
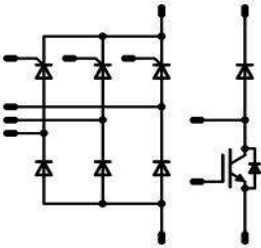


<i>flow90CON 1</i>	1600V/50A
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Features</p> <ul style="list-style-type: none"> 3- phase input rectifier with or without BRC *optional half controlled Compatible with flow 90PACK 1 Support designs with 90° mounting angle between heatsink and PCB Clip-in PCB mounting </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Target Applications</p> <ul style="list-style-type: none"> Motor drives Servo drives </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Types</p> <ul style="list-style-type: none"> V23990-P718-G-PM V23990-P718-G10-PM half controlled V23990-P718-H-PM w/o brake V23990-P718-H10-PM half controlled, w/o brake </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">flow90 housing</p>  </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Schematic</p>  </div>

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit	
Input Rectifier Diode					
Repetitive peak reverse voltage	V _{RRM}		1600	V	
Forward current per diode	I _{FAV}	DC current	T _h =80°C T _c =80°C	52 71	A
Surge forward current	I _{FSM}	t _p =10ms	T _j =45°C	850	A
I ² t-value	I ² t			3610	A ² s
Power dissipation per Diode	P _{tot}	T _j =T _{jmax}	T _h =80°C T _c =80°C	61 92	W
Maximum Junction Temperature	T _{jmax}			150	°C
Input Rectifier Thyristor					
Repetitive peak reverse voltage	V _{RRM}		1600	V	
Forward average current	I _{FAV}	sine, d=0.5 T _j =T _{jmax}	T _h =80°C T _c =80°C	43 50	A
Surge forward current	I _{FSM}	t _p =10ms	T _j =45°C	620	A
I ² t-value	I ² t			1920	A ² s
Power dissipation per Thyristor	P _{tot}	T _j =T _{jmax}	T _h =80°C T _c =80°C	60 91	W
Maximum Junction Temperature	T _{jmax}			150	°C

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Brake IGBT				
Collector-emitter Break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	31 40	A
Pulsed collector current	I_{Cpuls}	t_p limited by T_{jmax}	105	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	73 110	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$	10 1200	μs V
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Brake Inverse Diode

Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	8 8	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	6	A
Brake Inverse Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	20 30	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Brake FWD

Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	14 19	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	30	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	29 44	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Thermal Properties

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

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		
Input Rectifier Diode										
Forward voltage	V_F				59	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	0,8	1,23 1,21	1,5	V
Threshold voltage (for power loss calc. only)	V_{to}				59	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0,92 0,81		V
Slope resistance (for power loss calc. only)	r_t				59	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		5,0 6,8		m Ω
Reverse current	I_r			1500		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			0,05	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness \leq 50 μ m $\lambda = 0,61$ W/mK						1,15		K/W
Input Rectifier Thyristor										
Forward voltage	V_F				0,048	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1	1,36 1,38	1,9	V
Threshold voltage (for power loss calc. only)	V_{to}		$V_D=6$ V		35	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		1,00 0,89		V
Slope resistance (for power loss calc. only)	r_t				35	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0,01 0,01		m Ω
Reverse current	I_r			1200		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			0,05 5	mA
Gate controlled delay time	t_{GD}	$I_G=0,5$ A $V_D=1/2 V_{DRM}$				$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			2	μ s
Gate controlled rise time	t_{GR}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		tbd.		μ s
Critical rate of rise of off-state voltage	$(dv/dt)_{cr}$	$V_D=2/3 V_{DRM}$ linear voltage rise				$T_j=150^\circ\text{C}$			1000	V/ μ s
Critical rate of rise of on-state current	$(di/dt)_{cr}$	$V_D=2/3 V_{DRM}$ $I_G=0,45$ A; $f=50$ Hz	$t_p=200$ μ s		42	$T_j=150^\circ\text{C}$			500	A/ μ s
Circuit commutated turn-off time	t_q	$V_D=2/3 V_{DRM}$	$t_p=200$ μ s	100	42	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		150		μ s
Holding current	I_H		$V_D=6$ V			$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		75		mA
Latching current	I_L	$I_G=0,45$ A $t_p=10$ μ s				$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		125		mA
Gate trigger voltage	V_{GT}		$V_D=6$ V			$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			1,5	V
Gate trigger current	I_{GT}		$V_D=6$ V			$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			50	mA
Gate non-trigger voltage	V_{GD}	$V_D=2/3 V_{DRM}$				$T_j=150^\circ\text{C}$			0,2	V
Gate non-trigger current	I_{GD}	$V_D=2/3 V_{DRM}$				$T_j=150^\circ\text{C}$			5	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness \leq 50 μ m $\lambda = 0,61$ W/mK						1,16		K/W
Brake IGBT										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0015	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		35	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1,3	2,11 2,40	2,25	V
Collector-emitter cut-off incl diode	I_{CES}		0	1200		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			0,25	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			650	nA
Integrated Gate resistor	R_{gint}							6		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon}=32$ Ω $R_{goff}=16$ Ω	± 15	600	35	$T_j=25^\circ\text{C}$		56	ns	
Rise time	t_r					$T_j=125^\circ\text{C}$		56		
Turn-off delay time	$t_{d(off)}$					$T_j=25^\circ\text{C}$		19		
Fall time	t_f					$T_j=125^\circ\text{C}$		26		
Turn-on energy loss per pulse	E_{on}					$T_j=25^\circ\text{C}$		492		
Turn-off energy loss per pulse	E_{off}					$T_j=125^\circ\text{C}$		577		
						$T_j=25^\circ\text{C}$		109		
		$T_j=125^\circ\text{C}$		167						
		$T_j=25^\circ\text{C}$		2,06						
		$T_j=125^\circ\text{C}$		2,42						
		$T_j=25^\circ\text{C}$		1,79						
		$T_j=125^\circ\text{C}$		2,79						
Input capacitance	C_{ies}							2530		
Output capacitance	C_{oss}	$f=1$ MHz	0	25		$T_j=25^\circ\text{C}$		132		
Reverse transfer capacitance	C_{riss}							115		
Gate charge	Q_{gate}					$T_j=25^\circ\text{C}$		205		
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness \leq 50 μ m $\lambda = 0,61$ W/mK						0,96		K/W

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		
Brake Inverse Diode										
Diode forward voltage	V_F			3	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1	1,60 1,57	2,2		V
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness \leq 50um $\lambda = 0,61$ W/mK					3,22			K/W
Brake FWD										
Diode forward voltage	V_F			15	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1	2,07 2,45	2,3		V
Reverse leakage current	I_r		± 15	300	25	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		250		μA
Peak reverse recovery current	I_{RRM}	$R_{gon}=32 \Omega$	± 15	300	25	$T_j=25^\circ\text{C}$	16,77			A
Reverse recovery time	t_{rr}					$T_j=125^\circ\text{C}$	17,11			ns
Reverse recovered charge	Q_{rr}					$T_j=25^\circ\text{C}$	332			
Peak rate of fall of recovery current	$di(\text{rec})_{\text{max}}/dt$					$T_j=125^\circ\text{C}$	505			
Reverse recovery energy	E_{rec}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1,79 2,78			mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness \leq 50um $\lambda = 0,61$ W/mK					2,40			K/W

Brake

Figure 1 Brake IGBT

Typical output characteristics

$I_C = f(V_{CE})$

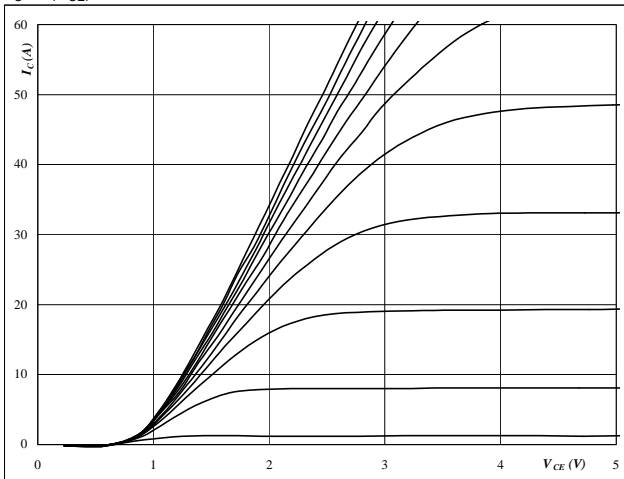

At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 Brake IGBT

Typical output characteristics

$I_C = f(V_{CE})$

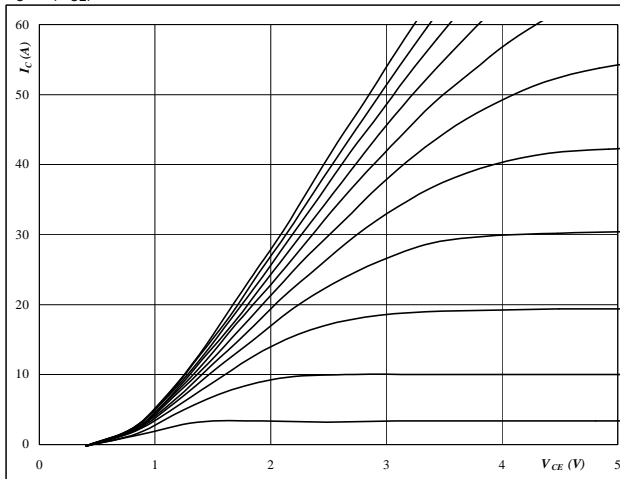
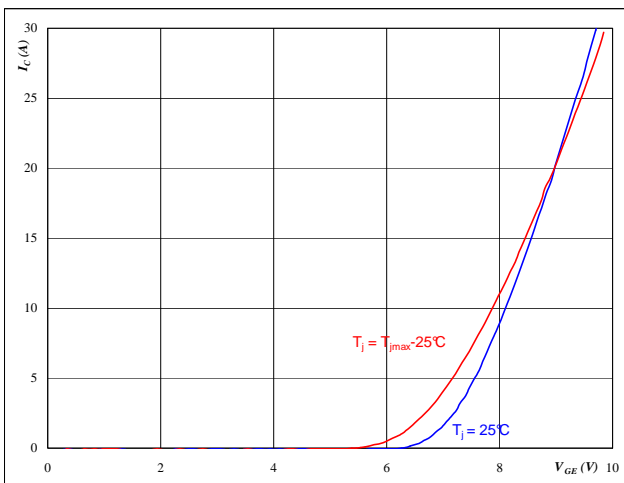

At
 $t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 Brake IGBT

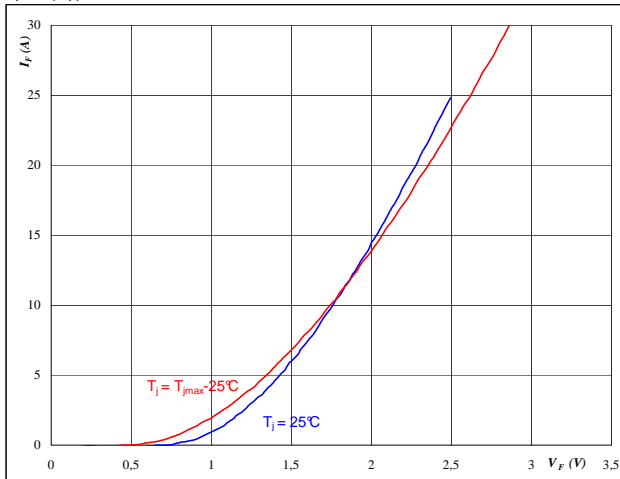
Typical transfer characteristics

$I_C = f(V_{GE})$


At
 $t_p = 250 \mu s$
 $V_{CE} = 10 V$
Figure 4 Brake FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

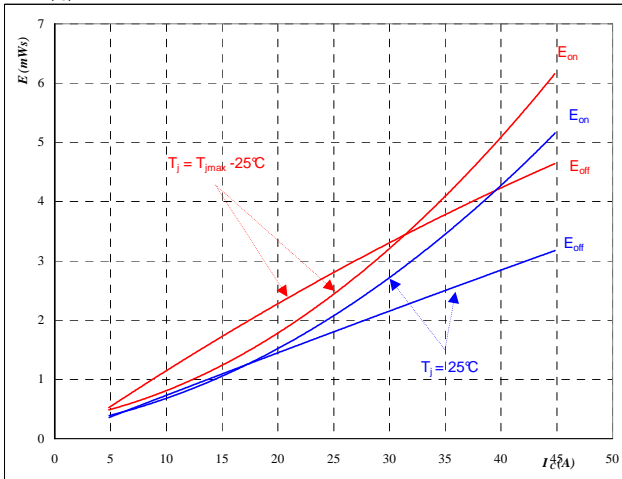

At
 $t_p = 250 \mu s$

Brake

Figure 5 Brake IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



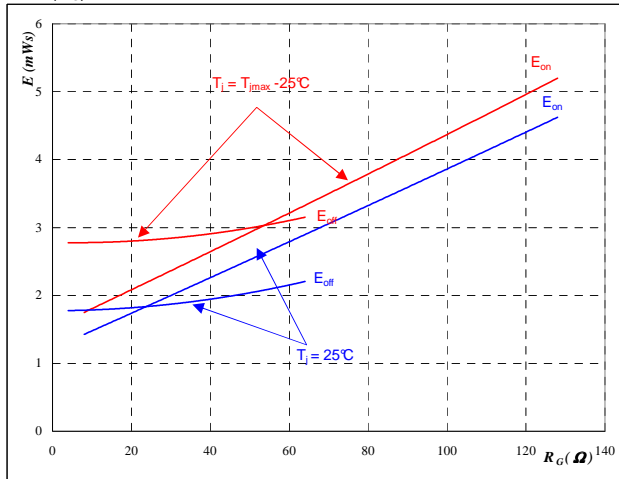
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 600$ V
 $V_{GE} = 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 16$ Ω

Figure 6 Brake IGBT

Typical switching energy losses
as a function of gate resistor

$$E = f(R_G)$$



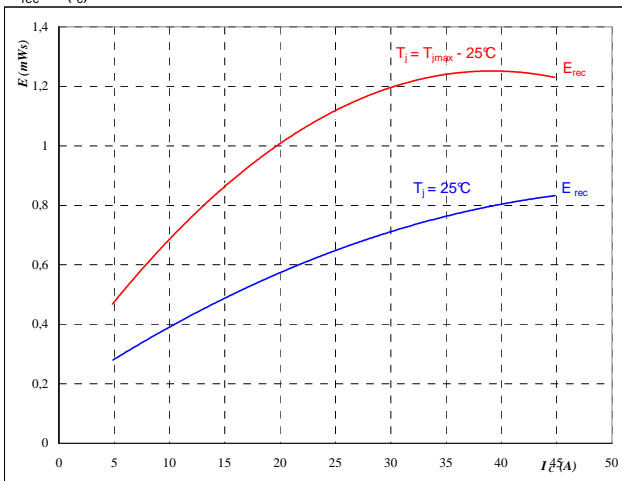
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 600$ V
 $V_{GE} = 15$ V
 $I_C = 25$ A

Figure 7 Brake IGBT

Typical reverse recovery energy loss
as a function of collector current

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



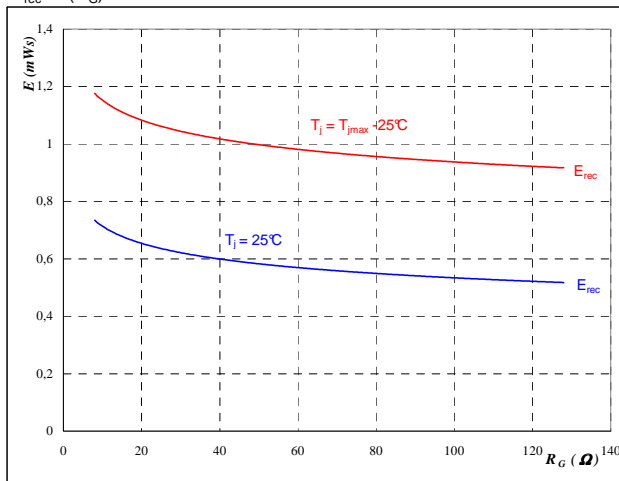
With an inductive load at

$T_j = 25/125$ °C
 $V_{CE} = 600$ V
 $V_{GE} = 15$ V
 $R_{gon} = 32$ Ω

Figure 8 Brake IGBT

Typical reverse recovery energy loss
as a function of gate resistor

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



With an inductive load at

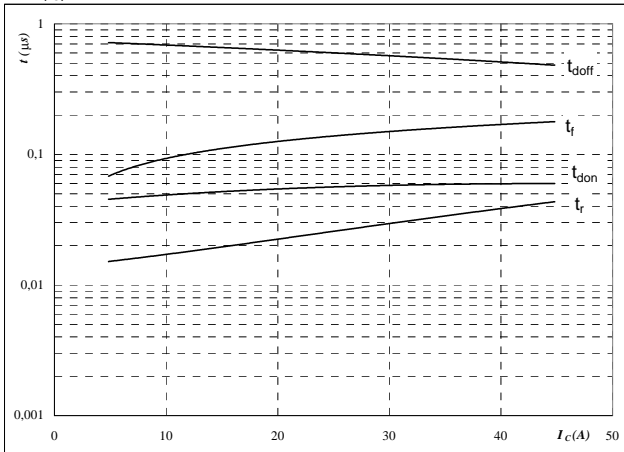
$T_j = 25/125$ °C
 $V_{CE} = 600$ V
 $V_{GE} = 15$ V
 $I_C = 25$ A

Brake

Figure 9 Brake IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



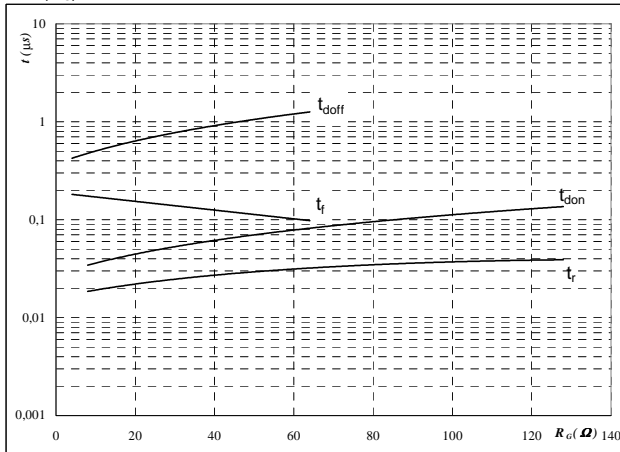
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	600	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	16	Ω

Figure 10 Brake IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



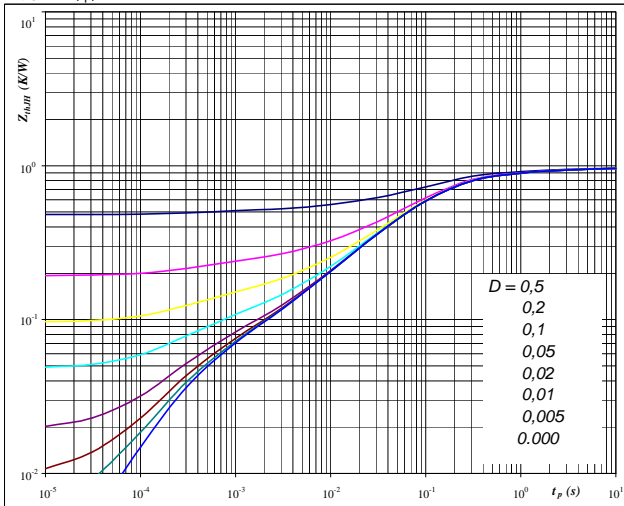
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	600	V
$V_{GE} =$	15	V
$I_C =$	25	A

Figure 11 Brake IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



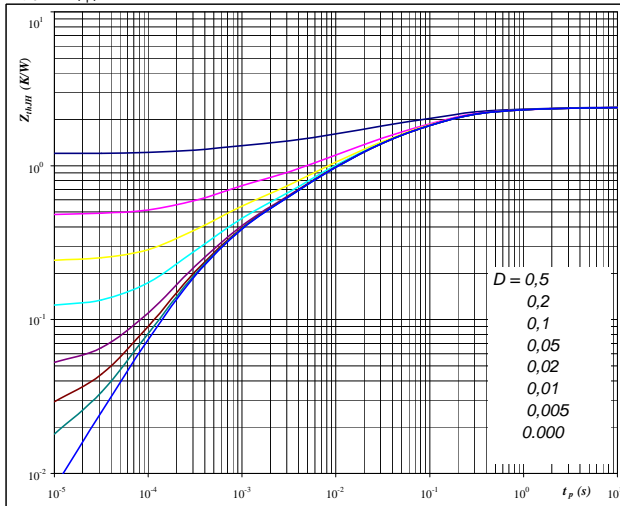
At

$D =$	t_p / T	
$R_{thJH} =$	0,96	K/W

Figure 12 Brake FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



At

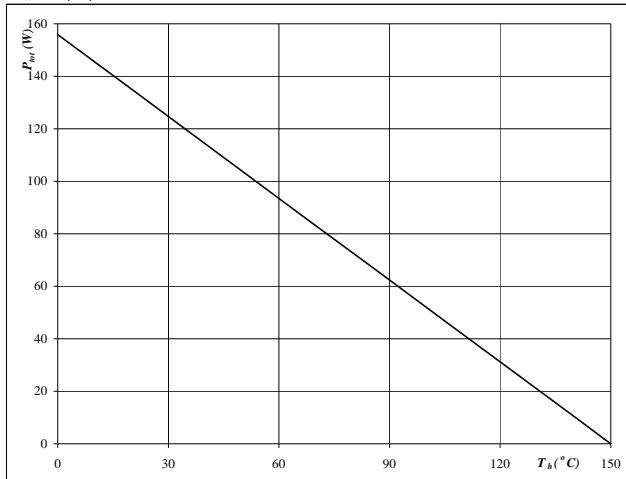
$D =$	t_p / T	
$R_{thJH} =$	2,40	K/W

Brake

Figure 13 Brake IGBT

Power dissipation as a function of heatsink temperature

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

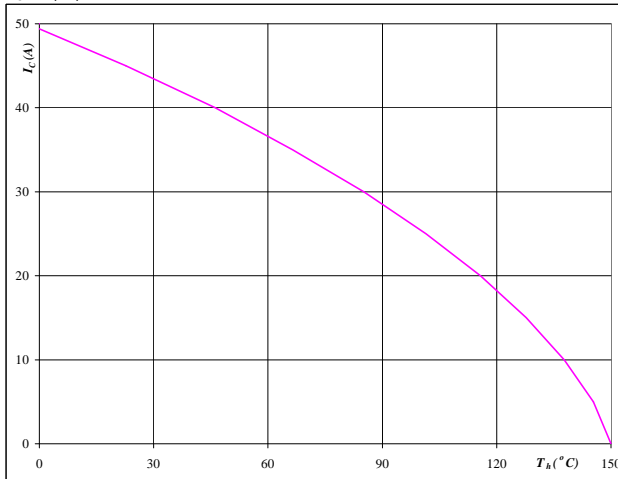


At
 $T_j = 150$ °C

Figure 14 Brake IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

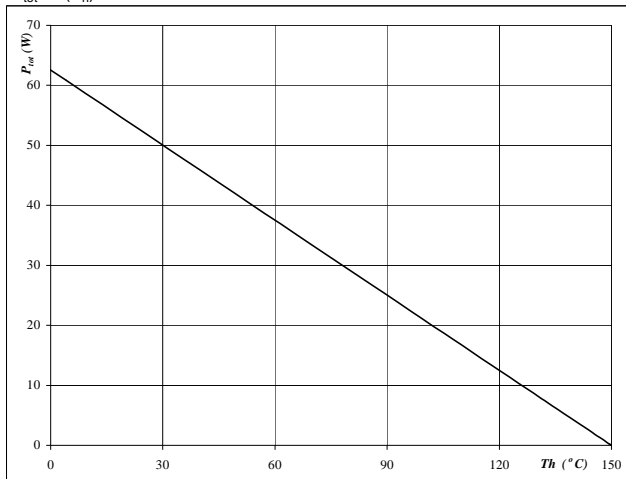


At
 $T_j = 150$ °C
 $V_{GE} = 15$ V

Figure 15 Brake FWD

Power dissipation as a function of heatsink temperature

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

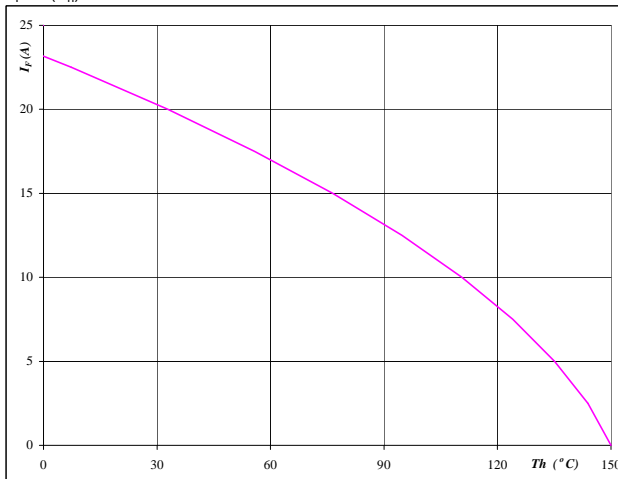


At
 $T_j = 150$ °C

Figure 16 Brake FWD

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



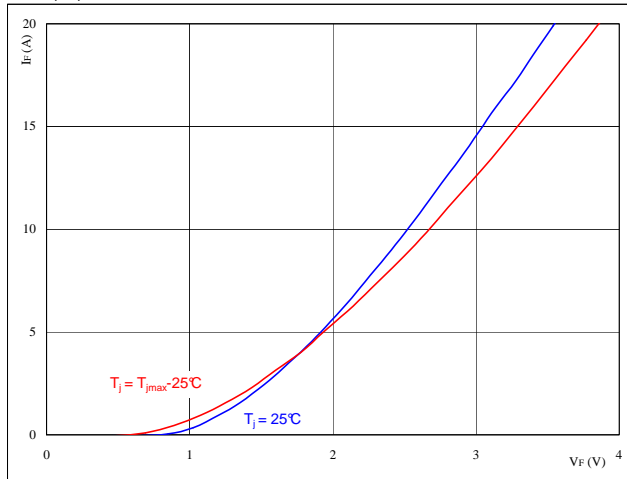
At
 $T_j = 150$ °C

Brake Inverse Diode

Figure 1 Brake inverse diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



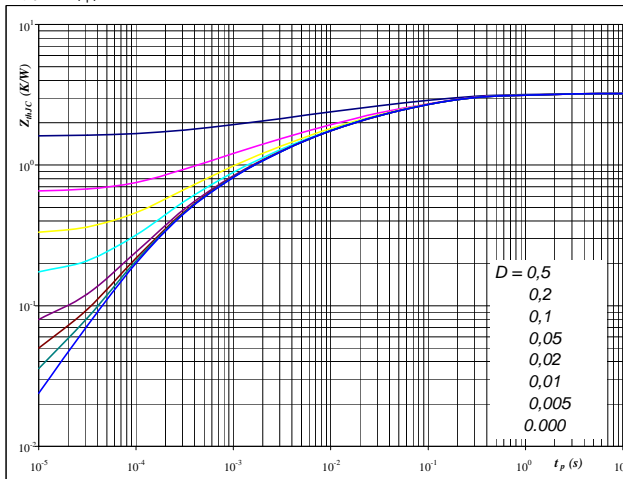
At

$$t_p = 250 \mu\text{s}$$

Figure 2 Brake inverse diode

Diode transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



At

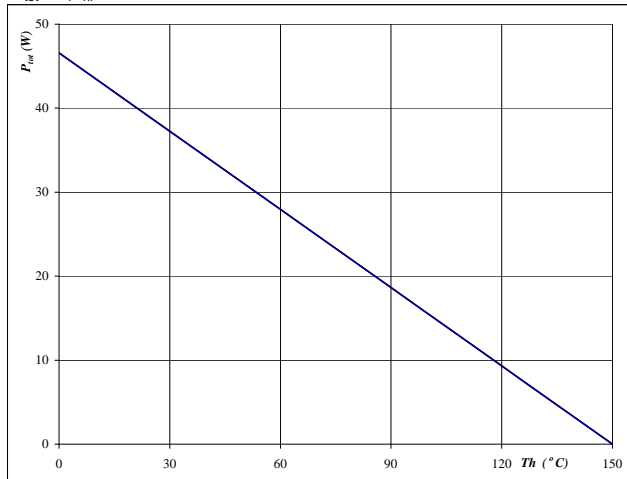
$$D = t_p / T$$

$$R_{thJH} = 3,22 \text{ K/W}$$

Figure 3 Brake inverse diode

Power dissipation as a function of heatsink temperature

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



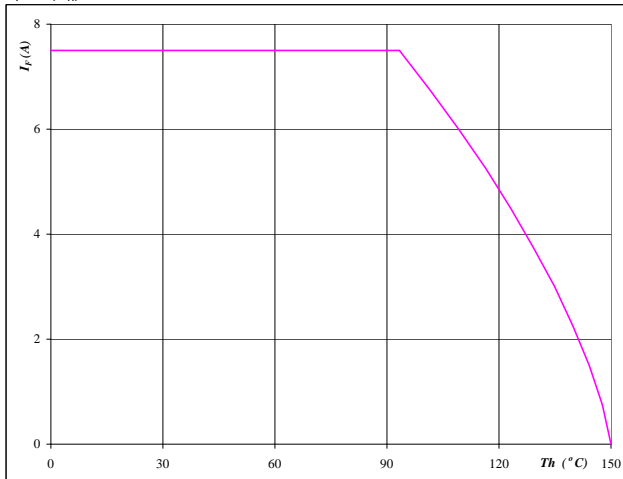
At

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

Figure 4 Brake inverse diode

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



At

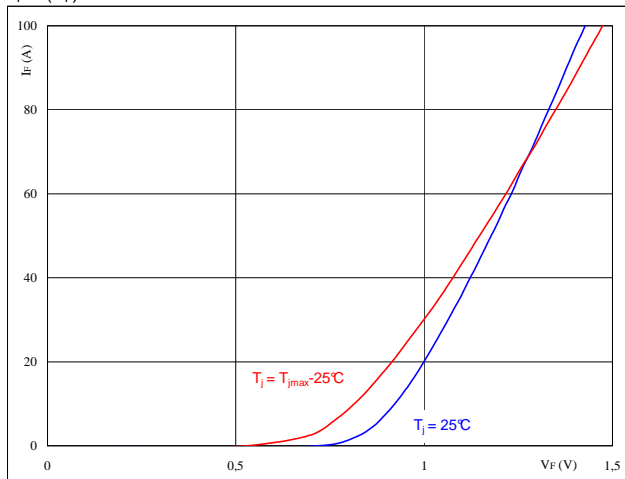
$$T_j = 150 \text{ }^\circ\text{C}$$

Input Rectifier Diode

Figure 1 Rectifier diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



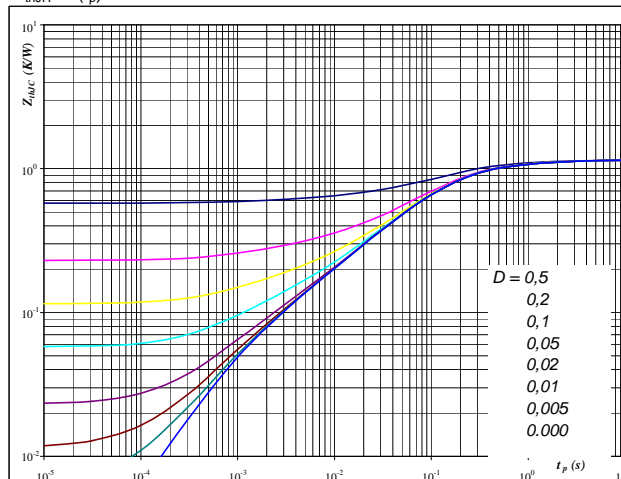
At

$$t_p = 250 \mu\text{s}$$

Figure 2 Rectifier diode

Diode transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



At

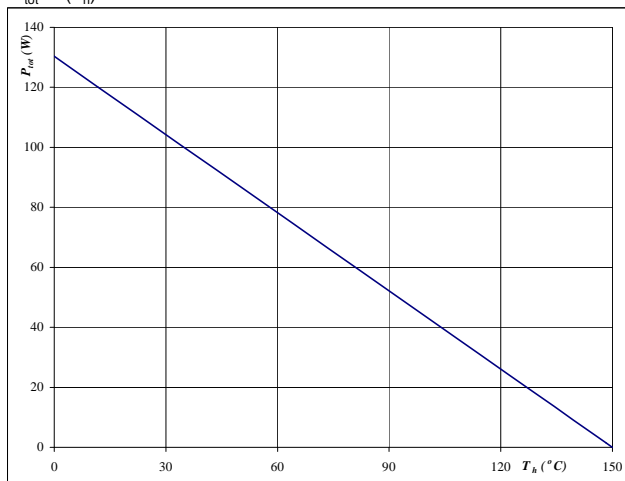
$$D = t_p / T$$

$$R_{thJH} = 1,15 \text{ K/W}$$

Figure 3 Rectifier diode

Power dissipation as a function of heatsink temperature

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



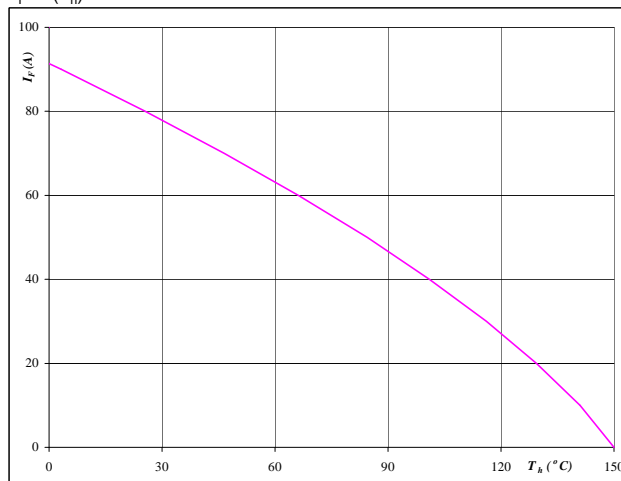
At

$$T_j = 150 \text{ °C}$$

Figure 4 Rectifier diode

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



At

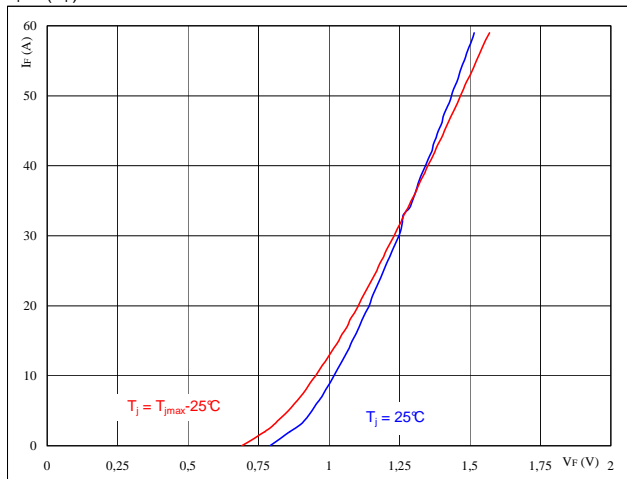
$$T_j = 150 \text{ °C}$$

Thyristor

Figure 1 Thyristor

Typical thyristor forward current as a function of forward voltage

$$I_F = f(V_F)$$

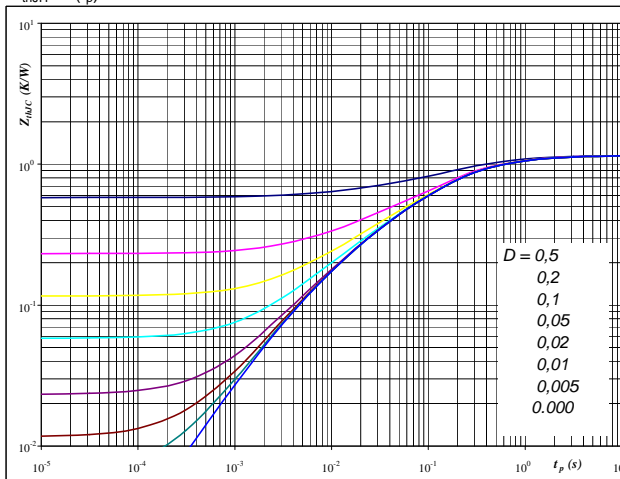


At
 $t_p = 250 \mu s$

Figure 2 Thyristor

Thyristor transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$

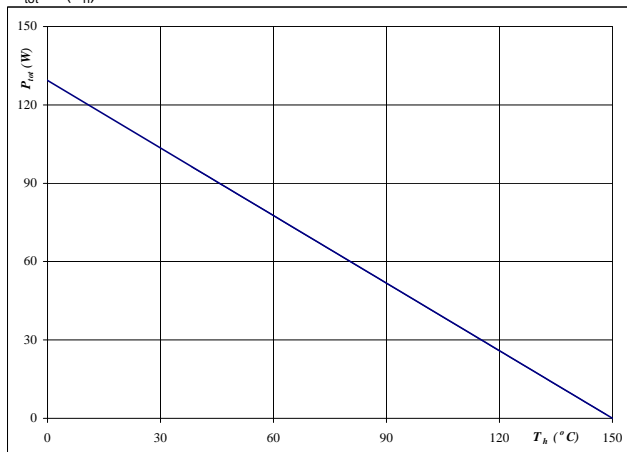


At
 $D = t_p / T$
 $R_{thJH} = 1,16 \text{ K/W}$

Figure 3 Thyristor

Power dissipation as a function of heatsink temperature

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

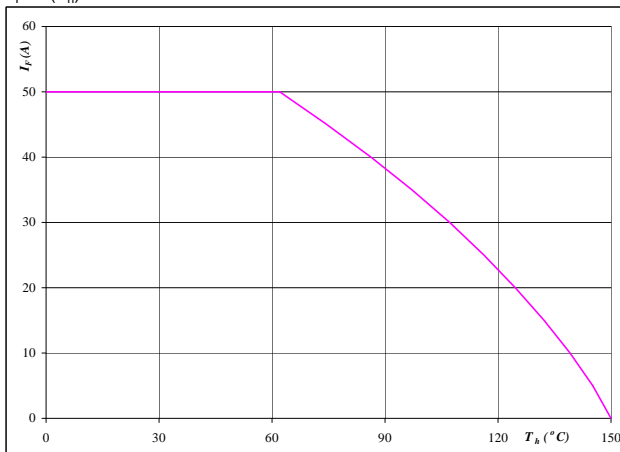


At
 $T_j = 150 \text{ °C}$

Figure 4 Thyristor

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$

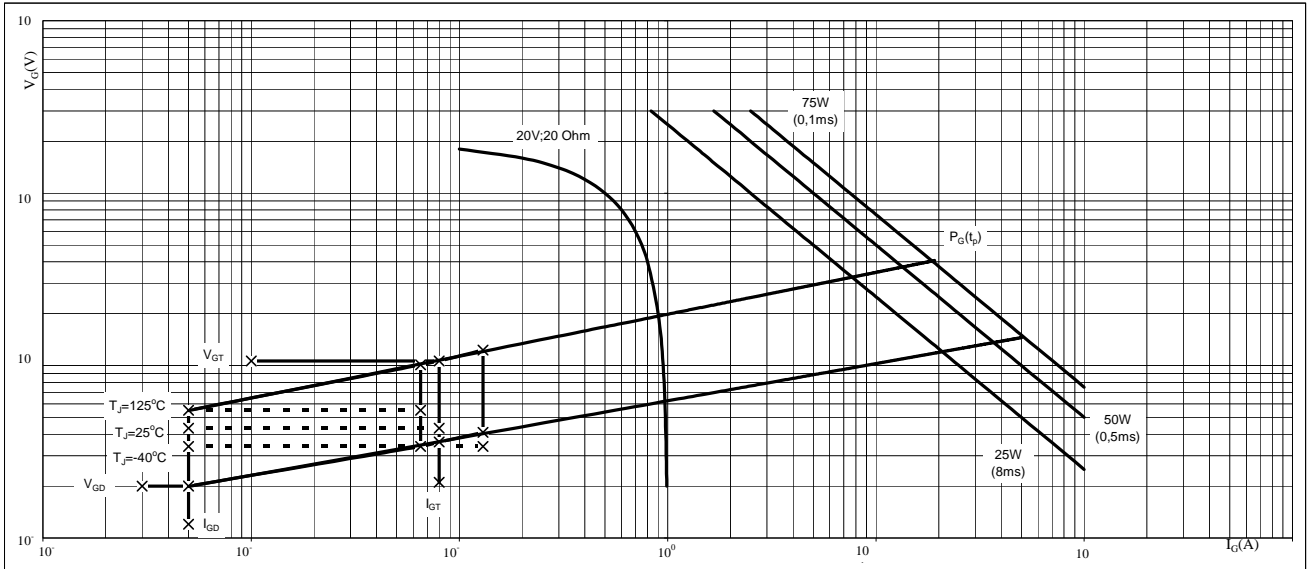


At
 $T_j = 150 \text{ °C}$

Thyristor

Figure 5

Thyristor

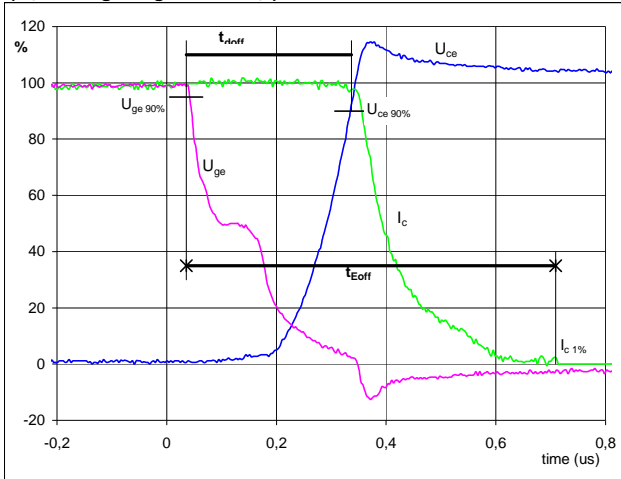
Gate trigger characteristics


Switching Definitions Output Inverter

General conditions

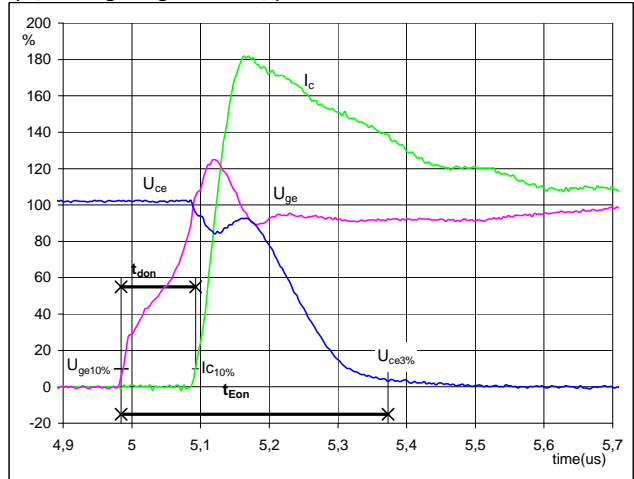
T_j	=	125 °C
R_{gon}	=	4 Ω
R_{goff}	=	4 Ω

Figure 1 Output inverter IGBT

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


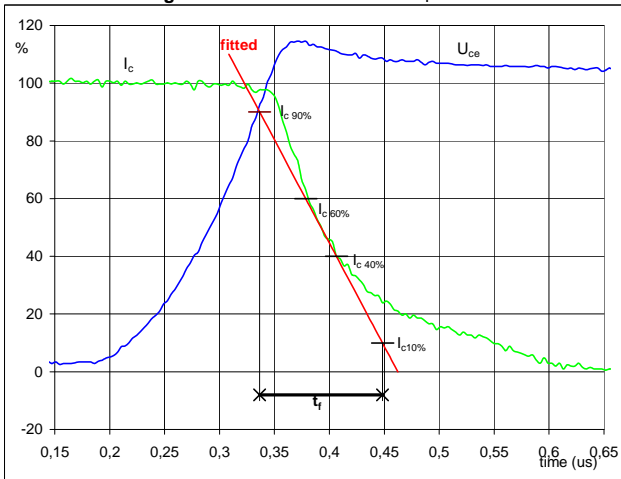
$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	100	A
t_{doff}	=	0,29	μs
t_{Eoff}	=	0,67	μs

Figure 2 Output inverter IGBT

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


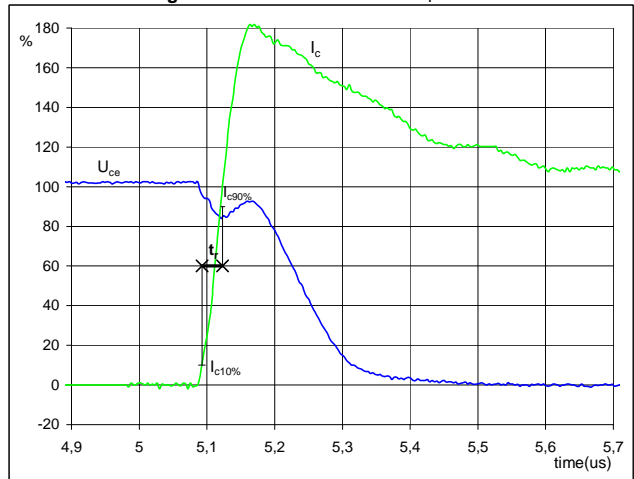
$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	100	A
t_{don}	=	0,11	μs
t_{Eon}	=	0,39	μs

Figure 3 Output inverter IGBT

Turn-off Switching Waveforms & definition of t_f


$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	100	A
t_f	=	0,11	μs

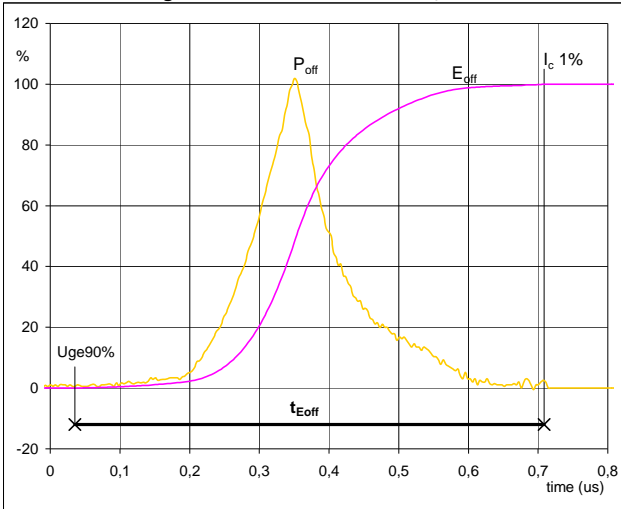
Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r


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

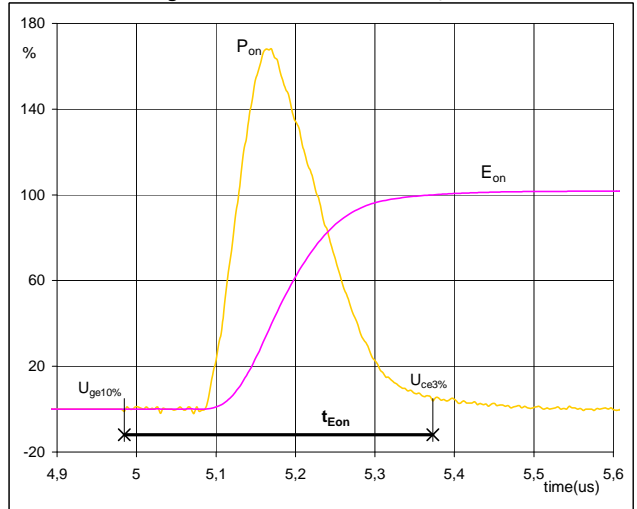
Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

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


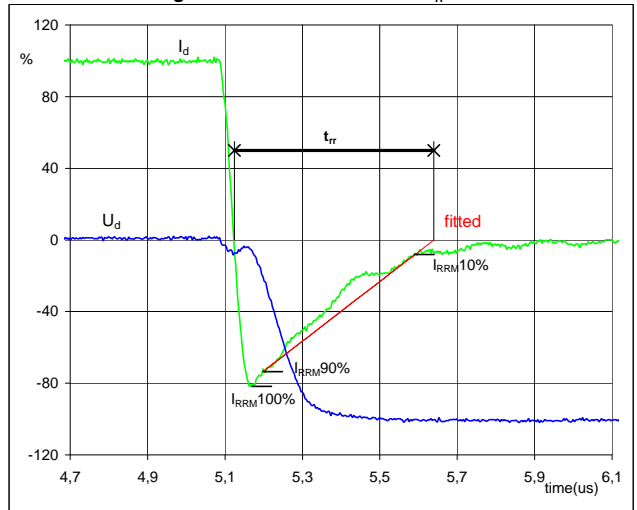
$P_{off} (100\%) = 59,91 \text{ kW}$
 $E_{off} (100\%) = 8,87 \text{ mJ}$
 $t_{Eoff} = 0,67 \text{ } \mu\text{s}$

Figure 6 Output inverter IGBT

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


$P_{on} (100\%) = 59,91 \text{ kW}$
 $E_{on} (100\%) = 12,48 \text{ mJ}$
 $t_{Eon} = 0,39 \text{ } \mu\text{s}$

Figure 7 Output inverter FWD

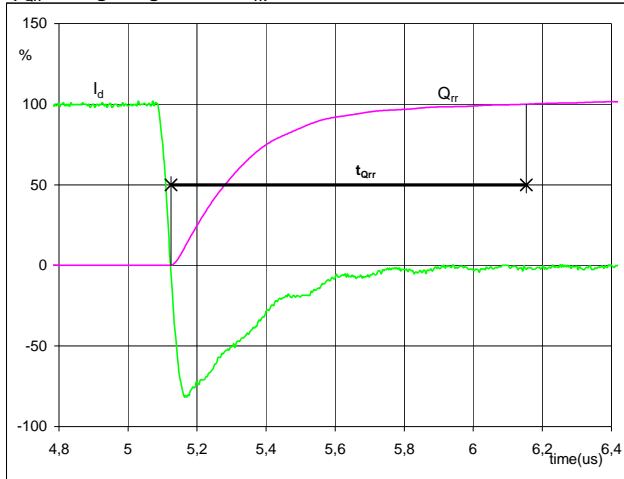
Turn-off Switching Waveforms & definition of t_{rr}


$V_d (100\%) = 600 \text{ V}$
 $I_d (100\%) = 100 \text{ A}$
 $I_{RRM} (100\%) = -83 \text{ A}$
 $t_{rr} = 0,51 \text{ } \mu\text{s}$

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

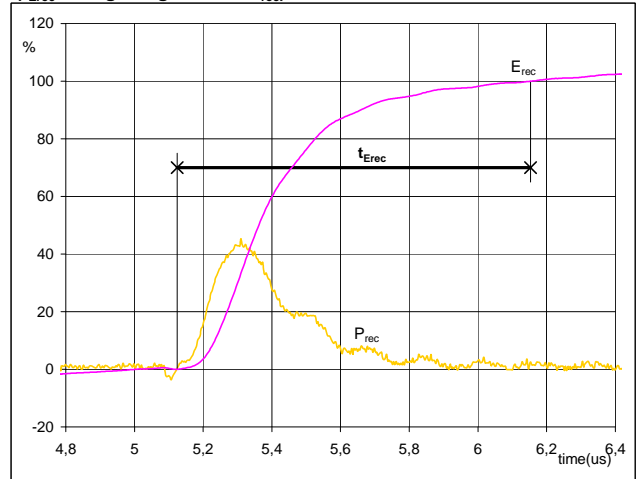
Turn-on Switching Waveforms & definition of t_{Qrr}
 (t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	100	A
Q_{rr} (100%) =	20,73	μC
t_{Qrr} =	1,03	μs

Figure 9 Output inverter FWD

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



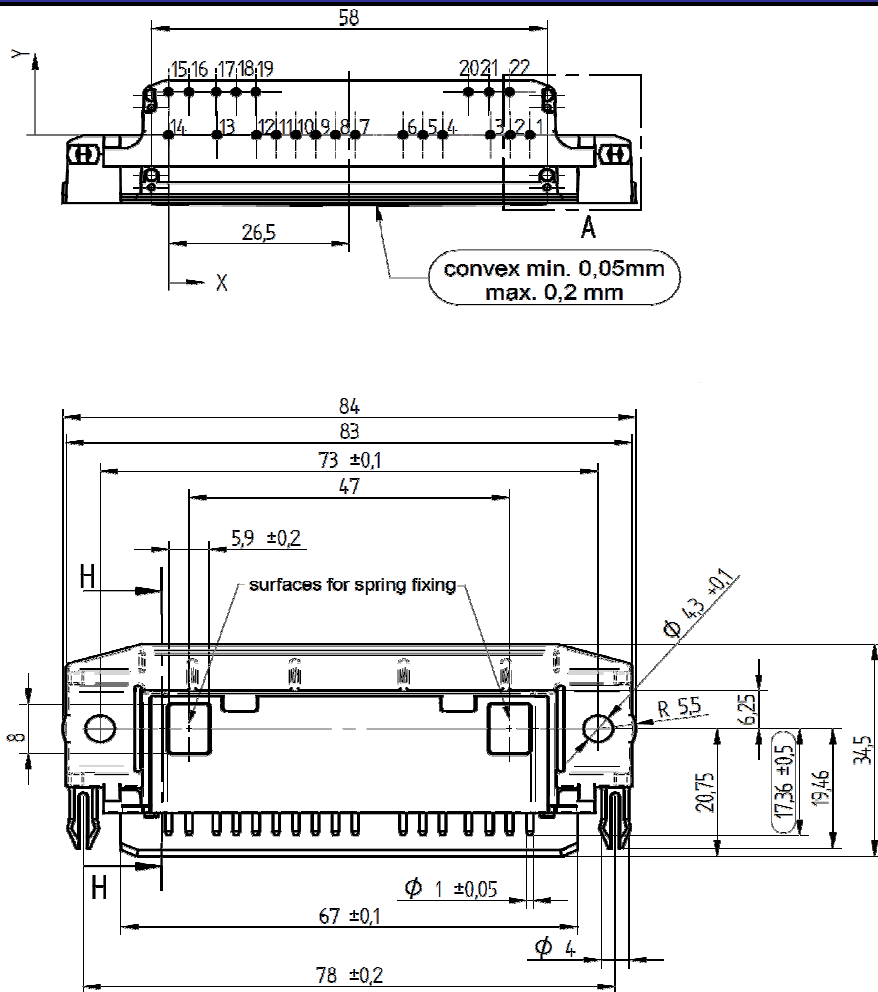
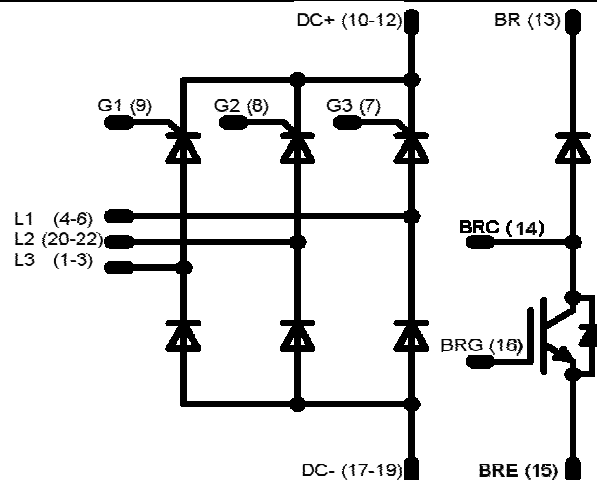
P_{rec} (100%) =	59,91	kW
E_{rec} (100%) =	7,85	mJ
t_{Erec} =	1,03	μs

Ordering Code and Marking - Outline - Pinout
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste 12mm housing	V23990-P718-G-PM	P718-G	P718-G
without thermal paste 12mm housing	V23990-P718-G10-PM	P718-G10	P718-G10
without thermal paste 12mm housing	V23990-P718-H-PM	P718-H	P718-H
without thermal paste 12mm housing	V23990-P718-H10-PM	P718-H10	P718-H10

Outline

Pin table	Pin	X	Y
	1	53	0
	2	50,1	0
	3	47,2	0
	4	40,2	0
	5	37,3	0
	6	34,4	0
	7	27,4	0
	8	24,5	0
	9	21,6	0
	10	18,7	0
	11	15,8	0
	12	12,9	0
	13	7,1	0
	14	0	0
	15	0	7
	16	3	7
	17	7	7
	18	9,9	7
	19	12,8	7
	20	44	7
	21	47	7
	22	50	7


Pinout


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