GaNPower Breakthrough in 1200V GaNFET Dynamic Ron

(New release June 2024)

For 1200V GaNFET GaNPower recently demonstrates good dynamic switching performance for a wide temperature range and voltage range 25-125C, from Vbus=100-1200V, at a switching current of 20A.

For lateral GaNFET at higher voltages, the first bottleneck is substrate leakage and this is especially true for the popular GaN/Silicon material system. p-doped silicon substrate in GaN/Si is not a good leakage current blocker and high voltage is more challenging.

GaNPower (www.iganpower.com) was the first to overcome the substrate leakage and achieve 1200V-1500V breakdown voltages for GaN/Silicon emode GaNFET[1].

The second bottleneck is how to obtain good switching performance at high bus voltage. The new challenge after achieving high DC breakdown voltage is how to obtain good dynamic switching performance. Specifically, good switching behavior means when the power device switches at high frequency between high bus voltage (say 800V or above) off-state and low voltage on-state, the on-state resistance must be close to its static on-state value. Such an on-state resistance at high voltage switching is called dynamic on-state resistance, or dynamic Ron.

The dynamic Ron generally depends on blocking voltage, switching frequency and switching current. For lateral GaNFET, the physical trend is that dynamic Ron increases with blocking voltage, switching frequency, and switching current, respecitvely. For most applications, the requirement is less than two times the static value.

For high voltage GaNFET, recent researches found that dynamic Ron experiences an abrupt increase after blocking voltage exceeds 700V, and the situation is worsened when switching current is increased, making it difficult for applications requiring both high voltage and high current, such as EV motor drivers.

The physical reason behind the increase in dynamic Ron is illustrated in Figure 1. Lateral GaNFET (both EMODE and DMODE) consists of epi layers GaN/AlGaN grown on silicon or sapphire and the layers inevitably generate defects and traps between material interfaces. These defects are electrically active when off-state voltage or electrical field is high and they form the so-called virtual-gate. The trapped charges interact with conduction electrons in on-state and prevent the conduction channel from being fully turned-on. A partially turned-on conduction channel reveals itself as having an increased dynamic Ron parameter and this causes increased device heating and loss of switching efficiency.

After the invention of single die 1200V GaN/silicon GaNFET, GaNPower went through generations of technology upgrades of its 1200V technology. The most recent 3rd generation overcomes the negative effect from the defects and traps using a special technique (propriatary and patent pending) to enable an integrated circuit (all-GaN-IC) to mitigate the effect.

Figure 2 illustrates the static IDVD showing typical DC breakdown greater than 1400V.

Figure 3 is the experimental set up for double pusle testing (DPT). The results are summarized indicated in Figure 4.Good dynamic switching waveform can be seen in Figure 5 showing stable dynamic Ron at 1000V at a max current.

GaNPower's capability for both high DC voltage and fast switching with low dynamic Ron is a first from a commercial EMODE GaNFET vendor.

Engineering samples for device in this news release (GPI's 1200V/p2p/20A GaNFET in TO247-4) are available for selected customers. Please contact www.iganpower.com for more details.

[1]US patent 11,107,755 B2, Li et al, "Packaging for lateral High Voltage GaN Power Devices."

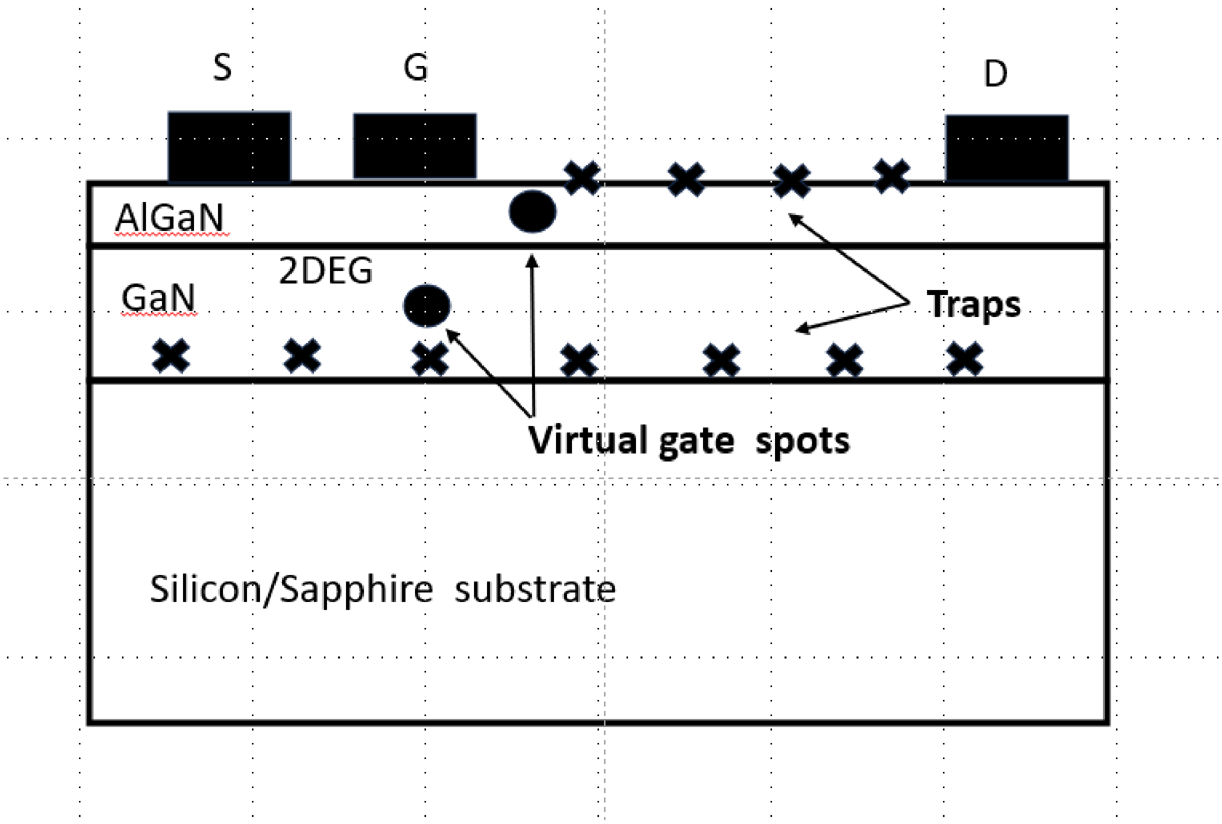

Figure 1: Illustration of how defects and traps in GaNFET can affect the turn-on of conduction channel at high voltages.

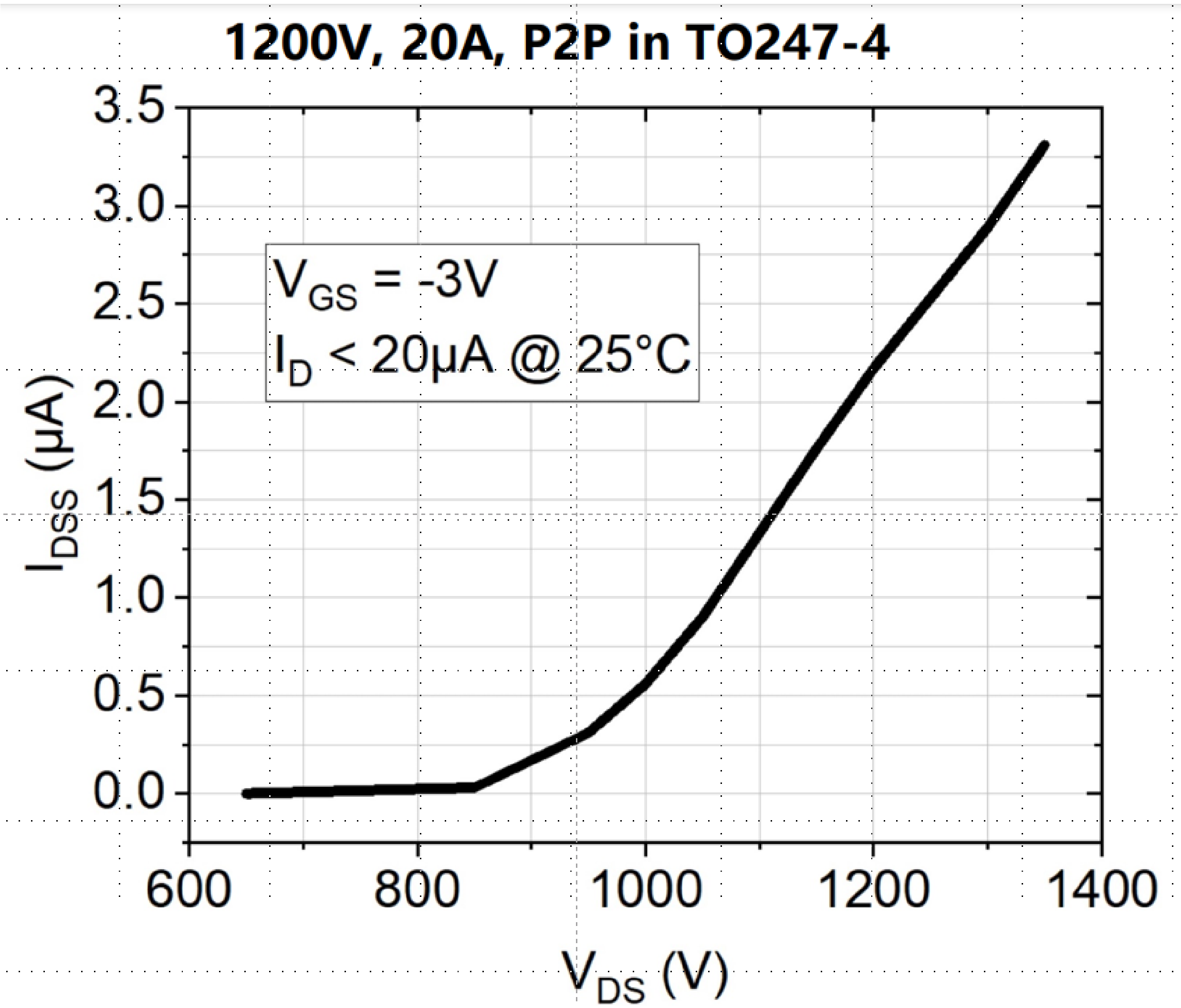

Figure 2: Typical static high voltage leakage characteristics of the 1200V GaNPower GaNFET in TO247-4 package.

Dynamic Test

- DPT1.5（Rgon=33Ω Rgoff=0）
- F=333kHz，double pulse
- load inductance128uH
- VGS=0~+12V，Vbus=100-1000V
- Ids measured by current shunt

Figure 3: Double pulse testing parameters and PCB for the 1200V TO247-4.

GaNPower device type: 1200V/20A in TO247-4

f(Hz)	Duty(%)	L(uH)	Vbus(V)	VS(V)	Ids(A)	Rdson(mΩ/25°C)
333k	50	128	600	2.388	14.0	113.4
333k	50	128	700	2.713	16.4	116.6
333k	50	128	800	3.025	18.7	119.0
333k	50	128	900	3.350	20.9	122.0
333k	50	128	1000	3.738	23.1	127.2

1. VF=800mV;
2. $R_{\mathrm{dson}} = \frac{VS-VF}{I_{\mathrm{ds}}} * 1000mohm$ 。

Figure 4: Test data showing stable dynamic Ron behavior at high voltage and high current.

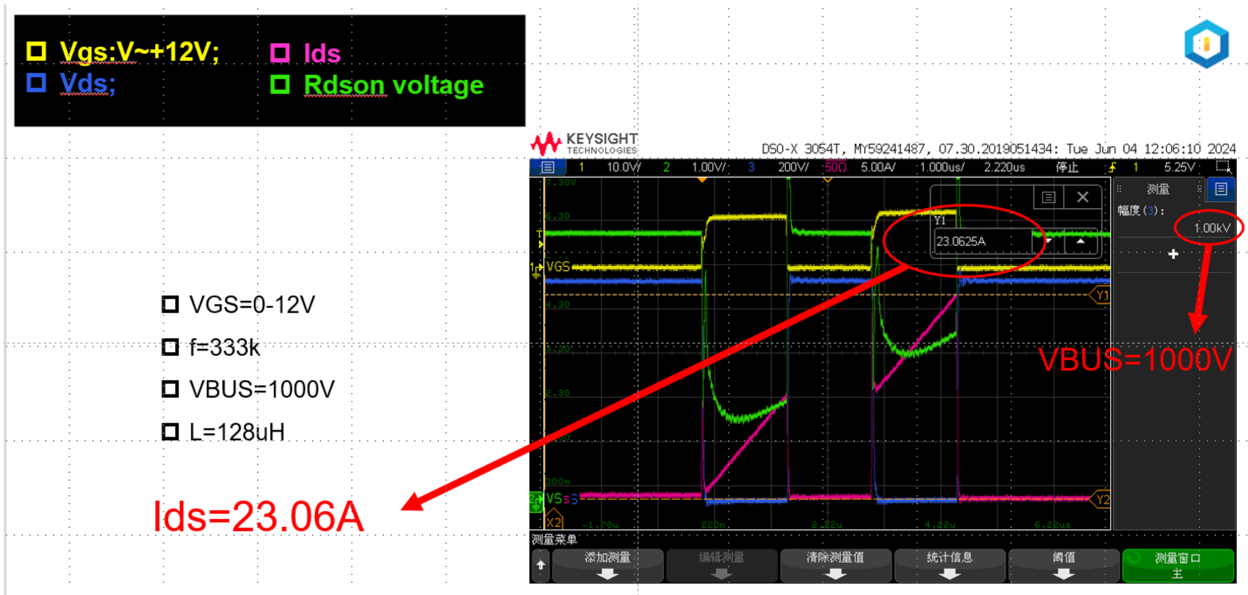

Figure 5: Typical waveforms of the 1200V GaNFET at bus voltage of 1000V.