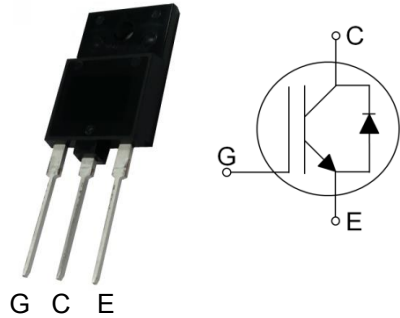


Features

- 600V Field Stop Trench IGBT Technology
- Low Conduction Loss
- Positive Temperature Coefficient
- Easy Parallel Operation
- RoHS Compliant
- JEDEC Qualification



Applications

UPS, Welder, Inverter, Solar

Device	Package	Marking	Remark
TGAF40N60F2D	TO-3PF	TGAF40N60F2D	RoHS

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	600	V
Gate-Emitter Voltage	V_{GES}	± 20	V
Continuous Collector Current	I_C	$T_C = 25\text{ }^\circ\text{C}$	80
		$T_C = 100\text{ }^\circ\text{C}$	40
Pulsed Collector Current (Note 1)	I_{CM}	120	A
Diode Continuous Forward Current	$T_C = 100\text{ }^\circ\text{C}$	I_F	40
Diode Pulsed Forward Current (Note 2)	I_{FM}	200	A
Power Dissipation	P_D	$T_C = 25\text{ }^\circ\text{C}$	79
		$T_C = 100\text{ }^\circ\text{C}$	31
Operating Junction Temperature	T_{vj}	-55 ~ 150	$^\circ\text{C}$
Storage Temperature Range	T_{STG}	-55 ~ 150	$^\circ\text{C}$
Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds	T_L	300	$^\circ\text{C}$

- Notes :
- (1) Repetitive rating : Pulse width limited by maximum junction temperature, During production, high current switching capability is 100% verified with the inductive load single-pulse switching test. ($I_C=120A$)
 - (2) Repetitive rating : Pulse width limited by maximum junction temperature.

Thermal Characteristics

Parameter	Symbol	Value	Unit
Maximum Thermal resistance, Junction-to-Case	$R_{\theta JC}$ (IGBT)	1.59	$^\circ\text{C}/\text{W}$
Maximum Thermal resistance, Junction-to-Case	$R_{\theta JC}$ (DIODE)	2.99	$^\circ\text{C}/\text{W}$
Maximum Thermal resistance, Junction-to-Ambient	$R_{\theta JA}$	40	$^\circ\text{C}/\text{W}$

Electrical Characteristics of the IGBT $T_{vj}=25^{\circ}\text{C}$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
OFF						
Collector – Emitter Breakdown Voltage	BV_{CES}	$V_{GE} = 0V, I_C = 1mA$	600	--	--	V
Zero Gate Voltage Collector Current	I_{CES}	$V_{CE} = 600V, V_{GE} = 0V$	--	--	250	μA
Gate – Emitter Leakage Current	I_{GES}	$V_{CE} = 0V, V_{GE} = \pm 20V$	--	--	± 250	nA
Integrated Gate Resistance	$R_{G(int)}$	$f = 1MHz, \text{Open Collector}$	--	2.2	--	Ω
ON						
Gate – Emitter Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}, I_C = 40mA$	4.5	6.0	7.5	V
Collector – Emitter Saturation Voltage	$V_{CE(SAT)}$	$V_{GE} = 15V, I_C = 40A, T_{vj} = 25^{\circ}\text{C}$	--	1.70	2.20	V
		$V_{GE} = 15V, I_C = 40A, T_{vj} = 150^{\circ}\text{C}$	--	2.10	--	V
DYNAMIC						
Input Capacitance	C_{IES}	$V_{CE} = 30V$ $V_{GE} = 0V$ $f = 1MHz$	--	2620	--	pF
Output Capacitance	C_{OES}		--	129	--	pF
Reverse Transfer Capacitance	C_{RES}		--	74	--	pF
Total Gate Charge	Q_g	$V_{CC} = 400V, I_C = 40A$ $V_{GE} = 15V$	--	110	165	nC
Gate-Emitter Charge	Q_{ge}		--	17	26	nC
Gate-Collector Charge	Q_{gc}		--	57	86	nC
SWITCHING (Note 3)						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 20A$ $R_G = 5\Omega, V_{GE} = 15V$ Inductive Load, $T_{vj} = 25^{\circ}\text{C}$	--	28	--	ns
Rise Time	t_r		--	35	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	80	--	ns
Fall Time	t_f		--	14	--	ns
Turn-On Switching Loss	E_{ON}		--	0.47	--	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.07	--	mJ
Total Switching Loss	E_{TS}	--	0.54	--	mJ	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 40A$ $R_G = 5\Omega, V_{GE} = 15V$ Inductive Load, $T_{vj} = 25^{\circ}\text{C}$	--	25	--	ns
Rise Time	t_r		--	67	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	78	--	ns
Fall Time	t_f		--	21	--	ns
Turn-On Switching Loss	E_{ON}		--	1.30	1.95	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.16	0.24	mJ
Total Switching Loss	E_{TS}		--	1.46	2.19	mJ

Electrical Characteristics of the IGBT $T_{vj}=25^{\circ}\text{C}$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
SWITCHING (Note 3)						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{V}, I_C = 20\text{A}$ $R_G = 5\Omega, V_{GE} = 15\text{V}$ Inductive Load, $T_{vj} = 150^{\circ}\text{C}$	--	22	--	ns
Rise Time	t_r		--	27	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	88	--	ns
Fall Time	t_f		--	20	--	ns
Turn-On Switching Loss	E_{ON}		--	0.88	--	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.20	--	mJ
Total Switching Loss	E_{TS}	--	1.08	--	mJ	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{V}, I_C = 40\text{A}$ $R_G = 5\Omega, V_{GE} = 15\text{V}$ Inductive Load, $T_{vj} = 150^{\circ}\text{C}$	--	24	--	ns
Rise Time	t_r		--	65	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	80	--	ns
Fall Time	t_f		--	25	--	ns
Turn-On Switching Loss	E_{ON}		--	1.88	2.82	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.34	0.51	mJ
Total Switching Loss	E_{TS}	--	2.22	3.33	mJ	
Short Circuit Withstanding Time	t_{SC}	$V_{CC} = 300\text{V}, V_{GE} = 15\text{V}, T_{vj} = 125^{\circ}\text{C}$	--	5	--	μs

Notes :

(3) Not subject to production test – verified by design/characterization

Electrical Characteristics of the DIODE $T_{vj}=25^{\circ}\text{C}$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_{FM}	$I_F = 20\text{A}, T_{vj} = 25^{\circ}\text{C}$	--	1.70	--	V
		$I_F = 20\text{A}, T_{vj} = 150^{\circ}\text{C}$	--	1.46	--	V
		$I_F = 40\text{A}, T_{vj} = 25^{\circ}\text{C}$	--	2.10	--	V
		$I_F = 40\text{A}, T_{vj} = 150^{\circ}\text{C}$	--	1.95	--	V
Reverse Recovery Time	t_{rr}	$I_F = 20\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 25^{\circ}\text{C}$	--	58	--	ns
Reverse Recovery Current	I_{rr}		--	5.0	--	A
Reverse Recovery Charge	Q_{rr}		--	168	--	nC
Reverse Recovery Time	t_{rr}	$I_F = 20\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 150^{\circ}\text{C}$	--	155	--	ns
Reverse Recovery Current	I_{rr}		--	10.2	--	A
Reverse Recovery Charge	Q_{rr}		--	950	--	nC
Reverse Recovery Time	t_{rr}	$I_F = 40\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 25^{\circ}\text{C}$	--	60	--	ns
Reverse Recovery Current	I_{rr}		--	5.7	--	A
Reverse Recovery Charge	Q_{rr}		--	196	--	nC
Reverse Recovery Time	t_{rr}	$I_F = 40\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 150^{\circ}\text{C}$	--	158	--	ns
Reverse Recovery Current	I_{rr}		--	10.8	--	A
Reverse Recovery Charge	Q_{rr}		--	1120	--	nC

IGBT Characteristics

Fig. 1 IGBT Output Characteristics

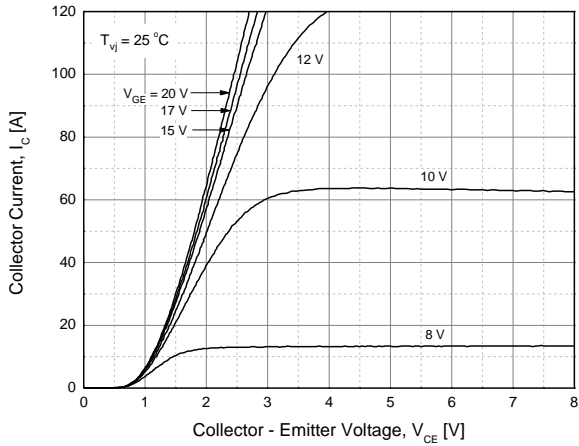


Fig. 2 IGBT Output Characteristics

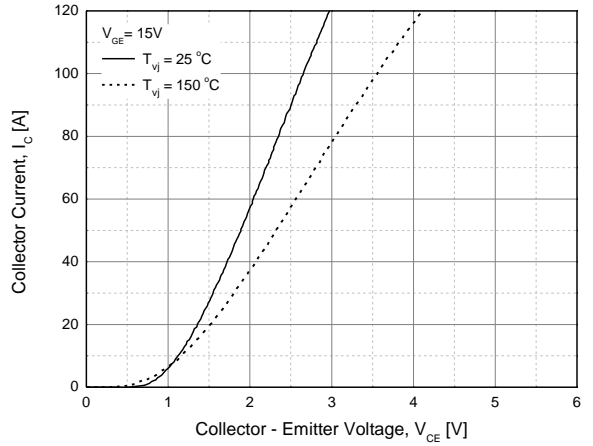


Fig. 3 IGBT Saturation Voltage vs. Junction Temperature

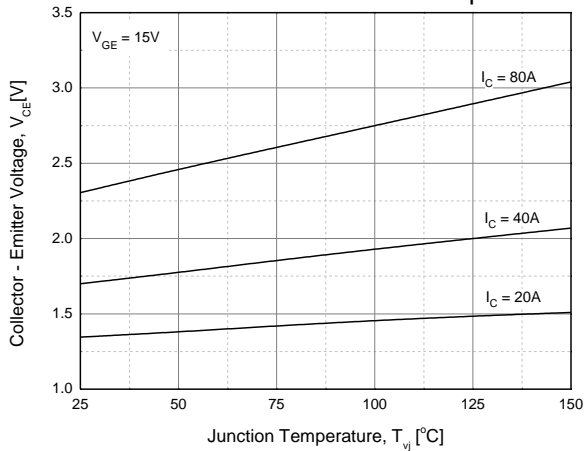


Fig. 4 IGBT Saturation Voltage vs. Gate Bias

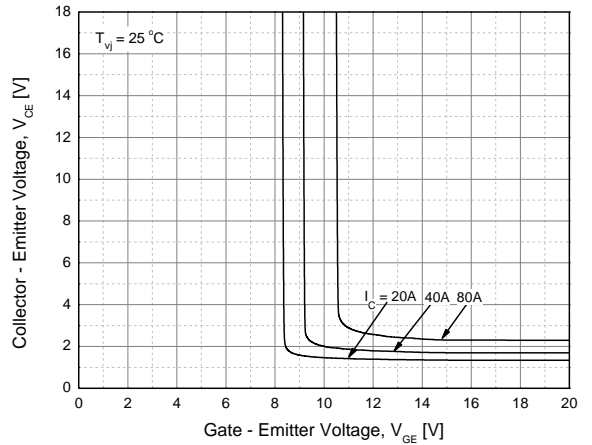


Fig. 5 IGBT Saturation Voltage vs. Gate Bias

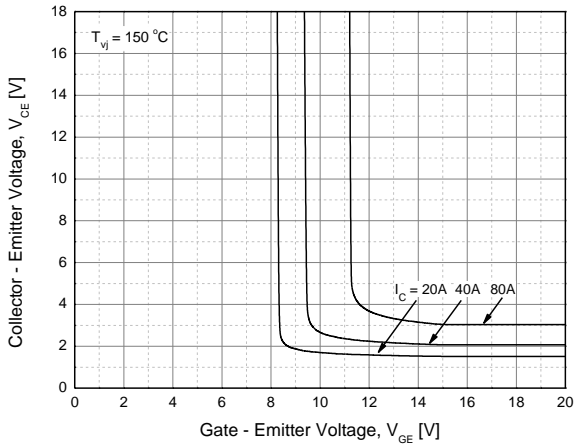
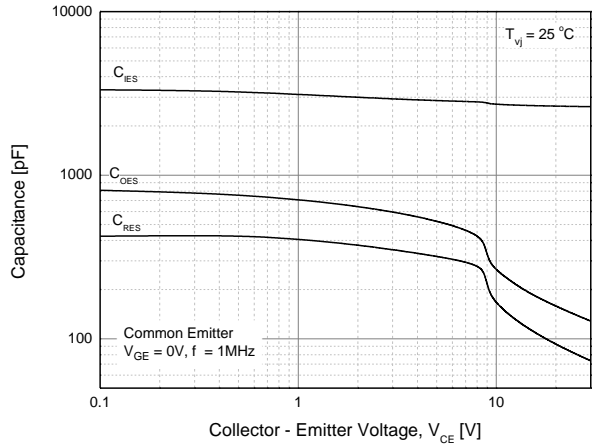


Fig. 6 IGBT Capacitance Characteristics



IGBT Characteristics

Fig. 7 Turn-on Time vs. Gate Resistor

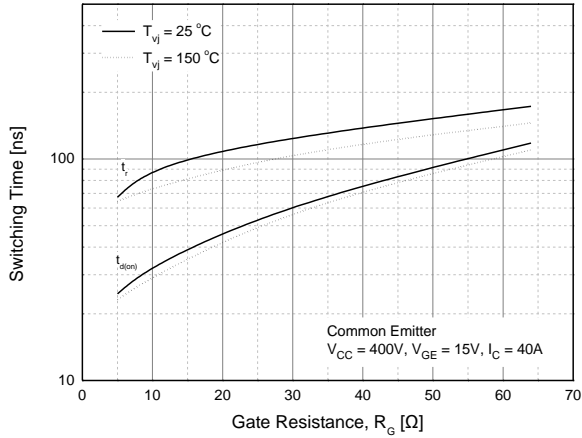


Fig. 8 Turn-off Time vs. Gate Resistor

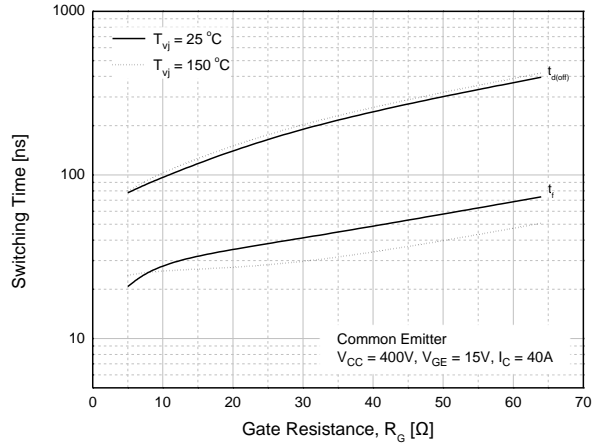


Fig. 9 Switching Loss vs. Gate Resistor

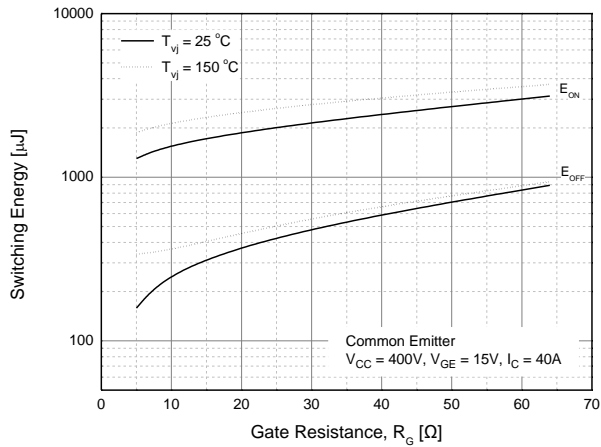


Fig. 10 Turn-on Time vs. Collector Current

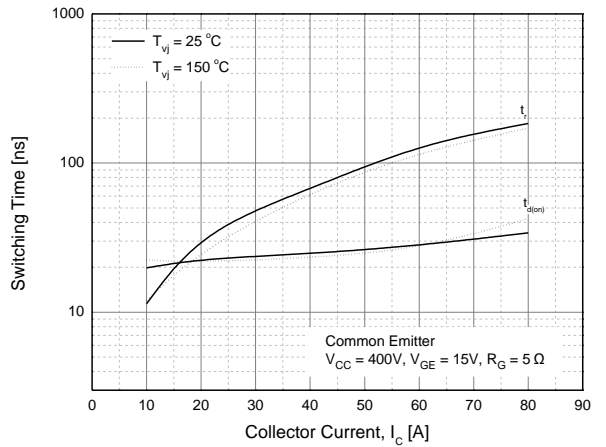


Fig. 11 Turn-off Time vs. Collector Current

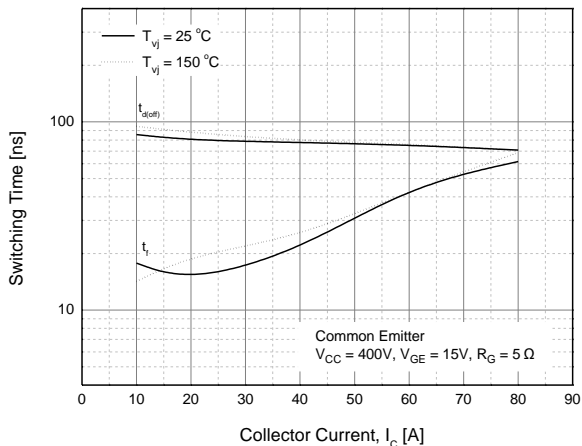
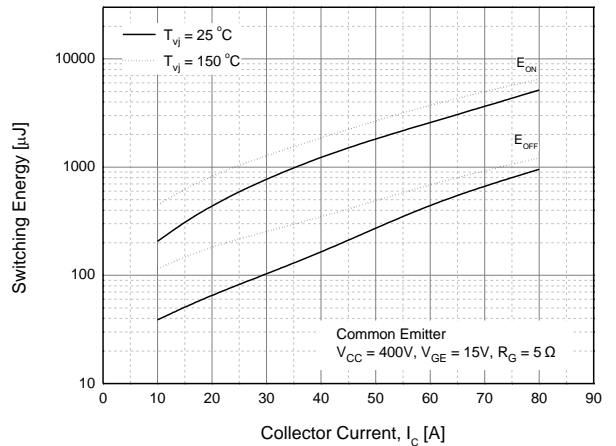


Fig. 12 Switching Loss vs. Collector Current



IGBT Characteristics

Fig. 13 Gate Charge Characteristics

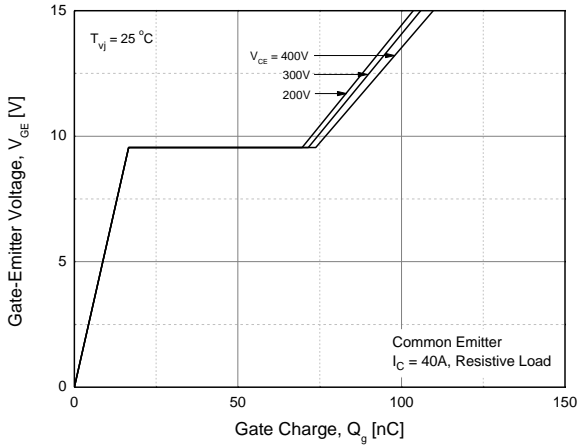


Fig. 14 SOA

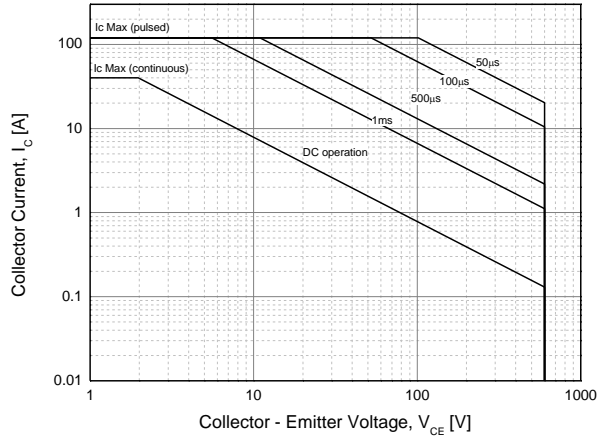


Fig. 15 RBSOA

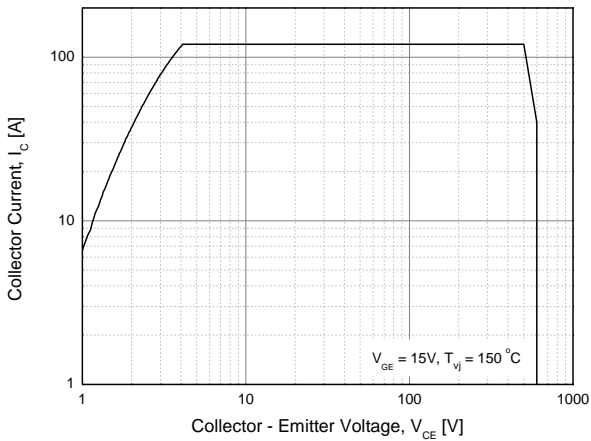


Fig. 16 Transient Thermal Impedance of IGBT

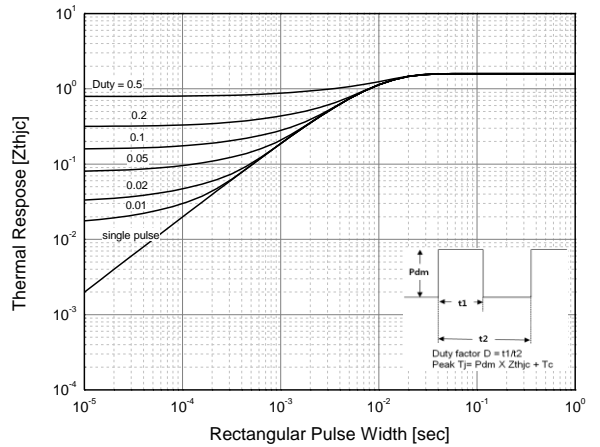
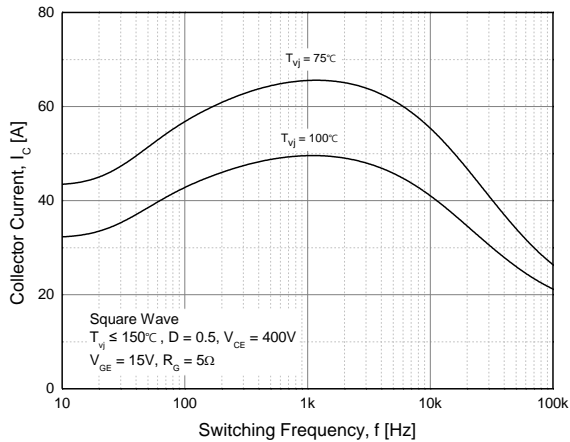


Fig. 17 Load Current vs. Frequency



Diode Characteristics

Fig. 18 Diode Conduction Characteristics

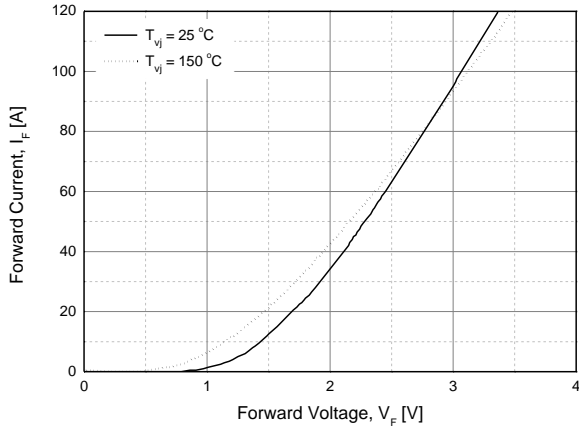


Fig. 19 Reverse Recovery Current vs. Forward Current

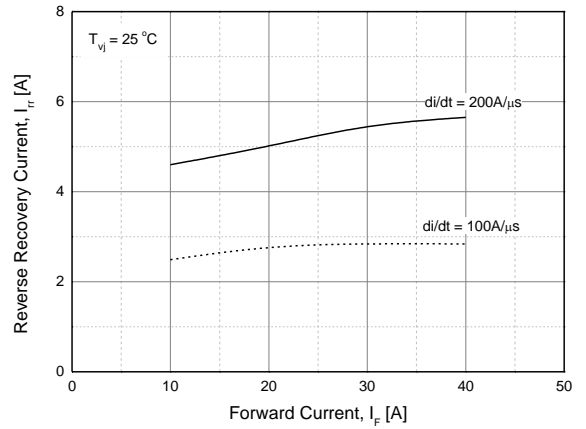


Fig. 20 Reverse Recovery Charge vs. Forward Current

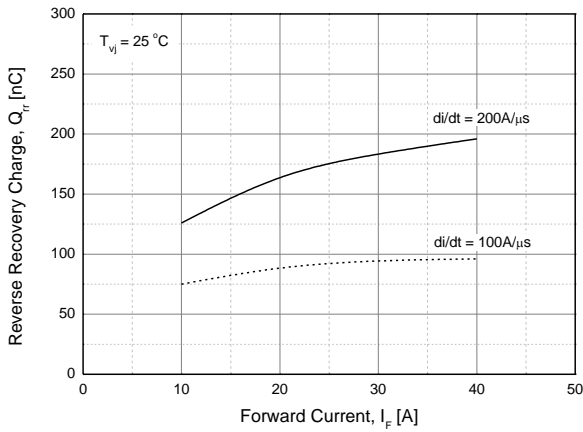
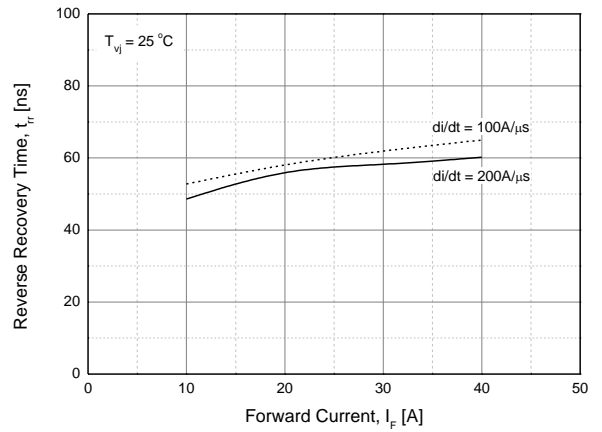
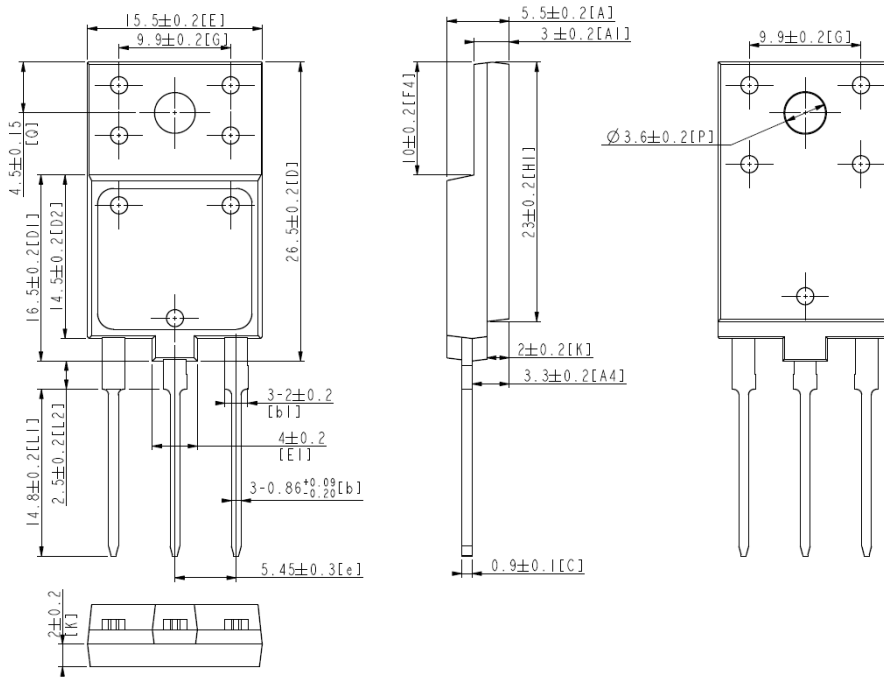


Fig. 21 Reverse Recovery Time vs. Forward Current



TO-3PF MECHANICAL DATA



SYMBOL	MIN	NOM	MAX
A	5.30	5.50	5.70
A1	2.80	3.00	3.20
A4	3.10	3.30	3.50
b	0.66	0.86	0.95
b1	1.80	2.00	2.20
C	0.80	0.90	1.00
D	26.30	26.50	26.70
D1	16.30	16.50	16.70
D2	14.30	14.50	14.70
E	15.30	15.50	15.70
E1	3.80	4.00	4.20
e	5.15	5.45	5.75
F4	9.80	10.00	10.20
G	9.70	9.90	10.10
H1	22.80	23.00	23.20
K	1.80	2.00	2.20
L1	14.60	14.80	15.00
L2	2.30	2.50	2.70
Q	4.35	4.50	4.65
ΦP	3.40	3.60	3.80

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