MiniSKiiP® 2 PIM — 1200V / 25A

Features

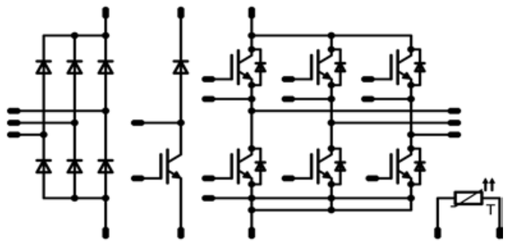
- Solderless interconnection
- Trench Fieldstop IGBT4 technology

MiniSKiiP® 2 housing

Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K229-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℃ Tc=80℃	40 40	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=150℃	270	A
I^2t-value	I^2t			360	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	T_h=80℃ Tc=80℃	56 85	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℃ Tc=80℃	33 40	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j$max		75	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j$max	T_h=80℃ Tc=80℃	89 135	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					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	T_j=$T_j$max	T_h=80℃ Tc=80℃	25 32	A
Repetitive peak forward current	I_{FRM}	t_p=10ms half sine		160	A
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80℃ Tc=80℃	62 95	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

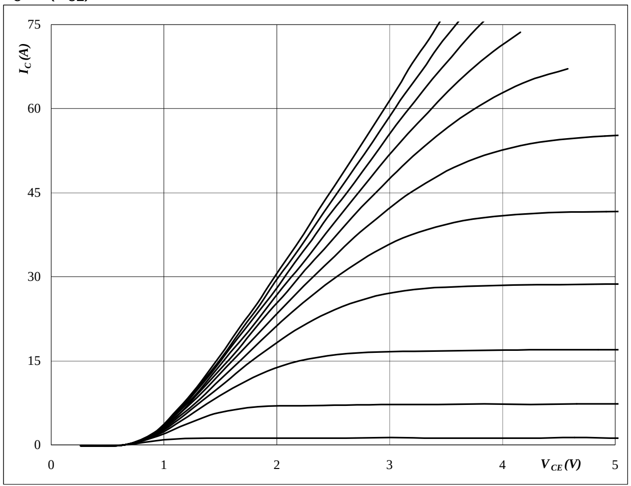
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Min	Typ	Max	
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				25	Tj=25℃ Tj=125℃	0,8	1,08 1,03	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}					Tj=25℃ Tj=125℃		0,9 0,78		V
Slope resistance (for power loss calc. only)	r_t					Tj=25℃ Tj=125℃		18 21		mΩ
Reverse current	I_r			1500		Tj=25℃ Tj=125℃			0,01 1,1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK						1,25		K/W
T1,T2,T3,T4,T5,T6,T7										
Gate emitter threshold voltage	$V_{GE(th)}$	V_{CE}=V_{GE}			0,00085	Tj=25℃ Tj=150℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		25	Tj=25℃ Tj=150℃	1,35	1,88 2,2	2,15	V
Collector-emitter cut-off current incl. diode	I_{CES}		0	1200		Tj=25℃ Tj=150℃			0,05	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=150℃			300	nA
Integrated Gate resistor	R_{gint}							-		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=32Ω Rgon=32Ω	±15	600	25	Tj=25℃ Tj=150℃		112 113		ns
Rise time	t_r					Tj=25℃ Tj=150℃		29,3 34,7		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=150℃		231 303		
Fall time	t_f					Tj=25℃ Tj=150℃		91 137		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=150℃		1,87 2,77		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=150℃		1,49 2,43		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		1430		pF
Output capacitance	C_{oss}							115		
Reverse transfer capacitance	C_{rss}							85		
Gate charge	Q_{Gate}	Vcc=960V	15		40	Tj=25℃		120		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK						1,2		K/W
D1,D2,D3,D4,D5,D6,D7										
Diode forward voltage	V_F				25	Tj=25℃ Tj=150℃	1,5	2,47 2,49	2,75	V
Peak reverse recovery current	I_{RRM}	Rgon=32Ω	±15	600	25	Tj=25℃ Tj=150℃		13,5 18,3		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=150℃		319 544		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=150℃		1,48 3,69		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=150℃		174 64		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=150℃		0,52 1,44		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK						1,52		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

$I_C = f(V_{CE})$



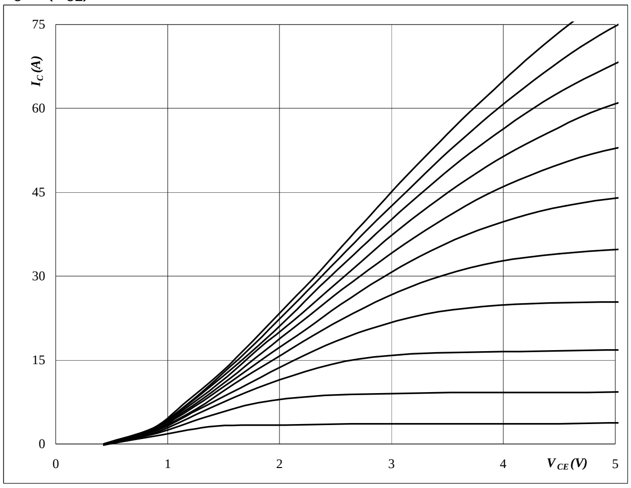
At

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

$I_C = f(V_{CE})$



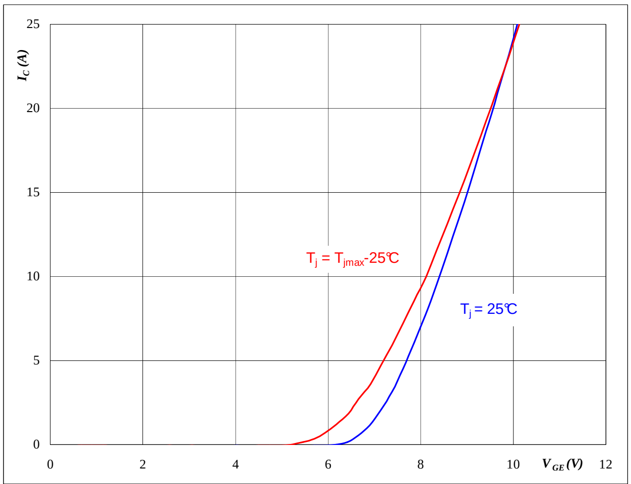
At

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

$I_C = f(V_{GE})$



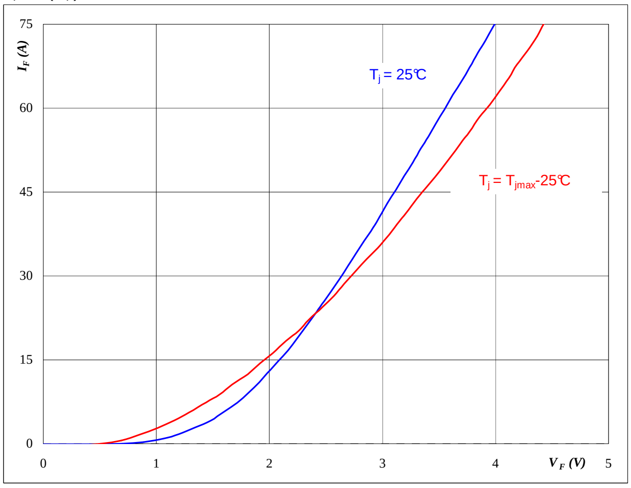
At

t_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

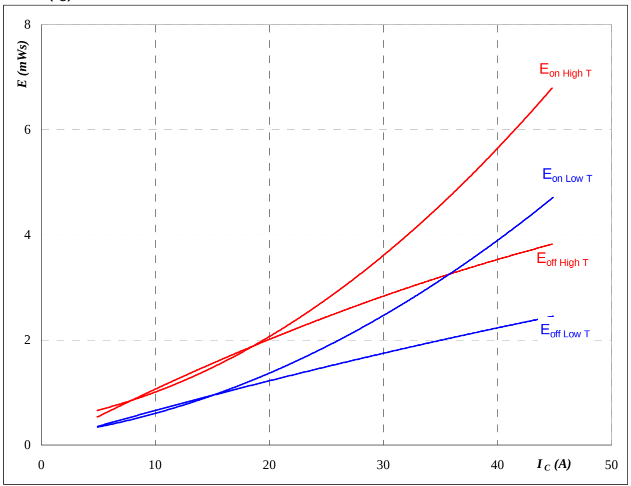
t_p =	250	μs

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

$E = f(I_C)$



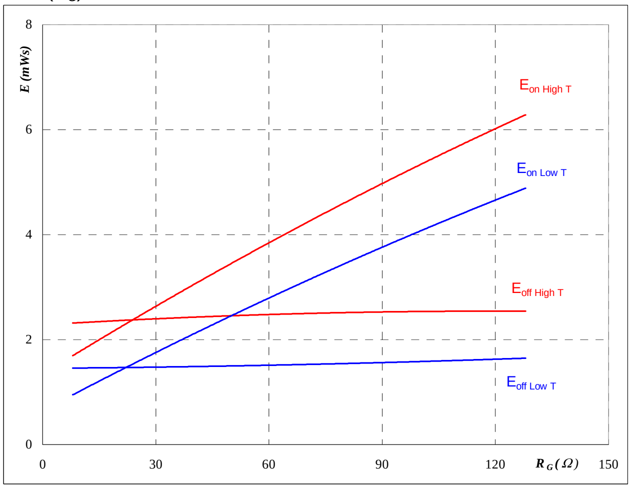
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	Ω
R_{goff} =	32	Ω

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

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



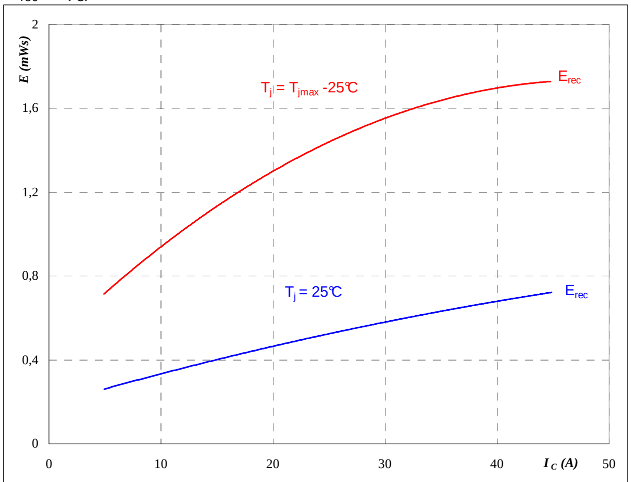
With an inductive load at

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

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

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



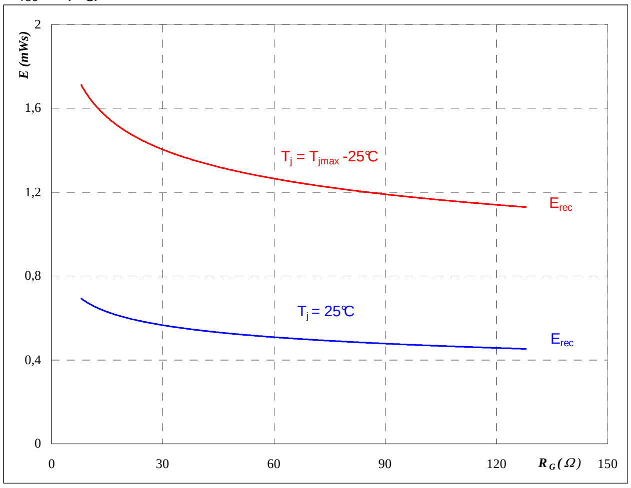
With an inductive load at

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	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

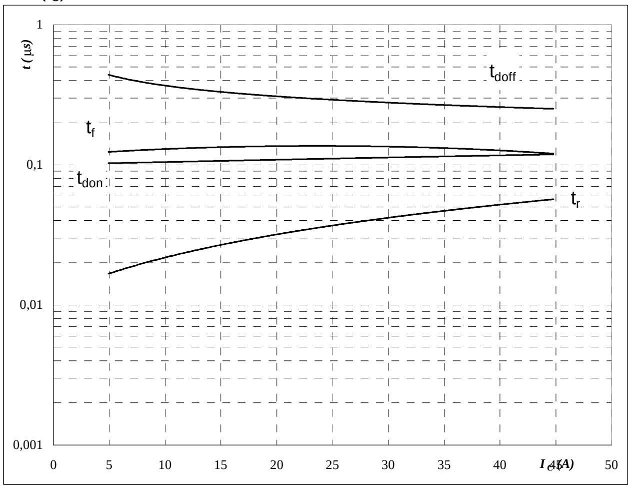
T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	A

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)



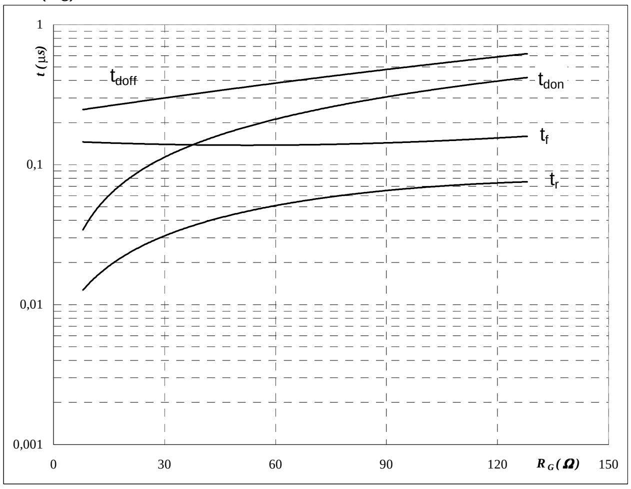
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	Ω
R_{goff} =	32	Ω

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

Typical switching times as a function of gate resistor

t = f(R_G)



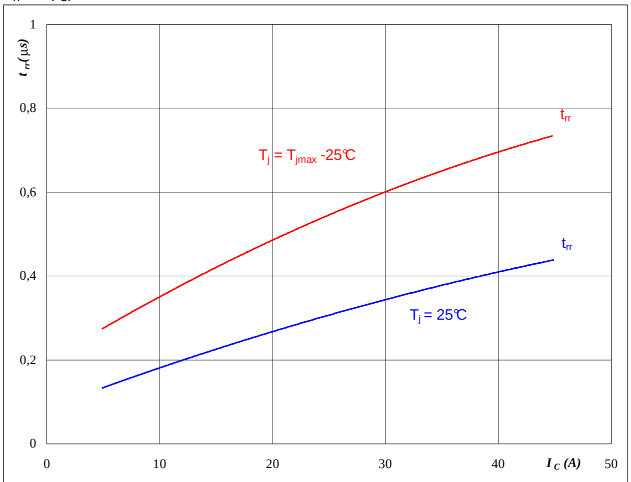
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	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)



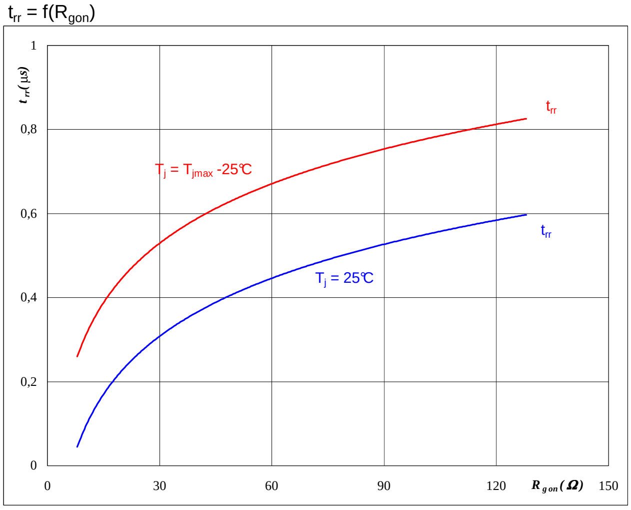
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	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

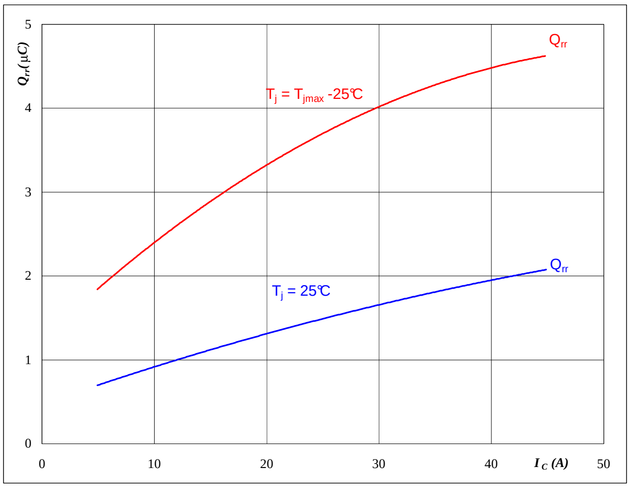
T_j =	25/150	°C
V_R =	600	V
I_F =	25	A
V_{GE} =	±15	V

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

$Q_{rr} = f(I_C)$



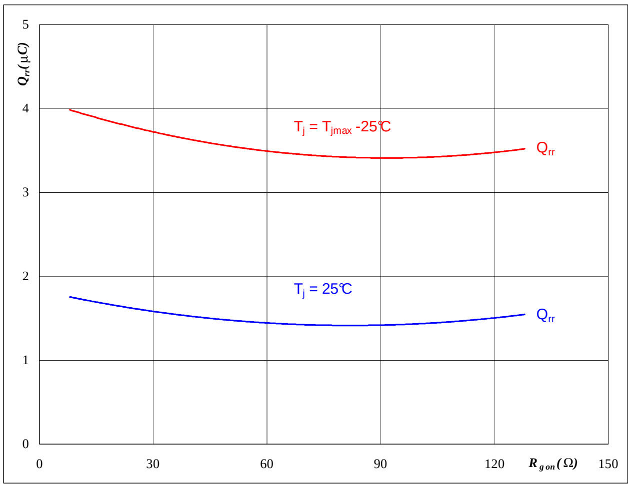
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	Ω

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

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

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



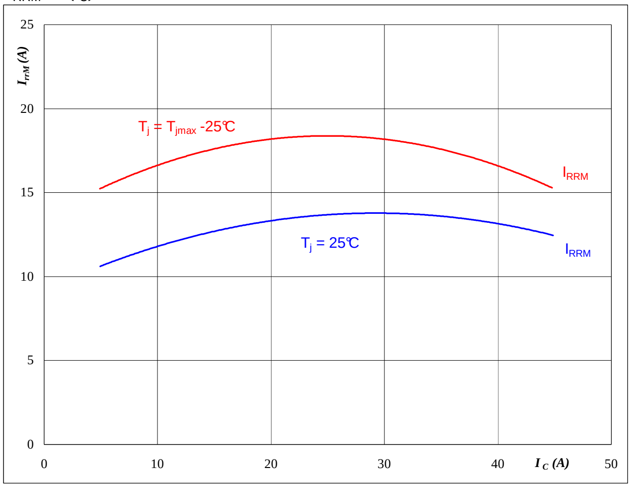
At

T_j =	25/150	°C
V_R =	600	V
I_F =	25	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

$I_{RRM} = f(I_C)$



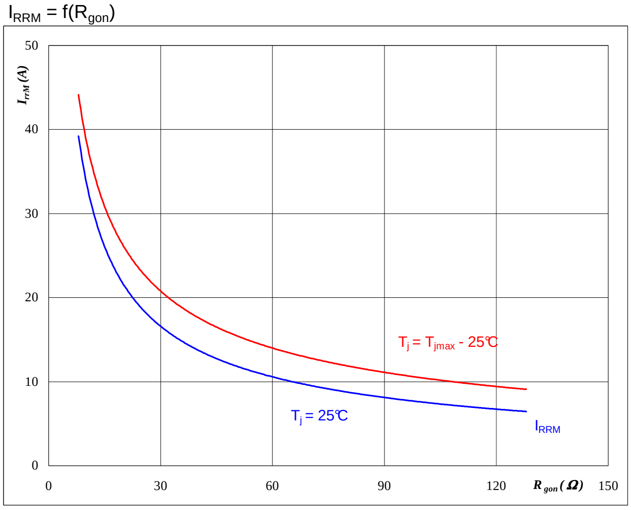
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	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

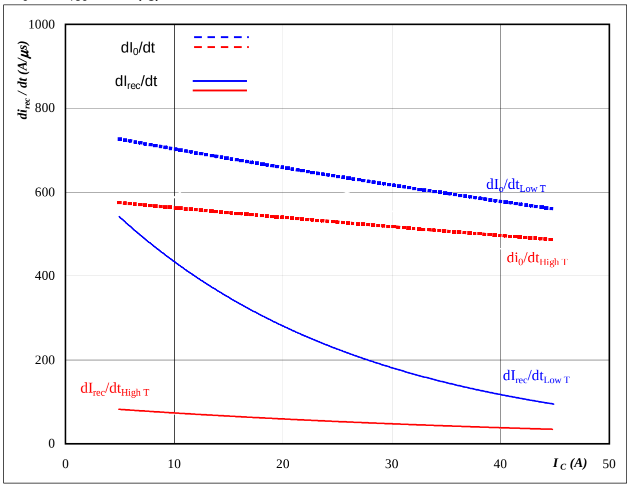
T_j =	25/150	°C
V_R =	600	V
I_F =	25	A
V_{GE} =	±15	V

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

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



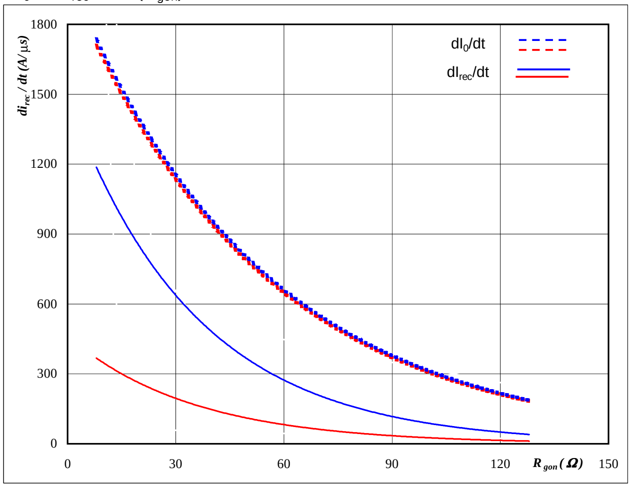
At

T_j =	25/150	℃
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	32	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

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



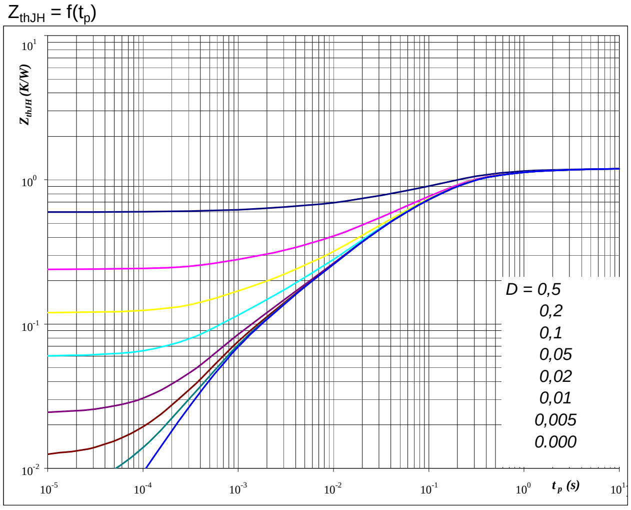
At

T_j =	25/150	℃
V_R =	600	V
I_F =	25	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} =	1,20	K/W

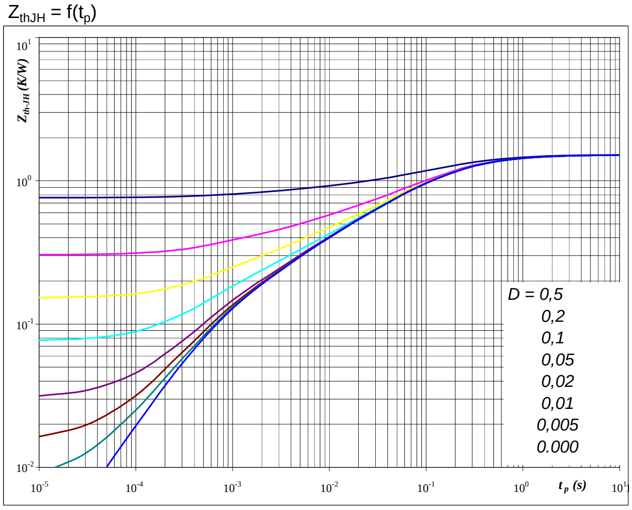
IGBT thermal model values

R (C/W)	Tau (s)
0,03	5,7E+00
0,14	8,1E-01
0,51	1,6E-01
0,27	4,9E-02
0,17	1,0E-02
0,07	9,8E-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} =	1,52	K/W

FWD thermal model values

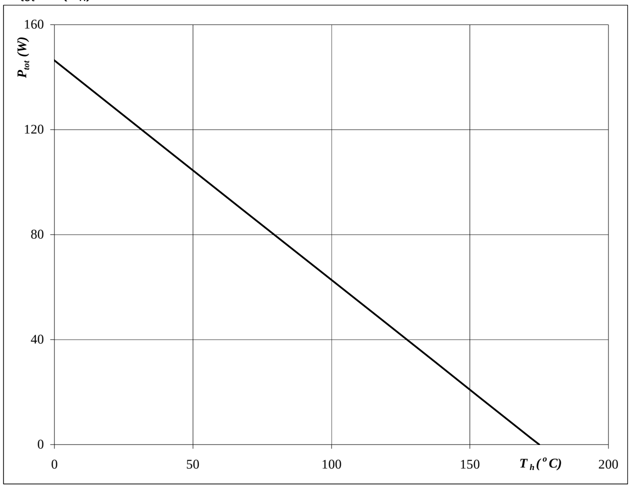
R (C/W)	Tau (s)
0,03	9,3E+00
0,22	7,6E-01
0,63	1,5E-01
0,37	3,0E-02
0,17	4,4E-03
0,10	6,5E-04

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

$P_{tot} = f(T_h)$



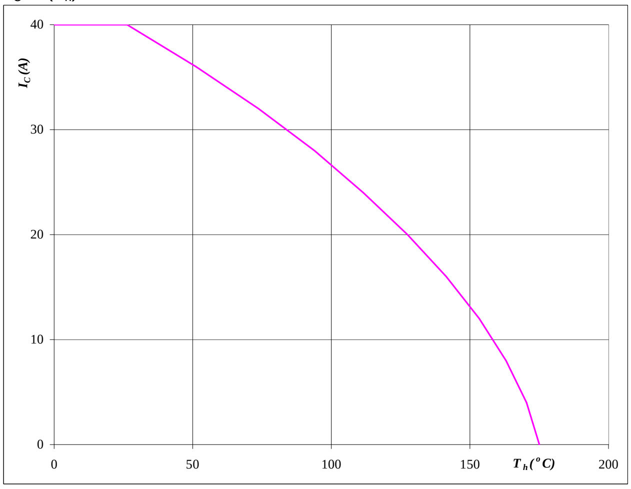
At

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

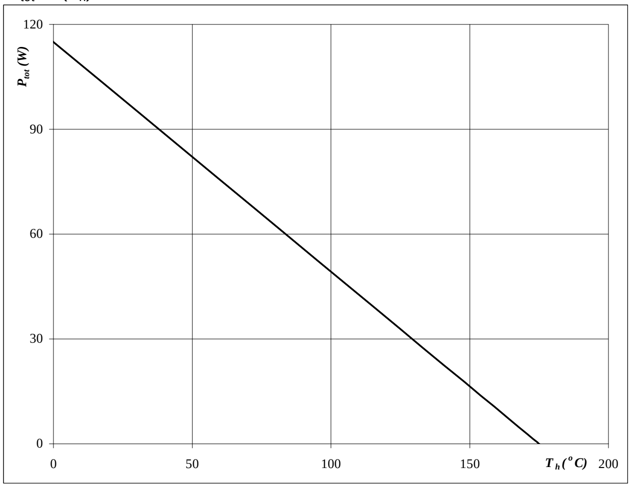
T_j = 175 ℃

V_{GE} = 15 V

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



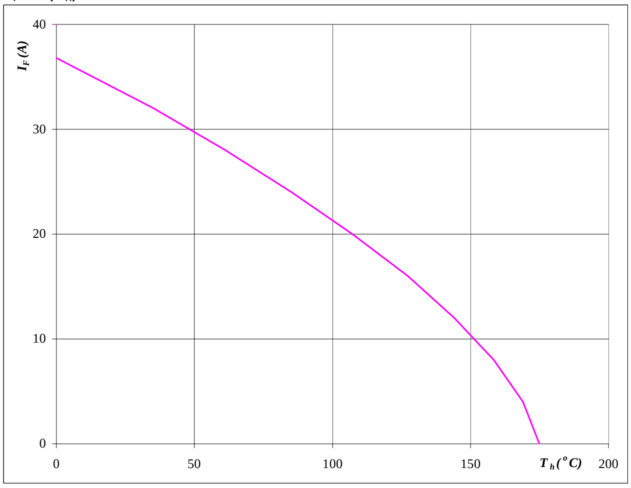
At

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

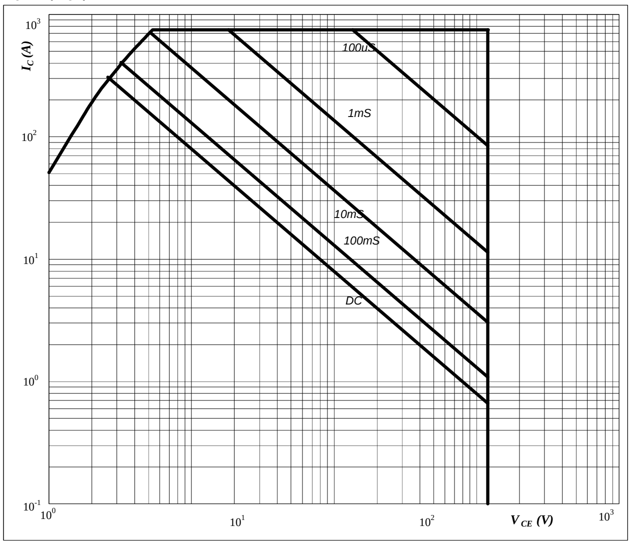
T_j = 175 ℃

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

$I_C = f(V_{CE})$



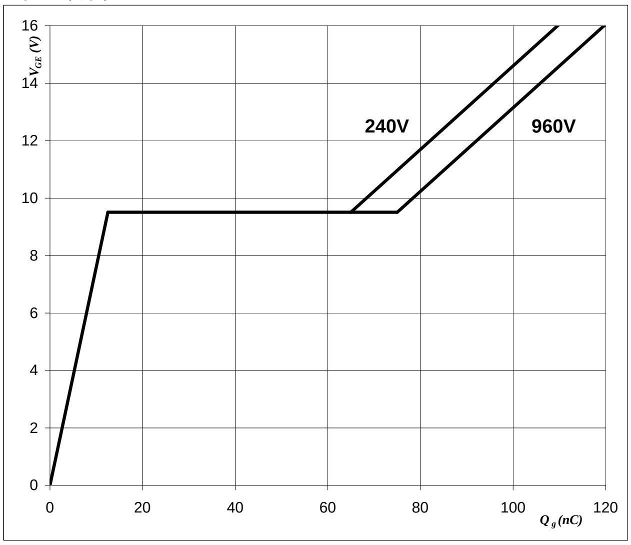
At

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

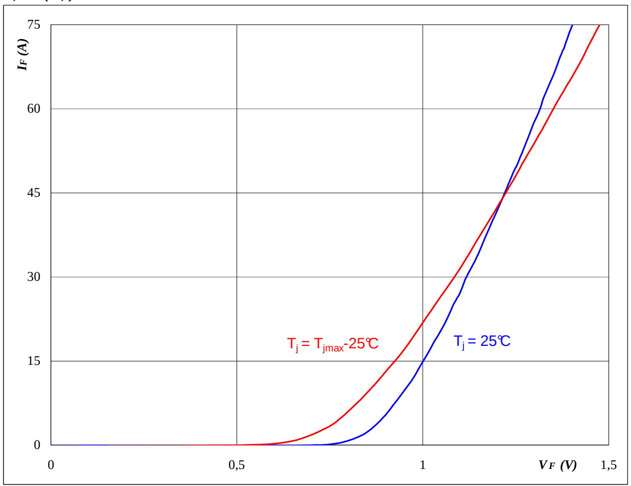
I_C =	25	A

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

$I_F = f(V_F)$



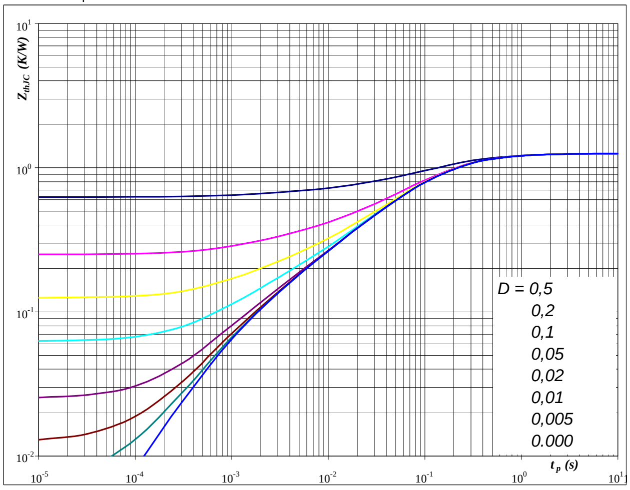
At

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

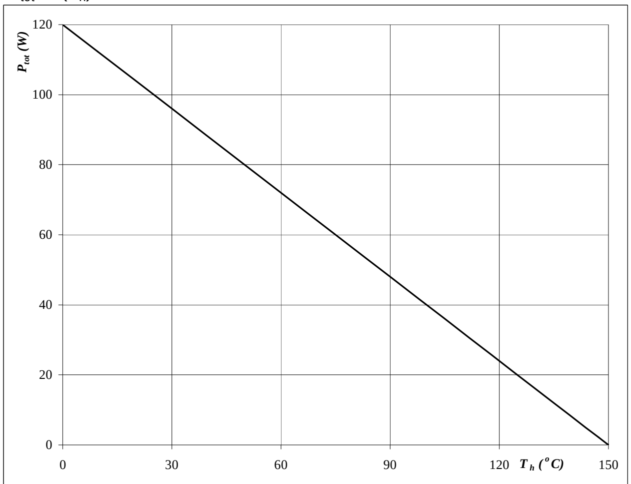
D = t_p / T

R_{thJH} = 1,250 K/W

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



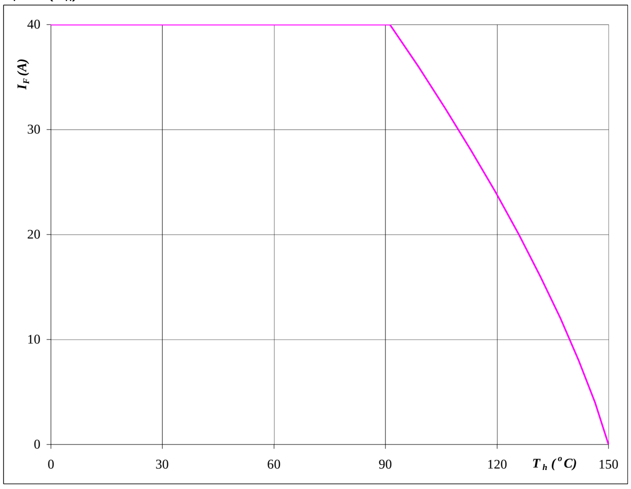
At

T_j = 150 ºC

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

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



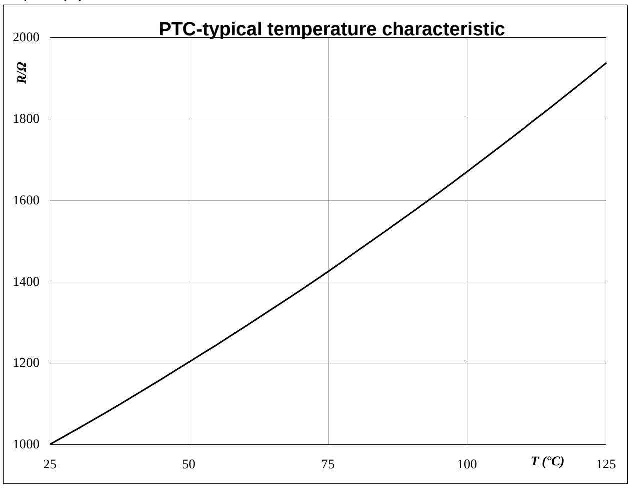
At

T_j = 150 ºC

Thermistor

Figure 1 Thermistor

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



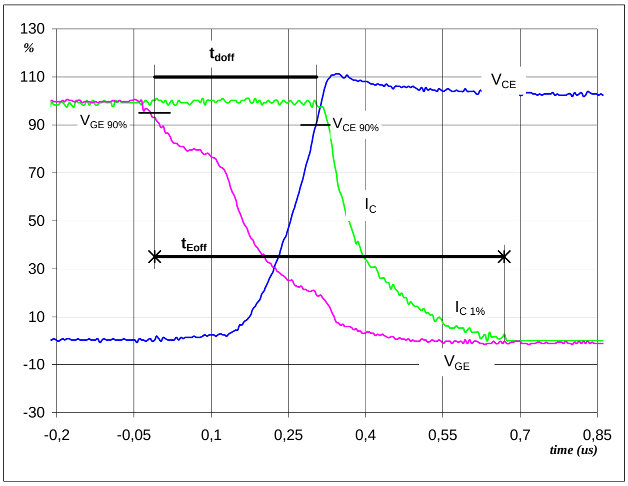
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	32 Ω
R_{goff}	=	32 Ω

Figure 1 Output inverter IGBT

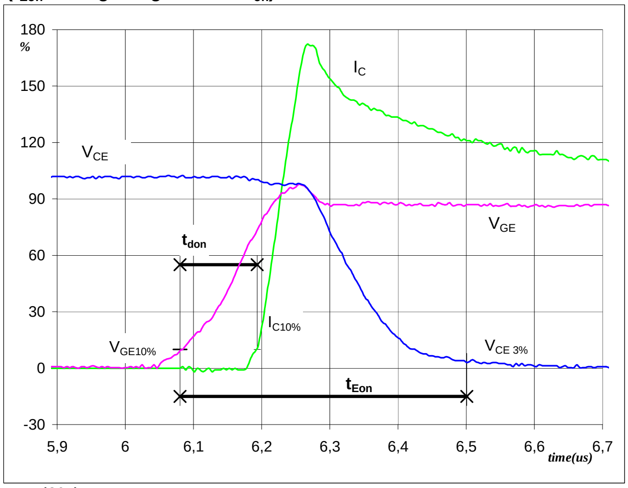
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	25	A
t_{doff} =	0,30	μs
t_{Eoff} =	0,68	μs

Figure 2 Output inverter IGBT

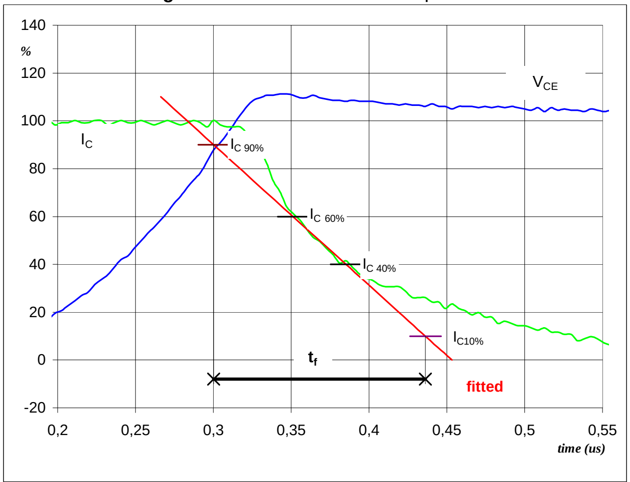
Turn-on Switching Waveforms & definition of tdon, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	25	A
t_{don} =	0,11	μs
t_{Eon} =	0,42	μs

Figure 3 Output inverter IGBT

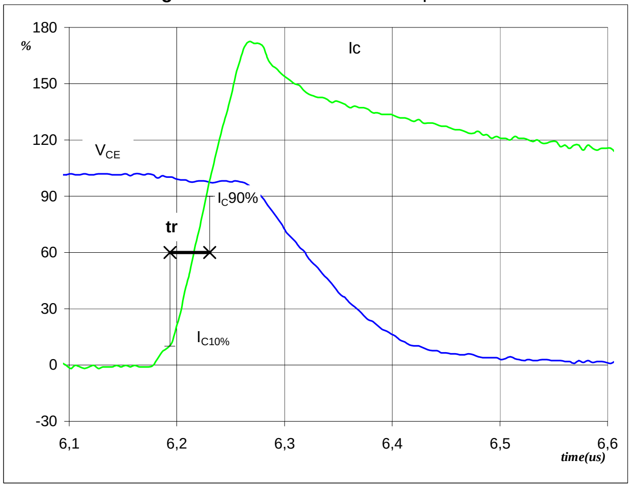
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	25	A
t_f =	0,14	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

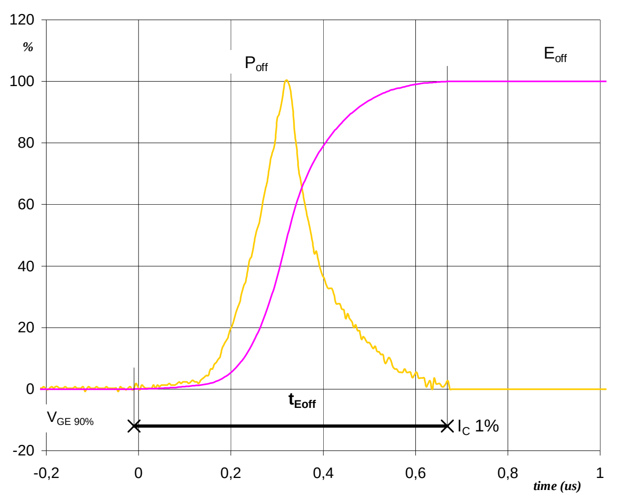


V_C (100%) =	600	V
I_C (100%) =	25	A
t_r =	0,03	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

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



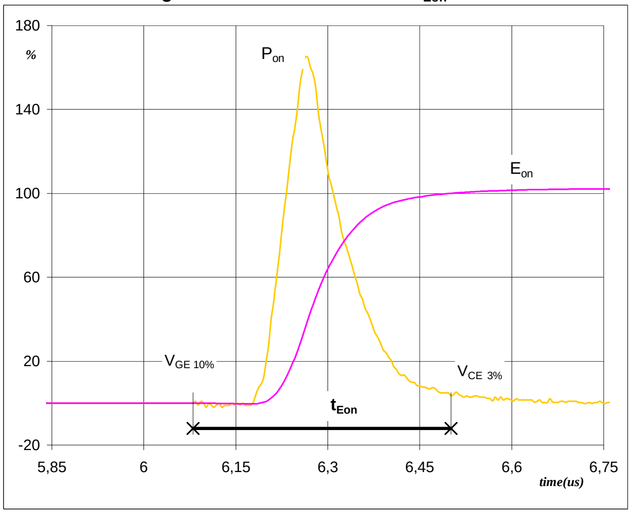
P_{off} (100%) = 14,95 kW

E_{off} (100%) = 2,43 mJ

t_{Eoff} = 0,68 µs

Figure 6 Output inverter IGBT

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



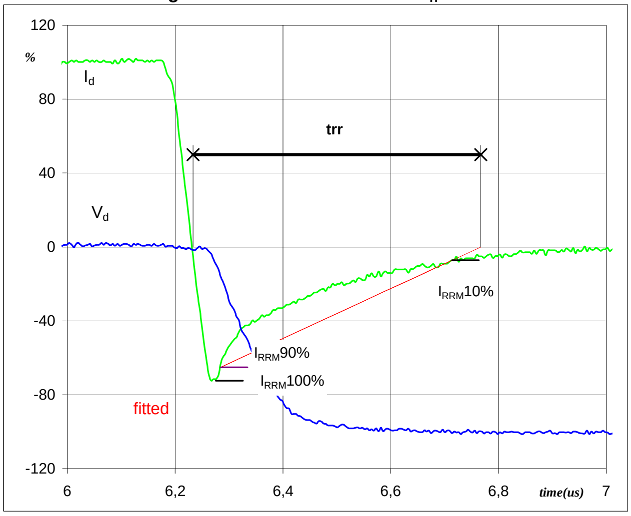
P_{on} (100%) = 14,95 kW

E_{on} (100%) = 2,77 mJ

t_{Eon} = 0,42 µs

Figure 7 Output inverter FWD

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



V_d (100%) = 600 V

I_d (100%) = 25 A

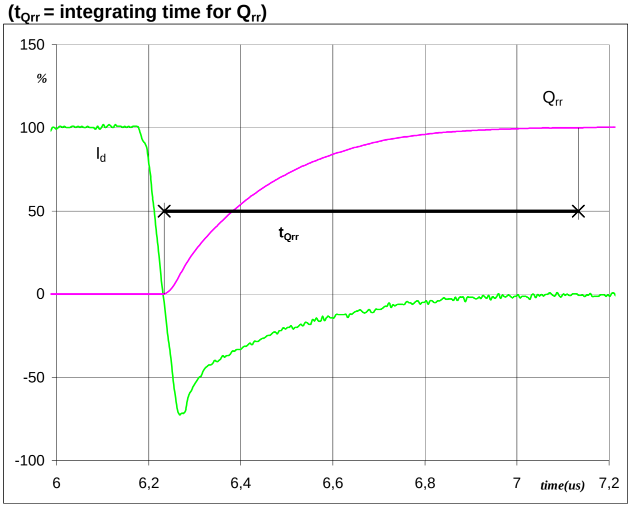
I_{RRM} (100%) = 18 A

t_{rr} = 0,54 µs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

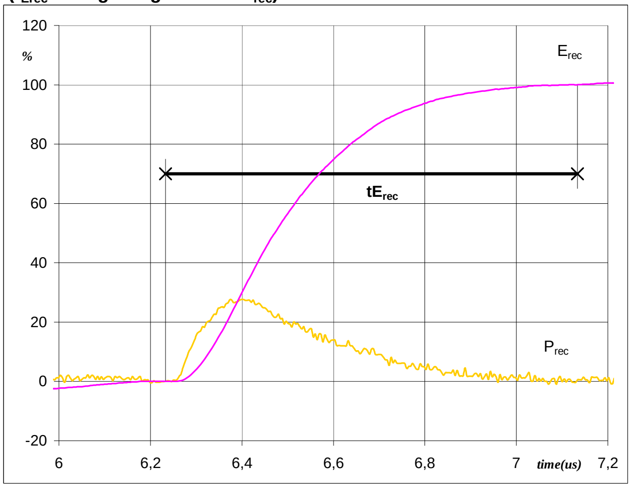
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	25	A
Q_{rr} (100%) =	3,69	μC
t_{Qrr} =	0,90	μs

Figure 9 Output inverter FWD

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



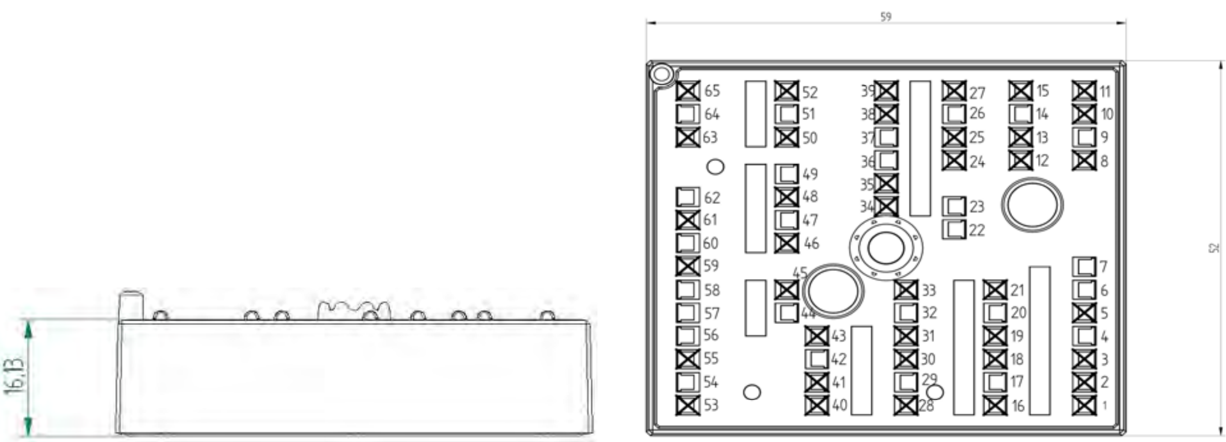
P_{rec} (100%) =	14,95	kW
E_{rec} (100%) =	1,44	mJ
t_{Erec} =	0,90	μs

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-K229-A40-/0A/-PM	K229A40	K229A40-/0A/
with std lid (black V23990-K12-T-PM) and P12	V23990-K229-A40-/1A/-PM	K229A40	K229A40-/1A/
with thin lid (white V23990-K13-T-PM)	V23990-K229-A40-/0B/-PM	K229A40	K229A40-/0B/
with thin lid (white V23990-K13-T-PM) and P12	V23990-K229-A40-/1B/-PM	K229A40	K229A40-/1B/

Outline



X = assembled pin position

Pinout