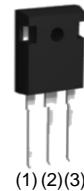


V_{CES}	650V
I_C	30A
$V_{CE(sat)}(\text{Typ.})$	1.65V
P_D	166W

●Outline

TO-247GE



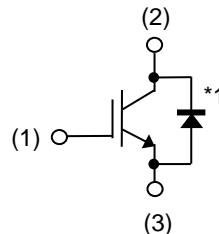
●Features

- 1) Low Collector - Emitter Saturation Voltage
- 2) Low Switching Loss
- 3) Short Circuit Withstand Time 5μs
- 4) Built in Very Fast & Soft Recovery FRD
- 5) Pb - free Lead Plating ; RoHS Compliant

●Application

General Inverter
UPS
Power Conditioner
Welder

●Inner Circuit



(1) Gate
(2) Collector
(3) Emitter

*1 Built in FRD

●Packaging Specifications

Type	Packaging	Tube
	Reel Size (mm)	-
	Tape Width (mm)	-
	Basic Ordering Unit (pcs)	600
	Packing Code	C13
	Marking	RGE60TS65D

●Absolute Maximum Ratings (at $T_C = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Value	Unit
Collector - Emitter Voltage	V_{CES}	650	V
Gate - Emitter Voltage	V_{GES}	± 30	V
Collector Current	I_C $T_C = 25^\circ\text{C}$	51	A
	I_C $T_C = 100^\circ\text{C}$	32	A
Pulsed Collector Current	I_{CP} *1	90	A
Diode Forward Current	I_F $T_C = 25^\circ\text{C}$	43	A
	I_F $T_C = 100^\circ\text{C}$	26	A
Diode Pulsed Forward Current	I_{FP} *1	90	A
Power Dissipation	P_D $T_C = 25^\circ\text{C}$	166	W
	P_D $T_C = 100^\circ\text{C}$	83	W
Operating Junction Temperature	T_j	-40 to +175	°C
Storage Temperature	T_{stg}	-55 to +175	°C

*1 Pulse width limited by T_{jmax} .

●Thermal Resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal Resistance IGBT Junction - Case	$R_{\theta(j-c)}$	-	-	0.90	°C/W
Thermal Resistance Diode Junction - Case	$R_{\theta(j-c)}$	-	-	1.48	°C/W

●IGBT Electrical Characteristics (at $T_j = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Collector - Emitter Breakdown Voltage	BV_{CES}	$I_C = 10\mu\text{A}, V_{\text{GE}} = 0\text{V}$	650	-	-	V
Collector Cut - off Current	I_{CES}	$V_{\text{CE}} = 650\text{V}, V_{\text{GE}} = 0\text{V}$	-	-	10	μA
Gate - Emitter Leakage Current	I_{GES}	$V_{\text{GE}} = \pm 30\text{V}, V_{\text{CE}} = 0\text{V}$	-	-	± 200	nA
Gate - Emitter Threshold Voltage	$V_{\text{GE}(\text{th})}$	$V_{\text{CE}} = 5\text{V}, I_C = 8.2\text{mA}$	5.0	6.0	7.0	V
Collector - Emitter Saturation Voltage	$V_{\text{CE}(\text{sat})}$	$I_C = 30\text{A}, V_{\text{GE}} = 15\text{V},$ $T_j = 25^\circ\text{C}$ $T_j = 175^\circ\text{C}$	-	1.65	2.05	V
			-	2.15	-	

●IGBT Electrical Characteristics (at $T_j = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input Capacitance	C_{ies}	$V_{CE} = 30\text{V}$, $V_{GE} = 0\text{V}$, $f = 1\text{MHz}$	-	1854	-	pF
Output Capacitance	C_{oes}		-	84	-	
Reverse transfer Capacitance	C_{res}		-	20	-	
Total Gate Charge	Q_g	$V_{CE} = 400\text{V}$, $I_C = 30\text{A}$, $V_{GE} = 15\text{V}$	-	63	-	nC
Gate - Emitter Charge	Q_{ge}		-	15	-	
Gate - Collector Charge	Q_{gc}		-	28	-	
Turn - on Delay Time	$t_{d(on)}$	$I_C = 30\text{A}$, $V_{CC} = 400\text{V}$, $V_{GE} = 15\text{V}$, $R_G = 10\Omega$, $T_j = 25^\circ\text{C}$ Inductive Load * E_{on} include diode reverse recovery	-	40	-	ns
Rise Time	t_r		-	16	-	
Turn - off Delay Time	$t_{d(off)}$		-	114	-	
Fall Time	t_f		-	78	-	
Turn-on Switching Loss	E_{on}		-	0.64	-	mJ
Turn-off Switching Loss	E_{off}		-	0.57	-	
Turn - on Delay Time	$t_{d(on)}$	$I_C = 30\text{A}$, $V_{CC} = 400\text{V}$, $V_{GE} = 15\text{V}$, $R_G = 10\Omega$, $T_j = 175^\circ\text{C}$ Inductive Load * E_{on} include diode reverse recovery	-	39	-	ns
Rise Time	t_r		-	18	-	
Turn - off Delay Time	$t_{d(off)}$		-	127	-	
Fall Time	t_f		-	107	-	
Turn-on Switching Loss	E_{on}		-	0.69	-	mJ
Turn-off Switching Loss	E_{off}		-	0.75	-	
Reverse Bias Safe Operating Area	RBSOA	$I_C = 90\text{A}$, $V_{CC} = 520\text{V}$, $V_p = 650\text{V}$, $V_{GE} = 15\text{V}$, $R_G = 100\Omega$, $T_j = 175^\circ\text{C}$	FULL SQUARE			-
Short Circuit Withstand Time	t_{sc}	$V_{CC} \leq 360\text{V}$, $V_{GE} = 15\text{V}$, $T_j = 25^\circ\text{C}$	5	-	-	μs

●FRD Electrical Characteristics (at $T_j = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Diode Forward Voltage	V_F	$I_F = 30\text{A}$, $T_j = 25^\circ\text{C}$	-	1.6	2.05	V
		$T_j = 175^\circ\text{C}$	-	1.65	-	
Diode Reverse Recovery Time	t_{rr}	$I_F = 30\text{A}$, $V_{CC} = 400\text{V}$, $di_F/dt = 500\text{A}/\mu\text{s}$, $T_j = 25^\circ\text{C}$	-	166	-	ns
Diode Peak Reverse Recovery Current	I_{rr}		-	11.0	-	A
Diode Reverse Recovery Charge	Q_{rr}	$di_F/dt = 500\text{A}/\mu\text{s}$, $T_j = 25^\circ\text{C}$	-	0.9	-	μC
Diode Reverse Recovery Energy	E_{rr}		-	168	-	μJ
Diode Reverse Recovery Time	t_{rr}	$I_F = 30\text{A}$, $V_{CC} = 400\text{V}$, $di_F/dt = 500\text{A}/\mu\text{s}$, $T_j = 175^\circ\text{C}$	-	190	-	ns
Diode Peak Reverse Recovery Current	I_{rr}		-	13.3	-	A
Diode Reverse Recovery Charge	Q_{rr}	$di_F/dt = 500\text{A}/\mu\text{s}$, $T_j = 175^\circ\text{C}$	-	1.5	-	μC
Diode Reverse Recovery Energy	E_{rr}		-	320	-	μJ

●Electrical Characteristic Curves

Fig.1 Power Dissipation
vs. Case Temperature

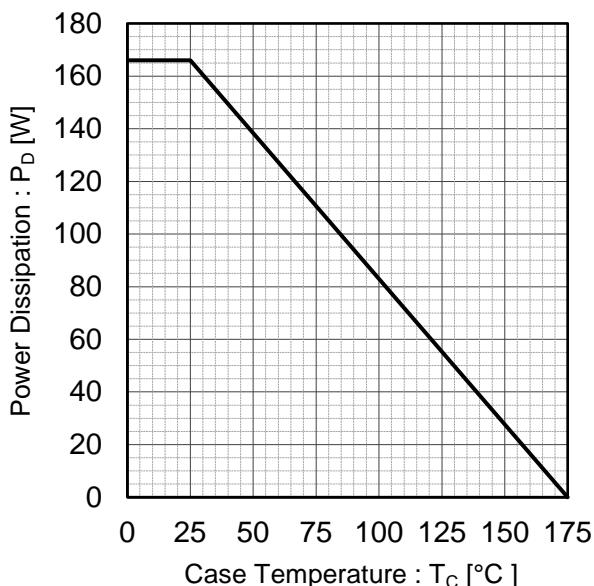


Fig.2 Collector Current
vs. Case Temperature

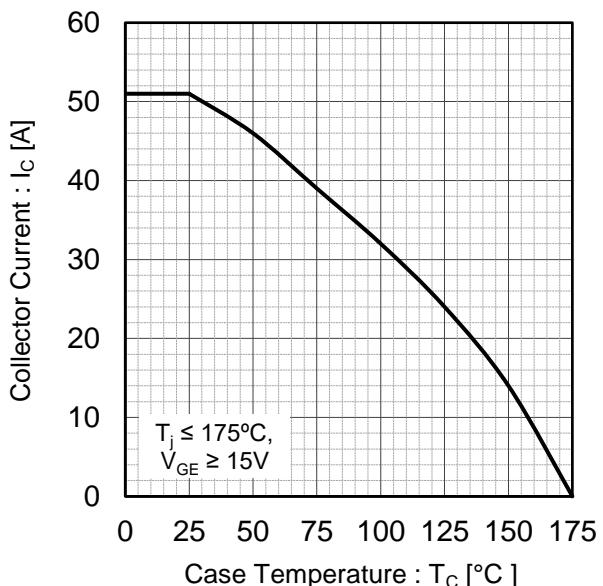


Fig.3 Forward Bias Safe Operating Area

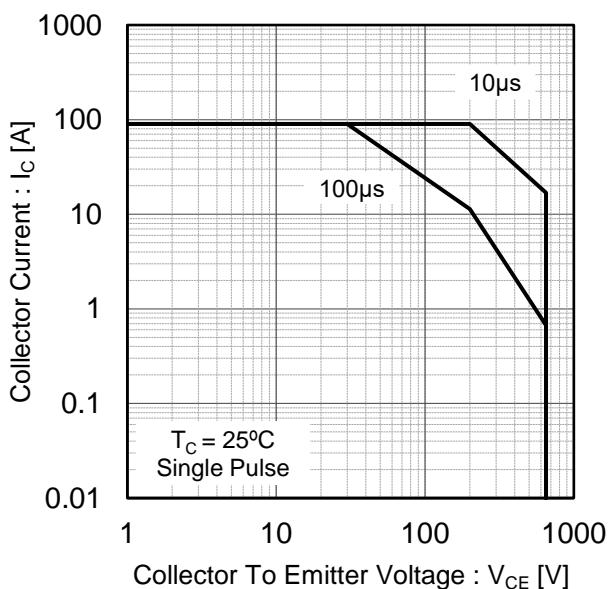
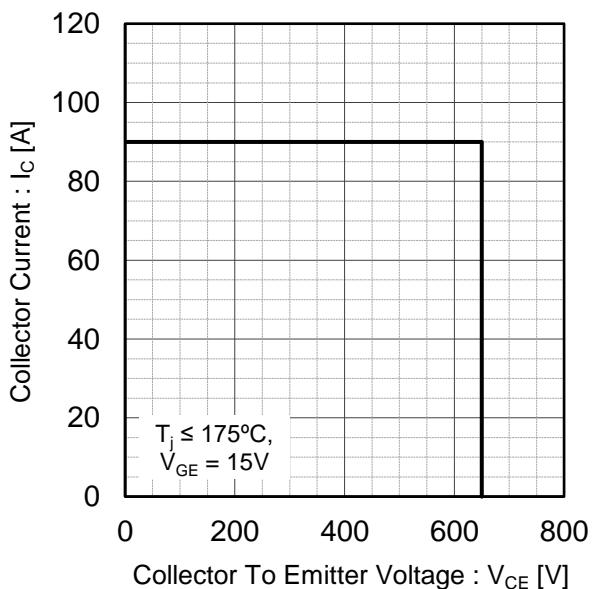


Fig.4 Reverse Bias Safe Operating Area



●Electrical Characteristic Curves

Fig.5 Typical Output Characteristics

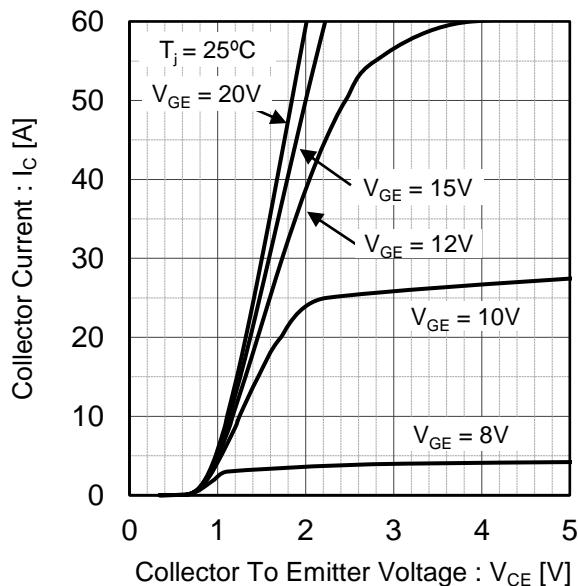


Fig.6 Typical Output Characteristics

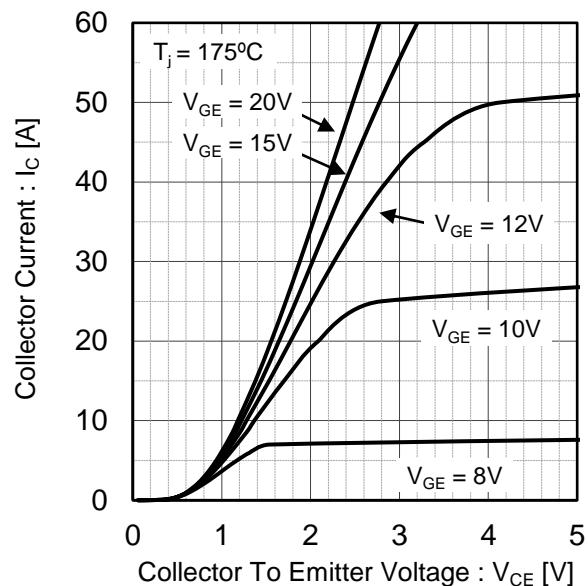


Fig.7 Typical Transfer Characteristics

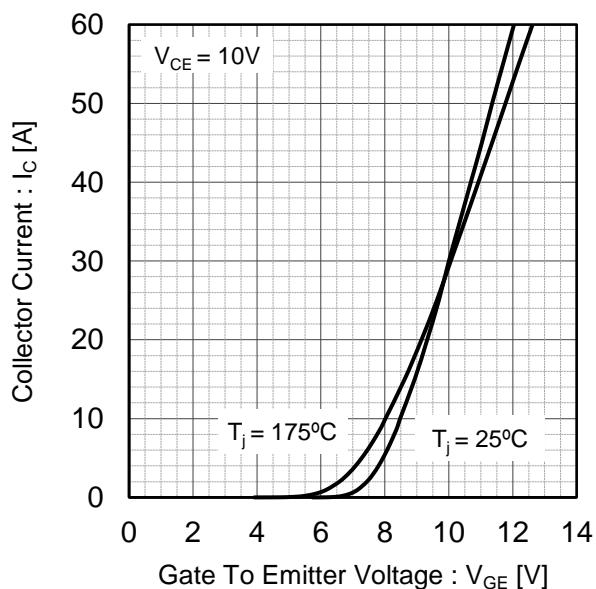
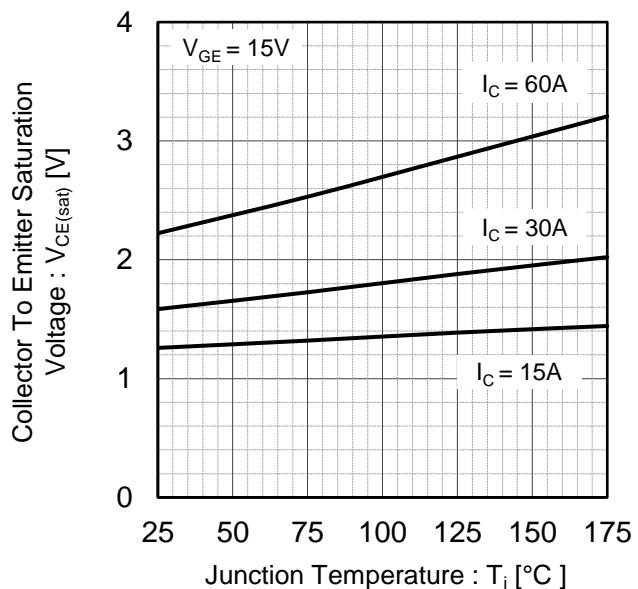


Fig.8 Typical Collector To Emitter Saturation Voltage vs. Junction Temperature



●Electrical Characteristic Curves

Fig.9 Typical Collector To Emitter Saturation Voltage vs. Gate To Emitter Voltage

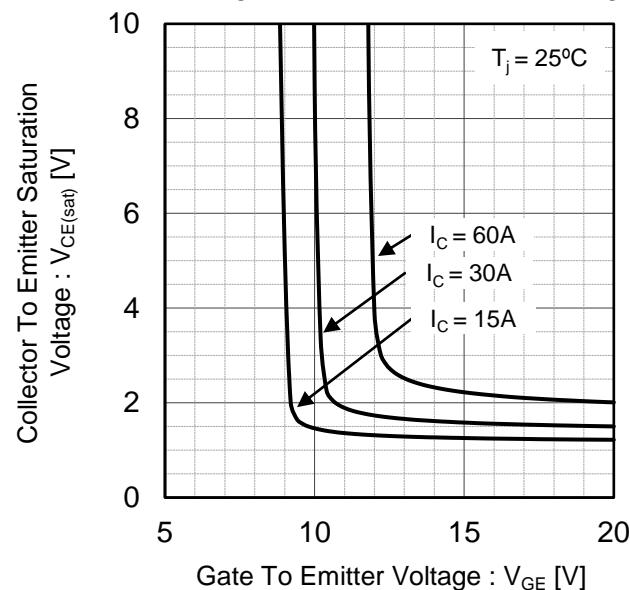


Fig.10 Typical Collector To Emitter Saturation Voltage vs. Gate To Emitter Voltage

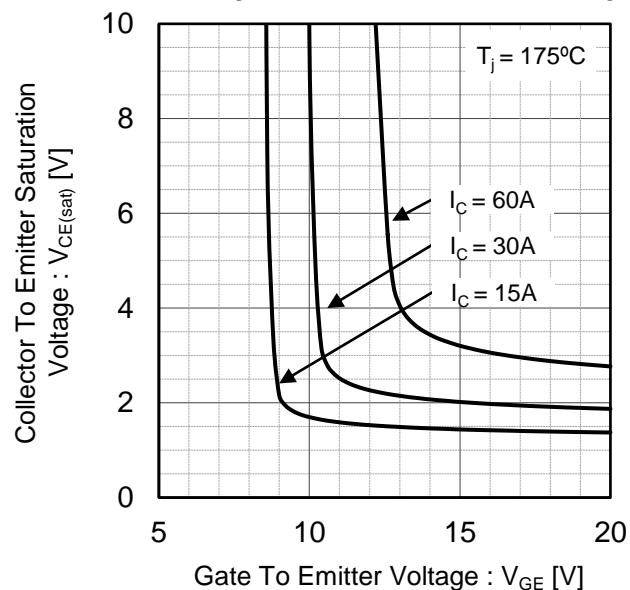


Fig.11 Typical Capacitance vs. Collector To Emitter Voltage

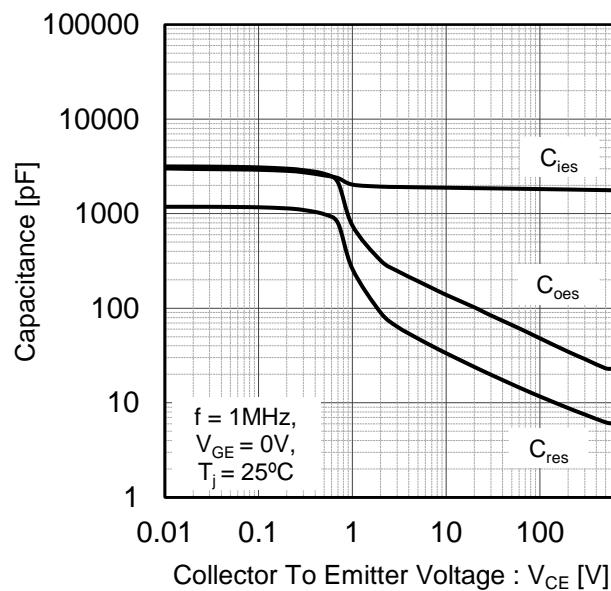
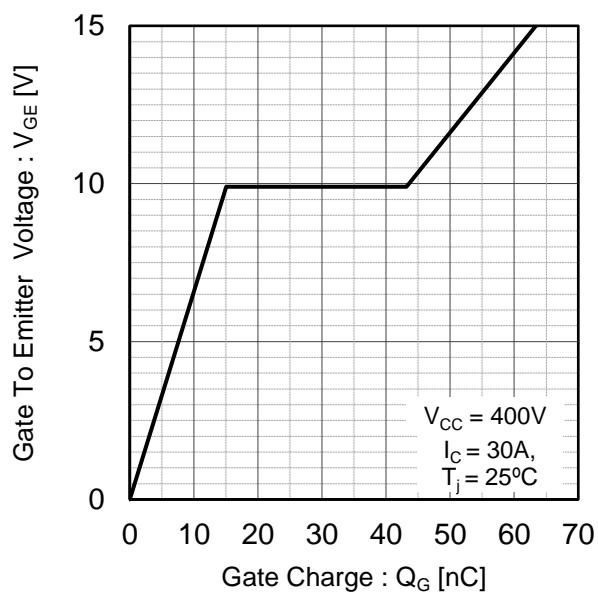


Fig.12 Typical Gate Charge



●Electrical Characteristic Curves

Fig.13 Typical Switching Time vs. Collector Current

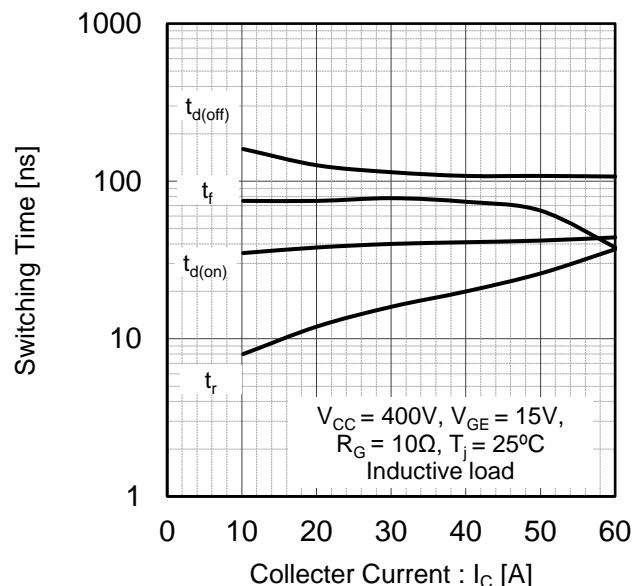


Fig.14 Typical Switching Time vs. Gate Resistance

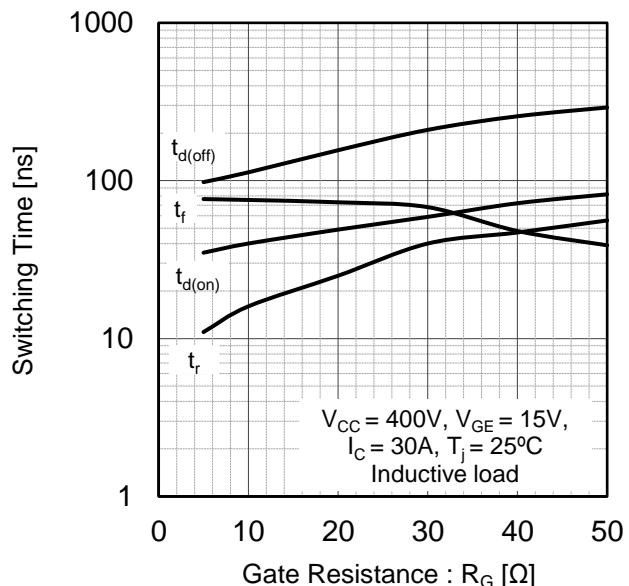


Fig.15 Typical Switching Energy Losses vs. Collector Current

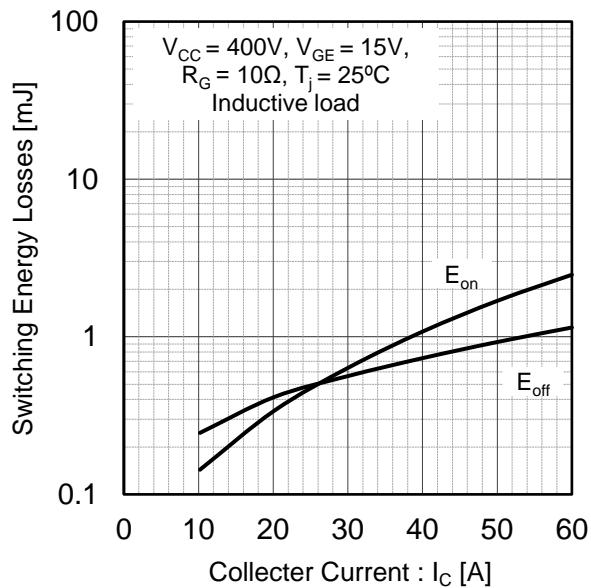
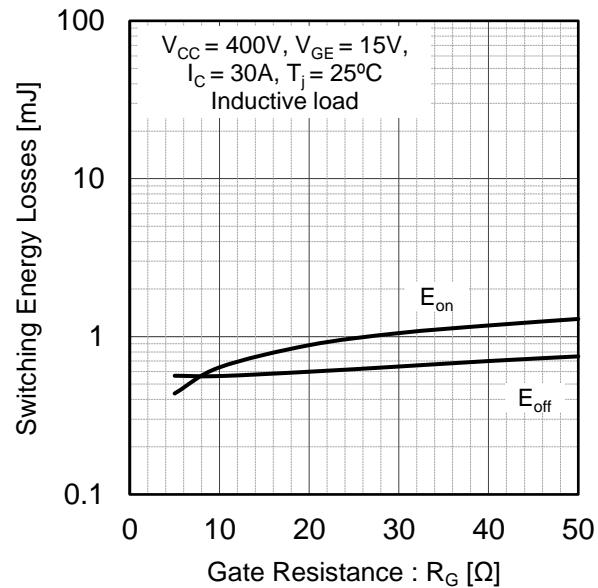


Fig.16 Typical Switching Energy Losses vs. Gate Resistance



●Electrical Characteristic Curves

Fig.17 Typical Switching Time vs. Collector Current

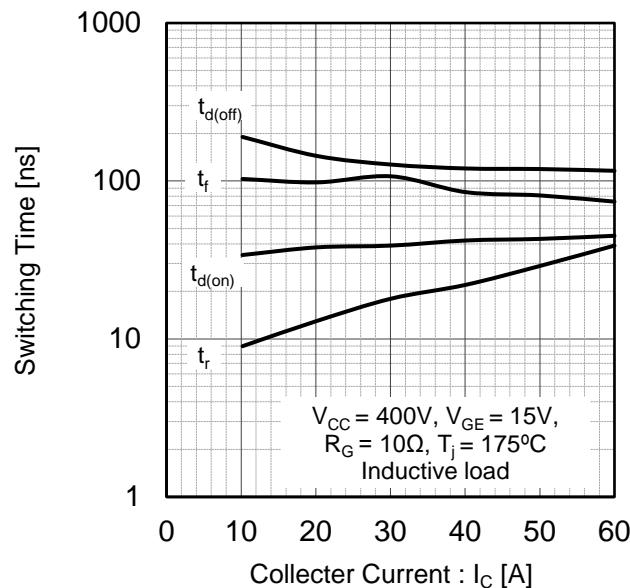


Fig.18 Typical Switching Time vs. Gate Resistance

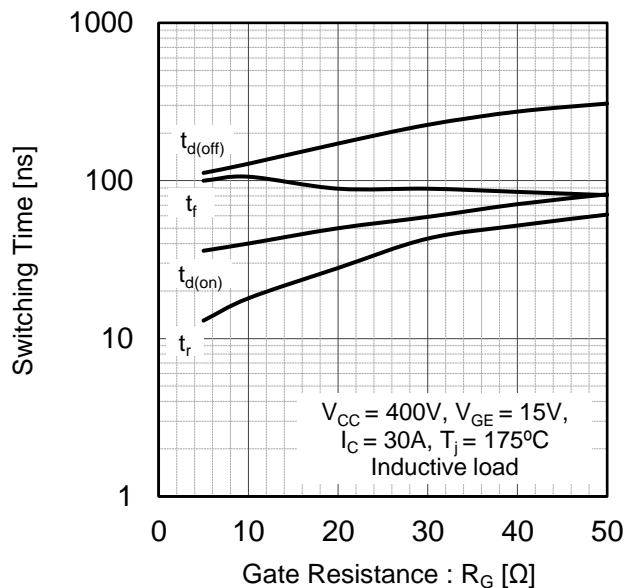


Fig.19 Typical Switching Energy Losses vs. Collector Current

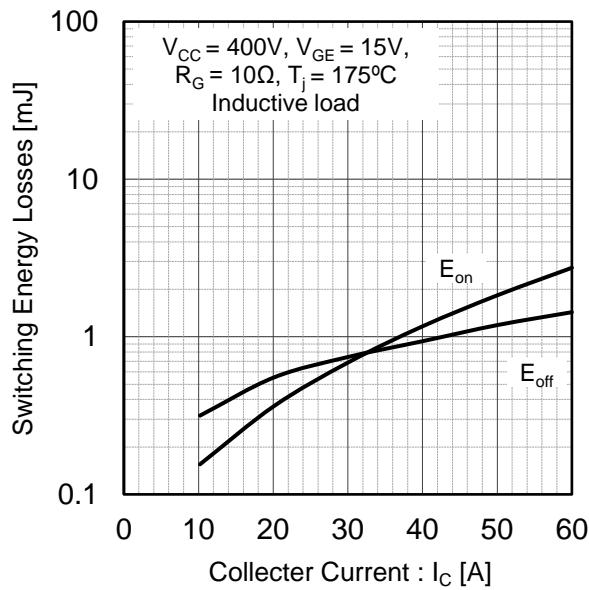
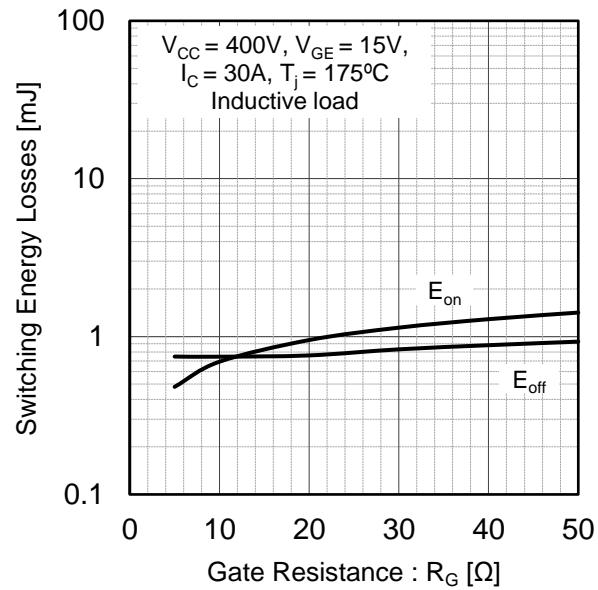


Fig.20 Typical Switching Energy Losses vs. Gate Resistance



●Electrical Characteristic Curves

Fig.21 Typical Diode Forward Current vs. Forward Voltage

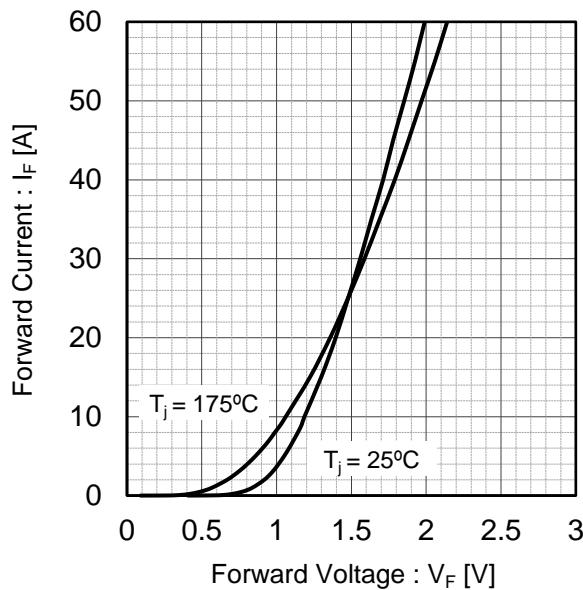


Fig.22 Typical Diode Reverse Recovery Time vs. Forward Current

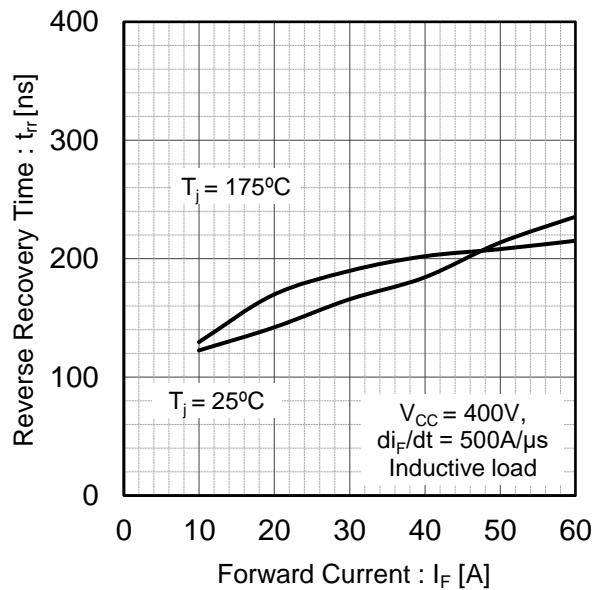


Fig.23 Typical Diode Reverse Recovery Current vs. Forward Current

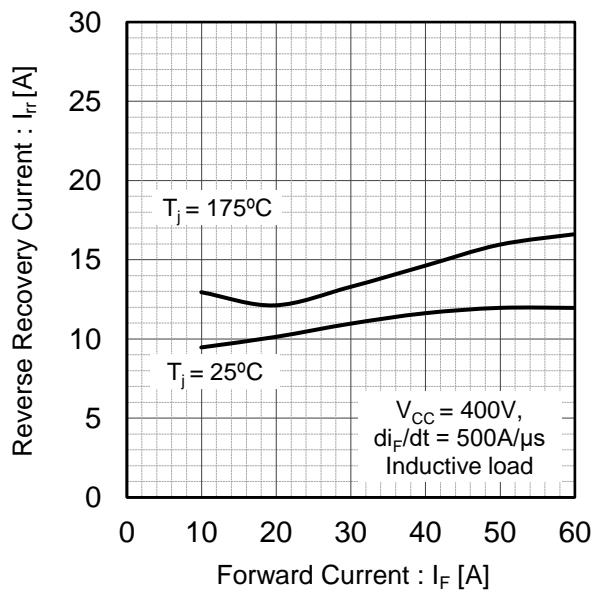
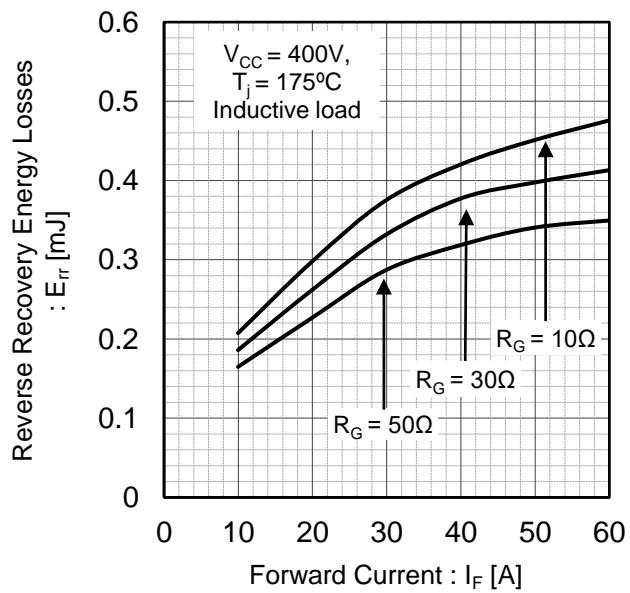


Fig.24 Typical Diode Reverse Recovery Energy Losses vs. Forward Current



●Electrical Characteristic Curves

Fig.25 Typical IGBT Transient Thermal Impedance

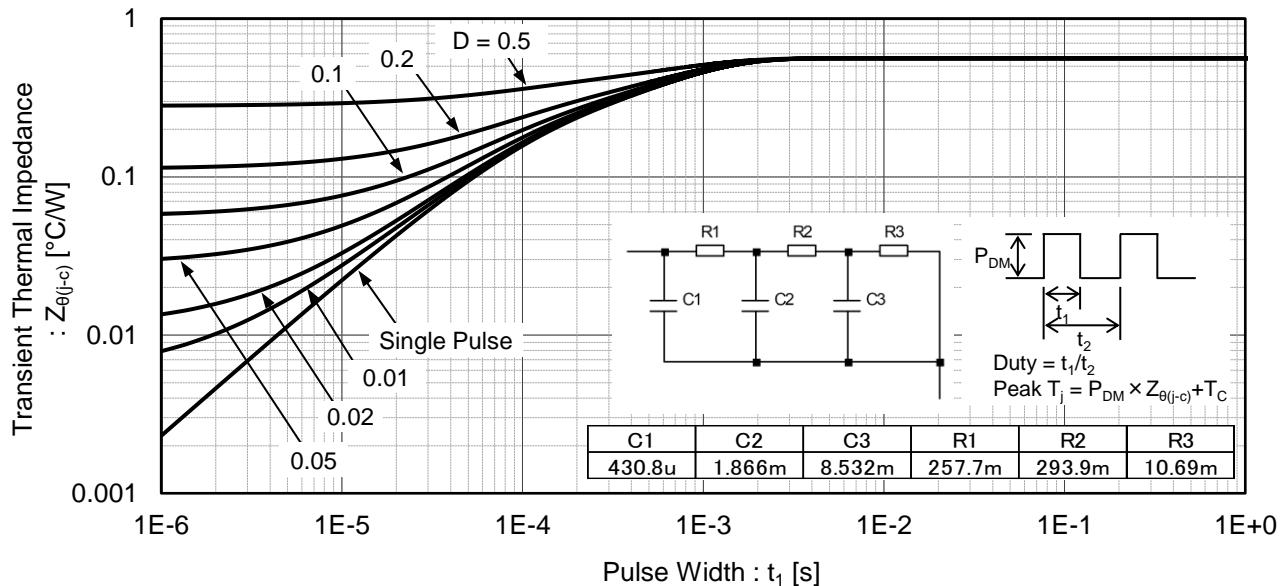
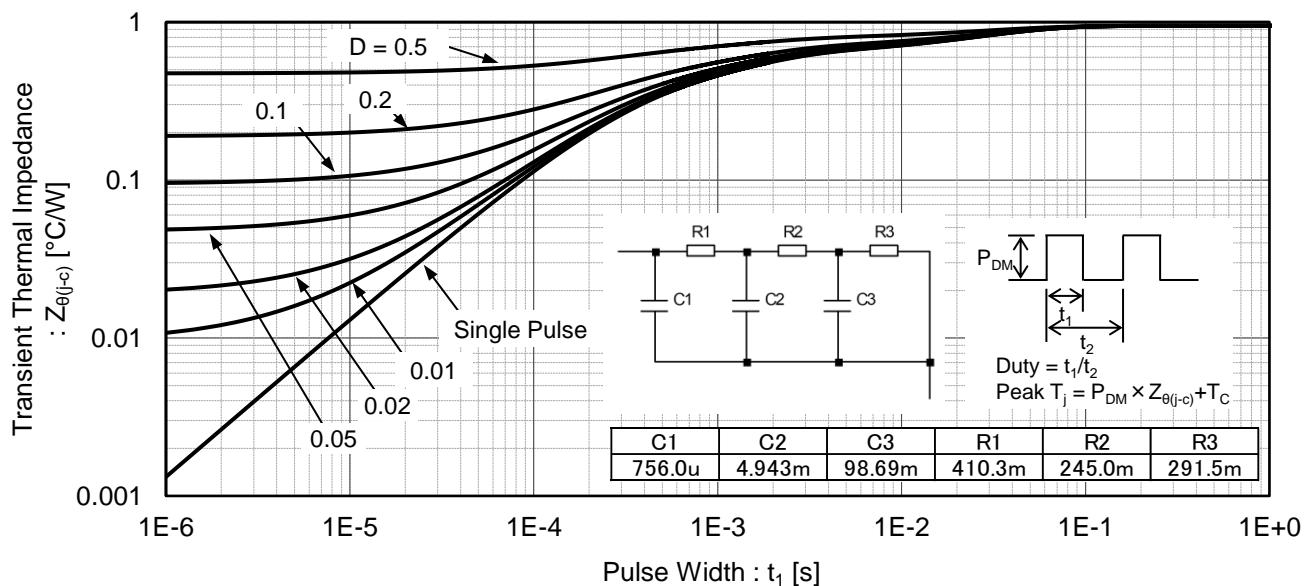


Fig.26 Typical Diode Transient Thermal Impedance



●Inductive Load Switching Circuit and Waveform and Short Circuit

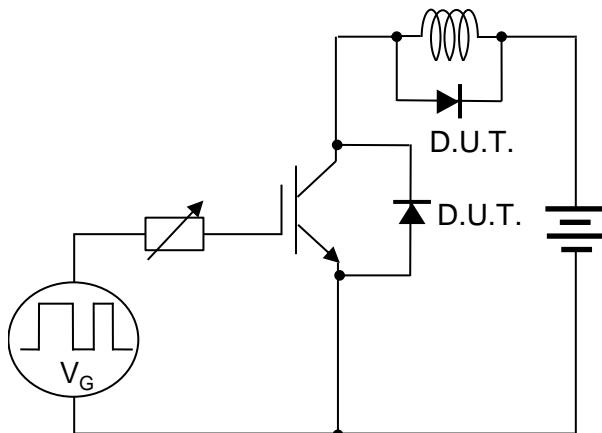


Fig.27 Inductive Load Circuit

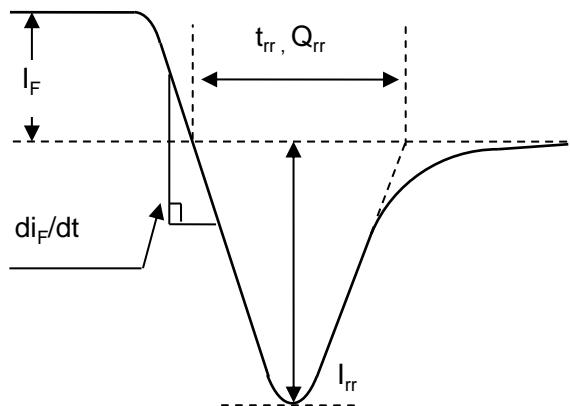


Fig.28 Diode Reverse Recovery Waveform

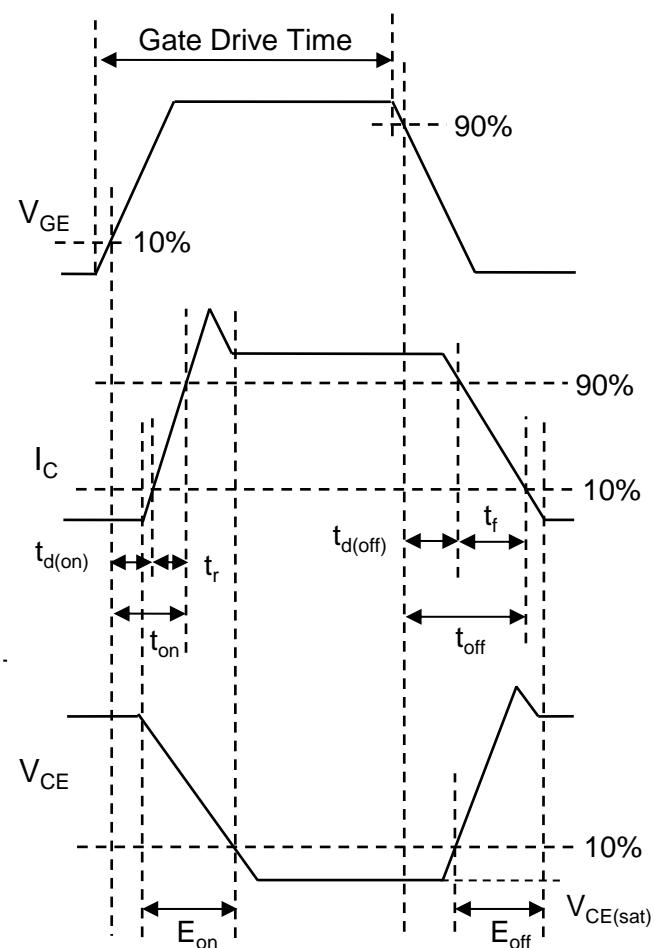


Fig.29 Inductive Load Waveform

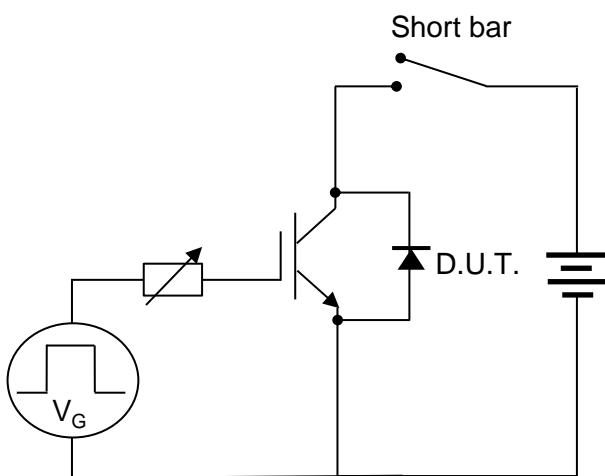


Fig.30 Short Circuit

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