

High-Speed IGBTs

NEW PRODUCT GUIDE

1. Features and Structure

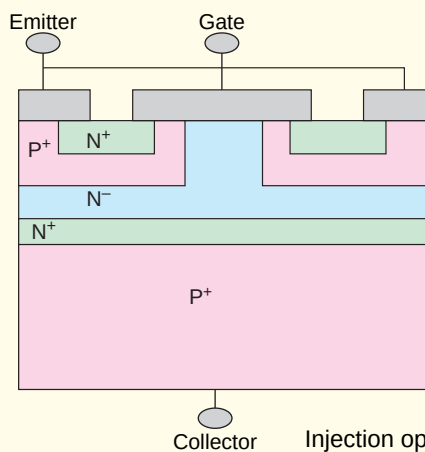
Features of high-speed IGBT (FS Series)

Combines injection optimization, wafer-thinning technology and trench technology.

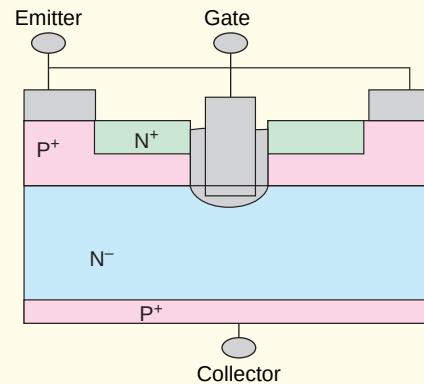
- Low $V_{CE(sat)}$ as a result of trench technology
- Low $V_{CE(sat)}$ and higher speed due to thin wafer
- High ruggedness due to optimized profile and pattern
- High-speed switching due to injection optimization technology; maximum operating frequency = 50 kHz (reference)

High-speed IGBT structure

Conventional product

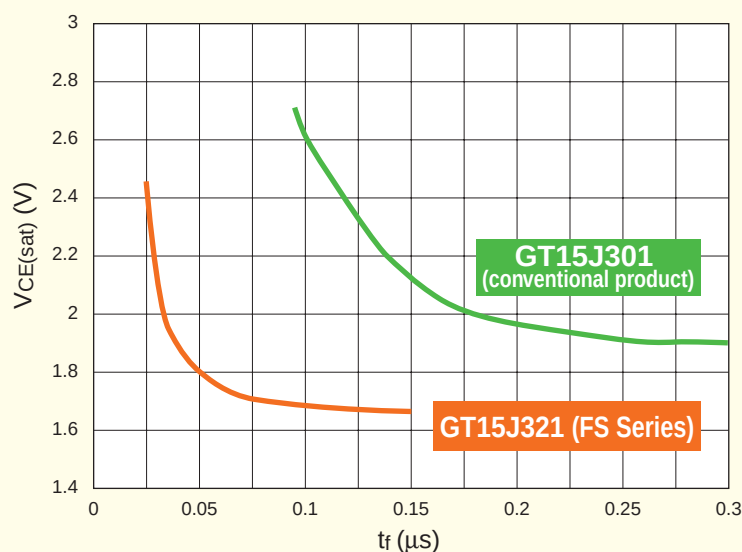


FS Series high-speed IGBT



Injection optimization + thin-wafer specification NPT structure + trench gate structure

FS Series high-speed IGBT trade-off characteristics



- Injection (density) optimization from collector's P-region

→ Faster turn-off

- No electron beam irradiation

→ Low-saturation voltage

- Trench gate structure

→ Low-saturation voltage, reduced chip size



2. FS Series High-Speed IGBT Line-up

Without built-in FRD

Product Number	V _{CES} (V)	I _C (A)	P _C (W)	V _{CE(sat)} (V)	t _f (μs)	Package
GT5J121	600	5	40	2.0	0.05	DP
GT30J121	600	30	155	2.0	0.05	TO-3P(N)
GT50J121	600	50	200	2.0	0.05	TO-3P(LH)

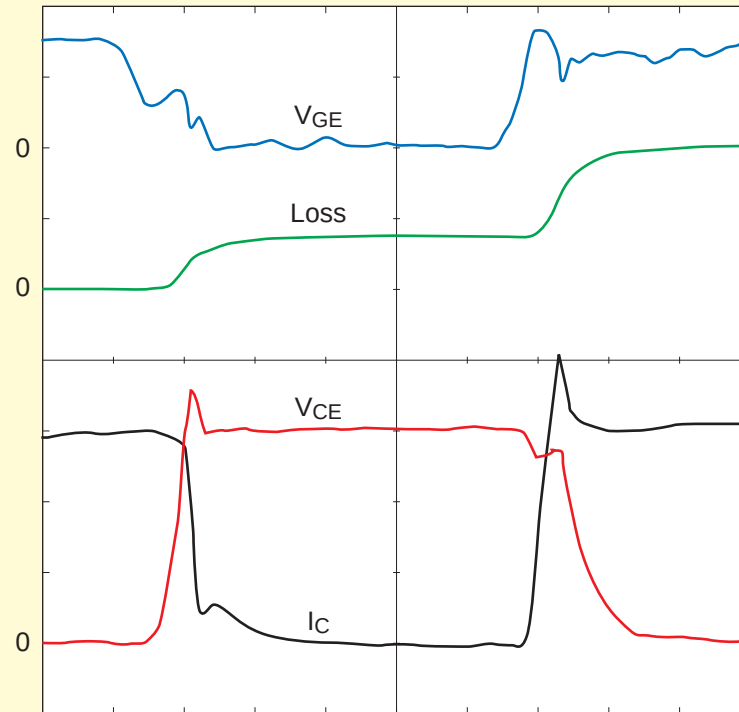
With built-in FRD

Product Number	V _{CES} (V)	I _C (A)	P _C (W)	V _{CE(sat)} (V)	t _f (μs)	Package
GT5J321	600	5	28	2.0	0.05	TO-220NIS
GT10J321	600	10	29	2.0	0.03	TO-220NIS
GT15J321	600	15	30	1.9	0.03	TO-220NIS
GT20J321	600	20	40	2.0	0.04	TO-220NIS
GT30J324	600	30	155	2.0	0.05	TO-3P(N)
GT50J325	600	50	200	2.0	0.05	TO-3P(LH)

3. Switching Characteristics of FS Series High-Speed IGBTs

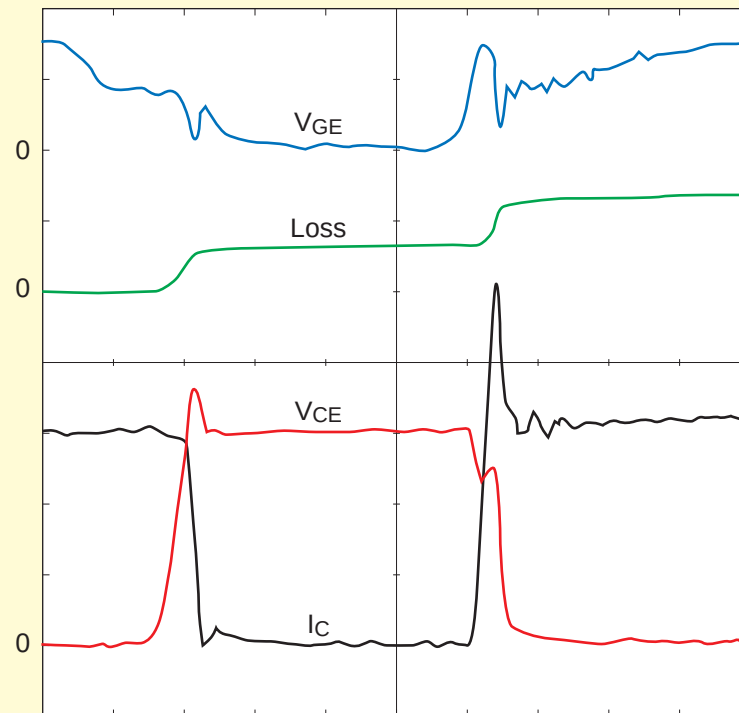
Total switching loss at least 30% less than that of conventional products

Conventional
product
(GT15J301)



$E_{on} = 0.58 \text{ mJ}$
 $E_{off} = 0.38 \text{ mJ}$

FS Series
high-speed
IGBT
(GT15J321)



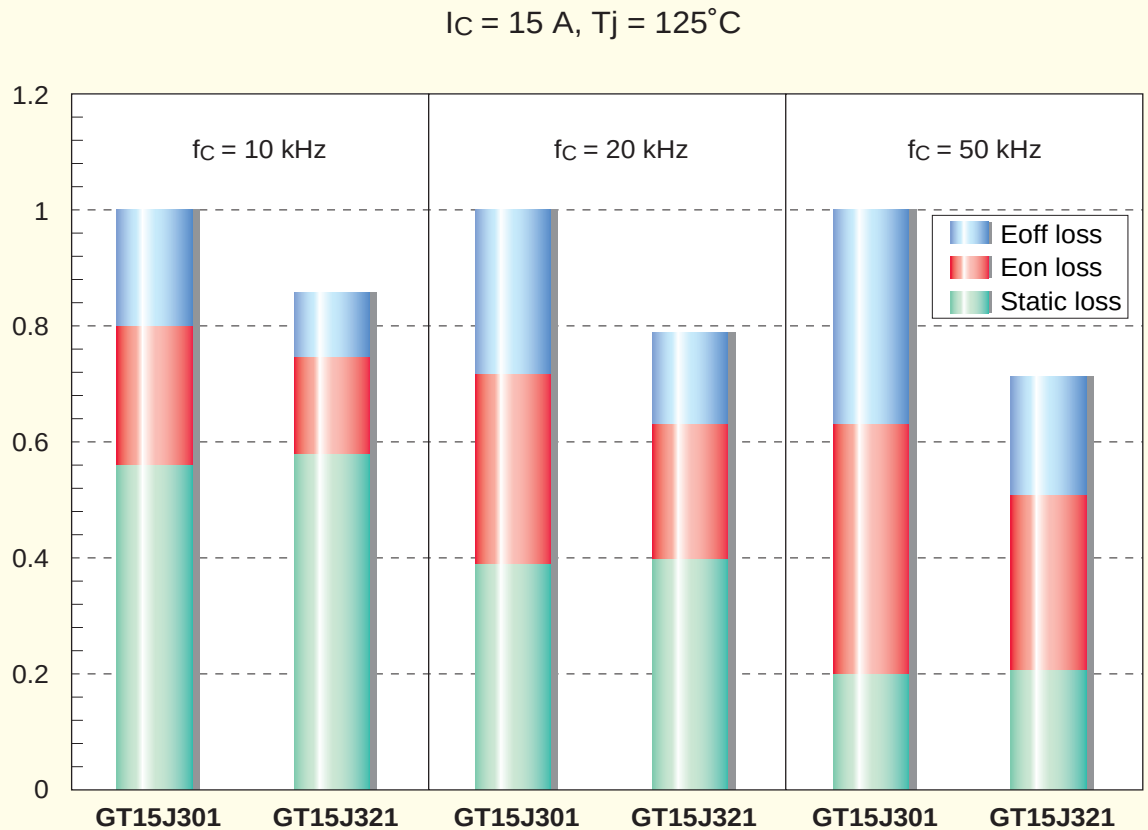
$E_{on} = 0.31 \text{ mJ}$
 $E_{off} = 0.31 \text{ mJ}$

(V_{GE} : 10 V/div, I_C : 5 A/div, V_{CE} : 100 V/div, Loss: 0.5 mJ/div, t : 0.2 μs /div)
Test conditions: $V_{GG} = 15 \text{ V}$, $V_{CC} = 300 \text{ V}$, inductive load, $T_c = 25^\circ\text{C}$



4. Loss Simulation

Total loss 30% less than that of conventional products (at $f_c = 50$ kHz)



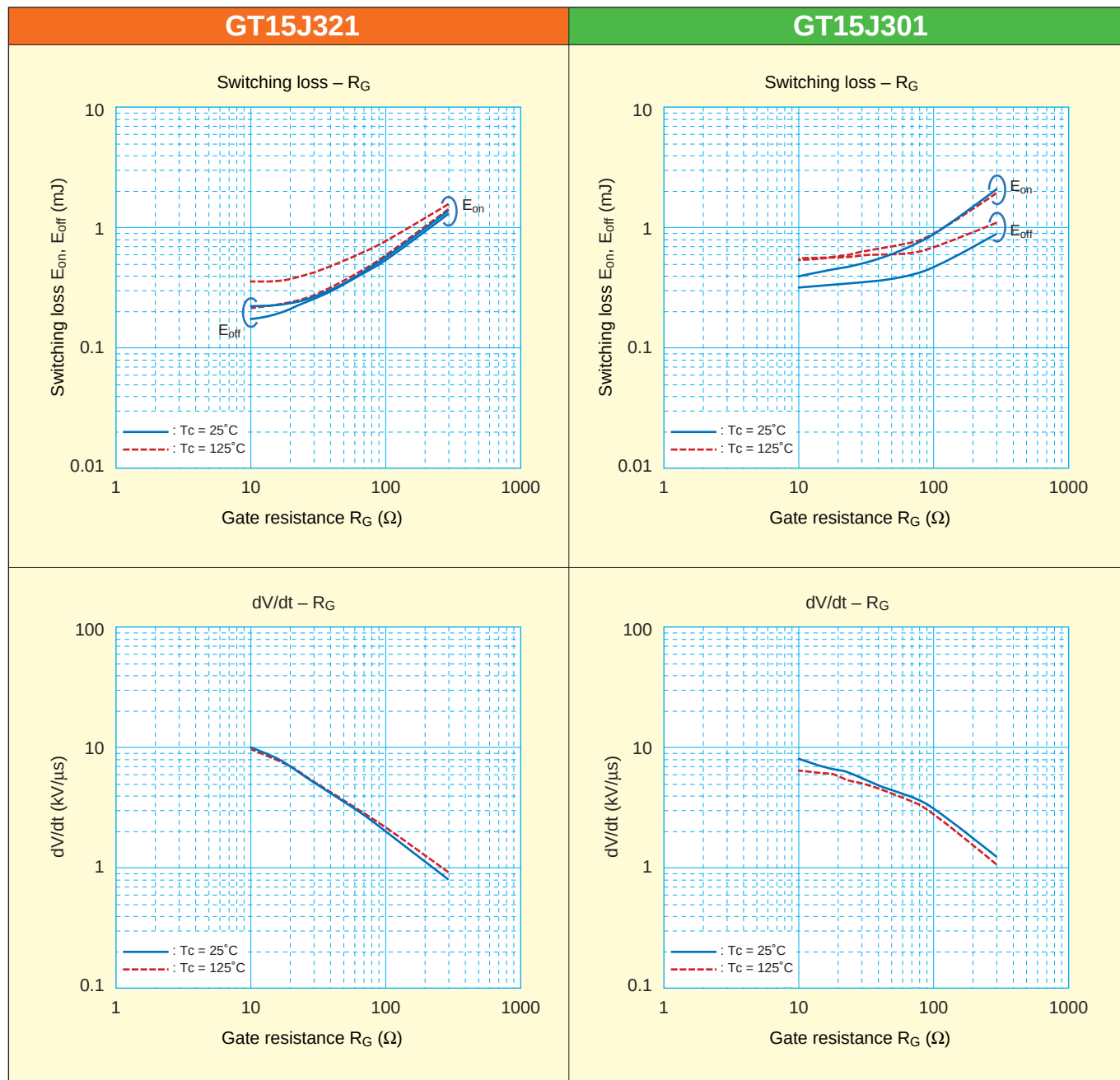
(Based on a 50% duty cycle)

(At each operating frequency total loss for GT15J301 = 1)

5. Dependence of dV/dt and Switching Loss on R_G

Switching loss is less than that of conventional IGBTs even though voltage change is minimized in order to reduce radiation noise.

Low emission and loss levels are achieved.



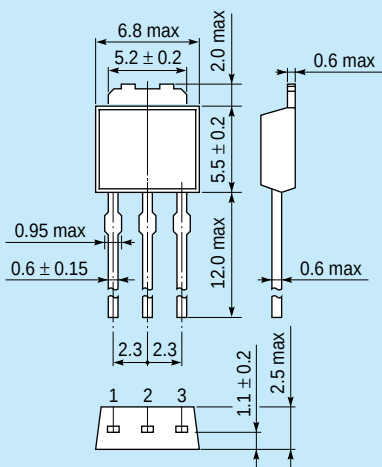
R_G and switching loss when $dV/dt = 3$ kV ($T_c = 125^\circ\text{C}$)

	GT15J321	GT15J301
R_G (Ω)	60	100
E_{on} (mJ)	0.59	0.95
E_{off} (mJ)	0.40	0.70
$E_{on} + E_{off}$ (mJ)	0.99	1.65

When $dV/dt = 3$ kV, the gate resistance (R_G) is 60 Ω for the new high-speed IGBT (GT15J321) and 100 Ω for the conventional GT15J301. The table on the left shows the switching losses for the GT15J321 and GT15J301 when $dV/dt = 3$ kV. The switching loss at $T_c = 125^\circ\text{C}$ is 0.99mJ for the new GT15J321, approximately 40% lower than that of the GT15J301 (1.65 mJ).

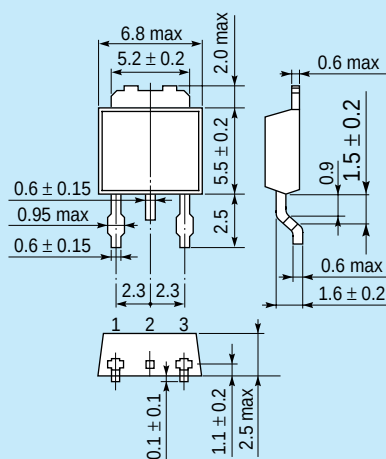
6. Packages

DP (straight)



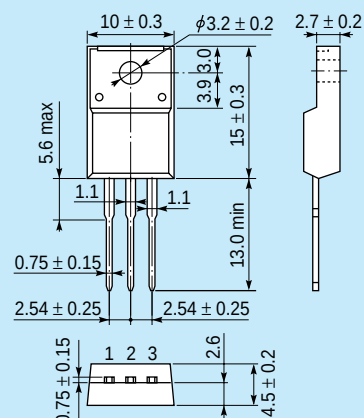
1. Gate
2. Collector
3. Emitter

DP (lead bend)



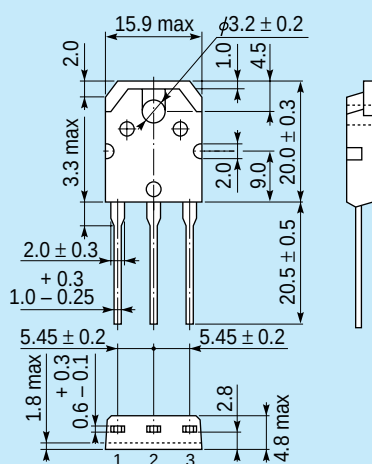
1. Gate
2. Collector
3. Emitter

TO-220NIS



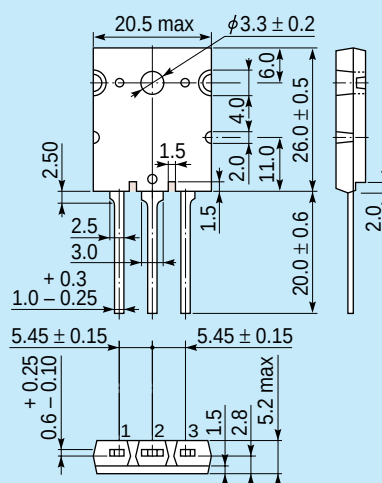
1. Gate
2. Collector
3. Emitter

TO-3P(N)



1. Gate
2. Collector
3. Emitter

TO-3P(LH)



1. Gate
2. Collector
3. Emitter

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TOSHIBA

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