

# “XS Series” 650-V Discrete IGBTs

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Global energy demand is increasing steadily and further energy conservation is called for.

In this situation, there is a strong demand for switching devices with a lower loss in order to improve the efficiency of uninterruptible power systems (UPSs) for equipment requiring high-quality power and power conditioning systems (PCSs) that convert direct current power generated by photovoltaic systems into alternating-current power.

Fuji Electric has developed and launched the “XS Series” 650-V discrete IGBTs as a product line that improves the on-state voltage and switching loss trade-off characteristic to improve the efficiency of UPSs and PCSs.

## 1. Features

Figure 1 shows the appearance of the XS Series and Table 1 the line-up. The major features are as follows:

- (a) Recommended drive frequency  $f_{sw} = 10$  to 50 kHz
- (b) On-state voltage  $V_{CE(sat)} = 1.5$  V ( $T_{vj} = 125^\circ\text{C}$ )
- (c) Turn-off loss  $E_{off} = 0.86$  mJ ( $T_{vj} = 125^\circ\text{C}$ , turn-off  $dv/dt = 10$  kV/ $\mu\text{s}$ )

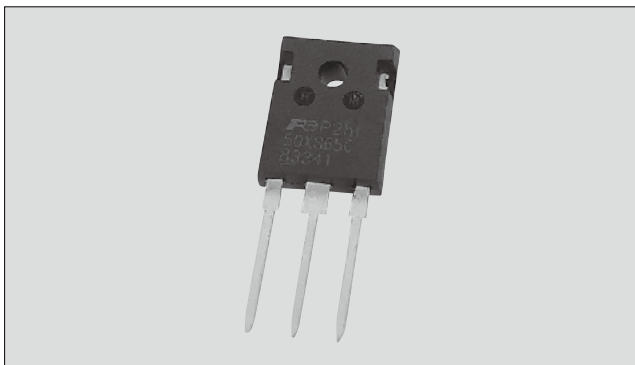


Fig.1 “XS Series” (TO-247 package)

## 2. Chip Technology

This product is based on the insulated gate bipolar transistor (IGBT) and free wheeling diode (FWD) chip technologies of the 7th-generation “X Series,” and it has the optimum design for discrete products used at  $f_{sw}$  of 10 to 50 kHz.

The IGBT uses the miniaturization and thin-wafer technologies of the 7th-generation chip technology as the basis and has a surface structure optimized for discrete applications and  $V_{CE(sat)}$  reduced. The collector layer features hole injection control to decrease the switching loss. This has achieved a significant improvement in the trade-off characteristic from that of the conventional products with a 0.5-V reduction in  $V_{CE(sat)}$  and an approximately 20% reduction in  $E_{off}$ , as shown in Fig. 2.

The FWD has also improved the  $V_F$  and  $E_{Tr}$  trade-off characteristic by making use of the thin wafer and lifetime optimization technologies of the 7th-generation chip technology as shown in Fig. 3. It also achieved a low surge voltage with a soft recovery characteristics and a reduction of  $V_F$  by approximately

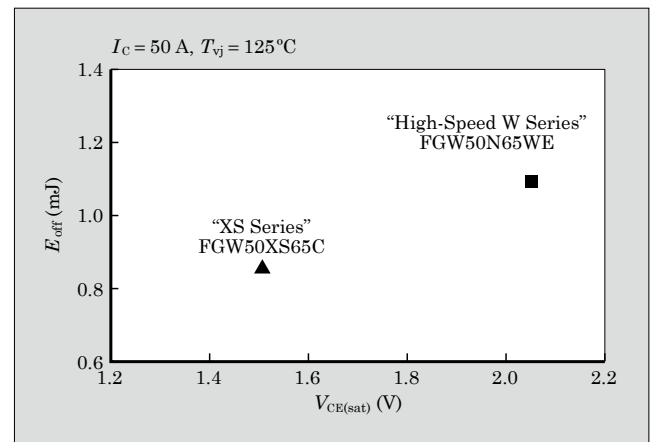


Fig.2 Trade-off characteristic (IGBTs)

Table 1 “XS Series” line-up

$V_{CE}$	Package	$I_C$ ( $T_c=100^\circ\text{C}$ )				Built-in FWD
		30 A	40 A	50 A	75 A	
650 V	TO-247	FGW30XS65	FGW40XS65	FGW50XS65	FGW75XS65	None
		FGW30XS65C	FGW40XS65C	FGW50XS65C	FGW75XS65C	Provided
	TO-247-4L	—	—	—	FGZ75XS65C	Provided

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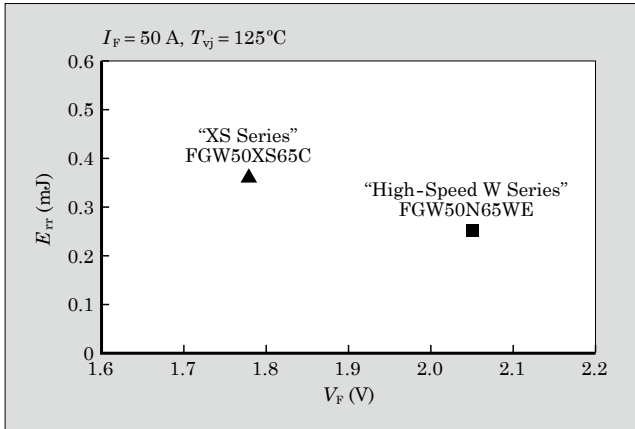


Fig.3 Trade-off characteristic (FWDs)

0.3 V from conventional products.

### 3. Package

As with conventional products, the industry standard TO-247 package has been employed. For the solder to connect between the chip and lead frame, lead-free solder is used, which conforms to the RoHS Directive\*1 (EU2011/65/EU).

### 4. Effect of Application

UPSs and PCSs of a few kilovolt-amperes to 50 kVA often use discrete IGBTs to compose the inverter circuits with 3-level inverters (I-type and T-type) shown in Fig. 4.

Figure 5 shows the calculation result of the generated loss in the discrete IGBT of the I-type 3-level inverter. As compared with the "High-Speed W Series," a conventional product line, the XS Series has the loss reduced on the outside (T1 and T4) and the inside (T2 and T3) by improving the V<sub>CE(sat)</sub> and E<sub>off</sub> trade-off characteristic.

Figure 6 shows the result of calculating the gener-

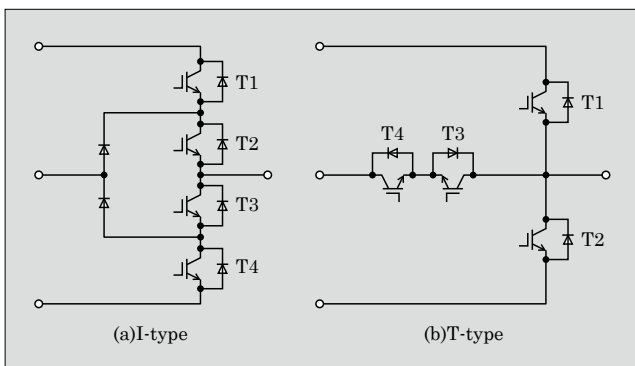


Fig.4 3-level inverter (I-type and T-type)

\*1: RoHS Directive: A European Union (EU) directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment

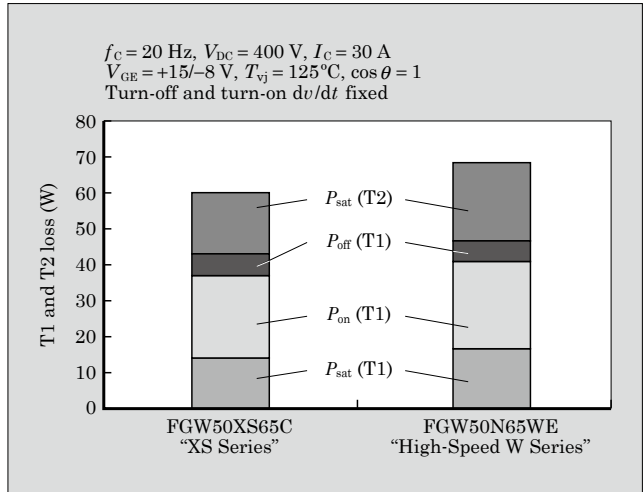


Fig.5 Device loss (3-level inverter I-type)

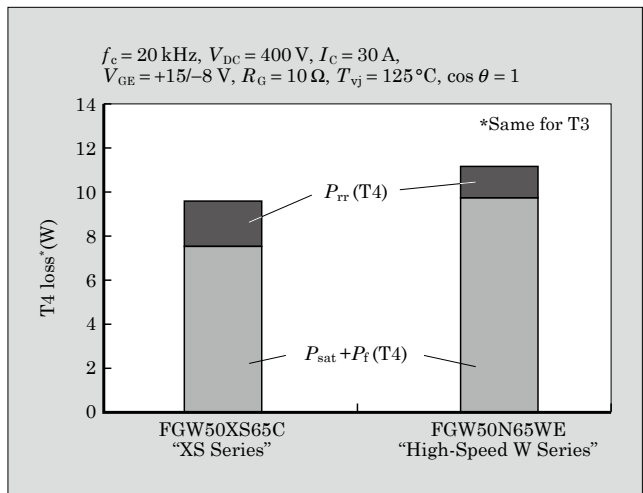


Fig.6 Device loss (3-level inverter T-type)

ated loss in the IGBT and FWD in the AC switch (T3 and T4) of a T-type 3-level inverter. The loss generated in the devices of the AC switch is composed of the conduction loss of the IGBT and FWD and the recovery loss of the FWD. As compared with the High-Speed W Series, the XS Series has a lower on-state voltage of the IGBT and FWD and features lower loss with the T-type as well.

### Launch time

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### Product Inquiries

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