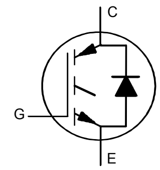
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features
- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- 5µs SCSOA
- Square RBSOA
- 100% of The Parts Tested for ILM①
- Positive $V_{CE\ (on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free, RoHS Compliant
- Automotive Qualified *



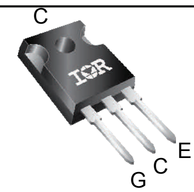
n-channel

V_{CES} = 600V

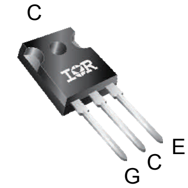
I_C = 24A, T_C = 100°C

$t_{SC} \geq$ 5µs, $T_{J(max)}$ = 175°C

$V_{CE(on)}$ typ. = 1.60V



TO-247AC
AUIRGP4062D



TO-247AD
AUIRGP4062D-E

G	C	E
Gate	Collector	Emitter

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

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

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°C	Continuous Collector Current	48	A
I_C @ T_C = 100°C	Continuous Collector Current	24	
I_{CM}	Pulse Collector Current V_{GE} =15V	72	
I_{LM}	Clamped Inductive Load Current V_{GE} =20V①	96	
I_F @ T_C = 25°C	Diode Continuous Forward Current	48	
I_F @ T_C = 100°C	Diode Continuous Forward Current	24	
I_{FSM}	Maximum Repetitive Forward Current ③	96	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	250	W
P_D @ T_C = 100°C	Maximum Power Dissipation	125	
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 www.infineon.com

Electrical Characteristics @ T_J = 25°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 = 100μA 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)	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.60	1.95	V	I_C = 24A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	2.03	—		I_C = 24A, V_{GE} = 15V, T_J = 150°C	9,10,11
		—	2.04	—		I_C = 24A, V_{GE} = 15V, T_J = 175°C	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	I_C = 700μA	9,10,
$\Delta V_{GE(th)}/\Delta TJ$	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 = 80μs	
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°C	
V_{FM}	Diode Forward Voltage Drop	—	1.80	2.6	V	I_F = 24A	8
		—	1.28			I_F = 24A, T_J = 175°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V, V_{CE} = 0V	

Switching Characteristics @ T_J = 25°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,	CT4
E_{off}	Turn-Off Switching Loss	—	600	700		V_{GE} = +15V, T_J = 25°C	
E_{total}	Total Switching Loss	—	715	901		R_G = 10Ω, L = 200μH, L_S = 150nH ,	
$t_{d(on)}$	Turn-On delay time	—	41	53	ns	Energy losses include tail & diode reverse recovery	
t_r	Rise time	—	22	31			
$t_{d(off)}$	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,	13,15, CT4 WF1,WF2
E_{off}	Turn-Off Switching Loss	—	840	—		V_{GE} = +15V, T_J = 175°C ④	
E_{total}	Total Switching Loss	—	1260	—		R_G = 10Ω, L = 200μH, L_S = 150nH	
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	Energy losses include tail & diode reverse recovery	14,16 CT4 WF1 WF2
t_r	Rise time	—	24	—			
$t_{d(off)}$	Turn-Off delay time	—	125	—			
t_f	Fall time	—	39	—			
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°C, I_C = 96A V_{CC} = 480V, Vp = 600V Rg = 10Ω, V_{GE} = +20V to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V_{CC} = 400V, Vp = 600V Rg = 10Ω, V_{GE} = +15V to 0V	22,CT3 WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	624	—	μJ	T_J = 175°C	17,18,19,
t_{rr}	Diode Reverse Recovery Time	—	89	—	ns	V_{CC} = 400V, I_F = 24A, V_{GE} = 15V,	20,21
I_{rr}	Peak Reverse Recovery Current	—	37	—	A	R_G = 10Ω, L = 200μH, L_S = 150nH	WF3

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 100μH, R_G = 10Ω.
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.

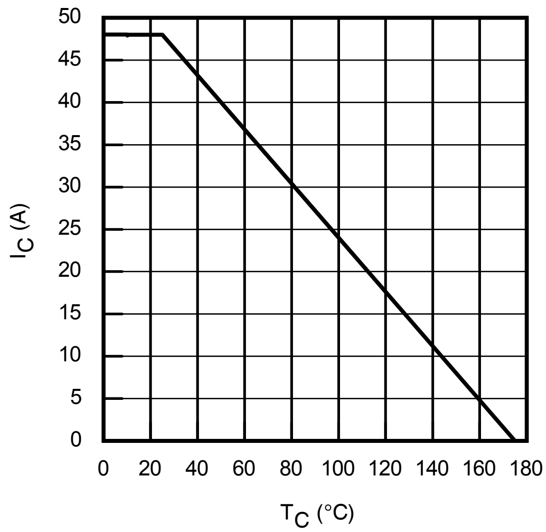


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

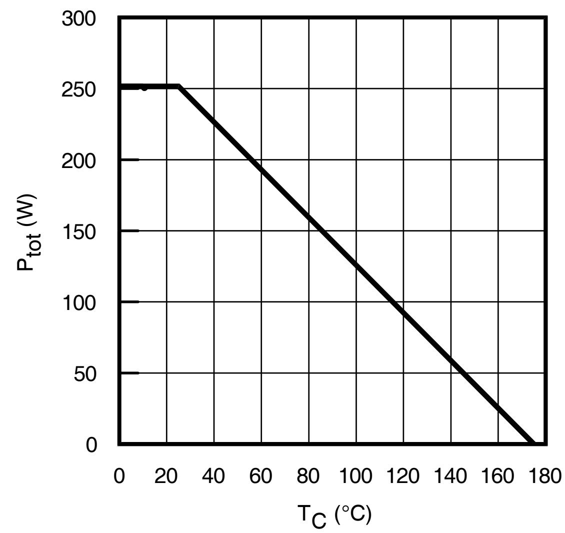


Fig. 2 - Power Dissipation vs. Case Temperature

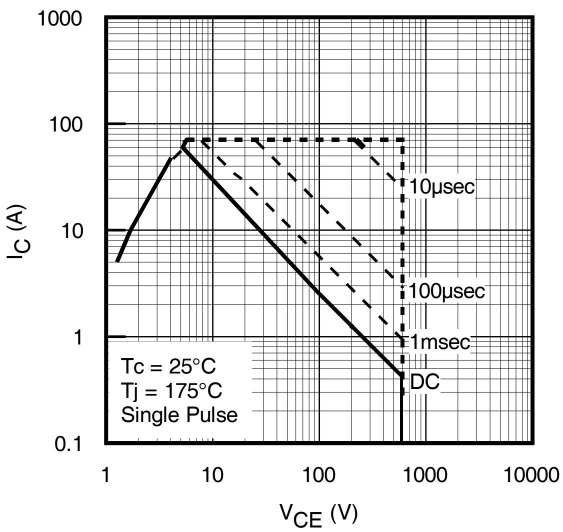


Fig. 3 - Forward SOA

Tc = 25°C, TJ ≤ 175°C; VGE =15V

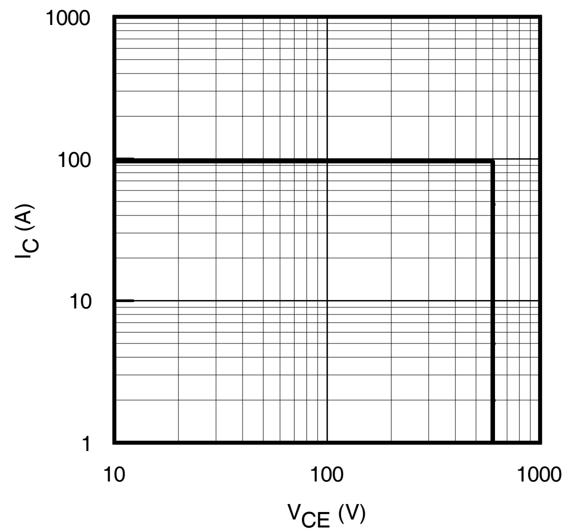


Fig. 4 - Reverse Bias SOA

T_J = 175°C; V_{GE} =20V

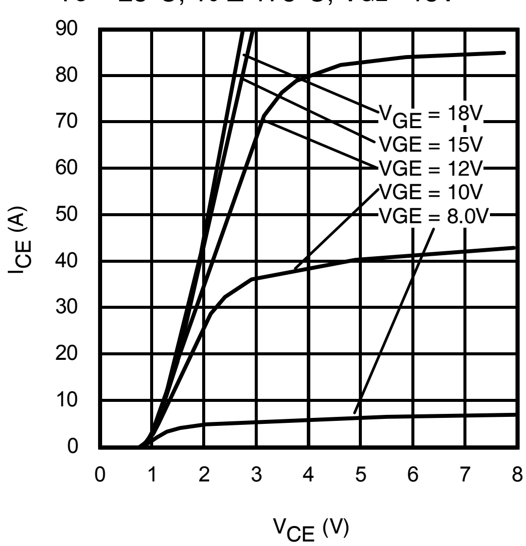


Fig. 5 - Typ. IGBT Output Characteristics

T_J = -40°C; tp = 80μs

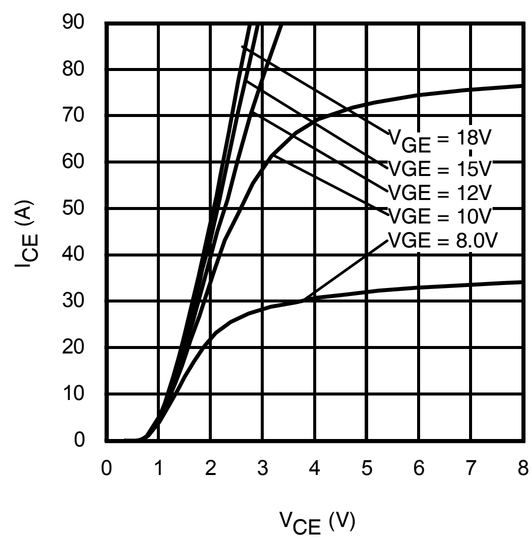


Fig. 6 - Typ. IGBT Output Characteristics

T_J = 25°C; tp = 80μs

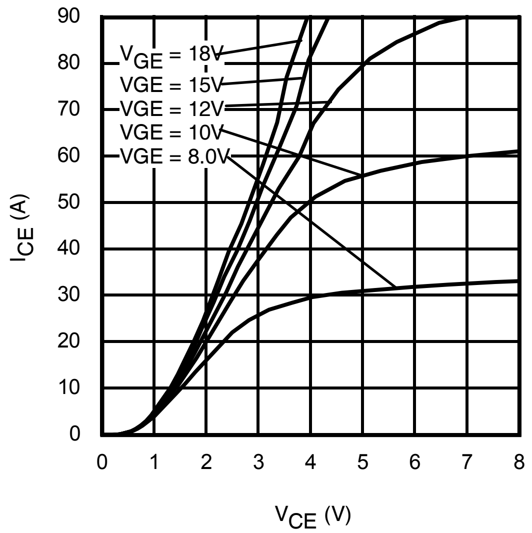


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

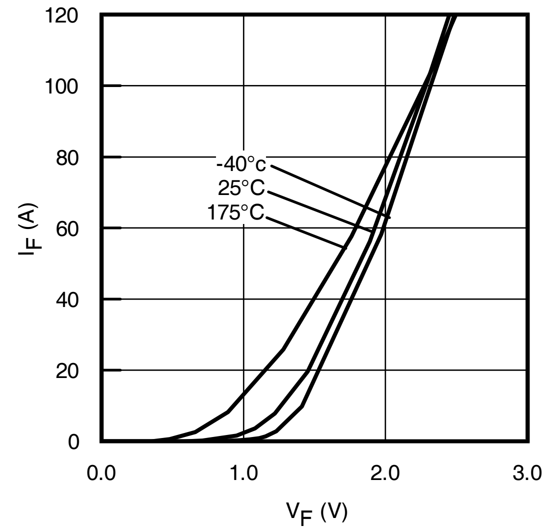


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

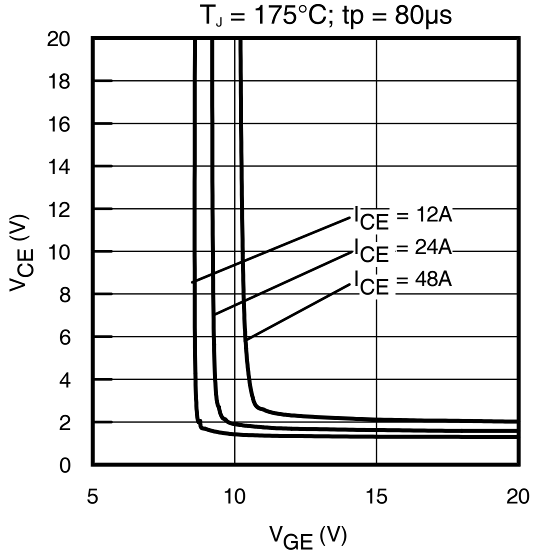


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

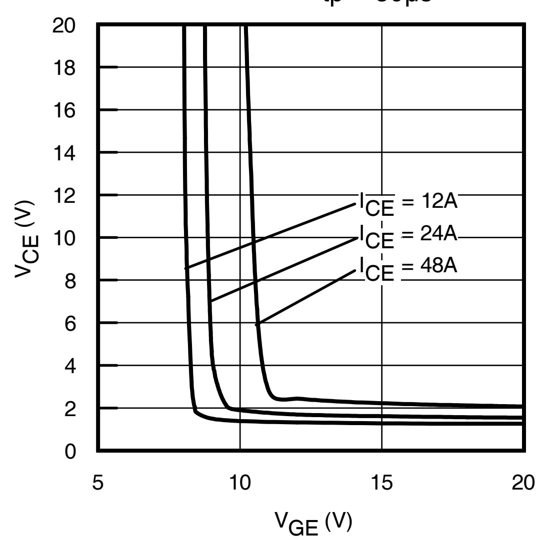


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

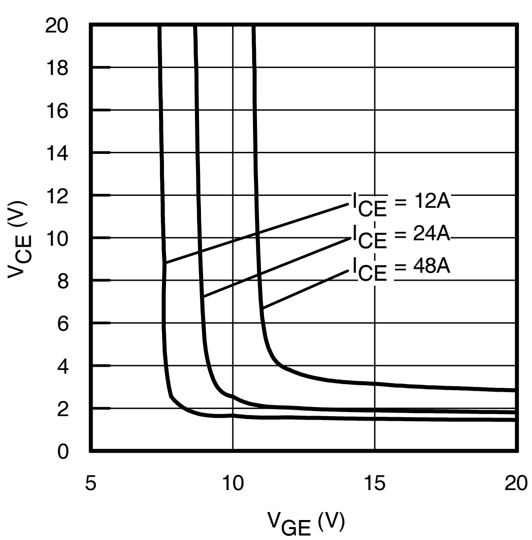


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

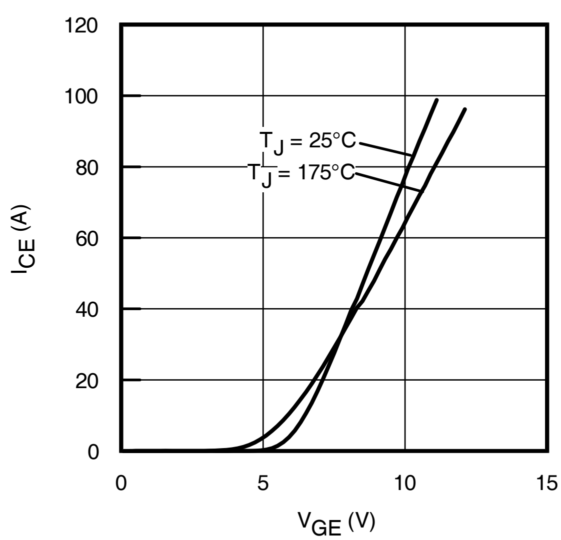


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

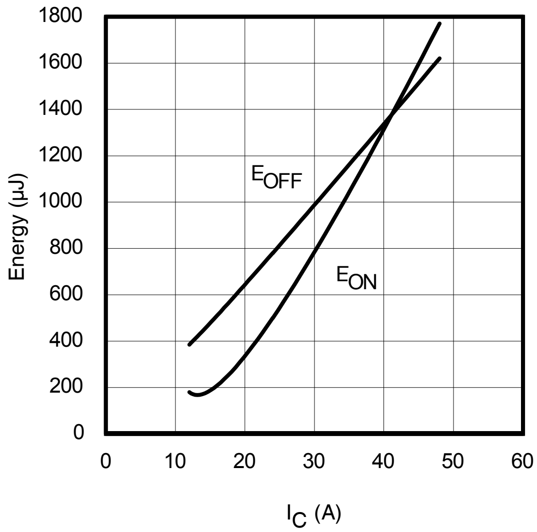


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 200µH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

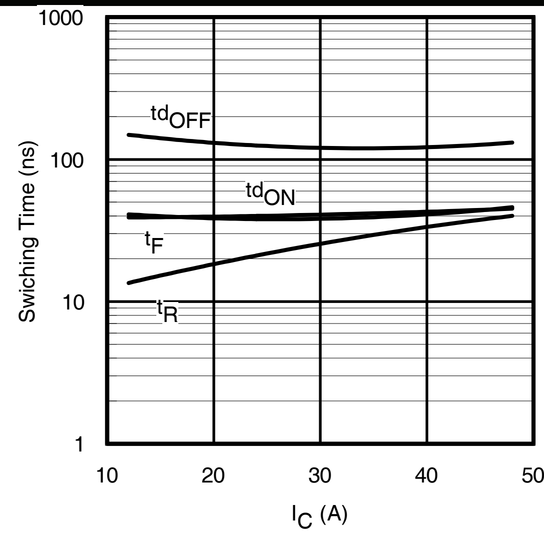


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 175°C; L = 200µH; V_{CE} = 400V, R_G = 10Ω; V_{GE} = 15V

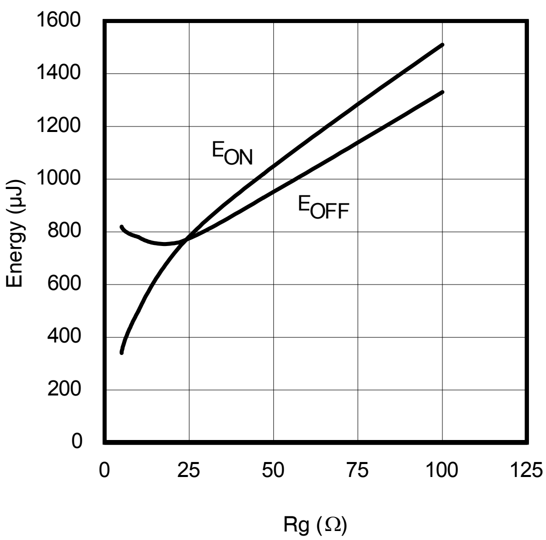


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 200µH; V_{CE} = 400V, I_{CE} = 24A; V_{GE} = 15V

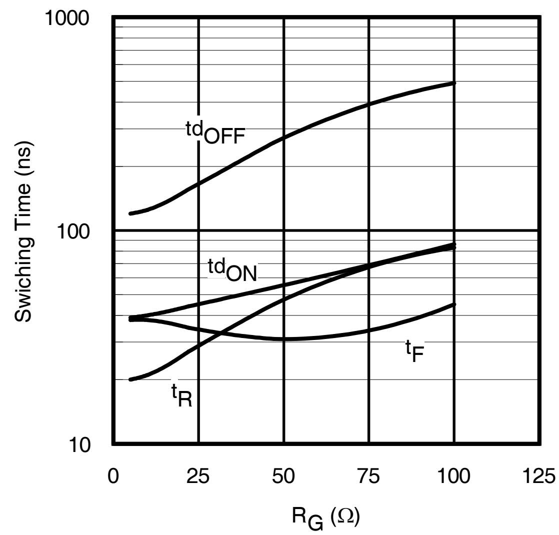


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 175°C; L = 200µH; V_{CE} = 400V, I_{CE} = 24A; V_{GE} = 15V

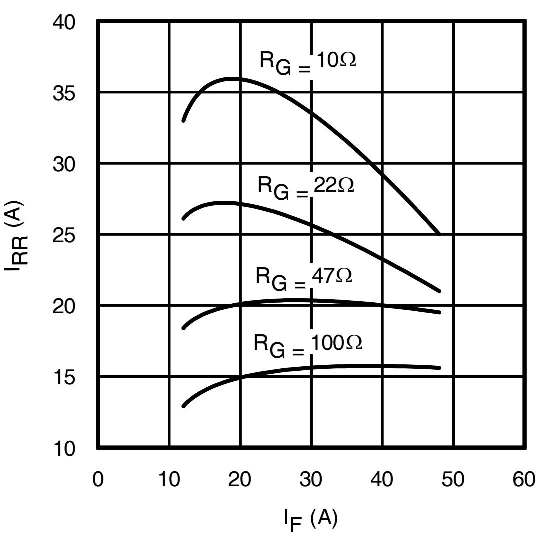


Fig. 17 - Typ. Diode I_{RR} vs. I_F
T_J = 175°C

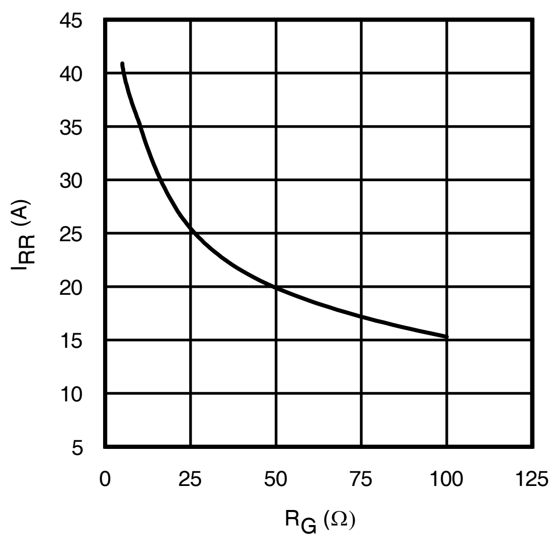


Fig. 18 Typ. Diode I_{RR} vs. R_G
T_J = 175°C

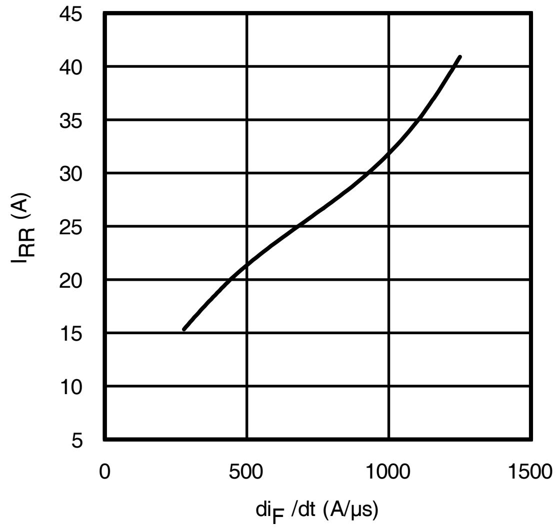


Fig. 19 - Typ. Diode I_{RR} vs. d_{iF}/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 24A; T_J = 175°C

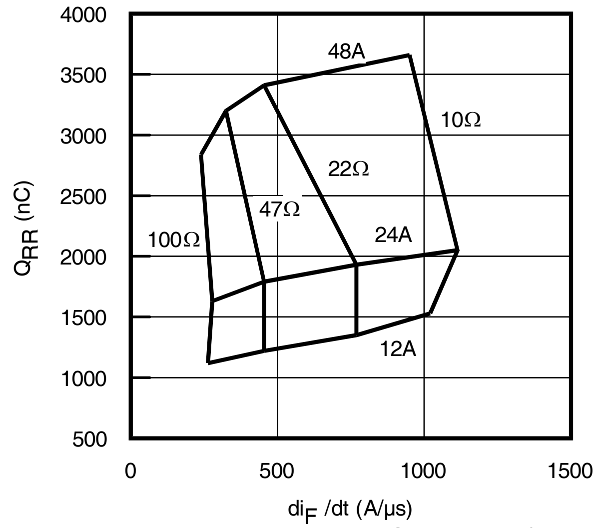


Fig. 20 - Typ. Diode QRR vs. d_{iF}/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C

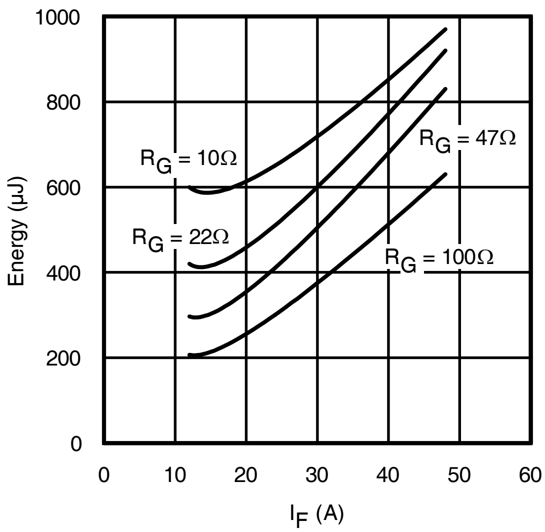


Fig. 21 - Typ. Diode E_{RR} vs. I_F
T_J = 175°C

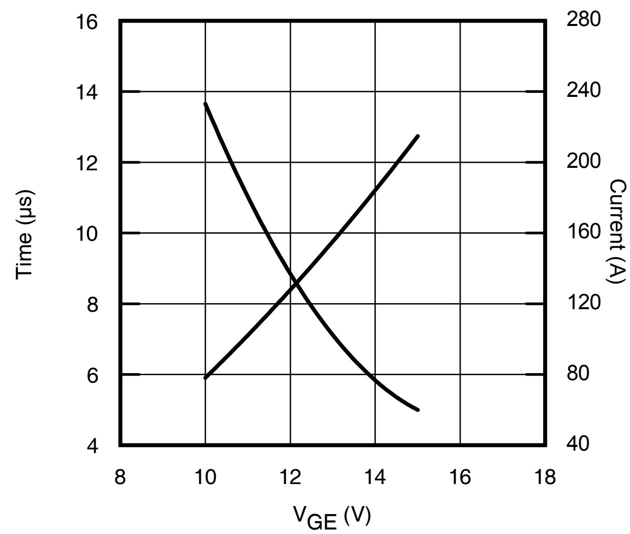


Fig. 22 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

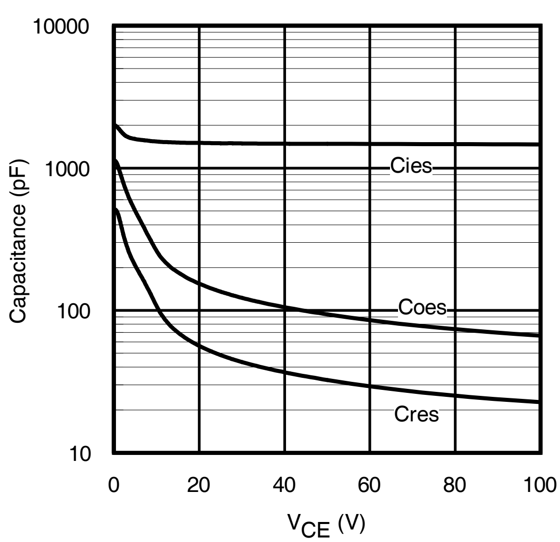


Fig. 23 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

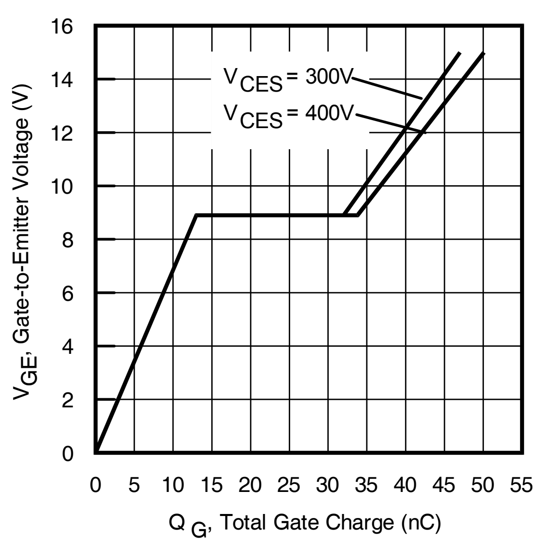
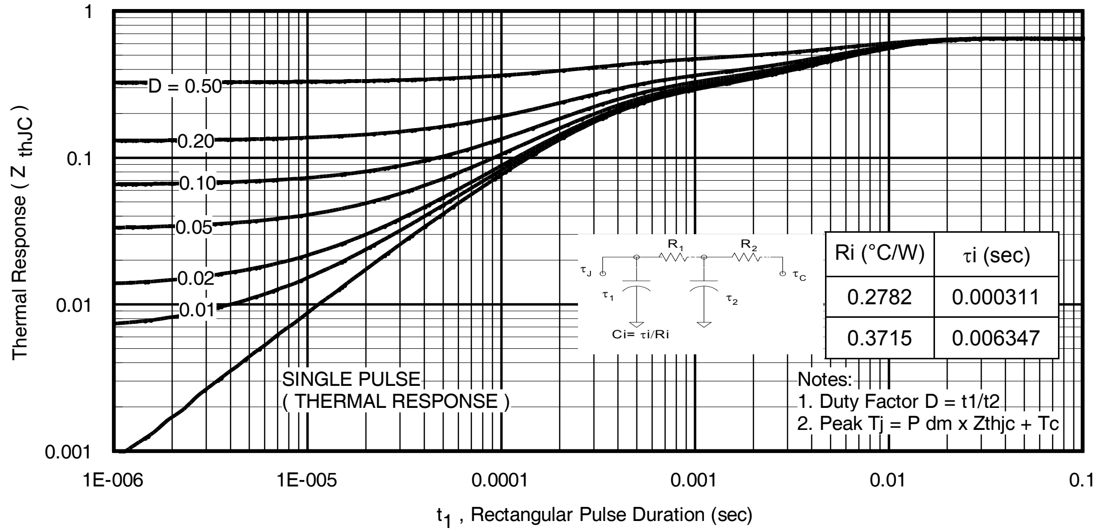
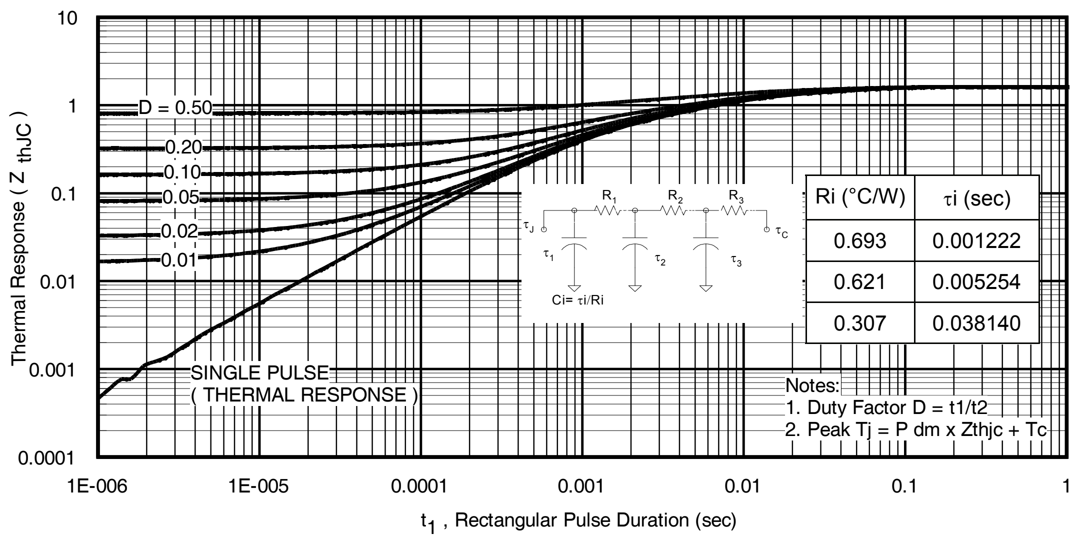


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 24A; L = 600µH



Ri (°C/W)	τi (sec)
0.2782	0.000311
0.3715	0.006347

Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



Ri (°C/W)	τi (sec)
0.693	0.001222
0.621	0.005254
0.307	0.038140

Fig 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

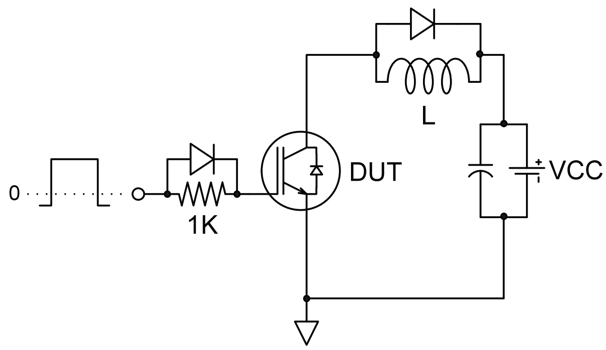


Fig.C.T.1 - Gate Charge Circuit (turn-off)

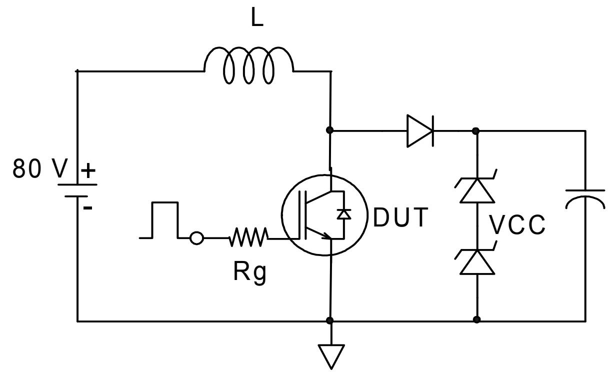


Fig.C.T.2 - RBSOA Circuit

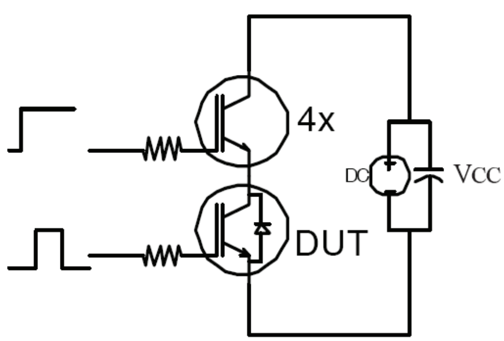


Fig.C.T.3 - S.C. SOA Circuit

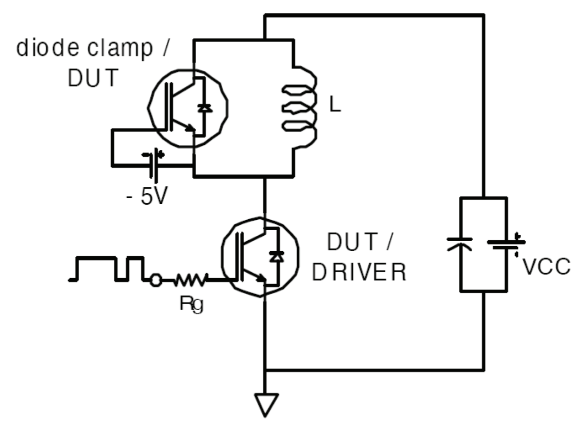


Fig.C.T.4 - Switching Loss Circuit

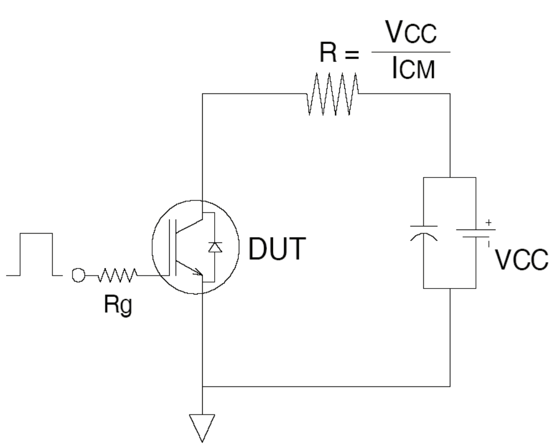


Fig.C.T.5 - Resistive Load Circuit

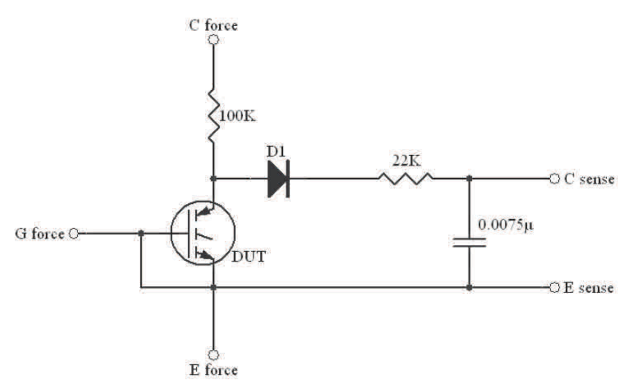


Fig.C.T.6 - BVCES Filter Circuit

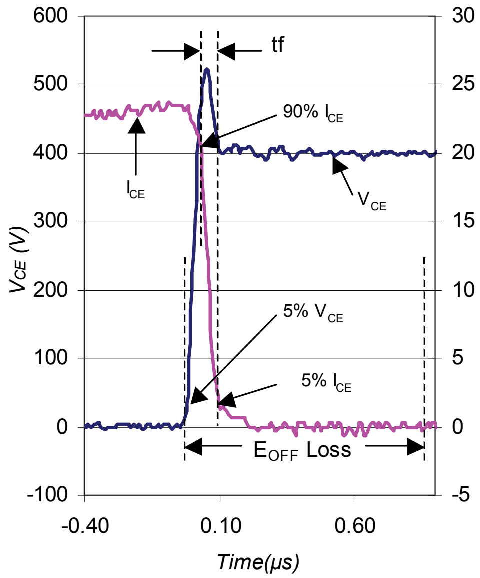


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

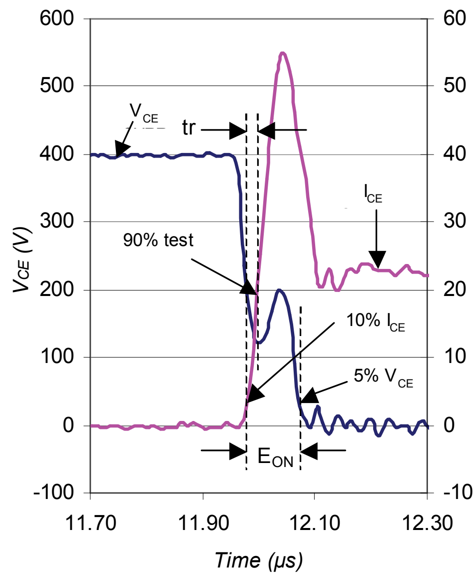


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4

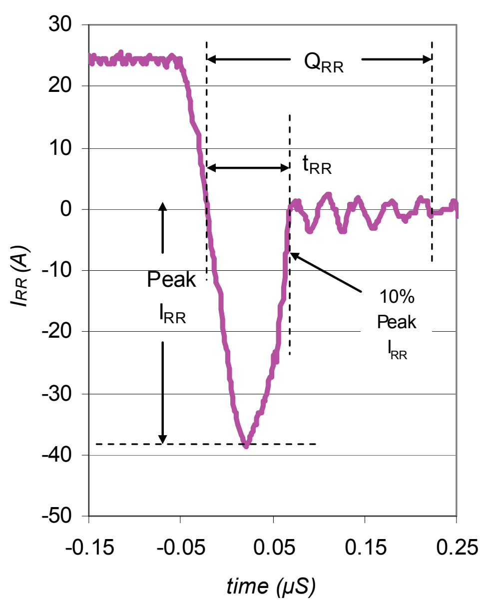


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 175°C using Fig. CT.4

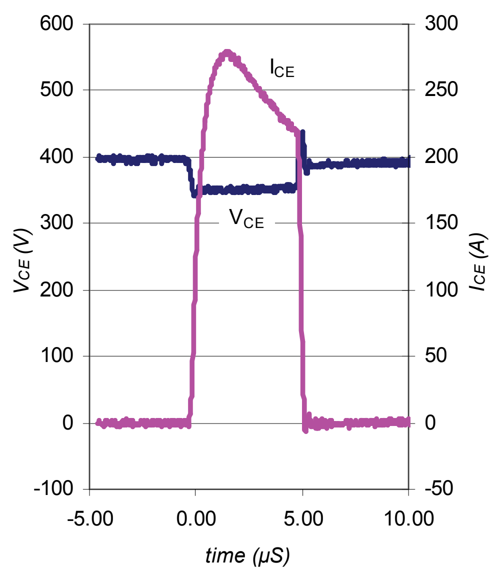
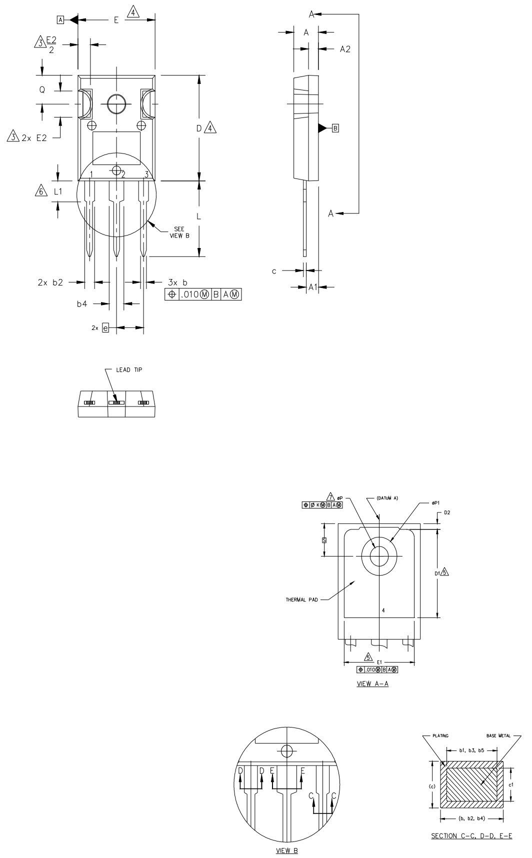


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 25°C using Fig. CT.3

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

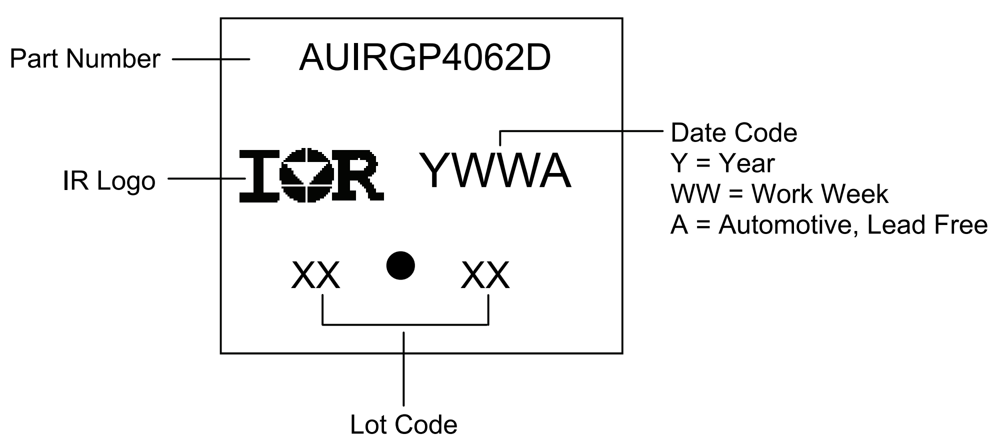
IGBTs, CoPACK

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

DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

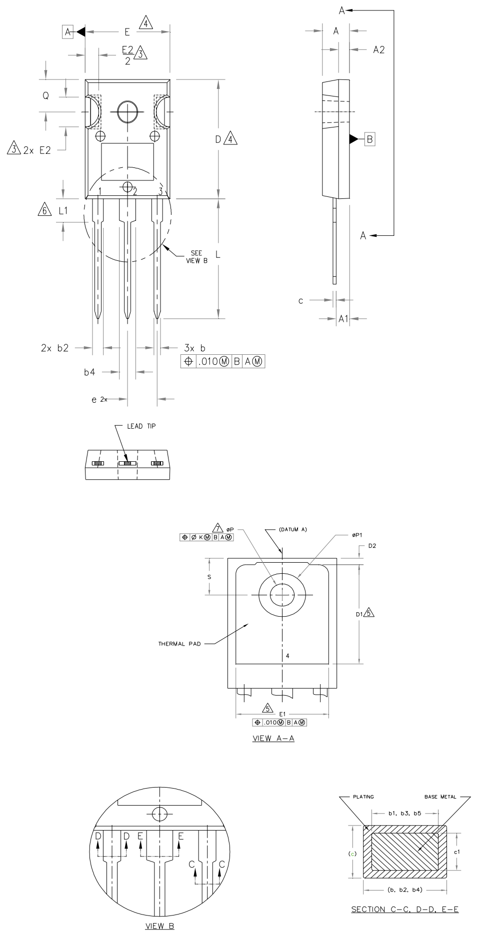
TO-247AC Part Marking Information



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

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	.190	.203	4.83	5.13	
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

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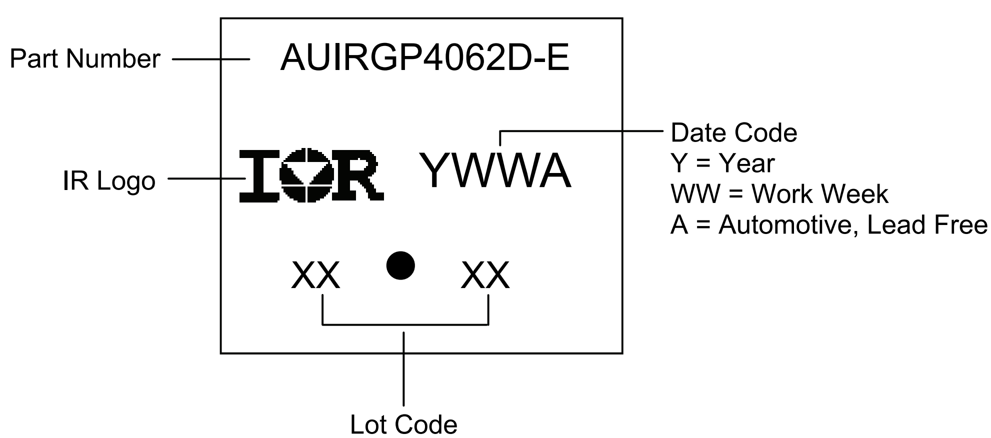
DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

TO-247AD Part Marking Information



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

Qualification Information

<table>
<tr><td rowspan="2" colspan="2">Qualification Level</td><td colspan="2">Automotive
(per AEC-Q101)</td></tr>
<tr><td colspan="2">This part number(s) passed Automotive qualification. Infineon's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.</td></tr>
<tr><td rowspan="2" colspan="2">Moisture Sensitivity Level</td><td>TO-247AC</td><td rowspan="2">N/A</td></tr>
<tr><td>TO-247AD</td></tr>
<tr><td rowspan="3">ESD</td><td>Machine Model</td><td colspan="2">Class M4(+/- 400V)†
AEC-Q101-002</td></tr>
<tr><td>Human Body Model</td><td colspan="2">Class H2(+/- 2000V)†
AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class C5 (+/- 1000V)†
AEC-Q101-005</td></tr>
<tr><td colspan="2">RoHS Compliant</td><td colspan="2">Yes</td></tr>
</table>

† Highest passing voltage.

Revision History

Date	Comments
8/24/2017	• Updated datasheet with corporate template • Corrected package outline –TO-247AD on page 11 • Corrected part marking on pages 10,11

Published by
Infineon Technologies AG
81726 München, Germany

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