MiniSKiiP® PIM 0	**600 V / 6 A**

Features

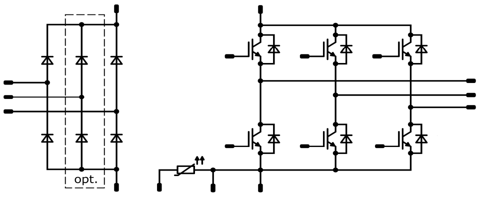
- Solderless interconnection
- Trench Fieldstop IGBT's for low saturation losses
- Optional 2- and 3-leg rectifier

MiniSKiiP®0 housing

Target Applications

- Industrial Drives
- Embedded Drives

Schematic



Types

80-M006PNB006SA01-K614D, 2-leg rectifier
80-M006PNB006SA-K614C, 3-leg rectifier

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 T_c = 80 °C	25 25	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j = 25 °C	220	A
I^2t-value	I^2t			240	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	46 70	W
Maximum Junction Temperature	T_{jmax}			150	°C
Inverter Switch					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	10 10	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		18	A
Turn off safe operating area		V_{CE} ≤ 1200V, T_j ≤ T_{op} max		18	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	40 60	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

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Inverter Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	10 10	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		22	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	31 47	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					
Insulation voltage	V_{is}	DC Voltage	t_p=2s	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative Tracking Index	CTI			<200	

Characteristic Values

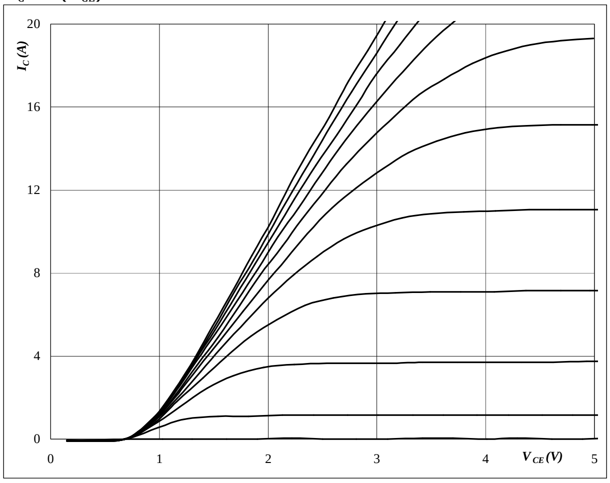
Parameter	Symbol	Conditions	V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j [°C]	Value Min	Value Typ	Value Max	Unit
Rectifier Diode										
Forward voltage	V_F				25	25 125		1,43 1,44	1,64	V
Threshold voltage (for power loss calc. only)	V_{to}				25	25 125		0,92 0,79		V
Slope resistance (for power loss calc. only)	r_t				25	25 125		20,29 26,11		mΩ
Reverse current	I_r			1500		25 125			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										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00009	25 150	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		6	25 150	1,24	1,59 1,84	2,04	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25 150			0,0004	mA
Gate-emitter leakage current	I_{GES}		20	0		25 150			300	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 64 Ω R_{gon} = 64 Ω	±15	300	6	25 150		105 102,4		ns
Rise time	t_r					25 150		21,8 27,8		ns
Turn-off delay time	$t_{d(off)}$					25 150		142,2 163,6		ns
Fall time	t_f					25 150		102,7 132,4		ns
Turn-on energy loss	E_{on}					25 150		0,15 0,22		mWs
Turn-off energy loss	E_{off}					25 150		0,15 0,19		mWs
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		368		pF
Output capacitance	C_{oss}							28		pF
Reverse transfer capacitance	C_{rss}							11		pF
Gate charge	Q_G		15	480	6	25		62	42	nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						2,4		K/W
Inverter Diode										
Diode forward voltage	V_F				6	25 150		1,42 1,36		V
Peak reverse recovery current	I_{RRM}	R_{gon} = 64 Ω	±15	300	6	25 150		3,92 5,82		A
Reverse recovery time	t_{rr}					25 150		182,7 288,1		ns
Reverse recovered charge	Q_{rr}					25 150		0,32 0,77		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		45 57		A/μs
Reverse recovered energy	E_{rec}					25 150		0,06 0,16		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						3		K/W
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R	$\Delta_{R/R}$	R_{25} = 1000 Ω R_{100} = 1670 Ω				25 100	-3 -2		3 2	%
R100	R_{100}					25		1670		Ω
Temperature coefficient								0,76		% /K
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 PTC Reference									E	

Inverter

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

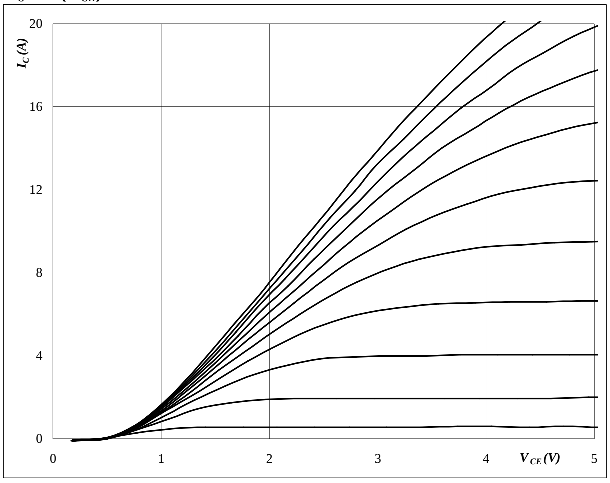


t_p = 250 µs
T_j = 25 °C
V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

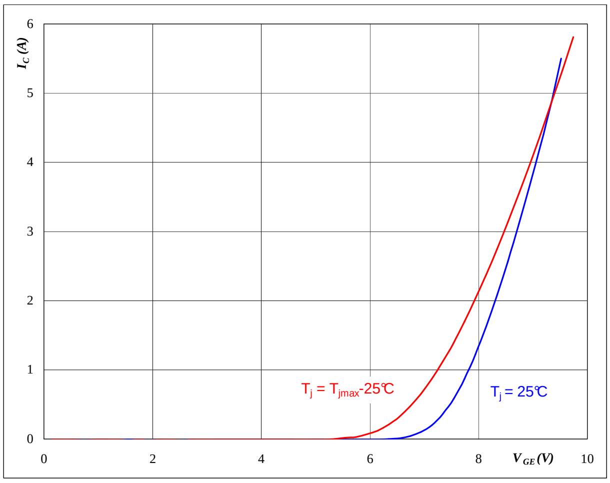


t_p = 250 µs
T_j = 150 °C
V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

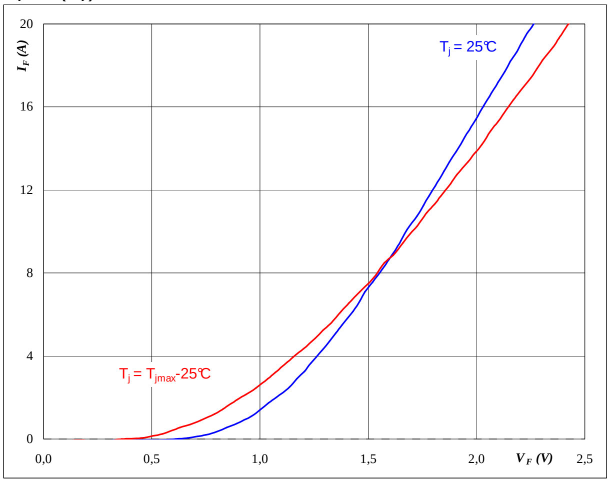


t_p = 250 µs
V_{CE} = 10 V

Figure 4 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



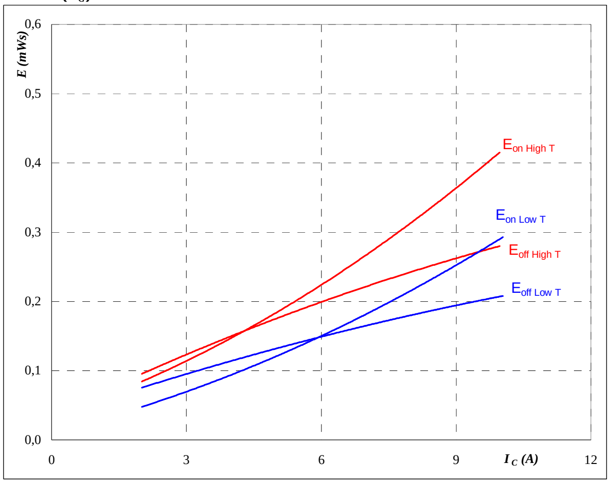
t_p = 250 µs

Inverter

Figure 5 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



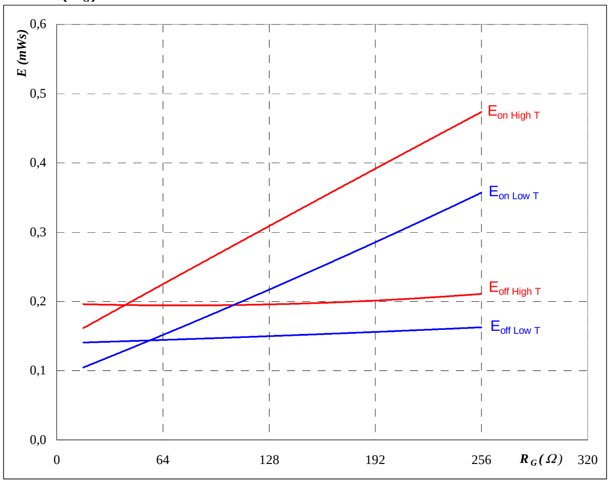
inductive load

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω
R_{goff} =	64	Ω

Figure 6 IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



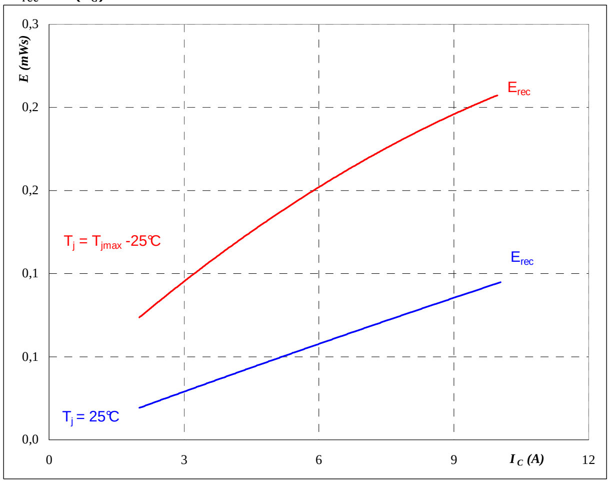
inductive load

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	6	A

Figure 7 FWD

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



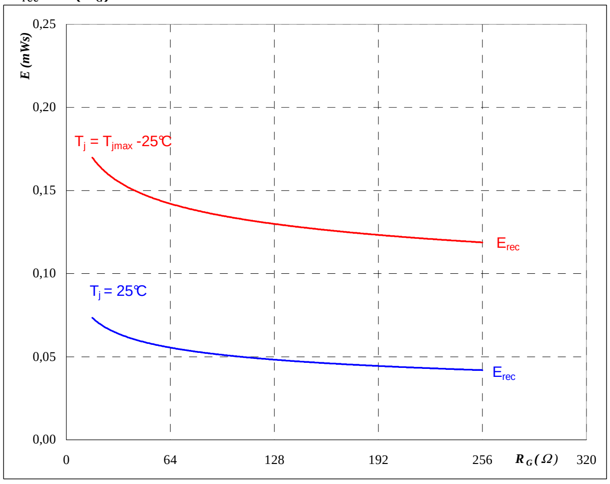
inductive load

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω

Figure 8 FWD

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



inductive load

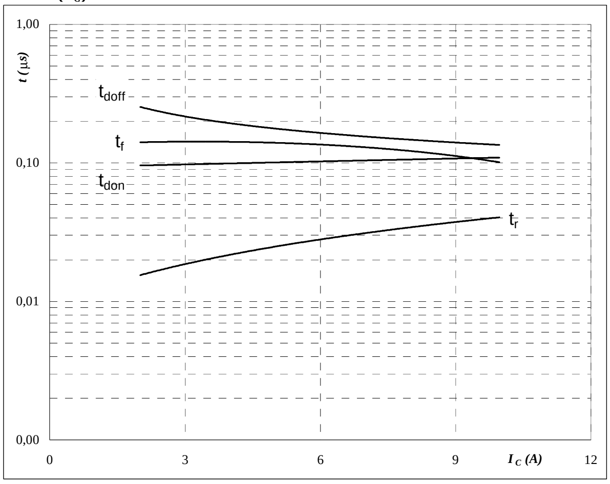
T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	6	A

Inverter

Figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



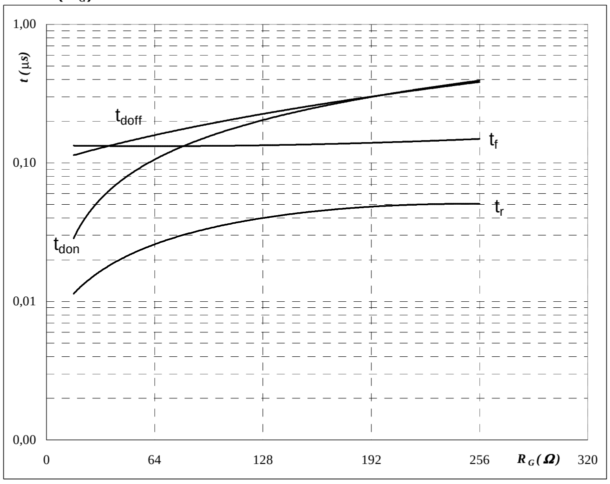
inductive load

T_j =	150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω
R_{goff} =	64	Ω

Figure 10 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



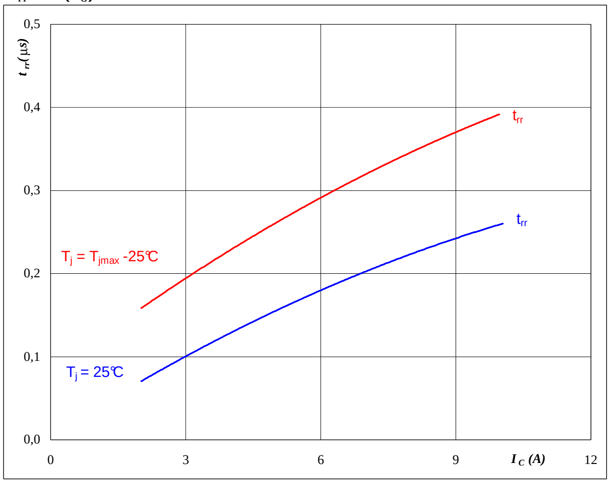
inductive load

T_j =	150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	6	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

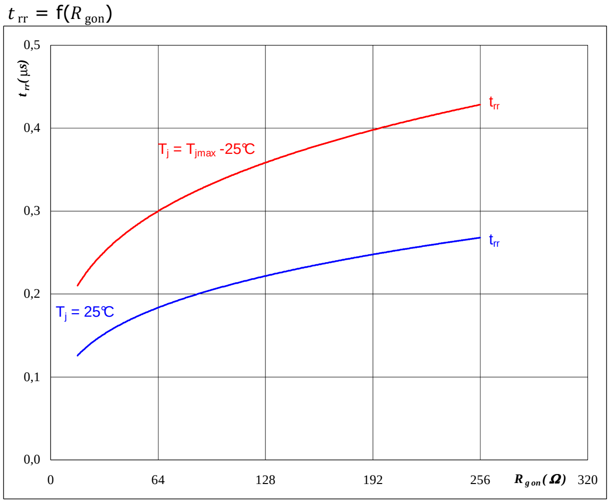


T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω

Figure 12 FWD

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

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



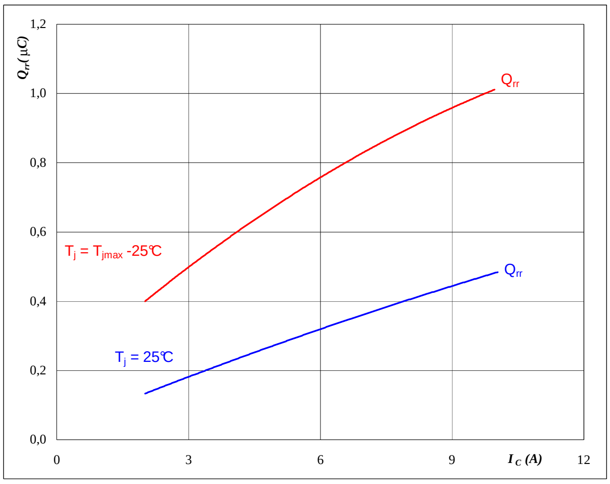
T_j =	25/150	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	±15	V

Inverter

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$

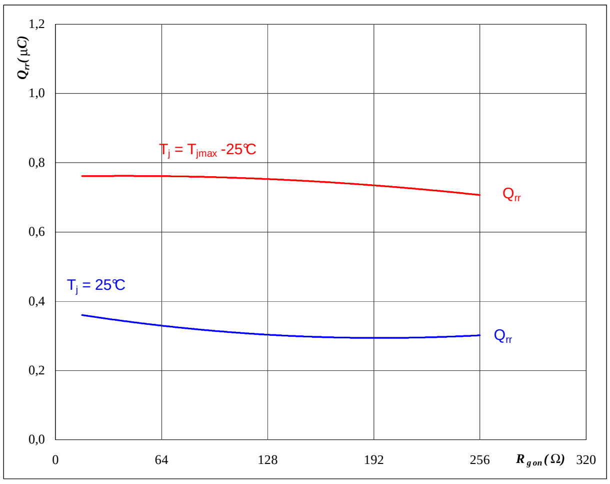


T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω

Figure 14 FWD

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

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

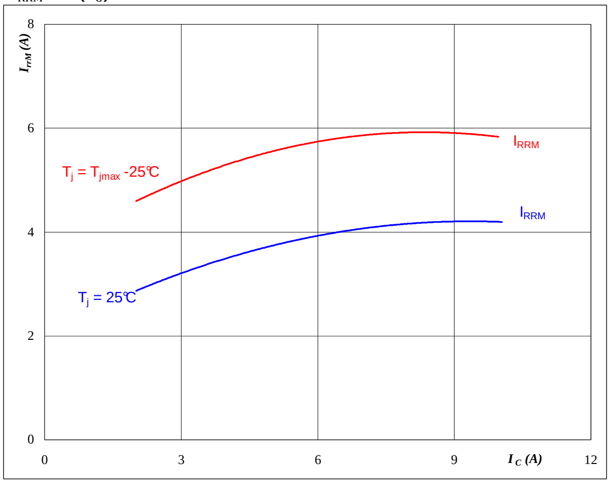


T_j =	25/150	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$

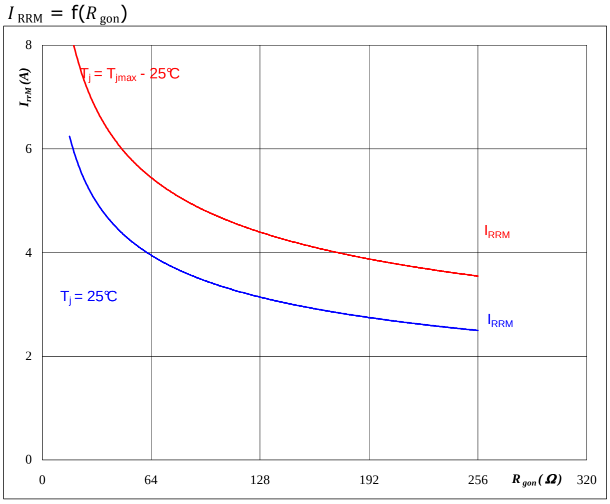


T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω

Figure 16 FWD

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

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



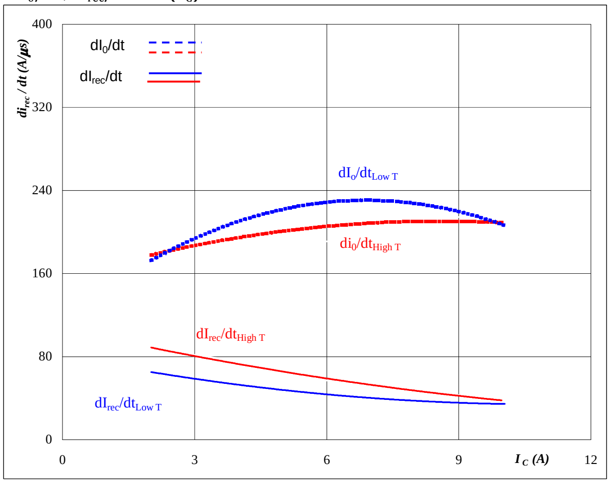
T_j =	25/150	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	±15	V

Inverter

Figure 17 FWD

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

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

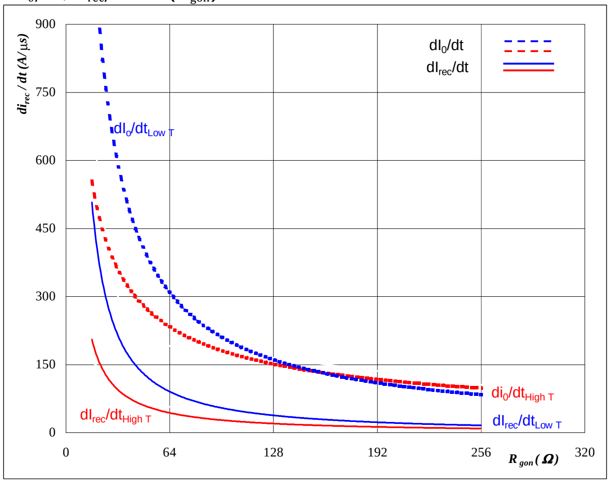


T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	64	Ω

Figure 18 FWD

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

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

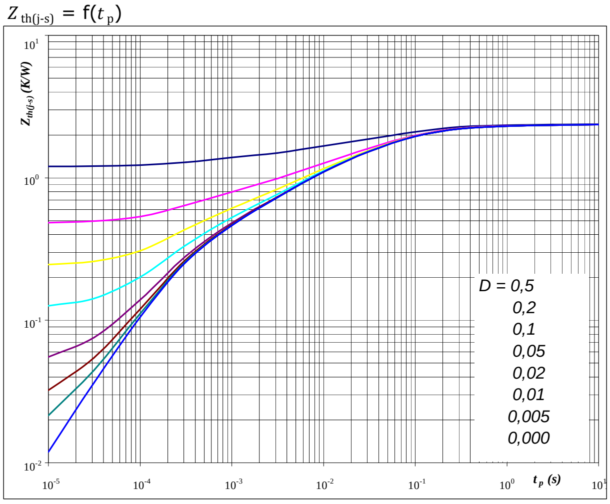


T_j =	25/150	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	±15	V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 2,40 K/W

IGBT thermal model values

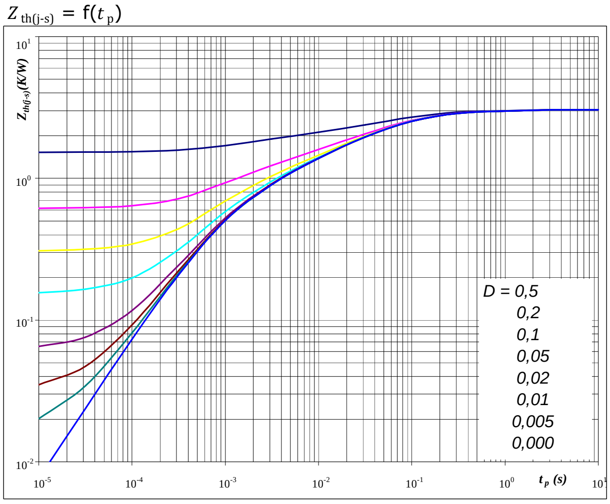
Thermal grease

R (K/W)	τ (s)
0,08	9,7E+00
0,18	4,8E-01
0,82	7,5E-02
0,59	1,5E-02
0,43	2,9E-03
0,30	3,0E-04

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 3 K/W

FWD thermal model values

Thermal grease

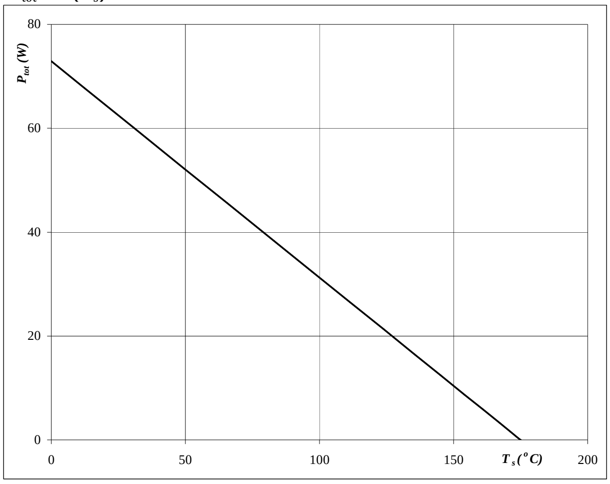
R (K/W)	τ (s)
0,17	1,2E+00
0,87	1,1E-01
0,95	2,6E-02
0,56	4,6E-03
0,50	8,4E-04

Inverter

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

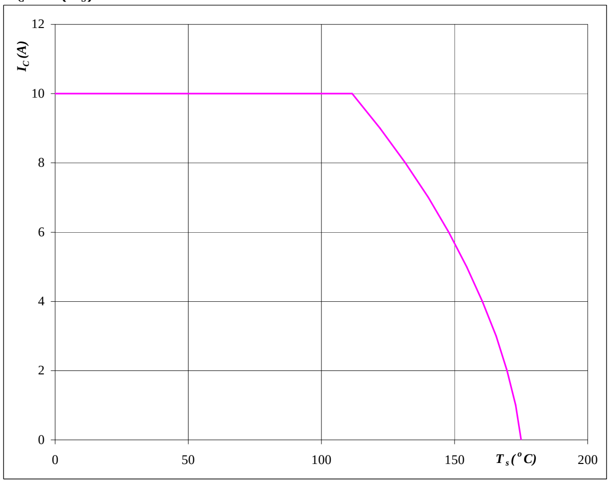


$T_j =$ 175 °C

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



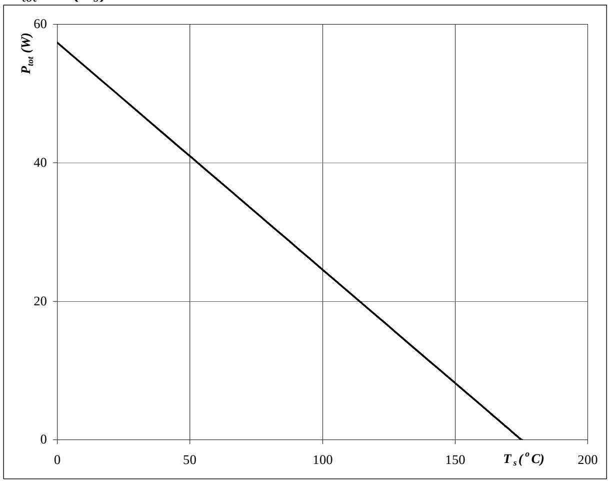
$T_j =$ 175 °C

$V_{GE} =$ 15 V

Figure 23 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

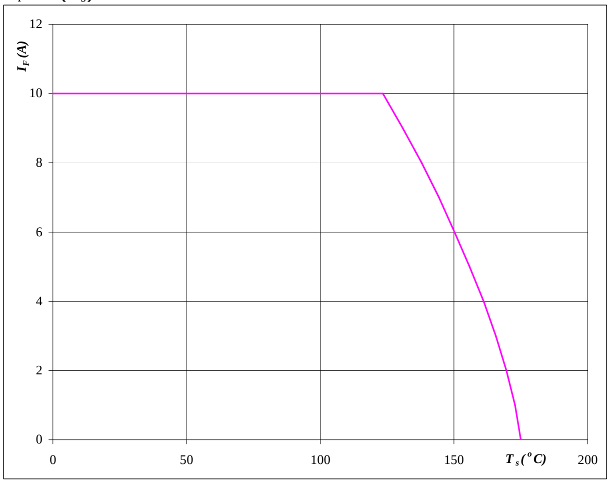


$T_j =$ 175 °C

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



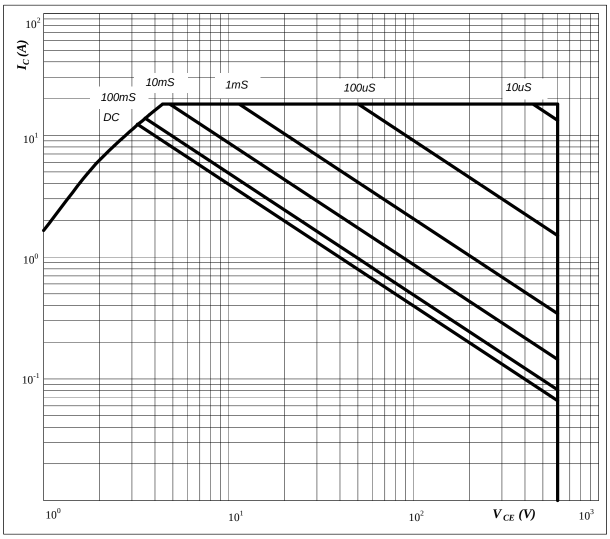
$T_j =$ 175 °C

Inverter

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$

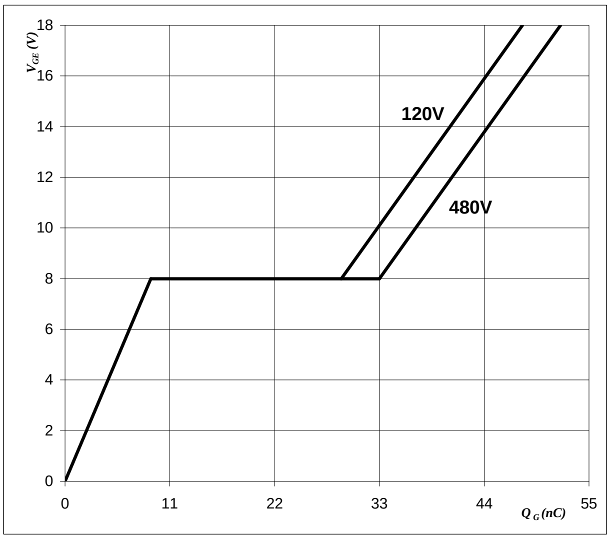


D = single pulse
T_s = 80 ºC
V_{GE} = ±15 V
T_j = T_{jmax} ºC

Figure 26 IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_G)$

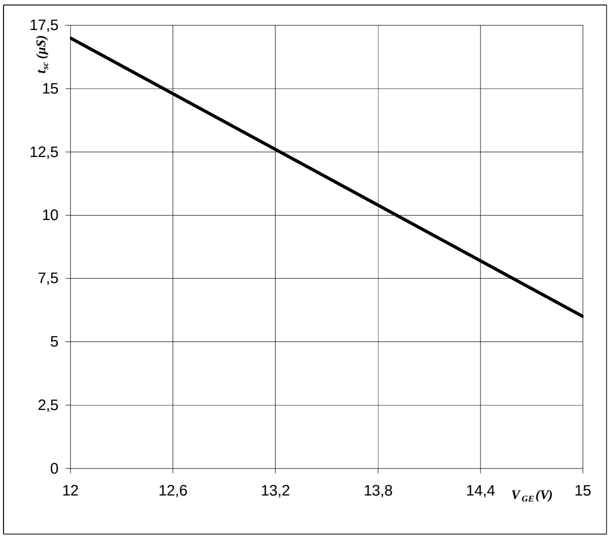


I_C = 6 A

Figure 27 IGBT

Short circuit withstand time as a function of gate-emitter voltage

$t_{sc} = f(V_{GE})$

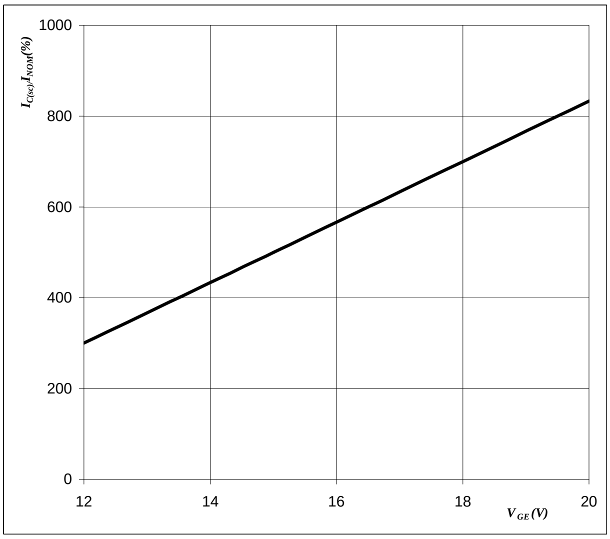


V_{CE} = 300 V
T_j ≤ 175 ºC

Figure 28 IGBT

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

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



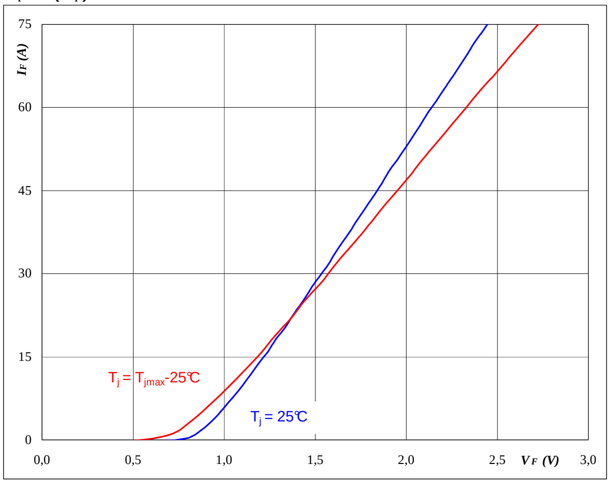
V_{CE} ≤ 300 V
T_j = 175 ºC

Rectifier Diode

Figure 1 Rectifier Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

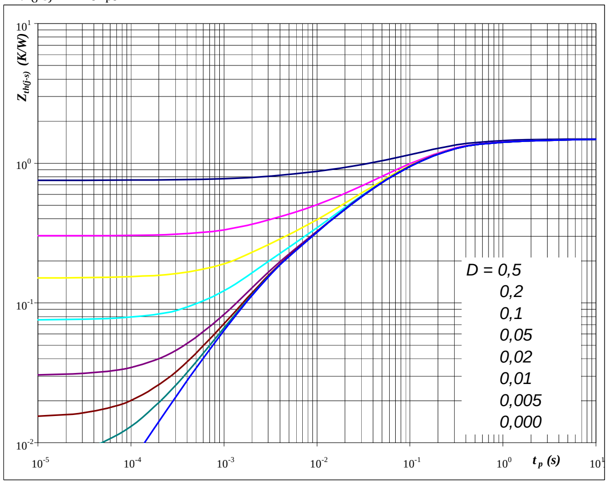


t_p = 250 µs

Figure 2 Rectifier Diode

Diode transient thermal impedance as a function of pulse width

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



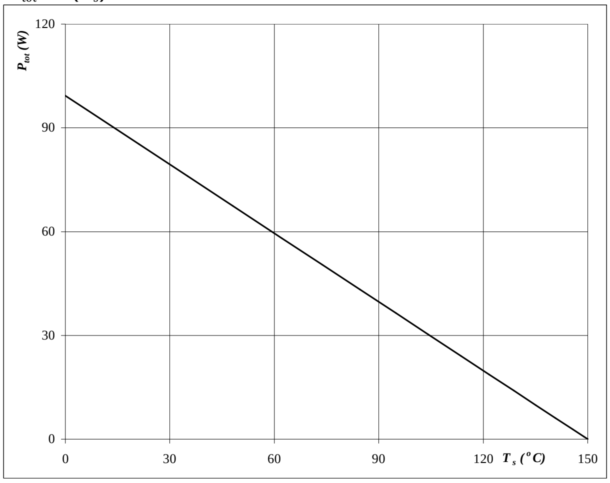
$D = t_p / T$

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

Figure 3 Rectifier Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

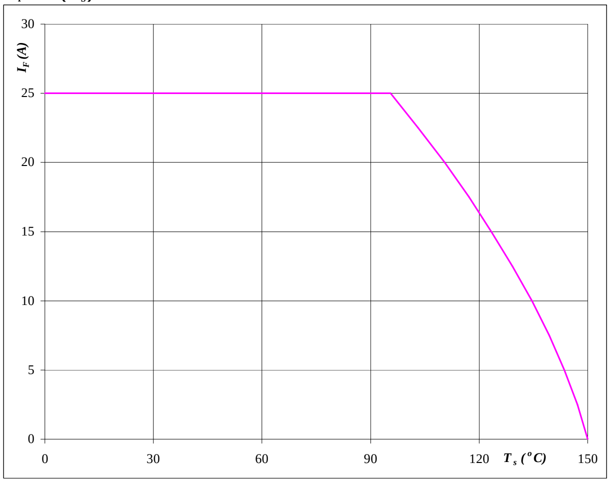


T_j = 150 ºC

Figure 4 Rectifier Diode

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



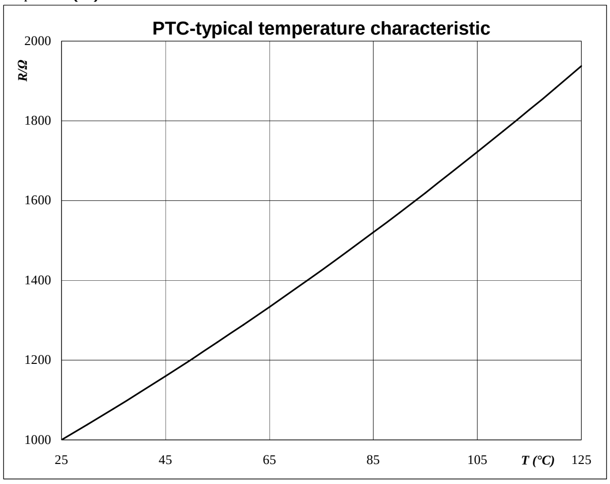
T_j = 150 ºC

Thermistor

Figure 1 Thermistor

Typical PTC characteristic as a function of temperature

$R_T = f(T)$



Thermistor

Equation of PTC resistance temperature dependency

$R(T) = 1000\ \Omega[1 + A*(T\text{-}25°C) + B*(T\text{-}25°C)^2]$ [Ω]

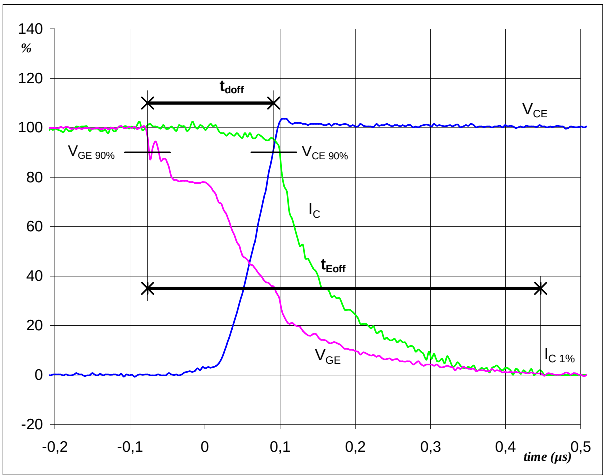
Switching Definitions Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	64 Ω
R_{goff}	=	64 Ω

Figure 1 Output inverter IGBT

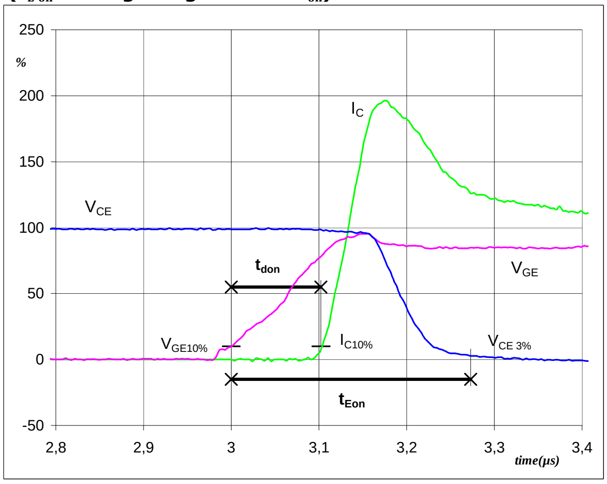
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	6	A
t_{doff} =	0,16	µs
$t_{E\,off}$ =	0,52	µs

Figure 2 Output inverter IGBT

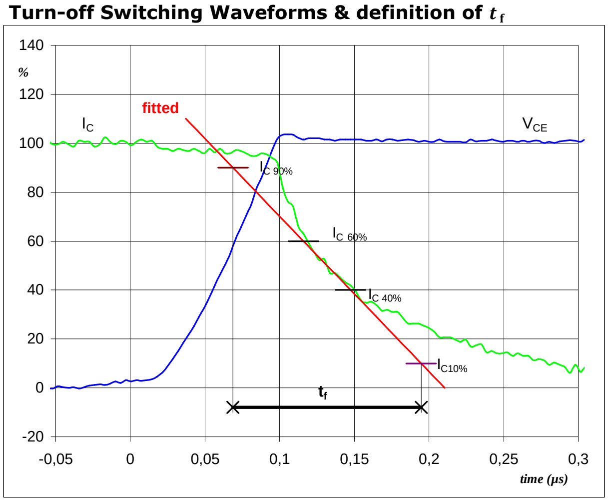
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	6	A
t_{don} =	0,10	µs
$t_{E\,on}$ =	0,27	µs

Figure 3 Output inverter IGBT

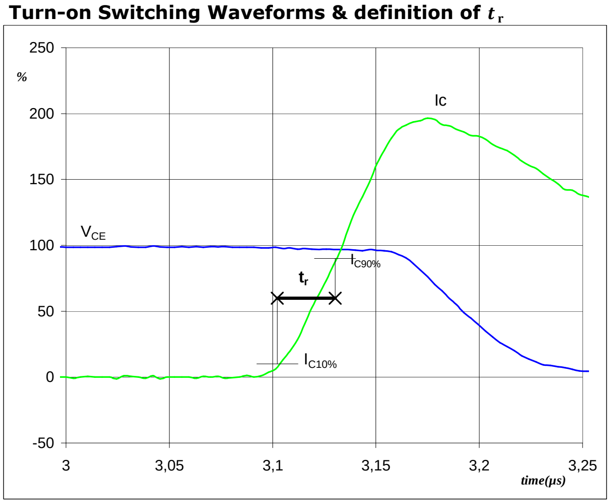
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	6	A
t_f =	0,13	µs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

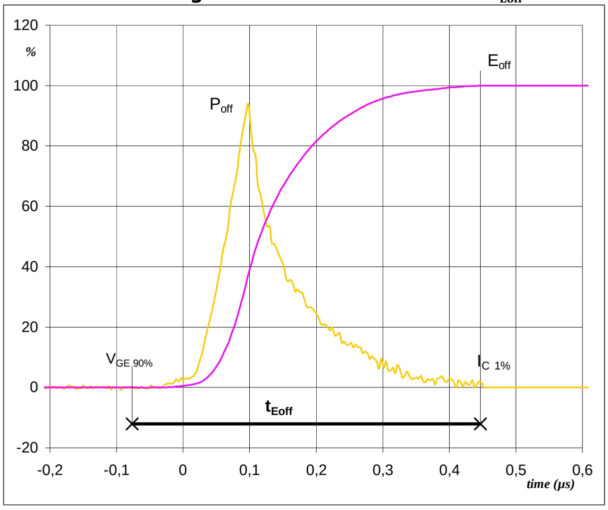


V_C (100%) =	300	V
I_C (100%) =	6	A
t_r =	0,03	µs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

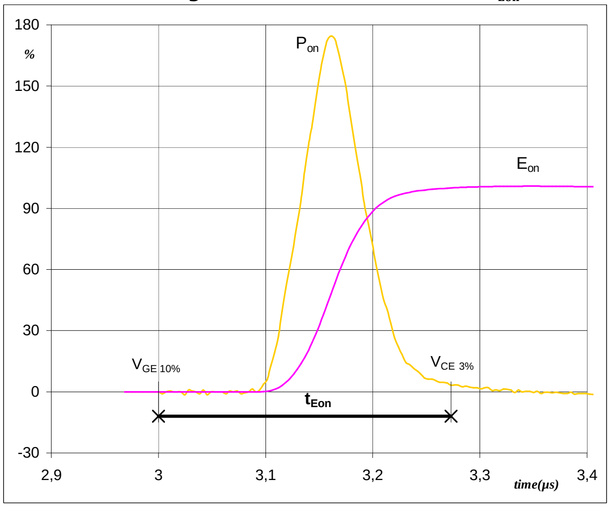
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	1,80	kW
E_{off} (100%) =	0,19	mJ
$t_{E\,off}$ =	0,52	µs

Figure 6 Output inverter IGBT

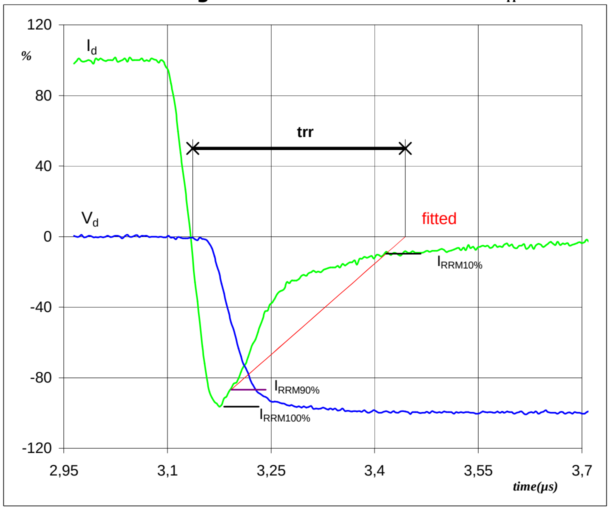
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	1,80	kW
E_{on} (100%) =	0,23	mJ
$t_{E\,on}$ =	0,27	µs

Figure 7 Output inverter FWD

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

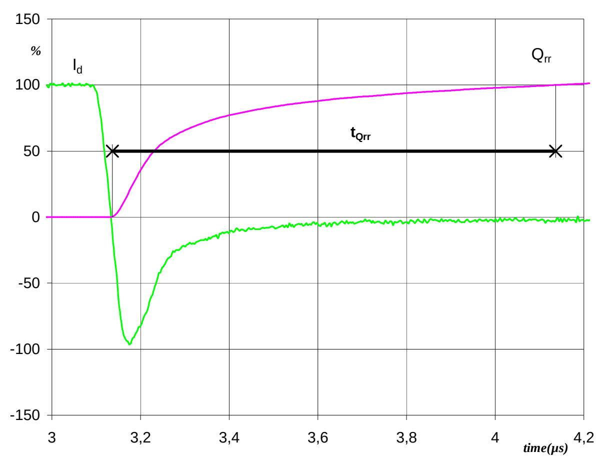


V_d (100%) =	300	V
I_d (100%) =	6	A
I_{RRM} (100%) =	-6	A
t_{rr} =	0,29	µs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

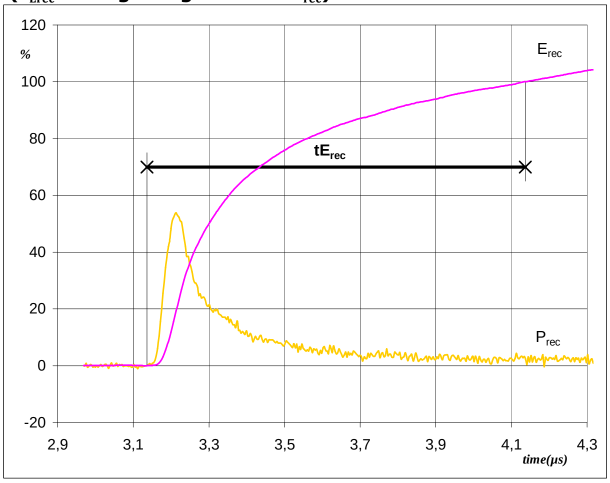
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	6	A
Q_{rr} (100%) =	0,78	μC
$t_{Q\,rr}$ =	1,00	μs

Figure 9 Output inverter FWD

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



P_{rec} (100%) =	1,80	kW
E_{rec} (100%) =	0,16	mJ
$t_{E\,rec}$ =	1,00	μs

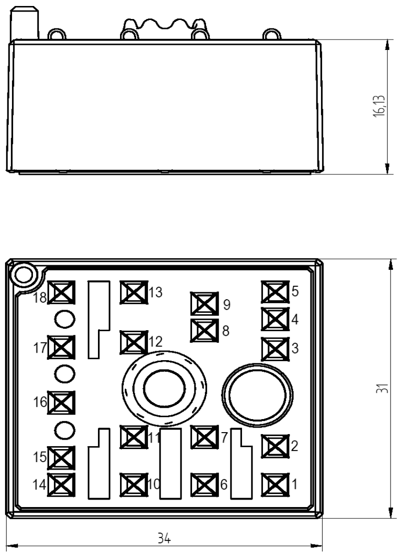
Ordering Code and Marking - Outline - Pinout - Identification

Ordering Code & Marking

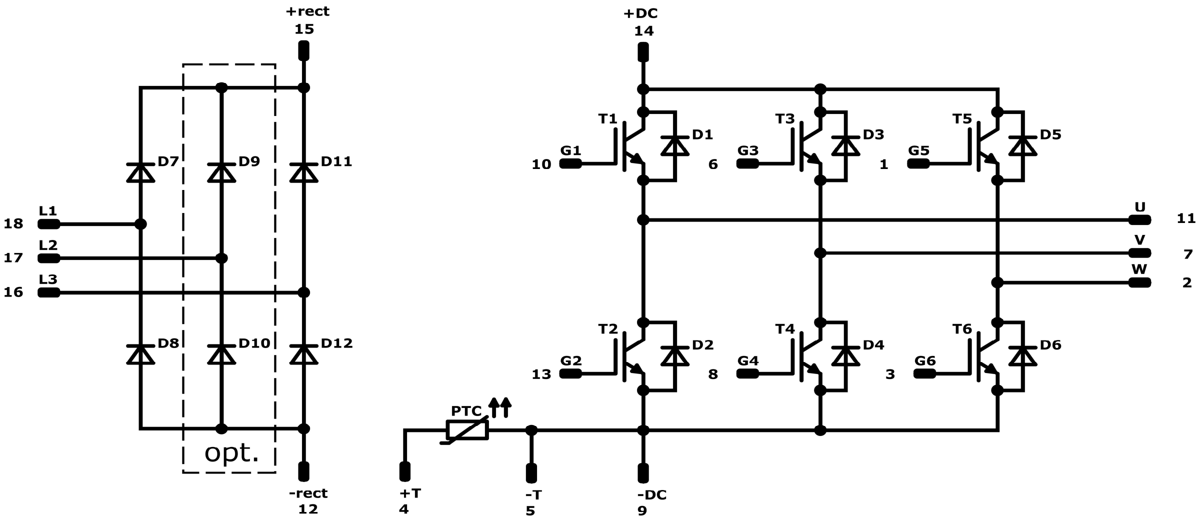
Version	Ordering Code
with 2-leg rectifier, std lid (black V23990-K02-T-PM)	80-M006PNB006SA01-K614D-/0A/
with 2-leg rectifier, std lid (black V23990-K02-T-PM) and P12	80-M006PNB006SA01-K614D-/1A/
with 2-leg rectifier, thin lid (white V23990-K03-T-PM)	80-M006PNB006SA01-K614D-/0B/
with 2-leg rectifier, thin lid (white V23990-K03-T-PM) and P12	80-M006PNB006SA01-K614D-/1B/
with 3-leg rectifier, std lid (black V23990-K02-T-PM)	80-M006PNB006SA-K614C-/0A/
with 3-leg rectifier, std lid (black V23990-K02-T-PM) and P12	80-M006PNB006SA-K614C-/1A/
with 3-leg rectifier, thin lid (white V23990-K03-T-PM)	80-M006PNB006SA-K614C-/0B/
with 3-leg rectifier, thin lid (white V23990-K03-T-PM) and P12	80-M006PNB006SA-K614C-/1B/

Text	Name		Type&Ver	Date code	Vinco&Lot	Serial&UL
	NN-NNNNNNNNNNNNNN		TTTTTTTVV	WWYY	Vinco LLLLL	SSSS UL
Datamatrix	Type&Ver	Lot number	Serial	Date code		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

Outline



Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	6 A	Inverter Switch	
D1-D6	FWD	600 V	6 A	Inverter Diode	
D7-D12	Rectifier Diode	1600 V	25 A	Rectifier Diode	
PTC	PTC	-	-	Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**198**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 0 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 0 packages see vincotech.com website.

Document No.:	Date:	Modification:	Pages
80-M006PNB010SAx-K614x-D3-14	12 Jan. 2016		