IGBT

Reverse conducting IGBT with monolithic body diode

IHD06N60RA

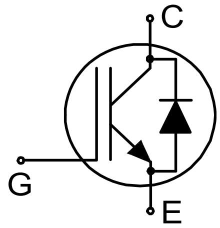
600V Soft Switching Series
Qualified to automotive standard AECQ101

Data sheet

Industrial Power Control

Reverse conducting IGBT with monolithic body diode

Features:



- Powerful monolithic body diode with low forward voltage designed for soft commutation only
- TRENCHSTOP™ technology applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - low V_{CEsat}
  - easy parallel switching capability due to positive temperature coefficient in V_{CEsat}
- Low EMI
- Qualified to automotive standard AECQ101
- Pb-free lead plating; RoHS compliant; solder temperature 260°C, MSL1
- Complete product spectrum and PSpice Models: http://www.infineon.com/igbt/

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
IHD06N60RA	600V	6A	1.45V	175°C	H06R60A	PG-TO252-3

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Maximum ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25°C$	V_{CE}	600	V
DC collector current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_C	12.0 6.0	A
Pulsed collector current, t_p limited by T_{vjmax}	I_{Cpuls}	18.0	A
Turn off safe operating area $V_{CE} \leq 600V$, $T_{vj} \leq 175°C$	-	18.0	A
Diode forward current, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	I_F	12.0 6.0	A
Diode pulsed current, t_p limited by T_{vjmax}	I_{Fpuls}	18.0	A
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time $V_{GE} = 15.0V$, $V_{CC} \leq 250V$ Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0s $T_{vj} = 150°C$	t_{SC}	10	µs
Power dissipation $T_C = 25°C$	P_{tot}	88.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-40...+175	°C
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	°C

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		1.70	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		1.70	K/W
Thermal resistance, min. footprint junction - ambient	$R_{th(j-a)}$		75	K/W
Thermal resistance, 6cm² Cu on PCB junction - ambient	$R_{th(j-a)}$		50	K/W

Electrical Characteristic, at T_{vj} = 25°C, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	V_{GE} = 0V, I_C = 0.20mA	600	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 6.0A T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	- - -	1.45 1.70 1.75	1.90 - -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 6.0A T_{vj} = 25°C T_{vj} = 150°C T_{vj} = 175°C	- - -	1.55 1.65 1.65	1.90 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.18mA, V_{CE} = V_{GE}	4.1	4.9	5.7	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 600V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	- -	- -	40.0 600.0	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 6.0A	-	3.7	-	S
Integrated gate resistor	r_G			none		Ω

Electrical Characteristic, at T_{vj} = 25°C, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	V_{CE} = 25V, V_{GE} = 0V, f = 1MHz	-	370	-	pF
Output capacitance	C_{oes}		-	28	-	
Reverse transfer capacitance	C_{res}		-	11	-	
Gate charge	Q_G	V_{CC} = 480V, I_C = 6.0A, V_{GE} = 15V	-	42.0	-	nC
Short circuit collector current Max. 1000 short circuits Time between short circuits: ≥ 1.0s	$I_{C(SC)}$	V_{GE} = 15.0V, V_{CC} ≤ 250V, t_{SC} ≤ 10µs T_{vj} = 150°C	-	39	-	A

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 6.0A, V_{GE} = 0.0/15.0V, r_G = 14.7Ω, $L\sigma$ = 60nH, $C\sigma$ = 40pF $L\sigma$, $C\sigma$ from Fig. E Diode used for turn on results: SDP04S60	-	25	-	ns
Rise time	t_r		-	20	-	ns
Turn-off delay time	$t_{d(off)}$		-	125	-	ns
Fall time	t_f		-	145	-	ns
Turn-on energy	E_{on}		-	0.05	-	mJ
Turn-off energy	E_{off}		-	0.15	-	mJ
Total switching energy	E_{ts}		-	0.20	-	mJ

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 175°C, V_{CC} = 400V, I_C = 6.0A, V_{GE} = 0.0/15.0V, r_G = 14.7Ω, $L\sigma$ = 60nH, $C\sigma$ = 40pF $L\sigma$, $C\sigma$ from Fig. E Diode used for turn on results: SDP04S60	-	28	-	ns
Rise time	t_r		-	22	-	ns
Turn-off delay time	$t_{d(off)}$		-	165	-	ns
Fall time	t_f		-	160	-	ns
Turn-on energy	E_{on}		-	0.06	-	mJ
Turn-off energy	E_{off}		-	0.25	-	mJ
Total switching energy	E_{ts}		-	0.31	-	mJ

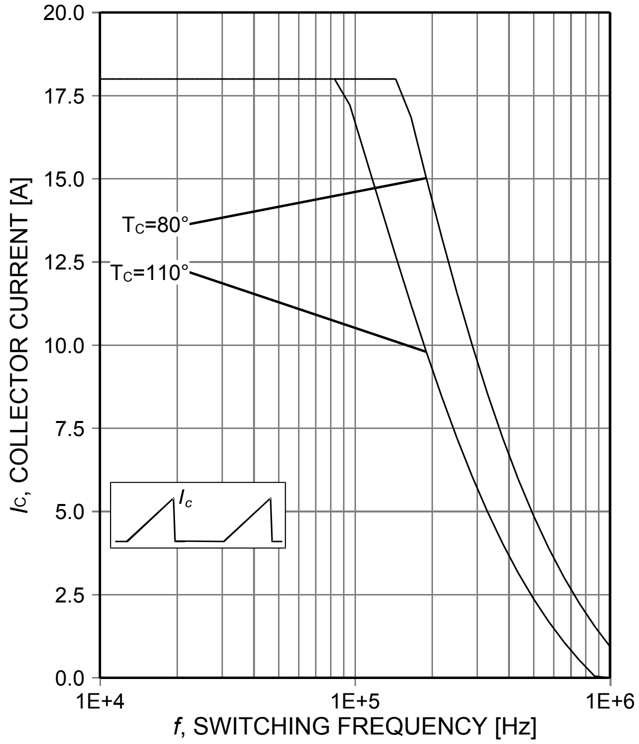


Figure 1. **Collector current as a function of switching frequency**
(T_{vj}≤175°C, D=0.5, V_{CE}=400V, V_{GE}=15/0V, r_G=14.7Ω)

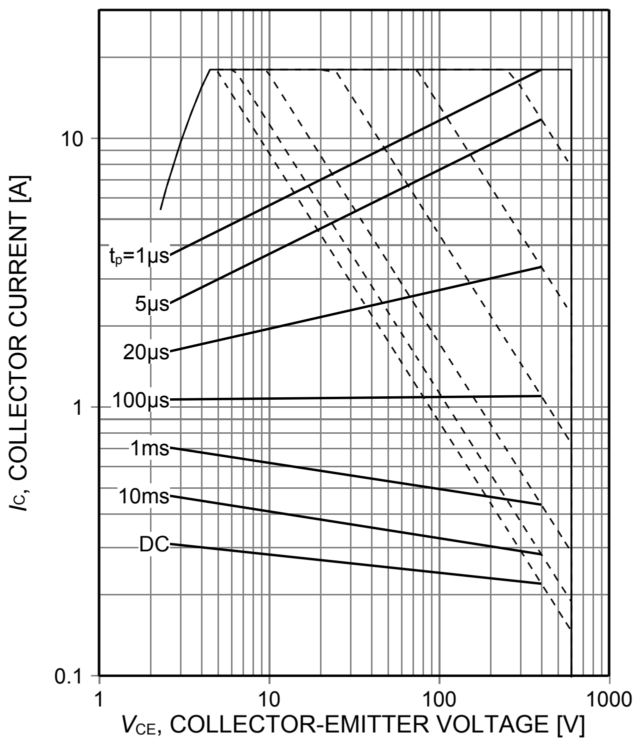


Figure 2. **Forward bias safe operating area**
(D=0, T_C=25°C, T_{vj}≤175°C; V_{GE}=15V)

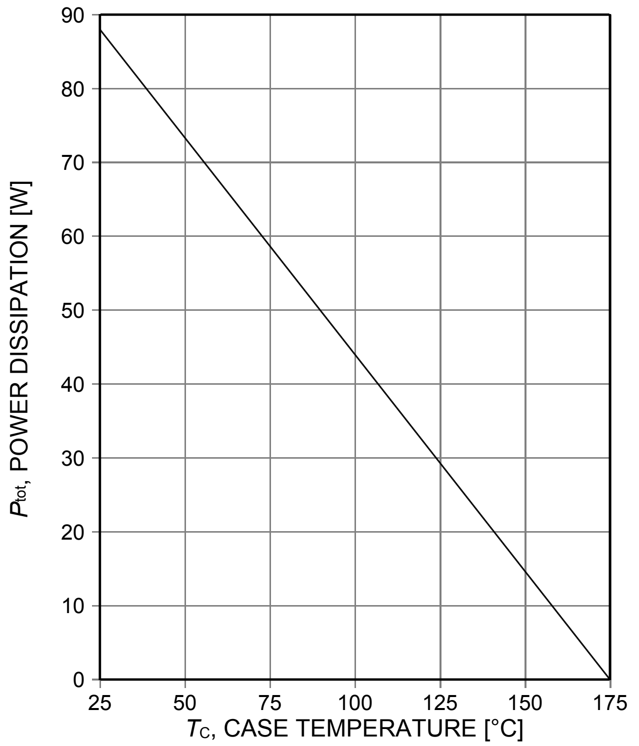


Figure 3. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)

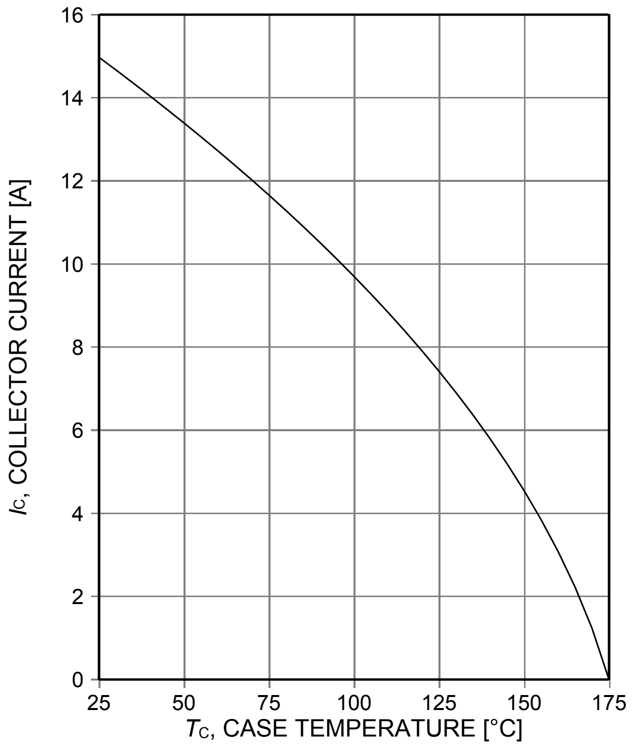


Figure 4. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)

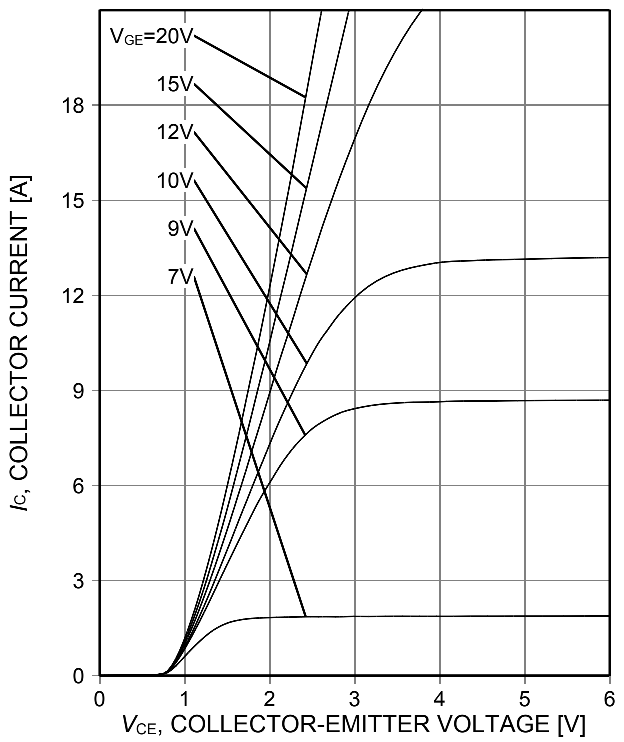


Figure 5. **Typical output characteristic**
(T_{vj}=25°C)

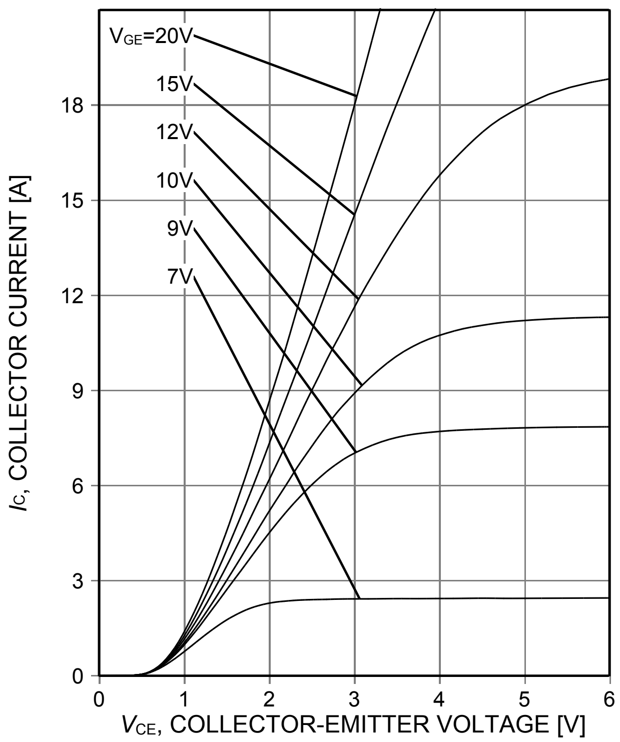


Figure 6. **Typical output characteristic**
(T_{vj}=175°C)

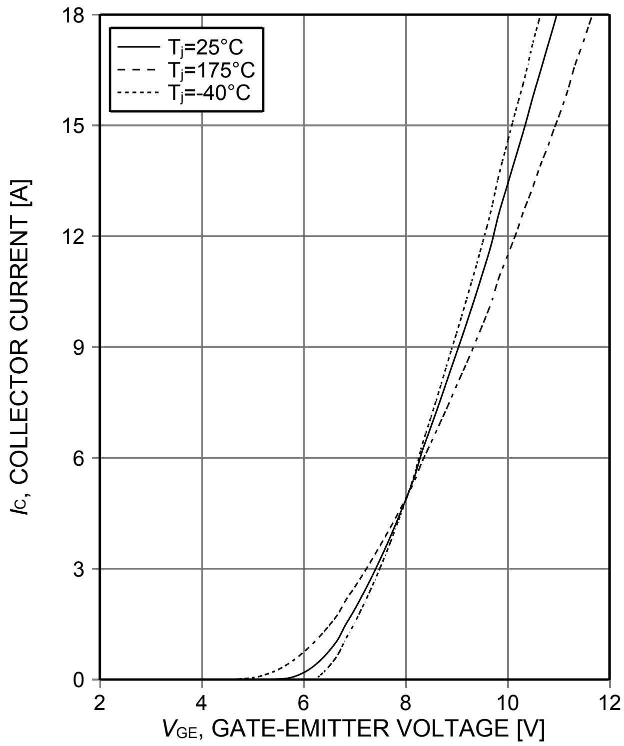


Figure 7. **Typical transfer characteristic**
(V_{CE}=20V)

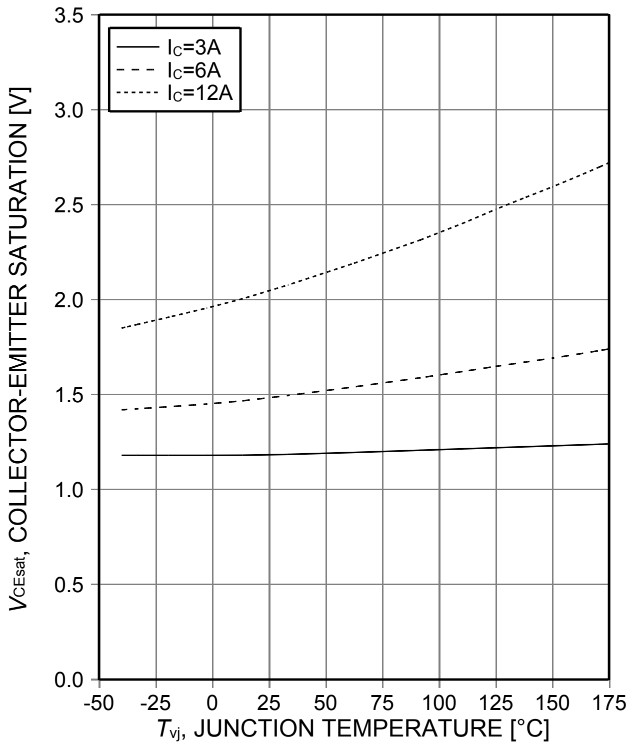


Figure 8. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

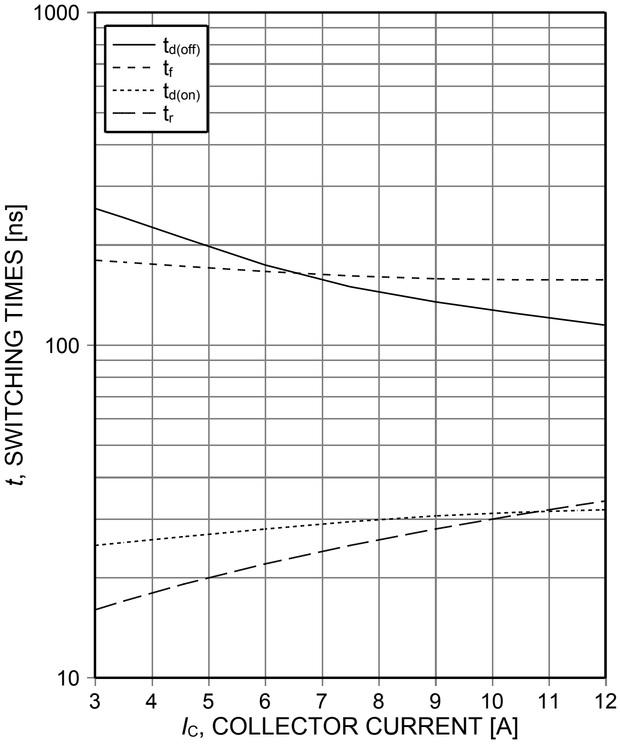


Figure 9. **Typical switching times as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=14.7Ω, Dynamic test circuit in Figure E. Used diode: SDP04S60)

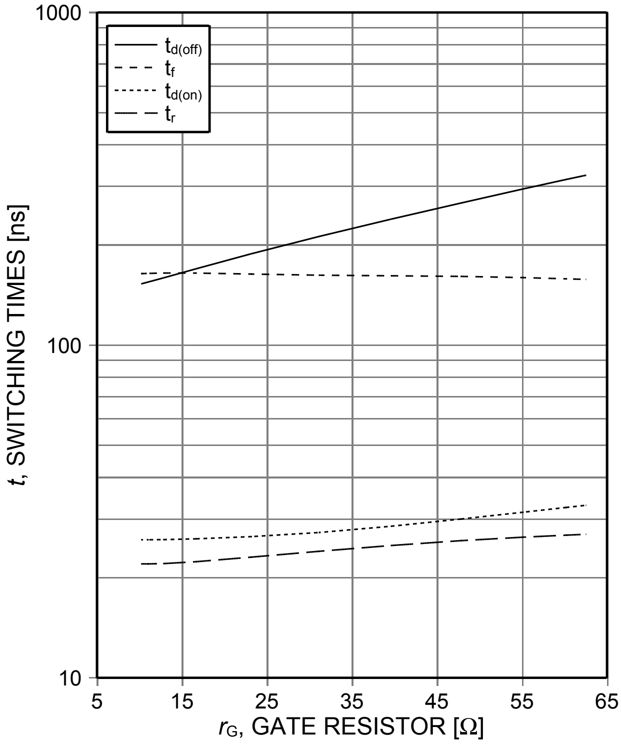


Figure 10. **Typical switching times as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=6A,Dynamic test circuit in Figure E. Used diode: SDP04S60)

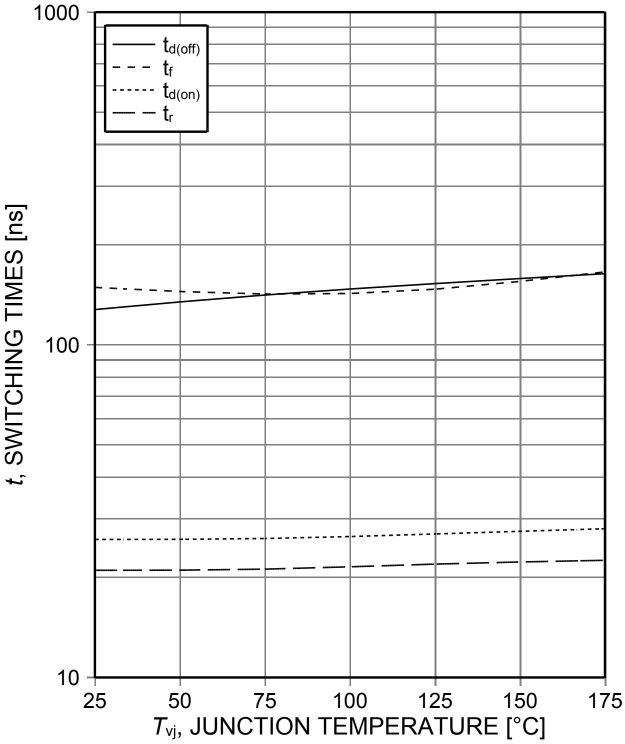


Figure 11. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=6A, r_G=14.7Ω,Dynamic test circuit in Figure E. Used diode: SDP04S60)

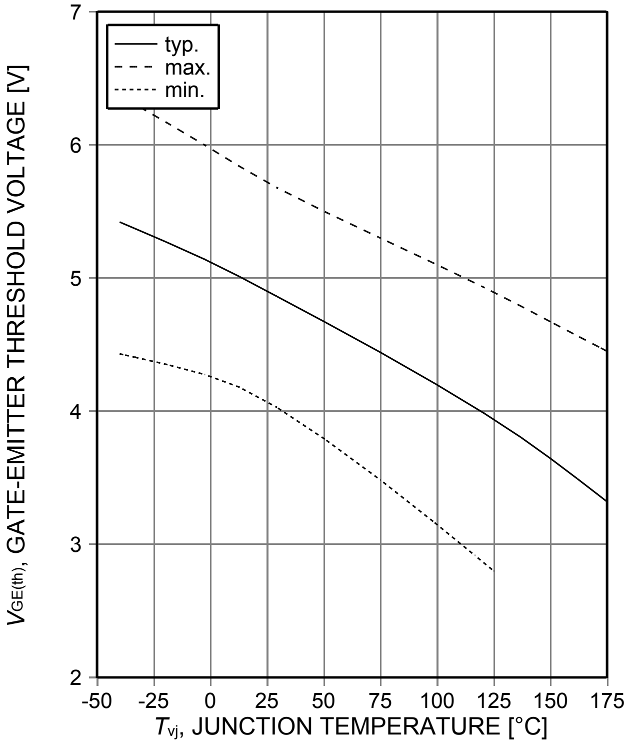


Figure 12. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.18mA)

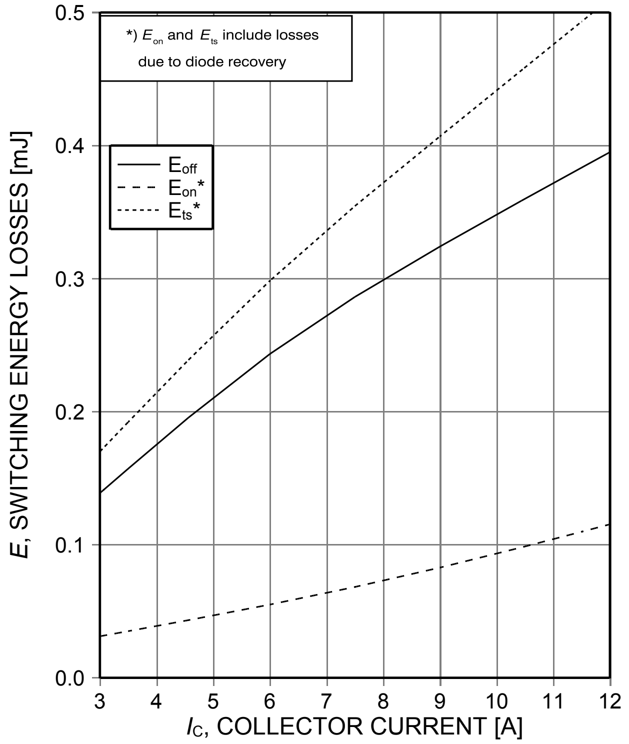


Figure 13. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, r_G=14.7Ω,Dynamic test circuit in Figure E. Used diode: SDP04S60)

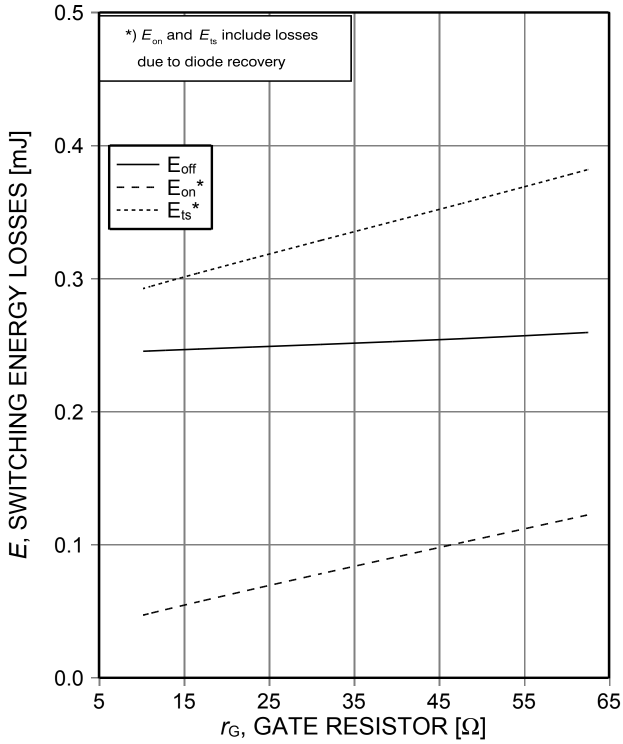


Figure 14. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_{vj}=175°C, V_{CE}=400V, V_{GE}=15/0V, I_C=6A, Dynamic test circuit in Figure E. Used diode: SDP04S60)

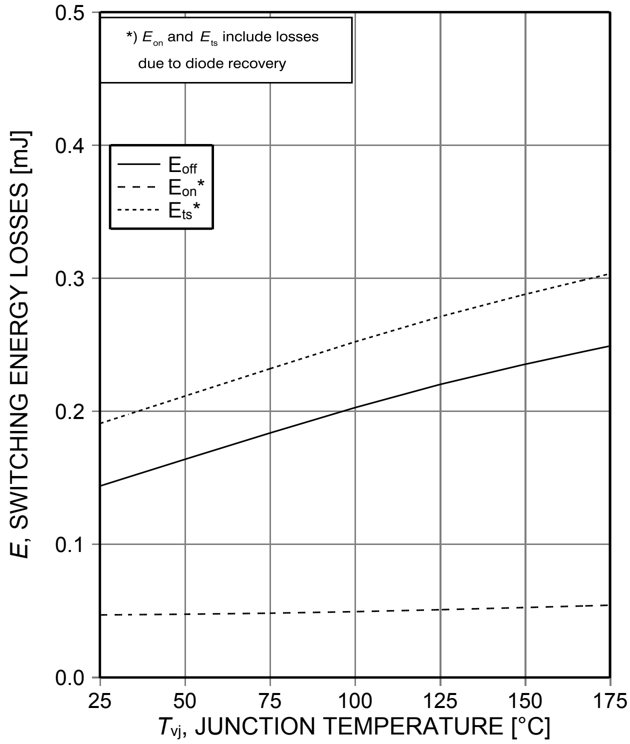


Figure 15. **Typical switching energy losses as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=6A, r_G=14.7Ω,Dynamic test circuit in Figure E. Used diode: SDP04S60)

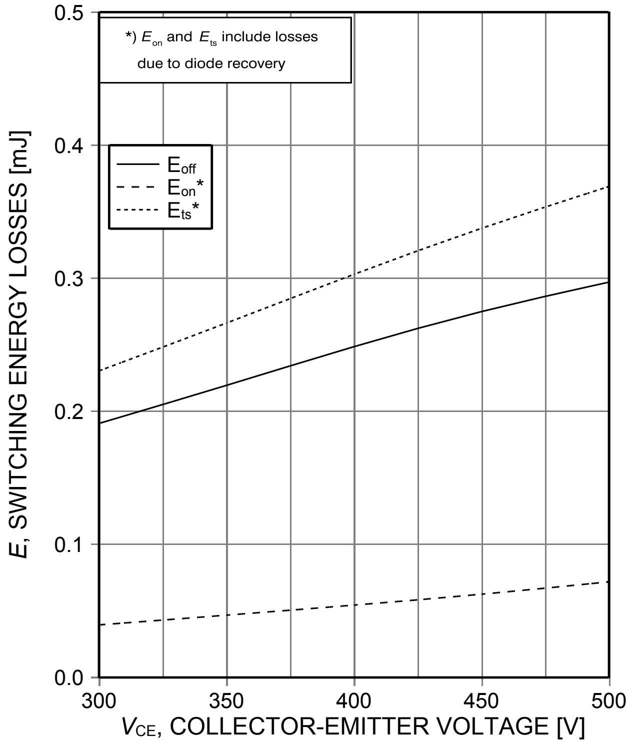


Figure 16. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, T_{vj}=175°C, V_{GE}=15/0V, I_C=6A, r_G=14.7Ω,Dynamic test circuit in Figure E. Used diode: SDP04S60)

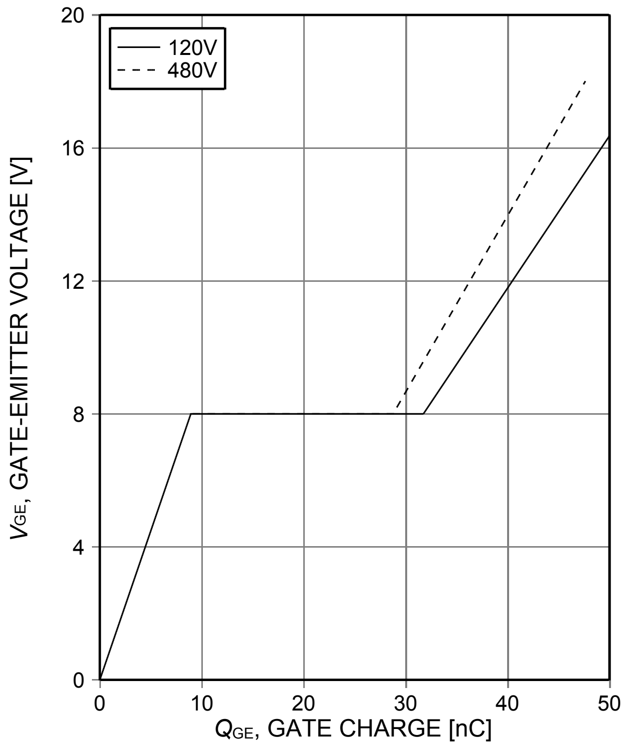


Figure 17. **Typical gate charge**
(I_C=6A)

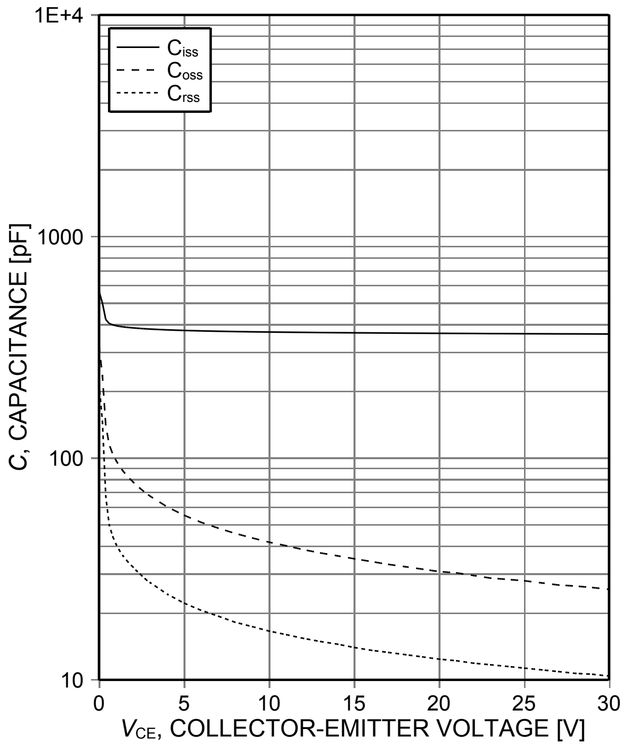


Figure 18. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

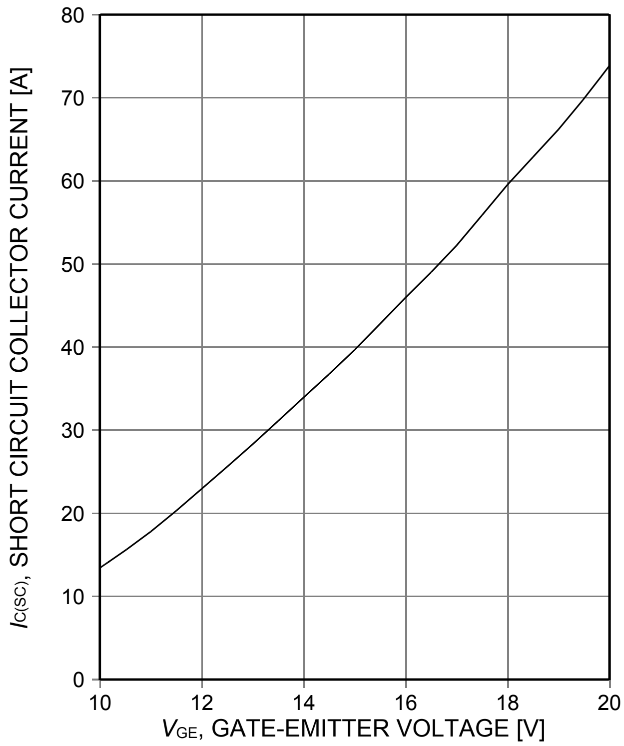


Figure 19. **Typical short circuit collector current as a function of gate-emitter voltage**
(V_{CE}=250V, T_{vj}=150°C)

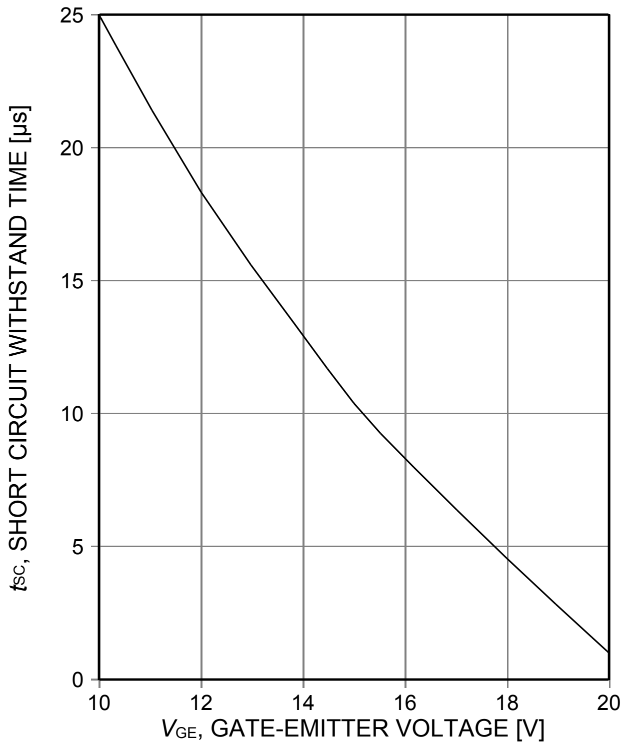


Figure 20. **Short circuit withstand time as a function of gate-emitter voltage**
(V_{CE}≤250V, start at T_{vj}≤150°C)

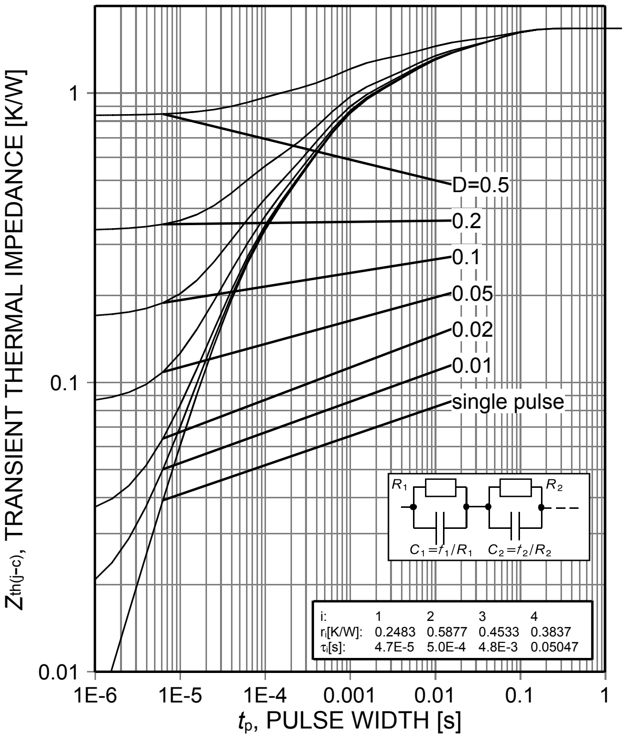


Figure 21. **IGBT transient thermal impedance** ($D=t_p/T$)

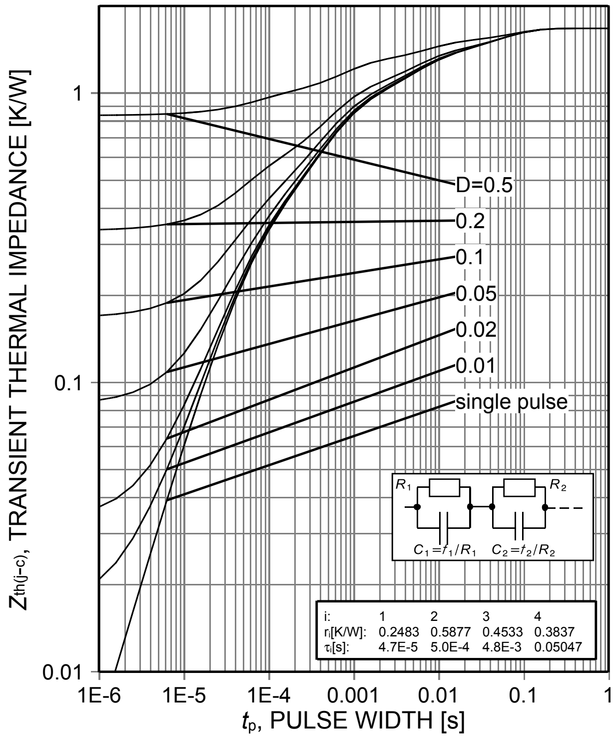


Figure 22. **Diode transient thermal impedance as a function of pulse width** ($D=t_p/T$)

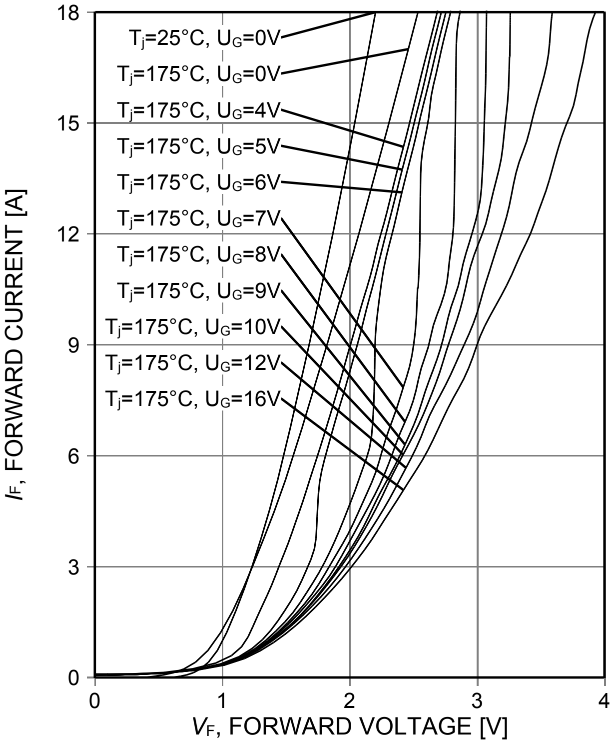


Figure 23. **Typical diode forward current as a function of forward voltage**

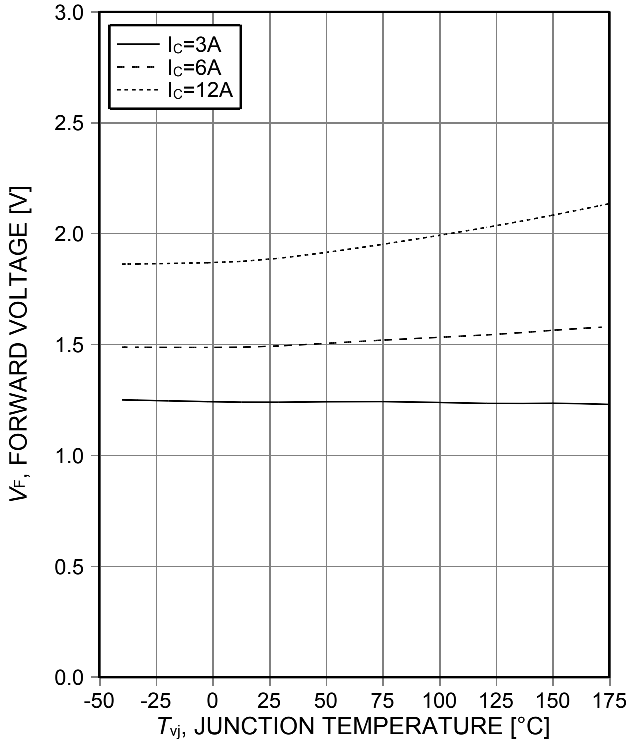
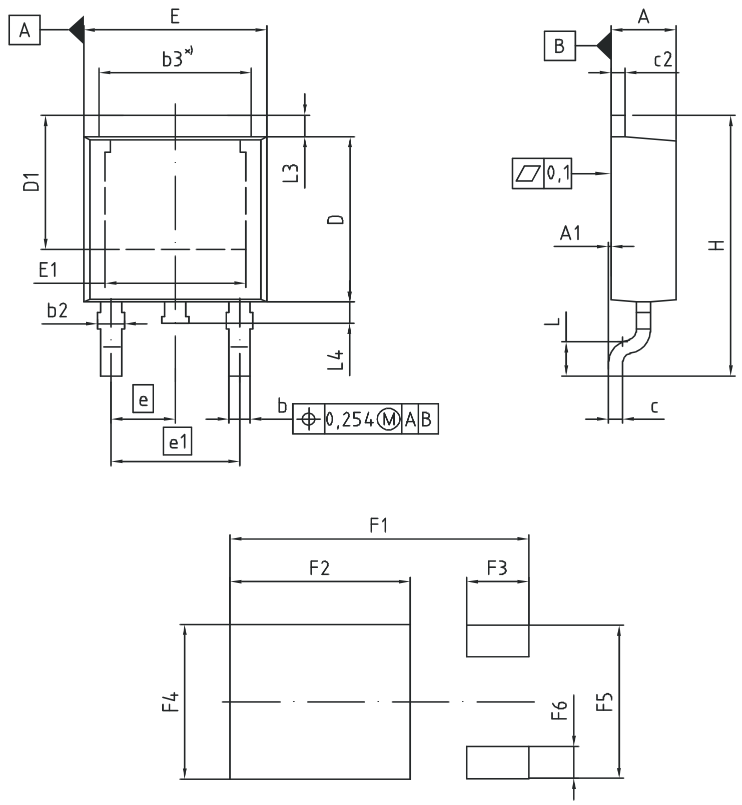


Figure 24. **Typical diode forward voltage as a function of junction temperature**

PG-TO252-3

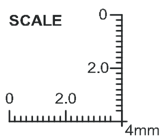


*) mold flash not included

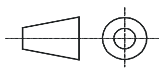
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.00	0.15	0.000	0.006
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b3	5.00	5.50	0.197	0.217
c	0.46	0.60	0.018	0.024
c2	0.46	0.98	0.018	0.039
D	5.97	6.22	0.235	0.245
D1	5.02	5.84	0.198	0.230
E	6.40	6.73	0.252	0.265
E1	4.70	5.21	0.185	0.205
e	2.29 (BSC)		0.090 (BSC)	
e1	4.57		0.180	
N	3		3	
H	9.40	10.48	0.370	0.413
L	1.18	1.70	0.046	0.067
L3	0.90	1.25	0.035	0.049
L4	0.51	1.00	0.020	0.039
F1	10.60		0.417	
F2	6.40		0.252	
F3	2.20		0.087	
F4	5.80		0.228	
F5	5.76		0.227	
F6	1.20		0.047	

DOCUMENT NO.
Z8B00003328

SCALE



EUROPEAN PROJECTION



ISSUE DATE
16-02-2011

REVISION
04

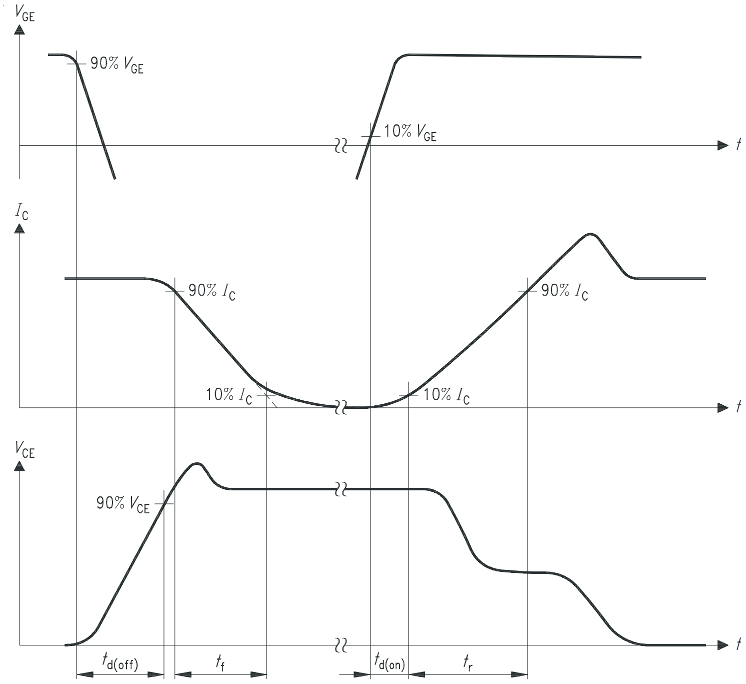


Figure A. Definition of switching times

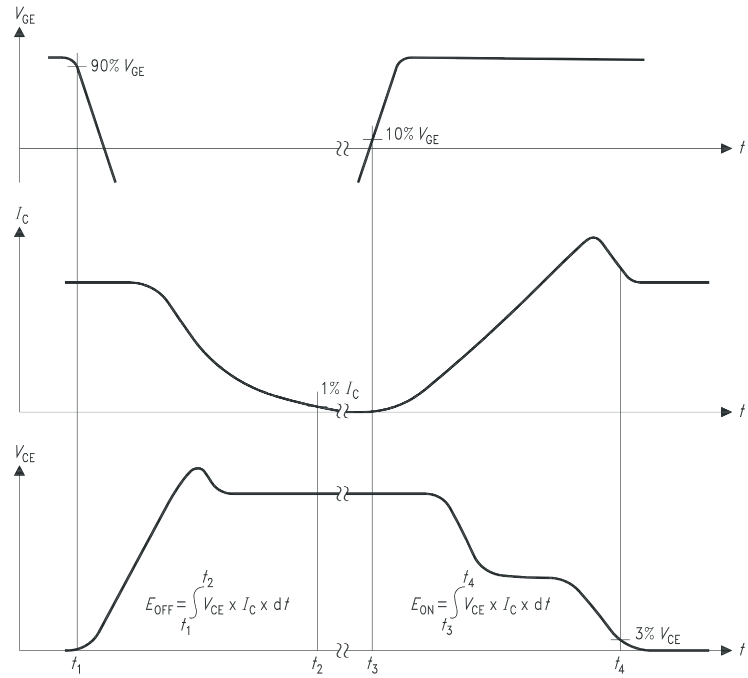


Figure B. Definition of switching losses

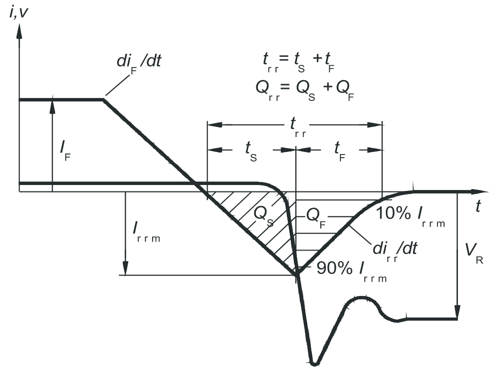


Figure C. Definition of diodes switching characteristics

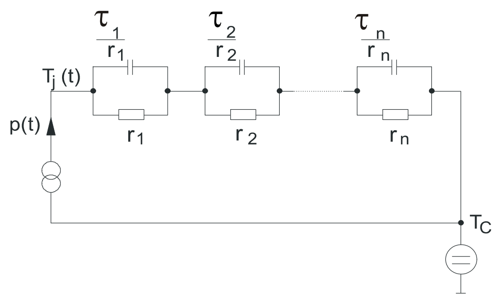


Figure D. Thermal equivalent circuit

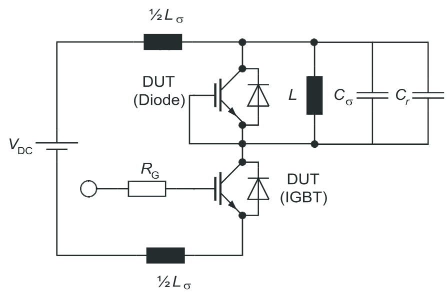


Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r
(only for ZVT switching)

Revision History

IHD06N60RA

Revision: 2013-02-19, Rev. 2.1

Previous Revision		
Revision	Date	Subjects (major changes since last revision)
0.1	2008-03-17	-
1.2	2008-07-22	-
1.3	2008-07-29	-
1.4	2009-07-14	-
2.1	2013-02-19	Final data sheet

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