

# AUIRGPS4067D1

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

- Low  $V_{CE(on)}$  Trench IGBT Technology
- Low Switching Losses
- 6 $\mu$ s SCSOA
- Square RBSOA
- 100% of the parts tested for  $I_{LM}$  ①
- Positive  $V_{CE(on)}$  Temperature Coefficient
- Soft Recovery Co-pak Diode
- Lead-Free, RoHS Compliant
- Automotive Qualified \*

### Benefits

- High Efficiency in a Wide Range of Applications
- Suitable for Applications in the Low to Mid-Range Frequencies
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation
- Low EMI

### Absolute Maximum Ratings

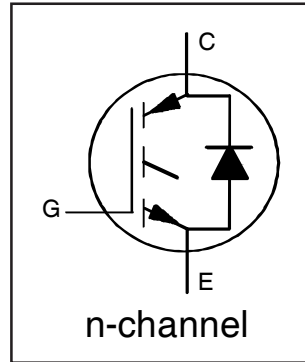
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated 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
$I_C @ T_C = 25^\circ\text{C}$	Continuous Collector Current	240 <sup>⑤</sup>	A
$I_C @ T_C = 100^\circ\text{C}$	Continuous Collector Current	160	
$I_{NOMINAL}$	Nominal Current	120	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15\text{V}$	360	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20\text{V}$ ①	480	
$I_{F,NOMINAL}$	Diode Nominal Current ②	120 <sup>⑤</sup>	A
$I_{FM}$	Diode Maximum Forward Current ②	480	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	750	W
$P_D @ T_C = 100^\circ\text{C}$	Maximum Power Dissipation	375	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

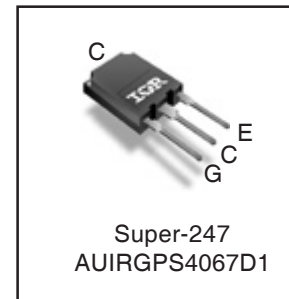
### Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT) ④	—	—	0.20	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ④	—	—	0.44	
$R_{\theta CS}$	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/>



$V_{CES} = 600\text{V}$
$I_C = 160\text{A}, T_C = 100^\circ\text{C}$
$t_{SC} \geq 6\mu\text{s}, T_{J(max)} = 175^\circ\text{C}$
$V_{CE(on)}$ typ. = 1.70V



<b>G</b>	<b>C</b>	<b>E</b>
Gate	Collector	Emitter

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 500μA ③
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.27	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 15mA (25°C-175°C)
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.70	2.05	V	I <sub>C</sub> = 120A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C
		—	2.15	—		I <sub>C</sub> = 120A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C
		—	2.20	—		I <sub>C</sub> = 120A, 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> = 5.6mA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-17	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 20mA (25°C - 175°C)
g <sub>fe</sub>	Forward Transconductance	—	85	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 120A
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	2.3	200	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	9.4	—	mA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 175°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.9	2.2	V	I <sub>F</sub> = 120A
		—	2.0	—		I <sub>F</sub> = 120A, 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
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	240	360	nC	I <sub>C</sub> = 120A
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	69	104		V <sub>GE</sub> = 15V
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	90	135		V <sub>CC</sub> = 400V
E <sub>on</sub>	Turn-On Switching Loss	—	8.2	10	mJ	I <sub>C</sub> = 120A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V
E <sub>off</sub>	Turn-Off Switching Loss	—	2.9	3.2		R <sub>G</sub> = 4.7Ω, L = 87μH, T <sub>J</sub> = 25°C
E <sub>total</sub>	Total Switching Loss	—	11.1	13.2		Energy losses include tail & diode reverse recovery
t <sub>d(on)</sub>	Turn-On delay time	—	69	82	ns	I <sub>C</sub> = 120A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V
t <sub>r</sub>	Rise time	—	65	82		R <sub>G</sub> = 4.7Ω, L = 87μH, T <sub>J</sub> = 25°C
t <sub>d(off)</sub>	Turn-Off delay time	—	198	230		
t <sub>f</sub>	Fall time	—	38	48		
E <sub>on</sub>	Turn-On Switching Loss	—	10	—	mJ	I <sub>C</sub> = 120A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V
E <sub>off</sub>	Turn-Off Switching Loss	—	3.8	—		R <sub>G</sub> = 4.7Ω, L = 87μH, T <sub>J</sub> = 175°C ③
E <sub>total</sub>	Total Switching Loss	—	13.8	—		Energy losses include tail & diode reverse recovery
t <sub>d(on)</sub>	Turn-On delay time	—	63	—	ns	I <sub>C</sub> = 120A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V
t <sub>r</sub>	Rise time	—	64	—		R <sub>G</sub> = 4.7Ω, L = 200μH
t <sub>d(off)</sub>	Turn-Off delay time	—	230	—		T <sub>J</sub> = 175°C
t <sub>f</sub>	Fall time	—	51	—		
C <sub>ies</sub>	Input Capacitance	—	7780	—	pF	V <sub>GE</sub> = 0V
C <sub>oes</sub>	Output Capacitance	—	505	—		V <sub>CC</sub> = 30V
C <sub>res</sub>	Reverse Transfer Capacitance	—	245	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 175°C, I <sub>C</sub> = 480A V <sub>CC</sub> = 480V, V <sub>p</sub> = 600V R <sub>G</sub> = 4.7Ω, V <sub>GE</sub> = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	6	—	—	μs	V <sub>CC</sub> = 400V, V <sub>p</sub> = 600V R <sub>G</sub> = 1.0Ω, V <sub>GE</sub> = +15V to 0V
E <sub>rec</sub>	Reverse Recovery Energy of the Diode	—	2440	—	μJ	T <sub>J</sub> = 175°C
t <sub>rr</sub>	Diode Reverse Recovery Time	—	360	—	ns	V <sub>CC</sub> = 400V, I <sub>F</sub> = 120A
I <sub>rr</sub>	Peak Reverse Recovery Current	—	53	—	A	V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L = 87μH

### Notes:

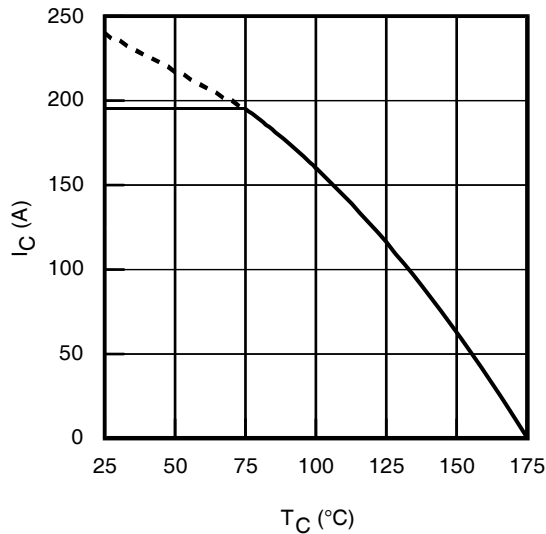
- V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 0.87μH, R<sub>G</sub> = 50Ω, tested in production I<sub>LM</sub> ≤ 400A.
- Pulse width limited by max. junction temperature.
- Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.
- R<sub>θ</sub> is measured at T<sub>J</sub> of approximately 90°C.
- Calculated continuous current based on maximum allowable junction temperature. Package IGBT current limit is 195A. Package diode current limit is 120A. Note that current limitations arising from heating of the device leads may occur.

**Qualification Information<sup>†</sup>**

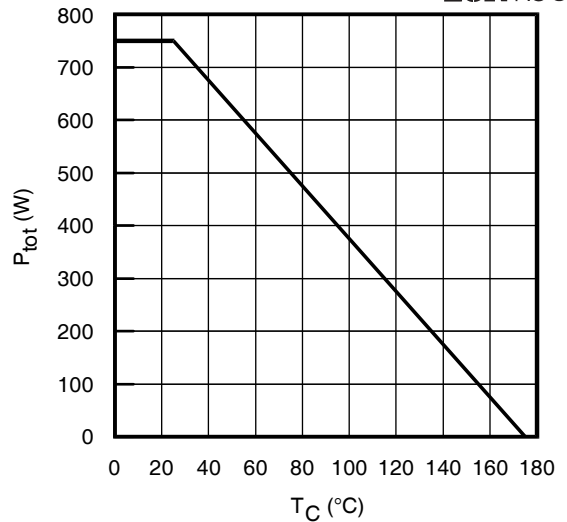
<b>Qualification Level</b>		Automotive (per AEC-Q101)	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		Super-247	N/A
<b>ESD</b>	Machine Model	Class M4 (+/- 400V) <sup>††</sup> AEC-Q101-002	
	Human Body Model	Class H3B (+/- 8000V) <sup>††</sup> AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000V) <sup>††</sup> 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>

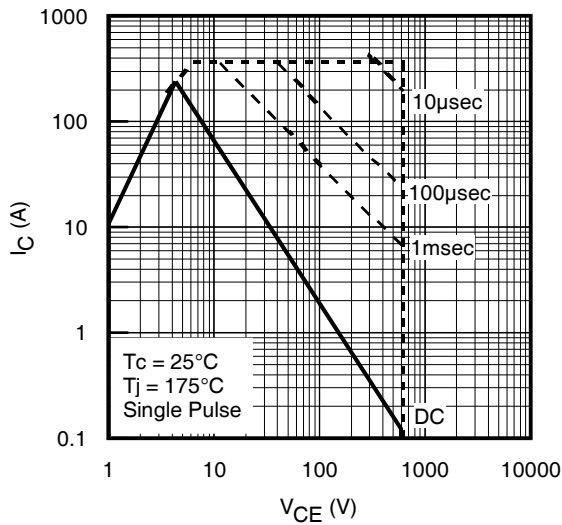
<sup>††</sup> Highest passing voltage.



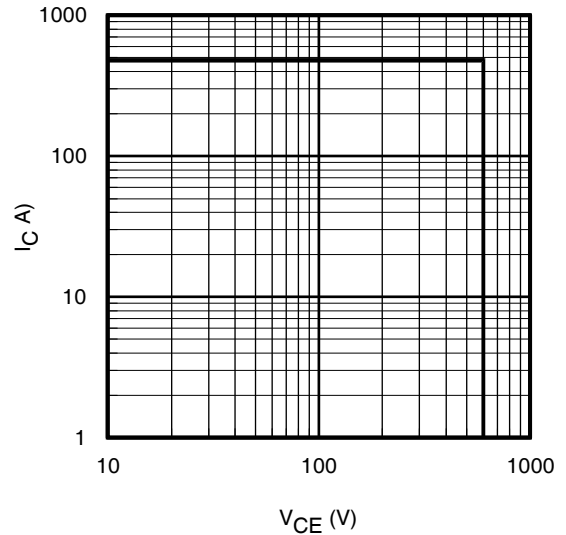
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



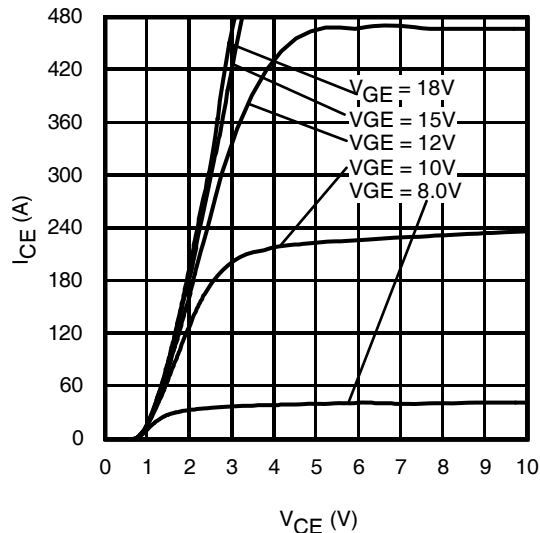
**Fig. 2** - Power Dissipation vs. Case Temperature



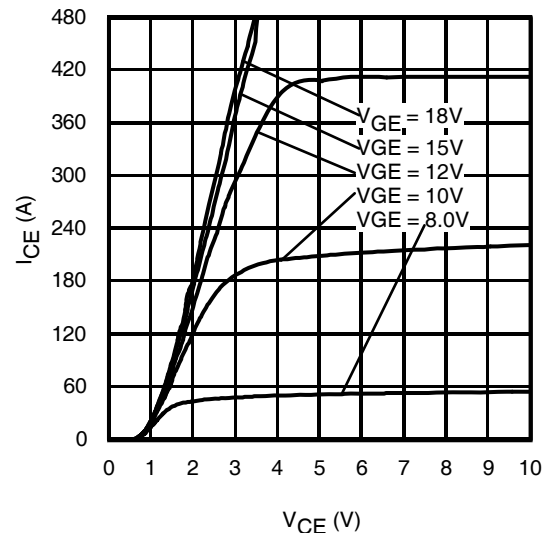
**Fig. 3** - Forward SOA  
 $T_C = 25^{\circ}C$ ,  $T_J \leq 175^{\circ}C$ ;  $V_{GE} = 15V$



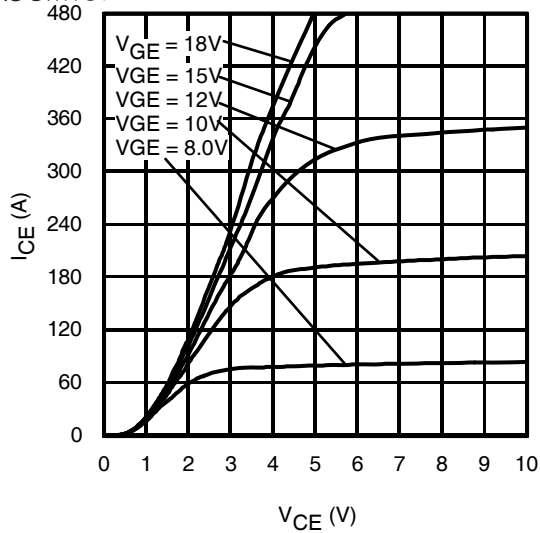
**Fig. 4** - Reverse Bias SOA  
 $T_J = 175^{\circ}C$ ;  $V_{GE} = 20V$



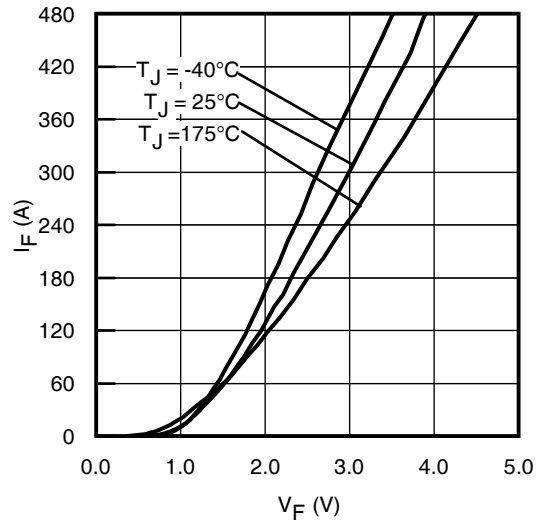
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}C$ ;  $t_p = 30 \mu s$



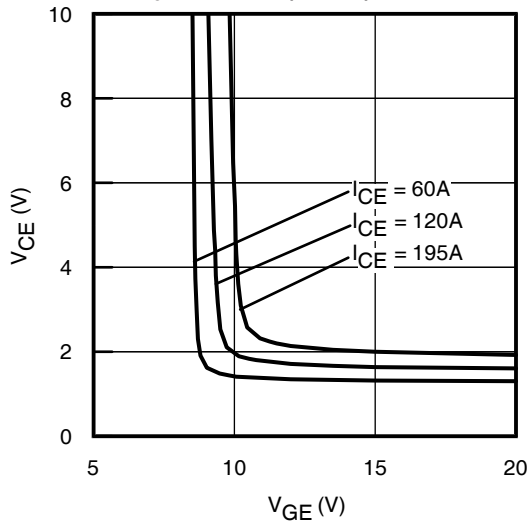
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}C$ ;  $t_p = 30 \mu s$



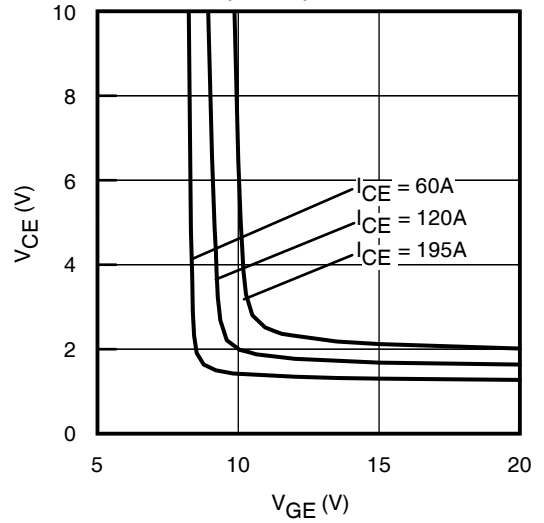
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 30\mu\text{s}$



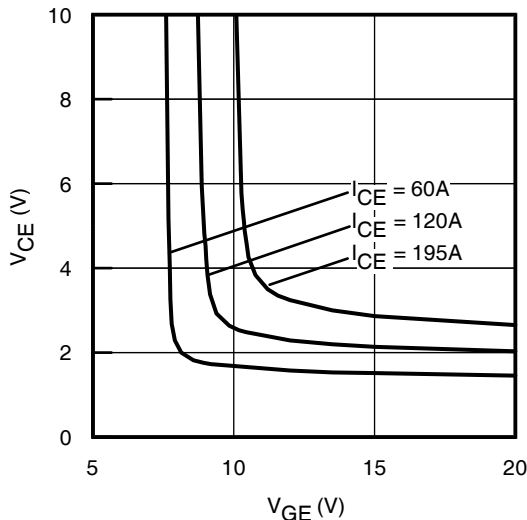
**Fig. 8 - Typ. Diode Forward Characteristics**  
 $t_p = 30\mu\text{s}$



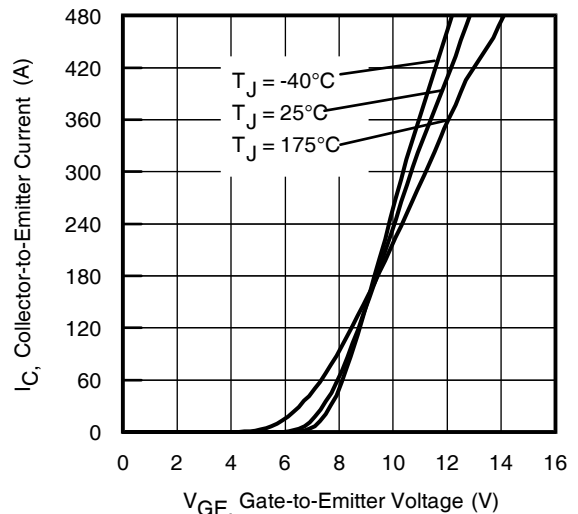
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



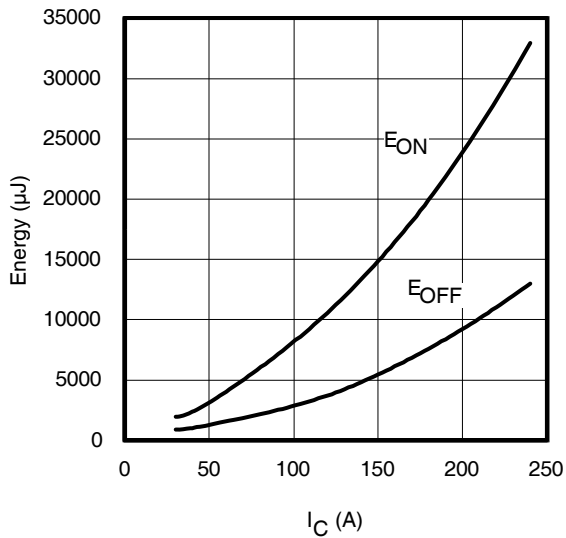
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



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

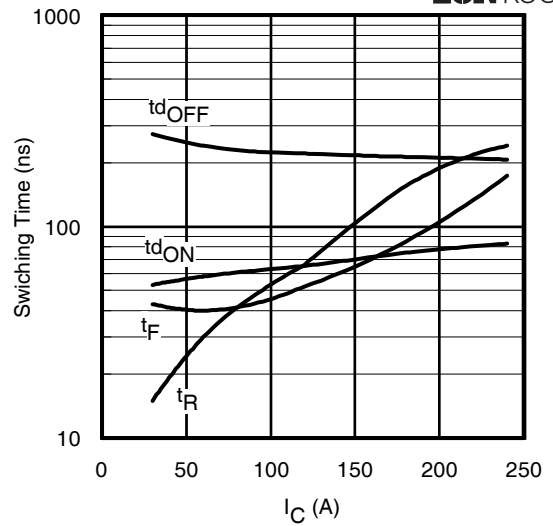


**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



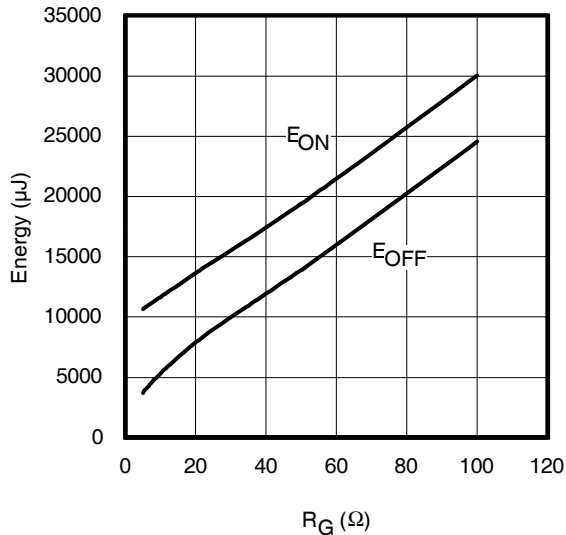
**Fig. 13** - Typ. Energy Loss vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 0.087\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 5.0\Omega$ ;  $V_{GE} = 15\text{V}$



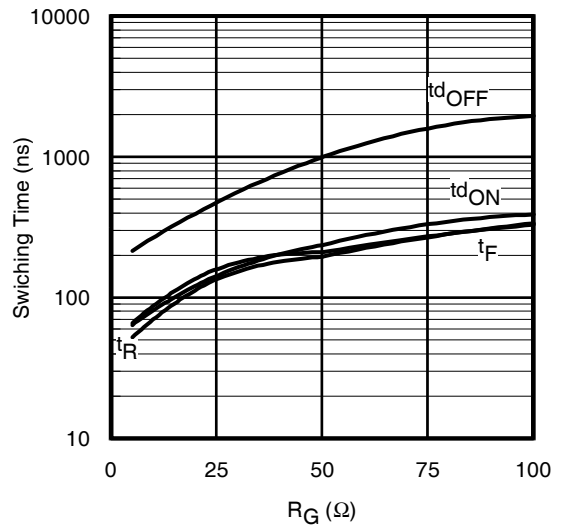
**Fig. 14** - Typ. Switching Time vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 0.087\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 5.0\Omega$ ;  $V_{GE} = 15\text{V}$



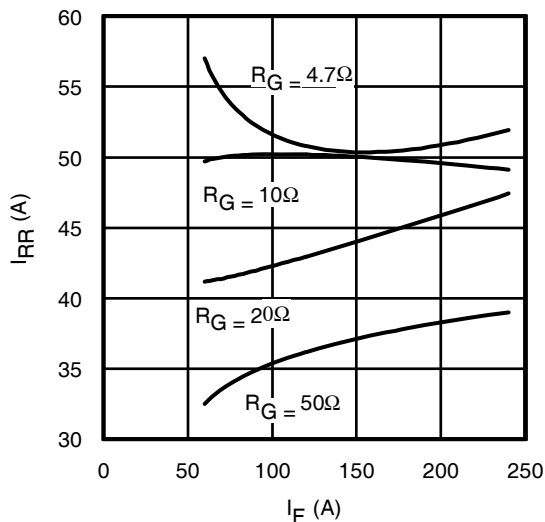
**Fig. 15** - Typ. Energy Loss vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 0.087\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 120\text{A}$ ;  $V_{GE} = 15\text{V}$



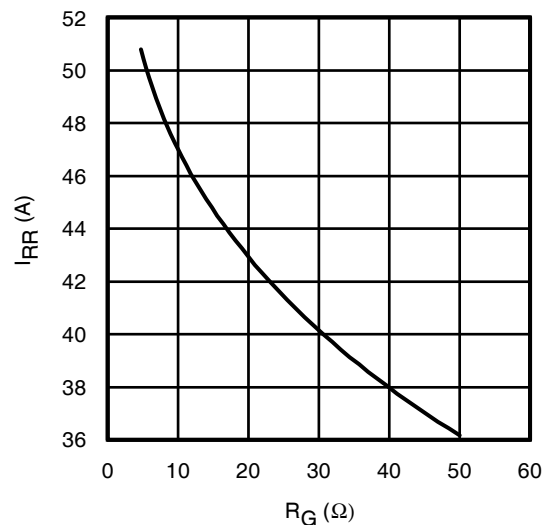
**Fig. 16** - Typ. Switching Time vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 0.087\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 120\text{A}$ ;  $V_{GE} = 15\text{V}$



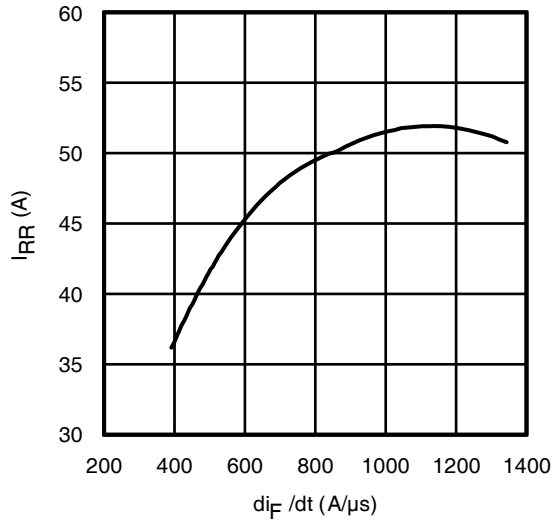
**Fig. 17** - Typ. Diode  $I_{RR}$  vs.  $I_F$

$T_J = 175^\circ\text{C}$

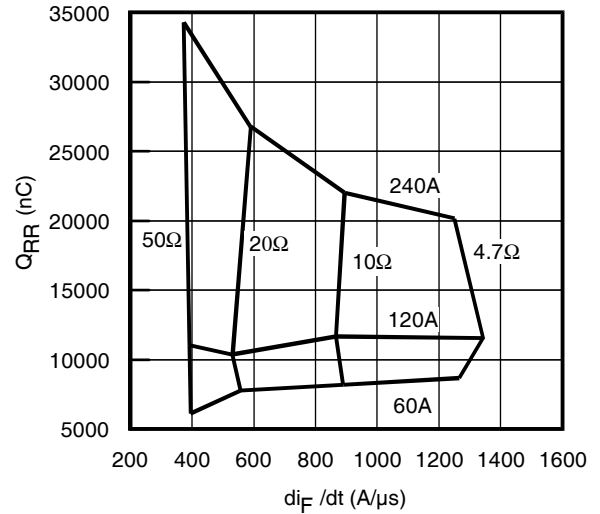


**Fig. 18** - Typ. Diode  $I_{RR}$  vs.  $R_G$

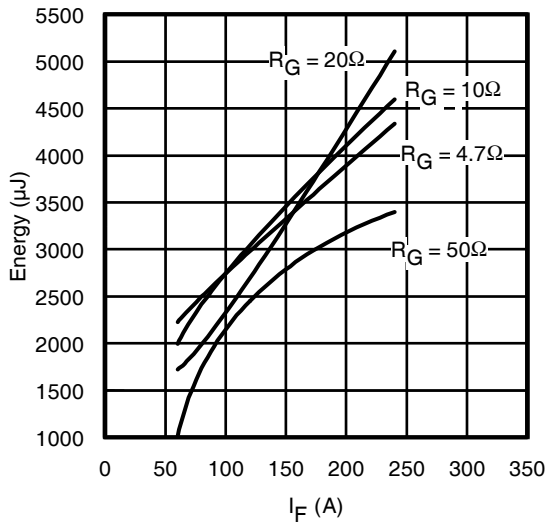
$T_J = 175^\circ\text{C}$



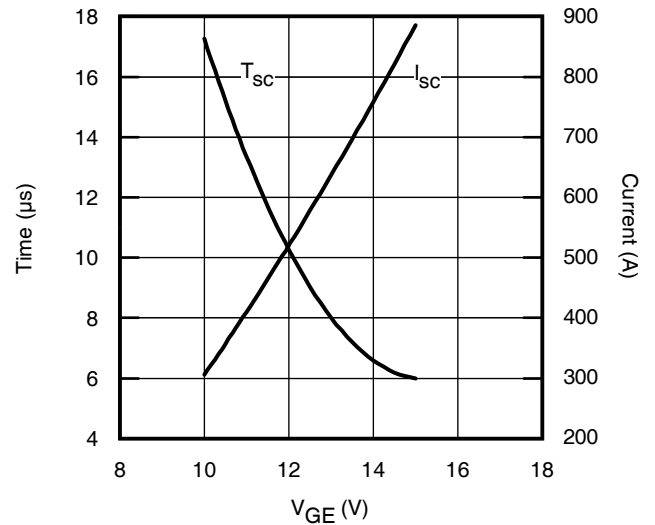
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $I_F = 120A$ ;  $T_J = 175^\circ C$



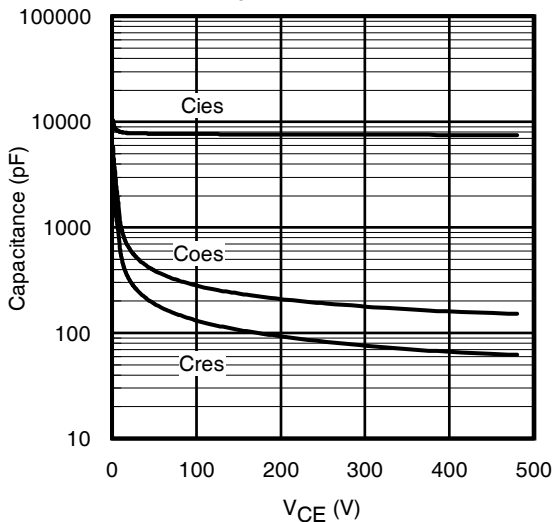
**Fig. 20** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $T_J = 175^\circ C$



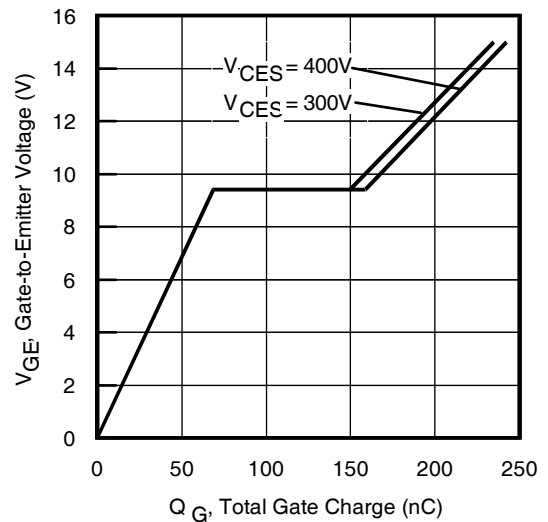
**Fig. 21** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ C$



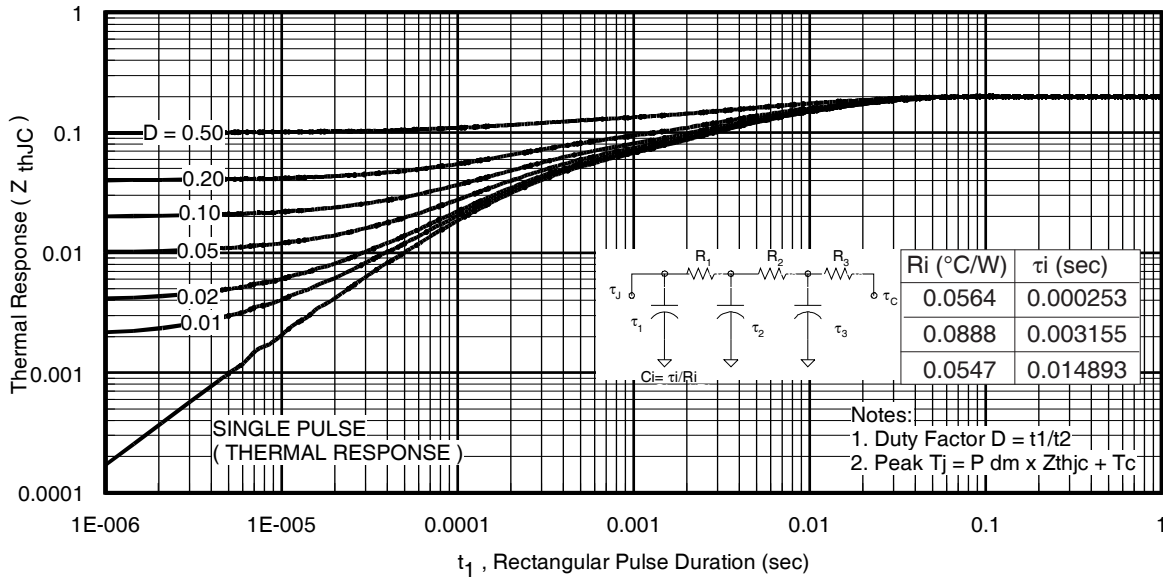
**Fig. 22** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400V$ ;  $T_C = 25^\circ C$



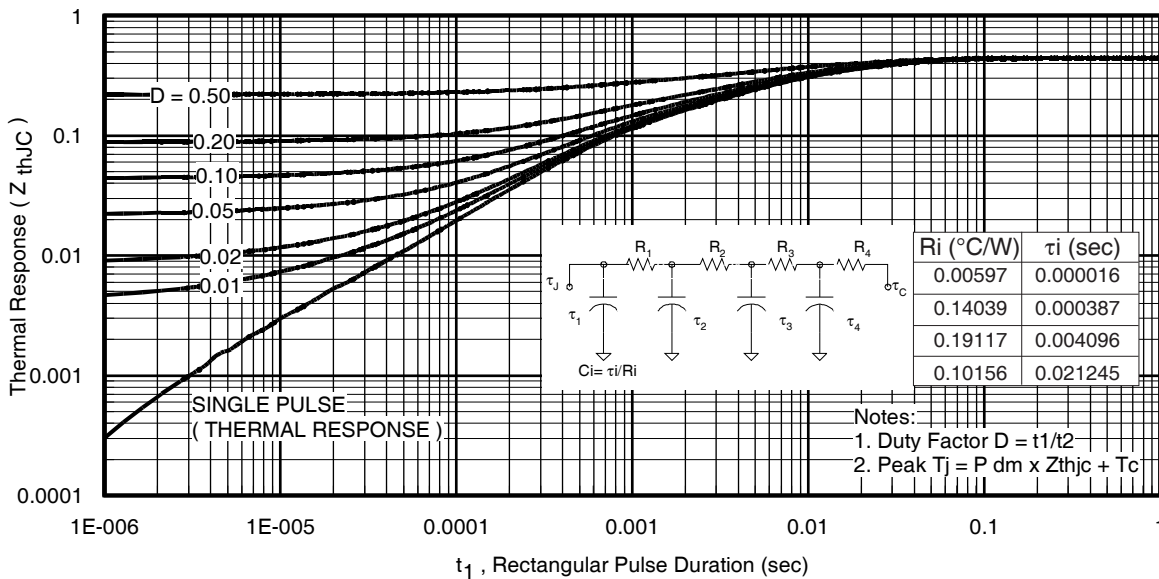
**Fig. 23** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



**Fig. 24** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 120A$



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



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



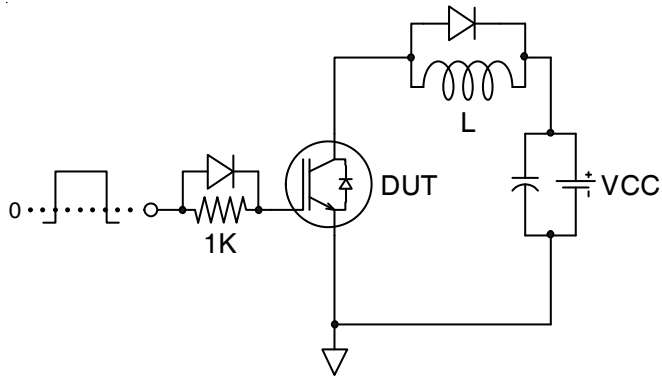


Fig.C.T.1 - Gate Charge Circuit (turn-off)

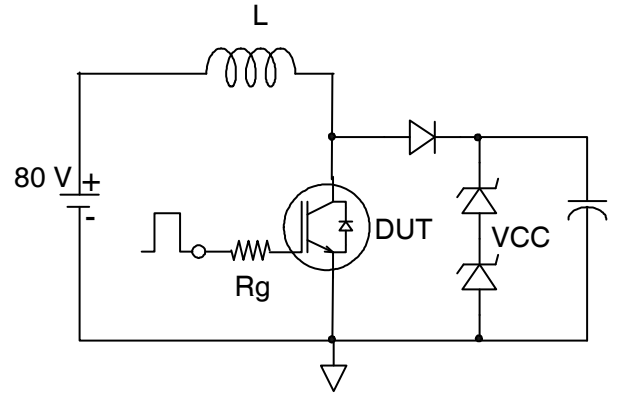


Fig.C.T.2 - RBSOA Circuit

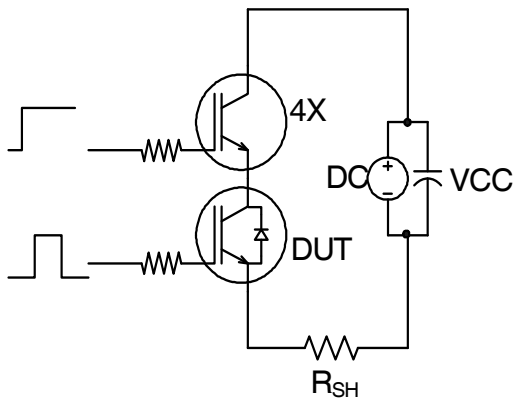


Fig.C.T.3 - S.C. SOA Circuit

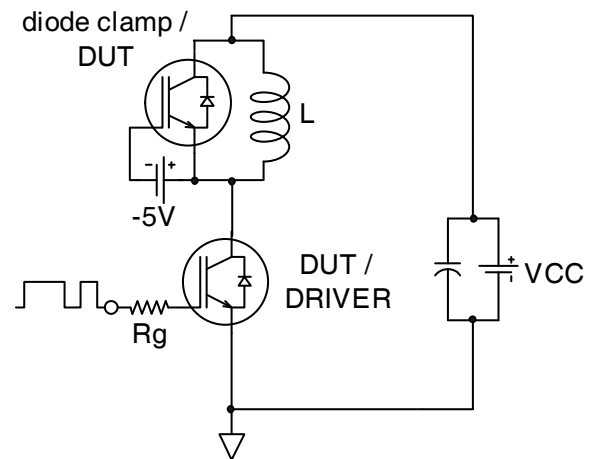


Fig.C.T.4 - Switching Loss Circuit

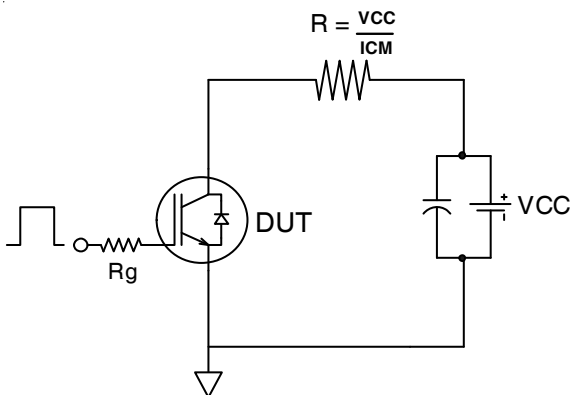


Fig.C.T.5 - Resistive Load Circuit

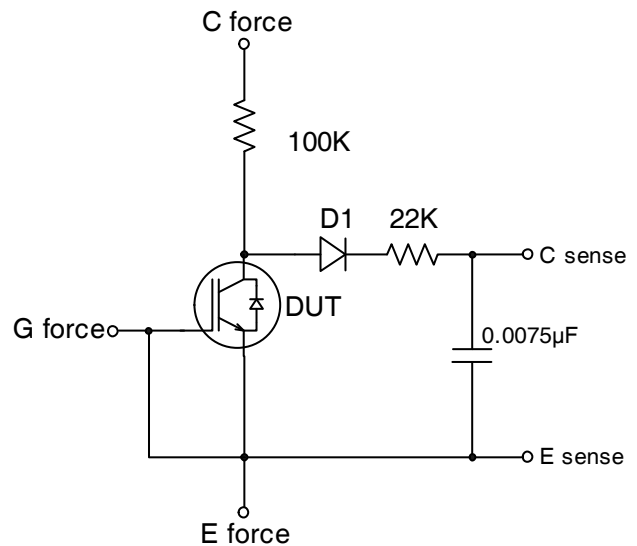
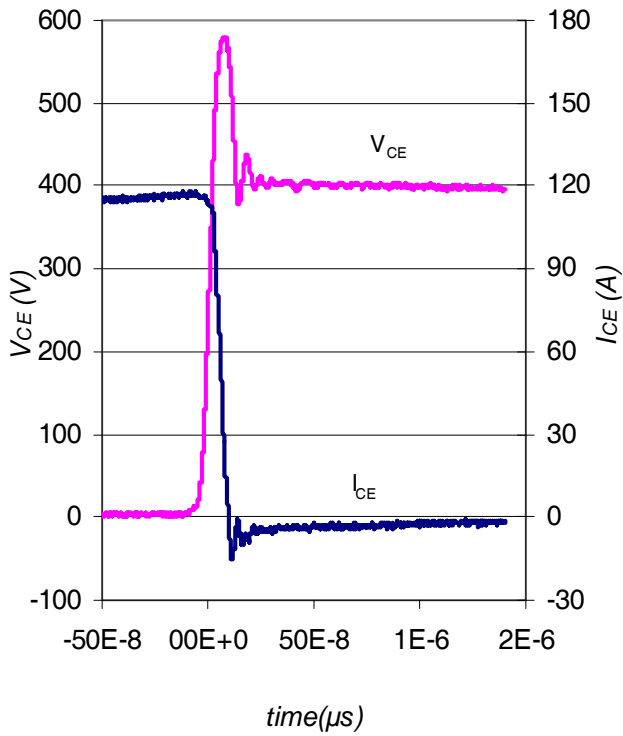
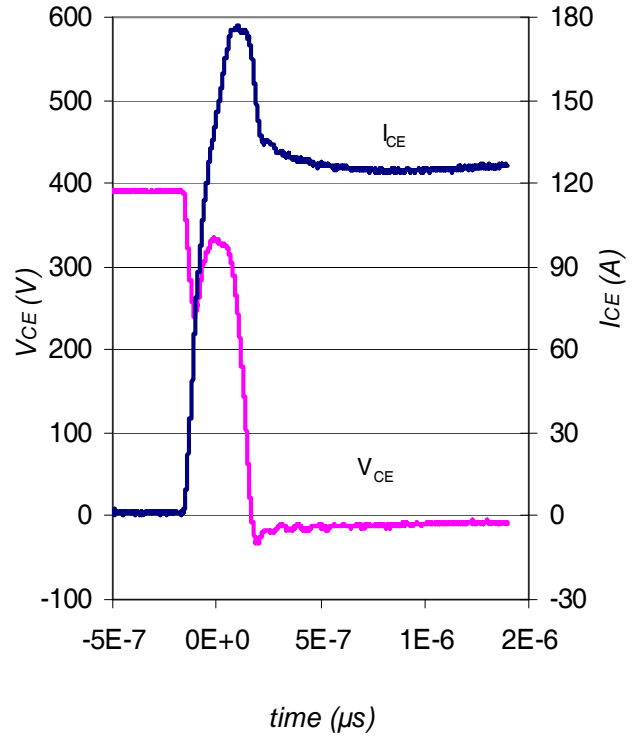


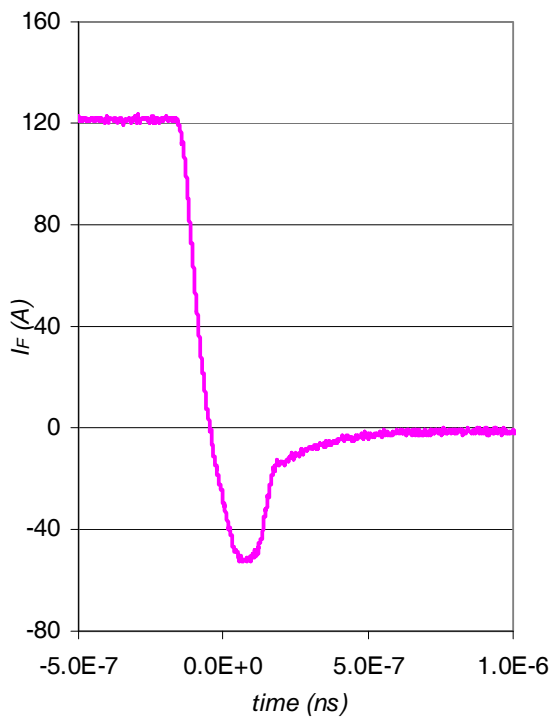
Fig.C.T.6 - BVCES Filter Circuit



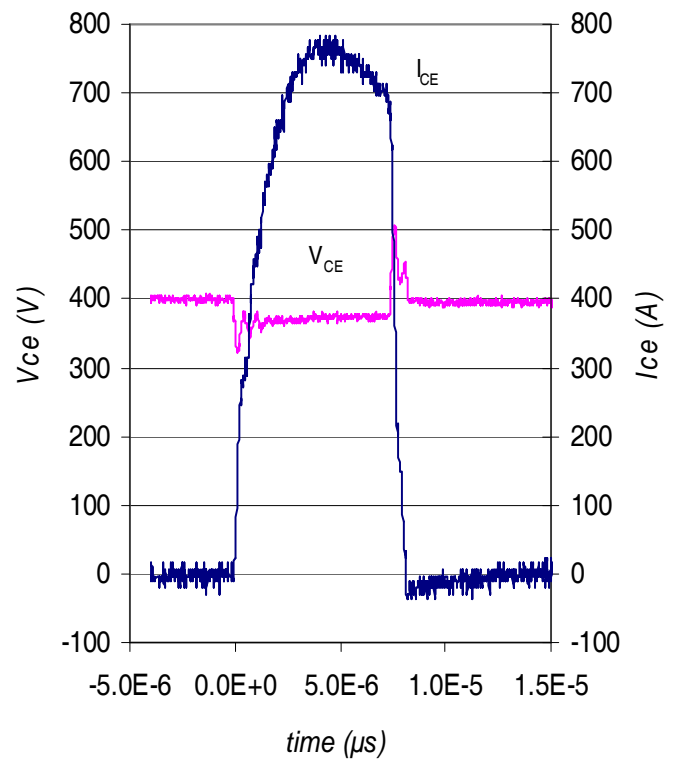
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

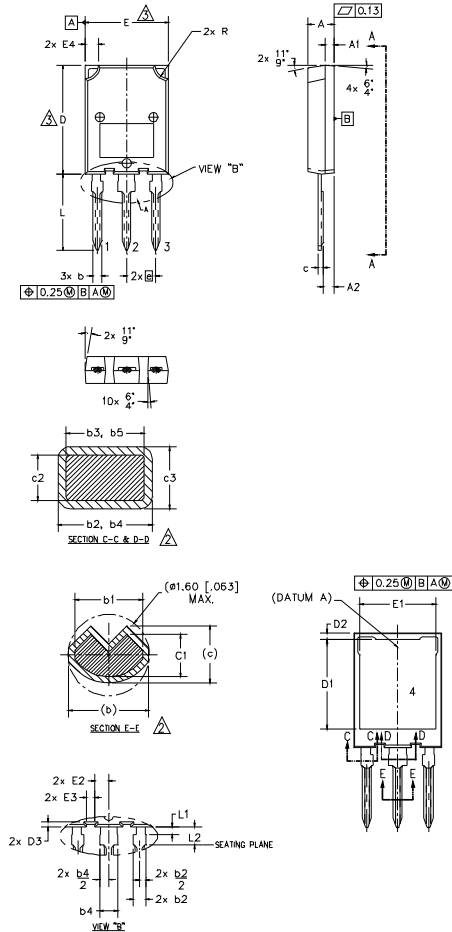


**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

Case Outline and Dimensions — Super-247



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
2. DIMENSIONS b1, b3, b5, c1 & c3 APPLY TO BASE METAL ONLY.
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTER EXTREMES OF THE PLASTIC BODY.
- 4.- ALL DIMENSIONS SHOWN IN MILLIMETERS.
- 5.- CONTROLLING DIMENSION: MILLIMETER.
- 6.- OUTLINE CONFORMS TO JEDEC OUTLINE TO-274AA

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.50	5.50	.177	.217	
A1	1.45	2.15	.057	.085	
A2	1.65	2.35	.065	.093	
b	1.45	1.60	.054	.063	
b1	1.40	1.50	.055	.059	2
b2	2.00	2.40	.079	.094	
b3	1.95	2.35	.077	.093	2
b4	3.00	3.15	.118	.124	
b5	2.95	3.35	.116	.132	2
c	1.10	1.30	.043	.051	
c1	0.90	1.10	.035	.043	2
c2	0.65	0.85	.026	.033	
c3	0.50	0.70	.020	.028	2
D	19.80	20.80	.780	.819	3
D1	15.50	16.10	.610	.634	
D2	0.70	1.30	.028	.051	
D3	0.75	1.25	.030	.049	
E	15.10	16.10	.594	.634	3
E1	13.30	13.90	.524	.547	
E2	2.25	2.70	.089	.109	
E3	1.20	1.70	.047	.067	
E4	2.00	3.00	.079	.118	
e	5.45 BSC		.215 BSC		
L	13.80	14.80	.535	.583	
L1	1.00	1.60	.039	.063	
L2	3.85	4.25	.152	.167	
R	2.00	3.00	.079	.118	

LEAD ASSIGNMENTS

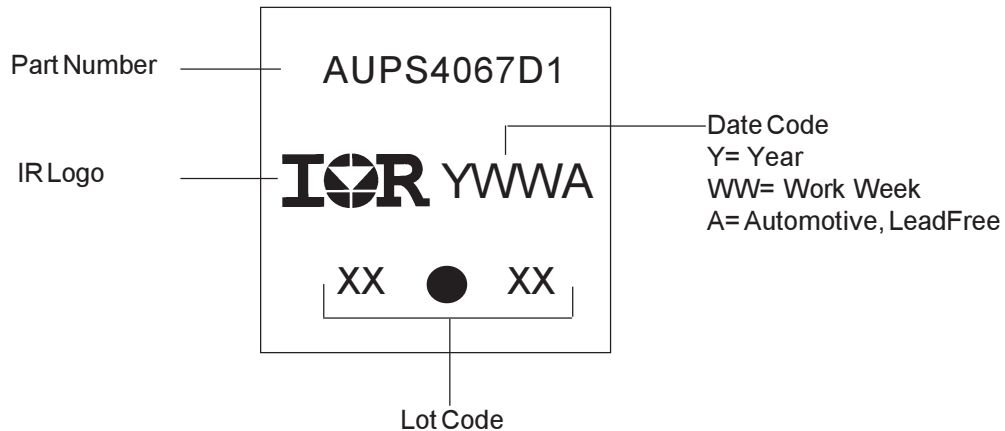
MOSFET

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

IGBT

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

Super-247 (TO-274AA) Part Marking Information



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

## Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRGPS4067D1	Super-247	Tube	25	AUIRGPS4067D1

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