## Vincotech

MiniSKiiP® 1 PIM
600 V / 10 A

Features

- Solderless interconnection
- Trench Fieldstop IGBT3 technology

MiniSKiiP® 1 housing

Target Applications

- Industrial drives

Schematic

Types

- V23990-K202-A-PM

Maximum Ratings

T_j = 25 °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 °C	29	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms half sine wave		220	A
I²t-value	I^2t			240	A²s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °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 °C	17	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		30	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	48	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150$ °C V_{GE} = 15 V		6 360	µs V
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter Diode / Brake Diode					
Repetitive peak reverse voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	19	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		38	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °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 s DC Test Voltage		4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative Tracking Index	CTI			>200	

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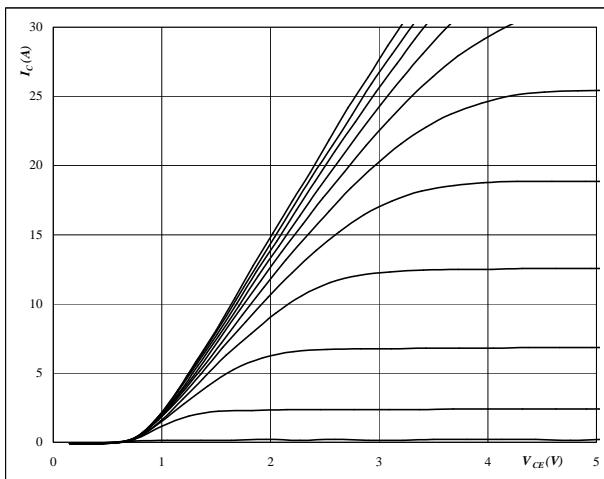
Characteristic Values

Parameter	Symbol	Conditions 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]	Min	Typ	Max	Unit
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 ≤ 50um λ = 1 W/mK					1,5		K/W
Inverter Switch / Brake Switch									
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$		0,00015	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}	15		10	25 / 150	1,1	1,68 / 1,91	1,9	V
Collector-emitter cut-off current incl. Diode	I_{CES}	0	600		25			0,6	mA
Gate-emitter leakage current	I_{GES}	20	0		25			300	nA
Integrated Gate resistor	R_{gint}						none		Ω
Turn-on delay time	$t_{d(on)}$				25 / 150		17 / 17		ns
Rise time	t_r				25 / 150		13 / 16		ns
Turn-off delay time	$t_{d(off)}$	R_{goff} = 16 Ω R_{gon} = 32 Ω	0/15	300	10	25 / 150	145 / 163		ns
Fall time	t_f				25 / 150		91 / 99		ns
Turn-on energy loss	E_{on}				25 / 150		0,229 / 0,309		mWs
Turn-off energy loss	E_{off}				25 / 150		0,224 / 0,283		mWs
Input capacitance	C_{ies}						551		pF
Output capacitance	C_{oss}	f = 1 MHz	0	25	25		40		pF
Reverse transfer capacitance	C_{rss}						17		pF
Gate charge	Q_G	15	300	10	25		62		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK					2,0		K/W
Inverter Diode / Brake Diode									
Diode forward voltage	V_F			10	25 / 125		1,44 / 1,42	1,6	V
Peak reverse recovery current	I_{RRM}				25 / 125		8,5 / 10,3		A
Reverse recovery time	t_{rr}				25 / 125		189 / 275		ns
Reverse recovered charge	Q_{rr}	di_F/dt = tbd A/us	0/15	300	10	25 / 125	0,64 / 1,12		μC
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$				25 / 125		90 / 55		A/μs
Reverse recovered energy	E_{rec}				25 / 125		0,12 / 0,22		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK					2,5		K/W
Thermistor									
Rated resistance	R				25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω			100	-3		3	%
R100	R				100		1670,3125		Ω
A-value	$B_{(25/50)}$				25		$7,635 \times 10^{-3}$		1/K
B-value	$B_{(25/100)}$				25		$1,731 \times 10^{-5}$		1/K²
Vincotech NTC Reference								E	

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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 1.	IGBT

Typical output characteristics

At
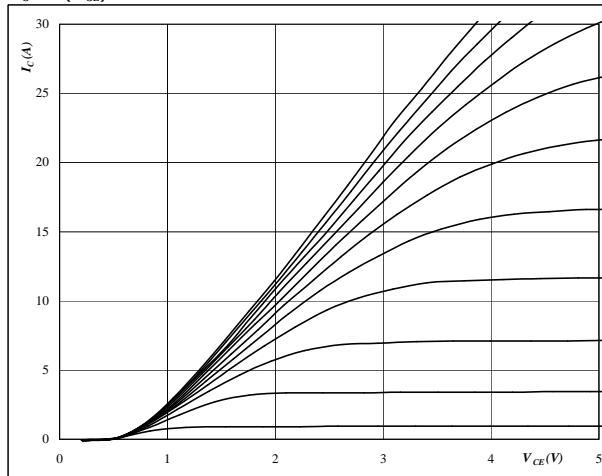
t_p = 250 µs
T_j = 25 °C
V_{GE} from 7 V to 17 V in steps of 1 V

figure 2.	IGBT

Typical output characteristics

$I_C = f(V_{CE})$

At
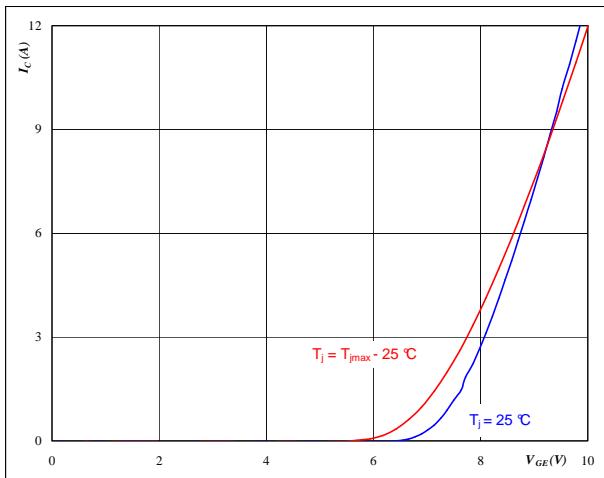
t_p = 250 µs
T_j = 125 °C
V_{GE} from 7 V to 17 V in steps of 1 V

figure 3.	IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

$T_j = T_{jmax} - 25\ °C$

$T_j = 25\ °C$

At
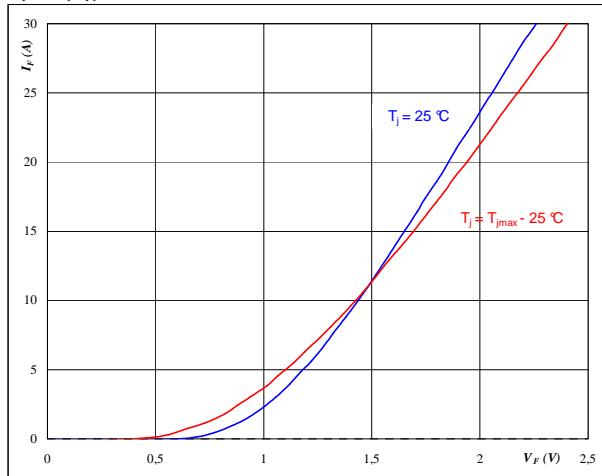
t_p = 250 µs
V_{CE} = 10 V

figure 4.	FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

$T_j = 25\ °C$

$T_j = T_{jmax} - 25\ °C$

At

t_p = 250 µs

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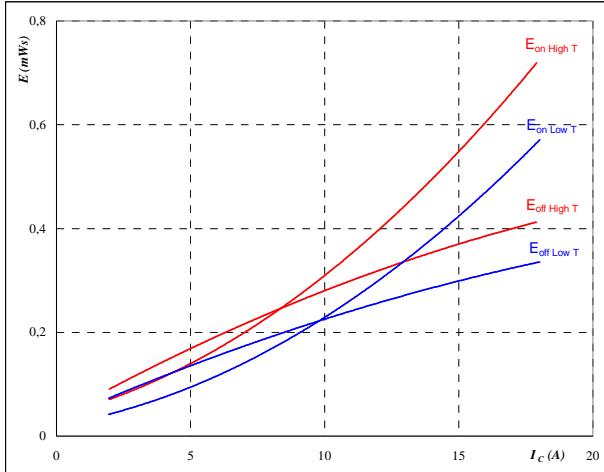
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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 5.	IGBT

Typical switching energy losses
**as a function of collector current**
$E = f(I_C)$

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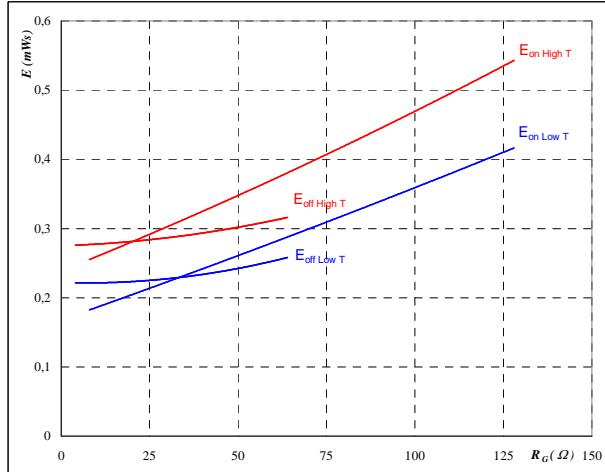
$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	16	Ω

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
$I_C =$	10	A

figure 7.	FWD
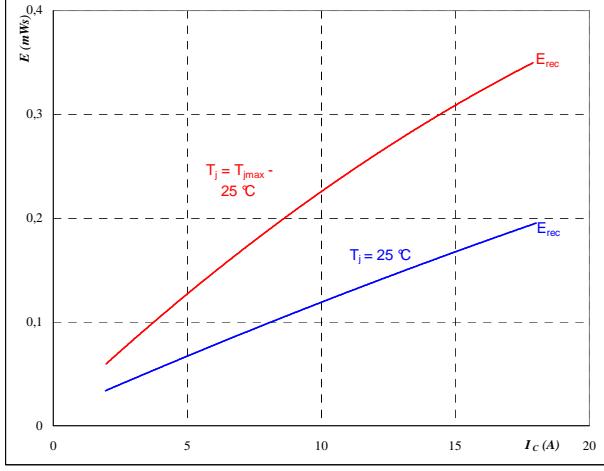
Typical reverse recovery energy loss
as a function of collector current
$E_{rec} = f(I_C)$

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
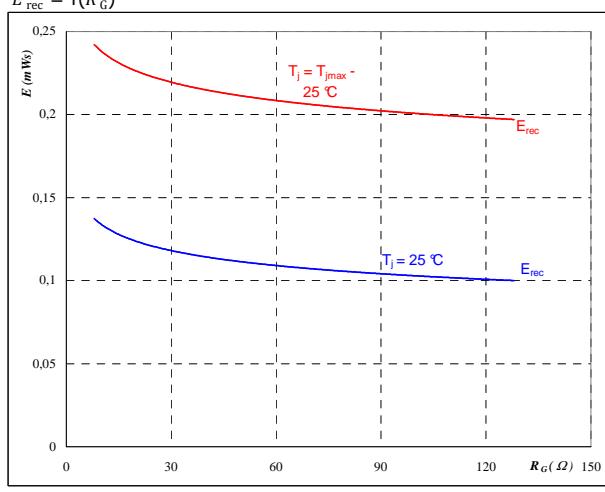
Typical reverse recovery energy loss
as a function of gate resistor
$E_{rec} = f(R_G)$

With an inductive load at

|		
$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	10	A
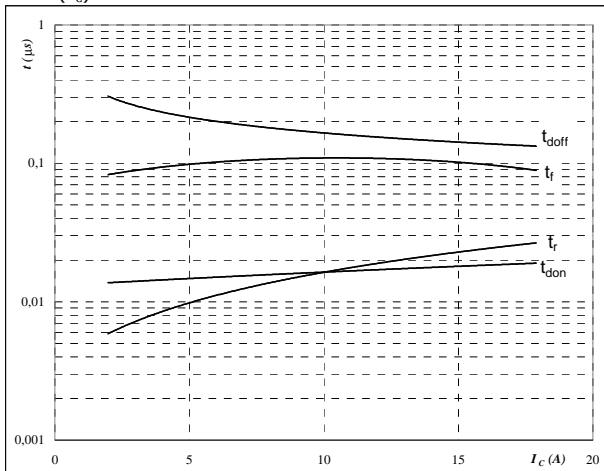
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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 9.	IGBT

**Typical switching times as a function of collector current**

$t = f(I_C)$

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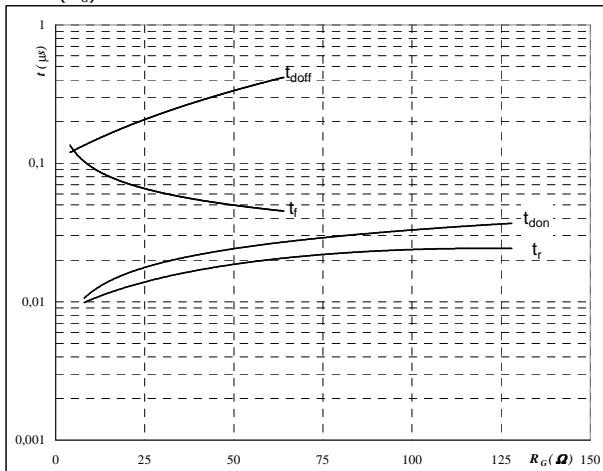
$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	16	Ω

figure 10.	IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$

With an inductive load at
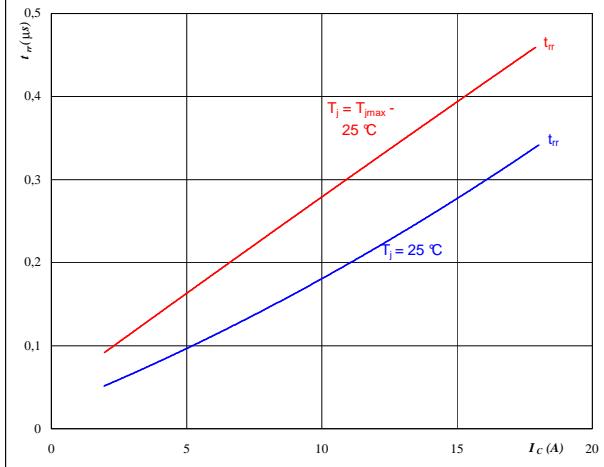
$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	10	A

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
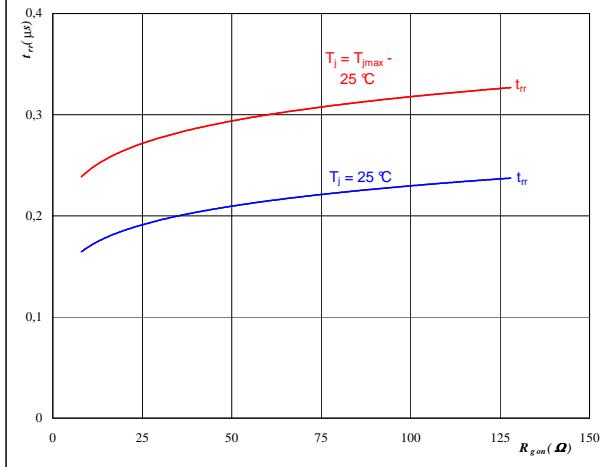
figure 12.	FWD

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
$I_F =$	10	A
$V_{GE} =$	15	V
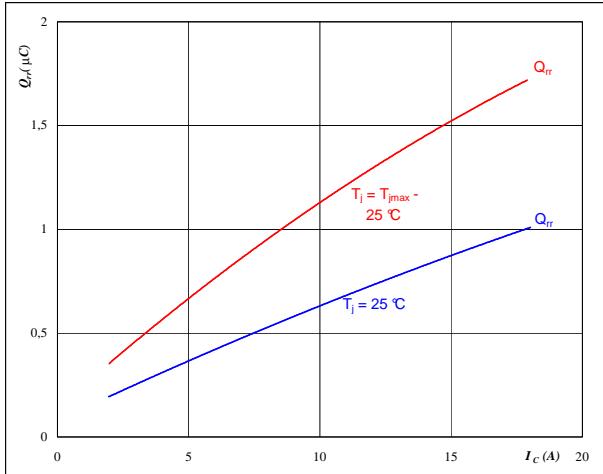
Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

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
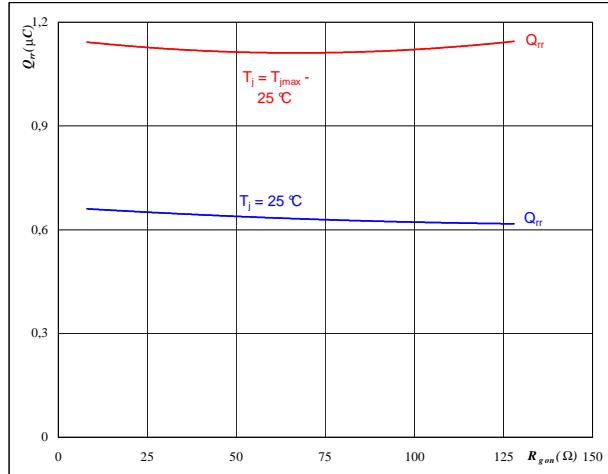
figure 14.	FWD

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

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

At
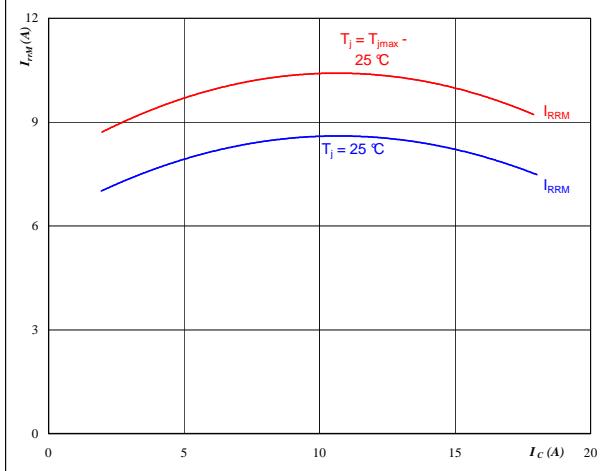
$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	10	A
$V_{GE} =$	15	V

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
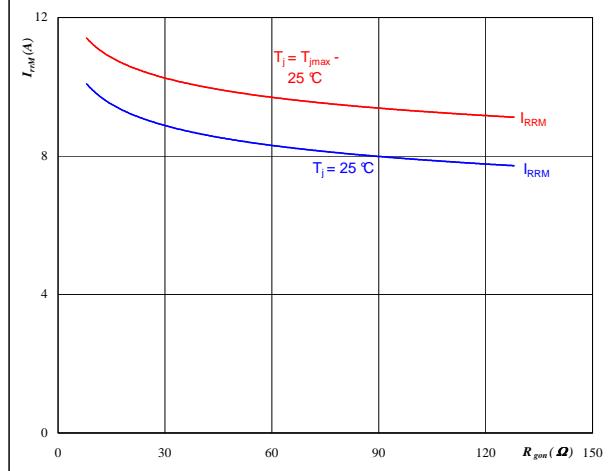
figure 16.	FWD

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
$I_F =$	10	A
$V_{GE} =$	15	V
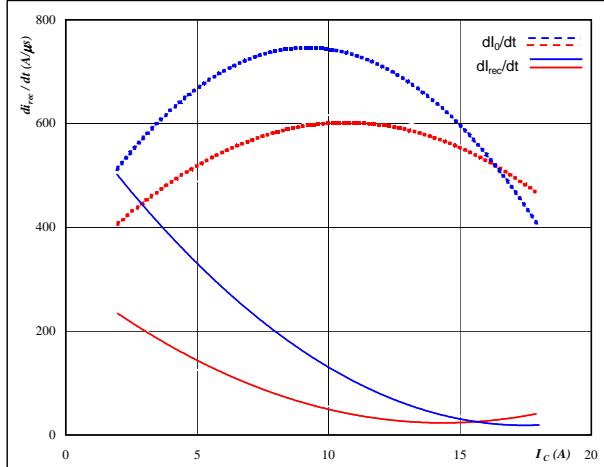
Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 17.   **FWD**

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

$\mathrm{d}I_0/\mathrm{d}t, \mathrm{d}I_{rec}/\mathrm{d}t = \mathrm{f}(I_C)$

At

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω
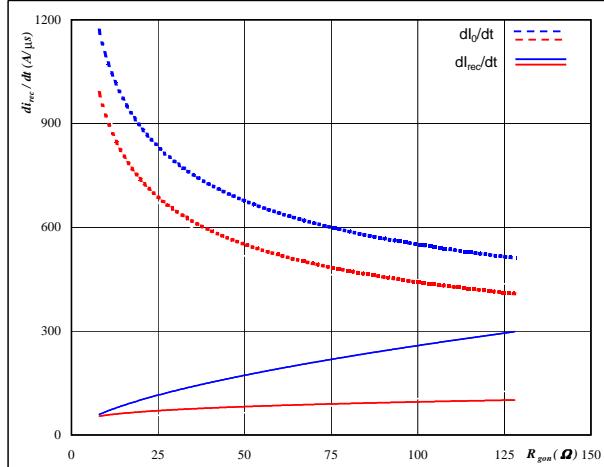
figure 18.   **FWD**

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

$\mathrm{d}I_0/\mathrm{d}t, \mathrm{d}I_{rec}/\mathrm{d}t = \mathrm{f}(R_{gon})$

At
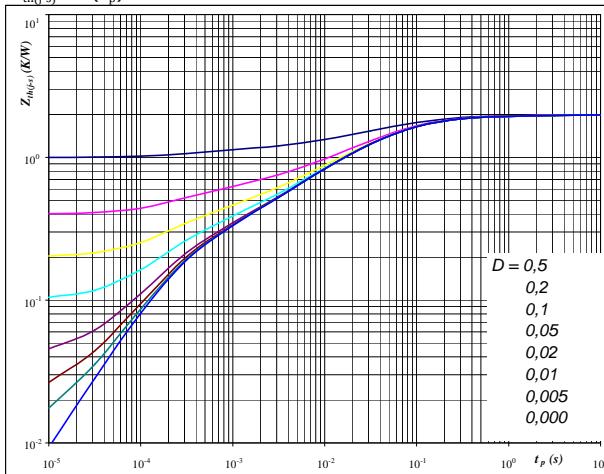
$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	10	A
$V_{GE} =$	15	V

figure 19.   **IGBT**

**IGBT transient thermal impedance
as a function of pulse width**

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

At

$D =$	t_p / T	
$R_{th(j-s)} =$	2,0	K/W
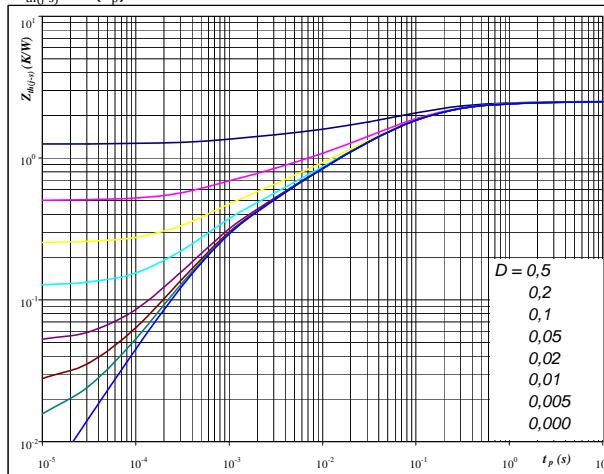
IGBT thermal model values

R (K/W)	Tau (s)
3,70E-02	5,89E+00
1,52E-01	5,25E-01
7,15E-01	7,49E-02
6,10E-01	1,75E-02
2,64E-01	2,82E-03
2,16E-01	2,68E-04

figure 20.   **FWD**

**FWD transient thermal impedance
as a function of pulse width**

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

At

$D =$	t_p / T	
$R_{th(j-s)} =$	2,5	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

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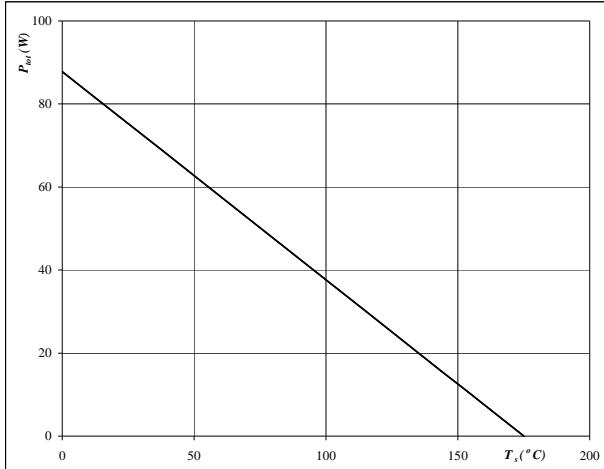
Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 21.	IGBT

**Power dissipation as a**
function of heatsink temperature
$P_{tot} = f(T_s)$
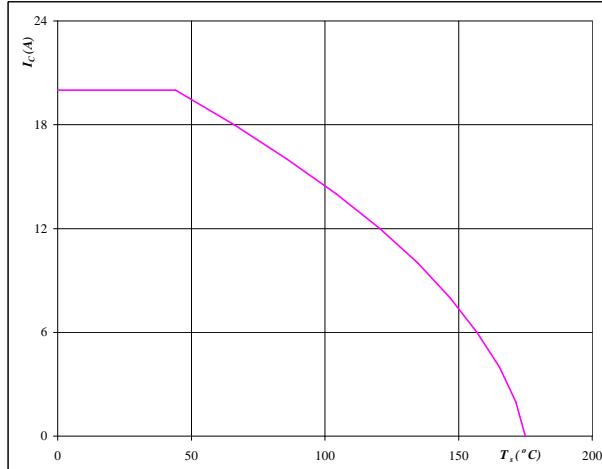
At
T_j = 175 °C

figure 22.	IGBT

Collector current as a
function of heatsink temperature
$I_C = f(T_s)$
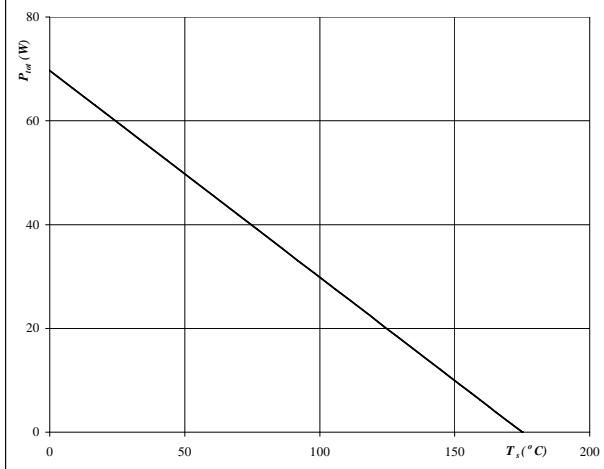
At
T_j = 175 °C
V_{GE} = 15 V

figure 23.	FWD

Power dissipation as a
function of heatsink temperature
$P_{tot} = f(T_s)$
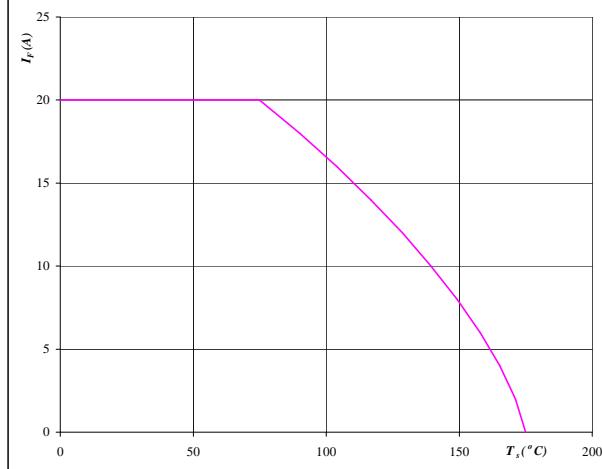
At
T_j = 175 °C

figure 24.	FWD

Forward current as a
function of heatsink temperature
$I_F = f(T_s)$

At
T_j = 175 °C

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 25.   **IGBT**

**Safe operating area as a function
of collector-emitter voltage**

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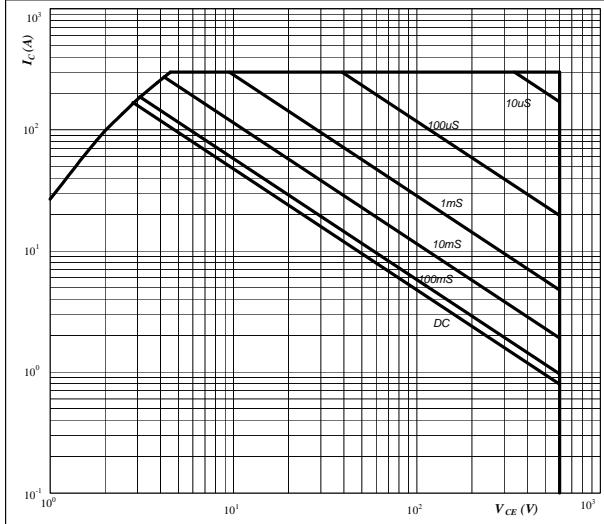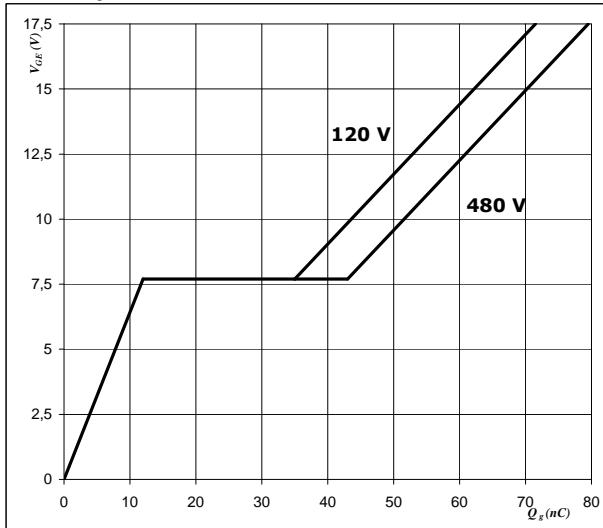
At

D =	single pulse	
T_s =	80	ºC
V_{GE} =	15	V
T_j =	T_{jmax}	

figure 26.   **IGBT**

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$
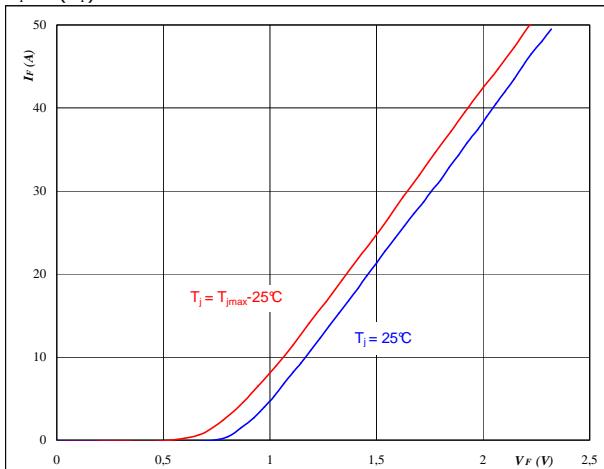
At

|		
I_C =	10	A

Rectifier Diode

figure 1. — **Rectifier Diode**

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$

At
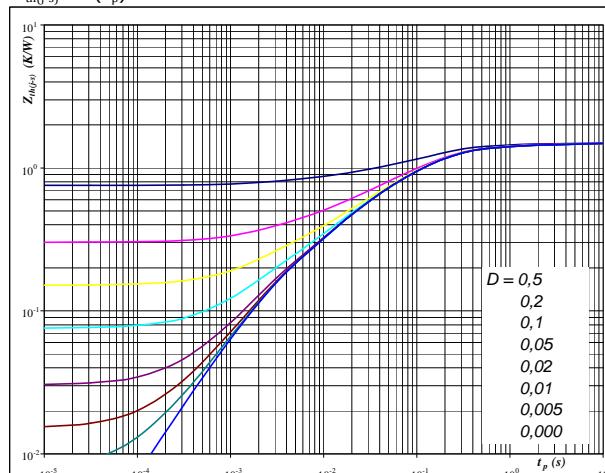
$t_p = $ 250 µs

figure 2. — **Rectifier Diode**

Diode transient thermal impedance as a function of pulse width

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

At
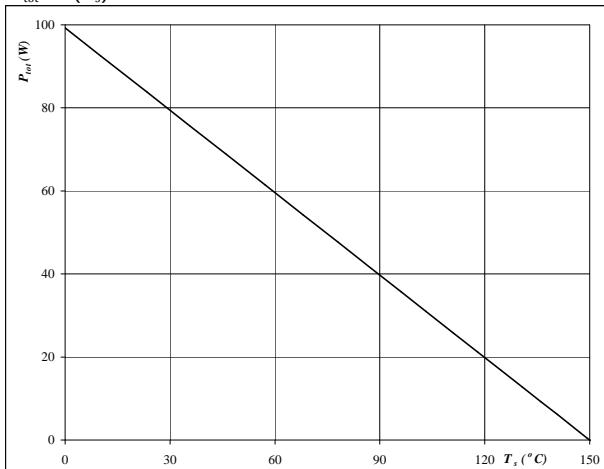
$D = $ t_p / T

$R_{th(j\text{-}s)} = $ 1,5 K/W

figure 3. — **Rectifier Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

At
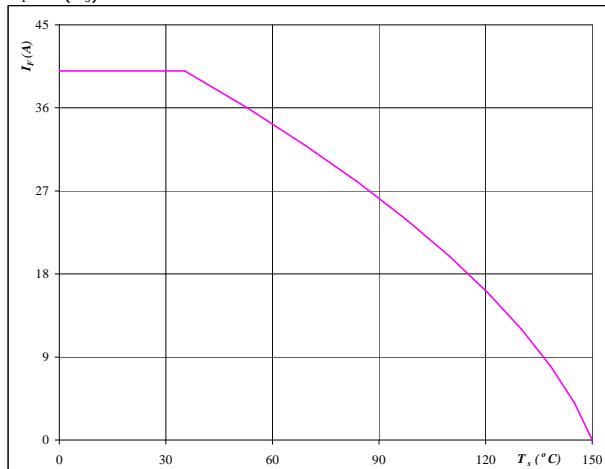
$T_j = $ 150 ºC

figure 4. — **Rectifier Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$

At
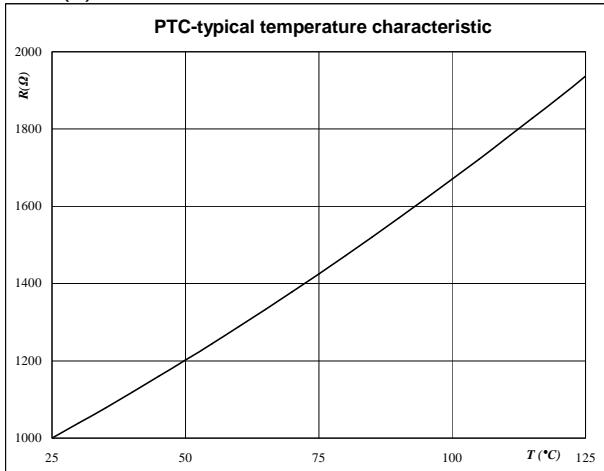
$T_j = $ 150 ºC

Thermistor

figure 1. **Thermistor**

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

$R = \mathrm{f}(T)$

PTC-typical temperature characteristic
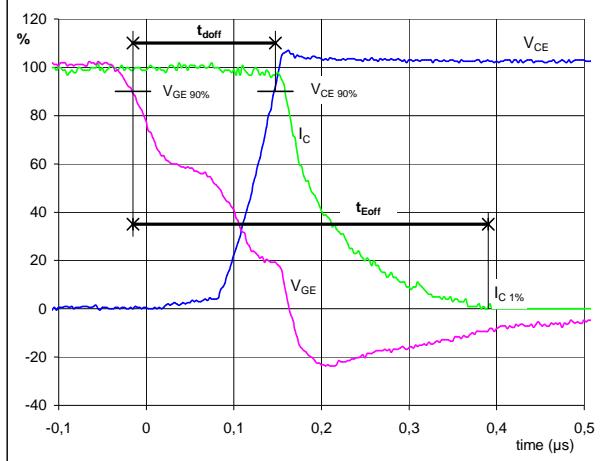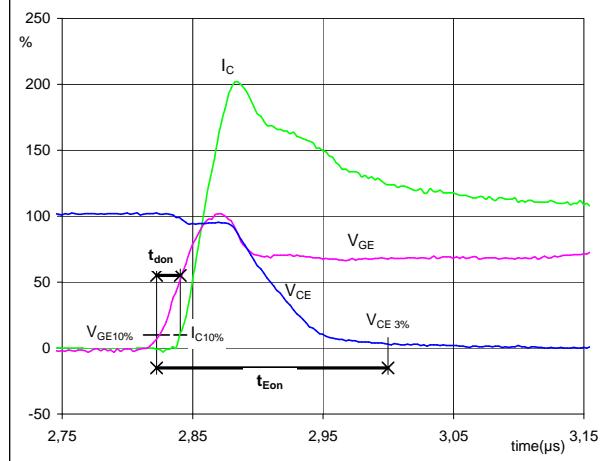
Switching Definitions Output Inverter

General conditions
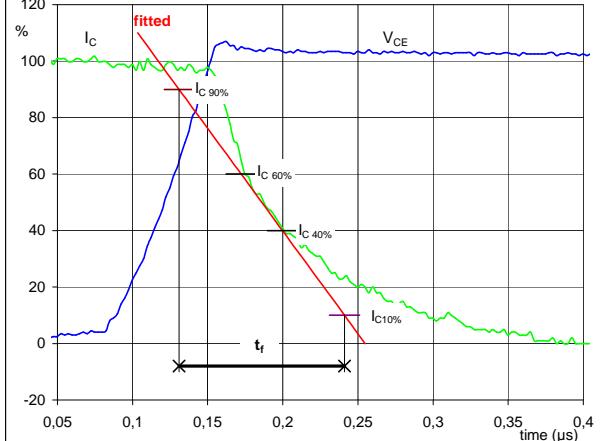
T_j	=	150 °C
R_{gon}	=	32 Ω
R_{goff}	=	16 Ω

figure 1.   **IGBT**

Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})
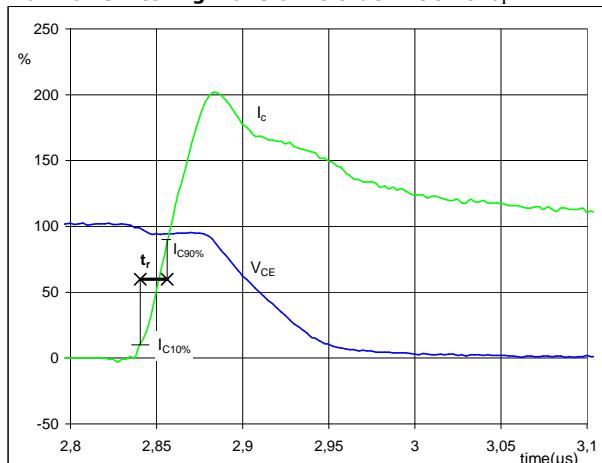
V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	10	A
t_{doff} =	0,16	µs
$t_{E\,off}$ =	0,41	µs

figure 2.   **IGBT**

Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = 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_{don} =	0,02	µs
$t_{E\,on}$ =	0,18	µs
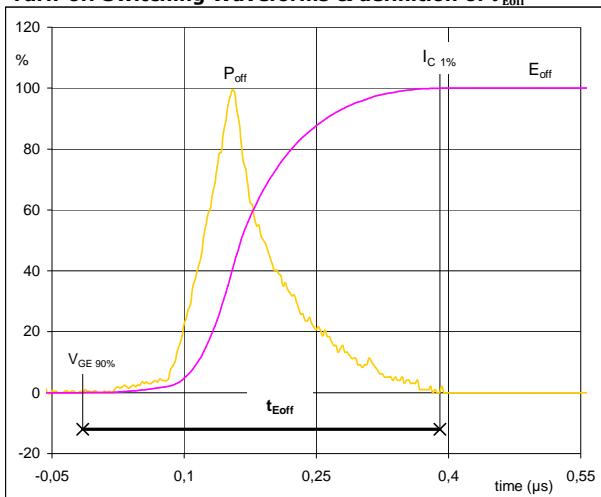
figure 3.   **IGBT**

Turn-off Switching Waveforms & definition of t_f

V_C (100%) =	300	V
I_C (100%) =	10	A
t_f =	0,10	µs
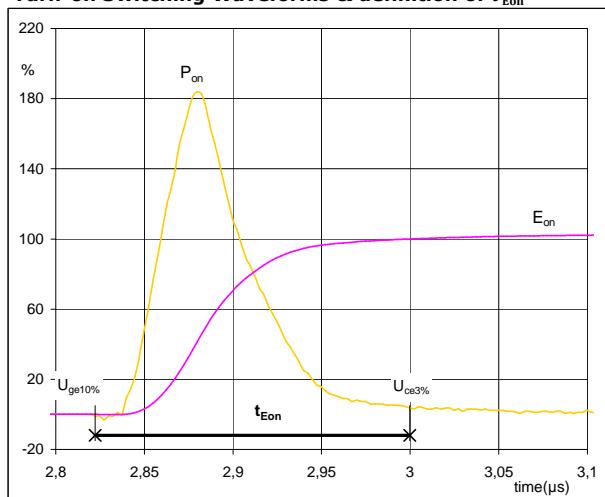
figure 4.   **IGBT**

Turn-on Switching Waveforms & definition of t_r

V_C (100%) =	300	V
I_C (100%) =	10	A
t_r =	0,02	µs
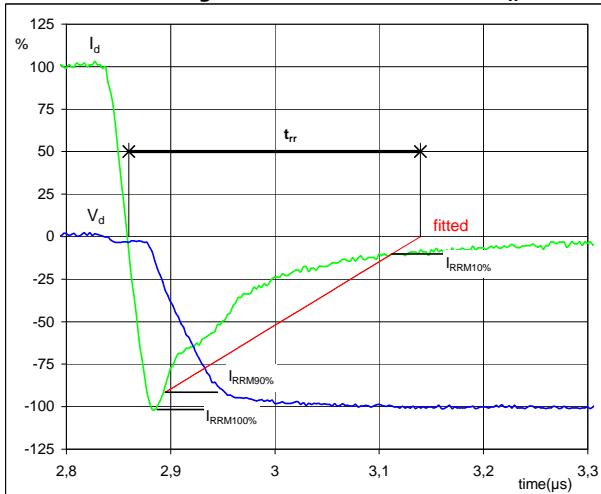
Switching Definitions Output Inverter

figure 5.   **IGBT**

Turn-off Switching Waveforms & definition of t_{Eoff}

P_{off} (100%) =	3,01	kW
E_{off} (100%) =	0,28	mJ
t_{Eoff} =	0,41	µs

figure 6.   **IGBT**

Turn-on Switching Waveforms & definition of t_{Eon}

P_{on} (100%) =	3,01	kW
E_{on} (100%) =	0,31	mJ
t_{Eon} =	0,18	µs
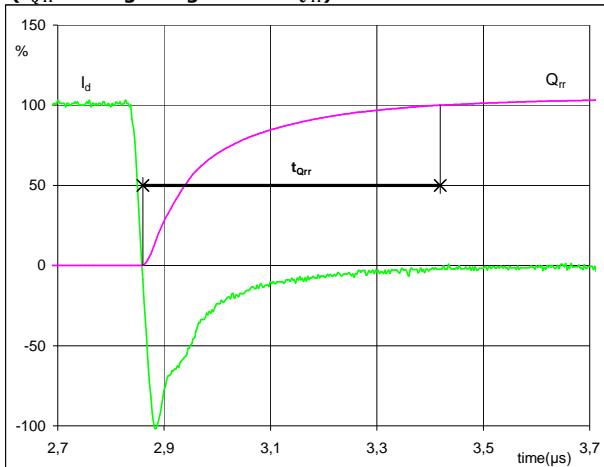
figure 7.   **FWD**

Turn-off Switching Waveforms & definition of t_{rr}

V_d (100%) =	300	V
I_d (100%) =	10	A
I_{RRM} (100%) =	10	A
t_{rr} =	0,28	µs

Switching Definitions Output Inverter

figure 8.	FWD
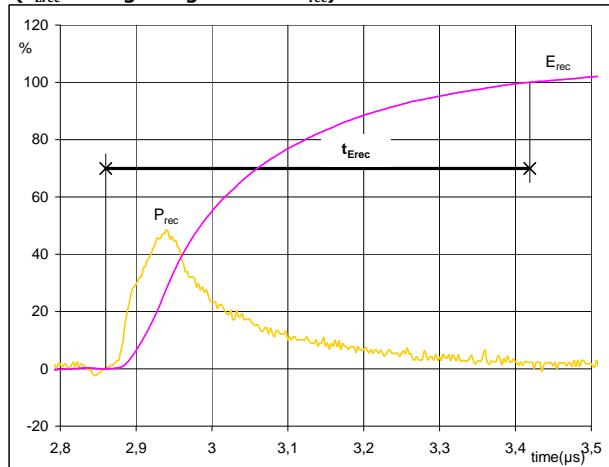
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})

I_d (100%) =	10	A
Q_{rr} (100%) =	1,12	µC
t_{Qrr} =	0,56	µs

figure 9.	FWD

Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec} = integrating time for E_{rec})
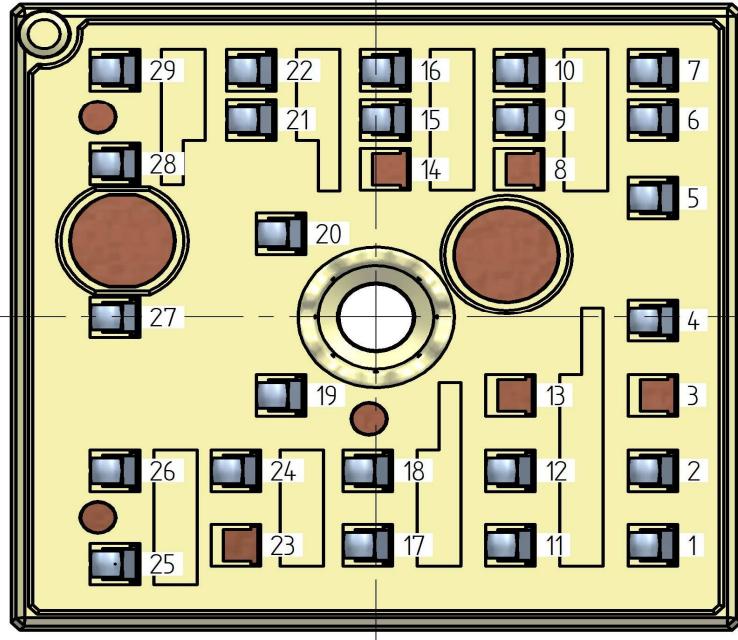
P_{rec} (100%) =	3,01	kW
E_{rec} (100%) =	0,22	mJ
t_{Erec} =	0,56	µs

Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K12-T-PM)	V23990-K202-A-/0A/-PM
with std lid (black V23990-K12-T-PM) and P12	V23990-K202-A-/1A/-PM
with thin lid (white V23990-K13-T-PM)	V23990-K202-A-/0B/-PM
with thin lid (white V23990-K13-T-PM) and P12	V23990-K202-A-/1B/-PM

	VIN WWYY NNNNNNNVV UL LLLLL SSSS	Text	VIN	Date code	Name&Ver	UL	Lot	Serial
			VIN	WWYY	NNNNNNVV	UL	LLLLL	SSSS
		Datamatrix	Type&Ver	Lot number	Serial	Date code		
			TTTTTTTVV	LLLLL	SSSS	WWYY		
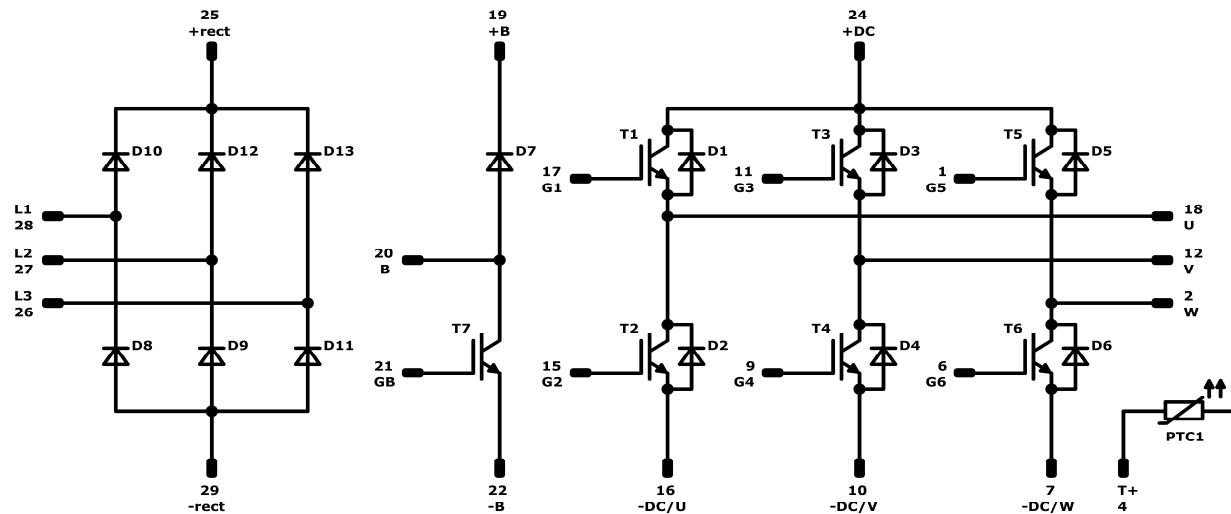
Outline

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	-15,02	-9,8	L3
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.

Pinout

Identification

ID	Component	Voltage	Current	Function	Comment
D8-D13	Rectifier	1600 V	25 A	Rectifier Diode	
T1-T6	IGBT	600 V	10 A	Inverter Switch	
D1-D6	FWD	600 V	20 A	Inverter Diode	
T7	IGBT	600 V	10 A	Brake Switch	
D7	FWD	600 V	20 A	Brake Diode	
PTC1	PTC			Thermistor	

Vincotech

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-K202-A-D4-14	28 Jul. 2016		

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2. 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.