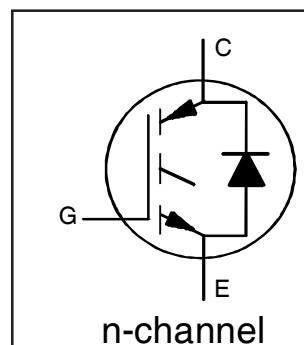


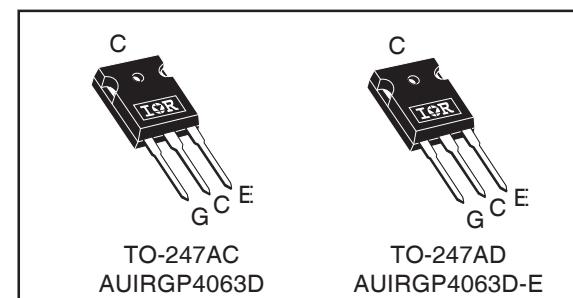
### INSULATED GATE BIPOLEAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

#### Features

- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5  $\mu$ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current ( $I_{LM}$ )
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package



$V_{CES} = 600V$   
 $I_C = 60A, T_C = 100^\circ C$   
 $t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$   
 $V_{CE(on)} \text{ typ.} = 1.6V$



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	
AUIRGP4063D	TO-247	Tube	25	AUIRGP4063D
AUIRGP4063D-E	TO-247	Tube	25	AUIRGP4063D-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
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	100	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	60	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15V$	144	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	192	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	82	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	50	
$I_{FM}$	Diode Maximum Forward Current ②	192	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	330	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	170	
$T_J$	Operating Junction and Storage Temperature Range	-55 to +175	
$T_{STG}$	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	°C
	Mounting Torque, 6-32 or M3 Screw	10 lbf·in (1.1 N·m)	

**Thermal Resistance**

	Parameter	Min.	Typ.	Max.	Units
R <sub>θJC</sub> (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT)	—	—	0.45	°C/W
R <sub>θJC</sub> (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	0.92	
R <sub>θCS</sub>	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	80	—	

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref. Fig
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 150µA ④	CT 6
V <sub>(BR)CES</sub>  /T <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-175°C)	CT 6
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.6	1.9	V	I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C	5.6.7
		—	1.9	—		I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C	9, 10, 11
		—	2.0	—		I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°C	
V <sub>GE(th)</sub>	Gate Threshold Voltage	4.0	—	6.5	V	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.4mA	9, 10,
V <sub>GE(th)</sub>  /T <sub>J</sub>	Threshold Voltage temp. coefficient	—	-21	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA (25°C - 175°C)	11, 12
gfe	Forward Transconductance	—	32	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 48A, PW = 80µs	
I <sub>ces</sub>	Collector-to-Emitter Leakage Current	—	1.0	150	µA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V	
		—	450	1000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 175°C	
V <sub>fm</sub>	Diode Forward Voltage Drop	—	1.95	2.91	V	I <sub>F</sub> = 48A	8
		—	1.45	—		I <sub>F</sub> = 48A, T <sub>J</sub> = 175°C	
I <sub>ges</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V	

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

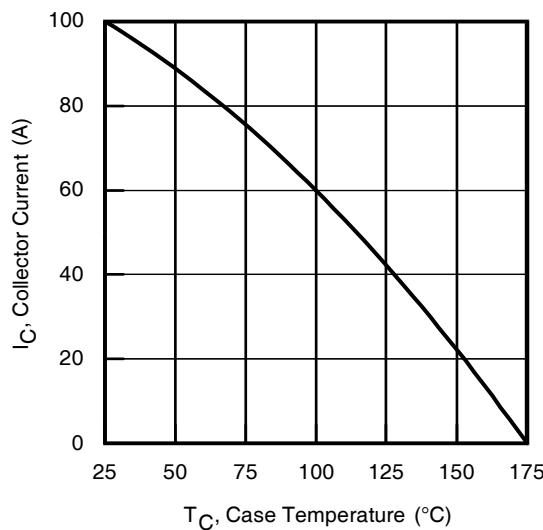
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref. Fig
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	95	140	nC	I <sub>C</sub> = 48A	24
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	28	42		V <sub>GE</sub> = 15V	CT 1
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	35	53		V <sub>CC</sub> = 400V	
E <sub>on</sub>	Turn-On Switching Loss	—	625	1141	µJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	CT 4
E <sub>off</sub>	Turn-Off Switching Loss	—	1275	1481		R <sub>G</sub> = 10Ω, L = 200µH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 25°C	
E <sub>total</sub>	Total Switching Loss	—	1900	2622		Energy losses include tail & diode reverse recovery	
t <sub>d(on)</sub>	Turn-On delay time	—	60	78	ns	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	CT 4
t <sub>r</sub>	Rise time	—	40	56		R <sub>G</sub> = 10Ω, L = 200µH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 25°C	
t <sub>d(off)</sub>	Turn-Off delay time	—	145	176			
t <sub>f</sub>	Fall time	—	35	46			
E <sub>on</sub>	Turn-On Switching Loss	—	1625	—	µJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	13, 15
E <sub>off</sub>	Turn-Off Switching Loss	—	1585	—		R <sub>G</sub> = 10Ω, L = 200µH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 175°C ④	
E <sub>total</sub>	Total Switching Loss	—	3210	—		Energy losses include tail & diode reverse recovery	WF 1, WF 2
t <sub>d(on)</sub>	Turn-On delay time	—	55	—	ns	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	14, 16
t <sub>r</sub>	Rise time	—	45	—		R <sub>G</sub> = 10Ω, L = 200µH, L <sub>S</sub> = 150nH	
t <sub>d(off)</sub>	Turn-Off delay time	—	165	—		T <sub>J</sub> = 175°C	WF 1
t <sub>f</sub>	Fall time	—	45	—			WF 2
C <sub>ies</sub>	Input Capacitance	—	3025	—	pF	V <sub>GE</sub> = 0V	23
C <sub>oes</sub>	Output Capacitance	—	245	—		V <sub>CC</sub> = 30V	
C <sub>res</sub>	Reverse Transfer Capacitance	—	90	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 175°C, I <sub>C</sub> = 192A V <sub>CC</sub> = 480V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	4 CT 2
SCSOA	Short Circuit Safe Operating Area	5	—	—	µs	V <sub>CC</sub> = 400V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	22, CT 3 WF 4
E <sub>rec</sub>	Reverse Recovery Energy of the Diode	—	845	—	µJ	T <sub>J</sub> = 175°C	17, 18, 19
t <sub>rr</sub>	Diode Reverse Recovery Time	—	115	—	ns	V <sub>CC</sub> = 400V, I <sub>F</sub> = 48A	20, 21
I <sub>rr</sub>	Peak Reverse Recovery Current	—	40	—	A	V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, L = 200µH, L <sub>S</sub> = 150nH	WF 3

**Notes:**

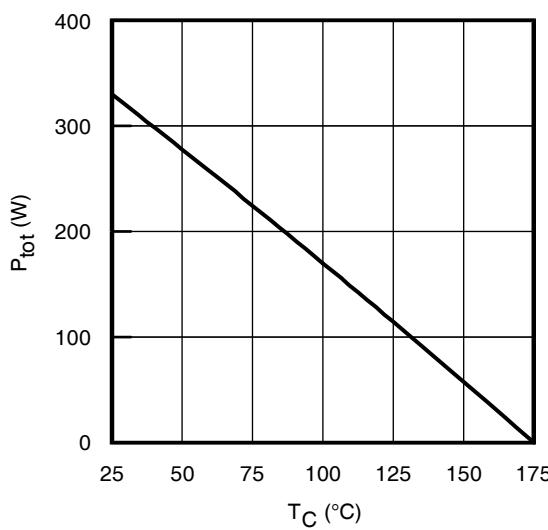
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 200µH, R<sub>G</sub> = 10Ω.  
 ② This is only applied to TO-247AC package.

③ Pulse width limited by max. junction temperature.

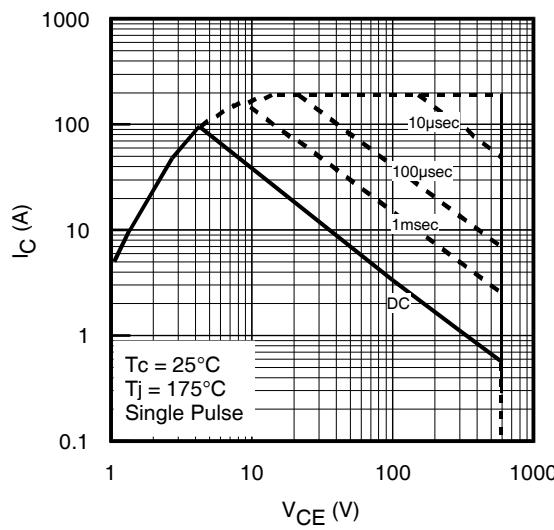
④ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.



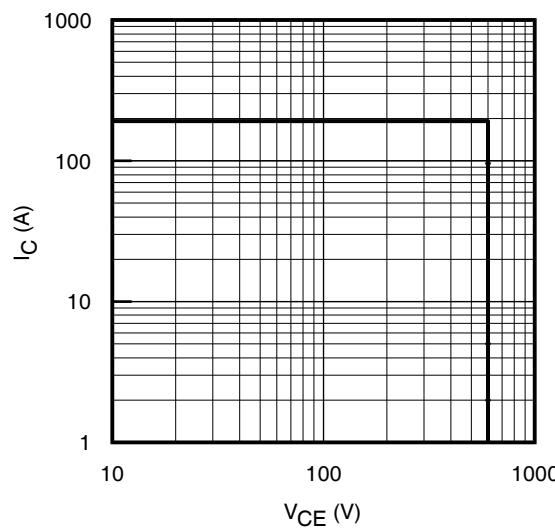
**Fig. 1 - Maximum DC Collector Current vs. Case Temperature**



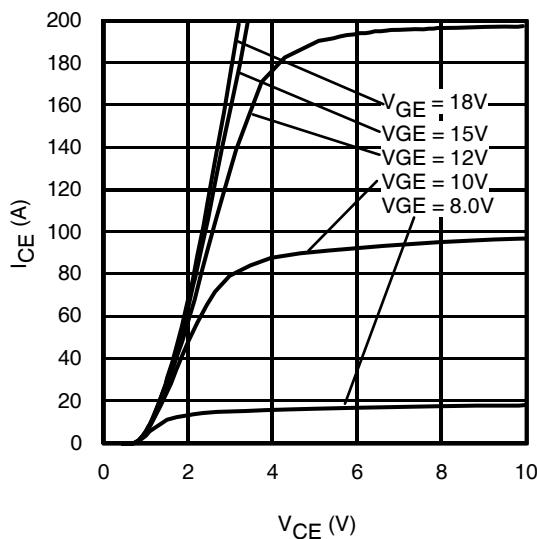
**Fig. 2 - Power Dissipation vs. Case Temperature**



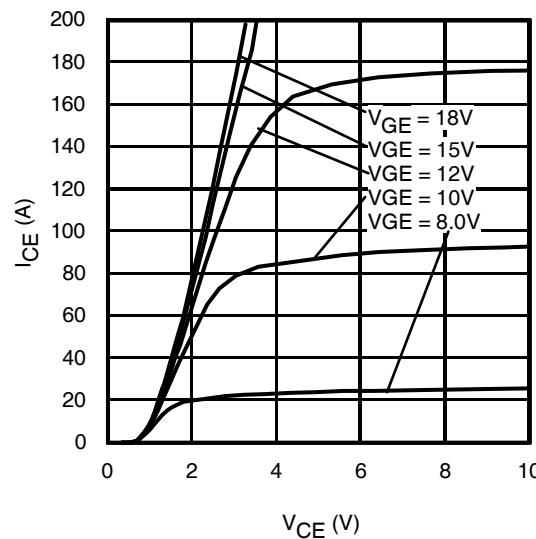
**Fig. 3 - Forward SOA**  
 $T_C = 25^\circ\text{C}$ ,  $T_J \leq 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



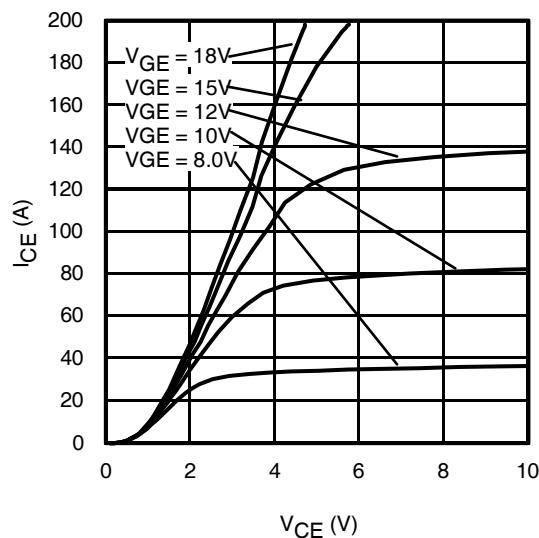
**Fig. 4 - Reverse Bias SOA**  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



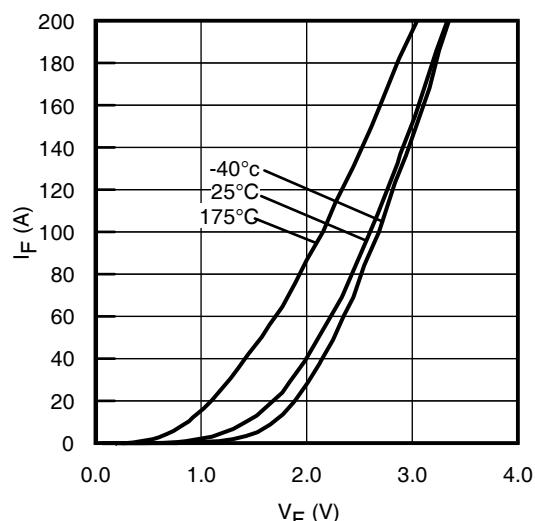
**Fig. 5 - Typ. IGBT Output Characteristics**  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



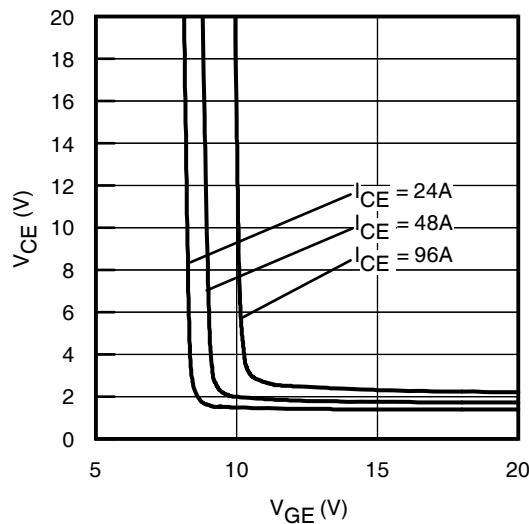
**Fig. 6 - Typ. IGBT Output Characteristics**  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



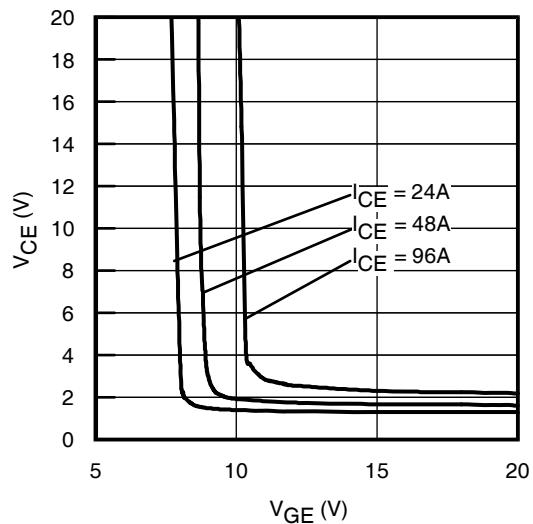
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



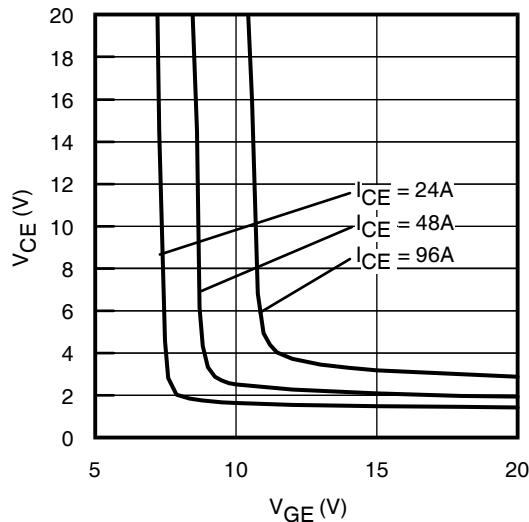
**Fig. 8 - Typ. Diode Forward Characteristics**  
 $t_p = 80\mu\text{s}$



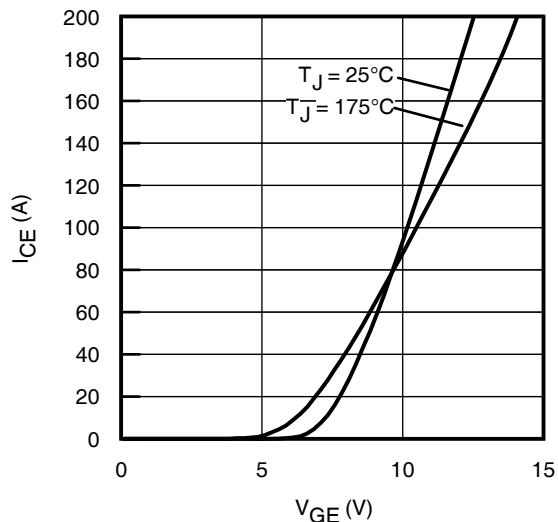
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



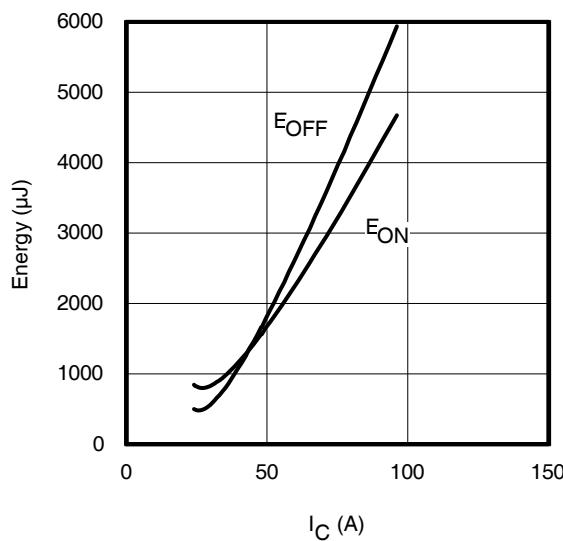
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



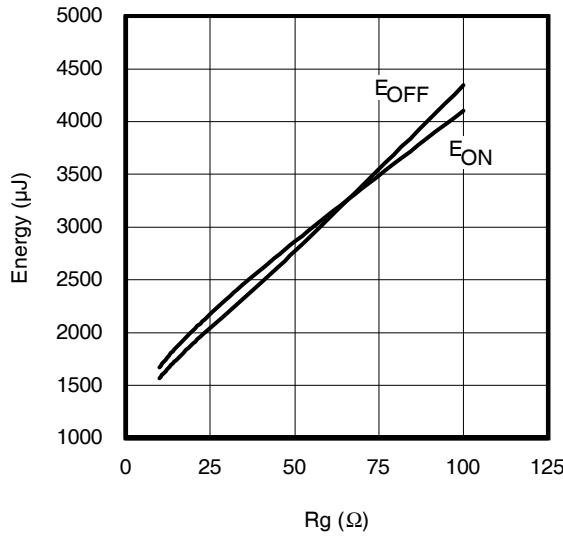
**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 175^\circ\text{C}$



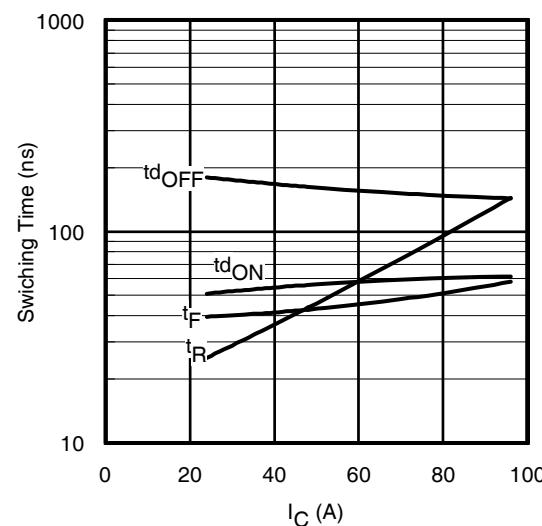
**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



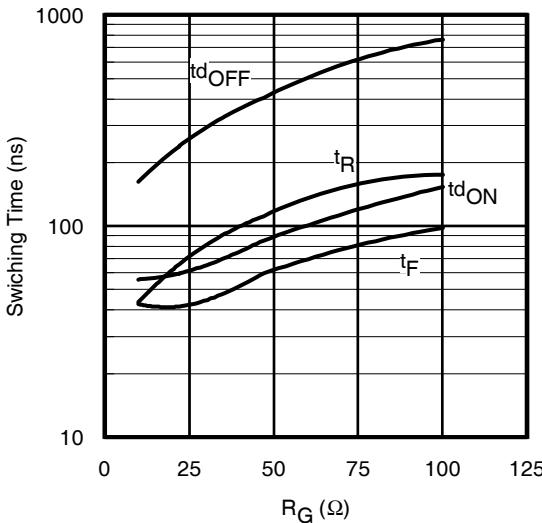
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



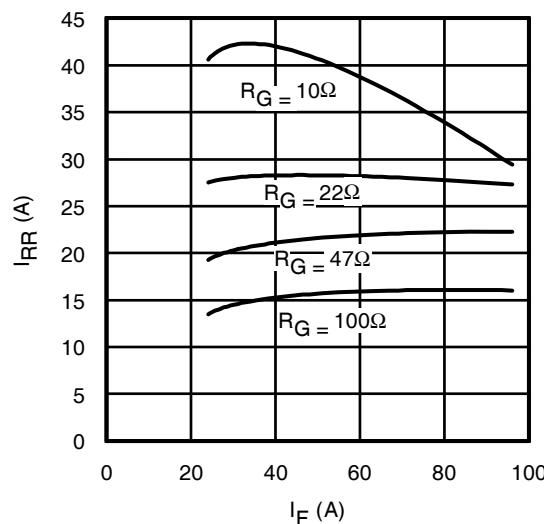
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 48\text{A}$ ;  $V_{GE} = 15\text{V}$



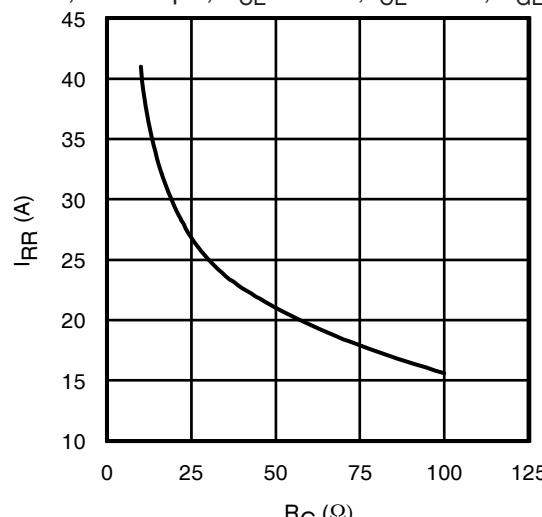
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



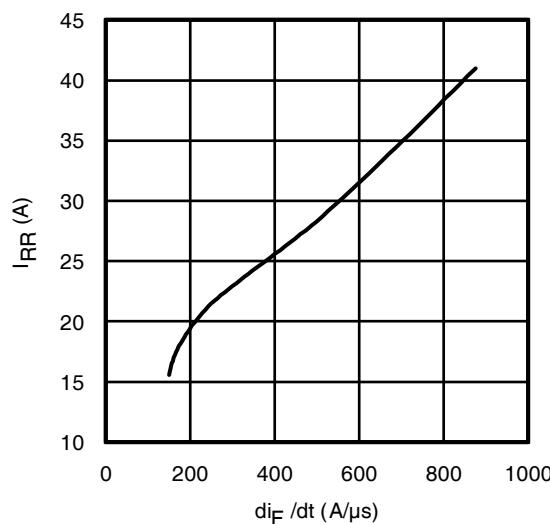
**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 48\text{A}$ ;  $V_{GE} = 15\text{V}$



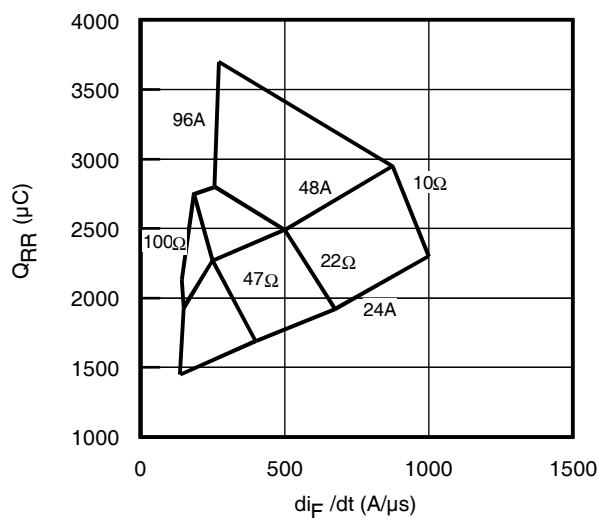
**Fig. 17 - Typ. Diode  $I_{RR}$  vs.  $I_F$**   
 $T_J = 175^\circ\text{C}$



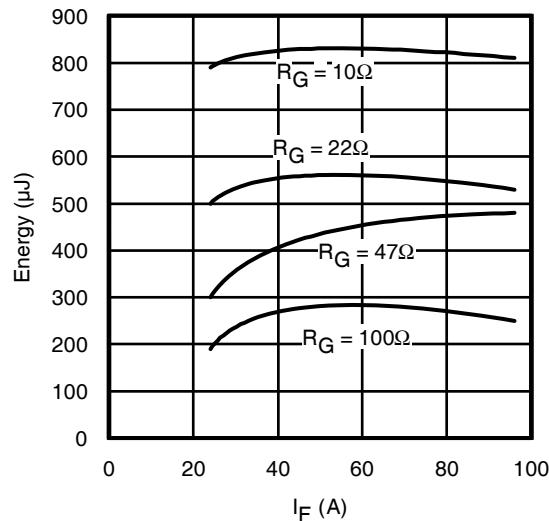
**Fig. 18 - Typ. Diode  $I_{RR}$  vs.  $R_G$**   
 $T_J = 175^\circ\text{C}$



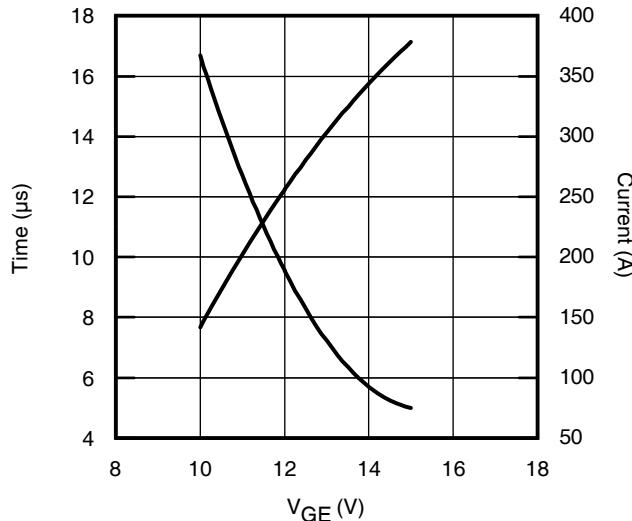
**Fig. 19 - Typ. Diode  $I_{RR}$  vs.  $dI_F/dt$**   
 $V_{CC} = 400V; V_{GE} = 15V; I_F = 48A; T_J = 175^{\circ}C$



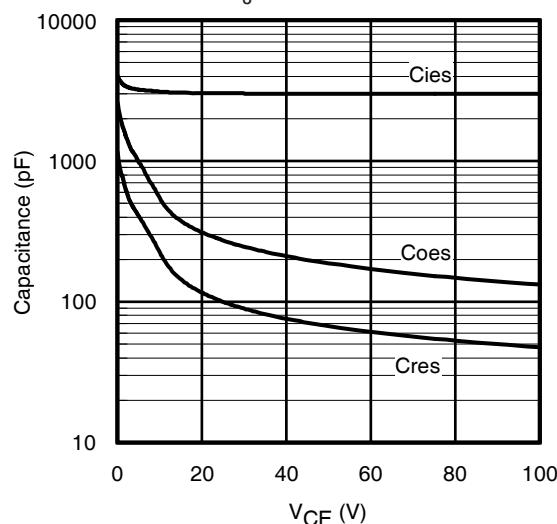
**Fig. 20 - Typ. Diode  $Q_{RR}$  vs.  $dI_F/dt$**   
 $V_{CC} = 400V; V_{GE} = 15V; T_J = 175^{\circ}C$



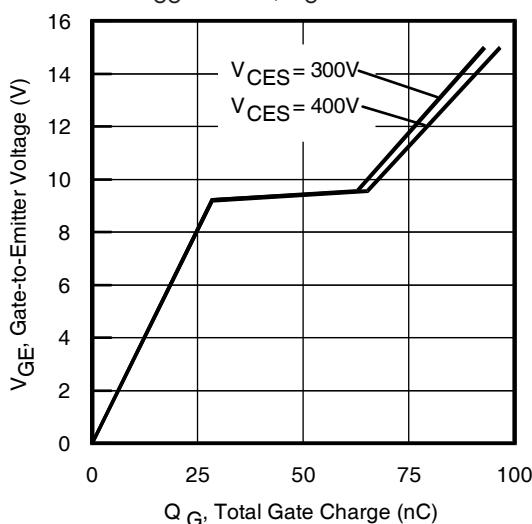
**Fig. 21 - Typ. Diode  $E_{RR}$  vs.  $I_F$**   
 $T_J = 175^{\circ}C$



**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.  $V_{GE}$**   
 $I_{CE} = 48A; L = 600\mu H$

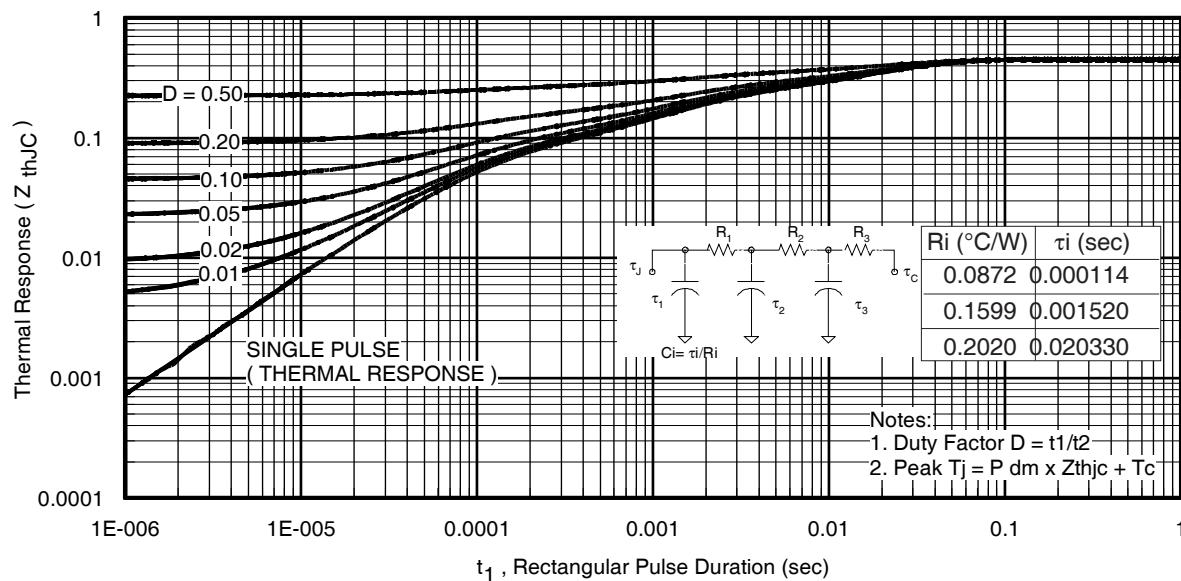


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

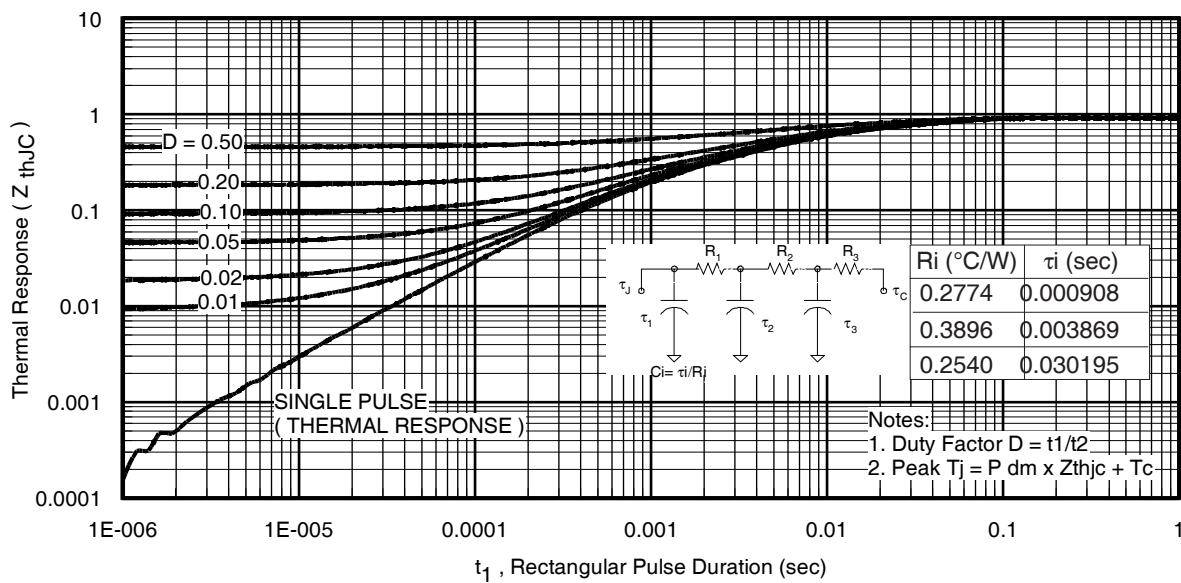


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

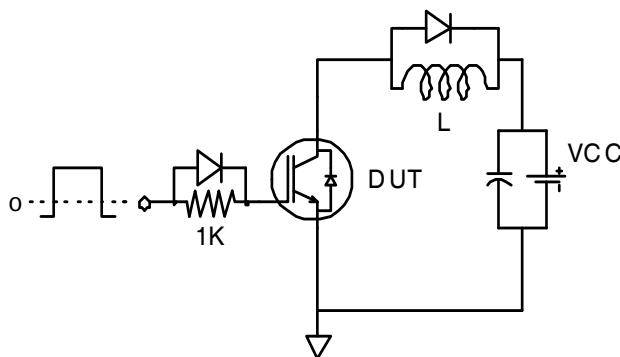


Fig.C.T.1 - Gate Charge Circuit (turn-off)

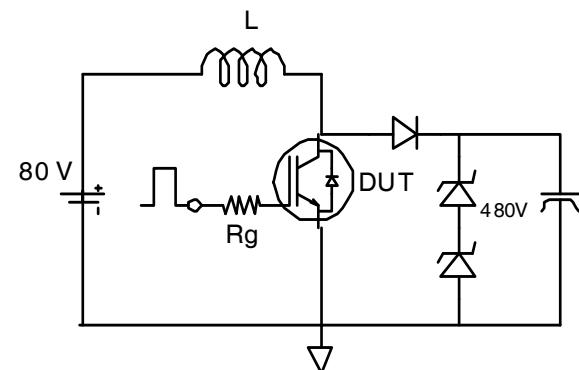


Fig.C.T.2 - RBSOA Circuit

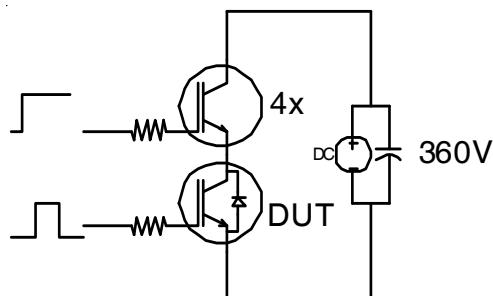


Fig.C.T.3 - S.C. SOA Circuit

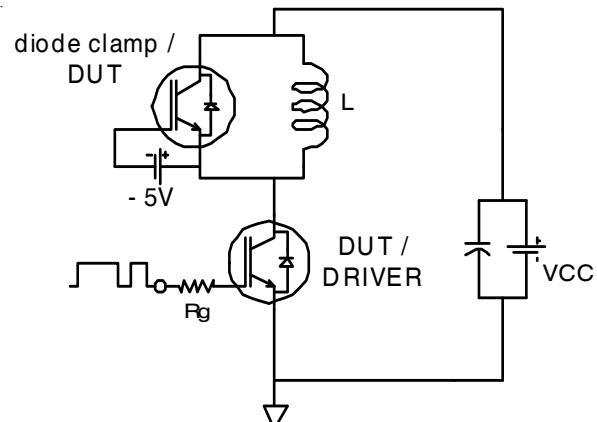


Fig.C.T.4 - Switching Loss Circuit

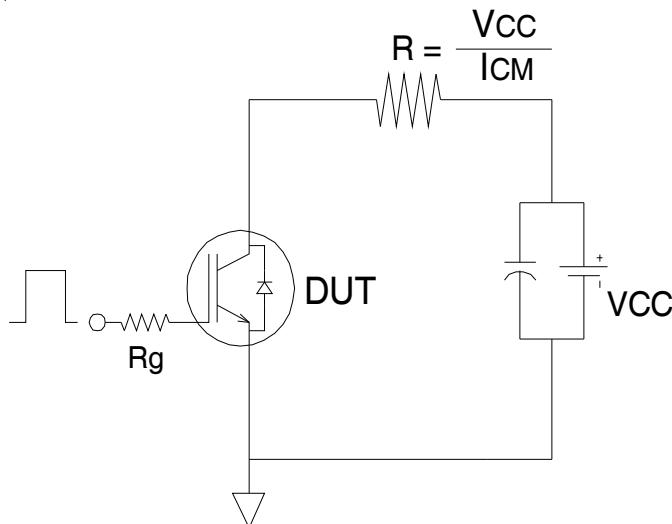


Fig.C.T.5 - Resistive Load Circuit

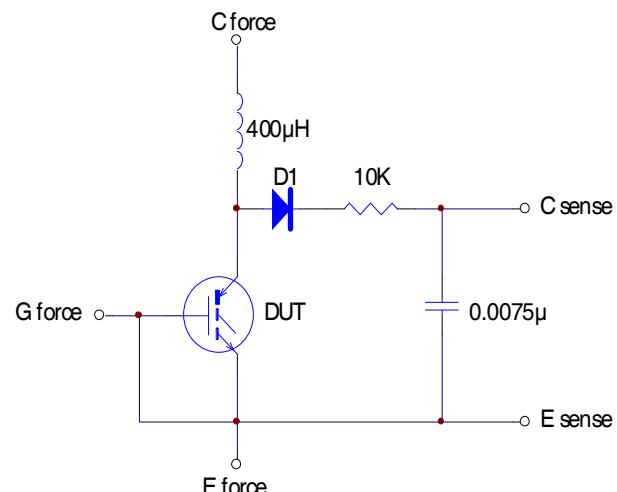
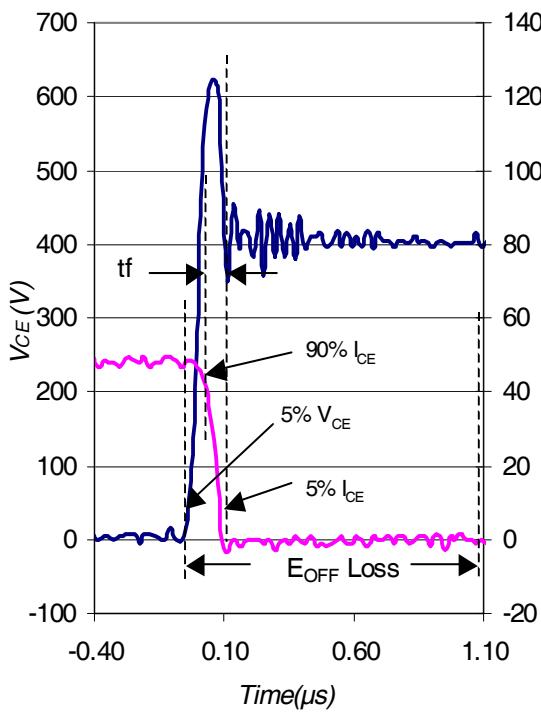
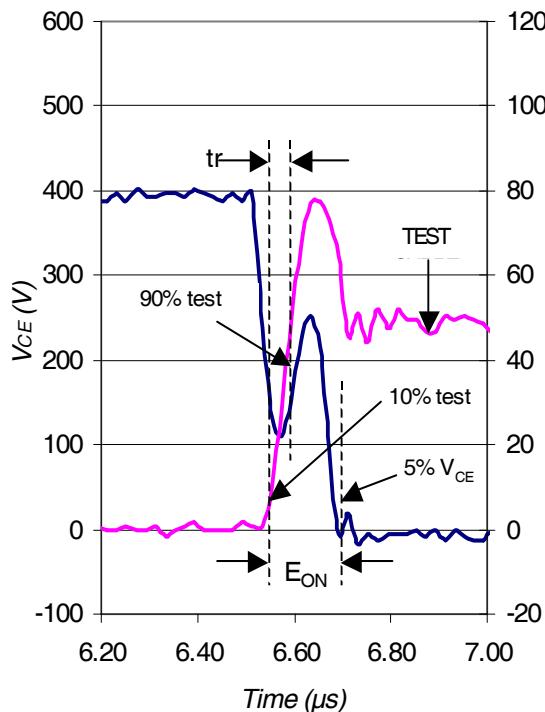


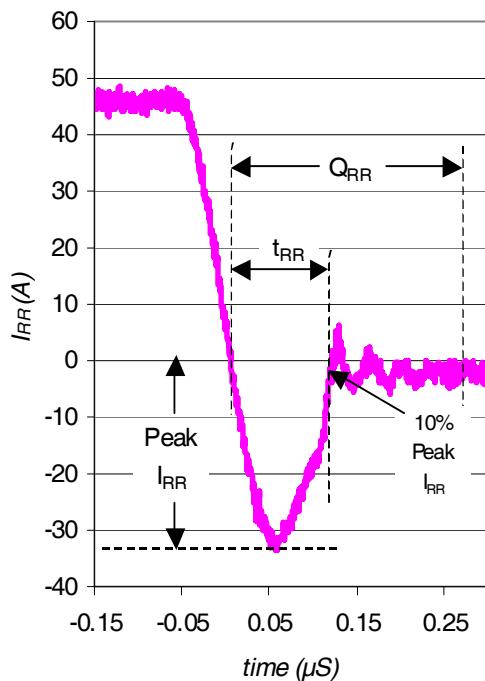
Fig.C.T.6 - BVCES Filter Circuit



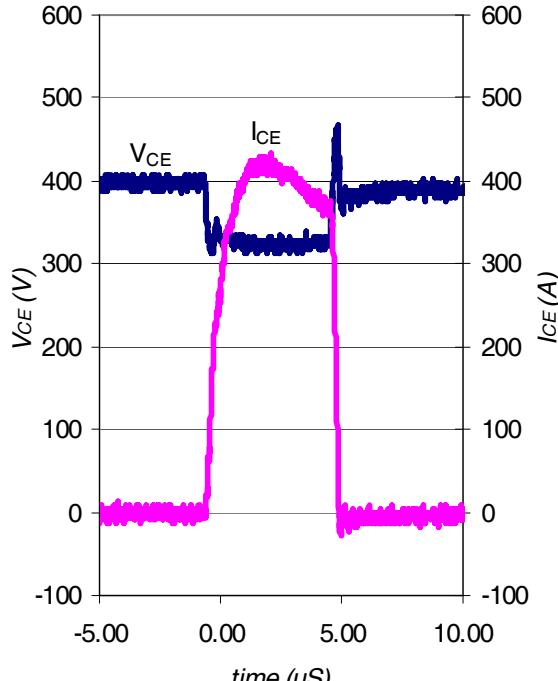
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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



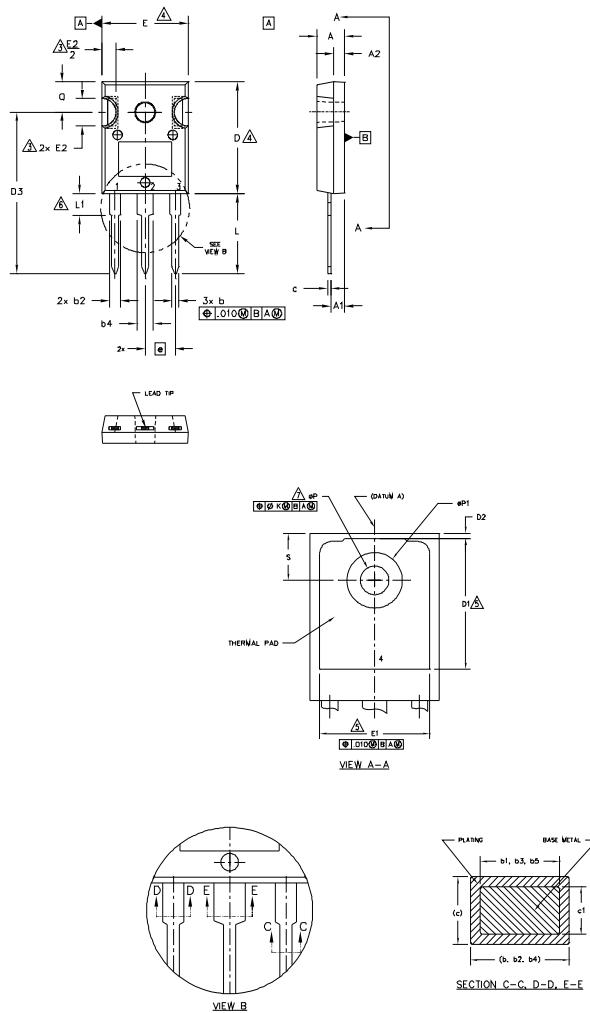
**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

## 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.	
A	.183	.209	4.65
A1	.087	.102	2.21
A2	.059	.098	2.49
b	.039	.055	0.99
b1	.039	.053	1.35
b2	.065	.094	1.65
b3	.065	.092	1.65
b4	.102	.135	2.59
b5	.102	.133	3.38
c	.015	.035	0.38
c1	.015	.033	0.38
D	.776	.815	19.71
D1	.515	—	20.70
D2	.020	.053	4
D3	1.122	1.161	13.08
E	.602	.625	28.50
E1	.530	—	15.29
E2	.178	.216	15.87
e	.215 BSC	5.46 BSC	5
Øk	.010	0.25	4
L	.559	.634	14.20
L1	.146	.169	16.10
ØP	.140	.144	3.71
ØP1	—	.291	4.29
Q	.209	.224	3.56
S	.217 BSC	5.51 BSC	7.39
			5.69

### SPECIAL NOTE:

- a) ADDED D3 FOR SPECIAL REQUIREMENT

### PART NUMBERS AFFECTED:

AUIRGP4PH50S  
 AUIRGP4066D1/E  
 AUIRGP4063D/E  
 AUIRGP50B60PD1/E  
 AUIRGP4062D1/E  
 AUIRGP65A20D0  
 AUIRGP65G20D0  
 AUIRGP/F66524D0  
 AUIRGP/F76524D0  
 AUIRGP/F66548D0  
 AUIRGP/F76548D0

### LEAD ASSIGNMENTS

#### HEXFET

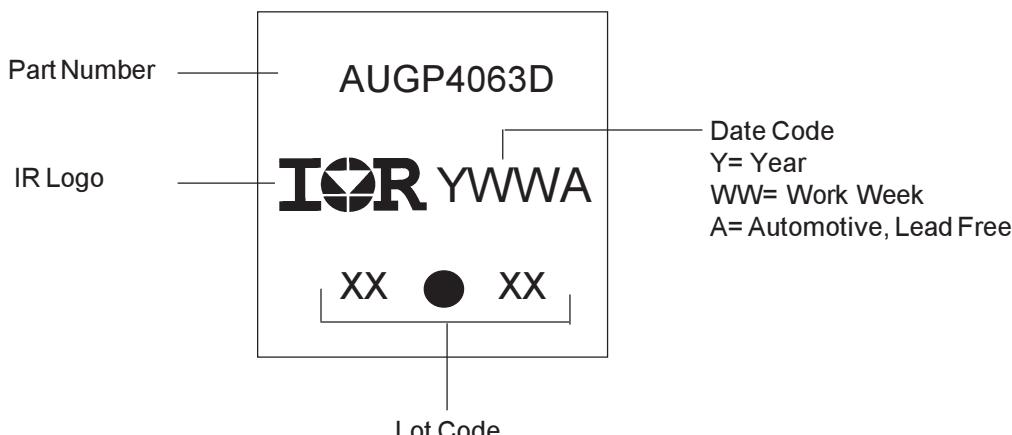
- 1.- GATE  
 2.- DRAIN  
 3.- SOURCE  
 4.- DRAIN

#### IGBTs, CoPACK

#### DIODES

- |               |                |
|---------------|----------------|
| 1.- GATE      | 1.- ANODE/OPEN |
| 2.- COLLECTOR | 2.- CATHODE    |
| 3.- Emitter   | 3.- ANODE      |
| 4.- COLLECTOR |                |

## TO-247AC Part Marking Information

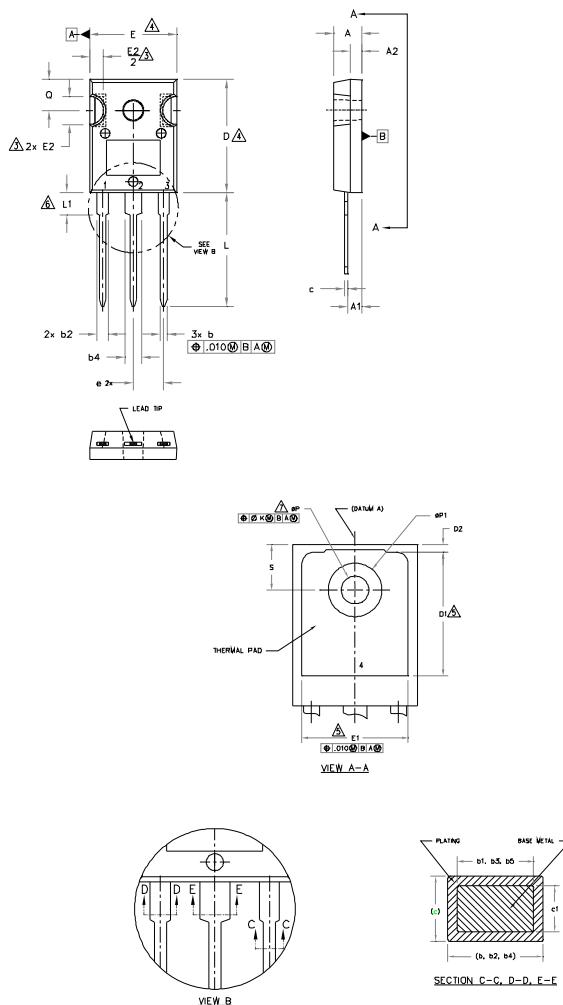


TO-247AC package is not recommended for Surface Mount Application.

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.
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	
φk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
φP	.140	.144	3.56	3.66	
φP1	—	.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

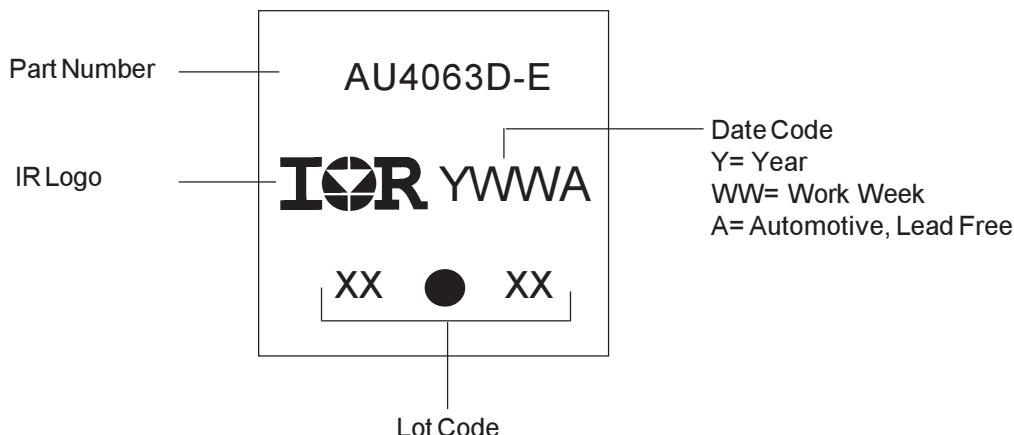
#### IGBTs, CoPACK

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

#### DIODES

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

## TO-247AD Part Marking Information



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<sup>†</sup>**

		Automotive (per AEC-Q101) <sup>†</sup>
<b>Qualification Level</b>		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.
<b>Moisture Sensitivity Level</b>	TO-247AC	N/A
	TO-247AD	N/A
<b>ESD</b>	Machine Model	Class M4 ( $\pm 425V$ ) <sup>††</sup> (per AEC-Q101-002)
	Human Body Model	Class H2 ( $\pm 4000V$ ) <sup>††</sup> (per AEC-Q101-001)
	Charged Device Model	Class C5 ( $\pm 1125V$ ) <sup>††</sup> (per AEC-Q101-005)
<b>RoHS Compliant</b>		Yes

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

<sup>††</sup> Highest passing voltage.

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