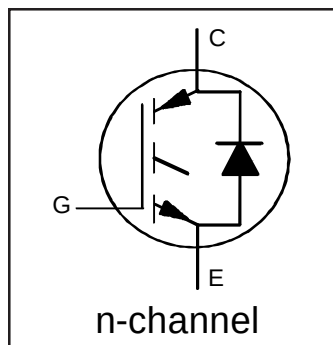


INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS

Features

- Low $V_{CE(ON)}$ trench IGBT Technology
- Low Switching Losses
- Square RBSOA
- Ultra-Low V_F Diode
- 1300Vpk Repetitive Transient Capacity
- 100% of the Parts Tested for I_{LM} ①
- Positive $V_{CE(ON)}$ Temperature Co-Efficient
- Tight Parameter Distribution
- Lead Free Package



$V_{CES} = 1200V$

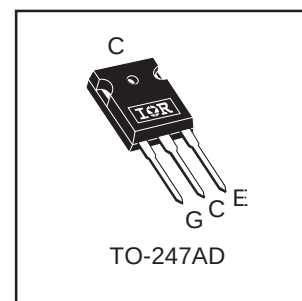
$I_C = 25A, T_C = 100^\circ C$

$T_{J(max)} = 150^\circ C$

$V_{CE(on)} \text{ typ.} = 1.9V @ I_C = 20A$

Benefits

- Device optimized for induction heating and soft switching applications
- High Efficiency due to Low $V_{CE(on)}$, low switching losses and Ultra-low V_F
- Rugged transient performance for increased reliability
- Excellent current sharing in parallel operation
- Low EMI



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable part number
		Form	Quantity	
IRG7PH35UD1MPbF	TO-247AD	Tube	25	IRG7PH35UD1MPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$V_{(BR)Transist}$	Repetitive Transient Collector-to-Emitter Voltage ⑥	1300	
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	50	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	25	
I_{CM}	Pulse Collector Current, $V_{GE}=15V$ ② ⑤	150	
I_{LM}	Clamped Inductive Load Current, $V_{GE}=20V$ ①	80	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	50	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	25	
I_{FM}	Diode Maximum Forward Current ②	80	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 30	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	179	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	71	
T_J	Operating Junction and	-55 to +150	$^\circ C$
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) ④	—	—	0.70	$^\circ C/W$
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ④	—	—	1.35	
$R_{\theta CS}$	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 Vdage	1200	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES} / \Delta T_J$	Temperature Coeff. of Breakdown Vdage	—	1.2	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.9	2.2	V	$I_C = 20A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.3	—		$I_C = 20A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0	V	$V_{CE} = V_{GE}, I_C = 600\mu A$
g_{fe}	Forward Transconductance	—	22	—	S	$V_{CE} = 50V, I_C = 20A, PW = 30\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	100	μA	$V_{GE} = 0V, V_{CE} = 1200V$
		—	120	—		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.15	1.26	V	$I_F = 20A$
		—	1.08	—		$I_F = 20A, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 30V$

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	85	130	nC	$I_C = 20A$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	15	20		$V_{GE} = 15V$
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	35	50		$V_{CC} = 600V$
E_{off}	Turn-Off Switching Loss	—	620	850	μJ	$I_C = 20A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$ Energy losses include tail
$t_{d(off)}$	Turn-Off delay time	—	160	180	ns	$I_C = 20A, V_{CC} = 600V, V_{GE} = 15V$
t_f	Fall time	—	80	105		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$
E_{off}	Turn-Off Switching Loss	—	1120	—	μJ	$I_C = 20A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 150^\circ\text{C}$ Energy losses include tail
$t_{d(off)}$	Turn-Off delay time	—	190	—	ns	$I_C = 20A, V_{CC} = 600V, V_{GE} = 15V$
t_f	Fall time	—	210	—		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 150^\circ\text{C}$
C_{ies}	Input Capacitance	—	1940	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	120	—		$V_{CC} = 30V$
C_{res}	Reverse Transfer Capacitance	—	40	—		$f = 1.0MHz$
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 80A$ $V_{CC} = 960V, V_p = 1200V$ $R_g = 10\Omega, V_{GE} = +20V$ to 0V

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, R_G = 10\Omega$.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ④ R_θ is measured at T_J approximately 90 $^\circ\text{C}$.
- ⑤ FBSOA operating conditions only.
- ⑥ $V_{GE} = 0V, T_J = 75^\circ\text{C}, PW \leq 10\mu s$.

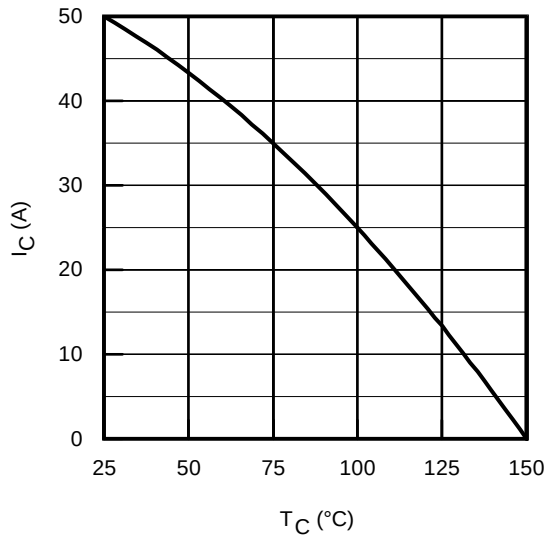


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

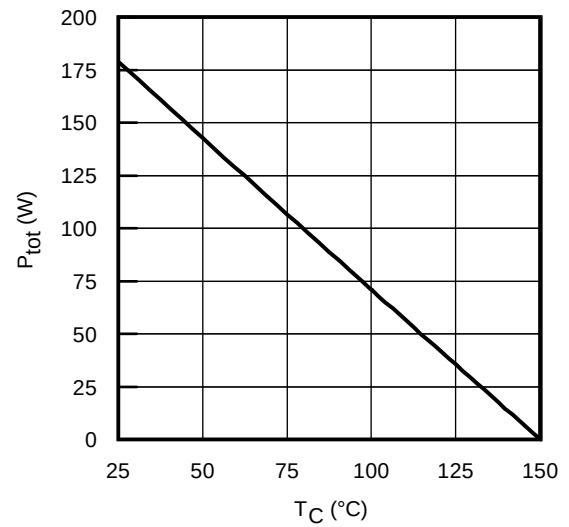


Fig. 2 - Power Dissipation vs. Case Temperature

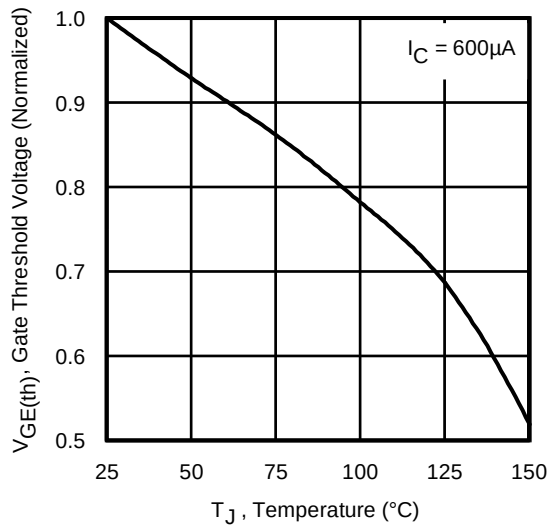


Fig. 3 - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

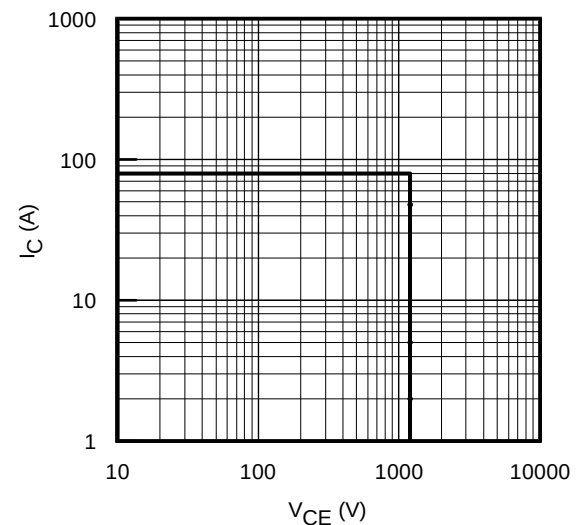


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 20\text{V}$

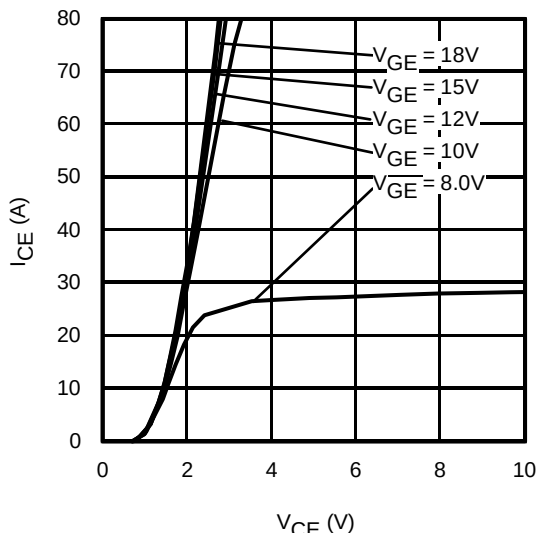


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 30\mu s$

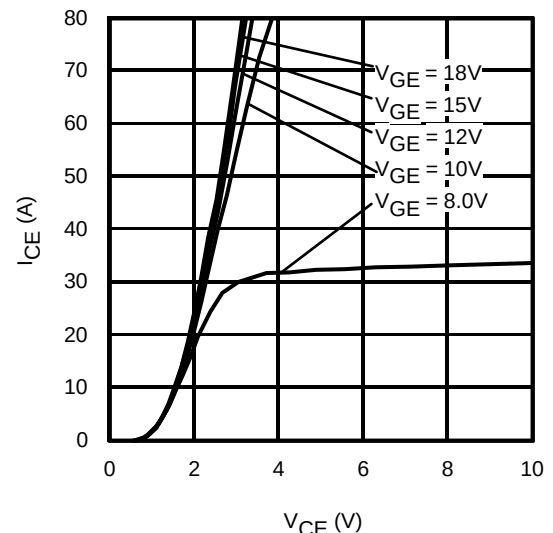


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 30\mu s$

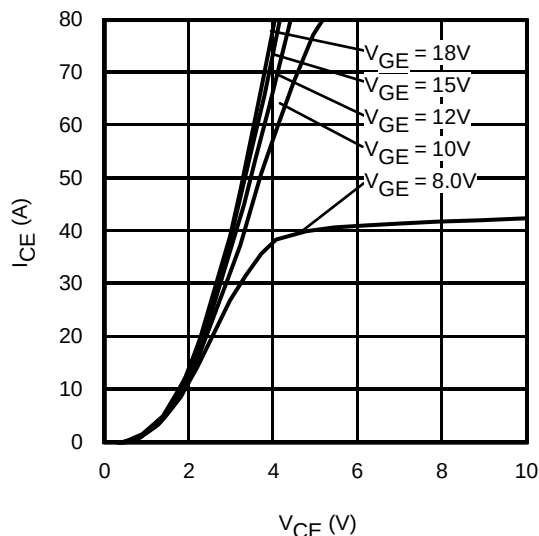


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 30\mu\text{s}$

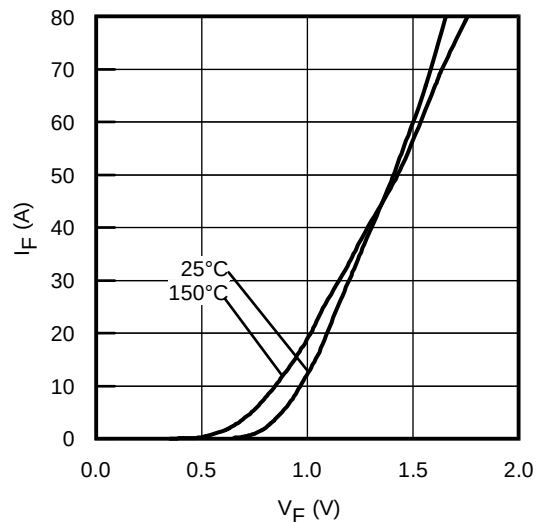


Fig. 8 - Typ. Diode Forward Voltage Drop Characteristics

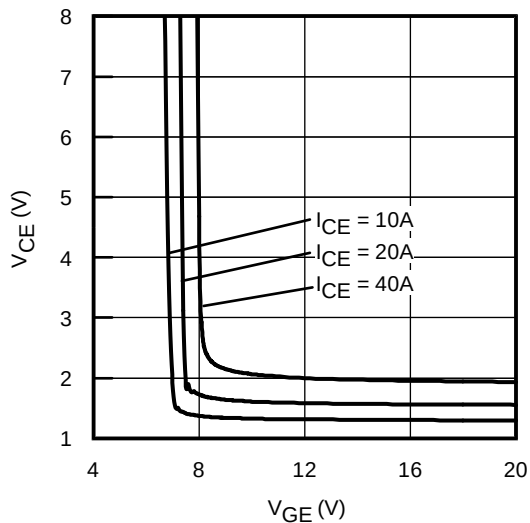


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

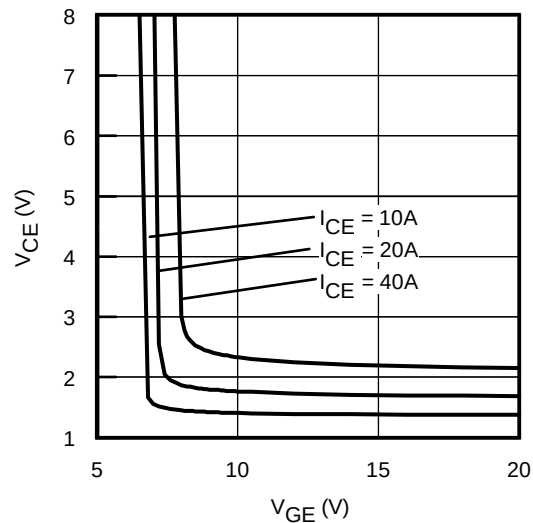


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

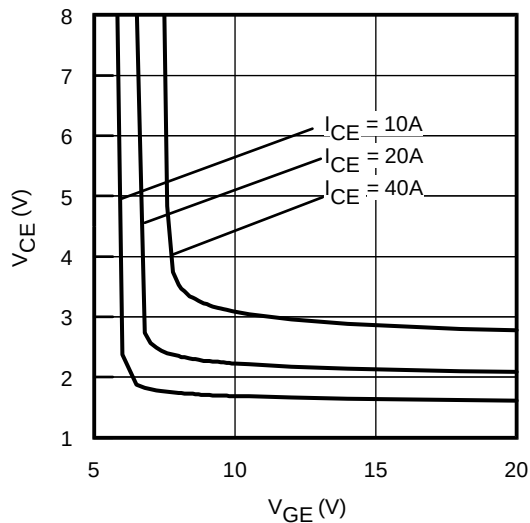


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

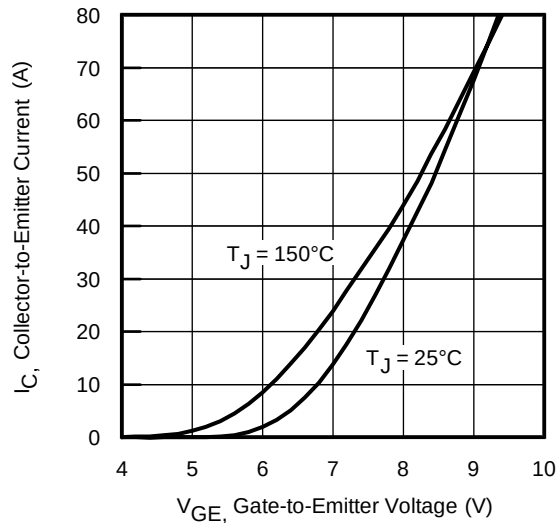


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 30\mu\text{s}$

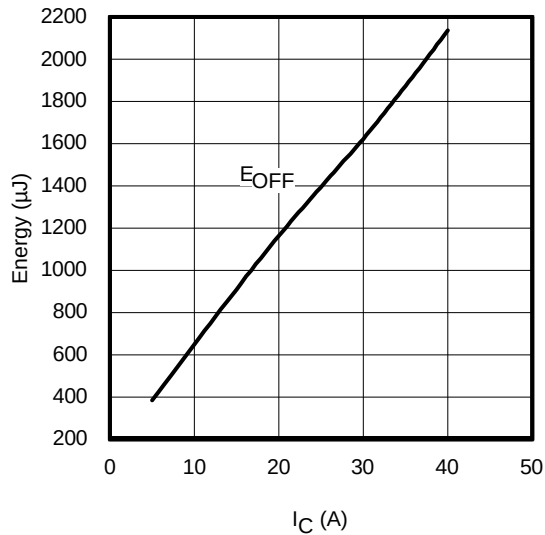


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 680\mu\text{H}$; $V_{CE} = 600\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

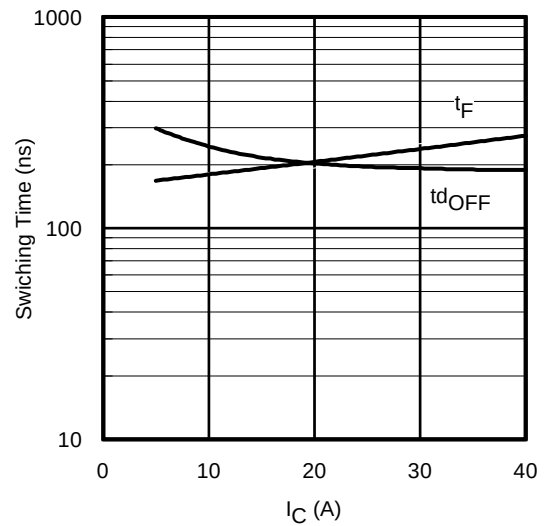


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 680\mu\text{H}$; $V_{CE} = 600\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

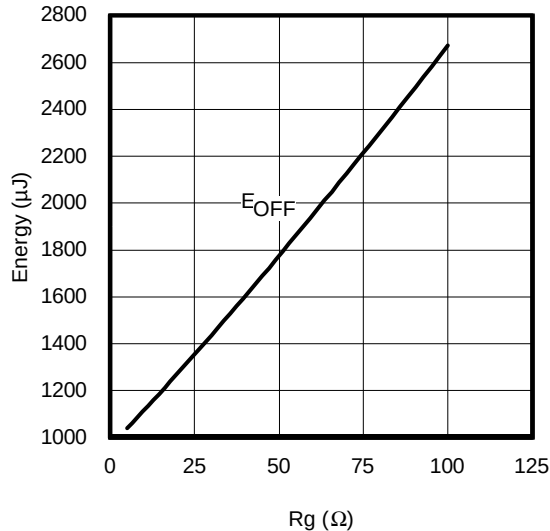


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 680\mu\text{H}$; $V_{CE} = 600\text{V}$; $I_{CE} = 20\text{A}$; $V_{GE} = 15\text{V}$

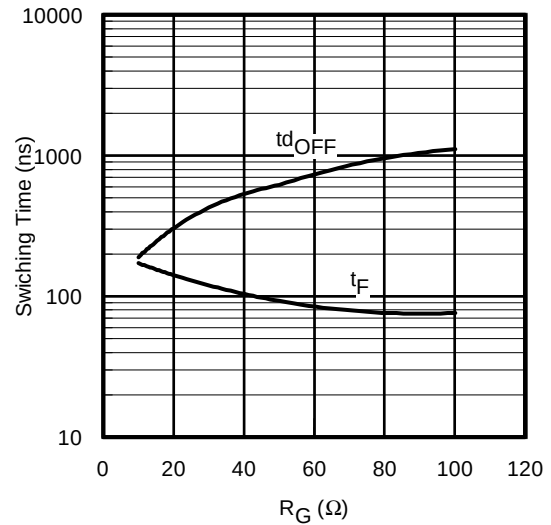


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 680\mu\text{H}$; $V_{CE} = 600\text{V}$; $I_{CE} = 20\text{A}$; $V_{GE} = 15\text{V}$

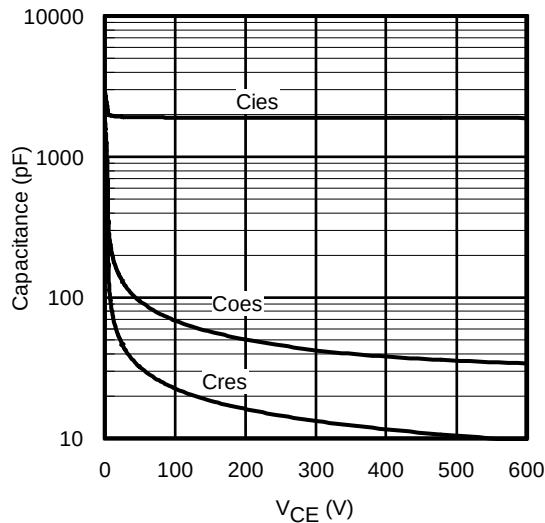


Fig. 17 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

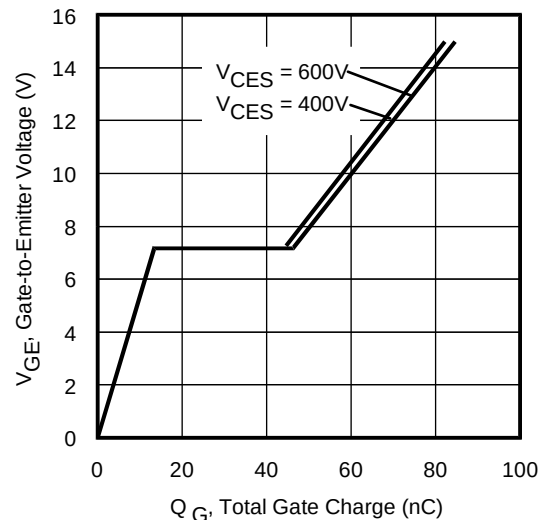
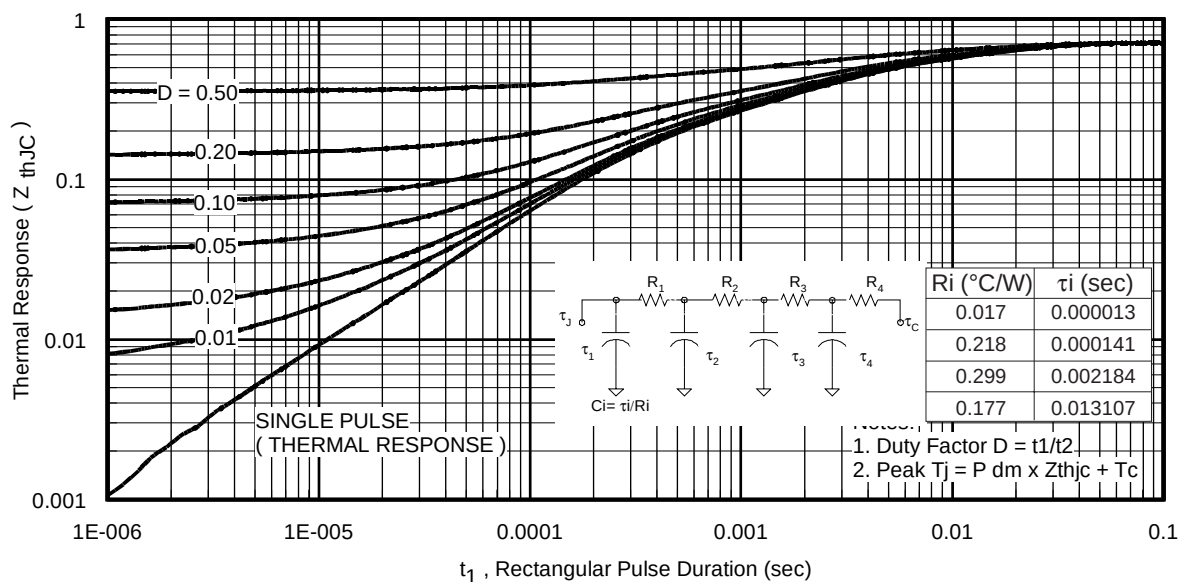
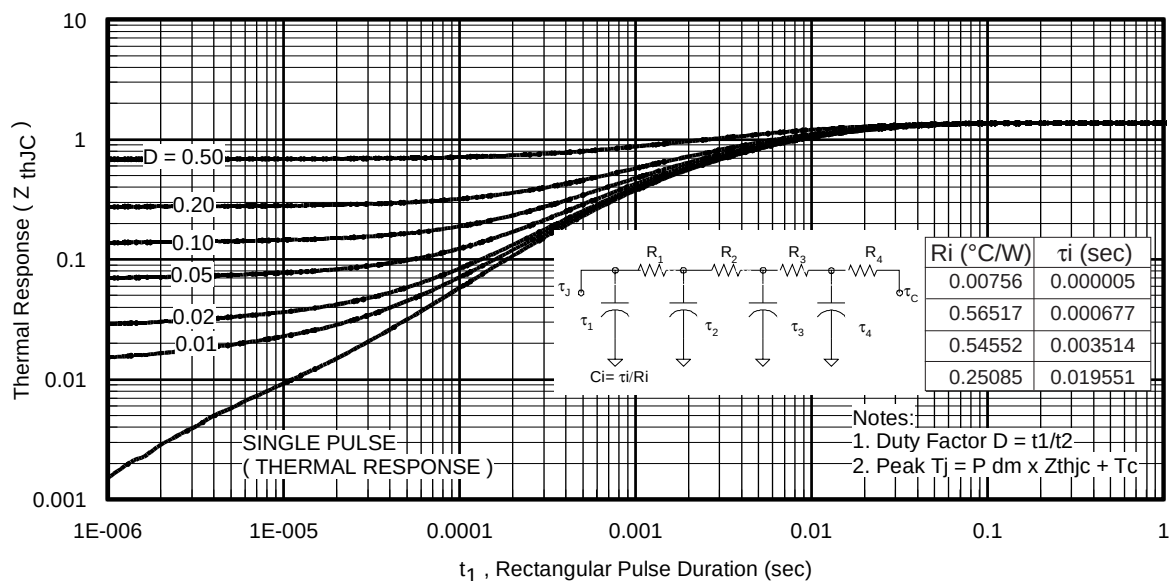
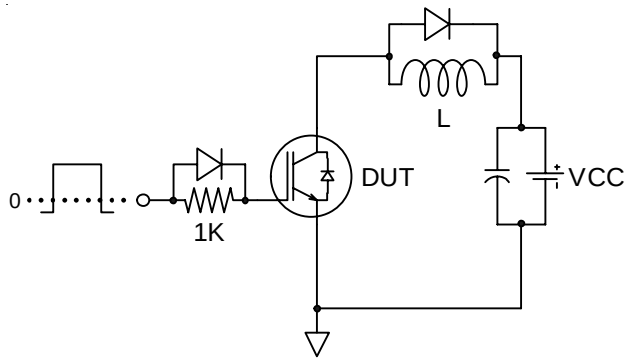
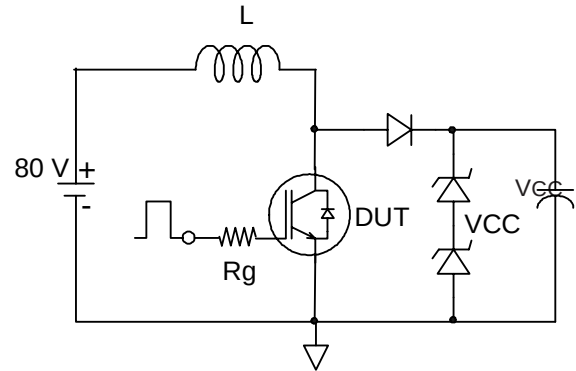
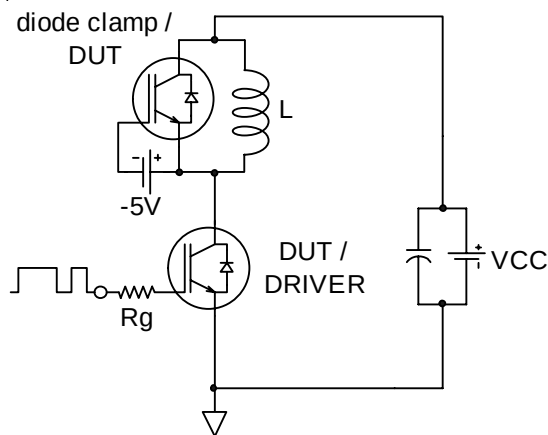
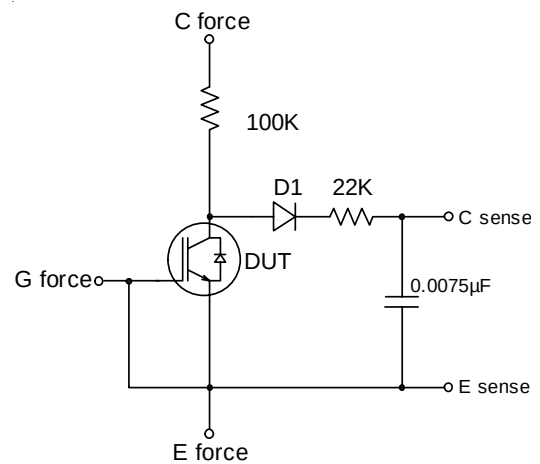
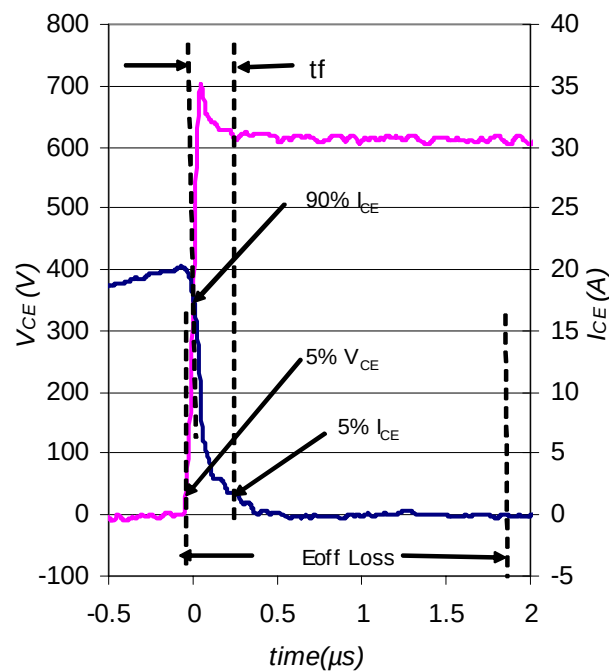


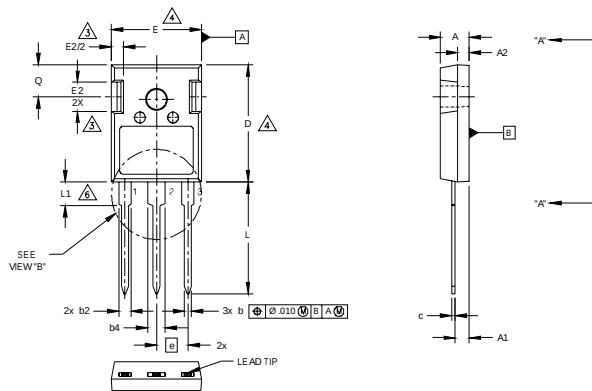
Fig. 18 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 20\text{A}$; $L = 2.4\text{mH}$


Fig 19. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

Fig. 20. 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 - Switching Loss Circuit

Fig.C.T.4 - BVCES Filter Circuit

Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.3

TO-247AD Package Outline

(Dimensions are shown in millimeters (inches))



SYMBOL	D I M E N S I O N S				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.190	.204	4.83	5.20	4 5 4
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	
D1	.640	.694	16.25	17.65	
E	.620	.635	15.75	16.13	
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	
ø P	.138	.143	3.51	3.65	
Q	.216	.236	5.49	6.00	
S	.238	.248	6.04	6.30	

LEAD ASSIGNMENTS

HEXFET

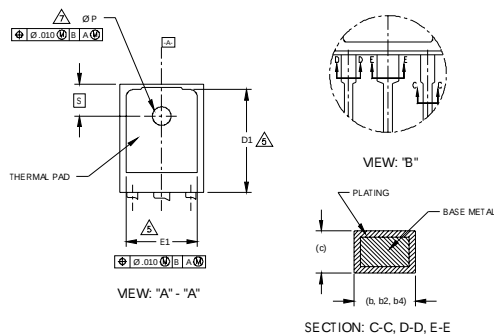
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

IGBTs, CoPACK

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

DIODES

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



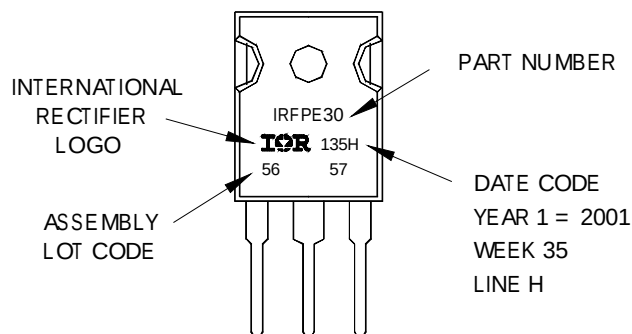
NOTES:

- 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 ø 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-247AD Part Marking Information

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-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[†]

Qualification level	Industrial ^{††} (per JEDEC JESD47F ^{†††} guidelines)	
Moisture Sensitivity Level	TO-247AD	N/A (per JEDEC J-STD-020D ^{†††})
RoHS compliant	Yes	

[†] Qualification standards can be found at International Rectifier's web site

<http://www.irf.com/product-info/reliability>

^{††} Higher qualification ratings may be available should the user have such requirements.
Please contact your International Rectifier sales representative for further information:

<http://www.irf.com/whoto-call/salesrep/>

^{†††} Applicable version of JEDEC standard at the time of product release.

International
 Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA
 To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>