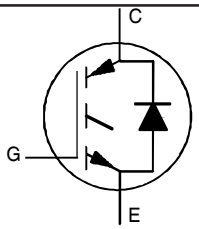
International
IOR Rectifier
AN INFINEON TECHNOLOGIES COMPANY

IRGIB10B60KD1P

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

V_{CES} = 600V

I_C = 10A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 1.7V


TO-220 Full-Pak

Features

- Low VCE (on) Non Punch Through IGBT Technology.
- Low Diode VF.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- Maximum Junction Temperature Rated at 175°C
- Lead-Free
- UL Certified

Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Excellent Current Sharing in Parallel Operation.

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGIB10B60KD1P	TO-220AB Full- Pak	Tube	50	IRGIB10B60KD1P

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	16	A
I_C @ T_C = 100°C	Continuous Collector Current	10	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	32	
I_{LM}	Clamped Inductive Load current ①	32	
I_F @ T_C = 25°C	Diode Continuous Forward Current	16	
I_F @ T_C = 100°C	Diode Continuous Forward Current	10	
I_{FM}	Diode Maximum Forward Current	32	
V_{ISOL}	RMS Isolation Voltage, Terminal to Case, t = 1 min	2500	V
V_{GE}	Gate-to-Emitter Voltage	±20	
P_D @ T_C = 25°C	Maximum Power Dissipation	44	W
P_D @ T_C = 100°C	Maximum Power Dissipation	22	
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 (1.1N.m)	

Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	—	—	3.4	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	—	—	5.3	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	62	
Wt	Weight	—	2.0	—	g

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 = 500µA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.99	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Voltage	1.50	1.70	2.10	V	I_C = 10A, V_{GE} = 15V, T_J = 25°C
		—	2.05	2.35		I_C = 10A, V_{GE} = 15V, T_J = 150°C
		—	2.06	2.35		I_C = 10A, V_{GE} = 15V, T_J = 175°C
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	V_{CE} = V_{GE}, I_C = 250µA
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 1mA (25°C-150°C)
gfe	Forward Transconductance	—	5.0	—	S	V_{CE} = 50V, I_C = 10A, PW = 80µs
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	µA	V_{GE} = 0V, V_{CE} = 600V
		—	90	250		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C
		—	150	400		V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C
V_{FM}	Diode Forward Voltage Drop	—	1.80	2.40	V	I_F = 5.0A, V_{GE} = 0V
		—	1.32	1.74		I_F = 5.0A, V_{GE} = 0V, T_J = 150°C
		—	1.23	1.62		I_F = 5.0A, V_{GE} = 0V, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V, V_{CE} = 0V

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	41	62	nC	I_C = 10A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	4.6	6.9		V_{CC} = 400V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	19	29		V_{GE} = 15V
E_{on}	Turn-On Switching Loss	—	156	264	µJ	I_C = 10A, V_{CC} = 400V
E_{off}	Turn-Off Switching Loss	—	165	273		V_{GE} = 15V, R_G = 50Ω, L = 1.07mH
E_{tot}	Total Switching Loss	—	321	434		Ls= 150nH, T_J = 25°C ②
$t_{d(on)}$	Turn-On delay time	—	25	33	ns	I_C = 10A, V_{CC} = 400V
t_r	Rise time	—	24	34		V_{GE} = 15V, R_G = 50Ω, L = 1.1mH
$t_{d(off)}$	Turn-Off delay time	—	180	250		Ls= 150nH, T_J = 25°C
t_f	Fall time	—	62	87		
E_{on}	Turn-On Switching Loss	—	261	372	µJ	I_C = 10A, V_{CC} = 400V
E_{off}	Turn-Off Switching Loss	—	313	425		V_{GE} = 15V, R_G = 50Ω, L = 1.07mH
E_{tot}	Total Switching Loss	—	574	694		Ls= 150nH, T_J = 150°C ②
$t_{d(on)}$	Turn-On delay time	—	22	31	ns	I_C = 8.0A, V_{CC} = 400V
t_r	Rise time	—	24	34		V_{GE} = 15V, R_G = 50Ω, L = 1.07mH
$t_{d(off)}$	Turn-Off delay time	—	240	340		Ls= 150nH, T_J = 150°C
t_f	Fall time	—	48	67		
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5 mm from package
C_{ies}	Input Capacitance	—	610	915	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	66	99		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	23	35		f = 1.0MHz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 32A, Vp = 600V V_{CC}=500V,V_{GE} = +15V to 0V,R_G = 50Ω
SCSOA	Short Circuit Safe Operating Area	10	—	—	µs	T_J = 150°C, Vp = 600V, R_G = 50Ω V_{CC}=360V,V_{GE} = +15V to 0V
$I_{SC\ (PEAK)}$	Peak Short Circuit Collector Current	—	100	—	A	
E_{rec}	Reverse Recovery Energy of the Diode	—	99	128	µJ	T_J = 150°C
t_{rr}	Diode Reverse Recovery Time	—	79	103	ns	V_{CC} = 400V, I_F = 10A, L = 1.07mH
I_{rr}	Peak Reverse Recovery Current	—	14	18	A	V_{GE} = 15V, R_G = 50Ω
Q_{rr}	Diode Reverse Recovery Charge	—	553	719	nC	di/dt = 500A/µs

① Vcc =80% (V_{CES}), V_{GE} = 20V, L =100µH, R_G = 50Ω.

② Energy losses include "tail" and diode reverse recovery.

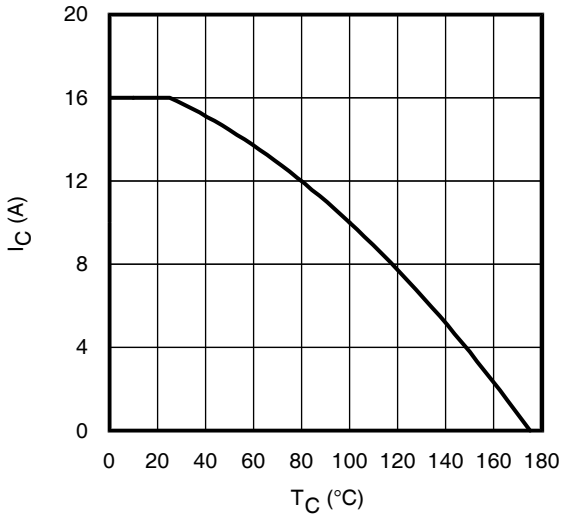


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

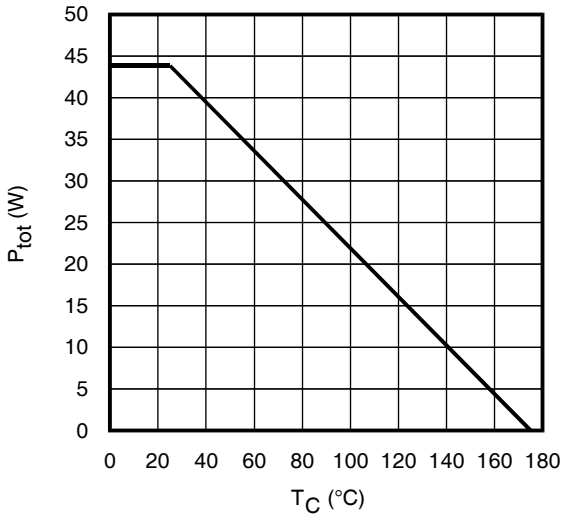


Fig. 2 - Power Dissipation vs. Case Temperature

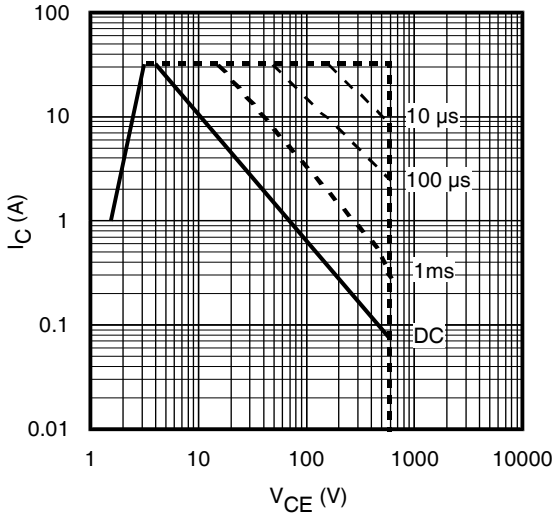


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \leq$ 175°C

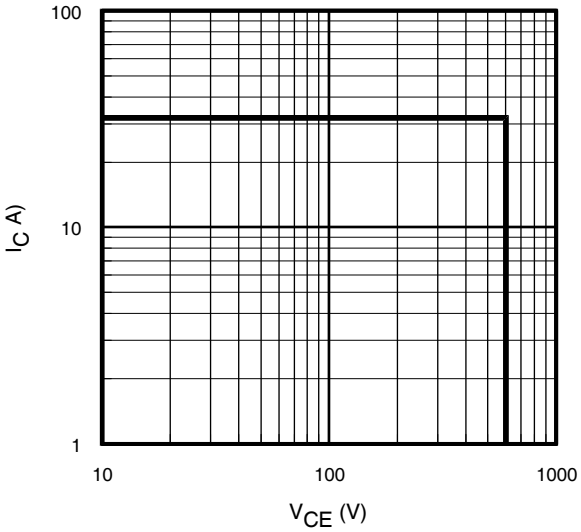


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} =15V

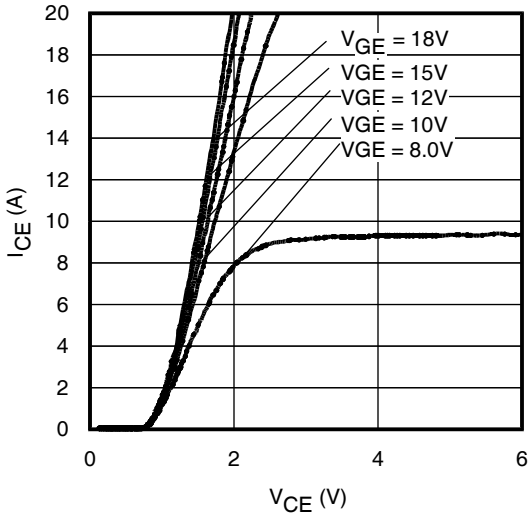


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

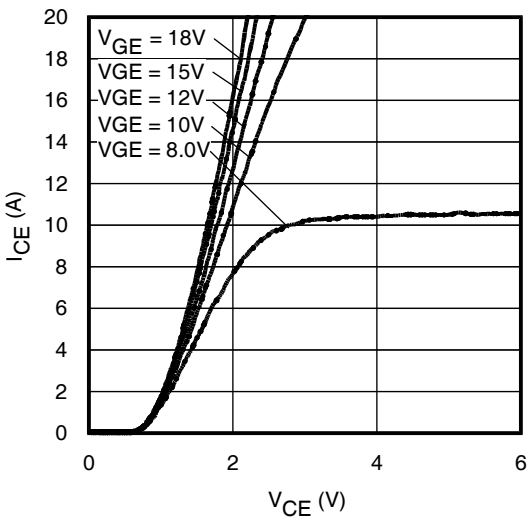


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

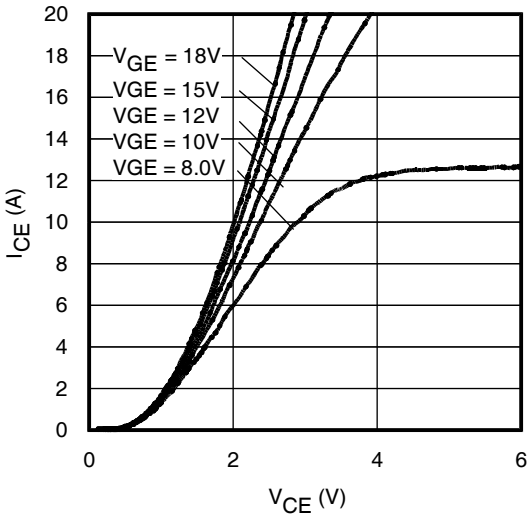


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

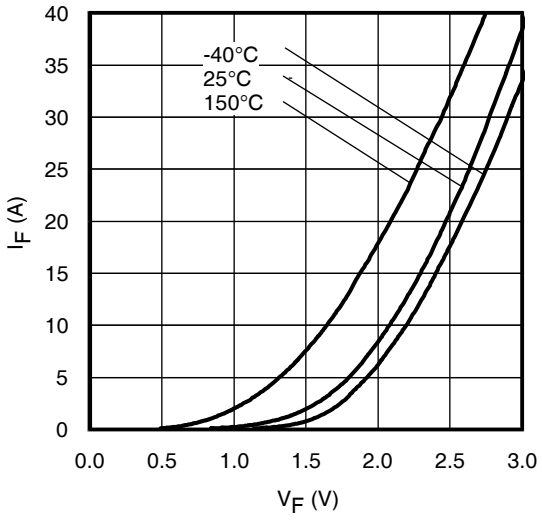


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

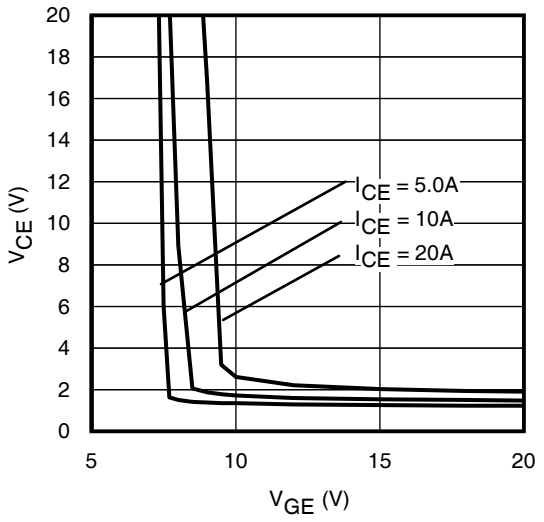


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

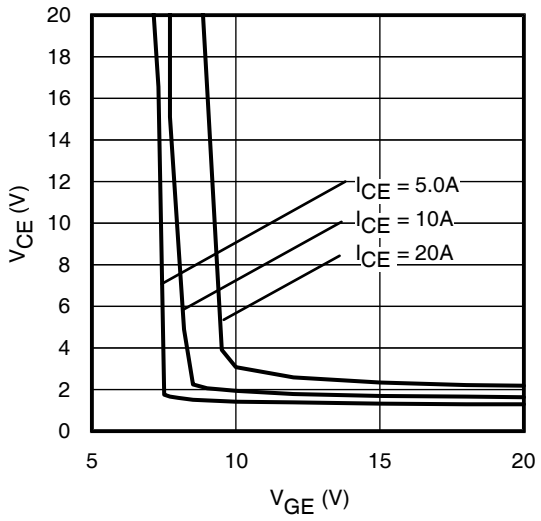


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

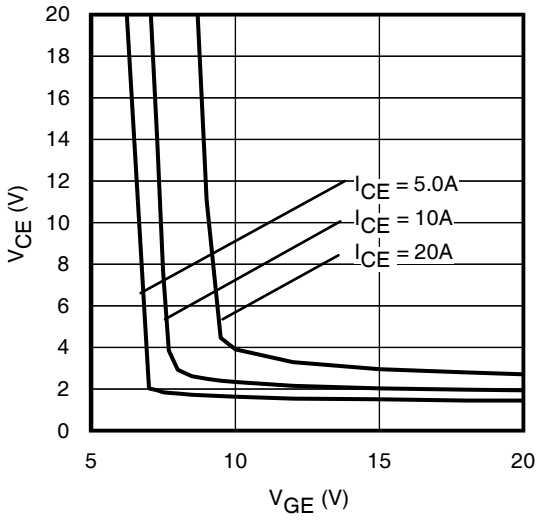


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

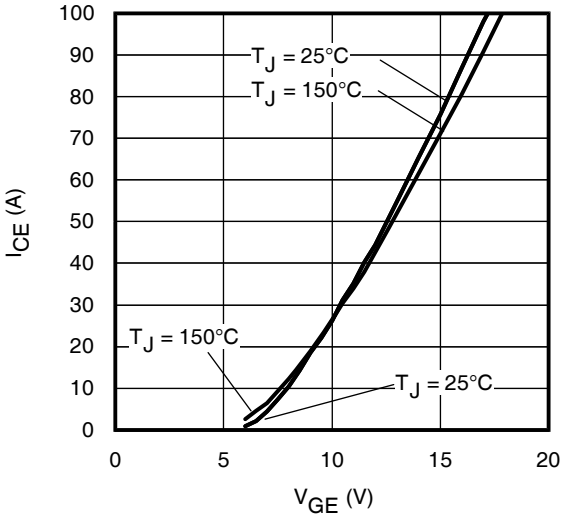


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

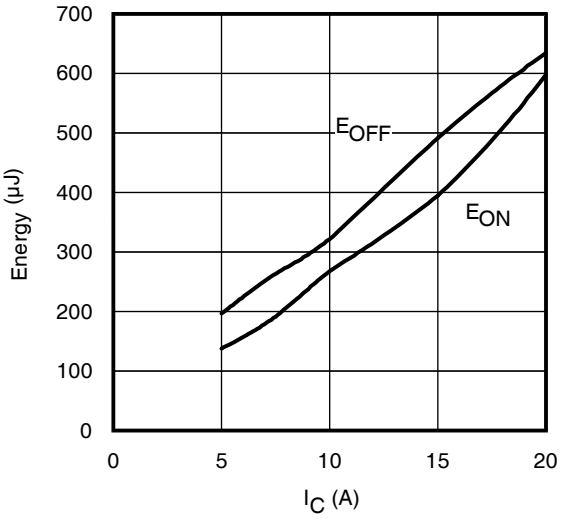


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 50Ω; V_{GE}= 15V

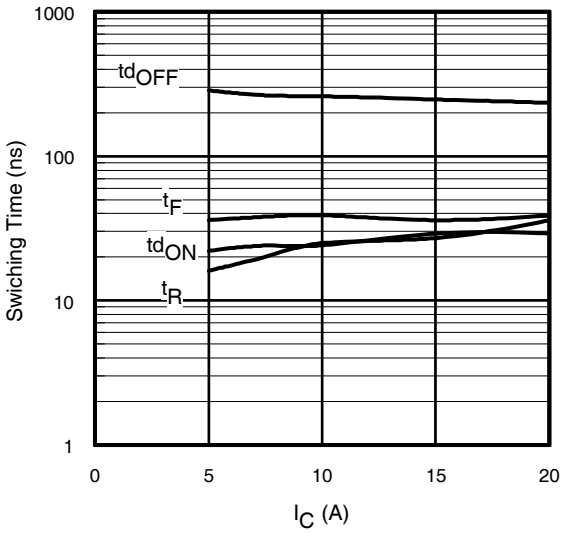


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 50Ω; V_{GE}= 15V

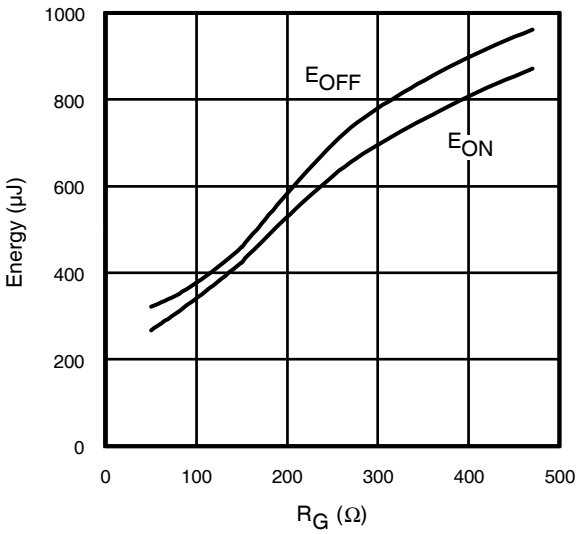


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 10A; V_{GE}= 15V

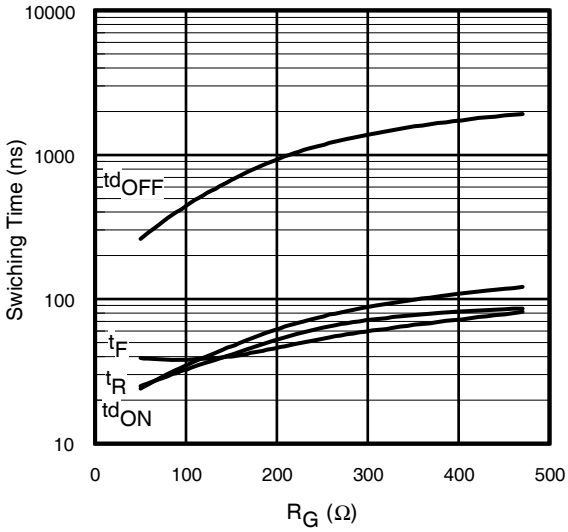


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 10A; V_{GE}= 15V

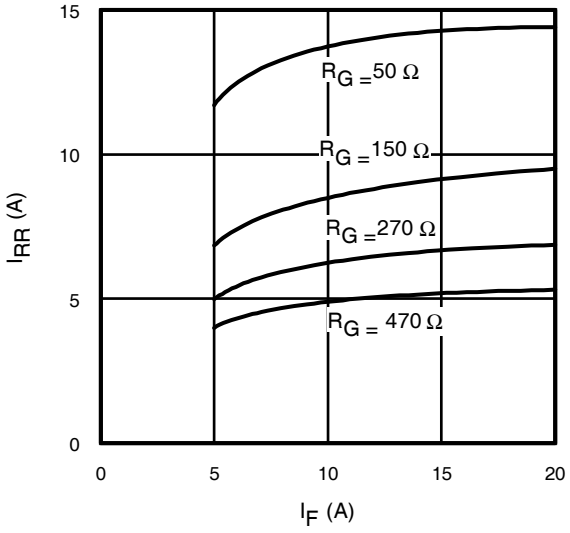


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

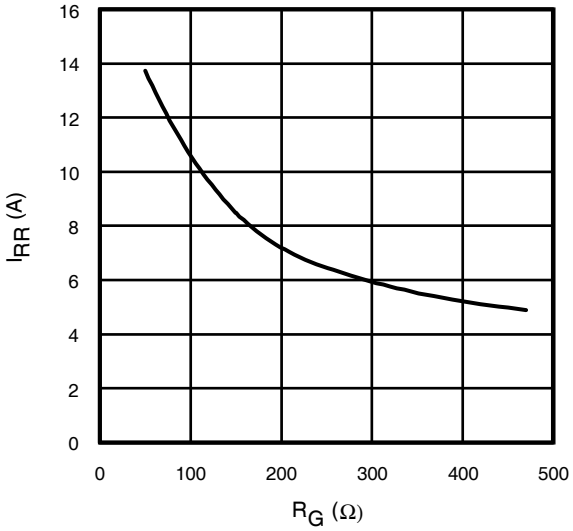


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 10A

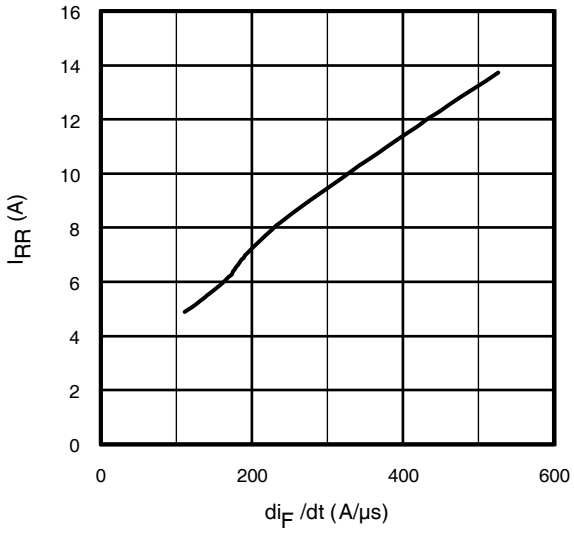


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 10A; T_J = 150°C

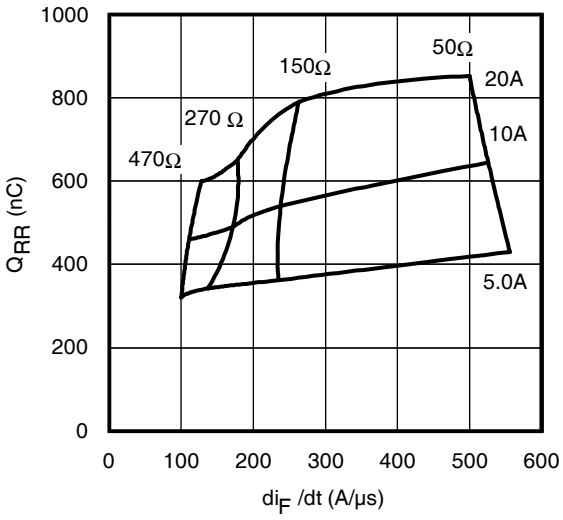


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;T_J = 150°C

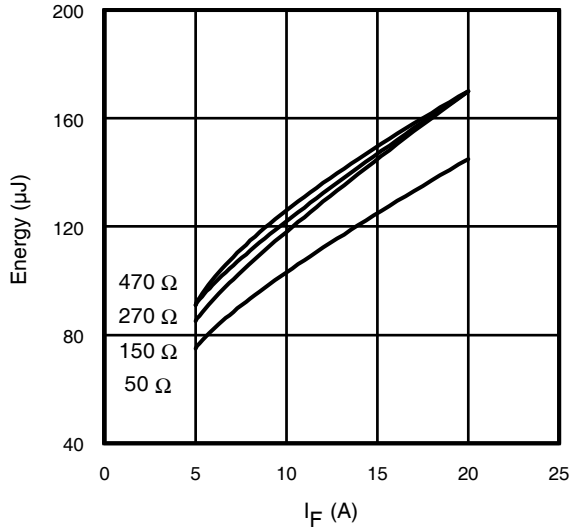


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

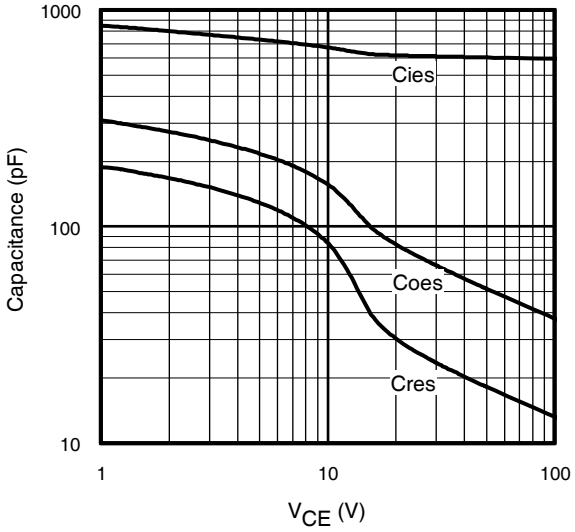


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

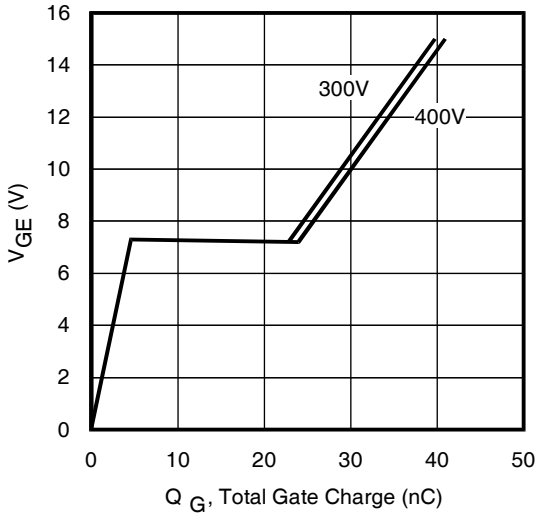


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 10A; L = 2500µH

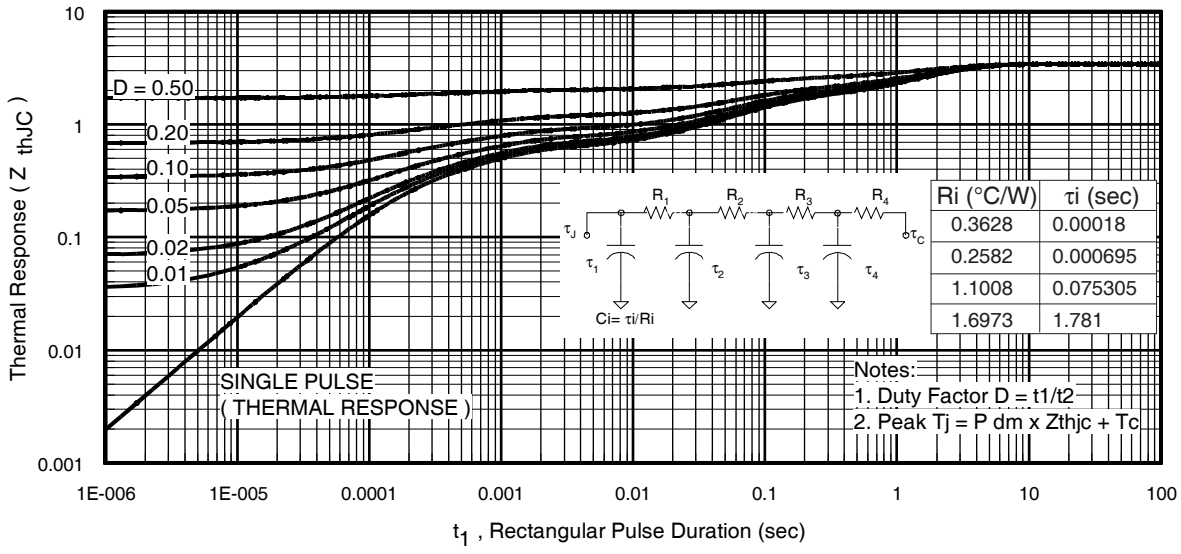


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

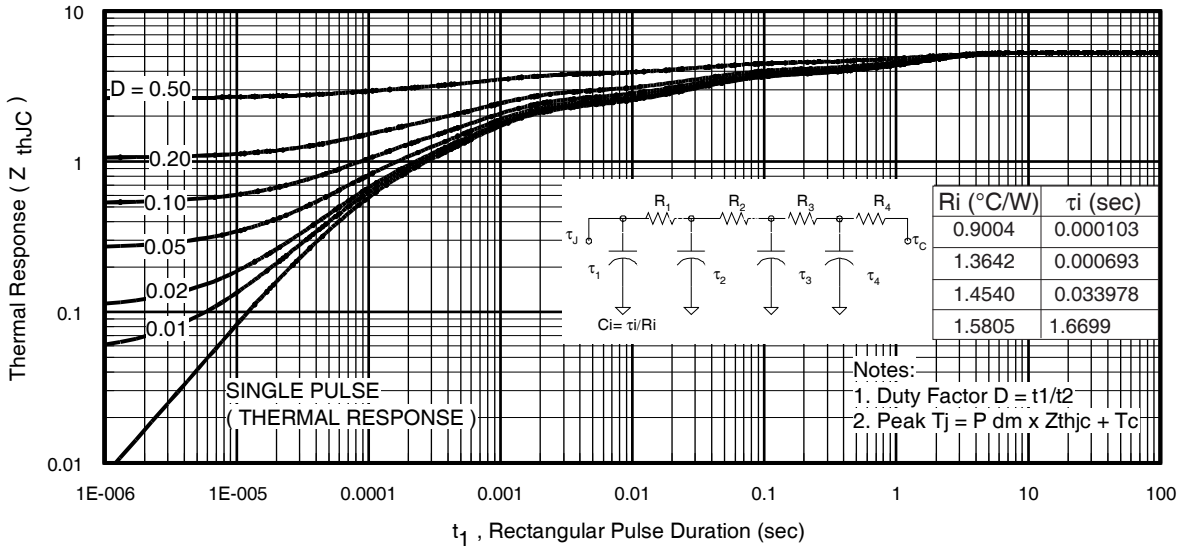


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

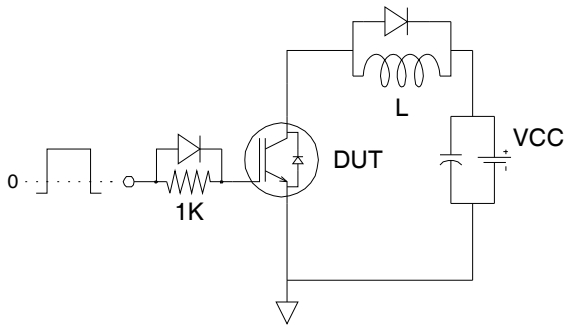


Fig.C.T.1 - Gate Charge Circuit (turn-off)

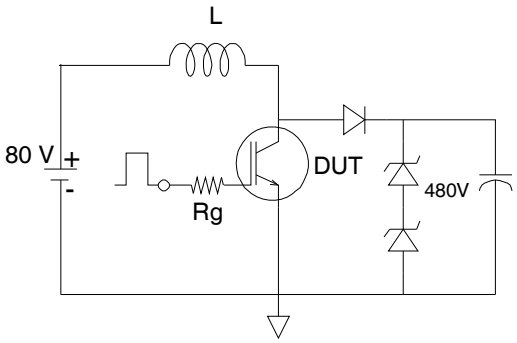


Fig.C.T.2 - RBSOA Circuit

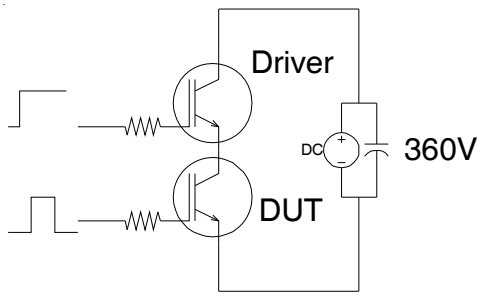


Fig.C.T.3 - S.C.SOA Circuit

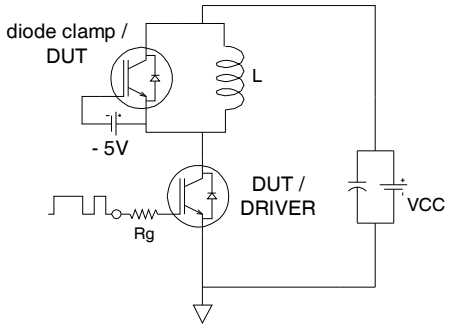


Fig.C.T.4 - Switching Loss Circuit

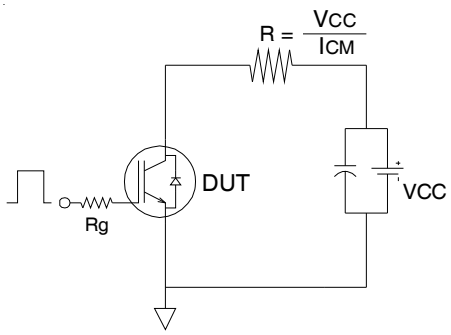


Fig.C.T.5 - Resistive Load Circuit

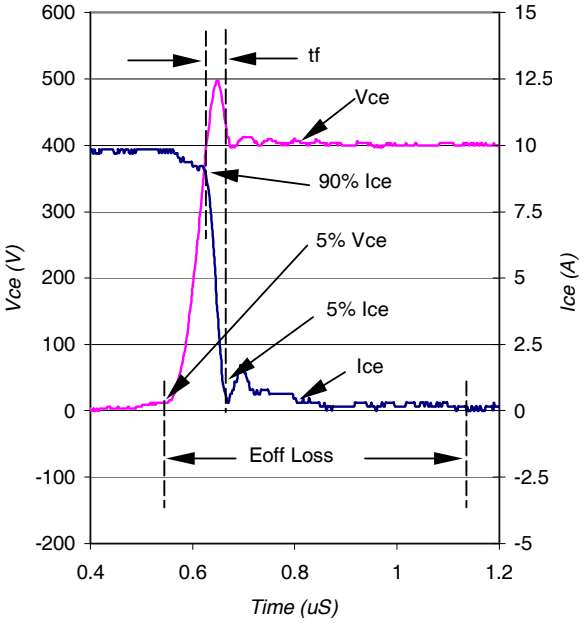


Fig. WF1- Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

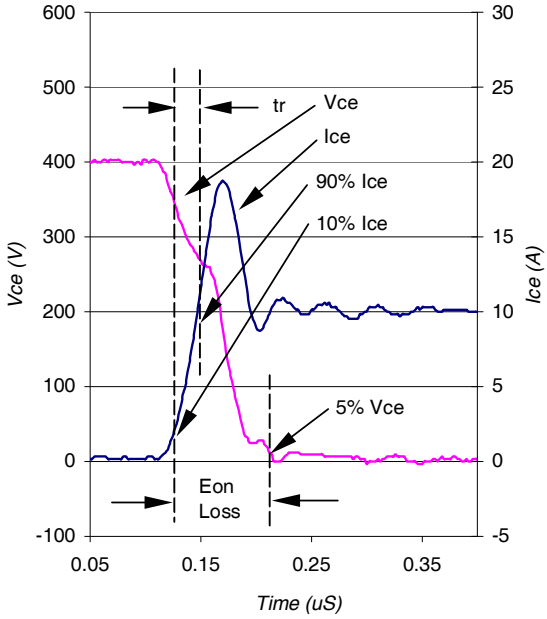


Fig. WF2- Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

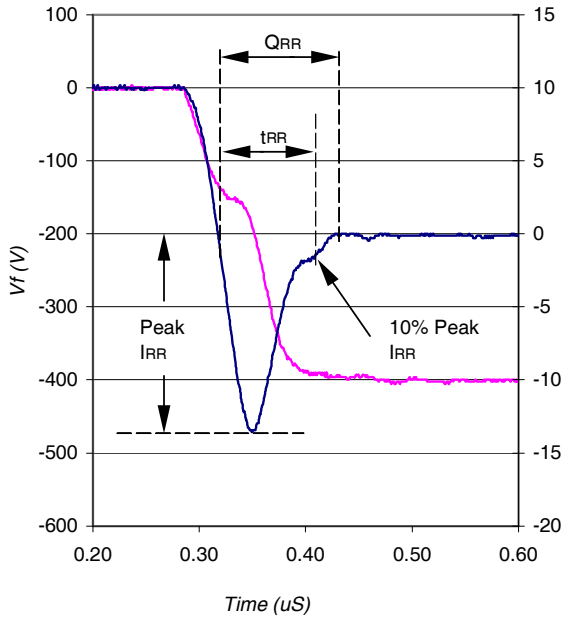


Fig. WF3- Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

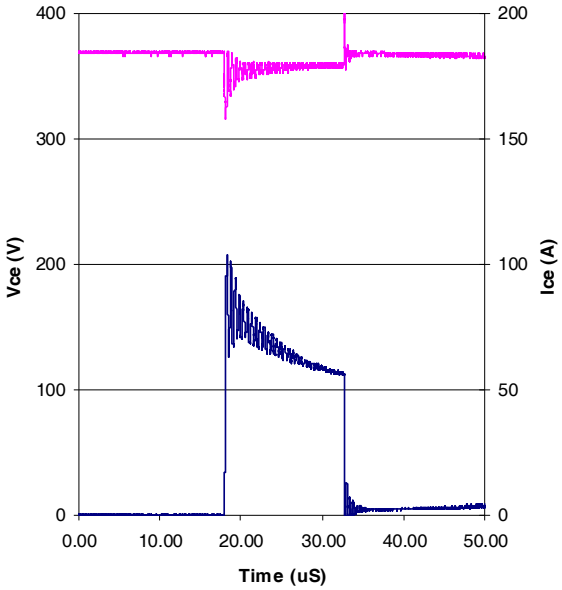
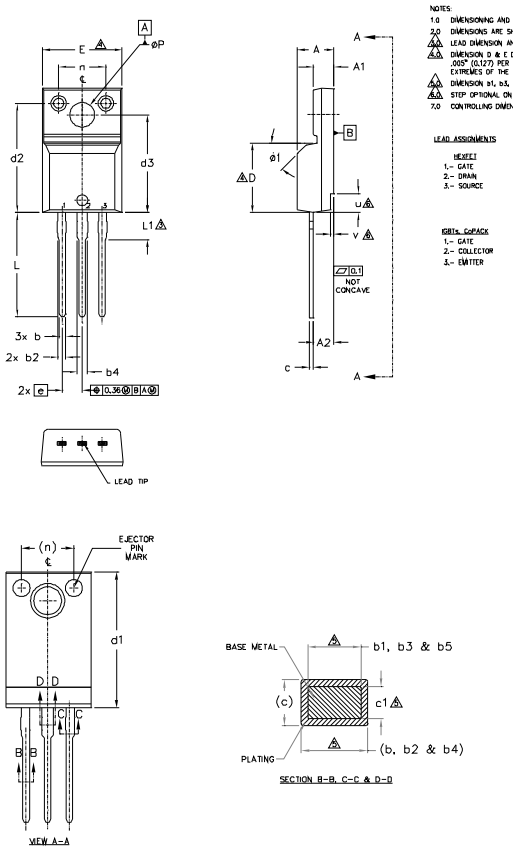


Fig. WF4- Typ. S.C Waveform
@ T_C = 150°C using Fig. CT.3

TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)

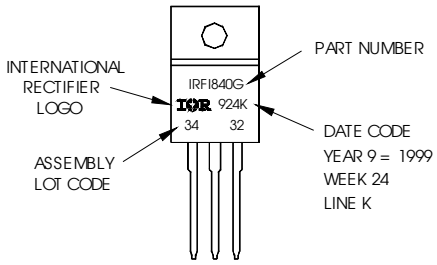


SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	.180	.190	
A1	2.57	2.82	.101	.111	
A2	2.51	2.92	.099	.115	
b	0.61	0.94	.024	.037	
b1	0.61	0.89	.024	.035	5
b2	0.76	1.27	.030	.050	
b3	0.76	1.22	.030	.048	5
b4	1.02	1.52	.040	.060	
b5	1.02	1.47	.040	.058	5
c	0.33	0.63	.013	.025	
c1	0.33	0.58	.013	.023	5
D	8.66	9.80	.341	.386	4
d1	15.80	16.13	.622	.635	
d2	13.97	14.22	.550	.560	
d3	12.29	12.93	.484	.509	
E	9.63	10.74	.379	.423	4
e	2.54 BSC		.100 BSC		
L	13.21	13.72	.520	.540	
L1	3.10	3.68	.122	.145	3
n	6.05	6.60	.238	.260	
øP	3.05	3.45	.120	.136	
u	2.39	2.49	.094	.098	6
v	0.41	0.51	.016	.020	6
ø1	–	45°	–	45°	

TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI840G
WITH ASSEMBLY
LOT CODE 3432
ASSEMBLED ON WW 24 1999
IN THE ASSEMBLY LINE "K"

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



TO-220 Full-Pak 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-220AB-Full-Pak	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
8/4/2015	• Updated data sheet with the new corporate template. • Added feature "UL Certified" on page 1. • Updated package outline on page 12. • Updated note ①from "V_{GE} =15V" to "V_{GE} = 20V" on page 2.

International
IOR Rectifier
AN INFINEON TECHNOLOGIES COMPANY
IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA
To contact International Rectifier, please visit http://www.irf.com/whoto-call/