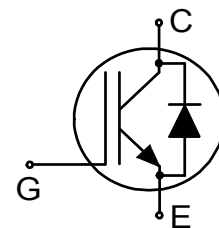


## TRENCHSTOP™ Series

Low Loss DuoPack: IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel 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 150°C
- Dynamically stress tested
- Short circuit withstand time 5µs
- Positive temperature coefficient in  $V_{CE(sat)}$
- Low EMI
- Low Gate Charge
- Green Package
- 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	$V_{CE}$	$I_C$	$V_{CEsat}, T_{vj}=25^{\circ}C$	$T_{vjmax}$	Marking	Package
AIKP20N60CT	600V	20A	1.5V	150°C	AK20DCT	PG-TO220-3



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## 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 $V_{CE} \leq 600\text{V}$ , $T_{vj} \leq 150^{\circ}\text{C}^{1)}$	-	60.0	A
Diode forward current, limited by $T_{vjmax}$ $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	$I_F$	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 $T_C = 25^{\circ}\text{C}$	$P_{tot}$	156.0	W
Operating junction temperature	$T_{vj}$	-40...+150	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$	-40...+150	$^{\circ}\text{C}$
Soldering temperature, 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><math>R_{th}</math> Characteristics</b>						
IGBT thermal resistance, junction - case	$R_{th(j-c)}$		-	-	0.90	K/W
Diode thermal resistance, junction - case	$R_{th(j-c)}$		-	-	1.50	K/W
Thermal resistance junction - ambient	$R_{th(j-a)}$		-	-	62	K/W

<sup>1)</sup>  $t_p \leq 1\mu\text{s}$

## 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	$V_{CEsat}$	$V_{GE} = 15.0\text{V}, I_C = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	- -	1.50 1.85	2.05 -	V
Diode forward voltage	$V_F$	$V_{GE} = 0\text{V}, I_F = 20.0\text{A}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	- -	1.65 1.65	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	$I_{CES}$	$V_{CE} = 600\text{V}, V_{GE} = 0\text{V}$ $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	- -	- 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
Integrated gate resistor	$r_G$			none		$\Omega$

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  $T_{vj} = 150^{\circ}\text{C}$ 

Turn-on delay time	$t_{d(on)}$	$T_{vj} = 150^{\circ}\text{C}$ , $V_{CC} = 400\text{V}$ , $I_C = 20.0\text{A}$ , $V_{GE} = 0.0/15.0\text{V}$ , $R_{G(on)} = 12.0\Omega$ , $R_{G(off)} = 12.0\Omega$ , $L\sigma = 131\text{nH}$ , $C\sigma = 31\text{pF}$ $L\sigma$ , $C\sigma$ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	18	-	ns
Rise time	$t_r$		-	17	-	ns
Turn-off delay time	$t_{d(off)}$		-	217	-	ns
Fall time	$t_f$		-	70	-	ns
Turn-on energy	$E_{on}$		-	0.47	-	mJ
Turn-off energy	$E_{off}$		-	0.60	-	mJ
Total switching energy	$E_{ts}$		-	1.07	-	mJ

Diode Characteristic, at  $T_{vj} = 150^{\circ}\text{C}$ 

Diode reverse recovery time	$t_{rr}$	$T_{vj} = 150^{\circ}\text{C}$ , $V_R = 400\text{V}$ , $I_F = 20.0\text{A}$ , $di_F/dt = 800\text{A}/\mu\text{s}$	-	201	-	ns
Diode reverse recovery charge	$Q_{rr}$		-	1.28	-	$\mu\text{C}$
Diode peak reverse recovery current	$I_{rrm}$		-	16.6	-	A
Diode peak rate of fall of reverse recovery current during $t_b$	$di_{rr}/dt$		-	481	-	$\text{A}/\mu\text{s}$

TRENCHSTOP™ Series

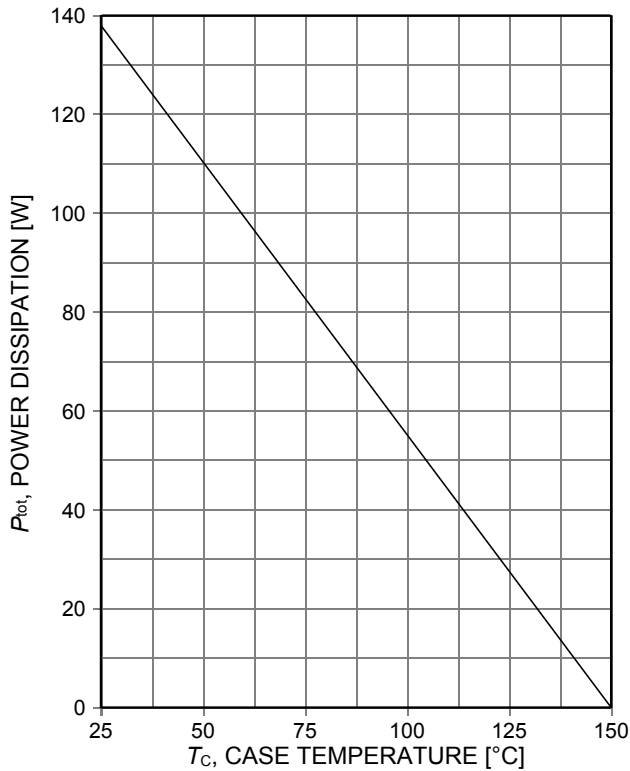


Figure 1. Power dissipation as a function of case temperature ( $T_j \leq 150^\circ\text{C}$ )

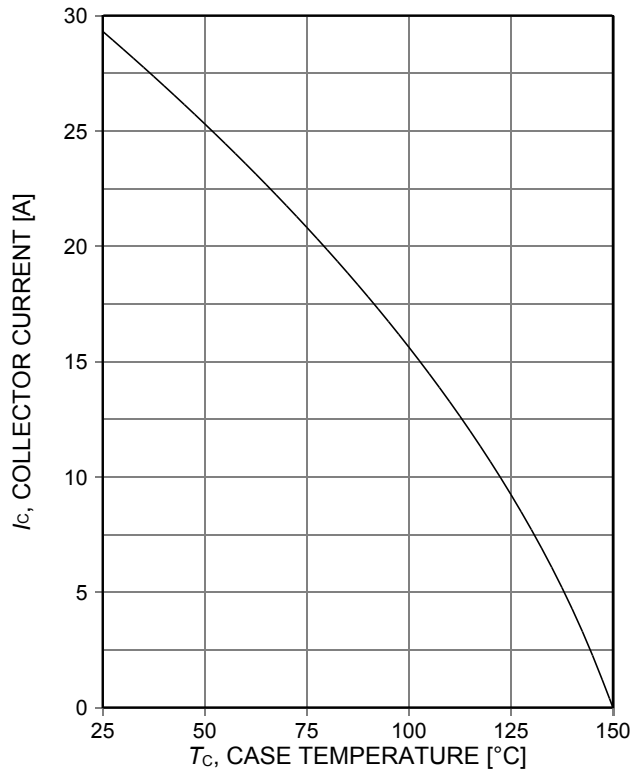


Figure 2. Collector current as a function of case temperature ( $V_{GE} \geq 15\text{V}$ ,  $T_j \leq 150^\circ\text{C}$ )

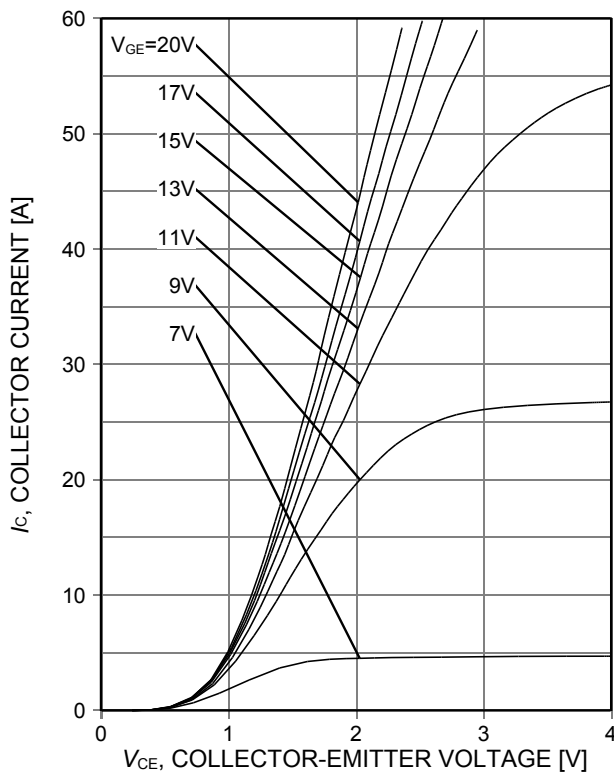


Figure 3. Typical output characteristic ( $T_j = 25^\circ\text{C}$ )

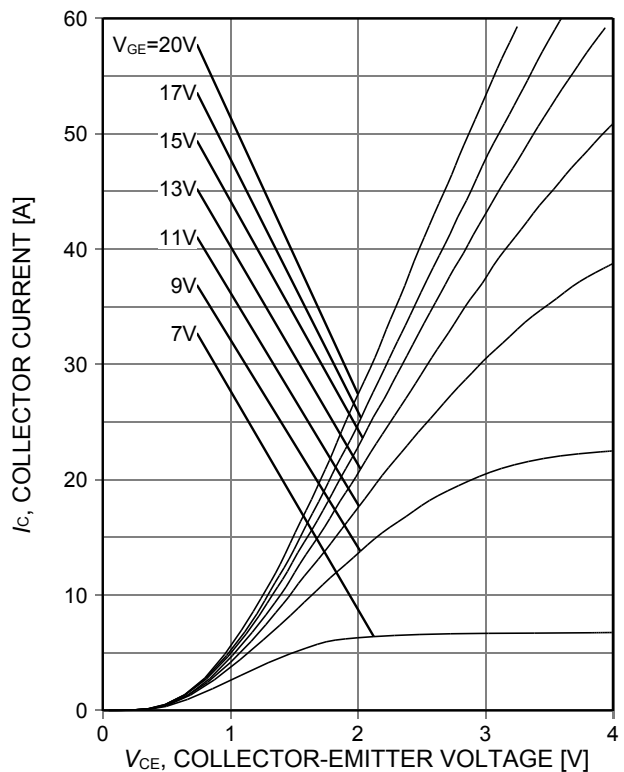


Figure 4. Typical output characteristic ( $T_j = 150^\circ\text{C}$ )

TRENCHSTOP™ Series

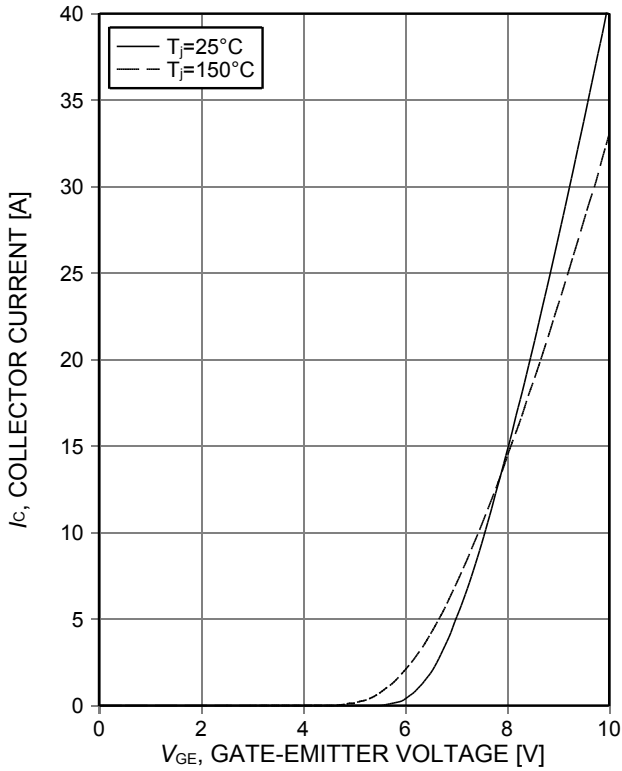


Figure 5. **Typical transfer characteristic**  
( $V_{CE}=10V$ )

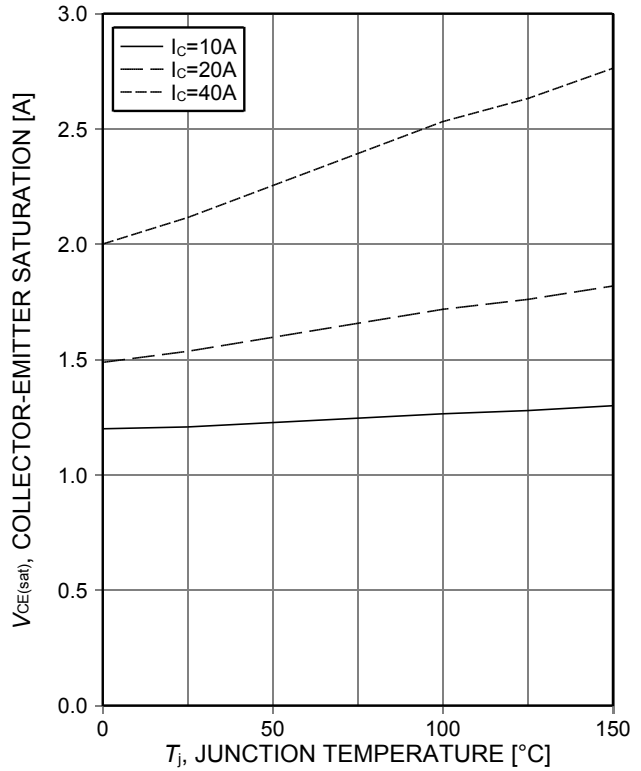


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**  
( $V_{GE}=15V$ )

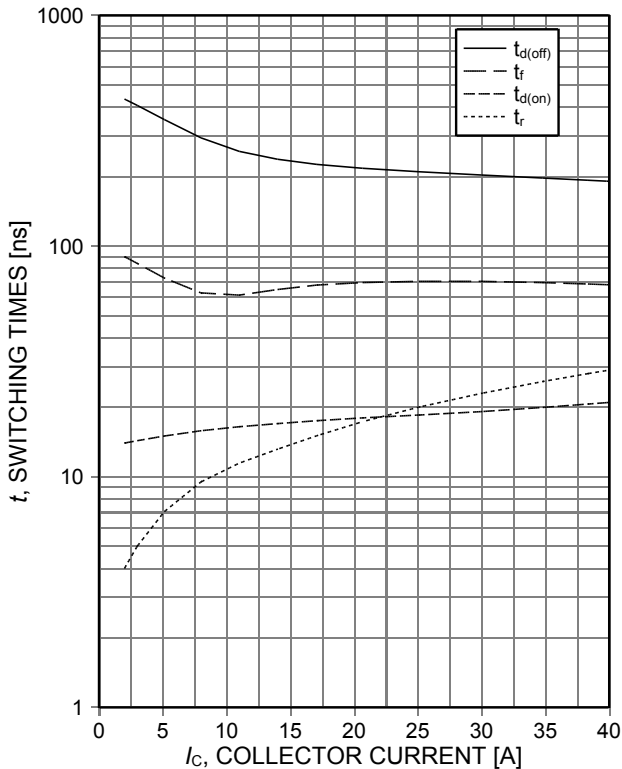


Figure 7. **Typical switching times as a function of collector current**  
(inductive load,  $T_j=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

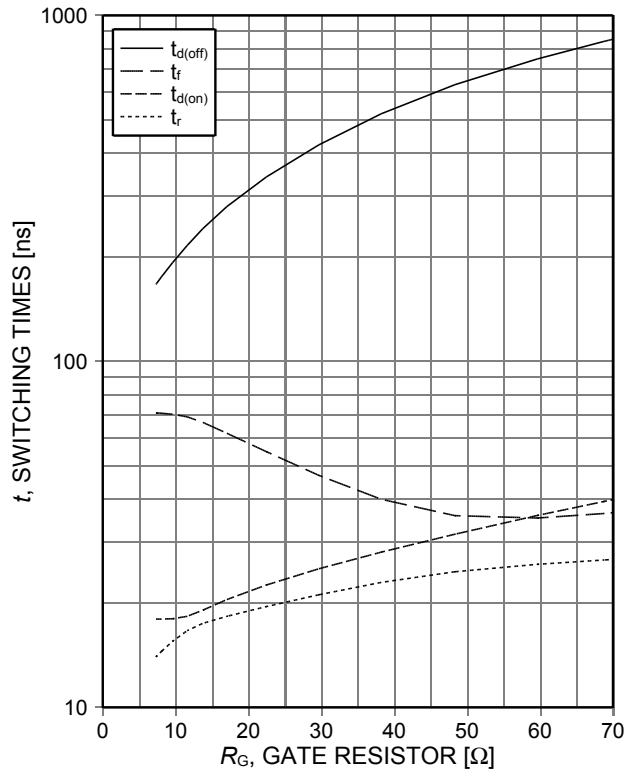


Figure 8. **Typical switching times as a function of gate resistor**  
(inductive load,  $T_j=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)

TRENCHSTOP™ Series

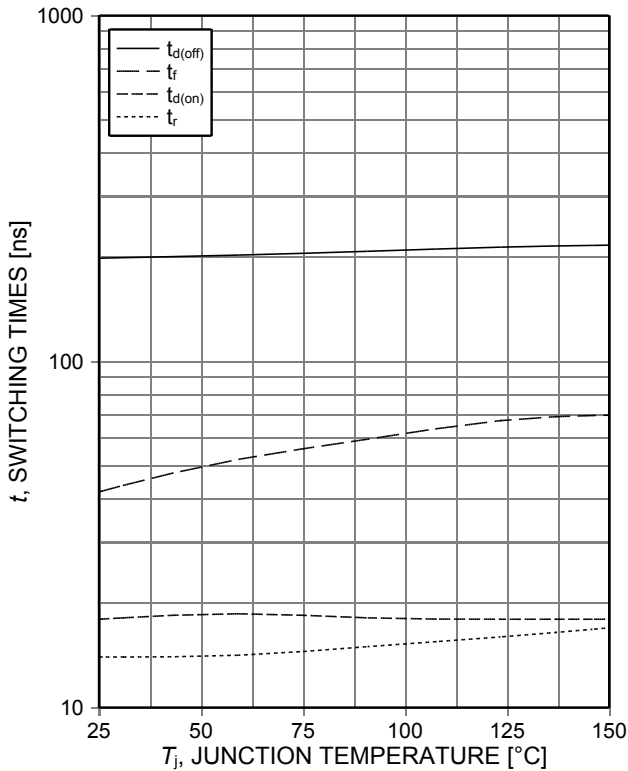


Figure 9. Typical switching times as a function of junction temperature (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

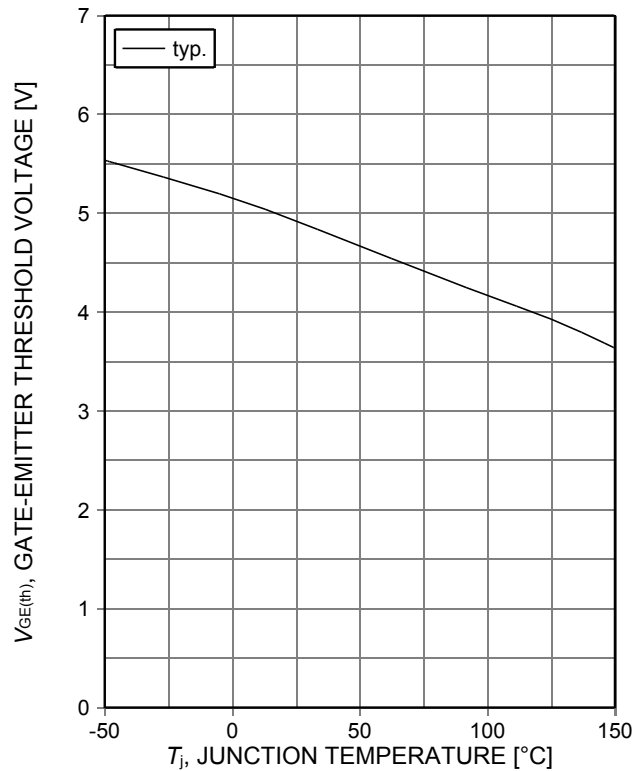


Figure 10. Gate-emitter threshold voltage as a function of junction temperature ( $I_C=0.29mA$ )

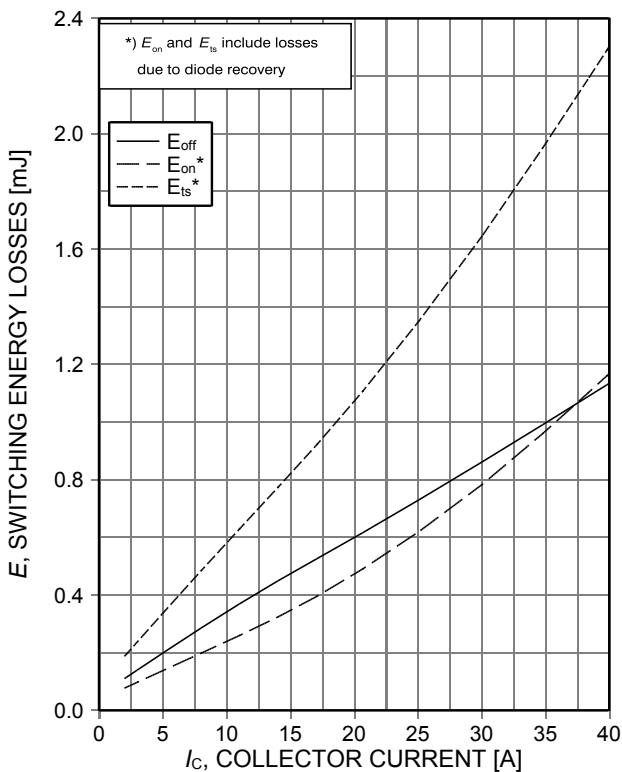


Figure 11. Typical switching energy losses as a function of collector current (inductive load,  $T_j=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

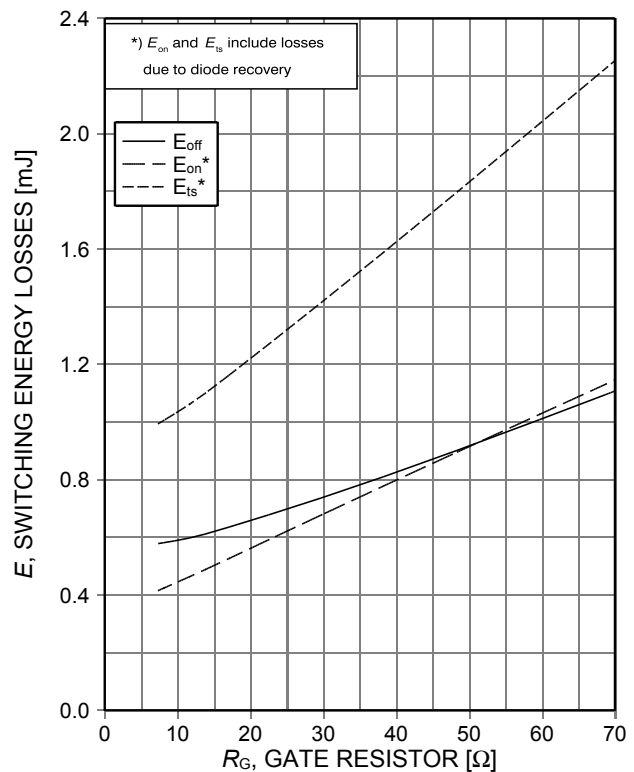


Figure 12. Typical switching energy losses as a function of gate resistor (inductive load,  $T_j=150^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ , Dynamic test circuit in Figure E)



TRENCHSTOP™ Series

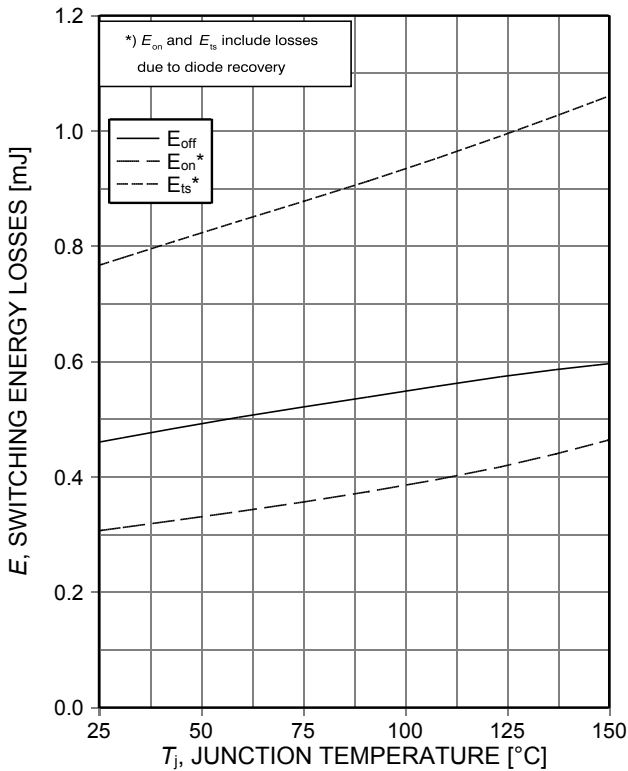


Figure 13. **Typical switching energy losses as a function of junction temperature** (inductive load,  $V_{CE}=400V$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

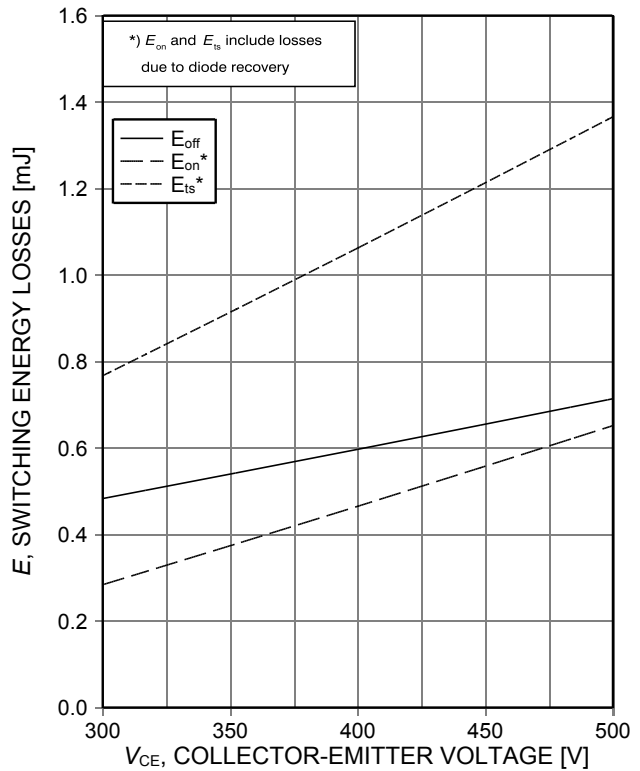


Figure 14. **Typical switching energy losses as a function of collector emitter voltage** (inductive load,  $T_j=150^\circ C$ ,  $V_{GE}=15/0V$ ,  $I_C=20A$ ,  $R_G=12\Omega$ , Dynamic test circuit in Figure E)

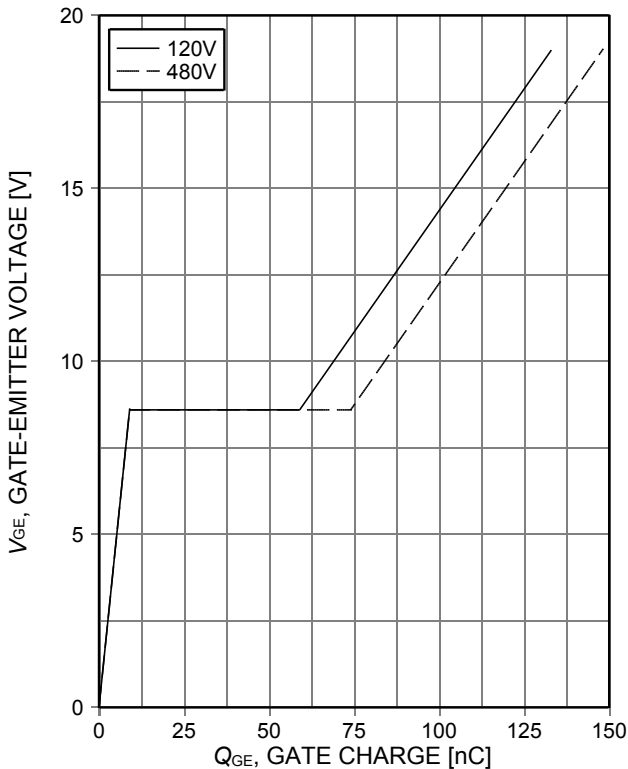


Figure 15. **Typical gate charge** ( $I_C=20A$ )

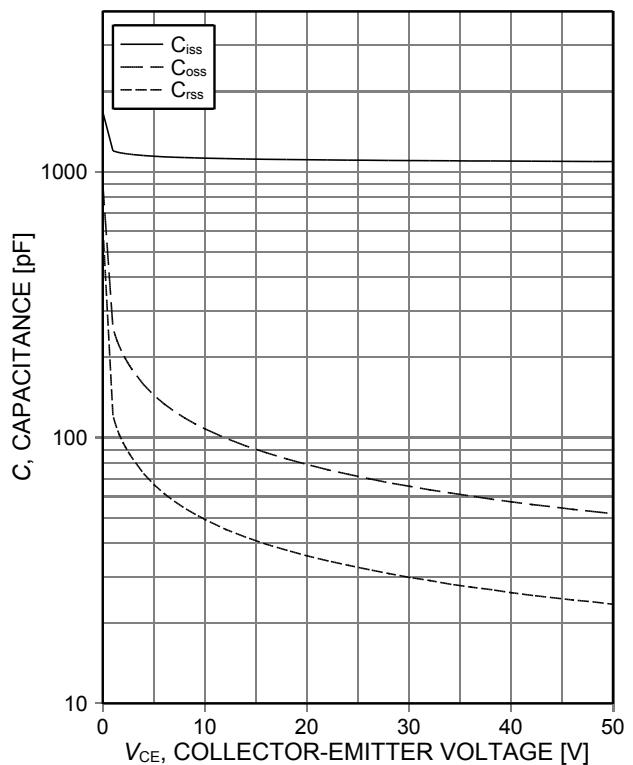


Figure 16. **Typical capacitance as a function of collector-emitter voltage** ( $V_{GE}=0V$ ,  $f=1MHz$ )

TRENCHSTOP™ Series

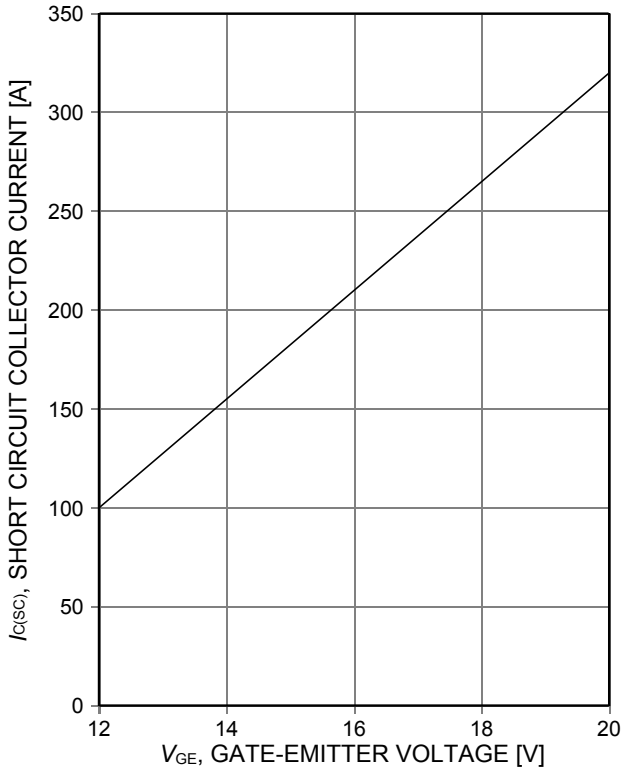


Figure 17. Typical short circuit collector current as a function of gate-emitter voltage (V<sub>CE</sub>≤400V, T<sub>J</sub>≤150°C)

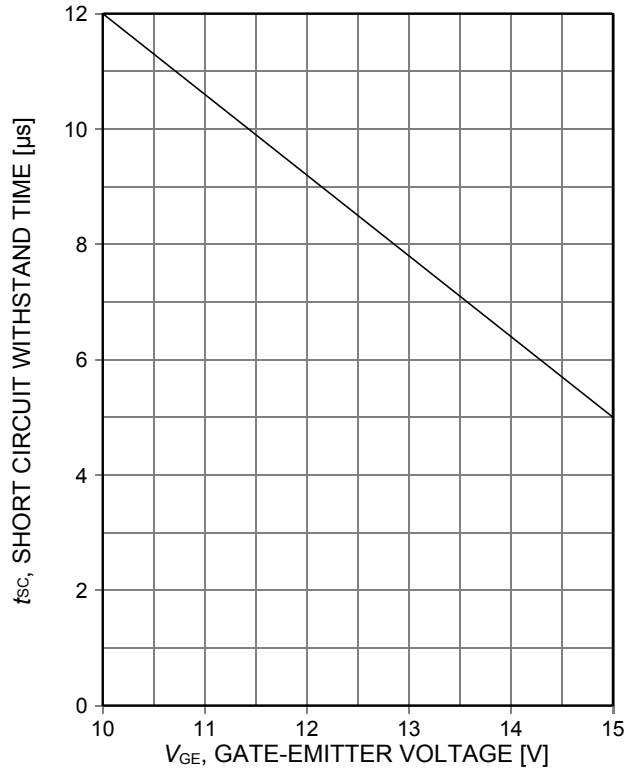


Figure 18. Short circuit withstand time as a function of gate-emitter voltage (V<sub>CE</sub>=400V, start at T<sub>J</sub>=25°C, T<sub>Jmax</sub>≤150°C)

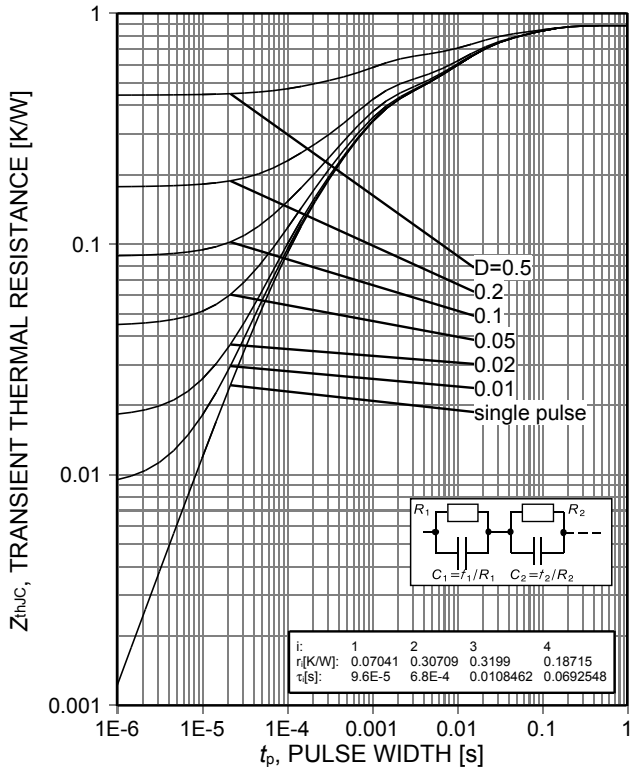


Figure 19. IGBT transient thermal resistance as a function of pulse width for different duty cycles D (D=t<sub>p</sub>/T)

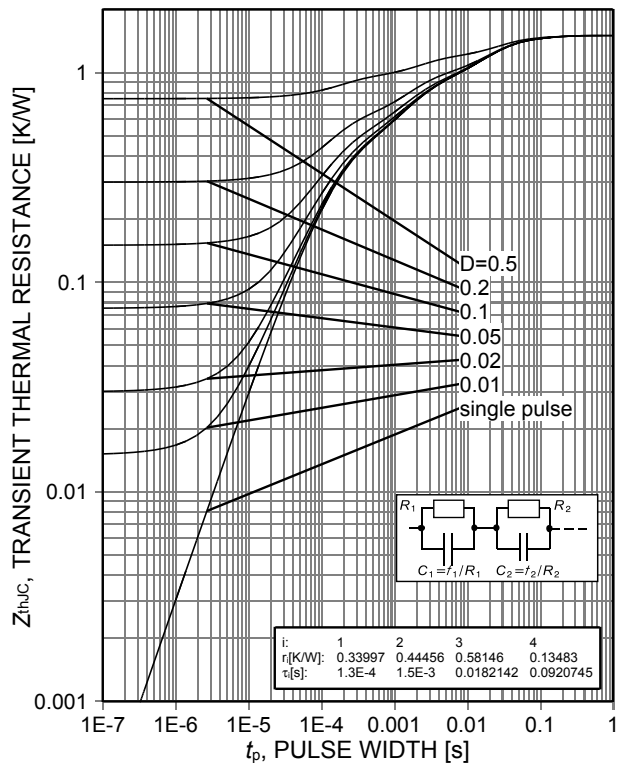


Figure 20. Diode transient thermal impedance as a function of pulse width for different duty cycles D (D=t<sub>p</sub>/T)

TRENCHSTOP™ Series

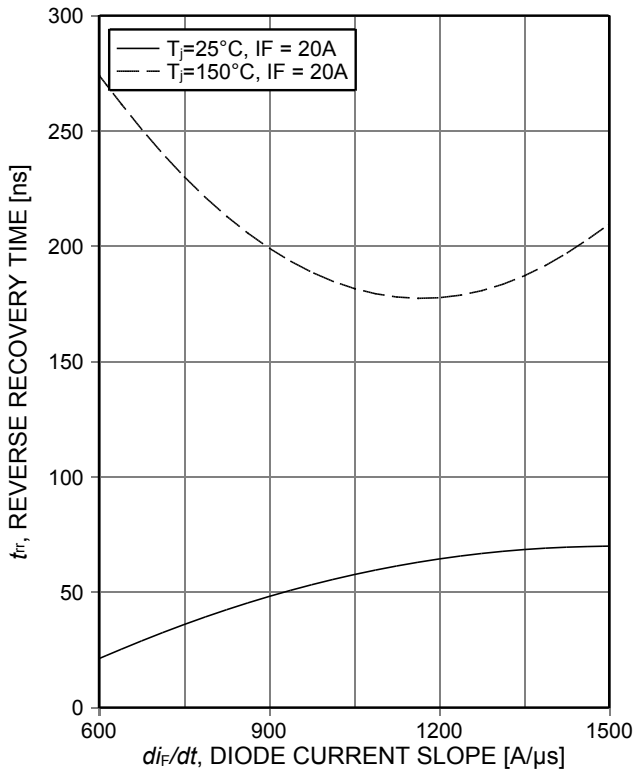


Figure 21. **Typical reverse recovery time as a function of diode current slope**  
( $V_R=400V$ , Dynamic test circuit in Figure E)

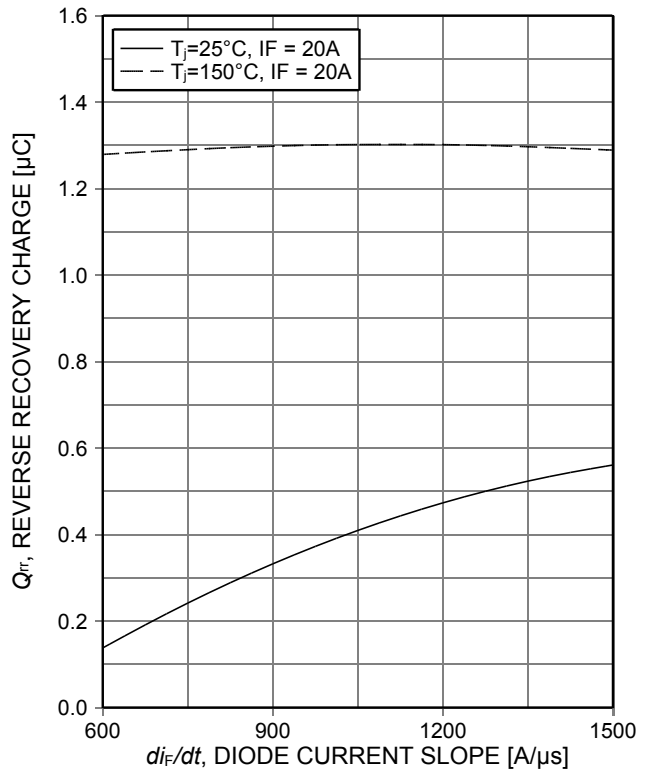


Figure 22. **Typical reverse recovery charge as a function of diode current slope**  
( $V_R=400V$ , Dynamic test circuit in Figure E)

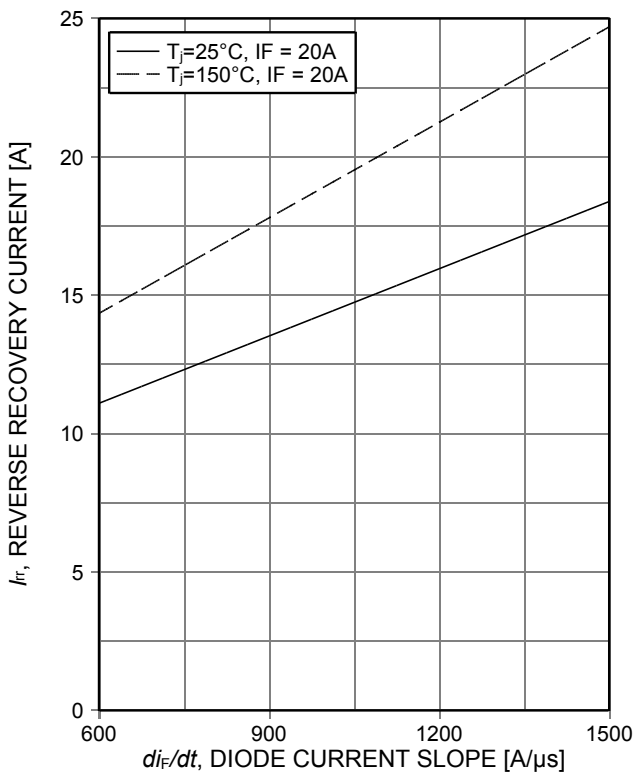


Figure 23. **Typical reverse recovery current as a function of diode current slope**  
( $V_R=400V$ , Dynamic test circuit in Figure E)

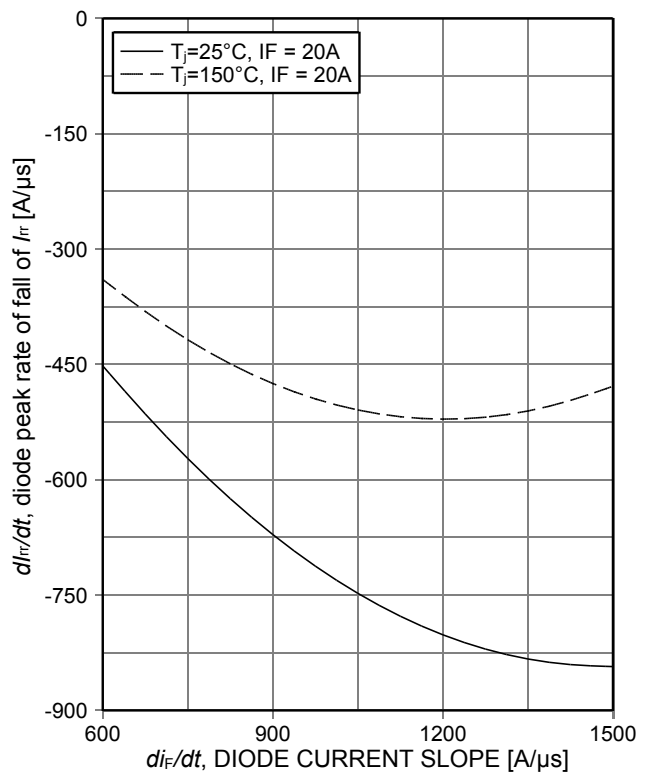


Figure 24. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**  
( $V_R=400V$ , Dynamic test circuit in Figure E)

TRENCHSTOP™ Series

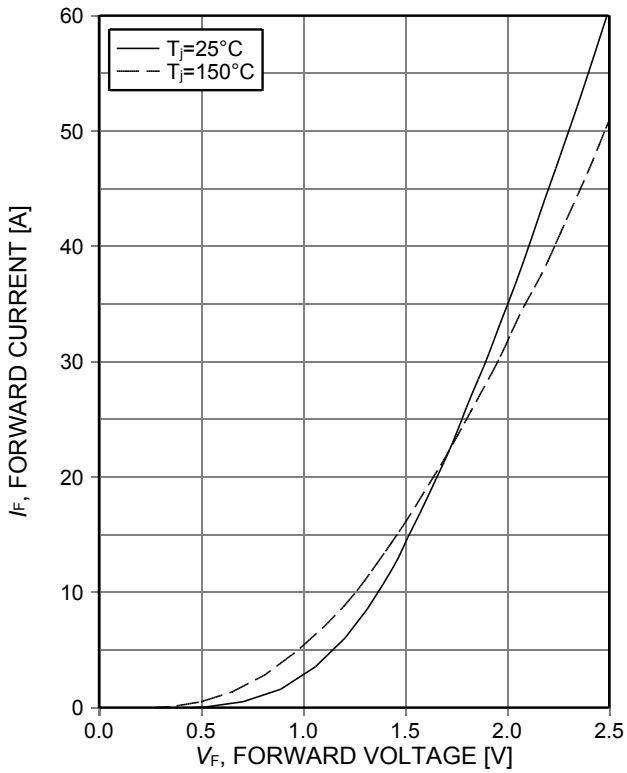


Figure 25. Typical diode forward current as a function of forward voltage

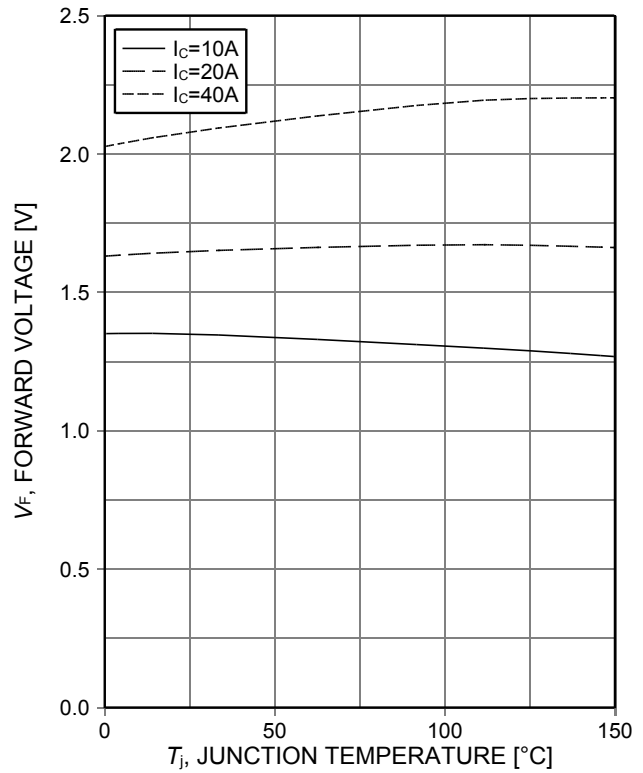
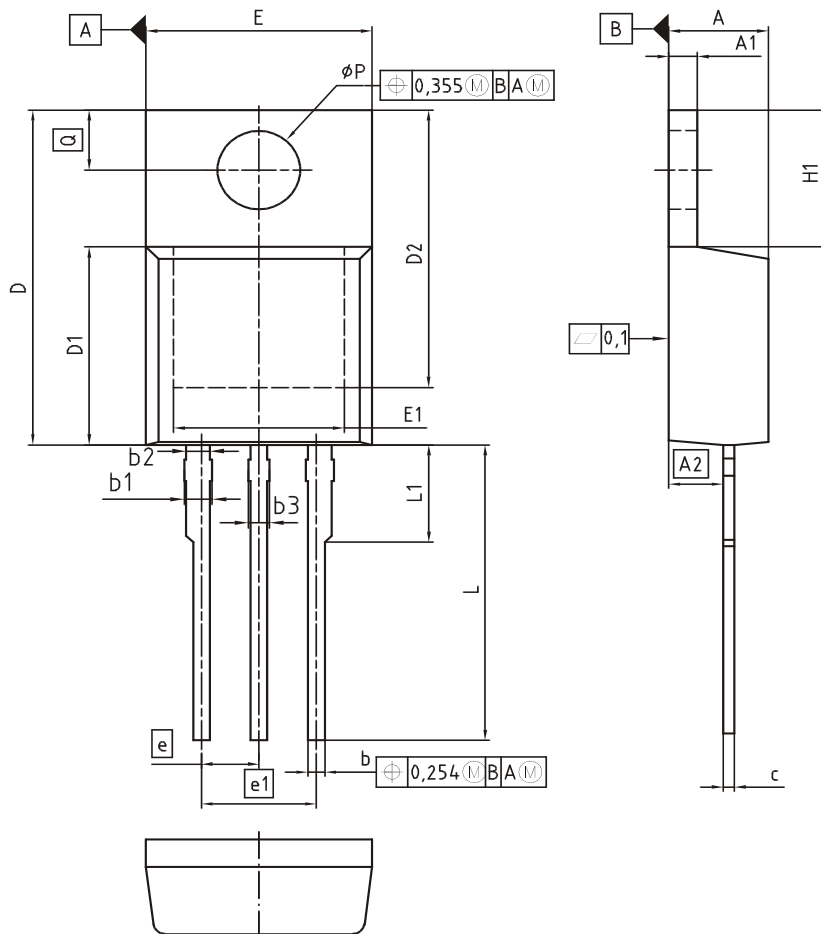


Figure 26. Typical diode forward voltage as a function of junction temperature

Package Drawing PG-TO220-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
$\phi P$	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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SCALE

EUROPEAN PROJECTION

ISSUE DATE  
30-07-2009

REVISION  
06

Testing Conditions



Figure A. Definition of switching times

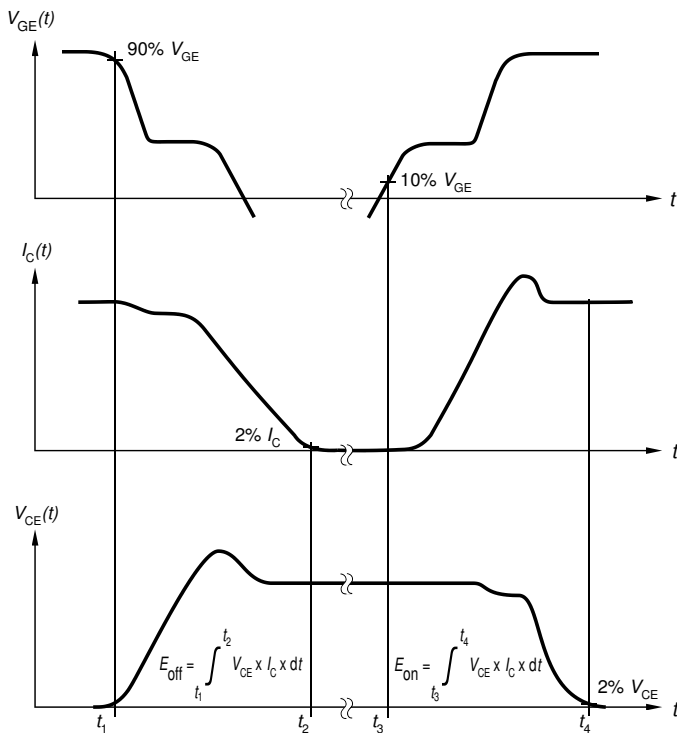


Figure B. Definition of switching losses

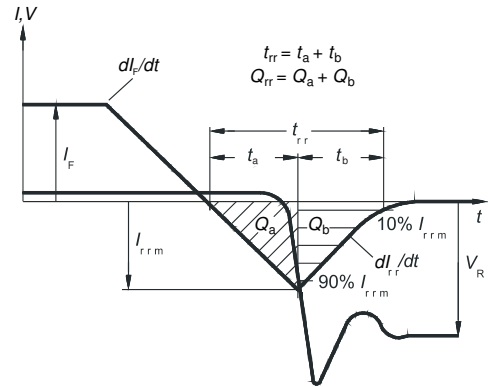


Figure C. Definition of diode switching characteristics

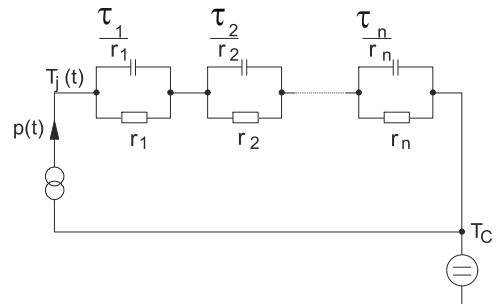


Figure D. Thermal equivalent circuit

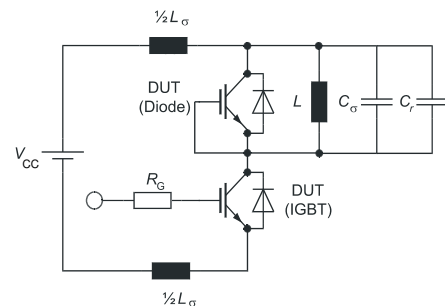


Figure E. **Dynamic test circuit**  
 Parasitic inductance  $L_{\sigma}$ ,  
 parasitic capacitor  $C_{\sigma}$ ,  
 relief capacitor  $C_r$ ,  
 (only for ZVT switching)



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TRENCHSTOP™ Series

**Revision History**

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AIKP20N60CT

**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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