

flowPIM 1 3rd gen
1200V / 35A
Features

- 3~ rectifier, BRC, Inverter, NTC
- Very compact housing, easy to route
- IGBT4 / EmCon4 technology for low saturation losses and improved EMC behaviour
- High performance with AlN substrate

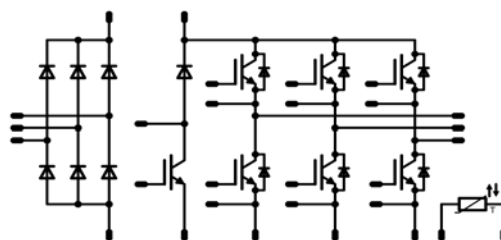
Target Applications

- Motor Drives
- Power Generation

Types

- V23990-P580-A46-PM

flowPIM1 housing

Schematic


Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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Input Rectifier Diode

Peak repetitive reverse voltage	V _{RRM}		1600	V
Forward current per diode	I _{FAV}	DC current T _h =80°C	50	A
Surge forward current	I _{FSM}	t _p =10ms T _j =45°C	320	A
I ² t-value	I ² t		510	A ² s
Power dissipation per diode	P _{tot}	T _j =T _{jmax} T _h =80°C	82	W
Maximum junction temperature	T _{jmax}		150	°C

Inverter Transistor

Collector-emitter break down voltage	V _{CE}		1200	V
DC collector current	I _C	T _j =T _{jmax} T _h =80°C	49	A
Repetitive peak collector current	I _{Cpulse}	t _p limited by T _{jmax}	105	A
Power dissipation per IGBT	P _{tot}	T _j =T _{jmax} T _h =80°C	152	W
Gate-emitter peak voltage	V _{GE}		±20	V
Short circuit ratings	t _{SC} V _{CC}	T _j ≤150°C V _{GE} =15V	10 800	µs V
Maximum junction temperature	T _{jmax}		175	°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	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	50	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	70	A
Power dissipation per diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	121	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	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	40	A
Repetitive peak collector current	I_{Cpuls}	t_p limited by T_{jmax}	75	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	133	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	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	20	A
Power dissipation per diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$	59	W
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$

Thermal Properties

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

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 _o [A]	T _J	Min	Typ	Max	
Input Rectifier Diode										
Forward voltage	V _F				50	T _J =25°C T _J =125°C	0.8	1.29 1.24	1.6	V
Threshold voltage (for power loss calc. only)	V _{to}				50	T _J =25°C T _J =125°C		0.93 0.82		V
Slope resistance (for power loss calc. only)	r _t				50	T _J =25°C T _J =125°C		0.007 0.009		Ω
Reverse current	I _r			1500		T _J =25°C T _J =125°C			0.02 2	mA
Thermal resistance chip to heatsink per chip	R _{thJH}	Thermal foil thickness=76um Kunze foil KU-ALF5						0.85		K/W
Thermal resistance chip to case per chip	R _{thJC}							N/A		
Inverter Transistor										
Gate emitter threshold voltage	V _{GE(th)}	VCE=VGE			0.0012	T _J =25°C T _J =150°C	5	5.8	6.5	V
Collector-emitter saturation voltage	V _{CE(sat)}		15		35	T _J =25°C T _J =150°C	1.6	1.95 2.39	2.3	V
Collector-emitter cut-off current incl. diode	I _{CES}		0	1200		T _J =25°C T _J =150°C			0.01	mA
Gate-emitter leakage current	I _{GES}		20	0		T _J =25°C T _J =150°C			200	nA
Integrated gate resistor	R _{gint}							-		Ω
Turn-on delay time	t _{d(on)}	Rgoff=16Ω Rgon=16Ω	±15	600	35	T _J =25°C T _J =150°C		92 91.6		ns
Rise time	t _r					T _J =25°C T _J =150°C		18 23.4		
Turn-off delay time	t _{d(off)}					T _J =25°C T _J =150°C		213 274		
Fall time	t _f					T _J =25°C T _J =150°C		75.3 105		
Turn-on energy loss per pulse	E _{on}					T _J =25°C T _J =150°C		1.62 2.49		mWs
Turn-off energy loss per pulse	E _{off}	T _J =25°C T _J =150°C		1.81 2.82						
Input capacitance	C _{ies}	f=1MHz	0	25		T _J =25°C		1950		pF
Output capacitance	C _{oss}							155		
Reverse transfer capacitance	C _{rss}							115		
Gate charge	Q _{Gate}	Vcc=960V	±15		35	T _J =25°C		270		nC
Thermal resistance chip to heatsink per chip	R _{thJH}	Thermal foil thickness=76um Kunze foil KU-ALF5						0.62		K/W
Thermal resistance chip to case per chip	R _{thJC}							N/A		
Inverter Diode										
Diode forward voltage	V _F				35	T _J =25°C T _J =150°C	1	1.83 1.8	2.2	V
Peak reverse recovery current	I _{RRM}	Rgoff=16Ω	±15	600	35	T _J =25°C T _J =150°C		68.9 78.7		A
Reverse recovery time	t _{rr}					T _J =25°C T _J =150°C		150 277		ns
Reverse recovered charge	Q _{rr}					T _J =25°C T _J =150°C		3.93 7.47		μC
Peak rate of fall of recovery current	di(rec)max /dt					T _J =25°C T _J =150°C		4100 2080		A/μs
Reverse recovered energy	E _{rec}					T _J =25°C T _J =150°C		1.69 3.31		mWs
Thermal resistance chip to heatsink per chip	R _{thJH}	Thermal foil thickness=76um Kunze foil KU-ALF5						0.78		K/W
Thermal resistance chip to case per chip	R _{thJC}							N/A		

Characteristic Values

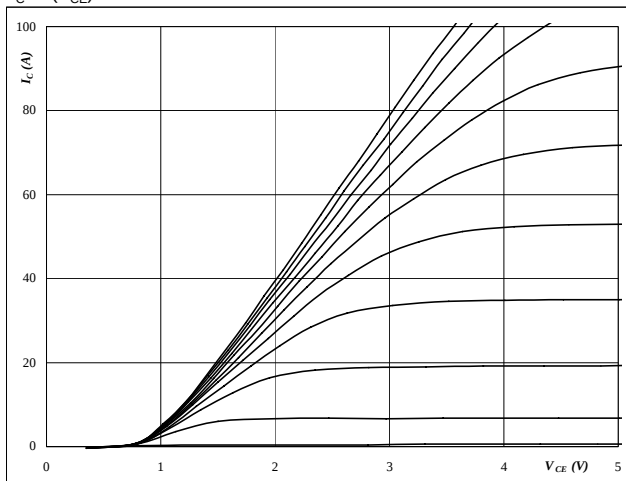
Parameter	Symbol	Conditions					Value			Unit
			V _{GE} [V] or V _{GS} [V]	V _r [V] or V _{CE} [V] or V _{DS} [V]	I _c [A] or I _f [A] or I _b [A]	T _j	Min	Typ	Max	
Brc Transistor										
Gate emitter threshold voltage	V _{GE(th)}	VCE=VGE			0.00085	Tj=25°C Tj=150°C	5	5.8	6.5	v
Collector-emitter saturation voltage	V _{CE(sat)}		15		25	Tj=25°C Tj=150°C	1.6	1.86 2.31	2.2	v
Collector-emitter cut-off incl. diode	I _{CES}		0	1200		Tj=25°C Tj=150°C			0.005	mA
Gate-emitter leakage current	I _{GES}		20	0		Tj=25°C Tj=150°C			200	nA
Integrated gate resistor	R _{gint}							-		Ω
Turn-on delay time	t _{d(on)}	Rgon=32Ω Rgoff=32Ω	±15	600	25	Tj=25°C Tj=150°C		127 129		ns
Rise time	t _r					Tj=25°C Tj=150°C		36 41.8		
Turn-off delay time	t _{d(off)}					Tj=25°C Tj=150°C		232 276		
Fall time	t _f					Tj=25°C Tj=150°C		73.7 112		
Turn-on energy loss per pulse	E _{on}					Tj=25°C Tj=150°C		1.81 2.42		mWs
Turn-off energy loss per pulse	E _{off}					Tj=25°C Tj=150°C		1.37 2.19		
Input capacitance	C _{ies}	f=1MHz	0	25		Tj=25°C		1430		pF
Output capacitance	C _{oss}							115		
Reverse transfer capacitance	C _{rss}							85		
Gate charge	Q _{Gate}	Vcc=960V	±15		25	Tj=25°C		200		nC
Thermal resistance chip to heatsink per chip	R _{thJH}	Thermal foil thickness=76um						0.71		K/W
Thermal resistance chip to case per chip	R _{thJC}	Kunze foil KU-ALF5						N/A		
Brc Diode										
Diode forward voltage	V _F				10	Tj=25°C Tj=150°C	1.3	1.85 1.76	2.2	v
Reverse leakage current	I _r		±15	600	10	Tj=25°C Tj=150°C			5	μA
Peak reverse recovery current	I _{RRM}	Rgon=32Ω	±15	600	10	Tj=25°C Tj=150°C		10.2 12.3		A
Reverse recovery time	t _{rr}					Tj=25°C Tj=150°C		396 624		ns
Reverse recovered charge	Q _{rr}					Tj=25°C Tj=150°C		1.55 3.03		μC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25°C Tj=150°C		36 32		A/μs
Reverse recovery energy	E _{rec}					Tj=25°C Tj=150°C		0.63 1.30		mWs
Thermal resistance chip to heatsink per chip	R _{thJH}					Thermal foil thickness=76um				
Thermal resistance chip to case per chip	R _{thJC}	Kunze foil KU-ALF5						N/A		
Thermistor										
Rated resistance	R					Tj=25°C Tj=125°C	20.9	22 0.75	23.1	kΩ
Operating current	I					Tj=25°C			0.3	mA
Power dissipation	P					Tj=25°C		200		mW
B-value	B _(25/50)	Tol. ±3%				Tj=25°C		3950		K

Output Inverter

Figure 1 Output inverter IGBT

Typical output characteristics

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

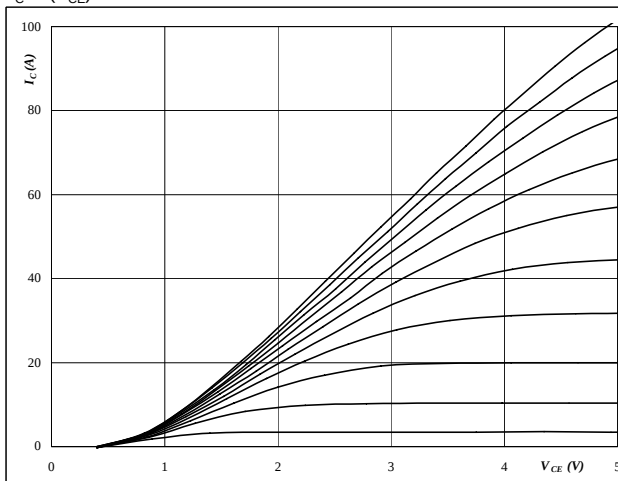


At
 $t_p = 250 \mu s$
 $T_j = 25^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 Output inverter IGBT

Typical output characteristics

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

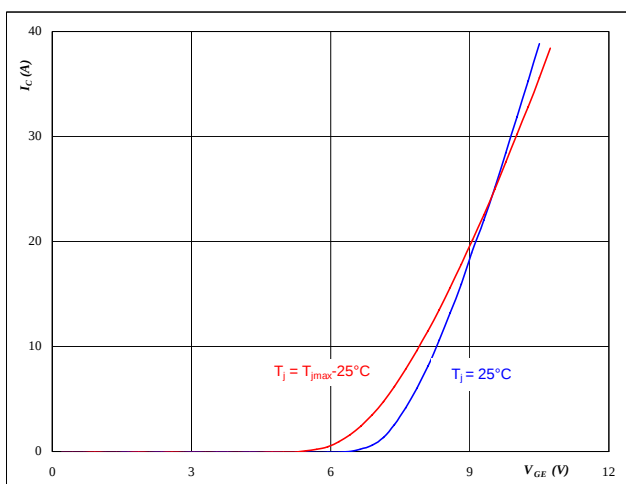


At
 $t_p = 250 \mu s$
 $T_j = 150^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 Output inverter IGBT

Typical transfer characteristics

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

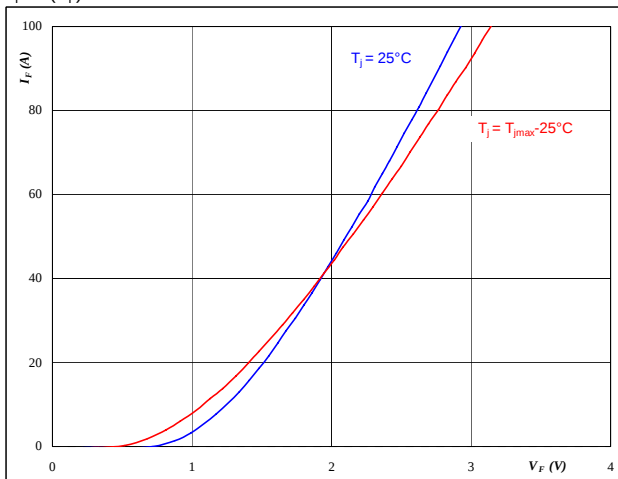


At
 $t_p = 250 \mu s$
 $V_{CE} = 10 V$

Figure 4 Output inverter FRED

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



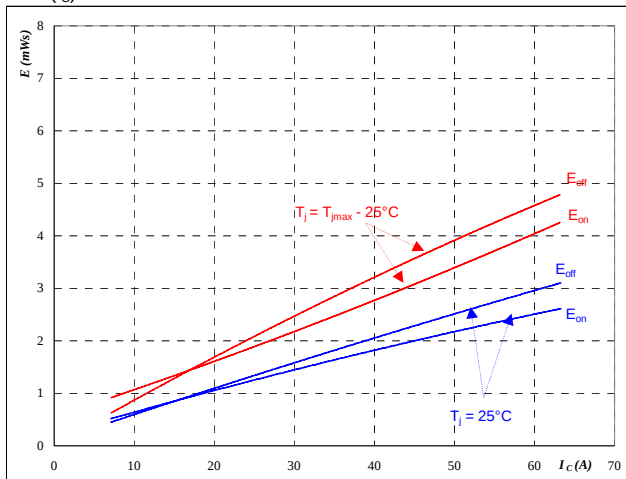
At
 $t_p = 250 \mu s$

Output Inverter

Figure 5 Output inverter IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



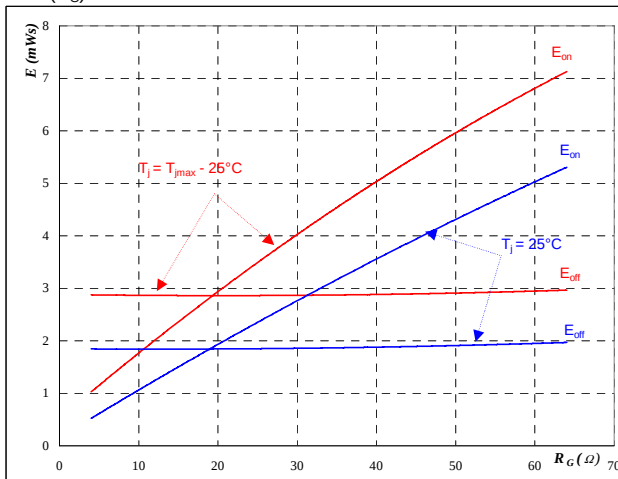
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	16	Ω

Figure 6 Output inverter IGBT

Typical switching energy losses
as a function of gate resistor

$$E = f(R_G)$$



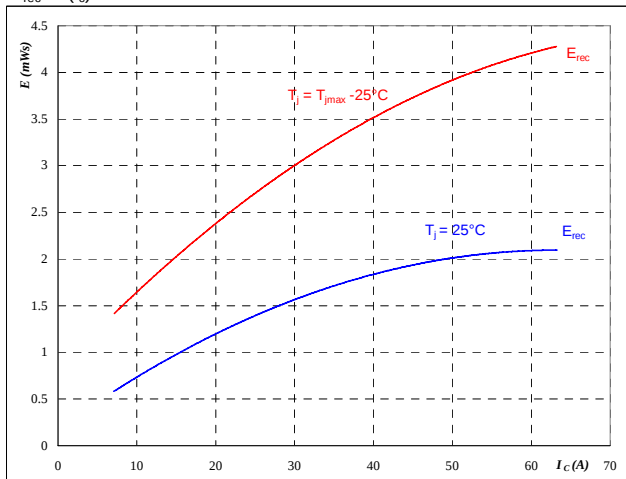
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	35	A

Figure 7 Output inverter IGBT

Typical reverse recovery energy loss
as a function of collector current

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



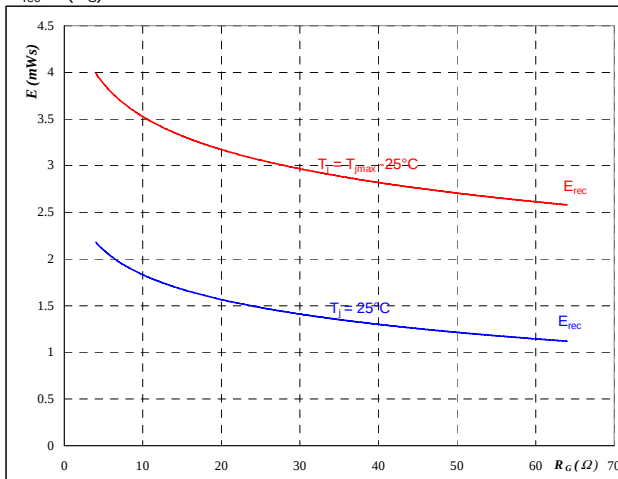
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	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

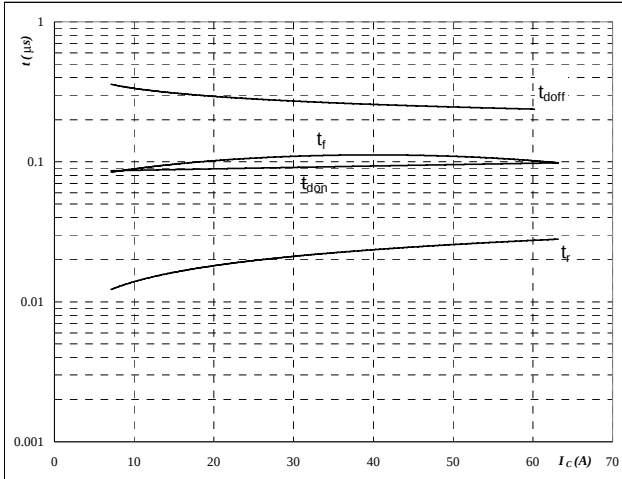
$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	35	A

Output Inverter

Figure 9 Output inverter IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



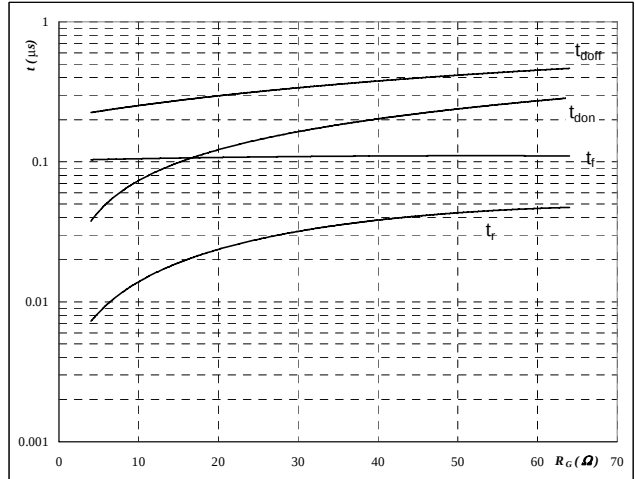
With an inductive load at

$T_J =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	16	Ω

Figure 10 Output inverter IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



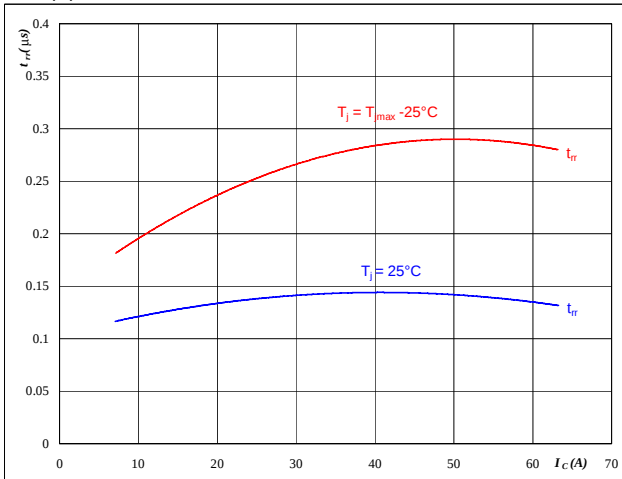
With an inductive load at

$T_J =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	35	A

Figure 11 Output inverter FRED

Typical reverse recovery time as a function of collector current

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



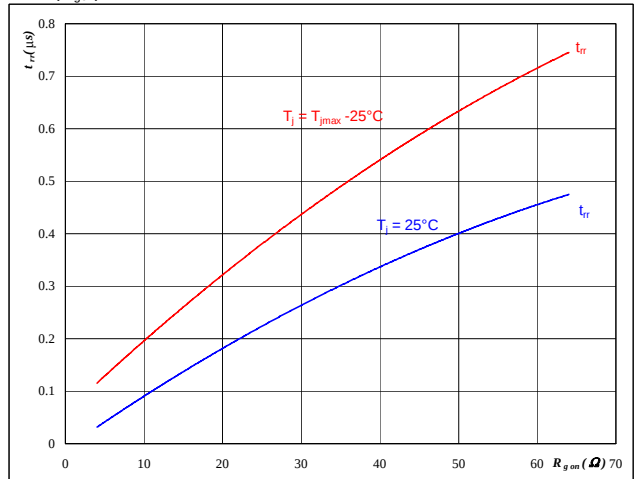
At

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	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

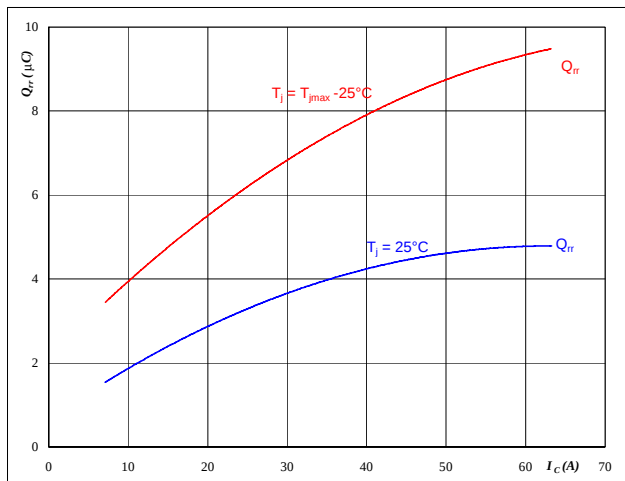
$T_J =$	25/150	°C
$V_R =$	600	V
$I_F =$	35	A
$V_{GE} =$	±15	V

Output Inverter

Figure 13 Output inverter FRED

Typical reverse recovery charge as a function of collector current

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

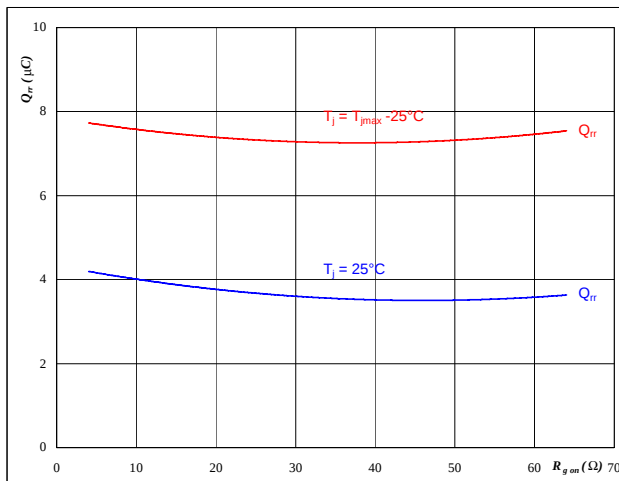


At
 $T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 14 Output inverter FRED

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

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

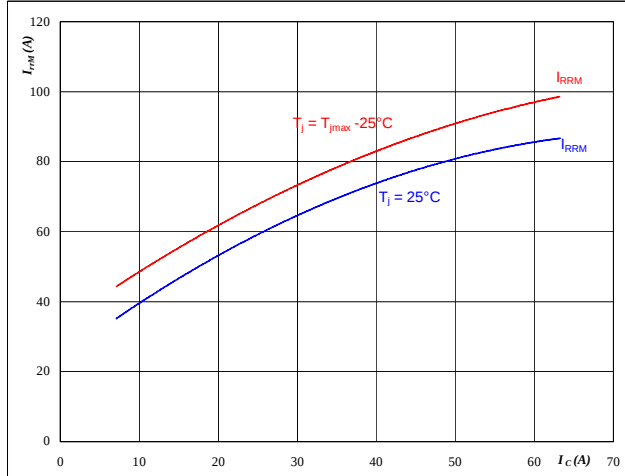


At
 $T_j = 25/150$ °C
 $V_R = 600$ V
 $I_F = 35$ A
 $V_{GE} = \pm 15$ V

Figure 15 Output inverter FRED

Typical reverse recovery current as a function of collector current

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

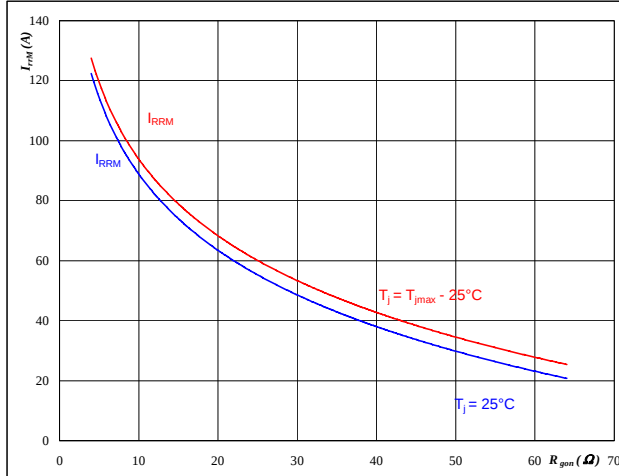


At
 $T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 16 Output inverter FRED

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

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



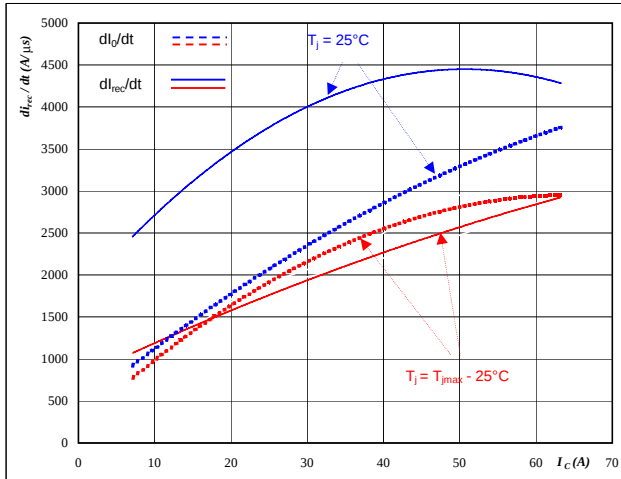
At
 $T_j = 25/150$ °C
 $V_R = 600$ V
 $I_F = 35$ A
 $V_{GE} = \pm 15$ V

Output Inverter

Figure 17 Output inverter FRED

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

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

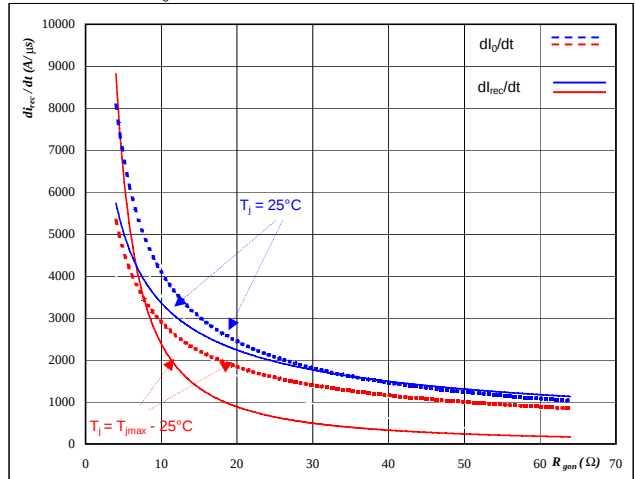


At
 $T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 18 Output inverter FRED

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

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

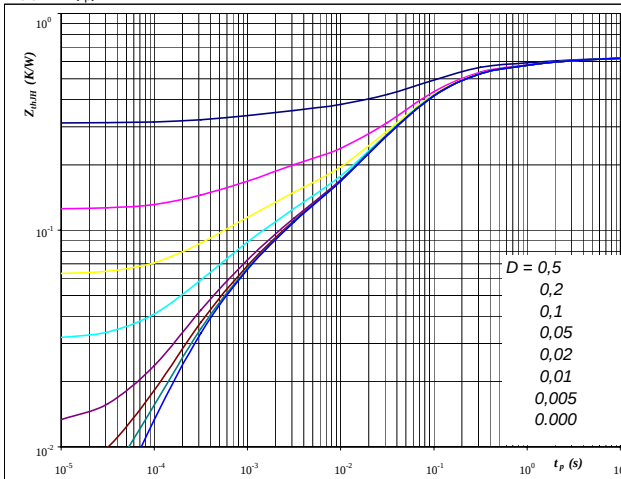


At
 $T_j = 25/150$ °C
 $V_R = 600$ V
 $I_F = 35$ A
 $V_{GE} = \pm 15$ V

Figure 19 Output inverter IGBT

IGBT transient thermal impedance
as a function of pulse width

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



At
 $D = t_p / T$
 $R_{thJH} = 0.62$ K/W

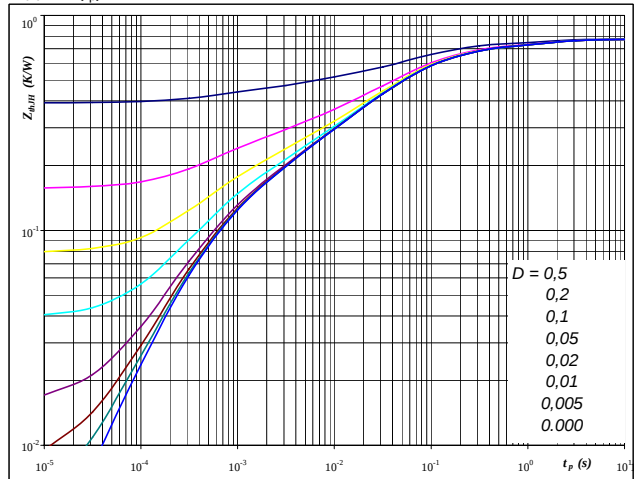
IGBT thermal model values

R (C/W)	Tau (s)
0.04	3.6E+00
0.09	5.8E-01
0.31	8.1E-02
0.09	1.7E-02
0.06	1.6E-03
0.03	2.8E-04

Figure 20 Output inverter FRED

FRED transient thermal impedance
as a function of pulse width

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



At
 $D = t_p / T$
 $R_{thJH} = 0.78$ K/W

FRED thermal model values

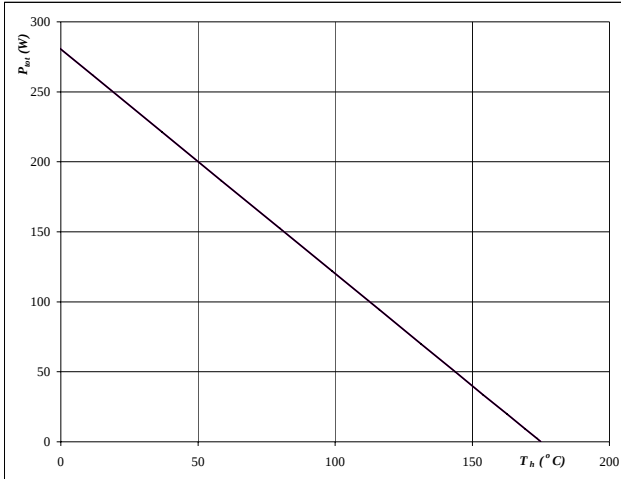
R (C/W)	Tau (s)
0.02	9.7E+00
0.09	9.8E-01
0.24	1.0E-01
0.22	2.5E-02
0.11	2.9E-03
0.09	4.1E-04

Output Inverter

Figure 21 Output inverter IGBT

Power dissipation as a function of heatsink temperature

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

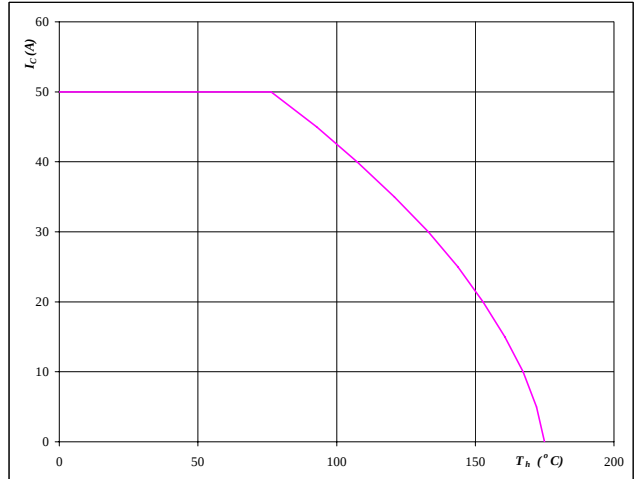


At $T_j = 175$ °C
 — single heating
 — overall heating

Figure 22 Output inverter IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

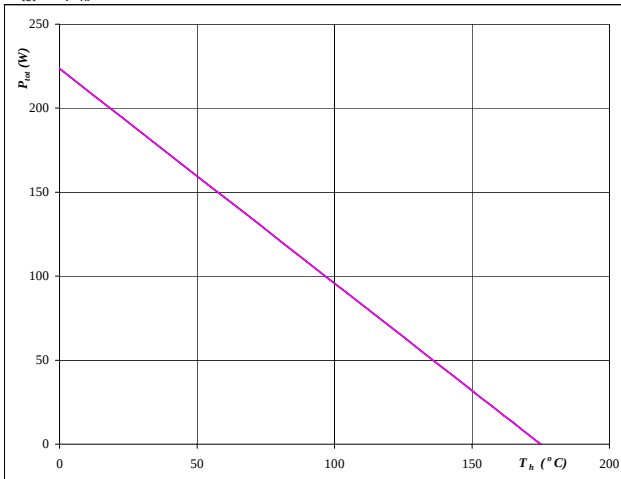


At $T_j = 175$ °C
 $V_{GE} = 15$ V

Figure 23 Output inverter FRED

Power dissipation as a function of heatsink temperature

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

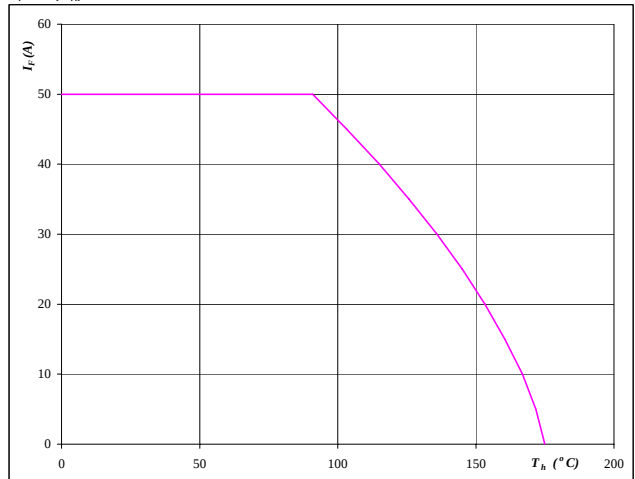


At $T_j = 175$ °C
 — single heating
 — overall heating

Figure 24 Output inverter FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



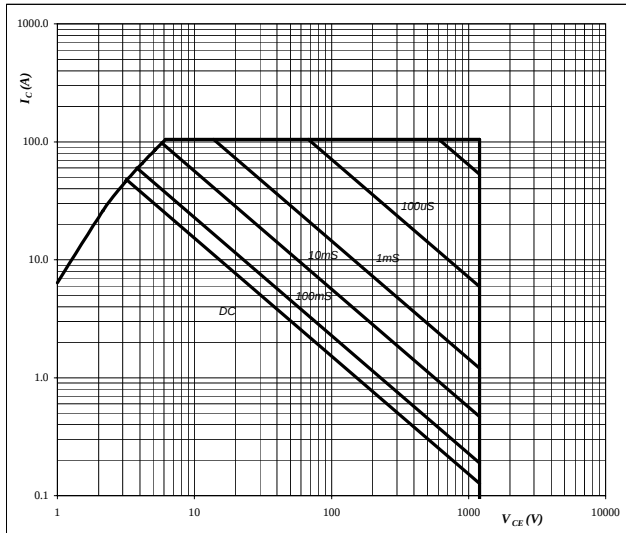
At $T_j = 175$ °C

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

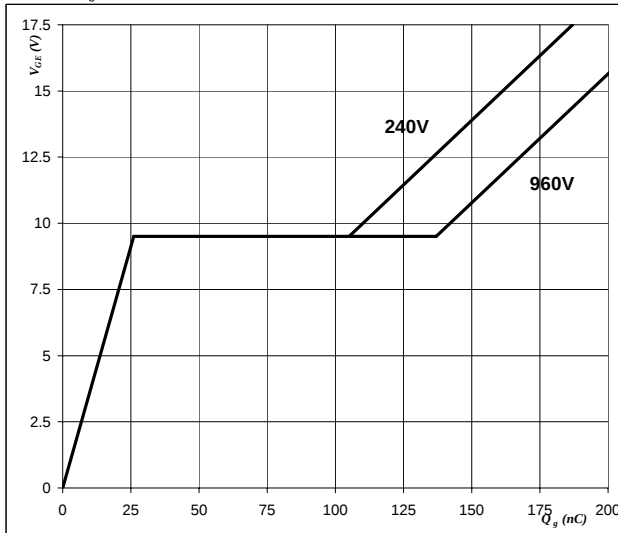
V_{GE} = ±15 V

T_J = T_{Jmax} °C

Figure 26 Output inverter IGBT

Gate voltage vs Gate charge

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



At

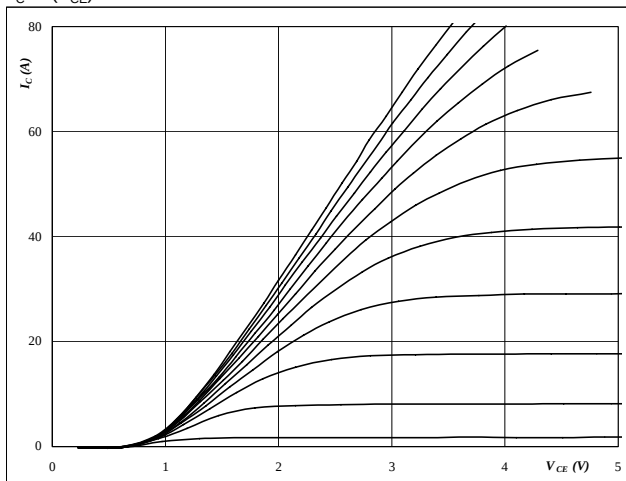
I_C = 35 A

Brake

Figure 1 Brake IGBT

Typical output characteristics

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



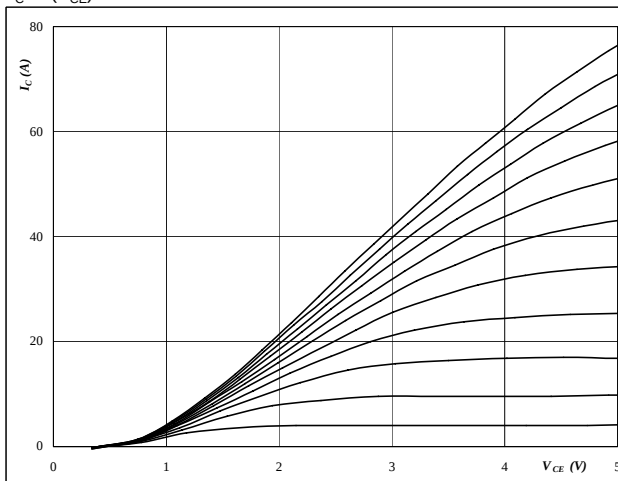
At

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

Figure 2 Brake IGBT

Typical output characteristics

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



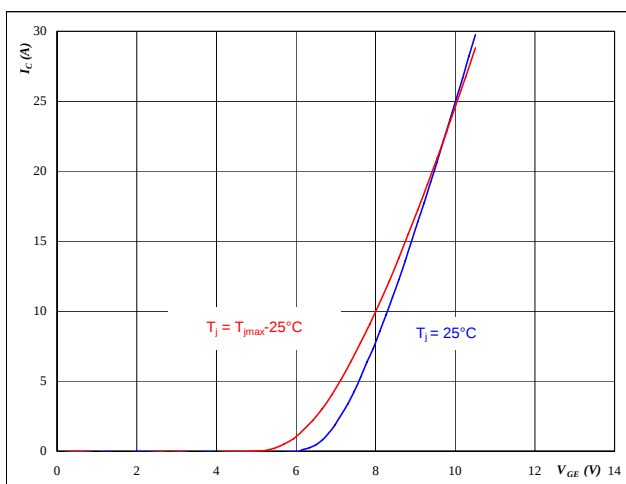
At

$t_p = 250 \mu s$
 $T_J = 150^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 Brake IGBT

Typical transfer characteristics

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



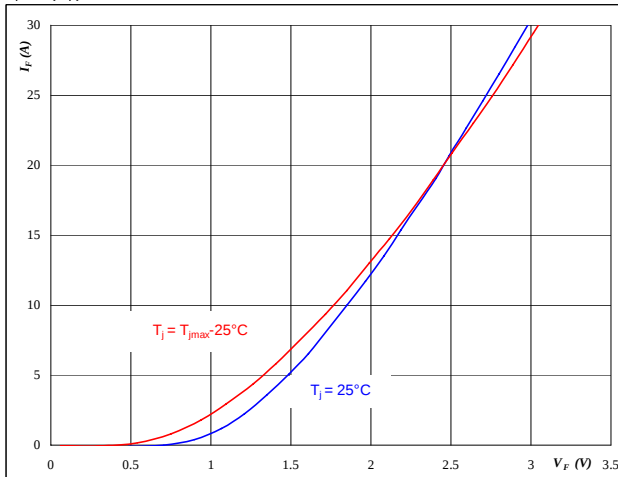
At

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

Figure 4 Brake FRED

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



At

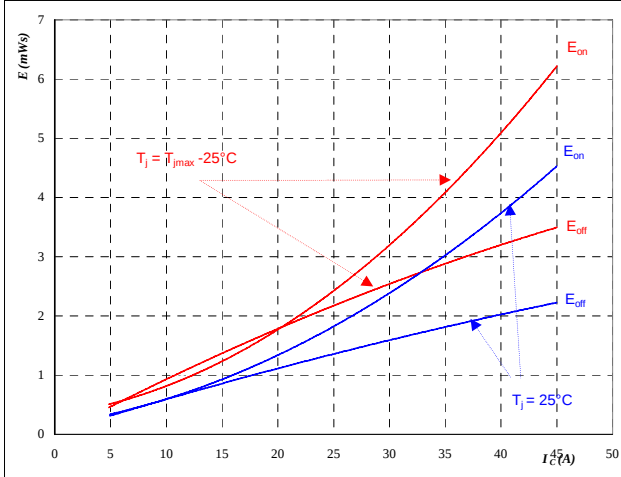
$t_p = 250 \mu s$

Brake

Figure 5 Brake IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



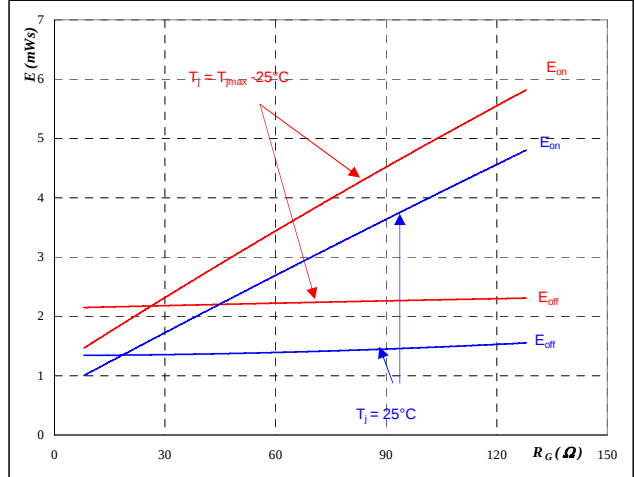
With an inductive load at

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	32	Ω

Figure 6 Brake IGBT

Typical switching energy losses
as a function of gate resistor

$$E = f(R_G)$$



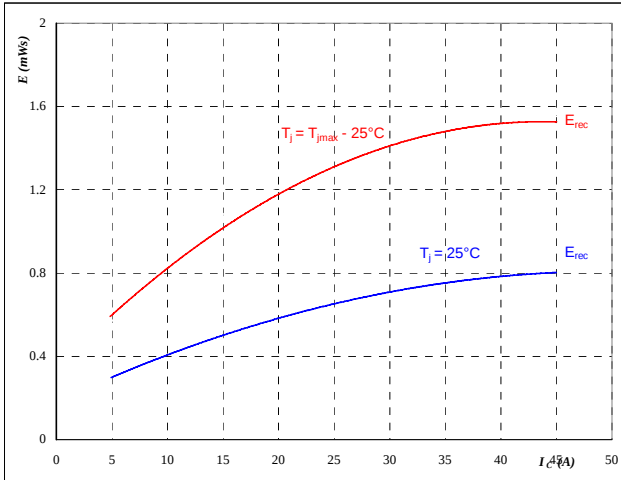
With an inductive load at

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

Figure 7 Brake IGBT

Typical reverse recovery energy loss
as a function of collector current

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



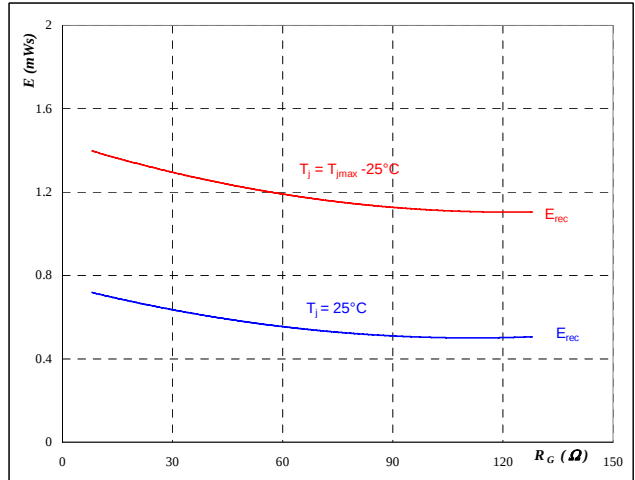
With an inductive load at

$T_j =$	25/150	°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

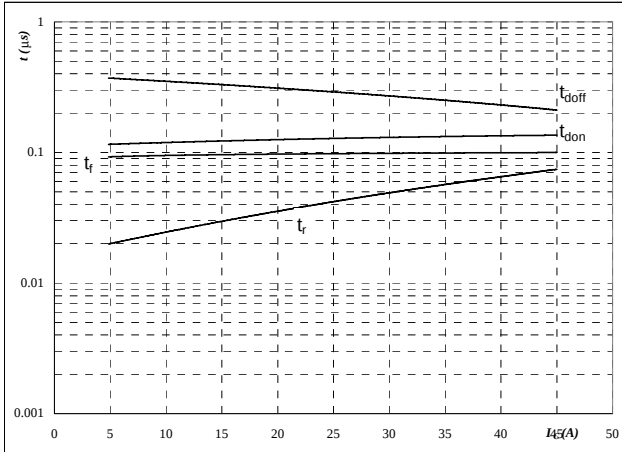
$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	25	A

Brake

Figure 9 Brake IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



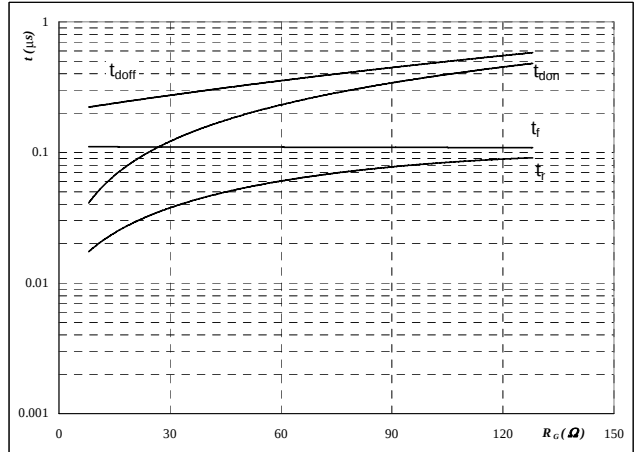
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	32	Ω

Figure 10 Brake IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



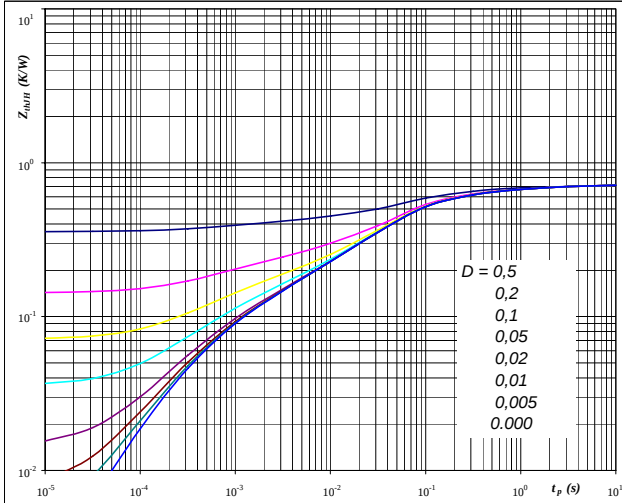
With an inductive load at

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

Figure 11 Brake IGBT

IGBT transient thermal impedance as a function of pulse width

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



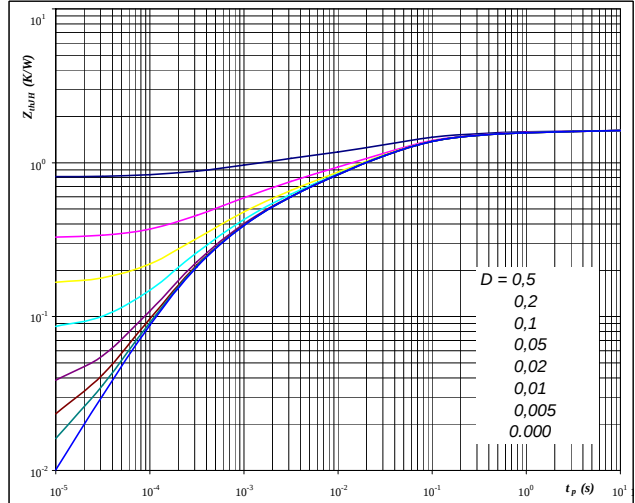
At

$D =$	t_p / T	
$R_{thJH} =$	0.71	K/W

Figure 12 Brake FRED

FRED transient thermal impedance as a function of pulse width

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



At

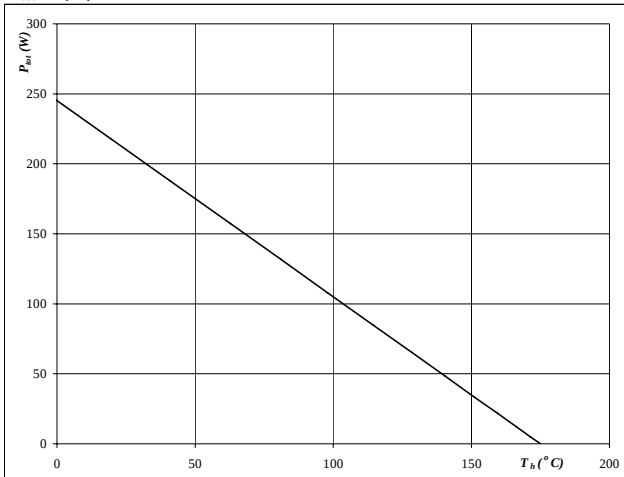
$D =$	t_p / T	
$R_{thJH} =$	1.62	K/W

Brake

Figure 13 Brake IGBT

Power dissipation as a function of heatsink temperature

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

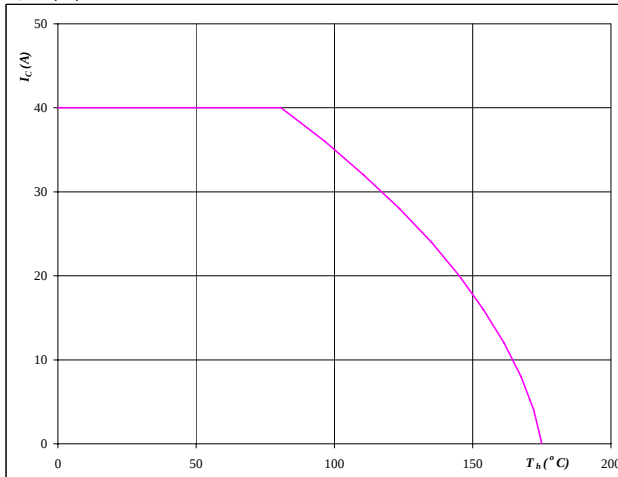


At
 $T_j = 175$ °C

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

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

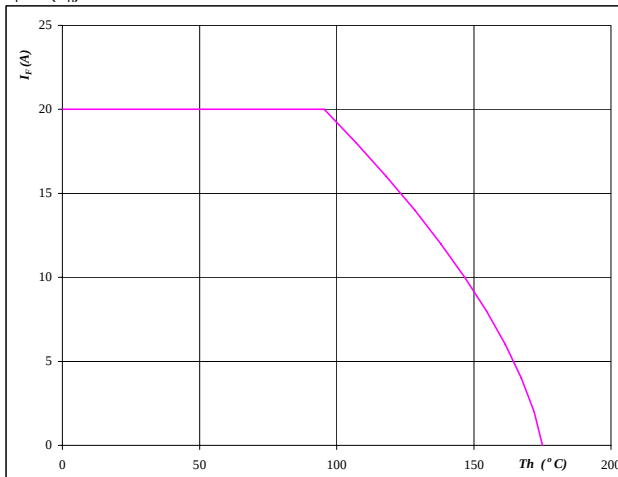


At
 $T_j = 175$ °C

Figure 16 Brake FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



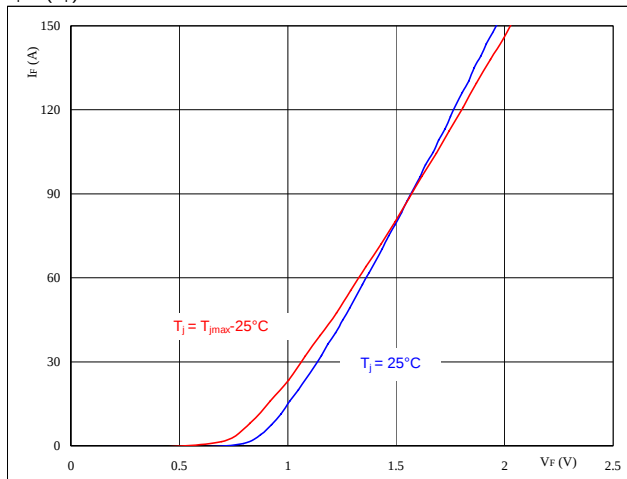
At
 $T_j = 175$ °C

Input Rectifier Bridge

Figure 1 Rectifier diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

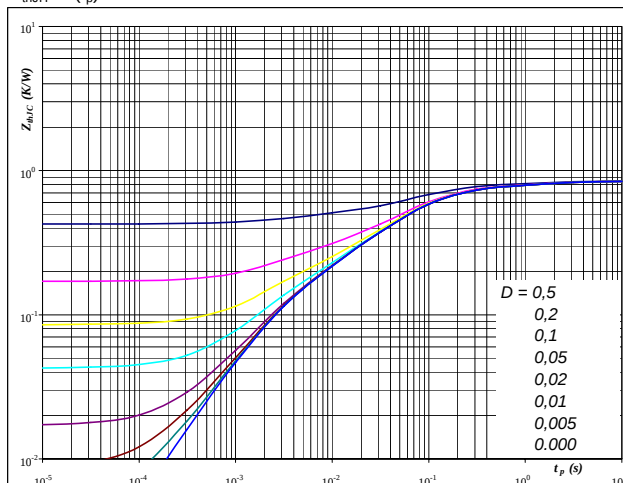


At
 $t_p = 250 \mu s$

Figure 2 Rectifier diode

Diode transient thermal impedance as a function of pulse width

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

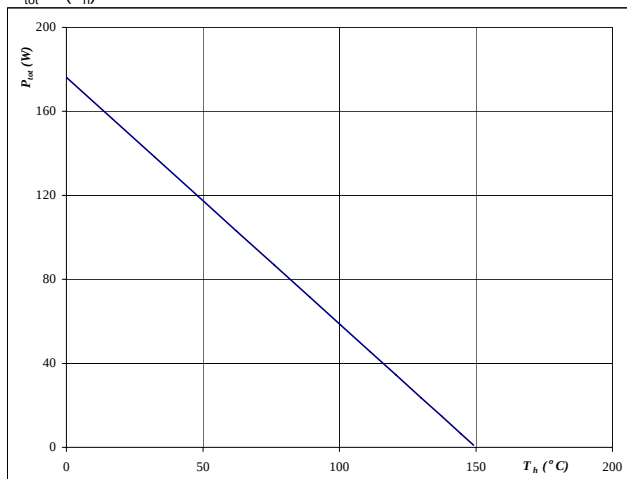


At
 $D = t_p / T$
 $R_{thJH} = 0.851 \text{ K/W}$

Figure 3 Rectifier diode

Power dissipation as a function of heatsink temperature

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

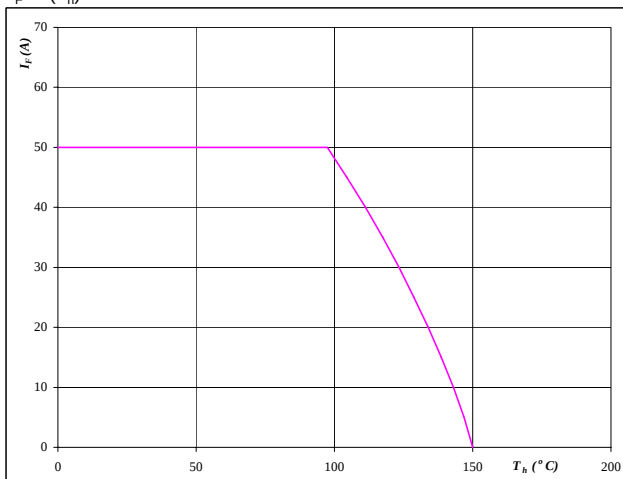


At
 $T_J = 150 \text{ °C}$

Figure 4 Rectifier diode

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



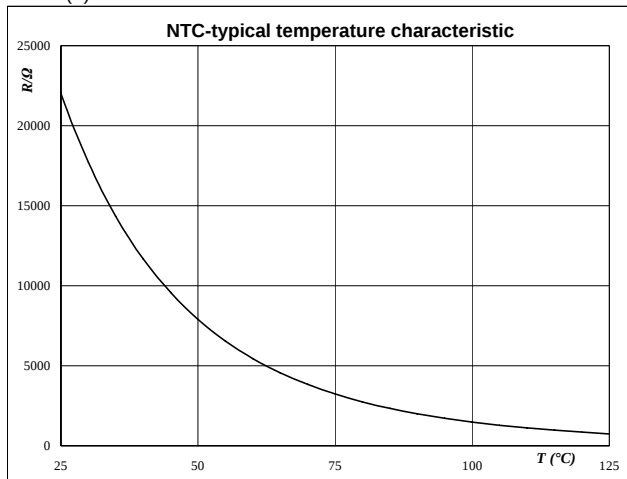
At
 $T_J = 150 \text{ °C}$

Thermistor

Figure 1 Thermistor

Typical NTC characteristic
as a function of temperature

$$R_T = f(T)$$



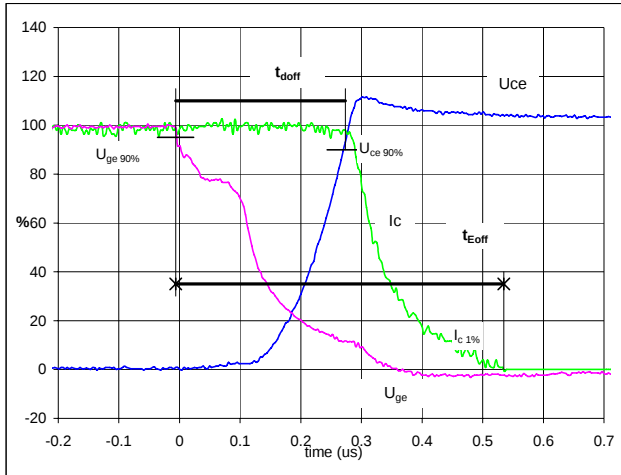
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	16 Ω
R_{goff}	=	16 Ω

Figure 1 Output inverter IGBT

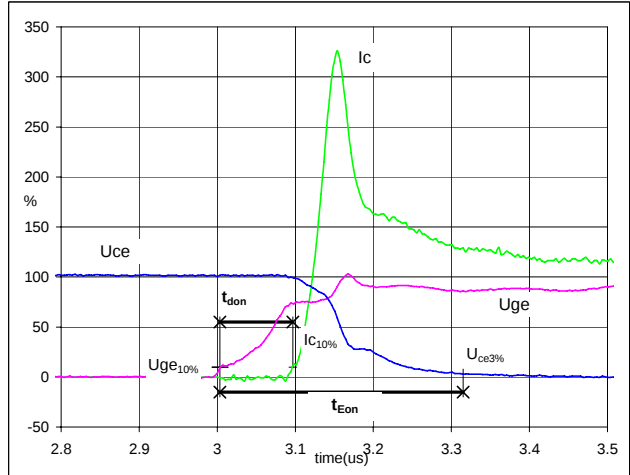
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	35	A
t_{doff}	=	0.27	μs
t_{Eoff}	=	0.54	μs

Figure 2 Output inverter IGBT

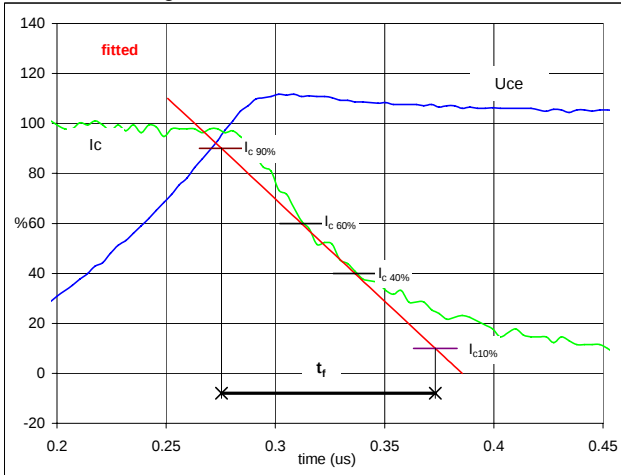
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
(t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	35	A
t_{don}	=	0.09	μs
t_{Eon}	=	0.31	μs

Figure 3 Output inverter IGBT

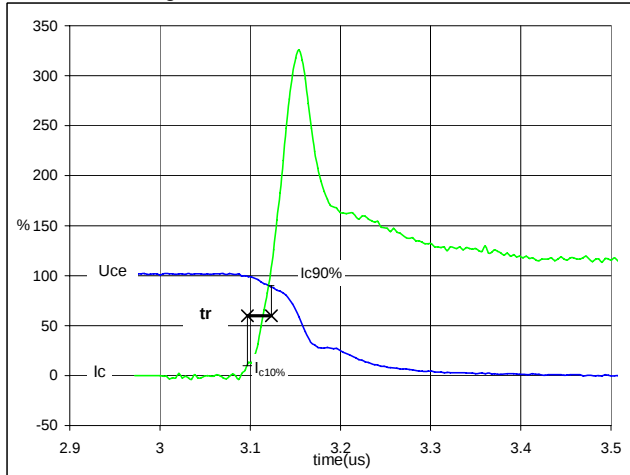
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	35	A
t_f	=	0.11	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

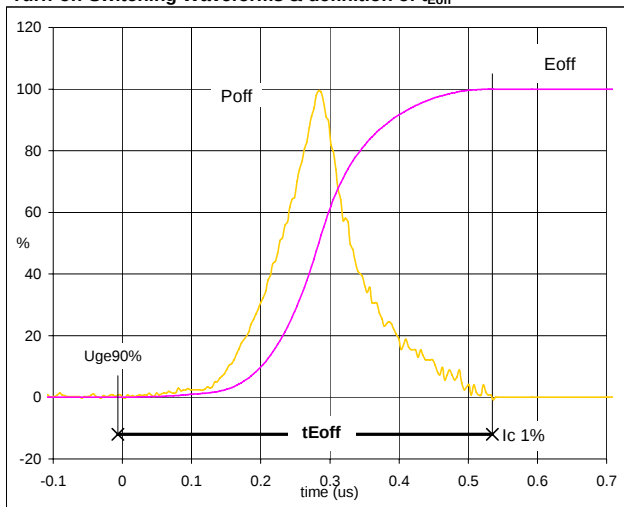


$V_C(100\%)$	=	600	V
$I_C(100\%)$	=	35	A
t_r	=	0.02	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

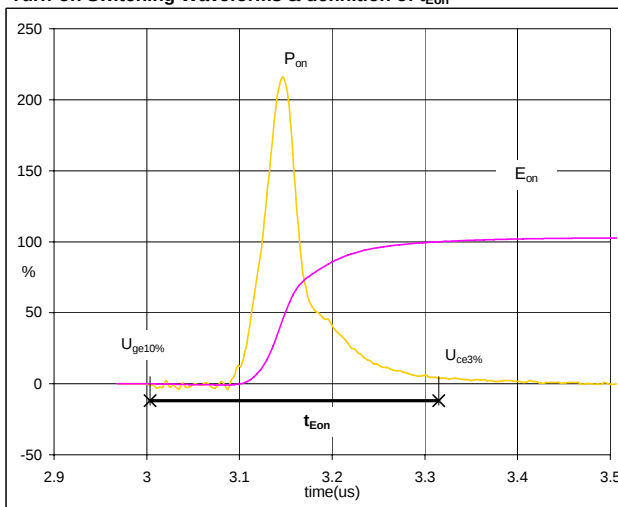
Turn-off Switching Waveforms & definition of t_{Eoff}



$P_{off}(100\%) = 21.01$ kW
 $E_{off}(100\%) = 2.82$ mJ
 $t_{Eoff} = 0.54$ μ s

Figure 6 Output inverter IGBT

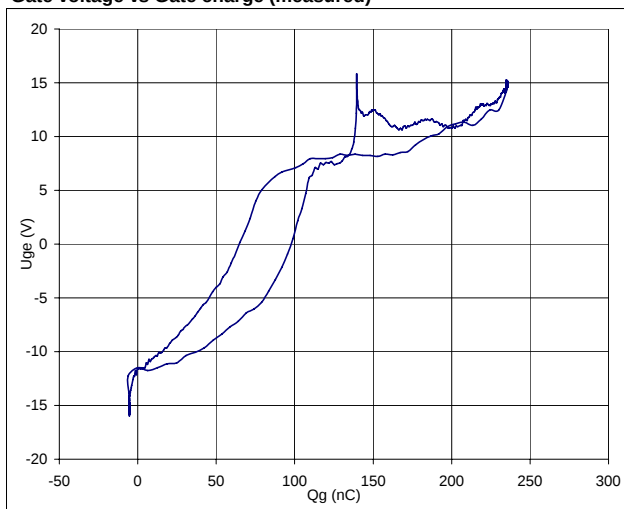
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on}(100\%) = 21.01$ kW
 $E_{on}(100\%) = 2.49$ mJ
 $t_{Eon} = 0.31$ μ s

Figure 7 Output inverter FRED

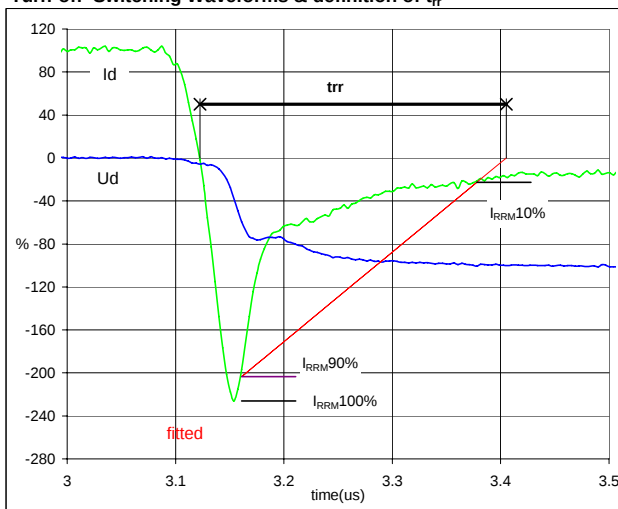
Gate voltage vs Gate charge (measured)



$V_{GEoff} = -15$ V
 $V_{GEon} = 15$ V
 $V_C(100\%) = 600$ V
 $I_C(100\%) = 35$ A
 $Q_g = 1239.53$ nC

Figure 8 Output inverter IGBT

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

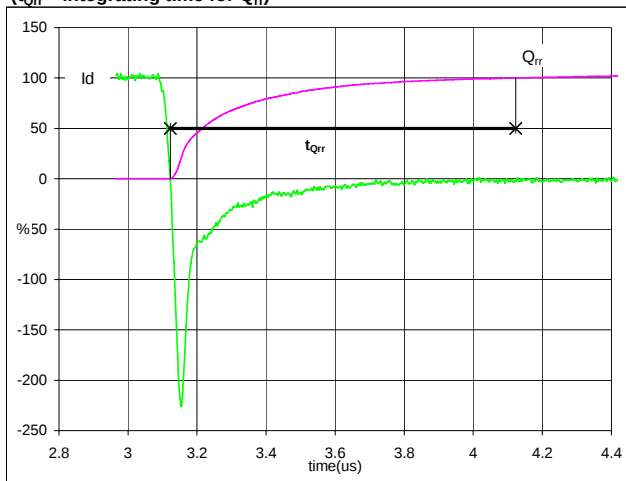


$V_d(100\%) = 600$ V
 $I_d(100\%) = 35$ A
 $I_{RRM}(100\%) = -79$ A
 $t_{tr} = 0.28$ μ s

Switching Definitions Output Inverter

Figure 9 Output inverter FRED

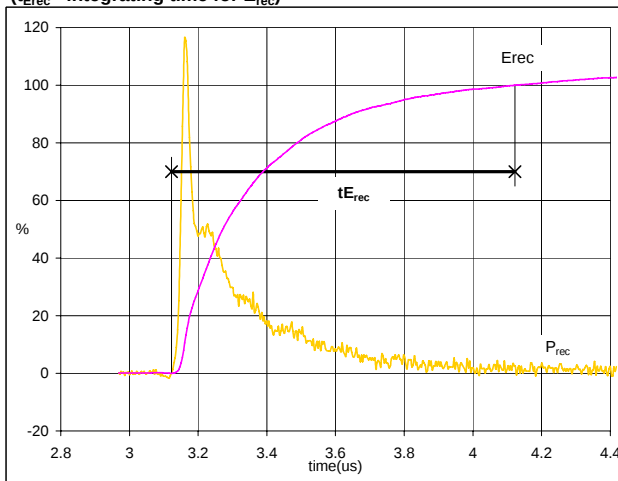
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 35 A
 Q_{rr} (100%) = 7.47 μC
 t_{Qrr} = 1.00 μs

Figure 10 Output inverter FRED

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



P_{rec} (100%) = 21.01 kW
 E_{rec} (100%) = 3.31 mJ
 t_{Erec} = 1.00 μs

General conditions
3phase SPWM

$$V_{GEon} = 15 \text{ V}$$

$$V_{GEoff} = -15 \text{ V}$$

$$R_{gon} = 16 \text{ } \Omega$$

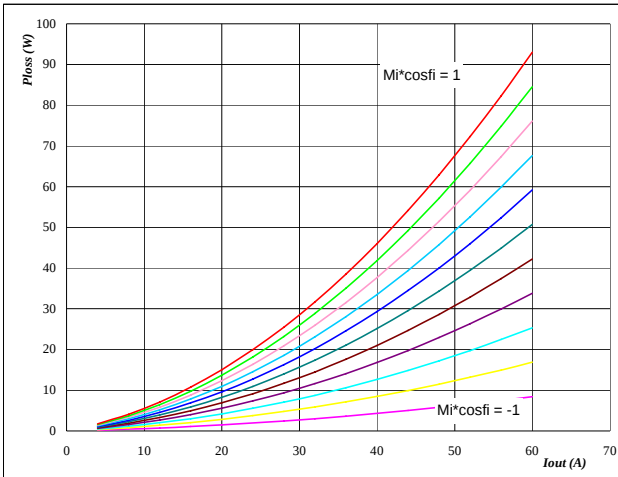
$$R_{goff} = 16 \text{ } \Omega$$

Figure 1

IGBT

Typical average static loss as a function of output current

$$P_{loss} = f(I_{out})$$


At

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

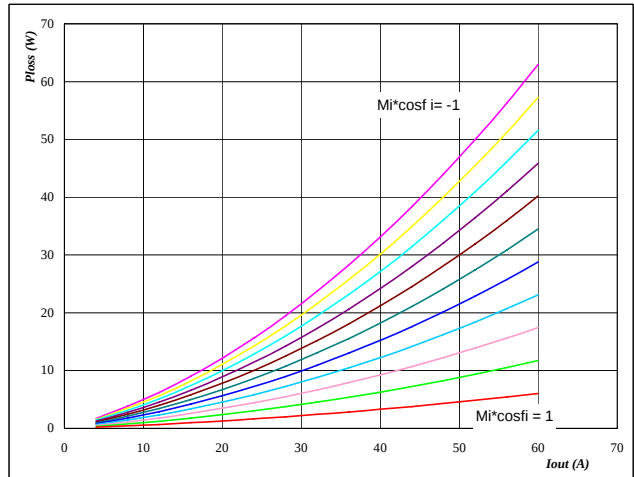
Mi*cosφ from -1 to 1 in steps of 0.2

Figure 2

FRED

Typical average static loss as a function of output current

$$P_{loss} = f(I_{out})$$


At

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

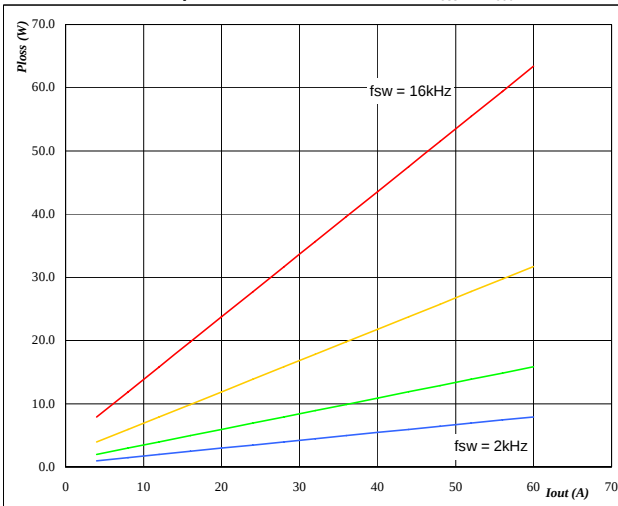
Mi*cosφ from -1 to 1 in steps of 0.2

Figure 3

IGBT

Typical average switching loss as a function of output current

$$P_{loss} = f(I_{out})$$


At

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

$$\text{DC link} = 600 \text{ V}$$

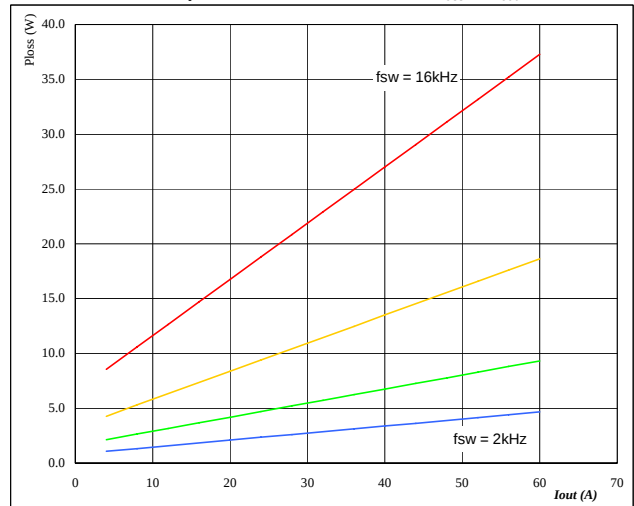
fsw from 2 kHz to 16 kHz in steps of factor 2

Figure 4

FRED

Typical average switching loss as a function of output current

$$P_{loss} = f(I_{out})$$


At

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

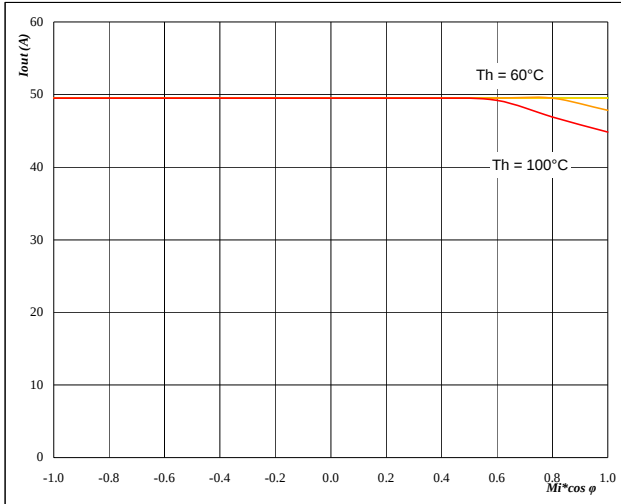
$$\text{DC link} = 600 \text{ V}$$

fsw from 2 kHz to 16 kHz in steps of factor 2

Figure 5 Phase

Typical available 50Hz output current
as a function $Mi \cdot \cos \phi$

$$I_{out} = f(Mi \cdot \cos \phi)$$

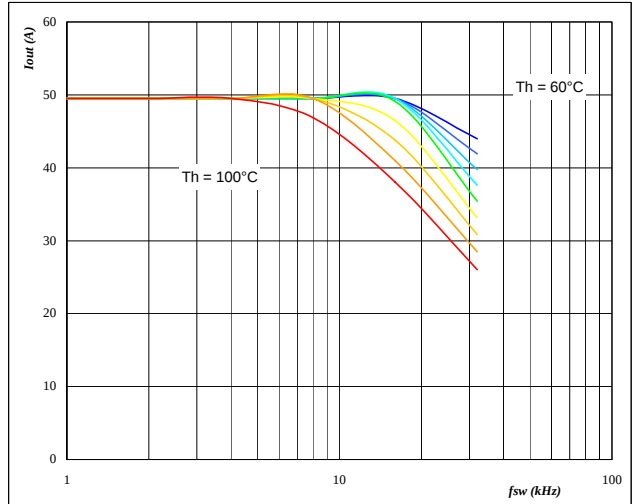


At
 $T_j = 150$ °C
 DC link = 600 V
 $f_{sw} = 8$ kHz
 T_h from 60 °C to 100 °C in steps of 5 °C

Figure 6 Phase

Typical available 50Hz output current
as a function of switching frequency

$$I_{out} = f(f_{sw})$$

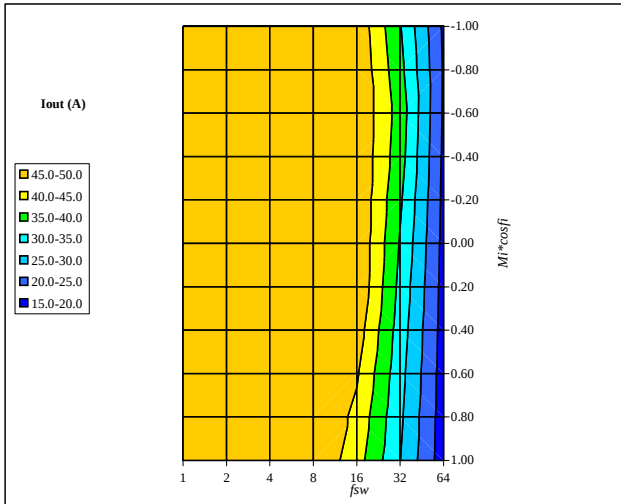


At
 $T_j = 150$ °C
 DC link = 600 V
 $Mi \cdot \cos \phi = 0.8$
 T_h from 60 °C to 100 °C in steps of 5 °C

Figure 7 Phase

Typical available 50Hz output current as a function of
 $Mi \cdot \cos \phi$ and switching frequency

$$I_{out} = f(f_{sw}, Mi \cdot \cos \phi)$$

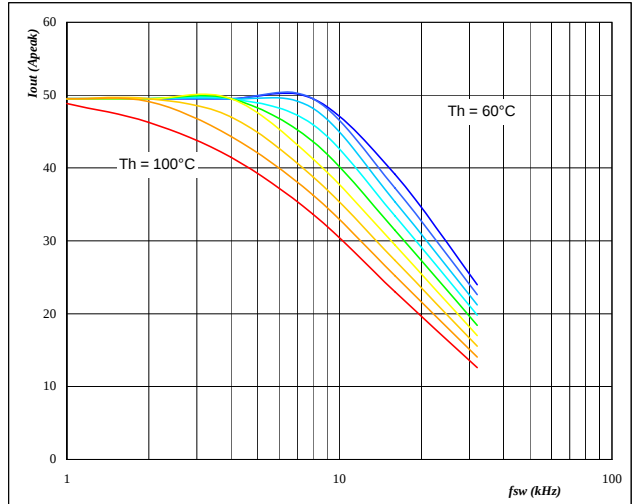


At
 $T_j = 150$ °C
 DC link = 600 V
 $T_h = 90$ °C

Figure 8 Phase

Typical available 0Hz output current as a function
of switching frequency

$$I_{outpeak} = f(f_{sw})$$



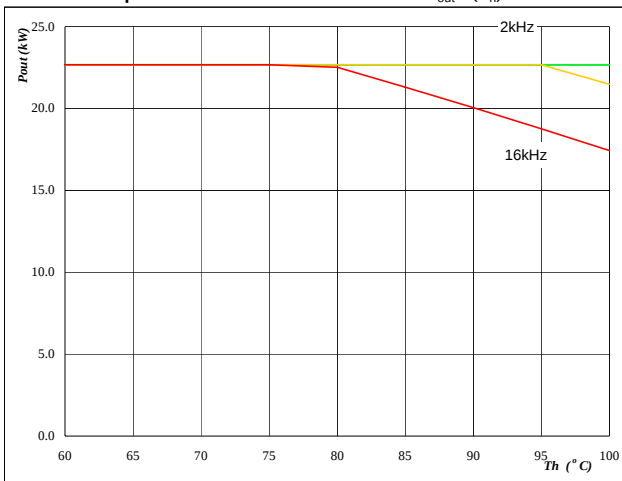
At
 $T_j = 150$ °C
 DC link = 600 V
 T_h from 60 °C to 100 °C in steps of 5 °C
 $Mi = 0$

Figure 9

Inverter

Typical available peak output power as a function of heatsink temperature

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



At

$T_j = 150$ °C

DC link = 600 V

Mi = 1

$\cos \varphi = 0.80$

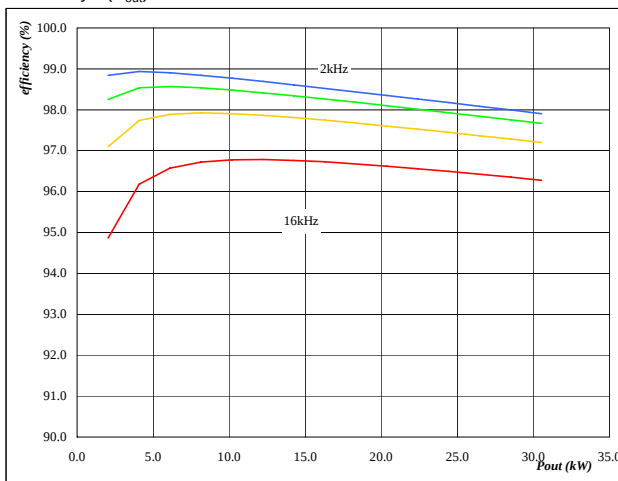
f_{sw} from 2 kHz to 16 kHz in steps of factor 2

Figure 10

Inverter

Typical efficiency as a function of output power

$$\text{efficiency} = f(P_{out})$$



At

$T_j = 150$ °C

DC link = 600 V

Mi = 1

$\cos \varphi = 0.80$

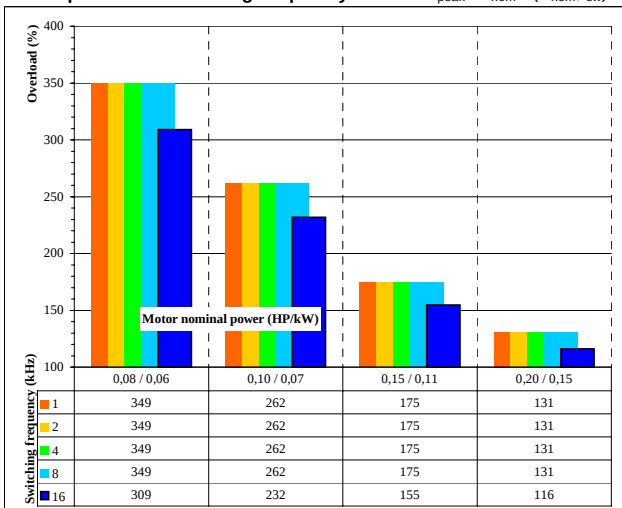
f_{sw} from 2 kHz to 16 kHz in steps of factor 2

Figure 11

Inverter

Typical available overload factor as a function of motor power and switching frequency

$$P_{peak} / P_{nom} = f(P_{nom}, f_{sw})$$



At

$T_j = 150$ °C

DC link = 600 V

Mi = 1

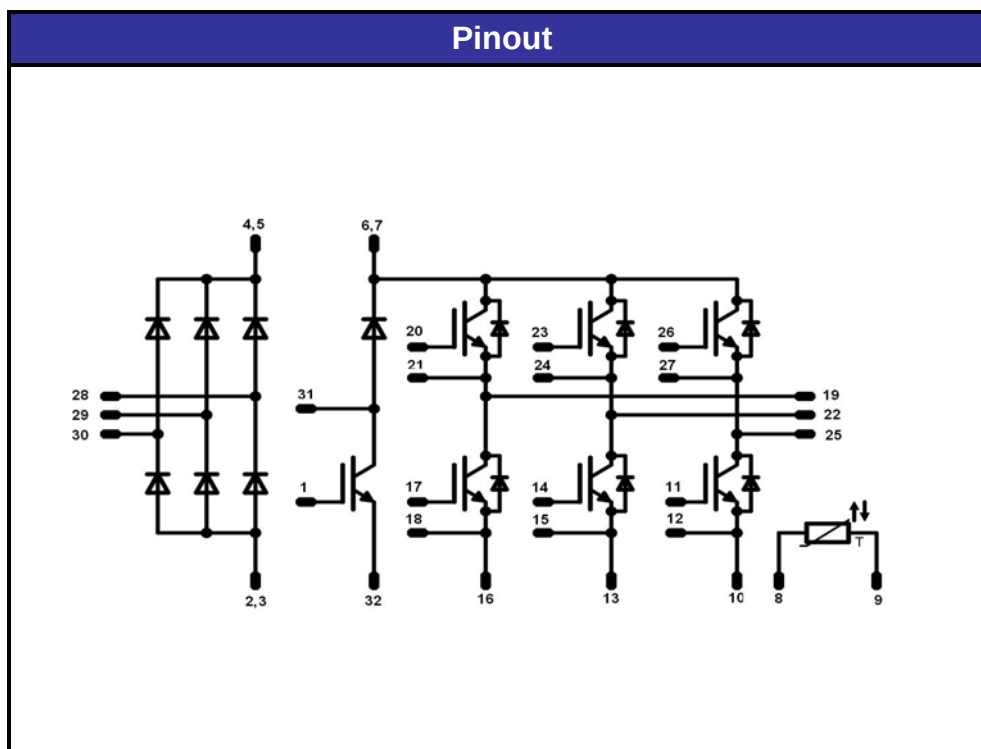
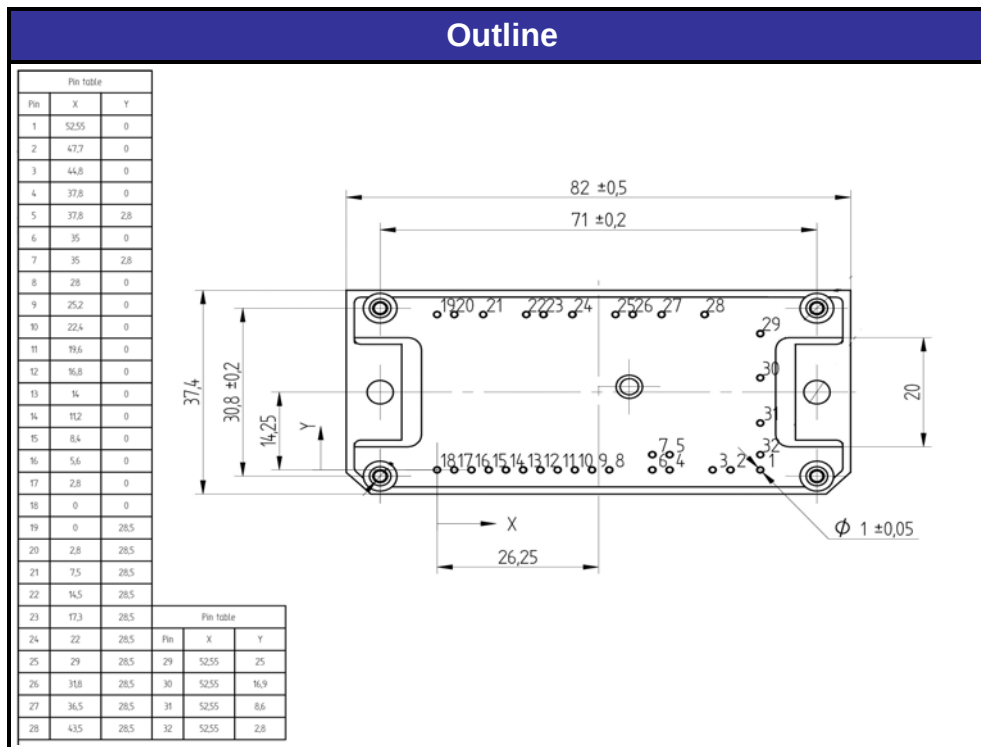
$\cos \varphi = 0.8$

f_{sw} from 1 kHz to 16kHz in steps of factor 2

$T_h = 90$ °C

Motor eff = 0.85

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.