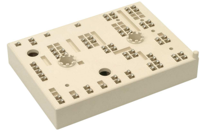
MiniSKiiP® 3 PIM **1200 V / 50 A**

Features

- Solderless interconnection
- Mitsubishi Generation 6.1 technology

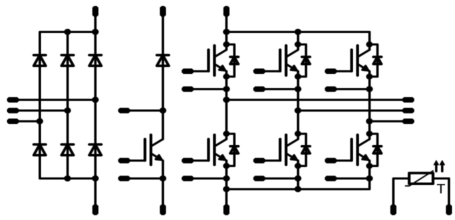
MiniSKiiP® 3 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K428-A60-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}	$T_j = T_{jmax}$	T_s = 80 °C	71	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j=150°C	490	A
I2t-value	I^2t			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	$T_j = T_{jmax}$	T_s = 80 °C	55	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		100	A
Turn off safe operating area		V_{CE} ≤ 1200V, T_j ≤ T_{op} max		100	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	127	W
Gate-emitter peak voltage	V_{GE}			20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		10 850	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					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	47	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		100	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	102	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 Test Voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative tracking index	CTI			>200	

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				50	25 125	1	1,09 1,02	1,8	V
Threshold voltage (for power loss calc. only)	V_{to}				50	25 125		0,90 0,74		V
Slope resistance (for power loss calc. only)	r_t				50	25		4,00 6,00		mΩ
Reverse current	I_r			1600		25 145			1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						0,90		K/W
Inverter Switch / Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,005	25	5,4	6	6,6	V
Collector-emitter saturation voltage	V_{CEsat}		15		50	25 150	1	1,79 2,12	2,3	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		25			0,25	mA
Gate-emitter leakage current	I_{GES}		20	0		25			500	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 16 Ω R_{gon} = 16 Ω	±15	600	50	25 150		106 104		ns
Rise time	t_r					25 150		28 31		
Turn-off delay time	$t_{d(off)}$					25 150		157 205		
Fall time	t_f					25 150		58 89		
Turn-on energy loss	E_{on}					25 150		2,61 4,39		mWs
Turn-off energy loss	E_{off}					25 150		2,49 4,09		
Input capacitance	C_{ies}	f = 1 MHz	0	10		25		5000		pF
Output capacitance	C_{oss}							1000		
Reverse transfer capacitance	C_{rss}							80		
Gate charge	Q_G		±15	600	50	25		117		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						0,75		K/W
Inverter Diode / Brake Diode										
Diode forward voltage	V_F				50	25 150	1	2,73 2,18	3,4	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 16 Ω	±15	600	50	25 150		33 45		A
Reverse recovery time	t_{rr}					25 150		388 727		ns
Reverse recovered charge	Q_{rr}					25 150		4,01 10,81		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		1018 295		A/μs
Reverse recovered energy	E_{rec}					25 150		1,84 5,14		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						0,93		K/W
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω				100	-3		3	%
Power dissipation	P					100		1670		Ω
Power dissipation constant						25		0,76		mW/K
B-value	$B_{(25/50)}$					25		$7,635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1,731 \cdot 10^{-5}$		1/K²
Vincotech NTC Reference									E	

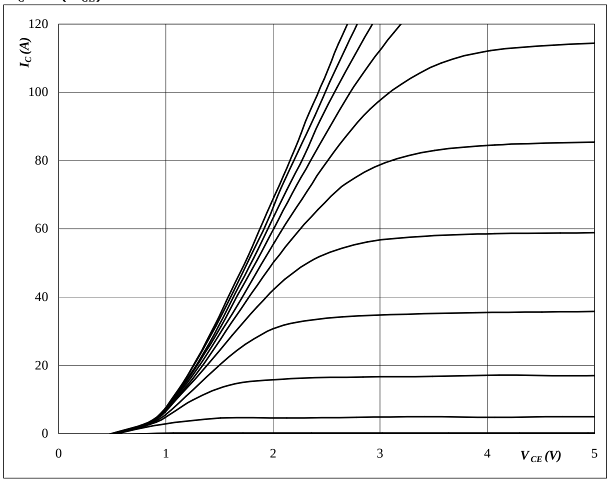
Vincotech

Inverter / Brake Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



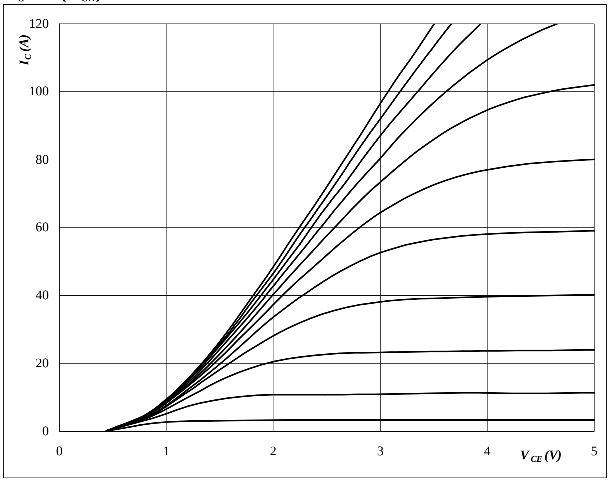
At

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

$I_C = f(V_{CE})$



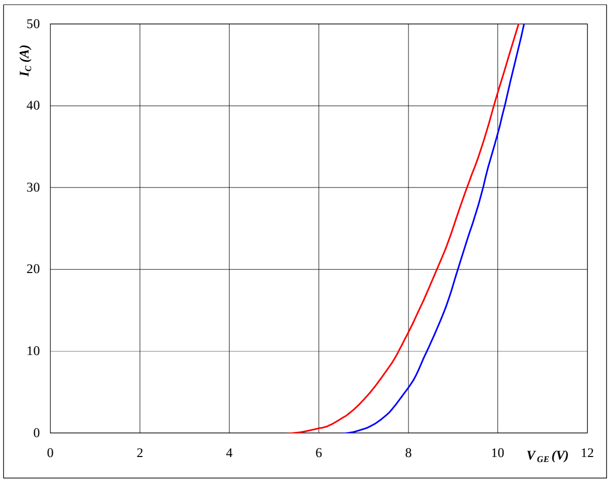
At

t_p =	250	μs
T_j =	151	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$



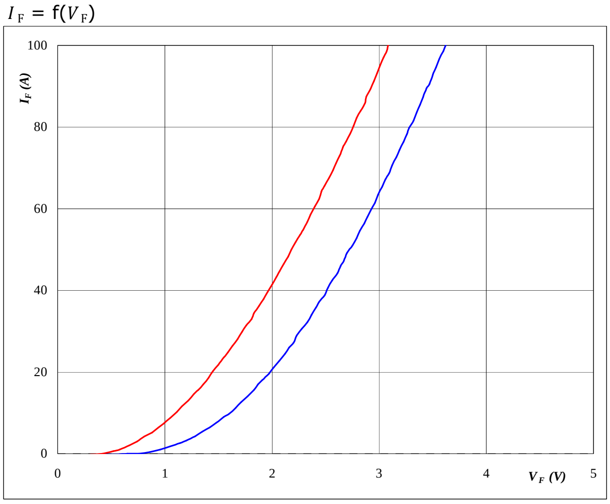
At

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

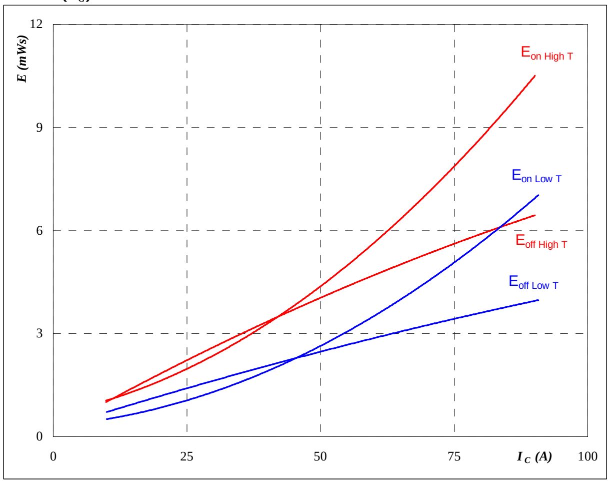
T_j =	25/150	°C
t_p =	250	μs

Inverter / Brake Characteristics

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



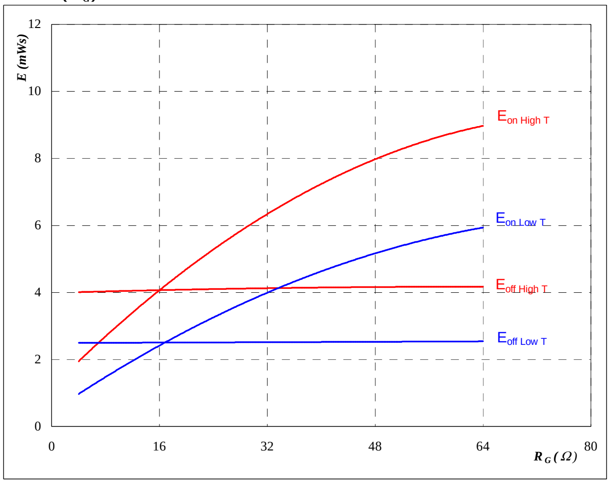
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



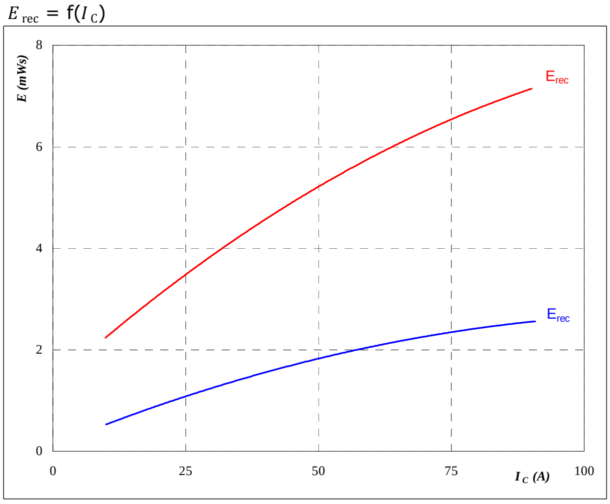
With an inductive load at

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

$E_{rec} = f(I_C)$



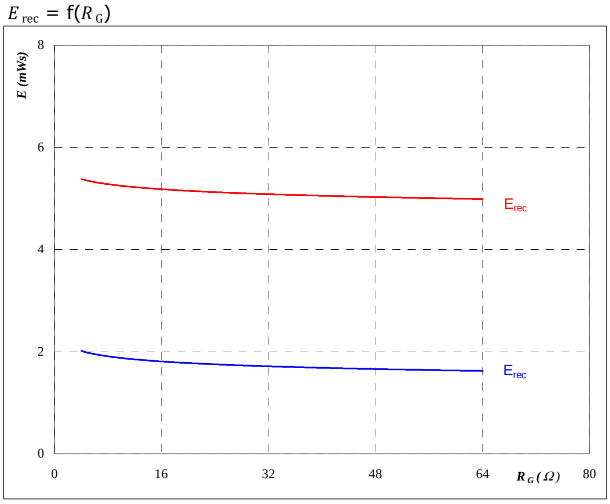
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	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

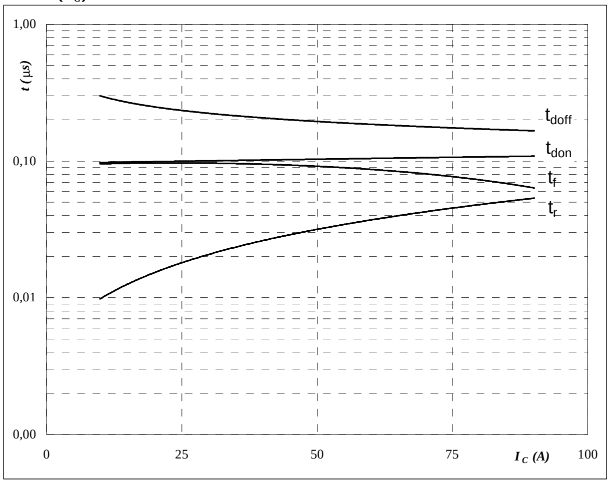
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Inverter / Brake Characteristics

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



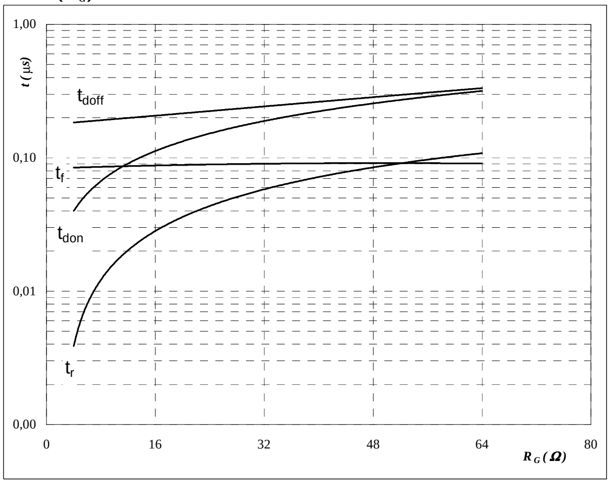
With an inductive load at

T_j =	151	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



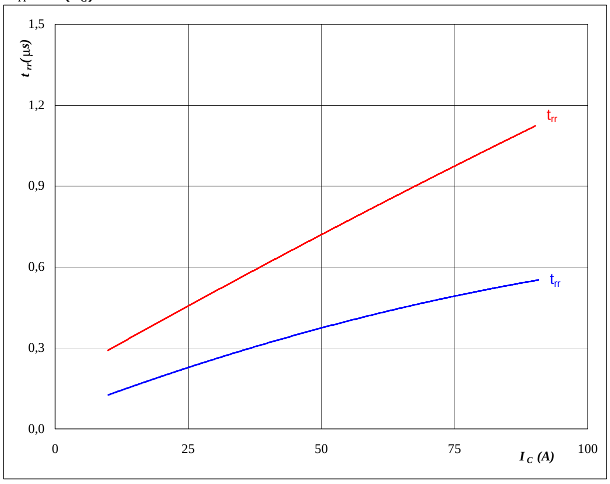
With an inductive load at

T_j =	151	°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

$t_{rr} = f(I_C)$



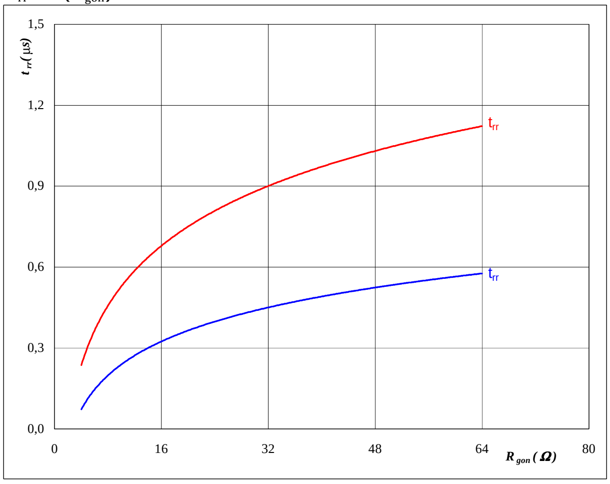
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 12. **FWD**

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

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



At

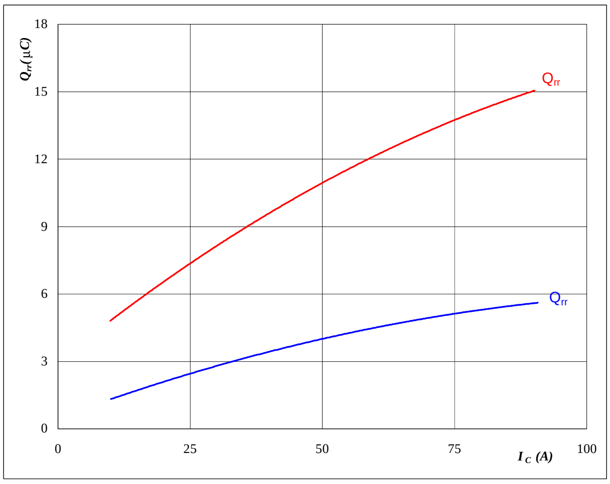
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

figure 13.	FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



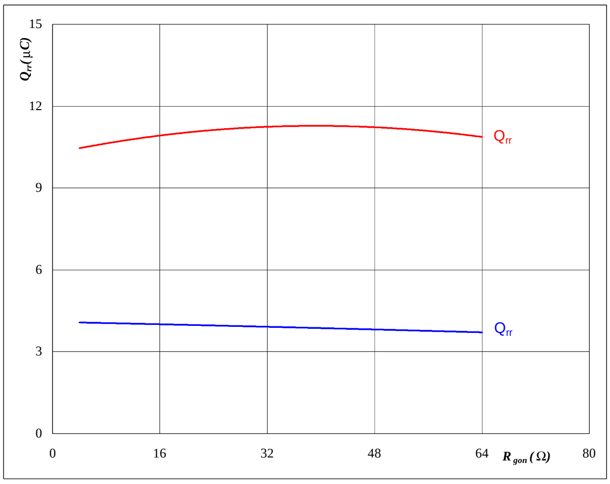
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 14.	FWD

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

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



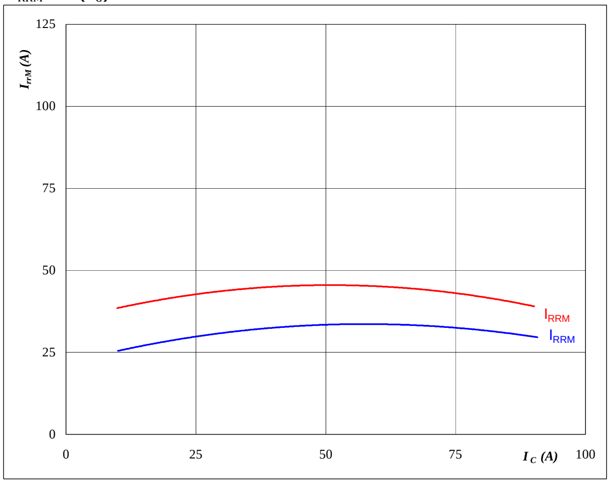
At

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

$I_{RRM} = f(I_C)$



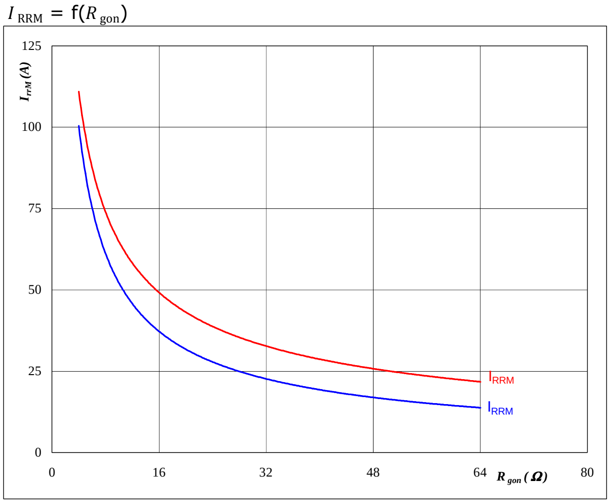
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 16.	FWD

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

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



At

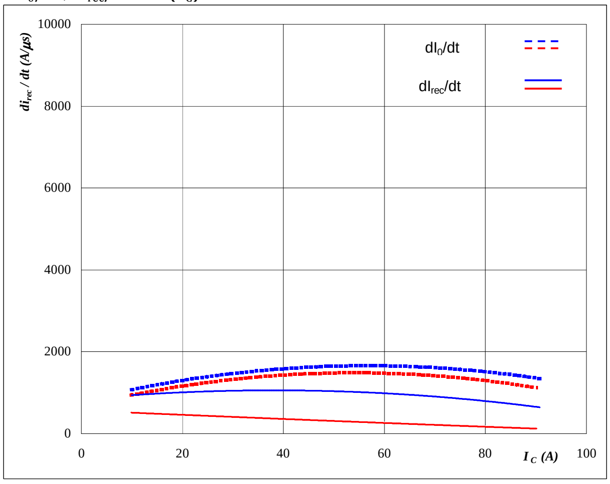
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

figure 17. **FWD**

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

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



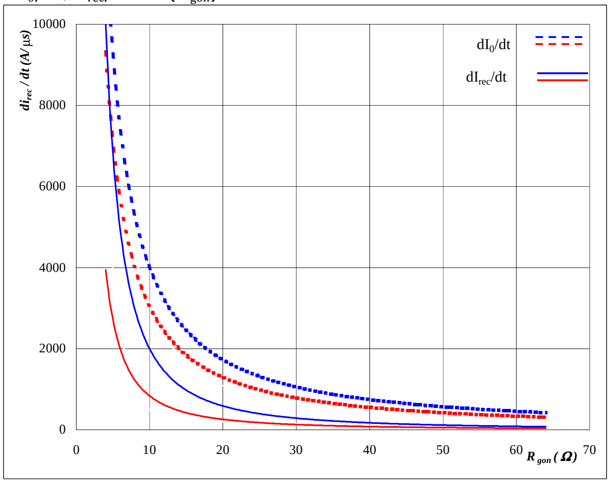
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 18. **FWD**

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

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



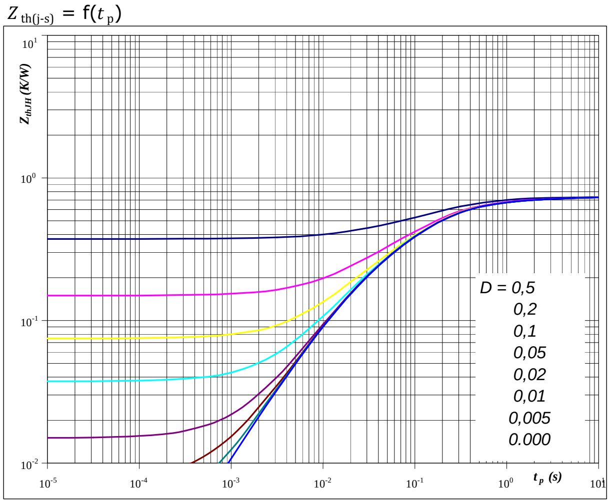
At

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

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



At

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

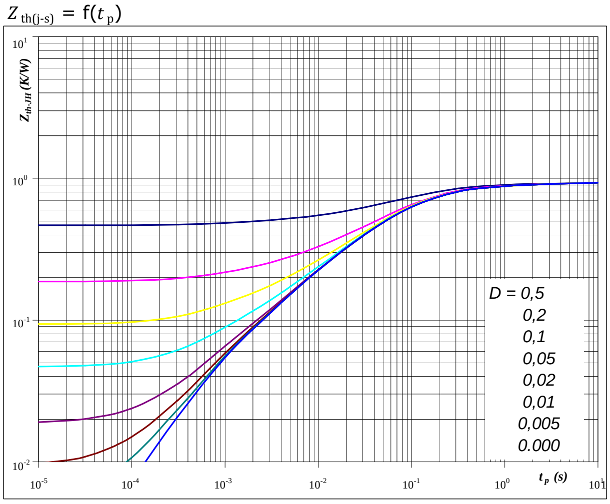
IGBT thermal model values

R (K/W)	Tau (s)
3,45E-02	1,63E+01
9,41E-02	1,22E+00
2,87E-01	2,14E-01
2,42E-01	7,08E-02
8,94E-02	1,45E-02

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	
$R_{th(j\text{-}s)}$ =	0,93	K/W

FWD thermal model values

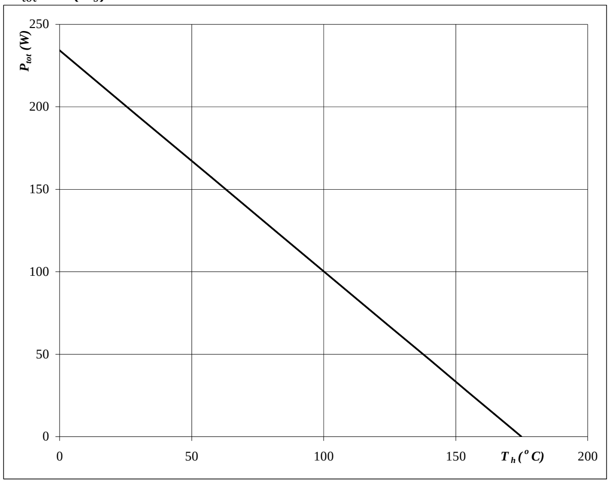
R (K/W)	Tau (s)
4,65E-02	3,38E+00
9,84E-02	5,93E-01
3,68E-01	1,19E-01
2,48E-01	3,74E-02
1,26E-01	8,06E-03
4,44E-02	9,03E-04

Inverter / Brake Characteristics

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



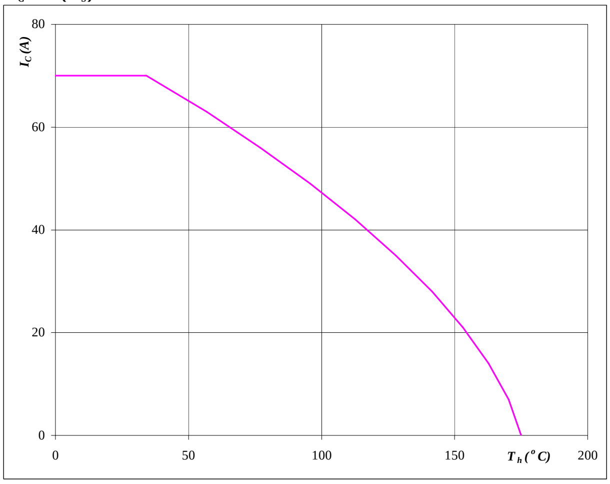
At

T_j = 175 °C

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

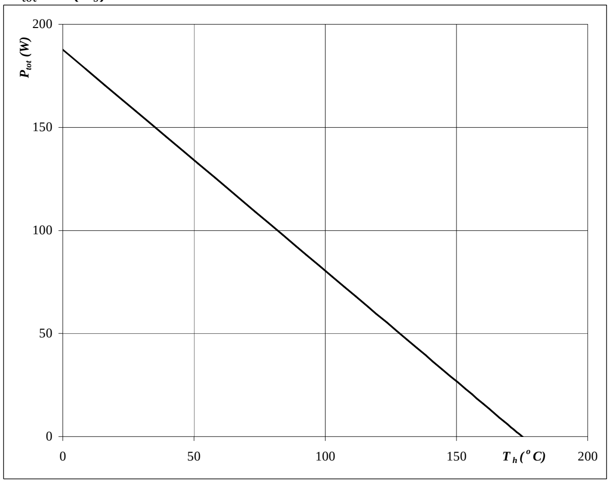
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



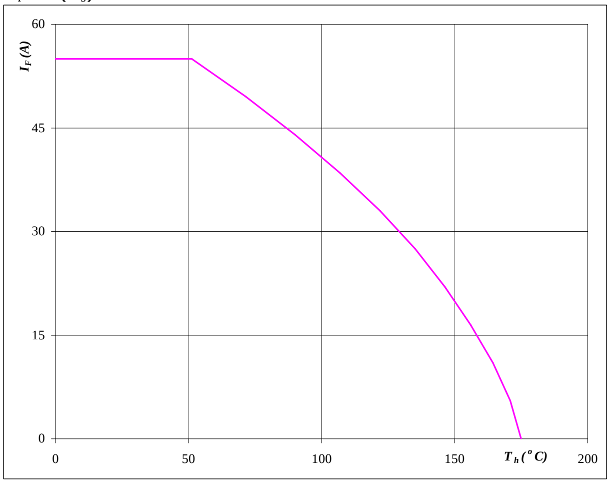
At

T_j = 175 °C

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

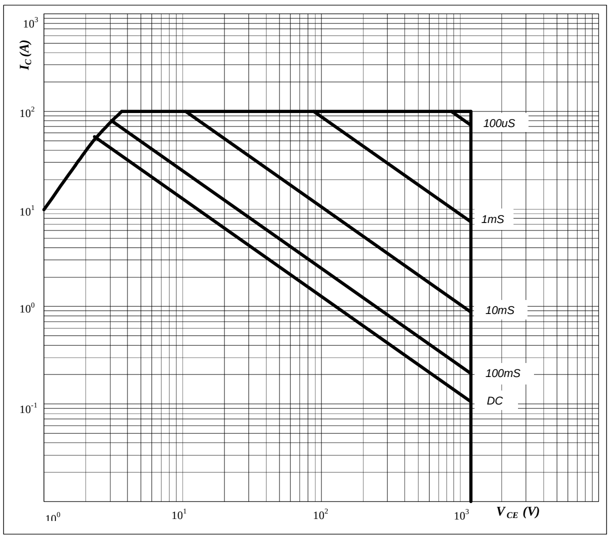
T_j = 175 °C

Inverter / Brake Characteristics

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



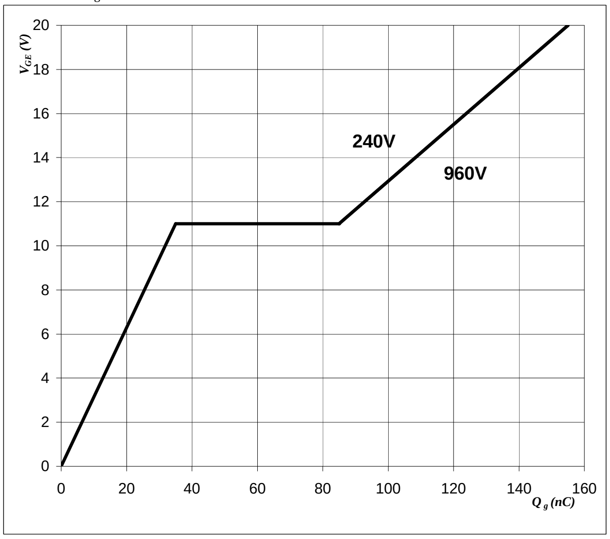
At

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

figure 26. **IGBT**

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



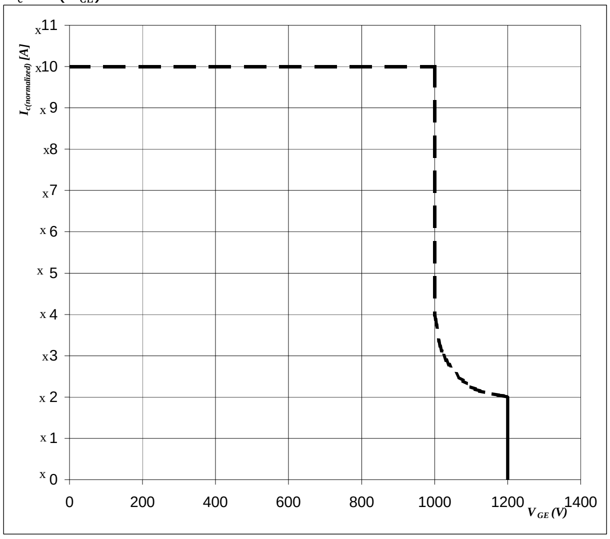
At

I_C =	50	A

figure 27. **IGBT**

Short circuit safe operating area (SCSOA)

$I_c = f(V_{CE})$



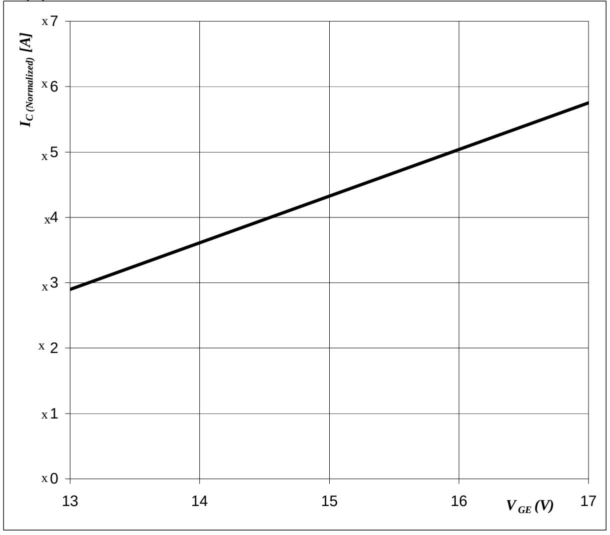
At

V_{CE} ≤	850	V	V_{GE}=	±15	V
T_j ≤	150	ºC	t_{SC} ≤	10	μS

figure 28. **IGBT**

Typical short circuit collector current as a function of gate-emitter voltage

$I_{C(sc)} = f(V_{GE})$



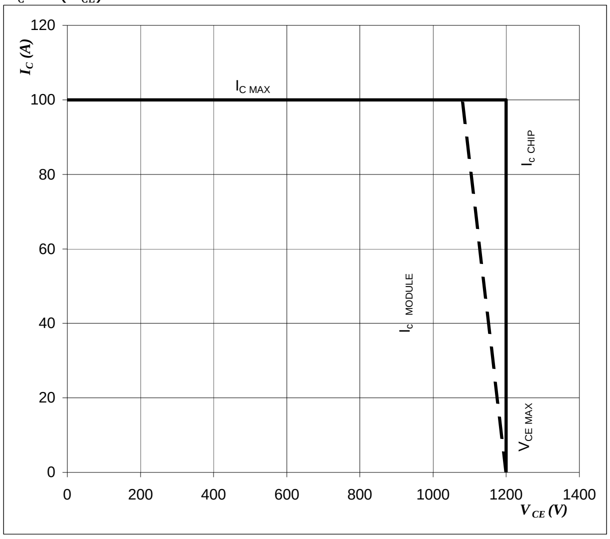
V_{CE}=	800	V
T_j=	150	ºC

Inverter / Brake Characteristics

figure 28.	IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

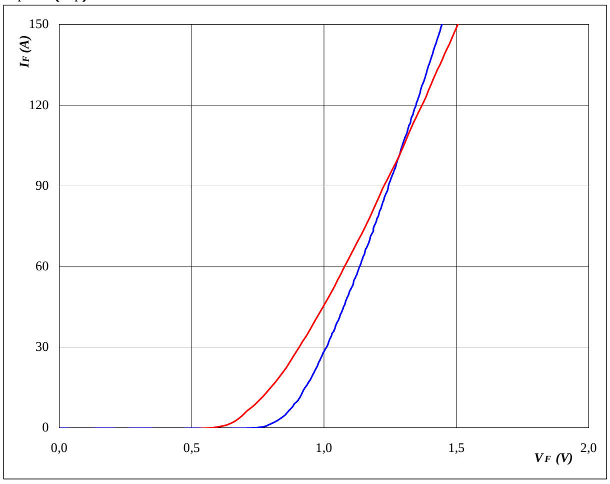
T_j =	T_{jmax}-25	ºC
$U_{ccminus}$=U_{ccplus}		
Switching mode :	3phase SPWM	

Rectifier Diode

figure 1. **Rectifier Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



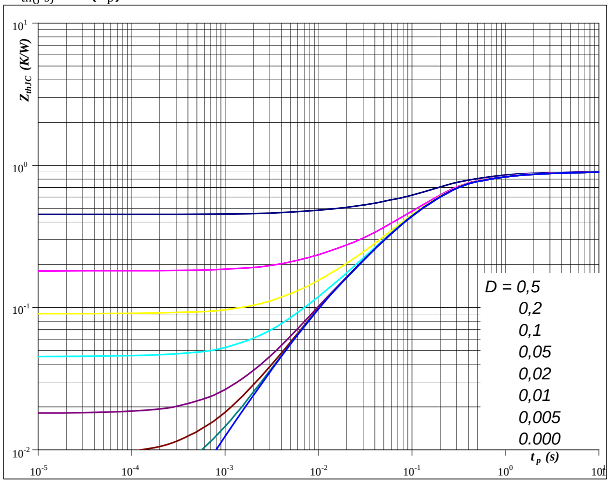
At

T_j =	25/125	°C
t_p =	250	µs

figure 2. **Rectifier Diode**

Diode transient thermal impedance as a function of pulse width

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



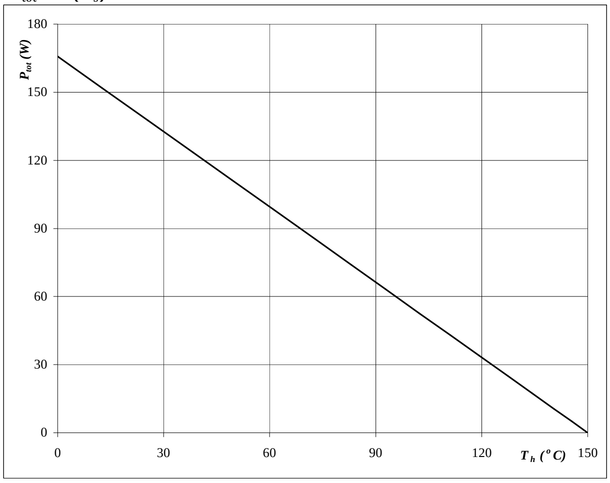
At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,90	K/W

figure 3. **Rectifier Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



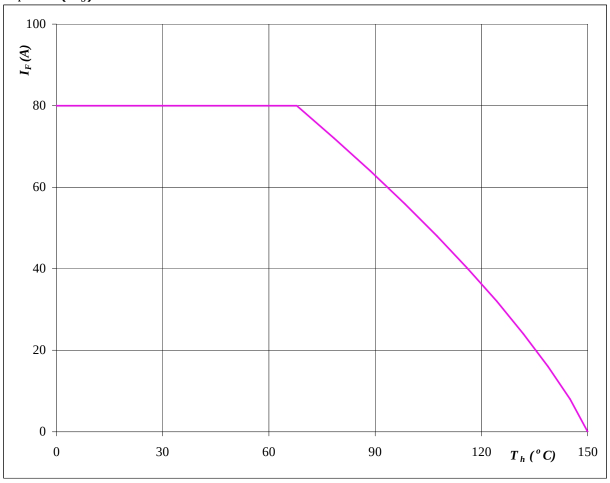
At

T_j =	150	ºC

figure 4. **Rectifier Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



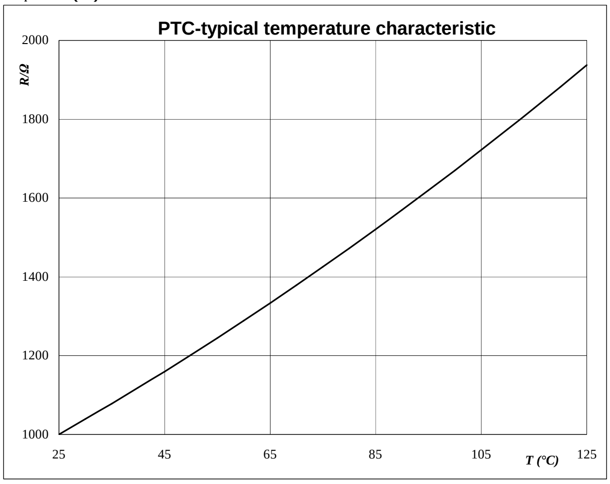
At

T_j =	150	ºC

Thermistor

figure 1.	Thermistor

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



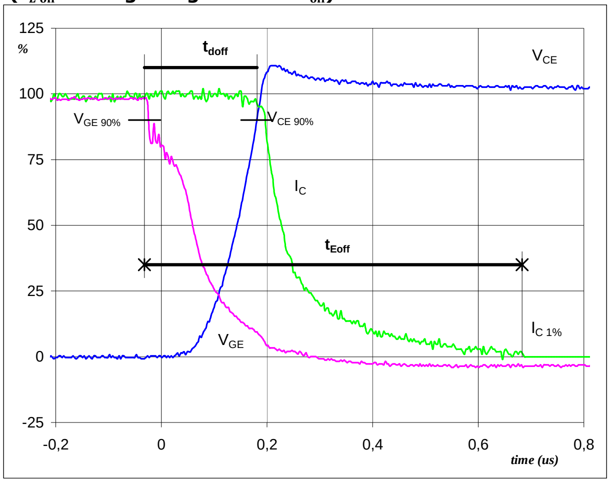
Switching Definitions Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	16 Ω
R_{goff}	=	16 Ω

figure 1. **IGBT**

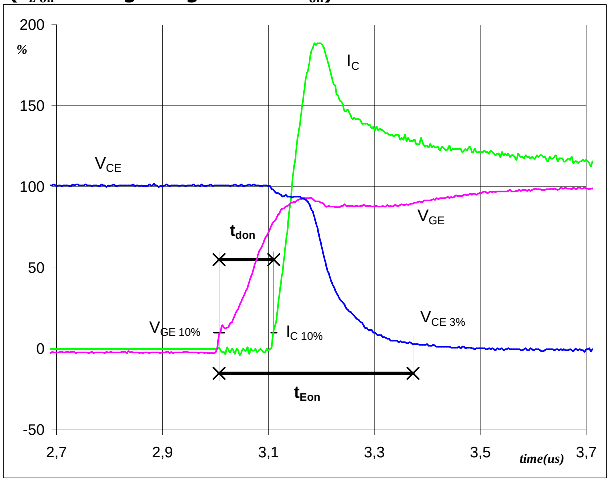
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{doff} =	0,205	µs
$t_{E off}$ =	0,715	µs

figure 2. **IGBT**

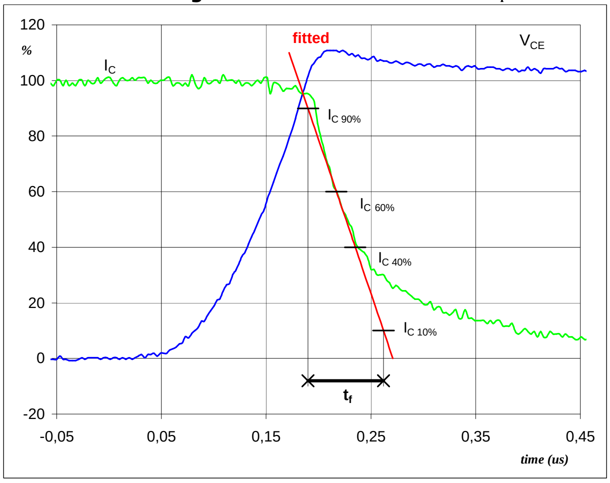
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{don} =	0,104	µs
$t_{E on}$ =	0,366	µs

figure 3. **IGBT**

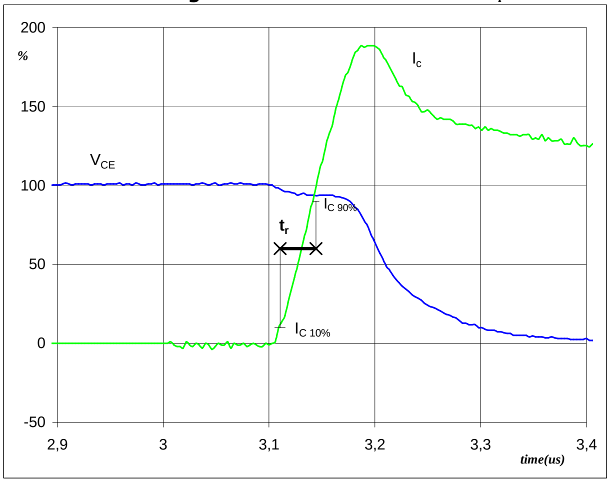
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	50	A
t_f =	0,09	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

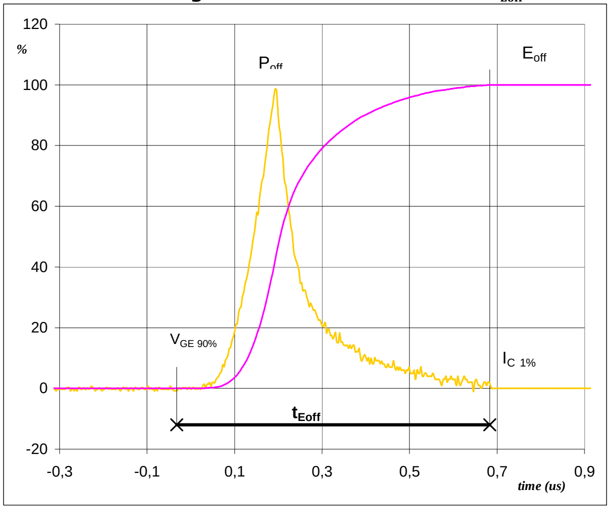


V_C (100%) =	600	V
I_C (100%) =	50	A
t_r =	0,03	µs

Switching Definitions Inverter

figure 5. **IGBT**

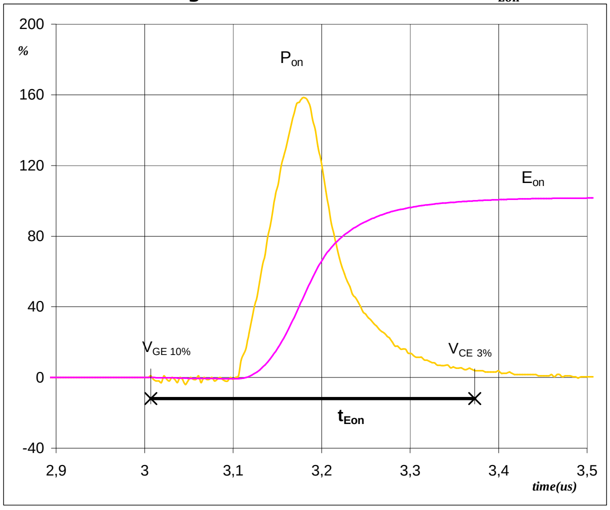
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	30,14	kW
E_{off} (100%) =	4,09	mJ
$t_{E\,off}$ =	0,72	µs

figure 6. **IGBT**

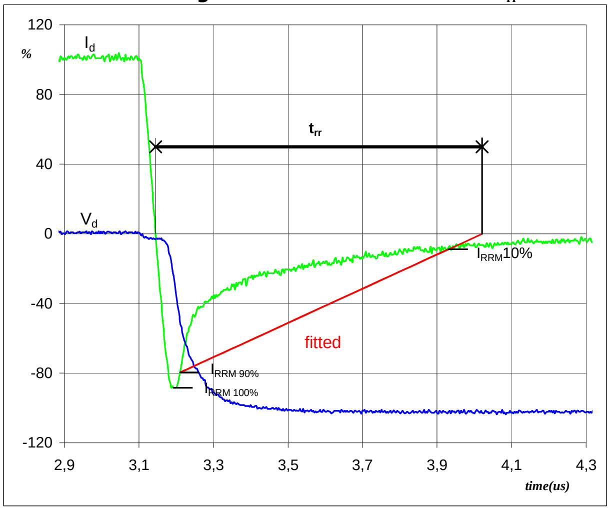
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	30,14	kW
E_{on} (100%) =	4,39	mJ
$t_{E\,on}$ =	0,37	µs

figure 7. **FWD**

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

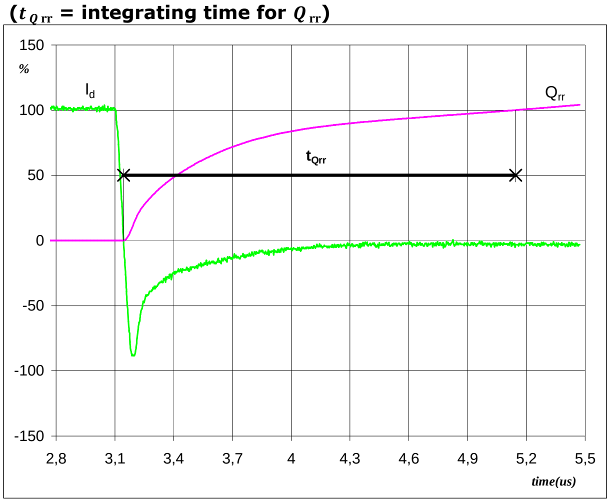


V_d (100%) =	600	V
I_d (100%) =	50	A
I_{RRM} (100%) =	-45	A
t_{rr} =	0,73	µs

Switching Definitions Inverter

figure 8. **FWD**

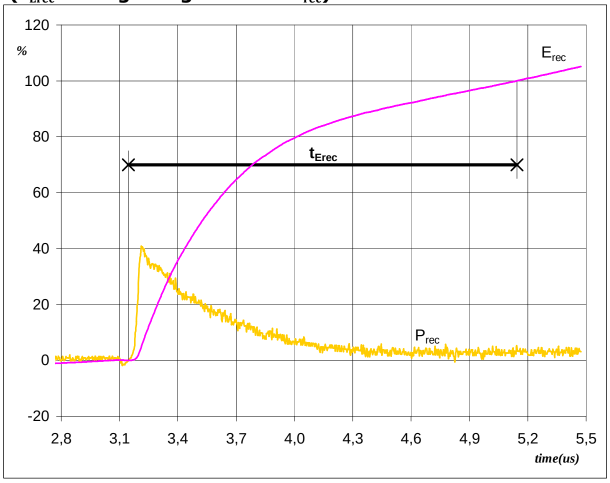
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	50	A
Q_{rr} (100%) =	10,81	μC
t_{Qrr} =	2,00	μs

figure 9. **FWD**

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



P_{rec} (100%) =	30,14	kW
E_{rec} (100%) =	5,14	mJ
t_{Erec} =	2,00	μs

Ordering Code and Marking - Outline - Pinout

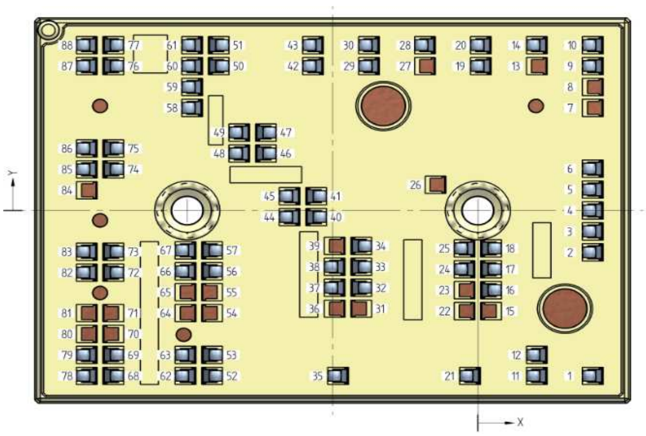
Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K32-T-PM)	V23990-K428-A60-/0A/-PM
with std lid (black V23990-K32-T-PM) and P12	V23990-K428-A60-/1A/-PM
with thin lid (white V23990-K33-T-PM)	V23990-K428-A60-/0B/-PM
with thin lid (white V23990-K33-T-PM) and P12	V23990-K428-A60-/1B/-PM

	VIN	Name&Ver	UL	Lot	Serial
Text	VIN	NNNNNNNVV	UL	LLLLL	SSSS
	Name&Ver	Serial	Date code		
Datamatrix	NNNNNNNVV	SSSS	WWYY		

Outline

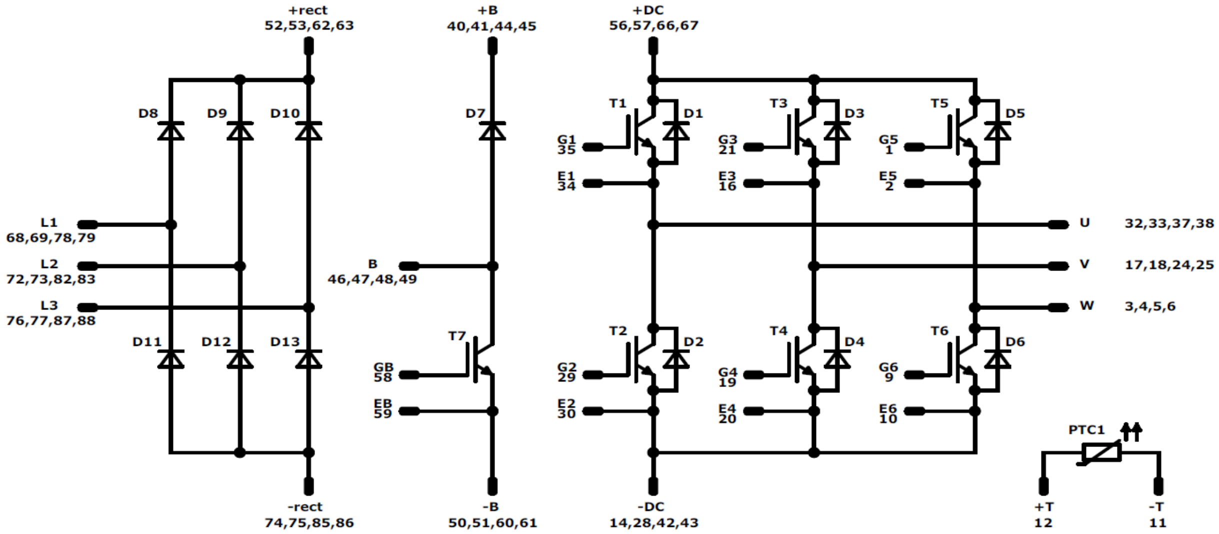
Pad table [mm]				Pad table [mm]			
Pad	X	Y	Function	Pad	X	Y	Function
1	15,83	-25,3	G5	45	-25,9	2,2	+B
2	15,83	-6,4	E5	46	10,82	8,74	B
3	15,83	-3,2	W	47	10,82	11,94	B
4	15,83	0	W	48	-32,82	8,74	B
5	15,83	3,2	W	49	-32,82	11,94	B
6	15,83	6,4	W	50	4,32	22,1	-B
7	Not assembled			51	4,32	25,3	-B
8	Not assembled			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

Ordering Code and Marking - Outline - Pinout

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	Thermistor			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**198**	>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-A60-D2-14	05 Aug. 2016	New brand, new outline drawings	all