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.

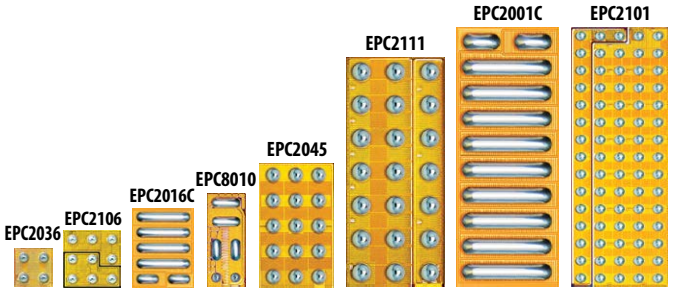

Figure 1: Examples of eGaN FETs

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.

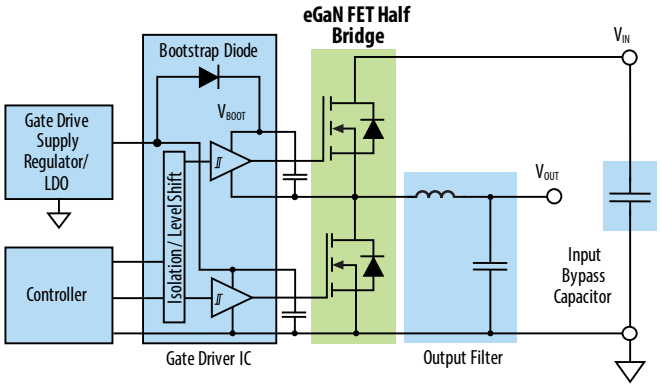

Figure 2: Circuit schematic of a typical synchronous eGaN FET based Buck converter, highlighting key components in the eGaN FET ecosystem

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 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.

Manufacturer	Part Number	Includes LDO	Key Feature	Application Example
Texas Instruments	UCC27611	Yes	Suitable for use in a half bridge with a digital isolator	EPC9081
Texas Instruments	LMG1020	No	Ultra-fast,1 ns pulse width	EPC9144
Texas Instruments	LMG1025-Q1	No	Automotive low-side gate driver with 5-V UVLO for narrow pulse applications	Contact EPC
uPI	uP1964	Yes	Integrated adjustable drive voltage regulator	—
IXYS	IXD_604	No	Dual driver, suitable for large FETs	—
Texas Instruments	LMG1025-Q1	No	Automotive 7-A/5-A single-channel low-side gate driver with 5-V UVLO for narrow pulse applications	—
Analog Devices	ADuM4120ARIZ	No	Isolated, single-channel driver with 2 A output	—
Analog Devices	ADuM4121ARIZ	No	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.

Manufacturer	Part Number	Working Voltage (V)	Bootstrap Management	Input	CMTI (V/ns)	Application Example
uPI	uP1966E	80	Yes	Lo & Hi	—	EPC9078
Texas Instruments	LM5113-Q1*‡	100	Yes	Lo & Hi	50	EPC9078
Texas Instruments	LMG1205*‡	100	Yes	Lo & Hi	50	EPC9078
MPS	MPQ1918	100	Yes	Lo & Hi	—	EPC9165
Texas Instruments	LMG1210	200	Yes	PWM	300	Contact EPC
Skyworks	Si8274GB1-IM	630	No	PWM	200	Contact EPC
Skyworks	Si8275GB-IM	630	No	Lo & Hi	200	Contact EPC
On Semiconductor	NCP51820	650	Yes	PWM	200	—

*Footprint compatible ‡ Pin compatible

Table 2: eGaN FET compatible half bridge gate drivers

Manufacturer	Part Number	Gate Driver Included	Activation / Deactivation time	FET Voltage (V)	DC Voltage (V)
Texas Instruments	UCD7138	Yes	14 ns / 5 ns	45	18
NXP	TEA1998TS	Yes	40 ns / 40 ns	60	10.5
NXP	TEA1995T	Yes (Dual)	80 ns / 40 ns	100	38
NXP	TEA1993TS	Yes	65 ns / 40 ns	120	38
ON-Semi	NCP4306A	Yes	55 ns / 70 ns	100	35
ON-Semi	NCP4308A	Yes	40 ns / 20 ns	150	35
ON-Semi	NCP4305A	Yes	35 ns / 12 ns	200	35

Table 3: eGaN FET compatible controllers for synchronous rectifiers

Part Number	Manufacturer	Description	Application Example
dsPIC33CK32MP102	Microchip	100 MHz Single-Core 16-bit DSC	Up to 100 MHz
NCP81111	On Semiconductor	3 Phase VR12.5-6 High Speed Digital Controller with SVID and I^2C Interfaces	250 kHz – 5 MHz
LTC7800	Analog Devices	Low I_Q , 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
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
EPC2152	EPC	70 V, 12.5 A ePower™ Stage	EPC90120
LMG5200	Texas Instruments	80 V GaN Half-Bridge Power Stage	LMG5200EVM-02

Table 5: Integrated Power Stages

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	Gate 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 6: Compatible ICs for High Reliability Applications