

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 $V_{CE(sat)}$ is lower or equivalent to NGTB20N60L2TF1G (Table.1).

As a feature, it is understood that $C_{ies}(C_{iss})$ 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	
$I_c(I_D)$ [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	

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3. Performance comparison between NGTB20N60TF1G and SJ-MOSFET

Two correlation plots of t_f vs. $V_{CE(sat)}$ (SJ-MOSFET: equivalent value) are shown in Fig.1. When converting $R_{DS(on)}$ of SJ-MOSFET into

$V_{CE(sat)}$, the value is lower than that of NGTB20N60TF1G. However, t_f tends to be high. (Test value of $I_c=15A$)

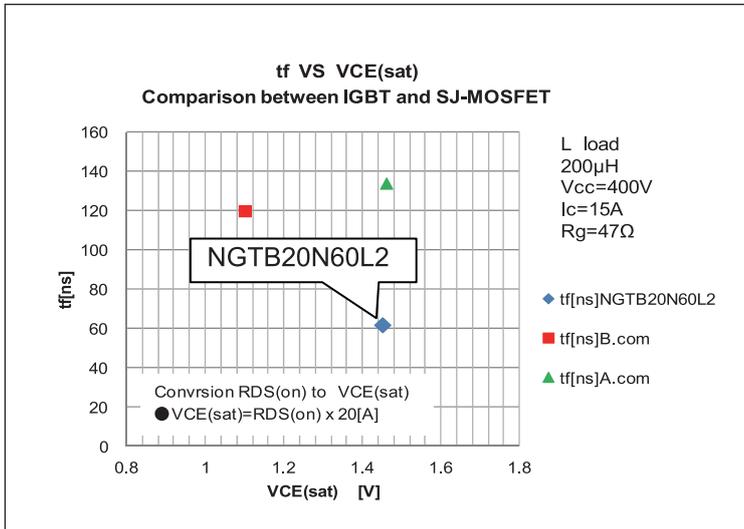


Fig.1 t_f VS $V_{CE(sat)}$

4. Conduction Loss comparison

For IGBT, $V_{CE(sat)}$ changes small with temperature change; but for MOSFET, $R_{DS(on)}$ changes greatly with temperature increase.

We compared at $T_c=25^\circ C$ (Fig.2) and

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

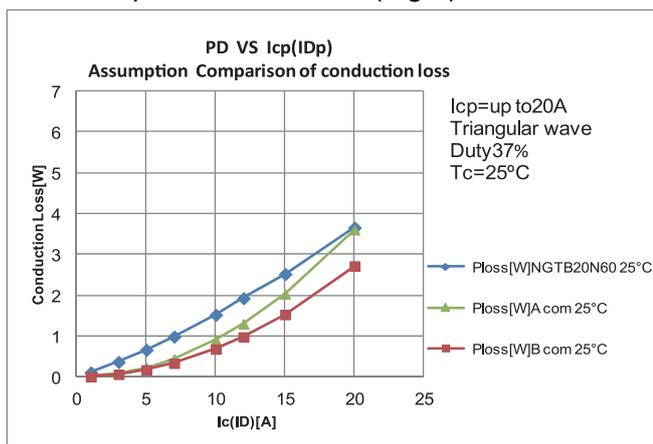


Fig. 2 Conduction loss VS $I_{cp}(I_{Dp})$ $T_c=25^\circ C$

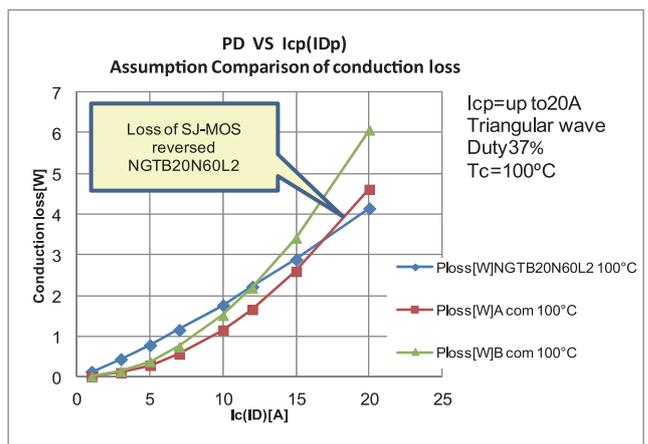


Fig.3 Conduction loss VS $I_{cp}(I_{Dp})$ $T_c=100^\circ C$

$T_c=100^\circ C$ (Fig.3). At $T_c=100^\circ C$, conduction loss of NGTB20N60L2TF1G becomes smaller than that of B.com.

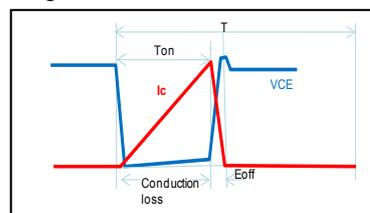


Fig.4 Waveform used for calculation

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5. Switching characteristic comparison (L-load)

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

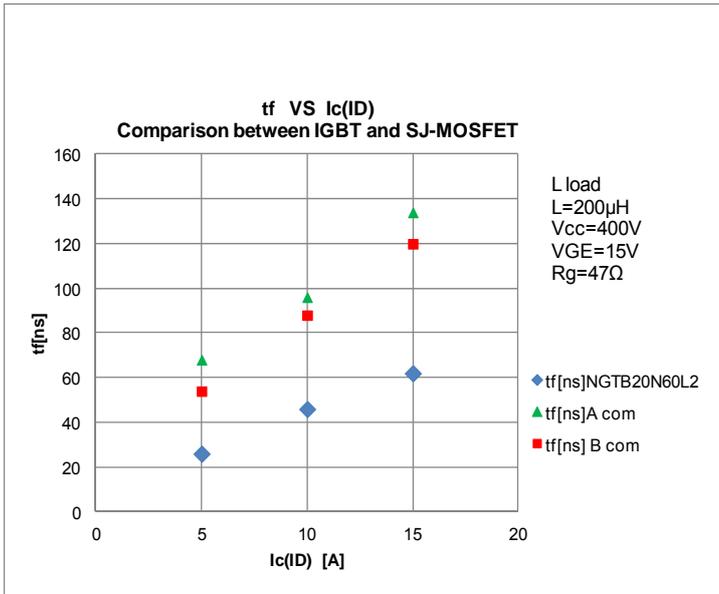


Fig.4 t_f VS $I_c(I_D)$

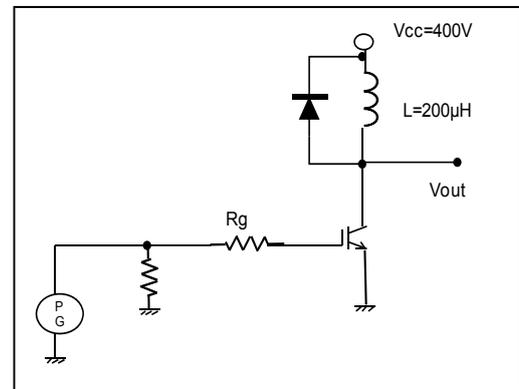


Fig.5 Test circuit

6. Full switching PFC operation comparison

We conducted operation comparison test at $f=35\text{kHz}$ 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, $I_c(I_D)$ at falling of cutoff is dominant. For NGTB20N60TF1G, because of its fast t_f and small E_{off} , it actually is advantageous in performance over SJ-MOSFET.

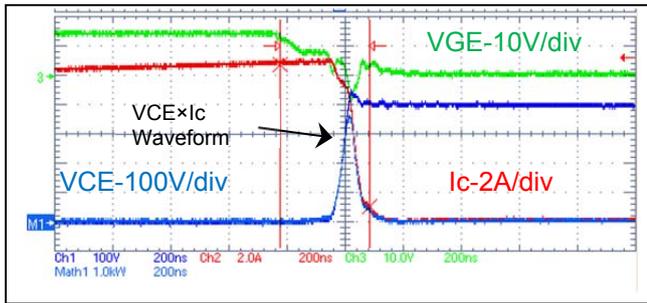
In addition, when comparing the waveforms (WP.1 to WP.3), it is understood that t_f of SJ-MOSFET is slow. Regarding switching loss, it is understood from $V_{CE} \times I_c$ waveform that the loss of NGTB20N60TF1G is the smallest. Furthermore, ringing was observed in the gate voltage waveform of SJ-MOSFET, which means countermeasure against noise will become necessary.

Table 2: Performance comparison

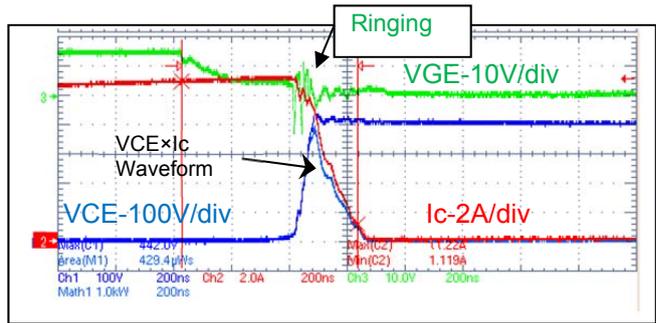
Condition: Full Switching PFC circuit at $V_{AC}=100\text{V}$, $I_{out}=2\text{A}$, $V_{out}\approx 385\text{V}$, $f=35\text{kHz}$

Device	$P_{in}[W]$	$P_{out}[W]$	$\eta[\%]$	$V_{CEp}[V]$	$I_{Dp}[A]$	$t_f[ns]$	$t_{off}[ns]$	$E_{off}[\mu J]$
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

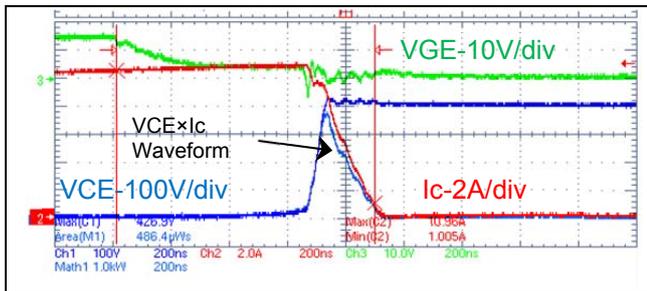
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WP.1 NGTB20N60TF1G



WP.2 A com



WP.3 B com

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