THE DATASHEET OF

AUIRGR4045DTRL

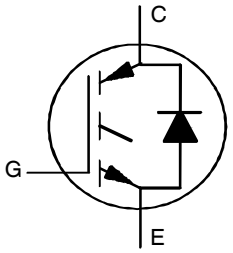
International
IOR Rectifier

AUTOMOTIVE GRADE

PD - 97637

AUIRGR4045D
AUIRGU4045D

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

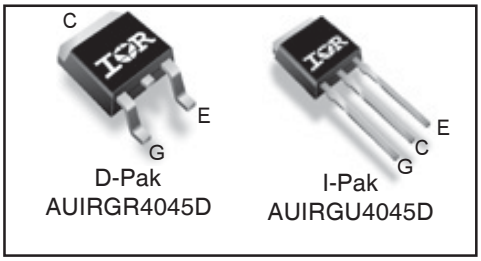
V_{CES} = 600V

I_C = 6.0A, T_C = 100°C

$V_{CE(on)\ typ.}$ = 1.7V

Features

- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5µs 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

G	C	E
Gate	Colletor	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 Breakdown Voltage	600	V
I_C@ T_C = 25°C	Continuous Collector Current	12	A
I_C@ T_C = 100°C	Continuous Collector Current	6.0	
I_{CM}	Pulsed Collector Current, V_{GE} = 15V	18	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	24	
I_F@T_C=25°C	Diode Continuous Forward Current	8.0	
I_F@T_C=100°C	Diode Continuous Forward Current	4.0	
I_{FM}	Diode Maximum Forward Current ②	24	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
P_D @ T_C =25°	Maximum Power Dissipation	77	W
P_D @ T_C =100°	Maximum Power Dissipation	39	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT ③	—	—	1.9	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode ③	—	—	6.8	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount) ⑤	—	—	50	
$R_{\theta JA}$	Junction-to-Ambient	—	—	110	

*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	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_c =100 µA ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.36	—	V/°C	V_{GE} = 0V, I_c = 250µA (25 -175 °C) ④	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	I_C = 6.0A, V_{GE} = 15V, T_J = 25°C	5,6,7,9, 10 ,11
		—	2.07	—		I_C = 6.0A, V_{GE} = 15V, T_J = 150°C	
		—	2.14	—		I_C = 6.0A, V_{GE} = 15V, T_J = 175°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	—	6.5	V	V_{CE} = V_{GE}, I_C = 150µA	9,10,11,12
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA (25 -175 °C)	
gfe	Forward Transconductance	—	5.8	—	S	V_{CE} = 25V, I_C = 6.0A, PW =80µs	
I_{CES}	Collector-to-Emitter Leakage Current	—	—	25	µA	V_{GE} = 0V,V_{CE} = 600V	8
		—	—	250		V_{GE} = 0V, V_{CE} = 600V, T_J =175°C	
V_{FM}	Diode Forward Voltage Drop	—	1.60	2.30	V	I_F = 6.0A	
		—	1.30	—		I_F = 6.0A, T_J = 175°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ± 20 V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q_g	Total Gate Charge (turn-on)	—	13	19.5	nC	I_C = 6.0A	24
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	3.1	4.65		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	6.4	9.6		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	56	86	µJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V	CT4
E_{off}	Turn-Off Switching Loss	—	122	143		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 25°C	
E_{total}	Total Switching Loss	—	178	229		Energy losses include tail and diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	27	35	ns	I_C = 6.0A, V_{CC} = 400V	CT4
t_r	Rise time	—	11	15		R_G = 47Ω, L=1mH, L_S= 150nH	
$t_{d(off)}$	Turn-Off delay time	—	75	93		T_J = 25°C	
t_f	Fall time	—	17	22			
E_{on}	Turn-On Switching Loss	—	140	—	µJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V	13,15
E_{off}	Turn-Off Switching Loss	—	189	—		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 175°C	CT4
E_{total}	Total Switching Loss	—	329	—		Energy losses include tail and diode reverse recovery	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	26	—	ns	I_C = 6.0A, V_{CC} = 400V	14,16
t_r	Rise time	—	12	—		R_G = 47Ω, L=1mH, L_S= 150nH	CT4
$t_{d(off)}$	Turn-Off delay time	—	95	—		T_J = 175°C	WF1,WF2
t_f	Fall time	—	32	—			
C_{ies}	Input Capacitance	—	350	—	pF	V_{GE} = 0V	23
C_{oes}	Output Capacitance	—	29	—		V_{CC} = 30V	
C_{res}	Reverse Transfer Capacitance	—	10	—		f = 1Mhz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 24A V_{CC} = 500V, Vp =600V R_G = 100Ω, V_{GE} = +20V to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	—	5	—	µs	V_{CC} = 400V, Vp =600V R_G = 100Ω, V_{GE} = +15V to 0V	22 CT3, WF4
Erec	Reverse recovery energy of the diode	—	178	—	µJ	T_J = 175°C	17,18,19
trr	Diode Reverse recovery time	—	74	—	ns	V_{CC} = 400V, I_F = 6.0A	20,21
Irr	Peak Reverse Recovery Current	—	12	—	A	V_{GE} = 15V, Rg = 47Ω, L=1mH, L_S=150nH	WF3

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 1.0mH, R_G = 47Ω.
② Pulse width limited by max. junction temperature.
③ R_θ is measured at T_J approximately 90°C.
④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
⑤ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

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		D-Pak	MSL1
		I-PAK	
ESD	Machine Model	Class M2 (+/- 200V)††† AEC-Q101-002	
	Human Body Model	Class H1A (+/- 500V)††† AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000V)††† AEC-Q101-005	
RoHS Compliant		Yes	

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

†† Exceptions to AEC-Q101 requirements are noted in the qualification report.

††† Highest passing voltage.

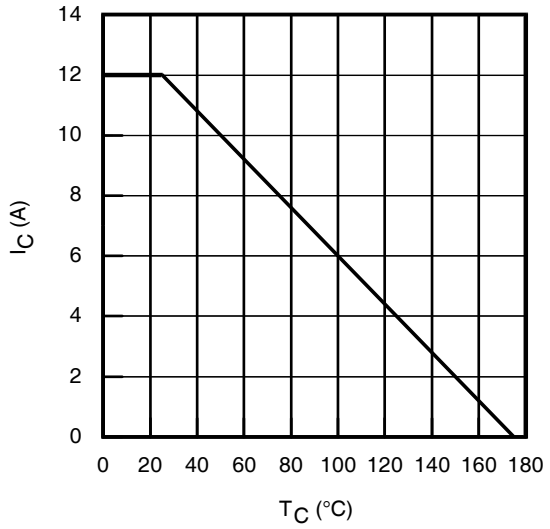


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

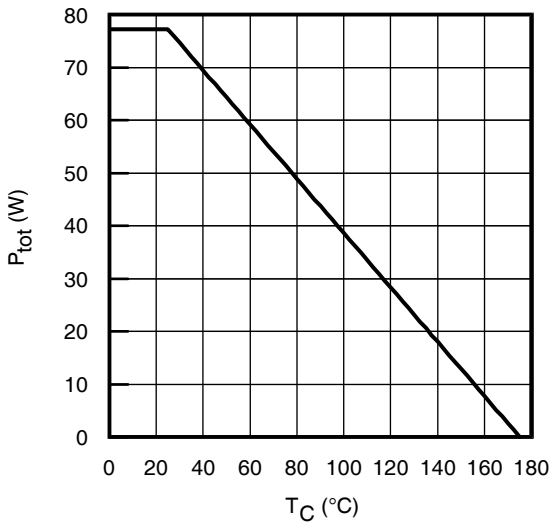


Fig. 2 - Power Dissipation vs. Case Temperature

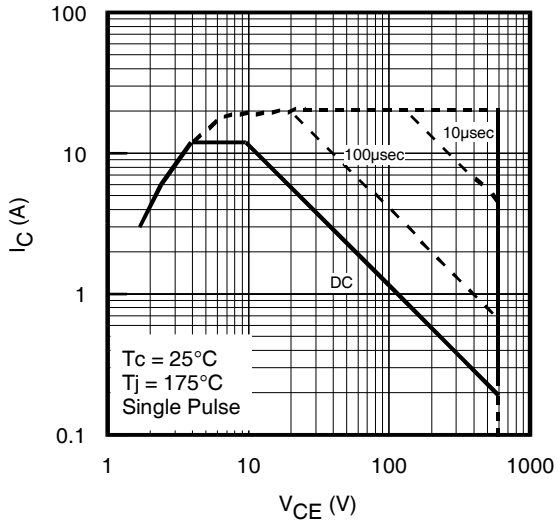


Fig. 3 - Forward SOA,
T_C = 25°C, $T_J \leq$ 175°C, V_{GE} = 15V

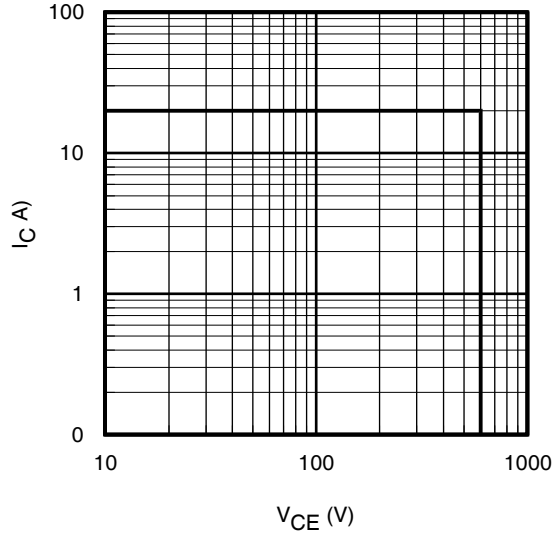


Fig. 4 - Reverse Bias SOA
T_J = 175°C, V_{GE} = 20V

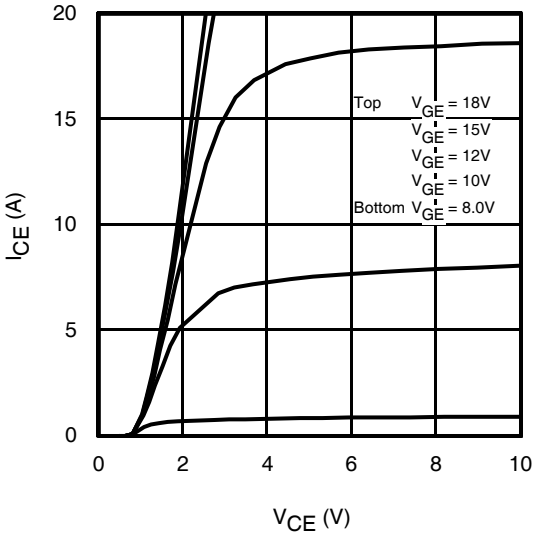


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

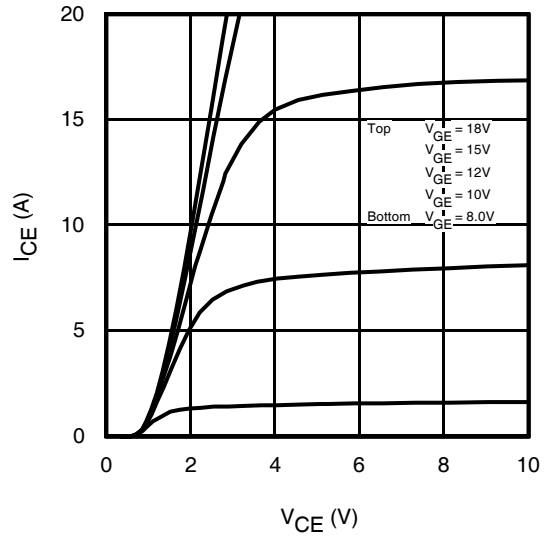


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

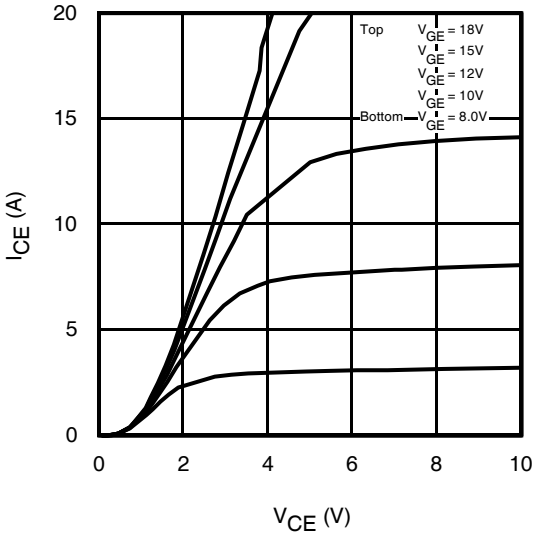


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

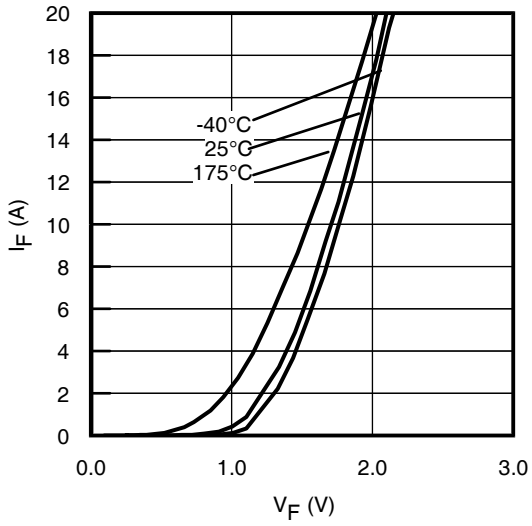


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

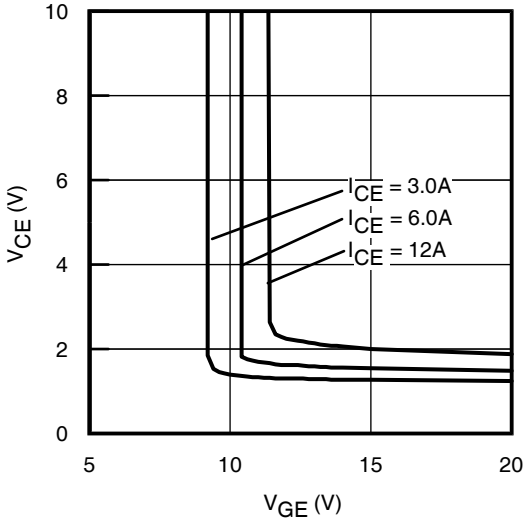


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

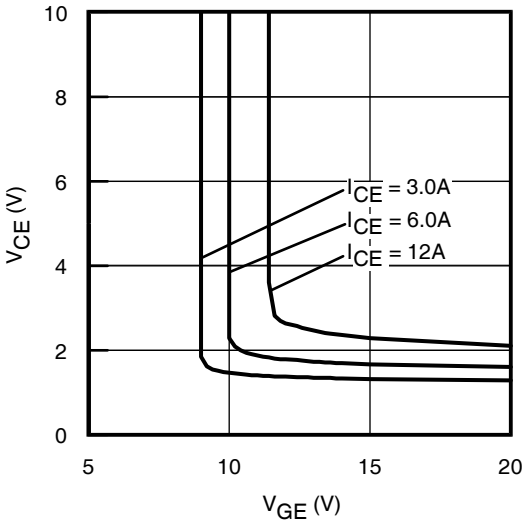


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

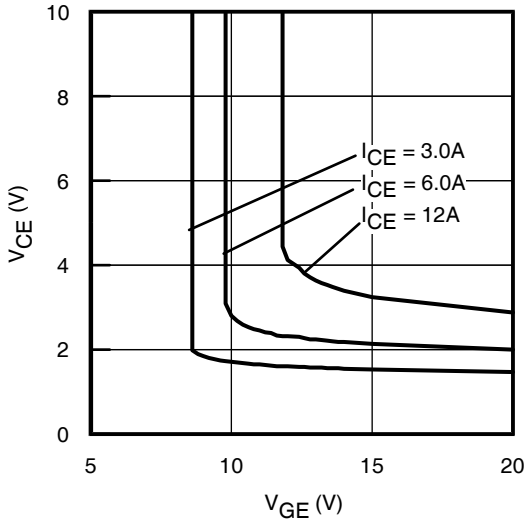


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

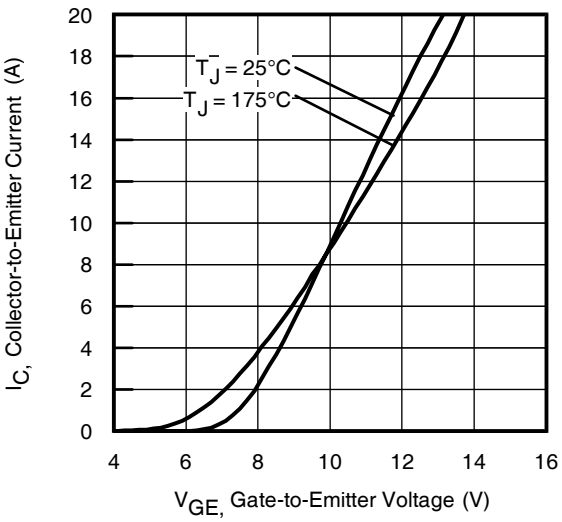


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

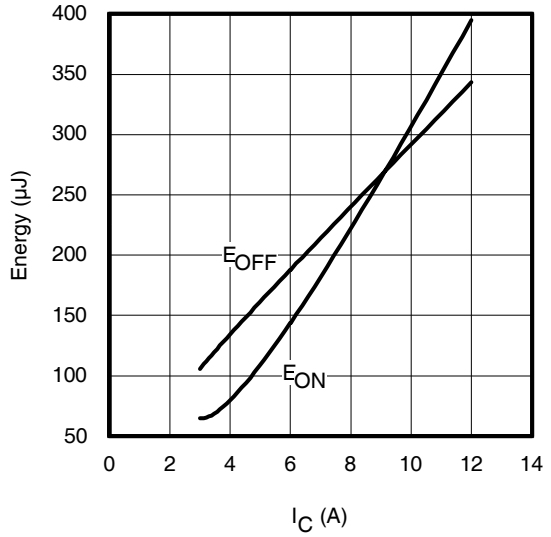


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 1mH; V_{CE} = 400V, R_G = 47Ω; V_{GE} = 15V.

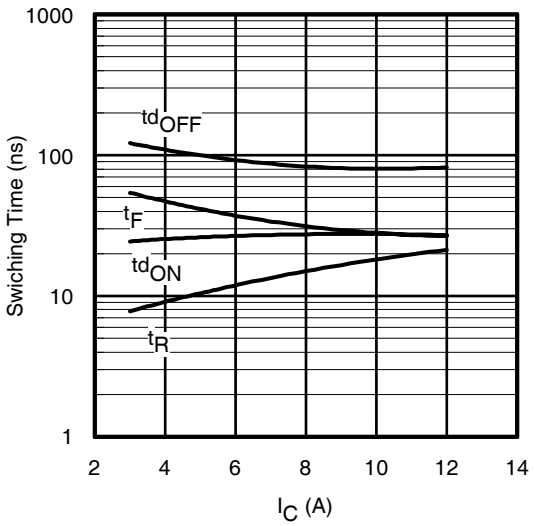


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 175°C; L=1mH; V_{CE}= 400V
R_G= 47Ω; V_{GE}= 15V

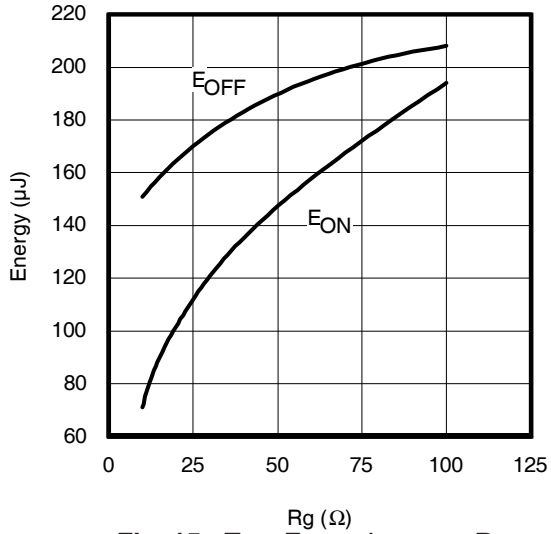


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 1mH; V_{CE} = 400V, I_{CE} = 6.0A; V_{GE} = 15V

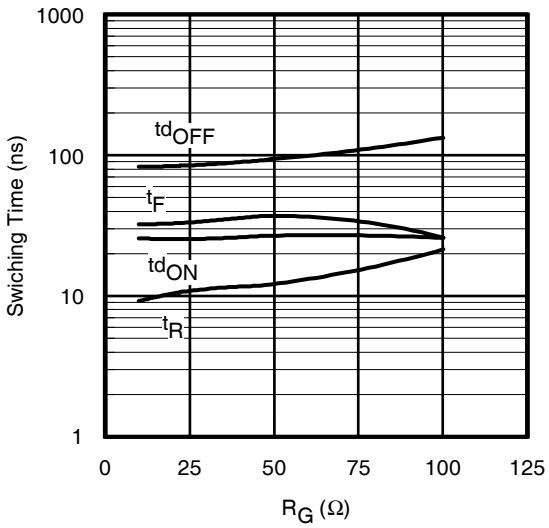


Fig. 16- Typ. Switching Time vs. R_G
T_J = 175°C; L=1mH; V_{CE}= 400V
I_{CE}= 6.0A; V_{GE}= 15V

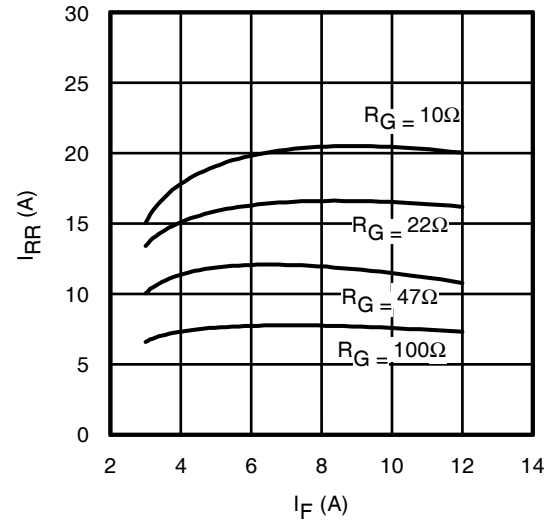


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 175°C

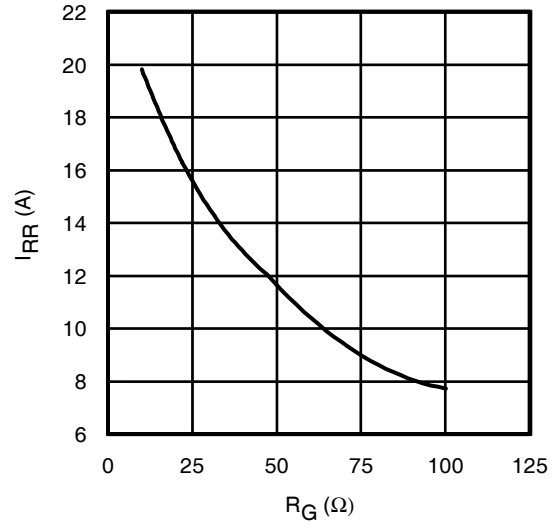


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 175°C; I_F = 6.0A

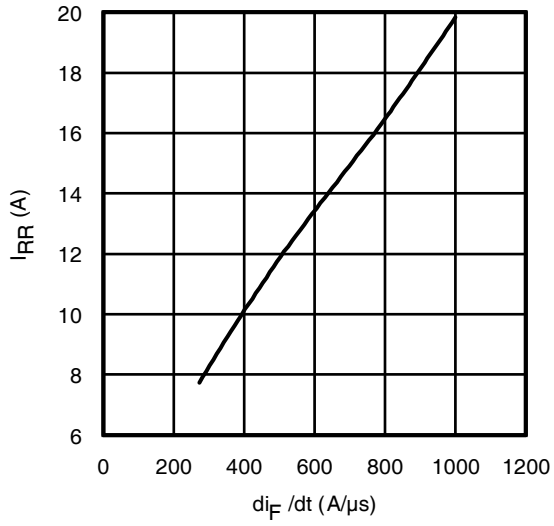


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 6.0A; T_J = 175°C

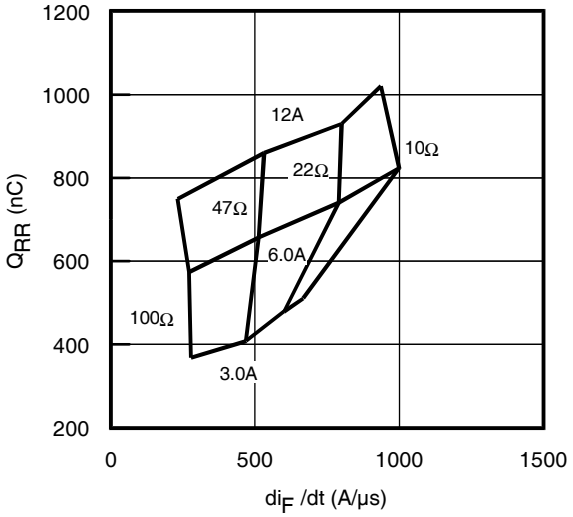


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V; T_J = 175°C

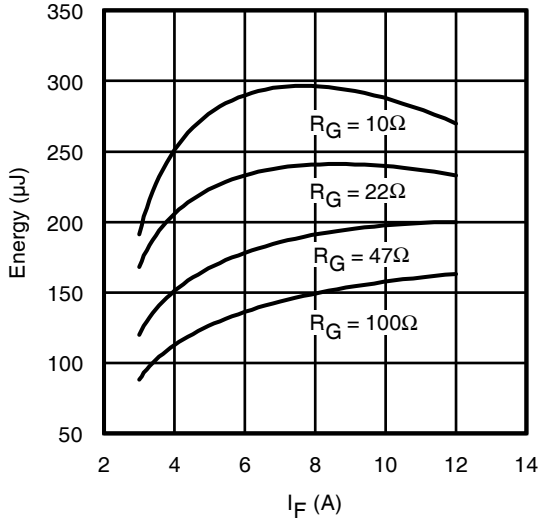


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 175°C

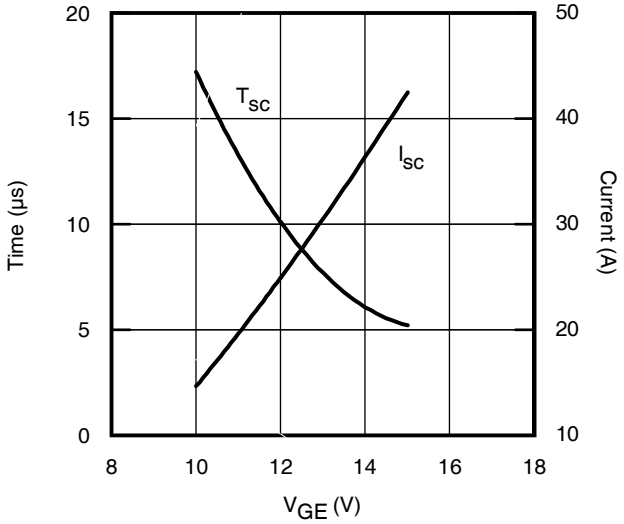


Fig. 22- Typ. V_{GE} vs. Short Circuit Time
V_{CC}=400V, T_C =25°C

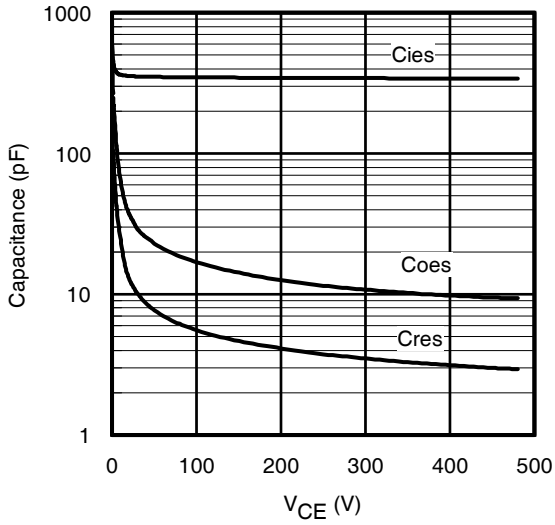


Fig. 23- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

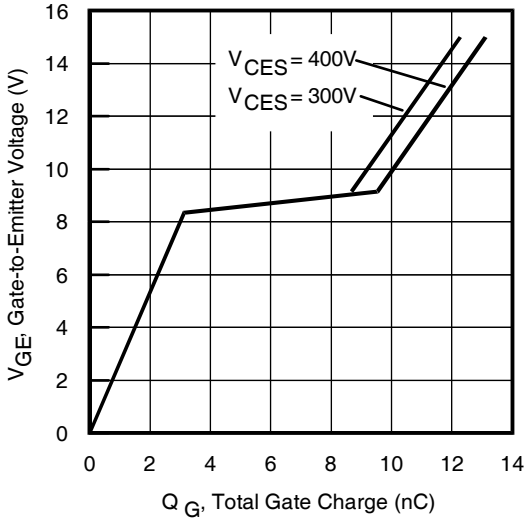


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 6.0A, L=600µH

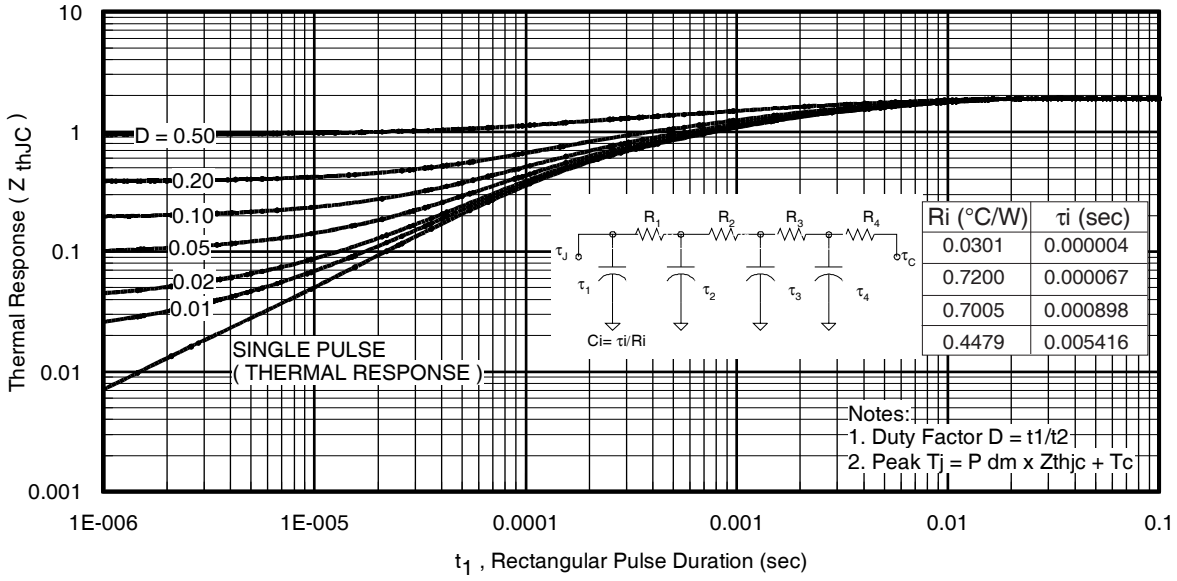


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

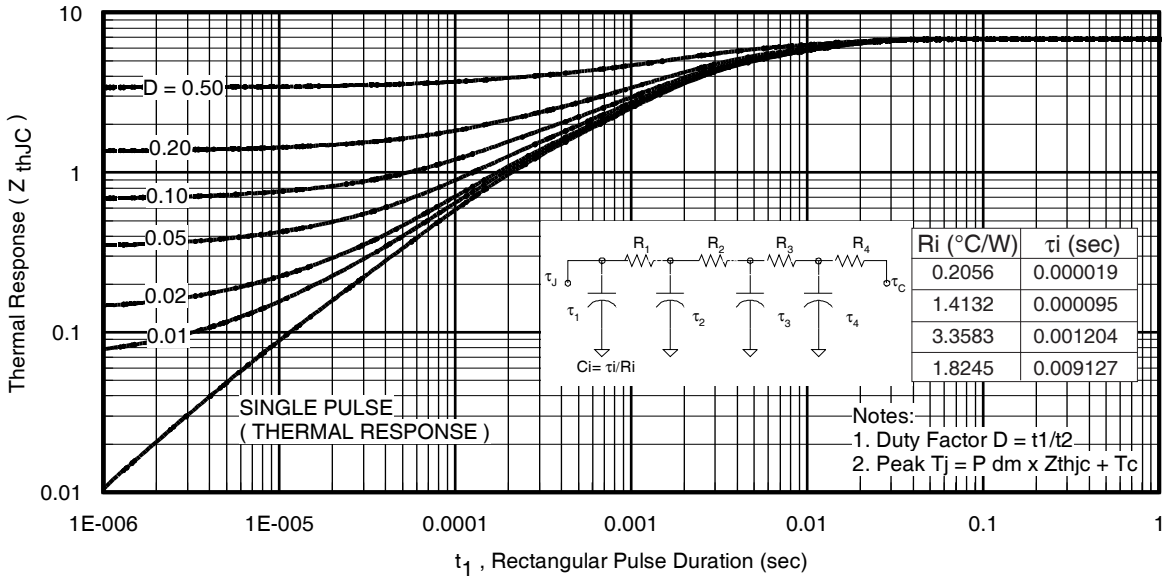


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

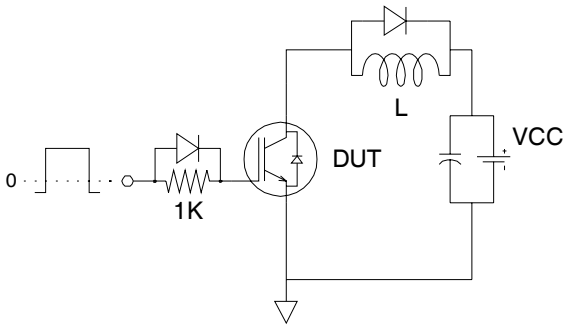


Fig.C.T.1 - Gate Charge Circuit (turn-off)

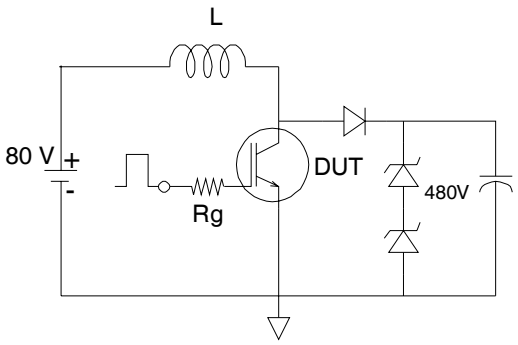


Fig.C.T.2 - RBSOA Circuit

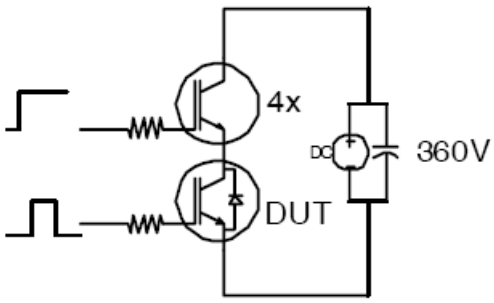


Fig.C.T.3 - S.C.SOA Circuit

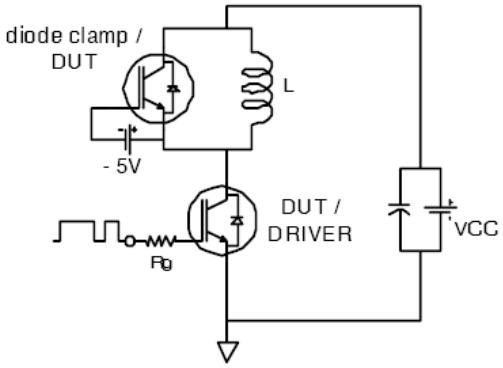


Fig.C.T.4 - Switching Loss Circuit

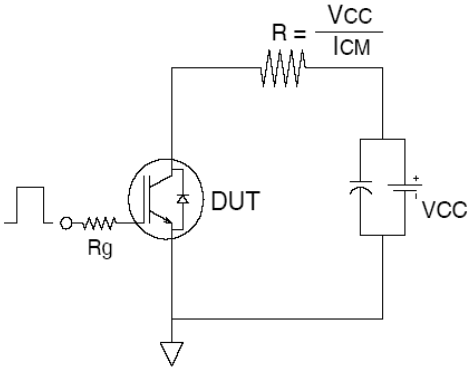


Fig.C.T.5 - Resistive Load Circuit

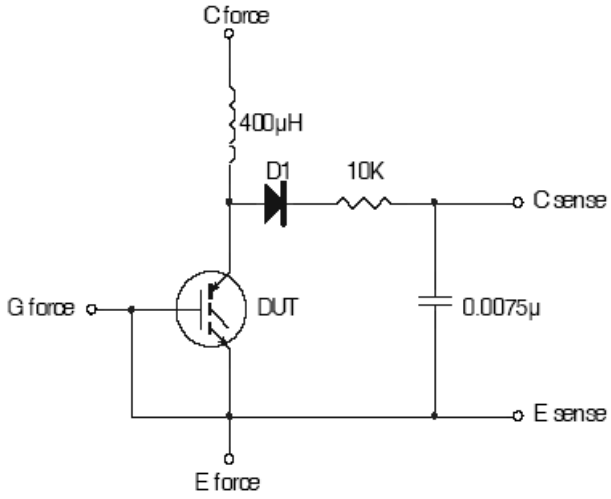


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

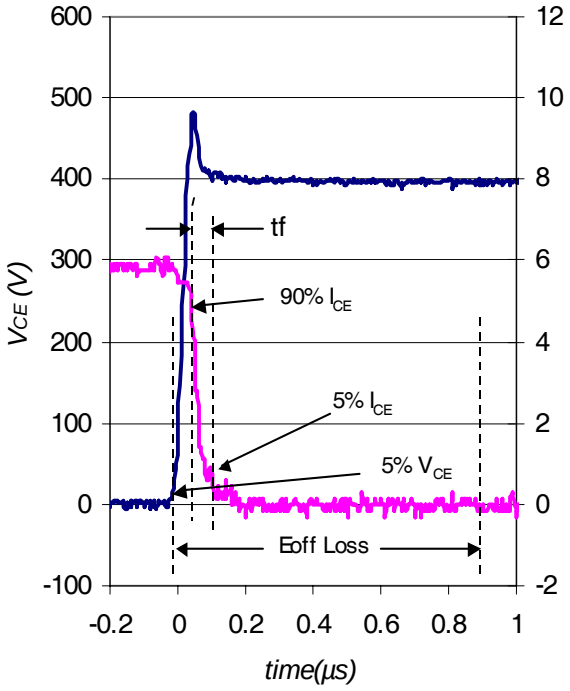


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

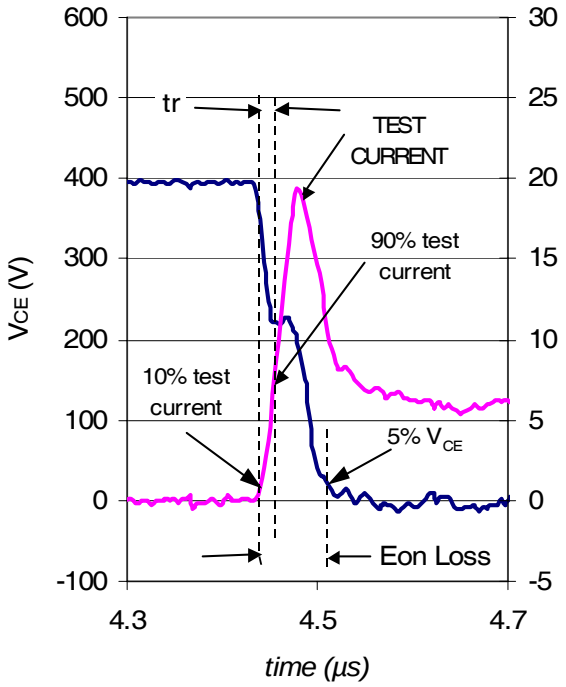
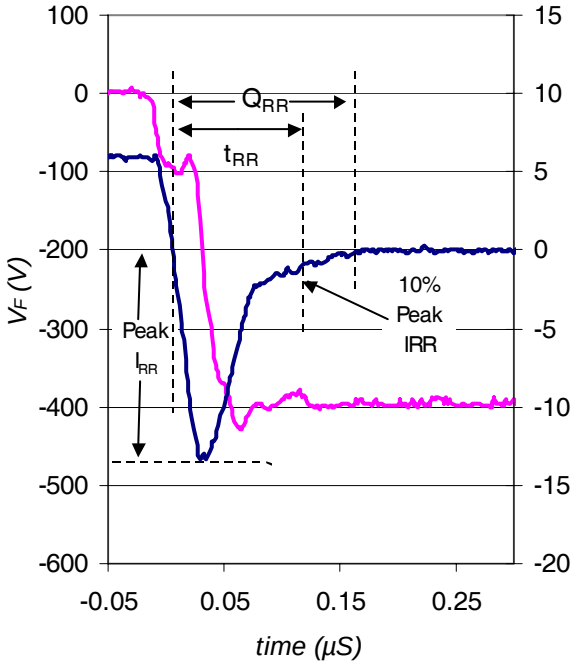
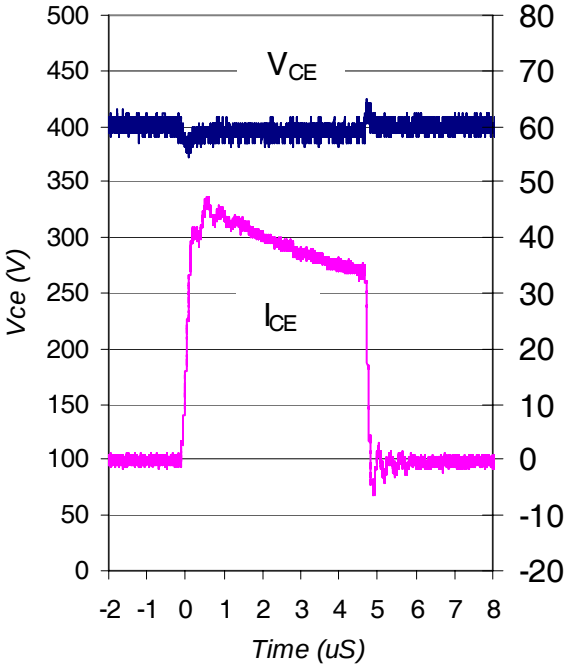


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4



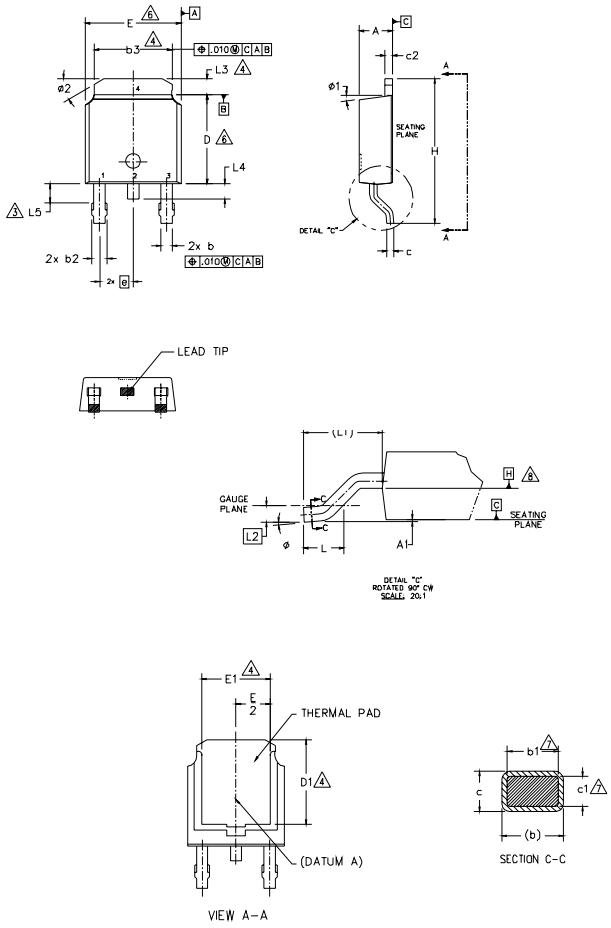
WF.3- Typ. Diode Recovery Waveform
@ T_J = 175°C using CT.4



WF.4- Typ. Short Circuit Waveform
@ T_J = 25°C using CT.3

D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.– DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

2.– DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].

3.– LEAD DIMENSION UNCONTROLLED IN L5.

4.– DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.

5.– SECTION C–C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.

6.– DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

7.– DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.

8.– DATUM A & B TO BE DETERMINED AT DATUM PLANE H.

9.– OUTLINE CONFORMS TO JEDEC OUTLINE TO–252AA.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	–	0.13	–	.005	
b	0.64	0.89	.025	.035	
b1	0.65	0.79	.025	.031	7
b2	0.76	1.14	.030	.045	
b3	4.95	5.46	.195	.215	4
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	7
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	6
D1	5.21	–	.205	–	4
E	6.35	6.73	.250	.265	6
E1	4.32	–	.170	–	4
e	2.29 BSC		.090 BSC		
H	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	4
L4	–	1.02	–	.040	
L5	1.14	1.52	.045	.060	3
ø	0°	10°	0°	10°	
ø1	0°	15°	0°	15°	
ø2	25°	35°	25°	35°	

LEAD ASSIGNMENTS

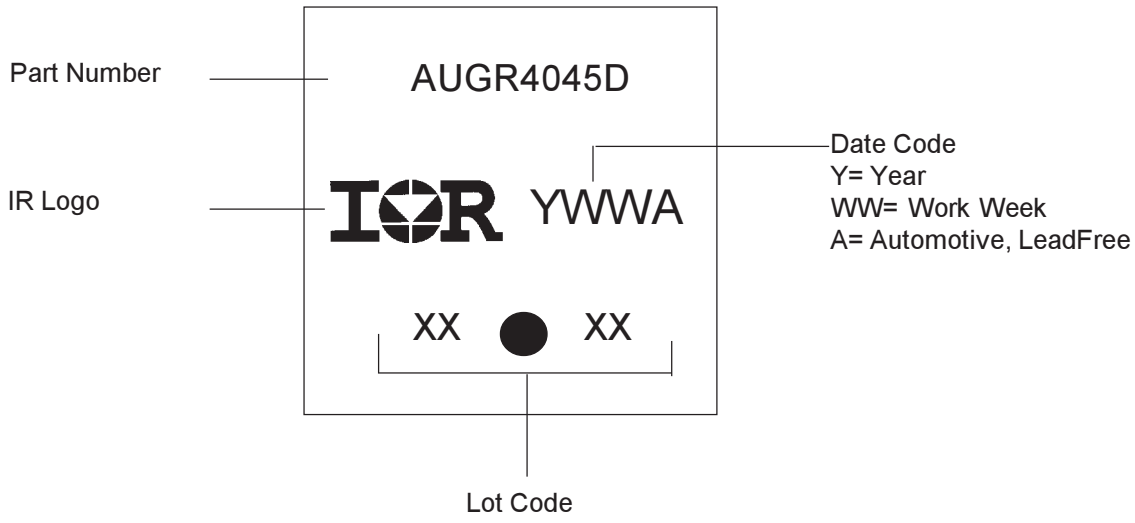
HEXFET

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

IGBT & CoPAK

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

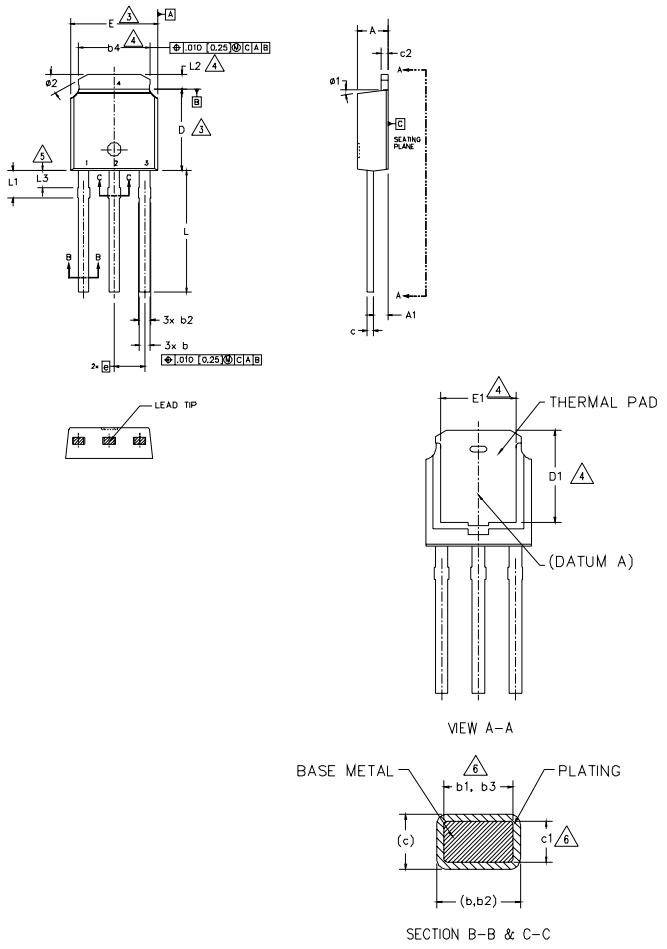
D-Pak Part Marking Information



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

I-Pak (TO-251AA) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.– DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

2.– DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].

3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

4.– THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.

5.– LEAD DIMENSION UNCONTROLLED IN L3.

6.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.

7.– OUTLINE CONFORMS TO JEDEC OUTLINE TO–251AA (Date 06/02).

8.– CONTROLLING DIMENSION : INCHES.

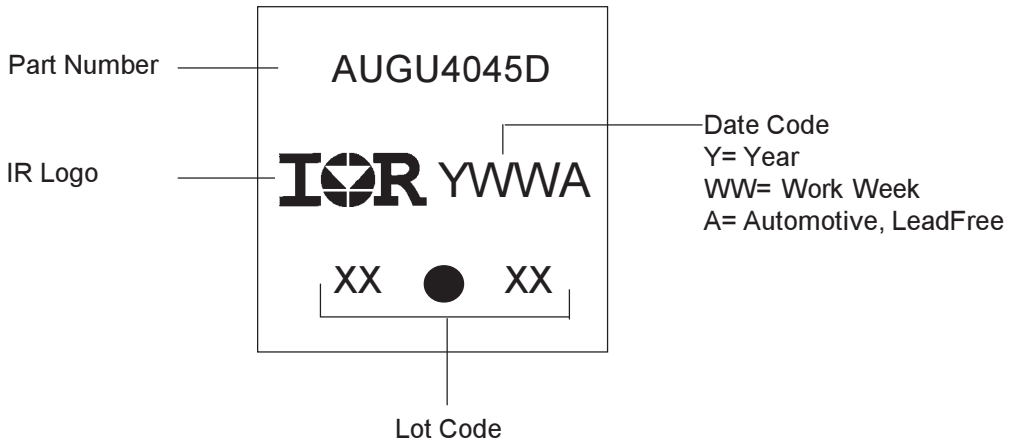
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	0.89	1.14	.035	.045	
b	0.64	0.89	.025	.035	
b1	0.65	0.79	.025	.031	6
b2	0.76	1.14	.030	.045	
b3	0.76	1.04	.030	.041	6
b4	4.95	5.46	.195	.215	4
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	6
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	3
D1	5.21	–	.205	–	4
E	6.35	6.73	.250	.265	3
E1	4.32	–	.170	–	4
e	2.29 BSC		.090 BSC		
L	8.89	9.65	.350	.380	
L1	1.91	2.29	.045	.090	
L2	0.89	1.27	.035	.050	4
L3	1.14	1.52	.045	.060	5
ø1	0°	15°	0°	15°	
ø2	25°	35°	25°	35°	

LEAD ASSIGNMENTS

HEXFET

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

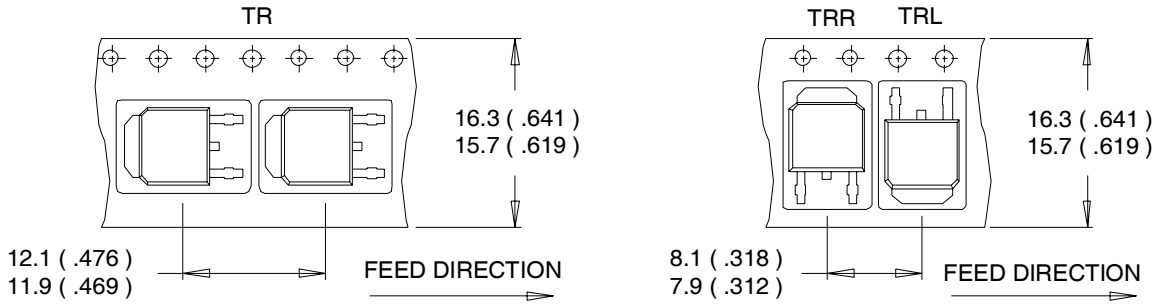
I-Pak Part Marking Information



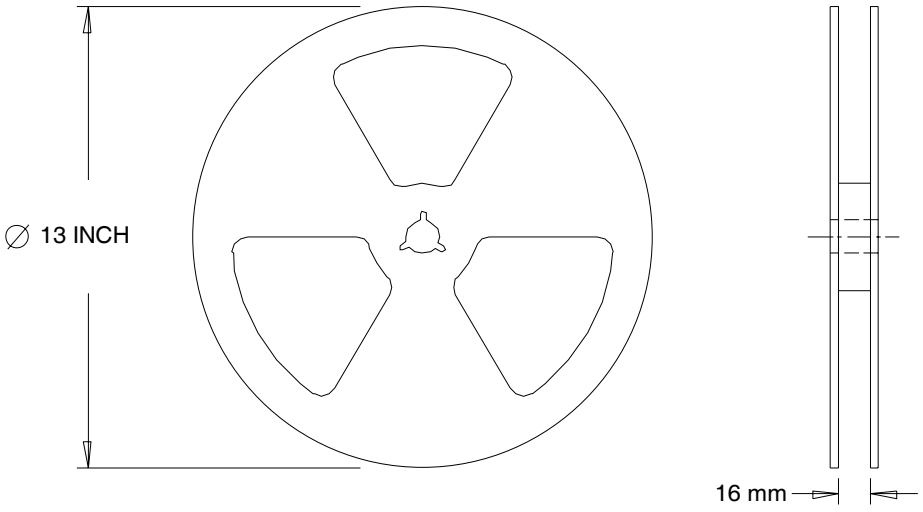
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D-Pak (TO-252AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



NOTES :
1. OUTLINE CONFORMS TO EIA-481.

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRGR4045D	Dpak	Tube	75	AUIRGR4045D
		Tape and Reel	2000	AUIRGR4045DTR
		Tape and Reel Left	3000	AUIRGR4045DTRL
		Tape and Reel Right	3000	AUIRGR4045DTRR
AUIRGU4045D	Ipak	Tube	75	AUIRGU4045D

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