

V_{CE} = 650 V, I_C = 30 A
Trench Field Stop IGBTs with Fast Recovery Diode
KGF65A3L, MGF65A3L, FGF65A3L

Description

KGF65A3L, MGF65A3L, and FGF65A3L are 650 V Field Stop IGBTs. Sanken original trench structure decreases gate capacitance, and achieves low saturation voltage and switching losses reduction. Thus, Field Stop IGBTs can improve the efficiency of your circuit.

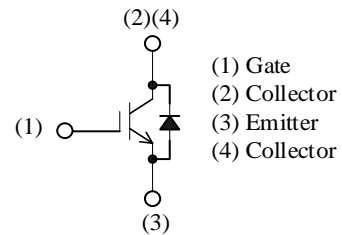
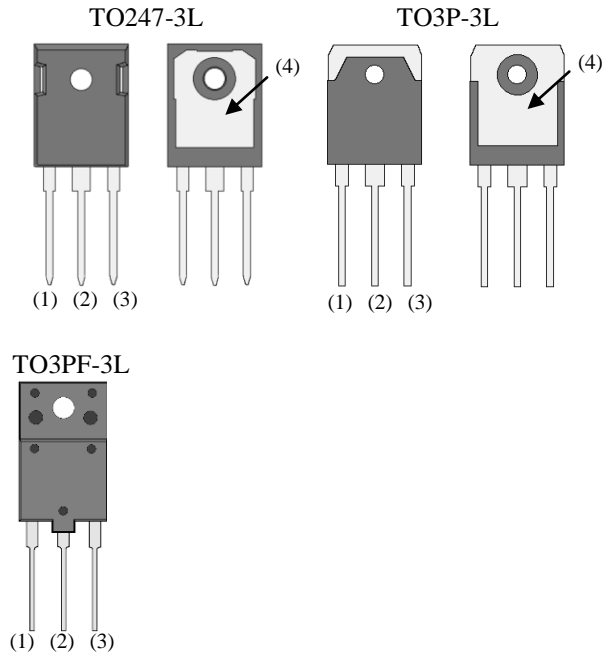
Features

- Low Saturation Voltage
 - High Speed Switching
 - With Integrated Fast Recovery Diode
 - Bare lead frame: Pb-free (RoHS compliant)
-
- V_{CE}----- 650 V
 - I_C (T_C = 100 °C)----- 30 A
 - Short Circuit Withstand Time ----- 5 μs
 - V_{CE(sat)}----- 1.6 V typ.
 - t_f (T_J = 175 °C) ----- 160 ns typ.
 - V_F----- 1.6 V typ.

Applications

- Uninterruptible Power Supply (UPS)
- Inverter Circuit
- Bridge Circuit

Package



Not to scale

Selection Guide

Part Number	Package
KGF65A3L	TO247-3L
MGF65A3L	TO3P-3L
FGF65A3L	TO3PF-3L

KGF65A3L, MGF65A3L, FGF65A3L

Absolute Maximum Ratings

Unless otherwise specified, $T_A = 25\text{ }^\circ\text{C}$

Parameter	Symbol	Conditions	Rating	Unit	Remarks
Collector to Emitter Voltage	V_{CE}		650	V	
Gate to Emitter Voltage	V_{GE}		± 30	V	
Continuous Collector Current ⁽¹⁾	I_C	$T_C = 25\text{ }^\circ\text{C}$	50	A	
		$T_C = 100\text{ }^\circ\text{C}$	30	A	
Pulsed Collector Current	$I_{C(PULSE)}$	$PW \leq 1\text{ ms}$, duty cycle $\leq 1\%$	90	A	
Diode Continuous Forward Current ⁽¹⁾	I_F	$T_C = 25\text{ }^\circ\text{C}$	40 ⁽²⁾	A	
		$T_C = 100\text{ }^\circ\text{C}$	30	A	
Diode Pulsed Forward Current	$I_{F(PULSE)}$	$PW \leq 1\text{ ms}$, duty cycle $\leq 1\%$	90	A	
Short Circuit Withstand Time	t_{SC}	$V_{GE} = 15\text{ V}$, $V_{CE} = 400\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$	5	μs	
Power Dissipation	P_D	$T_C = 25\text{ }^\circ\text{C}$	217	W	MGF65A3L KGF65A3L FGF65A3L
			72		
Operating Junction Temperature	T_J		175	$^\circ\text{C}$	
Storage Temperature Range	T_{STG}		-55 to 150	$^\circ\text{C}$	
Isolation Voltage	$V_{ISO(RMS)}$	Between surface of case and all pins that are shorted; AC, 60 Hz, 1 min	1500	V	FGF65A3L

Thermal Characteristics

Unless otherwise specified, $T_A = 25\text{ }^\circ\text{C}$

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Thermal Resistance of IGBT (Junction to Case)	$R_{\theta JC}$ (IGBT)		—	—	0.69	$^\circ\text{C/W}$	MGF65A3L KGF65A3L FGF65A3L
			—	—	2.08		
Thermal Resistance of Diode (Junction to Case)	$R_{\theta JC}$ (Di)		—	—	1.15	$^\circ\text{C/W}$	MGF65A3L KGF65A3L FGF65A3L
			—	—	2.28		

⁽¹⁾ I_C and I_F are determined by the maximum junction temperature for TO3P-3L package.

⁽²⁾ Determined by bonding wires capability.

KGF65A3L, MGF65A3L, FGF65A3L

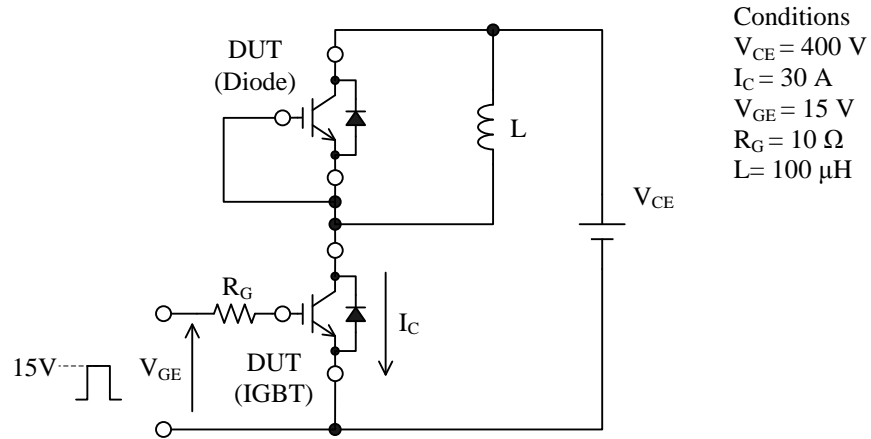
Electrical Characteristics

Unless otherwise specified, $T_A = 25\text{ }^\circ\text{C}$

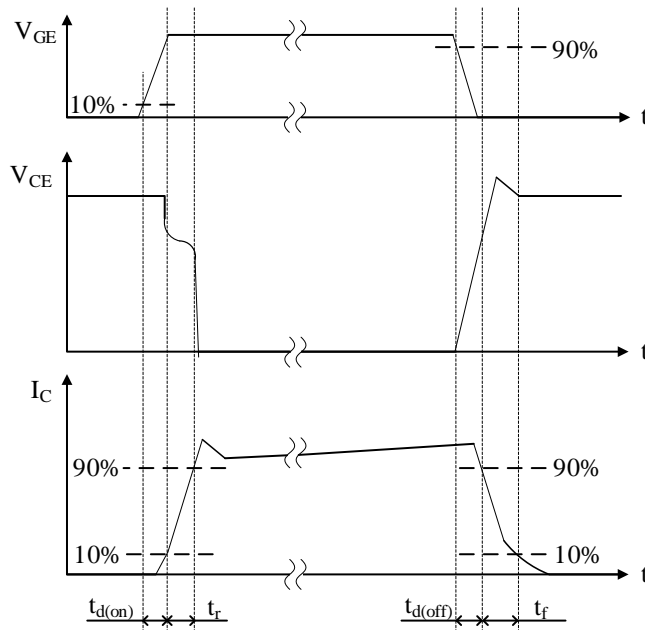
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
Collector to Emitter Breakdown Voltage	$V_{(BR)CES}$	$I_C = 100\text{ }\mu\text{A}$, $V_{GE} = 0\text{ V}$	650	—	—	V	
Collector to Emitter Leakage Current	I_{CES}	$V_{CE} = 650\text{ V}$, $V_{GE} = 0\text{ V}$	—	—	100	μA	
Gate to Emitter Leakage Current	I_{GES}	$V_{GE} = \pm 30\text{ V}$	—	—	± 500	nA	
Gate Threshold Voltage	$V_{GE(TH)}$	$V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	4.0	5.5	7.0	V	
Collector to Emitter Saturation Voltage	$V_{CE(sat)}$	$V_{GE} = 15\text{ V}$, $I_C = 30\text{ A}$	—	1.6	1.96	V	
Input Capacitance	C_{ies}	$V_{CE} = 20\text{ V}$, $V_{GE} = 0\text{ V}$, $f = 1.0\text{ MHz}$,	—	1800	—	pF	
Output Capacitance	C_{oes}		—	200	—		
Reverse Transfer Capacitance	C_{res}		—	80	—		
Gate charge	Q_g	$V_{CE} = 520\text{ V}$, $I_C = 30\text{ A}$, $V_{GE} = 15\text{ V}$	—	60	—	nC	
Turn-on Delay Time	$t_{d(on)}$	$T_J = 25\text{ }^\circ\text{C}$, see Figure 1.	—	30	—	ns	
Rise Time	t_r		—	30	—		
Turn-off Delay Time	$t_{d(off)}$		—	90	—		
Fall Time	t_f		—	40	—		
Turn-on Energy ⁽³⁾	E_{on}		—	0.6	—		mJ
Turn-off Energy	E_{off}	—	0.6	—			
Turn-on Delay Time	$t_{d(on)}$	$T_J = 175\text{ }^\circ\text{C}$, see Figure 1.	—	30	—	ns	
Rise Time	t_r		—	30	—		
Turn-off Delay Time	$t_{d(off)}$		—	120	—		
Fall Time	t_f		—	160	—		
Turn-on Energy ⁽³⁾	E_{on}		—	1.1	—		mJ
Turn-off Energy	E_{off}		—	1.1	—		
Emitter to Collector Diode Forward Voltage	V_F	$I_F = 30\text{ A}$	—	1.6	—	V	
Emitter to Collector Diode Reverse Recovery Time	t_{rr}	$I_F = 30\text{ A}$, $di/dt = 700\text{ A}/\mu\text{s}$	—	50	—	ns	

⁽³⁾ Energy losses include the reverse recovery of diode.

Test Circuits and Waveforms



(a) Test Circuit



(b) Waveform

Figure 1. Test Circuits and Waveforms of dv/dt and Switching Time

Rating and Characteristic Curves

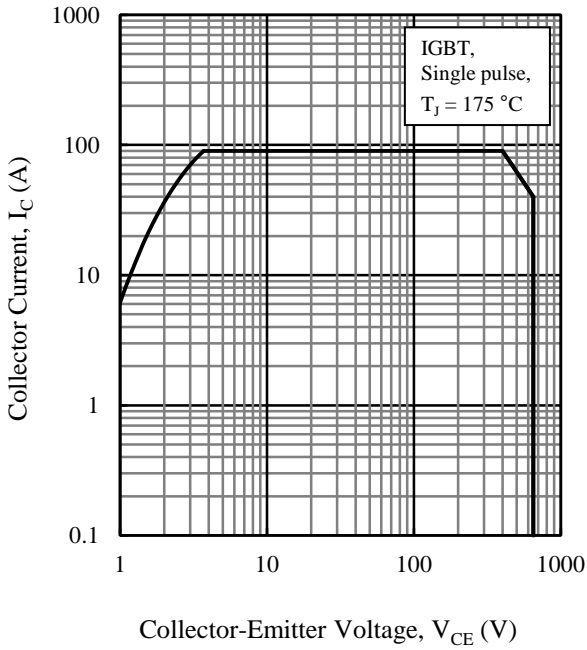


Figure 2. IGBT Reverse Bias Safe Operating Area

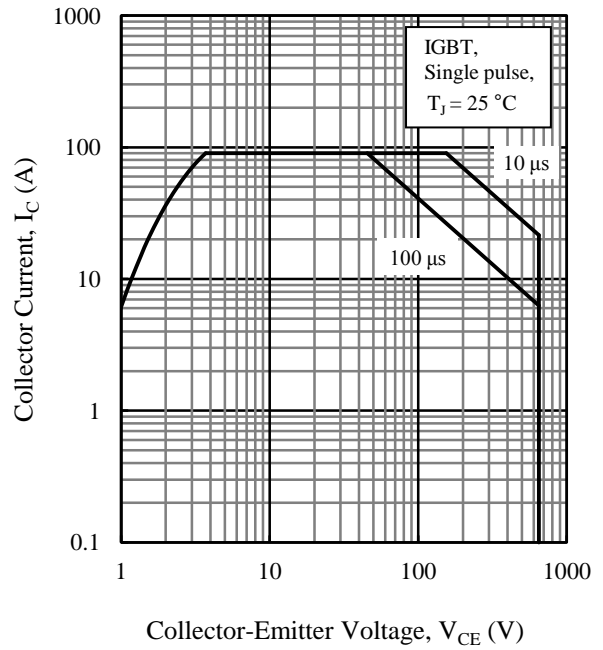


Figure 3. IGBT Safe Operating Area

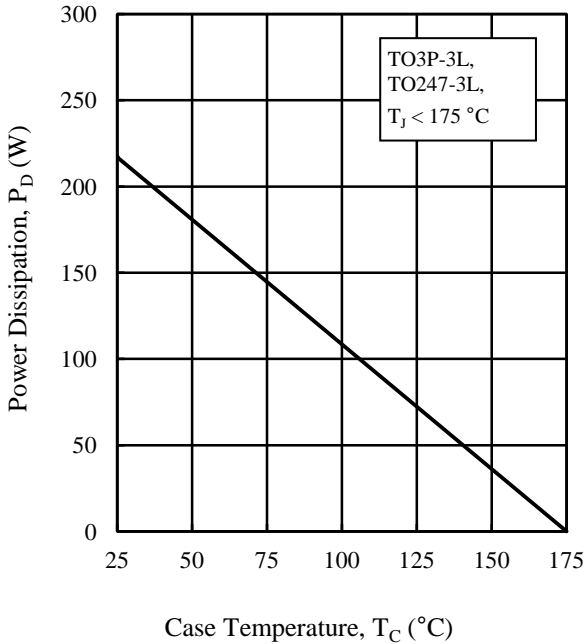


Figure 4. Power Dissipation vs. Case Temperature

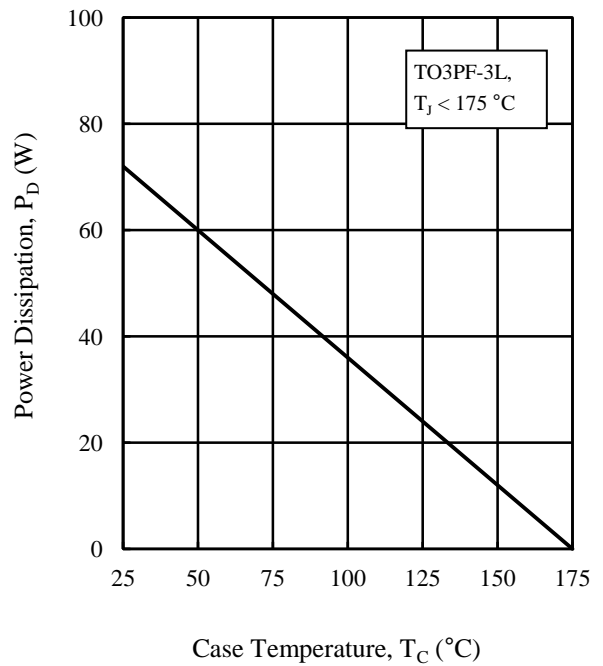


Figure 5. Power Dissipation vs. Case Temperature

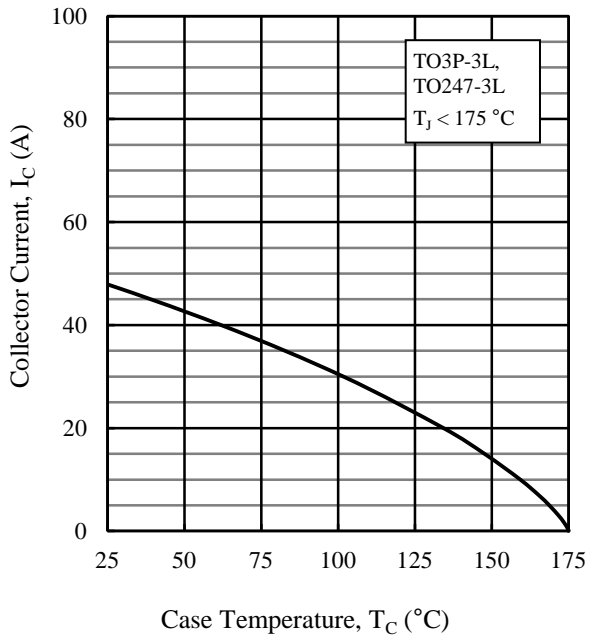


Figure 6. Collector Current vs. Case Temperature

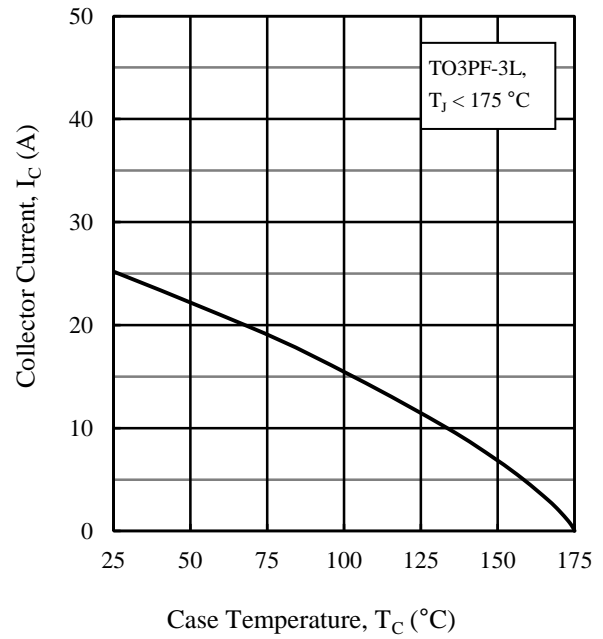


Figure 7. Collector Current vs. Case Temperature

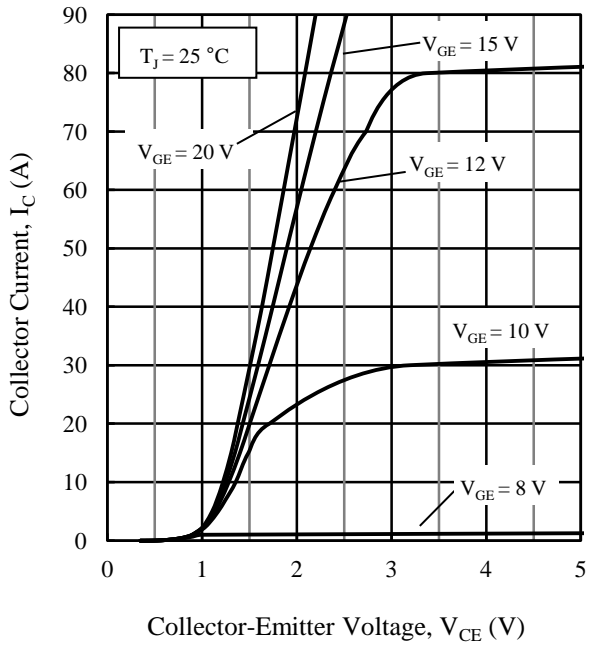


Figure 8. Output Characteristics ($T_J = 25^\circ\text{C}$)

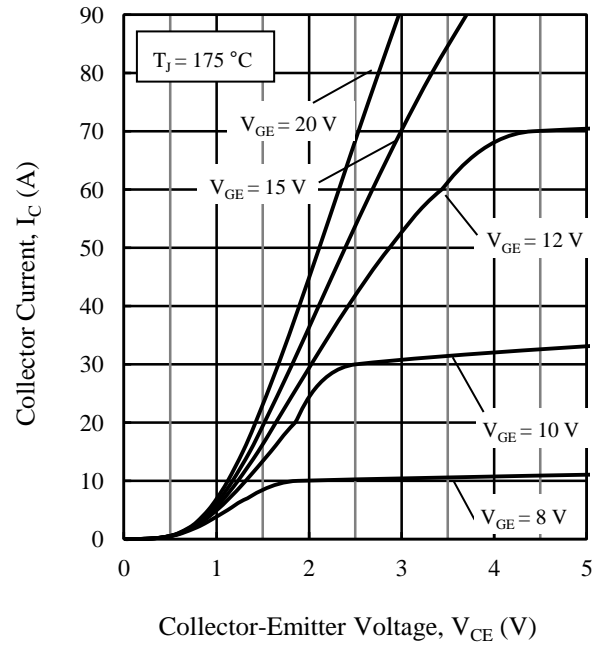


Figure 9. Output Characteristics ($T_J = 175^\circ\text{C}$)

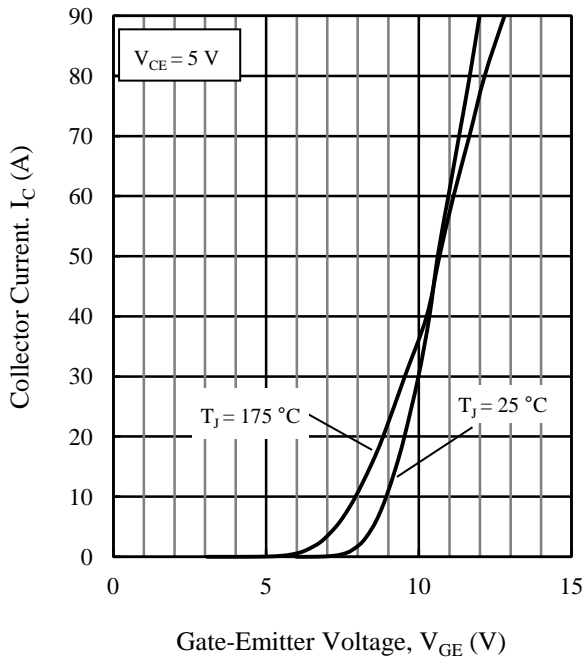


Figure 10. Transfer Characteristics

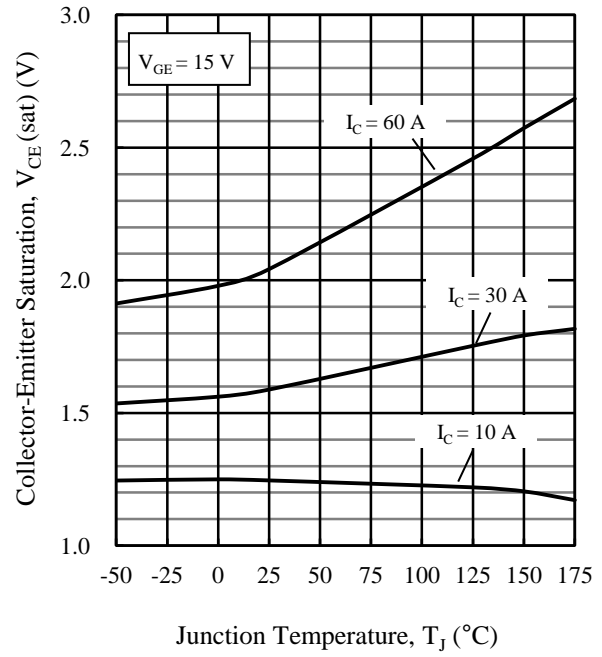


Figure 11. Saturation Voltage vs. Junction Temperature

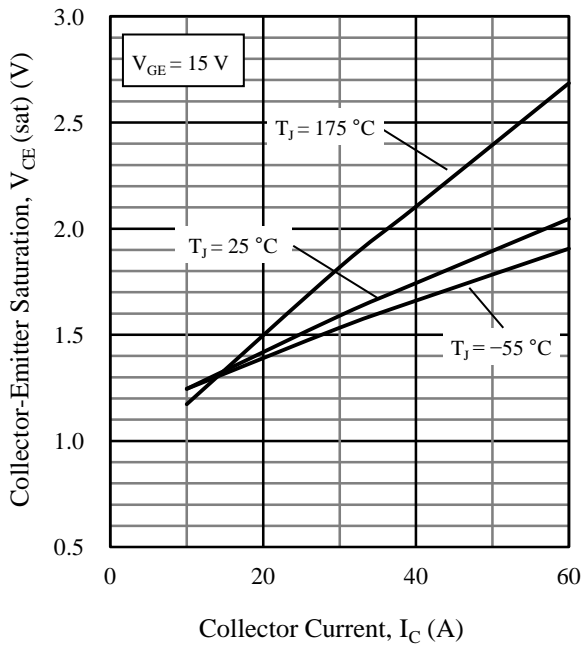


Figure 12. Saturation Voltage vs. Collector Current

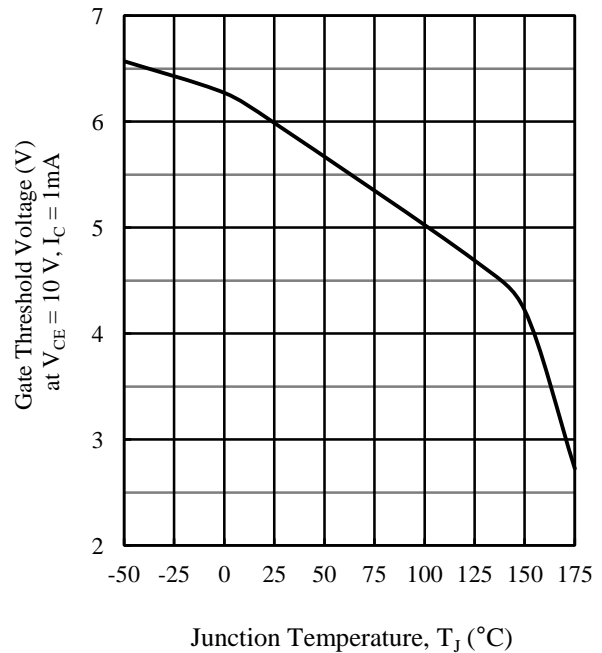


Figure 13. Gate Threshold Voltage vs. Junction Temperature

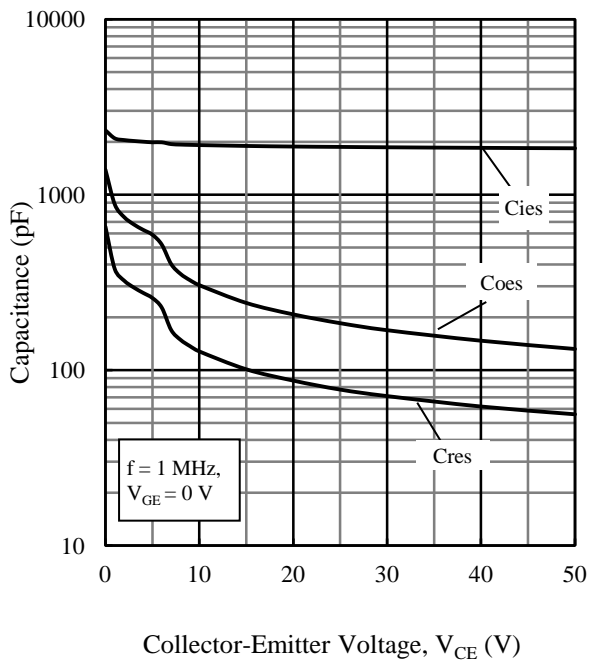


Figure 14. Capacitance Characteristics

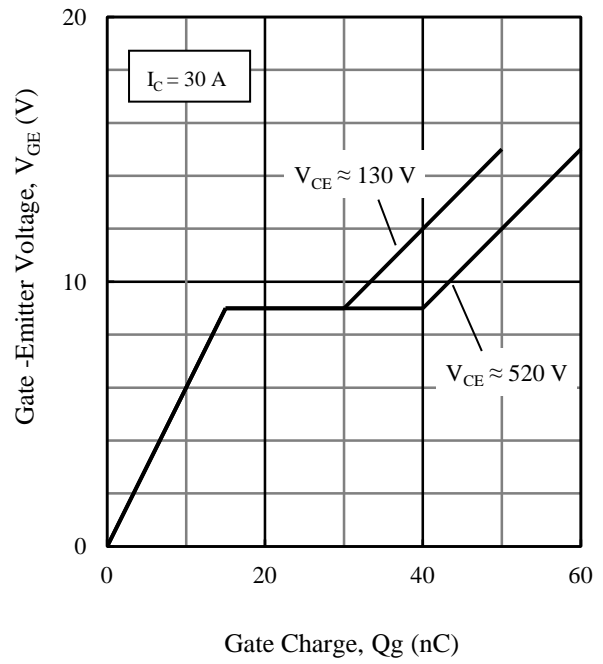


Figure 15. Typical Gate Charge

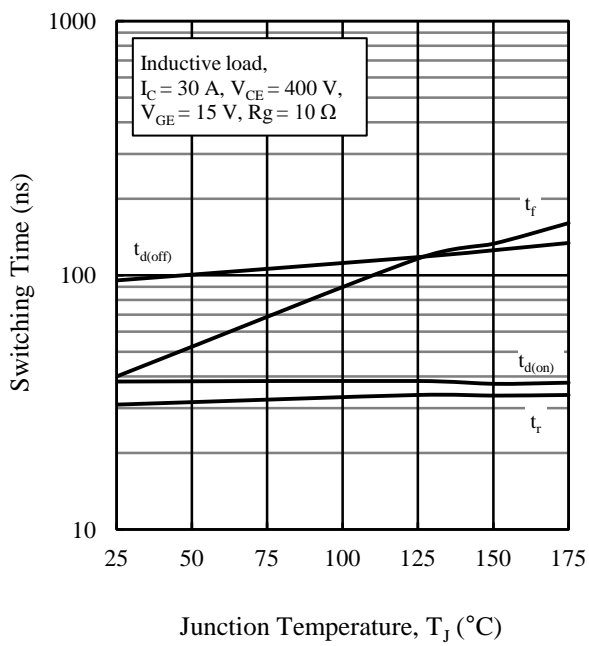


Figure 16. Switching Time vs. Junction Temperature

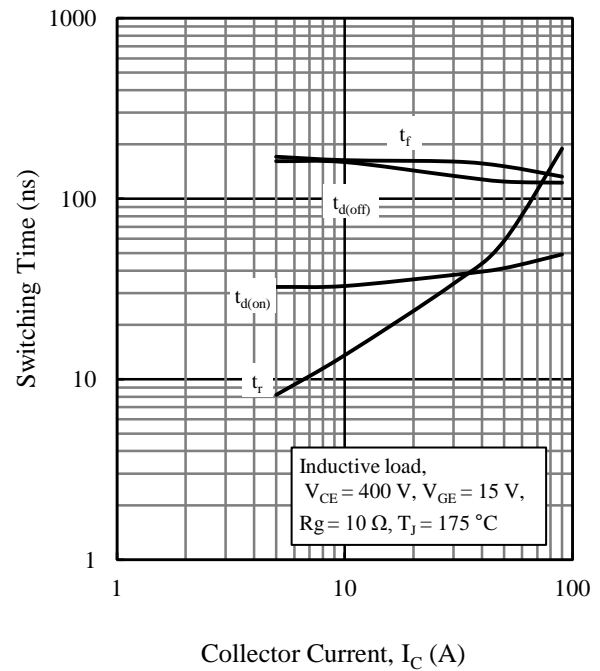


Figure 17. Switching Time vs. Collector Current

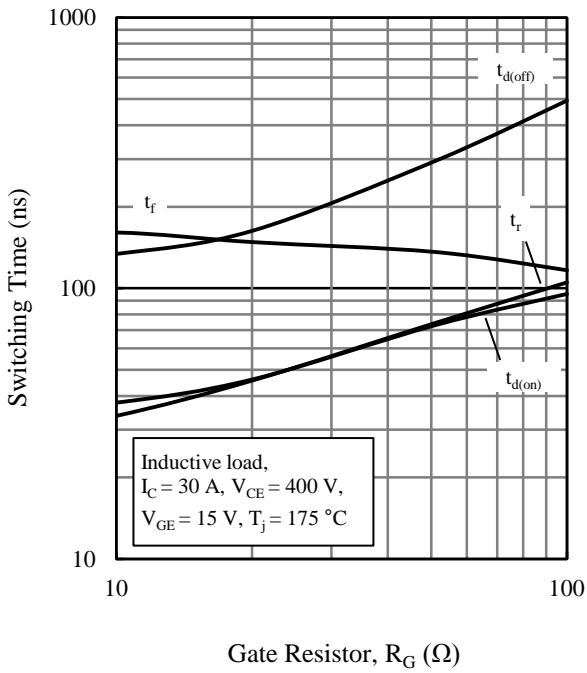


Figure 18. Switching Time vs. Gate Resistor

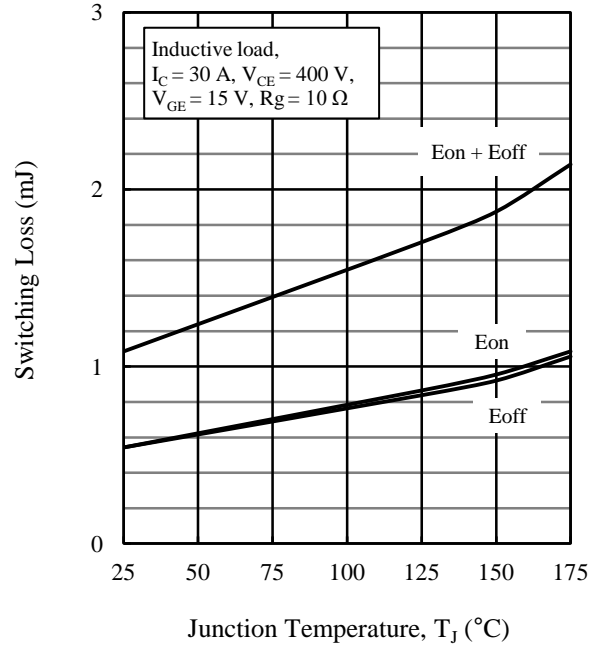


Figure 19. Switching Loss vs. Junction Temperature

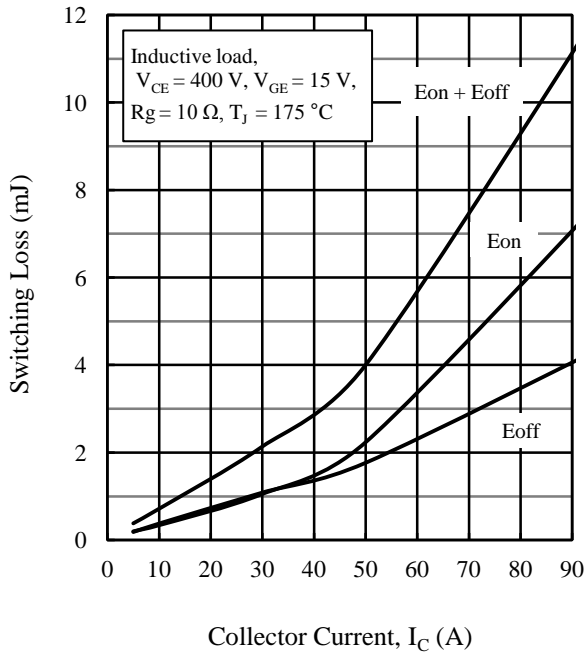


Figure 20. Switching Loss vs. Collector Current

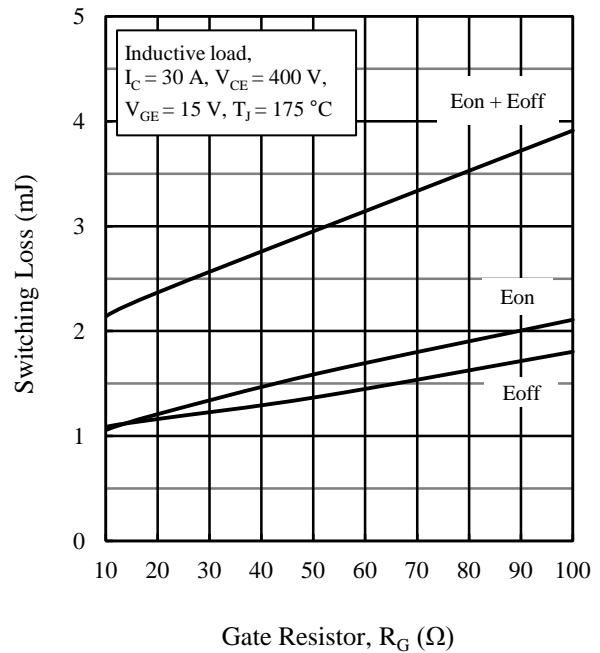


Figure 21. Switching Loss vs. Gate Resistor

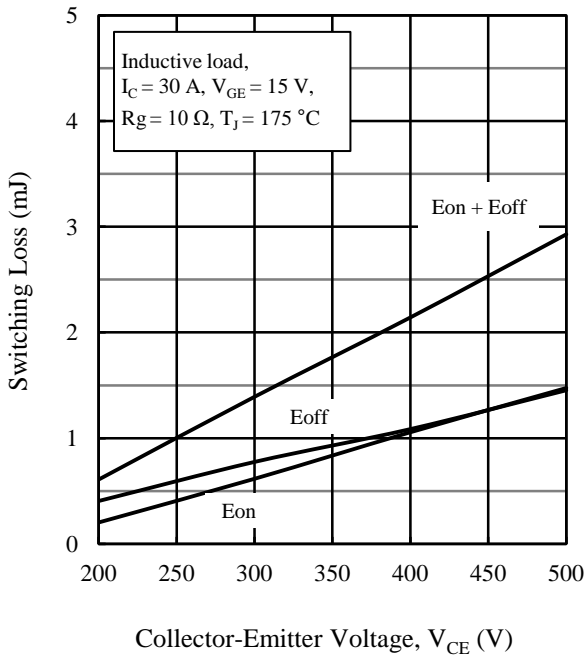


Figure 22. Switching Loss vs. Collector-Emitter Voltage

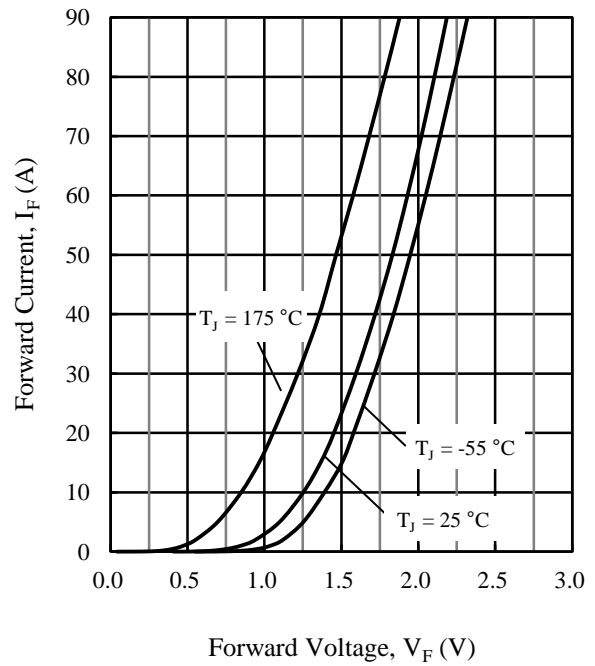


Figure 23. Diode Forward Characteristics

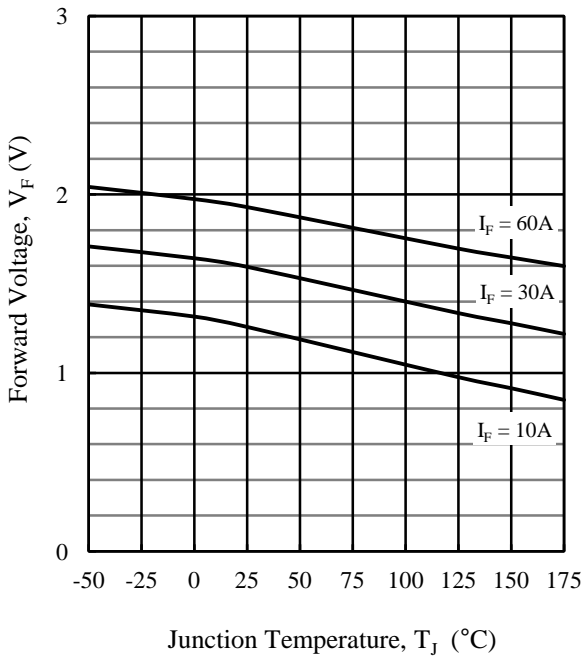


Figure 24. Diode Forward Voltage vs. Junction Temperature

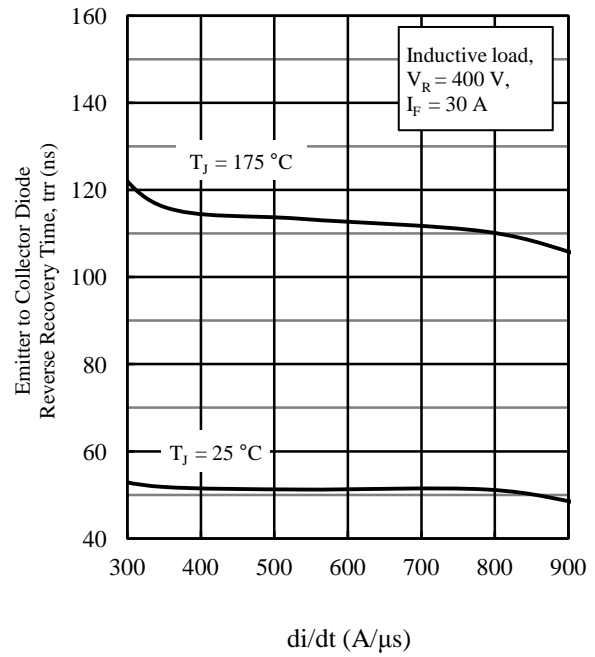


Figure 25. Emitter to Collector Diode Reverse Recovery Time vs. di/dt

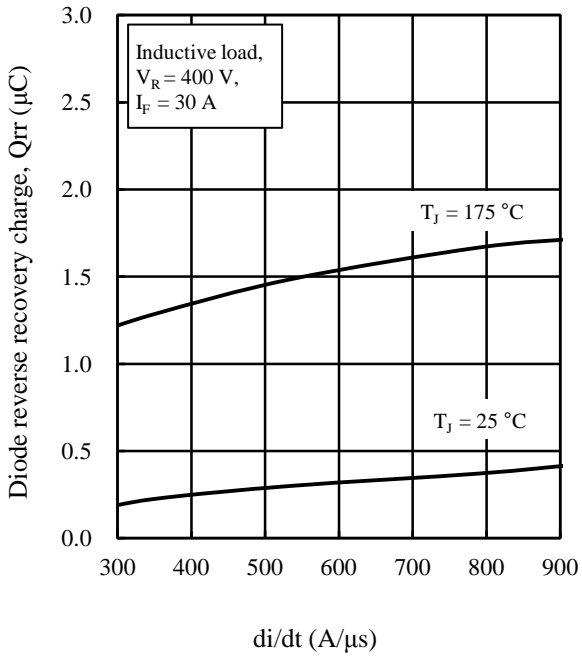


Figure 26. Diode Reverse Recovery Charge vs. di/dt

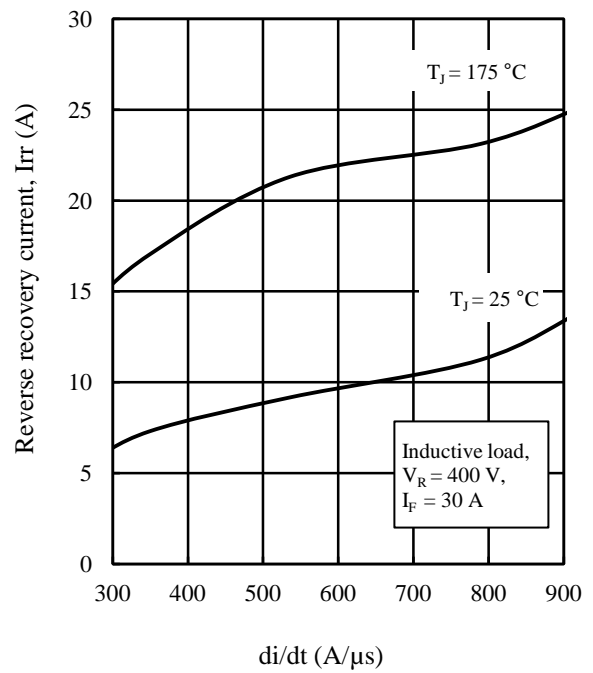


Figure 27. Recovery Current vs. di/dt

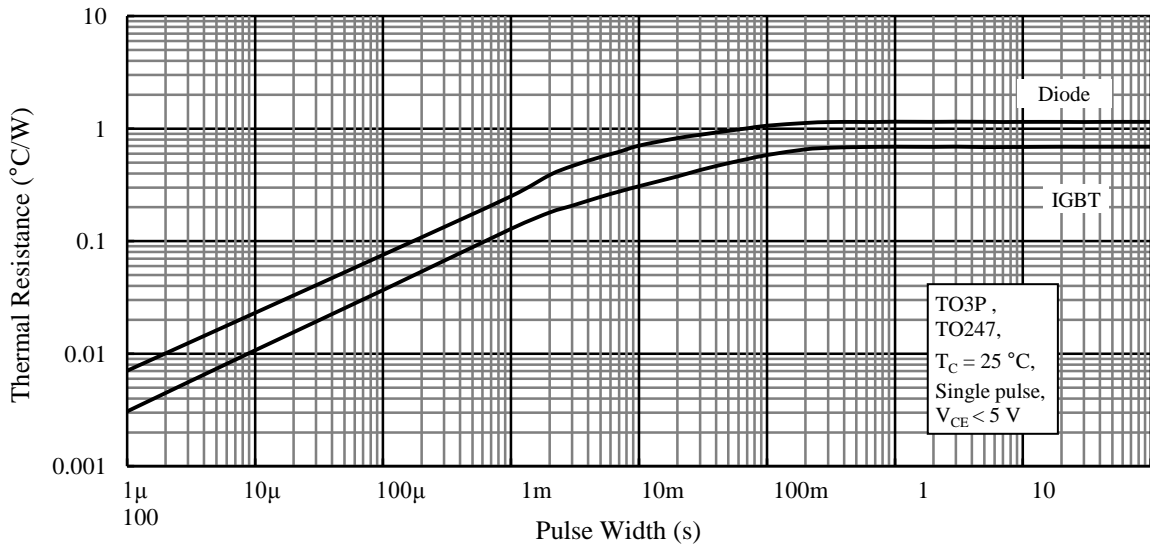


Figure 28. Transient Thermal Resistance

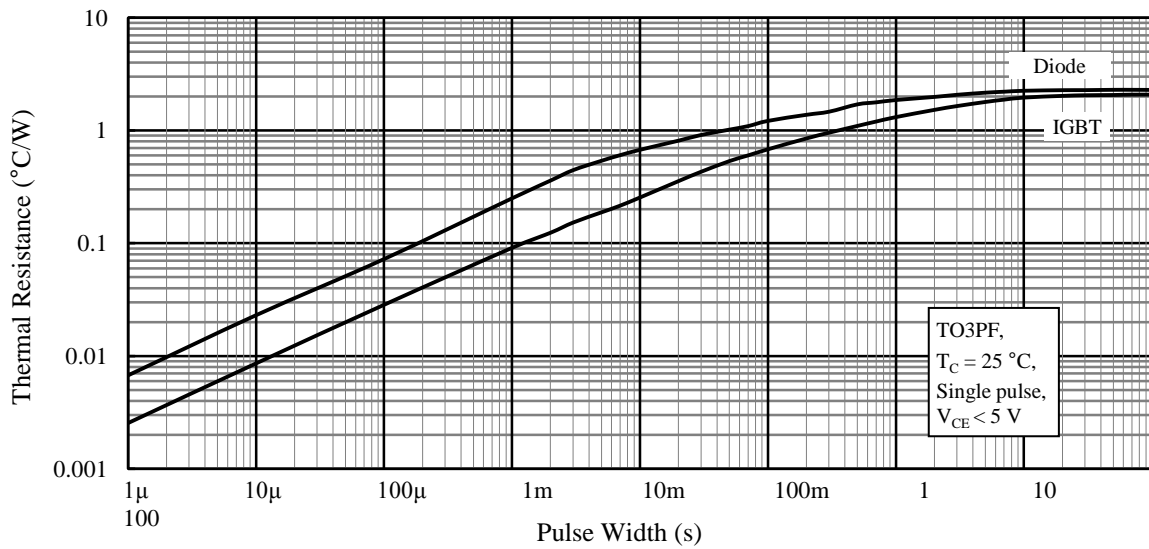
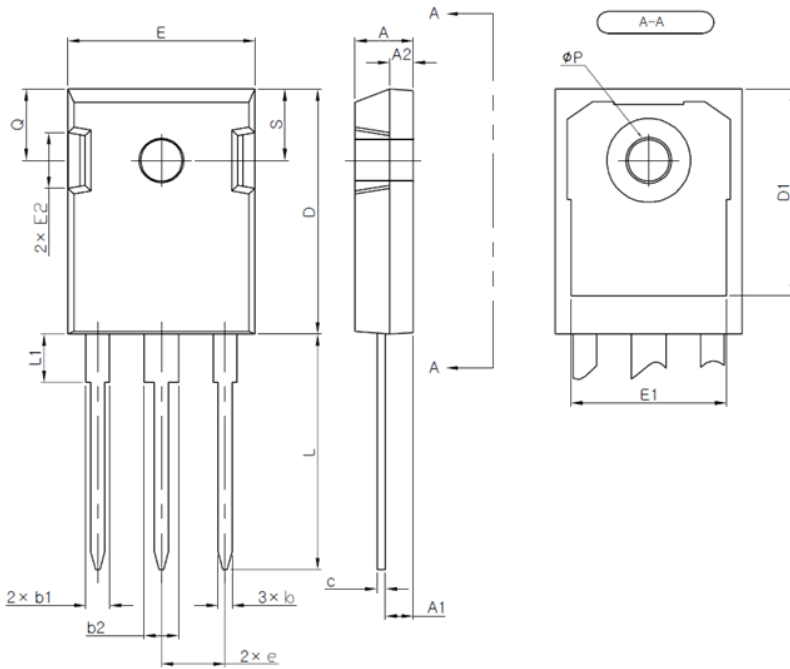


Figure 29. Transient Thermal Resistance

KGF65A3L, MGF65A3L, FGF65A3L

Physical Dimensions

● TO247-3L

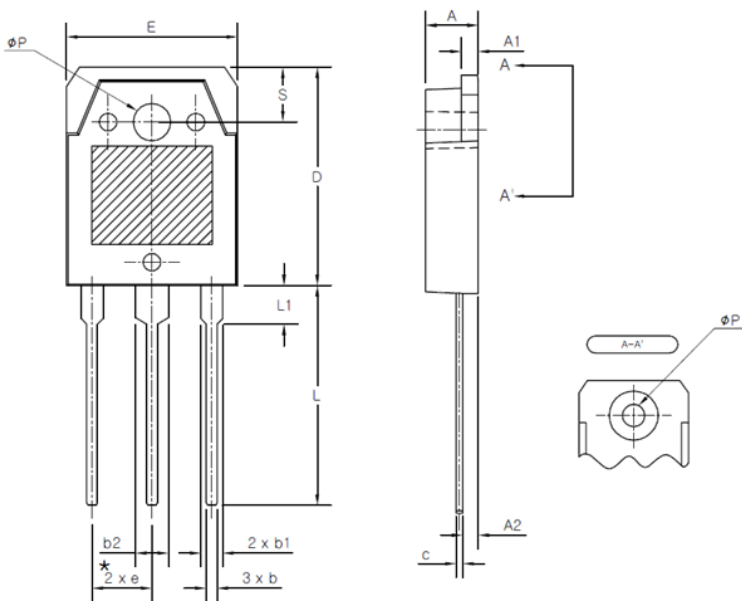


SYMBOL	MIN	NOM	MAX
A	4.83	5.02	5.21
A1	2.29	2.41	2.54
A2	1.91	2.04	2.16
b	1.14	1.27	1.40
b1	1.91	2.10	2.20
b2	2.92	3.10	3.20
c	0.61	0.71	0.80
D	20.80	21.07	21.34
D1	17.43	17.63	17.83
E	15.75	15.94	16.13
E1	13.06	13.26	13.46
E2	4.32	4.58	4.83
e	5.25	5.45	5.65
L	19.81	20.19	20.57
L1	3.81	4.07	4.32
φP	3.55	3.60	3.65
Q	5.59	5.90	6.20
S	6.15 BSC		

NOTE

1. THESE DIMENSION DO NOT INCLUDE MOLD PROTRUSION

● TO3P-3L



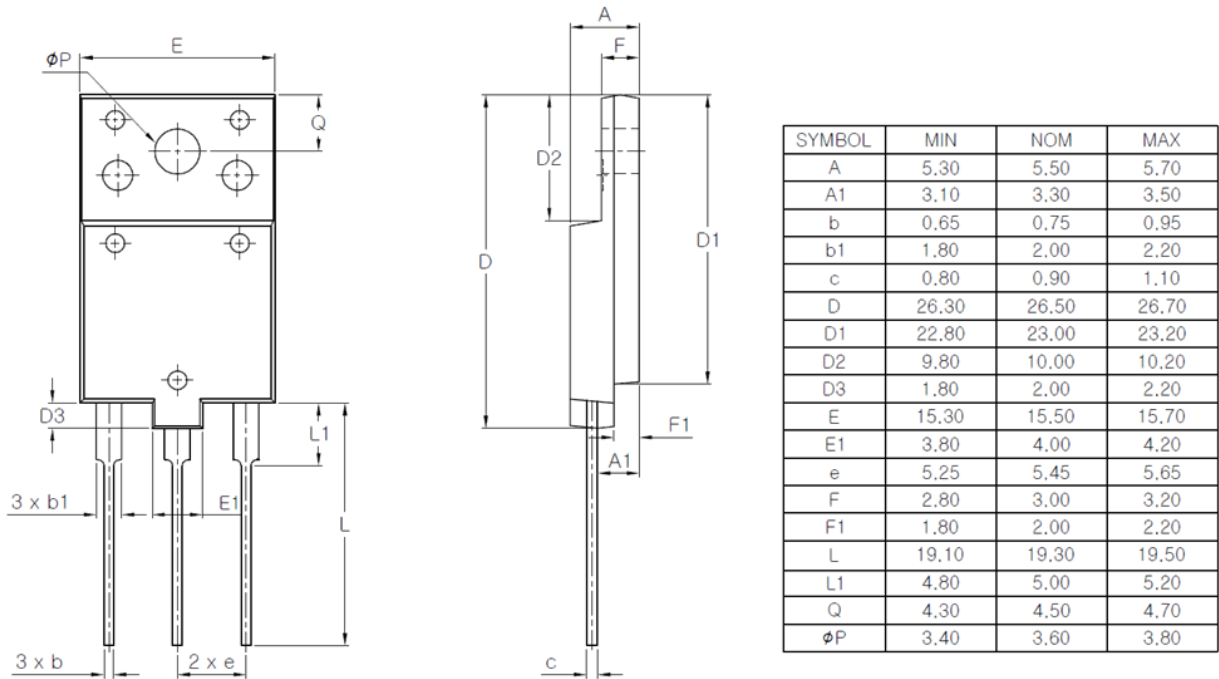
SYMBOL	MIN	NOM	MAX
A	4.60	4.80	5.00
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1.00	1.20
b1	1.80	2.00	2.20
b2	2.80	3.00	3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
E	15.40	15.60	15.80
*e	5.25	5.45	5.65
L	19.80	20.00	20.20
L1	3.30	3.50	3.70
φP	3.30	3.40	3.50
φP1	3.10	3.20	3.30
S	4.80	5.00	5.20

NOTE

1. THESE DIMENSIONS DO NOT INCLUDE PROTRUSIONS OF THE MOLD.
2. THE "*" MARK IS THE REFERENCE

KGF65A3L, MGF65A3L, FGF65A3L

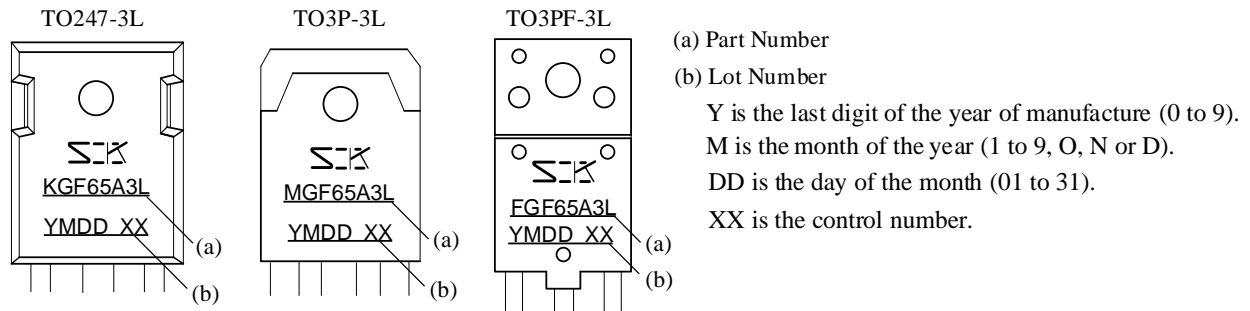
• TO3PF-3L



NOTES:

- Dimensions in millimeters
- Bare lead frame for TO247, TO3P and TO3PF: Pb-free (RoHS compliant)
- When soldering the products, make sure to minimize the working time within the following limits:
Flow: $260 \pm 5 \text{ }^\circ\text{C} / 10 \pm 1 \text{ s}$, 2 times
Soldering Iron: $380 \pm 10 \text{ }^\circ\text{C} / 3.5 \pm 0.5 \text{ s}$, 1 time (Soldering should be at a distance of at least 1.5 mm from the body of the products.)
- Soldering should be at a distance of at least 1.5 mm from the body of the products.
- The recommended screw torque for TO247 and TO3P: 0.686 to 0.882 N·m (7 to 9 kgf·cm)

Marking Diagram



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- No anti-radioactive ray design has been adopted for the Sanken Products.
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