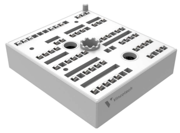
MiniSKiiP® 2 PIM — 600 V / 50 A

Features

- Solderless interconnection
- Trench Fieldstop technology

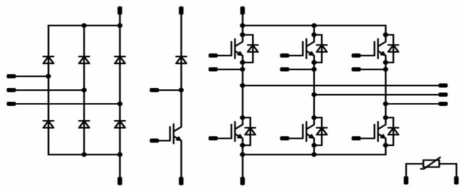
MiniSKiiP® 2 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K223-A-PM

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}		35	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms T_j = 25 °C	370	A
I2t-value	I^2t		360	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	64	W
Maximum Junction Temperature	T_{jmax}		150	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter Switch / Brake Switch					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C			50	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		150	A
Turn off safe operating area		V_{CE} ≤ 600 V, T_j ≤ T_{op} max		75	A
Power dissipation	P_{tot}	T_j = T_{jmax}	T_s = 80 °C	114	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		6 360	μs V
Maximum Junction Temperature	T_{jmax}			175	°C
Inverter Diode / Brake Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F			50	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j = 25 °C T_j = 150 °C	345 320	A
Power dissipation	P_{tot}	T_j = T_{jmax}	T_s = 80 °C	81	W
Maximum Junction Temperature	T_{jmax}			175	°C
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+(T_{jmax} - 25)	°C
Isolation Properties					
Isolation voltage	V_{is}	t = 2 s	DC voltage*	5500	V
		t = 2 s	Ac voltage	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

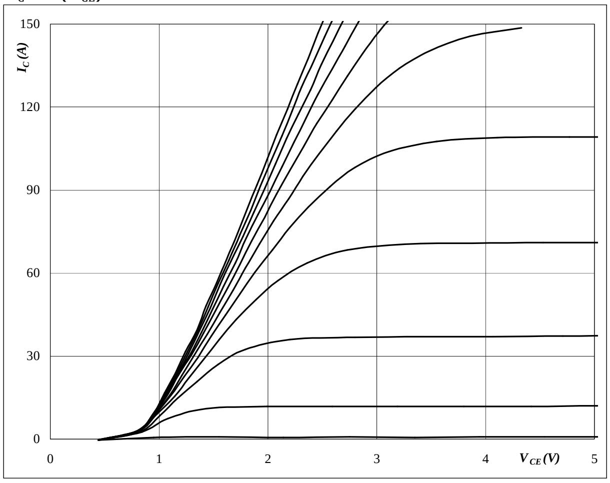
Parameter	Symbol	Conditions	V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Rectifier Diode										
Forward voltage	V_F				25	25 125	0,8	1,1 1,03	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					25 125		0,9 0,77		V
Slope resistance (for power loss calc. only)	r_t					25 125		10 10		mΩ
Reverse current	I_r			1500		25 125			0,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,08		K/W
Inverter Switch / Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,8	25 150	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		50	25 150		1,5 1,69		V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25 150			0,2	mA
Gate-emitter leakage current	I_{GES}		20	0		25 150			650	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 8 Ω	±15	300	50	25 150		96 95,7		ns
Rise time	t_r					25 150		17,8 19,5		
Turn-off delay time	$t_{d(off)}$					25 150		146,5 173,5		
Fall time	t_f					25 150		88,5 90,9		
Turn-on energy loss	E_{on}					25 150		1,18 1,62		mWs
Turn-off energy loss	E_{off}					25 150		1,26 1,57		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		3140		pF
Output capacitance	C_{oss}							200		
Reverse transfer capacitance	C_{rss}							93		
Gate charge	Q_G		±15			25		310		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,83		K/W
Inverter Diode / Brake Diode										
Diode forward voltage	V_F				50	25 150	1	1,48 1,54	2,7	V
Peak reverse recovery current	I_{RRM}	R_{goff} = 8 Ω	±15	300	30	25 150		48,42 50,65		A
Reverse recovery time	t_{rr}					25 150		187,6 270,8		ns
Reverse recovered charge	Q_{rr}					25 150		3,01 4,99		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		2442 1889		A/µs
Reverse recovered energy	E_{rec}					25 150		0,56 0,97		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,2		K/W
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω				100	-3		3	%
R_{100}	P					25		1670,3125		Ω
Power dissipation constant						25				mW/K
A-value	$B_{(25/50)}$	Tol. %				25		$7,635*10^{-3}$		1/K
B-value	$B_{(25/100)}$	Tol. %				25		$1,731*10^{-5}$		1/K²
Vincotech NTC Reference									E	

Inverter / Brake Characteristics

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



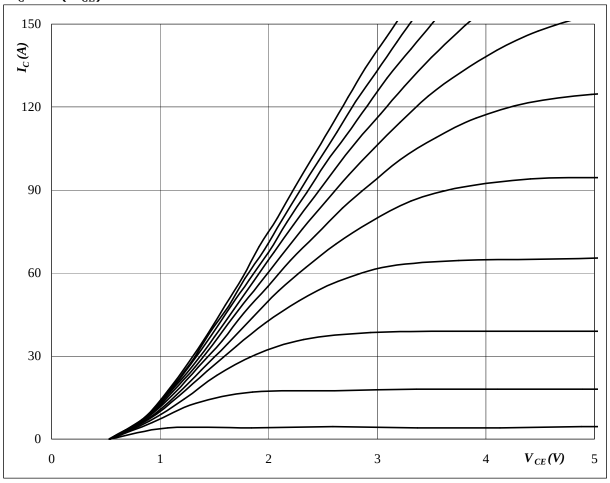
At

t_p =	250	µs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



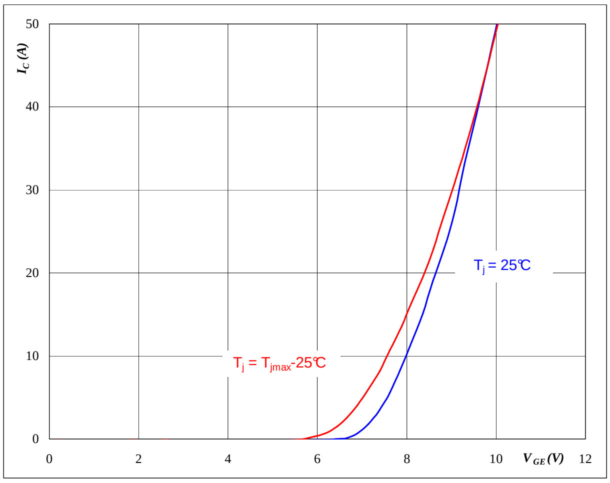
At

t_p =	250	µs
T_j =	125	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



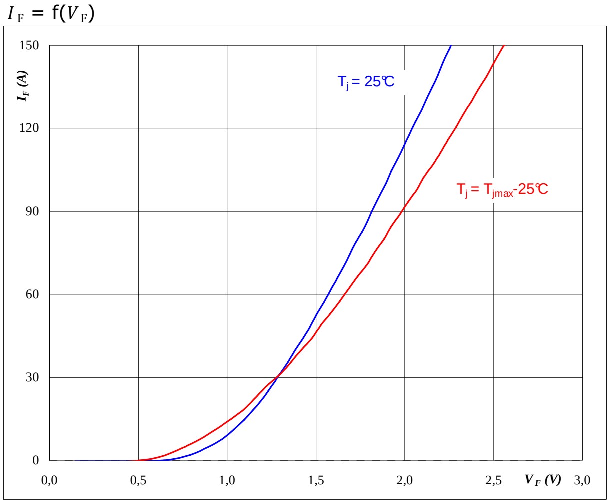
At

t_p =	250	µs
V_{CE} =	10	V

Figure 4 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

t_p =	250	µs

V23990-K223-A-PM

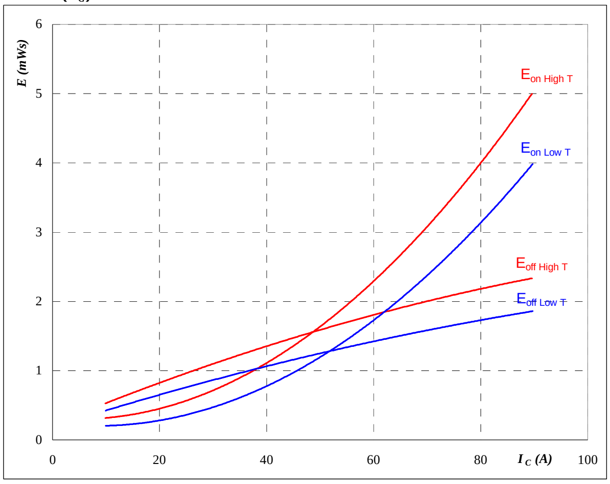
datasheet

Inverter / Brake Characteristics

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



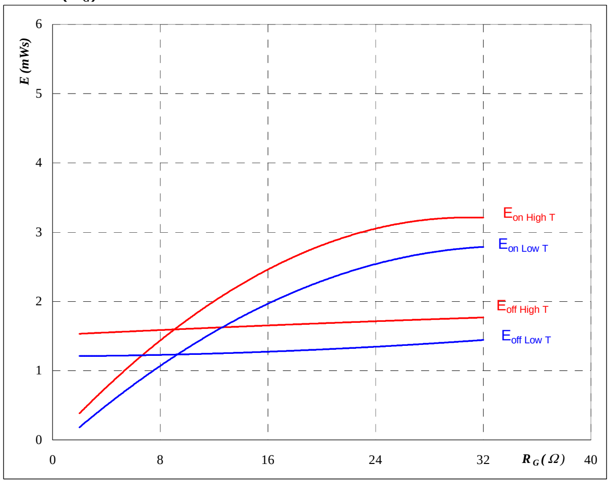
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



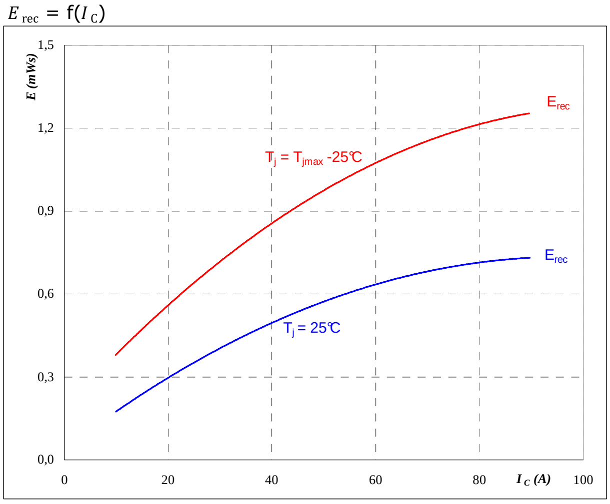
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	50	A

Figure 7 FWD

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_C)$



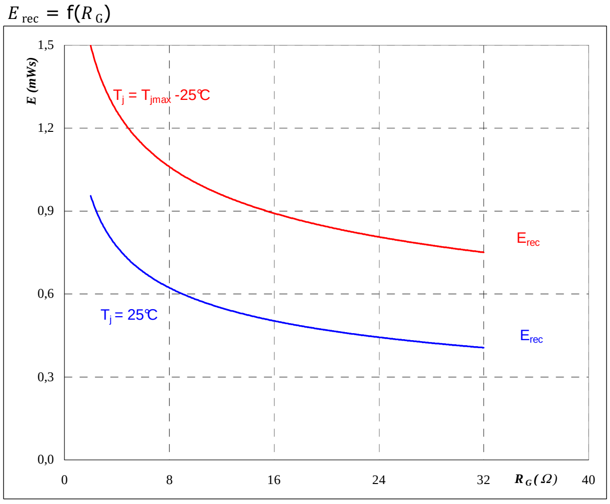
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 8 FWD

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$

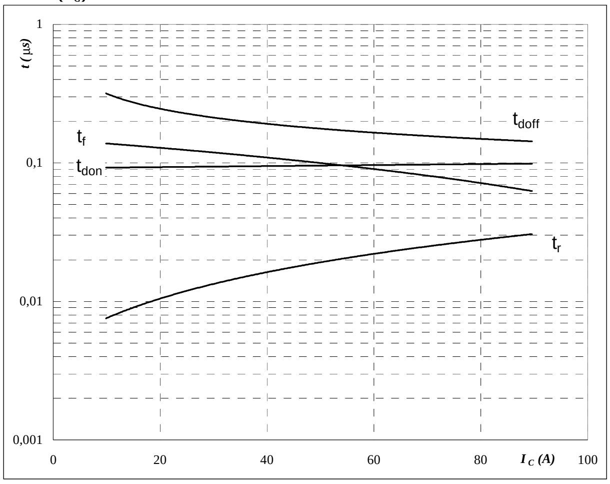


With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	50	A

Inverter / Brake Characteristics

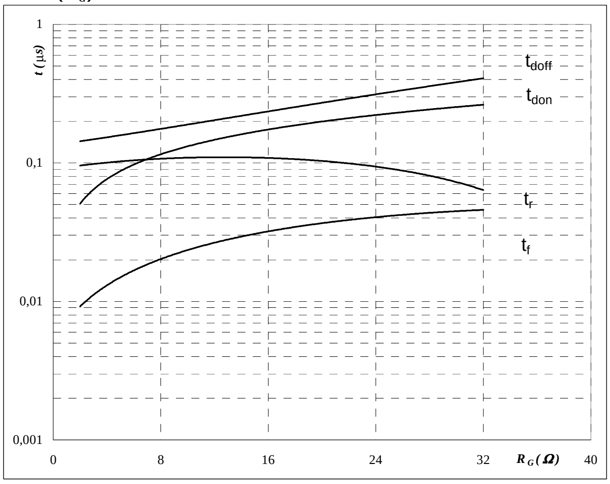
Figure 9 IGBT
Typical switching times as a function of collector current
$t = f(I_C)$



With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

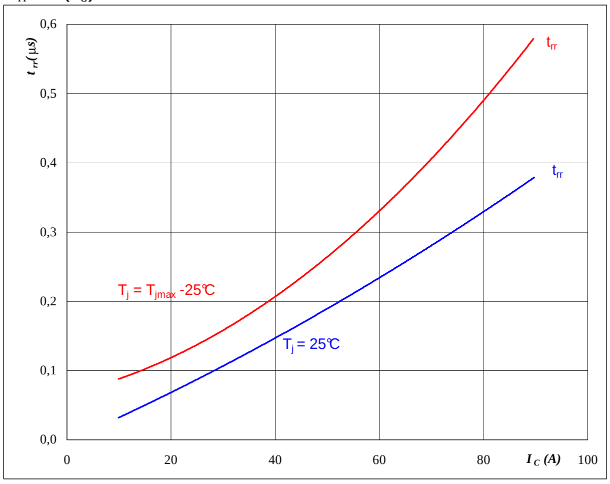
Figure 10 IGBT
Typical switching times as a function of gate resistor
$t = f(R_G)$



With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	50	A

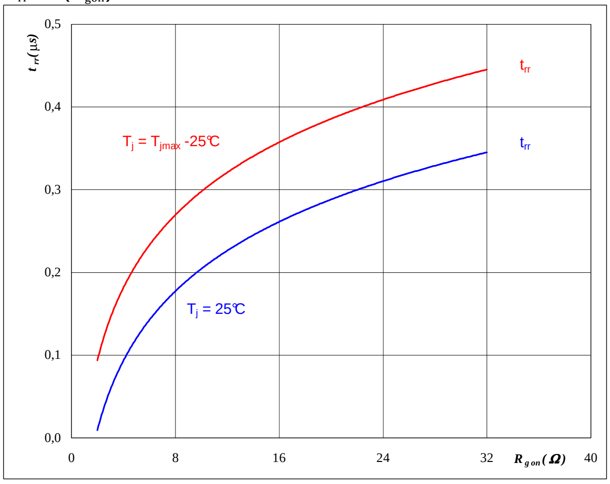
Figure 11 FWD
Typical reverse recovery time as a function of collector current
$t_{rr} = f(I_C)$



At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 12 FWD
Typical reverse recovery time as a function of IGBT turn on gate resistor
$t_{rr} = f(R_{gon})$



At

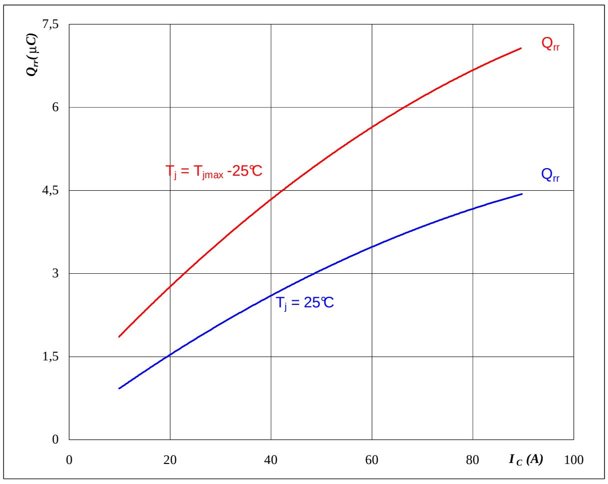
T_j =	25/125	°C
V_R =	300	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 13	FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



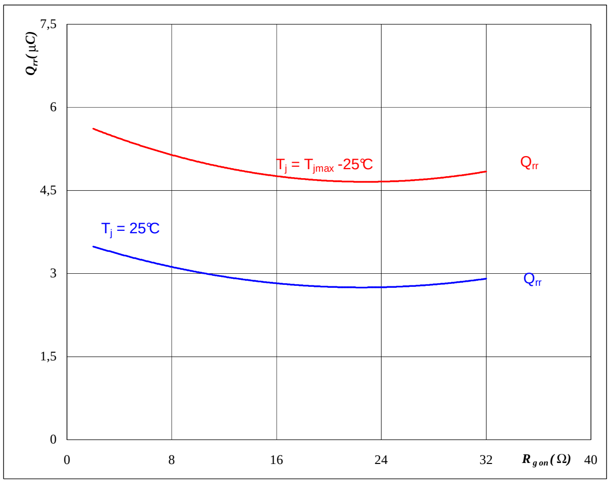
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 14	FWD

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

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



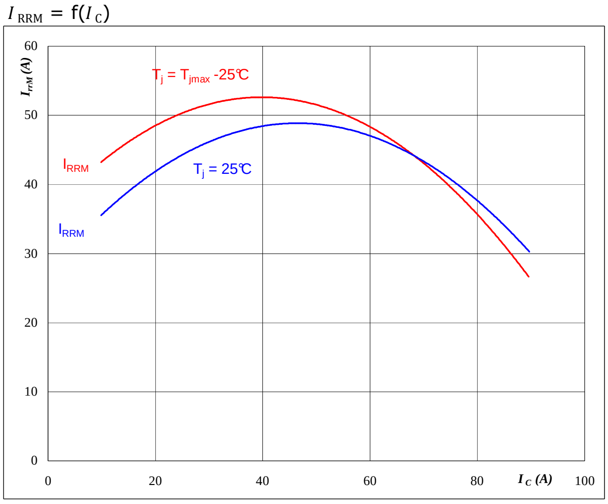
At

T_j =	25/125	°C
V_R =	300	V
I_F =	50	A
V_{GE} =	±15	V

Figure 15	FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



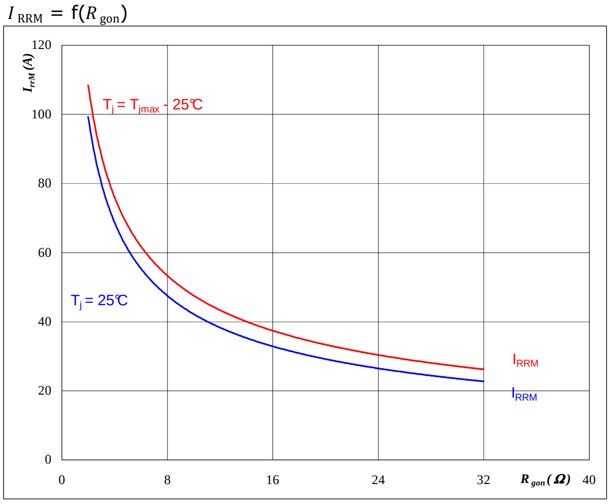
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 16	FWD

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

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



At

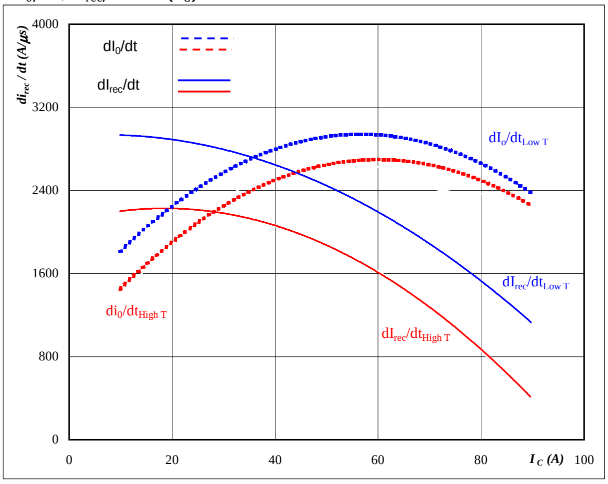
T_j =	25/125	°C
V_R =	300	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 17 FWD

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

$dI_0/dt, dI_{rec}/dt = f(I_C)$



At

T_j = 25/125 °C

V_{CE} = 300 V

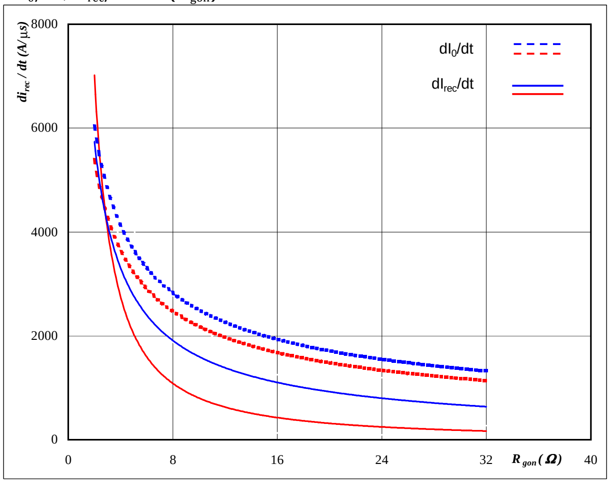
V_{GE} = ±15 V

R_{gon} = 8 Ω

Figure 18 FWD

Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



At

T_j = 25/125 °C

V_R = 300 V

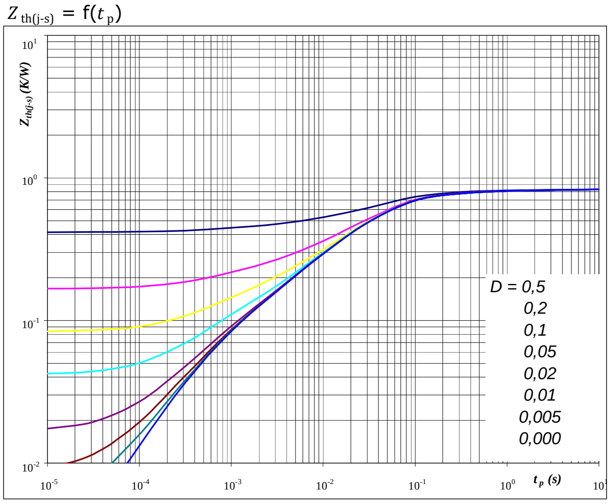
I_F = 50 A

V_{GE} = ±15 V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

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



At

D = t_p / T

$R_{th(j-s)}$ = 0,83 K/W

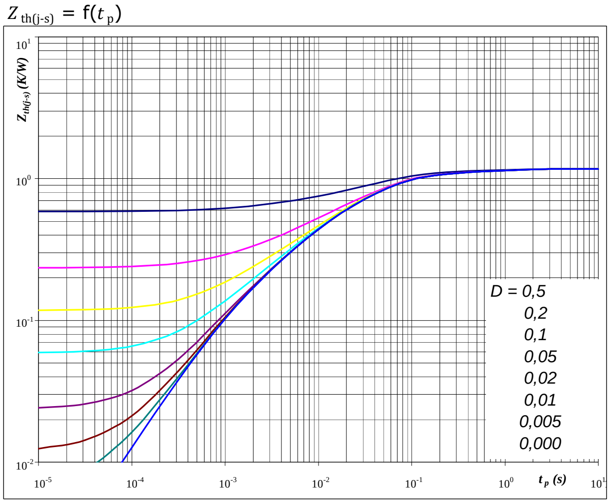
IGBT thermal model values

R (K/W)	Tau (s)
2,94E-02	1,33E+00
7,22E-02	1,75E-01
4,07E-01	2,43E-02
1,80E-01	8,30E-03
9,45E-02	1,77E-03
5,00E-02	2,53E-04

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

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



At

D = t_p / T

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

FWD thermal model values

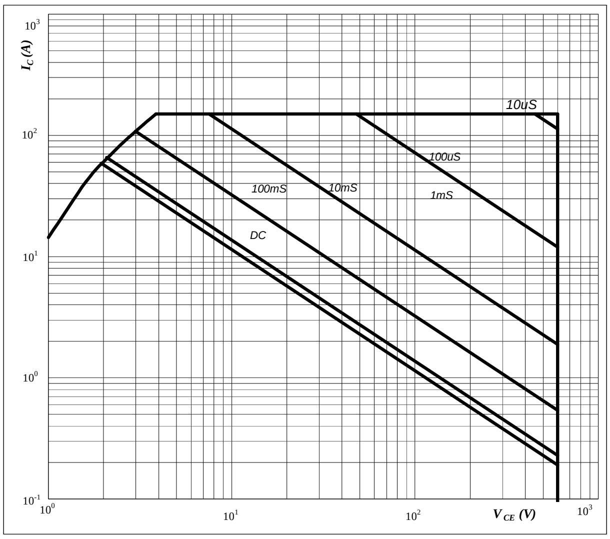
R (K/W)	Tau (s)
7,45E-02	1,00E+00
1,79E-01	1,16E-01
5,74E-01	2,88E-02
2,59E-01	5,49E-03
7,56E-02	1,02E-03
1,08E-02	5,73E-04

Inverter / Brake Characteristics

Figure 25	IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



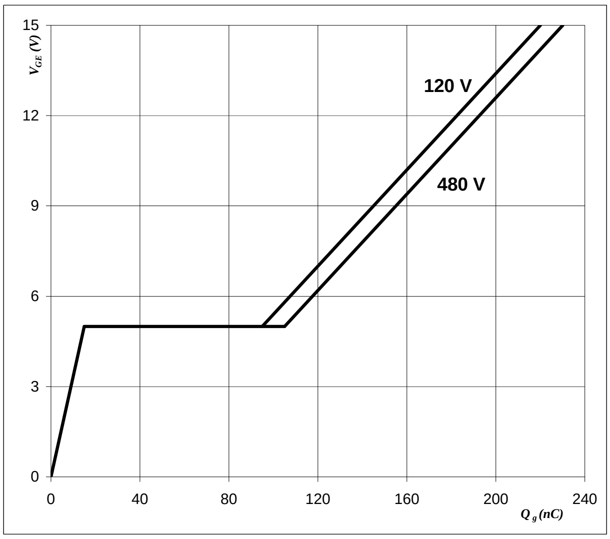
At

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

Figure 26	IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_G)$



At

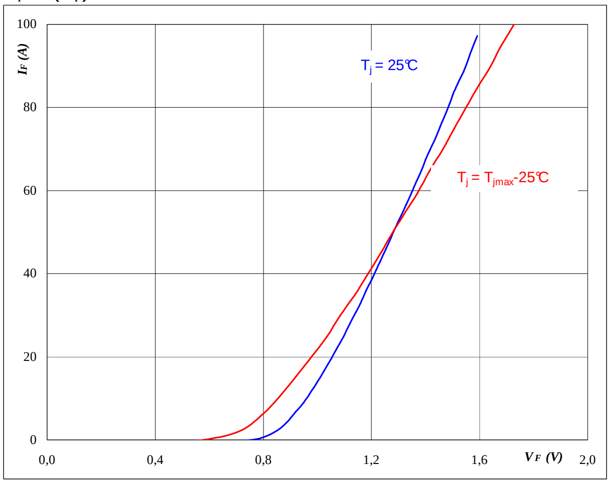
I_C =	50	A

Rectifier Diode

Figure 1 Rectifier Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



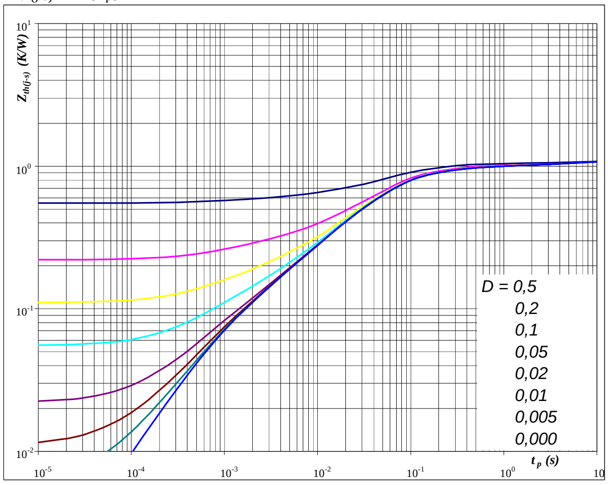
At

t_p = 250 µs

Figure 2 Rectifier Diode

Diode transient thermal impedance as a function of pulse width

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



At

D = t_p / T

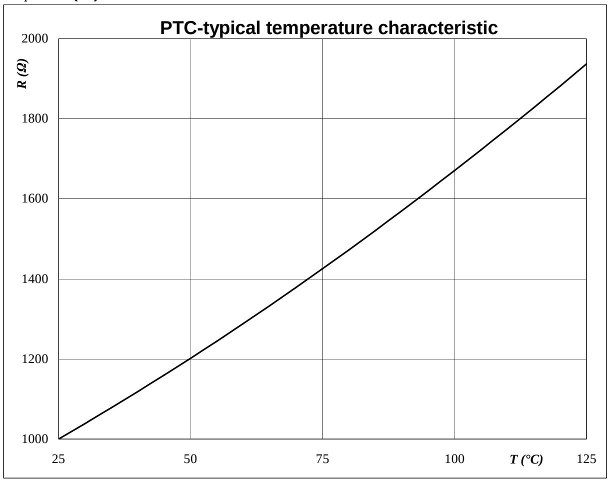
$R_{th(j-s)}$ = 1,08 K/W

Thermistor

Figure 1 Thermistor

Typical PTC characteristic as a function of temperature

$R_T = f(T)$



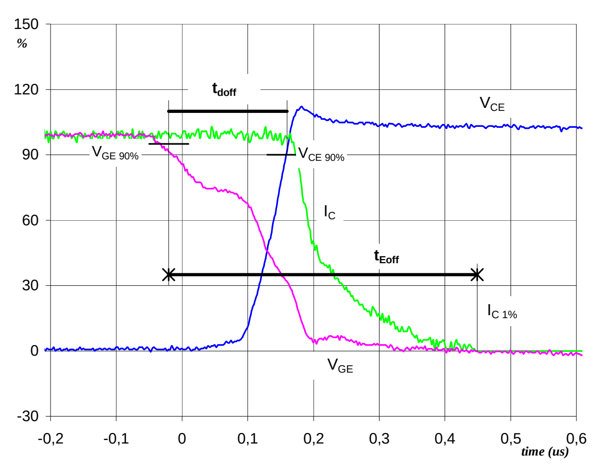
Switching Definitions Inverter

General conditions

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

Figure 1 IGBT

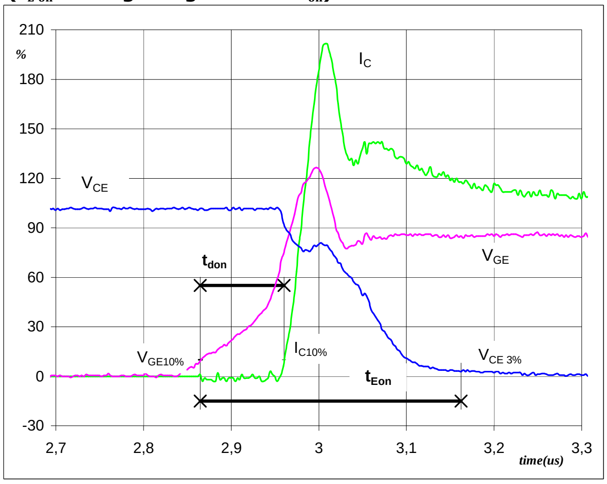
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	50	A
t_{doff} =	0,17	μs
$t_{E\,off}$ =	0,47	μs

Figure 2 IGBT

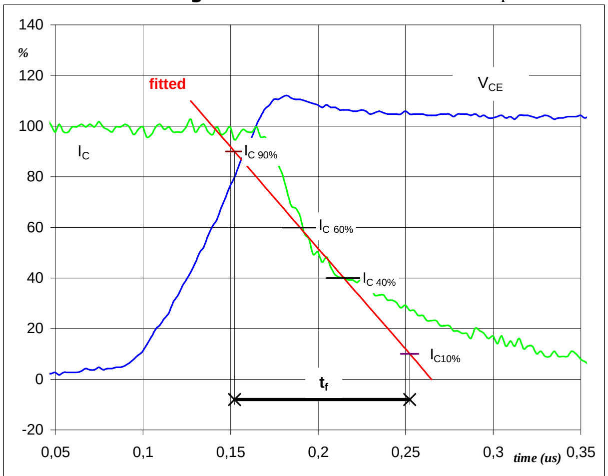
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	50	A
t_{don} =	0,10	μs
$t_{E\,on}$ =	0,30	μs

Figure 3 IGBT

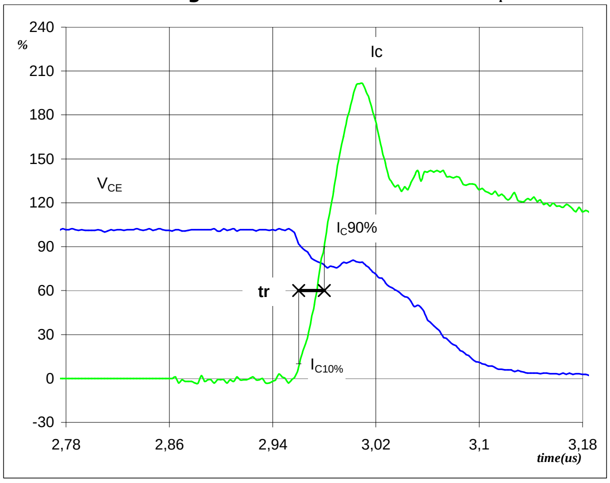
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	50	A
t_f =	0,09	μs

Figure 4 IGBT

Turn-on Switching Waveforms & definition of t_r

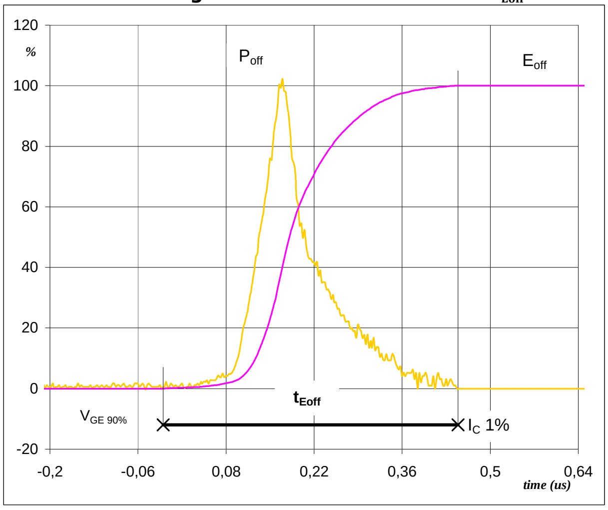


V_C (100%) =	300	V
I_C (100%) =	50	A
t_r =	0,02	μs

Switching Definitions Inverter

Figure 5 IGBT

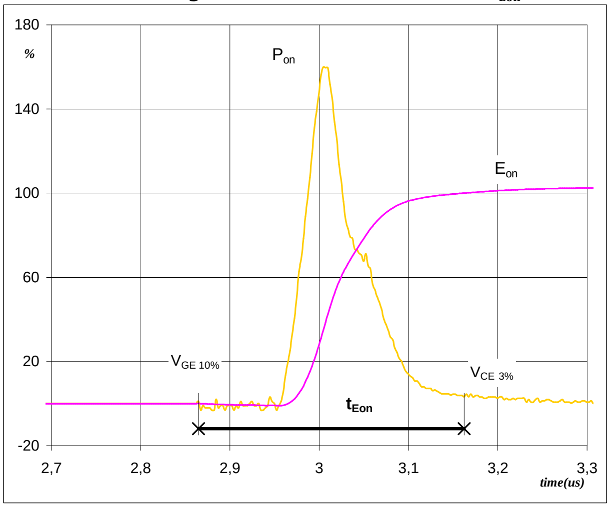
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	14,90	kW
E_{off} (100%) =	1,57	mJ
$t_{E\,off}$ =	0,47	μs

Figure 6 IGBT

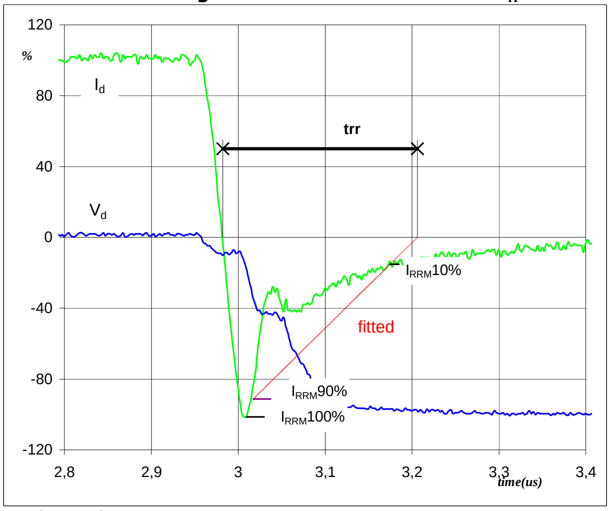
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	14,90	kW
E_{on} (100%) =	1,62	mJ
$t_{E\,on}$ =	0,30	μs

Figure 7 FWD

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

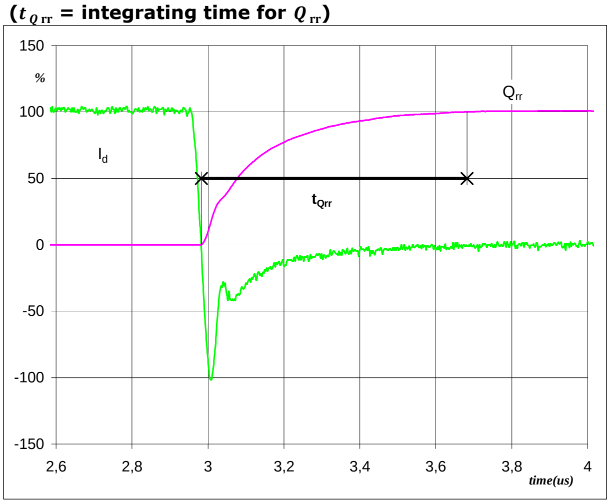


V_d (100%) =	300	V
I_d (100%) =	50	A
I_{RRM} (100%) =	51	A
t_{rr} =	0,27	μs

Switching Definitions Inverter

Figure 8 FWD

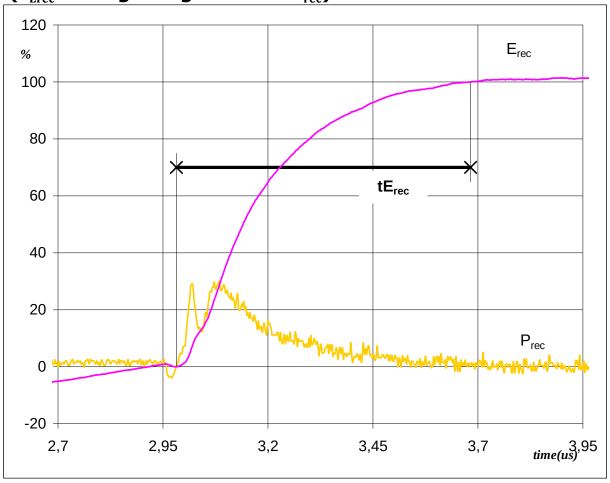
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	50	A
Q_{rr} (100%) =	4,99	μC
$t_{Q\,rr}$ =	0,70	μs

Figure 9 FWD

Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	14,90	kW
E_{rec} (100%) =	0,97	mJ
$t_{E\,rec}$ =	0,70	μs

Ordering Code and Marking - Outline - Pinout

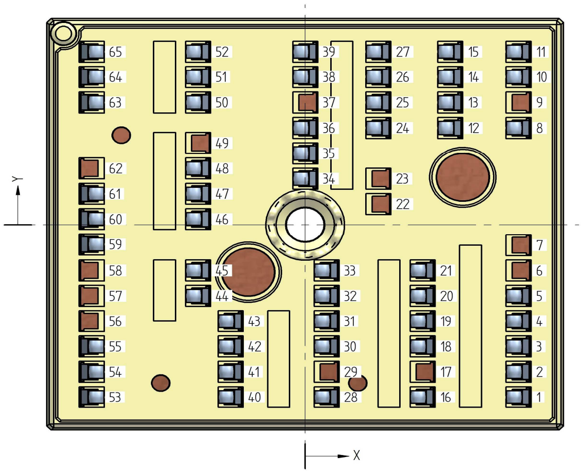
Ordering Code & Marking

Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K223-A-/0A/-PM
With thin lid (2.8mm height) + no thermal grease	V23990-K223-A-/0B/-PM
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K223-A-/1A/-PM
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K223-A-/1B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K223-A-/4A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K223-A-/4B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K223-A-/5A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K223-A-/5B/-PM

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

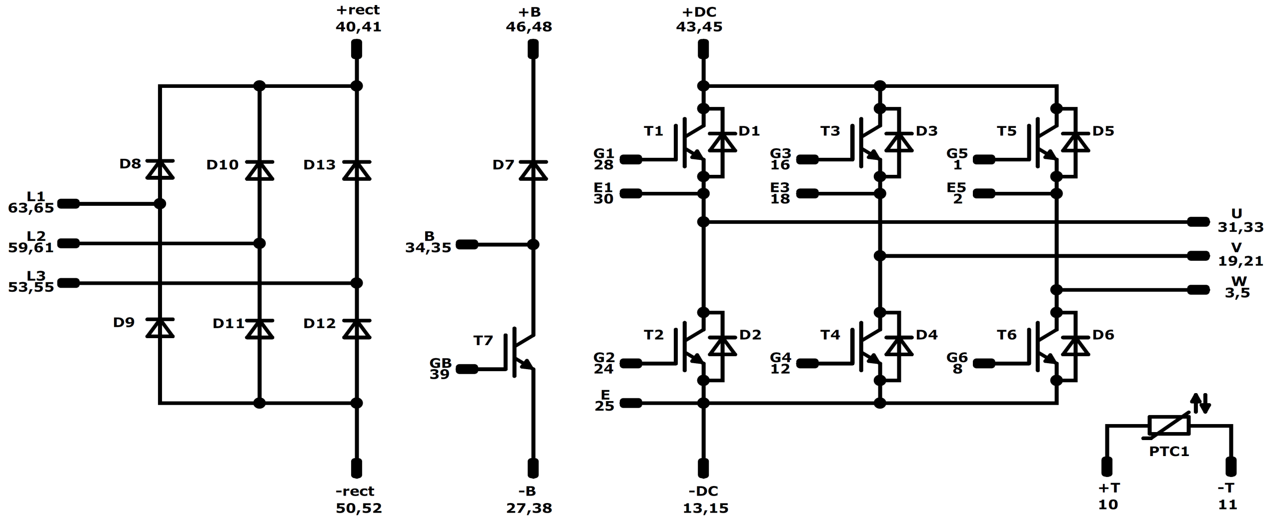
Outline

Pin	X	Y	Function	Pin	X	Y	Function
1	24,38	-22	G5	35	0,03	9	B
2	24,38	-19	E5	36	0,03	12,2	B
3	24,38	-15	W	37	Not assembled		
4	24,38	-12	W	38	0,03	18,6	-B
5	24,38	-9	W	39	0,03	21,8	GB
6	Not assembled			40	-8,5	-21,8	+rect
7	Not assembled			41	-8,5	-18,6	+rect
8	24,38	12,2	G6	42	-8,5	-15,4	+rect
9	Not assembled			43	-8,5	-12,2	+DC
10	24,38	18,6	+T	44	-12,2	-9	+DC
11	24,38	21,8	-T	45	-12,2	-5,8	+DC
12	16,58	12,2	G4	46	-12,2	0,7	+B
13	16,58	15,4	-DC	47	-12,2	3,9	+B
14	16,58	18,6	-DC	48	-12,2	7,1	+B
15	16,58	21,8	-DC	49	Not assembled		
16	13,42	-22	G3	50	-12,2	15,4	-rect
17	Not assembled			51	-12,2	18,6	-rect
18	13,42	-15	E3	52	-12,2	21,8	-rect
19	13,42	-12	V	53	-24,4	-21,8	L3
20	13,42	-9	V	54	-24,4	-18,6	L3
21	13,42	-5,8	V	55	-24,4	-15,4	L3
22	Not assembled			56	Not assembled		
23	Not assembled			57	Not assembled		
24	8,38	12,2	G2	58	Not assembled		
25	8,38	15,4	E	59	-24,4	-2,5	L2
26	8,38	18,6	-B	60	-24,4	0,7	L2
27	8,38	21,8	-B	61	-24,4	3,9	L2
28	2,46	-22	G1	62	Not assembled		
29	Not assembled			63	-24,4	15,4	L1
30	2,46	-15	E1	64	-24,4	18,6	L1
31	2,46	-12	U	65	-24,4	21,8	L1
32	2,46	-9	U				
33	2,46	-5,8	U				
34	0,03	5,8	B				



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

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	50 A	Inverter Switch	
D1-D6	FWD	600 V	50 A	Inverter Diode	
T7	IGBT	600 V	50 A	Brake Switch	
D7	FWD	600 V	50 A	Brake Diode	
D8-D13	Diode	1600 V	35 A	Rectifier Diode	
PTC1	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-K223-A-D5-14	08 Oct. 2018	Thermal interface change to HPTP	All