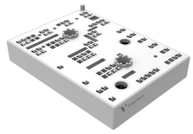
MiniSKiiP® 3 PIM **1200 V / 50 A**

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology

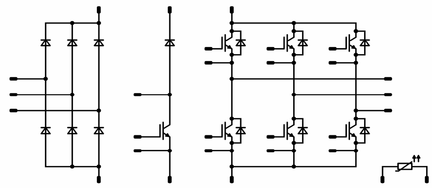
MiniSKiiP® 3 housing



Target Applications

- Industrial Drives

Schematic



Types

- V23990-K428-A40-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}		50	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms T_j = 25 °C	490	A
I^2t-value	I^2t	t_p = 10 ms T_j = 25 °C	1200	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	77	W
Maximum Junction Temperature	T_{jmax}		150	°C
Inverter Switch / Brake Switch				
Collector-emitter breakdown voltage	V_{CE}		1200	V
DC collector current	I_C		50	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	150	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	133	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j = 150 °C V_{GE} = 15 V	10 800	μs V
Maximum Junction Temperature	T_{jmax}		175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter Diode / Brake Diode					
Repetitive peak reverse voltage	V_{RRM}			1200	V
DC forward current	I_F			50	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		150	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	100	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}	DC test voltage*	t = 2 s	5500	V
		AC voltage	t = 1 min	2500	V
Creepage distance		With std lid For more information see handling instructions		6,3	mm
Clearance		With std lid For more information see handling instructions		6,3	mm
Comparative Tracking Index	CTI			>200	

* 100 % tested in production

Characteristic Values

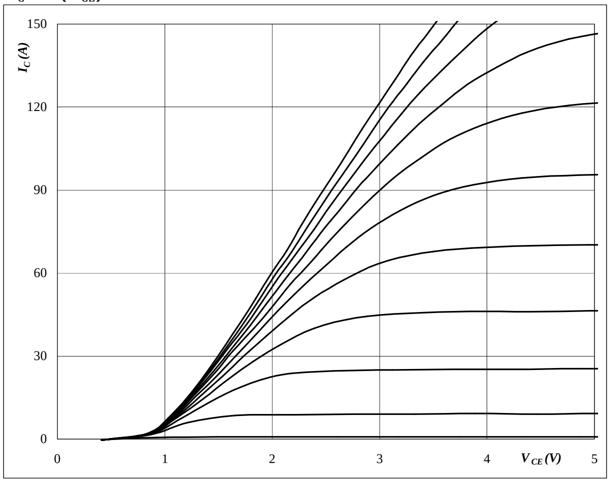
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	
Rectifier Diode										
Forward voltage	V_F				35	25 125	0,8	1,1 1,02	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					25 125		0,9 0,74		V
Slope resistance (for power loss calc. only)	r_t					25 125		0,004 0,006		Ω
Reverse current	I_r			1500		25 125			0,1 1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,75		K/W
Inverter Switch / Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0017	25 150	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		50	25 150	1,6	1,91 2,39	2,4	V
Collector-emitter cut-off current incl. Diode	I_{CES}			1200		25 150			0,06	mA
Gate-emitter leakage current	I_{GES}		20	0		25 150			600	nA
Integrated Gate resistor	R_{gint}							4		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 8 Ω	±15	600	50	25 150		106 111		ns
Rise time	t_r					25 150		18 25		
Turn-off delay time	$t_{d(off)}$					25 150		228 298		
Fall time	t_f					25 150		84 125		
Turn-on energy loss	E_{on}					25 150		2,66 4,46		mWs
Turn-off energy loss	E_{off}					25 150		2,78 4,58		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		2770		pF
Output capacitance	C_{oss}							205		
Reverse transfer capacitance	C_{rss}							160		
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,58		K/W
Inverter Diode / Brake Diode										
Diode forward voltage	V_F				50	25 150	1,5	2,19 2,21	2,9	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 8 Ω	±15	600	50	25 150		61,3 70,7		A
Reverse recovery time	t_{rr}					25 150		144 312		ns
Reverse recovered charge	Q_{rr}					25 150		3,74 8,8		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		3494 950		A/μs
Reverse recovered energy	E_{rec}					25 150		1,38 3,48		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,77		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					100		1670		Ω
Power dissipation constant						25				mW/K
A-value	$B_{(25/50)}$	Tol. %				25		$7{,}635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$	Tol. %				25		$1{,}731 \cdot 10^{-5}$		1/K²
Vincotech NTC Reference									E	

Inverter / Brake Characteristics

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



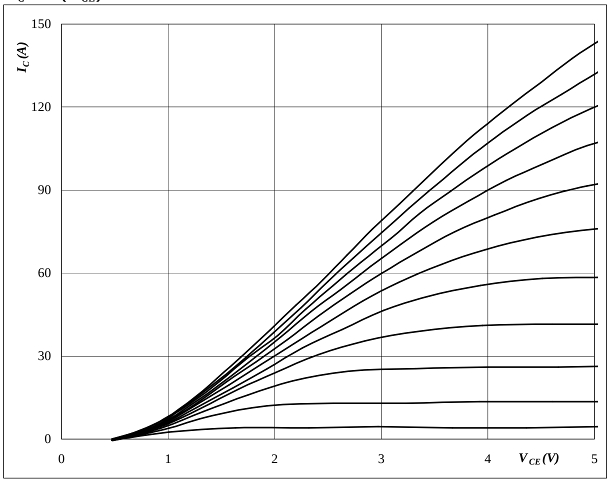
At

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

$I_C = f(V_{CE})$



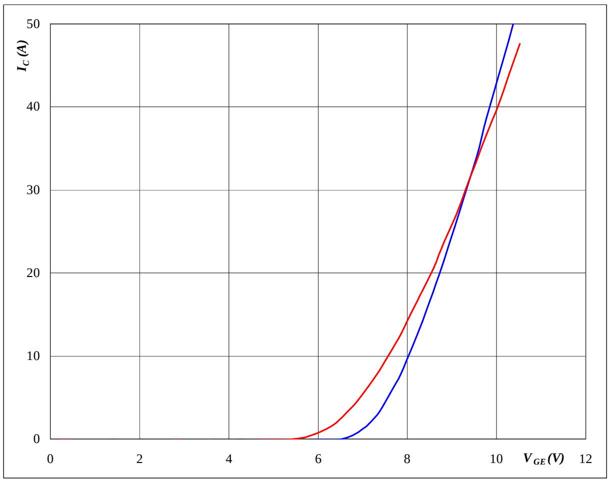
At

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

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



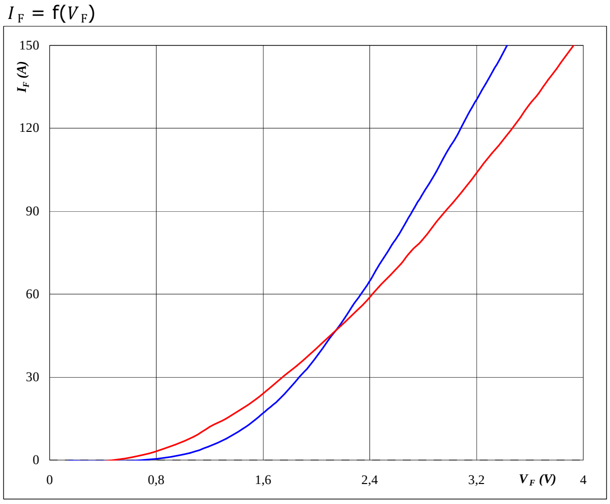
At

T_j =	25/150	°C
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

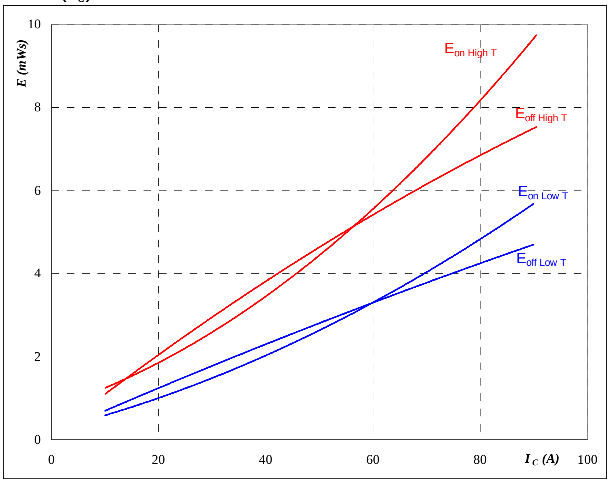
T_j =	25/150	°C
t_p =	250	µs

e Characteristics

Figure 5 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



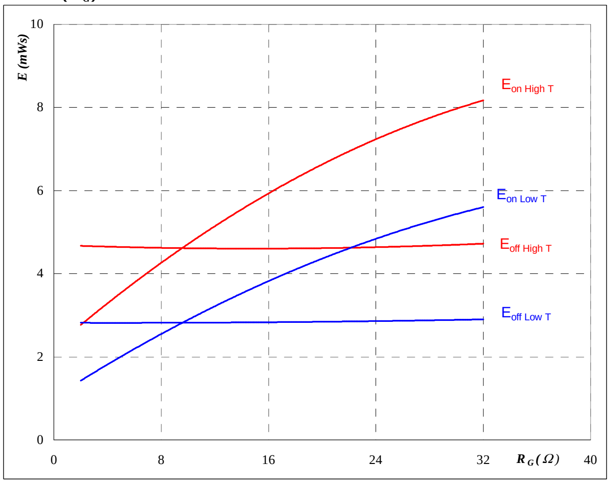
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	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

$E = f(R_G)$



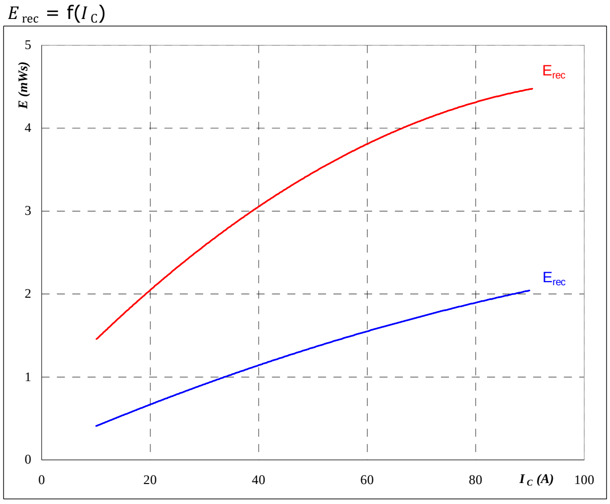
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Figure 7 FWD

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



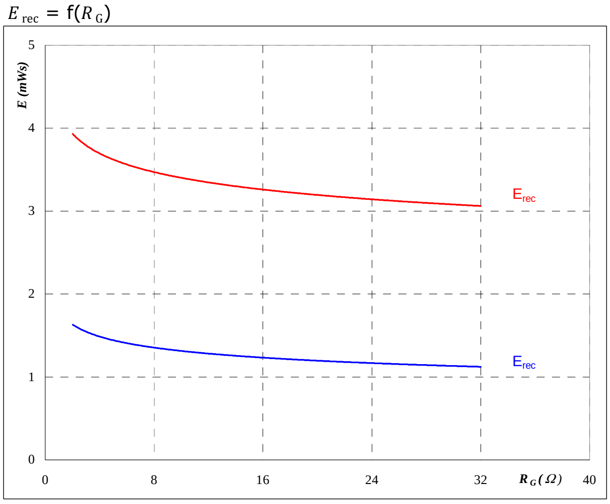
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	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

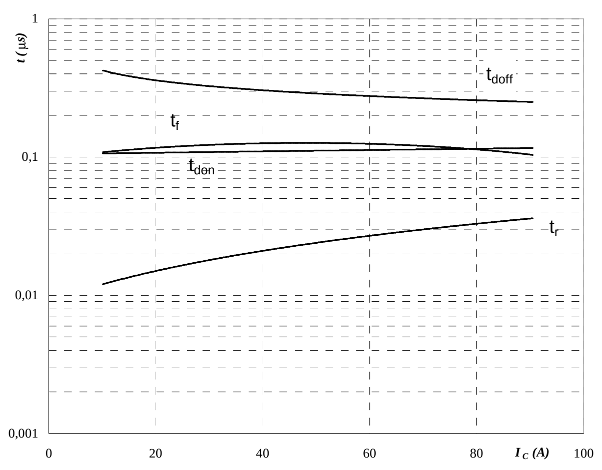
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Inverter / Brake Characteristics

Figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



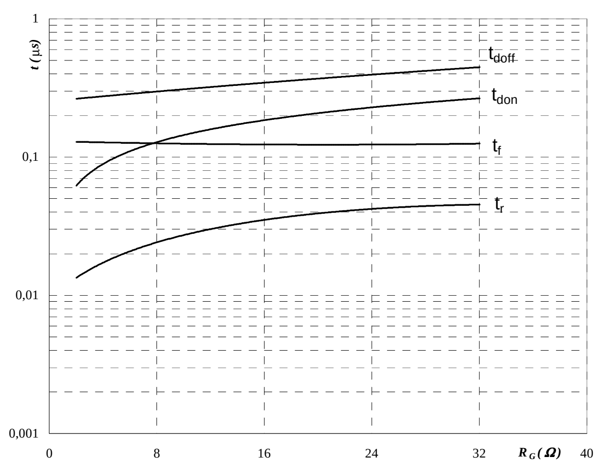
With an inductive load at

T_j =	150	°C
V_{CE} =	600	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

$t = f(R_G)$



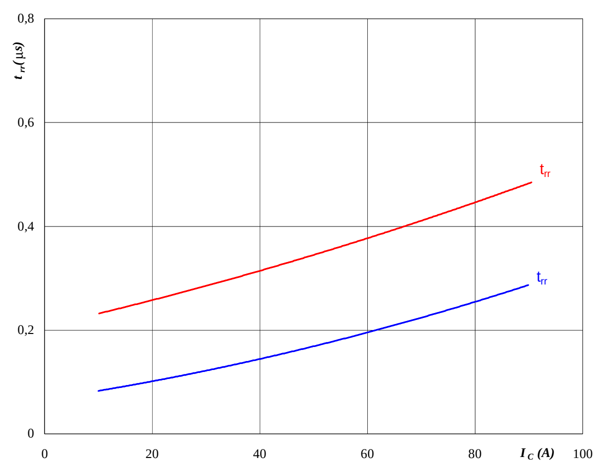
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



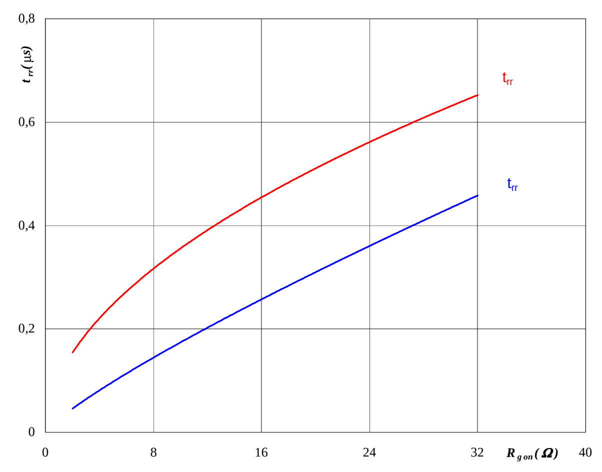
At

T_j =	25/150	°C
V_{CE} =	600	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

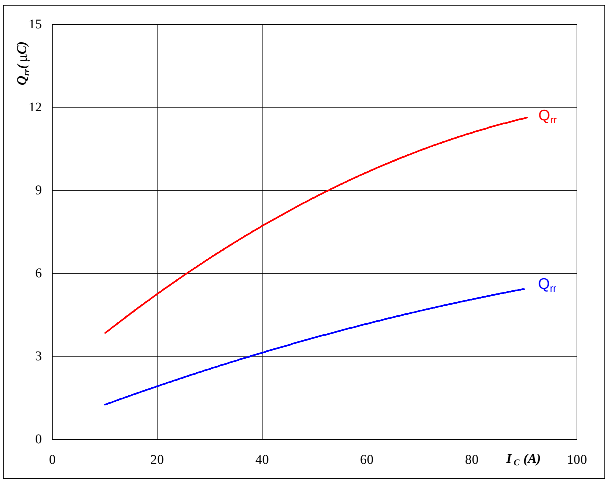
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



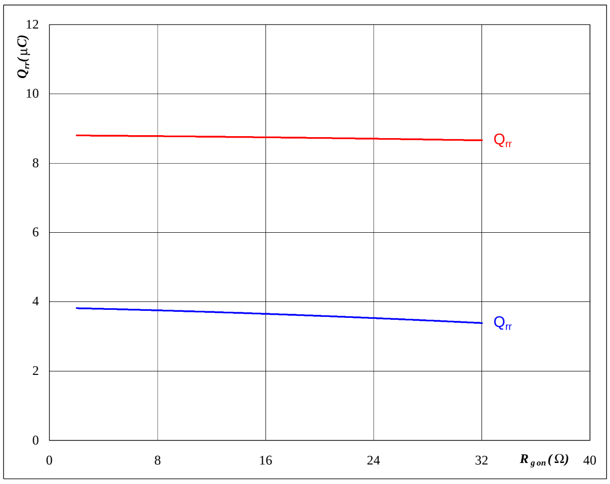
At

T_j =	25/150	°C
V_{CE} =	600	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

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



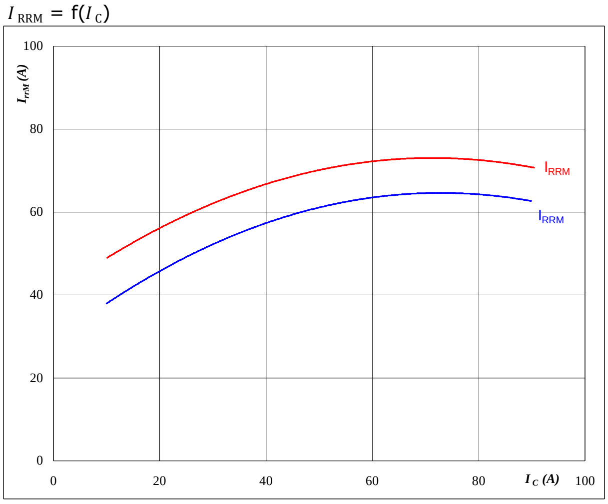
At

T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



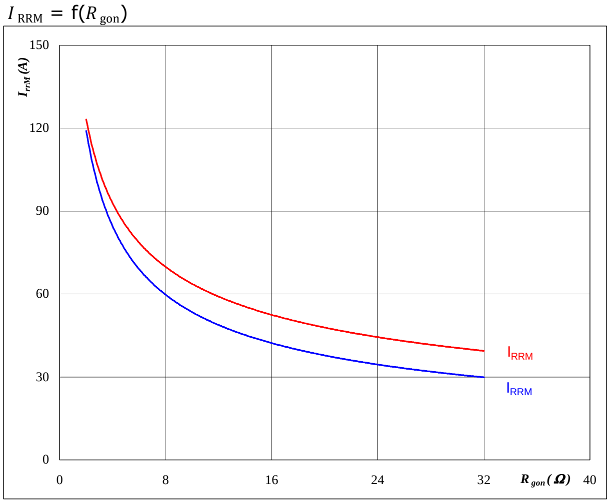
At

T_j =	25/150	°C
V_{CE} =	600	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

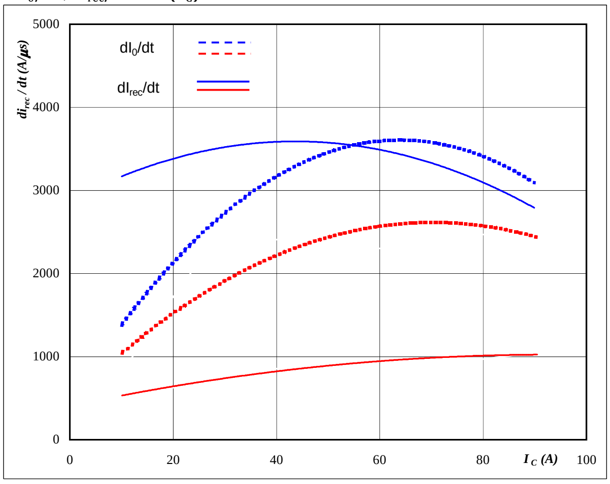
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 17 FWD

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

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



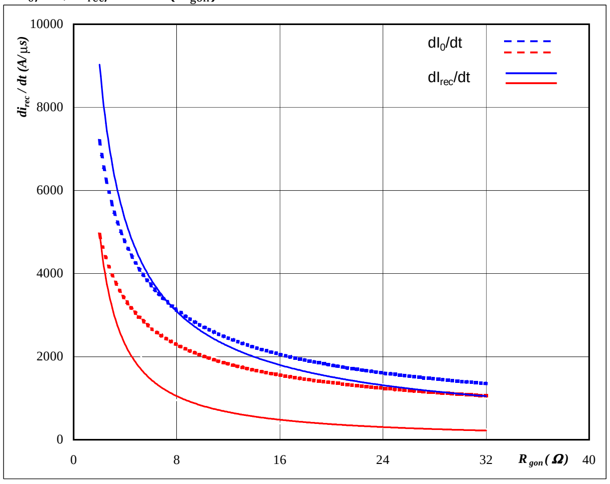
At

T_j =	25/150	°C
V_{CE} =	600	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

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



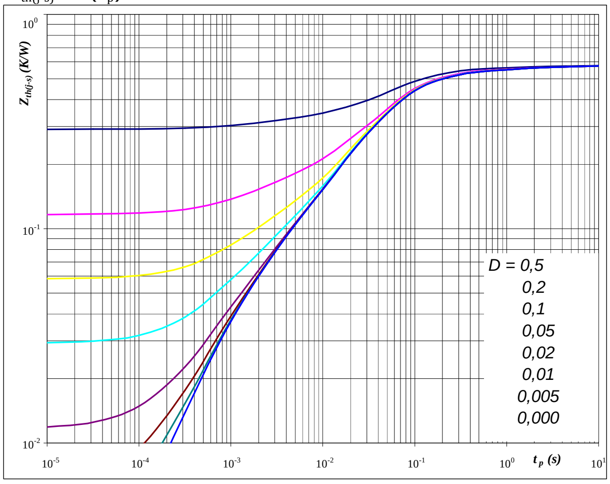
At

T_j =	25/150	°C
V_R =	600	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	
$R_{th(j-s)}$ =	0,58	K/W

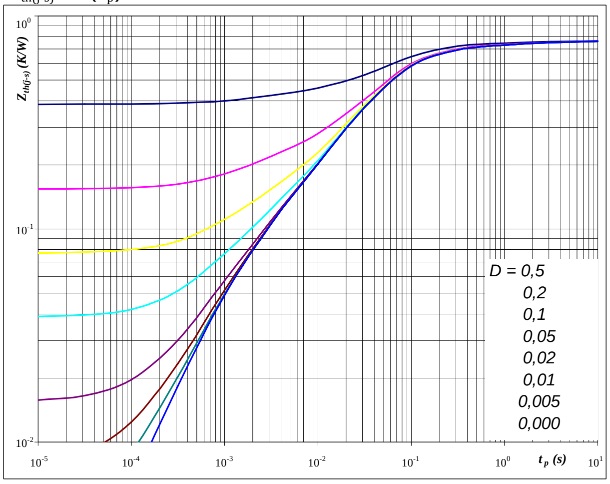
IGBT thermal model values

R (K/W)	Tau (s)
2,17E-02	4,34E+00
4,06E-02	3,69E-01
1,08E-01	6,60E-02
3,12E-01	2,21E-02
5,81E-02	4,29E-03
3,90E-02	6,58E-04
2,69E-03	3,18E-04

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

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



At

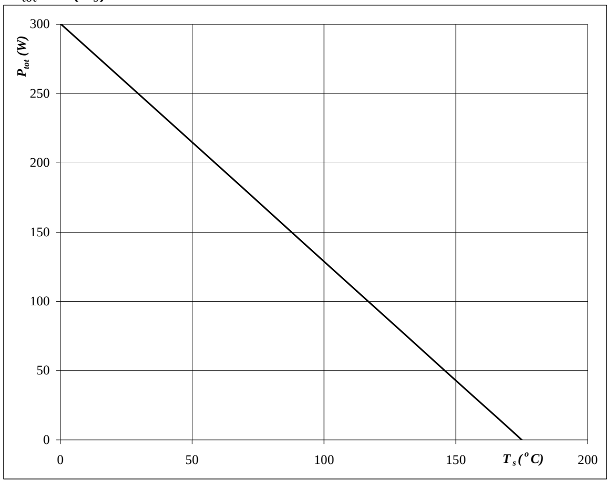
D =	t_p / T	
$R_{th(j-s)}$ =	0,77	K/W

FWD thermal model values

R (K/W)	Tau (s)
2,87E-02	5,74E+00
5,37E-02	4,89E-01
1,43E-01	8,73E-02
4,13E-01	2,92E-02
7,69E-02	5,67E-03
5,16E-02	8,71E-04
3,56E-03	4,21E-04

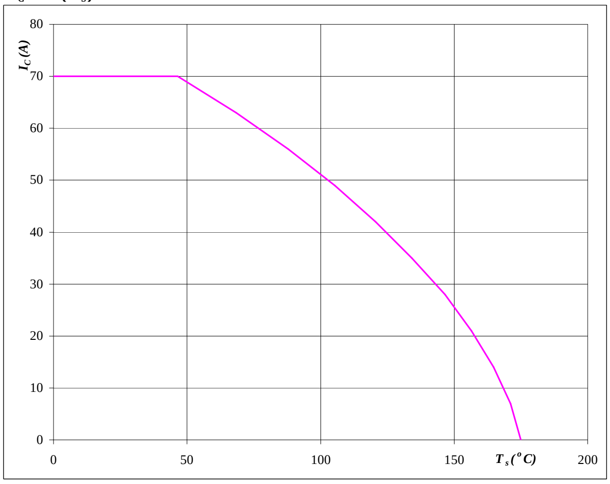
Inverter / Brake Characteristics

Figure 21 IGBT
Power dissipation as a function of heatsink temperature
$P_{tot} = f(T_s)$



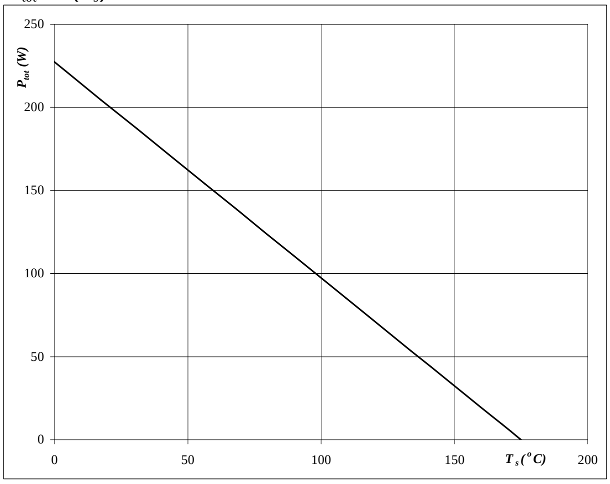
At
T_j = 175 °C

Figure 22 IGBT
Collector current as a function of heatsink temperature
$I_C = f(T_s)$



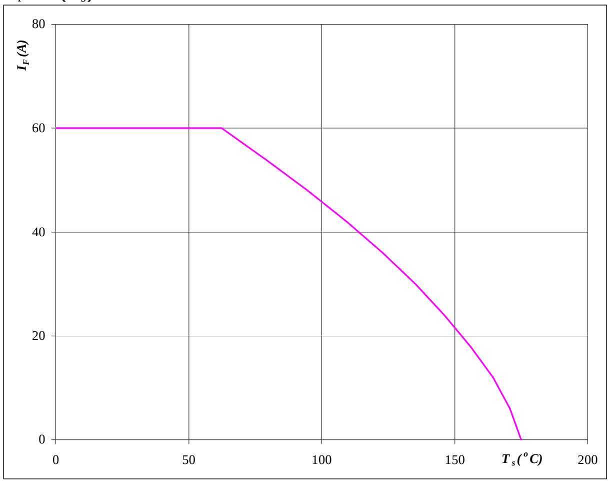
At
T_j = 175 °C
V_{GE} = 15 V

Figure 23 FWD
Power dissipation as a function of heatsink temperature
$P_{tot} = f(T_s)$



At
T_j = 175 °C

Figure 24 FWD
Forward current as a function of heatsink temperature
$I_F = f(T_s)$



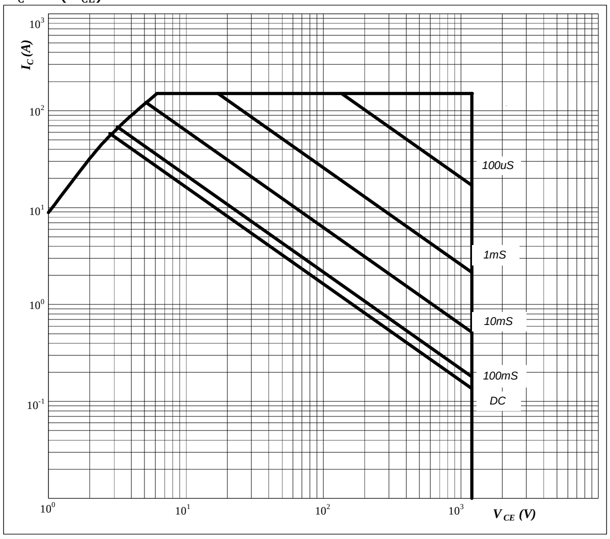
At
T_j = 175 °C

Inverter / Brake Characteristics

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



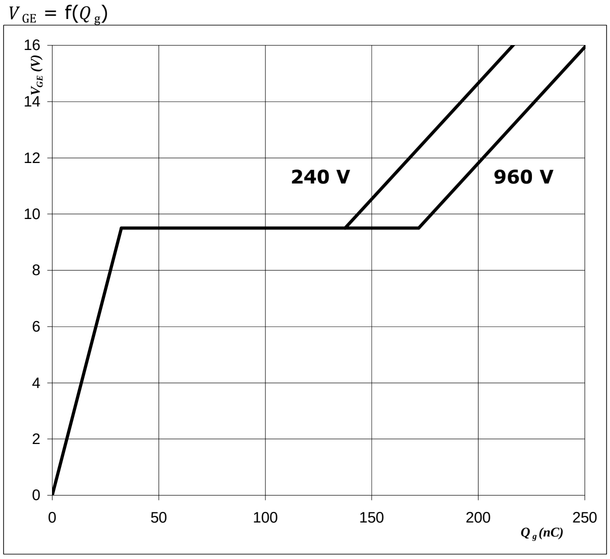
At

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

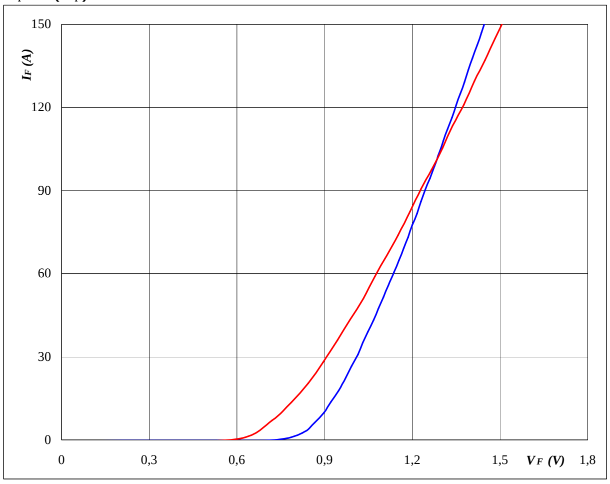
I_C =	50	A

Rectifier Diode

Figure 1 Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

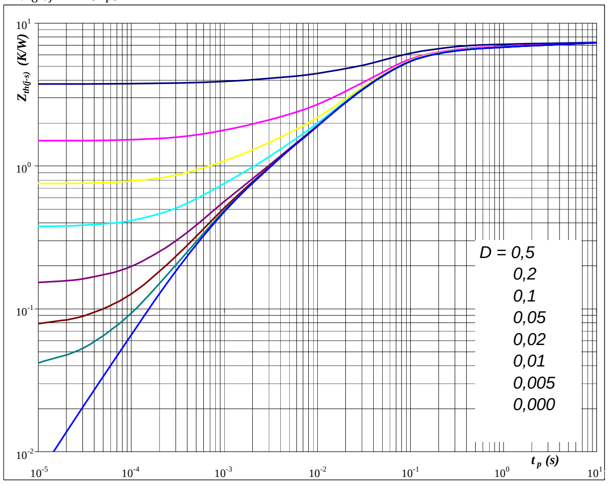
T_j = 25/125 °C

t_p = 250 μs

Figure 2 Diode

Diode transient thermal impedance as a function of pulse width

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



At

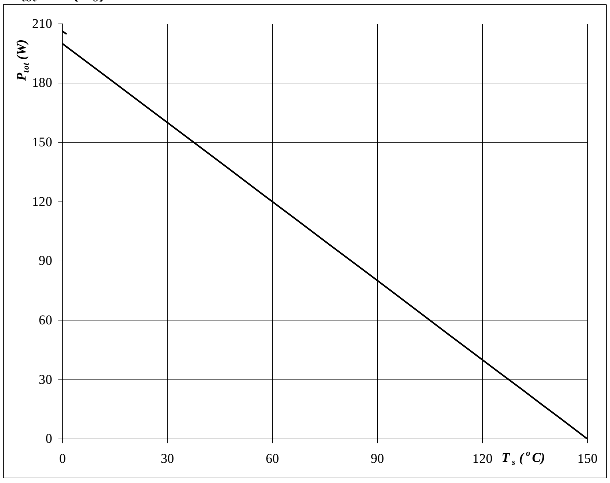
D = t_p / T

$R_{th(j\text{-}s)}$ = 0,75 K/W

Figure 3 Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



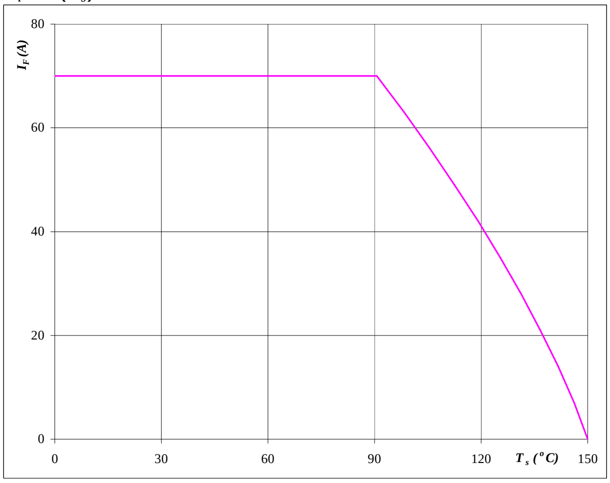
At

T_j = 150 ºC

Figure 4 Diode

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



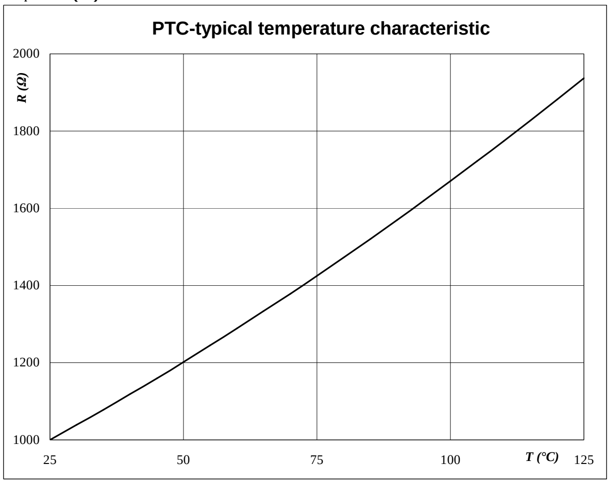
At

T_j = 150 ºC

Thermistor

Figure 1	Thermistor

Typical PTC characteristic
as a function of temperature
$R_T = f(T)$



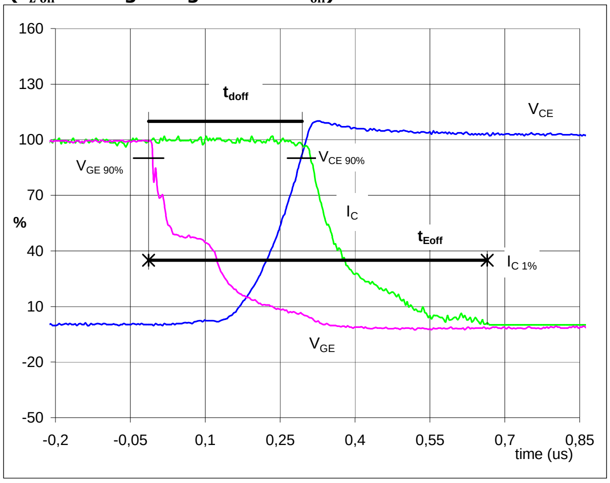
Switching Definitions Inverter

General conditions

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

Figure 1 IGBT

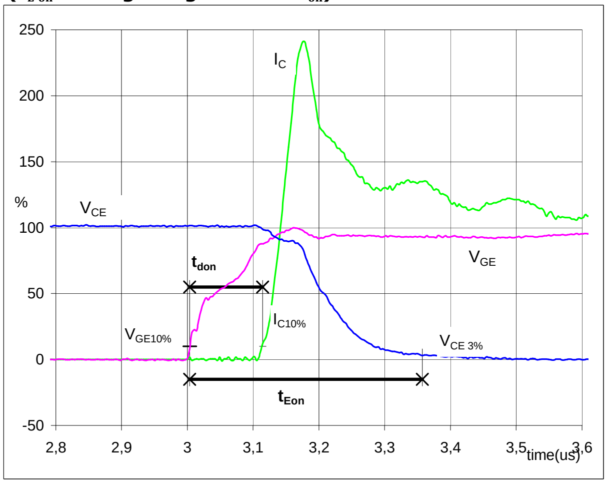
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{doff} =	0,30	μs
$t_{E\,off}$ =	0,68	μs

Figure 2 IGBT

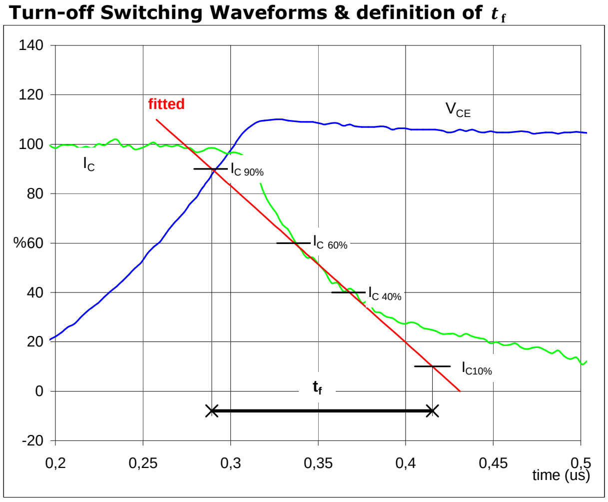
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{don} =	0,11	μs
$t_{E\,on}$ =	0,35	μs

Figure 3 IGBT

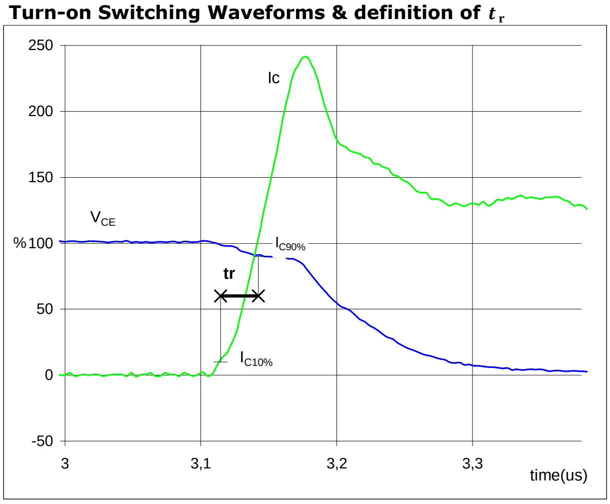
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	50	A
t_f =	0,13	μs

Figure 4 IGBT

Turn-on Switching Waveforms & definition of t_r

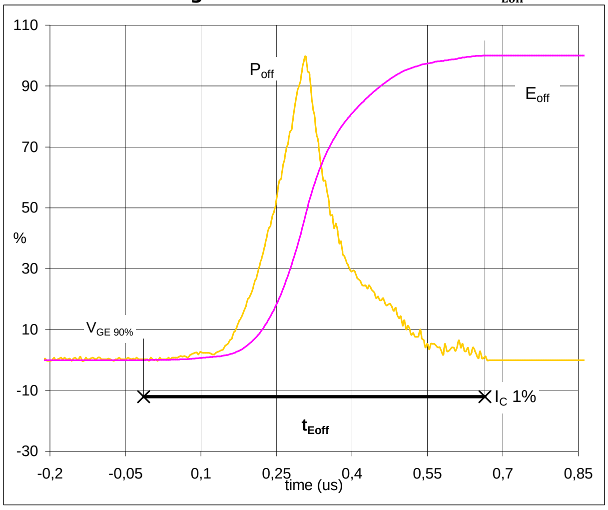


V_C (100%) =	600	V
I_C (100%) =	50	A
t_r =	0,03	μs

Switching Definitions Inverter

Figure 5 IGBT

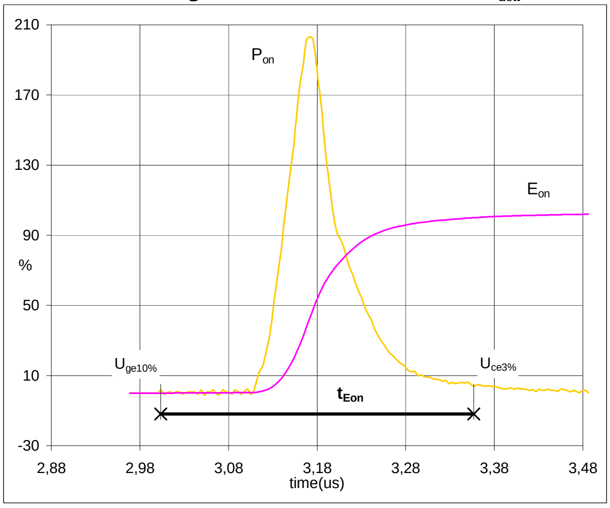
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	29,95	kW
E_{off} (100%) =	4,58	mJ
$t_{E\,off}$ =	0,68	µs

Figure 6 IGBT

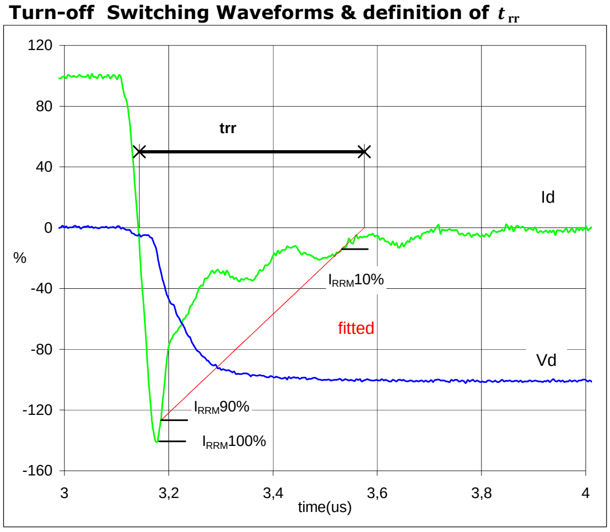
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	29,95	kW
E_{on} (100%) =	4,46	mJ
$t_{E\,on}$ =	0,35	µs

Figure 7 FWD

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

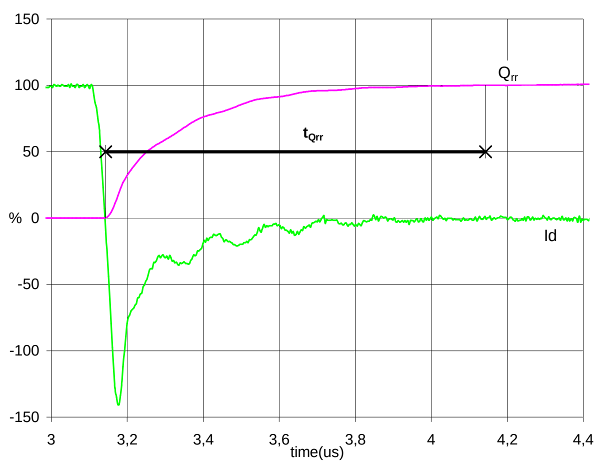


V_d (100%) =	600	V
I_d (100%) =	50	A
I_{RRM} (100%) =	-71	A
t_{rr} =	0,31	µs

Switching Definitions Output Inverter

Figure 8 FWD

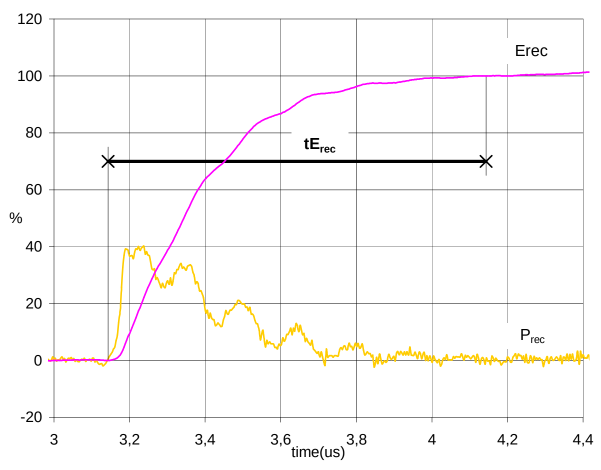
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	50	A
Q_{rr} (100%) =	8,80	μC
t_{Qrr} =	1,00	μs

Figure 9 FWD

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

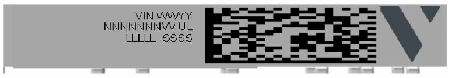


P_{rec} (100%) =	29,95	kW
E_{rec} (100%) =	3,48	mJ
t_{Erec} =	1,00	μs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

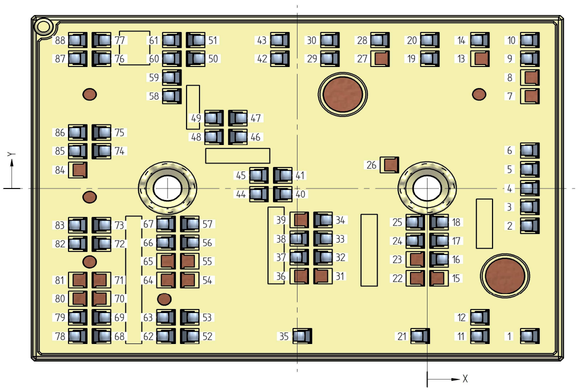
Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K428-A40-/0A/
With thin lid (2.8mm height) + no thermal grease	V23990-K428-A40-/0B/
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K428-A40-/1A/
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K428-A40-/1B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K428-A40-/4A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K428-A40-/4B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K428-A40-/5A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K428-A40-/5B/



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

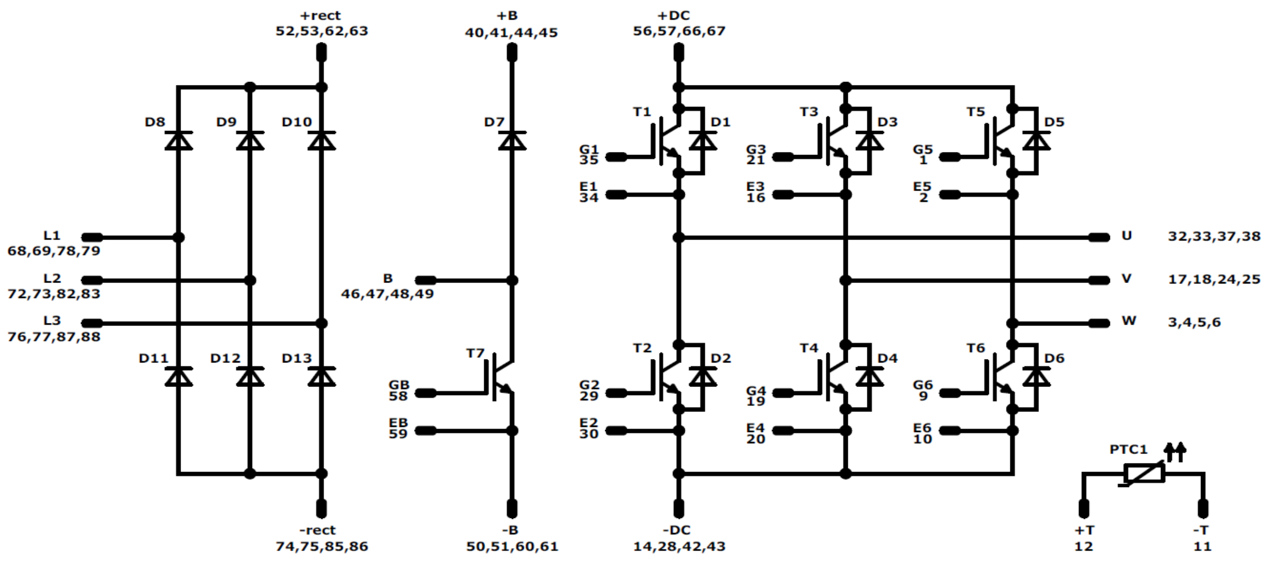
Outline

PCB pad table				PCB pad table			
Pin	X	Y	Function	Pin	X	Y	Function
1	15,83	-25,3	G5	45	-25,9	2,2	+B
2	15,83	-6,4	E5	46	10,82	8,74	B
3	15,83	-3,2	W	47	10,82	11,94	B
4	15,83	0	W	48	-32,82	8,74	B
5	15,83	3,2	W	49	-32,82	11,94	B
6	15,83	6,4	W	50	4,32	22,1	-B
7	Not assembled			51	4,32	25,3	-B
8	Not assembled			52	3,42	-25,3	+rect
9	15,83	22,1	G6	53	3,42	-22,1	+rect
10	15,83	25,3	E6	54	Not assembled		
11	8,13	-25,3	-T	55	Not assembled		
12	8,13	-22,1	+T	56	3,42	-9,3	+DC
13	Not assembled			57	3,42	-6,1	+DC
14	8,13	25,3	-DC	58	-39,32	15,7	GB
15	Not assembled			59	-39,32	18,9	EB
16	41,82	-12,2	E3	60	-39,32	22,1	-B
17	41,82	-8,98	V	61	-39,32	25,3	-B
18	41,82	-5,79	V	62	-40,22	-25,3	+rect
19	0,43	22,1	G4	63	-40,22	-22,1	+rect
20	0,43	25,3	E4	64	Not assembled		
21	-1,07	-25,3	G3	65	Not assembled		
22	Not assembled			66	-40,22	-9,3	+DC
23	Not assembled			67	-40,22	-6,09	+DC
24	-1,82	-8,98	V	68	-10,18	-25,3	L1
25	-1,82	-5,79	V	69	-10,18	-22,1	L1
26	Not assembled			70	Not assembled		
27	Not assembled			71	Not assembled		
28	-7,27	25,3	-DC	72	-10,18	-9,5	L2
29	-14,97	22,1	G2	73	-10,18	-6,3	L2
30	-14,97	25,3	E2	74	-10,18	6,3	-rect
31	Not assembled			75	-10,18	9,5	-rect
32	23,95	-11,8	U	76	-10,18	22,1	L3
33	23,95	-8,63	U	77	-10,18	25,3	L3
34	23,95	-5,42	E1	78	-53,82	-25,3	L1
35	-19,22	-25,3	G1	79	-53,82	-22,1	L1
36	Not assembled			80	Not assembled		
37	-19,7	-11,8	U	81	Not assembled		
38	-19,7	-8,62	U	82	-53,82	-9,5	L2
39	Not assembled			83	-53,82	-6,3	L2
40	17,74	-1	+B	84	Not assembled		
41	17,74	2,2	+B	85	-53,82	6,3	-rect
42	-22,67	22,1	-DC	86	-53,82	9,5	-rect
43	-22,67	25,3	-DC	87	-53,82	22,1	L3
44	-25,9	-1	+B	88	-53,82	25,3	L3



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,T2,T3,T4,T5,T6	IGBT	1200 V	50 A	Inverter Switch	
D1,D2,D3,D4,D5,D6	FWD	1200 V	50 A	Inverter Diode	
T7	IGBT	1200 V	50 A	Brake Switch	
D7	FWD	1200 V	50 A	Brake Diode	
D8,D9,D10,D11,D12,D13	Rectifier	1600 V	50 A	Rectifier Diode	
PTC1	PTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**48**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 3 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 3 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-K428-A40-D8-14	28 Jan. 2018	Updated with HPTP	all