Vincotech

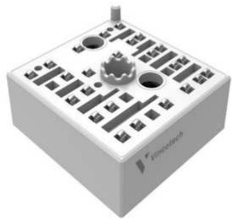
V23990-K209-A40
datasheet

MiniSKiiP® PIM 1 | **1200 V / 8 A**

Features

- Solderless interconnection
- Trench Filedstop IGBT4 technology

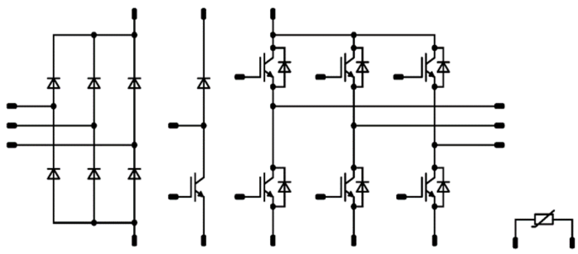
MiniSkiip® 1 housing



Target applications

- Industrial Motor Drives

Schematic



Types

- V23990-K209-A40

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Peak repetitive reverse voltage	V_{RRM}		1600	V
Continuous (direct) forward current	I_F		25	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms, T_j = 150 °C	200	A
Surge current capability	I^2t		200	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$, T_s = 80 °C	51	W
Maximum junction temperature	T_{jmax}		150	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter / Brake Switch					
Collector-emitter voltage	V_{CES}			1200	V
Collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	8	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		24	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	65	W
Gate-emitter voltage	V_{GES}			±20	V
Short circuit ratings	t_{SC}	T_j ≤ 150 °C V_{GE} = 15 V	V_{CE} = 800 V	10	μs
Maximum junction temperature	T_{jmax}			175	°C
Inverter / Brake Diode					
Peak repetitive reverse voltage	V_{RRM}			1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	8	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms	T_j = 150 °C	36	A
Surge current capability	I^2t	50 Hz Single Half Sine Wave t_p = 10 ms	T_j = 150 °C	6	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	53	W
Maximum junction temperature	T_{jmax}			175	°C

Module Properties

Thermal Properties

Parameter	Symbol	Condition		Value	Unit
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{jop}			-40…(T_{jmax} - 25)	°C

Isolation Properties

Parameter	Symbol	Condition		Value	Unit
Isolation voltage	V_{isol}	DC Test Voltage*	t_p = 2 s	5500	V
		AC Voltage	t_p = 1 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	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	Unit

Rectifier Diode

Static

Parameter	Symbol	Conditions	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	Unit
Forward voltage	V_F				25	25 125		1,22 1,21		V
Reverse leakage current	I_R			1600		25			50	µA

Thermal

Parameter	Symbol	Conditions	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	Unit
Thermal resistance junction to sink	$R_{th(j\text{-}s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,37		K/W

Inverter / Brake Switch

Static

Parameter	Symbol	Conditions	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	Unit
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00015	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CEsat}		15		8	25 150	1,58	2,01 2,38	2,07	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			1	µA
Gate-emitter leakage current	I_{GES}		20	0		25			120	nA
Internal gate resistance	r_g							none		Ω
Input capacitance	C_{ies}	f = 1 Mhz	0	25		25		490		pF
Reverse transfer capacitance	C_{res}							30		

Thermal

Parameter	Symbol	Conditions	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	Unit
Thermal resistance junction to sink	$R_{th(j\text{-}s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,45		K/W

Dynamic

Parameter	Symbol	Conditions	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	Unit
Turn-on delay time	$t_{d(on)}$	R_{gon} = 32 Ω R_{goff} = 32 Ω	±15	600	8	25 150		67 67		ns
Rise time	t_r					25 150		25 28		
Turn-off delay time	$t_{d(off)}$					25 150		188 253		
Fall time	t_f					25 150		84 128		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 6 µC Q_{rFWD} = 14,6 µC				25 150		0,438 0,709		mWs
Turn-off energy (per pulse)	E_{off}					25 150		0,471 0,760		

Characteristic Values

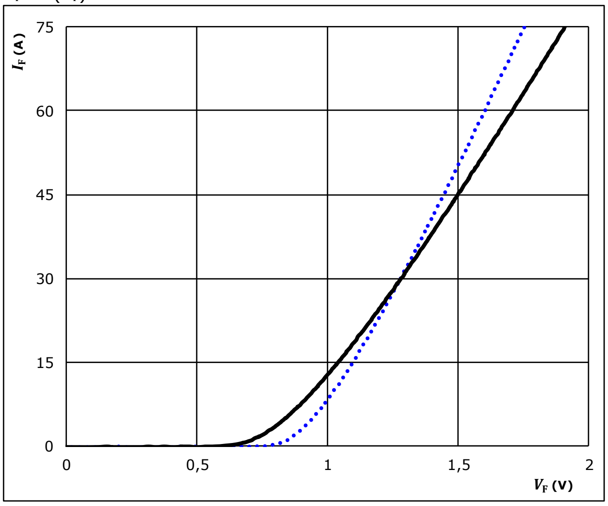
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
Inverter / Brake Diode										
Static										
Forward voltage	V_F				8	25 150		2,37 2,27	2,65	V
Reverse leakage current	I_R			1200		25 150			60 700	μA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,78		K/W
Dynamic										
Peak recovery current	I_{RRM}					25 150		6 8		A
Reverse recovery time	t_{rr}					25 150		2591 5196		ns
Recovered charge	Q_r	di/dt = 322 A/μs di/dt = 247 A/μs	±15	600	8	25 150		6,01 14,6		μC
Reverse recovered energy	E_{rec}					25 150		0,242 0,627		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		8 6		A/μs
Thermistor										
Rated resistance	R					25		1		kΩ
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/K²
Vincotech PTC Reference									E	

Rectifier Diode Characteristics

figure 1. **Rectifier Diode**

Typical forward characteristics

$I_F = f(V_F)$



t_p = 250 µs

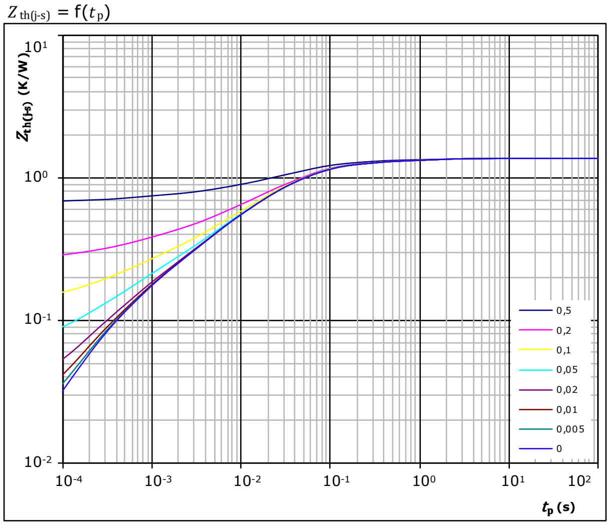
T_j: 25 °C ············

125 °C ———

figure 2. **Rectifier Diode**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

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

Diode thermal model values

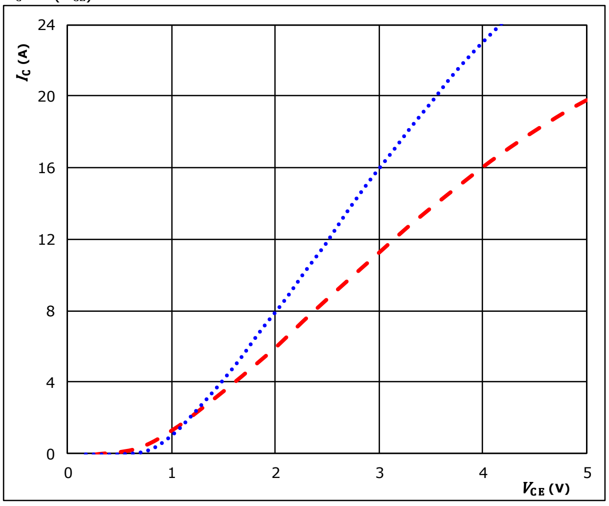
R (K/W)	τ (s)
6,75E-02	1,27E+00
1,34E-01	1,97E-01
6,34E-01	3,60E-02
3,25E-01	8,05E-03
1,24E-01	1,73E-03
8,71E-02	2,91E-04

Inverter / Brake Switch Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

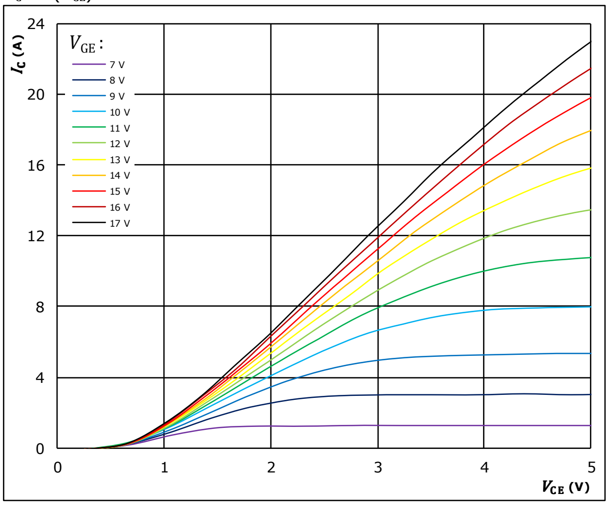


t_p =	250	μs	T_j:	25 °C	·········
V_{GE} =	15	V		150 °C	– – –

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

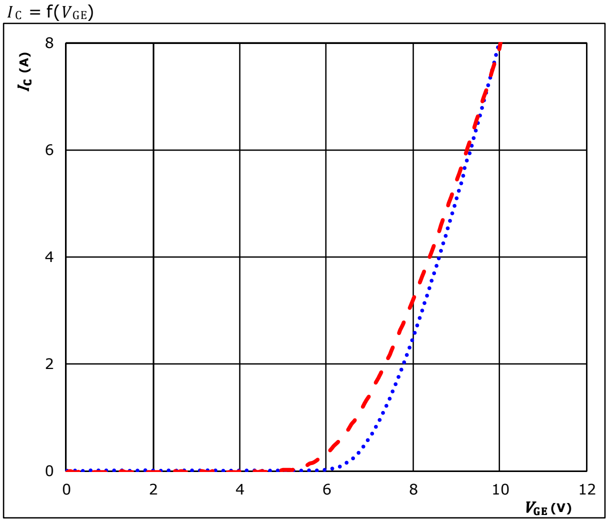


t_p =	250	μs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

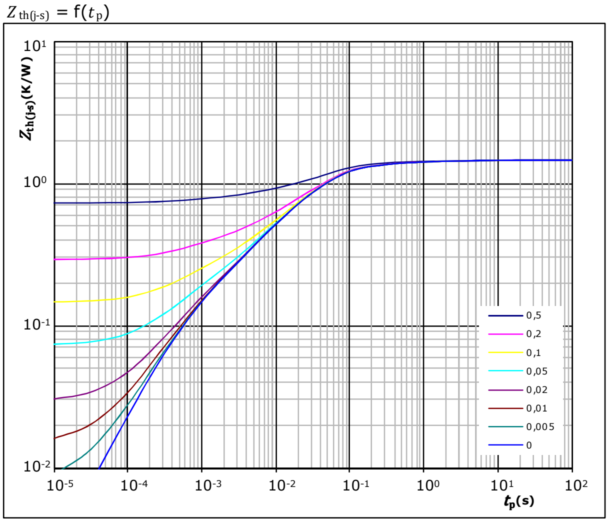


t_p =	100	μs	T_j:	25 °C	·········
V_{CE} =	10	V		150 °C	– – –

figure 4. **IGBT**

Transient thermal impedance as function of pulse duration

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



D = t_p / T

$R_{th(j\text{-}s)}$ = 1,45 K/W

IGBT thermal model values

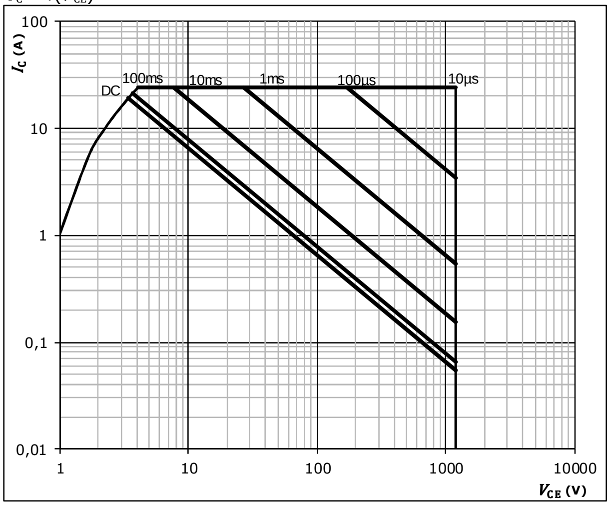
R (K/W)	τ (s)
5,13E-02	2,32E+00
1,26E-01	3,06E-01
7,11E-01	4,24E-02
3,14E-01	1,45E-02
1,65E-01	3,09E-03
8,72E-02	4,41E-04

Inverter / Brake Switch Characteristics

figure 5. **IGBT**

Safe operating area

$I_C = f(V_{CE})$



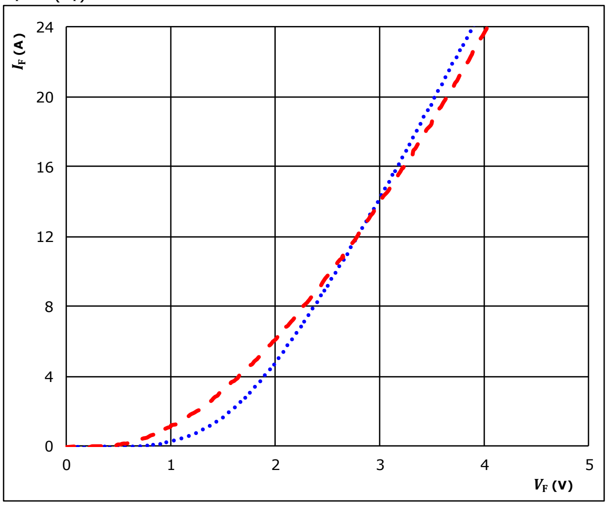
D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

Inverter / Brake Diode Characteristics

figure 1. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



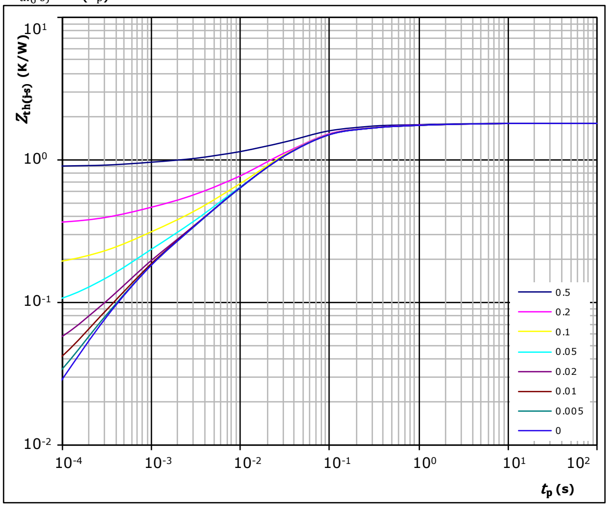
t_p = 250 µs

T_j: 25 °C
150 °C

figure 2. **FWD**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j\text{-}s)}$ = 1,78 K/W

FWD thermal model values

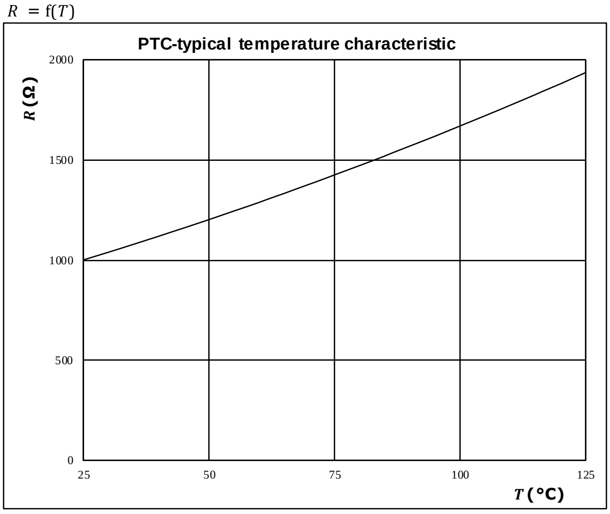
R (K/W)	τ (s)
6,27E-02	2,84E+00
1,54E-01	3,74E-01
8,68E-01	5,18E-02
3,84E-01	1,77E-02
2,02E-01	3,77E-03
1,07E-01	5,39E-04

Thermistor Characteristics

figure 1. **Thermistor**

Typical PTC characteristic as a function of temperature

$R = f(T)$



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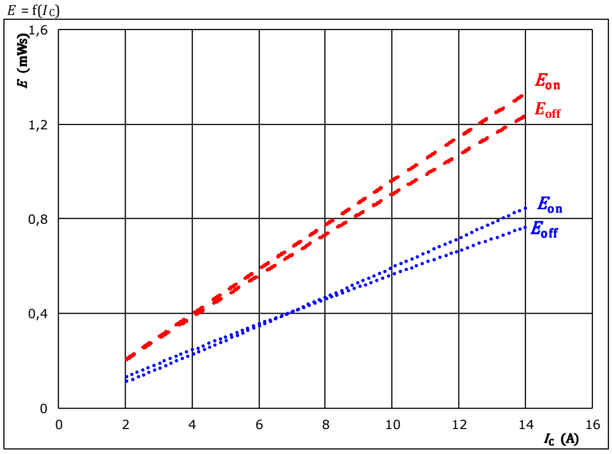
Inverter / Brake Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



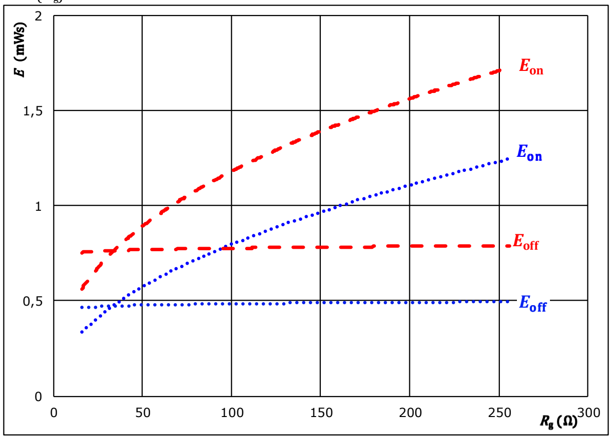
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
R_{gon} =	32	Ω			
R_{goff} =	32	Ω			

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



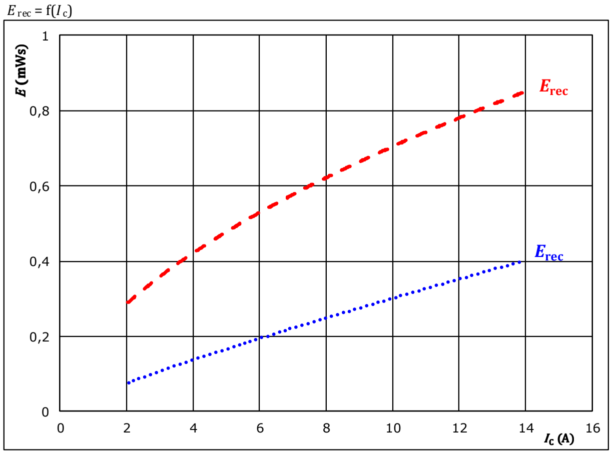
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
I_C =	8	A			

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_c)$



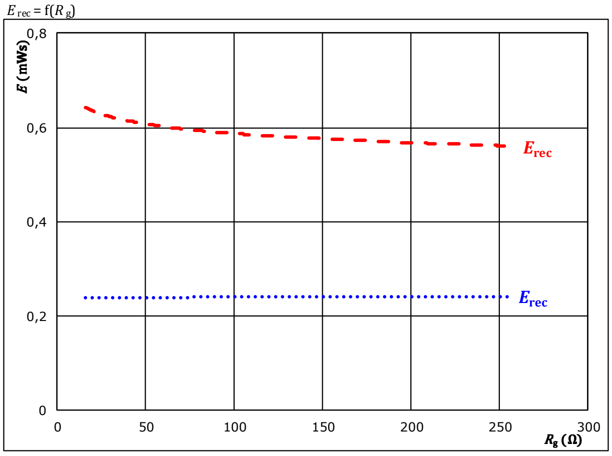
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
R_{gon} =	32	Ω			

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

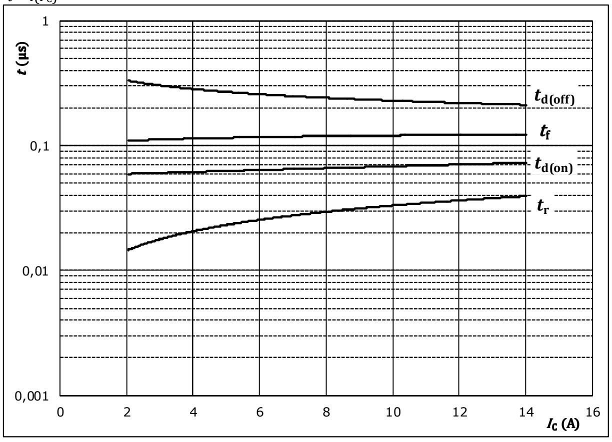
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
I_C =	8	A			

Inverter / Brake Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



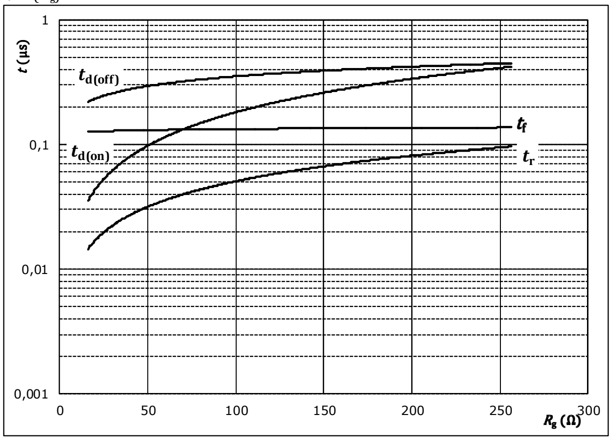
With an inductive load at

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

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



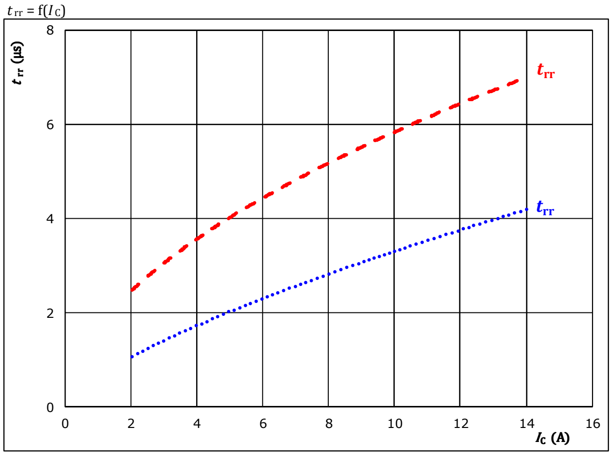
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	8	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

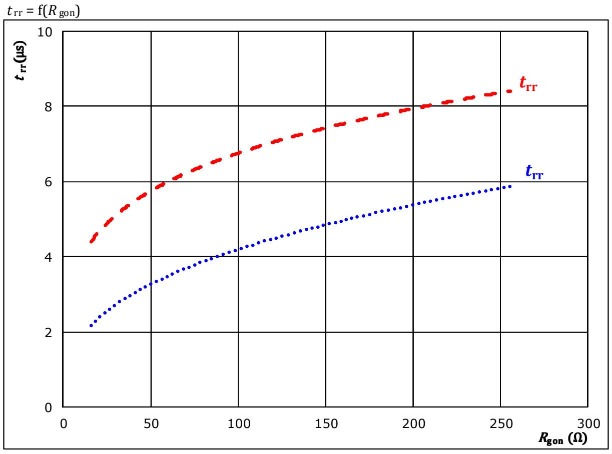


At						
V_{CE} =	600	V	T_j:	25	°C	···········
V_{GE} =	±15	V		150	°C	– – – –
R_{gon} =	32	Ω				

figure 8. **FWD**

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

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



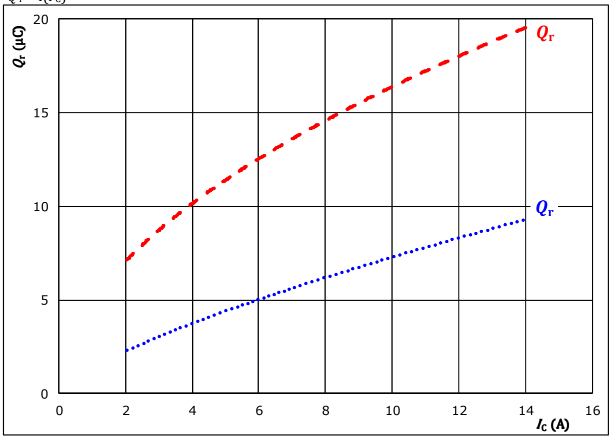
At						
V_{CE} =	600	V	T_j:	25	°C	···········
V_{GE} =	±15	V		150	°C	– – – –
I_C =	8	A				

Inverter / Brake Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

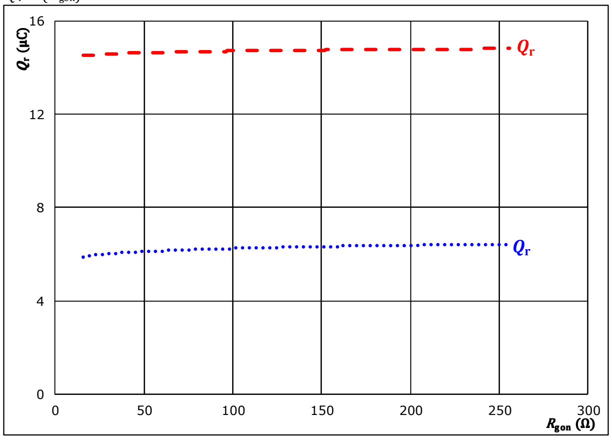


At				
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		150 °C
R_{gon} =	32	Ω		

figure 10. FWD

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

$Q_r = f(R_{gon})$

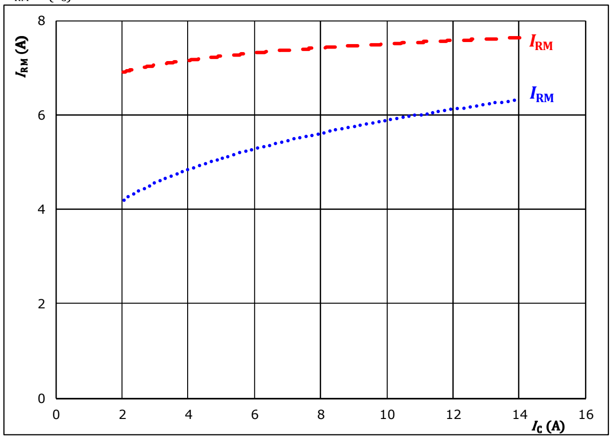


At				
V_{CE}=	600	V	T_j:	25 °C
V_{GE} =	±15	V		150 °C
I_C=	8	A		

figure 11. FWD

Typical peak reverse recovery current current as a function of collector current

$I_{RM} = f(I_C)$

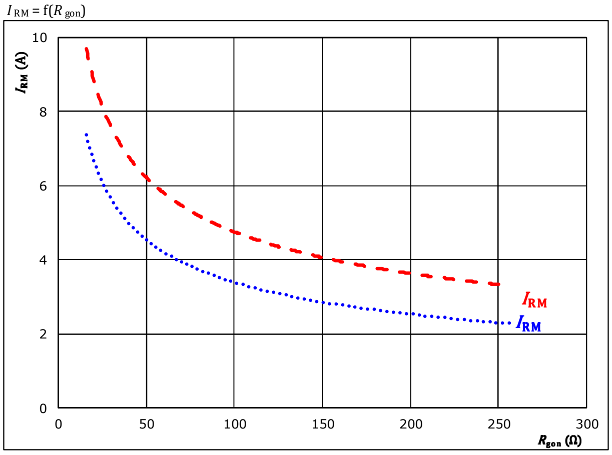


At				
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		150 °C
R_{gon} =	32	Ω		

figure 12. FWD

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

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



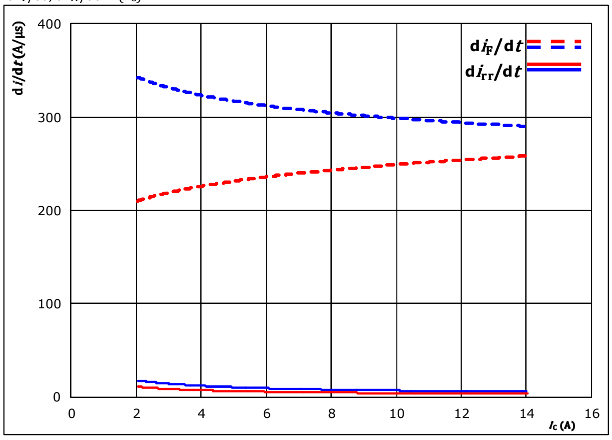
At				
V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		150 °C
I_C =	8	A		

Inverter / Brake Switching Characteristics

figure 13. **FWD**

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

di_F/dt, $di_{rr}/dt = f(I_C)$

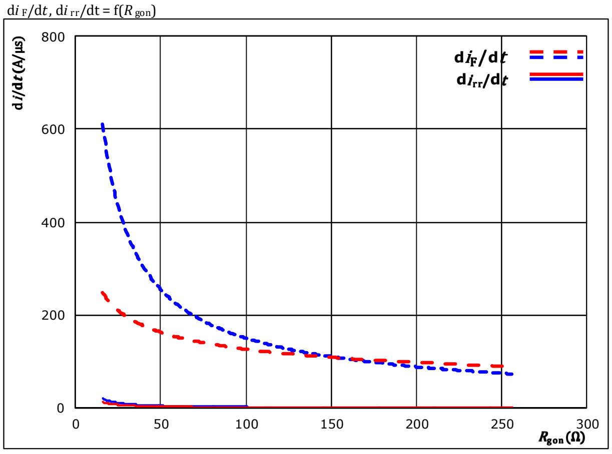


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
R_{gon} =	32	Ω		150	°C

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, $di_{rr}/dt = f(R_{gon})$

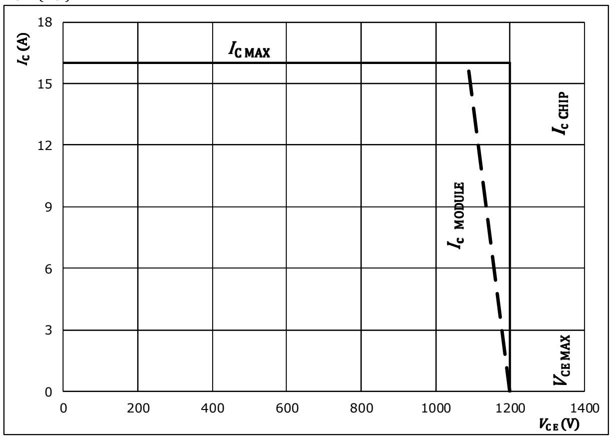


At					
V_{CE} =	600	V		25	°C
V_{GE} =	±15	V	T_j:	125	°C
I_C =	8	A		150	°C

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At		
T_j =	175	°C
R_{gon} =	32	Ω
R_{goff} =	32	Ω

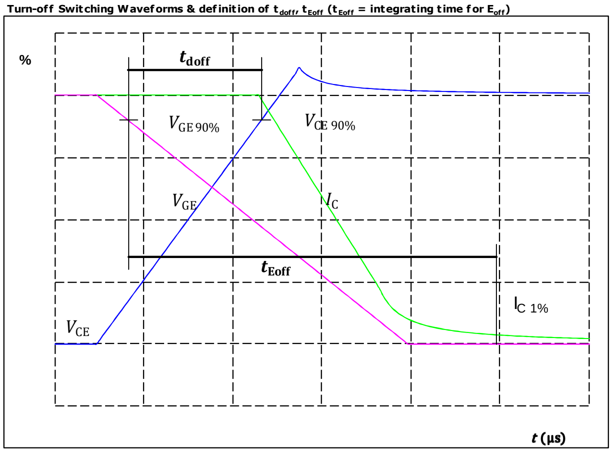
Inverter / Brake Switching Definitions

General conditions

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

figure 1. **IGBT**

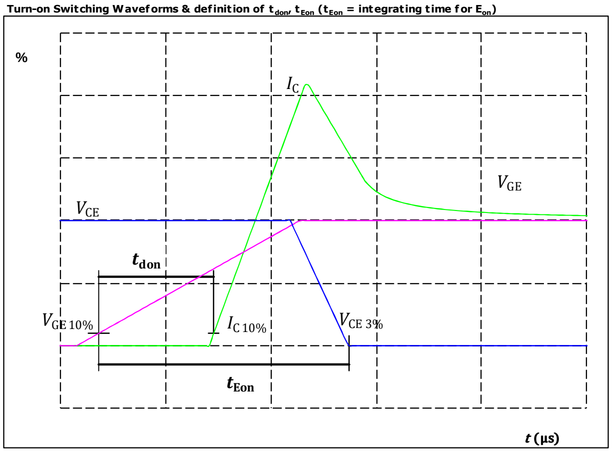
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	8	A
t_{doff} =	253	ns

figure 2. **IGBT**

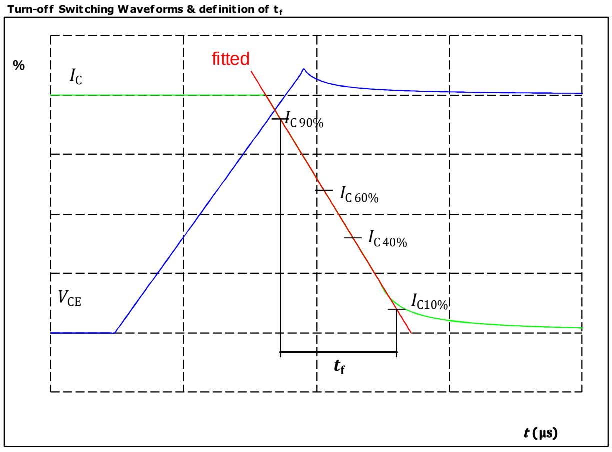
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	8	A
t_{don} =	67	ns

figure 3. **IGBT**

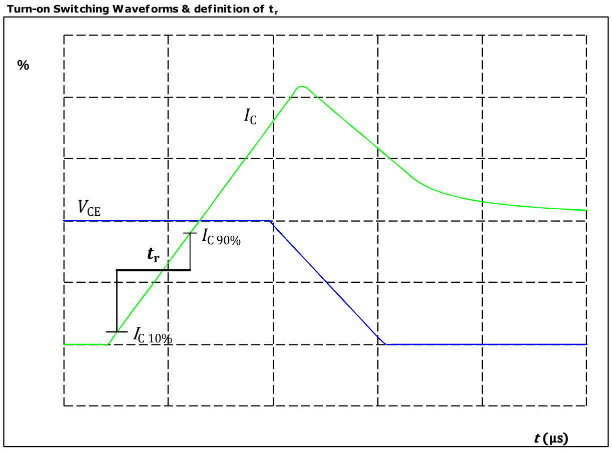
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	8	A
t_f =	128	ns

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

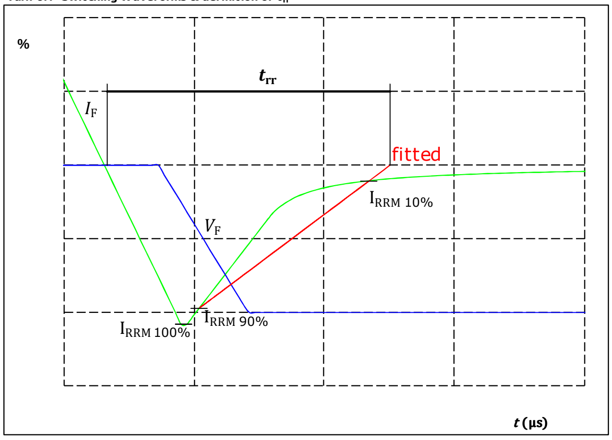


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	8	A
t_r =	28	ns

Inverter / Brake Switching Characteristics

figure 5. **FWD**

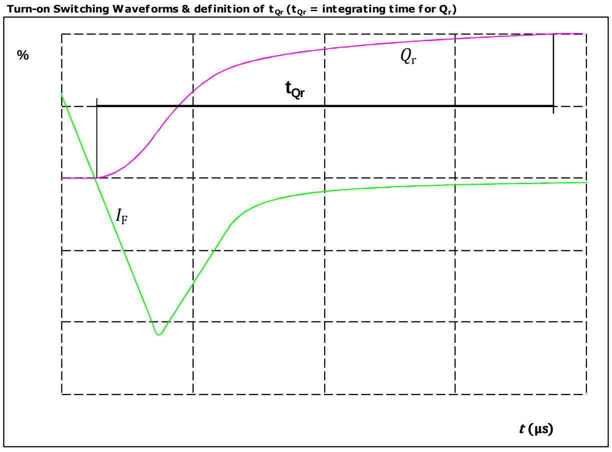
Turn-off Switching Waveforms & definition of t_{rr}



V_F (100%) =	600	V
I_F (100%) =	8	A
I_{RRM} (100%) =	8	A
t_{rr} =	5196	ns

figure 6. **FWD**

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



I_F (100%) =	8	A
Q_r (100%) =	14,55	µC

Ordering Code & Marking

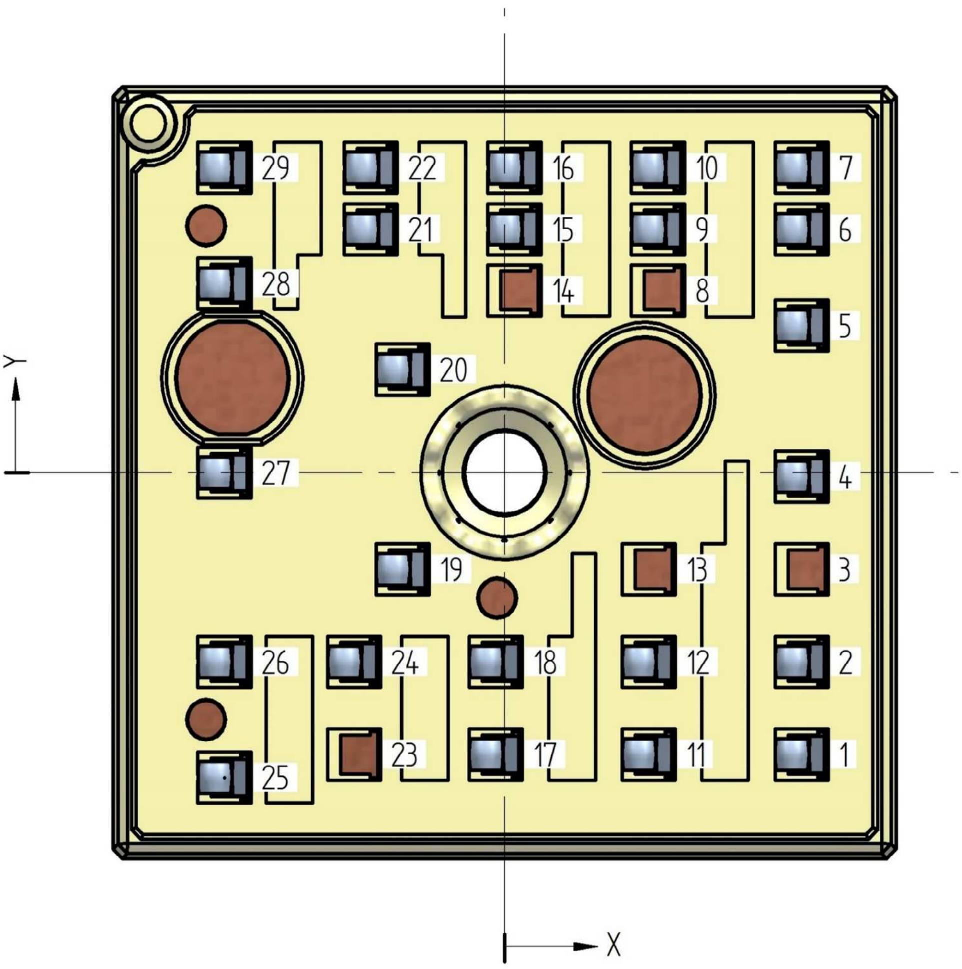
Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K209-A40-/0A/
With thin lid (2.8mm height) + no thermal grease	V23990-K209-A40-/0B/
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K209-A40-/1A/
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K209-A40-/1B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K209-A40-/4A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K209-A40-/4B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K209-A40-/5A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K209-A40-/5B/

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

Outline

PCB pad table

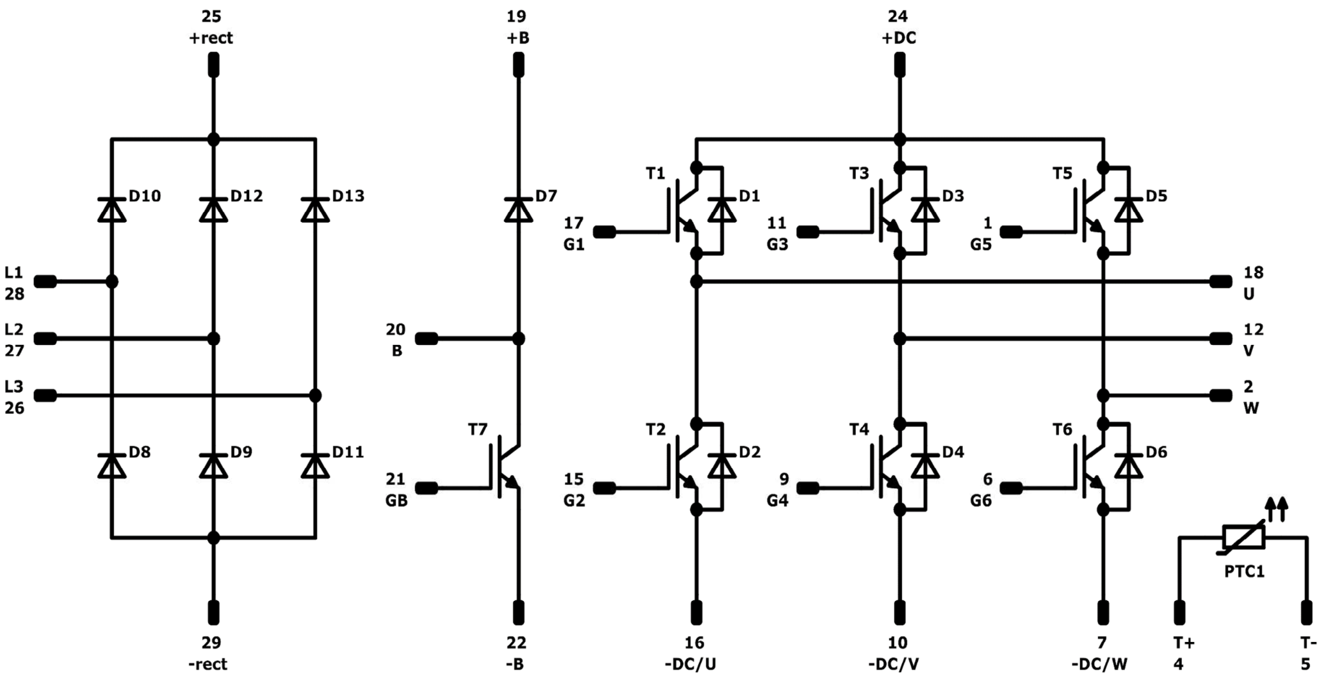
Pin	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	Not assembled		
4	15,93	-0,2	+T
5	15,93	7,62	-T
6	15,93	12,62	G6
7	15,93	15,8	-DC/W
8	Not assembled		
9	8,23	12,62	G4
10	8,23	15,8	-DC/V
11	7,73	-14,6	G3
12	7,73	-9,8	V
13	Not assembled		
14			
15	0,53	12,62	G2
16	0,53	15,8	-DC/U
17	-0,47	-14,6	G1
18	-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

Vincotech

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
D8, D10, D9, D11, D12, D13	Rectifier	1600 V	25 A	Rectifier Diode	
T2, T1, T4, T3, T6, T5	IGBT	1200 V	8 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	8 A	Inverter Diode	
T7	IGBT	1200 V	8 A	Brake Switch	
D7	FWD	1200 V	8 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-K209-A40-D7-14	27 Feb. 2018	Update with HPTP	All