

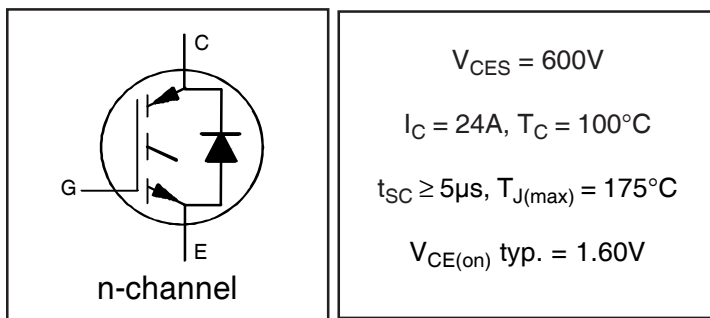
**INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE**

Features

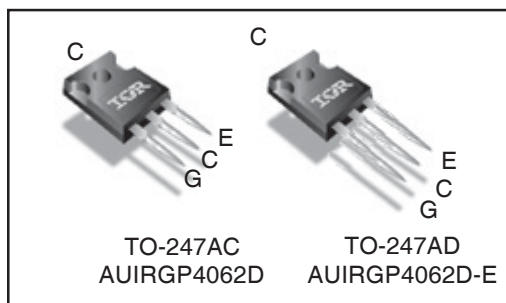
- Low $V_{CE(on)}$ Trench IGBT Technology
- Low Switching Losses
- 5 μ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for I_{LM} ①
- Positive $V_{CE(on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free, RoHS Compliant
- Automotive Qualified *

Benefits

- High Efficiency in a Wide Range of Applications
- Suitable for a Wide Range of Switching Frequencies due to Low $V_{CE(ON)}$ and Low Switching Losses
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation
- Low EMI



$V_{CES} = 600V$
 $I_C = 24A, T_C = 100^\circ C$
 $t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
 $V_{CE(on)} \text{ typ.} = 1.60V$



G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature (T_A) is 25°C, unless otherwise specified

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	48	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	24	
I_{CM}	Pulse Collector Current, $V_{GE} = 15V$	72	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	96	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	48	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	24	
I_{FM}	Diode Maximum Forward Current ③	96	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	250	W
	$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	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) TO-247	—	—	0.65	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) TO-247	—	—	1.62	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)-TO-247	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)- TO-247	—	40	—	

*Qualification standards can be found at <http://www.irf.com/>

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	$V_{GE} = 0V, I_C = 1mA$ (25°C-175°C)	CT6
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.60	1.95	V	$I_C = 24A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	2.03	—		$I_C = 24A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
		—	2.04	—		$I_C = 24A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 700\mu A$	9, 10,
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-18	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25°C - 175°C)	11, 12
gfe	Forward Transconductance	—	17	—	S	$V_{CE} = 50V, I_C = 24A, PW = 80\mu s$	
I_{CES}	Collector-to-Emitter Leakage Current	—	2.0	25	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	775	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	1.80	2.6	V	$I_F = 24A$	8
		—	1.28	—		$I_F = 24A, T_J = 175^\circ\text{C}$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q_g	Total Gate Charge (turn-on)	—	50	75	nC	$I_C = 24A$	24
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	13	20		$V_{GE} = 15V$	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	21	31		$V_{CC} = 400V$	
E_{on}	Turn-On Switching Loss	—	115	201	μJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$	CT4
E_{off}	Turn-Off Switching Loss	—	600	700		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$	
E_{total}	Total Switching Loss	—	715	901		Energy losses include tail & diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	41	53	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$	CT4
t_r	Rise time	—	22	31		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$	
$t_{d(off)}$	Turn-Off delay time	—	104	115			
t_f	Fall time	—	29	41			
E_{on}	Turn-On Switching Loss	—	420	—		μJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$
E_{off}	Turn-Off Switching Loss	—	840	—	$R_G = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 175^\circ\text{C}$ ②		CT4
E_{total}	Total Switching Loss	—	1260	—	Energy losses include tail & diode reverse recovery		WF1, WF2
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$	14, 16
t_r	Rise time	—	24	—		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH$	CT4
$t_{d(off)}$	Turn-Off delay time	—	125	—		$T_J = 175^\circ\text{C}$	WF1
t_f	Fall time	—	39	—			WF2
C_{ies}	Input Capacitance	—	1490	—	pF	$V_{GE} = 0V$	23
C_{oes}	Output Capacitance	—	129	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	45	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 96A$ $V_{CC} = 480V, V_p = 600V$ $R_G = 10\Omega, V_{GE} = +20V$ to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_G = 10\Omega, V_{GE} = +15V$ to 0V	22, CT3 WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	621	—	μJ	$T_J = 175^\circ\text{C}$	17, 18, 19
t_{rr}	Diode Reverse Recovery Time	—	89	—	ns	$V_{CC} = 400V, I_F = 24A$	20, 21
I_{rr}	Peak Reverse Recovery Current	—	37	—	A	$V_{GE} = 15V, R_G = 10\Omega, L = 200\mu H, L_S = 150nH$	WF3

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 10\Omega$.
- ② This is only applied to TO-220AB package.
- ③ Pulse width limited by max. junction temperature.
- ④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

Qualification Information[†]

Qualification Level		Automotive (per AEC-Q101) ^{††}	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		3L-TO-247AC	N/A
		3L-TO-247AD	
ESD	Machine Model	Class M4(+/- 400V) ^{†††} (per AEC-Q101-002)	
	Human Body Model	Class H1C(+/- 2000V) ^{†††} (per AEC-Q101-001)	
	Charged Device Model	Class C5(+/- 1000V) ^{†††} (per AEC-Q101-005)	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/>

†† Exceptions (if any) to AEC-Q101 requirements are noted in the qualification report.

††† Highest passing voltage

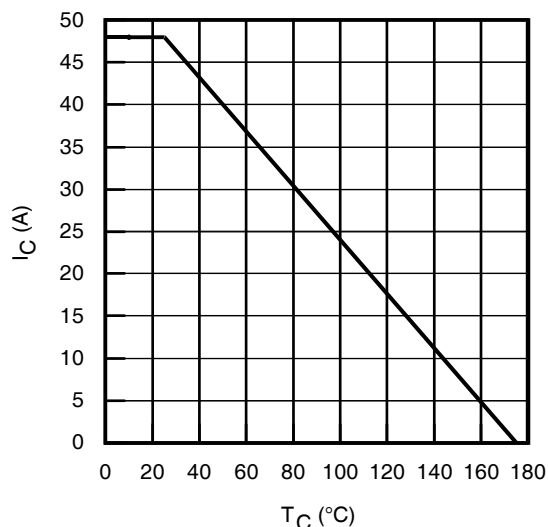


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

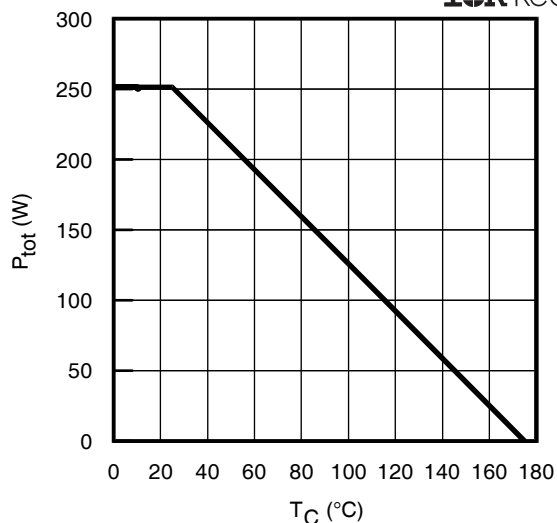


Fig. 2 - Power Dissipation vs. Case Temperature

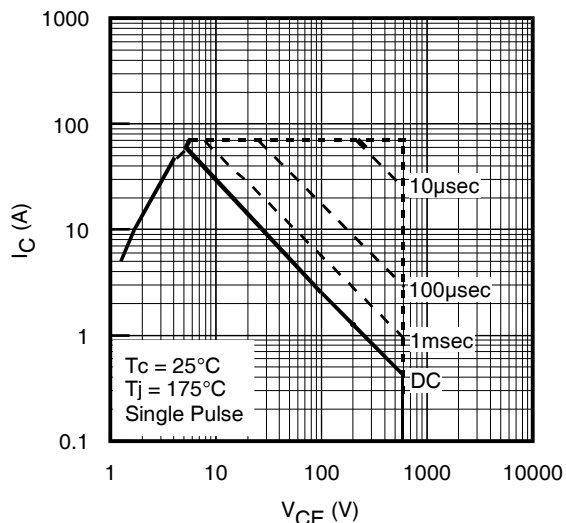


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}C$, $T_J \leq 175^{\circ}C$; $V_{GE} = 15V$

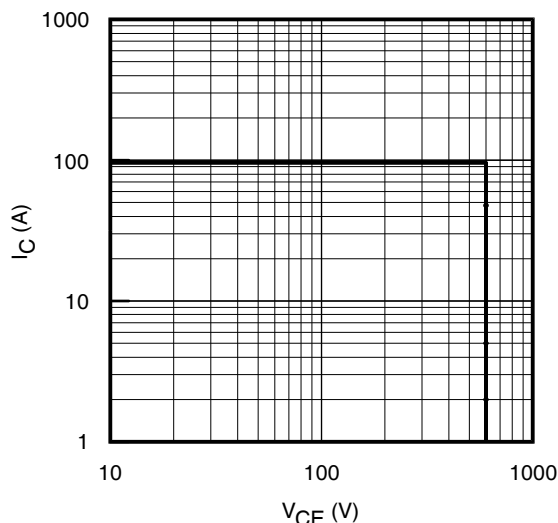


Fig. 4 - Reverse Bias SOA
 $T_J = 175^{\circ}C$; $V_{GE} = 20V$

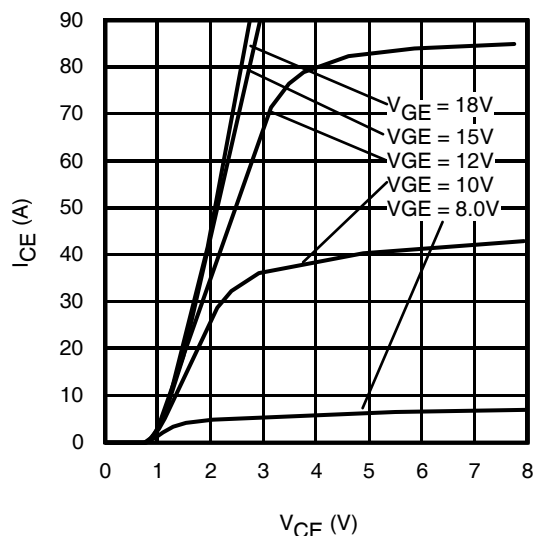


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}C$; $t_p = 80 \mu s$

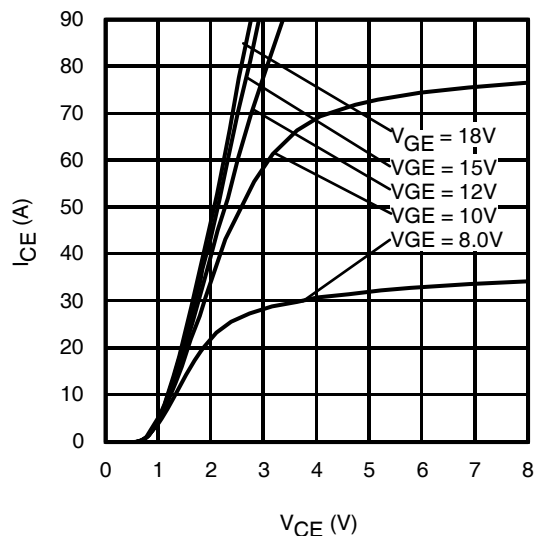


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}C$; $t_p = 80 \mu s$

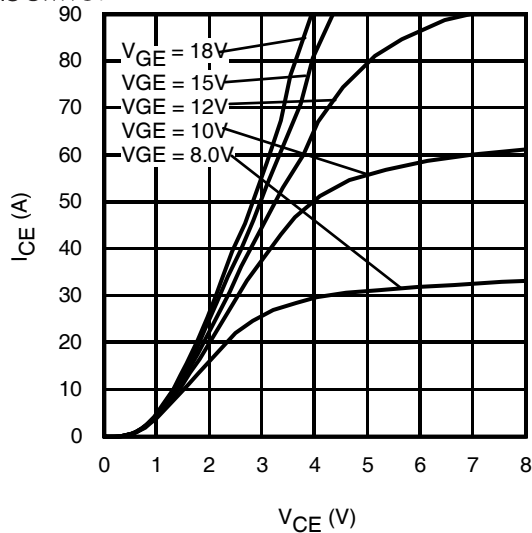


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 80\mu\text{s}$

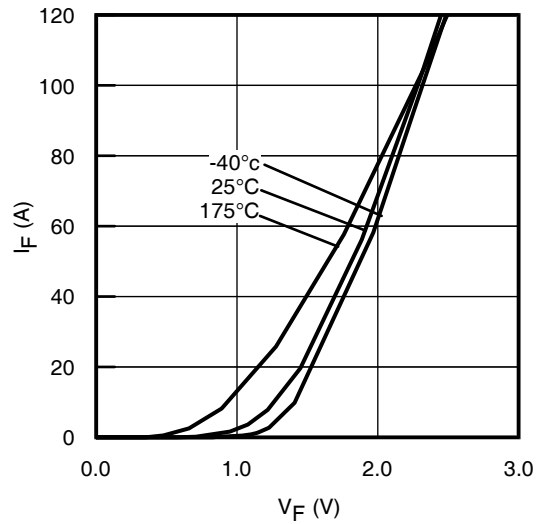


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

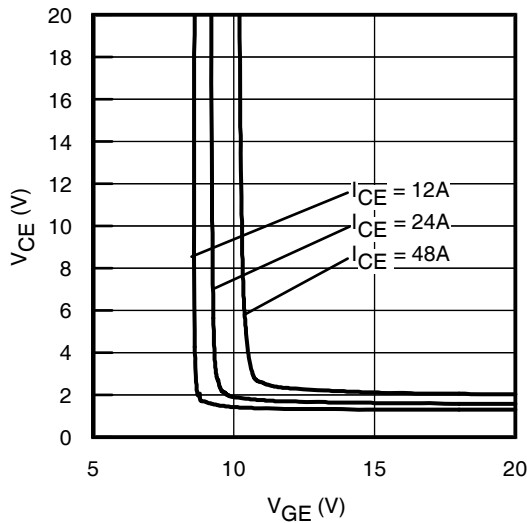


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

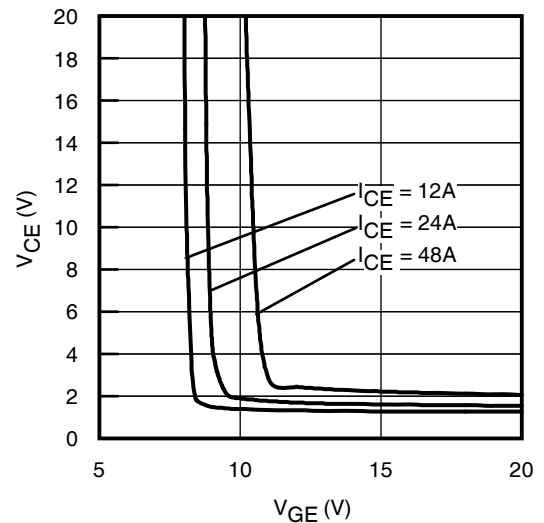


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

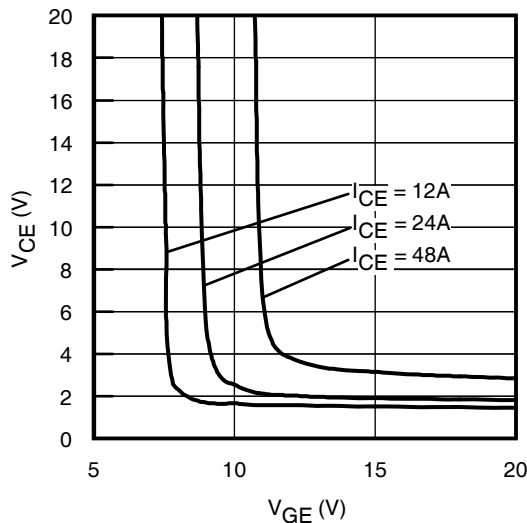


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

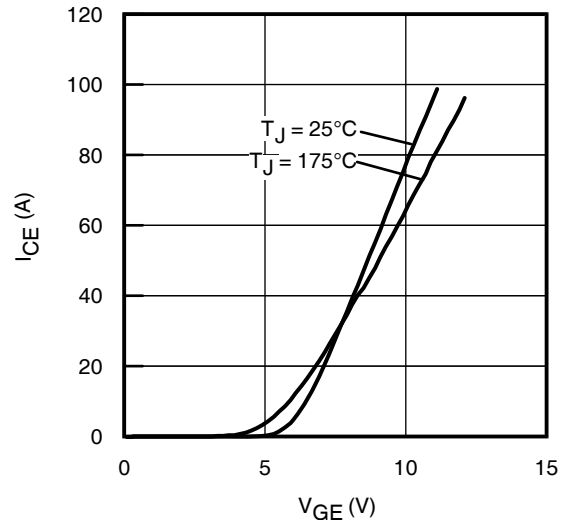


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

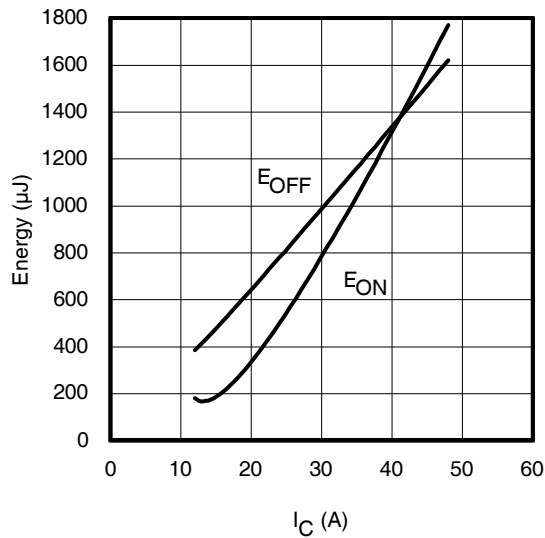


Fig. 13 - Typ. Energy Loss vs. I_C

T_J = 175°C; L = 200μH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

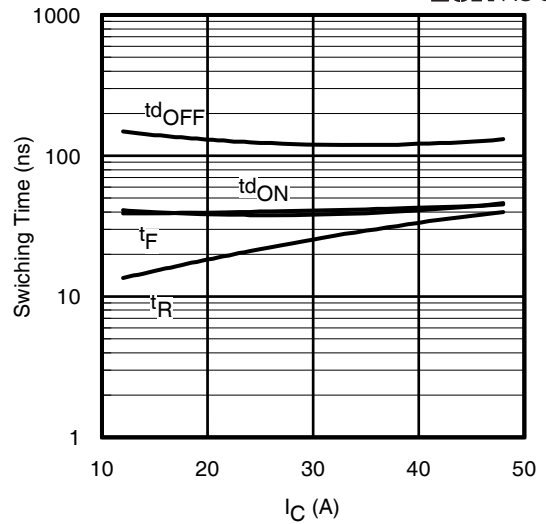


Fig. 14 - Typ. Switching Time vs. I_C

T_J = 175°C; L = 200μH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

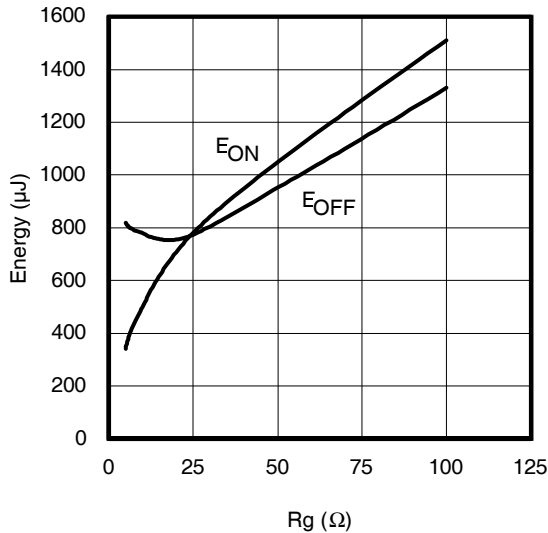


Fig. 15 - Typ. Energy Loss vs. R_G

T_J = 175°C; L = 200μH; V_{CE} = 400V, I_{CE} = 24A; V_{GE} = 15V

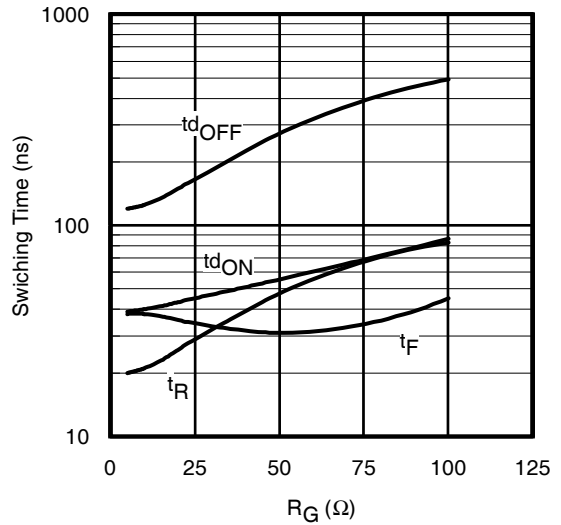


Fig. 16 - Typ. Switching Time vs. R_G

T_J = 175°C; L = 200μH; V_{CE} = 400V, I_{CE} = 24A; V_{GE} = 15V

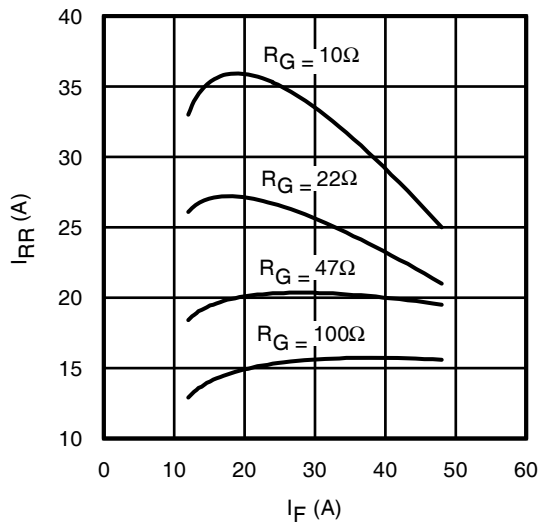


Fig. 17 - Typ. Diode I_{RR} vs. I_F

T_J = 175°C

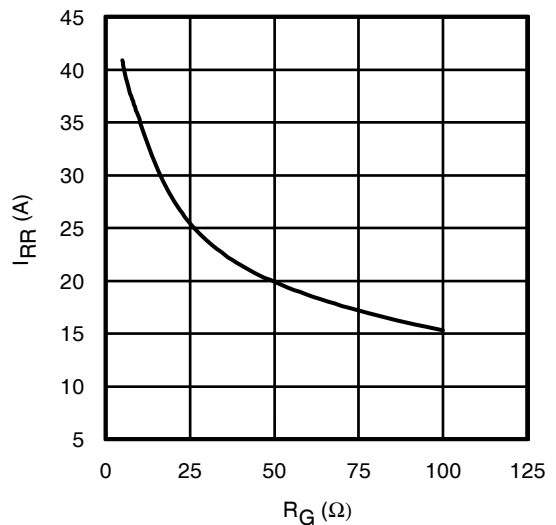


Fig. 18 - Typ. Diode I_{RR} vs. R_G

T_J = 175°C

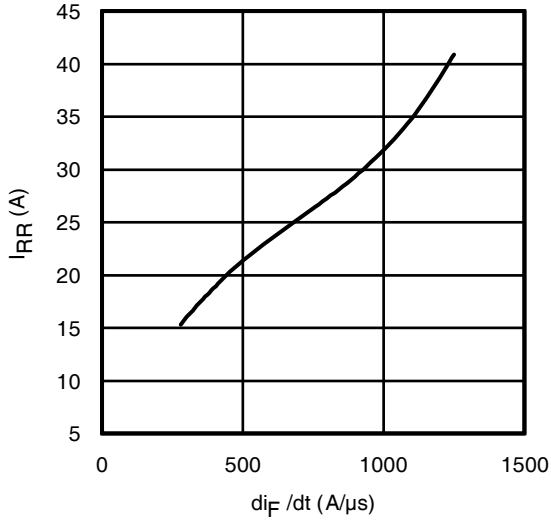


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $I_F = 24A$; $T_J = 175^\circ C$

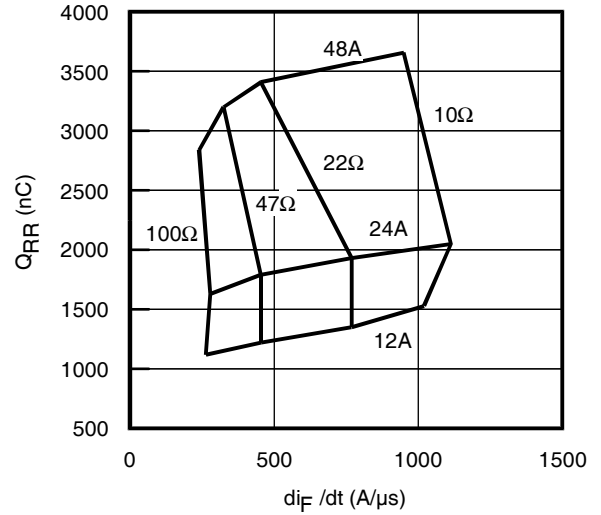


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $T_J = 175^\circ C$

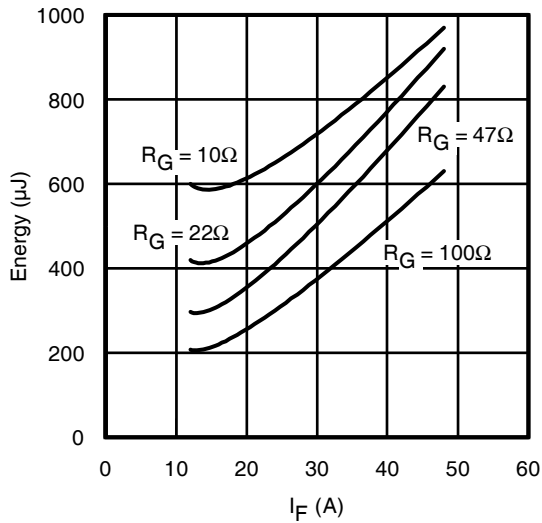


Fig. 21 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ C$

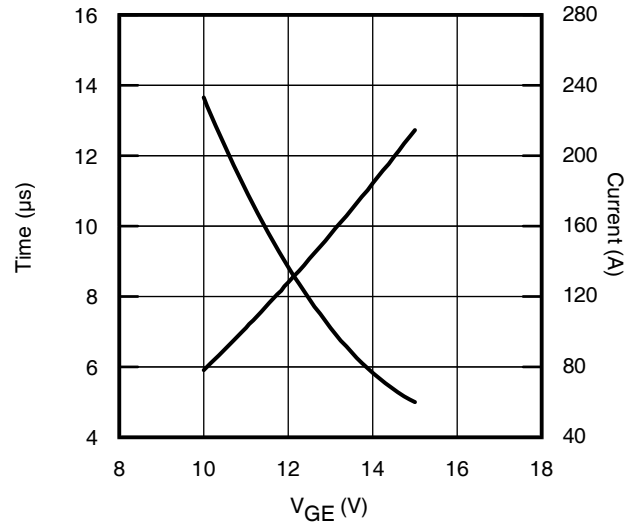


Fig. 22 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400V$; $T_C = 25^\circ C$

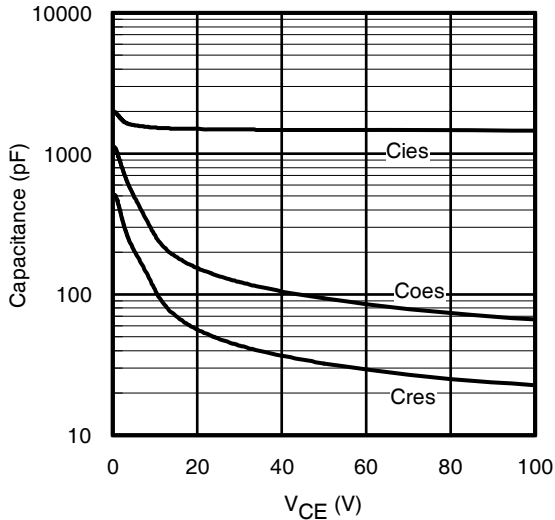


Fig. 23 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

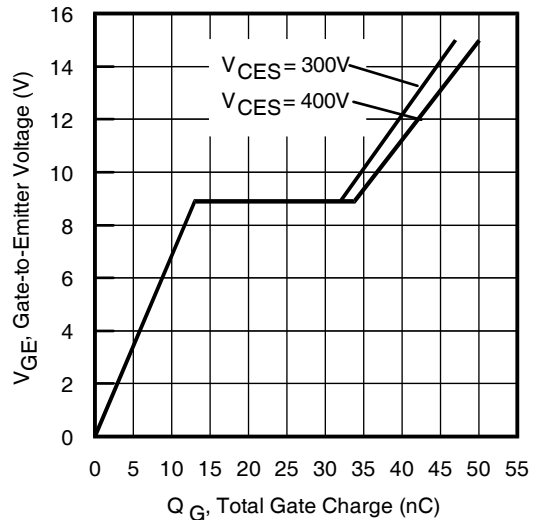


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 24A$; $L = 600\mu H$

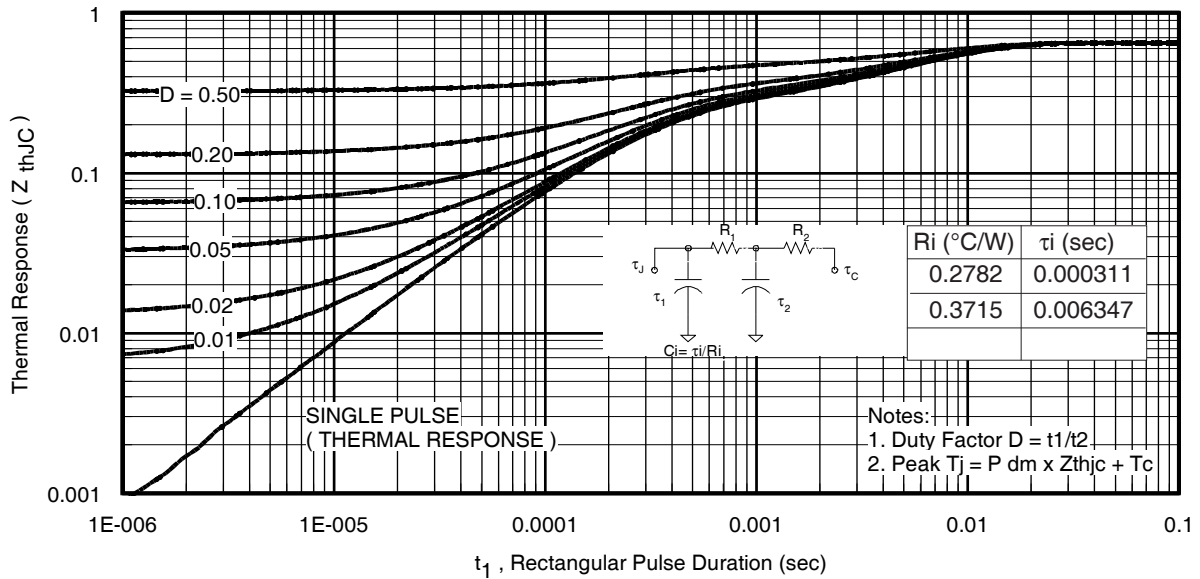


Fig 27. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT) TO-247AC

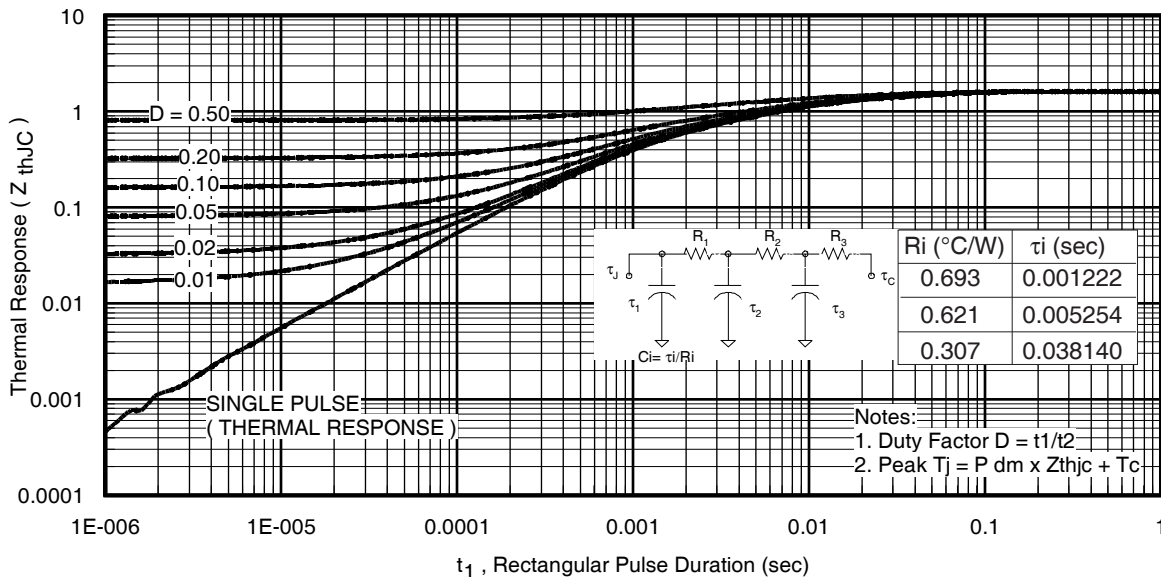


Fig. 28. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE) TO-247AC

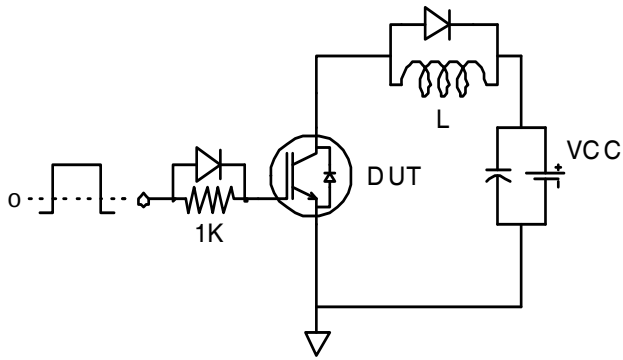


Fig.C.T.1 - Gate Charge Circuit (turn-off)

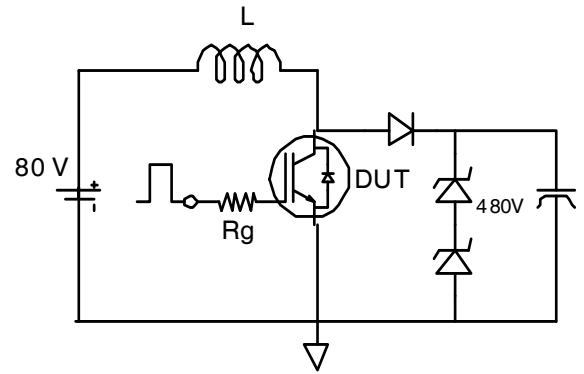


Fig.C.T.2 - RBSOA Circuit

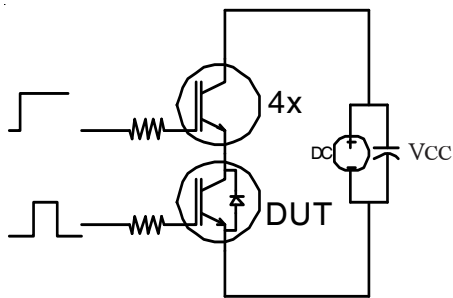


Fig.C.T.3 - S.C. SOA Circuit

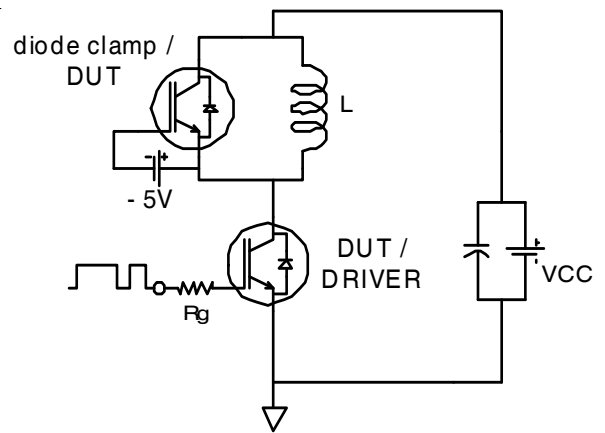


Fig.C.T.4 - Switching Loss Circuit

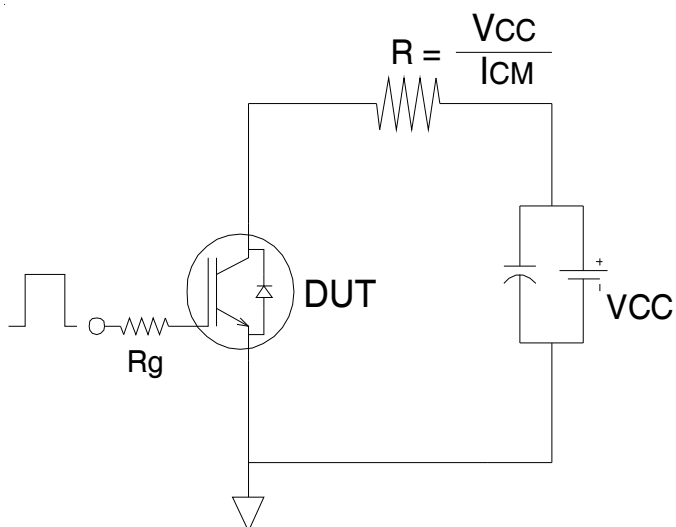


Fig.C.T.5 - Resistive Load Circuit

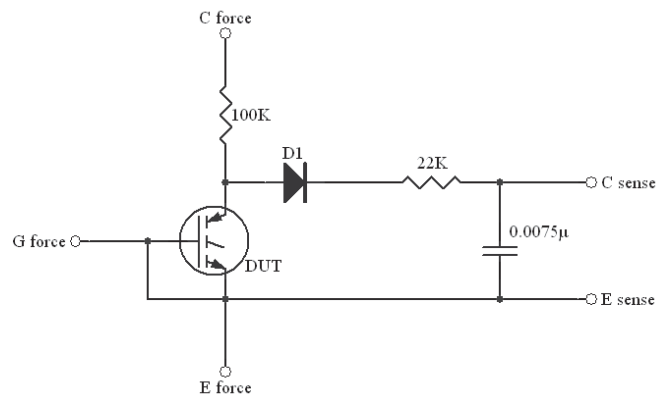


Fig.C.T.6 - BVCES Filter Circuit

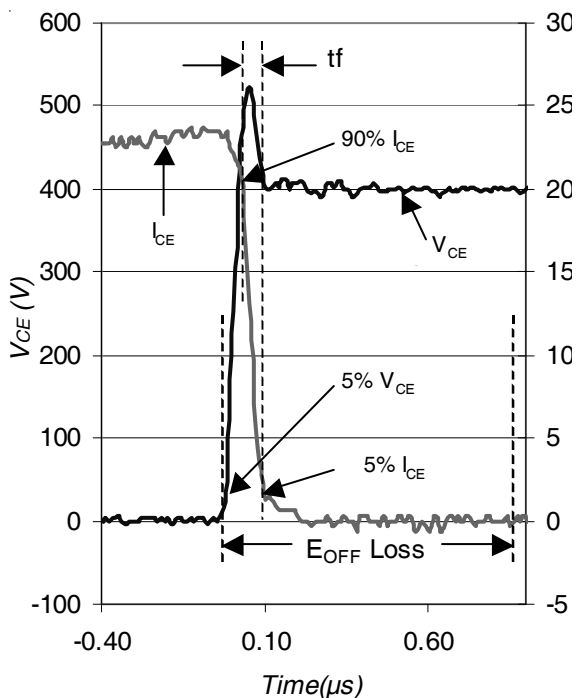


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

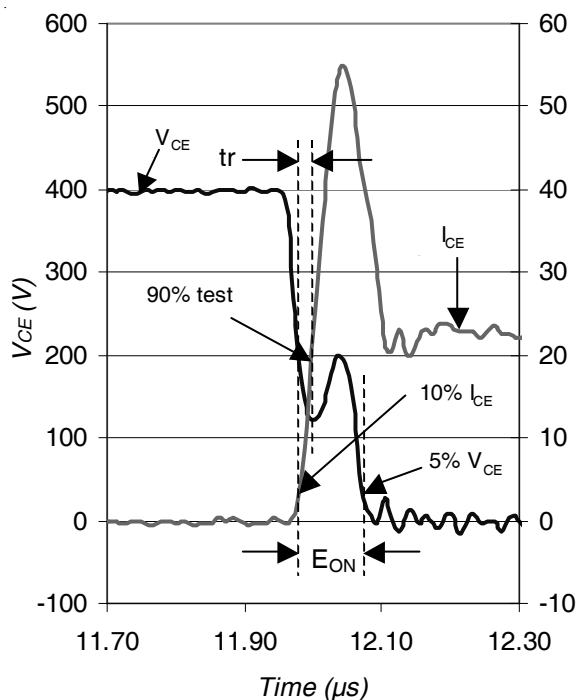


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

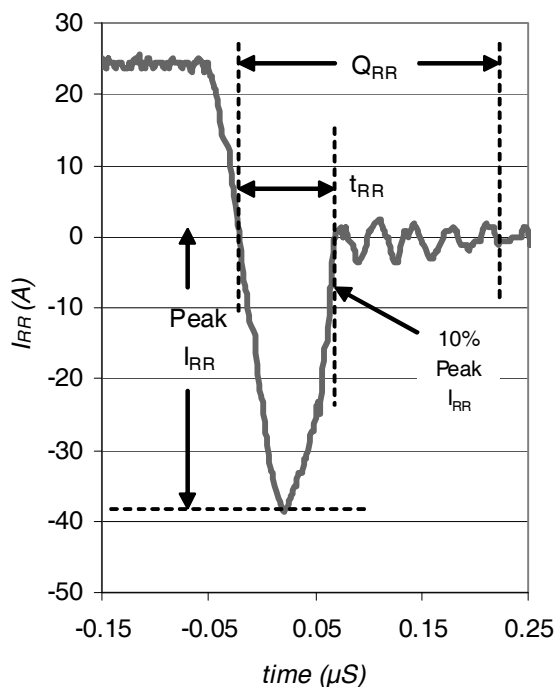


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

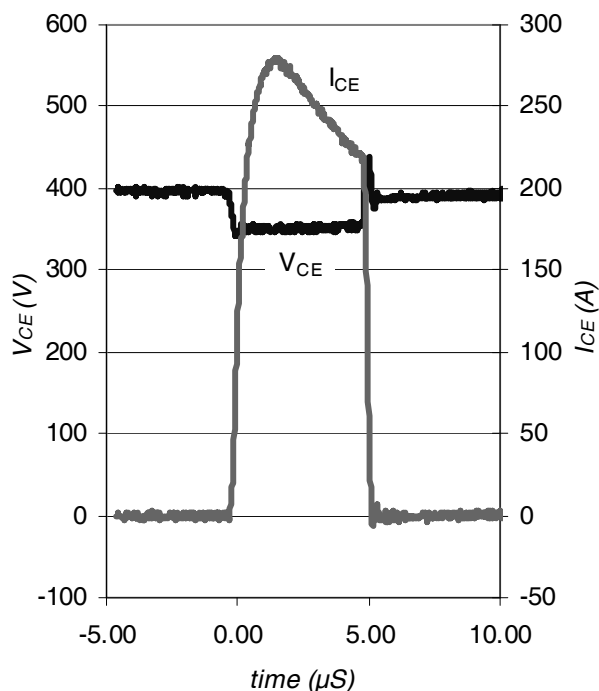
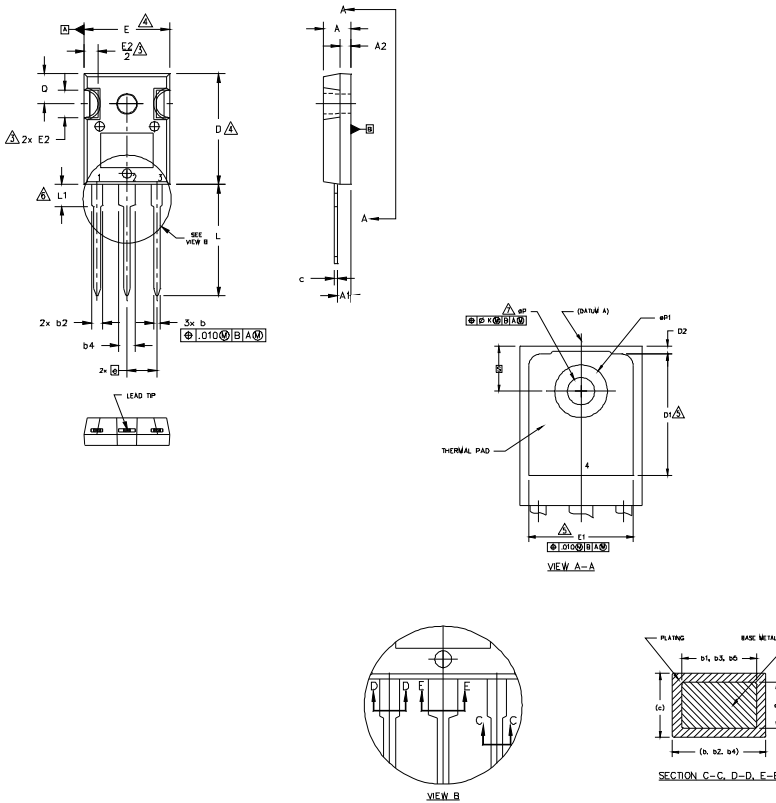


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 25^\circ\text{C}$ using Fig. CT.3

AUIRGP4062D/P4062D-E

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 MQLD FLASH. MQLD 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	Ø10		Ø25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
ØP1	.140	.144	3.56	3.66	
Q	-	.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

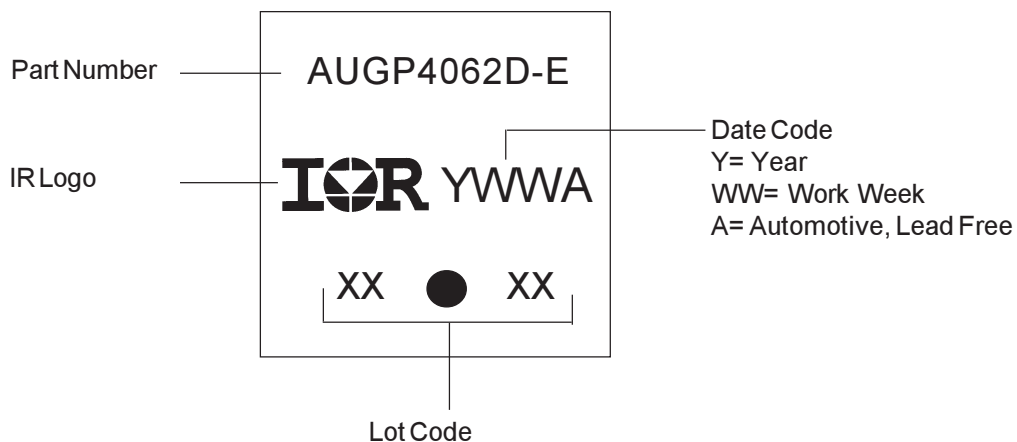
IGBTs, CoPACK

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

DIODES

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

TO-247AD Part Marking Information



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

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRGP4062D	TO-247AC	Tube	25	AUIRGP4062D
AUIRGP4062D-E	TO-247AD	Tube	25	AUIRGP4062D-E

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For technical support, please contact IR's Technical Assistance Center

<http://www.irf.com/technical-info/>

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