The Growing Ecosystem for eGaN® FET Power Conversion

Prologue

eGaN FET-based power conversion systems offer higher efficiency, increased power density, and lower overall system cost than Si-based alternatives. These advantageous characteristics have spurred the presence of an ever increasing ecosystem of power electronics components such as gate drivers, controllers, and passive components that specifically enhance eGaN FET performance. Some examples of eGaN FETs are shown in figure 1.

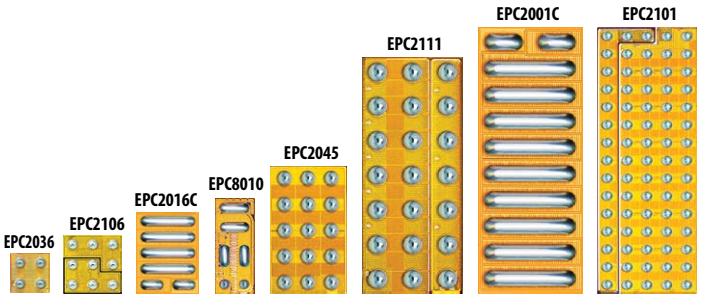

Figure 1: Examples of eGaN FETs

Overview of the eGaN FET ecosystem

The eGaN FET ecosystem can be broken down into three main categories: 1) gate driver, 2) controllers, and 3) passive components. A typical synchronous buck converter, as shown in figure 2, highlights these various components. The requirements for these components are driven by the characteristics of eGaN FETs, such as small footprint, fast switching, tight gate voltage requirement, and high frequency capability.

Gate drivers for eGaN FETs

The gate driver IC is critical for maximizing the switching speed capability of eGaN FETs. In order to be compatible with eGaN FETs, the gate driver must have a suitable UVLO for 5 V drive, low pull-up and pull-down resistances, small footprint, and isolation with sufficient common-mode transient immunity (CMTI) to withstand the high *dv/dt*. Other beneficial features of some eGaN compatible drivers include integrated voltage regulators, bootstrap management, and very narrow pulse width capability. Table 1 shows some examples of low side gate drivers suitable for use with eGaN FETs and table 2 similarly shows half bridge gate drivers.

For high voltage designs where no single IC solution exists, low side gate drivers can be used in combination with high voltage signal isolators that feature high CMTI.

Controllers for eGaN FETs

As eGaN FETs push converters to higher frequencies, controllers are required to operate in the MHz range with higher control bandwidth and tighter regulation for high-frequency converters. Many controllers

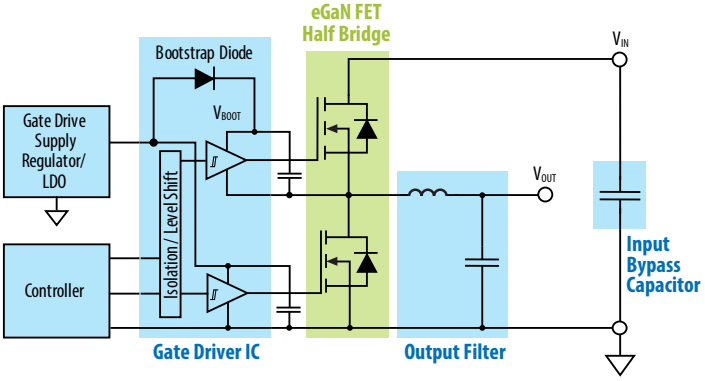

Figure 2: Circuit schematic of a typical synchronous eGaN FET based Buck converter, highlighting key components in the eGaN FET ecosystem

also incorporate a gate driver stage, which must meet the same gate driver requirements previously mentioned. Tables 3 and 4 show eGaN FET compatible controllers for synchronous rectification and buck and boost converter applications, respectively.

Digital controllers are also useful for many eGaN FET applications, such as multi-phase and multi-level architectures. Suitable examples include Microchip's PIC series and TI's Delfino and Piccolo series.

Part Number	Manufacturer	Description	Application Example
UCC27611	Texas Instruments	4 A/6 A High-Speed 5 V Optimized Single Gate Driver	EPC9081
LMG1020	Texas Instruments	5 V, 7 A/5 A Low Side GaN Driver With 60 MHz/1ns Speed	EPC9144
uP1964	uPI	Single-Channel Gate Driver for Enhancement Mode GaN Transistors	—
IXD_604	IXYS	4-Ampere Dual Low-Side Ultrafast Driver	—
LMG1025-Q1	Texas Instruments	Automotive 7-A/5-A single-channel low-side gate driver with 5-V UVLO for narrow pulse applications	—
ADuM4120ARIZ	Analog Devices	Isolated, single-channel driver with 2 A output	—
ADuM4121ARIZ	Analog Devices	2 A isolated, single-channel drivers	—

Table 1: eGaN FETs compatible low-side gate drivers

Passive components for eGaN FETs

The higher operating frequency of eGaN FET based converters requires passive components optimized for higher frequencies.

Key metrics in eGaN FET converter performance are power density and efficiency, which includes the input and output filters. Important inductor selection parameters include low series resistance (ESR) to minimize conduction loss, low core loss, and low parasitic capacitance.

Suitable ceramic capacitor selection for the bypass/decoupling are available from multiple vendors where temperature coefficients of X7R or X7S offer good results with highest power density.

Conclusion

As eGaN FETs continue to penetrate application designs, the surrounding ecosystem of supporting components needed to achieve the superior performance of eGaN FETs will also grow. Today this ecosystem is no longer a limiting factor in GaN-based designs, and designer have a rapidly growing number of gate drivers, controllers, and passive component options to choose from.

Part Number	Manufacturer	Description	Application Example
NCP51810	On Semi	150 V Half Bridge Gate Driver for GaN Power Switches	Contact EPC
NCP51820	On Semi	-3.5 to +650 V, adjustable dead time, dual LDOs	Contact EPC
LM5113	Texas Instruments	5 A, 100 V Half-Bridge Driver for eGaN FETs	EPC9078
LMG1205	Texas Instruments	1.2 A, 5 A, 100 V Half-Bridge Driver for eGaN FETs	EPC9078
uP1966E	uPI Semiconductor	80 V Dual-Channel Gate Driver for eGaN FETs	EPC9078
LMG1210	Texas Instruments	200 V, 1.5 A/3 A Half Bridge GaN Driver With Adjustable Dead-time	Contact EPC
Si827xGB-IM	Skyworks	Isolated, automotive, up to 2.5 kV isolation, 4 A. Dead time programmable. Use "GB" and "IM" suffixes.	EPC9084
LMG5200	Texas Instruments	200	LMG5200POLEVM-10
ADuM4221A	Analog Devices	—	—
MPQ1918-AEC1	MPS	50	Contact EPC
MP8699B	MPS	50	Contact EPC
STDRIVEG600	ST	—	EPC9167

Table 2: eGaN FET compatible half bridge gate drivers

Part Number	Manufacturer	Description	Gate Driver Included
UCD7138	Texas Instruments	Synchronous Rectifier Controller	Yes
TEA1993TS	NXP	Synchronous Rectifier Controller	Yes
TEA1995T	NXP	Dual Synchronous Rectifier Controller	Yes (Dual)
TEA1998TS	NXP	Synchronous Rectifier Controller	Yes
NCP4305A	On Semi	Secondary-side Synchronous Rectifier Controller	Yes
NCP4306A	On Semi	Synchronous Rectifier Controller	Yes
NCP4308A	On Semi	Synchronous Rectifier Controller	Yes

Table 3: eGaN FET compatible controllers for synchronous rectifiers

Part Number	Manufacturer	Description	Operating Frequency
dsPIC33CK32MP102	Microchip	100 MHz Single-Core 16-bit DSC	Up to 100 MHz
RT6190	Richtek	36 V, 4-Switch Bidirectional Buck-Boost Controller with I^2C Interface	250 kHz –1 MHz
NCP81111	On Semi	3 Phase VR12.5¬6 High Speed Digital Controller with SVID and I^2CInterfaces	250 kHz–5 MHz
LTC7800	Analog Devices	Low IQ , 60 V, High Frequency Synchronous Step-Down Controller	320 kHz –2.25 MHz
MIC2103/4	Microchip	Synchronous Buck Controller w/Adaptive On-Time Control	200 kHz –600 kHz
LM5140-Q1	Texas Instruments	Wide Input Range Dual Synchronous Buck Controller	440 kHz –2.2 MHz
TPS40400	Texas Instruments	3 V-20 V, 30 A, PMBus Synchronous Buck Controller	200 kHz –2 MHz
TPS53632G	Texas Instruments	Half-Bridge, D-CAP+ Controller for 48-V GaN DC/DC Converter	300 kHz –1 MHz
LTC7890	Analog Devices	Dual Synchronous step down controller with Half-Bridge driver	100 kHz –3 MHz
LTC7891	Analog Devices	100 V Synchronous step-down controller with GaN Half Bridge driver	100 kHz –3 MHz
ISL8117A	Renesas	Synchronous Step-Down PWM Controller	100 kHz –2 MHz
ISL81806	Renesas	80 V Dual Synchronous Buck Controller	100 kHz –2 MHz
ISL81807	Renesas	80 V Dual or 2-Phase Synchronous Boost Controller	100 kHz – 2 MHz

Table 4: eGaN FET compatible controllers for buck and boost converters

Part Number	Manufacturer	Description	Application Example
FBS-GAM01P-C-PSE	EPC Space	Single Output eGaN Gate Driver Module	Gate Driver
FBS-GAM02P-C-PSE	EPC Space	50 V Radiation Hardened High-Speed Multifunction Power eGaN® HEMT Driver	HEMT Driver
FBS-GAM02-P-R50	EPC Space	50 V/10 A Radiation Hardened Multifunction Power Module	Power Stage
ISL70040SEH	Renesas	Radiation Hardened Low Side GaN FET Driver	Gate Driver

Table 5: Compatible ICs for High Reliability Applications