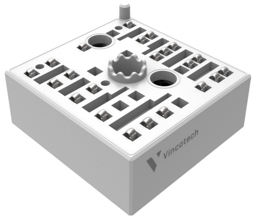
V23990-K210-F40-PM
datasheet

MiniSKiiP PACK 1	1200 V / 25 A

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology

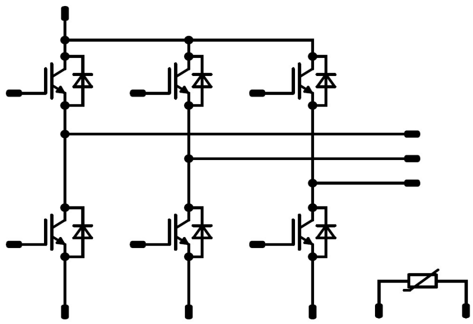
MiniSkiip 1 housing



Target applications

- Servo Drives
- Industrial Motor Drives
- UPS

Schematic



Types

- V23990-K210-F40-PM

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	34	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	75	A
Turn off safe operating area		V_{CE} ≤ 1200 V, $T_j \leq T_{opmax}$	50	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	113	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC}	V_{GE} = 15 V V_{cc} = 800 V T_j = 150 °C	10	µs
Maximum junction temperature	T_{jmax}		175	°C

Maximum Ratings

T_j = 25 °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	$T_j = T_{jmax}$	T_s = 80 °C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		75	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	81	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

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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 Switch										
Static										
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00085	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		25	25 150	1,6	2,09 2,52	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		1430		pF
Output capacitance	C_{oes}							115		
Reverse transfer capacitance	C_{res}							85		
Gate charge	Q_g		-15/15			25		200		nC
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,84		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 16 Ω R_{goff} = 16 Ω	±15	600	25	25 150		71 72		ns
Rise time	t_r					25 150		32 36		
Turn-off delay time	$t_{d(off)}$					25 150		199 270		
Fall time	t_f					25 150		90 135		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,5 µC Q_{rFWD} = 3,9 µC				25 150		1,61 2,46		mWs
Turn-off energy (per pulse)	E_{off}					25 150		1,53 2,5		

Characteristic Values

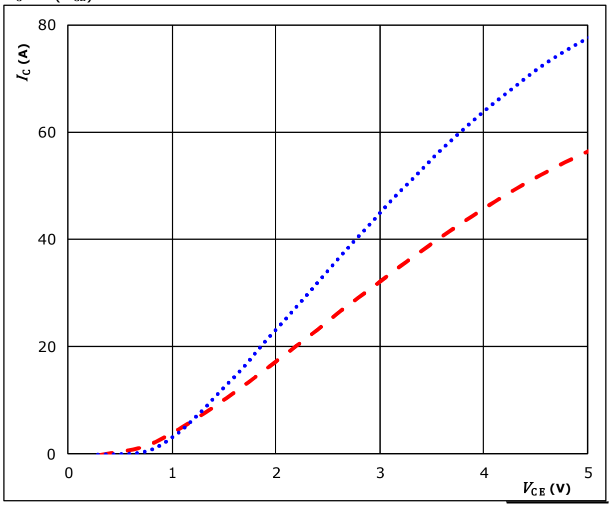
Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_{F} [V]	I_{C} [A] I_{D} [A] I_{F} [A]	T_j [°C]	Min	Typ	Max	Unit
Inverter Diode										
Static										
Forward voltage	V_F				25	25 150	1,3	2,64 2,64	2,8	V
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,17		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 690 A/µs di/dt = 578 A/µs	±15	600	25	25 150		11,9 17,4		A
Reverse recovery time	t_{rr}					25 150		277 580		ns
Recovered charge	Q_r					25 150		1,55 3,88		µC
Reverse recovered energy	E_{rec}					25 150		0,61 1,63		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		111 89		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	

Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

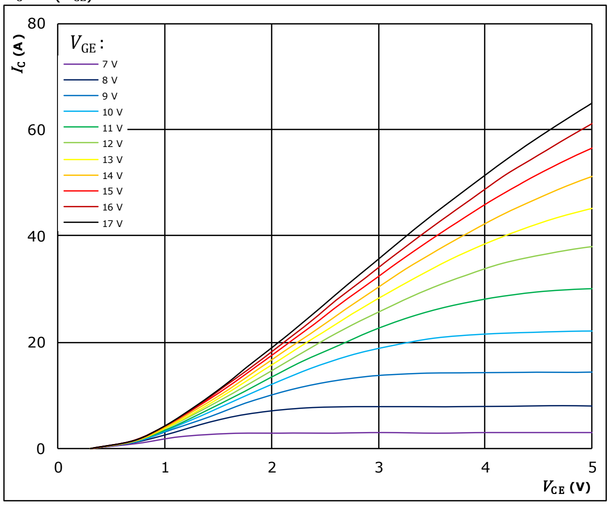


t_p =	250	µs	T_j:	25 °C	··········
V_{GE} =	15	V		150 °C	– – –

figure 2. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

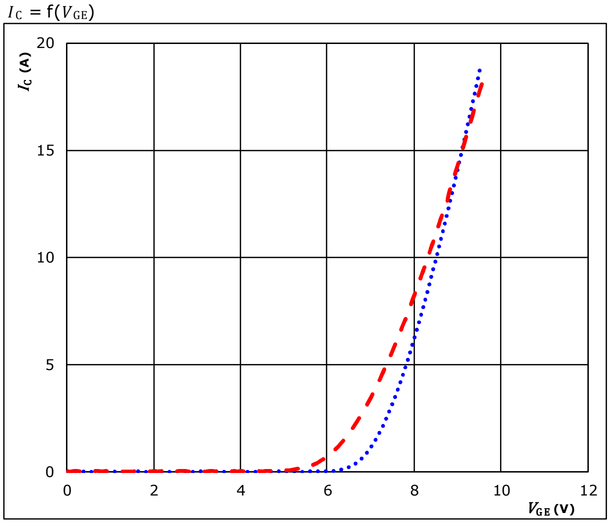


t_p =	250	µs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

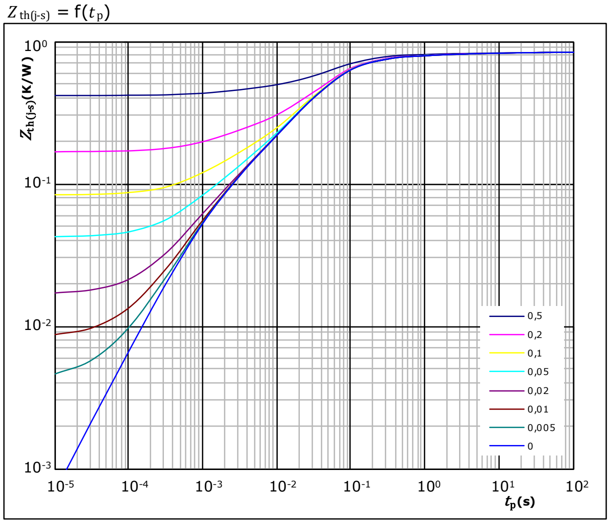


t_p =	100	µs	T_j:	25 °C	··········
V_{CE} =	10	V		150 °C	– – –

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



D = t_p / T

$R_{th(j-s)}$ = 0,84 K/W

IGBT thermal model values

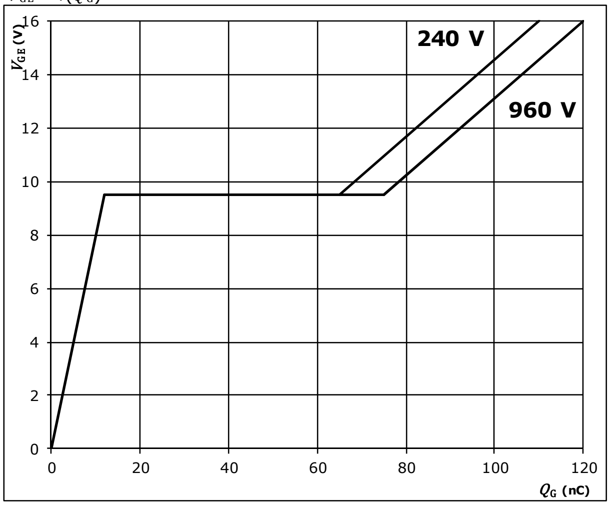
R (K/W)	τ (s)
3,13E-02	6,26E+00
5,86E-02	5,33E-01
1,55E-01	9,52E-02
4,50E-01	3,18E-02
8,39E-02	6,19E-03
5,63E-02	9,50E-04
3,88E-03	4,59E-04

Inverter Switch Characteristics

figure 5. **IGBT**

Gate voltage vs gate charge

$V_{GE} = f(Q_G)$

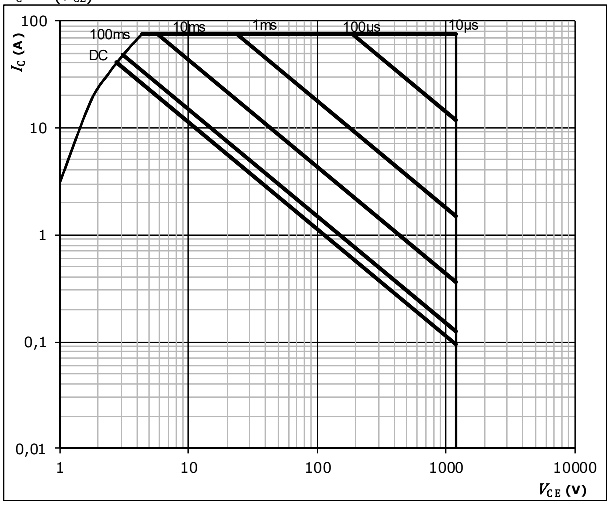


I_C = 25 A

figure 6. **IGBT**

Safe operating area

$I_C = f(V_{CE})$



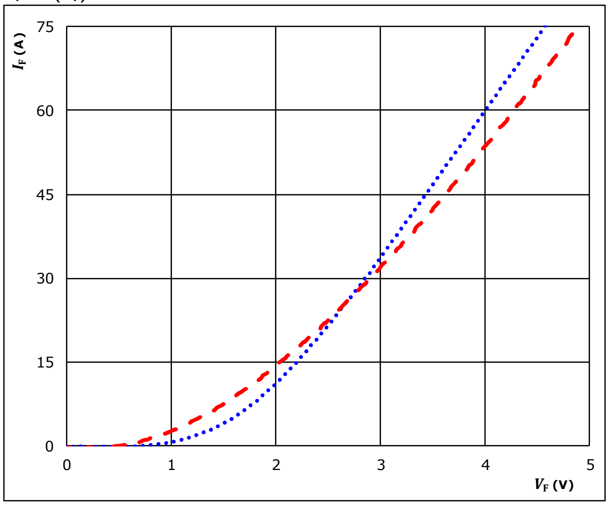
D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

Inverter Diode Characteristics

figure 1.	**FWD**

Typical forward characteristics

$I_F = f(V_F)$



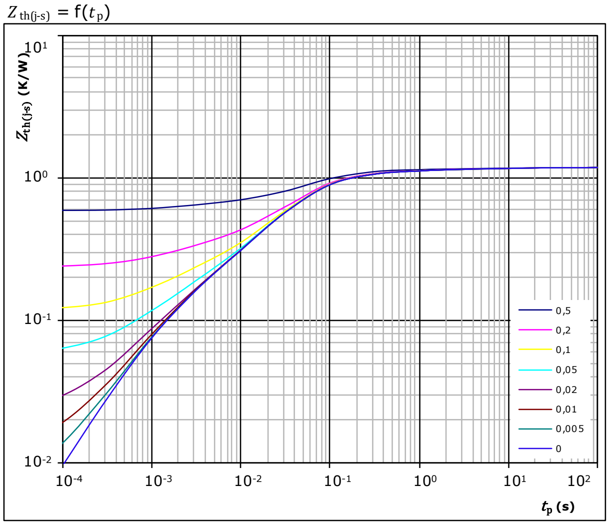
t_p = 250 µs

T_j: 25 °C (dotted), 150 °C (dashed)

figure 2.	**FWD**

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)}$ = 1,17 K/W

FWD thermal model values

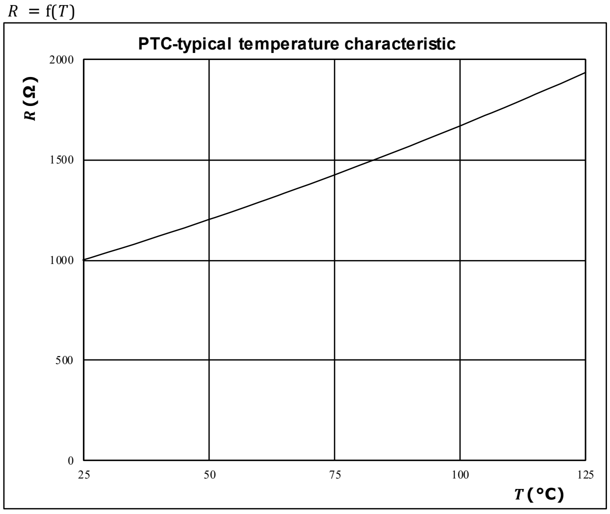
R (K/W)	τ (s)
4,37E-02	8,75E+00
8,19E-02	7,45E-01
2,17E-01	1,33E-01
6,29E-01	4,45E-02
1,17E-01	8,65E-03
7,87E-02	1,33E-03
5,43E-03	6,41E-04

Thermistor Characteristics

figure 1.	**Thermistor**

Typical PTC characteristic as a function of temperature

$R = f(T)$

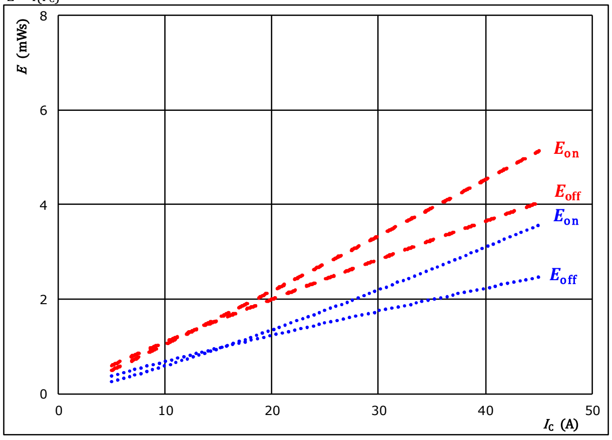


Inverter Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



With an inductive load at

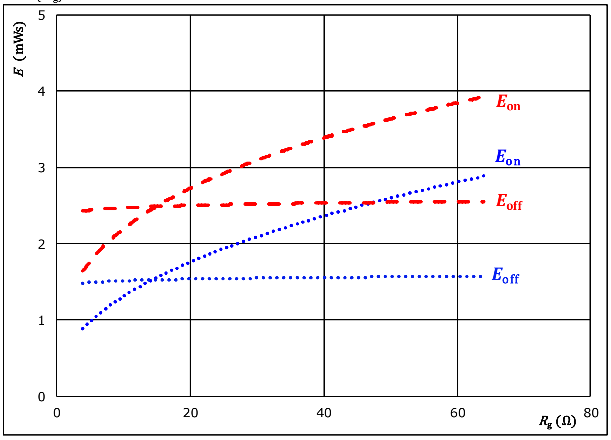
T_j: 25 °C (dotted), 150 °C (dashed)

V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



With an inductive load at

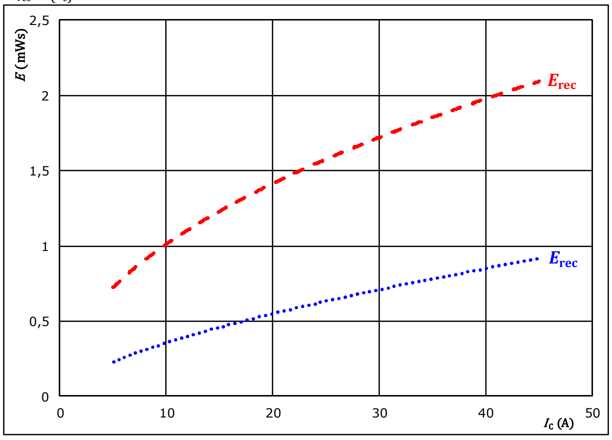
T_j: 25 °C (dotted), 150 °C (dashed)

V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	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

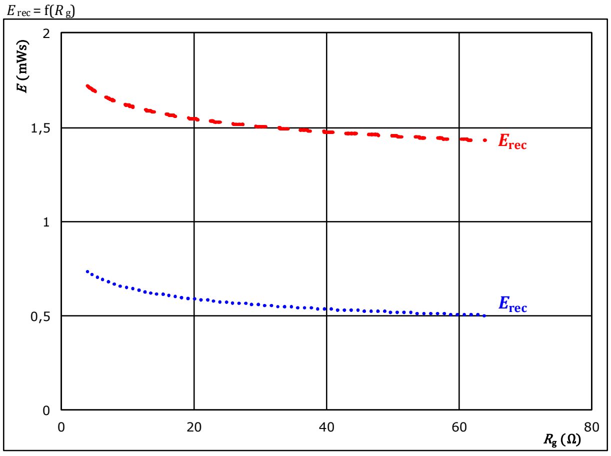
T_j: 25 °C (dotted), 150 °C (dashed)

V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	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

T_j: 25 °C (dotted), 150 °C (dashed)

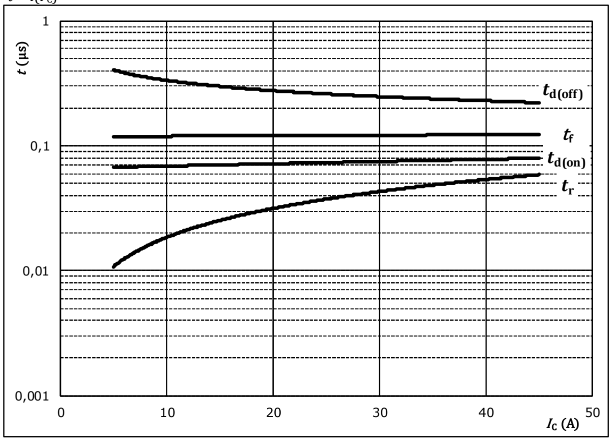
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	A

Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



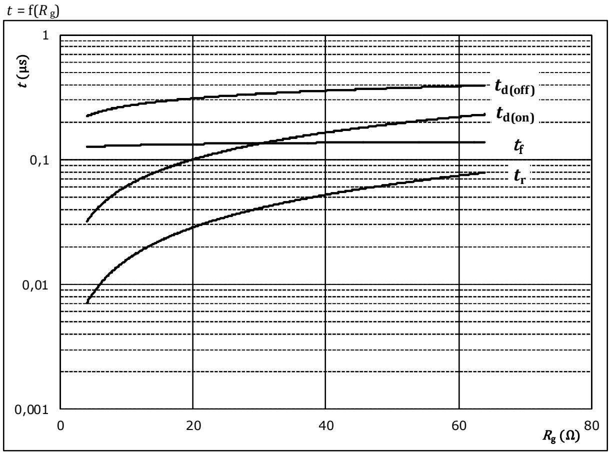
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$t = f(R_g)$



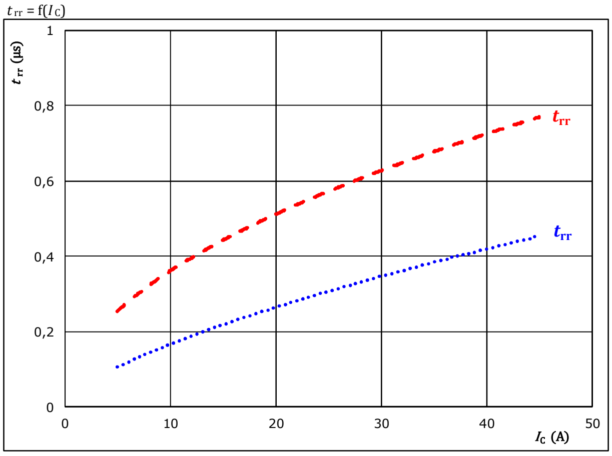
With an inductive load at

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

figure 7. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



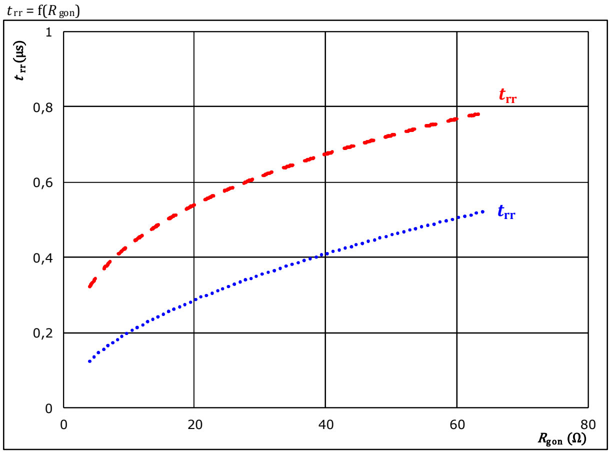
With an inductive load at

V_{CE}=	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
R_{gon} =	16	Ω			

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

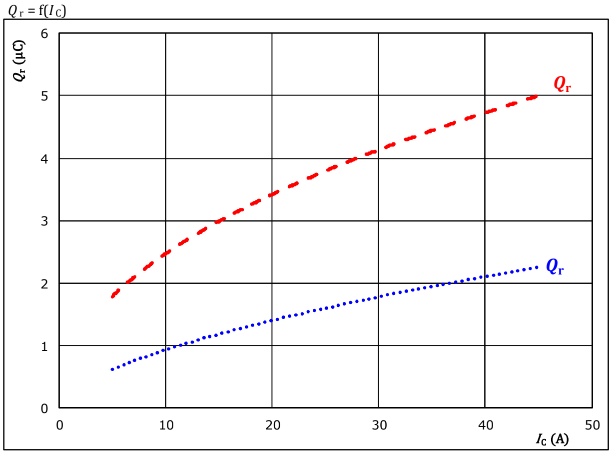
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
I_C =	25	A			

Inverter Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$



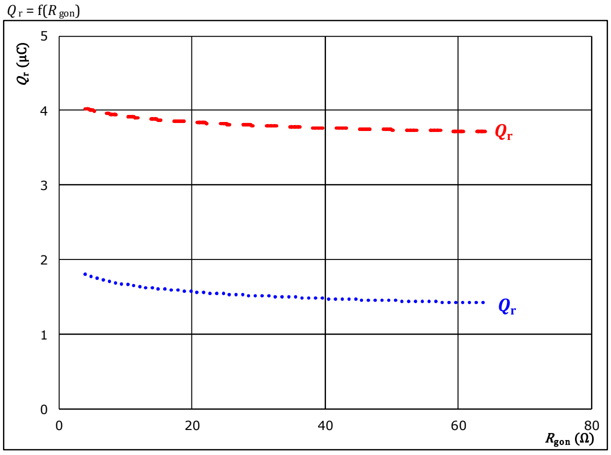
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
R_{gon} =	16	Ω			

figure 10. **FWD**

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

$Q_r = f(R_{gon})$



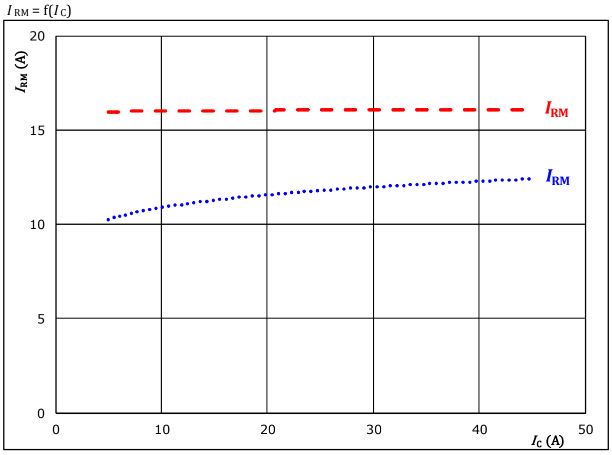
With an inductive load at

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

figure 11. **FWD**

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

$I_{RM} = f(I_C)$



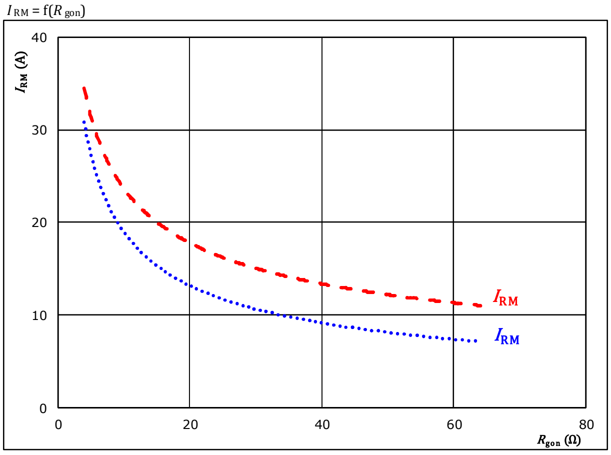
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
R_{gon} =	16	Ω			

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

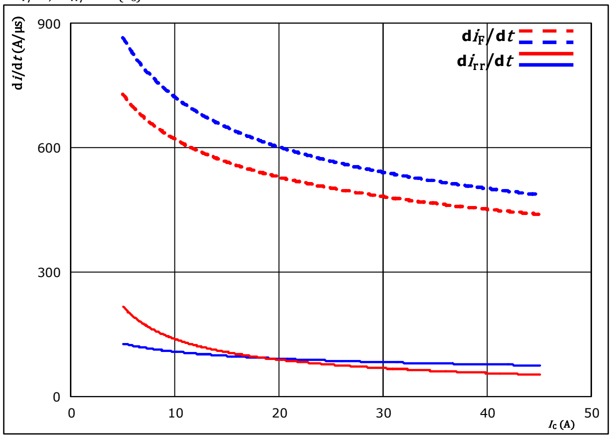
V_{CE} =	600	V	T_j:	25 °C	············
V_{GE} =	±15	V		150 °C	– – – –
I_C =	25	A			

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



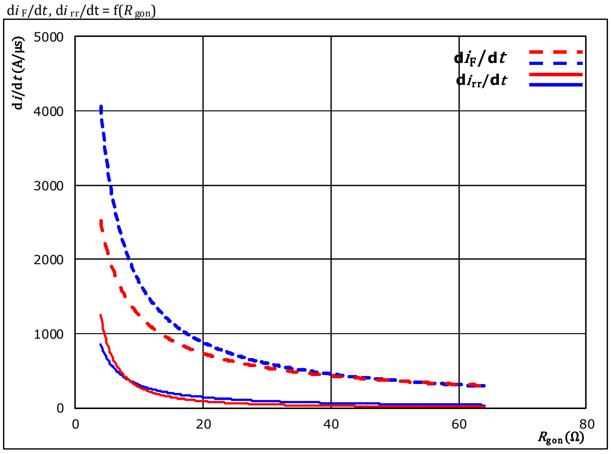
With an inductive load at

V_{CE} =	600	V	T_j:	25 °C
V_{GE} =	±15	V		150 °C
R_{gon} =	16	Ω		

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



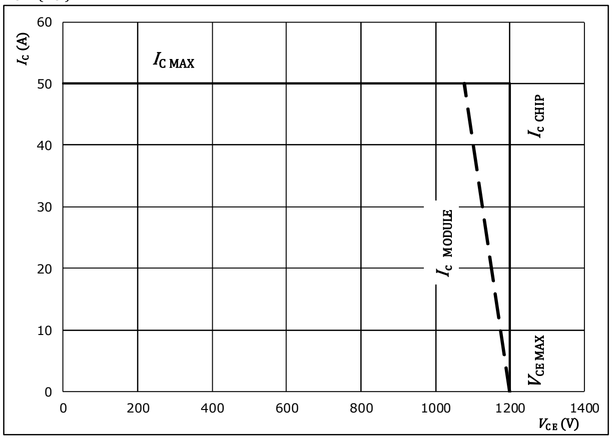
With an inductive load at

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

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

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

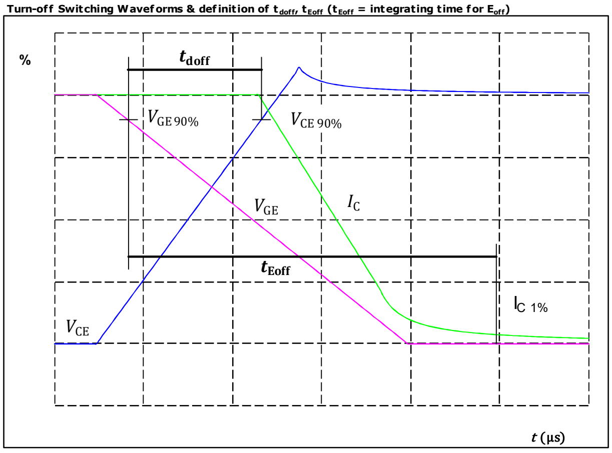
Inverter Switching Definitions

General conditions

T_j	=	**125 °C**
R_{gon}	=	**16 Ω**
R_{goff}	=	**16 Ω**

figure 1. **IGBT**

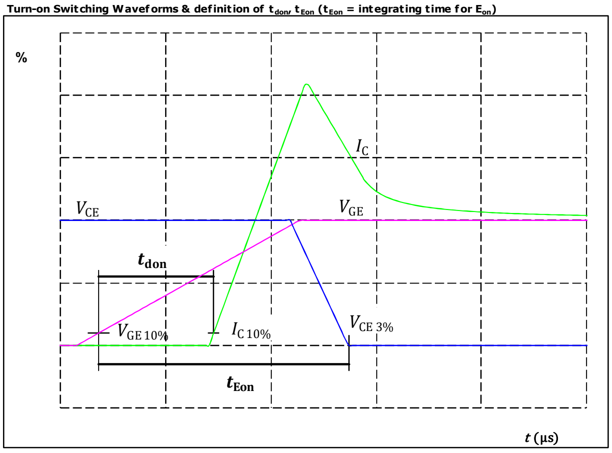
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_{doff} =	270	ns

figure 2. **IGBT**

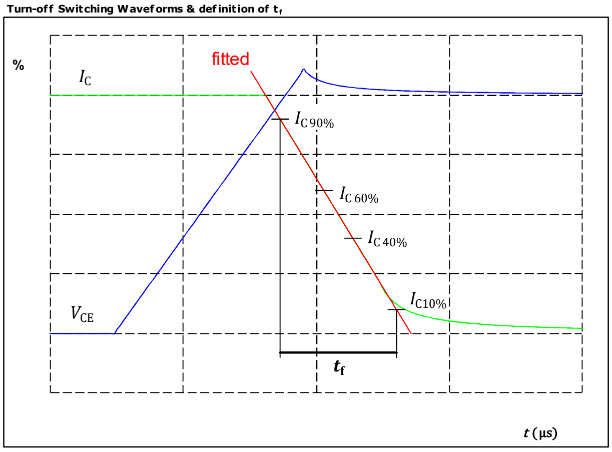
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_{don} =	72	ns

figure 3. **IGBT**

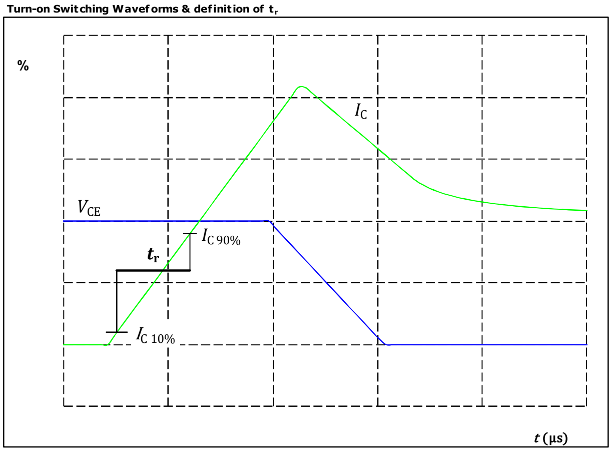
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_f =	135	ns

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

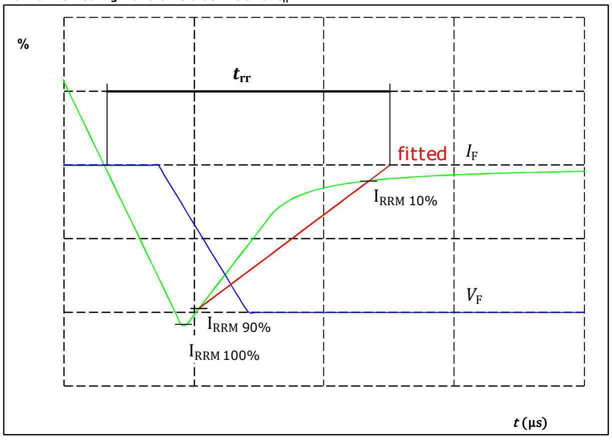


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_r =	36	ns

Inverter Switching Characteristics

figure 5. **FWD**

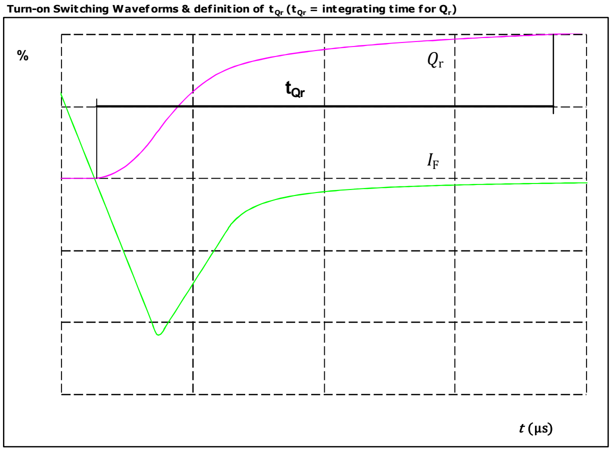
Turn-off Switching Waveforms & definition of t_{rr}



V_F (100%) =	600	V
I_F (100%) =	25	A
I_{RRM} (100%) =	17	A
t_{rr} =	580	ns

figure 6. **FWD**

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



I_F (100%) =	25	A
Q_r (100%) =	3,88	µC

Vincotech

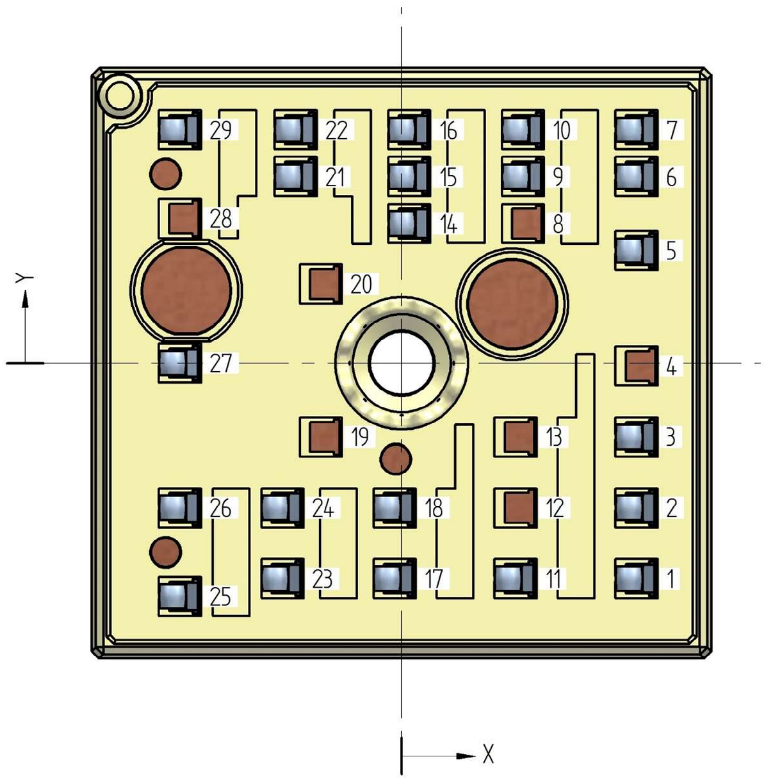
Ordering Code & Marking

Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K210-F40-/0A/-PM
With thin lid (2.8mm height) + no thermal grease	V23990-K210-F40-/0B/-PM
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K210-F40-/1A/-PM
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K210-F40-/1B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K210-F40-/4A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K210-F40-/4B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K210-F40-/5A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K210-F40-/5B/-PM

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

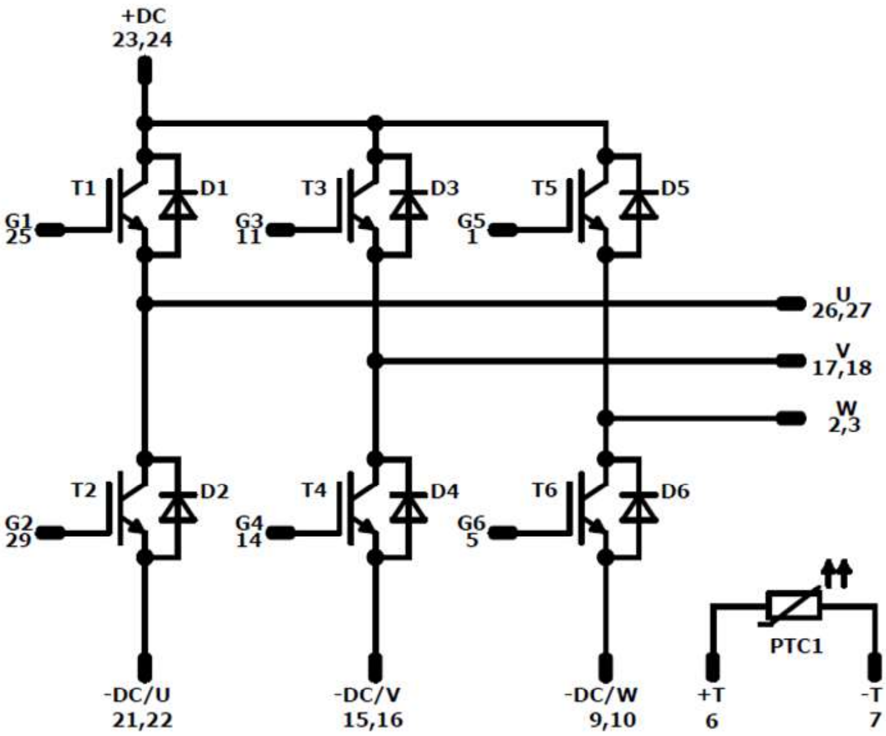
Outline

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

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T2, T1, T4, T3, T6, T5	IGBT	1200 V	25 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	25 A	Inverter 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-K210-F40-D4-14	20 Mar. 2019	Correction of I_c/I_f values	1,2