International
IOR Rectifier

IRGPS46160DPbF

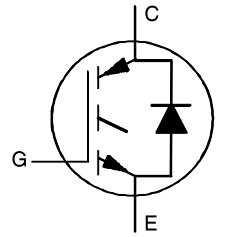
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

V_{CES} = 600V

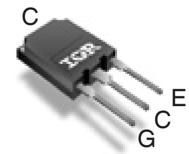
I_C = 160A, T_C = 100°C

$t_{SC} \geq 5\mu s$, $T_{J(max)}$ = 175°C

$V_{CE(on)}$ typ. = 1.70V @ I_C = 120A



n-channel



Super-247

G	C	E
Gate	Collector	Emitter

Applications
- Industrial Motor Drive
- Inverters
- UPS
- Welding

Features	→ Benefits
Low $V_{CE(ON)}$ and Switching Losses	High efficiency in a wide range of applications and switching frequencies
Square RBSOA and Maximum Junction Temperature 175°C	Improved reliability due to rugged hard switching performance and higher power capability
Positive $V_{CE\ (ON)}$ Temperature Coefficient	Excellent current sharing in parallel operation
5µs short circuit SOA	Enables short circuit protection scheme
Lead-Free, RoHS compliant	Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable part number
		Form	Quantity	
IRGPS46160DPbF	Super-247	Tube	25	IRGPS46160DPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	240⑤	A
I_C @ T_C = 100°C	Continuous Collector Current	160	
I_{CM}	Pulse Collector Current, V_{GE} = 15V	360	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	480	
I_F @ T_C = 25°C	Diode Continous Forward Current	240⑤	
I_F @ T_C = 100°C	Diode Continous Forward Current	160⑤	
I_{FM}	Diode Maximum Forward Current ②	480	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	750	W
P_D @ T_C = 100°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)	
	Mounting Torque, 6-32 or M3 Screw	10 lbf·in (1.1 N·m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Junction-to-Case (IGBT) ④	–––	–––	0.20	°C/W
$R_{\theta JC}$ (Diode)	Junction-to-Case (Diode) ④	–––	–––	0.63	
$R_{\theta CS}$	Case-to-Sink (flat, greased surface)	–––	0.24	–––	
$R_{\theta JA}$	Junction-to-Ambient (typical socket mount)	–––	–––	40	

Electrical Characteristics @ T_J = 25°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 = 100μA ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.27	—	V/°C	V_{GE} = 0V, I_C = 4.0mA (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.70	2.05	V	I_C = 120A, V_{GE} = 15V, T_J = 25°C
		—	2.15	—		I_C = 120A, V_{GE} = 15V, T_J = 150°C
		—	2.20	—		I_C = 120A, V_{GE} = 15V, T_J = 175°C
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 5.6mA
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-17	—	mV/°C	V_{CE} = V_{GE}, I_C = 5.6mA (25°C - 175°C)
gfe	Forward Transconductance	—	77	—	S	V_{CE} = 50V, I_C = 120A
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	150	μA	V_{GE} = 0V, V_{CE} = 600V
		—	2.3	—	mA	V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C
V_{FM}	Diode Forward Voltage Drop	—	2.4	3.0	V	I_F = 120A
		—	1.9	—		I_F = 120A, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±400	nA	V_{GE} = ±20V

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	—	240	—	nC	I_C = 120A
Q_{ge}	Gate-to-Emitter Charge	—	70	—		V_{GE} = 15V
Q_{gc}	Gate-to-Collector Charge	—	90	—		V_{CC} = 400V
E_{on}	Turn-On Switching Loss	—	5750	—	μJ	I_C = 120A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	3430	—		R_G = 4.7Ω, L = 66μH, T_J = 25°C
E_{total}	Total Switching Loss	—	9180	—		Energy losses include tail
$t_{d(on)}$	Turn-On delay time	—	80	—	ns	& diode reverse recovery
t_r	Rise time	—	70	—		
$t_{d(off)}$	Turn-Off delay time	—	190	—		
t_f	Fall time	—	40	—		
E_{on}	Turn-On Switching Loss	—	7740	—	μJ	I_C = 120A, V_{CC} = 400V, V_{GE}=15V
E_{off}	Turn-Off Switching Loss	—	4390	—		R_G=4.7Ω, L=66μH, T_J = 175°C
E_{total}	Total Switching Loss	—	12130	—		Energy losses include tail
$t_{d(on)}$	Turn-On delay time	—	80	—	ns	& diode reverse recovery
t_r	Rise time	—	75	—		
$t_{d(off)}$	Turn-Off delay time	—	230	—		
t_f	Fall time	—	55	—		
C_{ies}	Input Capacitance	—	7750	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	550	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	225	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 480A V_{CC} = 480V, Vp ≤ 600V Rg = 4.7 Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V_{CC} = 400V, Vp ≤ 600V Rg = 4.7 Ω, V_{GE} = +15V to 0V
Erec	Reverse Recovery Energy of the Diode	—	500	—	μJ	T_J = 175°C
t_{rr}	Diode Reverse Recovery Time	—	130	—	ns	V_{CC} = 400V, I_F = 120A
I_{rr}	Peak Reverse Recovery Current	—	36	—	A	V_{GE} = 15V, Rg = 4.7 Ω, L = 100μH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 66μH, R_G = 4.7Ω, tested in production I_{LM} ≤ 400A.
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 of approximately 90°C.
⑤ 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.

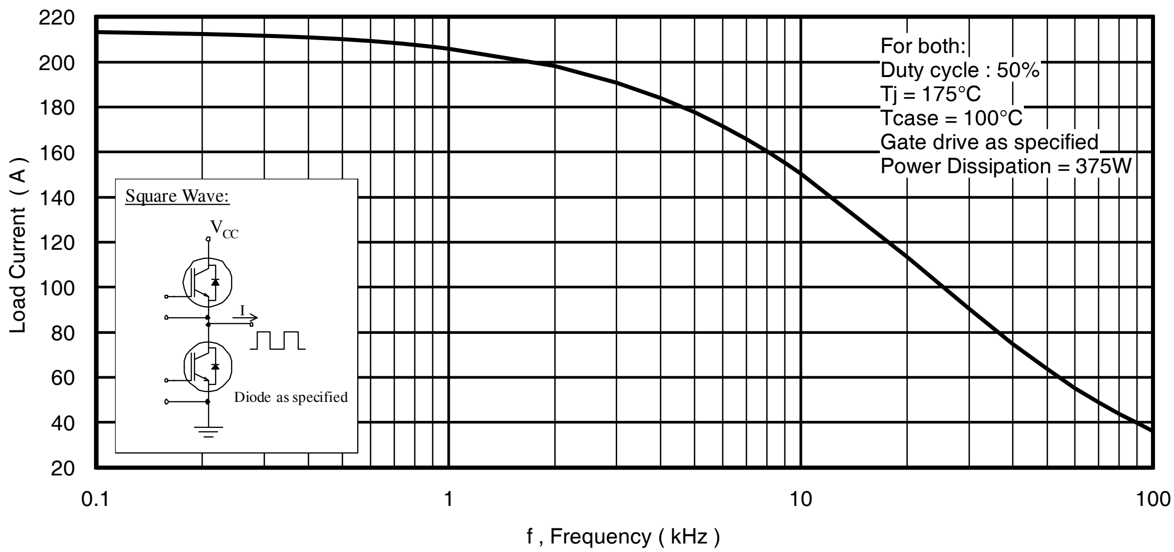


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

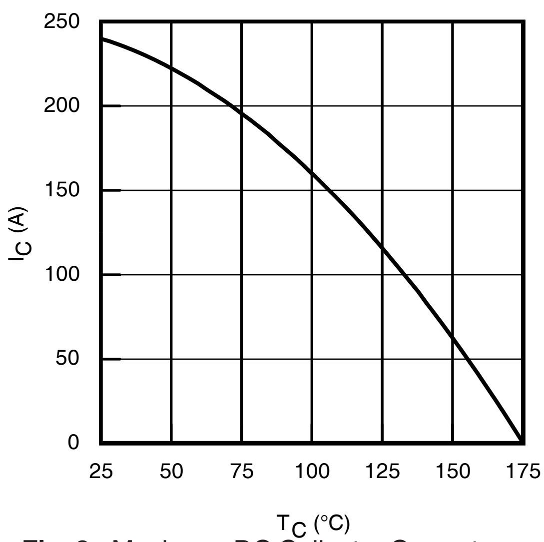


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

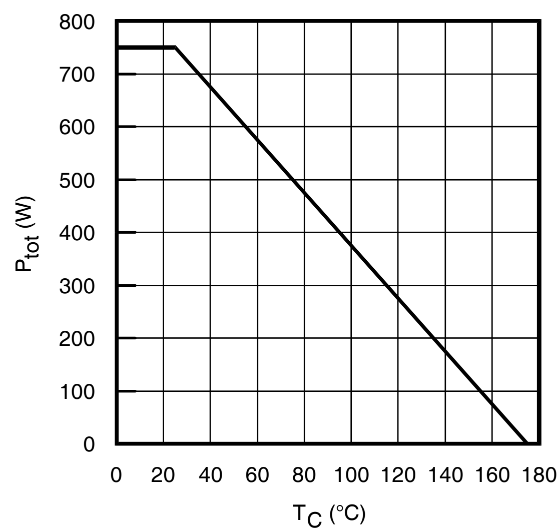


Fig. 3 - Power Dissipation vs. Case Temperature

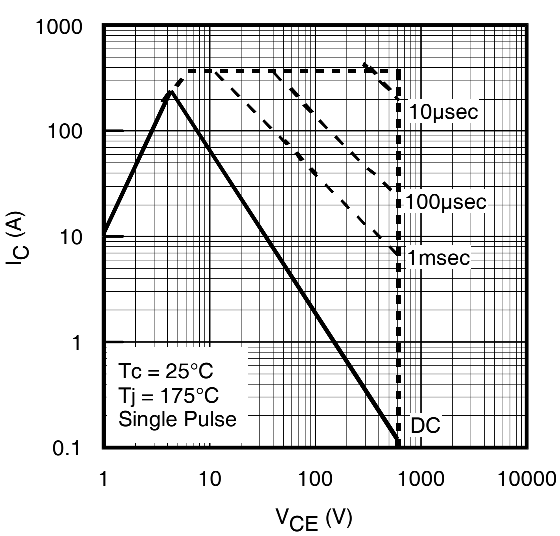


Fig. 4 - Forward SOA
T_C = 25°C, $T_J \leq$ 175°C; V_{GE} =15V

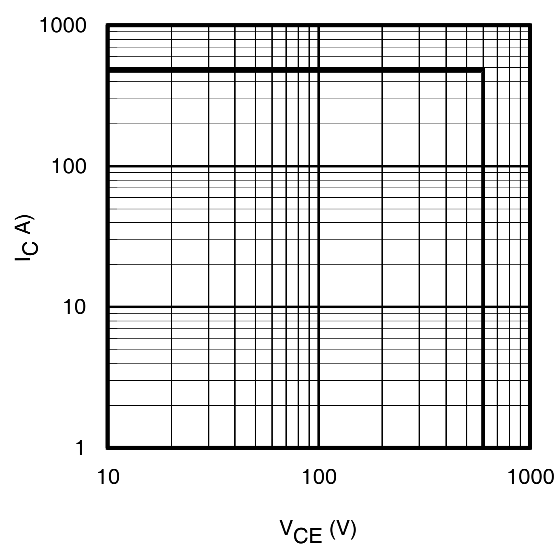


Fig. 5 - Reverse Bias SOA
T_J = 175°C; V_{GE} =20V

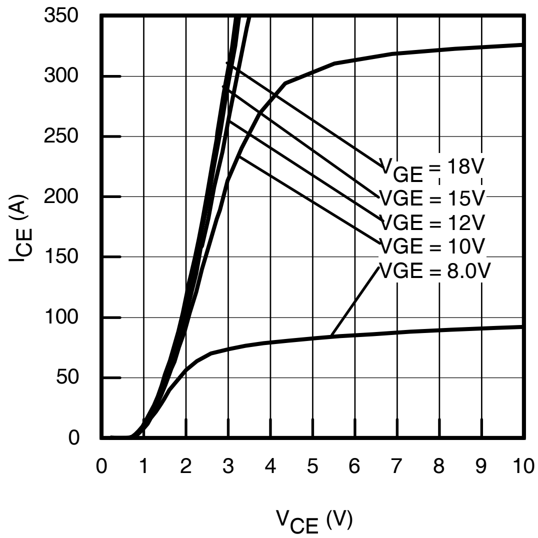


Fig. 6 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

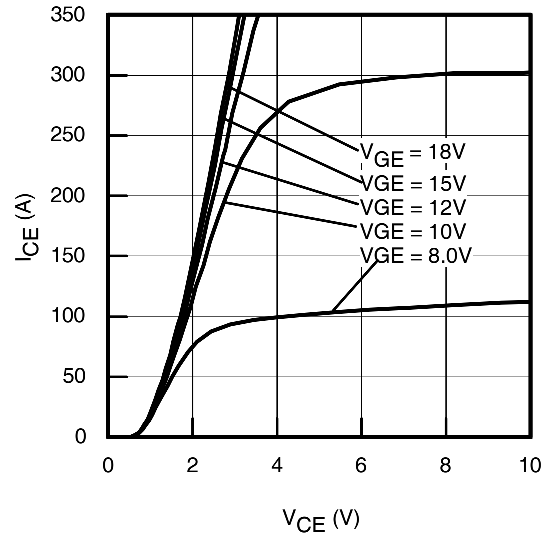


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

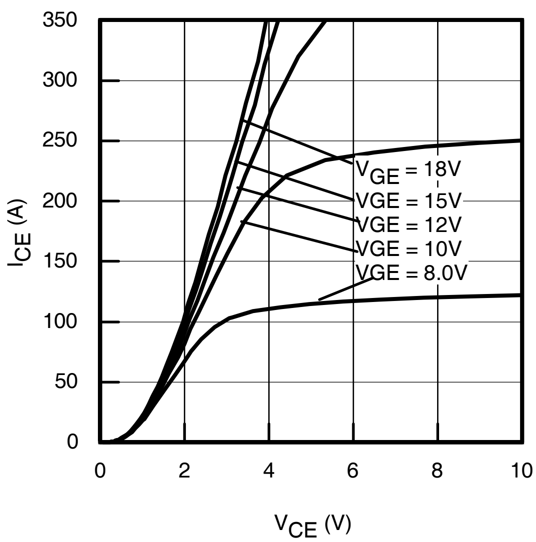


Fig. 8 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

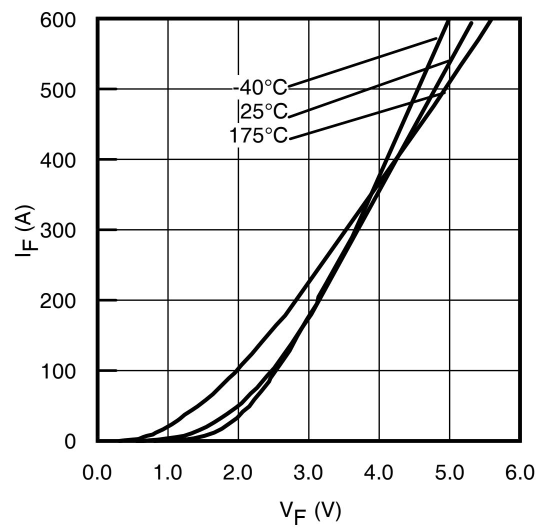


Fig. 9 - Typ. Diode Forward Characteristics
tp = 80µs

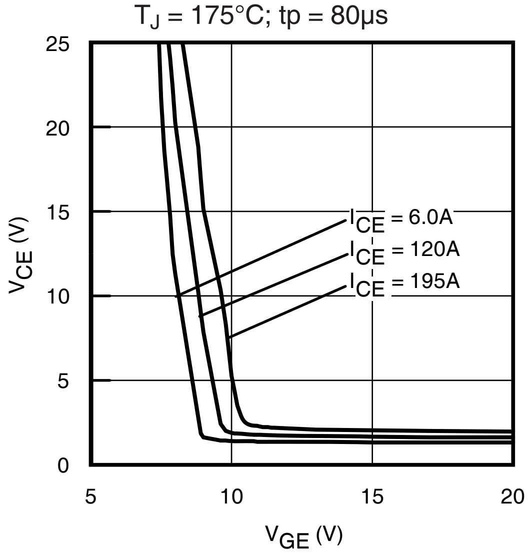


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

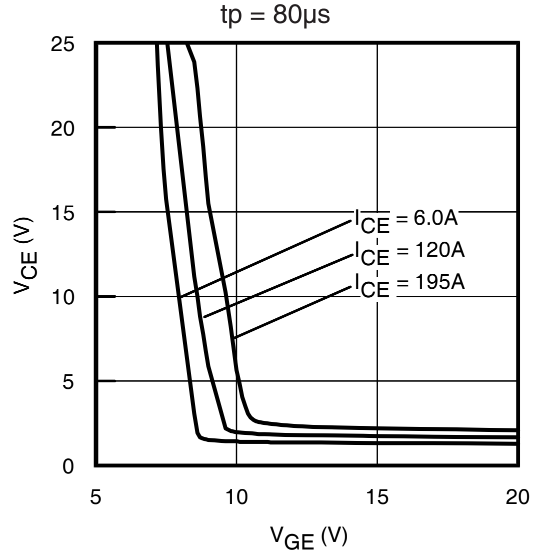


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

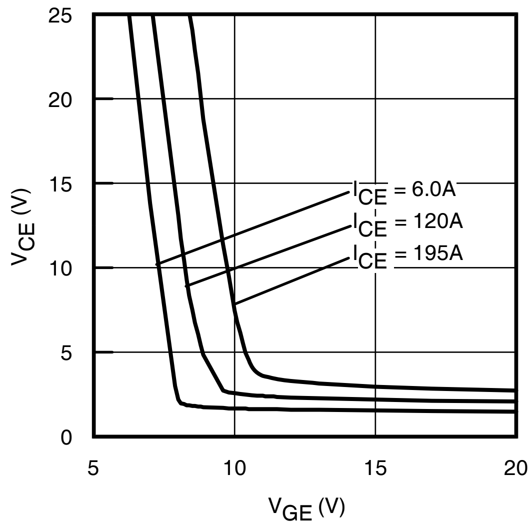


Fig. 12 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

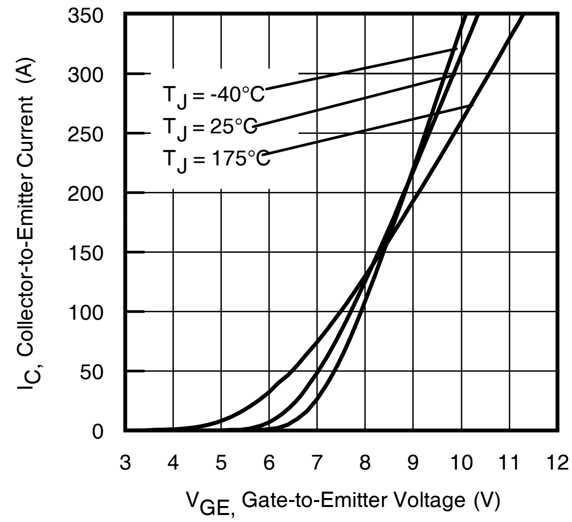


Fig. 13 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

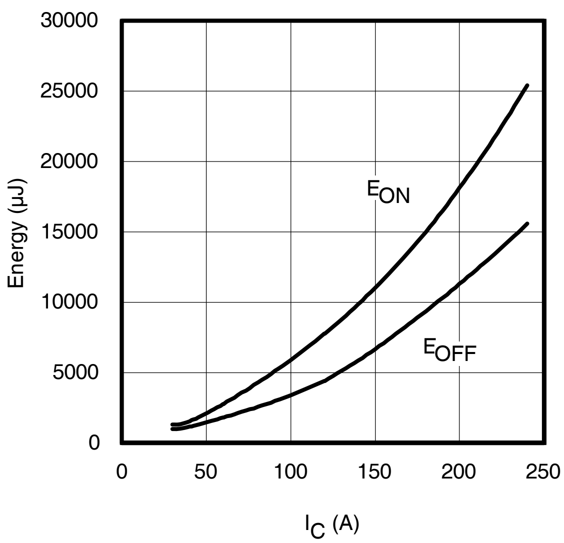


Fig. 14 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 66µH; V_{CE} = 400V, R_G = 4.7Ω; V_{GE} = 15V

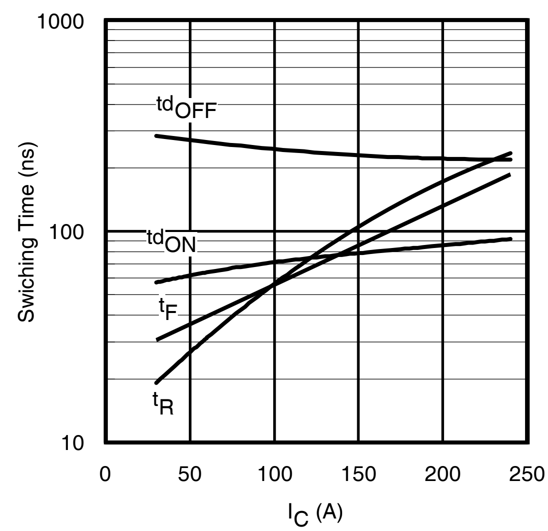


Fig. 15 - Typ. Switching Time vs. I_C
T_J = 175°C; L = 66µH; V_{CE} = 400V, R_G = 4.7Ω; V_{GE} = 15V

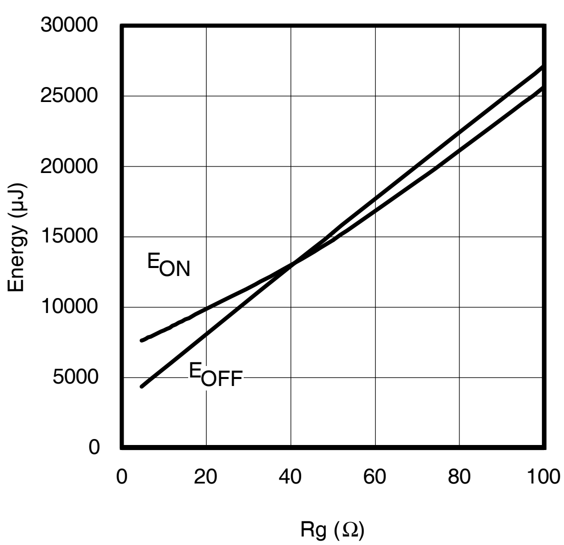


Fig. 16 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 66µH; V_{CE} = 400V, I_{CE} = 120A; V_{GE} = 15V

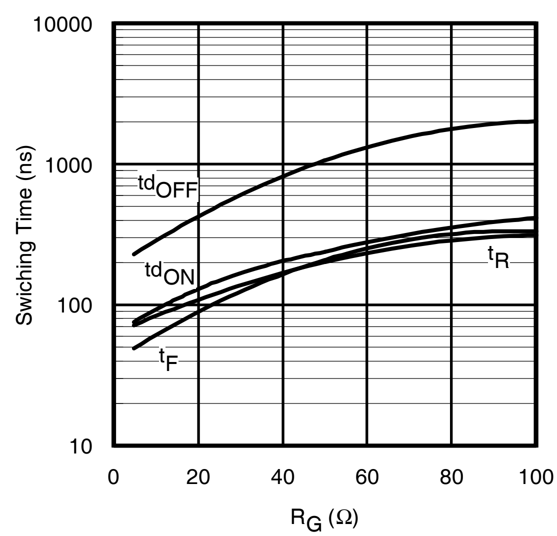


Fig. 17 - Typ. Switching Time vs. R_G
T_J = 175°C; L = 66µH; V_{CE} = 400V, I_{CE} = 120A; V_{GE} = 15V

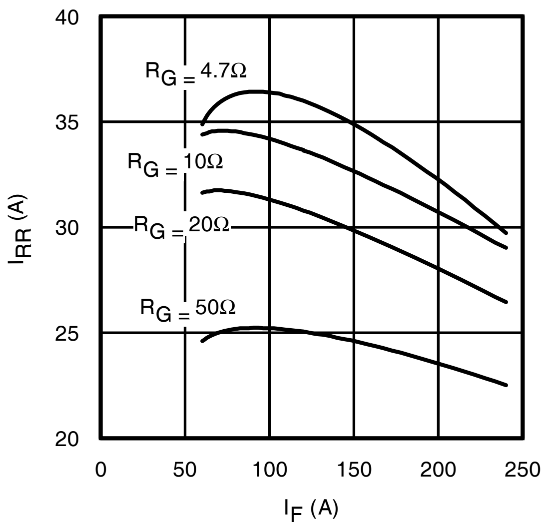


Fig. 18 - Typ. Diode I_{RR} vs. I_F
T_J = 175°C

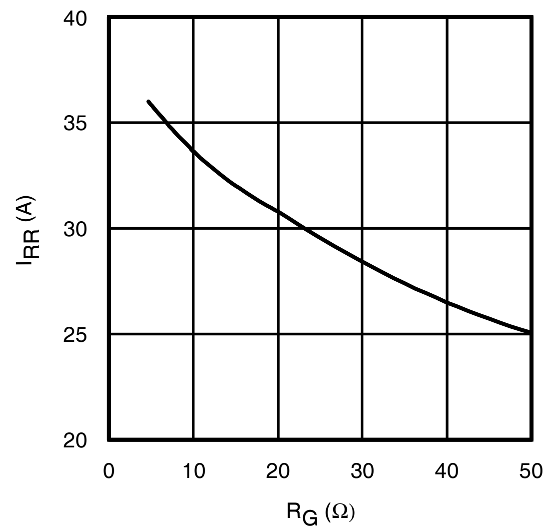


Fig. 19 - Typ. Diode I_{RR} vs. R_G
T_J = 175°C

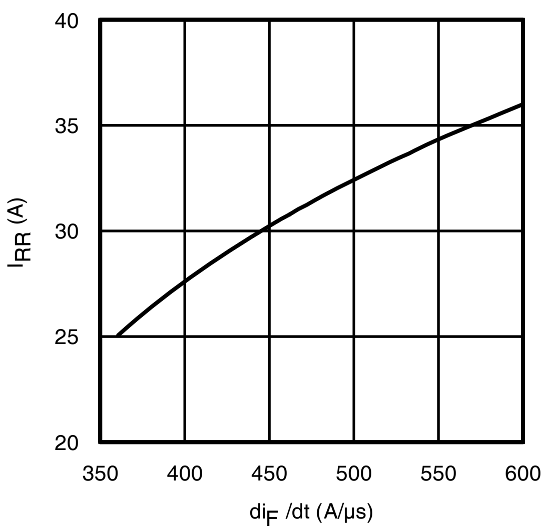


Fig. 20 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 120A; T_J = 175°C

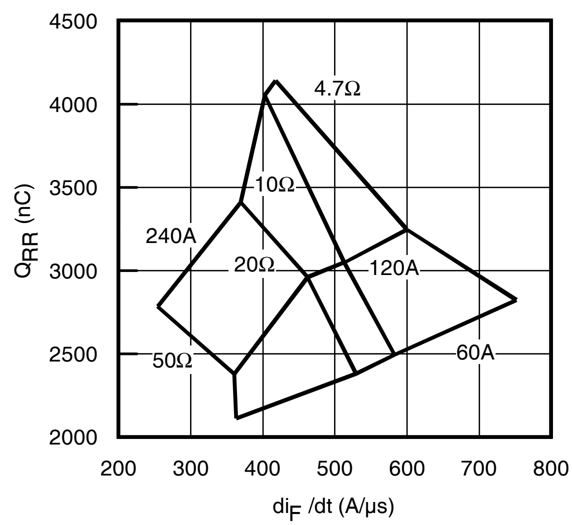


Fig. 21 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C

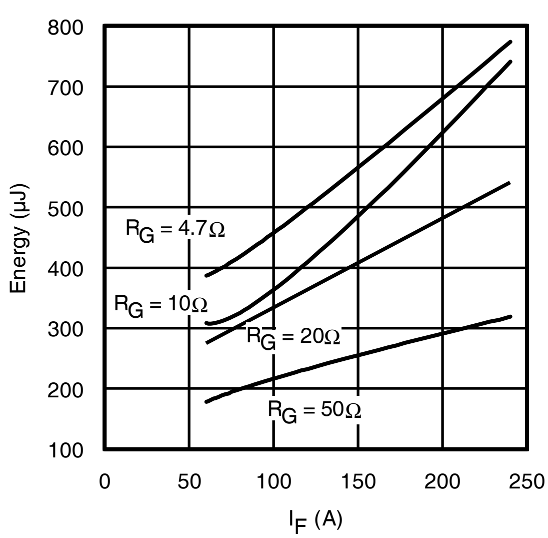


Fig. 22 - Typ. Diode E_{RR} vs. I_F
T_J = 175°C

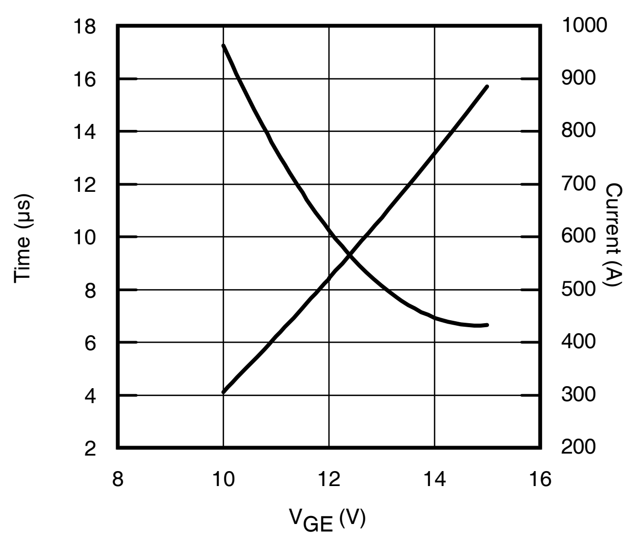


Fig. 23 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

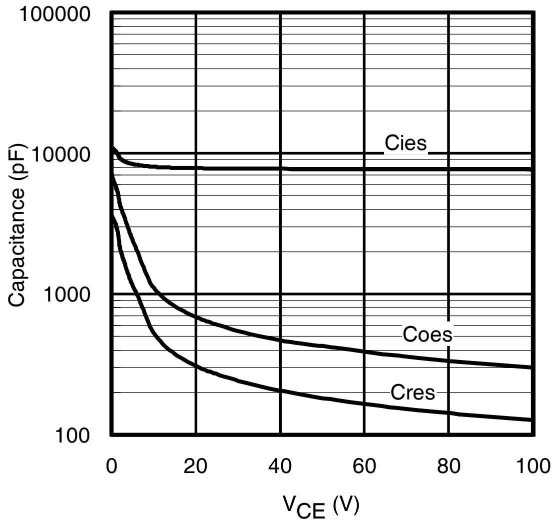


Fig. 24 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

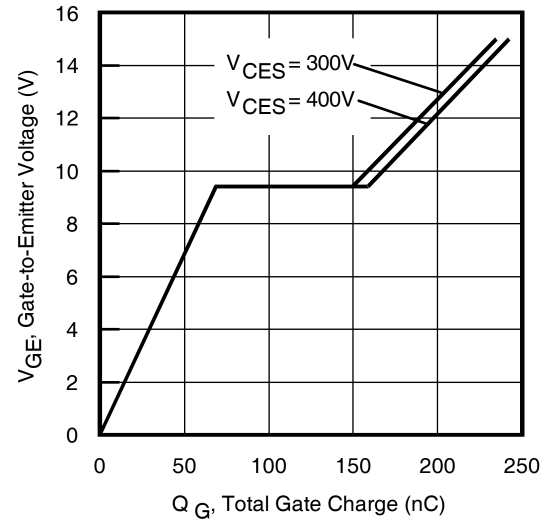
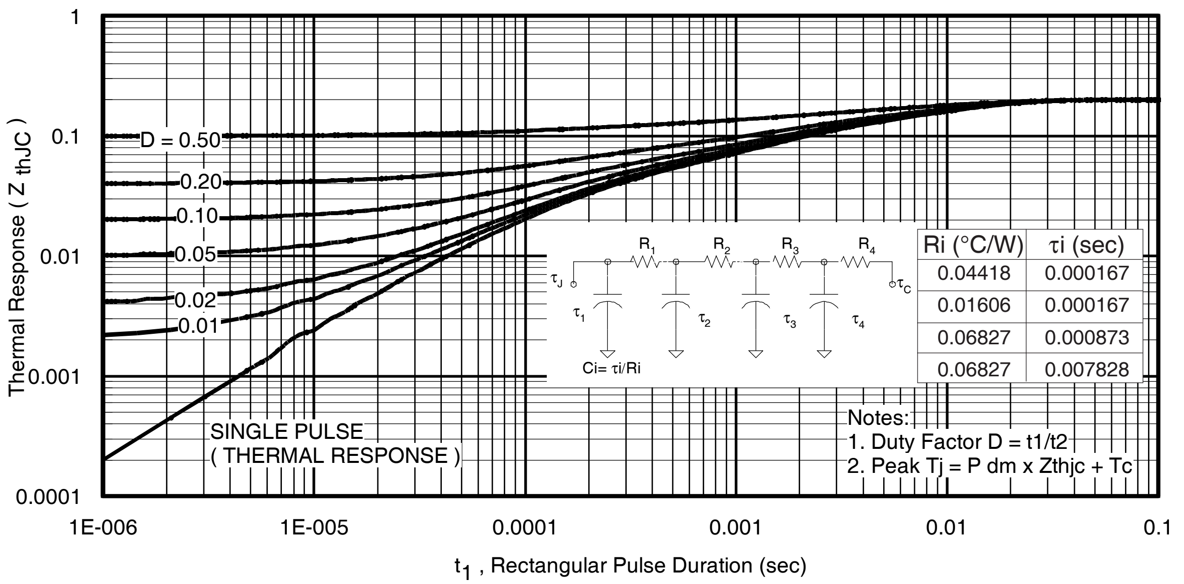
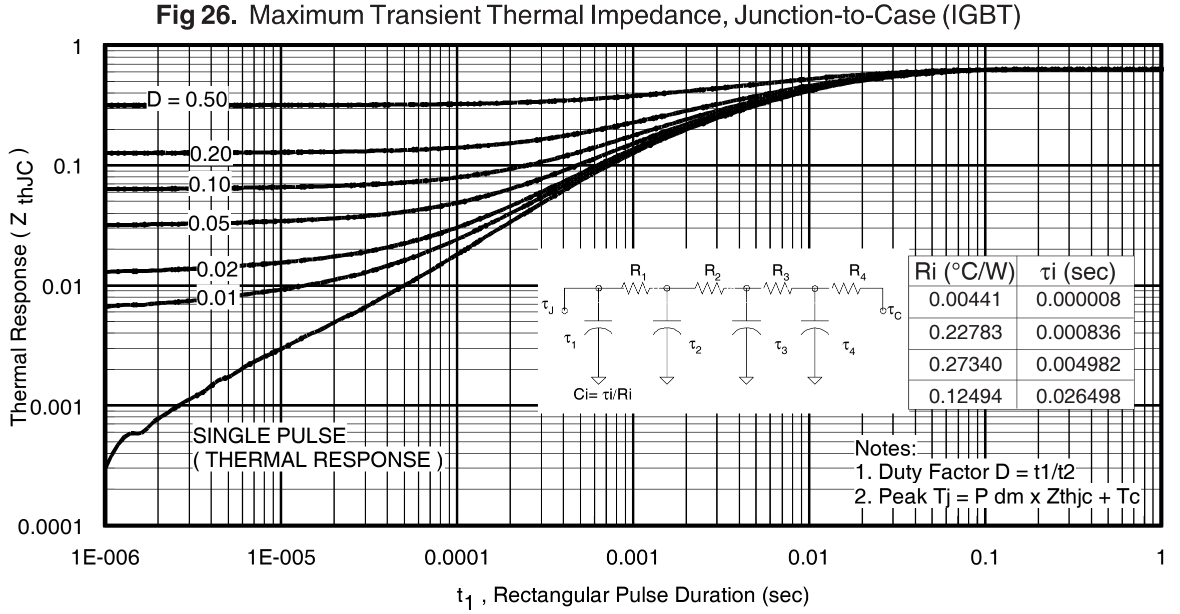


Fig. 25 - Typical Gate Charge vs. V_{GE}
I_{CE} = 120A; L = 100µH



Ri (°C/W)	τi (sec)
0.04418	0.000167
0.01606	0.000167
0.06827	0.000873
0.06827	0.007828

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



Ri (°C/W)	τi (sec)
0.00441	0.000008
0.22783	0.000836
0.27340	0.004982
0.12494	0.026498

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

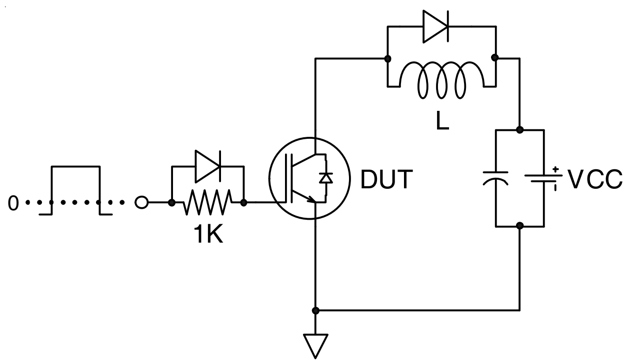


Fig.C.T.1 - Gate Charge Circuit (turn-off)

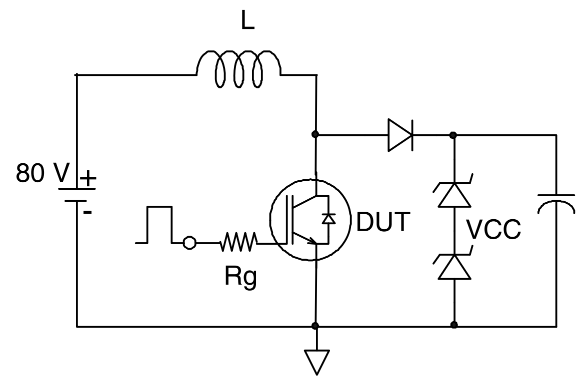


Fig.C.T.2 - RBSOA Circuit

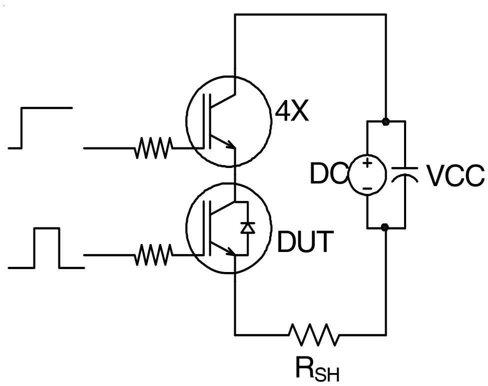


Fig.C.T.3 - S.C. SOA Circuit

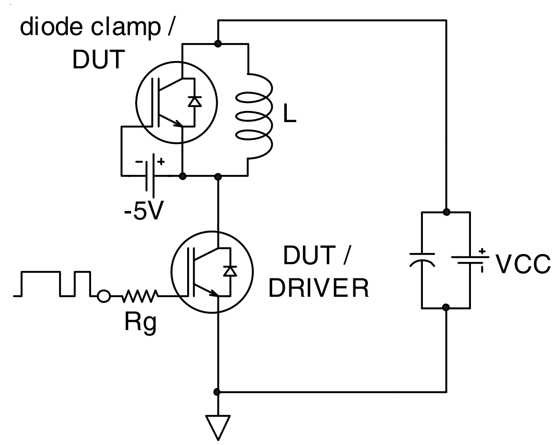


Fig.C.T.4 - Switching Loss Circuit

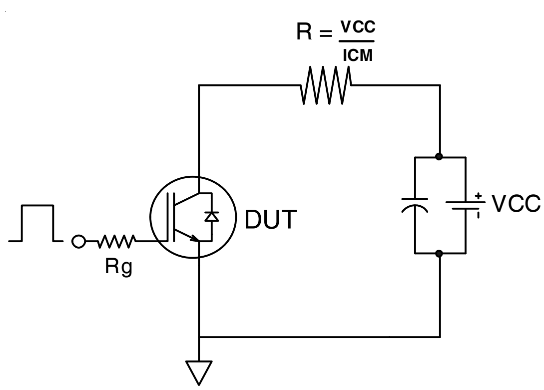


Fig.C.T.5 - Resistive Load Circuit

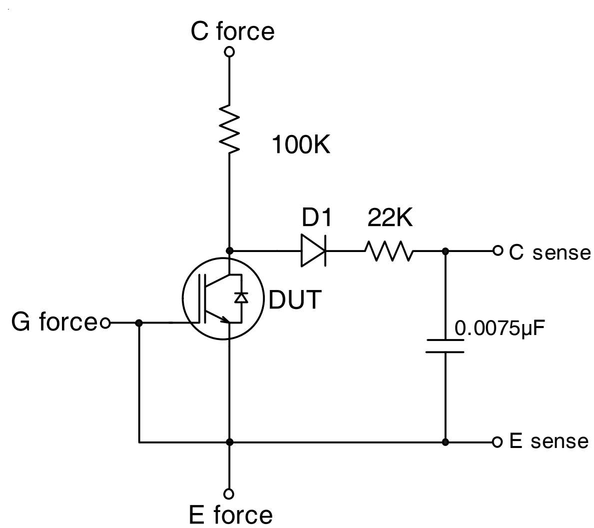


Fig.C.T.6 - BVCES Filter Circuit

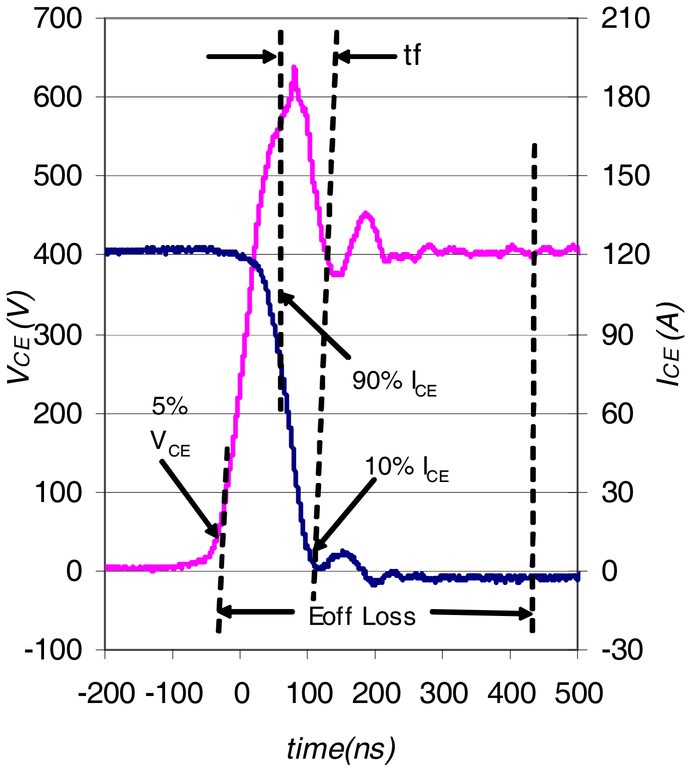


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

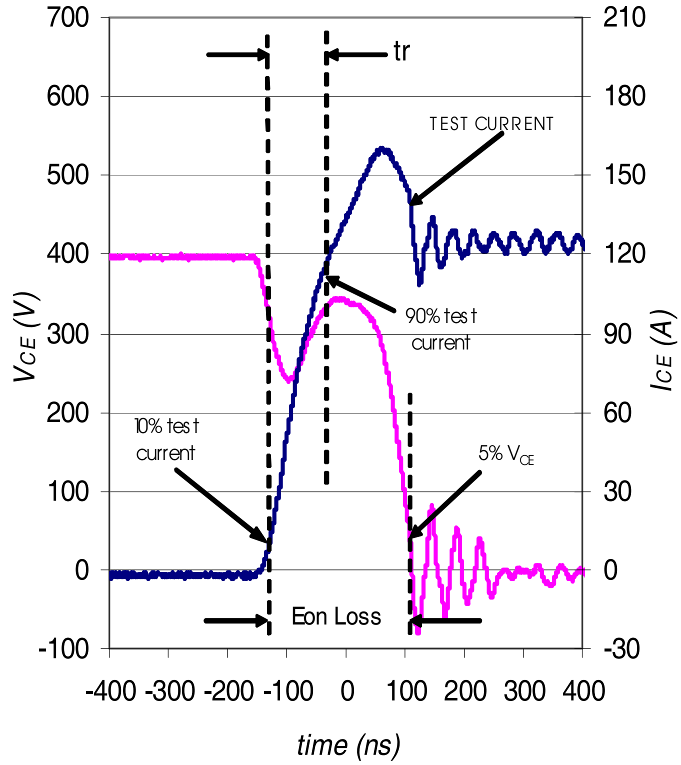


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4

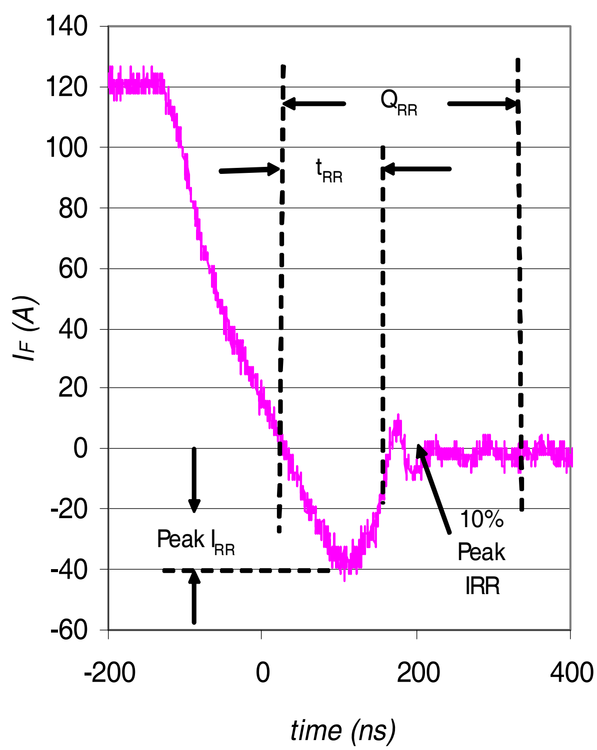


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 175°C using Fig. CT.4

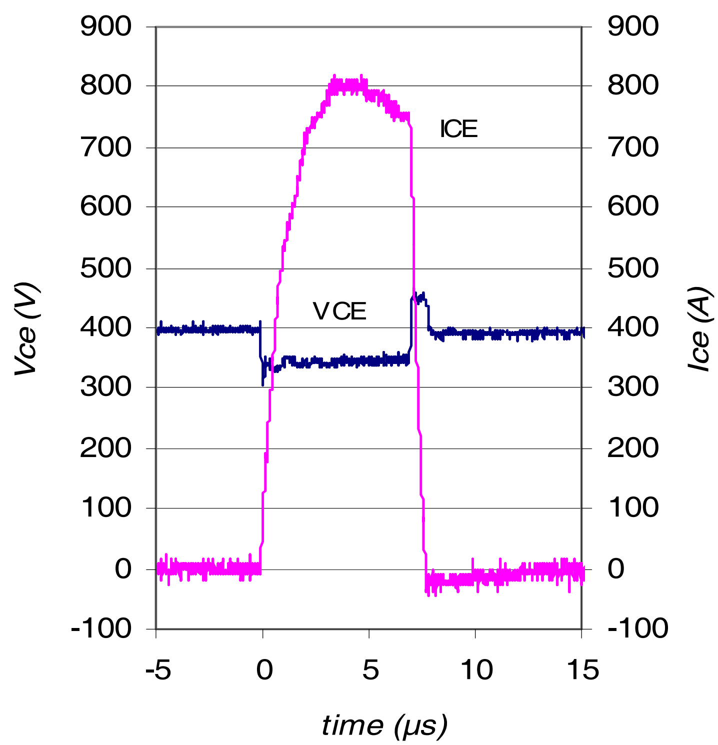
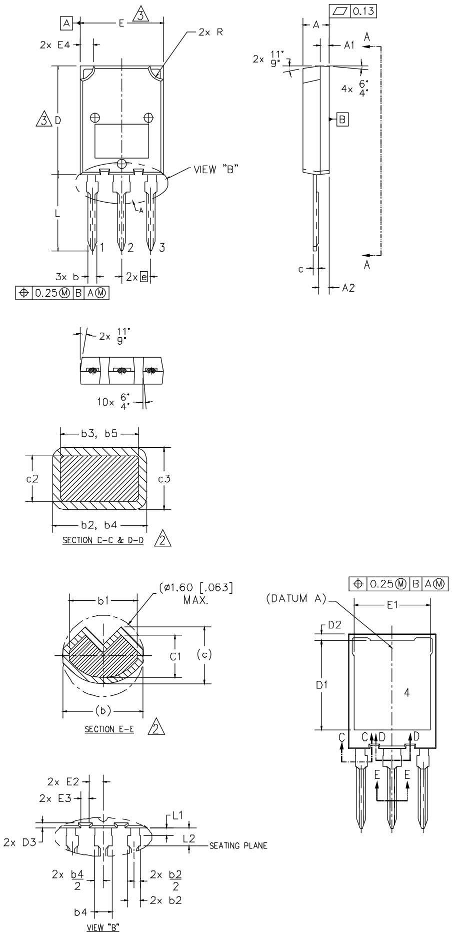


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 25°C using Fig. CT.3

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

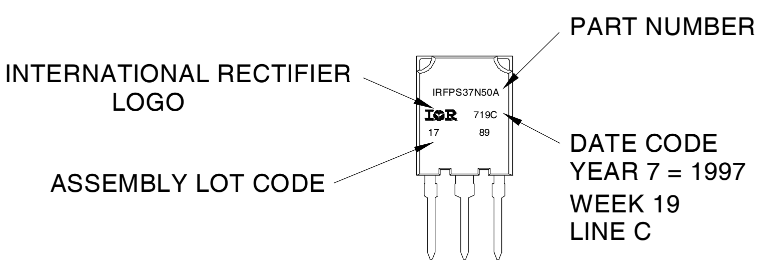
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

IGBT

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

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

EXAMPLE: THIS IS AN IRFPS37N50A WITH
ASSEMBLY LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"



Note: "P" in assembly line position indicates "Lead-Free"

TOP

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

Qualification Information†

Qualification Level		Industrial (per International Rectifier's internal guidelines)	
Moisture Sensitivity Level		Super-247	N/A
ESD	Human Body Model	Class H3B (8000V)†† AEC-Q101-001	
	Charged Device Model	Class C5 (1125V)†† AEC-Q101-005	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability
†† Highest passing voltage.

International Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA
To contact International Rectifier, please visit http://www.irf.com/whoto-call/

