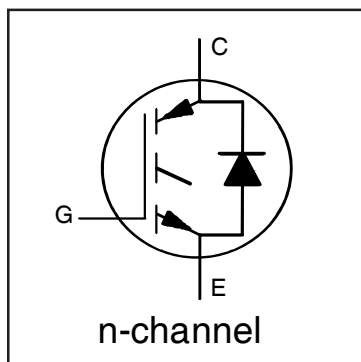


IRGB4061DPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

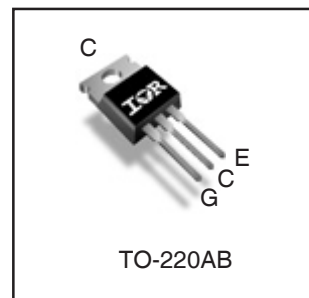
- Low $V_{CE(ON)}$ Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5 μ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current (I_{LM})
- Positive $V_{CE(ON)}$ Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package



$V_{CES} = 600V$
$I_C = 18A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(on)} \text{ typ.} = 1.65V$

Benefits

- High Efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to Low $V_{CE(ON)}$ and Low Switching losses
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI



G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	36	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	18	
I_{CM}	Pulse Collector Current	72	
I_{LM}	Clamped Inductive Load Current ①	72	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	36	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	18	
I_{FM}	Diode Maximum Forward Current ③	72	V
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	
	Transient Gate-to-Emitter Voltage	± 30	W
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	206	
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	103	$^\circ C$
T_J	Operating Junction and	-55 to +175	
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)	—	—	0.73	$^\circ C/W$
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	2.00	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.50	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	80	—	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.40	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$)	CT6
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.65	1.95	V	$I_C = 18A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	2.05	—		$I_C = 18A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
		—	2.15	—		$I_C = 18A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 500\mu A$	9, 10,
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-18	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25 $^\circ\text{C}$ - 175 $^\circ\text{C}$)	11, 12
g_{fe}	Forward Transconductance	—	12	—	S	$V_{CE} = 50V, I_C = 18A, PW = 80\mu s$	
I_{CES}	Collector-to-Emitter Leakage Current	—	2.0	25	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	550	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	2.30	3.30	V	$I_F = 18A$	8
		—	1.6	—		$I_F = 18A, T_J = 175^\circ\text{C}$	
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	Ref.Fig
Q_g	Total Gate Charge (turn-on)	—	35	55	nC	$I_C = 18A$	24
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	10	15		$V_{GE} = 15V$	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	15	25		$V_{CC} = 400V$	
E_{on}	Turn-On Switching Loss	—	95	140	μJ	$I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$	CT4
E_{off}	Turn-Off Switching Loss	—	350	405		$R_G = 22\Omega, L = 200\mu H, L_S = 150nH$	
E_{total}	Total Switching Loss	—	445	545		Energy losses include tail & diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	40	55	ns	$I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$	CT4
t_r	Rise time	—	25	35		$R_G = 22\Omega, L = 200\mu H, L_S = 150nH$	
$t_{d(off)}$	Turn-Off delay time	—	105	120			
t_f	Fall time	—	25	35			
E_{on}	Turn-On Switching Loss	—	285	—	μJ	$I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$	13, 15
E_{off}	Turn-Off Switching Loss	—	570	—		$R_G = 22\Omega, L = 200\mu H, L_S = 150nH, T_J = 175^\circ\text{C}$ ④	CT4
E_{total}	Total Switching Loss	—	855	—		Energy losses include tail & diode reverse recovery	WF1, WF2
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	$I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$	14, 16
t_r	Rise time	—	25	—		$R_G = 22\Omega, L = 200\mu H, L_S = 150nH$	CT4
$t_{d(off)}$	Turn-Off delay time	—	120	—		$T_J = 175^\circ\text{C}$	WF1
t_f	Fall time	—	40	—			WF2
C_{ies}	Input Capacitance	—	1043	—	pF	$V_{GE} = 0V$	23
C_{oes}	Output Capacitance	—	87	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	32	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 72A$ $V_{CC} = 480V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	22, CT3 WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	260	—	μJ	$T_J = 175^\circ\text{C}$	17, 18, 19
t_{rr}	Diode Reverse Recovery Time	—	100	—	ns	$V_{CC} = 400V, I_F = 18A$	20, 21
I_{rr}	Peak Reverse Recovery Current	—	23	—	A	$V_{GE} = 15V, R_G = 22\Omega, L = 200\mu H, L_S = 150nH$	WF3

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 22\Omega$.
 ② This is only applied to TO-220AB package.
 ③ Pulse width limited by max. junction temperature.
 ④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

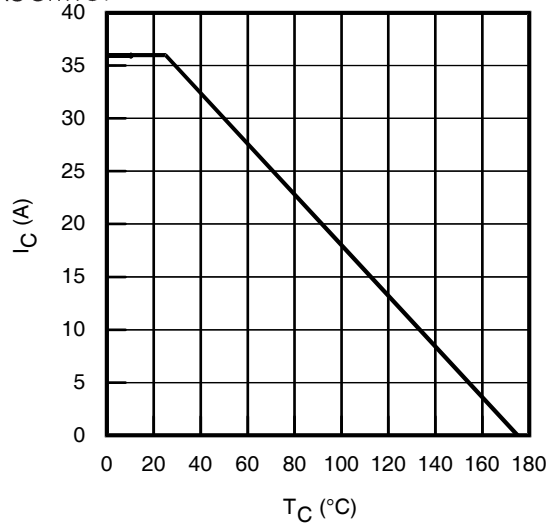


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

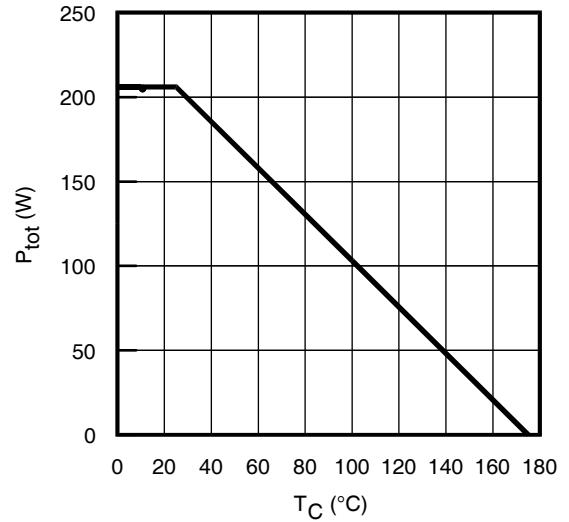


Fig. 2 - Power Dissipation vs. Case Temperature

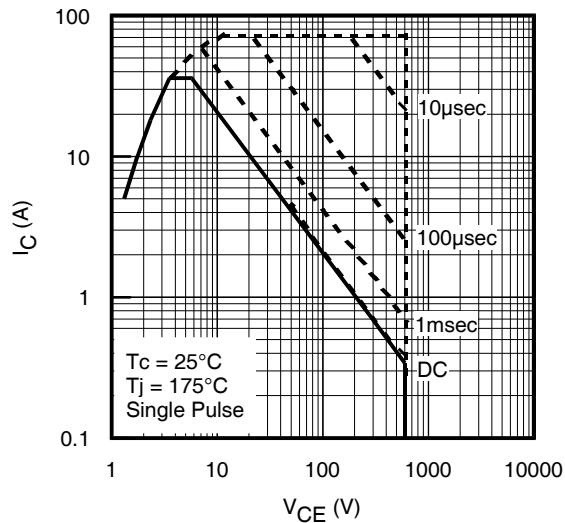


Fig. 3 - Forward SOA
 $T_C = 25^\circ\text{C}$, $T_J \leq 175^\circ\text{C}$; $V_{GE} = 15\text{V}$

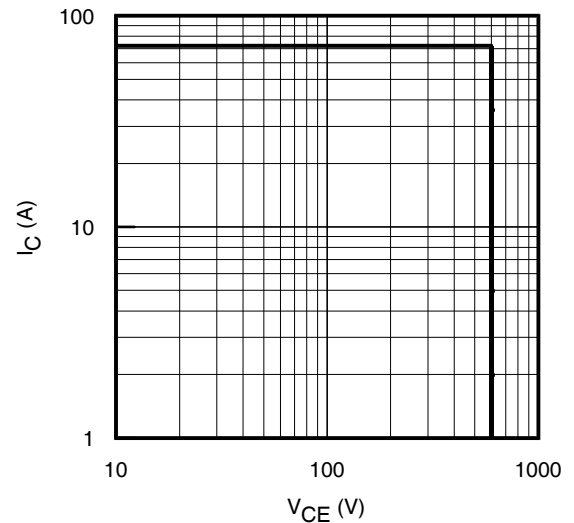


Fig. 4 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}$; $V_{GE} = 15\text{V}$

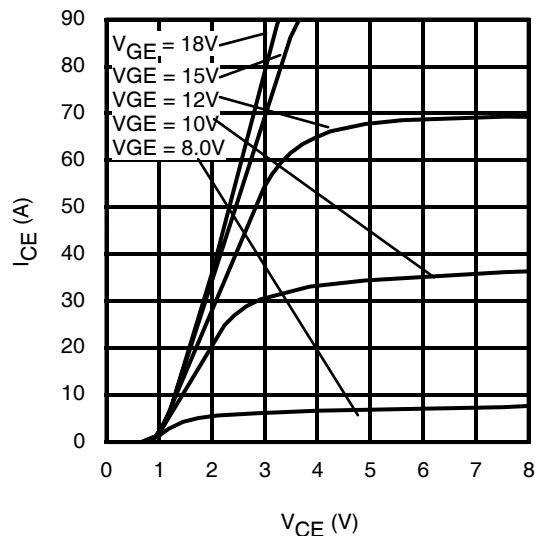


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

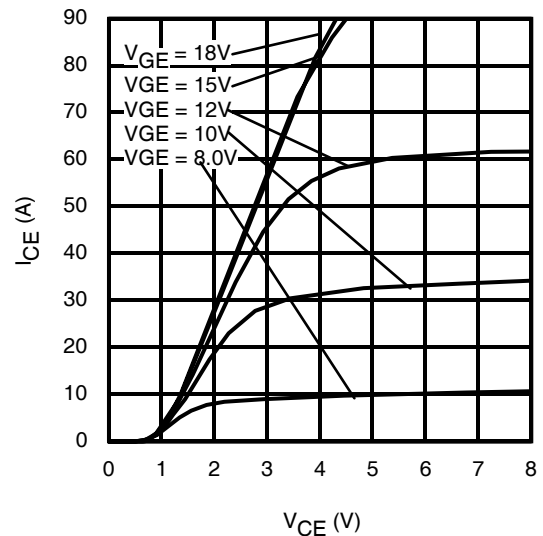


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

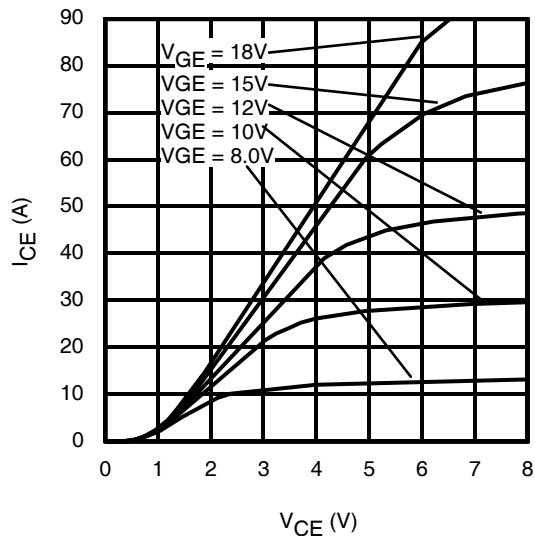


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 80\mu\text{s}$

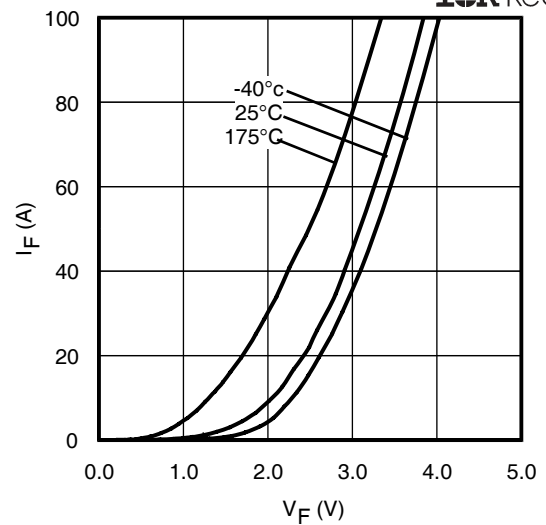


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

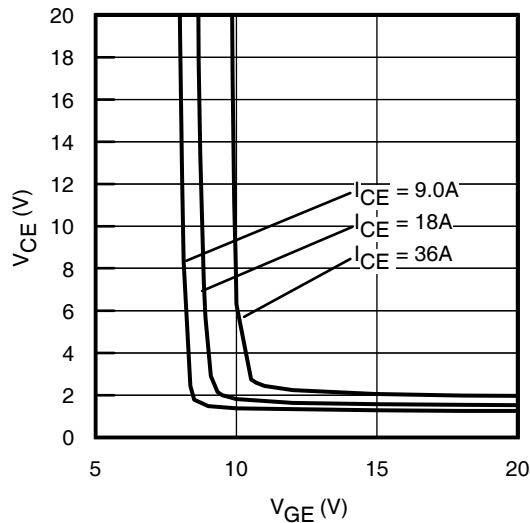


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

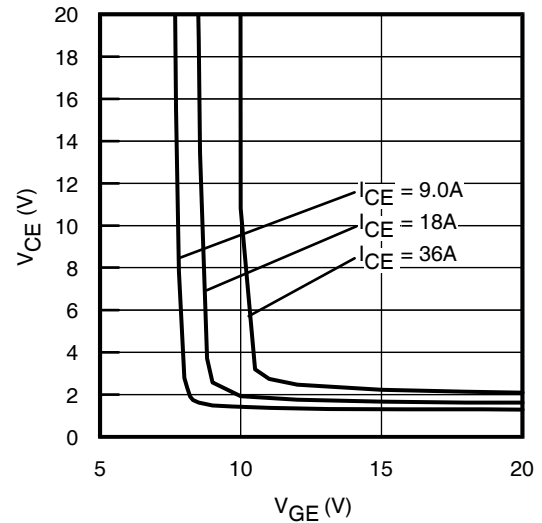


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

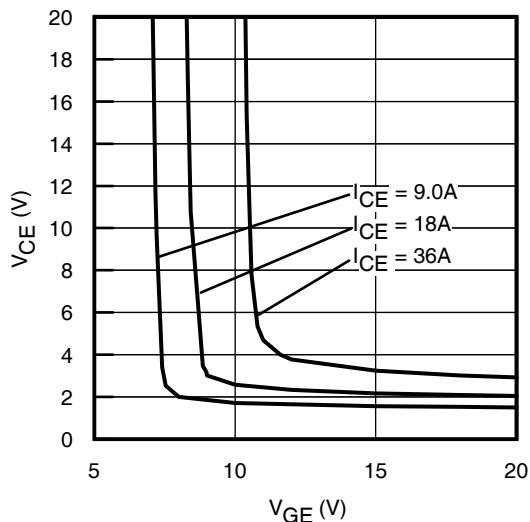


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

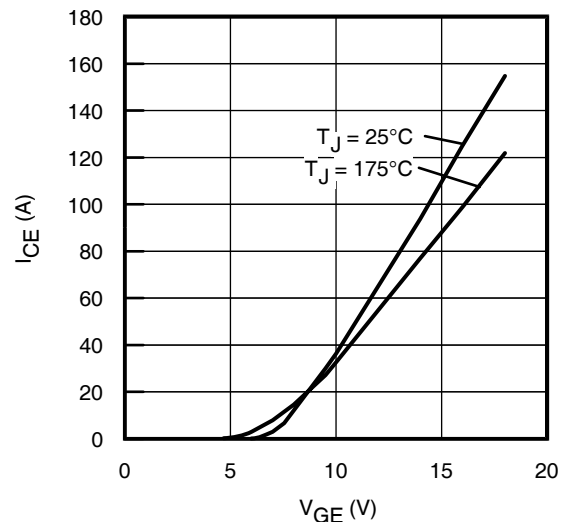


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

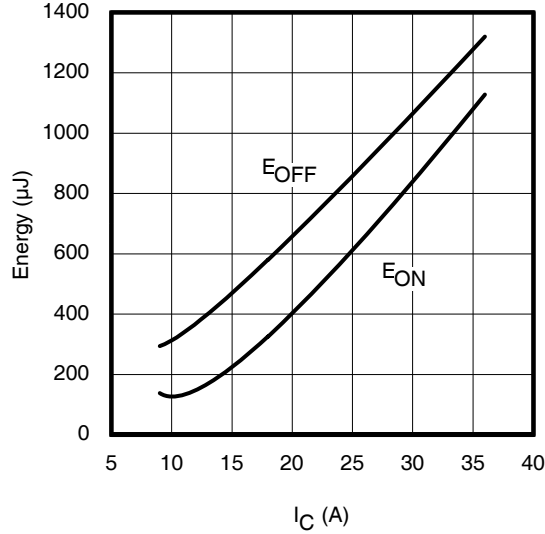


Fig. 13 - Typ. Energy Loss vs. I_C

$T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 22\Omega$; $V_{GE} = 15\text{V}$

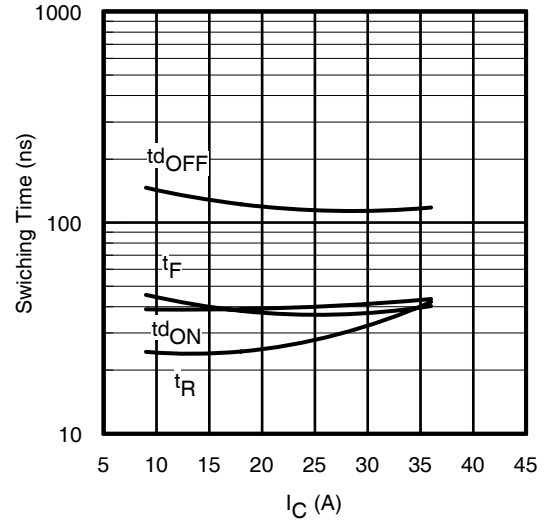


Fig. 14 - Typ. Switching Time vs. I_C

$T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 22\Omega$; $V_{GE} = 15\text{V}$

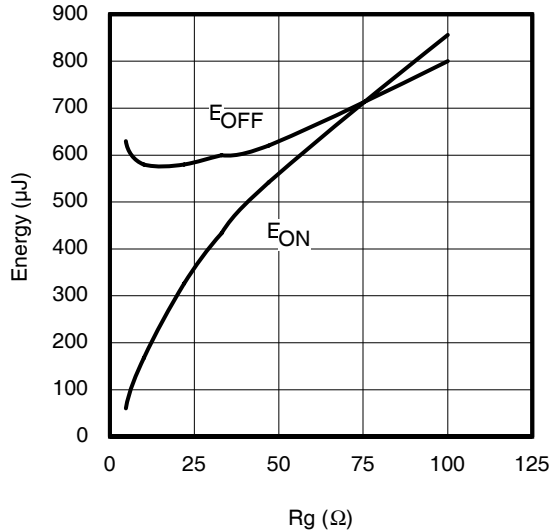


Fig. 15 - Typ. Energy Loss vs. R_G

$T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 18\text{A}$; $V_{GE} = 15\text{V}$

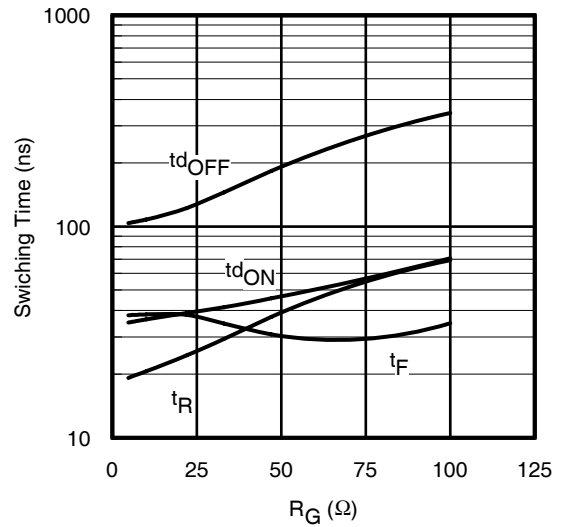


Fig. 16 - Typ. Switching Time vs. R_G

$T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 18\text{A}$; $V_{GE} = 15\text{V}$

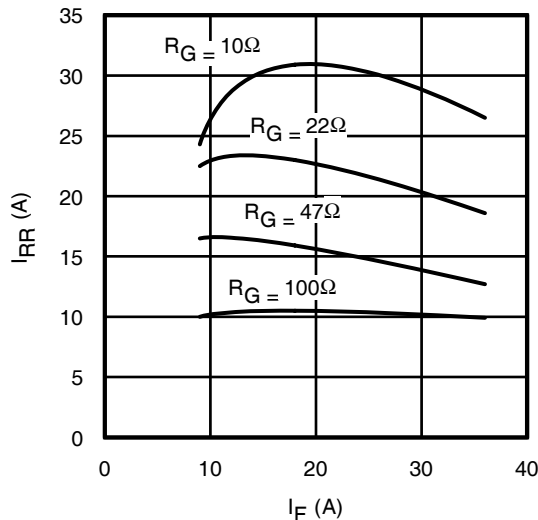


Fig. 17 - Typ. Diode I_{RR} vs. I_F

$T_J = 175^\circ\text{C}$

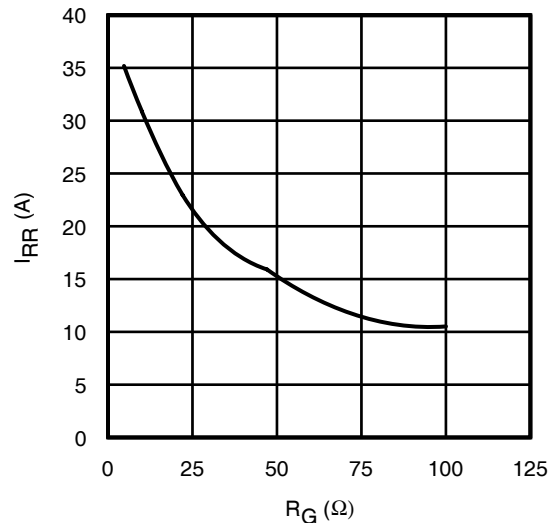


Fig. 18 - Typ. Diode I_{RR} vs. R_G

$T_J = 175^\circ\text{C}$

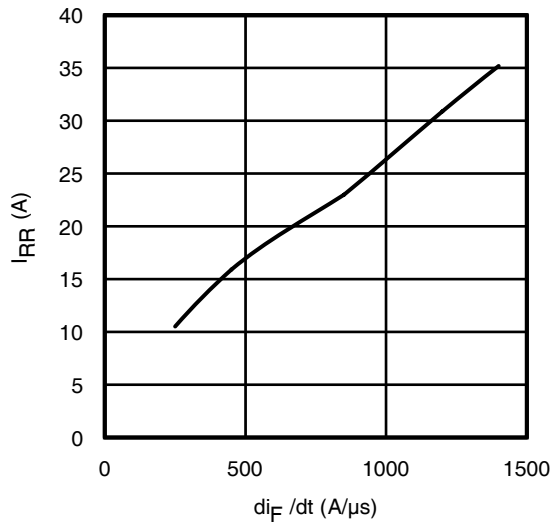


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $I_F = 18A$; $T_J = 175^\circ C$

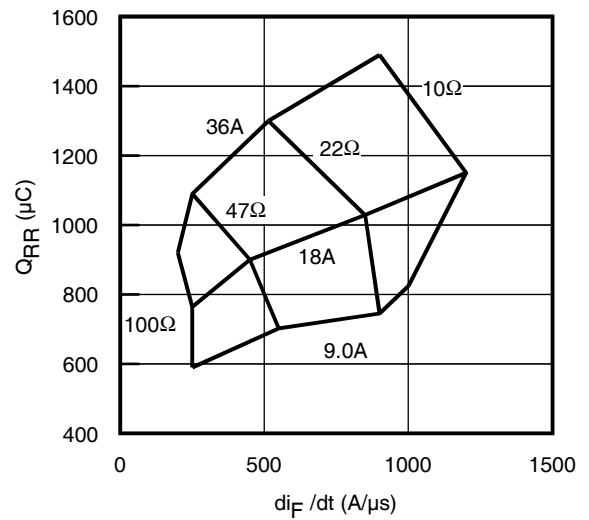


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $T_J = 175^\circ C$

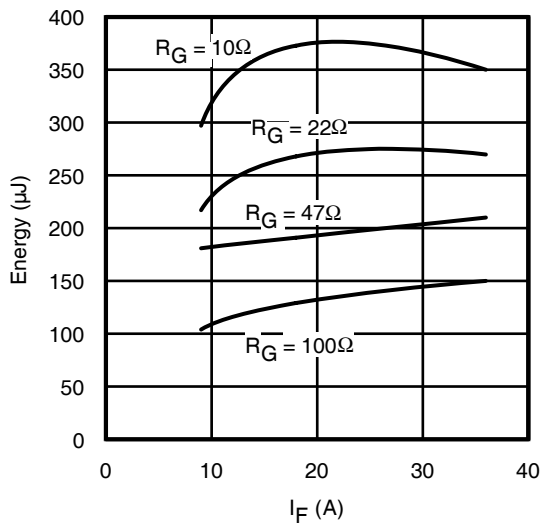


Fig. 21 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ C$

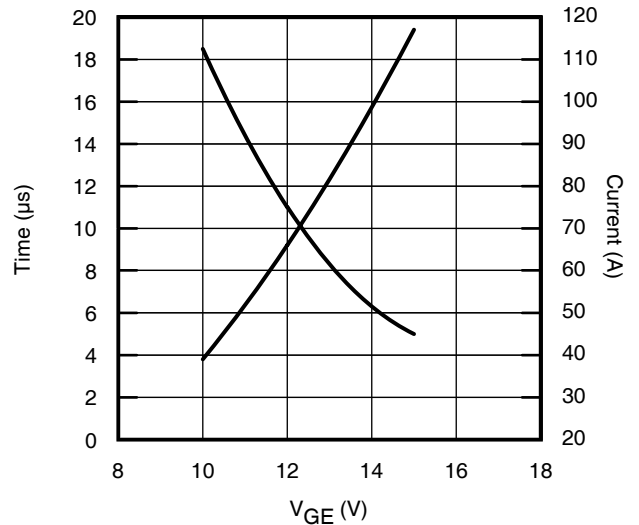


Fig. 22 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400V$; $T_C = 25^\circ C$

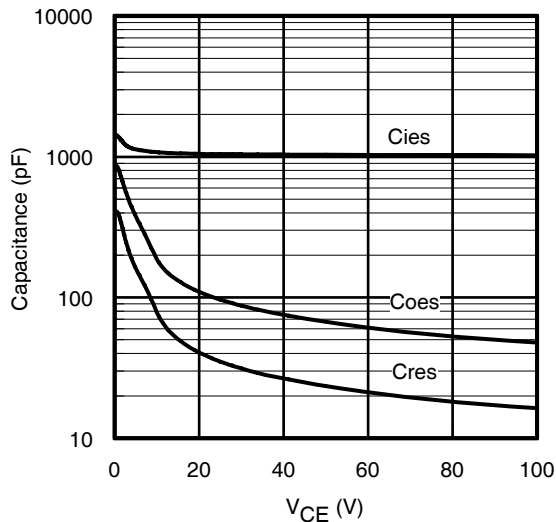


Fig. 23 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

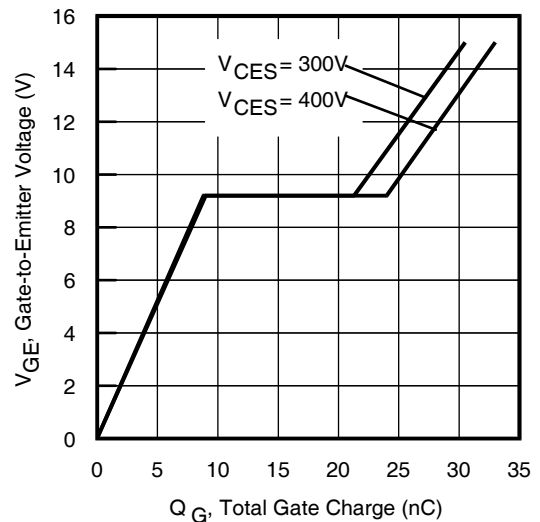


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 18A$; $L = 600\mu H$

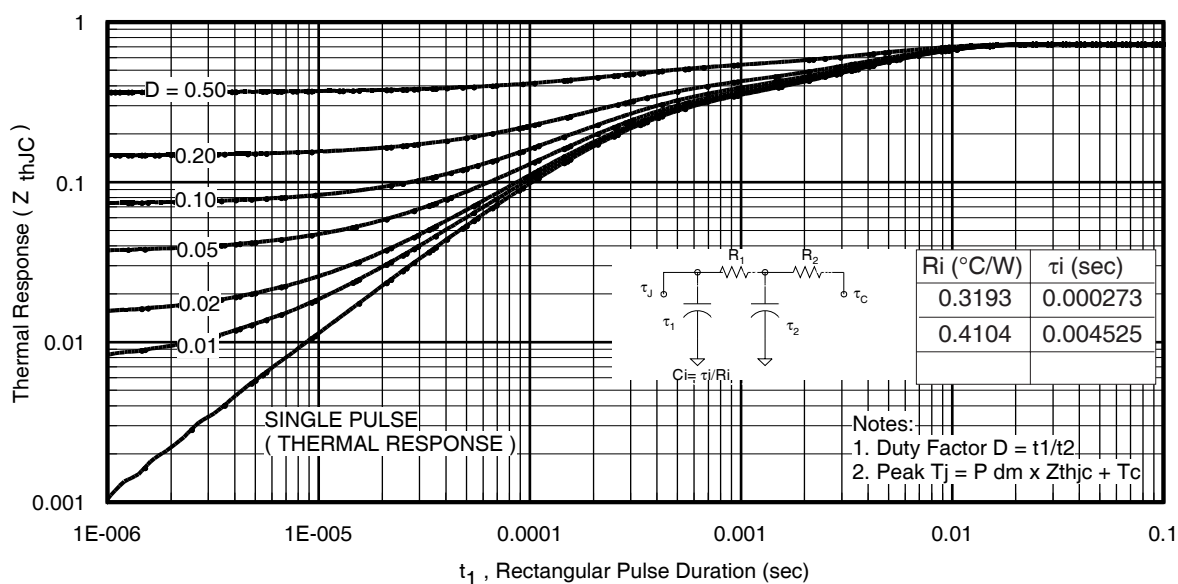


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

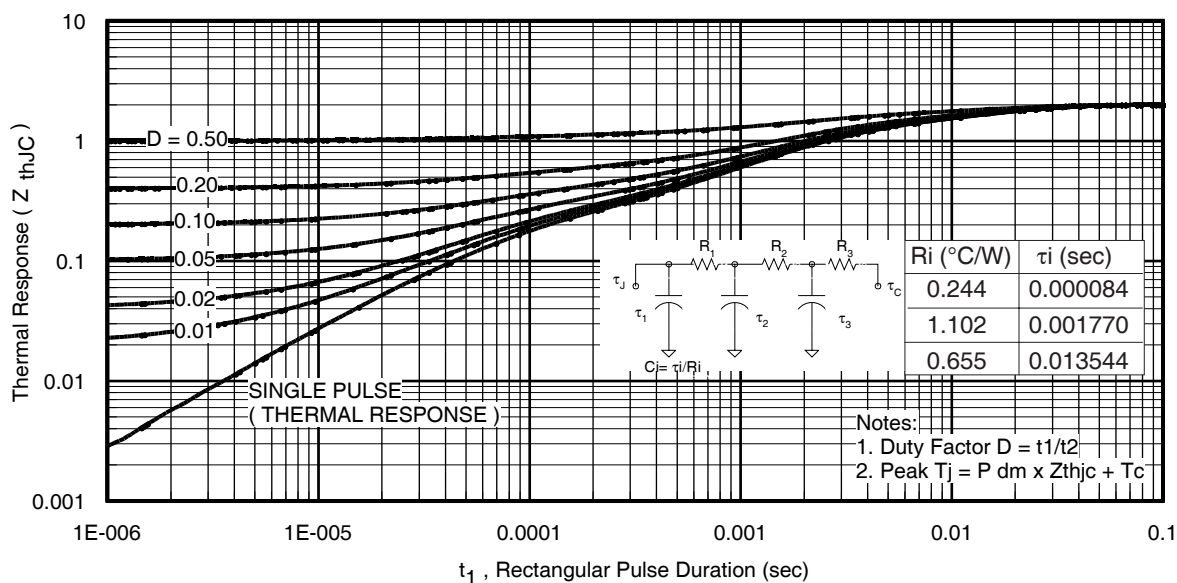


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

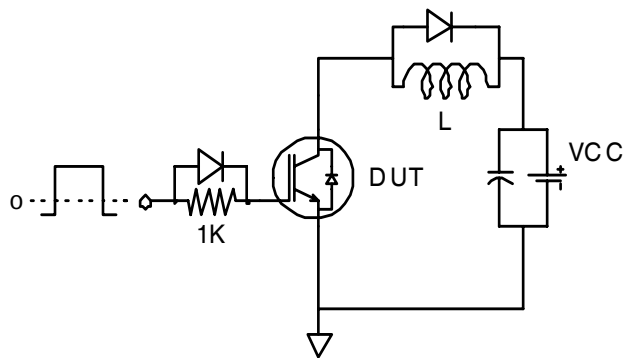


Fig.C.T.1 - Gate Charge Circuit (turn-off)

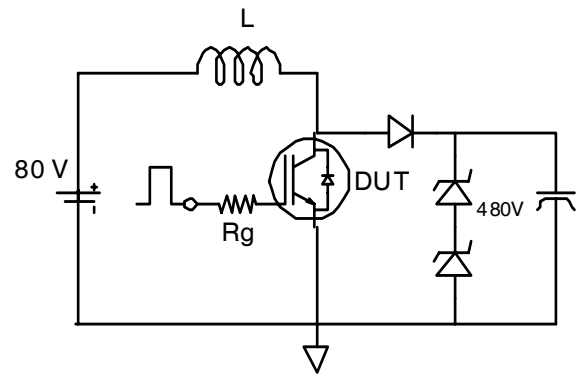


Fig.C.T.2 - RBSOA Circuit

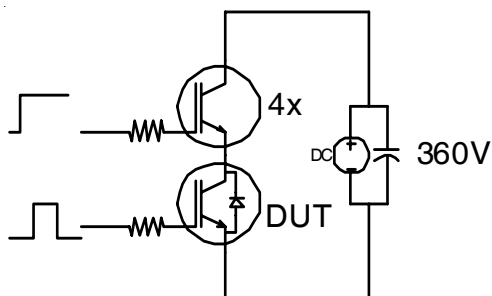


Fig.C.T.3 - S.C. SOA Circuit

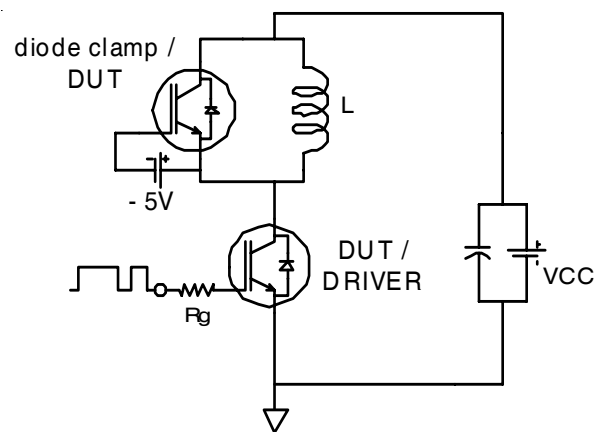


Fig.C.T.4 - Switching Loss Circuit

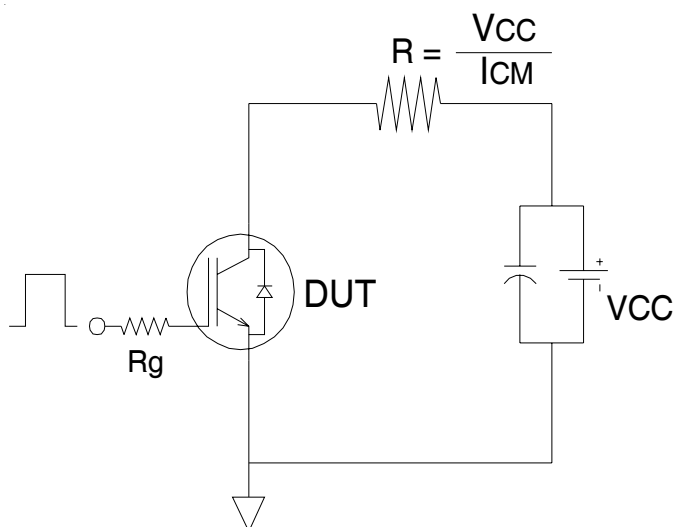


Fig.C.T.5 - Resistive Load Circuit

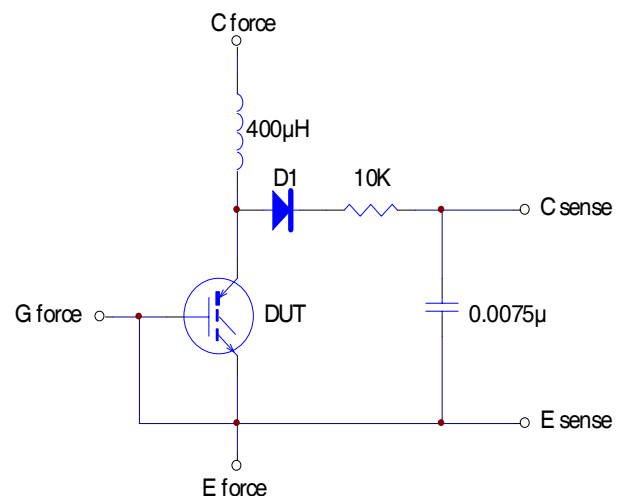


Fig.C.T.6 - BVCEs Filter Circuit

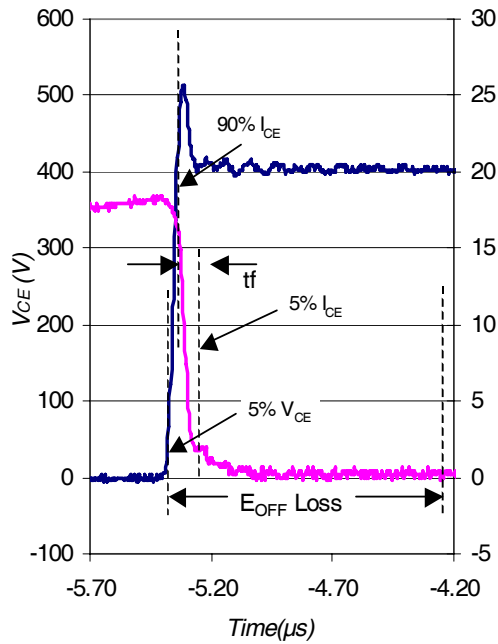


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

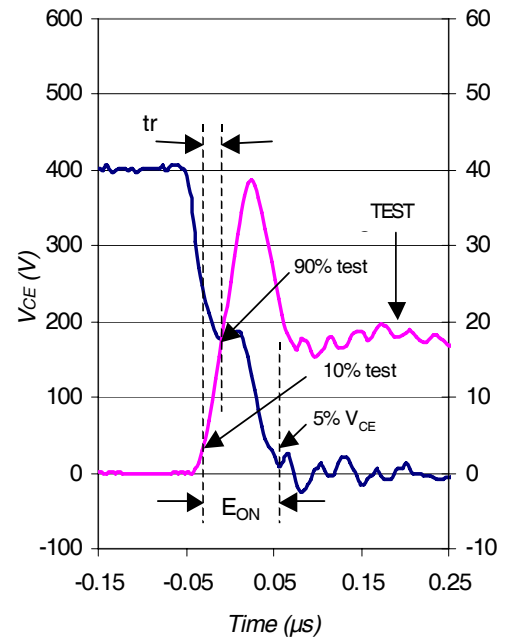


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

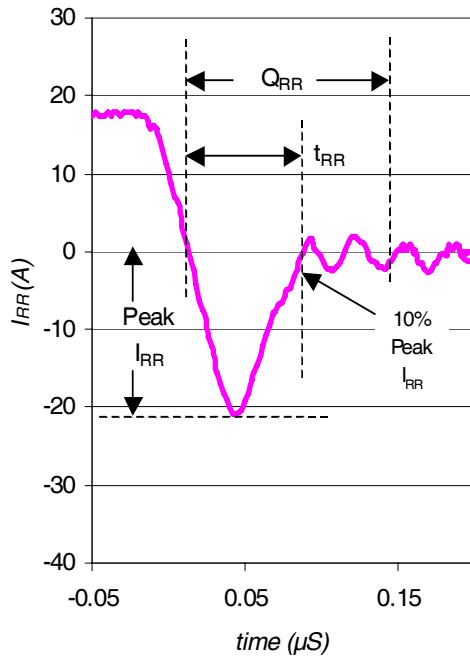


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

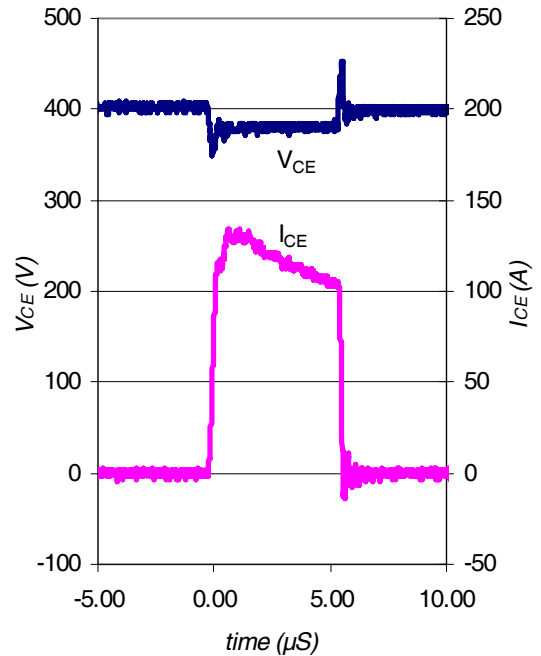
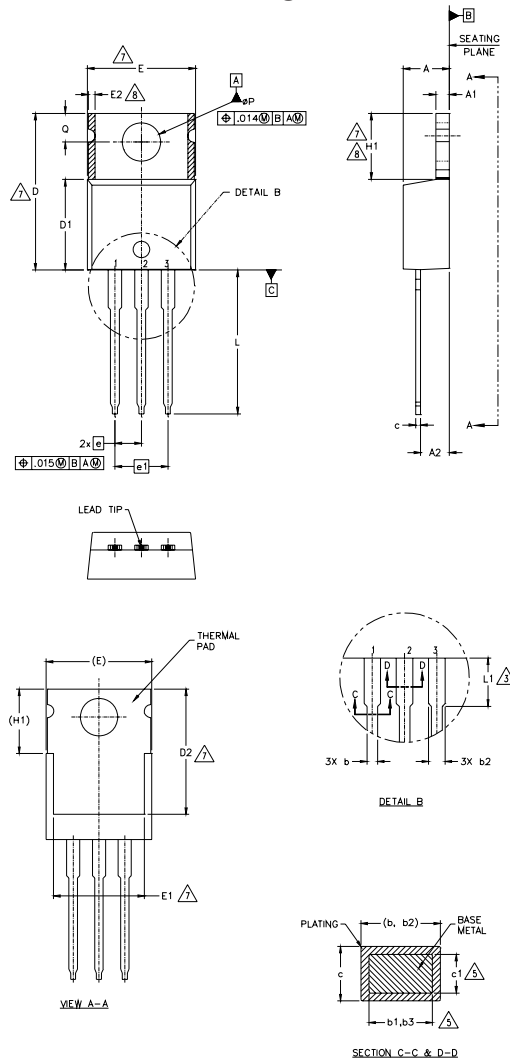


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 25^\circ\text{C}$ using Fig. CT.3

IRGB4061DPbF

TO-220AB Package Outline (Dimensions are shown in millimeters (inches))

International
IR Rectifier



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	0.51	1.40	.020	.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	5
b3	1.14	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	7
D2	11.68	12.88	.460	.507	
E	9.65	10.67	.380	.420	
E1	6.86	8.89	.270	.350	
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	3
L1	—	6.35	—	.250	
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

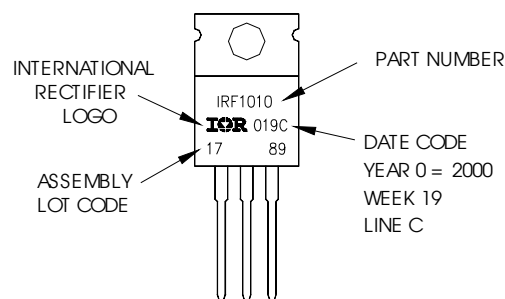
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

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

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 packages are not recommended for Surface Mount Application.

Data and specifications subject to change without notice.
This product has been designed and qualified for Industrial market.
Qualification Standards can be found on IR's Web site.

International
IR Rectifier

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