

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	$V_{GE} = 0V, I_C = 1mA (25^\circ\text{C}-175^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.60	1.95	V	$I_C = 24A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	2.03	—		$I_C = 24A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
		—	2.04	—		$I_C = 24A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$I_C = 700\mu A$	9,10,
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-18	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA (25^\circ\text{C}-175^\circ\text{C})$	11,12
g_{fe}	Forward Transconductance	—	17	—	S	$V_{CE} = 50V, I_C = 24A, PW = 80\mu s$	
I_{CES}	Collector-to-Emitter Leakage Current	—	2.0	25	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	775	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	1.80	2.6	V	$I_F = 24A$	8
		—	1.28	—		$I_F = 24A, T_J = 175^\circ\text{C}$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V, V_{CE} = 0V$	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref. Fig.
Q_g	Total Gate Charge (turn-on)	—	50	75	nC	$I_C = 24A$	24 CT1
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	13	20		$V_{GE} = 15V$	
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	21	31		$V_{CC} = 400V$	
E_{on}	Turn-On Switching Loss	—	115	201	μJ	$I_C = 24A, V_{CC} = 400V,$ $V_{GE} = +15V, T_J = 25^\circ\text{C}$ $R_G = 10\Omega, L = 200\mu H, L_S = 150nH,$ Energy losses include tail & diode reverse recovery	CT4
E_{off}	Turn-Off Switching Loss	—	600	700			
E_{total}	Total Switching Loss	—	715	901			
$t_{d(on)}$	Turn-On delay time	—	41	53	ns	$I_C = 24A, V_{CC} = 400V,$ $V_{GE} = +15V, T_J = 175^\circ\text{C}$ ④ $R_G = 10\Omega, L = 200\mu H, L_S = 150nH$ Energy losses include tail & diode reverse recovery	13,15, CT4 WF1,WF2
t_r	Rise time	—	22	31			
$t_{d(off)}$	Turn-Off delay time	—	104	115			
t_f	Fall time	—	29	41	μJ	$I_C = 24A, V_{CC} = 400V,$ $V_{GE} = +15V, T_J = 175^\circ\text{C}$ ④ $R_G = 10\Omega, L = 200\mu H, L_S = 150nH$ Energy losses include tail & diode reverse recovery	14,16 CT4 WF1 WF2
E_{on}	Turn-On Switching Loss	—	420	—			
E_{off}	Turn-Off Switching Loss	—	840	—			
E_{total}	Total Switching Loss	—	1260	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0Mhz$	23
$t_{d(on)}$	Turn-On delay time	—	40	—			
t_r	Rise time	—	24	—			
$t_{d(off)}$	Turn-Off delay time	—	125	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0Mhz$	23
t_f	Fall time	—	39	—			
C_{ies}	Input Capacitance	—	1490	—			
C_{oes}	Output Capacitance	—	129	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0Mhz$	23
C_{res}	Reverse Transfer Capacitance	—	45	—			
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 96A$ $V_{CC} = 480V, V_p = 600V$ $R_g = 10\Omega, V_{GE} = +20V \text{ to } 0V$	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_g = 10\Omega, V_{GE} = +15V \text{ to } 0V$	22,CT3 WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	624	—	μJ	$T_J = 175^\circ\text{C}$	17,18,19, 20,21 WF3
t_{rr}	Diode Reverse Recovery Time	—	89	—	ns	$V_{CC} = 400V, I_F = 24A, V_{GE} = 15V,$	
I_{rr}	Peak Reverse Recovery Current	—	37	—	A	$R_G = 10\Omega, L = 200\mu H, L_S = 150nH$	

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 10\Omega.$
- ② This is only applied to TO-220AB package.
- ③ Pulse width limited by max. junction temperature.
- ④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

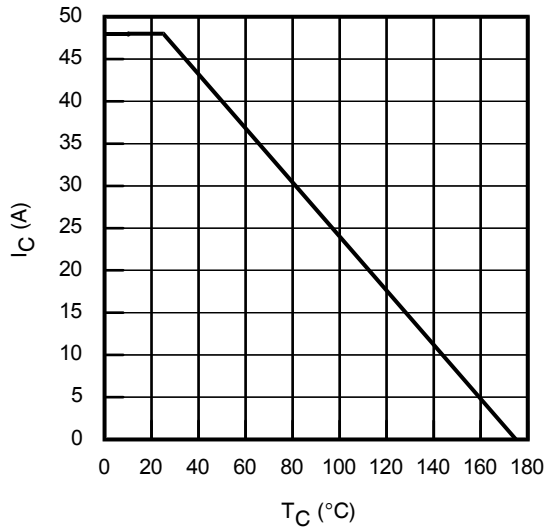


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

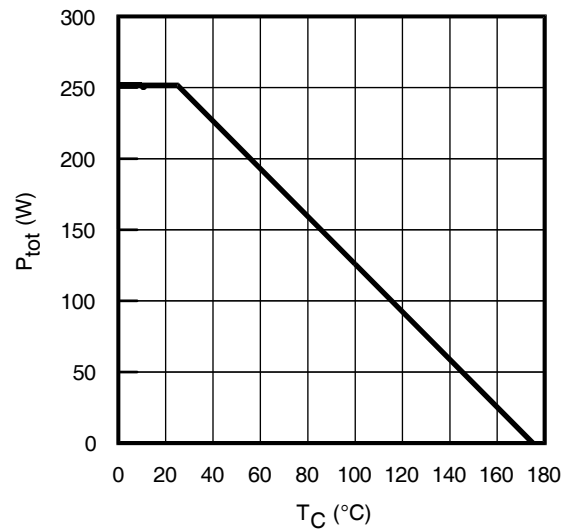


Fig. 2 - Power Dissipation vs. Case Temperature

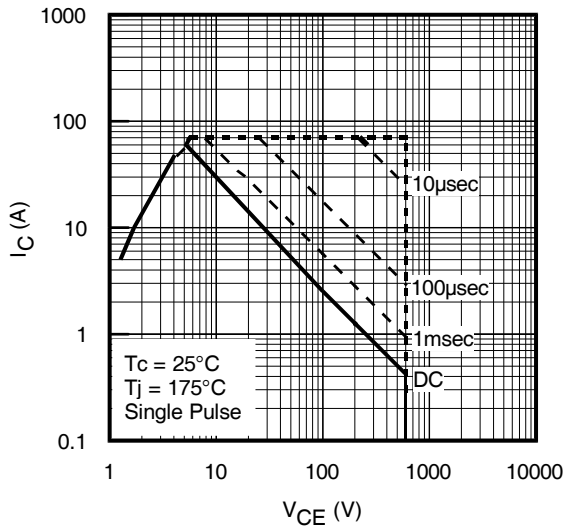


Fig. 3 - Forward SOA

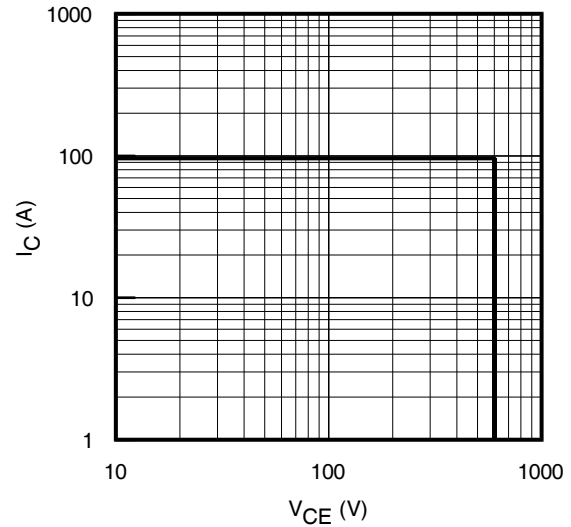


Fig. 4 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}$; $V_{GE} = 20\text{V}$

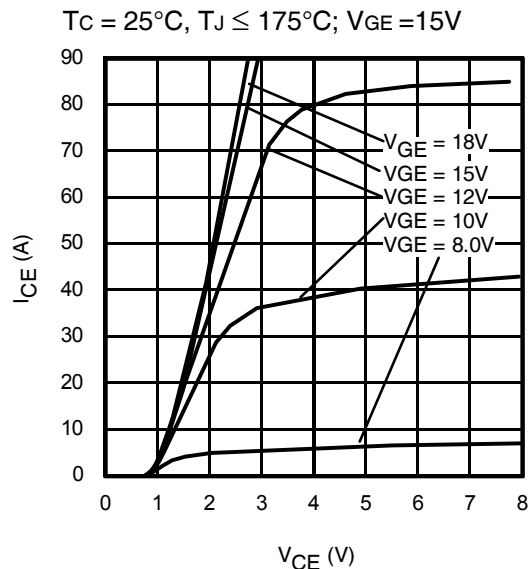


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

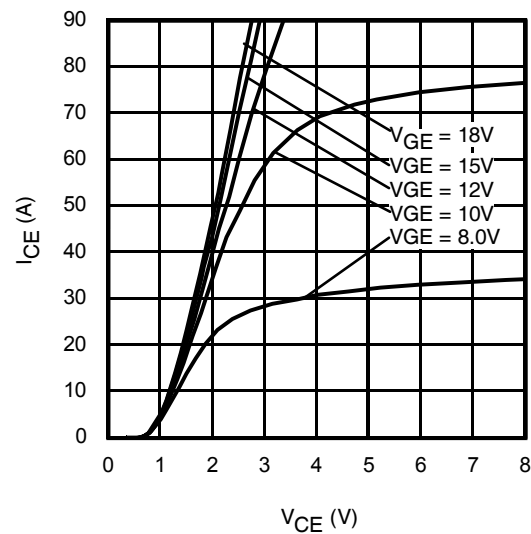


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

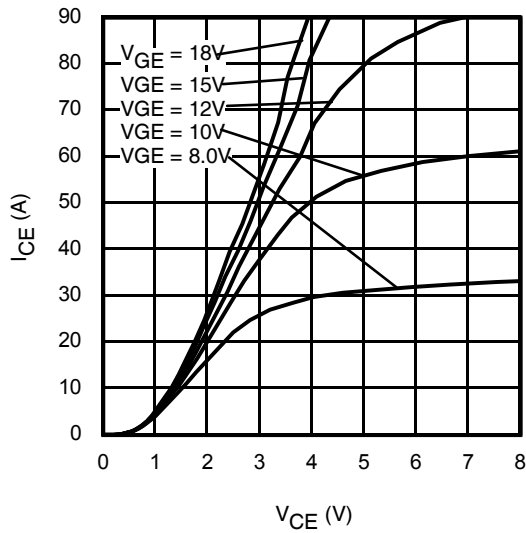


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 80\mu\text{s}$

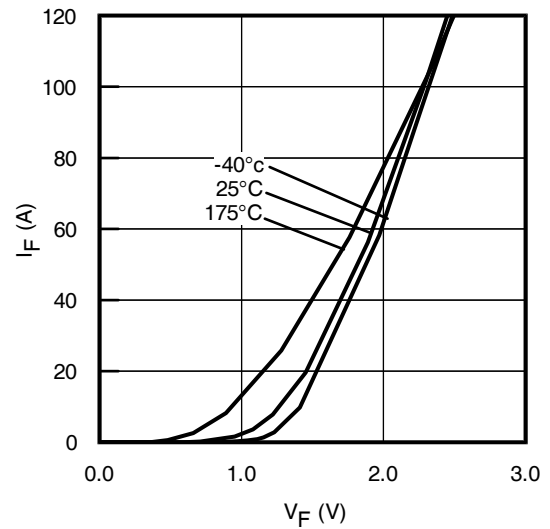


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

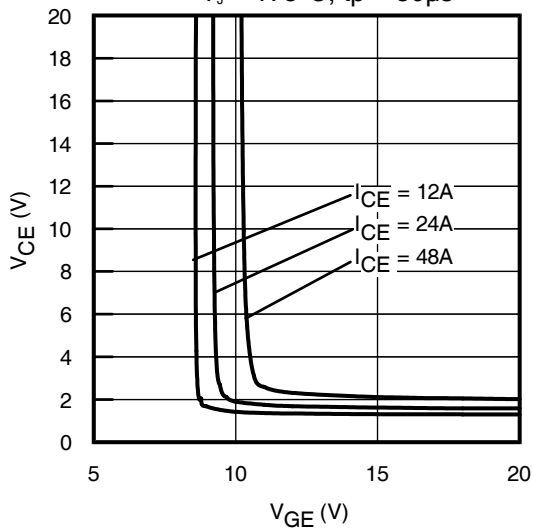


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

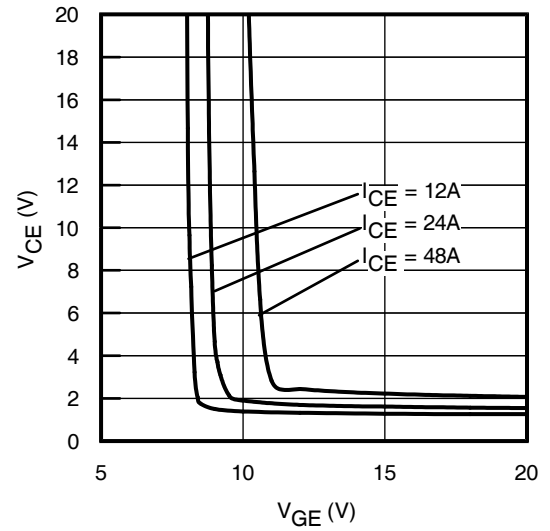


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

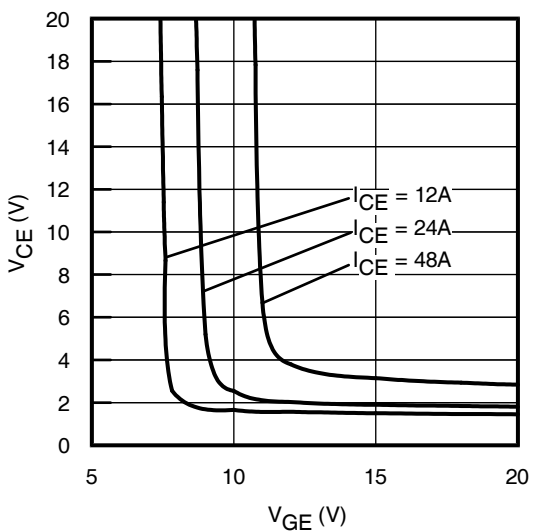


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

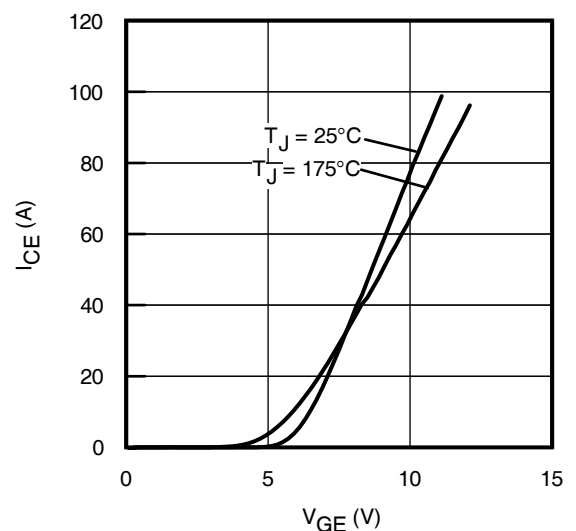
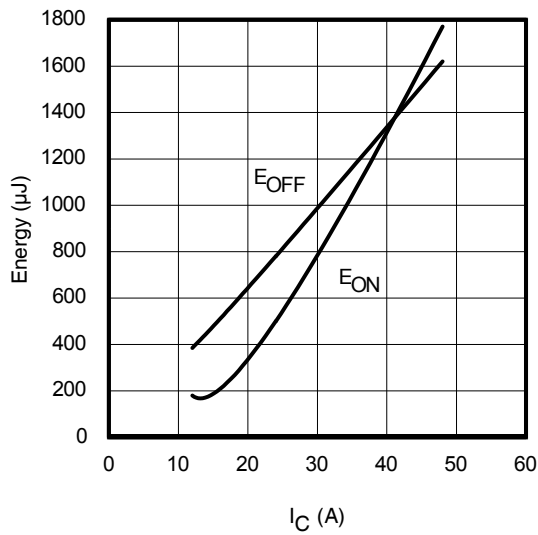
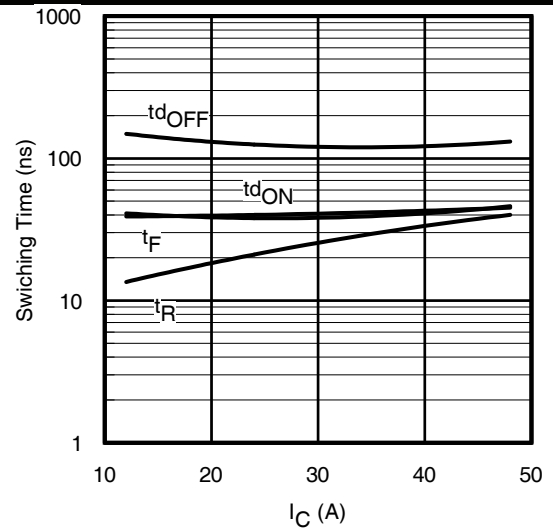
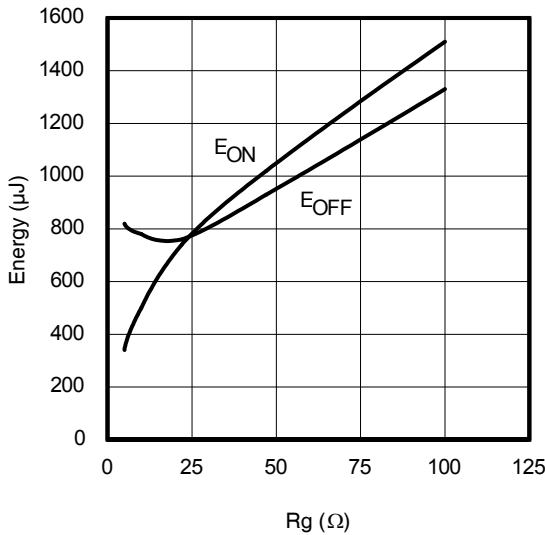
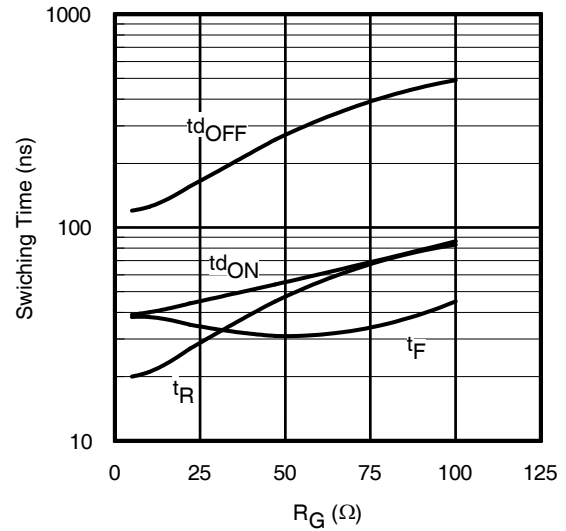
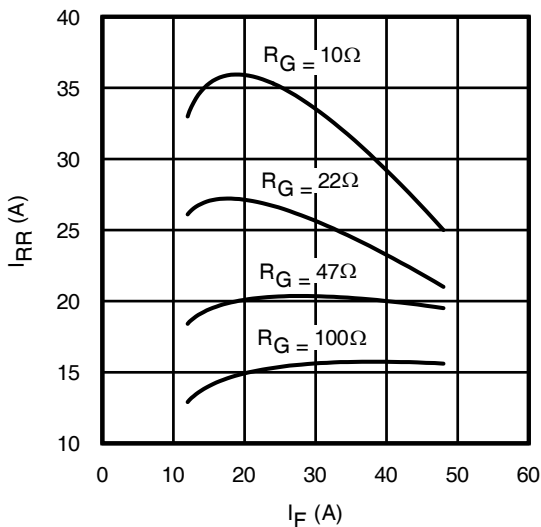
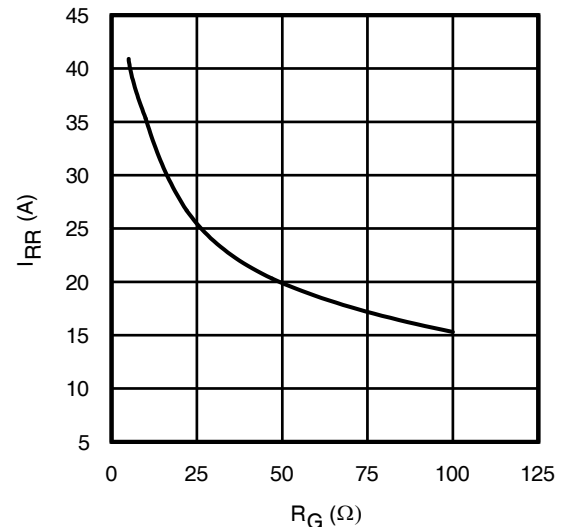


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$


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

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

Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 24\text{A}$; $V_{GE} = 15\text{V}$

Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 200\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 24\text{A}$; $V_{GE} = 15\text{V}$

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

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

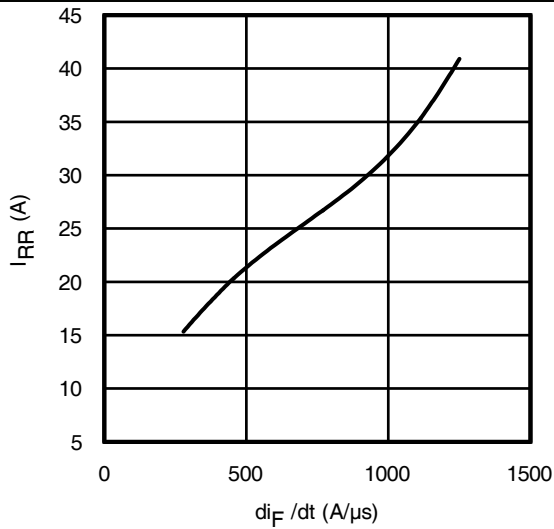


Fig. 19 - Typ. Diode I_{RR} vs. dI_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $I_F = 24A$; $T_J = 175^\circ C$

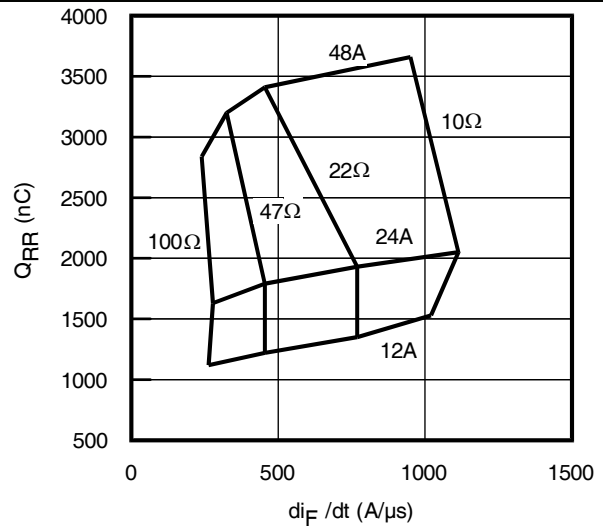


Fig. 20 - Typ. Diode Q_{RR} vs. dI_F/dt
 $V_{CC} = 400V$; $V_{GE} = 15V$; $T_J = 175^\circ C$

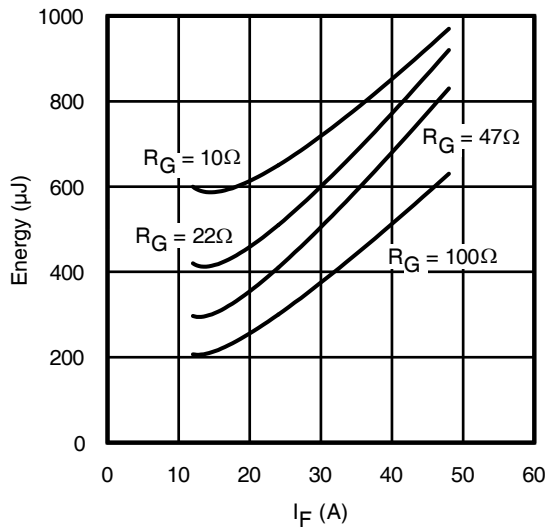


Fig. 21 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ C$

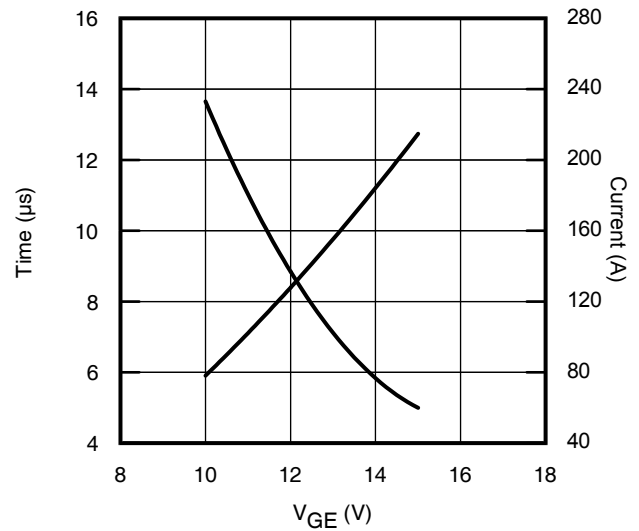


Fig. 22 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400V$; $T_C = 25^\circ C$

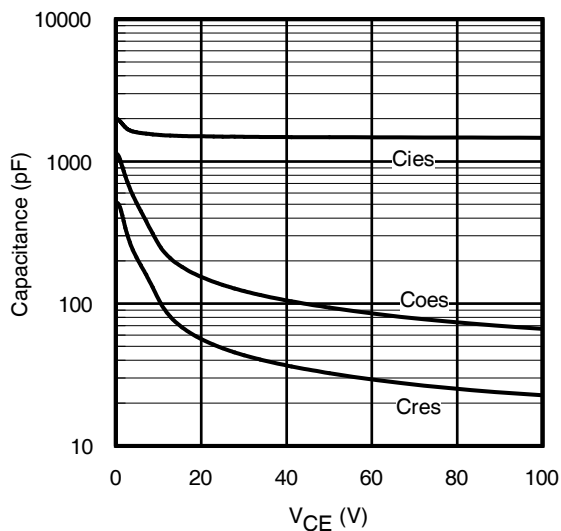


Fig. 23 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

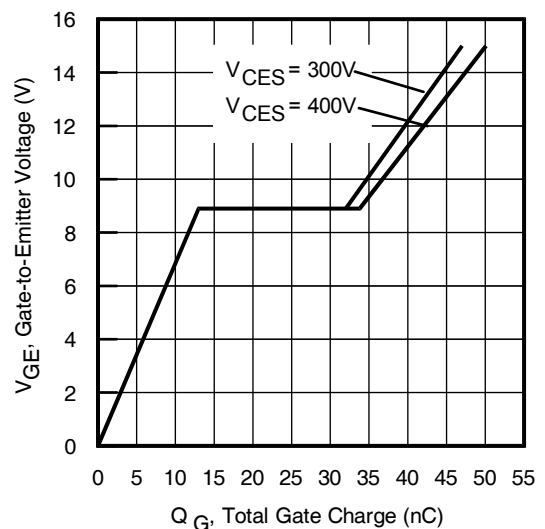
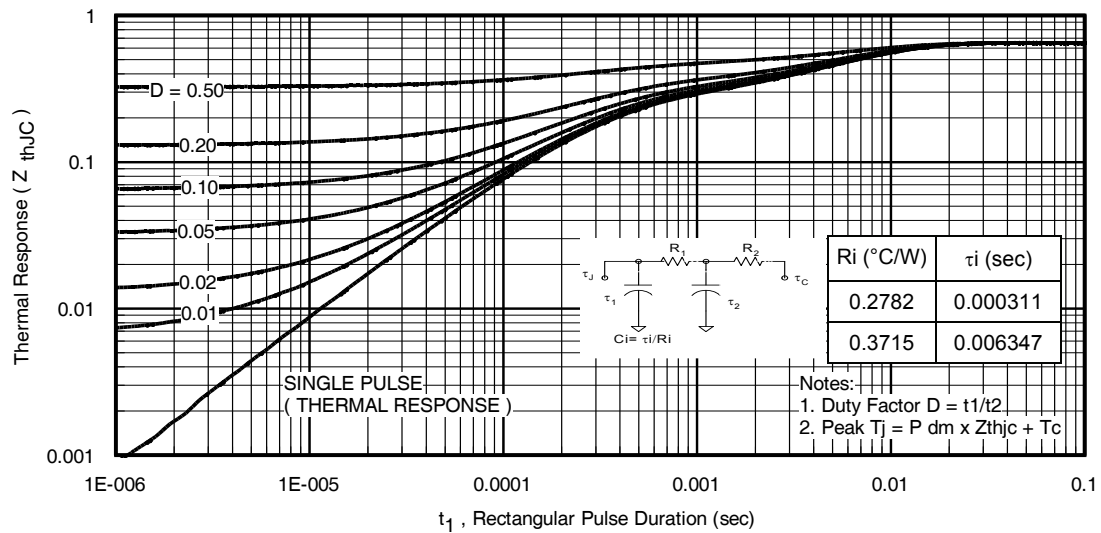
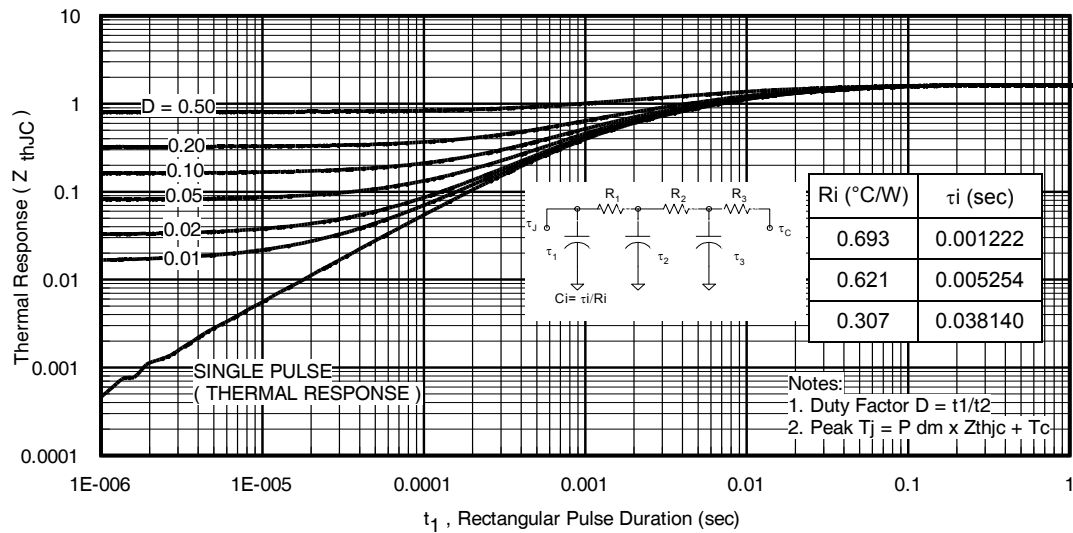
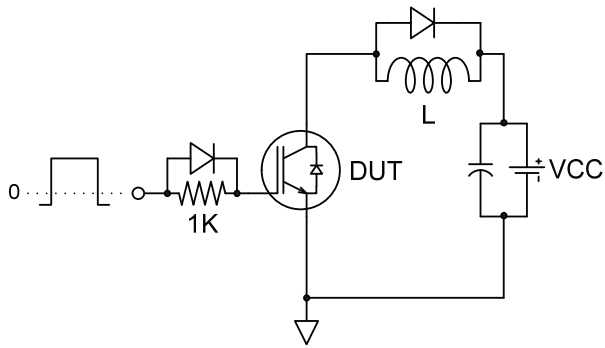
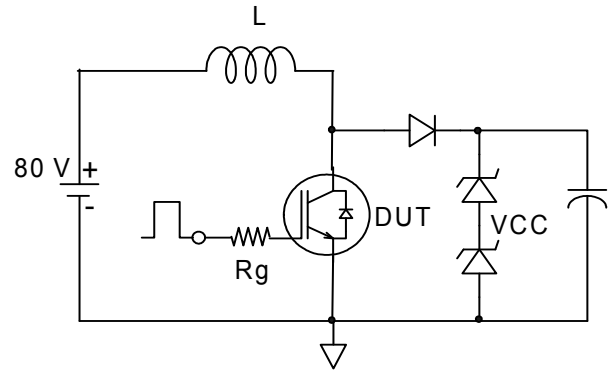
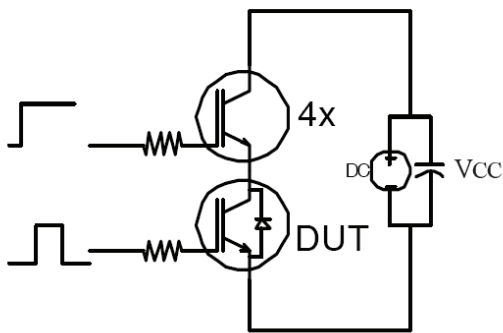
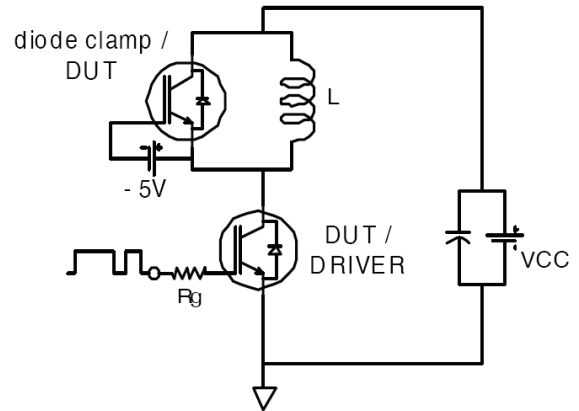
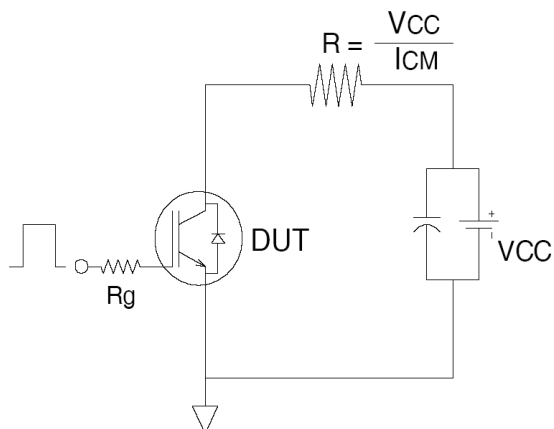
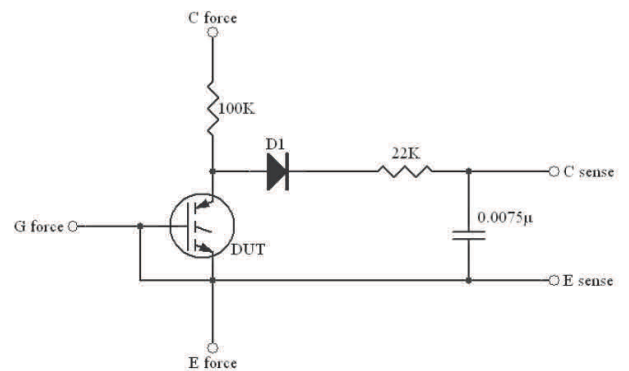


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 24A$; $L = 600\mu H$


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

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


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

Fig.C.T.2 - RBSOA Circuit

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

Fig.C.T.4 - Switching Loss Circuit

Fig.C.T.5 - Resistive Load Circuit

Fig.C.T.6 - BVCES Filter Circuit

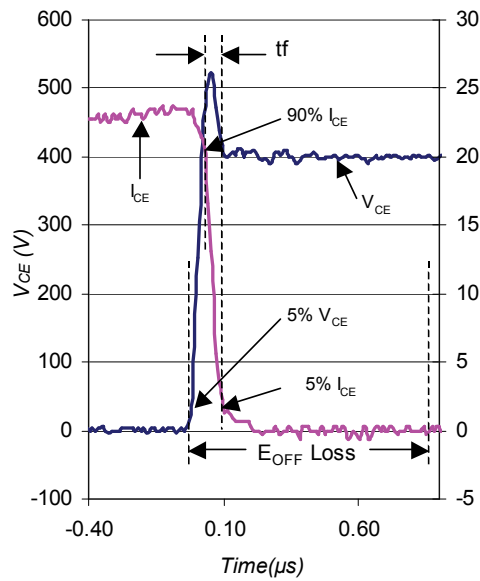


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

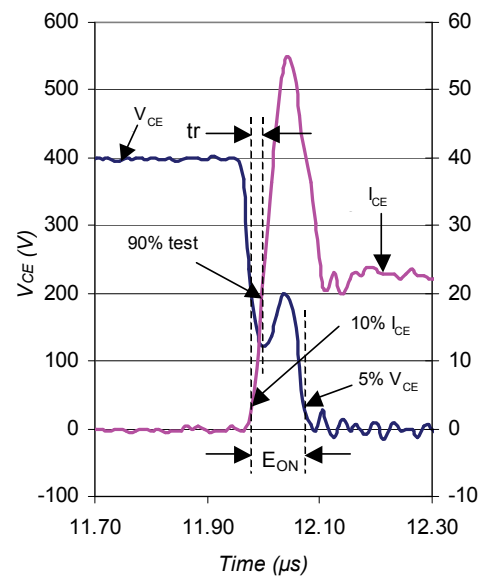


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

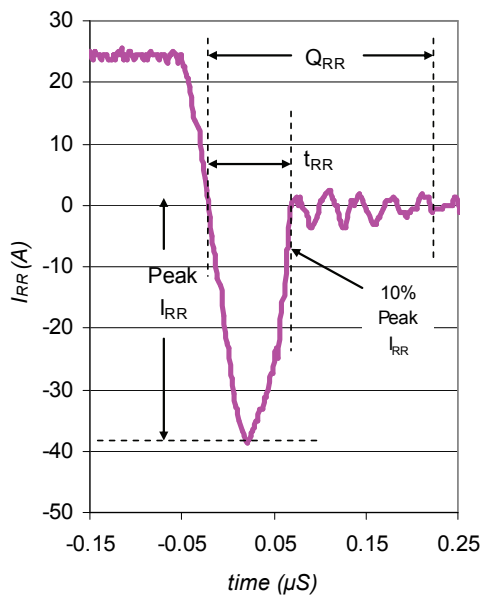


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

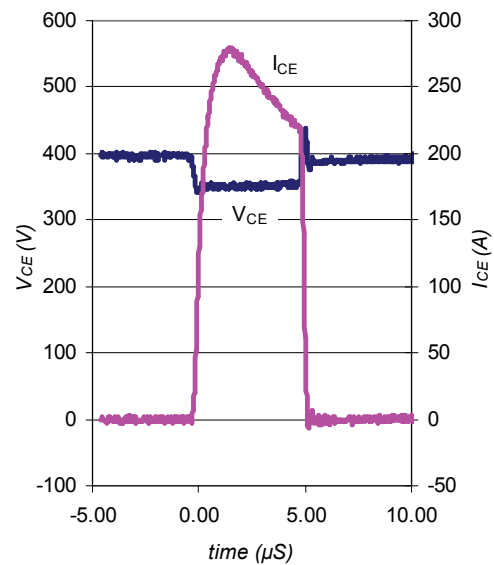
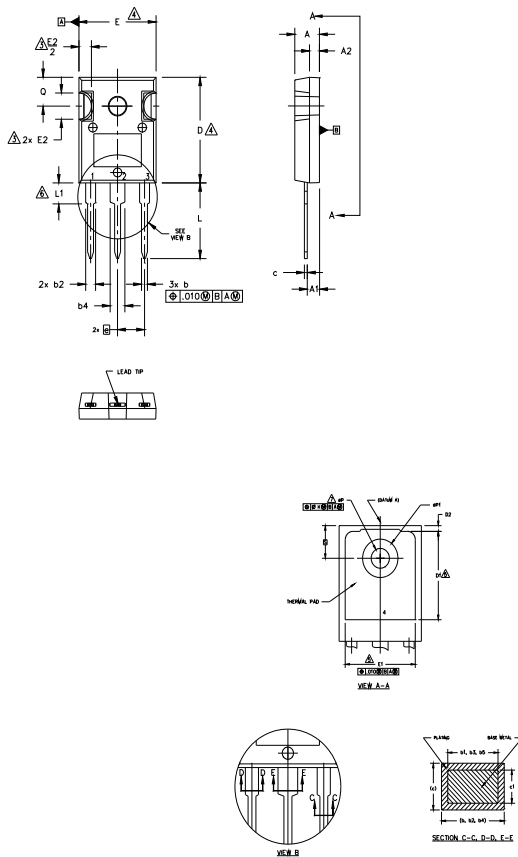


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 25^\circ\text{C}$ using Fig. CT.3

TO-247AC Package Outline

(Dimensions are shown in millimeters (inches))



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
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

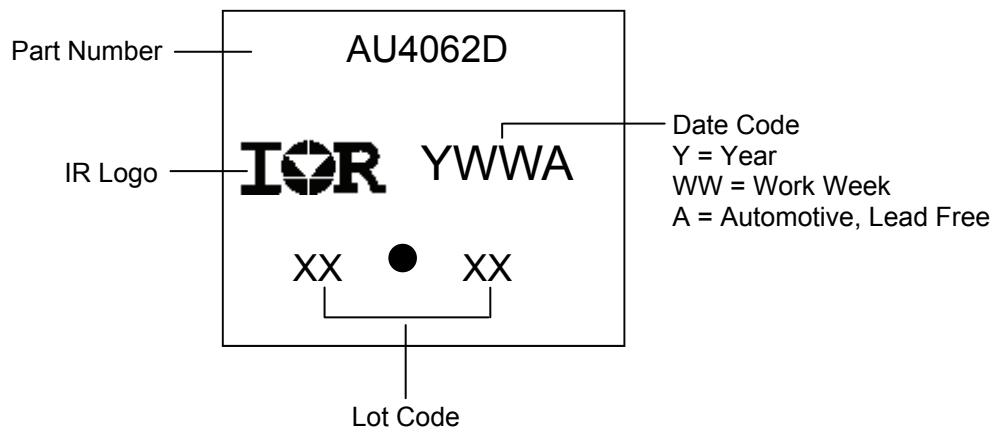
IGBTs, CoPACK

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

DIODES

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

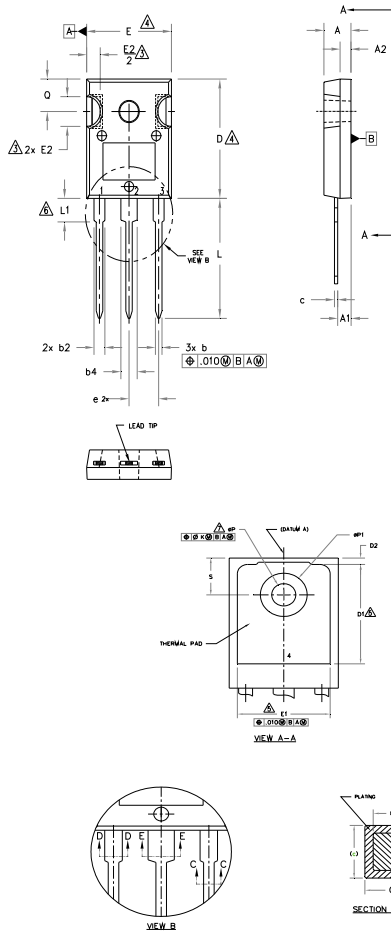
TO-247AC Part Marking Information



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

TO-247AD Package Outline

(Dimensions are shown in millimeters (inches))



NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

SYMBOL	DIMENSIONS				NOTES	
	INCHES		MILLIMETERS			
	MIN.	MAX.	MIN.	MAX.		
A	.190	.203	4.83	5.13		
A1	.087	.102	2.21	2.59		
A2	.059	.098	1.50	2.49		
b	.039	.055	0.99	1.40		
b1	.039	.053	0.99	1.35		
b2	.065	.094	1.65	2.39		
b3	.065	.092	1.65	2.34		
b4	.102	.135	2.59	3.43		
b5	.102	.133	2.59	3.38		
c	.015	.035	0.38	0.89		
c1	.015	.033	0.38	0.84	4	
D	.776	.815	19.71	20.70		
D1	.515	—	13.08	—		5
D2	.020	.053	0.51	1.35		4
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	.780	.827	19.57	21.00		
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

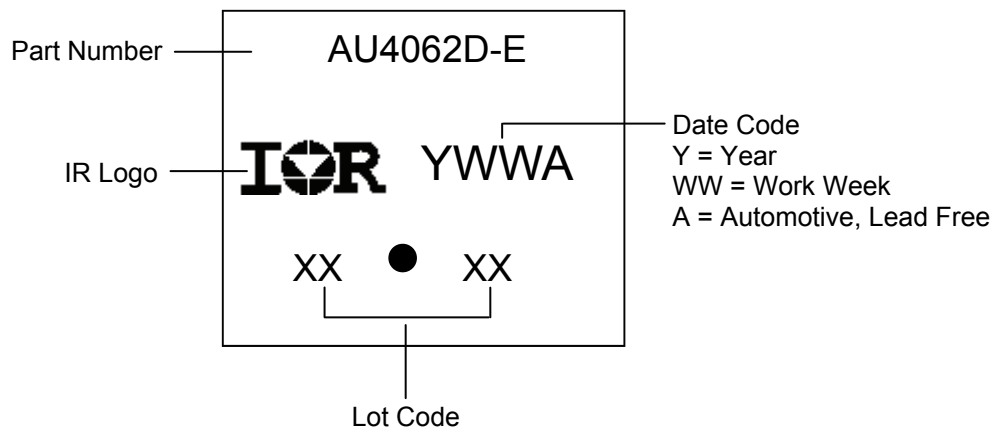
IGBTs, CoPACK

- 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.

Qualification Information

Qualification Level		Automotive (per AEC-Q101)	
		This part number(s) passed Automotive qualification. Infineon'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	Machine Model	Class M4(+/- 400V) [†] AEC-Q101-002	
	Human Body Model	Class H2(+/- 2000V) [†] AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000V) [†] AEC-Q101-005	
RoHS Compliant		Yes	

† Highest passing voltage.

Revision History

Date	Comments
8/24/2017	- Updated datasheet with corporate template - Corrected package outline –TO-247AD on page 11 - Corrected part marking on pages 10,11

Published by
Infineon Technologies AG
81726 München, Germany
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