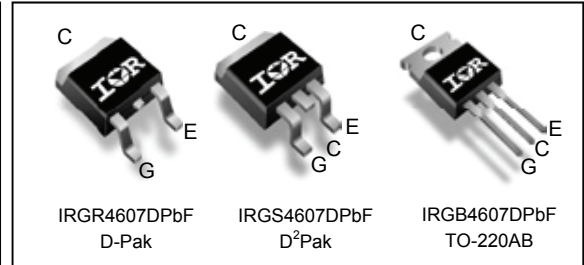
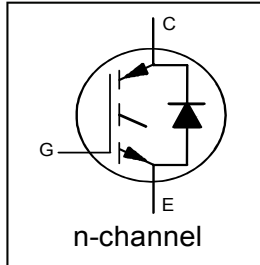


$V_{CES} = 600V$
$I_C = 7.0A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(ON)} \text{ typ.} = 1.75V @ I_C = 4.0A$

Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode



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
$5\mu s$ Short Circuit SOA		Rugged Transient Performance
Square RBSOA		
Maximum Junction Temperature $175^\circ C$		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	D²Pak	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
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	11	A
$I_C @ T_C = 100^\circ C$	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	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	8.0	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	5.0	V
I_{FM}	Diode Maximum Forward Current ④	16	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	58	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	29	
T_J	Operating Junction and Storage Temperature Range	-40 to +175	°C
T_{STG}			
	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 @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.52	—	V/°C	$V_{GE} = 0V, I_C = 100\mu A$ (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.75	2.05	V	$I_C = 4.0A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.15	—		$I_C = 4.0A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
		—	2.20	—		$I_C = 4.0A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 100\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage Temperature Coeff.	—	-19	—	mV/°C	$V_{CE} = V_{GE}, I_C = 100\mu A$ (25°C-175°C)
g_{fe}	Forward Transconductance	—	2.2	—	S	$V_{CE} = 50V, I_C = 4.0A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	0.50	25	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	100	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$
V_F	Diode Forward Voltage Drop	—	1.7	2.3	V	$I_F = 4.0A$
		—	1.5	—		$I_F = 4.0A, T_J = 175^\circ\text{C}$

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

	Parameter	Min.	Typ.	Max	Units	Conditions
Q_g	Total Gate Charge	—	9.0	—	nC	$I_C = 4.0\text{A}$ $V_{GE} = 15\text{V}$ $V_{CC} = 300\text{V}$
Q_{ge}	Gate-to-Emitter Charge	—	3.0	—		
Q_{gc}	Gate-to-Collector Charge	—	4.0	—		
E_{on}	Turn-On Switching Loss	—	140	—	μJ	$I_C = 4.0\text{A}$, $V_{CC} = 400\text{V}$, $V_{GE} = 15\text{V}$ $R_G = 100\Omega$, $T_J = 25^\circ\text{C}$
E_{off}	Turn-Off Switching Loss	—	62	—		
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	$I_C = 4.0\text{A}$, $V_{CC} = 400\text{V}$, $V_{GE} = 15\text{V}$ $R_G = 100\Omega$, $T_J = 175^\circ\text{C}$
E_{off}	Turn-Off Switching Loss	—	92	—		
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	$V_{GE} = 0\text{V}$ $V_{CC} = 30\text{V}$ $f = 1.0\text{Mhz}$
C_{oes}	Output Capacitance	—	20	—		
C_{res}	Reverse Transfer Capacitance	—	7.1	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}$, $I_C = 16\text{A}$ $V_{CC} = 480\text{V}$, $V_p \leq 600\text{V}$ $V_{GE} = +20\text{V to } 0\text{V}$
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400\text{V}$, $V_p \leq 600\text{V}$ $V_{GE} = +15\text{V to } 0\text{V}$
E_{rec}	Reverse Recovery Energy of the Diode	—	7.4	—	μJ	$T_J = 175^\circ\text{C}$
t_{rr}	Diode Reverse Recovery Time	—	48	—	ns	$V_{CC} = 400\text{V}$, $I_F = 4.0\text{A}$
I_{rr}	Peak Reverse Recovery Current	—	5.1	—	A	$V_{GE} = 15\text{V}$, $R_g = 100\Omega$

Notes:

- ① $V_{CC} = 80\%$ (V_{CES}), $V_{GE} = 20\text{V}$.
- 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>

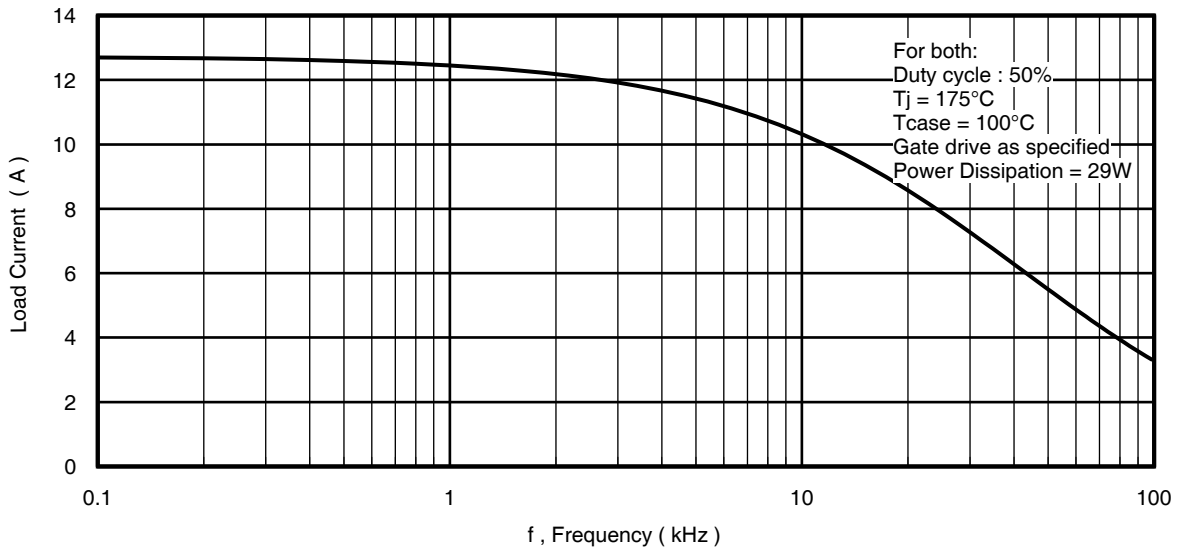


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

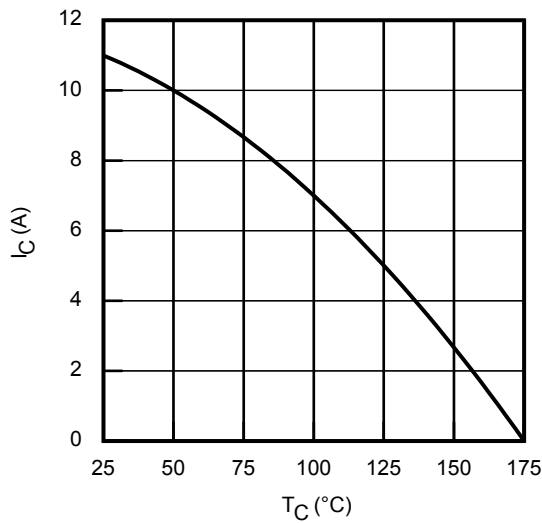


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

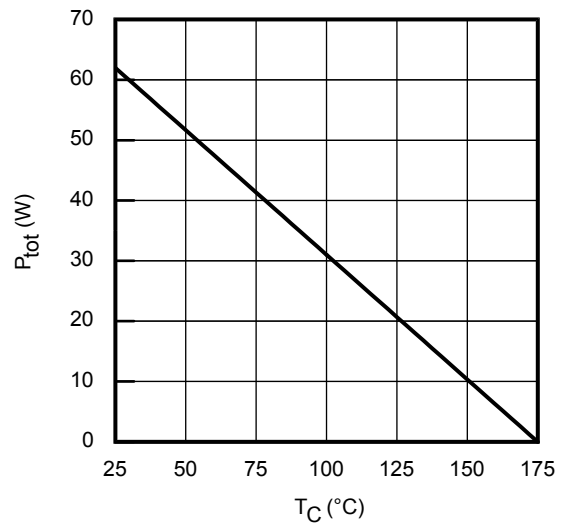


Fig. 3 - Power Dissipation vs. Case Temperature

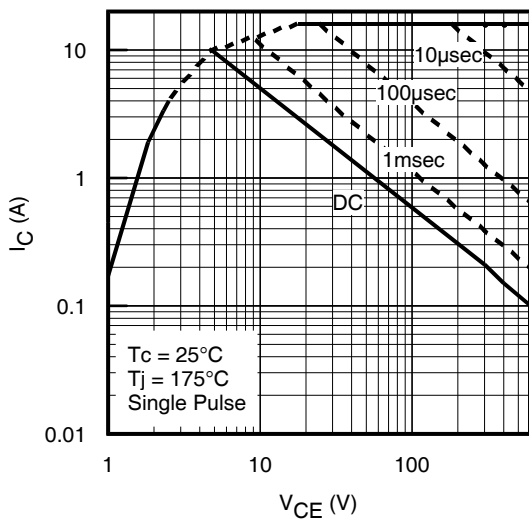


Fig. 4 - Forward SOA
 $T_C = 25^\circ\text{C}; T_J \leq 175^\circ\text{C}; V_{GE} = 15\text{V}$

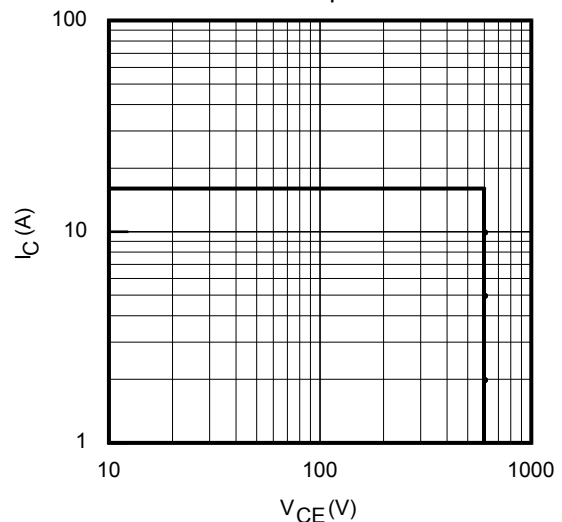


Fig. 5 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}; V_{GE} = 20\text{V}$

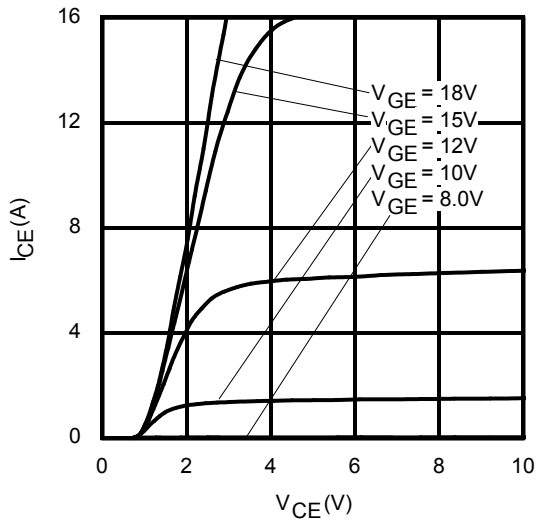


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 20\mu\text{s}$

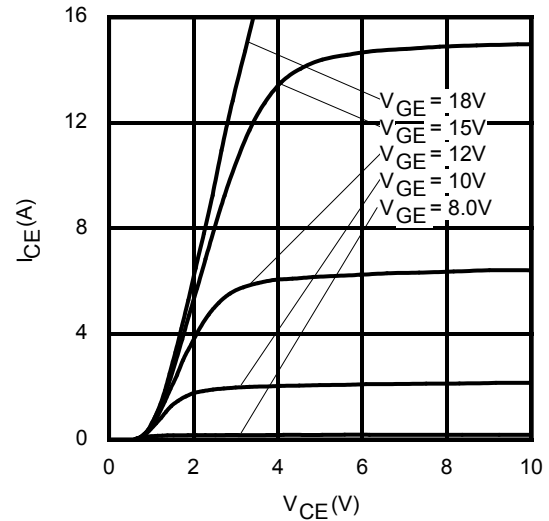


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 20\mu\text{s}$

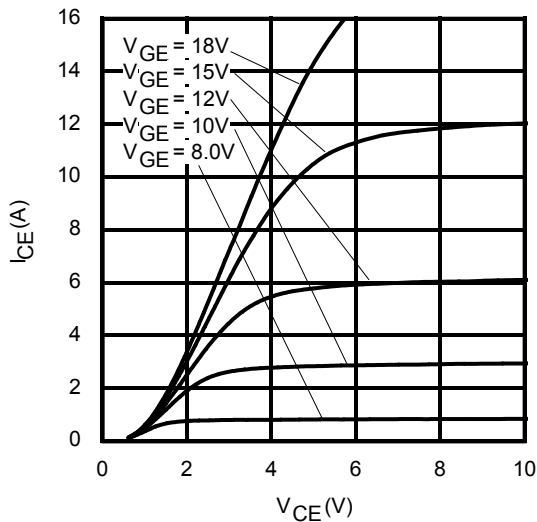


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 20\mu\text{s}$

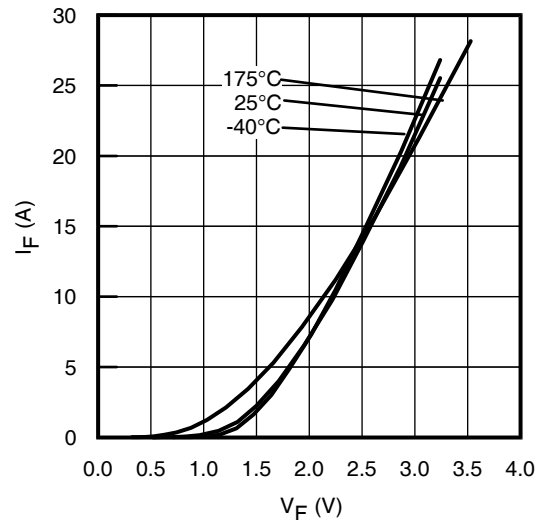


Fig. 9 - Typ. Diode Forward Voltage Drop Characteristics

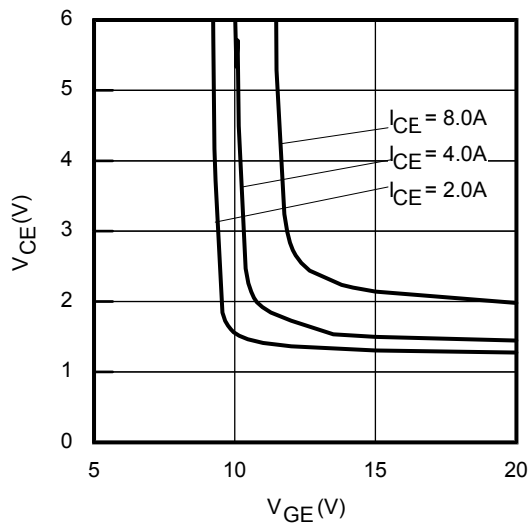


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

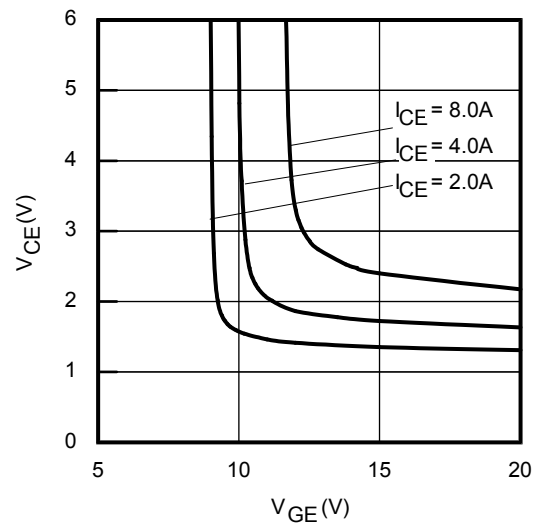


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

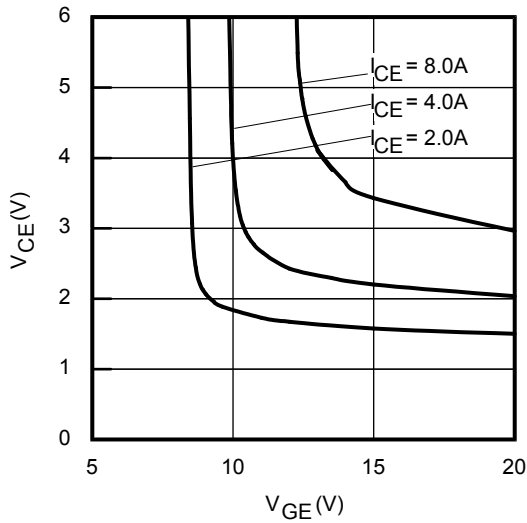


Fig. 12 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

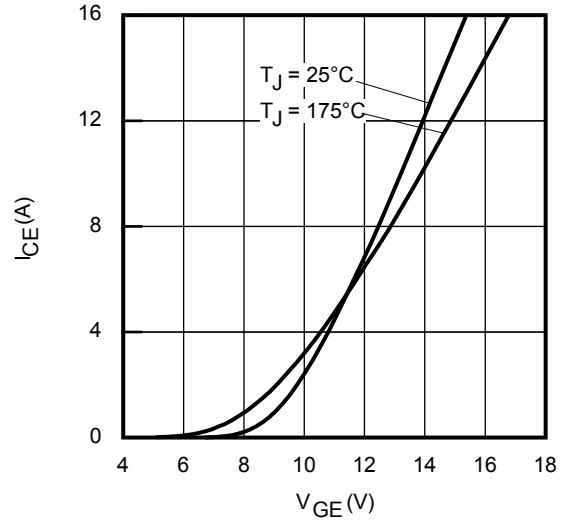


Fig. 13 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

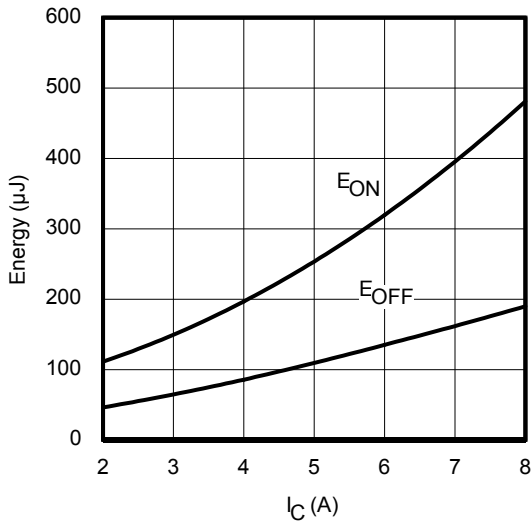


Fig. 14 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $R_G = 100\Omega$; $V_{GE} = 15\text{V}$

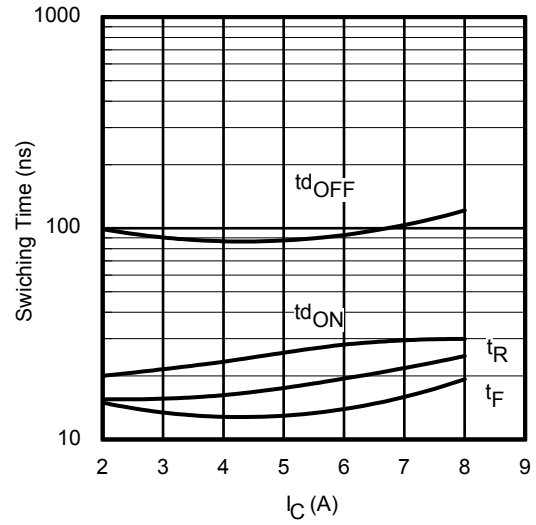


Fig. 15 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $R_G = 100\Omega$; $V_{GE} = 15\text{V}$

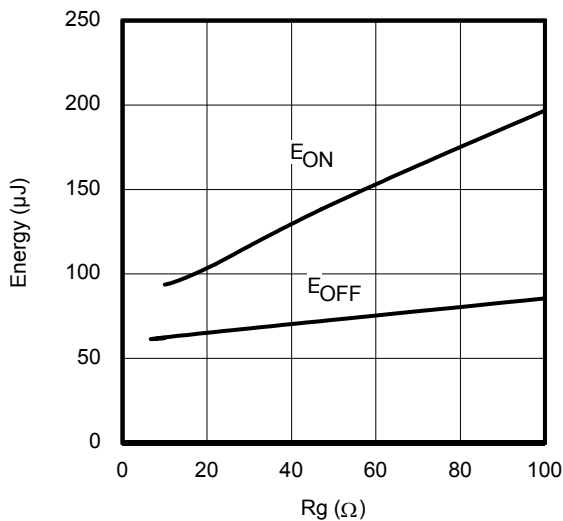


Fig. 16 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $I_{CE} = 4.0\text{A}$; $V_{GE} = 15\text{V}$

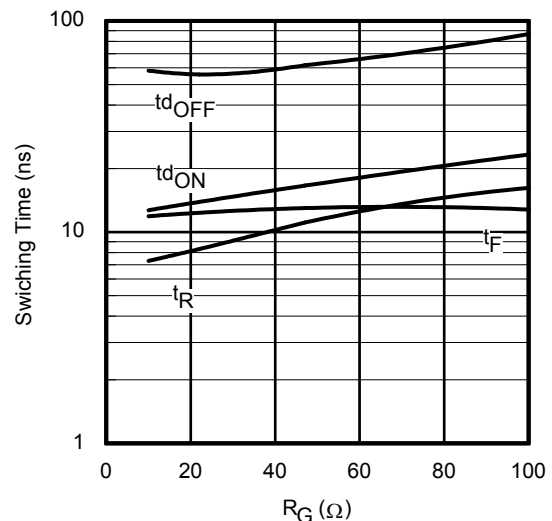


Fig. 17 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $I_{CE} = 4.0\text{A}$; $V_{GE} = 15\text{V}$

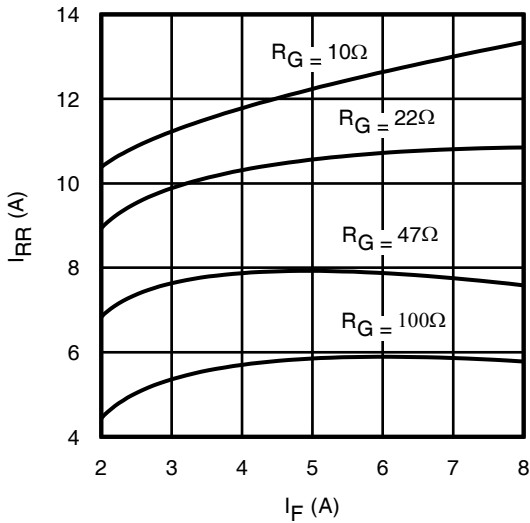


Fig. 18 - Typ. Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

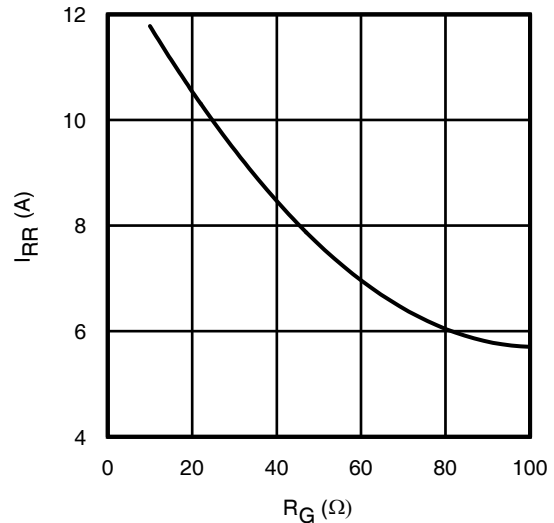


Fig. 19 - Typ. Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$

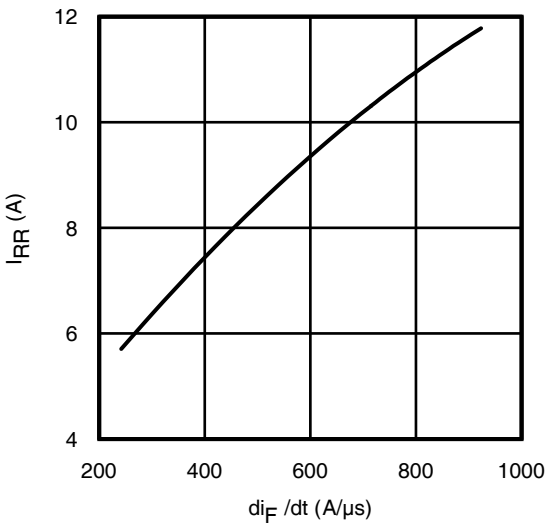


Fig. 20 - Typ. Diode I_{RR} vs. di_F/dt

$V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $I_F = 4.0\text{A}$; $T_J = 175^\circ\text{C}$

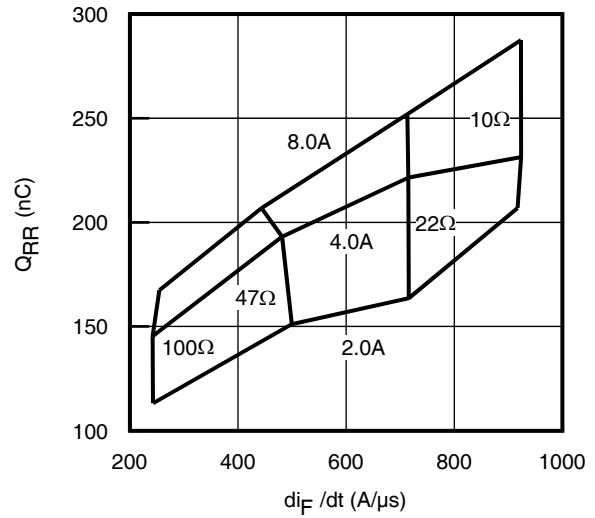


Fig. 21 - Typ. Diode Q_{RR} vs. di_F/dt

$V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 175^\circ\text{C}$

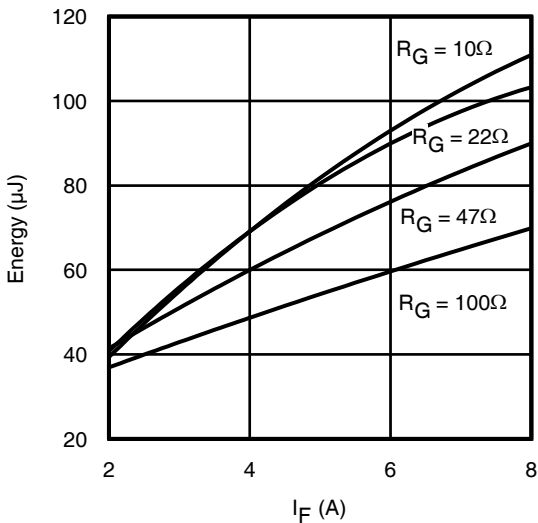


Fig. 22 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

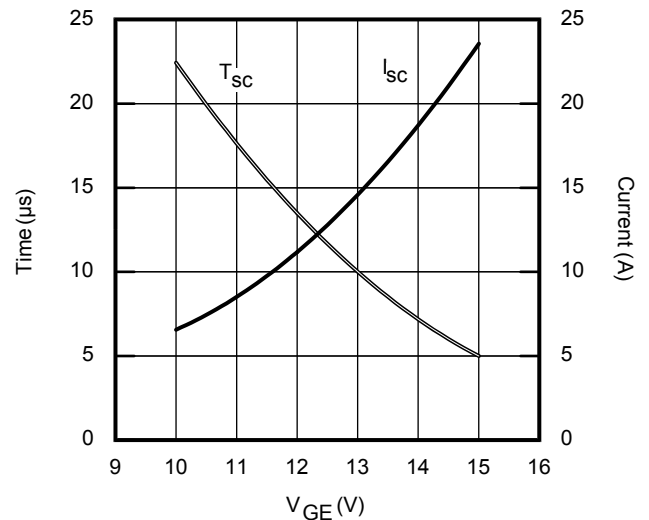


Fig. 23 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400\text{V}$; $T_C = 25^\circ\text{C}$

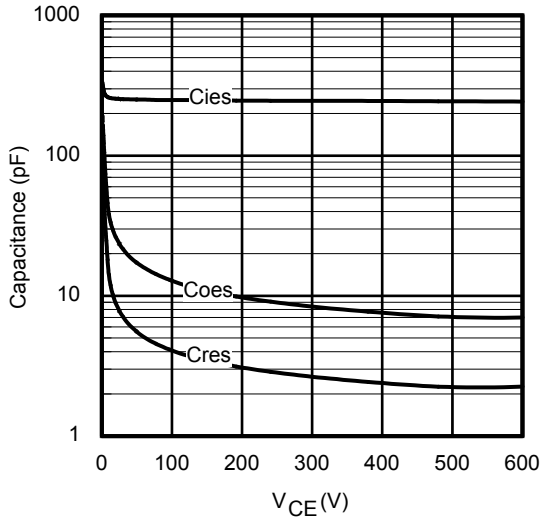


Fig. 24 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

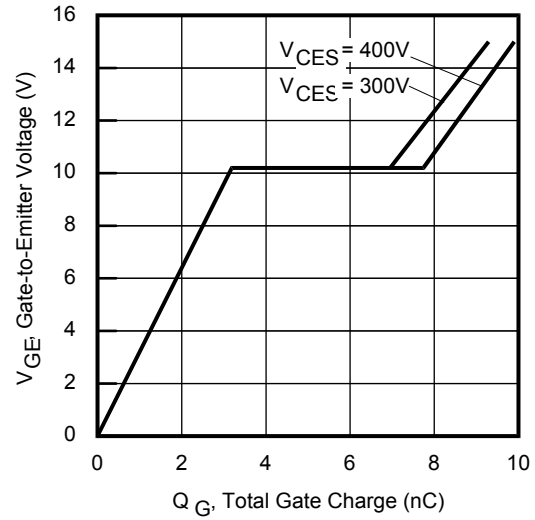


Fig. 25 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 4.0A$

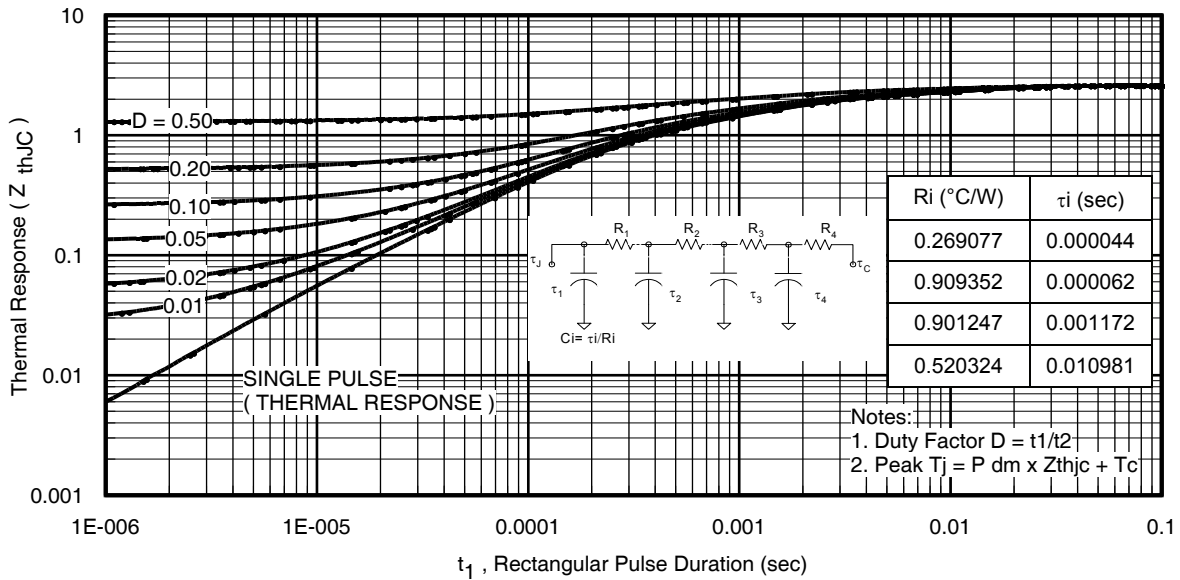


Fig. 26 - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

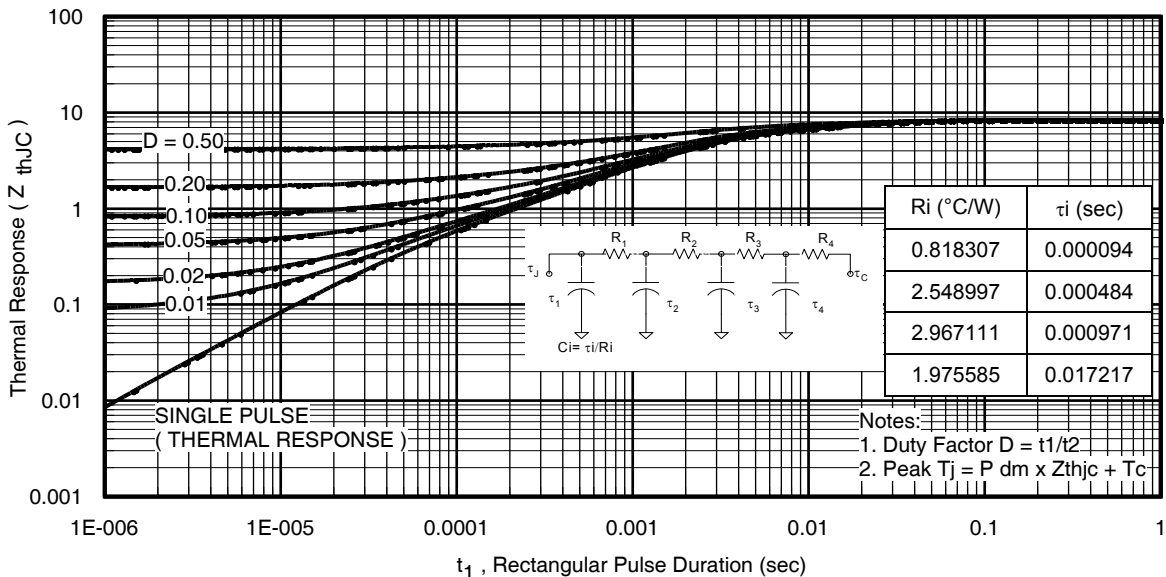
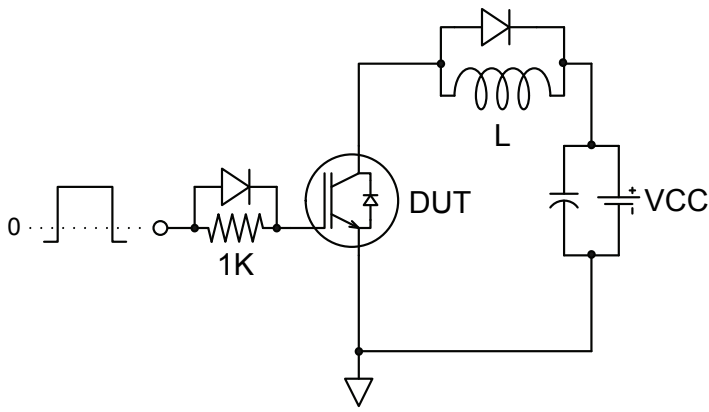
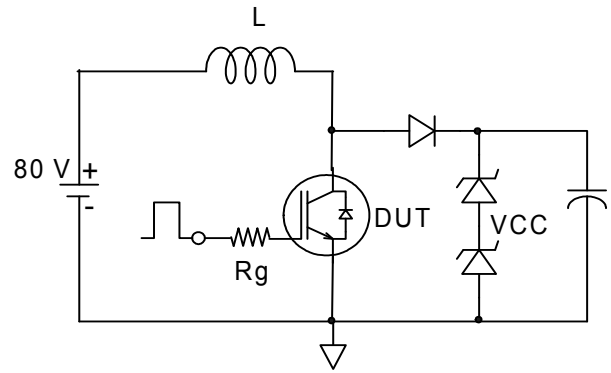
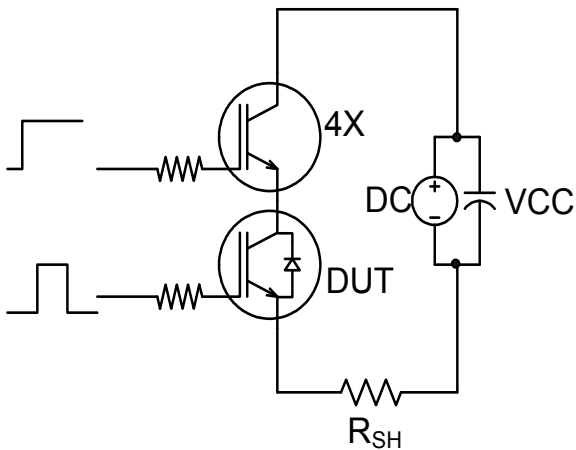
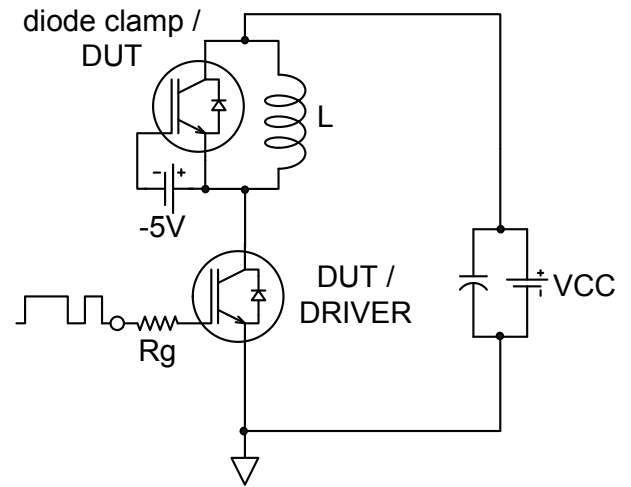
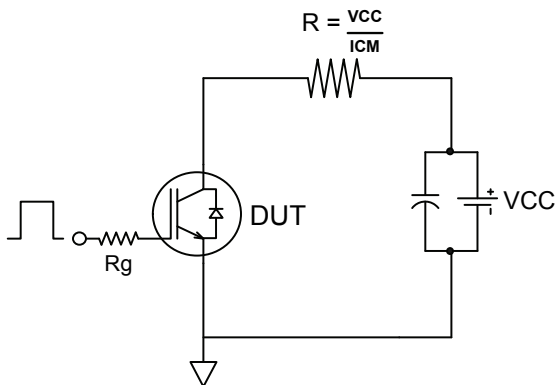
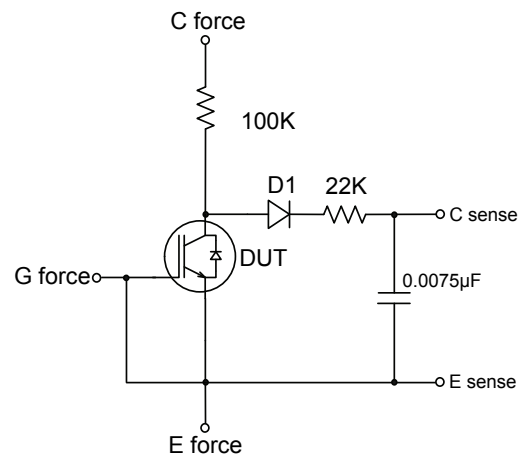


Fig. 27 - Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)


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

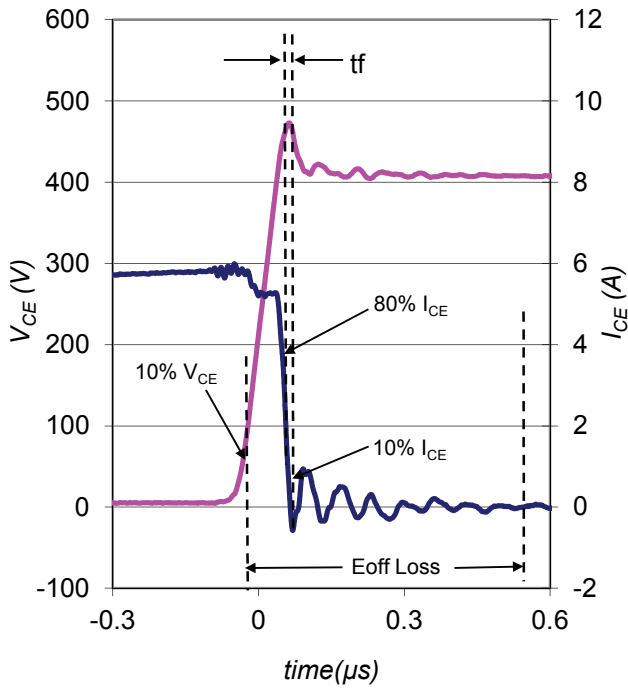


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

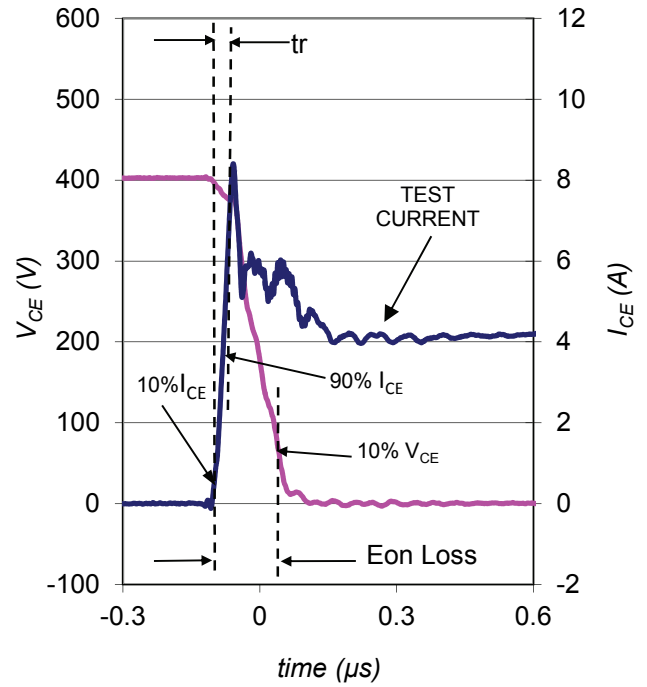


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

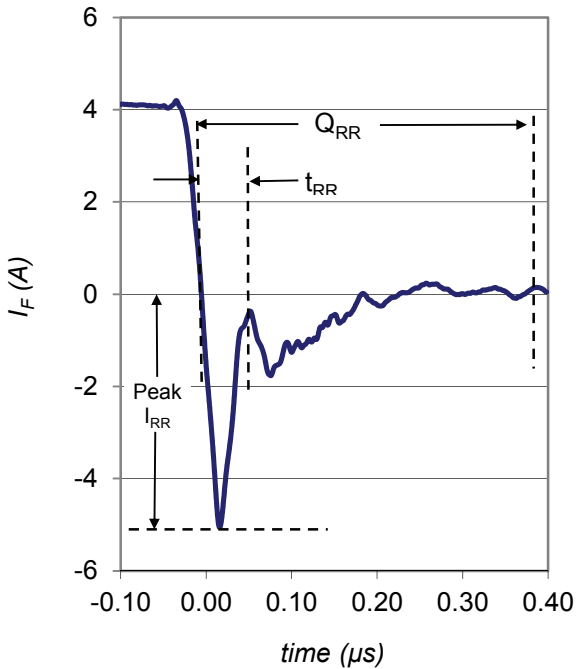


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

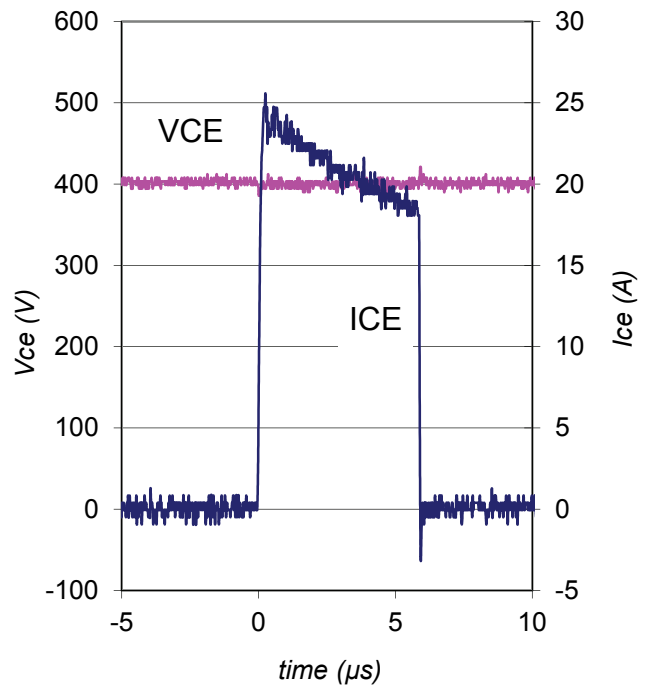
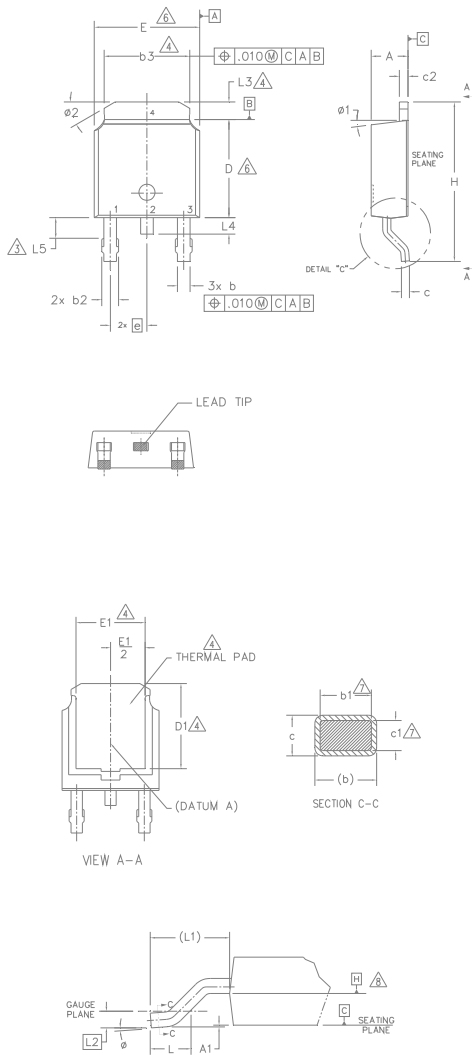


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.3

D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

- 1.- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
- 2.- DIMENSIONS 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

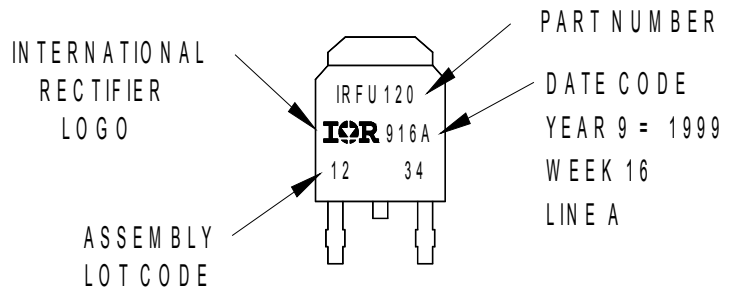
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

IGBT & CoPAK

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

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

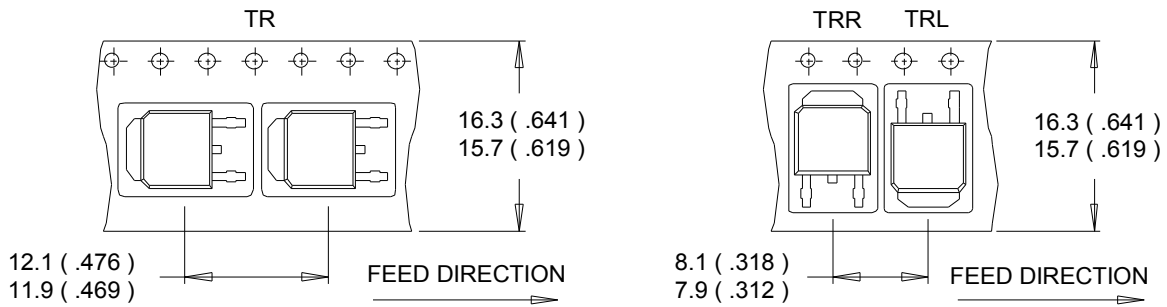
EXAMPLE: THIS IS AN IRFR120
 WITH ASSEMBLY
 LOT CODE 1234
 ASSEMBLED ON WW 16, 1999
 IN THE ASSEMBLY LINE "A"



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

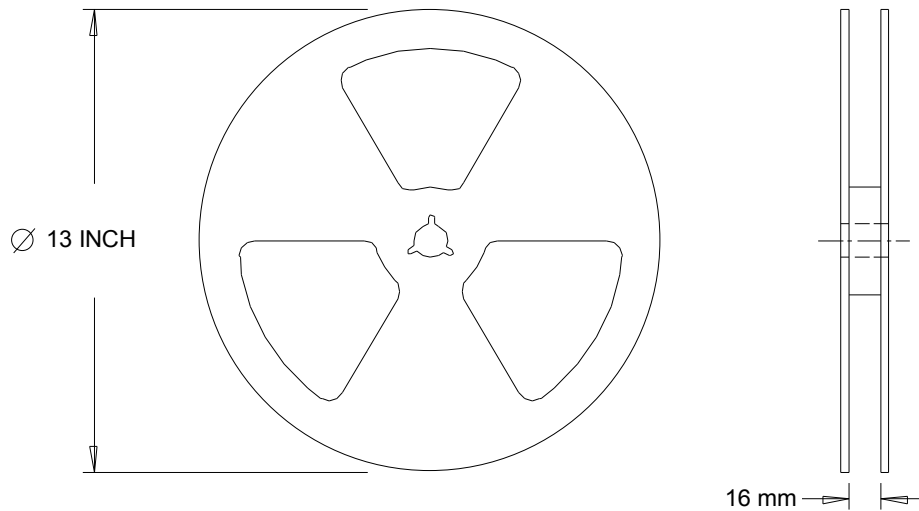
D-Pak (TO-252AA) Tape and Reel Information

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.



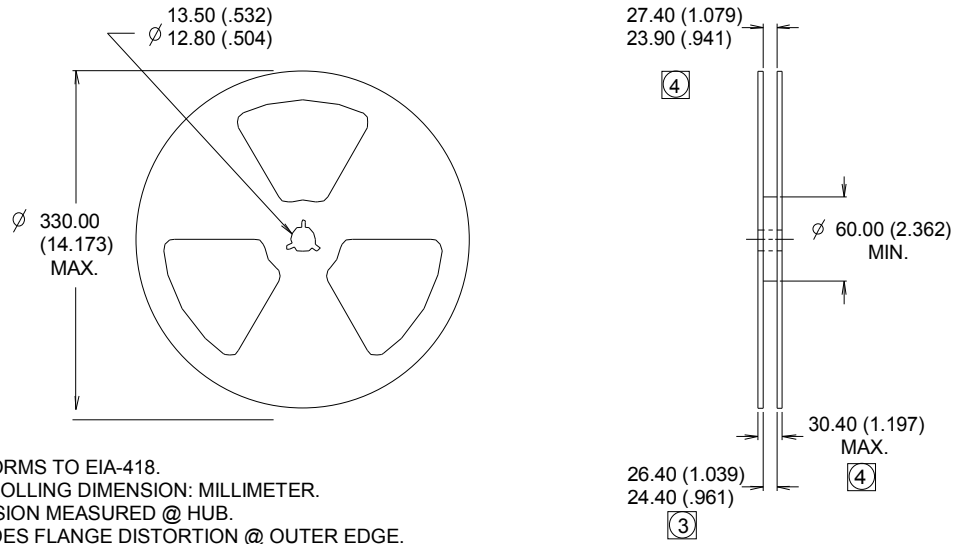
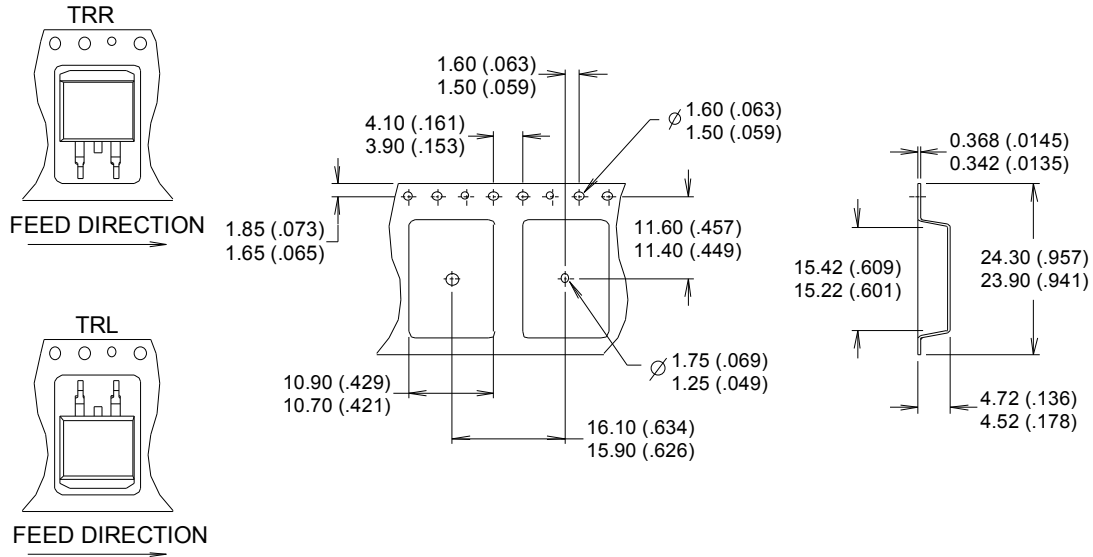
NOTES :

1. OUTLINE CONFORMS TO EIA-481.

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

D²Pak (TO-263AB) Tape & Reel Information

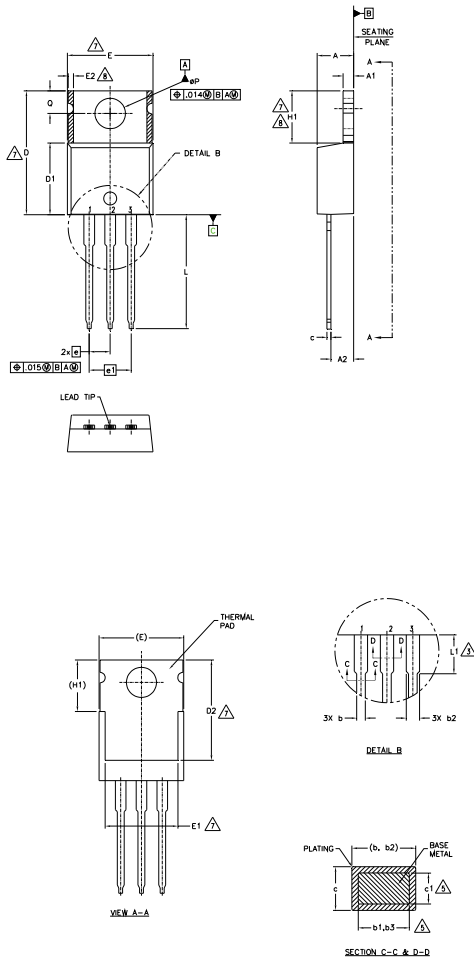
Dimensions are shown in millimeters (inches)



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

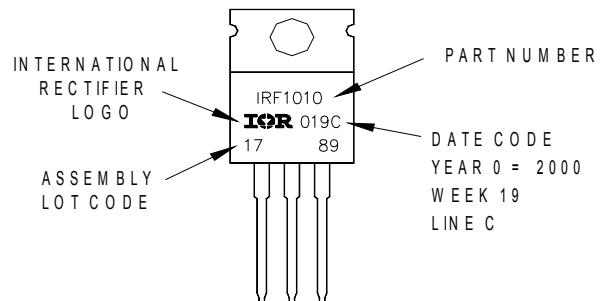
DIODES

- 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 ² Pak	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.