International
IOR Rectifier

IRGR4607DPbF
IRGS4607DPbF
IRGB4607DPbF

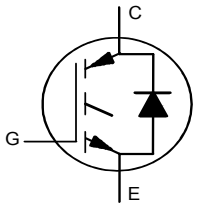
Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode

V_{CES} = 600V

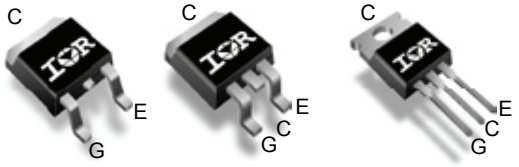
I_C = 7.0A, T_C =100°C

$t_{SC} \geq$ 5µs, $T_{J(max)}$ = 175°C

$V_{CE(ON)}$ typ. = 1.75V @ I_C = 4.0A



n-channel



IRGR4607DPbF D-Pak | IRGS4607DPbF D^2Pak | IRGB4607DPbF TO-220AB

G	C	E
Gate	Collector	Emitter

Applications
- Industrial Motor Drive
- UPS
- Solar Inverters
- Welding

Features	→	Benefits
Low $V_{CE(ON)}$ and Switching Losses		High Efficiency in a Wide Range of Applications
5µs Short Circuit SOA		Rugged Transient Performance
Square RBSOA		
Maximum Junction Temperature 175°C		Increased Reliability
Positive $V_{CE\ (ON)}$ Temperature Coefficient		Excellent Current Sharing in Parallel Operation

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGR4607DPbF	D-Pak	Tube	75	IRGR4607DPbF
		Tape and Reel	2000	IRGR4607DTRPbF
		Tape and Reel Left	3000	IRGR4607DTRLPbF
		Tape and Reel Right	3000	IRGR4607DTRRPbF
IRGS4607DPbF	D^2Pak	Tube	50	IRGS4607DPBF
		Tape and Reel Right	800	IRGS4607DTRRPbF
		Tape and Reel Left	800	IRGS4607DTRLPbF
IRGB4607DPbF	TO-220AB	Tube	50	IRGB4607DPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	11	A
I_C @ T_C = 100°C	Continuous Collector Current	7.0	
I_{CM}	Pulse Collector Current, V_{GE} = 15V	12	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	16	
I_F @ T_C = 25°C	Diode Continuous Forward Current	8.0	
I_F @ T_C = 100°C	Diode Continuous Forward Current	5.0	
I_{FM}	Diode Maximum Forward Current ④	16	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	58	W
P_D @ T_C = 100°C	Maximum Power Dissipation	29	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to +175	°C
	Soldering Temperature, for 10 sec. (1.6mm) from case)	300 (0.063 in.	
	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 (IGBT) ②	——	——	2.6	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction-to-Case (Diode) ②	——	——	8.3	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface) (TO-220)	——	0.50	——	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (PCB Mount) (D-Pak) ⑥	——	——	50	
	Thermal Resistance, Junction-to-Ambient (PCB Mount) (D^2-Pak) ⑥	——	——	40	
	Thermal Resistance, Junction-to-Ambient (Socket Mount) (TO-220)	——	——	62	

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	—	0.52	—	V/°C	V_{GE} = 0V, I_C = 100µA (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.75	2.05	V	I_C = 4.0A, V_{GE} = 15V, T_J = 25°C
		—	2.15	—		I_C = 4.0A, V_{GE} = 15V, T_J = 150°C
		—	2.20	—		I_C = 4.0A, V_{GE} = 15V, T_J = 175°C
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 100µA
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage Temperature Coeff.	—	-19	—	mV/°C	V_{CE} = V_{GE}, I_C =100µA (25°C-175°C)
gfe	Forward Transconductance	—	2.2	—	S	V_{CE} = 50V, I_C = 4.0A, PW = 20µs
I_{CES}	Collector-to-Emitter Leakage Current	—	0.50	25	µA	V_{GE} = 0V, V_{CE} = 600V
		—	100	—		V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V
V_F	Diode Forward Voltage Drop	—	1.7	2.3	V	I_F = 4.0A
		—	1.5	—		I_F = 4.0A, T_J = 175°C

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

	Parameter	Min.	Typ.	Max	Units	Conditions
Q_g	Total Gate Charge	—	9.0	—	nC	I_C = 4.0A
Q_{ge}	Gate-to-Emitter Charge	—	3.0	—		V_{GE} = 15V
Q_{gc}	Gate-to-Collector Charge	—	4.0	—		V_{CC} = 300V
E_{on}	Turn-On Switching Loss	—	140	—	μJ	I_C = 4.0A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	62	—		R_G = 100Ω, T_J = 25°C
E_{total}	Total Switching Loss	—	202	—		
$t_{d(on)}$	Turn-On delay time	—	27	—	ns	Energy losses include tail & diode reverse recovery ⑤
t_r	Rise time	—	15	—		
$t_{d(off)}$	Turn-Off delay time	—	120	—		
t_f	Fall time	—	10	—		
E_{on}	Turn-On Switching Loss	—	220	—	μJ	I_C = 4.0A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	92	—		R_G = 100Ω, T_J = 175°C
E_{total}	Total Switching Loss	—	312	—		
$t_{d(on)}$	Turn-On delay time	—	24	—	ns	Energy losses include tail & diode reverse recovery ⑤
t_r	Rise time	—	27	—		
$t_{d(off)}$	Turn-Off delay time	—	81	—		
t_f	Fall time	—	14	—		
C_{ies}	Input Capacitance	—	250	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	20	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	7.1	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 16A V_{CC} = 480V, Vp ≤ 600V V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V_{CC} = 400V, Vp ≤ 600V V_{GE} = +15V to 0V
Erec	Reverse Recovery Energy of the Diode	—	7.4	—	μJ	T_J = 175°C
t_{rr}	Diode Reverse Recovery Time	—	48	—	ns	V_{CC} = 400V, I_F = 4.0A
I_{rr}	Peak Reverse Recovery Current	—	5.1	—	A	V_{GE} = 15V, Rg = 100Ω

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V.

② R_θ is measured at T_J of approximately 90°C.

③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

④ Pulse width limited by max. junction temperature.

⑤ Values influenced by parasitic L and C in measurement.

⑥ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994: http://www.irf.com/technical-info/appnotes/an-994.pdf

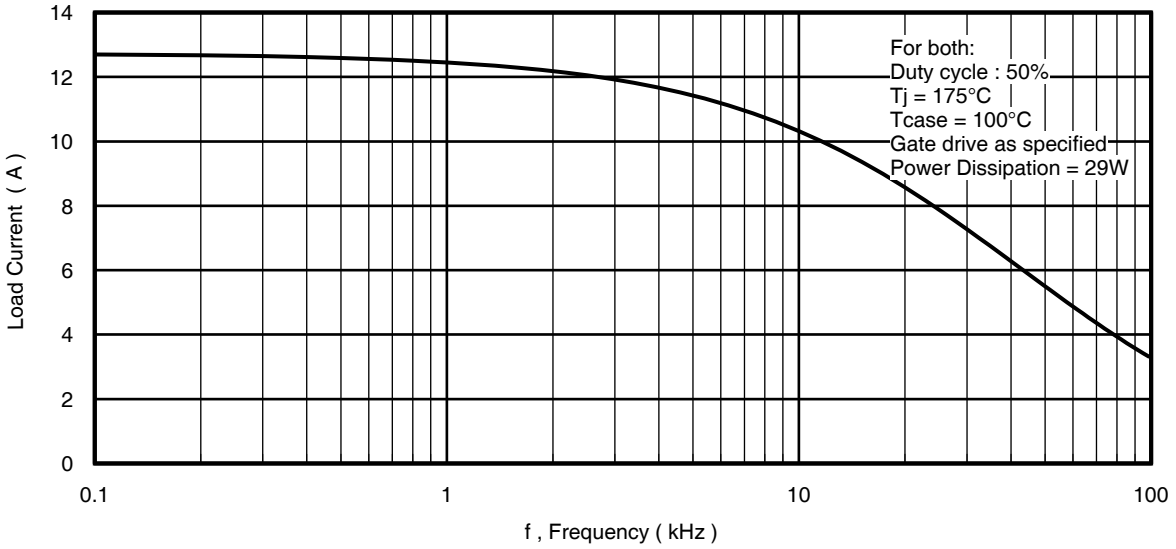


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

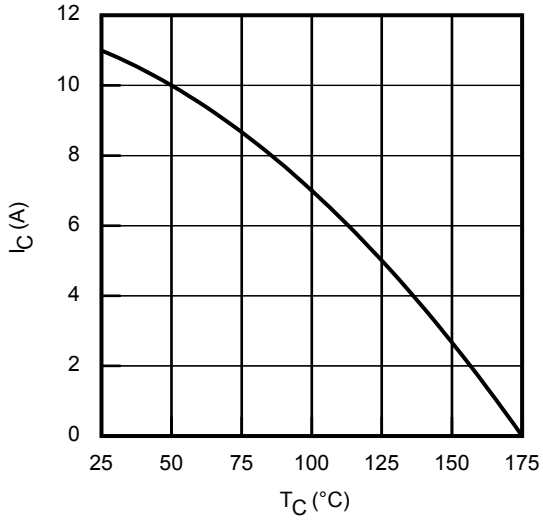


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

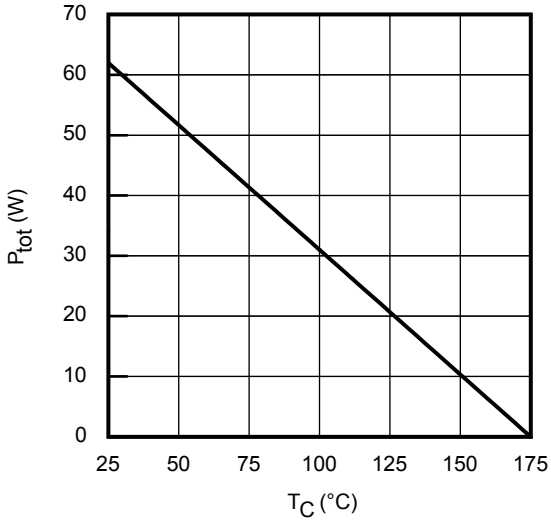


Fig. 3 - Power Dissipation vs. Case Temperature

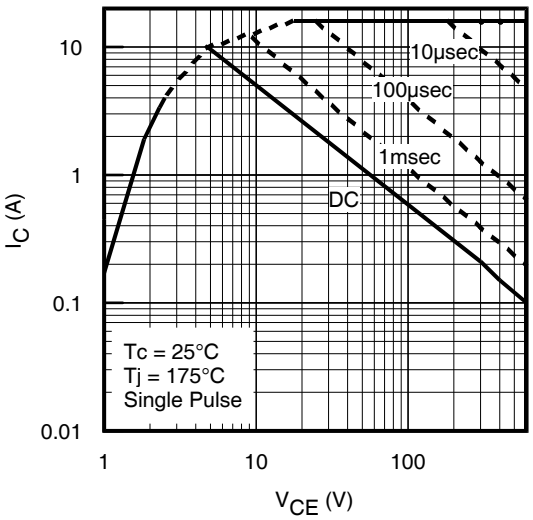


Fig. 4 - Forward SOA
T_C = 25°C; T_J ≤ 175°C; V_{GE} = 15V

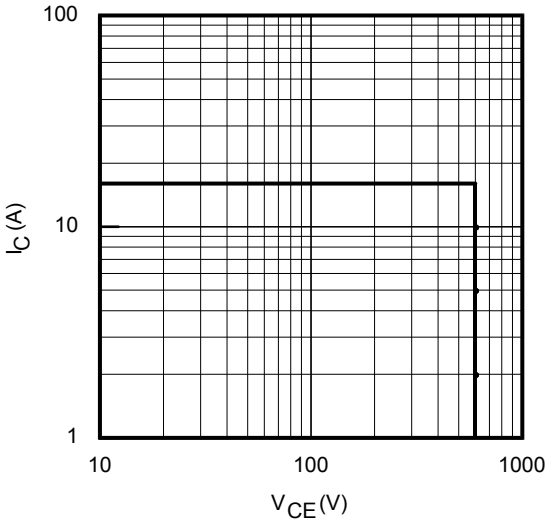


Fig. 5 - Reverse Bias SOA
T_J = 175°C; V_{GE} = 20V

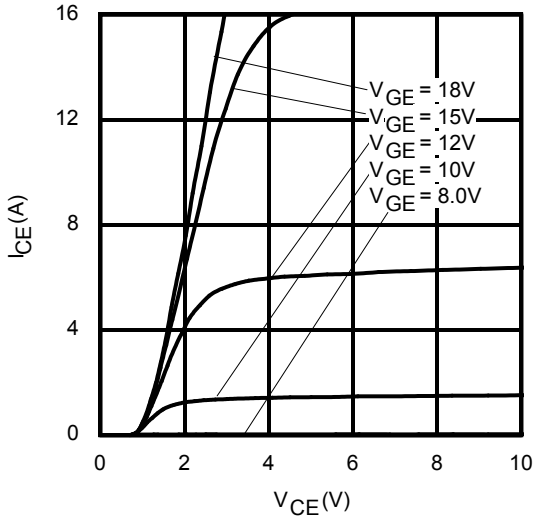


Fig. 6 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 20µs

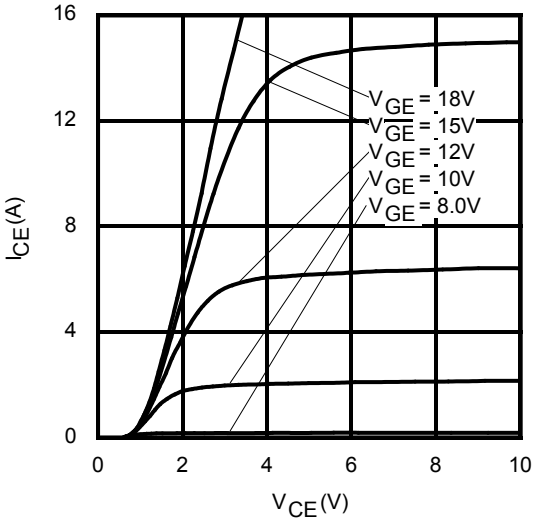


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 20µs

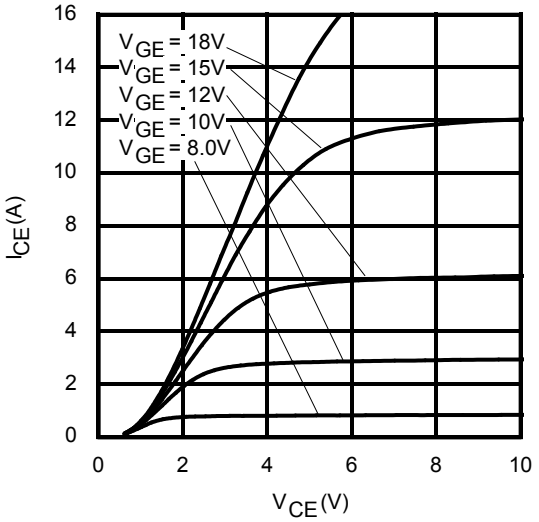


Fig. 8 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 20µs

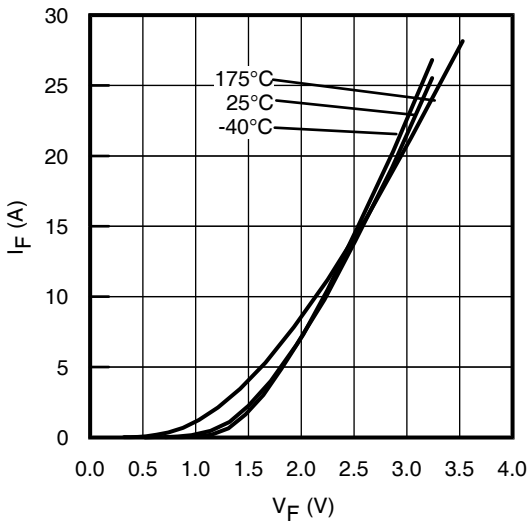


Fig. 9 - Typ. Diode Forward Voltage Drop Characteristics

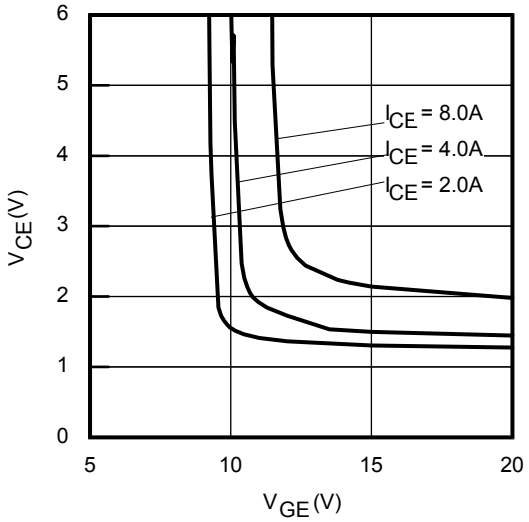


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

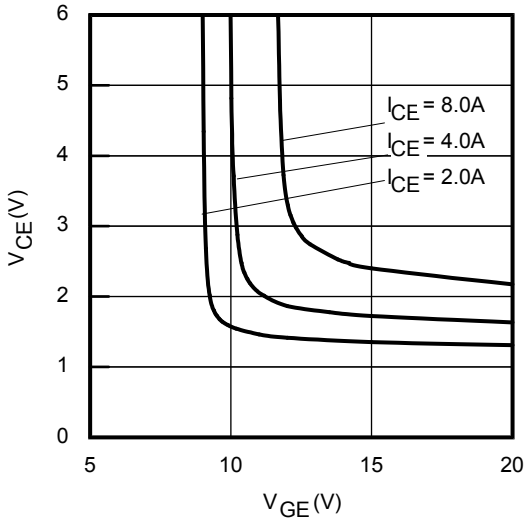


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

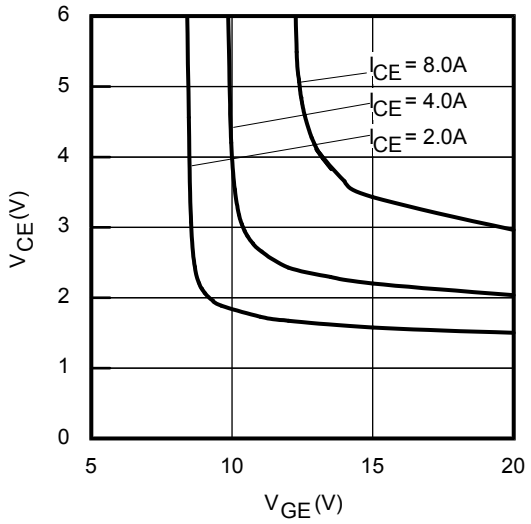


Fig. 12 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

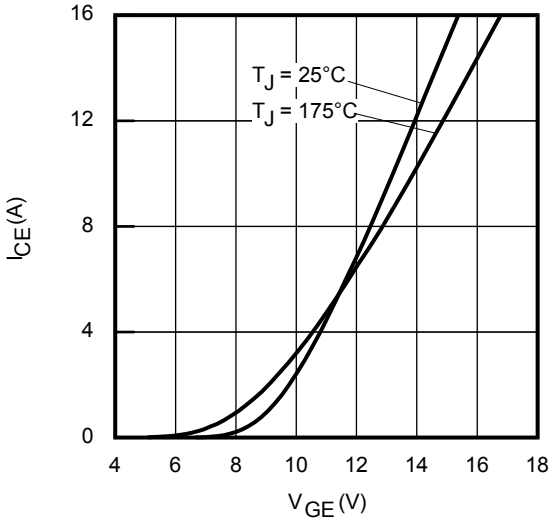


Fig. 13 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 20µs

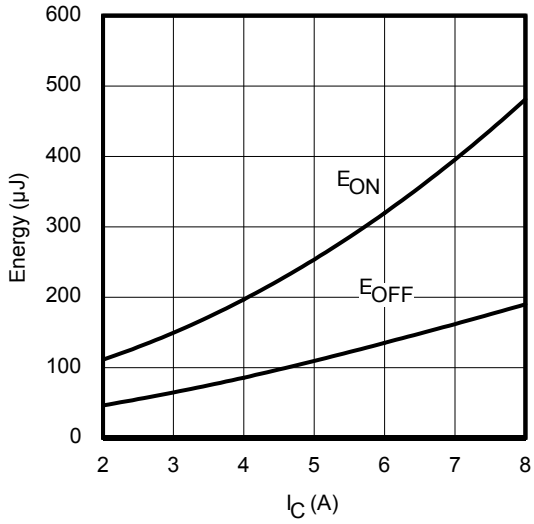


Fig. 14 - Typ. Energy Loss vs. I_C
T_J = 175°C; V_{CE} = 400V, R_G = 100Ω; V_{GE} = 15V

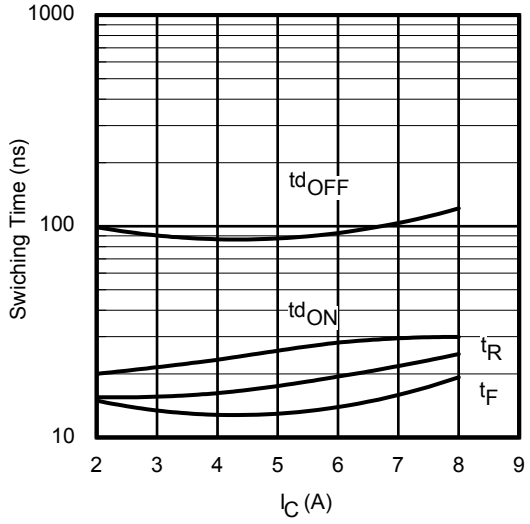


Fig. 15 - Typ. Switching Time vs. I_C
T_J = 175°C; V_{CE} = 400V, R_G = 100Ω; V_{GE} = 15V

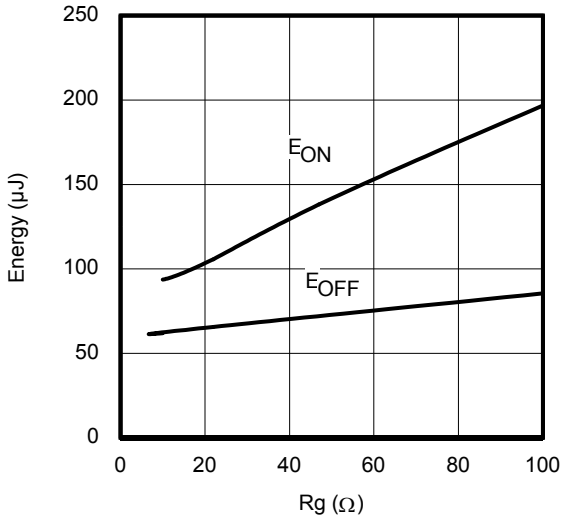


Fig. 16 - Typ. Energy Loss vs. R_G
T_J = 175°C; V_{CE} = 400V, I_{CE} = 4.0A; V_{GE} = 15V

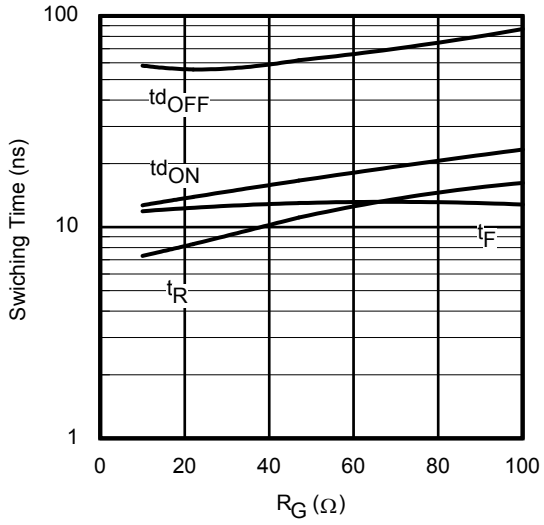


Fig. 17 - Typ. Switching Time vs. R_G
T_J = 175°C; V_{CE} = 400V, I_{CE} = 4.0A; V_{GE} = 15V

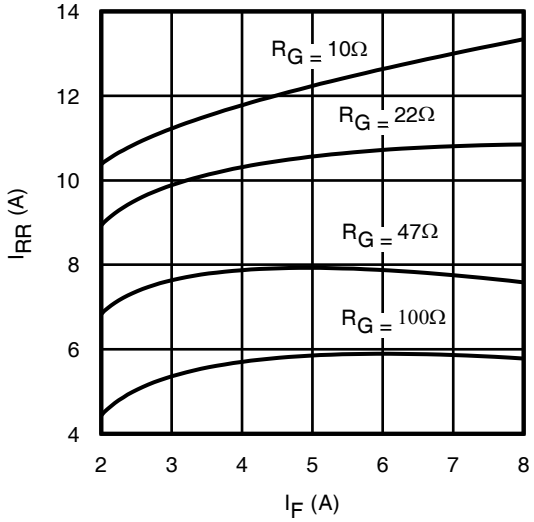


Fig. 18 - Typ. Diode I_{RR} vs. I_F
T_J = 175°C

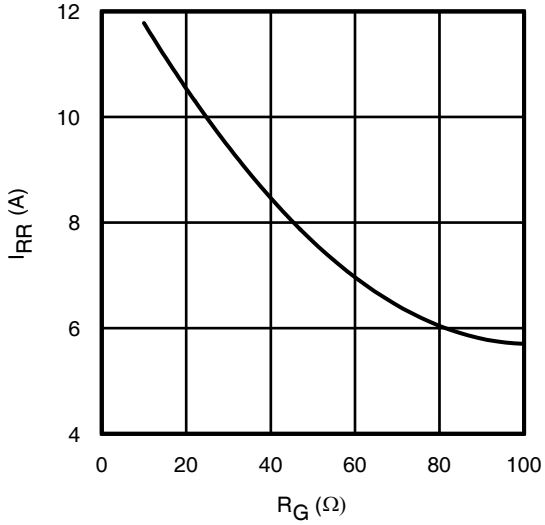


Fig. 19 - Typ. Diode I_{RR} vs. R_G
T_J = 175°C

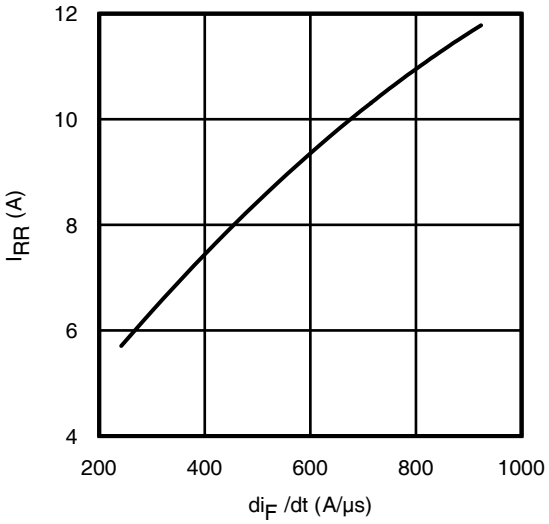


Fig. 20 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 4.0A; T_J = 175°C

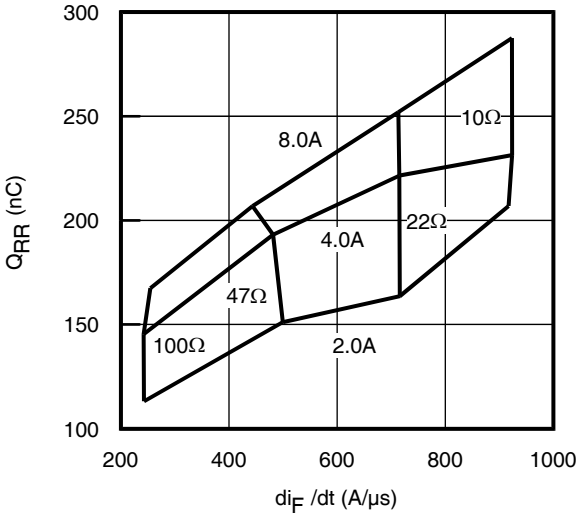


Fig. 21 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C

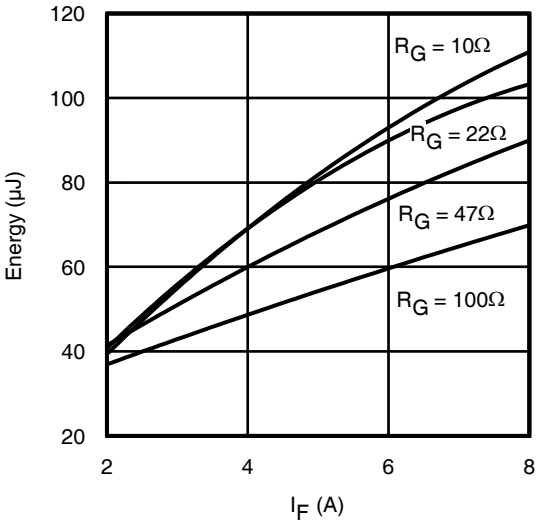


Fig. 22 - Typ. Diode E_{RR} vs. I_F
T_J = 175°C

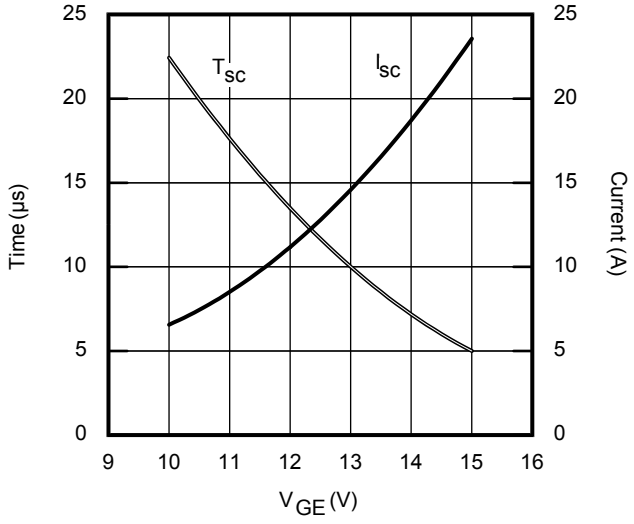


Fig. 23 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

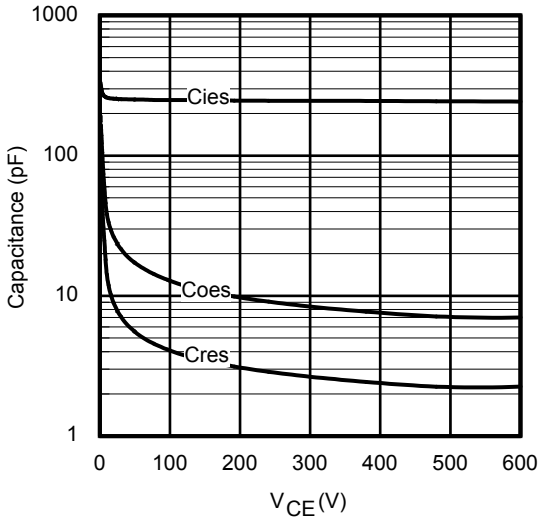


Fig. 24 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

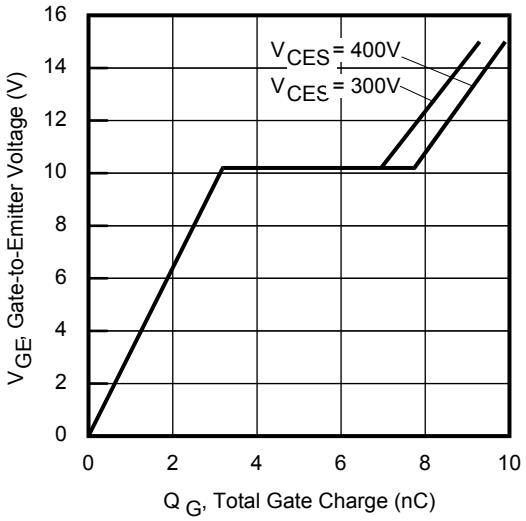


Fig. 25 - Typical Gate Charge vs. V_{GE}
I_{CE} = 4.0A

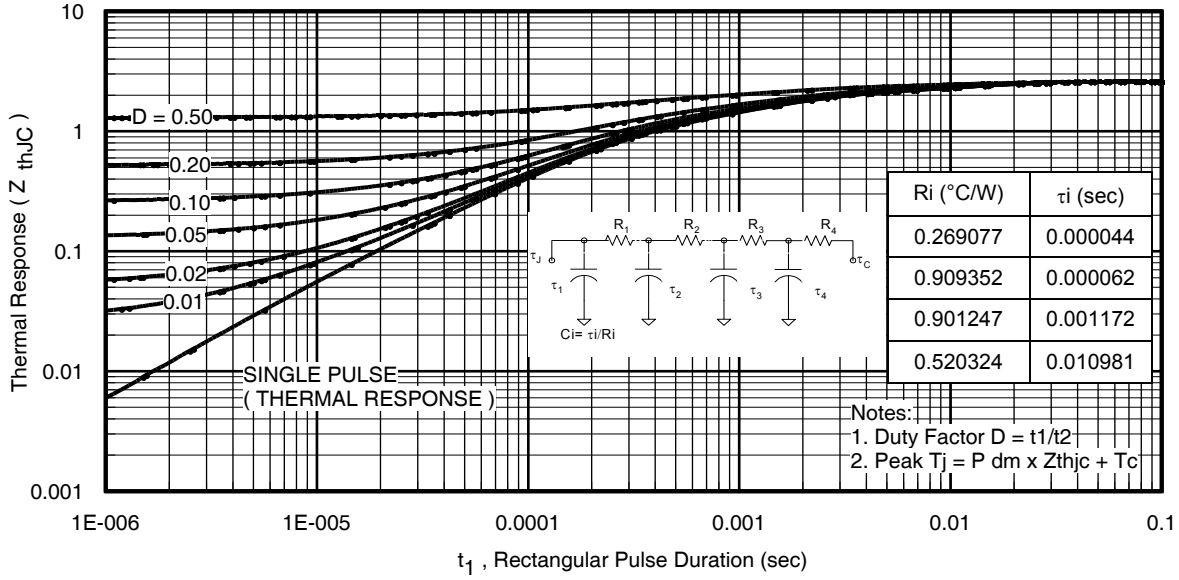


Fig. 26 - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

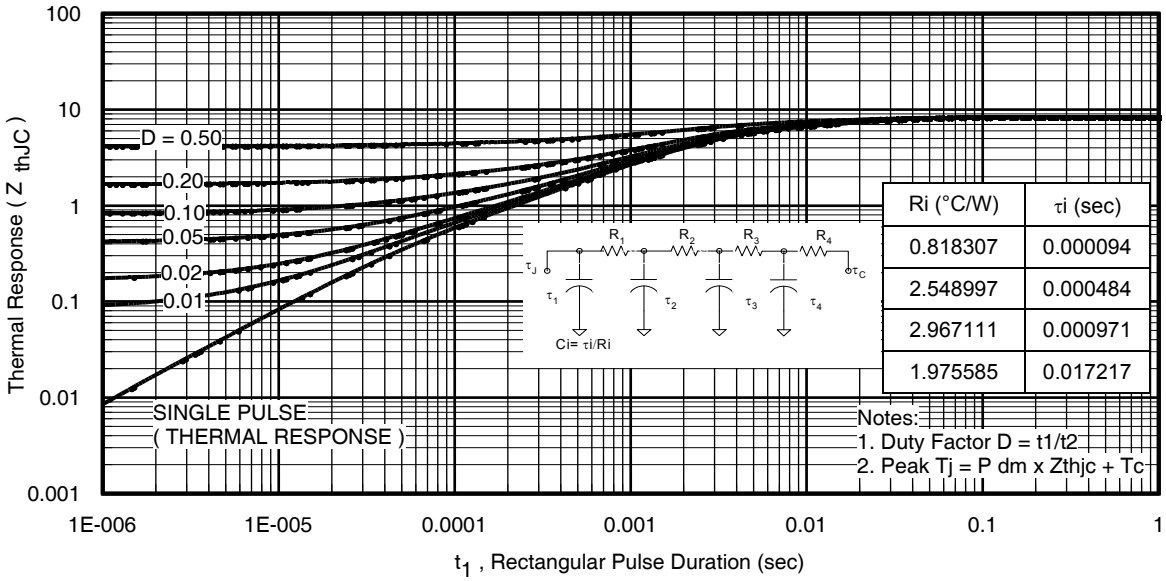


Fig. 27 - Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

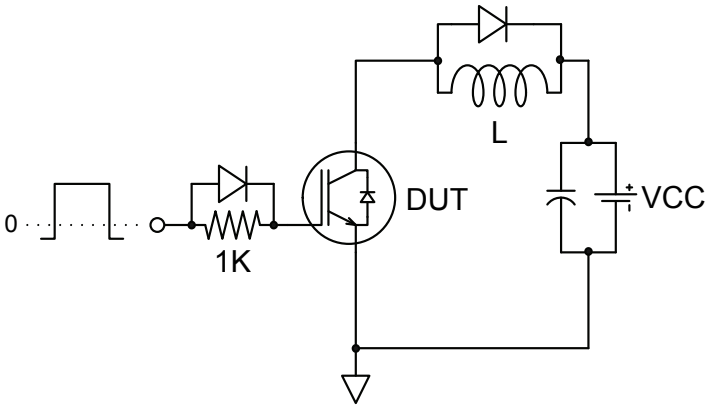


Fig.C.T.1 - Gate Charge Circuit (turn-off)

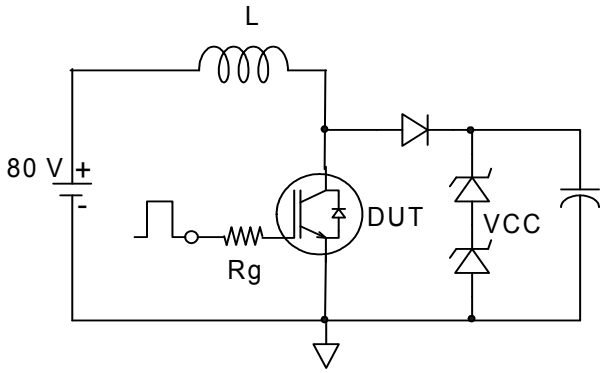


Fig.C.T.2 - RBSOA Circuit

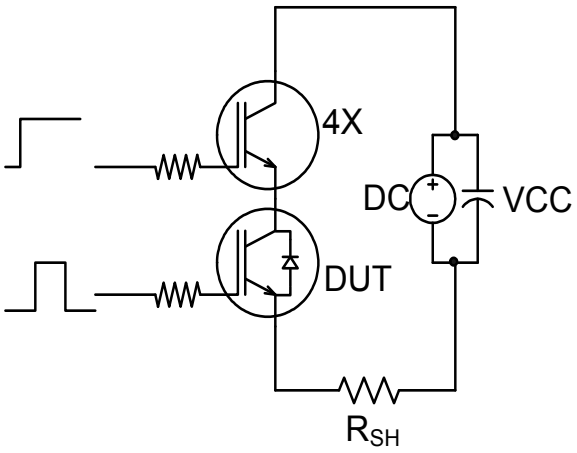


Fig.C.T.3 - S.C. SOA Circuit

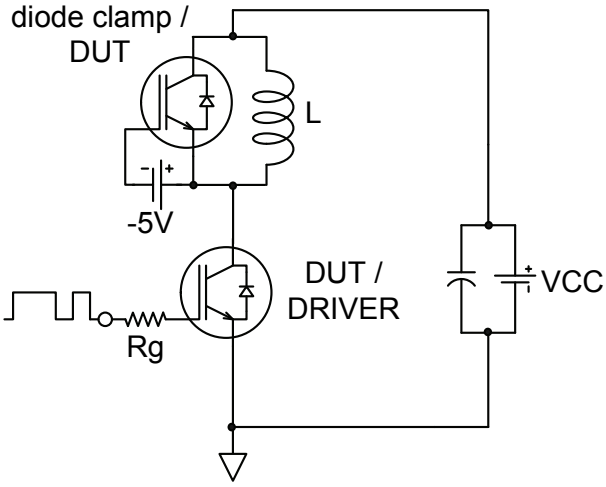


Fig.C.T.4 - Switching Loss Circuit

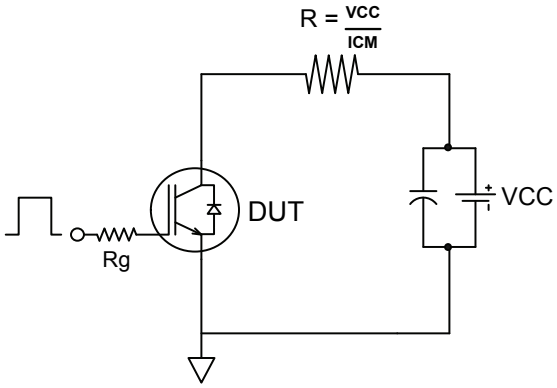


Fig.C.T.5 - Resistive Load Circuit

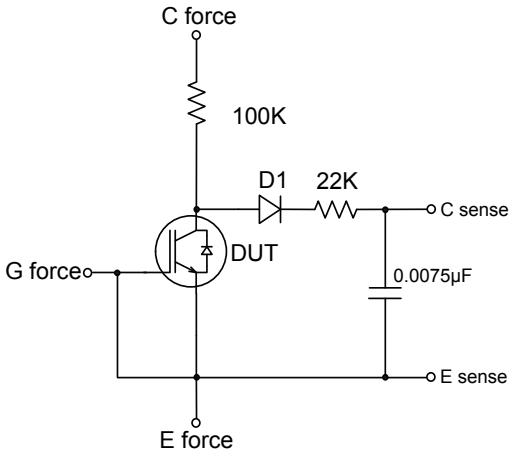


Fig.C.T.6 - BVCES Filter Circuit

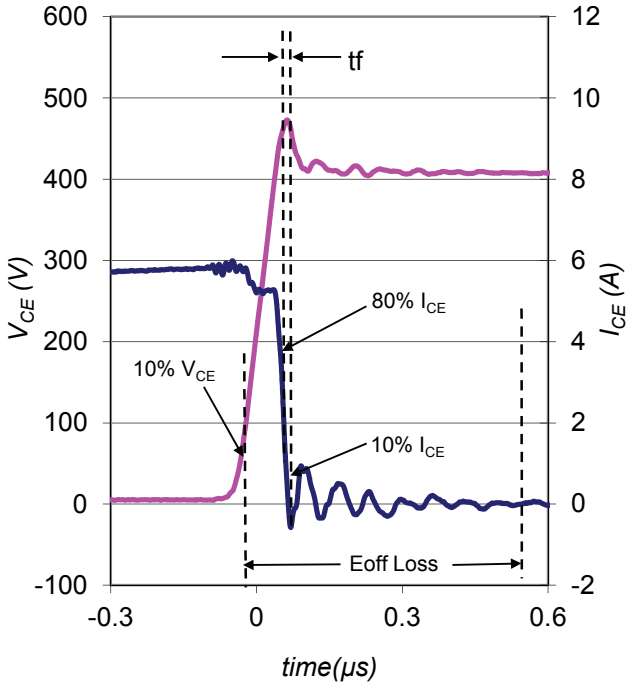


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

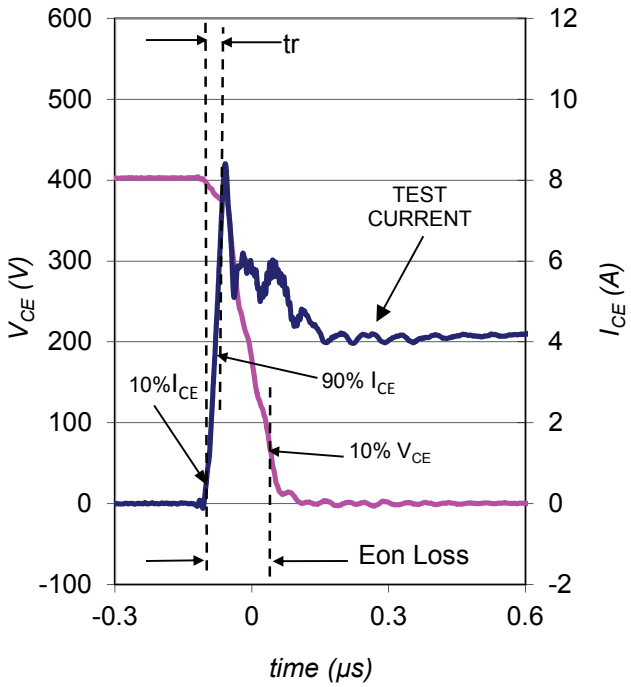


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4

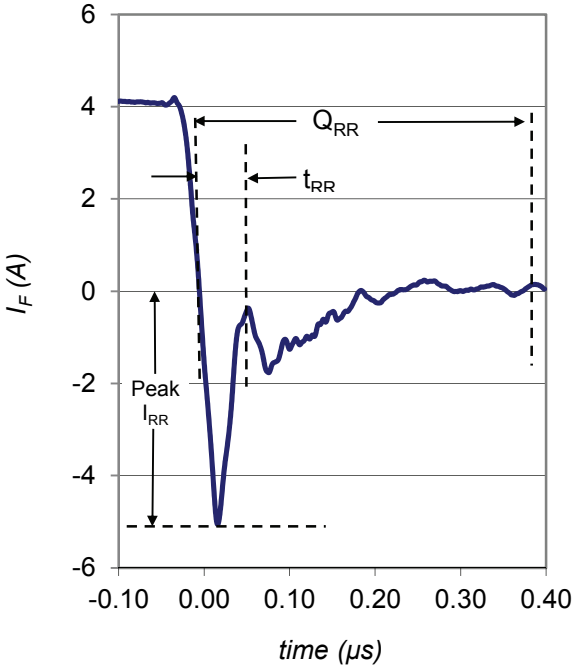


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 175°C using Fig. CT.4

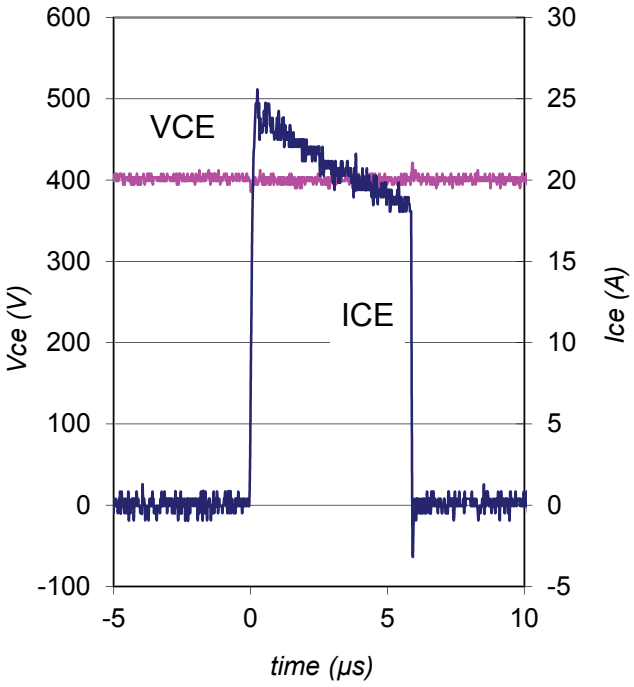
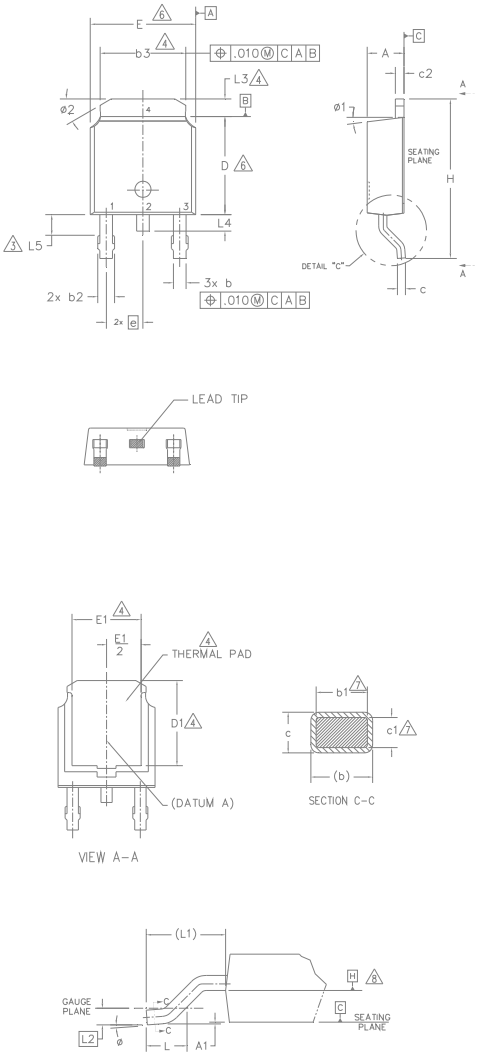


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 150°C using Fig. CT.3

D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.– DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

2.– DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].

3.– LEAD DIMENSION UNCONTROLLED IN L5.

4.– DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.

5.– SECTION C–C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.

6.– DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .006 [0.15] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

7.– DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.

8.– DATUM A & B TO BE DETERMINED AT DATUM PLANE H.

9.– OUTLINE CONFORMS TO JEDEC OUTLINE TO–252AA.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	–	0.13	–	.005	
b	0.64	0.89	.025	.035	
b1	0.64	0.79	.025	.031	7
b2	0.76	1.14	.030	.045	
b3	4.95	5.46	.195	.215	4
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	7
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	6
D1	5.21	–	.205	–	4
E	6.35	6.73	.250	.265	6
E1	4.32	–	.170	–	4
e	2.29 BSC		.090 BSC		
H	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	4
L4	–	1.02	–	.040	
L5	1.14	1.52	.045	.060	3
ø	0°	10°	0°	10°	
ø1	0°	15°	0°	15°	
ø2	25°	35°	25°	35°	

LEAD ASSIGNMENTS

HEXFET

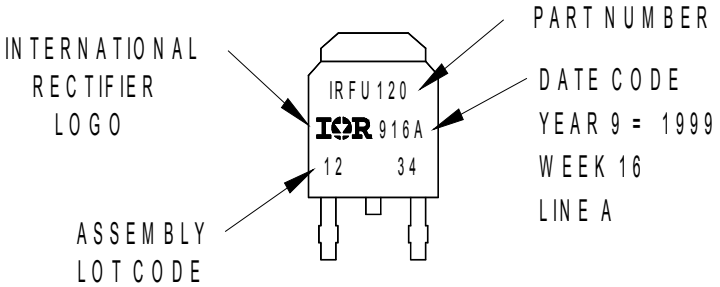
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

IGBT & CoPAK

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

D-Pak (TO-252AA) Part Marking Information

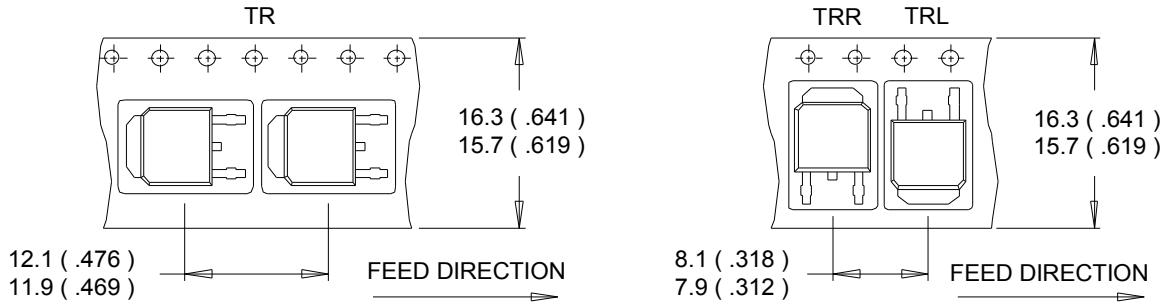
EXAMPLE: THIS IS AN IRFR120
WITH ASSEMBLY
LOT CODE 1234
ASSEMBLED ON WW 16, 1999
IN THE ASSEMBLY LINE "A"



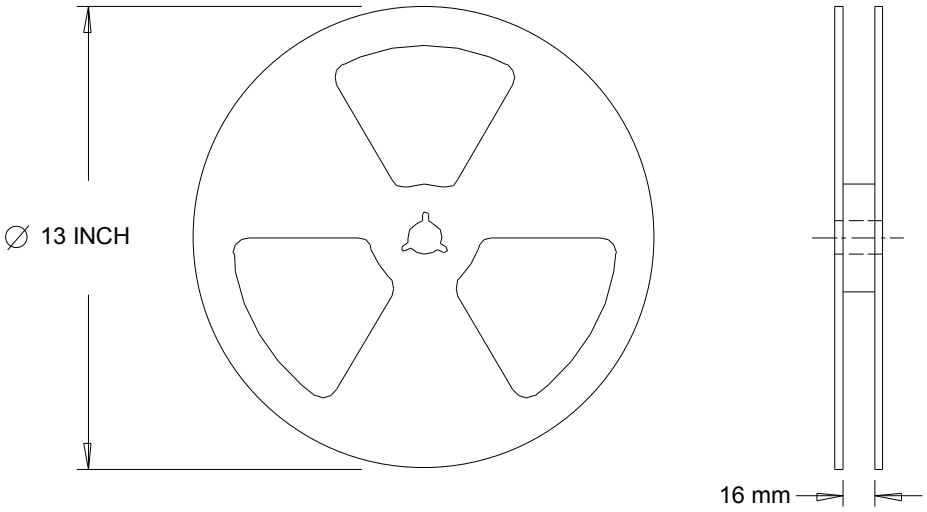
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D-Pak (TO-252AA) Tape and Reel Information

Dimensions are shown in millimeters (inches)



NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.

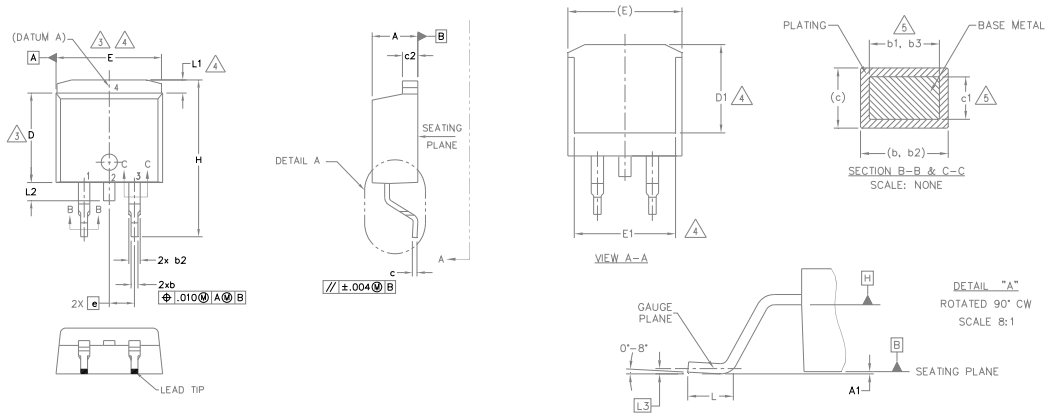


NOTES :
1. OUTLINE CONFORMS TO EIA-481.

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

D^2-PAK (TO-263AB) Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	0.00	0.254	.000	.010	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	–	.270	–	4
E	9.65	10.67	.380	.420	3,4
E1	6.22	–	.245	–	4
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1	–	1.68	–	.066	4
L2	–	1.78	–	.070	
L3	0.25 BSC		.010 BSC		

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1, b3 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

LEAD ASSIGNMENTS

DIODES

1.– ANODE (TWO DIE) / OPEN (ONE DIE)
2, 4.– CATHODE
3.– ANODE

HEXFET

1.– GATE
2, 4.– DRAIN
3.– SOURCE

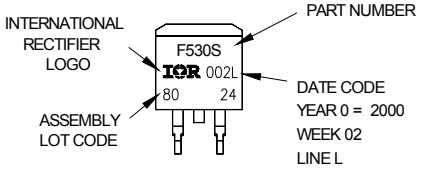
IGBTs, CoPACK

1.– GATE
2, 4.– COLLECTOR
3.– EMITTER

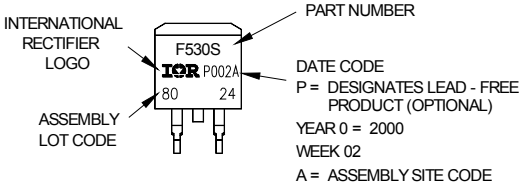
D^2-Pak (TO-263AB) Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH
LOT CODE 8024
ASSEMBLED ON WW 02, 2000
IN THE ASSEMBLY LINE "L"

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



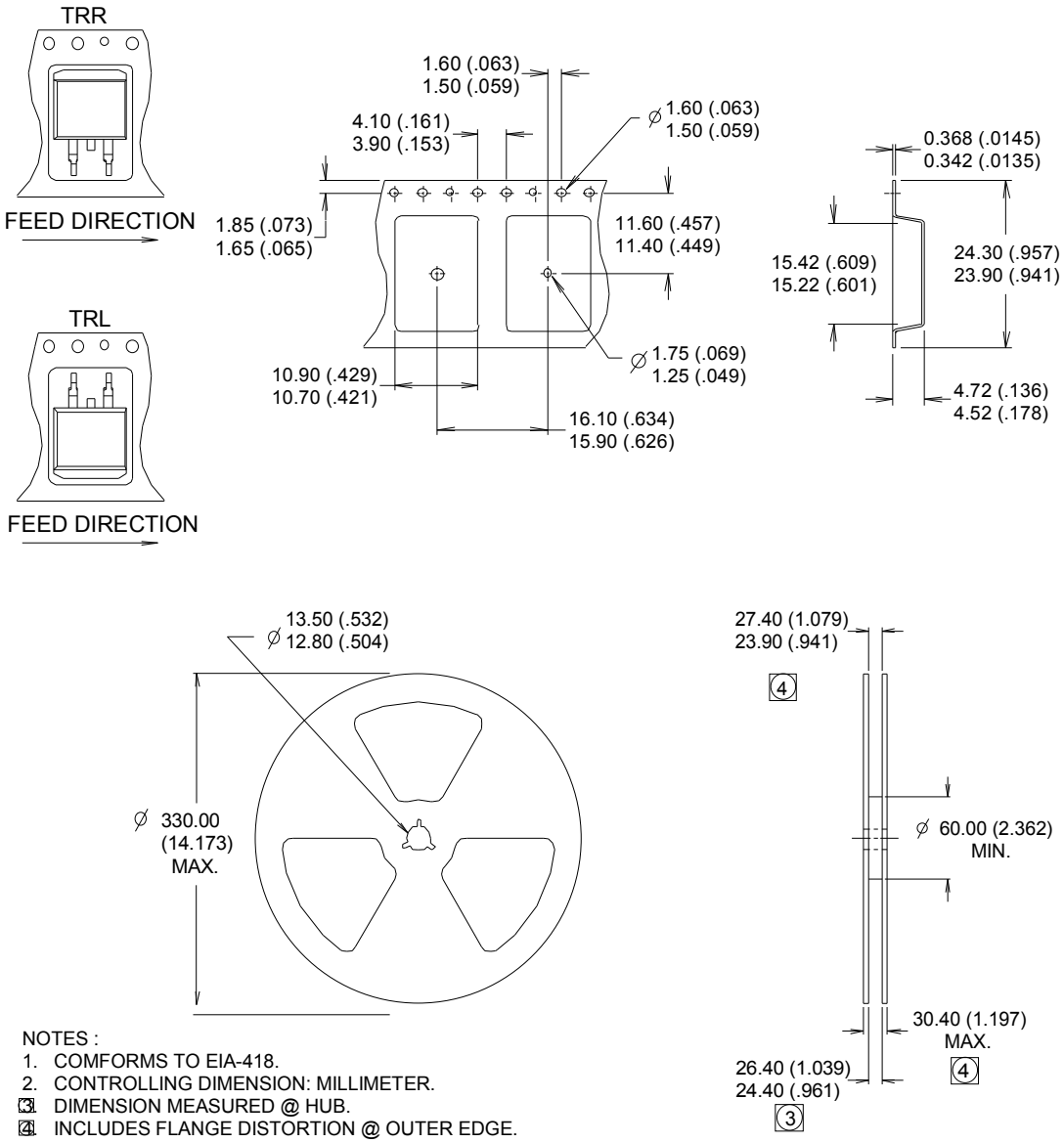
OR



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

D^{2}Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)

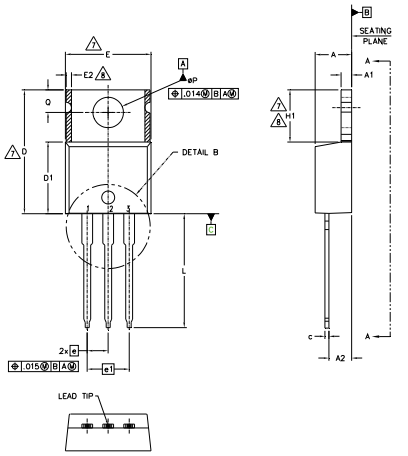


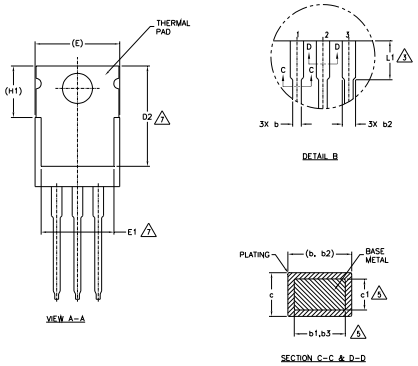
NOTES :
1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION MEASURED @ HUB.
4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.

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

TO-220AB Package Outline

(Dimensions are shown in millimeters (inches))





NOTES:

1.– DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M– 1994.
2.– DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.– LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.– DIMENSION D, D1 & 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.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.– CONTROLLING DIMENSION : INCHES.
7.– THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.– DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.– OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	1.14	1.40	.045	.055	
A2	2.03	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.97	.015	.038	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	–	0.76	–	.030	8
e	2.54 BSC		.100 BSC		
e1	5.08 BSC		.200 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	3.56	4.06	.140	.160	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

LEAD ASSIGNMENTS

HEXFET

1.– GATE
2.– DRAIN
3.– SOURCE

IGBTs, CoPACK

1.– GATE
2.– COLLECTOR
3.– EMITTER

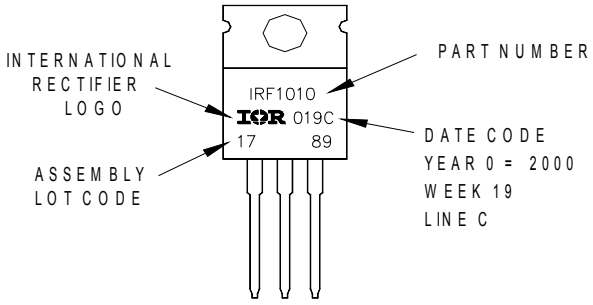
DIODES

1.– ANODE
2.– CATHODE
3.– ANODE

TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 2000
IN THE ASSEMBLY LINE "C"

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



TO-220AB 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	D-Pak	MSL1
	D^2Pak	MSL1
	TO-220	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	Comments
7/9/2014	• Updated typo on $V_{(BR)CES}$ test condition from "250uA" to "100uA" on page 2.
	• Updated Package outline on pages 11, 13 & 15.
11/14/2014	• Added note ④ to I_{FM} Diode Maximum Forward Current V_{GE} = 15V on page 1. • Removed note ④ from switching losses test condition on page 3.

International
IOR Rectifier

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

