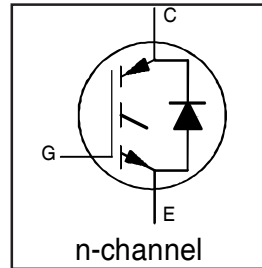


IRGB5B120KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

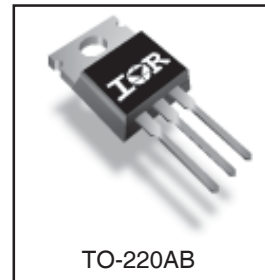
- Low VCE (on) Non Punch Through IGBT Technology.
- Low Diode VF.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- TO-220 Package.
- Lead-Free



$V_{CES} = 1200V$
$I_C = 6.0A, T_C = 100^\circ C$
$t_{sc} > 10\mu s, T_J = 150^\circ C$
$V_{CE(on)} \text{ typ.} = 2.75V$

Benefits

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



TO-220AB

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	12	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	6.0	
I_{CM}	Pulsed Collector Current	24	
I_{LM}	Clamped Inductive Load Current ①	24	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	12	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	6.0	
I_{FM}	Diode Maximum Forward Current	24	V
V_{GE}	Gate-to-Emitter Voltage	± 20	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	89	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	36	
T_J	Operating Junction and	-55 to +150	$^\circ C$
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
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	1.4	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	2.8	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	62	
Wt	Weight	—	2 (0.07)	—	g (oz)

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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	1200	—	—	V	$V_{GE} = 0V, I_C = 500\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.15	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.75	3.0	V	$I_C = 6.0A, V_{GE} = 15V$	5, 6, 7
		—	3.36	3.7		$I_C = 6.0A, V_{GE} = 15V, T_J = 125^\circ\text{C}$	9, 10, 11
$V_{GE(th)}$	Gate Threshold Voltage	4.0	5.0	6.0	V	$V_{CE} = V_{GE}, I_C = 250\mu A$	9, 10, 11
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	12
g_{fe}	Forward Transconductance	—	2.6	—	S	$V_{CE} = 50V, I_C = 6.0A, PW=80\mu s$	
I_{CES}	Zero Gate Voltage Collector Current	—	—	100	μA	$V_{GE} = 0V, V_{CE} = 1200V$	
		—	66	200		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 125^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	2.13	2.45	V	$I_F = 6.0A$	8
		—	2.38	2.75		$I_F = 6.0A, T_J = 125^\circ\text{C}$	
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.
Qg	Total Gate Charge (turn-on)	—	25	38	nC	$I_C = 6.0A$	23 CT1
Qge	Gate - Emitter Charge (turn-on)	—	3.7	5.6		$V_{CC} = 800V$	
Qgc	Gate - Collector Charge (turn-on)	—	13	20		$V_{GE} = 15V$	
E_{on}	Turn-On Switching Loss	—	390	440	μJ	$I_C = 6.0A, V_{CC} = 600V$	CT4
E_{off}	Turn-Off Switching Loss	—	330	440		$V_{GE} = 15V, R_G = 50\Omega, L = 3.7mH$	
E_{tot}	Total Switching Loss	—	720	880		$L_s = 150nH, T_J = 25^\circ\text{C} \text{ ②}$	
$t_{d(on)}$	Turn-On Delay Time	—	22	29	ns	$I_C = 6.0A, V_{CC} = 600V$	CT4
t_r	Rise Time	—	19	27		$V_{GE} = 15V, R_G = 50\Omega, L = 3.7mH$	
$t_{d(off)}$	Turn-Off Delay Time	—	100	120		$L_s = 150nH, T_J = 25^\circ\text{C}$	
t_f	Fall Time	—	19	25			
E_{on}	Turn-On Switching Loss	—	440	660	μJ	$I_C = 6.0A, V_{CC} = 600V$	CT4 13, 15 WF1 WF2
E_{off}	Turn-Off Switching Loss	—	370	560		$V_{GE} = 15V, R_G = 50\Omega, L = 3.7mH$	
E_{tot}	Total Switching Loss	—	810	1220		$L_s = 150nH, T_J = 125^\circ\text{C} \text{ ②}$	
$t_{d(on)}$	Turn-On Delay Time	—	21	27	ns	$I_C = 6.0A, V_{CC} = 600V$	14, 16 CT4 WF1 WF2
t_r	Rise Time	—	18	25		$V_{GE} = 15V, R_G = 50\Omega, L = 3.7mH$	
$t_{d(off)}$	Turn-Off Delay Time	—	110	150		$L_s = 150nH, T_J = 125^\circ\text{C}$	
t_f	Fall Time	—	22	29			
C_{ies}	Input Capacitance	—	370	—	pF	$V_{GE} = 0V$	22
C_{oes}	Output Capacitance	—	33	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	11	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 24A, V_p = 1200V$ $V_{CC} = 1000V, V_{GE} = +15V \text{ to } 0V, R_G = 50\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_p = 1200V, R_G = 50\Omega$ $V_{CC} = 900V, V_{GE} = +15V \text{ to } 0V$	CT3 WF4
Erec	Reverse Recovery energy of the diode	—	360	—	μJ	$T_J = 125^\circ\text{C}$	17, 18, 19
t_{rr}	Diode Reverse Recovery time	—	160	—	ns	$V_{CC} = 600V, I_F = 6.0A, L = 2.0mH$	20, 21
I_{rr}	Diode Peak Reverse Recovery Current	—	9.0	—	A	$V_{GE} = 15V, R_G = 50\Omega, L_s = 150nH$	CT4, WF3

Note:

① $V_{CC} = 80\% (V_{CES}), V_{GE} = 15V, L = 100\mu H, R_G = 50\Omega$.

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

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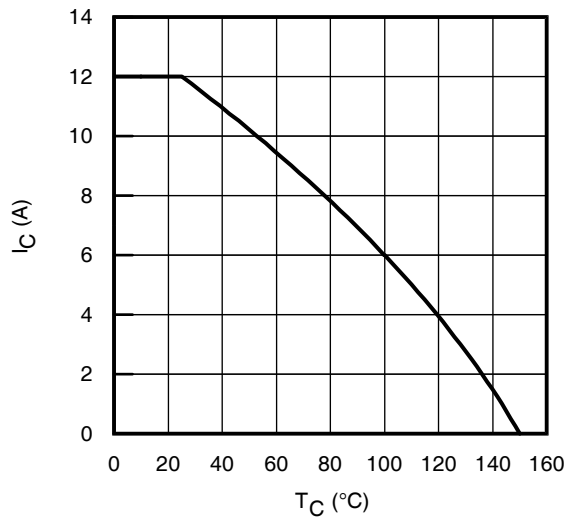


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

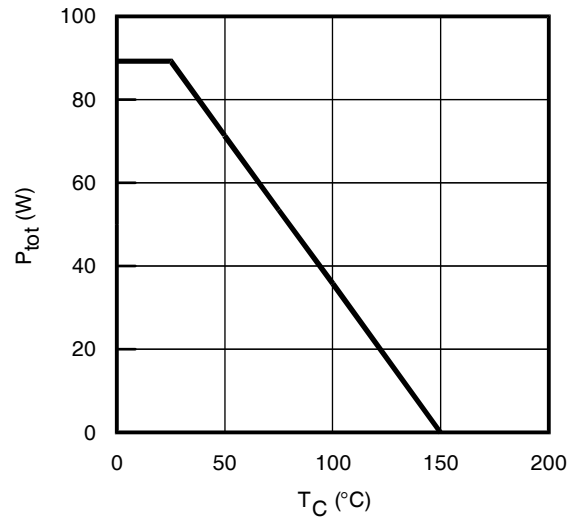


Fig. 2 - Power Dissipation vs. Case Temperature

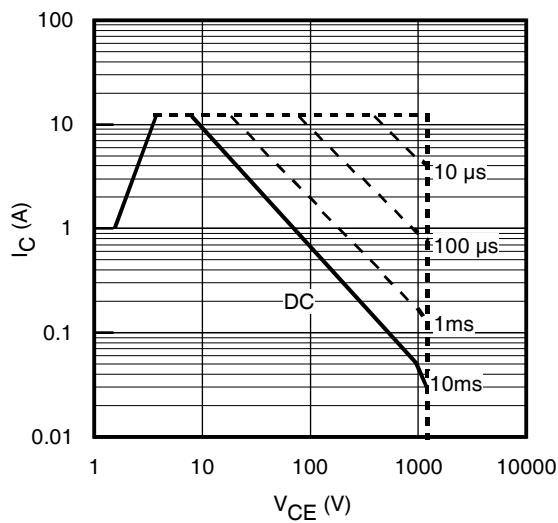


Fig. 3 - Forward SOA
 $T_C = 25^\circ\text{C}$; $T_J \leq 150^\circ\text{C}$

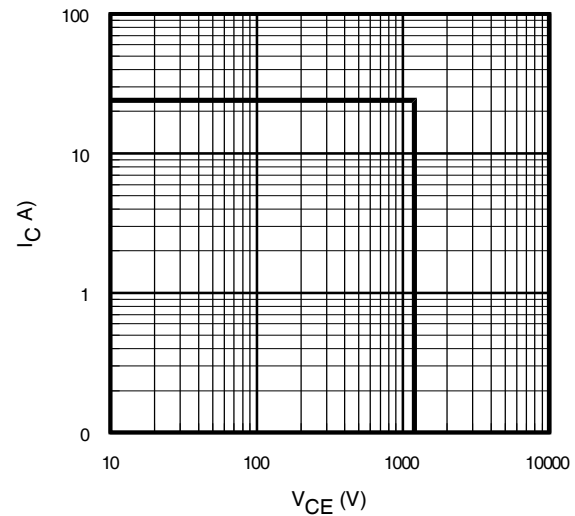


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 15\text{V}$

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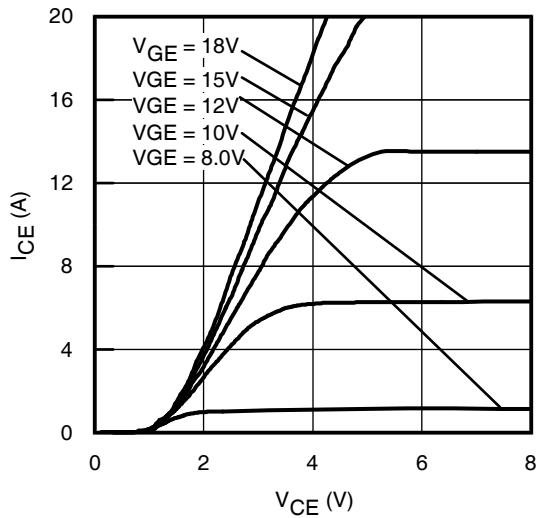


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

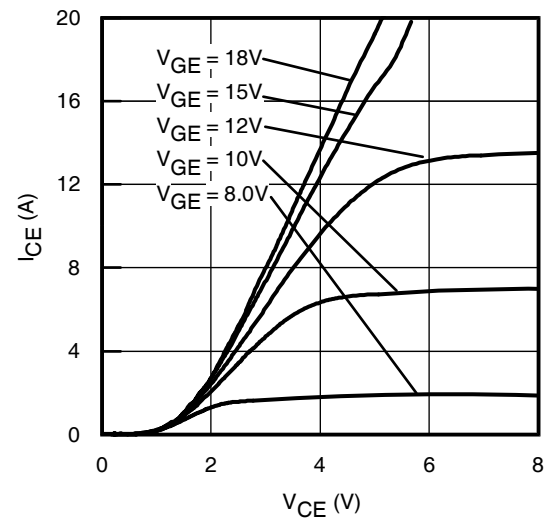


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

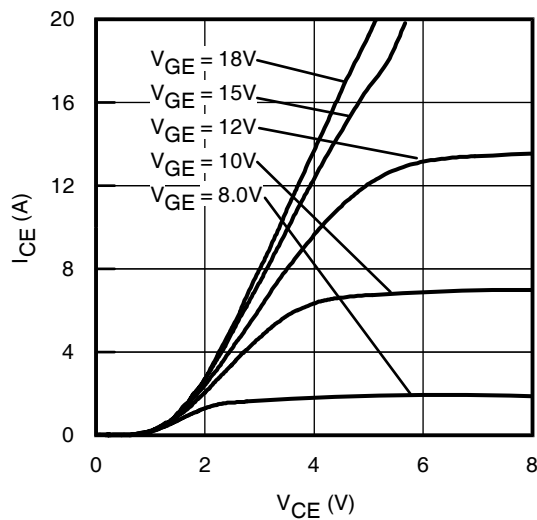


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 125^\circ\text{C}$; $t_p = 80\mu\text{s}$

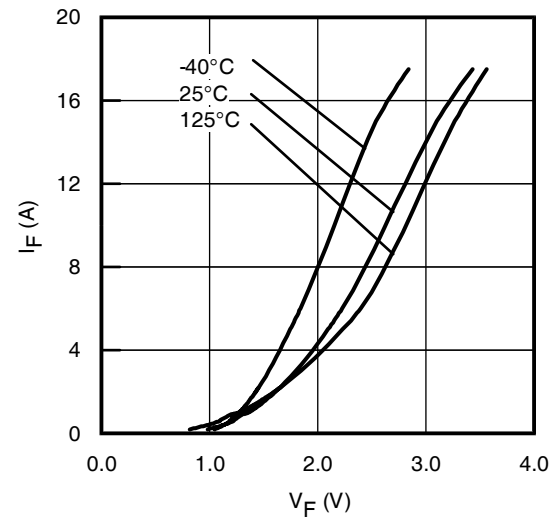


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

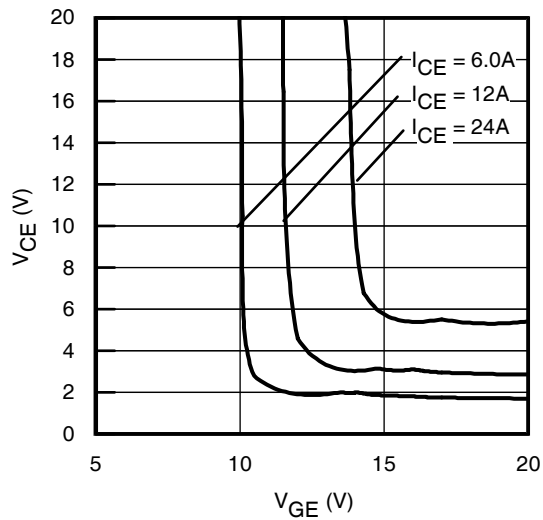


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

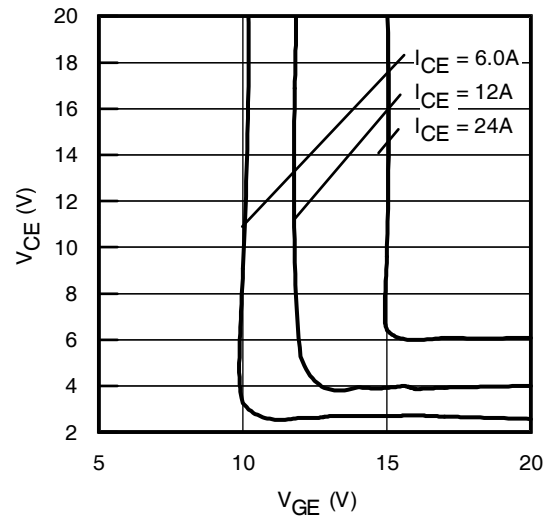


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

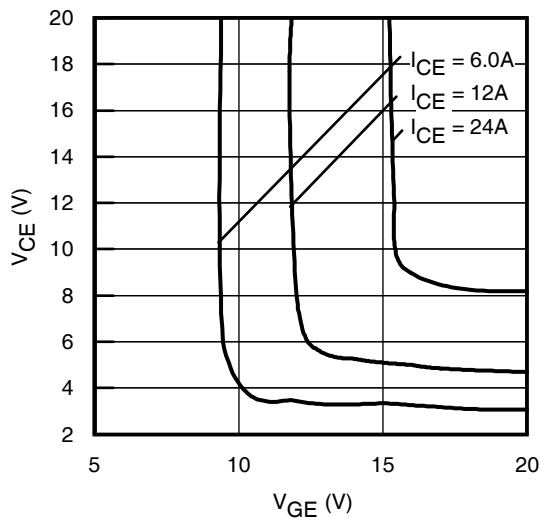


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 125^\circ\text{C}$

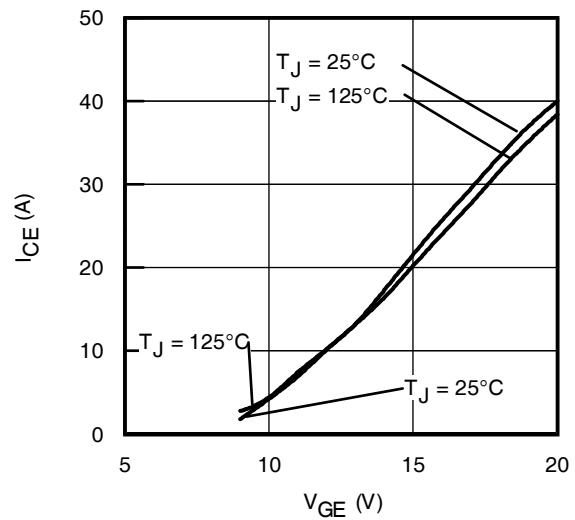


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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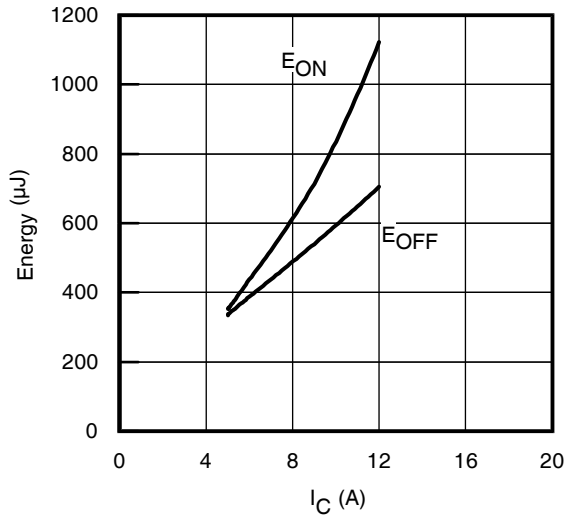


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 3.7\text{mH}$; $V_{CE} = 600\text{V}$
 $R_G = 50\Omega$; $V_{GE} = 15\text{V}$

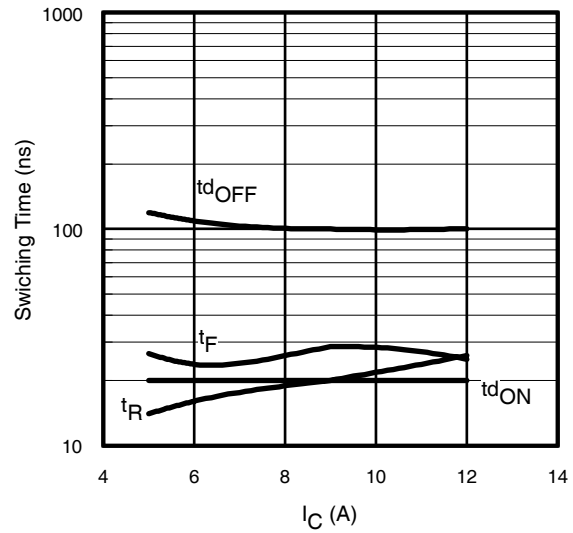


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L = 3.7\text{mH}$; $V_{CE} = 600\text{V}$
 $R_G = 50\Omega$; $V_{GE} = 15\text{V}$

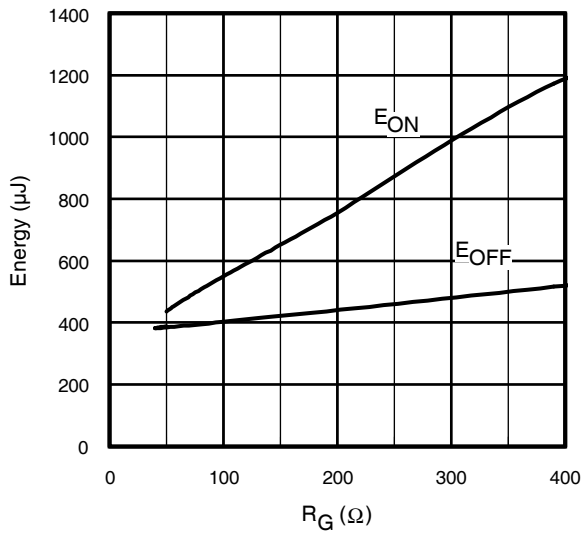


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 3.7\text{mH}$; $V_{CE} = 600\text{V}$
 $I_{CE} = 6.0\text{A}$; $V_{GE} = 15\text{V}$

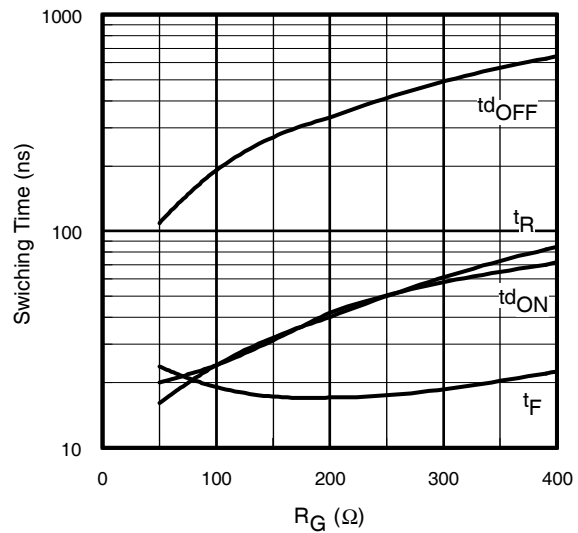


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L = 3.7\text{mH}$; $V_{CE} = 600\text{V}$
 $I_{CE} = 6.0\text{A}$; $V_{GE} = 15\text{V}$

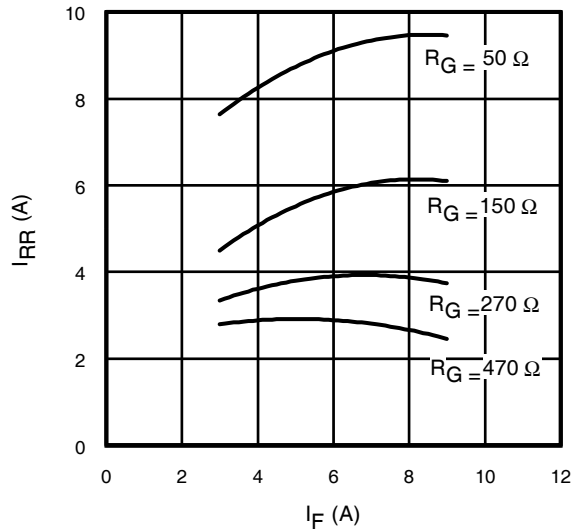


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

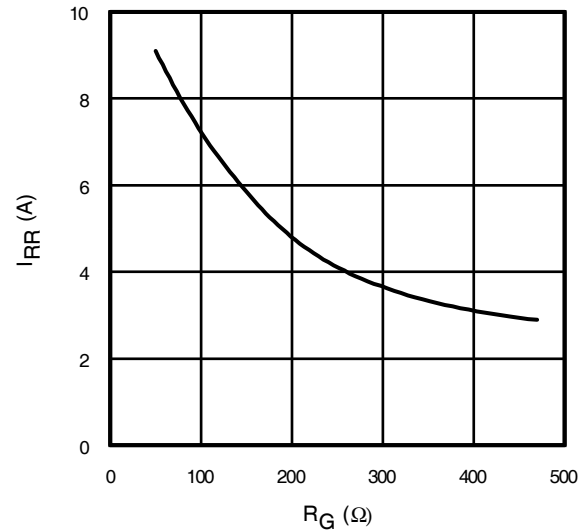


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}; I_F = 6.0\text{A}$

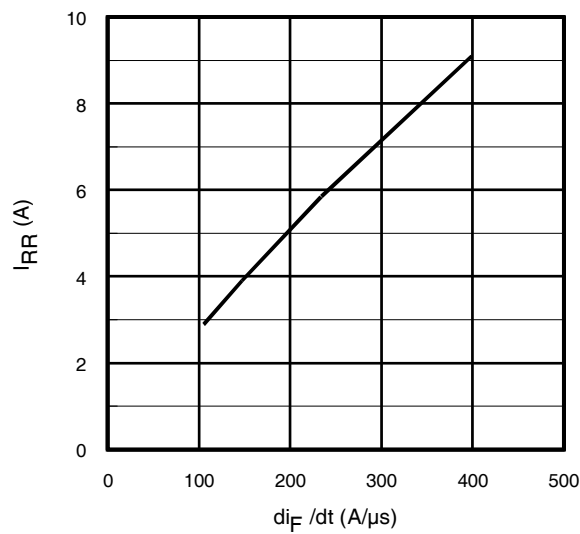


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V};$
 $I_F = 6.0\text{A}; T_J = 125^\circ\text{C}$

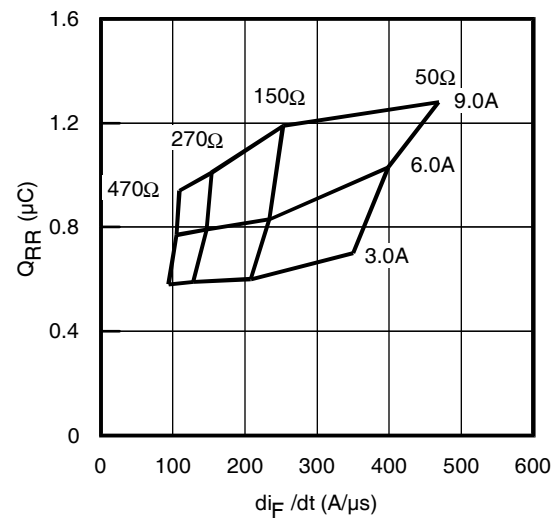


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V}; T_J = 125^\circ\text{C}$

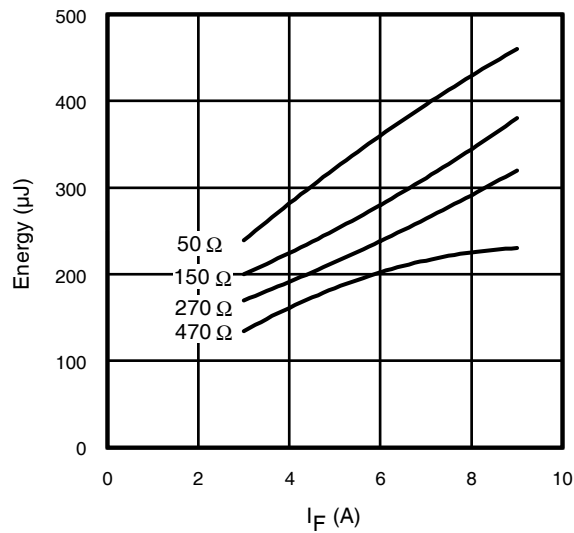


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

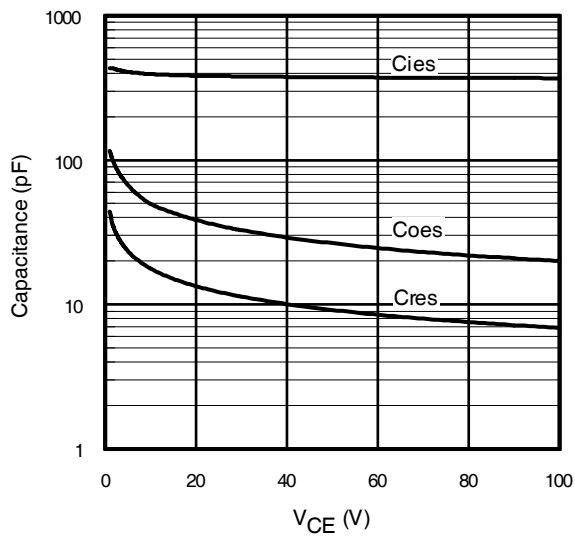


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

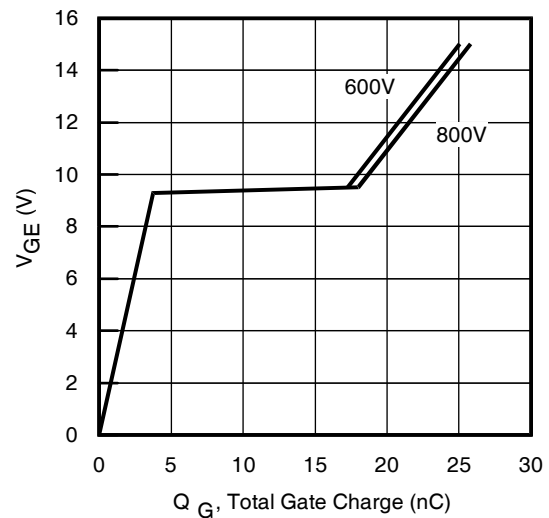


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 6.0\text{A}$; $L = 600\mu\text{H}$

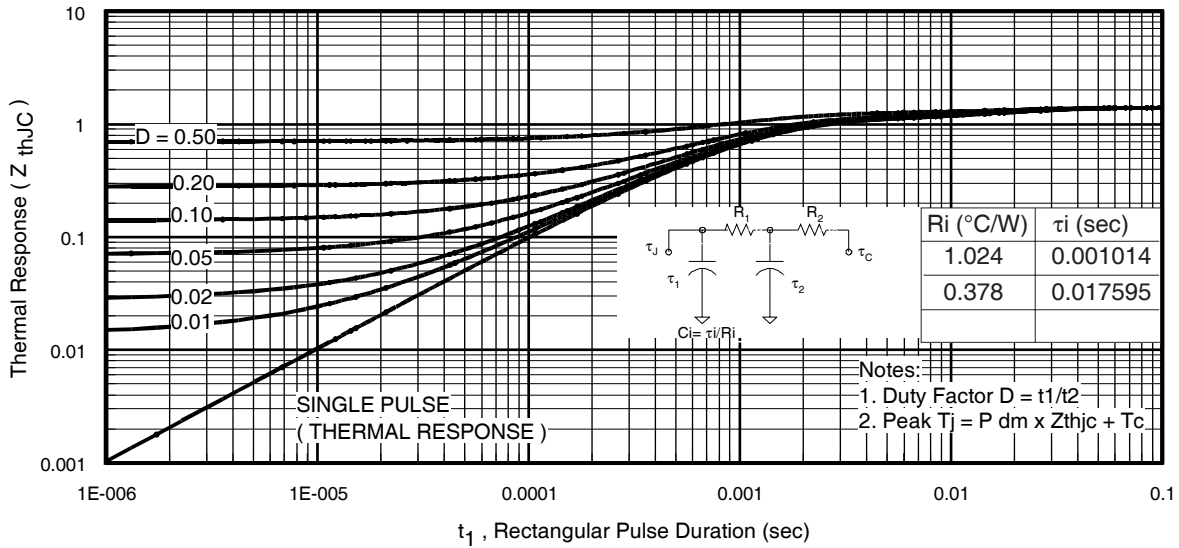


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

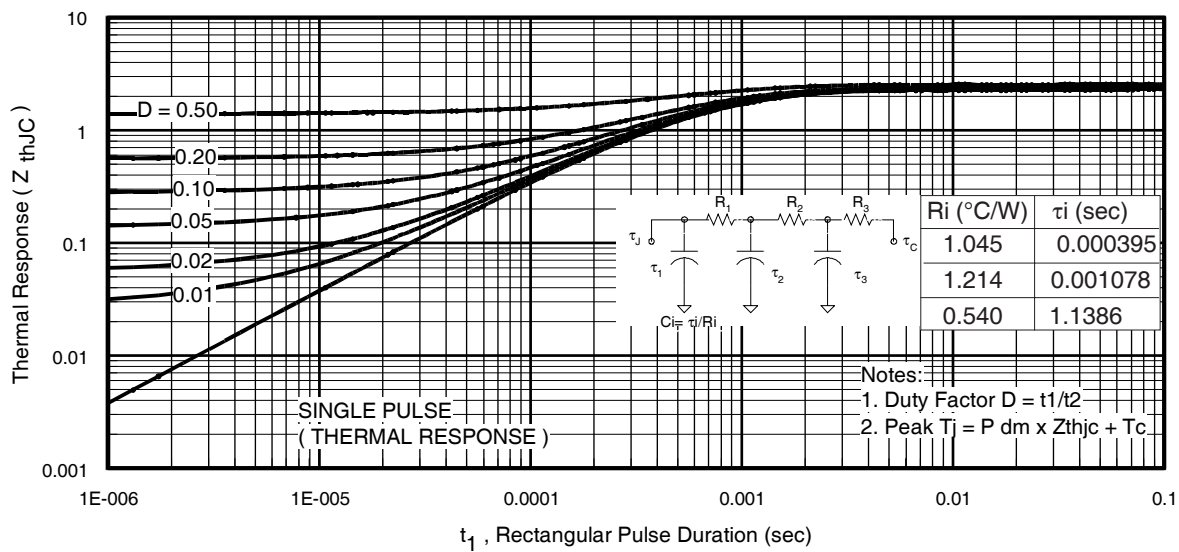


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

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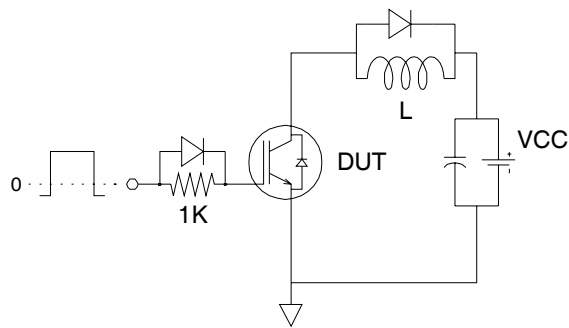


Fig.C.T.1 - Gate Charge Circuit (turn-off)

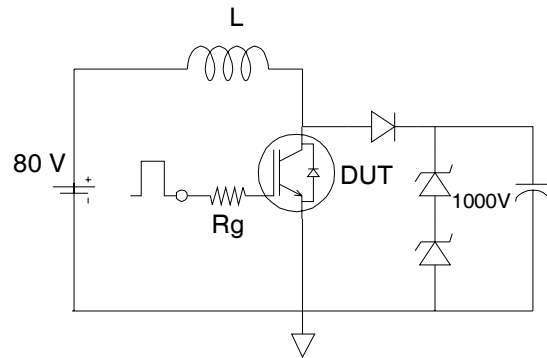


Fig.C.T.2 - RBSOA Circuit

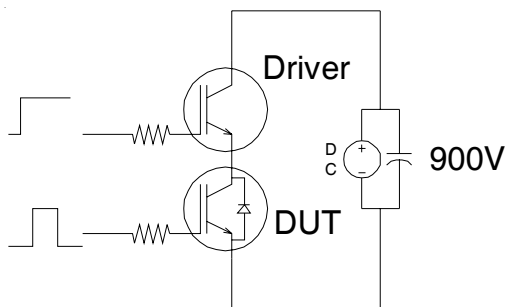


Fig.C.T.3 - S.C. SOA Circuit

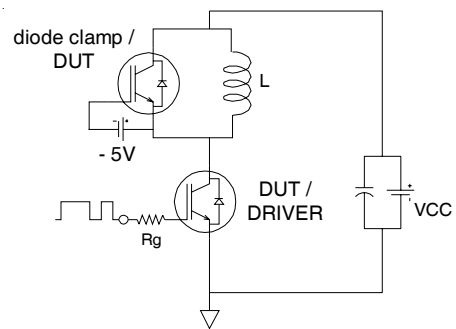


Fig.C.T.4 - Switching Loss Circuit

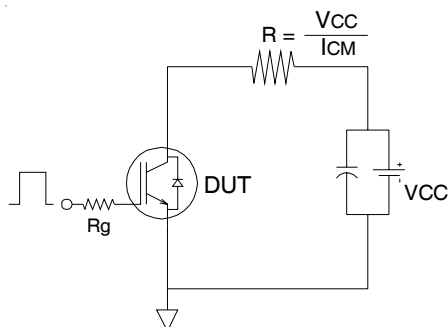


Fig.C.T.5 - Resistive Load Circuit

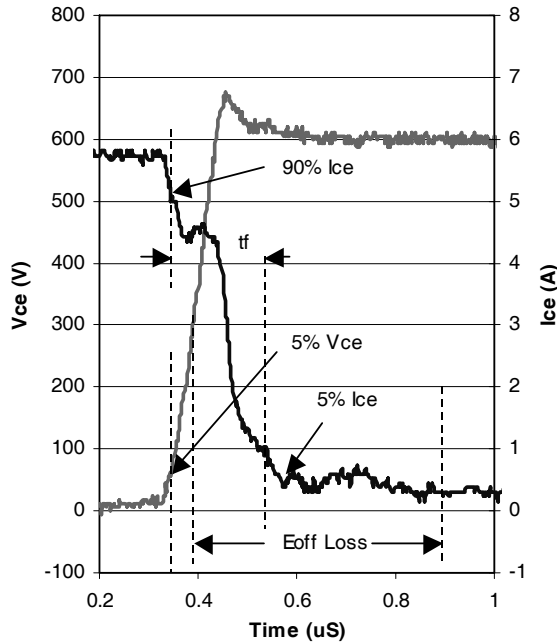


Fig.WF2-Typ. Turn-off Loss Waveform
@ $T_J = 125^\circ\text{C}$ using Fig. CT4

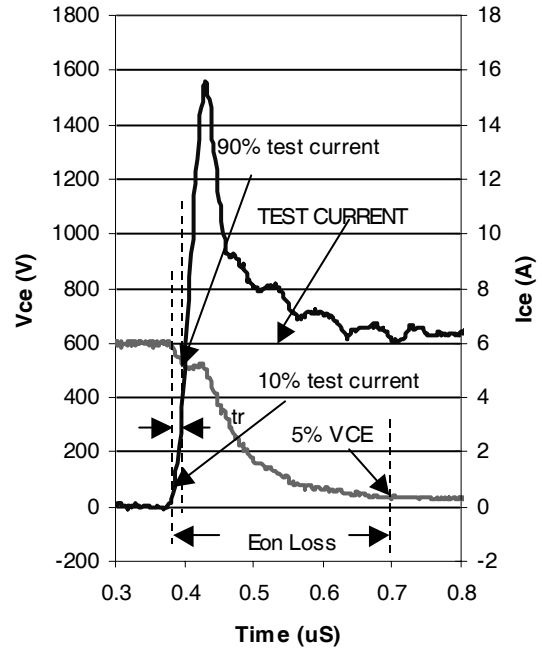


Fig.WF2-Typ. Turn-on Loss Waveform
@ $T_J = 125^\circ\text{C}$ using Fig. CT4

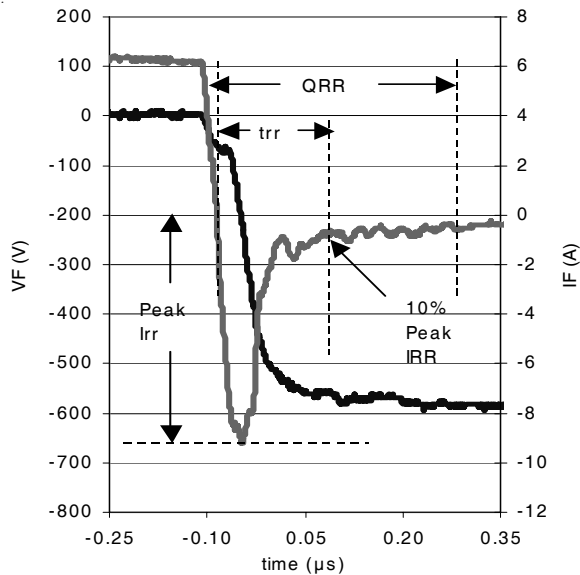


Fig.WF3-Typ. Diode Recovery Waveform
@ $T_J = 125^\circ\text{C}$ using Fig. CT4

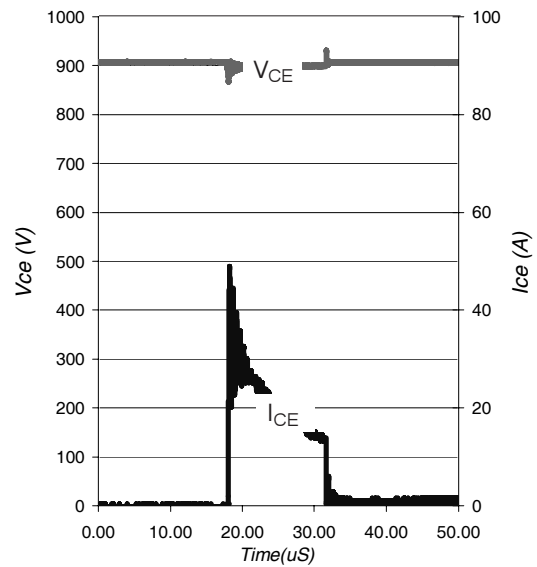


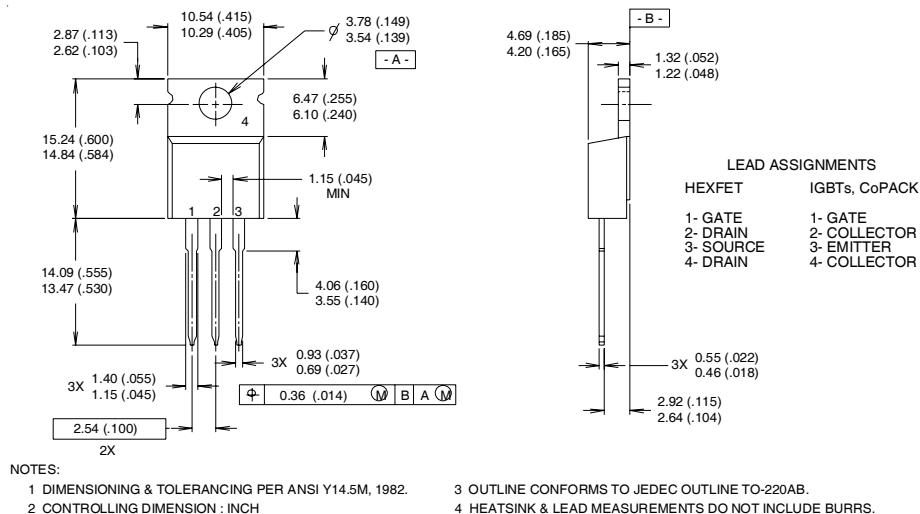
Fig.WF4-Typ. S.C. Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT3

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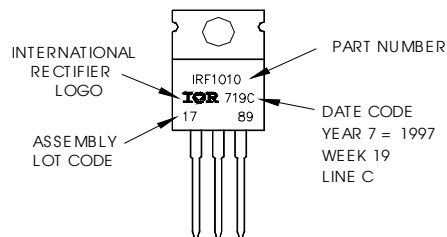
TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"
Note: "P" in assembly line
position indicates "Lead-Free"



TO-220AB package is 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.

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IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information. 08/04

www.irf.com

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