

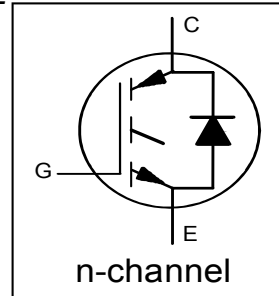
**INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE
FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS**

Features

- Low $V_{CE(ON)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175°C
- 5 μ s short circuit SOA
- Square RBSOA
- 100% of the parts tested for I_{LM} ①
- Positive $V_{CE(ON)}$ Temperature co-efficient
- Ultra-low VF Hyperfast Diode
- Tight parameter distribution

Benefits

- Device optimized for induction heating and soft switching applications
- High Efficiency due to Low $V_{CE(ON)}$, Low Switching Losses and Ultra-low V_F
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI

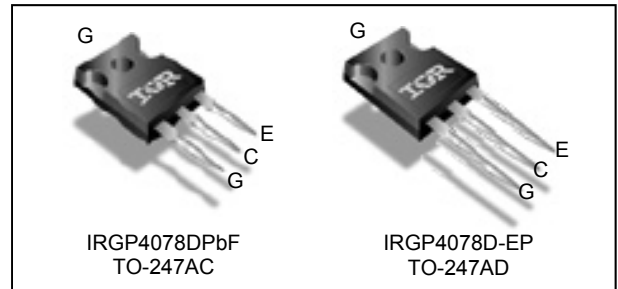


$$V_{CES} = 600V$$

$$I_{NOMINAL} = 50A$$

$$T_{J(MAX)} = 175^{\circ}C$$

$$V_{CE(ON)} \text{ typ.} = 1.9V$$



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGP4078DPbF	TO-247AC	Tube	25	IRGP4078DPbF
IRGP4078D-EPbF	TO-247AD	Tube	25	IRGP4078D-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	74	A
$I_C @ T_C = 100^{\circ}C$	Continuous Collector Current	50	
I_{CM}	Pulse Collector Current, $V_{GE} = 15V$	150	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	200	
$I_F @ T_C = 25^{\circ}C$	Diode Continuous Forward Current	44	
$I_F @ T_C = 100^{\circ}C$	Diode Continuous Forward Current	25	
$I_{FSM} @ T_C = 25^{\circ}C$	Diode Non Repetitive Peak Surge Current @ $T_J = 25^{\circ}C$ ② ⑥	120	A
$I_{FRM} @ T_C = 100^{\circ}C$	Diode Repetitive Peak Forward Current at $t_p=10\mu s$ ② ④	79	
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	278	W
$P_D @ T_C = 100^{\circ}C$	Maximum Power Dissipation	139	
T_J	Operating Junction and	-55 to +175	$^{\circ}C$
T_{STG}	Storage Temperature Range		
	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
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT)	—	—	0.54	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	2.55	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, 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	$V_{GE} = 0V$, $I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.45	—	V/°C	$V_{GE} = 0V$, $I_C = 1mA$ (25°C - 175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.9	2.2	V	$I_C = 50A$, $V_{GE} = 15V$, $T_J = 25^\circ\text{C}$
		—	2.5	—		$I_C = 50A$, $V_{GE} = 15V$, $T_J = 150^\circ\text{C}$
		—	2.6	—		$I_C = 50A$, $V_{GE} = 15V$, $T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}$, $I_C = 1.0mA$
g_{fe}	Forward Transconductance	—	26	—	S	$V_{CE} = 50V$, $I_C = 50A$, $PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	80	μA	$V_{GE} = 0V$, $V_{CE} = 600V$
		—	600	—		$V_{GE} = 0V$, $V_{CE} = 600V$, $T_J = 175^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.17	1.30	V	$I_F = 25A$
		—	1.06	—		$I_F = 25A$, $T_J = 175^\circ\text{C}$
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.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	61	92	nC	$I_C = 50A$ $V_{GE} = 15V$ $V_{CC} = 300V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	20	30		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	22	33		
E_{off}	Turn-Off Switching Loss	—	1.1	1.4	mJ	$I_C = 50A$, $V_{CC} = 400V$, $V_{GE} = 15V$ $R_G = 10\Omega$, $L = 210\mu H$, $T_J = 25^\circ C$
$t_{d(off)}$	Turn-Off delay time	—	116	—	ns	Energy losses include tail & diode reverse recovery
t_f	Fall time	—	33	—		
E_{off}	Turn-Off Switching Loss	—	1.5	—	mJ	$I_C = 50A$, $V_{CC} = 400V$, $V_{GE}=15V$ $R_G = 10\Omega$, $L = 210\mu H$, $T_J = 175^\circ C$
$t_{d(off)}$	Turn-Off delay time	—	113	—	ns	Energy losses include tail & diode reverse recovery
t_f	Fall time	—	54	—		
C_{ies}	Input Capacitance	—	2105	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
C_{oes}	Output Capacitance	—	131	—		
C_{res}	Reverse Transfer Capacitance	—	59	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ C$, $I_C = 200A$ $V_{CC} = 480V$, $V_p \leq 600V$ $R_g = 10\Omega$, $V_{GE} = +20V$ to $0V$
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V$, $V_p \leq 600V$ $R_g = 10\Omega$, $V_{GE} = +15V$ to $0V$

Notes:

- ① $V_{CC} = 80\%$ (V_{CES}), $V_{GE} = 20V$, $L = 23\mu H$, $R_G = 10\Omega$.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ④ $f_{sw} = 20KHz$, refer to figure 19.
- ⑤ R_θ is measured at T_J of approximately 90°C .
- ⑥ Sinusoidal half wave, $t = 10ms$.

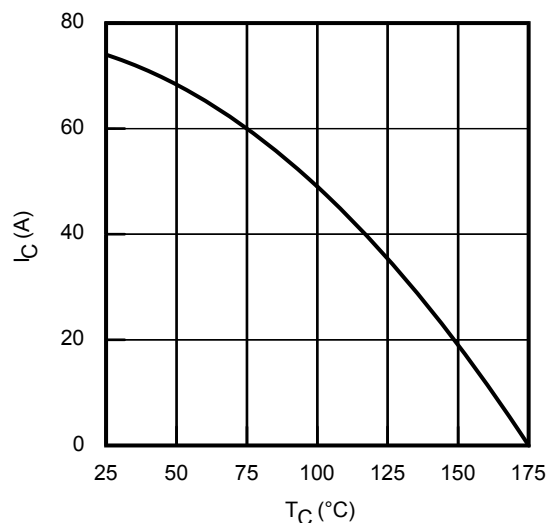


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

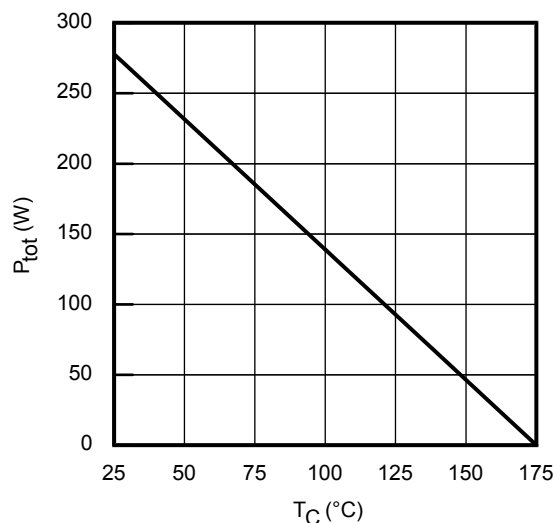


Fig. 2 - Power Dissipation vs. Case Temperature

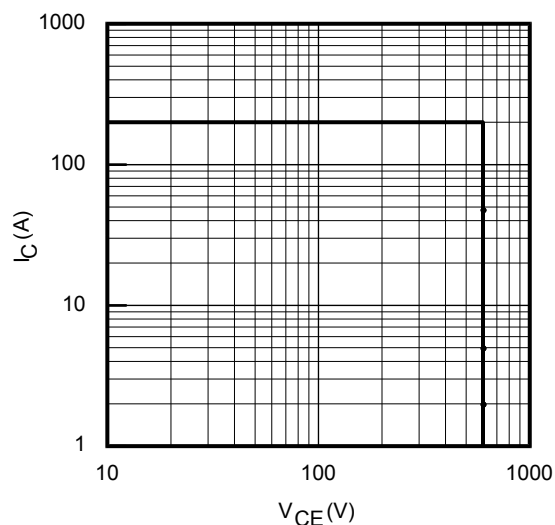


Fig. 3 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 20\text{V}$

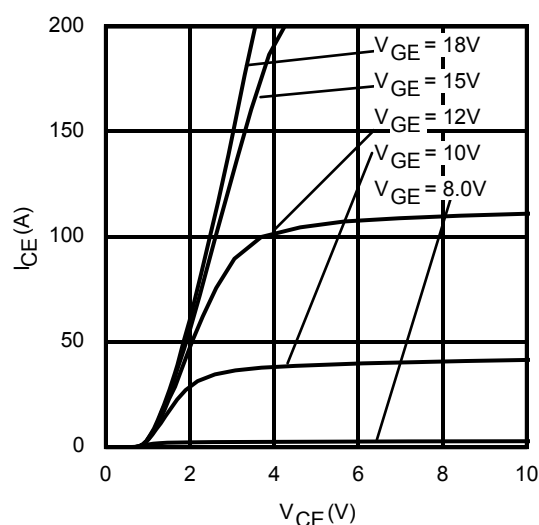


Fig. 4 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 20\mu\text{s}$

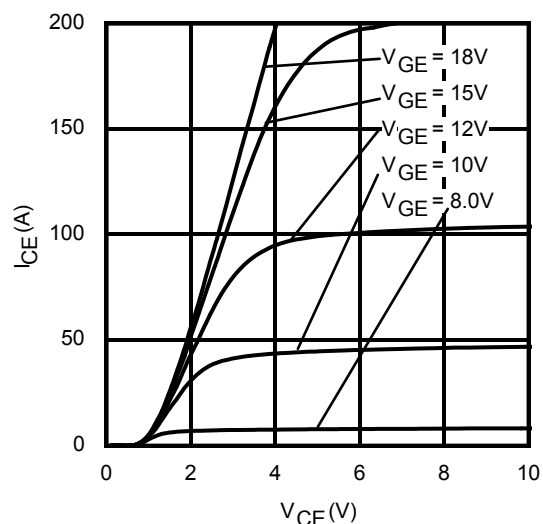


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 20\mu\text{s}$

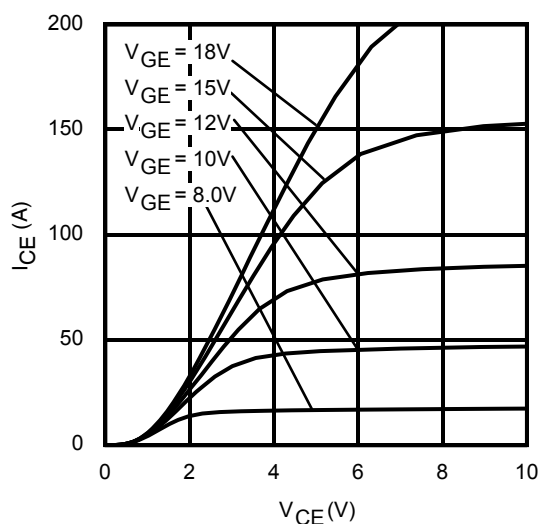


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 20\mu\text{s}$

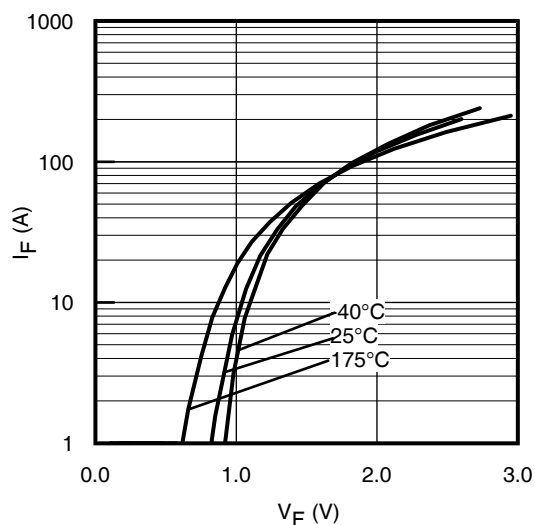


Fig. 7 - Typ. Diode Forward Voltage Drop Characteristics

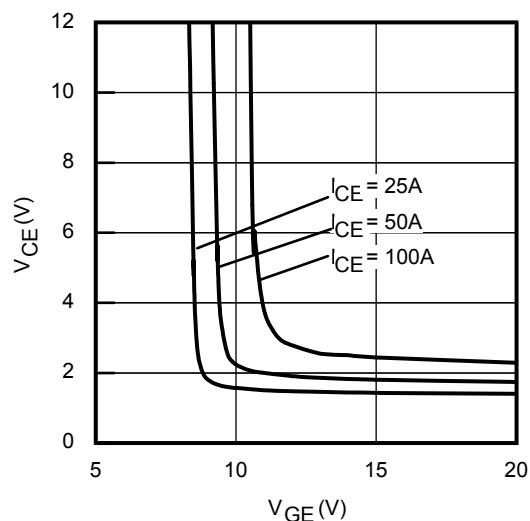


Fig. 8 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^{\circ}\text{C}$

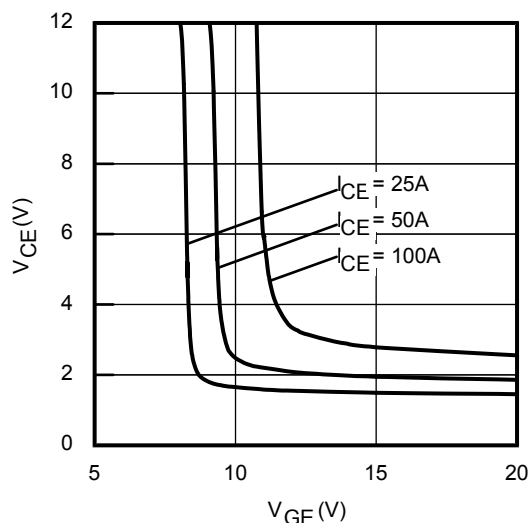


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^{\circ}\text{C}$

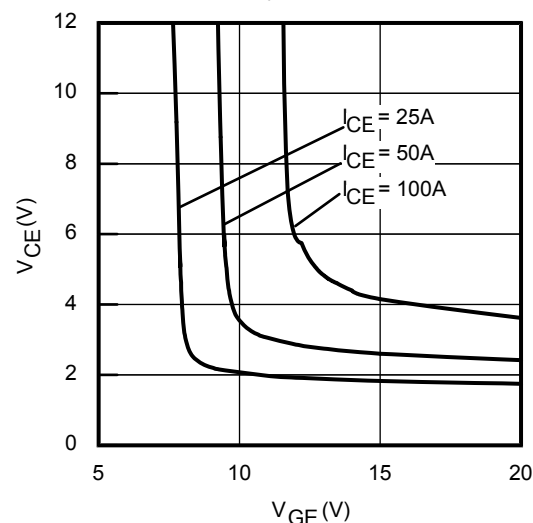


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^{\circ}\text{C}$

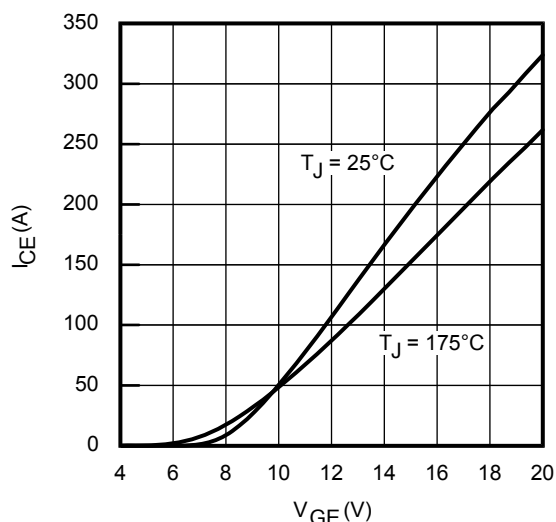


Fig. 11 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

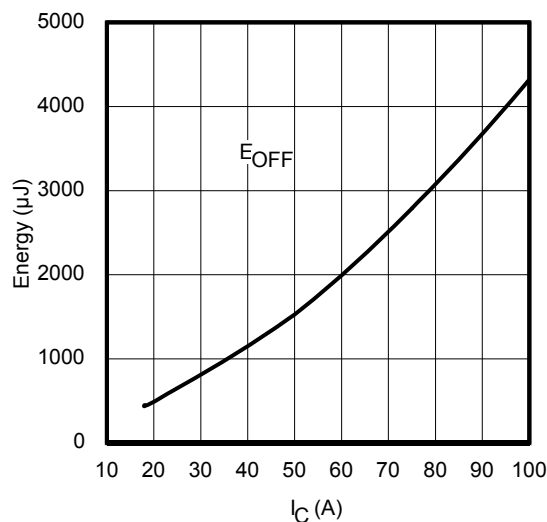
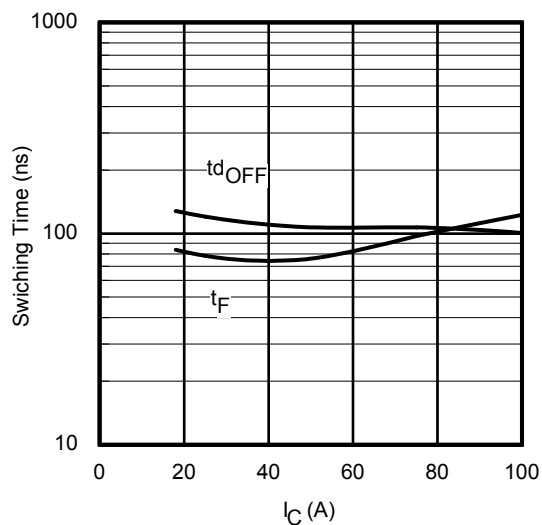
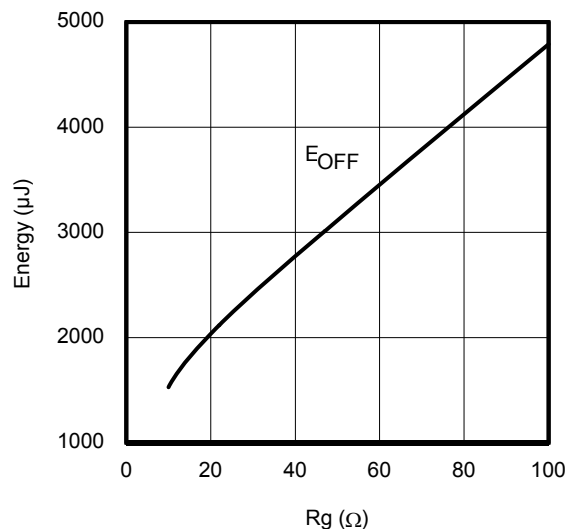
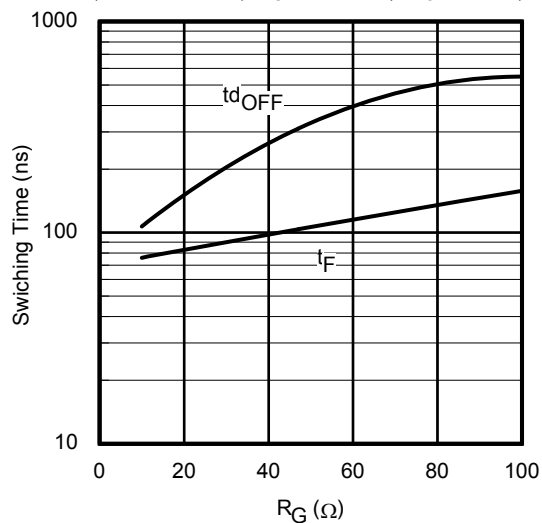
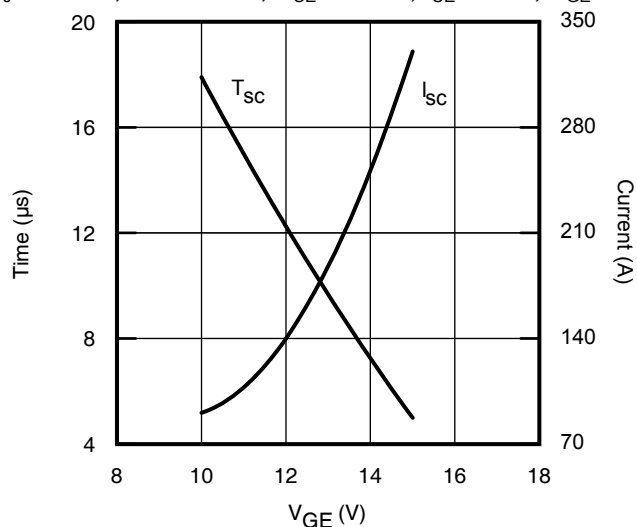
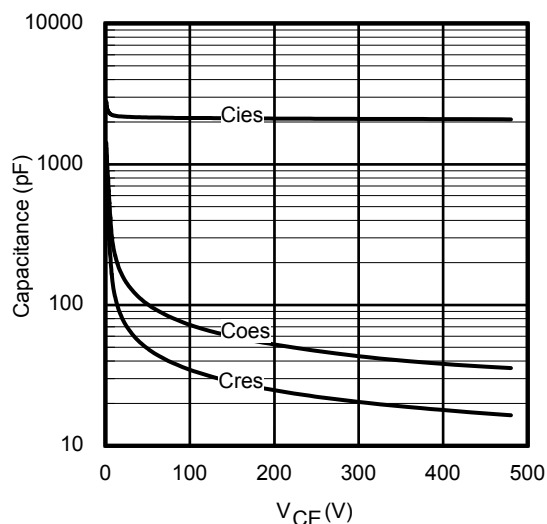
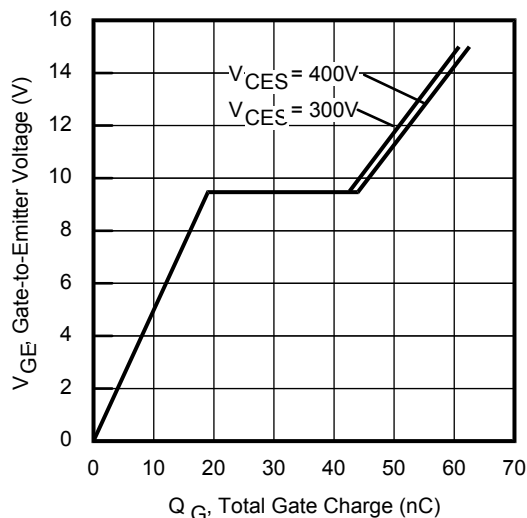


Fig. 12 - Typ. Energy Loss vs. I_C
 $T_J = 175^{\circ}\text{C}$; $L = 210\text{mH}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$


Fig. 13 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 210\text{mH}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

Fig. 14 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 210\text{mH}$; $V_{CE} = 400\text{V}$; $I_{CE} = 50\text{A}$; $V_{GE} = 15\text{V}$

Fig. 15 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 210\text{mH}$; $V_{CE} = 400\text{V}$; $I_{CE} = 50\text{A}$; $V_{GE} = 15\text{V}$

Fig. 16 - V_{GE} vs. Short Circuit

 $V_{CC} = 400\text{V}$; $T_C = 25^\circ\text{C}$

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

Fig. 18 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 50\text{A}$

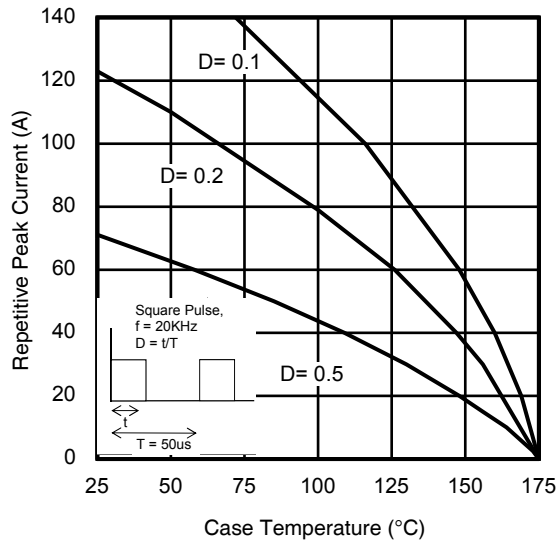


Fig. 19 - Maximum Diode Repetitive Forward Peak Current vs. Case Temperature

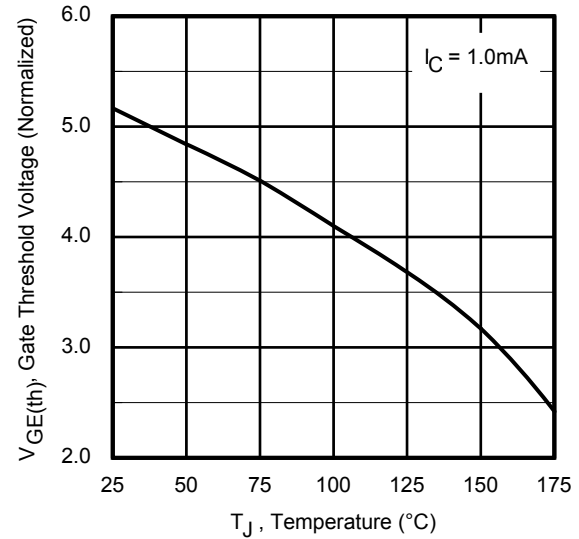


Fig. 20 - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

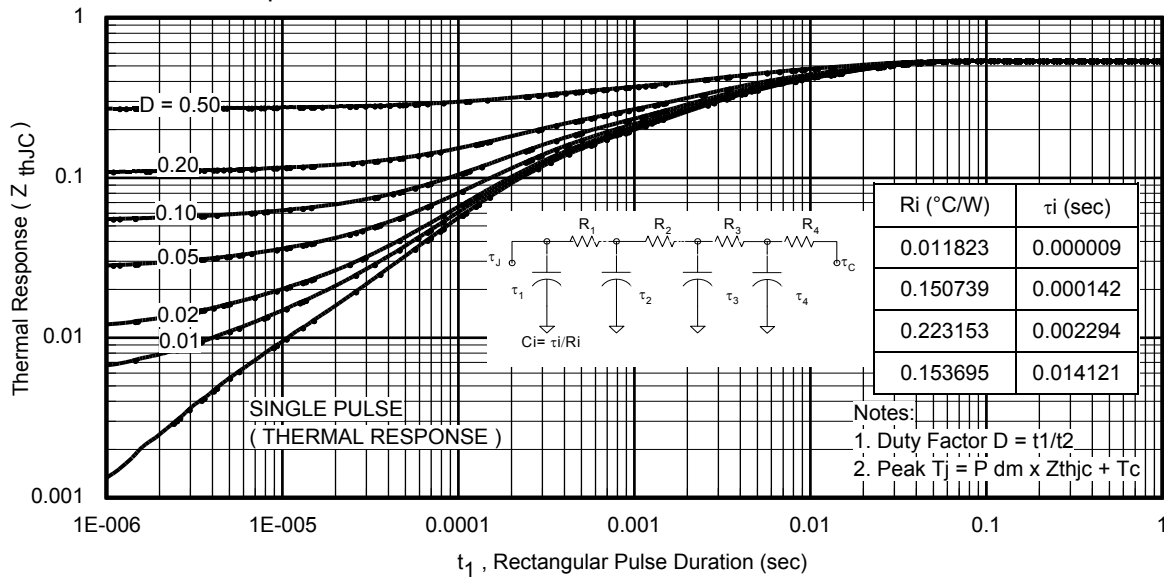


Fig 21. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

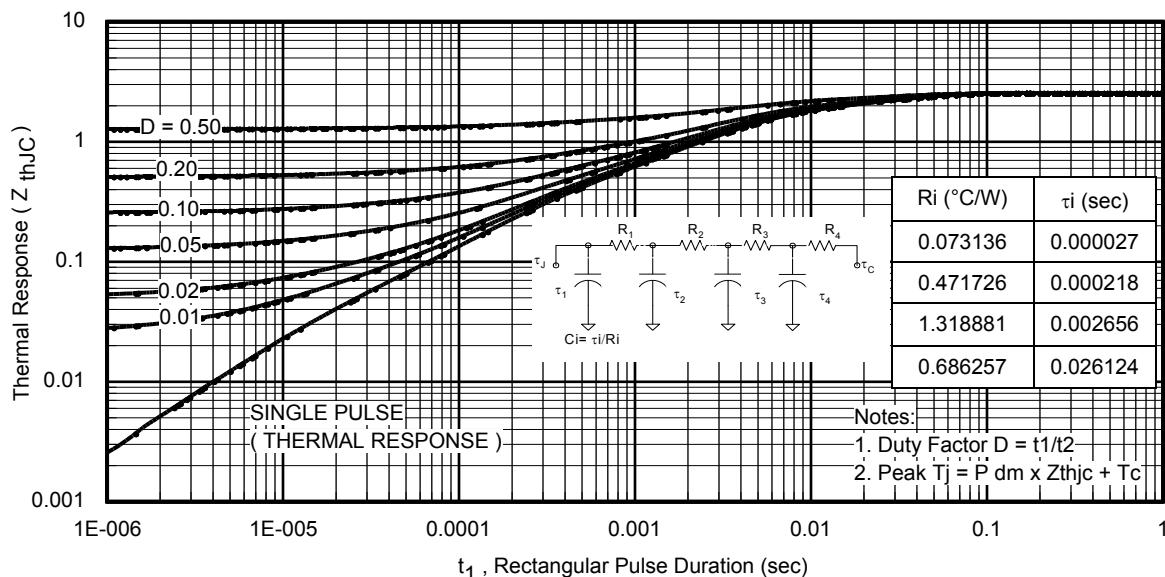
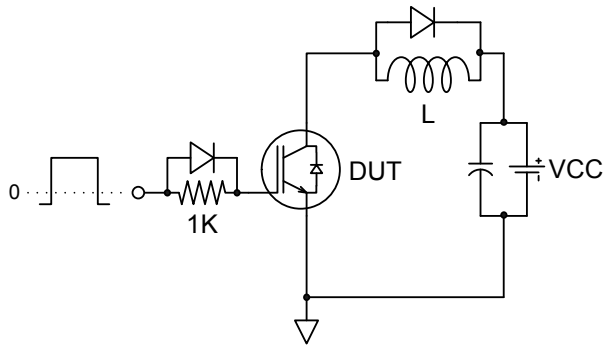
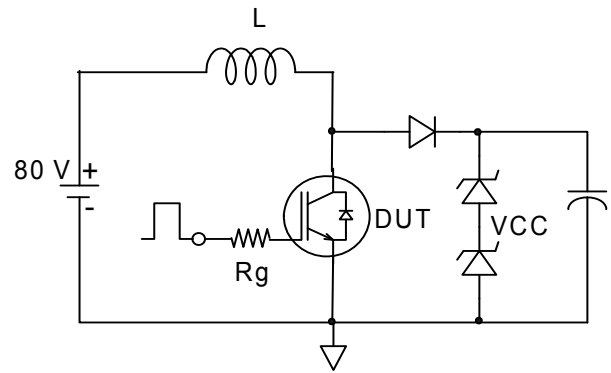
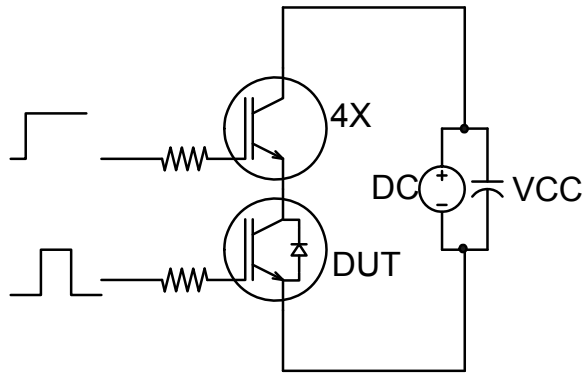
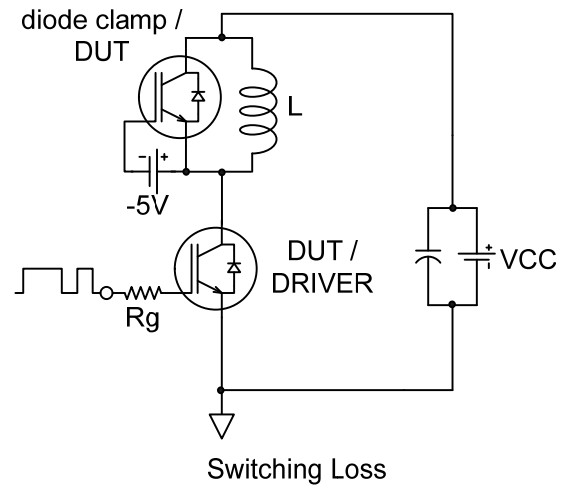
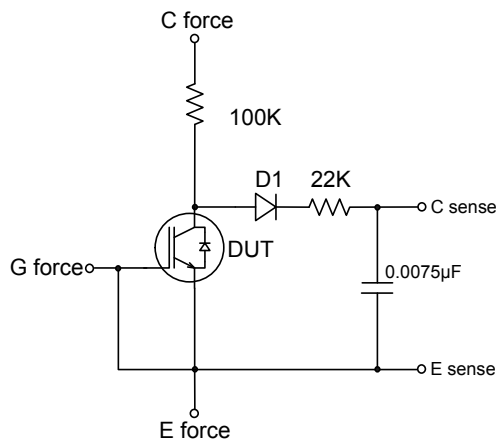


Fig 22. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)


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 - BVCES Filter Circuit

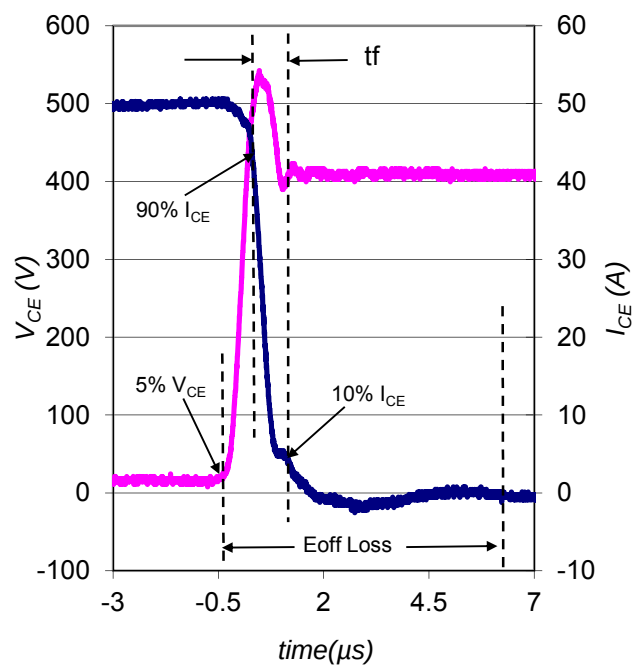


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

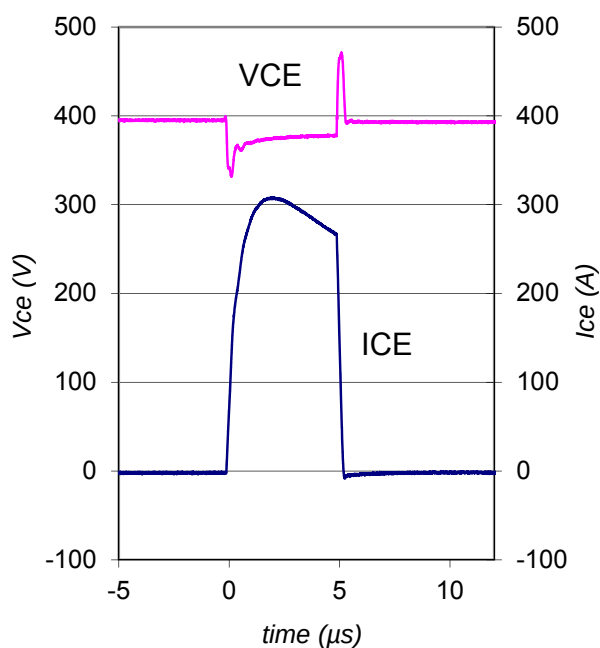
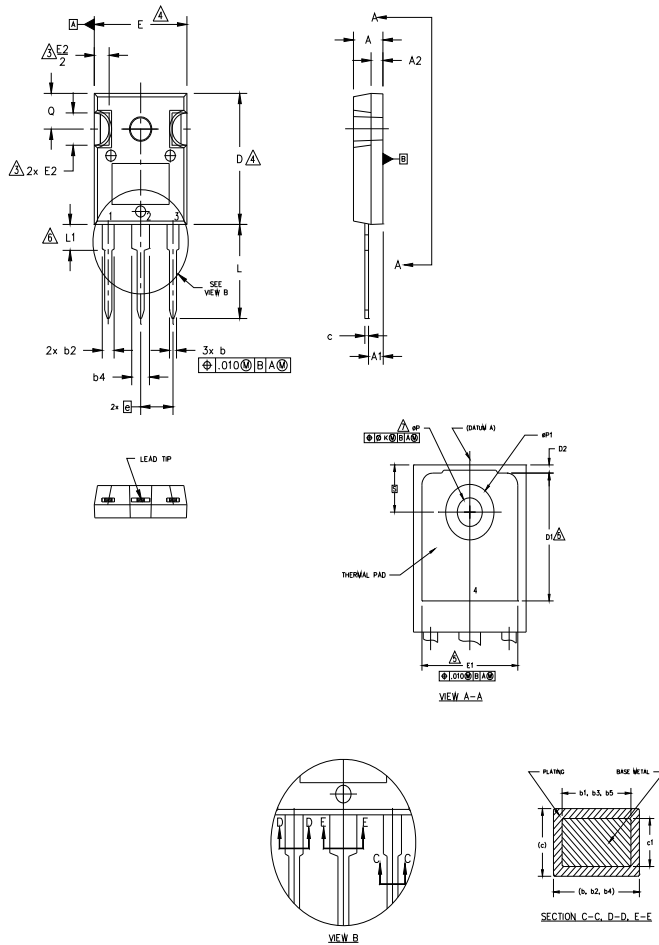


Fig. WF2 - Typ. S.C. Waveform @ $T_J = 25^\circ\text{C}$
using Fig. CT.3

TO-247AC Package Outline

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. ϕP 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

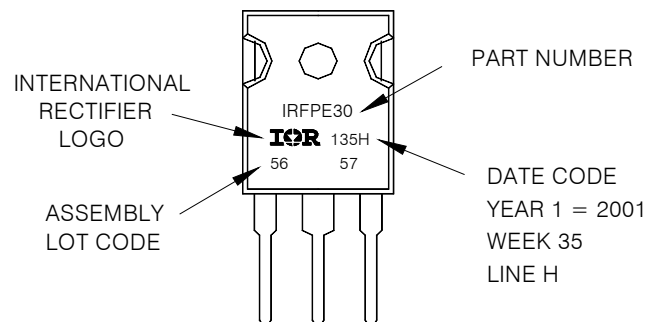
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

TO-247AC Part Marking Information

Notes: This part marking information applies to devices produced after 02/26/2001

EXAMPLE: THIS IS AN IRFPE30
WITH ASSEMBLY
LOT CODE 5657
ASSEMBLED ON WW 35, 2001
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position
indicates "Lead-Free"

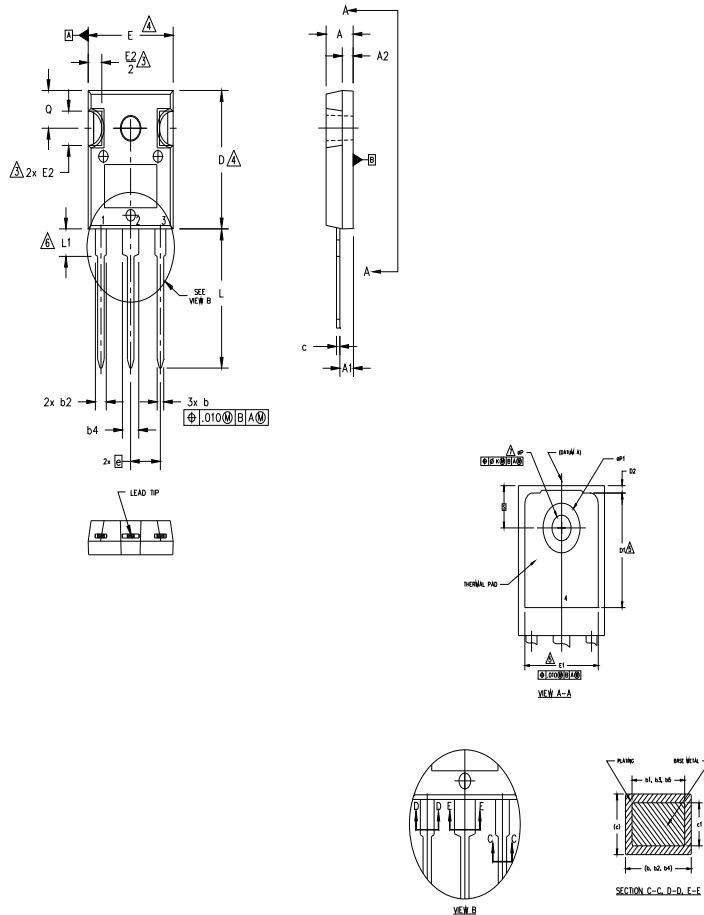


TO-247AC package is not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

TO-247AD Package Outline

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-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	.178	.216	4.52	5.49	
e	.215 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		

LEAD ASSIGNMENTS

HEXFET

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

IGBTs, CoPACK

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

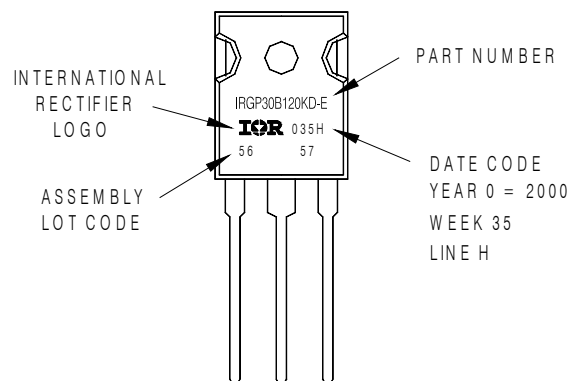
DIODES

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

TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRGP30B120KD-E
WITH ASSEMBLY
LOT CODE 5657
ASSEMBLED ON WW 35, 2000
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position
indicates "Lead-Free"



TO-247AD package is not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

Qualification Information[†]

Qualification Level	Industrial [†] (per JEDEC JESD47F) ^{††}	
Moisture Sensitivity Level	TO-247AC	N/A
	TO-247AD	N/A
RoHS Compliant	Yes	

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

^{††} Applicable version of JEDEC standard at the time of product release.

International
 Rectifier

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 To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>