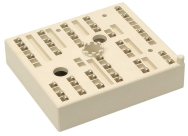
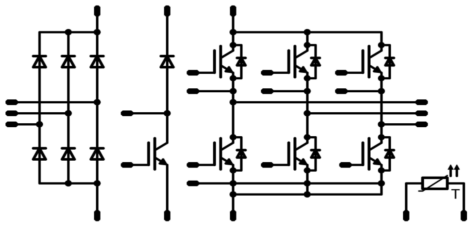
V23990-K223-A-PM
datasheet

MiniSKiiP® 2 PIM **600 V / 50 A**

Features
- Solderless interconnection
- Trench Fieldstop technology

MiniSKiiP® 2 housing


Target Applications
- Industrial Motor Drives

Schematic


Types
- V23990-K223-A-PM

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Rectifier Diode					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$	T_s = 80 °C	45	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j = 25 °C	370	A
I2t-value	I^2t			360	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	56	W
Maximum Junction Temperature	T_{jmax}			150	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter Switch / Brake Switch					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	53	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		150	A
Turn off safe operating area		V_{CE} ≤ 600 V, $T_j \le T_{op}$ max		75	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	100	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		6 360	µs V
Maximum Junction Temperature	T_{jmax}			175	°C
Inverter Diode / Brake Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	40	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j = 25 °C T_j = 150 °C	345 320	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	59	W
Maximum Junction Temperature	T_{jmax}			175	°C
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+(T_{jmax} - 25)	°C
Isolation Properties					
Isolation voltage	V_{is}	t = 2 s	DC voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm

Characteristic Values

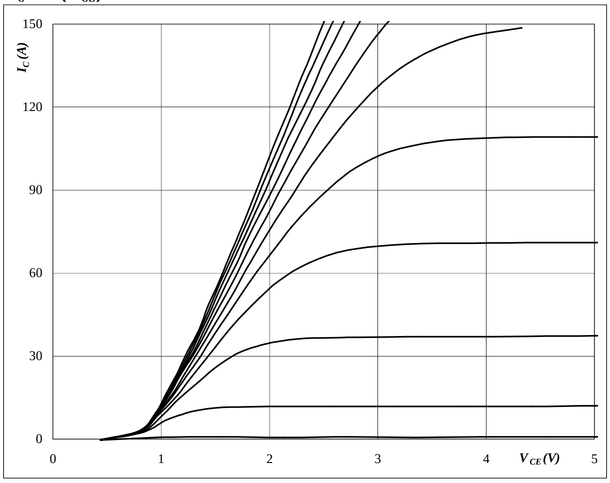
Parameter	Symbol	Conditions	V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Rectifier Diode										
Forward voltage	V_F				25	25 125	0,8	1,1 1,03	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					25 125		0,9 0,77		V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

Inverter / Brake Characteristics

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



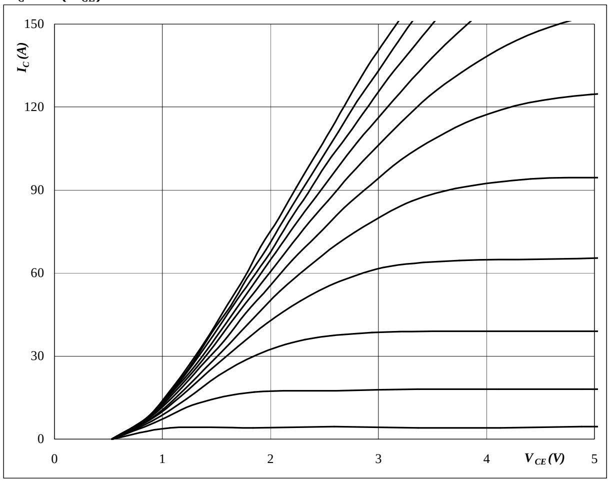
At

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

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



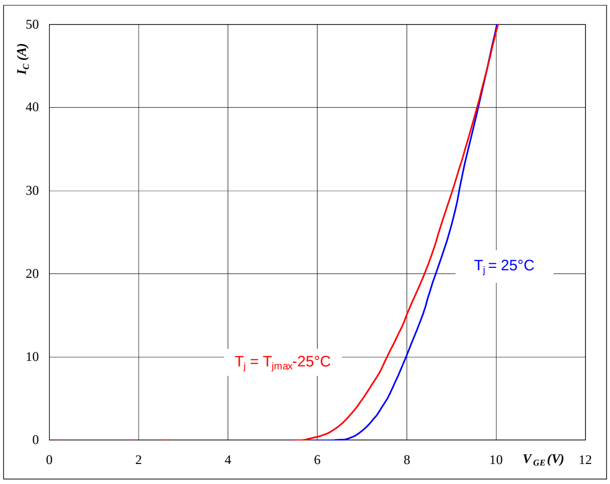
At

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

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



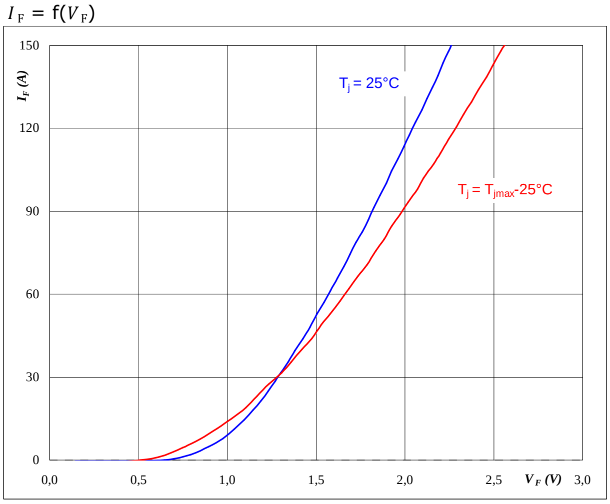
At

t_p =	250	μs
V_{CE} =	10	V

Figure 4 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

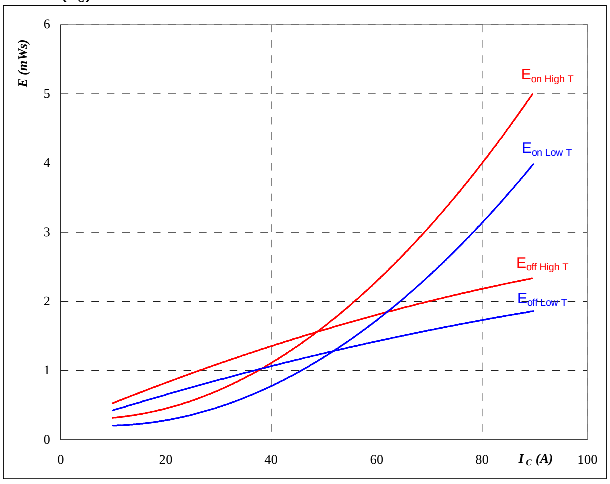
t_p =	250	μs

Inverter / Brake Characteristics

Figure 5 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



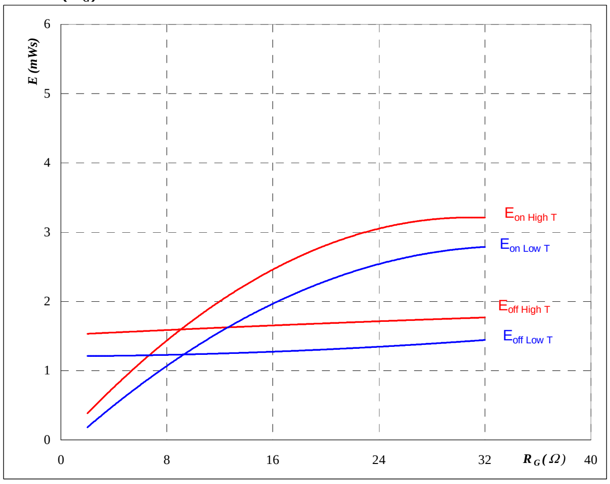
With an inductive load at

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

Figure 6 IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



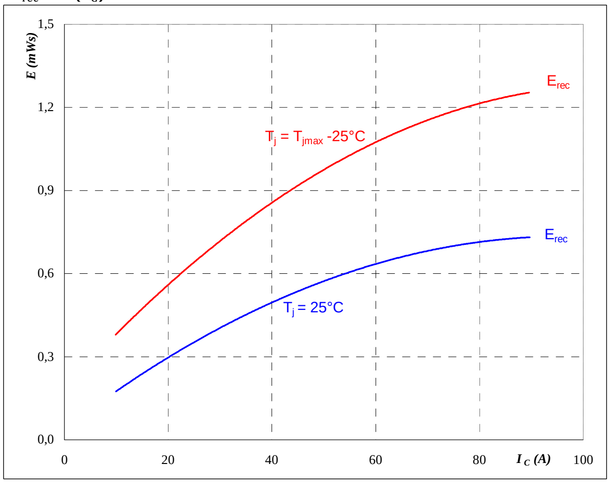
With an inductive load at

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

Figure 7 FWD

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



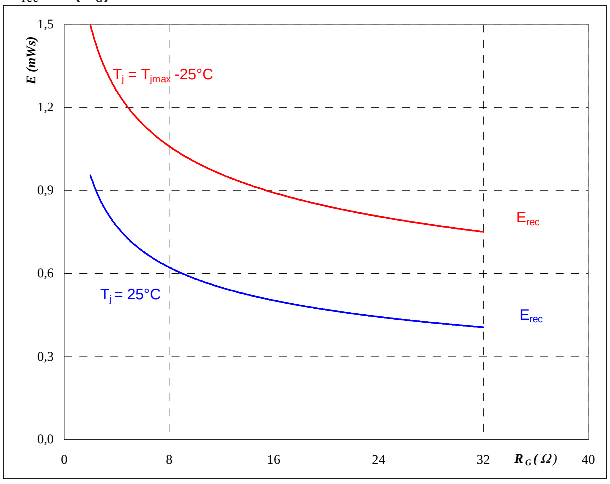
With an inductive load at

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

Figure 8 FWD

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

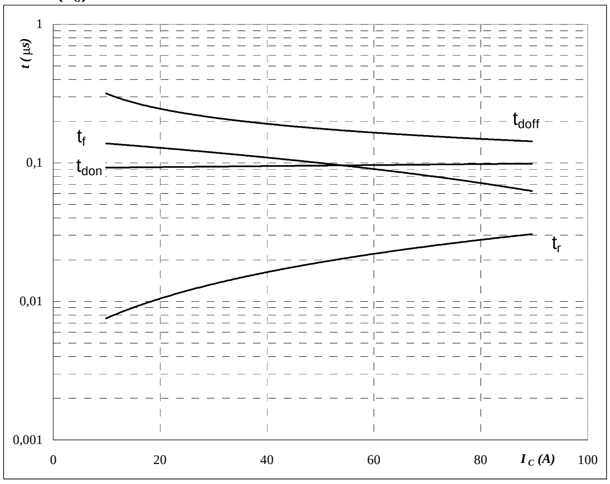
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	50	A

Inverter / Brake Characteristics

Figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



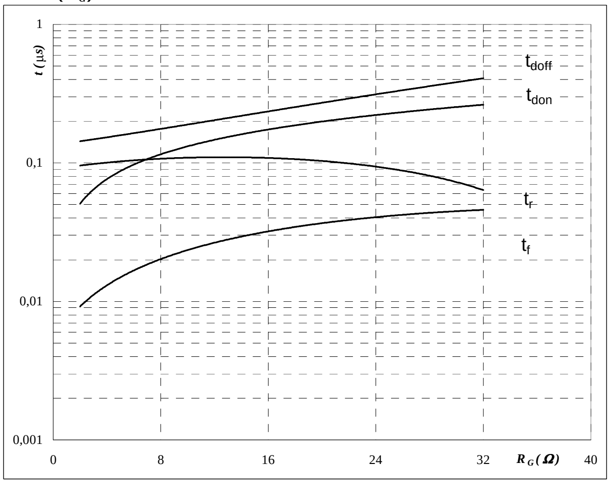
With an inductive load at

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

Figure 10 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



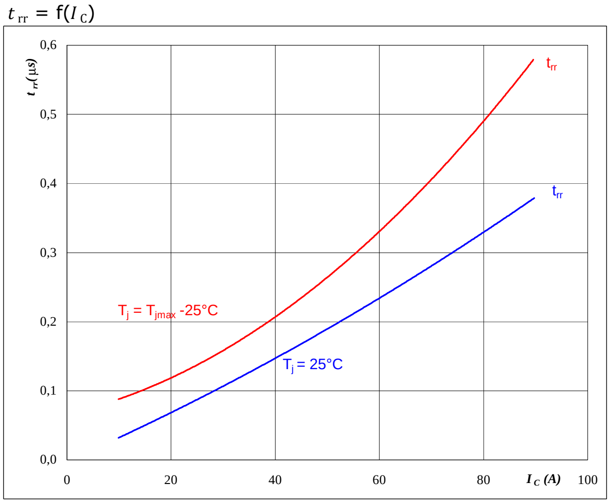
With an inductive load at

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

Figure 11 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



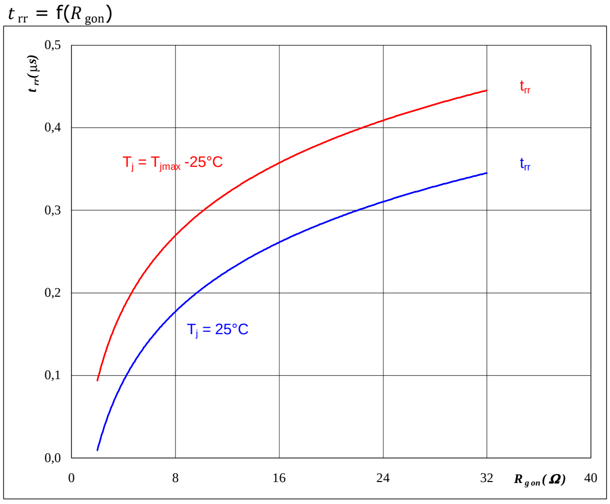
At

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

Figure 12 FWD

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

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



At

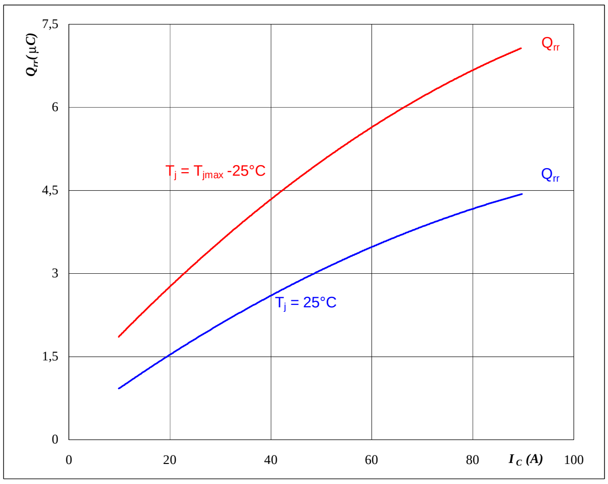
T_j =	25/125	°C
V_R =	300	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



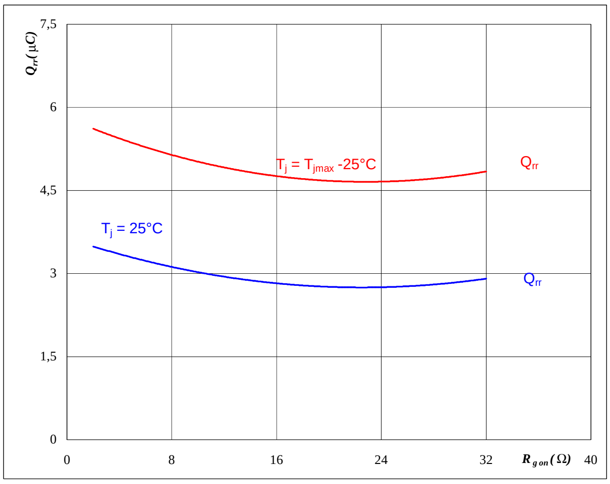
At

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

Figure 14 FWD

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

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



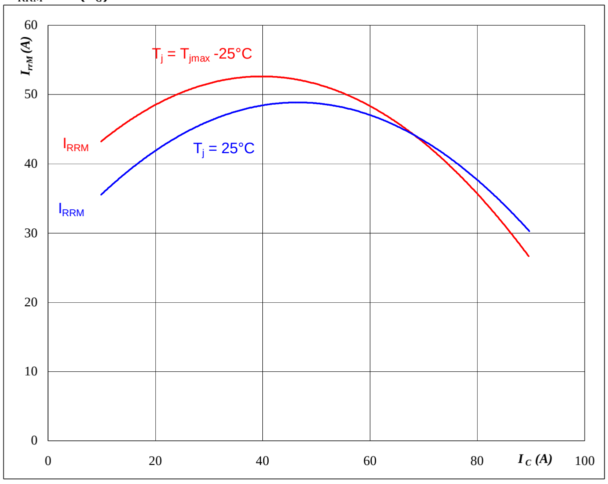
At

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

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



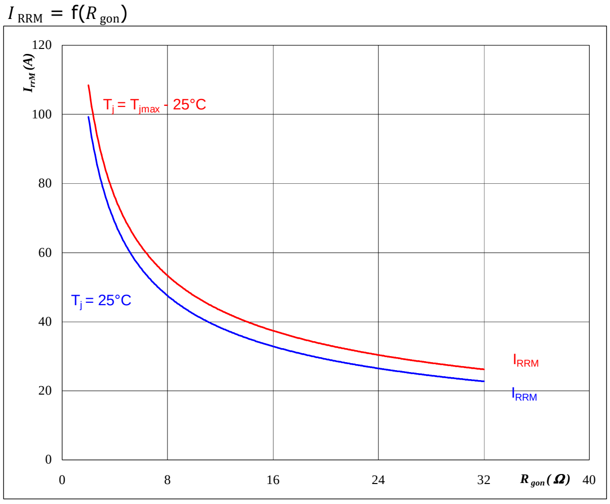
At

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

Figure 16 FWD

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

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



At

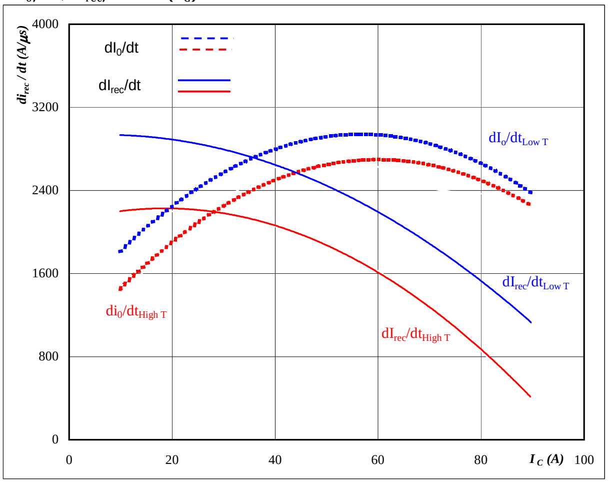
T_j =	25/125	°C
V_R =	300	V
I_F =	50	A
V_{GE} =	±15	V

Inverter / Brake Characteristics

Figure 17 FWD

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

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



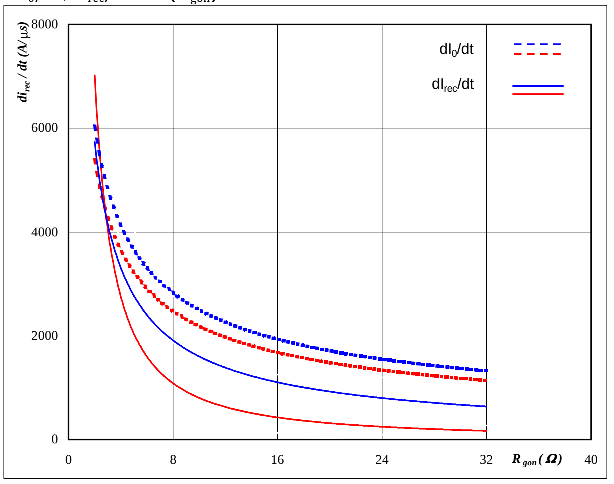
At

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

Figure 18 FWD

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

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



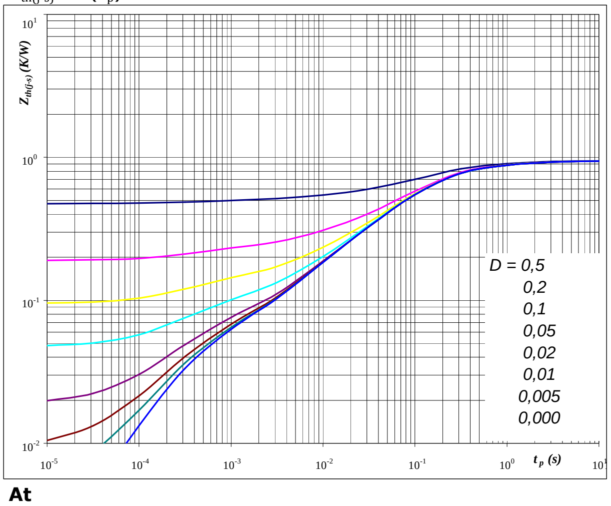
At

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

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	0,95	K/W

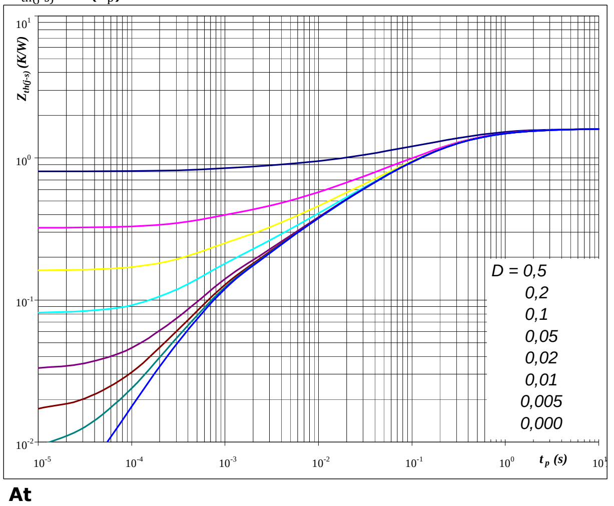
IGBT thermal model values

R (K/W)	Tau (s)
2,41E-02	9,91E+00
1,28E-01	9,63E-01
4,84E-01	1,53E-01
2,04E-01	3,37E-02
6,42E-02	5,23E-03
4,52E-02	3,54E-04

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	1,6	K/W

FWD thermal model values

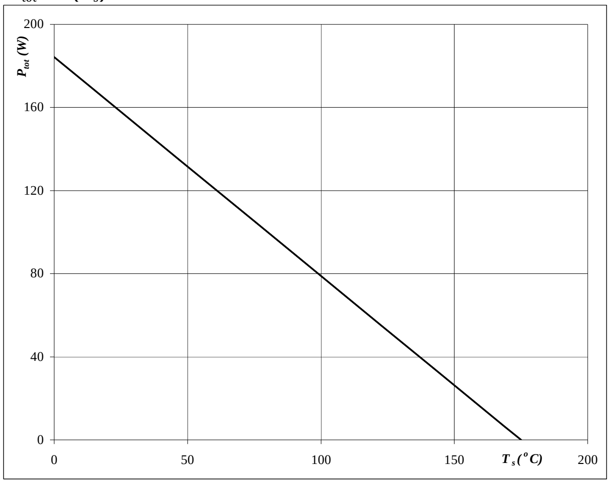
R (K/W)	Tau (s)
4,06E-02	9,24E+00
2,17E-01	1,02E+00
6,65E-01	2,05E-01
3,84E-01	3,97E-02
1,94E-01	6,99E-03
1,10E-01	7,49E-04

Inverter / Brake Characteristics

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



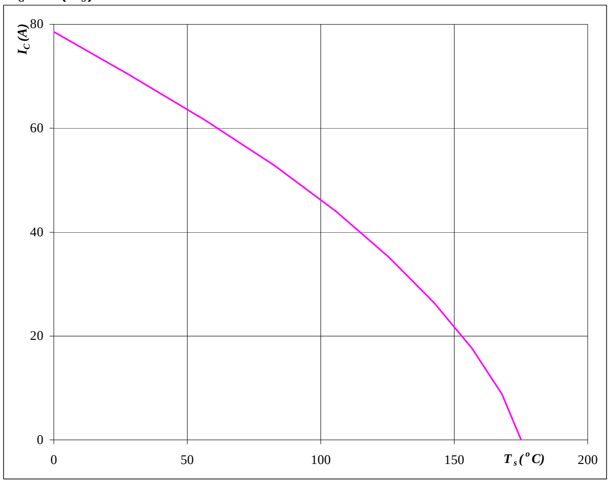
At

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

$P_{tot} = f(T_s)$

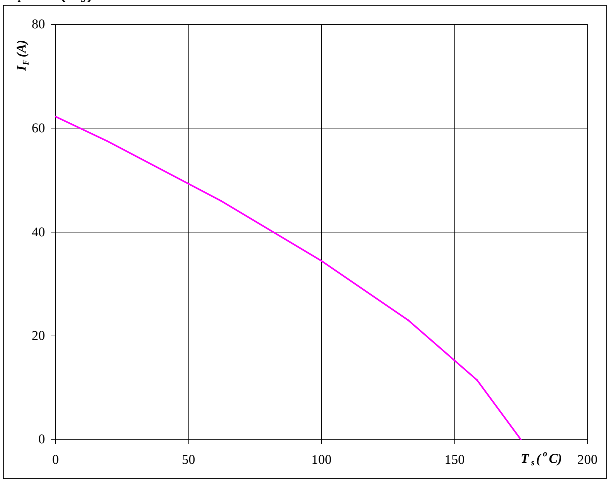
At

T_j = 175 °C

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

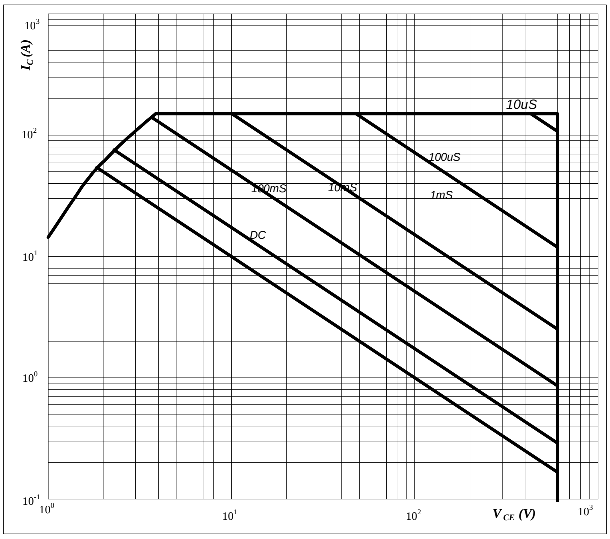
T_j = 175 °C

Inverter / Brake Characteristics

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



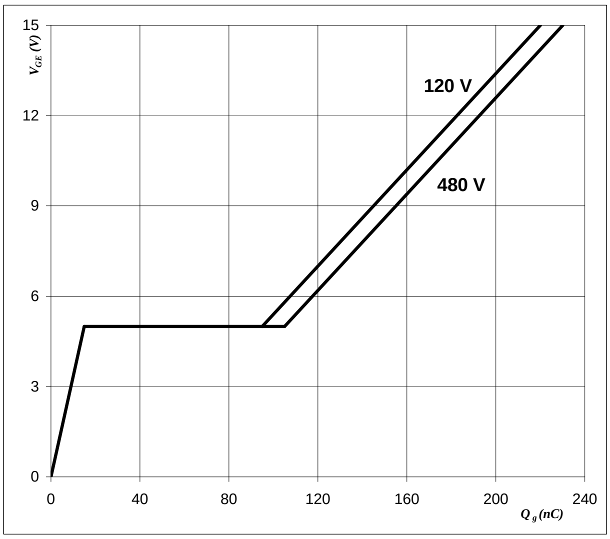
At

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

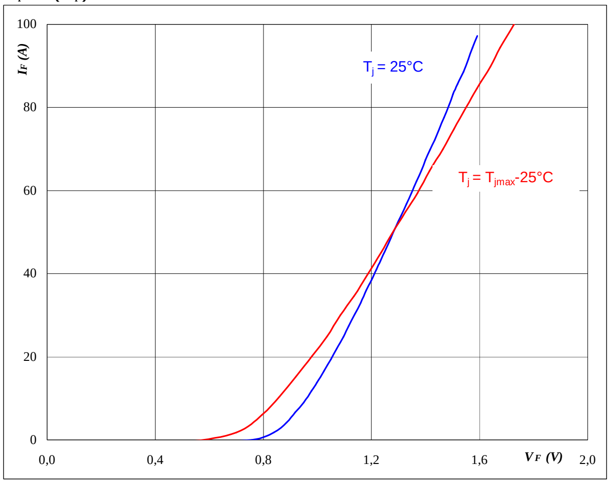
I_C =	50	A

Rectifier Diode

Figure 1 Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



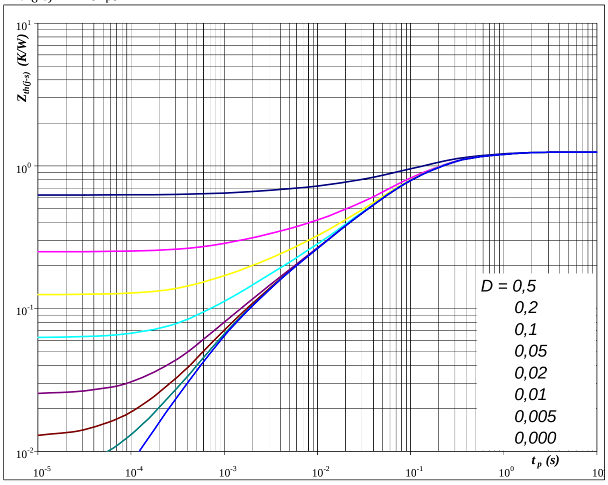
At

t_p = 250 µs

Figure 2 Diode

Diode transient thermal impedance as a function of pulse width

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



At

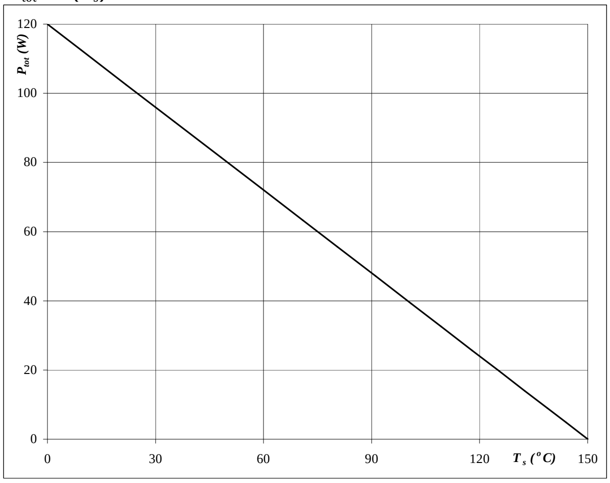
$D = t_p / T$

$R_{th(j-s)}$ = 1,25 K/W

Figure 3 Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



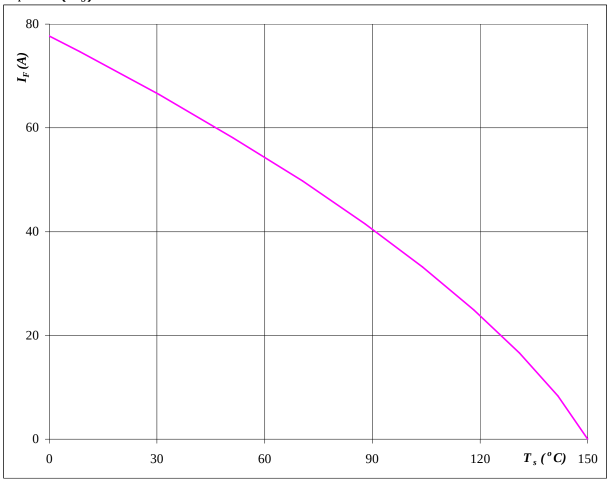
At

T_j = 150 ºC

Figure 4 Diode

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



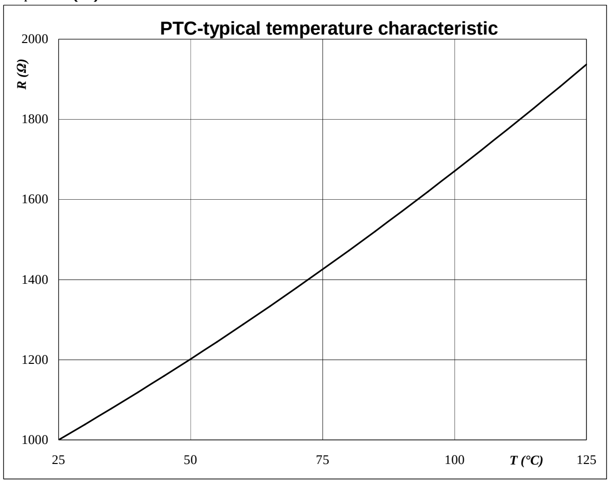
At

T_j = 150 ºC

Thermistor

Figure 1	Thermistor

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



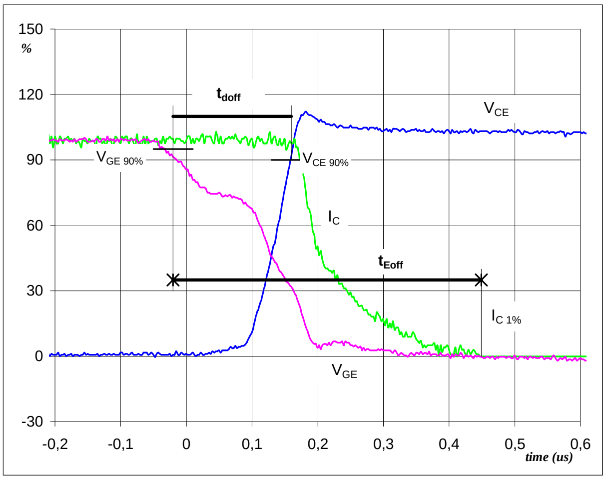
Switching Definitions Inverter

General conditions

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

Figure 1 IGBT

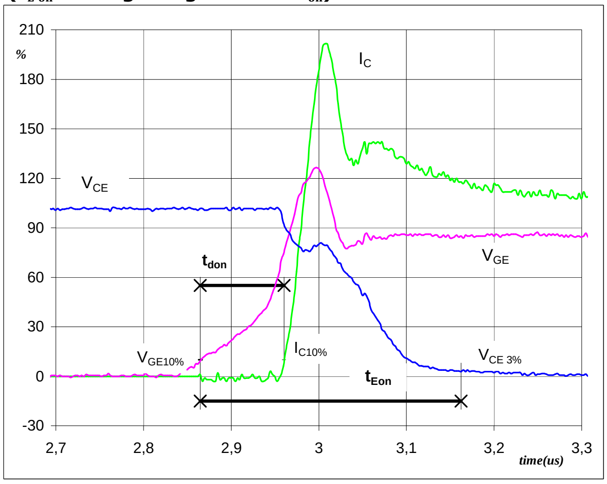
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\ off}$ = integrating time for E_{off})



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

Figure 2 IGBT

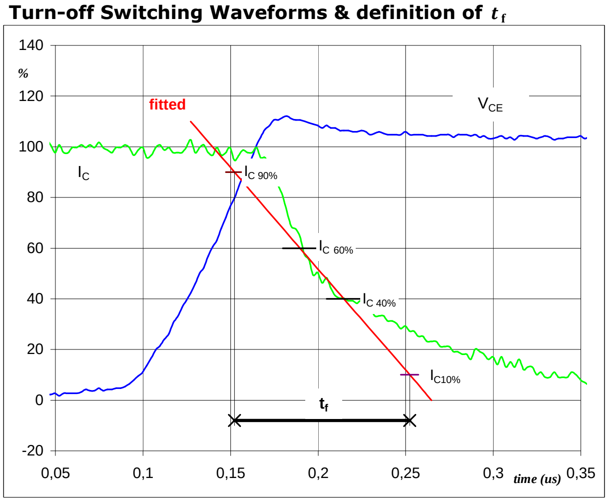
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\ on}$ = integrating time for E_{on})



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

Figure 3 IGBT

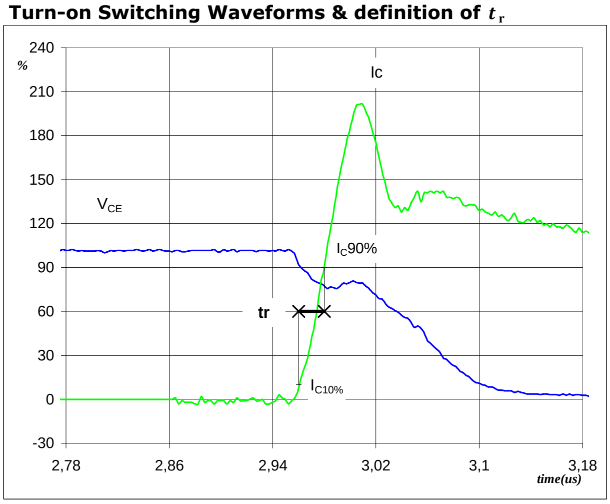
Turn-off Switching Waveforms & definition of t_f



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

Figure 4 IGBT

Turn-on Switching Waveforms & definition of t_r

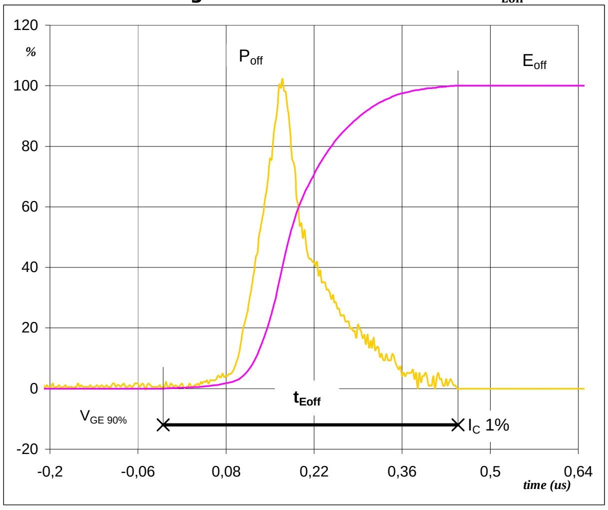


V_C (100%) =	300	V
I_C (100%) =	50	A
t_r =	0,02	μs

Switching Definitions Inverter

Figure 5 IGBT

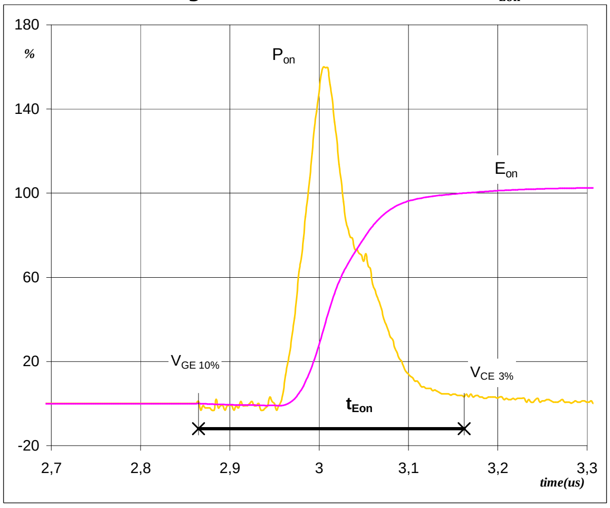
Turn-off Switching Waveforms & definition of *t* Eoff



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

Figure 6 IGBT

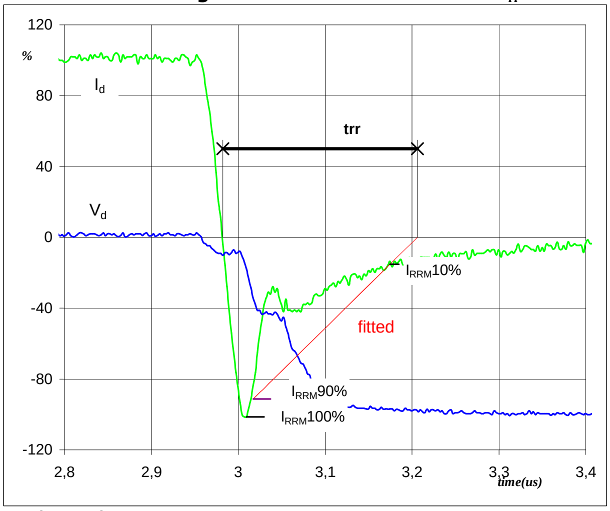
Turn-on Switching Waveforms & definition of *t* Eon



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

Figure 7 FWD

Turn-off Switching Waveforms & definition of *t* rr

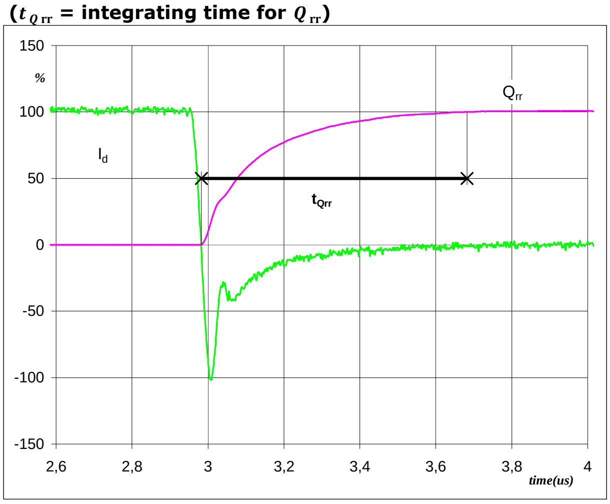


V_d (100%) =	300	V
I_d (100%) =	50	A
I_{RRM} (100%) =	51	A
t_{rr} =	0,27	μs

Switching Definitions Inverter

Figure 8 FWD

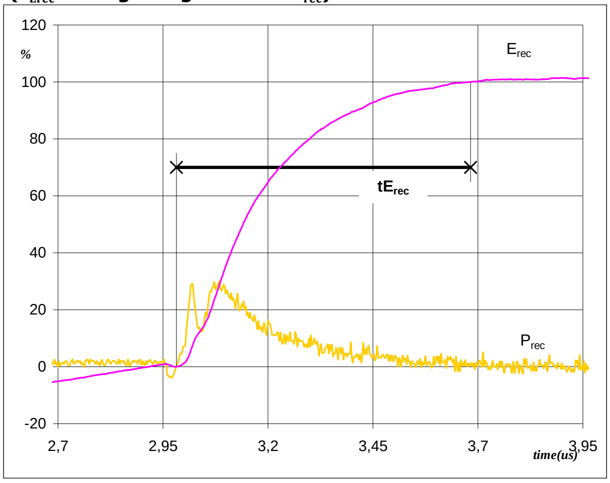
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



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

Figure 9 FWD

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



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

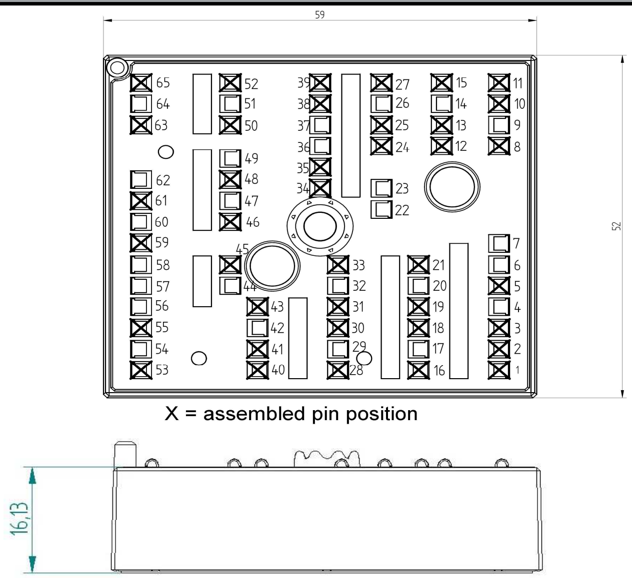
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K22-T-PM)	V23990-K223-A-/0A/-PM
with std lid (black V23990-K22-T-PM) and P12	V23990-K223-A-/1A/-PM
with thin lid (white V23990-K23-T-PM)	V23990-K223-A-/0B/-PM
with thin lid (white V23990-K23-T-PM) and P12	V23990-K223-A-/1B/-PM

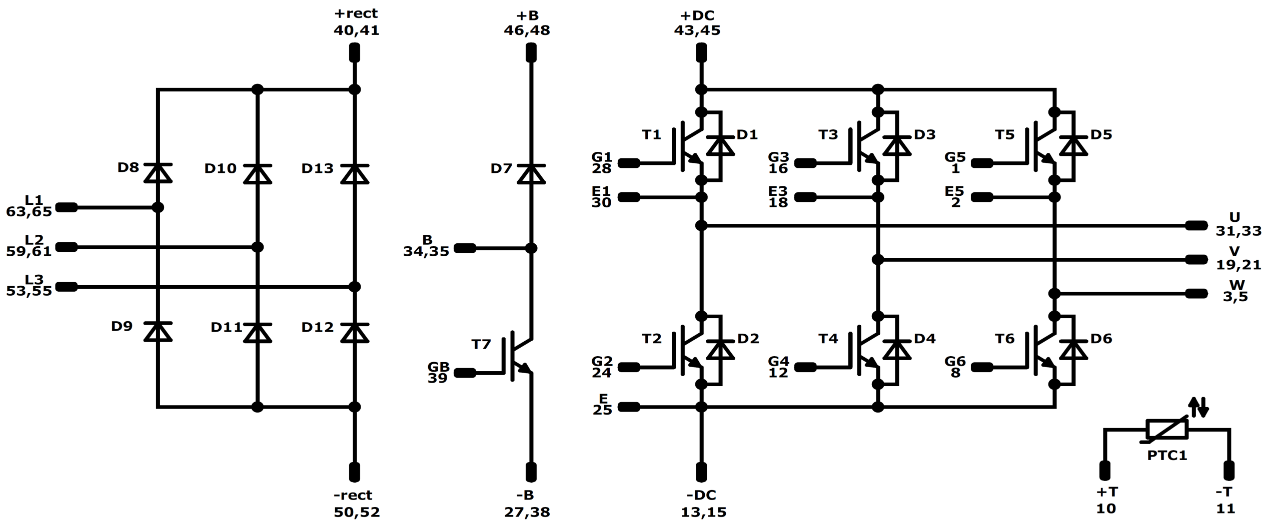
Text	VIN	Date code	Name&Ver	UL	Lot	Serial
	VIN	WWYY	NNNNNNNVV	UL	LLLLL	SSSS
Datamatrix	Type&Ver	Lot number	Serial	Date code		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

Outline



X = assembled pin position

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	50 A	Inverter Switch	
D1-D6	FWD	600 V	50 A	Inverter Diode	
T7	IGBT	600 V	50 A	Brake Switch	
D7	FWD	600 V	50 A	Brake Diode	
D8-D13	Diode	1600 V	35 A	Rectifier Diode	
PTC1	PTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**72**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 2 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 2 packages see vincotech.com website.

UL recognition and file number
This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.

Document No.:	Date:	Modification:	Pages
V23990-K223-A-D4-14	2016.06.30		

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.