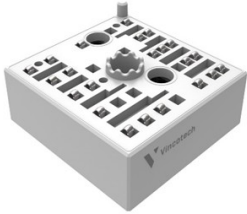
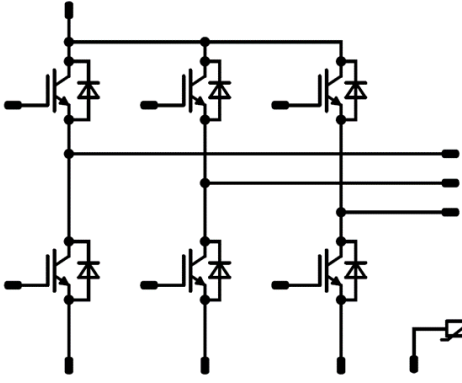




Vincotech

MiniSKiiP PACK 1	1200 V / 15 A
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">Features</p> <ul style="list-style-type: none"> Solderless interconnection Trench Fieldstop IGBT4 technology </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">Target applications</p> <ul style="list-style-type: none"> Servo Drives Industrial Motor Drives UPS </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">Types</p> <ul style="list-style-type: none"> V23990-K219-F40-PM </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">MiniSKiiP 1 housing</p>  </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #cccccc; margin: 0;">Schematic</p>  </div>

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C		20	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	45	A
Turn off safe operating area		$V_{CE} \leq 1200\text{ V}$, $T_j \leq T_{opmax}$	30	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	88	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$ $V_{CE} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	µs
Maximum junction temperature	T_{jmax}		175	°C



Vincotech

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Continuous (direct) forward current	I_F		15	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	45	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	66	W
Maximum junction temperature	T_{jmax}		175	°C

Module Properties

Thermal Properties

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

Isolation Properties

Isolation voltage	V_{isol}	DC Test Voltage* $t_p = 2\text{ s}$	5500	V
		AC Voltage $t_p = 1\text{ min}$	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



Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
		V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	

Inverter Switch

Static

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$				0,0005	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15			15	25 150	1,6	2,1 2,39	2,15	V
Collector-emitter cut-off current	I_{CES}		0	1200			25			60	μA
Gate-emitter leakage current	I_{GES}		20	0			25			200	nA
Internal gate resistance	r_g								none		Ω
Input capacitance	C_{ies}	$f = 1$ Mhz	0	25			25		900		pF
Output capacitance	C_{oes}								80		
Reverse transfer capacitance	C_{res}								55		
Gate charge	Q_g		±15				25		120		nC

Thermal

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5$ W/mK (HPTP)							1,08		K/W

Dynamic

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32$ Ω $R_{goff} = 32$ Ω	±15	600	15		25 150		97 98		ns
Rise time	t_r								30 35		
Turn-off delay time	$t_{d(off)}$								216 288		
Fall time	t_f								91 134		
Turn-on energy (per pulse)	E_{on}							$Q_{tFWD} = 1$ μC		1 1,52	
Turn-off energy (per pulse)	E_{off}	$Q_{tFWD} = 2,4$ μC		0,9 1,48							



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Characteristic Values

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

Inverter Diode

Static

Forward voltage	V_F				15	25 150	1,3	2,56 2,51	2,8	V
-----------------	-------	--	--	--	----	-----------	-----	--------------	-----	---

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5$ W/mK (HPTP)						1,44		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Dynamic

Peak recovery current	I_{RRM}	$di/dt = 392$ A/ μ s $di/dt = 390$ A/ μ s	± 15	600	15	25		8,13		A
Reverse recovery time	t_{rr}					150		11,5		
						25		289		
Recovered charge	Q_r					150		536		
						25		0,98		
Reverse recovered energy	E_{rec}					150		2,38		
		25		0,37						
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$	150		71						
		25		54						

Thermistor

Rated resistance	R					25		1		k Ω
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1670$ Ω				100	-2		+2	%
R_{100}	R					100		1670		Ω
Power dissipation constant						25		0,76		mW/K
A-value	$A_{(25/50)}$					25		$7,635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1,731 \cdot 10^{-5}$		1/K ²
Vincotech PTC Reference									E	

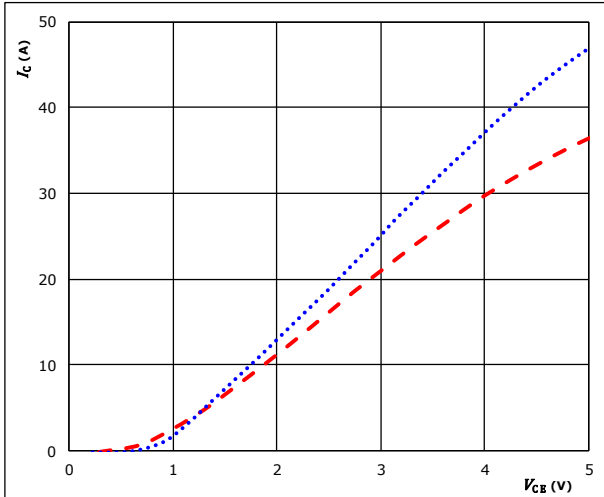


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

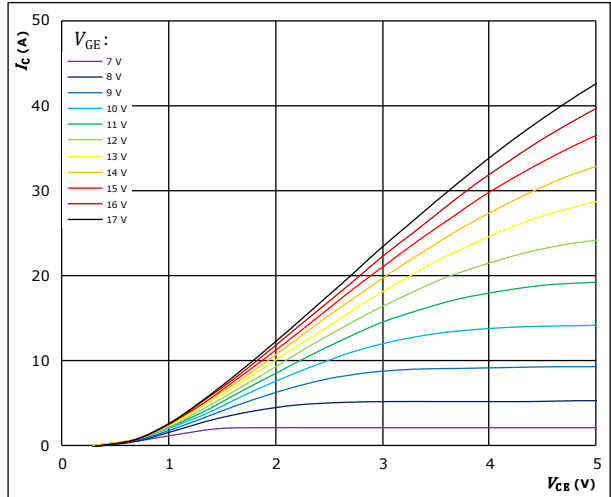


$t_p = 250 \mu\text{s}$
 $V_{GE} = 15 \text{ V}$
 $T_j: 25 \text{ }^\circ\text{C}$ (blue dotted line)
 $150 \text{ }^\circ\text{C}$ (red dashed line)

figure 2. IGBT

Typical output characteristics

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

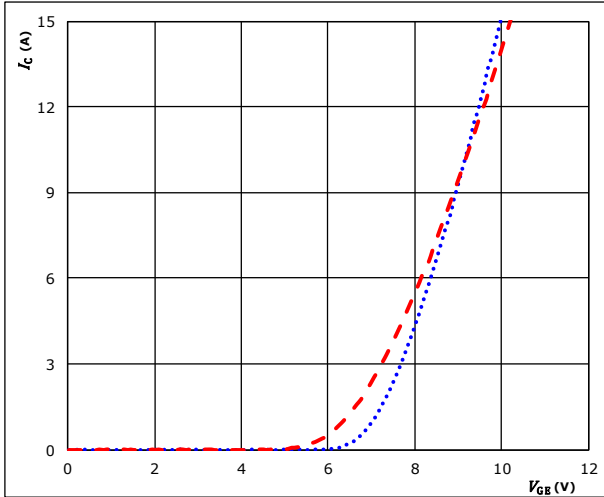


$t_p = 250 \mu\text{s}$
 $T_j = 150 \text{ }^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

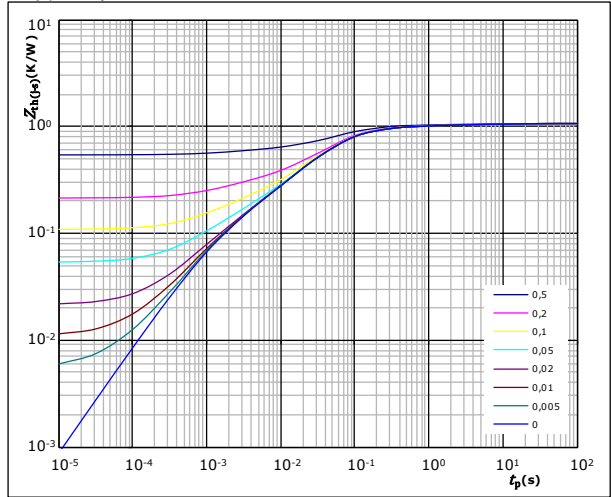


$t_p = 100 \mu\text{s}$
 $V_{CE} = 10 \text{ V}$
 $T_j: 25 \text{ }^\circ\text{C}$ (blue dotted line)
 $150 \text{ }^\circ\text{C}$ (red dashed line)

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 1,08 \text{ K/W}$

IGBT thermal model values

R (K/W)	τ (s)
4,02E-02	8,05E+00
7,53E-02	6,86E-01
2,00E-01	1,22E-01
5,79E-01	4,09E-02
1,08E-01	7,96E-03
7,24E-02	1,22E-03
4,99E-03	5,90E-04

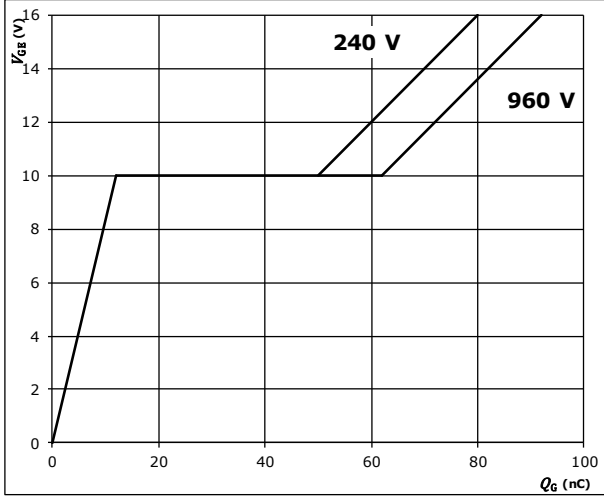


Inverter Switch Characteristics

figure 5. IGBT

Gate voltage vs gate charge

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

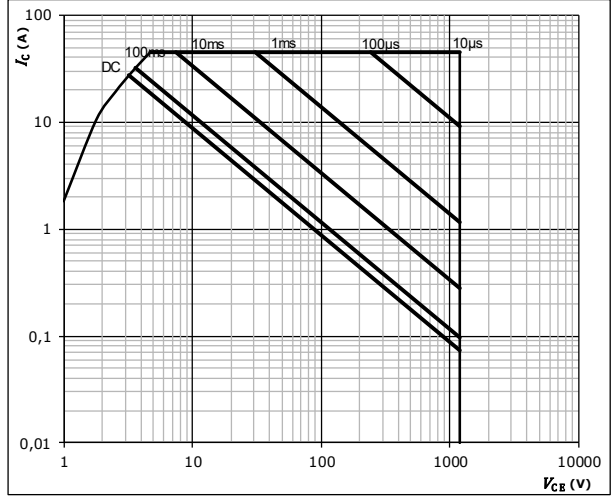


$I_C = 15$ A

figure 6. IGBT

Safe operating area

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



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

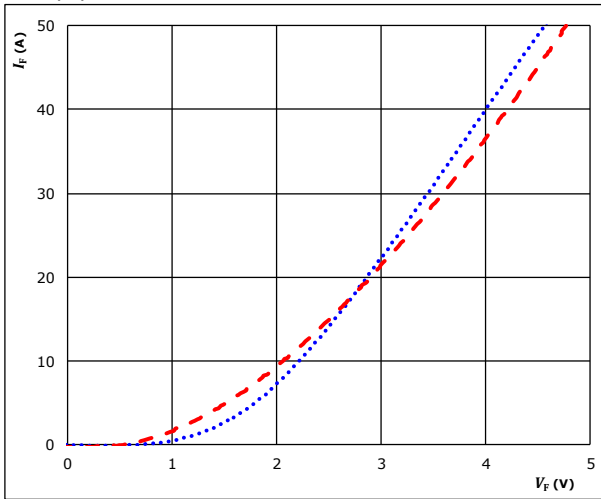


Inverter Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

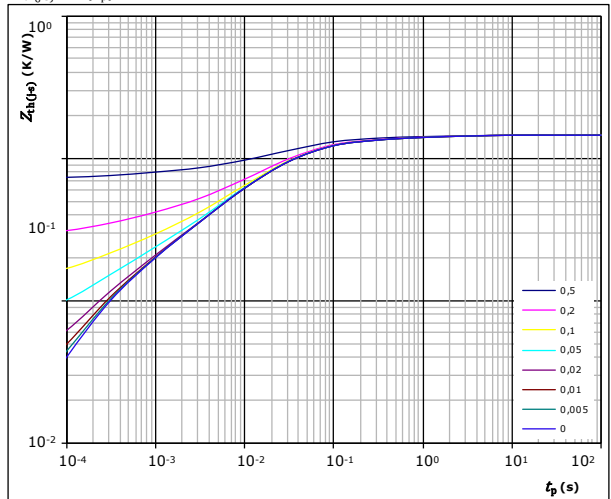


$t_p = 250 \mu s$
 T_j : 25 °C (blue dotted line), 150 °C (red dashed line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,44 \text{ K/W}$
FWD thermal model values

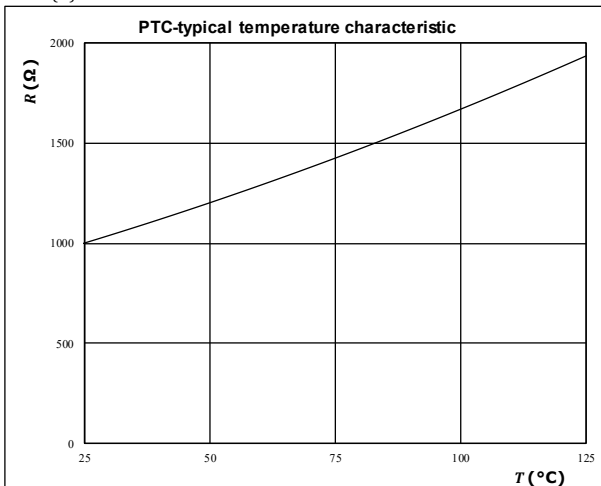
$R \text{ (K/W)}$	$\tau \text{ (s)}$
6,32E-02	2,64E+00
1,25E-01	3,53E-01
4,72E-01	5,08E-02
4,73E-01	1,56E-02
2,06E-01	2,93E-03
1,06E-01	3,09E-04

Thermistor Characteristics

figure 1. Thermistor

Typical PTC characteristic
as a function of temperature

$$R = f(T)$$



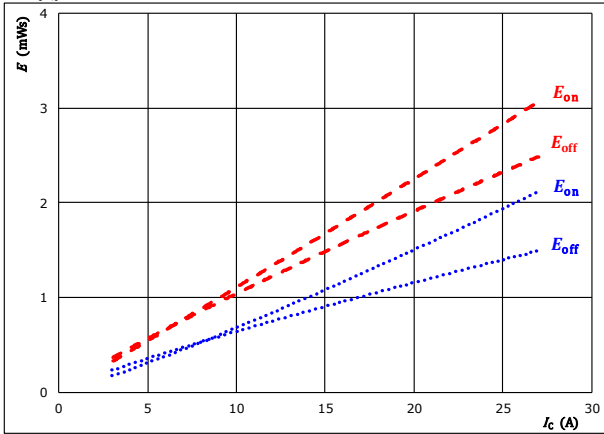


Inverter Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 32$ Ω

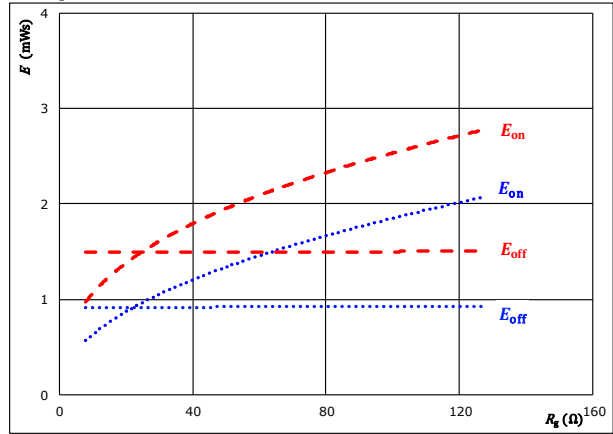
T_j :

25 °C (dotted blue)
150 °C (dashed red)

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

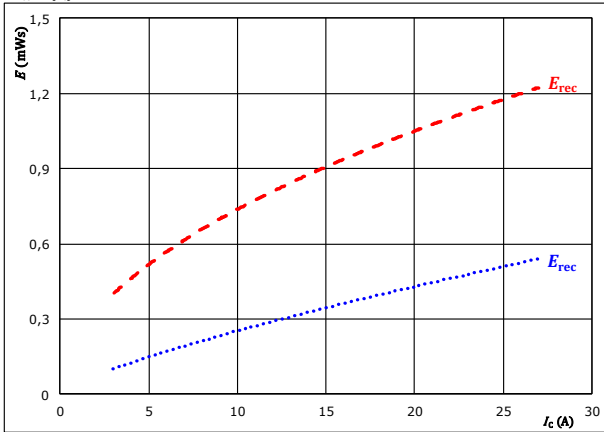
T_j :

25 °C (dotted blue)
150 °C (dashed red)

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω

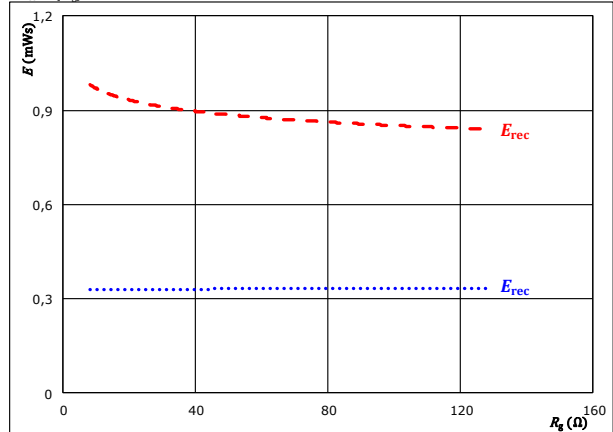
T_j :

25 °C (dotted blue)
150 °C (dashed red)

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

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



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j :

25 °C (dotted blue)
150 °C (dashed red)

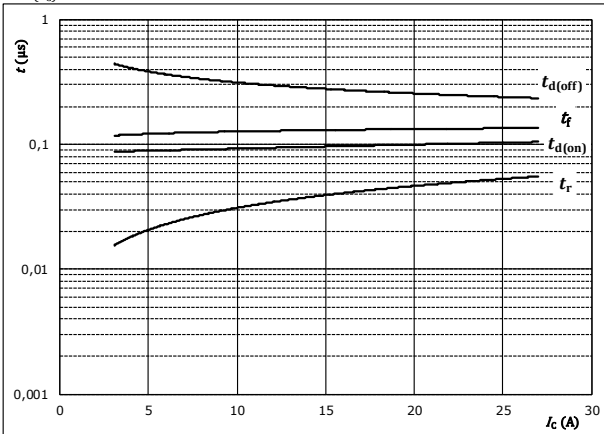


Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



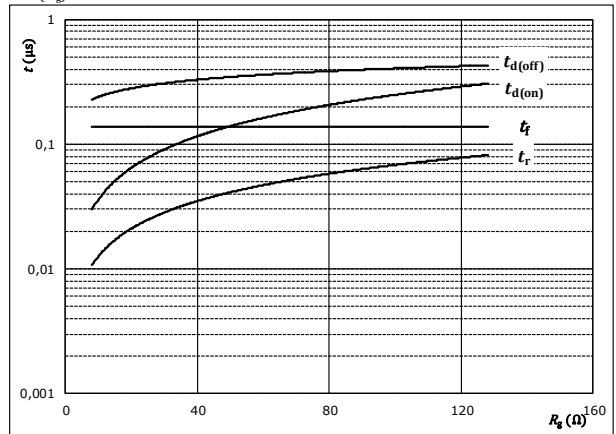
With an inductive load at

$T_j = 150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 32$ Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



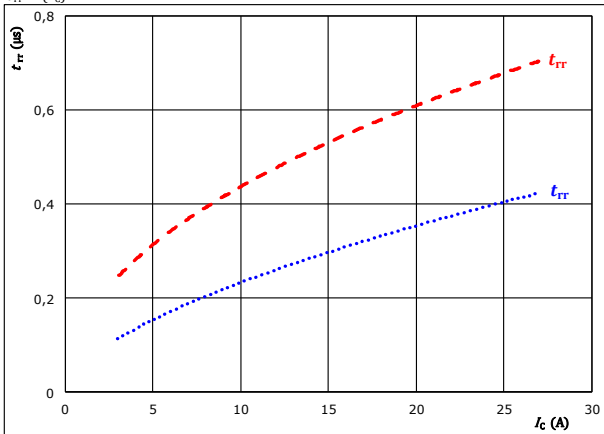
With an inductive load at

$T_j = 150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A

figure 7. FWD

Typical reverse recovery time as a function of collector current

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



With an inductive load at

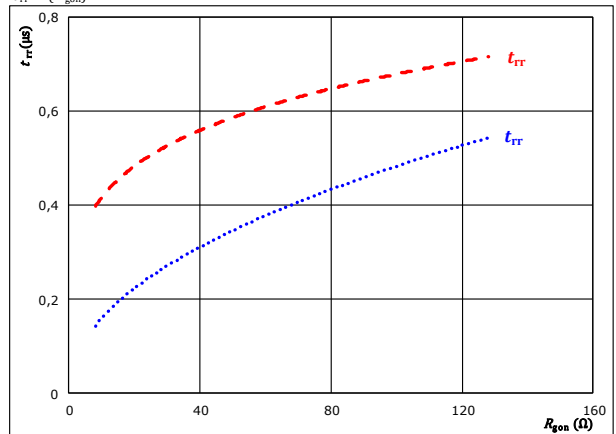
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω

T_j : 25 °C (dotted line)
 150 °C (dashed line)

figure 8. FWD

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

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



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A

T_j : 25 °C (dotted line)
 150 °C (dashed line)

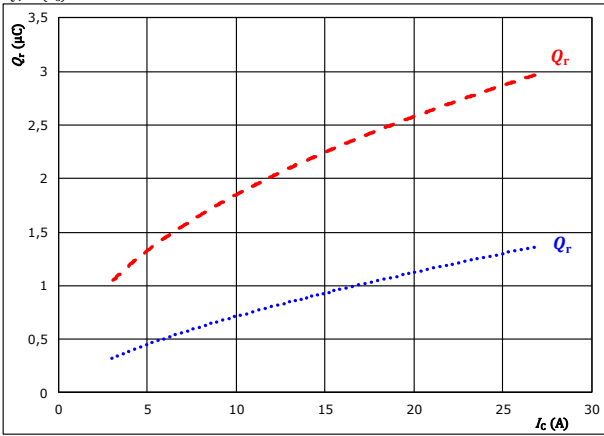


Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$

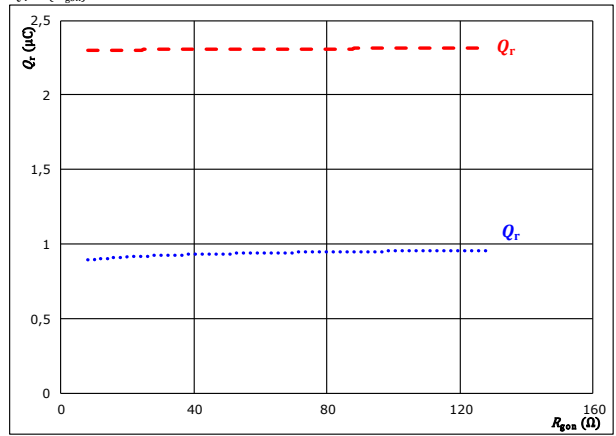


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 T_j : 25 °C (blue dotted line)
 150 °C (red dashed line)

figure 10. FWD

Typical recovered charge as a function of IGBT turn on gate resistor

$$Q_r = f(R_{gon})$$

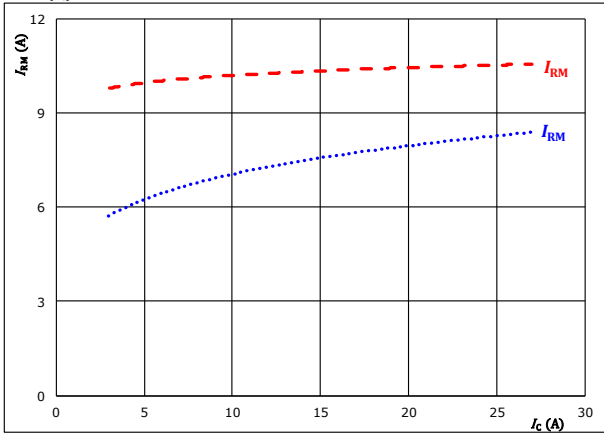


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A
 T_j : 25 °C (blue dotted line)
 150 °C (red dashed line)

figure 11. FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_c)$$

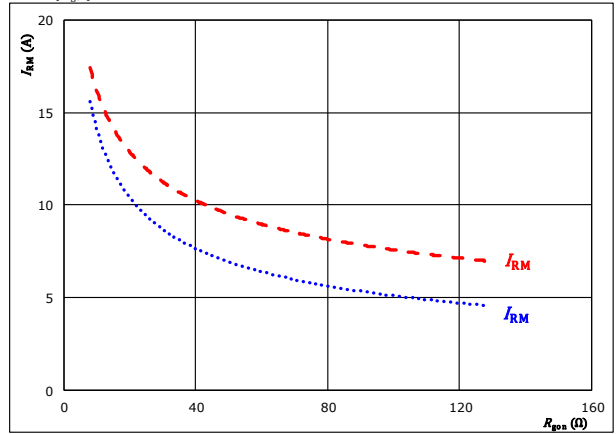


With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 T_j : 25 °C (blue dotted line)
 150 °C (red dashed line)

figure 12. FWD

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

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



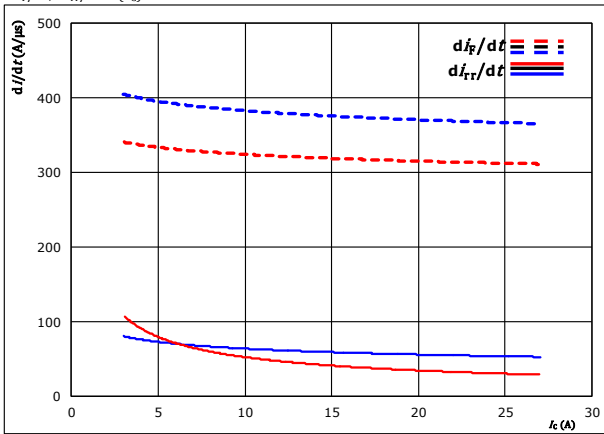
With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A
 T_j : 25 °C (blue dotted line)
 150 °C (red dashed line)



Inverter Switching Characteristics

figure 13. FWD

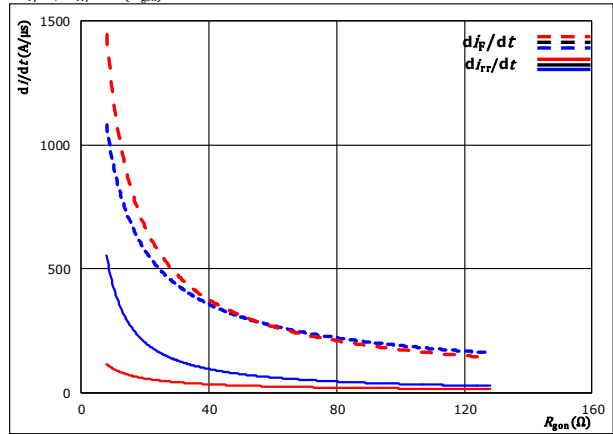
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_f/dt, di_{rr}/dt = f(I_C)$



With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{g\text{on}} = 32$ Ω
 $T_j: 25$ °C
 150 °C

figure 14. FWD

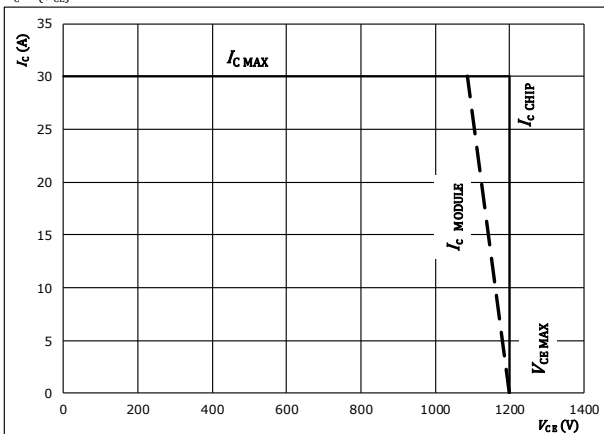
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $di_f/dt, di_{rr}/dt = f(R_{g\text{on}})$



With an inductive load at
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A
 $T_j: 25$ °C
 150 °C

figure 15. IGBT

Reverse bias safe operating area
 $I_C = f(V_{CE})$



At
 $T_j = 150$ °C
 $R_{g\text{on}} = 32$ Ω
 $R_{g\text{off}} = 32$ Ω

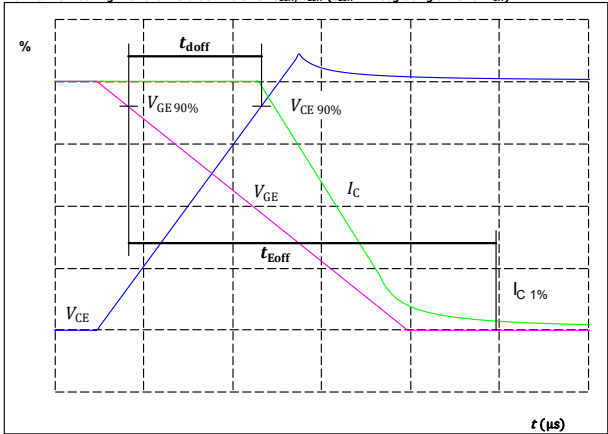


Inverter Switching Definitions

General conditions		
T_j	=	125 °C
R_{gon}	=	32 Ω
R_{goff}	=	32 Ω

figure 1. IGBT

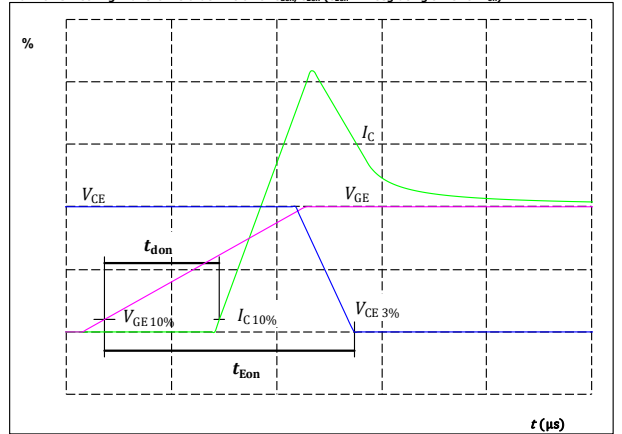
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{CE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{doff} =$	288	ns

figure 2. IGBT

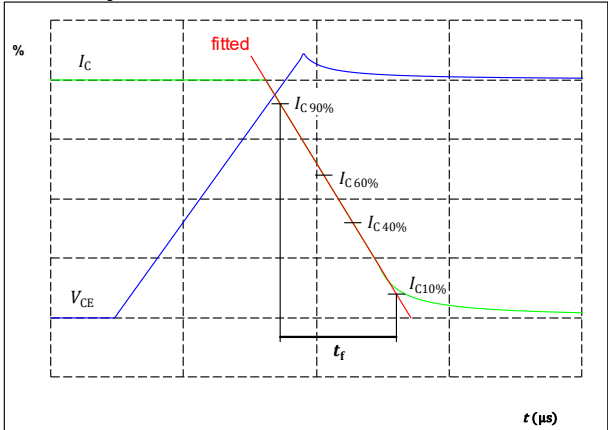
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{CE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{don} =$	98	ns

figure 3. IGBT

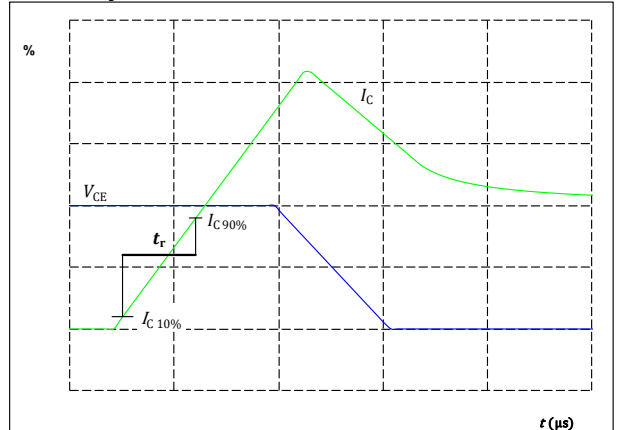
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_f =$	134	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r



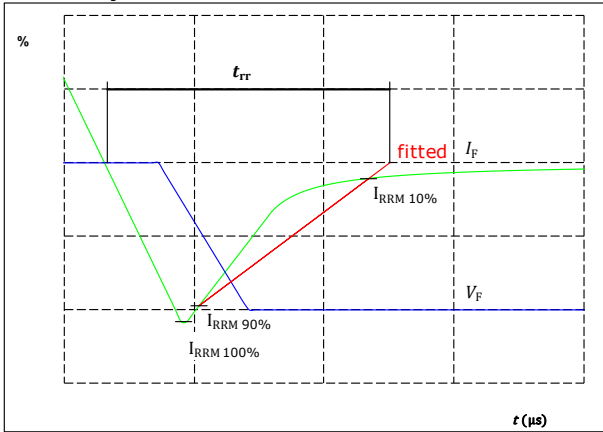
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_r =$	35	ns



Inverter Switching Characteristics

figure 5. FWD

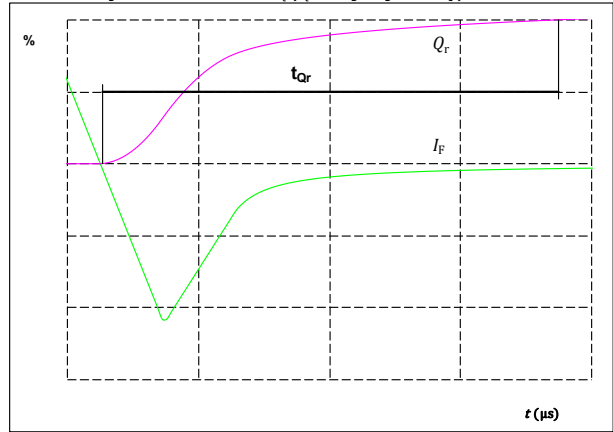
Turn-off Switching Waveforms & definition of t_{rr}



$V_F(100\%) =$	600	V
$I_F(100\%) =$	15	A
$I_{RRM}(100\%) =$	11	A
$t_{rr} =$	536	ns

figure 6. FWD

Turn-on Switching Waveforms & definition of t_{Qr} ($t_{Qr} =$ integrating time for Q_r)



$I_F(100\%) =$	15	A
$Q_r(100\%) =$	2,38	μC



Vincotech

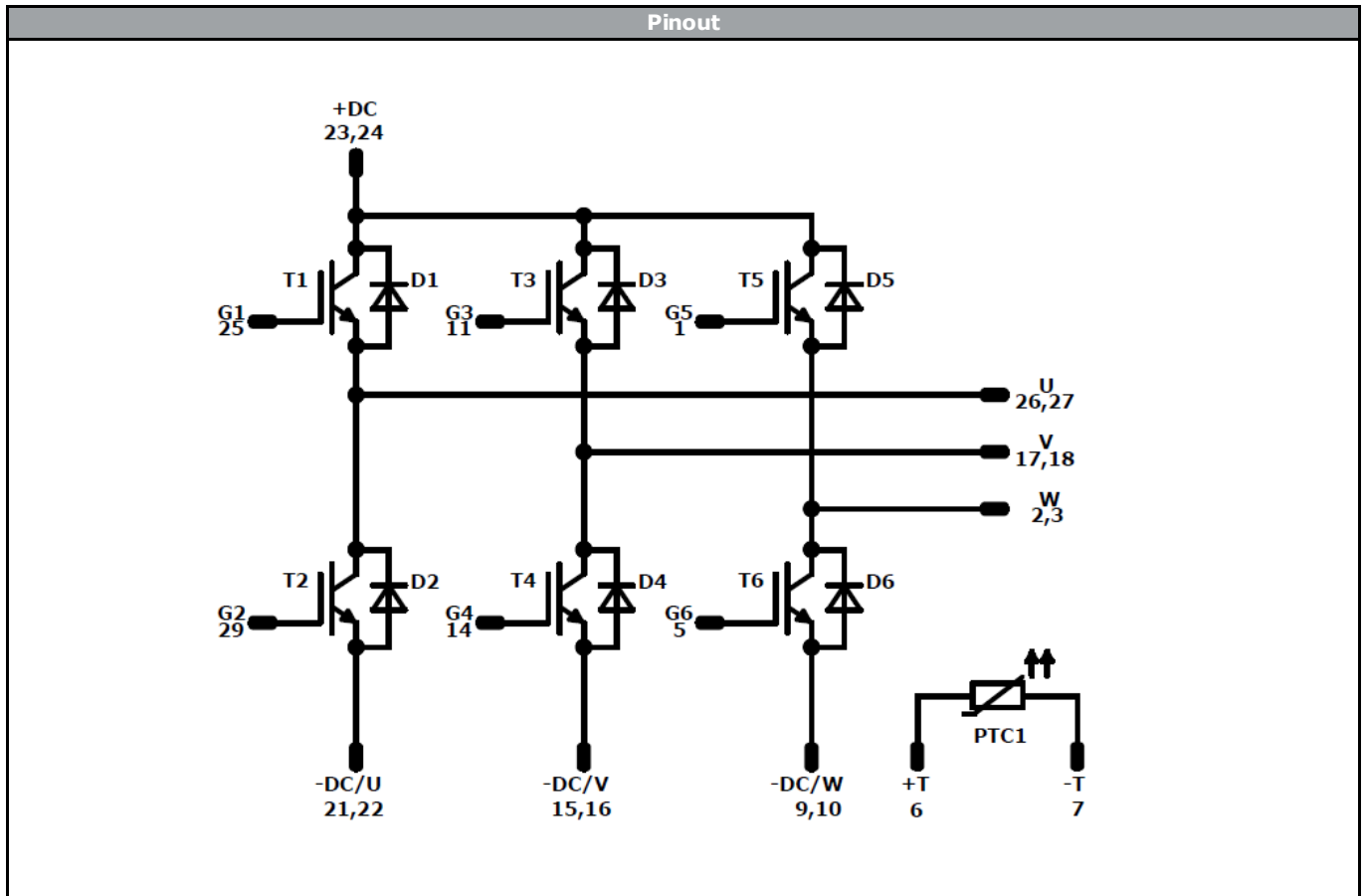
Ordering Code & Marking									
Version				Ordering Code					
With std lid (6.5mm height) + no thermal grease				V23990-K219-F40-/0A/-PM					
With thin lid (2.8mm height) + no thermal grease				V23990-K219-F40-/0B/-PM					
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K219-F40-/1A/-PM					
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K219-F40-/1B/-PM					
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K219-F40-/4A/-PM					
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K219-F40-/4B/-PM					
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K219-F40-/5A/-PM					
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K219-F40-/5B/-PM					
VIN WWYY NNNNNNVV LLLL 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		

PCB pad table			
Pin	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	15,93	-5	W
4	Not assembled		
5	15,93	7,62	G6
6	15,93	12,62	+T
7	15,93	15,8	-T
8	Not assembled		
9	8,23	12,62	-DC/W
10	8,23	15,8	-DC/W
11	7,73	-14,6	G3
12	Not assembled		
13	Not assembled		
14	0,53	9,45	G4
15	0,53	12,62	-DC/V
16	0,53	15,8	-DC/V
17	-0,47	-14,6	V
18	-0,47	-9,8	V
19	Not assembled		
20	Not assembled		
21	-7,17	12,62	-DC/U
22	-7,17	15,8	-DC/U
23	-8,07	-14,6	+DC
24	-8,07	-9,8	+DC
25	-15,02	-15,8	G1
26	-15,02	-9,8	U
27	-15,02	0	U
28	Not assembled		
29	-15,02	15,8	G2

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



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Identification					
ID	Component	Voltage	Current	Function	Comment
T2, T1, T4, T3, T6, T5	IGBT	1200 V	20 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	15 A	Inverter Diode	
PTC1	PTC			Thermistor	




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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-K219-F40-D3-14	13 Sep. 2018	HPTP introduced	all

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