

TRENCHSTOP™ RC-Drives Fast Series

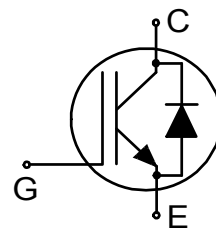
IGBT with integrated diode in packages offering space saving advantage

Features:

TRENCHSTOP™ Reverse Conducting (RC) technology for 600V applications offering

- Optimized E_{on} , E_{off} and Q_{rr} for low switching losses
- Operating range of 4 to 30kHz
- Smooth switching performance leading to low EMI levels
- Very tight parameter distribution
- Maximum junction temperature 175°C
- Dynamically stress tested
- Short circuit capability of 5μs
- Best in class current versus package size performance
- Qualified according to AEC-Q101
- Pb-free lead plating; RoHS compliant (solder temperature 260°C, MSL1)

Complete product spectrum and PSpice Models:
<http://www.infineon.com/igbt/>

**Applications:**

- Small drives
- Piezo injection
- Automotive lighting / HID

**Key Performance and Package Parameters**

Type	V_{CE}	I_C	V_{CEsat} , $T_{vj}=25^{\circ}C$	T_{vjmax}	Marking	Package
AIHD03N60RF	600V	2.5A	2.2V	175°C	AH03DRF	PG-TO252-3



TRENCHSTOP™ RC-Drives Fast Series

Table of Contents

Description 1

Table of Contents 2

Maximum Ratings 3

Thermal Resistance 3

Electrical Characteristics 4

Electrical Characteristics Diagrams 6

Package Drawing13

Testing Conditions14

Revision History15

Disclaimer16

TRENCHSTOP™ RC-Drives Fast 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	6.5 6.0	A
Pulsed collector current, t_p limited by $T_{vjmax}^{1)}$	I_{Cpuls}	7.5	A
Turn off safe operating area $V_{CE} \leq 600\text{V}$, $T_{vj} \leq 175^{\circ}\text{C}$, $t_p = 1\mu\text{s}^{1)}$	-	7.5	A
Diode forward current, limited by T_{vjmax} $T_C = 25^{\circ}\text{C}$ $T_C = 100^{\circ}\text{C}$	I_F	6.3 3.9	A
Diode pulsed current, t_p limited by $T_{vjmax}^{1)}$	I_{Fpuls}	7.5	A
Gate-emitter voltage	V_{GE}	± 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	μs
Power dissipation $T_C = 25^{\circ}\text{C}$	P_{tot}	53.6	W
Operating junction temperature	T_{vj}	$-40 \dots +175$	$^{\circ}\text{C}$
Storage temperature	T_{stg}	$-55 \dots +150$	$^{\circ}\text{C}$
Soldering temperature, reflow soldering (MSL1 according to JEDEC J-STA-020)		260	$^{\circ}\text{C}$

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R _{th} Characteristics						
IGBT thermal resistance, ²⁾ junction - case	R _{th(j-c)}		-	-	2.80	K/W
Diode thermal resistance, ³⁾ junction - case	R _{th(j-c)}		-	-	6.80	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

¹⁾ Defined by design. Not subject to production test.

²⁾ R_{th}/Z_{th} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the IGBT, is not possible using a thermocouple.

³⁾ R_{th}/Z_{th} based on single cooling pulse. Please be aware that a correct R_{th} measurement of the Diode, is not possible using a thermocouple.

TRENCHSTOP™ RC-Drives Fast Series

Electrical Characteristic, at $T_{vj} = 25^{\circ}\text{C}$, 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}	$V_{GE} = 15.0V, I_C = 2.5A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.20 2.30	2.50 -	V
Diode forward voltage	V_F	$V_{GE} = 0V, I_F = 2.5A$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	2.10 2.00	2.40 -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C = 0.05mA, V_{CE} = V_{GE}$	4.3	5.0	5.7	V
Zero gate voltage collector current	I_{CES}	$V_{CE} = 600V, V_{GE} = 0V$ $T_{vj} = 25^{\circ}C$ $T_{vj} = 175^{\circ}C$	- -	- 120	40 -	μA
Gate-emitter leakage current	I_{GES}	$V_{CE} = 0V, V_{GE} = 20V$	-	-	100	nA
Transconductance ¹⁾	g_{fs}	$V_{CE} = 10V, I_C = 2.5A$	-	1.3	-	S
Integrated gate resistor	r_G			none		Ω

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Dynamic Characteristic						
Input capacitance	C_{ies}	$V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$	-	200	-	pF
Output capacitance	C_{oes}		-	13	-	
Reverse transfer capacitance	C_{res}		-	7	-	
Gate charge	Q_G	$V_{CC} = 480V, I_C = 2.5A,$ $V_{GE} = 15V$	-	17.1	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7.0	-	nH
Short circuit collector current Max. 1000 short circuits Time between short circuits: $\geq 1.0s$	$I_{C(SC)}$	$V_{GE} = 15.0V, V_{CC} \leq 400V,$ $t_{SC} \leq 5\mu s$ $T_{vj} = 25^{\circ}C$	-	23	-	A

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(\text{on})}$	$T_{vj} = 25^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 2.5\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(\text{on})} = 68.0\Omega, R_{G(\text{off})} = 68.0\Omega,$ $L\sigma = 60\text{nH}, C\sigma = 40\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	10	-	ns
Rise time	t_r		-	8	-	ns
Turn-off delay time	$t_{d(\text{off})}$		-	128	-	ns
Fall time	t_f		-	93	-	ns
Turn-on energy	E_{on}		-	0.05	-	mJ
Turn-off energy	E_{off}		-	0.04	-	mJ
Total switching energy	E_{ts}		-	0.09	-	mJ

¹⁾ Typical value of transconductance determined at $T_{vj}=175^{\circ}\text{C}$.

TRENCHSTOP™ RC-Drives Fast Series

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 25^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 2.5\text{A},$ $di_F/dt = 470\text{A}/\mu\text{s}$	-	31	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.06	-	μC
Diode peak reverse recovery current	I_{rrm}		-	3.8	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-196	-	A/ μs

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	$t_{d(on)}$	$T_{vj} = 175^{\circ}\text{C},$ $V_{CC} = 400\text{V}, I_C = 2.5\text{A},$ $V_{GE} = 0.0/15.0\text{V},$ $R_{G(on)} = 68.0\Omega, R_{G(off)} = 68.0\Omega,$ $L\sigma = 60\text{nH}, C\sigma = 40\text{pF}$ $L\sigma, C\sigma$ from Fig. E	-	9	-	ns
Rise time	t_r		-	9	-	ns
Turn-off delay time	$t_{d(off)}$		-	142	-	ns
Fall time	t_f		-	123	-	ns
Turn-on energy	E_{on}		-	0.08	-	mJ
Turn-off energy	E_{off}		-	0.06	-	mJ
Total switching energy	E_{ts}		-	0.14	-	mJ

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

Diode reverse recovery time	t_{rr}	$T_{vj} = 175^{\circ}\text{C},$ $V_R = 400\text{V},$ $I_F = 2.5\text{A},$ $di_F/dt = 470\text{A}/\mu\text{s}$	-	66	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.19	-	μC
Diode peak reverse recovery current	I_{rrm}		-	6.2	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	-125	-	A/ μs

TRENCHSTOP™ RC-Drives Fast Series

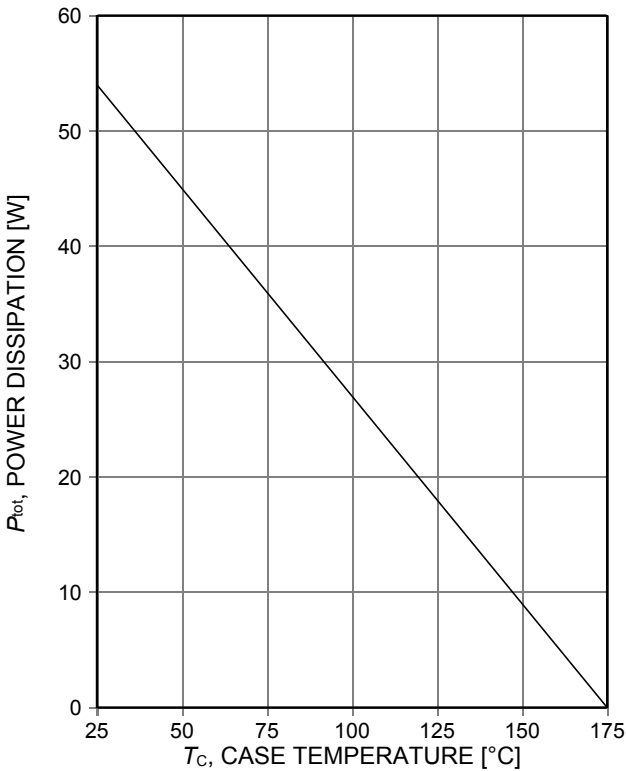


Figure 1. **Power dissipation as a function of case temperature**
($T_{vj} \leq 175^\circ\text{C}$)

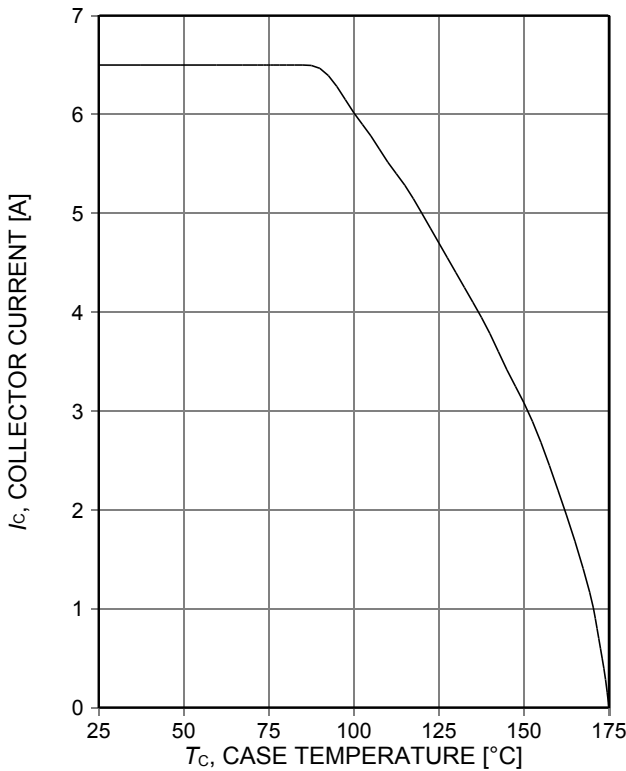


Figure 2. **Collector current as a function of case temperature**
($V_{GE} \geq 15\text{V}$, $T_{vj} \leq 175^\circ\text{C}$)

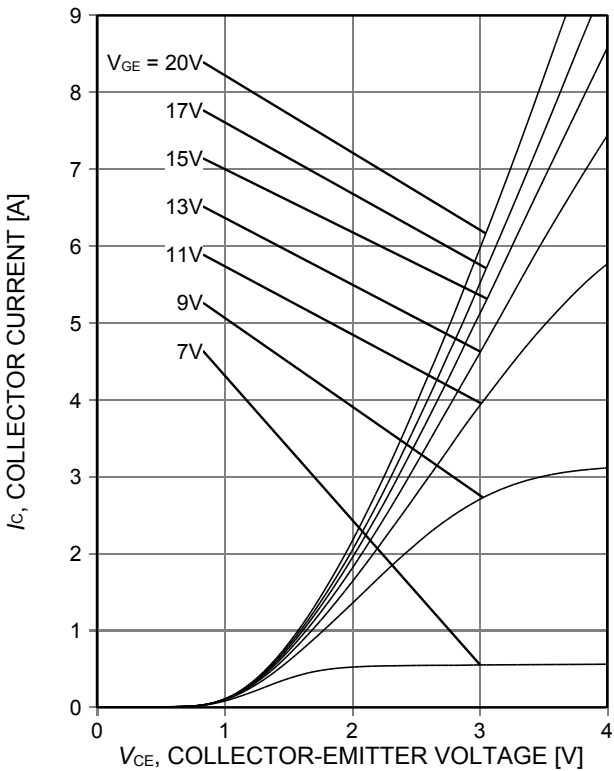


Figure 3. **Typical output characteristic**
($T_{vj} = 25^\circ\text{C}$)

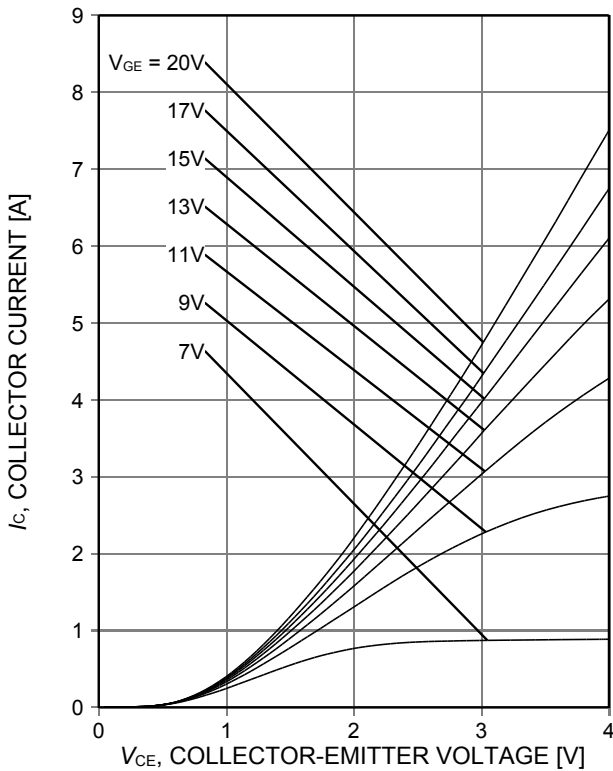


Figure 4. **Typical output characteristic**
($T_{vj} = 175^\circ\text{C}$)

TRENCHSTOP™ RC-Drives Fast Series

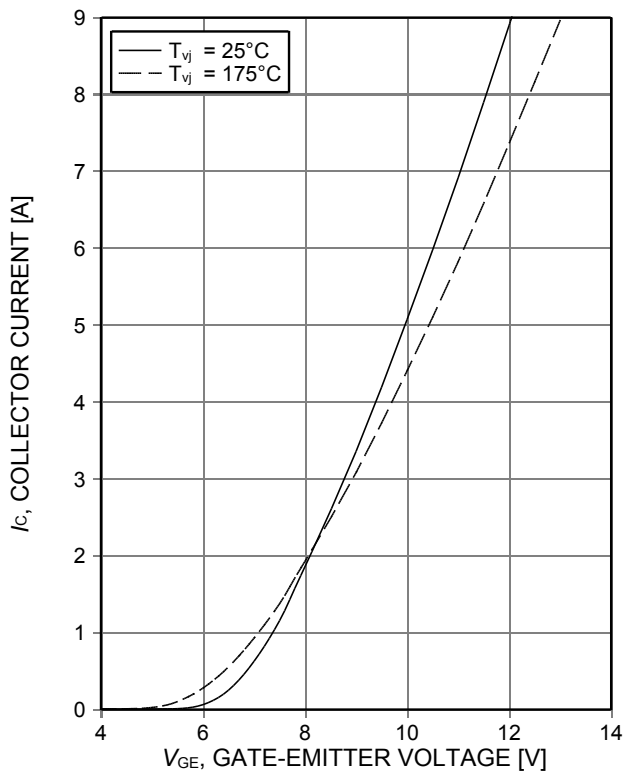


Figure 5. **Typical transfer characteristic**
($V_{CE}=10V$)

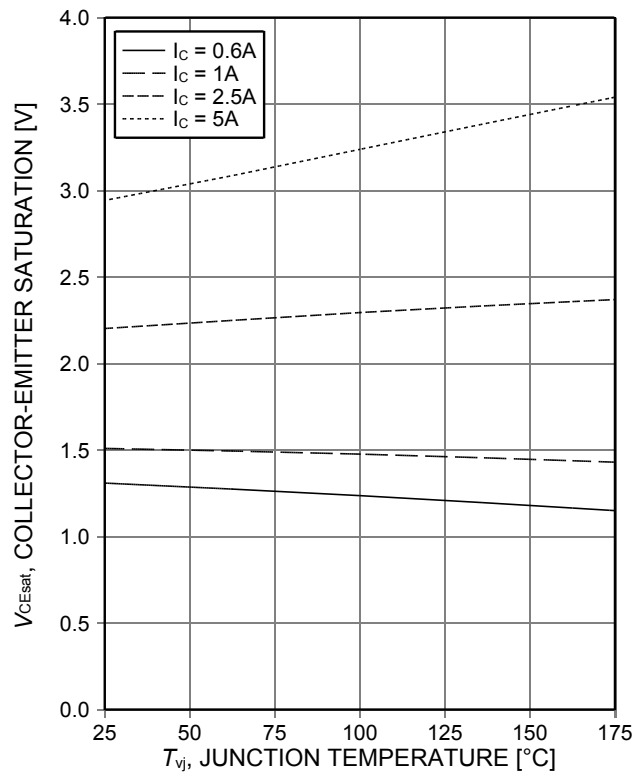


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
($V_{GE}=15V$)

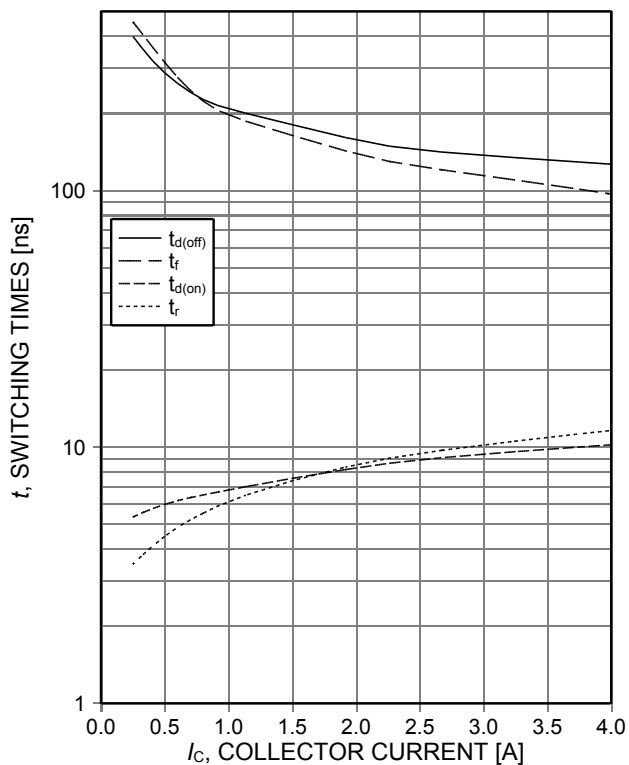


Figure 7. **Typical switching times as a function of collector current**
(inductive load, $T_{vj}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $R_{Gon}=68\Omega$, $R_{Goff}=68\Omega$, dynamic test circuit in Figure E)

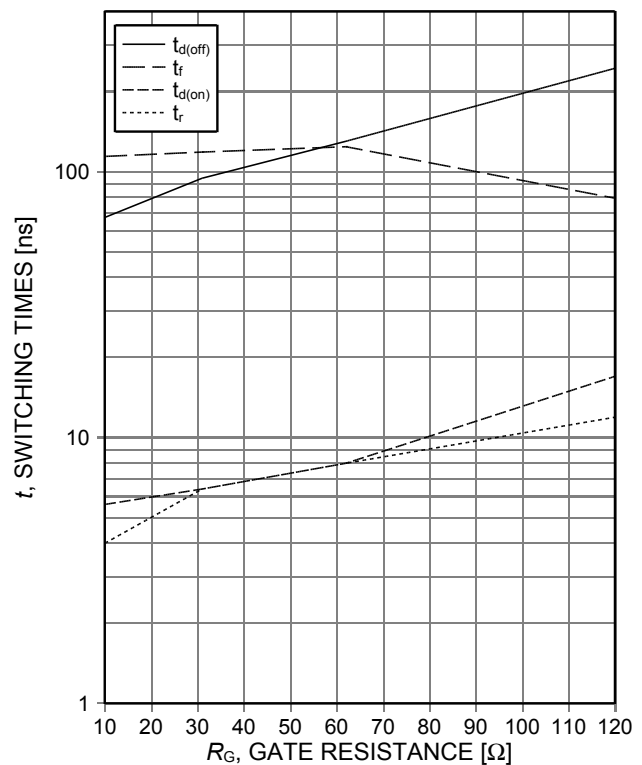


Figure 8. **Typical switching times as a function of gate resistance**
(inductive load, $T_{vj}=175^{\circ}C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=2,5A$, dynamic test circuit in Figure E)

TRENCHSTOP™ RC-Drives Fast Series

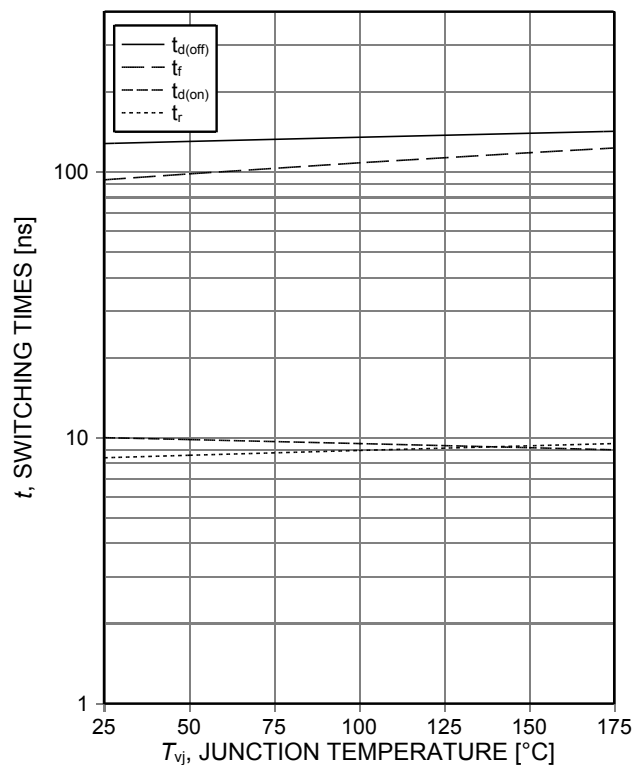


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=2,5A$, $R_{Gon}=68\Omega$, $R_{Goff}=68\Omega$, dynamic test circuit in Figure E)

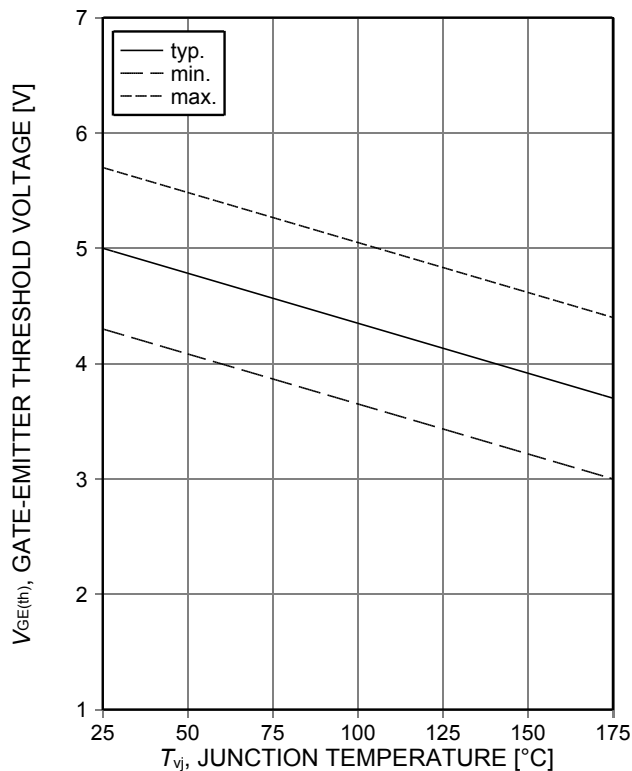


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
($I_C=0,05mA$)

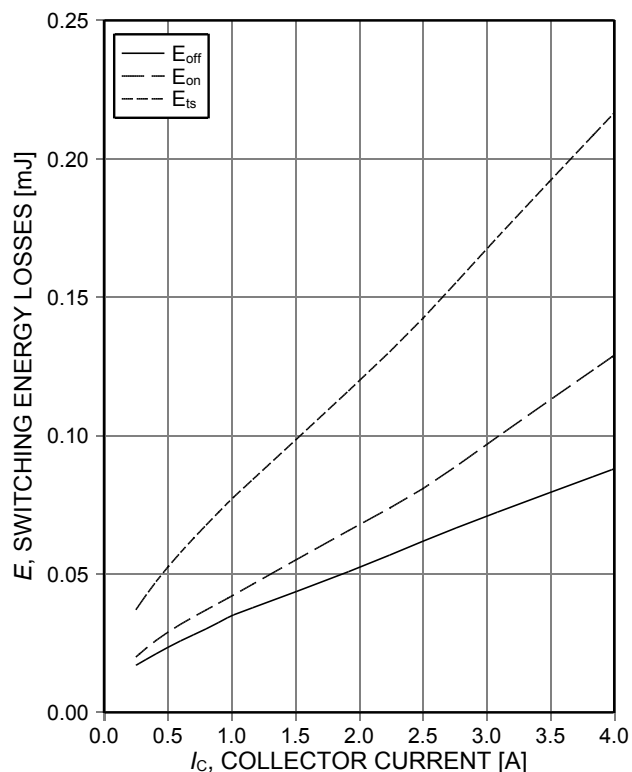


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, $T_{vj}=175^\circ C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $R_{Gon}=68\Omega$, $R_{Goff}=68\Omega$, dynamic test circuit in Figure E)

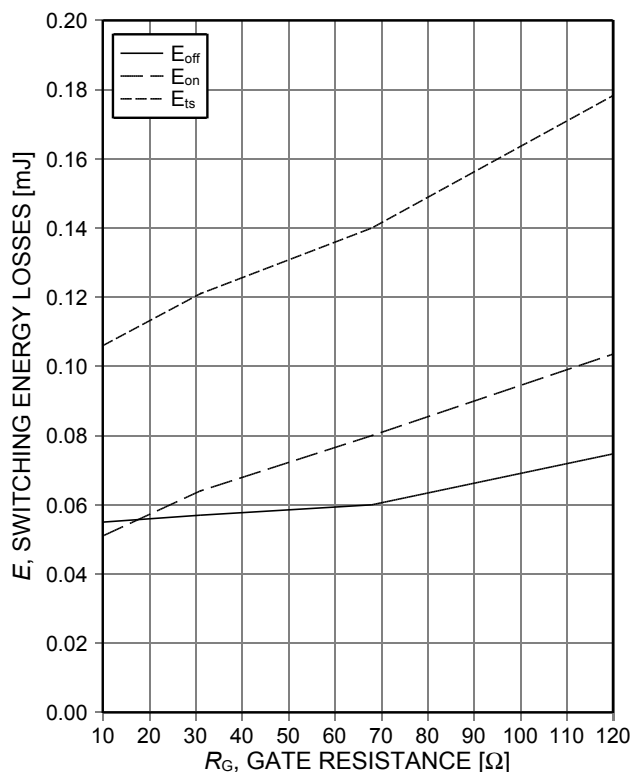


Figure 12. **Typical switching energy losses as a function of gate resistance**
(inductive load, $T_{vj}=175^\circ C$, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=2,5A$, dynamic test circuit in Figure E)

TRENCHSTOP™ RC-Drives Fast Series

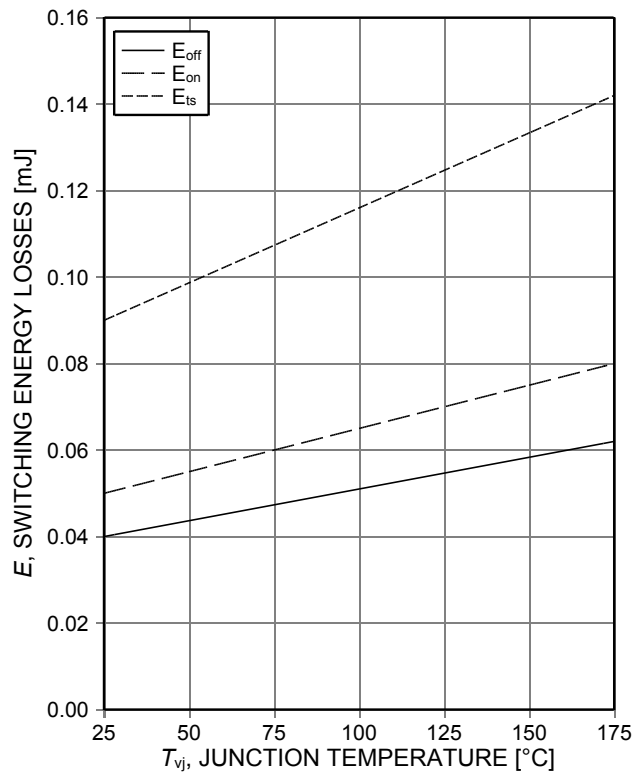


Figure 13. **Typical switching energy losses as a function of junction temperature**
(inductive load, $V_{CE}=400V$, $V_{GE}=0/15V$, $I_C=2,5A$, $R_{Gon}=68\Omega$, $R_{Goff}=68\Omega$, dynamic test circuit in Figure E)

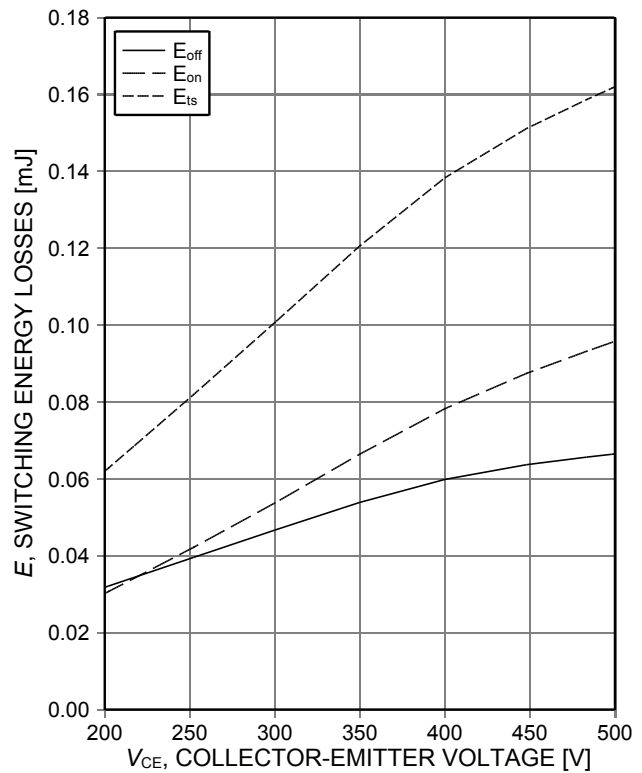


Figure 14. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, $T_{vj}=175^\circ C$, $V_{GE}=0/15V$, $I_C=2,5A$, $R_{Gon}=68\Omega$, $R_{Goff}=68\Omega$, dynamic test circuit in Figure E)

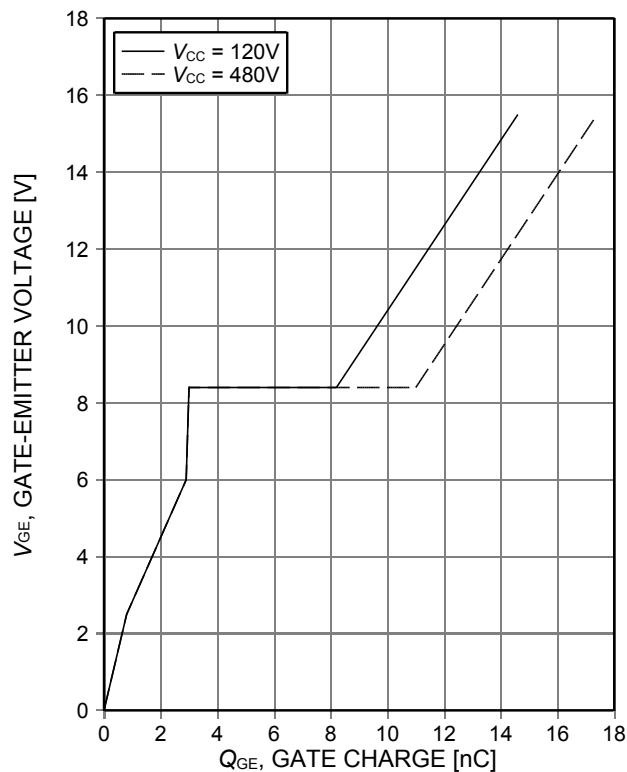


Figure 15. **Typical gate charge**
($I_C=2,5A$)

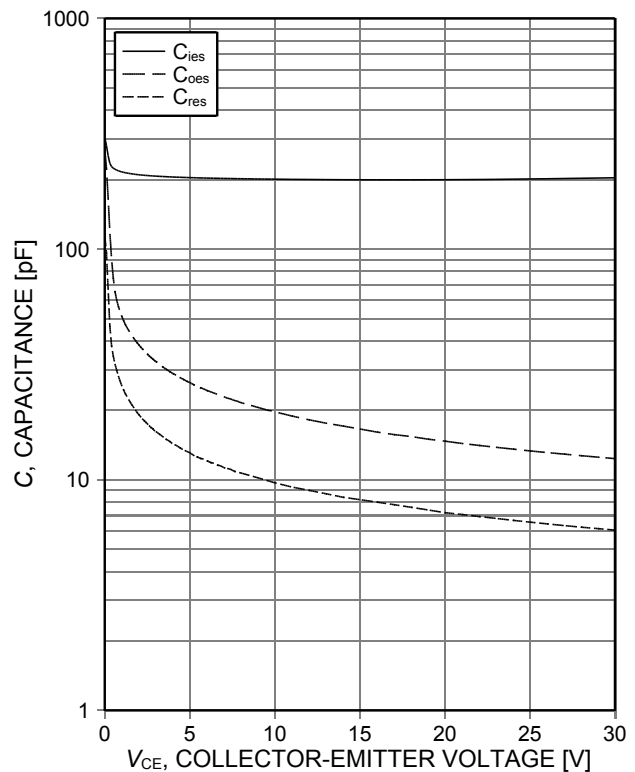


Figure 16. **Typical capacitance as a function of collector-emitter voltage**
($V_{GE}=0V$, $f=1MHz$)

TRENCHSTOP™ RC-Drives Fast Series

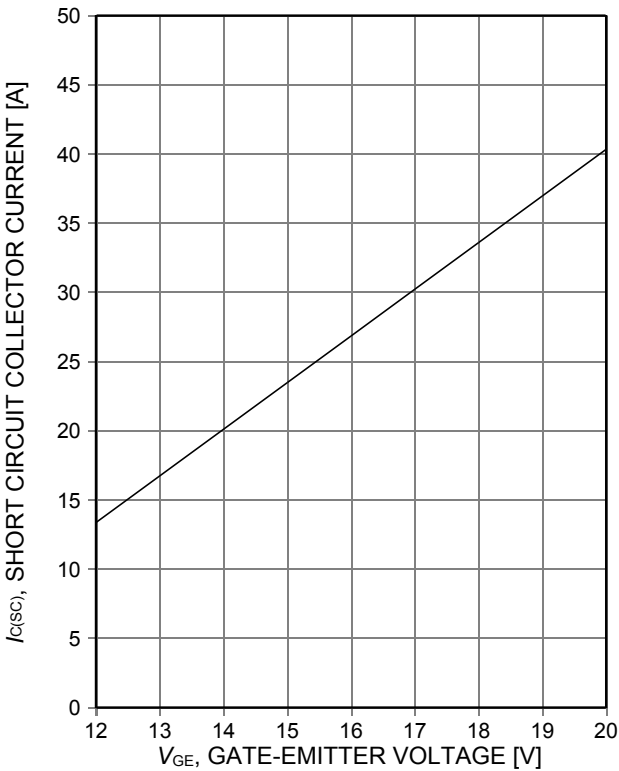


Figure 17. **Typical short circuit collector current as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, start at $T_{vj} = 25^{\circ}C$)

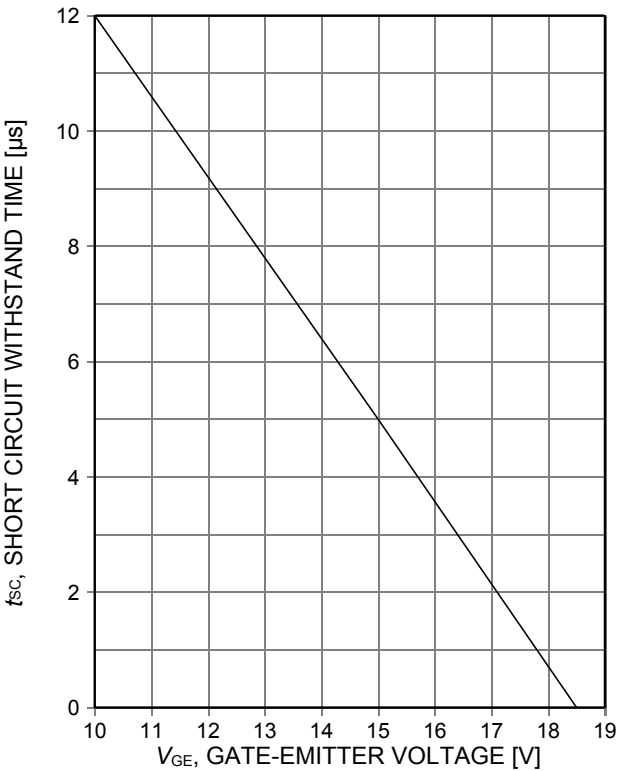


Figure 18. **Short circuit withstand time as a function of gate-emitter voltage**
($V_{CE} \leq 400V$, start at $T_{vj} = 150^{\circ}C$)

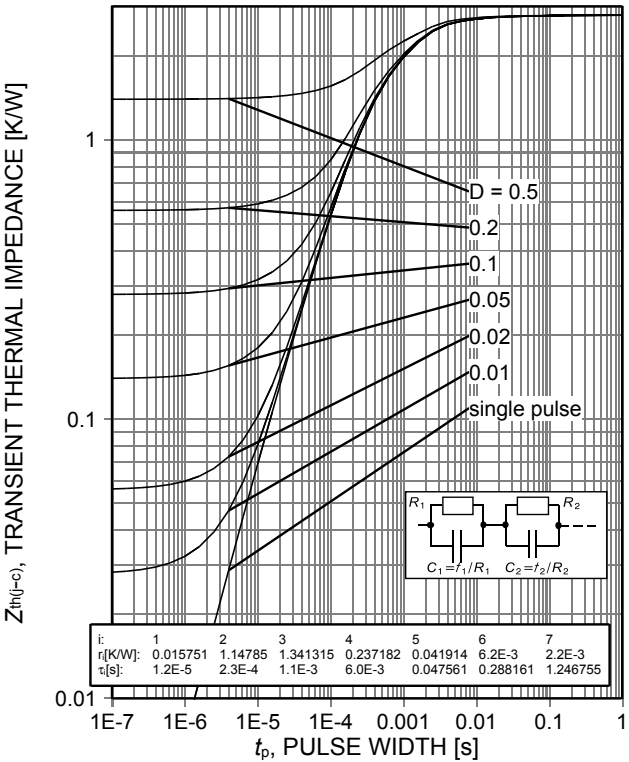


Figure 19. **IGBT transient thermal impedance as a function of pulse width (see page 4 ²⁾)**
($D = t_p / T$)

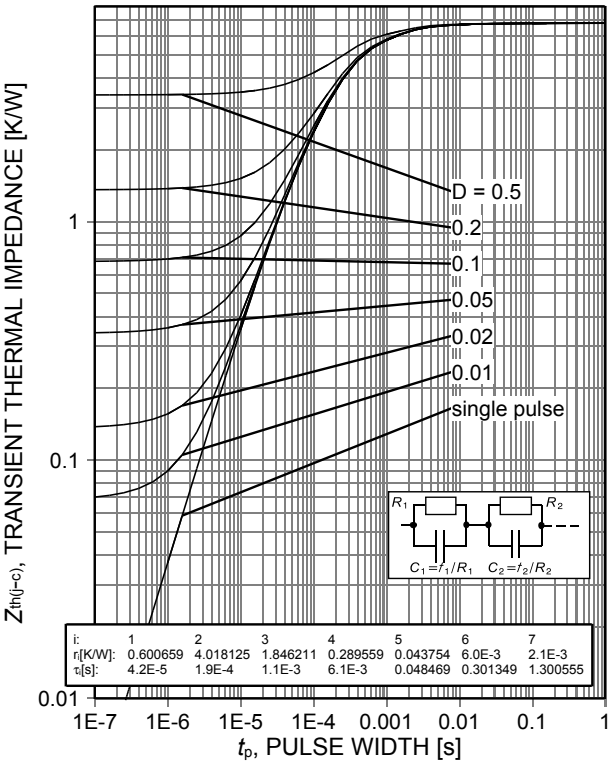


Figure 20. **Diode transient thermal impedance as a function of pulse width (see page 4 ³⁾)**
($D = t_p / T$)

TRENCHSTOP™ RC-Drives Fast Series

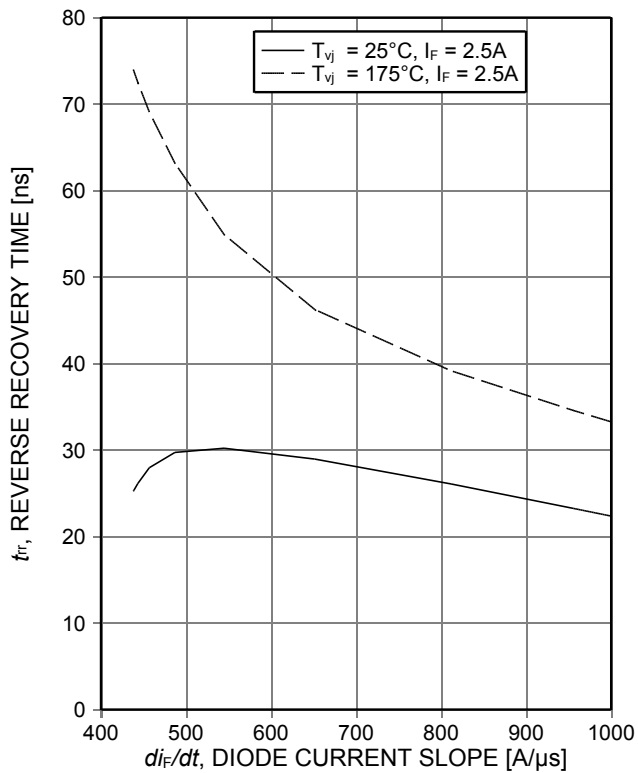


Figure 21. **Typical reverse recovery time as a function of diode current slope**
($V_R=400V$)

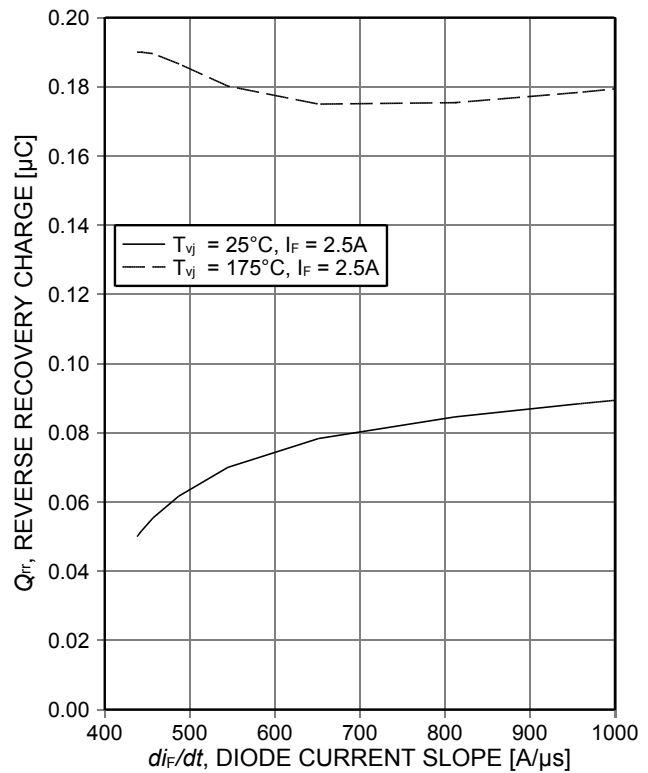


Figure 22. **Typical reverse recovery charge as a function of diode current slope**
($V_R=400V$)

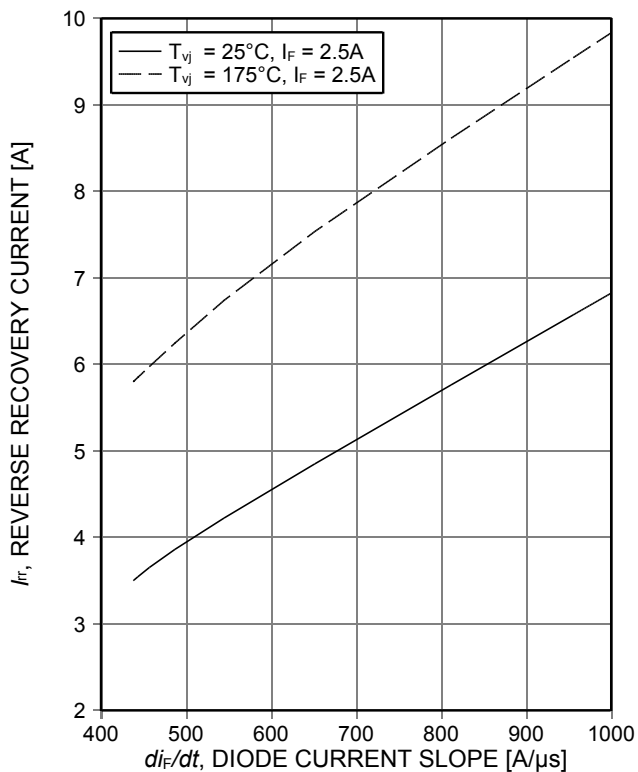


Figure 23. **Typical reverse recovery current as a function of diode current slope**
($V_R=400V$)

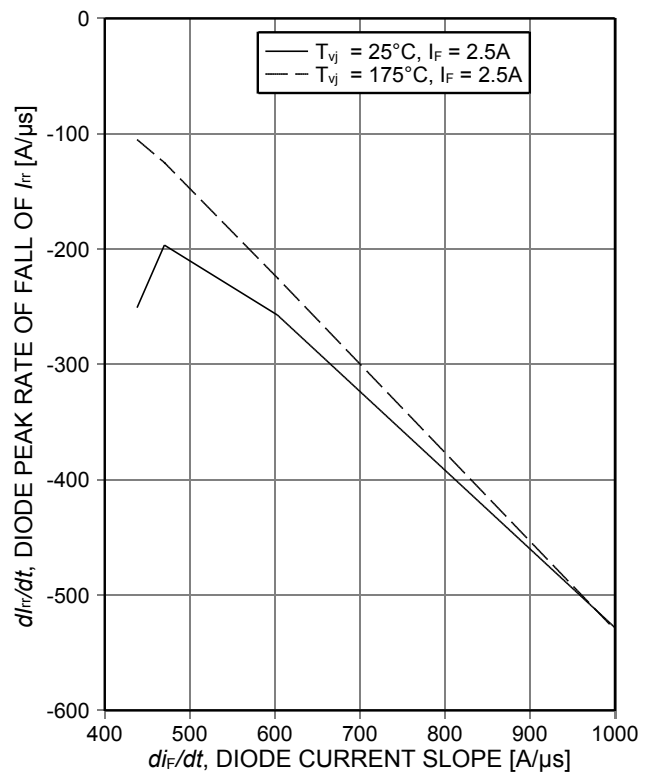


Figure 24. **Typical diode peak rate of fall of reverse recovery current as a function of diode current slope**
($V_R=400V$)

TRENCHSTOP™ RC-Drives Fast Series

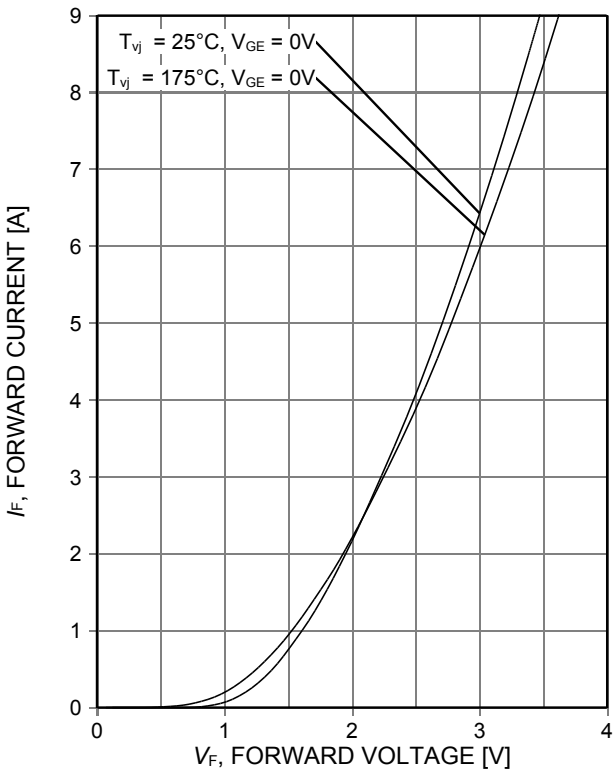


Figure 25. Typical diode forward current as a function of forward voltage

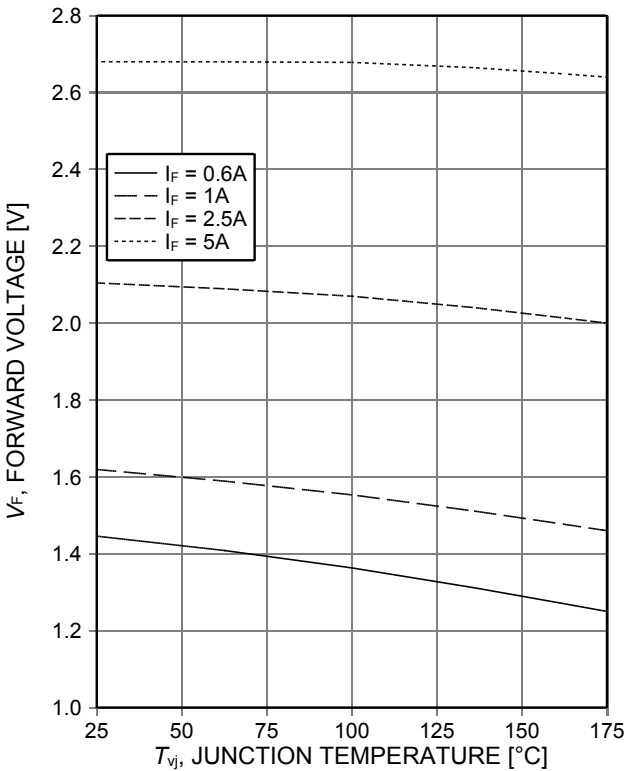
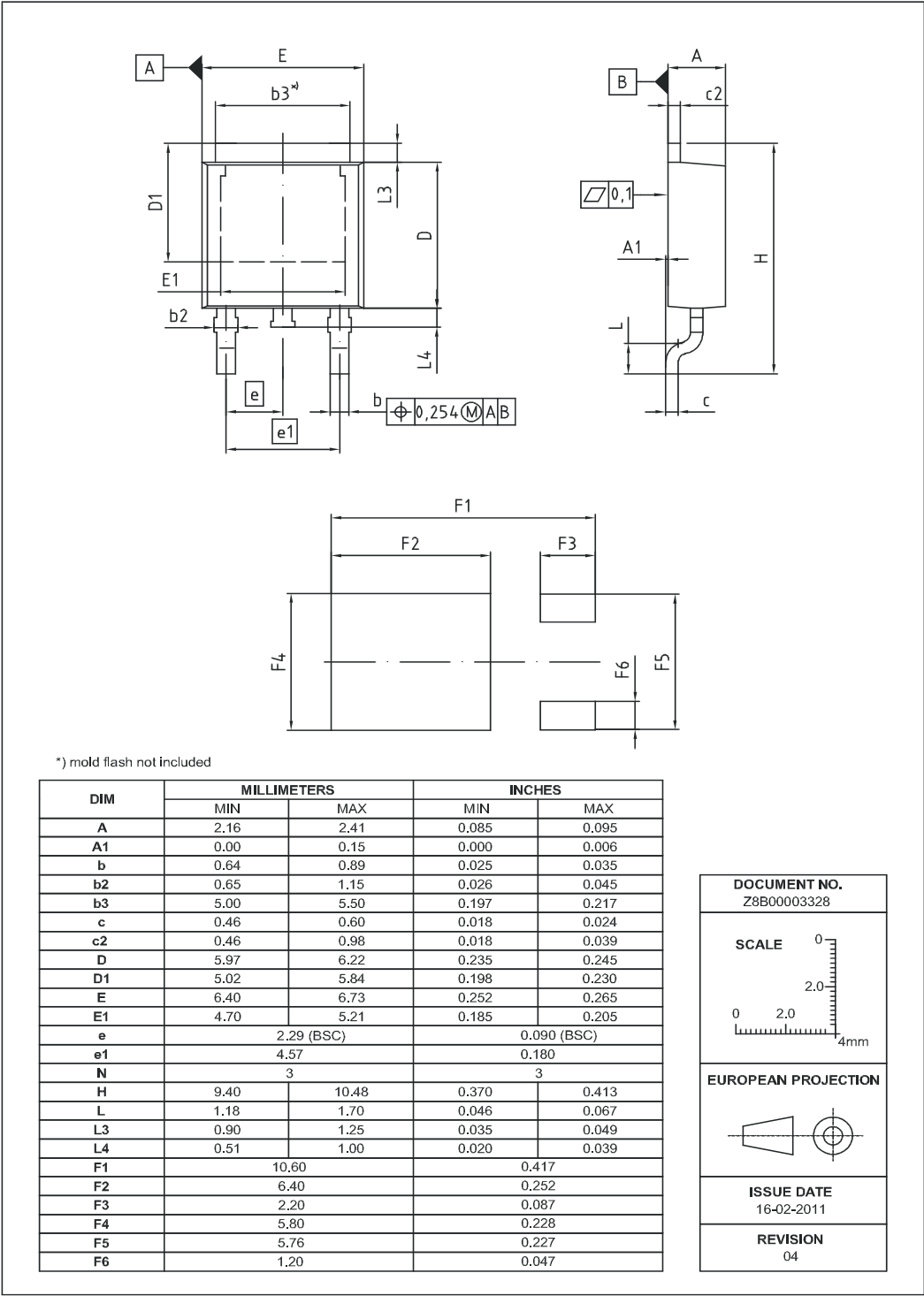


Figure 26. Typical diode forward voltage as a function of junction temperature

TRENCHSTOP™ RC-Drives Fast Series

Package Drawing PG-TO252-3



Testing Conditions

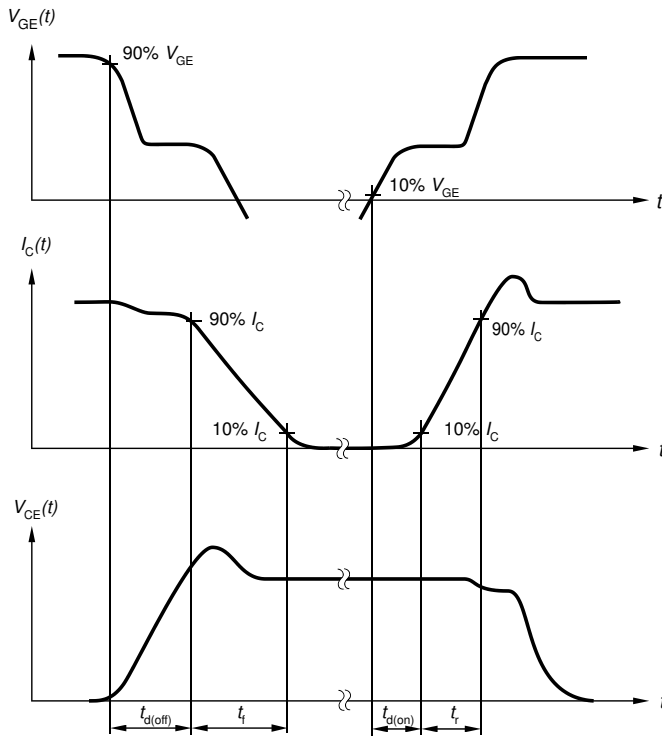


Figure A. Definition of switching times

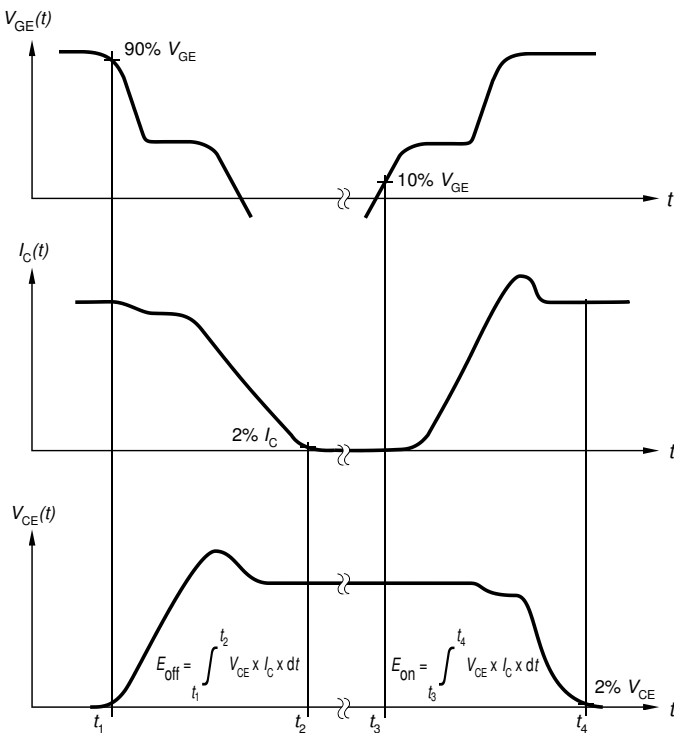


Figure B. Definition of switching losses

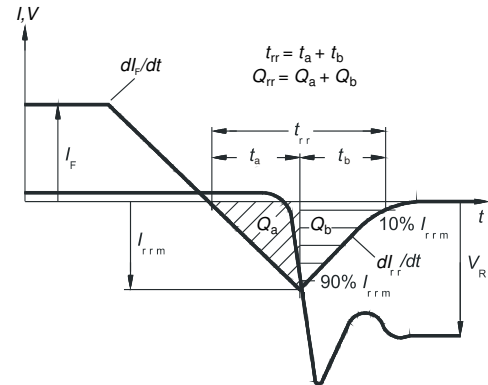


Figure C. Definition of diode switching characteristics

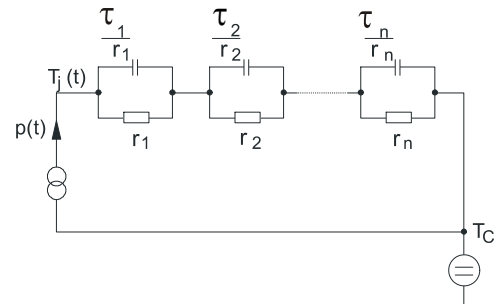


Figure D. Thermal equivalent circuit



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

TRENCHSTOP™ RC-Drives Fast Series**Revision History**

AIHD03N60RF**Revision: 2017-02-09, Rev. 2.1**

Previous Revision

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

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