MiniSKiiP® 3 PIM — 1200V/70A

Features

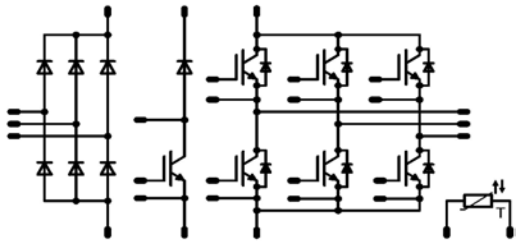
- IGBT3 technology for low saturation losses
- Solderless spring contact mounting system

MiniSkiip® 3 housing

Target Applications

- Industrial motor drives

Schematic



Types

- V23990-K240-A-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=$T_j$max	T_h=80℃ T_c=80℃	69 93	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25℃	700	A
I2t-value	I^2t	t_p=10ms	T_j=25℃	2450	A^2s
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80℃ T_c=80℃	77 117	W
Maximum Junction Temperature	$T_j$max			150	℃
T1,T2,T3,T4,T5,T6,T7					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	T_j=$T_j$max	T_h=80℃ T_c=80℃	66 66	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j$max		108	A
Turn off safe operating area		VCE ≤ 1200V, Tj ≤ Top max		108	A
Power dissipation per IGBT	P_{tot}	T_j=$T_j$max	T_h=80℃ T_c=80℃	142 215	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V		10 900	µs V
Maximum Junction Temperature	$T_j$max			150	℃

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
D1,D2,D3,D4,D5,D6,D7					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	T_j=$T_j$max	T_h=80℃ T_c=80℃	64 66	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max		102	A
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80℃ T_c=80℃	100 151	W
Maximum Junction Temperature	$T_j$max			150	℃
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

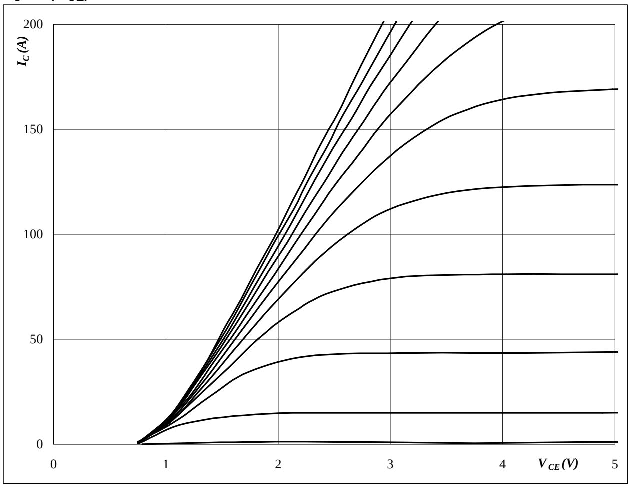
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Min	Typ	Max	
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				35	Tj=25℃ Tj=125℃	0,8	1,02 0,94	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}				35	Tj=25℃ Tj=125℃		0,88 0,75		V
Slope resistance (for power loss calc. only)	r_t				35	Tj=25℃ Tj=125℃		4,00 6,00		mΩ
Reverse current	I_r			1500		Tj=25℃ Tj=125℃			0,1 2	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,90		K/W
T1,T2,T3,T4,T5,T6,T7										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,003	Tj=25℃ Tj=125℃	5	5,80	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		70	Tj=25℃ Tj=125℃	1,35	1,79 2,07	2,15	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200	70	Tj=25℃ Tj=125℃			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=125℃			300	nA
Integrated Gate resistor	R_{gint}							3		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=14 Ω Rgon=14 Ω	±15	600	70	Tj=25℃ Tj=125℃		77		ns
Rise time	t_r					Tj=25℃ Tj=125℃		28		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=125℃		486		
Fall time	t_f					Tj=25℃ Tj=125℃		188		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=125℃		8,77		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=125℃		7,18		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		4,8		pF
Output capacitance	C_{oss}							1		
Reverse transfer capacitance	C_{rss}							0,6		
Gate charge	Q_{Gate}		±15			Tj=25℃		500		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,5		K/W
D1,D2,D3,D4,D5,D6,D7										
Diode forward voltage	V_F				70	Tj=25℃ Tj=125℃	1,25	1,67 1,73	1,8	V
Peak reverse recovery current	I_{RRM}	Rgoff=14 Ω	0	600	70	Tj=25℃ Tj=125℃		121		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=125℃		469		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=125℃		17,62		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=125℃		2787		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=125℃		6,89		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,7		K/W
Thermistor										
Rated resistance	R					T=25℃		1000		Ω
Deviation of R100	ΔR/R	R100=1670 Ω				T=100℃	-3		3	%
R100	P					T=100℃		1670,313		Ω
Power dissipation constant						T=25℃				mW/K
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 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



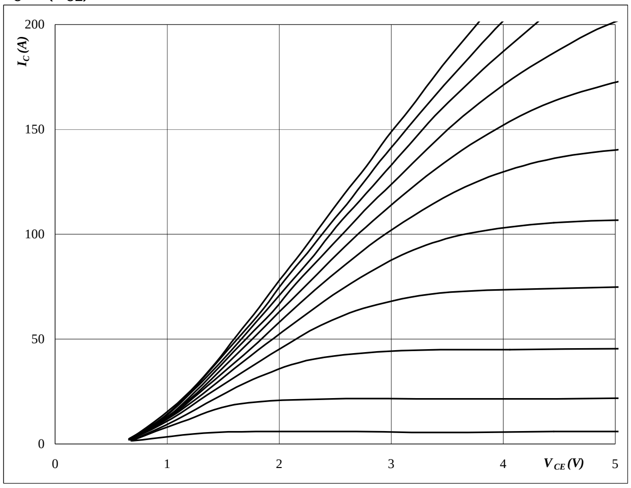
At

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

Figure 2 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



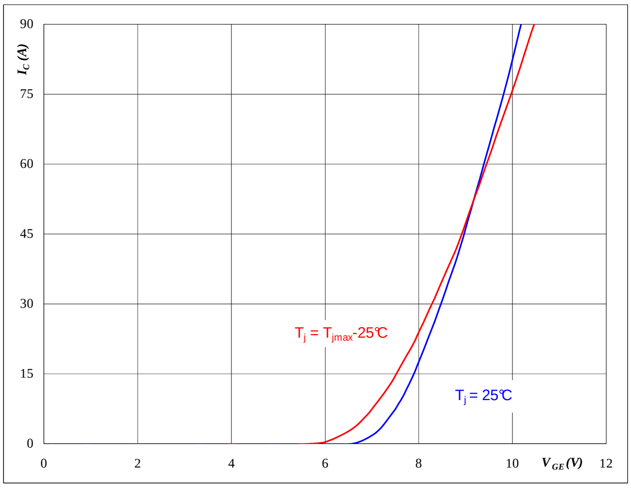
At

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

Figure 3 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



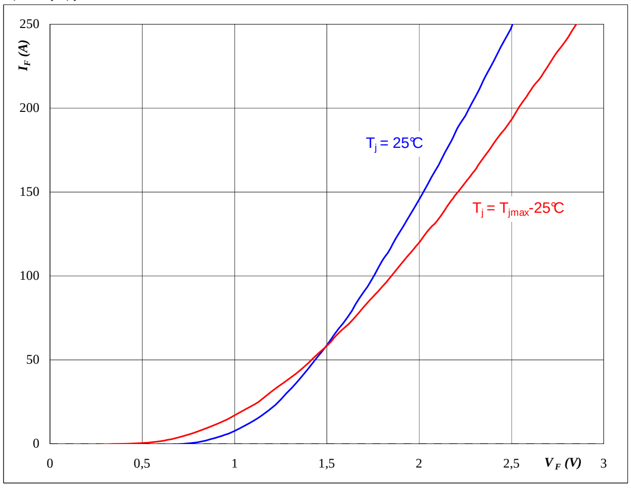
At

t_p =	250	μs
V_{CE} =	10	V

Figure 4 D1,D2,D3,D4,D5,D6,D7 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

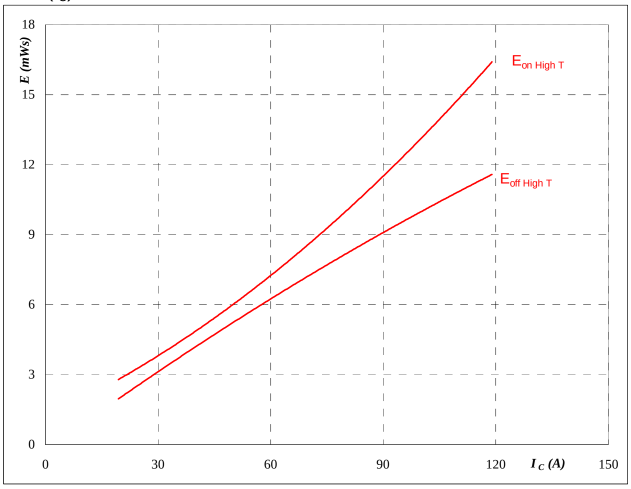
t_p =	250	μs

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

Figure 5 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



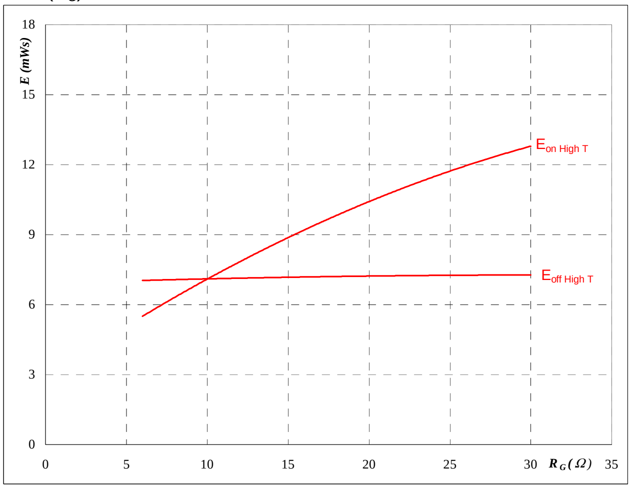
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω
R_{goff} =	14	Ω

Figure 6 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



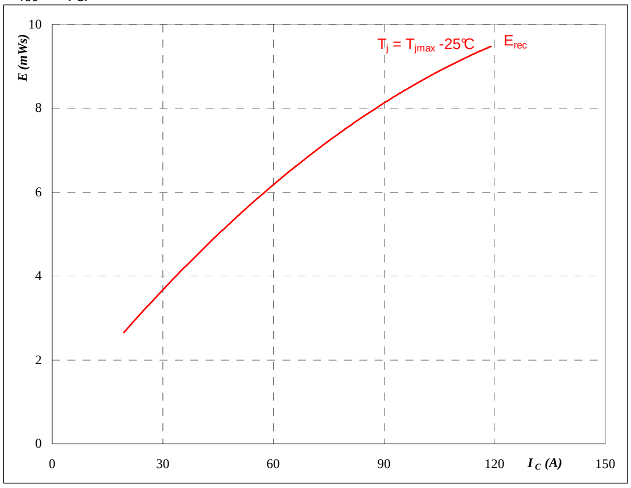
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	69	A

Figure 7 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



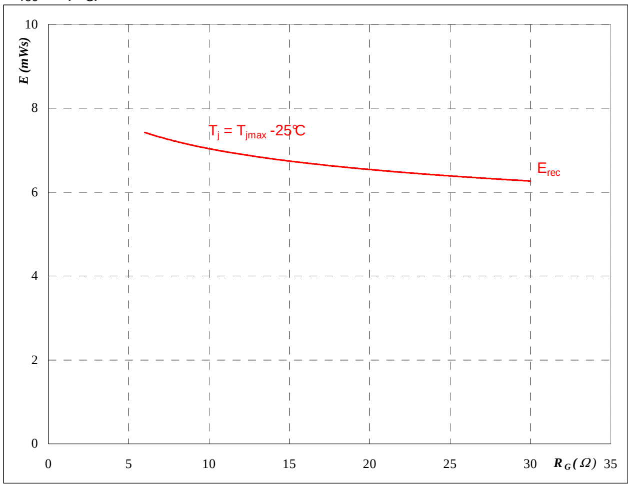
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω

Figure 8 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

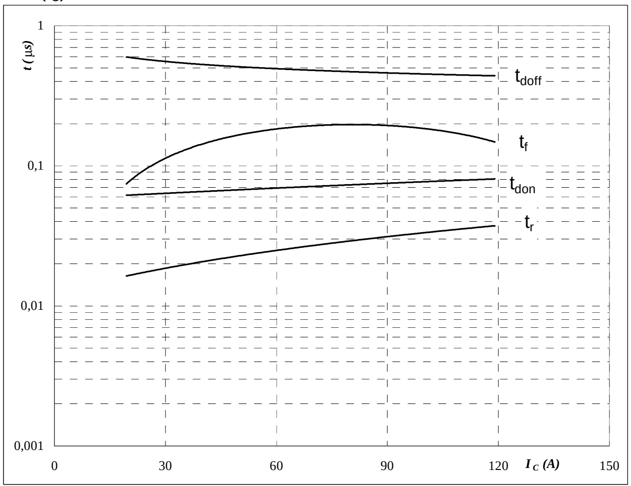
T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	69	A

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

Figure 9 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



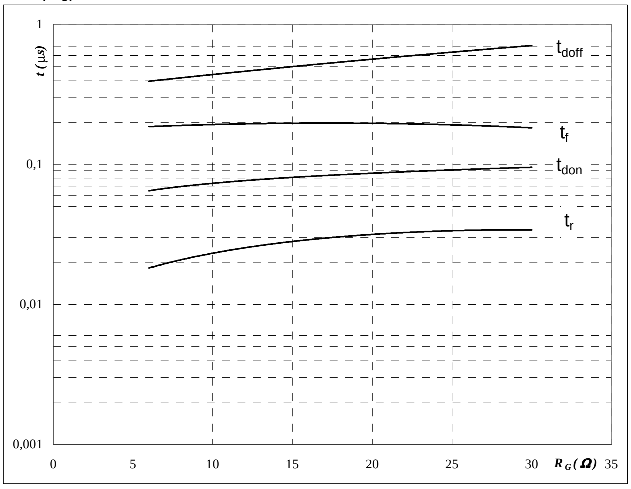
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω
R_{goff} =	14	Ω

Figure 10 T1,T2,T3,T4,T5,T6,T7 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



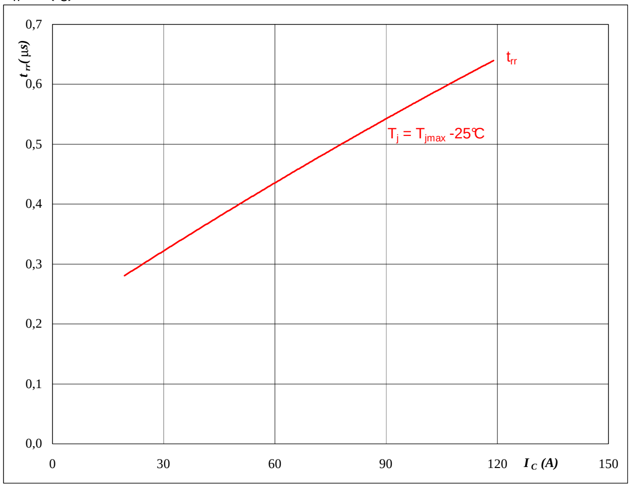
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	69	A

Figure 11 D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



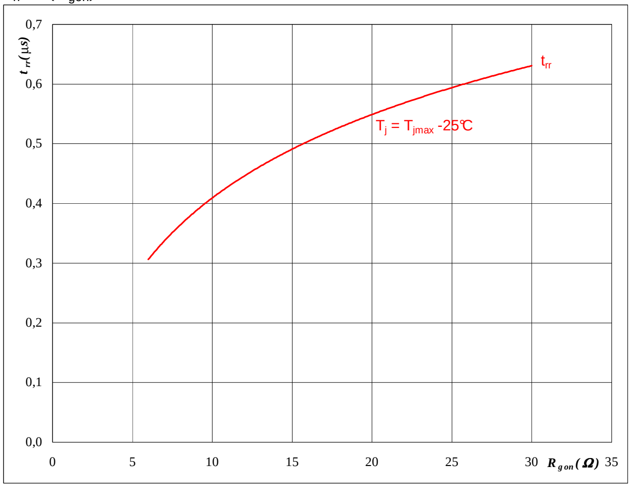
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω

Figure 12 D1,D2,D3,D4,D5,D6,D7 FWD

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

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



At

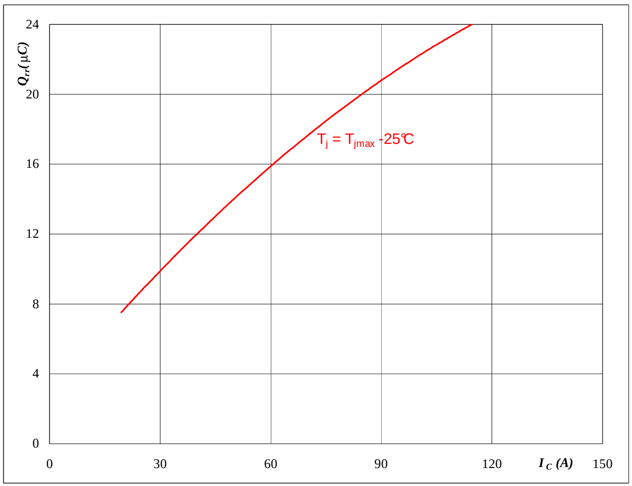
T_j =	125	°C
V_R =	600	V
I_F =	69	A
V_{GE} =	±15	V

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

Figure 13 D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



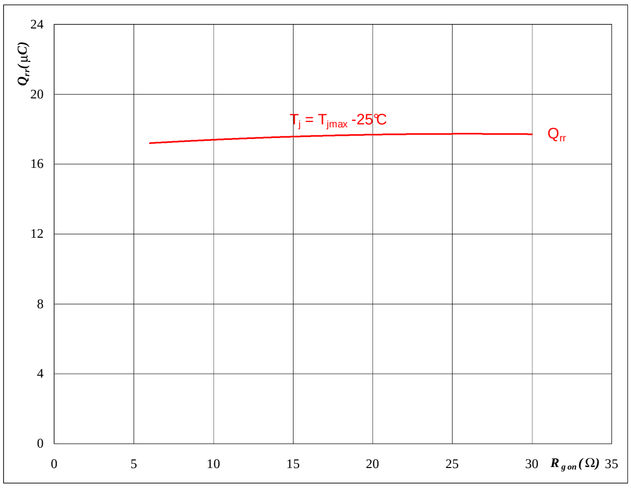
At

T_j =	125	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω

Figure 14 D1,D2,D3,D4,D5,D6,D7 FWD

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

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



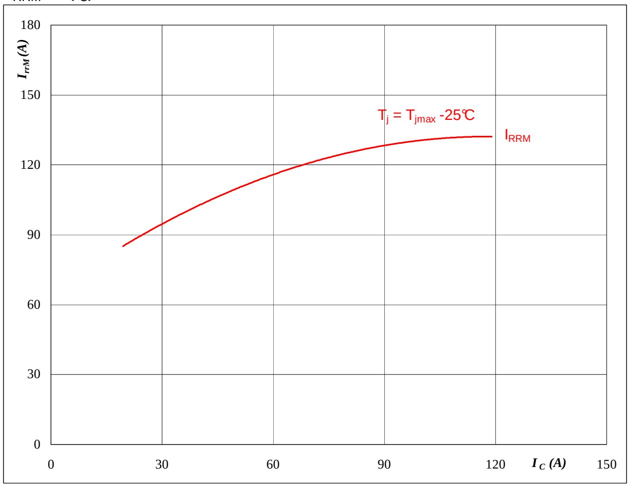
At

T_j =	125	℃
V_R =	600	V
I_F =	69	A
V_{GE} =	±15	V

Figure 15 D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



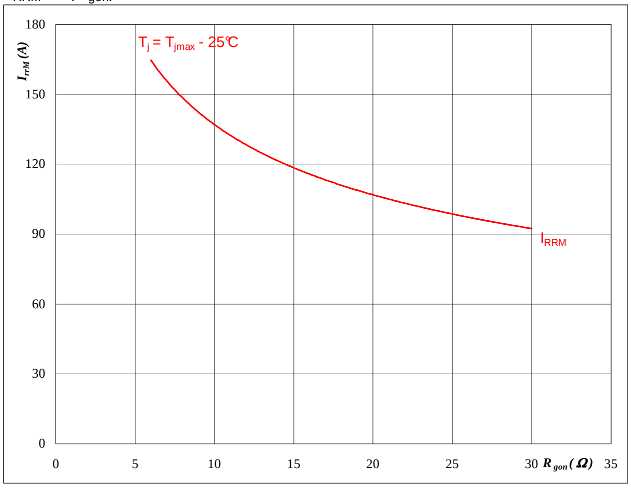
At

T_j =	125	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω

Figure 16 D1,D2,D3,D4,D5,D6,D7 FWD

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

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



At

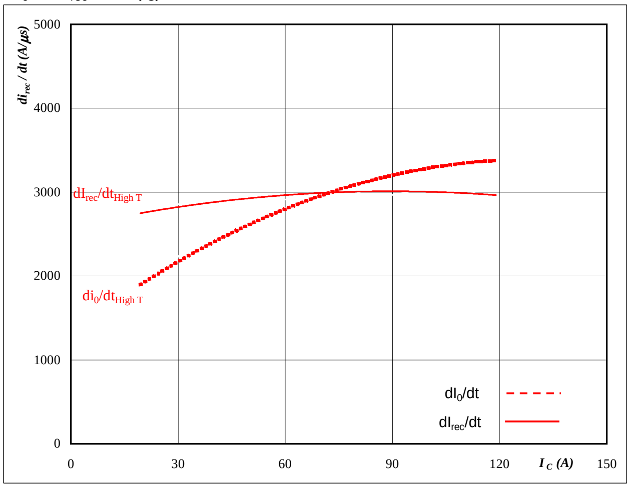
T_j =	125	℃
V_R =	600	V
I_F =	69	A
V_{GE} =	±15	V

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

Figure 17 D1,D2,D3,D4,D5,D6,D7 FWD

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

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



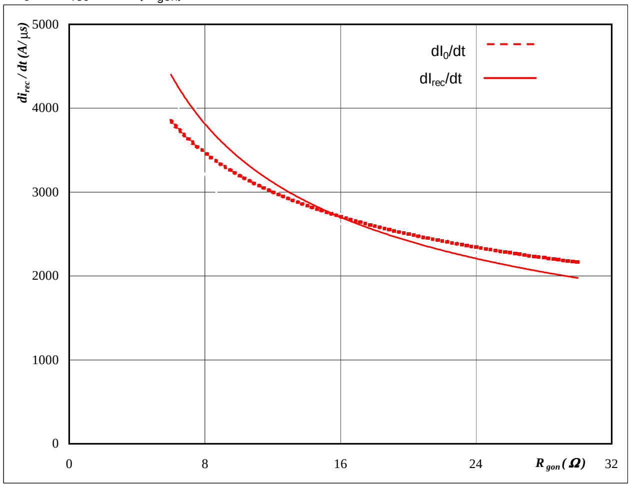
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	14	Ω

Figure 18 D1,D2,D3,D4,D5,D6,D7 FWD

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

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



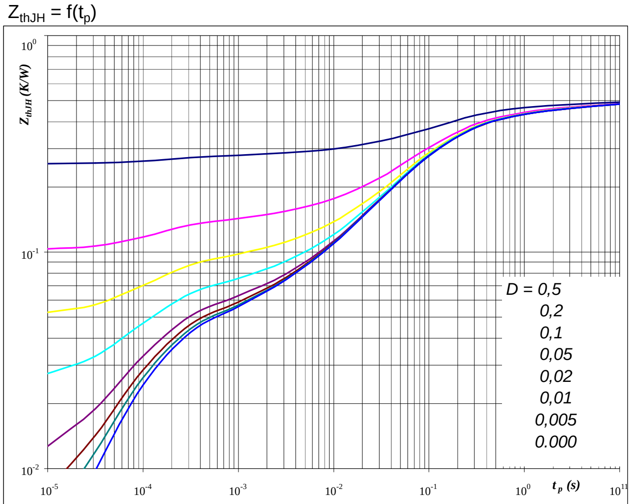
At

T_j =	125	°C
V_R =	600	V
I_F =	69	A
V_{GE} =	±15	V

Figure 19 T1,T2,T3,T4,T5,T6,T7 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	0,5	K/W

IGBT thermal model values

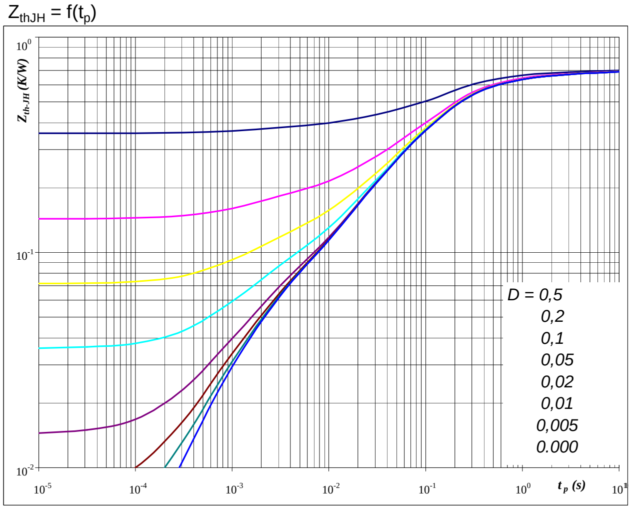
Thermal grease

R (C/W)	Tau (s)
0,04	2,4E+01
0,05	2,0E+00
0,11	3,3E-01
0,20	8,0E-02
0,05	1,1E-02
0,02	9,3E-04

Figure 20 D1,D2,D3,D4,D5,D6,D7 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	0,7	K/W

FWD thermal model values

Thermal grease

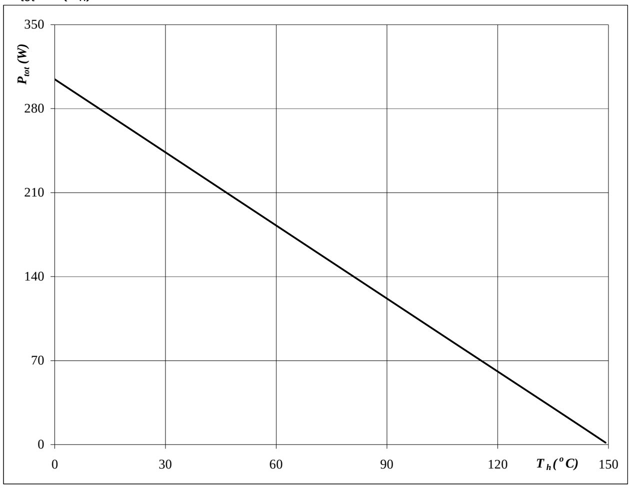
R (C/W)	Tau (s)
0,03	3,9E+01
0,05	2,8E+00
0,16	4,4E-01
0,35	1,1E-01
0,08	1,6E-02
0,04	1,4E-03

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

Figure 21	T1,T2,T3,T4,T5,T6,T7 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



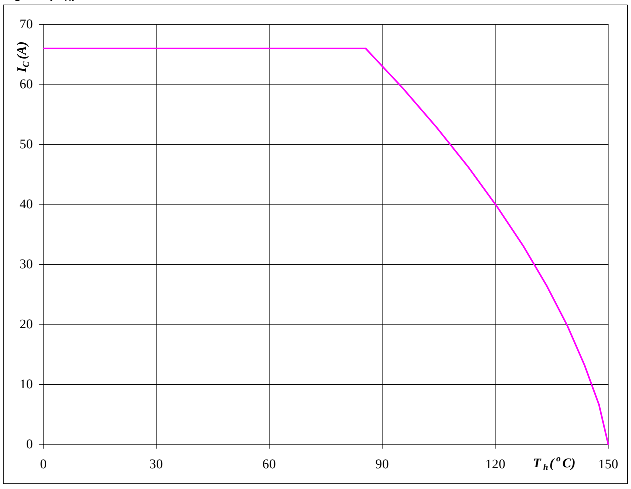
At

T_j = 150 ℃

Figure 22	T1,T2,T3,T4,T5,T6,T7 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

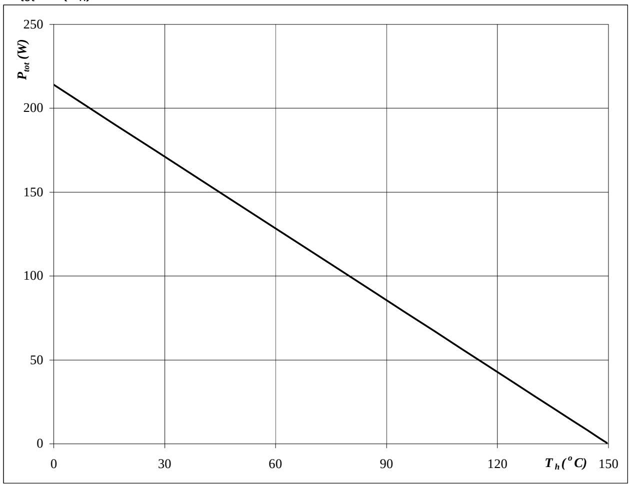
T_j = 150 ℃

V_{GE} = 15 V

Figure 23	D1,D2,D3,D4,D5,D6,D7 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



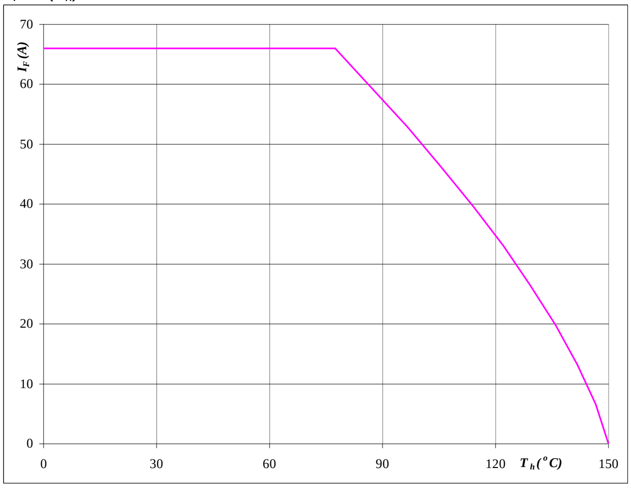
At

T_j = 150 ℃

Figure 24	D1,D2,D3,D4,D5,D6,D7 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

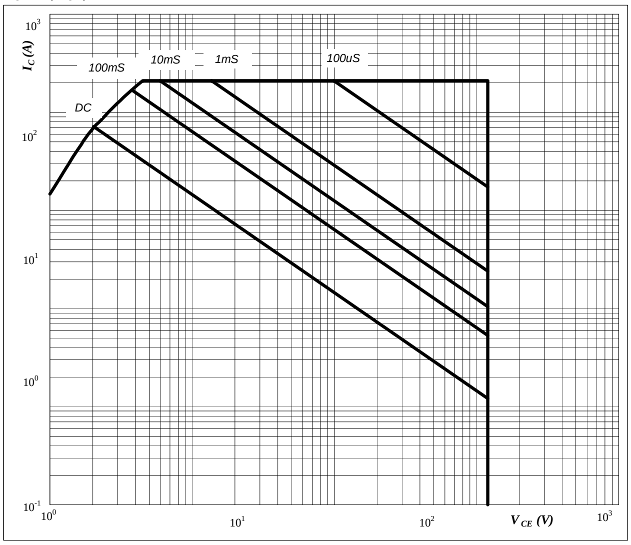
T_j = 150 ℃

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

Figure 25	T1,T2,T3,T4,T5,T6,T7 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



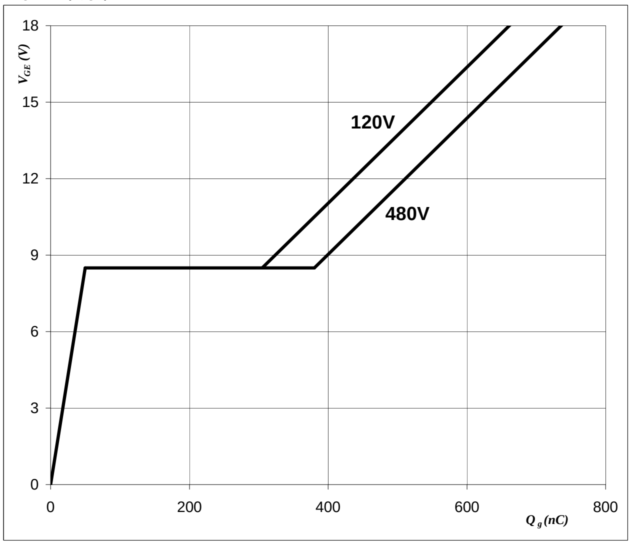
At

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

Figure 26	T1,T2,T3,T4,T5,T6,T7 IGBT

Gate voltage vs Gate charge

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



At

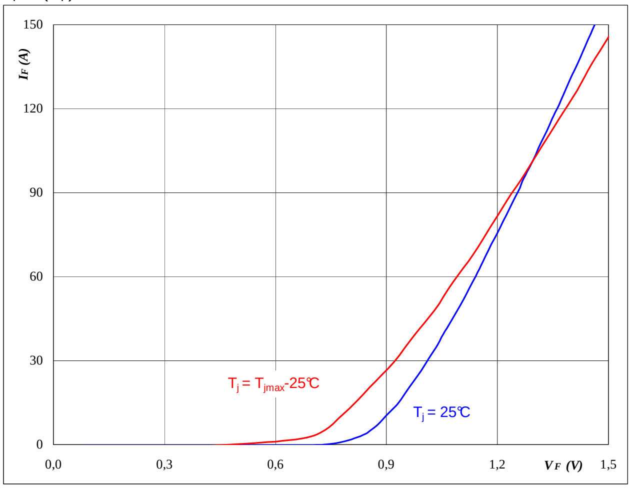
I_C =	69	A

D8,D9,D10,D11,D12,D13

Figure 1 D8,D9,D10,D11,D12,D13 diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



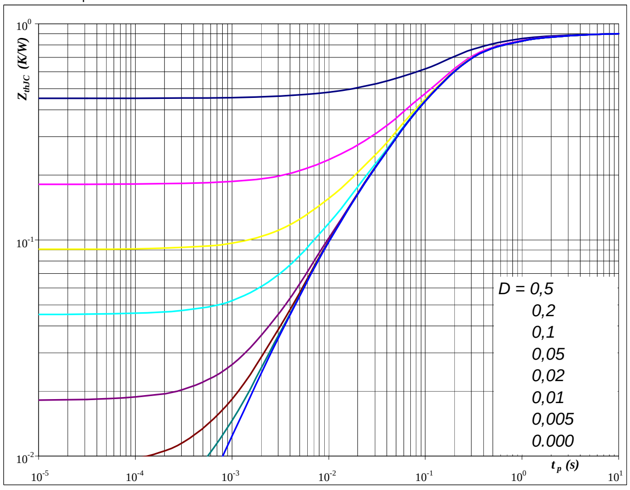
At

t_p = 250 µs

Figure 2 D8,D9,D10,D11,D12,D13 diode

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

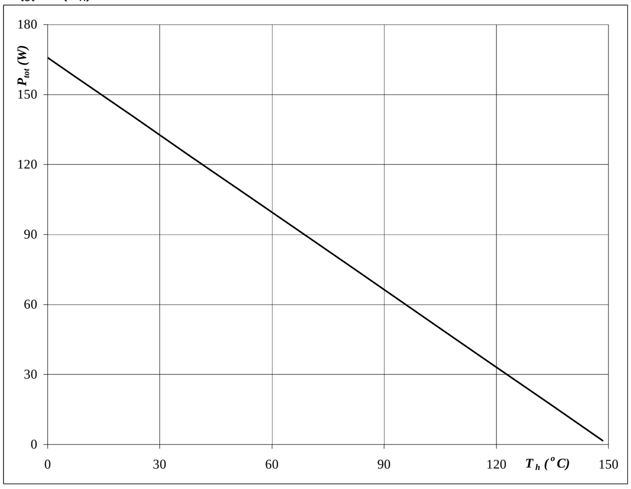
D = t_p / T

R_{thJH} = 0,90 K/W

Figure 3 D8,D9,D10,D11,D12,D13 diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



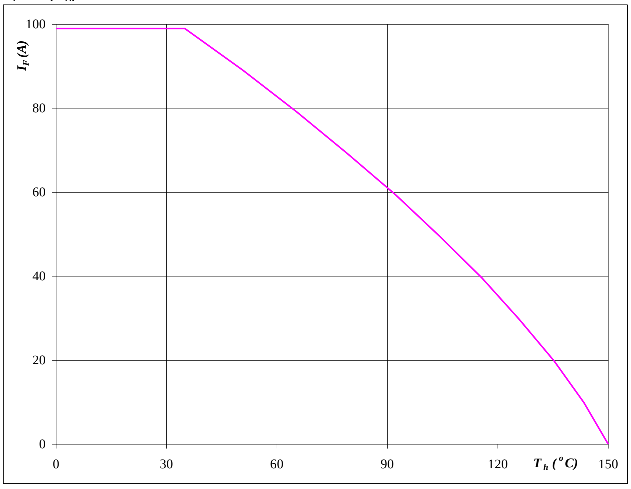
At

T_j = 150 ºC

Figure 4 D8,D9,D10,D11,D12,D13 diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



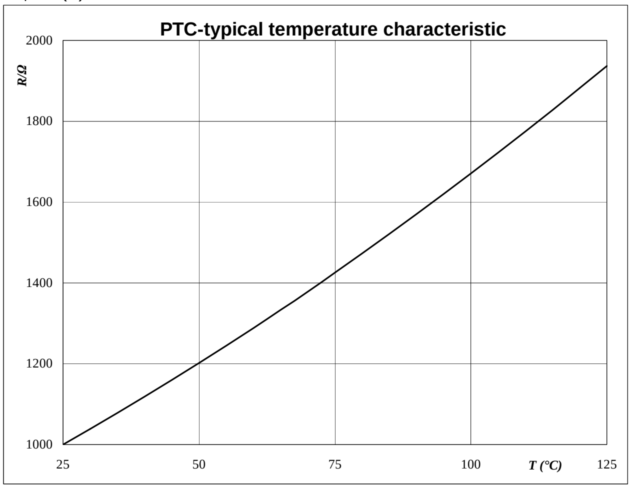
At

T_j = 150 ºC

Thermistor

Figure 1	Thermistor

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



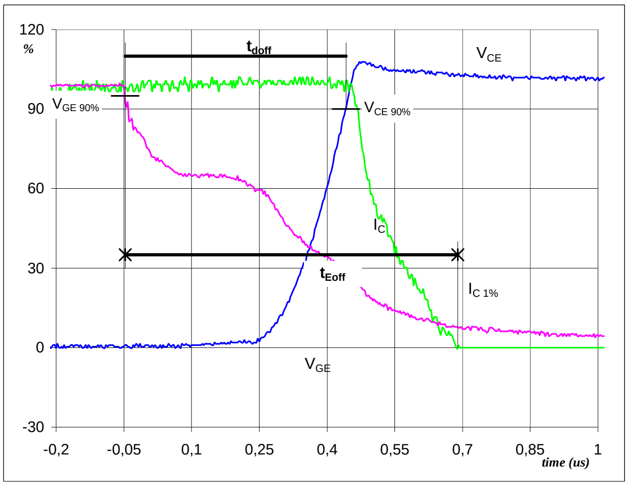
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	14 Ω
R_{goff}	=	14 Ω

Figure 1 Output inverter IGBT

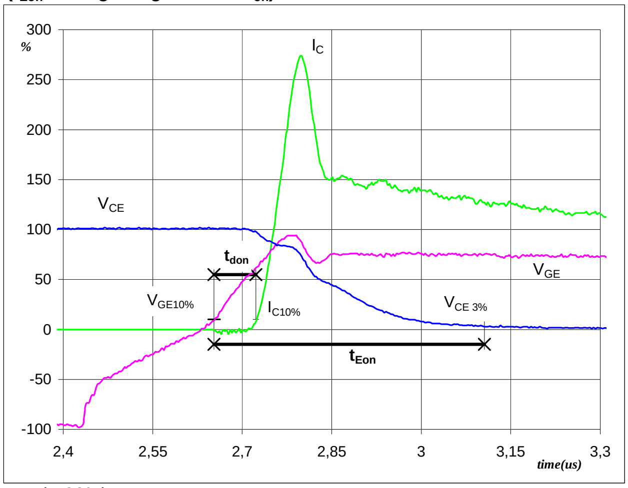
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	69	A
t_{doff} =	0,49	μs
t_{Eoff} =	0,74	μs

Figure 2 Output inverter IGBT

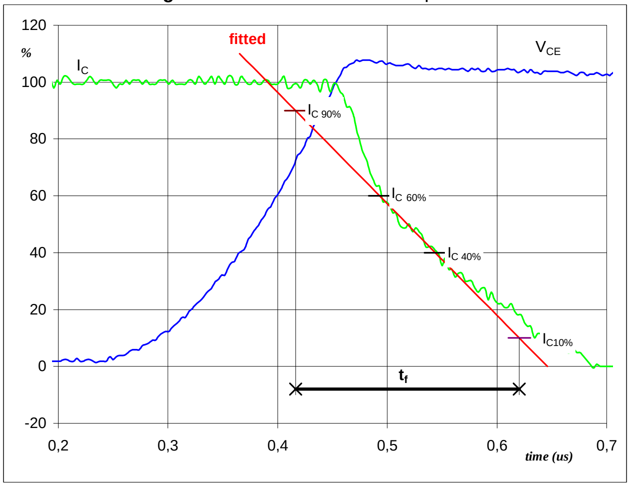
Turn-on Switching Waveforms & definition of tdon, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (-100%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	69	A
t_{don} =	0,07	μs
t_{Eon} =	0,45	μs

Figure 3 Output inverter IGBT

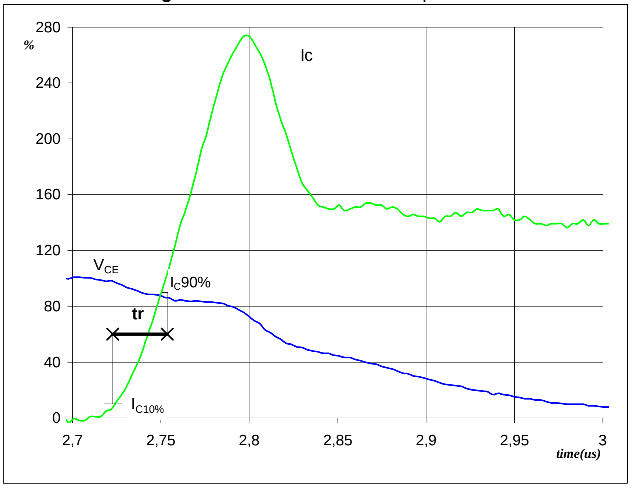
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	69	A
t_f =	2,00	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

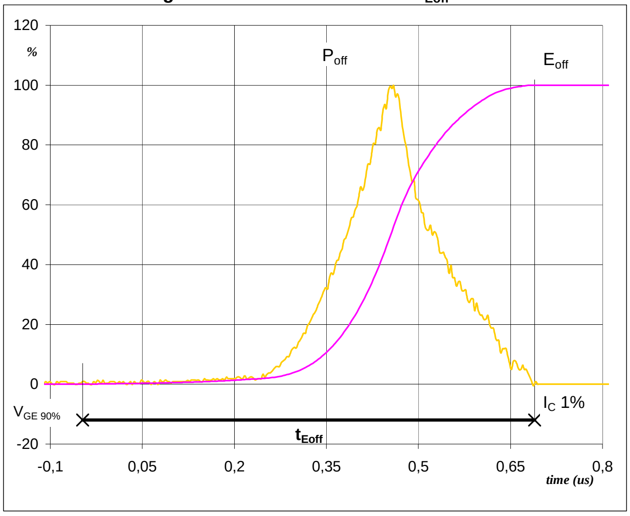


V_C (100%) =	600	V
I_C (100%) =	69	A
t_r =	0,03	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

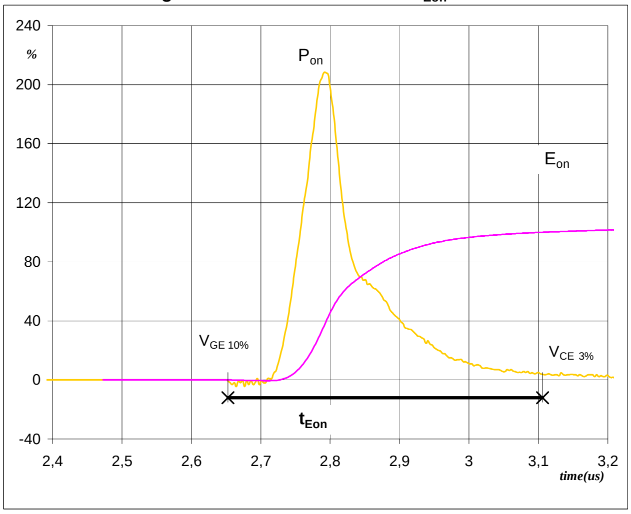
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	41,57	kW
E_{off} (100%) =	7,13	mJ
t_{Eoff} =	0,74	µs

Figure 6 Output inverter IGBT

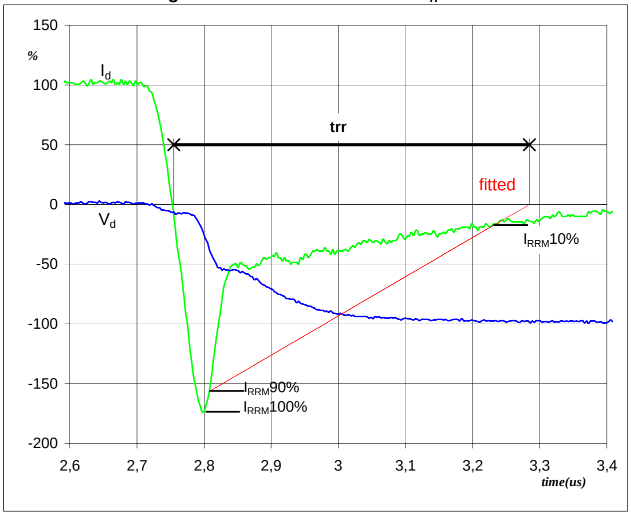
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	41,57	kW
E_{on} (100%) =	8,51	mJ
t_{Eon} =	0,45	µs

Figure 7 Output inverter FWD

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

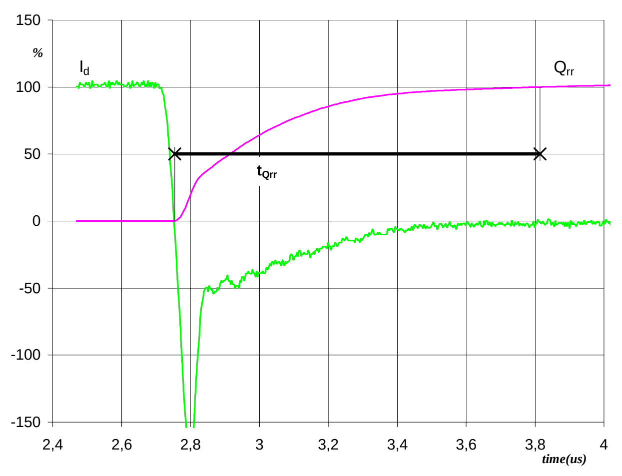


V_d (100%) =	600	V
I_d (100%) =	69	A
I_{RRM} (100%) =	121	A
t_{rr} =	0,47	µs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

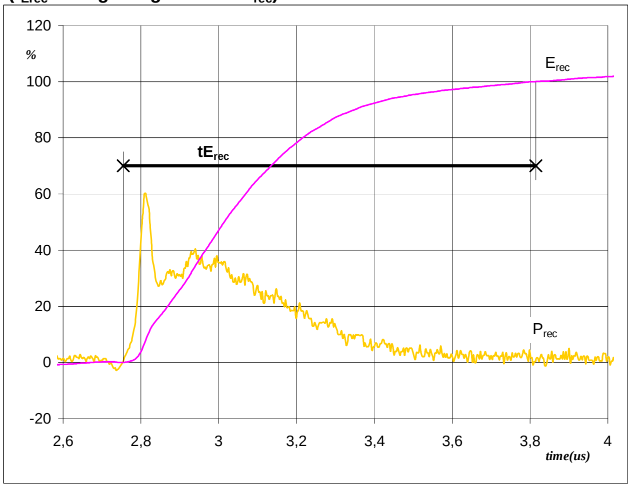
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	69	A
Q_{rr} (100%) =	17,62	µC
t_{Qrr} =	1,06	µs

Figure 9 Output inverter FWD

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



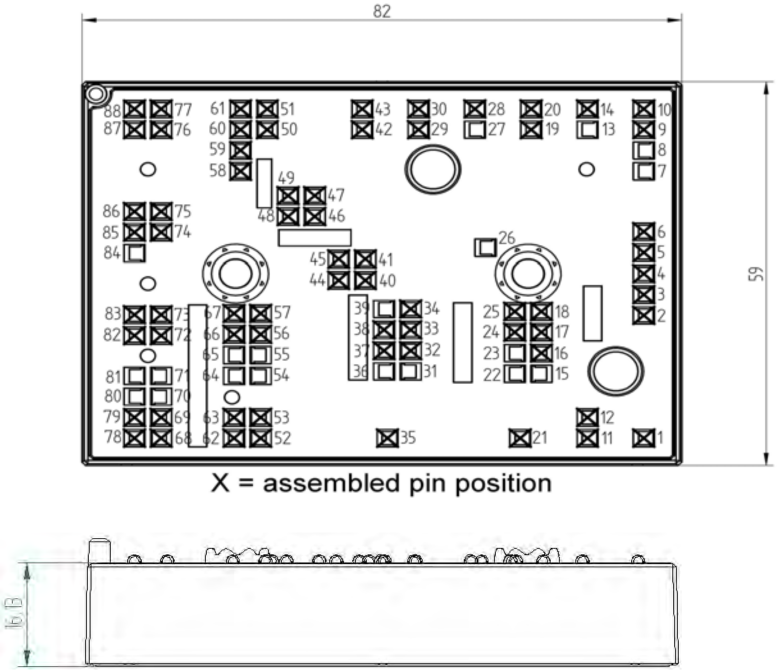
P_{rec} (100%) =	41,57	kW
E_{rec} (100%) =	6,89	mJ
t_{Erec} =	1,06	µs

Ordering Code and Marking - Outline - Pinout

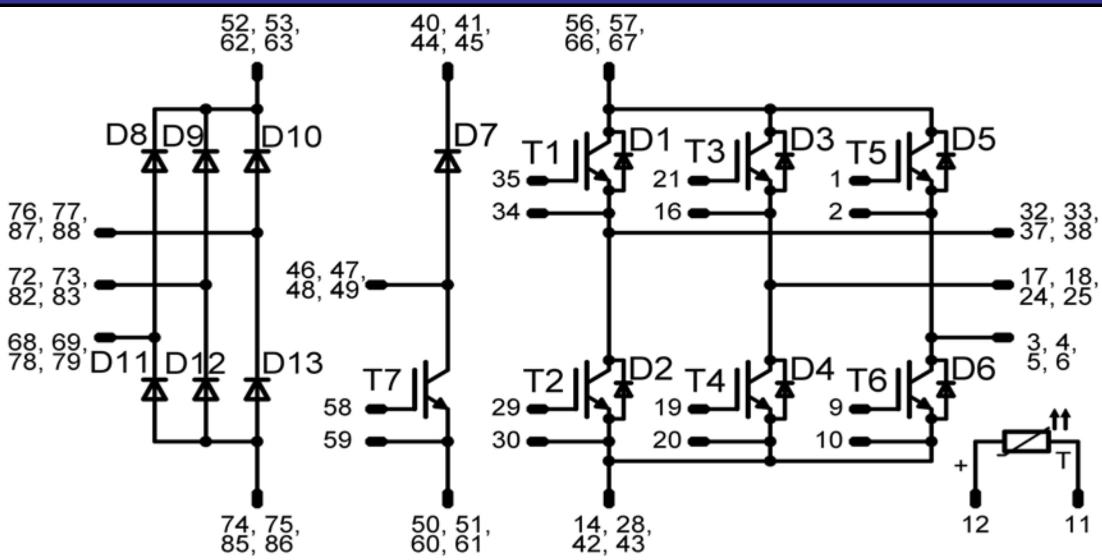
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K32-T-PM)	V23990-K240-A-/0A/-PM	K240A	K240A-/0A/
with std lid (black V23990-K32-T-PM) and P12	V23990-K240-A-/1A/-PM	K240A	K240A-/1A/
with thin lid (white V23990-K33-T-PM)	V23990-K240-A-/0B/-PM	K240A	K240A-/0B/
with thin lid (white V23990-K33-T-PM) and P12	V23990-K240-A-/1B/-PM	K240A	K240A-/1B/

Outline



Pinout



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