



Vincotech

MiniSKiiP® 1 PIM		600 V / 15 A
Features		MiniSKiiP® 1 housing
• Solderless interconnection • Trench Fieldstop IGBT3 technology		
Target Applications		Schematic
• Industrial drives		
Types		
• V23990-K203-A-PM		

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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Rectifier Diode

Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}		25	A
Surge (non-repetitive) forward current	I_{FSM}	$t_p = 10 \text{ ms}$ half sine wave	220	A
I^2t -value	I^2t		240	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	51	W
Maximum Junction Temperature	T_{jmax}		150	$^\circ\text{C}$

Inverter Switch / Brake Switch

Collector-emitter breakdown voltage	V_{CE}		600	V
DC collector current	I_C		15	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	45	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	54	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC}	$T_j \leq 150^\circ\text{C}$ $V_{GE} = 15 \text{ V}$ $V_{cc} = 360 \text{ V}$	6	μs
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$



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V23990-K203-A-PM

datasheet

Maximum Ratings

$T_j = 25^\circ\text{C}$, 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		20	A
Repetitive peak forward current	I_{PRM}	t_p limited by T_{jmax}	40	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80^\circ\text{C}$	45	W
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$

Thermal Properties

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

Isolation Properties

Isolation voltage	V_{is}	$t = 2\text{ s}$	DC Test Voltage*	5500	V
		$t = 1\text{ min}$	AC Voltage	2500	V
Creepage distance		With std lid For more informations see handling instructions		6,3	mm
Clearance		With std lid For more informations see handling instructions		6,3	mm
Comparative Tracking Index	CTI			>200	

* 100 % tested in production



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V23990-K203-A-PM

datasheet

Characteristic Values

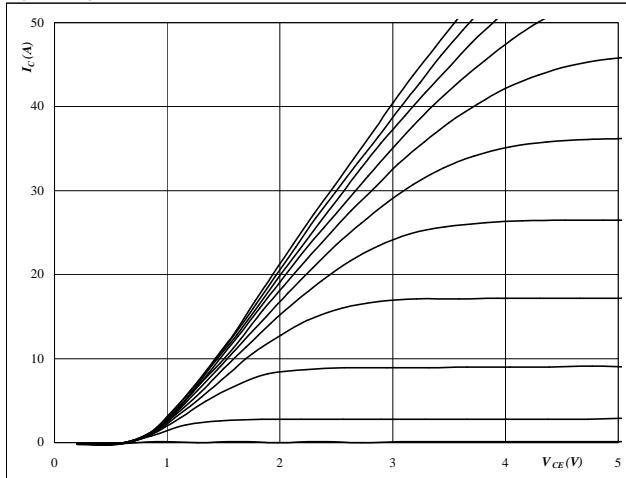
Parameter	Symbol	Conditions						Value			Unit
		V_{GE} [V]	V_r [V]	I_c [A]	I_F [A]	T_j [$^{\circ}$ C]	Min	Typ	Max		
		V_{GS} [V]	V_{CE} [V]	I_D [A]							
Rectifier Diode											
Forward voltage	V_F			25	25 125		1,51 1,42			V	
Threshold voltage (for power loss calc. only)	V_{to}			25	25 125		0,86 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	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)					1,37			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	$t_{d(on)}$	$R_{goff} = 8 \Omega$ $R_{gon} = 16 \Omega$	± 15	300	15	25 150	25			ns	
Rise time	t_r					25 150	25				
Turn-off delay time	$t_{d(off)}$					25 150	183 202				
Fall time	t_f					25 150	104 109				
Turn-on energy loss	E_{on}					25 150	0,46 0,58			mWs	
Turn-off energy loss	E_{off}					25 150	0,36 0,46				
Input capacitance	C_{ies}						860				
Output capacitance	C_{oss}	$f = 1 \text{ MHz}$	0	25		25	55			pF	
Reverse transfer capacitance	C_{rss}						24				
Gate charge	Q_G		15	300	15	25		87		nC	
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)					1,77			K/W	
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}	$di_V/dt = tbd \text{ A/us}$	0	300	15	25 125	8,5 10,3			A	
Reverse recovery time	t_{rr}					25 125	189 275			ns	
Reverse recovered charge	Q_{rr}					25 125	0,64 1,12			μC	
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125	90 55			$\text{A}/\mu\text{s}$	
Reverse recovered energy	E_{rec}					25 125	0,12 0,22			mWs	
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)					2,13			K/W	
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	
A-value	$B_{(25/50)}$				25		$7,635 \cdot 10^{-3}$			$1/\text{K}$	
B-value	$B_{(25/100)}$				25		$1,731 \cdot 10^{-5}$			$1/\text{K}^2$	
Vincotech NTC Reference							E				

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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 1.
Typical output characteristics

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


At

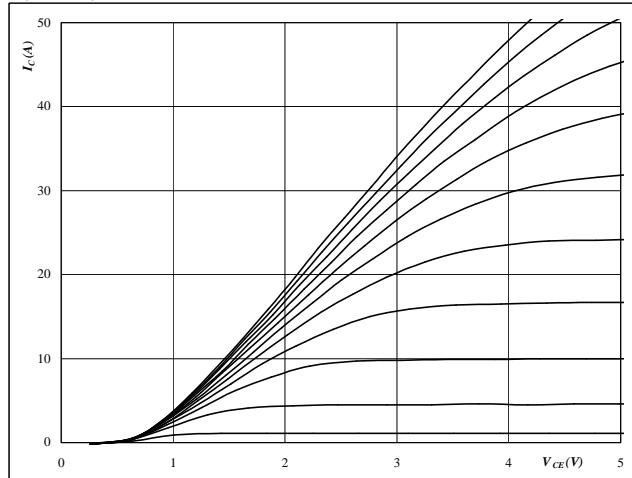
$$t_p = 250 \mu\text{s}$$

$$T_j = 25^\circ\text{C}$$

 V_{GE} from 7 V to 17 V in steps of 1 V

figure 2.
Typical output characteristics

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


At

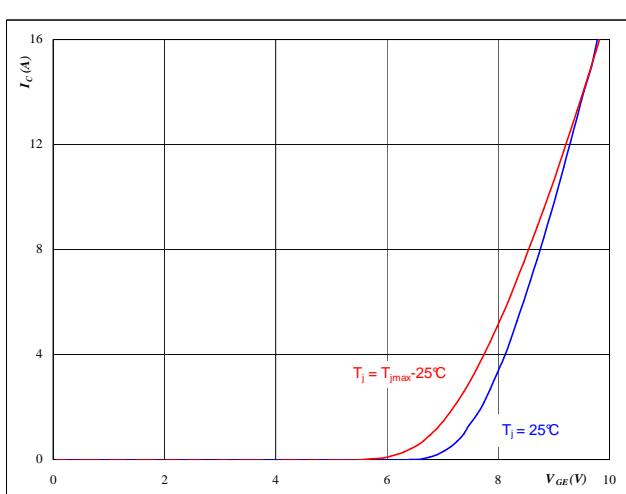
$$t_p = 250 \mu\text{s}$$

$$T_j = 125^\circ\text{C}$$

 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3.
Typical transfer characteristics

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

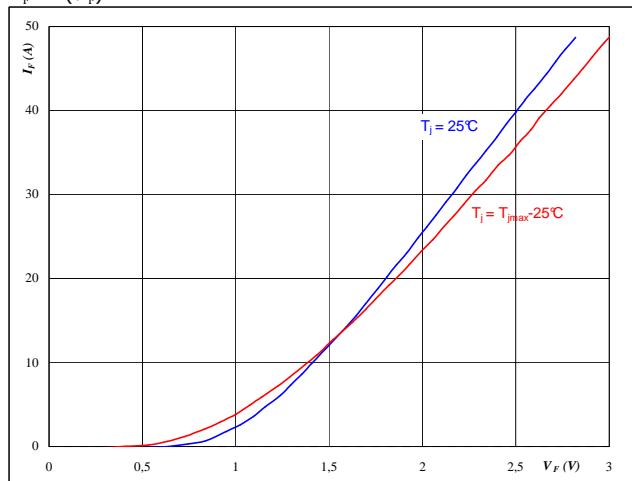

At

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

$$V_{CE} = 10 \text{ V}$$

figure 4.
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$


At

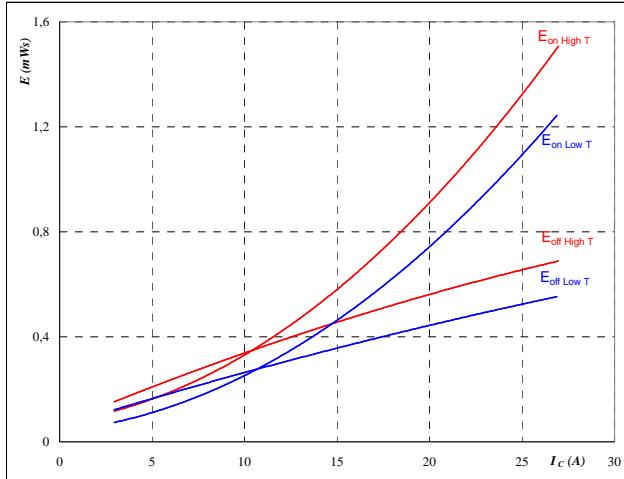
$$t_p = 250 \mu\text{s}$$

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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

$$T_j = \frac{25}{125} \text{ } ^\circ\text{C}$$

$$V_{CE} = 300 \text{ V}$$

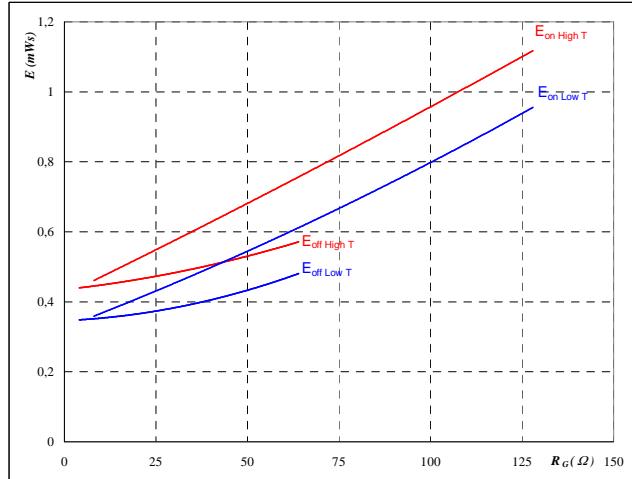
$$V_{GE} = 15 \text{ V}$$

$$R_{gon} = 32 \Omega$$

$$R_{goff} = 16 \Omega$$

figure 6.
IGBT
**Typical switching energy losses
as a function of gate resistor**

$$E = f(R_G)$$



With an inductive load at

$$T_j = \frac{25}{125} \text{ } ^\circ\text{C}$$

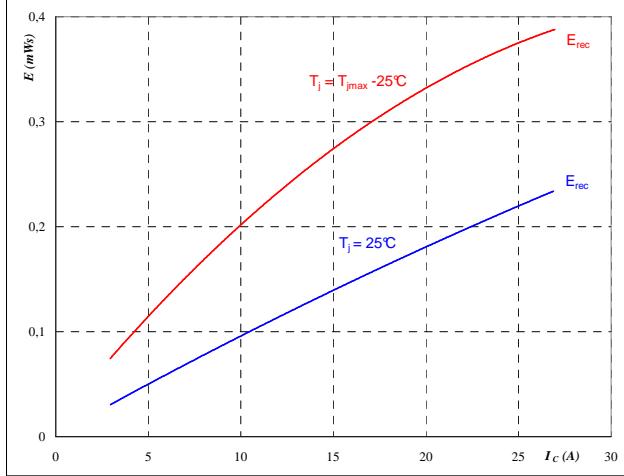
$$V_{CE} = 300 \text{ V}$$

$$V_{GE} = 15 \text{ V}$$

$$I_C = 15 \text{ A}$$

figure 7.
FWD
**Typical reverse recovery energy loss
as a function of collector current**

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



With an inductive load at

$$T_j = \frac{25}{125} \text{ } ^\circ\text{C}$$

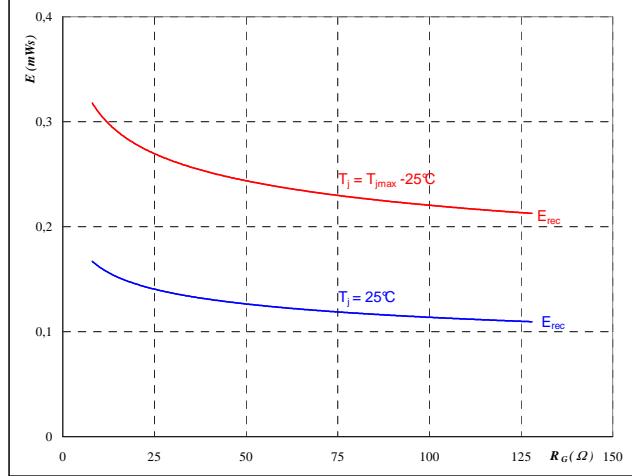
$$V_{CE} = 300 \text{ V}$$

$$V_{GE} = 15 \text{ V}$$

$$R_{gon} = 32 \Omega$$

figure 8.
FWD
**Typical reverse recovery energy loss
as a function of gate resistor**

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



With an inductive load at

$$T_j = \frac{25}{125} \text{ } ^\circ\text{C}$$

$$V_{CE} = 300 \text{ V}$$

$$V_{GE} = 15 \text{ V}$$

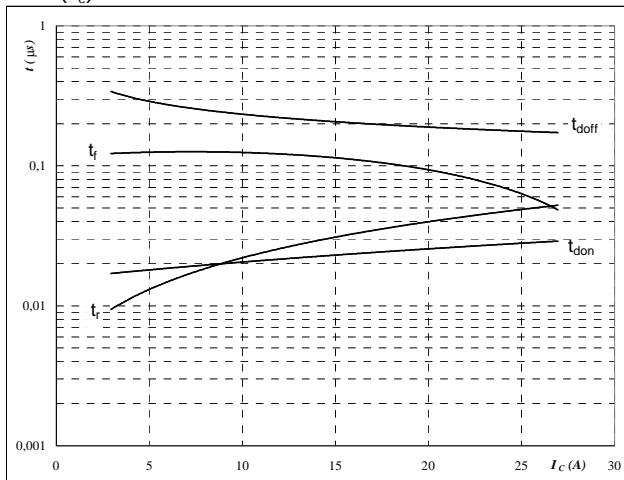
$$I_C = 15 \text{ A}$$

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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 9.
Typical switching times as a function of collector current

$$t = f(I_C)$$



With an inductive load at

$$T_j = 125 \quad ^\circ\text{C}$$

$$V_{CE} = 300 \quad \text{V}$$

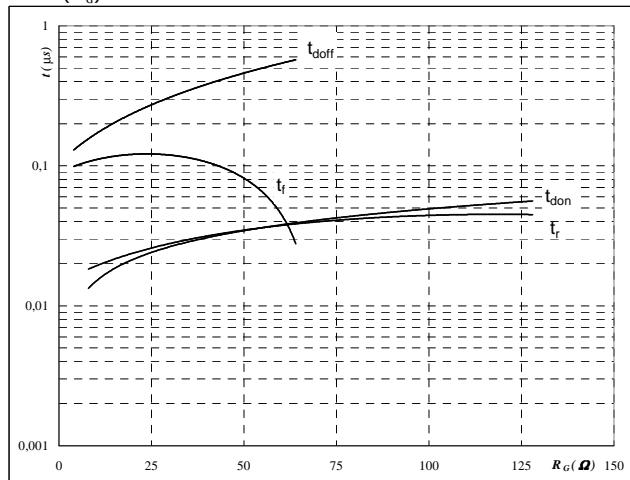
$$V_{GE} = 15 \quad \text{V}$$

$$R_{gon} = 32 \quad \Omega$$

$$R_{goff} = 16 \quad \Omega$$

IGBT
figure 10.
Typical switching times as a function of gate resistor

$$t = f(R_G)$$



With an inductive load at

$$T_j = 125 \quad ^\circ\text{C}$$

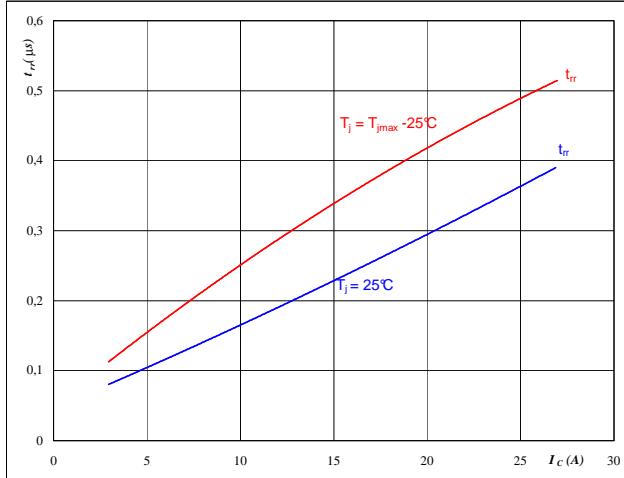
$$V_{CE} = 300 \quad \text{V}$$

$$V_{GE} = 15 \quad \text{V}$$

$$I_C = 15 \quad \text{A}$$

figure 11.
FWD
Typical reverse recovery time as a function of collector current

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


At

$$T_j = 25/125 \quad ^\circ\text{C}$$

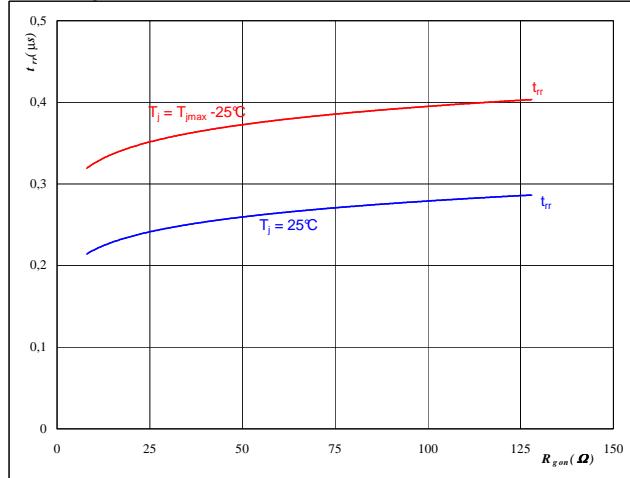
$$V_{CE} = 300 \quad \text{V}$$

$$V_{GE} = 15 \quad \text{V}$$

$$R_{gon} = 32 \quad \Omega$$

figure 12.
FWD
Typical reverse recovery time as a function of IGBT turn on gate resistor

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


At

$$T_j = 25/125 \quad ^\circ\text{C}$$

$$V_R = 300 \quad \text{V}$$

$$I_F = 15 \quad \text{A}$$

$$V_{GE} = 15 \quad \text{V}$$

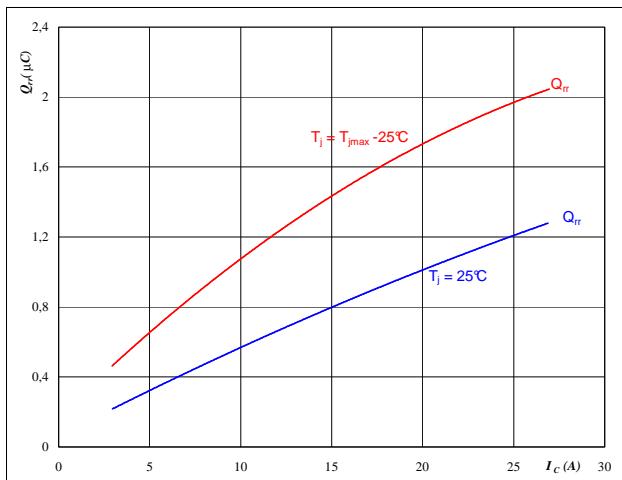
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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 13.
FWD

Typical reverse recovery charge as a function of collector current

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

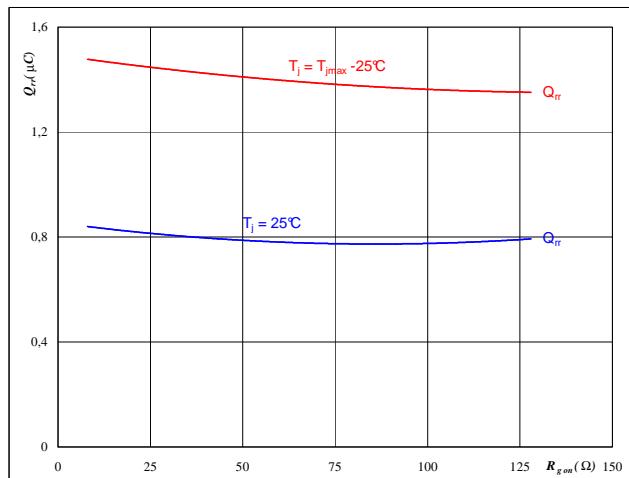

At

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

figure 14.
FWD

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

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

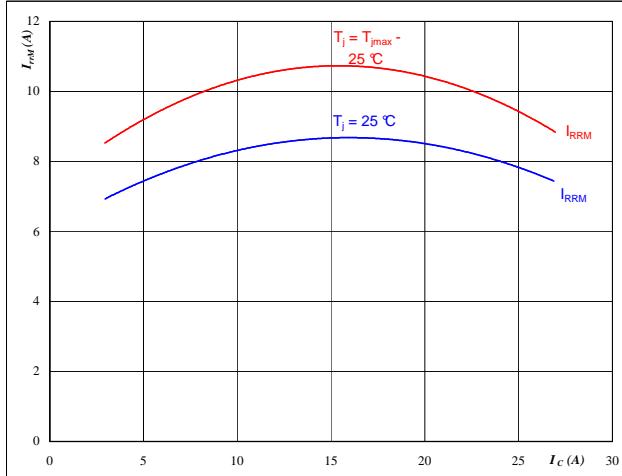

At

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

figure 15.
FWD

Typical reverse recovery current as a function of collector current

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

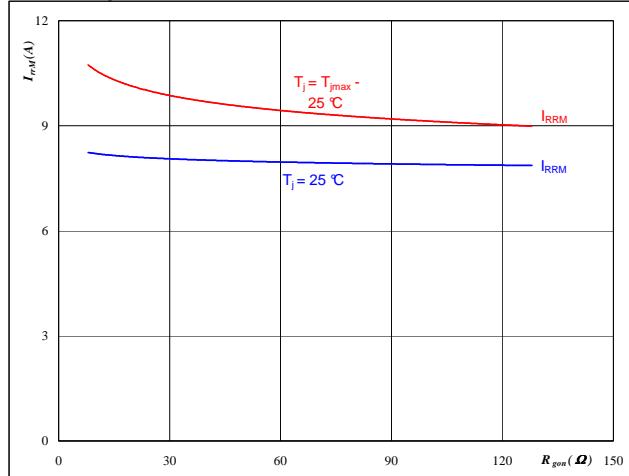

At

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

figure 16.
FWD

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

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


At

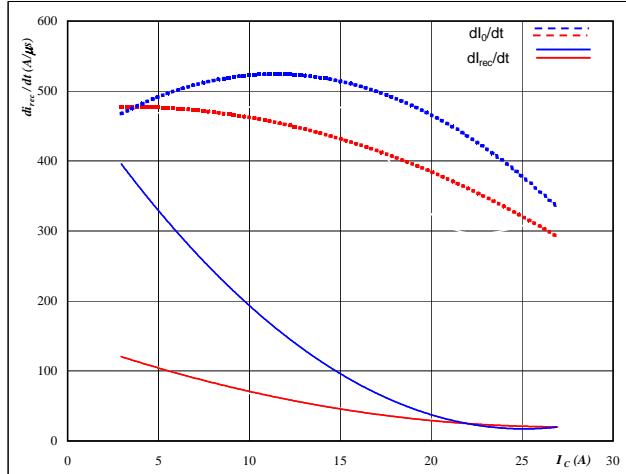
$T_j = \textcolor{blue}{25/125} \quad ^\circ\text{C}$
 $V_R = 300 \quad \text{V}$
 $I_F = 15 \quad \text{A}$
 $V_{GE} = 15 \quad \text{V}$

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Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 17.
FWD

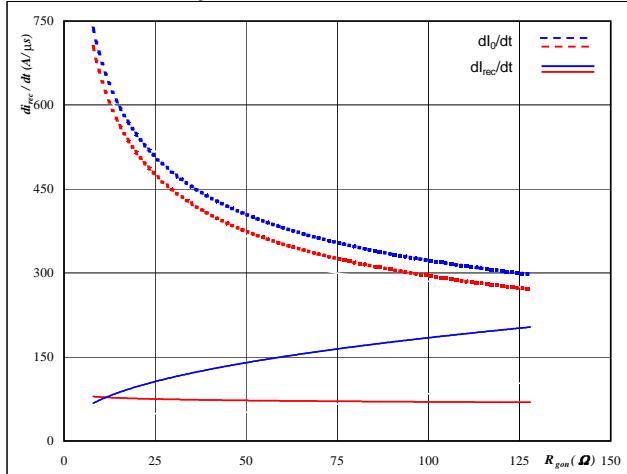
**Typical rate of fall of forward
and reverse recovery current as a
function of collector current**
 $dI_0/dt, dI_{rec}/dt = f(I_c)$


At

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

figure 18.
FWD

**Typical rate of fall of forward
and reverse recovery current as a
function of IGBT turn on gate resistor**
 $dI_0/dt, dI_{rec}/dt = f(R_{gon})$

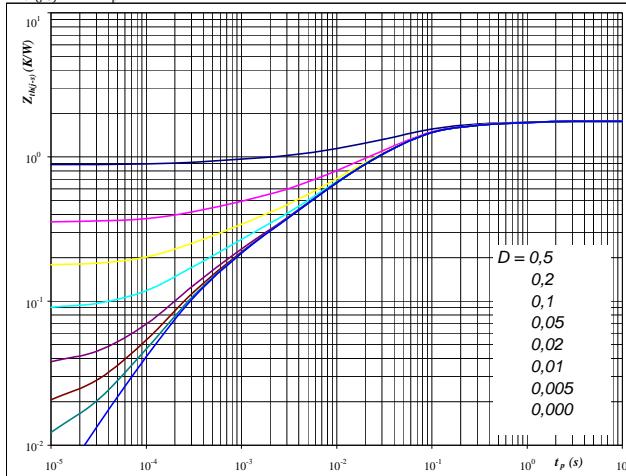

At

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

figure 19.
IGBT

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

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


At

$D = t_p / T$
 $R_{th(j-s)} = 1,77 \quad \text{K/W}$

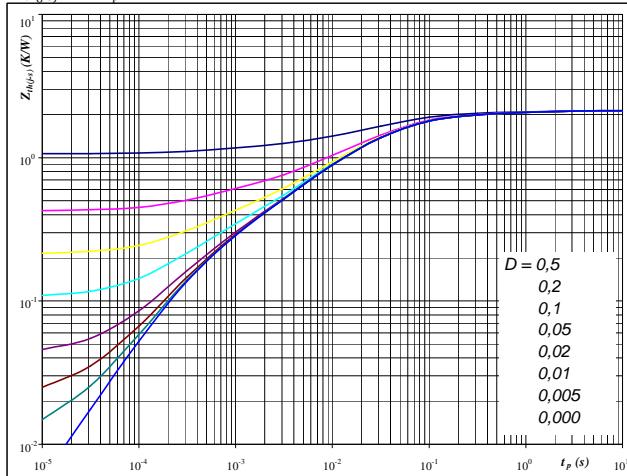
IGBT thermal model values

R (K/W)	Tau (s)
9,57E-02	1,14E+00
2,34E-01	1,65E-01
8,90E-01	4,39E-02
3,08E-01	8,39E-03
1,23E-01	2,26E-03
1,17E-01	3,61E-04

figure 20.
FWD

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

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


At

$D = t_p / T$
 $R_{th(j-s)} = 2,13 \quad \text{K/W}$

FWD thermal model values

R (K/W)	Tau (s)
1,19E-01	2,09E+00
2,02E-01	3,18E-01
8,81E-01	6,20E-02
5,30E-01	1,64E-02
2,37E-01	3,98E-03
1,60E-01	5,45E-04

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 25.
**Safe operating area as a function
of collector-emitter voltage**

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

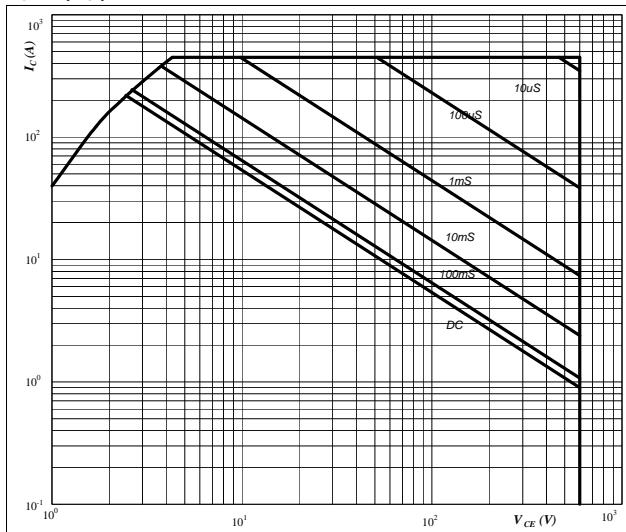
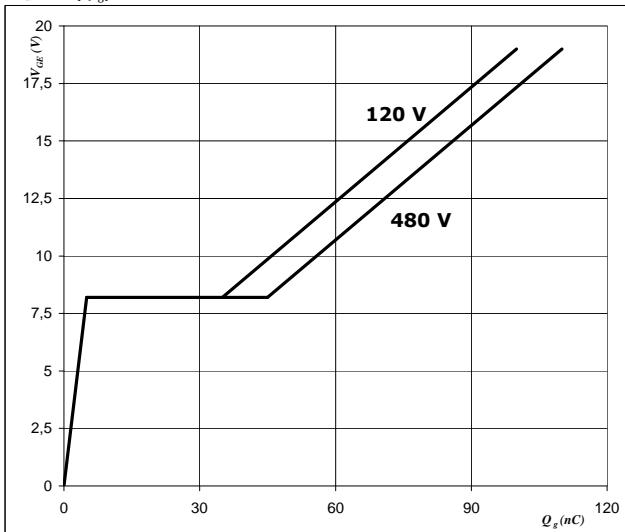

At
 $D = \text{single pulse}$
 $T_s = 80 \quad {}^\circ\text{C}$
 $V_{GE} = 15 \quad \text{V}$
 $T_j = T_{jmax}$
IGBT

figure 26.
Gate voltage vs Gate charge

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

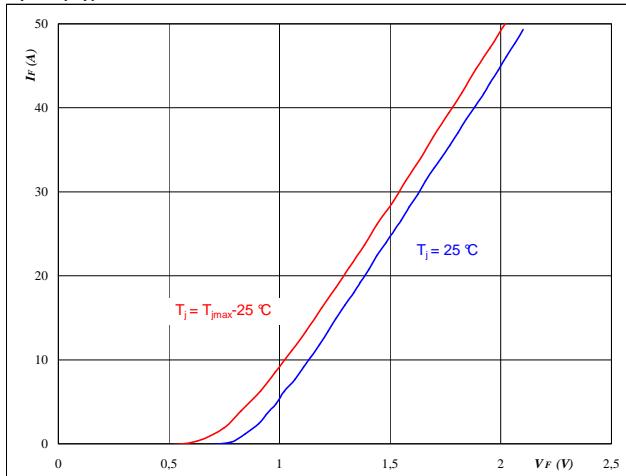

At
 $I_C = 15 \quad \text{A}$

Rectifier Diode

figure 1.
Rectifier Diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

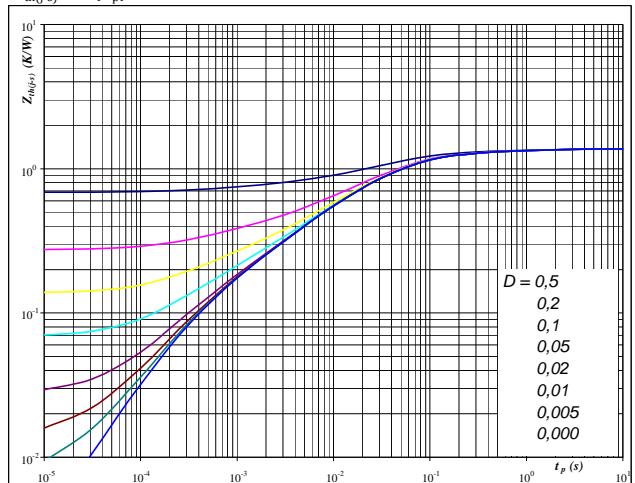

At

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

figure 2.
Rectifier Diode

Diode transient thermal impedance as a function of pulse width

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


At

$$D = t_p / T$$

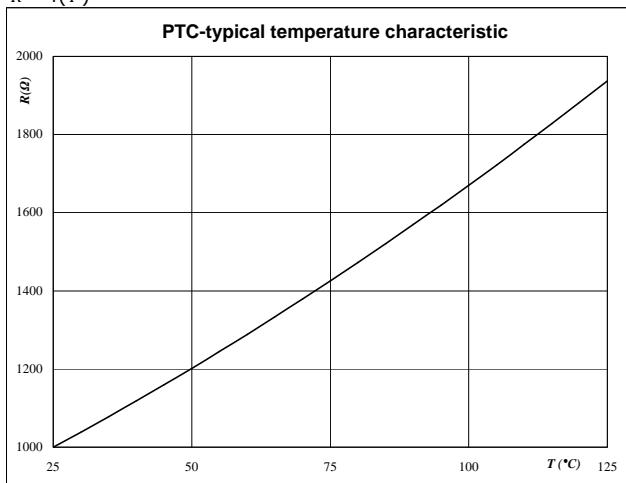
$$R_{th(j-s)} = 1,37 \text{ K/W}$$

Thermistor

figure 1.
Thermistor

Typical PTC characteristic as a function of temperature

$$R = f(T)$$



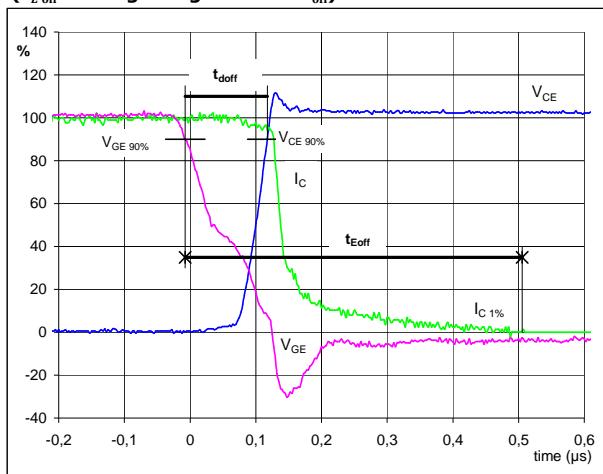
Switching Definitions Output Inverter

General conditions

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

figure 1.

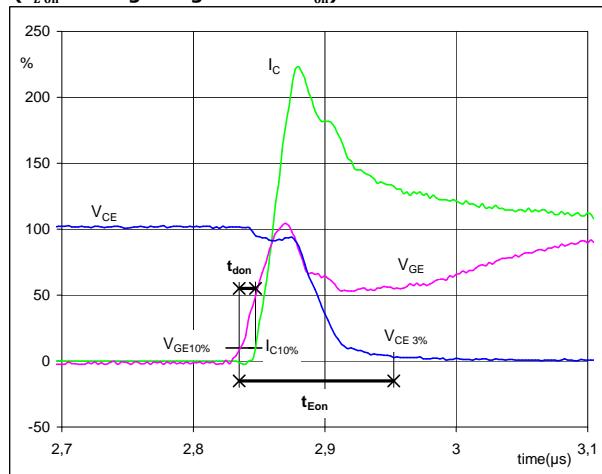
IGBT
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
 $(t_{Eoff} = \text{integrating time for } E_{off})$



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

figure 2.

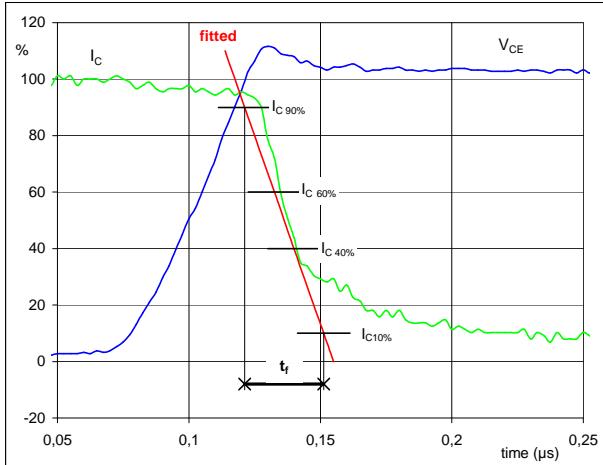
IGBT
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
 $(t_{Eon} = \text{integrating time for } E_{on})$



$V_{GE}(0\%) = 0 \text{ V}$
 $V_{GE}(100\%) = 15 \text{ V}$
 $V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 10 \text{ A}$
 $t_{don} = 0,01 \mu\text{s}$
 $t_{Eon} = 0,12 \mu\text{s}$

figure 3.

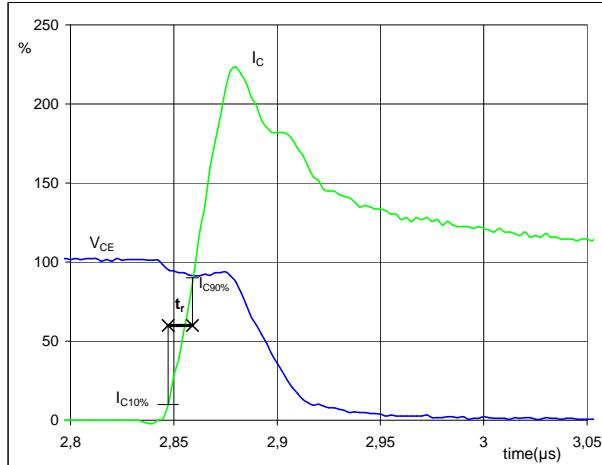
IGBT
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 10 \text{ A}$
 $t_f = 0,03 \mu\text{s}$

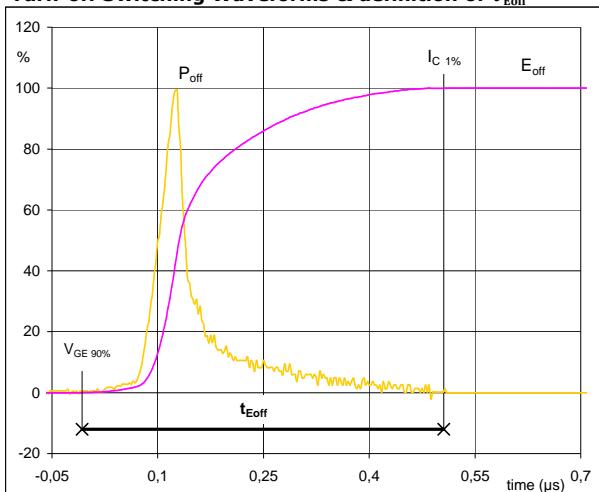
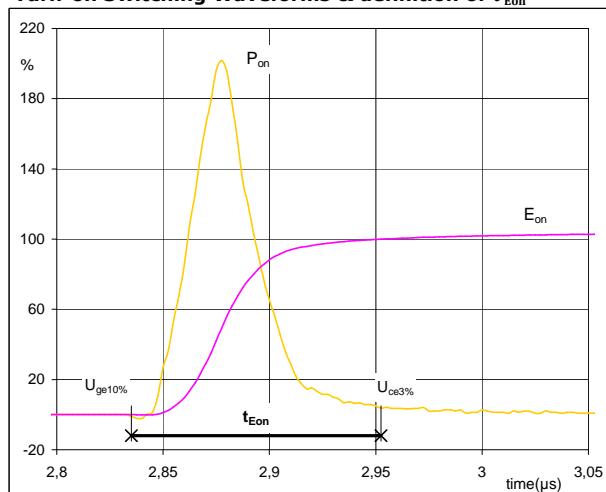
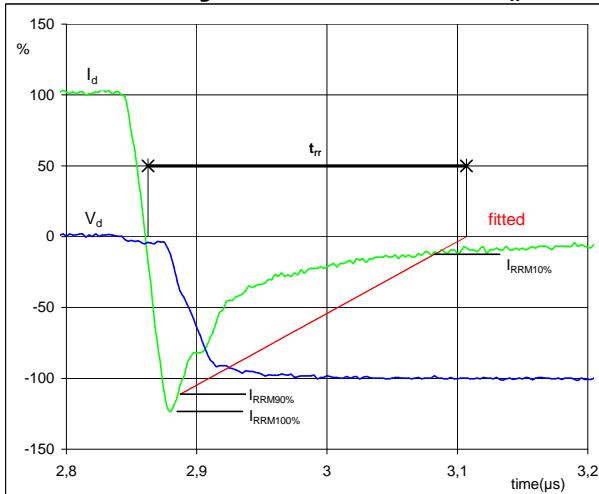
figure 4.

IGBT
Turn-on Switching Waveforms & definition of t_r



$V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 10 \text{ A}$
 $t_r = 0,01 \mu\text{s}$

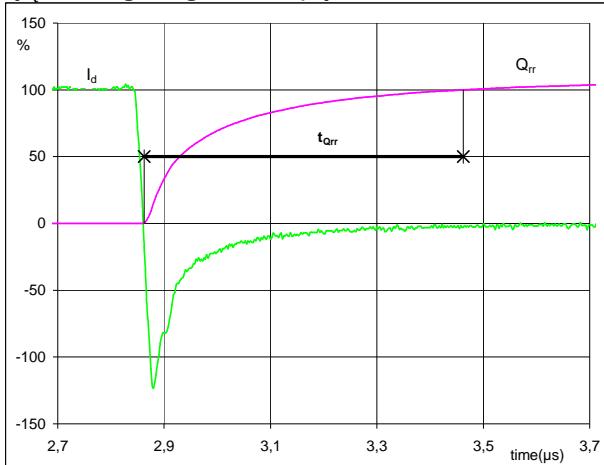
Switching Definitions Output Inverter

figure 5.**IGBT****Turn-off Switching Waveforms & definition of t_{Eoff}** **figure 6.****IGBT****Turn-on Switching Waveforms & definition of t_{Eon}** **figure 7.****IGBT****Turn-off Switching Waveforms & definition of t_{rr}** 

Switching Definitions Output Inverter

figure 8.**FWD**

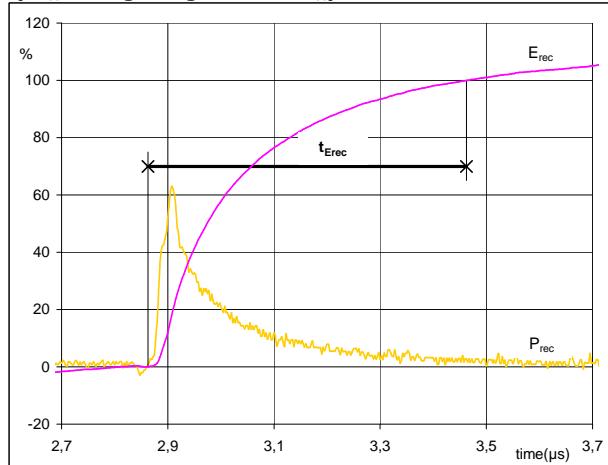
Turn-on Switching Waveforms & definition of t_{Qrr}
 $(t_{Qrr} = \text{integrating time for } Q_{rr})$



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}
 $(t_{Erec} = \text{integrating time for } E_{rec})$



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



Vincotech

V23990-K203-A-PM

datasheet

Ordering Code & Marking			
Version	Ordering Code		
With std lid (6.5mm height) + no thermal grease	V23990-K203-A-/0A/-PM		
With thin lid (2.8mm height) + no thermal grease	V23990-K203-A-/0B/-PM		
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K203-A-/1A/-PM		
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K203-A-/1B/-PM		
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K203-A-/4A/-PM		
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K203-A-/4B/-PM		
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K203-A-/5A/-PM		
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K203-A-/5B/-PM		

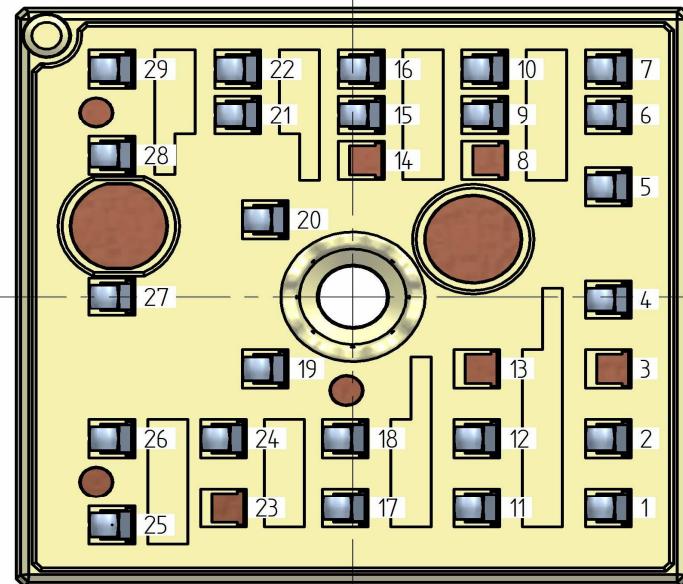
VIN WWYY
NNNNNNVV UL
LLLLL SSSS



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

Outline

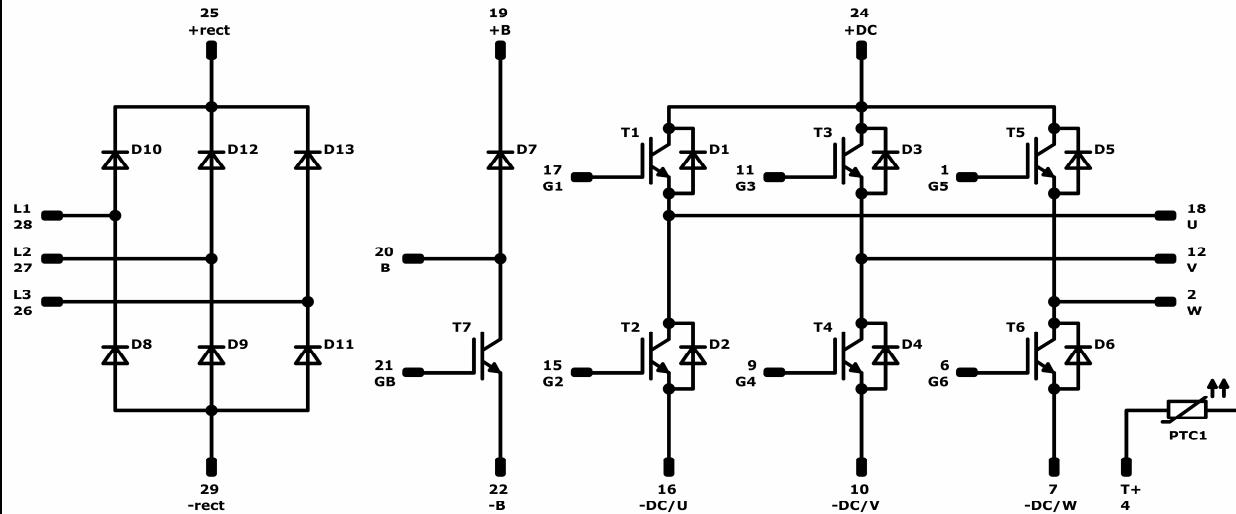
Pad table [mm]			
Pad	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	Not assembled		
4	15,93	-0,2	+T
5	15,93	7,62	-T
6	15,93	12,62	G6
7	15,93	15,8	-DC/W
8	Not assembled		
9	8,23	12,62	G4
10	8,23	15,8	-DC/V
11	7,73	-14,6	G3
12	7,73	-9,8	V
13	Not assembled		
14	Not assembled		
15	0,53	12,62	G2
16	0,53	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



The diagram shows a top-down view of the package outline with 29 numbered pads. Pad 1 is at the top left, and pad 29 is at the bottom left. Other pads are numbered 2 through 28 in a clockwise direction around the perimeter. Components shown include two large circular pads in the center, several rectangular pads, and some smaller circular features.

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	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	



Vincotech

V23990-K203-A-PM

datasheet

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

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-A-D5-14	27 Sep. 2018	Thermal interface changed to HPTP	1,2,3,8,10,14

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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.