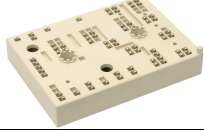
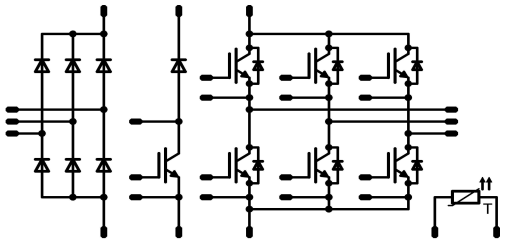


MiniSKiiP® 3 PIM		1200V / 75A	
Features - Solderless interconnection - Trench Fieldstop IGBT4 technology		MiniSKiiP® 3 housing 	
Target Applications Industrial Motor Drives		Schematic 	
Types V23990-K429-A40-PM			

Maximum Ratings

$T_j=25^{\circ}\text{C}$, 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}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	69	A
Surge forward current	I_{FSM}	$t_p=10\text{ms}$ $T_j=25^{\circ}\text{C}$	450	A
I^2t -value	I^2t		1020	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	77	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$
T1,T2,T3,T4,T5,T6,T7				
Collector-emitter break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	68	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by T_{jmax}	225	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	162	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j=150^{\circ}\text{C}$ $V_{GE}=15\text{V}$	10 800	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				
Repetitive peak reverse voltage	V_{RRM}		1200	V
DC forward current	I_{F}	$T_j=T_{j\text{max}}$ $T_h=80^{\circ}\text{C}$	67	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_{j\text{max}}$	225	A
Power dissipation per Diode	P_{tot}	$T_j=T_{j\text{max}}$ $T_h=80^{\circ}\text{C}$	131	W
Maximum Junction Temperature	$T_{j\text{max}}$		175	$^{\circ}\text{C}$

Thermal Properties

Storage temperature	T_{stg}		$-40\dots+125$	$^{\circ}\text{C}$
Operation temperature under switching condition	T_{op}		$-40\dots+(T_{j\text{max}} - 25)$	$^{\circ}\text{C}$

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	
D8,D9,D10,D11,D12,D13										
Forward voltage	V_F				35	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	0,8	1,03 0,93	1,35	V
Threshold voltage (for power loss calc. only)	V_{th}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,92 0,79		V
Slope resistance (for power loss calc. only)	r_t					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,004 0,005		Ω
Reverse current	I_r			1500		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			0,1 1,1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda=1W/mK$						0,90		K/W

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

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,003	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	1,6	1,97 2,42	2,4	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			600	nA
Integrated Gate resistor	R_{gint}							10		Ω
Turn-on delay time	$t_{d(on)}$	$R_{goff}=4\Omega$ $R_{gon}=4\Omega$	± 15	600	75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		173 189		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		30 40		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		284 359		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		78 120		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		6,51 10,61		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		4,25 6,68		
Input capacitance	C_{ies}	$f=1MHz$	0	25		$T_j=25^{\circ}C$		4400		pF
Output capacitance	C_{oss}							290		
Reverse transfer capacitance	C_{rss}							235		
Gate charge	Q_{Gate}		± 15			$T_j=25^{\circ}C$		570		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda=1W/mK$						0,58		K/W

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

Diode forward voltage	V_F				75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	1,5	2,01 2,05	2,8	V
Peak reverse recovery current	I_{RRM}	$R_{gon}=4\Omega$	± 15	600	75	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		57,3 68,4		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		310 602		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		6,29 14,8		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1733 384		A/ μs
Reverse recovered energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		2,21 5,51		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda=1W/mK$						0,75		K/W

Thermistor

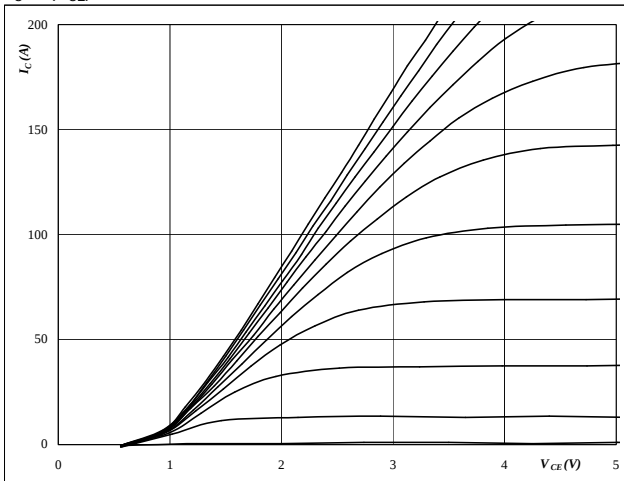
Rated resistance	R					$T=25^{\circ}C$		1000		Ω
Deviation of R100	$\Delta R/R$	R100=1670 Ω				$T=100^{\circ}C$	-3		3	%
R100	P					$T=100^{\circ}C$		1670,313		Ω
Power dissipation constant						$T=25^{\circ}C$				mW/K
A-value	B(25/50)	Tol. %				$T=25^{\circ}C$		7,635*10-3		1/K
B-value	B(25/100)	Tol. %				$T=25^{\circ}C$		1,731*10-5		1/K²
Vincotech PTC 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

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



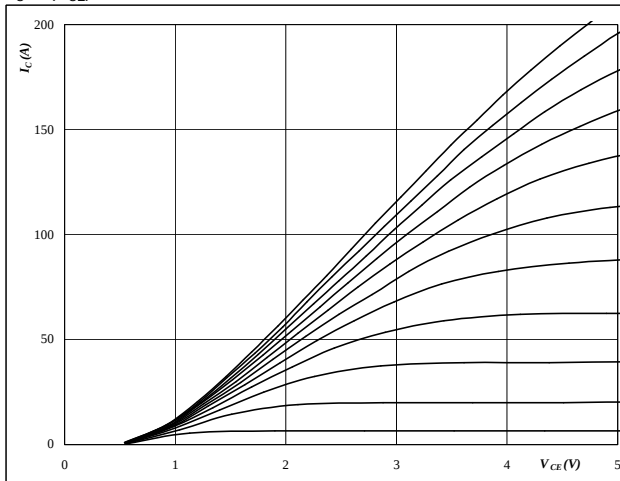
At

$t_p = 250 \mu s$
 $T_J = 25^\circ C$
 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

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



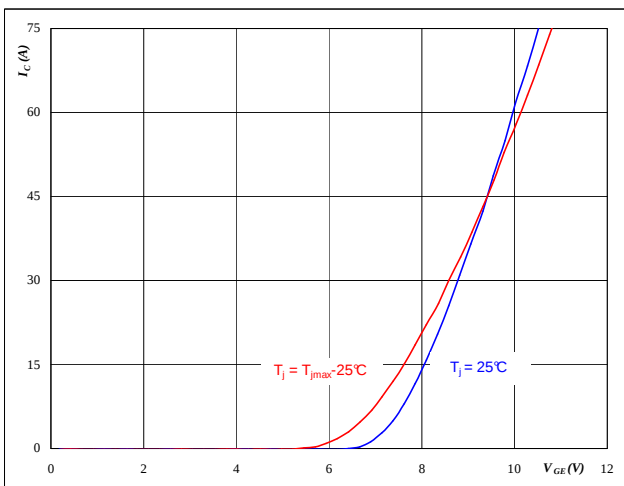
At

$t_p = 250 \mu s$
 $T_J = 150^\circ C$
 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

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



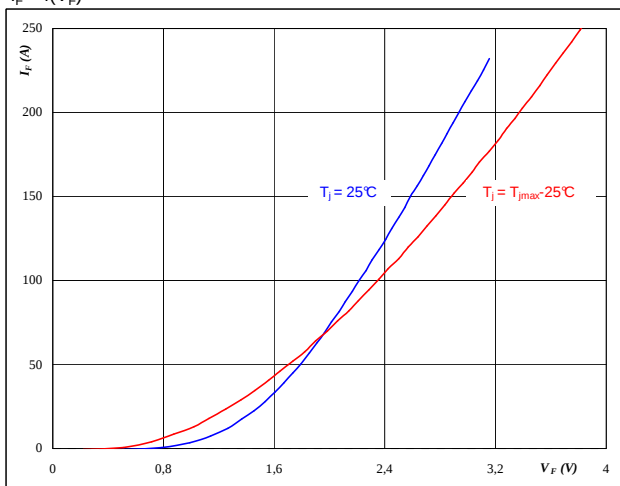
At

$t_p = 250 \mu s$
 $V_{CE} = 10 V$

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

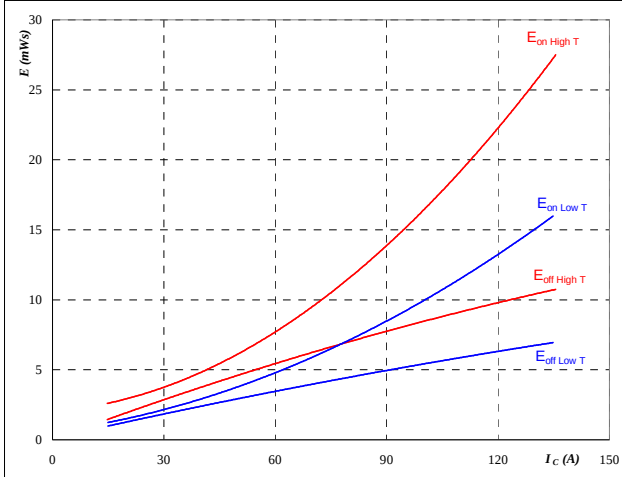
$t_p = 250 \mu s$

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

$$E = f(I_C)$$



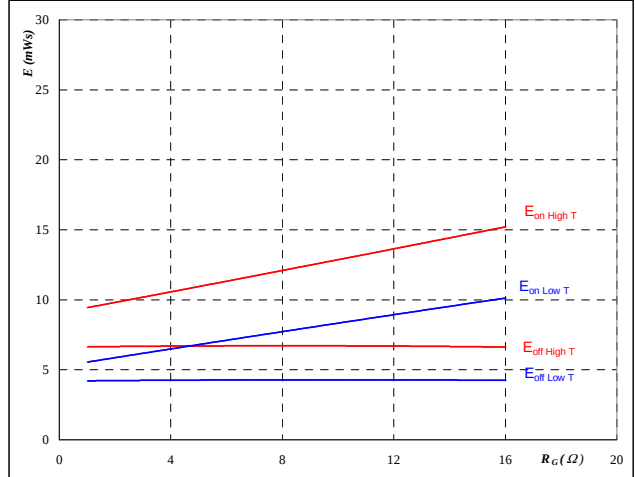
With an inductive load at

$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 4$ Ω
 $R_{goff} = 4$ Ω

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

Typical switching energy losses
as a function of gate resistor

$$E = f(R_G)$$



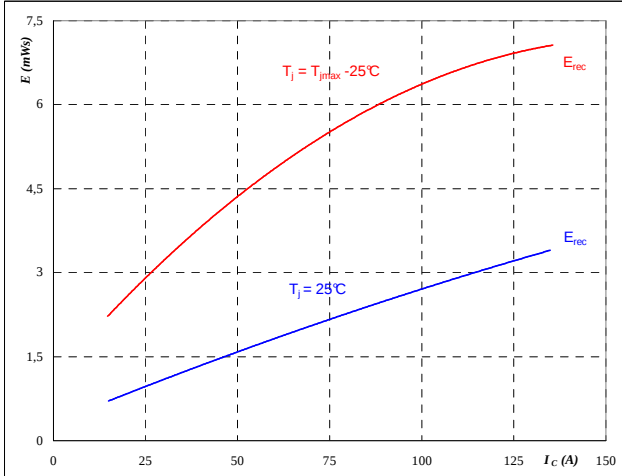
With an inductive load at

$T_J = 25/150$ °C
 $V_{CE} = 600$ 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

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



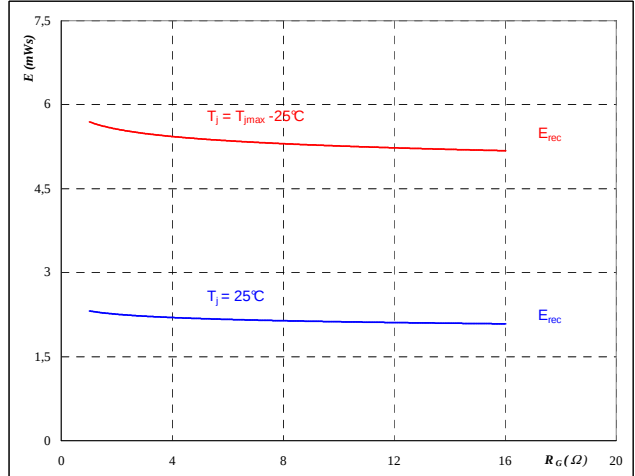
With an inductive load at

$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 4$ 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

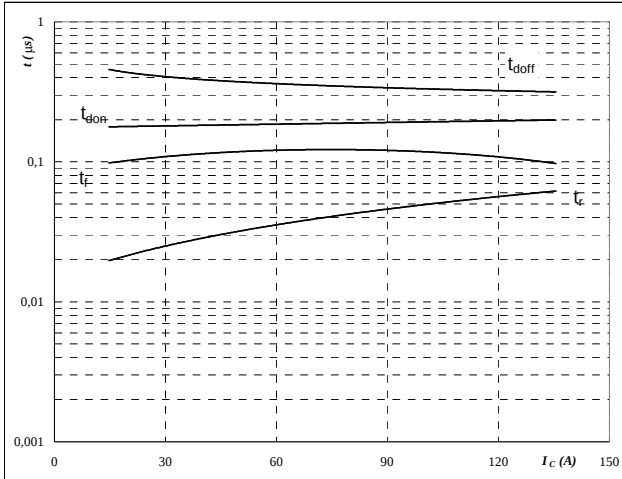
$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 75$ A

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

$$t = f(I_C)$$



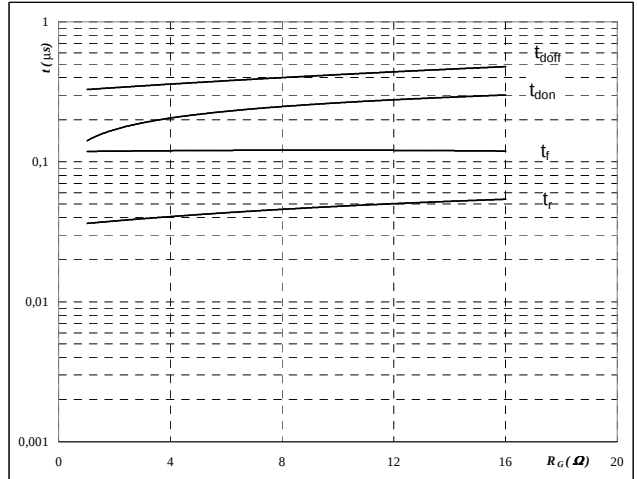
With an inductive load at

$T_J = 150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 4$ Ω
 $R_{goff} = 4$ Ω

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

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



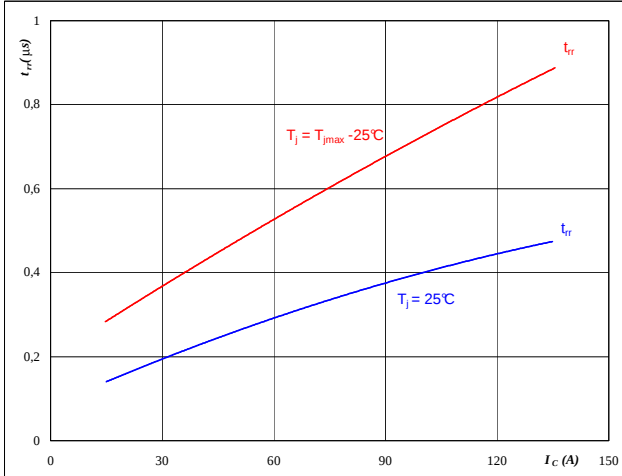
With an inductive load at

$T_J = 150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ 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

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



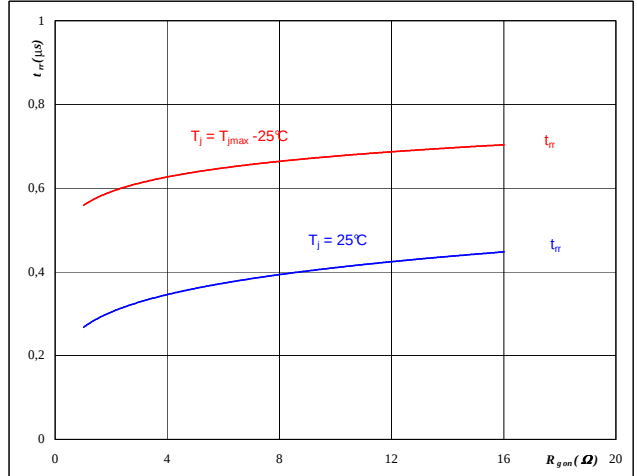
At

$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 4$ 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

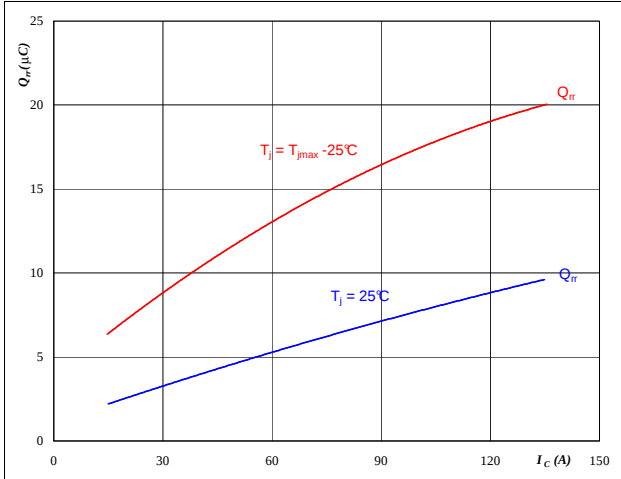
$T_J = 25/150$ °C
 $V_R = 600$ V
 $I_F = 75$ A
 $V_{GE} = \pm 15$ V

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

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



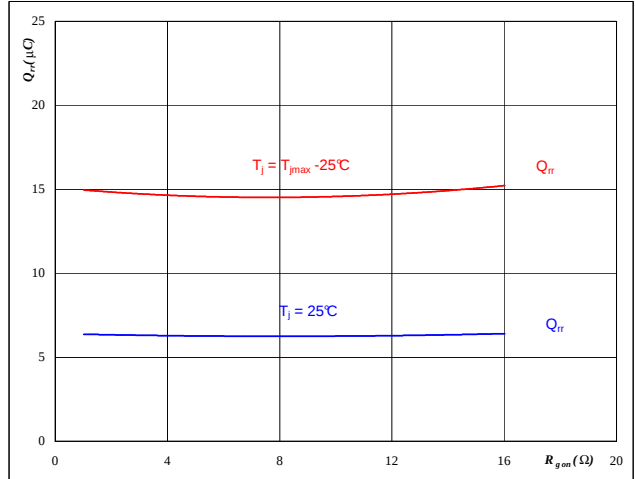
At

$T_j = 25/150^\circ\text{C}$
 $V_{CE} = 600\text{ V}$
 $V_{GE} = \pm 15\text{ V}$
 $R_{gon} = 4\ \Omega$

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

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

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



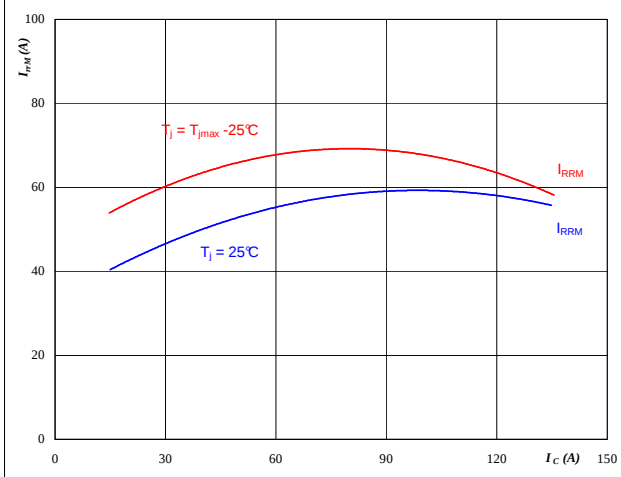
At

$T_j = 25/150^\circ\text{C}$
 $V_R = 600\text{ V}$
 $I_F = 75\text{ A}$
 $V_{GE} = \pm 15\text{ V}$

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

Typical reverse recovery current as a function of collector current

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



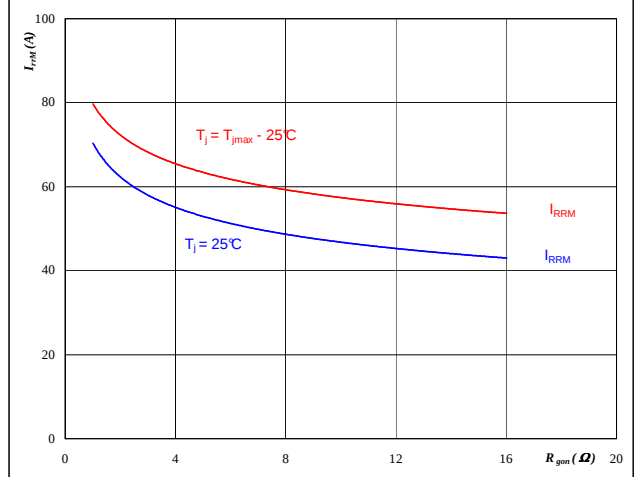
At

$T_j = 25/150^\circ\text{C}$
 $V_{CE} = 600\text{ V}$
 $V_{GE} = \pm 15\text{ V}$
 $R_{gon} = 4\ \Omega$

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

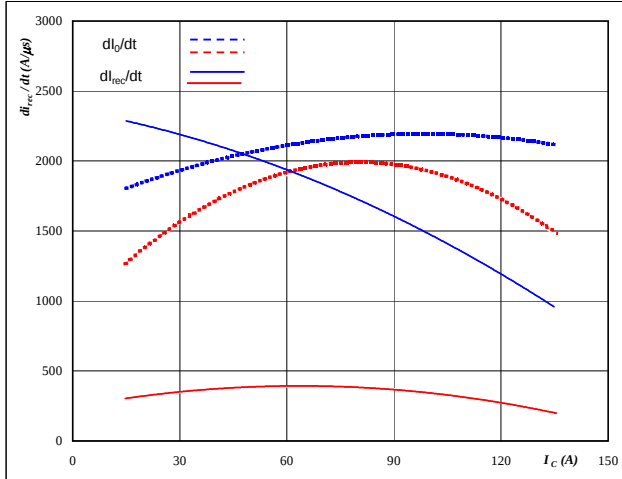
$T_j = 25/150^\circ\text{C}$
 $V_R = 600\text{ V}$
 $I_F = 75\text{ A}$
 $V_{GE} = \pm 15\text{ V}$

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

$$di_o/dt, di_{rec}/dt = f(I_c)$$



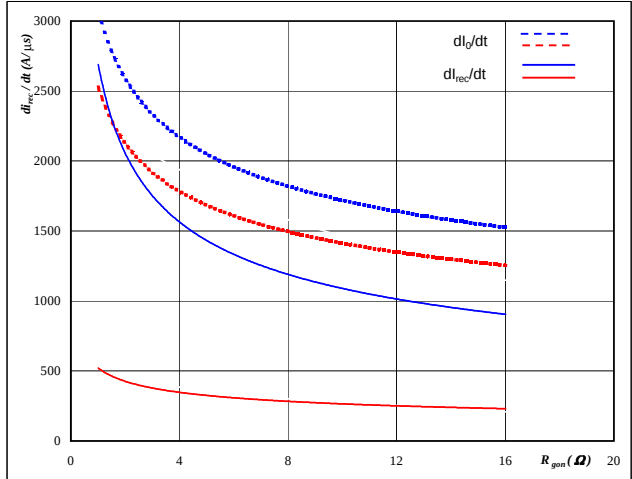
At

$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 4$ 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

$$di_o/dt, di_{rec}/dt = f(R_{gon})$$



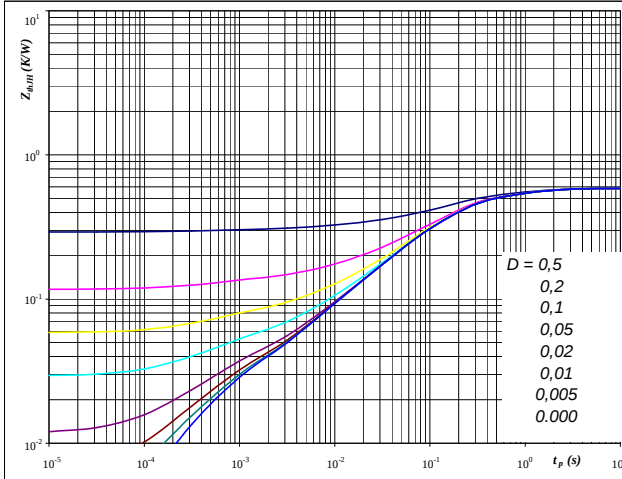
At

$T_j = 25/150$ °C
 $V_R = 600$ 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

$D = t_p / T$
 $R_{thJH} = 0,58$ K/W

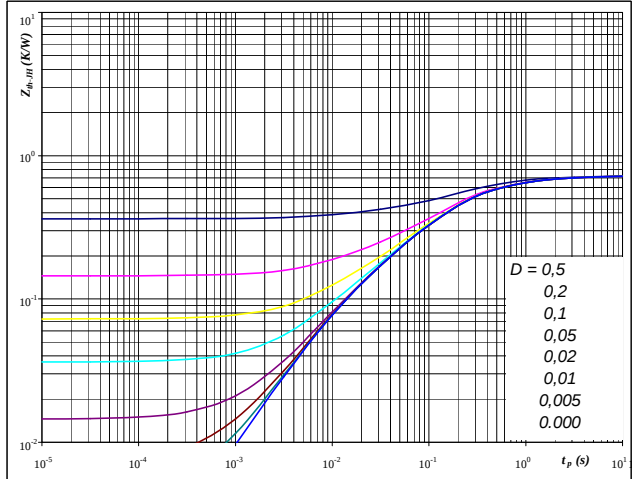
IGBT thermal model values

R (C/W)	Tau (s)
0,11	1,0E+00
0,33	1,5E-01
0,08	3,6E-02
0,04	7,3E-03
0,02	4,9E-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

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

FWD thermal model values

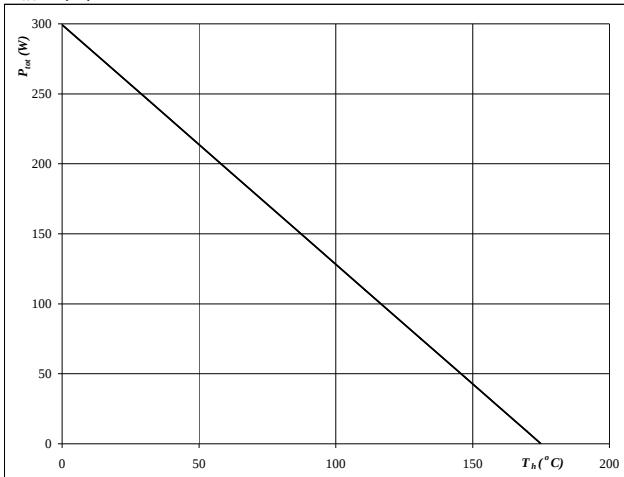
R (C/W)	Tau (s)
0,04	5,1E+00
0,12	9,5E-01
0,38	2,0E-01
0,12	6,1E-02
0,07	1,1E-02

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

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

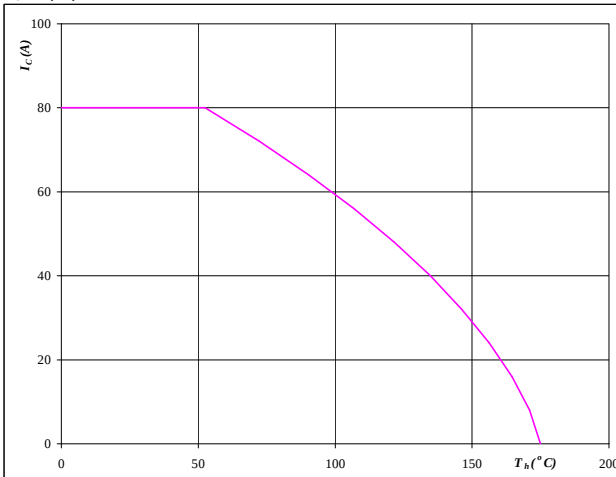


At
 $T_j = 175^{\circ}C$

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

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

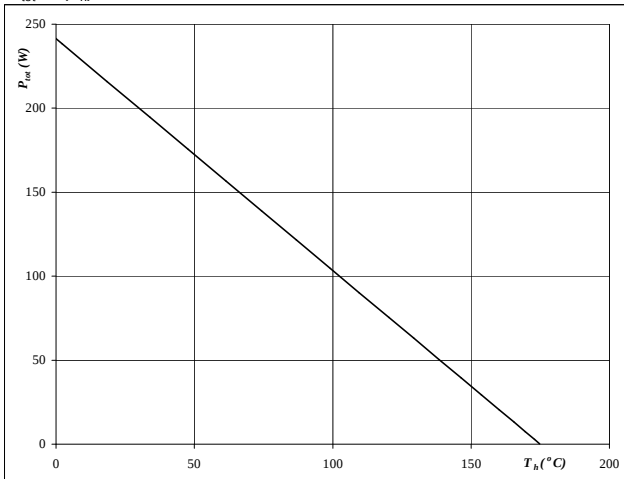


At
 $T_j = 175^{\circ}C$
 $V_{GE} = 15 V$

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

Power dissipation as a function of heatsink temperature

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

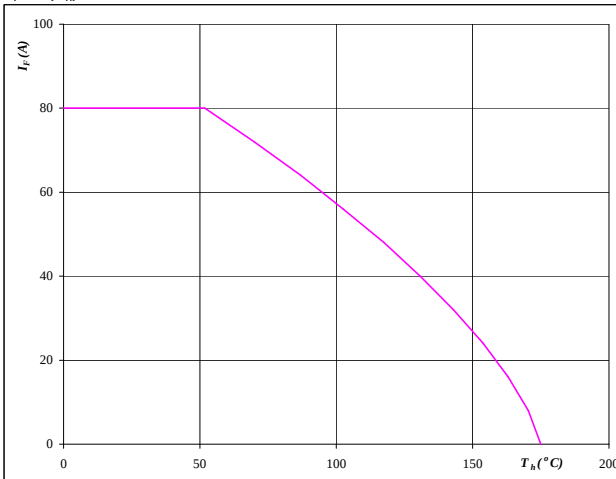


At
 $T_j = 175^{\circ}C$

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

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



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

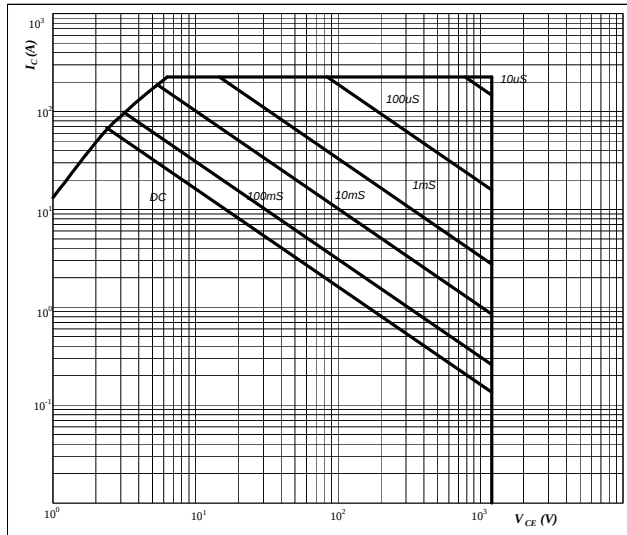
T1,T2,T3,T4,T5,T6,T7 / D1,D2,D3,D4,D5,D6,D7

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

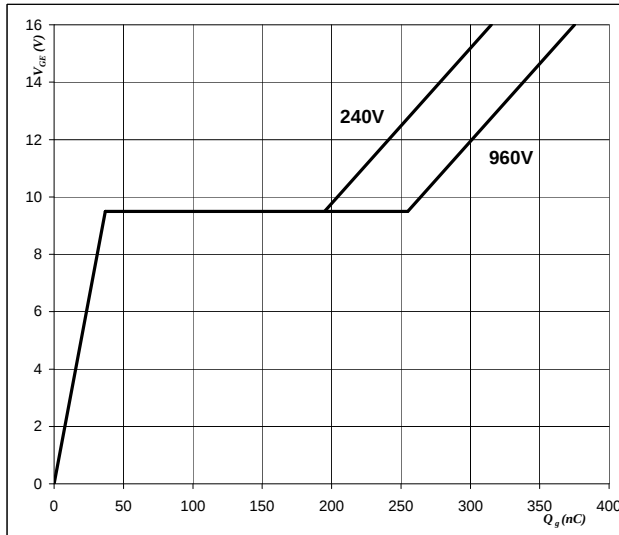
D = single pulse
 $T_h = 80$ °C
 $V_{GE} = \pm 15$ V
 $T_j = T_{jmax}$ °C

Figure 26

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

Gate voltage vs Gate charge

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



At

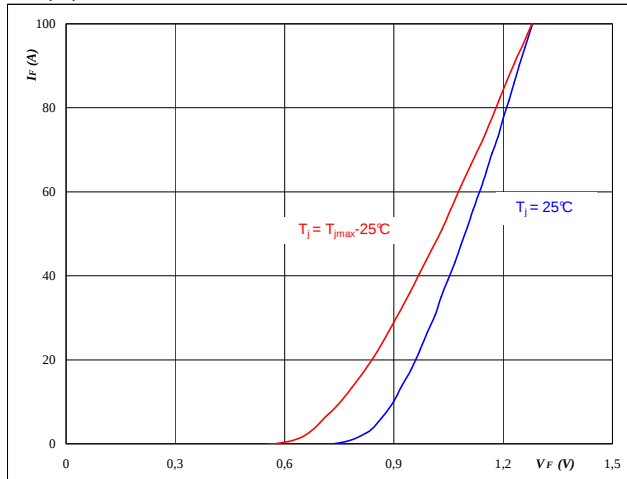
$I_C = 75$ A

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

$$I_F = f(V_F)$$

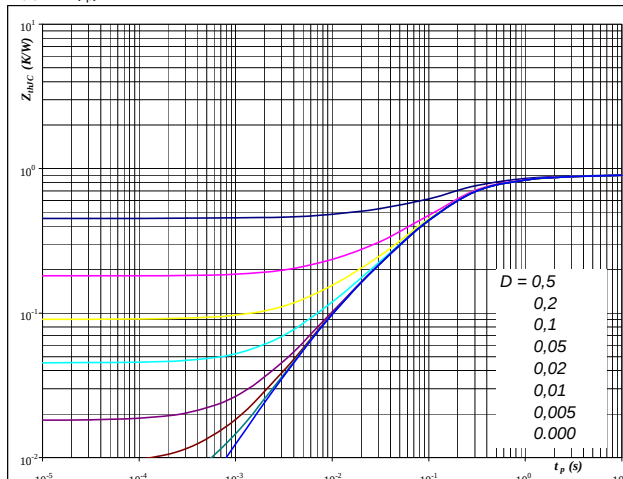


At
 $t_p = 250 \mu s$

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

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

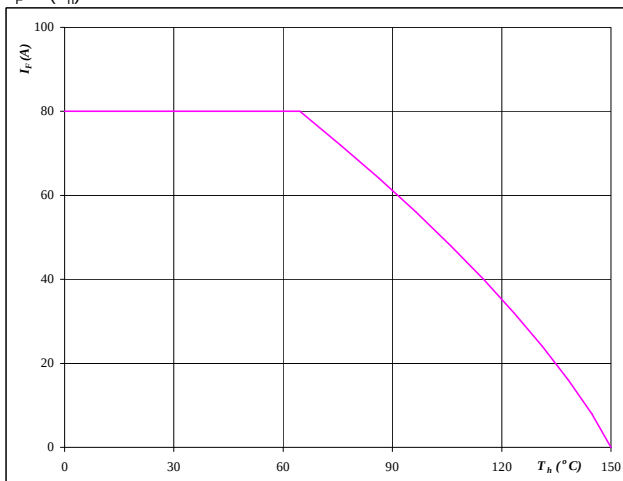


At
 $T_J = 150 \text{ °C}$

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

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



At
 $T_J = 150 \text{ °C}$

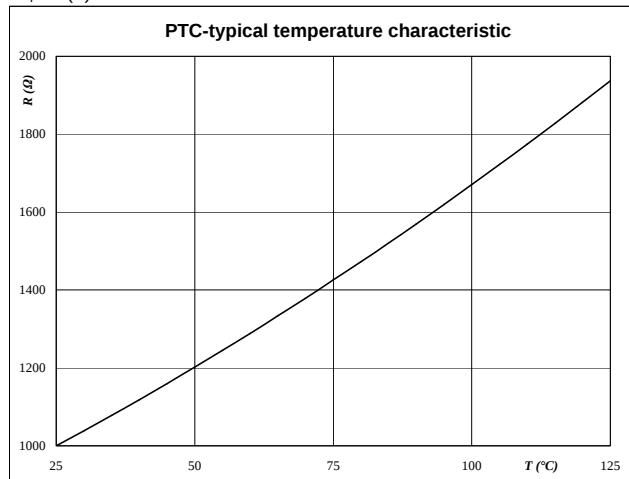
Thermistor

Figure 1

Thermistor

Typical PTC characteristic
as a function of temperature

$$R_T = f(T)$$



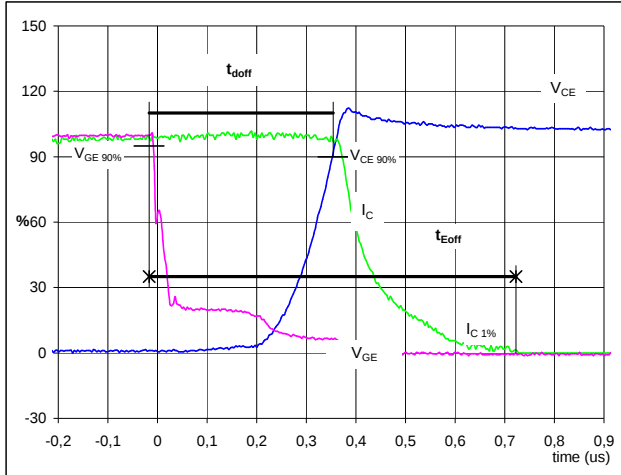
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	4 Ω
R_{goff}	=	4 Ω

Figure 1 Output inverter IGBT

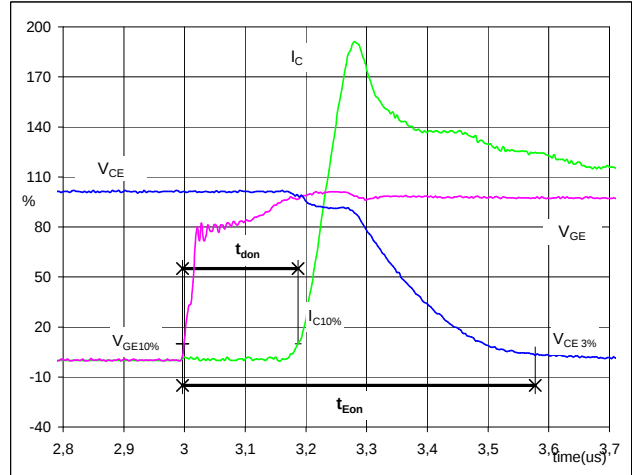
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	75	A
t_{doff}	=	0,36	μs
t_{Eoff}	=	0,74	μs

Figure 2 Output inverter IGBT

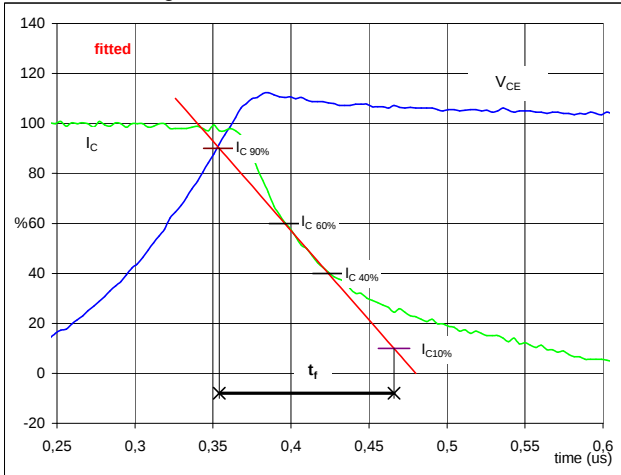
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
(t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	75	A
t_{don}	=	0,19	μs
t_{Eon}	=	0,58	μs

Figure 3 Output inverter IGBT

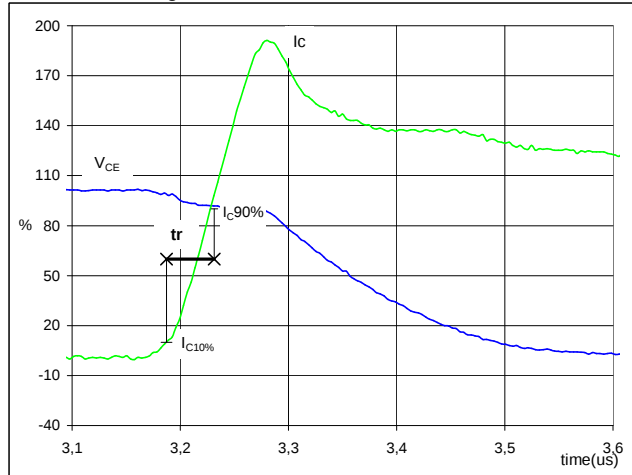
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	75	A
t_f	=	0,12	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

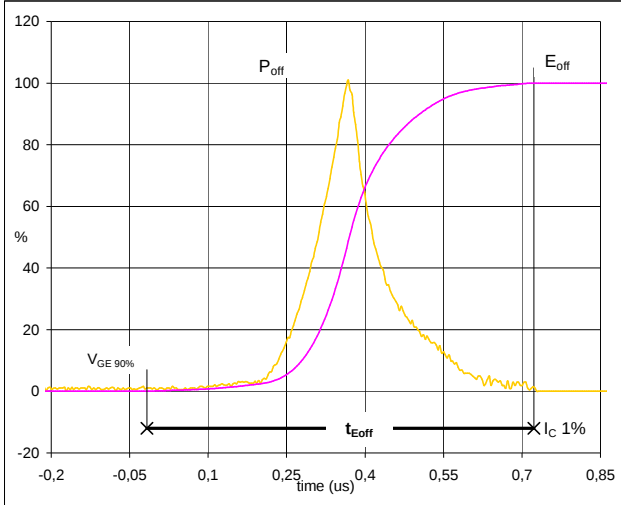


$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	75	A
t_r	=	0,04	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

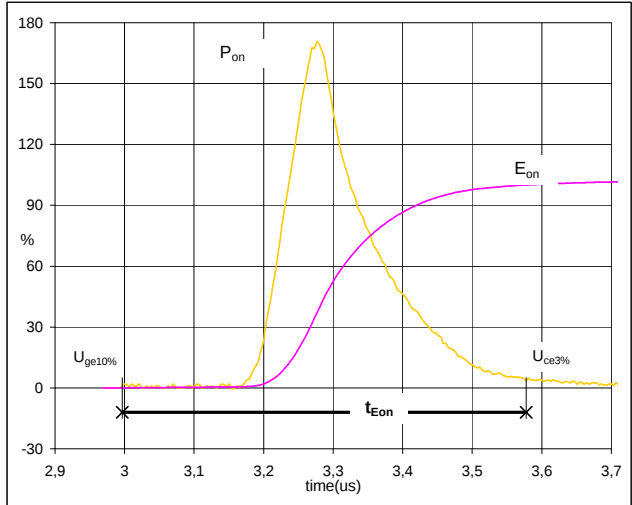
Turn-off Switching Waveforms & definition of t_{Eoff}



$P_{off}(100\%) = 45,10 \text{ kW}$
 $E_{off}(100\%) = 6,68 \text{ mJ}$
 $t_{Eoff} = 0,74 \text{ }\mu\text{s}$

Figure 6 Output inverter IGBT

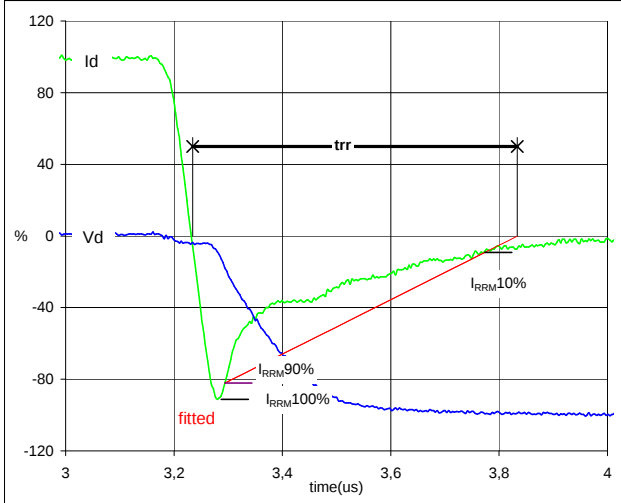
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on}(100\%) = 45,10 \text{ kW}$
 $E_{on}(100\%) = 10,61 \text{ mJ}$
 $t_{Eon} = 0,58 \text{ }\mu\text{s}$

Figure 7 Output inverter IGBT

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

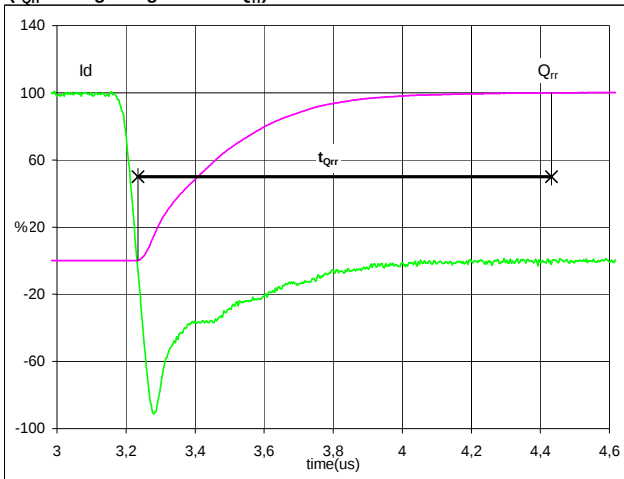


$V_d(100\%) = 600 \text{ V}$
 $I_d(100\%) = 75 \text{ A}$
 $I_{RRM}(100\%) = -68 \text{ A}$
 $t_{tr} = 0,60 \text{ }\mu\text{s}$

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

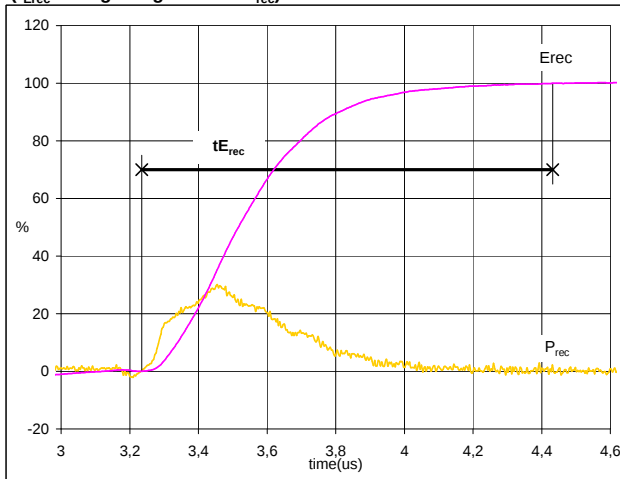
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 75 A
 Q_{rr} (100%) = 14,81 μC
 t_{Qrr} = 1,20 μs

Figure 9 Output inverter FWD

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



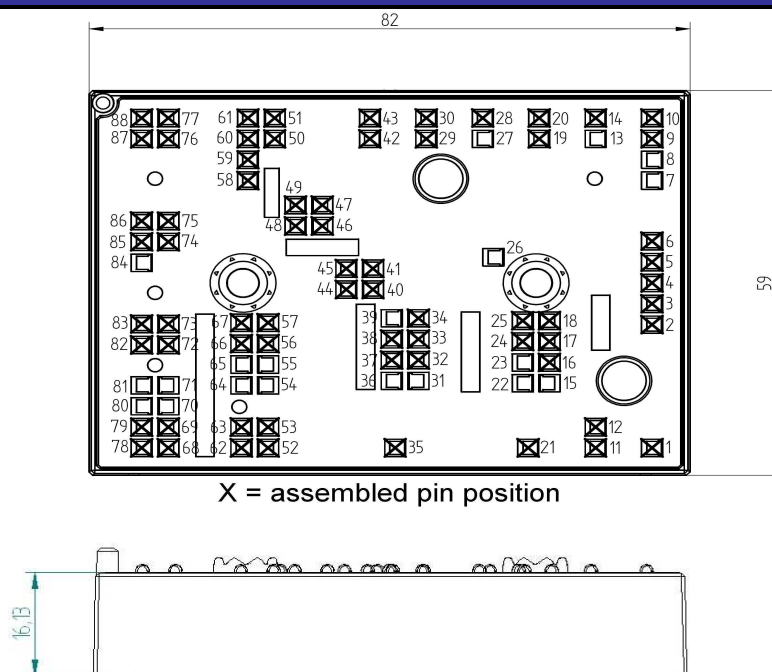
P_{rec} (100%) = 45,10 kW
 E_{rec} (100%) = 5,51 mJ
 t_{Erec} = 1,20 μs

Ordering Code and Marking - Outline - Pinout

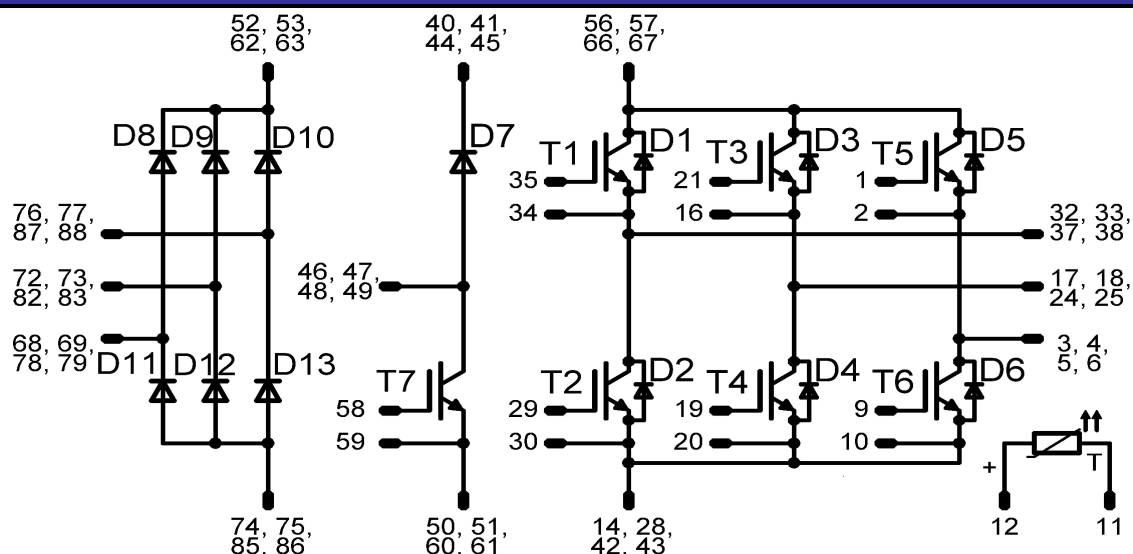
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K32-T-PM)	V23990-K429-A40-/0A/-PM	K429A40	K429A40-/0A/
with std lid (black V23990-K32-T-PM) and P12	V23990-K429-A40-/1A/-PM	K429A40	K429A40-/1A/
with thin lid (white V23990-K33-T-PM)	V23990-K429-A40-/0B/-PM	K429A40	K429A40-/0B/
with thin lid (white V23990-K33-T-PM) and P12	V23990-K429-A40-/1B/-PM	K429A40	K429A40-/1B/

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.