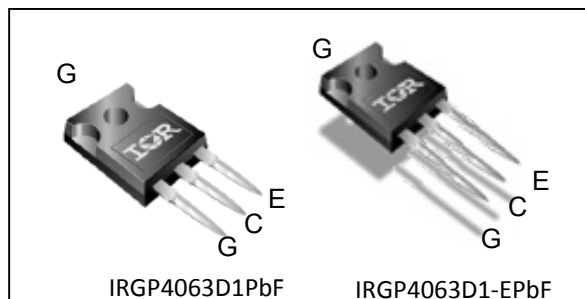
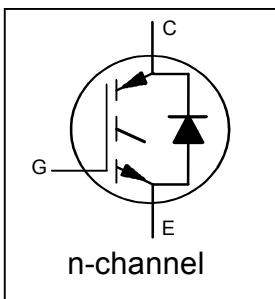


$V_{CES} = 600V$
$I_C = 60A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(ON)} \text{ typ.} = 1.65V @ I_C = 48A$

**Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode**



G	C	E
Gate	Collector	Emitter

- Applications
- Industrial Motor Drive
  - Inverters
  - UPS
  - Welding

Features	Benefits
Low $V_{CE(ON)}$ and switching losses	High efficiency in a wide range of applications and switching frequencies
Square RBSOA and maximum junction temperature $175^\circ C$	Improved reliability due to rugged hard switching performance and higher power capability
Positive $V_{CE(ON)}$ temperature coefficient	Excellent current sharing in parallel operation
$5\mu s$ short circuit SOA	Enables short circuit protection scheme
Lead-free, RoHS compliant	Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGP4063D1PbF	TO-247AC	Tube	25	IRGP4063D1PbF
IRGP4063D1-EPbF	TO-247AD	Tube	25	IRGP4063D1-EPbF

**Absolute Maximum Ratings**

Parameter	Max.	Units
$V_{CES}$ Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$ Continuous Collector Current	100	A
$I_C @ T_C = 100^\circ C$ Continuous Collector Current	60	
$I_{CM}$ Pulse Collector Current, $V_{GE} = 15V$	200	
$I_{LM}$ Clamped Inductive Load Current, $V_{GE} = 20V$ ①	192	
$I_F @ T_C = 25^\circ C$ Diode Continuous Forward Current	30	
$I_F @ T_C = 100^\circ C$ Diode Continuous Forward Current	15	
$I_{FM}$ Diode Maximum Forward Current ①	120	V
$V_{GE}$ Continuous Gate-to-Emitter Voltage	$\pm 20$	
	Transient Gate-to-Emitter Voltage	$\pm 30$
$P_D @ T_C = 25^\circ C$ Maximum Power Dissipation	330	W
$P_D @ T_C = 100^\circ C$ Maximum Power Dissipation	170	
$T_J$ Operating Junction and	-40 to +175	$^\circ C$
$T_{STG}$ 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
$R_{\theta JC}$ (IGBT) Thermal Resistance Junction-to-Case-(each IGBT) ②	—	—	0.45	$^\circ C/W$
$R_{\theta JC}$ (Diode) Thermal Resistance Junction-to-Case-(each Diode) ②	—	—	2.4	
$R_{\theta CS}$ Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$ Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	—	40	

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

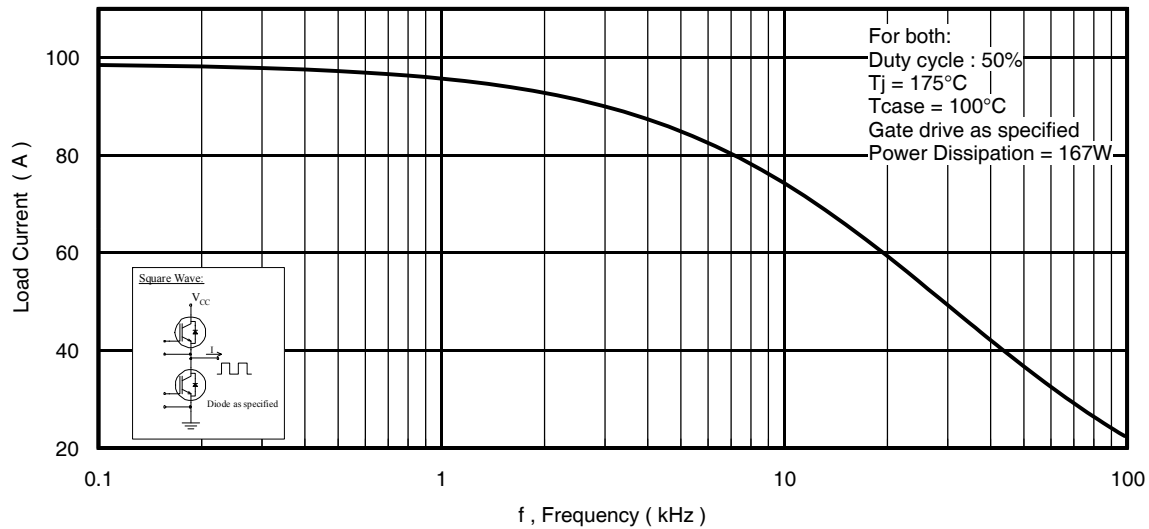
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu\text{A}$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.3	—	V/°C	$V_{GE}=0V, I_C=1mA (25^\circ\text{C}-175^\circ\text{C})$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.65	2.14	V	$I_C = 48A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.05	—		$I_C = 48A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 1.4mA$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-21	—	mV/°C	$V_{CE}=V_{GE}, I_C=1.4mA (25^\circ\text{C}-175^\circ\text{C})$
gfe	Forward Transconductance	—	32	—	S	$V_{CE} = 50V, I_C = 48A, PW = 20\mu\text{s}$
$I_{CES}$	Collector-to-Emitter Leakage Current	—	1.0	200	$\mu\text{A}$	$V_{GE} = 0V, V_{CE} = 600V$
		—	850	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	1.9	2.4	V	$I_F = 8A$
		—	1.2	—		$I_F = 8A, T_J = 175^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

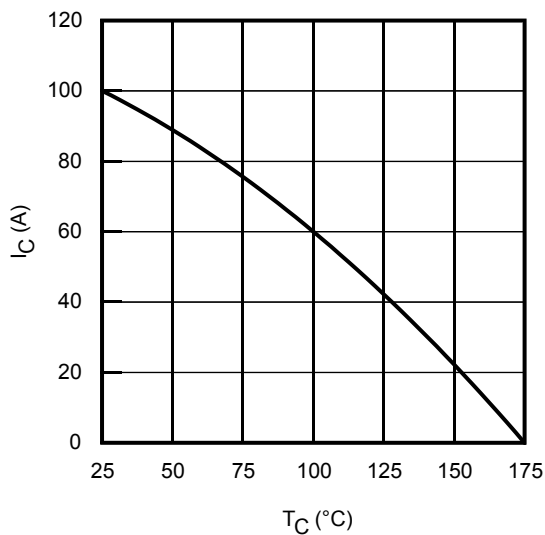
	Parameter	Min.	Typ.	Max.④	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	100	150	nC	$I_C = 48A$ $V_{GE} = 15V$ $V_{CC} = 400V$
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	25	40		
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	40	60		
$E_{on}$	Turn-On Switching Loss	—	1.4	2.3	mJ	$I_C = 48A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 485\mu\text{H}, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
$E_{off}$	Turn-Off Switching Loss	—	1.1	2.0		
$E_{total}$	Total Switching Loss	—	2.5	4.3		
$t_{d(on)}$	Turn-On delay time	—	60	80	ns	Energy losses include tail & diode reverse recovery ⑤⑥
$t_r$	Rise time	—	50	70		
$t_{d(off)}$	Turn-Off delay time	—	160	185		
$t_f$	Fall time	—	30	50		
$E_{on}$	Turn-On Switching Loss	—	2.0	—	mJ	$I_C = 48A, V_{CC} = 400V, V_{GE}=15V$ $R_G=10\Omega, L=485\mu\text{H}, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
$E_{off}$	Turn-Off Switching Loss	—	1.5	—		
$E_{total}$	Total Switching Loss	—	3.5	—		
$t_{d(on)}$	Turn-On delay time	—	50	—	ns	Energy losses include tail & diode reverse recovery ⑤⑥
$t_r$	Rise time	—	55	—		
$t_{d(off)}$	Turn-Off delay time	—	165	—		
$t_f$	Fall time	—	55	—		
$C_{ies}$	Input Capacitance	—	2900	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0\text{Mhz}$
$C_{oes}$	Output Capacitance	—	200	—		
$C_{res}$	Reverse Transfer Capacitance	—	90	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 192A$ $V_{CC} = 480V, V_p \leq 600V$ $R_g = 50\Omega, V_{GE} = +20V \text{ to } 0V$
SCSOA	Short Circuit Safe Operating Area	5	—	—	$\mu\text{s}$	$V_{CC} = 400V, V_p \leq 600V$ $R_g = 50\Omega, V_{GE} = +15V \text{ to } 0V$
Erec	Reverse Recovery Energy of the Diode	—	245	—	$\mu\text{J}$	$T_J = 175^\circ\text{C}$
$t_{rr}$	Diode Reverse Recovery Time	—	80	—	ns	$V_{CC} = 400V, I_F = 48A$
$I_{rr}$	Peak Reverse Recovery Current	—	20	—	A	$V_{GE} = 15V, R_g = 10\Omega, L = 485\mu\text{H}$

**Notes:**

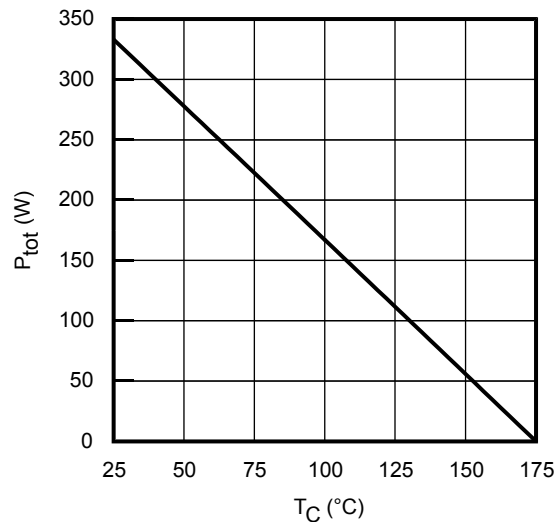
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 50\mu\text{H}, R_G = 50\Omega$ .
- ②  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .
- ③ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.
- ④ Maximum limits are based on statistical sample size characterization.
- ⑤ Pulse width limited by max. junction temperature.
- ⑥ Values influenced by parasitic L and C in measurement.



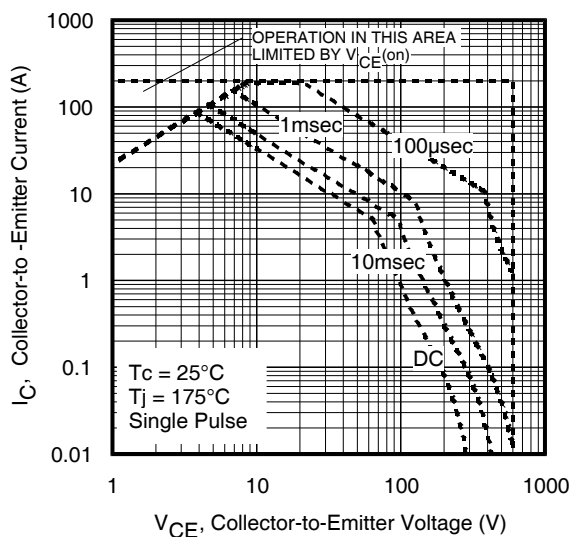
**Fig. 1 - Typical Load Current vs. Frequency**  
(Load Current =  $I_{RMS}$  of fundamental)



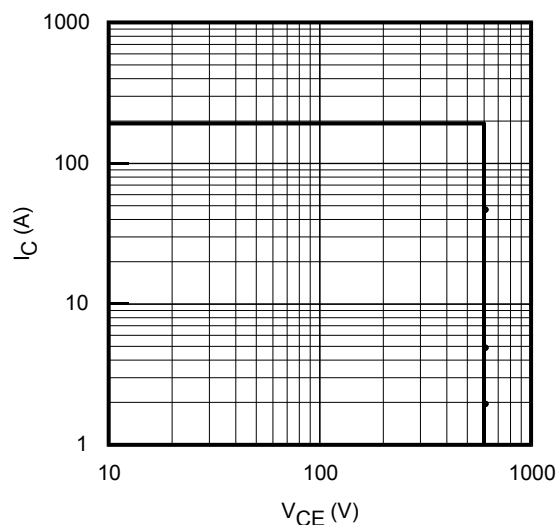
**Fig. 2 - Maximum DC Collector Current vs.**



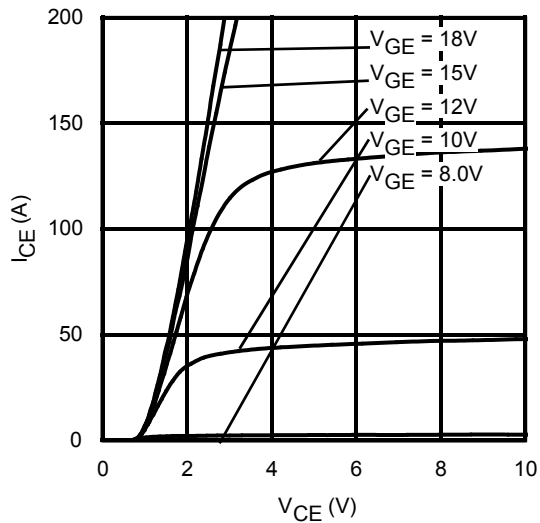
**Fig. 3 - Power Dissipation vs. Case Temperature**



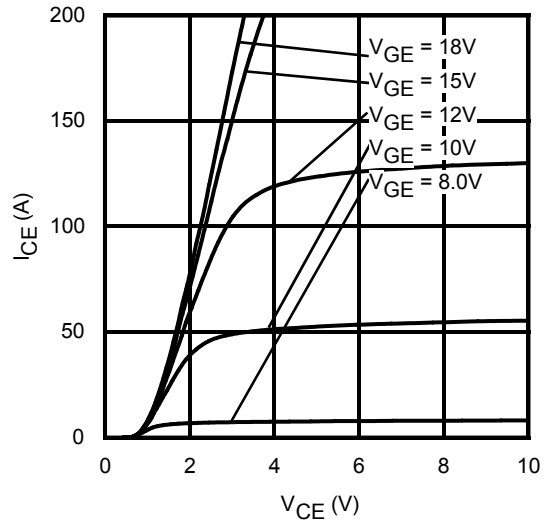
**Fig. 4 - Forward SOA**  
 $T_C = 25^\circ\text{C}$ ,  $T_J @ 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



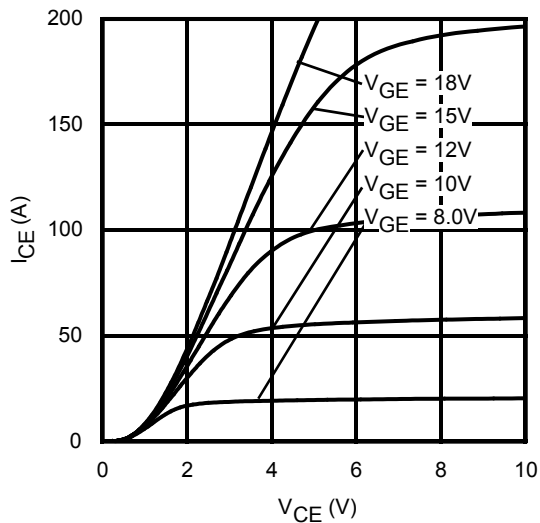
**Fig. 5 - Reverse Bias SOA**  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



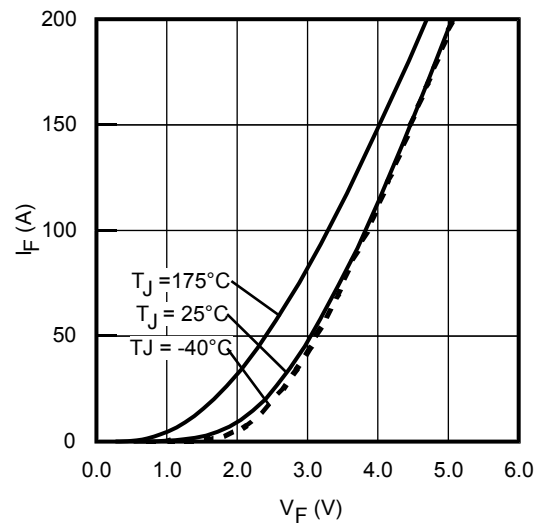
**Fig. 6 - Typ. IGBT Output Characteristics**  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



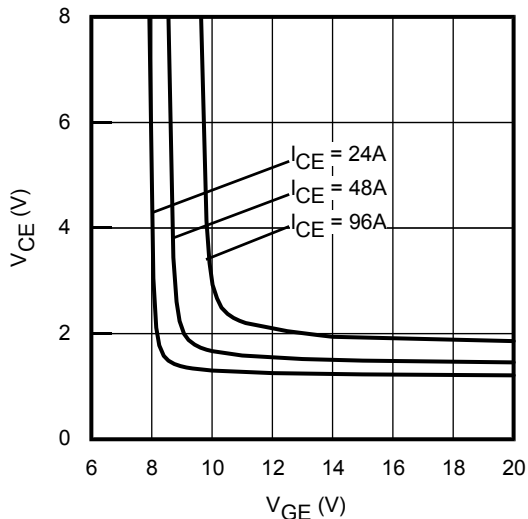
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



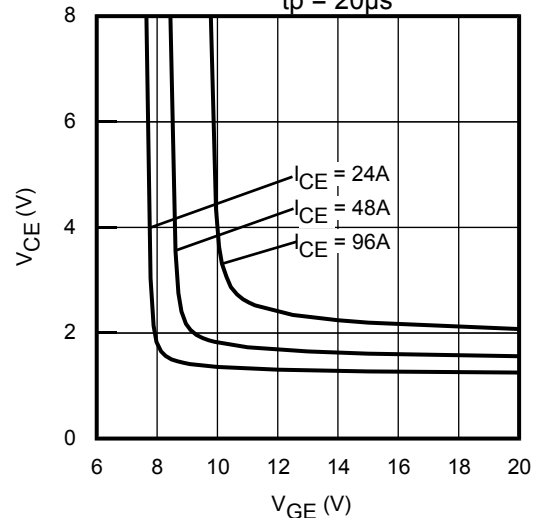
**Fig. 8 - Typ. IGBT Output Characteristics**  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



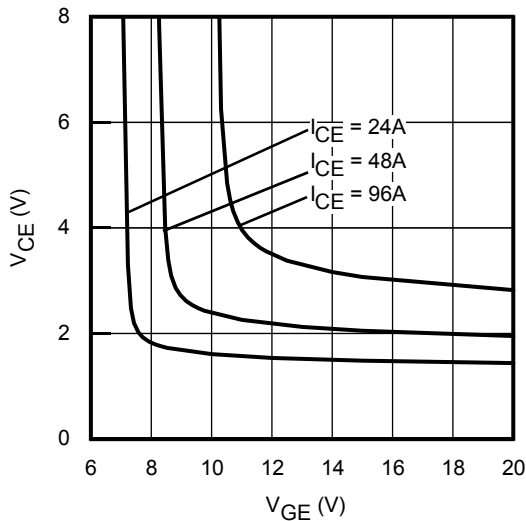
**Fig. 9 - Typ. Diode Forward Characteristics**  
 $t_p = 20\mu\text{s}$



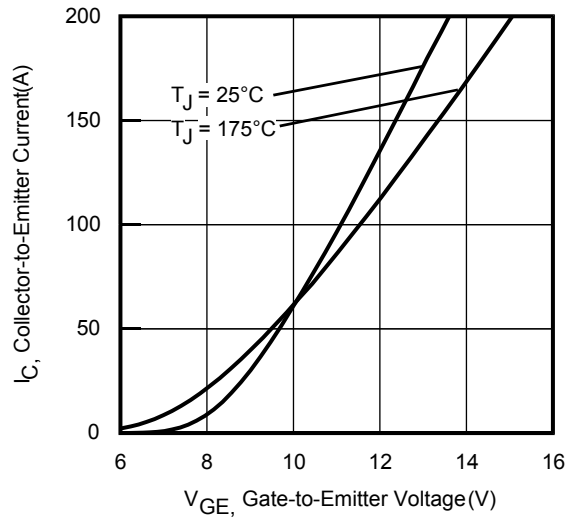
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



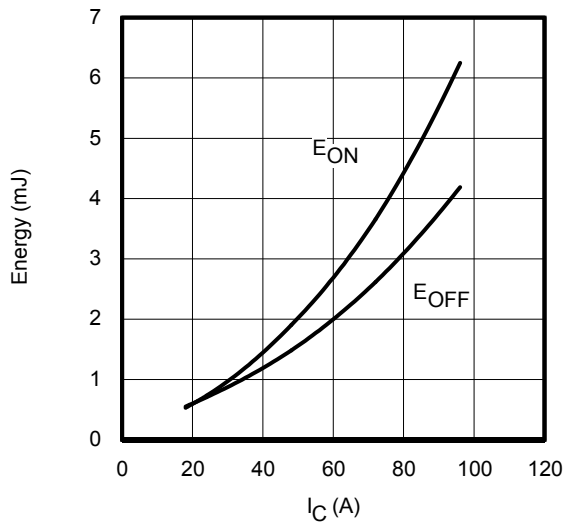
**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



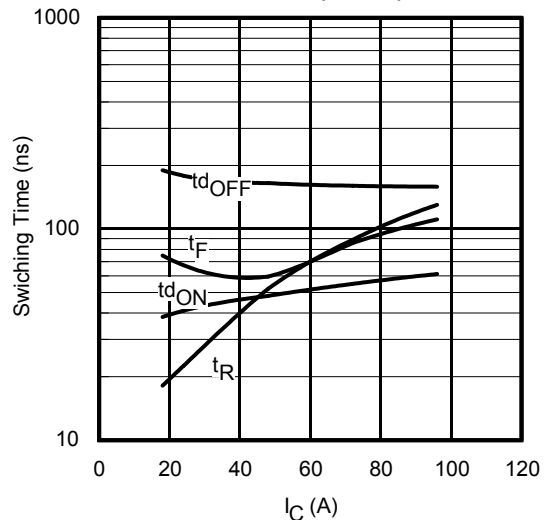
**Fig. 12** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$



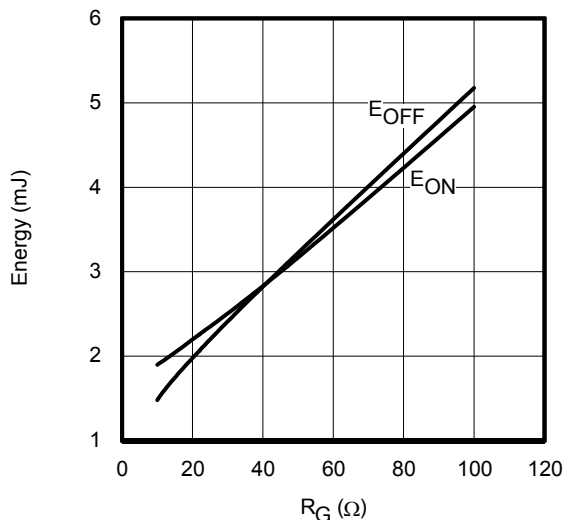
**Fig. 13** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}; t_p = 20\mu\text{s}$



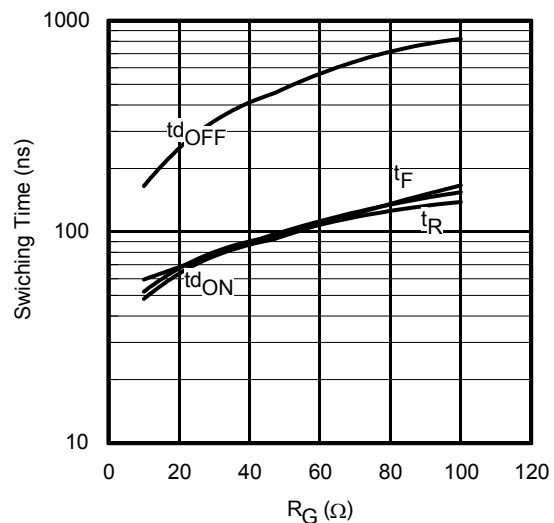
**Fig. 14** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 175^\circ\text{C}; L = 485\mu\text{H}; V_{CE} = 400\text{V}, R_G = 10\Omega; V_{GE} = 15\text{V}$



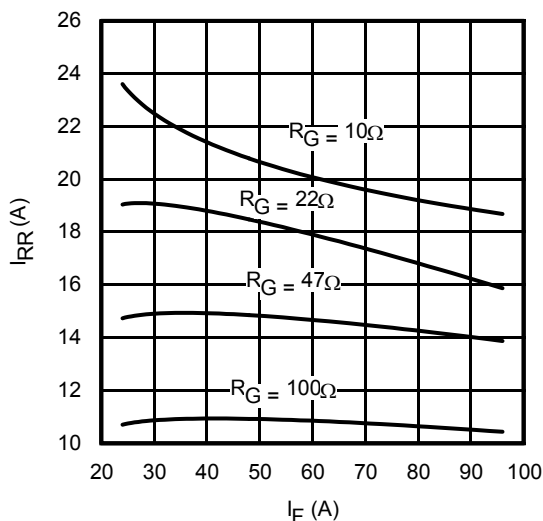
**Fig. 15** - Typ. Switching Time vs.  $I_C$   
 $T_J = 175^\circ\text{C}; L = 485\mu\text{H}; V_{CE} = 400\text{V}, R_G = 10\Omega; V_{GE} = 15\text{V}$



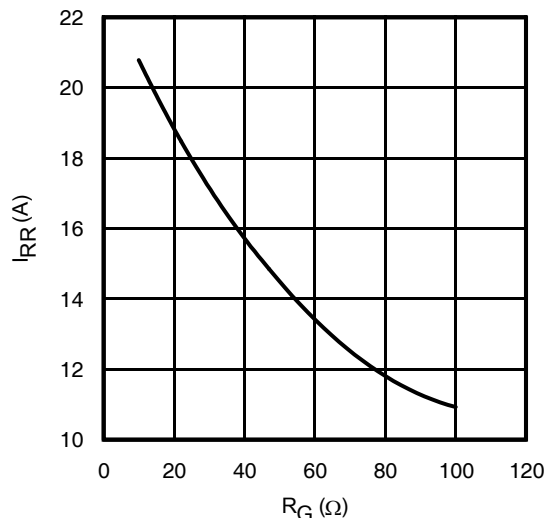
**Fig. 16** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 175^\circ\text{C}; L = 485\mu\text{H}; V_{CE} = 400\text{V}, I_{CE} = 48\text{A}; V_{GE} = 15\text{V}$



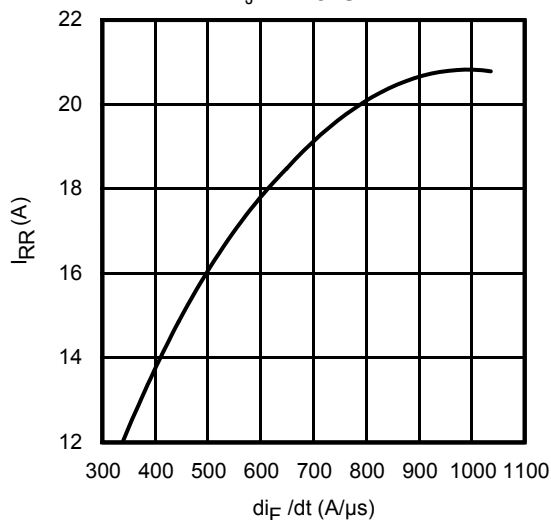
**Fig. 17** - Typ. Switching Time vs.  $R_G$   
 $T_J = 175^\circ\text{C}; L = 485\mu\text{H}; V_{CE} = 400\text{V}, I_{CE} = 48\text{A}; V_{GE} = 15\text{V}$



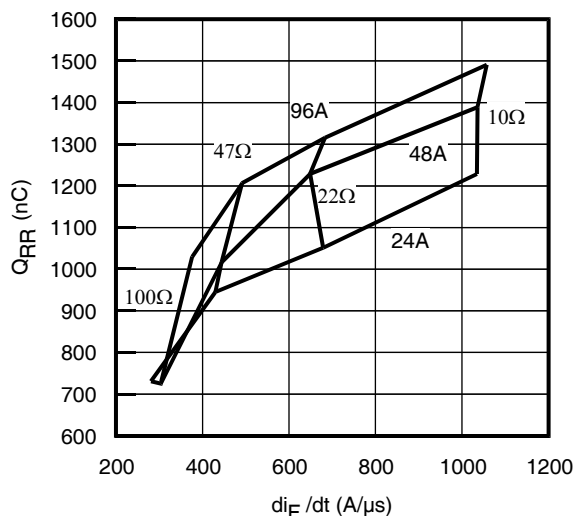
**Fig. 18** - Typ. Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ\text{C}$



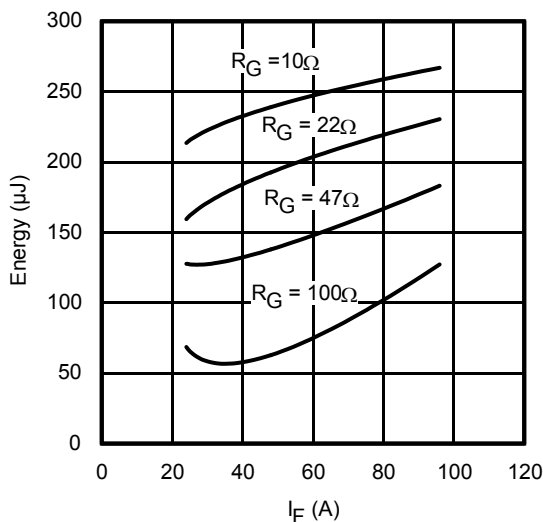
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 175^\circ\text{C}$



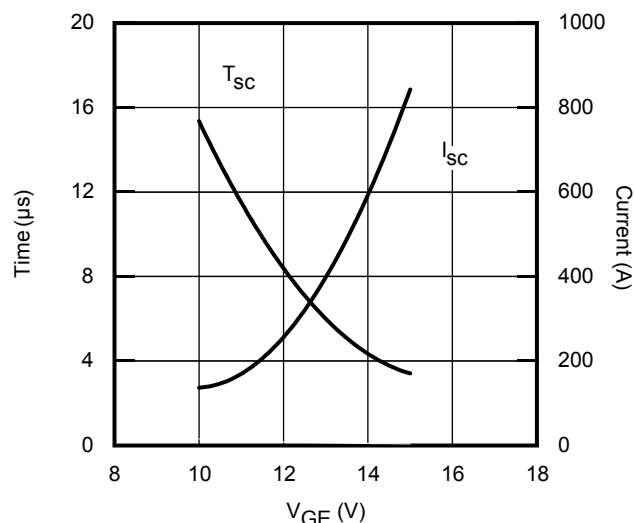
**Fig. 20** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400\text{V}; V_{GE} = 15\text{V}; I_F = 48\text{A}; T_J = 175^\circ\text{C}$



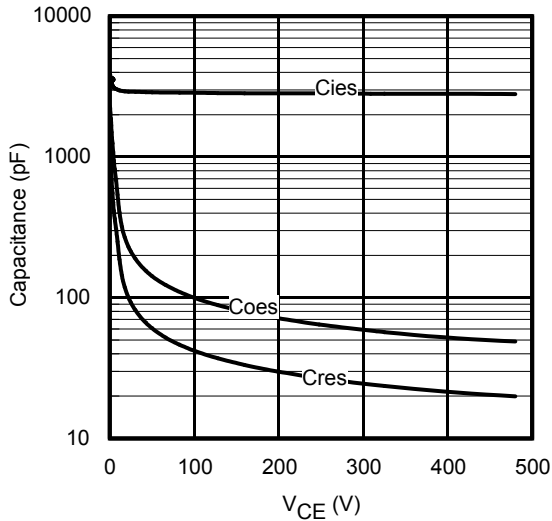
**Fig. 21** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400\text{V}; V_{GE} = 15\text{V}; T_J = 175^\circ\text{C}$



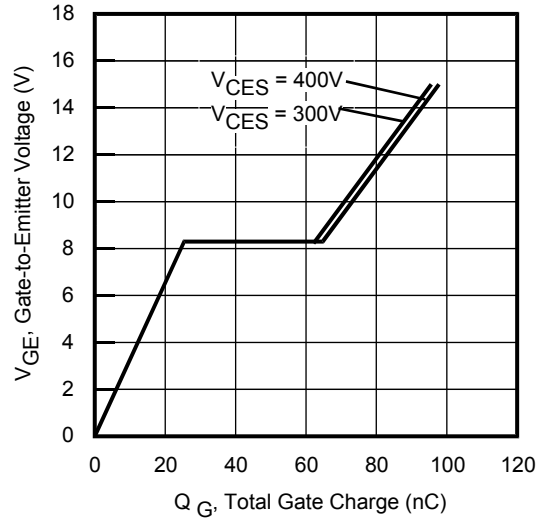
**Fig. 22** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ\text{C}$



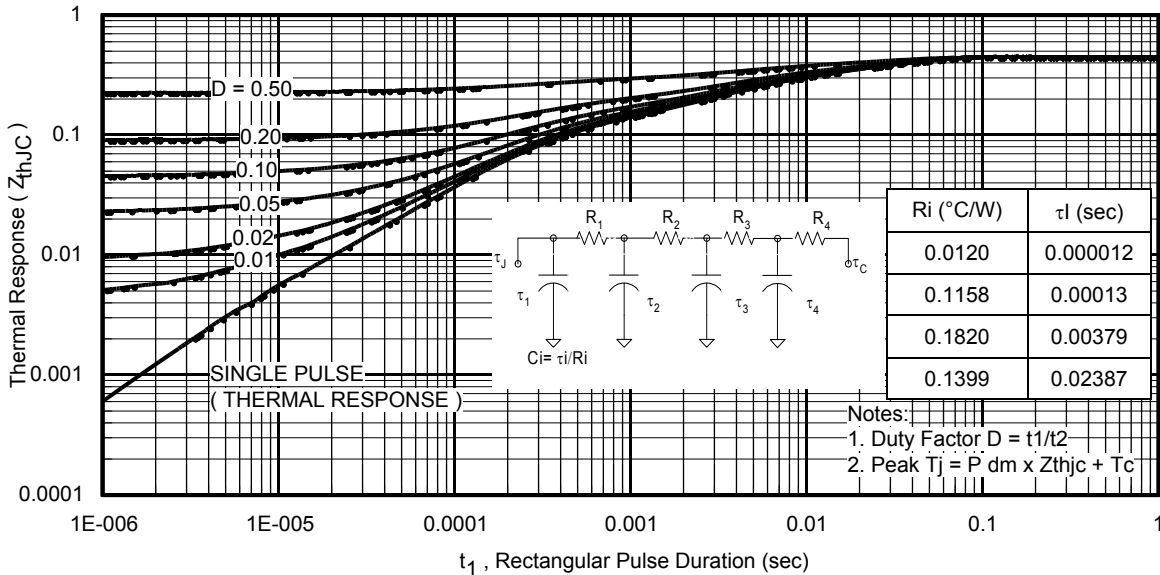
**Fig. 23** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400\text{V}; T_C = 25^\circ\text{C}$



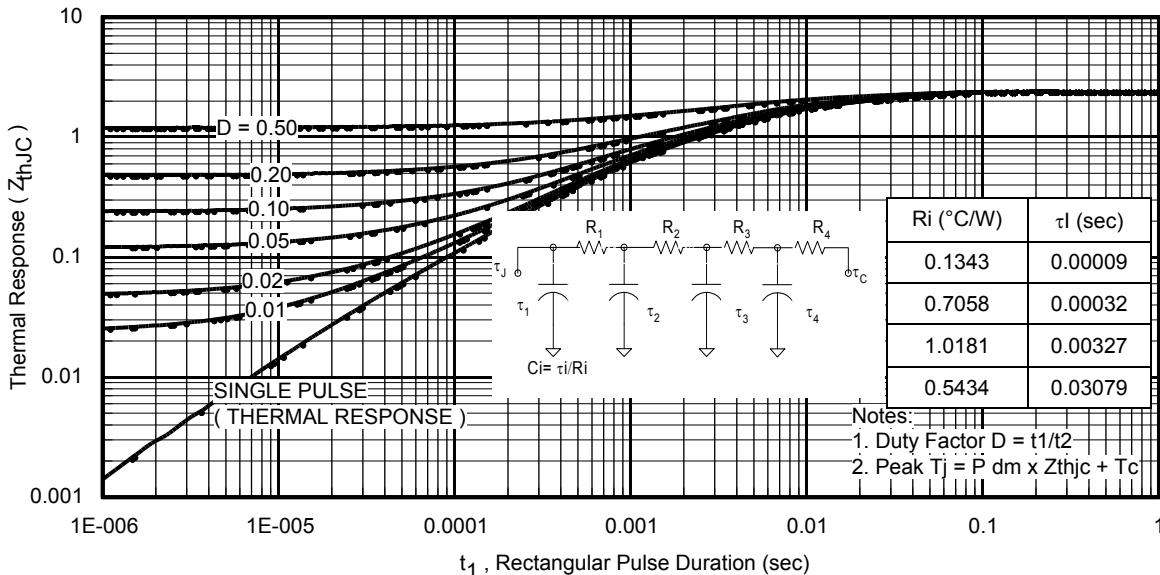
**Fig. 24** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



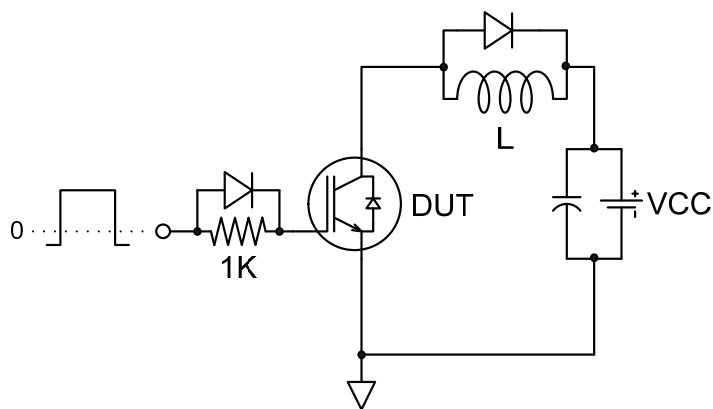
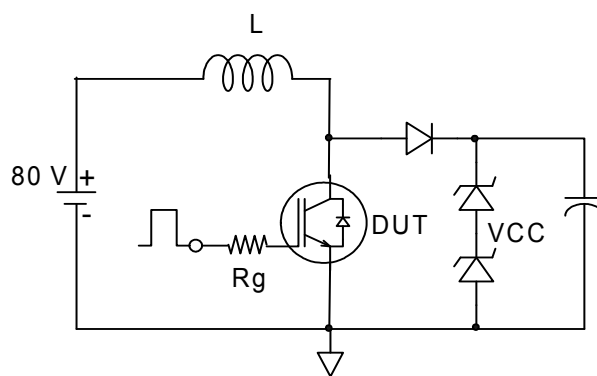
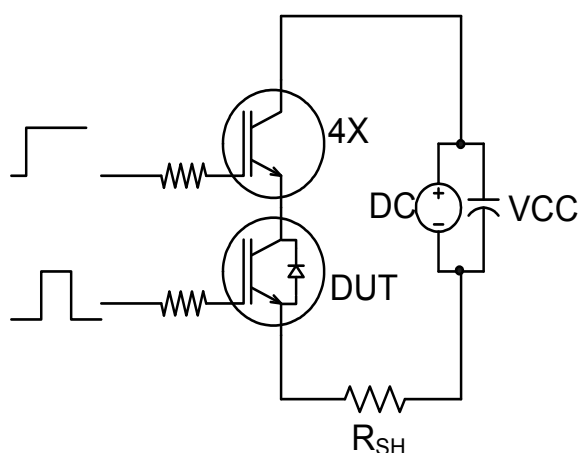
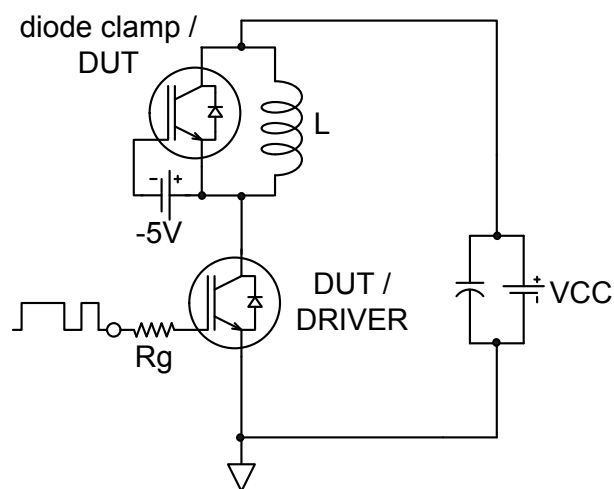
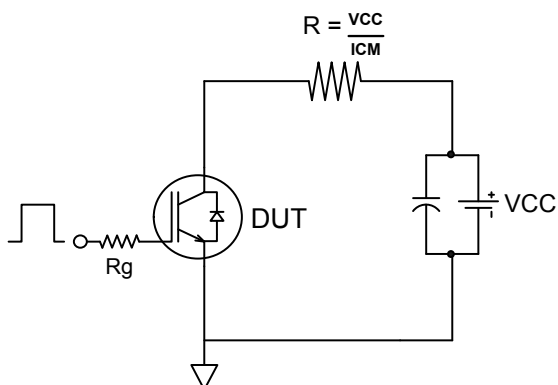
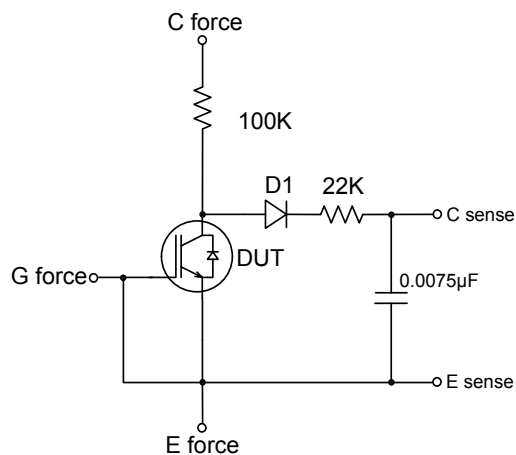
**Fig. 25** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 48A$



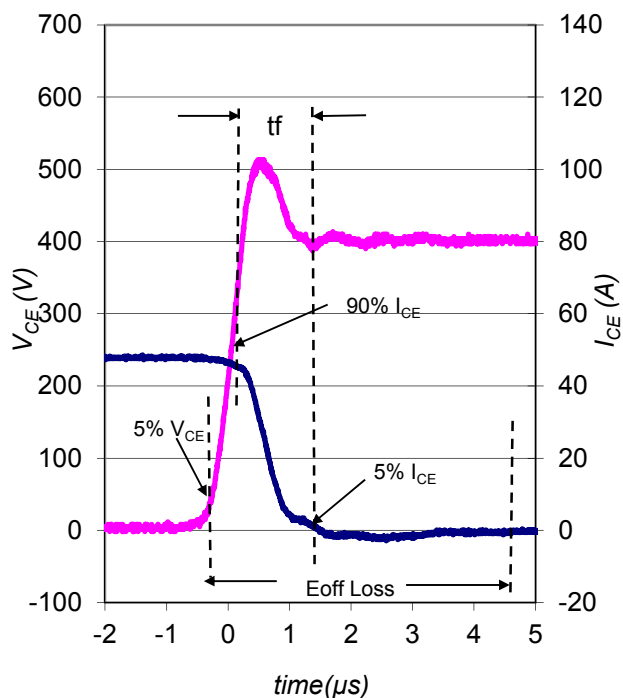
**Fig 27.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



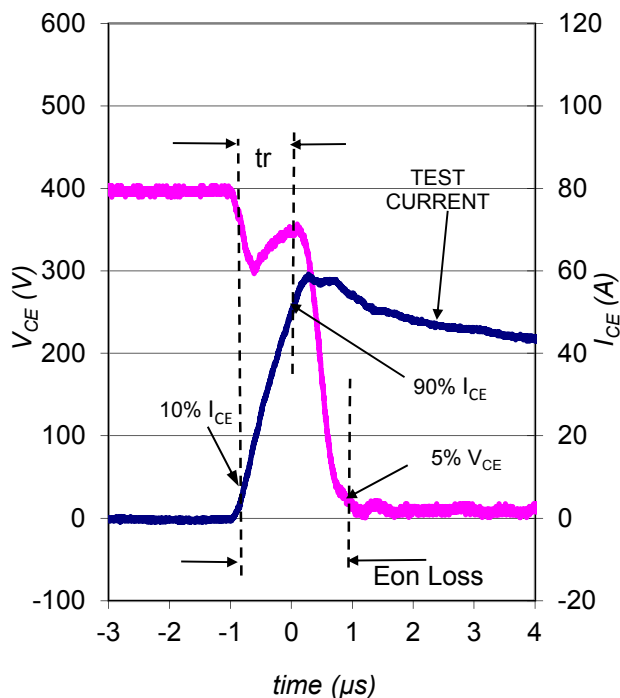
**Fig 28.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)


**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**

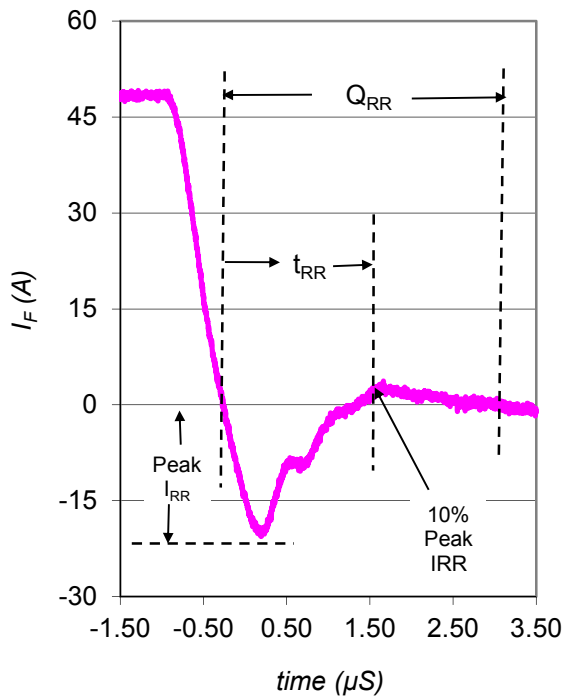




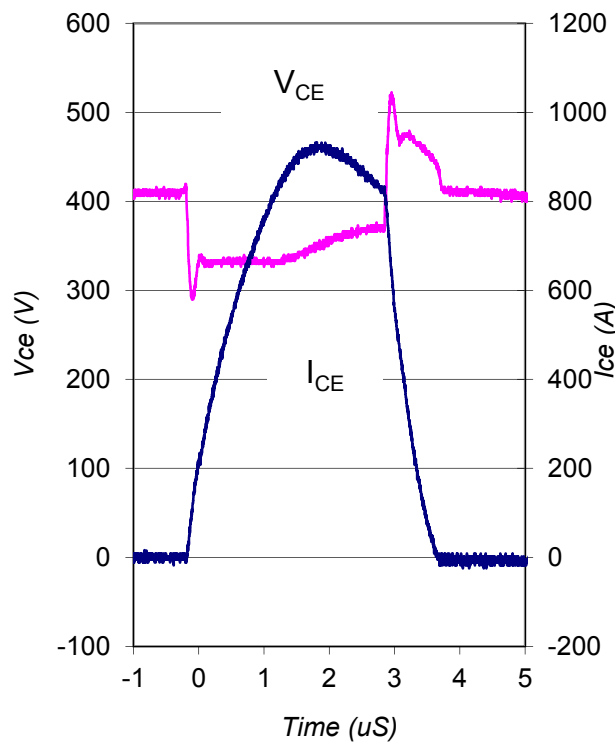
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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



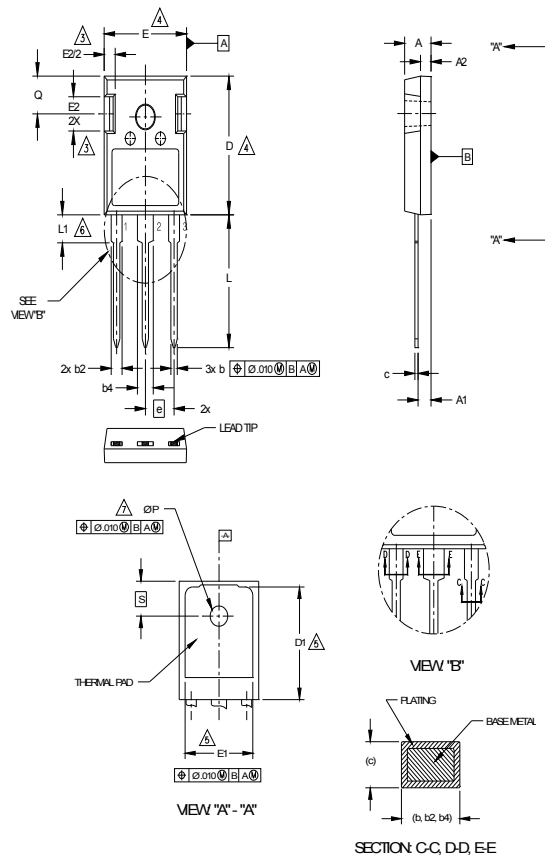
**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.190	.204	4.83	5.20	
A1	.090	.100	2.29	2.54	
A2	.075	.085	1.91	2.16	
b	.042	.052	1.07	1.33	
b2	.075	.094	1.91	2.41	
b4	.113	.133	2.87	3.38	
c	.022	.026	0.55	0.68	
D	.819	.830	20.80	21.10	4
D1	.640	.694	16.25	17.65	5
E	.620	.635	15.75	16.13	4
E1	.512	.570	13.00	14.50	
E2	.145	.196	3.68	5.00	
e	.215 Typical		5.45 Typical		
L	.780	.800	19.80	20.32	
L1	.161	.173	4.10	4.40	
∅ P	.138	.143	3.51	3.65	
Q	.216	.236	5.49	6.00	
S	.238	.248	6.04	6.30	

### LEAD ASSIGNMENTS

#### HEXFET

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

#### IGBTs, CoPACK

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

#### DIODES

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

### NOTES:

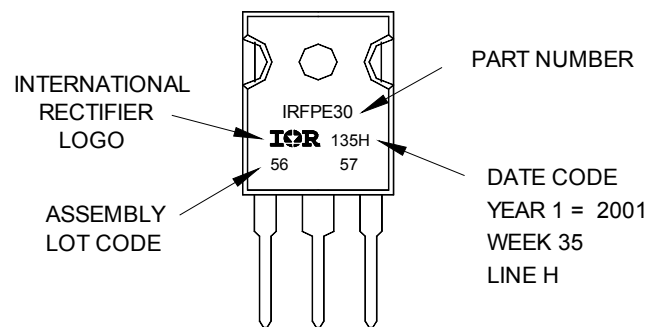
- 1 DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES AND MILLIMETERS.
- 3 CONTOUR OF SLOT OPTIONAL.
- 4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
- 6 LEAD FINISH UNCONTROLLED IN L1.
- 7 ∅ P TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.

## TO-247AC Part Marking Information

Notes: This part marking information applies to devices produced after 02/26/2001

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2001  
IN THE ASSEMBLY LINE "H"

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

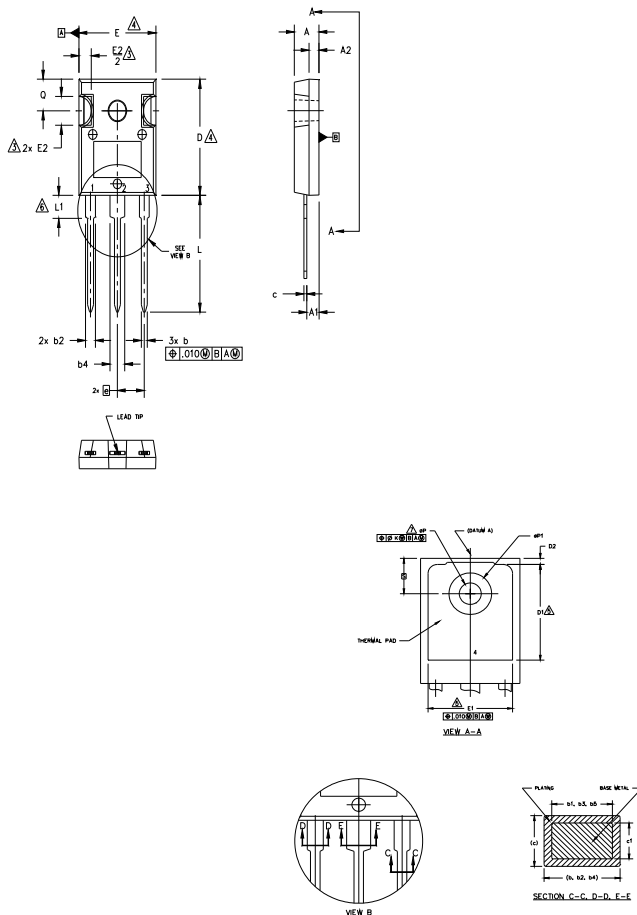


TO-247AC package is not recommended for Surface Mount Application.

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

## TO-247AD Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .006" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. φP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.71	20.70	4
D1	.515	-	13.08	-	5
D2	.020	.053	0.51	1.35	4
E	.602	.625	15.29	15.87	
E1	.530	-	13.46	-	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
φk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
φP	.140	.144	3.56	3.66	
φP1	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

**LEAD ASSIGNMENTS**

**HEXFET**

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

**IGBTs, CoPACK**

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

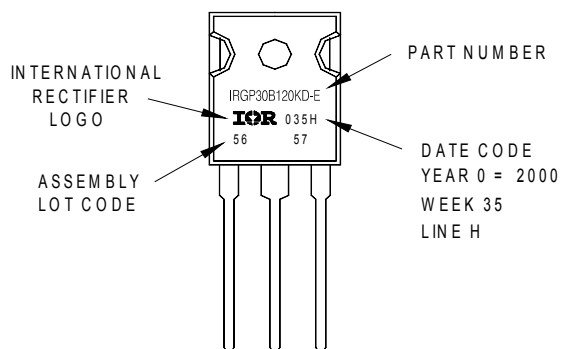
**DIODES**

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

## TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRGP30B120KD-E WITH ASSEMBLY LOT CODE 5657 ASSEMBLED ON WW 35, 2000 IN THE ASSEMBLY LINE "H"

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



TO-247AD 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<sup>†</sup>**

<b>Qualification Level</b>	Industrial (per JEDEC JESD47F) <sup>††</sup>	
<b>Moisture Sensitivity Level</b>	TO-247AC	N/A
	TO-247AD	
<b>RoHS Compliant</b>	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.

Data and specifications subject to change without notice.

International  
 Rectifier

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TAC Fax: (310) 252-7903

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