NGTB20N60L2TF1G
Application Note

Comparison with Super Junction-MOSFET

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1. At the beginning

In full switching PFC circuit of frequency>30kHz, Super Junction MOSFET (hereinafter called SJ-MOSFET) which is assumed that switching loss will decrease is used.

However, NGTB20N60L2TF1G, high-speed IGBT, is also a device recommendable for PFC circuit of the power supply of room air-conditioners. We conducted switching characteristic comparison and PFC circuit operation comparison with the case of using SJ-MOSFET, and proved the competitiveness of NGTB20N60L2TF1G.

2. Specification Comparison

We selected a SJ-MOSFET of which VCE(sat) is lower or equivalent to NGTB20N60L2TF1G (Table.1).

As a feature, it is understood that Cies(Ciss) of SJ-MOSFET is larger than that of IGBT.

Table.1 Data comparison between NGTB20N60L2TF1G and SJ-MOSFET

Parameter	NGTB20N60L2TF1G	A.com (SJ-MOSFET)	B.com (SJ-MOSFET)	Note
$V_{CES}(V_{DSS})$ [V]	600	600	600	
Ic(ID)[A]	40	30.8	44	
V_{GE}/V_{GS}(off)[V]	5.6	3.2	3.0	
$V_{CE(sat)}$[V]	**1.45**	**1.46**	**1.1**	**RDS(on)*Ic (20A)**
$C_{ies}(C_{iss})$[pF]	**2000**	**3000**	**4285**	
$C_{oes}(C_{oss})$[pF]	60	70	212	
$C_{res}(C_{rss})$[pF]	50	9.5	95	
Q_g[nC]	84	86	124	

3. Performance comparison between NGTB20N60TF1G and SJ-MOSFET

Two correlation plots of tf vs. VCE(sat) (SJ-MOSFET: equivalent value) are shown in Fig.1. When converting RDS(on) of SJ-MOSFET into VCE(sat), the value is lower than that of NGTB20N60TF1G. However, tf tends to be high. (Test value of Ic=15A)

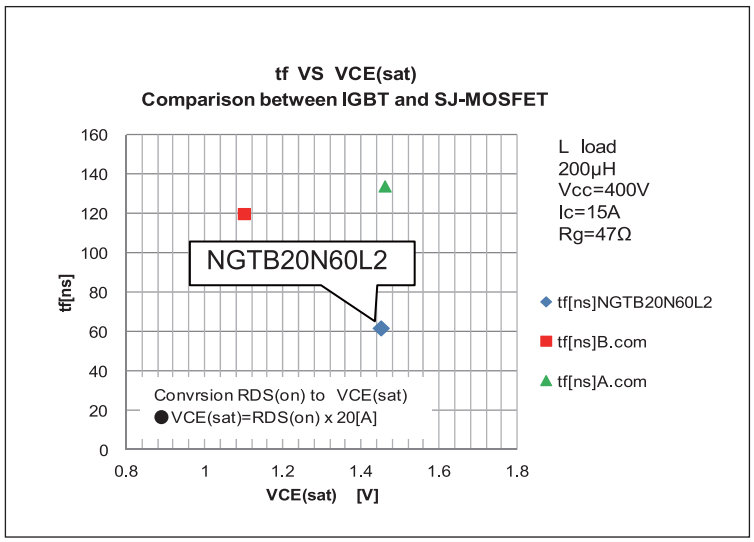


Fig.1 tf VS VCE(sat)

4. Conduction Loss comparison

For IGBT, VCE(sat) changes small with temperature change; but for MOSFET, RDS(on) changes greatly with temperature increase.
We compared at Tc=25°C (Fig.2) and Tc=100°C (Fig.3). At Tc=100°C, conduction loss of NGTB20N60L2TF1G becomes smaller than that of B com.

In conduction loss comparison, we assume operation Ic(I_D) as triangle wave as shown in Fig.4, and calculated.

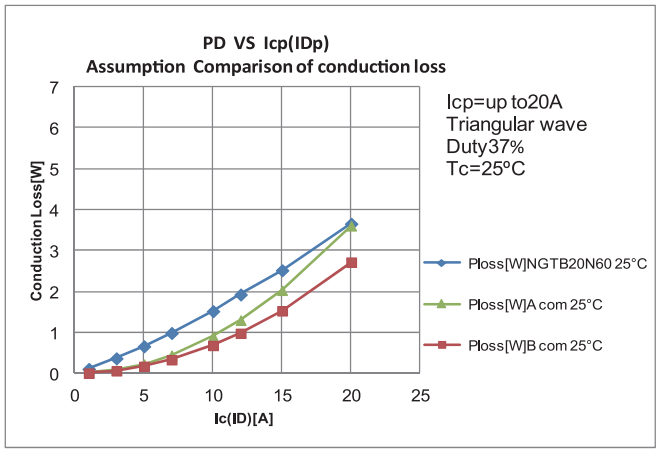


Fig. 2 Conduction loss VS Icp(I_{Dp}) Tc=25°C

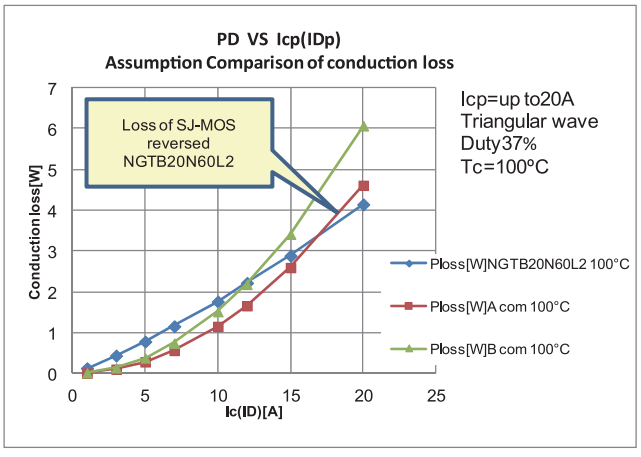


Fig.3 Conduction loss VS Icp(I_{Dp}) Tc=100°C

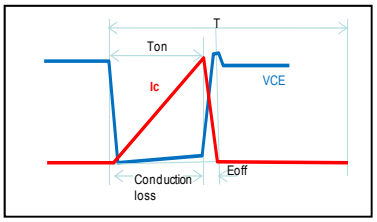


Fig.4 Waveform used for calculation

5. Switching characteristic comparison (L-load)

We compared switching characteristic with L load. For NGTB20N60TF1G, tf (current cutoff direction) is faster than that of SJ-MOSFET even when changing the current value.

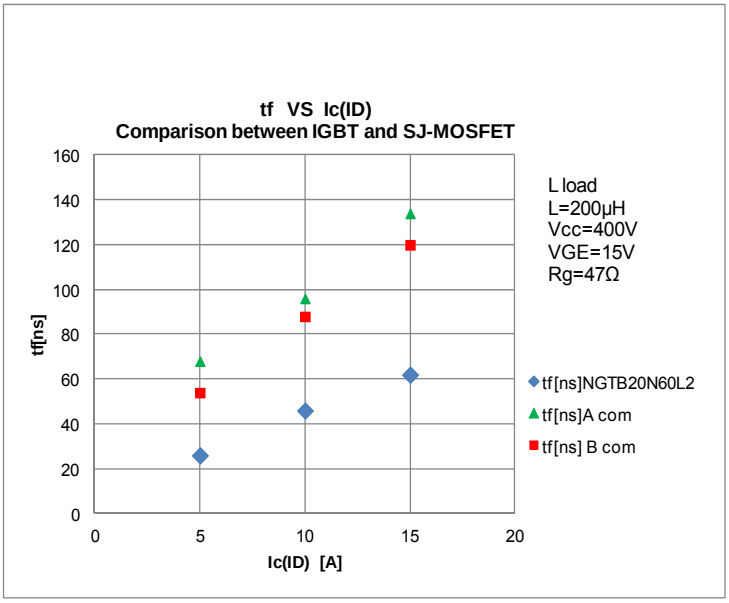


Fig.4 tf VS Ic(I_D)

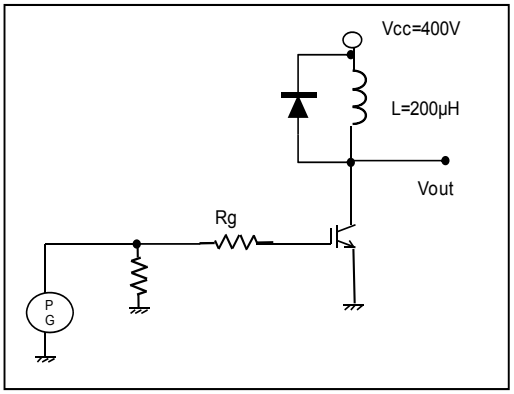


Fig.5 Test circuit

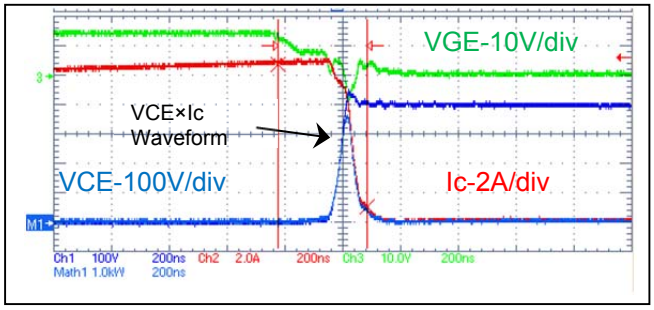
6. Full switching PFC operation comparison

We conducted operation comparison test at f=35kHz in full switching PFC circuit. Test result showed the efficiency of NGTB20N60L2TF1G was higher (Table.2).
Operation waveform of PFC is triangle wave or trapezoidal wave. But as switching loss, Ic(ID) at falling of cutoff is dominant.
For NGTB20N60TF1G, because of its fast tf and small Eoff, it actually is advantageous in performance over SJ-MOSFET.

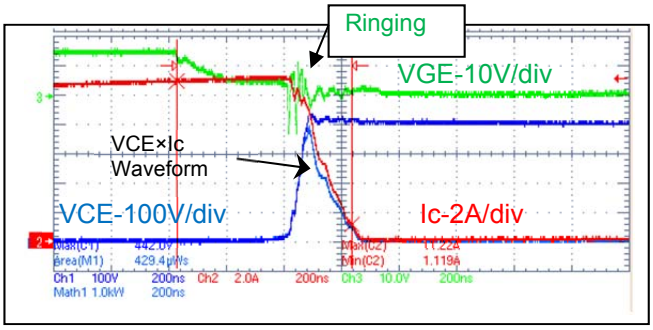
In addition, when comparing the waveforms (WP.1 to WP.3), it is understood that tf of SJ-MOSFET is slow. Regarding switching loss, it is understood from VCE x Ic waveform that the loss of NGTB20N60TF1G is the smallest.
Furthermore, ringing was observed in the gate voltage waveform of SJ-MOSFET, which means countermeasure against noise will become necessary.

Table 2: Performance comparison
Condition: Full Switching PFC circuit at VAC=100V, Iout=2A, Vout≈385V, f=35kHz

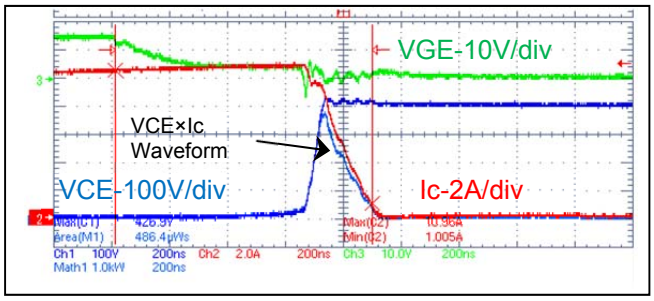
Device	Pin[W]	Pout[W]	η[%]	V_{CEp}[V]	I_{Dp}[A]	tf[ns]	toff[ns]	Eoff[µJ]
NGTB20N60L2TF1G	816	769	94.27	443	11.1	110	342	252
A com	820	770	93.85	442	11.2	200	604	429
B com	825	772	93.53	427	11.0	214	887	486



WP.1 NGTB20N60TF1G



WP.2 A com



WP.3 B com