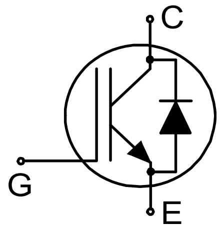
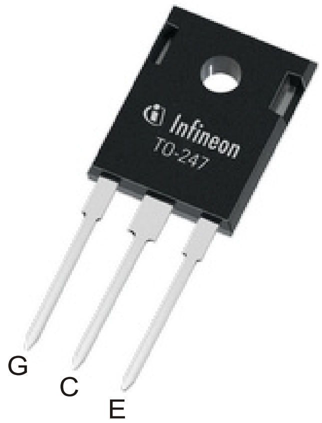
Discrete 650V Hybrid with TRENCHSTOP™ 5 Fast-Switching IGBT and CoolSiC™ Schottky Diode G5 for Automotive

Features and Benefits:

- Best-in-Class efficiency in hard switching and resonant topologies
- 650V break-down voltage
- Trenchstop™ 5 fast-switching IGBT
- CoolSiC™ Schottky Diode G5
- Low gate charge Q_G
- Maximum junction temperature 175°C
- Qualified according to AEC-Q101/100
- Pb-free lead plating; RoHS compliant





Applications:

- On-board charger
- DC/DC converter

Package pin definition:

- Pin 1 - gate
- Pin 2 & backside - collector
- Pin 3 - emitter

Key Performance and Package Parameters

Type	V_{CE}	I_C	V_{CEsat}, T_{vj}=25°C	T_{vjmax}	Marking	Package
AIKW50N65RF5	650V	50A	1.6V	175°C	AK50ERF5	PG-TO247-3

Table of Contents

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage	V_{CE}	650	V
DC collector current, limited by T_{vjmax}[1)] T_c = 25°C value limited by bondwire T_c = 100°C	I_C	80.0 46.0	A
Pulsed collector current, t_p limited by T_{vjmax}[1)]	I_{Cpuls}	150.0	A
Turn off safe operating area $V_{CE} \leq 650$V, $T_{vj} \leq 175$°C[1)]	-	150.0	A
Diode forward current, limited by T_{vjmax}[1)] T_c = 25°C value limited by bondwire T_c = 100°C	I_F	40.0 27.0	A
Diode pulsed current, t_p limited by T_{vjmax}[1)]	I_{Fpuls}	100.0	A
Gate-emitter voltage[1)] Transient Gate-emitter voltage ($t_p \leq 10$µs, $D < 0.010$)	V_{GE}	±20 ±30	V
Power dissipation T_c = 25°C[1)] Power dissipation T_c = 100°C	P_{tot}	250.0 125.0	W
Operating junction temperature	T_{vj}	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	°C
Soldering temperature, wave soldering 1.6mm (0.063in.) from case for 10s		260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

Thermal Resistance

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
R_{th} Characteristics						
IGBT thermal resistance,[1)] junction - case	$R_{th(j-c)}$		-	0.45	0.60	K/W
Diode thermal resistance,[1)] junction - case	$R_{th(j-c)}$		-	1.00	1.40	K/W
Thermal resistance[1)] junction - ambient	$R_{th(j-a)}$		-	-	40	K/W

[1)] Not subject to production test. Verified by design/characterization

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	650	-	-	V
Collector-emitter saturation voltage	V_{CEsat}	V_{GE} = 15.0V, I_C = 50.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	- - -	1.60 1.80 1.90	2.10 - -	V
Diode forward voltage	V_F	V_{GE} = 0V, I_F = 20.0A T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 175°C	- - -	1.45 1.60 1.80	1.70 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C = 0.50mA, V_{CE} = V_{GE}	3.2	4.0	4.8	V
Zero gate voltage collector current	I_{CES}	V_{CE} = 650V, V_{GE} = 0V T_{vj} = 25°C T_{vj} = 175°C	- -	- 1500	120 -	µA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0V, V_{GE} = 20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE} = 20V, I_C = 50.0A	-	61.0	-	S

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 = 1000kHz	-	2850	-	pF
Output capacitance	C_{oes}		-	240	-	pF
Reverse transfer capacitance	C_{res}		-	8	-	pF
Gate charge	Q_G	V_{CC} = 520V, I_C = 50.0A, V_{GE} = 15V	-	109.0	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	13.0	-	nH

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 = 25.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	20	-	ns
Rise time	t_r		-	12	-	ns
Turn-off delay time	$t_{d(off)}$		-	156	-	ns
Fall time	t_f		-	13	-	ns
Turn-on energy	E_{on}		-	0.31	-	mJ
Turn-off energy	E_{off}		-	0.12	-	mJ
Total switching energy	E_{ts}		-	0.43	-	mJ

Turn-on delay time	$t_{d(on)}$	T_{vj} = 25°C, V_{CC} = 400V, I_C = 6.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	18	-	ns
Rise time	t_r		-	4	-	ns
Turn-off delay time	$t_{d(off)}$		-	173	-	ns
Fall time	t_f		-	10	-	ns
Turn-on energy	E_{on}		-	0.07	-	mJ
Turn-off energy	E_{off}		-	0.04	-	mJ
Total switching energy	E_{ts}		-	0.11	-	mJ

Diode Characteristic, at T_{vj} = 25°C

Diode reverse recovery charge	Q_{rr}	T_{vj} = 25°C, V_R = 400V, I_F = 25.0A, di_F/dt = 200A/μs	-	0.03	-	μC

Switching Characteristic, Inductive Load

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic, at T_{vj} = 150°C						
Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 400V, I_C = 25.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	20	-	ns
Rise time	t_r		-	15	-	ns
Turn-off delay time	$t_{d(off)}$		-	191	-	ns
Fall time	t_f		-	6	-	ns
Turn-on energy	E_{on}		-	0.33	-	mJ
Turn-off energy	E_{off}		-	0.19	-	mJ
Total switching energy	E_{ts}		-	0.52	-	mJ

Turn-on delay time	$t_{d(on)}$	T_{vj} = 150°C, V_{CC} = 400V, I_C = 6.0A, V_{GE} = 0.0/15.0V, $R_{G(on)}$ = 12.0Ω, $R_{G(off)}$ = 12.0Ω, $L\sigma$ = 30nH, $C\sigma$ = 30pF $L\sigma$, $C\sigma$ from Fig. E Energy losses include “tail” and diode reverse recovery.	-	17	-	ns
Rise time	t_r		-	6	-	ns
Turn-off delay time	$t_{d(off)}$		-	229	-	ns
Fall time	t_f		-	26	-	ns
Turn-on energy	E_{on}		-	0.07	-	mJ
Turn-off energy	E_{off}		-	0.07	-	mJ
Total switching energy	E_{ts}		-	0.14	-	mJ

Diode Characteristic, at T_{vj} = 150°C

Diode reverse recovery charge[1)]	Q_{rr}	T_{vj} = 150°C, V_R = 400V, I_F = 25.0A, di_F/dt = 200A/μs	-	0.03	-	μC

[1)] There is no reverse recovery of Schottky barrier diodes. Qrr denotes capacitive charge Qc.

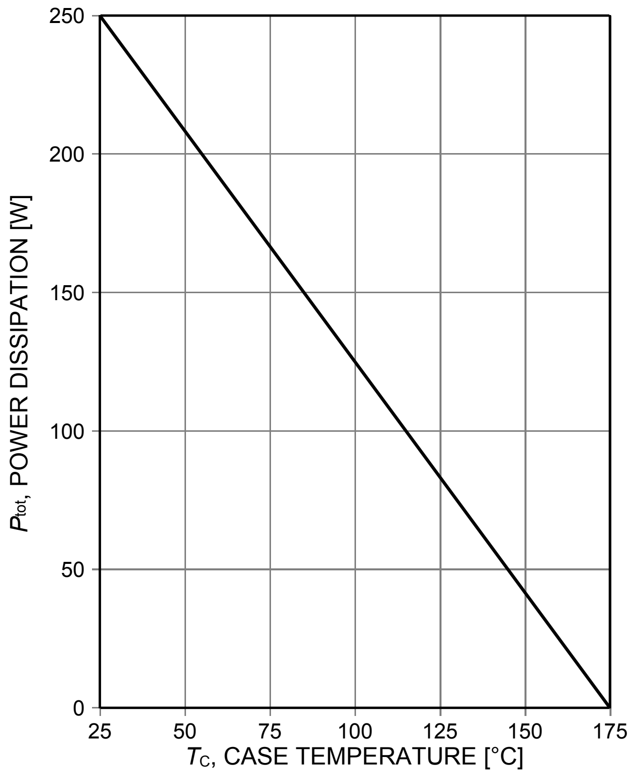


Figure 1. **Power dissipation as a function of case temperature**
(T_{vj}≤175°C)

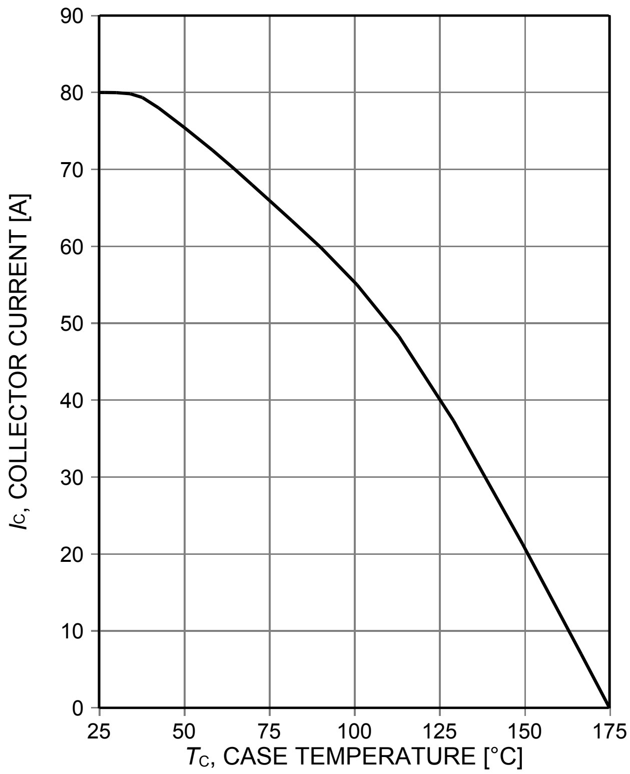


Figure 2. **Collector current as a function of case temperature**
(V_{GE}≥15V, T_{vj}≤175°C)

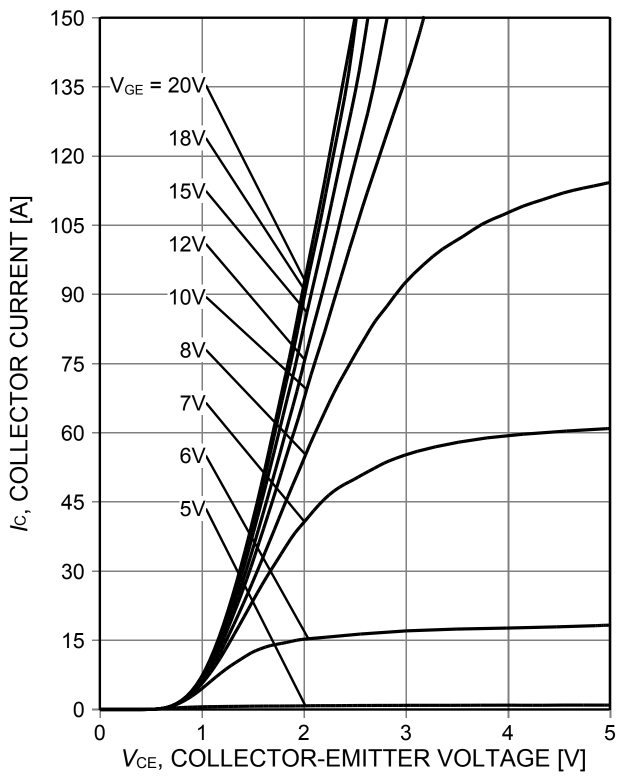


Figure 3. **Typical output characteristic**
(T_{vj}=25°C)

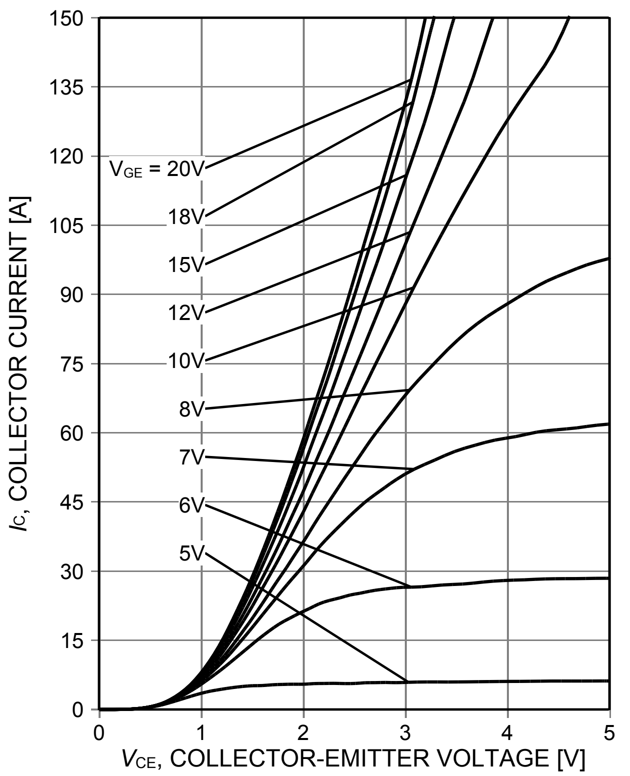


Figure 4. **Typical output characteristic**
(T_{vj}=150°C)

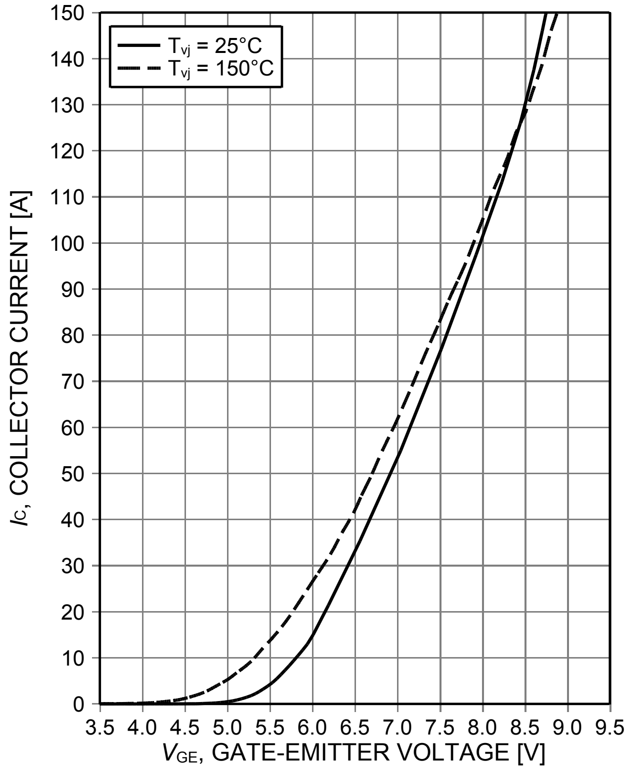


Figure 5. **Typical transfer characteristic**
(V_{CE}=20V)

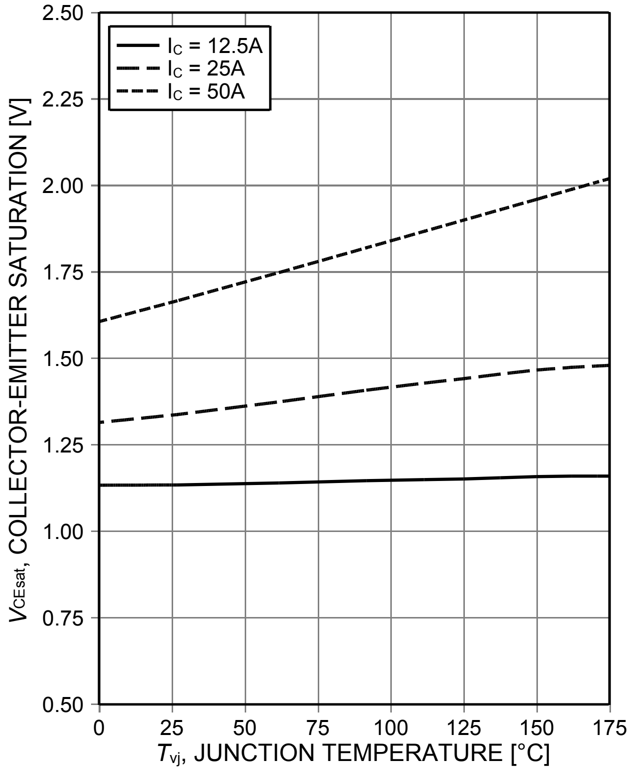


Figure 6. **Typical collector-emitter saturation voltage as a function of junction temperature**
(V_{GE}=15V)

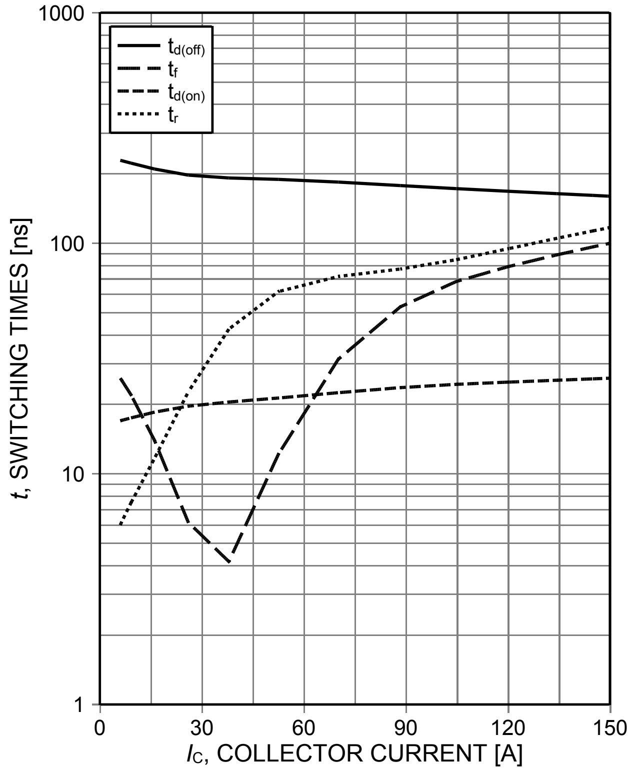


Figure 7. **Typical switching times as a function of collector current**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, r_G=12Ω, Dynamic test circuit in Figure E)

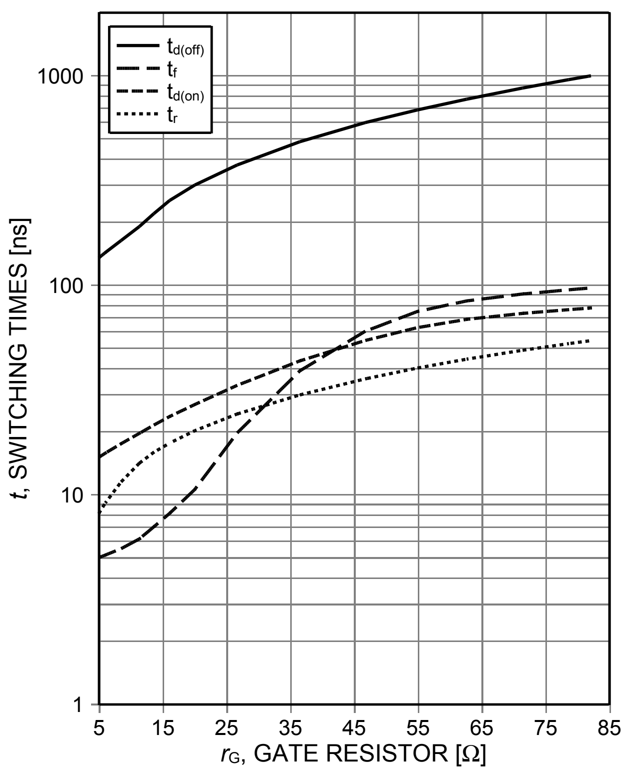


Figure 8. **Typical switching times as a function of gate resistor**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=25A,Dynamic test circuit in Figure E)

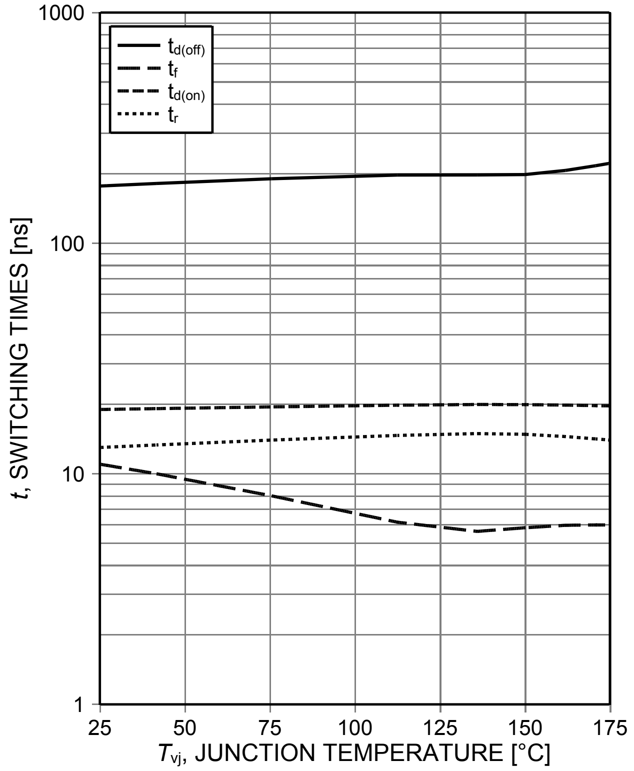


Figure 9. **Typical switching times as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=25A, r_G=12Ω,Dynamic test circuit in Figure E)

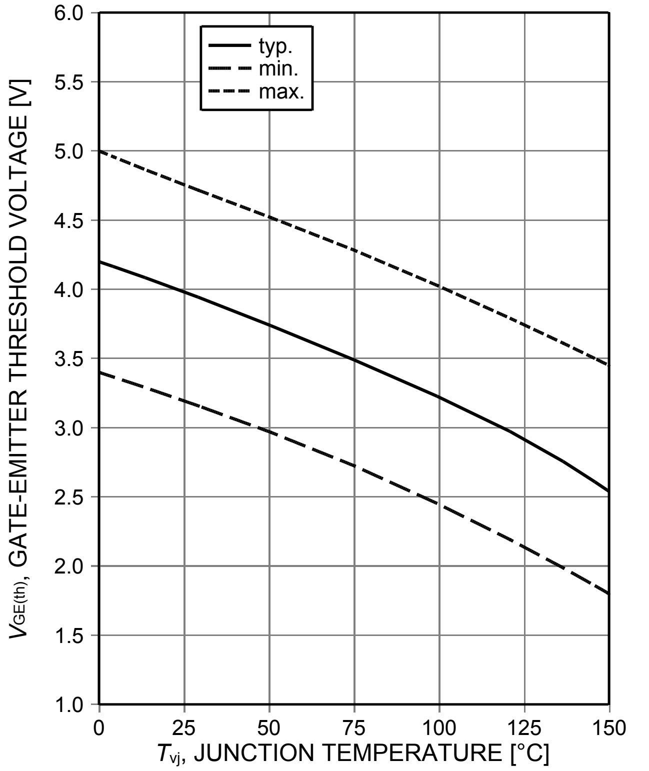


Figure 10. **Gate-emitter threshold voltage as a function of junction temperature**
(I_C=0.5mA. Only values at 25°C subject to production test. All other values are verified by design/characterization)

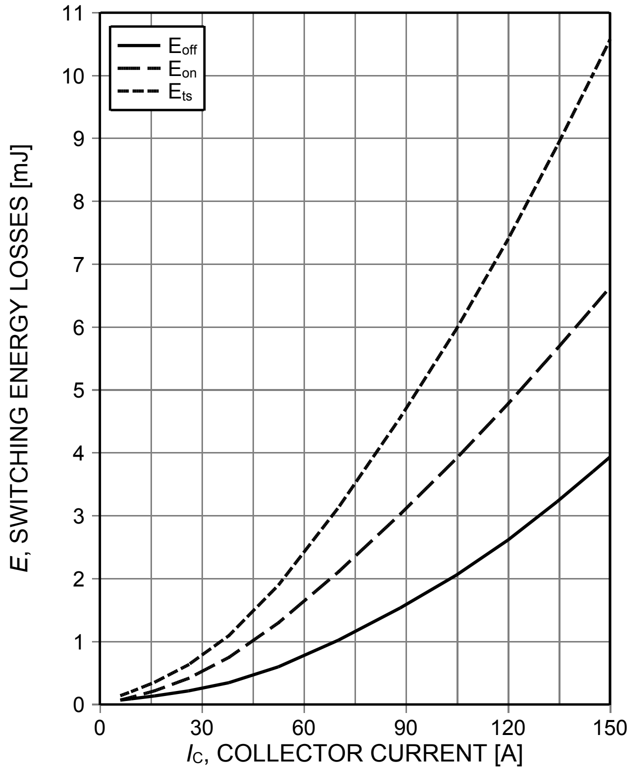


Figure 11. **Typical switching energy losses as a function of collector current**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, r_G=12Ω,Dynamic test circuit in Figure E)

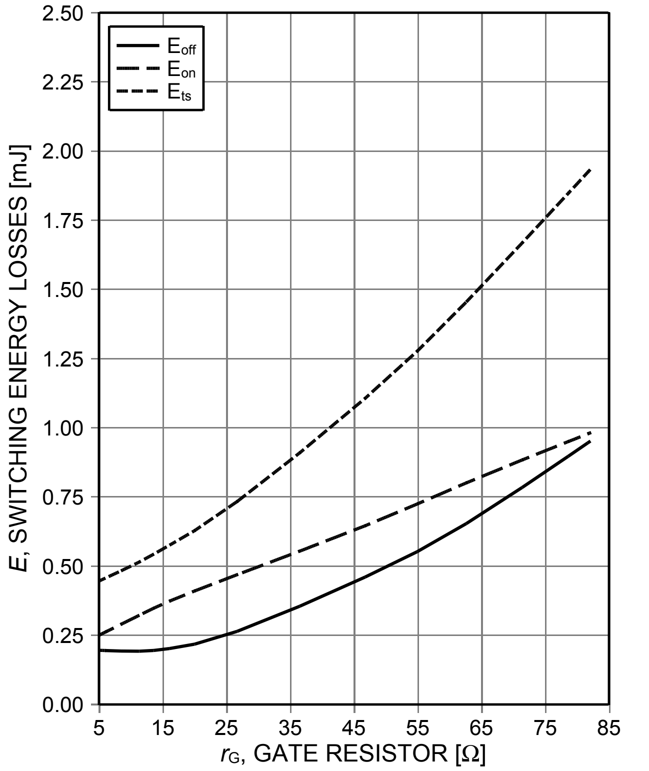


Figure 12. **Typical switching energy losses as a function of gate resistor**
(inductive load, T_{vj}=150°C, V_{CE}=400V, V_{GE}=15/0V, I_C=25A, Dynamic test circuit in Figure E)

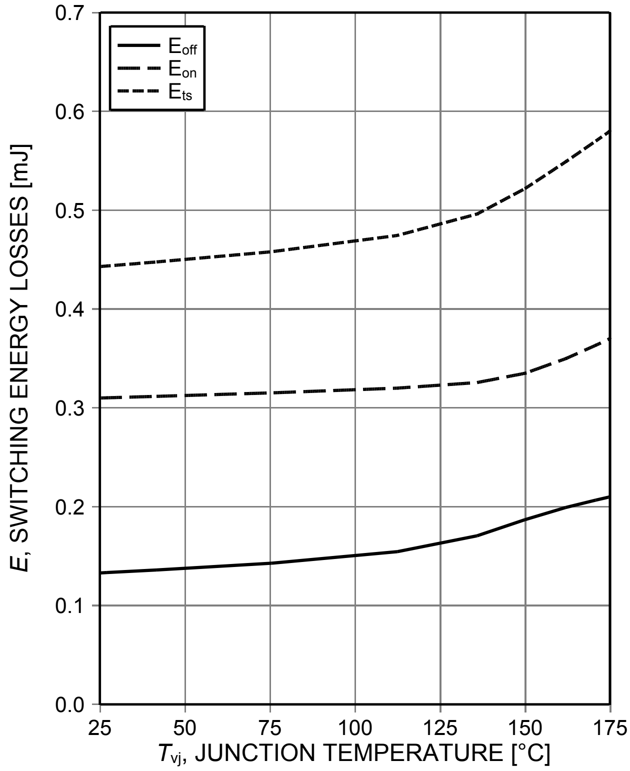


Figure 13. **Typical switching energy losses as a function of junction temperature**
(inductive load, V_{CE}=400V, V_{GE}=15/0V, I_C=25A, r_G=12Ω,Dynamic test circuit in Figure E)

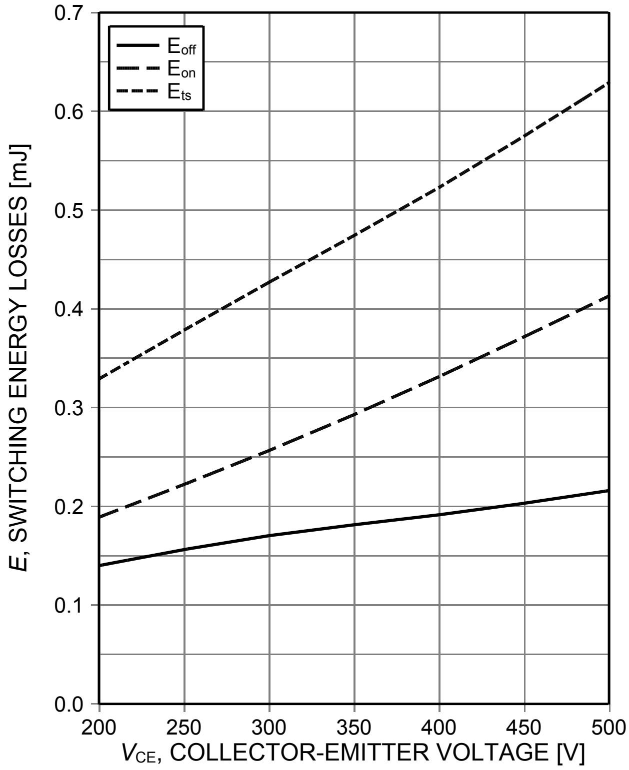


Figure 14. **Typical switching energy losses as a function of collector emitter voltage**
(inductive load, T_{vj}=150°C, V_{GE}=15/0V, I_C=25A, r_G=12Ω,Dynamic test circuit in Figure E)

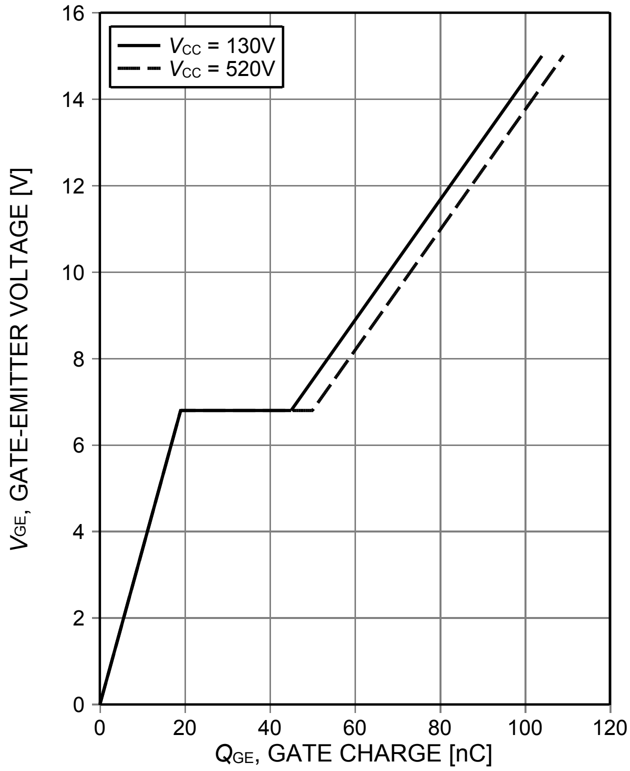


Figure 15. **Typical gate charge**
(I_C=50A)

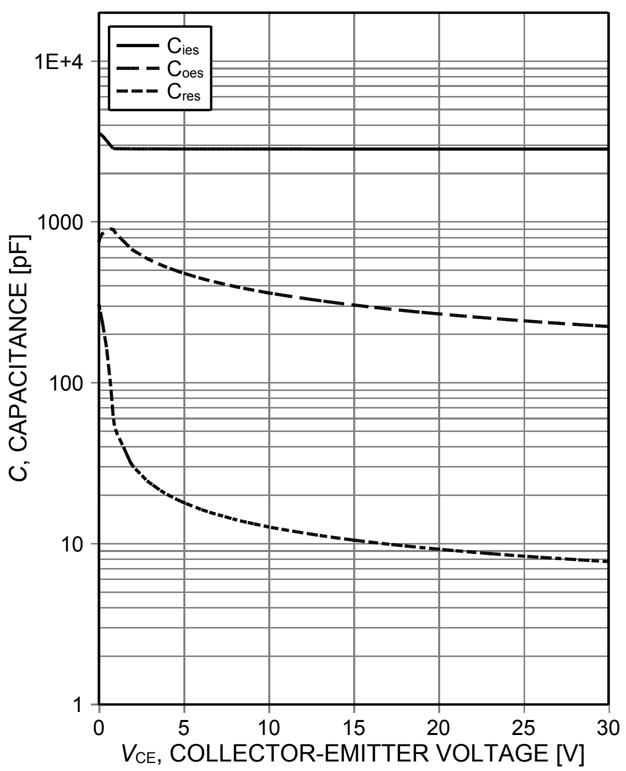


Figure 16. **Typical capacitance as a function of collector-emitter voltage**
(V_{GE}=0V, f=1MHz)

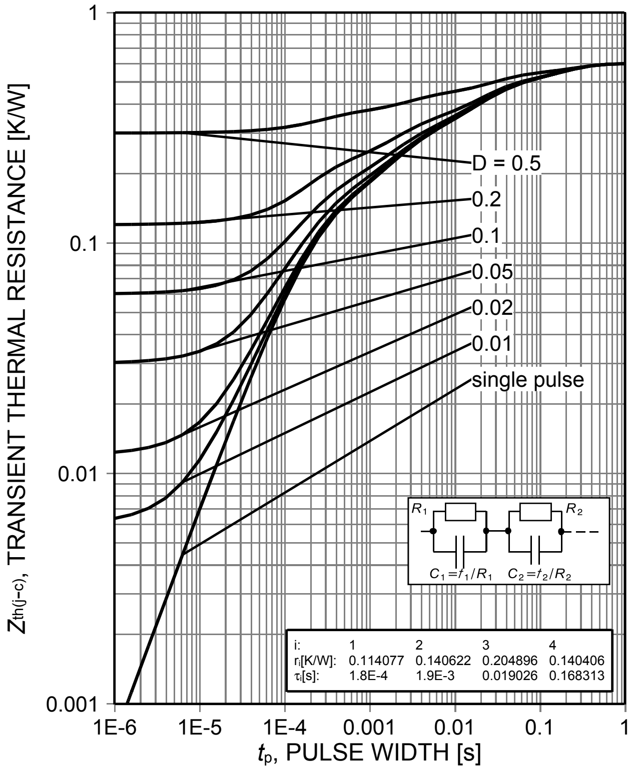


Figure 17. **IGBT transient thermal resistance**
($D=t_p/T$)

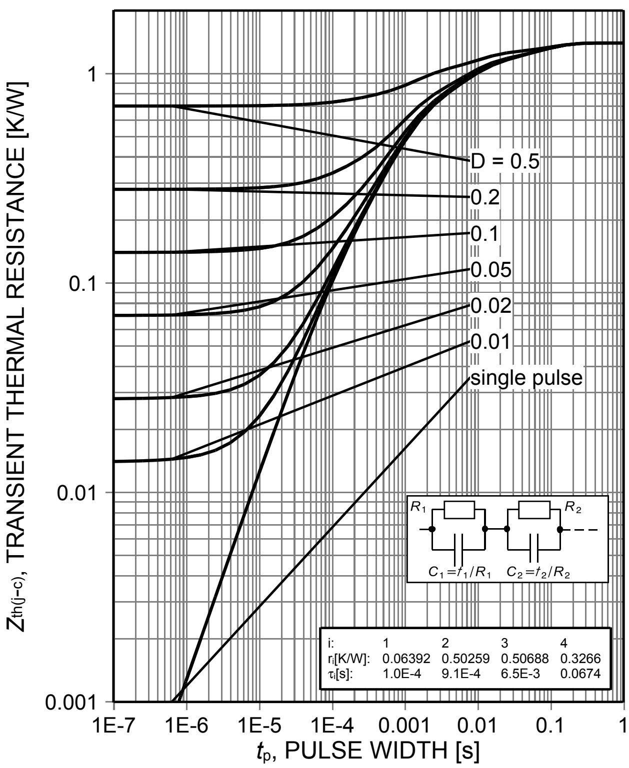


Figure 18. **Diode transient thermal impedance as a function of pulse width**
($D=t_p/T$)

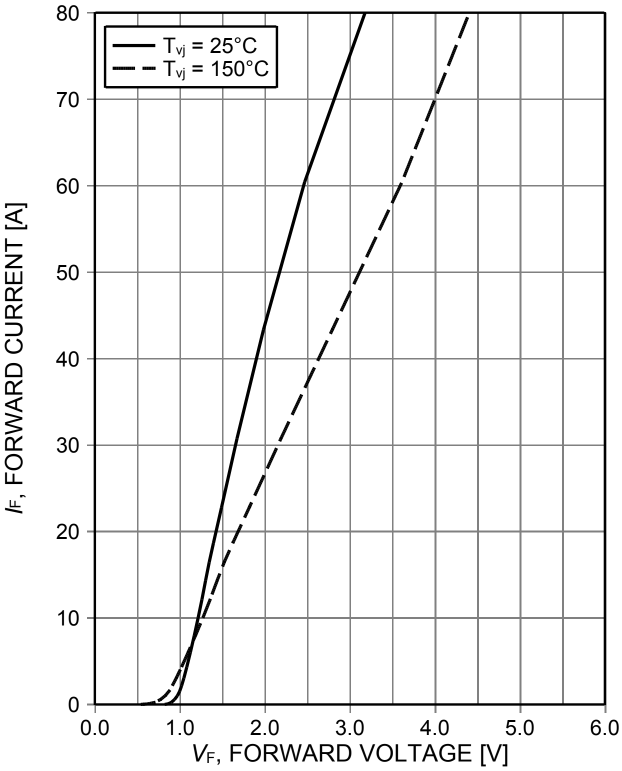


Figure 19. **Typical diode forward current as a function of forward voltage**

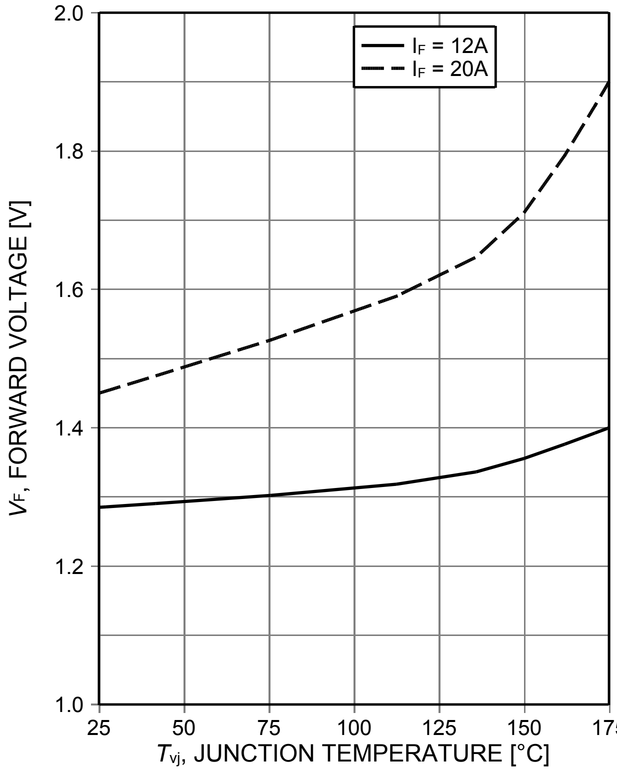
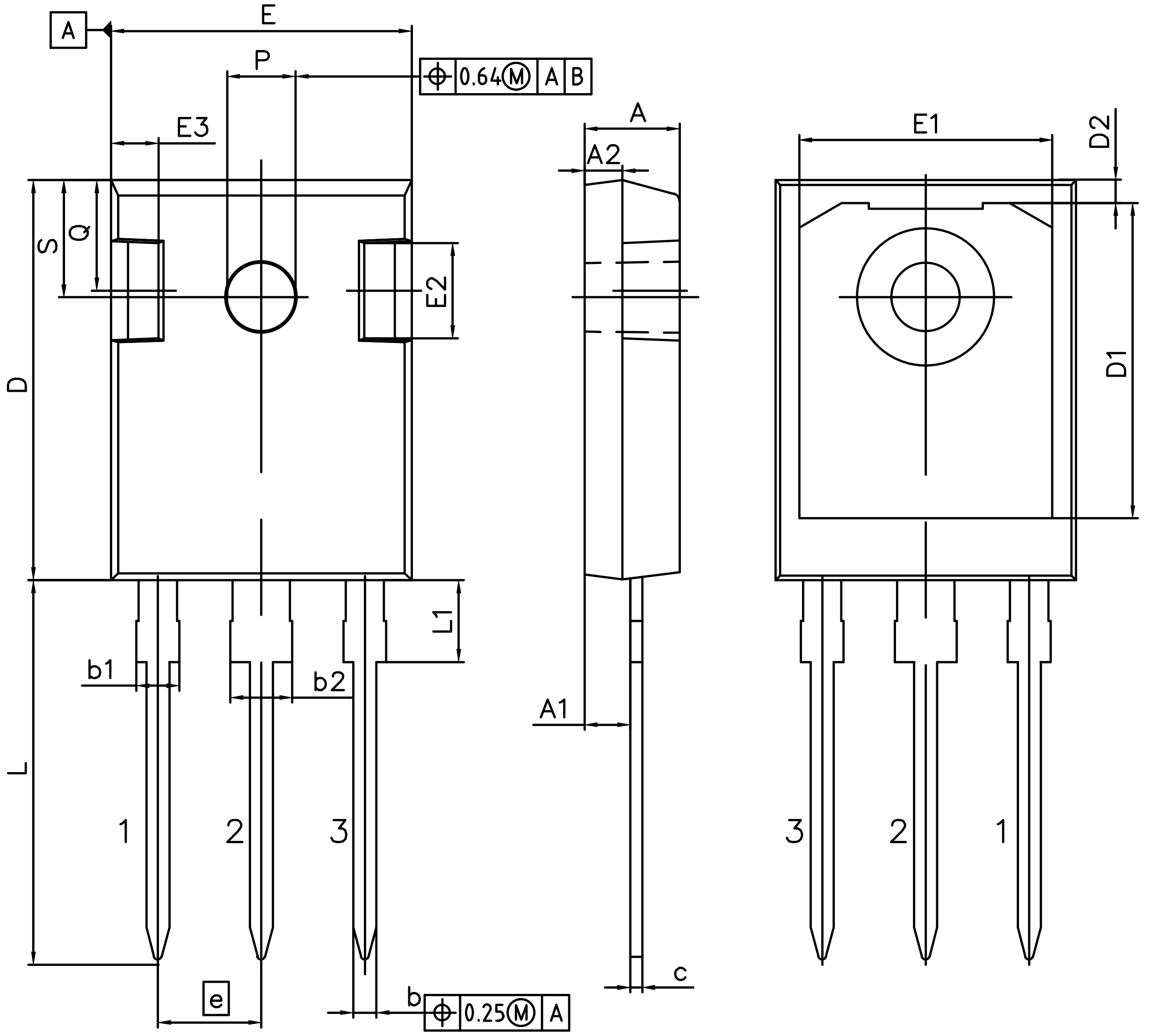


Figure 20. **Typical diode forward voltage as a function of junction temperature**

Package Drawing PG-TO247-3



DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.70	5.30
A1	2.20	2.60
A2	1.50	2.50
b	1.00	1.40
b1	1.60	2.41
b2	2.57	3.43
c	0.38	0.89
D	20.70	21.50
D1	13.08	17.65
D2	0.51	1.35
E	15.50	16.30
E1	12.38	14.15
E2	3.40	5.10
E3	1.00	2.60
e	5.44	
L	19.80	20.40
L1	3.85	4.50
P	3.50	3.70
Q	5.35	6.25
S	6.04	6.30

DOCUMENT NO. Z8B00003327
REVISION 06
SCALE 3:1 0 1 2 3 4 5mm
EUROPEAN PROJECTION
ISSUE DATE 25.07.2018

Testing Conditions

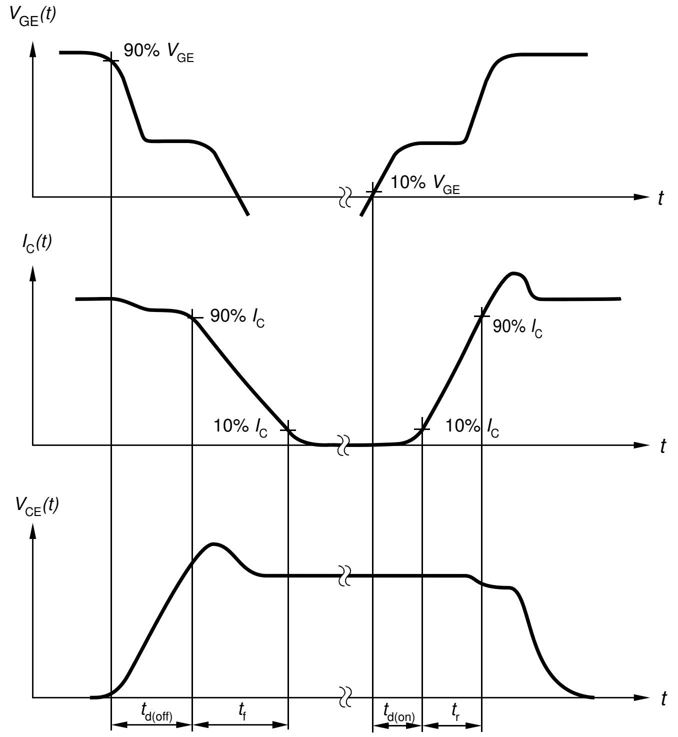


Figure A. **Definition of switching times**

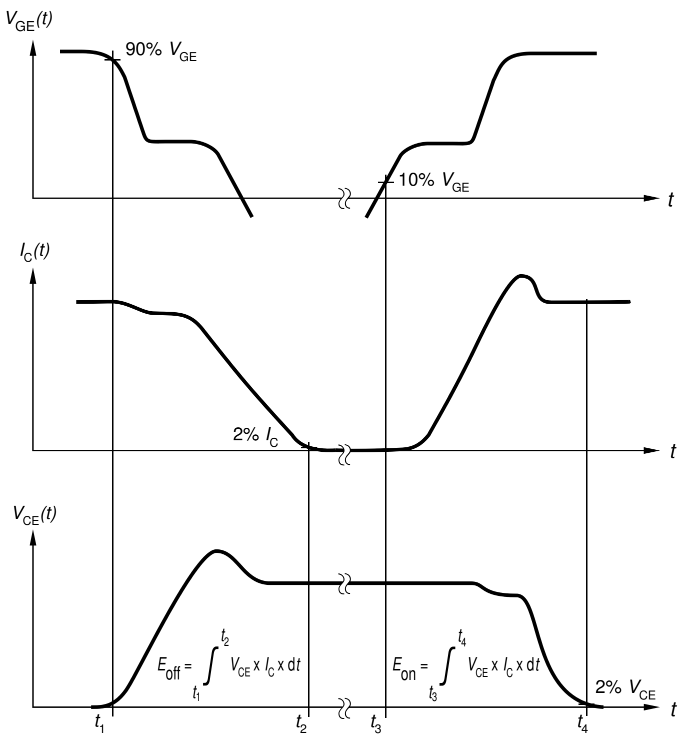


Figure B. **Definition of switching losses**

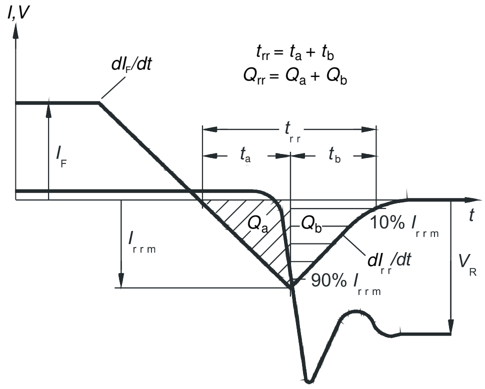


Figure C. **Definition of diode switching characteristics**

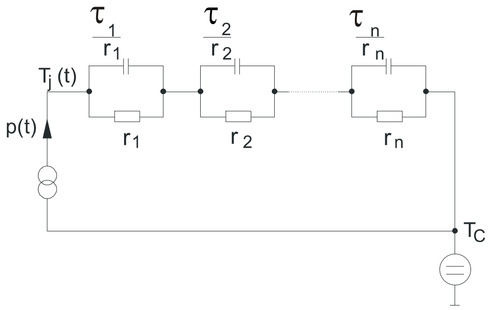


Figure D. **Thermal equivalent circuit**

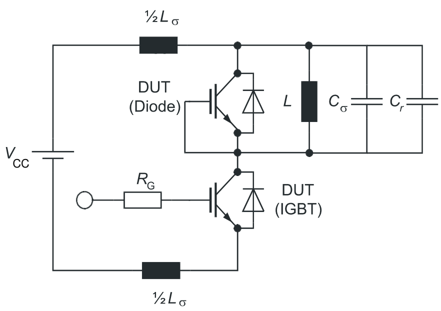


Figure E. **Dynamic test circuit**
Parasitic inductance L_σ,
parasitic capacitor C_σ,
relief capacitor C_r,
(only for ZVT switching)

Revision History

AIKW50N65RF5

Revision: 2021-02-09, Rev. 2.5

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.1	2020-02-27	Final Data Sheet
2.2	2020-03-03	Disclaimer changed to Automotive.
2.3	2020-09-17	Update figure 15 typical gate charge
2.4	2020-12-03	Open market branding
2.5	2021-02-09	Update product family name to CoolSiC™ Hybrid Discrete

Trademarks

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