

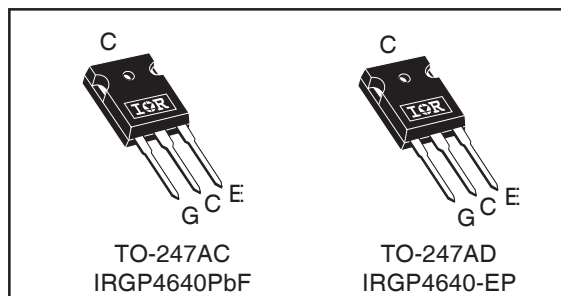
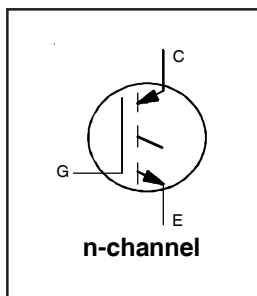
$$V_{CES} = 600V$$

$$I_C = 40A, T_C = 100^{\circ}C$$

$$t_{SC} \geq 5\mu s, T_{J(max)} = 175^{\circ}C$$

$$V_{CE(on)} \text{ typ.} = 1.60V @ I_C = 24A$$

INSULATED GATE BIPOLAR TRANSISTOR



G	C	E
Gate	Collector	Emitter

Applications

- Inverters
- UPS
- Welding

Features	Benefits
Low $V_{CE(ON)}$ and Switching Losses	High efficiency in a wide range of applications and switching frequencies
Square RBSOA and Maximum Junction Temperature $175^{\circ}C$	Improved reliability due to rugged hard switching performance and higher power capability
Positive $V_{CE(ON)}$ Temperature Coefficient	Excellent current sharing in parallel operation
$5\mu s$ short circuit SOA	Enables short circuit protection scheme
Lead-Free, RoHS compliant	Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable part number
		Form	Quantity	
IRGP4640PbF	TO-247AC	Tube	25	IRGP4640PbF
IRGP4640-EPbF	TO-247AD	Tube	25	IRGP4640-EPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^{\circ}C$	Continuous Collector Current	65	A
$I_C @ T_C = 100^{\circ}C$	Continuous Collector Current	40	
I_{CM}	Pulse Collector Current, $V_{GE} = 15V$ ①	72	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ②	96	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	250	W
$P_D @ T_C = 100^{\circ}C$	Maximum Power Dissipation	125	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to +175	$^{\circ}C$
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw	10 lbf-in (1.1 N·m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ③	—	—	0.60	$^{\circ}C/W$
$R_{\theta CS}$	Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient (typical socket mount)	—	—	40	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④
$\Delta V_{(BR)CES} / \Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	$V_{GE} = 0V, I_C = 1mA$ (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.60	1.90	V	$I_C = 24A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.00	—		$I_C = 24A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 700\mu A$
$\Delta V_{GE(th)} / \Delta T_J$	Threshold Voltage temp. coefficient	—	-18	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25°C - 175°C)
g_{fe}	Forward Transconductance	—	17	—	S	$V_{CE} = 50V, I_C = 24A, PW = 80\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	20	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	600	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$

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

	Parameter	Min.	Typ.	Max. ⑤	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	50	75	nC	$I_C = 24A$ $V_{GE} = 15V$ $V_{CC} = 400V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	15	20		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	20	30		
E_{on}	Turn-On Switching Loss	—	0.1	0.2	mJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ ⑥ $R_G = 10\Omega, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery
E_{off}	Turn-Off Switching Loss	—	0.6	0.7		
E_{total}	Total Switching Loss	—	0.7	0.9		
$t_{d(on)}$	Turn-On delay time	—	40	55	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ ⑥ $R_G = 10\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
t_r	Rise time	—	20	30		
$t_{d(off)}$	Turn-Off delay time	—	105	115		
t_f	Fall time	—	30	40		
E_{on}	Turn-On Switching Loss	—	0.4	—	mJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ ⑥ $R_G = 10\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
E_{off}	Turn-Off Switching Loss	—	0.85	—		
E_{total}	Total Switching Loss	—	1.25	—		
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ ⑥ $R_G = 10\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
t_r	Rise time	—	25	—		
$t_{d(off)}$	Turn-Off delay time	—	125	—		
t_f	Fall time	—	40	—		
C_{ies}	Input Capacitance	—	1490	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
C_{oes}	Output Capacitance	—	130	—		
C_{res}	Reverse Transfer Capacitance	—	45	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 96A$ $V_{CC} = 480V, V_p = 600V$ $R_g = 10\Omega, V_{GE} = +20V$ to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_g = 10\Omega, V_{GE} = +15V$ to 0V

Notes:

- ① Pulse width limited by max. junction temperature.
- ② $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 10\Omega$.
- ③ R_G is measured at T_J of approximately 90°C .
- ④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ⑤ Maximum limits are based on statistical sample size characterization.
- ⑥ Values are influenced by parasitic L and C in measurement.

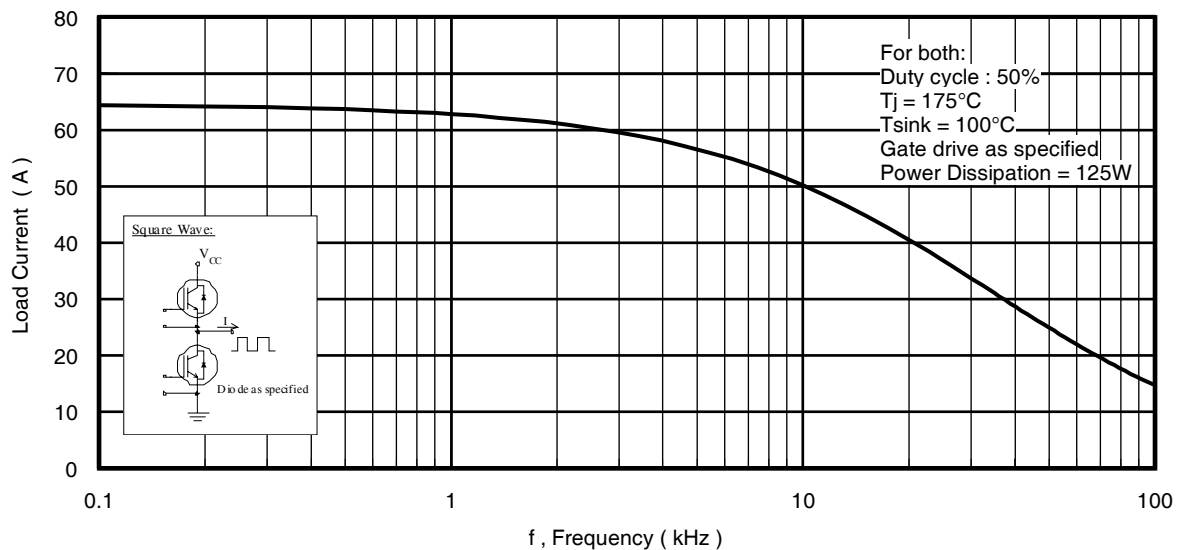


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

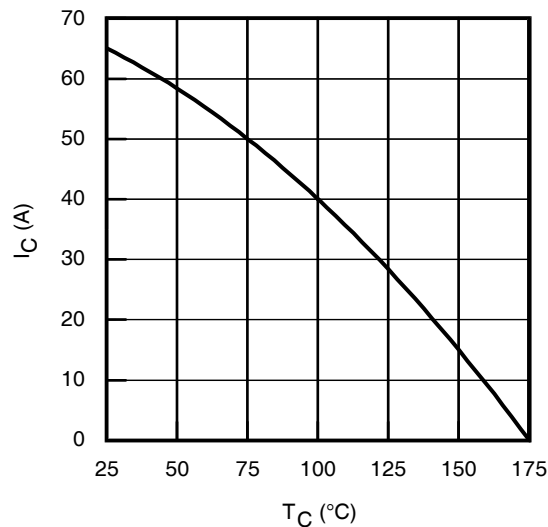


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

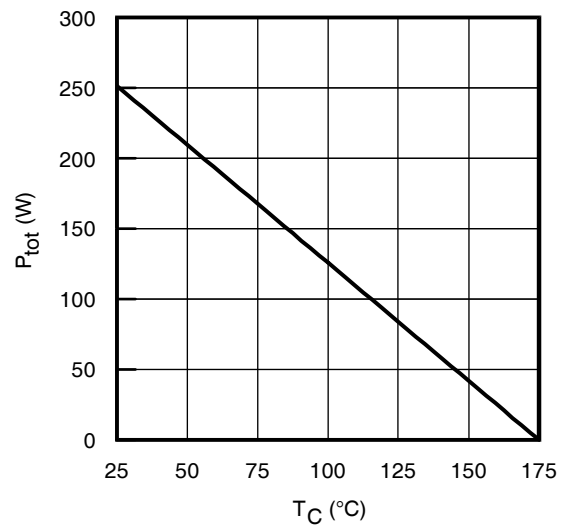


Fig. 3 - Power Dissipation vs. Case Temperature

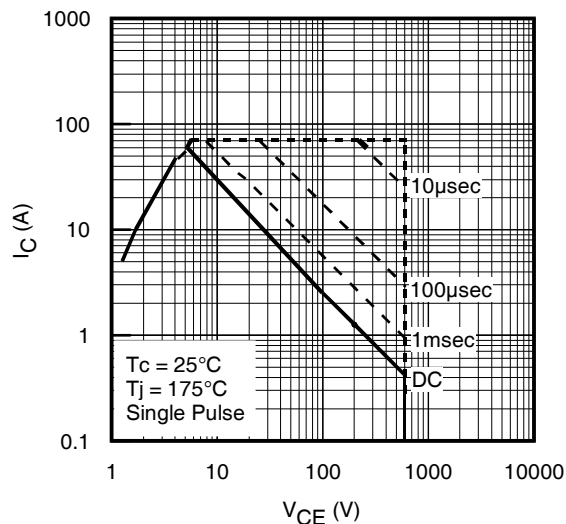


Fig. 4 - Forward SOA
 $T_C = 25^{\circ}\text{C}$, $T_j \leq 175^{\circ}\text{C}$; $V_{GE} = 15\text{V}$

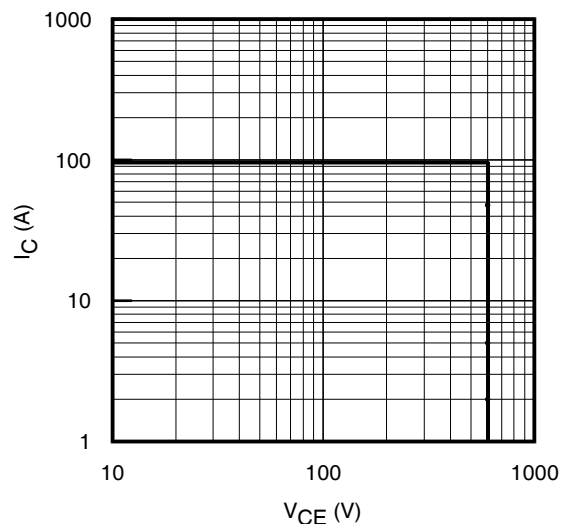


Fig. 5 - Reverse Bias SOA
 $T_j = 175^{\circ}\text{C}$; $V_{GE} = 20\text{V}$

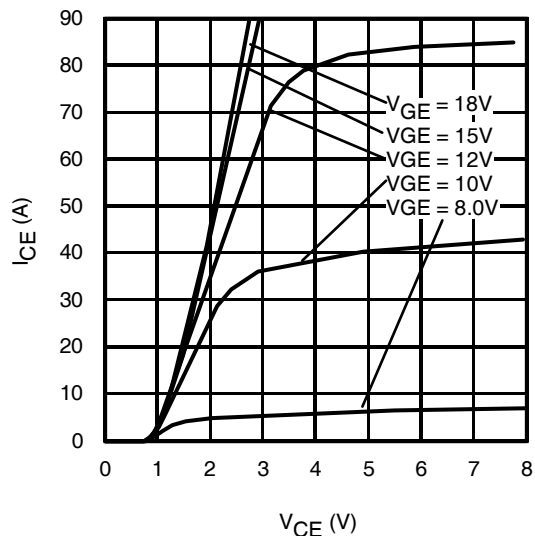


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

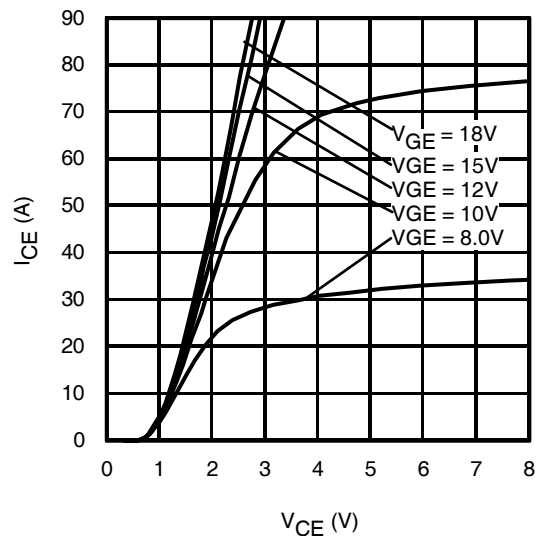


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

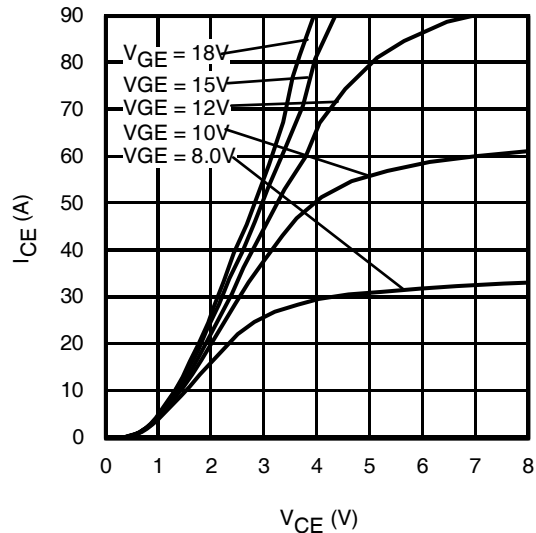


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

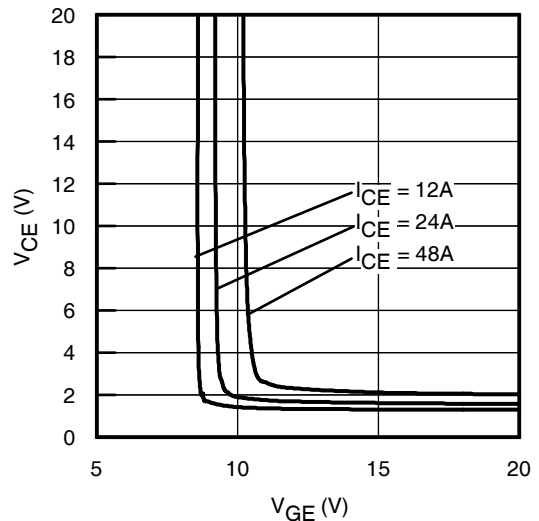


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^{\circ}\text{C}$

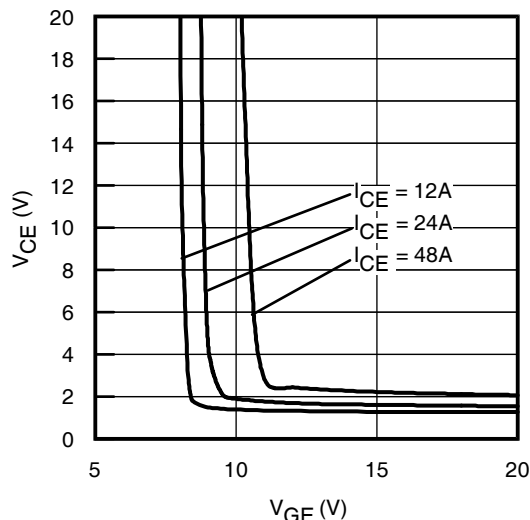


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^{\circ}\text{C}$

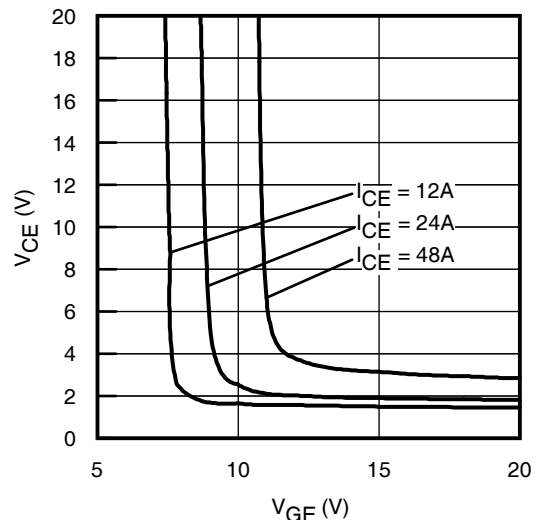


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^{\circ}\text{C}$

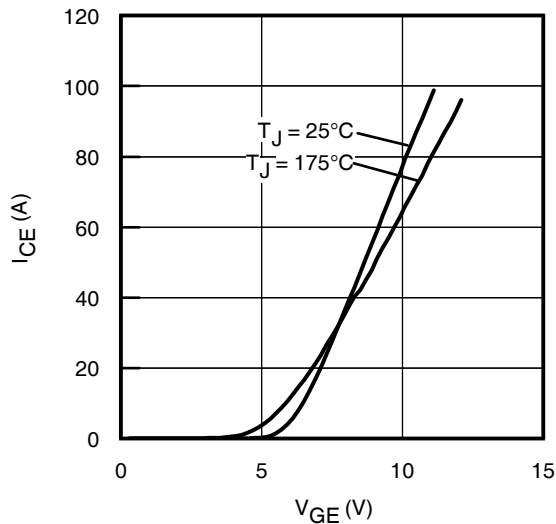


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50V$; $t_p = 10\mu s$

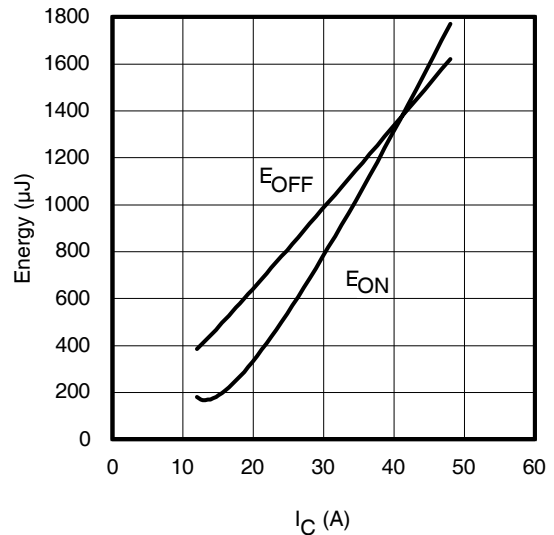


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 400V$; $R_G = 10\Omega$; $V_{GE} = 15V$

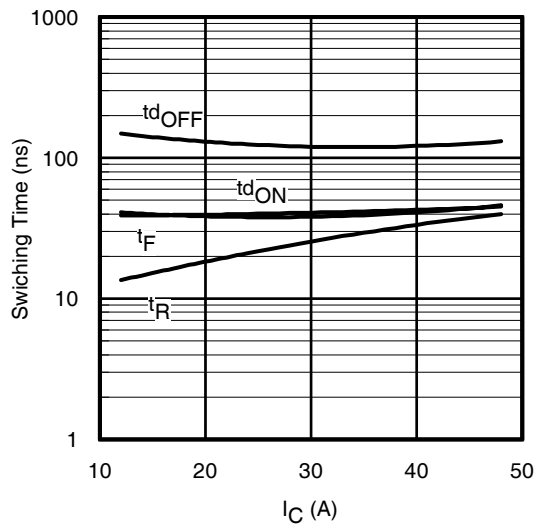


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 400V$; $R_G = 10\Omega$; $V_{GE} = 15V$

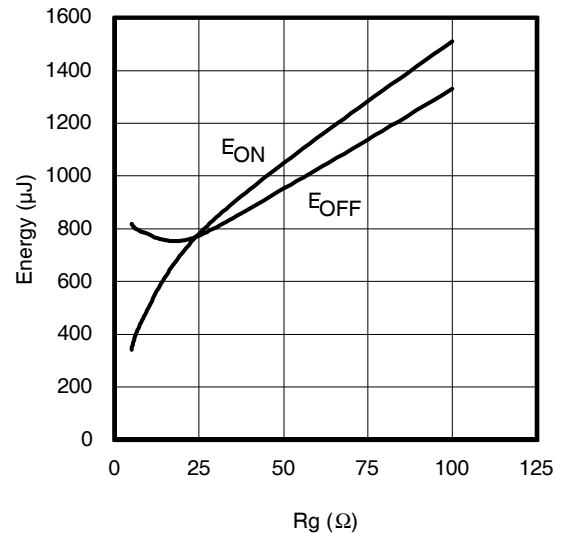


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 400V$; $I_{CE} = 24A$; $V_{GE} = 15V$

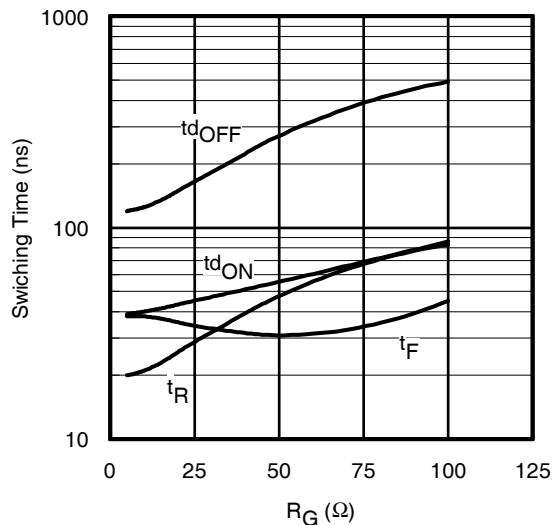


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 400V$; $I_{CE} = 24A$; $V_{GE} = 15V$

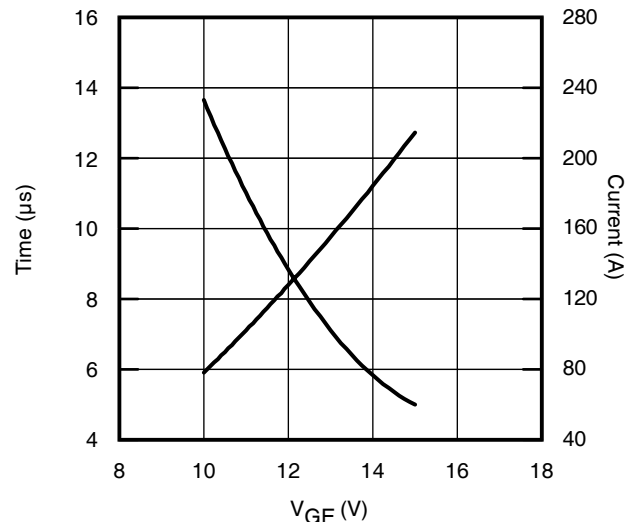


Fig. 17 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400V$; $T_C = 25^\circ C$

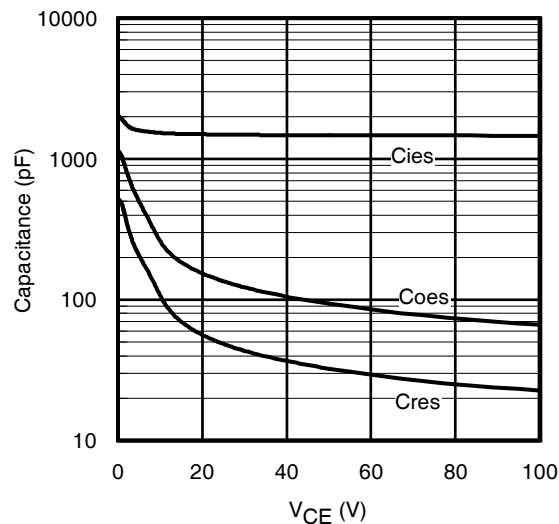


Fig. 18 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

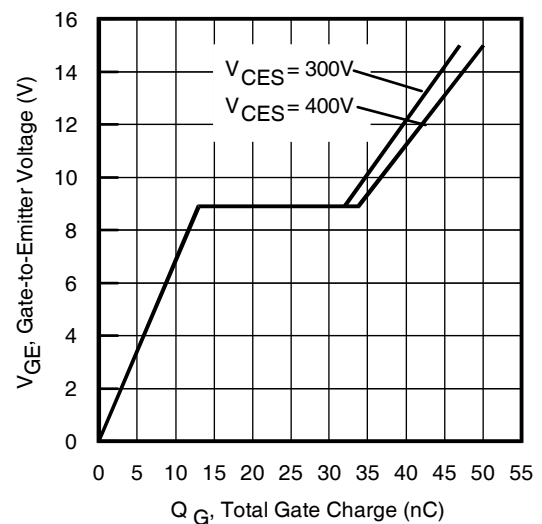


Fig. 19 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 24A$; $L = 600\mu H$

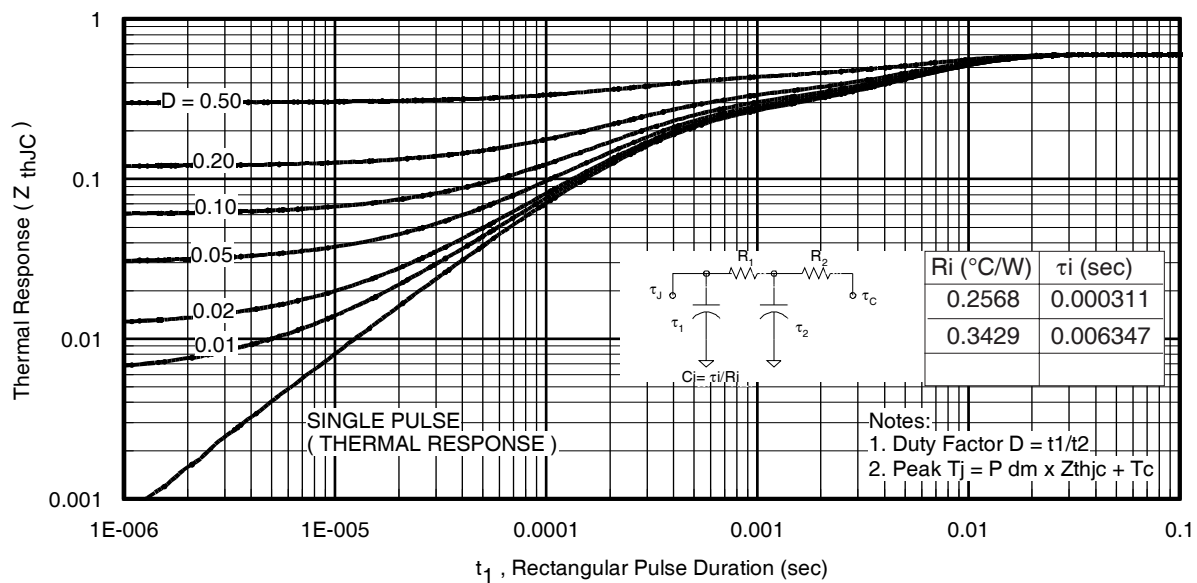
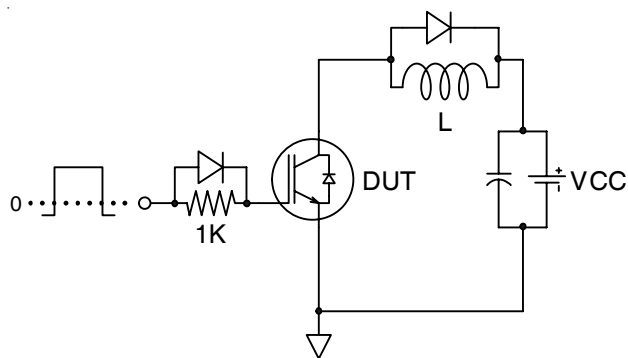
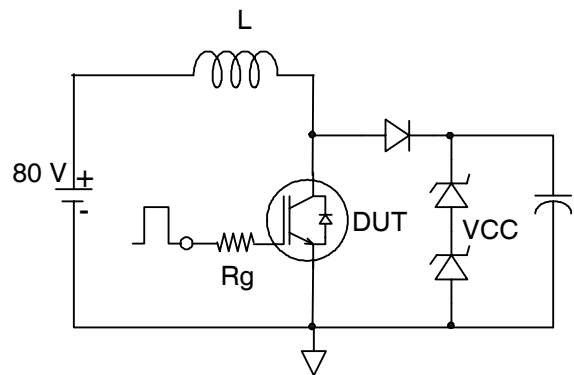
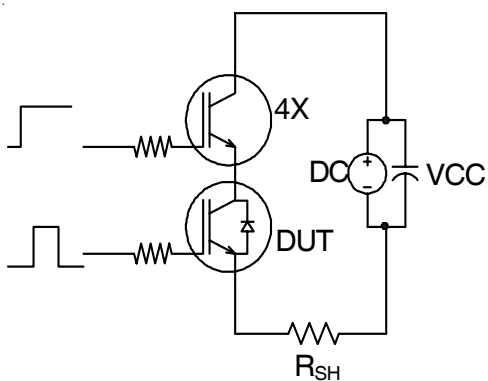
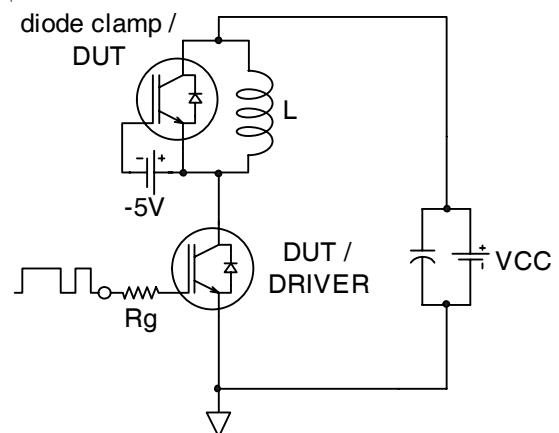
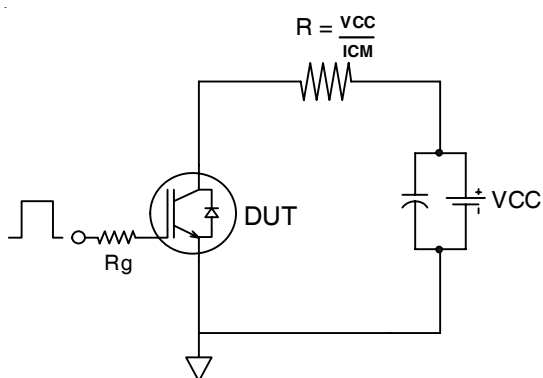
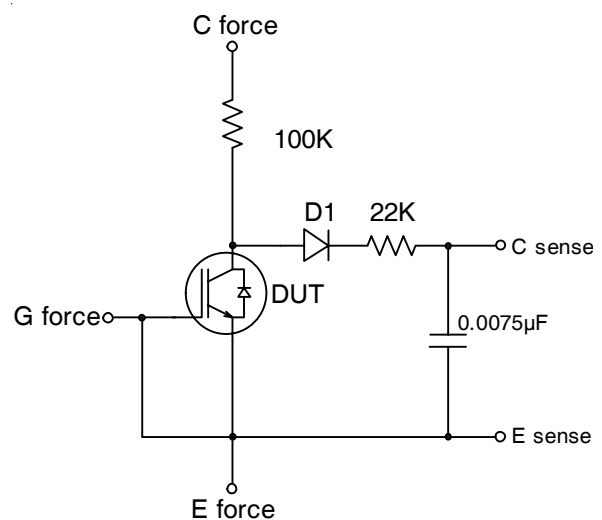


Fig 20. Maximum Transient Thermal Impedance, Junction-to-Case


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

Fig.C.T.2 - RBSOA Circuit

Fig.C.T.3 - S.C. SOA Circuit

Fig.C.T.4 - Switching Loss Circuit

Fig.C.T.5 - Resistive Load Circuit

Fig.C.T.6 - BVCES Filter Circuit

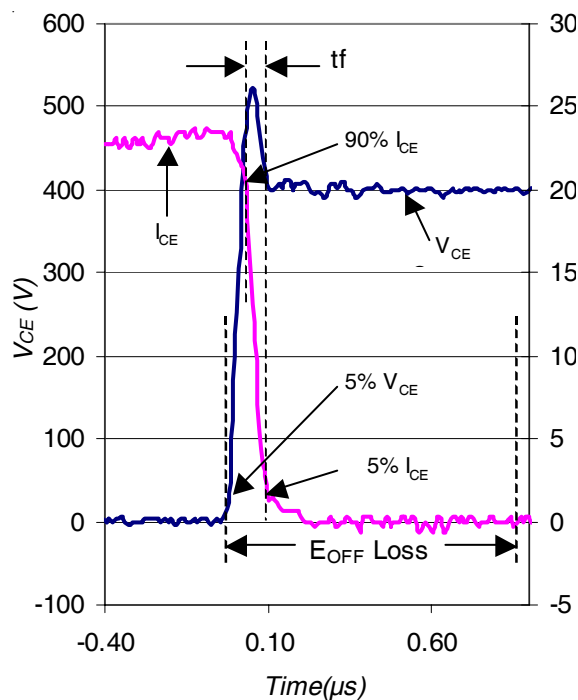


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

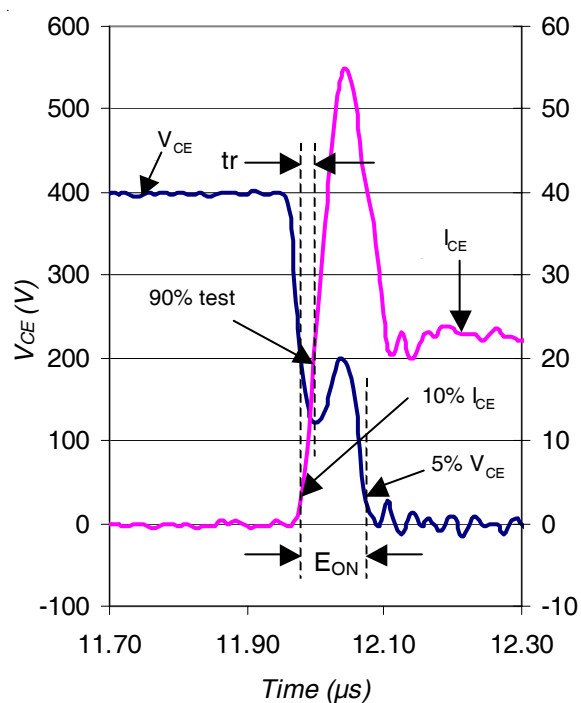


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

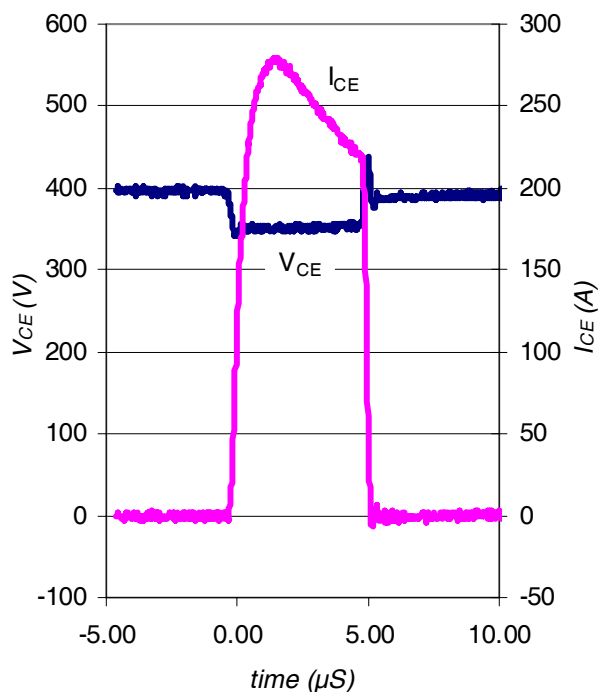


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 25^\circ\text{C}$ using Fig. CT.3

Dimensions are shown in millimeters (inches)

NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
d	.776	.815	19.71	20.70	4
D1	.515	—	13.08	—	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	—	13.46	—	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
øk	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
øP	.140	.144	3.56	3.66	
øP1	—	.291	—	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

LEAD ASSIGNMENTS

HEXFET

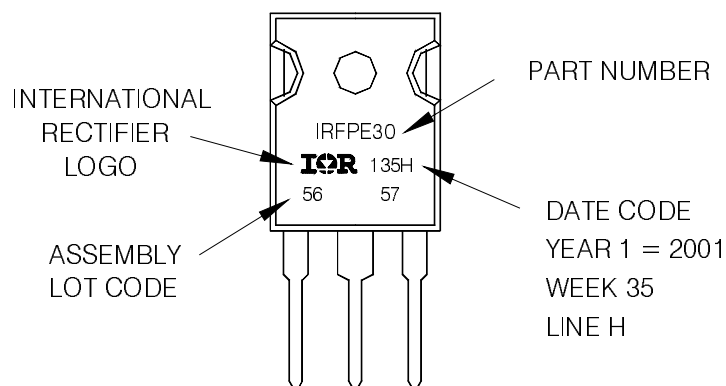
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

IGBTs, CoPACK

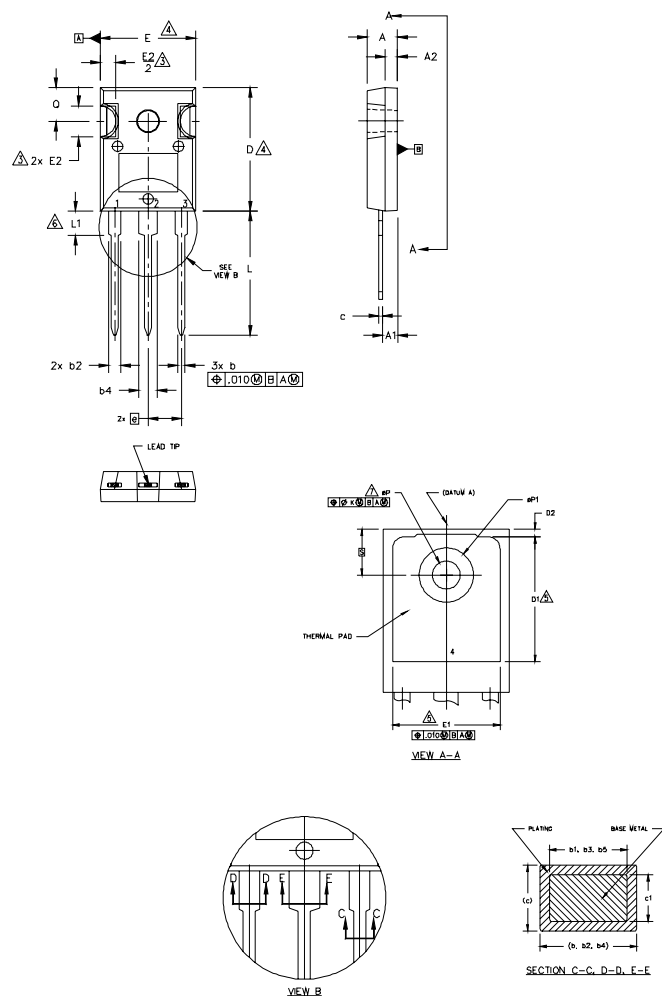
- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

DIODES

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE



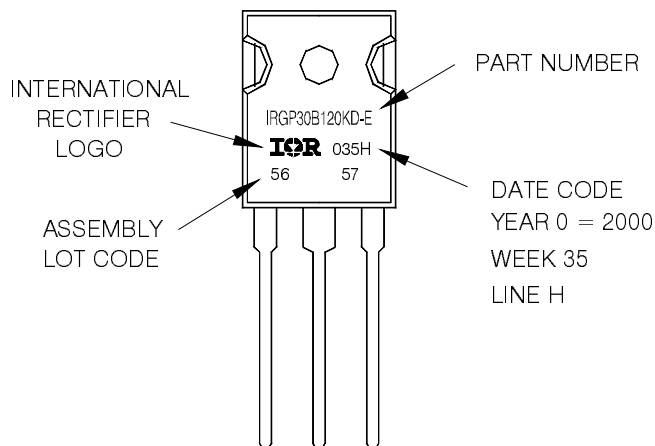
Dimensions are shown in millimeters (inches)



8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.71	20.70	4
D1	.515	—	13.08	—	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	—	13.46	—	
E2	.218	.216	4.52	5.49	
e	.275 BSC		5.46 BSC		
Øk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
øP	.140	.144	3.56	3.66	
øP1	—	.291	—	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE



Qualification Information[†]

Qualification Level		Industrial (per International Rectifier's internal guidelines)	
Moisture Sensitivity Level		TO-247AC	N/A
		TO-247AD	N/A
ESD	Human Body Model	Class H1C (+/- 2000V) ^{††} (per JEDEC JESD22-A114)	
	Charged Device Model	Class C5 (+/- 1000V) ^{††} (per JEDEC JESD22-C101)	
RoHS Compliant		Yes	

[†] Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability>

^{††} Highest passing voltage.