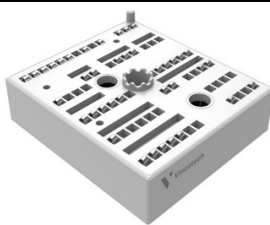
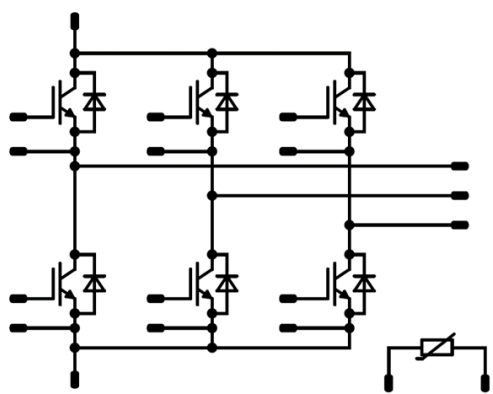




MiniSKiiP PACK 2		1200 V / 70 A
Features • Solder less interconnection • Designed for motor drives up to 7 kW • Temperature sensor • Standard (6.5mm) and thin (2.8mm) lids, 16mm housing • Optional with pre-applied thermal grease		MiniSKiiP 2 housing 
Target applications • Servo Drives • Industrial Motor Drives • UPS		Schematic 
Types • V23990-K230-F40-PM		

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C		70	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	210	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ }^{\circ}\text{C}$	246	W
Gate-emitter voltage	V_{GES}		± 20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$ $V_{CC} = 800\text{ V}$ $T_j = 150\text{ }^{\circ}\text{C}$	10	μs
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$



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	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	71	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	430	A
Surge current capability	I^2t		925	A ² s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	154	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_{jop}		-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 in- structions	6,3	mm
Clearance		With std lid For more informations see handling in- structions	6,3	mm
Comparative Tracking Index	CTI		> 200	

*100 % tested in production



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	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,0024	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CEsat}		15		70	25 150	1,5	1,95 2,31	2,2	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			120	μA
Gate-emitter leakage current	I_{GES}		20	0		25			240	nA
Internal gate resistance	r_g							none		Ω
Input capacitance	C_{ies}	$f = 1 \text{ Mhz}$	0	25		25		4000		pF
Reverse transfer capacitance	C_{res}							140		
Gate charge	Q_g		-15/15			25		540		nC

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)						0,39		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{goff} = 8 \Omega$	± 15	600	70	25 150		98 98		ns
Rise time	t_r					25 150		21 27		
Turn-off delay time	$t_{d(off)}$					25 150		217 285		
Fall time	t_f					25 150		87 126		
Turn-on energy (per pulse)	E_{on}	$Q_{rFWD} = 4,5 \mu C$ $Q_{rFWD} = 11,5 \mu C$				25 150		3,740 6,385		mWs
Turn-off energy (per pulse)	E_{off}					25 150		4,093 6,632		



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				75	25 150		2,33 2,26	2,6	V
Reverse leakage current	I_R			1200		25 150			120 14000	μA

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)						0,62		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Dynamic

Peak recovery current	I_{RRM}	$di/dt = 3024 \text{ A/}\mu\text{s}$ $di/dt = 2913 \text{ A/}\mu\text{s}$	± 15	600	70	25 150		67 85		A
Reverse recovery time	t_{rr}					25 150		129 312		ns
Recovered charge	Q_r					25 150		4,457 11,545		μC
Reverse recovered energy	E_{rec}					25 150		1,592 4,429		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		3099 606		A/μs

Thermistor

Rated resistance	R					25		1		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1670 \Omega$				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	



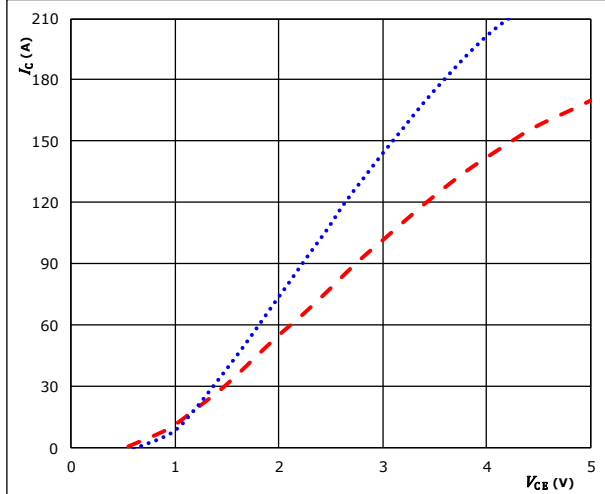
Vincotech

Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

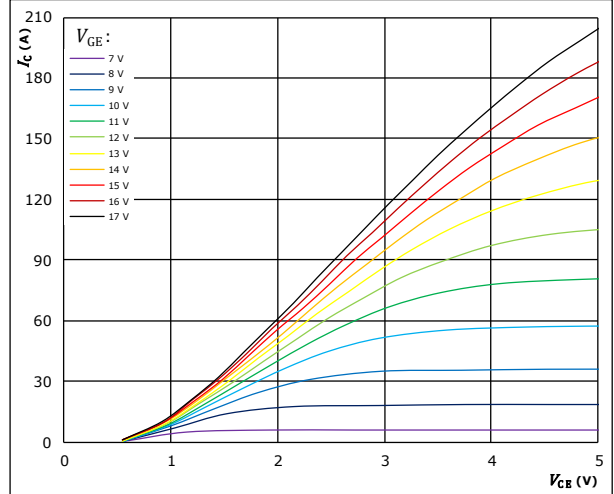


$t_p = 250 \mu s$
 $V_{GE} = 15 V$
 $T_j: 25 \text{ } ^\circ C$ (blue dotted line)
 $150 \text{ } ^\circ C$ (red dashed line)

figure 2. IGBT

Typical output characteristics

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

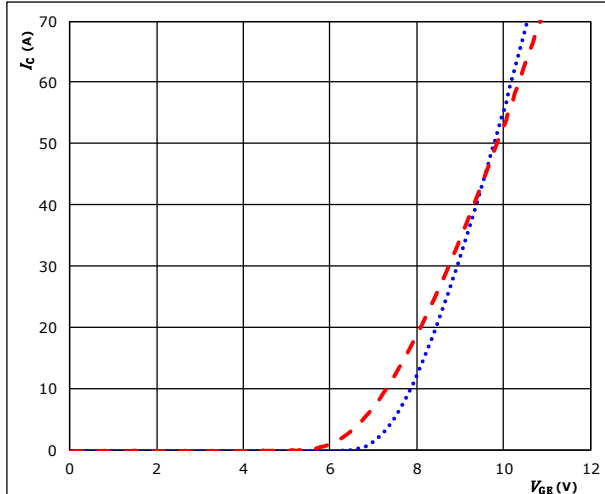


$t_p = 250 \mu s$
 $T_j = 150 \text{ } ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

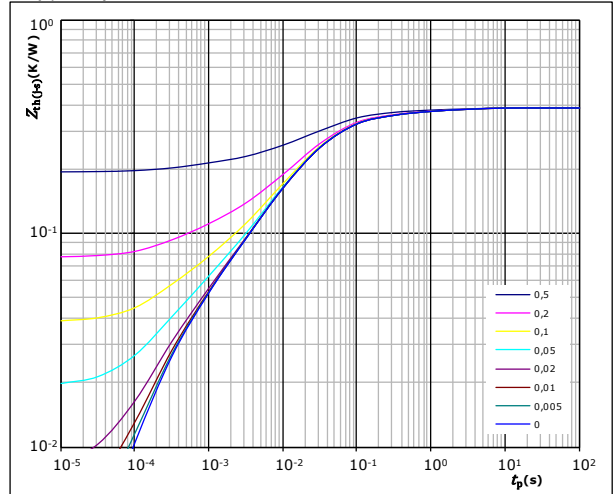


$t_p = 100 \mu s$
 $V_{CE} = 10 V$
 $T_j: 25 \text{ } ^\circ C$ (blue dotted line)
 $150 \text{ } ^\circ C$ (red dashed line)

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 0,39 \text{ K/W}$

IGBT thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
1,69E-02	7,05E-01
3,35E-02	9,42E-02
1,26E-01	1,36E-02
1,26E-01	4,15E-03
5,49E-02	7,81E-04
2,83E-02	8,24E-05



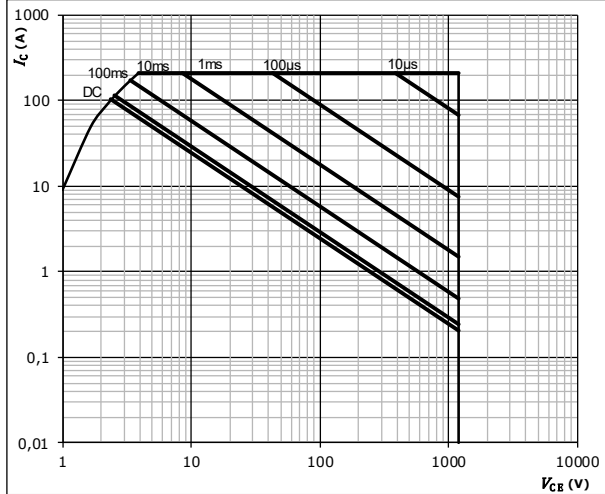
Vincotech

Inverter Switch Characteristics

figure 5. IGBT

Safe operating area

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



$D =$ single pulse
 $T_s =$ 80 °C
 $V_{GE} =$ 0 V
 $T_j = T_{jmax}$



Inverter Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

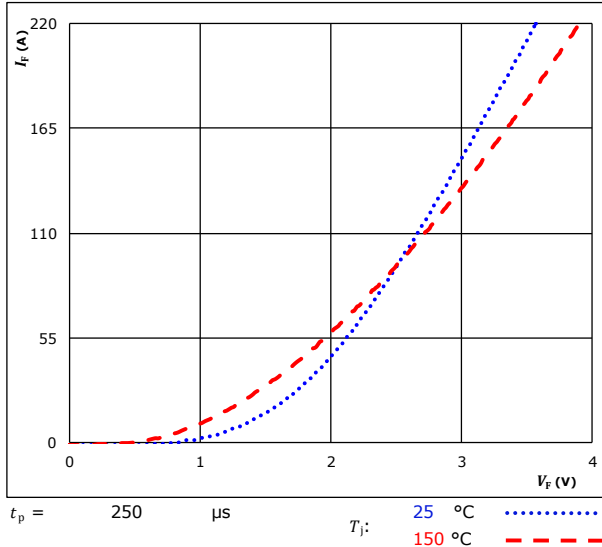
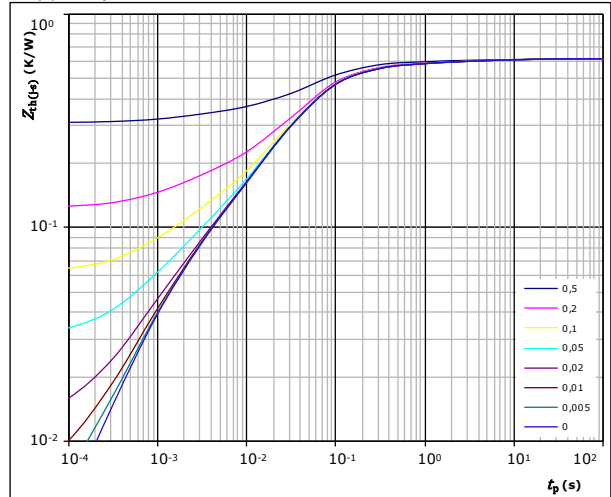


figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$$D = t_p / T$$

$$R_{th(j-s)} = 0,62 \text{ K/W}$$

FWD thermal model values

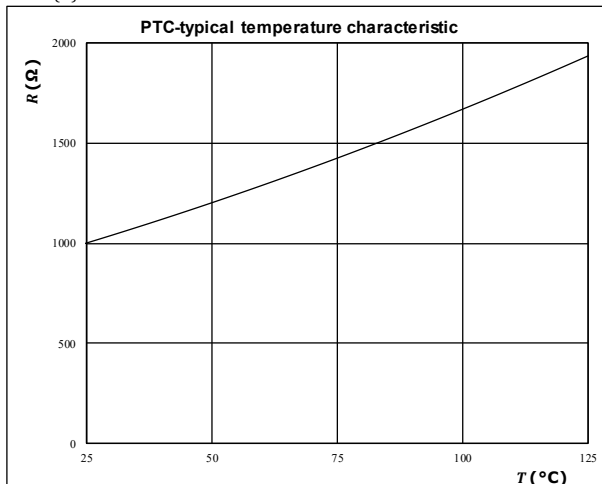
R (K/W)	τ (s)
2,30E-02	4,61E+00
4,31E-02	3,92E-01
1,14E-01	7,01E-02
3,31E-01	2,34E-02
6,18E-02	4,55E-03
4,14E-02	6,99E-04
2,86E-03	3,38E-04

Thermistor Characteristics

figure 1. Thermistor

Typical PTC characteristic
as a function of temperature

$$R = f(T)$$



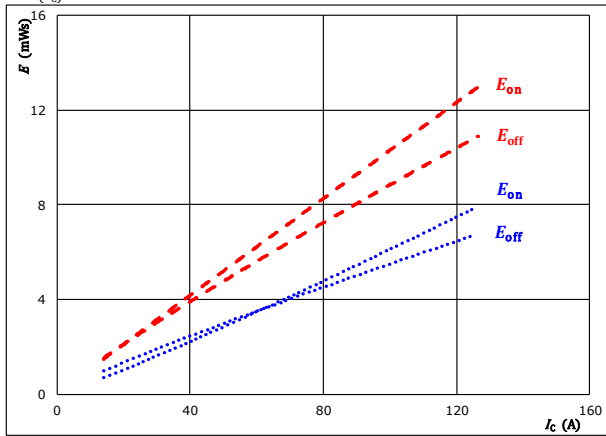


Inverter Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$



With an inductive load at

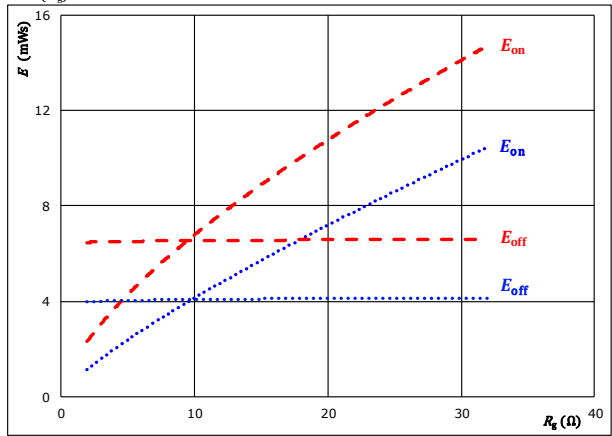
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 8 \text{ } \Omega$
 $R_{goff} = 8 \text{ } \Omega$

T_j : $25 \text{ } ^\circ\text{C}$ (blue dotted)
 $150 \text{ } ^\circ\text{C}$ (red dashed)

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

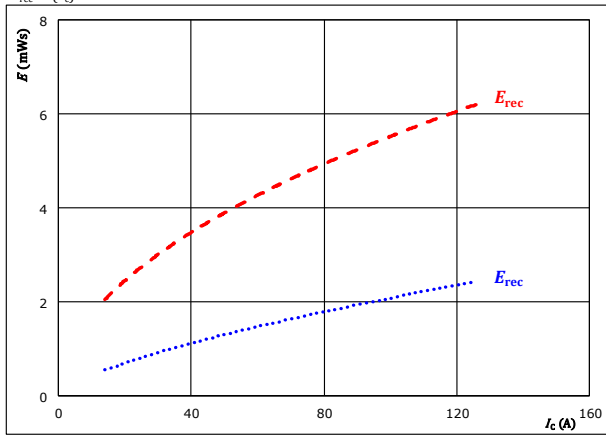
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_C = 70 \text{ A}$

T_j : $25 \text{ } ^\circ\text{C}$ (blue dotted)
 $150 \text{ } ^\circ\text{C}$ (red dashed)

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

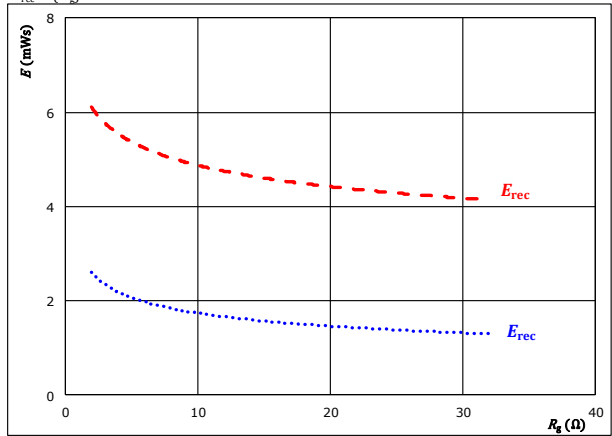
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 8 \text{ } \Omega$

T_j : $25 \text{ } ^\circ\text{C}$ (blue dotted)
 $150 \text{ } ^\circ\text{C}$ (red dashed)

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

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



With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_C = 70 \text{ A}$

T_j : $25 \text{ } ^\circ\text{C}$ (blue dotted)
 $150 \text{ } ^\circ\text{C}$ (red dashed)

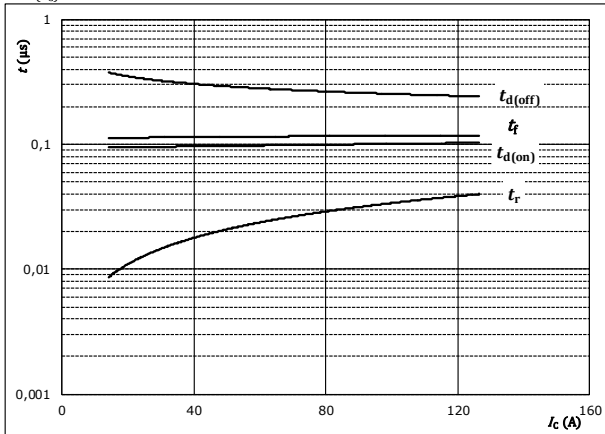


Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



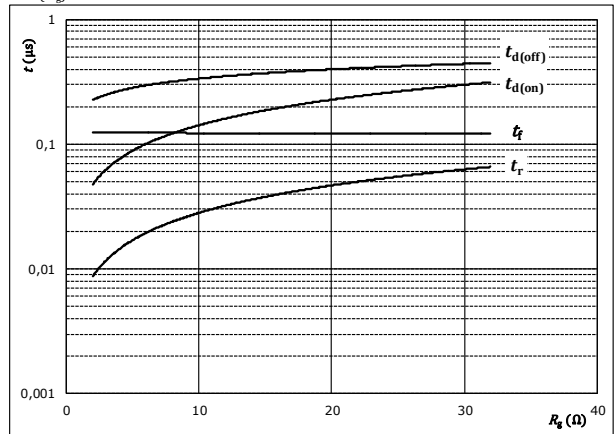
With an inductive load at

$T_j =$	150	$^{\circ}C$
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$R_{gon} =$	8	Ω
$R_{goff} =$	8	Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



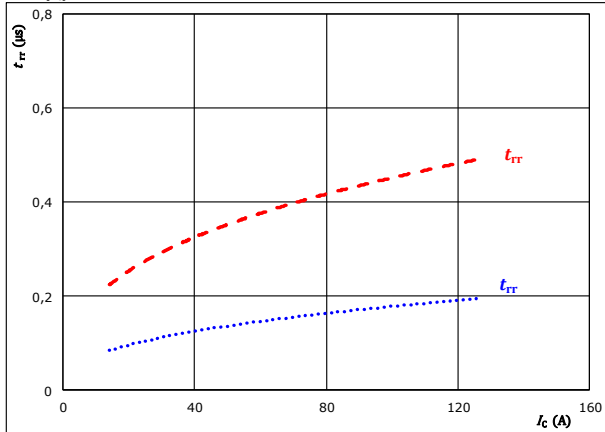
With an inductive load at

$T_j =$	150	$^{\circ}C$
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$I_C =$	70	A

figure 7. FWD

Typical reverse recovery time as a function of collector current

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



With an inductive load at

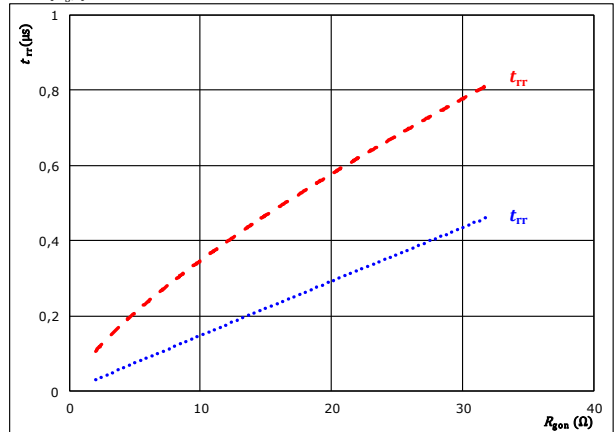
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$R_{gon} =$	8	Ω

T_j : 25 $^{\circ}C$
150 $^{\circ}C$ - - - - -

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
$V_{GE} =$	± 15	V
$I_C =$	70	A

T_j : 25 $^{\circ}C$
150 $^{\circ}C$ - - - - -

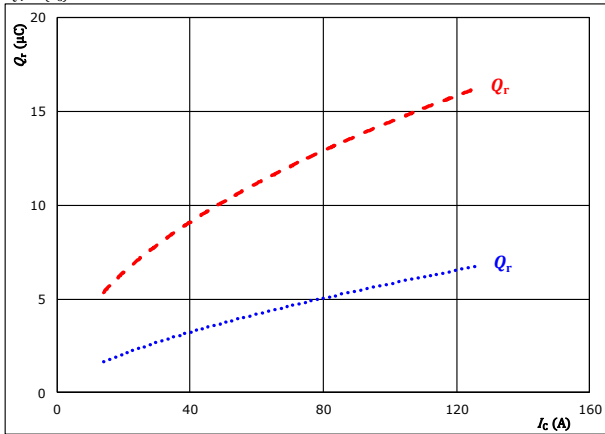


Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_C)$$



With an inductive load at

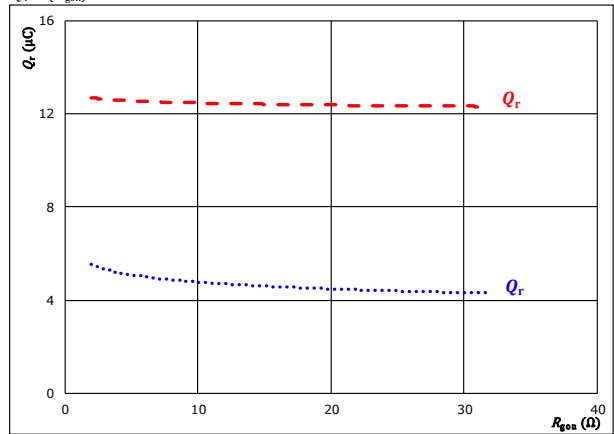
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

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

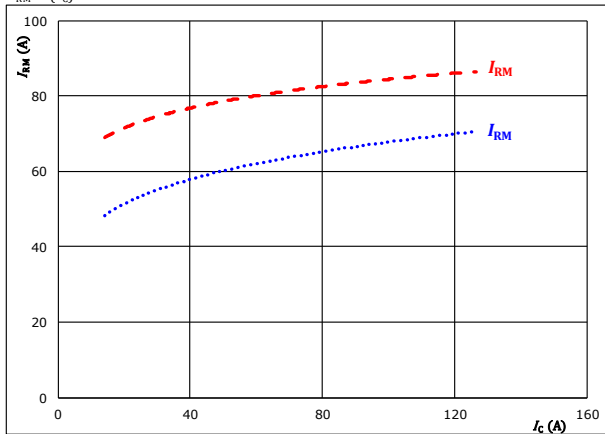
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 70$ A

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

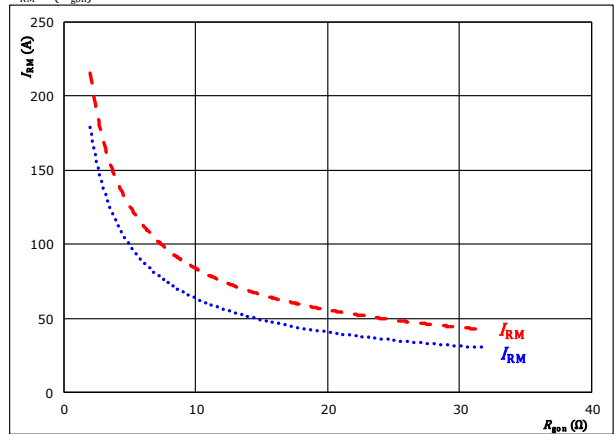
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

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
 $I_C = 70$ A

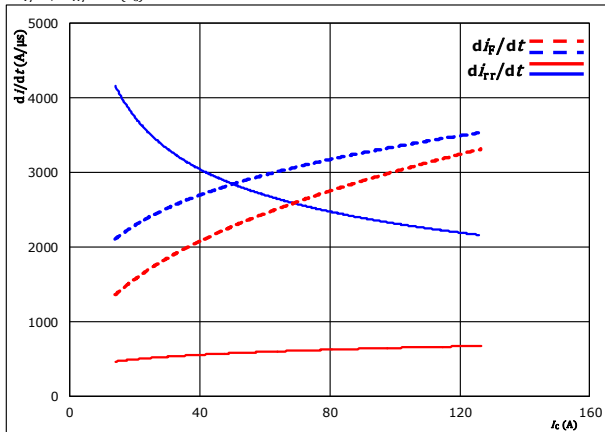
T_j : 25 °C (blue dotted line)
150 °C (red dashed line)



Inverter Switching Characteristics

figure 13. FWD

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



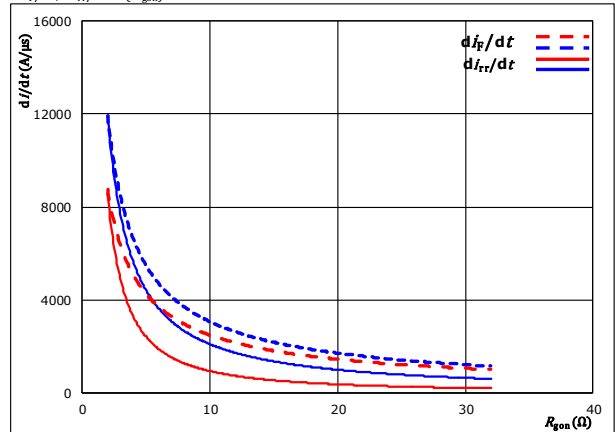
With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ 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
 $di_f/dt, di_{rr}/dt = f(R_{gon})$



With an inductive load at

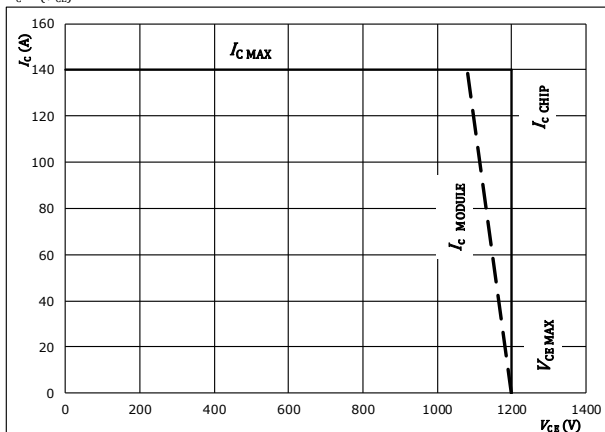
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 70$ A

T_j : 25 °C
150 °C

figure 15. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

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



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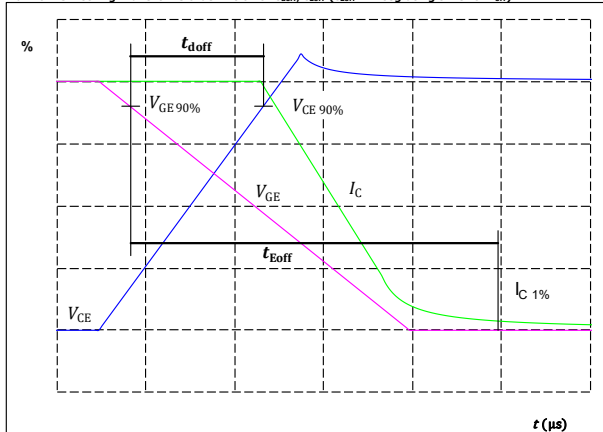
Inverter Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

figure 1. IGBT

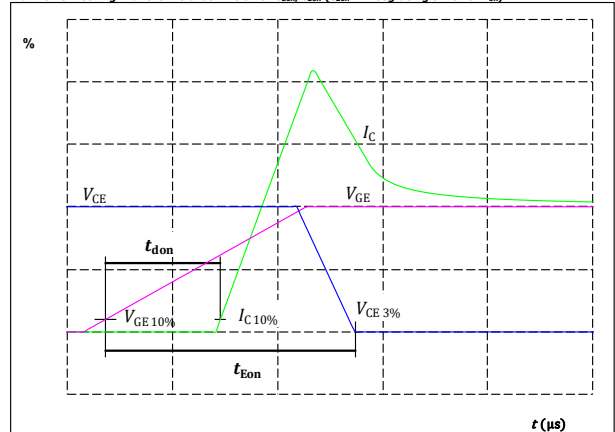
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	70	A
$t_{doff} =$	285	ns

figure 2. IGBT

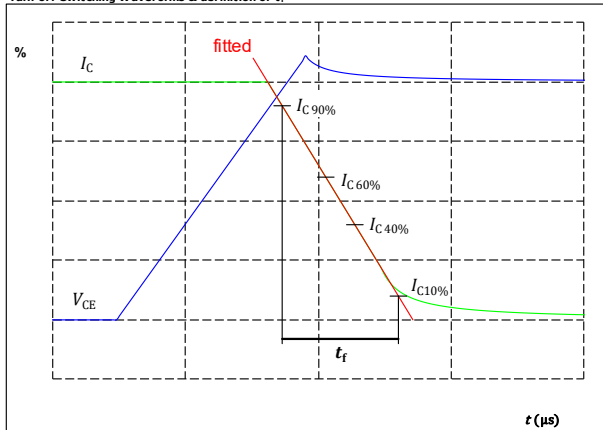
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	70	A
$t_{don} =$	98	ns

figure 3. IGBT

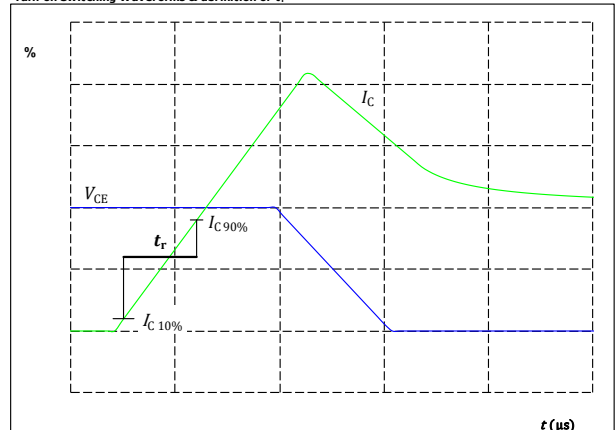
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) =$	600	V
$I_C(100\%) =$	70	A
$t_f =$	126	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r



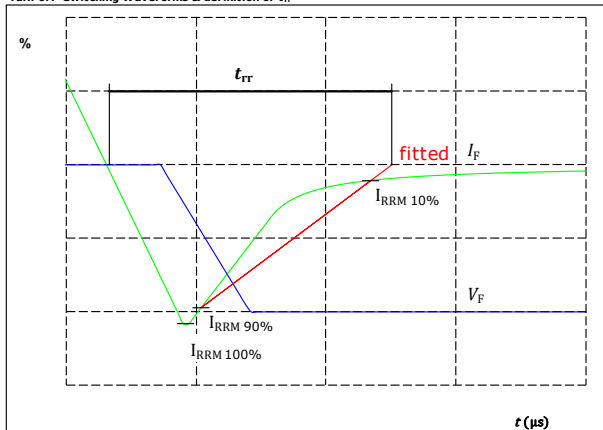
$V_C(100\%) =$	600	V
$I_C(100\%) =$	70	A
$t_r =$	27	ns



Inverter Switching Characteristics

figure 5. FWD

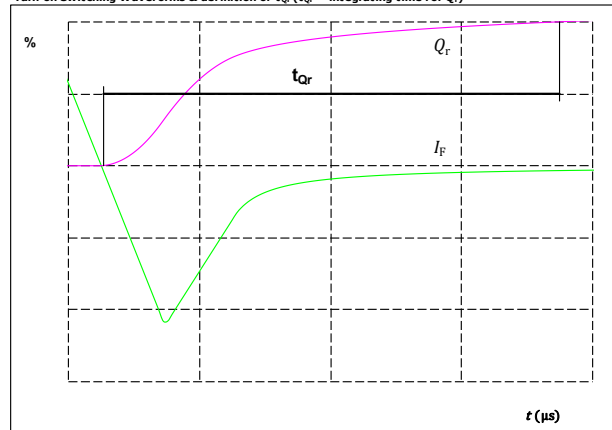
Turn-off Switching Waveforms & definition of t_{rr}



$V_F(100\%) =$	600	V
$I_F(100\%) =$	70	A
$I_{RRM}(100\%) =$	85	A
$t_{rr} =$	312	ns

figure 6. FWD

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

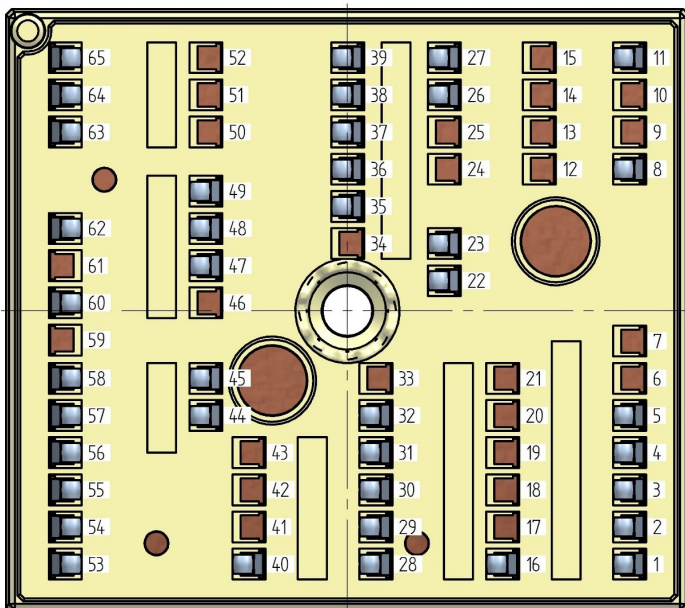


$I_F(100\%) =$	70	A
$Q_r(100\%) =$	11,55	μC



Vincotech

Ordering Code & Marking							
Version				Ordering Code			
With std lid (6.5mm height) + no thermal grease				V23990-K230-F40-/0A/-PM			
With thin lid (2.8mm height) + no thermal grease				V23990-K230-F40-/0B/-PM			
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K230-F40-/1A/-PM			
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K230-F40-/1B/-PM			
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K230-F40-/4A/-PM			
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K230-F40-/4B/-PM			
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K230-F40-/5A/-PM			
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K230-F40-/5B/-PM			
		Text		VIN	Date code	Name&Ver	UL
		VIN		WWYY	NNNNNNNVV	UL	LLLLL
		Datamatrix		Type&Ver	Lot number	Serial	Date code
		NNNNNNNVV		LLLLL	SSSS	WWYY	

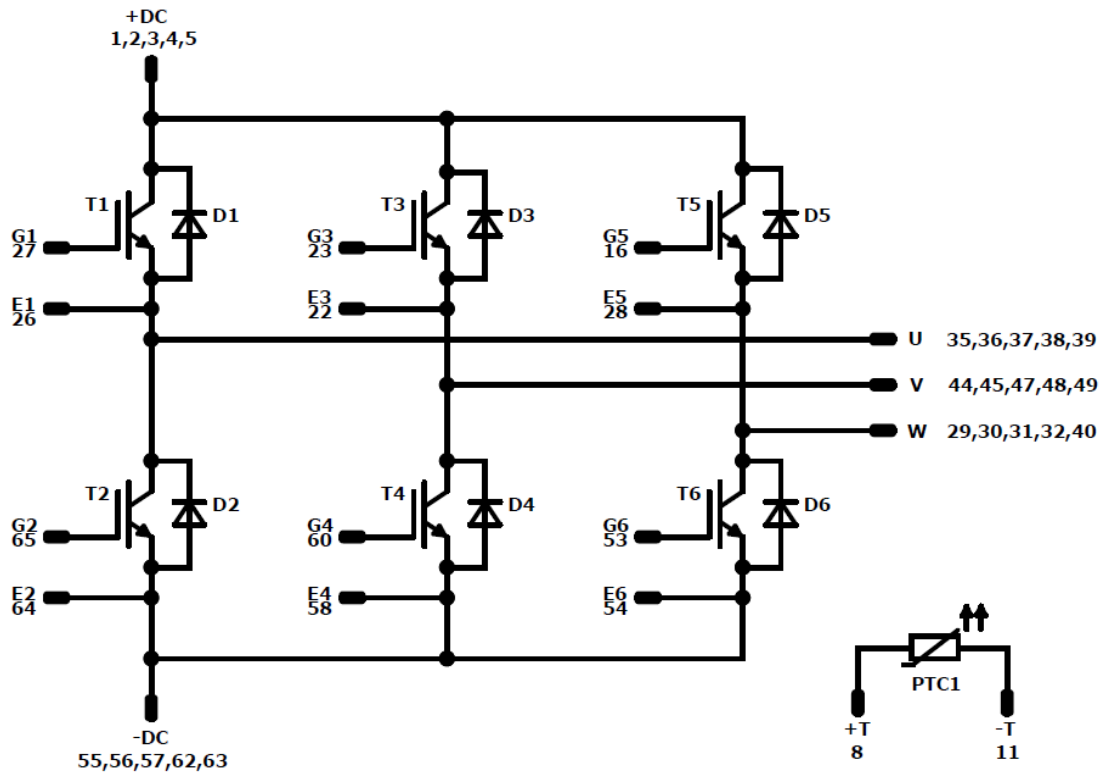
Outline							
PCB pad table				PCB pad table			
Pin	X	Y	Function	Pin	X	Y	Function
1	24,38	-21,8	+DC	48	-12,22	7,1	V
2	24,38	-18,6	+DC	49	-12,22	10,3	V
3	24,38	-15,4	+DC	50	Not assembled		
4	24,38	-12,2	+DC	51	Not assembled		
5	24,38	-9	+DC	52	Not assembled		
6	Not assembled			53	-24,38	-21,8	G6
7	Not assembled			54	-24,38	-18,6	E6
8	24,38	12,2	+T	55	-24,38	-15,4	-DC
9	Not assembled			56	-24,38	-12,2	-DC
10	Not assembled			57	-24,38	-9	-DC
11	24,38	21,8	-T	58	-24,38	-5,8	E4
12	Not assembled			59	Not assembled		
13	Not assembled			60	-24,38	0,7	G4
14	Not assembled			61	Not assembled		
15	Not assembled			62	-24,38	7,1	-DC
16	13,42	-21,8	G5	63	-24,38	15,4	-DC
17	Not assembled			64	-24,38	18,6	E2
18	Not assembled			65	-24,38	21,8	G2
19	Not assembled						
20	Not assembled						
21	Not assembled						
22	8,38	2,6	E3				
23	8,38	5,8	G3				
24	Not assembled						
25	Not assembled						
26	8,38	18,6	E1				
27	8,38	21,8	G1				
28	2,46	-21,8	E5				
29	2,46	-18,6	W				
30	2,46	-15,4	W				
31	2,46	-12,2	W				
32	2,46	-9	W				
33	Not assembled						
34	Not assembled						
35	0,03	9	U				
36	0,03	12,2	U				
37	0,03	15,4	U				
38	0,03	18,6	U				
39	0,03	21,8	U				
40	-8,5	-21,8	W				
41	Not assembled						
42	Not assembled						
43	Not assembled						
44	-12,22	-9	V				
45	-12,22	-5,8	V				
46	Not assembled						
47	-12,22	3,9	V				

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
T2, T1, T4, T3, T6, T5	IGBT	1200 V	70 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	75 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.

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-K230-F40-D3-14	07 Sep. 2018	HPTP introduced	all

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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.