
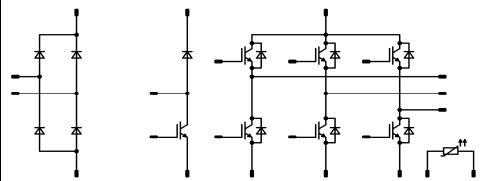




MiniSKiiP® 1 PIM	600 V / 15 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Features</div> <ul style="list-style-type: none"> Solderless interconnection Trench Fieldstop IGBT3 technology 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">MiniSKiiP® 1 housing</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Target Applications</div> <ul style="list-style-type: none"> Industrial drives 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Schematic</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Types</div> <ul style="list-style-type: none"> V23990-K203-B-PM 	

Maximum Ratings

$T_j = 25\text{ °C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	29	A
Surge (non-repetitive) forward current	I_{FSM}	$t_p = 10\text{ ms}$ half sine wave	220	A
I ² t-value	I^2t		240	A ² s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	46	W
Maximum Junction Temperature	T_{jmax}		150	°C
Inverter Switch / Brake Switch				
Collector-emitter breakdown voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	20	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	45	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	53	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC}	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	6	µs
	V_{CC}		360	V
Maximum Junction Temperature	T_{jmax}		175	°C

**Maximum Ratings** $T_j = 25\text{ °C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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Inverter Diode / Brake Diode

Repetitive peak reverse voltage	V_{RRM}		600	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	40	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	38	W
Maximum Junction Temperature	T_{jmax}		175	°C

Thermal Properties

Storage temperature	T_{stg}		-40...+125	°C
Operation temperature under switching condition	T_{op}		-40...+($T_{jmax} - 25$)	°C

Isolation Properties

Isolation voltage	V_{is}	$t = 2\text{ s}$ DC Test Voltage	4000	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm
Comparative Tracking Index	CTI		>200	



Characteristic Values

Parameter	Symbol	Conditions					Value			Unit	
		V_{GE} [V]	V_{GS} [V]	V_r [V]	V_{CE} [V]	V_{DS} [V]	I_C [A]	I_F [A]	I_D [A]		T_j [°C]

Rectifier Diode

Forward voltage	V_F					25	25 125				1,51 1,42		V	
Threshold voltage (for power loss calc. only)	V_{to}					25	25 125				0,86 0,79		V	
Slope resistance (for power loss calc. only)	r_t					25	25 125				0,03 0,03		Ω	
Reverse current	I_r				1500		25					0,05	mA	
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm λ = 1 W/mK										1,50		K/W

Inverter Switch / Brake Switch

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$				0,00021	25				5	5,8	6,5	V			
Collector-emitter saturation voltage	V_{CESat}		15			15	25 150				1,1	1,73 1,87	1,9	V			
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600			25						0,0085	mA			
Gate-emitter leakage current	I_{GES}		20	0			25						300	nA			
Integrated Gate resistor	R_{gint}											none		Ω			
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 8 \Omega$ $R_{gon} = 16 \Omega$	0/15	300	15		25					25		ns			
Rise time	t_r						150				25					23	
Turn-off delay time	$t_{d(off)}$						150				25					30	
Fall time	t_f						150				25					183	
Turn-on energy loss	E_{on}						150				25					202	
Turn-off energy loss	E_{off}					25				104			mWs				
Input capacitance	C_{ies}					150				109							
Output capacitance	C_{oss}	$f = 1 \text{ MHz}$	0	25			25				0,46			pF			
Reverse transfer capacitance	C_{rss}									0,58							
Gate charge	Q_G		0/15	480	15	25					0,36			nC			
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm λ = 1 W/mK										0,46					

Inverter Diode / Brake Diode

Diode forward voltage	V_F					15	25 125					1,44 1,42	1,6	V				
Peak reverse recovery current	I_{RRM}	$di_{rr}/dt = t_{bd} \text{ A/us}$	0/15	300	15		25					8,5		A				
Reverse recovery time	t_{rr}						125				25					10,3		
Reverse recovered charge	Q_{rr}						125				25				189			µC
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						125				25				275			
Reverse recovered energy	E_{rec}										25				90			mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm λ = 1 W/mK										0,12 0,22						

Thermistor

Rated resistance	R					25						1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1670 \Omega$				100					-3		3	%
R_{100}	R					100						1670,3125		Ω
Power dissipation constant						25								mW/K
A-value	$B_{(25/50)}$					25						$7,635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$					25						$1,731 \cdot 10^{-5}$		1/K ²
Vincotech NTC Reference													E	

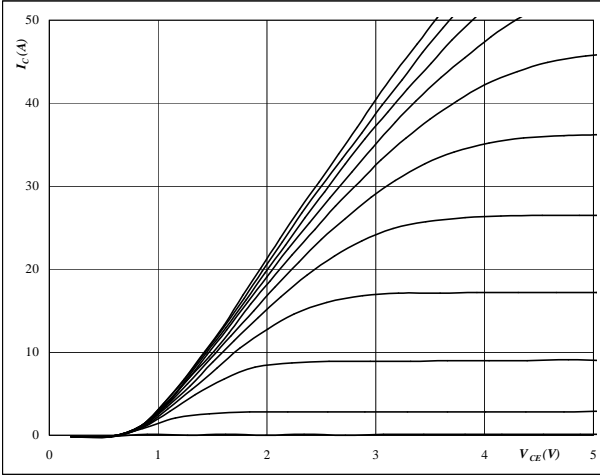


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 1. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$



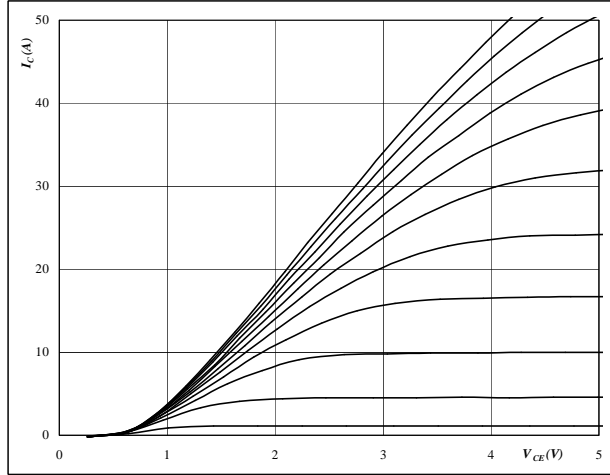
At

$t_p = 250 \mu s$
 $T_j = 25 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 2. IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$



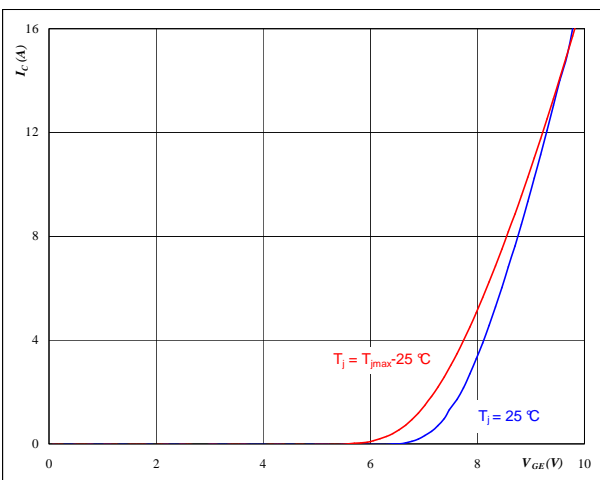
At

$t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

$$I_C = f(V_{GE})$$



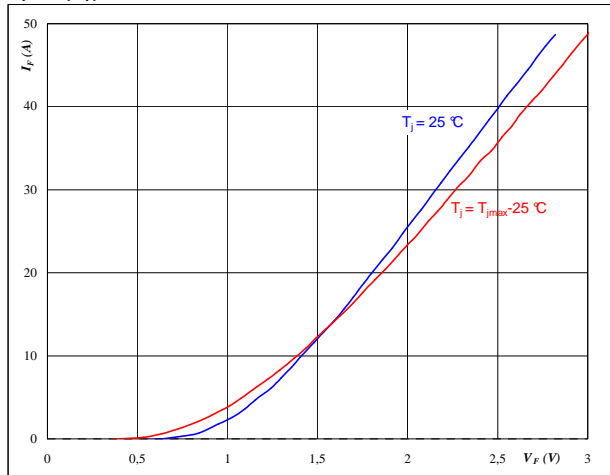
At

$t_p = 250 \mu s$
 $V_{CE} = 10 \text{ V}$

figure 4. FWD

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



At

$t_p = 250 \mu s$

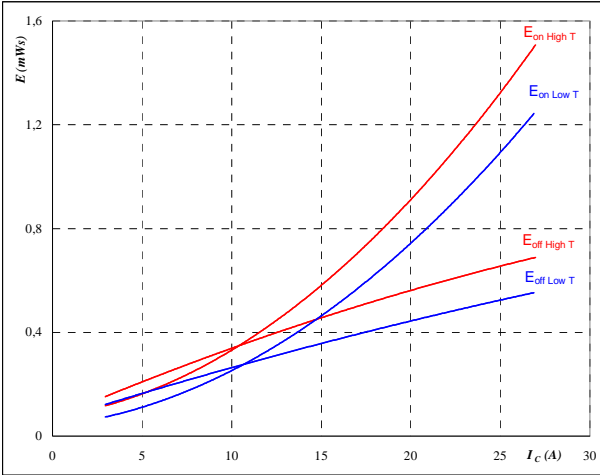


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 5. IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



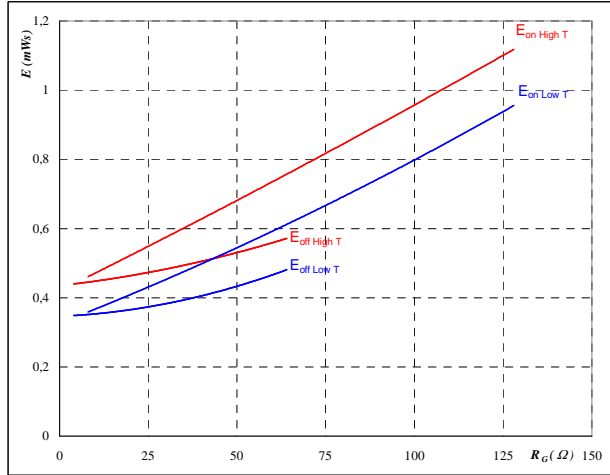
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 16$ Ω

figure 6. IGBT

Typical switching energy losses
as a function of gate resistor

$$E = f(R_G)$$



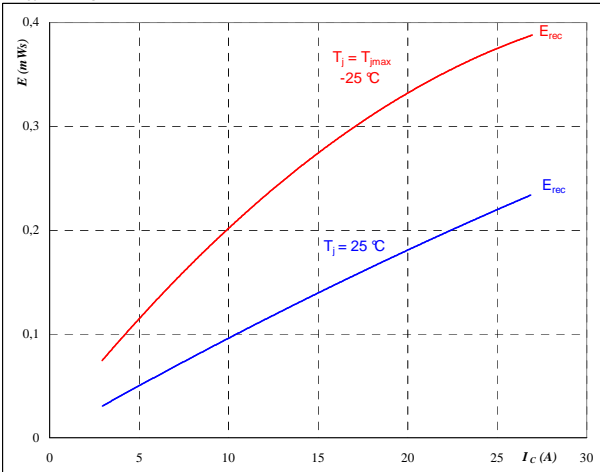
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 15$ V
 $I_C = 15$ A

figure 7. FWD

Typical reverse recovery energy loss
as a function of collector current

$$E_{rec} = f(I_C)$$



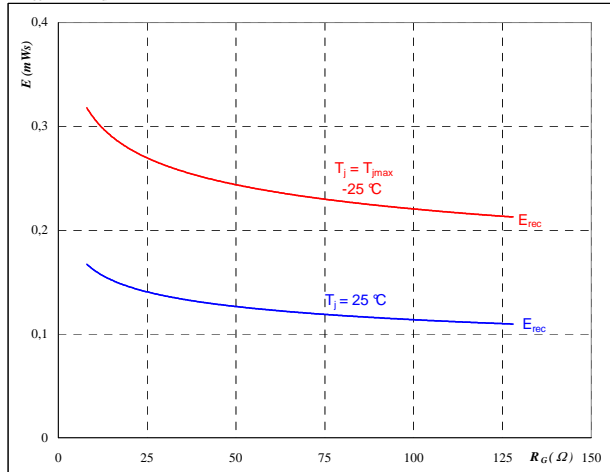
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 15$ V
 $R_{gon} = 32$ Ω

figure 8. FWD

Typical reverse recovery energy loss
as a function of gate resistor

$$E_{rec} = f(R_G)$$



With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 15$ V
 $I_C = 15$ A

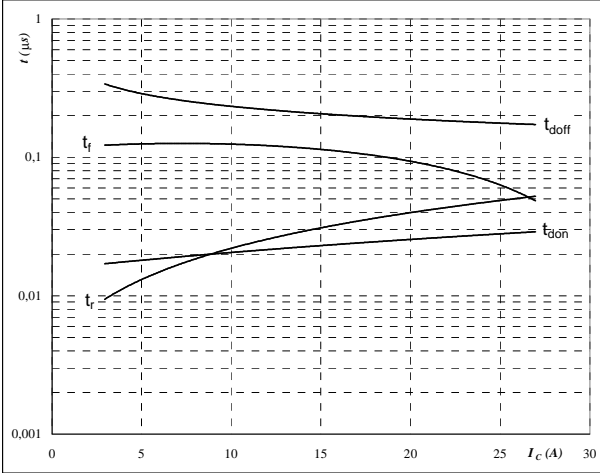


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 9. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



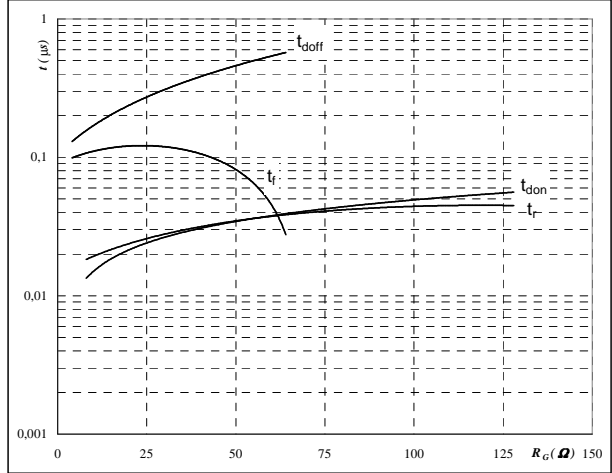
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	16	Ω

figure 10. IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



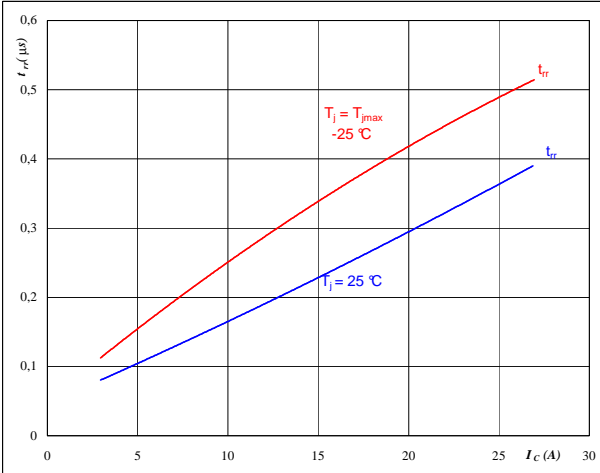
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	15	A

figure 11. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



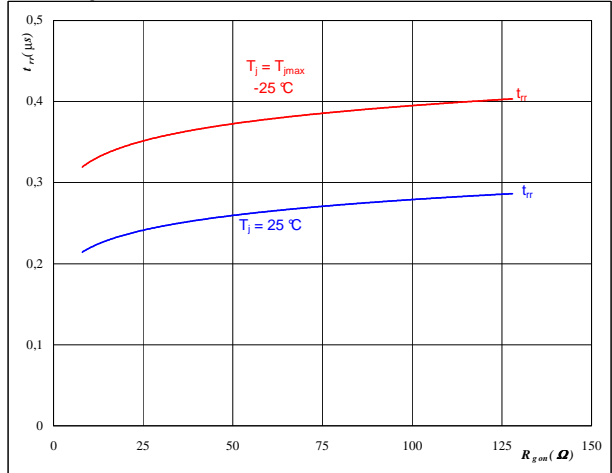
At

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω

figure 12. FWD

Typical reverse recovery time as a function of IGBT turn on gate resistor

$t_{rr} = f(R_{gon})$

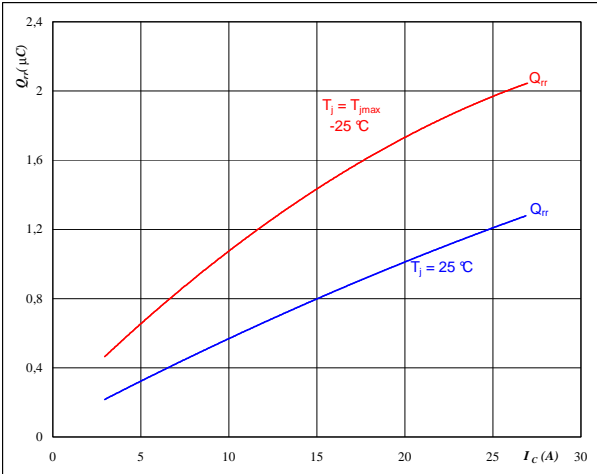


At

$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	15	A
$V_{GE} =$	15	V

**Inverter Switch / Brake Switch / Inverter Diode / Brake Diode****figure 13.** FWD**Typical reverse recovery charge as a function of collector current**

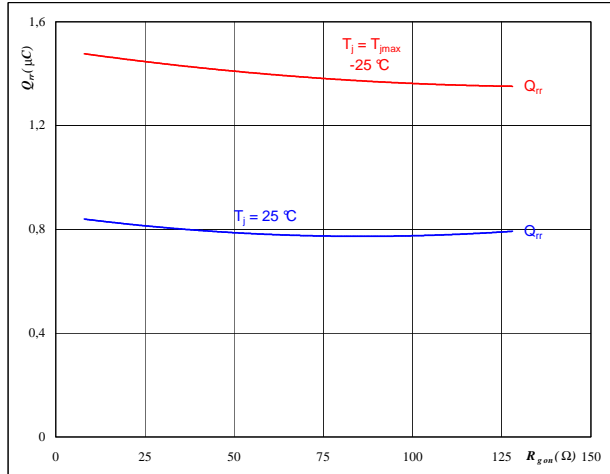
$$Q_{rr} = f(I_C)$$

**At**

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω

figure 14. FWD**Typical reverse recovery charge as a function of IGBT turn on gate resistor**

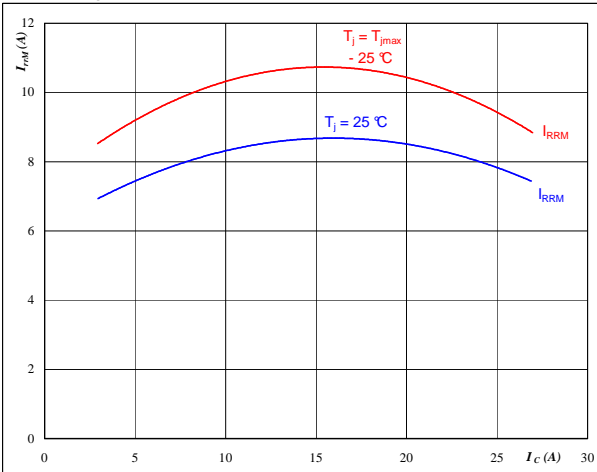
$$Q_{rr} = f(R_{gon})$$

**At**

$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	15	A
$V_{GE} =$	15	V

figure 15. FWD**Typical reverse recovery current as a function of collector current**

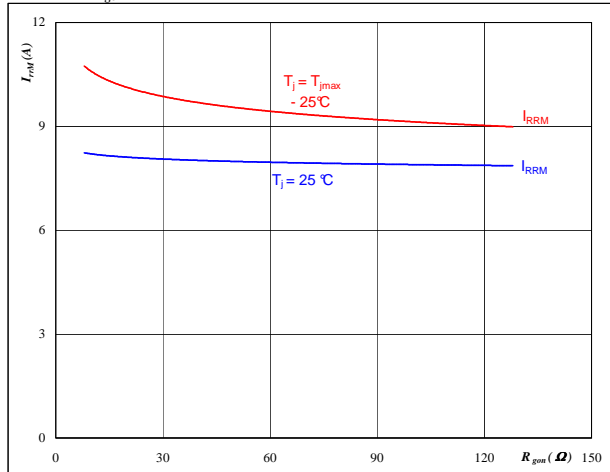
$$I_{RRM} = f(I_C)$$

**At**

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω

figure 16. FWD**Typical reverse recovery current as a function of IGBT turn on gate resistor**

$$I_{RRM} = f(R_{gon})$$

**At**

$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	15	A
$V_{GE} =$	15	V

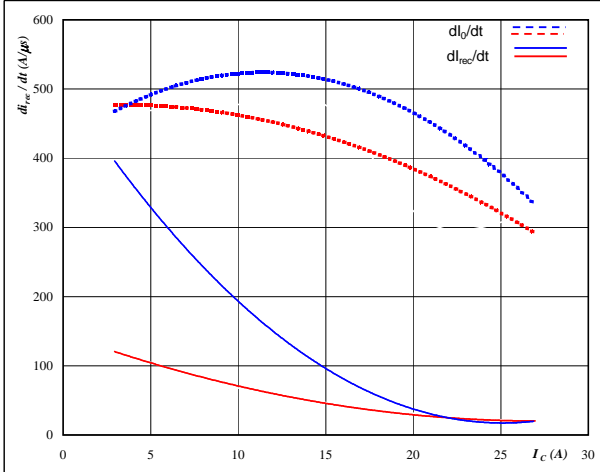


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 17. FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current

$$dI_0/dt, dI_{rec}/dt = f(I_C)$$

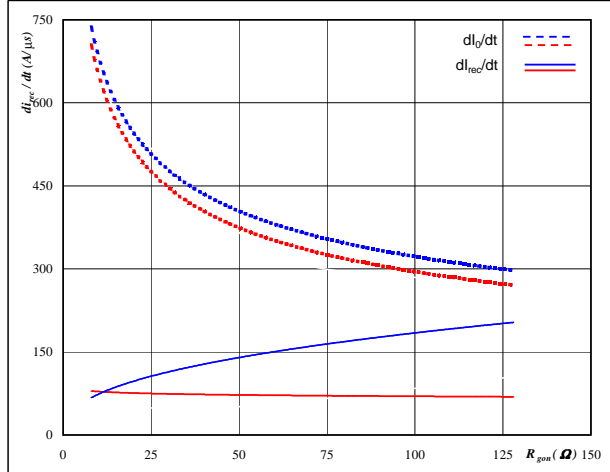


At
 $T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 300 \text{ V}$
 $V_{GE} = 15 \text{ V}$
 $R_{gon} = 32 \text{ } \Omega$

figure 18. FWD

Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

$$dI_0/dt, dI_{rec}/dt = f(R_{gon})$$

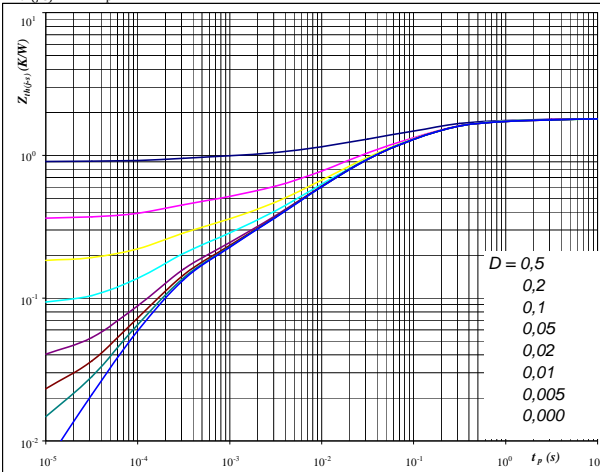


At
 $T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_R = 300 \text{ V}$
 $I_F = 15 \text{ A}$
 $V_{GE} = 15 \text{ V}$

figure 19. IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



At
 $D = t_p / T$
 $R_{th(j-s)} = 1,81 \text{ K/W}$

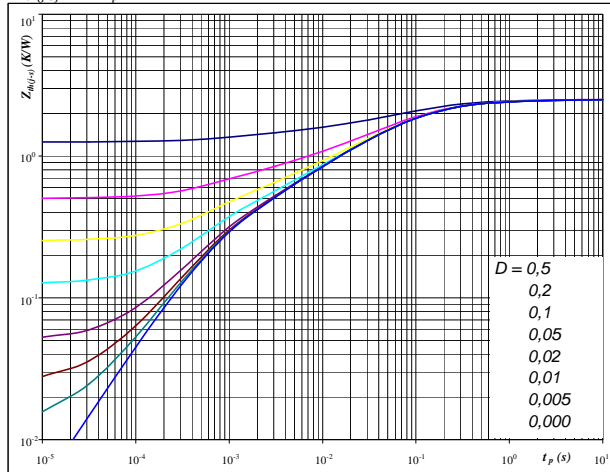
IGBT thermal model values

R (K/W)	Tau (s)
4,79E-02	6,42E+00
2,09E-01	5,50E-01
7,40E-01	1,07E-01
5,03E-01	1,63E-02
1,67E-01	2,67E-03
1,40E-01	2,31E-04

figure 20. FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



At
 $D = t_p / T$
 $R_{th(j-s)} = 2,51 \text{ K/W}$

FWD thermal model values

R (K/W)	Tau (s)
5,06E-02	9,02E+00
2,53E-01	6,56E-01
8,83E-01	1,18E-01
7,35E-01	2,86E-02
3,35E-01	4,82E-03
2,57E-01	6,88E-04

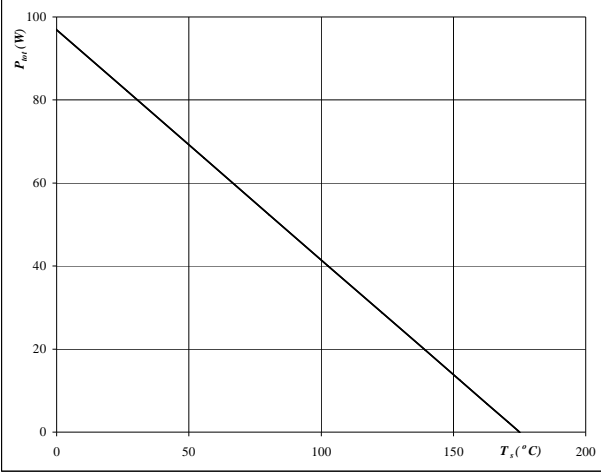


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 21. IGBT

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_s)$$

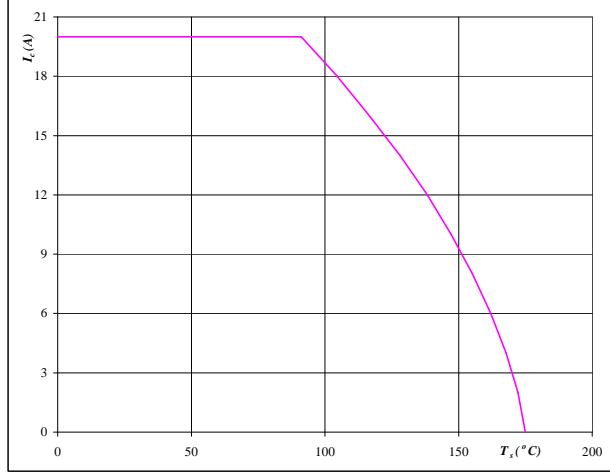


At
 $T_j = 175 \text{ } ^\circ\text{C}$

figure 22. IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_s)$$

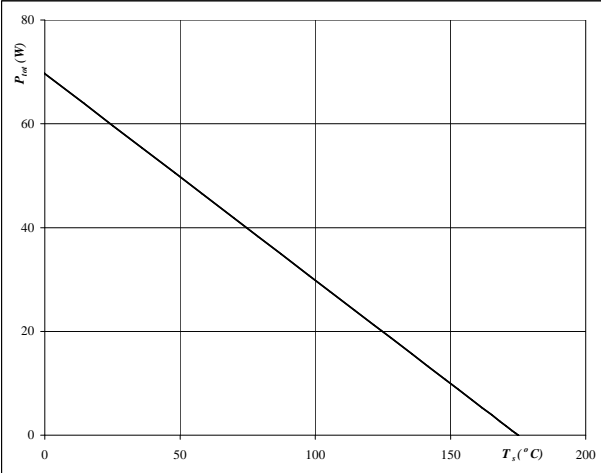


At
 $T_j = 175 \text{ } ^\circ\text{C}$
 $V_{GE} = 15 \text{ V}$

figure 23. FWD

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_s)$$

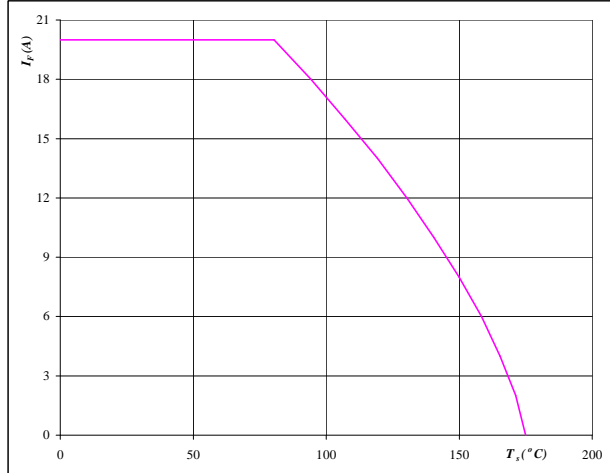


At
 $T_j = 175 \text{ } ^\circ\text{C}$

figure 24. FWD

Forward current as a function of heatsink temperature

$$I_F = f(T_s)$$



At
 $T_j = 175 \text{ } ^\circ\text{C}$

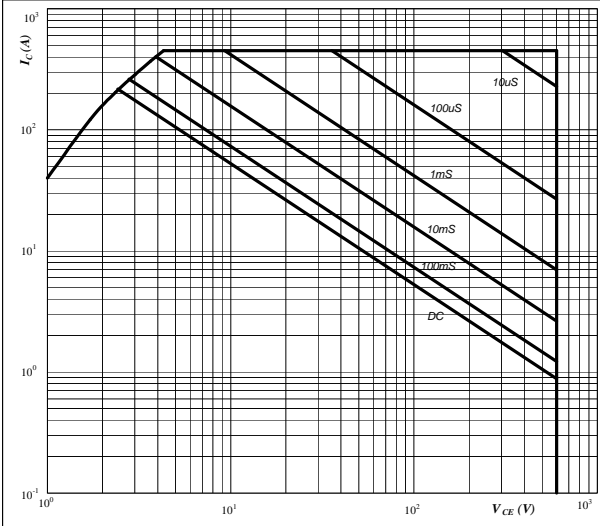


Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 25. IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



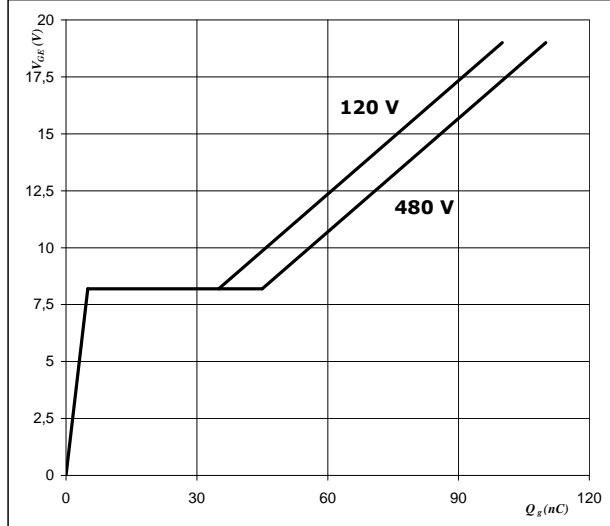
At

- D = single pulse
- T_s = 80 °C
- V_{GE} = 15 V
- T_j = T_{jmax}

figure 26. IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



At

- I_C = 15 A

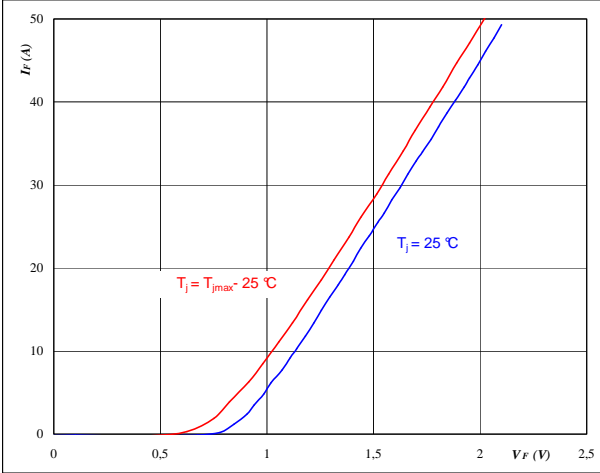


Rectifier Diode

figure 1. Rectifier Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

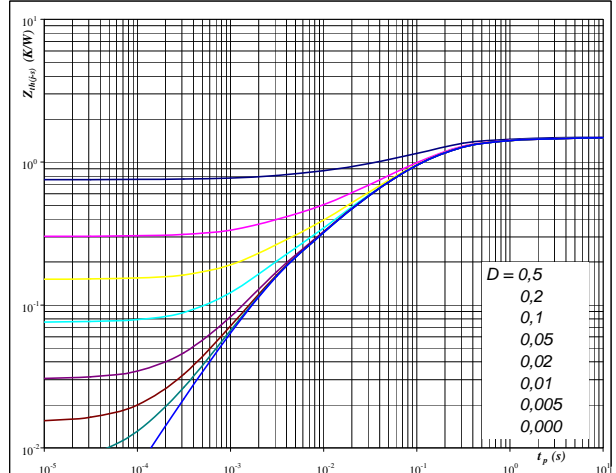


At
 $t_p = 250\text{ }\mu\text{s}$

figure 2. Rectifier Diode

Diode transient thermal impedance as a function of pulse width

$Z_{th(j-s)} = f(t_p)$

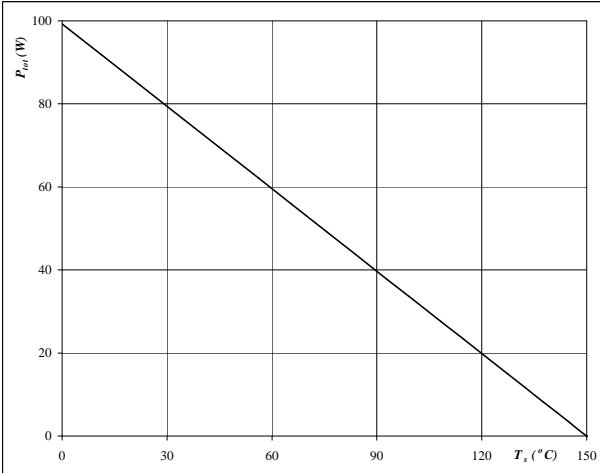


At
 $D = t_p / T$
 $R_{th(j-s)} = 1,51\text{ K/W}$

figure 3. Rectifier Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

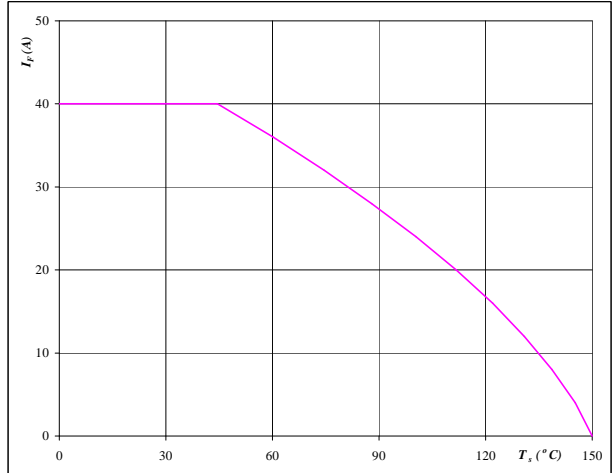


At
 $T_j = 150\text{ °C}$

figure 4. Rectifier Diode

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At
 $T_j = 150\text{ °C}$

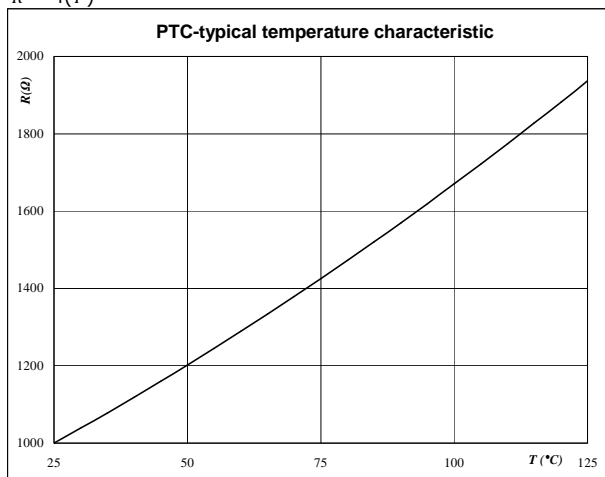


Thermistor

figure 1. Thermistor

**Typical PTC characteristic
as a function of temperature**

$$R = f(T)$$





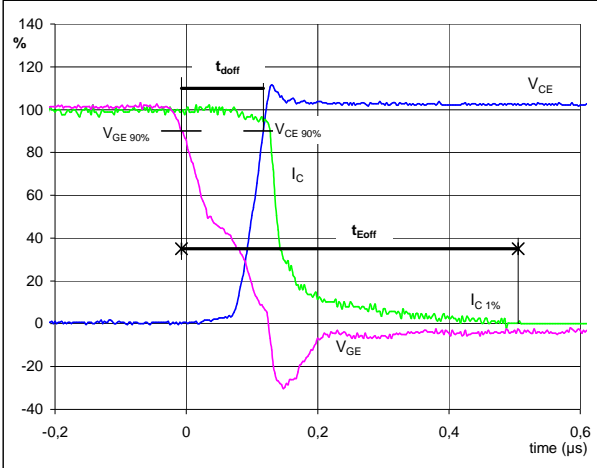
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	16 Ω
R_{goff}	=	8 Ω

figure 1. IGBT

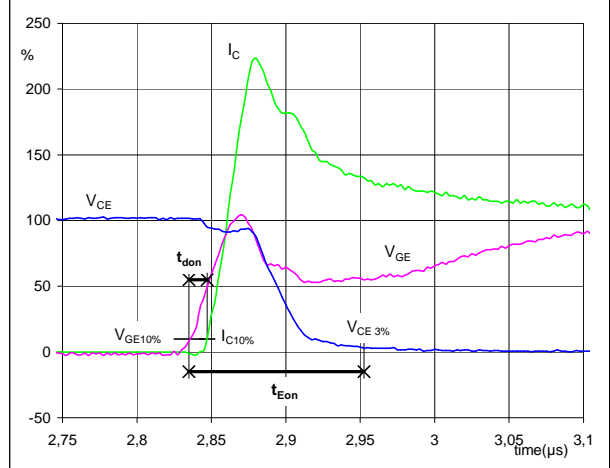
Turn-off Switching Waveforms & definition of t_{doff} t_{Eoff}
 (t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	10	A
t_{doff} =	0,12	μ s
t_{Eoff} =	0,51	μ s

figure 2. IGBT

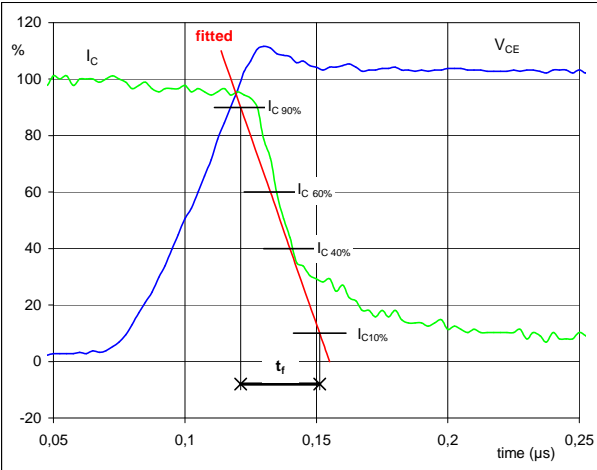
Turn-on Switching Waveforms & definition of t_{donr} t_{Eon}
 (t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	10	A
t_{donr} =	0,01	μ s
t_{Eon} =	0,12	μ s

figure 3. IGBT

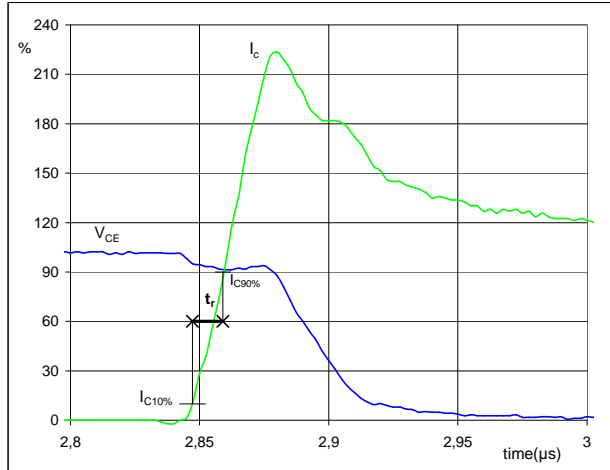
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	10	A
t_f =	0,03	μ s

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

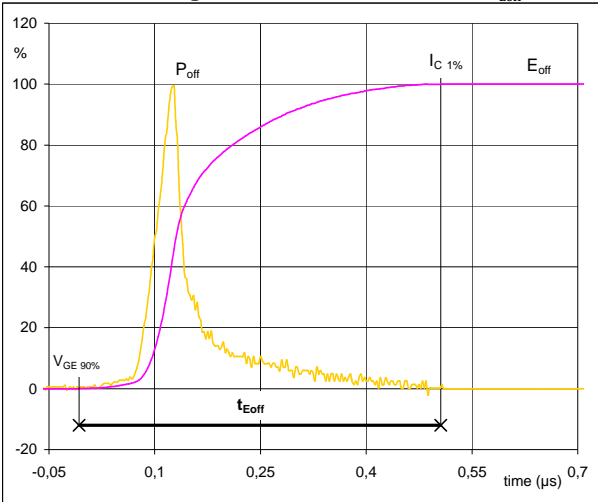


V_C (100%) =	300	V
I_C (100%) =	10	A
t_r =	0,01	μ s



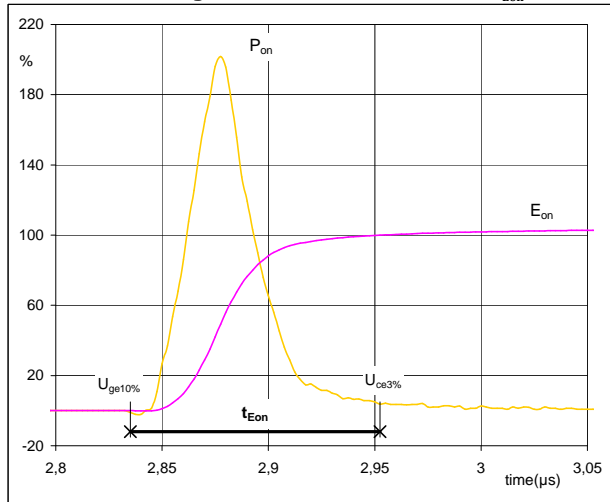
Switching Definitions Output Inverter

figure 5. IGBT
Turn-off Switching Waveforms & definition of t_{Eoff}



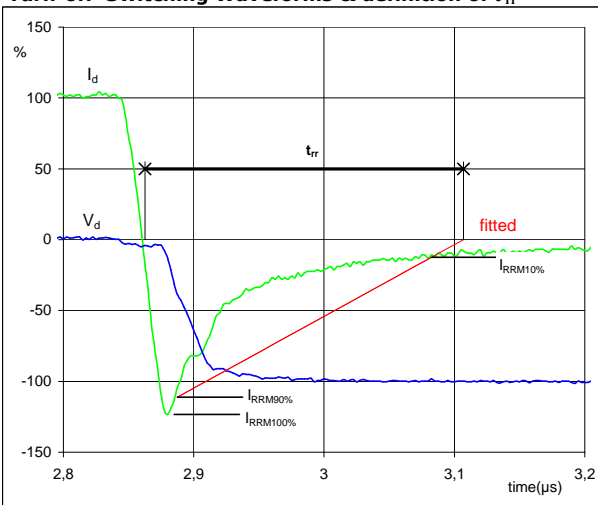
$P_{off} (100\%) = 2,97 \text{ kW}$
 $E_{off} (100\%) = 0,20 \text{ mJ}$
 $t_{Eoff} = 0,51 \text{ μs}$

figure 6. IGBT
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on} (100\%) = 2,97 \text{ kW}$
 $E_{on} (100\%) = 0,21 \text{ mJ}$
 $t_{Eon} = 0,12 \text{ μs}$

figure 7. IGBT
Turn-off Switching Waveforms & definition of t_{rr}



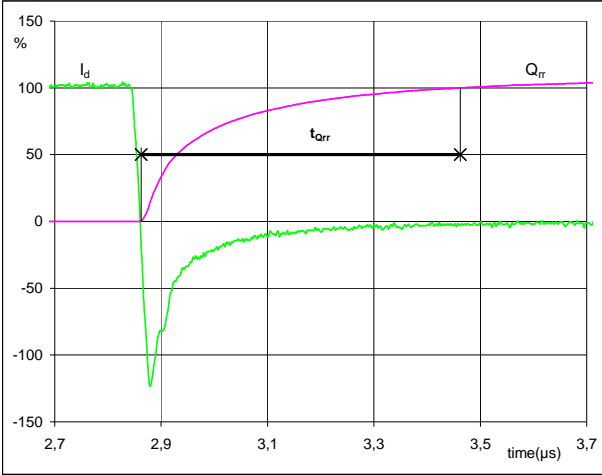
$V_d (100\%) = 300 \text{ V}$
 $I_d (100\%) = 10 \text{ A}$
 $I_{RRM} (100\%) = 12 \text{ A}$
 $t_{rr} = 0,22 \text{ μs}$



Switching Definitions Output Inverter

figure 8. FWD

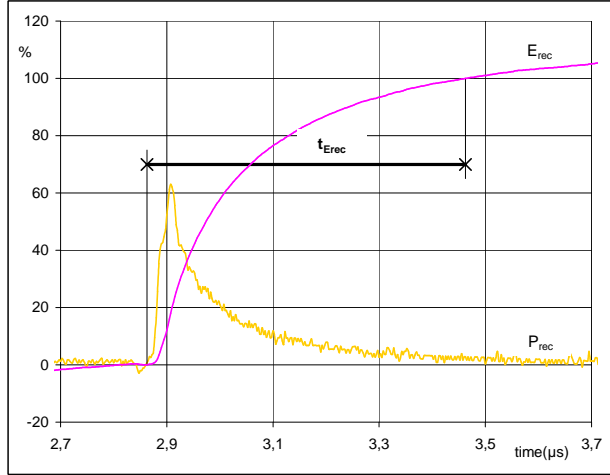
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	10	A
Q_{rr} (100%) =	1,02	μC
t_{Qrr} =	0,60	μs

figure 9. FWD

Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec} = integrating time for E_{rec})



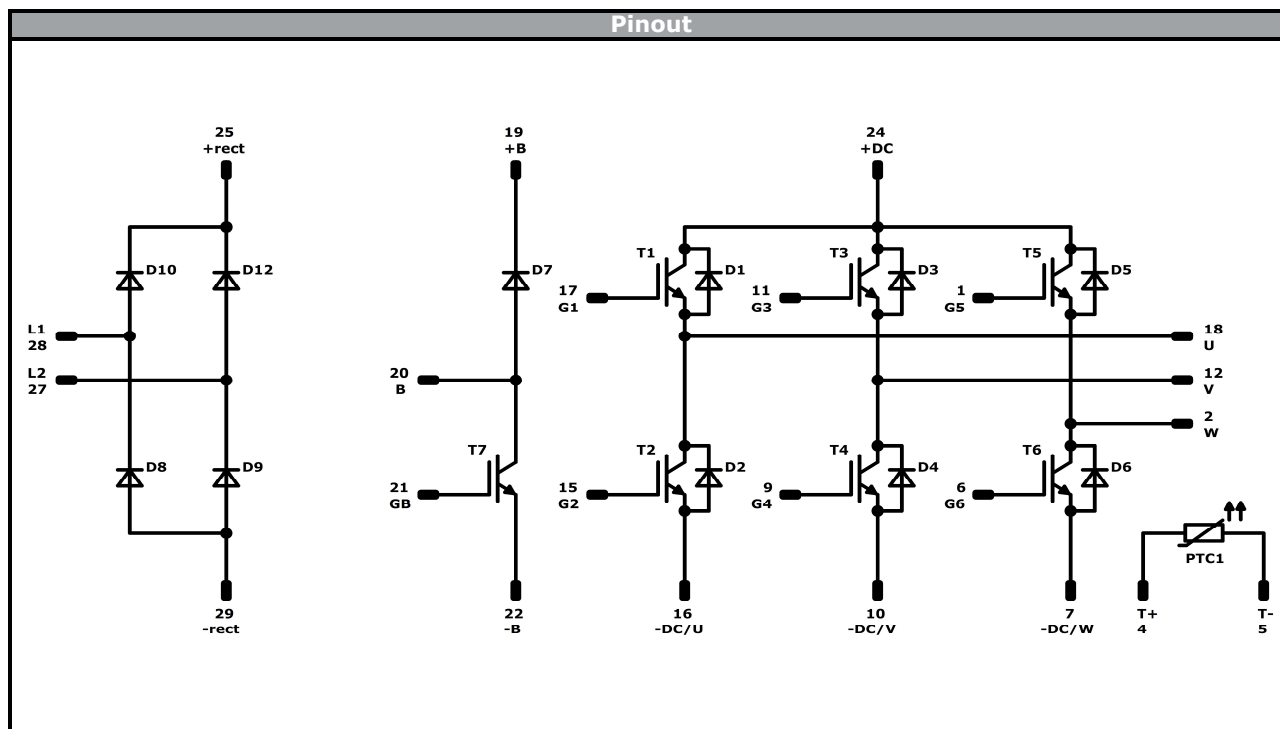
P_{rec} (100%) =	2,97	kW
E_{rec} (100%) =	0,22	mJ
t_{Erec} =	0,60	μs



Ordering Code & Marking							
Version			Ordering Code				
with std lid (black V23990-K12-T-PM)			V23990-K203-B-/0A/-PM				
with std lid (black V23990-K12-T-PM) and P12			V23990-K203-B-/1A/-PM				
with thin lid (white V23990-K13-T-PM)			V23990-K203-B-/0B/-PM				
with thin lid (white V23990-K13-T-PM) and P12			V23990-K203-B-/1B/-PM				
	Text	VIN	Date code	Name&Ver	UL	Lot	Serial
		VIN	WWYY	NNNNVVV	UL	LLLL	SSSS
	Datamatrix	Type&Ver	Lot number	Serial	Date code		
		TTTTTIV	LLLL	SSSS	WWYY		

Pad table [mm]			
Pad	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	Not assembled		
4	15,93	-0,2	+T
5	15,93	7,62	-T
6	15,93	12,62	G6
7	15,93	15,8	-DC/W
8	Not assembled		
9	8,23	12,62	G4
10	8,23	15,8	-DC/V
11	7,73	-14,6	G3
12	7,73	-9,8	V
13	Not assembled		
14	Not assembled		
15	0,53	12,62	G2
16	0,53	15,8	-DC/U
17	-0,47	-14,6	G1
18	-0,47	-9,8	U
19	-5,47	-5	+B
20	-5,47	5,35	B
21	-7,17	12,62	GB
22	-7,17	15,8	-B
23	Not assembled		
24	-8,07	-9,8	+DC
25	-15,02	-15,8	+RECT
26	Not assembled		
27	-15,02	0	L2
28	-15,02	9,8	L1
29	-15,02	15,8	-RECT

Pad positions refers to center point. For more informations on pad design please see package data.




Identification					
ID	Component	Voltage	Current	Function	Comment
D8, D9, D10, D11	Rectifier	1600 V	25 A	Rectifier Diode	
T1-T6	IGBT	600 V	15 A	Inverter Switch	
D1-D6	FWD	600 V	20 A	Inverter Diode	
T7	IGBT	600 V	15 A	Brake Switch	
D7	FWD	600 V	20 A	Brake Diode	
PTC1	PTC			Thermistor	



Packaging instruction			
Standard packaging quantity (SPQ)	120	>SPQ Standard	<SPQ Sample

Handling instruction
Handling instructions for MiniSkiiP [®] 1 packages see vincotech.com website.

Package data
Package data for MiniSkiiP [®] 1 packages see vincotech.com website.

UL recognition and file number
This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website. 

Document No.:	Date:	Modification:	Pages
V23990-K203-B-D2-14	03 Aug. 2016		

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- A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.