

flowPIM 2 3rd
1200V/4A
Features

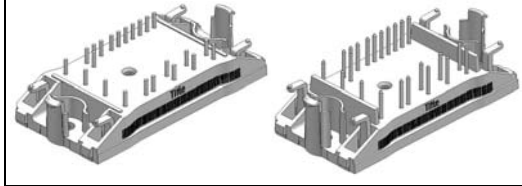
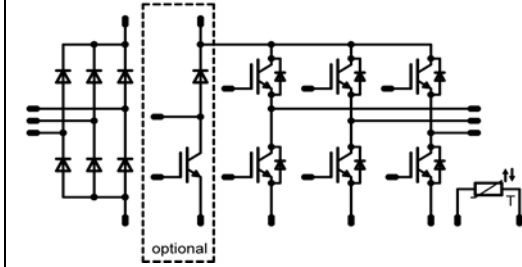
- 2 Clips housing in 12 and 17mm height
- Trench Fieldstop Technology IGBT4
- Optional w/o BRC

Target Applications

- Industrial Drives
- Embedded Generation

Types

- V23990-P848-A48-PM 12mm height
- V23990-P848-A49-PM 17mm height
- V23990-P848-C48-PM 12mm height; w/o BRC
- V23990-P848-C49-PM 17mm height; w/o BRC

flow0 Housing

Schematics


Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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Input Rectifier Diode

Repetitive peak reverse voltage	V_{RRM}		1600	V
Forward current per diode	I_{FAV}	DC current $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	28	A
Surge forward current	I_{FSM}	$t_p=10\text{ms}$ $T_j=25^{\circ}\text{C}$	220	A
I^2t -value	I^2t		220	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	33	W
Maximum Junction Temperature	T_{jmax}			$^{\circ}\text{C}$

Inverter Transistor

Collector-emitter break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	9	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by T_{jmax} $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	12	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	38	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$	10 800	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
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Inverter Diode

Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25^{\circ}\text{C}$	1200	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	10	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax} $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	32	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	37	W
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Brc Transistor

Collector-emitter break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	8	A
Repetitive peak collector current	I_{Cpuls}	$t_p=1\text{ms}$ $T_h=80^{\circ}\text{C}$	12	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	32	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$	10 800	μs V
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Brc. Diode

Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25^{\circ}\text{C}$	1200	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	9	A
Repetitive peak forward current	I_{FRM}	$t_p=1\text{ms}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	6	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	18	W
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}	$t=2\text{s}$	4000	V_{DC}
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				30	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1	1,22 1,19	1,9	V
Threshold voltage (for power loss calc. only)	V_{th}				30	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,93 0,81		V
Slope resistance (for power loss calc. only)	r_t					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,009 0,013		Ω
Reverse current	I_r			1600		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			0,1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 W/mK$						2,12		K/W
Inverter Transistor										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,00015	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		1,95 2,28		V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			0,05	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			200	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon}=64\Omega$ $R_{goff}=64\Omega$	15	600	4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		77 75		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		18 23		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		176 226		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		83 110		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,32 0,56		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,21 0,31		
Input capacitance	C_{ies}	$f=1MHz$	0	25		$T_j=25^{\circ}C$		250		pF
Output capacitance	C_{oss}							25		
Reverse transfer capacitance	C_{iss}							15		
Gate charge	Q_{Gate}		15	960	4	$T_j=25^{\circ}C$		25		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 W/mK$						2,51		K/W
Inverter Diode										
Diode forward voltage	V_F				10	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1,35	1,41 1,25	2,2	V
Peak reverse recovery current	I_{RRM}	$R_{gon}=32\Omega$	15	600	10	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		5 6		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		248 431		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,58 1,24		uC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		95 49		A/ μs
Reverse recovered energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,21 0,47		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 W/mK$						2,56		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	

Brc Transistor

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,00015	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		1,96 2,27		V
Collector-emitter cut-off incl diode	I_{CES}		0	1200		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			0,05	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			200	nA
Integrated Gate resistor	R_{gnt}							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon}=64\Omega$ $R_{goff}=64\Omega$	15	600	4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		78 75		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		18 24		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		170 217		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		81 103		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,24 0,36		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,22 0,33		
Input capacitance	C_{ies}	f=1MHz	0	25		$T_j=25^{\circ}C$		250		pF
Output capacitance	C_{oss}							25		
Reverse transfer capacitance	C_{iss}							15		
Gate charge	Q_{Gate}		15	960	4	$T_j=25^{\circ}C$		25		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 W/mK$						2,95		K/W

Brc. Diode

Diode forward voltage	V_F				4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1	1,88 1,79	2,35	V
Reverse leakage current	I_r		15	600	4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			250	μA
Peak reverse recovery current	I_{RRM}	$R_{gon}=64\Omega$	15	600	4	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		4 5		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		276 485		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,43 0,87		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		37 31		A/ μs
Reverse recovery energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0,43 0,87		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 W/mK$						3,86		K/W

Thermistor

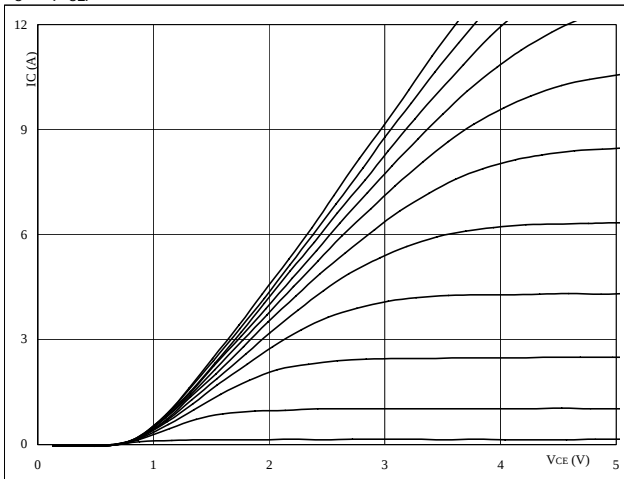
Rated resistance	R_{25}	Tol. $\pm 13\%$				$T_j=25^{\circ}C$	19,1	22	24,9	k Ω
	R_{100}	Tol. $\pm 5\%$				$T_j=100^{\circ}C$	1411	1486	1560	Ω
Power dissipation given Epcos-Typ	P					$T_j=25^{\circ}C$		210		mW
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				$T_j=25^{\circ}C$		4000		K

Output Inverter

Figure 1 Output inverter IGBT

Typical output characteristics

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



At

$$t_p = 250 \mu s$$

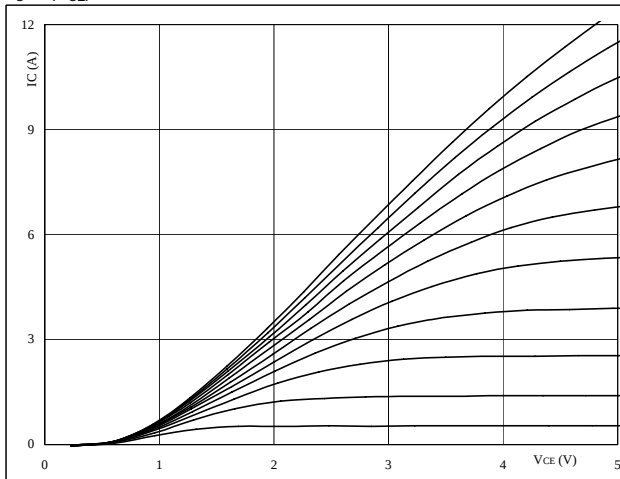
$$T_J = 25^\circ C$$

V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 Output inverter IGBT

Typical output characteristics

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



At

$$t_p = 250 \mu s$$

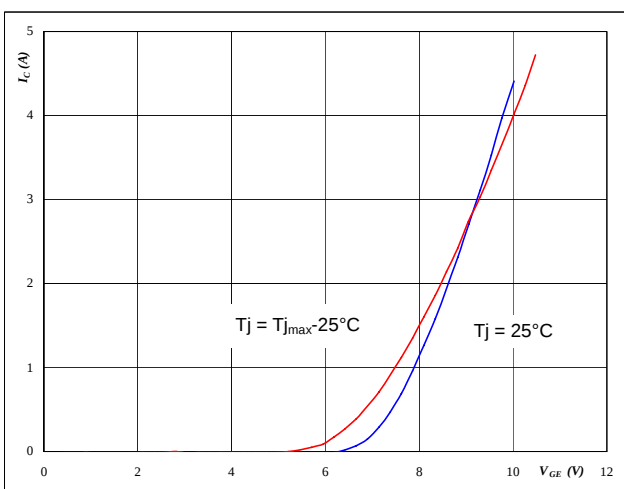
$$T_J = 150^\circ C$$

V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 Output inverter IGBT

Typical transfer characteristics

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



At

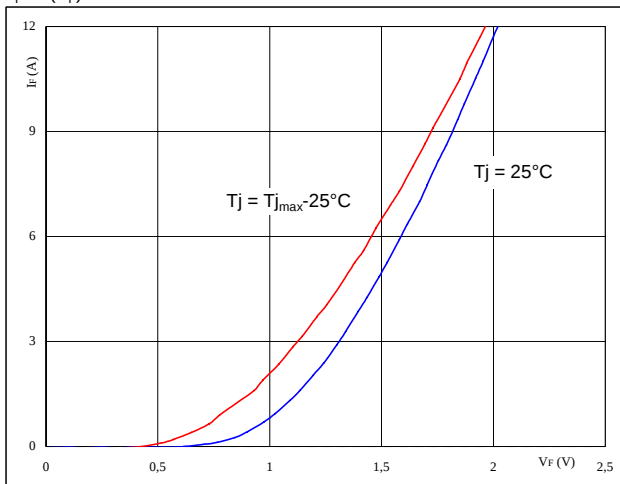
$$t_p = 250 \mu s$$

$$V_{CE} = 10 V$$

Figure 4 Output inverter FRED

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



At

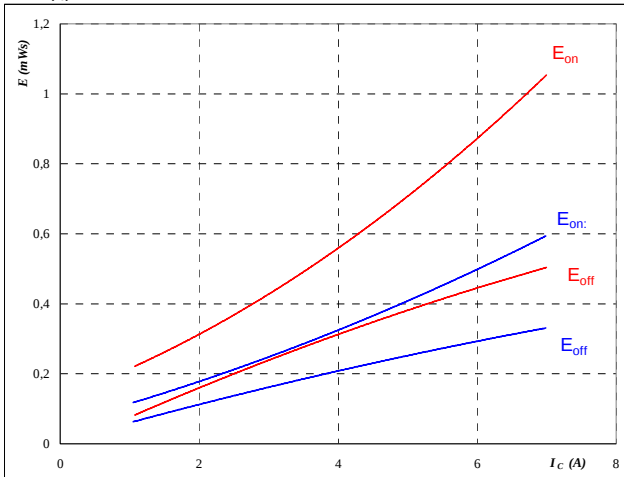
$$t_p = 250 \mu s$$

Output Inverter

Figure 5 Output inverter IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_c)$$



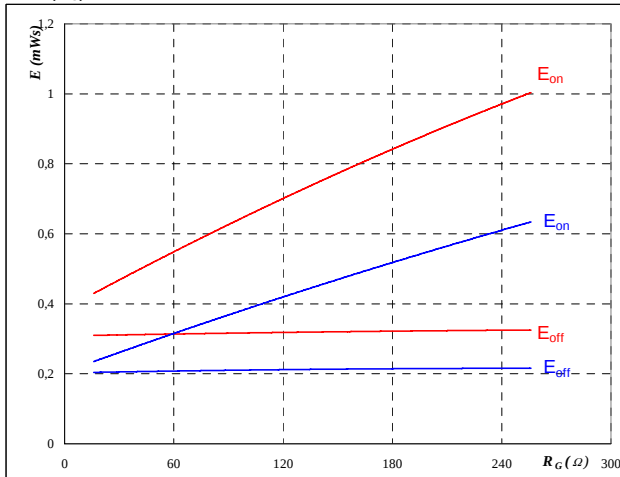
With an inductive load at

$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 64$ Ω
 $R_{goff} = 64$ Ω

Figure 6 Output inverter IGBT

Typical switching energy losses
as a function of gate resistor

$$E = f(R_g)$$



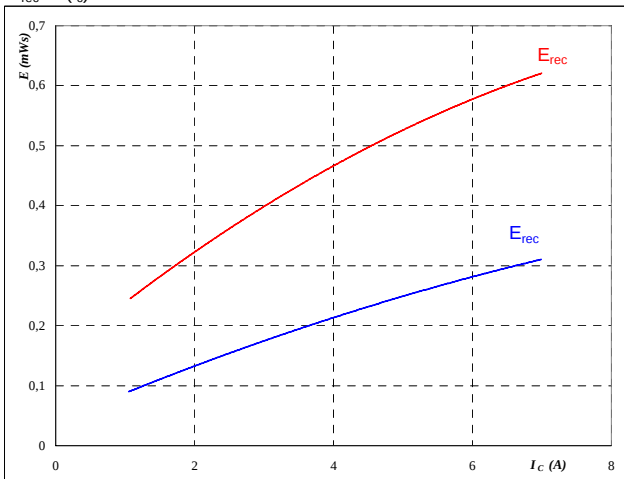
With an inductive load at

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

Figure 7 Output inverter IGBT

Typical reverse recovery energy loss
as a function of collector current

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



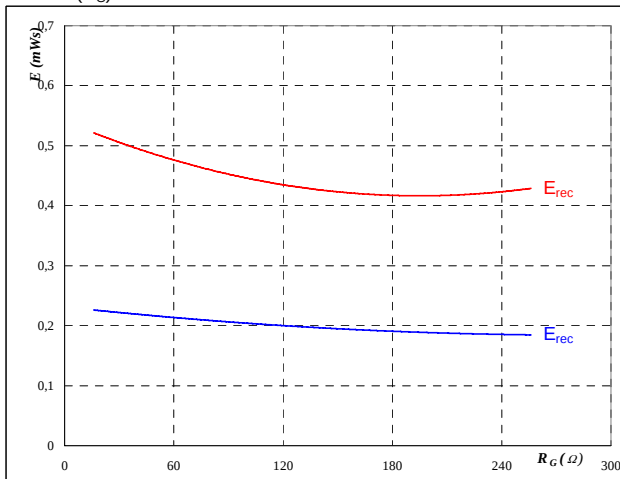
With an inductive load at

$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 64$ Ω

Figure 8 Output inverter IGBT

Typical reverse recovery energy loss
as a function of gate resistor

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



With an inductive load at

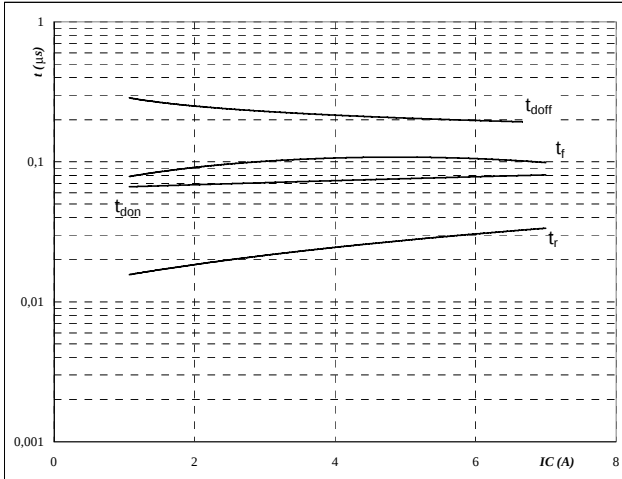
$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 4$ A

Output Inverter

Figure 9 Output inverter IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



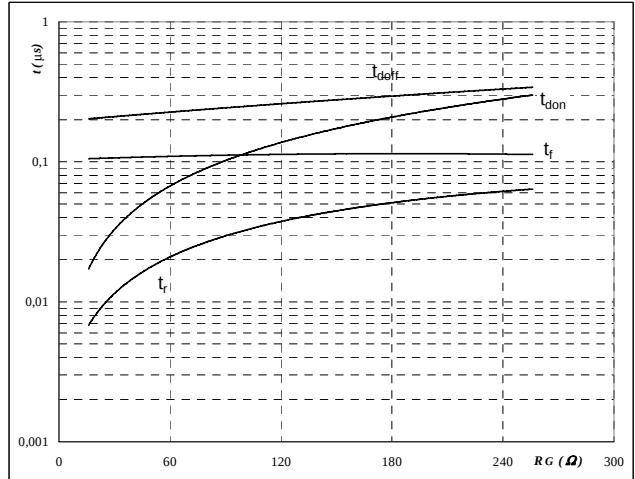
With an inductive load at

$T_J =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω
$R_{goff} =$	64	Ω

Figure 10 Output inverter IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



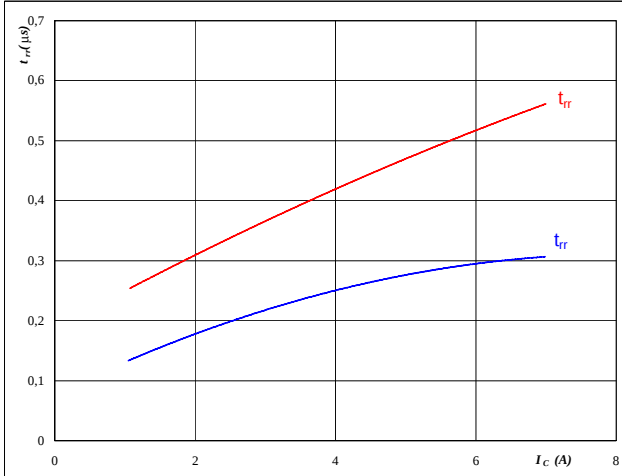
With an inductive load at

$T_J =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	4	A

Figure 11 Output inverter FRED

Typical reverse recovery time as a function of collector current

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



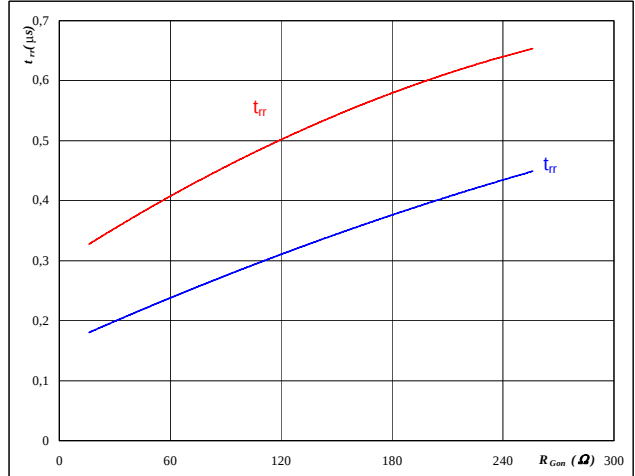
At

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω

Figure 12 Output inverter FRED

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
$I_F =$	4	A
$V_{GE} =$	±15	V

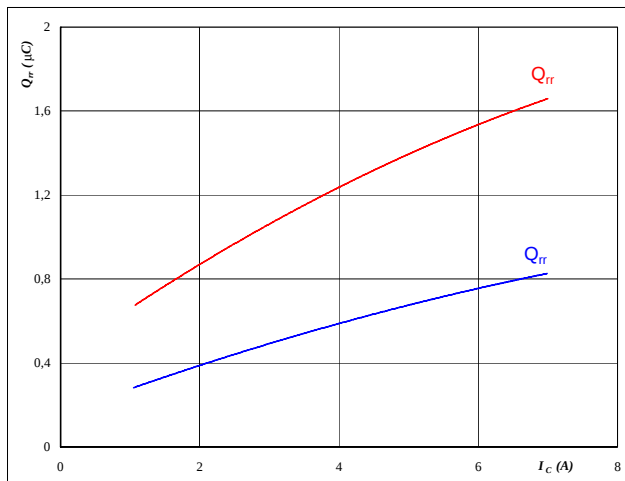
Output Inverter

Figure 13

Output inverter FRED

Typical reverse recovery charge as a function of collector current

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


At

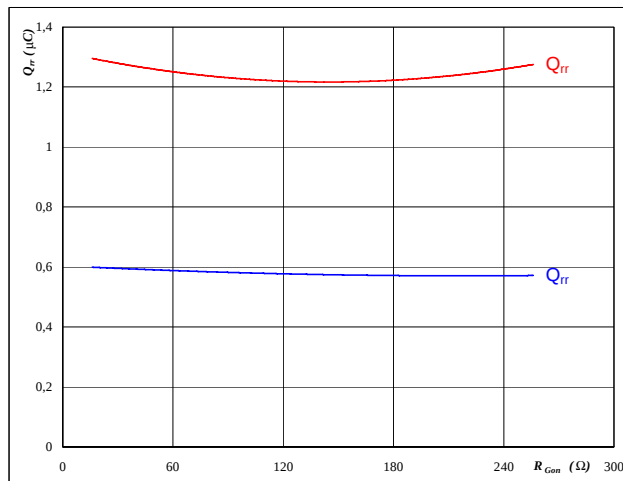
$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω

Figure 14

Output inverter FRED

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

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


At

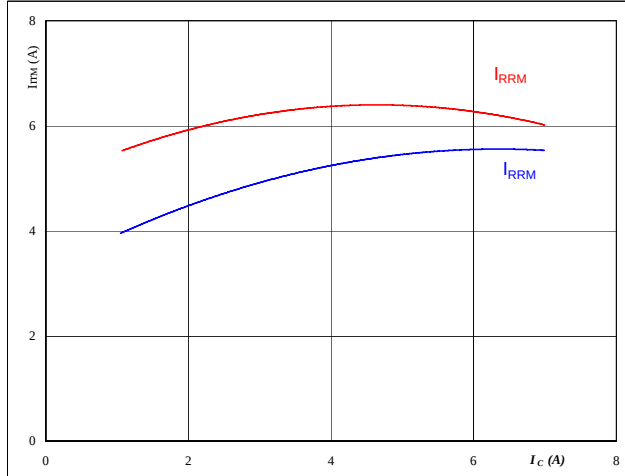
$T_J =$	25/150	°C
$V_R =$	600	V
$I_F =$	4	A
$V_{GE} =$	±15	V

Figure 15

Output inverter FRED

Typical reverse recovery current as a function of collector current

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


At

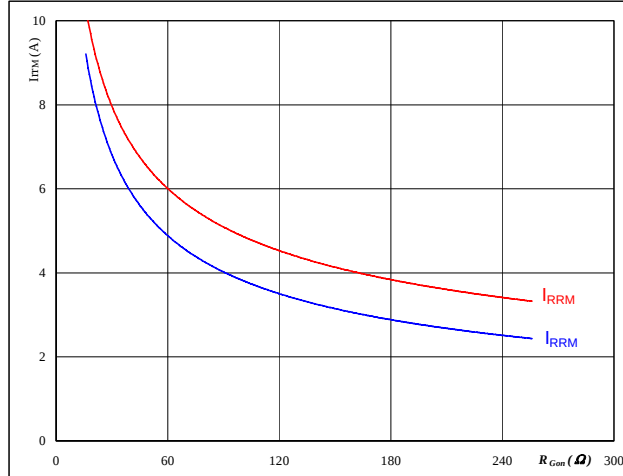
$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω

Figure 16

Output inverter FRED

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

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


At

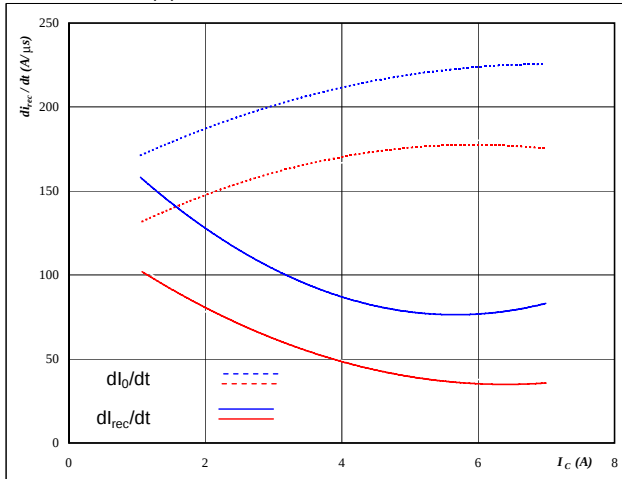
$T_J =$	25/150	°C
$V_R =$	600	V
$I_F =$	4	A
$V_{GE} =$	±15	V

Output Inverter

Figure 17 Output inverter FRED

Typical rate of fall of forward
and reverse recovery current as a
function of collector current

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



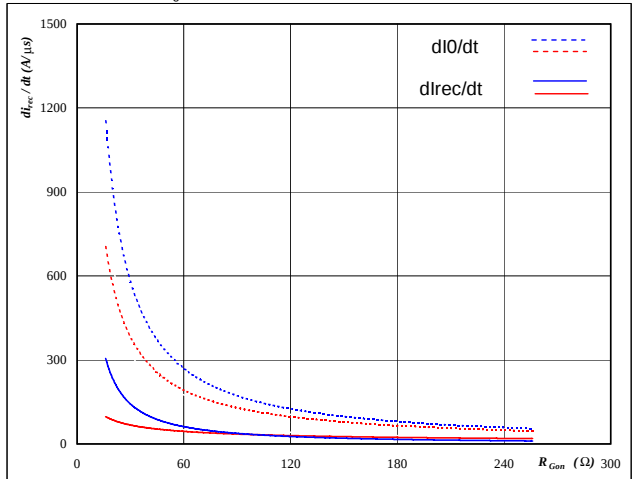
At

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω

Figure 18 Output inverter FRED

Typical rate of fall of forward
and reverse recovery current as a
function of IGBT turn on gate resistor

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



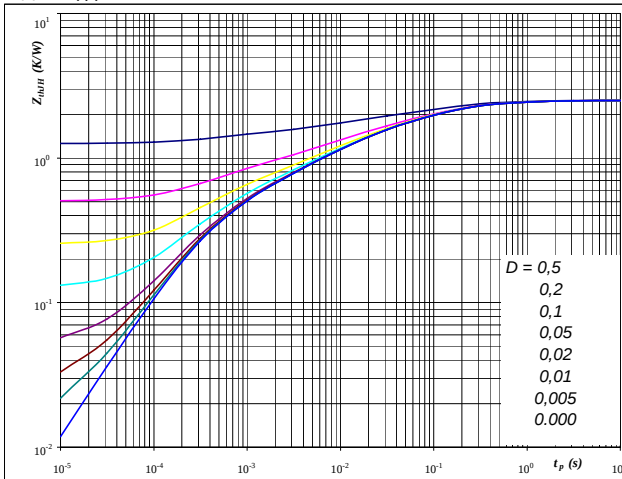
At

$T_J =$	25/150	°C
$V_R =$	600	V
$I_F =$	4	A
$V_{GE} =$	±15	V

Figure 19 Output inverter IGBT

IGBT transient thermal impedance
as a function of pulse width

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



At

$D =$	t_p / T	
$R_{thJH} =$	2,51	K/W

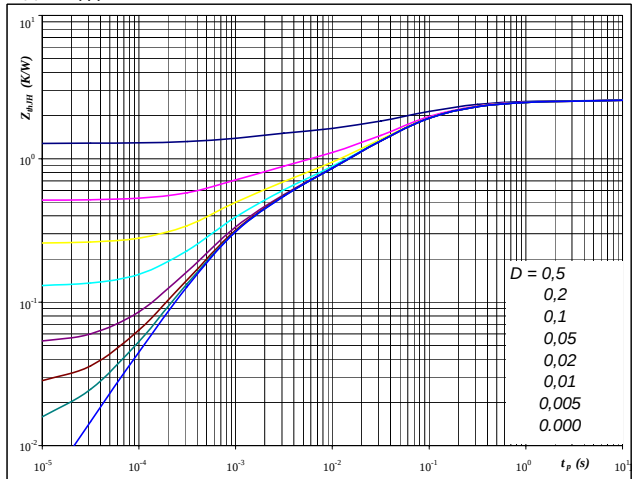
IGBT thermal model values

R (C/W)	Tau (s)
0,05	6,2E+00
0,26	4,9E-01
0,85	8,6E-02
0,64	1,3E-02
0,38	2,2E-03
0,33	3,4E-04

Figure 20 Output inverter FRED

FRED transient thermal impedance
as a function of pulse width

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



At

$D =$	t_p / T	
$R_{thJH} =$	2,56	K/W

FRED thermal model values

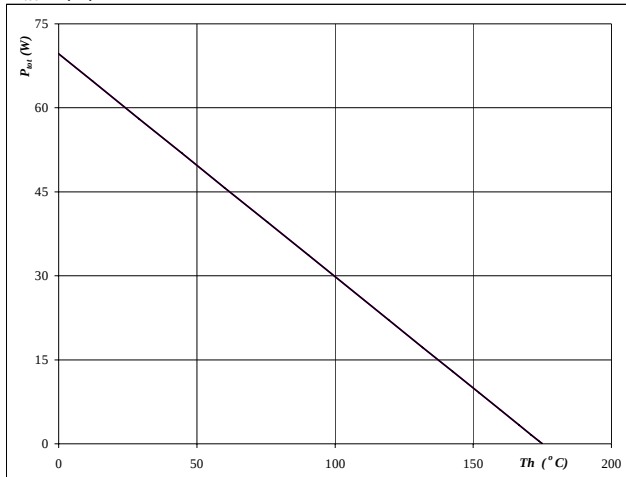
R (C/W)	Tau (s)
0,12	2,8E+00
0,62	2,1E-01
1,10	4,8E-02
0,37	7,2E-03
0,35	8,8E-04

Output Inverter

Figure 21 Output inverter IGBT

Power dissipation as a function of heatsink temperature

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

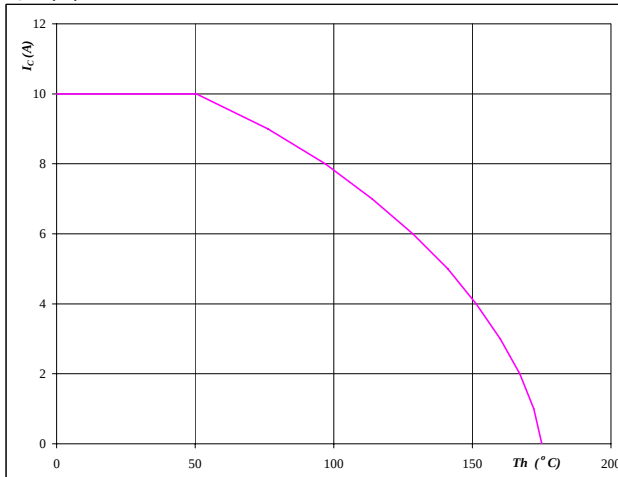


At $T_j = 175$ °C
 — single heating
 — overall heating

Figure 22 Output inverter IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

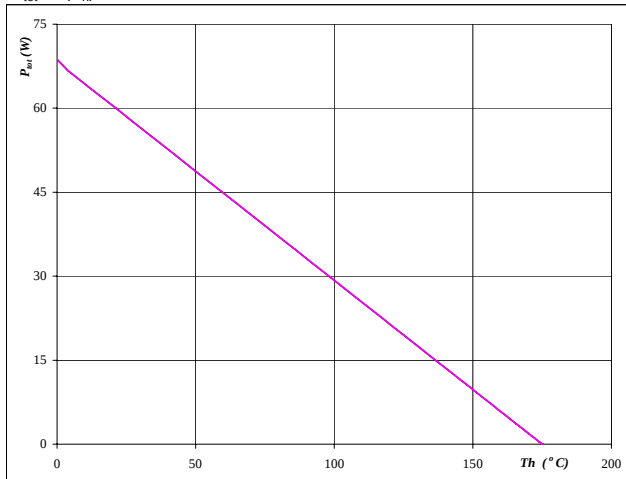


At $T_j = 175$ °C
 $V_{GE} = 15$ V

Figure 23 Output inverter FRED

Power dissipation as a function of heatsink temperature

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

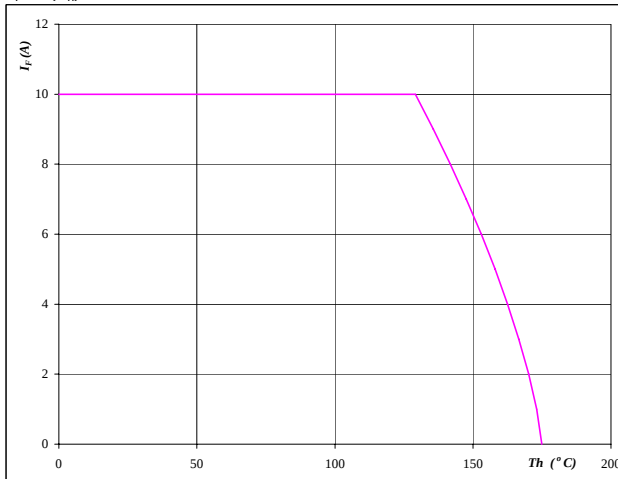


At $T_j = 175$ °C
 — single heating
 — overall heating

Figure 24 Output inverter FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



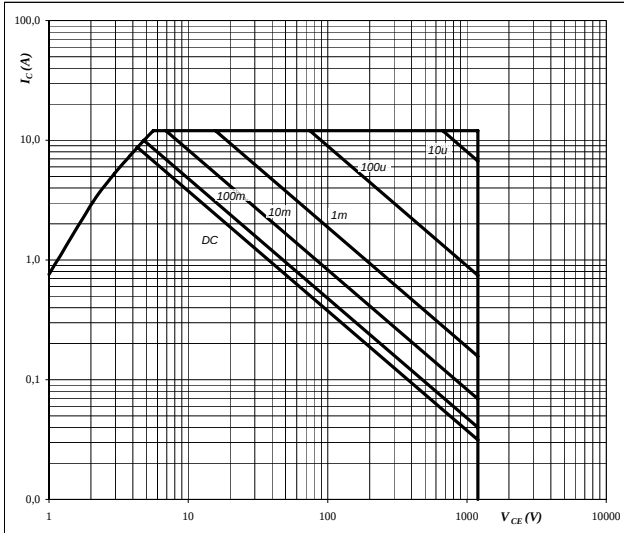
At $T_j = 175$ °C

Output Inverter

Figure 25 Output inverter IGBT

**Safe operating area as a function
of collector-emitter voltage**

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



At

D = single pulse

Th = 80 °C

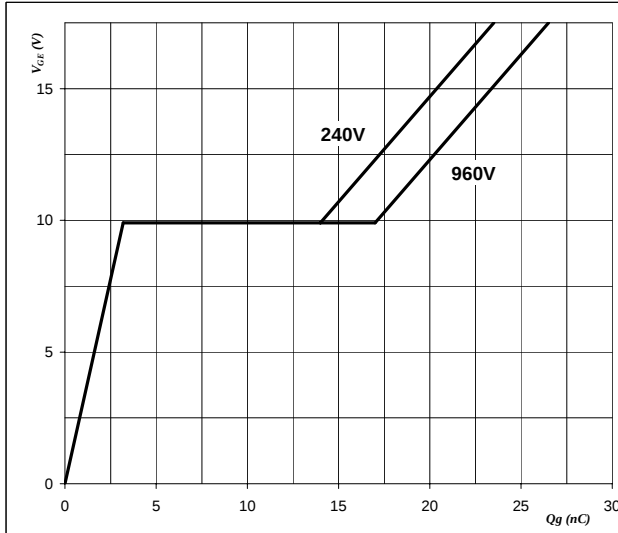
V_{GE} = ±15 V

T_j = T_{jmax} °C

Figure 26 Output inverter IGBT

Gate voltage vs Gate charge

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



At

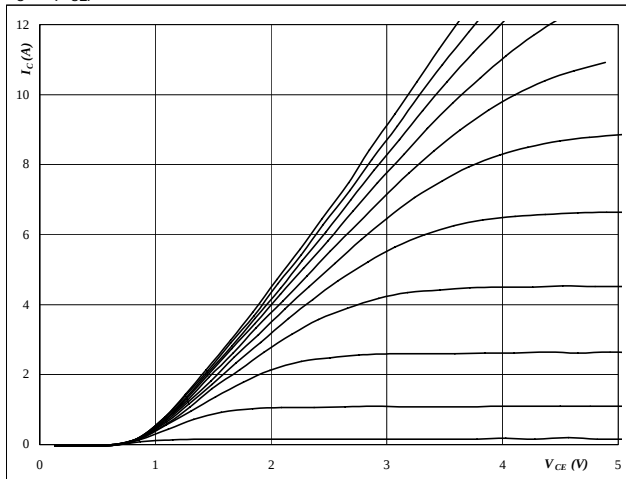
I_C = 4 A

Brake

Figure 1 Brake IGBT

Typical output characteristics

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


At

$$t_p = 250 \mu s$$

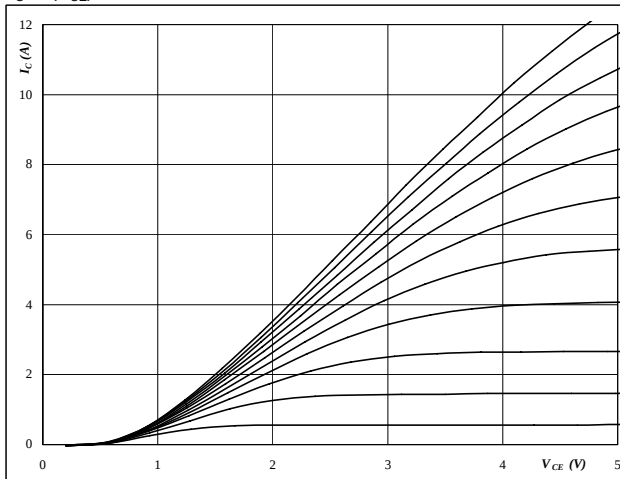
$$T_j = 25 ^\circ C$$

VGE from 7 V to 17 V in steps of 1 V

Figure 2 Brake IGBT

Typical output characteristics

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


At

$$t_p = 250 \mu s$$

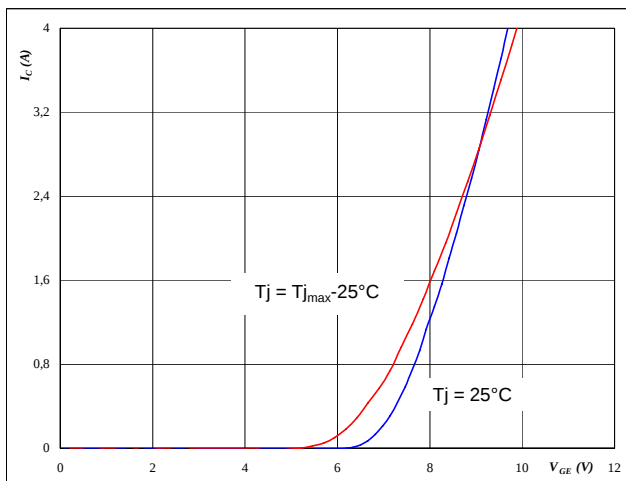
$$T_j = 150 ^\circ C$$

VGE from 7 V to 17 V in steps of 1 V

Figure 3 Brake IGBT

Typical transfer characteristics

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


At

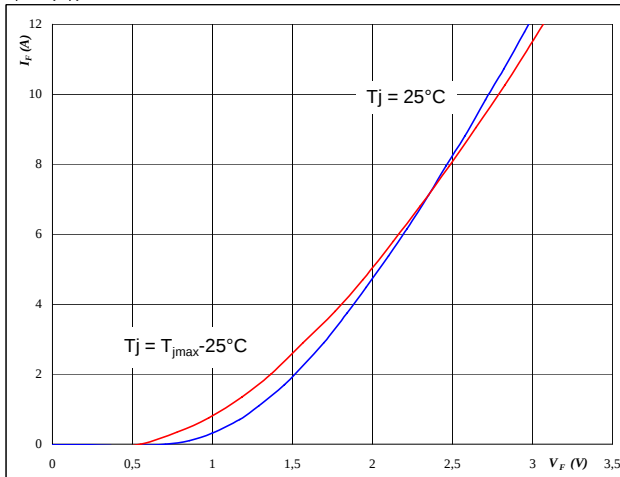
$$t_p = 250 \mu s$$

$$V_{CE} = 10 V$$

Figure 4 Brake FRED

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$


At

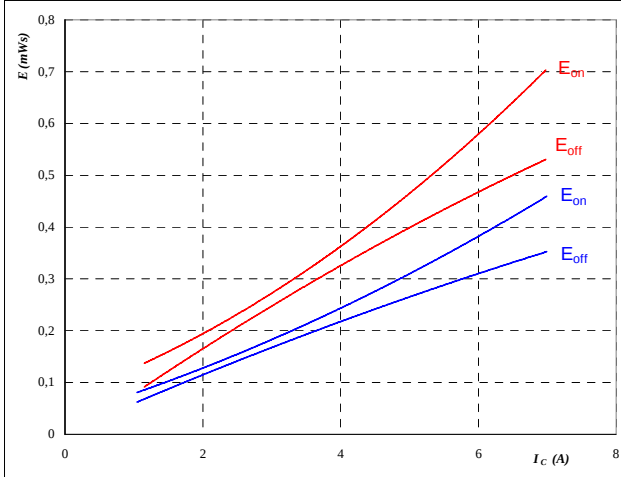
$$t_p = 250 \mu s$$

Brake

Figure 5 Brake IGBT

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

$$E = f(I_C)$$



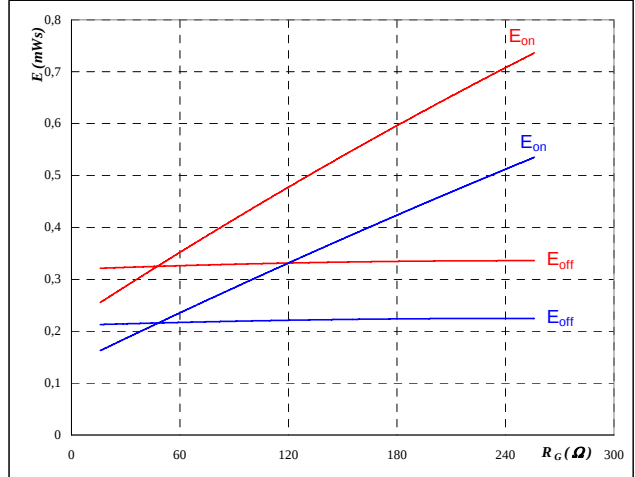
With an inductive load at

$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 64$ Ω
 $R_{goff} = 64$ Ω

Figure 6 Brake IGBT

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

$$E = f(R_G)$$



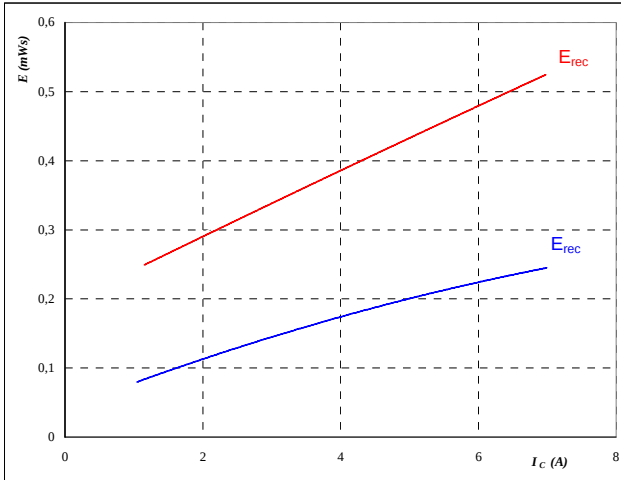
With an inductive load at

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

Figure 7 Brake IGBT

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

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



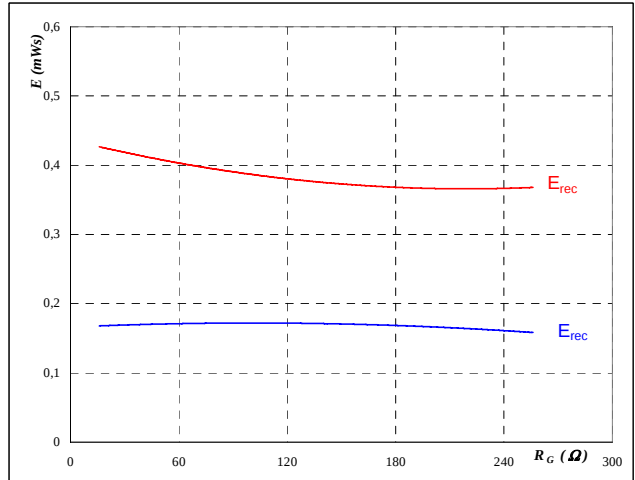
With an inductive load at

$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 64$ 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

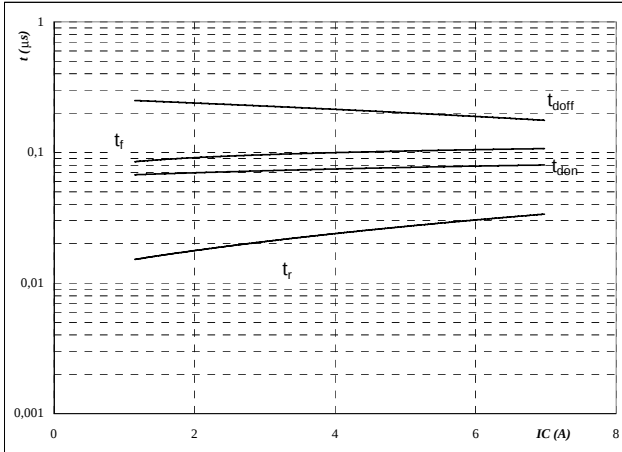
$T_J = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 4$ A

Brake

Figure 9 Brake IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



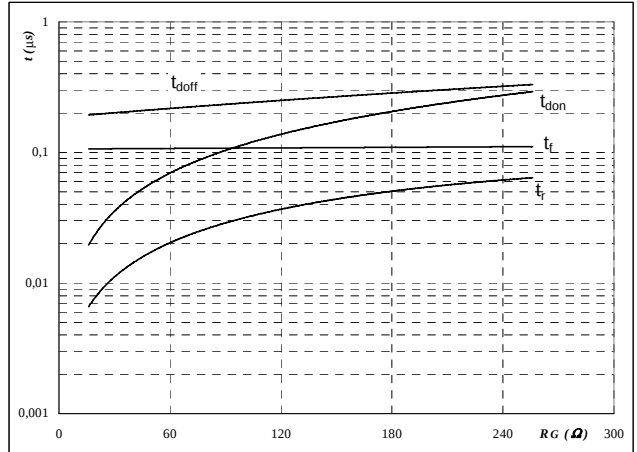
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	64	Ω
$R_{goff} =$	64	Ω

Figure 10 Brake IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



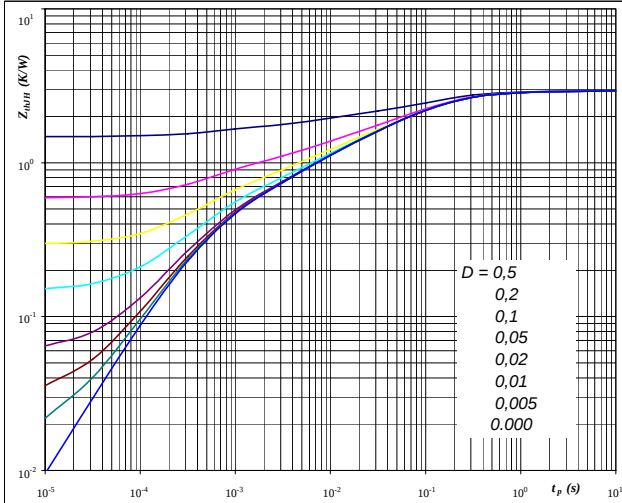
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	4	A

Figure 11 Brake IGBT

IGBT transient thermal impedance as a function of pulse width

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



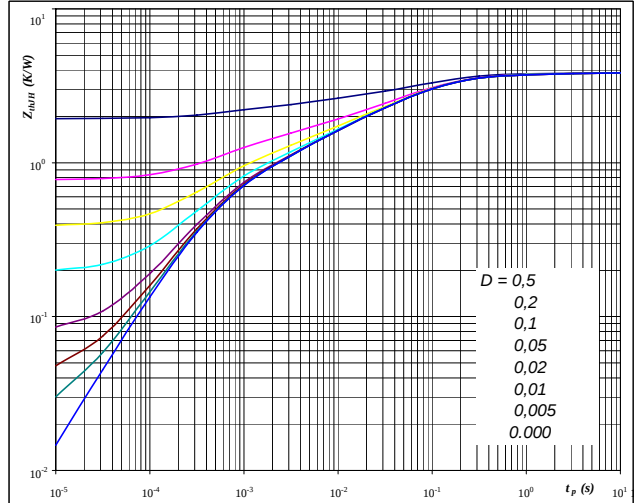
At

$D =$	t_p / T	
$R_{thJH} =$	2,95	K/W

Figure 12 Brake FRED

FRED transient thermal impedance as a function of pulse width

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



At

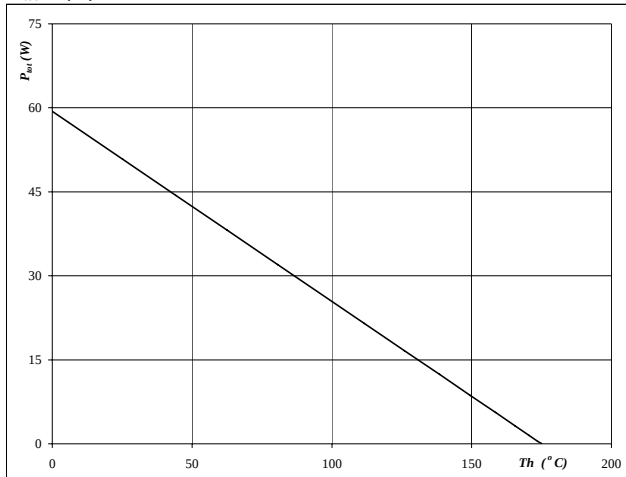
$D =$	t_p / T	
$R_{thJH} =$	3,86	K/W

Brake

Figure 13 Brake IGBT

Power dissipation as a function of heatsink temperature

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

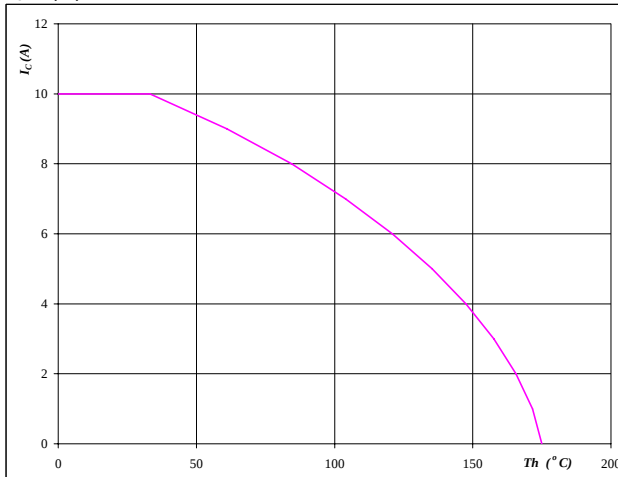


At
 $T_j = 175$ °C

Figure 14 Brake IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

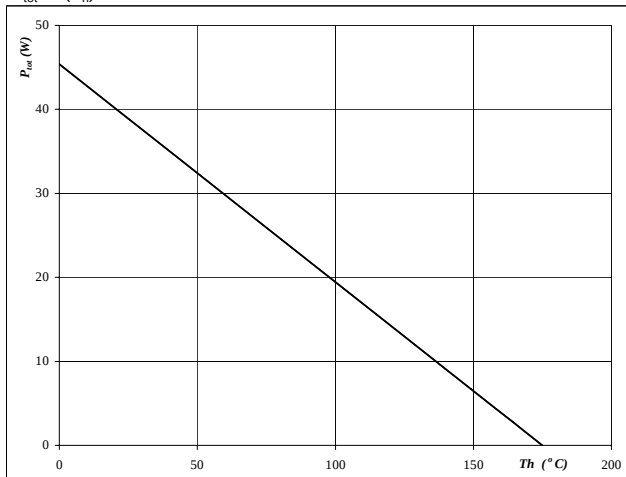


At
 $T_j = 175$ °C
 $V_{GE} = 15$ V

Figure 15 Brake FRED

Power dissipation as a function of heatsink temperature

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

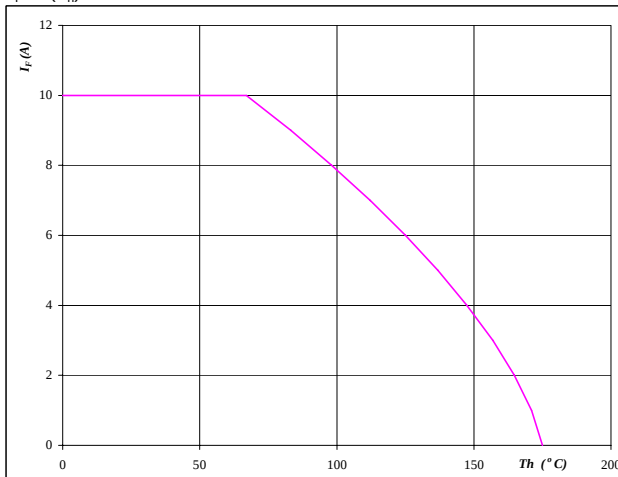


At
 $T_j = 175$ °C

Figure 16 Brake FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



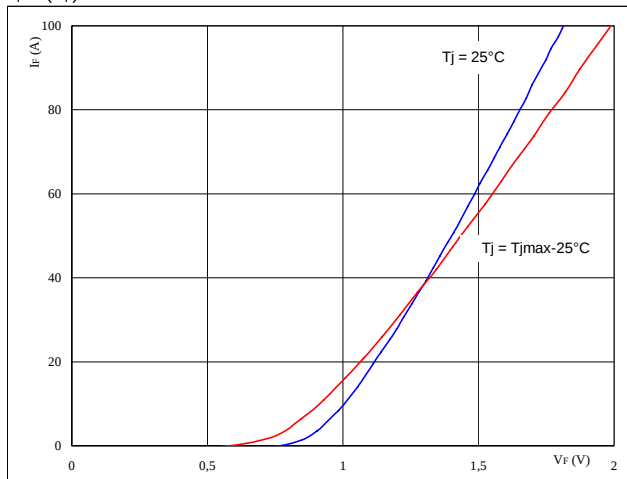
At
 $T_j = 175$ °C

Input Rectifier Bridge

Figure 1 Rectifier diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

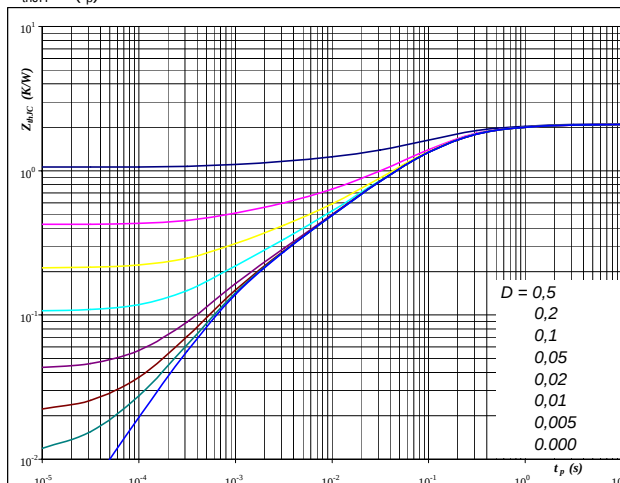


At
 $t_p = 250 \mu s$

Figure 2 Rectifier diode

Diode transient thermal impedance as a function of pulse width

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

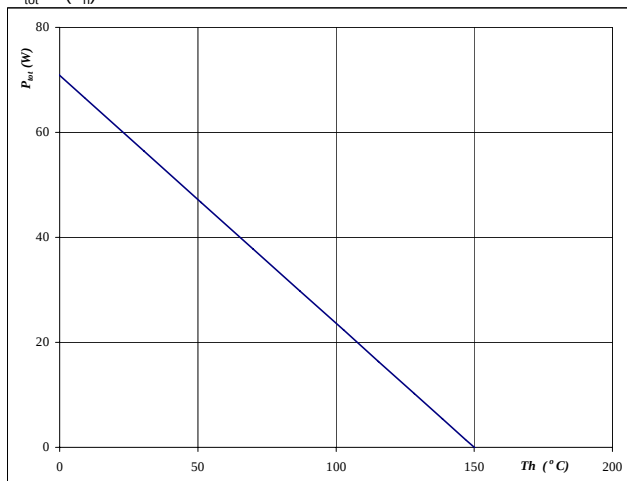


At
D = t_p / T
 $R_{thJH} = 2,117 \text{ K/W}$

Figure 3 Rectifier diode

Power dissipation as a function of heatsink temperature

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

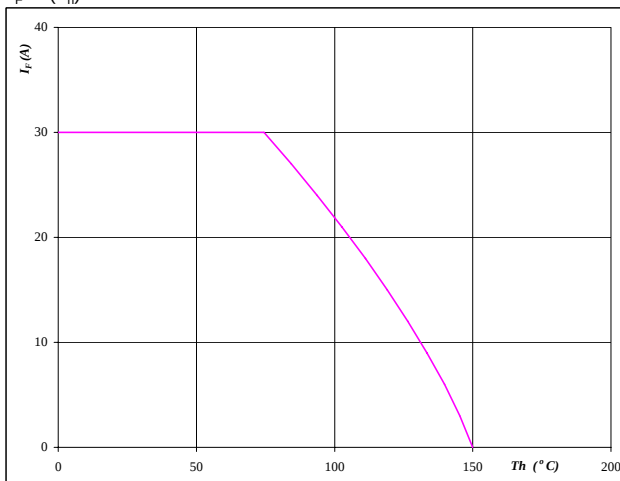


At
 $T_j = 150 \text{ °C}$

Figure 4 Rectifier diode

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



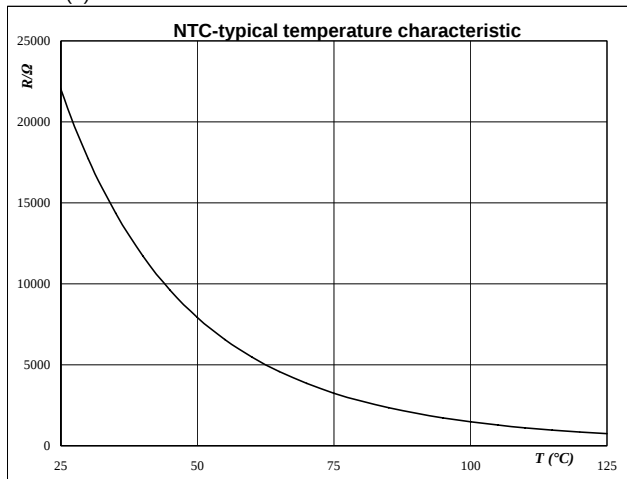
At
 $T_j = 150 \text{ °C}$

Thermistor

Figure 1 Thermistor

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

$$R_T = f(T)$$



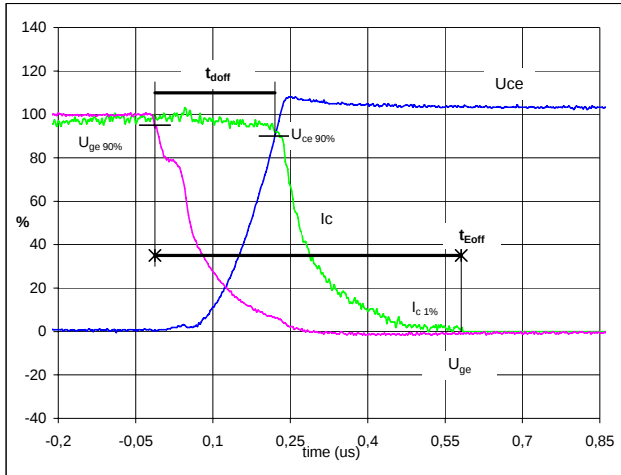
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	64 Ω
R_{goff}	=	64 Ω

Figure 1 Output inverter IGBT

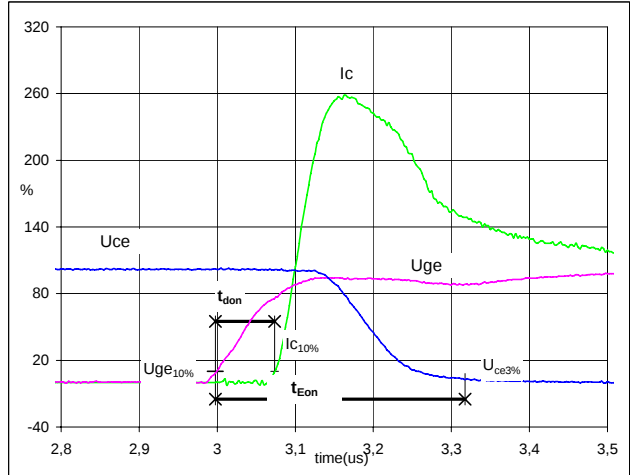
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	4	A
t_{doff}	=	0,23	μs
t_{Eoff}	=	0,59	μs

Figure 2 Output inverter IGBT

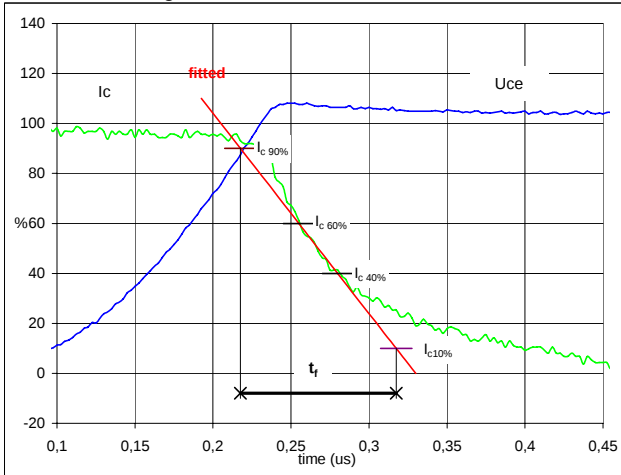
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
(t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	4	A
t_{don}	=	0,08	μs
t_{Eon}	=	0,32	μs

Figure 3 Output inverter IGBT

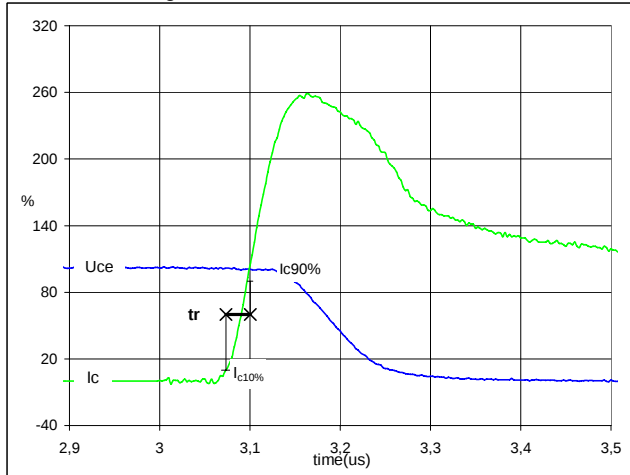
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	4	A
t_f	=	0,11	μs

Figure 4 Output inverter IGBT

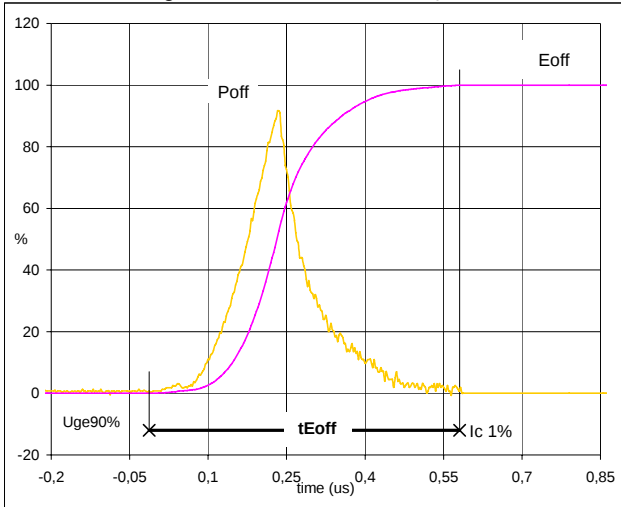
Turn-on Switching Waveforms & definition of t_r



$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	4	A
t_r	=	0,02	μs

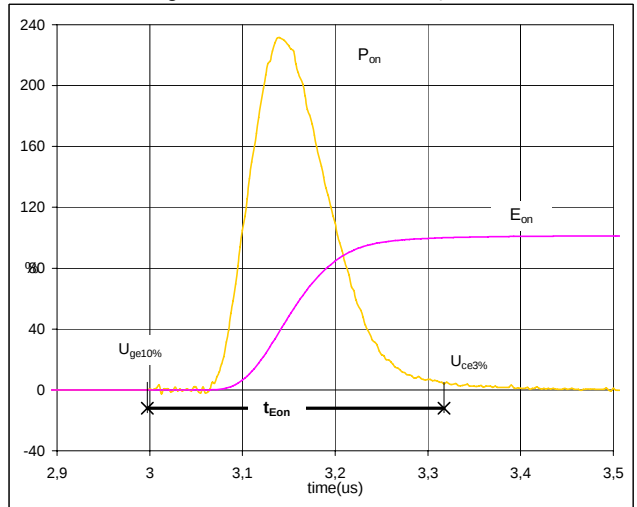
Switching Definitions Output Inverter

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



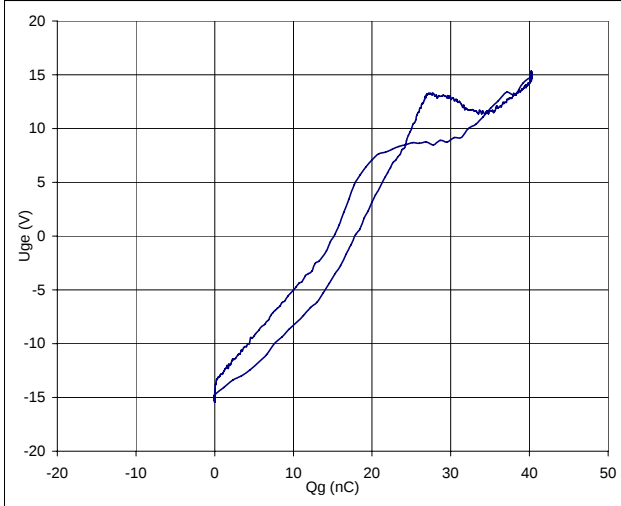
$P_{off} (100\%) = 2,41$ kW
 $E_{off} (100\%) = 0,32$ mJ
 $t_{Eoff} = 0,59$ μ s

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



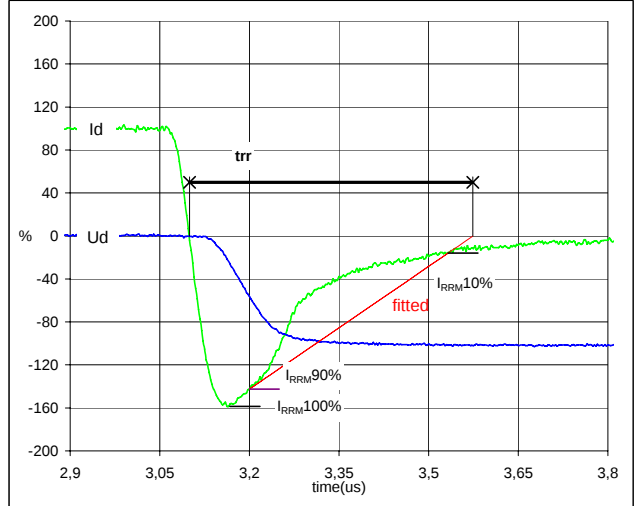
$P_{on} (100\%) = 2,41$ kW
 $E_{on} (100\%) = 0,56$ mJ
 $t_{Eon} = 0,32$ μ s

Figure 7 Output inverter FRED
Gate voltage vs Gate charge (measured)



$V_{GEoff} = -15$ V
 $V_{GEon} = 15$ V
 $V_C (100\%) = 600$ V
 $I_C (100\%) = 4$ A
 $Q_g = 40,28$ nC

Figure 8 Output inverter IGBT
Turn-off Switching Waveforms & definition of t_{rr}

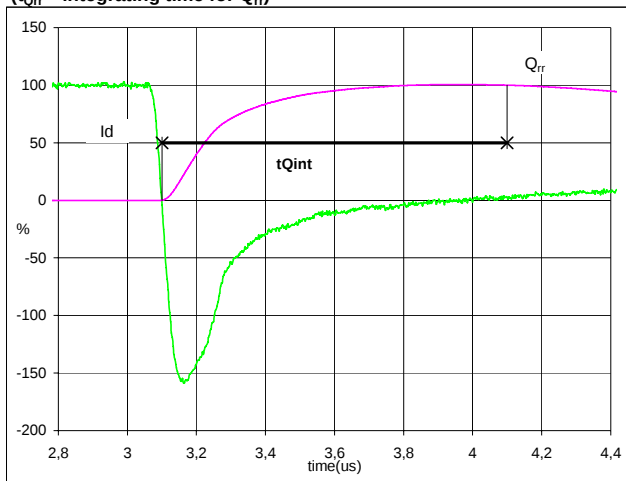


$V_d (100\%) = 600$ V
 $I_d (100\%) = 4$ A
 $I_{RRM} (100\%) = -6$ A
 $t_{rr} = 0,43$ μ s

Switching Definitions Output Inverter

Figure 9 Output inverter FRED

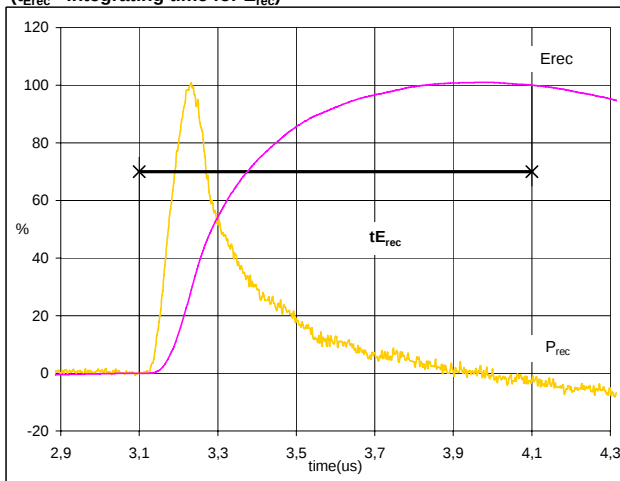
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 4 A
 Q_{rr} (100%) = 1,24 μ C
 t_{Qint} = 1,00 μ s

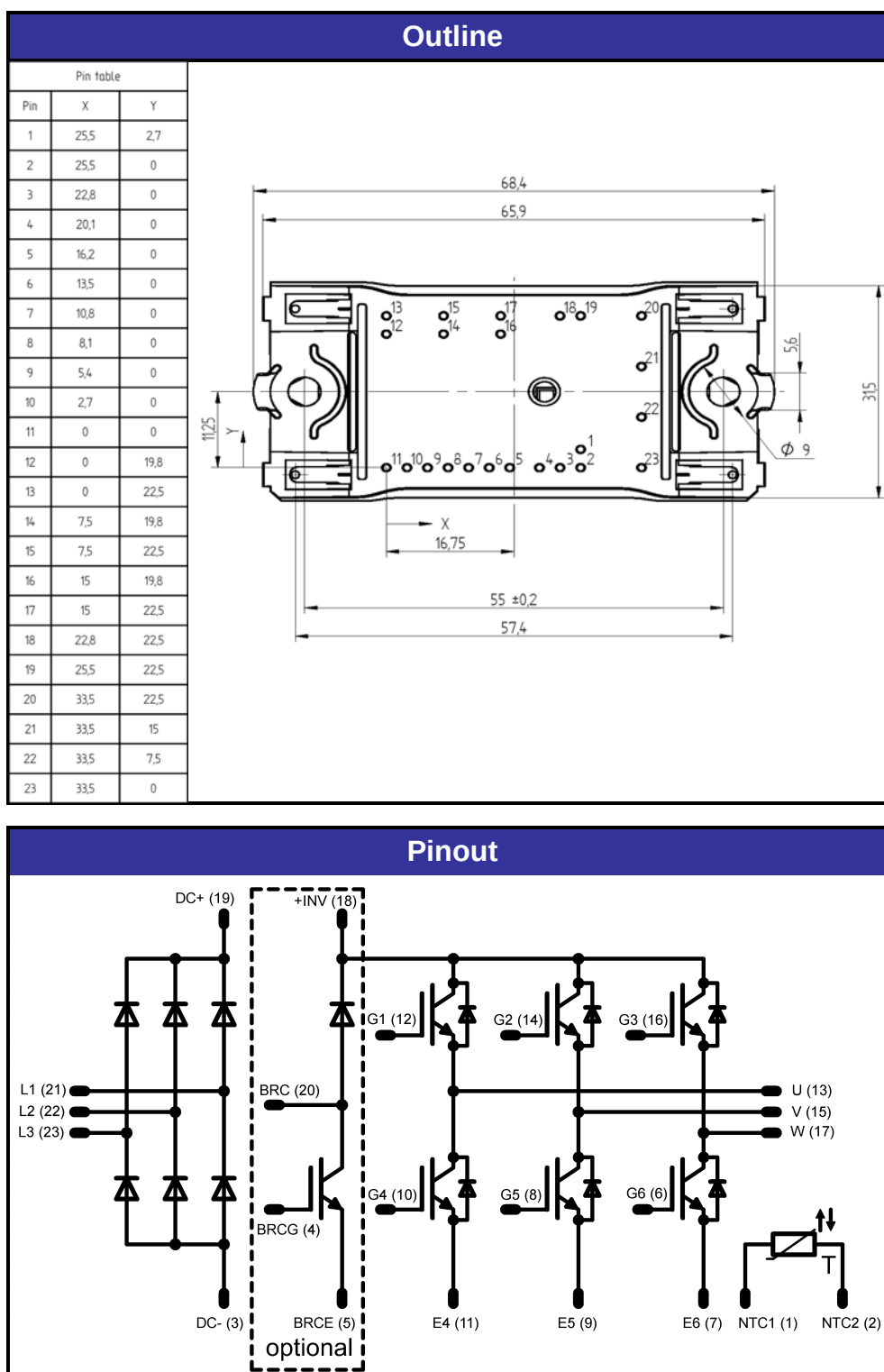
Figure 10 Output inverter FRED

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



P_{rec} (100%) = 2,41 kW
 E_{rec} (100%) = 0,47 mJ
 t_{Erec} = 1,00 μ s

Package Outline and Pinout



PRODUCT STATUS DEFINITIONS

Datasheet Status	Product Status	Definition
Target	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data may be published at a later date. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.
Final	Full Production	This datasheet contains final specifications. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.

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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.