

MiniSKiiP® 2 PACK
600 V/75 A
Features

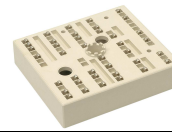
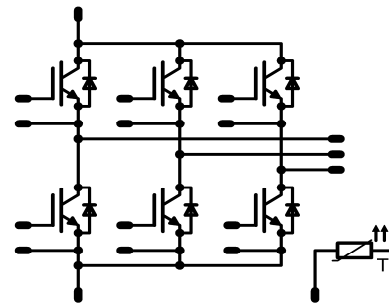
- SixPack (inverter) topology
- Solder less interconnection
- Designed for motor drives up to 7 kW
- Fully compatible with Semikron pedant 27AC066V1
- Temperature sensor
- Standard (6.5mm) and thin (2.8mm) lids, 16mm housing
- Optional with pre-applied thermal grease

Target Applications

- Industrial Motor Drives
- Power Generation
- UPS

Types

- V23990-K233-F-PM

MiniSKiiP® 2 Housing

Schematic


Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
T1, T2, T3, T4, T5, T6				
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 78	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by T_{jmax}	225	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	127 193	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	$^{\circ}\text{C}$
D1, D2, D3, D4, D5, D6				
Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25^{\circ}\text{C}$	600	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	59 80	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	118	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	78 119	W
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
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Thermal Properties

Storage temperature	T_{stg}		-40...+125	°C
Operation temperature under switching condition	T_{op}		-40...+(T_{jmax} - 25)	°C

Insulation Properties

Insulation voltage	V_{is}	$t=2\text{s}$ 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			
T1,T2,T3,T4,T5,T6											
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0012	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	5	5,8	6,5	V	
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		75	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		1,54 1,76		V	
Collector-emitter cut-off current incl. Diode	I_{CES}		0	612		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			0,2	mA	
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			700	nA	
Integrated Gate resistor	R_{gint}							4		Ω	
Turn-on delay time	$t_{d(on)}$	$R_{goff}=8\ \Omega$ $R_{gon}=8\ \Omega$	± 15	300	75	$T_j=25^\circ\text{C}$		215		ns	
Rise time	t_r					$T_j=125^\circ\text{C}$		222			
Turn-off delay time	$t_{d(off)}$					$T_j=25^\circ\text{C}$		26			
Fall time	t_f					$T_j=125^\circ\text{C}$		30			
Turn-on energy loss per pulse	E_{on}					$T_j=25^\circ\text{C}$		255			
Turn-off energy loss per pulse	E_{off}					$T_j=125^\circ\text{C}$		274			
Input capacitance	C_{ies}	f=1MHz	0	25		$T_j=25^\circ\text{C}$		4700		pF	
Output capacitance	C_{oss}						$T_j=25^\circ\text{C}$		300		
Reverse transfer capacitance	C_{rss}						$T_j=25^\circ\text{C}$		145		
Gate charge	Q_{Gate}		± 15			$T_j=25^\circ\text{C}$		470		nC	
Thermal resistance chip to heatsink per chip	$R_{th,JH}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1\ \text{W/mK}$						0,75		K/W	

D1,D2,D3,D4,D5,D6

Diode forward voltage	V_F				75	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		1,39 1,43		V
Peak reverse recovery current	I_{RRM}	$R_{goff}=8\ \Omega$	± 15	300	75	$T_j=25^\circ\text{C}$		72		A
Reverse recovery time	t_{rr}					$T_j=125^\circ\text{C}$		82		
Reverse recovered charge	Q_{rr}					$T_j=25^\circ\text{C}$		203		
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=125^\circ\text{C}$		333		
Reverse recovered energy	E_{rec}					$T_j=25^\circ\text{C}$		5,70		
						$T_j=125^\circ\text{C}$		9,14		
Thermal resistance chip to heatsink per chip	$R_{th,JH}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1\ \text{W/mK}$						1,2		K/W

Thermistor

Rated resistance	R					$T=25^\circ\text{C}$		1000		Ω
Deviation of R100	$\Delta R/R$	R100=1670 Ω				$T=100^\circ\text{C}$	-3		3	%
R100	P					$T=100^\circ\text{C}$		1670,3125		Ω
A-value	B(25/50)	Tol. %				$T=25^\circ\text{C}$		$7,635 \cdot 10^{-3}$		1/K
B-value	B(25/100)	Tol. %				$T=25^\circ\text{C}$		$1,731 \cdot 10^{-5}$		1/K ²
Vincotech NTC Reference									E	

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 1 T1,T2,T3,T4,T5,T6 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

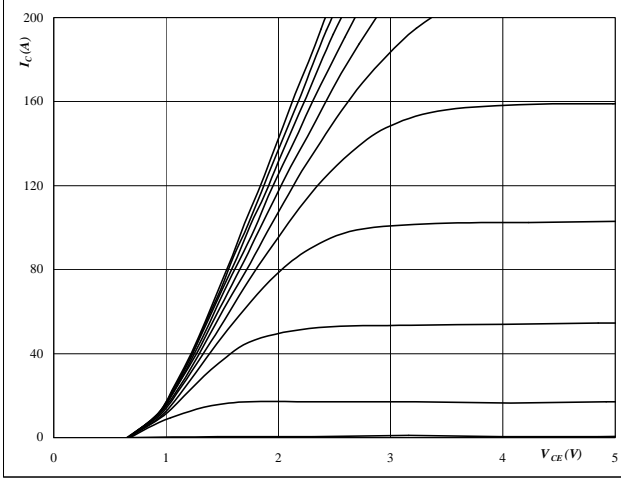

At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

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

Typical output characteristics

$I_C = f(V_{CE})$

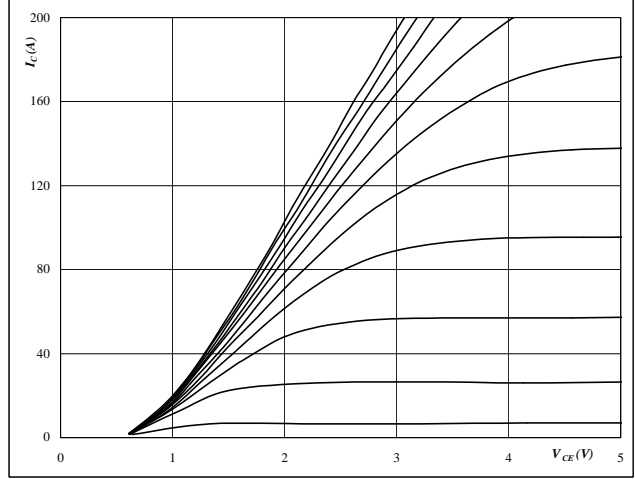
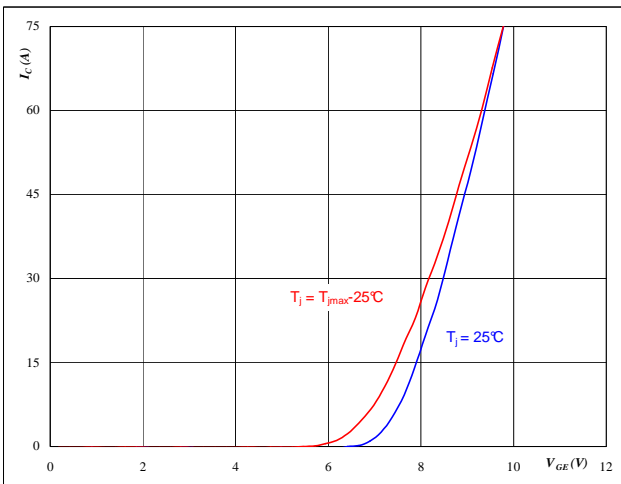

At
 $t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

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

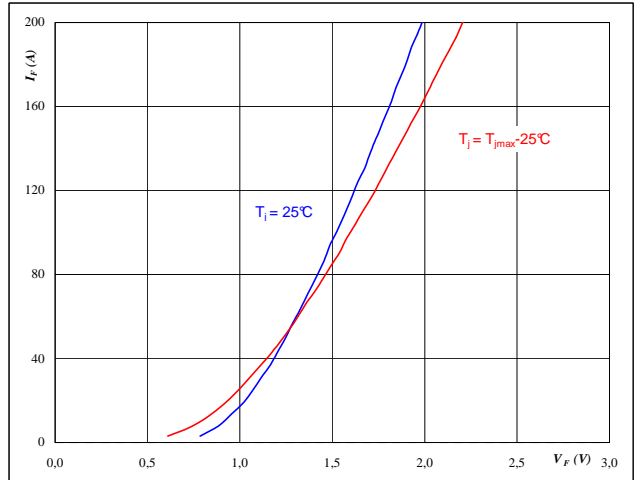
Typical transfer characteristics

$I_C = f(V_{GE})$


At
 $T_j = 25/125 \text{ }^\circ C$
 $t_p = 250 \mu s$
 $V_{CE} = 10 \text{ V}$
Figure 4 D1,D2,D3,D4,D5,D6 FWD

Typical diode forward current as a function of forward voltage

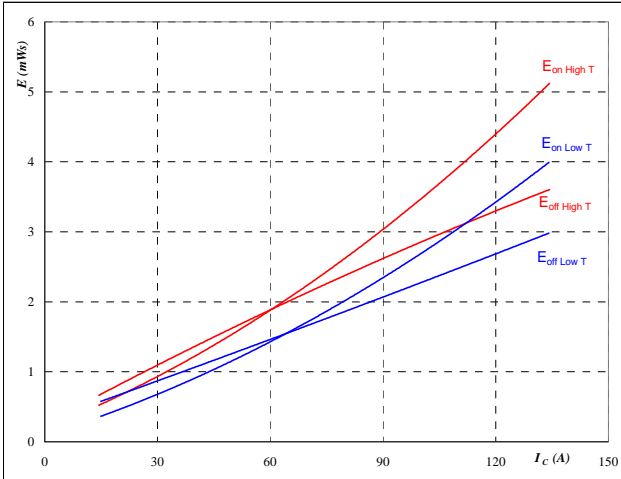
$I_F = f(V_F)$


At
 $t_p = 250 \mu s$

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 5 T1,T2,T3,T4,T5,T6 IGBT

**Typical switching energy losses
as a function of collector current**

$$E = f(I_C)$$



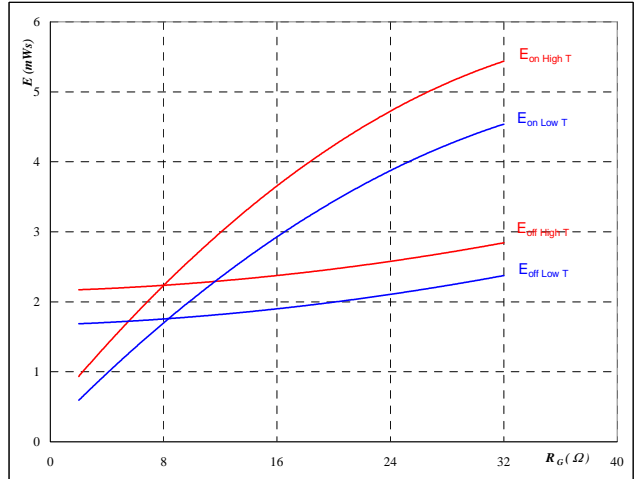
With an inductive load at

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

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

**Typical switching energy losses
as a function of gate resistor**

$$E = f(R_G)$$



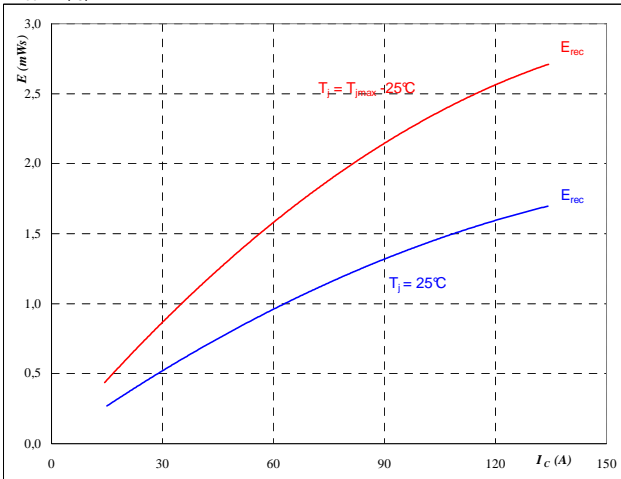
With an inductive load at

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

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

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

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



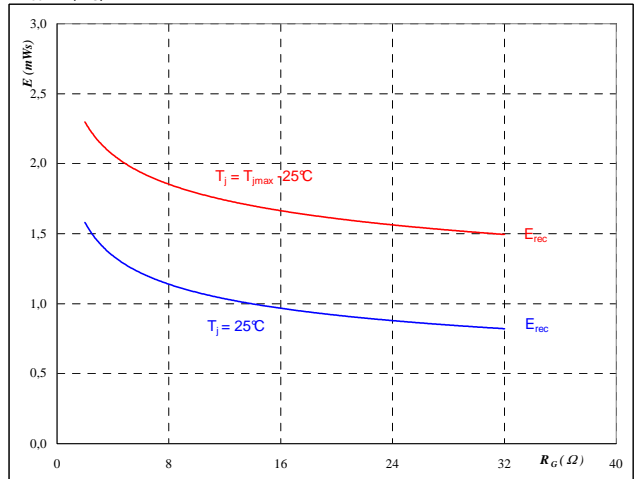
With an inductive load at

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

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

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

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



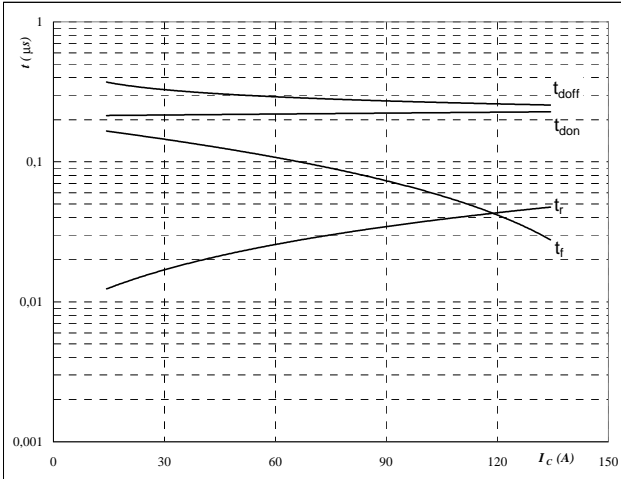
With an inductive load at

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

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 9 T1,T2,T3,T4,T5,T6 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



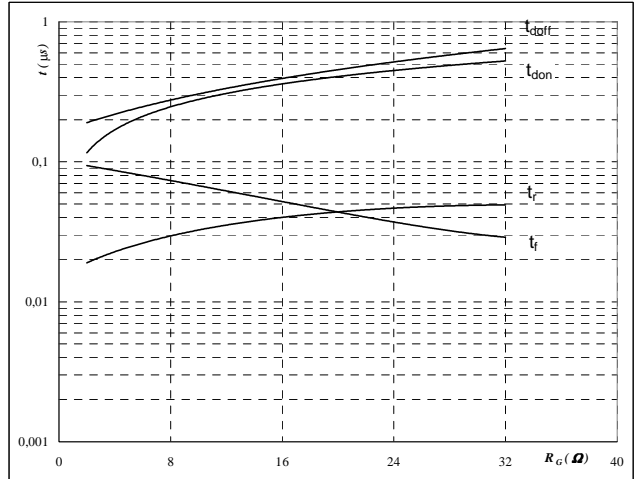
With an inductive load at

$T_J =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω
$R_{goff} =$	8	Ω

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

Typical switching times as a function of gate resistor

$t = f(R_G)$



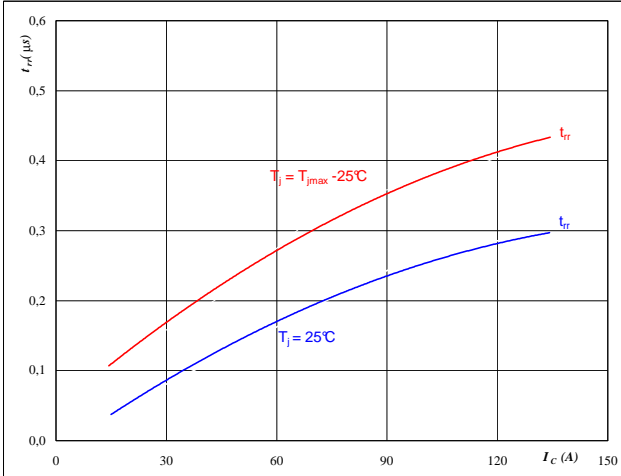
With an inductive load at

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

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

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

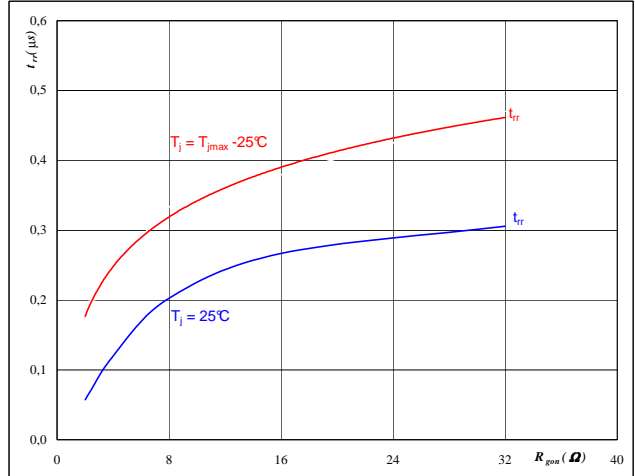

At

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

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

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

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

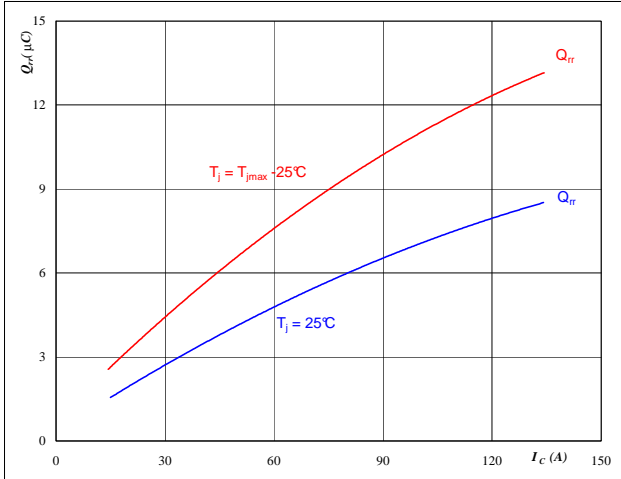

At

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

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 13 D1,D2,D3,D4,D5,D6 FWD

Typical reverse recovery charge as a function of collector current

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

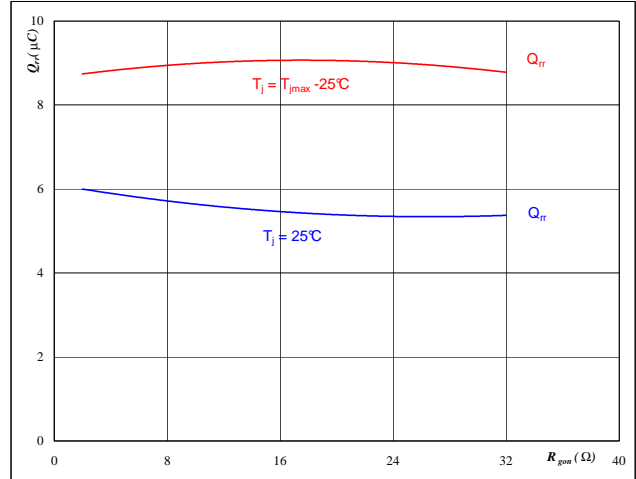

At

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

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

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

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

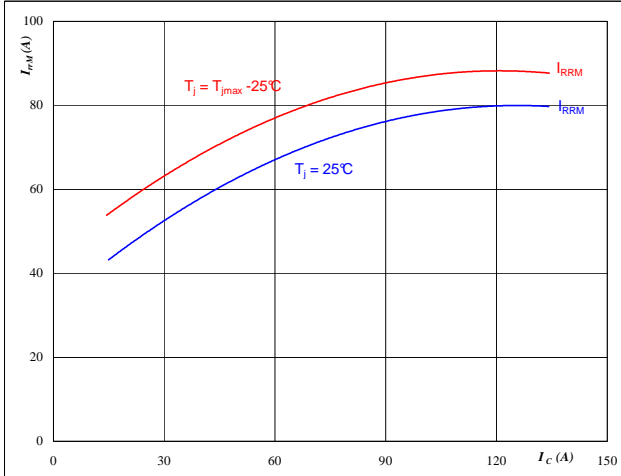

At

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

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

Typical reverse recovery current as a function of collector current

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

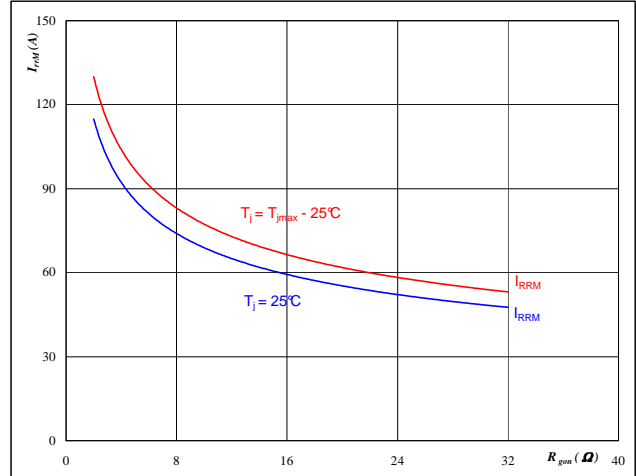

At

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

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

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

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

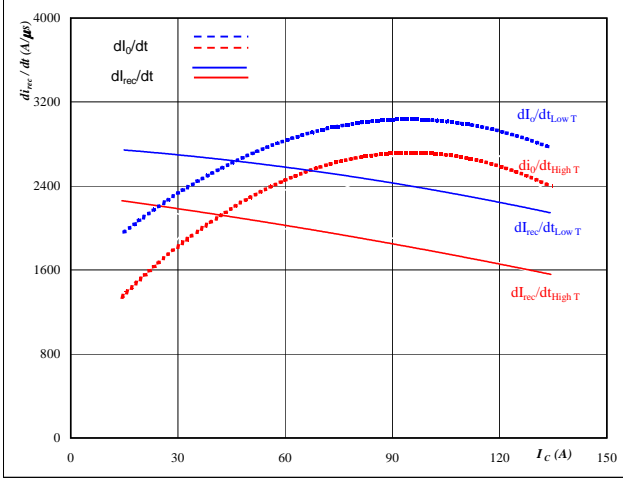

At

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

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

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

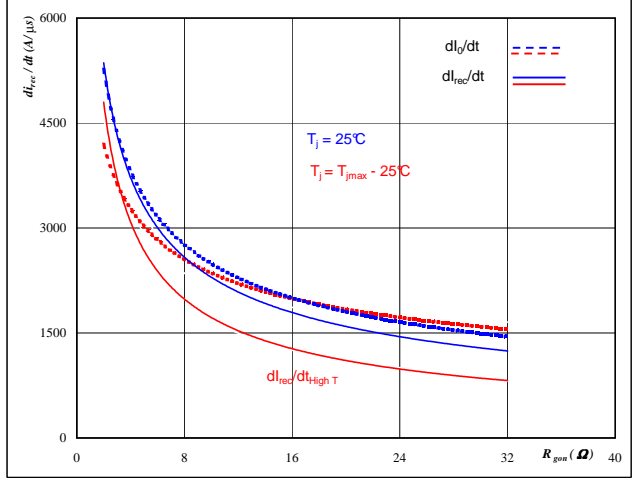
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_f/dt, di_{rec}/dt = f(I_c)$



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

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

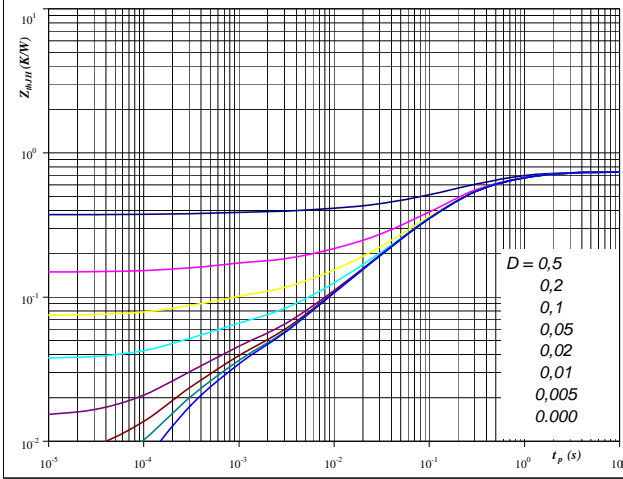
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $di_f/dt, di_{rec}/dt = f(R_{gon})$



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

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

IGBT transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



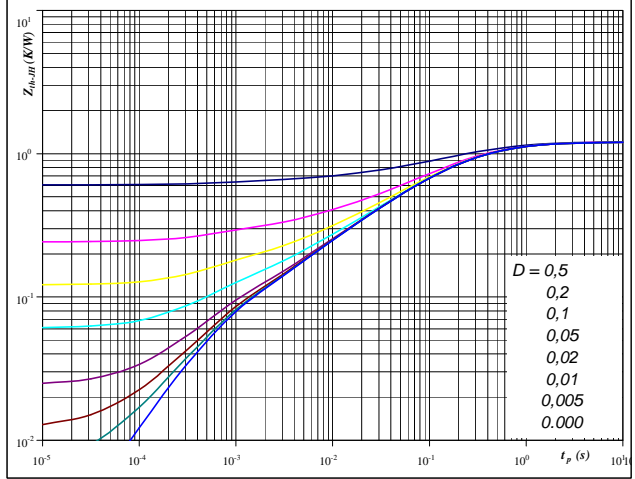
At
 $D = t_p / T$
 $R_{thJH} = 0,75 \text{ K/W}$

IGBT thermal model values

Thermal grease	
R (C/W)	Tau (s)
0,03	8,2E+00
0,15	9,4E-01
0,40	1,9E-01
0,11	3,6E-02
0,04	6,2E-03
0,02	3,7E-04

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

FWD transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



At
 $D = t_p / T$
 $R_{thJH} = 1,21 \text{ K/W}$

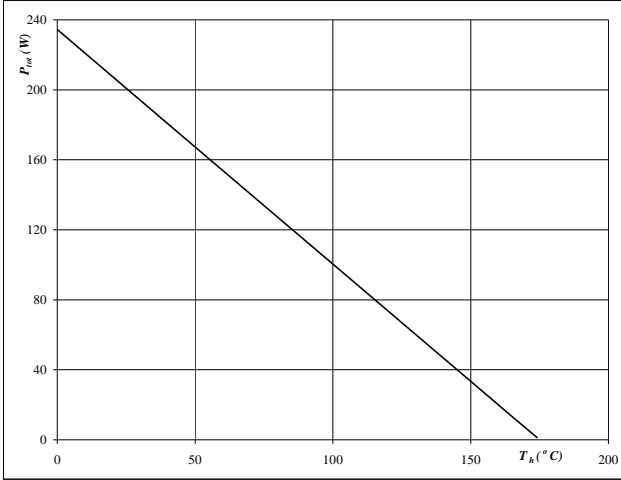
FWD thermal model values

Thermal grease	
R (C/W)	Tau (s)
0,02	9,2E+00
0,17	1,1E+00
0,55	2,0E-01
0,28	4,3E-02
0,13	7,2E-03
0,07	6,7E-04

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 21 T1,T2,T3,T4,T5,T6 IGBT

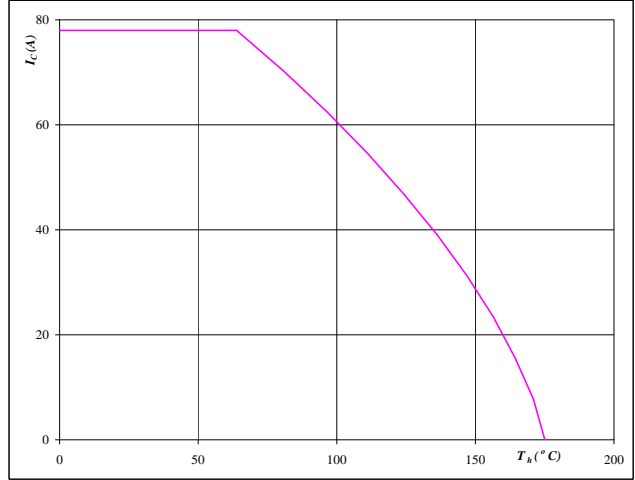
Power dissipation as a function of heatsink temperature

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


At
 $T_j = 175 \text{ } ^\circ\text{C}$
Figure 22 T1,T2,T3,T4,T5,T6 IGBT

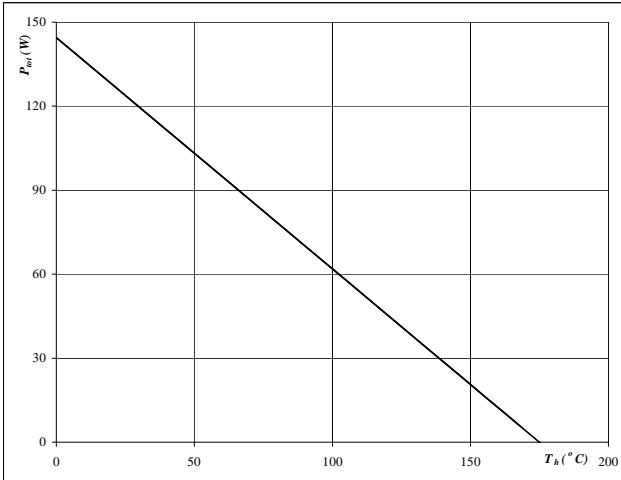
Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$


At
 $T_j = 175 \text{ } ^\circ\text{C}$
 $V_{GE} = 15 \text{ V}$
Figure 23 D1,D2,D3,D4,D5,D6 FWD

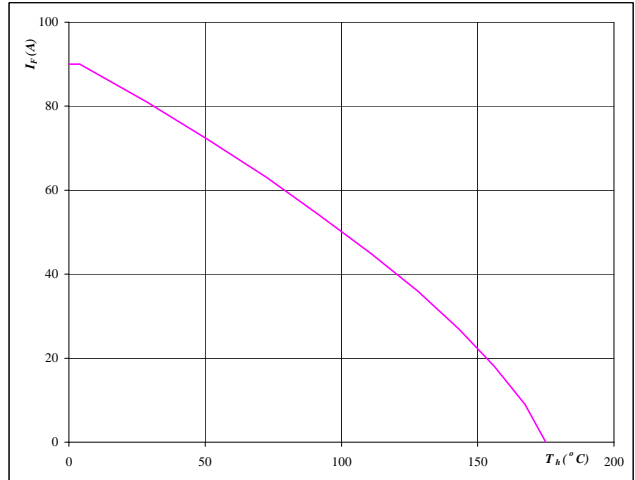
Power dissipation as a function of heatsink temperature

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


At
 $T_j = 175 \text{ } ^\circ\text{C}$
Figure 24 D1,D2,D3,D4,D5,D6 FWD

Forward current as a function of heatsink temperature

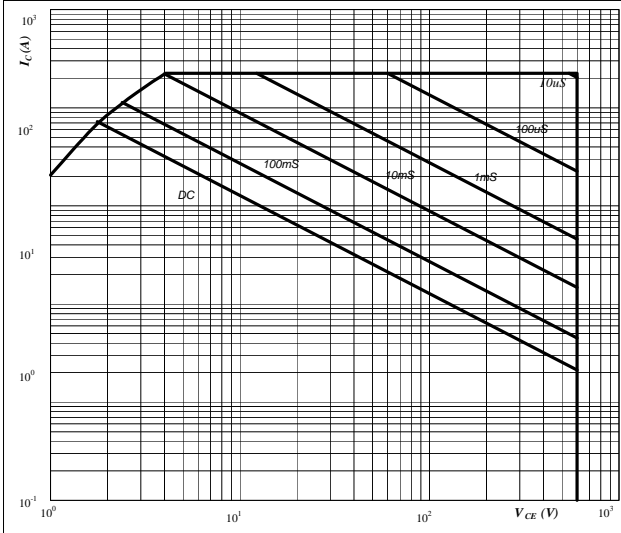
$$I_F = f(T_h)$$


At
 $T_j = 175 \text{ } ^\circ\text{C}$

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6
Figure 25 T1,T2,T3,T4,T5,T6 IGBT

Safe operating area as a function of collector-emitter voltage

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

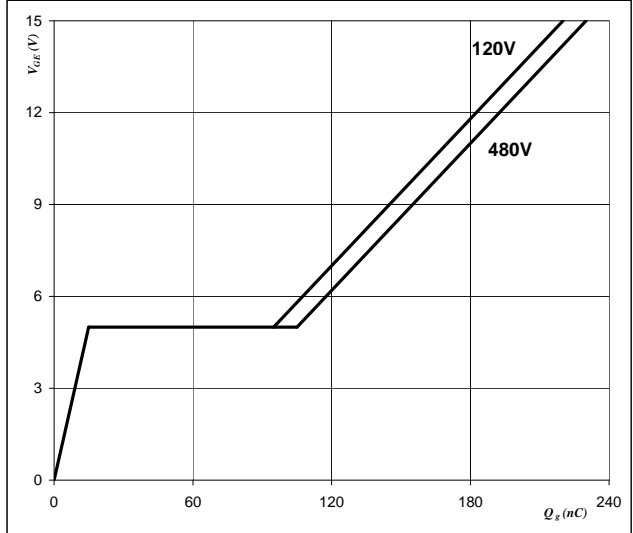


At
 D = single pulse
 $T_h = 80$ °C
 $V_{GE} = \pm 15$ V
 $T_j = T_{jmax}$ °C

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

Gate voltage vs Gate charge

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

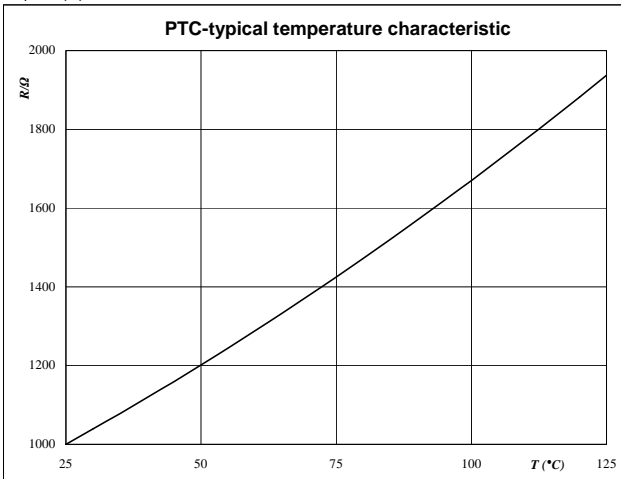


At
 $I_C = 75$ A

Thermistor
Figure 1 Thermistor

Typical PTC characteristic as a function of temperature

$$R_T = f(T)$$

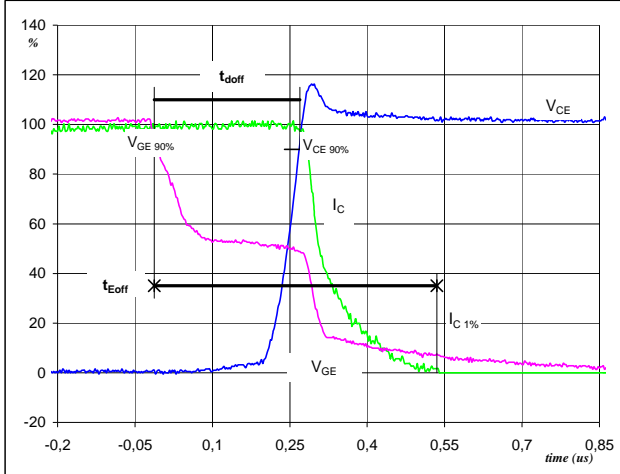


Switching Definitions Output Inverter

General conditions

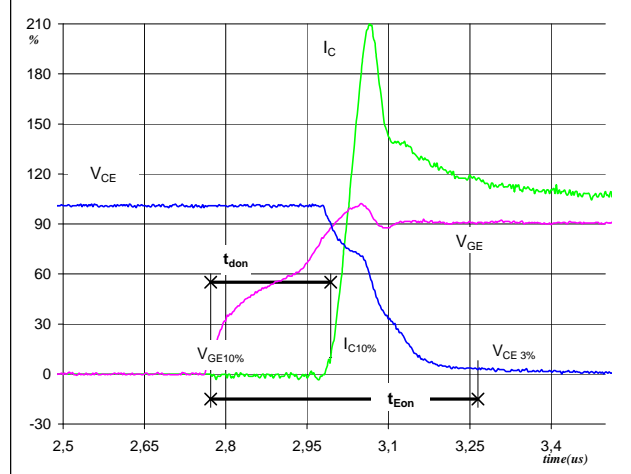
T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

Figure 1 Output inverter IGBT

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


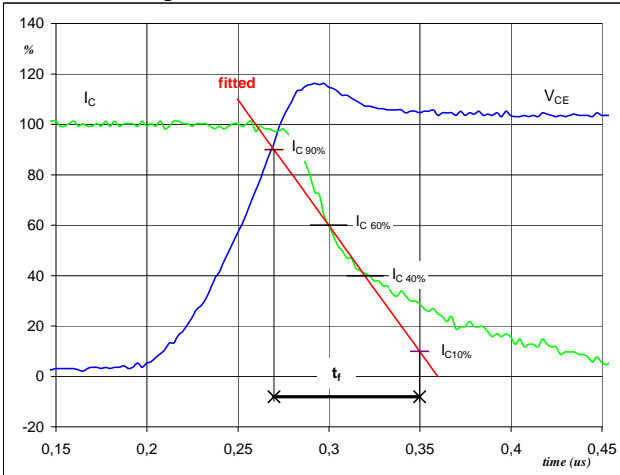
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	75	A
$t_{doff} =$	0,27	μs
$t_{Eoff} =$	0,55	μs

Figure 2 Output inverter IGBT

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


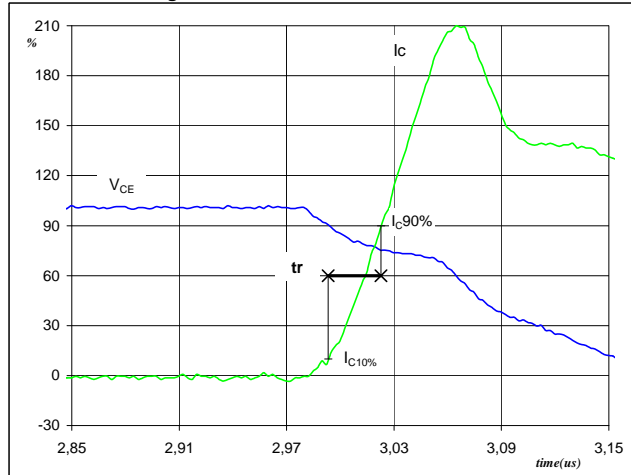
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	75	A
$t_{don} =$	0,22	μs
$t_{Eon} =$	0,49	μs

Figure 3 Output inverter IGBT

Turn-off Switching Waveforms & definition of t_f


$V_C(100\%) =$	300	V
$I_C(100\%) =$	75	A
$t_f =$	0,09	μs

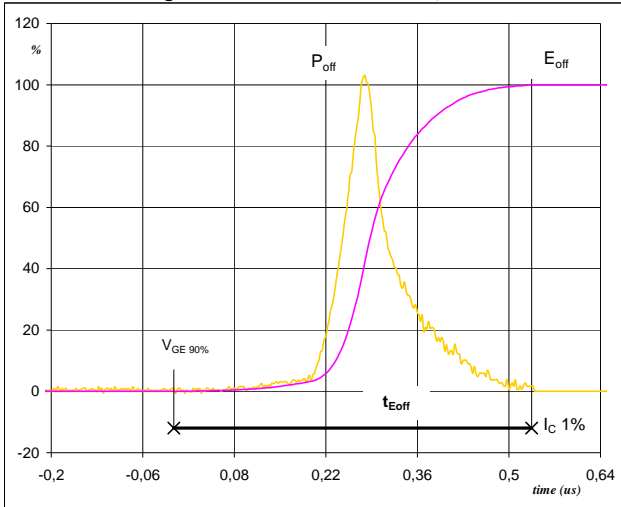
Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r


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

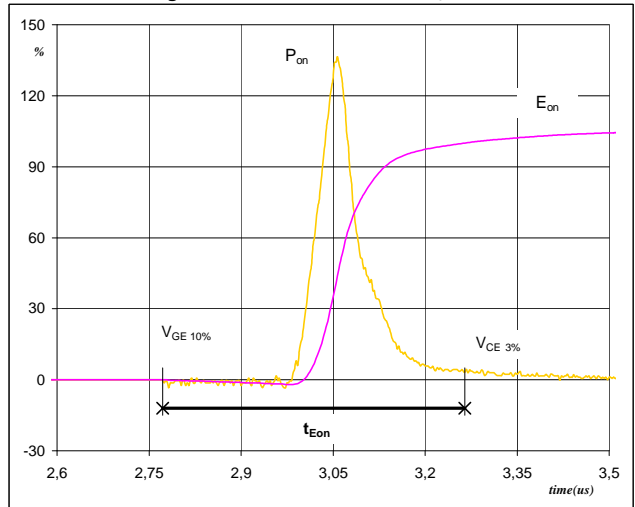
Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

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


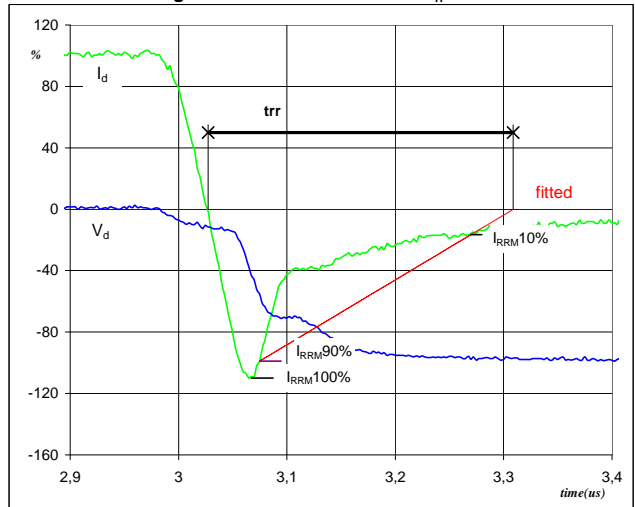
P_{off} (100%) =	22,36	kW
E_{off} (100%) =	2,22	mJ
t_{Eoff} =	0,55	μ s

Figure 6 Output inverter IGBT

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


P_{on} (100%) =	22,36	kW
E_{on} (100%) =	2,42	mJ
t_{Eon} =	0,49	μ s

Figure 7 Output inverter IGBT

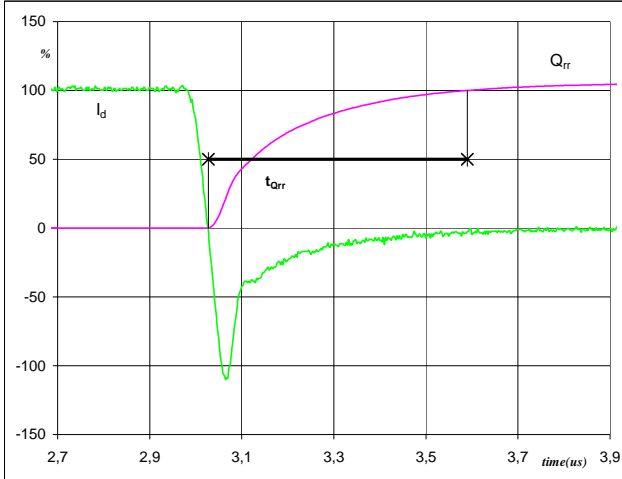
Turn-off Switching Waveforms & definition of t_{rr}


V_d (100%) =	300	V
I_d (100%) =	75	A
I_{RRM} (100%) =	82	A
t_{rr} =	0,33	μ s

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

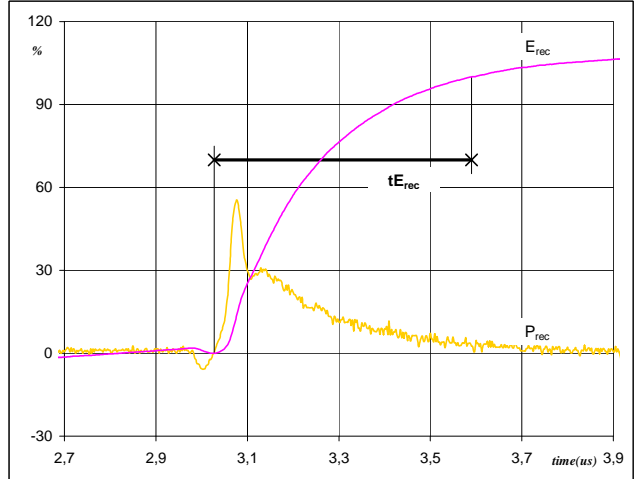
Turn-on Switching Waveforms & definition of t_{Qrr}
 (t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	75	A
Q_{rr} (100%) =	9,14	μC
t_{Qrr} =	0,56	μs

Figure 9 Output inverter FWD

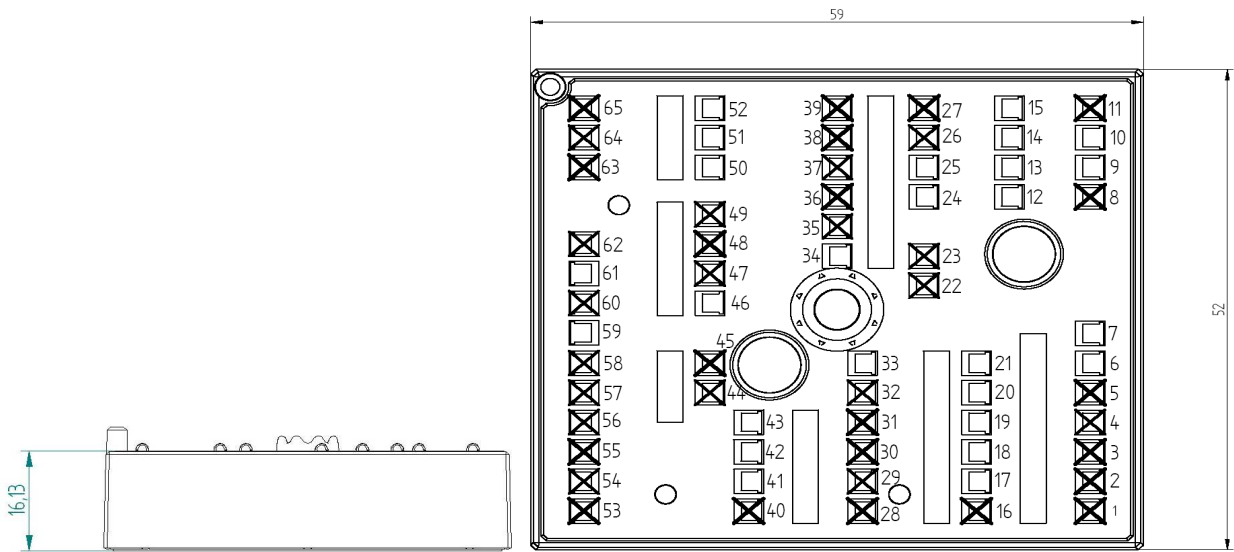
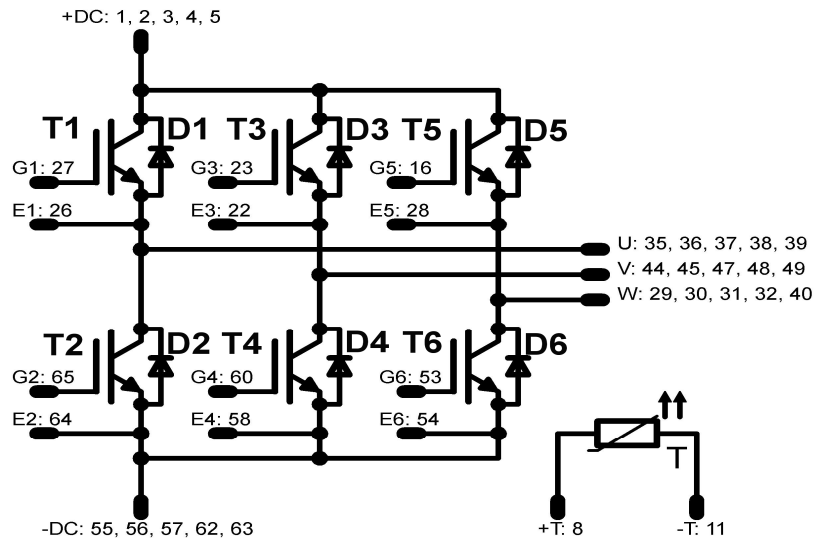
Turn-on Switching Waveforms & definition of t_{Erec}
 (t_{Erec} = integrating time for E_{rec})



P_{rec} (100%) =	22,36	kW
E_{rec} (100%) =	1,93	mJ
t_{Erec} =	0,56	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-K233-F-/1A/	K233F	K233-F
with std lid (black V23990-K22-T-PM) and P12	V23990-K233-F-/1B/	K233F	K233-F
with thin lid (white V23990-K23-T-PM)	V23990-K233-F-/0A/	K233F	K233-F
with thin lid (white V23990-K23-T-PM) and P12	V23990-K233-F-/0B/	K233F	K233-F

Outline

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.