

$V_{CES}$	650V
$I_C$	20A
$V_{CE(sat)}$ (Typ.)	1.65V
$P_D$	177W

### ●Features

- 1) Qualified to AEC-Q101
- 2) Low Collector - Emitter Saturation Voltage
- 3) Short Circuit Withstand Time 8μs
- 4) Built in Very Fast & Soft Recovery FRD
- 5) Pb - free Lead Plating ; RoHS Compliant

### ●Application

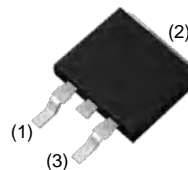
General Inverter

for Automotive and Industrial Use

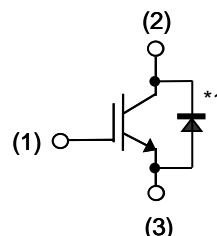
Heater for Automotive

### ●Outline

LPDL (TO-263L)



### ●Inner Circuit



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

\*1 Built in FRD

### ●Packaging Specifications

Type	Packaging	Taping
	Reel Size (mm)	330
	Tape Width (mm)	24
	Basic Ordering Unit (pcs)	1,000
	Packing Code	TL
	Marking	RGS40NL65D

### ●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	$T_C = 25^\circ\text{C}$	$I_C$	42	A
	$T_C = 100^\circ\text{C}$	$I_C$	28	A
Pulsed Collector Current		$I_{CP}^{*1}$	60	A
Diode Forward Current	$T_C = 25^\circ\text{C}$	$I_F$	43	A
	$T_C = 100^\circ\text{C}$	$I_F$	25	A
Diode Pulsed Forward Current		$I_{FP}^{*1}$	60	A
Power Dissipation	$T_C = 25^\circ\text{C}$	$P_D$	177	W
	$T_C = 100^\circ\text{C}$	$P_D$	88	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	$R_{\theta(j-c)}$	-	-	0.85	°C/W
Thermal Resistance Diode Junction - Case	$R_{\theta(j-c)}$	-	-	1.55	°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	$BV_{CES}$	$I_C = 10\mu\text{A}$ , $V_{GE} = 0\text{V}$	650	-	-	V
Collector Cut - off Current	$I_{CES}$	$V_{CE} = 650\text{V}$ , $V_{GE} = 0\text{V}$ , $T_j = 25^\circ\text{C}$	-	-	10	$\mu\text{A}$
		$T_j = 175^\circ\text{C}$	-	0.1	-	mA
Gate - Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 30\text{V}$ , $V_{CE} = 0\text{V}$	-	-	$\pm 200$	nA
Gate - Emitter Threshold Voltage	$V_{GE(th)}$	$V_{CE} = 5\text{V}$ , $I_C = 1.0\text{mA}$	5.0	6.0	7.0	V
Collector - Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 20\text{A}$ , $V_{GE} = 15\text{V}$ , $T_j = 25^\circ\text{C}$	-	1.65	2.10	V
		$T_j = 175^\circ\text{C}$	-	2.15	-	V

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input Capacitance	$C_{ies}$	$V_{CE} = 30\text{V},$	-	881	-	pF
Output Capacitance	$C_{oes}$	$V_{GE} = 0\text{V},$	-	55	-	
Reverse transfer Capacitance	$C_{res}$	$f = 1\text{MHz}$	-	7	-	
Total Gate Charge	$Q_g$	$V_{CE} = 400\text{V},$	-	28	-	nC
Gate - Emitter Charge	$Q_{ge}$	$I_C = 20\text{A},$	-	7	-	
Gate - Collector Charge	$Q_{gc}$	$V_{GE} = 15\text{V}$	-	11	-	
Turn - on Delay Time	$t_{d(on)}$	$I_C = 20\text{A}, V_{CC} = 400\text{V},$ $V_{GE} = 15\text{V}, R_G = 10\Omega,$ $T_j = 25^\circ\text{C}$ Inductive Load * $E_{on}$ include diode reverse recovery	-	24	-	ns
Rise Time	$t_r$		-	12	-	
Turn - off Delay Time	$t_{d(off)}$		-	87	-	
Fall Time	$t_f$		-	89	-	
Turn - on Switching Loss	$E_{on}$	Inductive Load * $E_{on}$ include diode reverse recovery	-	0.56	-	mJ
Turn - off Switching Loss	$E_{off}$		-	0.49	-	
Turn - on Delay Time	$t_{d(on)}$	$I_C = 20\text{A}, V_{CC} = 400\text{V},$ $V_{GE} = 15\text{V}, R_G = 10\Omega,$ $T_j = 175^\circ\text{C}$ Inductive Load * $E_{on}$ include diode reverse recovery	-	24	-	ns
Rise Time	$t_r$		-	15	-	
Turn - off Delay Time	$t_{d(off)}$		-	104	-	
Fall Time	$t_f$		-	114	-	
Turn - on Switching Loss	$E_{on}$	Inductive Load * $E_{on}$ include diode reverse recovery	-	0.60	-	mJ
Turn - off Switching Loss	$E_{off}$		-	0.65	-	
Reverse Bias Safe Operating Area	RBSOA	$I_C = 60\text{A}, V_{CC} = 520\text{V},$ $V_P = 650\text{V}, V_{GE} = 15\text{V},$ $R_G = 50\Omega, T_j = 175^\circ\text{C}$	FULL SQUARE			-
Short Circuit Withstand Time	$t_{sc}$	$V_{CC} \leq 360\text{V},$ $V_{GE} = 15\text{V}, T_j = 25^\circ\text{C}$	8	-	-	$\mu\text{s}$
Short Circuit Withstand Time	$t_{sc}^{*2}$	$V_{CC} \leq 360\text{V},$ $V_{GE} = 15\text{V}, T_j = 150^\circ\text{C}$	6	-	-	$\mu\text{s}$

\*2 Design assurance without measurement

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Diode Forward Voltage	$V_F$	$I_F = 20\text{A}$ , $T_j = 25^\circ\text{C}$ $T_j = 175^\circ\text{C}$	- -	1.45 1.6	1.9 -	V
Diode Reverse Recovery Time	$t_{rr}$	$I_F = 20\text{A}$ , $V_{CC} = 400\text{V}$ , $di_F/dt = 200\text{A}/\mu\text{s}$ , $T_j = 25^\circ\text{C}$	-	93	-	ns
Diode Peak Reverse Recovery Current	$I_{rr}$		-	6.5	-	A
Diode Reverse Recovery Charge	$Q_{rr}$		-	0.33	-	$\mu\text{C}$
Diode Reverse Recovery Energy	$E_{rr}$		-	14	-	$\mu\text{J}$
Diode Reverse Recovery Time	$t_{rr}$	$I_F = 20\text{A}$ , $V_{CC} = 400\text{V}$ , $di_F/dt = 200\text{A}/\mu\text{s}$ , $T_j = 175^\circ\text{C}$	-	124	-	ns
Diode Peak Reverse Recovery Current	$I_{rr}$		-	7.7	-	A
Diode Reverse Recovery Charge	$Q_{rr}$		-	0.58	-	$\mu\text{C}$
Diode Reverse Recovery Energy	$E_{rr}$		-	30	-	$\mu\text{J}$

## ●Electrical Characteristic Curves

Fig.1 Power Dissipation  
vs. Case Temperature

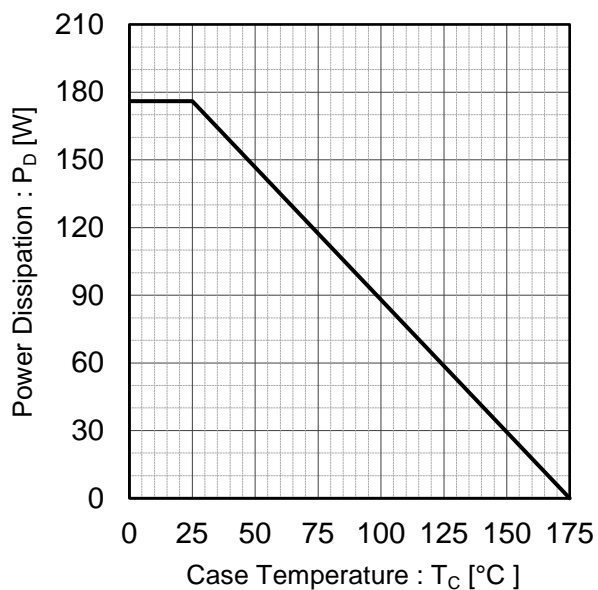


Fig.2 Collector Current  
vs. Case Temperature

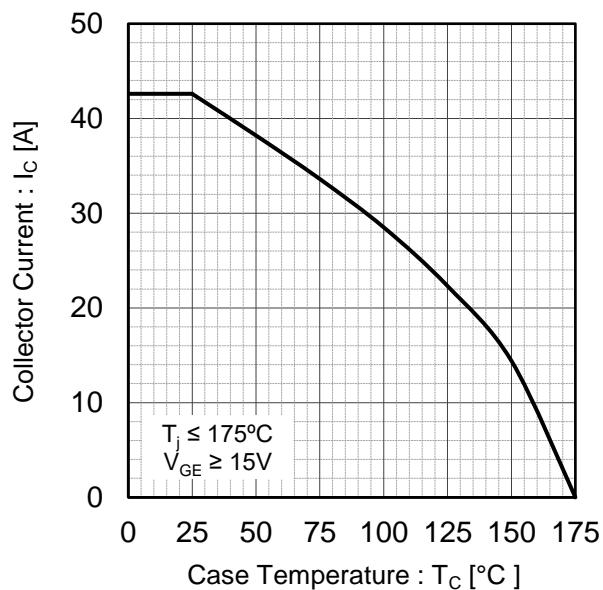


Fig.3 Forward Bias Safe Operating Area

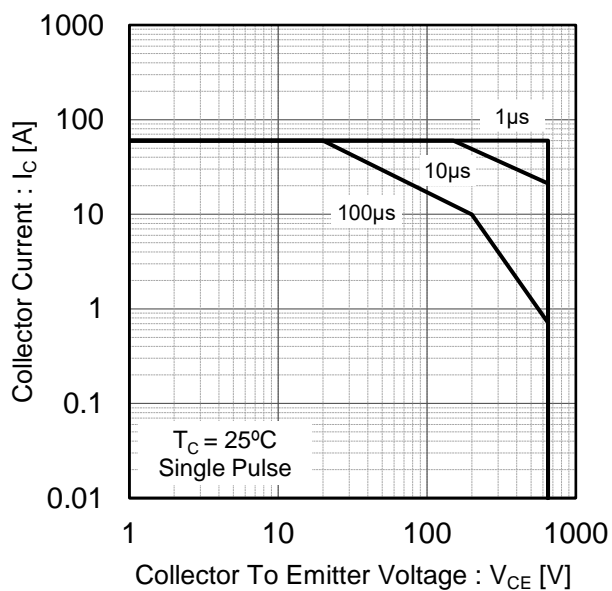
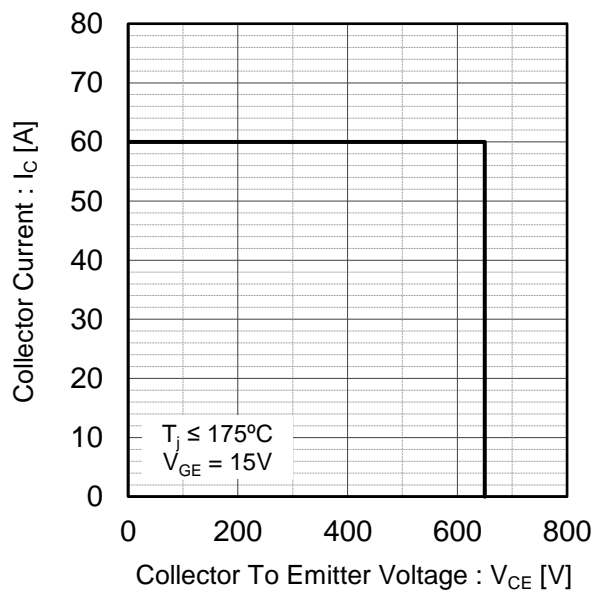


Fig.4 Reverse Bias Safe Operating Area



## ●Electrical Characteristic Curves

Fig.5 Typical Output Characteristics

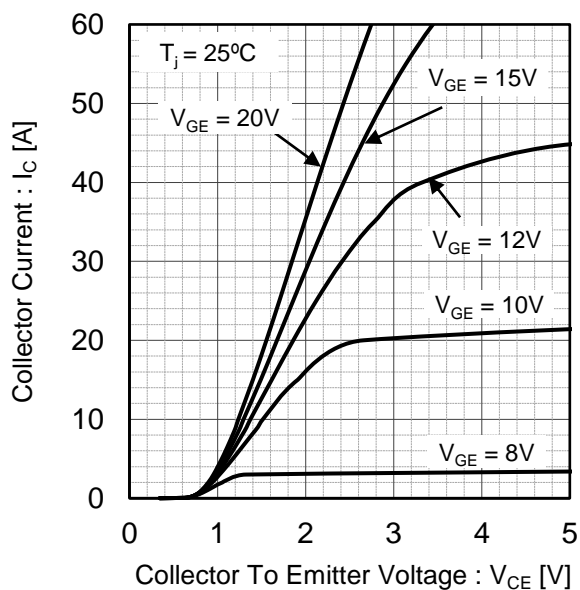


Fig.6 Typical Output Characteristics

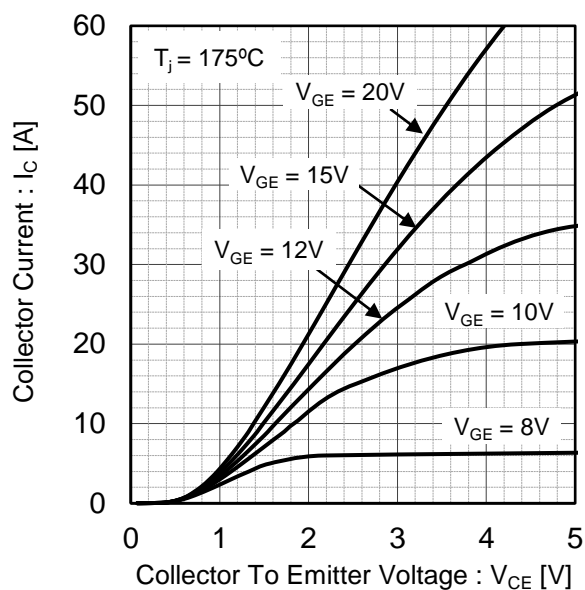


Fig.7 Typical Transfer Characteristics

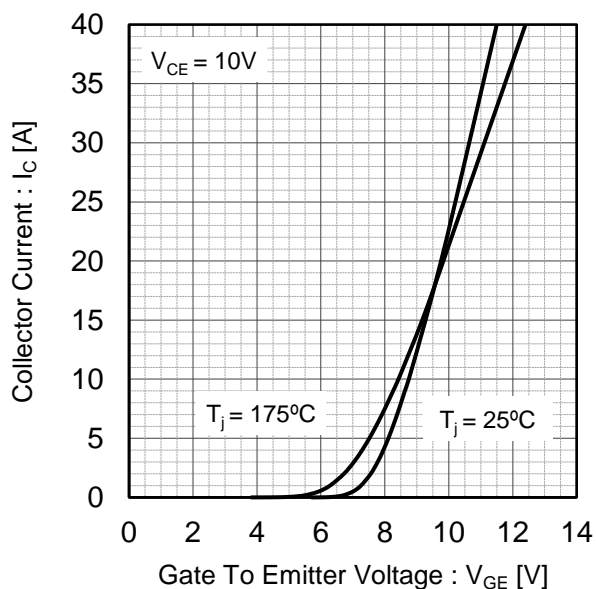
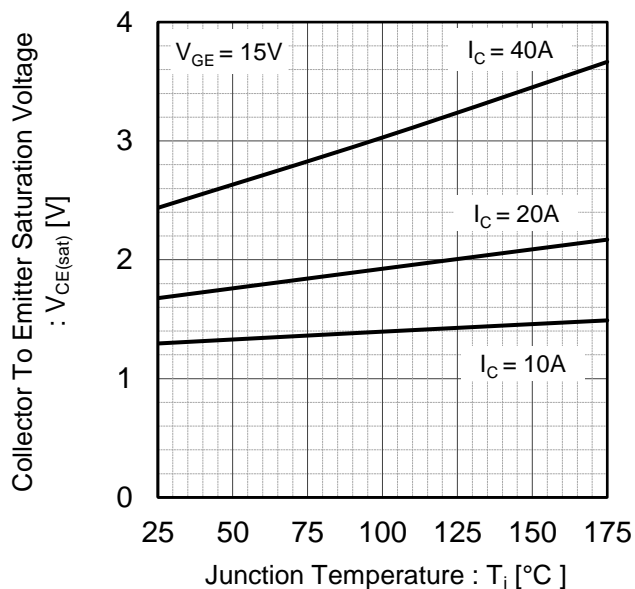


Fig.8 Typical Collector To Emitter Saturation Voltage vs. Junction Temperature



## ●Electrical Characteristic Curves

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

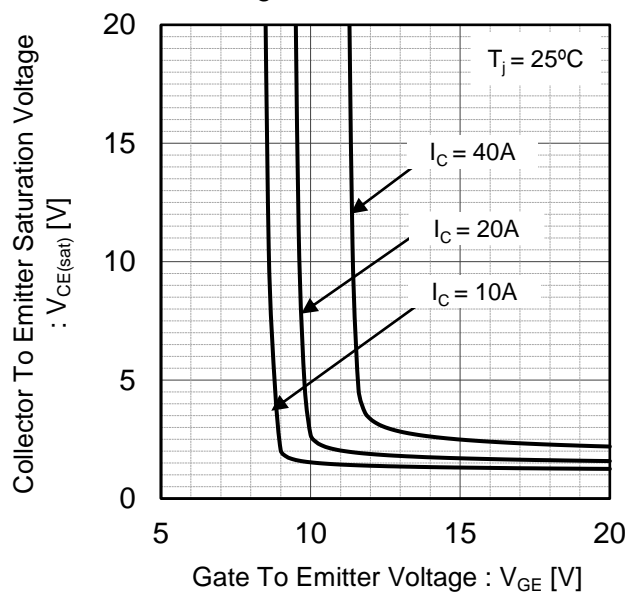


Fig.10 Typical Collector To Emitter Saturation Voltage vs. Gate To Emitter Voltage

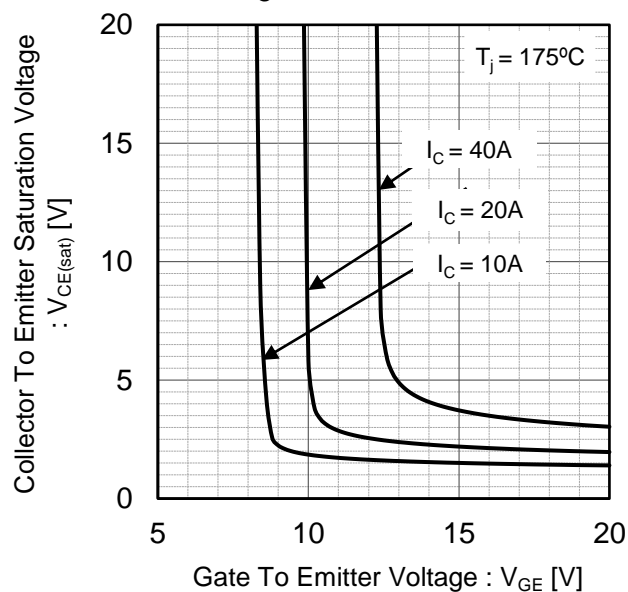


Fig.11 Typical Capacitance vs. Collector To Emitter Voltage

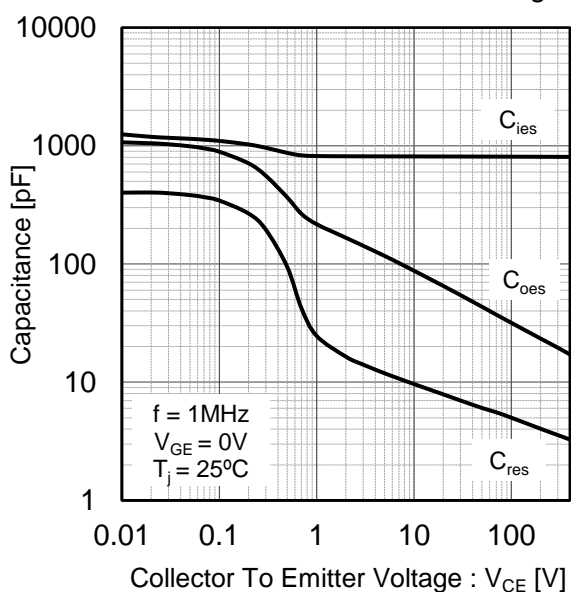
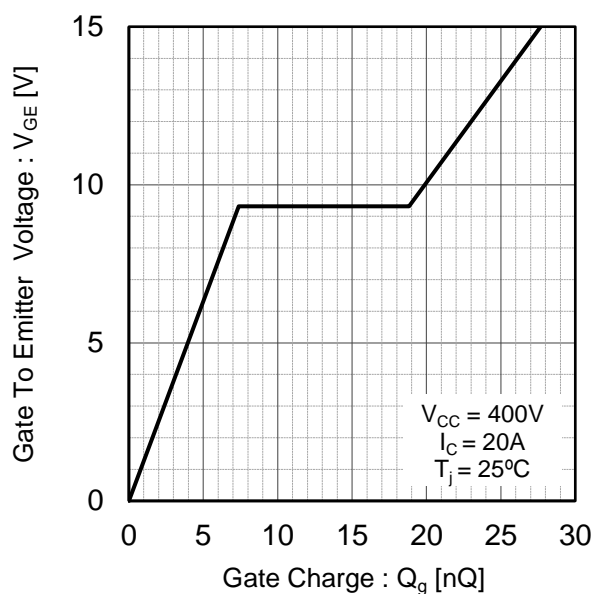


Fig.12 Typical Gate Charge



## ●Electrical Characteristic Curves

Fig.13 Typical Switching Time vs. Collector Current

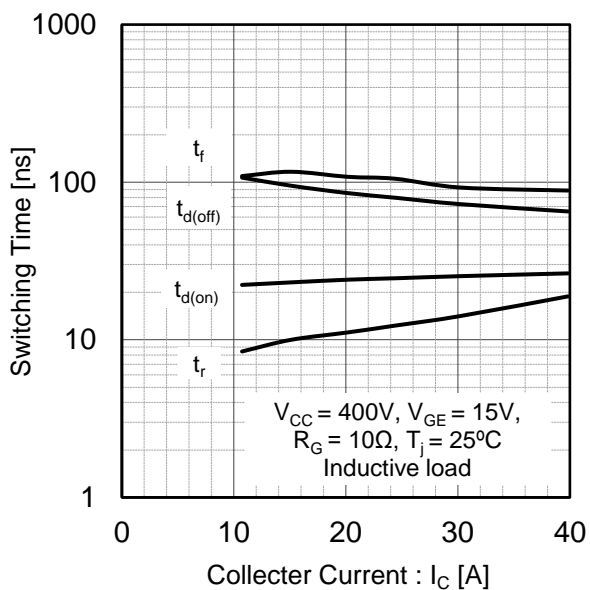


Fig.14 Typical Switching Time vs. Gate Resistance

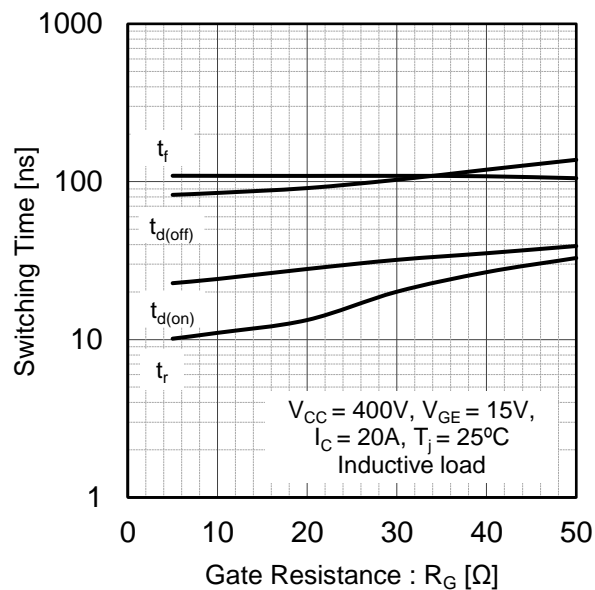


Fig.15 Typical Switching Energy Losses vs. Collector Current

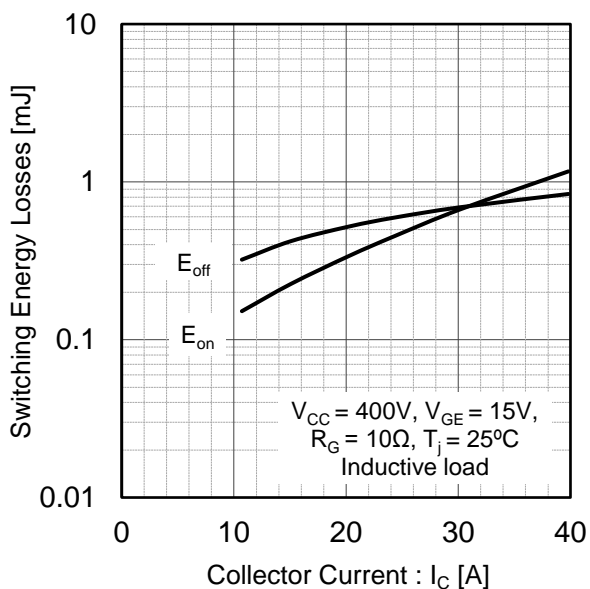
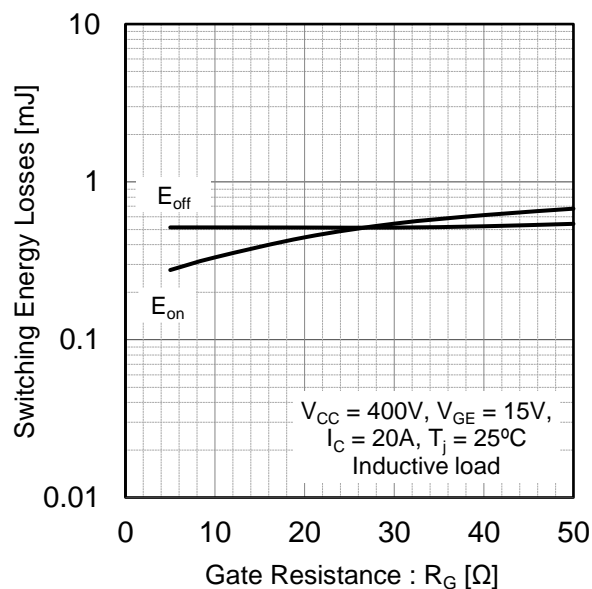


Fig.16 Typical Switching Energy Losses vs. Gate Resistance





## ●Electrical Characteristic Curves

Fig.17 Typical Switching Time vs. Collector Current

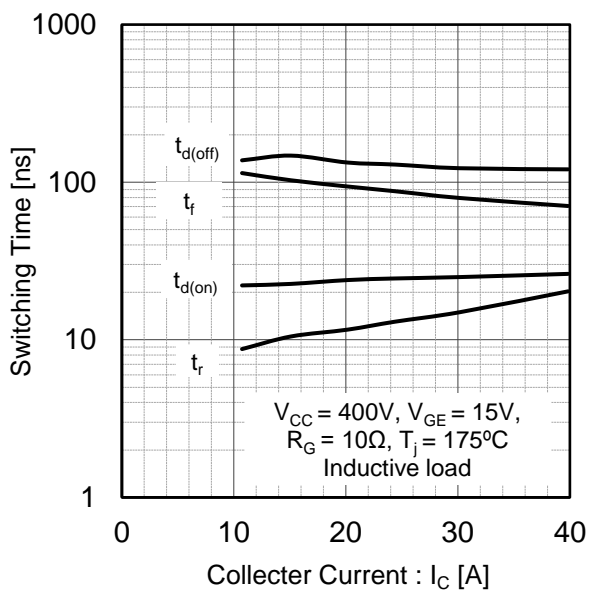


Fig.18 Typical Switching Time vs. Gate Resistance

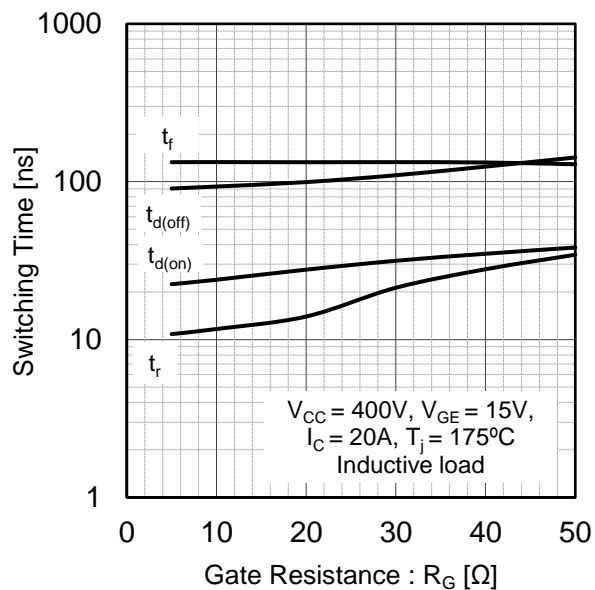


Fig.19 Typical Switching Energy Losses vs. Collector Current

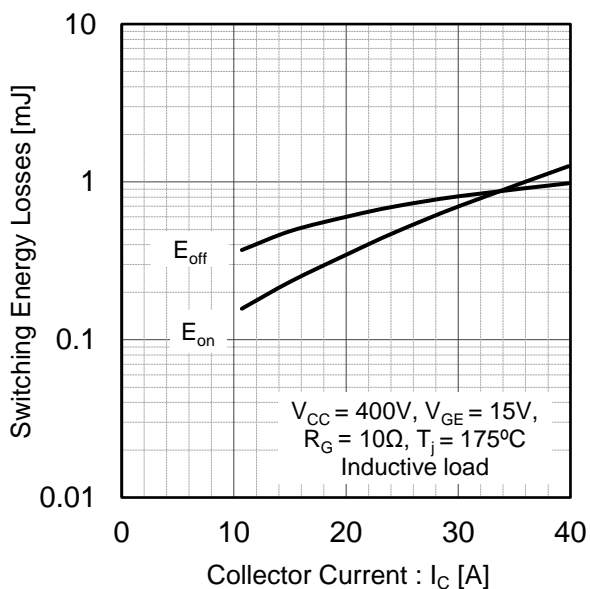
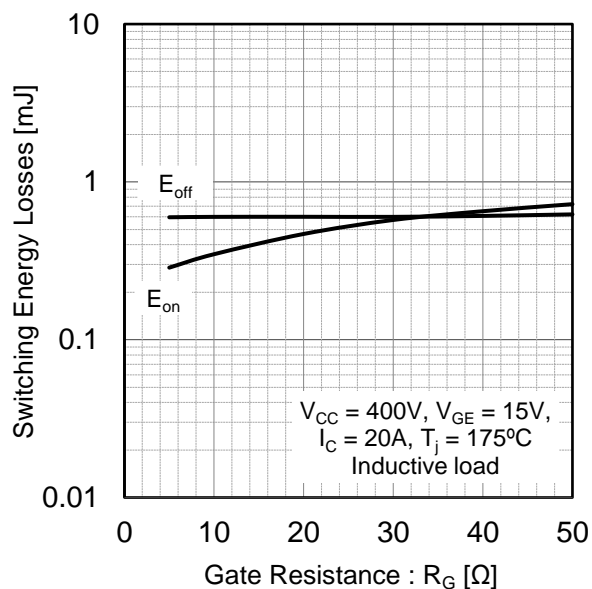


Fig.20 Typical Switching Energy Losses vs. Gate Resistance



## ●Electrical Characteristic Curves

Fig.21 Typical Diode Forward Current vs. Forward Voltage

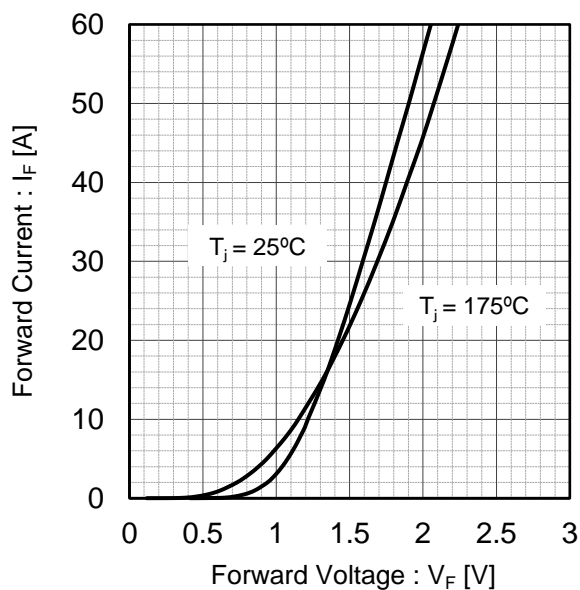


Fig.22 Typical Diode Reverse Recovery Time vs. Forward Current

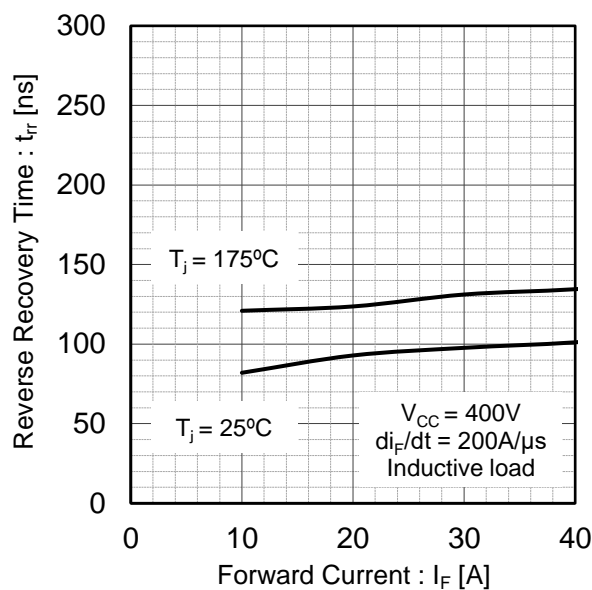


Fig.23 Typical Diode Reverse Recovery Current vs. Forward Current

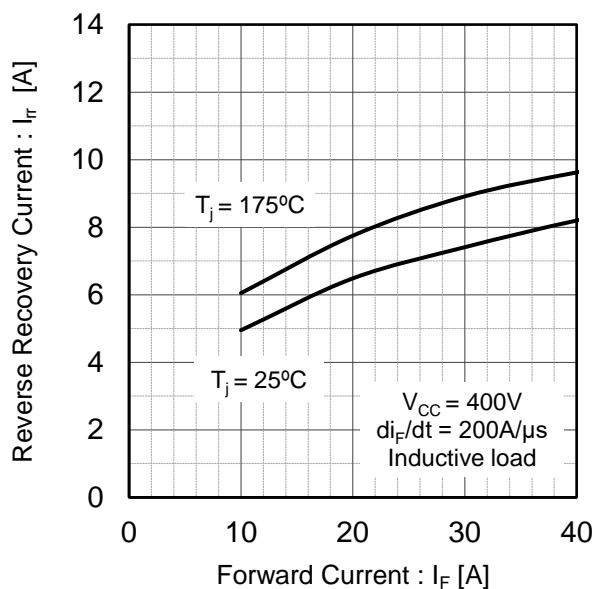
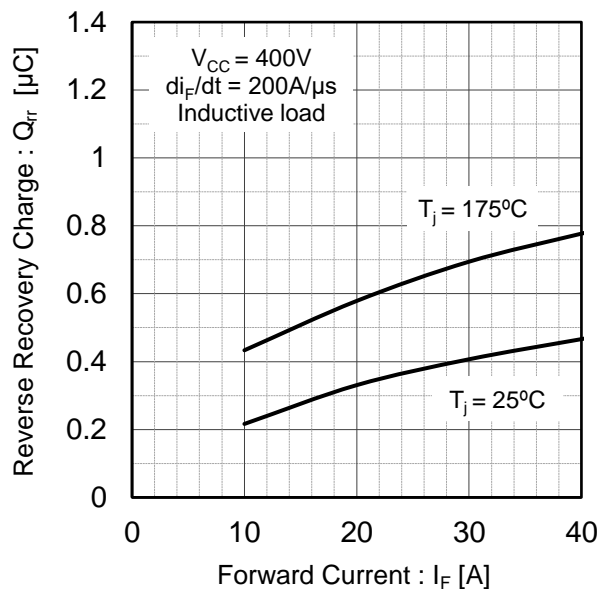


Fig.24 Typical Diode Reverse Recovery Charge vs. Forward Current



# ●Electrical Characteristic Curves

Fig.25 Typical IGBT Transient Thermal Impedance

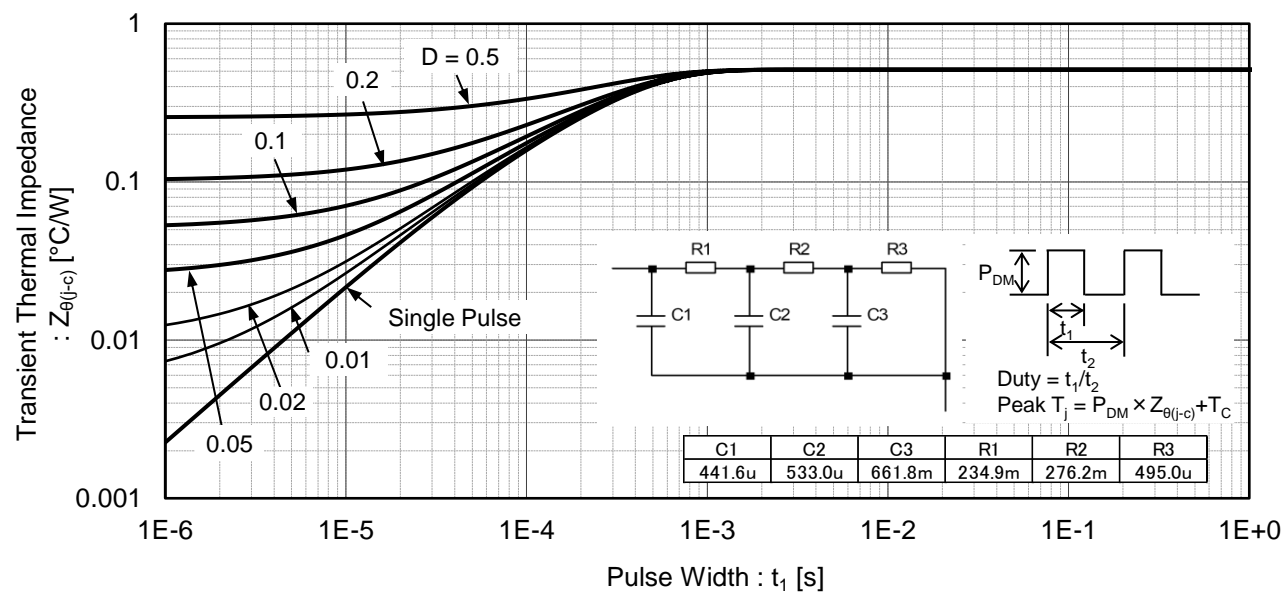
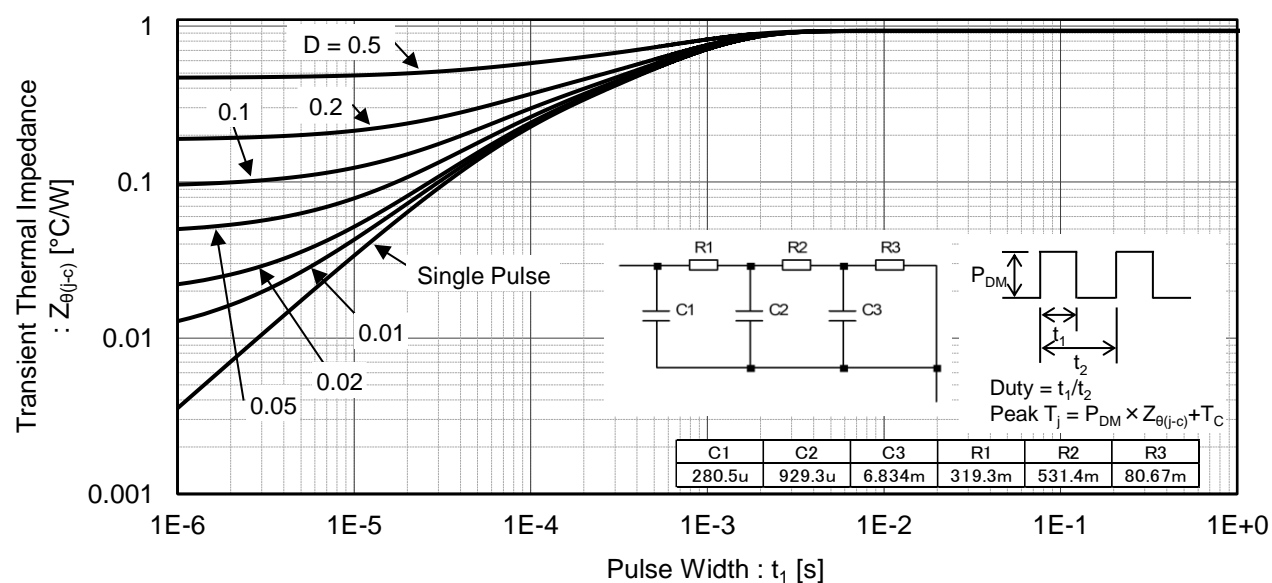


Fig.26 Typical Diode Transient Thermal Impedance



# Inductive Load Switching Circuit and Waveform

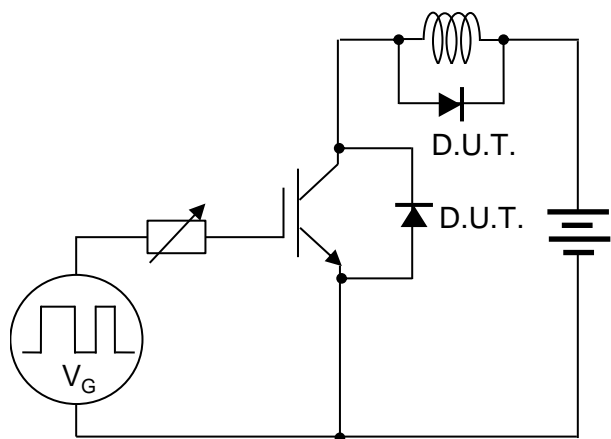


Fig.27 Inductive Load Circuit

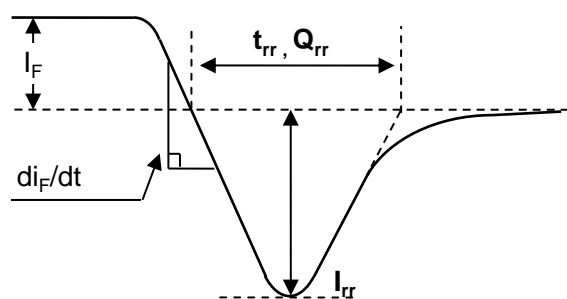


Fig.29 Diode Reverse Recovery Waveform

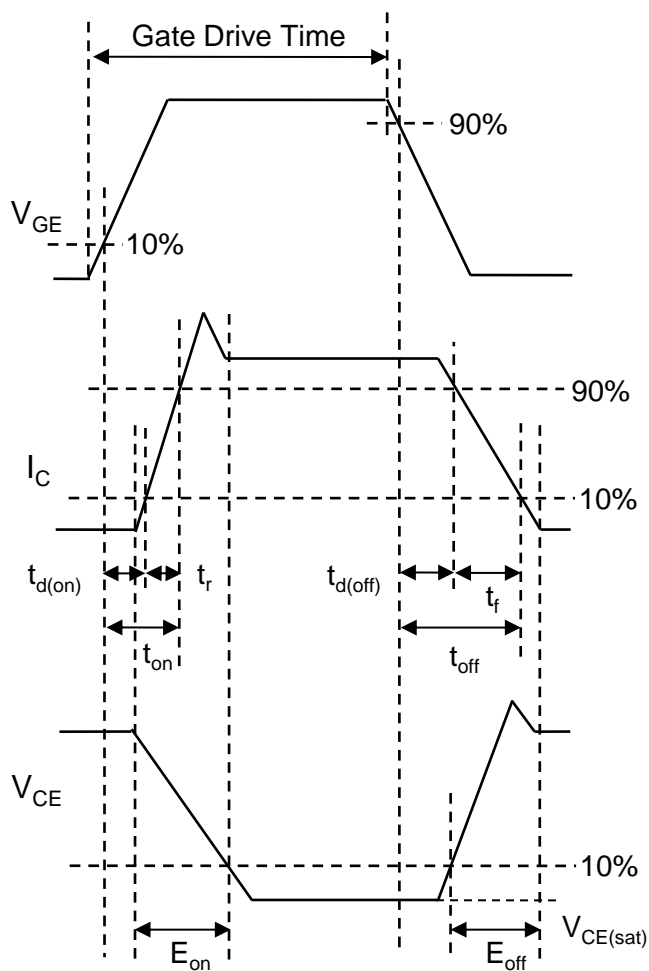


Fig.28 Inductive Load Waveform

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