

COOLiRIGBT™

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

$$V_{CES} = 600V$$

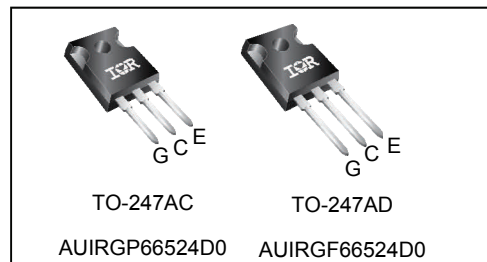
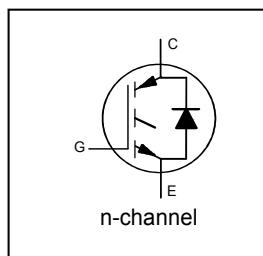
$$I_{NOMINAL} = 24A$$

$$T_{sc} \geq 6\mu s, T_{J(MAX)} = 175^{\circ}C$$

$$V_{CE(ON)} \text{ typ.} = 1.60V$$

Applications

- Air Conditioning Compressor
- Auxiliary Motor Drive



G	C	E
Gate	Collector	Emitter

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 μs SCSCOA 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 $25^{\circ}C$, 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	V
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	Operating Junction and	-55 to +175	$^{\circ}C$
T_{STG}	Storage Temperature Range		
	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)
gfe	Forward Transconductance	—	21	—	S	$V_{CE} = 50V, I_C = 24A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.1	50	μA	$V_{GE} = 0V, V_{CE} = 600V$
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	—	—	±100	nA	$V_{GE} = \pm 20V$

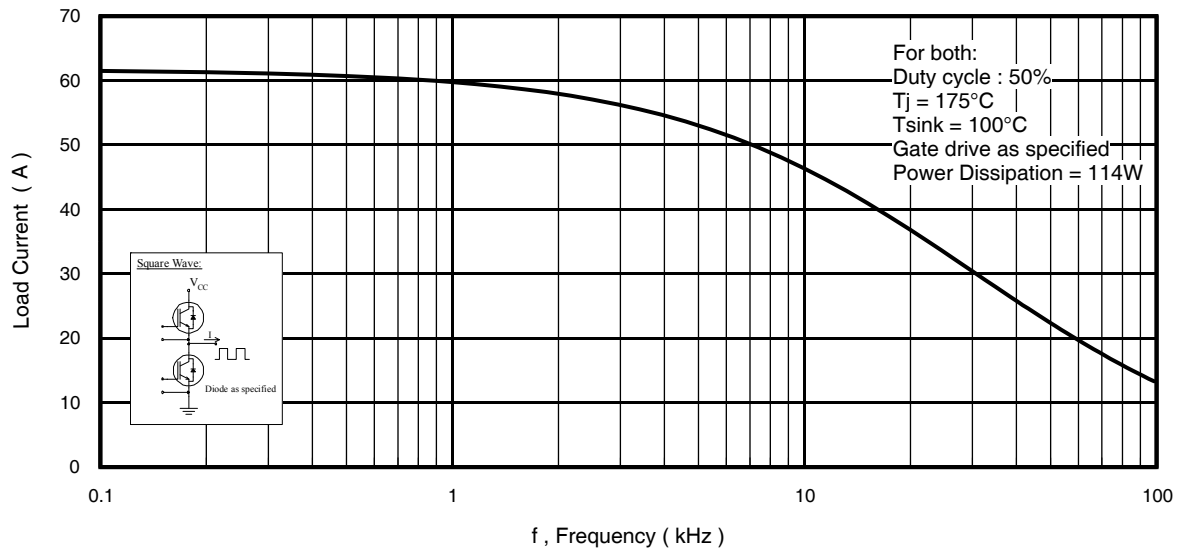
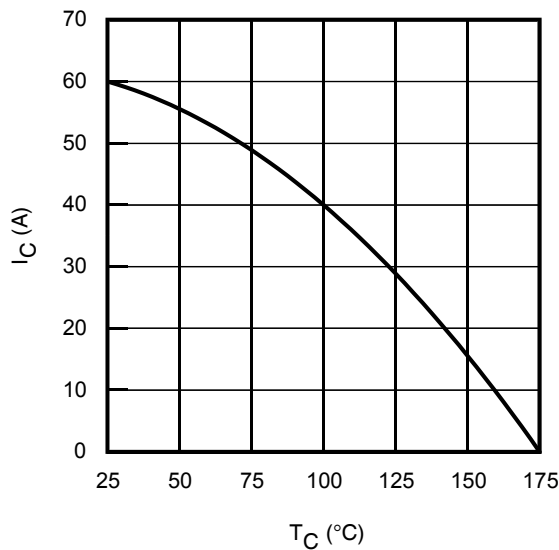
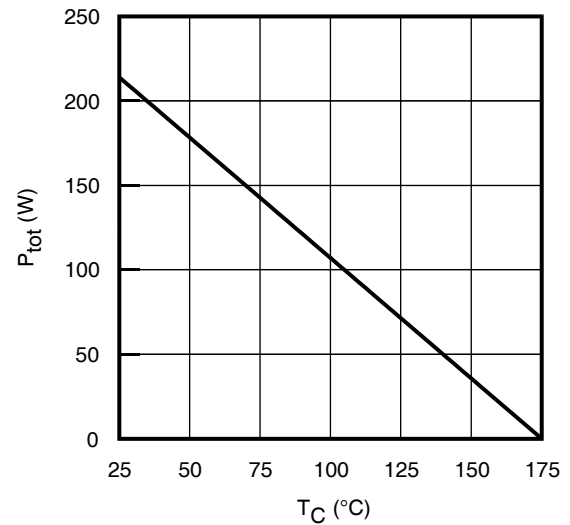
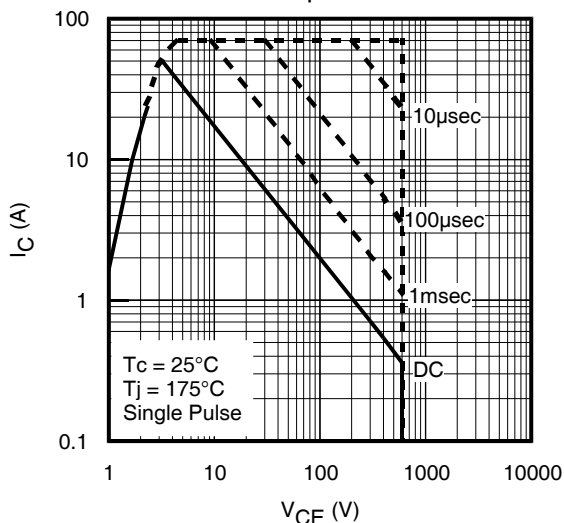
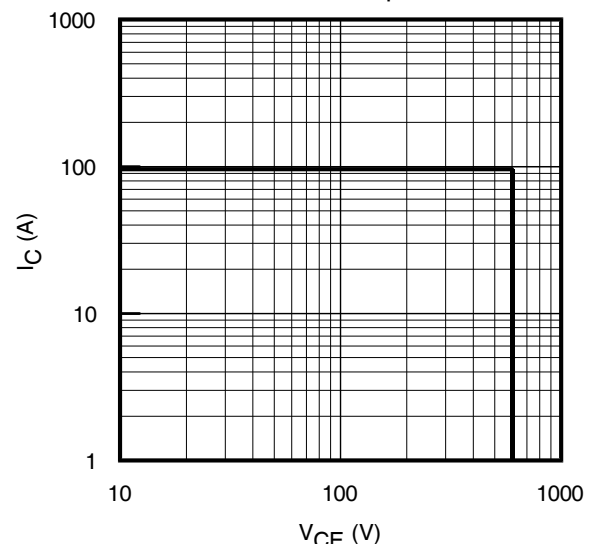
Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	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	μJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 25^\circ\text{C}$ 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	μJ	$I_C = 24A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 740\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery
E_{on}	Turn-On Switching Loss	—	1280	—		
E_{off}	Turn-Off Switching Loss	—	550	—		
E_{total}	Total Switching Loss	—	1830	—	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
$t_{d(on)}$	Turn-On delay time	—	30	—		
t_r	Rise time	—	25	—		
$t_{d(off)}$	Turn-Off delay time	—	100	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
t_f	Fall time	—	95	—		
C_{ies}	Input Capacitance	—	1460	—		
C_{oes}	Output Capacitance	—	120	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
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	—	—	μs	$T_J = 150^\circ\text{C}, V_{CC} = 400V, V_p \leq 600V$ $R_G = 50\Omega, V_{GE} = +15V$ to 0V
E_{rec}	Reverse Recovery Energy of the Diode	—	570	—	μJ	$T_J = 175^\circ\text{C}$
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_{θ} 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
 $T_J = 175^{\circ}\text{C}$; $V_{GE} = 20\text{V}$

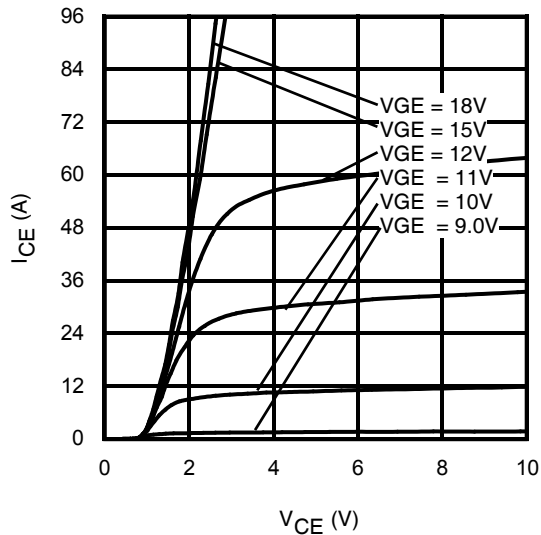


Fig. 6 - - Typ. IGBT Output Characteristics
T_J = -40°C; t_p = 20μs

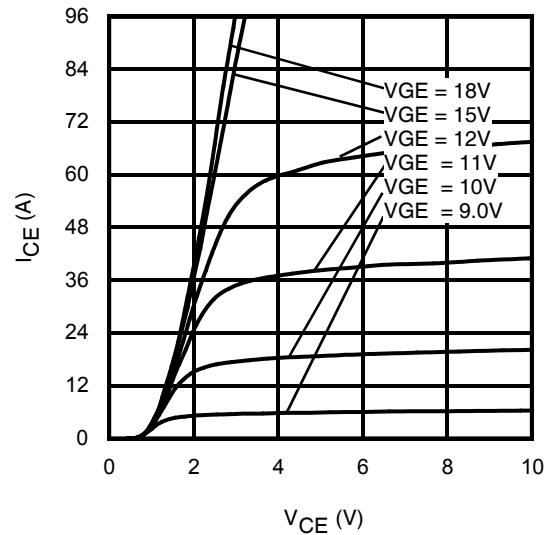


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 25°C; t_p = 20μs

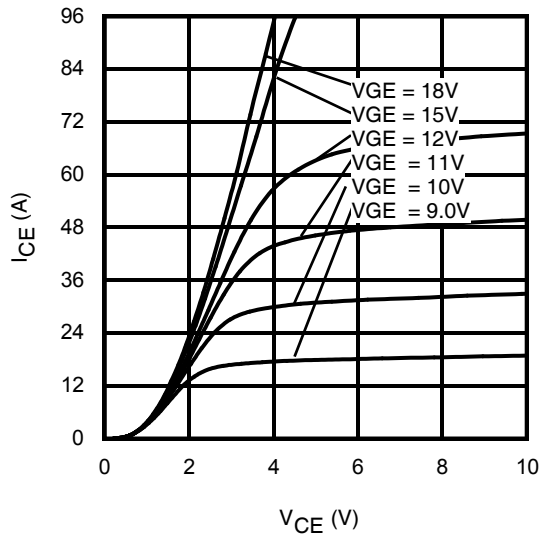


Fig. 8 - Typ. IGBT Output Characteristics
T_J = 175°C; t_p = 20μs

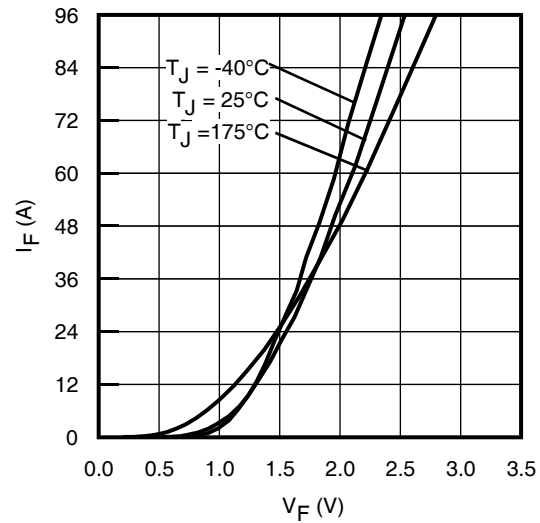


Fig. 9 - Typ. Diode Forward Characteristics
t_p = 20μs

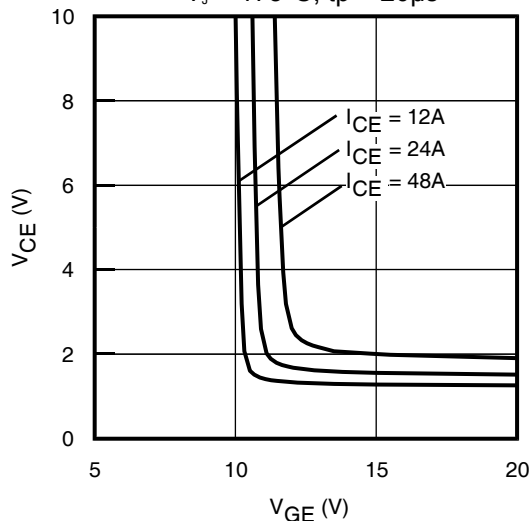


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

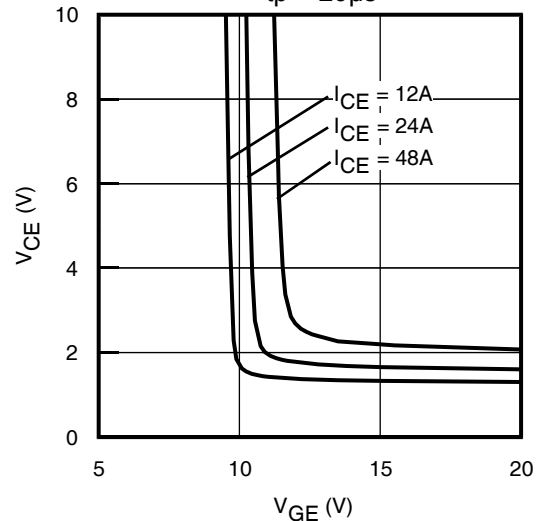


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

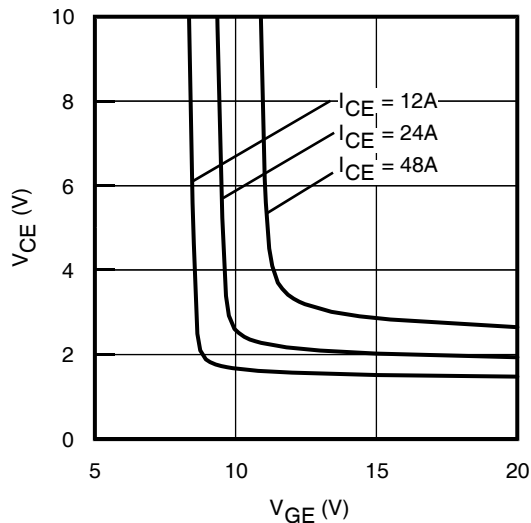


Fig. 12 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

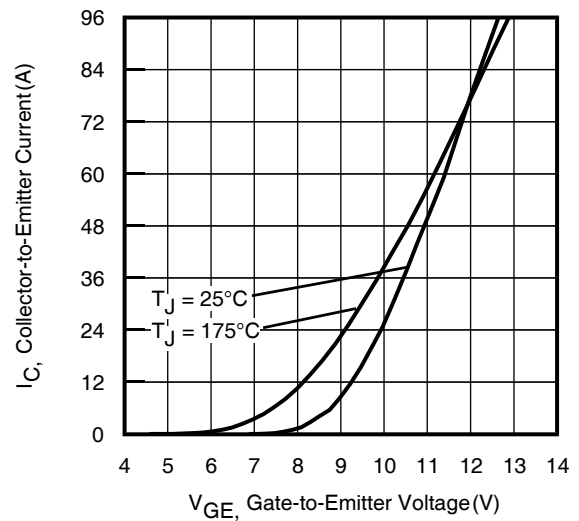


Fig. 13 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

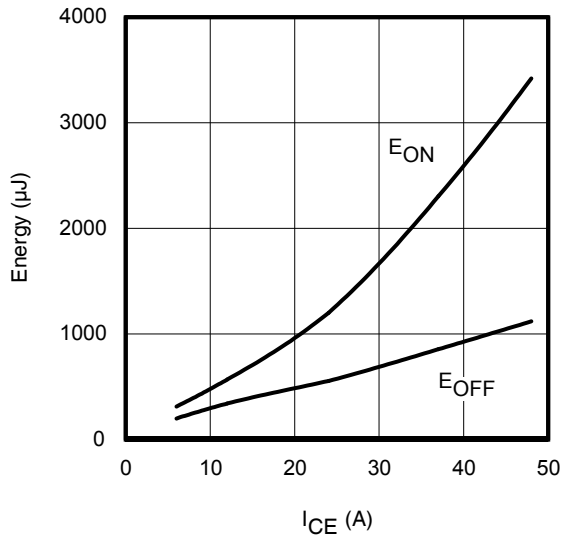


Fig. 14 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 740\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

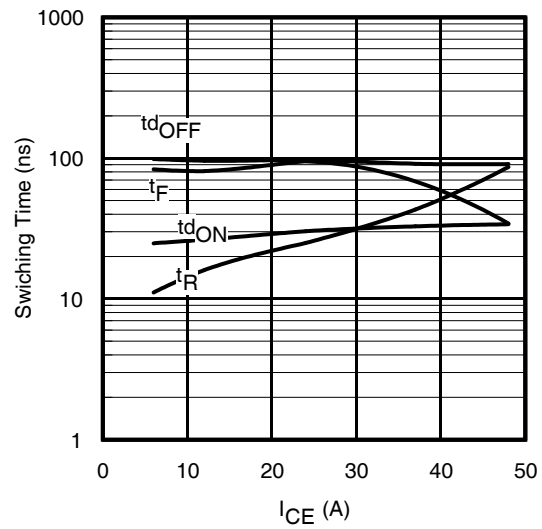


Fig. 15 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 740\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

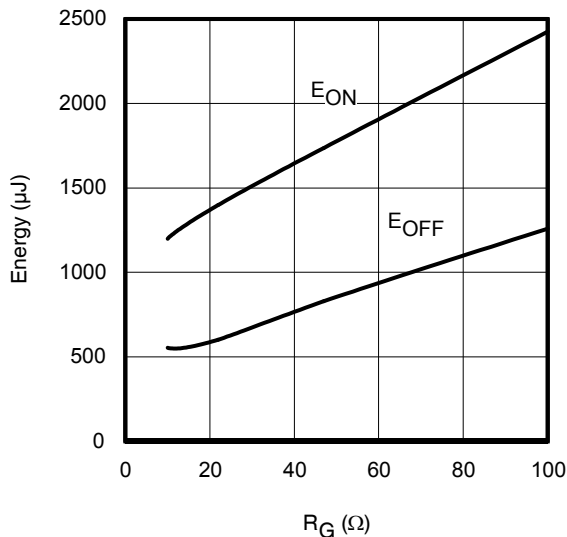


Fig. 16 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 740\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 24\text{A}$; $V_{GE} = 15\text{V}$

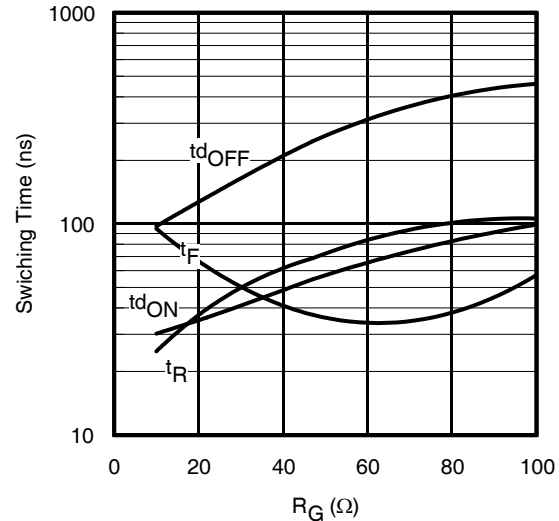


Fig. 17 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 740\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 24\text{A}$; $V_{GE} = 15\text{V}$

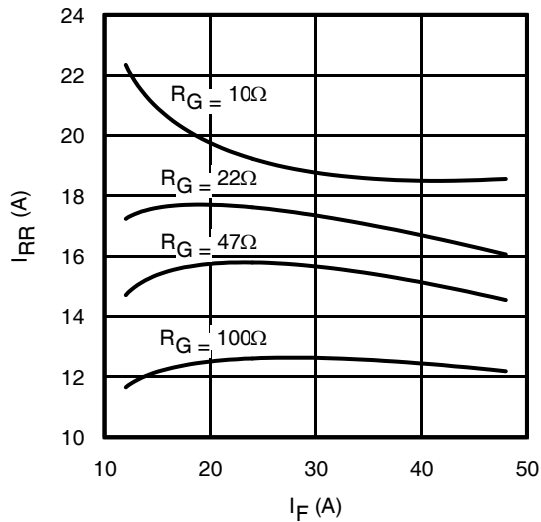


Fig. 18 - Typ. Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

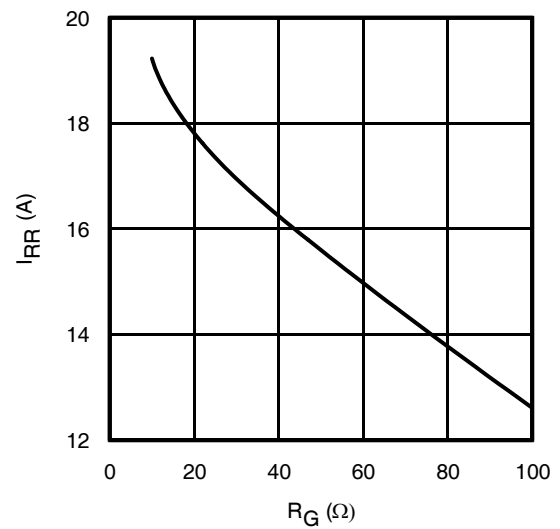


Fig. 19 - Typ. Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$

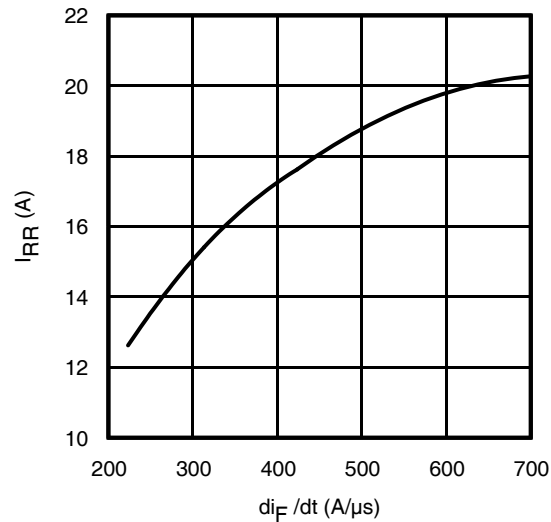


Fig. 20 - Typ. Diode I_{RR} vs. diF/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $I_F = 24\text{A}$; $T_J = 175^\circ\text{C}$

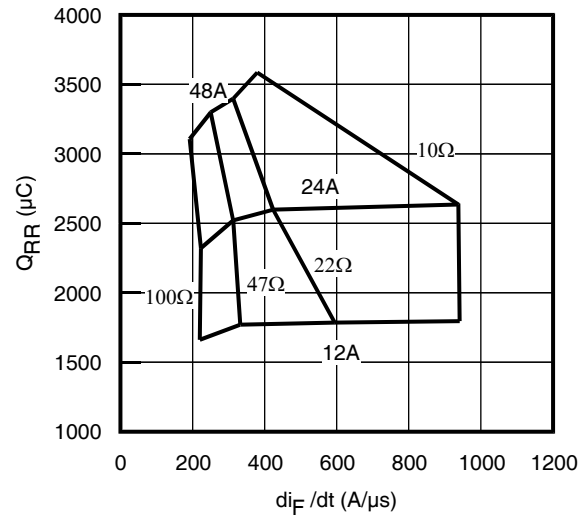


Fig. 21 - Typ. Diode Q_{RR} vs. diF/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 175^\circ\text{C}$

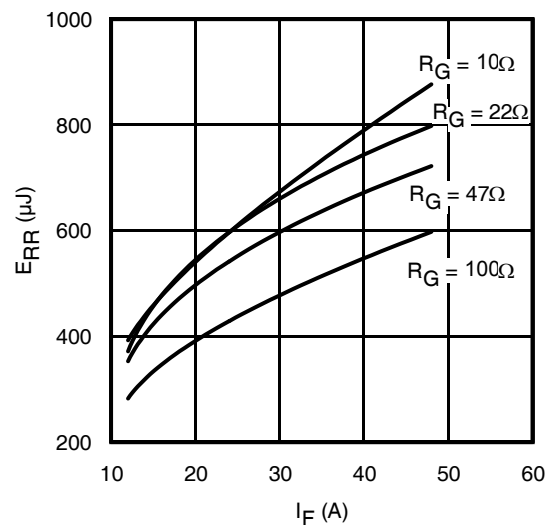


Fig. 22 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

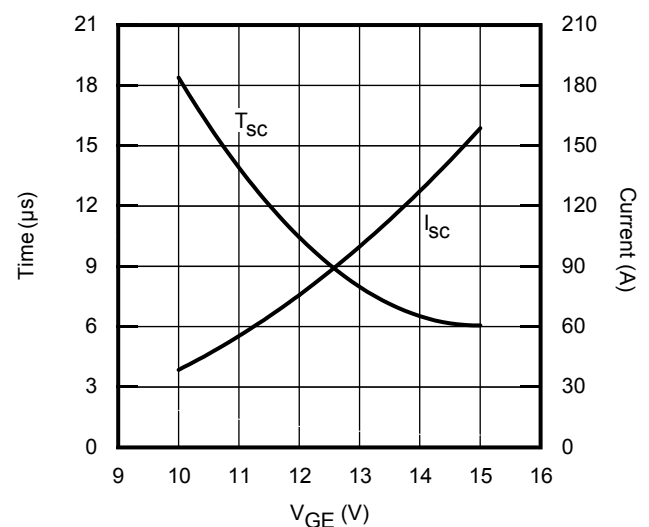


Fig. 23 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400\text{V}$; $T_C = 150^\circ\text{C}$

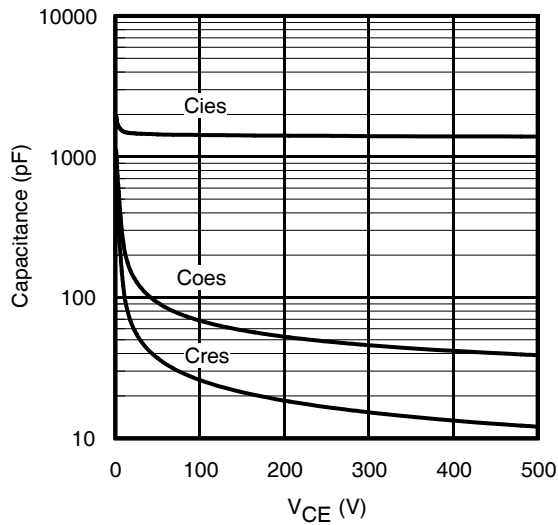


Fig. 24 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

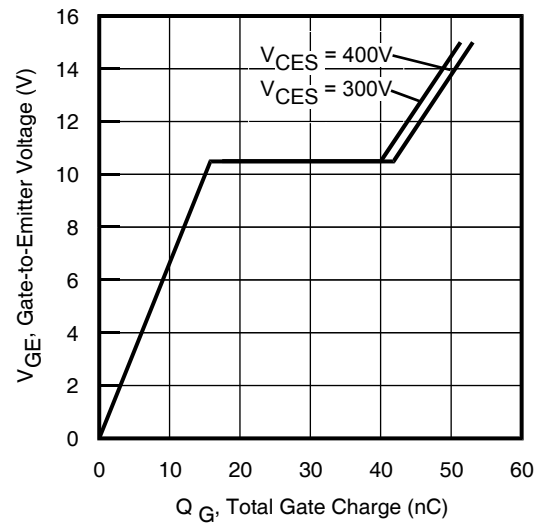


Fig. 25 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 24A$; $L = 485\mu H$

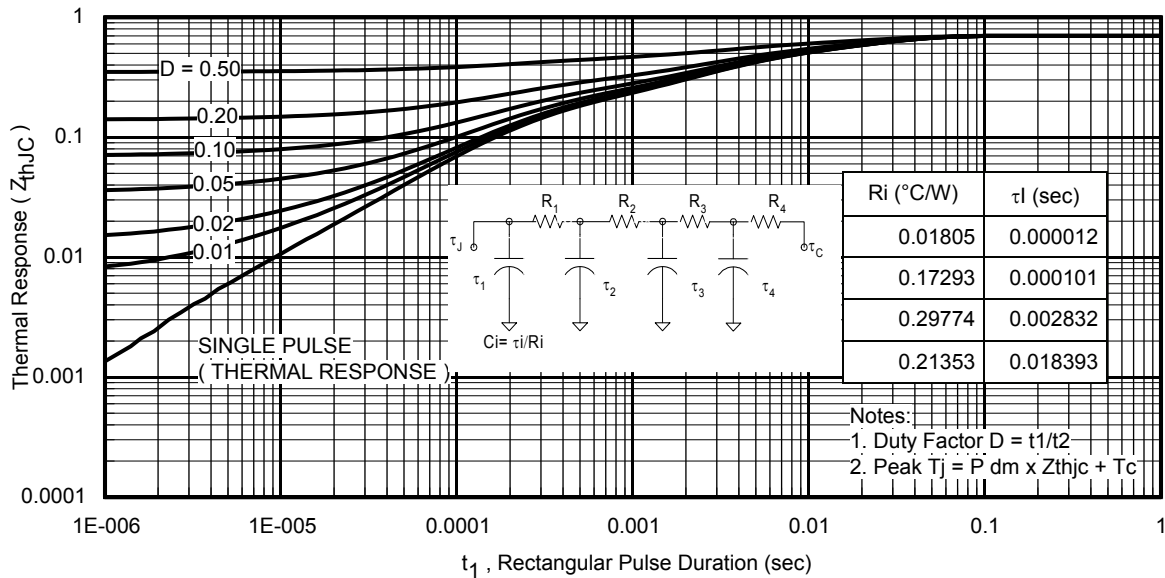


Fig 26. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

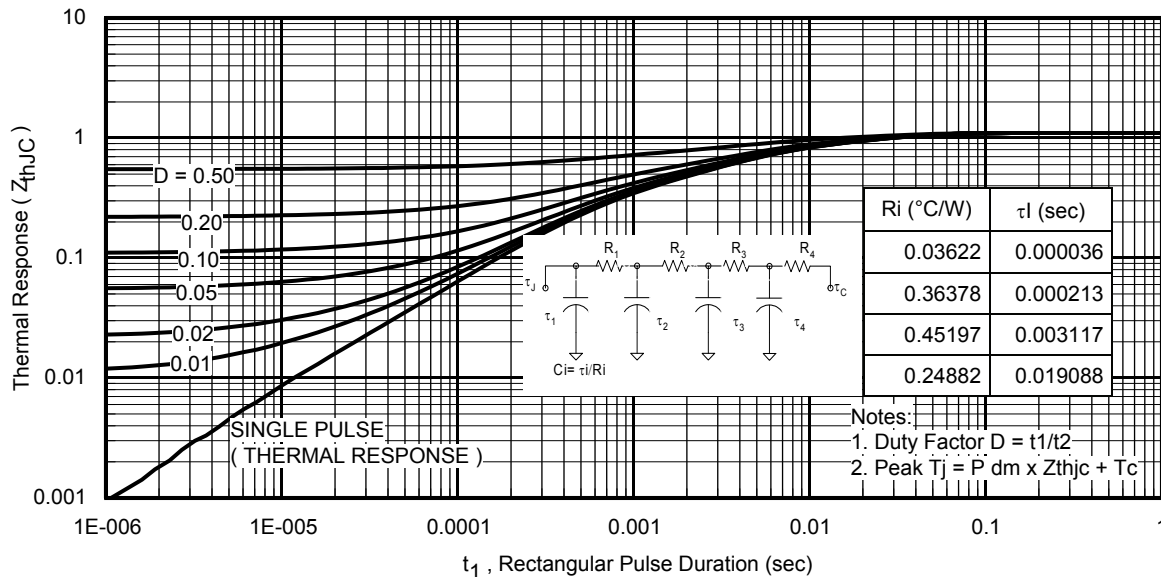
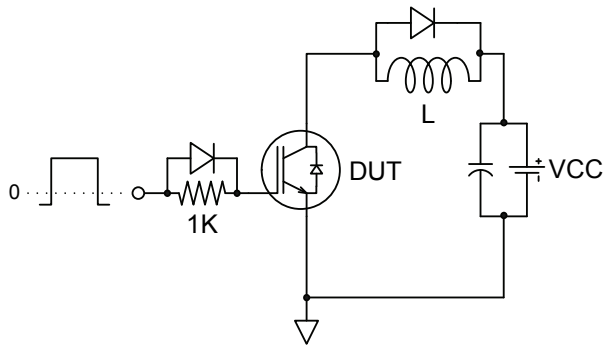
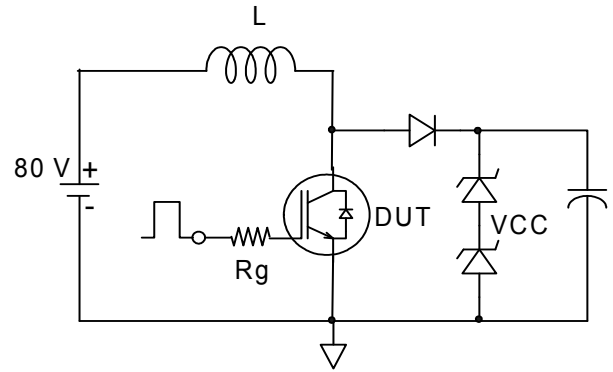


Fig 27. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



Gate Charge Circuit

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



RBSOA Circuit

Fig.C.T.2 - RBSOA Circuit

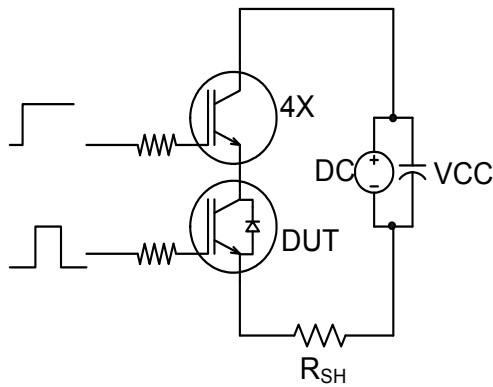


Fig.C.T.3 - S.C. SOA Circuit

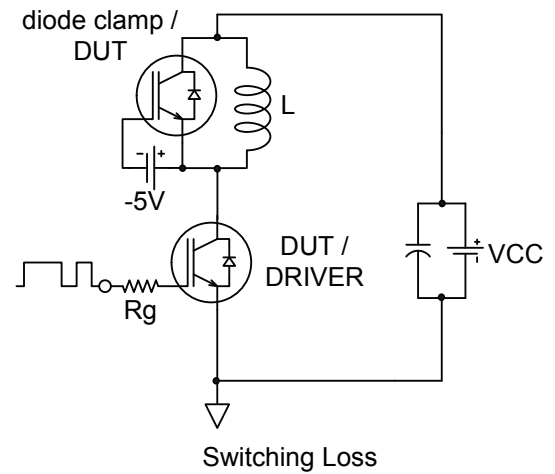


Fig.C.T.4 - Switching Loss Circuit

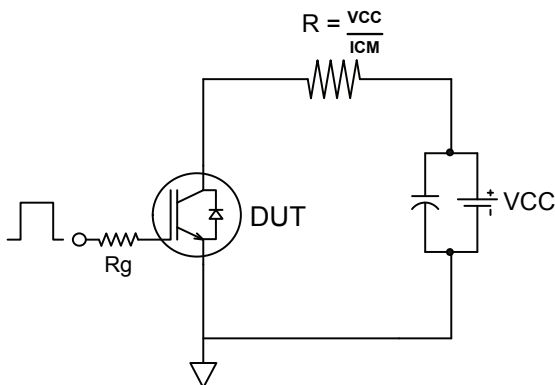


Fig.C.T.5 - Resistive Load Circuit

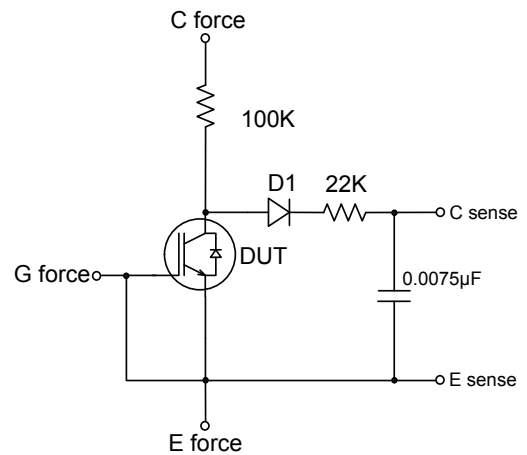


Fig.C.T.6 - BVES Filter Circuit

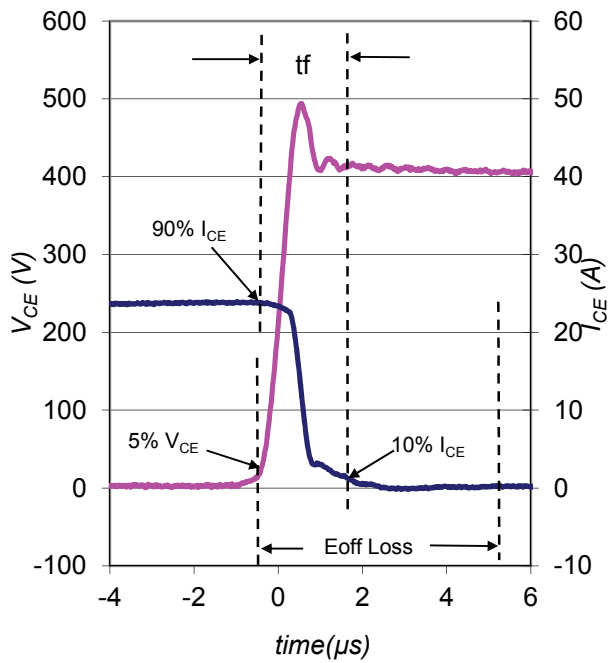


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

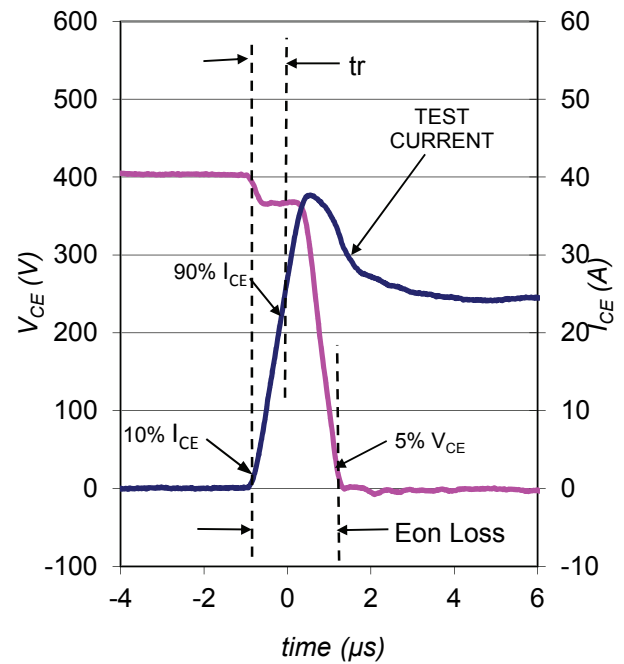


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

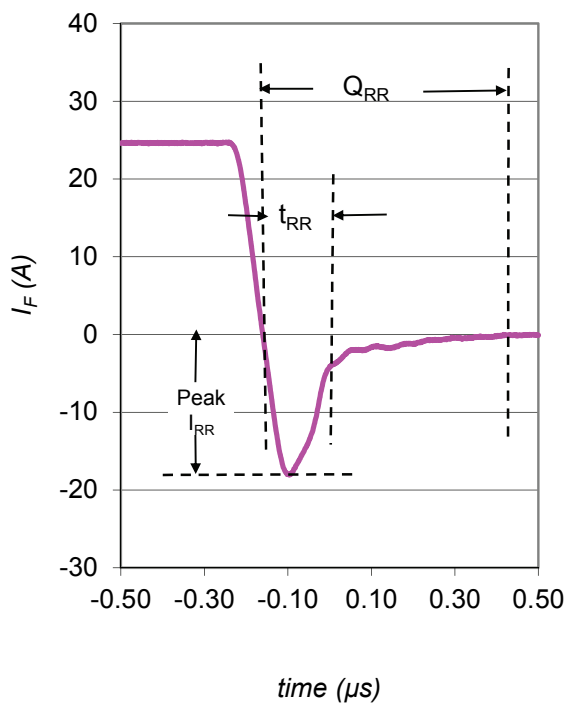


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

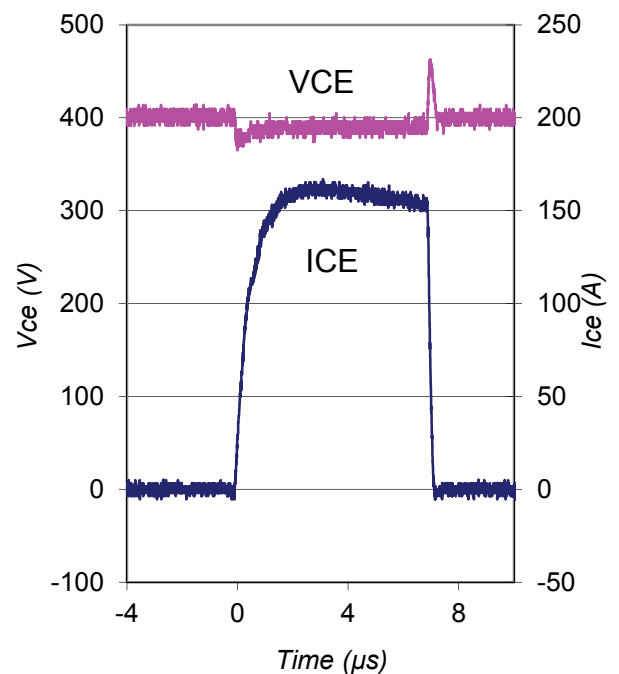
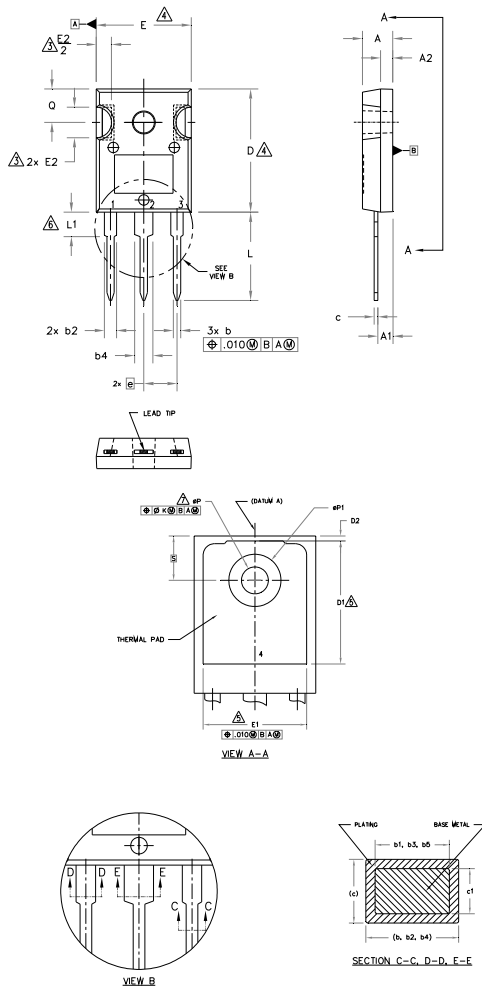


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.3

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	4
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	5
D	.776	.815	19.71	20.70	
D1	.515	—	13.08	—	4
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	
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

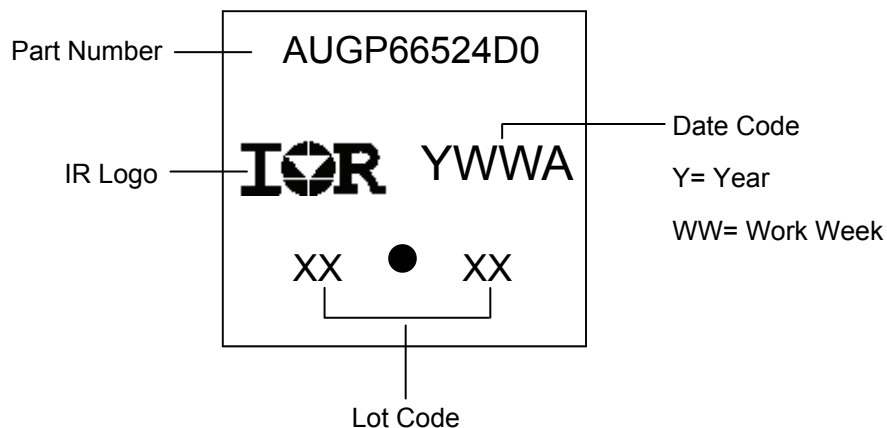
IGBTs, CoPACK

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

DIODES

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

TO-247AC Part Marking Information

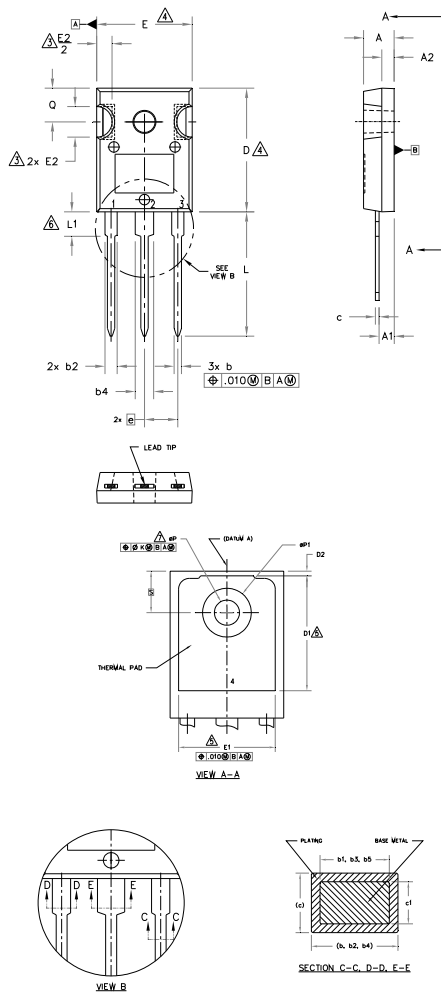


TO-247AC package is not recommended for Surface Mount Application.

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. ϕP 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		
ϕk	.010		0.25		
L	.791	.823	20.10	20.90	
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

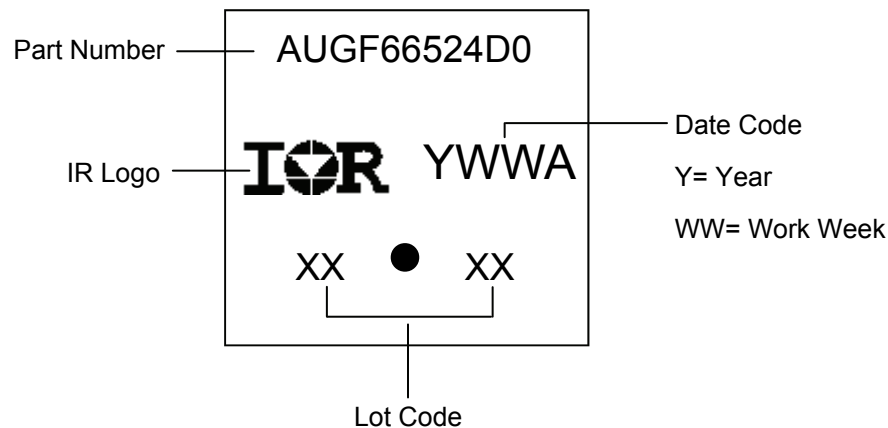
IGBTs, CoPACK

- 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[†]

Qualification Level		Automotive (per AEC-Q101) [†]	
		This part number(s) passed Automotive qualification. IR’s Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level		TO-247AC	N/A
		TO-247AD	
ESD	Human Body Model	Class H1C(+/- 2000) ^{††} AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000) ^{††} AEC-Q101-005	
RoHS Compliant		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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