



Preliminary Data

SMSR40P120AX

INSULATED GATE BIPOLAR TRANSISTOR

Features:

- Low $V_{CE(sat)}$ Planar IGBT Technology
- Low Switching Loss
- Square RBSOA
- 100% of The Parts Tested for I_{LM} ^①
- Positive $V_{CE(sat)}$ Temperature Co-efficient

Benefits:

- Device Optimized for Soft Switching Applications
- High Efficiency due to Low $V_{CE(sat)}$, Low Switching Loss
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation
- Low EMI

Applications:

- PTC Heater
- Relay Replacement



Absolute Maximum Rated Values ($T_J=25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Description	Conditions	Values	Units
V_{CES}	Collector-Emitter Blocking Voltage		1200	V
V_{GES}	Continuous Gate-Emitter Voltage		± 20	V
	Transient Gate-Emitter Voltage		± 30	
I_C	Continuous Collector Current	$T_C=100^{\circ}\text{C}$	81	A
		$T_C=25^{\circ}\text{C}$	141④	A
I_{CM}	Pulse Collector Current	$V_{GE}=15\text{V}②$	99	A
I_{LM}	Clamped Inductive Load Current	$V_{GE}=20\text{V}①$	99	A
t_{sc}	Short Circuit Withstand Time	$V_{CC}=600\text{V}$, $V_{GE}=15\text{V}$ $T_J=150^{\circ}\text{C}$	>10	μs
P_D	Maximum Power Dissipation	$T_C=25^{\circ}\text{C}$	543	W
		$T_C=100^{\circ}\text{C}$	217	W
T_J	Operating Junction Temperature Range		$-55\sim 150$	$^{\circ}\text{C}$
T_{STG}	Storage Temperature Range		$-55\sim 150$	$^{\circ}\text{C}$

Electrical Characteristics ($T_J=25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Description	Conditions	Min.	Typ.	Max.	Units
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	$V_{GE}=0\text{V}$, $I_C=250\mu\text{A}$	1200			V
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	$V_{GE}=0\text{V}$, $I_C=1\text{mA}$ ($25^{\circ}\text{C}\sim 150^{\circ}\text{C}$)		1.2		$\text{V}/^{\circ}\text{C}$
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	$I_C=250\mu\text{A}$, $V_{CE}=V_{GE}$	5.0		6.0	V
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	$V_{CE}=V_{GE}$, $I_C=250\mu\text{A}$ ($25^{\circ}\text{C}\sim 150^{\circ}\text{C}$)		-15		$\text{mV}/^{\circ}\text{C}$
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C=33\text{A}$, $V_{GE}=15\text{V}$	$T_J=25^{\circ}\text{C}$	1.39	1.59	V
			$T_J=150^{\circ}\text{C}$	1.47		V
g_{fs}	Forward Transconductance	$V_{CE}=50\text{V}$, $I_C=33\text{A}$, $P_W=20\mu\text{s}$		30		S
I_{CES}	Collector-Emitter Leakage Current	$V_{GE}=0\text{V}$, $V_{CE}=1200\text{V}$	$T_J=25^{\circ}\text{C}$		250	μA
			$T_J=150^{\circ}\text{C}$		1000	μA
I_{GES}	Gate-Emitter Leakage Current	$V_{GE}=\pm 20\text{V}$	$T_J=25^{\circ}\text{C}$		± 100	nA



Switching Characteristics ($T_J=25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Description	Conditions		Min.	Typ.	Max.	Units
C _{ies}	Input Capacitance	V _{CC} =30V, V _{GE} =0V, f=1MHz			3804		pF
C _{oes}	Output Capacitance				161		pF
C _{res}	Reverse Transfer Capacitance				31		pF
t _{d(off)}	Turn-off Delay Time	V _{CC} =600V, I _C =33A, R _G =5Ω, V _{GE} =15V, L=400μH	T _J =25℃		485	616	ns
			T _J =150℃		689		
t _f	Fall Time		T _J =25℃		1193	1371	ns
			T _J =150℃		2462		
E _{off}	Turn-off Switching Loss	V _{CC} =600V, I _C =33A, R _G =5Ω, V _{GE} =15V, L=400μH, Energy losses include tail	T _J =25℃		15	16	mJ
			T _J =150℃		29		
Q _g	Total Gate Charge(turn on)	I _C =33A, V _{GE} =15V, V _{CC} =600V			151	227	nC
Q _{ge}	Gate-to-Emitter Charge (turn on)				26	39	nC
Q _{gc}	Gate-to-Collector Charge (turn on)				62	93	nC
RBSOA	I _C =99A, V _{CC} =960V, V _p ≤1200V, R _G =5Ω, V _{GE} =+20V to 0V, T _J =150℃			Full Square			
R _{θJC}	Thermal Resistance: Junction-to-Case(each IGBT)③					0.23	℃/W

Notes:

- ① $V_{CC}=80\%(V_{CES})$, $V_{GE}=20\text{V}$, $L=400\mu\text{A}$, $R_G=50\Omega$.
- ② Pulse width limited by max. junction temperature.
- ③ R_{θ} is measured at T_J of approximately 90°C .
- ④ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 78A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.

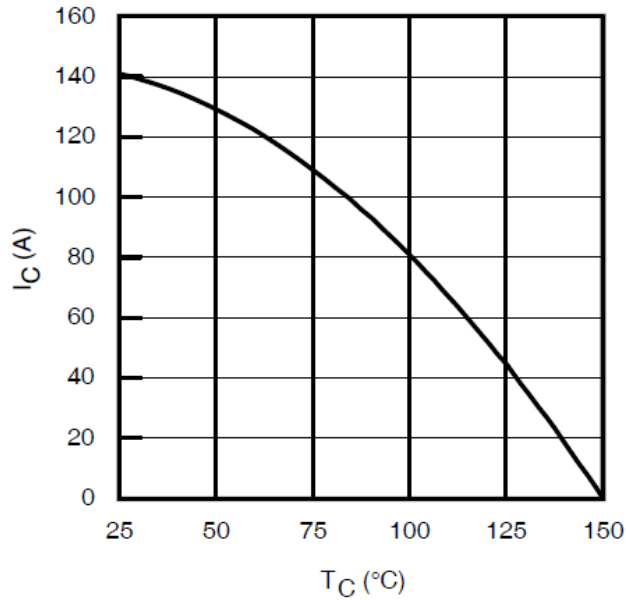


Fig. 1 Maximum DC Collector Current vs. Case Temperature

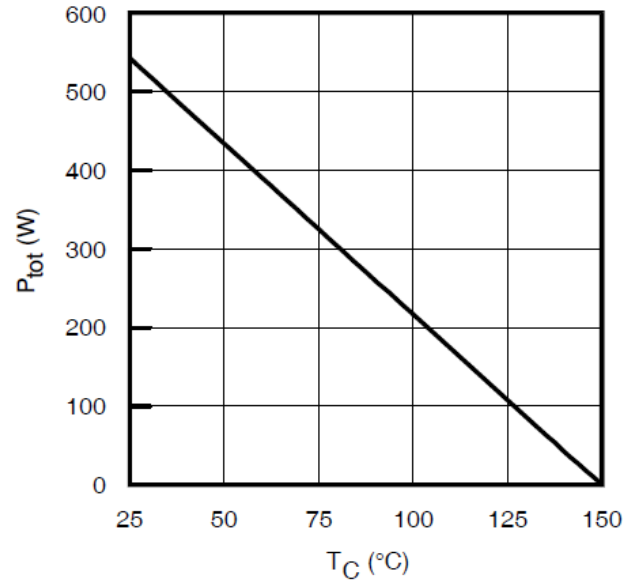


Fig. 2 Power Dissipation vs. Case Temperature

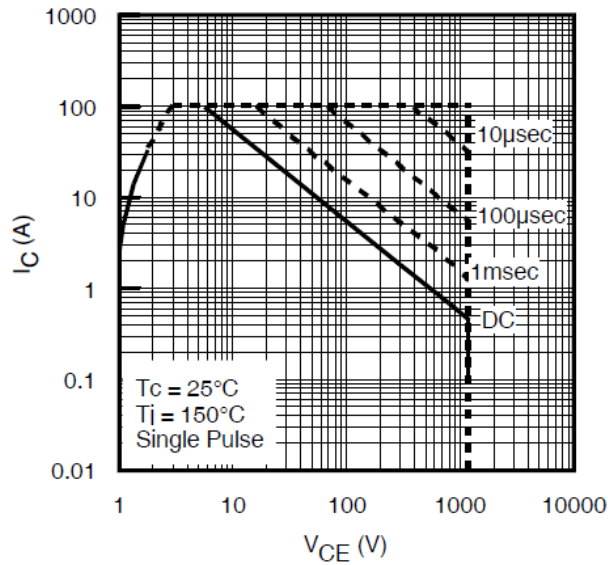


Fig. 3 Forward SOA
 $T_C=25^\circ\text{C}$, $T_J \leq 150^\circ\text{C}$; $V_{GE}=15\text{V}$

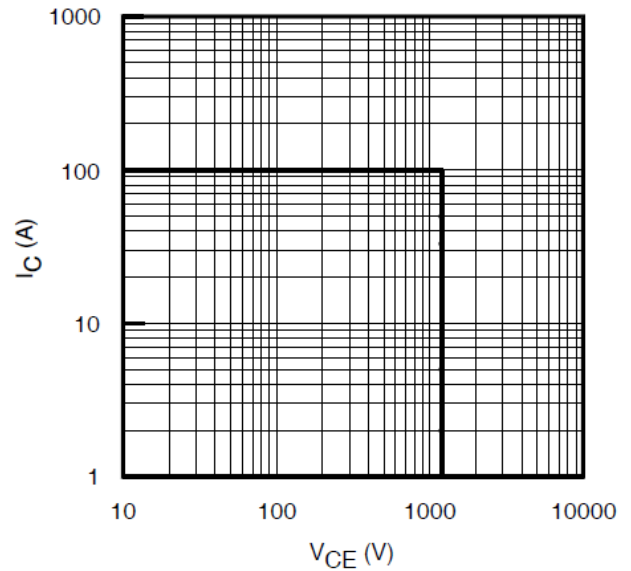


Fig. 4 Reverse Bias SOA
 $T_J=150^\circ\text{C}$; $V_{GE}=20\text{V}$

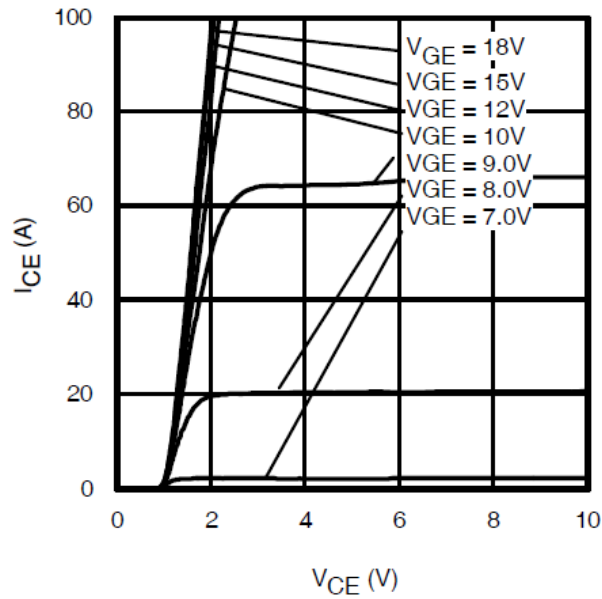


Fig. 5 Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

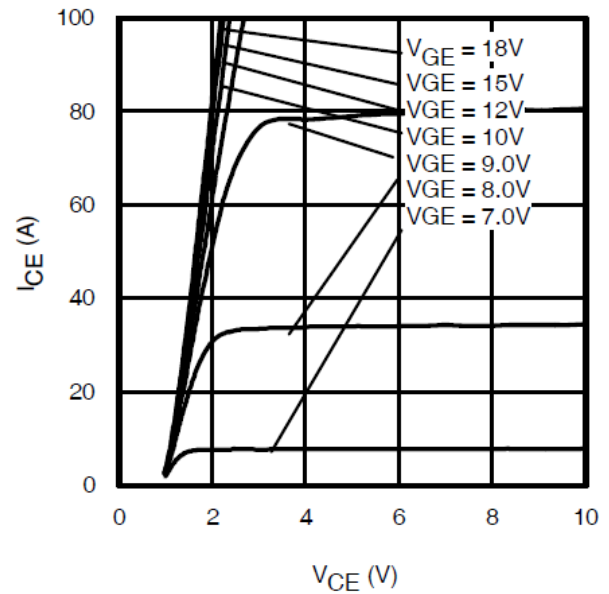


Fig. 6 Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

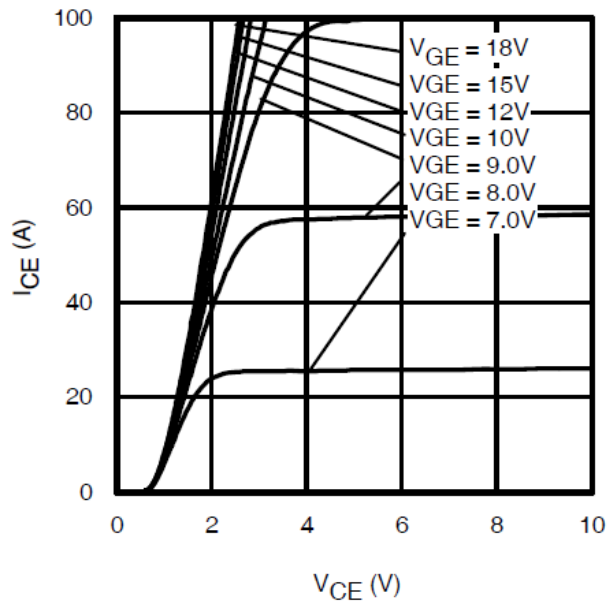


Fig. 7 Typ. IGBT Output Characteristics
 $T_J = 150^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

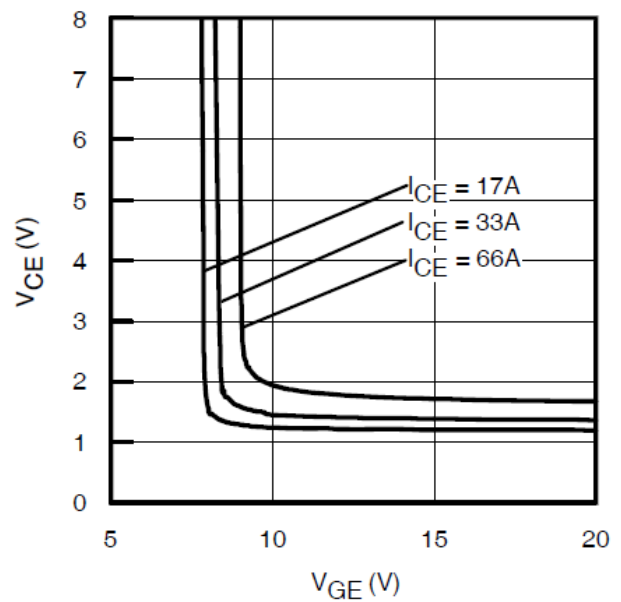


Fig. 8 Typical V_{CE} vs. V_{GE}
 $T_J = -40^{\circ}\text{C}$

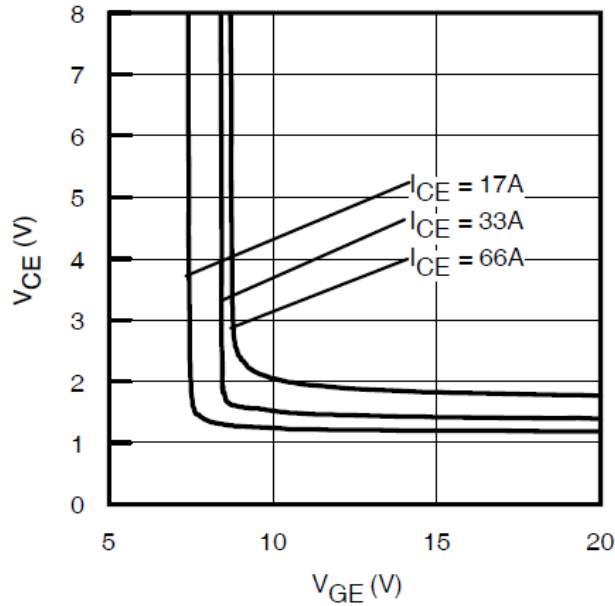


Fig. 9 Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

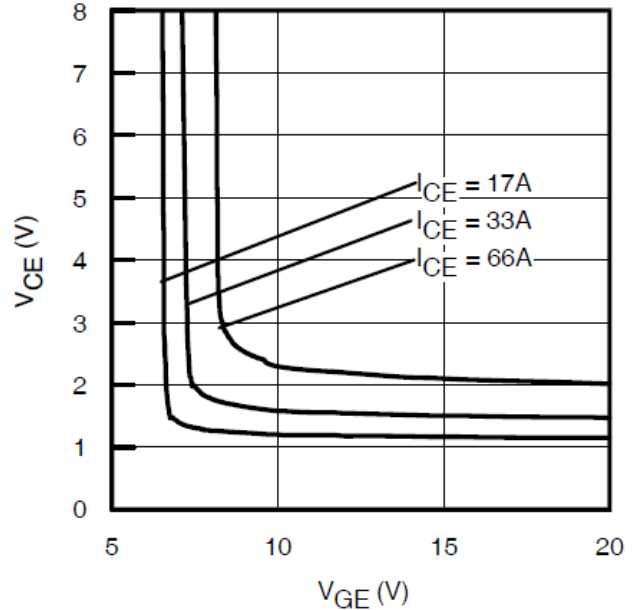


Fig. 10 Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

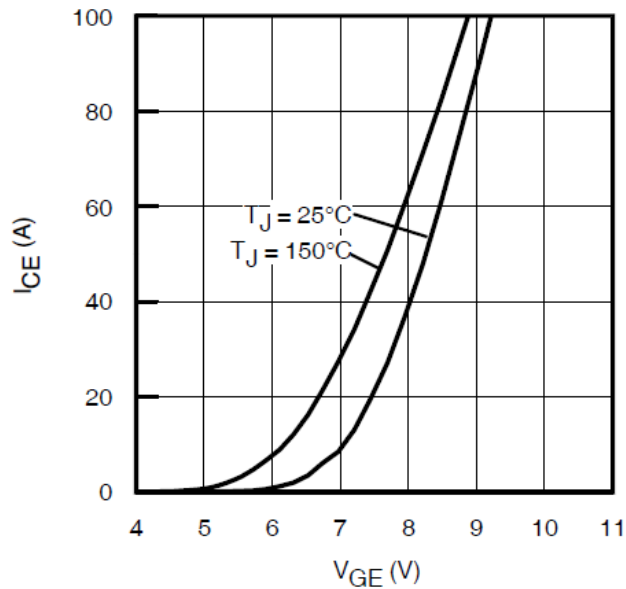


Fig. 11 Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

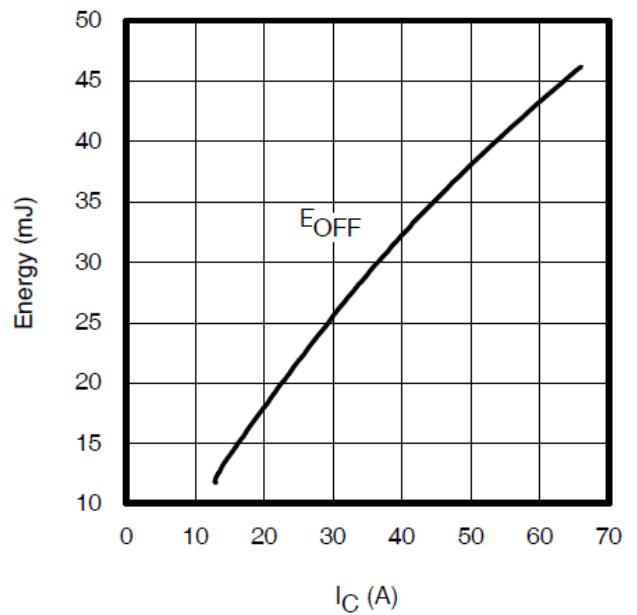


Fig. 12 Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 400\mu\text{H}$; $V_{CE} = 600\text{V}$; $R_G = 5\Omega$; $V_{GE} = 15\text{V}$

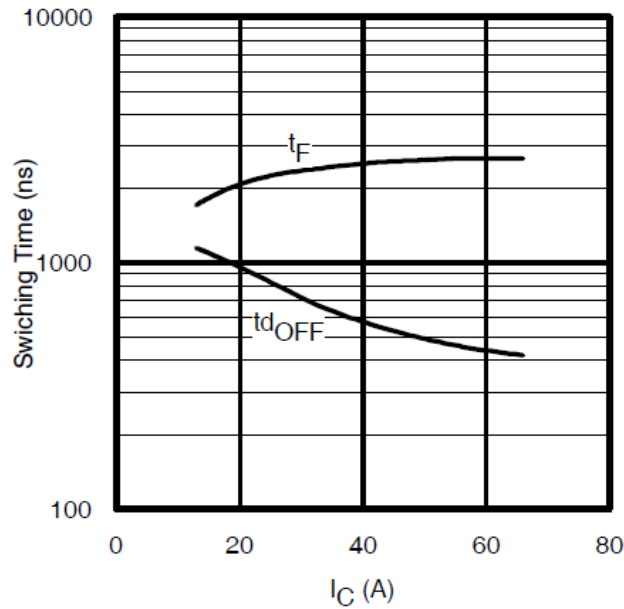


Fig. 13 Typ. Switching Time vs. I_C
 $T_J=150^{\circ}\text{C}$; $L=400\mu\text{H}$; $V_{CE}=600\text{V}$; $R_G=5\Omega$; $V_{GE}=15\text{V}$

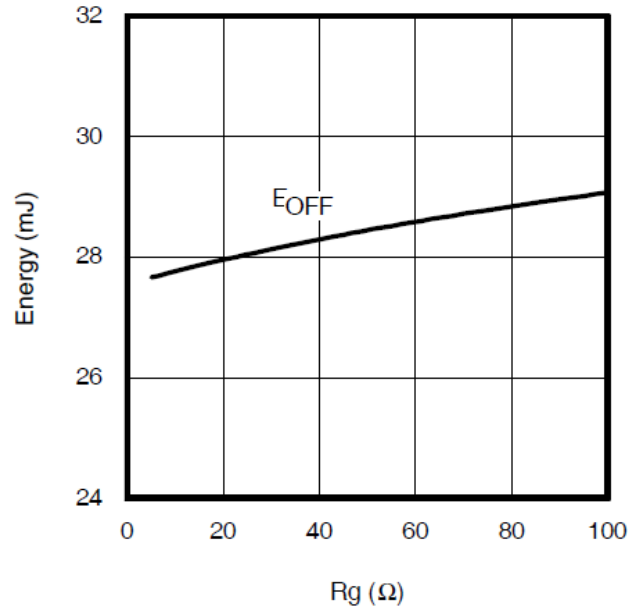


Fig. 14 Typ. Energy Loss vs. R_G
 $T_J=150^{\circ}\text{C}$; $L=400\mu\text{H}$; $V_{CE}=600\text{V}$; $I_{CE}=33\text{A}$; $V_{GE}=15\text{V}$

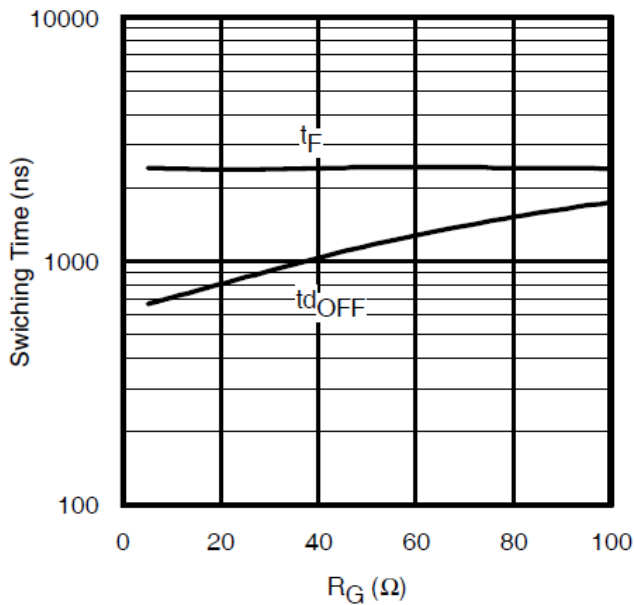


Fig. 15 Typ. Switching Time vs. R_G
 $T_J=150^{\circ}\text{C}$; $L=400\mu\text{H}$; $V_{CE}=600\text{V}$; $I_{CE}=33\text{A}$; $V_{GE}=15\text{V}$

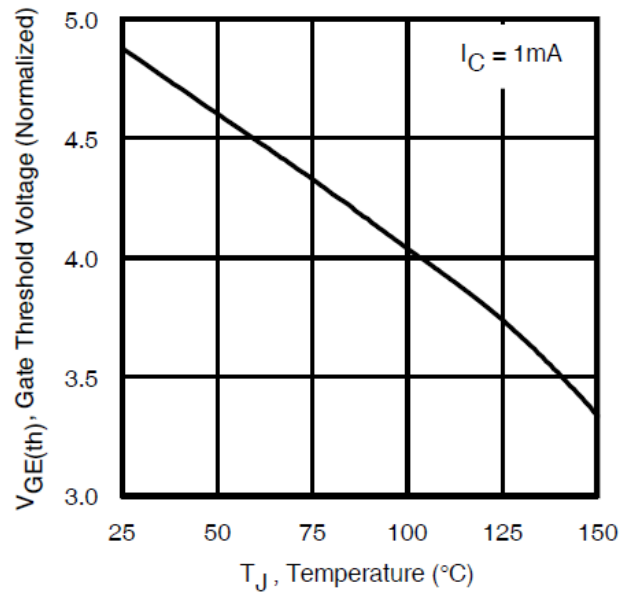


Fig. 16 Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

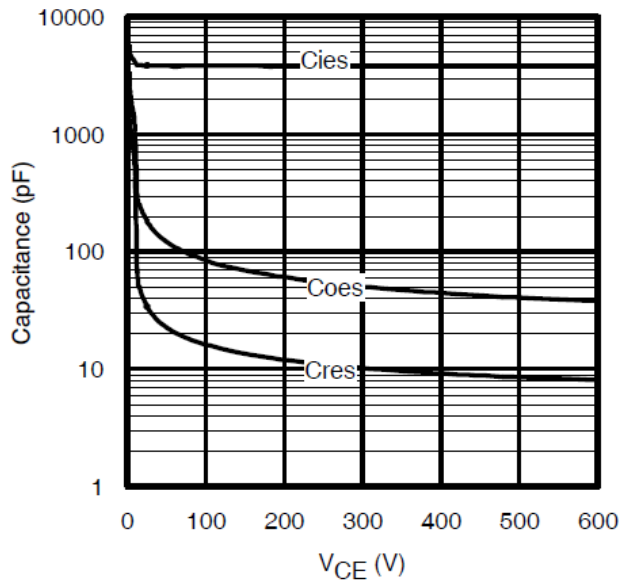


Fig. 17 Typ. Capacitance vs. V_{CE}
 $V_{GE}=0V$; $f=1MHz$

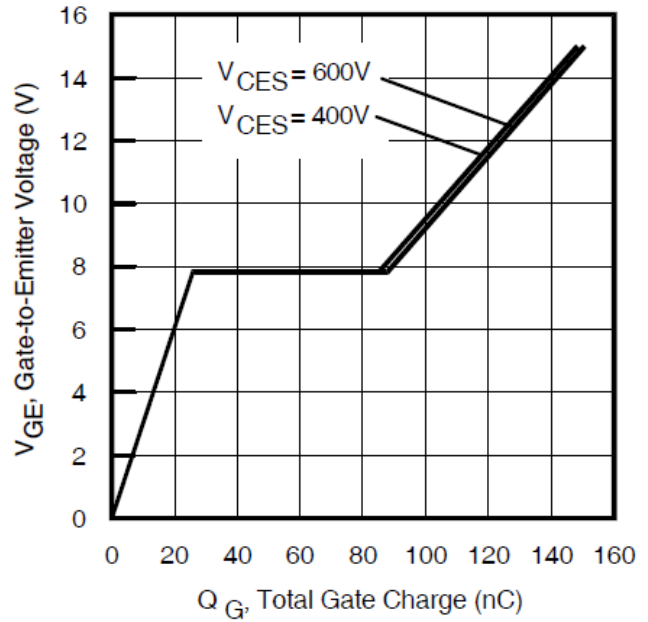


Fig. 18 Typical Gate Charge vs. V_{GE}
 $I_{CE}=33A$; $L=2.0mH$

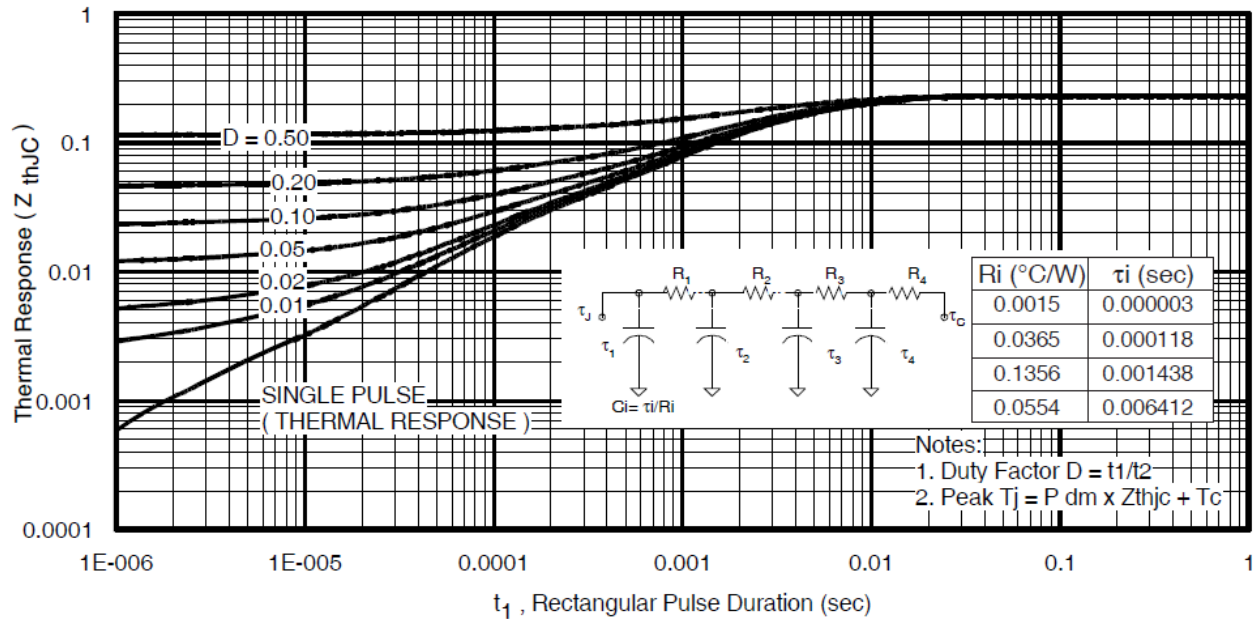


Fig.19 Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



Test Circuit:

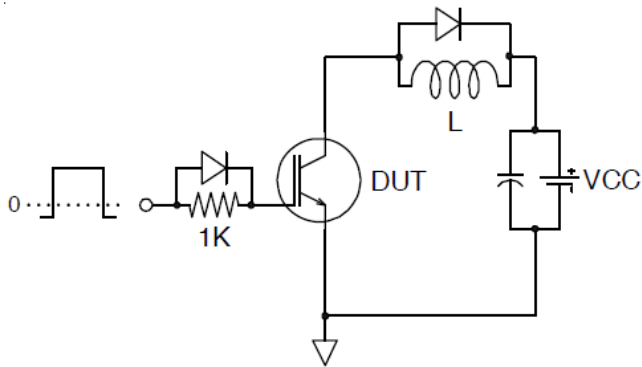


Fig.20 Gate Charge Circuit (turn-off)

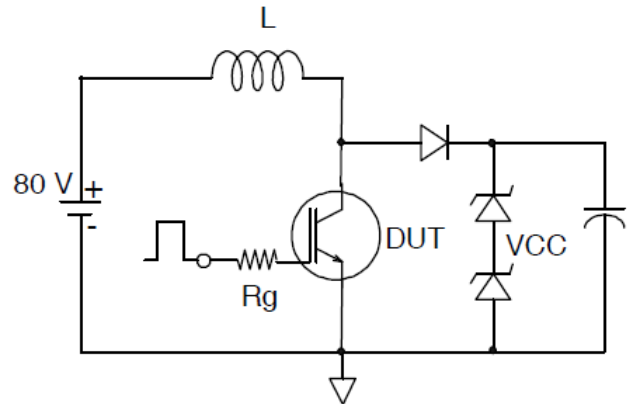


Fig.21 RBSOA Circuit

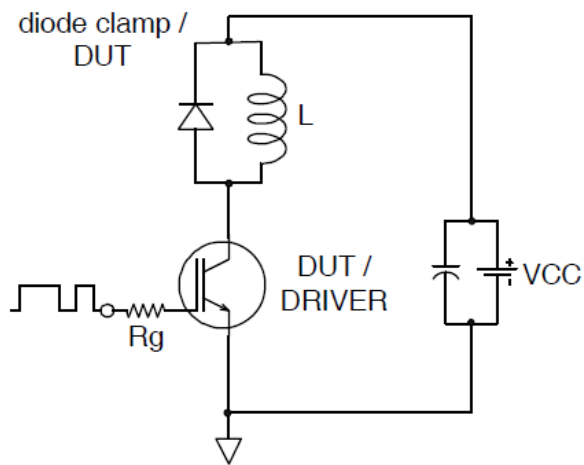


Fig.22 Switching Loss Circuit

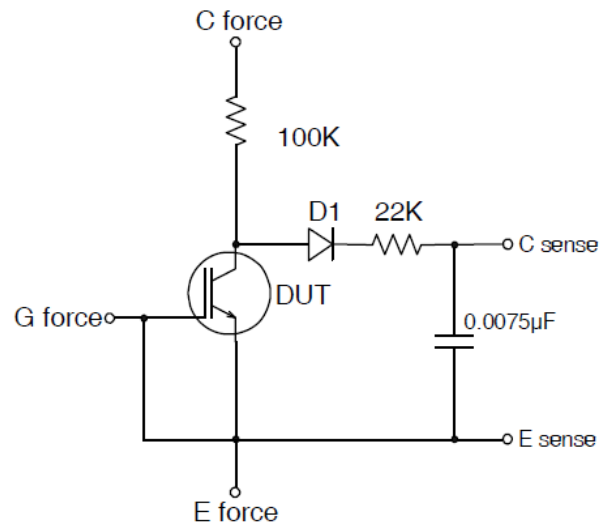


Fig.23 BV_{CES} Filter Circuit



Test Waveform:

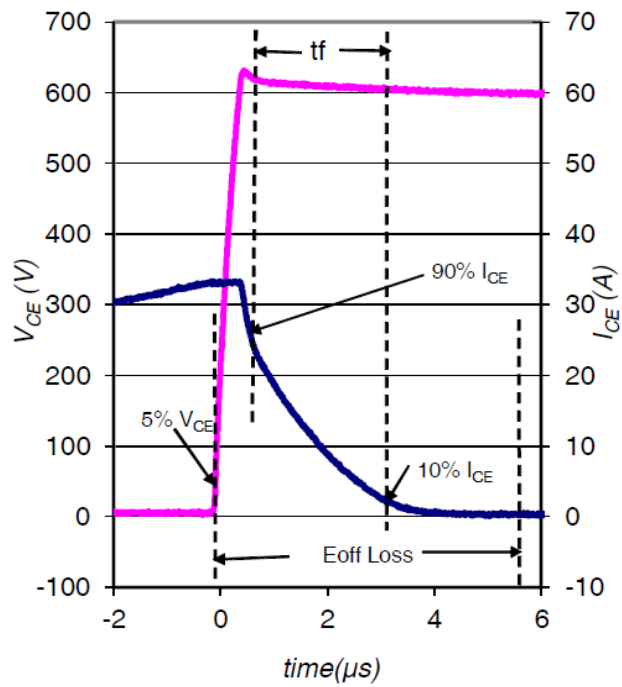
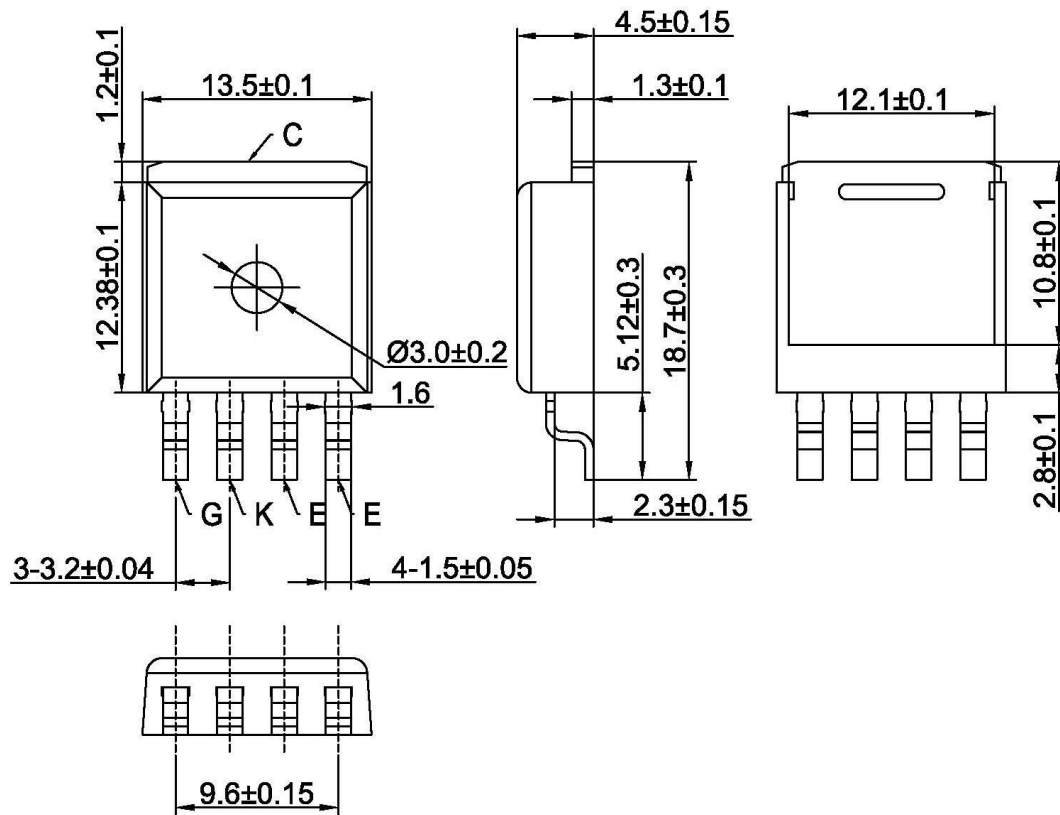


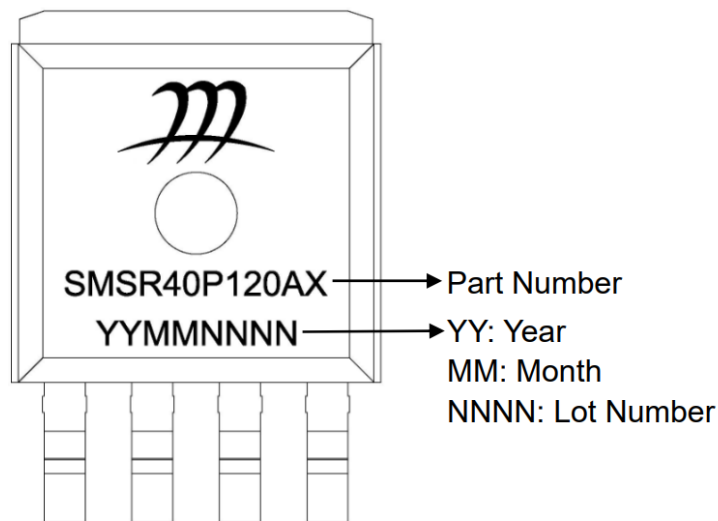
Fig.24 Typ. Turn-off Loss Waveform
@ $T_J=150^{\circ}C$ using Fig.22



TOSM Package Outline (Unit: mm):



TOSM Part Marking Information:





Revision	Notes
01	Initial Release
02	Updated Package Outline
03	Delete Features 'Lead Free'
04	Added 'Short Circuit Withstand Time'

Announcement

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The released datasheet would be issued with “REV.” + “alphabet characters”.