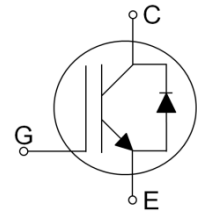
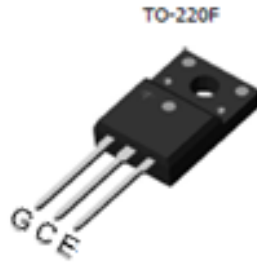


### Features

- 600V Field Stop Trench IGBT Technology
- High Speed Switching
- Low Conduction Loss
- Positive Temperature Coefficient
- Easy Parallel Operation
- Short Circuit Withstanding Time 5 $\mu$ s
- 175°C Operating Temperature
- RoHS Compliant
- JEDEC Qualification



### Applications

Motor Drive, Air Conditioner, Inverter, Solar

Device	Package	Marking	Remark
TGPF20N60FDR	TO-220F	TGPF20N60FDR	RoHS

### Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	
Collector-Emitter Voltage	$V_{CES}$	600	V	
Gate-Emitter Voltage	$V_{GES}$	$\pm 20$	V	
Continuous Collector Current	$I_C$	$T_C = 25\text{ }^\circ\text{C}$	40	A
		$T_C = 100\text{ }^\circ\text{C}$	20	A
Pulsed Collector Current (Note 1)	$I_{CM}$	60	A	
Diode Continuous Forward Current	$I_F$	20	A	
Diode Pulsed Forward Current (Note 1)	$I_{FM}$	100	A	
Power Dissipation	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	48	W
		$T_C = 100\text{ }^\circ\text{C}$	24	W
Operating Junction Temperature	$T_{vj}$	-55 ~ 175	$^\circ\text{C}$	
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

### Thermal Characteristics

Parameter	Symbol	Value	Unit
Maximum Thermal resistance, Junction-to-Case	$R_{\theta JC}$ (IGBT)	3.1	$^\circ\text{C/W}$
Maximum Thermal resistance, Junction-to-Case	$R_{\theta JC}$ (DIODE)	4.9	$^\circ\text{C/W}$
Maximum Thermal resistance, Junction-to-Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$

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

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
<b>OFF</b>						
Collector – Emitter Breakdown Voltage	$BV_{CES}$	$V_{GE} = 0V, I_C = 1mA$	600	--	--	V
Zero Gate Voltage Collector Current	$I_{CES}$	$V_{CE} = 600V, V_{GE} = 0V$	--	--	1	mA
Gate – Emitter Leakage Current	$I_{GES}$	$V_{CE} = 0V, V_{GE} = \pm 20V$	--	--	$\pm 250$	nA
Integrated Gate Resistance	$R_{G(int)}$	$f = 1MHz, \text{Open Collector}$	--	9.5	--	$\Omega$
<b>ON</b>						
Gate – Emitter Threshold Voltage	$V_{GE(TH)}$	$V_{GE} = V_{CE}, I_C = 20mA$	4.5	6.0	7.5	V
Collector – Emitter Saturation Voltage	$V_{CE(SAT)}$	$V_{GE} = 15V, I_C = 20A, T_{vj} = 25^{\circ}\text{C}$	--	1.50	2.00	V
		$V_{GE} = 15V, I_C = 20A, T_{vj} = 125^{\circ}\text{C}$	--	1.75	--	
		$V_{GE} = 15V, I_C = 20A, T_{vj} = 175^{\circ}\text{C}$	--	1.85	--	V
<b>DYNAMIC</b>						
Input Capacitance	$C_{IES}$	$V_{CE} = 30V$ $V_{GE} = 0V$ $f = 1MHz$	--	1080	--	pF
Output Capacitance	$C_{OES}$		--	80	--	pF
Reverse Transfer Capacitance	$C_{RES}$		--	55	--	pF
Total Gate Charge	$Q_g$	$V_{CC} = 400V, I_C = 20A$ $V_{GE} = 15V$	--	102	153	nC
Gate-Emitter Charge	$Q_{ge}$		--	10	15	nC
Gate-Collector Charge	$Q_{gc}$		--	61	91	nC
<b>SWITCHING</b> (Note 2)						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 10A$ $R_G = 5\Omega, V_{GE} = 15V$ Inductive Load, $T_{vj} = 25^{\circ}\text{C}$	--	13	--	ns
Rise Time	$t_r$		--	9	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	140	--	ns
Fall Time	$t_f$		--	24	--	ns
Turn-On Switching Loss	$E_{ON}$		--	0.17	--	mJ
Turn-Off Switching Loss	$E_{OFF}$		--	0.12	--	mJ
Total Switching Loss	$E_{TS}$	--	0.29	--	mJ	
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 20A$ $R_G = 5\Omega, V_{GE} = 15V$ Inductive Load, $T_{vj} = 25^{\circ}\text{C}$	--	14	--	ns
Rise Time	$t_r$		--	14	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	124	--	ns
Fall Time	$t_f$		--	28	--	ns
Turn-On Switching Loss	$E_{ON}$		--	0.34	0.51	mJ
Turn-Off Switching Loss	$E_{OFF}$		--	0.27	0.41	mJ
Total Switching Loss	$E_{TS}$	--	0.61	0.92	mJ	

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

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
<b>SWITCHING</b> (Note 2)						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400\text{V}, I_C = 10\text{A}$ $R_G = 5\Omega, V_{GE} = 15\text{V}$ Inductive Load, $T_{vj} = 175^{\circ}\text{C}$	--	10	--	ns
Rise Time	$t_r$		--	13	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	173	--	ns
Fall Time	$t_f$		--	88	--	ns
Turn-On Switching Loss	$E_{ON}$		--	0.39	--	mJ
Turn-Off Switching Loss	$E_{OFF}$		--	0.24	--	mJ
Total Switching Loss	$E_{TS}$		--	0.63	--	mJ
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, $T_{vj} = 175^{\circ}\text{C}$	--	14	--	ns
Rise Time	$t_r$		--	16	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	155	--	ns
Fall Time	$t_f$		--	95	--	ns
Turn-On Switching Loss	$E_{ON}$		--	0.68	1.02	mJ
Turn-Off Switching Loss	$E_{OFF}$		--	0.51	0.77	mJ
Total Switching Loss	$E_{TS}$		--	1.19	1.79	mJ
Short Circuit Withstanding Time	$t_{SC}$	$V_{CC} = 300\text{V}, V_{GE} = 15\text{V}, T_{vj} = 125^{\circ}\text{C}$	5	--	--	$\mu\text{s}$

Notes :

(2) 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	$V_{FM}$	$I_F = 10\text{A}, T_{vj} = 25^{\circ}\text{C}$	--	1.70	--	V
		$I_F = 10\text{A}, T_{vj} = 125^{\circ}\text{C}$	--	1.48	--	V
		$I_F = 10\text{A}, T_{vj} = 175^{\circ}\text{C}$	--	1.36	--	V
		$I_F = 20\text{A}, T_{vj} = 25^{\circ}\text{C}$	--	2.08	--	V
		$I_F = 20\text{A}, T_{vj} = 125^{\circ}\text{C}$	--	1.89	--	V
		$I_F = 20\text{A}, T_{vj} = 175^{\circ}\text{C}$	--	1.82	--	V
Reverse Recovery Time	$t_{rr}$	$I_F = 10\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 25^{\circ}\text{C}$	--	48	--	ns
Reverse Recovery Current	$I_{rr}$		--	4.4	--	A
Reverse Recovery Charge	$Q_{rr}$		--	114	--	nC
Reverse Recovery Time	$t_{rr}$	$I_F = 10\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 175^{\circ}\text{C}$	--	116	--	ns
Reverse Recovery Current	$I_{rr}$		--	9.0	--	A
Reverse Recovery Charge	$Q_{rr}$		--	612	--	nC
Reverse Recovery Time	$t_{rr}$	$I_F = 20\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 25^{\circ}\text{C}$	--	52	--	ns
Reverse Recovery Current	$I_{rr}$		--	5.0	--	A
Reverse Recovery Charge	$Q_{rr}$		--	152	--	nC
Reverse Recovery Time	$t_{rr}$	$I_F = 20\text{A},$ $di/dt = 200\text{A}/\mu\text{s},$ $T_{vj} = 175^{\circ}\text{C}$	--	125	--	ns
Reverse Recovery Current	$I_{rr}$		--	10.2	--	A
Reverse Recovery Charge	$Q_{rr}$		--	780	--	nC

### IGBT Characteristics

Fig. 1 IGBT Output Characteristics

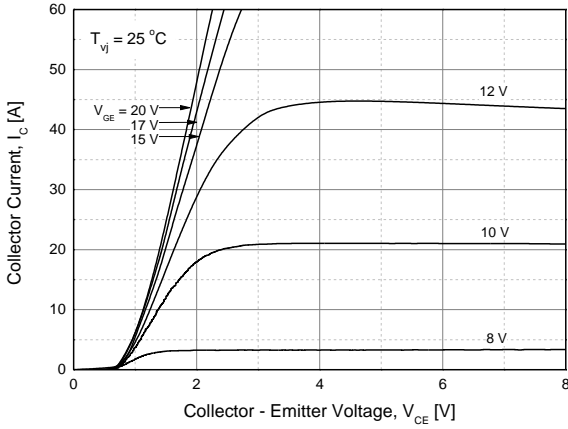


Fig. 2 IGBT Output Characteristics

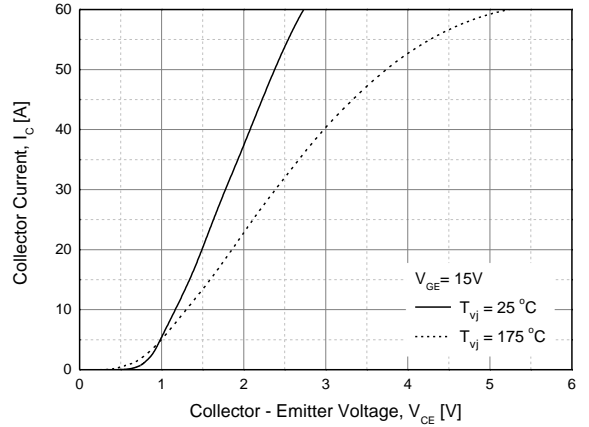


Fig. 3 IGBT Saturation Voltage vs. Junction Temperature

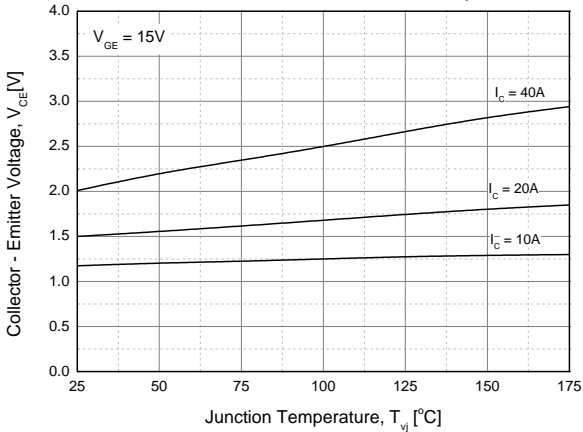


Fig. 4 IGBT Saturation Voltage vs. Gate Bias

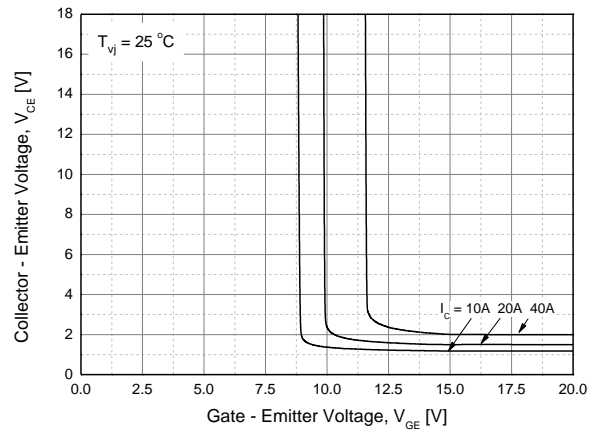


Fig. 5 IGBT Saturation Voltage vs. Gate Bias

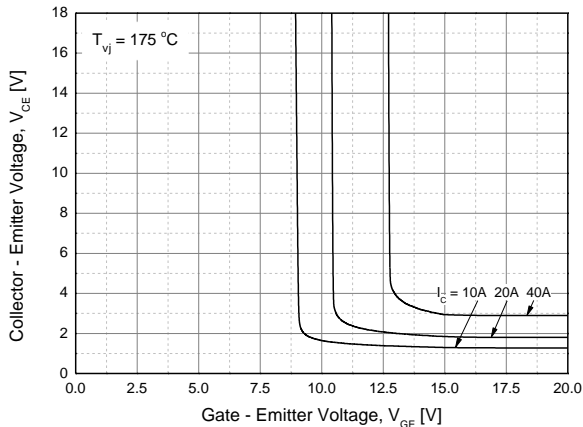
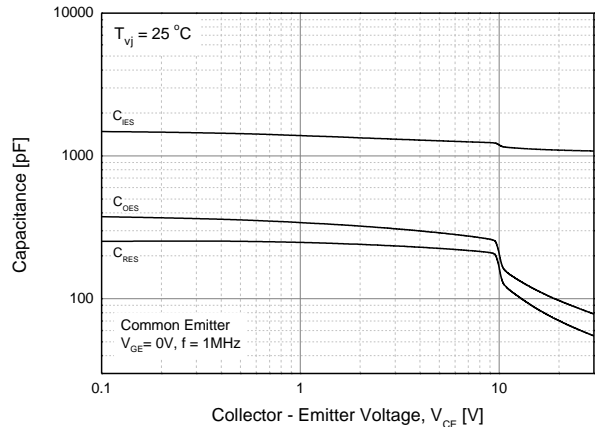


Fig. 6 IGBT Capacitance Characteristics



### IGBT Characteristics

Fig. 7 Turn-on Time vs. Gate Resistor

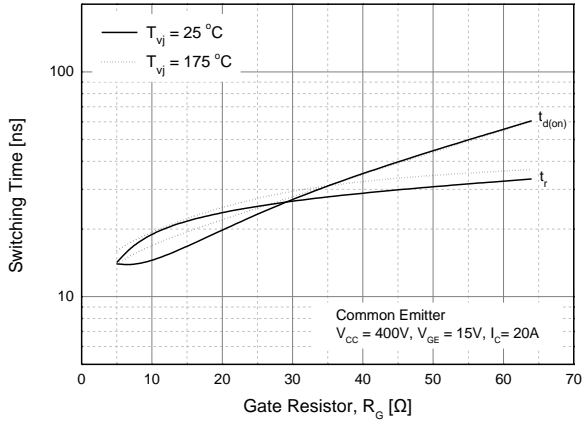


Fig. 8 Turn-off Time vs. Gate Resistor

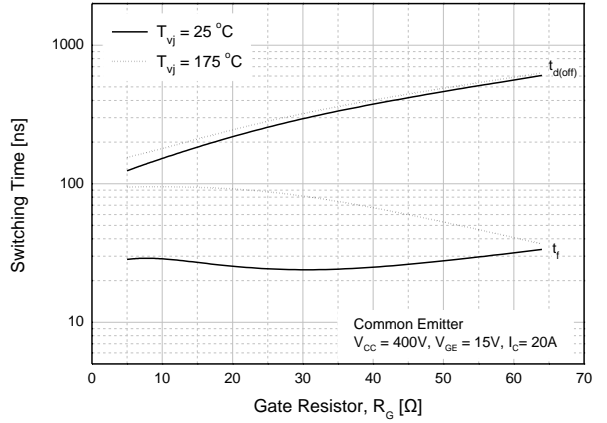


Fig. 9 Switching Loss vs. Gate Resistor

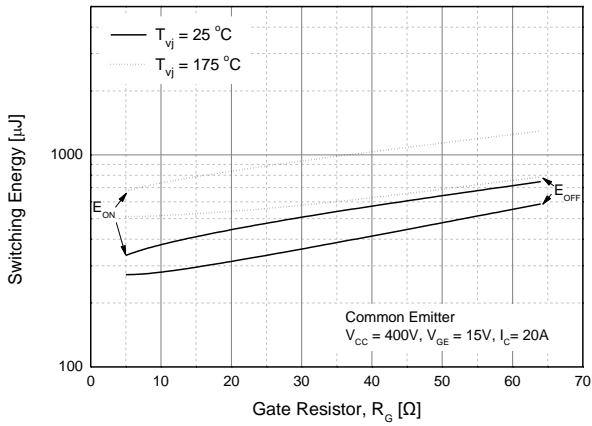


Fig. 10 Turn-on Time vs. Collector Current

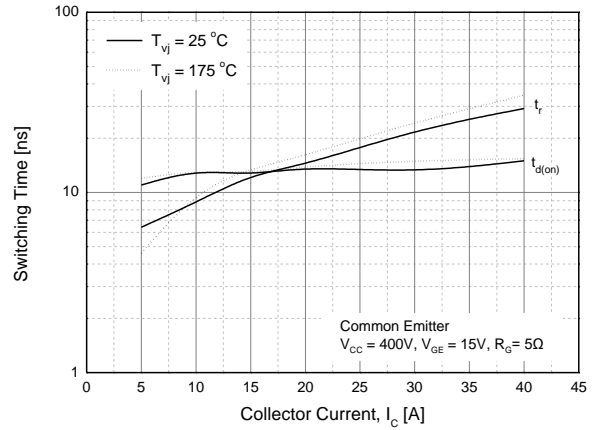


Fig. 11 Turn-off Time vs. Collector Current

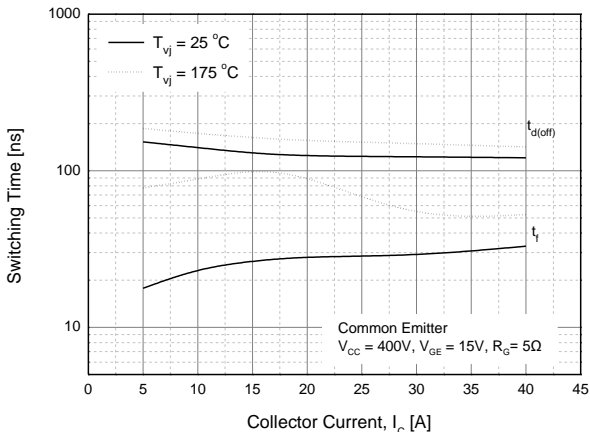
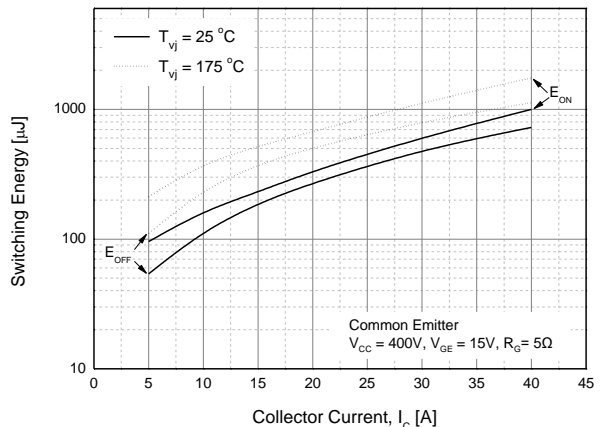


Fig. 12 Switching Loss vs. Collector Current



**IGBT Characteristics**

Fig. 13 Gate Charge Characteristics

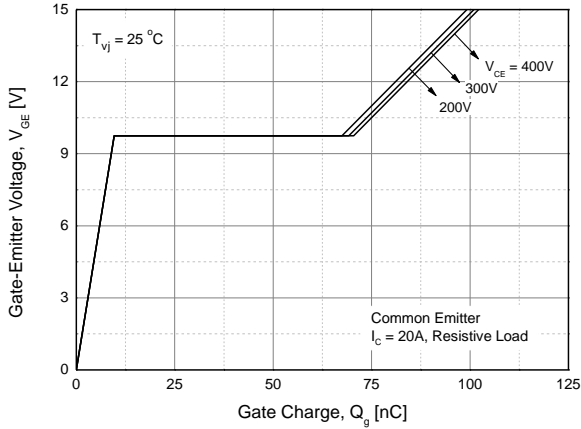


Fig. 14 SOA

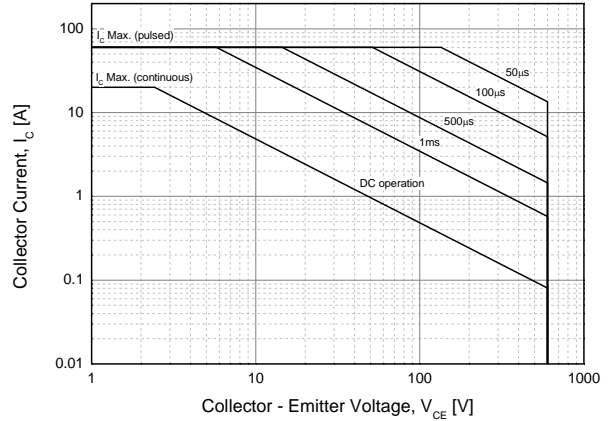


Fig. 15 RBSOA

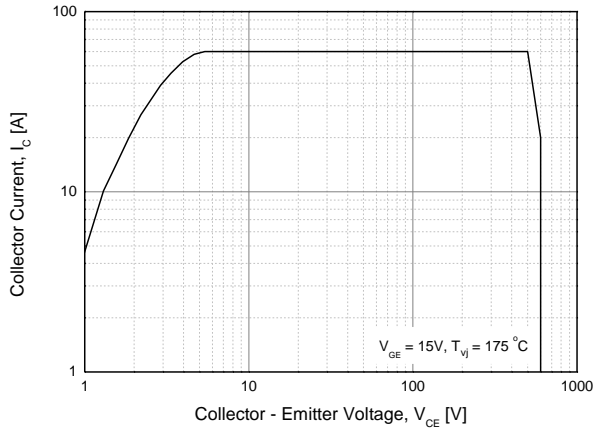


Fig. 16 Transient Thermal Impedance of IGBT

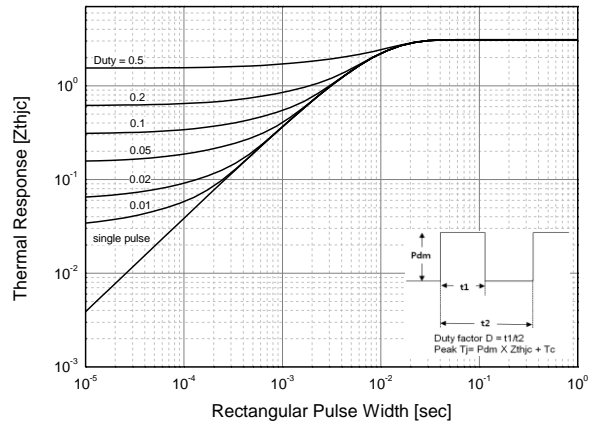
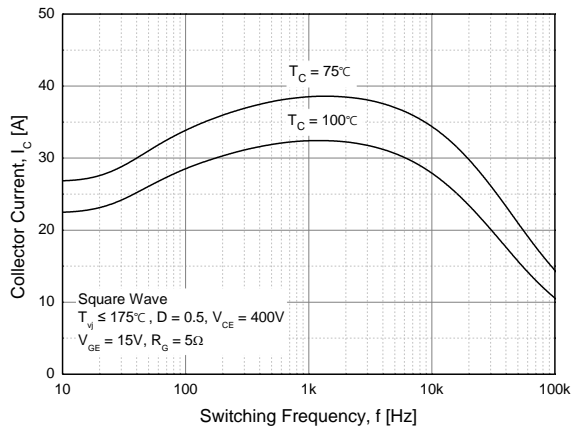


Fig. 17 Load Current vs. Frequency



## DIODE Characteristics

Fig. 18 Diode Conduction Characteristics

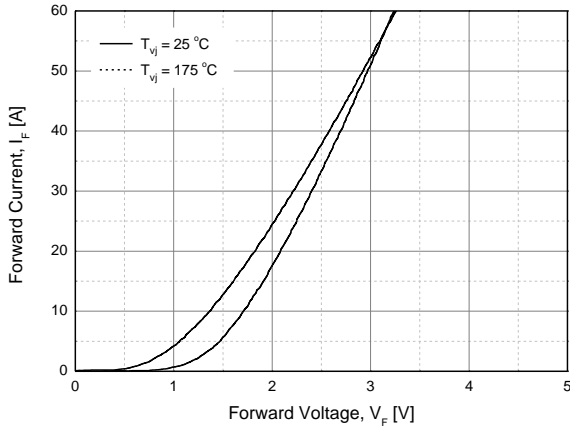


Fig. 19 Reverse Recovery Current vs. Forward Current

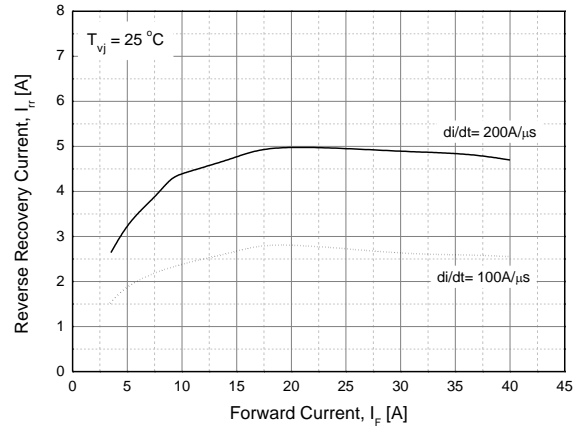


Fig. 20 Reverse Recovery Charge vs. Forward Current

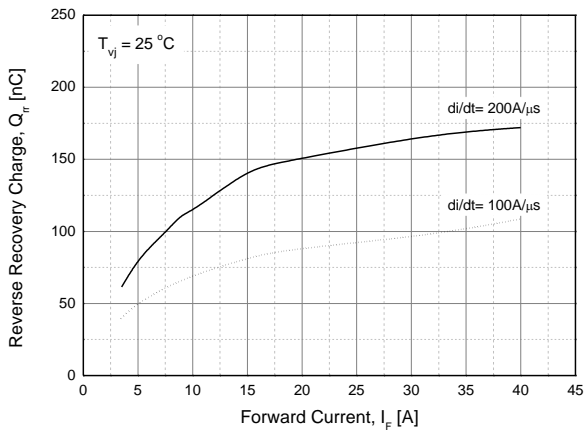
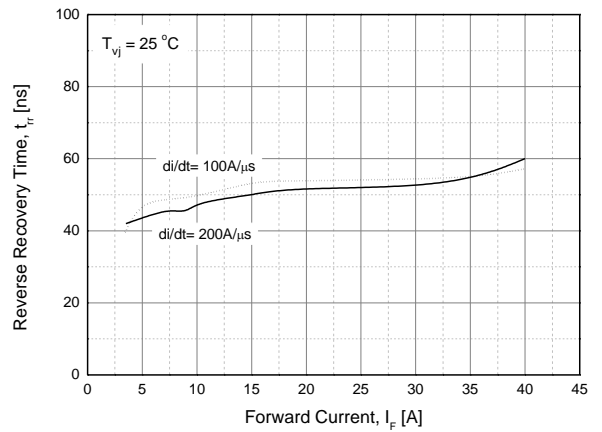
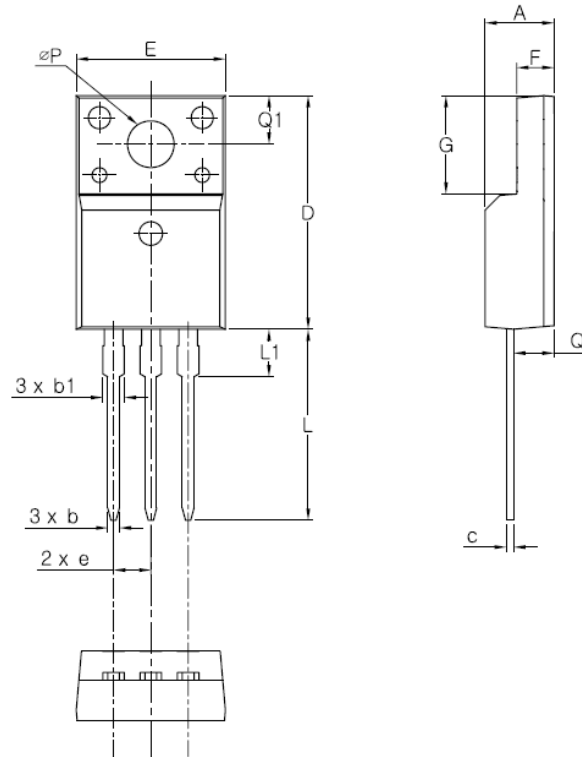


Fig. 21 Reverse Recovery Time vs. Forward Current





**TO-220F-3L MECHANICAL DATA**



SYMBOL	MIN	MAX
A	4.50	4.93
b	0.70	0.91
b1	1.15	1.47
c	0.36	0.60
D	15.67	16.07
E	6.96	10.36
e	2.54 BSC	
F	2.34	2.74
G	6.48	6.90
L	12.37	13.18
L1	2.23	3.43
Q	2.56	2.96
Q1	3.10	3.50
ØP	2.98	3.38

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