# TGAN40N65F2DR
Field Stop Trench IGBT

Features
- 650V Field Stop Trench IGBT Technology
- Low Conduction Loss
- Positive Temperature Coefficient
- Easy Parallel Operation
- 175℃ Operating Temperature
- Short Circuit Withstanding Time 5μs
- RoHS Compliant
- JEDEC Qualification

Applications
UPS, Welder, Inverter, Solar

Device	Package	Marking	Remark
TGAN40N65F2DR	TO-3PN	TGAN40N65F2DR	RoHS

Absolute Maximum Ratings

Parameter		Symbol	Value	Unit
Collector-Emitter Voltage		V_{CES}	650	V
Gate-Emitter Voltage		V_{GES}	±20	V
Continuous Collector Current	$T_C = 25$ ℃	I_C	80	A
	$T_C = 100$ ℃		40	A
Pulsed Collector Current (Note 1)		I_{CM}	120	A
Diode Continuous Forward Current	$T_C = 100$ ℃	I_F	40	A
Diode Pulsed Current (Note 2)		I_{FM}	200	A
Power Dissipation	$T_C = 25$ ℃	P_D	283	W
	$T_C = 100$ ℃		142	W
Operating Junction Temperature		T_{vj}	-55 ~ 175	℃
Storage Temperature Range		T_{STG}	-55 ~ 150	℃
Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds		T_L	300	℃

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. (Ic=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)	0.53	℃/W
Maximum Thermal resistance, Junction-to-Case	$R_{\theta JC}$ (DIODE)	1.43	℃/W
Maximum Thermal resistance, Junction-to-Ambient	$R_{\theta JA}$	40	℃/W

Electrical Characteristics of the IGBT $T_{vj}=25℃$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
OFF						
Collector – Emitter Breakdown Voltage	BV_{CES}	$V_{GE} = 0V$, $I_C = 1mA$	650	--	--	V
Zero Gate Voltage Collector Current	I_{CES}	$V_{CE} = 650V$, $V_{GE} = 0V$	--	--	1	mA
Gate – Emitter Leakage Current	I_{GES}	$V_{CE} = 0V$, $V_{GE} = \pm 20V$	--	--	± 250	nA
Integrated Gate Resistance	$R_{G(int)}$	f = 1MHz, Open Collector	--	3.9	--	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	$V_{CE(SAT)}$	$V_{GE} = 15V$, $I_C = 40A$, $T_{vj} = 25℃$	--	1.60	2.10	V
		$V_{GE} = 15V$, $I_C = 40A$, $T_{vj} = 125℃$	--	1.81	--	V
		$V_{GE} = 15V$, $I_C = 40A$, $T_{vj} = 175℃$	--	1.94	--	V
DYNAMIC						
Input Capacitance	C_{IES}	$V_{CE} = 30V$ $V_{GE} = 0V$ f = 1MHz	--	2274	--	pF
Output Capacitance	C_{OES}		--	114	--	pF
Reverse Transfer Capacitance	C_{RES}		--	72	--	pF
Total Gate Charge	Q_g	$V_{CC} = 400V$, $I_C = 40A$ $V_{GE} = 15V$	--	121	182	nC
Gate-Emitter Charge	Q_{ge}		--	15	22	nC
Gate-Collector Charge	Q_{gc}		--	59	89	nC
SWITCHING [Note 3]						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V$, $I_C = 20A$ $R_G = 5Ω$, $V_{GE} = 15V$ Inductive Load, $T_{vj} = 25℃$	--	25	--	ns
Rise Time	t_r		--	18	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	126	--	ns
Fall Time	t_f		--	34	--	ns
Turn-On Switching Loss	E_{ON}		--	0.36	--	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.26	--	mJ
Total Switching Loss	E_{TS}		--	0.62	--	mJ
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V$, $I_C = 40A$ $R_G = 5Ω$, $V_{GE} = 15V$ Inductive Load, $T_{vj} = 25℃$	--	28	--	ns
Rise Time	t_r		--	29	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	108	--	ns
Fall Time	t_f		--	37	--	ns
Turn-On Switching Loss	E_{ON}		--	1.06	1.59	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.55	0.83	mJ
Total Switching Loss	E_{TS}		--	1.61	2.42	mJ

Electrical Characteristics of the IGBT $T_{vj}=25℃$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
SWITCHING [(Note 3)]						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 20A$ $R_G = 5Ω, V_{GE} = 15V$ Inductive Load, $T_{vj} = 175℃$	--	23	--	ns
Rise Time	t_r		--	16	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	166	--	ns
Fall Time	t_f		--	115	--	ns
Turn-On Switching Loss	E_{ON}		--	0.74	--	mJ
Turn-Off Switching Loss	E_{OFF}		--	0.59	--	mJ
Total Switching Loss	E_{TS}		--	1.33	--	mJ
Turn-On Delay Time	$t_{d(on)}$	$V_{CC} = 400V, I_C = 40A$ $R_G = 5Ω, V_{GE} = 15V$ Inductive Load, $T_{vj} = 175℃$	--	27	--	ns
Rise Time	t_r		--	32	--	ns
Turn-Off Delay Time	$t_{d(off)}$		--	137	--	ns
Fall Time	t_f		--	101	--	ns
Turn-On Switching Loss	E_{ON}		--	1.66	2.48	mJ
Turn-Off Switching Loss	E_{OFF}		--	1.01	1.52	mJ
Total Switching Loss	E_{TS}		--	2.67	4.00	mJ
Short Circuit Withstanding Time	t_{SC}	$V_{CC} = 300V, V_{GE} = 15V, T_{vj} = 125℃$	5	--	--	μs

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

Electrical Characteristics of the DIODE $T_{vj}=25℃$, unless otherwise noted

Parameter	Symbol	Test condition	Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_{FM}	I_F = 20A, T_{vj} = 25 ℃	--	1.70	--	V
		I_F = 20A, T_{vj} = 125 ℃	--	1.54	--	V
		I_F = 20A, T_{vj} = 175 ℃	--	1.41	--	V
		I_F = 40A, T_{vj} = 25 ℃	--	2.10	--	V
		I_F = 40A, T_{vj} = 125 ℃	--	2.03	--	V
		I_F = 40A, T_{vj} = 175 ℃	--	1.94	--	V
Reverse Recovery Time	t_{rr}	I_F = 20A, di/dt = 200A/μs, T_{vj} = 25 ℃	--	99	--	ns
Reverse Recovery Current	I_{rr}		--	5.6	--	A
Reverse Recovery Charge	Q_{rr}		--	256	--	nC
Reverse Recovery Time	t_{rr}	I_F = 20A, di/dt = 200A/μs, T_{vj} = 175 ℃	--	163	--	ns
Reverse Recovery Current	I_{rr}		--	12.6	--	A
Reverse Recovery Charge	Q_{rr}		--	1266	--	nC
Reverse Recovery Time	t_{rr}	I_F = 40A, di/dt = 200A/μs, T_{vj} = 25 ℃	--	113	--	ns
Reverse Recovery Current	I_{rr}		--	5.9	--	A
Reverse Recovery Charge	Q_{rr}		--	322	--	nC
Reverse Recovery Time	t_{rr}	I_F = 40A, di/dt = 200A/μs, T_{vj} = 175 ℃	--	201	--	ns
Reverse Recovery Current	I_{rr}		--	13.3	--	A
Reverse Recovery Charge	Q_{rr}		--	1660	--	nC

IGBT Characteristics

Fig. 1 IGBT Output Characteristics
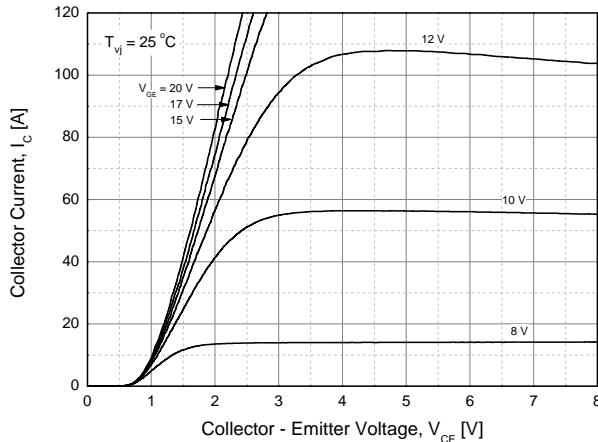
Fig. 2 IGBT Output Characteristics
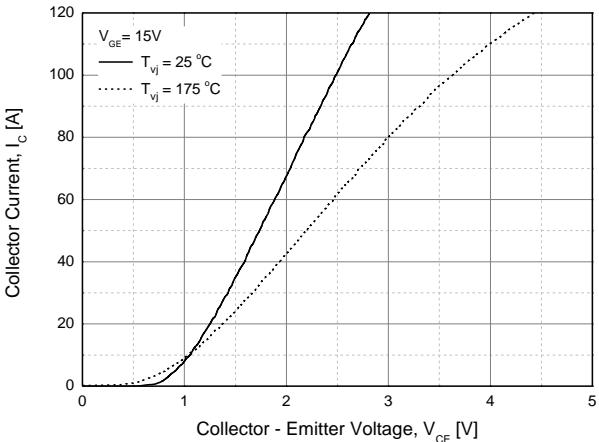
Fig. 3 IGBT Saturation Voltage
vs. Junction Temperature
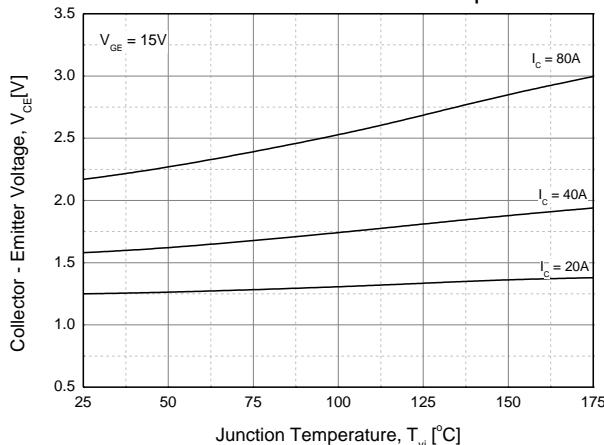
Fig. 4 IGBT Saturation Voltage vs. Gate Bias
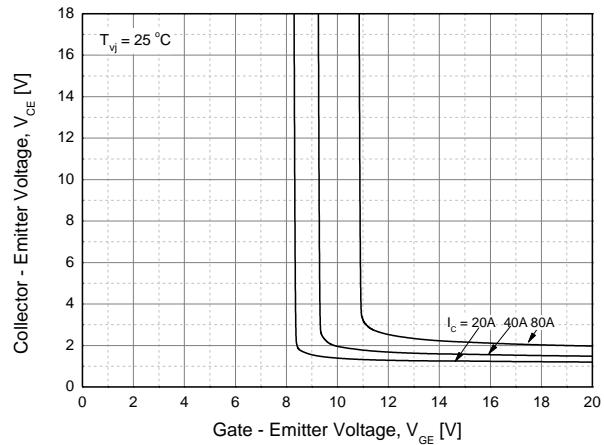
Fig. 5 IGBT Saturation Voltage vs. Gate Bias
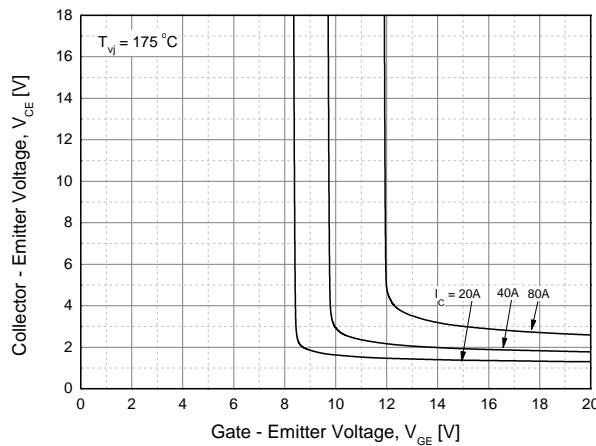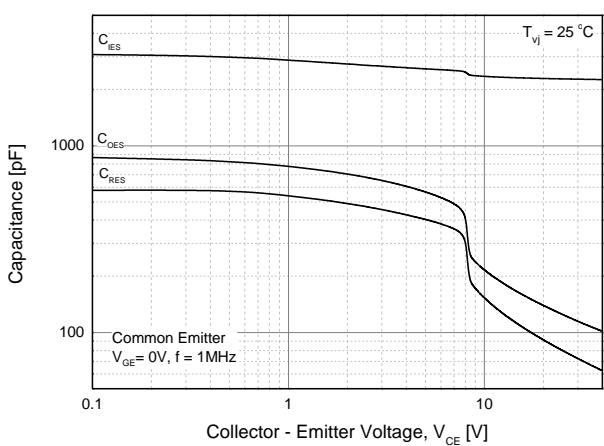
Fig. 6 IGBT Capacitance Characteristics

## IGBT Characteristics

Fig. 7 Turn-on Time vs. Gate Resistor
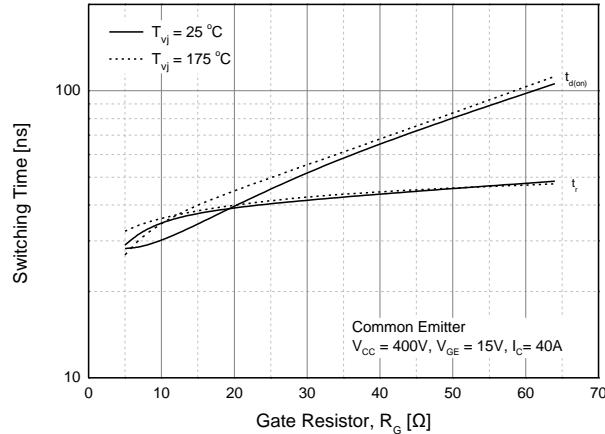

Fig. 8 Turn-off Time vs. Gate Resistor
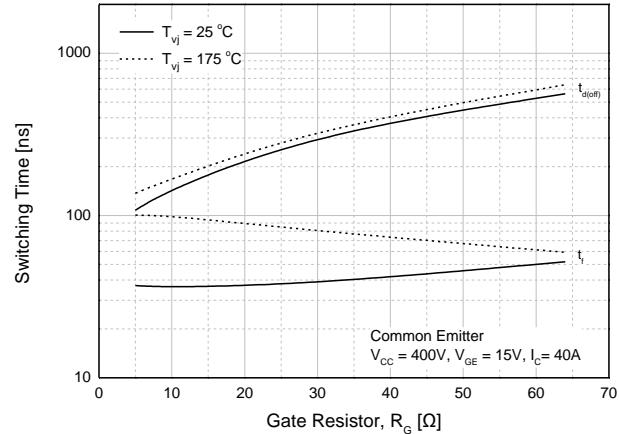

Fig. 9 Switching Loss vs. Gate Resistor
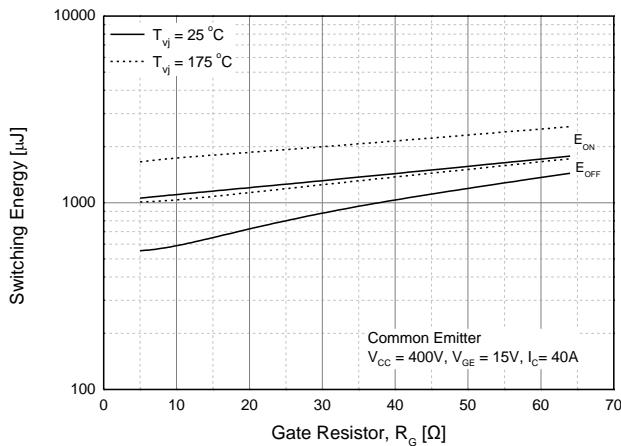
Fig. 10 Turn-on Time vs. Collector Current
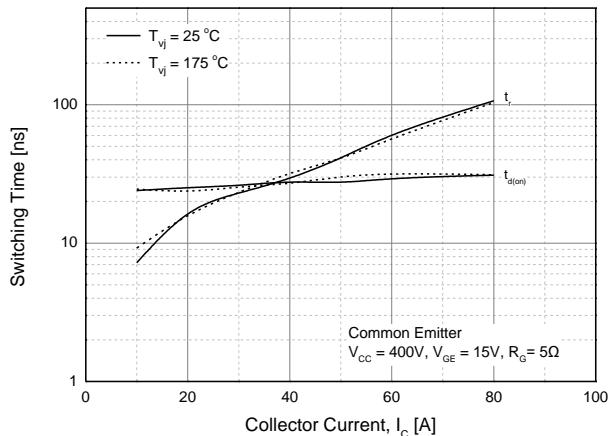
Fig. 11 Turn-off Time vs. Collector Current
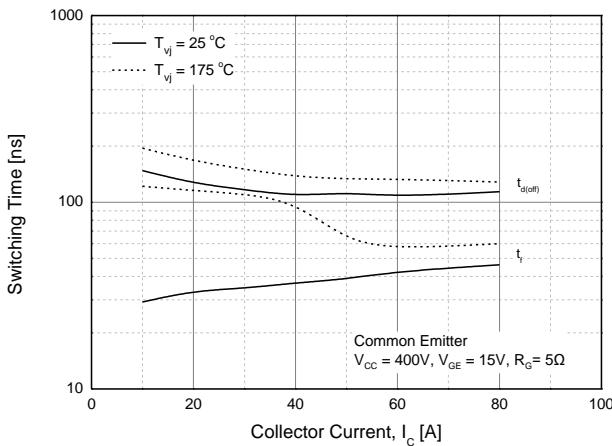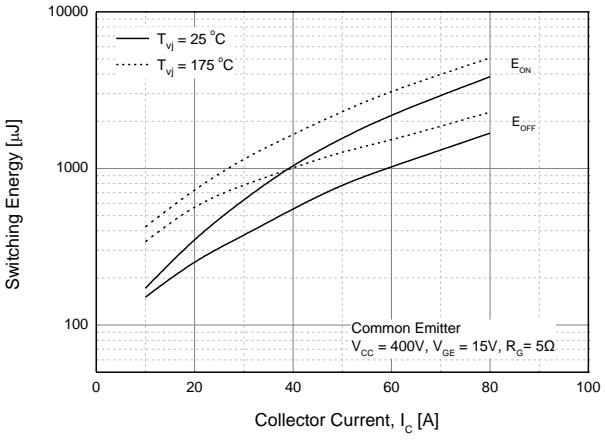
Fig. 12 Switching Loss vs. Collector Current

IGBT Characteristics

Fig. 13 Gate Charge Characteristics
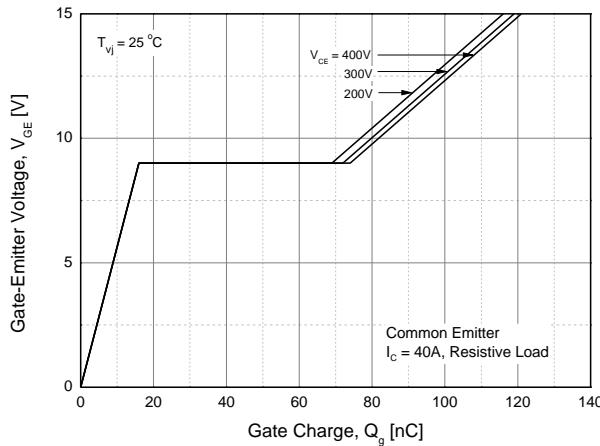
Fig. 14 SOA
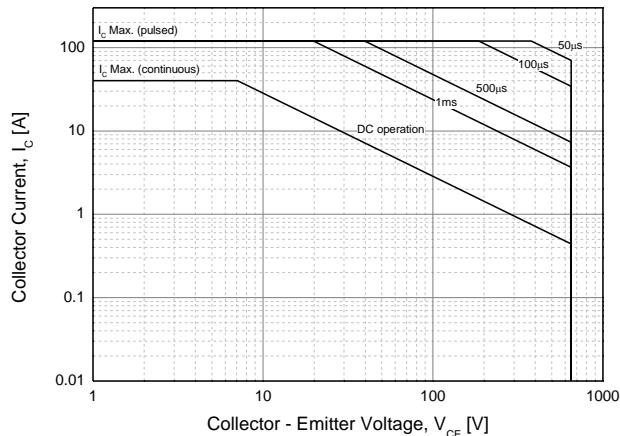
Fig. 15 RBSOA
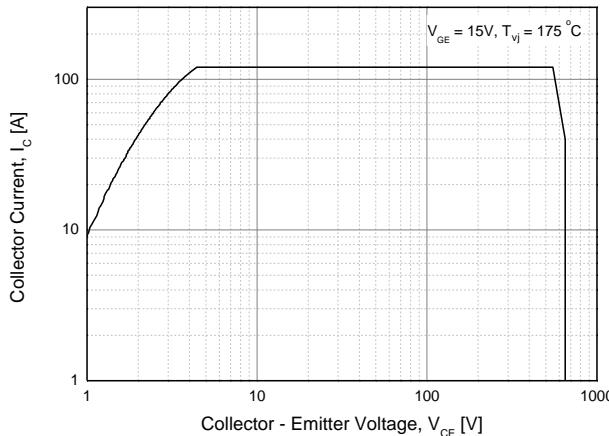
Fig. 16 Transient Thermal Impedance of IGBT
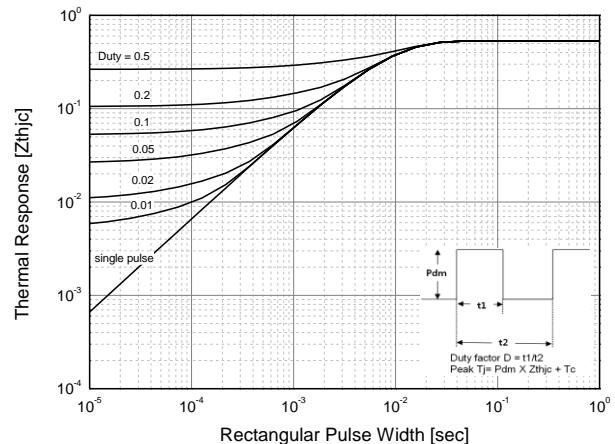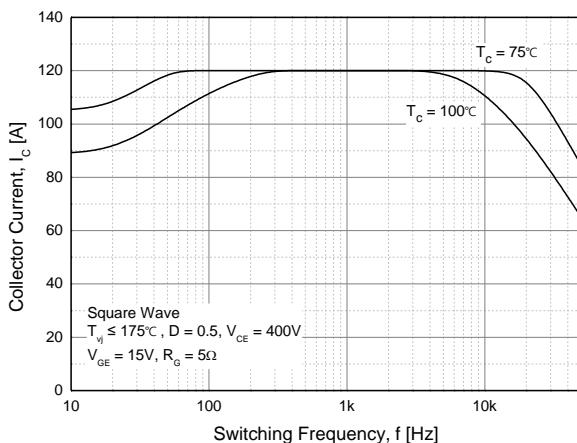
Fig. 17 Load Current vs. Frequency

Diode Characteristics

Fig. 18 Diode Conduction Characteristics
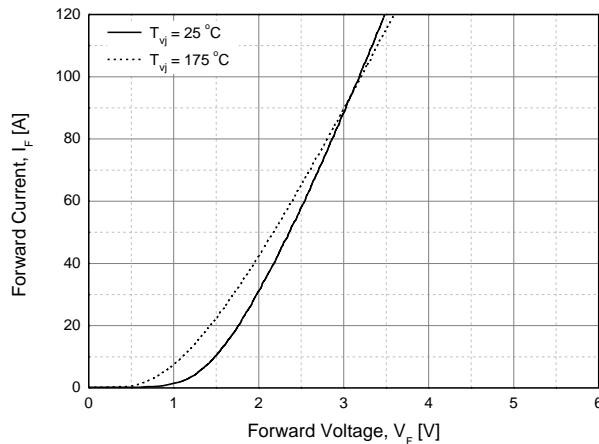
Fig. 19 Reverse Recovery Current vs. Forward Current
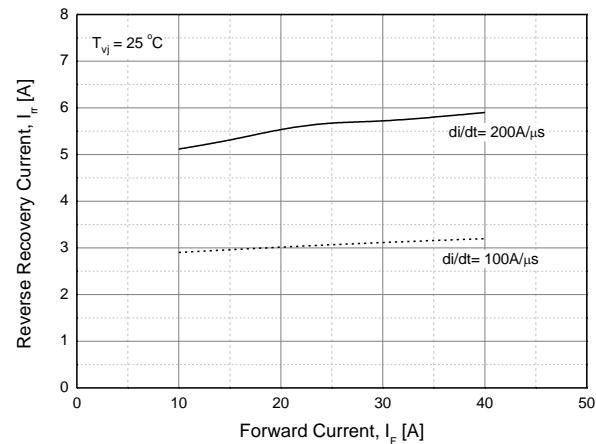
Fig. 20 Reverse Recovery Charge vs. Forward Current
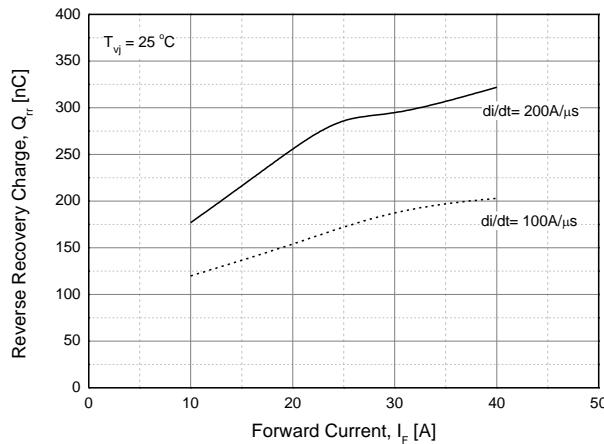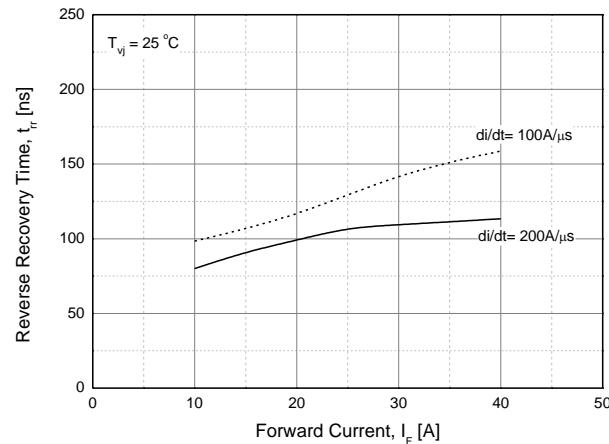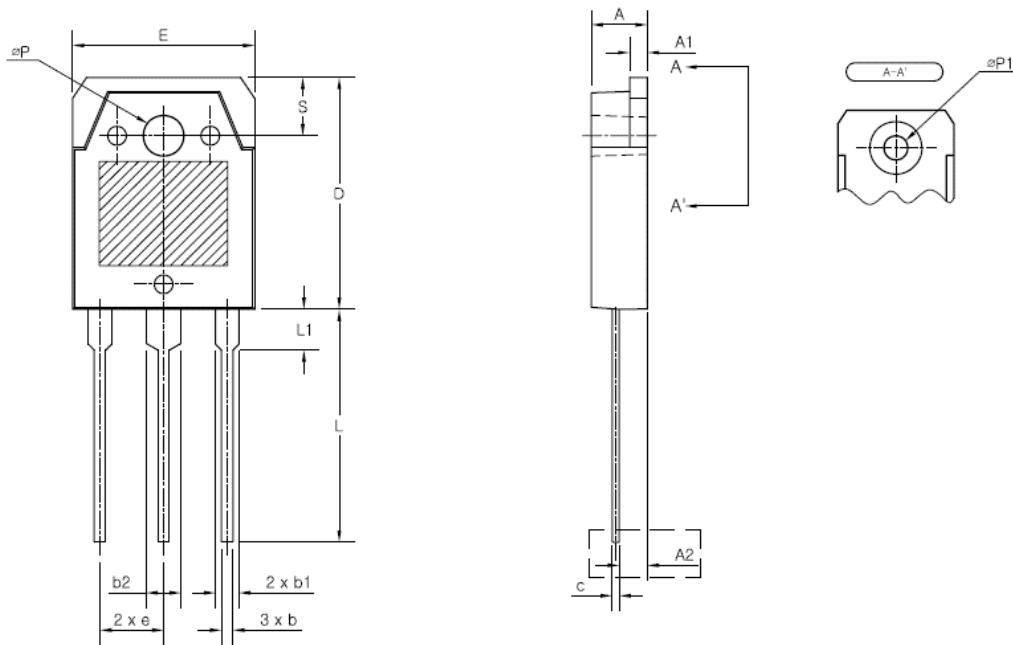
Fig. 21 Reverse Recovery Time vs. Forward Current

TO-3PN MECHANICAL DATA

SYMBOL	mm		
	MIN	NOM	MAX
A	4.6	4.8	5.0
A1	1.45	1.5	1.65
A2	2.2	2.4	2.6
b	0.8	1	1.2
b1	2.8	3	3.2
b2	1.8	2	2.2
c	0.55	0.6	0.75
D	19.20	19.65	20.10
E	15.4	15.6	15.8
e	5.15	5.45	5.75
L	19.8	20	20.2
L1	3.3	3.5	3.7
ΦP	3.5		
ΦP1	3.2		
S	5		

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