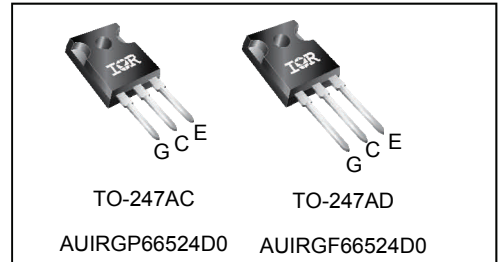
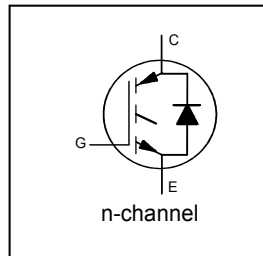


**COOLiRIGBT™**

**INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE**

$V_{CES} = 600V$
$I_{NOMINAL} = 24A$
$T_{sc} \geq 6\mu s, T_{J(MAX)} = 175^{\circ}C$
$V_{CE(ON)} \text{ typ.} = 1.60V$



G	C	E
Gate	Collector	Emitter

**Applications**

- Air Conditioning Compressor
- Auxiliary Motor Drive

Features	→	Benefits
Low $V_{CE(on)}$ Trench IGBT Technology		High Efficiency in a Wide Range of Applications
Low Switching Losses		Suitable for a Wide Range of Switching Frequencies
6 $\mu s$ SC SOA Guaranteed		Enables Short Circuit Protection Scheme
Square RBSOA and 100% Clamp IL Tested		Rugged Hard Switching Operation
Positive $V_{CE(on)}$ Temperature Coefficient		Enables Easy Paralleling of Devices
Ultra Fast Soft Recovery Co-pak Diode		Better Efficiency and Improved EMI Performance
Lead-Free, RoHS Compliant, Automotive Qualified *		Environmentally Friendly

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRGP66524D0	TO-247AC	Tube	25	AUIRGP66524D0
AUIRGF66524D0	TO-247AD	Tube	25	AUIRGF66524D0

**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
$I_{Nominal}$	Nominal Collector Current	24	A
$I_C @ T_C = 25^{\circ}C$	Continuous Collector Current	60	
$I_C @ T_C = 100^{\circ}C$	Continuous Collector Current	40	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15V$	72	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	96	
$I_F @ T_C = 25^{\circ}C$	Diode Continuous Forward Current	55	
$I_F @ T_C = 100^{\circ}C$	Diode Continuous Forward Current	35	
$I_{FM}$	Diode Maximum Forward Current ②	72	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
dV/dt	Maximum Voltage Transient	15	V/ns
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	214	W
$P_D @ T_C = 100^{\circ}C$	Maximum Power Dissipation	107	
$T_J$ $T_{STG}$	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)	

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

**Thermal Resistance**

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case (each IGBT) ④	—	0.7	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case (each Diode) ④	—	1.1	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	40	

**Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.21	—	V/°C	$V_{GE} = 0V, I_C = 20mA$ (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.60	1.90	V	$I_C = 24A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	1.95	—		$I_C = 24A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
		—	2.0	—		$I_C = 24A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	5.5	6.5	7.5	V	$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-28	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1mA$ (25°C-175°C)
$g_{fe}$	Forward Transconductance	—	21	—	S	$V_{CE} = 50V, I_C = 24A, PW = 20\mu s$
$I_{CES}$	Collector-to-Emitter Leakage Current	—	1.1	50	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
$V_{FM}$	Diode Forward Voltage Drop	—	1.50	1.90	V	$I_F = 24A$
		—	1.40	—		$I_F = 24A, T_J = 175^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

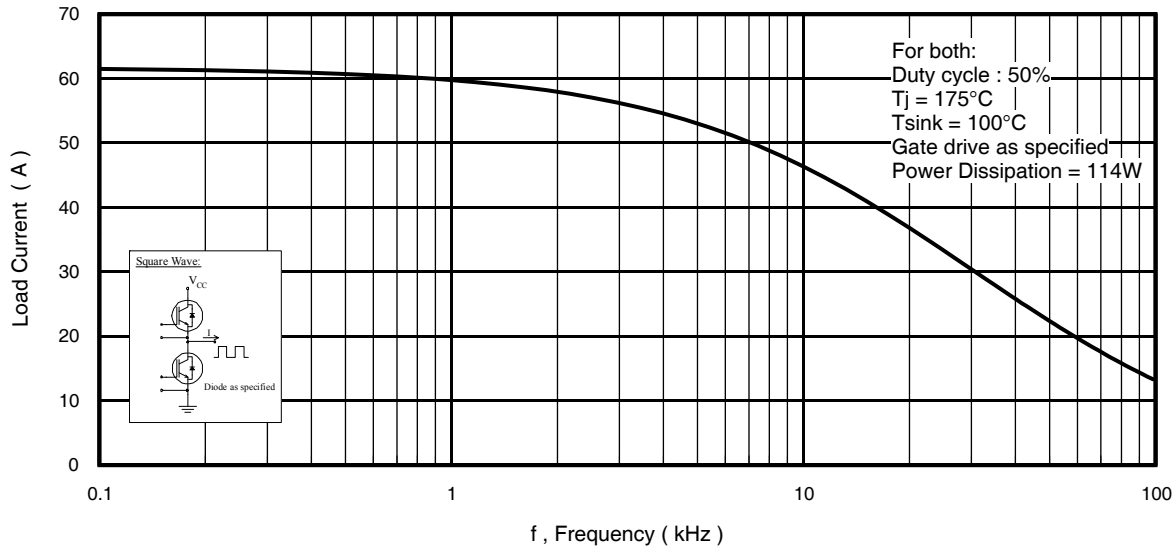
**Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	50	80	nC	$I_C = 24A$ $V_{GE} = 15V$ $V_{CC} = 400V$
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	16	24		
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	26	39		
$E_{on}$	Turn-On Switching Loss	—	915	1045	$\mu J$	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery
$E_{off}$	Turn-Off Switching Loss	—	280	395		
$E_{total}$	Total Switching Loss	—	1195	1440		
$t_{d(on)}$	Turn-On delay time	—	30	50	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
$t_r$	Rise time	—	25	45		
$t_{d(off)}$	Turn-Off delay time	—	75	95		
$t_f$	Fall time	—	25	45		
$E_{on}$	Turn-On Switching Loss	—	1280	—	$\mu J$	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
$E_{off}$	Turn-Off Switching Loss	—	550	—		
$E_{total}$	Total Switching Loss	—	1830	—		
$t_{d(on)}$	Turn-On delay time	—	30	—	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
$t_r$	Rise time	—	25	—		
$t_{d(off)}$	Turn-Off delay time	—	100	—		
$t_f$	Fall time	—	95	—		
$C_{ies}$	Input Capacitance	—	1460	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	120	—		
$C_{res}$	Reverse Transfer Capacitance	—	50	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 96A$ $V_{CC} = 480V, V_p \leq 600V$ $R_g = 10\Omega, V_{GE} = +20V$ to 0V
SCSOA	Short Circuit Safe Operating Area	6	—	—	$\mu s$	$T_J = 150^\circ\text{C}, V_{CC} = 400V, V_p \leq 600V$ $R_g = 50\Omega, V_{GE} = +15V$ to 0V
$E_{rec}$	Reverse Recovery Energy of the Diode	—	570	—	$\mu J$	$T_J = 175^\circ\text{C}$
$t_{rr}$	Diode Reverse Recovery Time	—	176	—	ns	$V_{CC} = 400V, I_F = 24A$
$I_{rr}$	Peak Reverse Recovery Current	—	19	—	A	$V_{GE} = 15V, R_g = 10\Omega, L = 740\mu H$

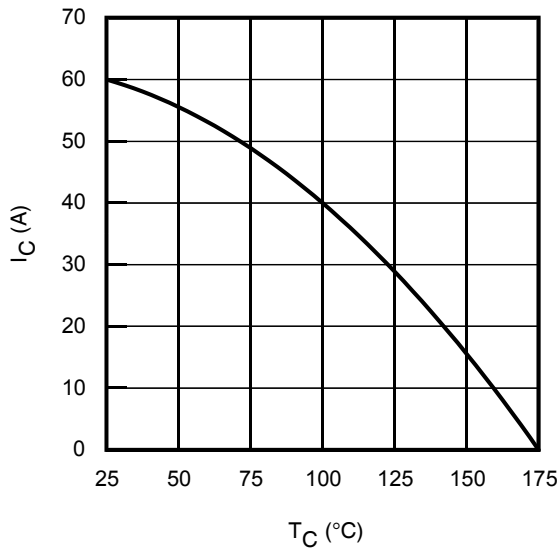
**Notes:**

- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 740\mu H, R_G = 10\Omega$ .  
 ② Pulse width limited by max. junction temperature.

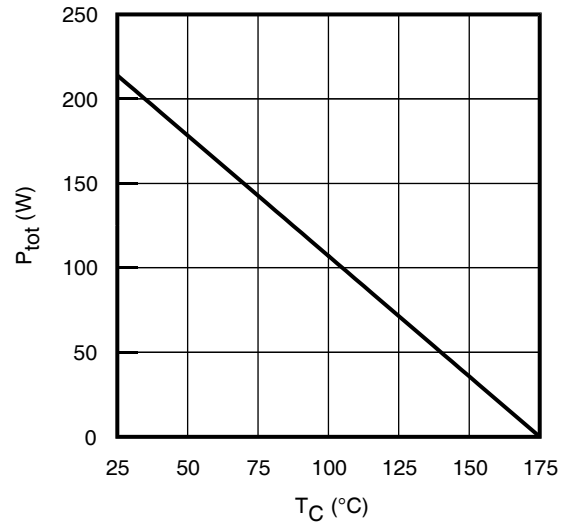
- ③ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.  
 ④  $R_{\theta}$  is measured at  $T_J$  approximately 90°C.



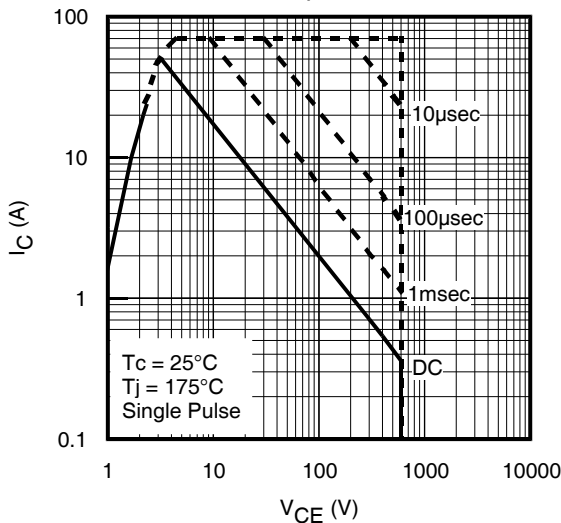
**Fig. 1 - Typical Load Current vs. Frequency**



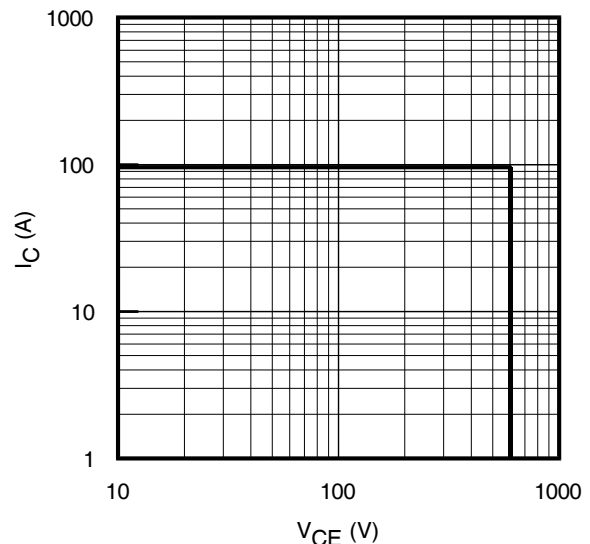
**Fig. 2 - Maximum DC Collector Current vs. Case Temperature**



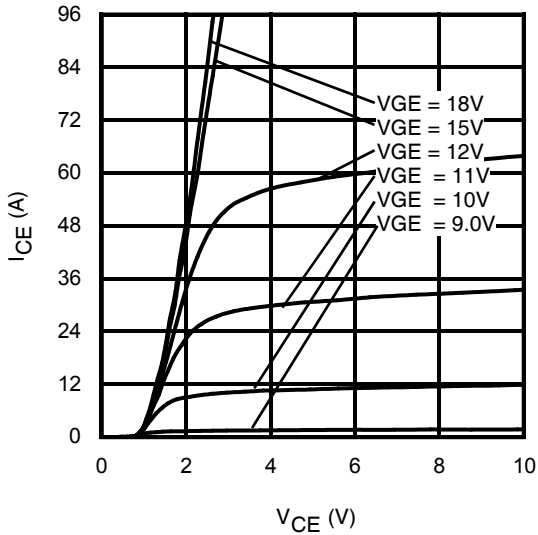
**Fig. 3 - Power Dissipation vs. Case Temperature**



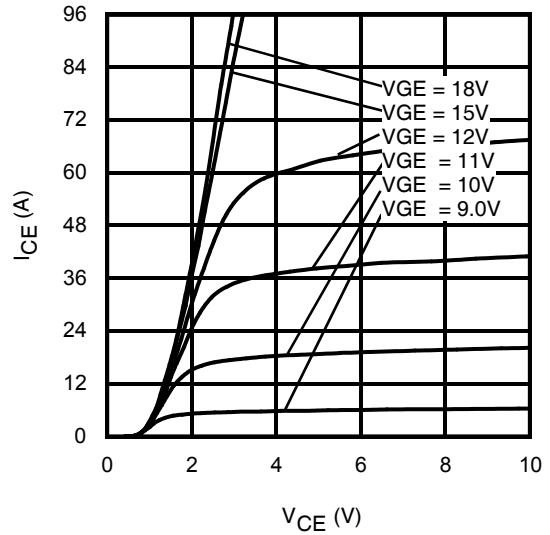
**Fig. 4 - Forward SOA**  
 $T_C = 25^\circ\text{C}$ ,  $T_J @ 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



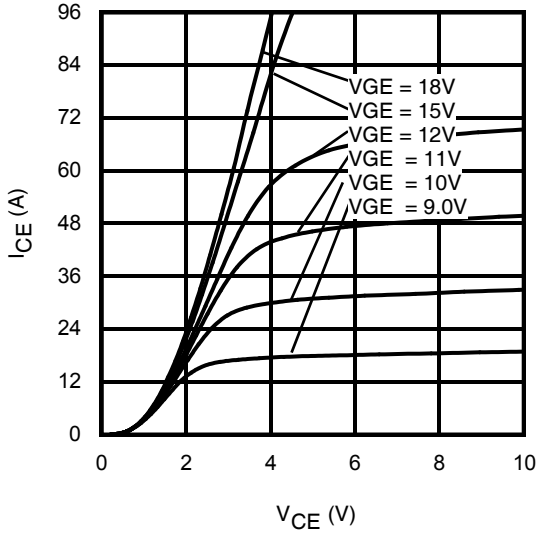
**Fig. 5 - Reverse Bias SOA**  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



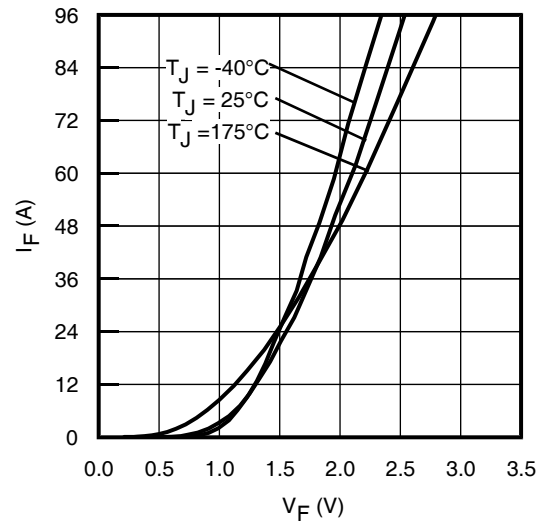
**Fig. 6** - - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



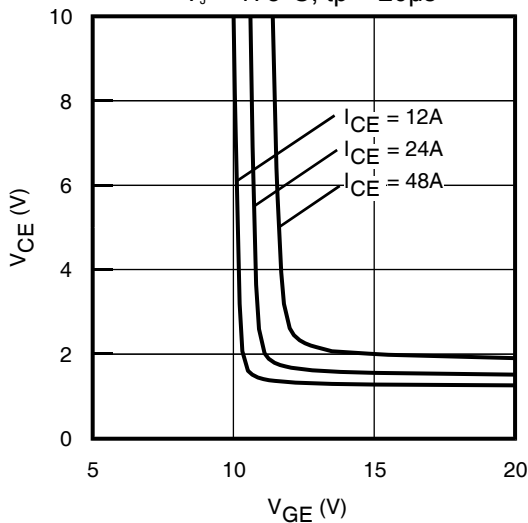
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



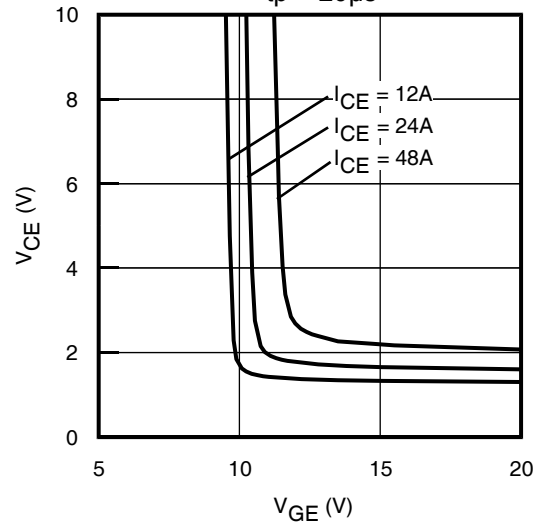
**Fig. 8** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



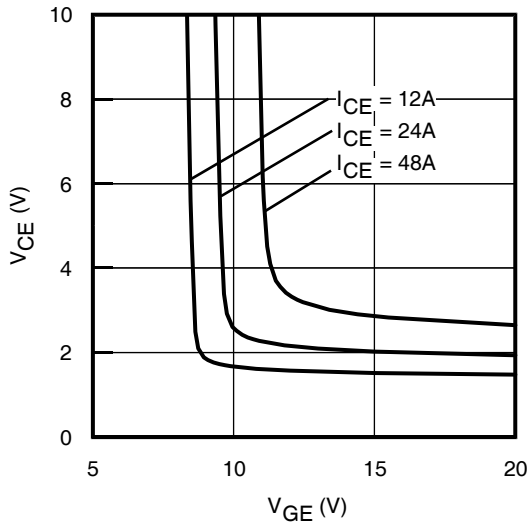
**Fig. 9** - Typ. Diode Forward Characteristics  
 $t_p = 20\mu\text{s}$



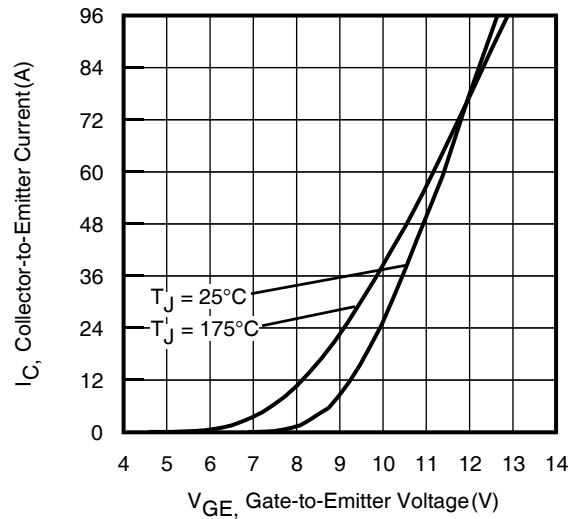
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



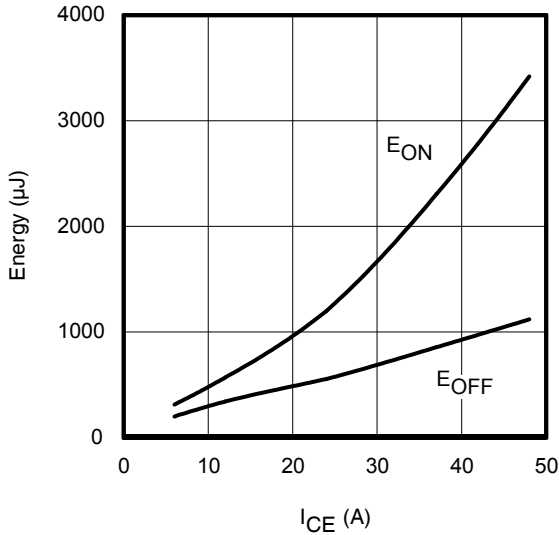
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



**Fig. 12** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$

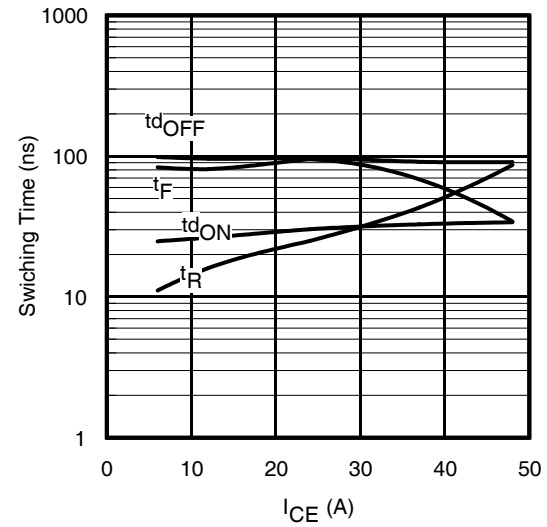


**Fig. 13** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 20\mu\text{s}$



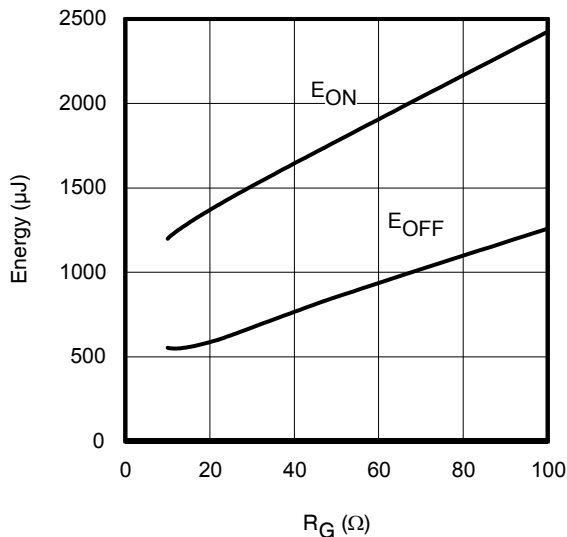
**Fig. 14** - Typ. Energy Loss vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 740\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



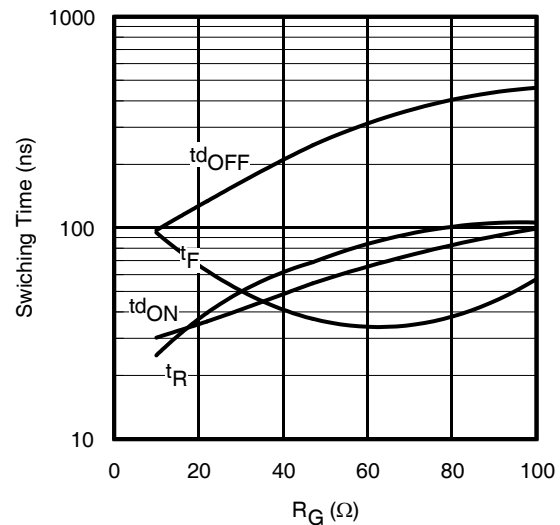
**Fig. 15** - Typ. Switching Time vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 740\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



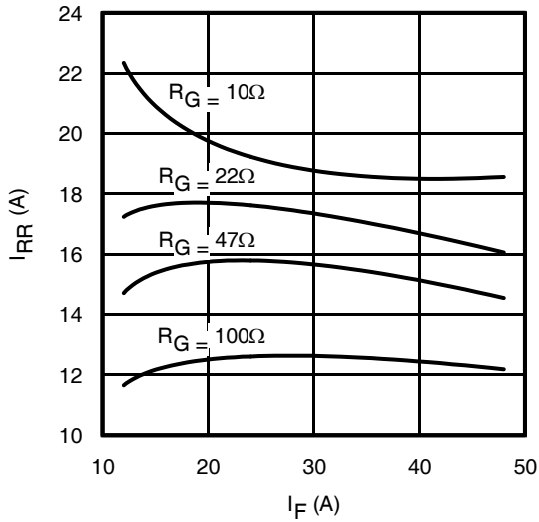
**Fig. 16** - Typ. Energy Loss vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 740\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 24\text{A}$ ;  $V_{GE} = 15\text{V}$

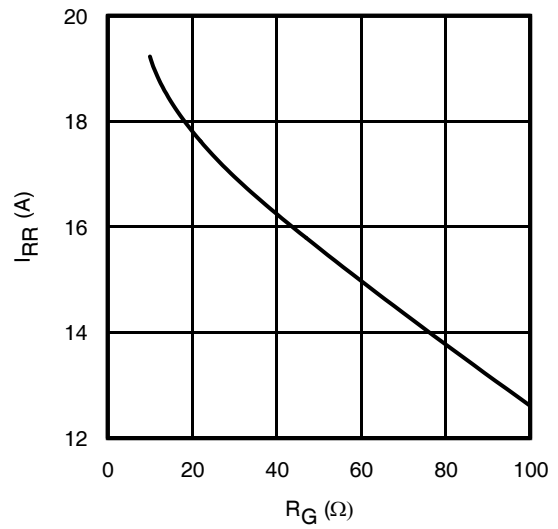


**Fig. 17** - Typ. Switching Time vs.  $R_G$

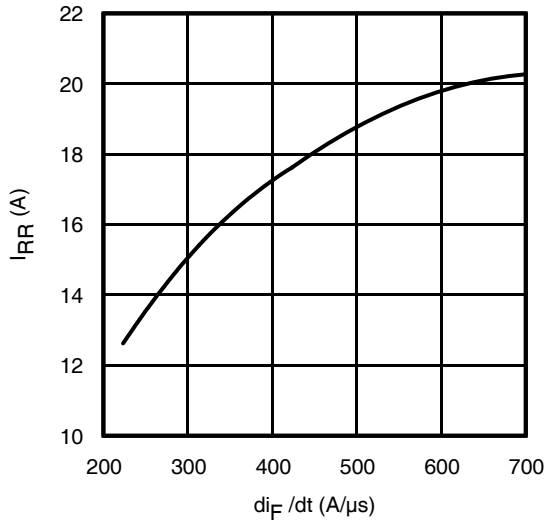
$T_J = 175^\circ\text{C}$ ;  $L = 740\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 24\text{A}$ ;  $V_{GE} = 15\text{V}$



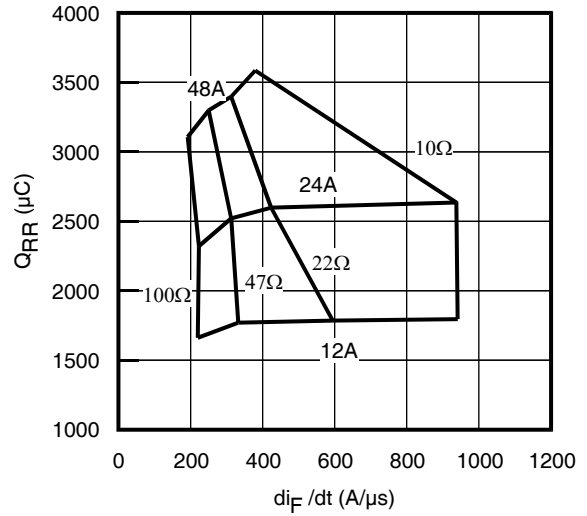
**Fig. 18** - Typ. Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ\text{C}$



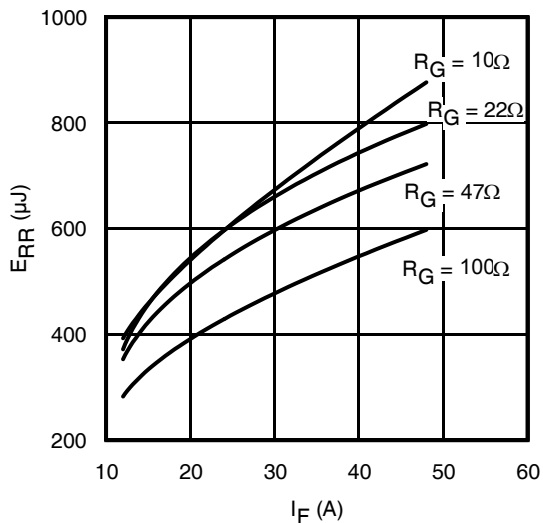
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 175^\circ\text{C}$



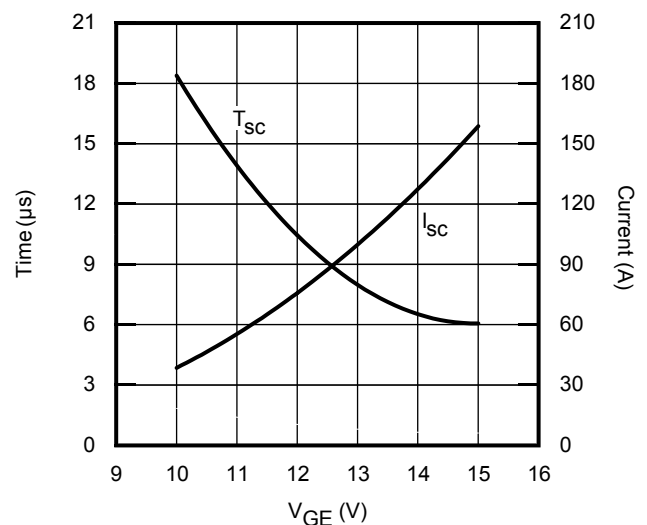
**Fig. 20** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400\text{V}$ ;  $V_{GE} = 15\text{V}$ ;  $I_F = 24\text{A}$ ;  $T_J = 175^\circ\text{C}$



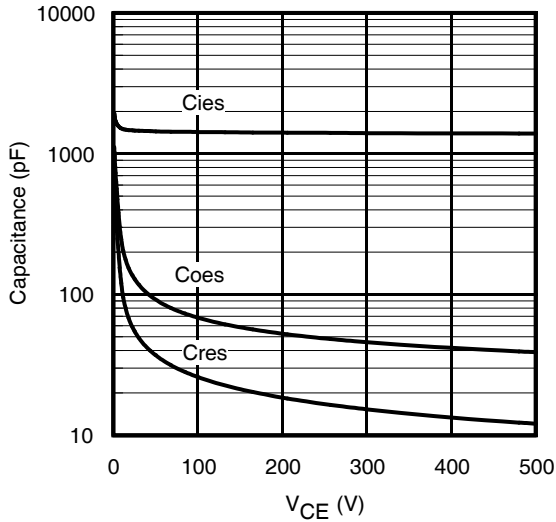
**Fig. 21** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400\text{V}$ ;  $V_{GE} = 15\text{V}$ ;  $T_J = 175^\circ\text{C}$



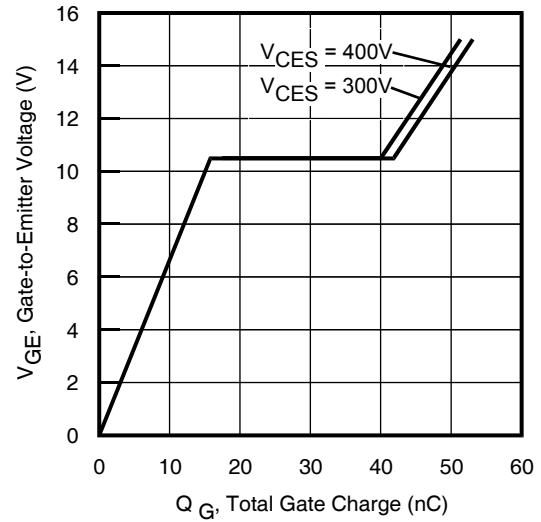
**Fig. 22** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ\text{C}$



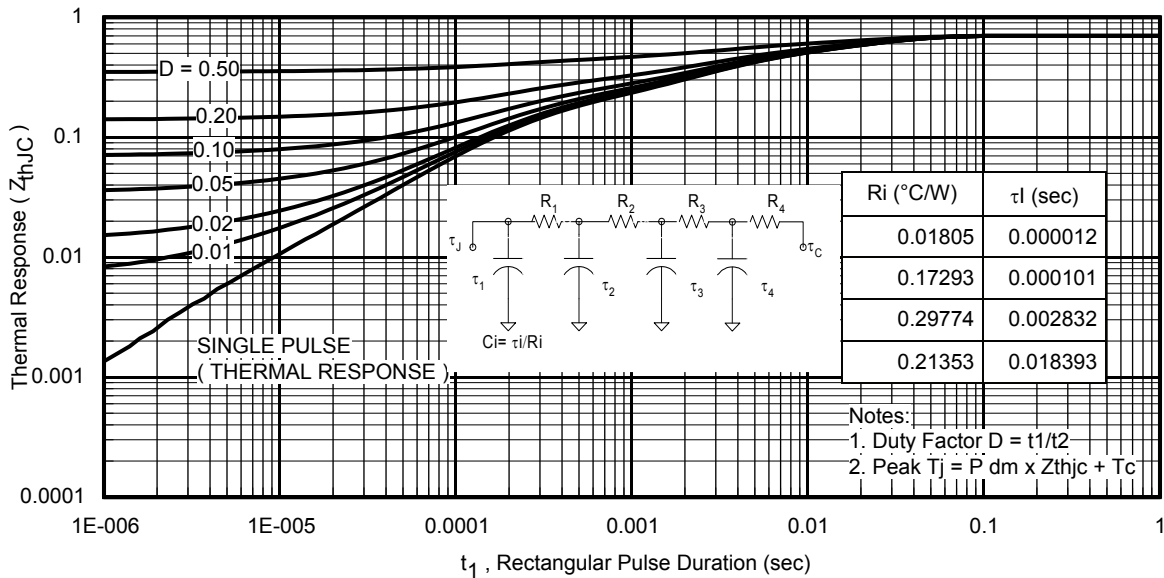
**Fig. 23** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400\text{V}$ ;  $T_C = 150^\circ\text{C}$



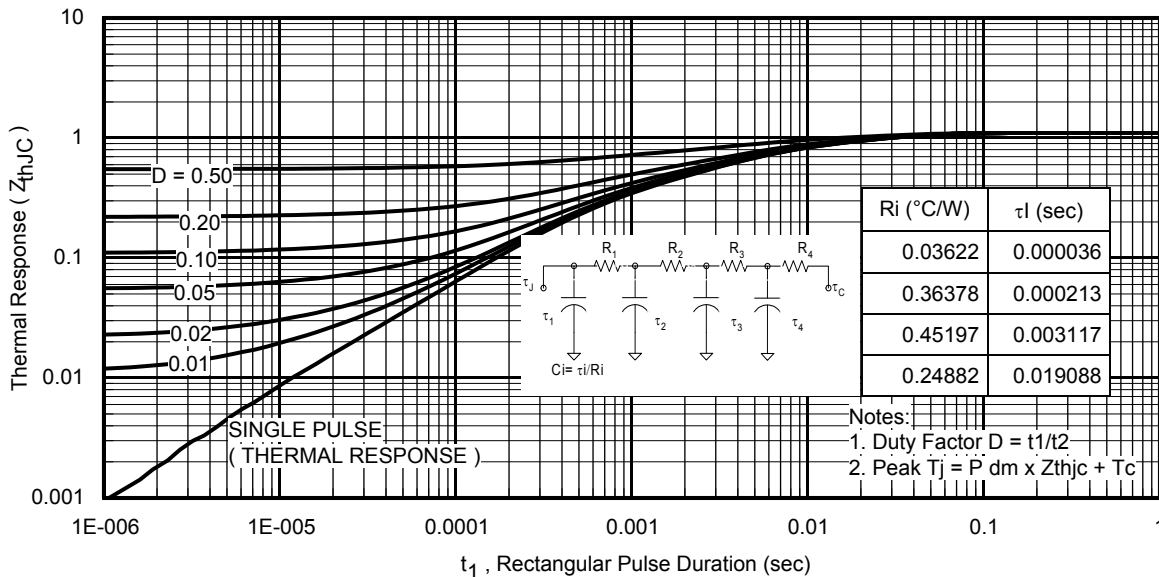
**Fig. 24** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



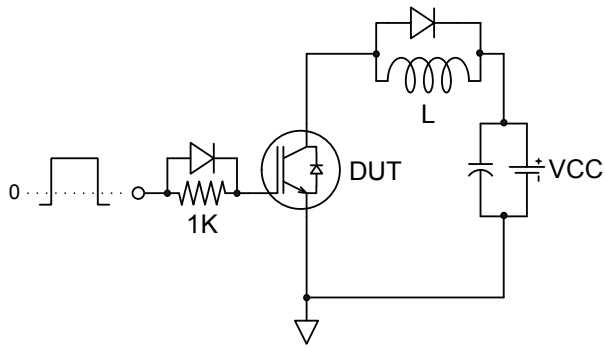
**Fig. 25** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 24A$ ;  $L = 485\mu H$



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

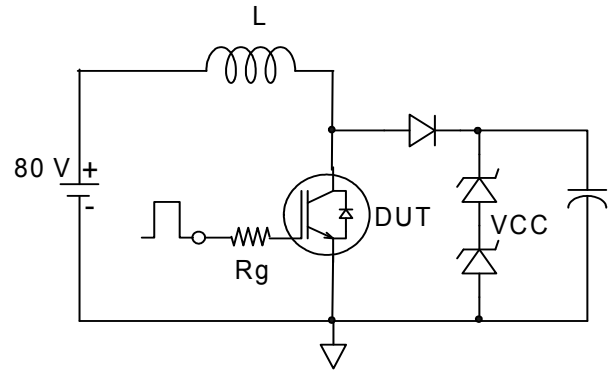


**Fig 27.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



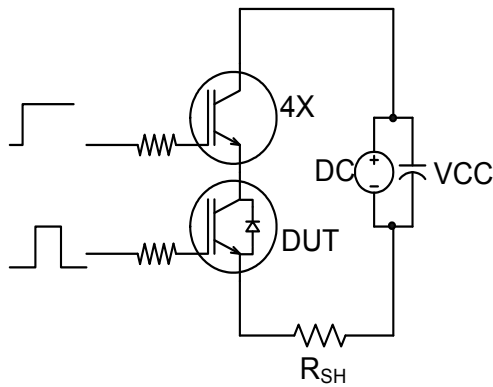
Gate Charge Circuit

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

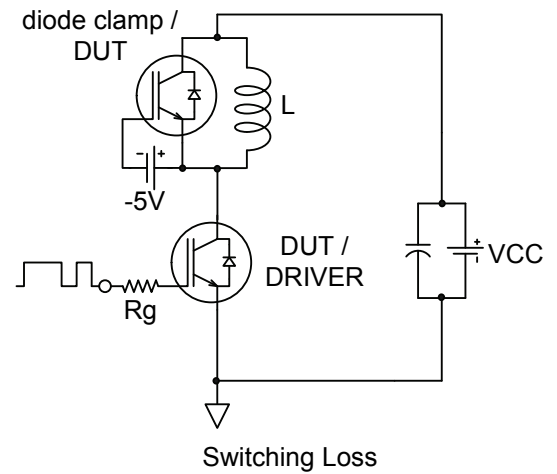


RBSOA Circuit

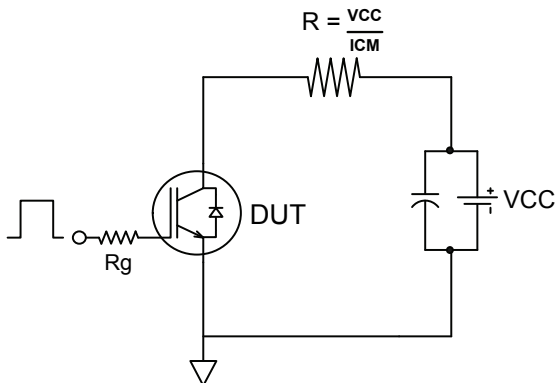
**Fig.C.T.2 - RBSOA Circuit**



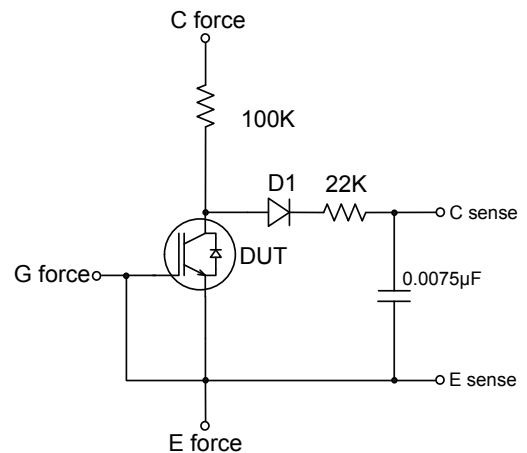
**Fig.C.T.3 - S.C. SOA Circuit**



**Fig.C.T.4 - Switching Loss Circuit**

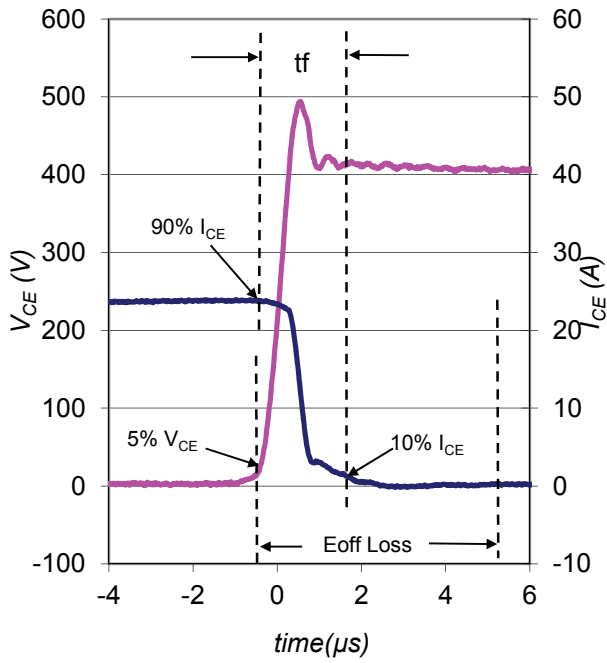


**Fig.C.T.5 - Resistive Load Circuit**

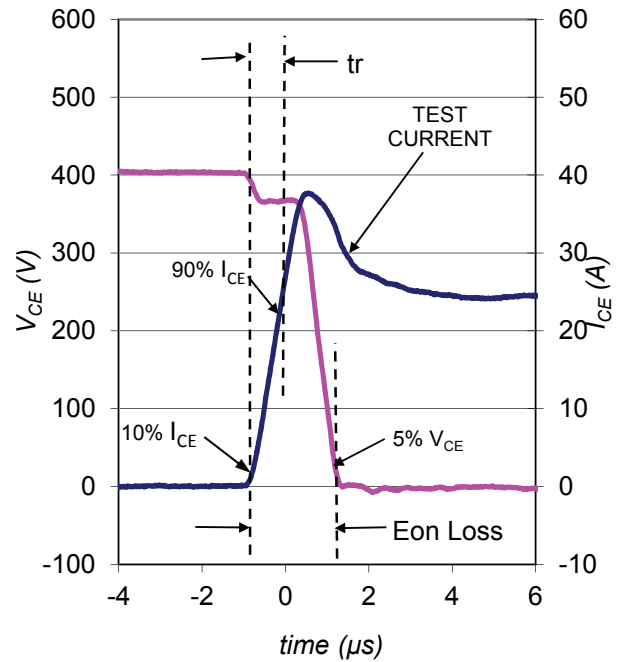


**Fig.C.T.6 - BVES Filter Circuit**

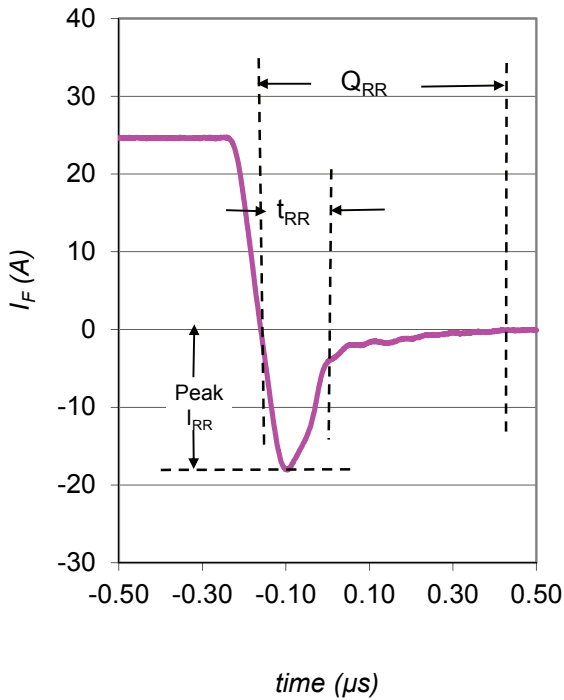




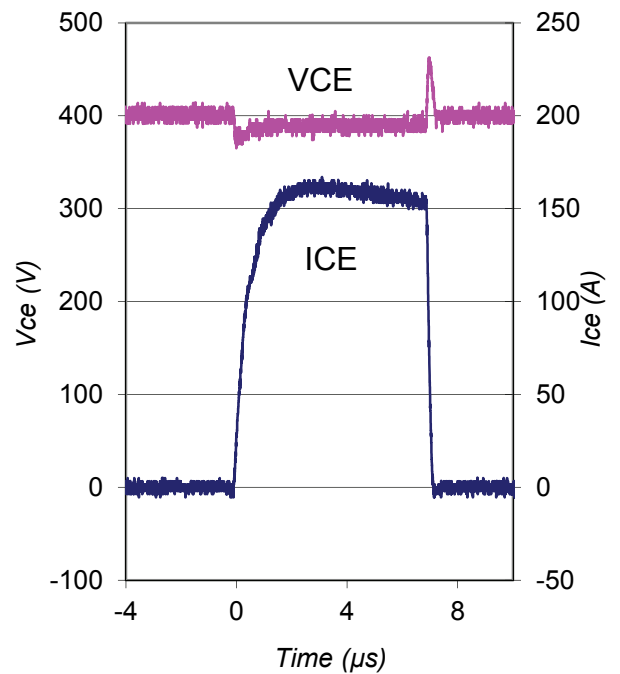
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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



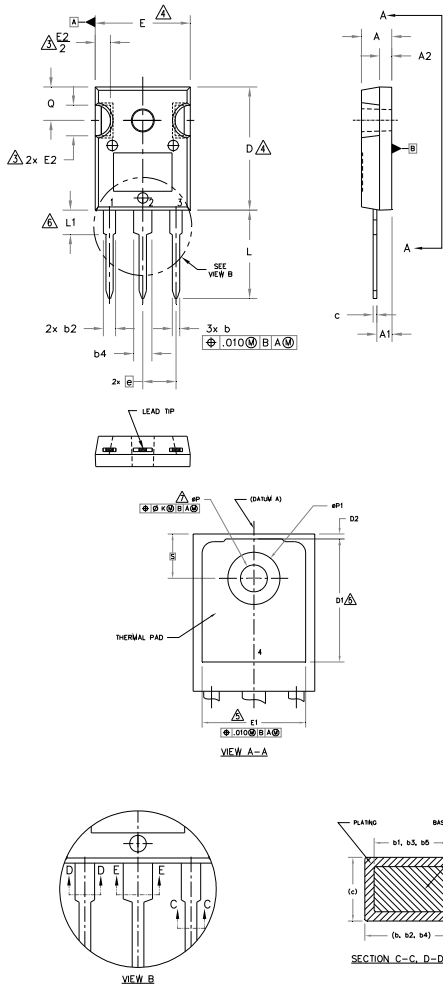
**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



**Fig. WF4** - Typ. S.C. Waveform  
@  $T_J = 150^\circ\text{C}$  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 .
9. DIMENSION "A" HAS TIGHTER TOLERANCE WITH REFERENCE TO 115-0051 POD

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	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
ØP	.140	.144	3.56	3.66	
ØP1	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

**LEAD ASSIGNMENTS**

**HEXFET**

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

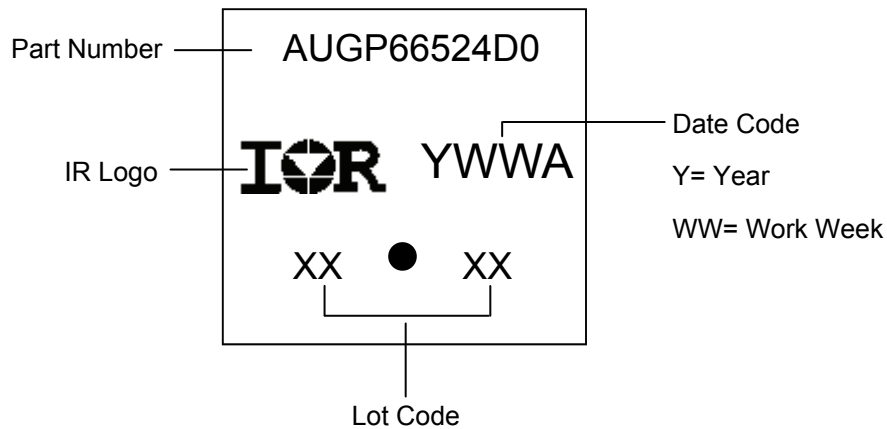
**IGBTs, CoPACK**

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

**DIODES**

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

## TO-247AC Part Marking Information

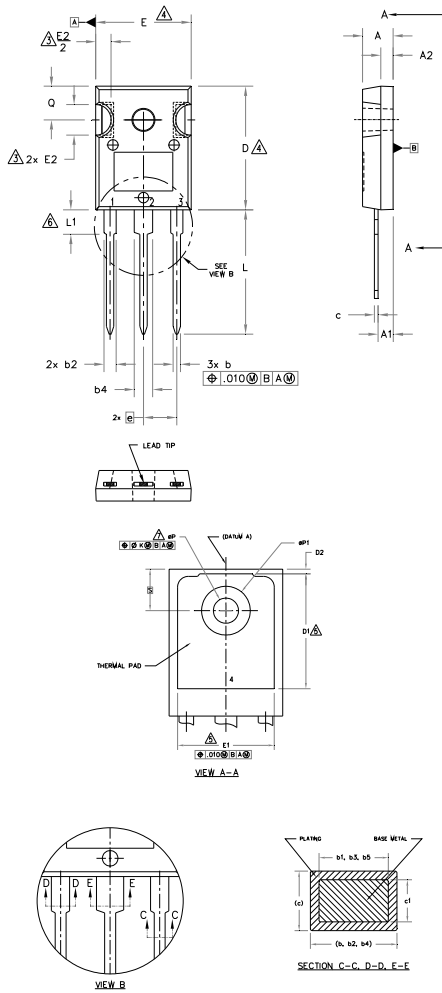


TO-247AC package is not recommended for Surface Mount Application.

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.
9. TIGHTEN DIMENSIONS A, b, b2, b4, c, D, E, E1, L.

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	.041	.051	1.04	1.30	
b1	.039	.053	0.99	1.35	
b2	.080	.094	2.02	2.38	
b3	.065	.092	1.65	2.34	
b4	.118	.134	3.00	3.40	
b5	.102	.133	2.59	3.38	
c	.017	.035	0.44	0.88	
c1	.015	.033	0.38	0.84	
D	.780	.795	19.80	20.20	4
D1	.515	-	13.08	-	5
D2	.020	.053	0.51	1.35	
E	.604	.624	15.35	15.85	4
E1	.530	.544	13.46	13.82	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
Øk	.010		0.25		
L	.791	.823	20.10	20.90	
L1	.146	.169	3.71	4.29	
ØP	.140	.144	3.56	3.66	
ØP1	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

LEAD ASSIGNMENTS

HEXFET

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

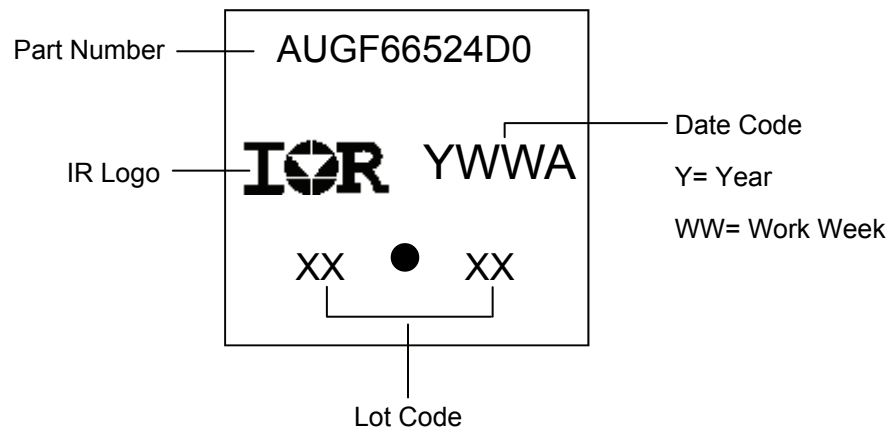
IGBTs, CoPACK

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

DIODES

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

## TO-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>**

<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>†</sup>	
		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	
<b>ESD</b>	Human Body Model	Class H1C(+/- 2000) <sup>††</sup> AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000) <sup>††</sup> AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

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

†† Highest passing voltage.

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For technical support, please contact IR's Technical Assistance Center

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

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