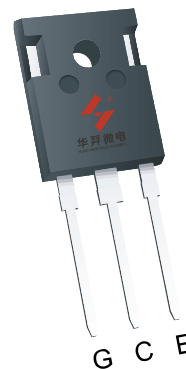


Feature

- 1200V/40A
 $V_{CE(sat)} = 1.90V(\text{typ.}) @ I_C = 40A$
- Positive temperature coefficient
- Fast Switching
- Low $V_{CE(sat)}$
- Reliable and Rugged
- Halogen Free and Green Devices Available
(RoHS Compliant)

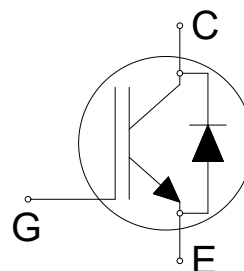
Pin Description



TO-247A-3L

Applications

- Motor drives
- Solar Inverter
- Resonant converters



Ordering and Marking Information

HYG  40T120F1DH XXXXXXXX	Package Code W: TO-247A-3L Date Code XXXXXXXX
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Note: HUAYI halogen free products contain molding compounds and 100% matte tin plate Termination finish; which are fully compliant with RoHS. HUAYI halogen free products meet or exceed the halogen free requirements of IPC/JEDEC J-STD-020 for MSL classification at halogen free peak reflow temperature. HUAYI defines "Green" to mean halogen free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

HUAYI reserves the right to make changes, corrections, enhancements, modifications, and improvements to this product and/or to this document at any time without notice.

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
Common Ratings (T _C =25°C Unless Otherwise Noted)				
V _{CES}	Collector-Emitter Voltage		1200	V
V _{GES}	Gate-Emitter Voltag		±30	V
T _J	Junction Temperature Range		-55 to 175	°C
T _{STG}	Storage Temperature Range			°C
Mounted on Large Heat Sink				
I _{CM}	Pulsed Collector Current *	T _C =25°C	160	A
I _C	Continuous Collector Current	T _C =25°C	80	A
		T _C =100°C	40	A
I _{FM}	Diode Maximum Forward Current *	T _C =25°C	160	A
I _F	Diode Continuous Forward Cuurrent	T _C =25°C	80	A
		T _C =100°C	40	A
P _D	Maximum Power Dissipation	T _C =25°C	469	W
R _{θJC}	Thermal Resistance, Junction-to-Case (IGBT)		0.32	°C/W
R _{θJC}	Thermal Resistance, Junction-to-Case (Diode)		0.90	°C/W
R _{θJA}	Thermal Resistance, Junction-to-Ambient **		40	°C/W

Note: * Repetitive rating; pulse width limited by max.junction temperature.

** Surface mounted on 1in2 FR-4 board.

Electrical Characteristics ($T_C = 25^{\circ}\text{C}$ Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	HYG40T120F1DHW			Unit
			Min.	Typ.	Max.	
Static Characteristics*						
BV _{CES}	Collector-Emitter Breakdown Voltage	V _{GE} =0V, I _C =250μA	1200	-	-	V
I _{CES}	Collector-to-Emitter Leakage Current	V _{CE} =1200V, V _{GE} =0V	-	-	1	μA
V _{GE(th)}	Gate Threshold Voltage	V _{CE} =V _{GE} , I _C =1mA	4.3	5.3	6.3	V
I _{GES}	Gate-Emitter Leakage Current	V _{GE} =±20V, V _{CE} =0V	-	-	±100	nA
V _{CE(sat)}	Collector-Emitter Saturation Voltage	V _{GE} =15V, I _C =40A, T _J =25°C	-	1.90	2.25	V
		V _{GE} =15V, I _C =40A, T _J =125°C	-	2.24	-	V
		V _{GE} =15V, I _C =40A, T _J =175°C	-	2.35	-	V
V _F	Diode Forward Voltage	I _C =40A, T _J =25°C	-	1.95	2.35	V
		I _C =40A, T _J =125°C	-	1.82	-	V
		I _C =40A, T _J =175°C	-	1.73	-	V

Electrical Characteristics (Cont.) ($T_C = 25^\circ\text{C}$ Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	HYG40T120F1DHW			Unit
			Min.	Typ.	Max.	
Dynamic Characteristics						
C _{ies}	Input Capacitance	V _{GE} =0V, V _{CE} =25V, f=1MHz	-	6592	-	pF
C _{oes}	Output Capacitance		-	108	-	
C _{res}	Reverse Transfer Capacitance		-	29	-	
Q _g	Total Gate Charge	V _{CC} =960V, I _C =40A, V _{GE} =15V	-	283	-	nC
Q _{ge}	Gate-Emitter Charge		-	57	-	
Q _{gc}	Gate-Collector Charge		-	96	-	
IGBT Switching Characteristics						
t _{d(ON)}	Turn-on Delay Time	I _C =40A V _{CC} =600V V _{GE} =15V R _g =5Ω T _J =25°C Inductive Load	-	32	-	ns
t _r	Turn-on Rise Time		-	64	-	
t _{d(OFF)}	Turn-off Delay Time		-	192	-	
t _f	Turn-off Fall Time		-	63	-	
E _{ON}	Turn-on Switching Loss		-	1.75	-	mJ
E _{OFF}	Turn-off Switching Loss		-	1.28	-	
E _{ts}	Total Switching Loss		-	3.03	-	
IGBT Switching Characteristics (T _J =175°C)						
t _{d(ON)}	Turn-on Delay Time	I _C =40A V _{CC} =600V V _{GE} =15V R _g =5Ω T _J =175°C Inductive Load	-	35	-	ns
t _r	Turn-on Rise Time		-	112	-	
t _{d(OFF)}	Turn-off Delay Time		-	232	-	
t _f	Turn-off Fall Time		-	85	-	
E _{ON}	Turn-on Switching Loss		-	2.01	-	mJ
E _{OFF}	Turn-off Switching Loss		-	1.65	-	
E _{ts}	Total Switching Loss		-	3.66	-	
Diode Characteristics						
t _{rr}	Reverse Recovery Time	I _F =40A, di/dt=200A/μs	-	388	-	ns
Q _{rr}	Reverse Recovery Charge		-	1085	-	nC
I _{rrm}	Reverse Recovery Current		-	6.9	-	A
Diode Characteristics (T _J =175°C)						
t _{rr}	Reverse Recovery Time	I _F =40A, di/dt=200A/μs	-	456	-	ns
Q _{rr}	Reverse Recovery Charge		-	1423	-	nC
I _{rrm}	Reverse Recovery Current		-	8.2	-	A

Note: *Pulse test, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

Typical Operating Characteristics

Figure 1: Power Dissipation

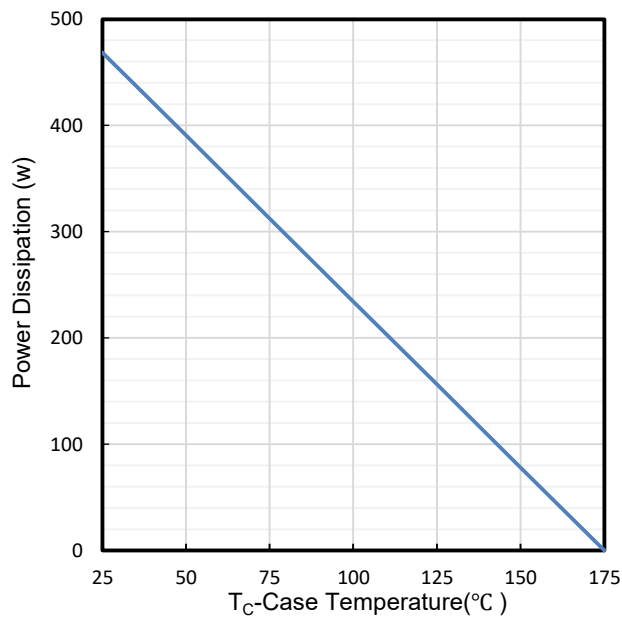


Figure 2: Collector Current

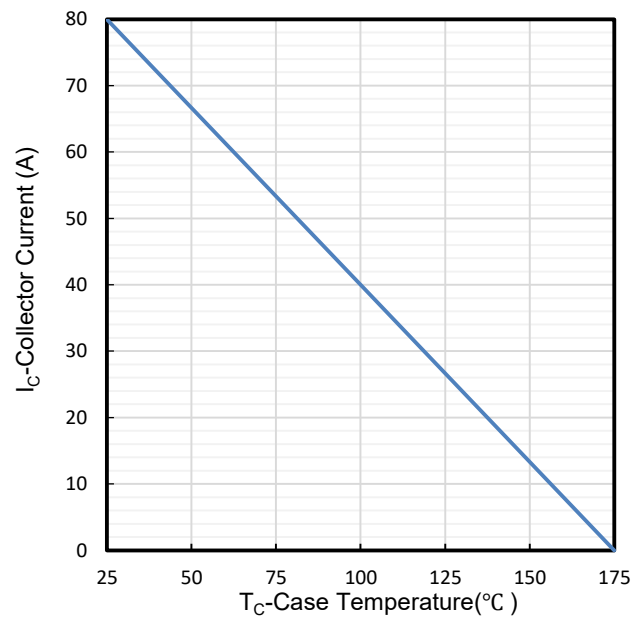


Figure 3: Safe Operation Area

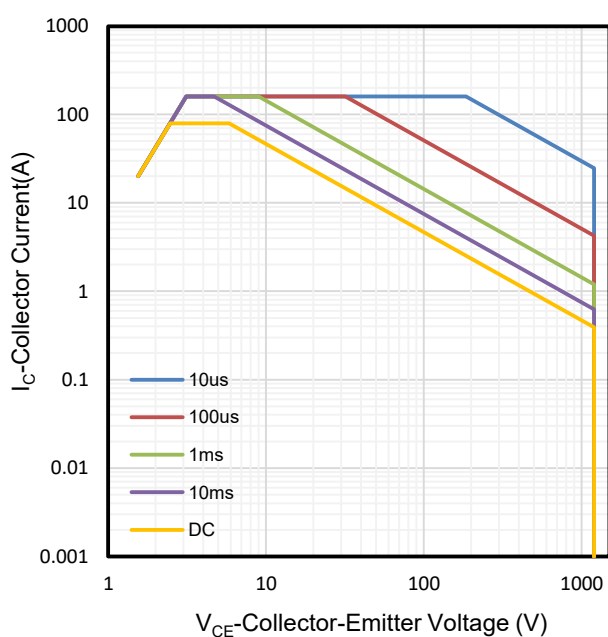
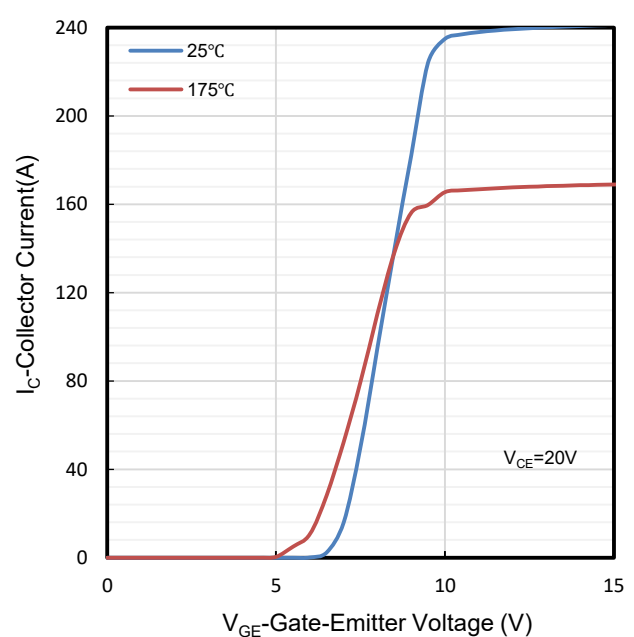


Figure 4: Typical Transfer Characteristics



Typical Operating Characteristics(Cont.)

Figure 5: Output Characteristics

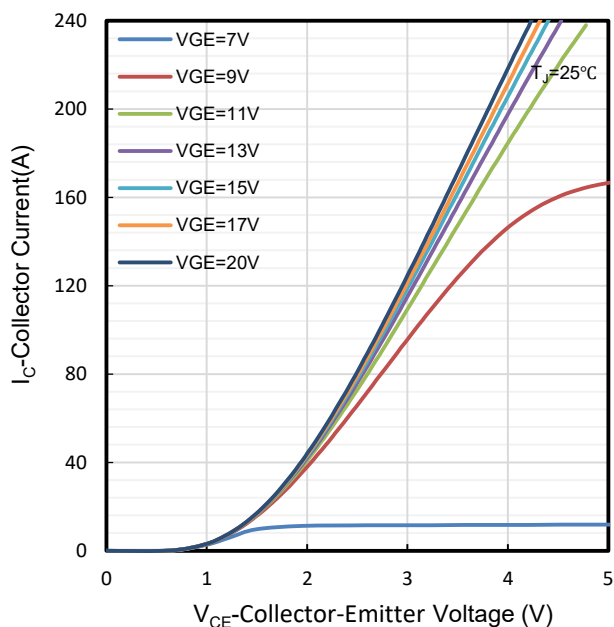


Figure 6: Output Characteristics

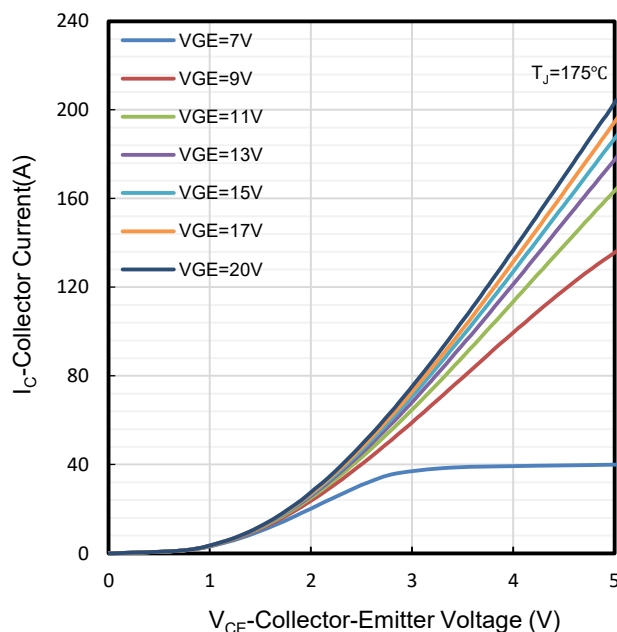


Figure 7: Typical Collector-Emitter Saturation Voltage vs. Junction Temperature

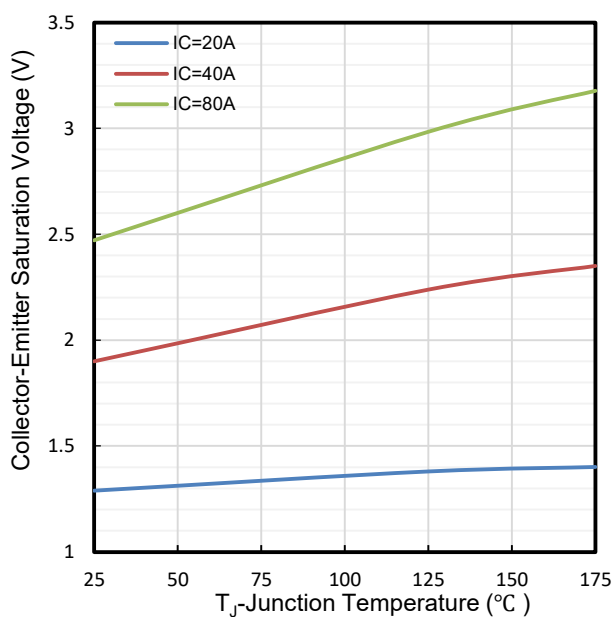
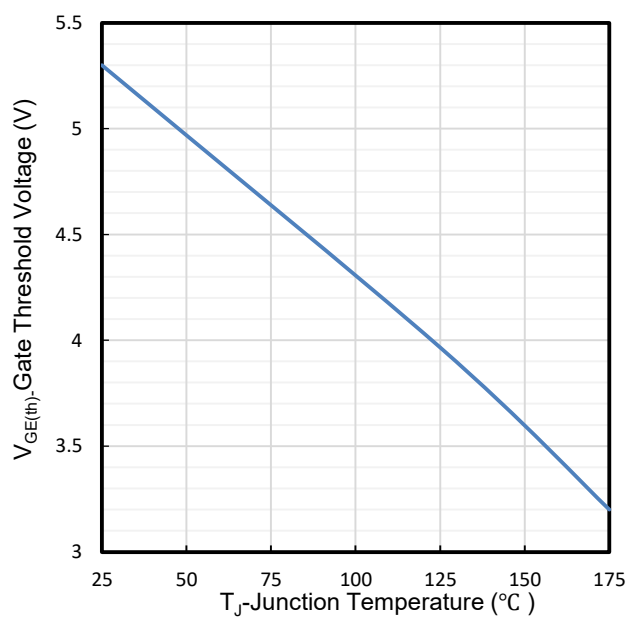


Figure 8: Typical Gate-Emitter Threshold Voltage vs. Junction Temperature



Typical Operating Characteristics(Cont.)

Figure 9: Typical Switching Times vs. Gate Resistor
($T_J=25^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

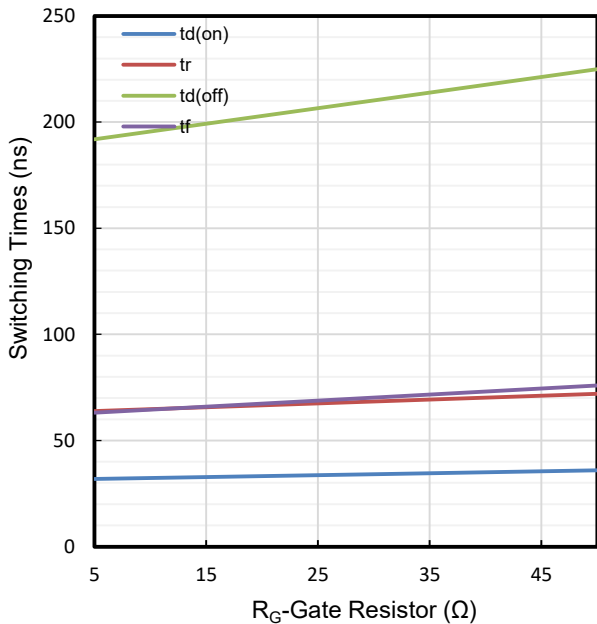


Figure 10: Typical Switching Energy vs. Gate Resistor
($T_J=25^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

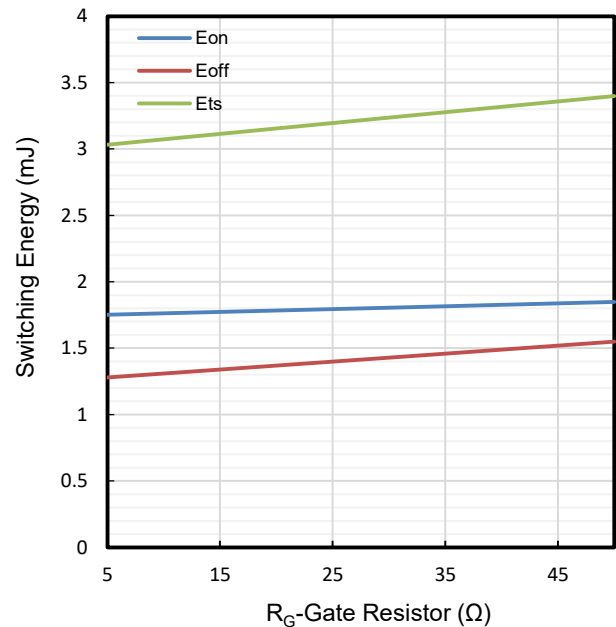


Figure 11: Typical Switching Times vs. Junction Temperature
($V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

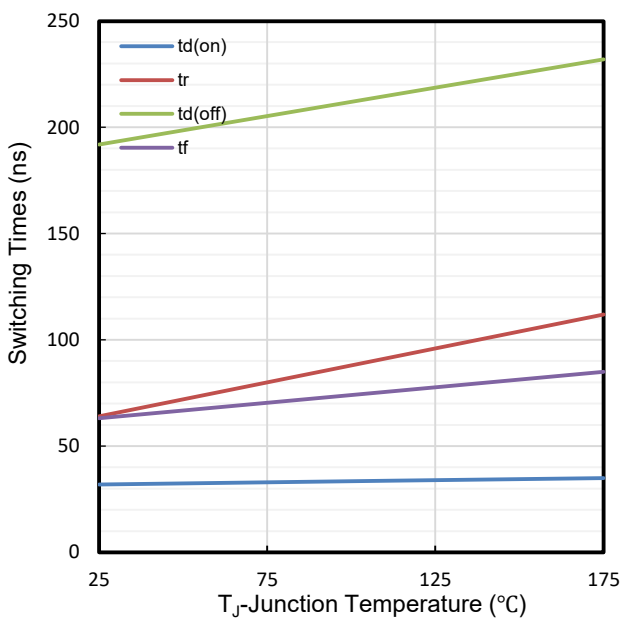
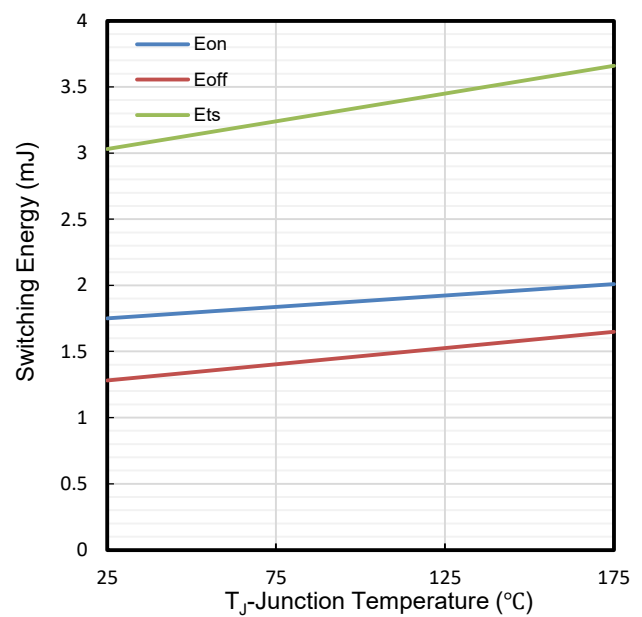


Figure 12: Typical Switching Energy vs. Junction Temperature
($V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)



Typical Operating Characteristics(Cont.)

Figure 13: Typical Switching Times vs. Collector Current
($T_J=25^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$)

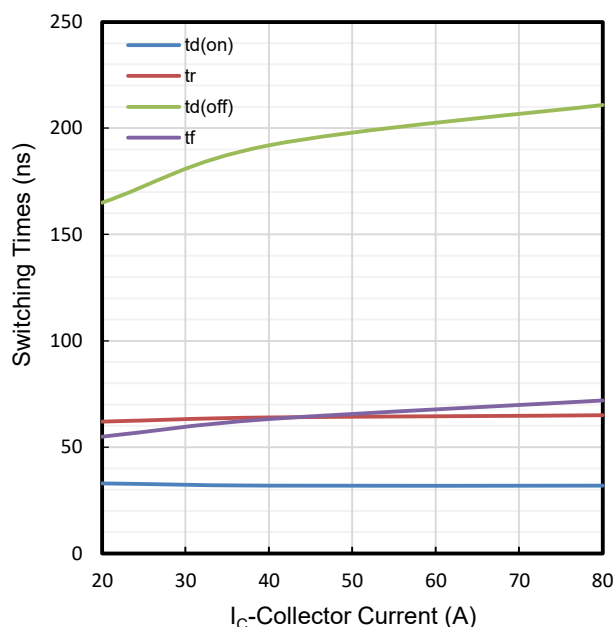


Figure 14: Typical Switching Energy vs. Collector Current
($T_J=25^{\circ}\text{C}$, $V_{CE}=600\text{V}$, $V_{GE}=15/0\text{V}$)

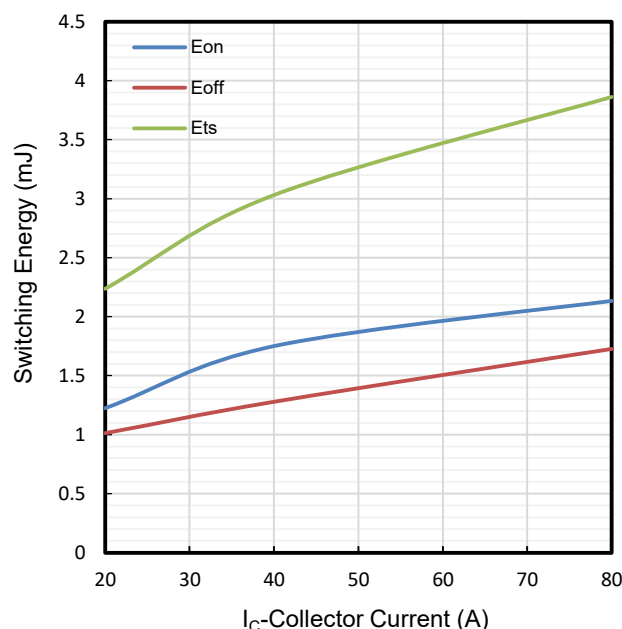


Figure 15: Typical Switching Times vs. Collector- Emitter Voltage
($T_J=25^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

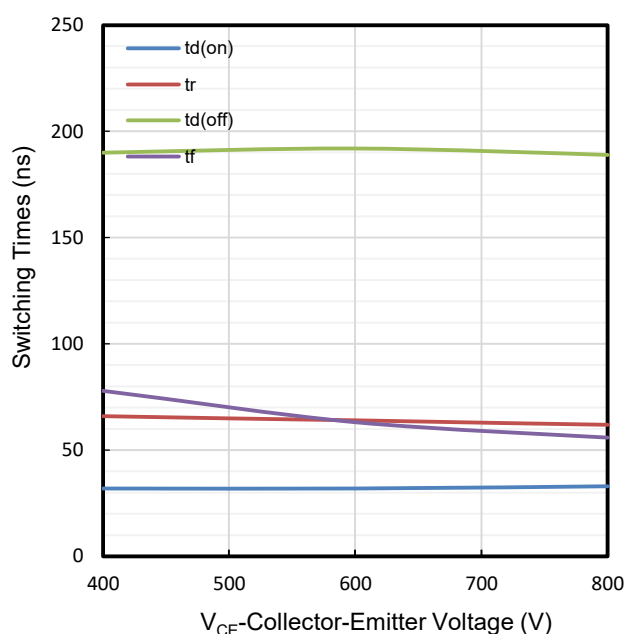
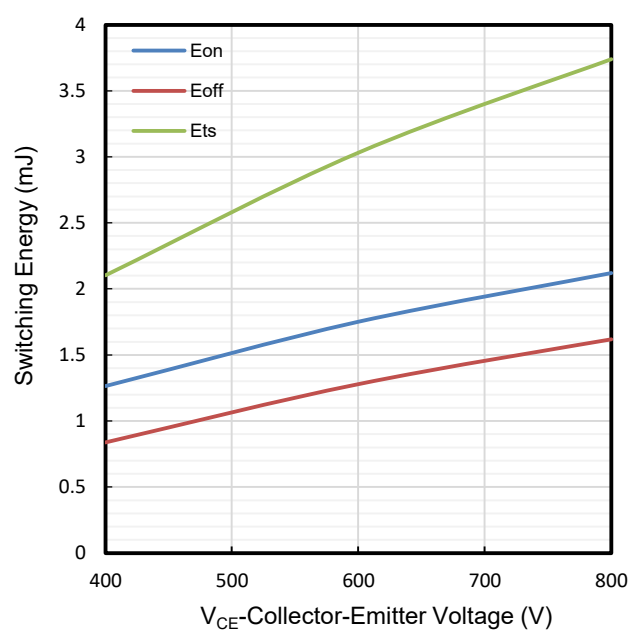


Figure 16: Typical Switching Energy vs. Collector- Emitter Voltage
($T_J=25^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)



Typical Operating Characteristics(Cont.)

Figure 17: Typical Gate Charge

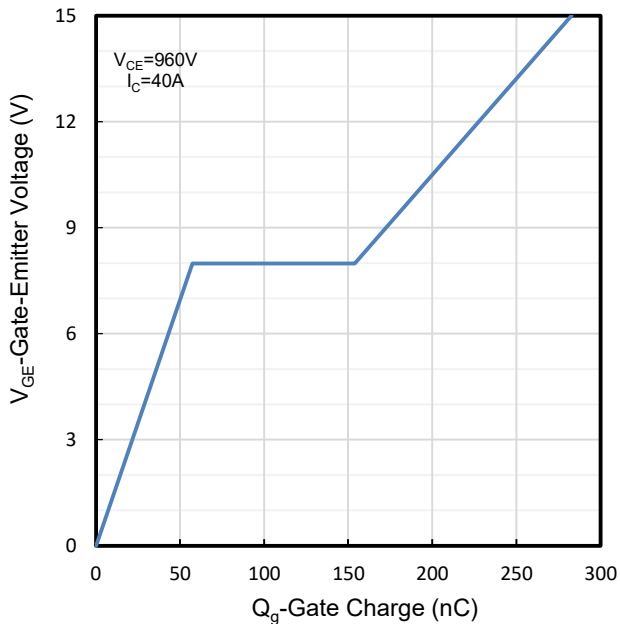


Figure 18: Typical Capacitance vs. Collector- Emitter Voltage

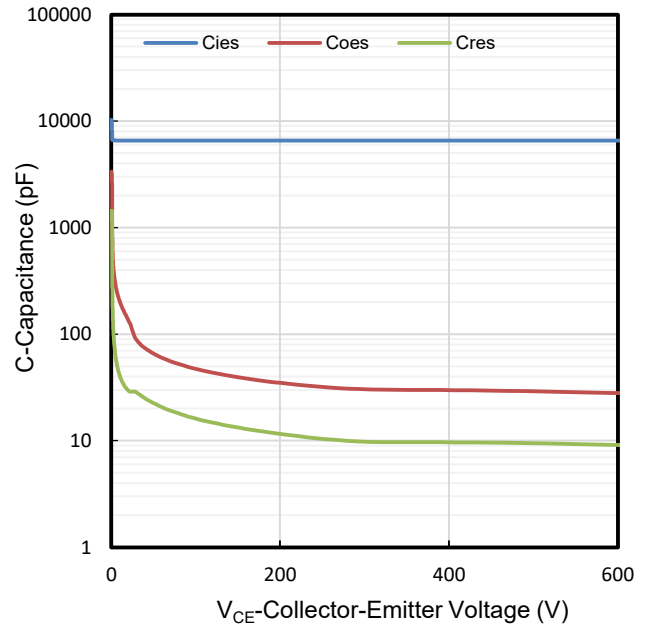


Figure 19: IGBT Transient Thermal Impedance vs. Pulse Width

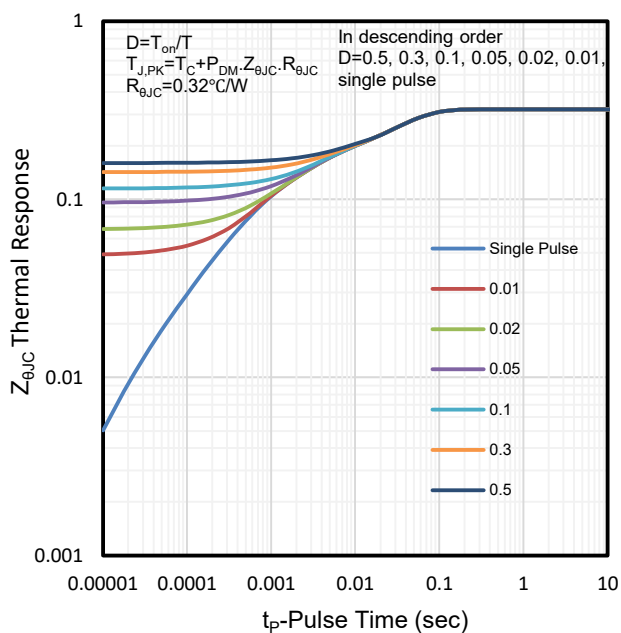
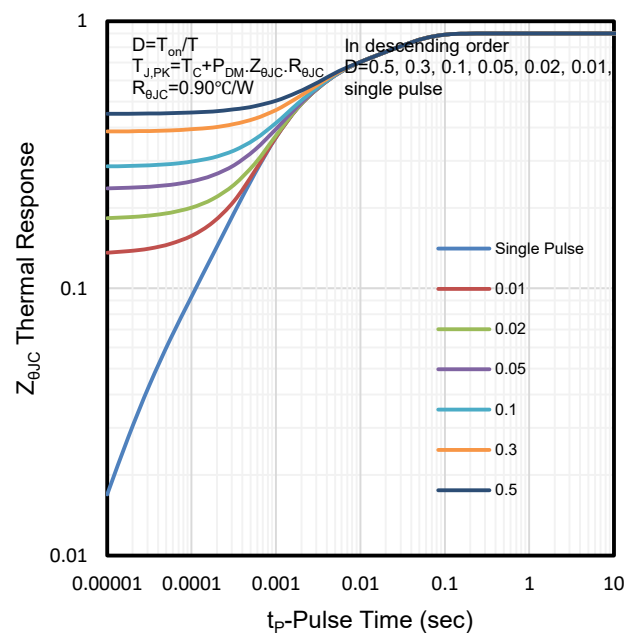
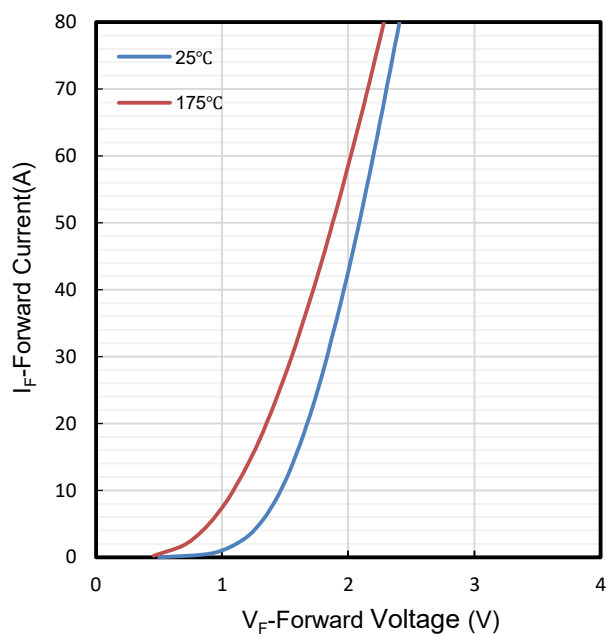


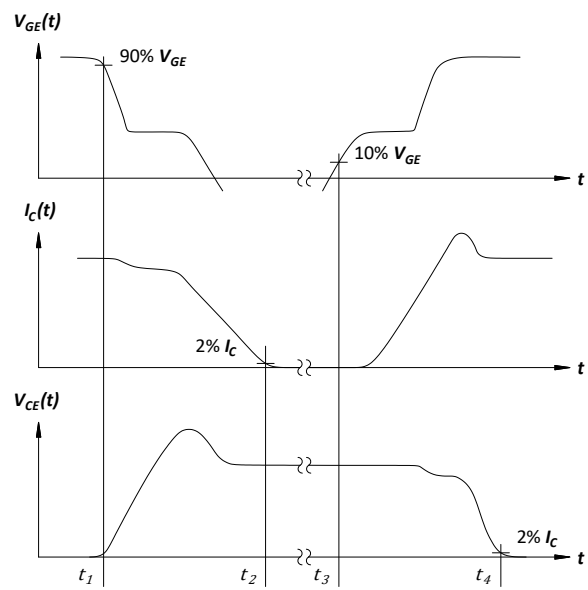
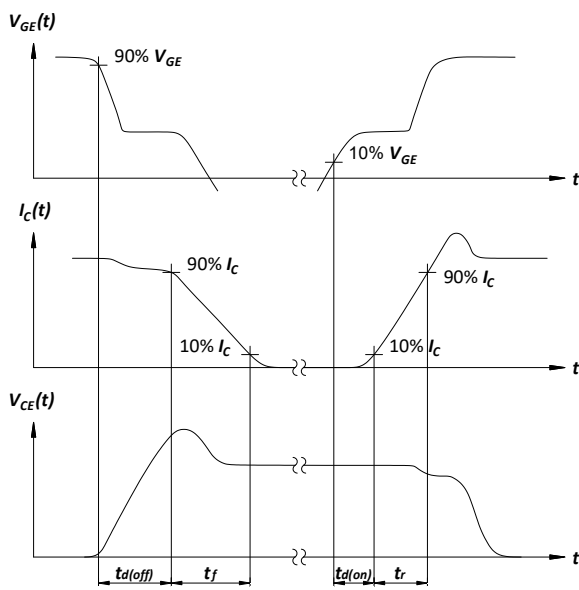
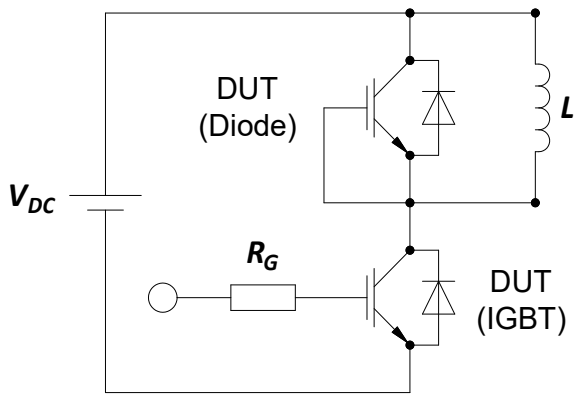
Figure 20: Diode Transient Thermal Impedance vs. Pulse Width



Typical Operating Characteristics(Cont.)

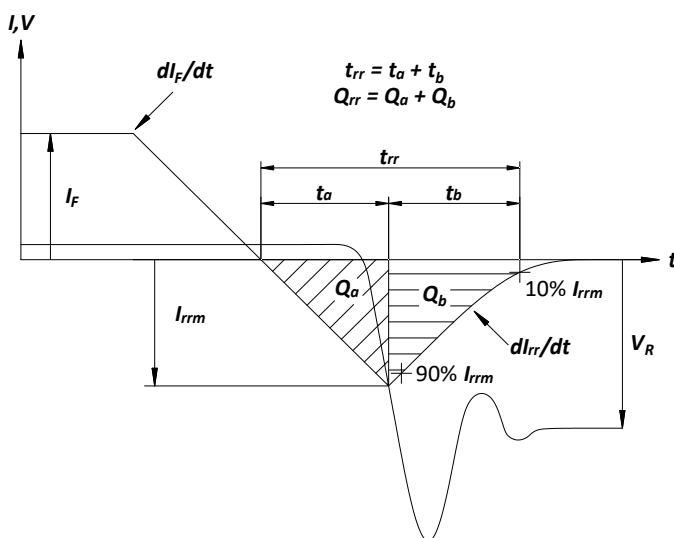
**Figure 21: Typical Diode Forward Current
vs. Forward Voltage**

Switching Time Test Circuit



$$E_{off} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt \quad E_{on} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$

Definition of diode switching characteristics

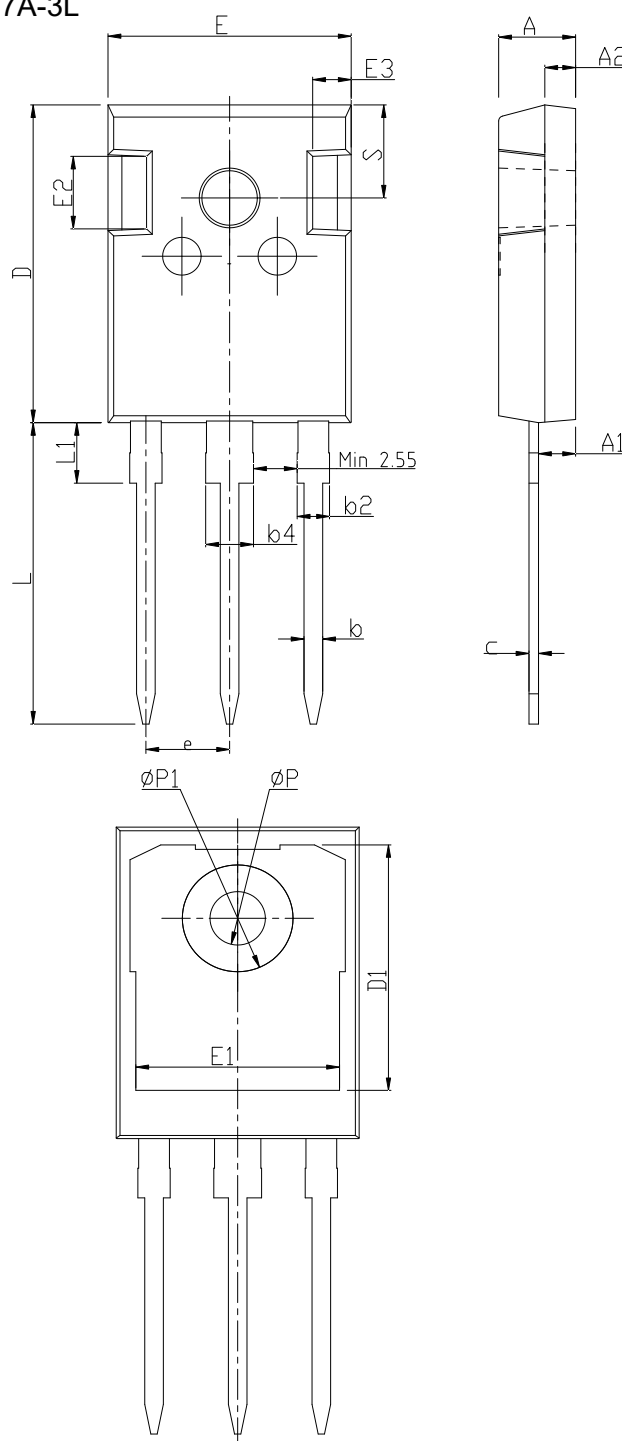


Device Per Unit

Package Type	Unit	Quantity
TO-247A-3L	Tube	30

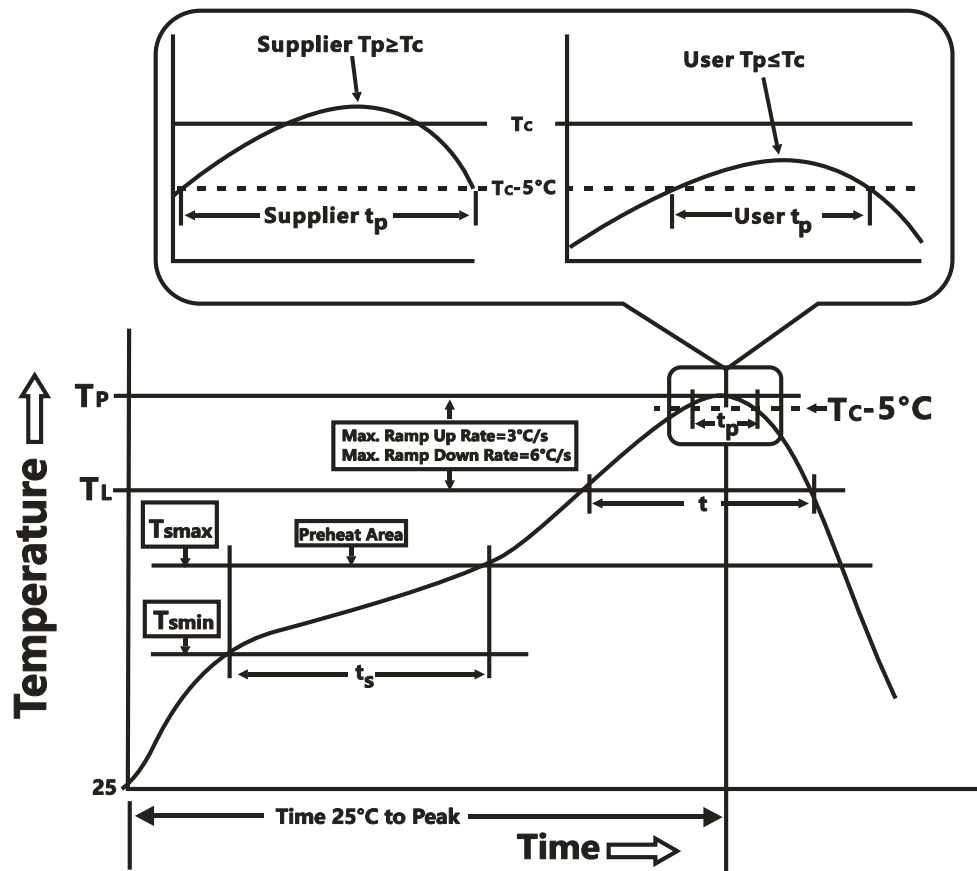
Package Information

TO-247A-3L



COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.21	2.41	2.59
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
ϕP	3.40	3.60	3.80
$\phi P1$	-	-	7.30
S	6.15BSC		

Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak		
Temperature min (T_{smin})	100 °C	150 °C
Temperature max (T_{smax})	150 °C	200 °C
Time (T_{smin} to T_{smax}) (t_s)	60-120 seconds	60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L)	183 °C	217 °C
Time at liquidous (t_L)	60-150 seconds	60-150 seconds
Peak package body Temperature (T_P)*	See Classification Temp in table1	See Classification Temp in table2
Time (t_p)** within 5°C of the specified classification temperature (T_C)	20** seconds	30** seconds
Average ramp-down rate (T_P to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_P) is defined as a supplier minimum and a user maximum.		
** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (T_C)

Package	Volume mm ³	Volume mm ³
Thickness	<350	≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (T_C)

Package	Volume mm ³	Volume mm ³	Volume mm ³
Thickness	<350	350-2000	≥2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
PCT	JESD22-A102	121°C, 100%RH, 96hours, 205kPa
TCT	JESD22-A104	250/500 Cycles, -55°C~150°C
HTRB	JESD22-A108B	168/500 Hrs, 80% BV_{DSS} @150°C
HTGB	JESD22-A108B	168/500 Hrs, 100% V_{GS} @150°C

Revision History

Revision	Date	Change Information
V1.0	2025/10/22	Official version released
V2.0	2026/1/9	Update template

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