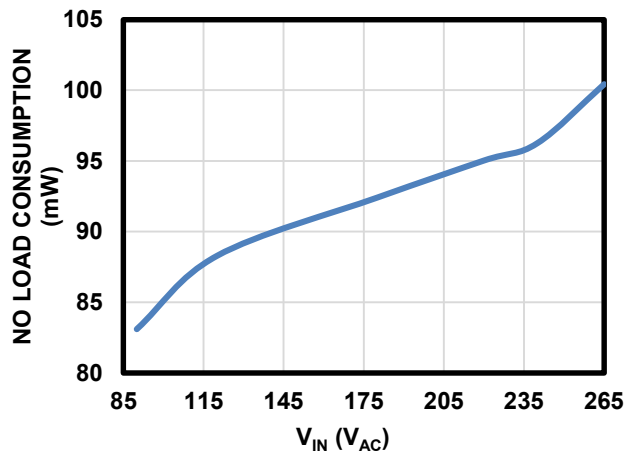
PF and THD



Load Regulation vs. Load



No Load Consumption

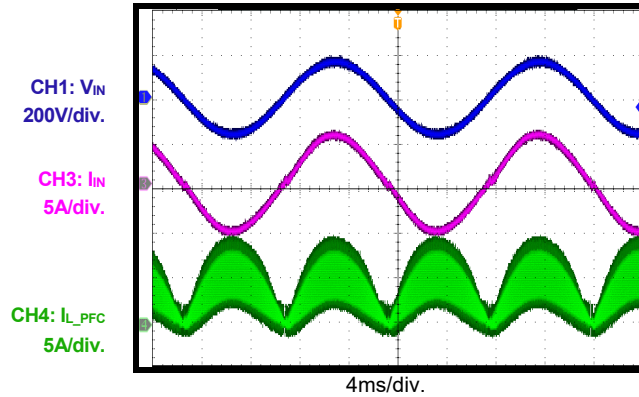


EVB TEST RESULTS *(continued)*

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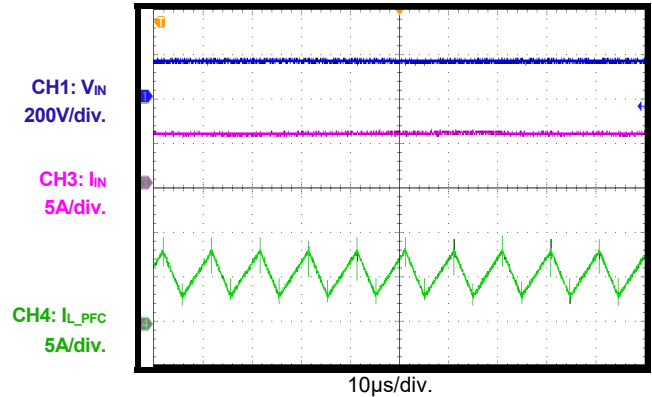
Input Voltage and Current

$V_{IN} = 115V_{AC}$, full load



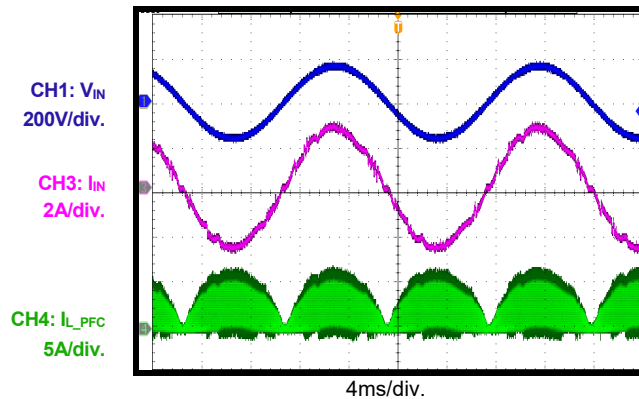
Input Voltage and Current

$V_{IN} = 115V_{AC}$, full load



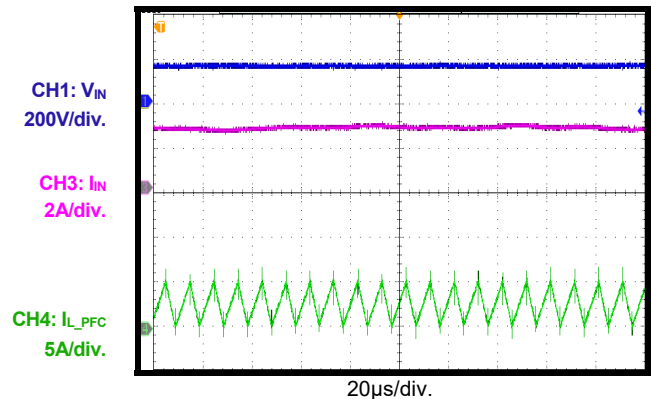
Input Voltage and Current

$V_{IN} = 115V_{AC}$, 50% load



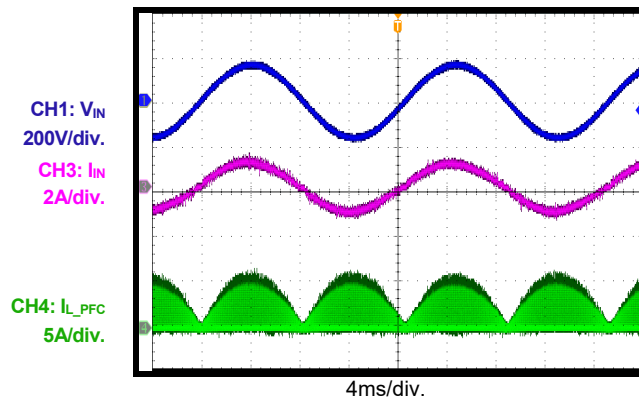
Input Voltage and Current

$V_{IN} = 115V_{AC}$, 50% load



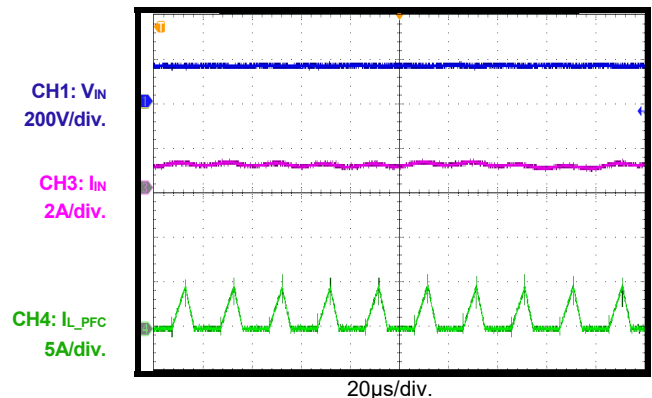
Input Voltage and Current

$V_{IN} = 115V_{AC}$, 25% load



Input Voltage and Current

$V_{IN} = 115V_{AC}$, 25% load

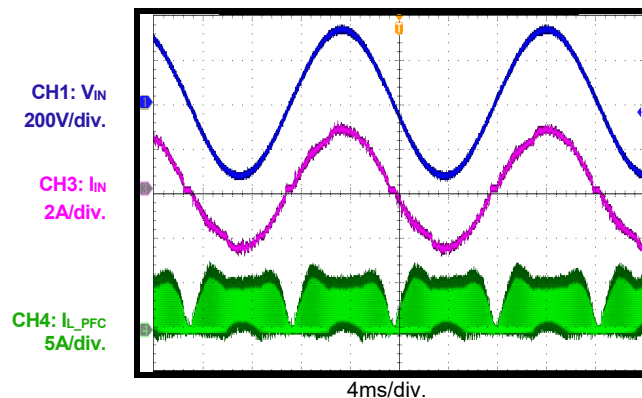


EVB TEST RESULTS (continued)

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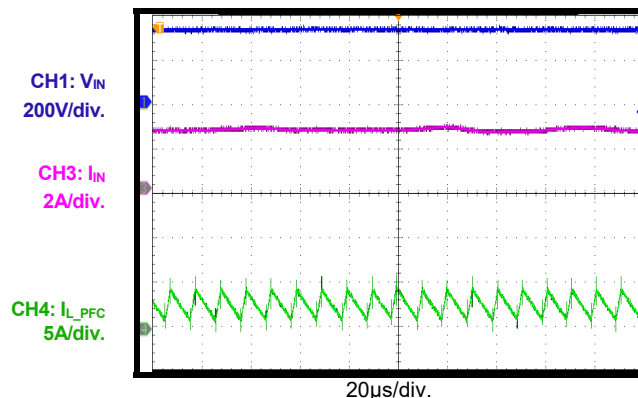
Input Voltage and Current

$V_{IN} = 230V_{AC}$, full load



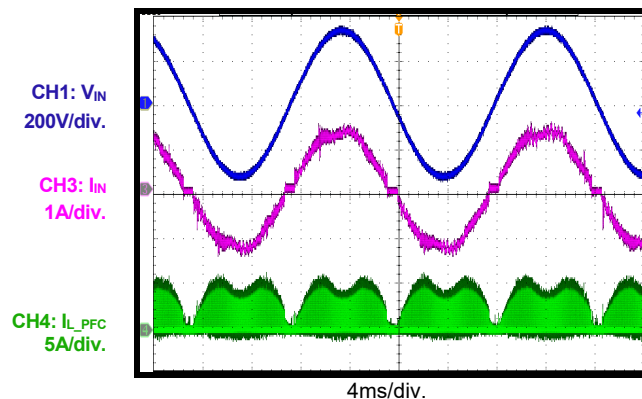
Input Voltage and Current

$V_{IN} = 230V_{AC}$, full load



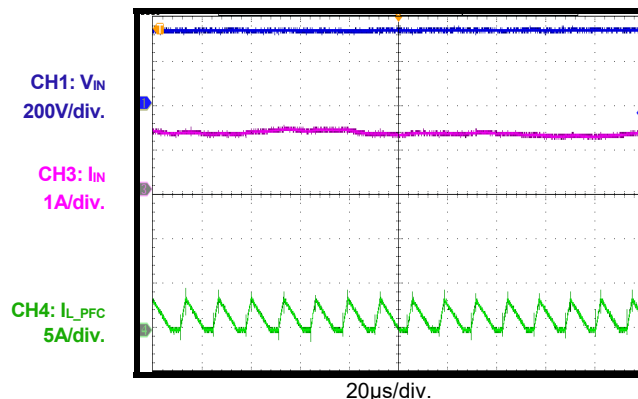
Input Voltage and Current

$V_{IN} = 230V_{AC}$, 50% load



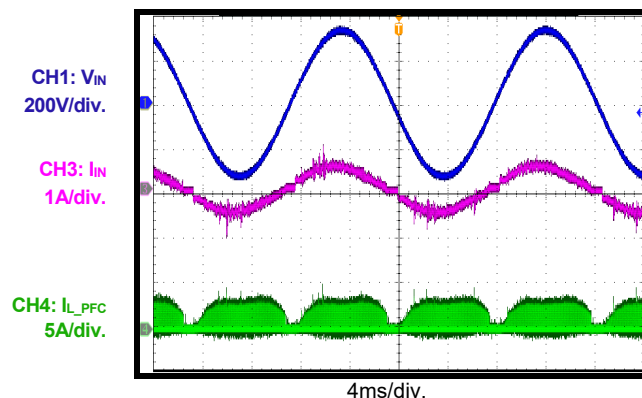
Input Voltage and Current

$V_{IN} = 230V_{AC}$, 50% load



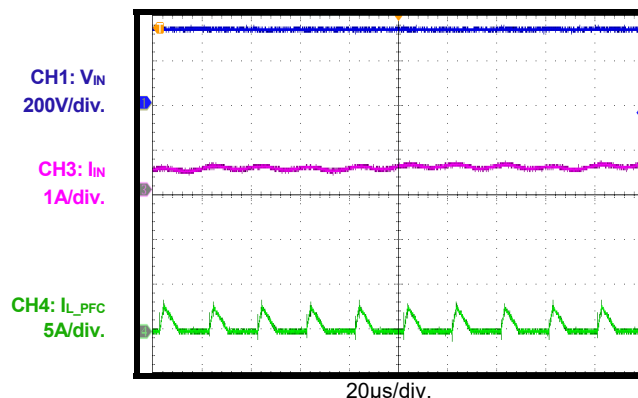
Input Voltage and Current

$V_{IN} = 230V_{AC}$, 25% load



Input Voltage and Current

$V_{IN} = 230V_{AC}$, 25% load

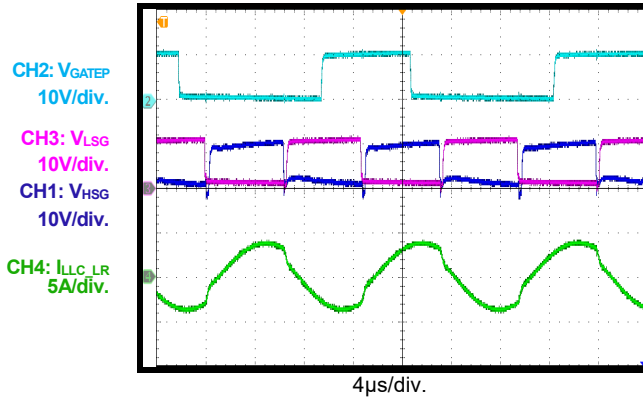


EVB TEST RESULTS (continued)

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

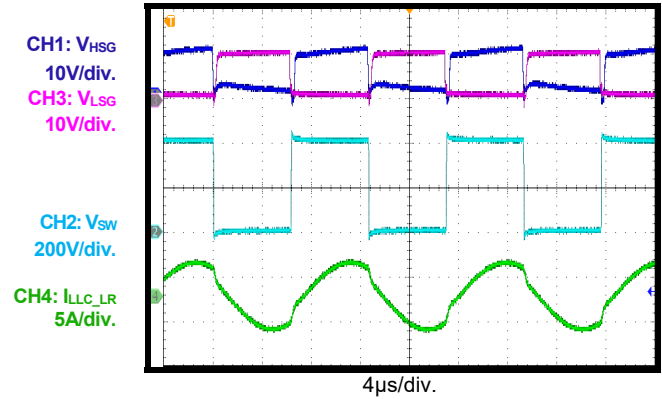
LLC Steady State

Full load



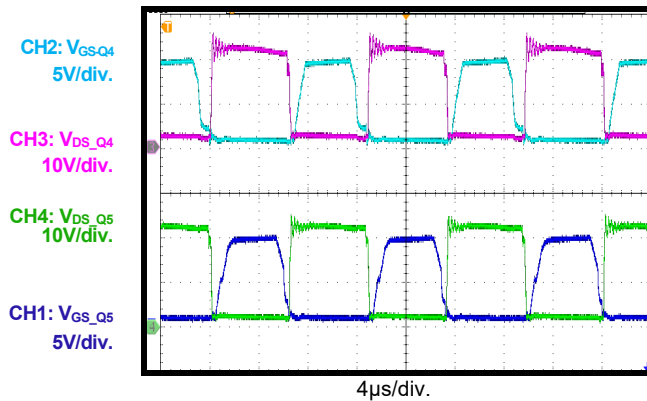
LLC Steady State

Full load



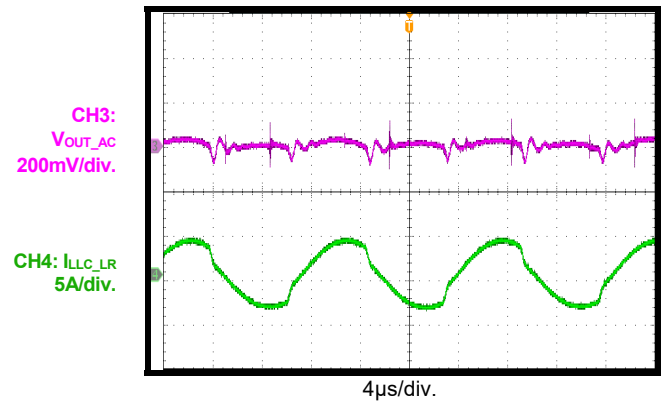
SR Operation

Full load



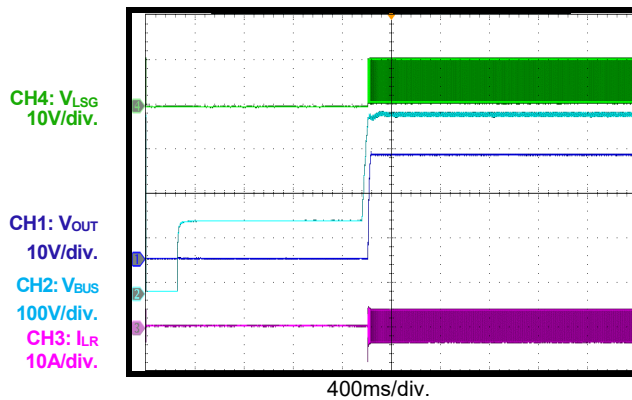
Output Ripple

Full load



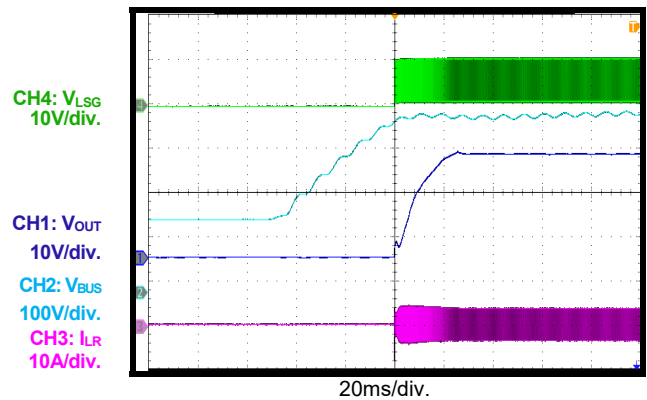
Start-Up

$V_{IN} = 115V_{AC}$, full load



Output Rise Time

$V_{IN} = 115V_{AC}$, full load

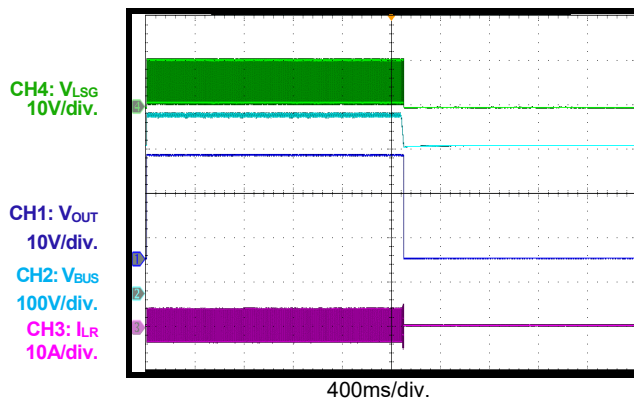


EVB TEST RESULT (continued)

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

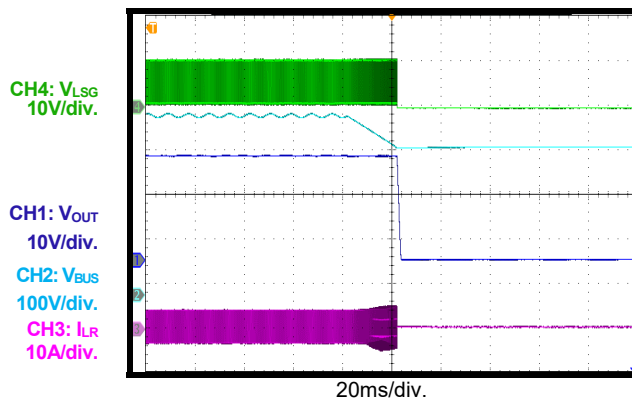
Shutdown

$V_{IN} = 115V_{AC}$, full load



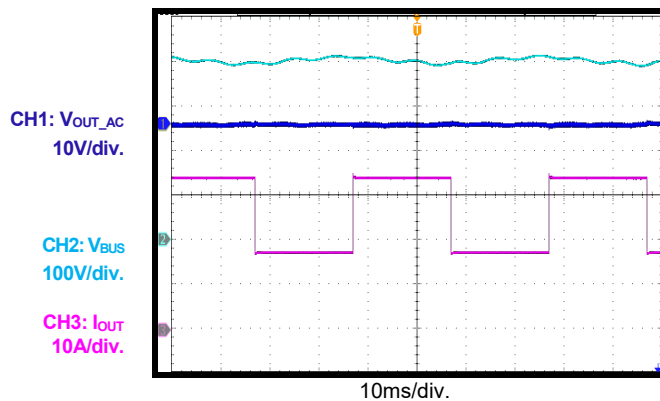
Hold-Up Time

$V_{IN} = 115V_{AC}$, full load



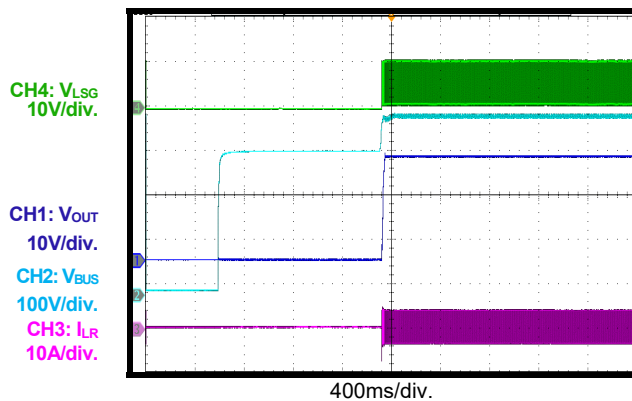
Load Transient

$V_{IN} = 115V_{AC}$, 1A/ μ s



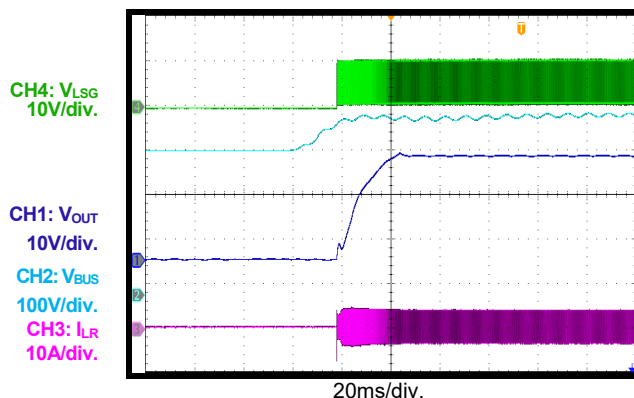
Start-Up

$V_{IN} = 115V_{AC}$, full load



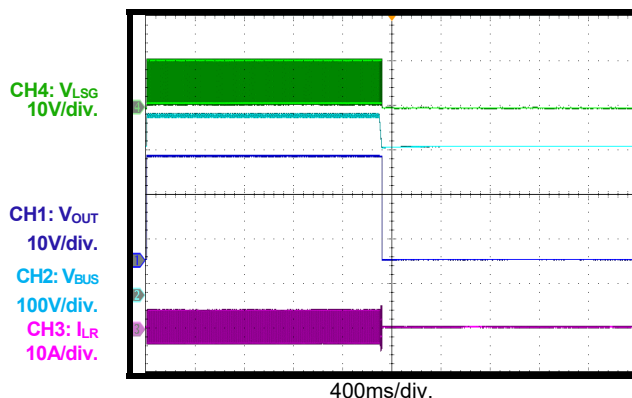
Output Rise Time

Full load



Shutdown

Full load

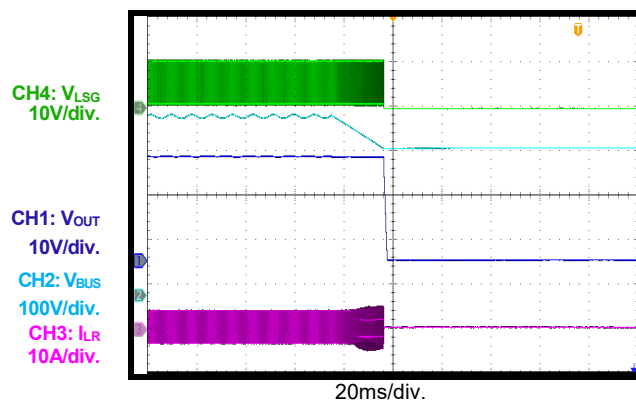


EVB TEST RESULTS *(continued)*

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

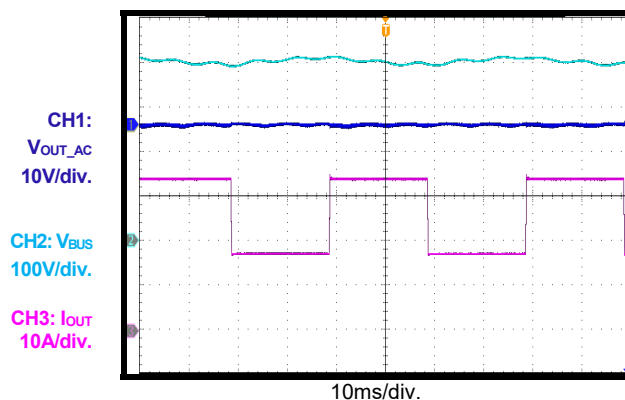
Hold-Up Time

$V_{IN} = 230V_{AC}$, full load



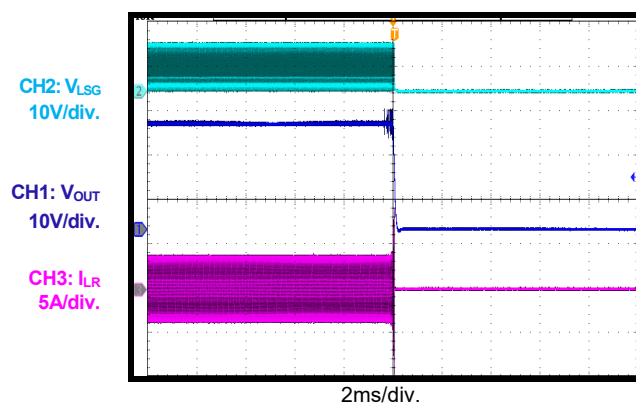
Load Transient

$V_{IN} = 230V_{AC}$, $1A/\mu s$



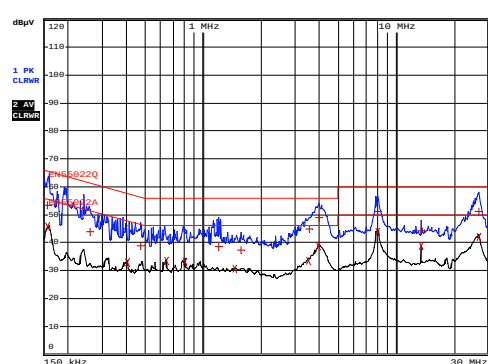
SCP Latch

Full load



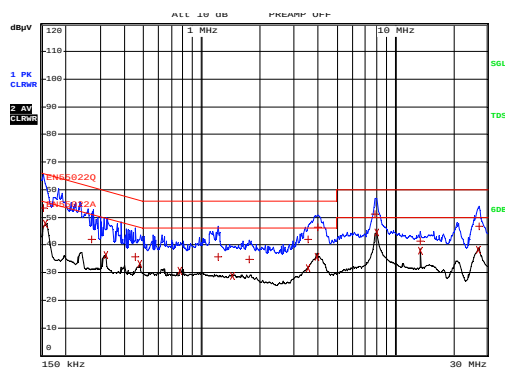
EMI Test

$230V_{AC}$, L wire



EMI Test

$230V_{AC}$, N wire



PCB LAYOUT

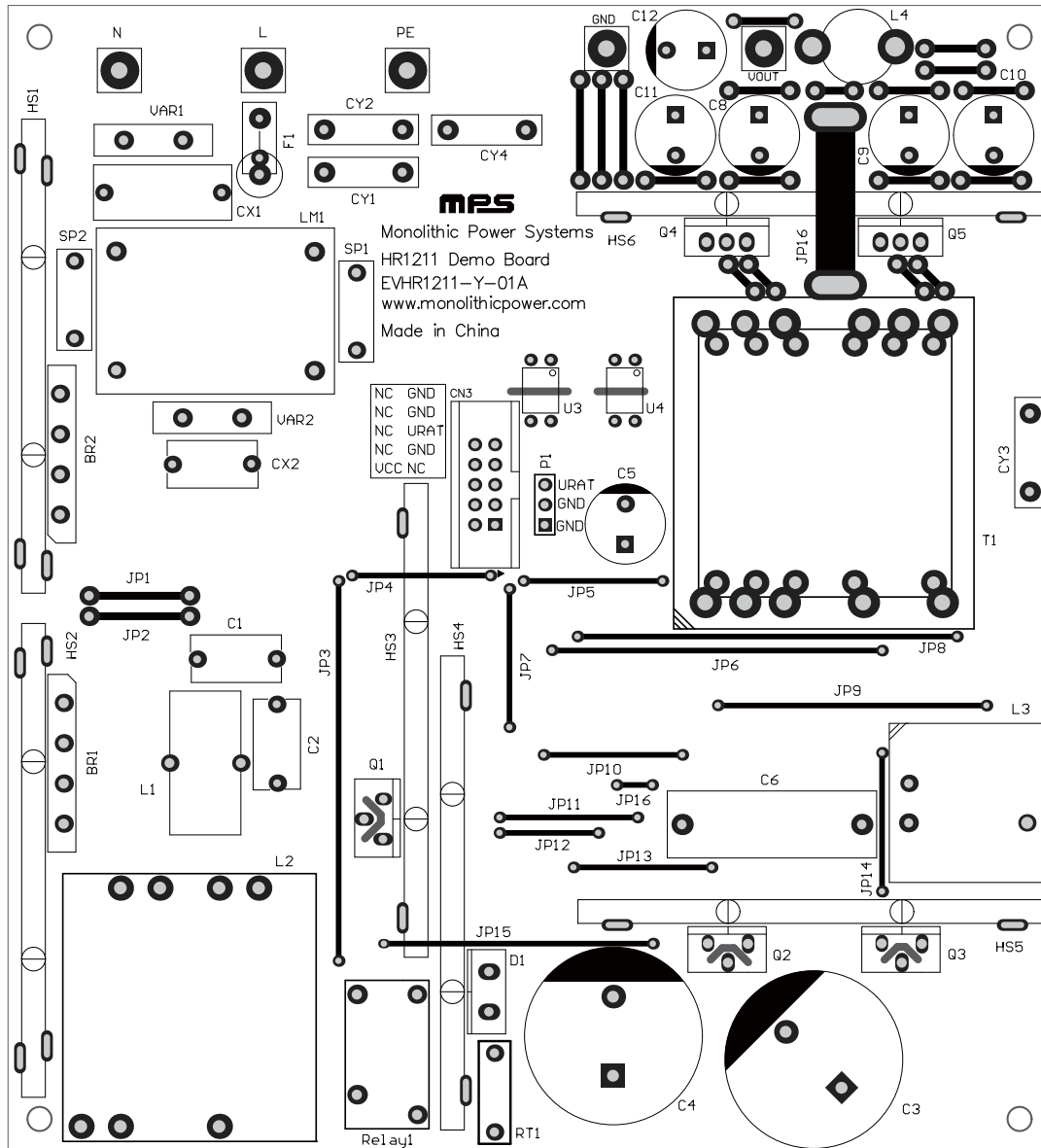


Figure 2: Top Silk and Top Layer

PCB LAYOUT (continued)

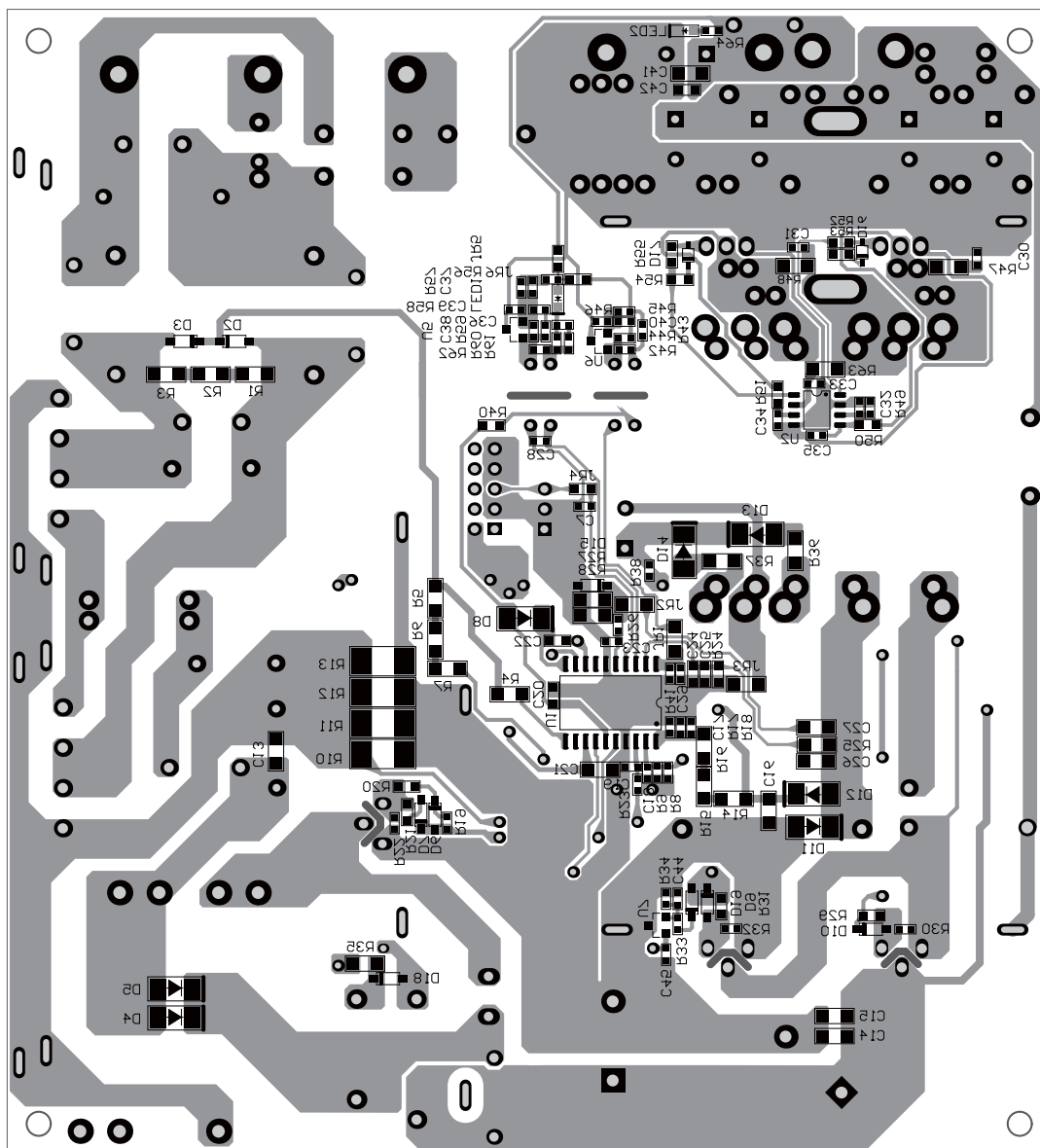


Figure 3: Bottom Layer and Bottom Silk

APPENDIX 1: PFC INDUCTOR SPECIFICATION (PQ3230)

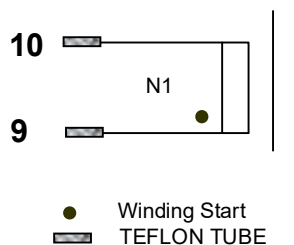


Figure 4: Electrical Diagram

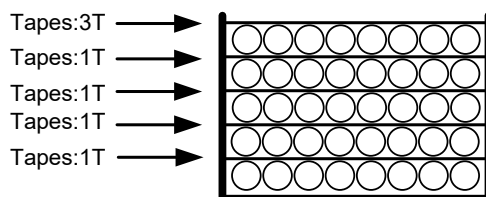


Figure 5: Winding Diagram

Table 1: Winding Specifications

Winding No.	Start and End	Wire Diameter (mm)	Turns	Tube
N1	9 to 10	0.1mm x 100	45	Match wire

Table 2: Electrical Characteristics

No.	Parameter	Test Pin	Condition	Value
1	Inductance	9 to 10	100kHz	0.19mH $\pm$ 5%
2	Electrical Strength	9 to Core	60Hz, <5mA	500V _{AC}

APPENDIX 2: LLC RESONANT INDUCTOR SPECIFICATION (EF20)

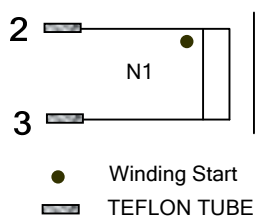


Figure 6: Electrical Diagram

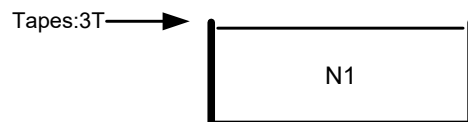


Figure 7: Winding Diagram

Table 3: Winding Specifications

Winding No.	Start and End	Wire Diameter (mm)	Turns	Tube
N1	2 to 3	0.1mm x 50	30	Match wire

Table 4: Electrical Characteristics

No.	Parameter	Test Pin	Condition	Value
1	Inductance	2 to 3	100kHz	45μH ±5%
2	Electrical Strength	2 to Core	60Hz, <5mA	500V _{AC}

APPENDIX 3: LLC TRANSFORMER SPECIFICATION (PQ3535)

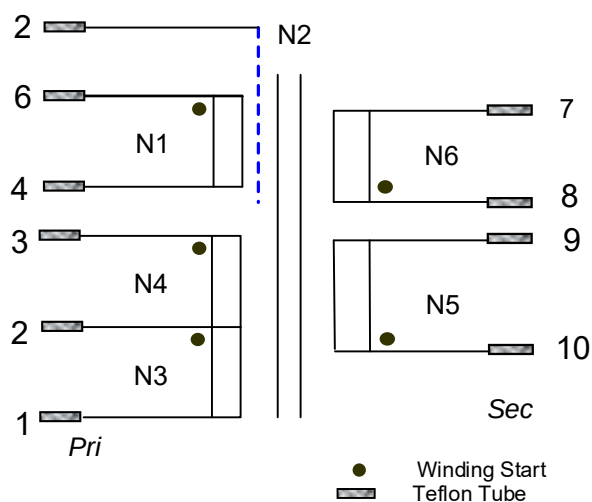


Figure 8: Electrical Diagram

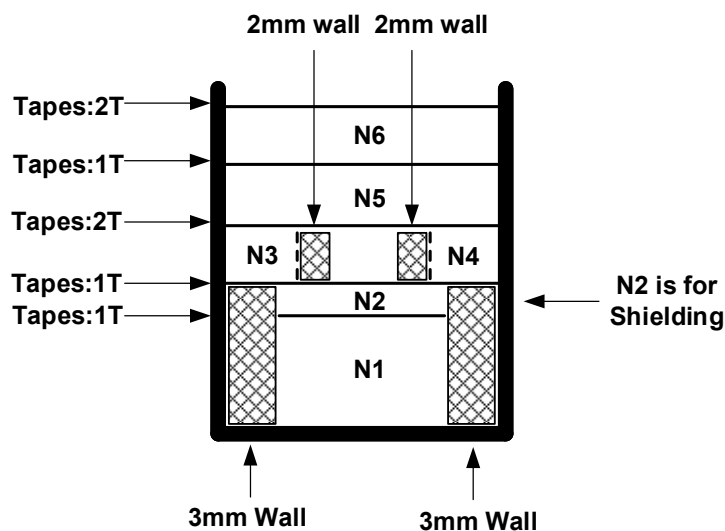


Figure 9: Winding Diagram

Table 5: Winding Specifications

Tape	Wall	Winding No.	Start and End	Wire Diameter (mm)	Turns	Tube
1	3mm each side	N1	6 to 4	0.1mm x 50	32	Match wire
2	3mm each side	N2	2 to NC	15mm copper tape	1	Match wire
1		N3	2 to 1	0.3mm T.I.W	4	Match wire
1		N4	3 to 2	0.3mm T.I.W	4	Match wire
1		N5	10 to 9	0.3mmx20mm copper	2	Match wire
1		N6	8 to 7	0.3mmx20mm copper	2	Match wire

APPENDIX 3: LLC TRANSFORMER SPECIFICATION (PQ3535) *(continued)*

Table 6: Electrical Characteristics

No.	Parameter	Test Pin	Value	Condition
1	Inductance	4 to 6	400 μ H $\pm$ 5%	100kHz
2	Electrical strength	2/4 to 8/9	3500V _{AC}	60Hz, <5mA
		4 to core	500V _{AC}	
		8/9 to core	3500V _{AC}	

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	06/10/2021	Initial Release	-

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