

MiniSKiiP® 3 PIM
600V/75A
Features

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

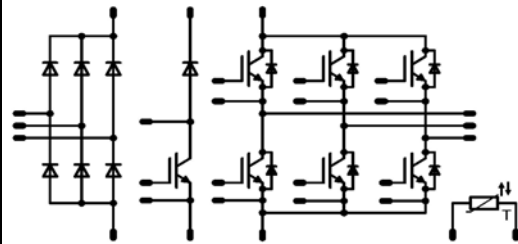
Target Applications

- Industrial motor drives

Types

- V23990-K242-A-PM

MiniSKiiP® 3 housing

Schematic


Maximum Ratings

 $T_j = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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D8,D9,D10,D11,D12,D13

Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$ $T_h = 80^\circ\text{C}$ $T_c = 80^\circ\text{C}$	69 93	A
Surge forward current	I_{FSM}	$t_p = 10\text{ms}$ $T_j = 25^\circ\text{C}$	700	A
I^2t -value	I^2t		2450	A^2s
Power dissipation per Diode	P_{tot}	$T_j = T_{jmax}$ $T_h = 80^\circ\text{C}$ $T_c = 80^\circ\text{C}$	77 117	W
Maximum Junction Temperature	T_{jmax}		150	$^\circ\text{C}$

T1,T2,T3,T4,T5,T6,T7

Collector-emitter break down voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$ $T_h = 80^\circ\text{C}$ $T_c = 80^\circ\text{C}$	70 92	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by T_{jmax}	225	A
Turn off safe operating area		$V_{CE} \leq 1200\text{V}$, $T_j \leq T_{op max}$	225	A
Power dissipation per IGBT	P_{tot}	$T_j = T_{jmax}$ $T_h = 80^\circ\text{C}$ $T_c = 80^\circ\text{C}$	126 191	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^\circ\text{C}$ $V_{GE} = 15\text{V}$	6 360	μs V
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$

Maximum Ratings

$T_j=25^{\circ}\text{C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
D1,D2,D3,D4,D5,D6,D7				
Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25^{\circ}\text{C}$	600	V
DC forward current	I_F	$T_j=T_{jmax}$	55	A
		$T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	72	
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	45	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$	79	W
		$T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	120	
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Thermal Properties

Storage temperature	T_{stg}		-40...+125	$^{\circ}\text{C}$
Operation temperature under switching condition	T_{op}		-40...+125	$^{\circ}\text{C}$

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	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	0,8	1,02 0,94	1,35	V
Threshold voltage (for power loss calc. only)	V_{th}				35	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,88 0,75		V
Slope resistance (for power loss calc. only)	r_t				35	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		4 6		m Ω
Reverse current	I_r			1500		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			0,1 2	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq$ 50um $\lambda = 1$ W/mK						0,90		K/W

T1,T2,T3,T4,T5,T6,T7

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0012	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,54 1,75		V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	612		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			0,1	mA
Gate-emitter leakage current	I_{GES}		± 25	0		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			650	nA
Integrated Gate resistor	R_{gint}							4		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=8 Ω Rgon=8 Ω	± 15	300	75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		217 223		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		27 30		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		266 290		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		55 81		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,58 2,07		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,79 2,24		
Input capacitance	C_{ies}	f=1MHz	0	25		$T_j=25^{\circ}C$		4700		pF
Output capacitance	C_{oss}							300		
Reverse transfer capacitance	C_{rss}							145		
Gate charge	Q_{Gate}		± 15			$T_j=25^{\circ}C$		470		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq$ 50um $\lambda = 1$ W/mK						0,75		K/W

D1,D2,D3,D4,D5,D6,D7

Diode forward voltage	V_F				75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	1	1,54 1,6	2,6	V
Peak reverse recovery current	I_{RRM}	Rgoff=8 Ω		300	75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		63,45 74,57		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		58,2 262,4		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		3,74 6,47		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		3216 2350		A/ μs
Reverse recovered energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		0,74 1,33		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq$ 50um $\lambda = 1$ W/mK						1,2		K/W

Thermistor

Rated resistance	R					$T=25^{\circ}C$		1000		Ω
Deviation of R100	$\Delta R/R$	R100=1670 Ω				$T=100^{\circ}C$	-3		3	%
R100	P					$T=100^{\circ}C$		1670,313		Ω
Power dissipation constant						$T=25^{\circ}C$				mW/K
A-value	B(25/50)	Tol. %				$T=25^{\circ}C$		7,635*10-3		1/K
B-value	B(25/100)	Tol. %				$T=25^{\circ}C$		1,731*10-5		1/K ²
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

$$I_C = f(V_{CE})$$

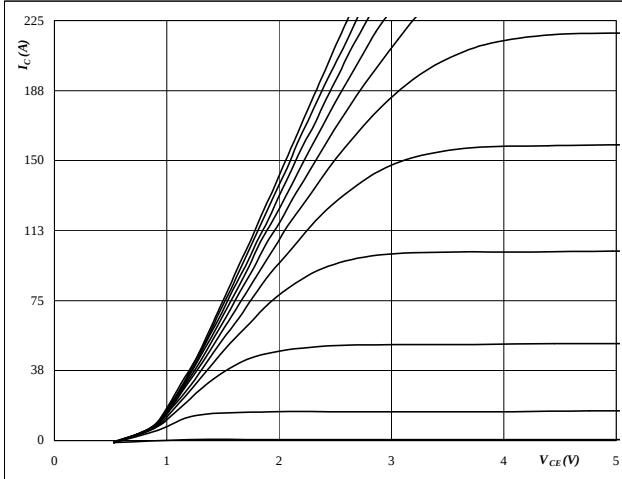

At
 $t_p = 250 \mu s$
 $T_J = 25 ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

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

Typical output characteristics

$$I_C = f(V_{CE})$$

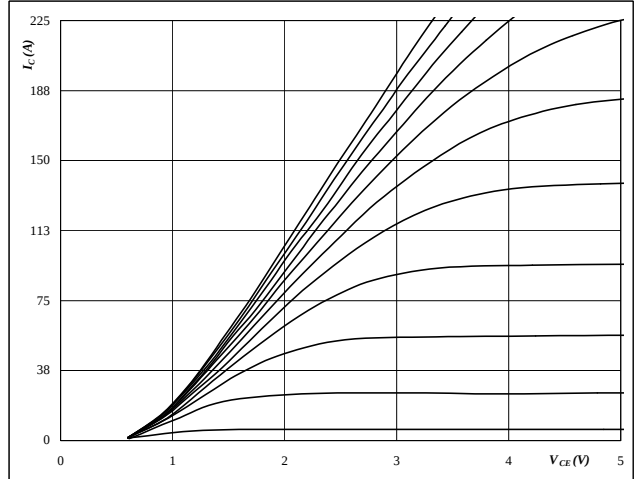
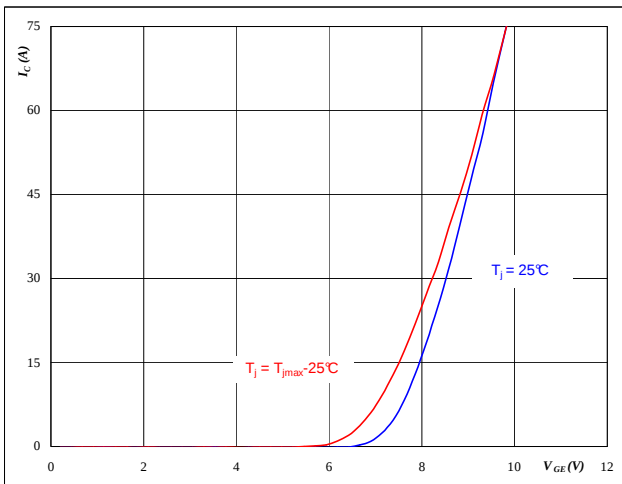

At
 $t_p = 250 \mu s$
 $T_J = 125 ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

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

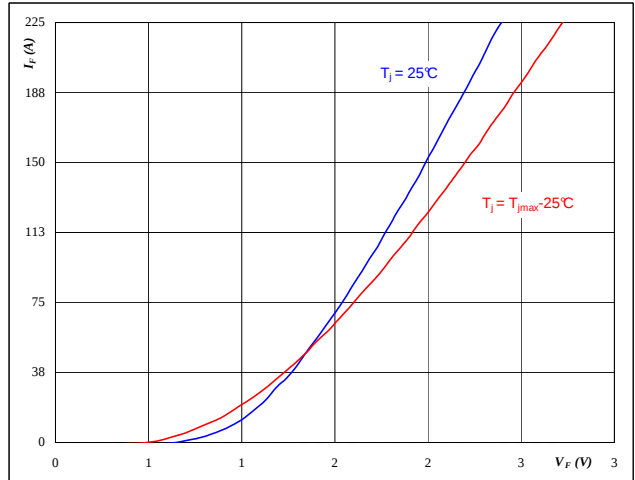
Typical transfer characteristics

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


At
 $t_p = 250 \mu s$
 $V_{CE} = 10 V$
Figure 4 D1,D2,D3,D4,D5,D6,D7 FWD

Typical diode forward current as a function of forward voltage

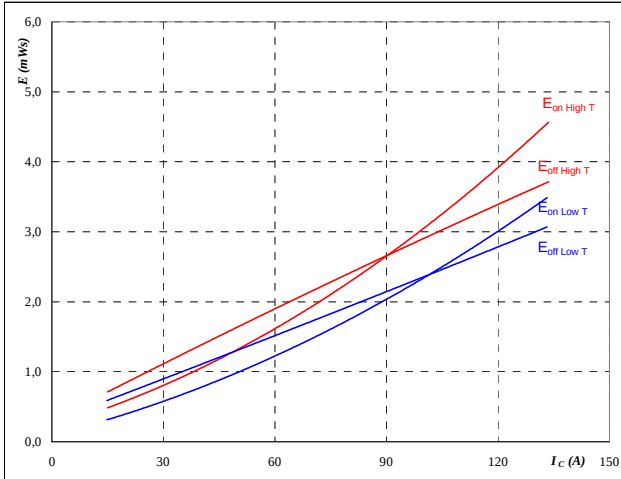
$$I_F = f(V_F)$$


At
 $t_p = 250 \mu s$

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**

$$E = f(I_C)$$



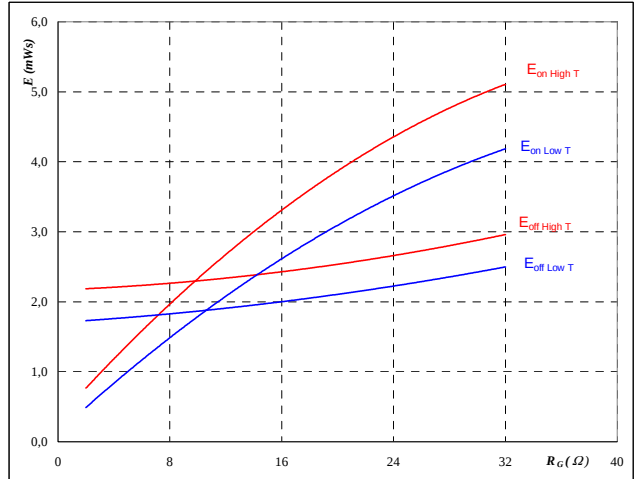
With an inductive load at

$T_J = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ 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**

$$E = f(R_G)$$



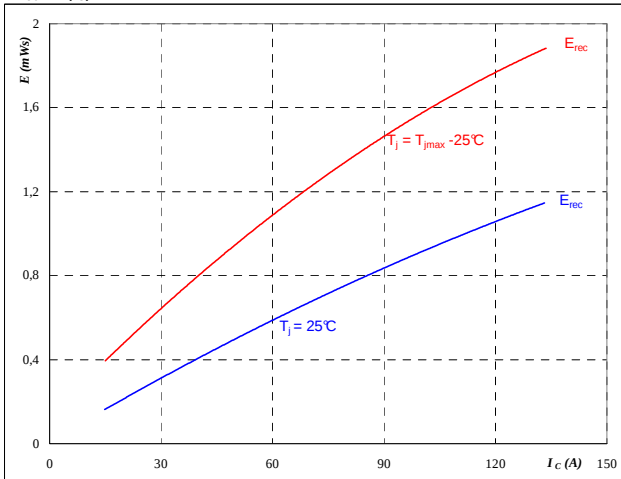
With an inductive load at

$T_J = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $I_C = 75$ A

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

**Typical reverse recovery energy loss
as a function of collector current**

$$E_{rec} = f(I_C)$$



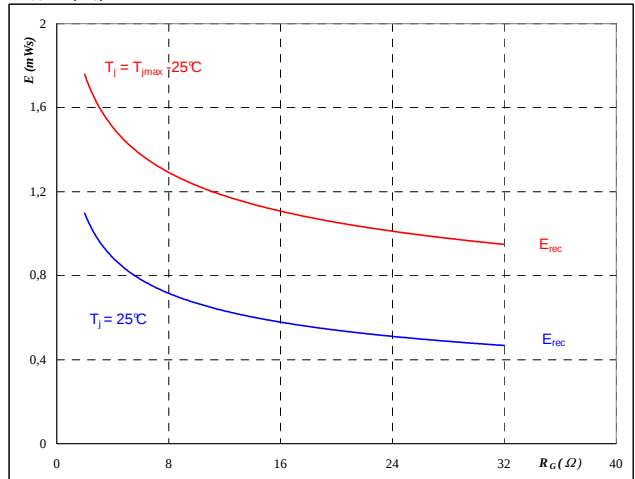
With an inductive load at

$T_J = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

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

**Typical reverse recovery energy loss
as a function of gate resistor**

$$E_{rec} = f(R_G)$$



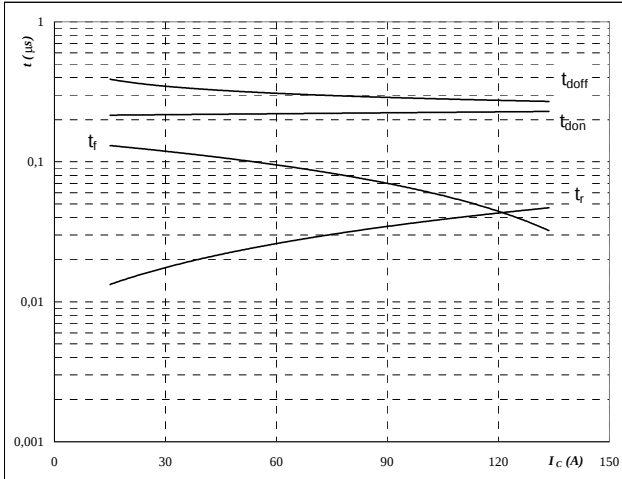
With an inductive load at

$T_J = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $I_C = 75$ 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

$$t = f(I_C)$$



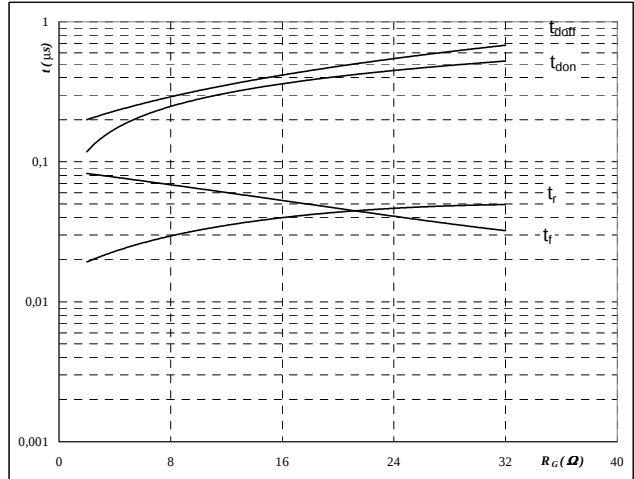
With an inductive load at

$T_J = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ 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

$$t = f(R_G)$$



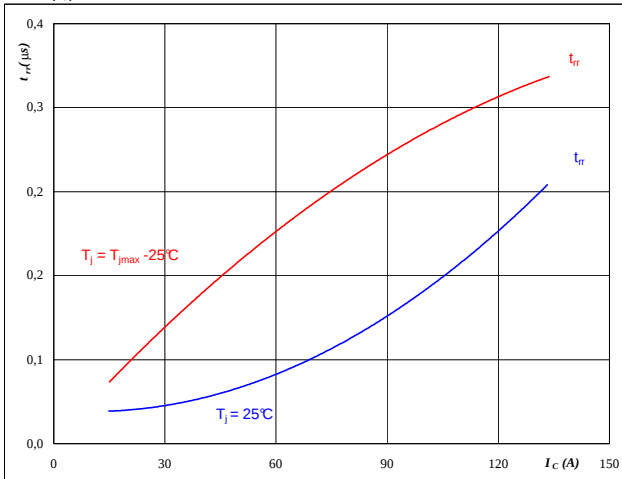
With an inductive load at

$T_J = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $I_C = 75$ A

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

Typical reverse recovery time as a function of collector current

$$t_{rr} = f(I_C)$$



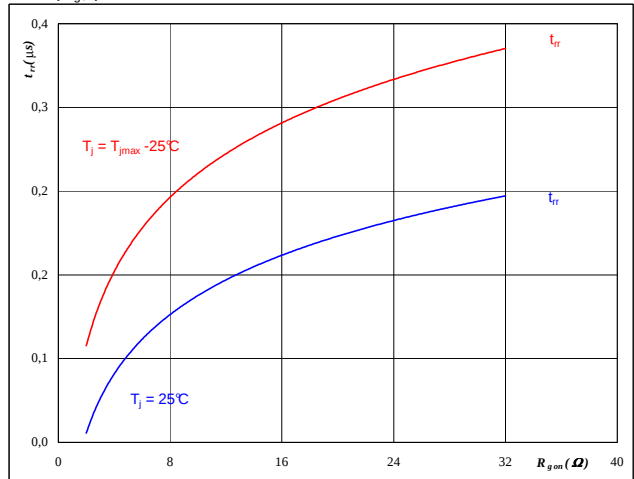
At

$T_J = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ 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

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



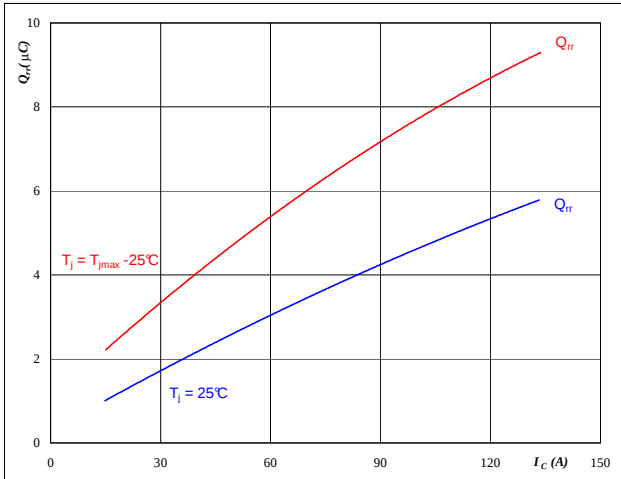
At

$T_J = 25/125$ °C
 $V_R = 300$ V
 $I_F = 75$ A
 $V_{GE} = \pm 15$ 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

$$Q_{rr} = f(I_C)$$



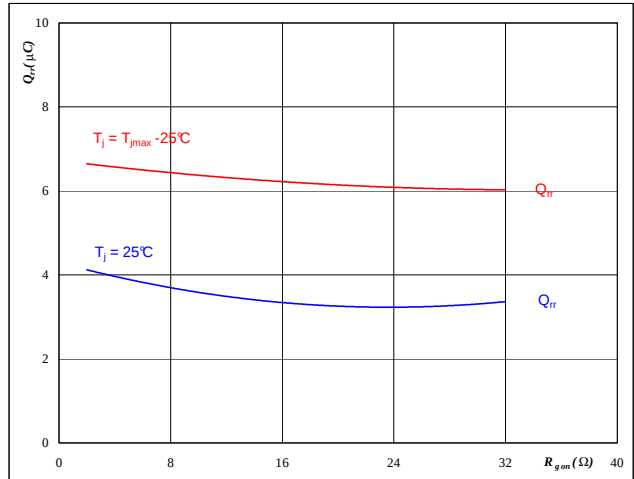
At

$T_j = 25/125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = \pm 15\text{ V}$
 $R_{gon} = 8\ \Omega$

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

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

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



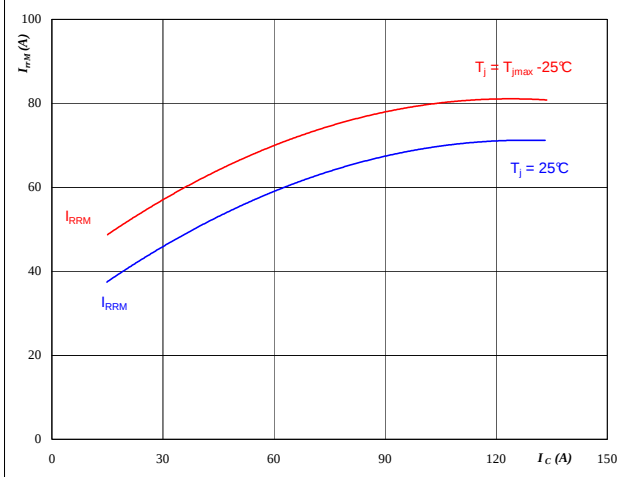
At

$T_j = 25/125^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 75\text{ A}$
 $V_{GE} = \pm 15\text{ V}$

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

Typical reverse recovery current as a function of collector current

$$I_{RRM} = f(I_C)$$



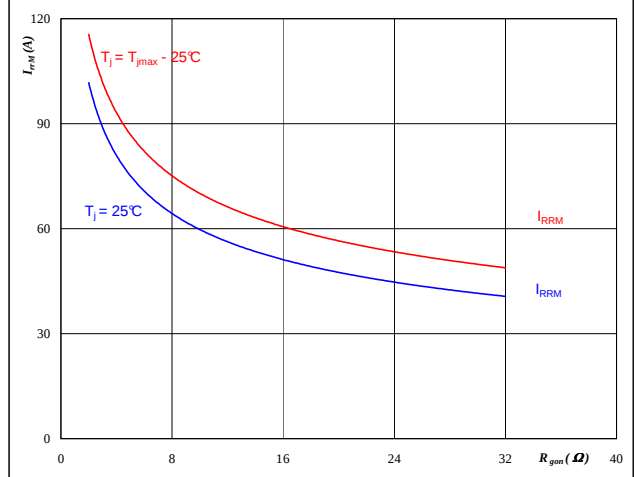
At

$T_j = 25/125^\circ\text{C}$
 $V_{CE} = 300\text{ V}$
 $V_{GE} = \pm 15\text{ V}$
 $R_{gon} = 8\ \Omega$

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

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

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



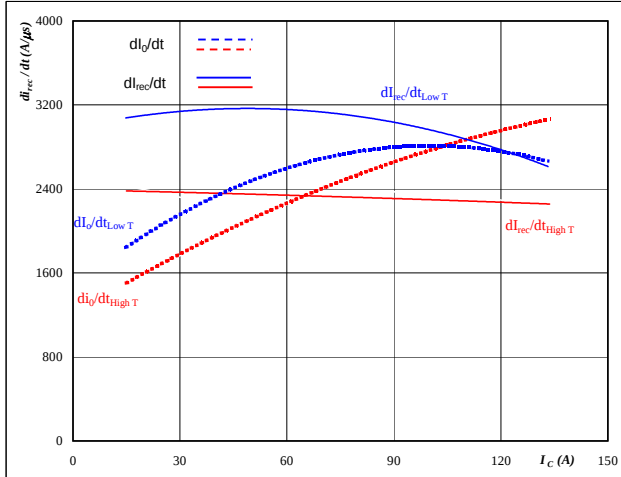
At

$T_j = 25/125^\circ\text{C}$
 $V_R = 300\text{ V}$
 $I_F = 75\text{ A}$
 $V_{GE} = \pm 15\text{ V}$

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

$$dI_o/dt, dI_{rec}/dt = f(I_c)$$



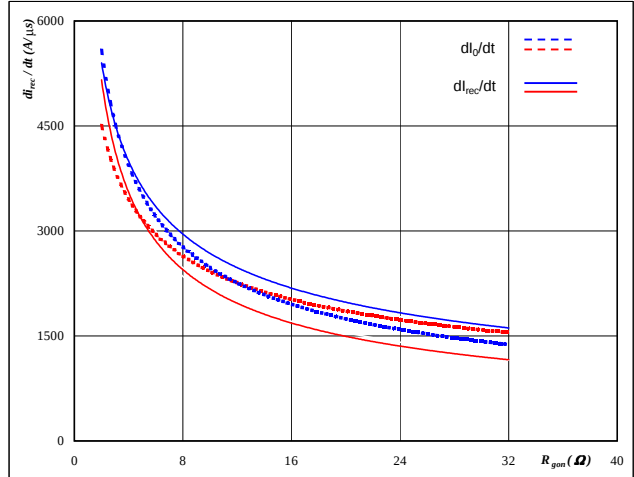
At

$T_j = 25/125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ 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

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



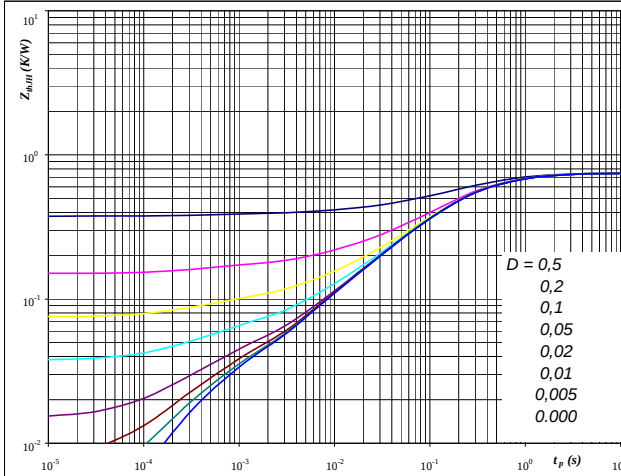
At

$T_j = 25/125$ °C
 $V_R = 300$ V
 $I_F = 75$ A
 $V_{GE} = \pm 15$ 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

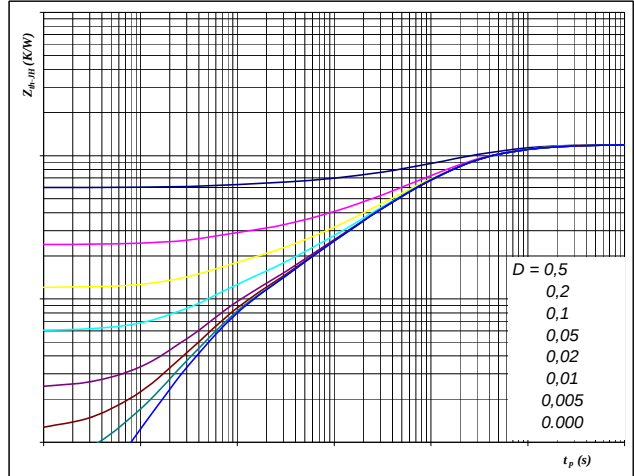
Thermal grease

R (C/W)	Tau (s)
0,02	9,4E+00
0,12	1,1E+00
0,41	2,1E-01
0,14	4,0E-02
0,04	6,3E-03
0,02	4,0E-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

$D = t_p / T$
 $R_{thJH} = 1,20$ K/W

FWD thermal model values

Thermal grease

R (C/W)	Tau (s)
0,02	9,9E+00
0,19	1,0E+00
0,54	1,8E-01
0,27	3,4E-02
0,11	6,0E-03
0,07	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

$$P_{tot} = f(T_h)$$

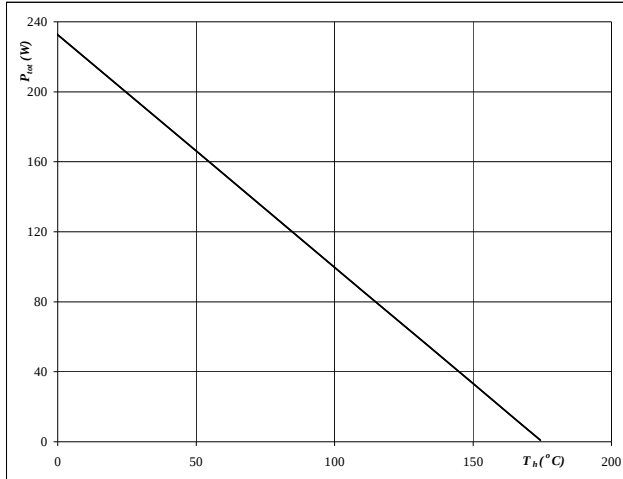

At
 $T_j = 175$ °C

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

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

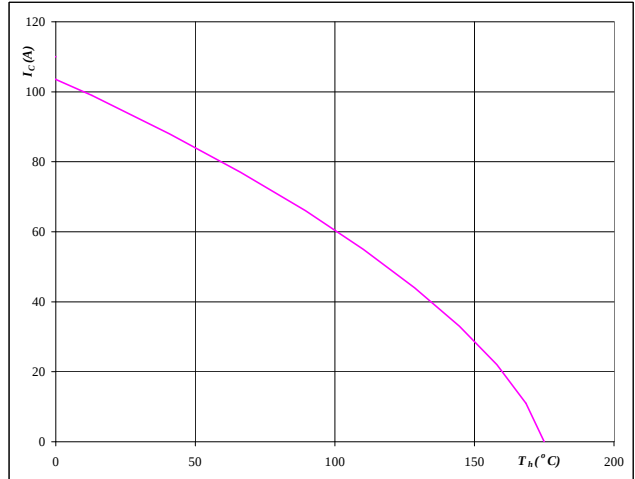

At
 $T_j = 175$ °C
 $V_{GE} = 15$ V

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

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

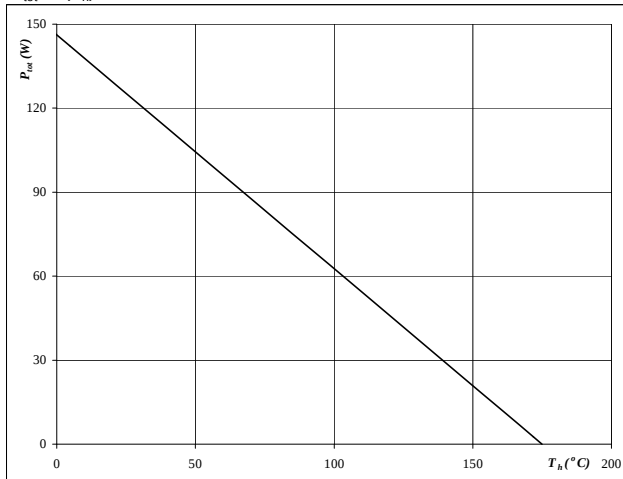
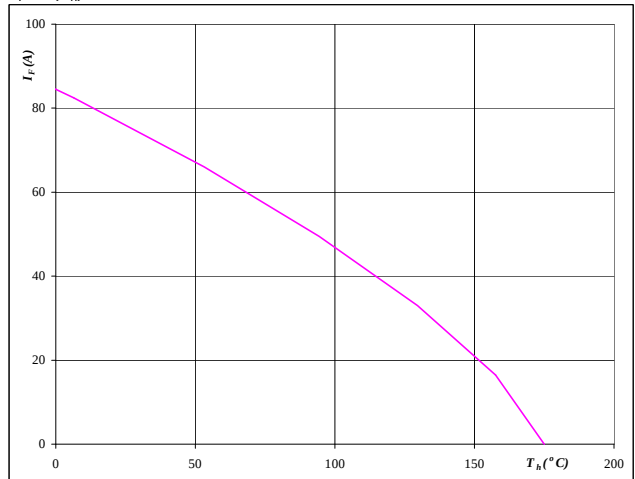

At
 $T_j = 175$ °C

Figure 24 Output inverter FWD

Forward current as a function of heatsink temperature

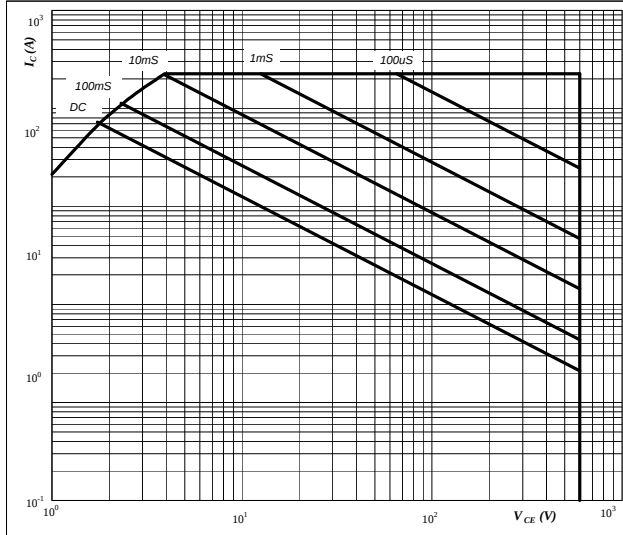
$$I_F = f(T_h)$$


At
 $T_j = 175$ °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**

$$I_C = f(V_{CE})$$

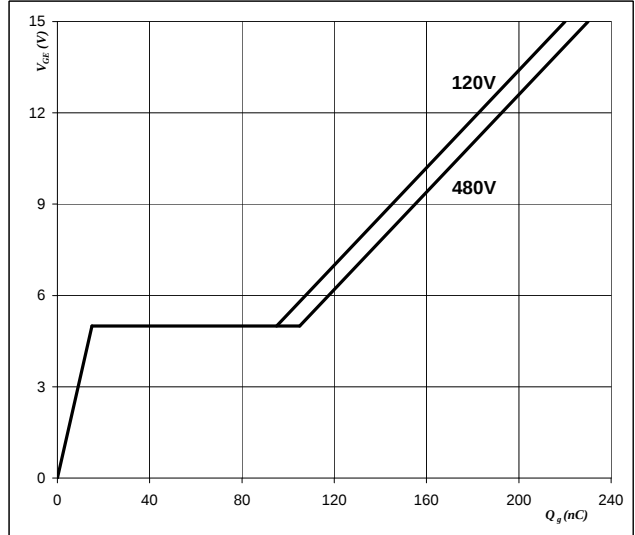


At
D = single pulse
T_h = 80 °C
V_{GE} = ±15 V
T_j = T_{jmax} °C

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

Gate voltage vs Gate charge

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



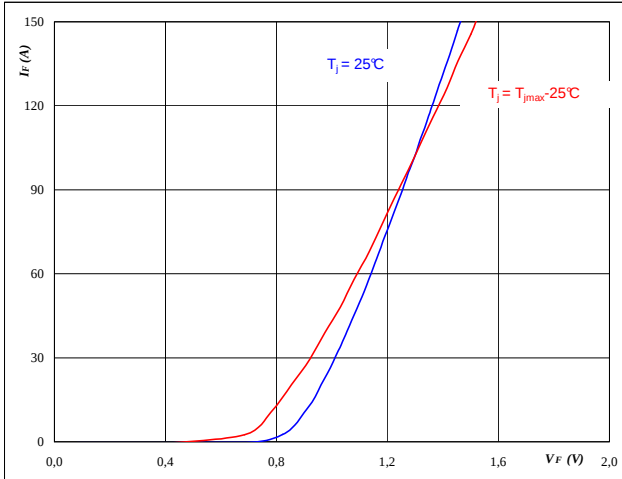
At
I_C = 75 A

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

$$I_F = f(V_F)$$

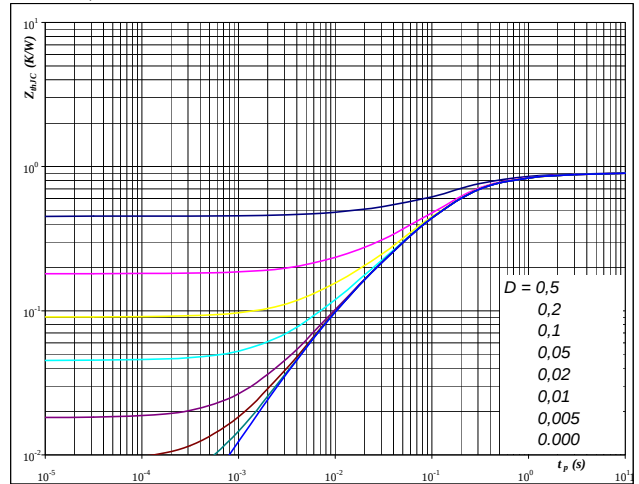


At
 $t_p = 250 \mu s$

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
 $D = t_p / T$
 $R_{thJH} = 0,90 \text{ K/W}$

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

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

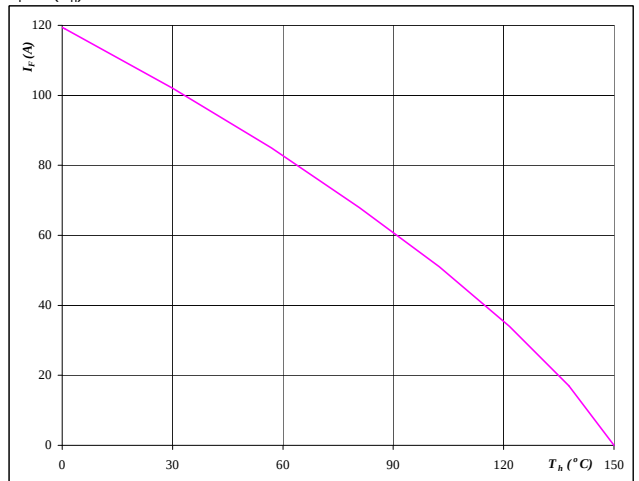


At
 $T_j = 150 \text{ } ^\circ\text{C}$

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

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



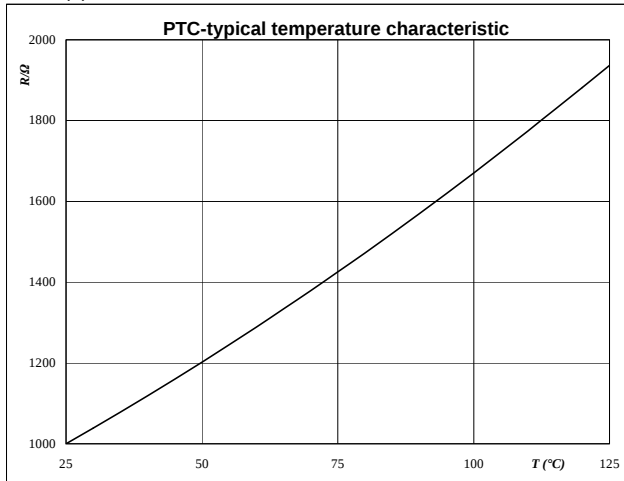
At
 $T_j = 150 \text{ } ^\circ\text{C}$

Thermistor

Figure 1 Thermistor

**Typical PTC characteristic
as a function of temperature**

$$R_T = f(T)$$



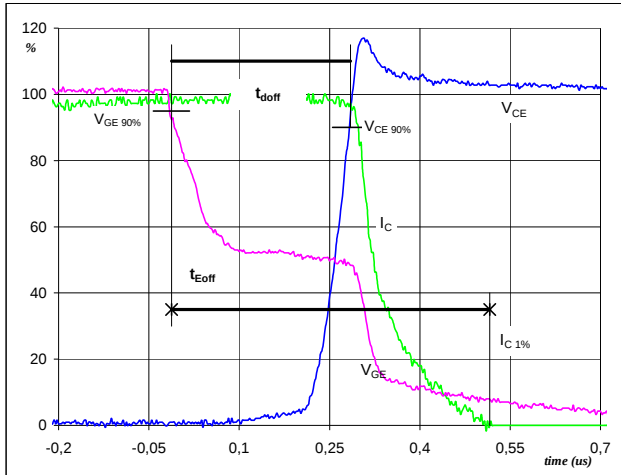
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

Figure 1 Output inverter IGBT

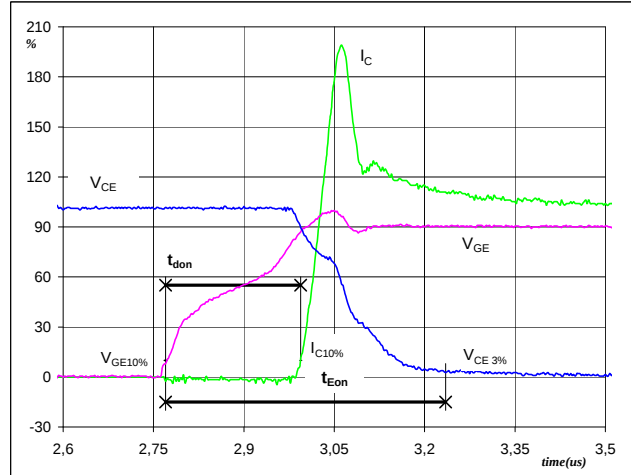
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	75	A
t_{doff}	=	0,29	μs
t_{Eoff}	=	0,53	μs

Figure 2 Output inverter IGBT

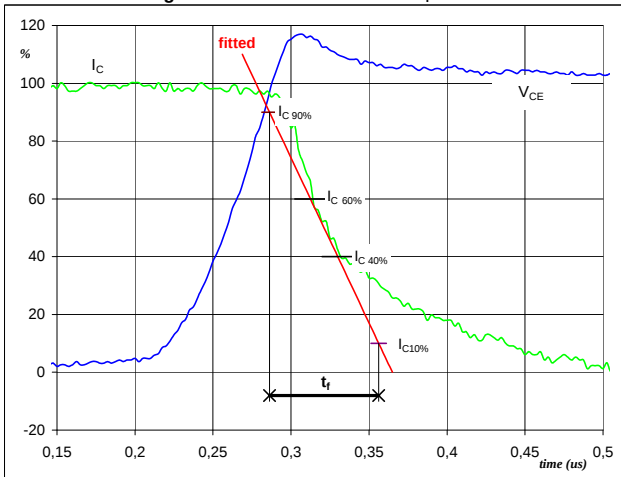
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
(t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	75	A
t_{don}	=	0,22	μs
t_{Eon}	=	0,47	μs

Figure 3 Output inverter IGBT

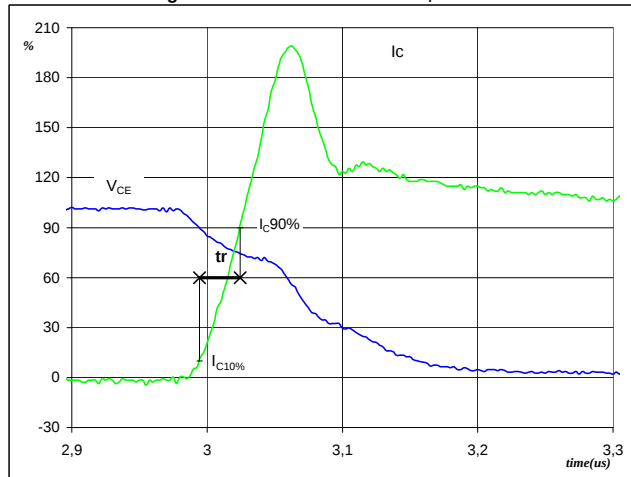
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	75	A
t_f	=	0,08	μs

Figure 4 Output inverter IGBT

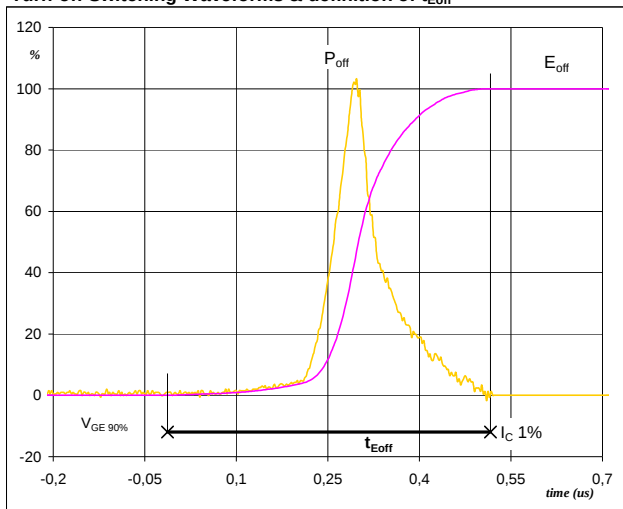
Turn-on Switching Waveforms & definition of t_r



$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	75	A
t_r	=	0,03	μs

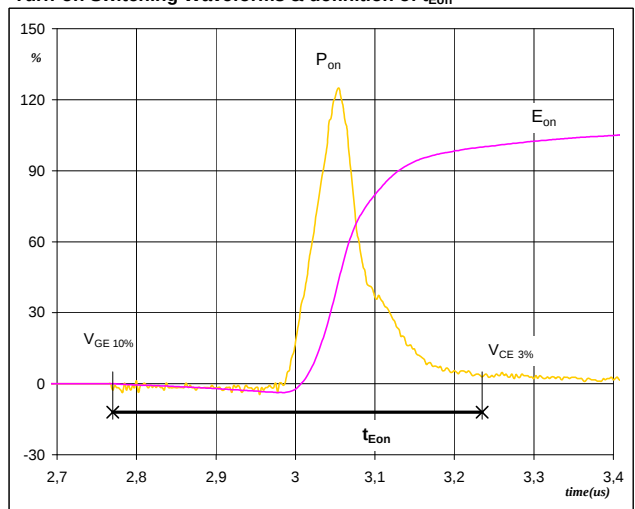
Switching Definitions Output Inverter

Figure 5 Output inverter IGBT
Turn-off Switching Waveforms & definition of t_{Eoff}



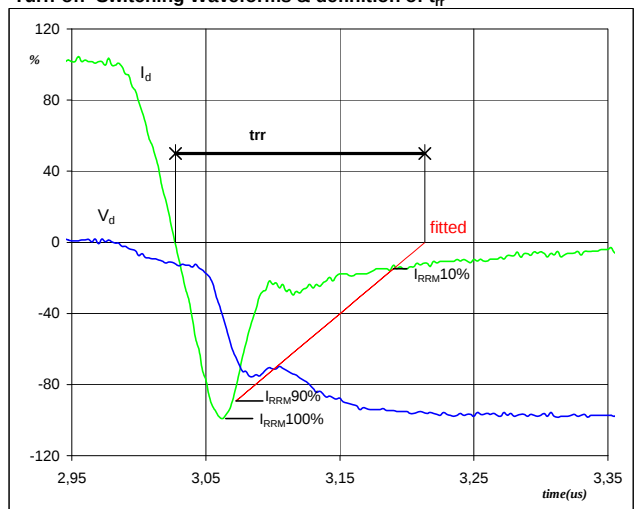
$P_{off} (100\%) = 22,50$ kW
 $E_{off} (100\%) = 2,24$ mJ
 $t_{Eoff} = 0,53$ μs

Figure 6 Output inverter IGBT
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on} (100\%) = 22,50$ kW
 $E_{on} (100\%) = 2,07$ mJ
 $t_{Eon} = 0,47$ μs

Figure 7 Output inverter FWD
Turn-off Switching Waveforms & definition of t_{tr}

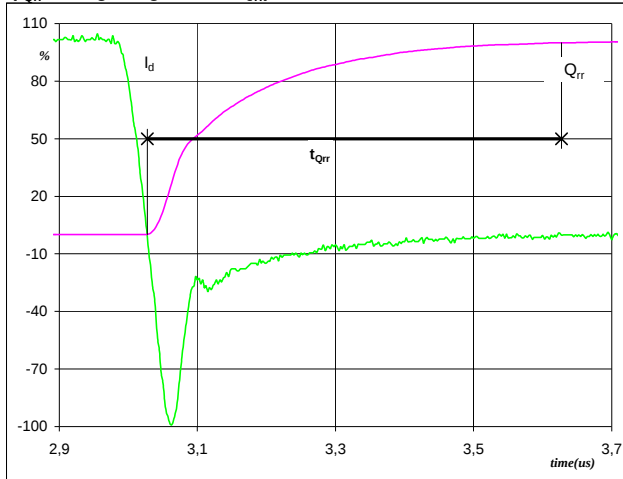


$V_d (100\%) = 300$ V
 $I_d (100\%) = 75$ A
 $I_{RRM} (100\%) = 75$ A
 $t_{tr} = 0,26$ μs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

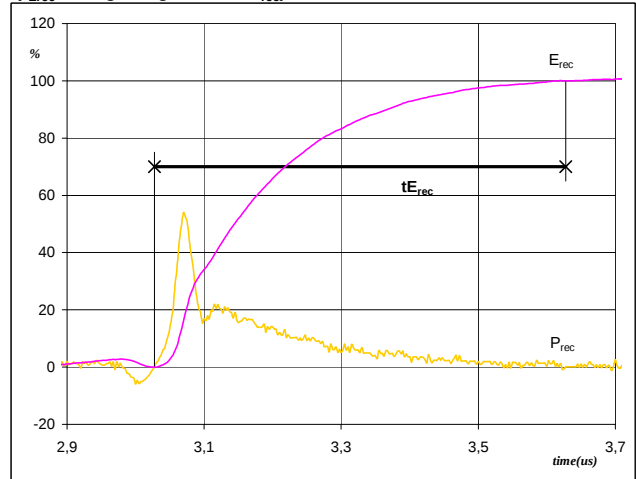
Turn-on Switching Waveforms & definition of t_{Qrr}
 (t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 75 A
 Q_{rr} (100%) = 6,47 μ C
 t_{Qrr} = 0,60 μ s

Figure 9 Output inverter FWD

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



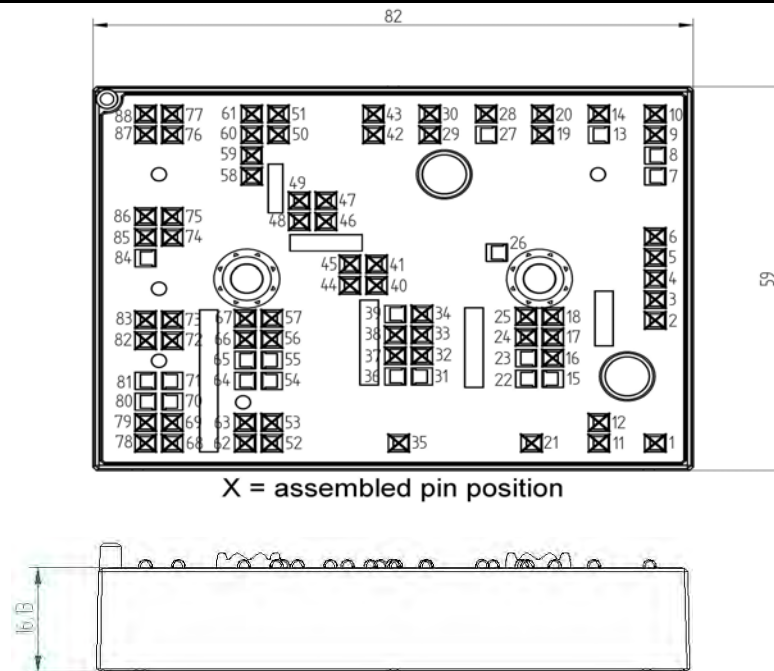
P_{rec} (100%) = 22,50 kW
 E_{rec} (100%) = 1,33 mJ
 t_{Erec} = 0,60 μ s

Ordering Code and Marking - Outline - Pinout

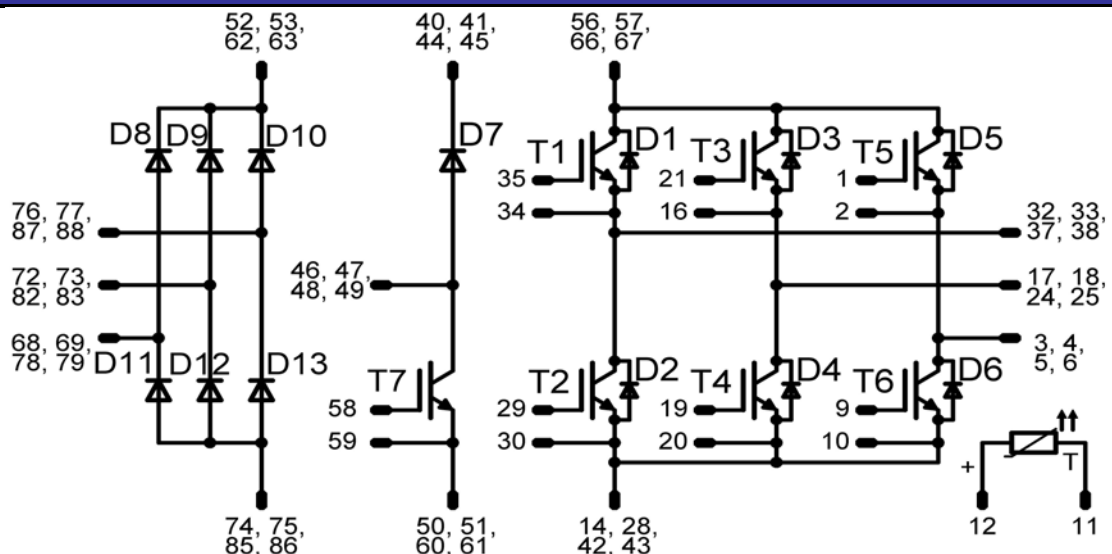
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K32-T-PM)	V23990-K242-A-/0A/-PM	K242A	K242A-/0A/
with std lid (black V23990-K32-T-PM) and P12	V23990-K242-A-/1A/-PM	K242A	K242A-/1A/
with thin lid (white V23990-K33-T-PM)	V23990-K242-A-/0B/-PM	K242A	K242A-/0B/
with thin lid (white V23990-K33-T-PM) and P12	V23990-K242-A-/1B/-PM	K242A	K242A-/1B/

Outline



Pinout



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