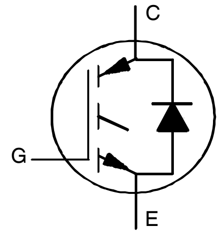
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

V_{CES} = 600V

$I_{C(Nominal)}$ = 75A

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

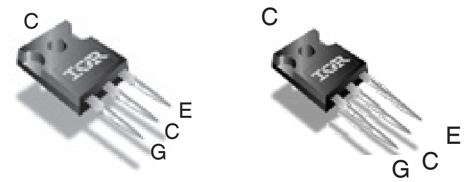
$V_{CE(on)}$ typ. = 1.70V

Features

- Low $V_{CE\ (ON)}$ Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5 µS short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current (I_{LM})①
- Positive $V_{CE\ (ON)}$ Temperature Coefficient
- Soft Recovery Co-Pak Diode
- Tight parameter distribution
- 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



TO-247AC
AUIRGP4066D1

TO-247AD
AUIRGP4066D1-E

G	C	E
Gate	Collector	Emitter

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRGP4066D1	TO-247AC	Tube	25	AUIRGP4066D1
AUIRGP4066D1-E	TO-247AD	Tube	25	AUIRGP4066D1-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	140⑤	A
I_C @ T_C = 100°C	Continuous Collector Current	90	
$I_{NOMINAL}$	Nominal Current	75	
I_{CM}	Pulse Collector Current V_{GE} = 15V	225	
I_{LM}	Clamped Inductive Load Current V_{GE} = 20V ①	300	
$I_{F\ NOMINAL}$	Diode Nominal Current②	75⑤	
I_{FM}	Diode Maximum Forward Current ②	300	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	454	W
P_D @ T_C = 100°C	Maximum Power Dissipation	227	
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) ④	—	—	0.33	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)④	—	—	0.53	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	40	—	

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

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 200μA ④
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	V_{GE} = 0V, I_C = 15mA (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.70	2.1	V	I_C = 75A, V_{GE} = 15V, T_J = 25°C ②
		—	2.0	—		I_C = 75A, V_{GE} = 15V, T_J = 150°C②
		—	2.1	—		I_C = 75A, V_{GE} = 15V, T_J = 175°C②
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 2.1mA
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 20mA (25°C - 175°C)
gfe	Forward Transconductance	—	50	—	S	V_{CE} = 50V, I_C = 75A, PW = 25μs
I_{CES}	Collector-to-Emitter Leakage Current	—	3.0	200	μA	V_{GE} = 0V, V_{CE} = 600V
		—	10	—	mA	V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C
V_{FM}	Diode Forward Voltage Drop	—	1.60	1.77	V	I_F = 75A
		—	1.54	—		I_F = 75A, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	150	225		I_C = 75A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	40	60	nC	V_{GE} = 15V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	60	90		V_{CC} = 400V
E_{on}	Turn-On Switching Loss	—	4240	5190		I_C = 75A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	2170	3060	μJ	R_G = 10Ω, L = 100μH, T_J = 25°C
E_{total}	Total Switching Loss	—	6410	8250		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	50	70		I_C = 75A, V_{CC} = 400V, V_{GE} = 15V
t_r	Rise time	—	80	100	ns	R_G = 10Ω, L = 100μH
$t_{d(off)}$	Turn-Off delay time	—	200	230		TJ = 25°C
t_f	Fall time	—	60	80		
E_{on}	Turn-On Switching Loss	—	6210	—		I_C = 75A, V_{CC} = 400V, V_{GE}=15V
E_{off}	Turn-Off Switching Loss	—	2815	—	μJ	R_G=10Ω, L=100μH, T_J = 175°C
E_{total}	Total Switching Loss	—	9025	—		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	45	—		I_C = 75A, V_{CC} = 400V, V_{GE}=15V
t_r	Rise time	—	70	—	ns	R_G=10Ω, L=100μH
$t_{d(off)}$	Turn-Off delay time	—	240	—		T_J = 175°C
t_f	Fall time	—	80	—		
C_{ies}	Input Capacitance	—	4470	—		V_{GE} = 0V
C_{oes}	Output Capacitance	—	350	—	pF	V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	140	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 300A V_{CC} = 480V, Vp ≤600V Rg = 10Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V_{CC} = 400V, Vp ≤600V Rg = 10Ω, V_{GE} = +15V to 0V
Erec	Reverse Recovery Energy of the Diode	—	680	—	μJ	T_J = 175°C
t_{rr}	Diode Reverse Recovery Time	—	240	—	ns	V_{CC} = 400V, I_F = 75A
I_{rr}	Peak Reverse Recovery Current	—	50	—	A	V_{GE} = 15V, Rg = 10Ω, L =100μH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 100μH, R_G = 50Ω, tested in production I_{LM} ≤ 400A.
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 Calculated continuous current based on maximum allowable junction temperature. Package IGBT current limit is 120A. Package diode current limit is120A. Note that current limitations arising from heating of the device leads may occur.

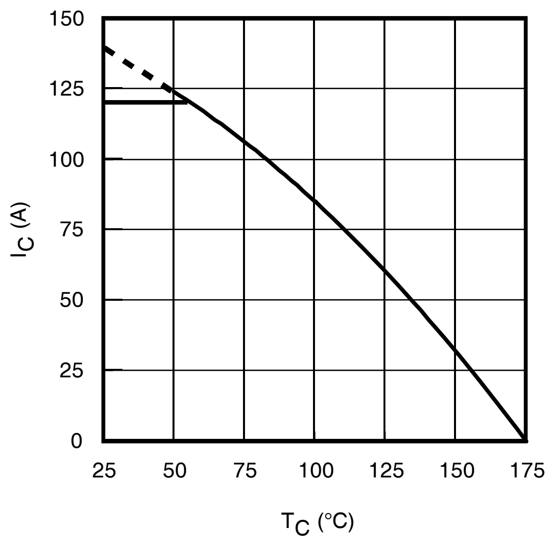


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

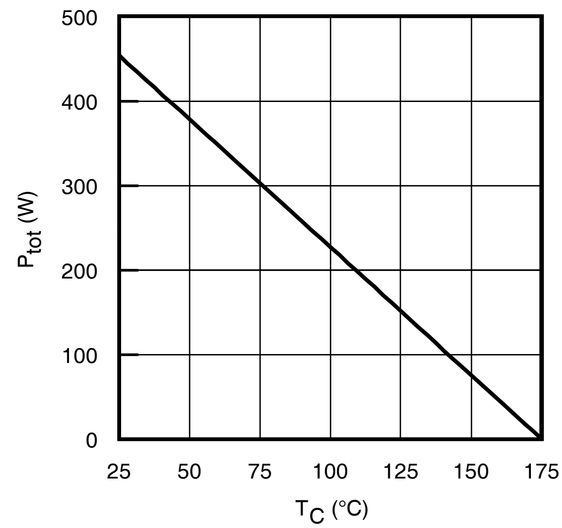


Fig. 2 - Power Dissipation vs. Case Temperature

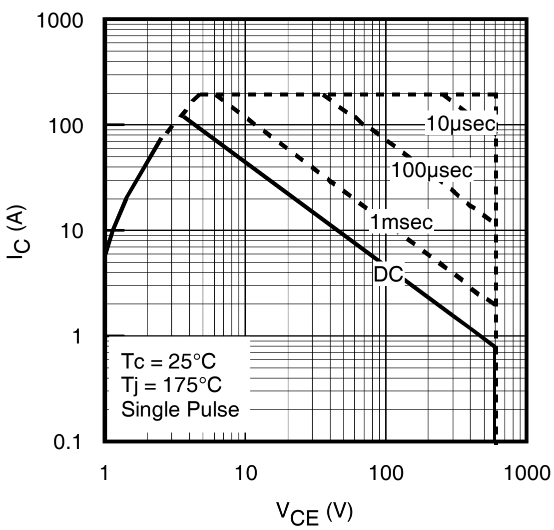


Fig. 3 - Forward SOA
T_C = 25°C, $T_J \leq$ 175°C; V_{GE} =15V

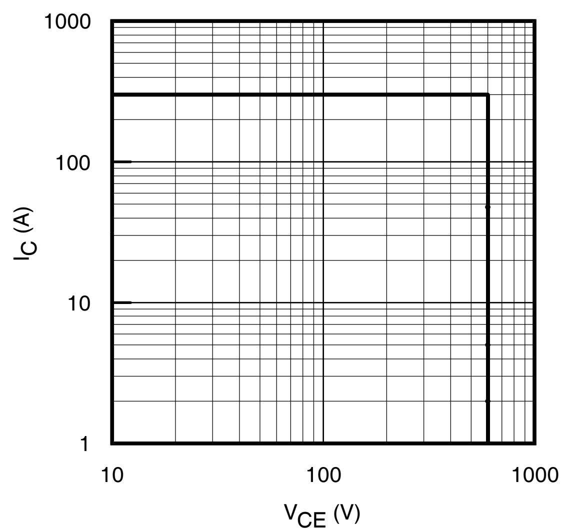


Fig. 4 - Reverse Bias SOA
T_J = 175°C; V_{GE} =20V

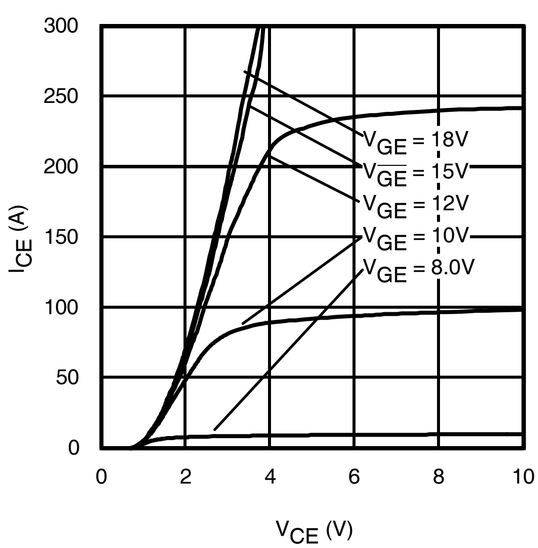


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = ≤60µs

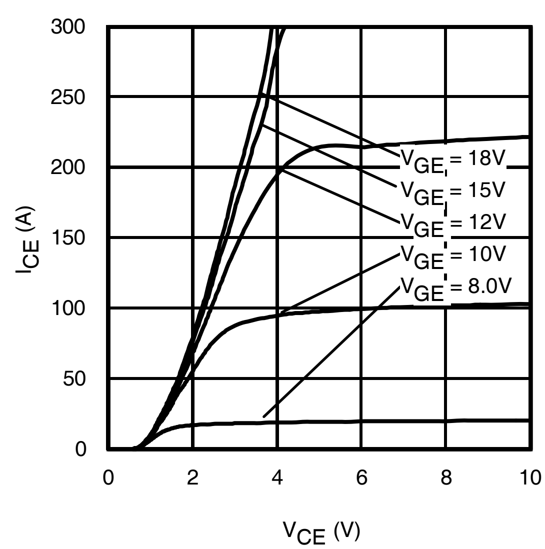


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = ≤60µs

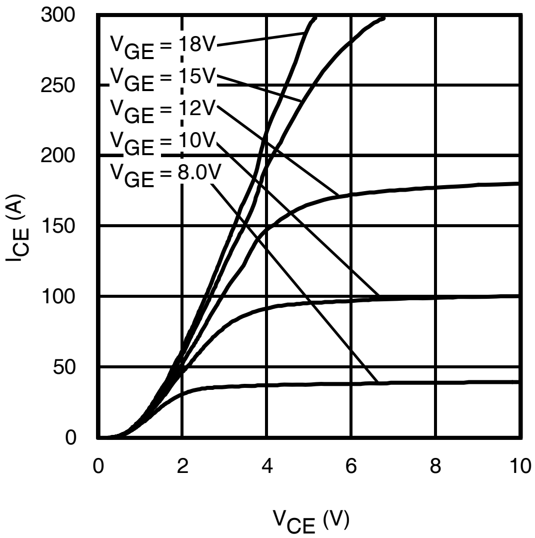


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = ≤60µs

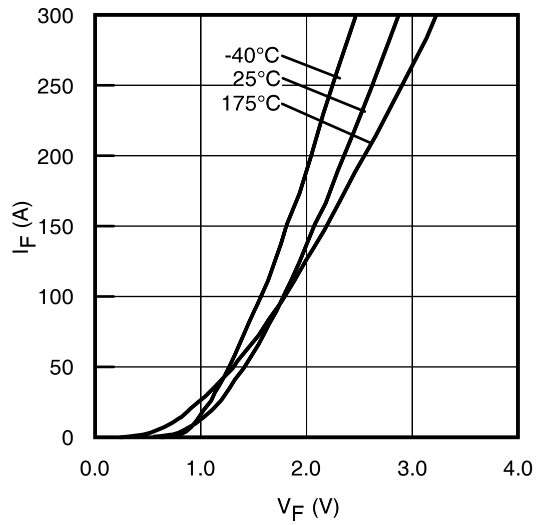


Fig. 8 - Typ. Diode Forward Characteristics
tp = ≤60µs

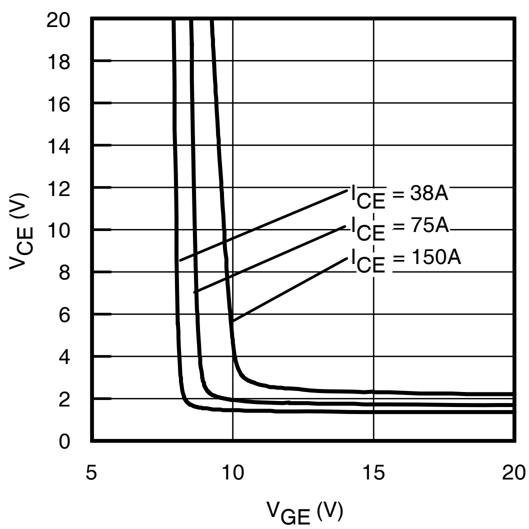


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

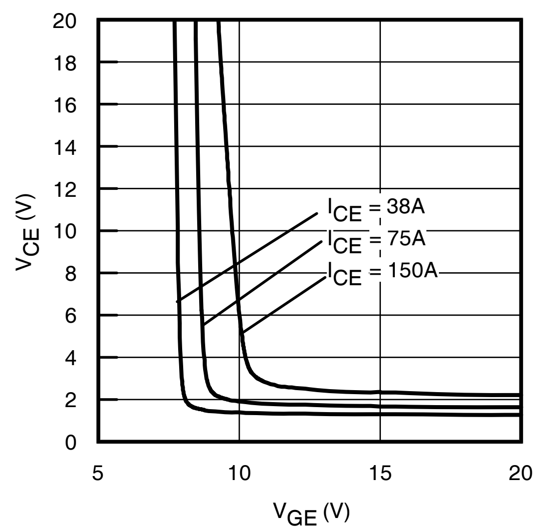


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

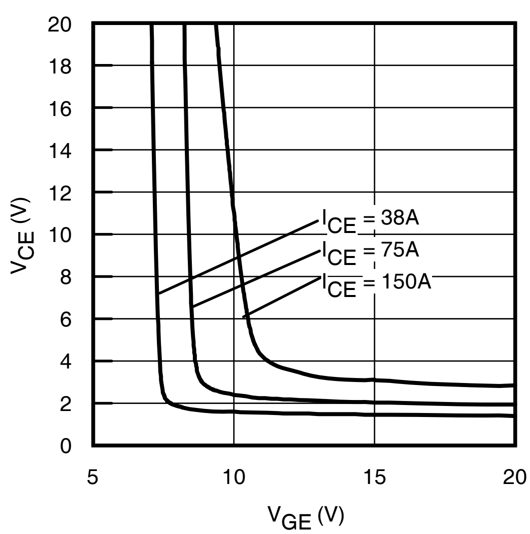


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

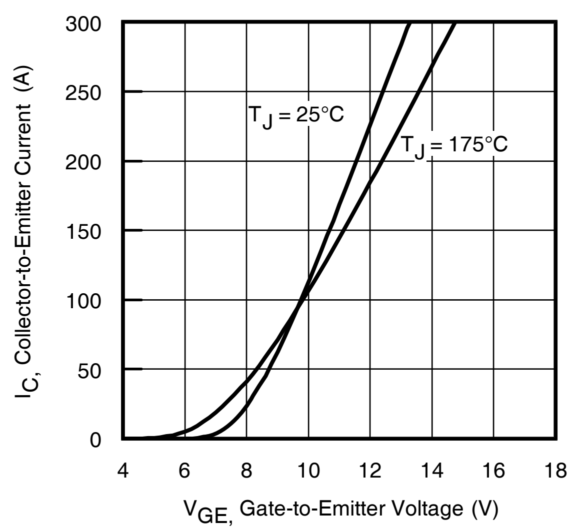


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = ≤60µs

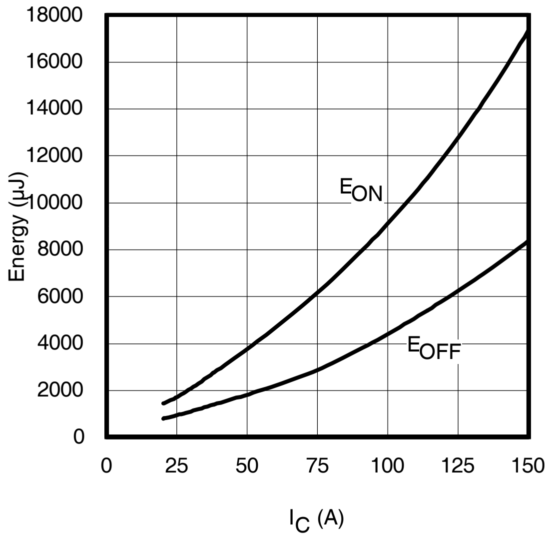


Fig. 13 - Typ. Energy Loss vs. I_C
$T_J = 175°C$; $L = 100\mu H$; $V_{CE} = 400V$, $R_G = 10\Omega$; $V_{GE} = 15V$

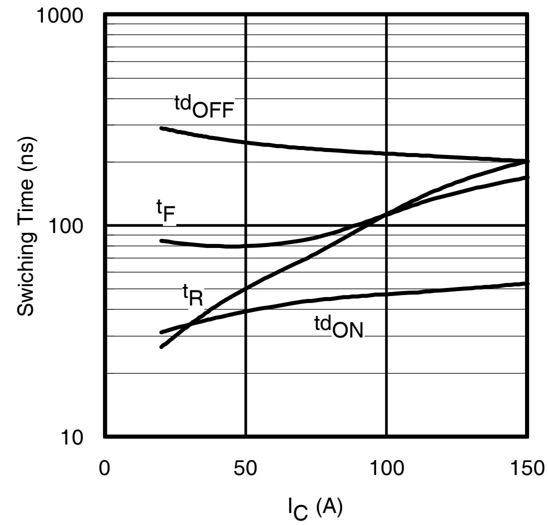


Fig. 14 - Typ. Switching Time vs. I_C
$T_J = 175°C$; $L = 100\mu H$; $V_{CE} = 400V$, $R_G = 10\Omega$; $V_{GE} = 15V$

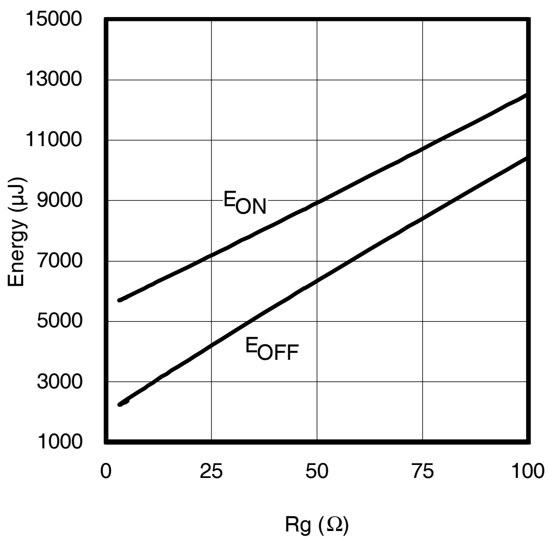


Fig. 15 - Typ. Energy Loss vs. R_G
$T_J = 175°C$; $L = 100\mu H$; $V_{CE} = 400V$, $I_{CE} = 75A$; $V_{GE} = 15V$

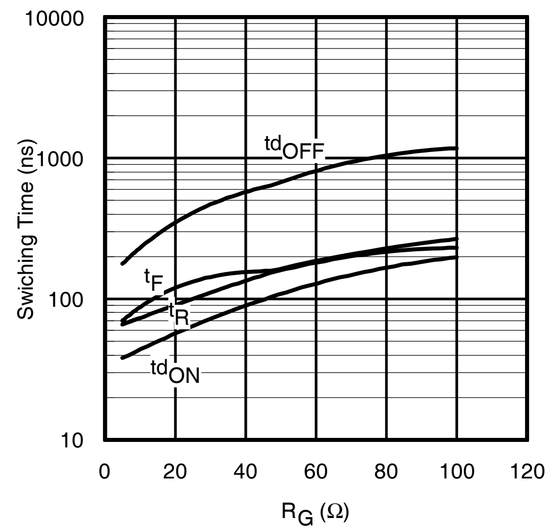


Fig. 16 - Typ. Switching Time vs. R_G
$T_J = 175°C$; $L = 100\mu H$; $V_{CE} = 400V$, $I_{CE} = 75A$; $V_{GE} = 15V$

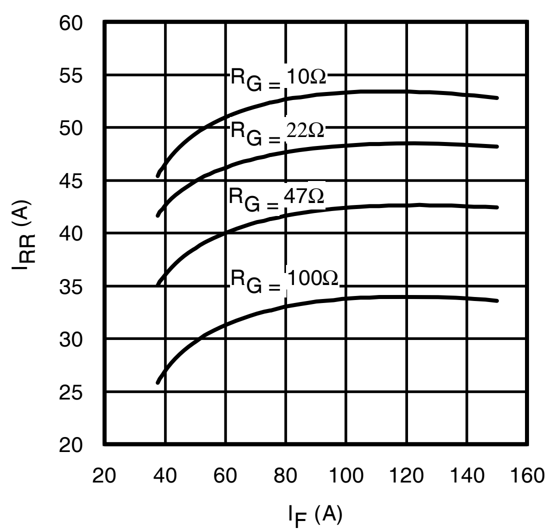


Fig. 17 - Typ. Diode I_{RR} vs. I_F
$T_J = 175°C$

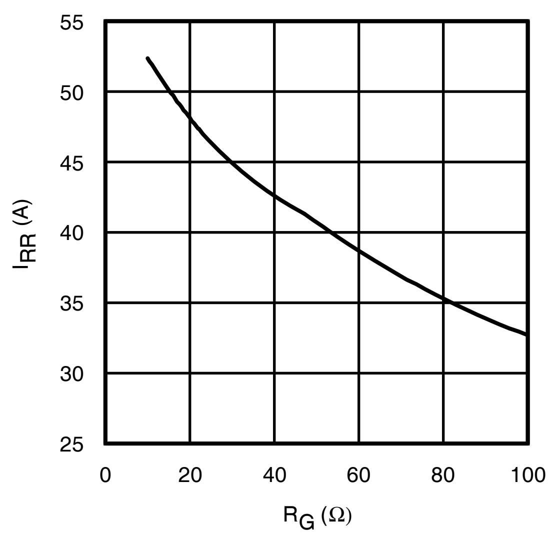


Fig. 18 - Typ. Diode I_{RR} vs. R_G
$T_J = 175°C$

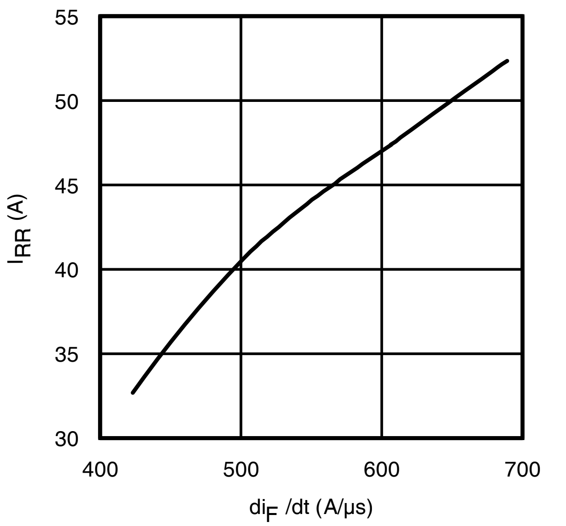


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 75A; T_J = 175°C

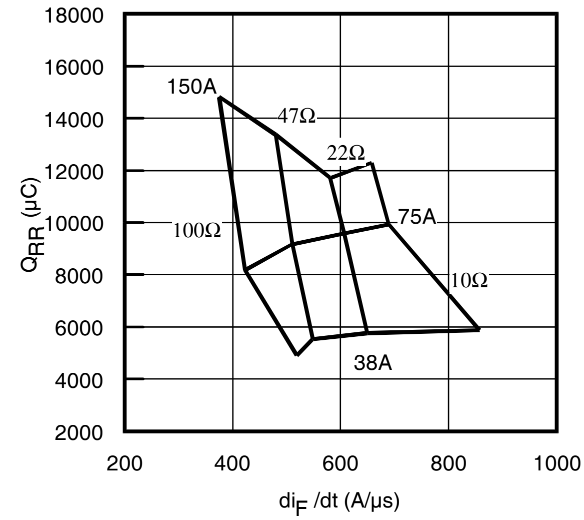


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C

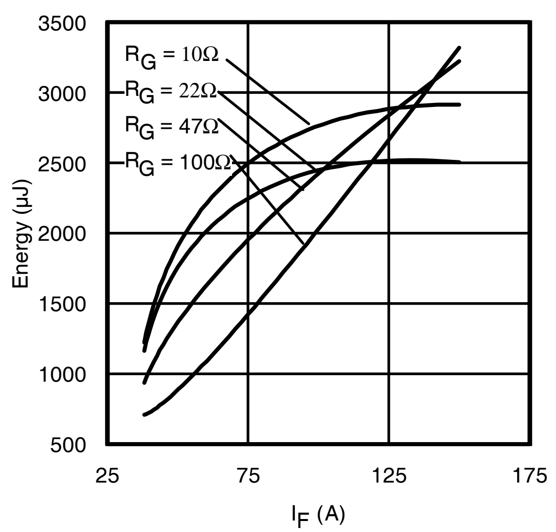


Fig. 21 - Typ. Diode E_{RR} vs. I_F
T_J = 175°C

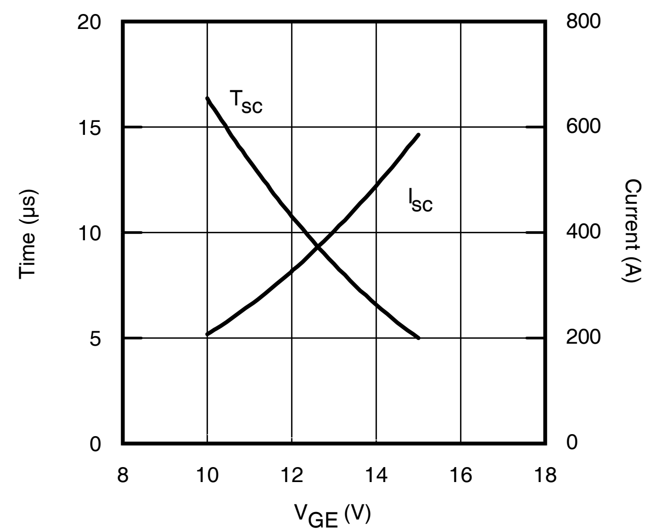


Fig. 22 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

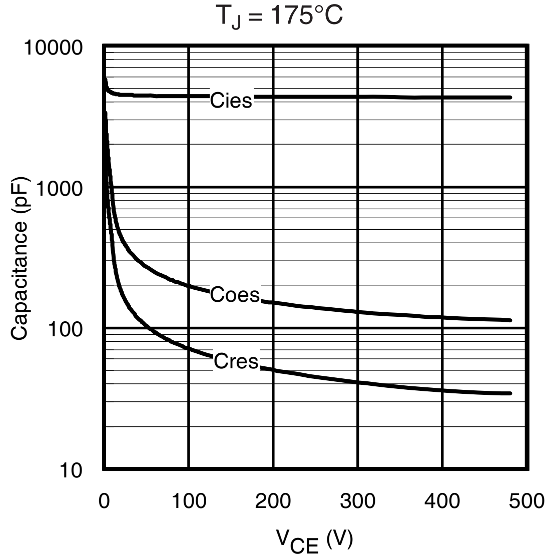


Fig. 23 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

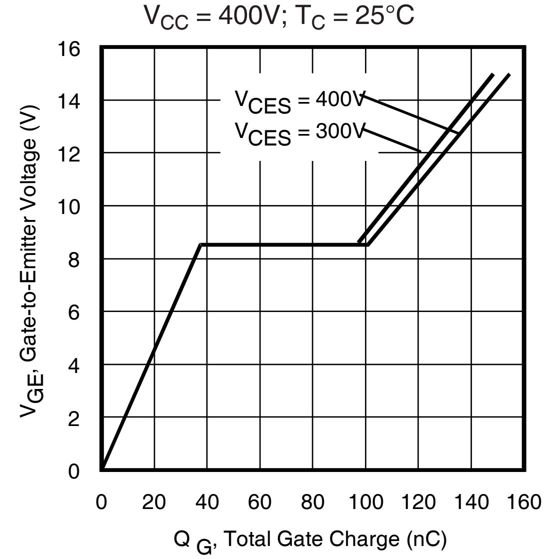
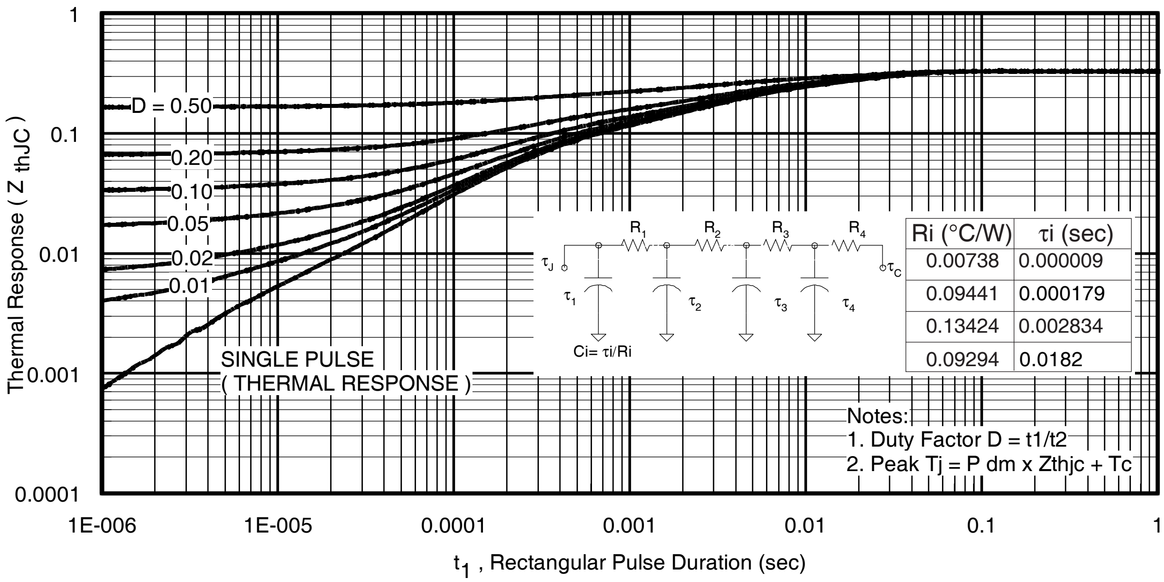
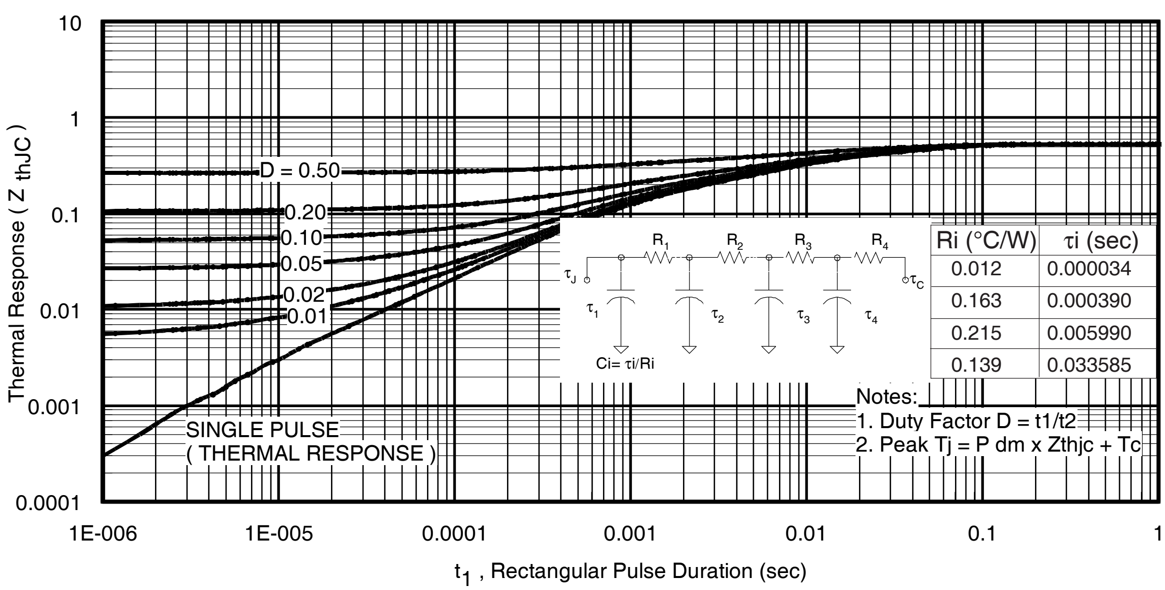


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 75A; L = 485µH



Ri (°C/W)	τi (sec)
0.00738	0.000009
0.09441	0.000179
0.13424	0.002834
0.09294	0.0182

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



Ri (°C/W)	τi (sec)
0.012	0.000034
0.163	0.000390
0.215	0.005990
0.139	0.033585

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

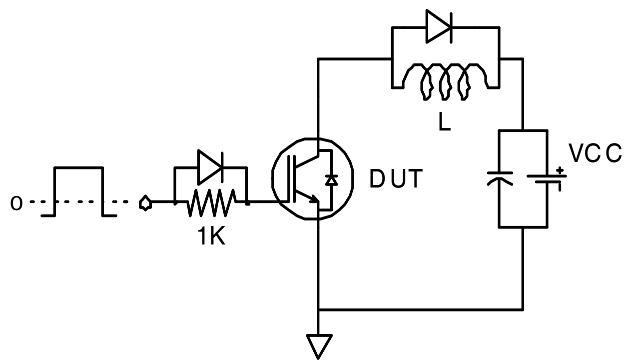


Fig.C.T.1 - Gate Charge Circuit (turn-off)

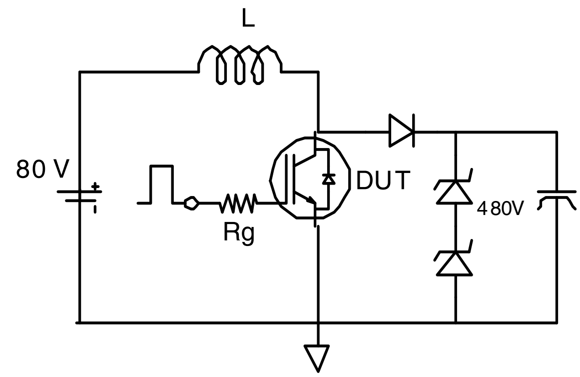


Fig.C.T.2 - RBSOA Circuit

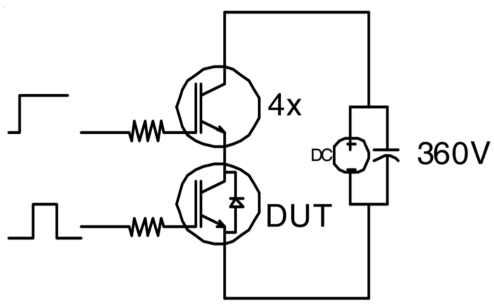


Fig.C.T.3 - S.C. SOA Circuit

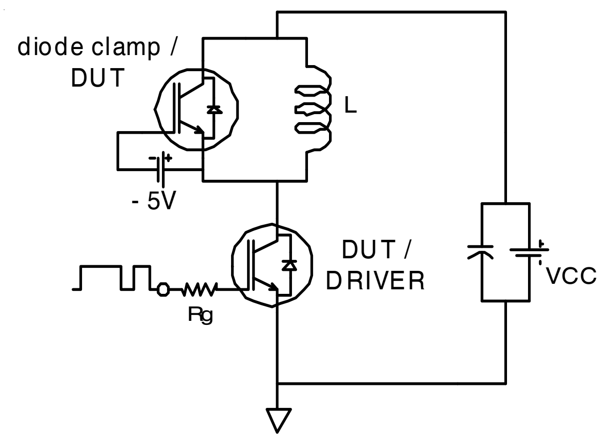


Fig.C.T.4 - Switching Loss Circuit

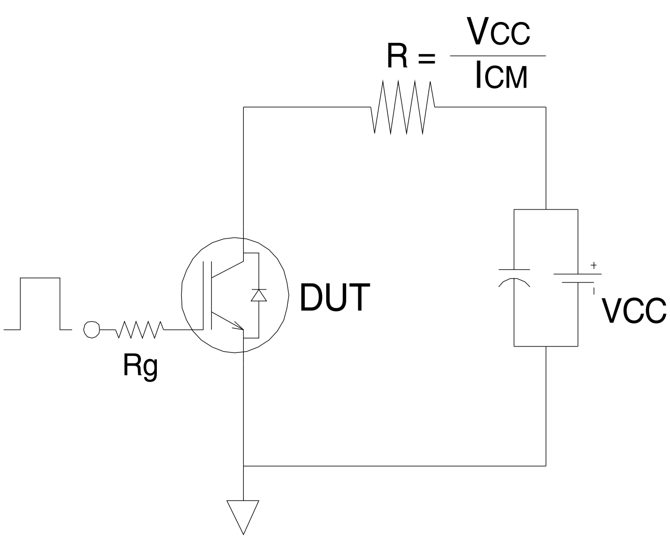


Fig.C.T.5 - Resistive Load Circuit

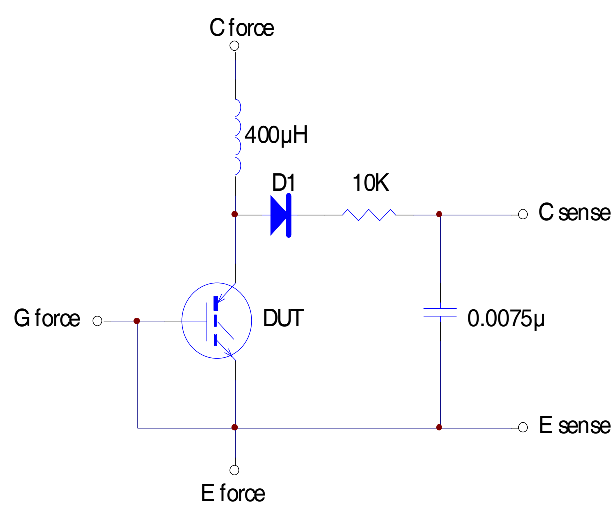


Fig.C.T.6 - BVCES Filter Circuit

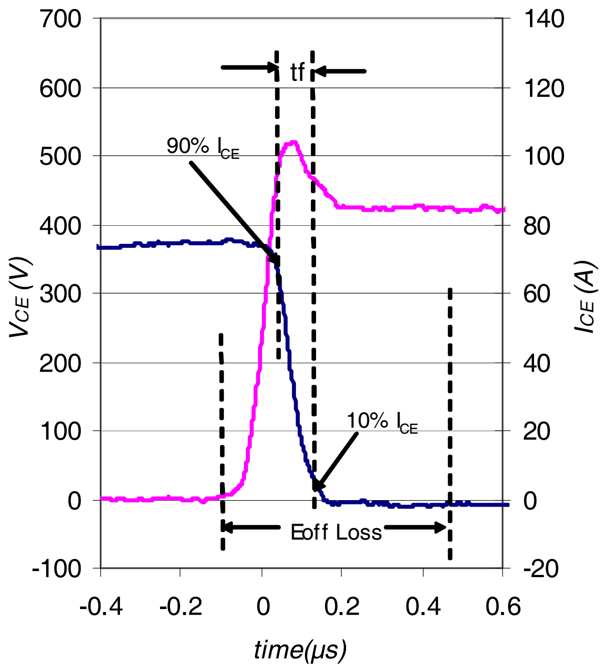


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

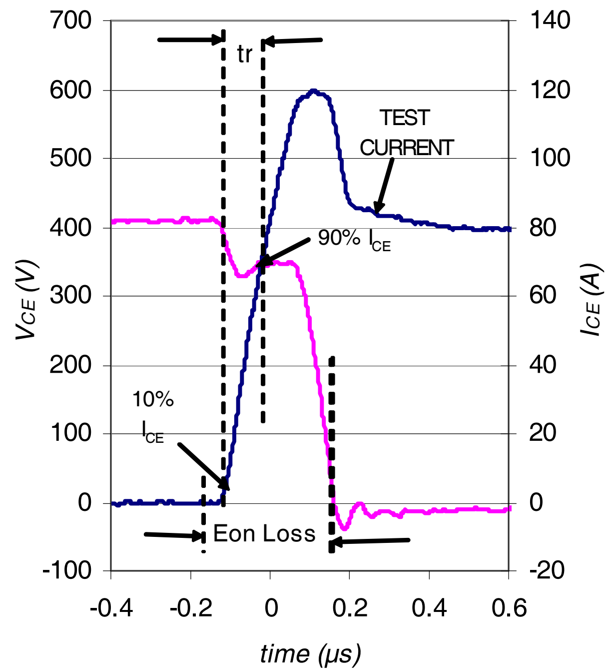


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4

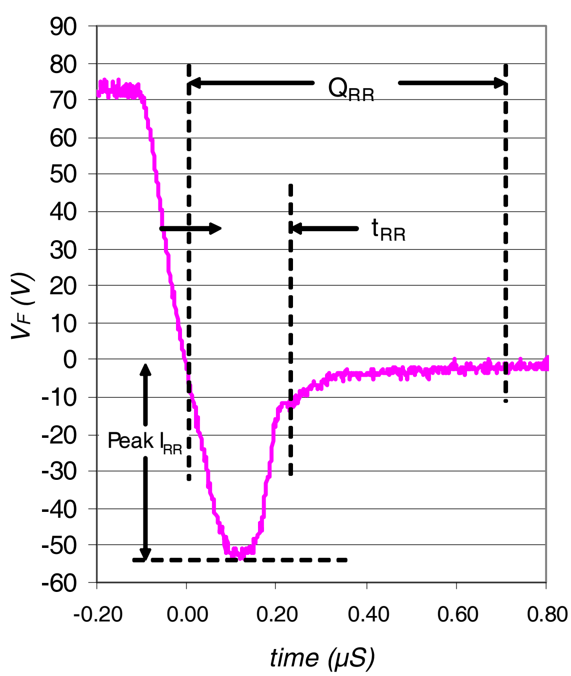


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 175°C using Fig. CT.4

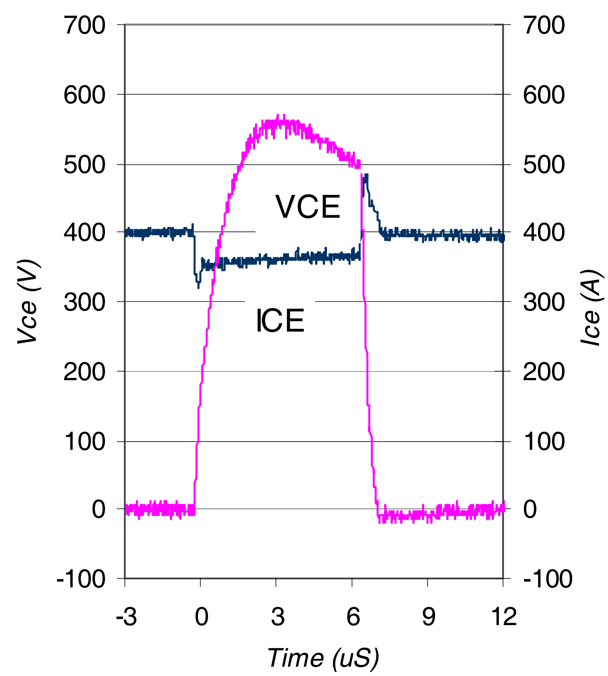
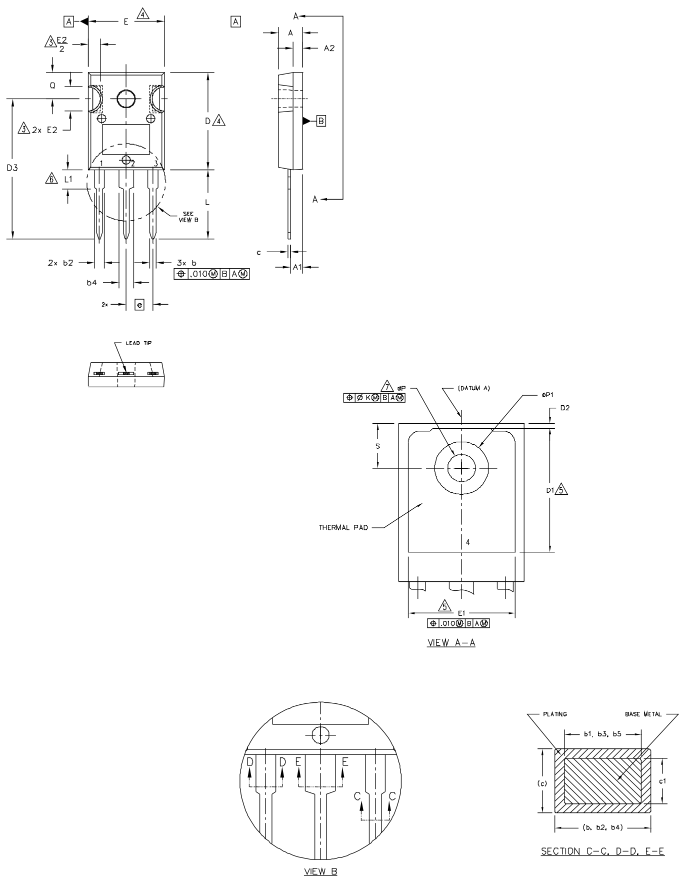


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 25°C using Fig. CT.3

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	
D3	1.122	1.161	28.50	29.50	
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		

SPECIAL NOTE:

a) ADDED D3 FOR SPECIAL REQUIREMENT

PART NUMBERS AFFECTED:

AUIRG4PH50S
AUIRGP4066D1/E
AUIRGP4063D/E
AUIRGP50B60PD1/E
AUIRGP35B60PD/E
AUIRGP4062D1/E
AUIRGP65A20D0
AUIRGP65G20D0
AUIRGP/F66524D0
AUIRGP/F76524D0
AUIRGP/F66548D0
AUIRGP/F76548D0

LEAD ASSIGNMENTS

HEXFET

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

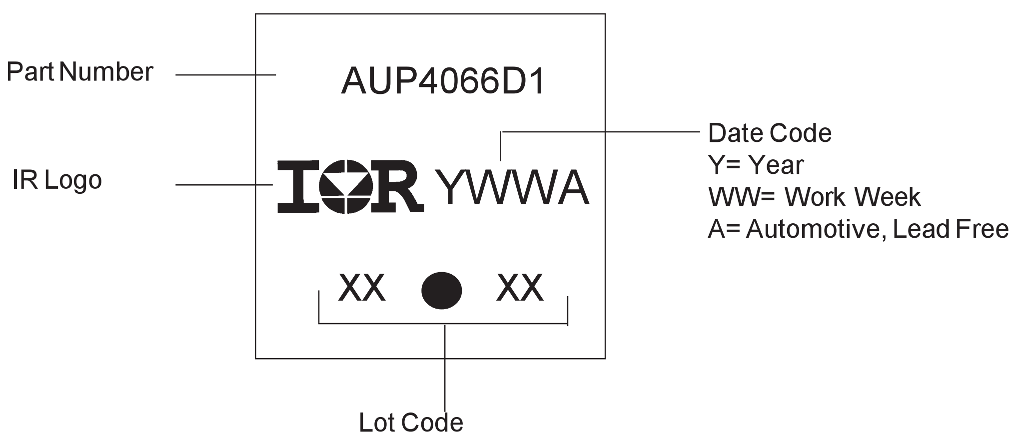
IGBTs, CoPACK

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

DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

TO-247AC Part Marking Information

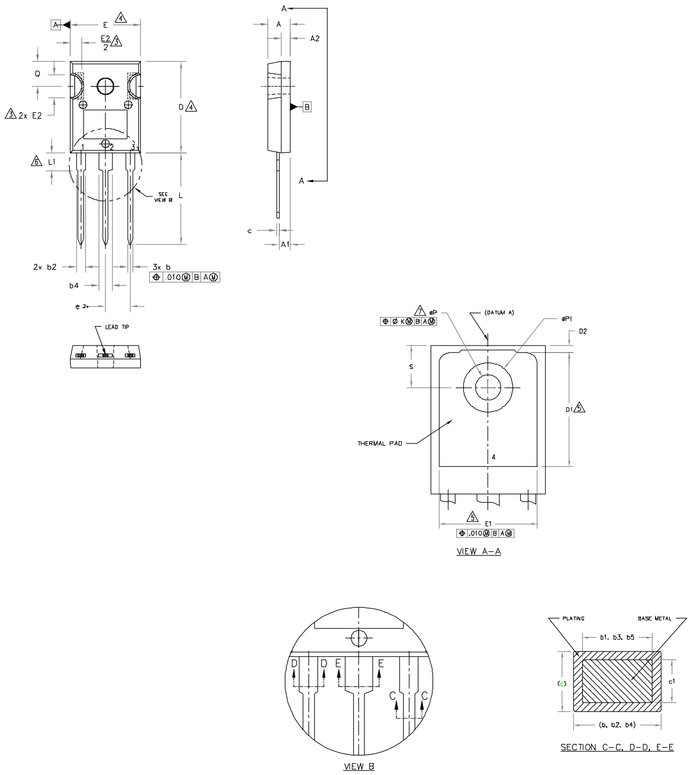


TO-247AC package is not recommended for Surface Mount Application.

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.
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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		

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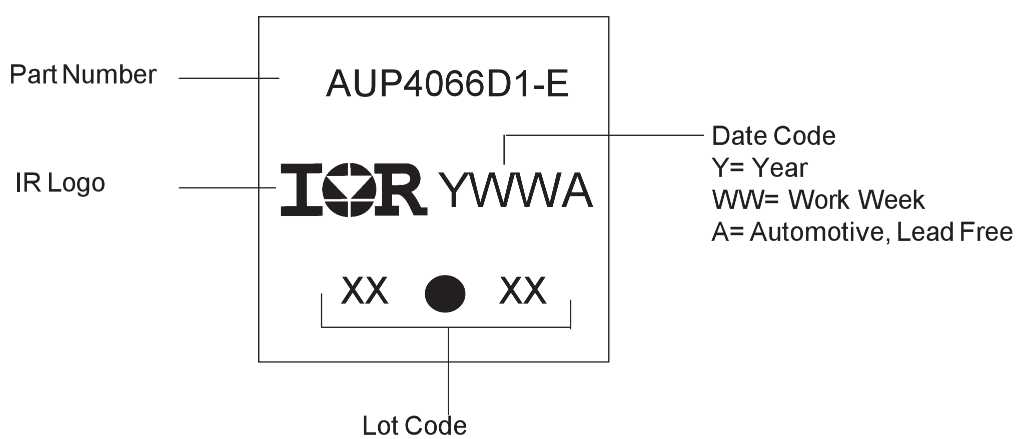
TO-247AD Part Marking Information



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†

<table>
<tr><td colspan="2" rowspan="2">Qualification Level</td><td colspan="2">Automotive
(per AEC-Q101)</td></tr>
<tr><td colspan="2">Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.</td></tr>
<tr><td colspan="2" rowspan="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 (+/-425V) ††
AEC-Q101-002</td></tr>
<tr><td>Human Body Model</td><td colspan="2">Class H2 (+/-4000V) ††
AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class C5 (+/-1125V) ††
AEC-Q101-005</td></tr>
<tr><td colspan="2">RoHS Compliant</td><td colspan="2">Yes</td></tr>
</table>

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

†† Highest passing voltage

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

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