MiniSKiiP® 3 PIM — 1200V / 50A

Features

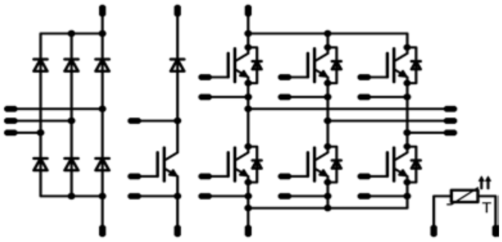
- Solderless interconnection
- Trench Fieldstop IGBT4 technology

MiniSKiiP® 3 housing

Target Applications

- Industrial Drives

Schematic



Types

- V23990-K428-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}	$T_j=T_j$max	T_h=80℃	69	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25℃	450	A
I^2t-value	I^2t			1020	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	T_h=80℃	77	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℃	52	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j$max		150	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j$max	T_h=80℃	133	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	$T_j$max			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℃	46	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j max$		335	A
Power dissipation per Diode	P_{tot}	$T_j=T_j max$	T_h=80℃	100	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

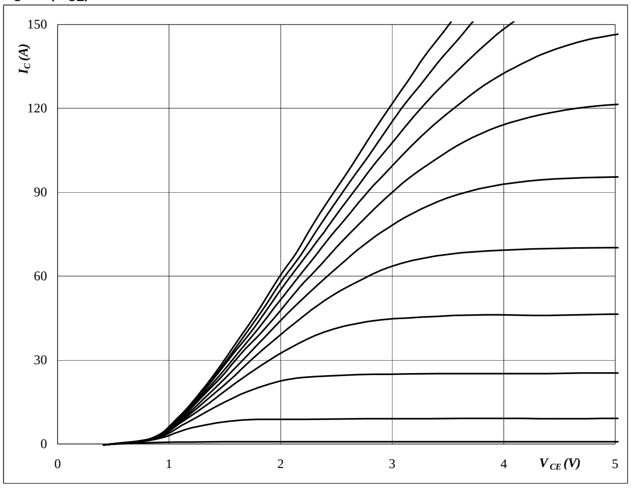
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Min	Typ	Max	
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				35	Tj=25℃ Tj=125℃	0,8	1,1 1,02	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					Tj=25℃ Tj=125℃		0,9 0,74		V
Slope resistance (for power loss calc. only)	r_t					Tj=25℃ Tj=125℃		0,004 0,006		Ω
Reverse current	I_r			1500		Tj=25℃ Tj=125℃			0,1 1,1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50μm λ=1W/mK						0,90		K/W
T1,T2,T3,T4,T5,T6,T7										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0017	Tj=25℃ Tj=150℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		50	Tj=25℃ Tj=150℃	1,6	1,91 2,39	2,4	V
Collector-emitter cut-off current incl. Diode	I_{CES}			1200		Tj=25℃ Tj=150℃			0,06	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=150℃			600	nA
Integrated Gate resistor	R_{gint}							4		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=8Ω Rgon=8Ω	±15	600	50	Tj=25℃ Tj=150℃		106 111		ns
Rise time	t_r					Tj=25℃ Tj=150℃		18 25		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=150℃		228 298		
Fall time	t_f					Tj=25℃ Tj=150℃		84 125		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=150℃		2,66 4,46		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=150℃		2,78 4,58		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		2770		pF
Output capacitance	C_{oss}							205		
Reverse transfer capacitance	C_{rss}							160		
Gate charge	Q_{Gate}		±15			Tj=25℃		380		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50μm λ=1W/mK						0,71		K/W
D1,D2,D3,D4,D5,D6,D7										
Diode forward voltage	V_F				50	Tj=25℃ Tj=150℃	1,5	2,19 2,21	2,9	V
Peak reverse recovery current	I_{RRM}	Rgon=8Ω	±15	600	50	Tj=25℃ Tj=150℃		61,3 70,7		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=150℃		144 312		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=150℃		3,74 8,8		μC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=150℃		3494 950		A/μs
Reverse recovered energy	Erec					Tj=25℃ Tj=150℃		1,38 3,48		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50μm λ=1W/mK						0,95		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

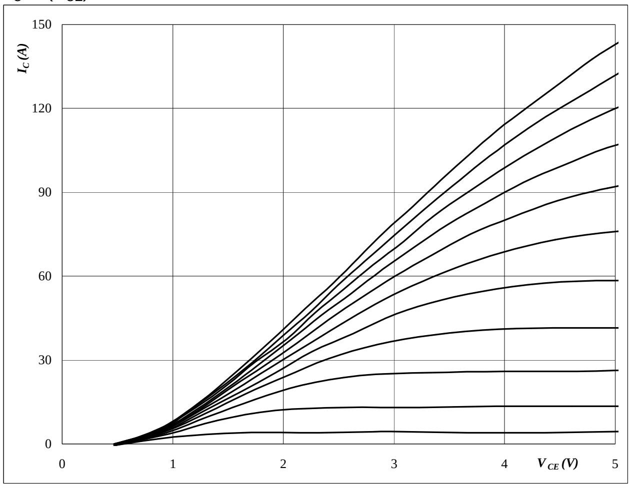
T_j = 25 ℃

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

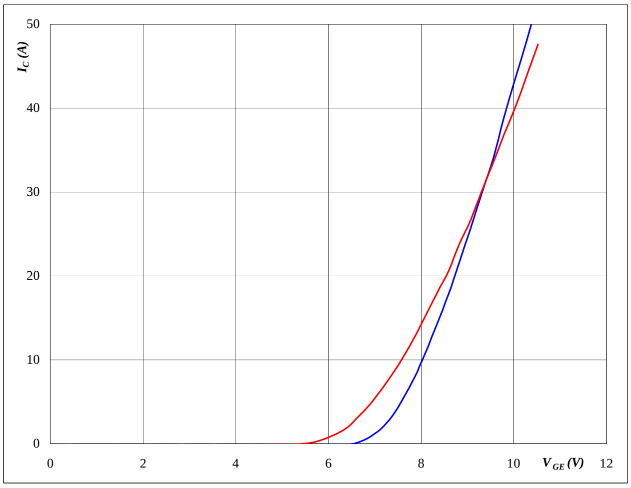
T_j = 150 ℃

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_j = 25/150 ℃

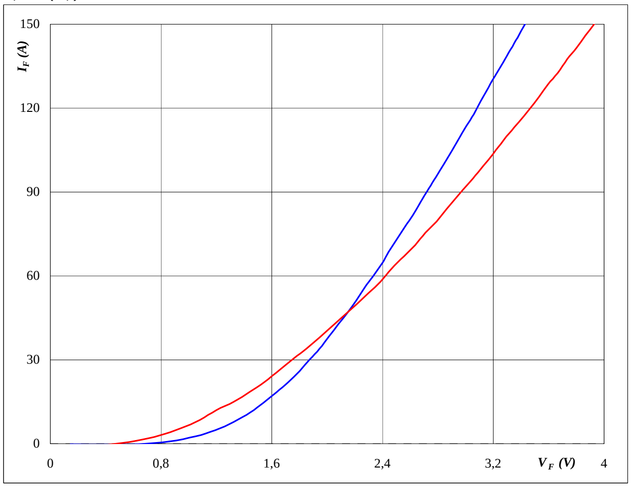
t_p = 250 µs

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_j = 25/150 ℃

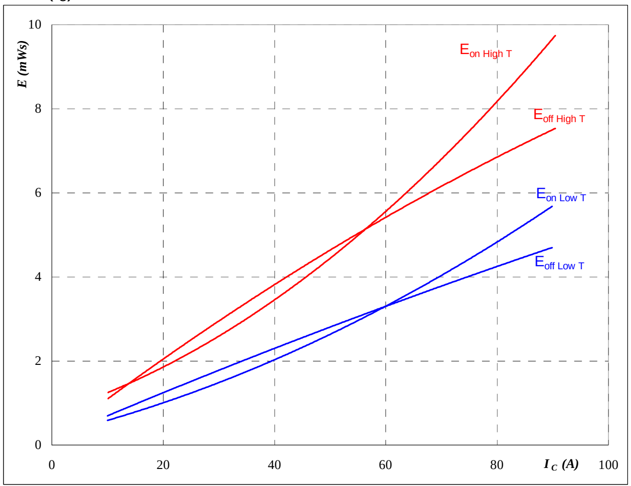
t_p = 250 µs

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

$E = f(I_C)$



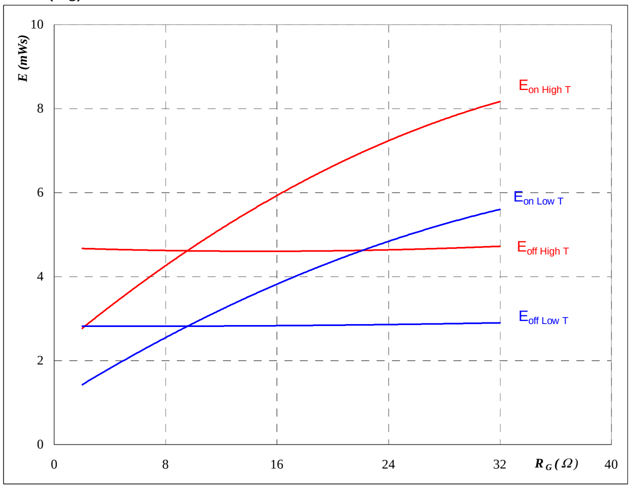
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

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

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



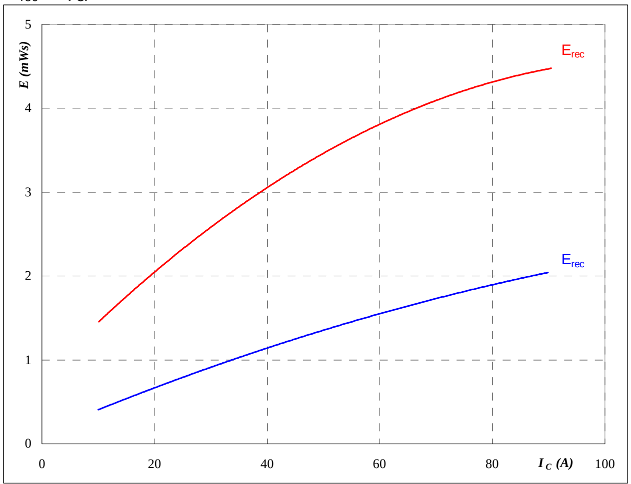
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Figure 7 D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



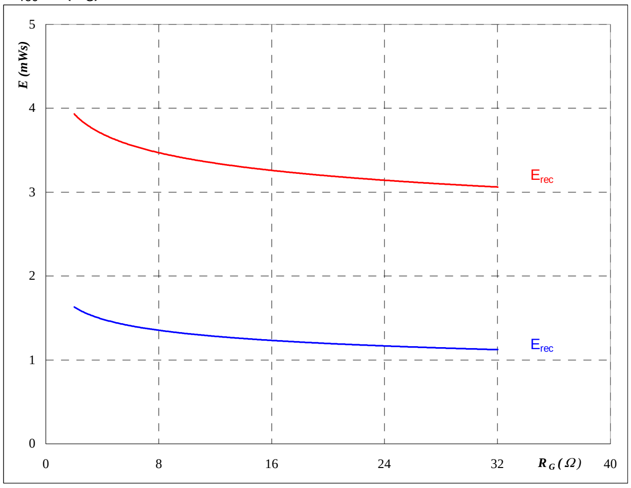
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 8 D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

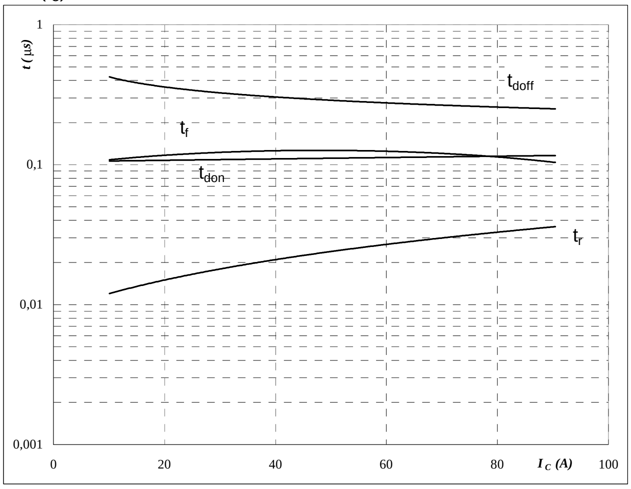
T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

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

$t = f(I_C)$



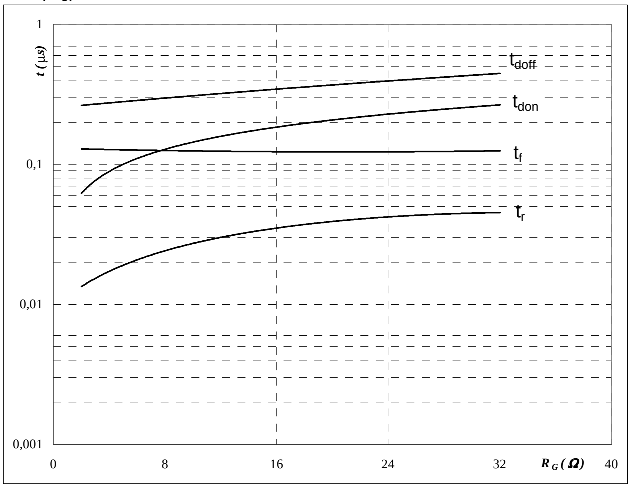
With an inductive load at

T_j =	150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

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

Typical switching times as a function of gate resistor

$t = f(R_G)$



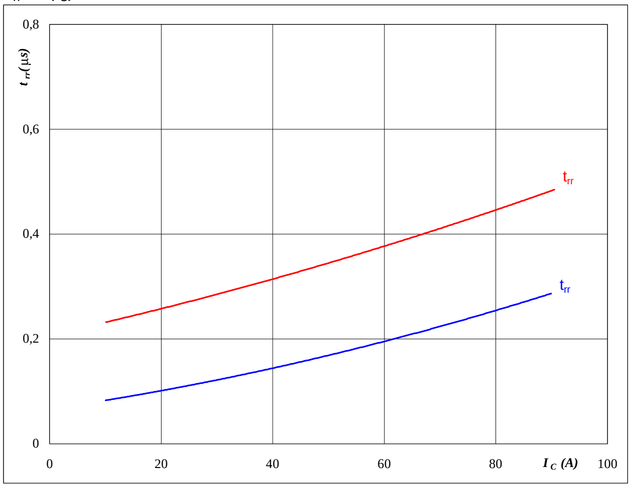
With an inductive load at

T_j =	150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

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

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



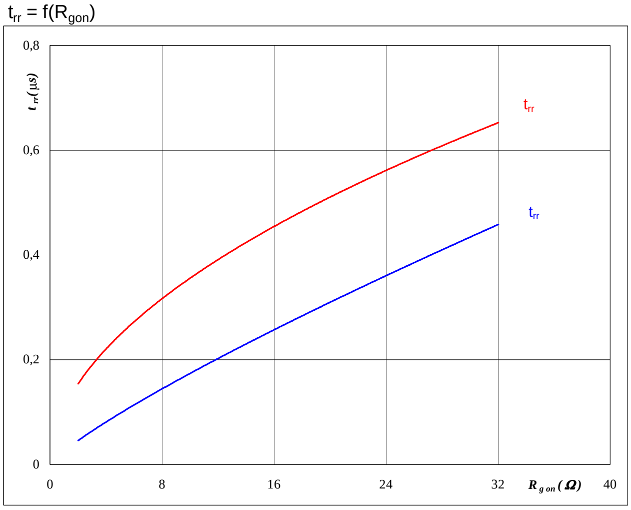
At

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

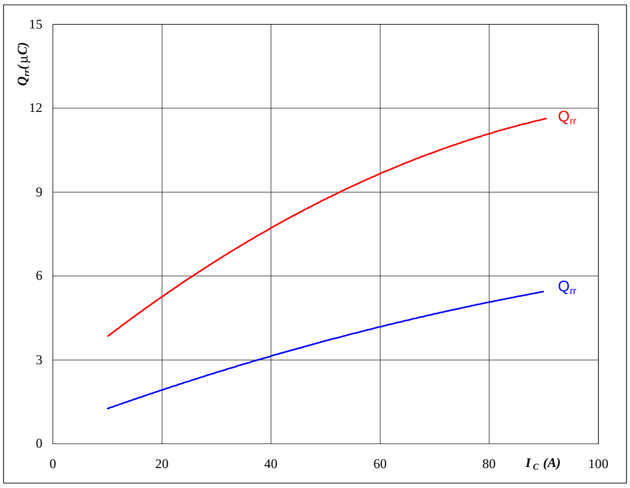
T_j =	25/150	℃
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

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

$Q_{rr} = f(I_C)$



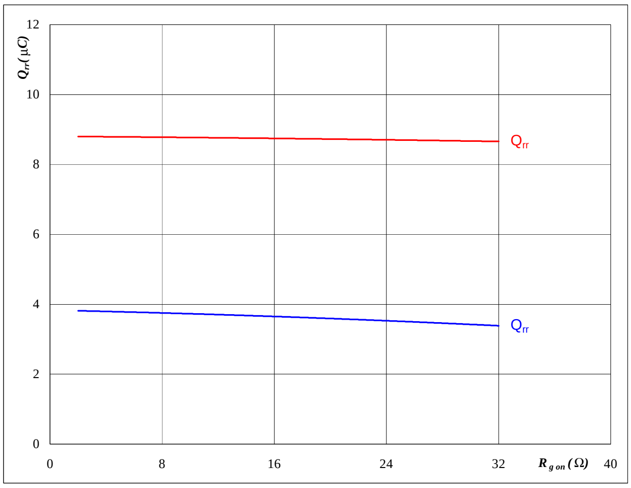
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

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

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

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



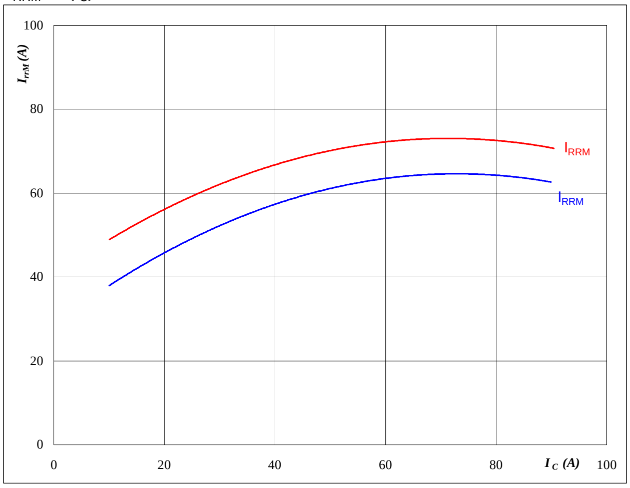
At

T_j =	25/150	℃
V_R =	600	V
I_F =	50	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

$I_{RRM} = f(I_C)$



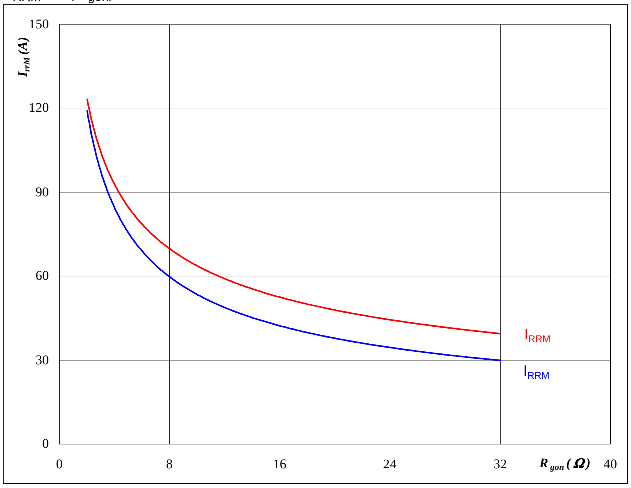
At

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

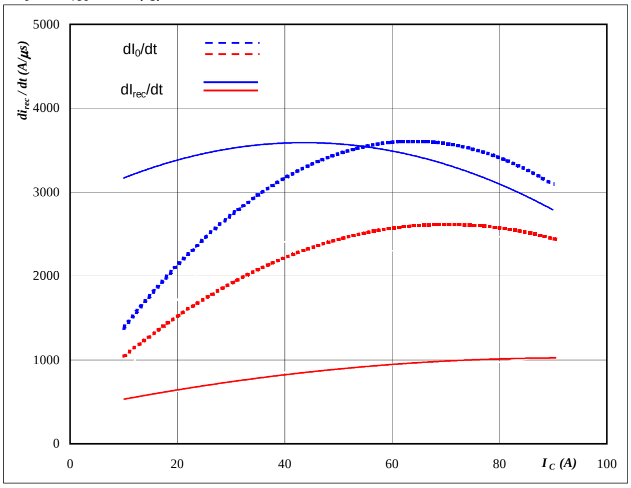
T_j =	25/150	℃
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

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

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



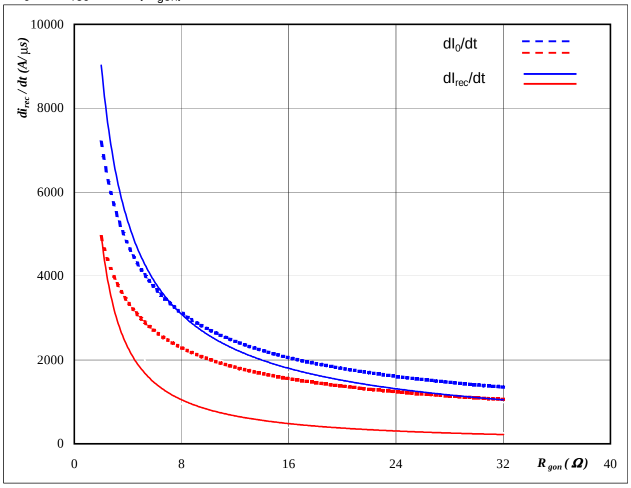
At

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

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



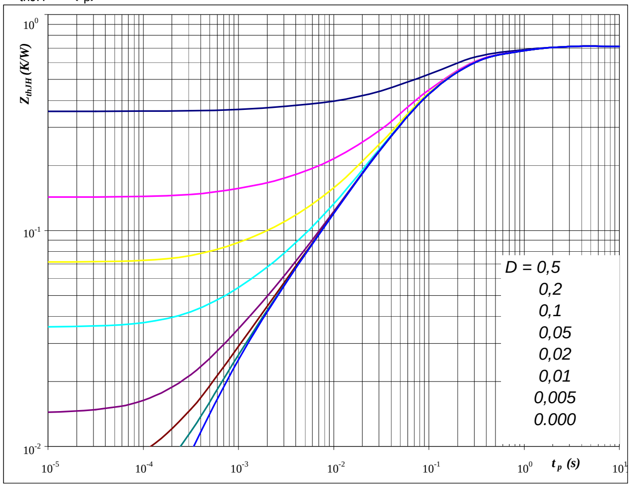
At

T_j =	25/150	℃
V_R =	600	V
I_F =	50	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} =	0,71	K/W

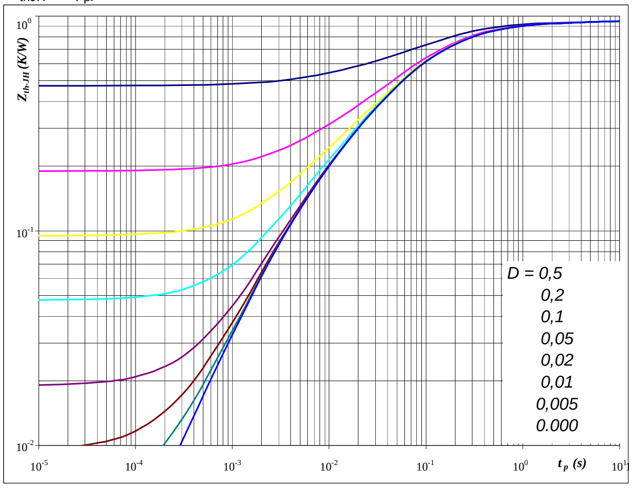
IGBT thermal model values

R (C/W)	Tau (s)
0,11	7,7E-01
0,36	1,3E-01
0,16	4,6E-02
0,06	8,2E-03
0,02	1,1E-03

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} =	0,95	K/W

FWD thermal model values

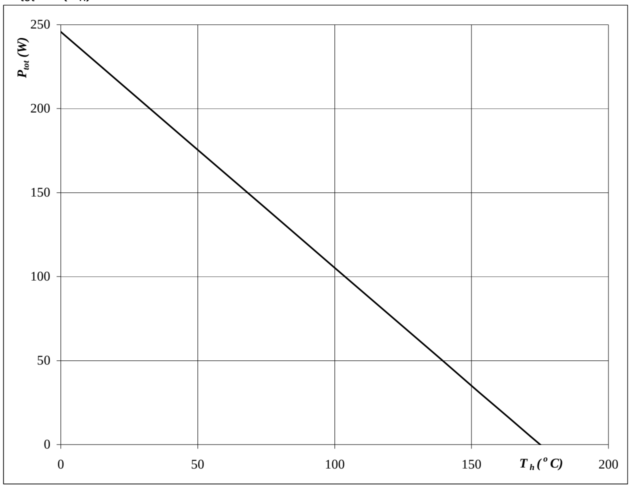
R (C/W)	Tau (s)
0,06	2,5E+00
0,21	3,5E-01
0,44	7,8E-02
0,17	1,7E-02
0,07	3,6E-03

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

$P_{tot} = f(T_h)$



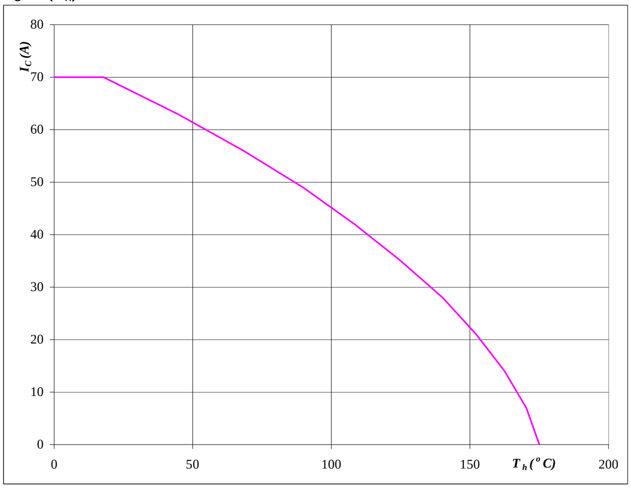
At

$T_j =$ 175 ℃

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

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

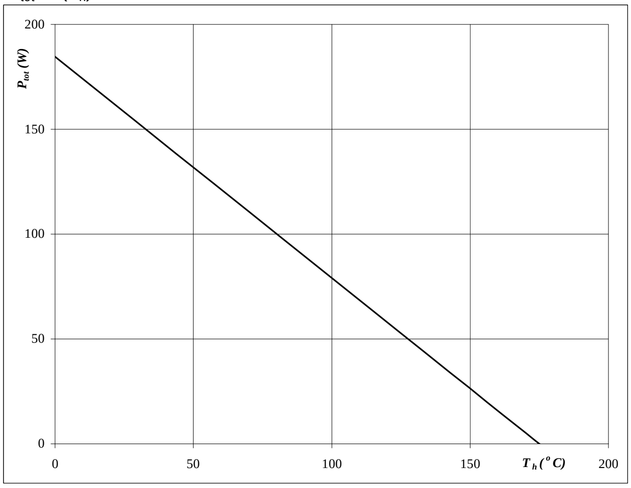
$T_j =$ 175 ℃

$V_{GE} =$ 15 V

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



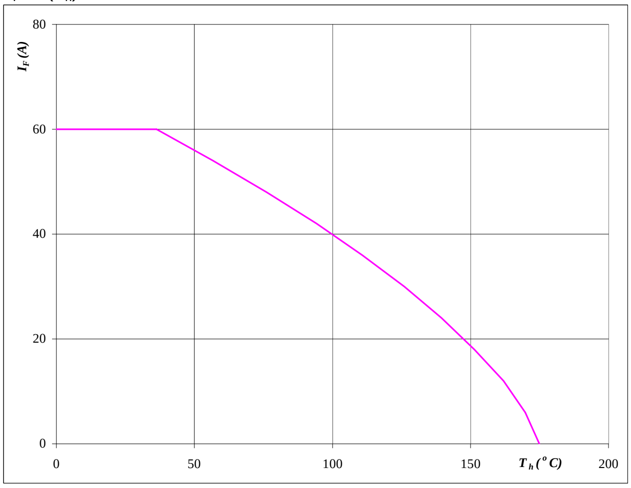
At

$T_j =$ 175 ℃

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

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

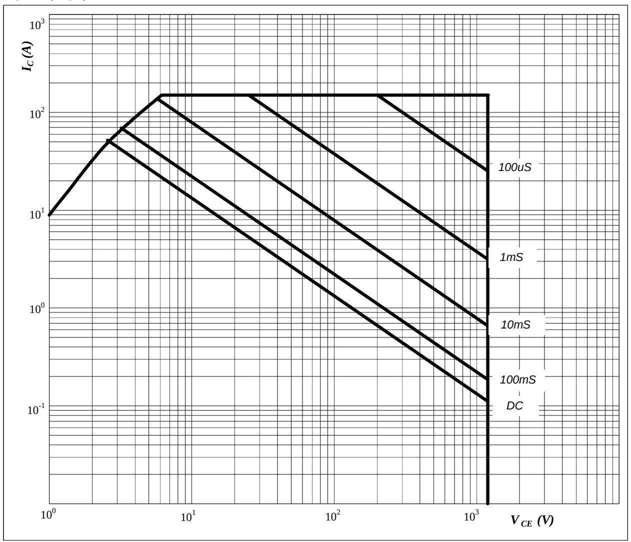
$T_j =$ 175 ℃

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

$I_C = f(V_{CE})$



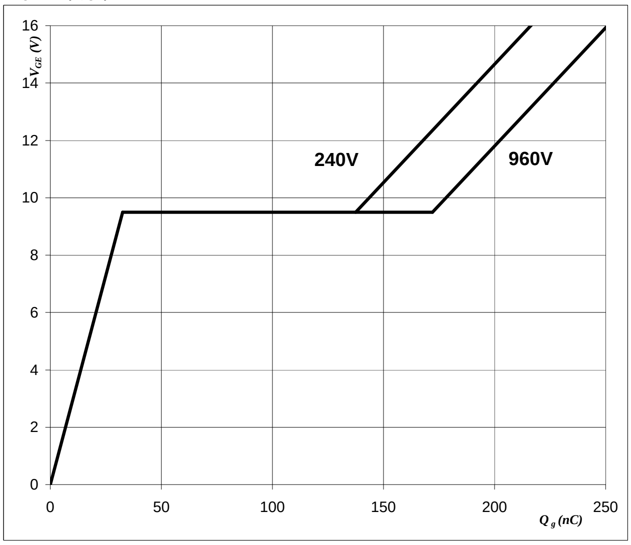
At

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

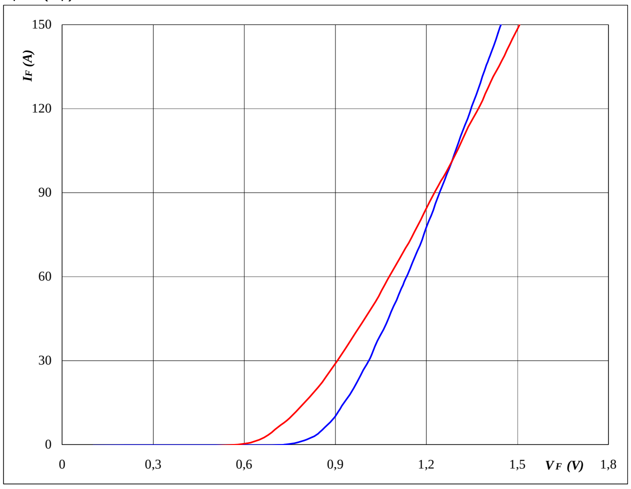
I_C =	50	A

D8,D9,D10,D11,D12,D13

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

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



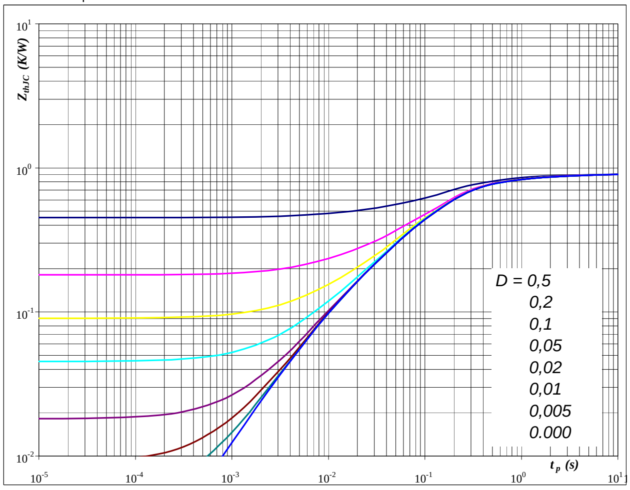
At

Tj =	25/125	℃
t_p =	250	μs

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

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



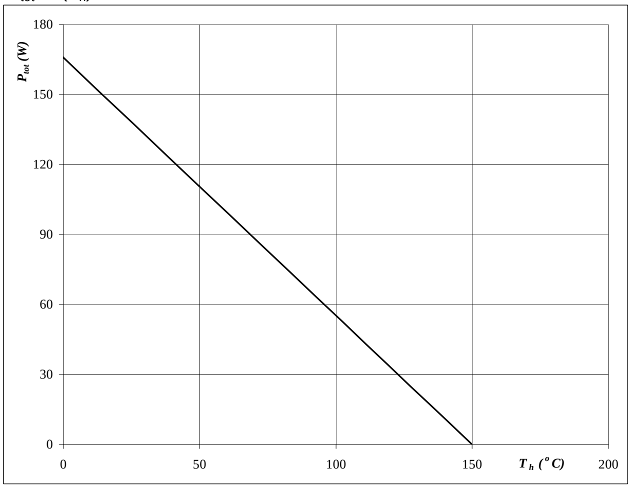
At

D =	t_p / T	
R_{thJH} =	0,9	K/W

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



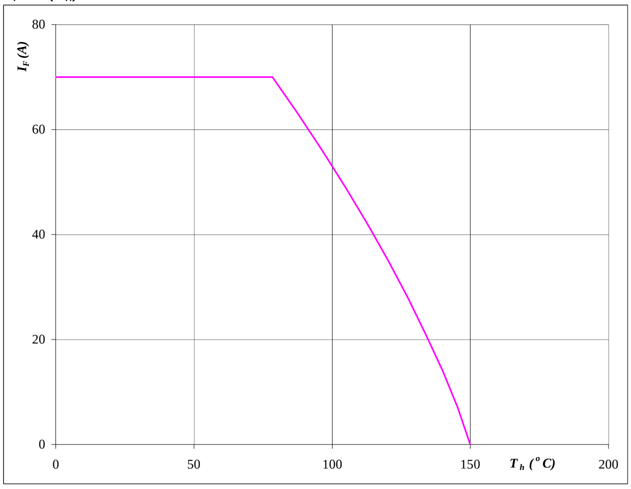
At

T_j =	150	ºC

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

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



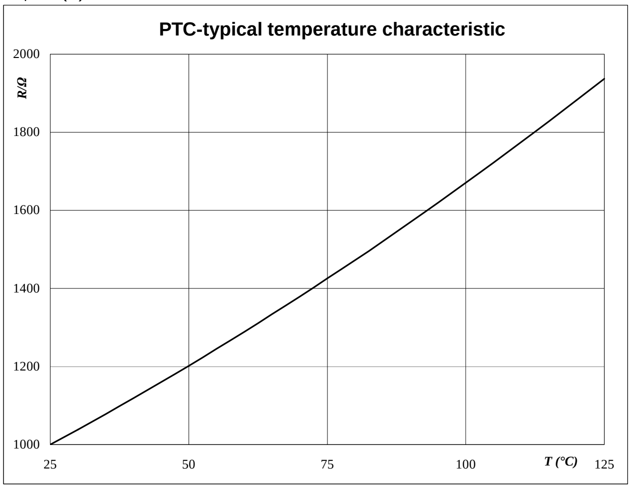
At

T_j =	150	ºC

Thermistor

Figure 1	Thermistor

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



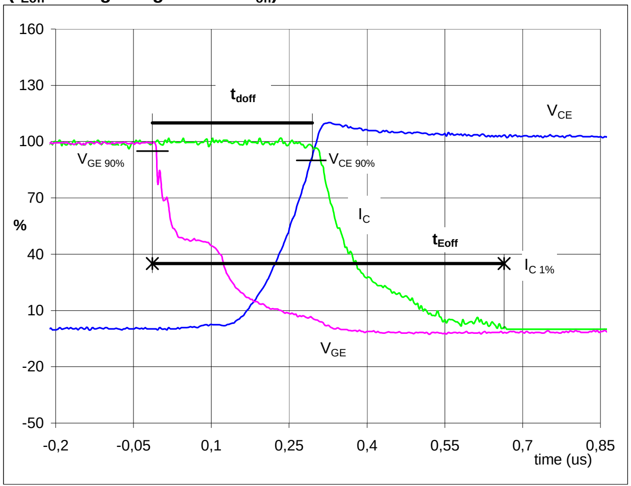
Switching Definitions Output Inverter

General conditions

T_j	**=**	**150 °C**
R_{gon}	**=**	**8 Ω**
R_{goff}	**=**	**8 Ω**

Figure 1 T1,T2,T3,T4,T5,T6,T7 IGBT

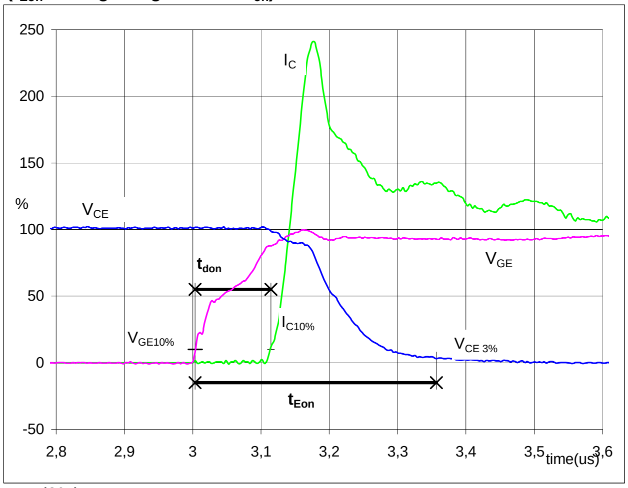
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{doff} =	0,30	µs
t_{Eoff} =	0,68	µs

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

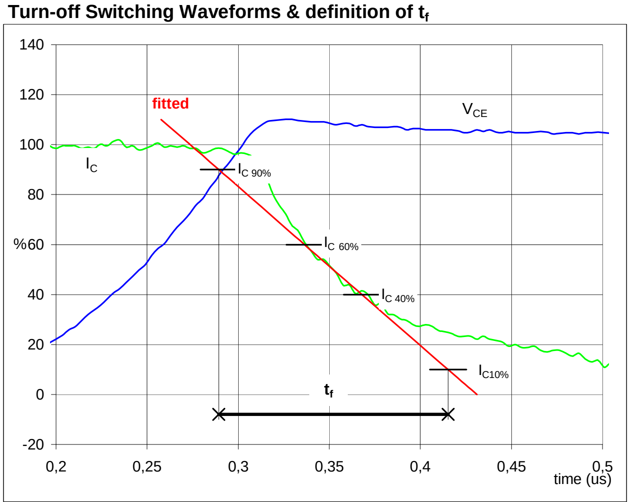
Turn-on Switching Waveforms & definition of tdon, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{don} =	0,11	µs
t_{Eon} =	0,35	µs

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

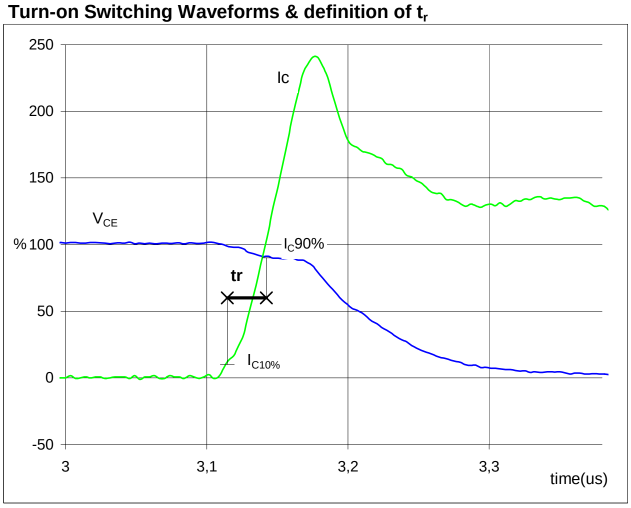
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	50	A
t_f =	0,13	µs

Figure 4 T1,T2,T3,T4,T5,T6,T7 IGBT

Turn-on Switching Waveforms & definition of t_r

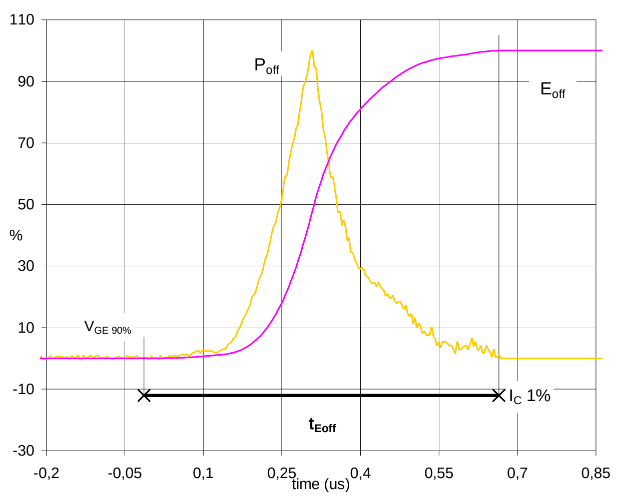


V_C (100%) =	600	V
I_C (100%) =	50	A
t_r =	0,03	µs

Switching Definitions Output Inverter

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

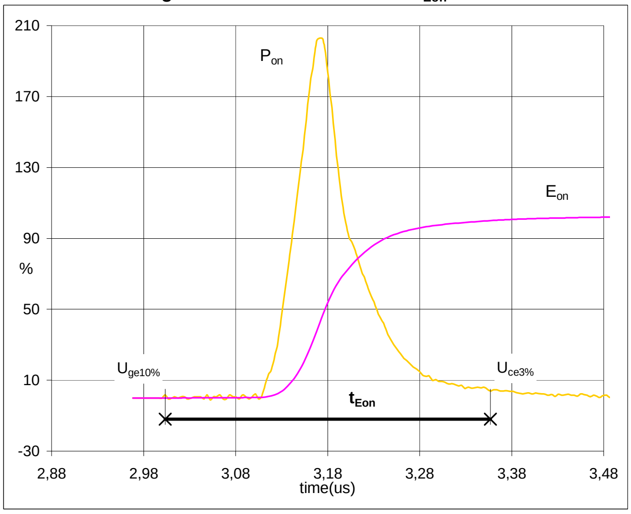
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	29,95	kW
E_{off} (100%) =	4,58	mJ
t_{Eoff} =	0,68	μs

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

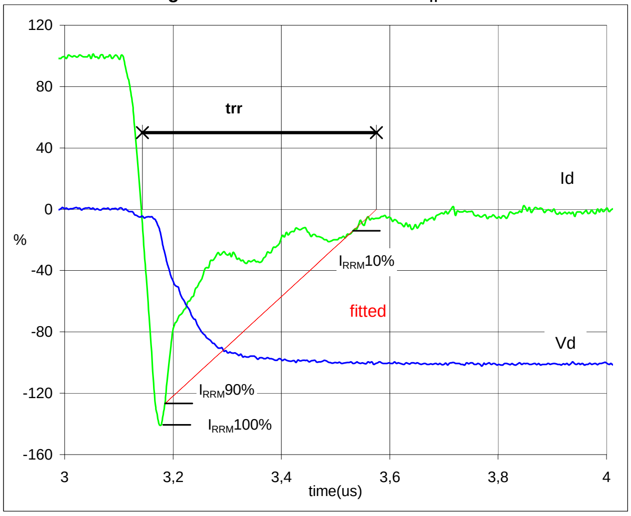
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	29,95	kW
E_{on} (100%) =	4,46	mJ
t_{Eon} =	0,35	μs

Figure 78 D1,D2,D3,D4,D5,D6,D7 FWD

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

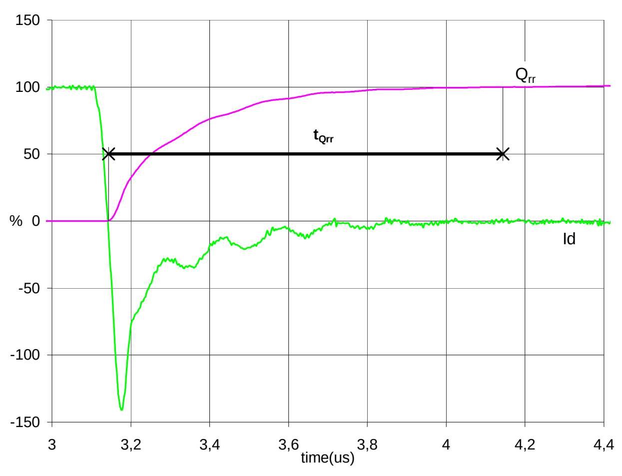


V_d (100%) =	600	V
I_d (100%) =	50	A
I_{RRM} (100%) =	-71	A
t_{rr} =	0,31	μs

Switching Definitions Output Inverter

Figure 8 D1,D2,D3,D4,D5,D6,D7 FWD

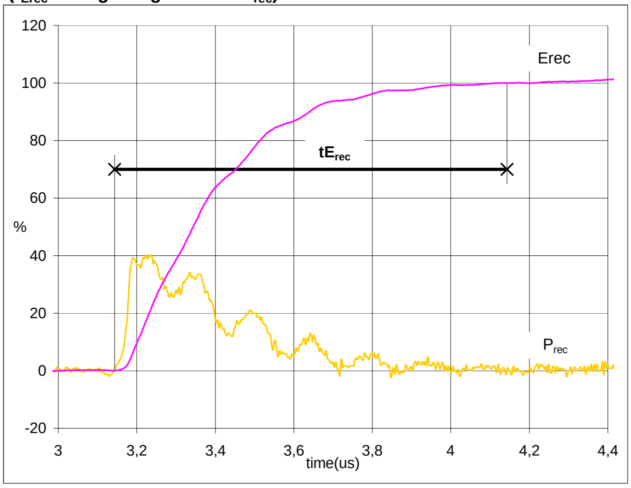
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	50	A
Q_{rr} (100%) =	8,80	µC
t_{Qrr} =	1,00	µs

Figure 9 D1,D2,D3,D4,D5,D6,D7 FWD

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



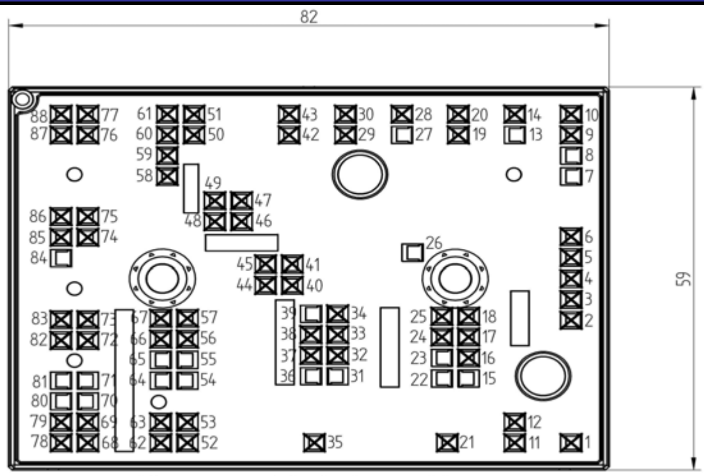
P_{rec} (100%) =	29,95	kW
E_{rec} (100%) =	3,48	mJ
t_{Erec} =	1,00	µs

Ordering Code and Marking - Outline - Pinout

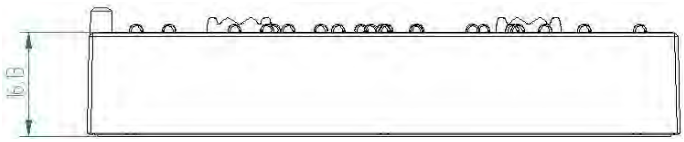
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K32-T-PM)	V23990-K428-A40-/0A/-PM	K428A40	K428A40-/0A/
with std lid (black V23990-K32-T-PM) and P12	V23990-K428-A40-/1A/-PM	K428A40	K428A40-/1A/
with thin lid (white V23990-K33-T-PM)	V23990-K428-A40-/0B/-PM	K428A40	K428A40-/0B/
with thin lid (white V23990-K33-T-PM) and P12	V23990-K428-A40-/1B/-PM	K428A40	K428A40-/1B/

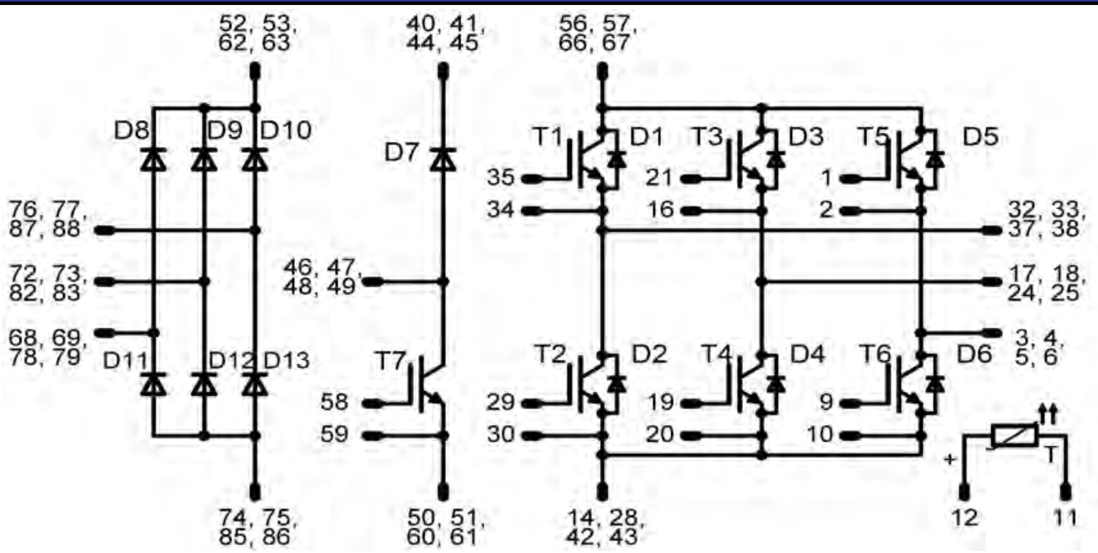
Outline



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.