

650V GaN FETs in a Totem-Pole PFC

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Introduction

In AC/DC power-factor correction (PFC) rectifiers, GaN FETs are crucial. The latter have incredibly straightforward topologies; just the inductor is magnetic among all the parts, and it's often a constant-frequency continuous-conduction-mode inductor. Thus, the effect of GaN FETs on the functionality of PFC rectifiers may be demonstrated directly.



Switching losses are decreased by the 650V GaN FETs' smaller parasitic capacitances. In addition, 650V GaN FETs have lower on-resistance than 650V Si MOSFETs within the same chip size, and GaN FETs do not suffer from reverse recovery loss.

GaN FETs raise the peak efficiency of switching power supply to 99%. The efficiency and density enhancements made possible by GaN FET performance eventually reduce the overall cost of switching power supply systems.

GaN PFC Topology

The GaN PFC topology is a high-performance power correction topology that uses Gallium Nitride transistors to achieve high efficiency and high-power density. It is a popular choice for applications that require high power conversion efficiency, such as data centers, electric vehicles, and renewable energy systems. The GaN PFC topology provides several benefits including reduced system size, improved thermal performance, and increased reliability.

Totem-pole PFC, which has the lowest power losses of all topologies, includes simply one high-frequency FET and one low-frequency silicon FET conducting during both the on-state and the off-state.

Totem-pole PFC also uses the least amount of power semiconductor components overall. To further reduce costs, a diode might be used in place of the low-frequency FET in the totem-pole PFC. Totem-pole PFC is a desirable topology when considering cost, efficiency, and component count, as it is advantageous in terms of lower cost, high power density, higher efficiency, and small inductor.

GaN in Totem-Pole PFC-Based Power Designs

Most current trends use an AC/DC power supply, which draws power from the AC grid and distributes it as a well-regulated DC to the electrical equipment. The accompanying energy losses in the AC/DC power conversion process constitute a substantial part of the total cost equation because of the rising power demand in these systems. The cost of ownership for the end application may be decreased by reducing losses in the AC/DC power supply.

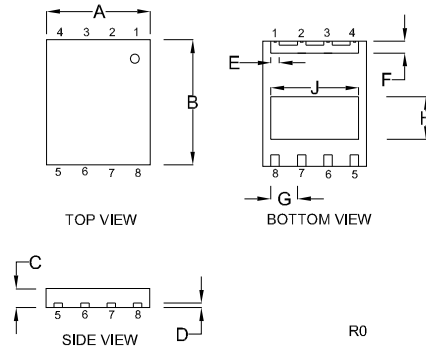
To provide a clean power draw from the grid, the AC/DC supply uses a PFC stage. A PFC makes the electrical equipment behave like a pure resistor with no reactive power by shaping the AC input current to match the curve of the AC input voltage and maximizing the real power drawn from the grid. Without a PFC stage, electrical equipment's reactive power is consumed by the grid, increasing prices for customers since power providers must produce more energy for transmission and distribution. PFCs can be added to power converters to provide a switching step that lowers losses, saving energy produced by power companies.

Central's 650V GaN FETs are essentially designed as power FETs for low gate charge, low output charge and ultra-high switching frequency applications.

LEAD CODE:

- 1) Drain 5) Source
- 2) Drain 6) Source
- 3) Drain 7) Kelvin Source
- 4) Drain 8) Gate

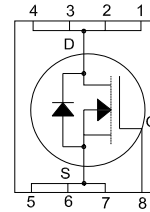
Pins 5, 6, 7 are common to the pad



DIMENSIONS				
SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.197		5.00	
B	0.236		6.00	
C	0.031	0.039	0.80	1.00
D	0.008		0.20	
E	0.012	0.020	0.30	0.50
F	0.018	0.030	0.45	0.75
G	0.050		1.27	
H	0.077	0.085	1.95	2.15
J	0.164	0.175	4.16	4.45

DFN5X6A (REV: R0)

PIN CONFIGURATION



DFN5X6A Package Specifications

ELECTRICAL CHARACTERISTICS: (T_J=25°C unless otherwise noted)

SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I _{GSSF}	V _{GS} =6.0V, V _{DS} =0		60		μA
I _{GSSR}	V _{GS} =1.0V, V _{DS} =0		60		μA
I _{DSS}	V _{DS} =650V, V _{GS} =0		0.45	20	μA
BV _{DSS}	V _{GS} =0, I _D =250μA	650			V
V _{GS(th)}	V _{GS} =V _{DS} , I _D =12.2mA	1.2	1.7	2.5	V
V _{SD}	V _{GS} =0, I _S =3.9A		2.6		V
r _{DS(ON)}	V _{GS} =6.0V, I _D =3.9A		138	190	mΩ
C _{iss}	V _{DS} =400V, V _{GS} =0, f=100kHz		96		pF
C _{oss}	V _{DS} =400V, V _{GS} =0, f=100kHz		30		pF
C _{rss}	V _{DS} =400V, V _{GS} =0, f=100kHz		0.5		pF
C _{oss(er)}	V _{DS} =0 to 400V, V _{GS} =0		43		pF
C _{oss(tr)}	V _{DS} =0 to 400V, V _{GS} =0		60		pF
Q _{g(tot)}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =3.9A		2.8		nC
Q _{gd}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =3.9A		1.1		nC
Q _{gs}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =3.9A		0.25		nC

ELECTRICAL CHARACTERISTICS - Continued: (T_J=25°C unless otherwise noted)

SYMBOL	TEST CONDITIONS	TYP	UNITS
t _{d(on)}	V _{DS} =400V, V _{GS} =6.0V, I _D =8.0A R _{G(on)} =10Ω, L=318μH	1.4	ns
t _{d(off)}	V _{DS} =400V, V _{GS} =6.0V, I _D =8.0A R _{G(on)} =10Ω, L=318μH	1.7	ns
t _r	V _{DS} =400V, V _{GS} =6.0V, I _D =8.0A R _{G(on)} =10Ω, L=318μH	4.0	ns
t _f	V _{DS} =400V, V _{GS} =6.0V, I _D =8.0A R _{G(on)} =10Ω, L=318μH	4.0	ns

ELECTRICAL CHARACTERISTICS: (T_J=25°C unless otherwise noted)

SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I _{GSSF}	V _{GS} =6.0V, V _{DS} =0		70		μA
I _{GSSR}	V _{GS} =1.0V, V _{DS} =0		70		μA
I _{DSS}	V _{DS} =650V, V _{GS} =0		0.6	25	μA
BV _{DSS}	V _{GS} =0, I _D =250μA	650			V
V _{GS(th)}	V _{GS} =V _{DS} , I _D =17.2mA	1.2	1.7	2.5	V
V _{SD}	V _{GS} =0, I _S =5.0A		2.4		V
r _{DS(ON)}	V _{GS} =6.0V, I _D =5.0A		106	140	mΩ
C _{iss}	V _{DS} =400V, V _{GS} =0, f=100kHz		125		pF
C _{oss}	V _{DS} =400V, V _{GS} =0, f=100kHz		41		pF
C _{rss}	V _{DS} =400V, V _{GS} =0, f=100kHz		0.4		pF
C _{oss(er)}	V _{DS} =0 to 400V, V _{GS} =0		59		pF
C _{oss(tr)}	V _{DS} =0 to 400V, V _{GS} =0		82		pF
Q _{g(tot)}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =5.0A		3.5		nC
Q _{gd}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =5.0A		1.2		nC
Q _{gs}	V _{DS} =400V, V _{GS} =0 to 6.0V, I _D =5.0A		0.3		nC

ELECTRICAL CHARACTERISTICS - Continued: (T_J=25°C unless otherwise noted)

SYMBOL	TEST CONDITIONS	TYP	UNITS
t _{d(on)}	V _{DS} =400V, V _{GS} =6.0V, I _D =10A R _{G(on)} =10Ω, L=318μH	3.0	ns
t _{d(off)}	V _{DS} =400V, V _{GS} =6.0V, I _D =10A R _{G(on)} =10Ω, L=318μH	4.0	ns
t _r	V _{DS} =400V, V _{GS} =6.0V, I _D =10A R _{G(on)} =10Ω, L=318μH	5.0	ns
t _f	V _{DS} =400V, V _{GS} =6.0V, I _D =10A R _{G(on)} =10Ω, L=318μH	4.0	ns

CDF56G6511N Electrical Characteristics

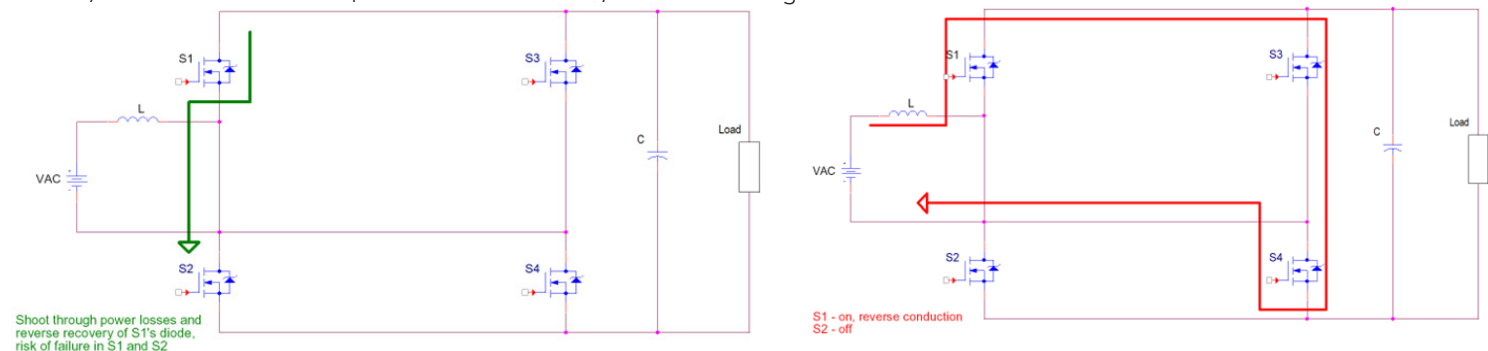
CDF56G6517N Electrical Characteristics

How Central's GaN FETs are beneficial in a Totem-Pole PFC

As there is no body diode, GaN technology is becoming more and more preferred for building a totem-pole PFC because it has zero reverse-recovery losses. For totem-pole PFC, silicon MOSFETs are not advised due to their body diode's rapid reverse recovery, which results in large power losses and the possibility of shoot-through damage.

GaN is the ideal solution because it has zero reverse-recovery losses and generally reduced switching energy losses, making it the best option for a transistor PFC. Low-frequency FETs S3 and S4 contrast with the high-frequency FETs S1 and S2. The high-frequency FETs alternately switch on and off, but one of them has a conducting body diode during the dead time.

The reverse recovery of the S1's body diode will flow via S2 because of this body-diode conduction during dead time when the high-frequency FET is turned on, creating a shoot-through condition. The lack of a body diode in a GaN is exactly what makes totem-pole PFCs advantageous in this regard



Conclusion

The 650V totem-pole PFC is a power correction topology that uses high-voltage MOSFETs to achieve high efficiency and high-power density. The totem-pole allows for the use of high-voltage MOSFETs in a half-bridge configuration, which reduces the conduction and switching losses and improves the overall efficiency of the system. The 650V totem-pole PFC is a promising technology that has the potential to revolutionize the power electronics industry.

In addition to the 650V, Central is offering a selection of 40V GaN FETs offering high electron mobility, low ON resistance, and fast-switching speeds, for application in power supply, DC-DC converters, and Class D audio amplifiers. Their efficiency and compact size make them particularly attractive in emerging technologies like electric vehicles and renewable energy systems.

40V GaN FETs are often used in high-frequency, high-efficiency power supplies. Their fast-switching speeds reduce switching losses, making them ideal when energy efficiency is crucial. This is especially significant in data centers, telecommunications equipment, and electric vehicles where power supplies play a critical role. The compact size and improved performance contribute to more energy efficient and space saving power supply designs.

In power supplies, 40V GaN FETs shine by enhancing efficiency and minimizing energy losses. Their rapid switching speeds allow for higher frequency operation, reducing the size of passive components like inductors and capacitors. High efficiency translates to less heat generation and cooler operating temperatures. This not only contributes to energy savings but extends the lifespan of the components. Overall, the use of 40V GaN FETs in power supplies is a game changer, offering a potent combination of efficiency, size reduction, and reliability.

