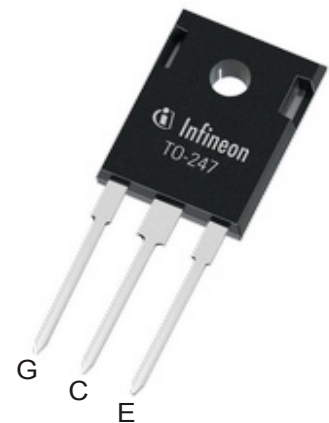
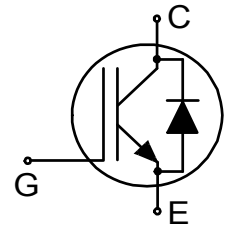


## TRENCHSTOP™ Series

## Low Loss DuoPack: IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery antiparallel Emitter Controlled diode

### Features:

- Automotive AEC-Q101 qualified
- Designed for DC/AC converters for Automotive Application
- Very low  $V_{CE(sat)}$  1.5V (typ.)
- Maximum junction temperature 175°C
- Dynamically stress tested
- Short circuit withstand time 5 $\mu$ s
- 100% short circuit tested
- 100% of the parts are dynamically tested
- Positive temperature coefficient in  $V_{CE(sat)}$
- Low EMI
- Low gate charge  $Q_G$
- Green package
- Very soft, fast recovery antiparallel Emitter Controlled HE diode
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers:
  - very tight parameter distribution
  - high ruggedness, temperature stable behavior
  - very high switching speed



### Applications:

- Main inverter
- Climate compressor
- PTC heater
- Motor drives



### Key Performance and Package Parameters

Type	$V_{CE}$	$I_C$	$V_{CE(sat)}$ , $T_{vj}=25^\circ\text{C}$	$T_{vjmax}$	Marking	Package
AIKW20N60CT	600V	20A	1.5V	175°C	AK20DCT	PG-TO247-3



**Table of Contents**

Description ..... 1

Table of Contents ..... 2

Maximum Ratings ..... 3

Thermal Resistance ..... 3

Electrical Characteristics ..... 4

Electrical Characteristics Diagrams ..... 6

Package Drawing .....13

Testing Conditions .....14

Revision History .....15

Disclaimer .....16

## TRENCHSTOP™ Series

## Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_{vj} \geq 25^{\circ}\text{C}$	$V_{CE}$	600	V
DC collector current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	$I_C$	40.0 20.0	A
Pulsed collector current, $t_p$ limited by $T_{vjmax}$	$I_{Cpuls}$	60.0	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p = 1\mu\text{s}$	-	60.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ value limited by bondwire $T_C = 100^{\circ}\text{C}$	$I_F$	40.0 20.0	A
Diode pulsed current, $t_p$ limited by $T_{vjmax}$	$I_{Fpuls}$	60.0	A
Gate-emitter voltage	$V_{GE}$	$\pm 20$	V
Short circuit withstand time $V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 400\text{V}$ Allowed number of short circuits < 1000 Time between short circuits: $\geq 1.0\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{SC}$	5	$\mu\text{s}$
Power dissipation $T_C = 25^{\circ}\text{C}$	$P_{tot}$	166.0	W
Operating junction temperature	$T_{vj}$	-40...+175	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-55...+150	$^{\circ}\text{C}$
Soldering temperature, <sup>1)</sup> wave soldering 1.6mm (0.063in.) from case for 10s		260	$^{\circ}\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	$M$	0.6	Nm

## Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>R<sub>th</sub> Characteristics</b>						
IGBT thermal resistance, <sup>2)</sup> junction - case	$R_{th(j-c)}$		-	-	0.90	K/W
Diode thermal resistance, <sup>2)</sup> junction - case	$R_{th(j-c)}$		-	-	1.50	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

<sup>1)</sup> Package not recommended for surface mount application

<sup>2)</sup> Thermal resistance of thermal grease  $R_{th(c-s)}$  (case to heat sink) of more than 0.1K/W not included.

## TRENCHSTOP™ Series

Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Static Characteristic</b>						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE} = 0\text{V}, I_C = 0.20\text{mA}$	600	-	-	V
Collector-emitter saturation voltage	$V_{CEsat}$	$V_{GE} = 15.0\text{V}, I_C = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.50 1.90	2.05 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	1.65 1.60	2.05 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.29\text{mA}, V_{CE} = V_{GE}$	4.1	4.9	5.7	V
Zero gate voltage collector current	$I_{CES}$	$V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 175^{\circ}\text{C}$	- -	- 550	40 -	$\mu\text{A}$
Gate-emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}, V_{GE} = 20\text{V}$	-	-	100	nA
Transconductance	$g_{fs}$	$V_{CE} = 20\text{V}, I_C = 20.0\text{A}$	-	11.0	-	S

Electrical Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ , unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>Dynamic Characteristic</b>						
Input capacitance	$C_{ies}$	$V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	1100	-	pF
Output capacitance	$C_{oes}$		-	71	-	
Reverse transfer capacitance	$C_{res}$		-	32	-	
Gate charge	$Q_G$	$V_{CC} = 480\text{V}, I_C = 20.0\text{A},$ $V_{GE} = 15\text{V}$	-	120.0	-	nC
Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0\text{s}$	$I_{C(SC)}$	$V_{GE} = 15.0\text{V}, V_{CC} \leq 400\text{V},$ $t_{SC} \leq 5\mu\text{s}$ $T_{vj} = 150^{\circ}\text{C}$	-	183	-	A

## Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
<b>IGBT Characteristic, at <math>T_{vj} = 25^{\circ}\text{C}</math></b>						
Turn-on delay time	$t_{d(on)}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 20.0\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 12.0\Omega, R_{G(off)} = 12.0\Omega,$ $L_{\sigma} = 131\text{nH}, C_{\sigma} = 31\text{pF}$ $L_{\sigma}, C_{\sigma}$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	14	-	ns
Turn-off delay time	$t_{d(off)}$		-	199	-	ns
Fall time	$t_f$		-	42	-	ns
Turn-on energy	$E_{on}$		-	0.31	-	mJ
Turn-off energy	$E_{off}$		-	0.46	-	mJ
Total switching energy	$E_{ts}$		-	0.77	-	mJ

## TRENCHSTOP™ Series

Diode Characteristic, at  $T_{vj} = 25^{\circ}\text{C}$ 

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 20.0\text{A}$ , $di_F/dt = 880\text{A}/\mu\text{s}$	-	41	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	0.31	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	13.3	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-711	-	$\text{A}/\mu\text{s}$

## Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	

IGBT Characteristic, at  $T_{vj} = 175^{\circ}\text{C}$ 

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 20.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L\sigma = 131\text{nH}$ , $C\sigma = 31\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	18	-	ns
Turn-off delay time	$t_{d(off)}$		-	223	-	ns
Fall time	$t_f$		-	76	-	ns
Turn-on energy	$E_{on}$		-	0.51	-	mJ
Turn-off energy	$E_{off}$		-	0.64	-	mJ
Total switching energy	$E_{ts}$		-	1.15	-	mJ

Diode Characteristic, at  $T_{vj} = 175^{\circ}\text{C}$ 

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 175^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 20.0\text{A}$ , $di_F/dt = 880\text{A}/\mu\text{s}$	-	176	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.46	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	18.9	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	-467	-	$\text{A}/\mu\text{s}$

TRENCHSTOP™ Series

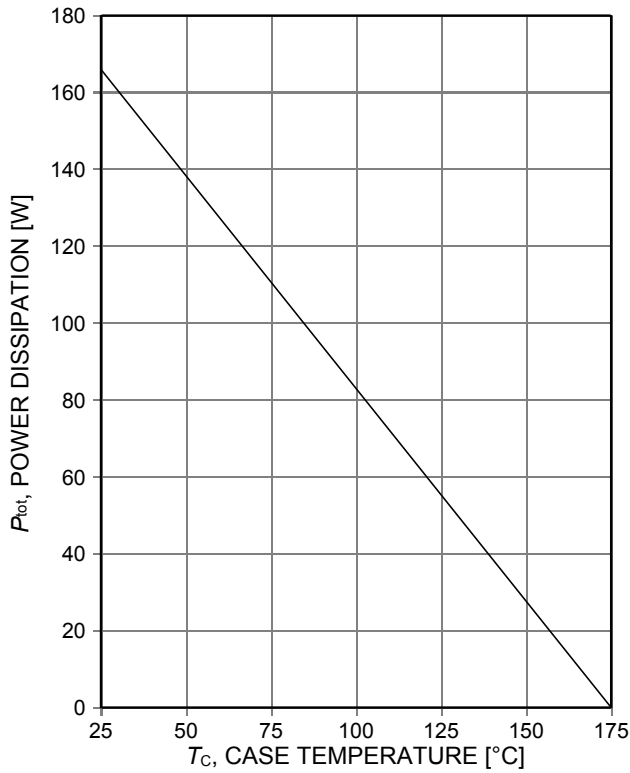


Figure 1. Power dissipation as a function of case temperature ( $T_j \leq 175^\circ\text{C}$ )

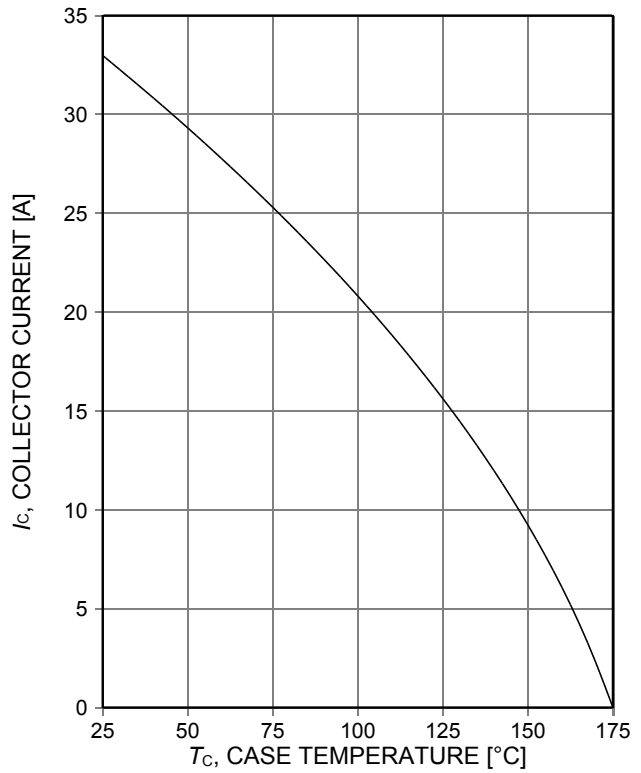


Figure 2. Collector current as a function of case temperature ( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 175^\circ\text{C}$ )

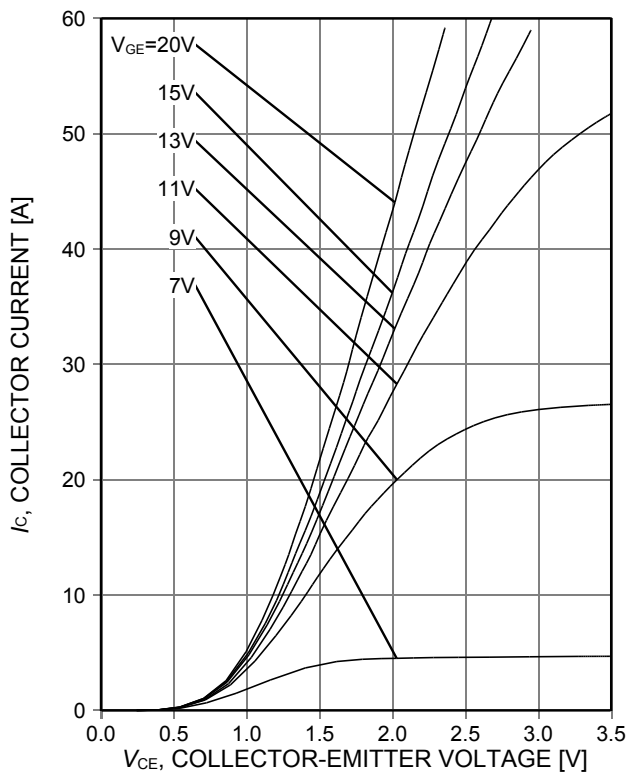


Figure 3. Typical output characteristic ( $T_j = 25^\circ\text{C}$ )

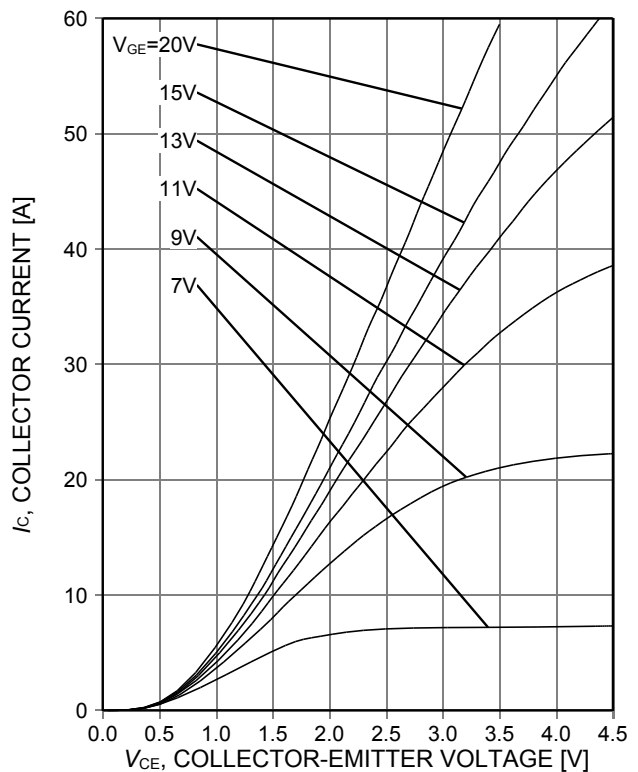


Figure 4. Typical output characteristic ( $T_j = 175^\circ\text{C}$ )

TRENCHSTOP™ Series

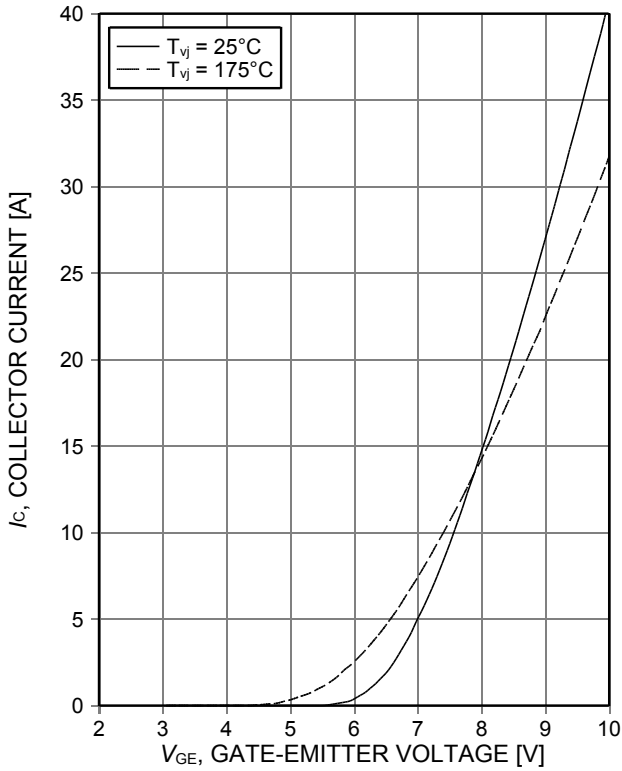


Figure 5. **Typical transfer characteristic**  
( $V_{CE}=20V$ )

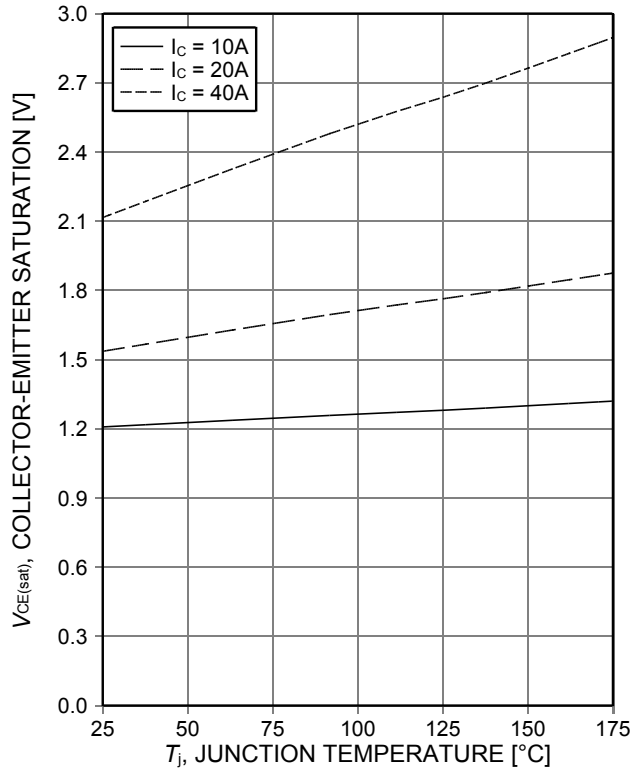


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15V$ )

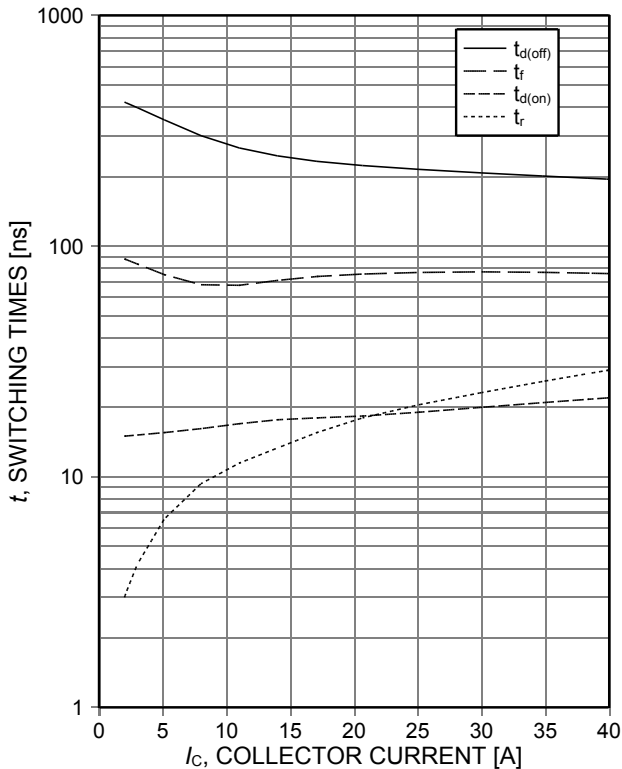


Figure 7. **Typical switching times as a function of collector current**  
(inductive load,  $T_j=175^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

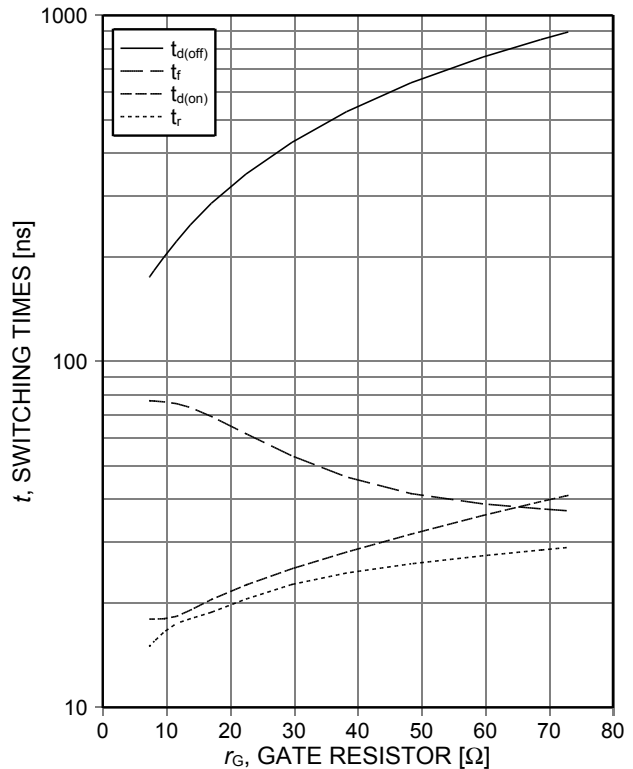


Figure 8. **Typical switching times as a function of gate resistor**  
(inductive load,  $T_j=175^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)

TRENCHSTOP™ Series

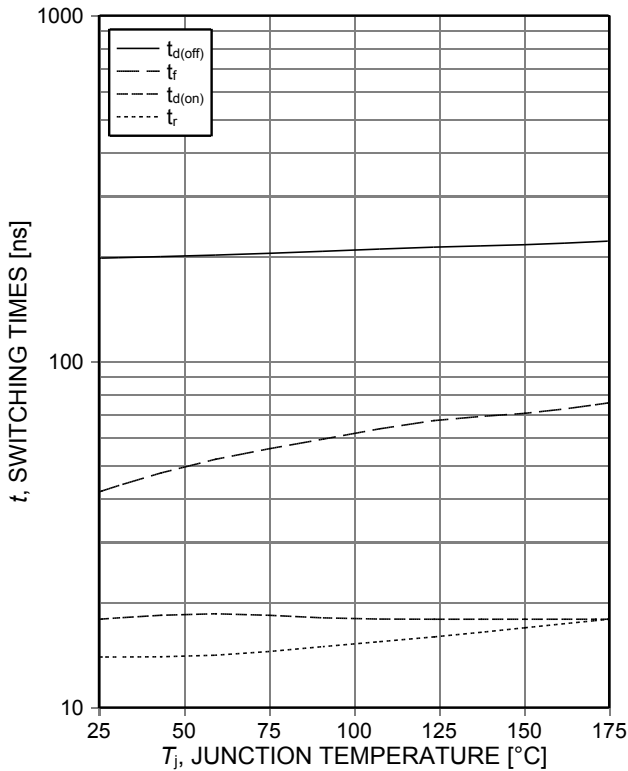


Figure 9. **Typical switching times as a function of junction temperature**  
 (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=20A$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

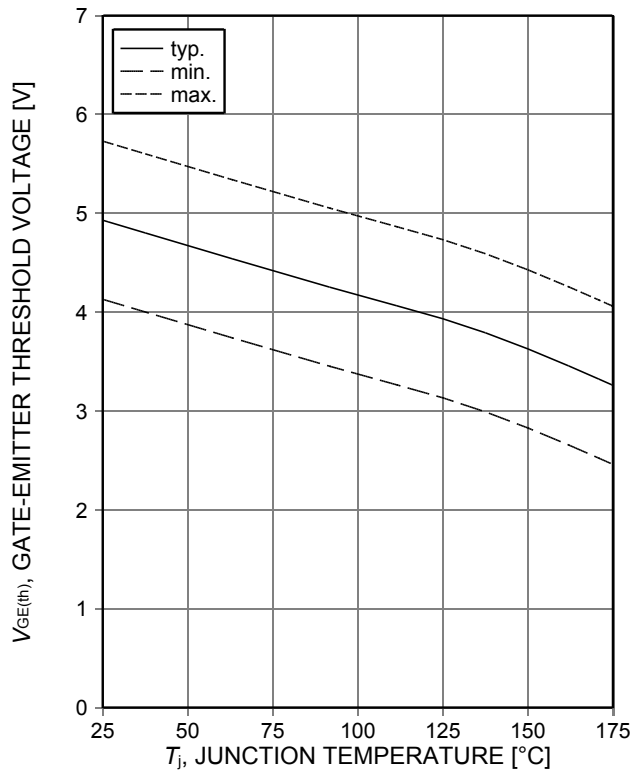


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**  
 ( $I_C=0,29mA$ )

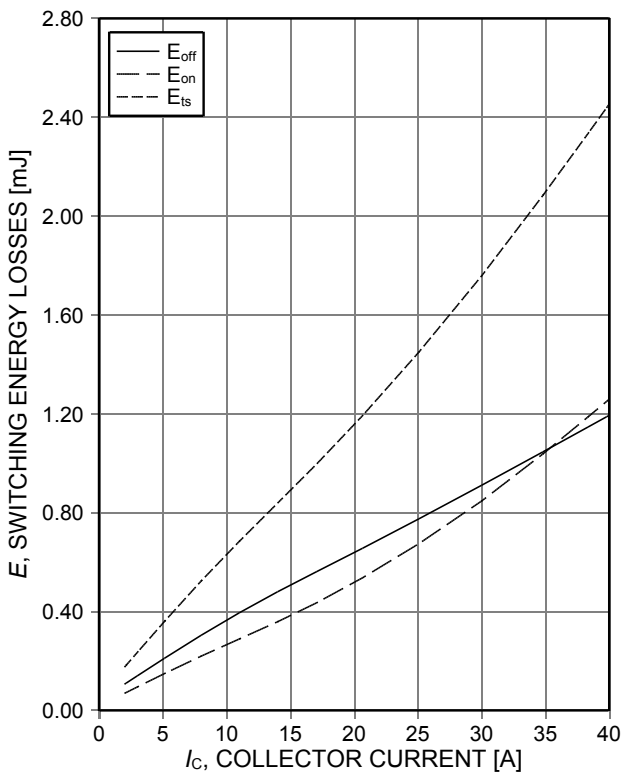


Figure 11. **Typical switching energy losses as a function of collector current**  
 (inductive load,  $T_j=175^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

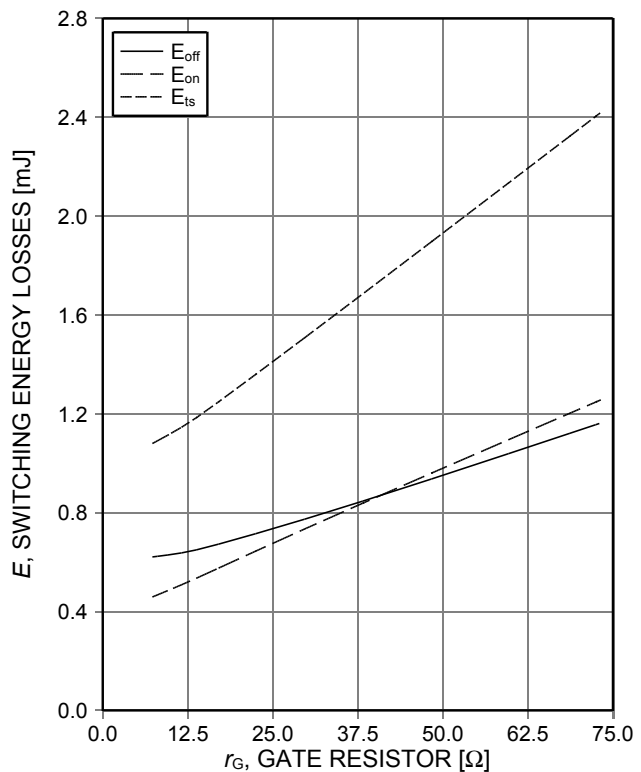


Figure 12. **Typical switching energy losses as a function of gate resistor**  
 (inductive load,  $T_j=175^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)



TRENCHSTOP™ Series

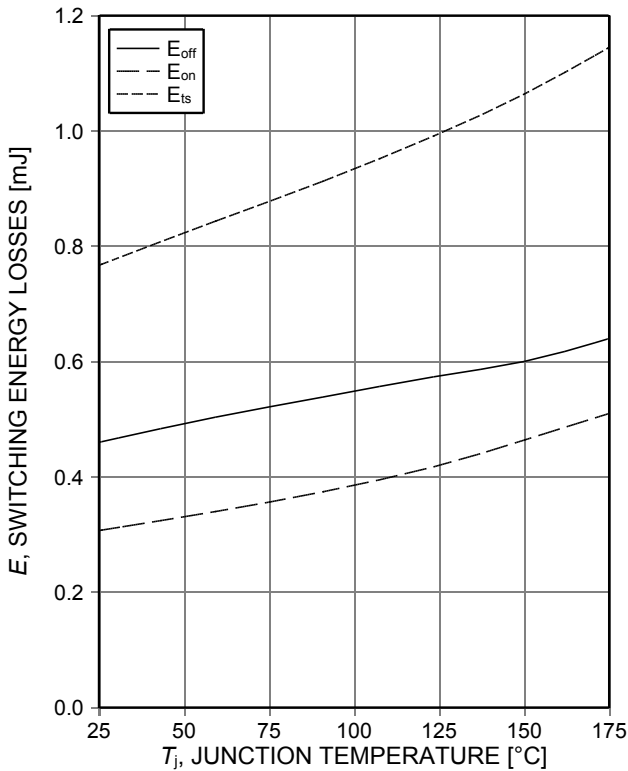


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=0/15V$ ,  $I_C=20A$ ,  $r_G=12\Omega$ , Dynamic test circuit in Figure E)

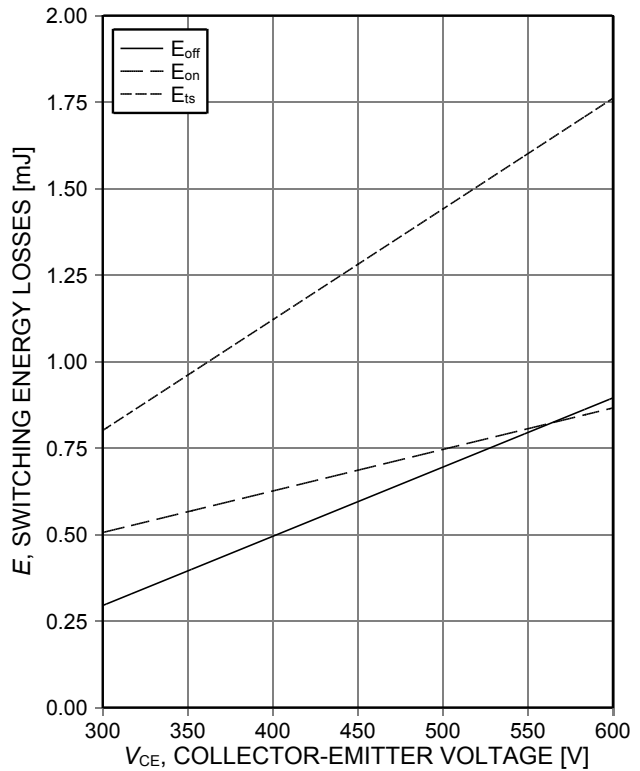


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load,  $T_j=175^\circ C$ ,  $V_{GE}=0/15V$ ,  $I_C=20A$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

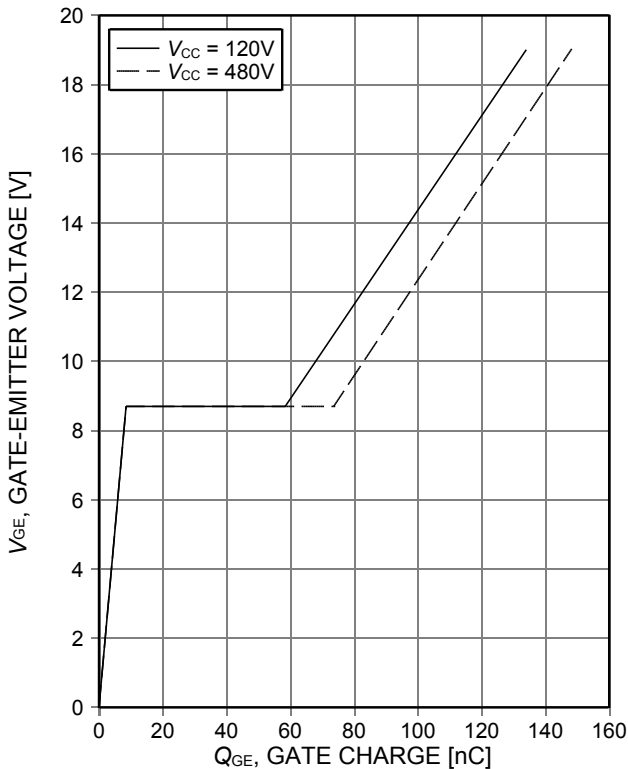


Figure 15. **Typical gate charge** ( $I_C=20A$ )

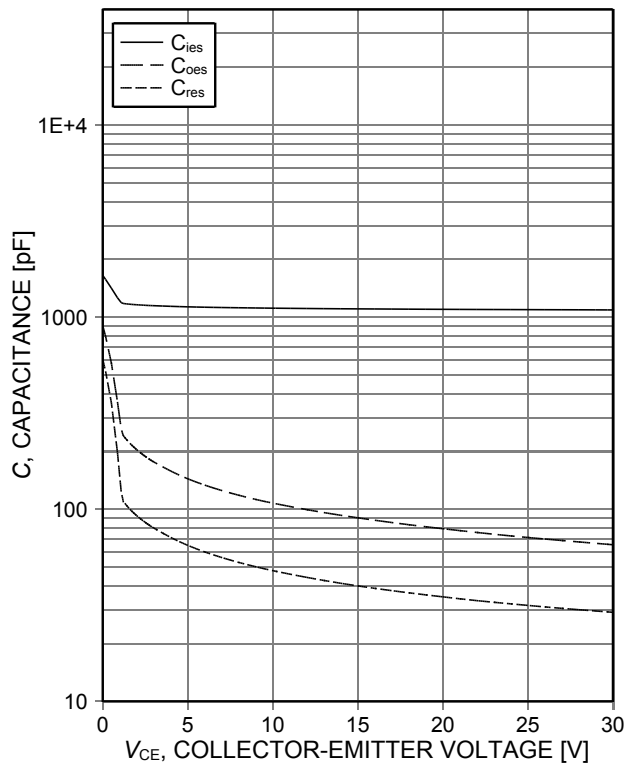


Figure 16. **Typical capacitance as a function of collector-emitter voltage** ( $V_{GE}=0V$ ,  $f=1MHz$ )

TRENCHSTOP™ Series

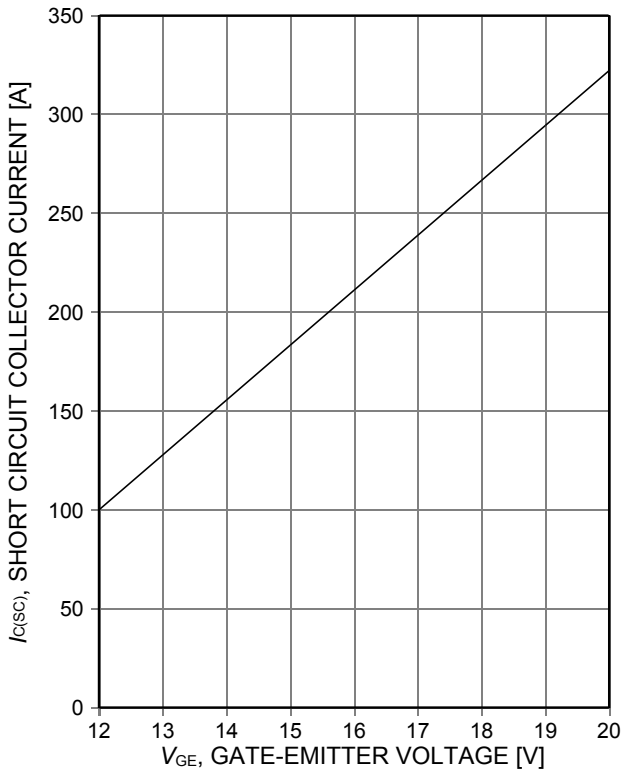


Figure 17. Typical short circuit collector current as a function of gate-emitter voltage ( $V_{CE} \leq 400V$ , start at  $T_j \leq 150^\circ C$ )

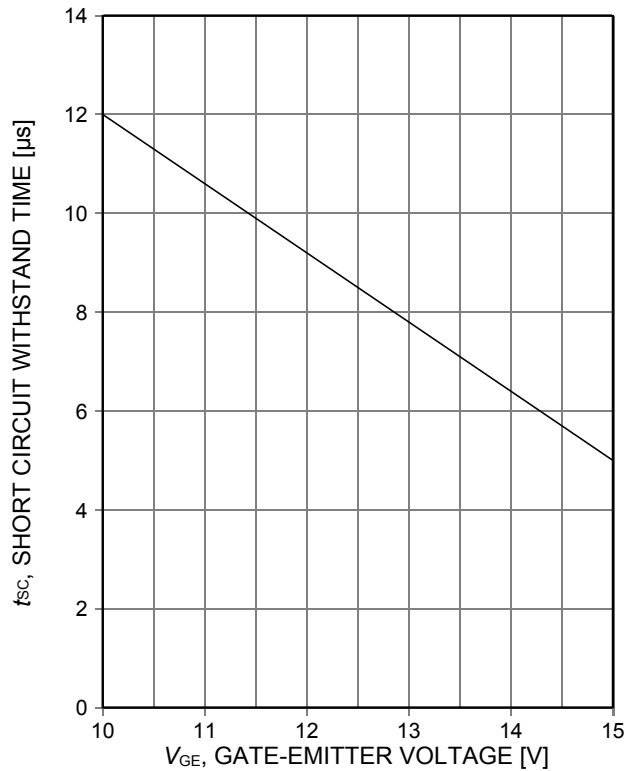


Figure 18. Short circuit withstand time as a function of gate-emitter voltage ( $V_{CE} = 400V$ , start at  $T_j = 25^\circ C$ ,  $T_{jmax} \leq 150^\circ C$ )

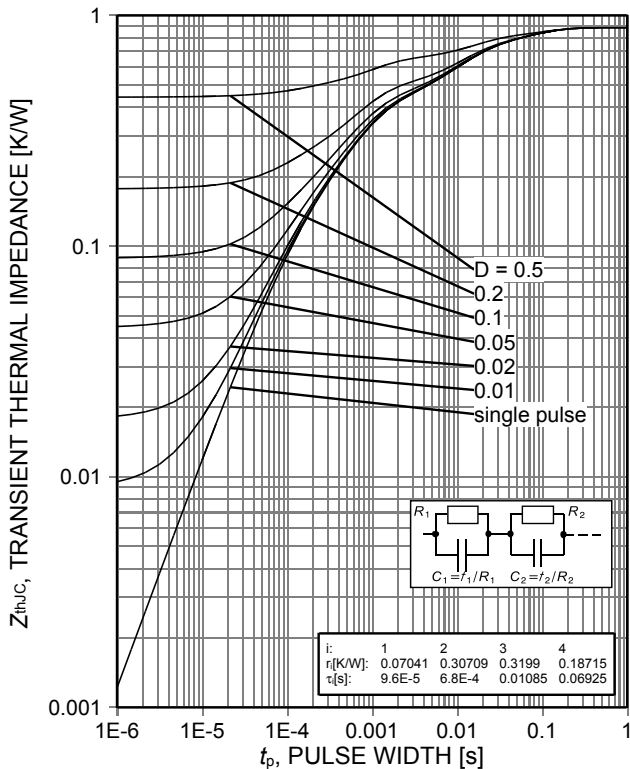


Figure 19. IGBT transient thermal impedance as a function of pulse width for different duty cycles  $D$  ( $D = t_p/T$ )

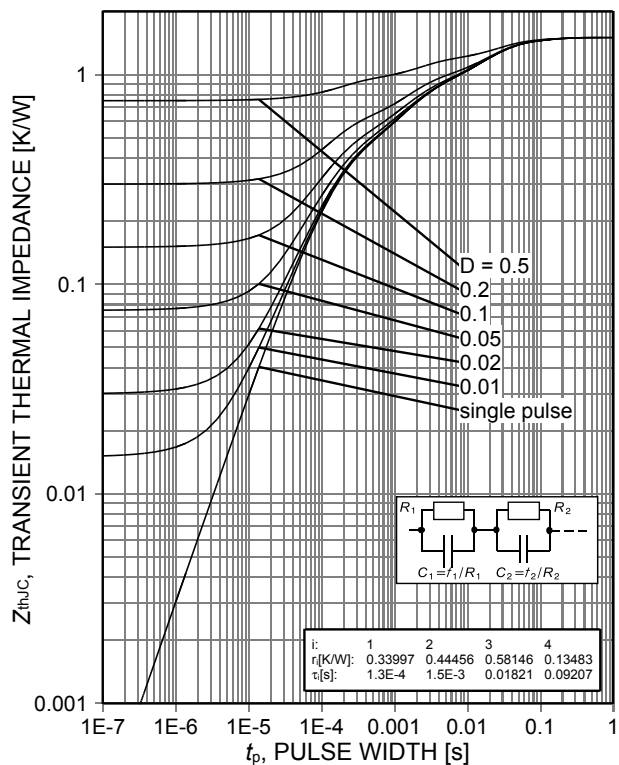


Figure 20. Diode transient thermal impedance as a function of pulse width for different duty cycles  $D$  ( $D = t_p/T$ )

TRENCHSTOP™ Series

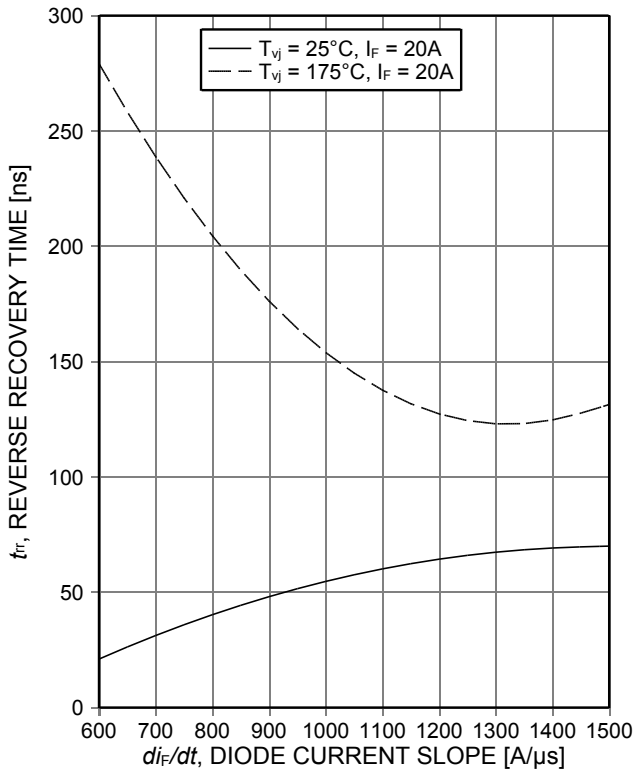


Figure 21. **Typical reverse recovery time as a function of diode current slope** ( $V_R=400V$ , Dynamic test circuit in Figure E)

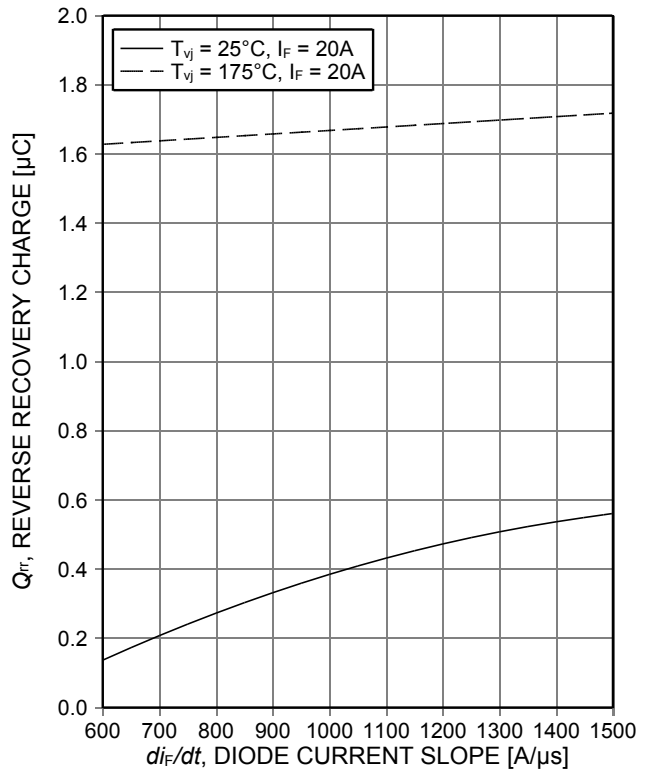


Figure 22. **Typical reverse recovery charge as a function of diode current slope** ( $V_R=400V$ , Dynamic test circuit in Figure E)

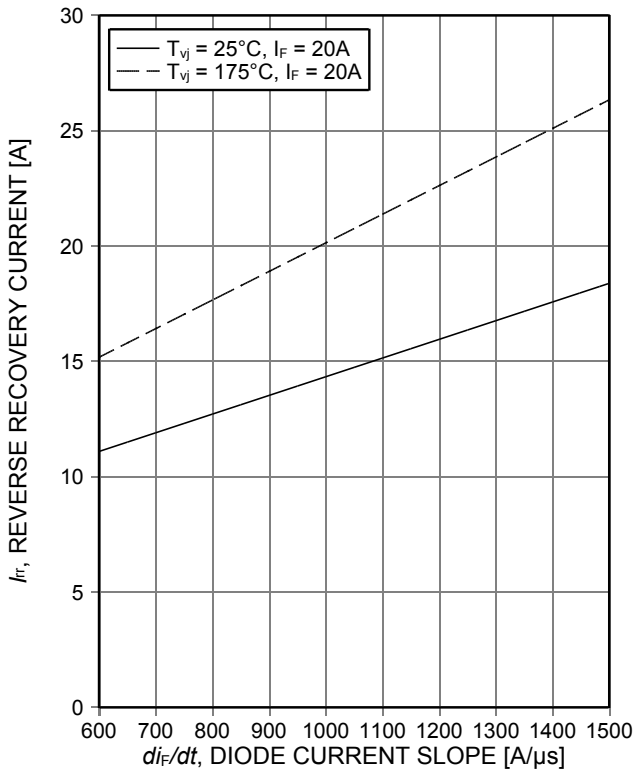


Figure 23. **Typical reverse recovery current as a function of diode current slope** ( $V_R=400V$ , Dynamic test circuit in Figure E)

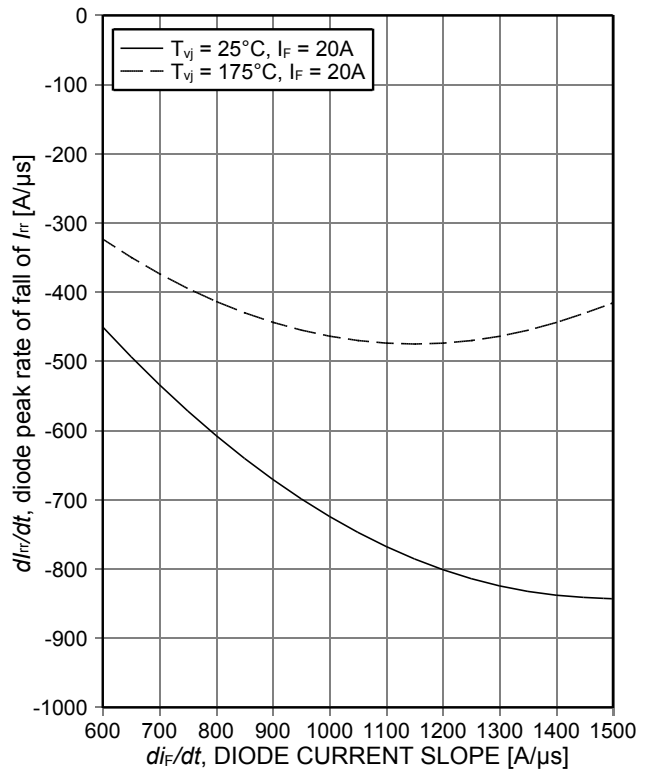


Figure 24. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope** ( $V_R=400V$ , Dynamic test circuit in Figure E)

TRENCHSTOP™ Series

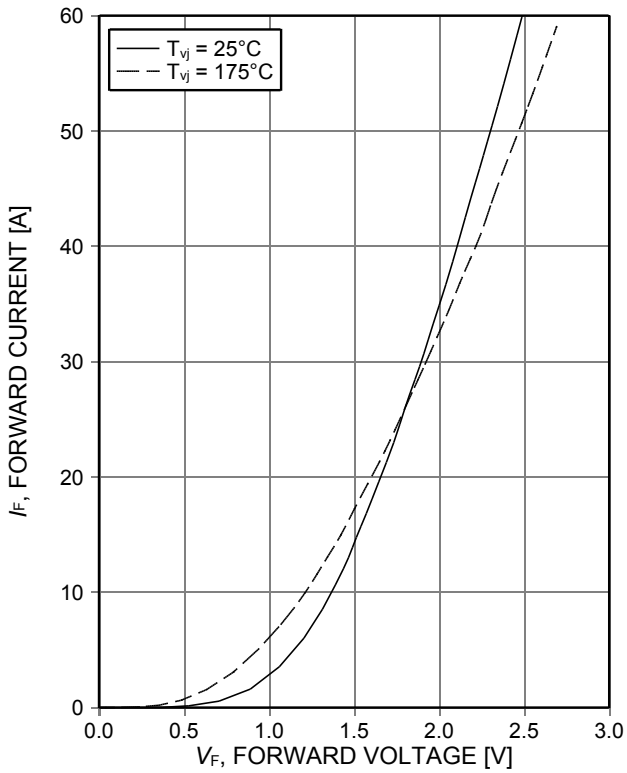


Figure 25. Typical diode forward current as a function of forward voltage

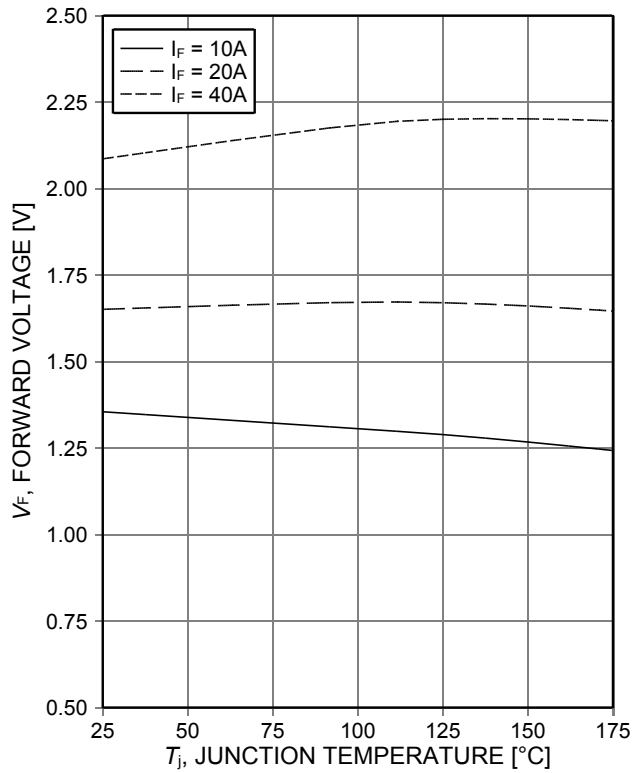
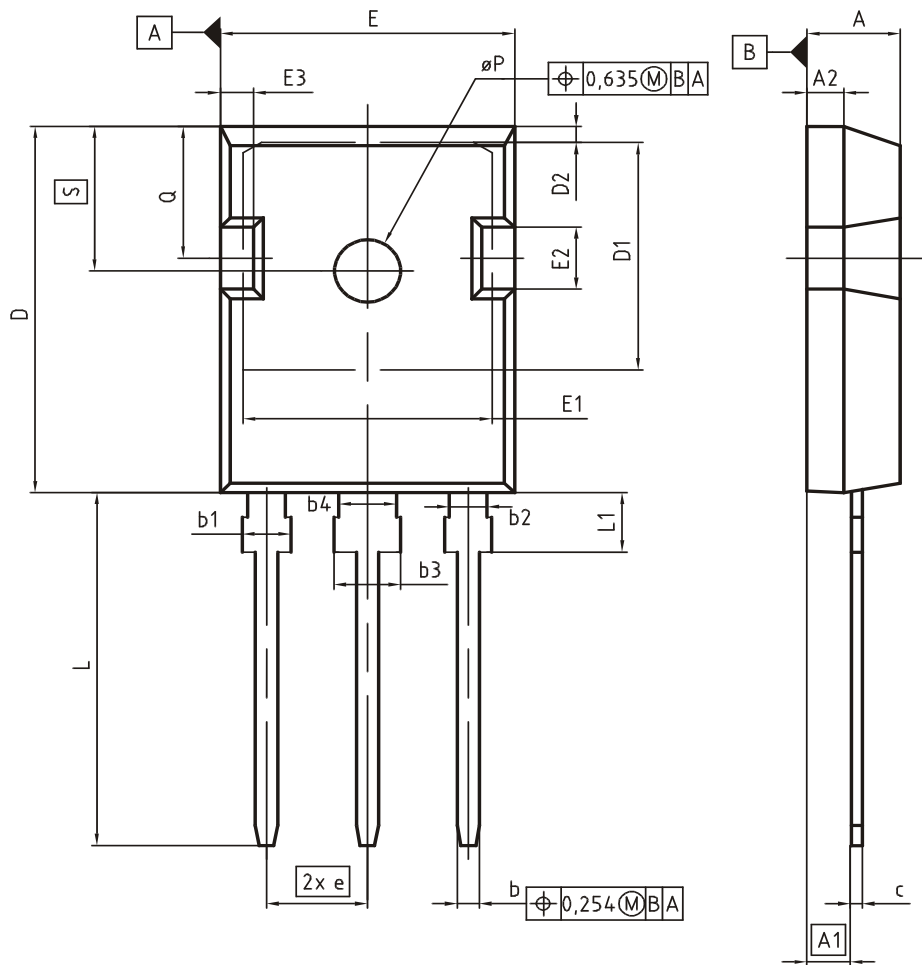


Figure 26. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO.  
Z8B00003327

SCALE

EUROPEAN PROJECTION

ISSUE DATE  
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REVISION  
05

Testing Conditions

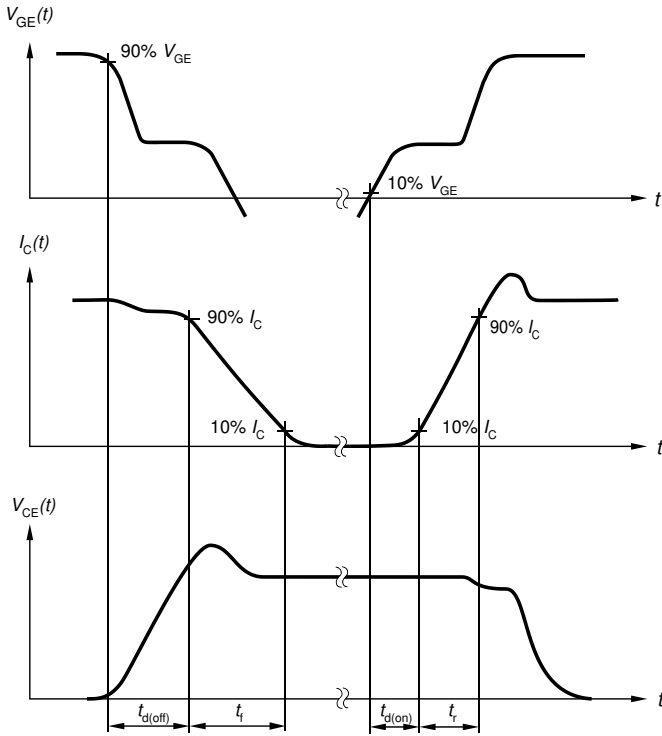


Figure A. Definition of switching times

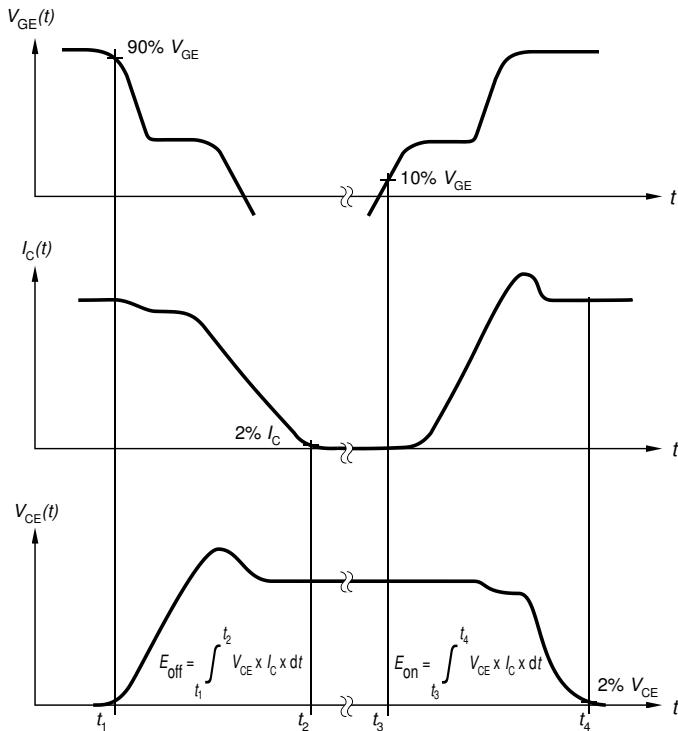


Figure B. Definition of switching losses

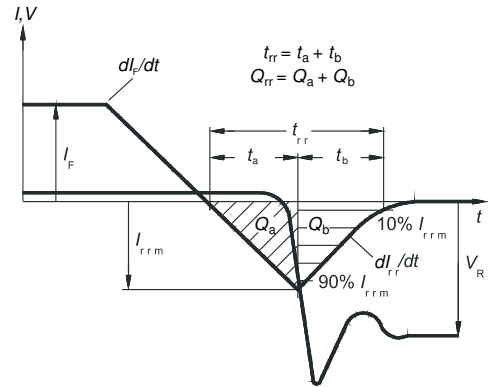


Figure C. Definition of diode switching characteristics

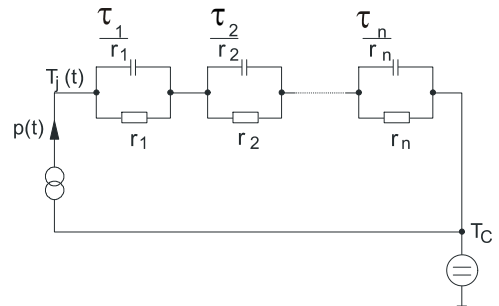


Figure D. Thermal equivalent circuit

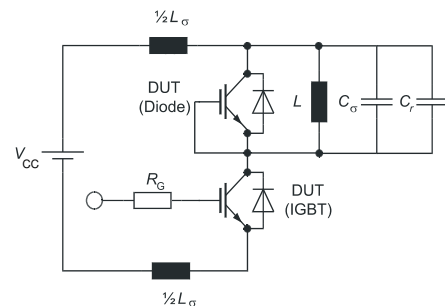


Figure E. Dynamic test circuit  
Parasitic inductance  $L_{\sigma}$ ,  
parasitic capacitor  $C_{\sigma}$ ,  
relief capacitor  $C_r$ ,  
(only for ZVT switching)

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TRENCHSTOP™ Series

## Revision History

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AIKW20N60CT

**Revision: 2017-02-09, Rev. 2.1**

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Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2017-02-09	Data sheet created

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