

$V_{CES}$	650V
$I_C$	60A
$V_{CE(sat)}$ (Typ.)	1.55V
$P_D$	277W

### ●Features

- 1) Qualified to AEC-Q101
- 2) Short Circuit Withstand Time 7 $\mu$ s
- 3) Low Collector - Emitter Saturation Voltage
- 4) Built in Very Fast & Soft Recovery FRD
- 5) Pb - free Lead Plating ; RoHS Compliant

### ●Application

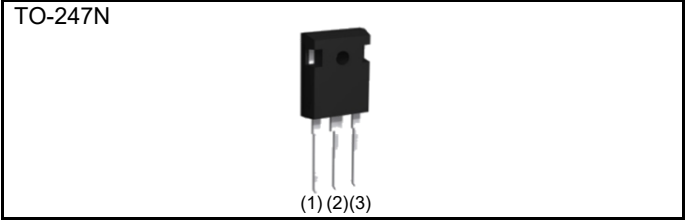
General Inverter

for Automotive and Industrial Use

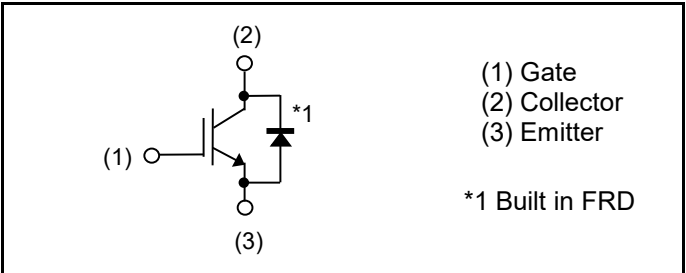
Heater for Automotive

Relay Circuit (ex. Pre Charge Relay)

### ●Outline



### ●Inner Circuit



### ●Packaging Specifications

Type	Packaging	Tube
	Reel Size (mm)	-
	Tape Width (mm)	-
	Basic Ordering Unit (pcs)	450
	Packing Code	C11
	Marking	RGAX2TS65E

### ●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	$V_{GES}^{*1}$	$\pm 30$	V	
Collector Current	$T_C = 25^\circ\text{C}$	$I_C$	93	A
	$T_C = 100^\circ\text{C}$	$I_C$	60	A
Pulsed Collector Current	$I_{CP}^{*2}$	180	A	
Diode Forward Current	$T_C = 25^\circ\text{C}$	$I_F$	83	A
	$T_C = 100^\circ\text{C}$	$I_F$	50	A
Diode Pulsed Forward Current	$I_{FP}^{*2}$	180	A	
Power Dissipation	$T_C = 25^\circ\text{C}$	$P_D$	277	W
	$T_C = 100^\circ\text{C}$	$P_D$	138	W
Operating Junction Temperature	$T_j$	-40 to +175	$^\circ\text{C}$	
Storage Temperature	$T_{stg}$	-55 to +175	$^\circ\text{C}$	

\*1 Please be advised not to use IGBTs with VGE below 10V as doing so may cause thermal runaway.

\*2 Pulse width limited by  $T_{jmax}$ .

### ● Thermal Resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal Resistance IGBT Junction - Case	$R_{\theta(j-c)}$	-	-	0.54	°C/W
Thermal Resistance Diode Junction - Case	$R_{\theta(j-c)}$	-	-	0.80	°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	$BV_{CES}$	$I_C = 1\mu\text{A}, V_{GE} = 0\text{V}$	650	-	-	V
Collector Cut - off Current	$I_{CES}$	$V_{CE} = 650\text{V}, V_{GE} = 0\text{V},$ $T_j = 25^\circ\text{C}$	-	-	1	$\mu\text{A}$
		$T_j = 175^\circ\text{C}$	-	200	-	$\mu\text{A}$
Gate - Emitter Leakage Current	$I_{GES}$	$V_{GE} = \pm 30\text{V}, V_{CE} = 0\text{V}$	-	-	$\pm 500$	nA
Gate - Emitter Threshold Voltage	$V_{GE(th)}$	$V_{CE} = 5\text{V}, I_C = 14.2\text{mA}$	5.2	6.0	6.8	V
Collector - Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 60\text{A}, V_{GE} = 15\text{V},$ $T_j = 25^\circ\text{C}$	-	1.55	1.85	V
		$T_j = 175^\circ\text{C}$	-	2.00	-	V

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

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input Capacitance	$C_{ies}$	$V_{CE} = 30\text{V}$ ,	-	4500	-	pF
Output Capacitance	$C_{oes}$	$V_{GE} = 0\text{V}$ ,	-	166	-	
Reverse transfer Capacitance	$C_{res}$	$f = 1\text{MHz}$	-	37	-	
Total Gate Charge	$Q_g$	$V_{CE} = 400\text{V}$ ,	-	165	-	nC
Gate - Emitter Charge	$Q_{ge}$	$I_C = 60\text{A}$ ,	-	48	-	
Gate - Collector Charge	$Q_{gc}$	$V_{GE} = 15\text{V}$	-	74	-	
Turn - on Delay Time	$t_{d(on)}$	$I_C = 60\text{A}$ , $V_{CC} = 400\text{V}$ , $V_{GE} = 15\text{V}$ , $R_G = 10\Omega$ , $T_j = 25^\circ\text{C}$ Inductive Load * $E_{on}$ does not include diode reverse recovery	-	60	-	ns
Rise Time	$t_r$		-	35	-	
Turn - off Delay Time	$t_{d(off)}$		-	209	-	
Fall Time	$t_f$		-	77	-	
Turn-on Switching Loss	$E_{on}$		-	2.06	-	
Turn-off Switching Loss	$E_{off}$	-	1.30	-		
Turn - on Delay Time	$t_{d(on)}$	$I_C = 60\text{A}$ , $V_{CC} = 400\text{V}$ , $V_{GE} = 15\text{V}$ , $R_G = 10\Omega$ , $T_j = 175^\circ\text{C}$ Inductive Load * $E_{on}$ does not include diode reverse recovery	-	61	-	ns
Rise Time	$t_r$		-	43	-	
Turn - off Delay Time	$t_{d(off)}$		-	224	-	
Fall Time	$t_f$		-	118	-	
Turn-on Switching Loss	$E_{on}$		-	2.38	-	
Turn-off Switching Loss	$E_{off}$	-	1.71	-		
Reverse Bias Safe Operating Area	$RBSOA^{*2}$	$I_C = 180\text{A}$ , $V_{CC} = 550\text{V}$ , $V_p = 650\text{V}$ , $V_{GE} = 15\text{V}$ , $R_G = 50\Omega$ , $T_j = 175^\circ\text{C}$	FULL SQUARE			-
Short Circuit Withstand Time	$t_{sc}$	$V_{GE} = 15\text{V}$ , $T_j = 25^\circ\text{C}$ ,	7	-	-	$\mu\text{s}$
		$V_{CC} \leq 360\text{V}^{*2}$ $V_{CC} \leq 400\text{V}$	6.5	-	-	$\mu\text{s}$
Short Circuit Withstand Time	$t_{sc}^{*2}$	$V_{GE} = 15\text{V}$ , $T_j = 150^\circ\text{C}$ , $V_{CC} \leq 400\text{V}$	5	-	-	$\mu\text{s}$

\*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	$V_F$	$I_F = 60\text{A}$ , $T_j = 25^\circ\text{C}$ $T_j = 175^\circ\text{C}$	- -	1.50 1.60	1.85 -	V
Diode Reverse Recovery Time	$t_{rr}$		-	135	-	ns
Diode Peak Reverse Recovery Current	$I_{rr}$	$I_F = 60\text{A}$ , $V_{CC} = 400\text{V}$ ,	-	16.7	-	A
Diode Reverse Recovery Charge	$Q_{rr}$	$di_F/dt = 500\text{A}/\mu\text{s}$ , $T_j = 25^\circ\text{C}$	-	1.2	-	$\mu\text{C}$
Diode Reverse Recovery Energy	$E_{rr}$		-	213	-	$\mu\text{J}$
Diode Reverse Recovery Time	$t_{rr}$		-	194	-	ns
Diode Peak Reverse Recovery Current	$I_{rr}$	$I_F = 60\text{A}$ , $V_{CC} = 400\text{V}$ ,	-	21.0	-	A
Diode Reverse Recovery Charge	$Q_{rr}$	$di_F/dt = 500\text{A}/\mu\text{s}$ , $T_j = 175^\circ\text{C}$	-	2.5	-	$\mu\text{C}$
Diode Reverse Recovery Energy	$E_{rr}$		-	531	-	$\mu\text{J}$

●Electrical Characteristic Curves

Fig.1 Power Dissipation vs. Case Temperature

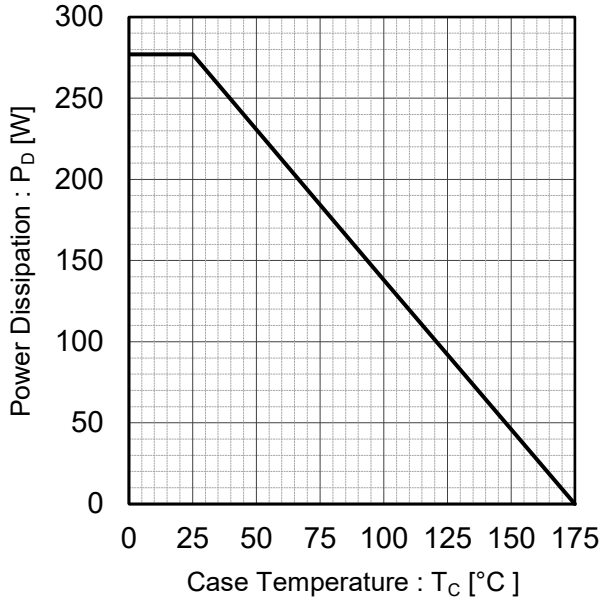


Fig.2 Collector Current vs. Case Temperature

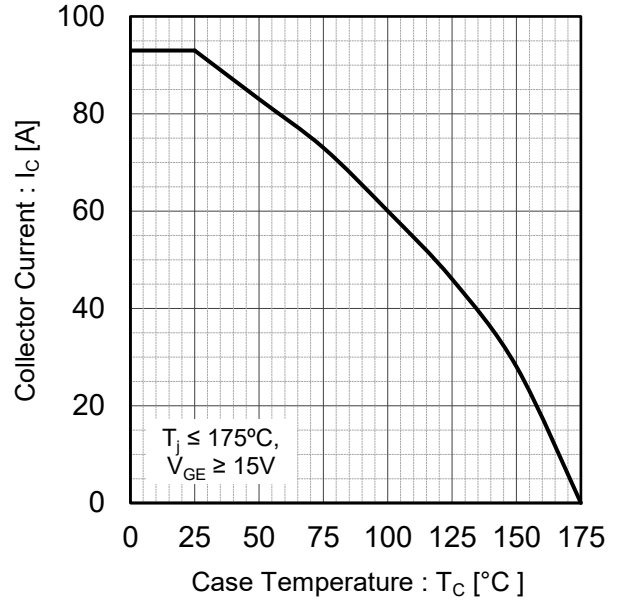


Fig.3 Forward Bias Safe Operating Area

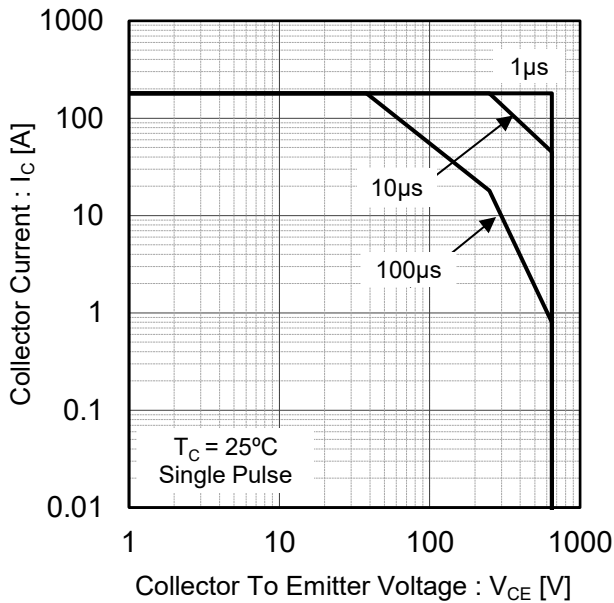
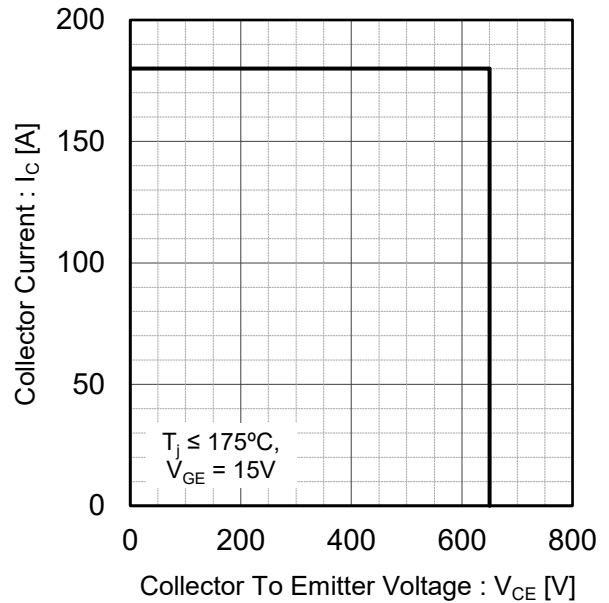


Fig.4 Reverse Bias Safe Operating Area



●Electrical Characteristic Curves

Fig.5 Typical Output Characteristics

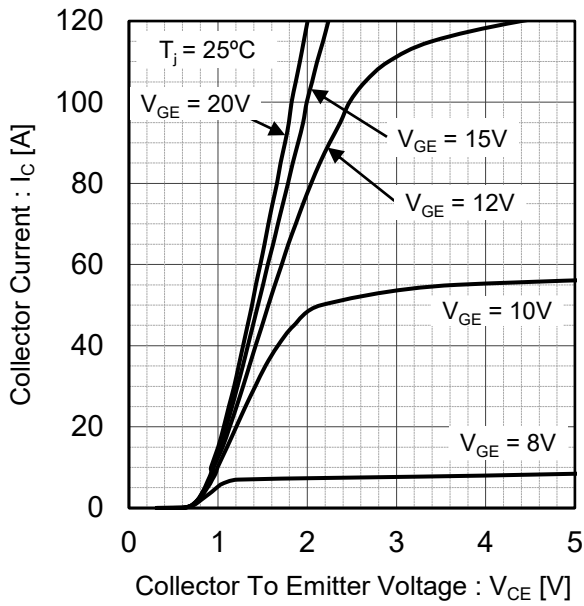


Fig.6 Typical Output Characteristics

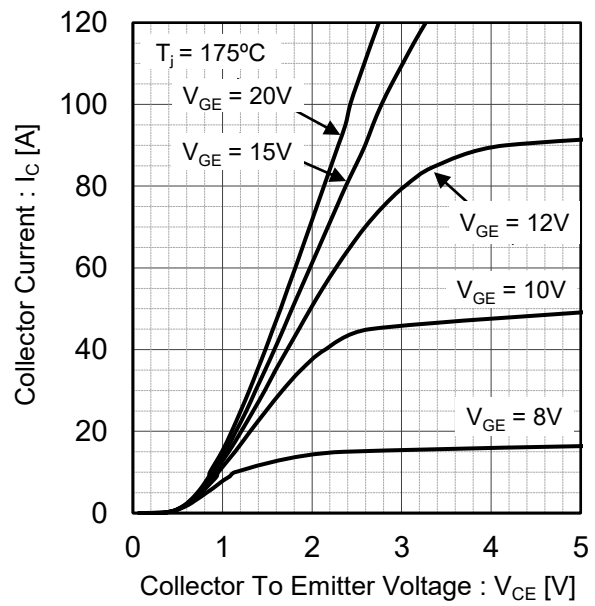


Fig.7 Typical Transfer Characteristics

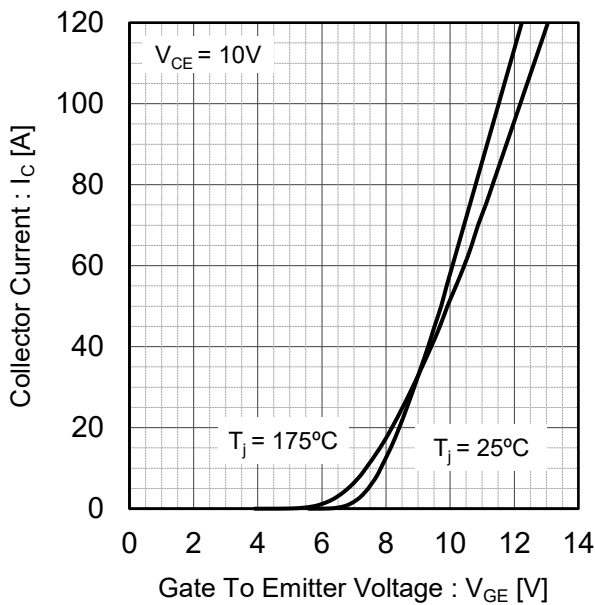
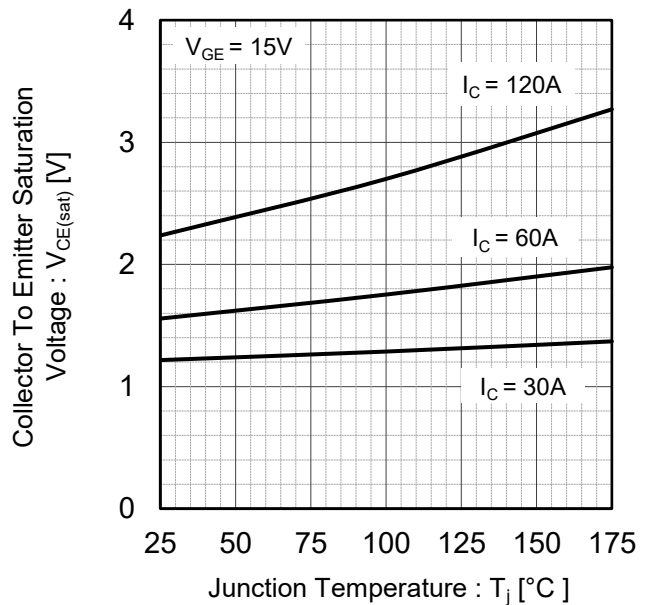


Fig.8 Typical Collector To Emitter Saturation Voltage vs. Junction Temperature



●Electrical Characteristic Curves

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

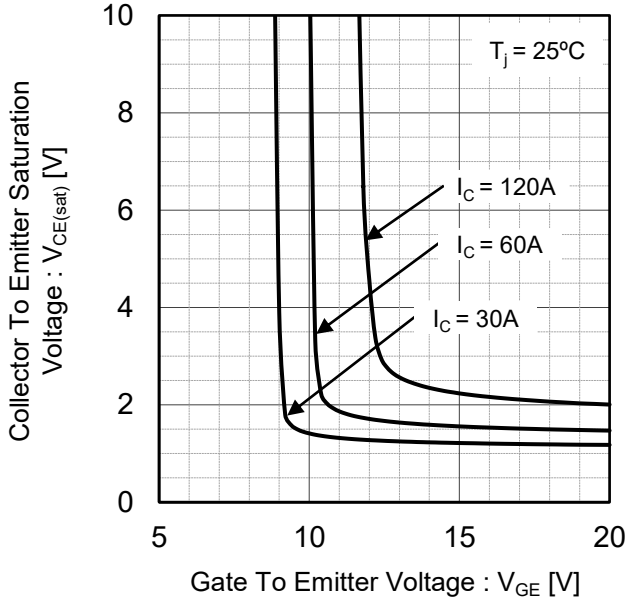


Fig.10 Typical Collector To Emitter Saturation Voltage vs. Gate To Emitter Voltage

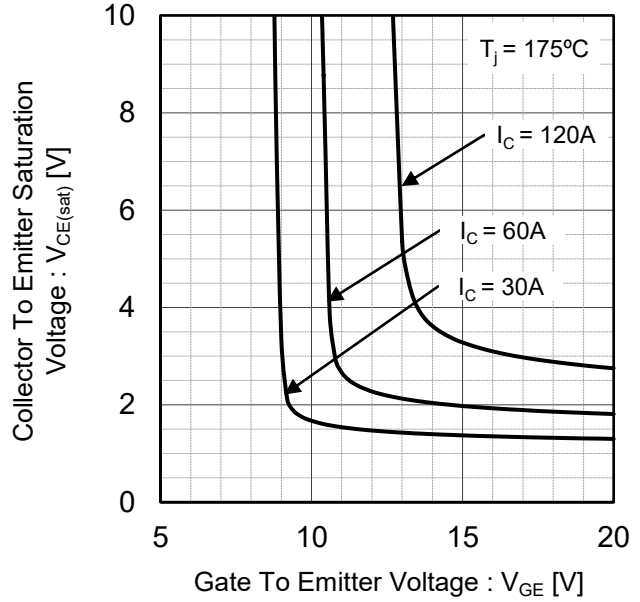


Fig.11 Typical Capacitance vs. Collector To Emitter Voltage

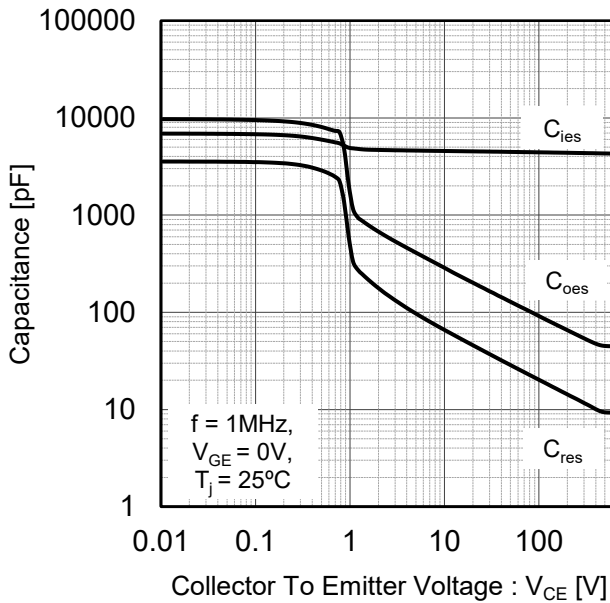
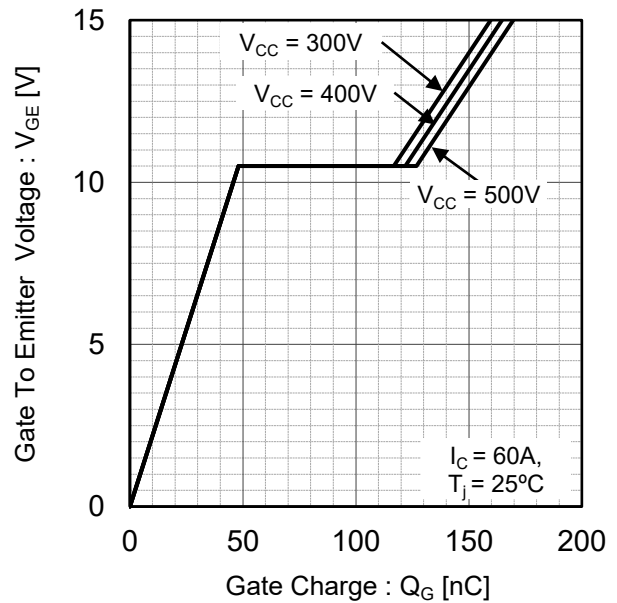


Fig.12 Typical Gate Charge



●Electrical Characteristic Curves

Fig.13 Typical Switching Time vs. Collector Current

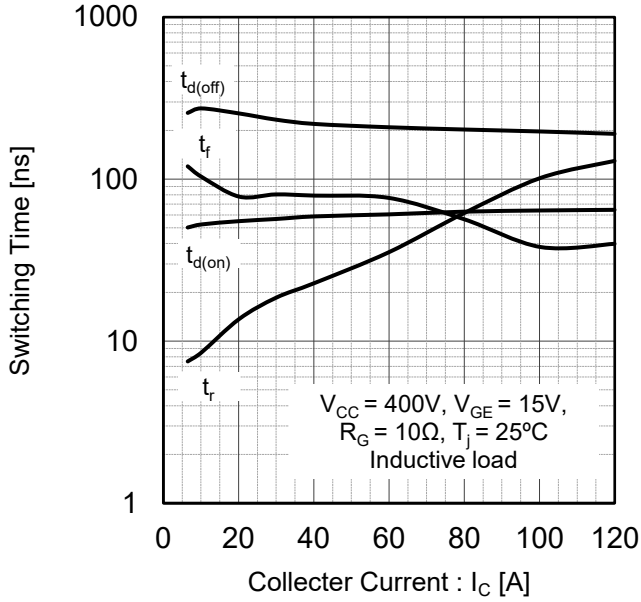


Fig.14 Typical Switching Time vs. Gate Resistance

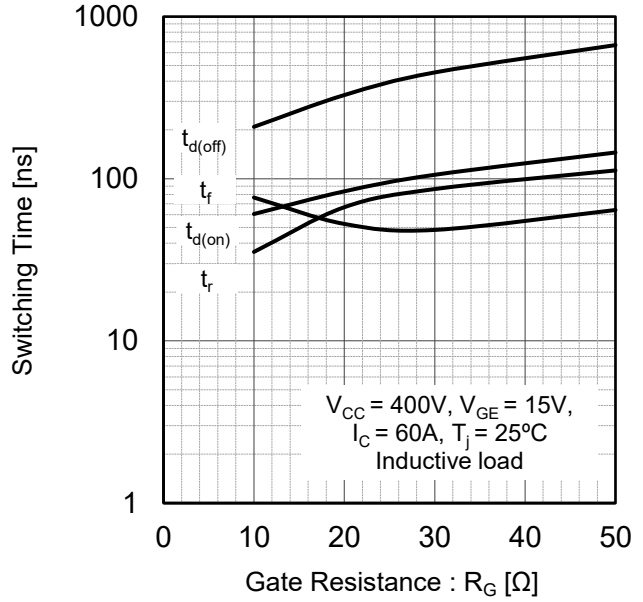


Fig.15 Typical Switching Energy Losses vs. Collector Current

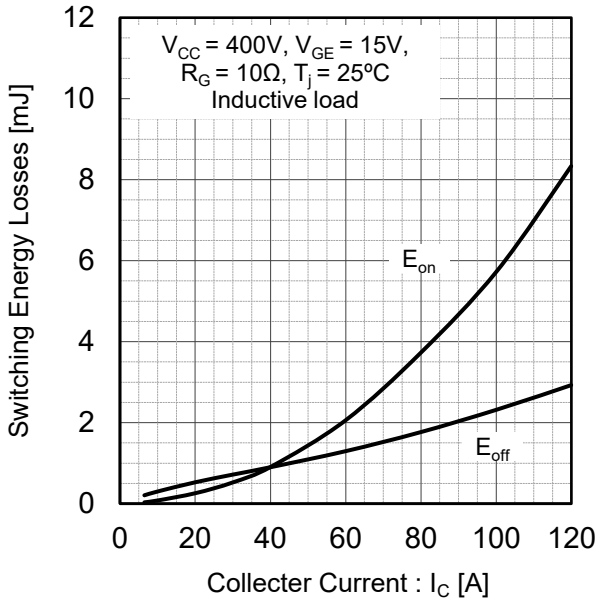
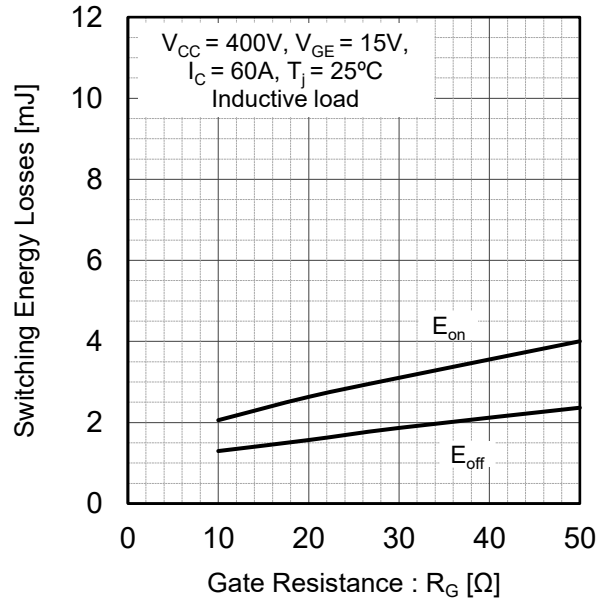


Fig.16 Typical Switching Energy Losses vs. Gate Resistance



●Electrical Characteristic Curves

Fig.17 Typical Switching Time vs. Collector Current

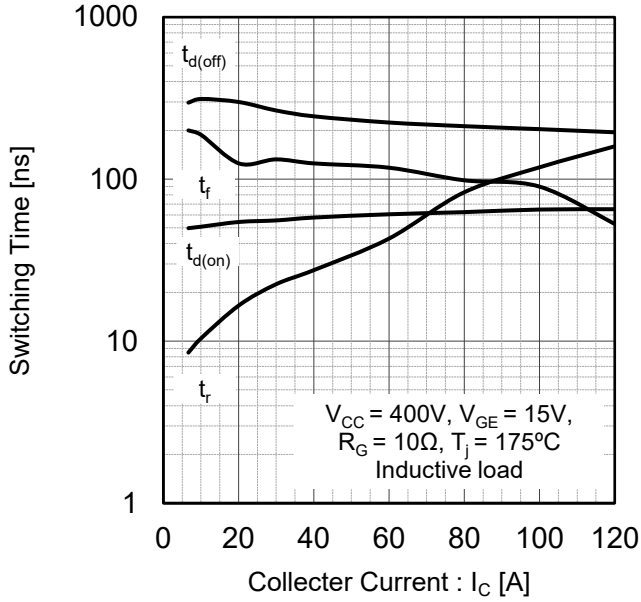


Fig.18 Typical Switching Time vs. Gate Resistance

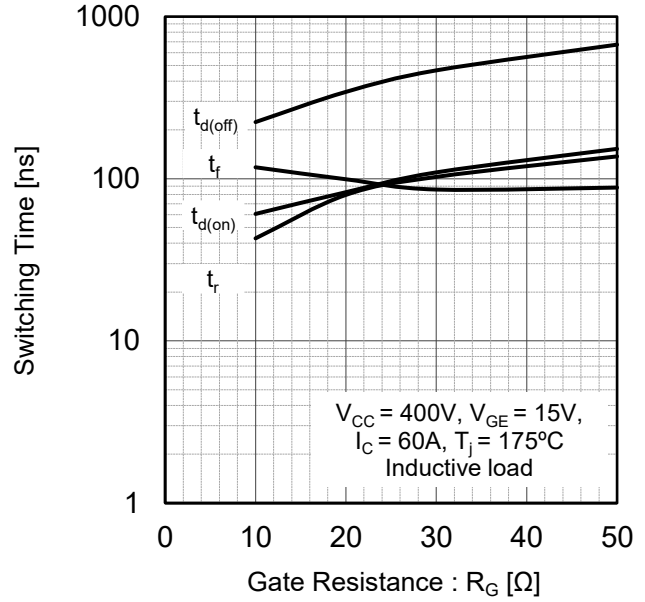


Fig.19 Typical Switching Energy Losses vs. Collector Current

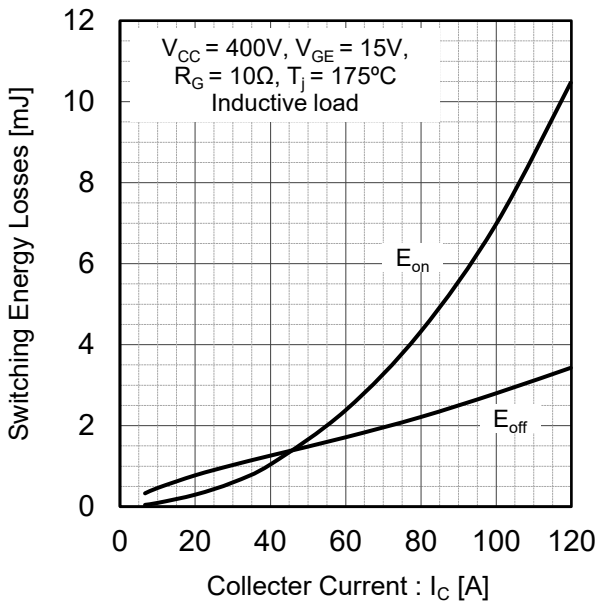
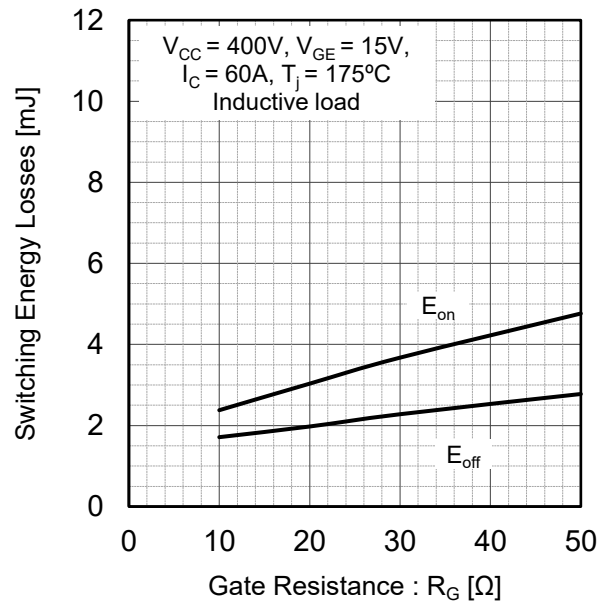


Fig.20 Typical Switching Energy Losses vs. Gate Resistance



●Electrical Characteristic Curves

Fig.21 Typical Diode Forward Current vs. Forward Voltage

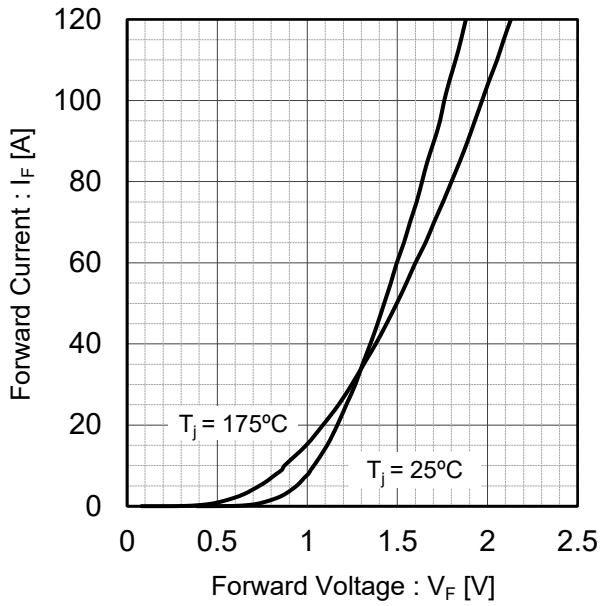


Fig.22 Typical Diode Reverse Recovery Time vs. Forward Current

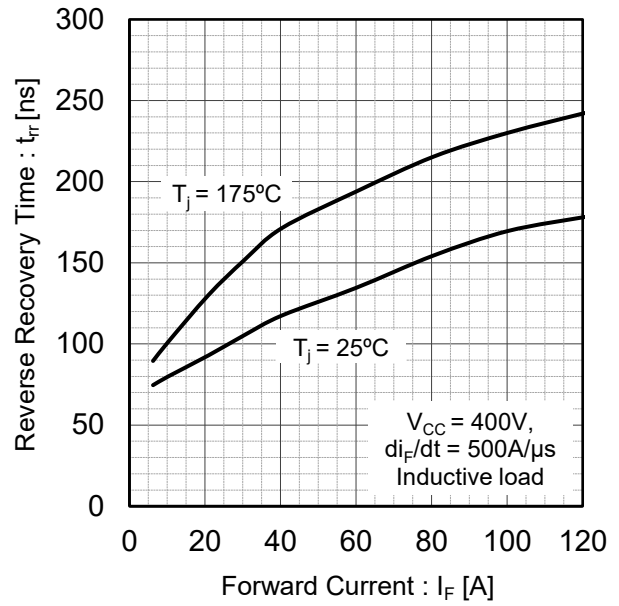


Fig.23 Typical Diode Reverse Recovery Current vs. Forward Current

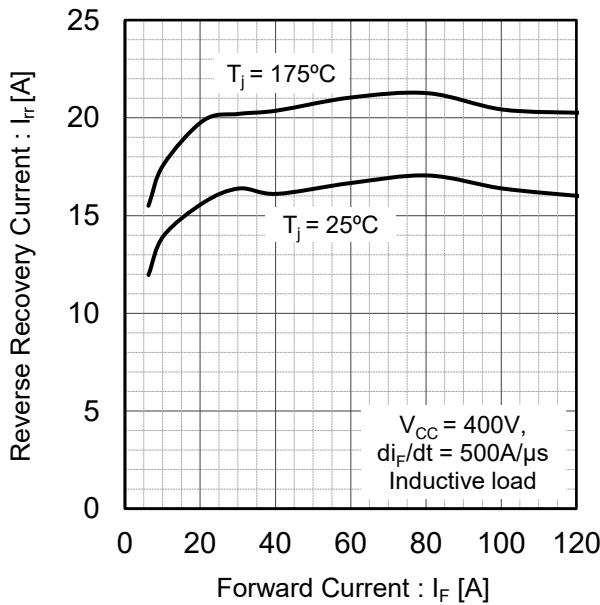
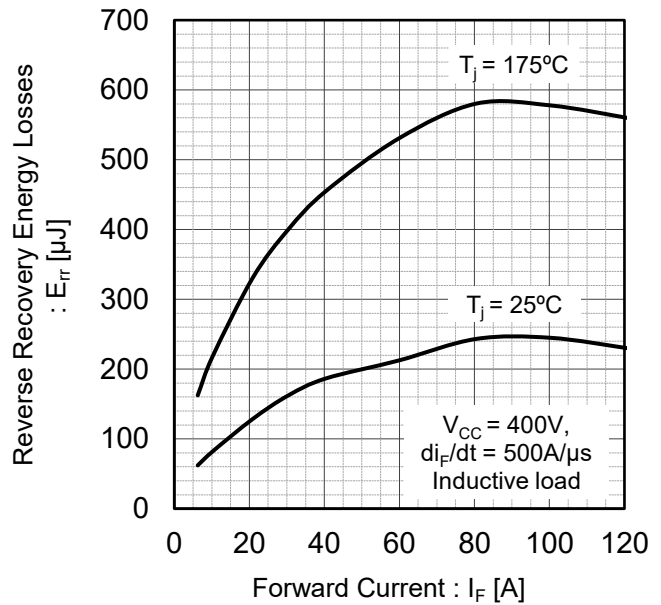


Fig.24 Typical Diode Reverse Recovery Energy Losses vs. Forward Current



●Electrical Characteristic Curves

Fig.25 Typical IGBT Transient Thermal Impedance

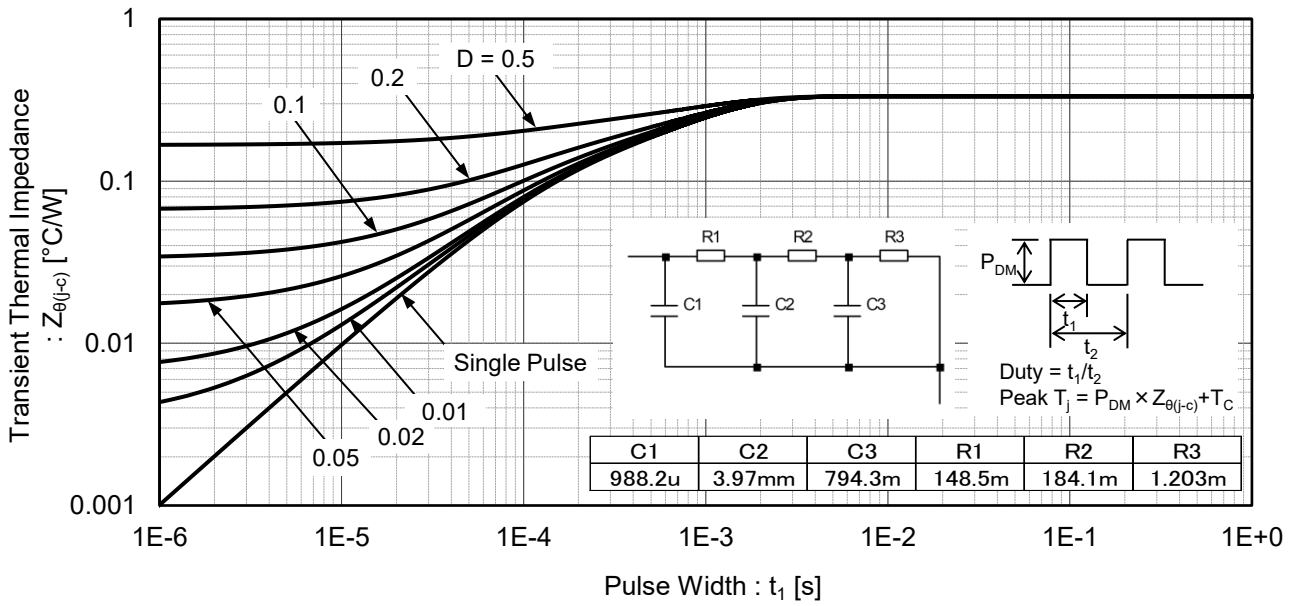
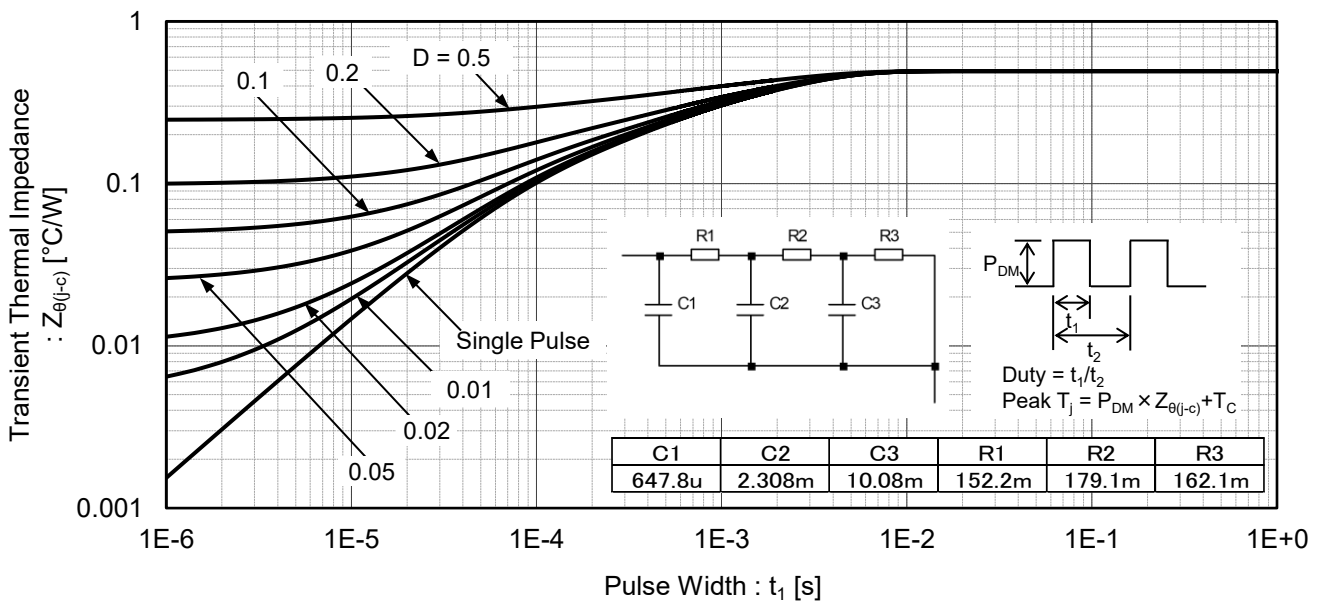


Fig.26 Typical Diode Transient Thermal Impedance



● Inductive Load Switching Circuit and Waveform and Short Circuit

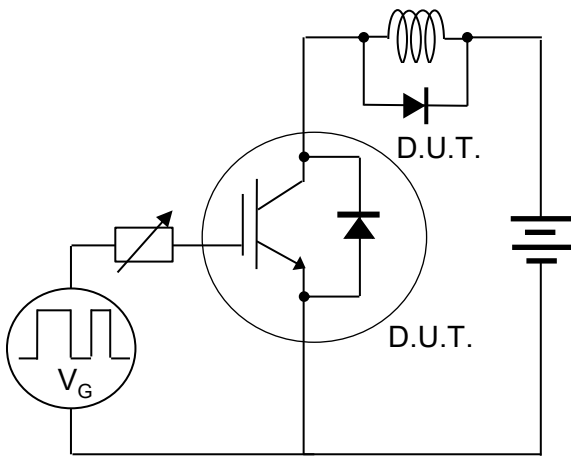


Fig.27 Inductive Load Circuit

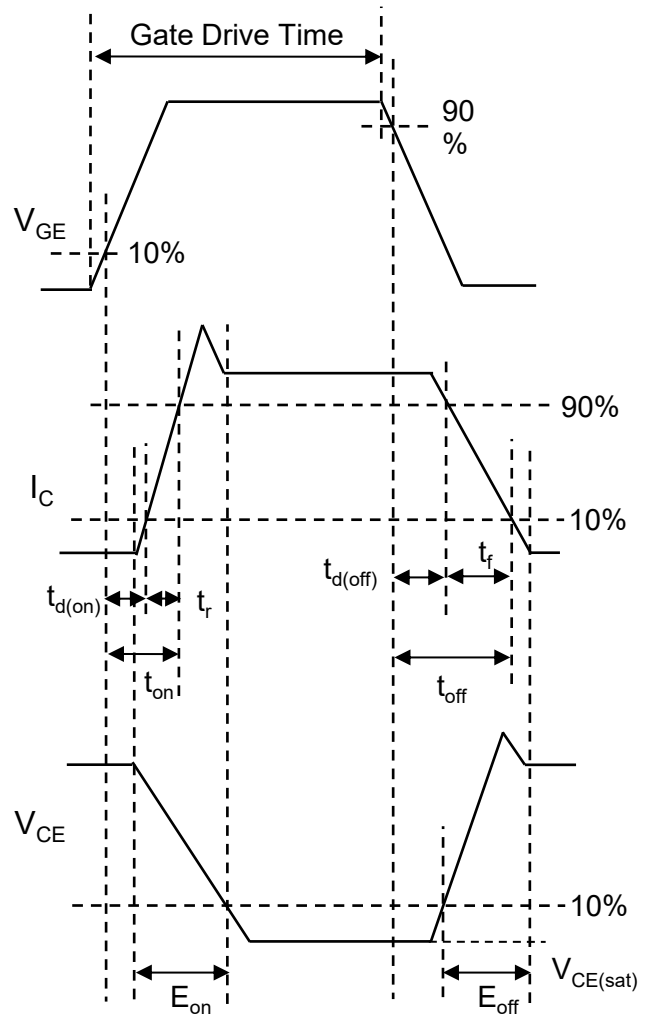


Fig.29 Inductive Load Waveform

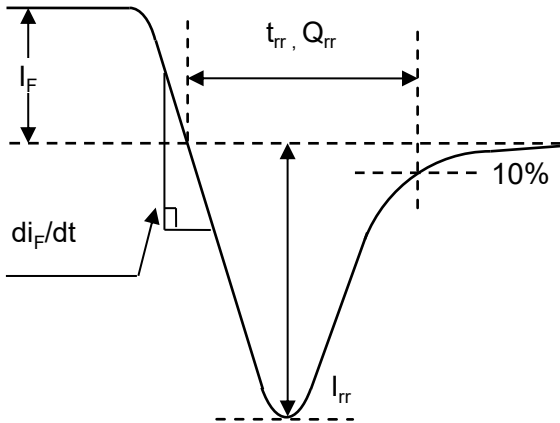


Fig.28 Diode Reverse Recovery Waveform

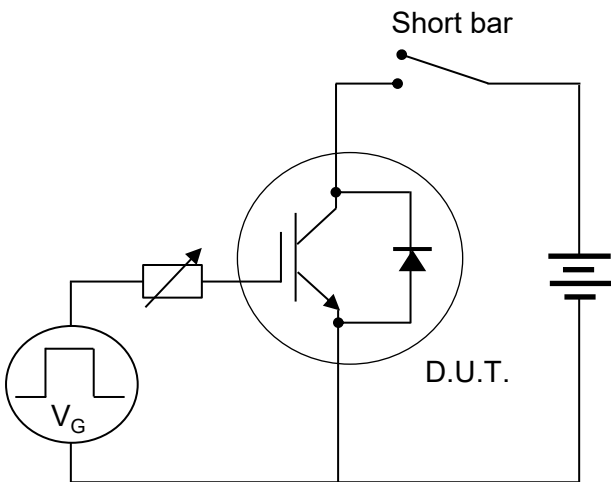


Fig.30 Short Circuit

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