Vincotech

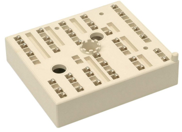
V23990-K220-A-PM

MiniSKiiP® 2 PIM — 1200 V / 35 A

Features

- Solderless interconnection
- Trench Fieldstop technology

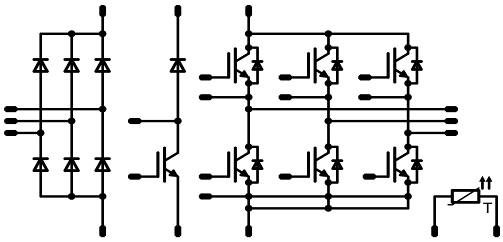
MiniSKiiP® 2 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K220-A-PM

Maximum Ratings

T_j=25°C, 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°C	40	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25°C	370	A
I2t-value	I^2t			680	A^2s
Power dissipation	P_{tot}	$T_j=T_j max$	T_h=80°C	56	W
Maximum Junction Temperature	T_{jmax}			150	°C
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°C	41	A
Pulsed collector current	I_{Cpulse}	t_p limited by $T_j$max		105	A
Turn off safe operating area		VCE ≤ 1200V, Tj ≤ Top max		105	A
Power dissipation	P_{tot}	$T_j=T_j max$	T_h=80°C	93	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150°C V_{GE}=15V		10 <1200	μs V
Maximum Junction Temperature	T_{jmax}			150	°C

Maximum Ratings

T_j=25°C, 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	$T_j=T_jmax$	T_h=80°C	27	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_jmax		200	A
Power dissipation	P_{tot}	$T_j=T_jmax$	T_h=80°C	47	W
Maximum Junction Temperature	T_{jmax}			150	°C
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+125	°C
Insulation Properties					
Insulation voltage	V_{is}	t=2s	DC voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative tracking index	CTI			>200	

Characteristic Values

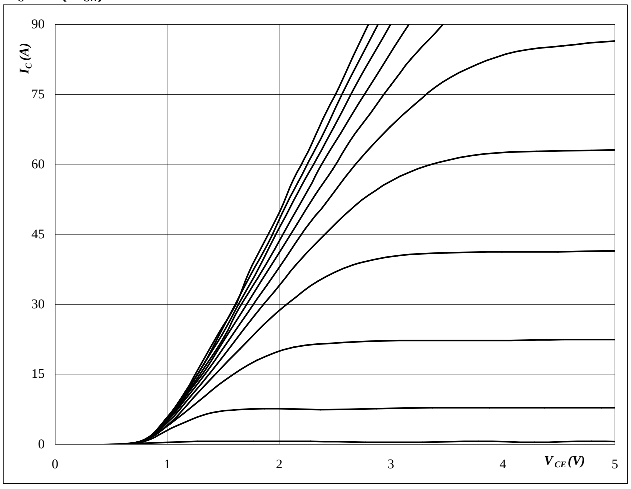
Parameter	Symbol	Conditions	V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Value Min	Value Typ	Value Max	Unit
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				25	Tj=25°C Tj=125°C	1,09 1,05	1,19 1,14	1,31 1,26	V
Threshold voltage (for power loss calc. only)	V_{to}				25	Tj=25°C Tj=125°C	0,82 0,71	0,9 0,77	0,96 0,83	V
Slope resistance (for power loss calc. only)	r_t				25	Tj=25°C Tj=125°C	9 10	13 15	17 20	mΩ
Reverse current	I_r			1600		Tj=25°C Tj=125°C			0,1	mA
Thermal resistance chip to heatsink	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1,25		K/W
T1,T2,T3,T4,T5,T6,T7										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0015	Tj=25°C Tj=125°C	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		35	Tj=25°C Tj=125°C		1,75 1,95		V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		Tj=25°C Tj=125°C			0,4 4	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25°C Tj=125°C			600	nA
Integrated Gate resistor	R_{gint}							6		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=28 Ω Rgon=28 Ω	±15	600	35	Tj=25°C Tj=125°C		80		ns
Rise time	t_r					Tj=25°C Tj=125°C		29		
Turn-off delay time	$t_{d(off)}$					Tj=25°C Tj=125°C		486		
Fall time	t_f					Tj=25°C Tj=125°C		188		
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		4,98		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		3,57		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25°C		2500		pF
Output capacitance	C_{oss}							130		
Reverse transfer capacitance	C_{rss}							110		
Gate charge	Q_G		±15			Tj=25°C		203		nC
Thermal resistance chip to heatsink	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,75		K/W
D1,D2,D3,D4,D5,D6,D7										
Diode forward voltage	V_F				28	Tj=25°C Tj=125°C		1,48 1,5		V
Peak reverse recovery current	I_{RRM}	Rgon=28 Ω	±15	600	35	Tj=25°C Tj=125°C		34		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		715		ns
Reverse recovered charge	Q_{rr}					Tj=25°C Tj=125°C		9,12		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25°C Tj=125°C		204		A/µs
Reverse recovered energy	E_{rec}					Tj=25°C Tj=125°C		3,66		mWs
Thermal resistance chip to heatsink	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1,5		K/W
Thermistor										
Rated resistance	R					T=25°C		1000		Ω
Deviation of R100	ΔR/R	R100=1670 Ω				T=100°C	-3		3	%
R100	R					T=100°C		1670,31		Ω
Power dissipation constant						T=25°C				mW/K
A-value	B(25/50)					T=25°C		$7,635*10^{-3}$		1/K
B-value	B(25/100)					T=25°C		$1,731*10^{-5}$		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

$I_C = f(V_{CE})$



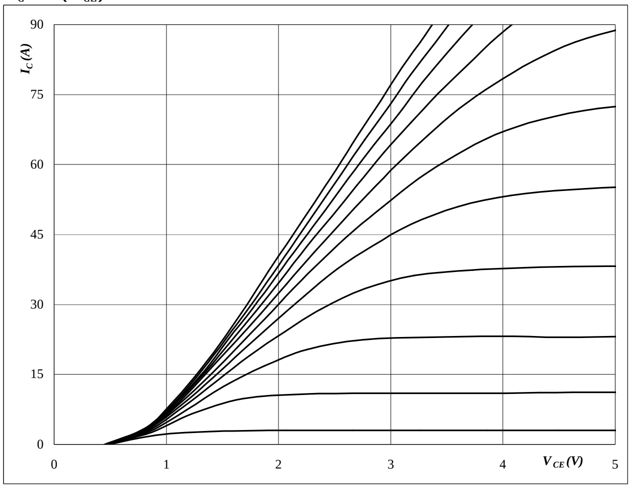
At

t_p =	250	µs
T_j =	25	°C
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

$I_C = f(V_{CE})$



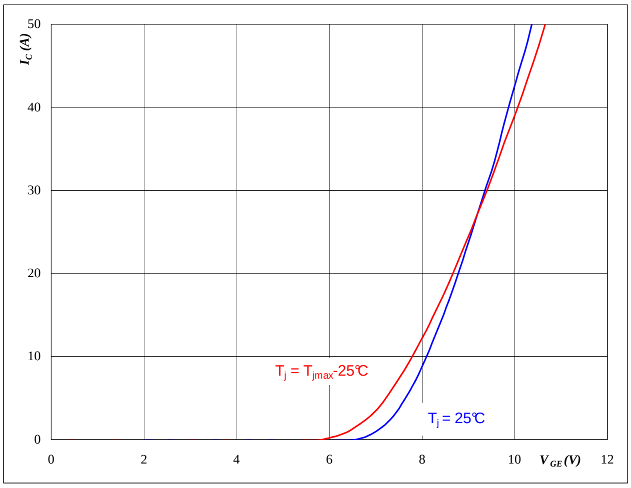
At

t_p =	250	µs
T_j =	125	°C
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

$I_C = f(V_{GE})$



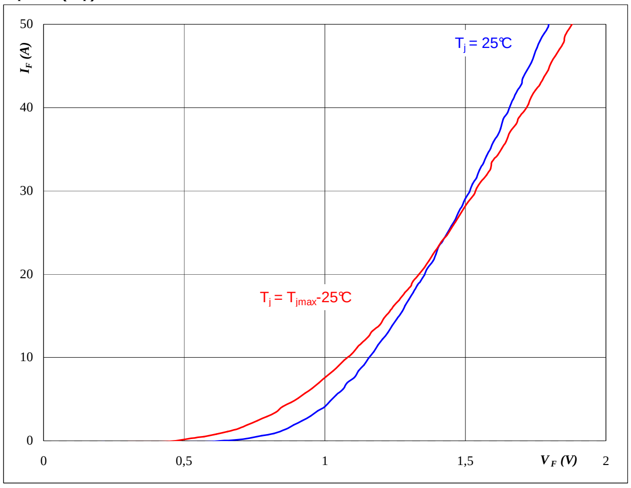
At

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

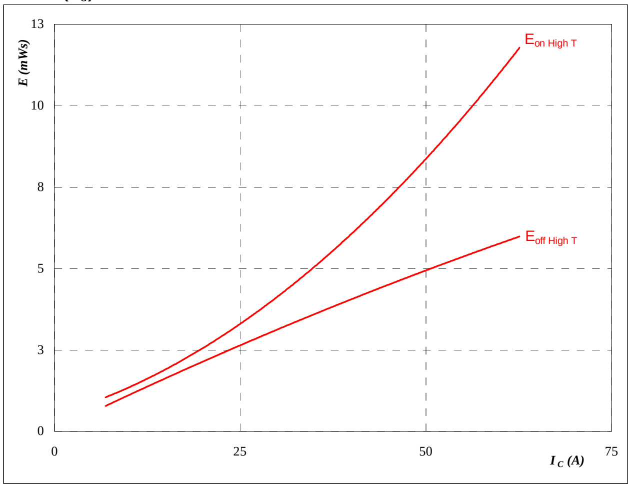
t_p =	250	µs

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

$E = f(I_C)$



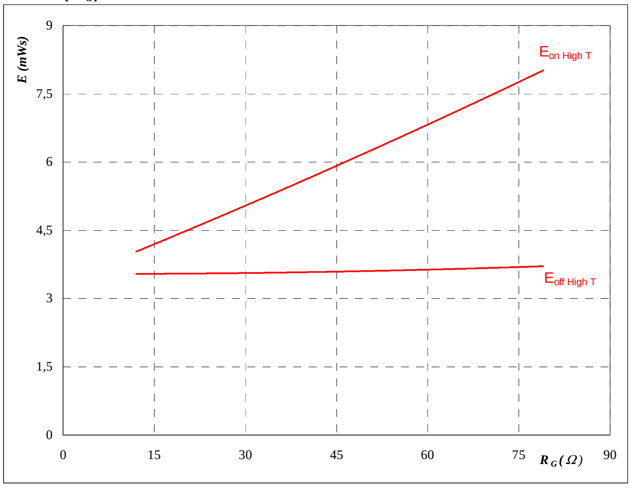
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	Ω
R_{goff} =	28	Ω

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

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



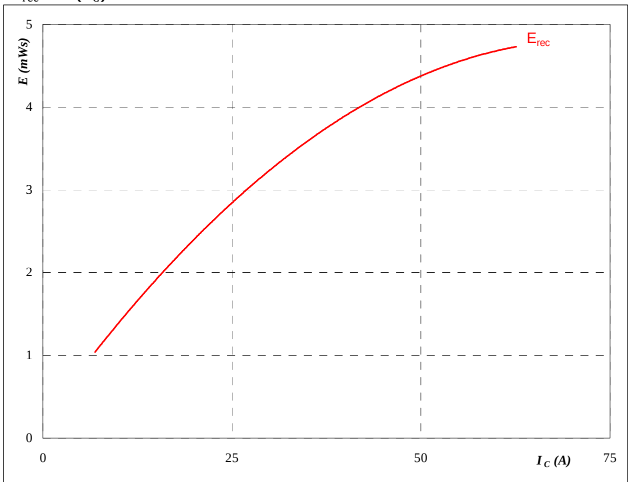
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

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

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



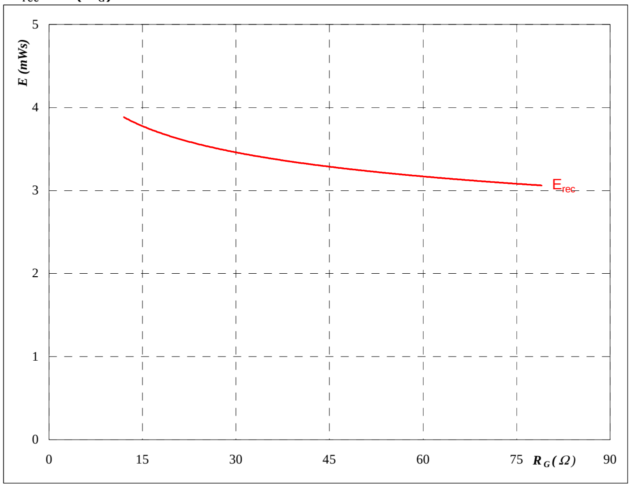
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	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

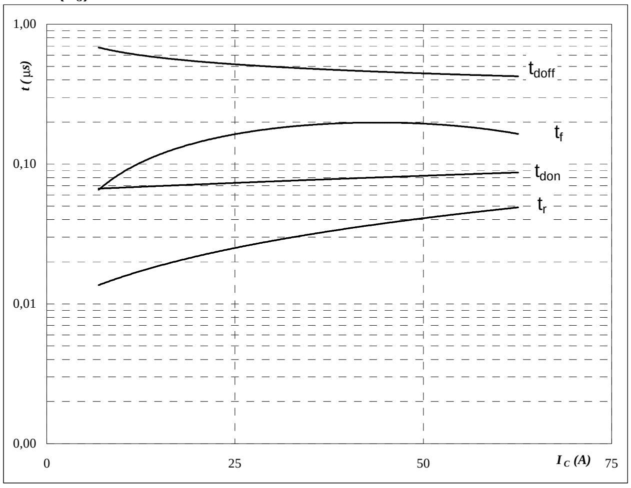
T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

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

$t = f(I_C)$



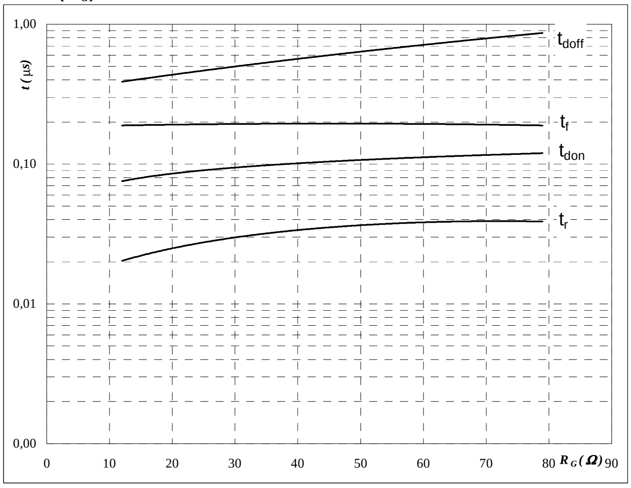
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	Ω
R_{goff} =	28	Ω

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

Typical switching times as a function of gate resistor

$t = f(R_G)$



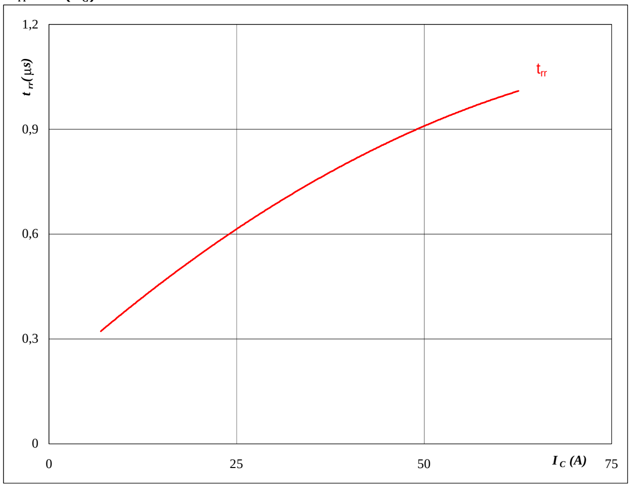
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

Figure 11 Output inverter FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



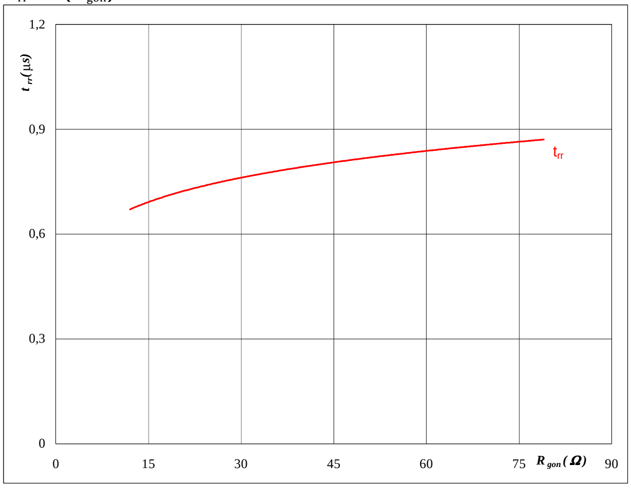
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	Ω

Figure 12 Output inverter FWD

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

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



At

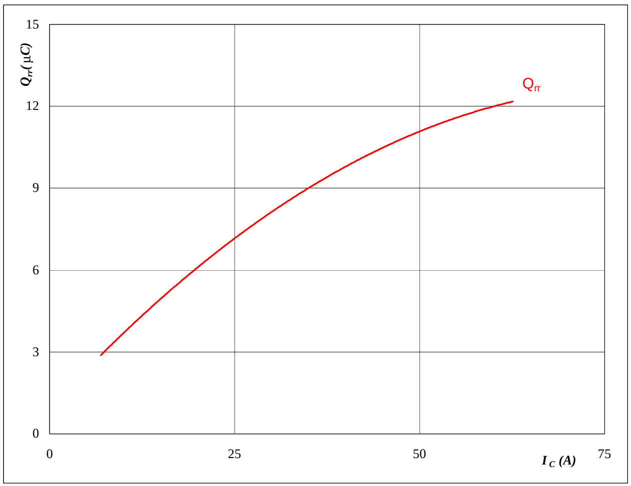
T_j =	125	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

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

$Q_{rr} = f(I_C)$



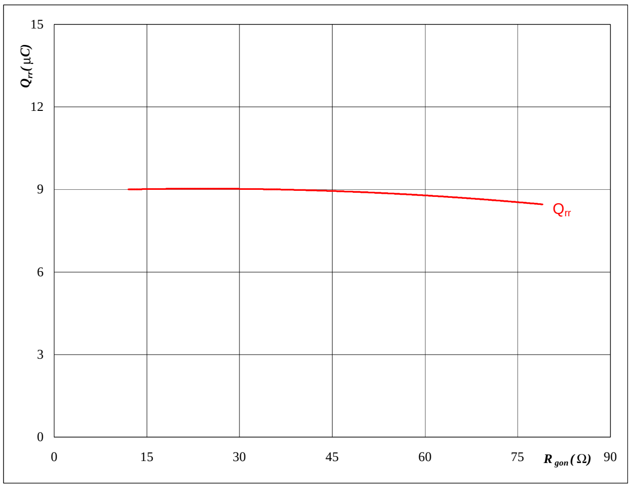
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	Ω

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

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

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



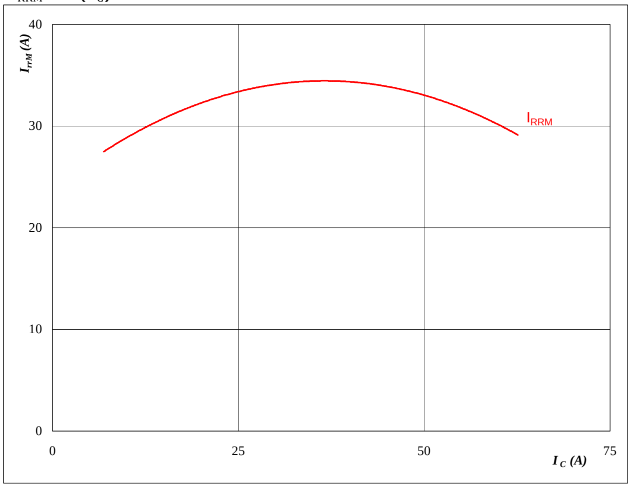
At

T_j =	125	°C
V_R =	600	V
I_F =	35	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

$I_{RRM} = f(I_C)$



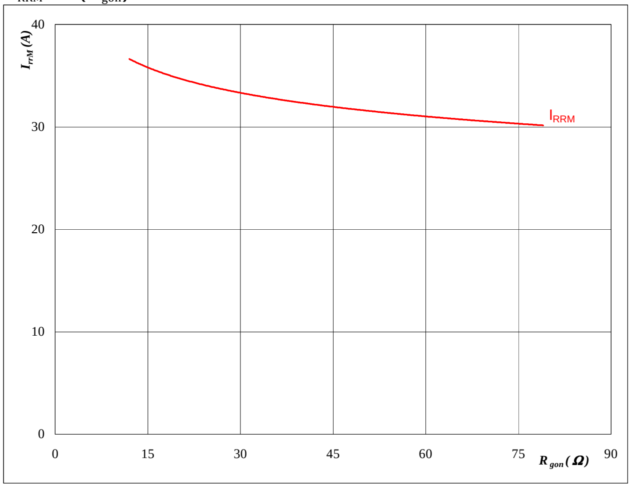
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	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

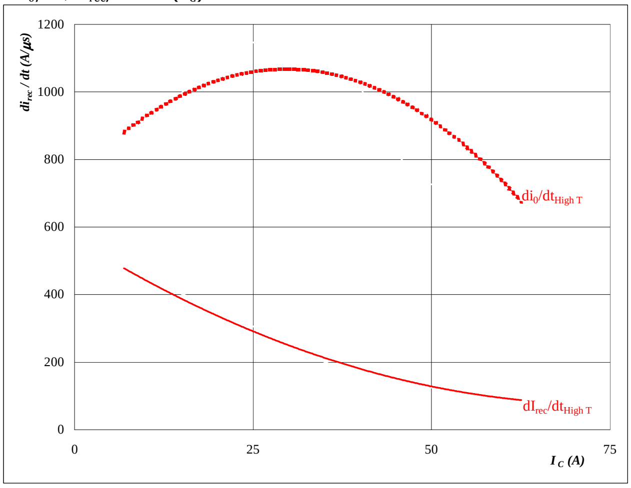
T_j =	125	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

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

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



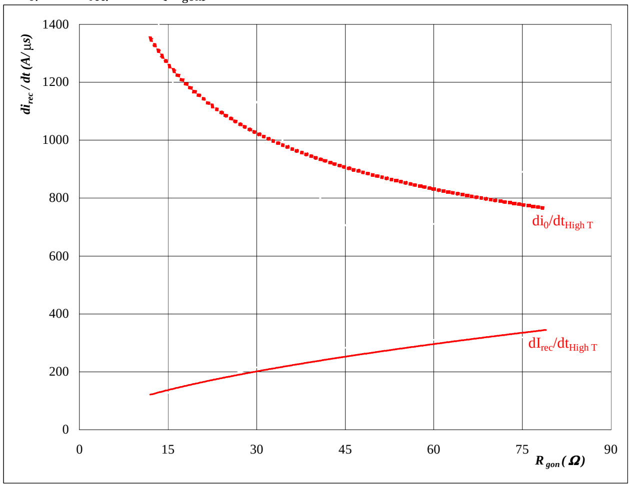
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	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

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



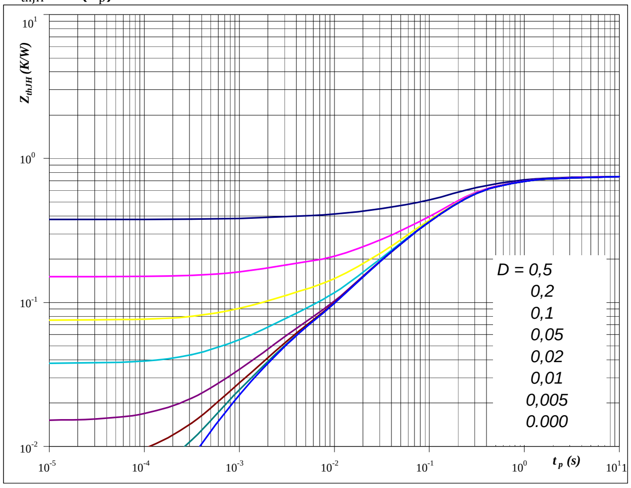
At

T_j =	125	°C
V_R =	600	V
I_F =	35	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} =	0,75	K/W

IGBT thermal model values

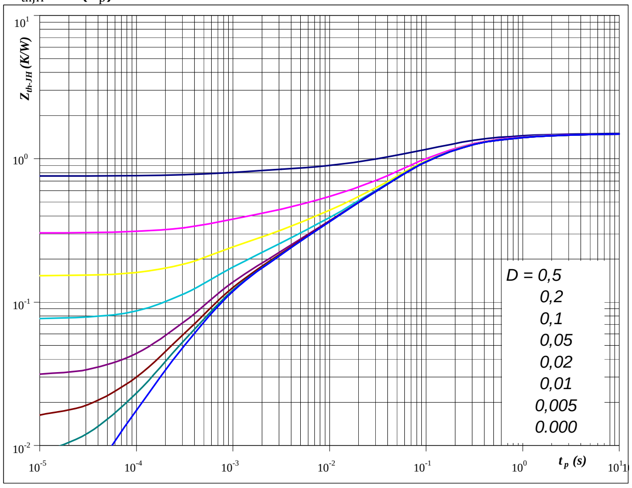
Thermal grease

R (K/W)	Tau (s)
0,04	4,0E+00
0,16	6,0E-01
0,43	1,5E-01
0,09	2,0E-02
0,03	1,5E-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} =	1,50	K/W

FWD thermal model values

Thermal grease

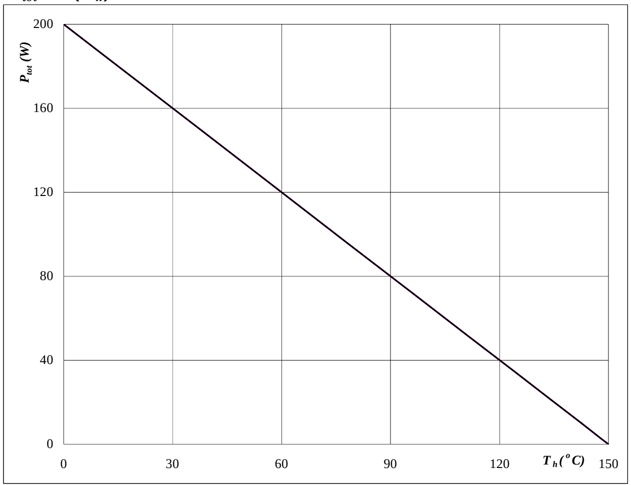
R (K/W)	Tau (s)
0,04	6,4E+01
0,12	1,8E+00
0,44	2,4E-01
0,62	6,3E-02
0,19	7,6E-03
0,12	7,8E-04

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

$P_{tot} = f(T_h)$



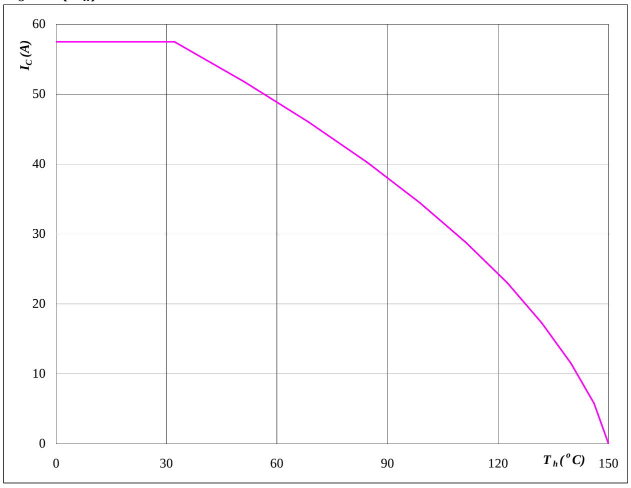
At

T_j = 150 °C

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

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

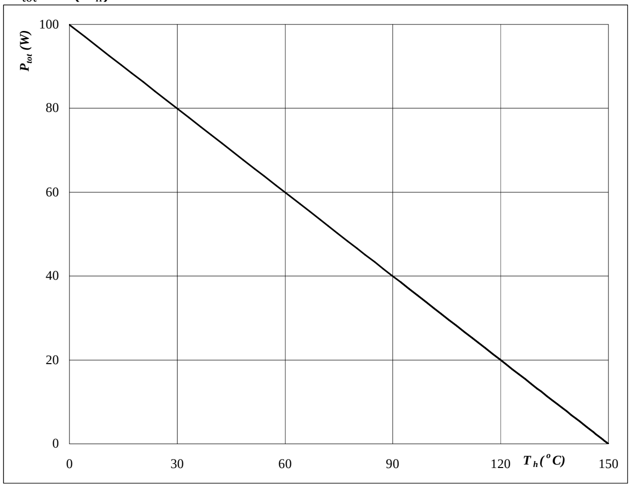
T_j = 150 °C

V_{GE} = 15 V

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



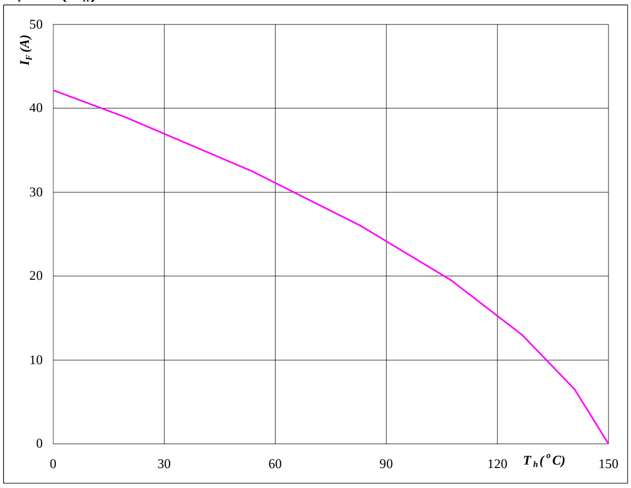
At

T_j = 150 °C

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

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

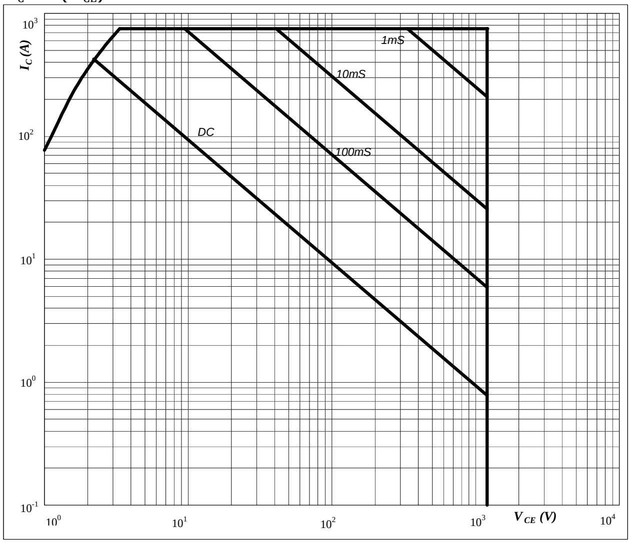
T_j = 150 °C

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

$I_C = f(V_{CE})$



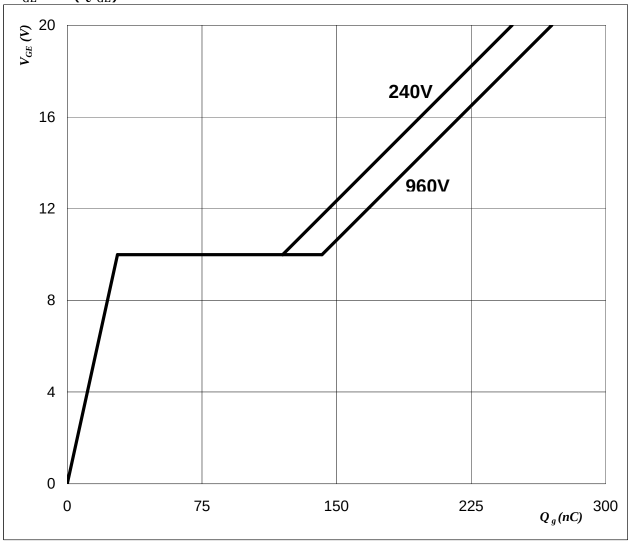
At

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

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



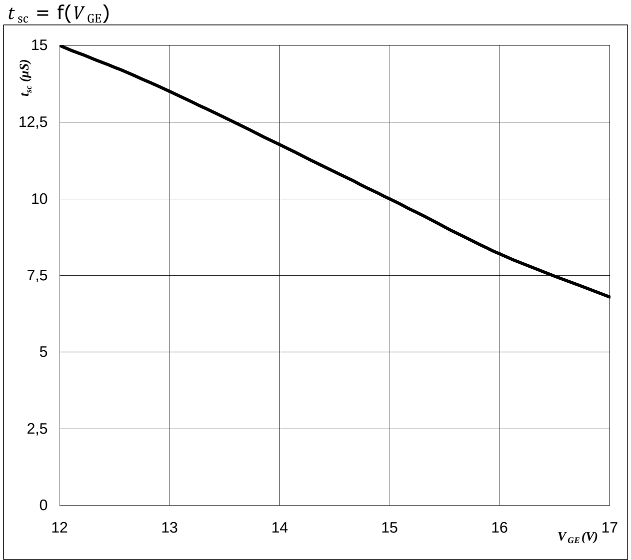
At

I_C =	35	A

Figure 27 T1,T2,T3,T4,T5,T6,T7 IGBT

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

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



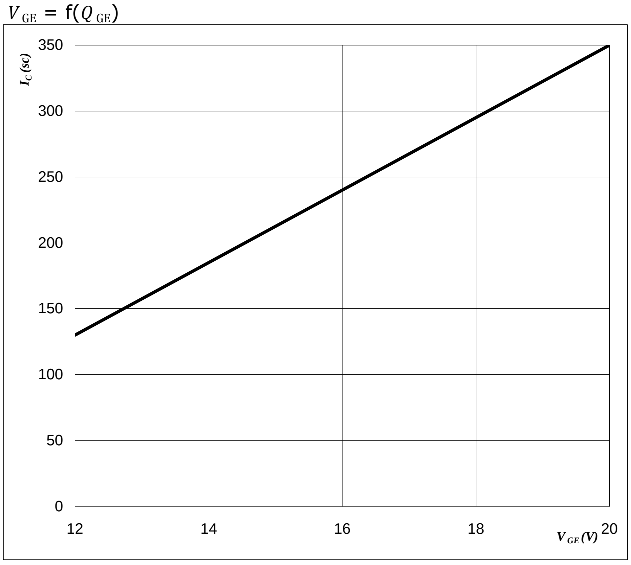
At

V_{CE} =	1200	V
T_j ≤	150	ºC

Figure 28 T1,T2,T3,T4,T5,T6,T7 IGBT

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

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



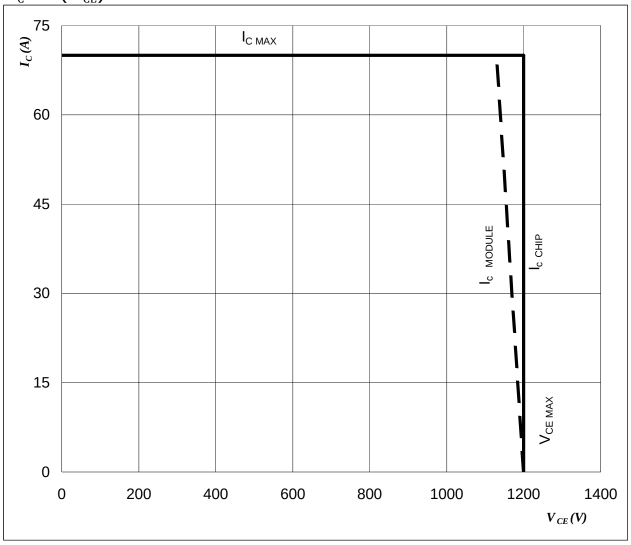
At

V_{CE} ≤	1200	V
T_j =	150	ºC

Figure 29 T1,T2,T3,T4,T5,T6,T7 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j = 125 °C

R_{gon} = 28 Ω

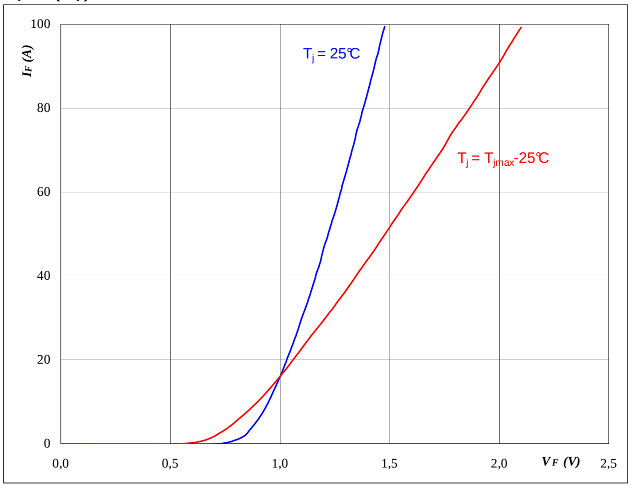
R_{goff} = 28 Ω

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

$I_F = f(V_F)$



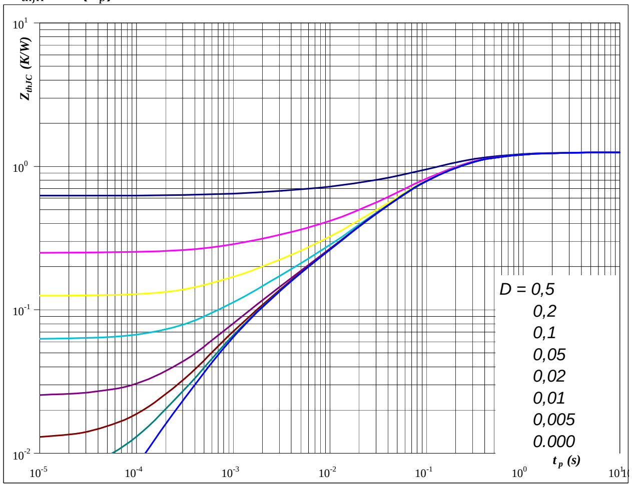
At

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

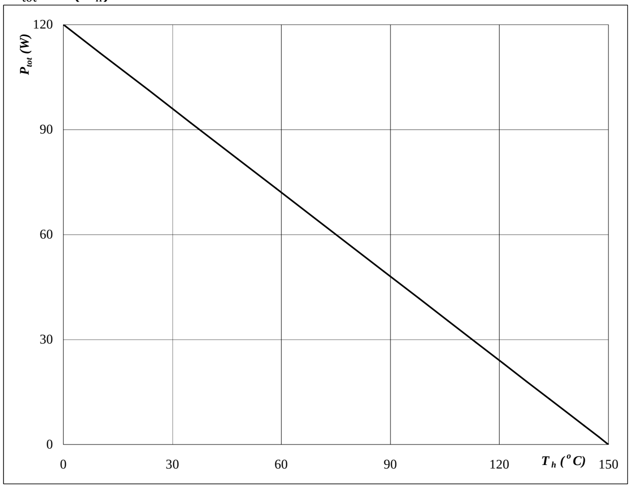
D = tp / T

R_{thJH} = 1,25 K/W

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

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



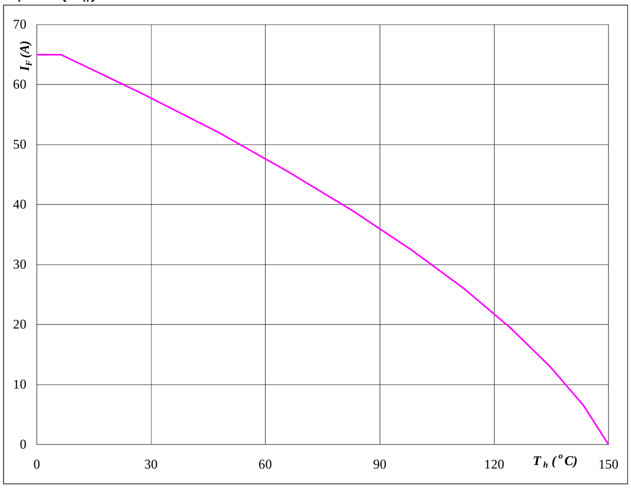
At

T_j = 150 ºC

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

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



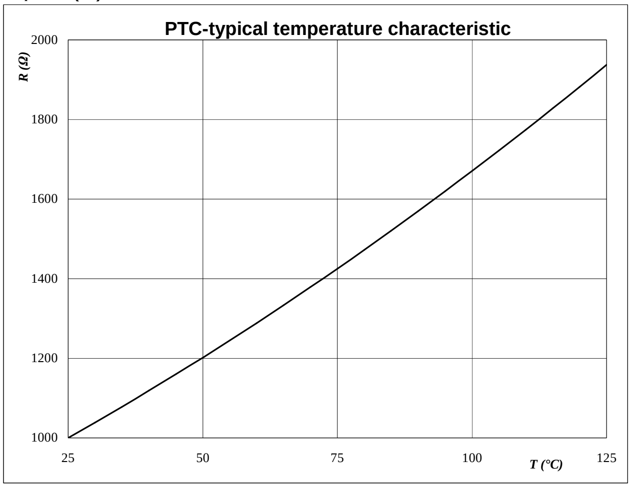
At

T_j = 150 ºC

Thermistor

Figure 1	Thermistor

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



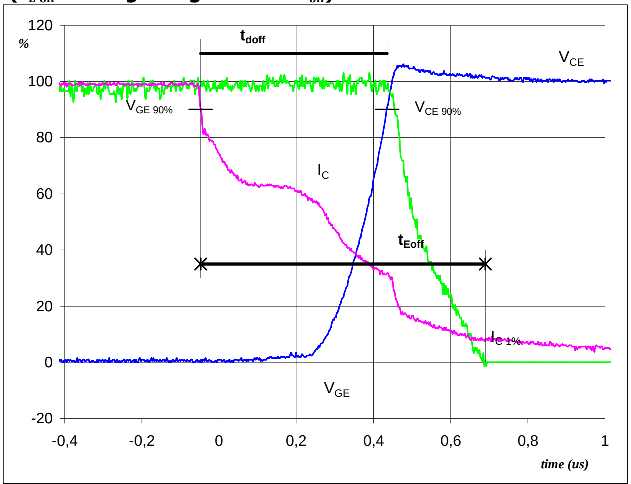
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	28 Ω
R_{goff}	=	28 Ω

Figure 1 Output inverter IGBT

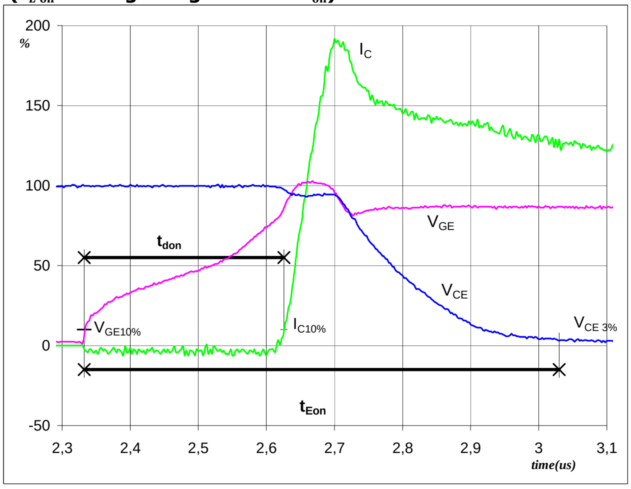
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	35	A
t_{doff} =	0,49	μs
$t_{E\,off}$ =	0,74	μs

Figure 2 Output inverter IGBT

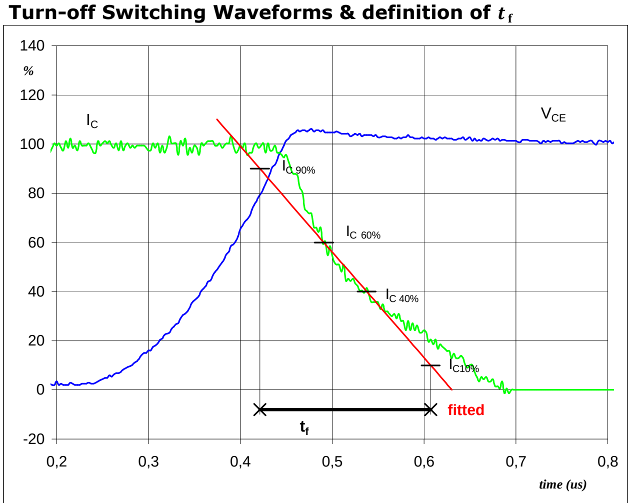
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	35	A
t_{don} =	0,08	μs
$t_{E\,on}$ =	0,70	μs

Figure 3 Output inverter IGBT

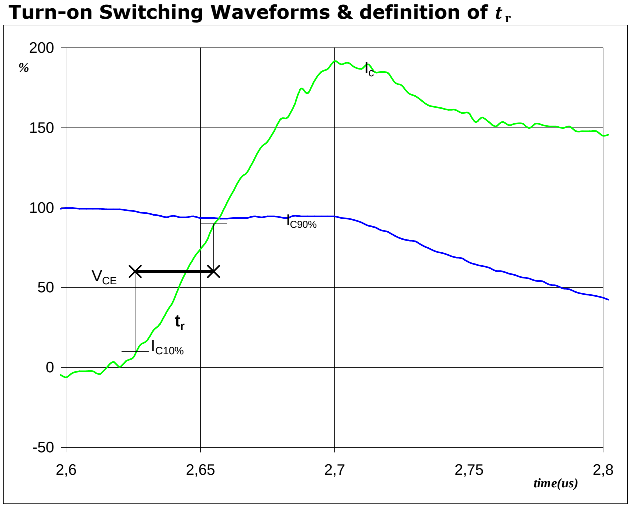
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	35	A
t_f =	0,19	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

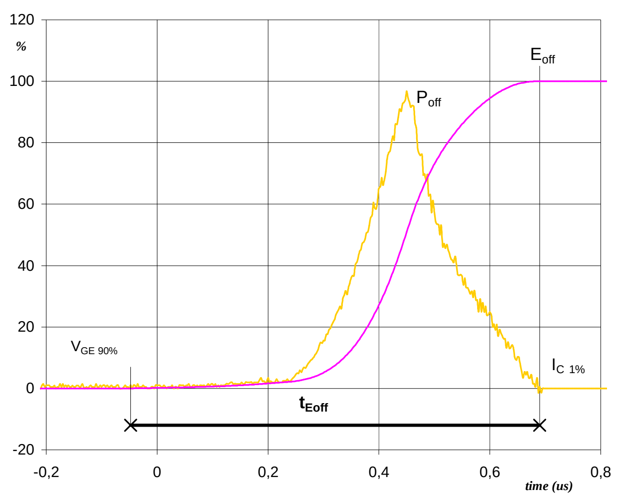


V_C (100%) =	600	V
I_C (100%) =	35	A
t_r =	0,03	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

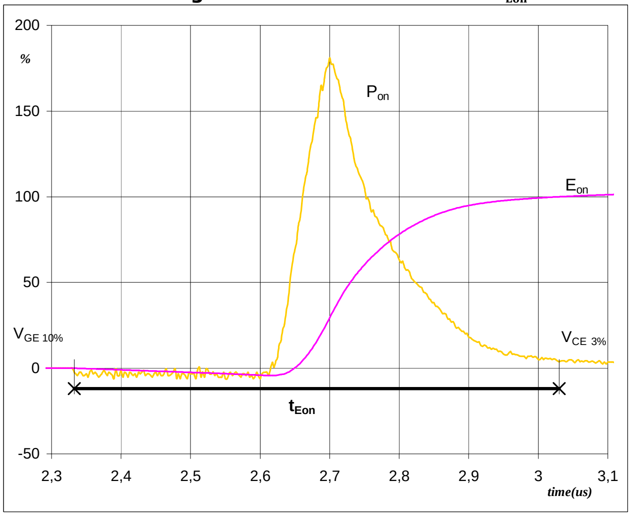
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	20,92	kW
E_{off} (100%) =	3,60	mJ
$t_{E\,off}$ =	0,74	μs

Figure 6 Output inverter IGBT

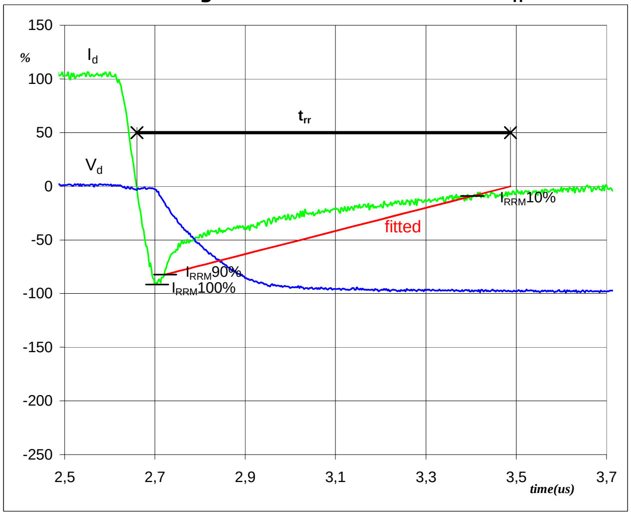
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	20,92	kW
E_{on} (100%) =	5,00	mJ
$t_{E\,on}$ =	0,70	μs

Figure 7 Output inverter FWD

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

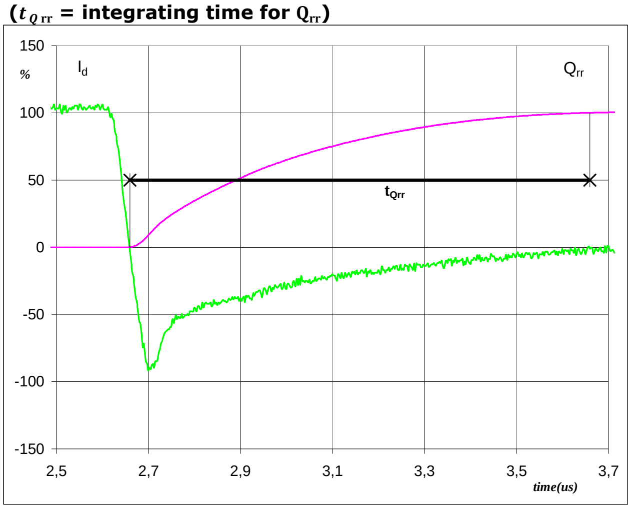


V_d (100%) =	600	V
I_d (100%) =	34	A
I_{RRM} (100%) =	33	A
t_{rr} =	0,72	μs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

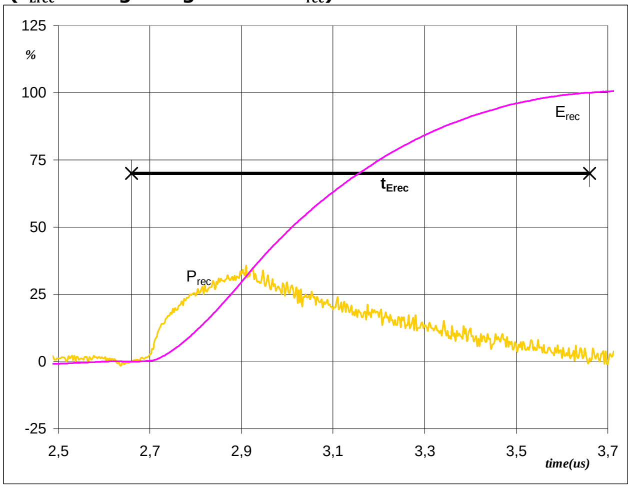
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	35	A
Q_{rr} (100%) =	9,12	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})



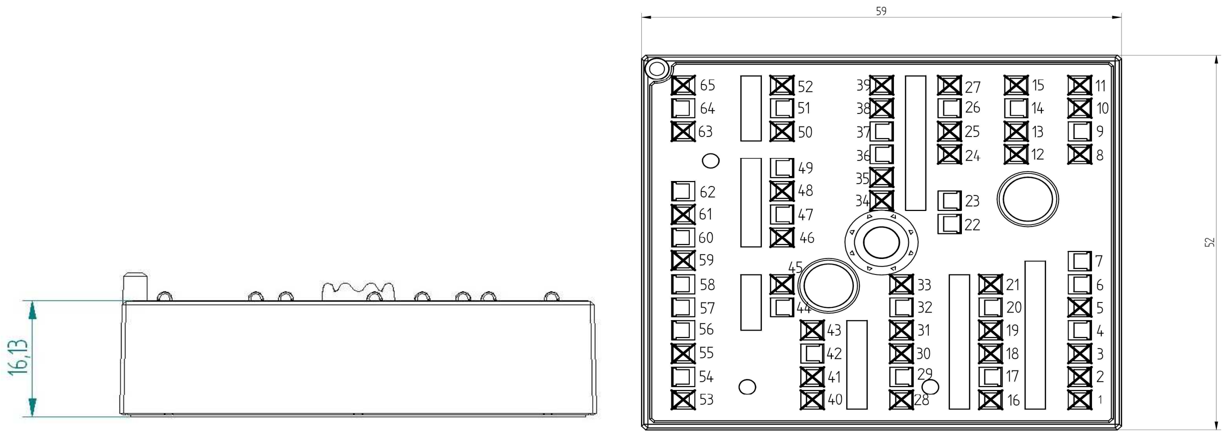
P_{rec} (100%) =	20,92	kW
E_{rec} (100%) =	3,54	mJ
$t_{E\,rec}$ =	1,00	µs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

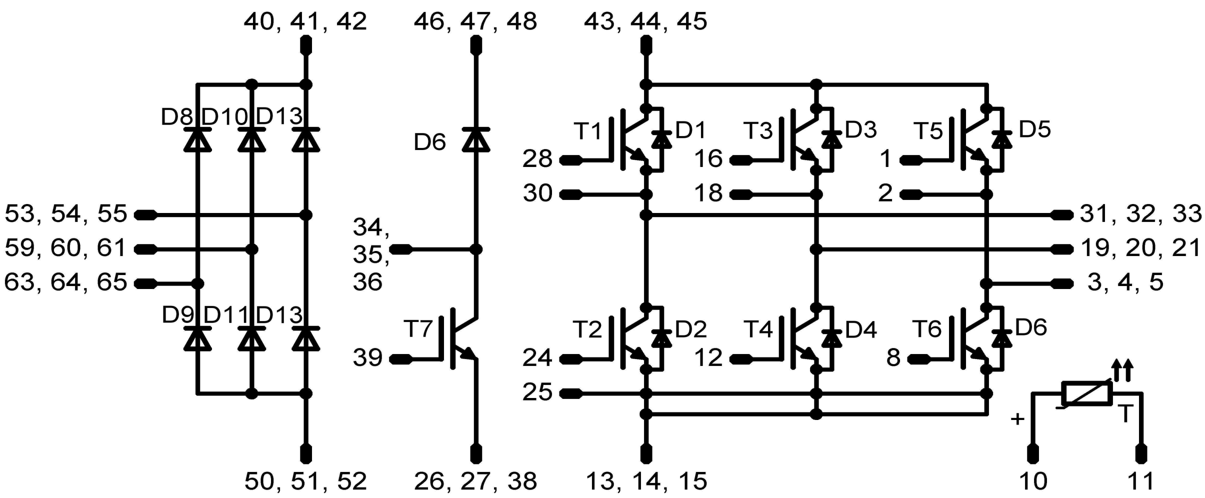
Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K22-T-PM)	V23990-K220-A-/0A/-PM	K220A	K220A-/0A/
with std lid (black V23990-K22-T-PM) and P12	V23990-K220-A-/1A/-PM	K220A	K220A-/1A/
with thin lid (white V23990-K23-T-PM)	V23990-K220-A-/0B/-PM	K220A	K220A-/0B/
with thin lid (white V23990-K23-T-PM) and P12	V23990-K220-A-/1B/-PM	K220A	K220A-/1B/

Outline



X = assembled pin position

Pinout



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