Fairchild Reference Design RD-549

This reference design supports inclusion of 2-phase interleave BCM PFC controller FAN9611, 2-phase interleave CCM PFC controller FAN9672, and Fairchild Integrated Power Switch FSL336LRN; in a design of a Power-Factor-Correction (PFC) front-end up to 3 KW. This document should be used in conjunction with the FAN9611, FAN9672 and FSL336LR datasheets as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at: www.fairchildsemi.com.

Application	Fairchild Device	Input Voltage Range	Maximum Power	Output Condition	Topology
PFC Front-end with Auxiliary Power	FAN9611 FAN9672 FSL336LR	160-264 V_{AC}	3000 W	400 V_{DC}	2 Phase Interleaved Boost PFC, HV Buck.

General Description

This reference design is made for a high efficiency, high power PFC up to 3 KW. It can be used in applications such as inverter type air conditioner, welding machine, EV charger, UPS etc. To achieve higher efficiency and power density, we adopted a two-channel interleave topology. To make the solution more flexible, we provided two control methods: Continuous Conduction Mode (CCM) and Boundary Conduction Mode (BCM) for options. Selecting the control mode is easily done by changing the two different daughter boards. Each control mode has its advantages and disadvantages, which are explained in the following description and test results. To adopt the IGBT as the switching device, we placed a frequency up limit circuit on the BCM control board. It can be disabled while using the MOSFET as the switching device. A buck mode auxiliary power was applied since no insulation is required on the PFC stage, and because the Buck converter is simple and cheaper than the flyback converter.

Key Features for System

- Two phase/channel interleaved boost topology to achieve high efficiency and low current ripple.
- Inductors on board reduces system size.
- Auxiliary power built in. Plug and Play evaluation.
- Temperature monitoring heat sink fan control. Decreased standby power and increased the life time.
- Output voltage is adjustable by potentiometer.
- BCM/CCM control optional by selecting different daughter board.
- Optional switching frequency limitation on BCM allowing IGBT as the switching device.

1. BCM PFC Control Daughter Board

This daughter board contains an Interleaved Dual CrCM (BCM) PFC Controller FAN9611MX and the peripheral components. Please refer to the FAN9611 Product Folder for more information about the device.

Key Features of FAN9611MX

- Sync-Lock™ Interleaving Technology for 180° Out-of-Phase Synchronization Under All Conditions
- Automatic Phase Disable at Light-Load
- Dead-Phase Detect Protection
- 2.0 A Sink, 1.0 A Source, High-Current Gate Drivers
- High Power Factor, Low Total Harmonic Distortion
- Voltage-Mode Control with $(V_{IN})^2$Feed-forward
- Closed-Loop Soft-Start with User-Programmable Soft-Start Time for Reduced Overshoot
- Minimum Restart Frequency to Avoid Audible Noise
- Maximum Switching Frequency Clamp
- Brownout Protection with Soft Recovery
- Non-Latching OVP on FB Pin and Latching Second-Level Protection on OVP Pin
- Open-Feedback Protection
- Power-Limit and Current Protection for Each Phase
- Low Startup Current of 80 µA Typical
- Works with DC and 50 Hz to 400 Hz AC Inputs

Additional Frequency Limitation

The switching frequency of the FAN9611 is limited between 16.5 kHz and 525 kHz. Since it's too high for the high power switching device especially for the IGBT, we setup an additional frequency limitation circuit for the option to decrease the switching loss when needed. This circuit is composed by a Dual Re-triggerable Monostable Multivibrator using the 74VHC123AM and peripheral components, shown in Figure 1.

The output of the monostable multivibrator inhibited the falling edge of ZCD signal during the high level period which is triggered by the gate drive signal. The frequency of limitation is determined by the period of high level. It can be adjusted by C13, R25 and C14, R29. The frequency limiter can be disabled by removing the D1, D2 or R22, R26. More information about the monostable multivibrator, please refer to the 74VHC123A Product Folder.

PCB Layout Tips for FAN9611

The PCB layout is critical for the interleave BCM PFC especially in the high power solutions because the sensitivity of the Zero-Current Detection (ZCD) signal is very easy influenced by the switching noise of the alternating channel. The OCP level of the FAN9611 is 0.21 V. The low trigger voltage is helpful to decrease the power loss on the current sense resistors, it also makes the OCP miss-trigger easily. If the sensitive input signal is not carefully considered, the PFC may be unstable.

Below are recommendations to avoid this issue:

(1) Use differential path on the ZCD winding. An often mistake of layout on ZCD winding is connecting the GND pin to nearby GND copper directly. The correct way is connect the GND pin of winding to pin 5 of the FAN9611. Please refer Figure 14.

(2) The path of CS signals should be close to the GND path which connects pin 11 of the FAN9611 and the switching devices.

(3) Drive switching devices by Totem poles instead of driving directly. The Totem poles need to be close to the switching devices. The drive ability of the FAN9611 is big enough, but if we drive the switching device by the FAN9611 directly, the charge/discharge current of the input capacitance of the switching device will add noise on the GND path between IC and switching devices. This noise will insert to the CS pins further more.

1.1. Photographs

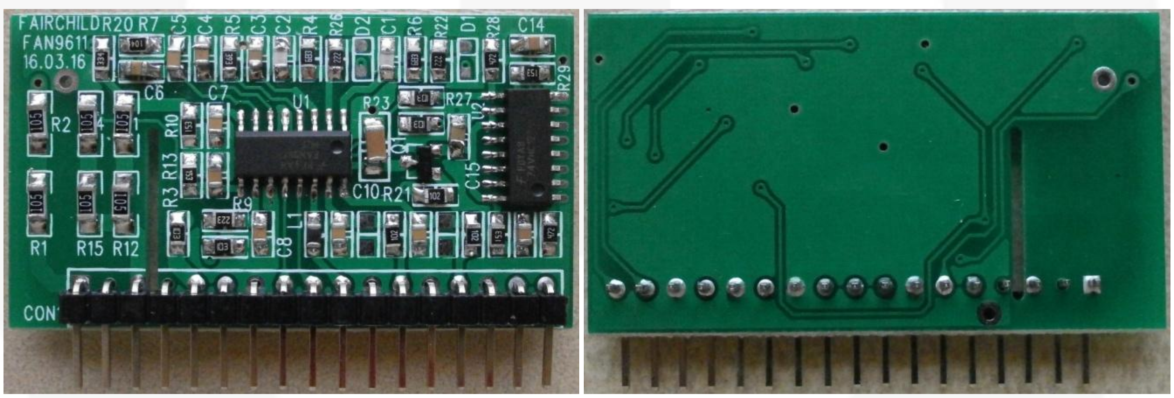


Figure 1. BCM PFC Control Daughter Board

1.2. Schematic

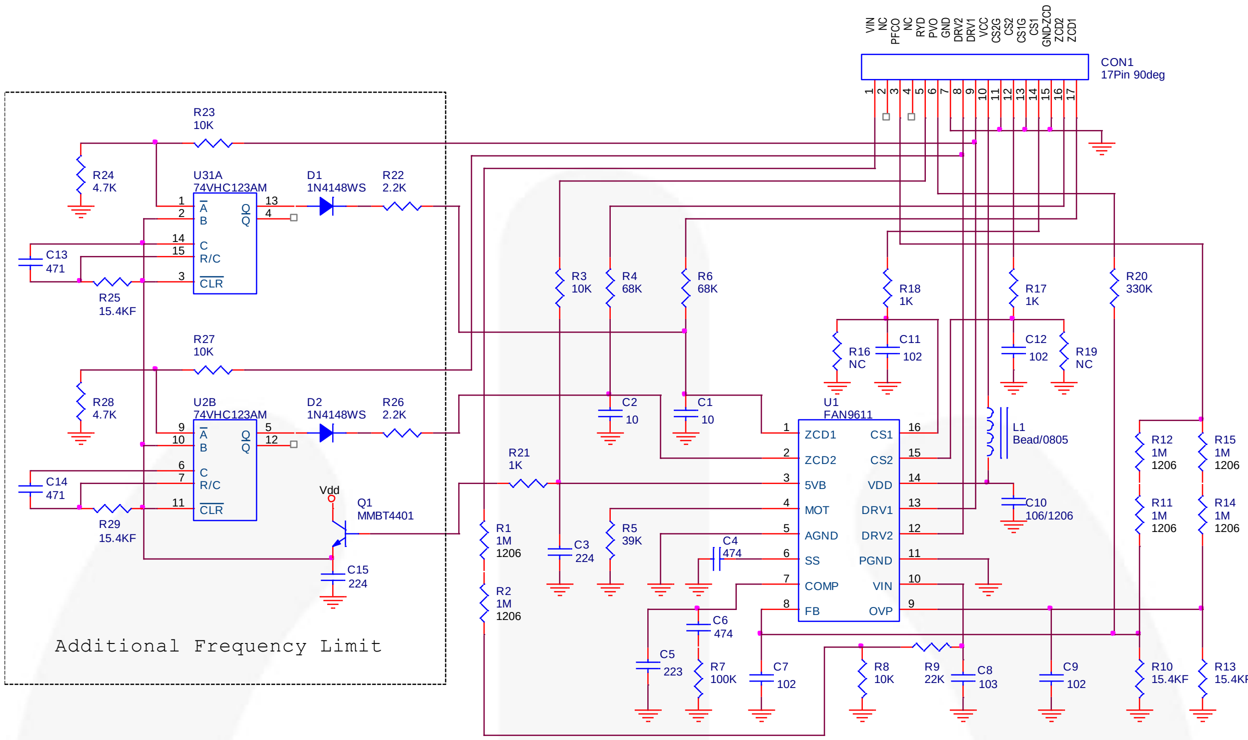


Figure 2. Schematic of BCM PFC control

2. CCM PFC Control Daughter Board

This daughter board contains the Interleaved Dual CCM PFC Controller FAN9672Q and the peripheral components. Please refer to the FAN9672 Product Folder for more information about the device.

Key Features for FAN9672Q

- Continuous Conduction Mode Control
- Two-Channel PFC Control (Maximum)
- Average Current-Mode Control
- PFC Slave Channel Management Function
- Programmable Operation Frequency Range: 18 kHz~40 kHz or 55 kHz~75 kHz
- Programmable PFC Output Voltage
- Two Current-Limit Functions
- TriFault Detect™ Protects Against Feedback Loop Failure
- SAG Protection
- Programmable Soft-Start
- Under-Voltage Lockout (UVLO)
- Differential Current Sensing
- Available in 32-Pin LQFP Package

2.1. Photographs

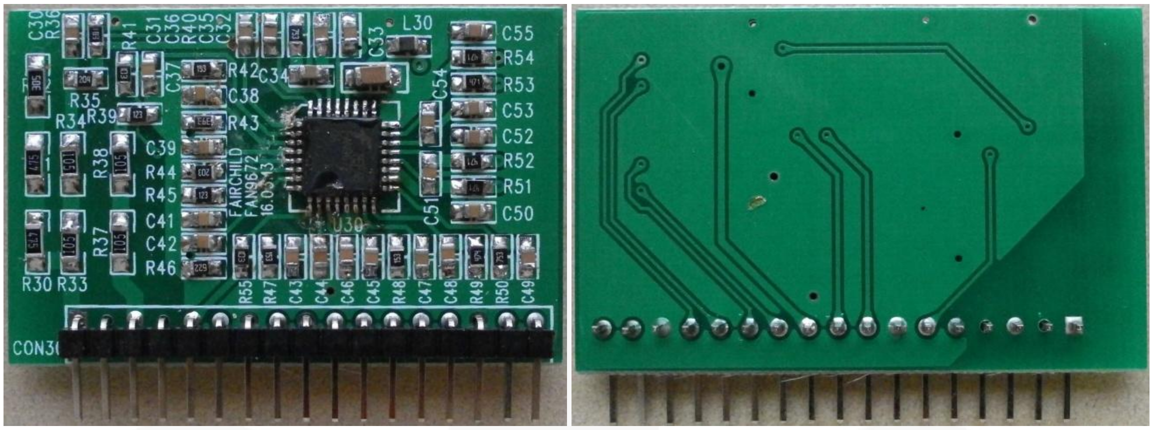


Figure 3. CCM PFC Control Daughter Board

2.2. Schematic

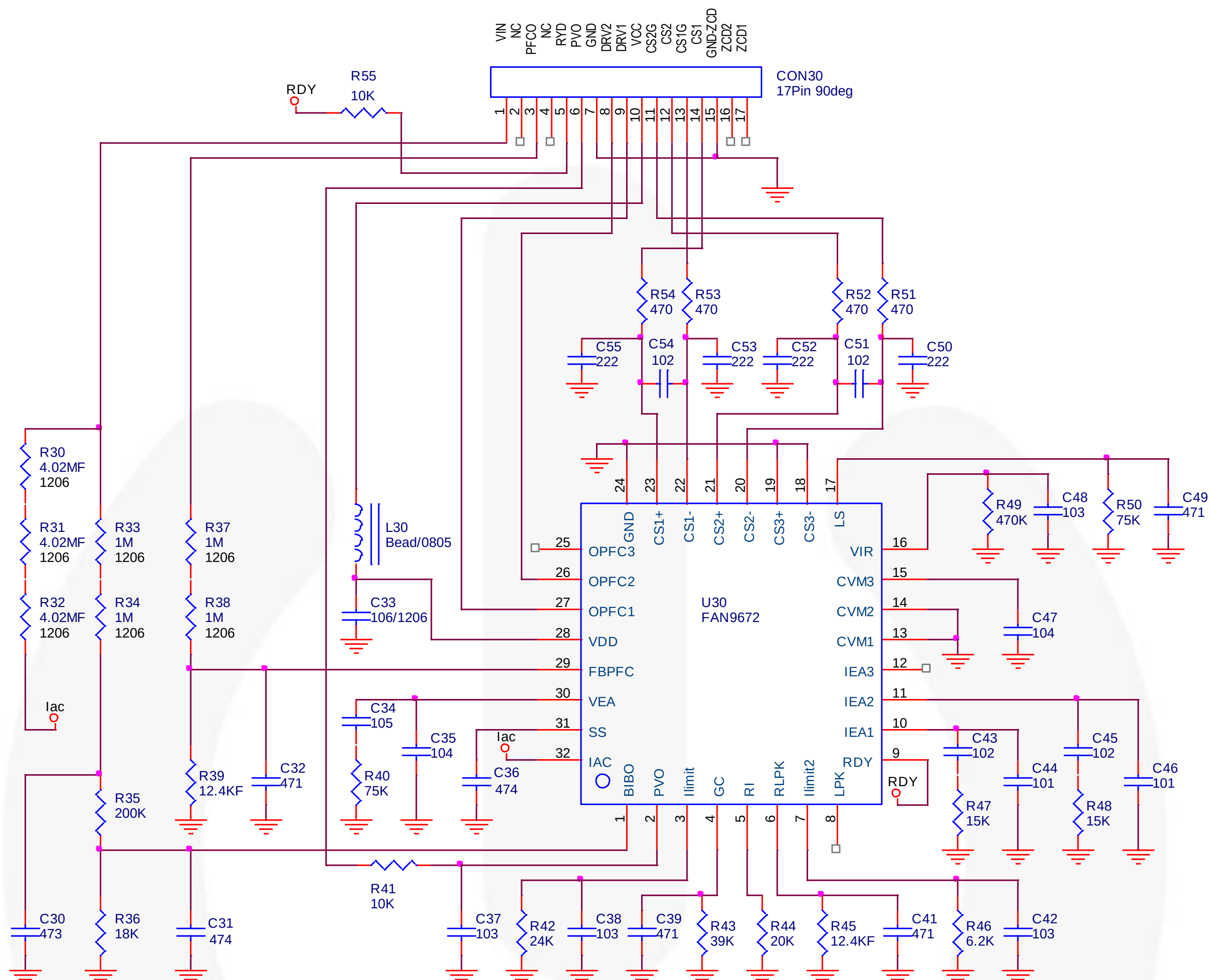


Figure 4. Schematic of CCM PFC Control

3. Power Stage

In this reference design, we used the same main PCB to achieve the BCM and CCM functions by changing the daughter boards. The key parts such as Inductors and switching devices must be changed according to the solutions.

3.1. Photographs

Figure 5 shows the whole system of the reference design.

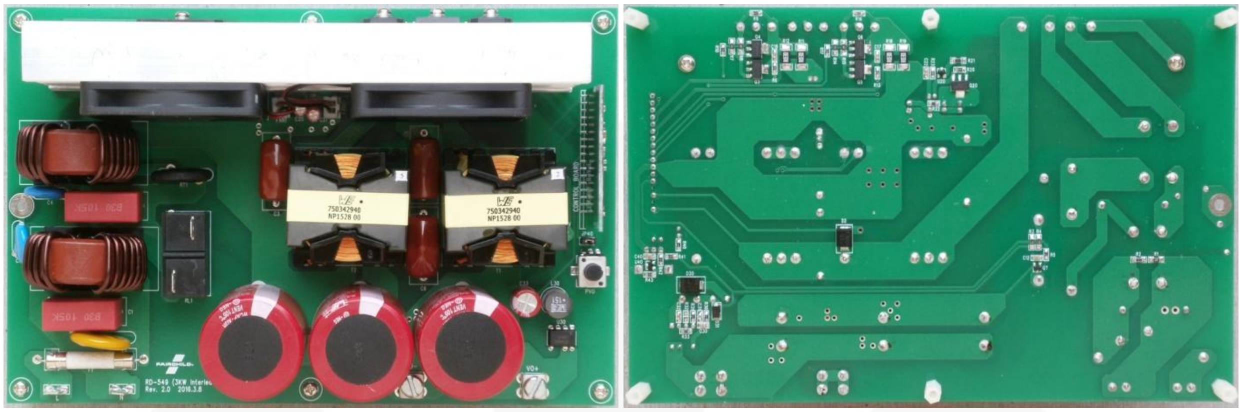


Figure 5. Picture of the 3 KW Interleaved PFC

3.2. Schematic

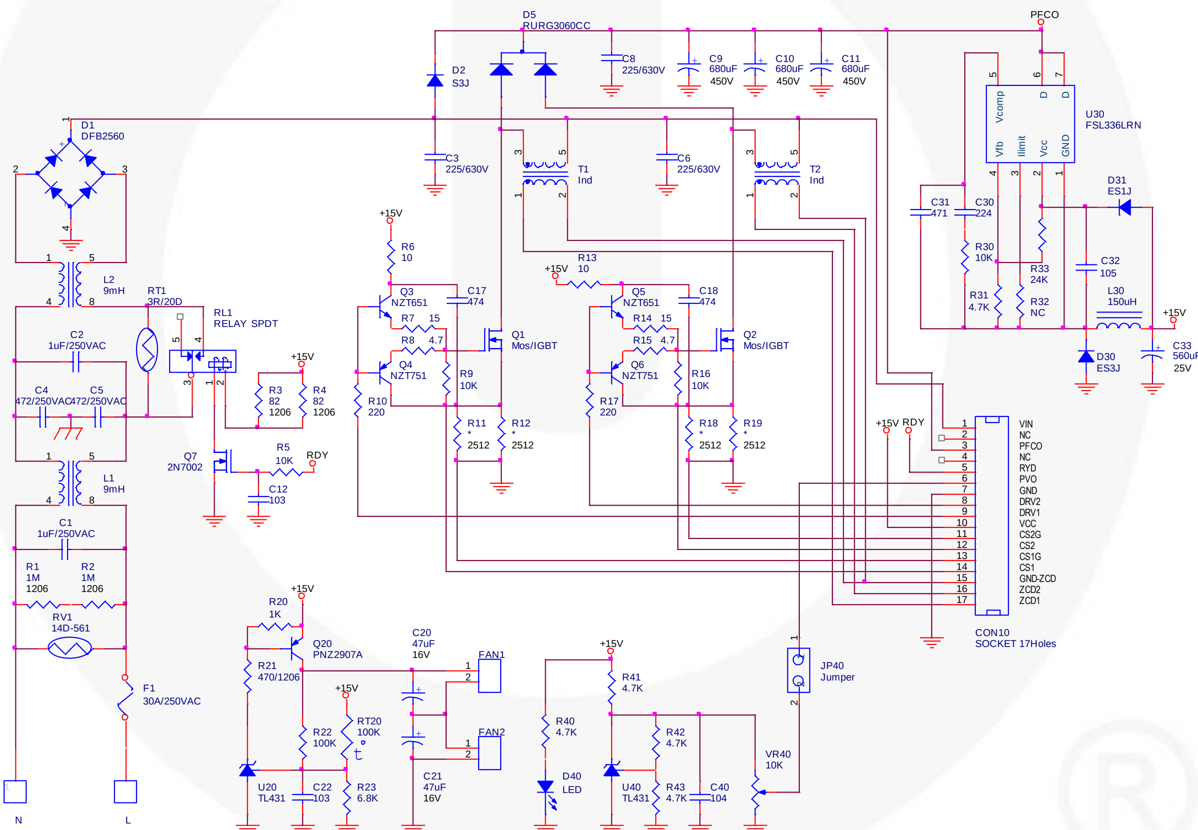


Figure 6. Schematic of the Interleave PFC

The U20 and the peripheral components create a cooling fan control circuit. When the temperature sensor RT20 senses overheating on the heatsink (around 60°C) the fans will turn on.

U40 and the peripheral components create an accurate voltage source. VR40 uses this voltage source adjusting the output voltage by PVO function in CCM solution and by adding the bias current on FB pin in BCM solution.

3.3. Mechanical

In this reference design we mounted the Rectifier Bridge, PFC MOSFET/IGBTs and PFC diodes on the same heatsink. The heatsink is cooled by two fans, shown in Figure 7. All dimensions are in mm.

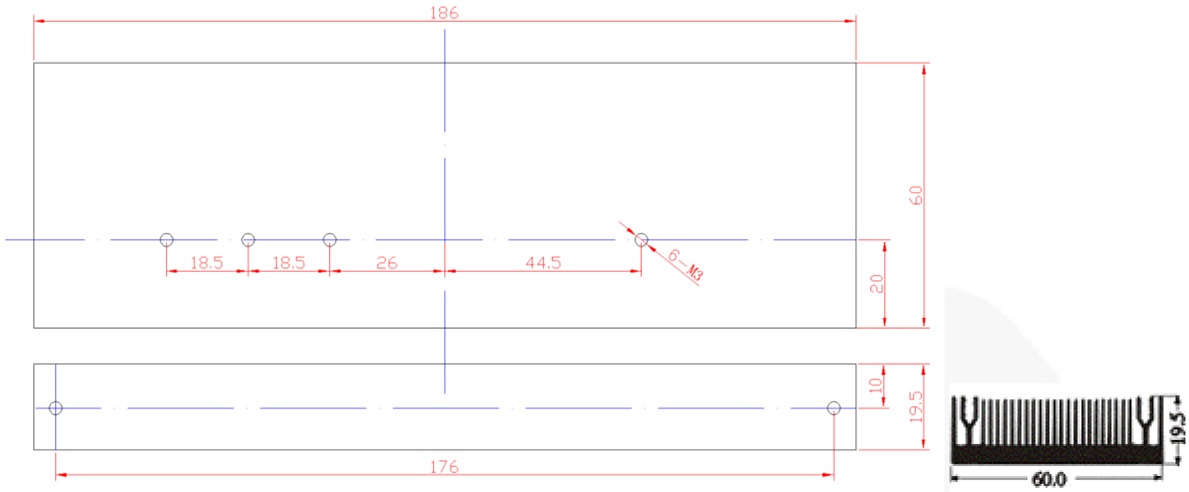
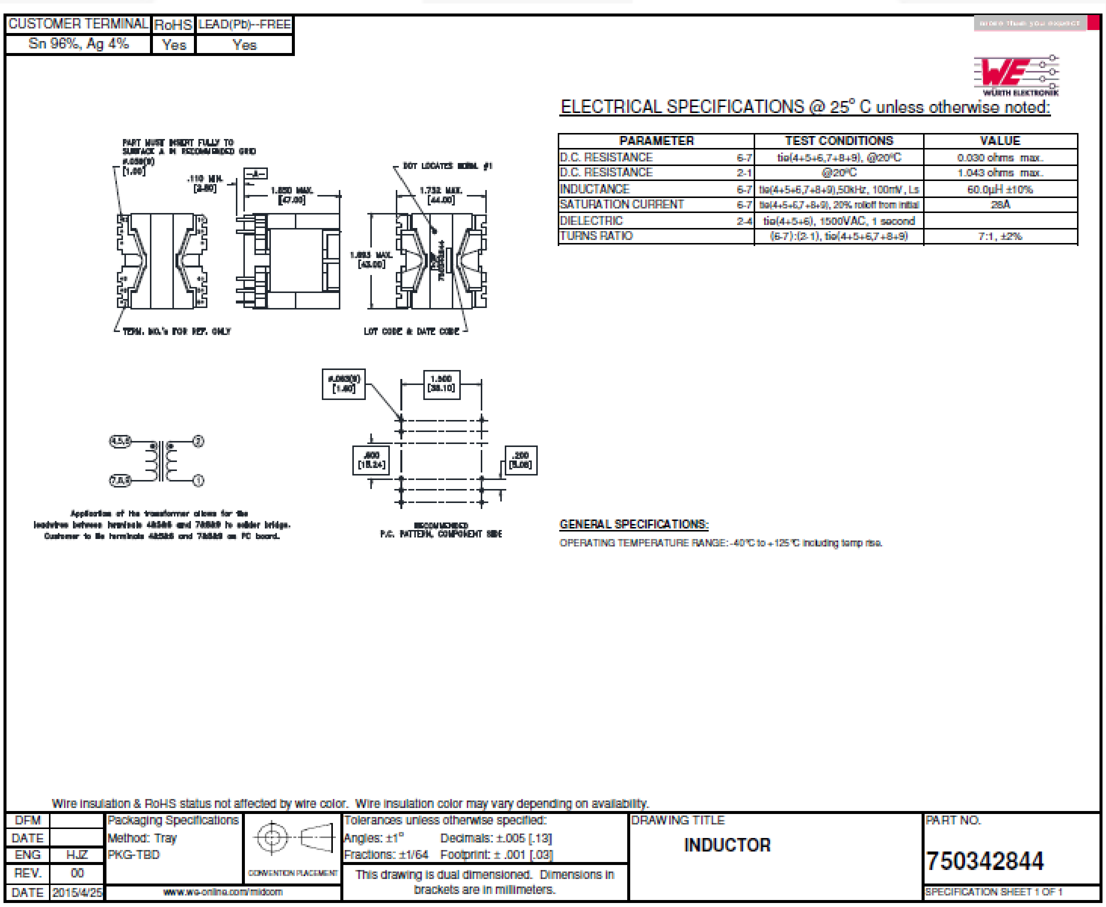


Figure 7. Mechanical Dimension of the Heat Sink

3.4. Magnetic Components



CUSTOMER TERMINAL	RoHS	LEAD(Pb)-FREE
Sn 96%, Ag 4%	Yes	Yes

ELECTRICAL SPECIFICATIONS @ 25° C unless otherwise noted:

PARAMETER		TEST CONDITIONS	VALUE
D.C. RESISTANCE	6-7	tie(4+5+6,7+8+9), @20°C	0.030 ohms max.
D.C. RESISTANCE	2-1	@20°C	1.043 ohms max.
INDUCTANCE	6-7	tie(4+5+6,7+8+9),50kHz, 100mV, Ls	60.0µH ±10%
SATURATION CURRENT	6-7	tie(4+5+6,7+8+9), 20% rolloff from initial	28A
DIELECTRIC	2-4	tie(4+5+6), 1500VAC, 1 second	
TURNS RATIO		(6-7):(2-1), tie(4+5+6,7+8+9)	7:1, ±2%

GENERAL SPECIFICATIONS:

OPERATING TEMPERATURE RANGE: -40°C to +125°C including temp rise.

Wire insulation & RoHS status not affected by wire color. Wire insulation color may vary depending on availability.

DFM		Packaging Specifications	Tolerances unless otherwise specified:
DATE		Method: Tray	Angles: ±1° Decimals: ±.005 [.13]
ENG	HJZ	PKG-TBD	Fractions: ±1/64 Footprint: ± .001 [.03]
REV.	00		This drawing is dual dimensioned. Dimensions in brackets are in millimeters.
DATE	2015/4/25	www.we-online.com/midcom	

DRAWING TITLE: INDUCTOR

PART NO. 750342844

SPECIFICATION SHEET 1 OF 1

Figure 8. BCM PFC Inductor Specification

Figure 8 shows the PFC inductors for BCM, and Figure 9 shows the PFC inductors for CCM.

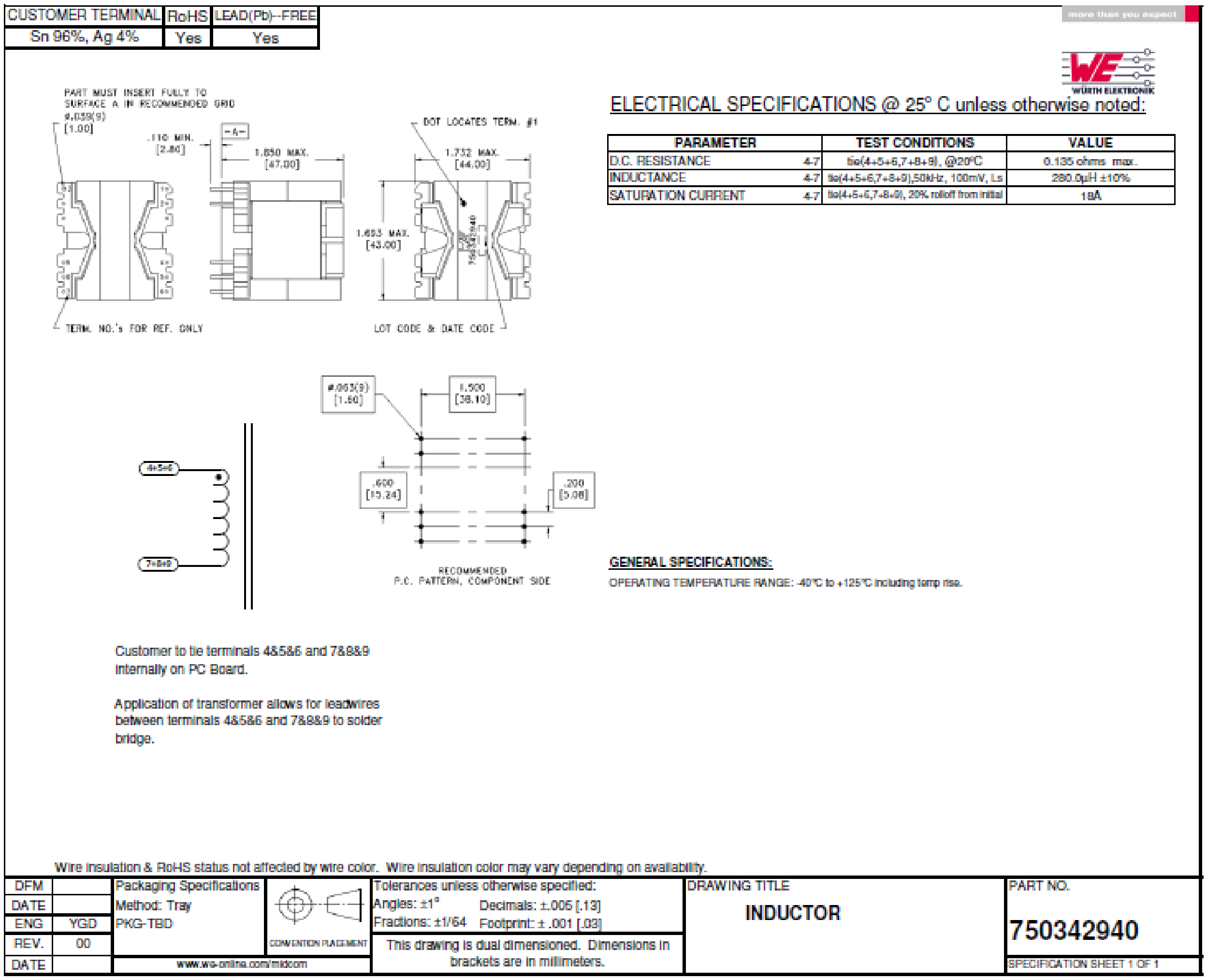


Figure 9. CCM PFC Inductor Specification

3.5. Test Results on BCM

Table 1. Efficiency

Load	MOSFET without F-Limit	MOESFET with F-Limit	IGBT without F-Limit	IGBT with F-limit
10% (P_O=300 W)	94.64%	95.24%	92.88%	94.88%
25% (P_O=750 W)	96.02%	96.77%	94.56%	96.14%
50% (P_O=1500 W)	97.34%	97.34%	95.66%	97.02%
75% (P_O=2250 W)	97.53%	97.40%	97.15%	98.34%
100% (P_O=3000 W)	97.47%	97.24%	97.57%	97.92%

Note:

1. V_{IN}=220 V_{AC}, V_O=400 V_{DC}, MOSFET=FCH072N60. IGBT=FGA3060ADF.

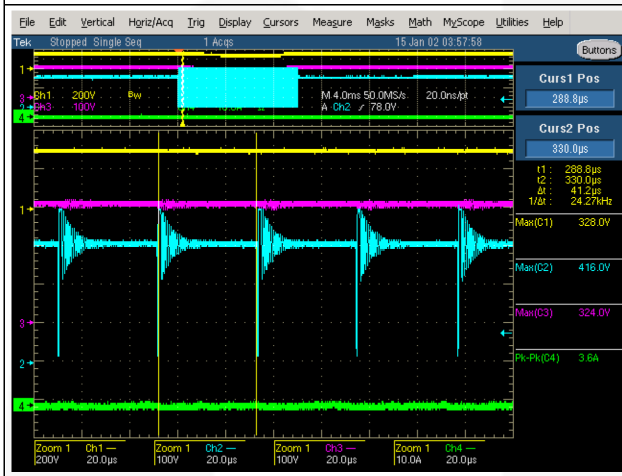
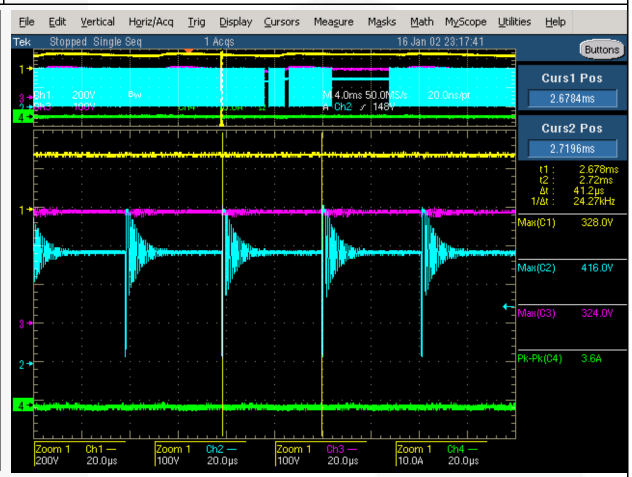
Table 2. Power Factor and THD

Load	MOSFET without Frequency Limiter		IGBT with Frequency Limiter	
	PF	THD	PF	THD
25%	0.992	8.83%	0.938	25.37%
50%	0.995	7.66%	0.959	26.28%
75%	0.996	6.95%	0.962	27.22%
100%	0.998	5.79%	0.986	16.28%

Note:

2. V_{IN}=220 V_{AC}, V_O=400 V_{DC}, MOSFET=FCH072N60. IGBT=FGA3060ADF.

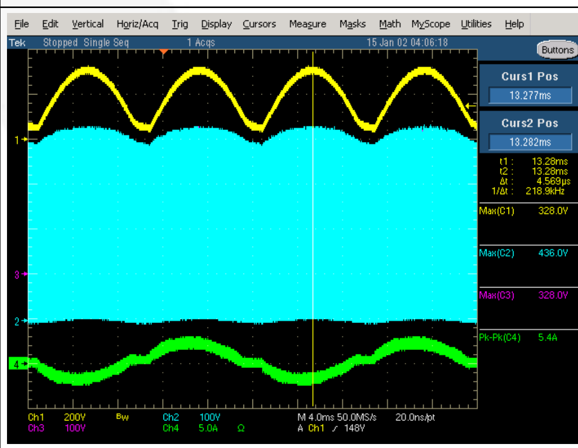
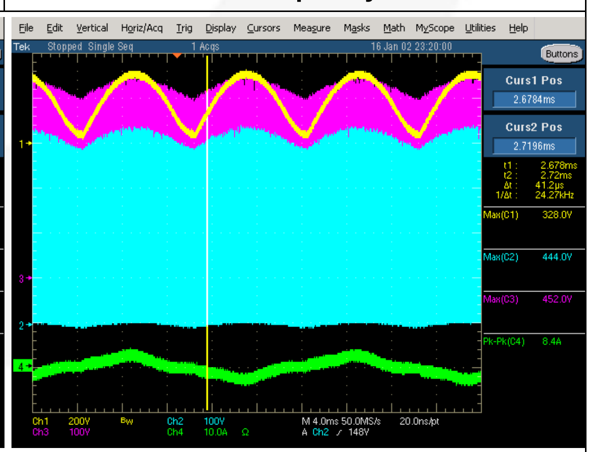
Table 3. Waveforms at No Load

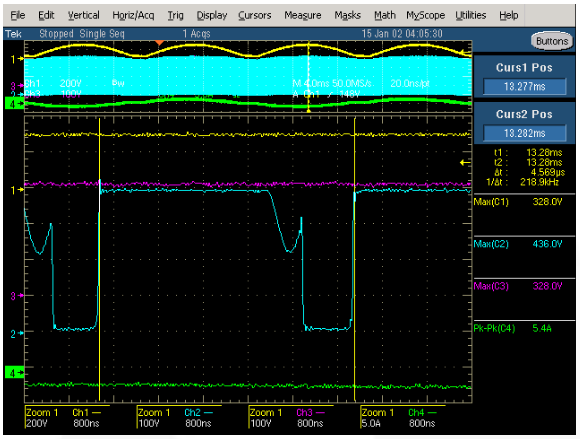
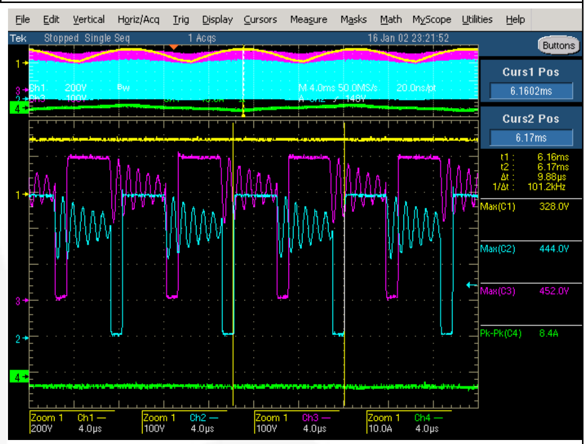
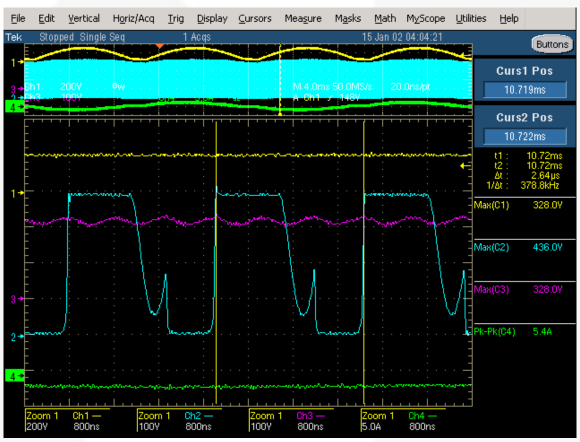
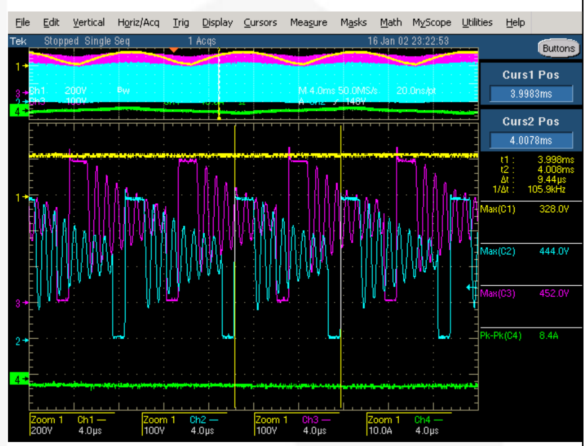
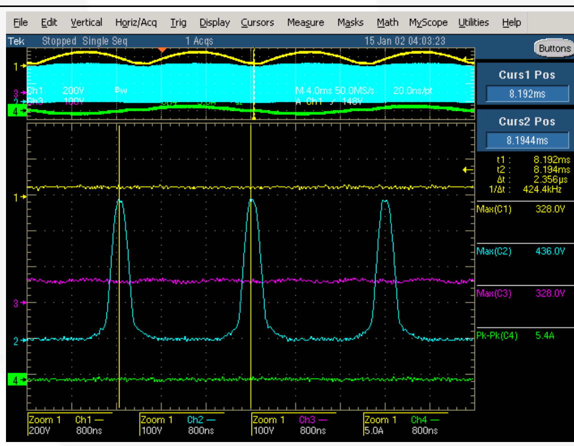
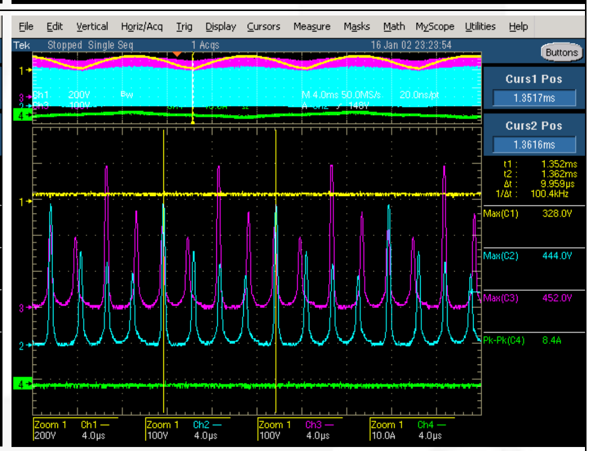
MOSFET without Frequency Limiter	IGBT with Frequency Limiter
	

Notes:

3. CH1(Yellow)=V_{IN}; CH2(Blue)=V_{DC}(V_{CE})1; CH3(Pink)=V_{DS}(V_{CE})2; CH4(Green)=I_{IN}.
4. Testing under V_{IN}=220V_{AC}, V_O=400V_{DC}.

Table 4. Waveforms at 10% Load

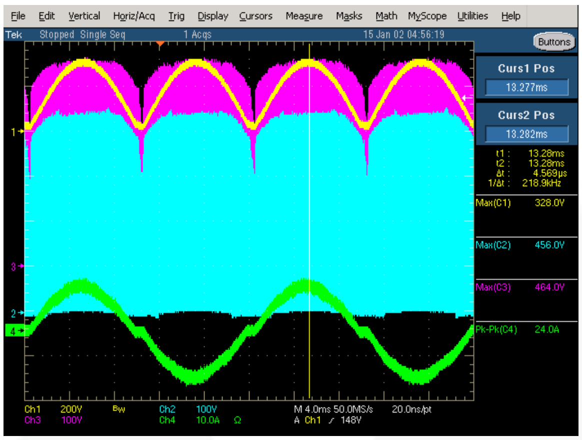
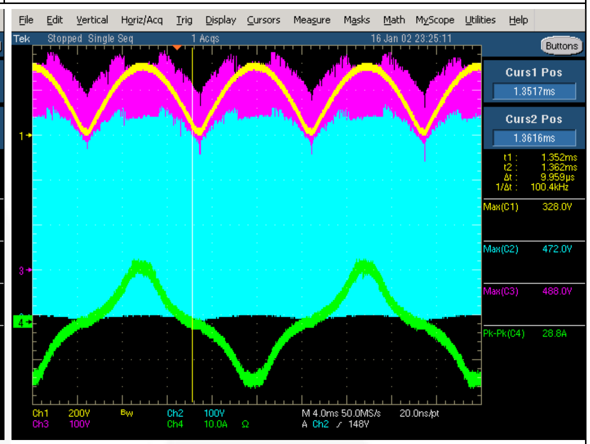
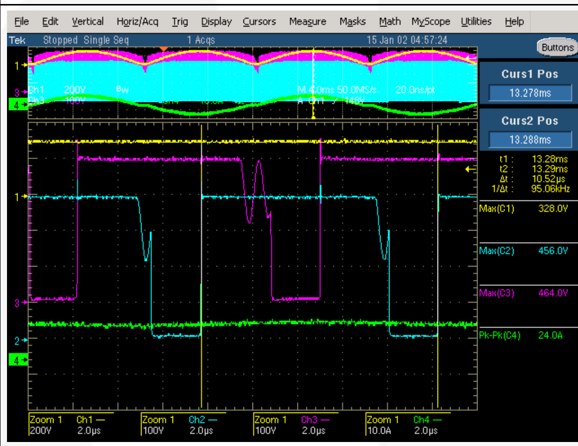
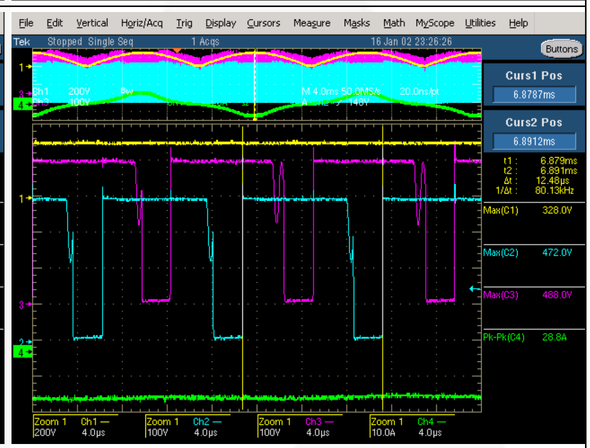
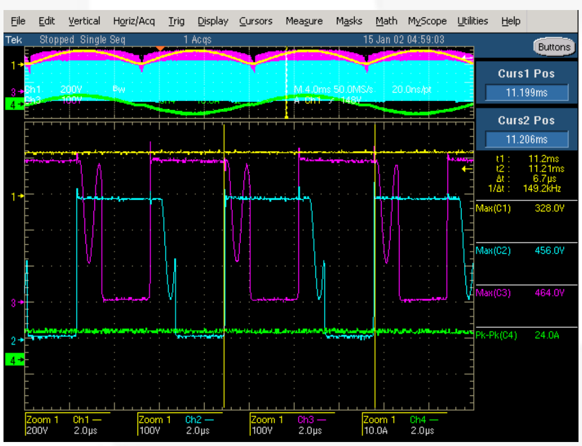
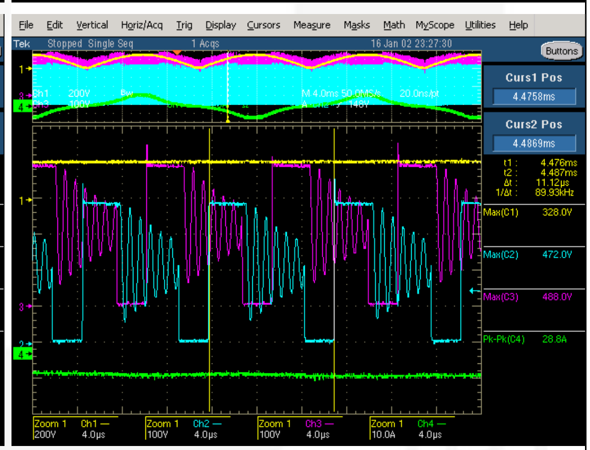
	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom Out		

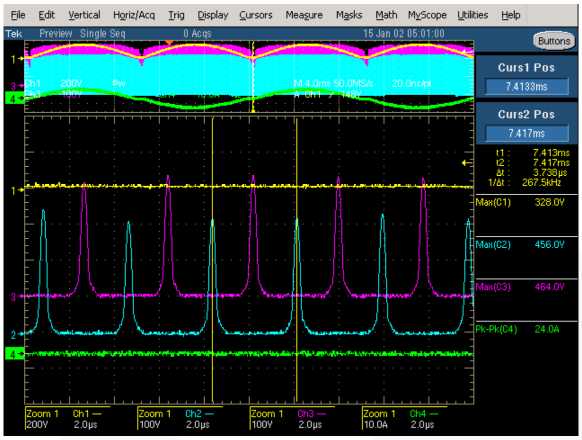
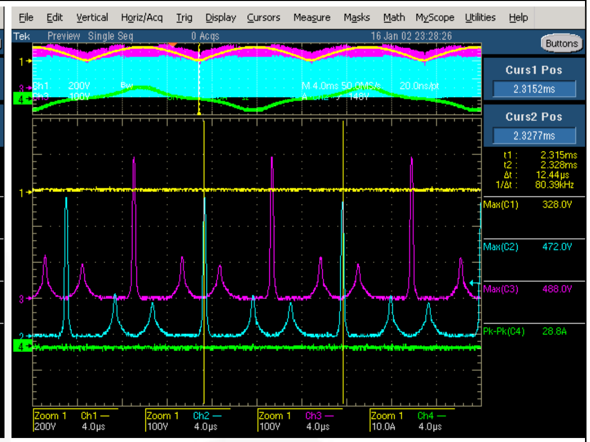
	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom In at Peak Point		
Zoom In at Middle Point		
Zoom In at Valley Point		

Notes:

5. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
6. Testing under V_{IN}=220V_{AC}, V_O=400V_{DC}.

Table 5. Waveforms at 50% Load

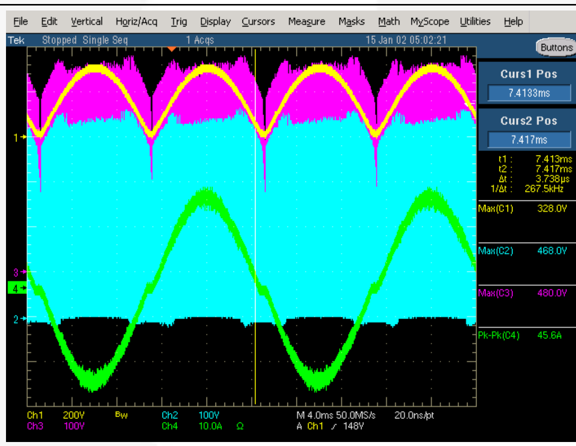
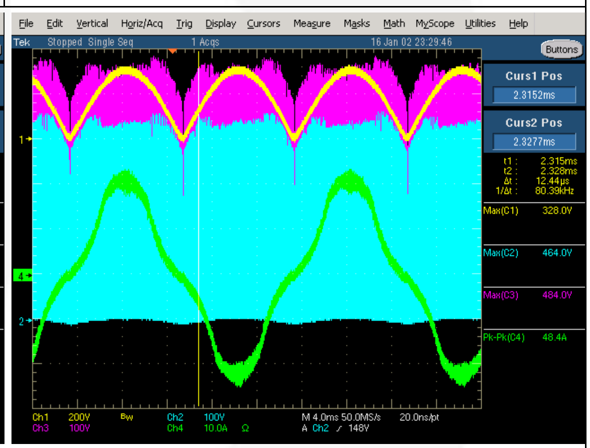
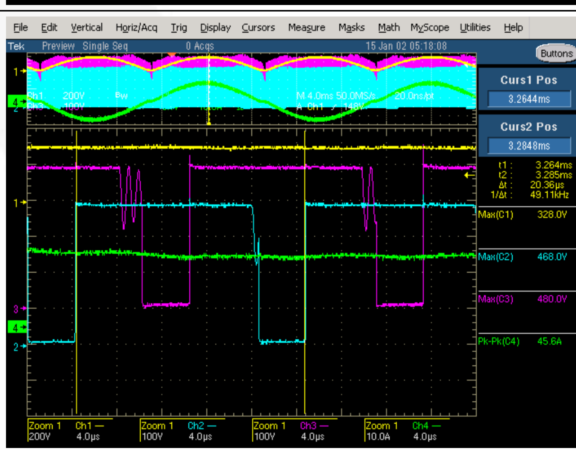
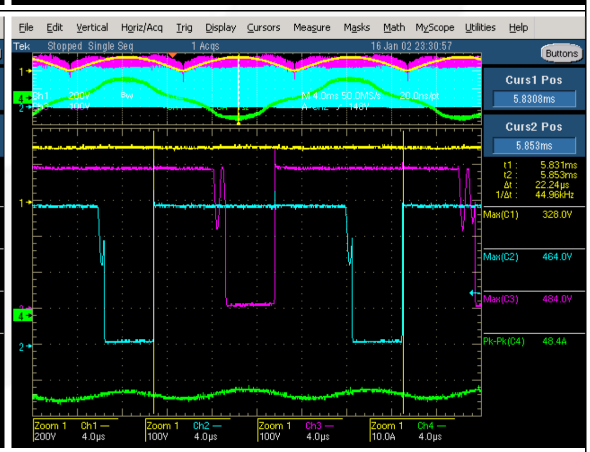
	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom Out		
Zoom In at Peak Point		
Zoom In at Middle Point		

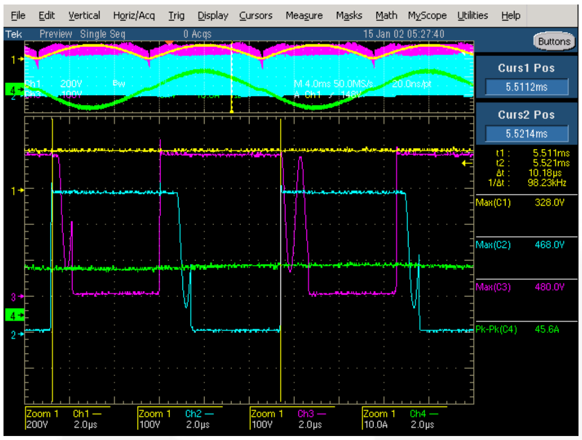
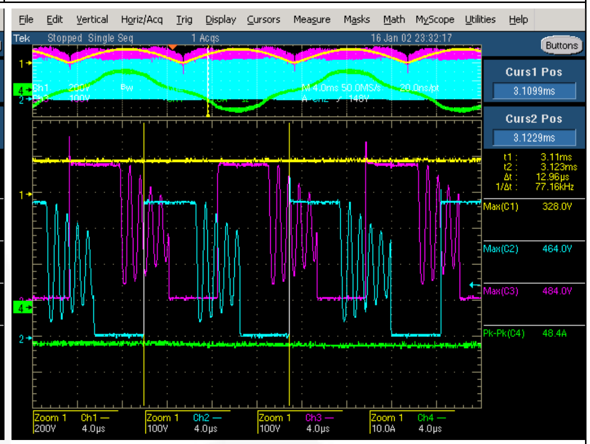
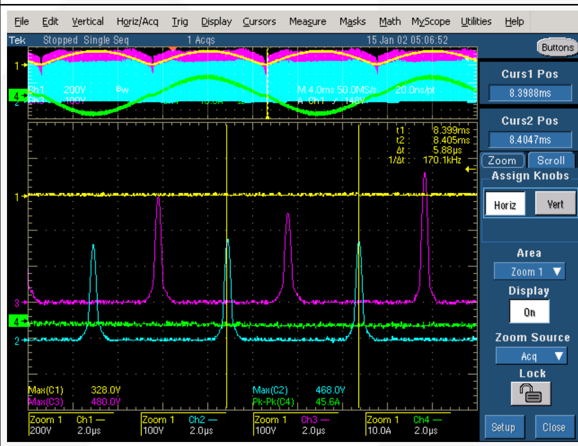
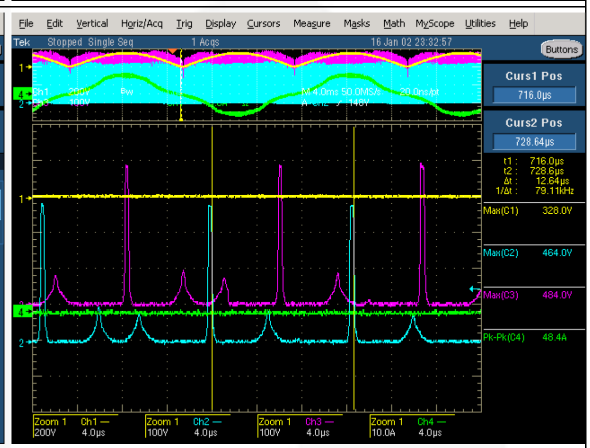
	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom In at Valley Point		

Notes:

7. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
8. Testing under V_{IN}=220V_{AC}, V_O=400V_{DC}.

Table 6. Waveforms at 100% Load

	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom Out		
Zoom In at Peak Point		

	MOSFET without Frequency Limiter	IGBT with Frequency Limiter
Zoom In at Middle Point		
Zoom In at Valley Point		

Notes:

9. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
10. Testing under V_{IN}=220V_{AC}, V_O=400V_{DC}.

3.6. Test Results on CCM

Table 7. Efficiency

Load	10% (P_O=300 W)	25% (P_O=750 W)	50% (P_O=1500 W)	75% (P_O=2250 W)	100% (P_O=3000 W)
Efficiency	96.15%	97.02%	97.72%	97.28%	97.09%

Note:

11. V_{IN}=220 V_{AC}, V_O=400 V_{DC}, IGBT=FGA3060ADF.

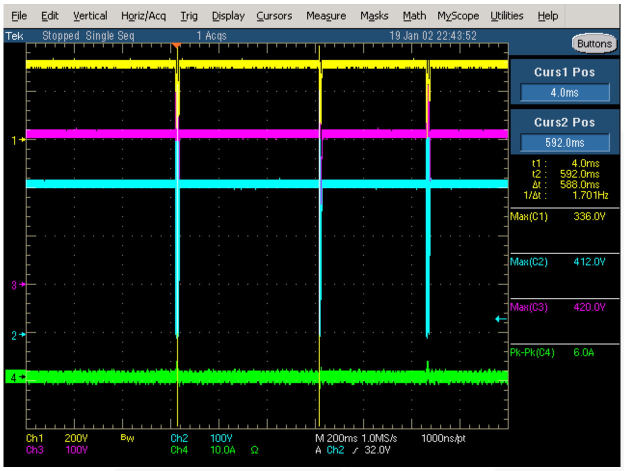
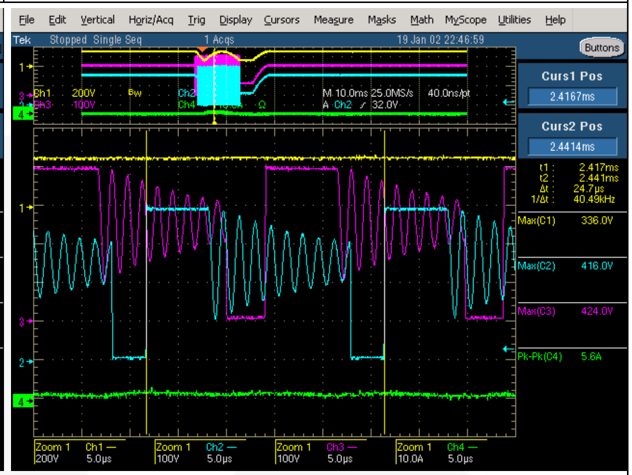
Table 8. Power Factor (PF) and Total Harmonic Distortion (THD)

Load	10% (P_O=300 W)	25% (P_O=750 W)	50% (P_O=1500 W)	75% (P_O=2250 W)	100% (P_O=3000 W)
PF	0.917	0.989	0.997	0.998	0.997
THD	15.69%	4.61%	5.32%	5.87%	5.73%

Note:

12. V_{IN}=220 V_{AC}, V_O=400 V_{DC}, IGBT=FGA3060ADF.

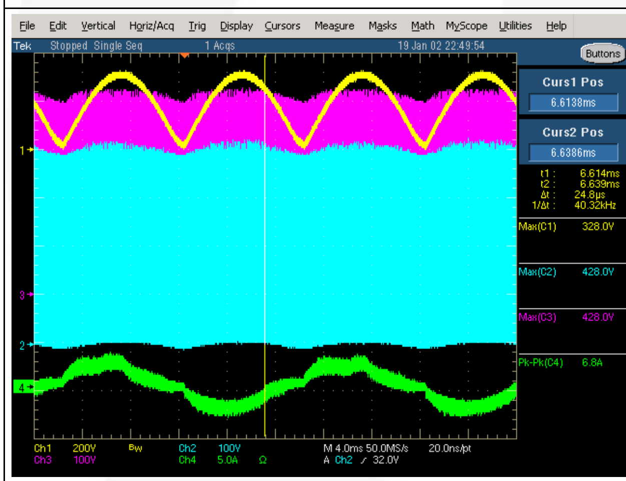
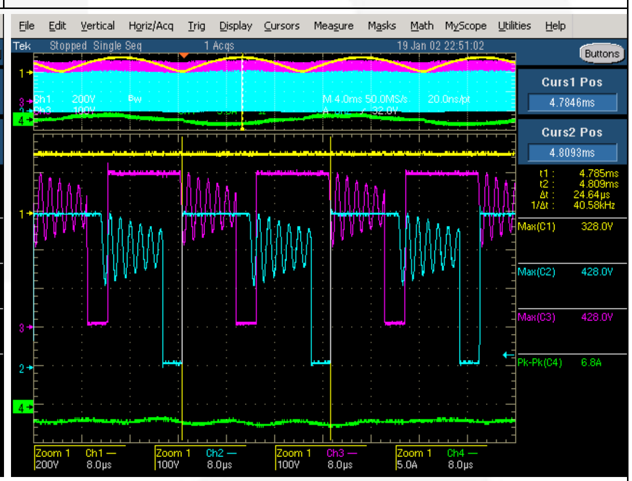
Table 9. Waveforms at No Load

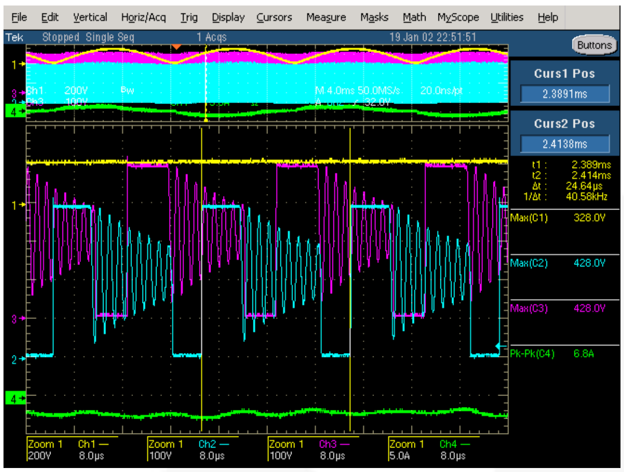
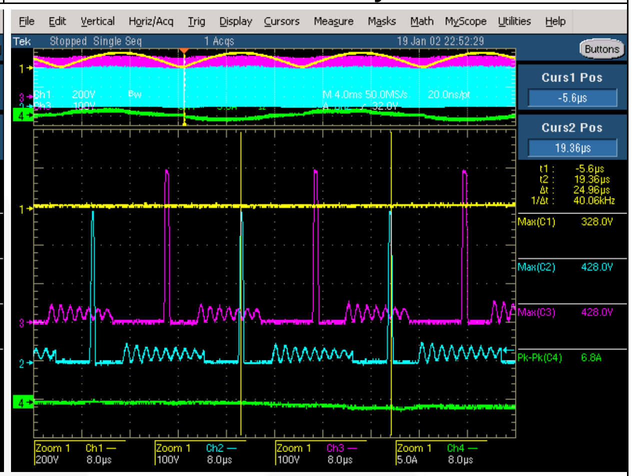
Zoom Out	Zoom In
	

Notes:

13. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
14. Testing under V_{IN}=220V_{AC}, V_O=400V_{DC}.

Table 10. Waveforms at 10% Load

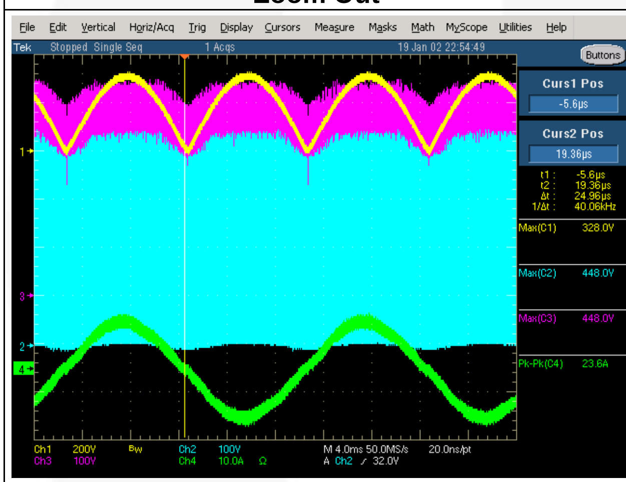
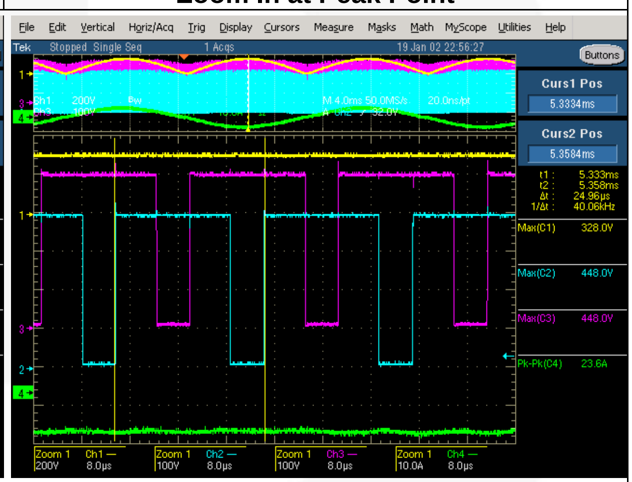
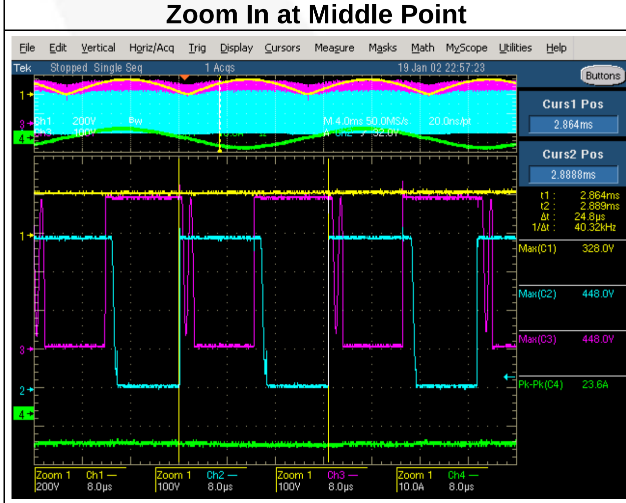
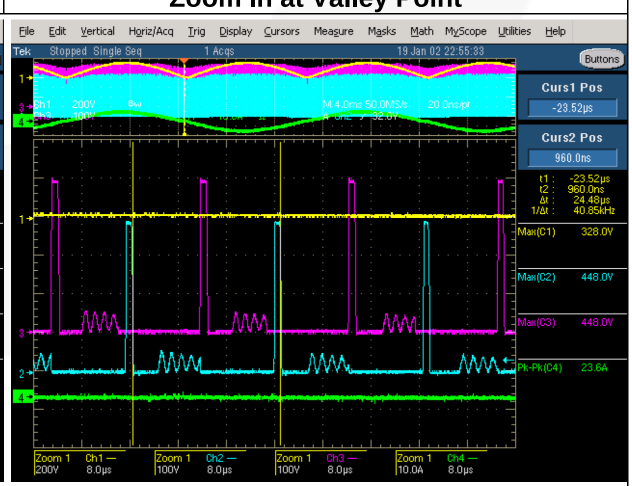
Zoom Out	Zoom In at Peak Point
	

Zoom In at Middle Point	Zoom In at Valley Point
	

Notes:

15. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
16. Testing under V_{IN}=220V_{AC}, V_O=400V_{DS}.

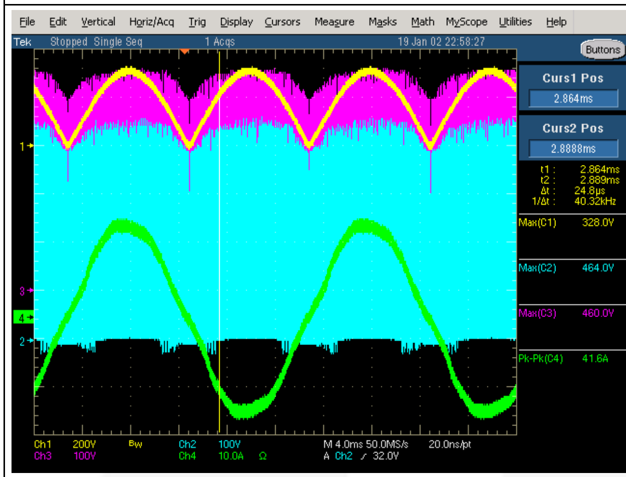
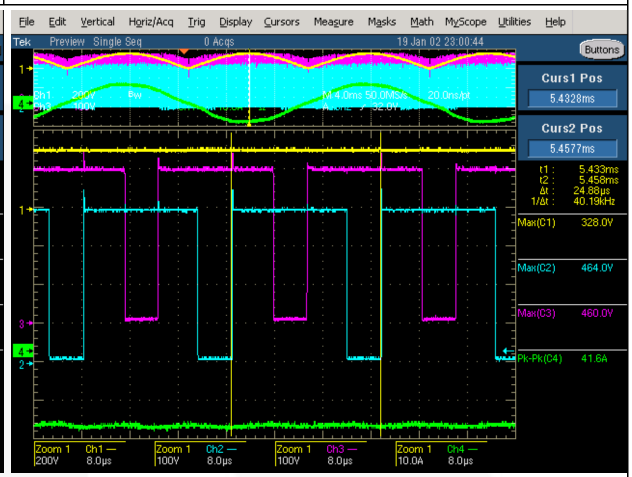
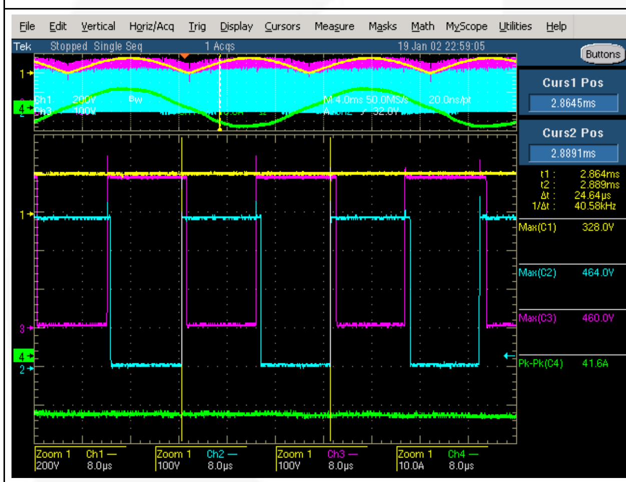
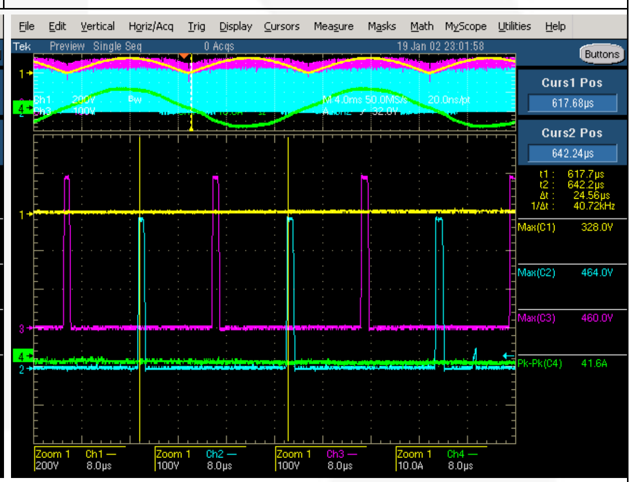
Table 11. Waveforms at 50% Load

Zoom Out	Zoom In at Peak Point
	
Zoom In at Middle Point	**Zoom In at Valley Point**
	

Notes:

17. CH1(Yellow)=V_{IN}; CH2(Blue)=V_{DS}(VCE)1; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
18. Testing under V_{IN}=220 V_{AC}, V_O=400 V_{DC}.

Table 12. Waveforms at 100% Load

Zoom Out	Zoom In at Peak Point
	
Zoom In at Middle Point	**Zoom In at Valley Point**
	

Notes:

19. CH1(Yellow)=V_{IN}; CH2(Blue)=$V_{DS}(V_{CE})1$; CH3(Pink)=$V_{DS}(V_{CE})2$; CH4(Green)=I_{IN}.
20. Testing under V_{IN}=220 V_{AC}, V_O=400 V_{DC}.

4. Auxiliary Power

This reference design need only a +15 V non-insulation auxiliary power to supply the controller board, gate driver, NTC bypass relay, and cooling fans. The total load current is around 0.5 A. To meet these requirements in the most cost-effective way, the HV buck converter by FSL336LRN was created. Please refer to the FSL336LR Product Folder for more information about the device.

Key Features for FSL336LR

- Built-in Avalanche-Rugged SenseFET: 650 V
- Fixed Operating Frequency: 50 kHz
- No-Load Power Consumption:
  - <25 mW at 230 V_{AC} with External Bias;
  - <120 mW at 230 V_{AC} without External Bias
- No Need for Auxiliary Bias Winding
- Frequency Modulation for Attenuating EMI
- Pulse-by-Pulse Current Limiting
- Ultra-Low Operating Current: 250 µA
- Built-in Soft-Start and Startup Circuit
- Adjustable Peak Current Limit
- Built-in Transconductance (Error) Amplifier
- Various Protections: Overload Protection (OLP), Over-Voltage Protection (OVP), Feedback Open-Loop Protection (FB_OLP), Thermal Shutdown (TSD)
- Fixed 650 ms Restart Time for Safe Auto-Restart of All Protections

4.1. Photographs

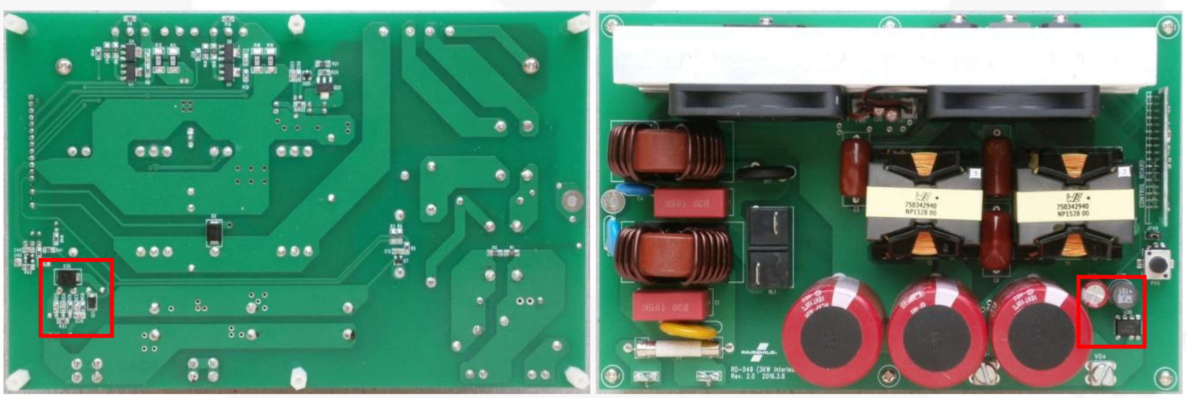


Figure 10. Auxiliary Power Stage indicated by the Red Block

4.2. Schematic

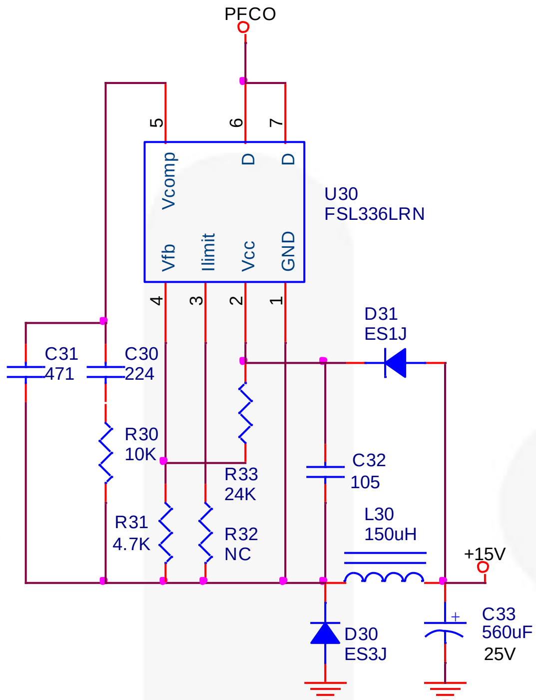


Figure 11. Schematic of Auxiliary Power

4.3. Test Results

Table 13. Efficiency

V_{IN} (V_{AC})	150 V_{AC}		283 V_{AC} (PFCO=400 V)	
	Input Power	Efficiency	Input Power	Efficiency
I_O=5 mA	0.03 W		0.4 W	
I_O=100 mA	1.80 W	83.3%	2.27 W	66.1%
I_O=500 mA	8.61 W	87.1%	9.0 W	83.3%

Note:
21. Control daughter board was removed during testing.

Table 14. Load Regulation and OCP

I_O (A)	0.005	0.1	0.2	0.5	0.8	0.9
V_O (V)	15.39	14.86	14.72	14.38	13.96	OLP

Note:
22. Tested under V_{IN}=283 V_{AC}. Control daughter board was removed during testing.

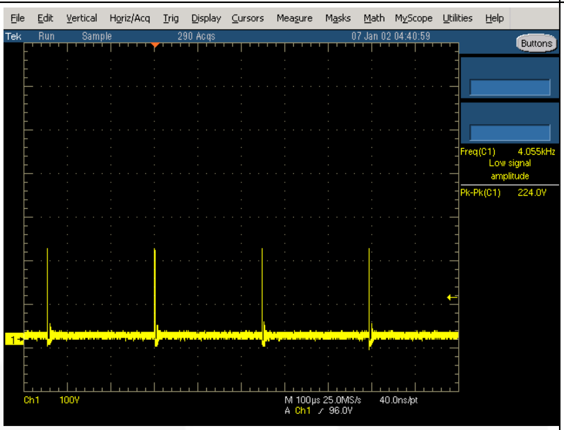
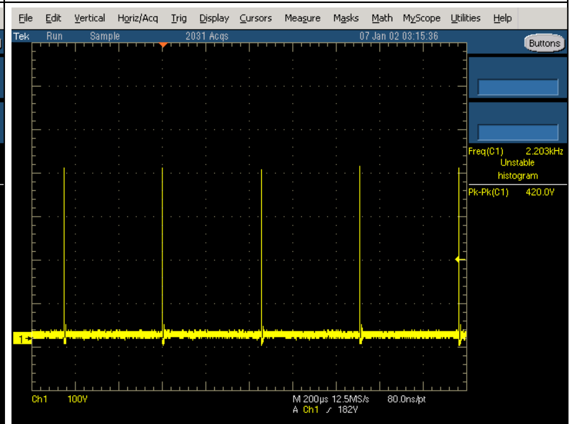
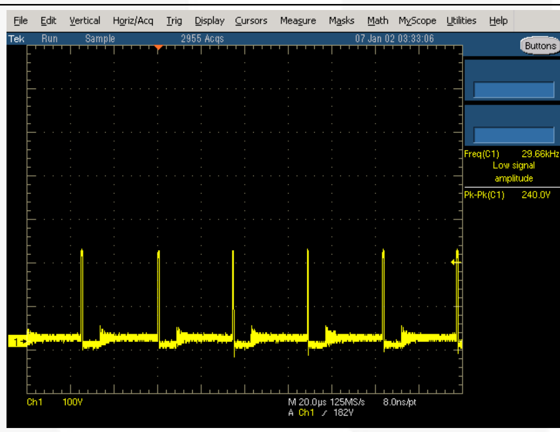
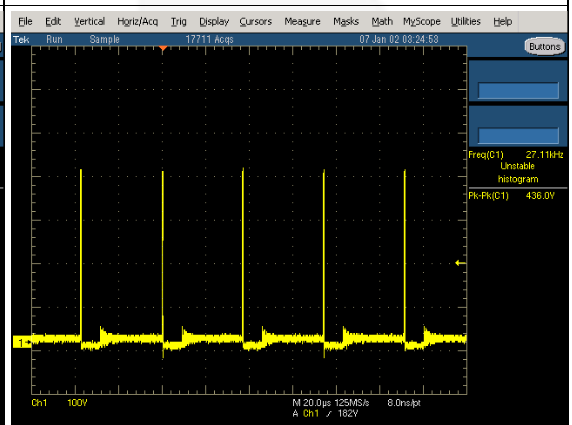
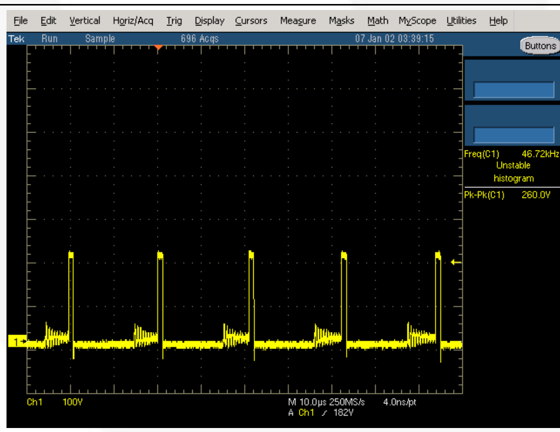
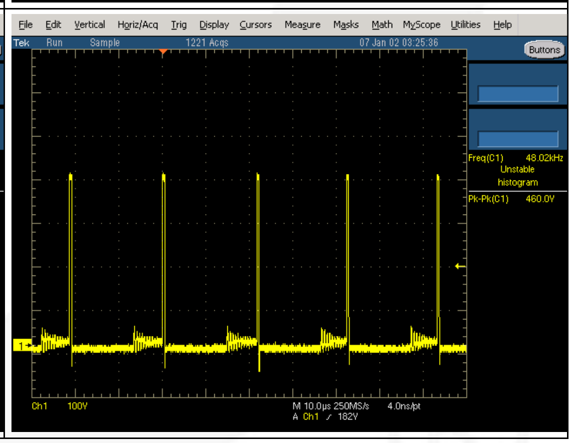
Table 15. Thermo Test

Device	FSL336LRN	Inductor	Freewheel Diode
Temperature (°C)	44	54	50

Note:
23. T_A=22°C; V_{IN}=283 V_{AC}. I_O=0.5 A. Control daughter board was removed during testing.

4.4. Waveforms

CH1: Voltage from U30 pin1 to GND.

$V_{IN}(V_{AC})$	150 V_{AC}	283 V_{AC}
I_O=5 mA		
I_O=0.1 A		
I_O=0.5 A		

5. PCB Layout

Figure 12 and Figure 13 show the main PCB layout on Top and Bottom.

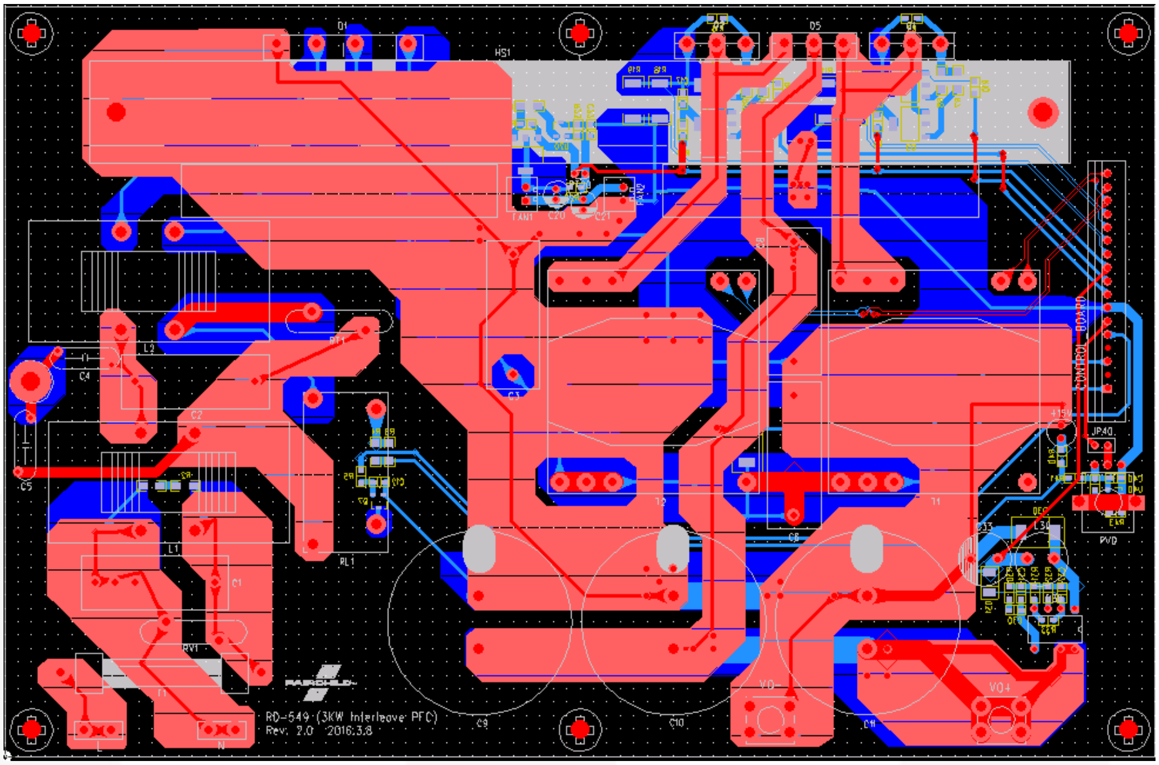


Figure 12. Top Side

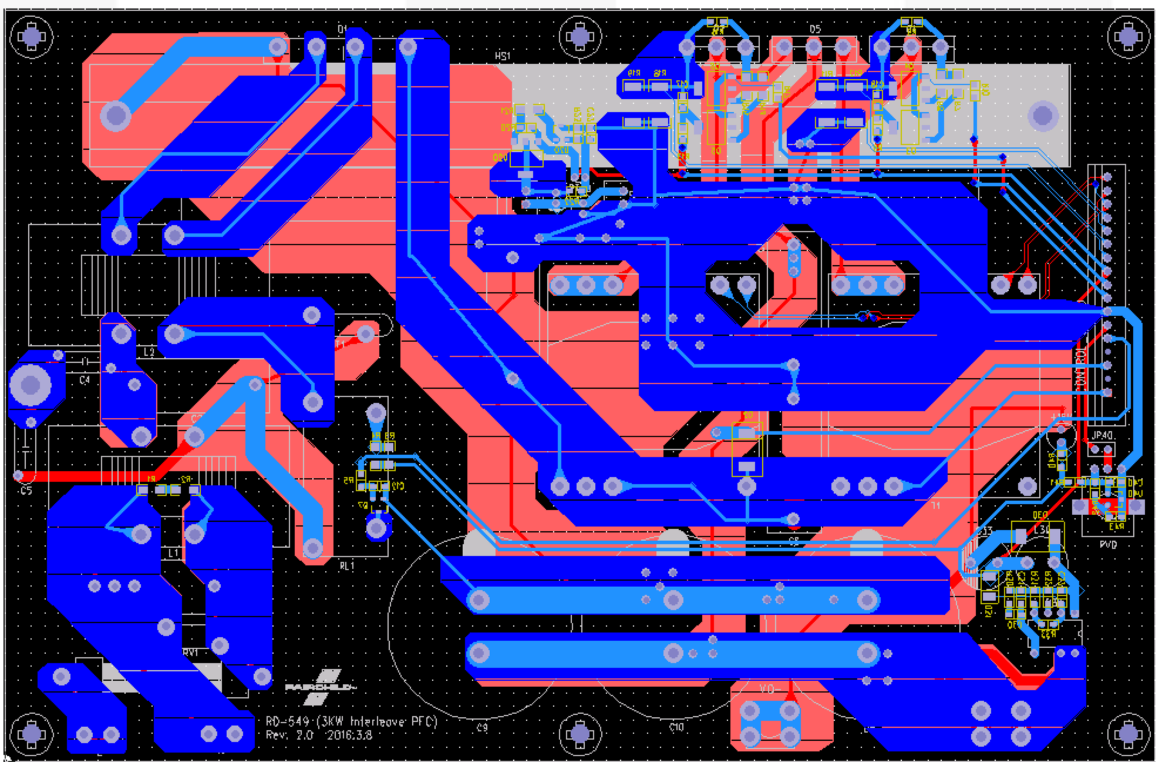


Figure 13. Bottom Side

Figure 14 shows the daughter PCBs layout on Top and Bottom. The upper one is the CCM control board, and the lower one is the BCM control board.

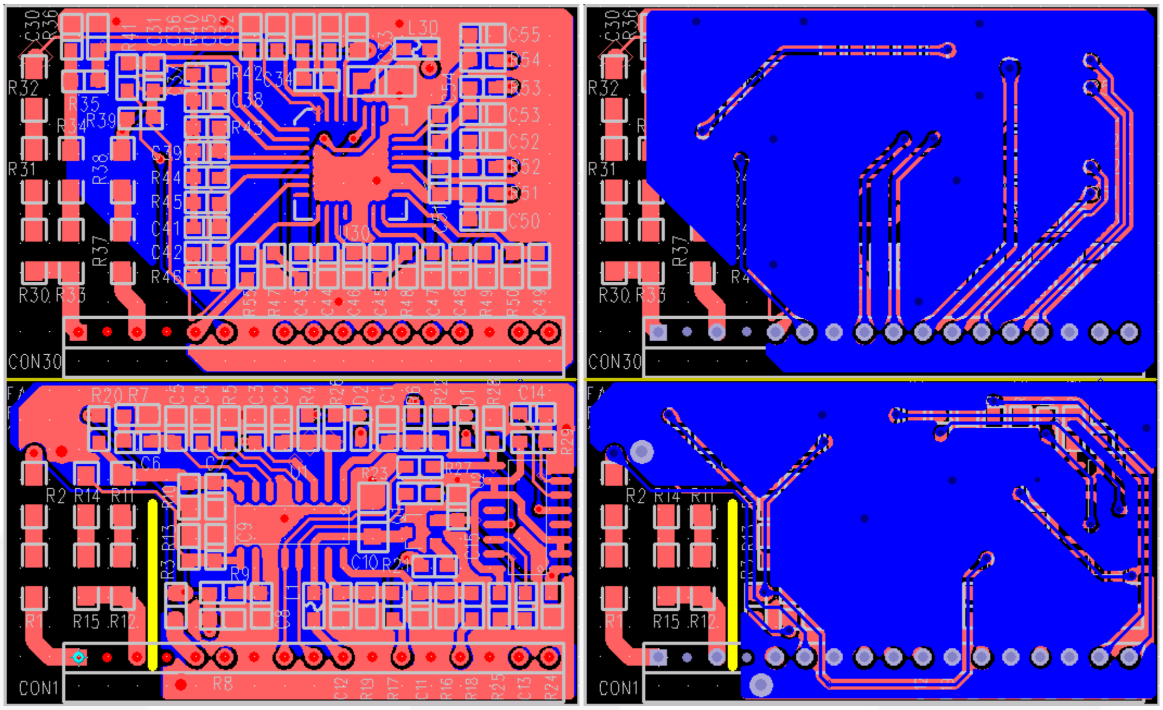


Figure 14. PCB Layout (Top CCM Control Board, Bottom BCM Control Board

6. Bill of Materials (BOM)

6.1. Main Board

(Shaded by component type)

Part Number	Description	Qty.	Designator	Manufacturer
IC 3 A Power Switch FSL336LRN	MDIP 7L	1	U30	Fairchild
IC Shunt Regulator LM431SACM32X	SOT23-3L	2	U20, U40	Fairchild
MOSFET 600 V 72 mΩ FCH072N60E	TO-247	2	Q1, Q2 (For option)	Fairchild
IGBT 600 V 30 A FGA3060ADF	TO-3PN	2	Q1, Q2 (For option)	Fairchild
Transistor 60 V 4 A NPN NZT651	SOT223	2	Q3, Q5	Fairchild
Transistor 60 V 4 A PNP NZT751	SOT223	2	Q4, Q6	Fairchild
Transistor 60 V 0.8 A PNP PZT2907A	SOT223	1	Q20	Fairchild
MOSFET 60 V 5 Ω 2N7002	SOT23-3L	1	Q7	Fairchild
Bridge Diode DFB2560 600 V 25 A	TS-6P 4L	1	D1	Fairchild
Diode S3J 3 A 600 V	SMC	1	D2	Fairchild
Diode RHRG3060CC 60 A 600 V	TO-247	1	D5	Fairchild
Diode ES3J 3 A 600 V 35 nS	SMC	1	D30	Fairchild
Diode ES1J 1 A 600 V 35 nS	SMA	1	D31	Fairchild
LED Green 151051VS04000	5 mm THT	1	Power	WURTH
SMD Resistor 0805 10 Ω ±5%	REEL	2	R6, R13	Any
SMD Resistor 0805 220 Ω ±5%	REEL	2	R10, R17	Any
SMD Resistor 0805 1 KΩ ±5%	REEL	1	R20	Any

Part Number	Description	Qty.	Designator	Manufacturer
SMD Resistor 0805 4.7 KΩ ±5%	REEL	5	R31, R40, R41, R42, R43	Any
SMD Resistor 0805 6.8 KΩ ±5%	REEL	1	R23	Any
SMD Resistor 0805 10 KΩ ±5%	REEL	4	R5, R9, R16, R30	Any
SMD Resistor 0805 24 KΩ ±5%	REEL	1	R33	Any
SMD Resistor 0805 100 KΩ ±5%	REEL	1	R22	Any
SMD Resistor 1206 4.7 Ω ±5%	REEL	2	R8, R15	Any
SMD Resistor 1206 15 Ω ±5%	REEL	2	R7, R14	Any
SMD Resistor 1206 82 Ω ±5%	REEL	2	R3, R4	Any
SMD Resistor 1206 470 Ω ±5%	REEL	1	R21	Any
SMD Resistor 1206 1 MKΩ ±5%	REEL	2	R1, R2	Any
SMD Resistor SM25M2FR010T 2512 10 mΩ ±1%	REEL	4	R11, R12, R18, R19 (For BCM)	SART
SMD Resistor SMF25M2FR030T 2512 30 mΩ ±1%	REEL	4	R11, R12, R18, R19 (For CCM)	SART
Potentiometer 10 KΩ 10x11 mm	Vertical	1	PVO	Any
NTC 100 KΩ D=2 mm	DIP	1	RT20	Any
NTC 3 Ω D=20 mm	DIP	1	RT1	Any
MOV 820423211 320 V D=20 mm	DIP	1	RV1	WURTH
MLCC 885012207084 50 V 470 pF-M	0805	1	C31	WURTH
MLCC 885012207092 50 V 10 nF-M	0805	2	C12, C22	WURTH
MLCC 885012207072 25 V 100 nF-M	0805	1	C40	WURTH
MLCC 885012207074 25 V 220 nF-M	0805	1	C30	WURTH
MLCC 885012207076 25 V 470 nF-M	0805	2	C17, C18	WURTH
MLCC 885012207078 25 V 1 µF-M	0805	1	C32	WURTH
E-Cap 860020372004 47 µF 16 V	Radial	2	C20, C21	WURTH
E-Cap 860020475015 560 µF 25 V	Radial	1	C33	WURTH
E-Cap 861141486026 680 µF 450 V	Snap-in	3	C9, C10, C11	WURTH
Film-Cap 2.2 µF 630 V	DIP	3	C3, C6, C8	Any
X-Cap 890324026027CS 1 µF 275 V_{AC} X2	DIP	2	C1, C2	WURTH
Y-Cap 4700 pF 300 V_{AC}	DIP	2	C4, C5	Any
Common Choke 7448262510 25 A	1 mH	2	L1, L2	WURTH
Inductor 7447480151 150 µH 2 A	Radial THT	1	L30	WURTH
Inductor 750342844 60 µH with ZCD	PQ4040	2	T30, T40 (For BCM)	WURTH
Inductor 750342940 280 µH	PQ4040	2	T30, T40 (For CCM)	WURTH
Connector 74760050 200x300mil	Screw type	2	V_O+, V_O-	WURTH
Connector 61300211121 2-Pins	2.54 mm	1	JP40	WURTH
Jumper with Test Point 60900213421	2.54 mm	1	JP40	WURTH
RELAY PCF-11202M		1	RL1	OEG

6.2. BCM Control Board

(Shaded by component type)

Part Number	Description	Qty.	Designator	Manufacturer
IC Interleaved Dual BCM PFC Controller FAN9611MX	SO 16L NB	1	U1	Fairchild
IC Dual Monastable Multivibrator 74VHC123AM	SO 16L NB	1	U2	Fairchild
Transistor 60 V 0.5 A NPN MMBT4401	SOT23-3L	1	Q1	Fairchild
Diode 1N4148WS 0.3 A 70 V	SOD-323	1	D1, D2	Fairchild
SMD Resistor 0805 1 KΩ ±5%	REEL	3	R17, R18, R21	Any
SMD Resistor 0805 2.2 KΩ ±5%	REEL	2	R22, R26	Any
SMD Resistor 0805 4.7 KΩ ±5%	REEL	2	R24, R28	Any
SMD Resistor 0805 10 KΩ ±5%	REEL	4	R3, R8, R23, R27	Any
SMD Resistor 0805 15.4 KΩ ±1%	REEL	4	R10, R13, R25, R29	Any
SMD Resistor 0805 22 KΩ ±5%	REEL	1	R9	Any
SMD Resistor 0805 39 KΩ ±5%	REEL	1	R5	Any
SMD Resistor 0805 68 KΩ ±5%	REEL	2	R4, R6	Any
SMD Resistor 0805 100 KΩ ±5%	REEL	1	R7	Any
SMD Resistor 0805 330 KΩ ±5%	REEL	1	R20	Any
SMD Resistor 1206 1 MKΩ ±5%	REEL	6	R1, R2, R11, R12, R14, R15	Any
MLCC 885012007051 50 V 10 pF-J	0805	2	C1, C2	WURTH
MLCC 885012207061 50 V 470 pF-J	0805	2	C13, C14	WURTH
MLCC 885012207086 50 V 1 nF-M	0805	4	C7, C9, C11, C12	WURTH
MLCC 885012207092 50 V 10 nF-M	0805	1	C8	WURTH
MLCC 885012207094 50 V 22 nF-M	0805	1	C5	WURTH
MLCC 885012207074 25 V 220 nF-M	0805	2	C3, C15	WURTH
MLCC 885012207076 25 V 470 nF-M	0805	2	C4, C6	WURTH
MLCC 885012208069 25V 10 µF-M	1206	1	C10	WURTH
Chip Inductor 7447905 1 µH	0805	1	L1	WURTH

6.3. CCM Control Board

(Shaded by component type)

Part Number	Description	Qty.	Designator	Manufacturer
IC ICCM PFC Controller FAN9672Q	QFP32	1	U30	Fairchild
SMD Resistor 0805 470 Ω ±5%	REEL	4	R51, R52, R53, R54	Any
SMD Resistor 0805 6.2 KΩ ±5%	REEL	1	R46	Any
SMD Resistor 0805 10 KΩ ±5%	REEL	2	R41, R55	Any
SMD Resistor 0805 12.4 KΩ ±1%	REEL	2	R39, R45	Any
SMD Resistor 0805 15 KΩ ±5%	REEL	2	R47, R48	Any
SMD Resistor 0805 18 KΩ ±5%	REEL	1	R36	Any
SMD Resistor 0805 20 KΩ ±5%	REEL	1	R44	Any
SMD Resistor 0805 24 KΩ ±5%	REEL	1	R42	Any
SMD Resistor 0805 39 KΩ ±5%	REEL	1	R43	Any
SMD Resistor 0805 75 KΩ ±5%	REEL	2	R40, R50	Any
SMD Resistor 0805 200 KΩ ±5%	REEL	1	R35	Any
SMD Resistor 0805 470 KΩ ±5%	REEL	1	R49	Any
SMD Resistor 1206 1 MKΩ ±5%	REEL	4	R33, R34, R37, R38	Any
SMD Resistor 1206 4.02 MKΩ ±1%	REEL	3	R30, R31, R32	Any
MLCC 885012007057 50 V 100 pF-J	0805	2	C44, C46	WURTH
MLCC 885012207061 50 V 470 pF-J	0805	4	C32, C39, C41, C49	WURTH
MLCC 885012207086 50 V 1 nF-M	0805	4	C43, C45, C51, C54	WURTH
MLCC 885012207088 50 V 2.2 nF-M	0805	4	C50, C52, C53, C55	WURTH
MLCC 885012207092 50 V 10 nF-M	0805	4	C37, C38, C42, C48	WURTH
MLCC 885012207096 50 V 47 nF-M	0805	1	C30	WURTH
MLCC 885012207072 25 V 100 nF-M	0805	2	C35, C47	WURTH
MLCC 885012207076 25 V 470 nF-M	0805	2	C31, C36	WURTH
MLCC 885012207078 25 V 1 µF-M	0805	1	C34	WURTH
MLCC 885012208069 25 V 10 µF-M	1206	1	C33	WURTH
Chip Inductor 7447905 1 µH	0805	1	L30	WURTH

Related Resources

FAN9611 − Interleaved Dual CrCM PFC Controller

74VHC123A - Dual Retriggerable Monastable Multivibrator

FAN9672 - Interleaved Two-Channel CCM PFC Controller

FSL336LR - 650V Integrated Power Switch with Error Amp and no bias winding for 9Watt offline buck converters