

IRGR3B60KD2PbF

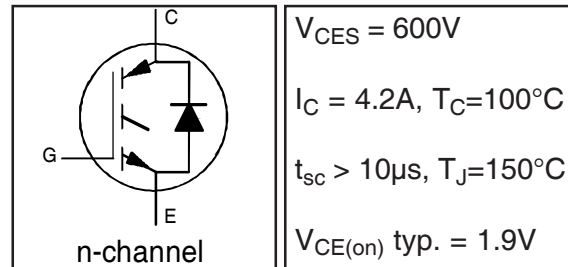
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

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.
- Lead-Free

Benefits

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



Absolute Maximum Ratings

	Parameter	Max.	Units
V _{CES}	Collector-to-Emitter Voltage	600	V
I _C @ T _C = 25°C	Continuous Collector Current	7.8	A
I _C @ T _C = 100°C	Continuous Collector Current	4.2	
I _{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	15.6	
I _{LM}	Clamped Inductive Load current ①	15.6	
I _F @ T _C = 25°C	Diode Continuous Forward Current	6.0	
I _F @ T _C = 100°C	Diode Continuous Forward Current	3.2	A
I _{FM}	Diode Maximum Forward Current	15.6	
V _{GE}	Gate-to-Emitter Voltage	±20	V
P _D @ T _C = 25°C	Maximum Power Dissipation	52	W
P _D @ T _C = 100°C	Maximum Power Dissipation	21	
T _J	Operating Junction and	-55 to +150	°C
T _{STG}	Storage Temperature Range		
	Soldering Temperature Range, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
R _{θJC}	Junction-to-Case- IGBT	—	—	2.4	°C/W
R _{θJC}	Junction-to-Case- Diode	—	—	8.8	
R _{θJA}	Junction-to-Ambient, (PCB Mount) ②	—	—	50	
Wt	Weight	—	0.3	—	g

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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	600	—	—	V	$V_{GE} = 0V, I_C = 500\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.32	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	1.9	2.4	V	$I_C = 3.0A, V_{GE} = 15V$	5,6,7
		—	2.2	2.6		$I_C = 3.0A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-8.5	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$	12
gfe	Forward Transconductance	—	1.9	—	S	$V_{CE} = 50V, I_C = 3.0A, PW = 80\mu s$	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	200	500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	1.5	1.8	V	$I_F = 3.0A, V_{GE} = 0V$	8
		—	1.5	1.8		$I_F = 3.0A, V_{GE} = 0V, T_J = 150^\circ\text{C}$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V, V_{CE} = 0V$	

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)	—	13	20	nC	$I_C = 3.0A$	23
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	1.5	2.3		$V_{CC} = 400V$	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	6.6	9.9		$V_{GE} = 15V$	
E_{on}	Turn-On Switching Loss	—	62	75	μJ	$I_C = 3.0A, V_{CC} = 400V$	CT4
E_{off}	Turn-Off Switching Loss	—	39	50		$V_{GE} = 15V, R_G = 100\Omega, L = 2.5mH$	
E_{tot}	Total Switching Loss	—	100	120		$T_J = 25^\circ\text{C}$ ③	
$t_{d(on)}$	Turn-On delay time	—	18	22	ns	$I_C = 3.0A, V_{CC} = 400V$	CT4
t_r	Rise time	—	15	21		$V_{GE} = 15V, R_G = 100\Omega, L = 2.5mH$	
$t_{d(off)}$	Turn-Off delay time	—	110	120		$T_J = 25^\circ\text{C}$	
t_f	Fall time	—	68	80			
E_{on}	Turn-On Switching Loss	—	91	100	μJ	$I_C = 3.0A, V_{CC} = 400V$	CT4
E_{off}	Turn-Off Switching Loss	—	98	140		$V_{GE} = 15V, R_G = 100\Omega, L = 2.5mH$	13,15
E_{tot}	Total Switching Loss	—	190	230		$T_J = 150^\circ\text{C}$ ③	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	18	22	ns	$I_C = 3.0A, V_{CC} = 400V$	14,16
t_r	Rise time	—	17	22		$V_{GE} = 15V, R_G = 100\Omega, L = 2.5mH$	CT4
$t_{d(off)}$	Turn-Off delay time	—	120	140		$T_J = 150^\circ\text{C}$	WF1
t_f	Fall time	—	91	105			WF2
C_{ies}	Input Capacitance	—	190	—	pF	$V_{GE} = 0V$	22
C_{oes}	Output Capacitance	—	23	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	6.6	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 15.6A, V_p = 600V$ $V_{CC}=500V, V_{GE}=+15V \text{ to } 0V, R_G = 100\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_p = 600V, R_G = 100\Omega$ $V_{CC}=360V, V_{GE} = +15V \text{ to } 0V$	CT3 WF4
Erec	Reverse Recovery Energy of the Diode	—	38	44	μJ	$T_J = 150^\circ\text{C}$	17,18,19
t_{rr}	Diode Reverse Recovery Time	—	77	84	ns	$V_{CC} = 400V, I_F = 3.0A, L = 2.5mH$	20,21
I_{rr}	Diode Peak Reverse Recovery Current	—	4.8	5.3	A	$V_{GE} = 15V, R_G = 100\Omega$	CT4,WF3

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

③ Energy losses include "tail" and diode reverse recovery.

② When mounted on 1" square PCB (FR-4 or G-10 Material) . For recommended footprint and soldering techniques refer to application note #AN-994.

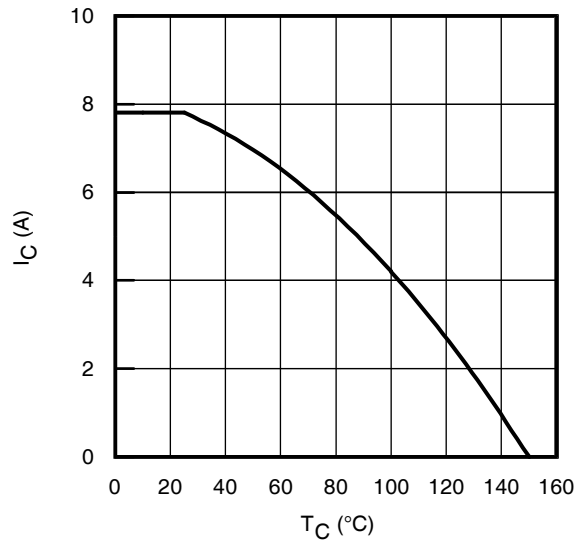


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

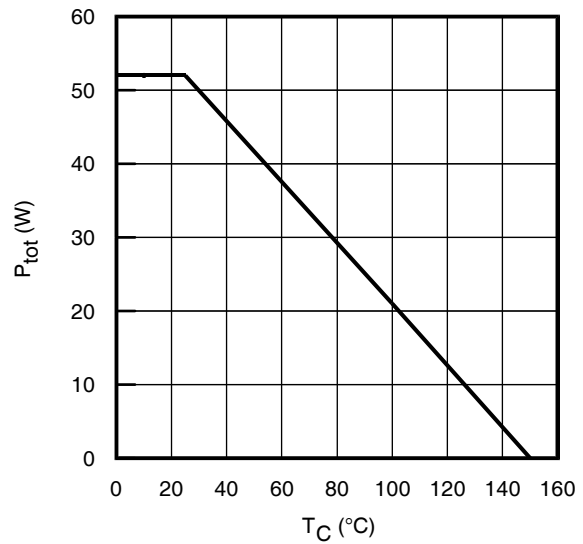


Fig. 2 - Power Dissipation vs. Case Temperature

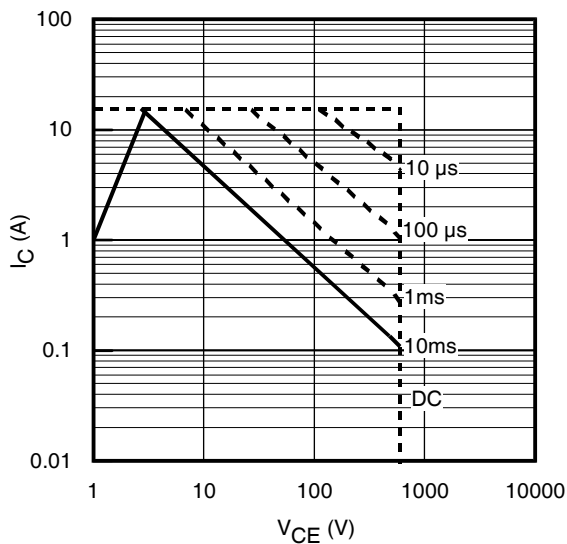


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}\text{C}$; $T_J \leq 150^{\circ}\text{C}$

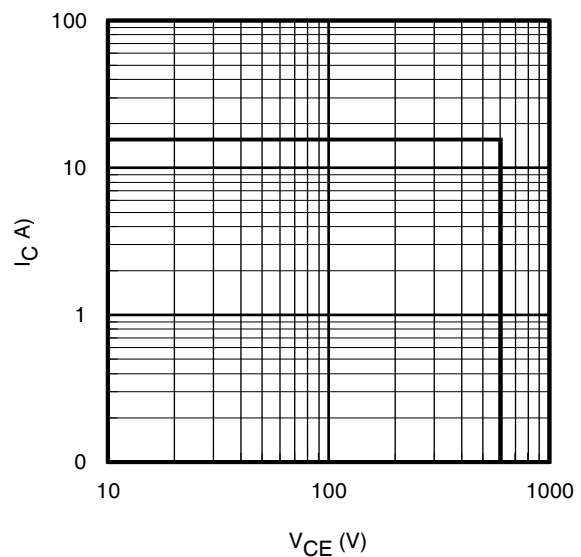


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}\text{C}$; $V_{GE} = 15\text{V}$

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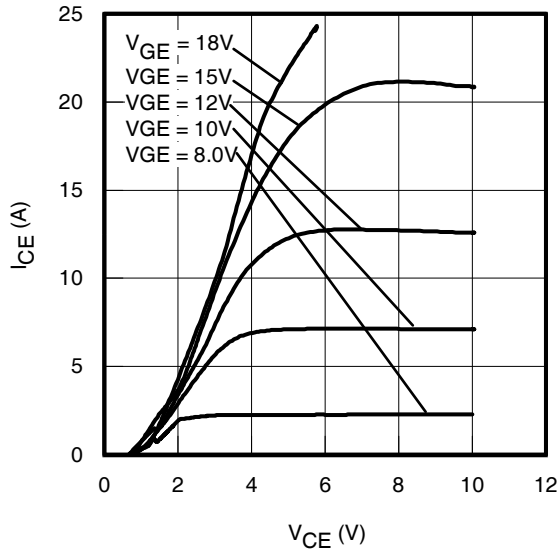


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

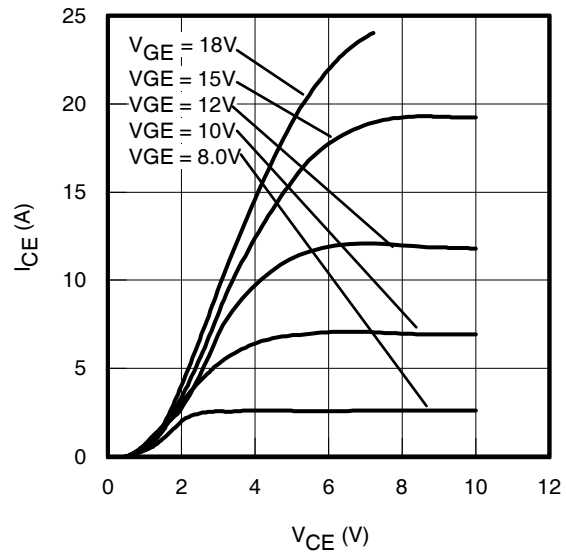


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

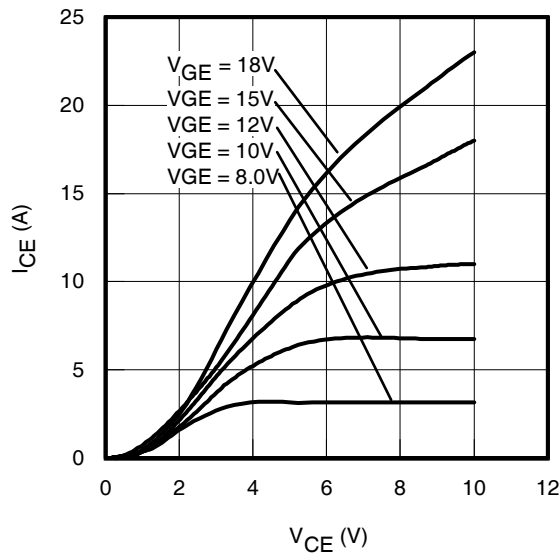


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^{\circ}\text{C}$; $t_p = 80\mu\text{s}$

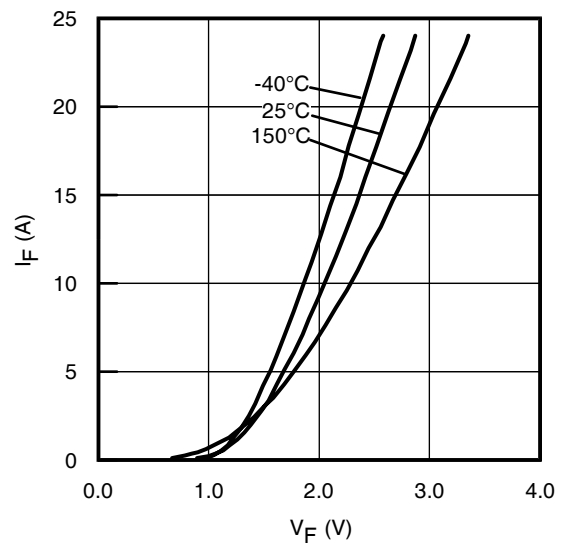


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

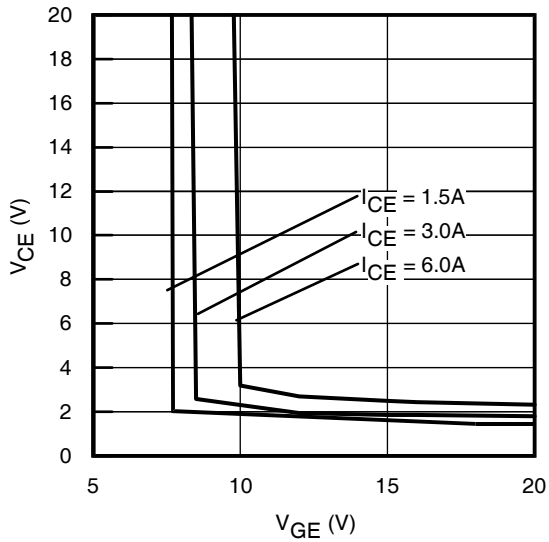


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

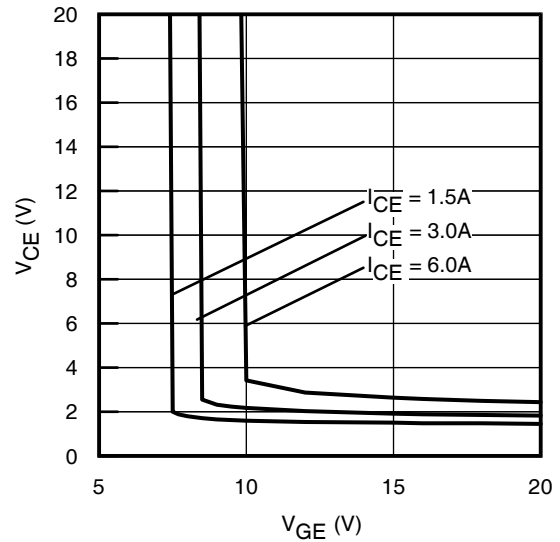


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

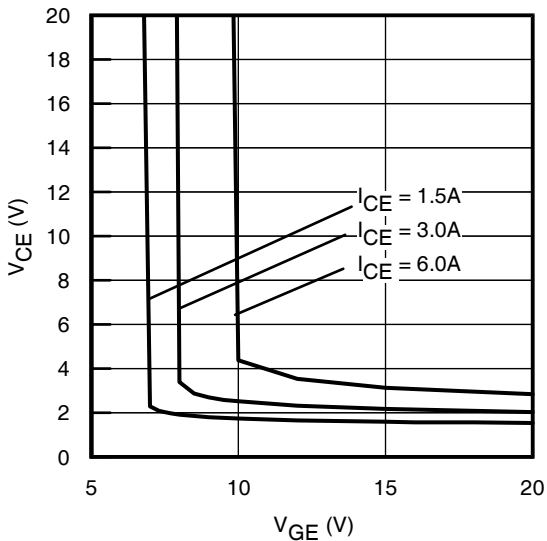


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

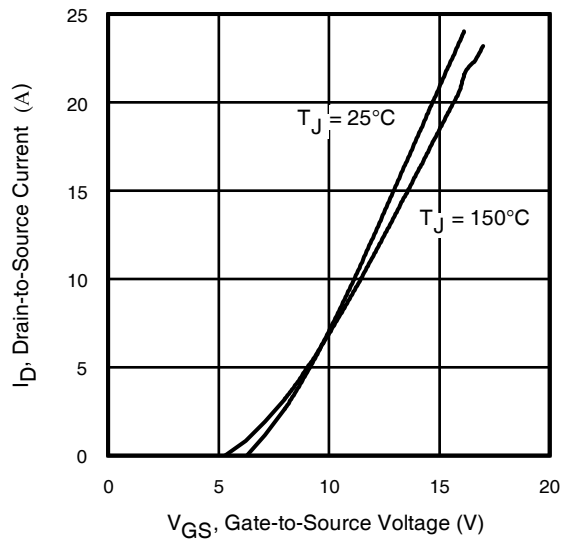


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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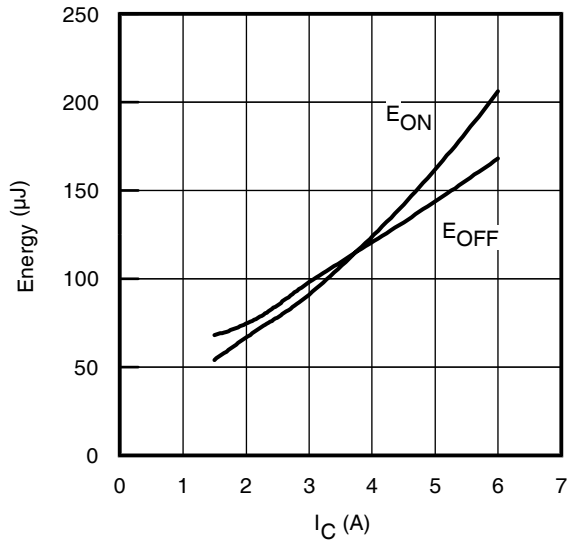


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 2.5\text{mH}$; $V_{CE} = 400\text{V}$
 $R_G = 100\Omega$; $V_{GE} = 15\text{V}$

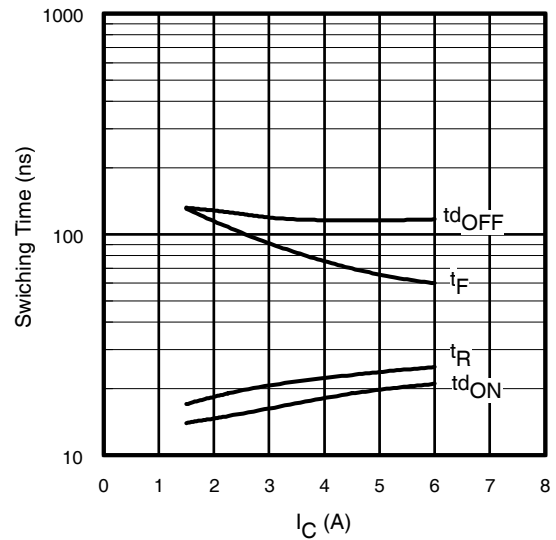


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 2.5\text{mH}$; $V_{CE} = 400\text{V}$
 $R_G = 100\Omega$; $V_{GE} = 15\text{V}$

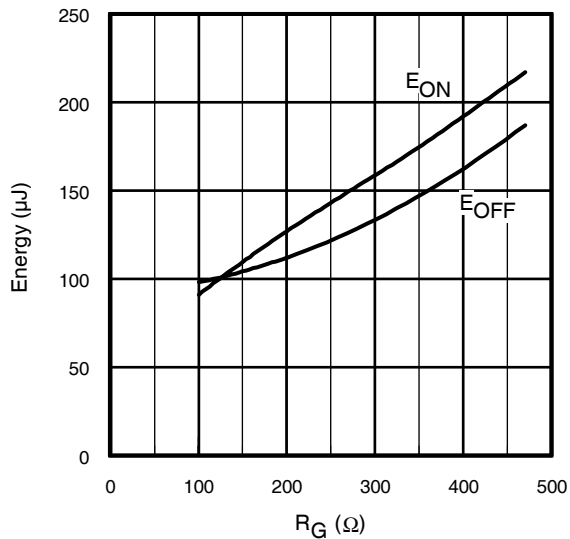


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 2.5\text{mH}$; $V_{CE} = 400\text{V}$
 $I_{CE} = 3.0\text{A}$; $V_{GE} = 15\text{V}$

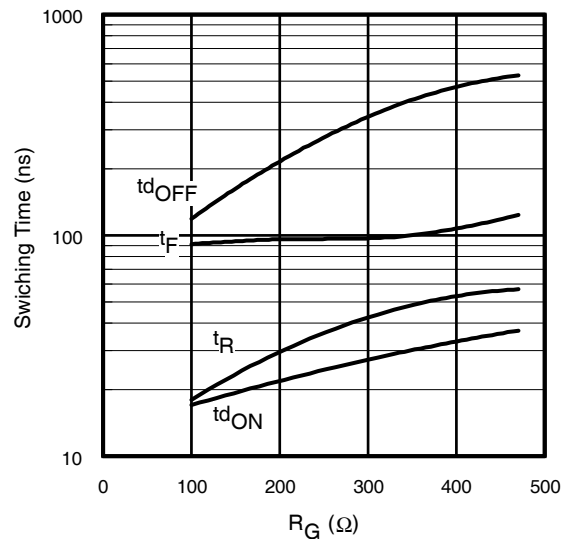


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 2.5\text{mH}$; $V_{CE} = 400\text{V}$
 $I_{CE} = 3.0\text{A}$; $V_{GE} = 15\text{V}$

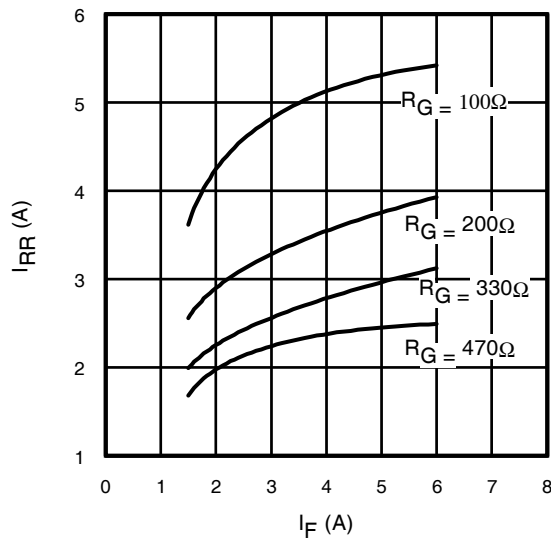


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

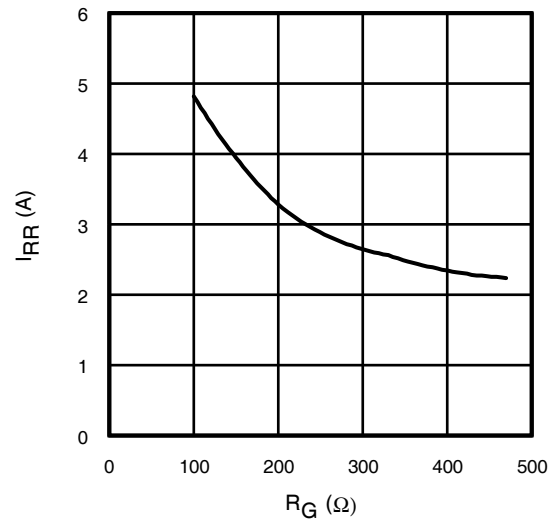


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150^\circ\text{C}$; $I_F = 3.0\text{A}$

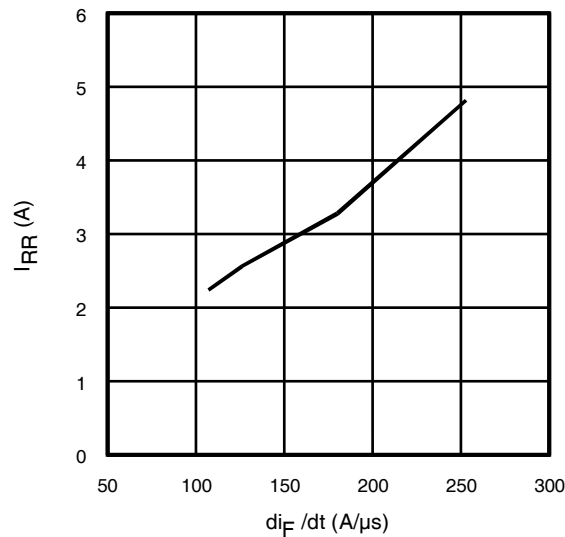


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$;
 $I_F = 3.0\text{A}$; $T_J = 150^\circ\text{C}$

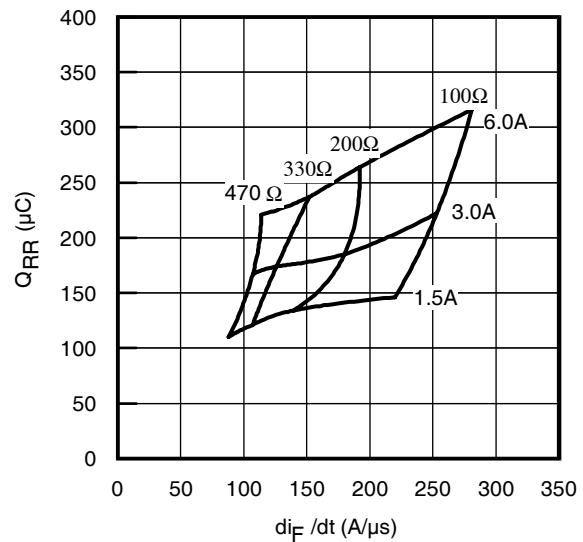


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 150^\circ\text{C}$

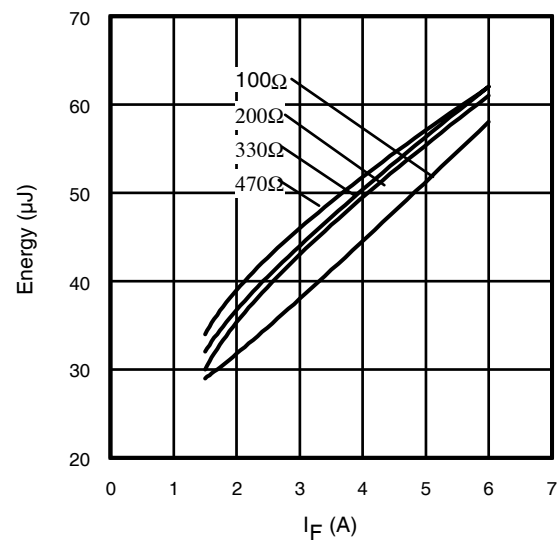


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

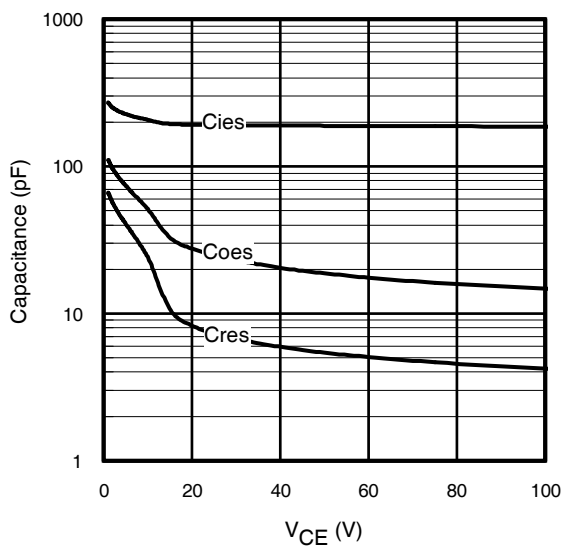


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

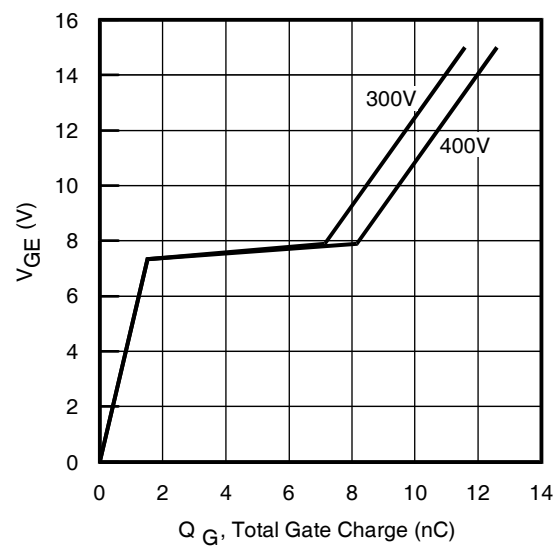


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 3.0\text{A}$; $L = 600\mu\text{H}$

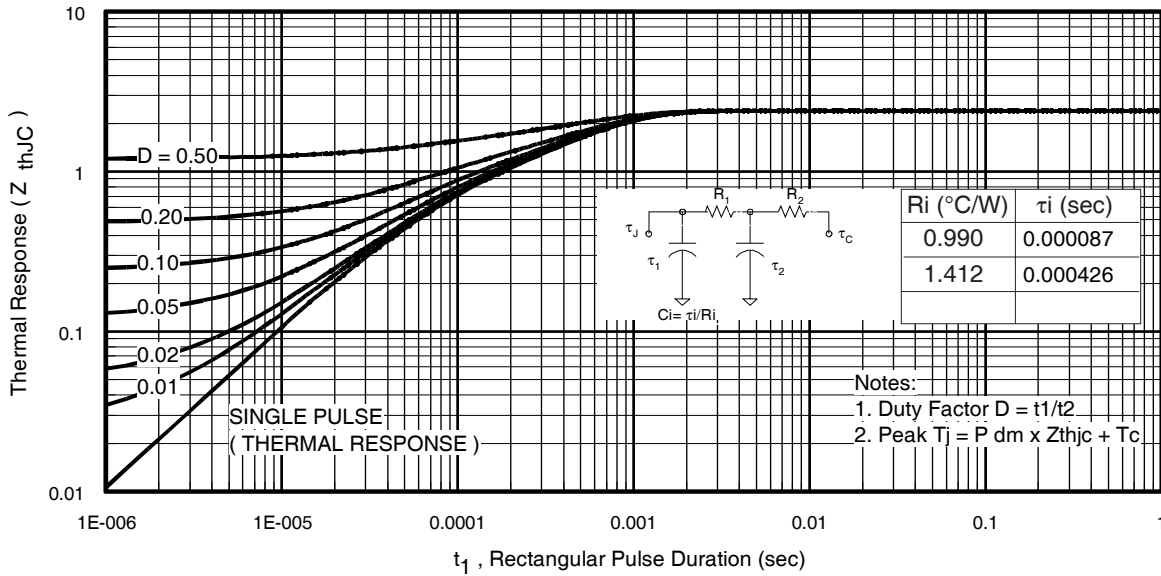


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

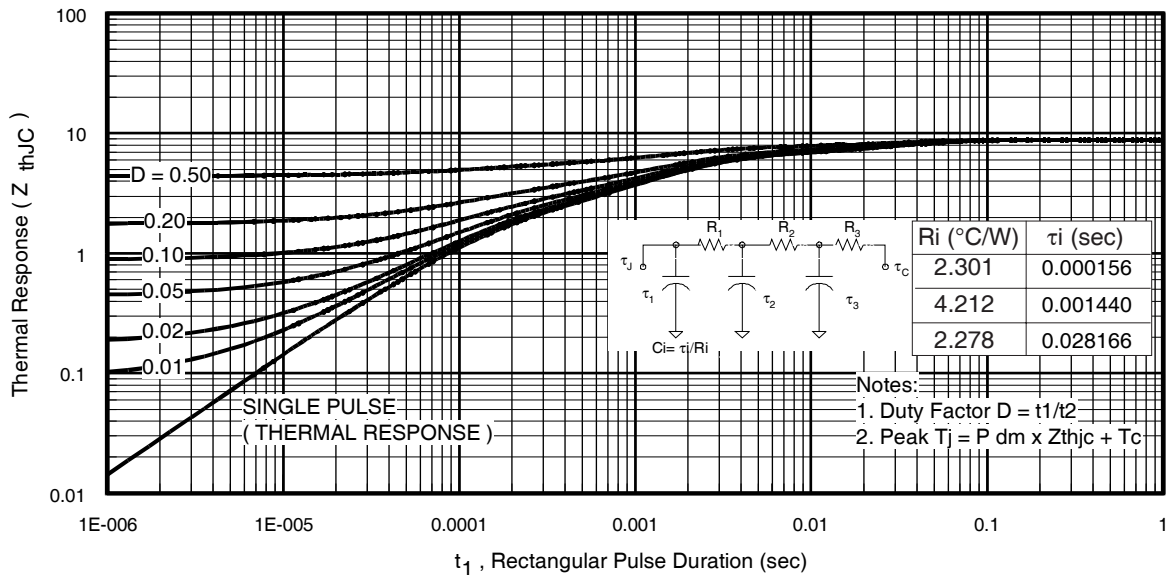


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

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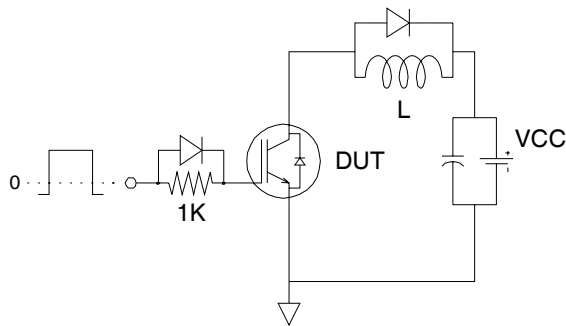


Fig.C.T.1 - Gate Charge Circuit (turn-off)

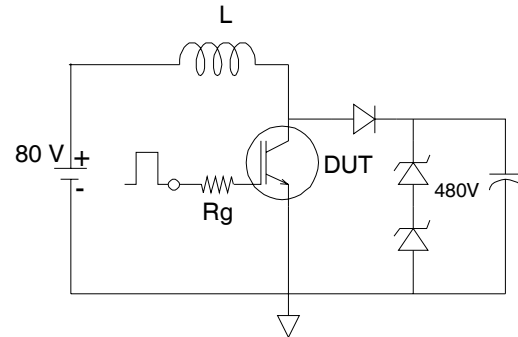


Fig.C.T.2 - RBSOA Circuit

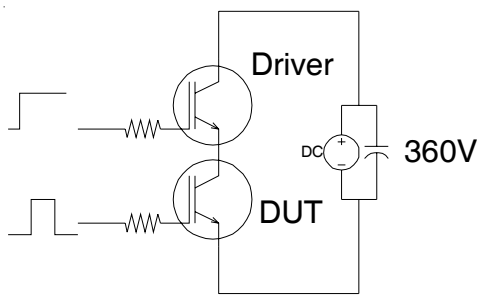


Fig.C.T.3 - S.C.SOA Circuit

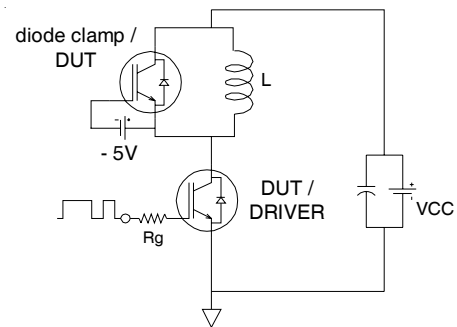


Fig.C.T.4 - Switching Loss Circuit

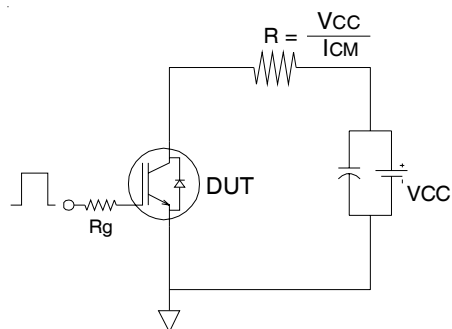


Fig.C.T.5 - Resistive Load Circuit

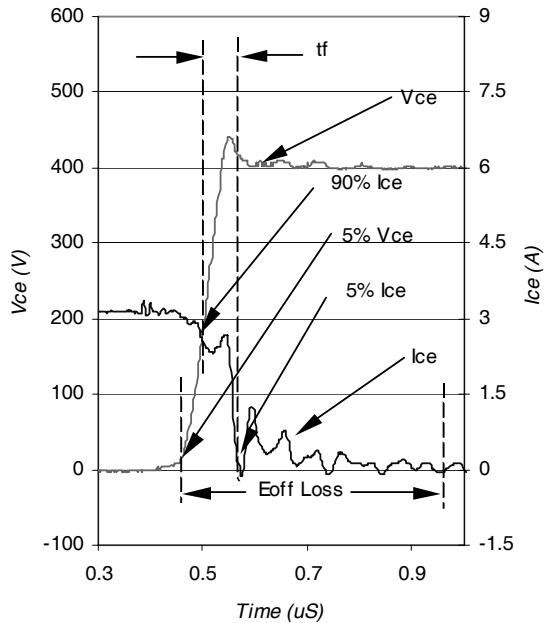


Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

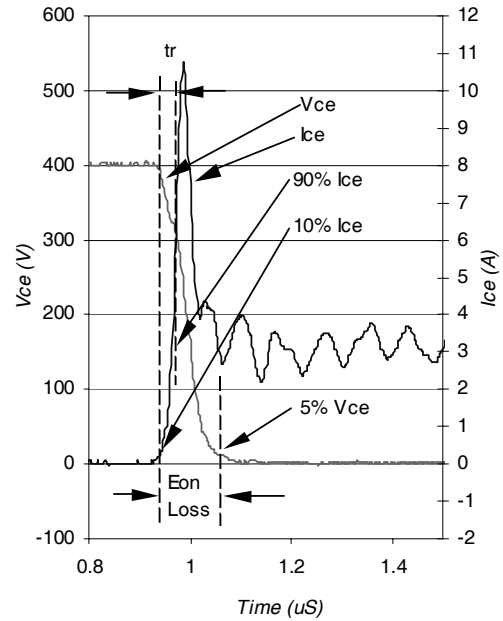


Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

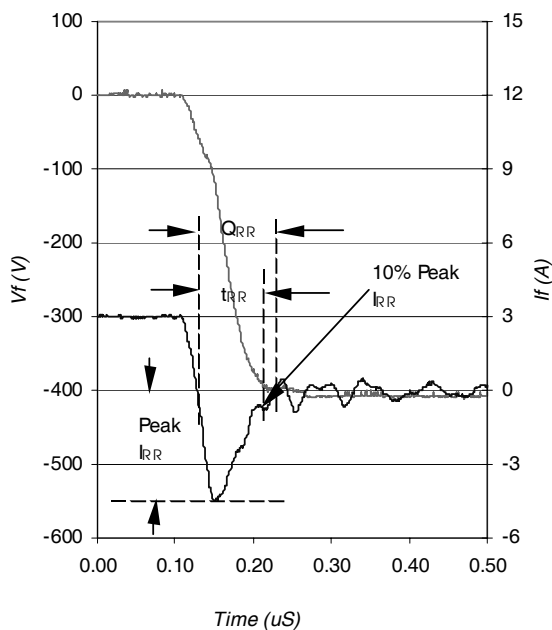


Fig. WF3- Typ. Diode Recovery Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

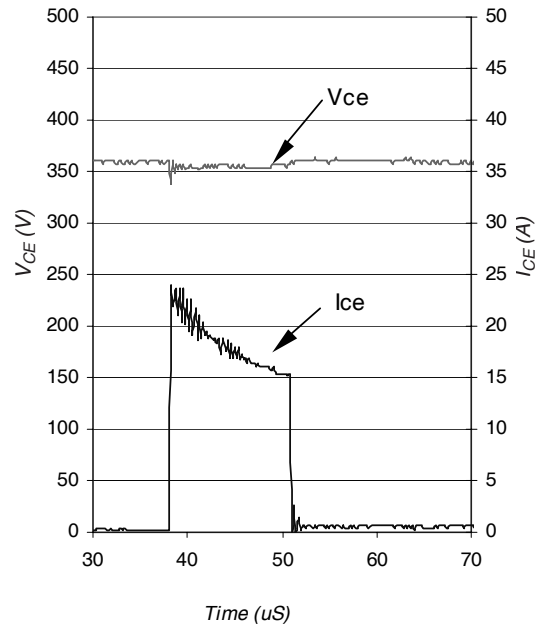


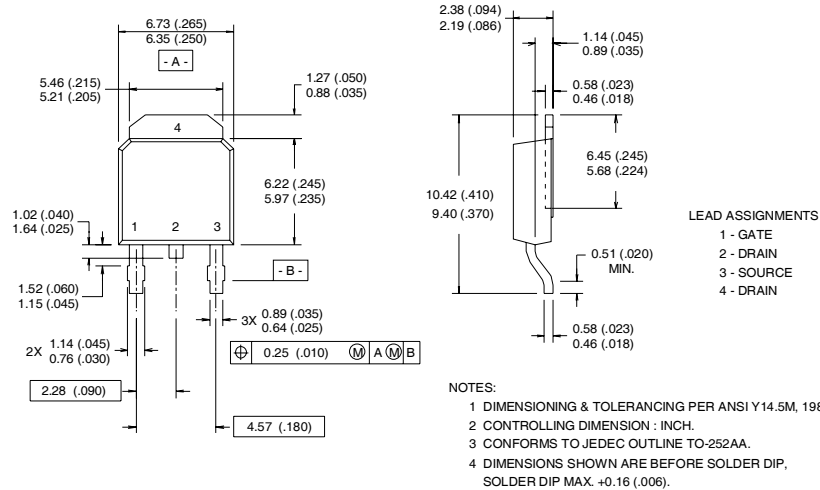
Fig. WF4- Typ. S.C Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT.3

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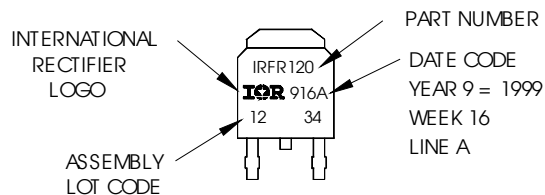
D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)

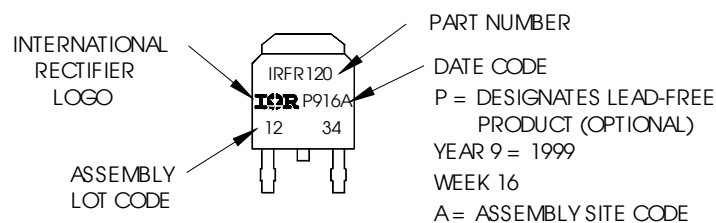


D-Pak (TO-252AA) Part Marking Information (Lead-Free)

EXAMPLE: THIS IS AN IRFR120
WITH ASSEMBLY
LOT CODE 1234
ASSEMBLED ON VW 16, 1999
IN THE ASSEMBLY LINE "A"
Note: "P" in assembly line
position indicates "Lead-Free"

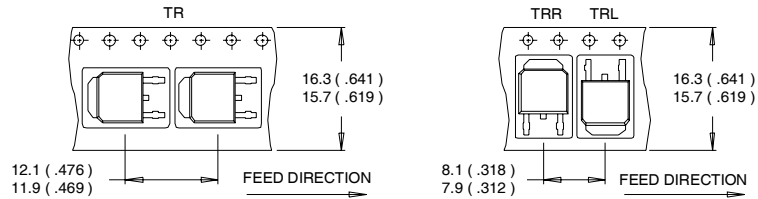


OR



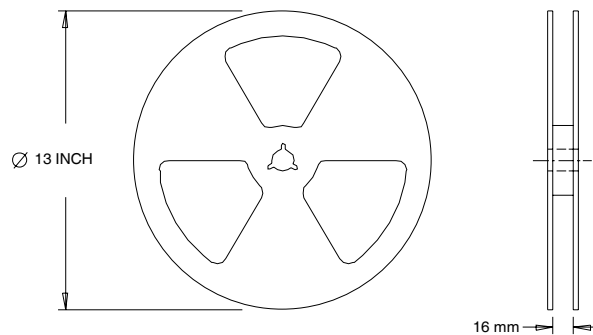
D-Pak (TO-252AA) Tape & Reel Information

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.

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

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TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information.02/04

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