flow PHASE 3 — 1200V/450A

Features

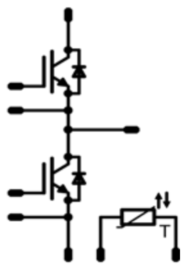
- High Power screw contacts
- Low loss Trench Fieldstop Technology IGBT
- High Current Density FRED

flow SCREW3 housing

Target Applications

- Motor Drives
- Power Generation
- Uninterruptable Power Supply

Schematic



Types

- V23990-P660-F02
- V23990-P669-F02

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Transistor Inverter					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	$T_j=T_j$max	$T_h=80°C$ $T_c=80°C$	350 455	A
Repetitive peak collector current	I_{Cpuls}	tp limited by $T_j$max		1350	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j$max	$T_h=80°C$ $T_c=80°C$	748 1134	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	Tj≤125°C VGE=15V		10 900	µs V
Maximum Junction Temperature	T_{jmax}			150	°C
Diode Inverter					
Peak Repetitive Reverse Voltage	VRRM			1200	V
DC forward current	I_F	$T_j=T_j$max	$T_h=80°C$ $T_c=80°C$	294 384	A
Repetitive peak forward current	I_{FRM}	tp limited by $T_j$max		900	A
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	$T_h=80°C$ $T_c=80°C$	491 744	W
Maximum Junction Temperature	T_{jmax}			150	°C

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Thermal properties				
Storage temperature	T_{stg}		-40…+125	°C
Operation temperature	T_{jop}		-40…+125	°C
Insulation properties				
Insulation voltage	V_{is}	t=2s DC voltage	4000	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm

Characteristic Values

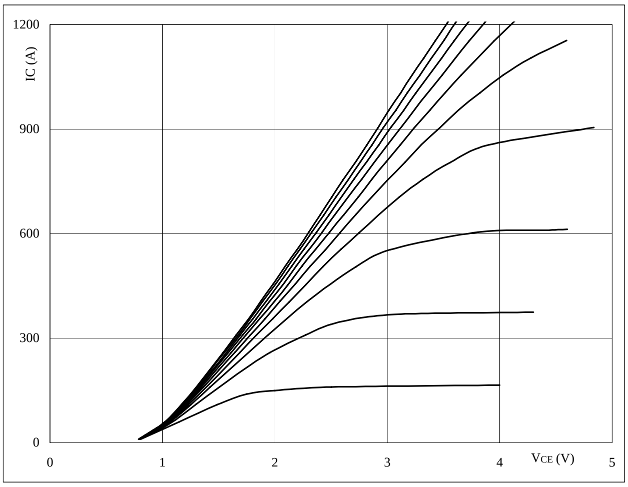
Parameter	Symbol	Conditions					Value			Unit
			V_{GE}(V) or V_{GS}(V)	V_r(V) or V_{CE}(V) or V_{DS}(V)	I_C(A) or I_F(A) or I_D(A)	T(°C)	Min		Max	
Transistor Inverter										
Gate emitter threshold voltage	$V_{GE(th)}$	VCE=VGE			0,018	Tj=25°C Tj=125°C	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		450	Tj=25°C Tj=125°C	1,3	2,06 2,43	2,3	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		Tj=25°C Tj=125°C			0,25	mA
Gate-emitter leakage current	I_{GES}		30	0		Tj=25°C Tj=125°C			650	nA
Integrated Gate resistor	R_{gint}							1,67		Ohm
Turn-on delay time	$t_{d(on)}$	Rgoff=2 Ω Rgon=2 Ω	±15	600	450	Tj=25°C Tj=125°C		422		ns
Rise time	t_r					Tj=25°C Tj=125°C		48,6		ns
Turn-off delay time	$t_{d(off)}$					Tj=25°C Tj=125°C		614,4		ns
Fall time	t_f					Tj=25°C Tj=125°C		146,4		ns
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		31,3		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		54,2		mWs
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25°C		32,3		nF
Output capacitance	C_{oss}							1,689		nF
Reverse transfer capacitance	C_{rss}							1,464		nF
Gate charge	Q_{Gate}		±15			Tj=25°C		3700		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						0,095		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,063		K/W
Diode Inverter										
Diode forward voltage	V_F				450	Tj=25°C Tj=125°C	1	1,96 2,04	2,4	V
Peak reverse recovery current	I_{RRM}	Rgon=2 Ω	±15	600	450	Tj=25°C Tj=125°C		598,13		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		340,9		ns
Reverse recovered charge	Q_{rr}					Tj=25°C Tj=125°C		82,94		mC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25°C Tj=125°C		7944		A/ms
Reverse recovered energy	Erec					Tj=25°C Tj=125°C		36,011		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						0,146		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,096		K/W
Thermistor										
Rated resistance	R_{25}	Tol. ±5%				Tj=25°C	4,2	4,7	5,8	kOhm
Deviation of R100	$D_{R/R}$	R100=435Ω				Tc=100°C		2,6		%/K
Power dissipation given Epcos-Typ	P					Tj=25°C			210	mW
B-value	$B_{(25/100)}$	Tol. ±3%				Tj=25°C		3530		K

Output Inverter

Figure 1 Output inverter IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

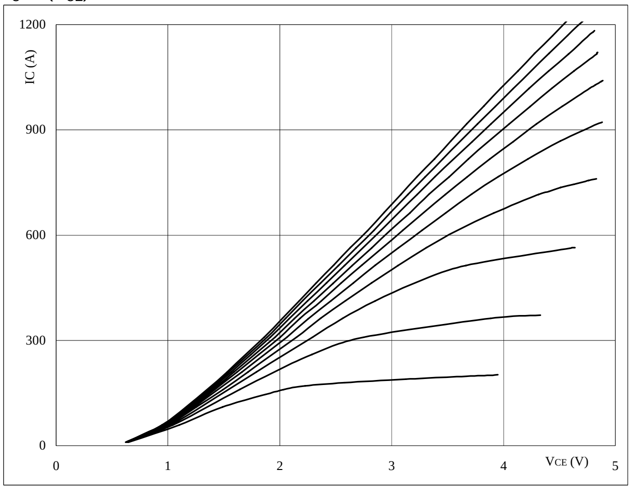
t_p =	250	µs
T_j =	25	°C

VGE from 8 V to 17 V in steps of 1 V

Figure 2 Output inverter IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

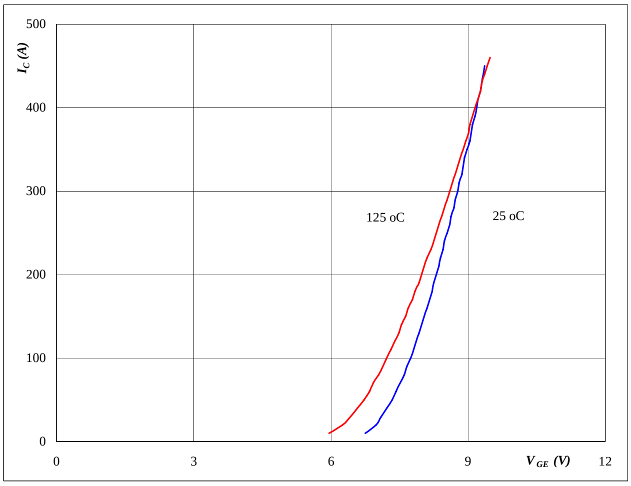
t_p =	250	µs
T_j =	125	°C

VGE from 8 V to 17 V in steps of 1 V

Figure 3 Output inverter IGBT

Typical transfer characteristics

$Ic = f(V_{GE})$



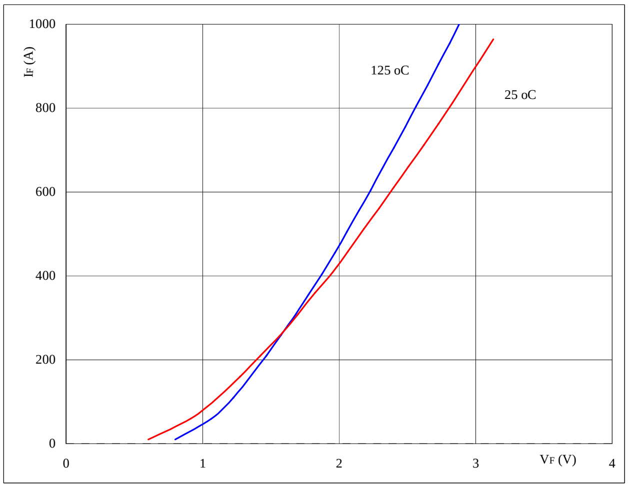
At

t_p =	250	µs
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

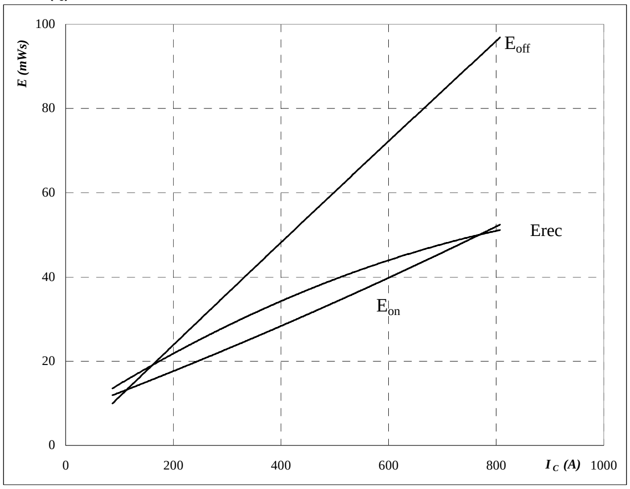
t_p =	250	µs

Output Inverter

Figure 5	Output inverter IGBT

Typical switching energy losses as a function of collector current

E = f(I_c)



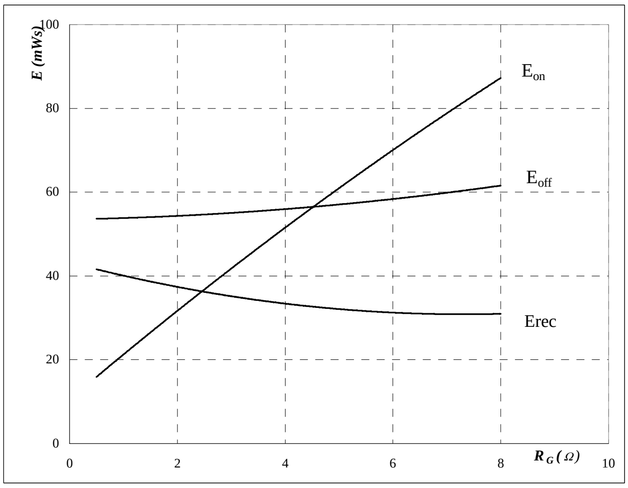
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

Figure 6	Output inverter IGBT

Typical switching energy losses as a function of gate resistor

E = f(R_G)



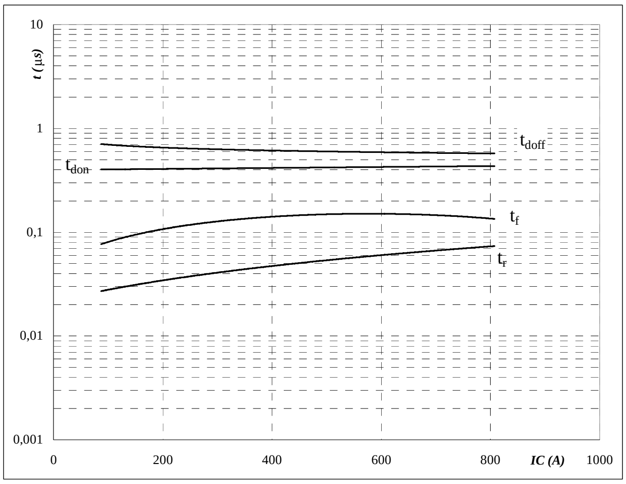
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	448	A

Figure 7	Output inverter IGBT

Typical switching times as a function of collector current

t = f(I_C)



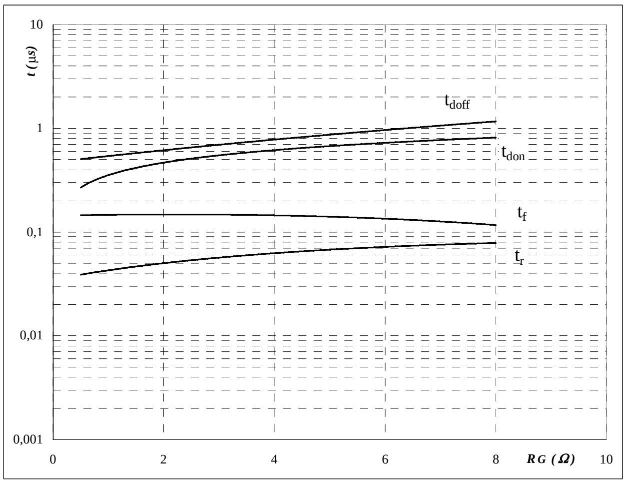
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	2	Ω
R_{goff} =	2	Ω

Figure 8	Output inverter IGBT

Typical switching times as a function of gate resistor

t = f(R_G)



With an inductive load at

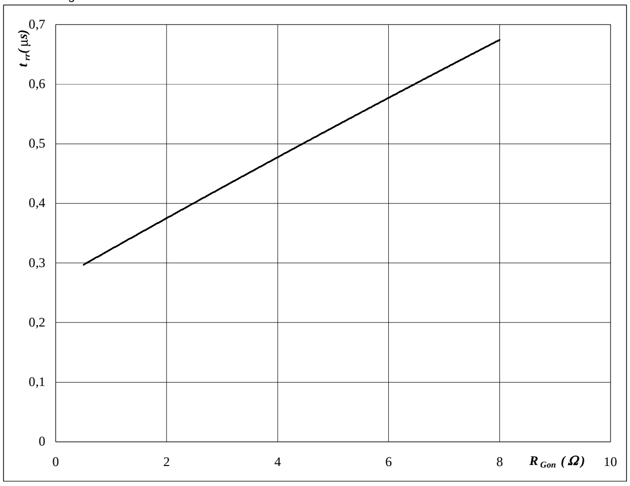
T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	448	A

Output Inverter

Figure 9 Output inverter FRED diode

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

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



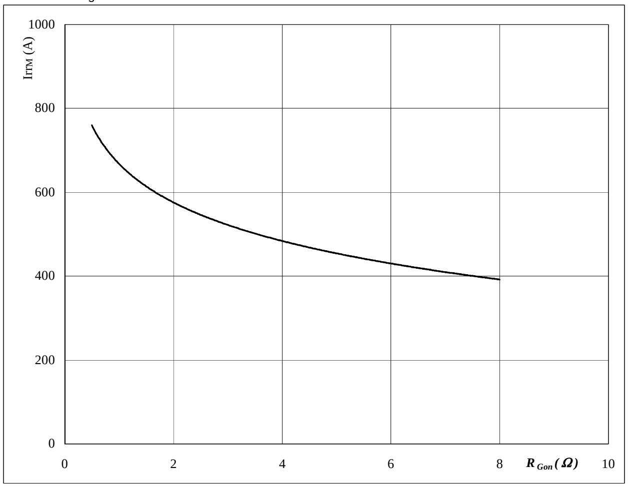
At

T_j =	125	°C
V_R =	600	V
I_F =	448	A
V_{GE} =	±15	V

Figure 10 Output inverter FRED diode

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

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



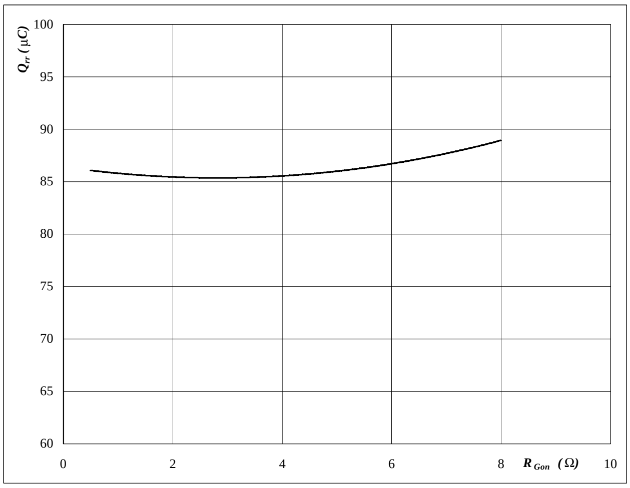
At

T_j =	125	°C
V_R =	600	V
I_F =	448	A
V_{GE} =	±15	V

Figure 11 Output inverter FRED diode

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

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



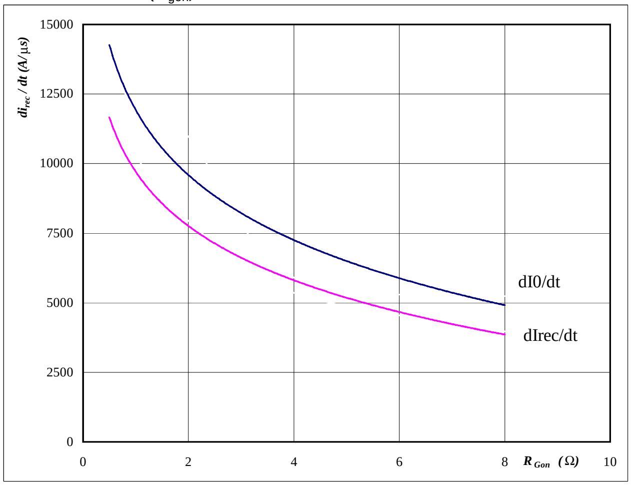
At

T_j =	125	°C
V_R =	600	V
I_F =	448	A
V_{GE} =	±15	V

Figure 12 Output inverter FRED diode

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

$dI0/dt, dIrec/dt = f(R_{gon})$



At

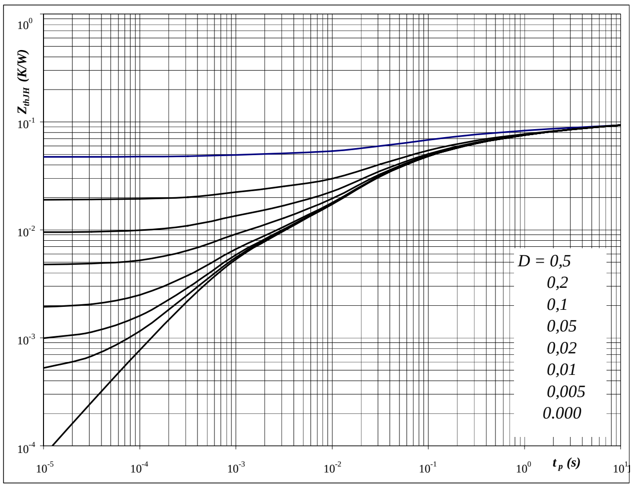
T_j =	125	°C
V_R =	600	V
I_F =	448	A
V_{GE} =	±15	V

Output Inverter

Figure 13

IGBT transient thermal impedance
as a function of pulse width

$Z_{thJH} = f(tp)$



With

D = tp / T

R_{thJH} = 0,095 K/W

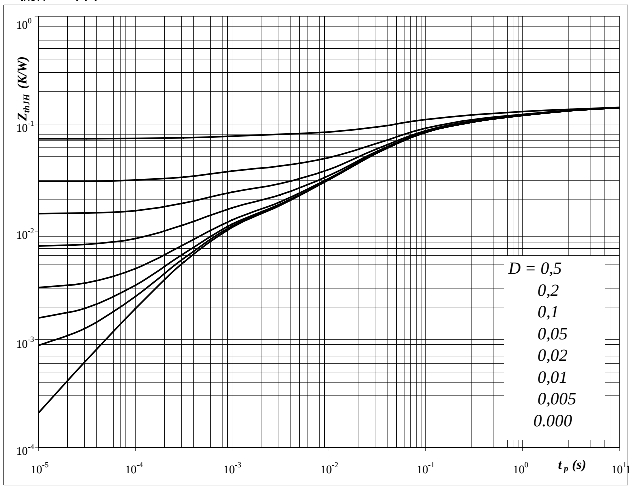
IGBT thermal model values

R (C/W)	Tau (s)
0,02	3,8E+00
0,02	5,1E-01
0,03	8,5E-02
0,02	1,8E-02
0,01	8,5E-04

Figure 14

FRED transient thermal impedance
as a function of pulse width

$Z_{thJH} = f(tp)$



With

D = tp / T

R_{thJH} = 0,146 K/W

FRED thermal model values

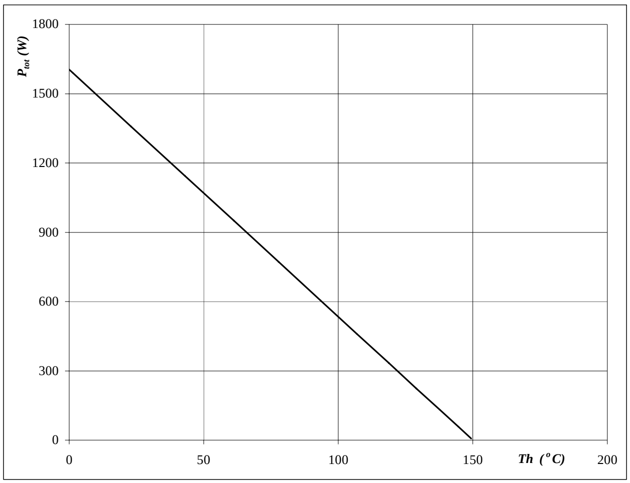
R (C/W)	Tau (s)
0,01	9,6E+00
0,03	1,7E+00
0,04	2,0E-01
0,05	3,9E-02
0,01	8,2E-03
0,01	5,4E-04

Output Inverter

Figure 15	Output inverter IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



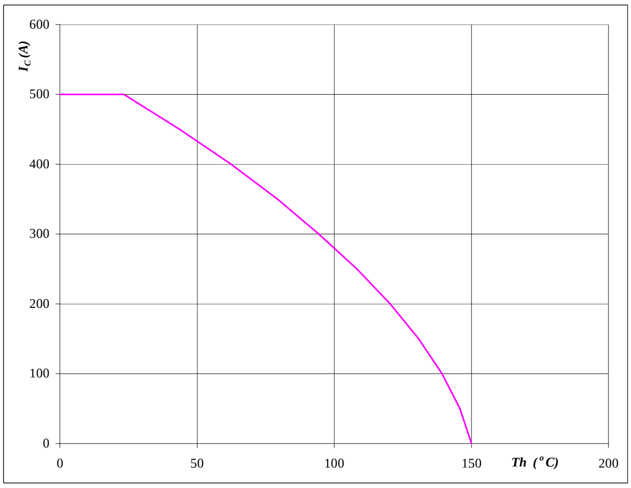
At

T_j = 150 °C

Figure 16	Output inverter IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

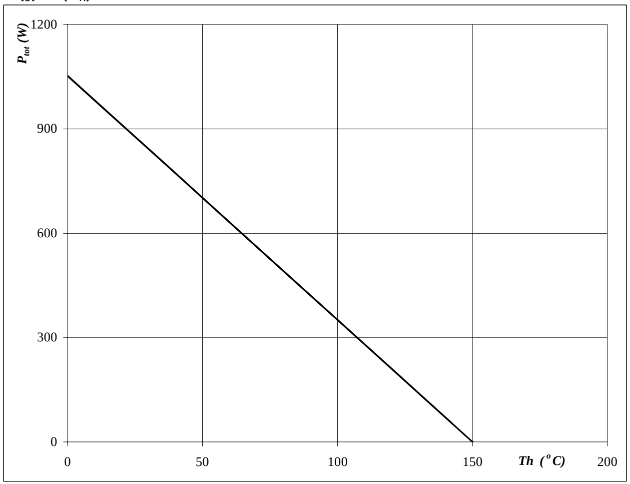
T_j = 150 °C

V_{GE} = 15 V

Figure 17	Output inverter FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



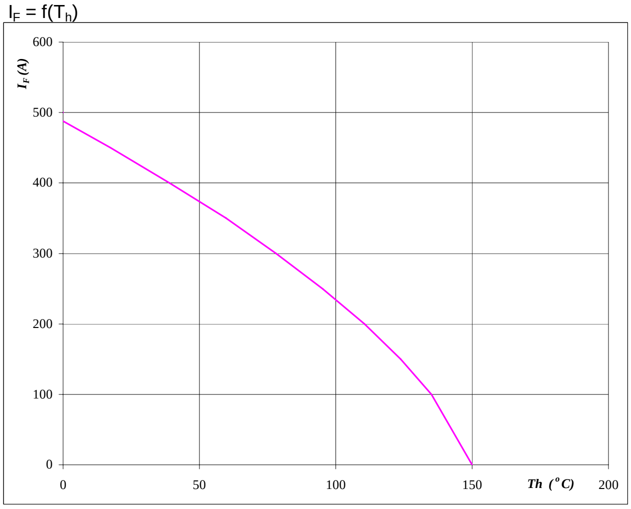
At

T_j = 150 °C

Figure 18	Output inverter FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



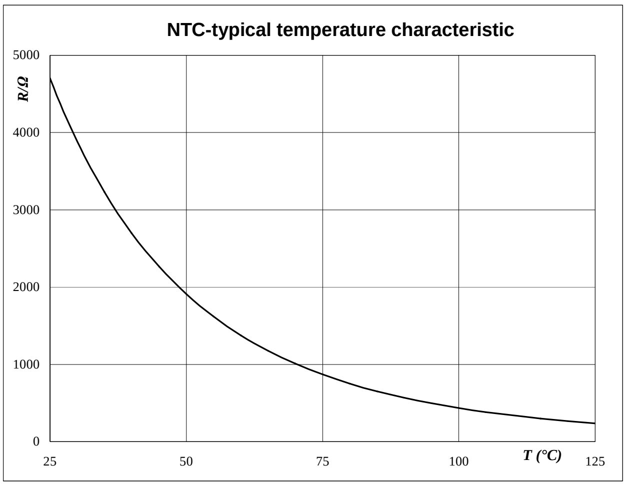
At

T_j = 150 °C

Thermistor

Figure 19	Thermistor

Typical NTC characteristic
as a function of temperature
$R_T = f(T)$



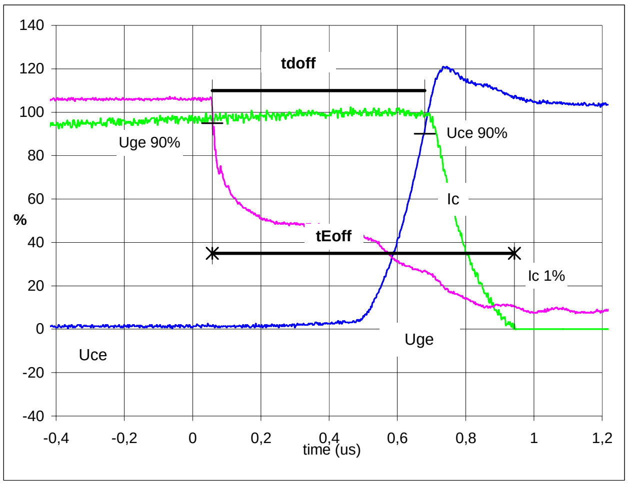
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

Figure 1 Output inverter IGBT

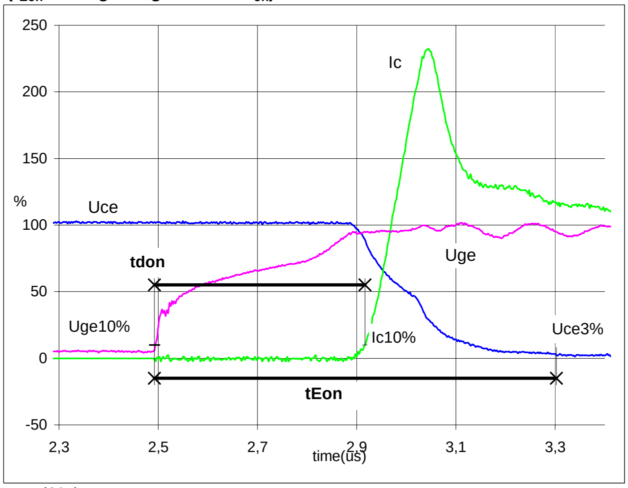
Turn-off Switching Waveforms & definition of tdoff, tEoff
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	448	A
t_{doff} =	0,61	μs
t_{Eoff} =	0,89	μs

Figure 2 Output inverter IGBT

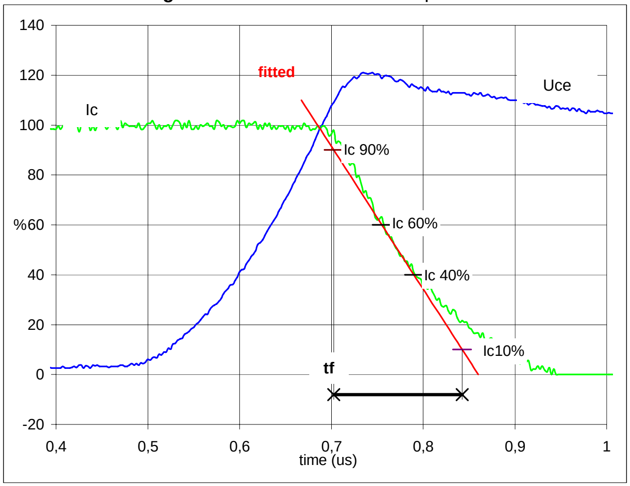
Turn-on Switching Waveforms & definition of tdon, tEon
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	448	A
t_{don} =	0,42	μs
t_{Eon} =	0,81	μs

Figure 3 Output inverter IGBT

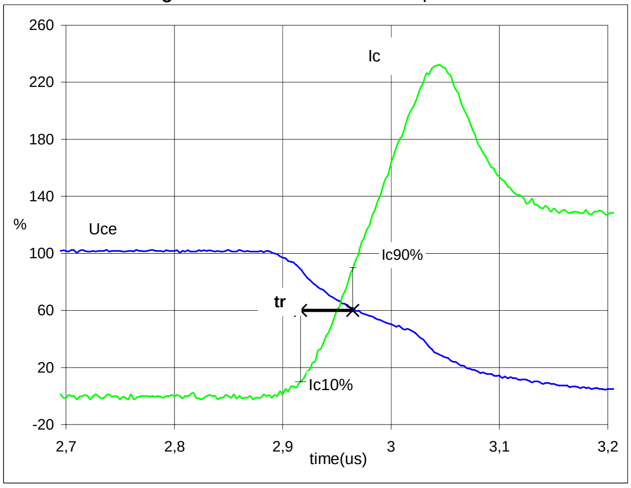
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	448	A
t_f =	0,146	μs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

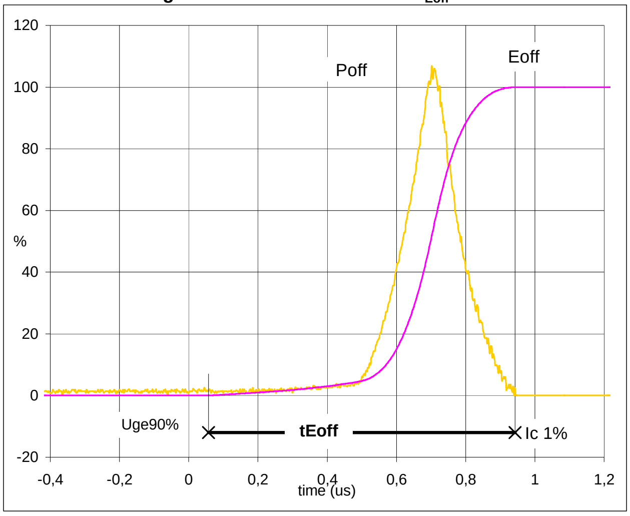


V_C (100%) =	600	V
I_C (100%) =	448	A
t_r =	0,049	μs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

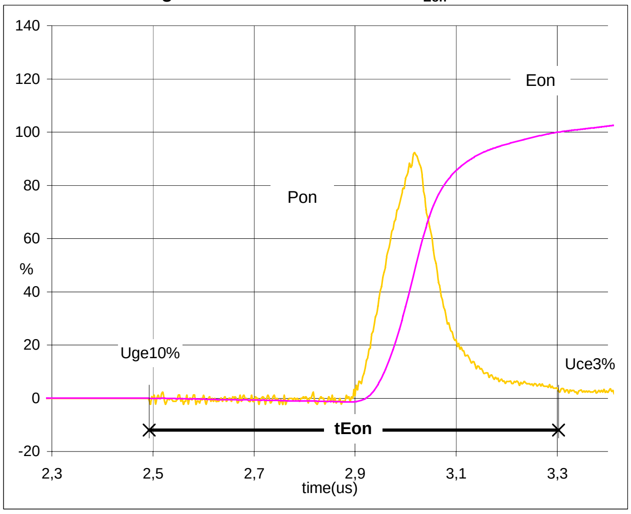
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	269,06	kW
E_{off} (100%) =	54,21	mJ
t_{Eoff} =	0,89	μs

Figure 6 Output inverter IGBT

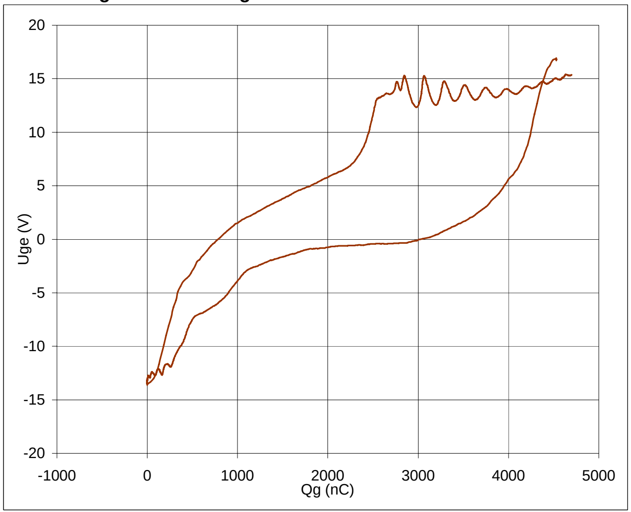
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	269,0604	kW
E_{on} (100%) =	31,27	mJ
t_{Eon} =	0,81	μs

Figure 7 Output inverter IGBT

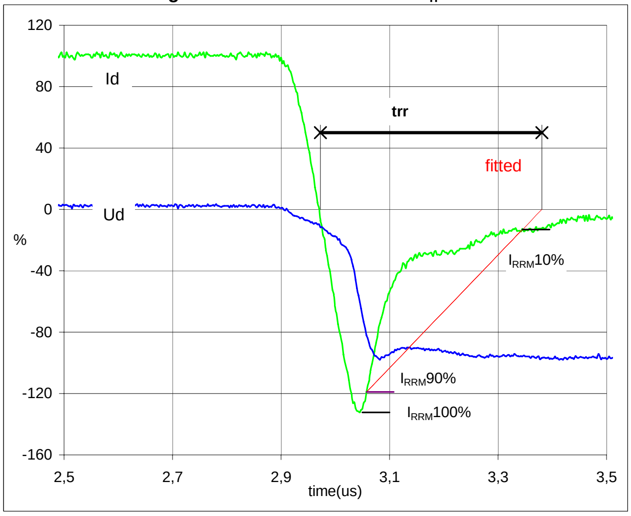
Gate voltage vs Gate charge



V_{GEoff} =	-15	V
V_{GEon} =	15	V
V_C (100%) =	600	V
I_C (100%) =	448	A
Q_g =	4698,4335	nC

Figure 8 Output inverter FRED

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

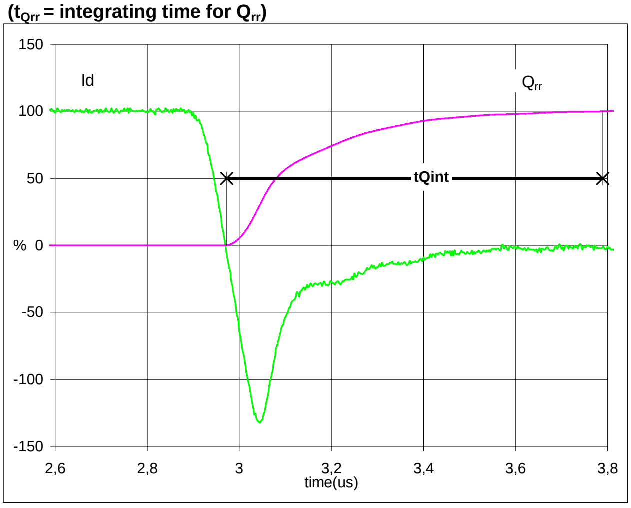


V_d (100%) =	600	V
I_d (100%) =	448	A
I_{RRM} (100%) =	-598	A
t_{rr} =	0,341	μs

Switching Definitions Output Inverter

Figure 9	Output inverter FRED

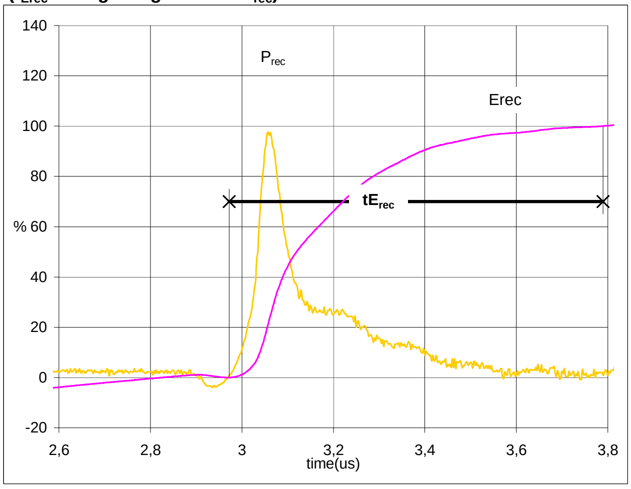
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	448	A
Q_{rr} (100%) =	82,939	μC
t_{Qint} =	0,82	μs

Figure 10	Output inverter FRED

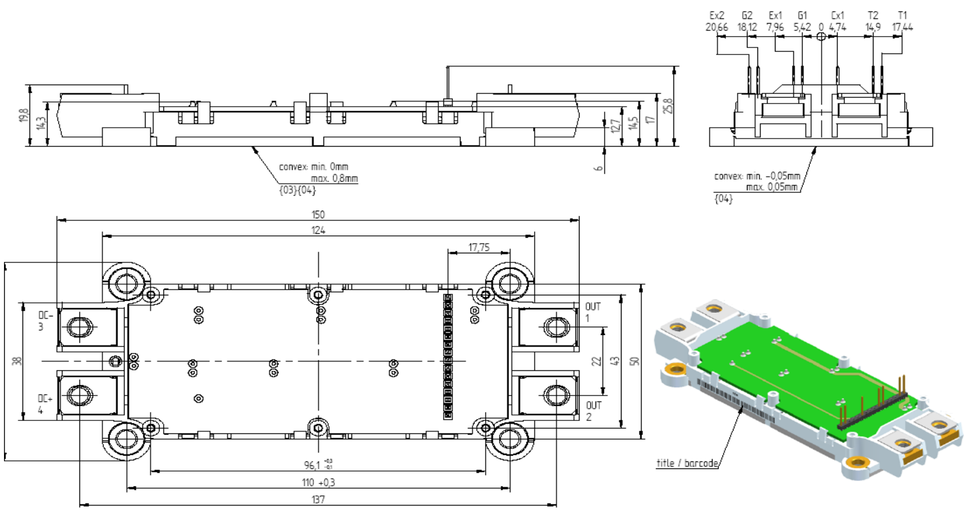
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



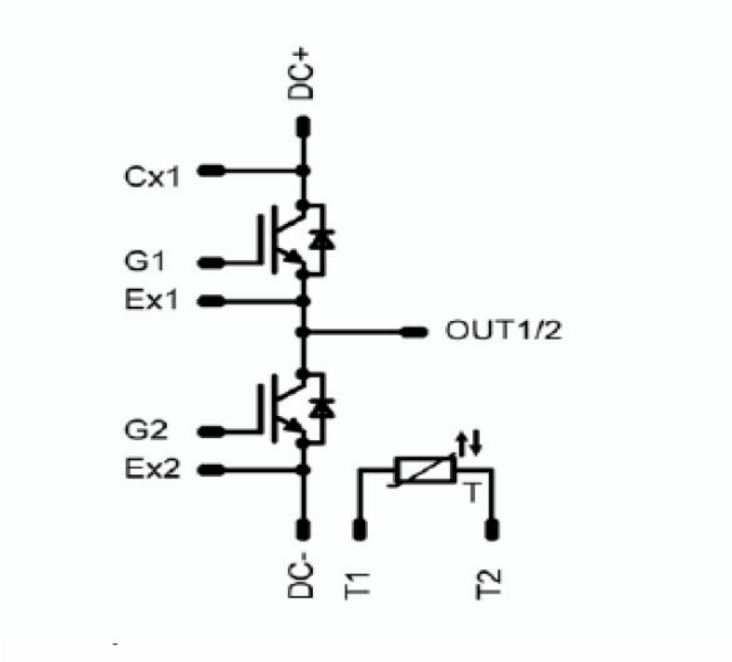
P_{rec} (100%) =	269,0604	kW
E_{rec} (100%) =	36,011	mJ
t_{Erec} =	0,82	μs

Package Outline and Pinout

Outline



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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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.

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.

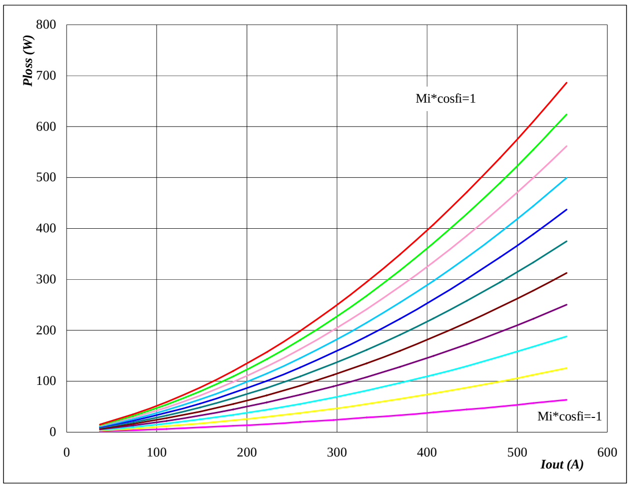
flow PHASE 3 Output Inverter Application 1200V/450A

General conditions

3phase SPWM		
V_{GEon}	=	15 V
V_{GEoff}	=	-15 V
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

Figure 1 IGBT

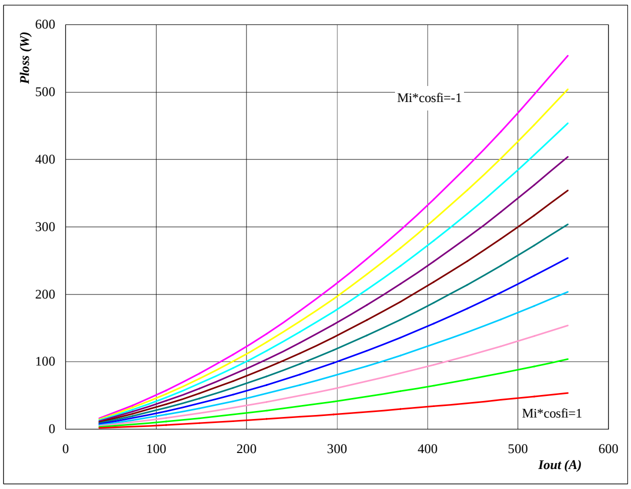
Typical average static loss as a function of output current
$P_{loss} = f(I_{out})$



At
Tj=125°C
Mi*cosfi from -1 to 1 in steps of 0,2

Figure 2 FRED

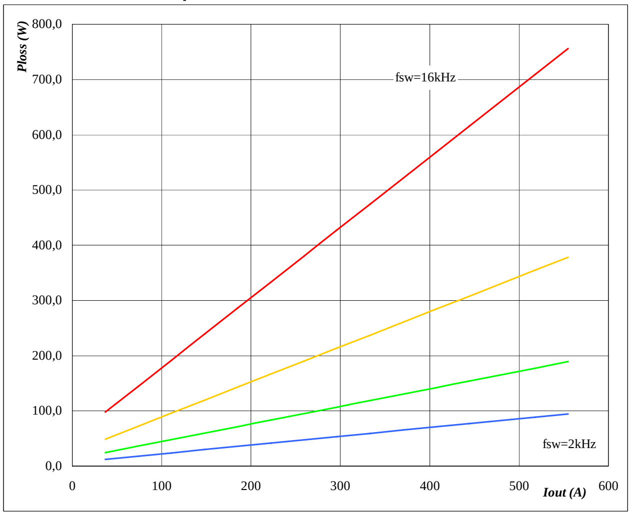
Typical average static loss as a function of output current
$P_{loss} = f(I_{out})$



At
Tj=125°C
Mi*cosfi from -1 to 1 in steps of -0,2

Figure 3 IGBT

Typical average switching loss as a function of output current $P_{loss} = f(I_{out})$



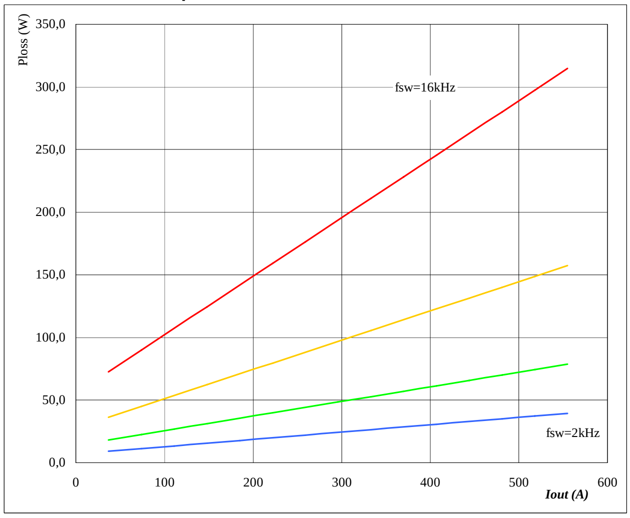
At

T_j =	125	°C
DC link =	600	V

fsw from 2 kHz to 16 kHz in 2 steps

Figure 4 FRED

Typical average switching loss as a function of output current $P_{loss} = f(I_{out})$



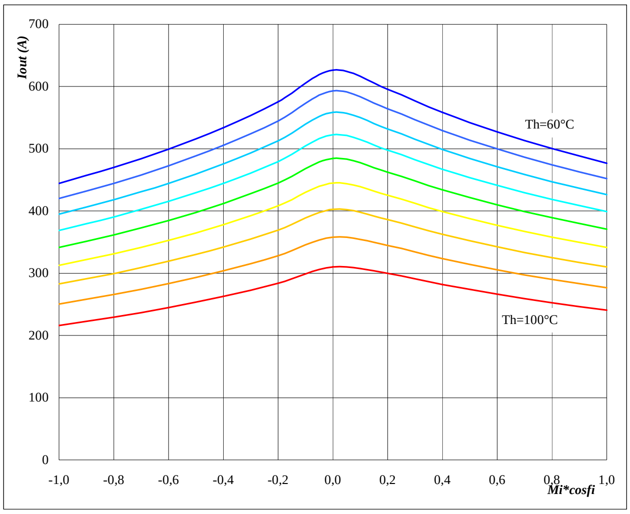
At

T_j =	125	°C
DC link =	600	V

fsw from 2 kHz to 16 kHz in 2 steps

Figure 5 Phase

Typical available 50Hz output current as a function Mi*cosfi $I_{out} = f(Mi*cosfi)$



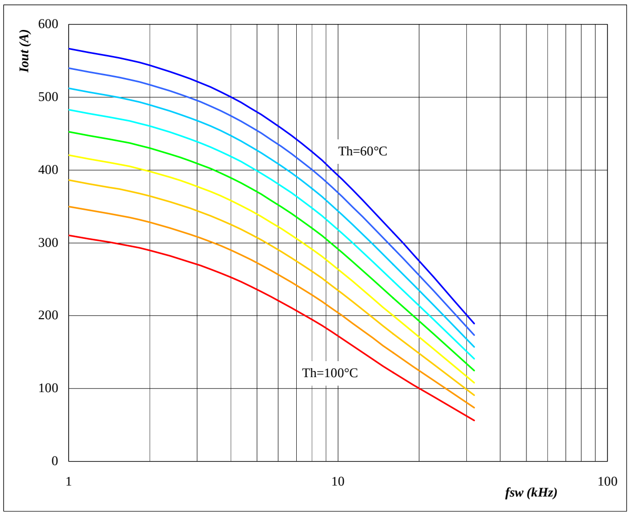
At

T_j =	125	°C
DC link =	600	V
fsw =	4	kHz

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



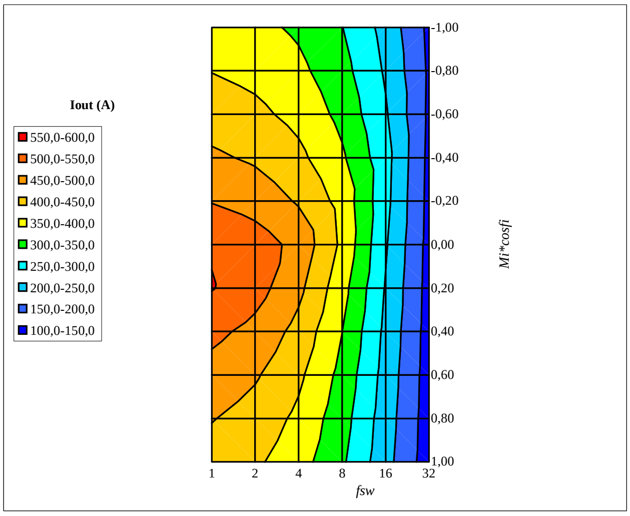
At

T_j =	125	°C
DC link =	600	V
Mi*cosfi =	0,8	

Th from 60 °C to 100 °C in steps of 5 °C

Figure 7 Phase

Typical available 50Hz output current as a function of Mi*cosfi and switching frequency $I_{out} = f(f_{sw}, Mi*cosfi)$

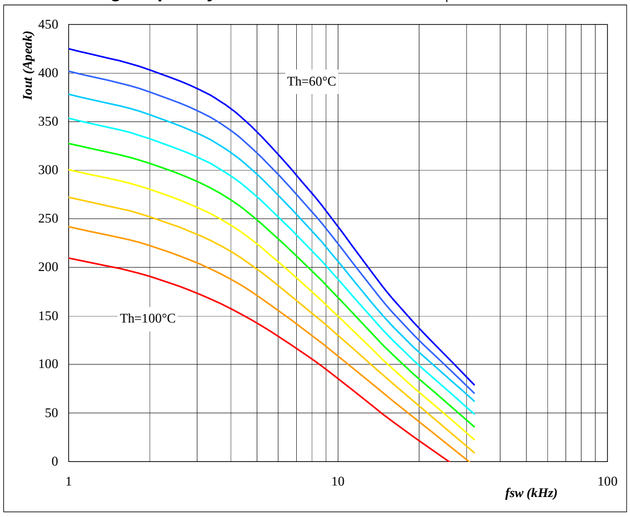


At

T_j =	125	°C
DC link =	600	V
T_h =	80	°C

Figure 8 Phase

Typical available 0Hz output current as a function of switching frequency $I_{outpeak} = f(f_{sw})$



At

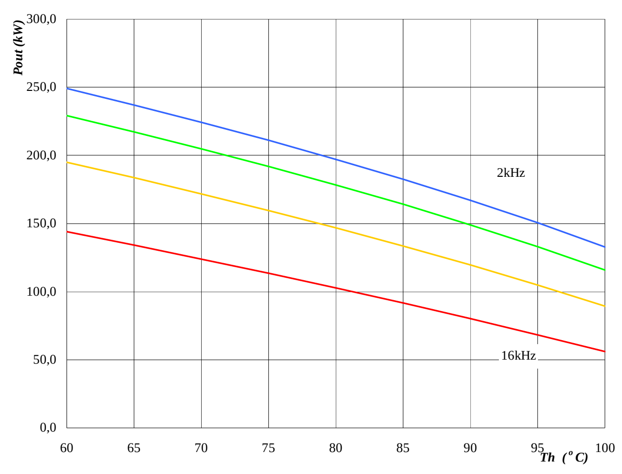
T_j =	125	°C
DC link =	600	V

Th from 60 °C to 100 °C in steps of 5 °C

flow PHASE 3 | Output Inverter Application | 1200V/450A

Figure 9 Inverter

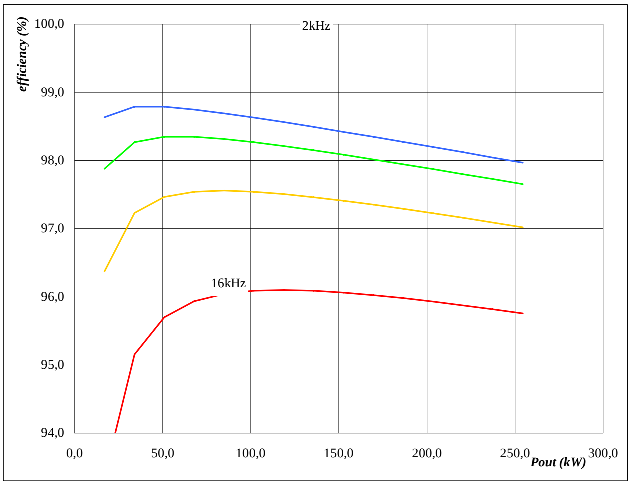
Typical available peak output power as a function of heatsink temperature $P_{out}=f(T_h)$



At
T_j = 125 °C
DC link = 600 V
Mi = 1
cosfi = 0,80
fsw from 2 kHz to 16 kHz in 2 steps

Figure 10 Inverter

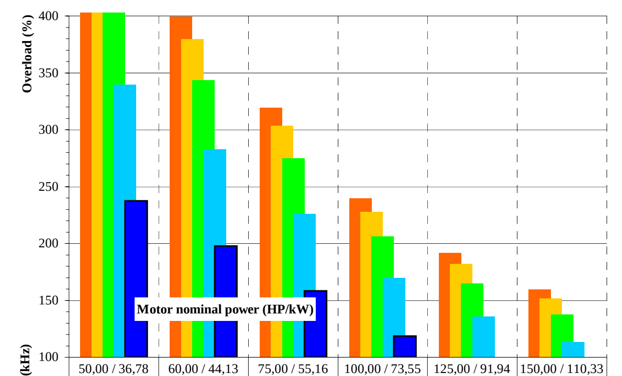
Typical efficiency as a function of output power
efficiency=f(P_{out})



At
T_j = 125 °C
DC link = 600 V
Mi = 1
cosfi = 0,80
fsw from 2 kHz to 16 kHz in 2 steps

Figure 11 Inverter

Typical available overload factor as a function of motor power and switching frequency P_{peak} / $P_{nom}=f(P_{nom},f_{sw})$



Switching frequency (kHz)	50,00 / 36,78	60,00 / 44,13	75,00 / 55,16	100,00 / 73,55	125,00 / 91,94	150,00 / 110,33
1	479	399	319	240	192	160
2	456	380	304	228	182	152
4	412	343	275	206	165	137
8	339	283	226	170	136	113
16	237	198	158	119	0	0

At
T_j = 125 °C
DC link = 600 V
Mi = 1
cosfi = 0,8
fsw from 1 kHz to 16 kHz in 2 steps
Th = 80 °C
Motor eff = 0,85

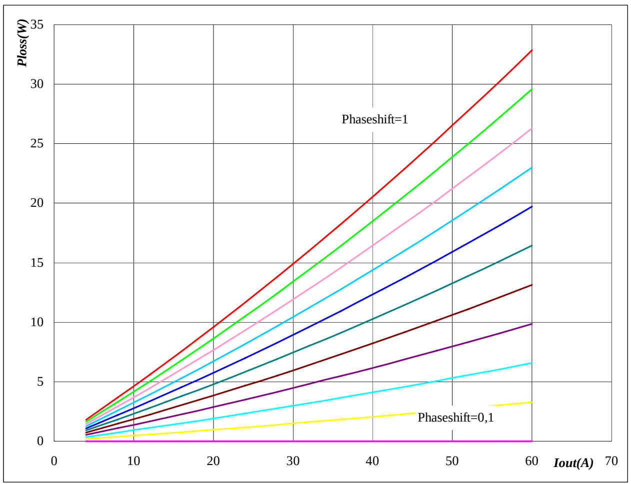
flow PHASE 3 — ZVS Application — 1200V/450A

General conditions

Phase shifted ZVS		
V_{GEon}	=	15 V
V_{GEoff}	=	-15 V
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

Figure 1 — IGBT

Typical static loss of shifted switch as a function of output current — $P_{loss} = f(I_{out})$



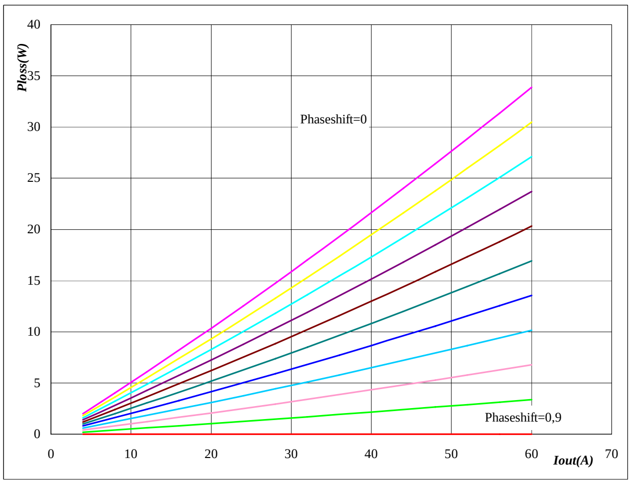
At

Tj=125°C

Phaseshift from 0,1 to 1 in steps of 0,1

Figure 2 — FRED

Typical static loss of shifted switch as a function of output current — $P_{loss} = f(I_{out})$



At

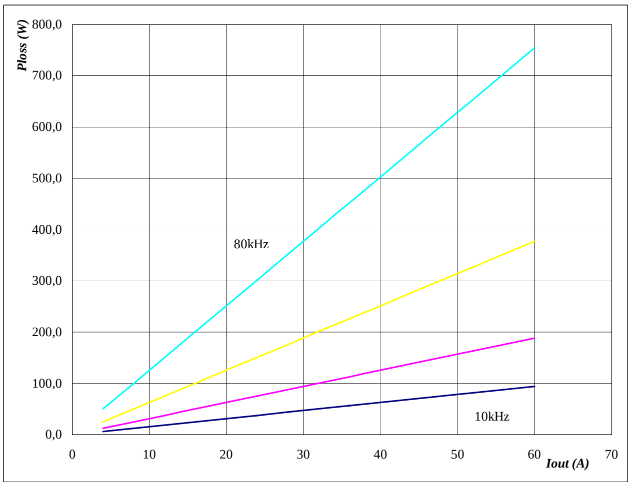
Tj=125°C

Phaseshift from 0,1 to 1 in steps of 0,1

Figure 3 — IGBT

Typical switching loss as a function of output current

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



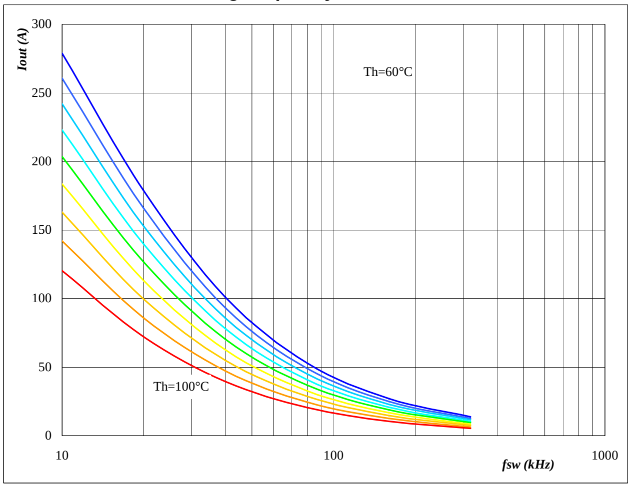
At

T_j =	125	°C
DC link =	600	V
I_{outpk}/I_{out} =	1,3	
Phaseshift =	1	

fsw from 10 kHz to 80 kHz in 2 steps

Figure 4 — Phase

Typical available output current as a function of switching frequency — $I_{out} = f(f_{sw})$



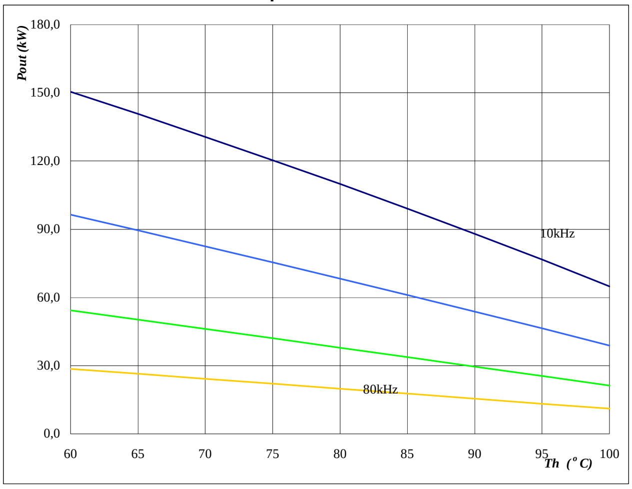
At

T_j =	125	°C
DC link =	600	V
I_{outpk}/I_{out} =	1,3	
Phaseshift =	1	

Th from 60 °C to 100 °C in steps of 5 °C

Figure 5 Inverter

Typical available electric peak output power as a function of heatsink temperature $P_{out} = f(T_h)$



At

T_j = 125 °C

DC link = 600 V

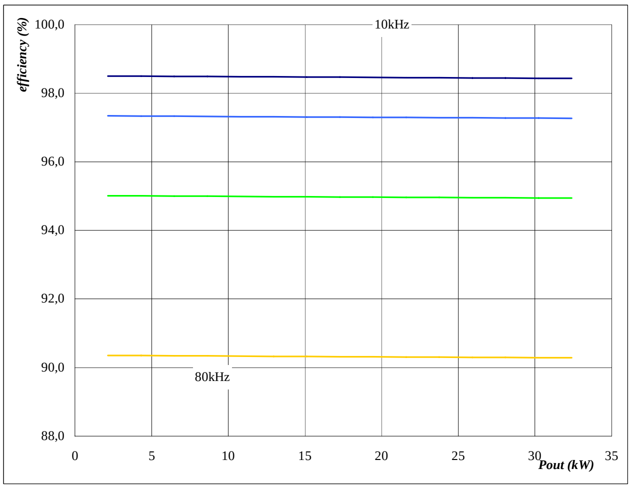
I_{outpk}/I_{out} = 1,3

Phaseshift = 1

fsw from 10 kHz to 80 kHz in 2 steps

Figure 6 Inverter

Typical efficiency as a function of output power
efficiency=f(P_{out})



At

T_j = 125 °C

DC link = 600 V

I_{outpk}/I_{out} = 1,3

Phaseshift = 1

fsw from 10 kHz to 80 kHz in 2 steps