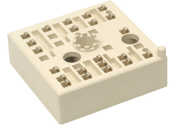
MiniSKiiP® 1 PIM **1200V / 8A**

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology

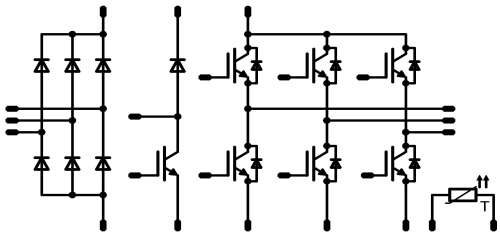
MiniSKiiP® 1 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K209-A40-PM

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
D8,D9,D10,D11,D12,D13					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	$T_j=T_jmax$	T_h=80℃	29	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25℃	220	A
I^2t-value	I^2t			240	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_jmax$	T_h=80℃	46	W
Maximum Junction Temperature	T_jmax			150	℃
T1,T2,T3,T4,T5,T6,T7					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	$T_j=T_jmax$	T_h=80℃	14	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by T_jmax		24	A
Power dissipation per IGBT	P_{tot}	$T_j=T_jmax$	T_h=80℃	52	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V		10 800	µs V
Maximum Junction Temperature	T_jmax			175	℃

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
D1,D2,D3,D4,D5,D6,D7				
Repetitive peak reverse voltage	V_{RRM}		1200	V
DC forward current	I_F	T_j=$T_j$max T_h=80℃	13	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max	24	A
Power dissipation per Diode	P_{tot}	T_j=$T_j$max T_h=80℃	38	W
Maximum Junction Temperature	$T_j$max		175	℃
Thermal Properties				
Storage temperature	T_{stg}		-40…+125	℃
Operation temperature under switching condition	T_{op}		-40…+(Tjmax - 25)	℃
Insulation Properties				
Insulation voltage	V_{is}	t=2s DC voltage	4000	V
Creepage distance			min 12.7	mm
Clearance			min 12.7	mm

Characteristic Values

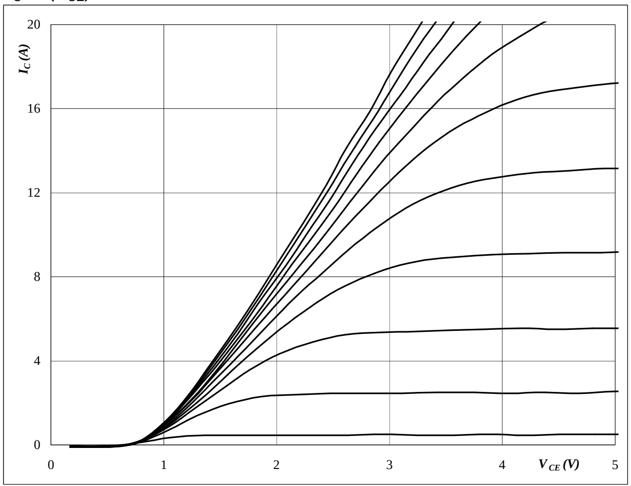
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Min	Typ	Max	
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				25	Tj=25℃ Tj=125℃		1,51 1,42		V
Threshold voltage (for power loss calc. only)	V_{to}				25	Tj=25℃ Tj=125℃		0,86 0,79		V
Slope resistance (for power loss calc. only)	r_t				25	Tj=25℃ Tj=125℃		0,03 0,03		Ŏ
Reverse current	I_r			1500		Tj=25℃ Tj=125℃			0,05	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50ᵞm λ=1 W/mK						1,5		K/W
T1,T2,T3,T4,T5,T6,T7										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0003	Tj=25℃ Tj=150℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		8	Tj=25℃ Tj=150℃	1,6	2,01 2,38	2,5	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		Tj=25℃ Tj=150℃			0,06	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=150℃			180	nA
Integrated Gate resistor	R_{gint}							-		Ŏ
Turn-on delay time	$t_{d(on)}$	Rgoff=64Ŏ Rgon=64Ŏ	±15	600	8	Tj=25℃ Tj=150℃		115 126		ns
Rise time	t_r					Tj=25℃ Tj=150℃		33 39		ns
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=150℃		225 290		ns
Fall time	t_f					Tj=25℃ Tj=150℃		89 130		ns
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=150℃		0,56 0,88		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=150℃		0,48 0,77		mWs
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		490		pF
Output capacitance	C_{oss}							50		pF
Reverse transfer capacitance	C_{rss}							30		pF
Gate charge	Q_{Gate}	Vcc=960V	15		8	Tj=25℃		53		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50ᵞm λ=1 W/mK						1,84		K/W
D1,D2,D3,D4,D5,D6,D7										
Diode forward voltage	V_F				8	Tj=25℃ Tj=150℃	1,5	2,37 2,28	2,9	V
Peak reverse recovery current	I_{RRM}	Rgoff=64Ŏ	±15	600	8	Tj=25℃ Tj=150℃		4,49 6,2		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=150℃		362 574		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=150℃		0,61 1,47		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=150℃		31 22		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=150℃		0,24 0,62		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50ᵞm λ=1 W/mK						2,53		K/W
PTC										
Rated resistance	R					T=25℃		1000		Ŏ
Deviation of R100	ΔR/R	R100=1670 Ŏ				T=100℃	-3		3	%
R100	R					T=25℃		1670,313		Ŏ
A-value	B(25/50)	Tol. %				T=25℃		7,635*10-3		1/K
B-value	B(25/100)	Tol. %				T=25℃		1,731*10-5		1/K²
Vincotech NTC Reference									E	

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 μs

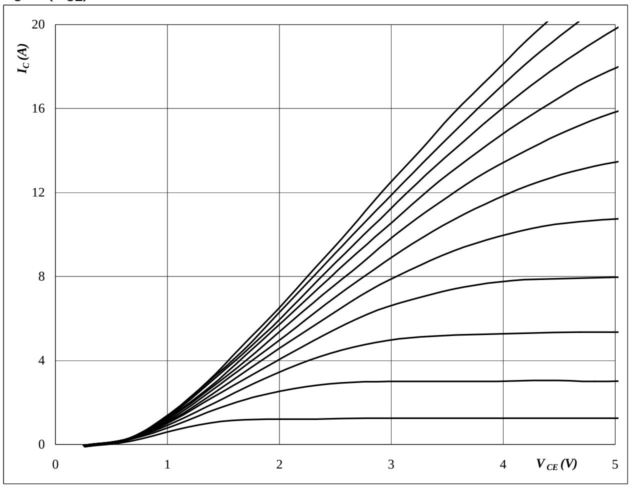
T_j = 25 ℃

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

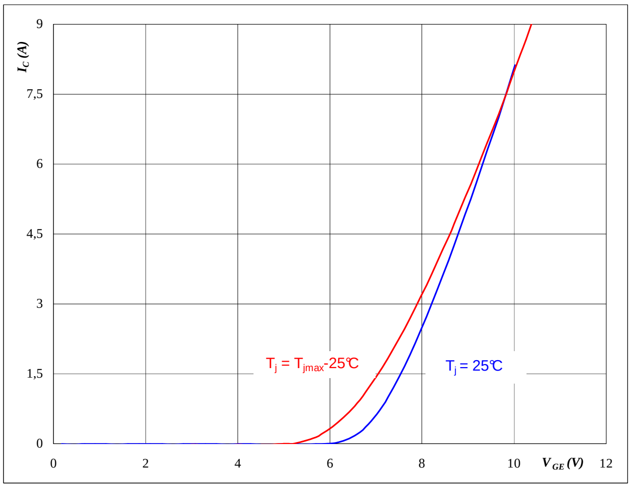
T_j = 150 ℃

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

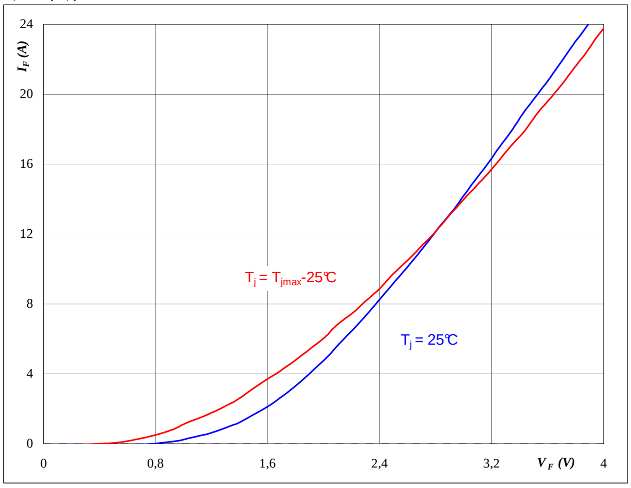
t_p = 250 μs

V_{CE} = 10 V

Figure 4 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

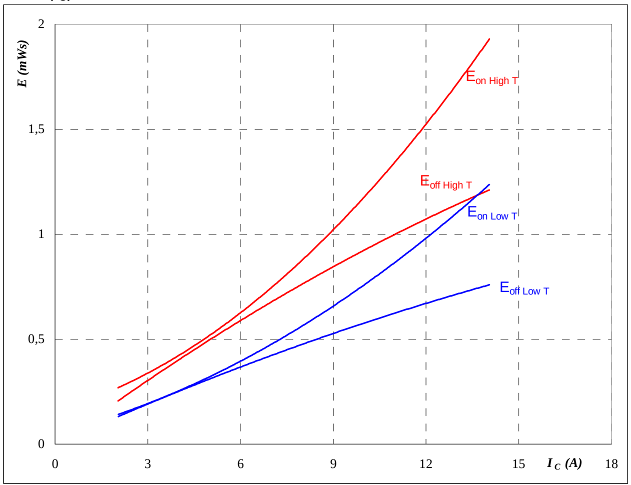
t_p = 250 μs

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

E = f(I_C)



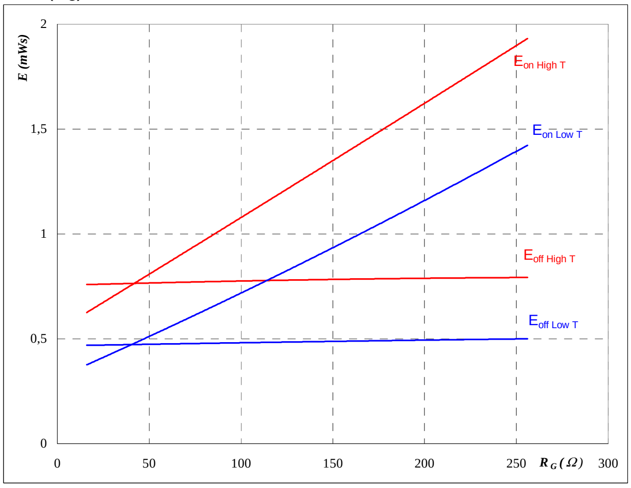
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ŏ
R_{goff} =	64	Ŏ

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor

E = f(R_G)



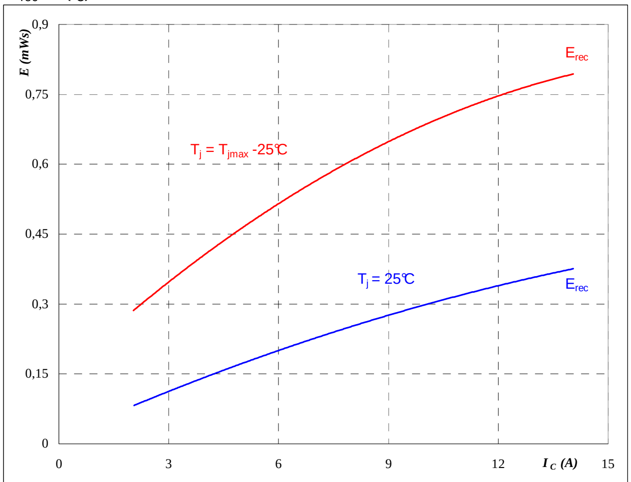
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	8	A

Figure 7 IGBT

Typical reverse recovery energy loss
as a function of collector current

E_{rec} = f(I_C)



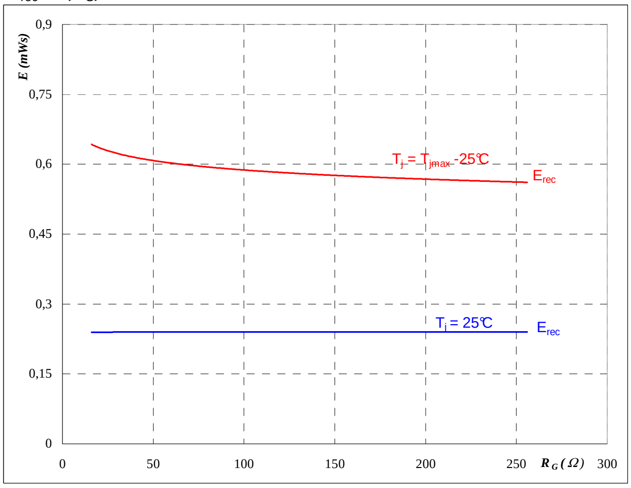
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ŏ

Figure 8 IGBT

Typical reverse recovery energy loss
as a function of gate resistor

E_{rec} = f(R_G)



With an inductive load at

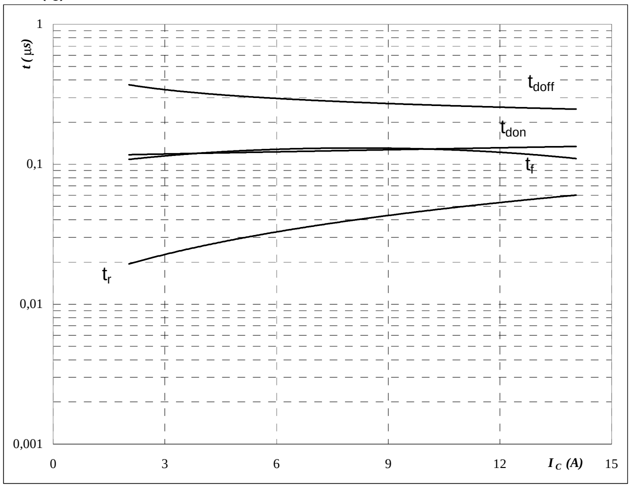
T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	8	A

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



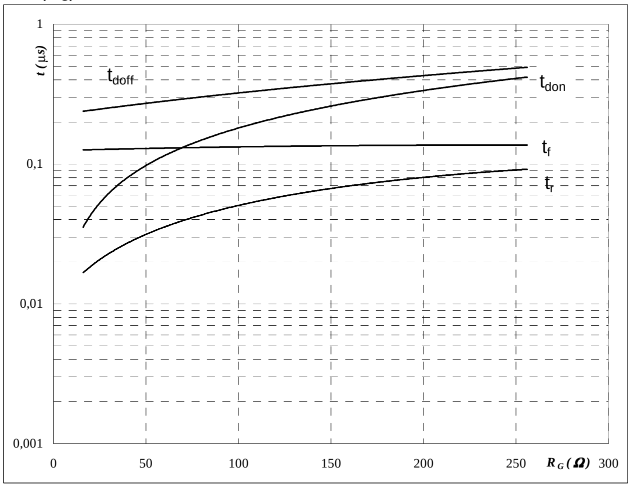
With an inductive load at

T_j =	150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ǒ
R_{goff} =	64	Ǒ

Figure 10 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



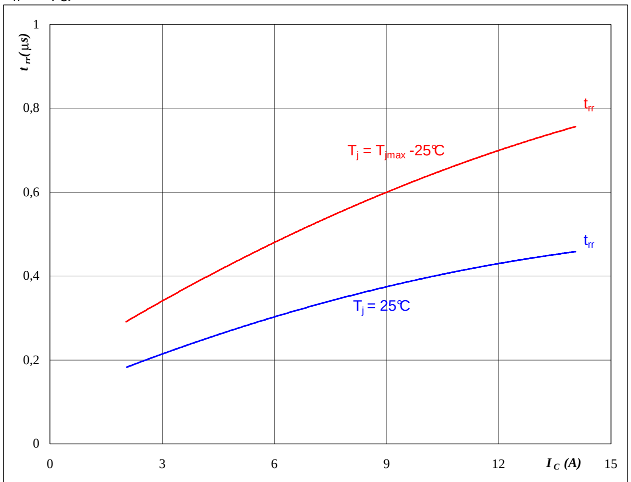
With an inductive load at

T_j =	150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	8	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



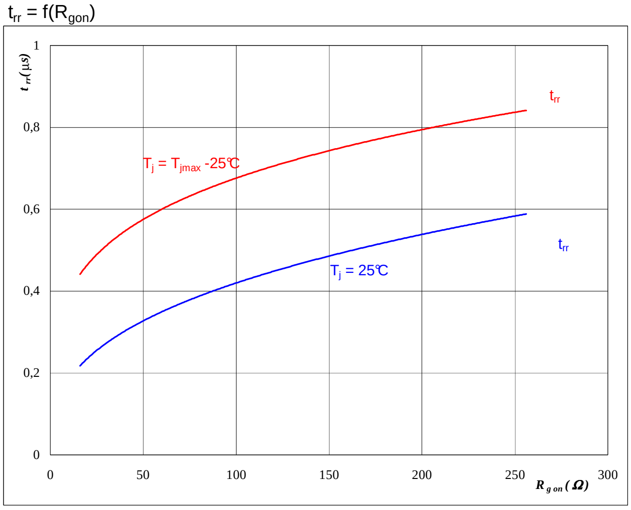
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ǒ

Figure 12 FWD

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

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



At

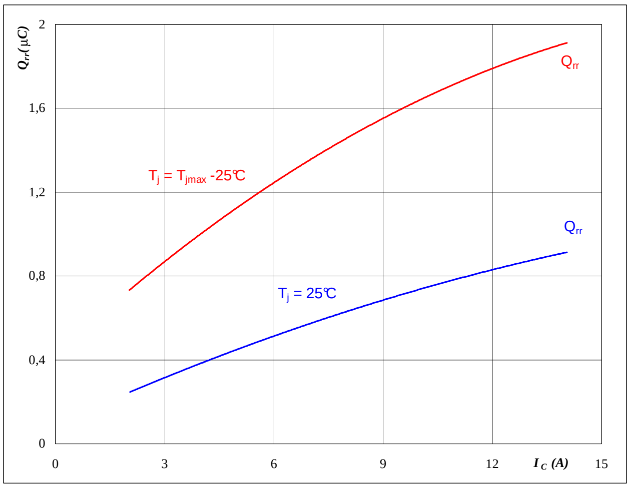
T_j =	25/150	℃
V_R =	600	V
I_F =	8	A
V_{GE} =	±15	V

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



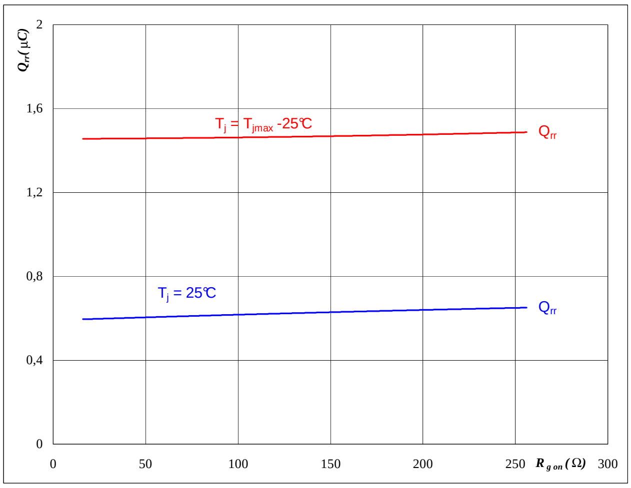
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ŏ

Figure 14 FWD

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

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



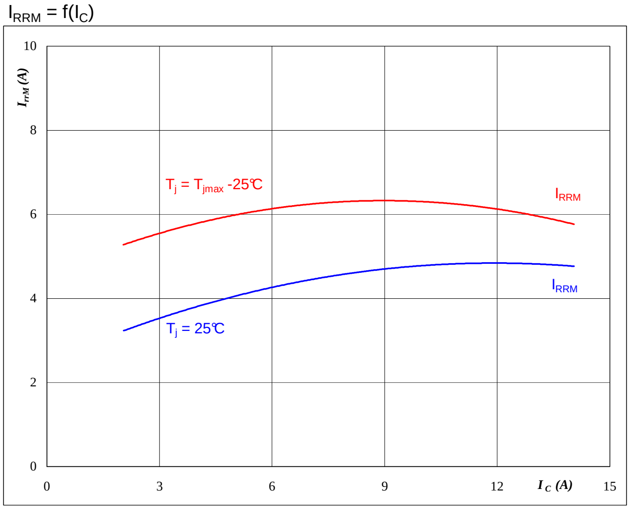
At

T_j =	25/150	℃
V_R =	600	V
I_F =	8	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



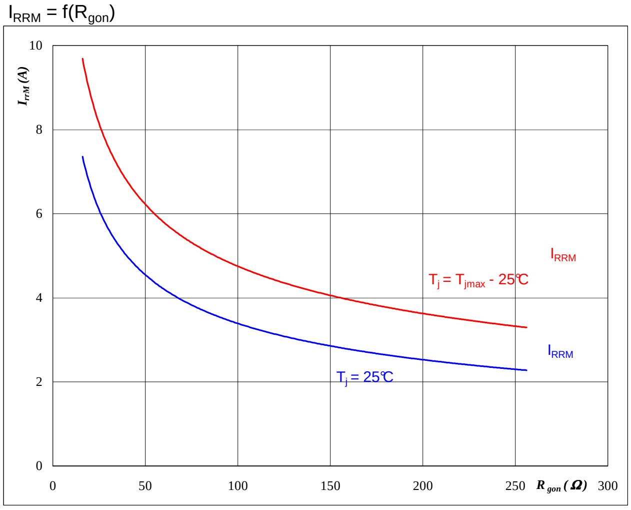
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ŏ

Figure 16 FWD

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

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



At

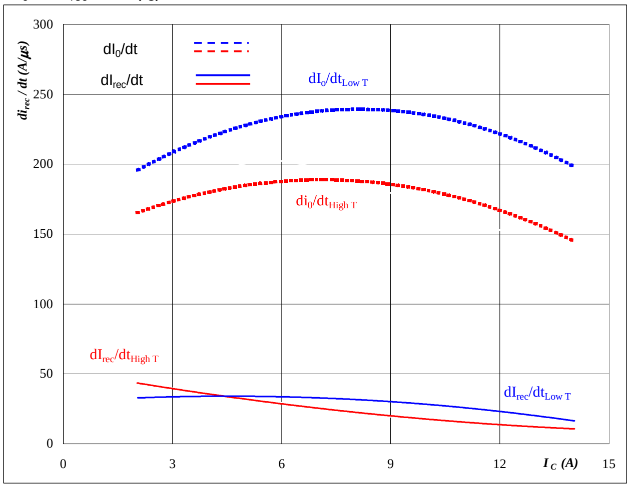
T_j =	25/150	℃
V_R =	600	V
I_F =	8	A
V_{GE} =	±15	V

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 17 FWD

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

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



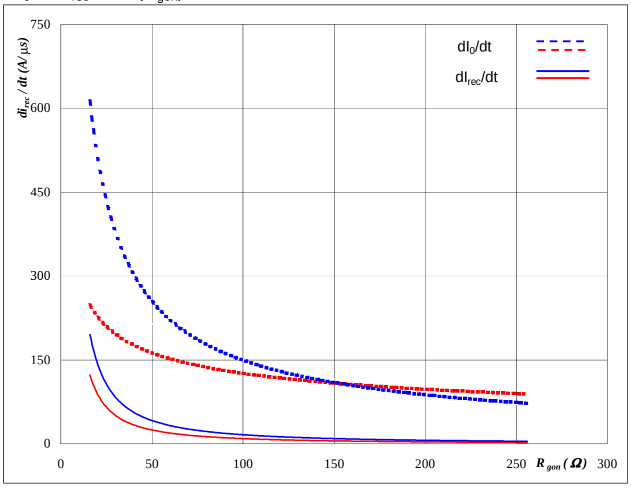
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	64	Ŏ

Figure 18 FWD

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

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



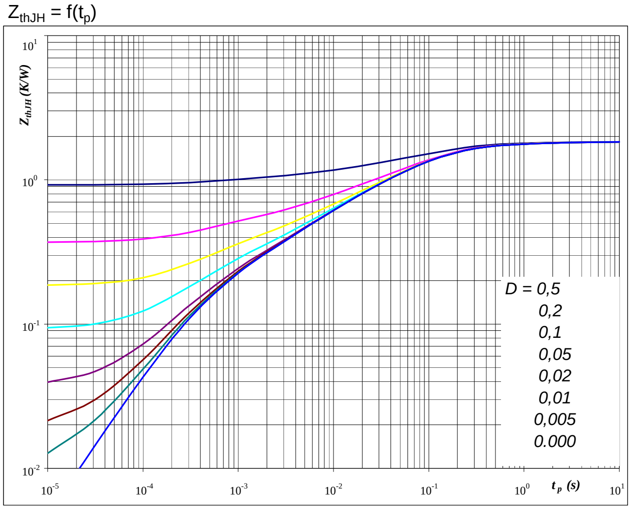
At

T_j =	25/150	℃
V_R =	600	V
I_F =	8	A
V_{GE} =	±15	V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	1,84	K/W

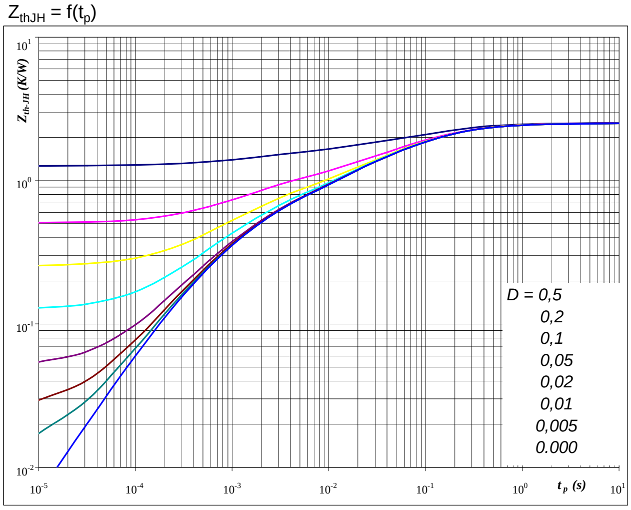
IGBT thermal model values

R (C/W)	Tau (s)
0,05	4,8E+00
0,14	5,9E-01
0,65	1,2E-01
0,45	3,8E-02
0,29	8,5E-03
0,13	1,7E-03

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	2,53	K/W

FWD thermal model values

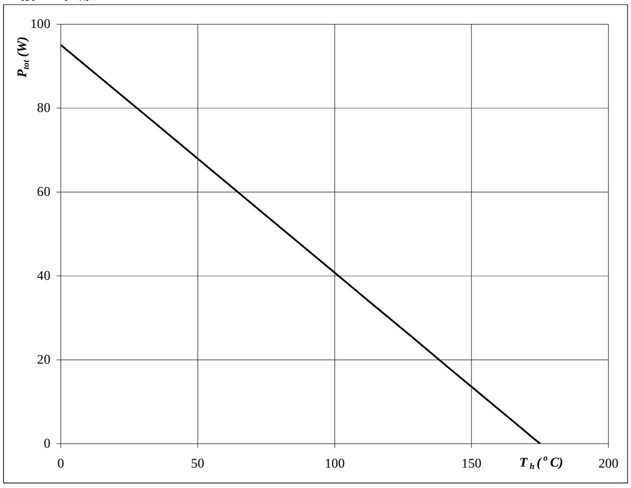
R (C/W)	Tau (s)
0,06	9,0E+00
0,40	4,4E-01
1,02	7,9E-02
0,55	1,2E-02
0,41	1,4E-03
0,09	2,9E-04

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



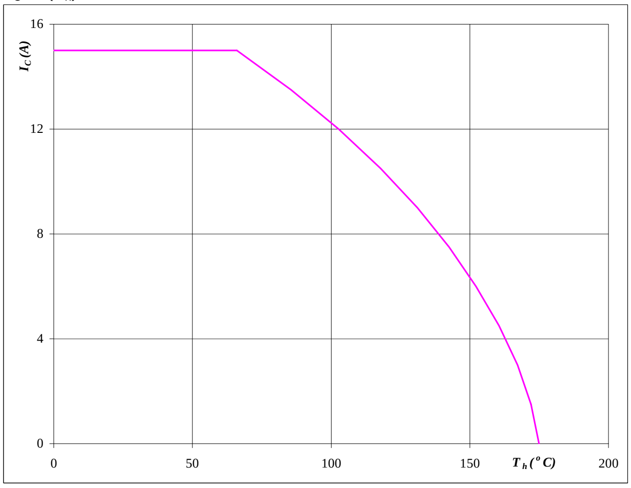
At

$T_j =$ 175 ℃

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

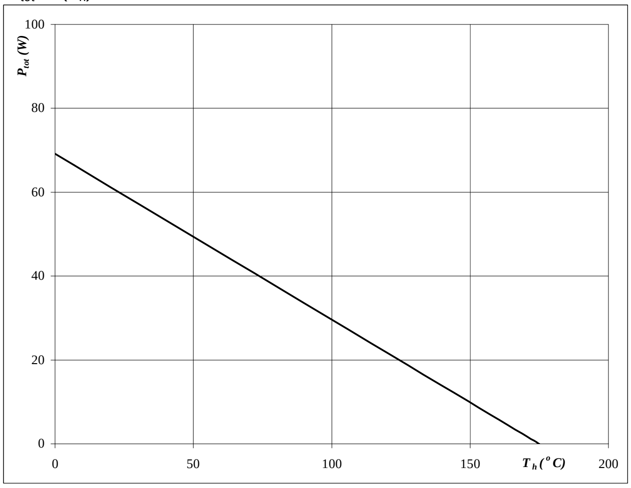
$T_j =$ 175 ℃

$V_{GE} =$ 15 V

Figure 23 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



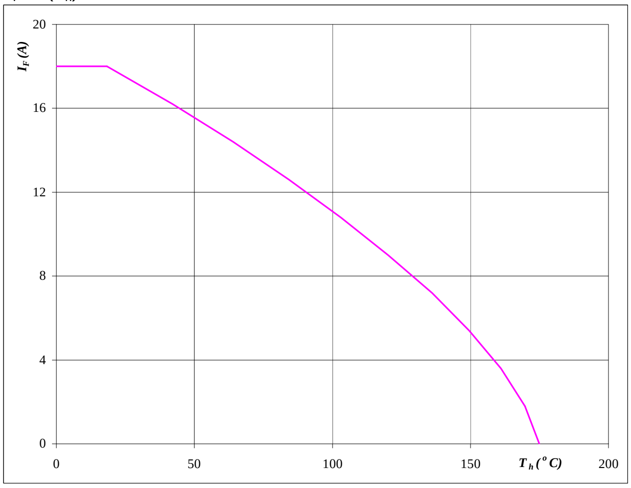
At

$T_j =$ 175 ℃

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

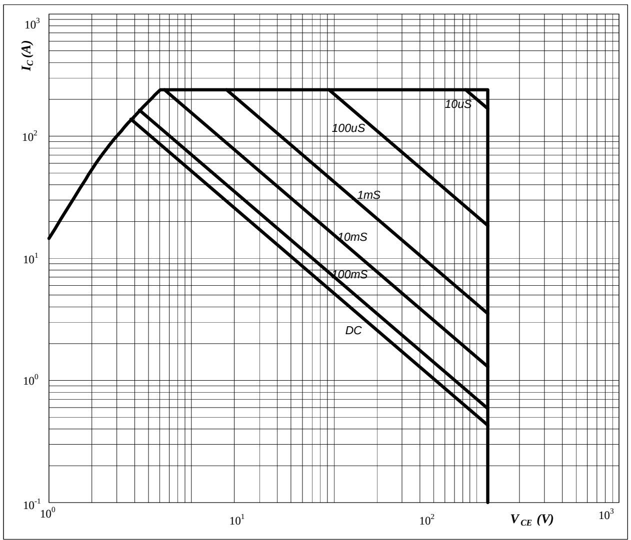
$T_j =$ 175 ℃

T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



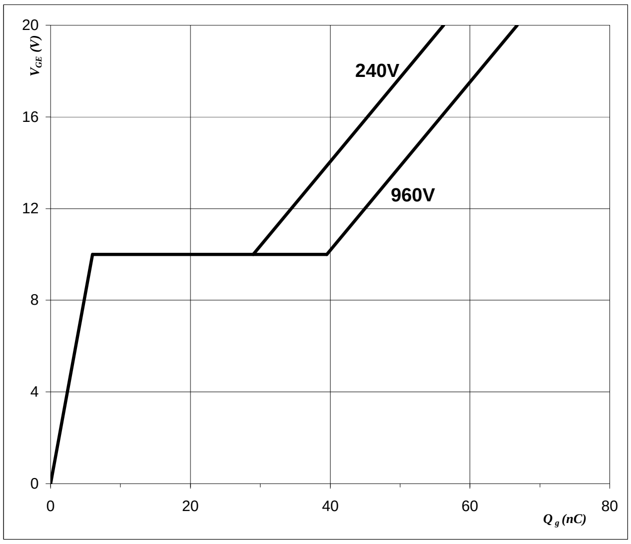
At

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

Figure 26 IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_{GE})$



At

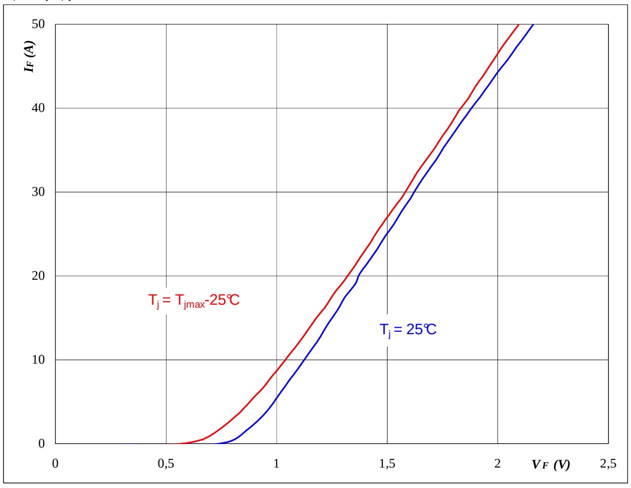
I_C =	8	A

D8,D9,D10,D11,D12,D13

Figure 1 Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



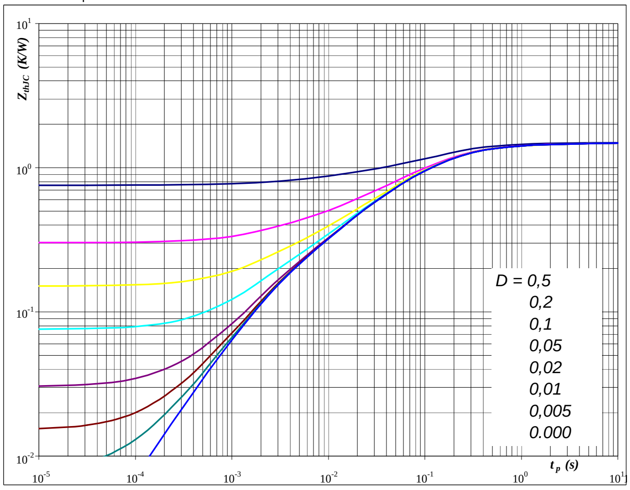
At

t_p = 250 μs

Figure 2 Diode

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

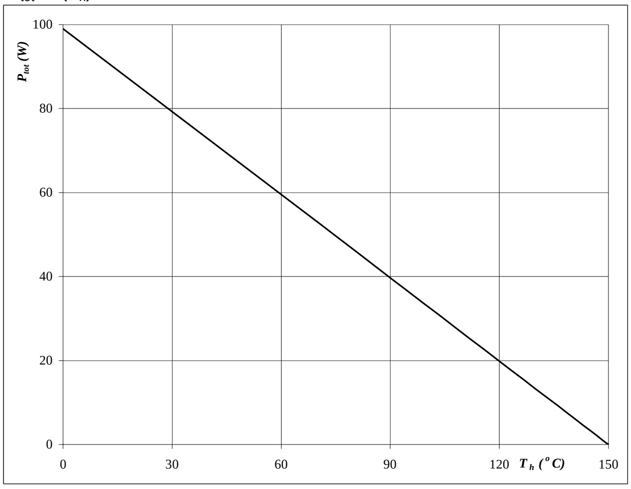
D = t_p / T

R_{thJH} = 1,5 K/W

Figure 3 Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



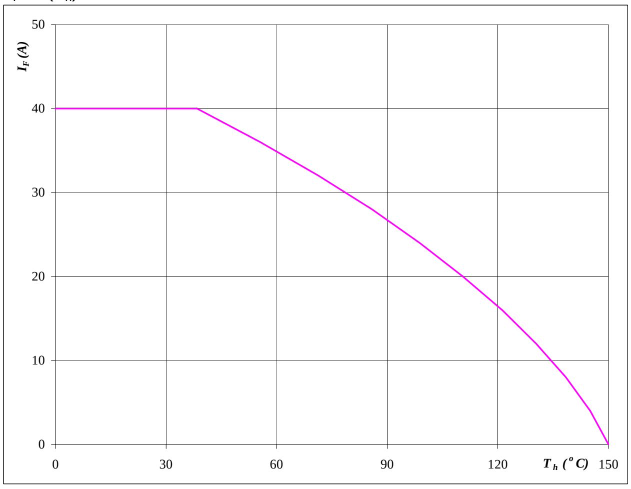
At

T_j = 150 ºC

Figure 4 Diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



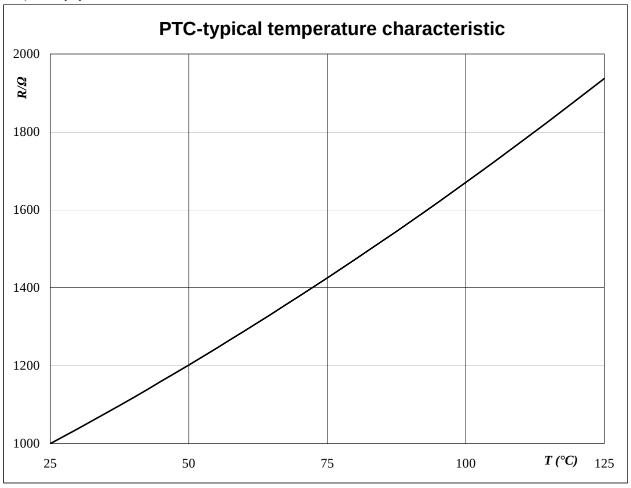
At

T_j = 150 ºC

Thermistor

Figure 1	Thermistor

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



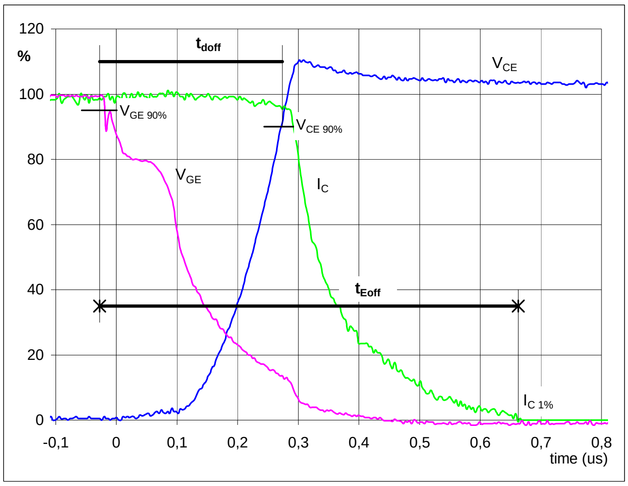
Switching Definitions Output Inverter

General conditions

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

Figure 1 Output inverter IGBT

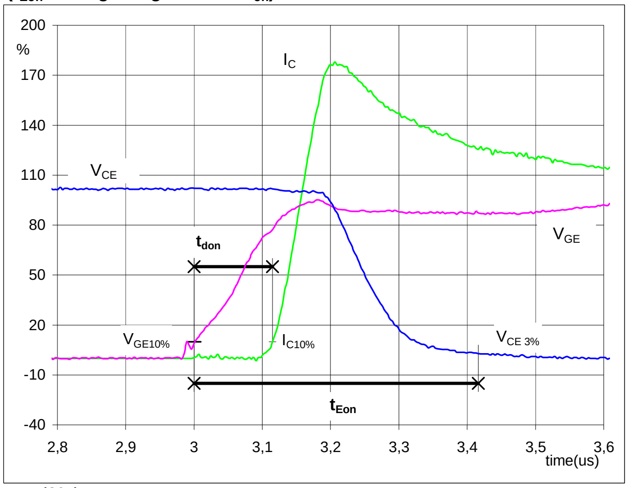
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	8	A
t_{doff} =	0,29	µs
t_{Eoff} =	0,69	µs

Figure 2 Output inverter IGBT

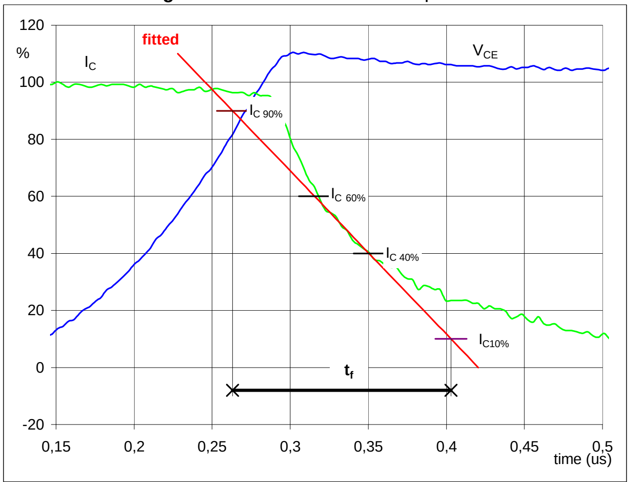
Turn-on Switching Waveforms & definition of tdon, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	8	A
t_{don} =	0,13	µs
t_{Eon} =	0,42	µs

Figure 3 Output inverter IGBT

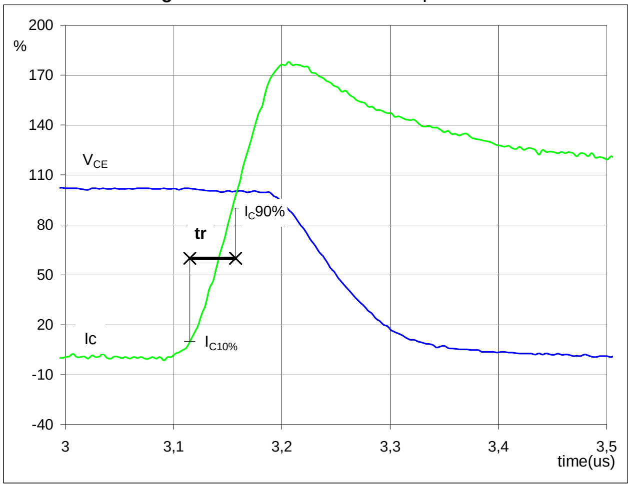
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	8	A
t_f =	0,13	µs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

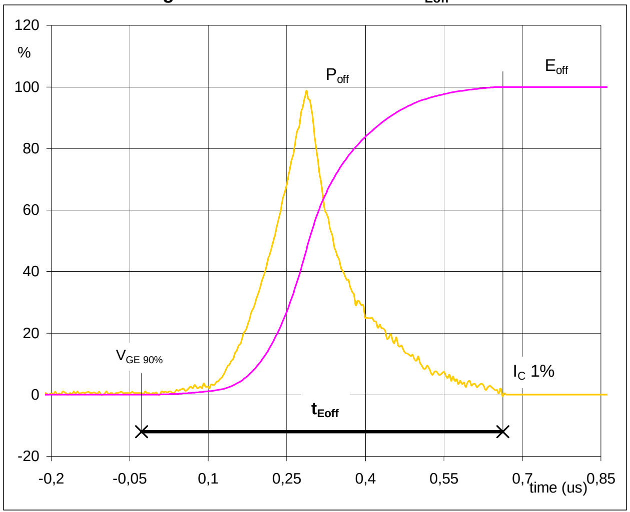


V_C (100%) =	600	V
I_C (100%) =	8	A
t_r =	0,04	µs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

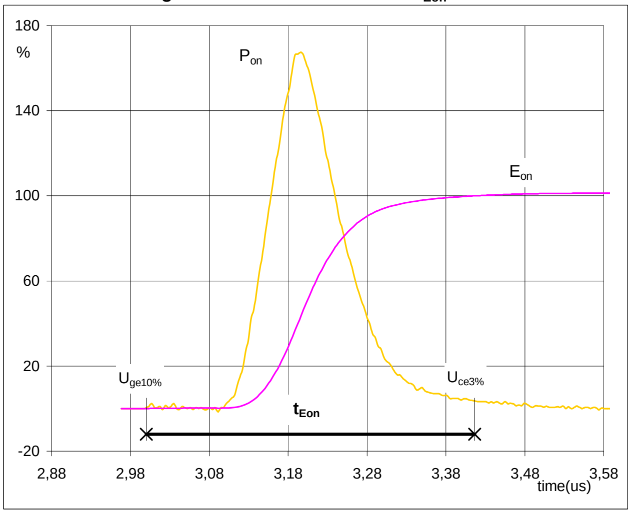
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	4,81	kW
E_{off} (100%) =	0,77	mJ
t_{Eoff} =	0,69	Ys

Figure 6 Output inverter IGBT

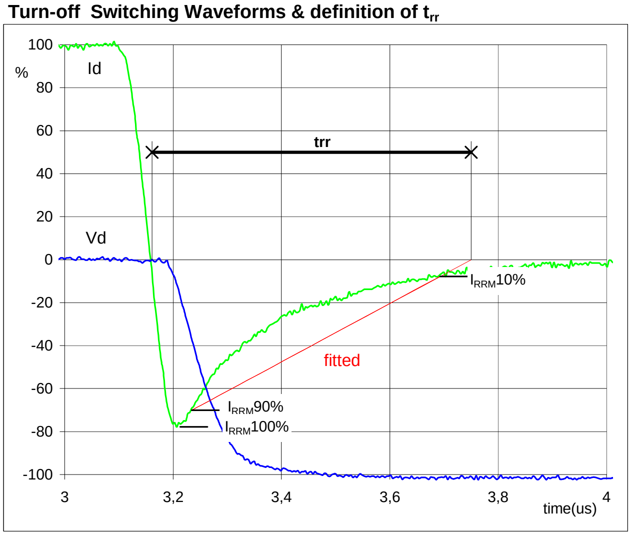
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	4,81	kW
E_{on} (100%) =	0,88	mJ
t_{Eon} =	0,42	Ys

Figure 7 Output inverter FWD

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

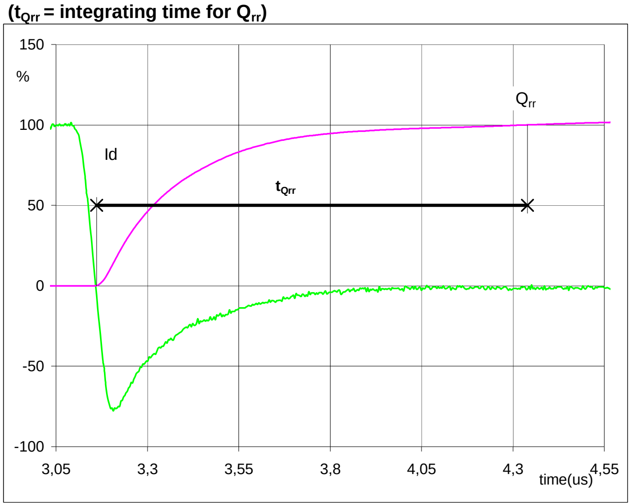


V_d (100%) =	600	V
I_d (100%) =	8	A
I_{RRM} (100%) =	-6	A
t_{rr} =	0,57	Ys

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

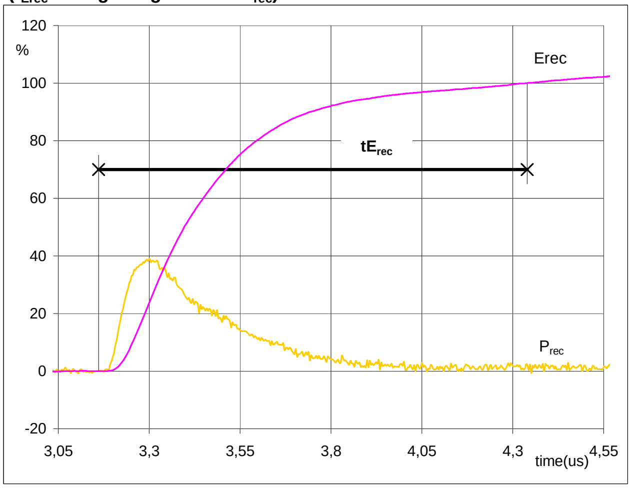
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	8	A
Q_{rr} (100%) =	1,47	µC
t_{Qrr} =	1,18	µs

Figure 9 Output inverter FWD

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



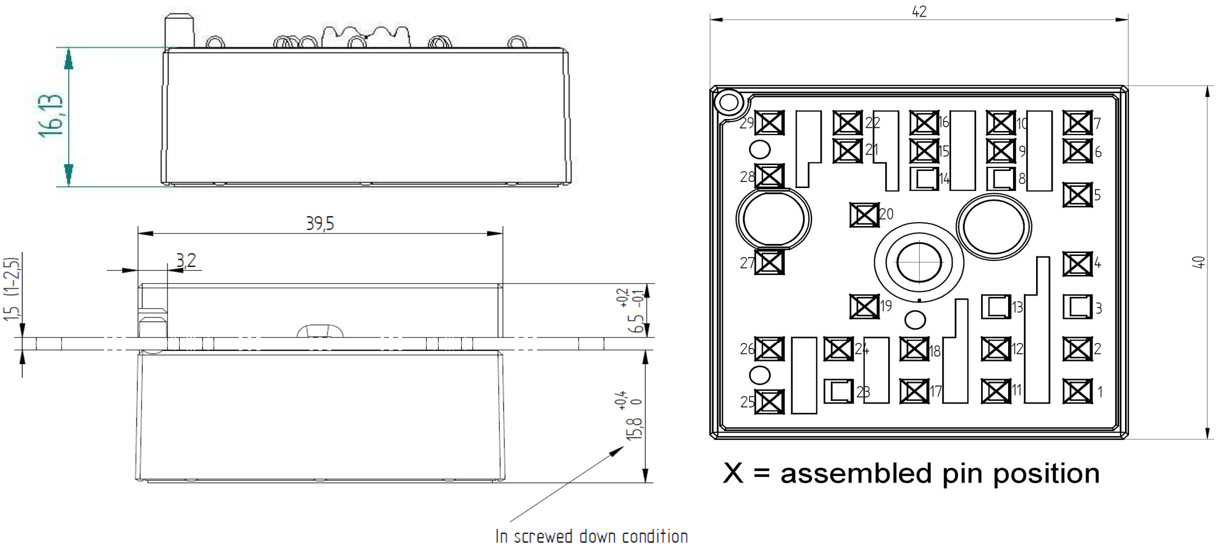
P_{rec} (100%) =	4,81	kW
E_{rec} (100%) =	0,62	mJ
t_{Erec} =	1,18	µs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

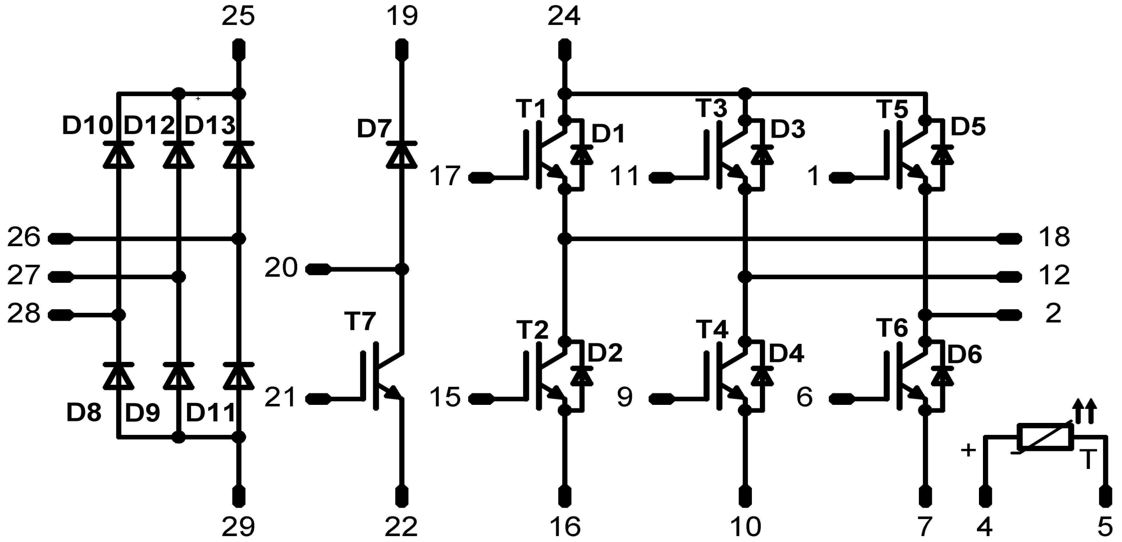
Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K12-T-PM)	V23990-K209-A40-/0A/-PM	K209A40	K209A40-/0A/
with std lid (black V23990-K12-T-PM) and P12	V23990-K209-A40-/1A/-PM	K209A40	K209A40-/1A/
with thin lid (white V23990-K13-T-PM)	V23990-K209-A40-/0B/-PM	K209A40	K209A40-/0B/
with thin lid (white V23990-K13-T-PM) and P12	V23990-K209-A40-/1B/-PM	K209A40	K209A40-/1B/

Outline



X = assembled pin position

Pinout



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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.