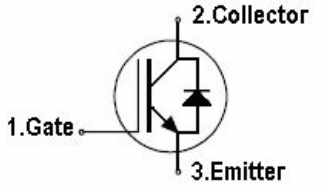
TSG48N60

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

DRAWING

G C E



Features

- Low $V_{CE\ (ON)}$ Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5 µS short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current (I_{LM})
- Positive $V_{CE\ (ON)}$ Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package

Benefits

- Package:TO-247
- High Efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to Low $V_{CE\ (ON)}$ and Low Switching losses
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI

Absolute Maximum Ratings

Symbol	Parameter		Spec	Units
V_{CES}	Collector-Emitter Voltage		600	V
V_{GES}	Gate-Emitter Voltage		±20	V
	Transient Gate-to-Emitter Voltage		±30	V
I_C	Collector Current	T_C=25℃	96	A
	Collector Current	T_C=100℃	48	
I_{CM}	Pulsed Collector Current		200	
I_{LM}	Clamped Inductive Load Current. (Note 1)		192	
I_F	Diode Continuous Forward Current	T_C=25℃	96	
		T_C=100℃	48	
I_{FM}	Diode Maximum Forward Current. (Note 2)		192	
P_D	Maximum Power Dissipation	T_C=25℃	330	W
		T_C=100℃	170	
T_J	Operating Junction Temperature		-55 to +175	℃
T_{STG}	Storage Temperature Range		-55 to +175	
	Soldering Temperature, for 10 sec.		300 (0.063 in. (1.6mm) from case)	

Thermal Characteristics

Symbol	Parameter	Spec	Units
R_{θ} j-c	Thermal Resistance, Junction to case for IGBT	0.45	℃/W
R_{θ} j-c	Thermal Resistance, Junction to case for Diode	0.92	
R_{θ} j-a	Thermal Resistance, Junction to Ambient	40	

Electrical Characteristics (T_J=25℃ unless otherwise noted)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Units
BV_{CES}	Collector-Emitter Breakdown Voltage	V_{GE}= 0V, I_C= 150uA		600			V
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	V_{GE}= 0V, I_C=1mA,(25℃to175℃)		–	0.3	–	V/℃
I_{CES}	Collector-to-Emitter Leakage Current	V_{CE}=600V, V_{GE}= 0V			1.0	150	uA
		T_J =175℃, V_{CE}=600V, V_{GE}= 0V			450	1000	
I_{GES}	G-E Leakage Current	V_{GE}=±20V				±100	nA
gfe	Forward Transconductance	V_{CE}=50V, I_C=48A,PW=80us			32		S
V_{FM}	Diode Forward Voltage Drop	I_F=48A			1.95	2.91	V
		I_F=48A,T_J =175℃			1.45		
$V_{GE(th)}$	G-E Threshold Voltage	I_C= 1.4mA, V_{CE}=V_{GE}		4.0		6.5	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE}=15V, I_C= 48A	Tj=25℃		1.65	2.14	V
			Tj=150℃		2.0		
			Tj=175℃		2.05		
Switching Characteristics @ TJ = 25°C (unless otherwise specified)							
Cies	Input Capacitance	V_{CE}=30V			3025		pF
Coes	Output Capacitance	V_{GE}=0V			245		
Cres	Reverse Transfer Capacitance	f = 1MHz			90		
t d(on)	Turn-on Delay Time	V_{CC}=400V,I_C=48A			60	78	ns
t r	Turn-on Rise Time	V_{GE}=15V,R_G=10 Ω			40	56	
t d(off)	Turn-off Delay Time	L = 200μH, Ls = 150nH,			145	176	
t f	Turn-off Fall Time	T_J=25℃			35	46	
Eon	Turn-on Switching Loss	V_{CC}=400V,I_C=48A,V_{GE}=15V,			625	1141	uJ
Eoff	Turn-off Switching Loss	R_G=10 Ω ,L = 200μH,			1275	1481	
Ets	Total Switching Loss	Ls = 150nH, T_J=25℃ Energy losses include tail & diode reverse recovery			1900	2622	
t d(on)	Turn-on Delay Time	V_{CC}=400V,I_C=48A			55		ns
t r	Turn-on Rise Time	V_{GE}=15V,R_G=10 Ω			45		
t d(off)	Turn-off Delay Time	L = 200μH, Ls = 150nH,			165		
t f	Turn-off Fall Time	T_J=175℃			45		
Eon	Turn-on Switching Loss	V_{CC}=400V,I_C=48A,V_{GE}=15V,			1625		uJ
Eoff	Turn-off Switching Loss	R_G=10 Ω ,L = 200μH,			1585		
Ets	Total Switching Loss	Ls = 150nH, T_J=175℃ Energy losses include tail & diode			3210		

		reverse recovery				
Qg	Total Gate Charge(turn-on)	V_{CE}=400V		95	140	nC
Qge	Gate to Emitter Charge(turn-on)	V_{GE}=15V		28	42	nC
Qgc	Gate to Collector Charge(turn-on)	I_C=48A		35	53	nC
RBSOA	Reverse Bias Safe Operating Area	V_{CC}=480V,I_C=192A,V_P=600V, R_G=10 Ω , V_{GE}=+15V to 0V T_J=175℃	FULL SQUARE			
SCSOA	Short Circuit Safe Operating Area	V_{CC}=400V,V_P=600V, R_G=10 Ω , V_{GE}=+15V to 0V	5			us
Erce	Reverse Recovery Energy of the Diode	V_{CC}=400V,I_C=48A		845		uJ
t_{rr}	Diode Reverse Recovery Time	V_{GE}=15V,R_G=10 Ω		115		ns
I_{rr}	Peak Reverse Recovery Current	L = 200μH, Ls = 150nH, T_J=175℃		40		A

Notes:

1.V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 200μH, R_G = 10 Ω .

2. Pulse width limited by max. junction temperature.

Typical Characteristics

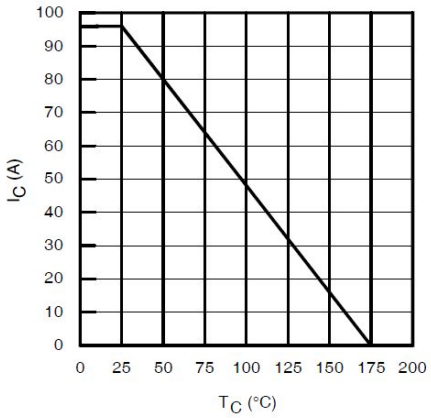


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

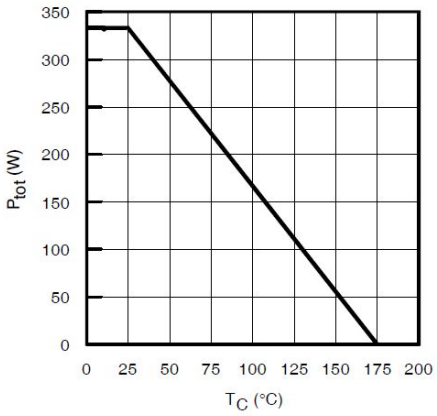


Fig. 2 - Power Dissipation vs. Case Temperature

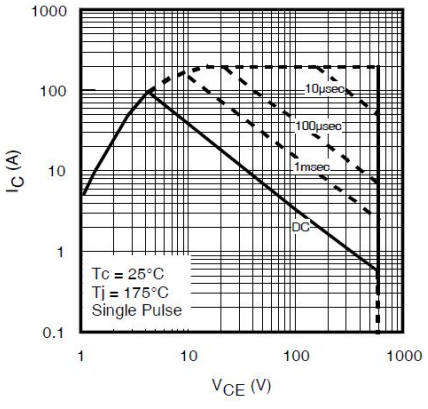


Fig. 3 - Forward SOA
T_C = 25°C, $T_J \leq$ 175°C; V_{GE} =15V

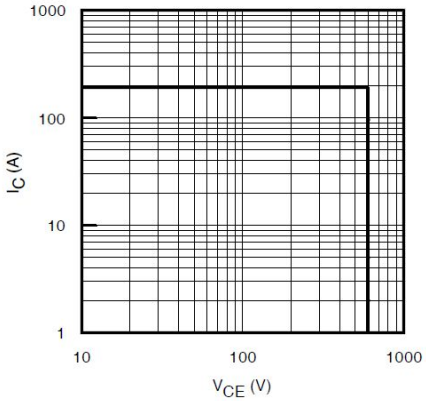


Fig. 4 - Reverse Bias SOA
T_J = 175°C; V_{GE} =15V

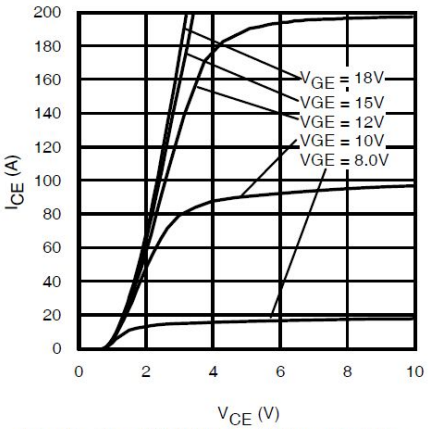


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

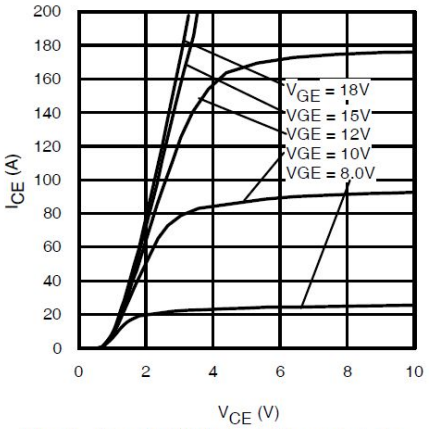


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

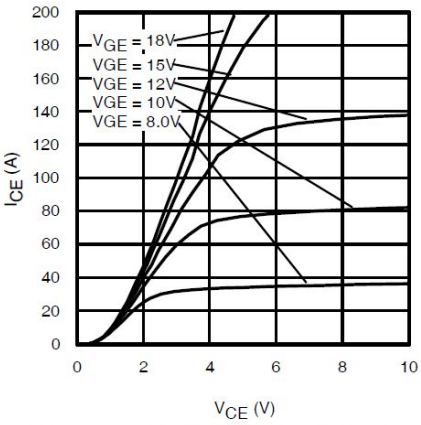


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

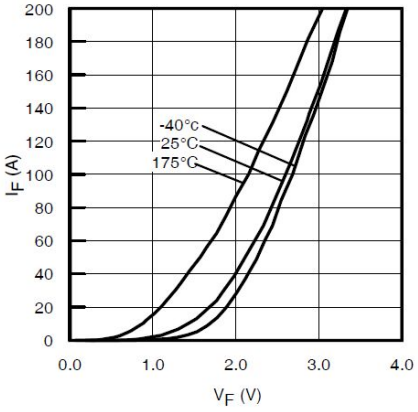


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

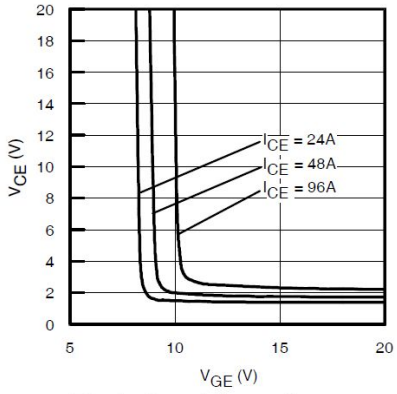


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

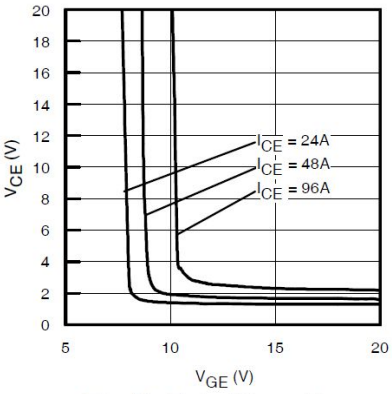


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

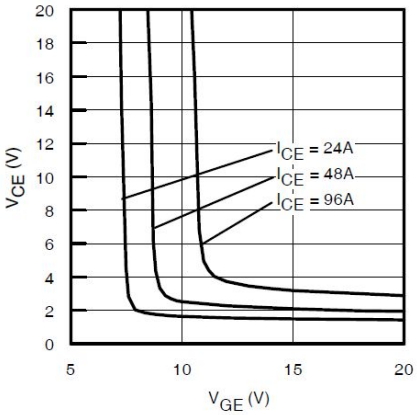


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

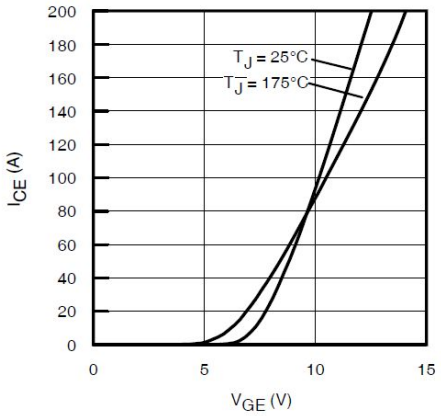


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

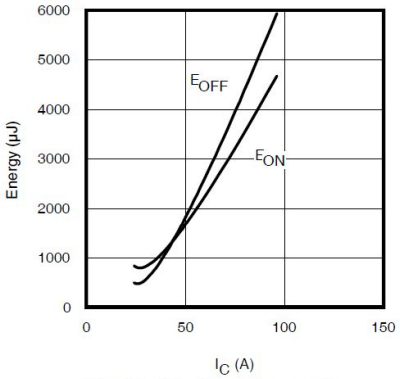


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 200µH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

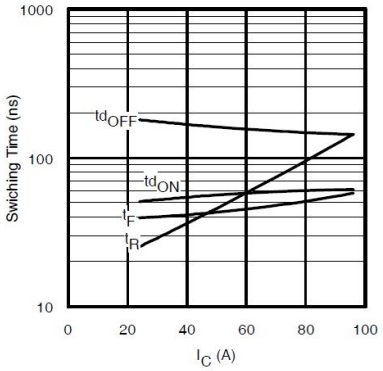


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 175°C; L = 200µH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

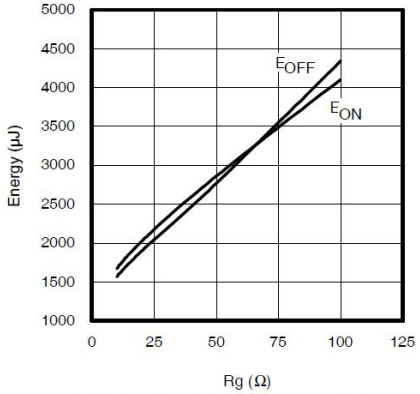


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 200µH; V_{CE} = 400V, I_{CE} = 48A; V_{GE} = 15V

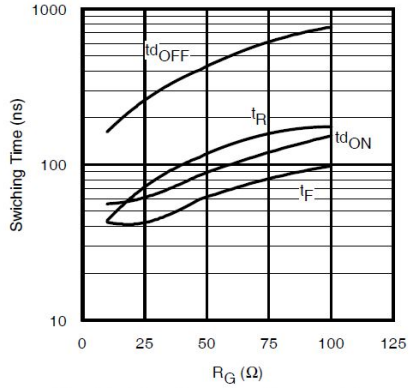


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 175°C; L = 200µH; V_{CE} = 400V, I_{CE} = 48A; V_{GE} = 15V

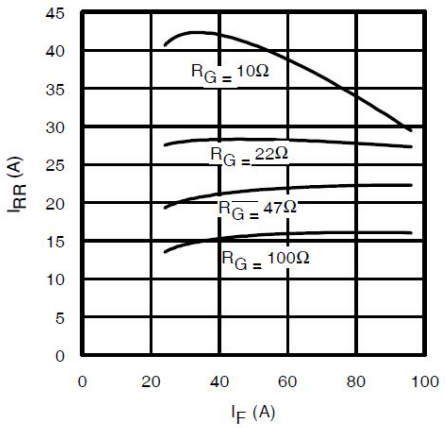


Fig. 17 - Typ. Diode I_{RR} vs. I_F
T_J = 175°C

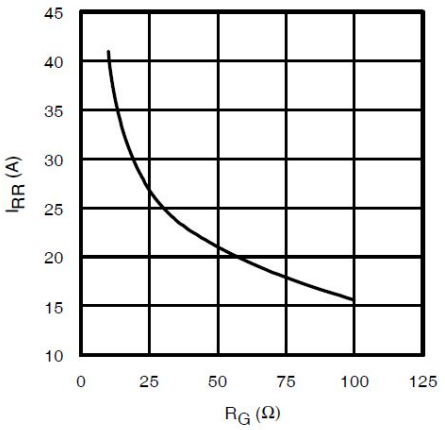


Fig. 18 - Typ. Diode I_{RR} vs. R_G
T_J = 175°C

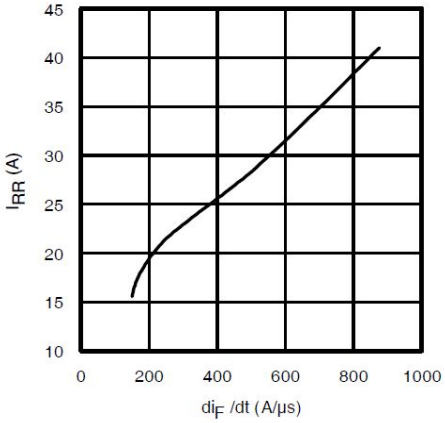


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 48A; T_J = 175°C

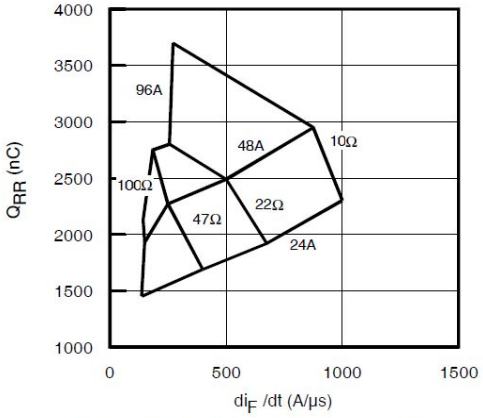


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C

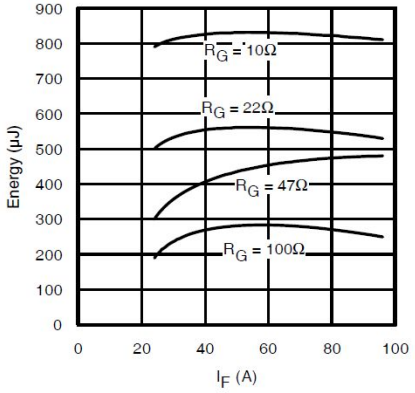


Fig. 21 - Typ. Diode E_{RR} vs. I_F
T_J = 175°C

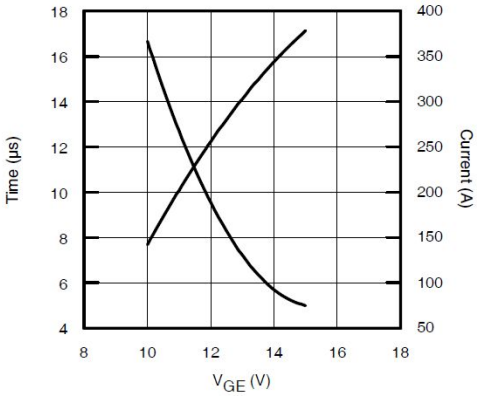


Fig. 22 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

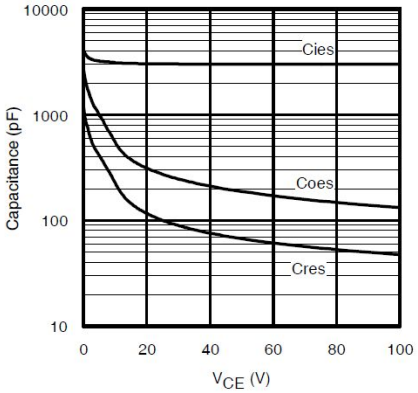


Fig. 23 - Typ. Capacitance vs. VCE

VGE= 0V; f = 1MHz

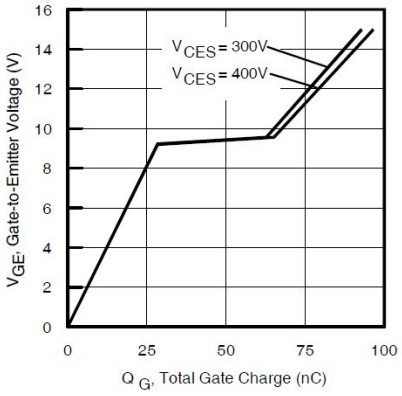


Fig. 24 - Typical Gate Charge vs. VGE

ICE = 48A; L = 600µH

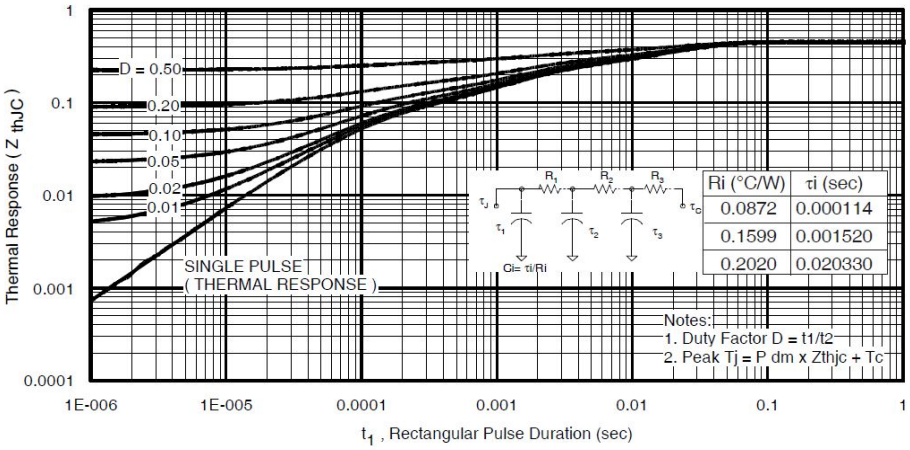


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

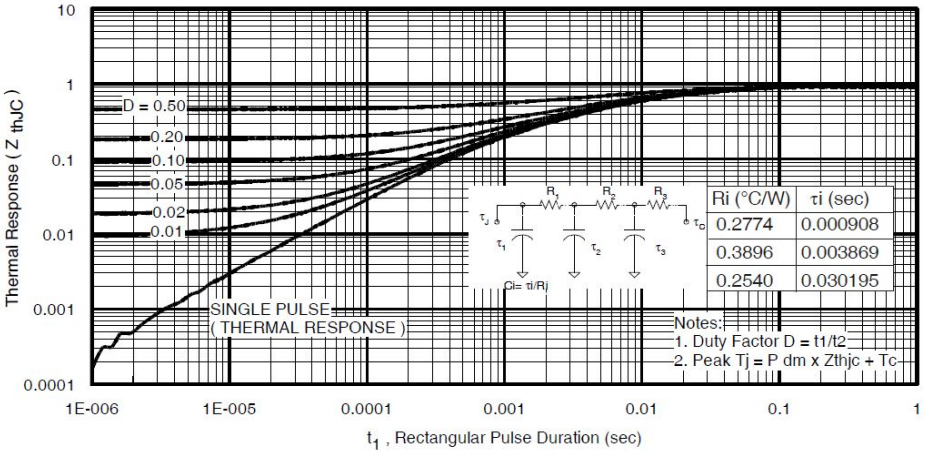


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

Test circuits and waveforms

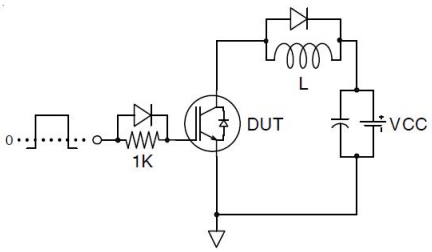


Fig. 1 - Gate Charge Circuit (turn-off)

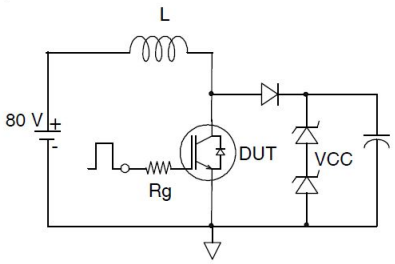


Fig. 2 - RBSOA Circuit

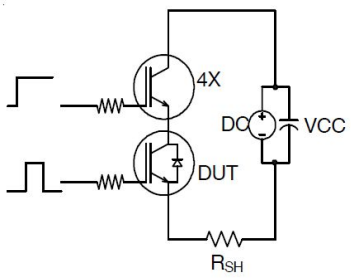


Fig. 3 - S.C. SOA Circuit

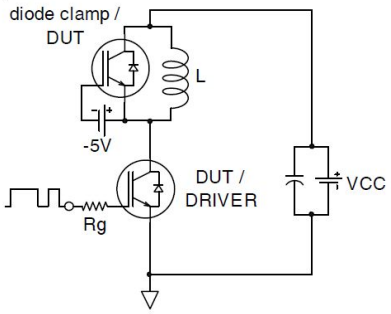


Fig. 4 - Switching Loss Circuit

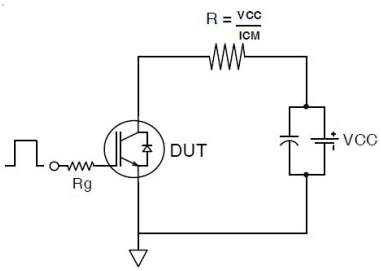


Fig. 5 - Resistive Load Circuit

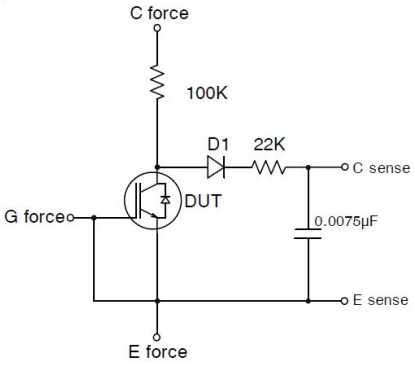


Fig. 6 - BVCES Filter Circuit

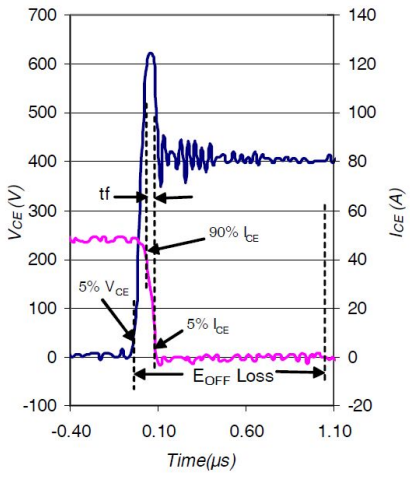


Fig. 7 - Typ. Turn-off Loss Waveform
@ TJ = 175°C using Fig.4

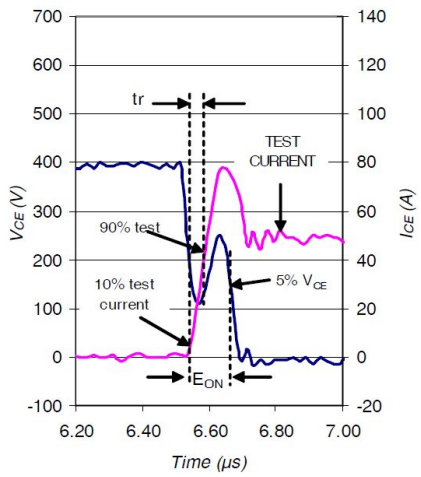


Fig. 8 - Typ. Turn-on Loss Waveform
@ TJ = 175°C using Fig.4

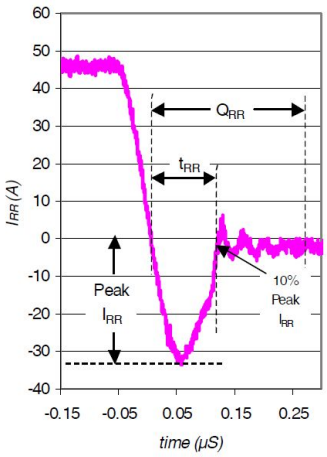


Fig. 9 - Typ. Diode Recovery Waveform
@ TJ = 175°C using Fig.4

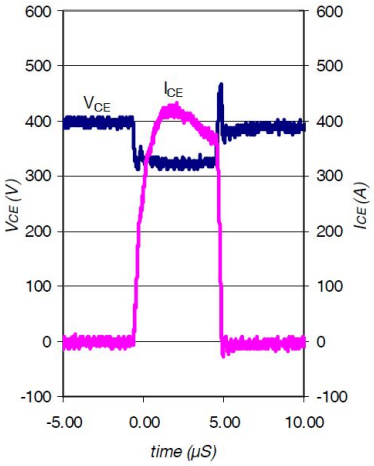


Fig. 10 - Typ. S.C. Waveform
@ TJ = 25°C using Fig.3

Mechanical Dimensions