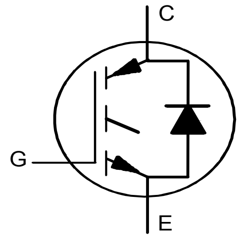
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS



n-channel

V_{CES} = 600V

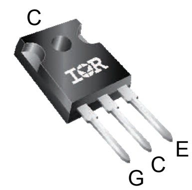
I_C = 50A, T_C =100°C

$T_{J(MAX)}$ = 175°C

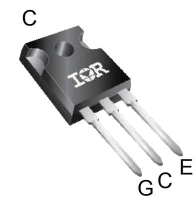
$V_{CE(ON)}$ typ. = 1.9V

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 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



IRGP4078DPbF
TO-247AC



IRGP4078D-EP
TO-247AD

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°C	Continuous Collector Current	74	A
I_C @ T_C = 100°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°C	Diode Continuous Forward Current	44	
I_F @ T_C = 100°C	Diode Continuous Forward Current	25	
I_{FSM} @ T_C = 25°C	Diode Non Repetitive Peak Surge Current @ T_J = 25°C②⑥	120	
I_{FRM} @Tc = 100°C	Diode Repetitive Peak Forward Current at tp=10µs ②④	79	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	278	W
P_D @ T_C = 100°C	Maximum Power Dissipation	139	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°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
$R_{\theta JC}$ (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°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 = 100µA 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°C
		—	2.5	—		I_C = 50A, V_{GE} = 15V, T_J = 150°C
		—	2.6	—		I_C = 50A, V_{GE} = 15V, T_J = 175°C
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 1.0mA
gfe	Forward Transconductance	—	26	—	S	V_{CE} = 50V, I_C = 50A, PW = 20µs
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°C
V_{FM}	Diode Forward Voltage Drop	—	1.17	1.30	V	I_F = 25A
		—	1.06	—		I_F = 25A, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	61	92	nC	I_C = 50A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	20	30		V_{GE} = 15V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	22	33		V_{CC} = 300V
E_{off}	Turn-Off Switching Loss	—	1.1	1.4	mJ	I_C = 50A, V_{CC} = 400V, V_{GE} = 15V R_G = 10Ω, L = 210µH, T_J = 25°C
$t_{d(off)}$	Turn-Off delay time	—	116	—	ns	Energy losses include tail & diode
t_f	Fall time	—	33	—		reverse recovery
E_{off}	Turn-Off Switching Loss	—	1.5	—	mJ	I_C = 50A, V_{CC} = 400V, V_{GE}=15V R_G = 10Ω, L = 210µH, T_J = 175°C
$t_{d(off)}$	Turn-Off delay time	—	113	—	ns	Energy losses include tail & diode
t_f	Fall time	—	54	—		reverse recovery
C_{ies}	Input Capacitance	—	2105	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	131	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	59	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 200A V_{CC} = 480V, Vp ≤ 600V Rg = 10Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	µs	V_{CC} = 400V, Vp ≤ 600V Rg = 10Ω, V_{GE} = +15V to 0V

Notes:

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

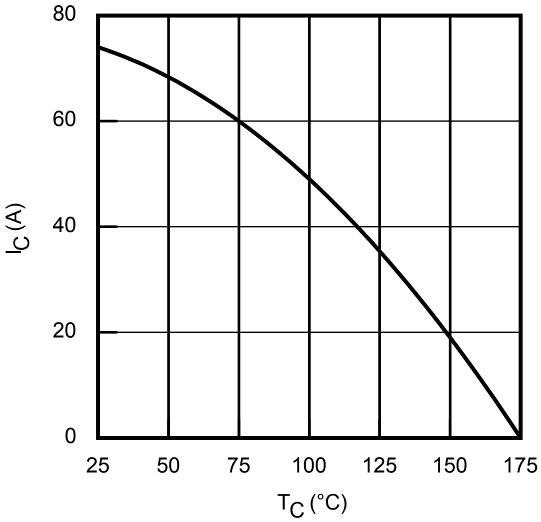


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

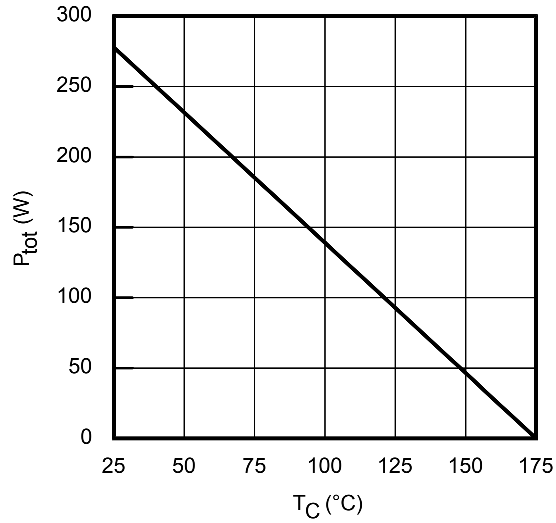


Fig. 2 - Power Dissipation vs. Case Temperature

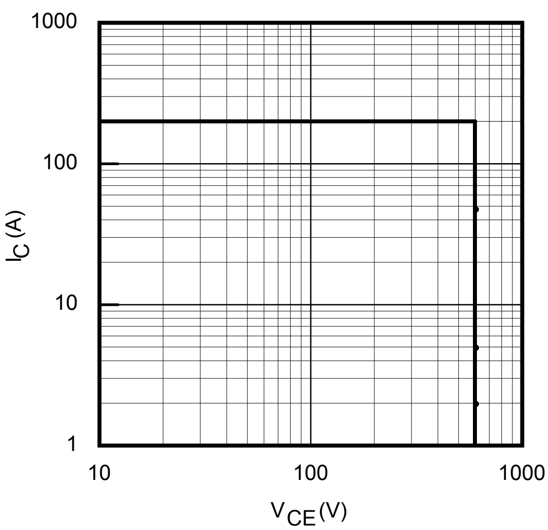


Fig. 3 - Reverse Bias SOA
T_J = 150°C; V_{GE} = 20V

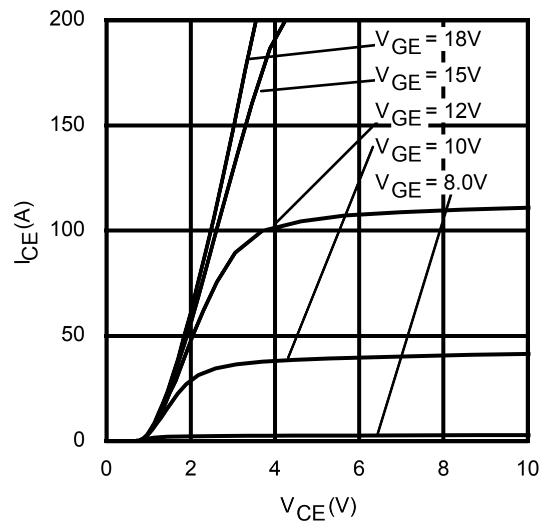


Fig. 4 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 20µs

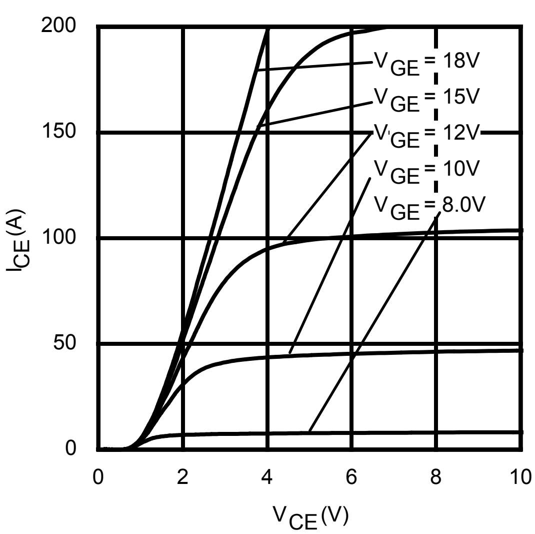


Fig. 5 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 20µs

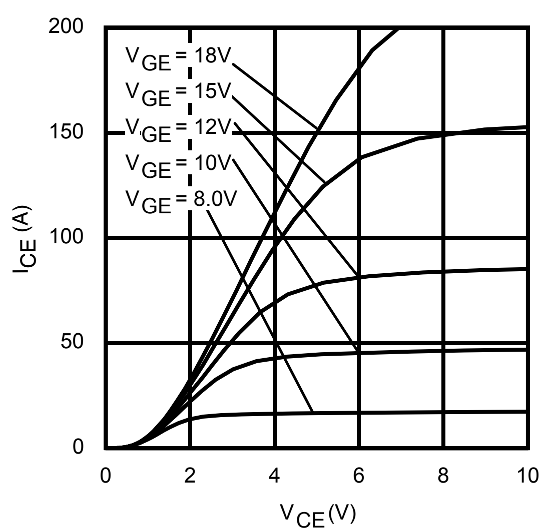


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 20µs

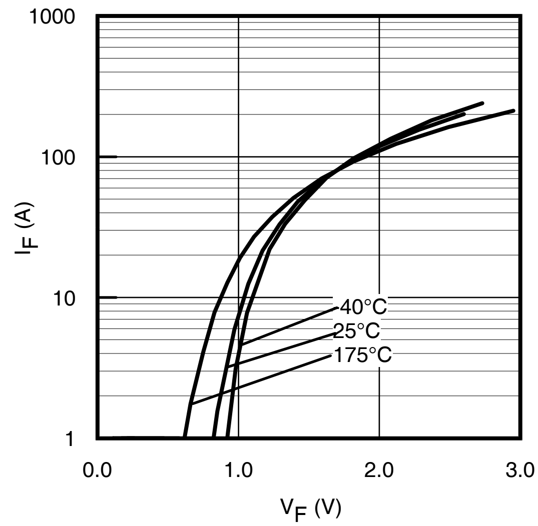


Fig. 7 - Typ. Diode Forward Voltage Drop Characteristics

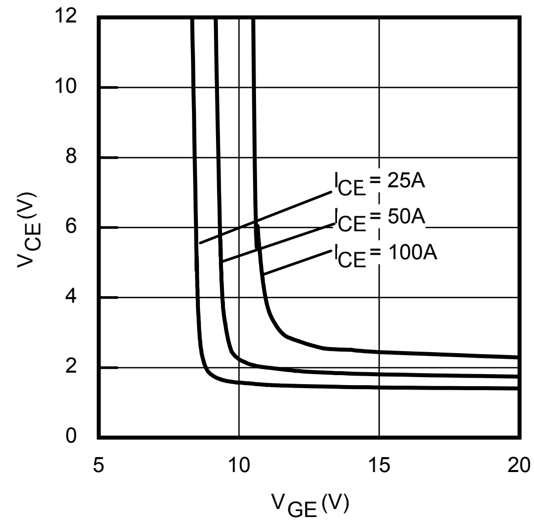


Fig. 8 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

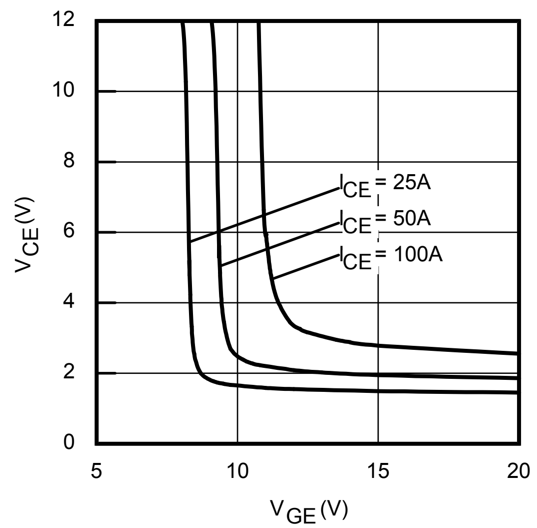


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

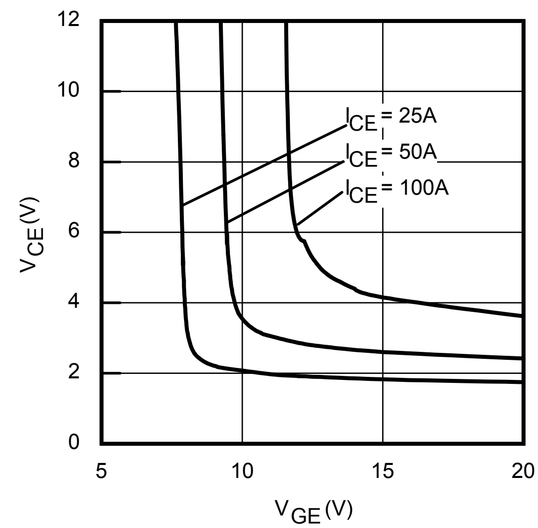


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

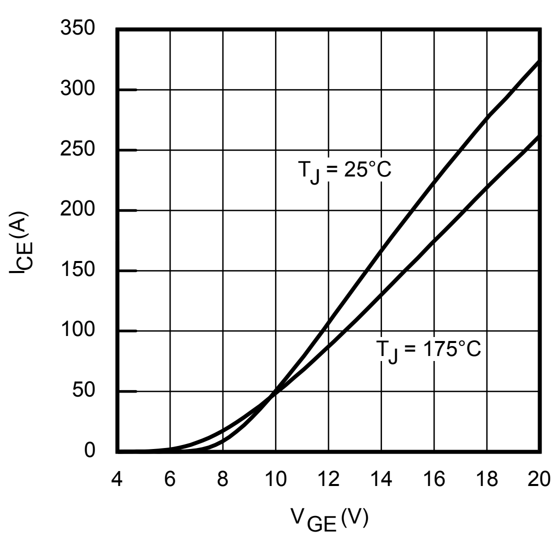


Fig. 11 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 20µs

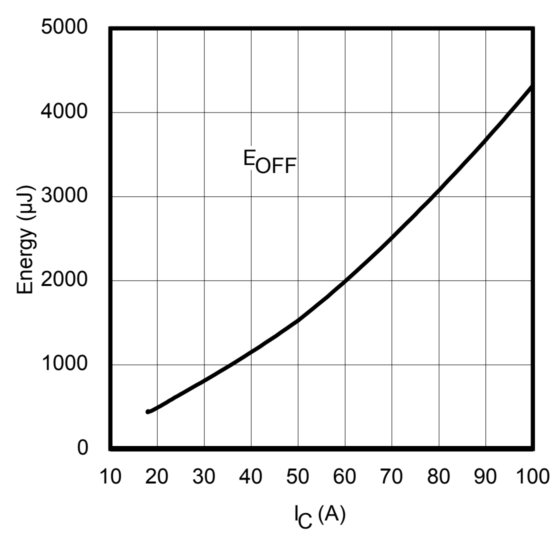


Fig. 12 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 210mH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

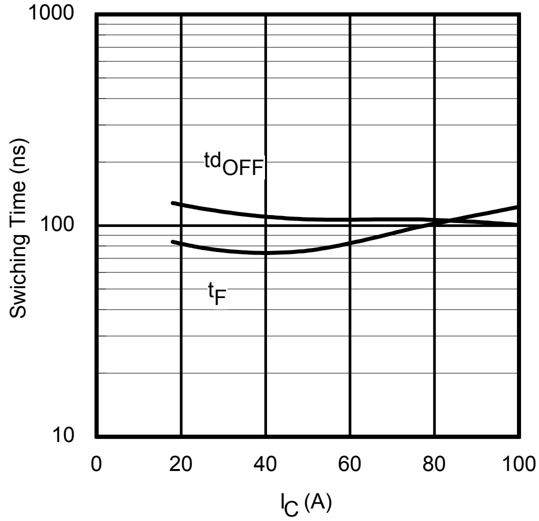


Fig. 13 - Typ. Switching Time vs. I_C
T_J = 175°C; L = 210mH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

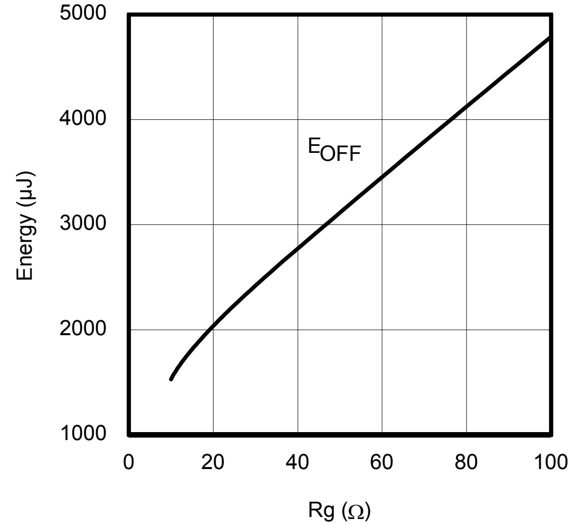


Fig. 14 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 210mH; V_{CE} = 400V, I_{CE} = 50A; V_{GE} = 15V

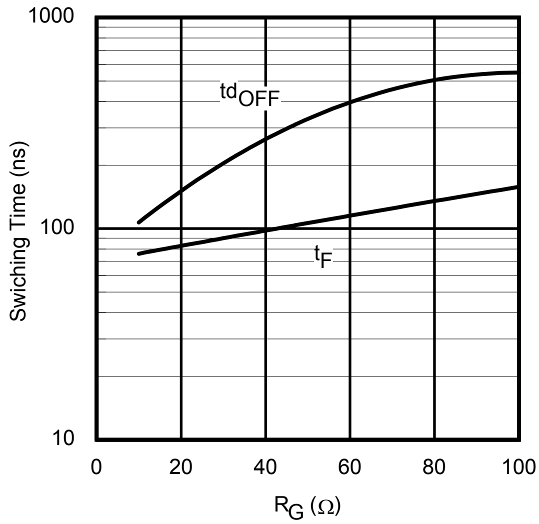


Fig. 15 - Typ. Switching Time vs. R_G
T_J = 175°C; L = 210mH; V_{CE} = 400V, I_{CE} = 50A; V_{GE} = 15V

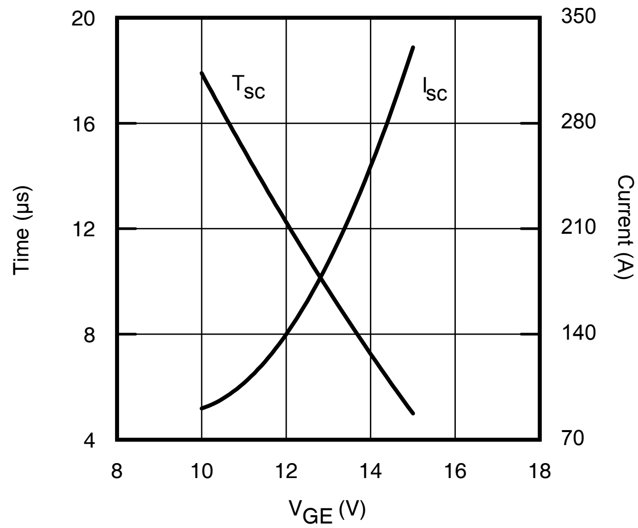


Fig. 16 - V_{GE} vs. Short Circuit
V_{CC} = 400V; T_C = 25°C

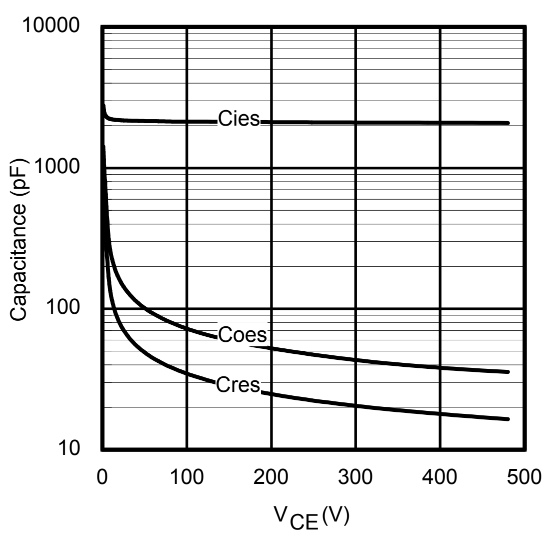


Fig. 17 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

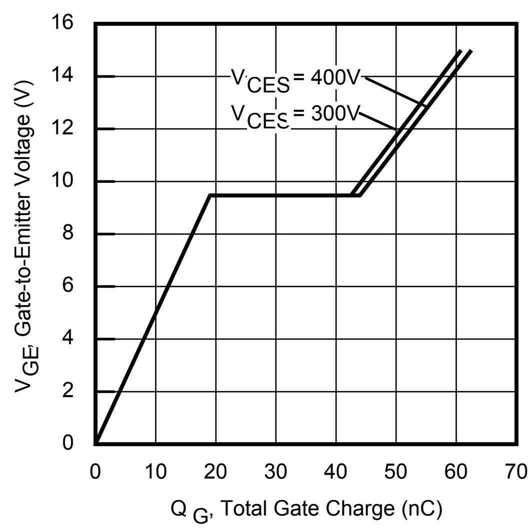


Fig. 18 - Typical Gate Charge vs. V_{GE}
I_{CE} = 50A

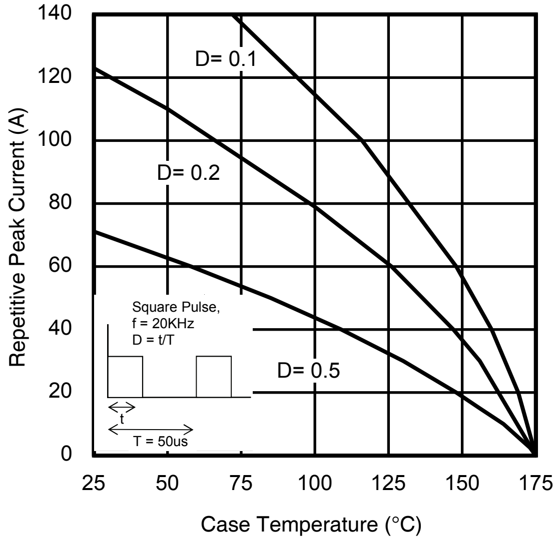


Fig. 19 - Maximum Diode Repetitive Forward Peak Current vs. Case Temperature

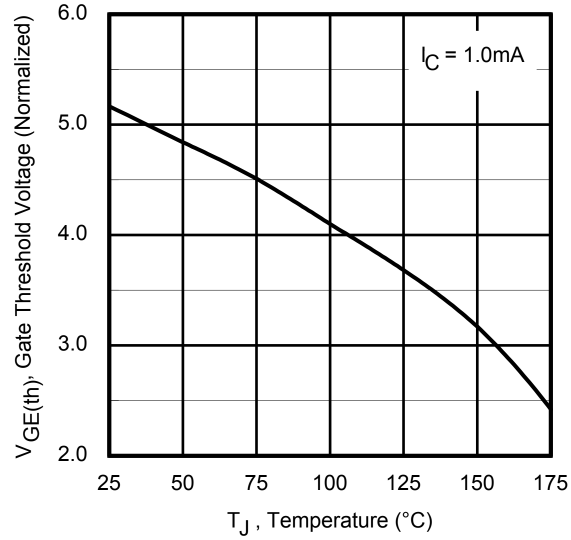
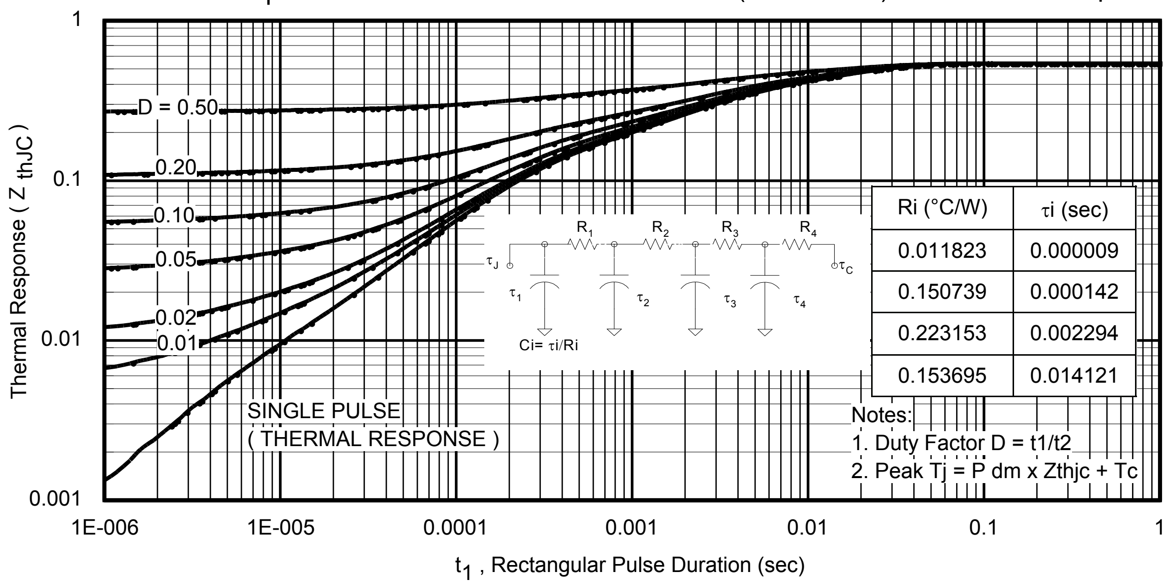
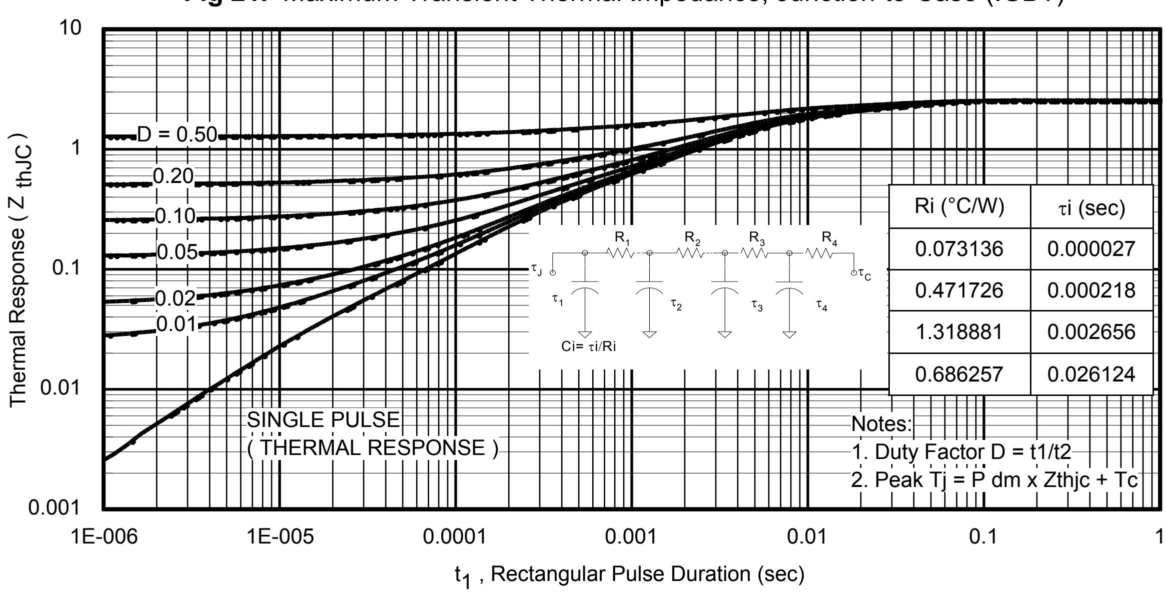


Fig. 20 - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature



Ri (°C/W)	τi (sec)
0.011823	0.000009
0.150739	0.000142
0.223153	0.002294
0.153695	0.014121

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



Ri (°C/W)	τi (sec)
0.073136	0.000027
0.471726	0.000218
1.318881	0.002656
0.686257	0.026124

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

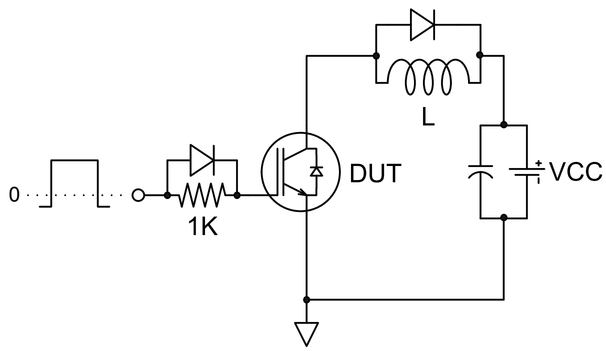


Fig.C.T.1 - Gate Charge Circuit (turn-off)

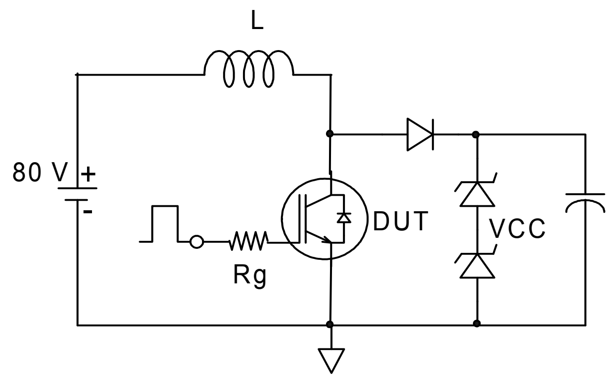


Fig.C.T.2 - RBSOA Circuit

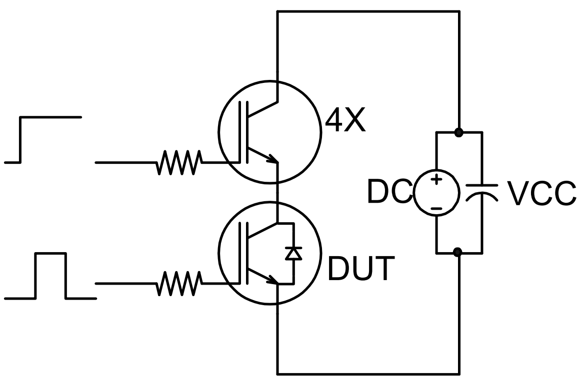


Fig.C.T.3 - S.C. SOA Circuit

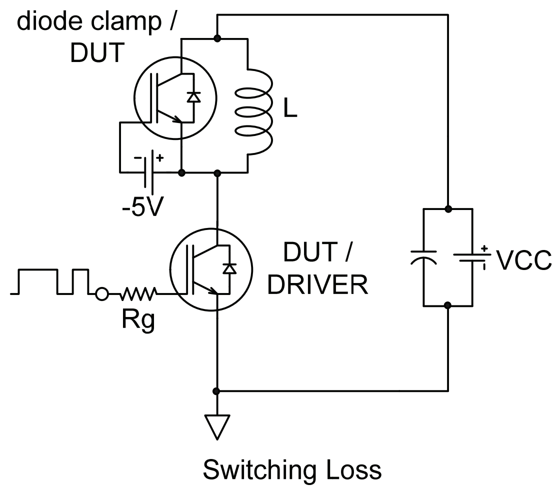


Fig.C.T.4 - Switching Loss Circuit

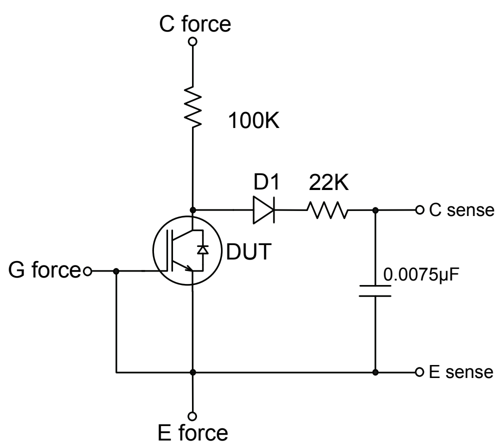


Fig.C.T.5 - BVCES Filter Circuit

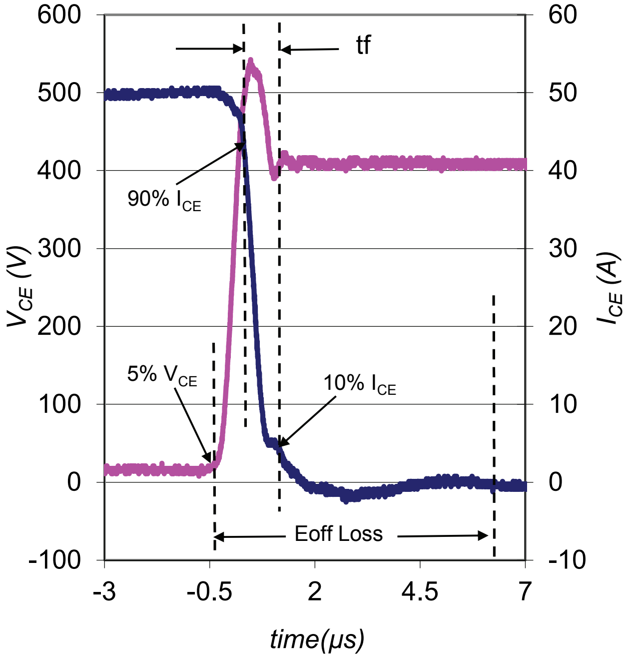


Fig. WF1 - Typ. Turn-off Loss Waveform @ T_J = 175°C using Fig. CT.4

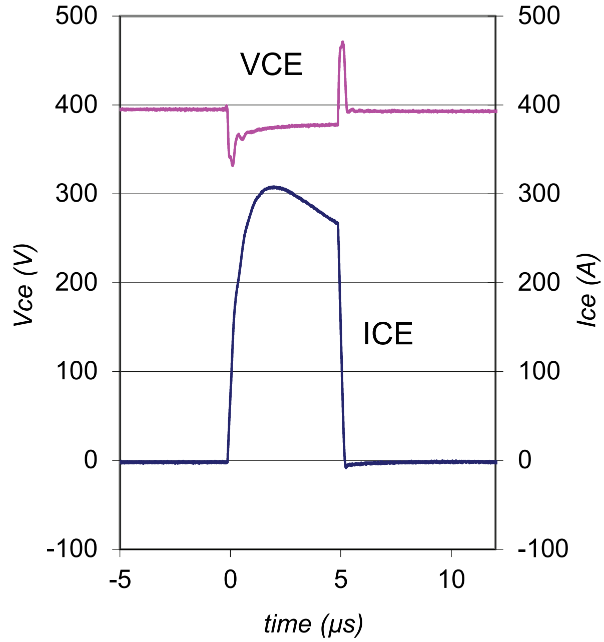
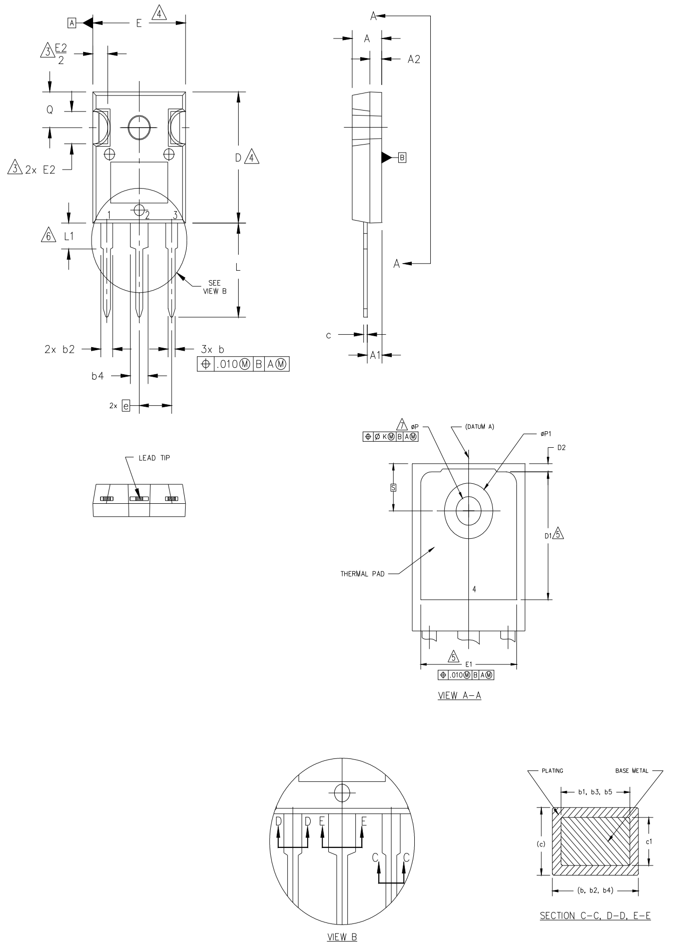


Fig. WF2 - Typ. S.C. Waveform @ T_J = 25°C using Fig. CT.3

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. 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

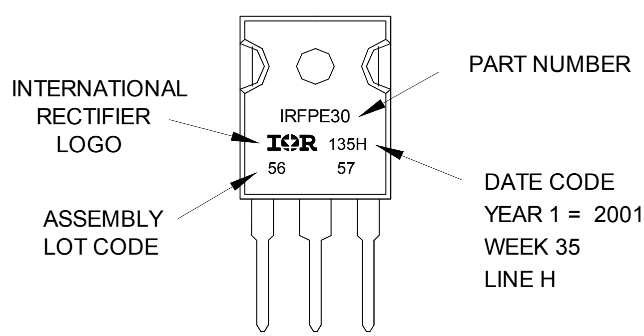
1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

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"

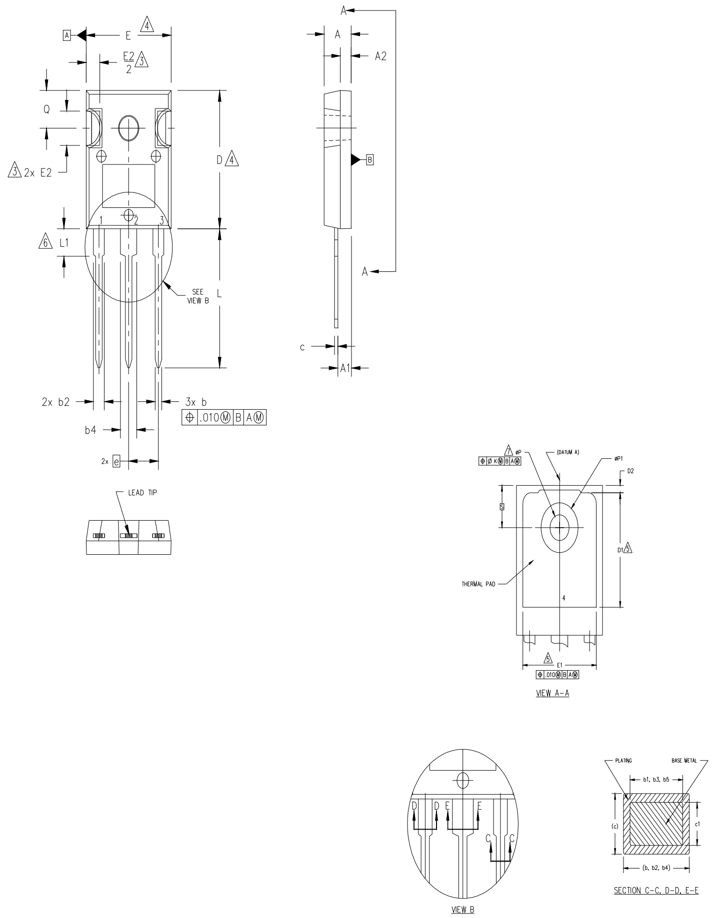


TO-247AC package is not recommended for Surface Mount Application.

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.
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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

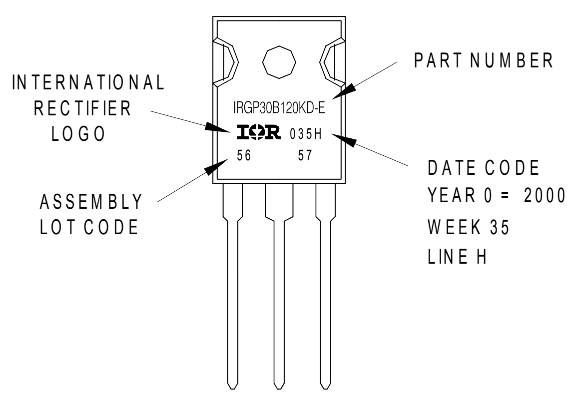
DIODES

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.

Revision History

Date	Comment
7/17/2014	• Corrected from "$I_{NOMINAL}$ = 50A" to "I_C= 50A, T_C = 100C" on page1

International Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA

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

