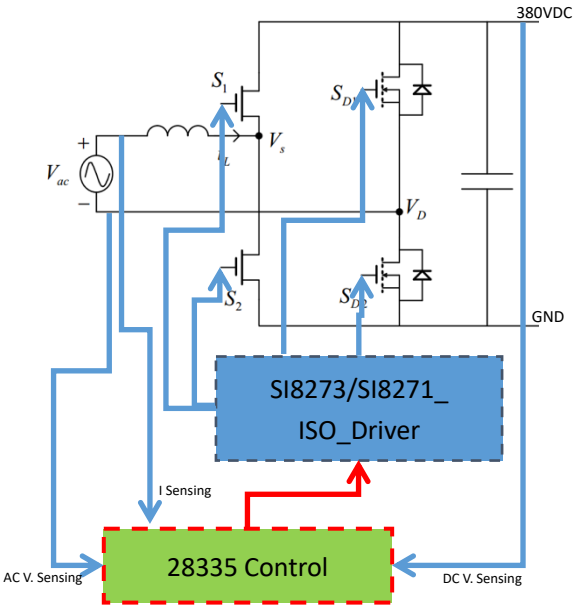
GaN-based High Efficiency 1.6kW CCM Totem Pole PFC Regulator Reference Design

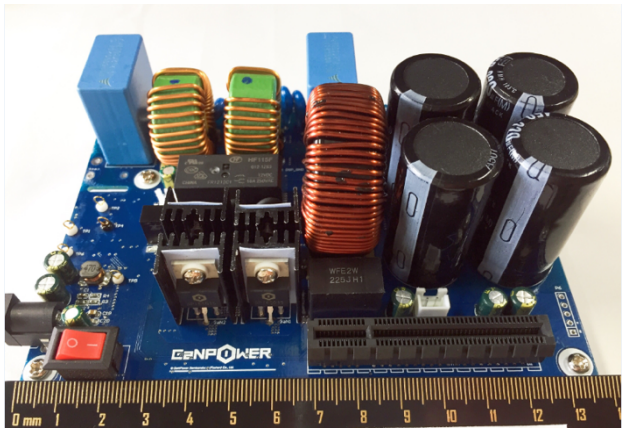
Abstract

Critical-Conduction Mode (CCM) totem pole PFC is a low cost and high efficiency solution using GaN. The present reference design uses GanPower device GPI65015 and TI controller DSP28XX. This single phase CCM PDF is most suitable for high density and low cost small to medium power supply, such as cloud server, telecom and industrial power supplies. Lack of recovery charge in GaN makes it especially suitable for CCM operation with high efficiency.

Features

- Volume 138x100x45mm
- Efficiency at 220V and full load: 98.6%
- Critical-Conduction Mode (CCM) reducing use of magnetic components
- Single phase 1.6kW minimizing the use of power devices
- 0.99 power factor
- No cooling necessary under 800W load





1、System Description

The reference design includes two input power sources. The first one is 12VDC powering the MOS and relay switches. It is also converted to 5V, 3.3V and -3.3V as needed by other analogue circuits. The other is the main AC input supplying the 1.6kW to the load.

Current control is achieved via INA826 with 12.5 times amplification； DC voltage sensing and control is accomplished using Op-Amp OPA188. Input AC sensing and control utilizes OPA2188. The whole system functional blocks are indicated in Fig. 1.

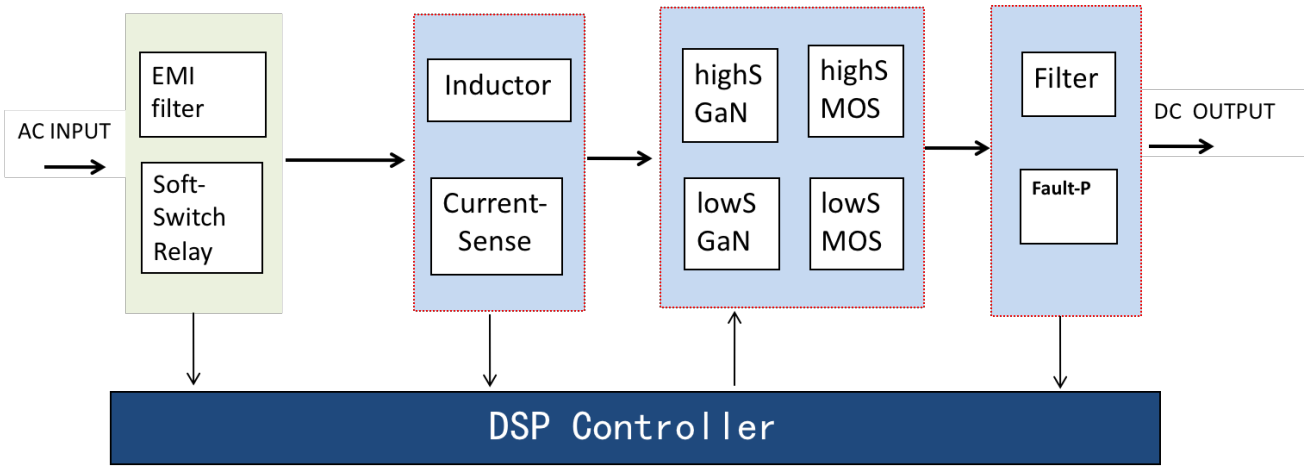


Figure 1 block diagram of the PFC system.

1.1、System Parameters

Parameter	Remark	MIN	NOM	MAX	Unit
Input Characteristics					
Input	--	180	220	265	V
Freq	--	47	50/60	63	Hz
Zero Load Power	Vin=220V,Iout=0A	--	--	1	W
Auxiliary Power	--	--	12	--	V
Output Characteristics					
Output	--	--	380	--	V
Current	--	--	4.3	--	A
Voltage Ripple	Peak-peak	--	25	--	V
Power	--	--	--	1600	W
System feature					
Efficiency	Input 220V， full-load	--	98.6%	--	%
Temperature	--	0	25	55	℃
Volume	L x W x H	138x100x45			mm

Table 1. System parameters

2、Testing Results

2.1 Efficiency vs. load

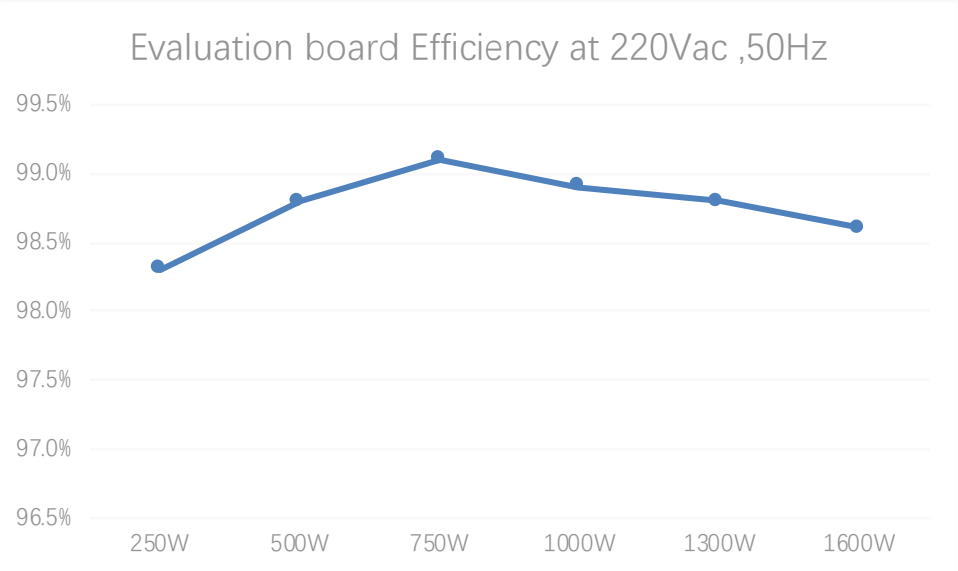


Figure 2. Efficiency at 220V input.

Power-In	Power-out	Power-factor	Efficiency
254.32	250W	0.85	98.3%
506.07	500W	0.95	98.8%
756.81	750W	0.98	99.1%
1011.12	1000W	0.98	98.9%
1315.79	1300W	0.99	98.8%
1622.72	1600W	0.99	98.60%

Table 2 Testing results at 220V input.

- Above data obtained at ambient with wind cooling.

2.2 Measured Waveforms

Rem： CH1 is low-side driving voltage， CH2 is high-side driving voltage.

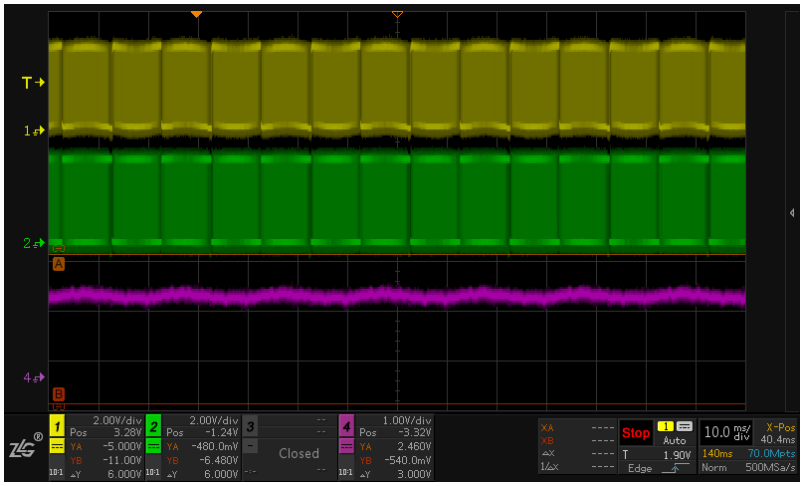


Figure 3: Driving voltages

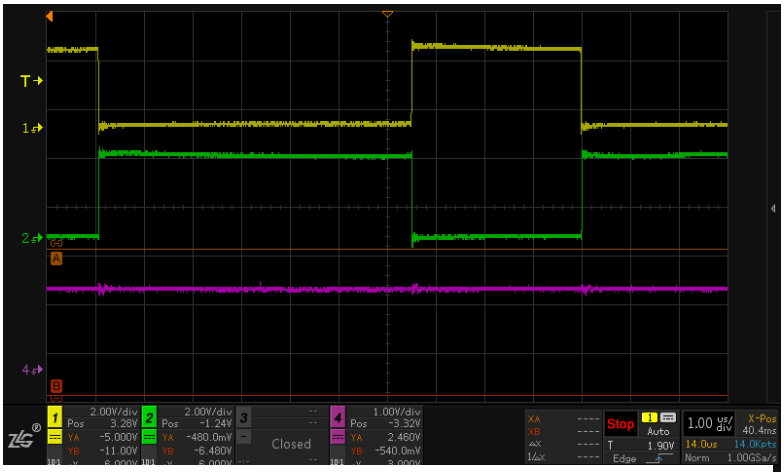


Figure 4: Driving voltage magnified

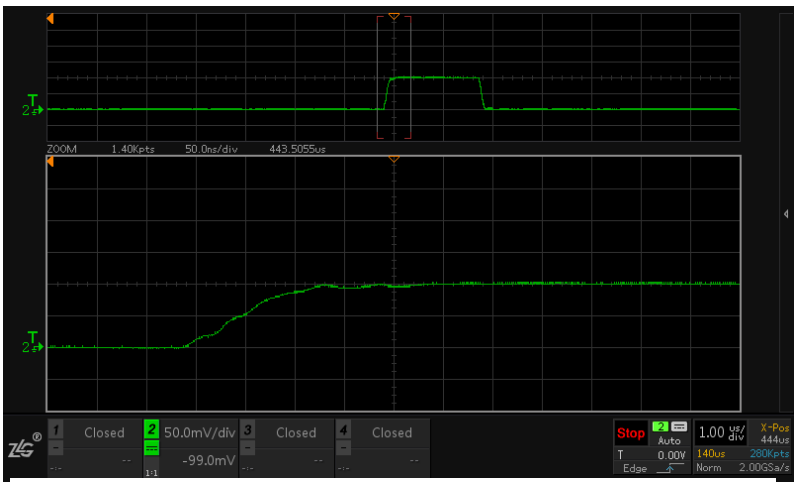


Figure 5. Rising wave form

3、Reference Design

3.1 PCB layout

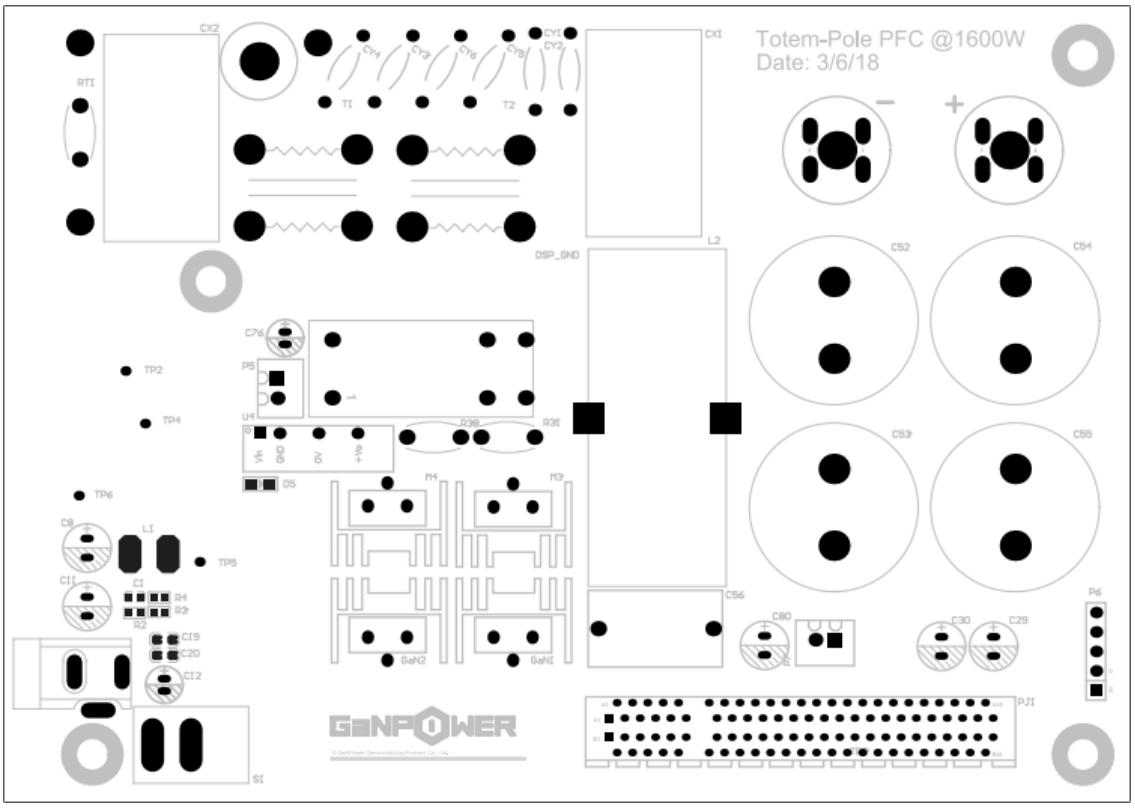


Figure 6. PCB top view

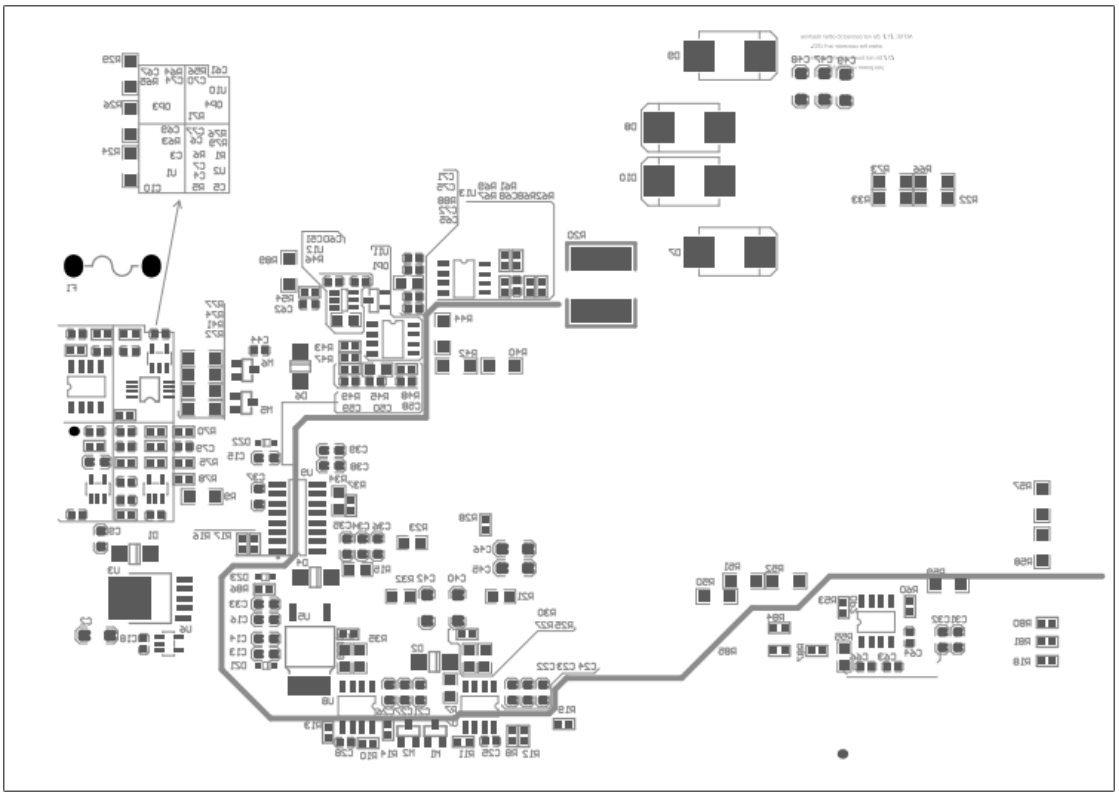


Figure 7 PCB bottom view

3.2 System Photo

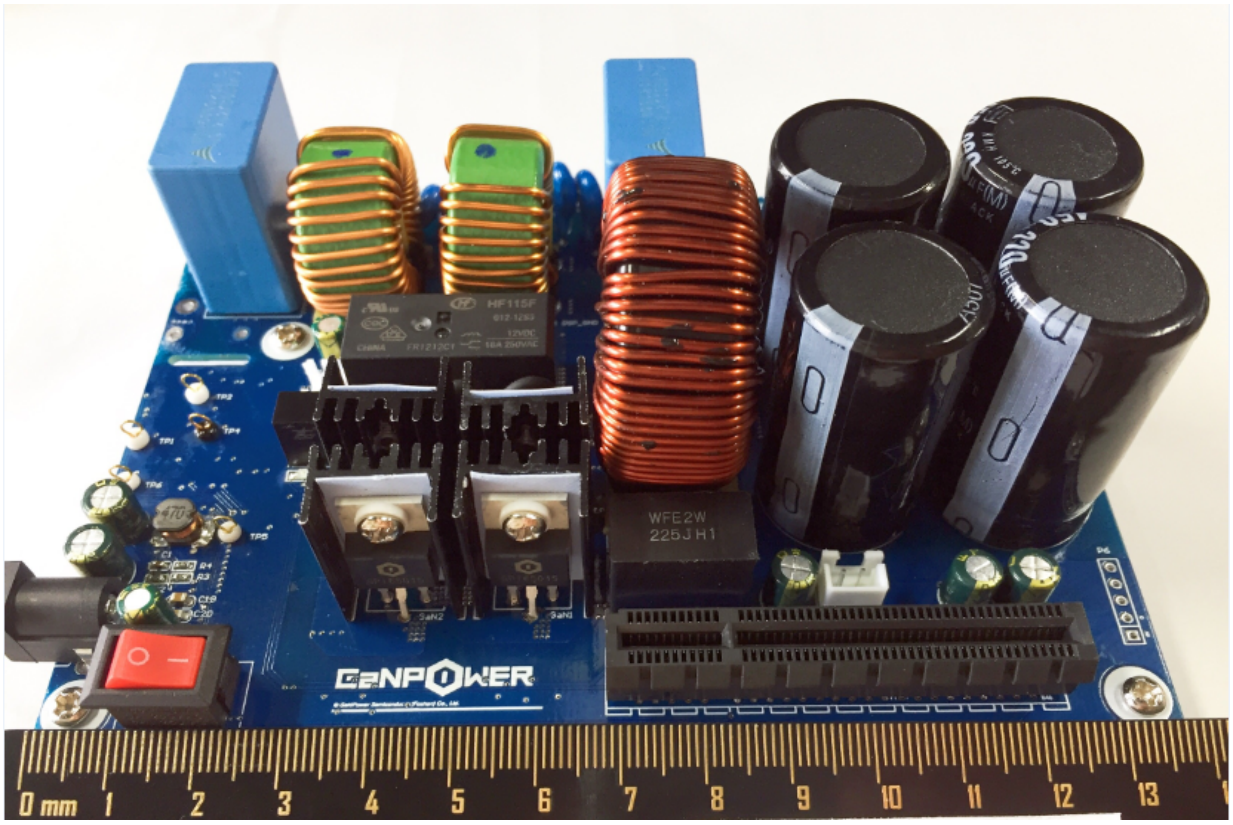


Figure 8. Demo system photo

About

GaNPower Semiconductor (Foshan) Co. Ltd is a joint venture of GaNPower Int'l Inc. (www.iganpower.com Vancouver, Canada based) and two other companies.