

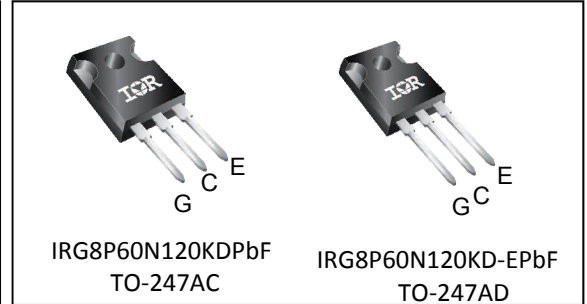
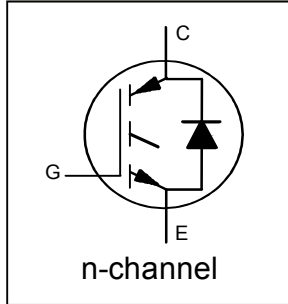
Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode

$$V_{CES} = 1200V$$

$$I_C = 60A, T_C = 100^\circ C$$

$$t_{SC} \geq 10\mu s, T_{J(max)} = 150^\circ C$$

$$V_{CE(ON)} \text{ typ.} = 1.7V @ I_C = 40A$$



G	C	E
Gate	Collector	Emitter

Applications

- Industrial Motor Drive
- UPS
- Solar Inverters
- Welding

Features	Benefits
Benchmark Low $V_{CE(ON)}$	High Efficiency in a Motor Drive Applications
10 μs Short Circuit SOA	Increases margin for short circuit protection scheme
Positive $V_{CE(ON)}$ Temperature Coefficient	Excellent Current Sharing in Parallel Operation
Square RBSOA and high I_{LM} rating	Rugged Transient Performance
Lead-Free, RoHS compliant	Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRG8P60N120KDPbF	TO-247AC	Tube	25	IRG8P60N120KDPbF
IRG8P60N120KD-EPbF	TO-247AD	Tube	25	IRG8P60N120KD-EPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current (Silicon Limited)	100	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	60	
I_{CM}	Pulse Collector Current (see fig. 2)	120	
I_{LM}	Clamped Inductive Load Current (see fig. 3)①	160	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	50	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	30	V
I_{FM}	Diode Maximum Forward Current ⑤	160	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 30	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	420	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	170	
T_J	Operating Junction and	-40 to +150	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 (IGBT) ②	—	—	0.3	$^\circ C/W$
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case (Diode) ②	—	—	0.8	
$R_{\theta CS}$	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	1200	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.0	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 5.0mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	$I_C = 40A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.1	—		$I_C = 40A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	5.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 1.6mA$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage Temperature Coeff.	—	-16	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.6mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$)
g_{fe}	Forward Transconductance	—	22	—	S	$V_{CE} = 50V, I_C = 40A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	35	μA	$V_{GE} = 0V, V_{CE} = 1200V$
		—	1.2	—	mA	$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 400	nA	$V_{GE} = \pm 30V$
V_F	Diode Forward Voltage Drop	—	2.3	2.9	V	$I_F = 40A$
		—	2.5	—		$I_F = 40A, T_J = 150^\circ\text{C}$

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

	Parameter	Min.	Typ.	Max④	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	230	345	nC	$I_C = 40A$ $V_{GE} = 15V$ $V_{CC} = 600V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	15	25		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	140	210		
E_{on}	Turn-On Switching Loss	—	2.8	—	mJ	$I_C = 40A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 5.0\Omega, T_J = 25^\circ\text{C}$
E_{off}	Turn-Off Switching Loss	—	2.3	—		
E_{total}	Total Switching Loss	—	5.1	—		
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	Energy losses include tail & diode reverse recovery ⑥
t_r	Rise time	—	30	—		
$t_{d(off)}$	Turn-Off delay time	—	240	—		
t_f	Fall time	—	110	—		
E_{on}	Turn-On Switching Loss	—	4.4	—	mJ	$I_C = 40A, V_{CC} = 600V, V_{GE} = 15V$ $R_G = 5.0\Omega, T_J = 150^\circ\text{C}$
E_{off}	Turn-Off Switching Loss	—	4.2	—		
E_{total}	Total Switching Loss	—	8.6	—		
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	Energy losses include tail & diode reverse recovery ⑥
t_r	Rise time	—	30	—		
$t_{d(off)}$	Turn-Off delay time	—	310	—		
t_f	Fall time	—	110	—		
C_{ies}	Input Capacitance	—	3700	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
C_{oes}	Output Capacitance	—	215	—		
C_{res}	Reverse Transfer Capacitance	—	120	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 160A$ $V_{CC} = 960V, V_p \leq 1200V$ $V_{GE} = +20V$ to 0V
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_{CC} = 600V, V_p \leq 1200V$ $V_{GE} = +15V$ to 0V
E_{rec}	Reverse Recovery Energy of the Diode	—	1.8	—	mJ	$T_J = 150^\circ\text{C}$
t_{rr}	Diode Reverse Recovery Time	—	210	—	ns	$V_{CC} = 600V, I_F = 40A$
I_{rr}	Peak Reverse Recovery Current	—	21	—	A	$V_{GE} = 15V, R_g = 5.0\Omega$

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V$.
- ② R_θ 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.

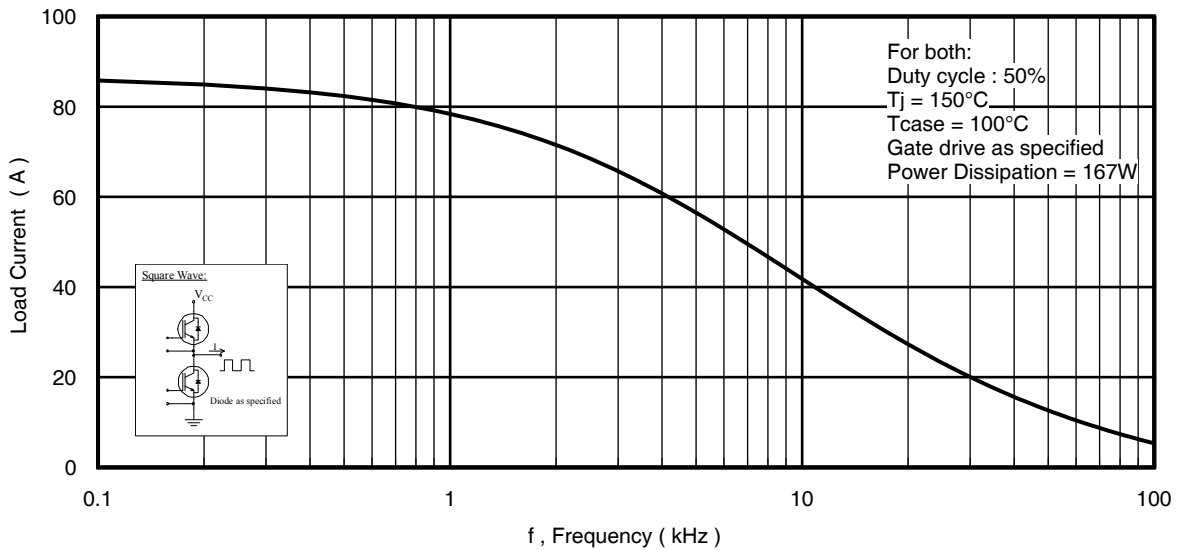


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

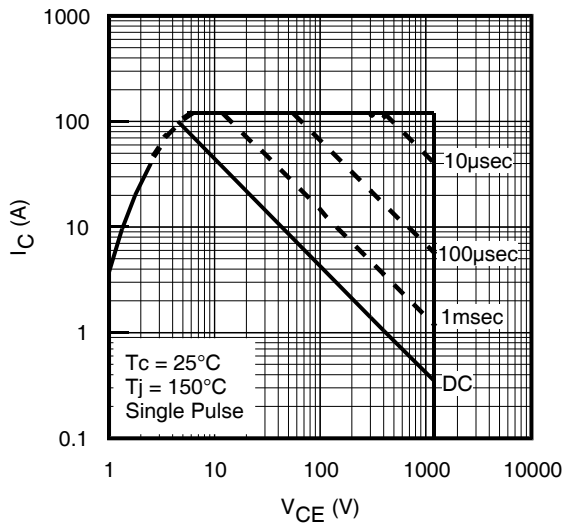


Fig. 2 - Forward SOA
 $T_c = 25^\circ\text{C}$; $T_j \leq 150^\circ\text{C}$; $V_{\text{GE}} = 15\text{V}$

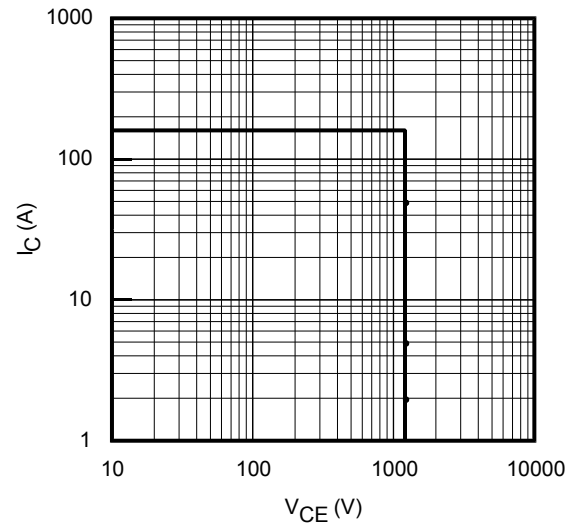


Fig. 3 - Reverse Bias SOA
 $T_j = 150^\circ\text{C}$; $V_{\text{GE}} = 20\text{V}$

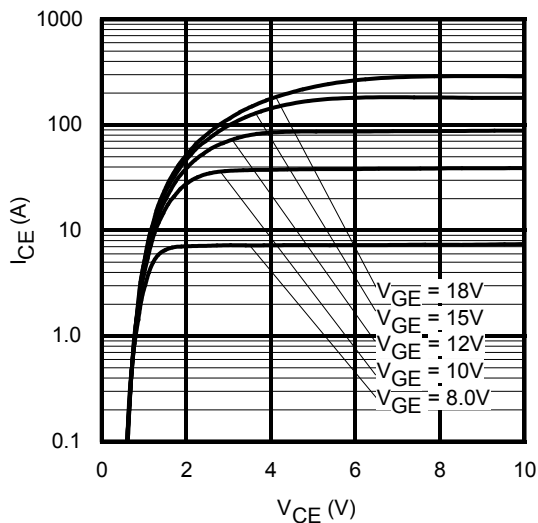


Fig. 4 - Typ. IGBT Output Characteristics
 $T_j = 25^\circ\text{C}$; $t_p = 20\mu\text{s}$

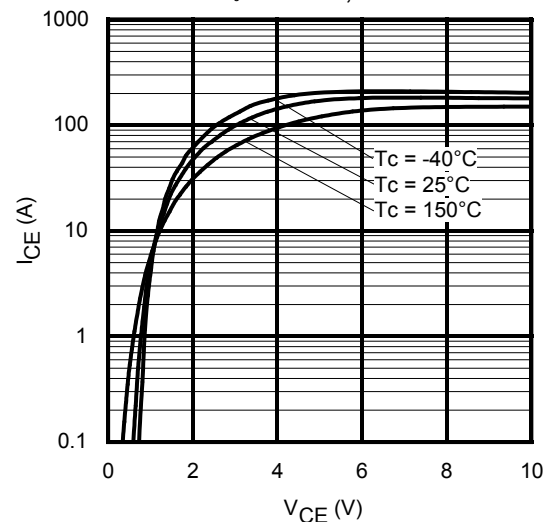


Fig. 5 - Typ. IGBT Saturation Voltage
 $V_{\text{GE}} = 15\text{V}$; $t_p = 20\mu\text{s}$

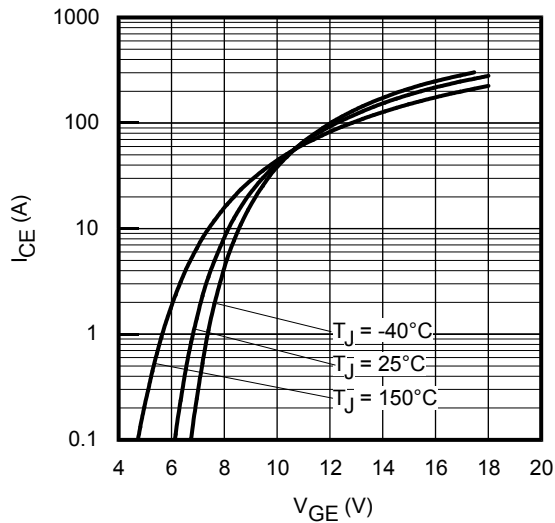


Fig. 6 - Typ. Transfer Characteristics
 $V_{CE} = 50V$; $t_p = 20\mu s$

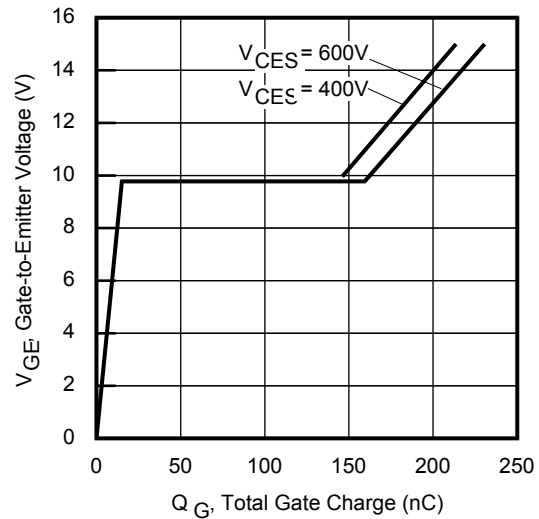


Fig. 7 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 40A$

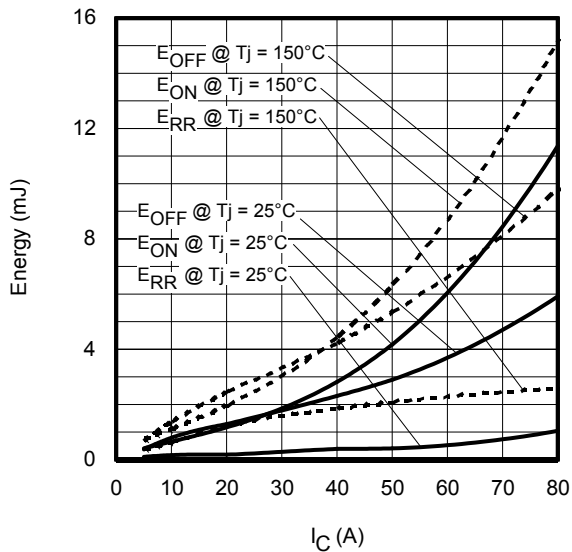


Fig. 8 - Typ. Energy Loss vs. I_C
 $V_{CE} = 600V$, $R_G = 5.0\Omega$; $V_{GE} = 15V$

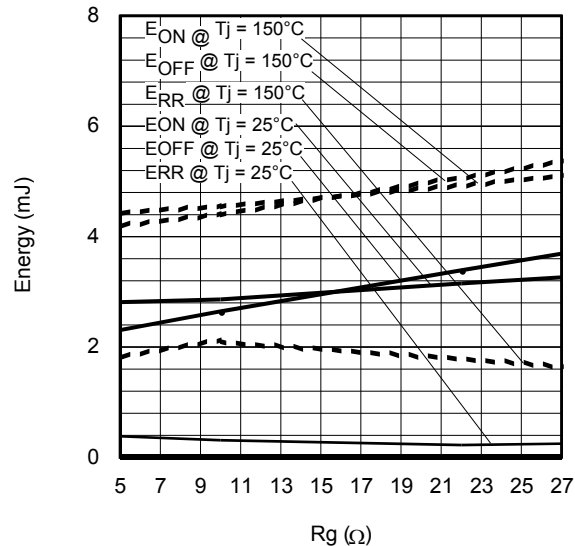


Fig. 10 - Typ. Energy Loss vs. R_G
 $V_{CE} = 600V$, $I_{CE} = 40A$; $V_{GE} = 15V$

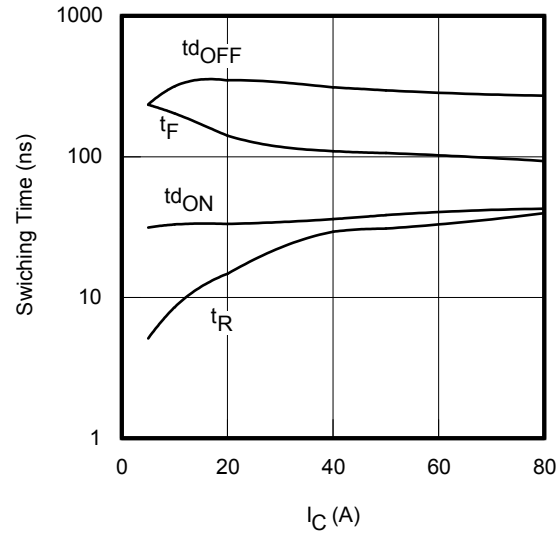


Fig. 9 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ C$; $V_{CE} = 600V$, $R_G = 5.0\Omega$; $V_{GE} = 15V$

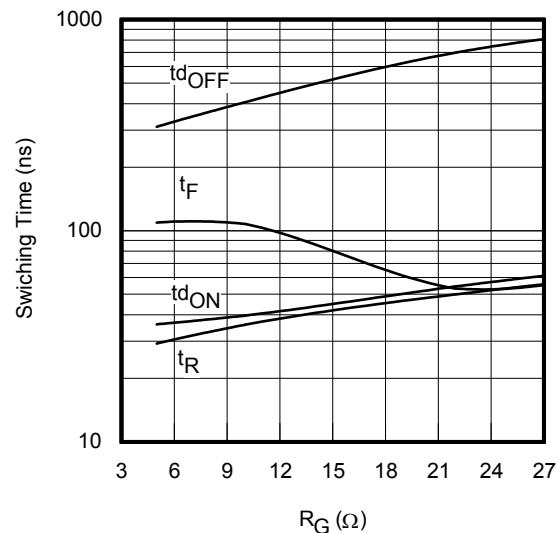


Fig. 11 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ C$; $V_{CE} = 600V$, $I_{CE} = 40A$; $V_{GE} = 15V$

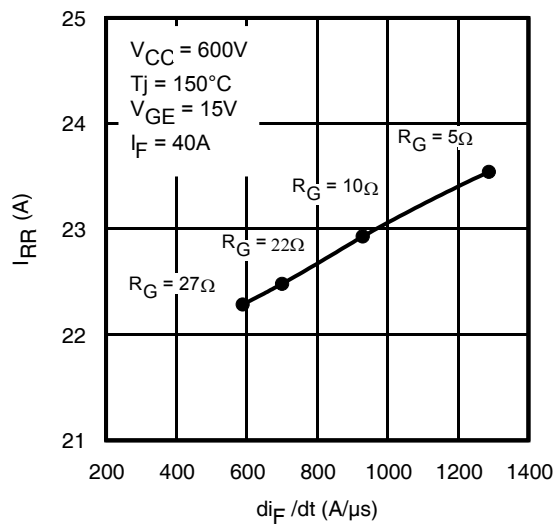


Fig. 12 - Typ. I_{RR} vs. di/dt

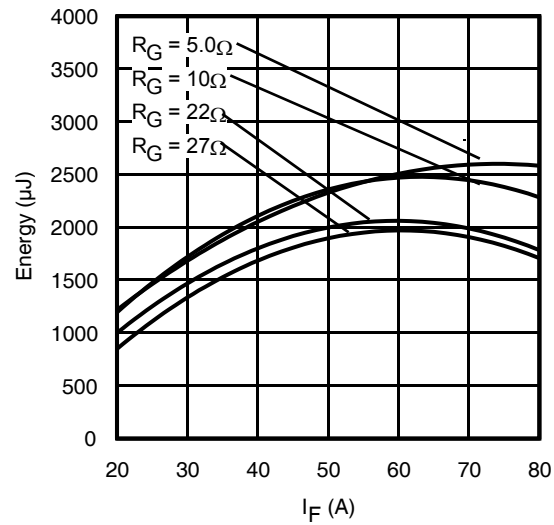


Fig. 13 - Typ. Diode E_{RR} vs. I_F
 $T_J = 150^\circ C$

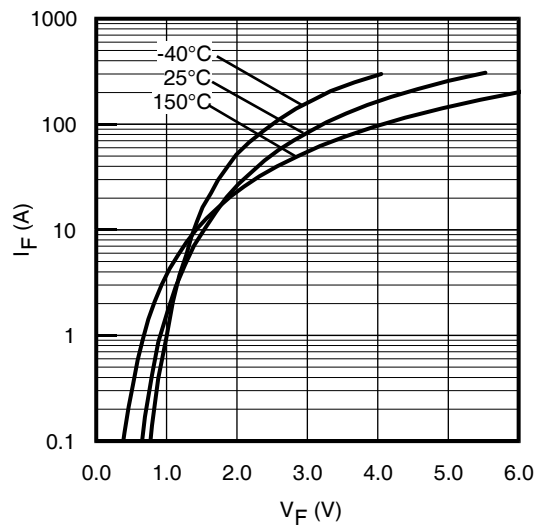
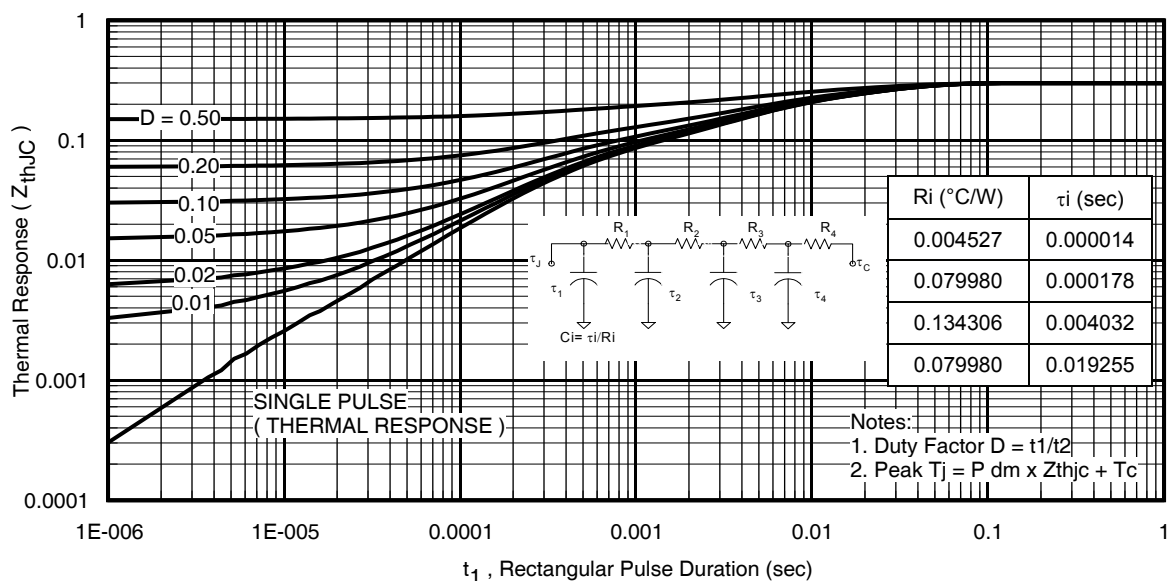
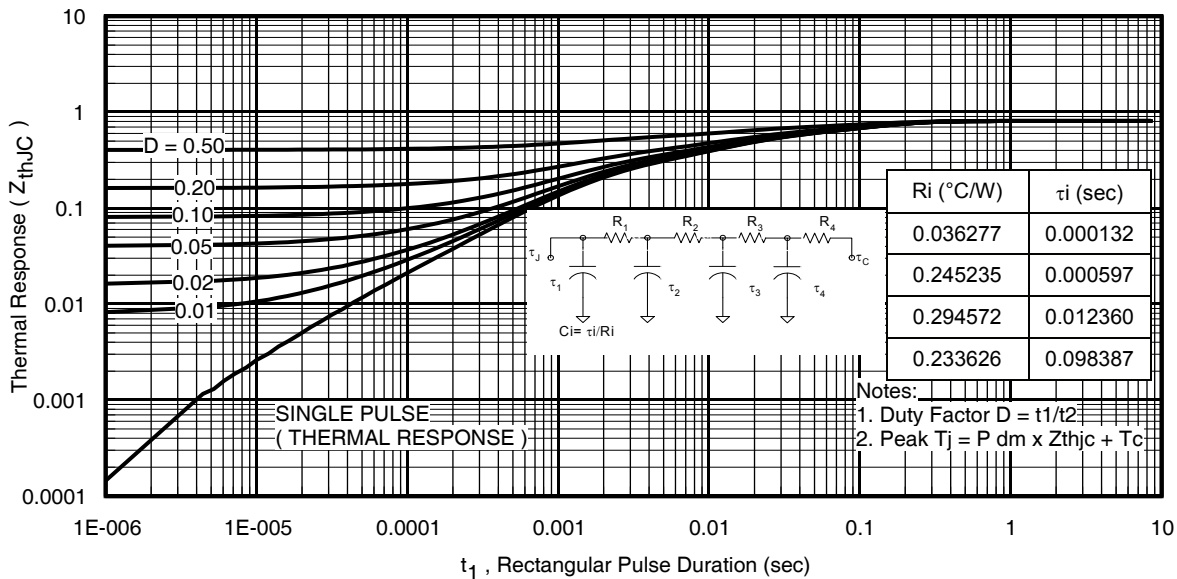
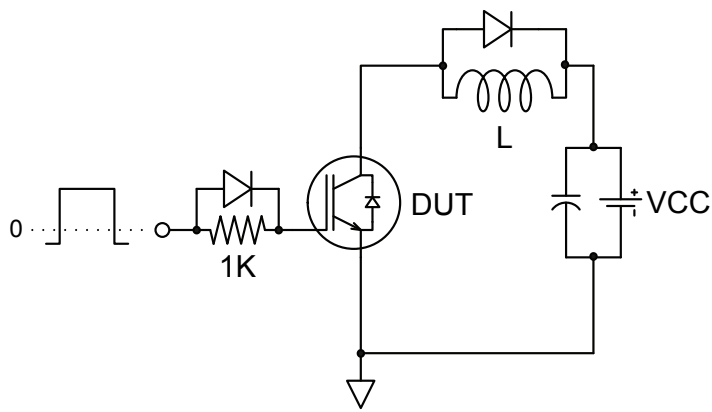
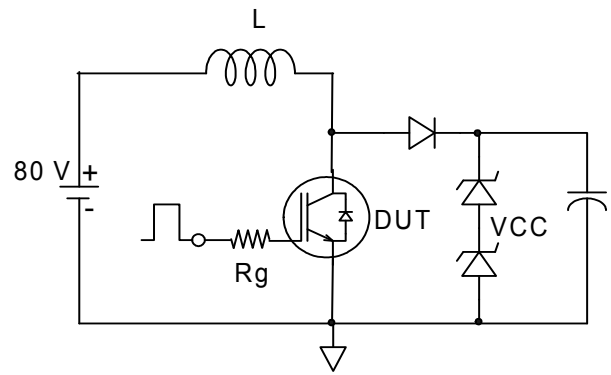
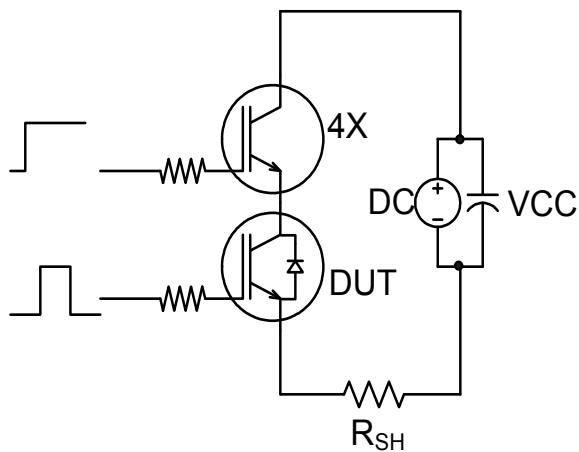
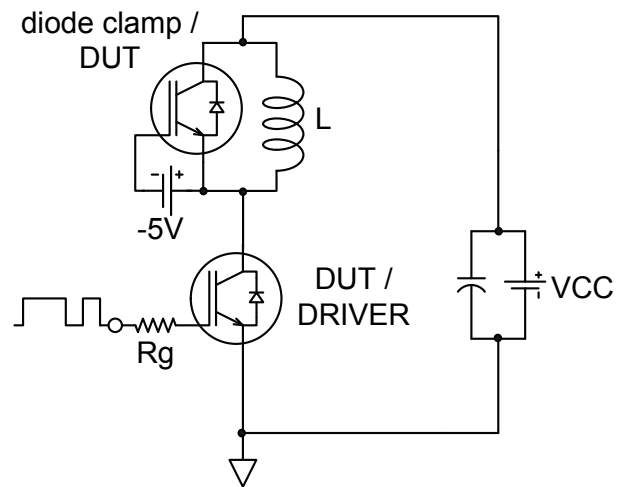
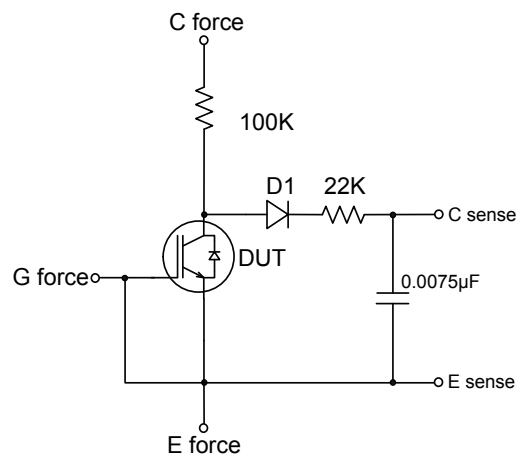


Fig. 14 - Typ. Diode Forward Voltage Drop Characteristics


Fig. 15- Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

Fig. 16 - 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
(Board Stray Inductance 180nH)

Fig.C.T.5 - BV CES Filter Circuit

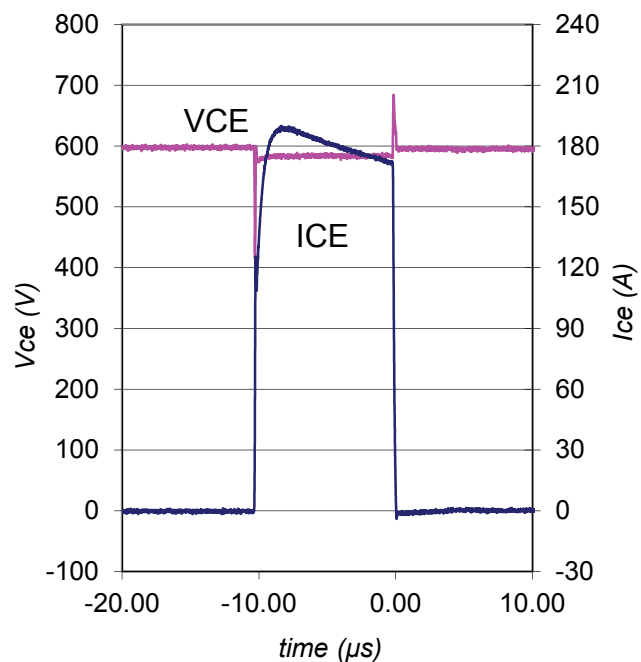
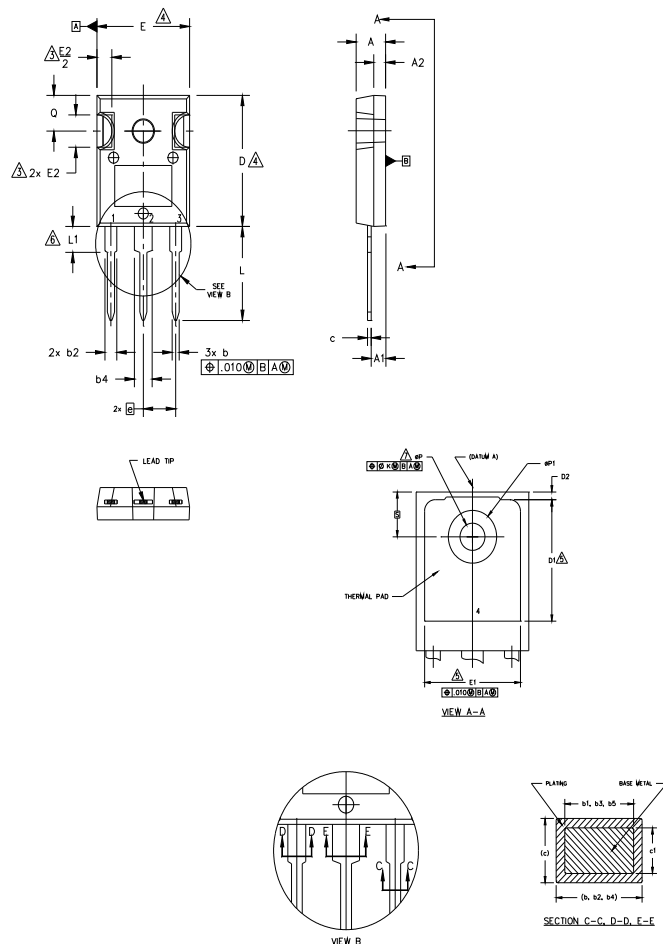


Fig. WF1 - Typ. S.C. Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.3

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. ØP 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		
Øk	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
ØP	.140	.144	3.56	3.66	
ØP1	—	.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

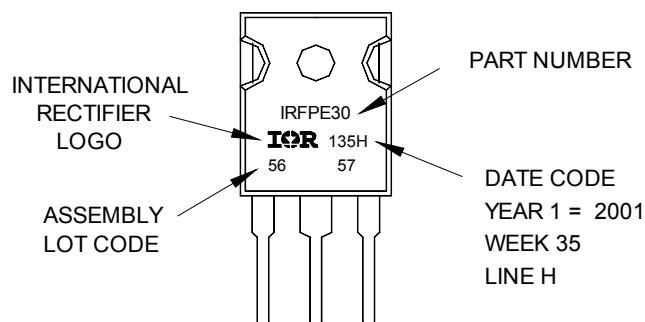
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

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"

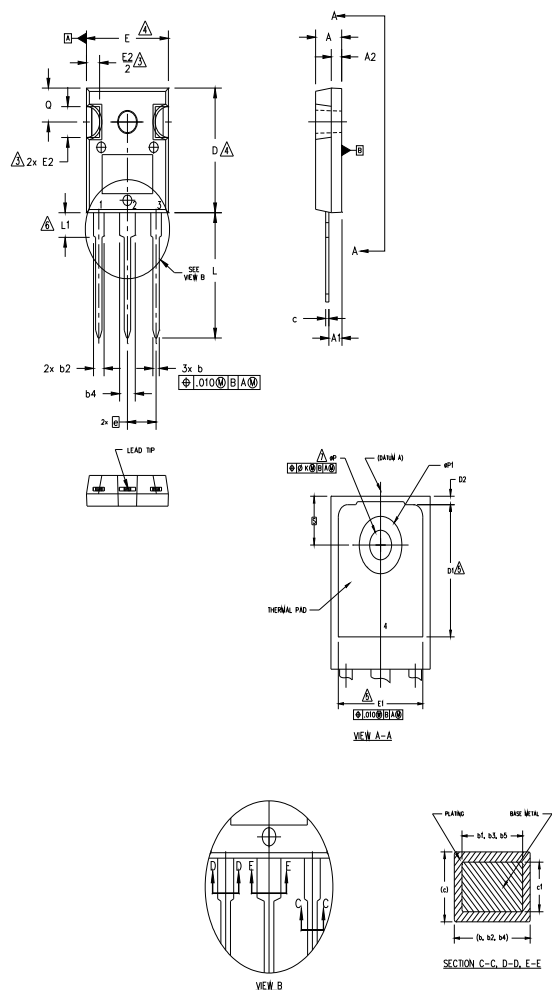


TO-247AC package is not recommended for Surface Mount Application.

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)



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. ØP 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	
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		
Øk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
ØP	.140	.144	3.56	3.66	
ØP1	—	.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
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IGBTs, CoPACK

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

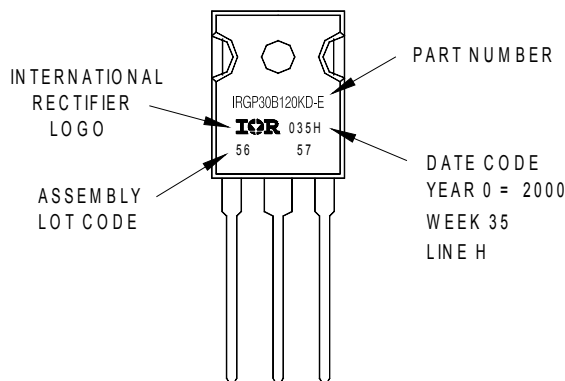
DIODES

- 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[†]

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.

International
 Rectifier

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

Mouser Electronics

Authorized Distributor

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[IRG8P60N120KDPBF](#) [IRG8P60N120KD-EPBF](#)