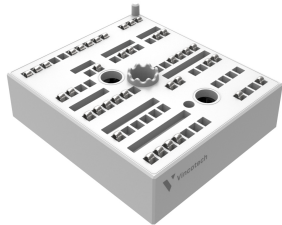
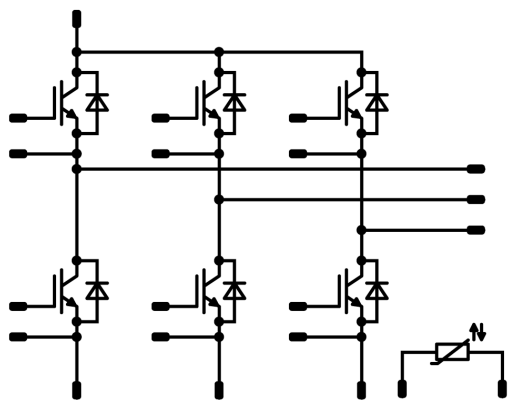




MiniSKiiP PACK 2	1200 V / 50 A
<p><b>Topology features</b></p> <ul style="list-style-type: none"><li>• Inverter</li><li>• Kelvin Emitter for improved switching performance</li><li>• Open Emitter configuration</li><li>• Temperature sensor</li></ul>	<p><b>MiniSKiiP® 2 16 mm housing</b></p> 
<p><b>Component features</b></p> <ul style="list-style-type: none"><li>• Easy paralleling</li><li>• Low turn-off losses</li><li>• Low collector emitter saturation voltage</li><li>• Positive temperature coefficient</li><li>• Short tail current</li></ul>	
<p><b>Housing features</b></p> <ul style="list-style-type: none"><li>• Base isolation: Al<sub>2</sub>O<sub>3</sub></li><li>• Easy assembly in one mounting step</li><li>• Flexible PCB design w/o pin holes</li><li>• Rugged solderless spring contacts</li></ul>	
<p><b>Target applications</b></p> <ul style="list-style-type: none"><li>• Embedded Drives</li><li>• Industrial Drives</li></ul>	
<p><b>Types</b></p> <ul style="list-style-type: none"><li>• V23990-K359-F40</li></ul>	
	<p><b>Schematic</b></p> 



## Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	60	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	150	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	163	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	$\mu\text{s}$
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

## Inverter Diode

Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	54	A
Surge (non-repetitive) forward current	$I_{FSM}$	Single Half Sine Wave, $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	270	A
Surge current capability	$I^2t$		365	$\text{A}^2\text{s}$
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	123	W
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

## Module Properties

### Thermal Properties

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

### Isolation Properties

Isolation voltage	$V_{isol}$	DC Test Voltage* $t_p = 2\text{ s}$	5500	V
Isolation voltage	$V_{isol}$	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		$\geq 600$	

\*100 % tested in production



### Characteristic Values

Parameter	Symbol	Conditions					Values			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	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0017	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		50	25 150	1,58	1,93 2,34	2,07 <sup>(1)</sup>	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	$r_g$							4		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25		25		2800		pF
Reverse transfer capacitance	$C_{res}$							100		pF
Gate charge	$Q_g$		±15		0	25		380		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)						0,58		K/W
--	---------------	--	--	--	--	--	--	------	--	-----

##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{goff} = 8 \Omega$	±15	600	50	25		101,4		ns
Rise time	$t_r$					150		106,4		ns
						25		19		ns
Turn-off delay time	$t_{d(off)}$					150		224		ns
						25		296		ns
Fall time	$t_f$					25		89,31		ns
						150		115,98		ns
Turn-on energy (per pulse)	$E_{on}$	$Q_{trFD} = 3,25 \mu\text{C}$				25		2,64		mWs
		$Q_{trFD} = 8,66 \mu\text{C}$				150		4,62		mWs
Turn-off energy (per pulse)	$E_{off}$					25		2,89		mWs
						150		4,75		mWs



### Characteristic Values

Parameter	Symbol	Conditions					Values			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	$V_F$				50	25 150		2,21 2,21	2,54 <sup>(1)</sup> 2,5 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_i = 1200$ V				25 150		4400	60 8800	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 2,5$ W/mK (HPTP)						0,77		K/W
--	---------------	--	--	--	--	--	--	------	--	-----

##### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=3197$ A/μs $di/dt=2339$ A/μs	±15	600	50	25 150		53,59 66,98		A
Reverse recovery time	$t_{rr}$					25 150		121,41 293,86		ns
Recovered charge	$Q_r$					25 150		3,25 8,66		μC
Reverse recovered energy	$E_{rec}$					25 150		1,12 3,35		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25		2708		A/μs
						150		466,93		



### Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		$V_{GS}$ [V]	$V_{GE}$ [V]	$V_{DS}$ [V]	$V_{CE}$ [V]	$I_D$ [A]	$I_C$ [A]	$T_j$ [°C]	Min	

### Thermistor

#### Static

Rated resistance	$R$					25		1		kΩ
Deviation of $R_{100}$	$A_{R/R}$	$R_{100} = 1670 \Omega$				100	-2		2	%
Maximum Current	$I_{max}$							3		mA
Power dissipation constant	$d$					25		0,76		mW/K
A-value	$A$							$7,635 \times 10^{-3}$		1/K
B-value	$B$							$1,73 \times 10^{-5}$		1/K <sup>2</sup>
Vincotech Thermistor Reference									E	

(1) Value at chip level

(2) Only valid with pre-applied Vincotech thermal interface material.

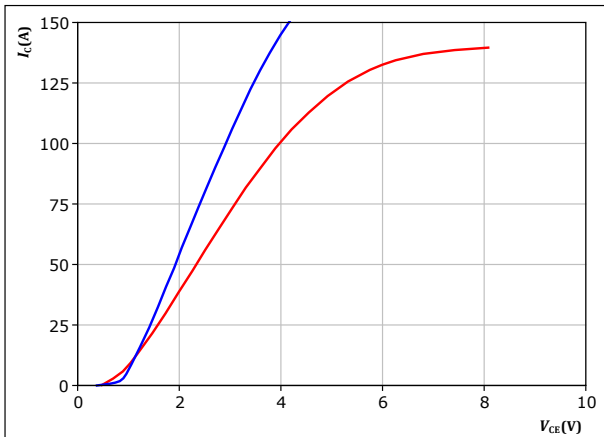


## Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

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

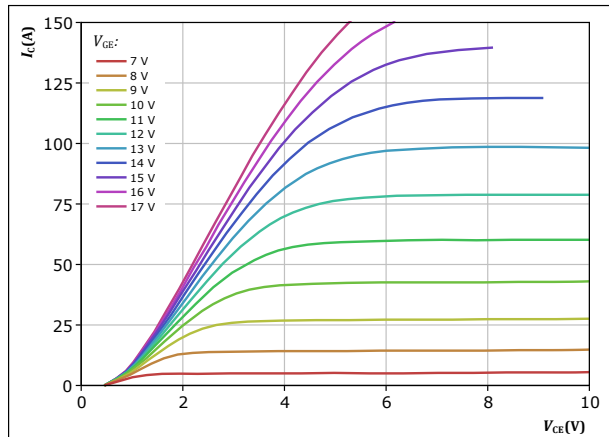


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j: 25^\circ C$  (blue),  $150^\circ C$  (red)

**figure 2.** IGBT

Typical output characteristics

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

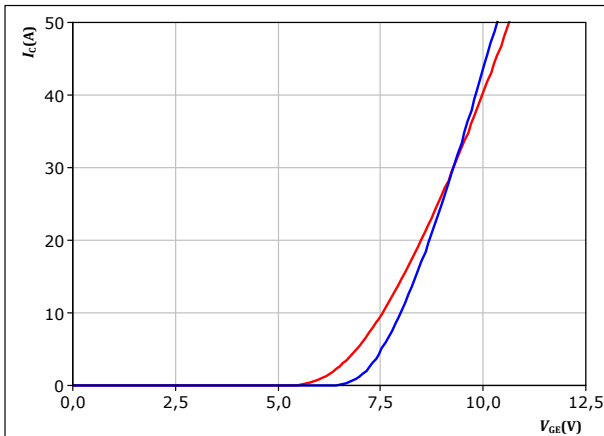


$t_p = 250 \mu s$   
 $T_j = 150^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

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

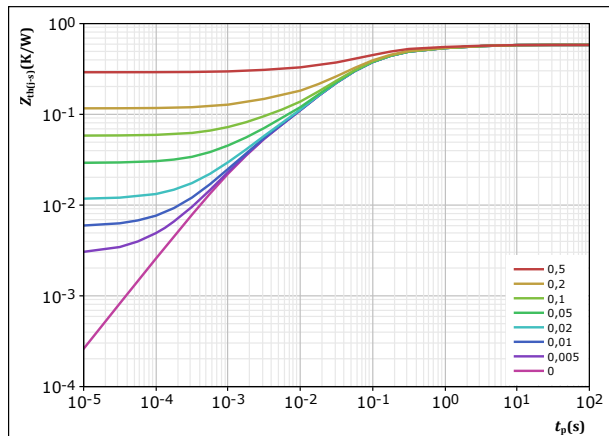


$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_j: 25^\circ C$  (blue),  $150^\circ C$  (red)

**figure 4.** IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 0,582 K/W$   
IGBT thermal model values

R (K/W)	$\tau$ (s)
4,36E-02	3,29E+00
7,77E-02	5,45E-01
3,13E-01	8,58E-02
1,16E-01	2,13E-02
3,15E-02	1,87E-03

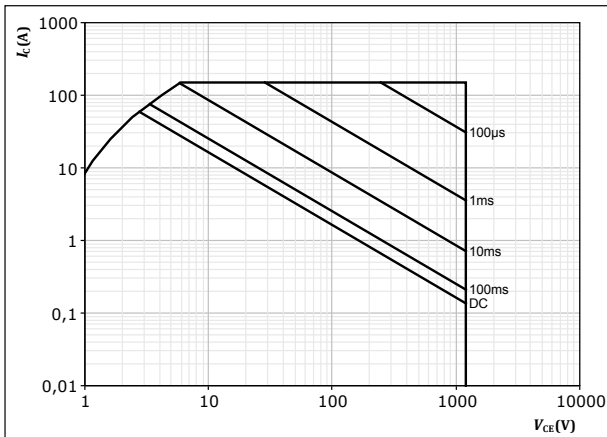


## Inverter Switch Characteristics

figure 5. IGBT

Safe operating area

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



$D =$  single pulse

$T_s = 80$  °C

$V_{CE} = 15$  V

$T_j = T_{jmax}$



## Inverter Diode Characteristics

figure 6. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

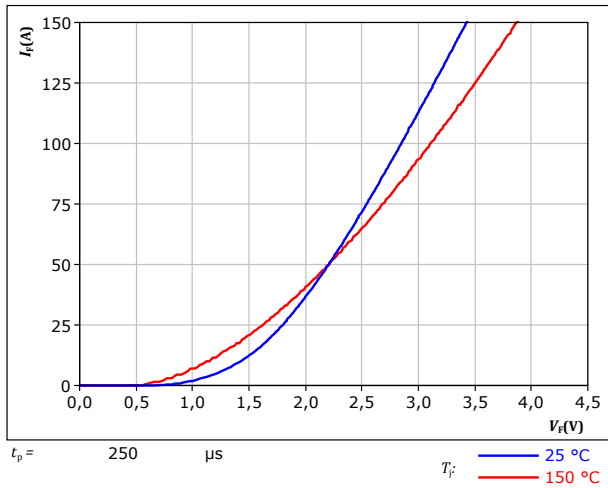
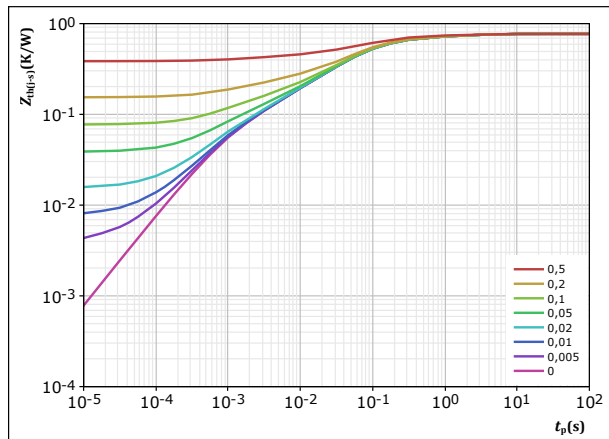


figure 7. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)} = 0,77 \text{ K/W}$

FWD thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
6,81E-02	2,32E+00
1,41E-01	2,74E-01
4,03E-01	6,14E-02
1,01E-01	8,37E-03
5,84E-02	9,85E-04



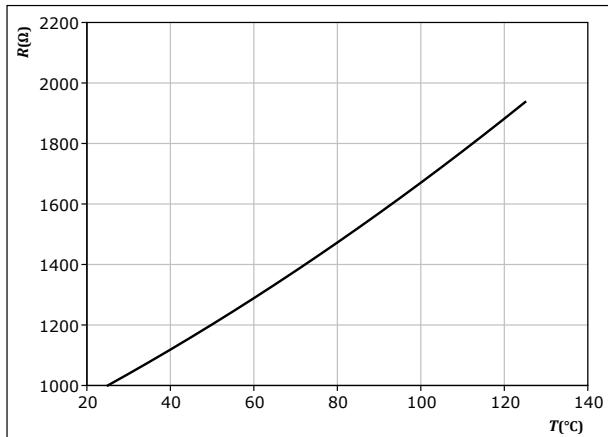


## Thermistor Characteristics

figure 8. Thermistor

Typical PTC characteristic as function of temperature

$$R_T = f(T)$$

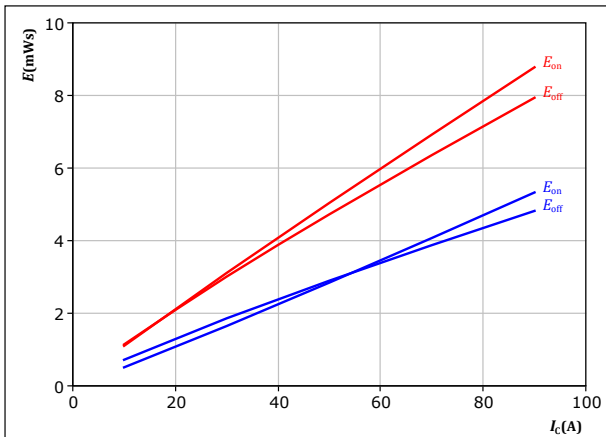




## Inverter Switching Characteristics

**figure 9.** IGBT

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



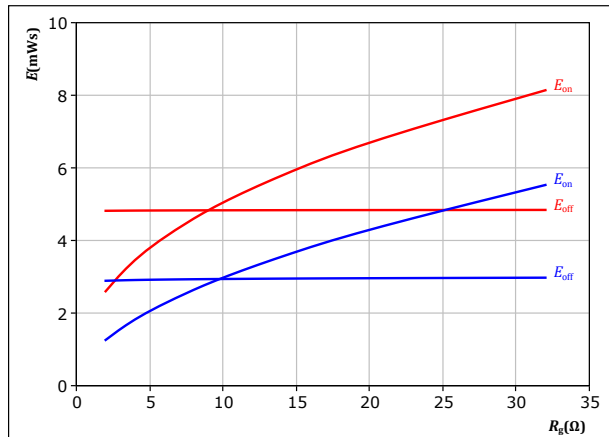
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g\text{on}} = 8 \ \Omega$   
 $R_{g\text{off}} = 8 \ \Omega$

$T_j$ : — 25 °C  
 — 150 °C

**figure 10.** IGBT

Typical switching energy losses as a function of IGBT turn on gate resistor  
 $E = f(R_g)$



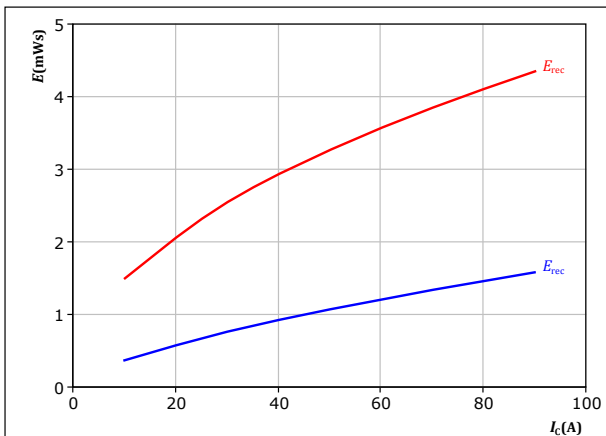
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 50 \text{ A}$

$T_j$ : — 25 °C  
 — 150 °C

**figure 11.** FWD

Typical reverse recovered energy loss as a function of collector current  
 $E_{rec} = f(I_c)$



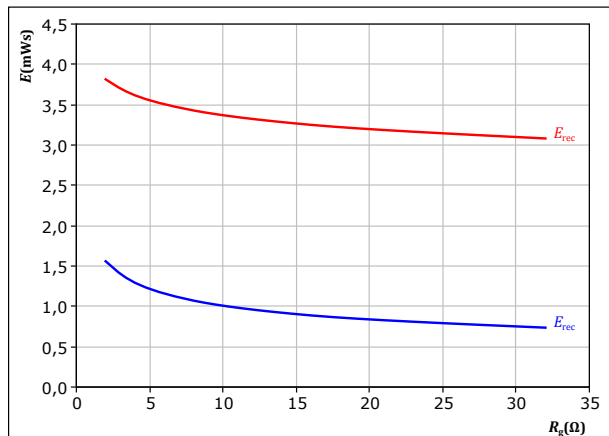
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{g\text{on}} = 8 \ \Omega$

$T_j$ : — 25 °C  
 — 150 °C

**figure 12.** FWD

Typical reverse recovered energy loss as a function of IGBT turn on gate resistor  
 $E_{rec} = f(R_g)$



With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 50 \text{ A}$

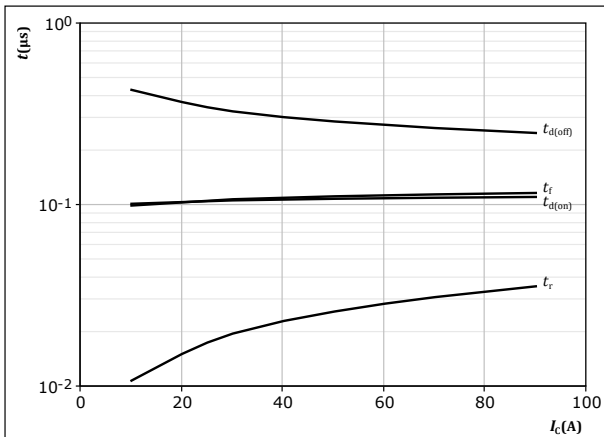
$T_j$ : — 25 °C  
 — 150 °C



## Inverter Switching Characteristics

**figure 13.** IGBT

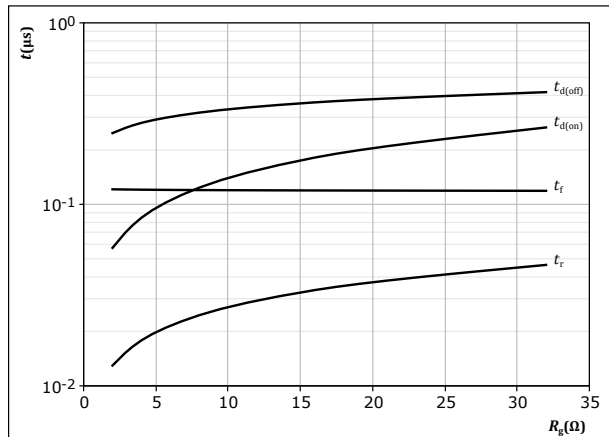
Typical switching times as a function of collector current  
 $t = f(I_c)$



With an inductive load at  
 $T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 8$  Ω  
 $R_{goff} = 8$  Ω

**figure 14.** IGBT

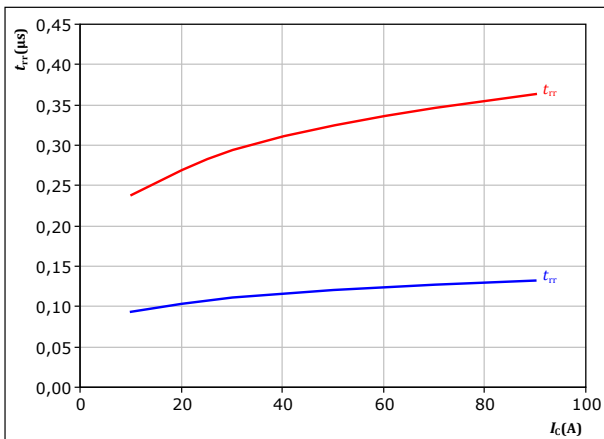
Typical switching times as a function of IGBT turn on gate resistor  
 $t = f(R_g)$



With an inductive load at  
 $T_j = 150$  °C  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 50$  A

**figure 15.** FWD

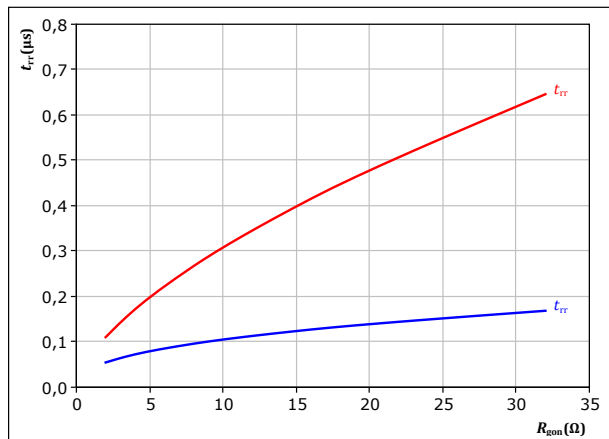
Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_c)$



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 8$  Ω  
 $T_j$ : — 25 °C  
— 150 °C

**figure 16.** 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  
 $I_c = 50$  A  
 $T_j$ : — 25 °C  
— 150 °C

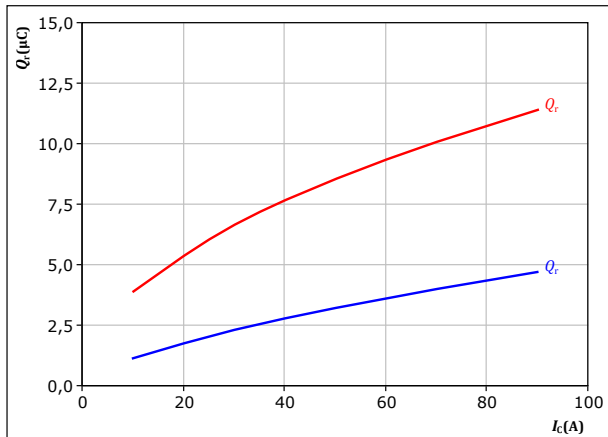


## Inverter Switching Characteristics

**figure 17.** FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

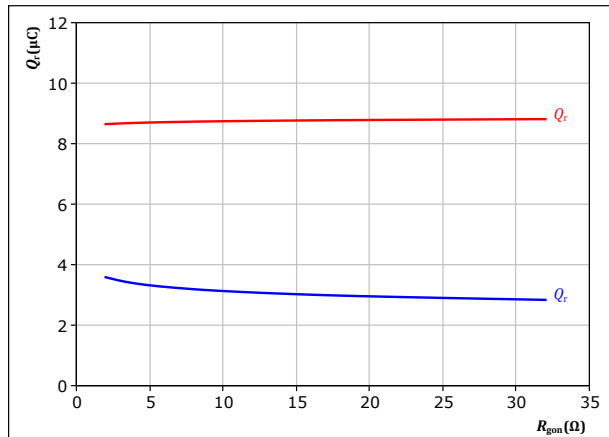
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 8$  Ω

$T_j$ : — 25 °C  
— 150 °C

**figure 18.** FWD

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

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



With an inductive load at

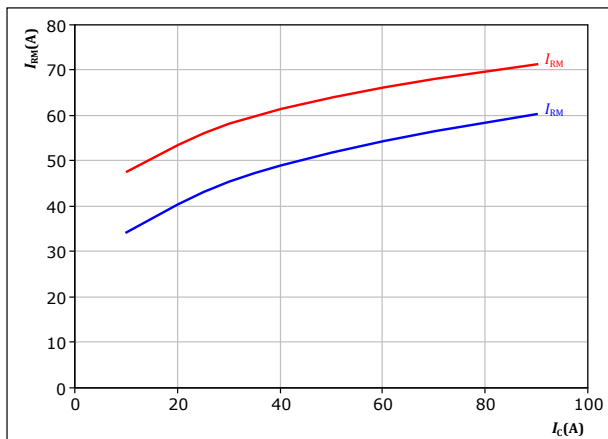
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 50$  A

$T_j$ : — 25 °C  
— 150 °C

**figure 19.** FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

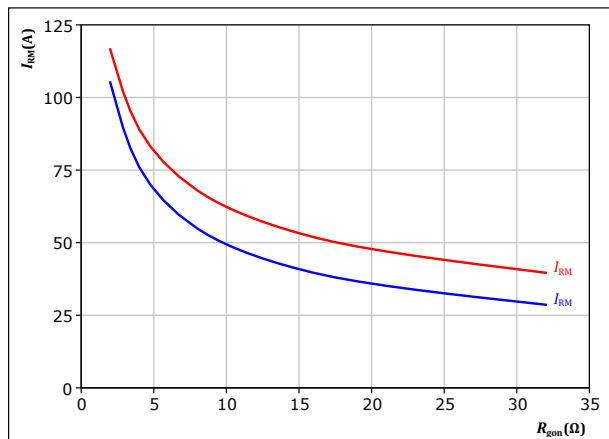
$V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 8$  Ω

$T_j$ : — 25 °C  
— 150 °C

**figure 20.** 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  
 $I_c = 50$  A

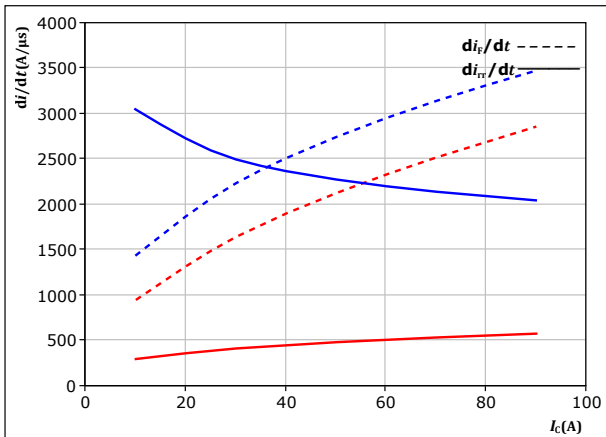
$T_j$ : — 25 °C  
— 150 °C



## Inverter Switching Characteristics

**figure 21.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_r/dt = f(I_c)$



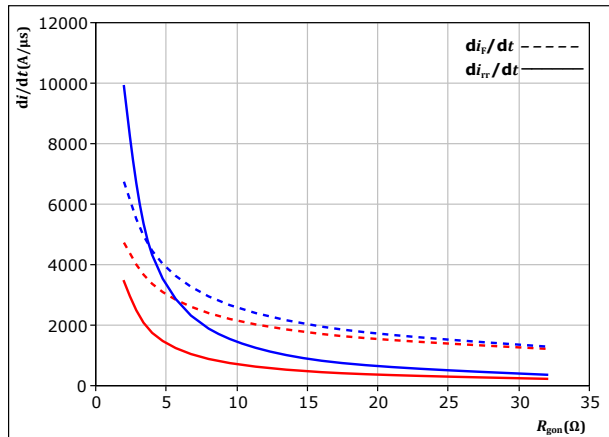
With an inductive load at

$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 8 \ \Omega$

$T_j$ : — 25 °C  
 — 150 °C

**figure 22.** FWD

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



With an inductive load at

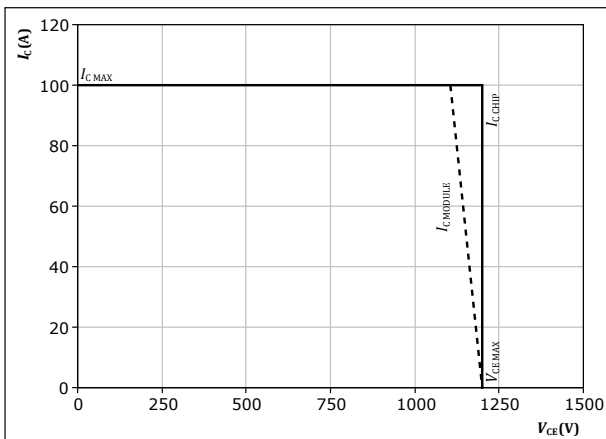
$V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_c = 50 \text{ A}$

$T_j$ : — 25 °C  
 — 150 °C

**figure 23.** IGBT

Reverse bias safe operating area

$I_c = f(V_{CE})$

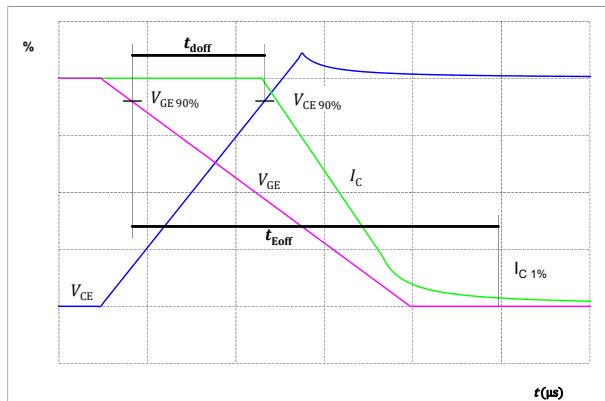


At  $T_j = 150 \text{ °C}$   
 $R_{gon} = 8 \ \Omega$   
 $R_{goff} = 8 \ \Omega$



## Inverter Switching Definitions

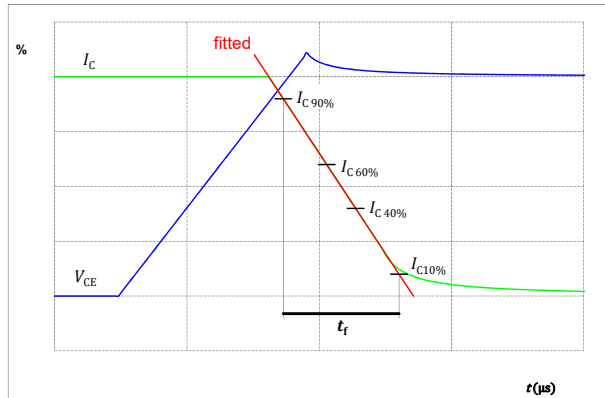
**figure 24.** IGBT  
Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$  ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



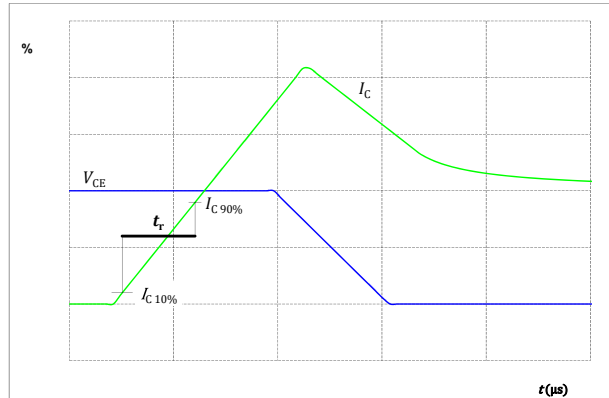
**figure 25.** IGBT  
Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$  ( $t_{Eon}$  = integrating time for  $E_{on}$ )



**figure 26.** IGBT  
Turn-off Switching Waveforms & definition of  $t_f$



**figure 27.** IGBT  
Turn-on Switching Waveforms & definition of  $t_r$





## Inverter Switching Definitions

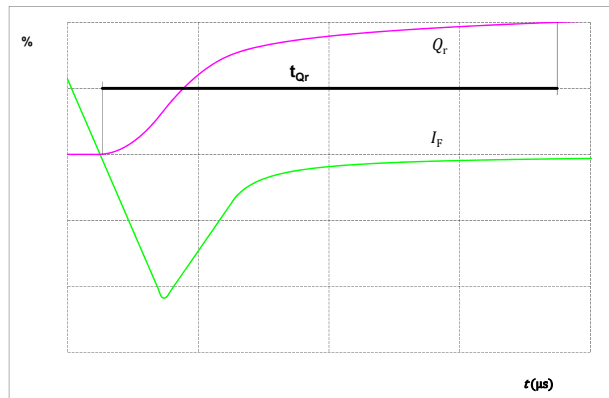
figure 28. FWD

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




figure 29. FWD

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

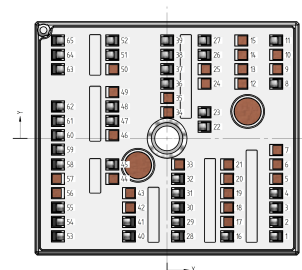




Ordering Code	
Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K359-F40-/0A/
With thin lid (2.8mm height) + no thermal grease	V23990-K359-F40-/0B/
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K359-F40-/1A/
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K359-F40-/1B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K359-F40-/4A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K359-F40-/4B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K359-F40-/5A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K359-F40-/5B/

Marking							
Text	VIN	Date code	Type&Ver	UL	Lot	Serial	
	VIN	WWYY	TTTTTTTV	UL	LLLLL	SSSS	
	Type&Ver	Lot number	Serial	Date code			
	TTTTTTTV	LLLLL	SSSS	WWYY			

Outline							
Pin table [mm]							
Pin	X	Y	Function	34	not assembled		
1	24,38	-21,8	DC+123	35	not assembled		
2	24,38	-18,6	DC+123	36	0,03	12,2	Ph1
3	24,38	-15,4	DC+123	37	0,03	15,4	Ph1
4	24,38	-12,2	DC+123	38	0,03	18,6	Ph1
5	not assembled			39	0,03	21,8	Ph1
6	not assembled			40	-8,5	-21,8	S15
7	not assembled			41	-8,5	-18,6	G15
8	24,38	12,2	Therm1	42	not assembled		
9	not assembled			43	not assembled		
10	not assembled			44	not assembled		
11	24,38	21,8	Therm2	45	-12,22	-5,8	Ph2
12	not assembled			46	not assembled		
13	not assembled			47	-12,22	3,9	Ph2
14	not assembled			48	-12,22	7,1	Ph2
15	not assembled			49	not assembled		
16	13,42	-21,8	G16	50	not assembled		
17	not assembled			51	-12,22	18,6	G11
18	not assembled			52	-12,22	21,8	S11
19	not assembled			53	-24,38	-21,8	DC-3
20	not assembled			54	-24,38	-18,6	DC-3
21	not assembled			55	-24,38	-15,4	DC-3
22	8,38	2,6	S14	56	not assembled		
23	8,38	5,8	G14	57	not assembled		
24	not assembled			58	-24,38	-5,8	DC-2
25	not assembled			59	-24,38	-2,5	DC-2
26	8,38	18,6	S12	60	-24,38	0,7	DC-2
27	8,38	21,8	G12	61	-24,38	3,9	S13
28	2,38	-21,8	S16	62	-24,38	7,1	G13
29	2,46	-18,6	Ph3	63	-24,38	15,4	DC-1
30	2,46	-15,4	Ph3	64	-24,38	18,6	DC-1
31	2,46	-12,2	Ph3	65	-24,38	21,8	DC-1
32	2,46	-9	Ph3				
33	not assembled						

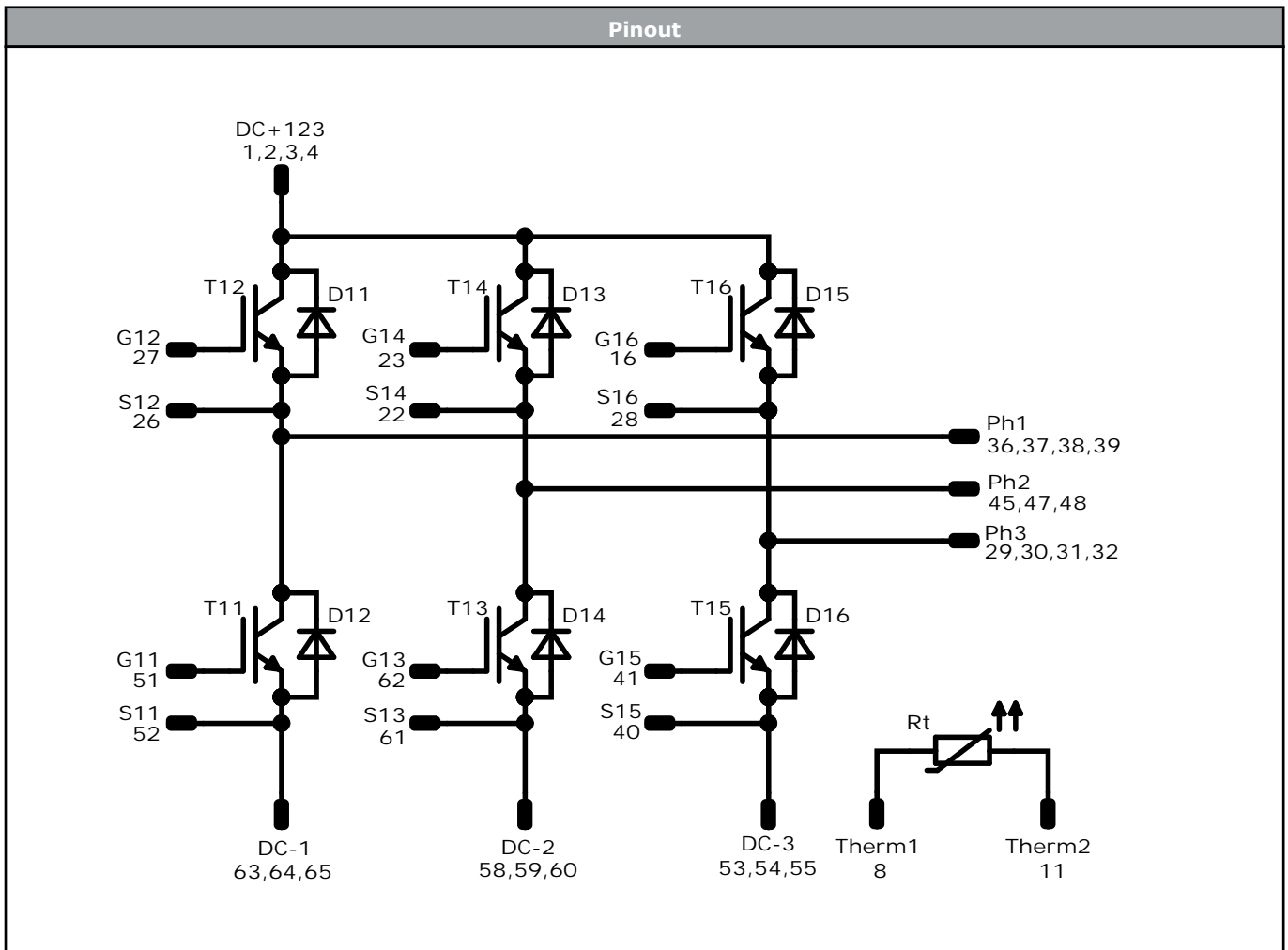


Pad positions refers to center point. For more informations on pad design please see package data





Vincotech



Identification					
ID	Component	Voltage	Current	Function	Comment
T11, T12, T13, T14, T15, T16	IGBT	1200 V	50 A	Inverter Switch	
D11, D12, D13, D14, D15, D16	FWD	1200 V	50 A	Inverter Diode	
Rt	PTC			Thermistor	




Packaging instruction				
Standard packaging quantity (SPQ) 72	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSKiiP® 2 packages see vincotech.com website.

Package data
Package data for MiniSKiiP® 2 packages see vincotech.com website.

Vincotech thermistor reference
See Vincotech thermistor reference table at 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-K359-F40-D4-14	30 Apr. 2022	New Datasheet format, module is unchanged Correct tau values of thermal characteristic	

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