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GaN Transistors Are Cheaper Than Silicon

Two eGaN power transistors from Efficient Power Conversion (EPC), the 60-V EPC2035 and 100-V EPC2036, are being hailed as the first GaN transistors to offer lower cost than their silicon MOSFET counterparts even as they outperform those silicon devices. According to the vendor, this announcement represents the first time in 60 years that a non-silicon technology is offering both superior performance and price compared with silicon.

According to Alex Lidow, chief executive officer of EPC, this development fulfills a cost reduction plan laid out in 2010 when the company launched its first eGaN products. The cost of the eGaN FETs has been lowered through improvements in "volume yields and process simplification—all the hard work that goes into any semiconductor process," says Lidow.

In quantities of 1000, unit pricing is $0.36 for the EPC2035 and $0.38 for the EPC2036. According to EPC, these figures are about two cents less than the cheapest available, comparably rated silicon MOSFETs with similar values of max $R_{DS(ON)}$ (see the table). This price comparison is based on data published by Digi-Key.

One caveat in this comparison is that EPC's parts are essentially unpackaged devices—passivated die with LGA style interconnects on the underside of the parts—while the silicon MOSFETs used for comparison have conventional overmolded packages with lead frames—an SO-8 in the case of the FDS5351 and a 5-mm x 6-mm PQFN for the FDMS8622.

EPC has argued from the beginning that removing the package is essential to product performance as it eliminates package parasitics, especially inductance. Lidow also notes that it improves reliability. "By eliminating the package, we eliminate virtually all the failure mechanisms MOSFETs have," says Lidow, adding that he recently presented field data showing that EPC devices have experienced less than 0.1 failures in 10^9 hours.

On the other hand, others have argued that removing the package simply makes the packaging issue the customer's problem. Whether that is true or not, GaN suppliers like EPC are working to develop packaging solutions that will make these new, very fast devices easier to use. (The figure below shows the fast transient response of the 60-V EPC2035 in a buck converter application.) For the most part, new packaging will be in the form of modules with multiple devices such as half-bridges or FETs + drivers, rather than just discrete transistors. The recently announced LMG5200 from Texas Instruments is an example of this modular approach.

This trend toward integration may somewhat complicate the issue of GaN product pricing. Having broken the silicon price barrier, Lidow says further reductions in eGaN pricing are coming. According to Lidow, this announcement is "indicative of where we are going in the future" and eGaN transistor pricing is "eventually going down one-half to one-third of MOSFETs."

However, at least in the near term, not all newly released eGaN FETs will cost less than their silicon counterparts. "Some of them will be," says Lidow, "but we're [also] going up toward more integration."

In addition to breaking ground with respect to cost, the EPC2035 and EPC2036 also extend EPC's product portfolio to meet the needs of lower-current and lower-power applications. These new 60-V and 100-V rated parts have smaller die than the 60-V and 100-V rated eGaN FETs previously introduced by EPC. These new parts target common applications such as dc-dc converters, point-of-load converters, class D audio amps, wireless power designs and small motor drives. These devices are also expected to find new applications.

To support evaluation and application of the new transistors, the company is offering two developments boards, the EPC9049 and EPC9050, which are priced at $104.40 each. Both the eGaN FETs and the development boards are available for immediate delivery from Digi-Key at http://www.digikey.com/Suppliers/us/Efficient-Power-Conversion.page?lang=en.

For more information see the datasheets and demo board design files.

Table 1. Comparison of electrical specifications and pricing between eGaN FETs and the lowest-cost, comparably rated silicon MOSFETs.

Device	V_{DS} max	$R_{DS(ON)}$ max	Q_{OSS} typ@50%BV	Q_{GD} typ @ 5 V	Q_G typ @5 V	C_{ISS} typ	C_{RSS} typ@ 50%BV	C_{OSS} typ@ 50%BV	Device area	Price comparison		
										1 ku	10 ku	100 ku
EPC2035	60 V	45 mΩ	3 nC	0.16 nC	1.2 nC	100 pF	16 pF	60 pF	0.81 mm^2	$0.360	$0.293	$0.230
FDS5351	60 V	35/42 mΩ	7 nC	3.5 nC	19/9 nC	985 pF	50 pF	90 pF	19.11 mm^2	$0.382	$0.313	$0.285
EPC2036	100 V	65 mΩ	4 nC	0.15 nC	1 nC	90 pF	0.8 pF	50 pF	0.81 mm^2	$0.376	$0.306	$0.240
FDMS8622	100 V	56/88 mΩ	6.5 nC	1.3 nC	2.8 nC	301 pF	3.6 pF	70 pF	32.5 mm^2	$0.396	$0.324	$0.295

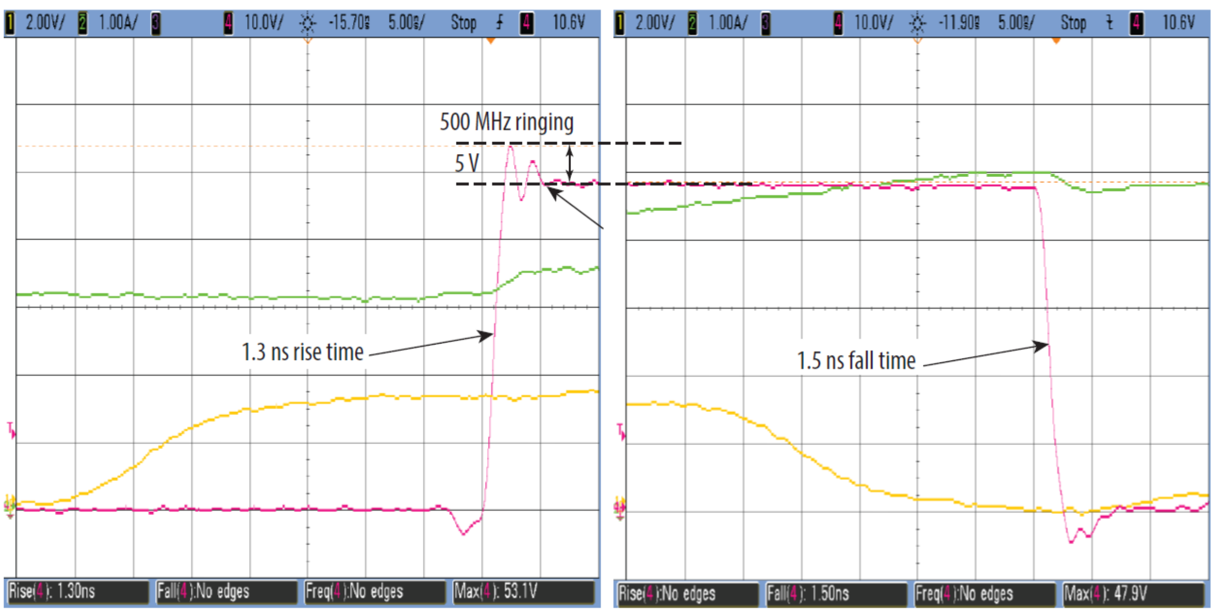

Figure. Typical waveforms for the EPC9049 development board featuring the EPC2035. This board implements a V_{IN} = 48-V to 5-V, 4-A buck converter switching at 1 MHz. The measurements here show the rising and falling edges for the converter's switching waveforms. CH1 is the input logic signal, CH2 is the output inductor current, and CH4 is the switch-node voltage.

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