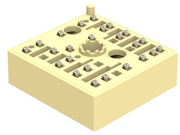
MiniSKiiP® 1 PIM **600 V / 20 A**

Features

- Solderless interconnection
- Trench Fieldstop IGBT3 technology

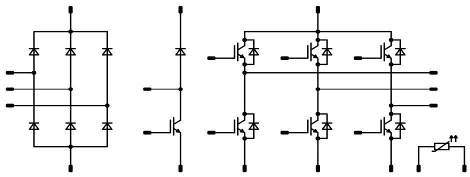
MiniSKiiP® 1 housing



Target Applications

- Industrial drives

Schematic



Types

- V23990-K204-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}	$T_j = T_{jmax}$ T_s = 80 °C	29	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms half sine wave	220	A
I^2t-value	I^2t		240	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	46	W
Maximum Junction Temperature	T_{jmax}		150	°C
Inverter Switch / Brake Switch				
Collector-emitter breakdown voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	24	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	60	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	59	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq$ 150 °C V_{GE} = 15 V	6 360	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}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		40	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	38	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

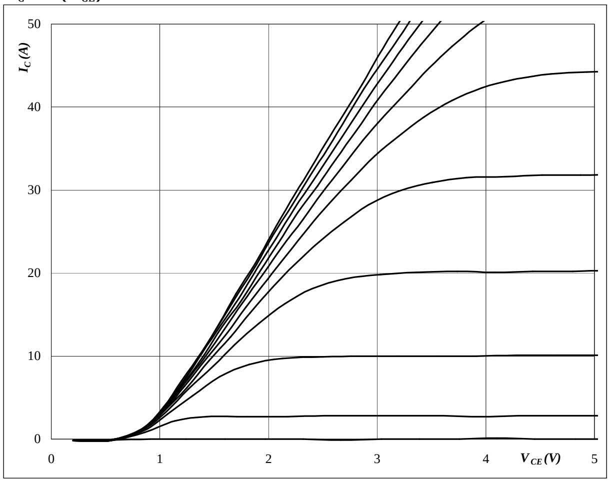
Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_{r} [V] V_{CE} [V] V_{DS} [V]	I_{C} [A] I_{F} [A] I_{D} [A]	T_{j} [°C]	Min	Typ	Max	Unit
Rectifier Diode										
Forward voltage	V_{F}				25	25 125		1,51 1,42		V
Threshold voltage (for power loss calc. only)	V_{to}				25	25 125		0,86 0,79		V
Slope resistance (for power loss calc. only)	r_{t}				25	25 125		0,03 0,03		Ω
Reverse current	I_{r}			1500		25			0,05	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,5		K/W
Inverter Switch / Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00029	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		15	25 150	1,1	1,87 2,04	1,9	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25			1,1	µA
Gate-emitter leakage current	I_{GES}		20	0		25			300	nA
Integrated Gate resistor	R_{gint}					25		none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 16 Ω	0/15	300	20	25 150		28 26		ns
Rise time	t_{r}					25 150		30 35		
Turn-off delay time	$t_{d(off)}$					25 150		225 245		
Fall time	t_{f}					25 150		79 117		
Turn-on energy loss	E_{on}					25 150		0,72 0,86		mWs
Turn-off energy loss	E_{off}					25 150		0,46 0,59		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		1100		pF
Output capacitance	C_{oss}							71		
Reverse transfer capacitance	C_{rss}							32		
Gate charge	Q_{G}		15	480	20	25		123		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,6		K/W
Inverter Diode / Brake Diode										
Diode forward voltage	V_{F}				20	25 125		1,84 1,85	1,6	V
Peak reverse recovery current	I_{RRM}	di_F/dt = tbd A/us	0/15	300	20	25 125		9,97 11,88		A
Reverse recovery time	t_{rr}					25 125		259 358		ns
Reverse recovered charge	Q_{rr}					25 125		1,02 1,66		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		225 64		A/µs
Reverse recovered energy	E_{rec}					25 125		0,18 0,31		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						2,5		K/W
Thersmitor										
Rated resistance	R					25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω				100	-3		3	%
R_{100}	R					100		1670,3125		Ω
A-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	

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

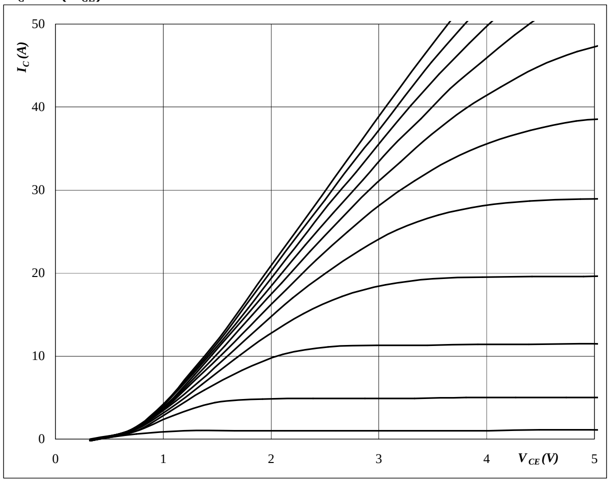
T_j = 25 °C

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

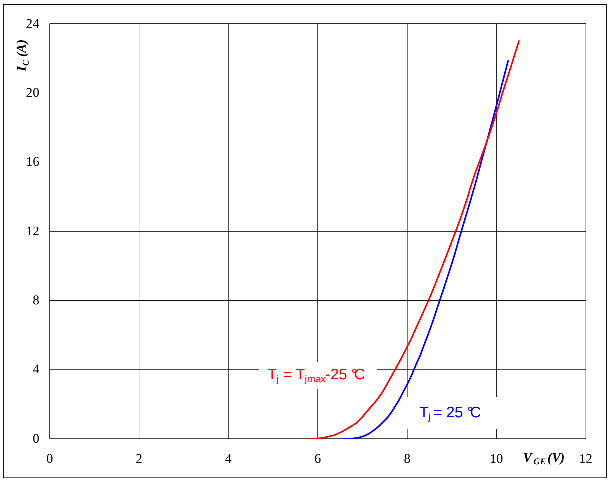
T_j = 125 °C

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

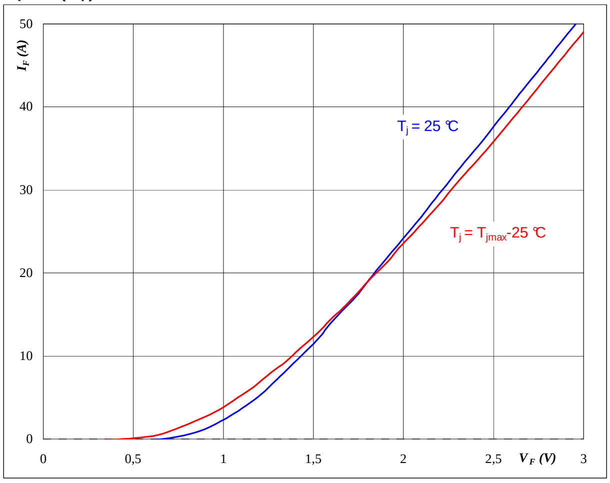
t_p = 250 µs

V_{CE} = 10 V

figure 4. **FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

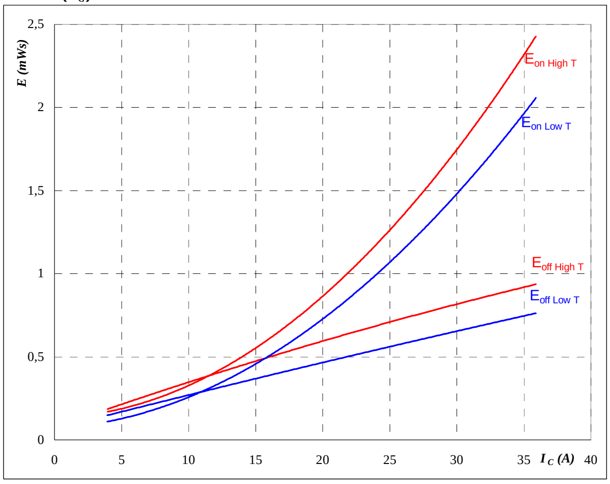
t_p = 250 µs

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



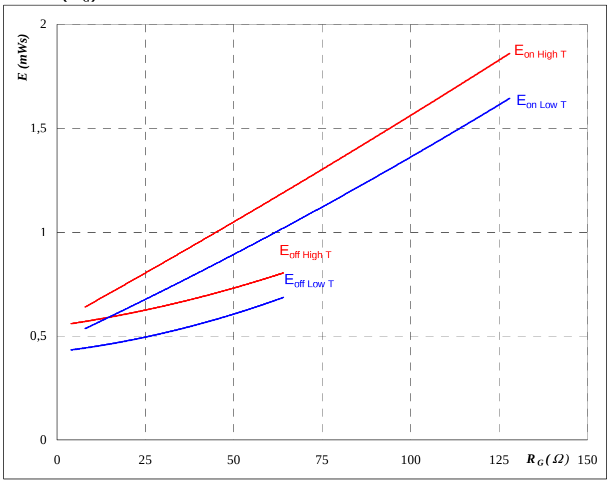
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω
R_{goff} =	16	Ω

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



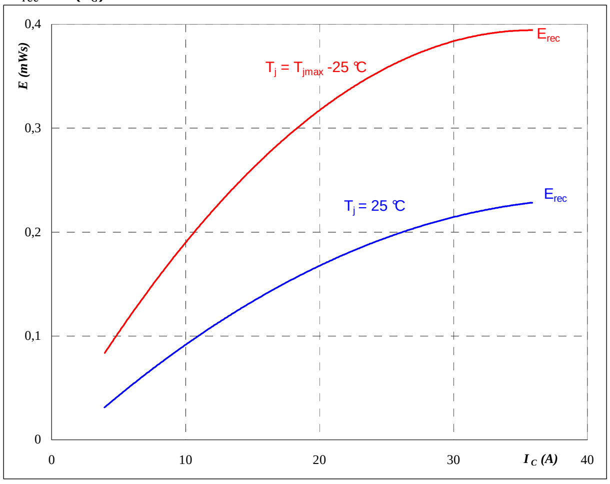
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	20	A

figure 7. **FWD**

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_C)$



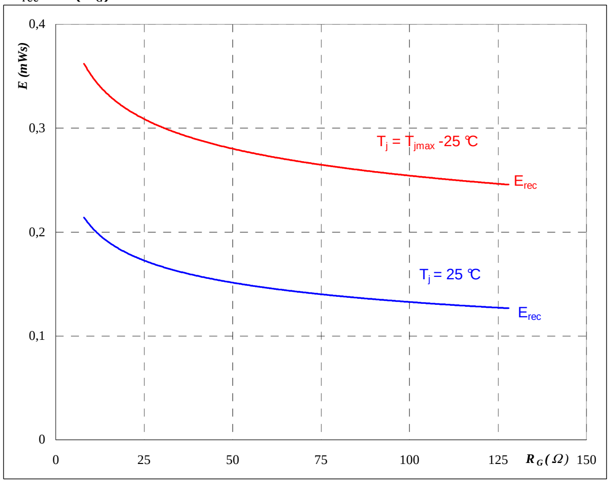
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	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

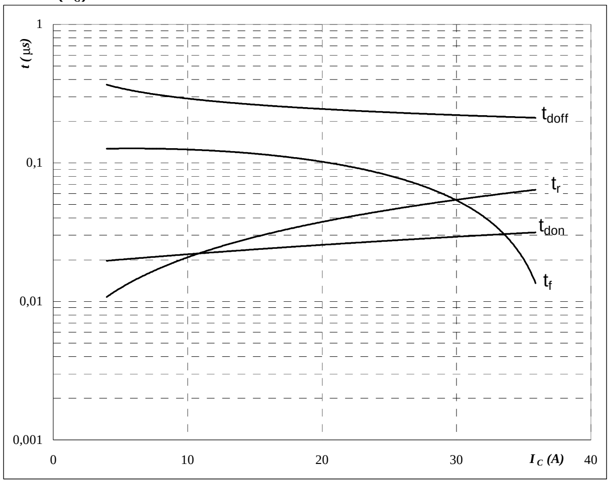
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	20	A

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



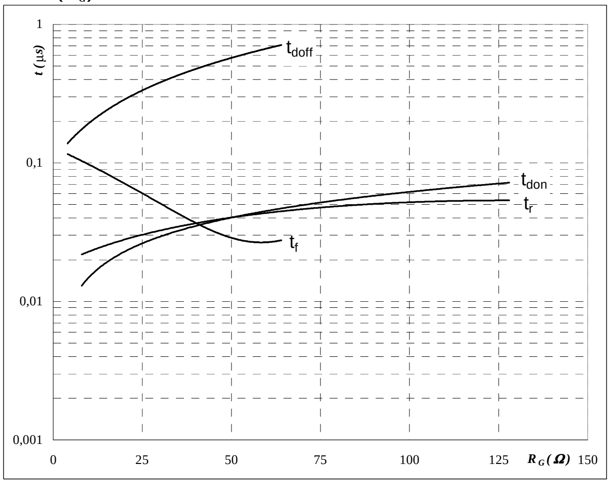
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω
R_{goff} =	16	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



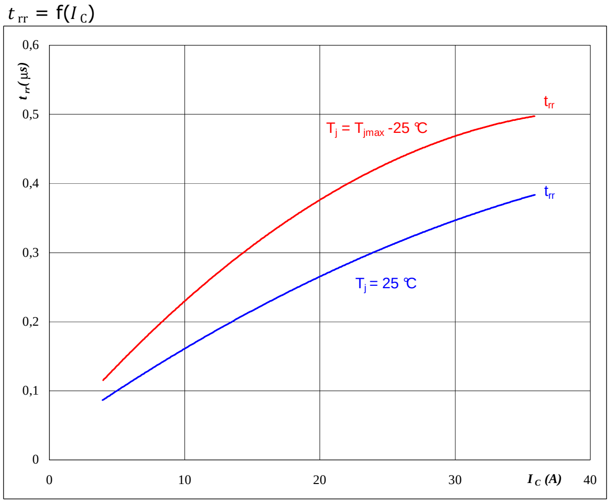
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	20	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



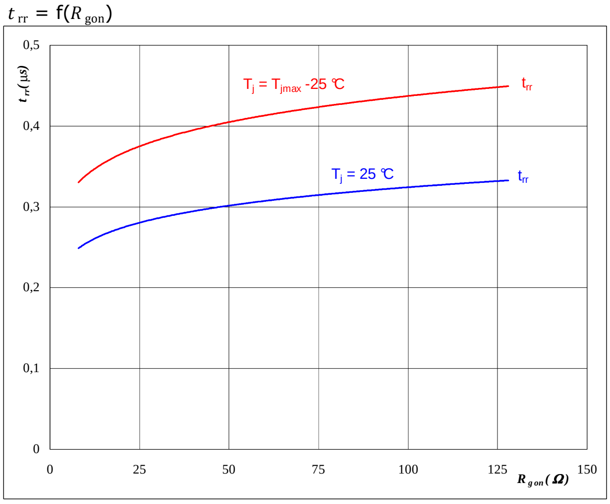
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

figure 12. **FWD**

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

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



At

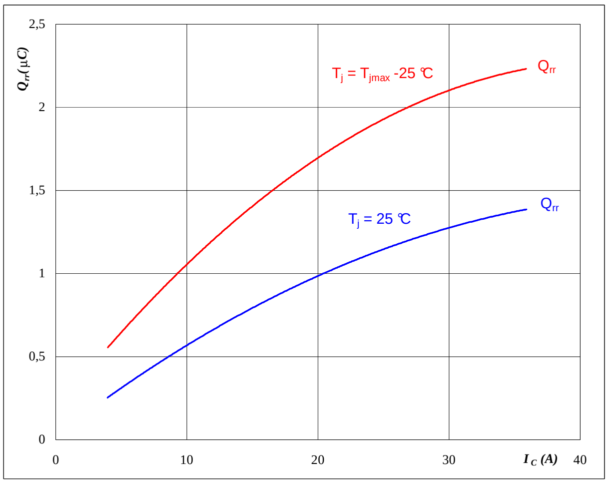
T_j =	25/125	°C
V_R =	300	V
I_F =	20	A
V_{GE} =	15	V

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



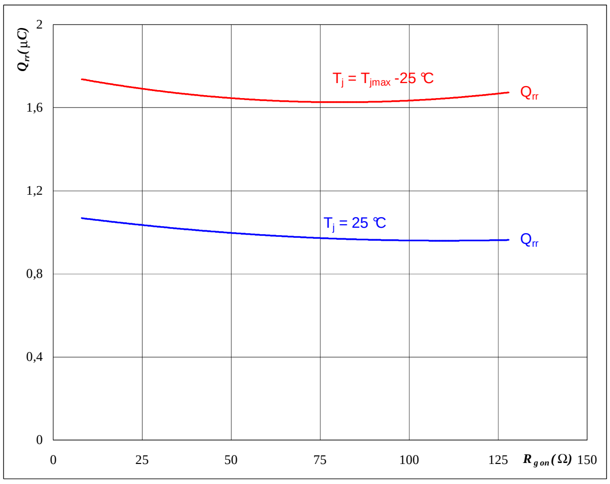
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

figure 14. **FWD**

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

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



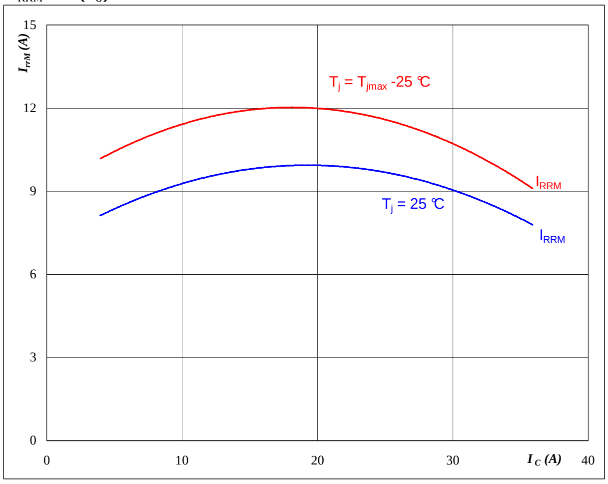
At

T_j =	25/125	°C
V_R =	300	V
I_F =	20	A
V_{GE} =	15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



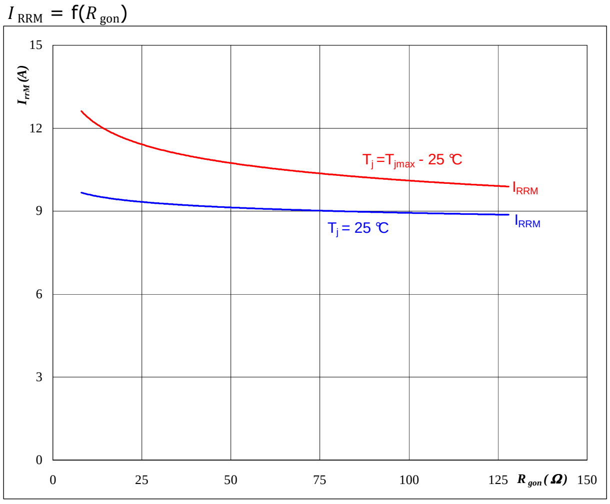
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

figure 16. **FWD**

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

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



At

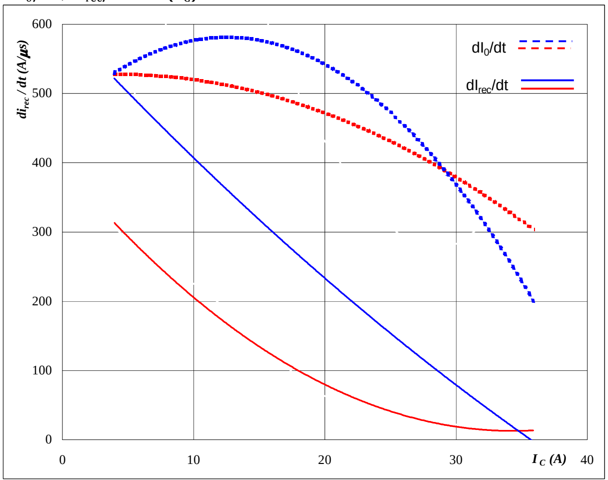
T_j =	25/125	°C
V_R =	300	V
I_F =	20	A
V_{GE} =	15	V

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

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



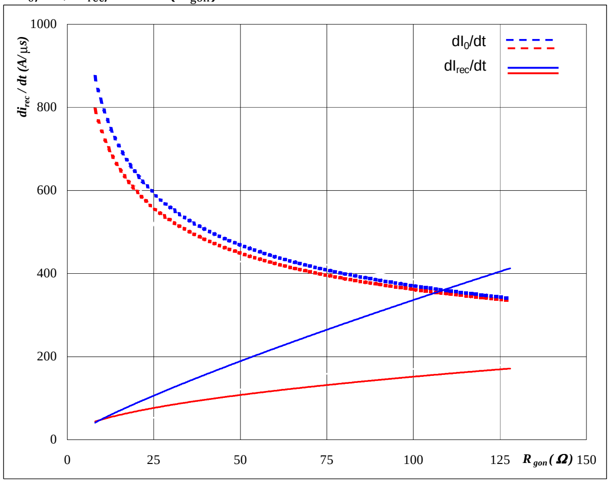
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

figure 18.	FWD

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

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



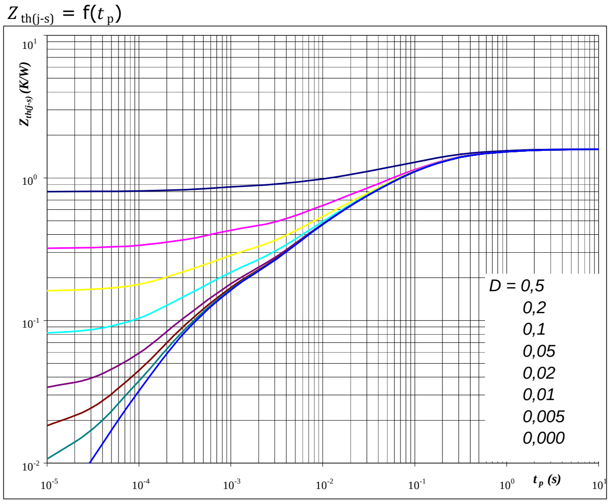
At

T_j =	25/125	°C
V_R =	300	V
I_F =	20	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	
$R_{th(j\text{-}s)}$ =	1,6	K/W

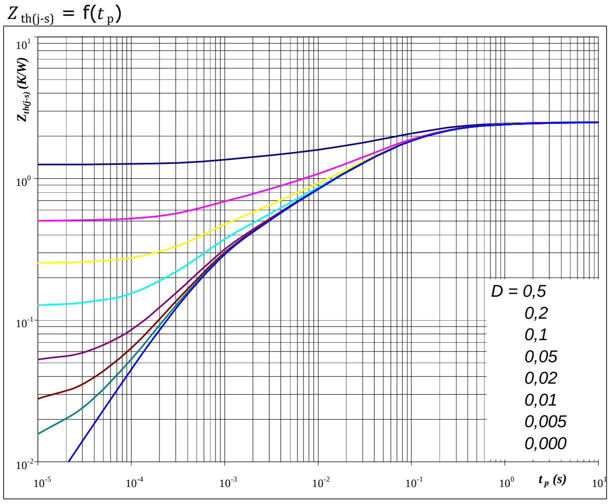
IGBT thermal model values

R (K/W)	Tau (s)
3,56E-02	9,51E+00
1,72E-01	7,35E-01
6,45E-01	1,27E-01
3,88E-01	3,01E-02
2,41E-01	6,09E-03
1,19E-01	3,98E-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	
$R_{th(j\text{-}s)}$ =	2,5	K/W

FWD thermal model values

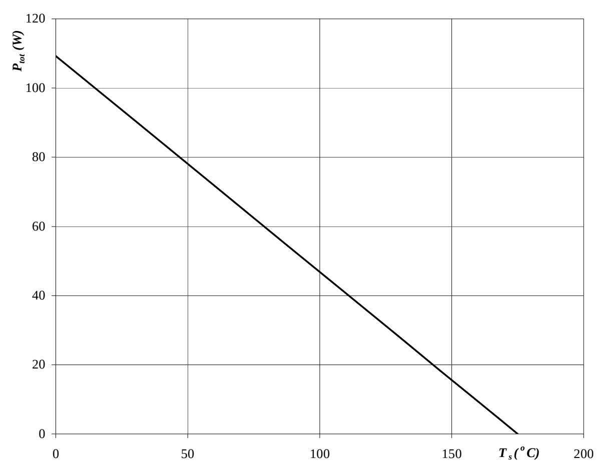
R (K/W)	Tau (s)
5,06E-02	9,02E+00
2,53E-01	6,56E-01
8,83E-01	1,18E-01
7,35E-01	2,86E-02
3,35E-01	4,82E-03
2,57E-01	6,88E-04

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



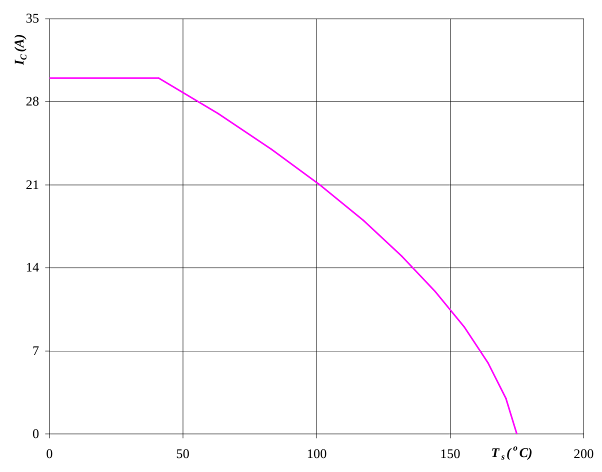
At

T_j = 175 °C

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

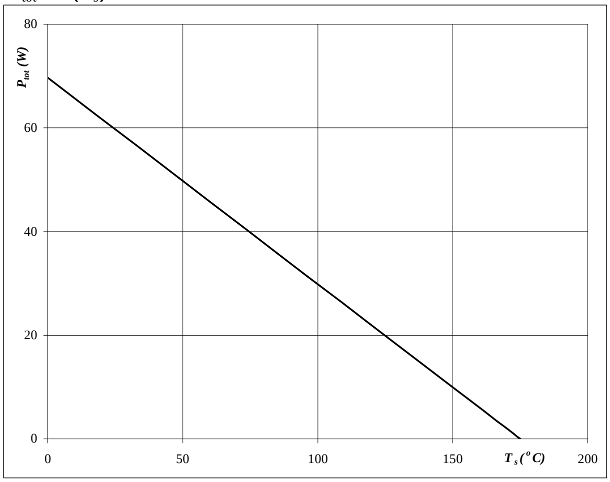
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



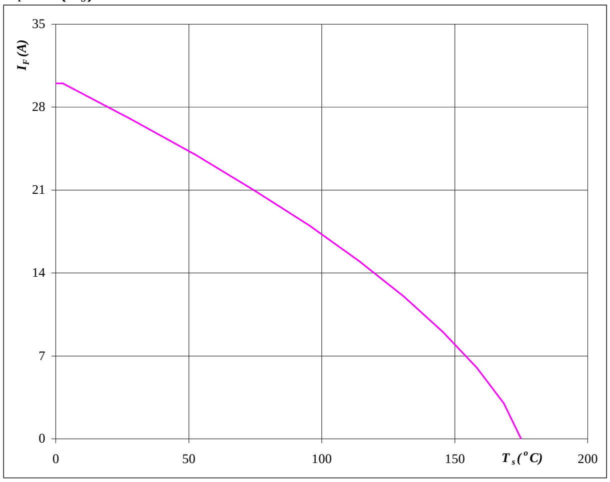
At

T_j = 175 °C

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

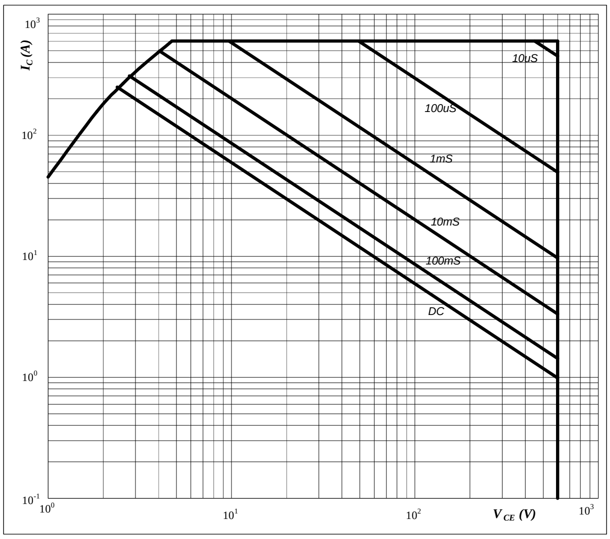
T_j = 175 °C

Inverter Switch / Brake Switch / Inverter Diode / Brake Diode

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



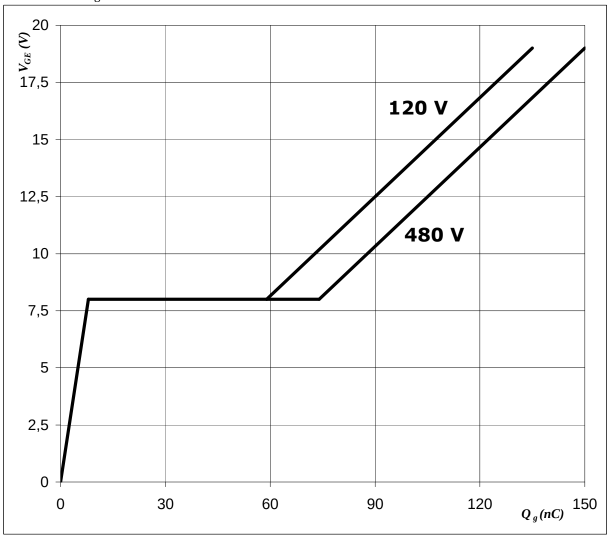
At

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

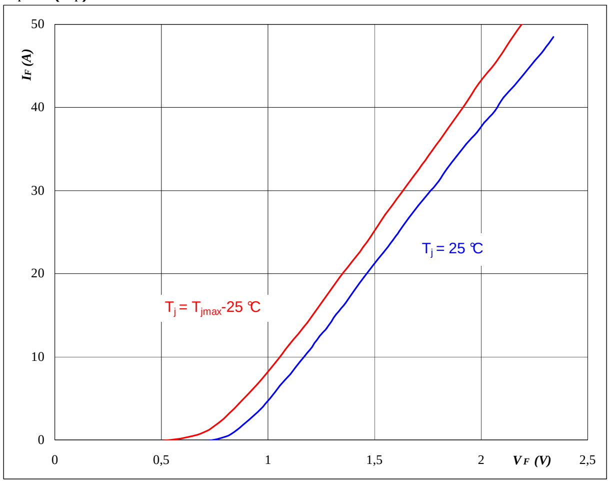
I_C =	20	A

Rectifier Diode

figure 1. **Rectifier Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



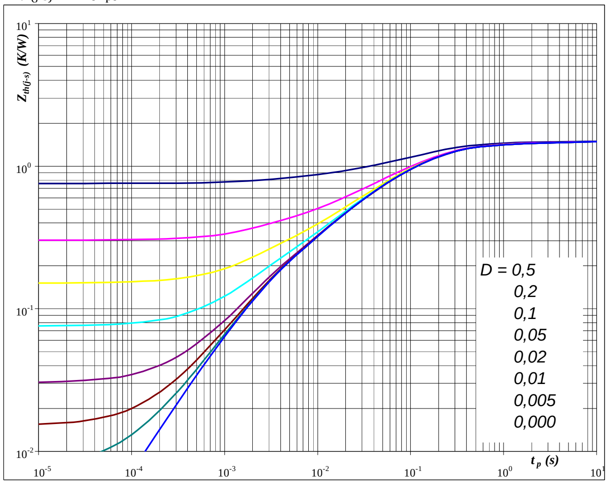
At

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

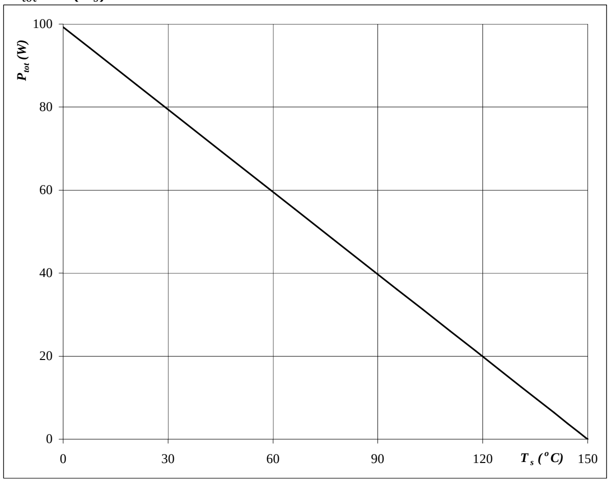
$D = t_p / T$

$R_{th(j-s)}$ = 1,5 K/W

figure 3. **Rectifier Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



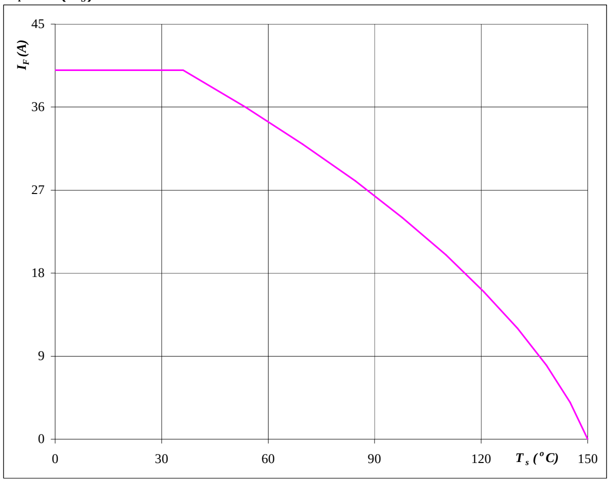
At

T_j = 150 ºC

figure 4. **Rectifier Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



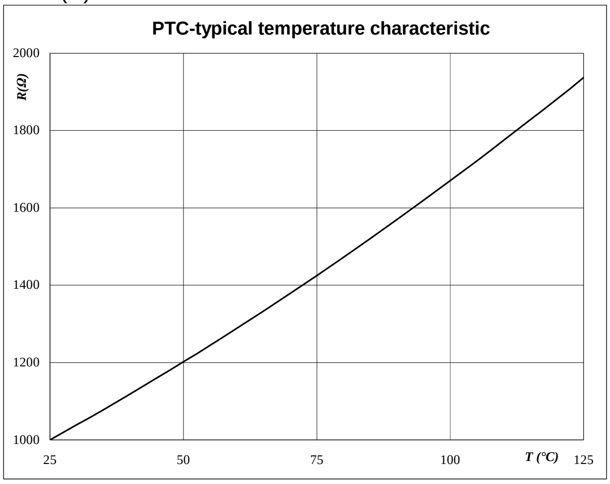
At

T_j = 150 ºC

Thermistor

figure 1.	Thermistor

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



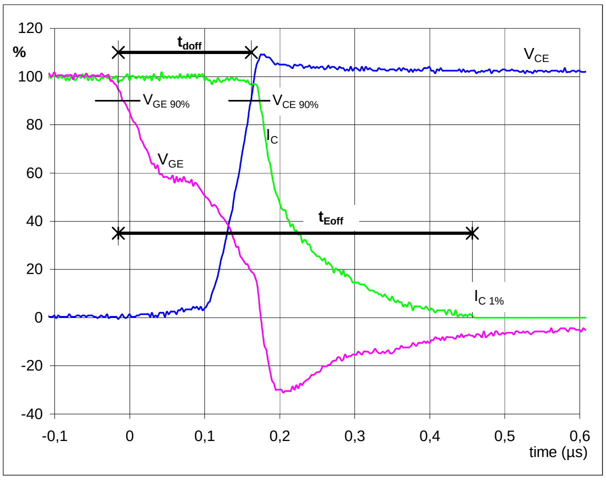
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	16 Ω
R_{goff}	=	8 Ω

figure 1. **IGBT**

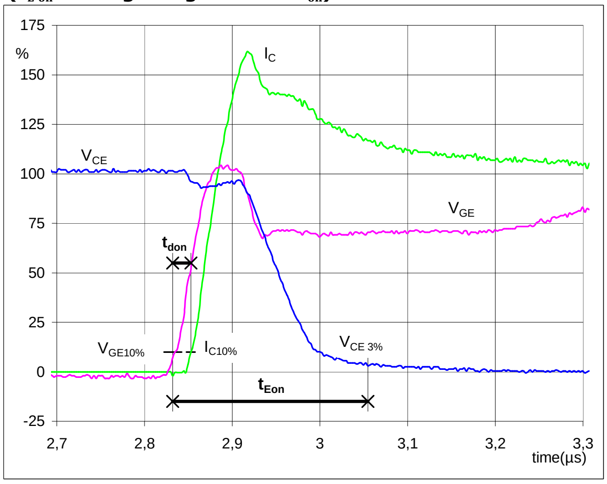
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	20	A
t_{doff} =	0,17	µs
$t_{E\,off}$ =	0,47	µs

figure 2. **IGBT**

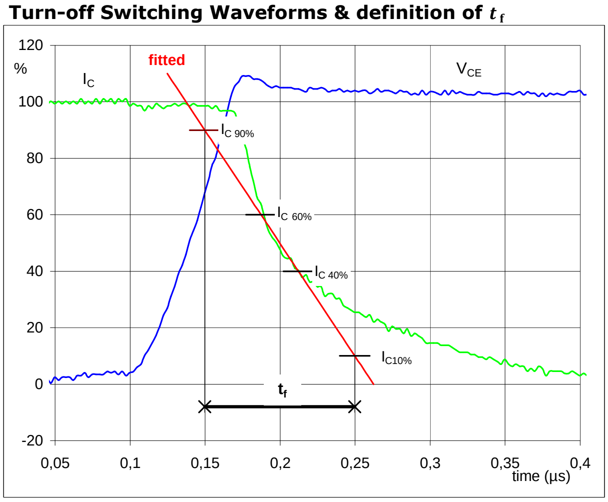
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	20	A
t_{don} =	0,02	µs
$t_{E\,on}$ =	0,22	µs

figure 3. **IGBT**

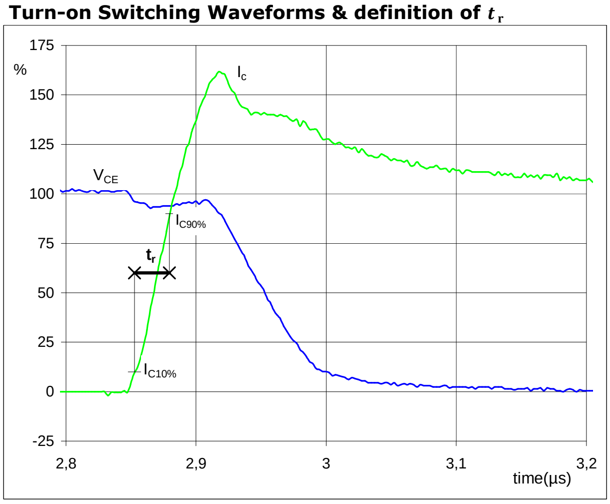
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	20	A
t_f =	0,10	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

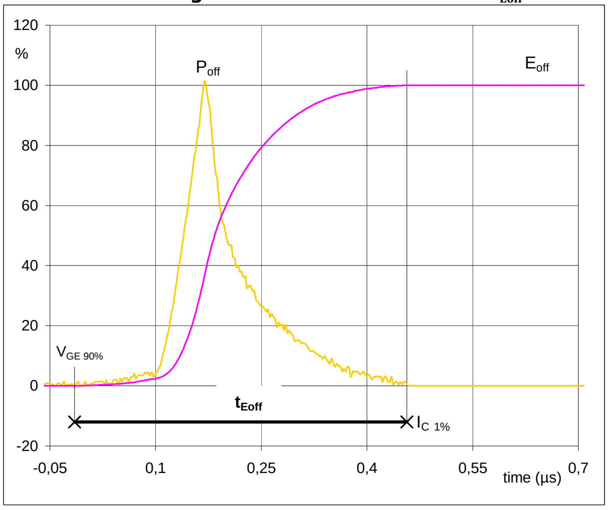


V_C (100%) =	300	V
I_C (100%) =	20	A
t_r =	0,03	µs

Switching Definitions Output Inverter

figure 5.	**IGBT**

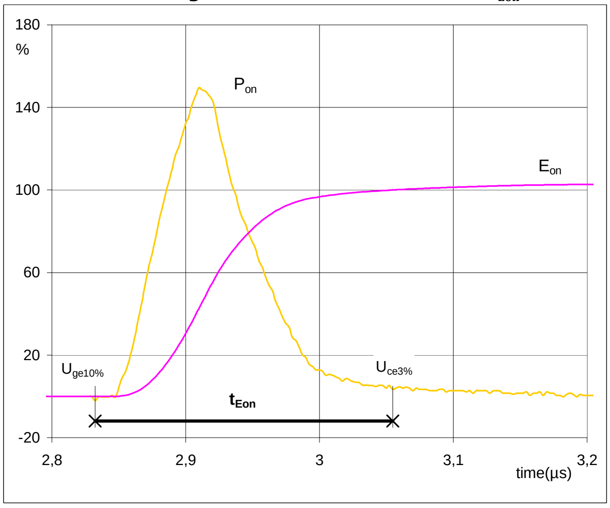
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	5,98	kW
E_{off} (100%) =	0,57	mJ
$t_{E\,off}$ =	0,47	µs

figure 6.	**IGBT**

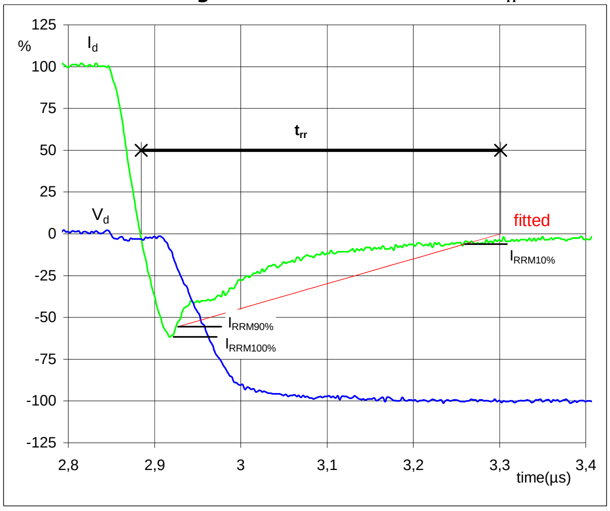
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	5,98	kW
E_{on} (100%) =	0,71	mJ
$t_{E\,on}$ =	0,22	µs

figure 7.	**FWD**

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

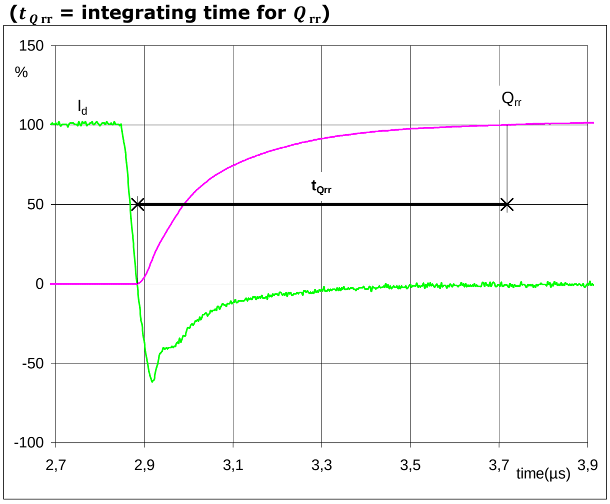


V_d (100%) =	300	V
I_d (100%) =	20	A
I_{RRM} (100%) =	12	A
t_{rr} =	0,35	µs

Switching Definitions Output Inverter

figure 8. **FWD**

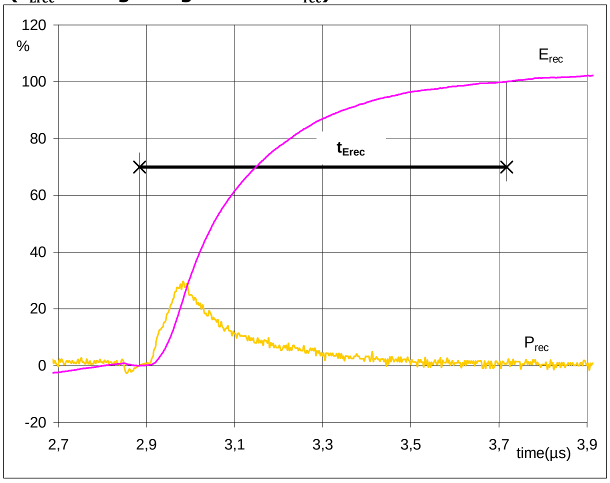
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	20	A
Q_{rr} (100%) =	1,69	µC
$t_{Q\,rr}$ =	0,83	µs

figure 9. **FWD**

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



P_{rec} (100%) =	5,98	kW
E_{rec} (100%) =	0,33	mJ
$t_{E\,rec}$ =	0,83	µs

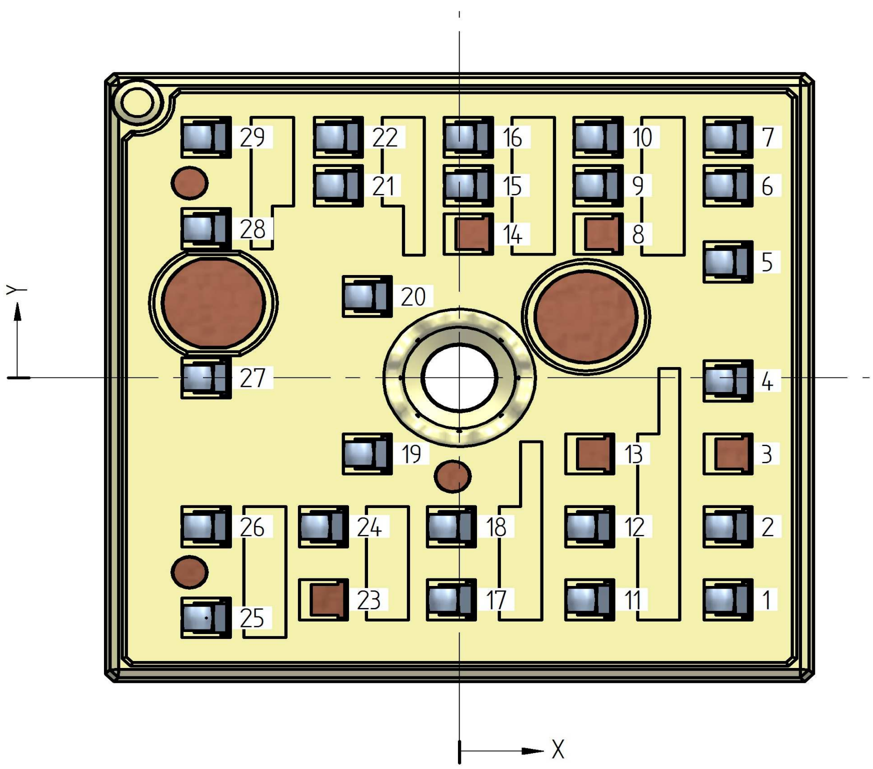
Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K12-T-PM)	V23990-K204-A-/0A/-PM
with std lid (black V23990-K12-T-PM) and P12	V23990-K204-A-/1A/-PM
with thin lid (white V23990-K13-T-PM)	V23990-K204-A-/0B/-PM
with thin lid (white V23990-K13-T-PM) and P12	V23990-K204-A-/1B/-PM

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

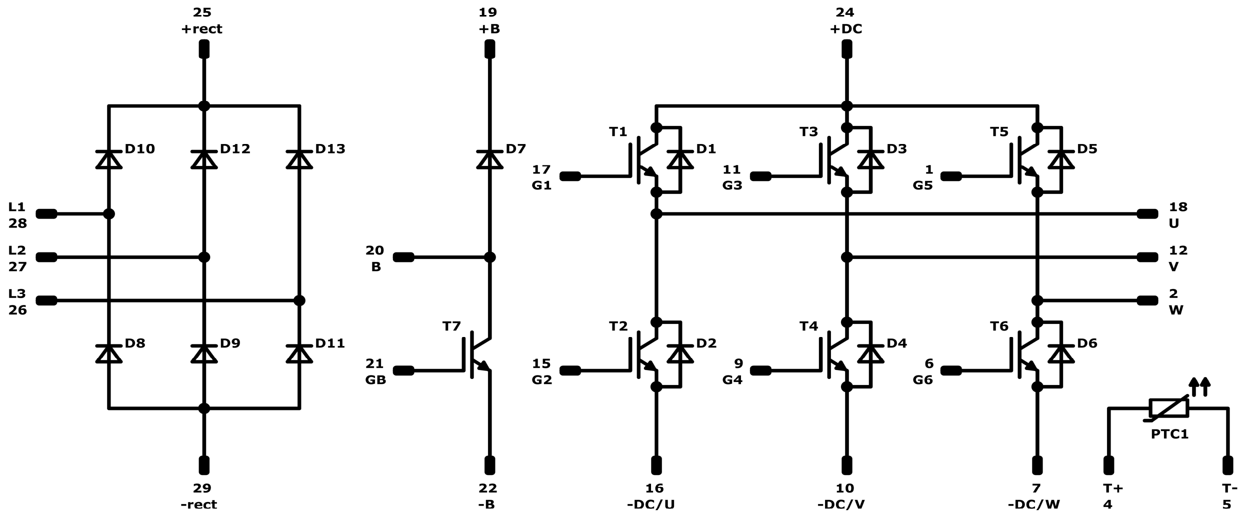
Outline

Pad table [mm]			
Pad	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	Not assembled		
4	15,93	-0,2	+T
5	15,93	7,62	-T
6	15,93	12,62	G6
7	15,93	15,8	-DC/W
8	Not assembled		
9	8,23	12,62	G4
10	8,23	15,8	-DC/V
11	7,73	-14,6	G3
12	7,73	-9,8	V
13	Not assembled		
14	Not assembled		
15	0,53	12,62	G2
16	0,53	15,8	-DC/U
17	-0,47	-14,6	G1
18	-0,47	-9,8	U
19	-5,47	-5	+B
20	-5,47	5,35	B
21	-7,17	12,62	GB
22	-7,17	15,8	-B
23	Not assembled		
24	-8,07	-9,8	+DC
25	-15,02	-15,8	+RECT
26	-15,02	-9,8	L3
27	-15,02	0	L2
28	-15,02	9,8	L1
29	-15,02	15,8	-RECT



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

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
D8-D13	Rectifier	1600 V	25 A	Rectifier Diode	
T1-T6	IGBT	600 V	20 A	Inverter Switch	
D1-D6	FWD	600 V	20 A	Inverter Diode	
T7	IGBT	600 V	20 A	Brake Switch	
D7	FWD	600 V	20 A	Brake Diode	
PTC1	PTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**120**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 1 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 1 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-K204-A-D4-14	03 Aug. 2016		