

$$V_{CES} = 650V$$

$$I_C = 15A, T_C = 100^\circ C$$

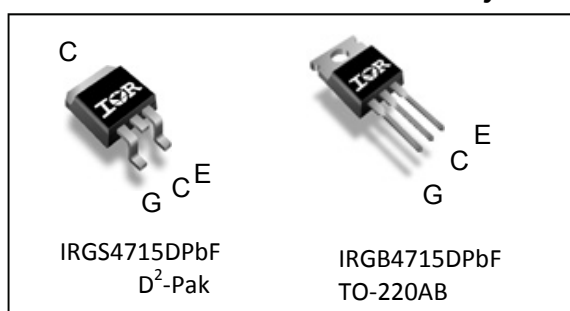
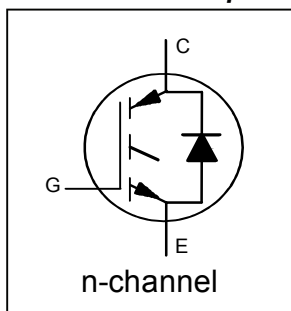
$$t_{SC} \geq 5.5\mu s, T_{J(max)} = 175^\circ C$$

$$V_{CE(ON)} \text{ typ.} = 1.7V @ I_C = 8A$$

Applications

- Industrial Motor Drive
- UPS
- Solar Inverters
- Welding

Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode



G	C	E
Gate	Collector	Emitter

Features	Benefits
Low $V_{CE(ON)}$ and Switching Losses	High Efficiency in a Wide Range of Applications
5.5 μs Short Circuit SOA	Rugged Transient Performance
Square RBSOA	Increased Reliability
Maximum Junction Temperature 175°C	Excellent Current Sharing in Parallel Operation
Positive $V_{CE(ON)}$ Temperature Coefficient	Environmentally friendly
Lead-Free, RoHs compliant	

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGB4715DPbF	TO-220	Tube	50	IRGB4715DPbF
IRGS4715DPbF	D²-Pak	Tube	50	IRGS4715DPbF
		Tape and Reel Left	800	IRGS4715DTRLpbF
		Tape and Reel Right	800	IRGS4715DTRRpF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	650	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	21	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	15	
I_{CM}	Pulse Collector Current, $V_{GE} = 15V$	24	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	32	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	21	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	13	V
I_{FM}	Diode Maximum Forward Current ⑤	32	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 30	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	100	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	50	
T_J	Operating Junction and	-40 to +175	C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 sec.		
	Mounting Torque, 6-32 or M3 Screw	300 (0.063 in. (1.6mm) from case) 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) ②	—	—	1.5	$^\circ C/W$
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ②	—	—	3.6	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.5	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (TO-220)	—	—	62	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (D²-Pak)	—	—	40	

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	650	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.8	—	V/°C	$V_{GE} = 0V, I_C = 1mA$ (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	$I_C = 8A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.1	—		$I_C = 8A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	5.5	—	7.4	V	$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage Temperature Coeff.	—	-19	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$ (25°C-175°C)
g_{fe}	Forward Transconductance	—	5.7	—	S	$V_{CE} = 50V, I_C = 8A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	25	μA	$V_{GE} = 0V, V_{CE} = 650V$
		—	1.0	—	mA	$V_{GE} = 0V, V_{CE} = 650V, T_J = 175^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 30V$
V_F	Diode Forward Voltage Drop	—	1.8	2.8	V	$I_F = 8A$
		—	1.3	—		$I_F = 8A, T_J = 175^\circ\text{C}$

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

	Parameter	Min.	Typ.	Max.④	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	20	30	nC	$I_C = 8A$ $V_{GE} = 15V$ $V_{CC} = 400V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	6	9		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	8	12		
E_{on}	Turn-On Switching Loss	—	200	310	μJ	$I_C = 8A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 50\Omega, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑥
E_{off}	Turn-Off Switching Loss	—	90	180		
E_{total}	Total Switching Loss	—	290	490		
$t_{d(on)}$	Turn-On delay time	—	30	50	ns	$I_C = 8A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 50\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑥
t_r	Rise time	—	20	30		
$t_{d(off)}$	Turn-Off delay time	—	100	120		
t_f	Fall time	—	20	30		
E_{on}	Turn-On Switching Loss	—	340	—	μJ	$I_C = 8A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 50\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑥
E_{off}	Turn-Off Switching Loss	—	170	—		
E_{total}	Total Switching Loss	—	510	—		
$t_{d(on)}$	Turn-On delay time	—	30	—	ns	$I_C = 8A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 50\Omega, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑥
t_r	Rise time	—	20	—		
$t_{d(off)}$	Turn-Off delay time	—	120	—		
t_f	Fall time	—	70	—		
C_{ies}	Input Capacitance	—	540	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
C_{oes}	Output Capacitance	—	50	—		
C_{res}	Reverse Transfer Capacitance	—	15	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 32A$ $V_{CC} = 520V, V_p \leq 650V$ $V_{GE} = +20V$ to 0V
SCSOA	Short Circuit Safe Operating Area	5.5	—	—	μs	$T_J = 150^\circ\text{C}, V_{CC} = 400V, V_p \leq 650V$ $V_{GE} = +15V$ to 0V
E_{rec}	Reverse Recovery Energy of the Diode	—	130	—	μJ	$T_J = 175^\circ\text{C}$
t_{rr}	Diode Reverse Recovery Time	—	86	—	ns	$V_{CC} = 400V, I_F = 8A$
I_{rr}	Peak Reverse Recovery Current	—	8	—	A	$V_{GE} = 15V, R_g = 50\Omega$

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V$.
- 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 Maximum limits are based on statistical sample size characterization.
- ⑤ Pulse width limited by max. junction temperature.
- ⑥ Values influenced by parasitic L and C in measurement.

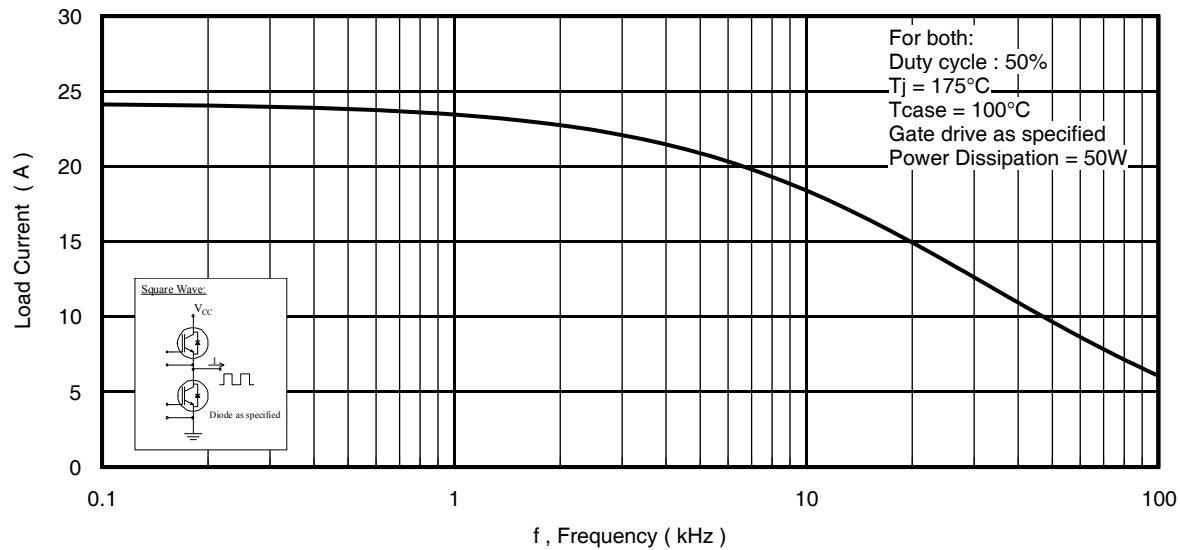


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

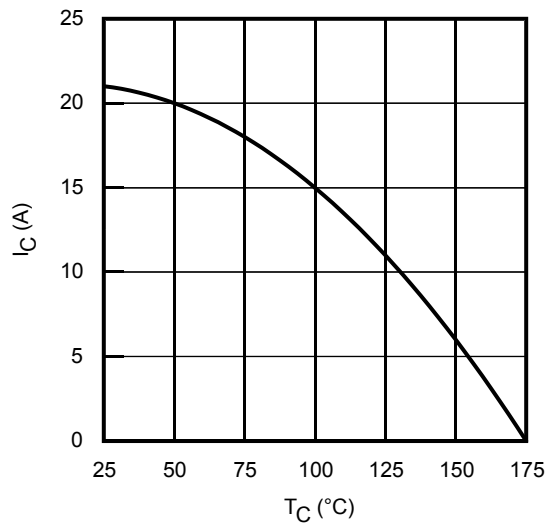


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

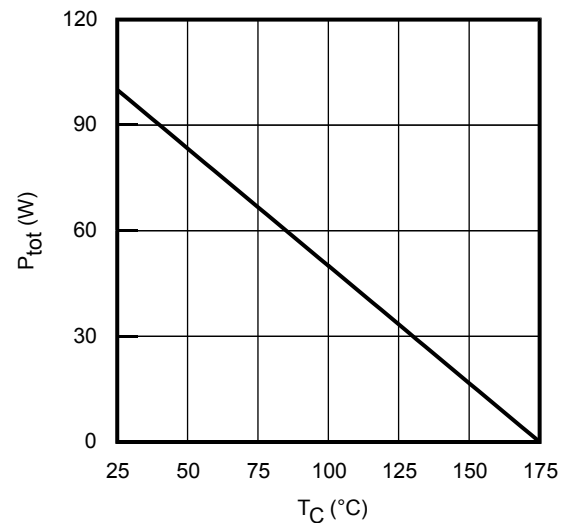


Fig. 3 - Power Dissipation vs. Case Temperature

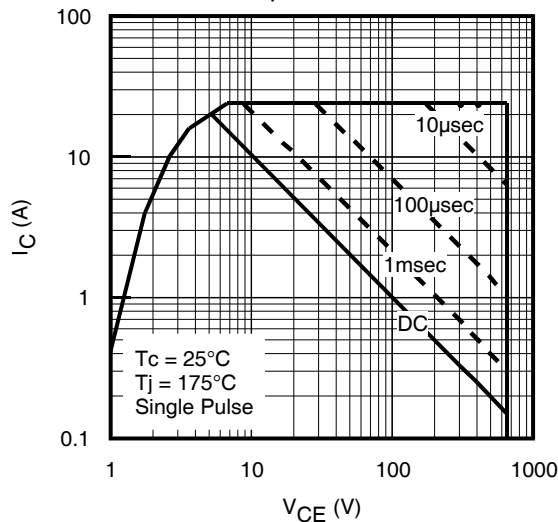


Fig. 4 - Forward SOA
 $T_C = 25^{\circ}\text{C}$; $T_j \leq 175^{\circ}\text{C}$; $V_{GE} = 15\text{V}$

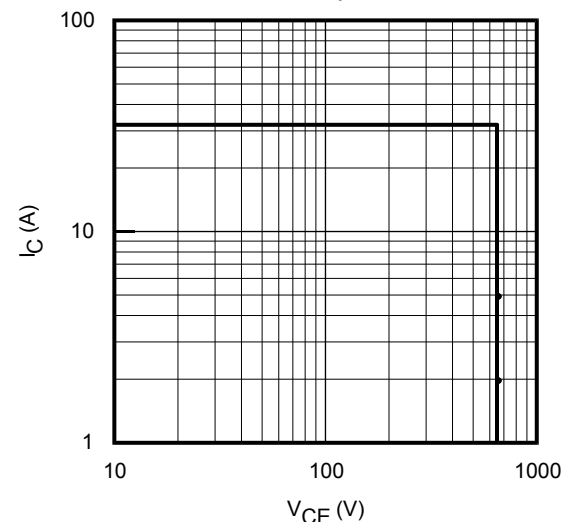


Fig. 5 - Reverse Bias SOA
 $T_j = 175^{\circ}\text{C}$; $V_{GE} = 20\text{V}$

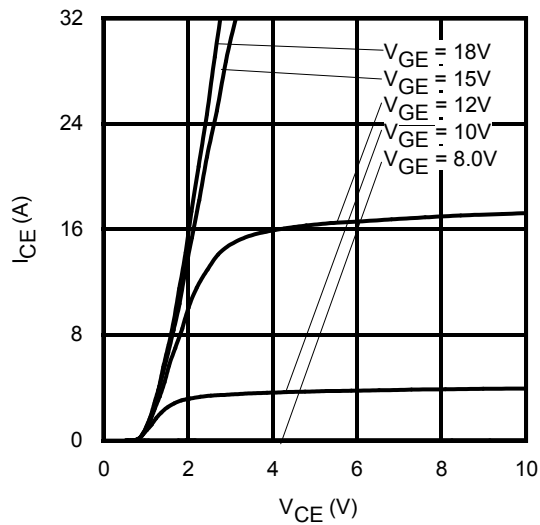


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

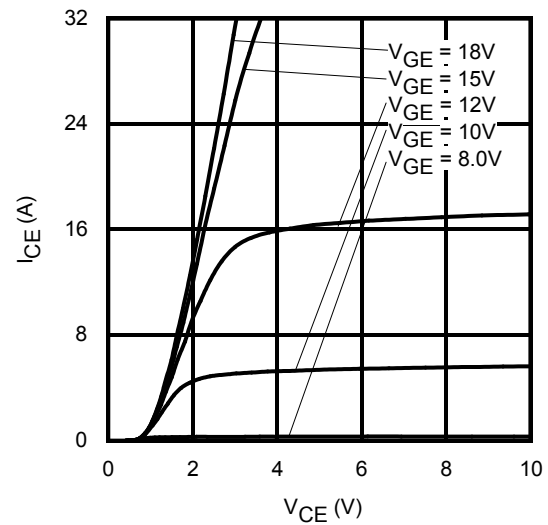


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

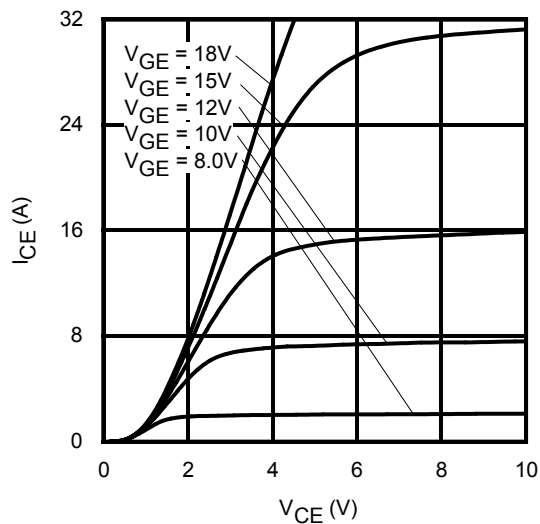


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

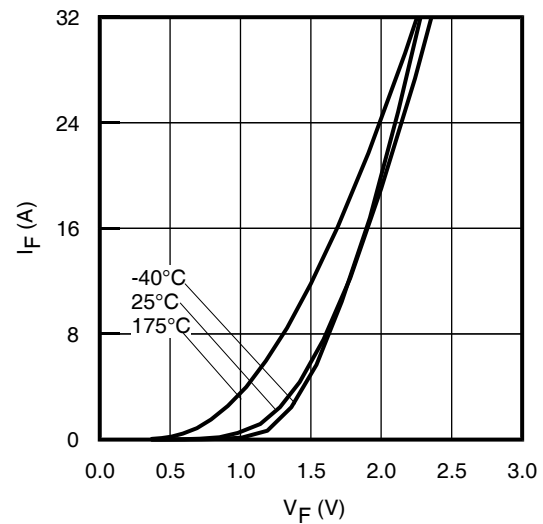


Fig. 9 - Typ. Diode Forward Voltage Drop Characteristics

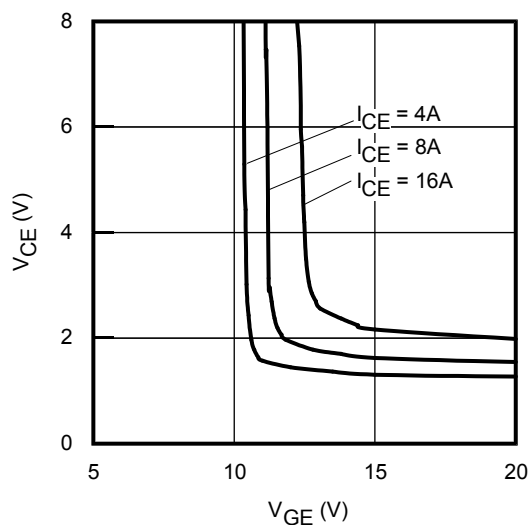


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^{\circ}\text{C}$

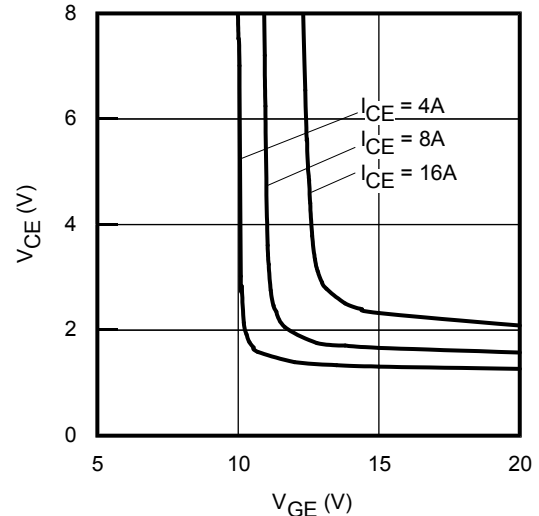


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^{\circ}\text{C}$

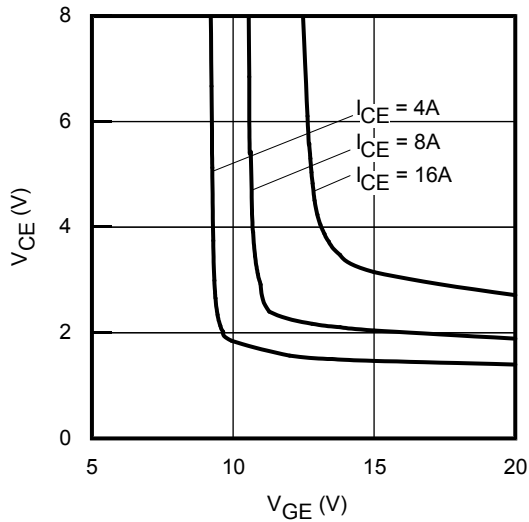


Fig. 12 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

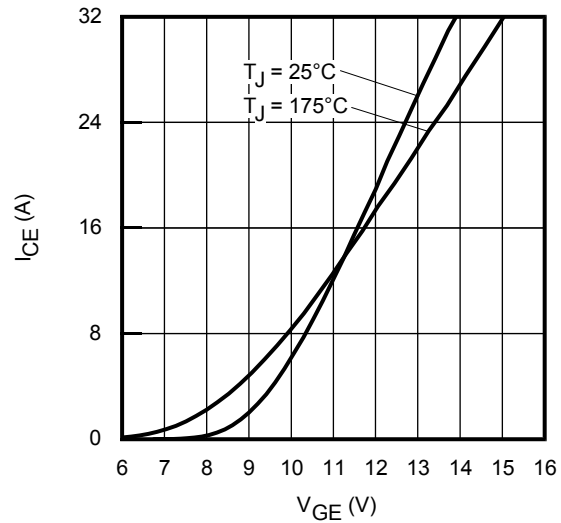


Fig. 13 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

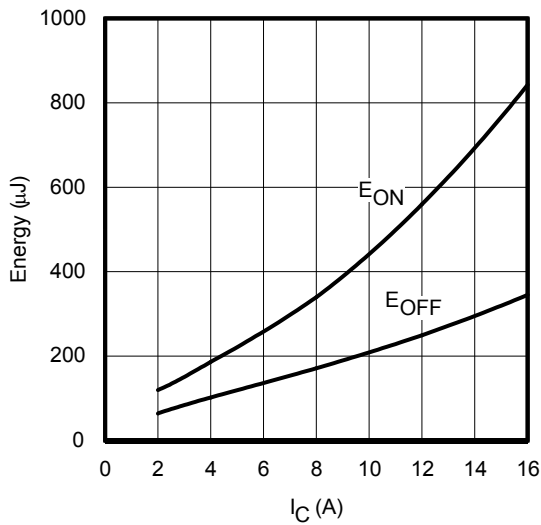


Fig. 14 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $R_G = 50\Omega$; $V_{GE} = 15\text{V}$

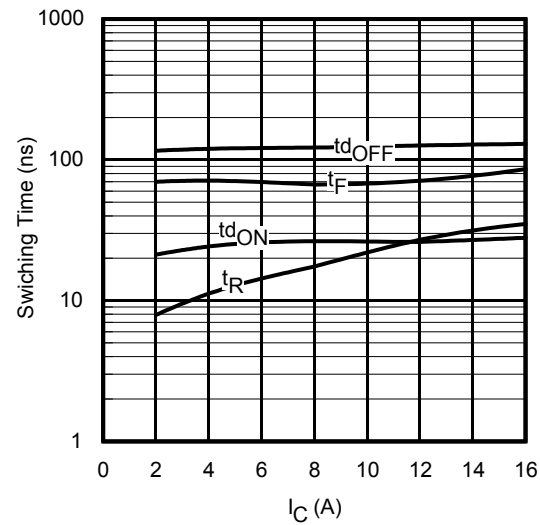


Fig. 15 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $R_G = 50\Omega$; $V_{GE} = 15\text{V}$

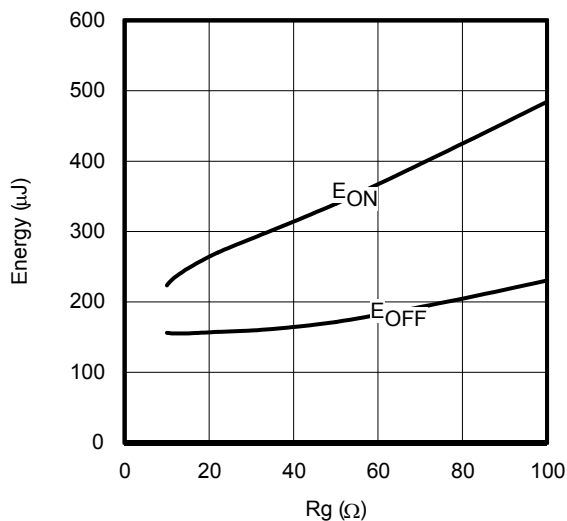


Fig. 16 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $I_{CE} = 8\text{A}$; $V_{GE} = 15\text{V}$

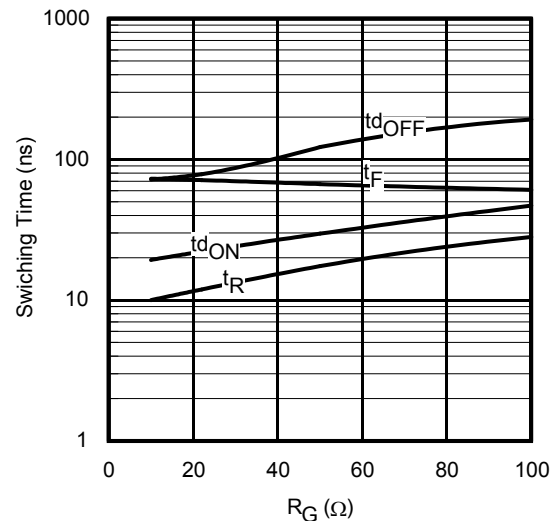


Fig. 17 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $V_{CE} = 400\text{V}$, $I_{CE} = 8\text{A}$; $V_{GE} = 15\text{V}$

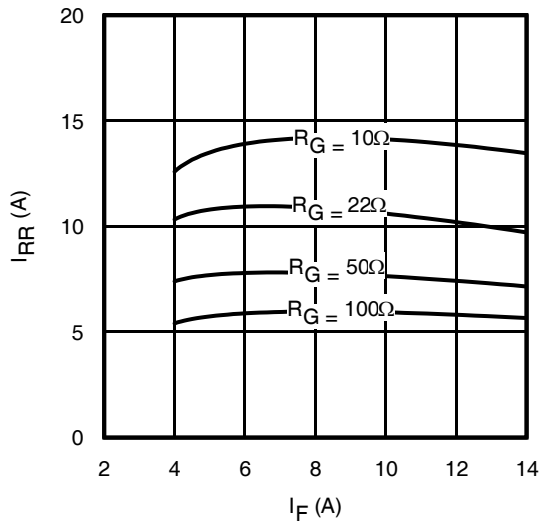


Fig. 18 - Typ. Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

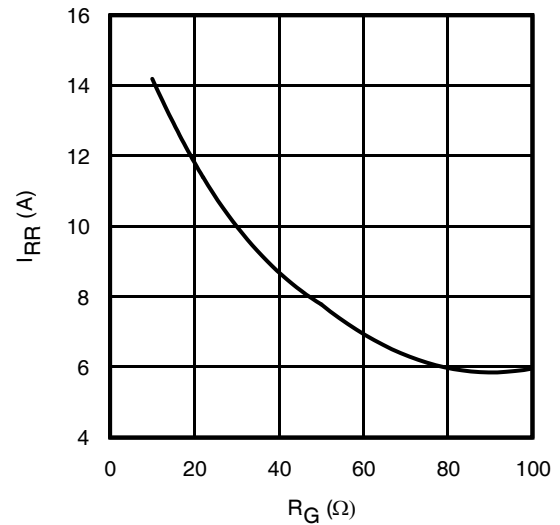


Fig. 19 - Typ. Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$

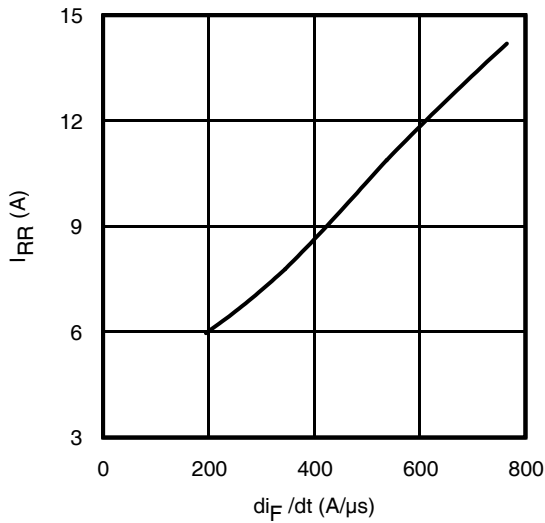


Fig. 20 - Typ. Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $I_F = 8\text{A}$; $T_J = 175^\circ\text{C}$

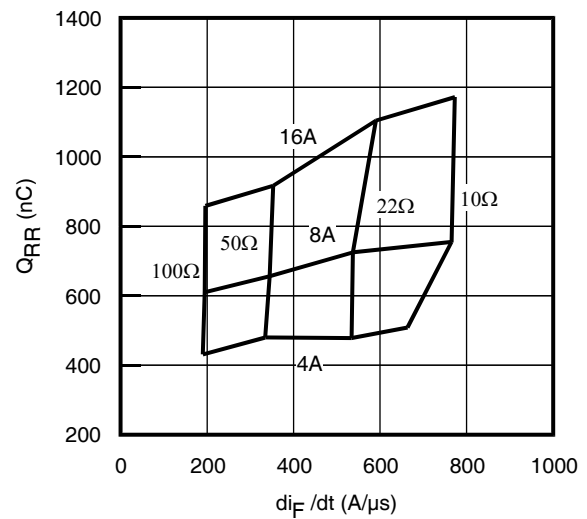


Fig. 21 - Typ. Diode Q_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 175^\circ\text{C}$

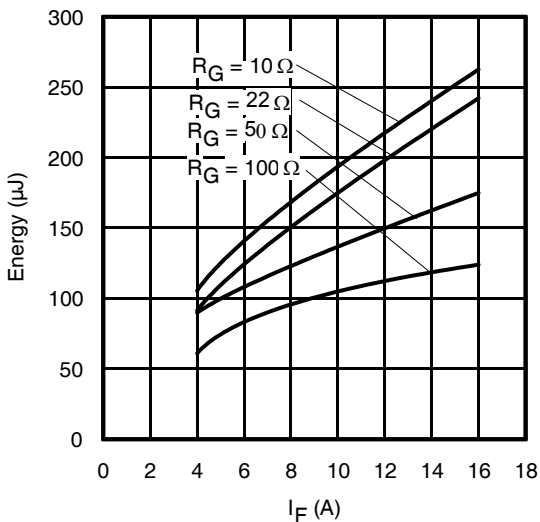


Fig. 22 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

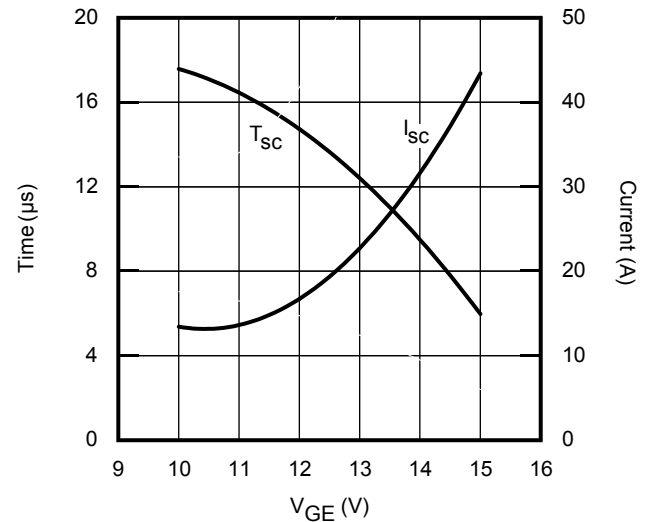


Fig. 23 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400\text{V}$; $T_C = 150^\circ\text{C}$

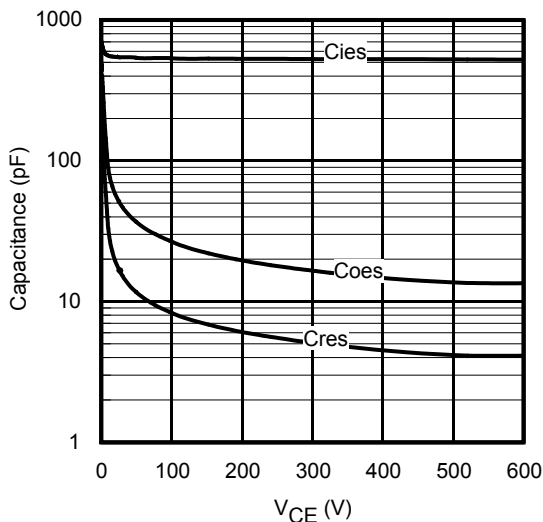


Fig. 24 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

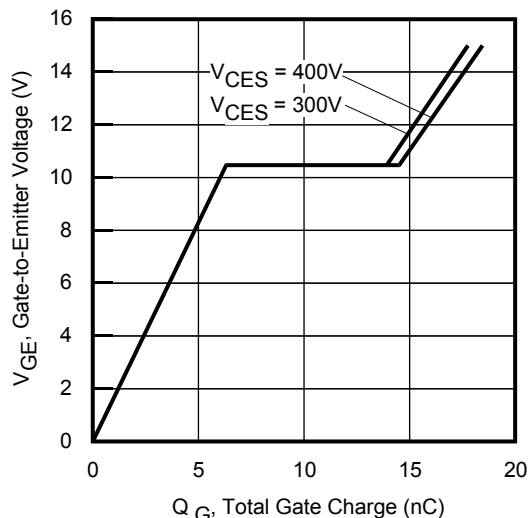


Fig. 25 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 8A$

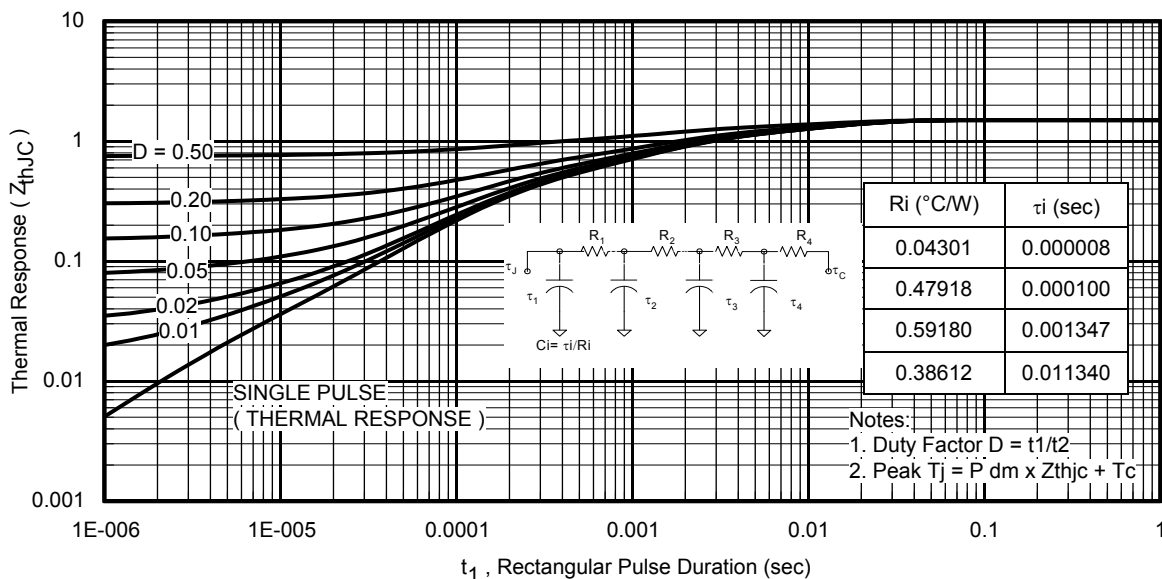


Fig. 26 - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

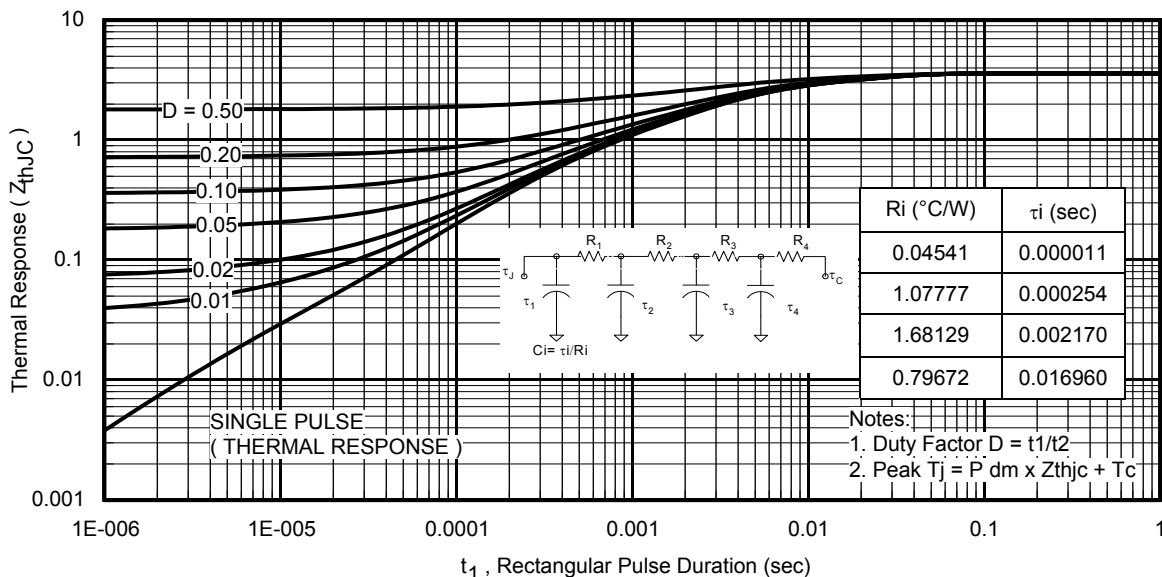


Fig. 27 - Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

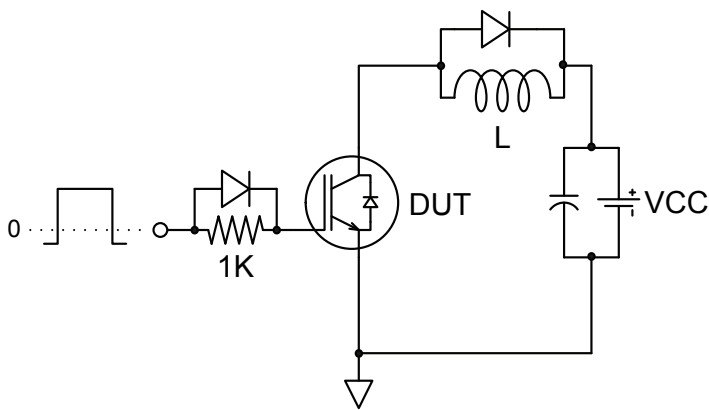


Fig.C.T.1 - Gate Charge Circuit (turn-off)

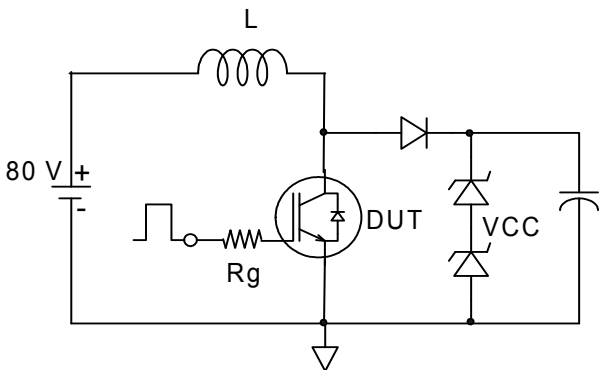


Fig.C.T.2 - RBSOA Circuit

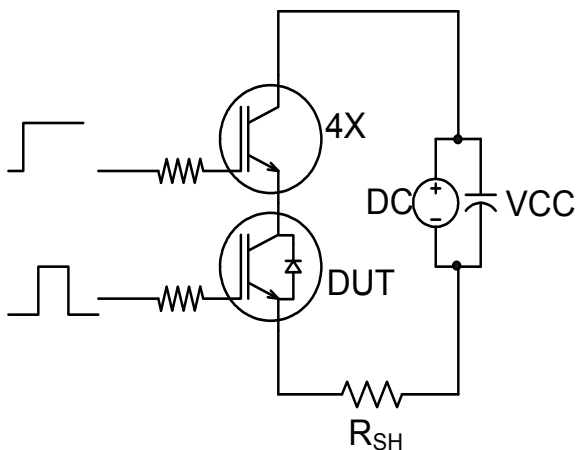


Fig.C.T.3 - S.C. SOA Circuit

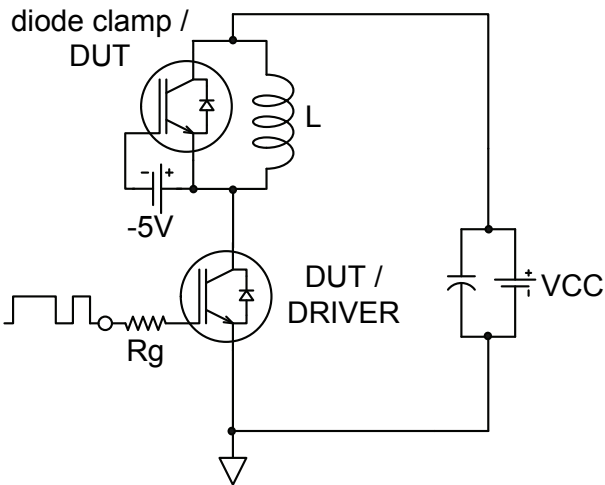


Fig.C.T.4 - Switching Loss Circuit

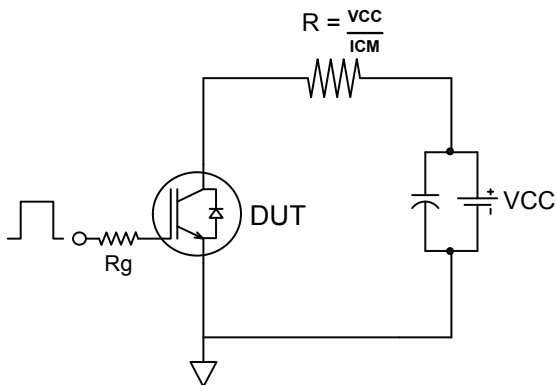


Fig.C.T.5 - Resistive Load Circuit

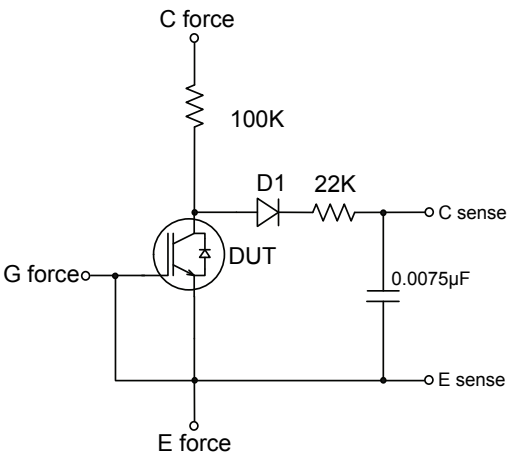


Fig.C.T.6 - BVCES Filter Circuit

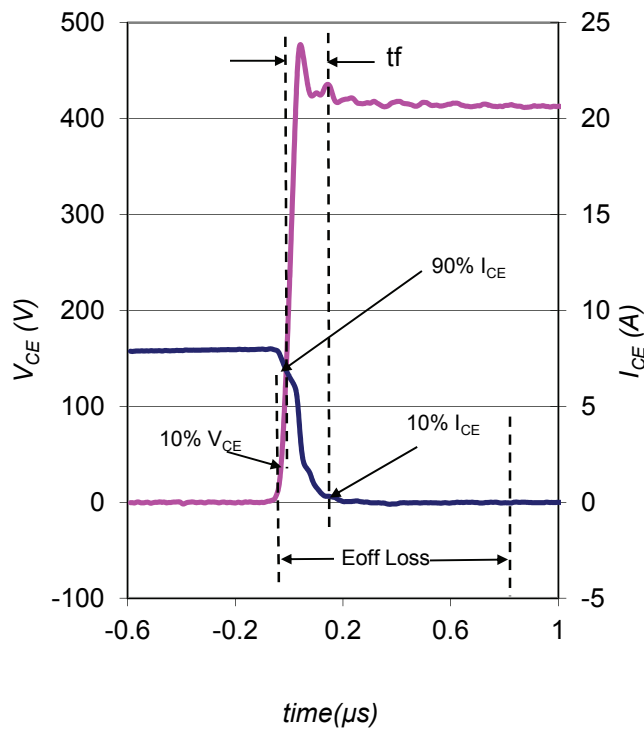


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

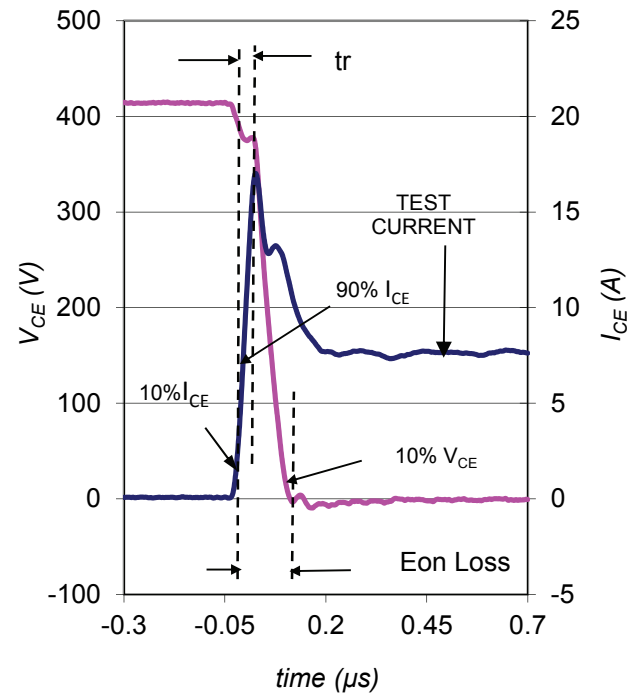


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

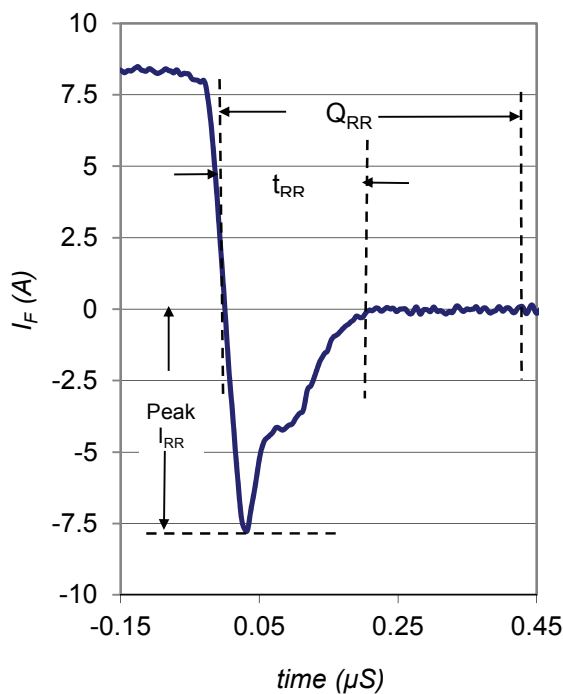


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

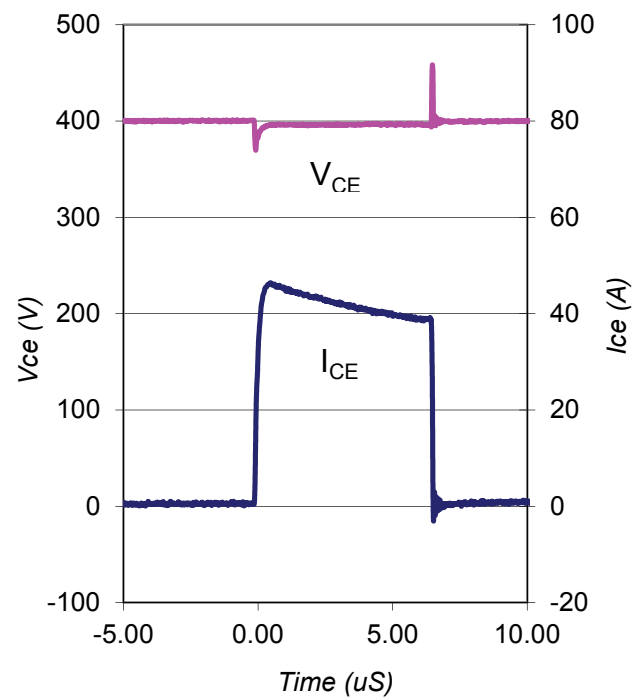
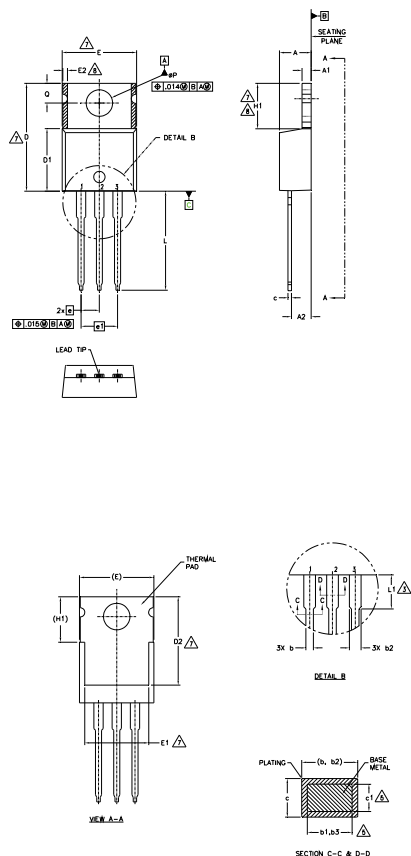


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.3

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 20--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

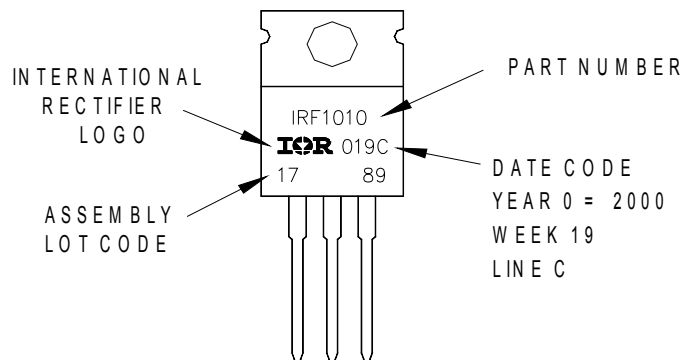
DIODES

- 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"

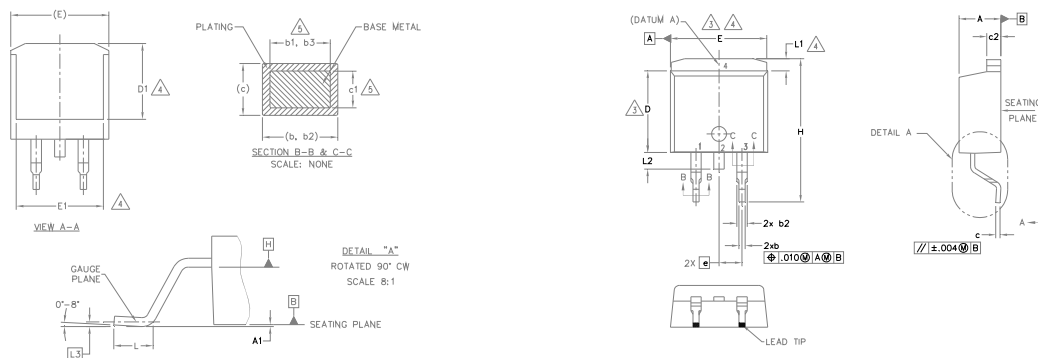
Note: "P" in assembly line position
indicates "Lead - Free"



TO-220AB packages are not recommended for Surface Mount Application.

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

D²Pak (TO-263AB) Package Outline (Dimensions are shown in millimeters (inches))



SYM- BO- L	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	5
A1	0.00	0.254	.000	.010	
b1	0.51	0.99	.020	.039	
b2	1.14	1.78	.045	.070	5
b3	1.14	1.73	.045	.068	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	
D1	6.86	—	.270	—	3
E	9.65	10.67	.380	.420	3, 4
E1	6.22	—	.245	—	4
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	4
L	1.78	2.79	.070	.110	
L1	—	1.68	—	.066	
L2	—	1.78	—	.070	
L3	0.25 BSC		.010 BSC		

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1, b3 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

LEAD ASSIGNMENTS

DIODES

- 1.- ANODE (TWO DIE) / OPEN (ONE DIE)
- 2, 4.- CATHODE
- 3.- ANODE

HEXFET

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

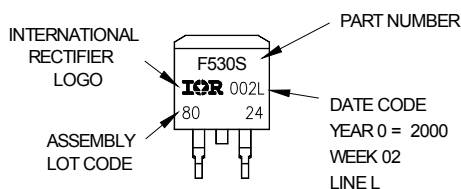
IGBTs, CoPACK

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

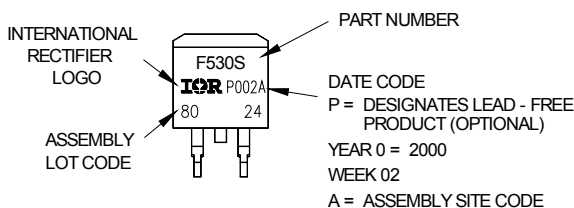
D²Pak (TO-263AB) Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH
LOT CODE 8024
ASSEMBLED ON VVW 02, 2000
IN THE ASSEMBLY LINE "L"

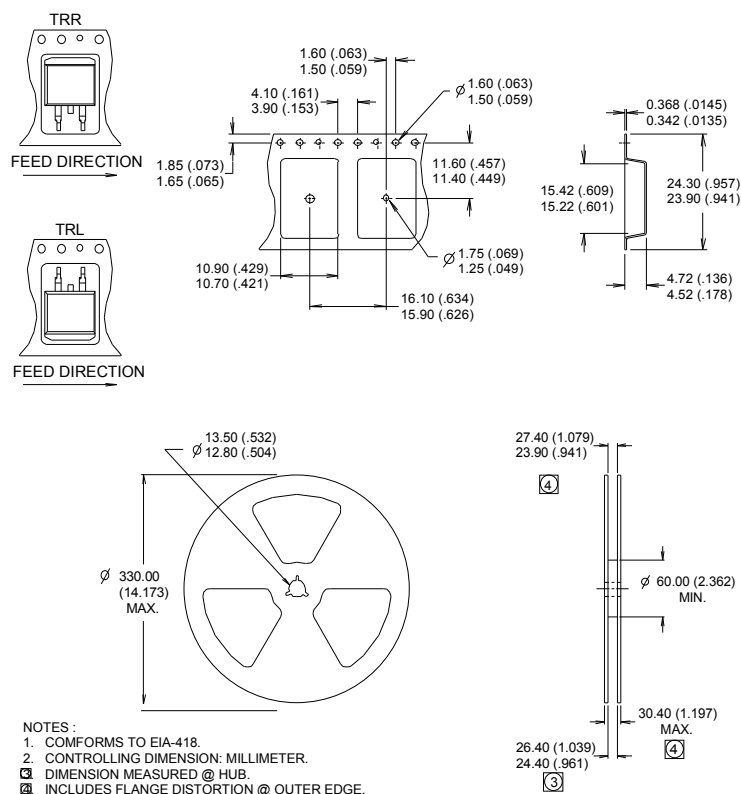
Note: "P" in assembly line position indicates "Lead - Free"



OR



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/>

Qualification Information[†]

Qualification Level	Industrial	
Moisture Sensitivity Level	TO-220	N/A
	D ² Pak	MSL 1
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
11/12/2014	- Added I_{FM} Diode Maximum Forward Current = 32A with the note ⑤ on page 1. - Removed note ⑤ from switching losses test condition on page 2.

International
IOR Rectifier

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To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>