

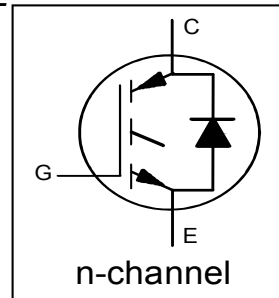
**INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW V_F DIODE
FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS**

Features

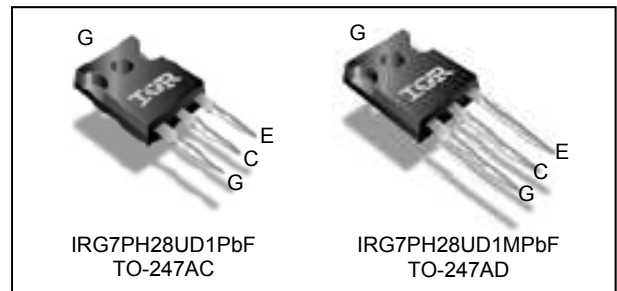
- Low V_{CE(ON)} trench IGBT technology
- Low switching losses
- Square RBSOA
- Ultra-low V_F diode
- 1300Vpk repetitive transient capacity
- 100% of the parts tested for I_{LM}①
- Positive V_{CE(ON)} temperature co-efficient
- Tight parameter distribution
- Lead-free package

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



V _{CES} = 1200V
I _C = 15A, T _C = 100°C
T _{J(MAX)} = 150°C
V _{CE(ON)} typ. = 1.95V



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRG7PH28UD1PbF	TO-247AC	Tube	25	IRG7PH28UD1PbF
IRG7PH28UD1MPbF	TO-247AD	Tube	25	IRG7PH28UD1MPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V _{CES}	Collector-to-Emitter Voltage	1200	V
V _{(BR) Transient}	Repetitive Transient Collector-to-Emitter Voltage ⑥	1300	
I _C @ T _C = 25°C	Continuous Collector Current	30	A
I _C @ T _C = 100°C	Continuous Collector Current	15	
I _{CM}	Pulse Collector Current, V _{GE} = 15V ②⑤	100	
I _{LM}	Clamped Inductive Load Current, V _{GE} = 20V ①	60	
I _F @ T _C = 25°C	Diode Continuous Forward Current	30	
I _F @ T _C = 100°C	Diode Continuous Forward Current	15	
I _{FM}	Diode Maximum Forward Current ②	60	
V _{GE}	Continuous Gate-to-Emitter Voltage	±30	V
P _D @ T _C = 25°C	Maximum Power Dissipation	115	W
P _D @ T _C = 100°C	Maximum Power Dissipation	46	
T _J	Operating Junction and Storage Temperature Range	-55 to +150	°C
T _{STG}			
	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)	Junction-to-Case (IGBT) ④	—	—	1.09	°C/W
$R_{\theta JC}$ (Diode)	Junction-to-Case (Diode) ④	—	—	1.35	
$R_{\theta CS}$	Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient (typical socket mount)	—	—	40	

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

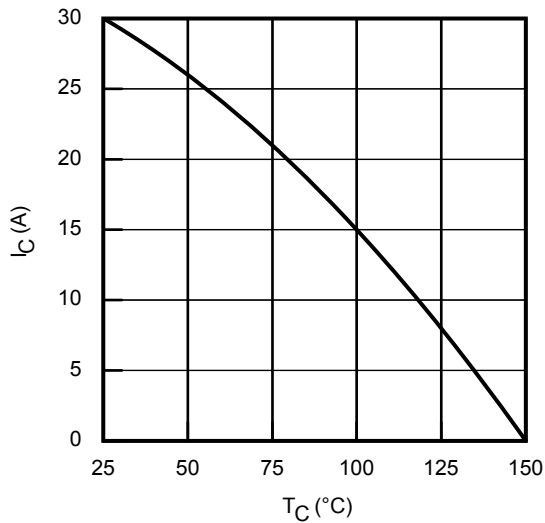
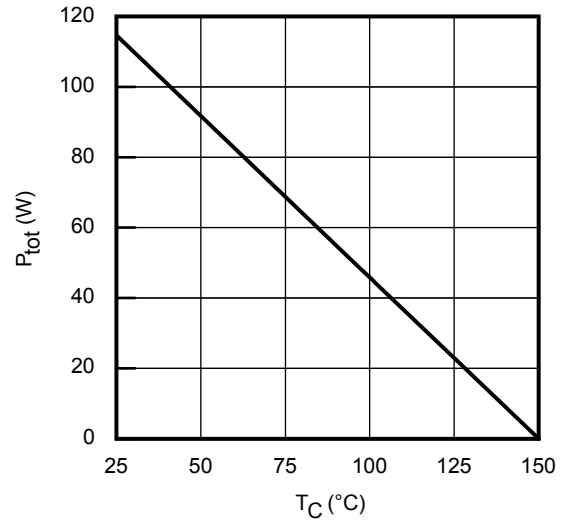
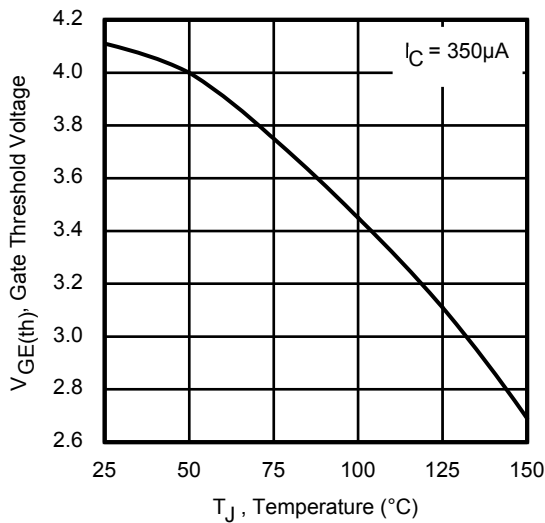
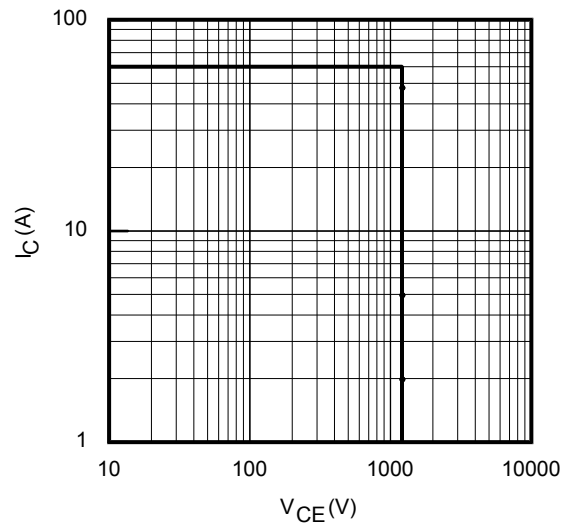
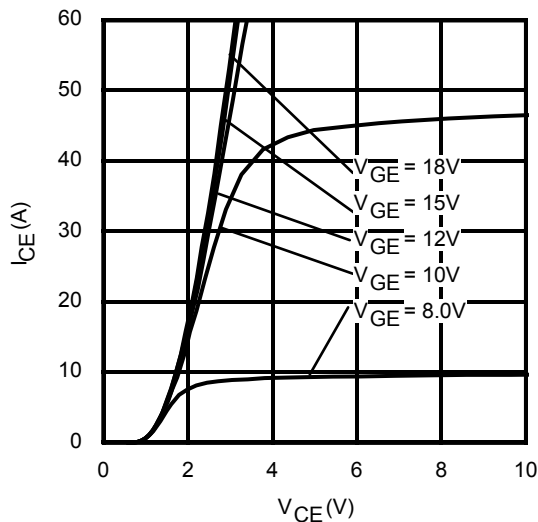
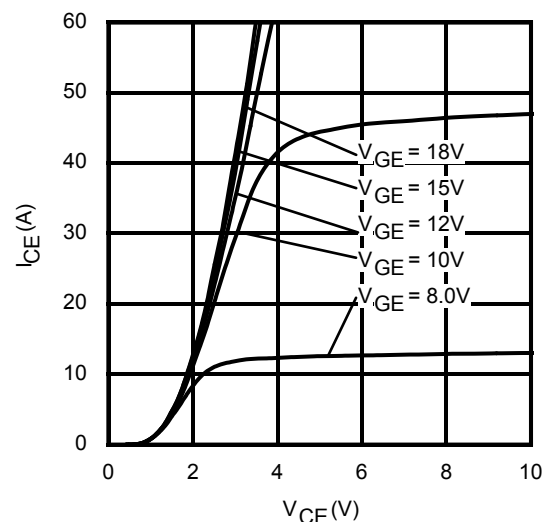
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.4	—	V/°C	$V_{GE} = 0V, I_C = 1mA$ (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.95	2.30	V	$I_C = 15A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.4	—		$I_C = 15A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0	V	$V_{CE} = V_{GE}, I_C = 350\mu A$
g_{fe}	Forward Transconductance	—	13	—	S	$V_{CE} = 50V, I_C = 15A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	100	μA	$V_{GE} = 0V, V_{CE} = 1200V$
		—	100	—		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.1	1.2	V	$I_F = 15A$
		—	1.0	—		$I_F = 15A, T_J = 150^\circ\text{C}$
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)	—	60	90	nC	$I_C = 15A$ $V_{GE} = 15V$ $V_{CC} = 600V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	10	15		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	27	40		
E_{off}	Turn-Off Switching Loss	—	543	766	μJ	$I_C = 15A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 22\Omega, L = 1.0mH, T_J = 25^\circ\text{C}$
$t_{d(off)}$	Turn-Off delay time	—	229	—	ns	Energy losses include tail & diode reverse recovery
t_f	Fall time	—	62	—		
E_{off}	Turn-Off Switching Loss	—	939	—	μJ	$I_C = 15A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 22\Omega, L = 1.0mH, T_J = 150^\circ\text{C}$
$t_{d(off)}$	Turn-Off delay time	—	272	—	ns	Energy losses include tail & diode reverse recovery
t_f	Fall time	—	167	—		
C_{ies}	Input Capacitance	—	1160	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0Mhz$
C_{oes}	Output Capacitance	—	55	—		
C_{res}	Reverse Transfer Capacitance	—	30	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 60A$ $V_{CC} = 960V, V_p \leq 1200V$ $R_g = 22\Omega, V_{GE} = +20V \text{ to } 0V$

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 25\mu H, R_G = 22\Omega$.
- 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 of approximately 90°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 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
 $T_J = -40^\circ\text{C}; t_p = 20\mu\text{s}$

Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}; t_p = 20\mu\text{s}$

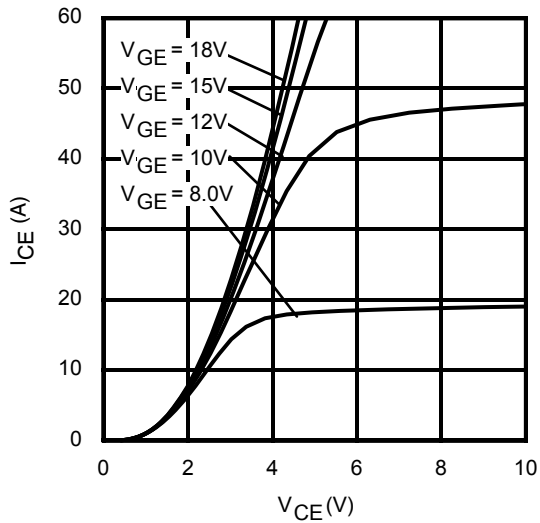


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 20\mu\text{s}$

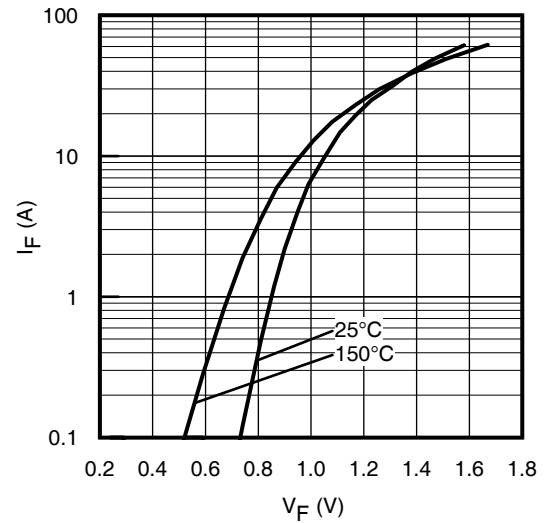


Fig. 8 - Typ. Diode Forward Voltage Drop Characteristics

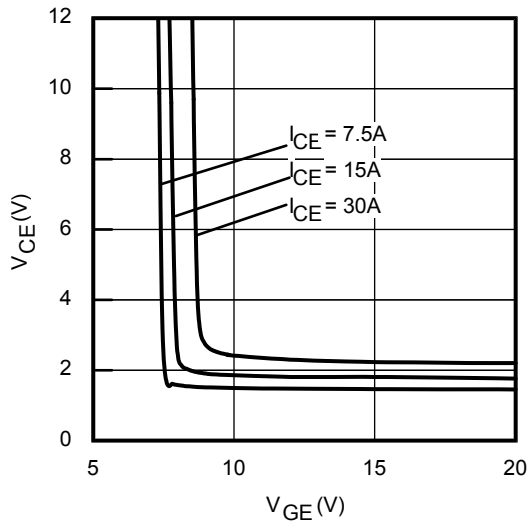


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

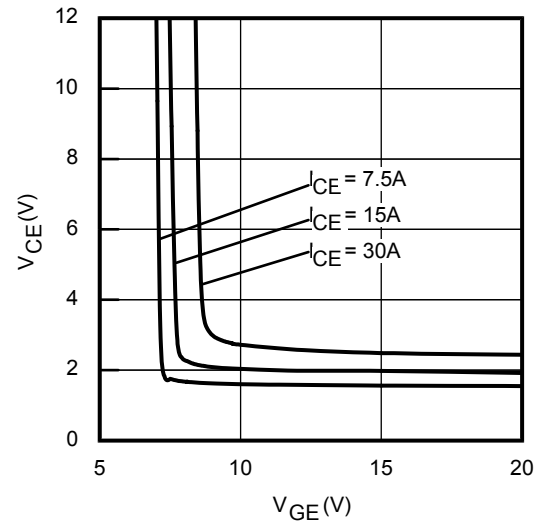


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

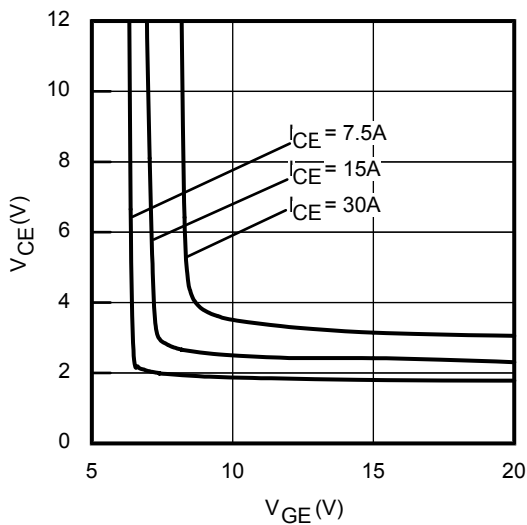


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

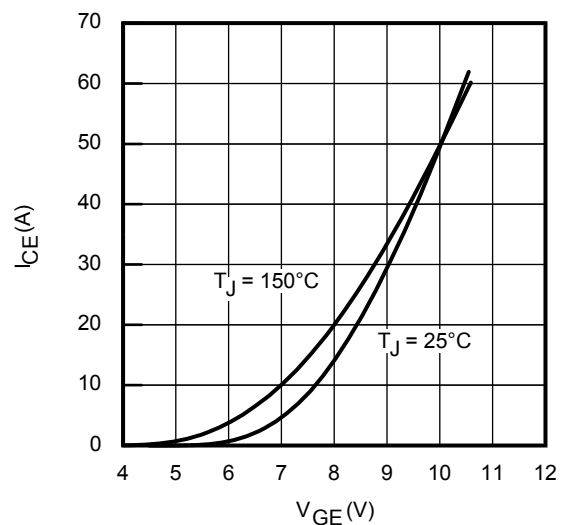
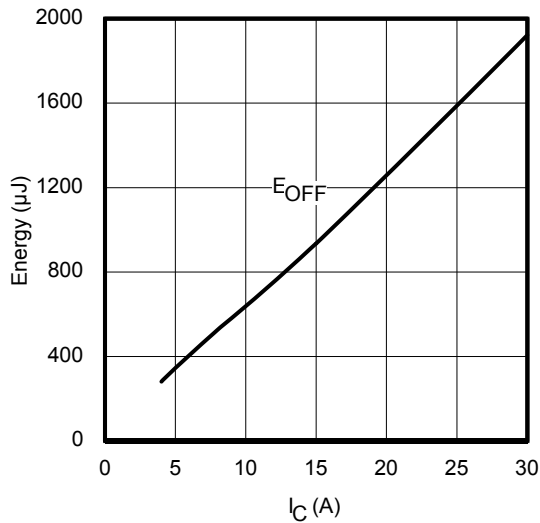
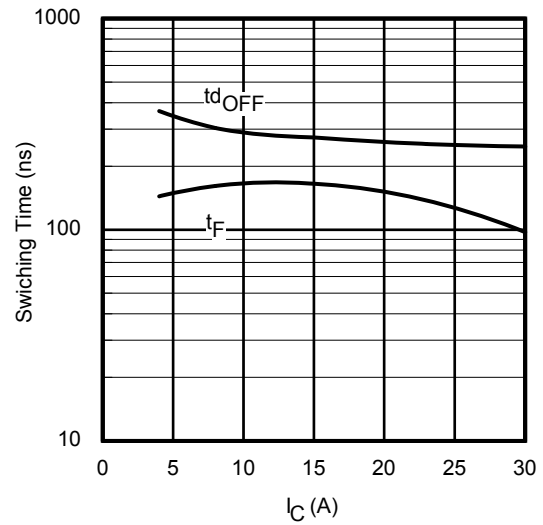
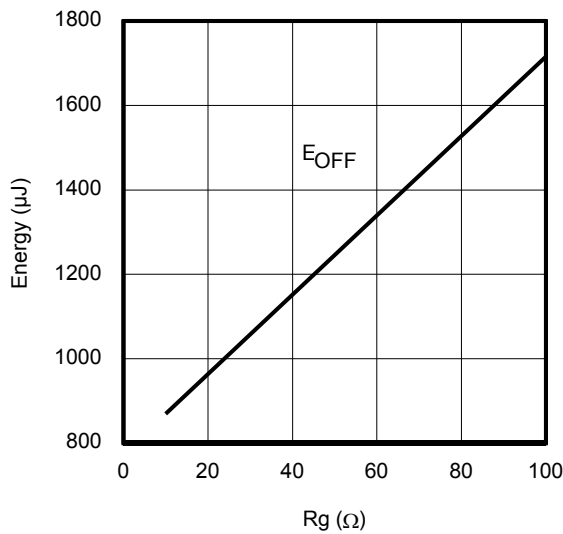
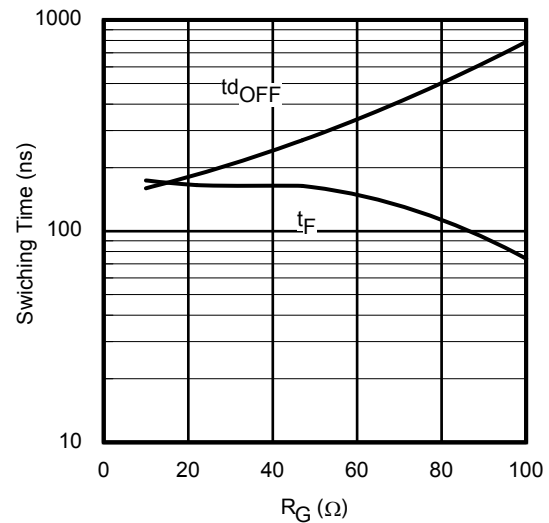
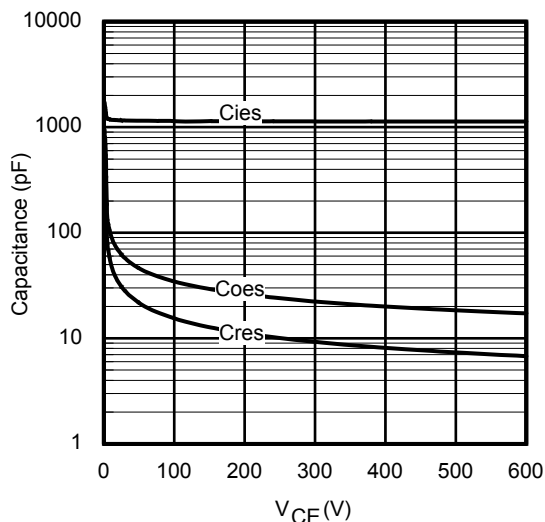
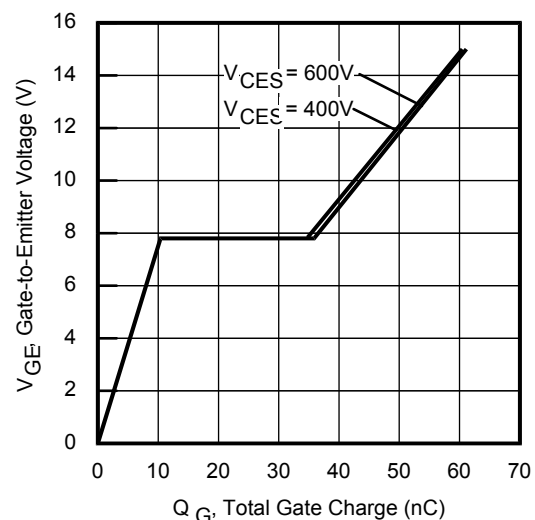
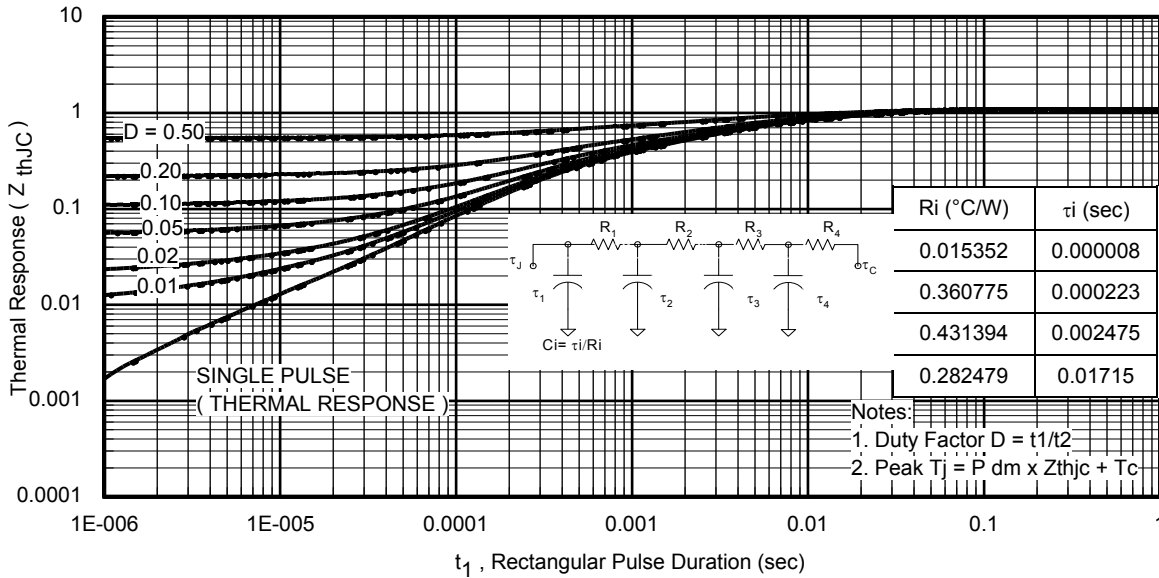
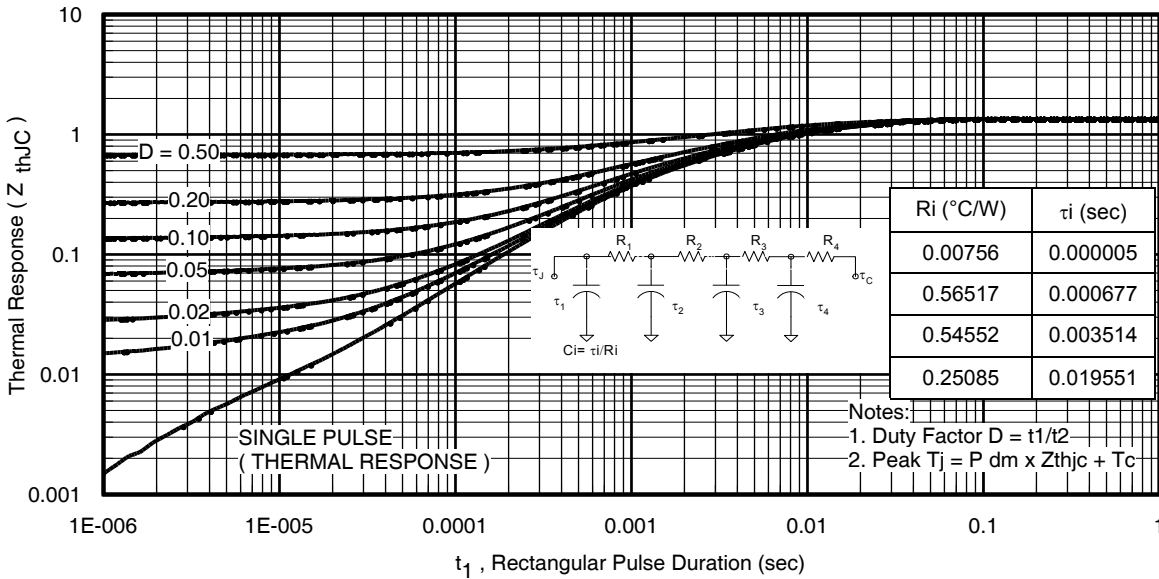
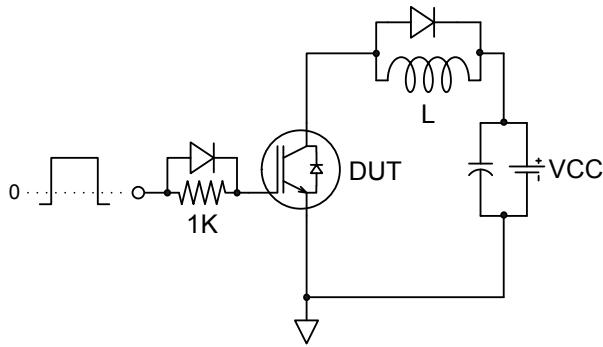
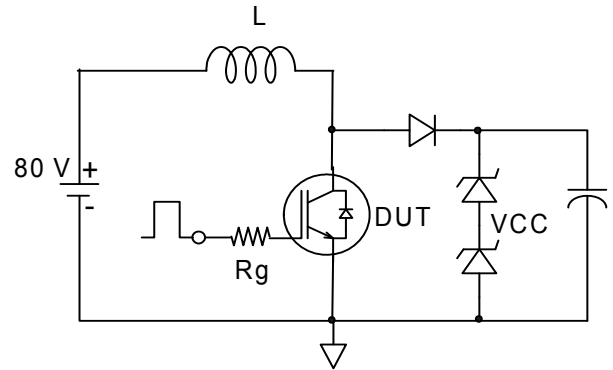
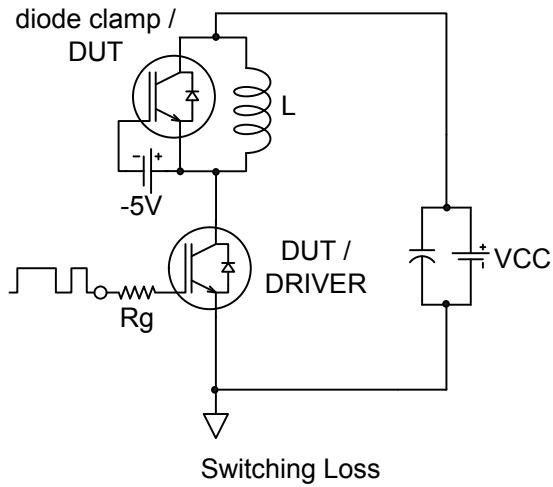
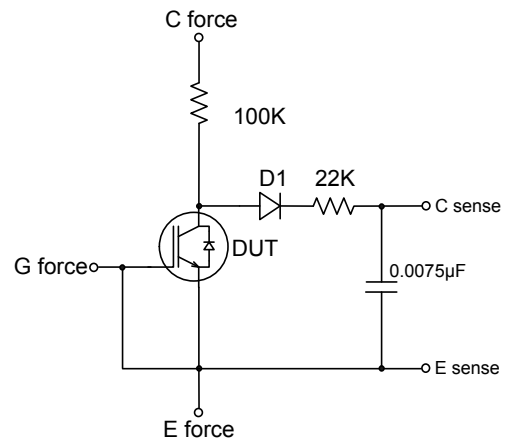
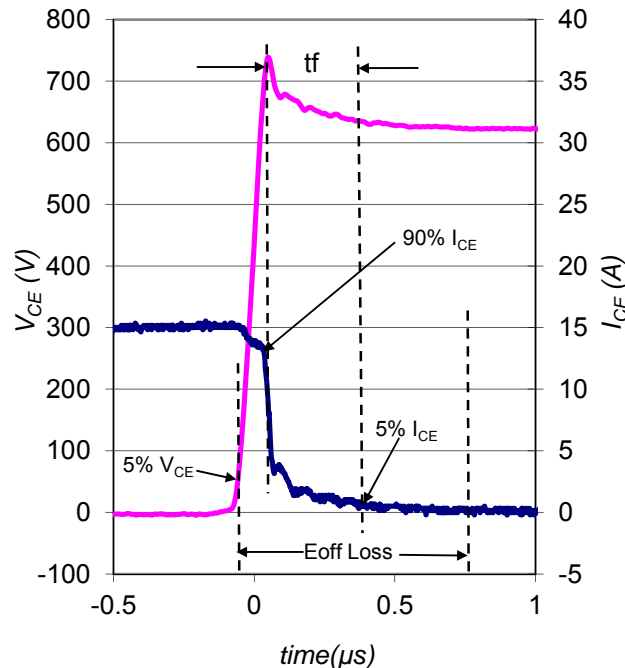


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

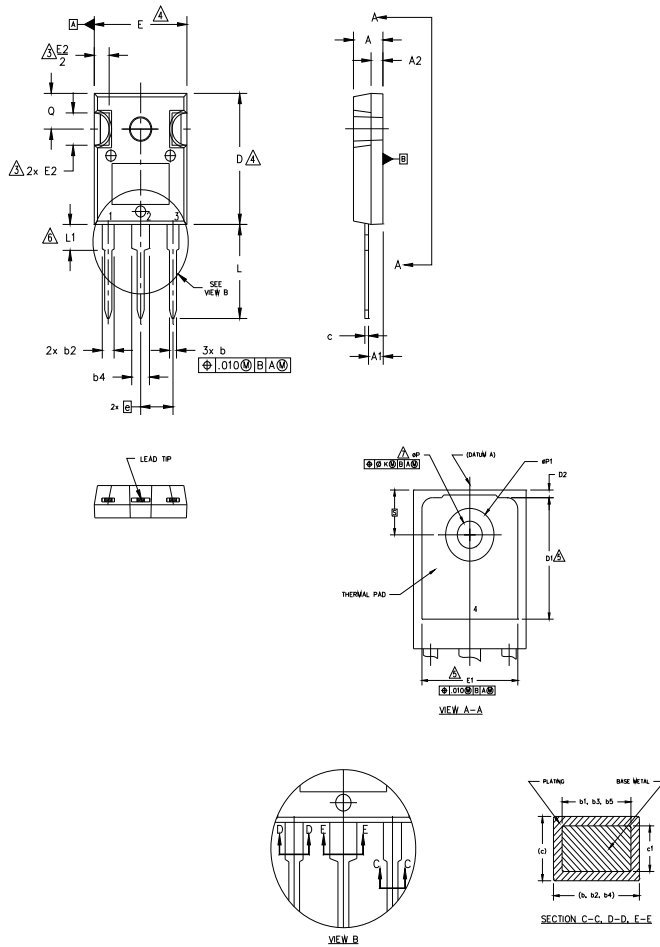

Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}; L = 1.0\text{mH}; V_{CE} = 600\text{V}, R_G = 22\Omega; V_{GE} = 15\text{V}$

Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}; L = 1.0\text{mH}; V_{CE} = 600\text{V}, R_G = 22\Omega; V_{GE} = 15\text{V}$

Fig. 15 - Typ. Energy Loss vs. R_G

Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}; L = 1.0\text{mH}; V_{CE} = 600\text{V}, I_{CE} = 15\text{A}; V_{GE} = 15\text{V}$

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

Fig. 18 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 15\text{A}$


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

Switching Loss
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-247AC 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 .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. 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-247AC .

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	
E	.602	.625	15.29	15.87	4
E1	.530	-	13.46	-	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
ϕk	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
ϕP	.140	.144	3.56	3.66	
$\phi P1$	-	.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

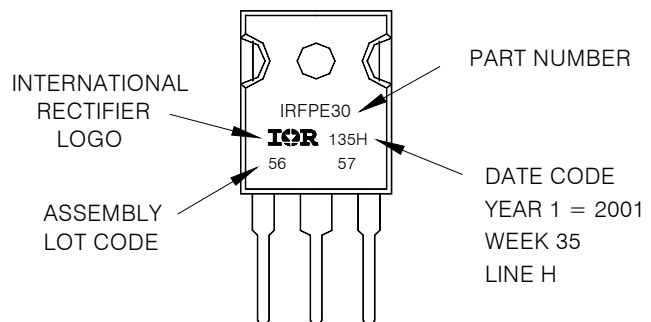
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

TO-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"

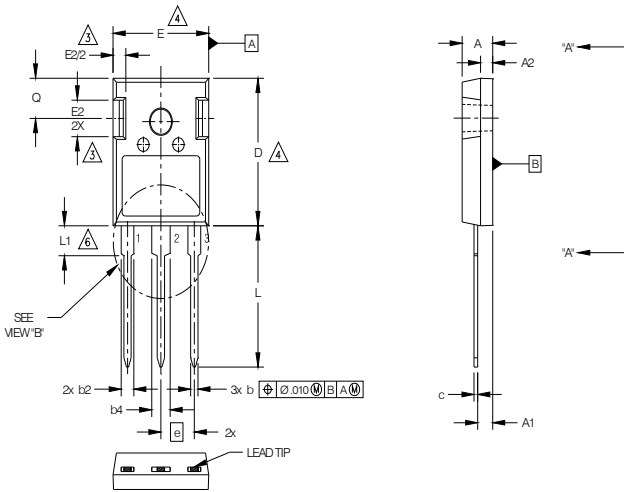


TO-247AC package is not recommended for Surface Mount Application.

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)



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

HEXFEEET

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

IGBTs, CoPACK

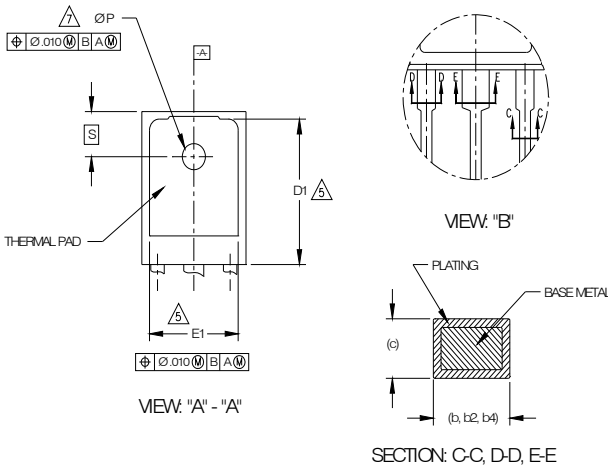
- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

DIODES

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

NOTES:

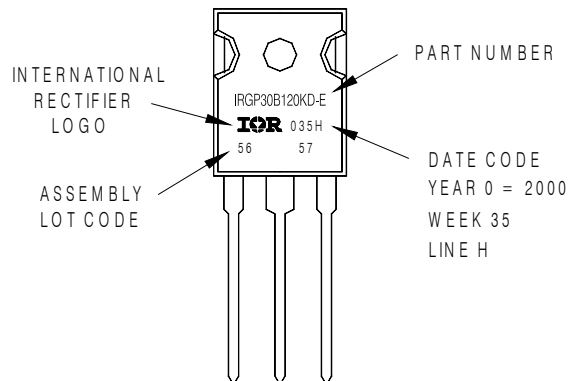
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- 5 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
- 6 LEAD FINISH UNCONTROLLED IN L1.
- 7 ∅ P TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.



TO-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[†]

Qualification Level	Industrial [†] (per JEDEC JESD47F) ^{††}	
Moisture Sensitivity Level	TO-247AC	N/A
	TO-247AD	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.