

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

**Features**

- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low Switching Losses
- 5 $\mu$ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for  $I_{LM}$ Ⓞ
- 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

**Applications**

- Air Conditioning Compressor

**Ordering Information**

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRGB4062D1	TO-220	Tube	50	AUIRGB4062D1
AUIRGL4062D1	TO-262	Tube	50	AUIRGL4062D1
AUIRGS4062D1	D2Pak	Tube	50	AUIRGS4062D1
		Tape and Reel Left	800	AUIRGS4062D1TRL
		Tape and Reel Right	800	AUIRGS4062D1TRR

**Absolute Maximum Ratings**

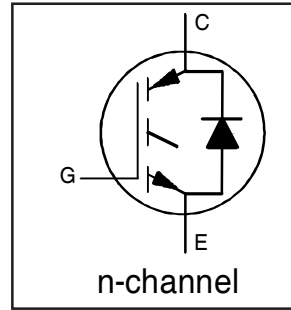
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated 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	59	A
$I_C @ T_C = 100^\circ C$ Continuous Collector Current	39	
$I_{NOMINAL}$ Nominal Current	24	
$I_{CM}$ Pulse Collector Current, $V_{GE} = 15V$	72	
$I_{LM}$ Clamped Inductive Load Current, $V_{GE} = 20V$ Ⓞ	96	
$I_F @ T_C = 25^\circ C$ Diode Continuous Forward Current	59	
$I_F @ T_C = 100^\circ C$ Diode Continuous Forward Current	39	V
$I_{FM}$ Diode Maximum Forward Current Ⓞ	96	
$V_{GE}$ 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	246	W
$P_D @ T_C = 100^\circ C$ Maximum Power Dissipation	123	
$T_J$ Operating Junction and Storage Temperature Range	-55 to +175	°C
Soldering Temperature, for 10 sec. (1.6mm from case)	300	
Mounting Torque, 6-32 or M3 Screw	10 lbf-in (1.1N-m)	

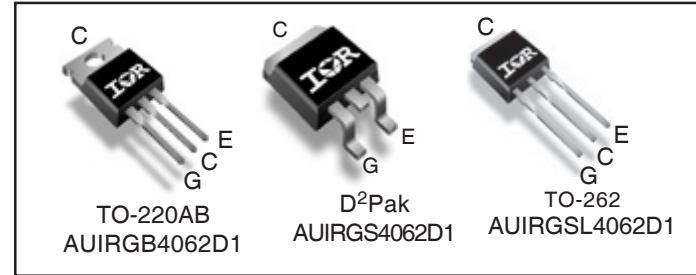
**Thermal Resistance**

Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT) Thermal Resistance Junction-to-Case (IGBT) Ⓞ	—	—	0.61	°C/W
$R_{\theta JC}$ (Diode) Thermal Resistance Junction-to-Case (Diode) Ⓞ	—	—	1.2	
$R_{\theta CS}$ Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.50	—	
$R_{\theta JA}$ Thermal Resistance, Junction-to-Ambient	—	62	—	

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



$V_{CES} = 600V$   
 $I_{C(Nominal)} = 24A$   
 $t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$   
 $V_{CE(ON)} \text{ typ.} = 1.57V$



G	C	E
Gate	Collector	Emitter

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

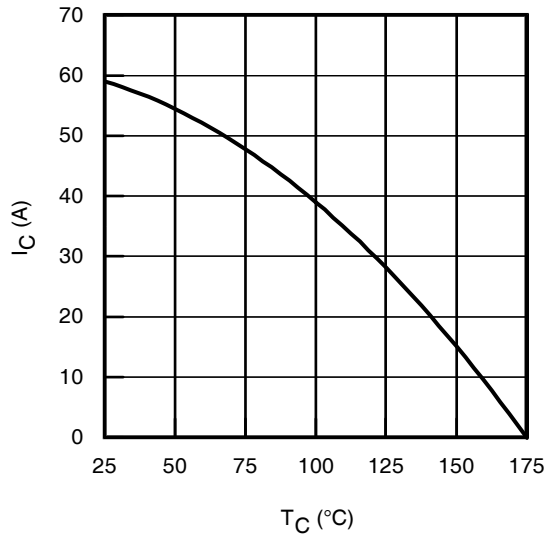
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.3	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 10mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$ )
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.57	1.77	V	$I_C = 24A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	1.87	—		$I_C = 24A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
		—	1.94	—		$I_C = 24A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 700\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-17	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25 $^\circ\text{C}$ - 175 $^\circ\text{C}$ )
$g_{fe}$	Forward Transconductance	—	12	—	S	$V_{CE} = 50V, I_C = 24A, PW = 20\mu s$
$I_{CES}$	Collector-to-Emitter Leakage Current	—	1.0	25	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	3.5	—	mA	$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	1.57	—	V	$I_F = 24A$
		—	1.40	—		$I_F = 19A$
		—	1.47	—		$I_F = 24A, T_J = 175^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

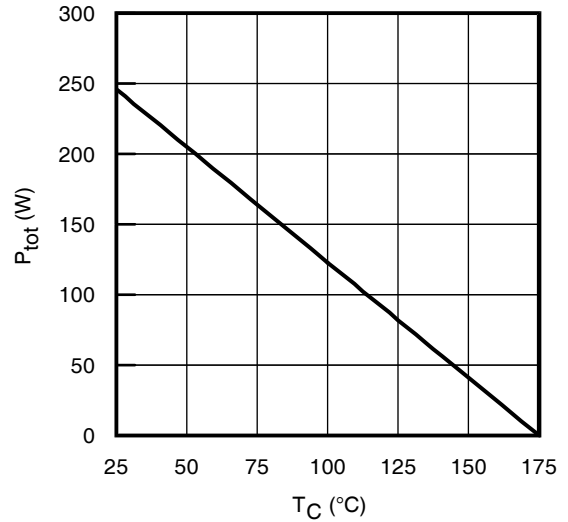
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	51	77	nC	$I_C = 24A$
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	14	21		$V_{GE} = 15V$
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	21	32		$V_{CC} = 400V$
$E_{on}$	Turn-On Switching Loss	—	532	754	$\mu J$	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$
$E_{off}$	Turn-Off Switching Loss	—	311	526		$R_G = 10\Omega, L = 210\mu H, T_J = 25^\circ\text{C}$
$E_{total}$	Total Switching Loss	—	843	1280		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	19	36	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$
$t_r$	Rise time	—	24	41		$R_G = 10\Omega, L = 210\mu H, T_J = 25^\circ\text{C}$
$t_{d(off)}$	Turn-Off delay time	—	90	109		
$t_f$	Fall time	—	23	40		
$E_{on}$	Turn-On Switching Loss	—	726	—		$\mu J$
$E_{off}$	Turn-Off Switching Loss	—	549	—	$R_G = 10\Omega, L = 210\mu H, T_J = 175^\circ\text{C}$ ③	
$E_{total}$	Total Switching Loss	—	1275	—	Energy losses include tail & diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	12	—	ns	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$
$t_r$	Rise time	—	23	—		$R_G = 10\Omega, L = 200\mu H, L_S = 150nH$
$t_{d(off)}$	Turn-Off delay time	—	92	—		$T_J = 175^\circ\text{C}$
$t_f$	Fall time	—	84	—		
$C_{ies}$	Input Capacitance	—	1487	—	pF	$V_{GE} = 0V$
$C_{oes}$	Output Capacitance	—	118	—		$V_{CC} = 30V$
$C_{res}$	Reverse Transfer Capacitance	—	44	—		$f = 1.0MHz$
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	5	—	—	$\mu s$	$V_{CC} = 400V, V_p \leq 600V$ $R_G = 10\Omega, V_{GE} = +15V$ to 0V
$E_{rec}$	Reverse Recovery Energy of the Diode	—	773	—	$\mu J$	$T_J = 175^\circ\text{C}$
$t_{rr}$	Diode Reverse Recovery Time	—	102	—	ns	$V_{CC} = 400V, I_F = 24A$
$I_{rr}$	Peak Reverse Recovery Current	—	32	—	A	$V_{GE} = 15V, R_G = 10\Omega, L = 210\mu H$

**Notes:**

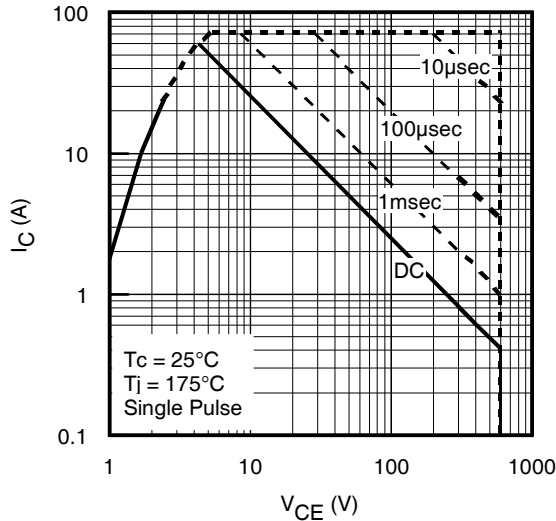
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 210\mu H, R_G = 50\Omega$ .
- ② Pulse width limited by max. junction temperature.
- ③  $R_\theta$  is measured at  $T_J$  of approximately 90 $^\circ\text{C}$ .
- ④ Maximum limits are based on statistical sample size characterization.



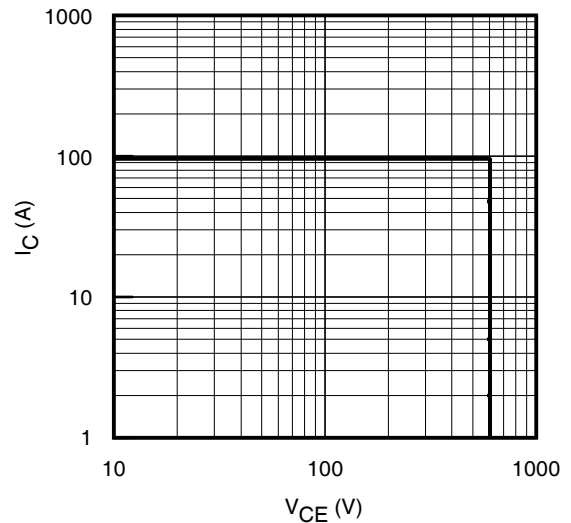
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



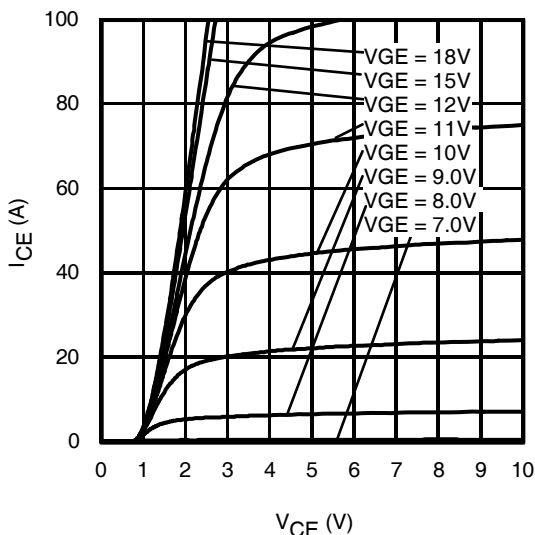
**Fig. 2** - Power Dissipation vs. Case Temperature



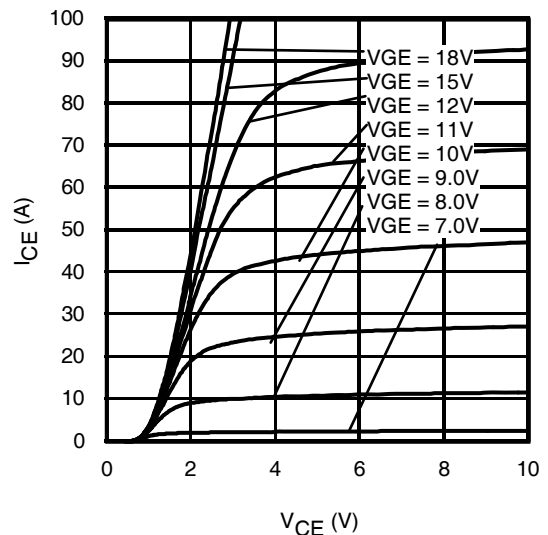
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ,  $T_J \leq 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



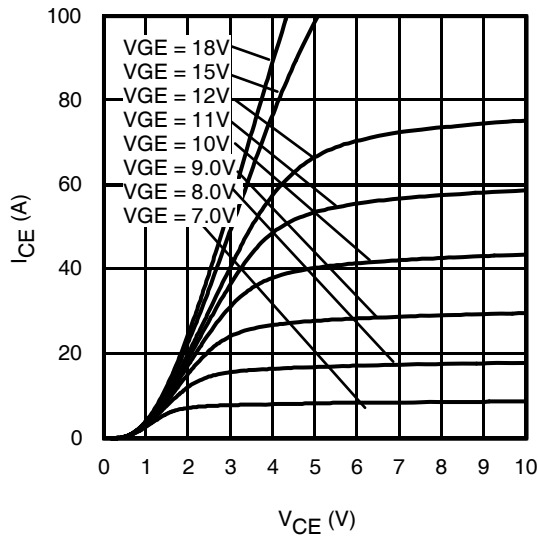
**Fig. 4** - Reverse Bias SOA  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



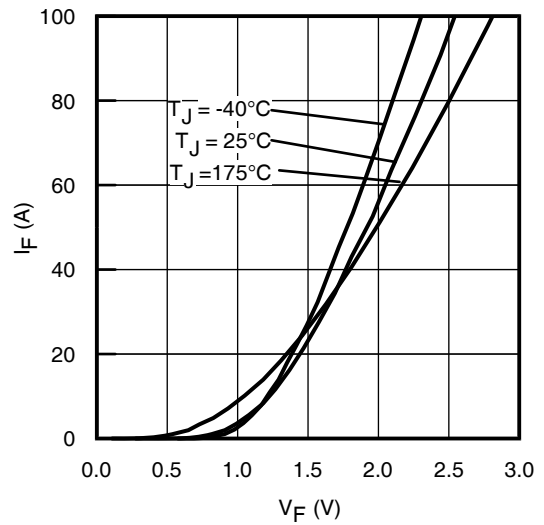
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



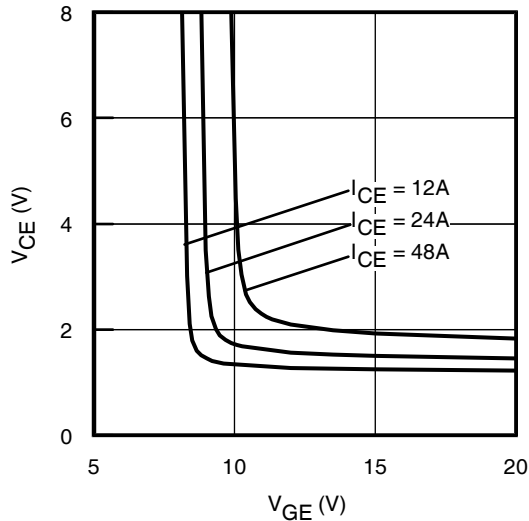
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



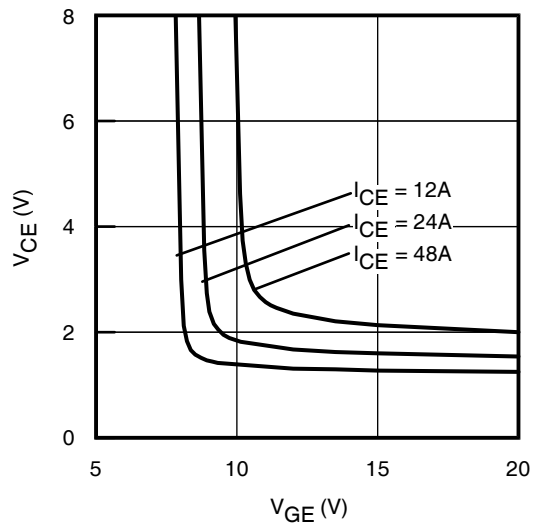
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



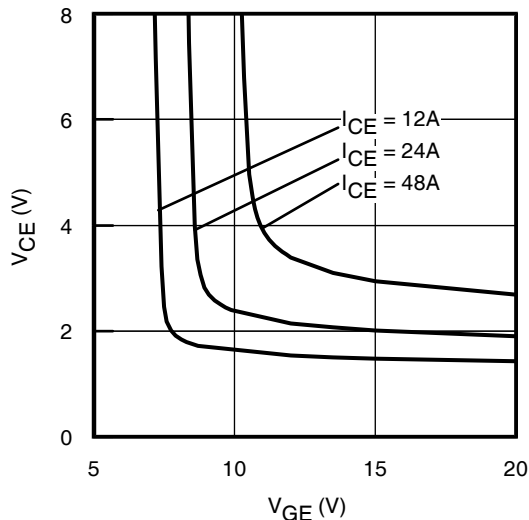
**Fig. 8 - Typ. Diode Forward Characteristics**  
 $t_p = 20\mu\text{s}$



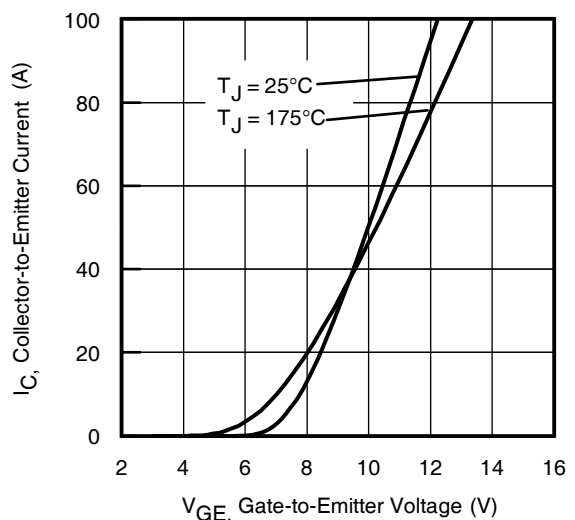
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



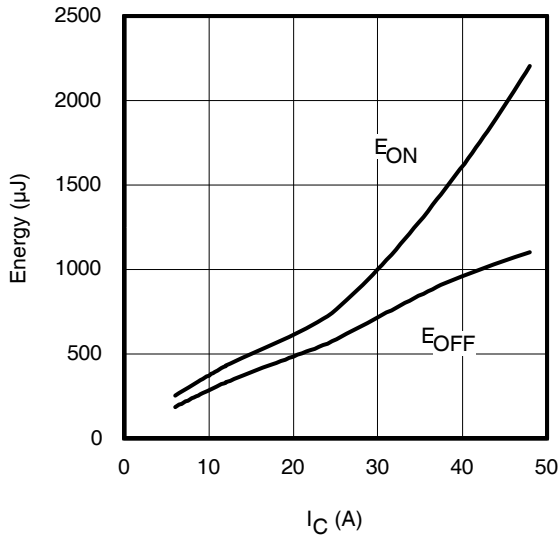
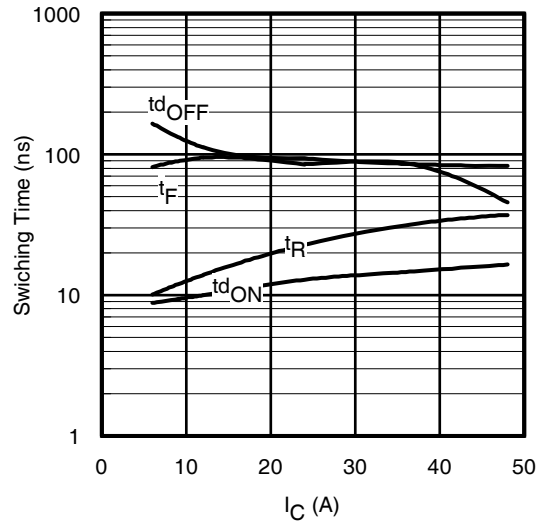
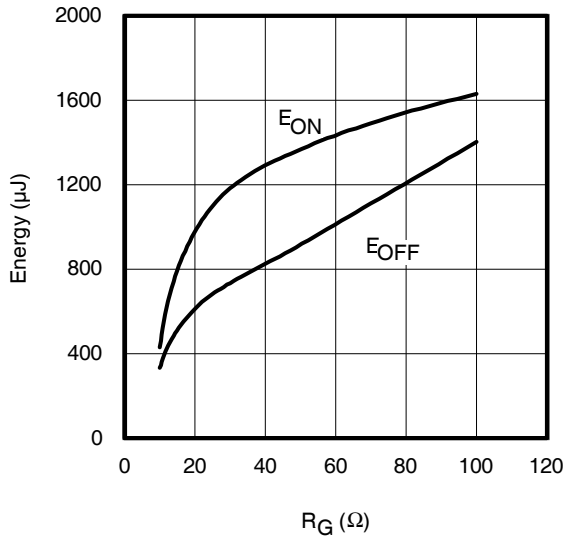
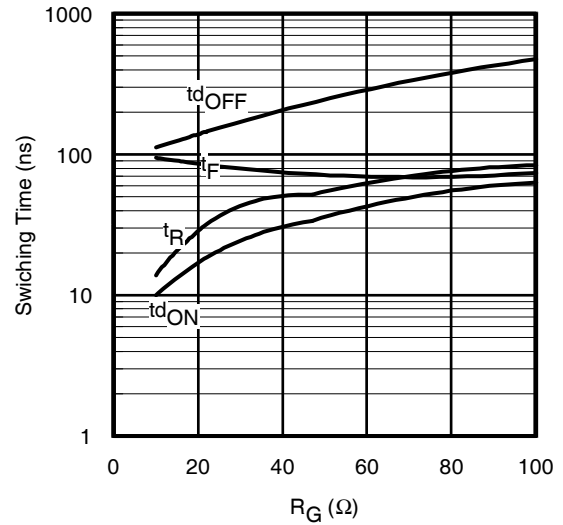
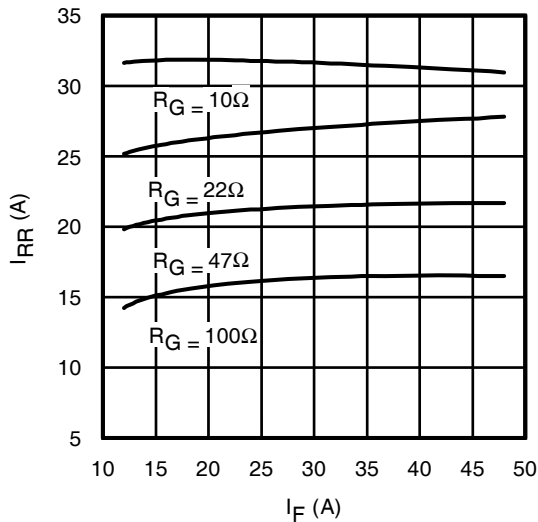
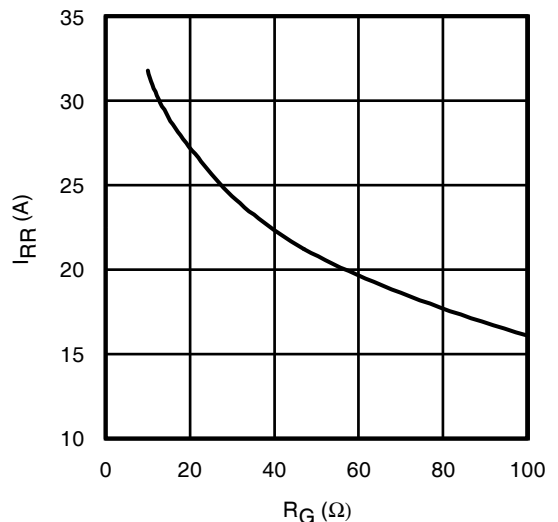
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$

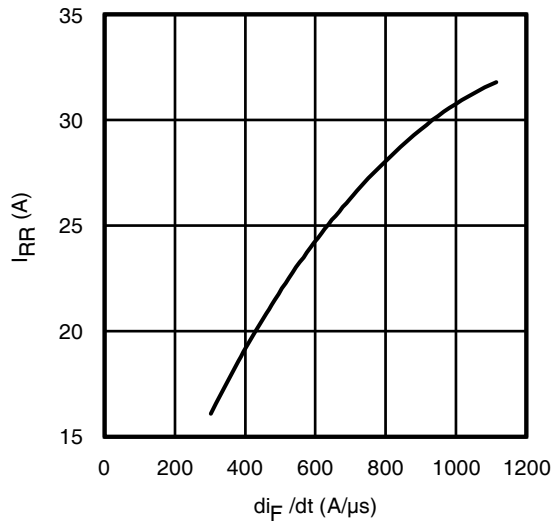


**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 175^\circ\text{C}$

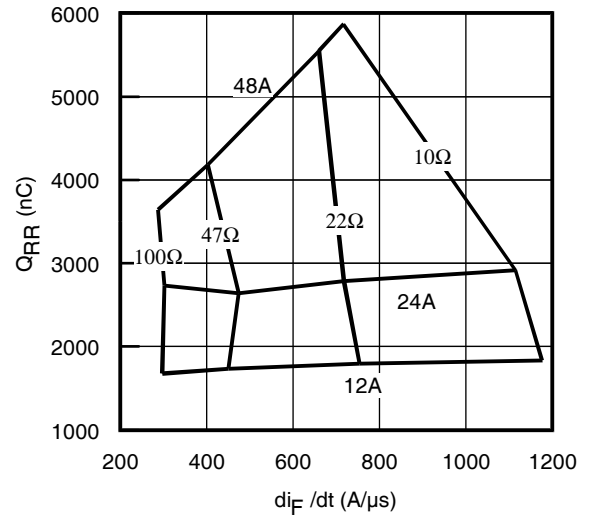


**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50\text{V}$ ;  $t_p = 20\mu\text{s}$

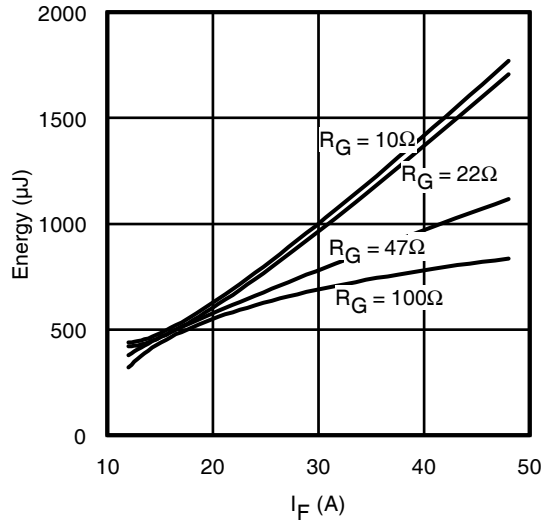

**Fig. 13 - Typ. Energy Loss vs.  $I_C$** 
 $T_J = 175^\circ\text{C}; L = 210\mu\text{H}; V_{CE} = 400\text{V}, R_G = 10\Omega; V_{GE} = 15\text{V}$ 

**Fig. 14 - Typ. Switching Time vs.  $I_C$** 
 $T_J = 175^\circ\text{C}; L = 210\mu\text{H}; V_{CE} = 400\text{V}, R_G = 10\Omega; V_{GE} = 15\text{V}$ 

**Fig. 15 - Typ. Energy Loss vs.  $R_G$** 
 $T_J = 175^\circ\text{C}; L = 210\mu\text{H}; V_{CE} = 400\text{V}, I_{CE} = 24\text{A}; V_{GE} = 15\text{V}$ 

**Fig. 16 - Typ. Switching Time vs.  $R_G$** 
 $T_J = 175^\circ\text{C}; L = 210\mu\text{H}; V_{CE} = 400\text{V}, I_{CE} = 24\text{A}; V_{GE} = 15\text{V}$ 

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

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



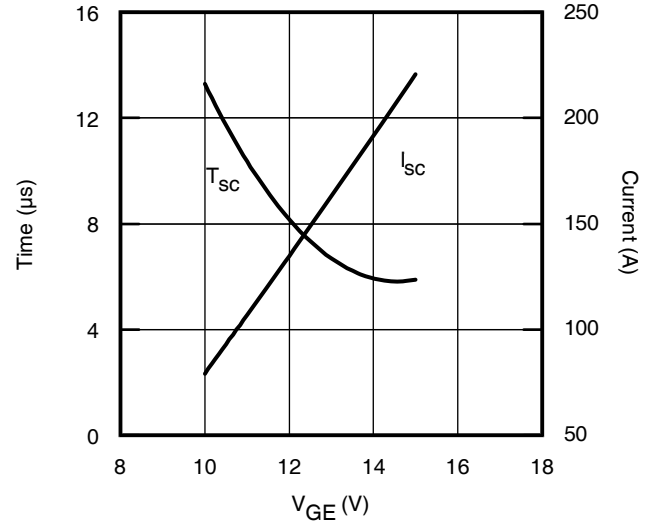
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $I_F = 24A$ ;  $T_J = 175^\circ C$



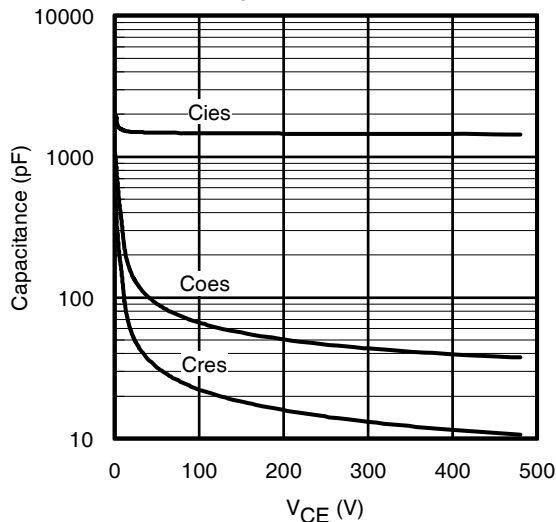
**Fig. 20** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $T_J = 175^\circ C$



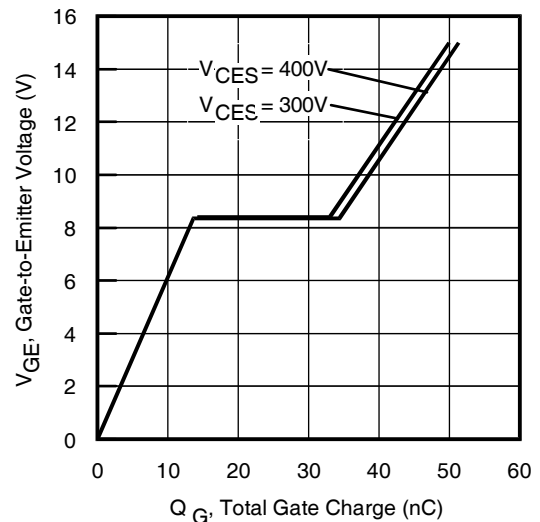
**Fig. 21** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ C$



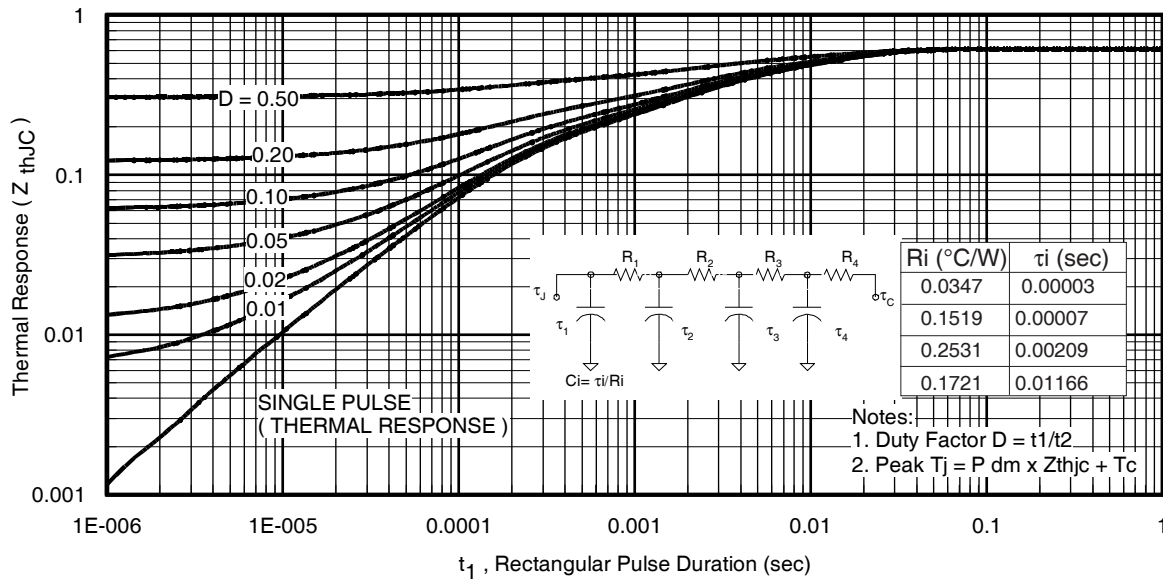
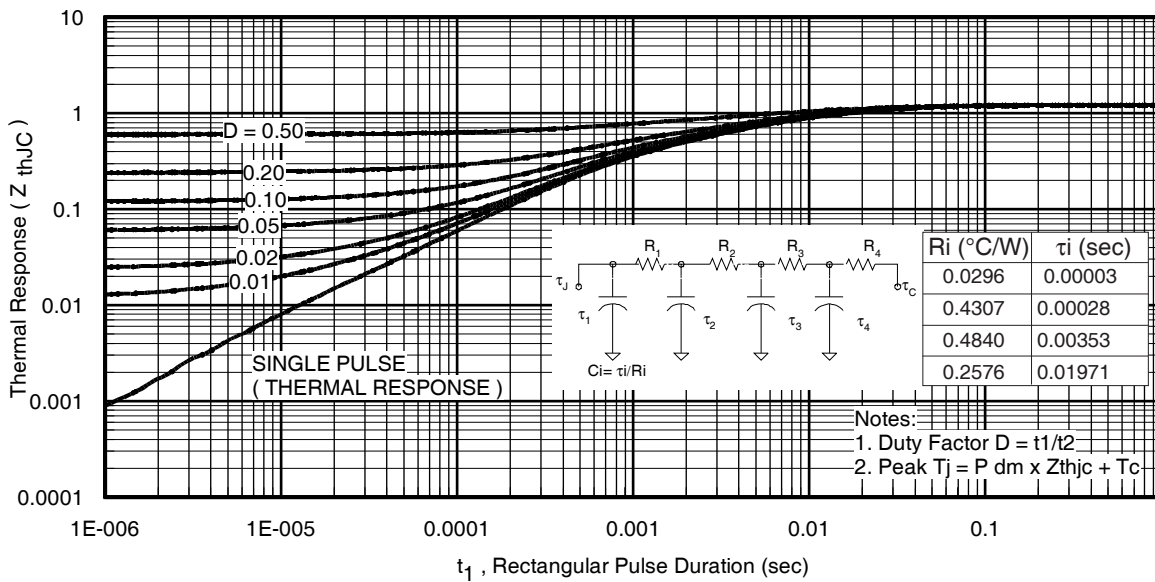
**Fig. 22** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400V$ ;  $T_C = 25^\circ C$

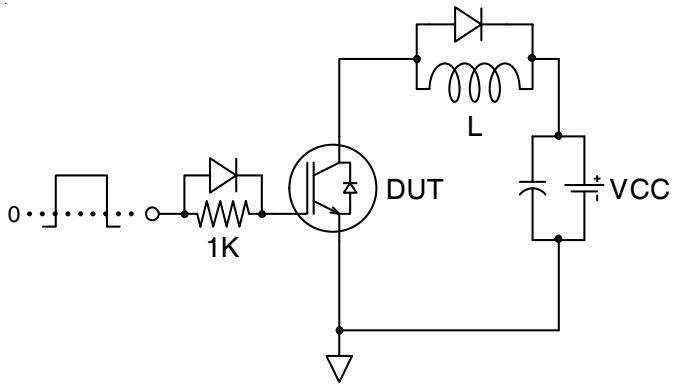
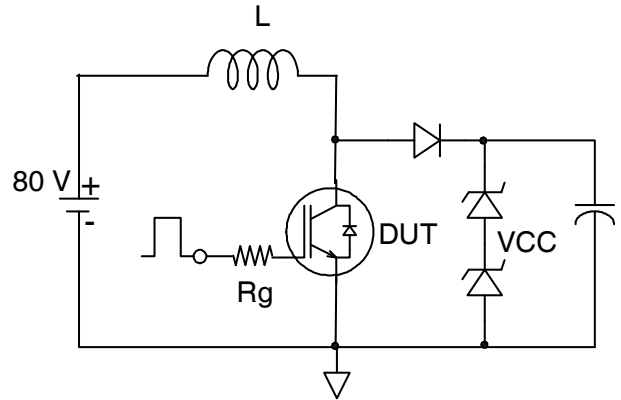
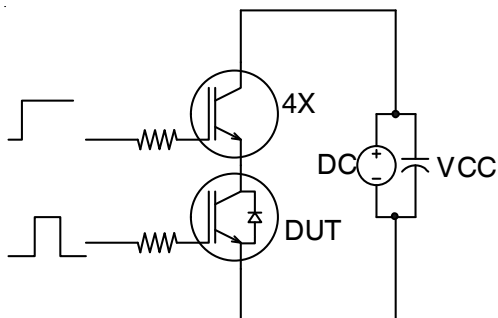
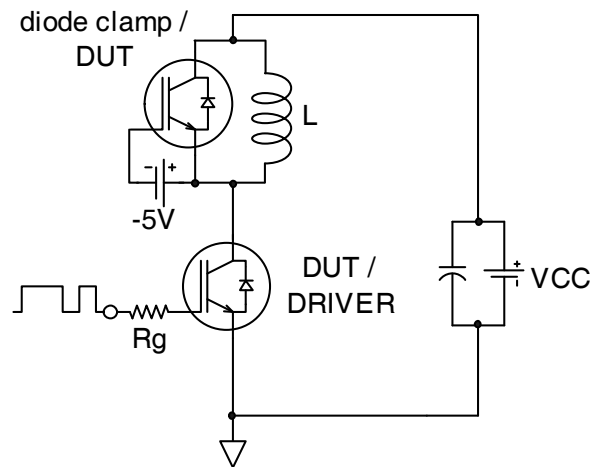
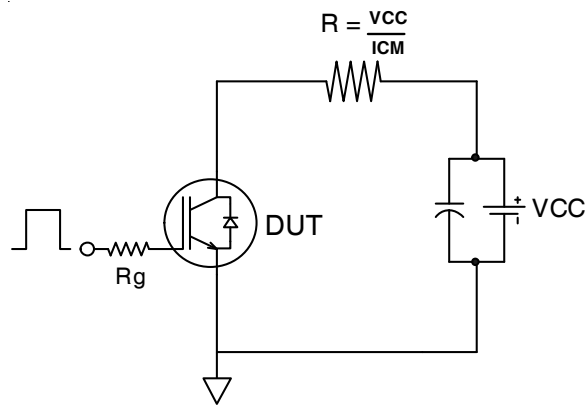


**Fig. 23** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$

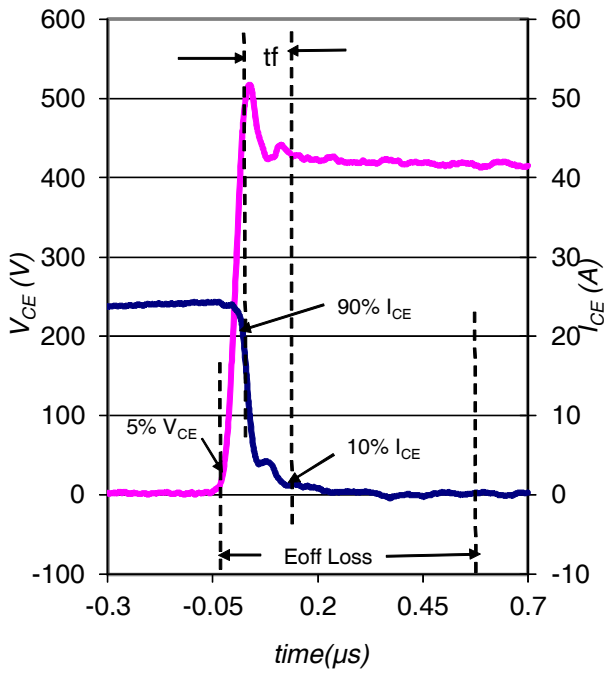


**Fig. 24** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 24A$ ;  $L = 585\mu H$

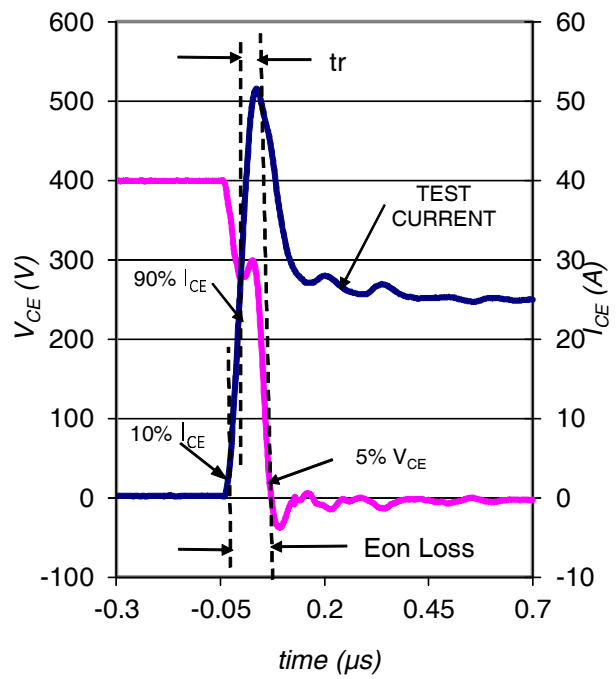

**Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)**

**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**

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

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

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

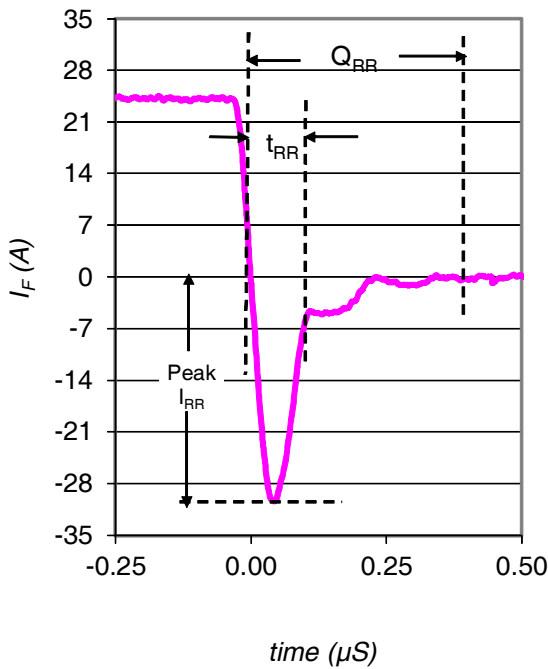




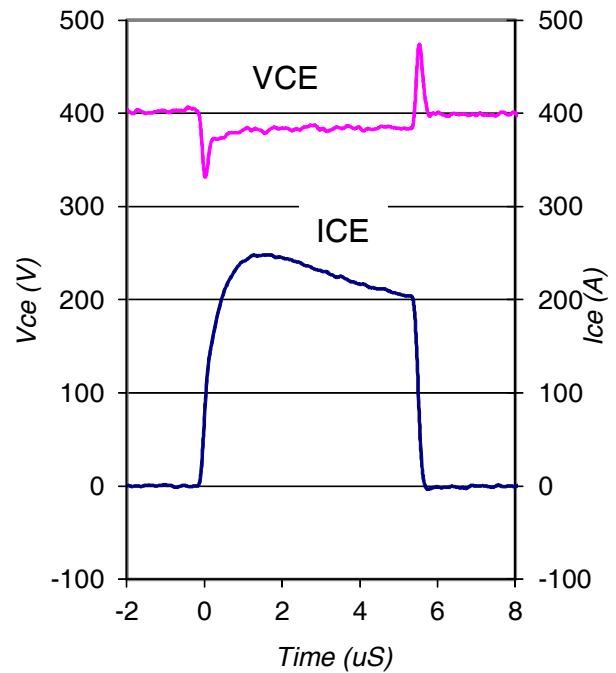
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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



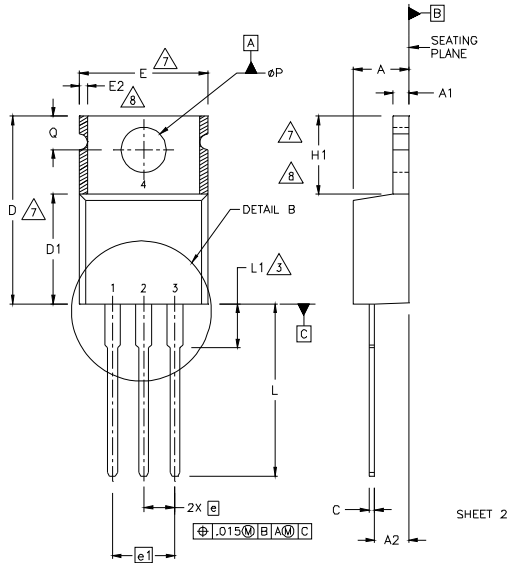
**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 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 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
- 6 CONTROLLING DIMENSION : INCHES.
- 7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
- 8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.

**LEAD ASSIGNMENTS**

- HEXFET**
- 1.- GATE
  - 2.- DRAIN
  - 3.- SOURCE

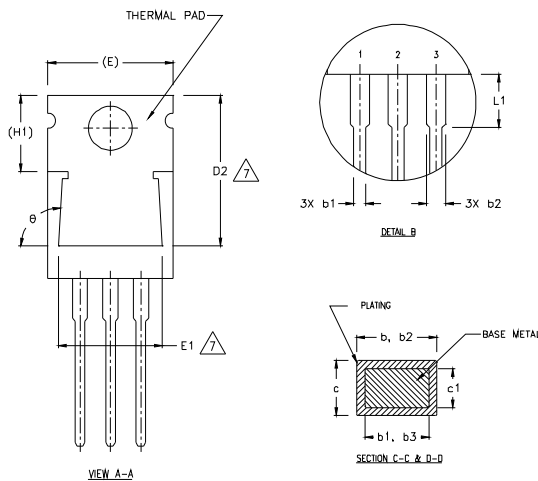
**IGBTs, CoPACK**

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

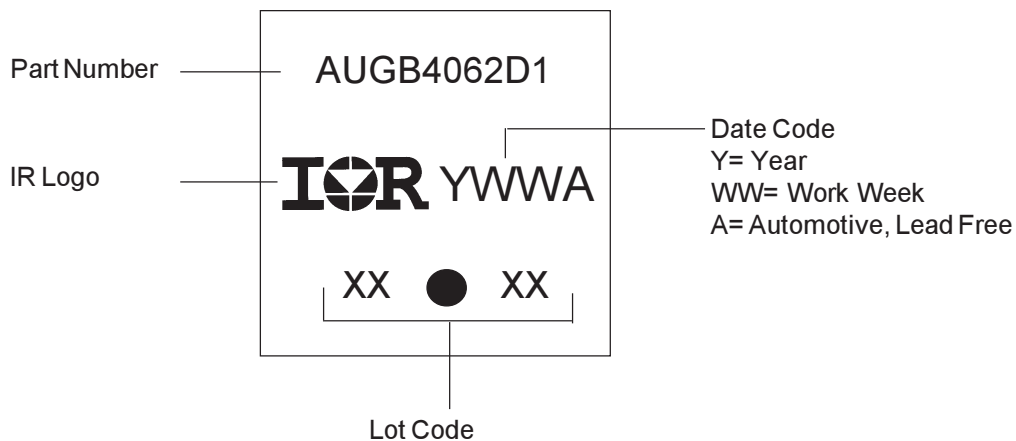
**DIODES**

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

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	5
b2	1.15	1.77	.045	.070	
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	12.19	12.88	.480	.507	7
E	9.66	10.66	.380	.420	4,7
E1	8.38	8.89	.330	.350	7
e	2.54 BSC		.100 BSC		
e1	5.08		.200 BSC		
H1	5.85	6.55	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	-	6.35	-	.250	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	
ø	90°-93°		90°-93°		



## TO-220AB Part Marking Information

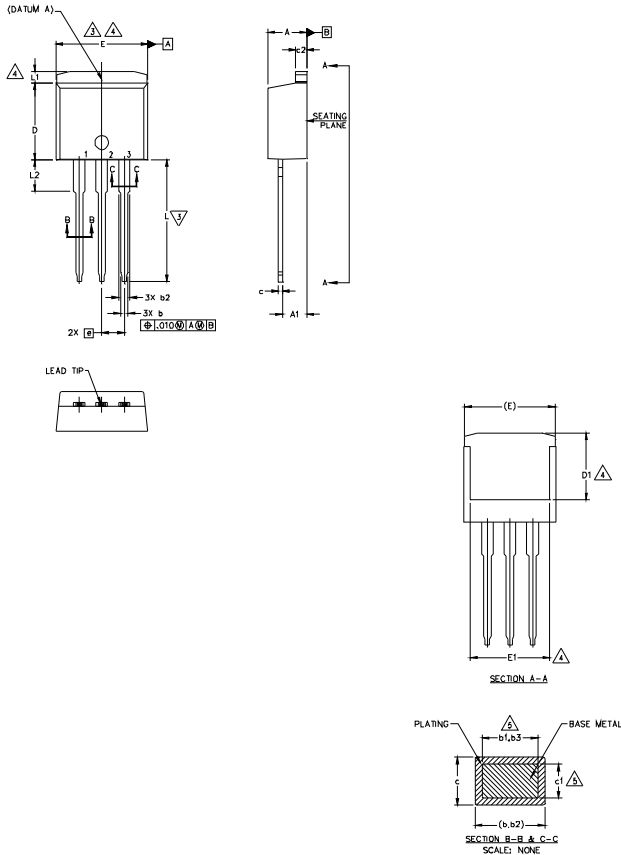


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>



## TO-262 Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7. OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.) AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	3.02	.080	.119	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	-	.270	-	4
E	9.65	10.67	.380	.420	3,4
E1	6.22	-	.245	-	4
e	2.54 BSC		.100 BSC		
L	13.46	14.10	.530	.555	
L1	-	1.65	-	.065	4
L2	3.56	3.71	.140	.146	

LEAD ASSIGNMENTS

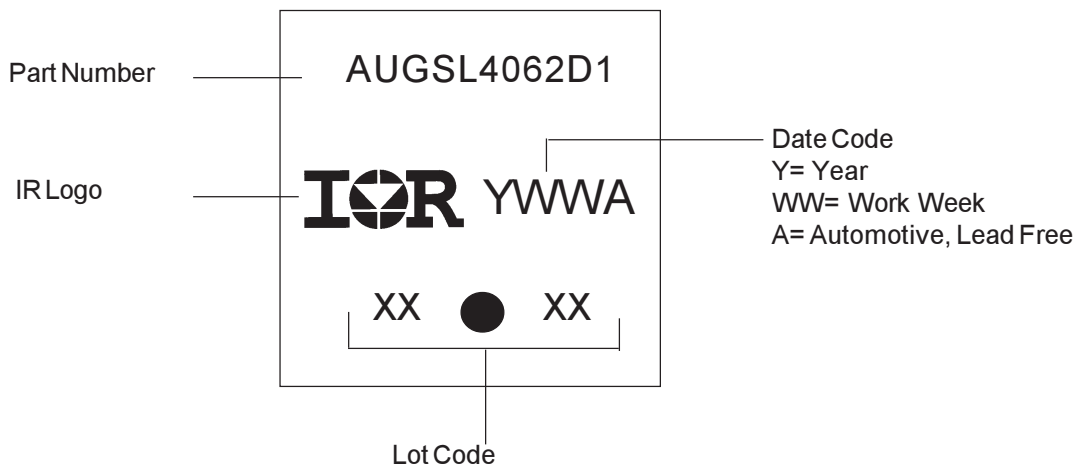
HEXFET

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

IGBTs, CoPACK

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

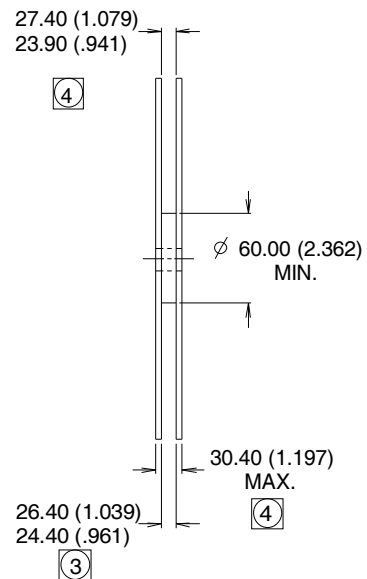
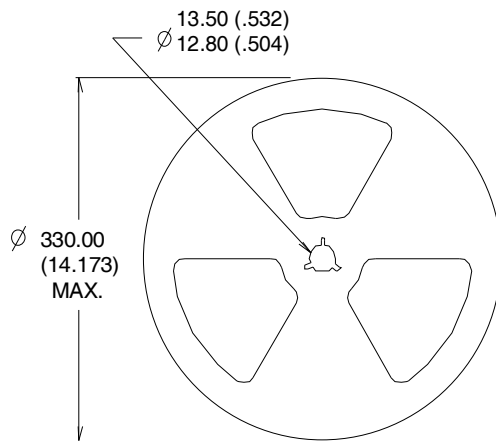
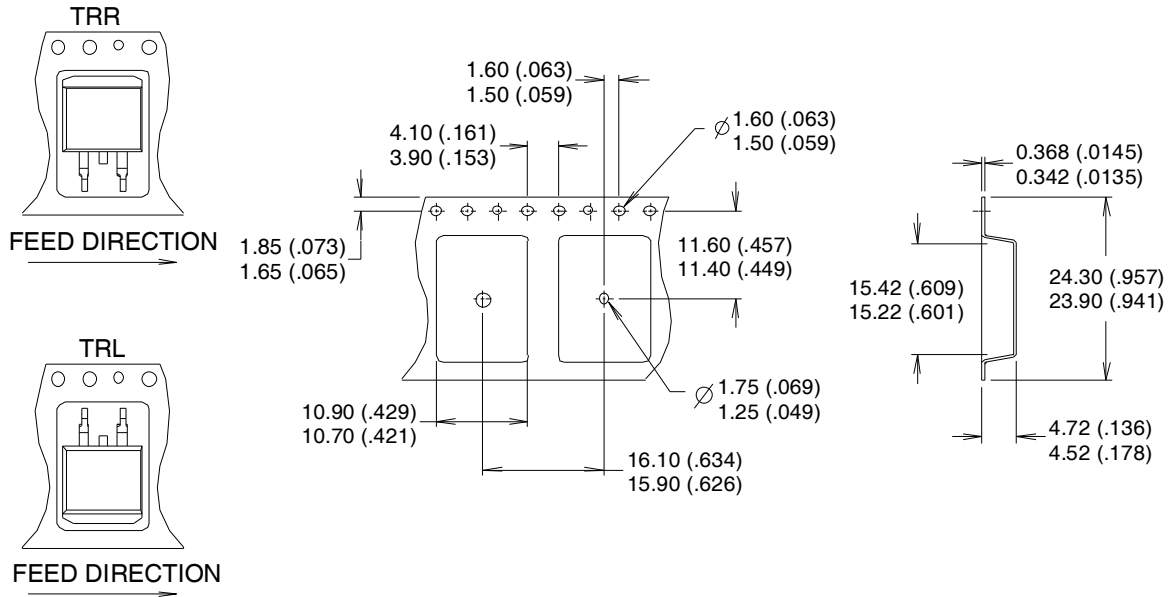
## TO-262 Part Marking Information



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

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



**NOTES :**

1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
- ③ DIMENSION MEASURED @ HUB.
- ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

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

<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>††</sup>	
		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>		3L-TO-220	N/A
		3L-TO-262	
		3L-D2 PAK	MSL1
<b>ESD</b>	Machine Model	Class M4 (+/- 700V ) (per AEC-Q101-002)	
	Human Body Model	Class H1C (+/- 2000V ) (per AEC-Q101-001)	
	Charged Device Model	Class C5 (+/- 2000V ) (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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For technical support, please contact IR’s Technical Assistance Center

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

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