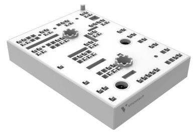
MiniSKiiP® 3 PIM **1200 V / 100 A**

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology

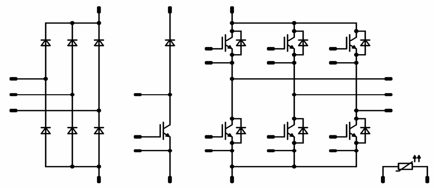
MiniSKiiP® 3 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K420-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}		75	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	500	A
I^2t-value	I^2t	t_p = 10 ms	1250	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	119	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		100	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	300	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	301	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	$T_j = T_{jmax}$	T_s = 80 °C	79	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		300	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	171	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_{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 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	0,97 0,88	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					25 125		0,85 0,71		V
Slope resistance (for power loss calc. only)	r_t					25 125		0,0035 0,0047		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)						0,59		K/W
Inverter Switch / Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0038	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		100	25 150	1,6	1,92 2,33	2,2	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		25			0,12	mA
Gate-emitter leakage current	I_{GES}		20	0		25			600	nA
Integrated Gate resistor	R_{gint}							7,5		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 4Ω R_{gon} = 4Ω	±15	600	100	25 150		204 216		ns
Rise time	t_r					25 150		35 42		
Turn-off delay time	$t_{d(off)}$					25 150		296 384		
Fall time	t_f					25 150		78 112		
Turn-on energy loss	E_{on}					25 150		7,83 12,12		mWs
Turn-off energy loss	E_{off}					25 150		5,72 9,25		
Input capacitance	C_{ies}							6150		pF
Output capacitance	C_{oss}	f = 1 MHz	0	25		25		405		
Reverse transfer capacitance	C_{rss}							345		
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,32		K/W
Inverter Diode / Brake Diode										
Diode forward voltage	V_F				100	25 150	1,5	2,47 2,46	2,7	V
Peak reverse recovery current	I_{RRM}					25 150		68,3 91,3		A
Reverse recovery time	t_{rr}					25 150		267 455		ns
Reverse recovered charge	Q_{rr}	R_{gon} = 4Ω	±15	600	100	25 150		5,69 15,08		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		2761 977		A/μs
Reverse recovered energy	E_{rec}					25 150		1,87 5,42		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,56		K/W

Characteristic Values

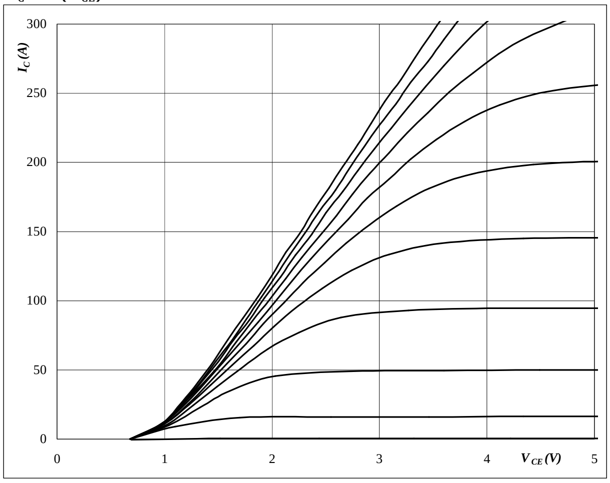
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100}=1670 Ω				100	-3		3	%
R_{100}	P					100		1670		Ω
Power 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 Switch / Brake Switch / Inverter Diode / Brake Diode

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



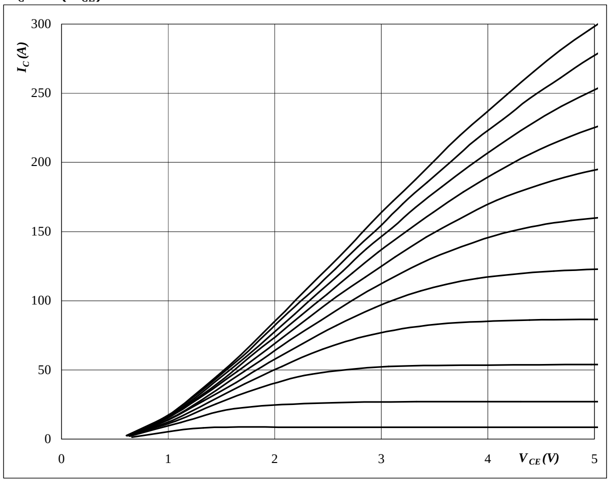
At

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

$I_C = f(V_{CE})$



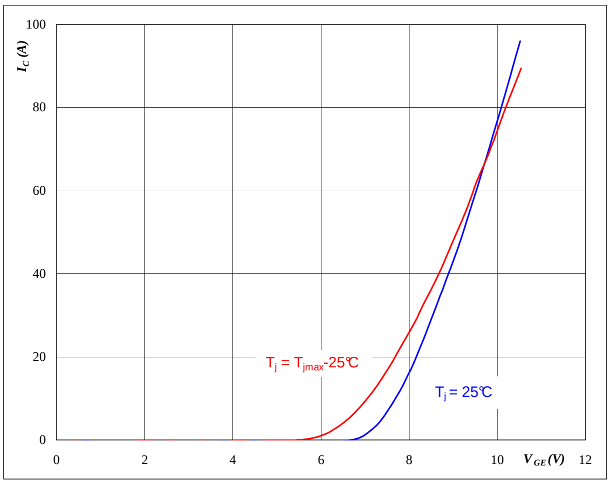
At

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

$I_C = f(V_{GE})$



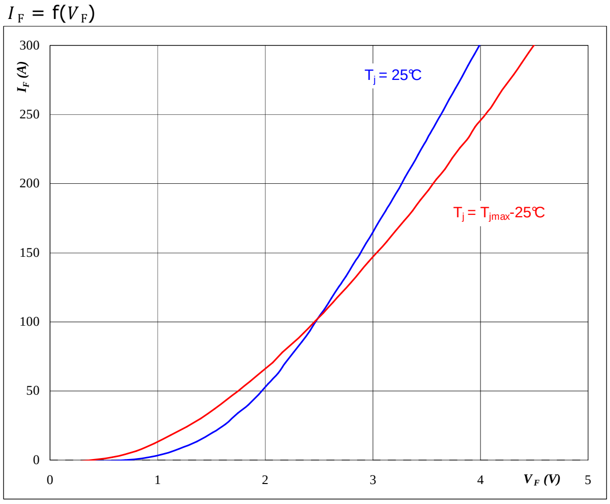
At

t_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

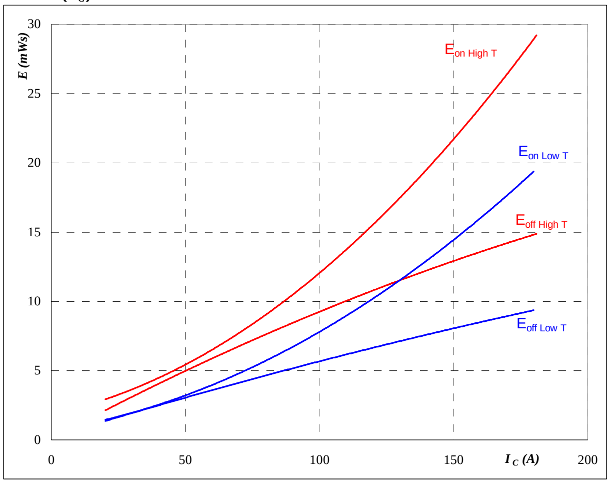
t_p =	250	μs

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 5. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



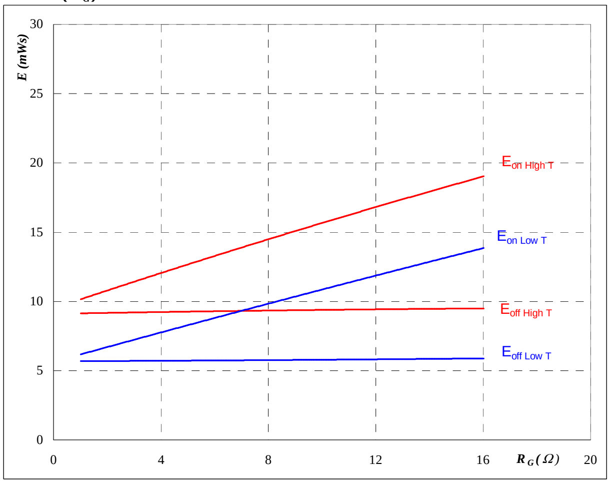
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

figure 6. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



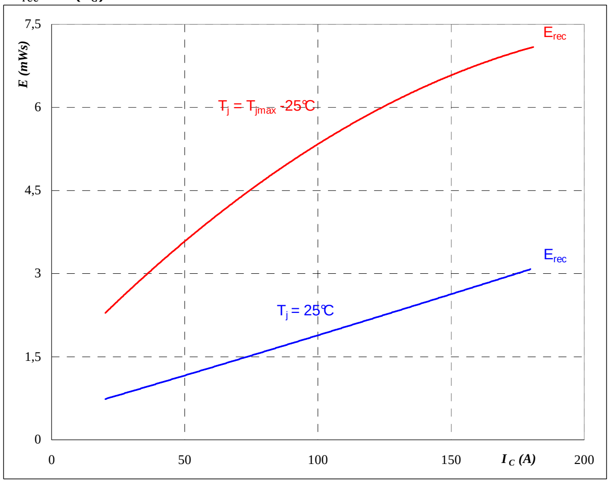
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	100	A

figure 7. **IGBT**

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



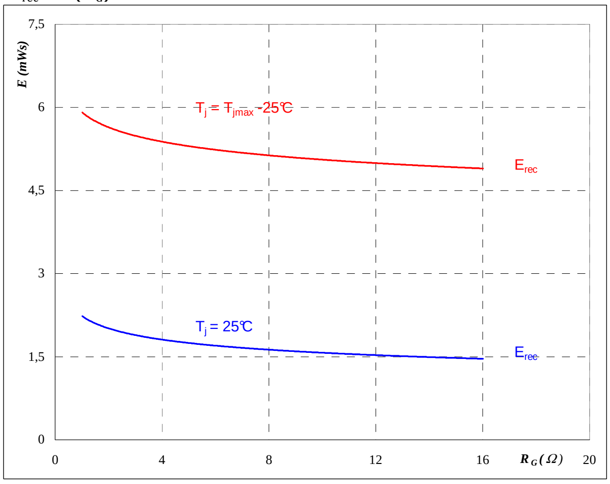
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω

figure 8. **IGBT**

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

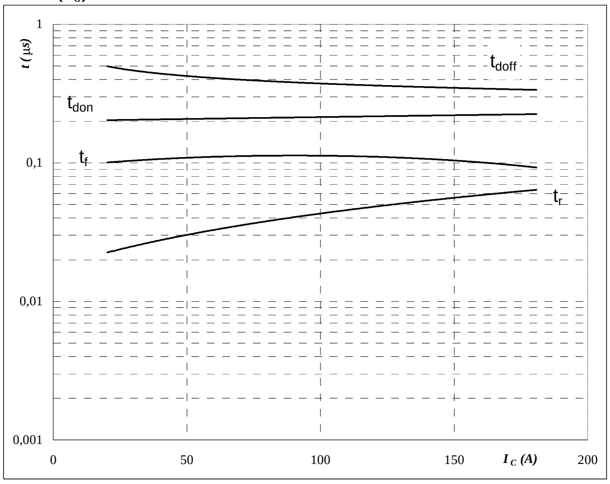
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	100	A

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



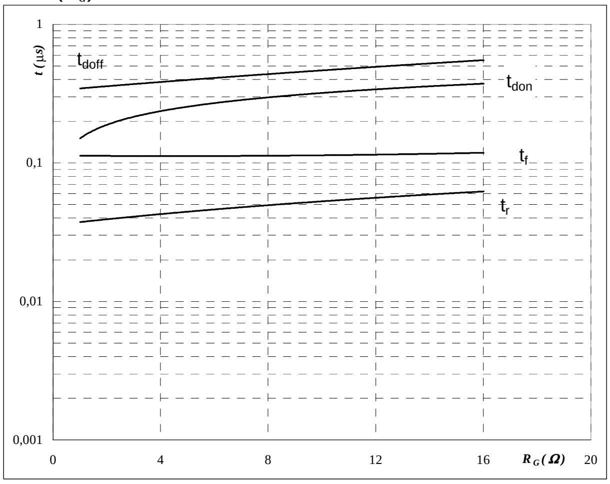
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



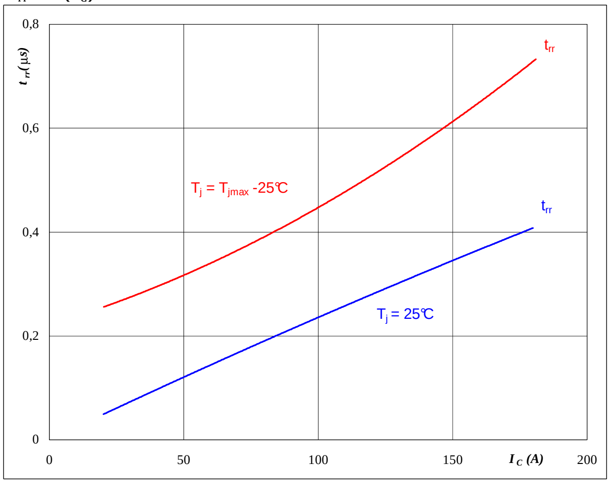
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	100	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



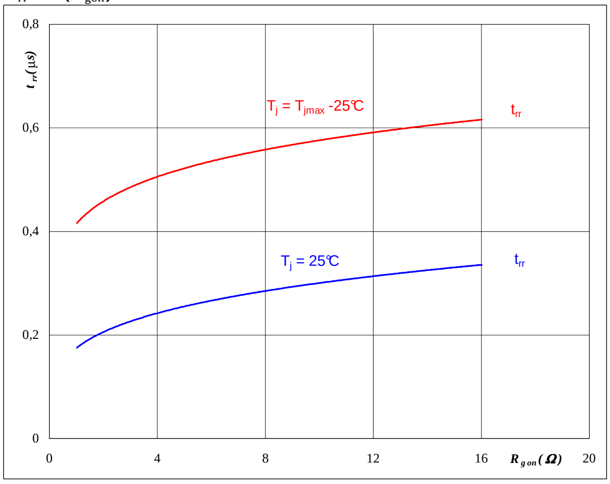
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω

figure 12. **FWD**

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

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



At

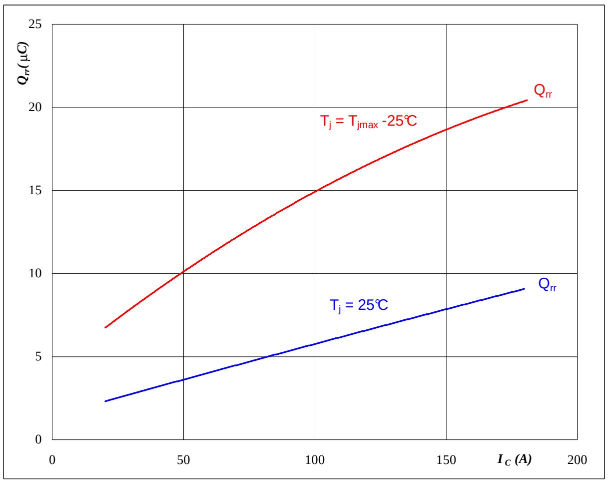
T_j =	25/150	°C
V_R =	600	V
I_F =	100	A
V_{GE} =	±15	V

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



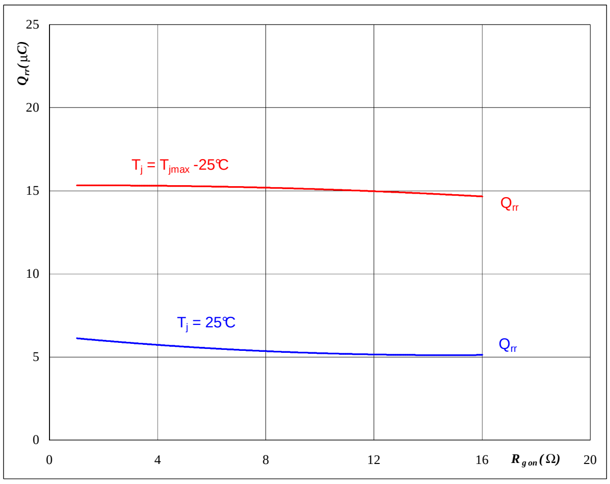
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω

figure 14. **FWD**

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

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



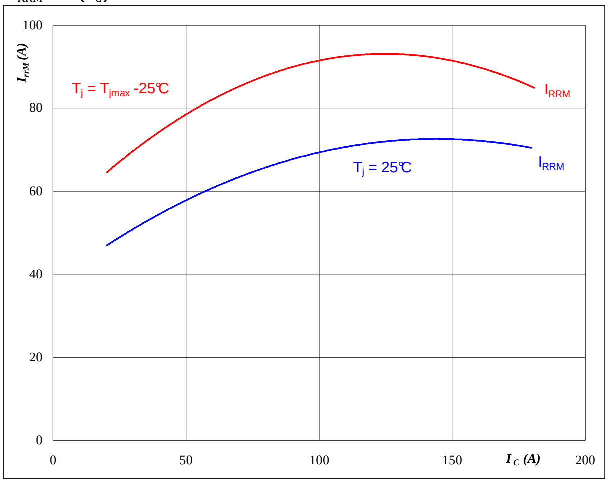
At

T_j =	25/150	°C
V_R =	600	V
I_F =	100	A
V_{GE} =	±15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



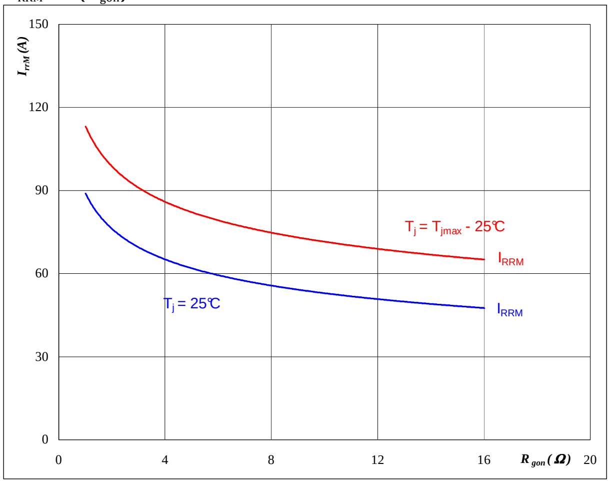
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω

figure 16. **FWD**

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

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



At

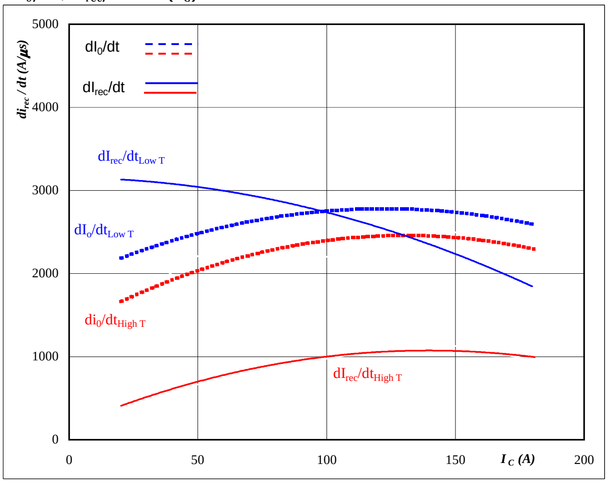
T_j =	25/150	°C
V_R =	600	V
I_F =	100	A
V_{GE} =	±15	V

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 17. **FWD**

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

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



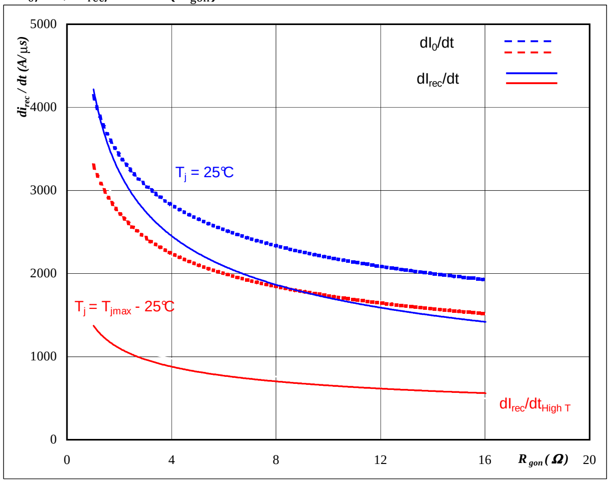
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	4	Ω

figure 18. **FWD**

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

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



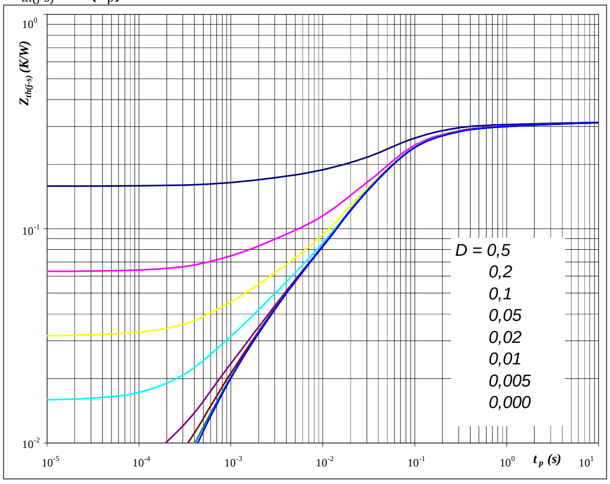
At

T_j =	25/150	°C
V_R =	600	V
I_F =	100	A
V_{GE} =	±15	V

figure 19. **IGBT**

IGBT transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,32	K/W

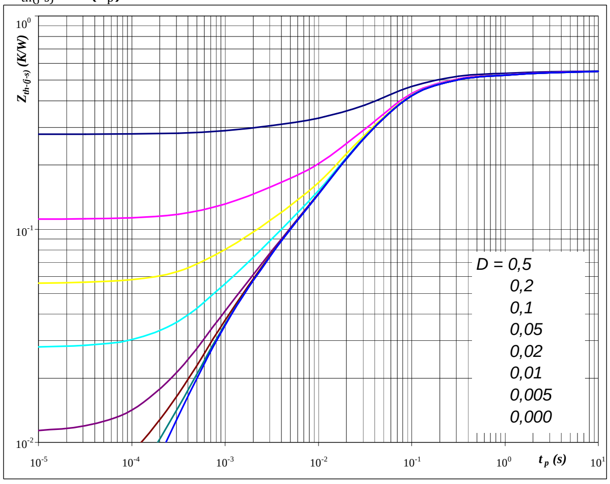
IGBT thermal model values

R (K/W)	Tau (s)
1,18E-02	2,36E+00
2,20E-02	2,01E-01
5,85E-02	3,58E-02
1,69E-01	1,20E-02
3,16E-02	2,33E-03
2,12E-02	3,57E-04
1,46E-03	1,7E-04

figure 20. **FWD**

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,56	K/W

FWD thermal model values

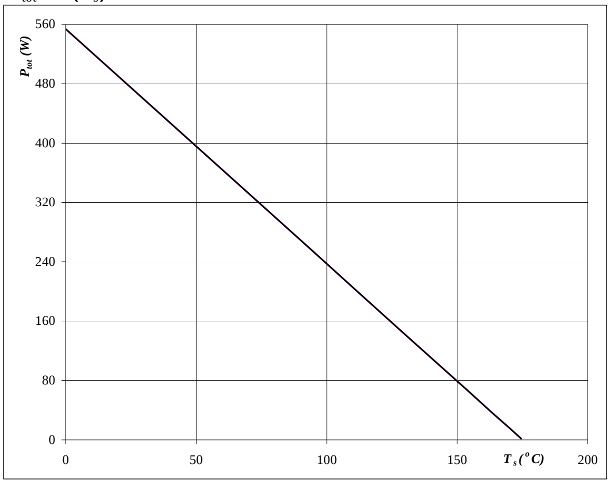
R (K/W)	Tau (s)
2,07E-02	4,15E+00
3,89E-02	3,54E-01
1,03E-01	6,31E-02
2,99E-01	2,11E-02
5,56E-02	4,10E-03
3,73E-02	6,30E-04
2,57E-03	3,0E-04

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



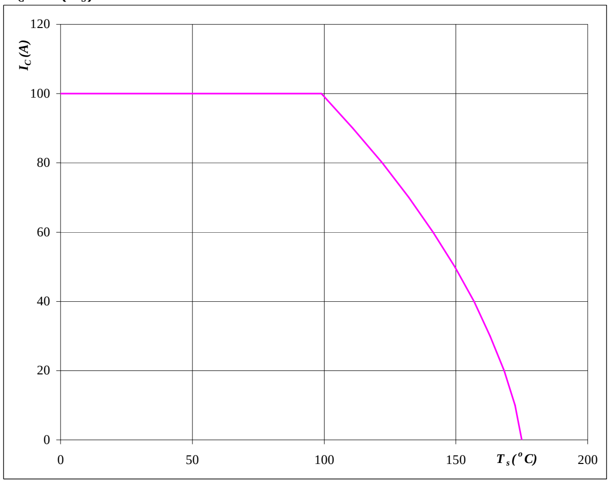
At

T_j = 175 °C

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

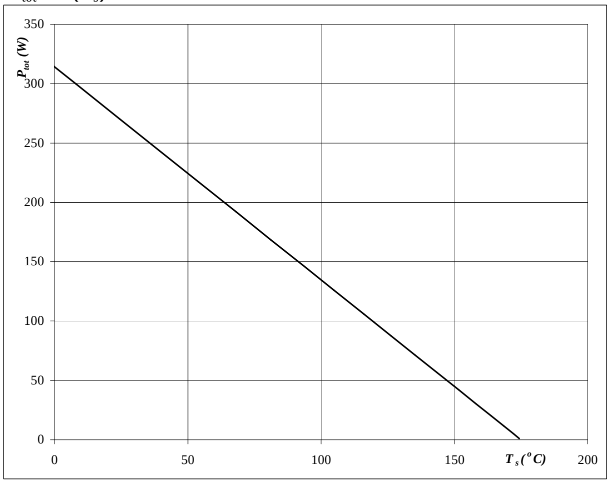
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



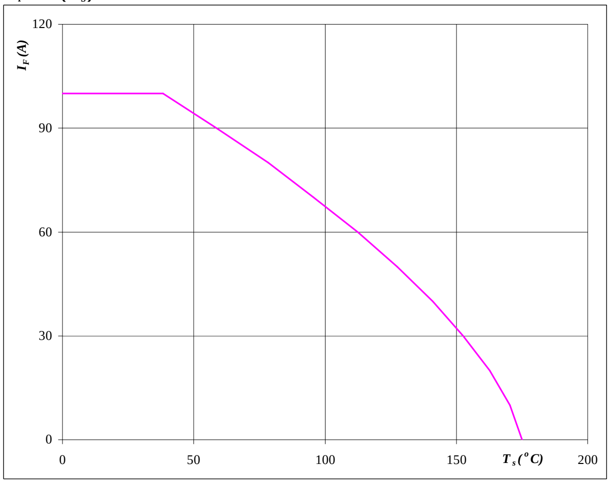
At

T_j = 175 °C

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

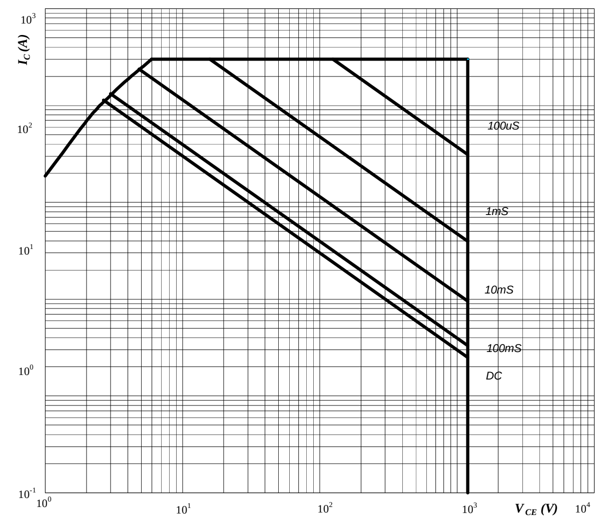
T_j = 175 °C

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



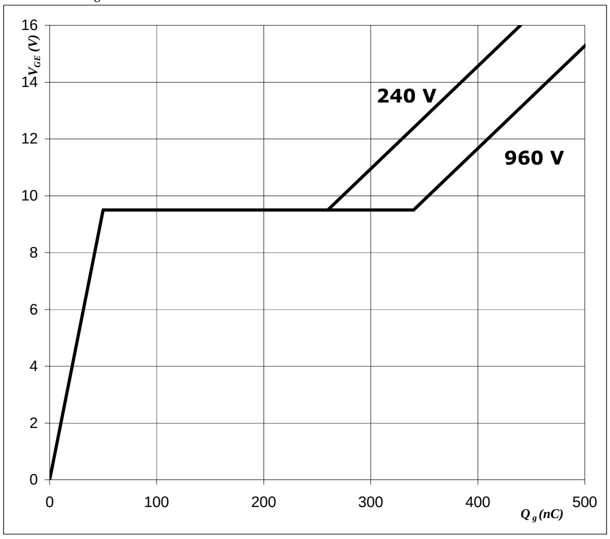
At

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

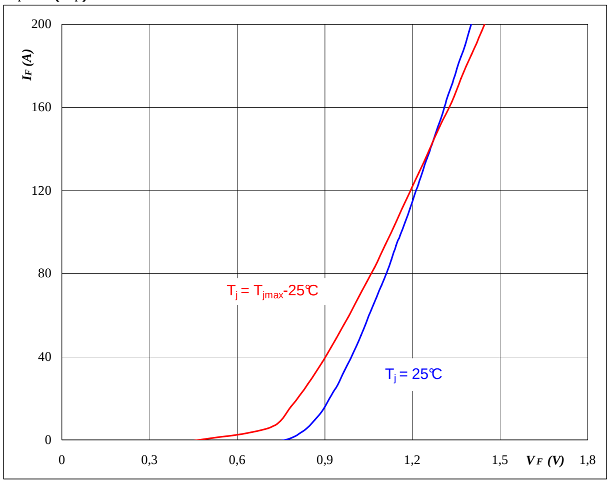
I_C =	100	A

Rectifier Diode

figure 1. **Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



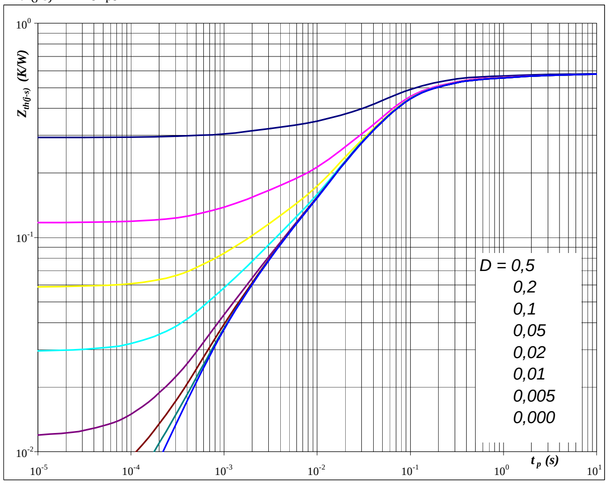
At

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

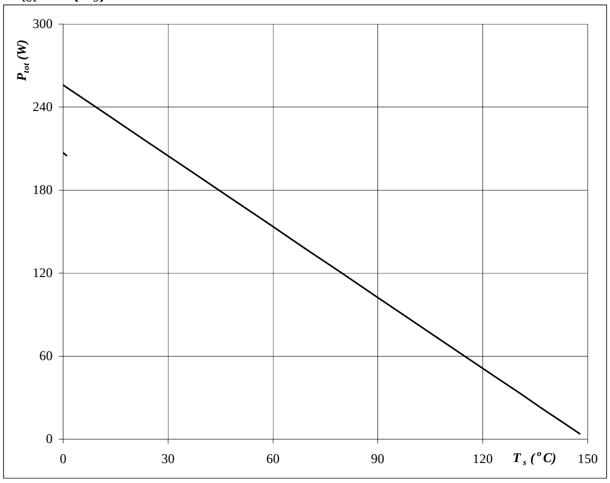
D = t_p / T

$R_{th(j\text{-}s)}$ = 0,59 K/W

figure 3. **Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



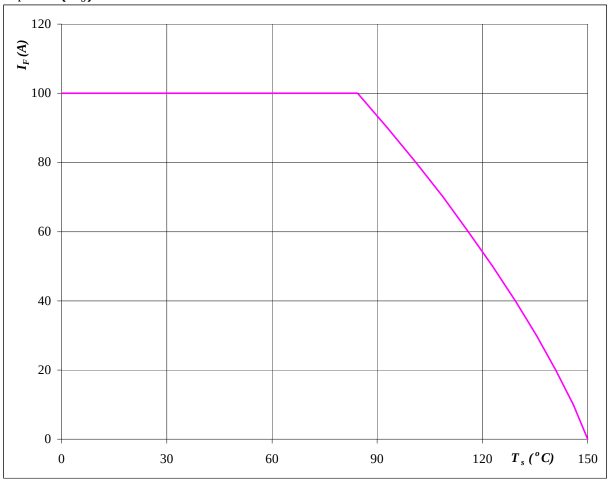
At

T_j = 150 ºC

figure 4. **Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

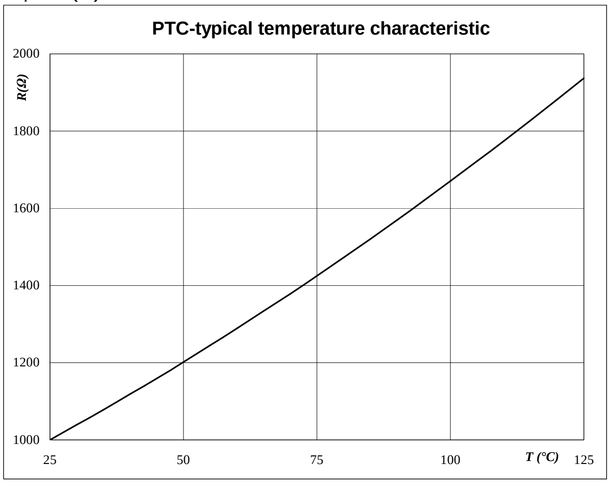
T_j = 150 ºC

Thermistor

figure 1.	Thermistor

Typical PTC characteristic
as a function of temperature

$R_T = f(T)$



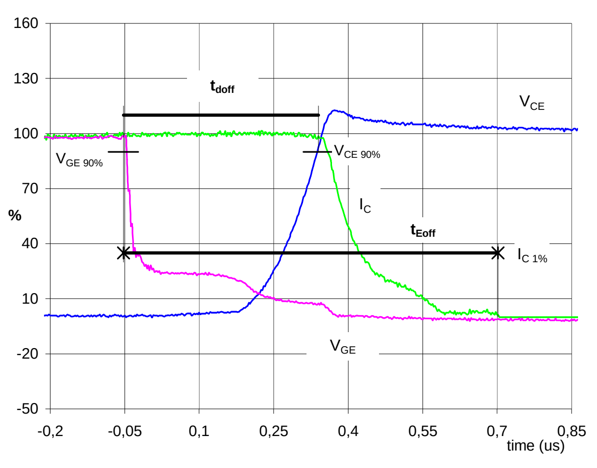
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	4 Ω
R_{goff}	=	4 Ω

figure 1. **IGBT**

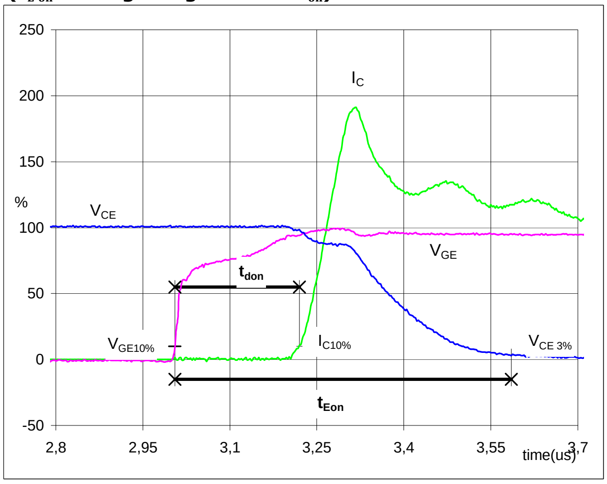
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	100	A
t_{doff} =	0,38	µs
$t_{E\,off}$ =	0,75	µs

figure 2. **IGBT**

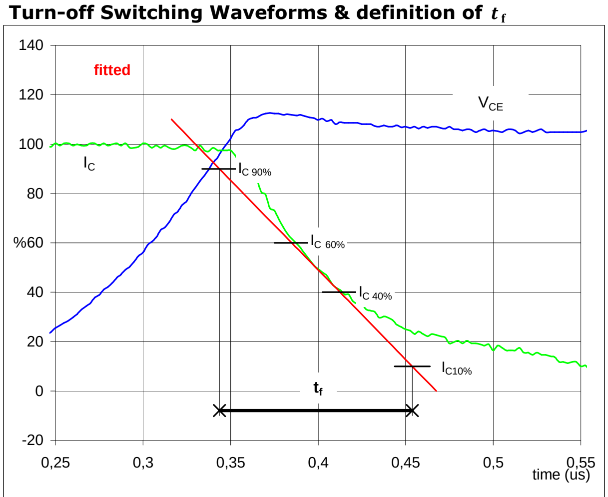
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	100	A
t_{don} =	0,22	µs
$t_{E\,on}$ =	0,58	µs

figure 3. **IGBT**

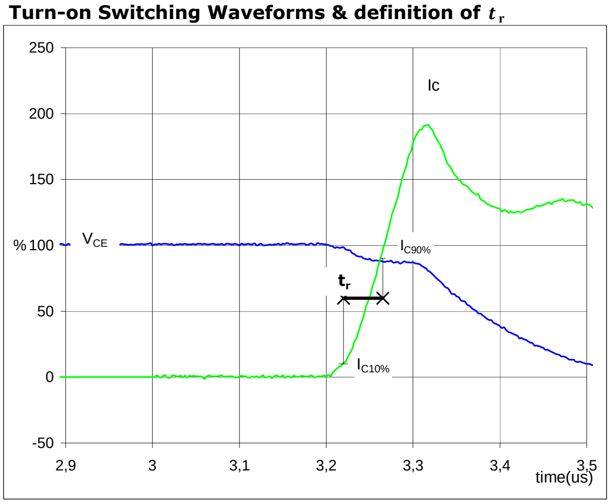
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	100	A
t_f =	0,11	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

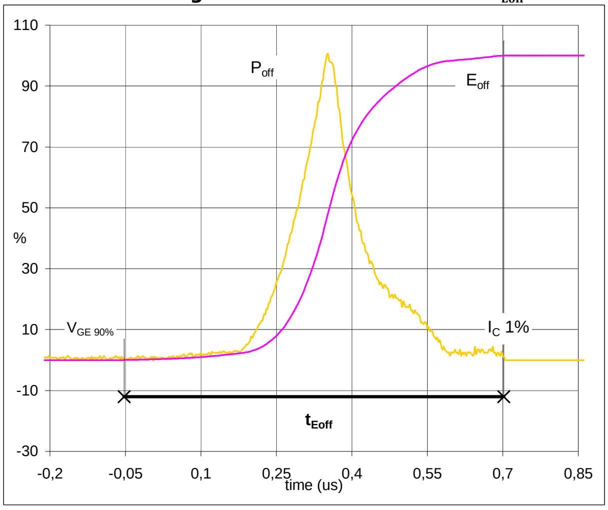


V_C (100%) =	600	V
I_C (100%) =	100	A
t_r =	0,04	µs

Switching Definitions Output Inverter

figure 5. **IGBT**

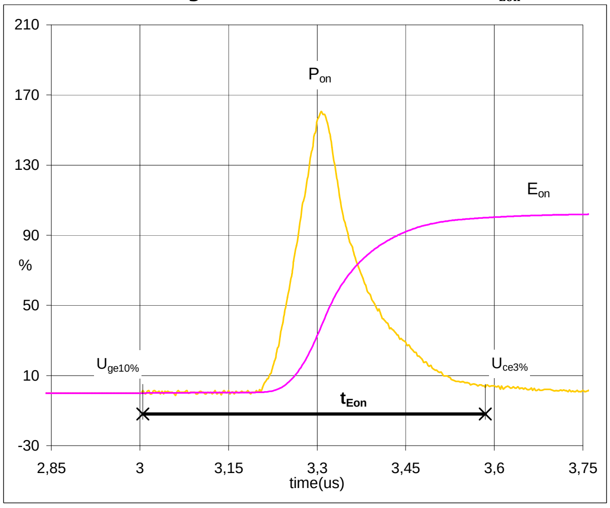
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) = 60,10 kW
E_{off} (100%) = 9,25 mJ
$t_{E\,off}$ = 0,75 μs

figure 6. **IGBT**

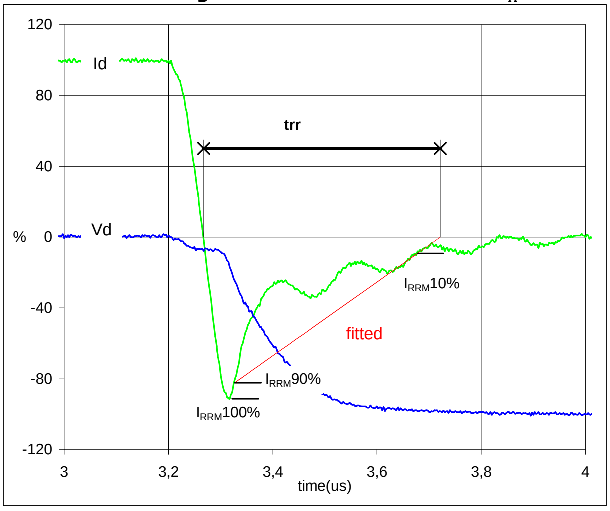
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) = 60,10 kW
E_{on} (100%) = 12,12 mJ
$t_{E\,on}$ = 0,58 μs

figure 8. **IGBT**

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

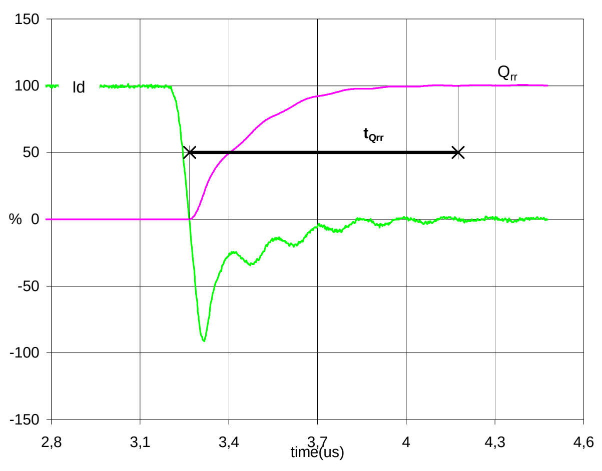


V_d (100%) = 600 V
I_d (100%) = 100 A
I_{RRM} (100%) = -91 A
t_{rr} = 0,46 μs

Switching Definitions Output Inverter

figure 9. **FWD**

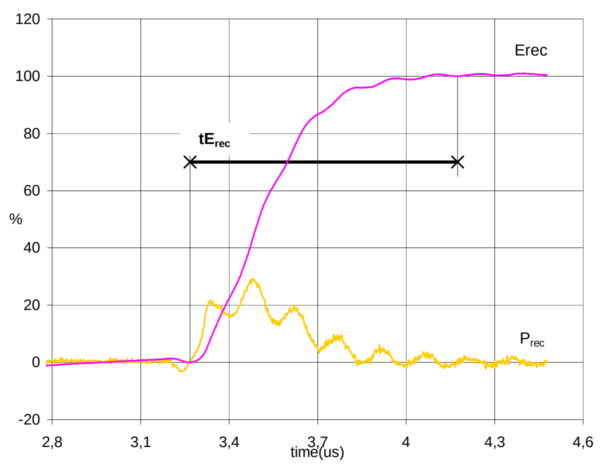
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	100	A
Q_{rr} (100%) =	15,08	μC
$t_{Q\,rr}$ =	0,91	μs

figure 10. **FWD**

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



P_{rec} (100%) =	60,10	kW
E_{rec} (100%) =	5,42	mJ
$t_{E\,rec}$ =	0,91	μs

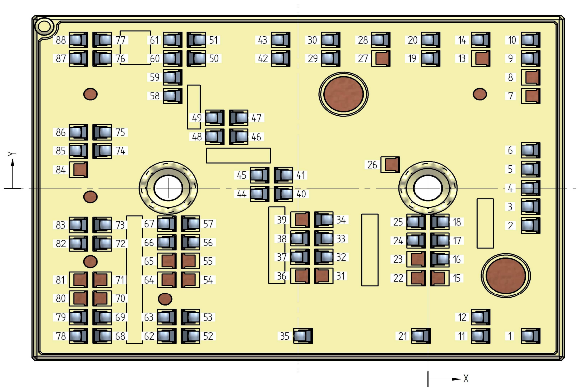
Ordering Code & Marking

Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K420-A40-/0A/-PM
With thin lid (2.8mm height) + no thermal grease	V23990-K420-A40-/0B/-PM
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K420-A40-/1A/-PM
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K420-A40-/1B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K420-A40-/4A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K420-A40-/4B/-PM
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K420-A40-/5A/-PM
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K420-A40-/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**		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

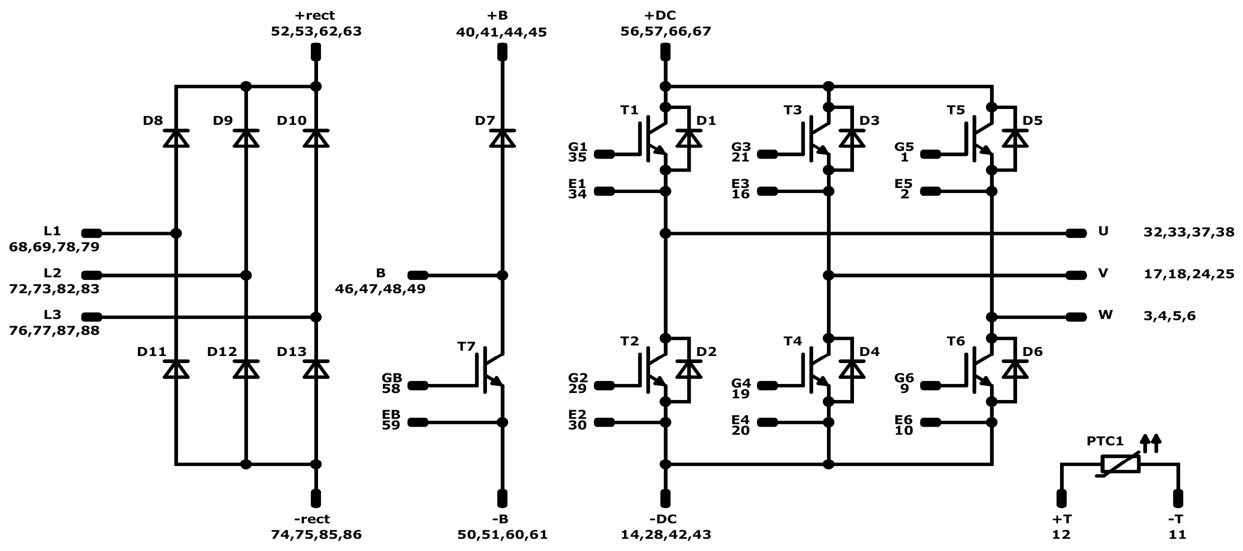
Outline

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	-12,18	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	-11,82	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	-11,82	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 - T6	IGBT	1200 V	100 A	Inverter Switch	
D1 - D6	FWD	1200 V	100 A	Inverter Diode	
T7	Rectifier	1200 V	100 A	Brake Switch	
D7	PTC	1200 V	100 A	Brake Diode	
D8 - D13	Rectifier	1600 V	75 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-K420-A40-D3-14	28 Jan. 2018	Updated with HPTP	all