***flow* PHASE 0 600V/ 200A** V23990-P565-F10-01-14

Maximum Ratings / Höchstzulässige Werte

Parameter	Condition	Symbol	Datasheet values max.	Unit
Transistor Inverter				
Transistor Wechselrichter				
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	T_j=175°C T_h=80°C, T_c=80°C	I_C	119 157	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	tp limited by Tj max	I_{cpuls}	600	A
Power dissipation per IGBT Verlustleistung pro IGBT	T_j=175°C T_h=80°C T_c=80°C	P_{tot}	164 249	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time* Kurzschlußverhalten*	Tj≤150°C V_{GE}=15V V_{CC}=360V	t_{SC}	5	us
Diode Inverter				
Diode Wechselrichter				
DC forward current Dauergleichstrom	T_j=175°C T_h=80°C, T_c=80°C	I_F	96 110, limited by bondwires	A
Repetitive peak forward current Periodischer Spitzenstrom	tp limited by Tj max	I_{FRM}	600	A
Power dissipation per Diode Verlustleistung pro Diode	T_j=175°C T_h=80°C T_c=80°C	P_{tot}	125 189	W
Thermal properties				
Thermische Eigenschaften				
max. Chip temperature max. Chiptemperatur		T_{jmax}	175	°C
Storage temperature Lagertemperatur		T_{stg}	-40…+125	°C
Operation temperature Betriebstemperatur		T_{op}	-40…+125	°C
Insulation properties				
Modulisolation				
Insulation voltage Isolationsspannung	t=1min	V_{is}	4000	Vdc
Creepage distance Kriechstrecke			min 12,7	mm
Clearance Luftstrecke			min 12,7	mm

Additional notes and remarks: ** Allowed number of short circuits must be less than 1000 times, and time duration between short circuits should be more than 1 second!*

***flow* PHASE 0 600V/ 200A** V23990-P565-F10-01-14

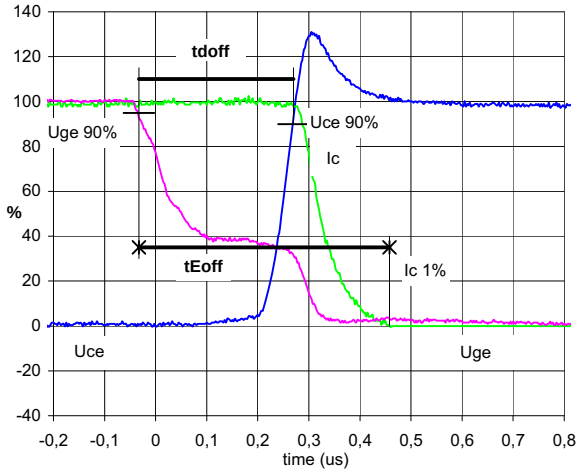
Characteristic values/ Charateristische Werte

Description	Symbol	Conditions					Datasheet values			Unit
		T(C°)	Other conditions (Rgon-Rgoff)	VGE(V) VGS(V)	VCE(V) VDS(V)	IC(A) IF(A) Id(A)	Min	Typ	Max	
Transistor Inverter **Transistor Wechselrichter**										
Gate emitter threshold voltage Gate-Schwellenspannung	$V_{GE(th)}$	Tj=25°C Tj=125°C	VCE=VGE			0,0032	5	5,8	6,5	
Collector-emitter saturation voltage Kollektor-Emitter Sättigungsspannung	$V_{CE(sat)}$	Tj=25°C Tj=125°C		15		200	1,3	1,54 1,73	2	V
Collector-emitter cut-off Kollektor-Emitter Reststrom	I_{CES}	Tj=25°C Tj=125°C		0	600				1,25	mA
Gate-emitter leakage current Gate-Emitter Reststrom	I_{GES}	Tj=25°C Tj=125°C		20	0				1000	nA
Integrated Gate resistor Integrirter Gate Widerstand	R_{gint}							2		Ohm
Turn-on delay time Einschaltverzögerungszeit	$t_{d(on)}$	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		153		ns
Rise time Anstiegszeit	t_r	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		33		ns
Turn-off delay time Abschaltverzögerungszeit	$t_{d(off)}$	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		305		ns
Fall time Fallzeit	t_f	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		71		ns
Turn-on energy loss per pulse Einschaltverlustenergie pro Puls	E_{on}	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		1,3		mWs
Turn-off energy loss per pulse Abschaltverlustenergie pro Puls	E_{off}	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		6,05		mWs
Input capacitance Eingangskapazität	C_{ies}	Tj=25°C Tj=125°C	f=1MHz	0	25			12,335		nF
Output capacitance Ausgangskapazität	C_{oss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,769		nF
Reverse transfer capacitance Rückwirkungskapazität	C_{rss}	Tj=25°C Tj=125°C	f=1MHz	0	25			0,366		nF
Gate charge Gate Ladung	Q_{Gate}	Tj=25°C Tj=125°C	Rgoff=2 Ω Rgon=2 Ω	±15	300	198		1397,2		nC
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal foil thickness=76um					0,58		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitfolie Dicke=76um Kunze Folien KU-ALF5					0,38		K/W
Coupled thermal resistance inverter diode-transistor Gekoppelte Wärmewiderstand Wechselrichter Diode-Transistor	R_{thJH}		Thermal foil thickness=76um					0,05		K/W
Coupled thermal resistance inverter transistor-transistor Gekoppelte Wärmewiderstand Wechselrichter Transistor-Transistor	R_{thJH}		Warmeleitfolie Dicke=76um Kunze Folien KU-ALF5					0,03		K/W
Diode Inverter **Diode Wechselrichter**										
Diode forward voltage Durchlaßspannung	V_F	Tj=25°C Tj=125°C				200	1	1,65 1,77	2,55	V
Peak reverse recovery current Rückstromspitze	I_{RM}	Tj=25°C Tj=125°C	Rgon=2 ohm di0/dt = 5211 A/us	-15	300	198		197,7		A
Reverse recovery time Sperreverzögerungszeit	t_{rr}	Tj=25°C Tj=125°C	Rgon=2 ohm di0/dt = 5211 A/us	-15	300	198		157		ns
Reverse recovered charge Sperrverzögerungsladung	Q_{rr}	Tj=25°C Tj=125°C	Rgon=2 ohm di0/dt = 5211 A/us	-15	300	198		14,27		uC
Reverse recovered energy Sperrverzögerungsenergie	Erec	Tj=25°C Tj=125°C	Rgon=2 ohm di0/dt = 5211 A/us	-15	300	198		3,62		mWs
Thermal resistance chip to heatsink per chip Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal foil thickness=76um					0,76		K/W
Thermal resistance chip to case per chip Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		Warmeleitfolie Dicke=76um Kunze Folien KU-ALF5					0,50		K/W
Coupled thermal resistance inverter transistor-diode Gekoppelte Wärmewiderstand Wechselrichter Transistor-Diode	R_{thJH}		Thermal foil thickness=76um					0,06		K/W
Coupled thermal resistance inverter diode-diode Gekoppelte Wärmewiderstand Wechselrichter Diode-Diode	R_{thJH}		Warmeleitfolie Dicke=76um Kunze Folien KU-ALF5					0,02		K/W

Switching definitions

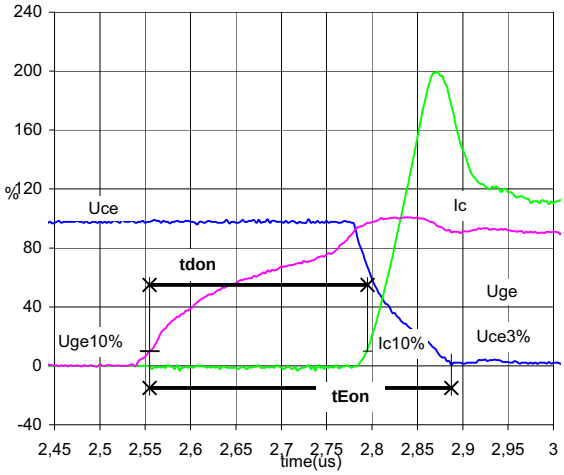
General conditions: Tj= 125 °C Rgon= 2 Ω Rgoff= 2,0 Ω

Figure 1. **Turn-off Switching Waveforms & definition of tdoff, t_{Eoff}**
(t_{Eoff} = integrating time for E_{off})
Output inverter IGBT



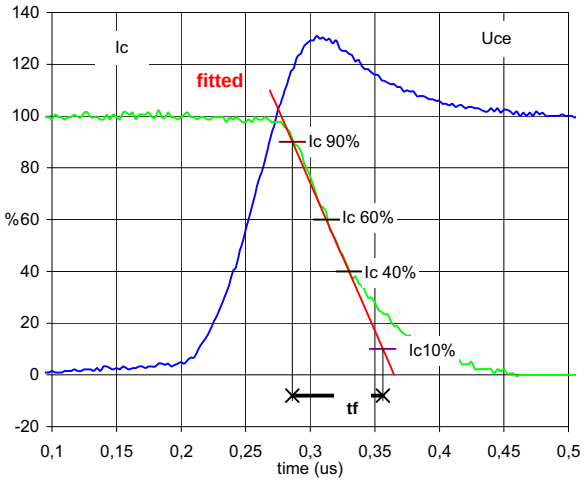
Uge(0%)= -15 V
Uge(100%)= 15 V
Uc(100%)= 300 V
Ic(100%)= 198 A
tdoff= 0,30 us
t_{Eoff}= 0,49 us

Figure 2. **Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}**
(t_{Eon} = integrating time for E_{on})
Output inverter IGBT



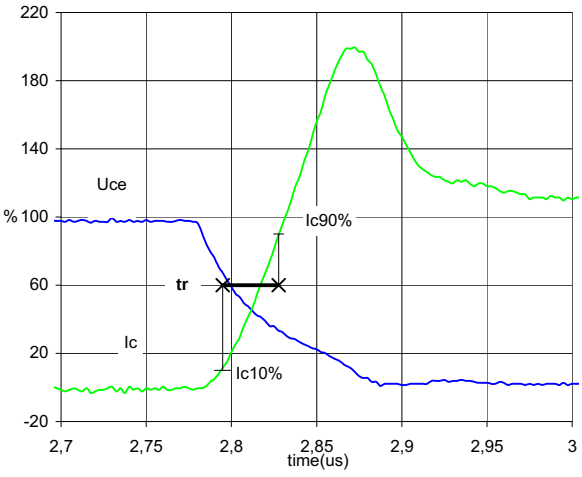
Uge(0%)= -15 V
Uge(100%)= 15 V
Uc(100%)= 300 V
Ic(100%)= 198 A
tdon= 0,15 us
t_{Eon}= 0,33 us

Figure 3. **Turn-off Switching Waveforms & definition of t_f**
Output inverter IGBT



Uc(100%)= 300 V
Ic(100%)= 198 A
t_f= 0,071 us

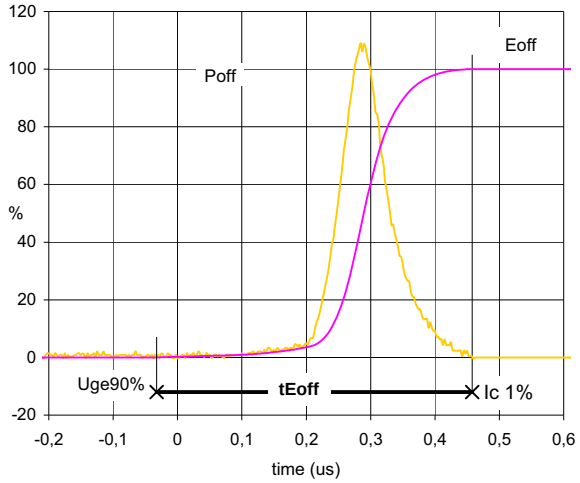
Figure 4. **Turn-on Switching Waveforms & definition of t_r**
Output inverter IGBT



Uc(100%)= 300 V
Ic(100%)= 198 A
t_r= 0,033 us

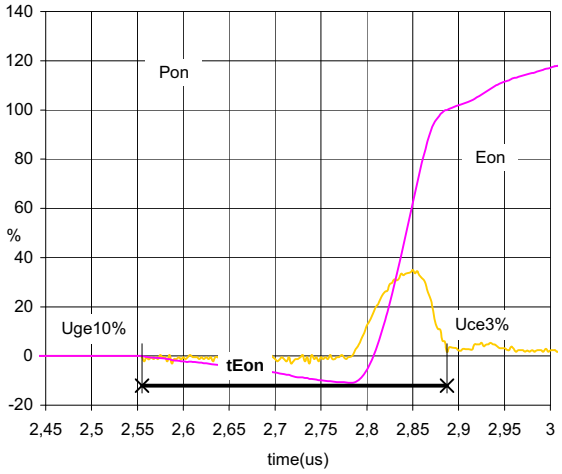
Switching definitions

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



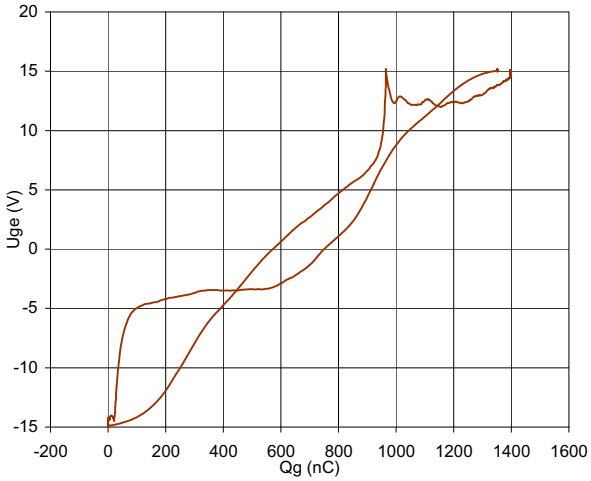
Poff(100%)= 59,25 kW
Eoff(100%)= 6,05 mJ
t_{Eoff}= 0,49 us

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



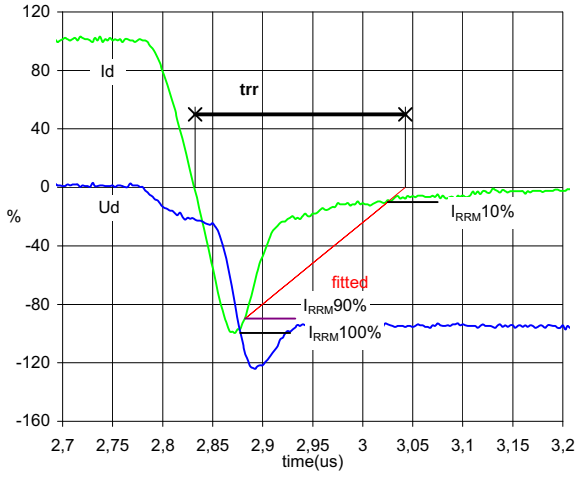
Pon(100%)= 59,3 kW
Eon(100%)= 1,30 mJ
t_{Eon}= 0,33 us

Figure 7. **Gate voltage vs Gate charge**
Output inverter IGBT



Ugeoff= -15 V
Ugeon= 15 V
Uc(100%)= 300 V
Ic(100%)= 198 A
Qg= 1397 nC

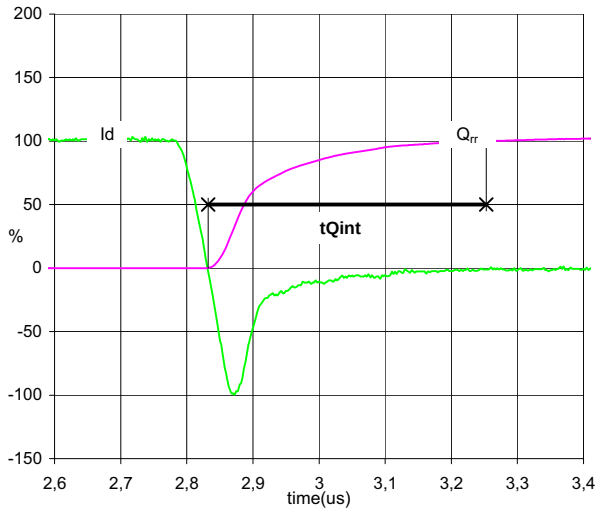
Figure 8. **Turn-off Switching Waveforms & definition of t_{rr}**
Output inverter FRED



Ud(100%)= 300 V
Id(100%)= 198 A
I_{RRM}(100%)= 198 A
trr= 0,16 us

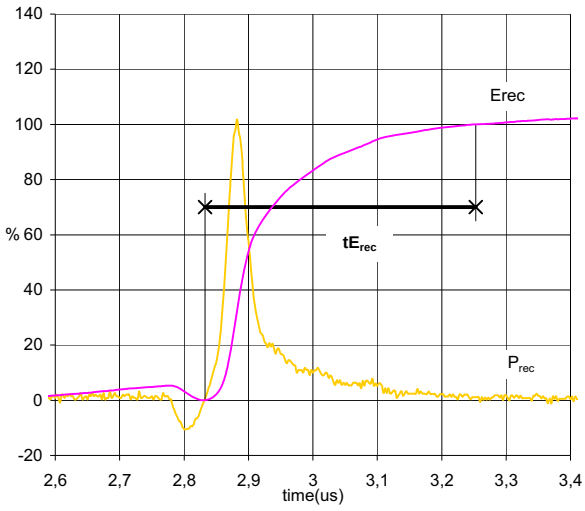
Switching definitions

Figure 9. Turn-on Switching Waveforms & definition of t_{Qrr}
(tQrr= integrating time for Qrr)
Output inverter FRED



Id(100%)= 198 A
Qrr(100%)= 14,27 uC
tQint= 0,42 us

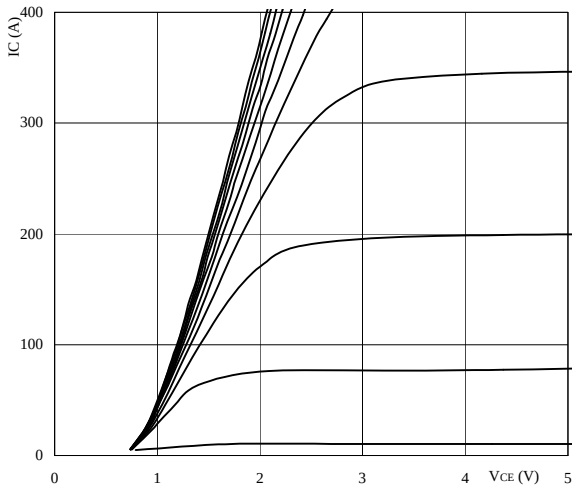
Figure 10. Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})
Output inverter FRED



Prec(100%)= 59,3 kW
Erec(100%)= 3,62 mJ
tErec= 0,42 us

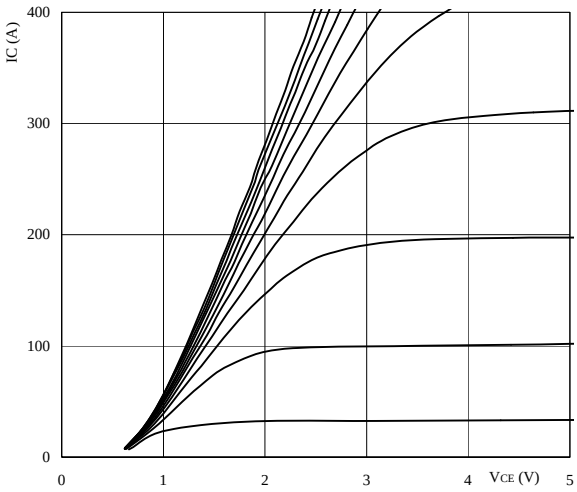
Output inverter

Figure 1. **Typical output characteristics**
Output inverter IGBT
Ic= f(VCE)



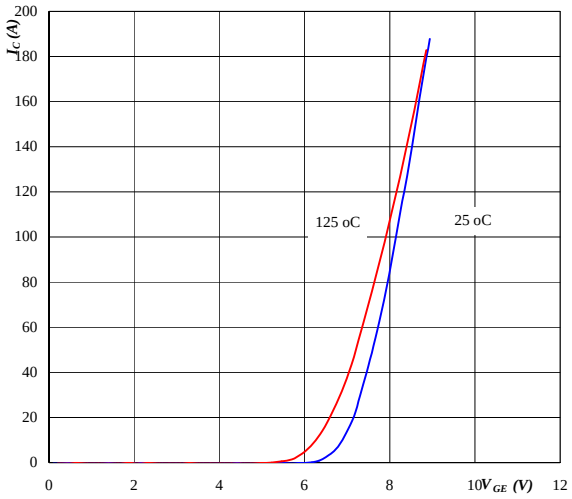
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

Figure 2. **Typical output characteristics**
Output inverter IGBT
Ic= f(VCE)



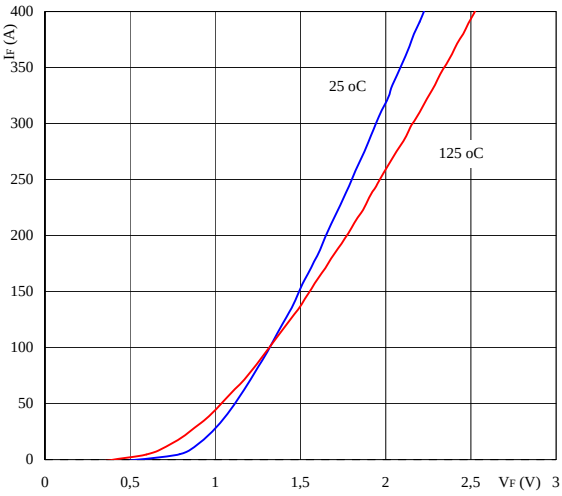
parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 7 V to 17 V
in 1 V steps

Figure 3. **Typical transfer characteristics**
Output inverter IGBT
Ic= f(VGE)



parameter: tp = 250 us VCE = 12 V

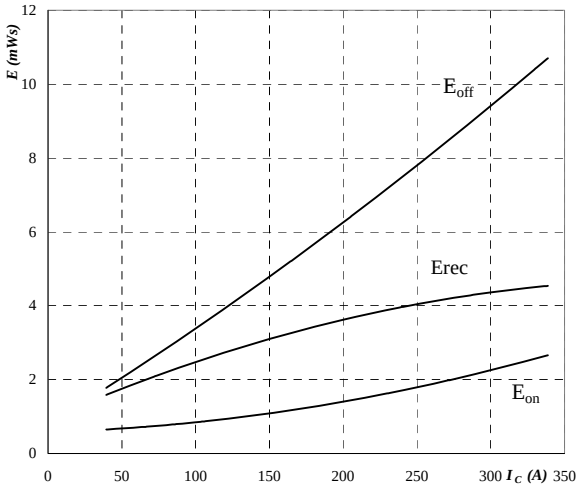
Figure 4. **Typical diode forward current as a function of forward voltage**
Output inverter FRED IF=f(VF)



parameter: tp = 250 us

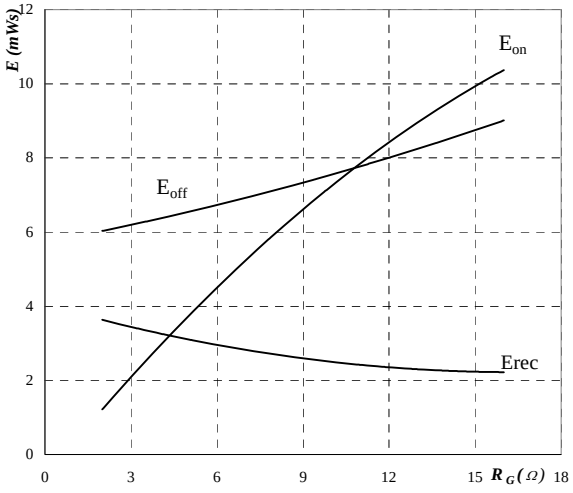
Output inverter

Figure 5. Typical switching energy losses as a function of collector current
Output inverter IGBT
E = f (Ic)



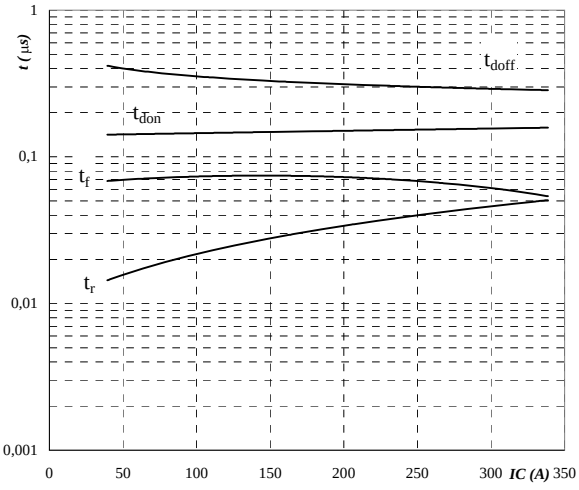
inductive load, Tj = 125 °C
V_{CE} = 300 V
V_{GE} = ±15 V
Rgon = 2 Ω
Rgoff = 2 Ω

Figure 6. Typical switching energy losses as a function of gate resistor
Output inverter IGBT
E = f (R_G)



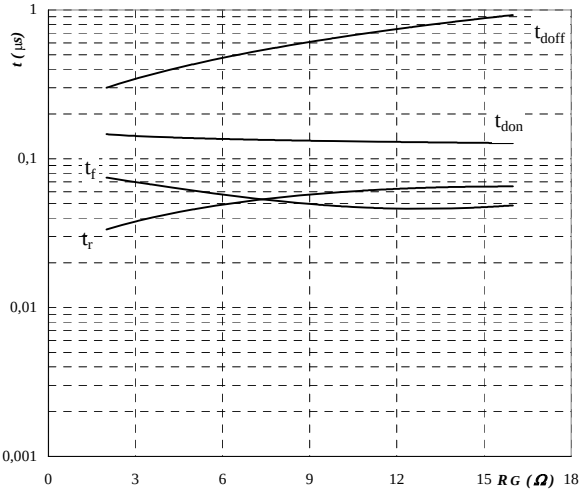
inductive load, Tj = 125 °C
V_{CE} = 300 V
V_{GE} = ±15 V
Ic = 198 A

Figure 7. Typical switching times as a function of collector current
Output inverter IGBT
t = f (Ic)



inductive load, Tj = 125 °C
V_{CE} = 300 V
V_{GE} = ±15 V
Rgon = 2 Ω
Rgoff = 2 Ω

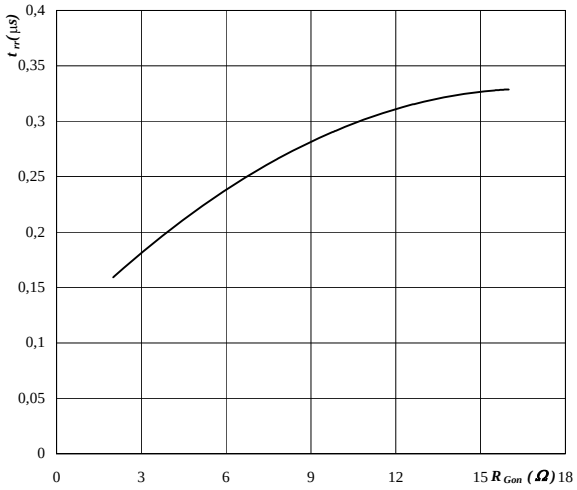
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
t = f (R_G)



inductive load, Tj = 125 °C
V_{CE} = 300 V
V_{GE} = ±15 V
Ic = 198 A

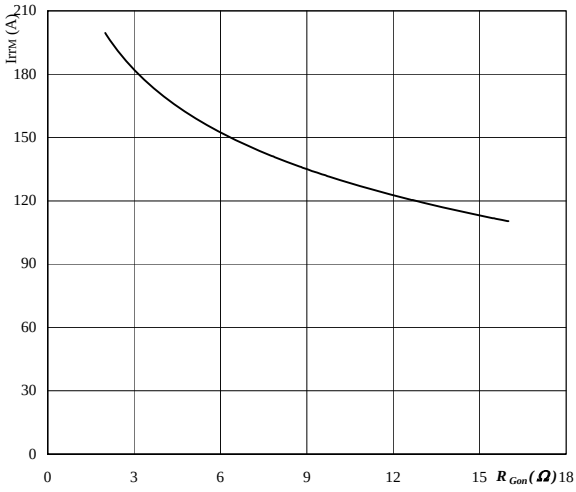
Output inverter

Figure 9. Typical reverse recovery time as a function of IGBT turn on gate resistor
Output inverter FRED diode
t_{rr} = f (Rgon)



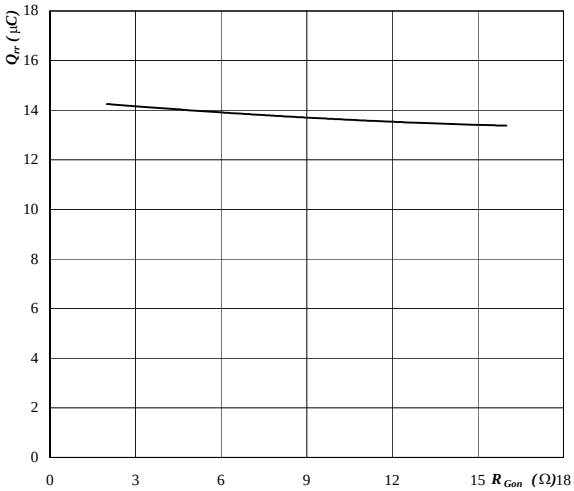
Tj = 125 °C
V_R = 300 V
I_F = 198 A
V_{GE} = ±15 V

Figure 10. Typical reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
I_{RRM} = f (Rgon)



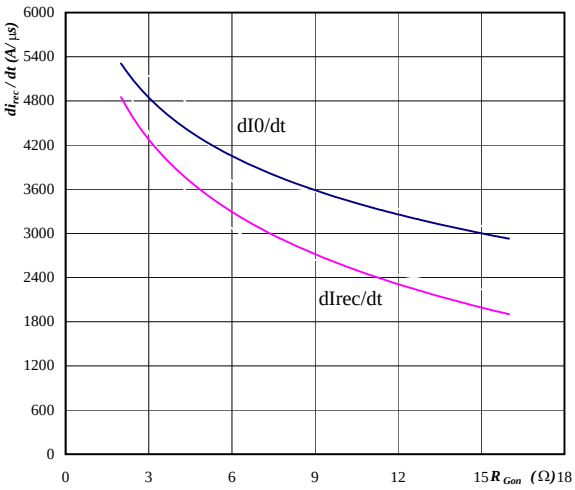
Tj = 125 °C
V_R = 300 V
I_F = 198 A
V_{GE} = ±15 V

Figure 11. Typical reverse recovery charge as a function of IGBT turn on gate resistor
Output inverter FRED diode
Q_{rr} = f (Rgon)



Tj = 125 °C
V_R = 300 V
I_F = 198 A
V_{GE} = ±15 V

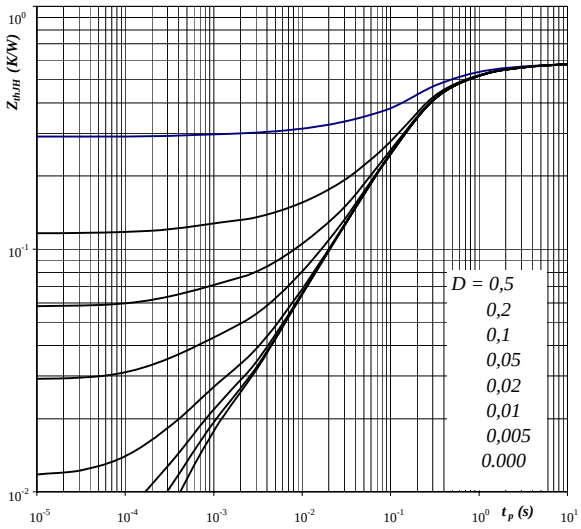
Figure 12. Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
Output inverter FRED diode
dI0/dt,dIrec/dt= f (Rgon)



Tj = 125 °C
V_R = 300 V
I_F = 198 A
V_{GE} = ±15 V

Output inverter

Figure 13. IGBT transient thermal impedance as a function of pulse width
ZthJH = f(tp)

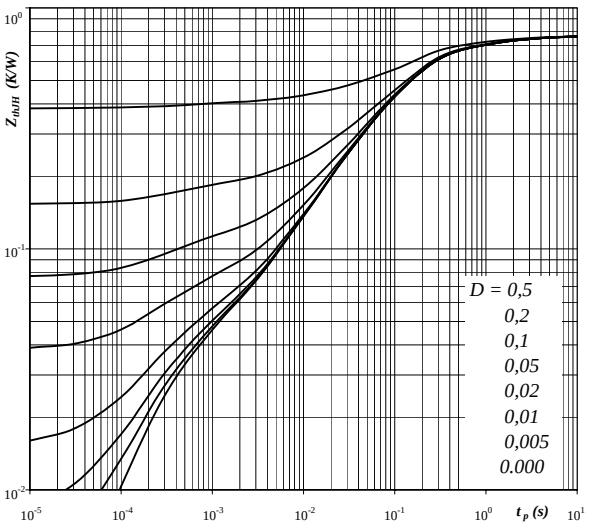


Parameter: D = tp / T RthJH= 0,58 K/W

IGBT thermal model values

R (C/W)	Tau (s)
0,05	3,6E+00
0,13	6,3E-01
0,34	1,5E-01
0,05	1,1E-02
0,01	5,3E-04

Figure 14. FRED transient thermal impedance as a function of pulse width
ZthJH = f(tp)



Parameter: D = tp / T RthJH= 0,76 K/W

FRED thermal model values

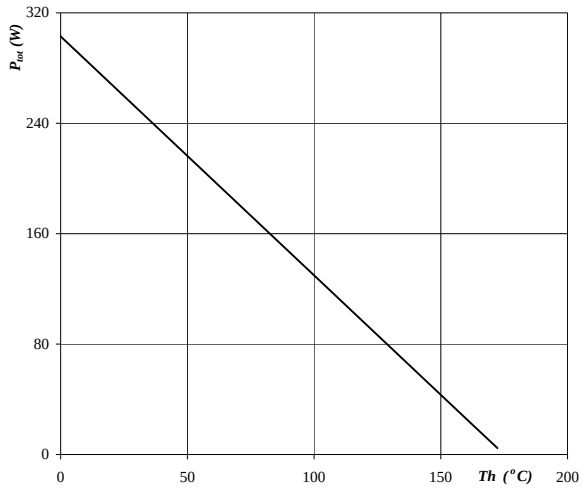
R (C/W)	Tau (s)
0,05	3,8E+00
0,11	6,4E-01
0,42	1,2E-01
0,12	2,2E-02
0,03	3,8E-03
0,03	3,1E-04

Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

Output inverter IGBT

P_{tot} = f (Th)

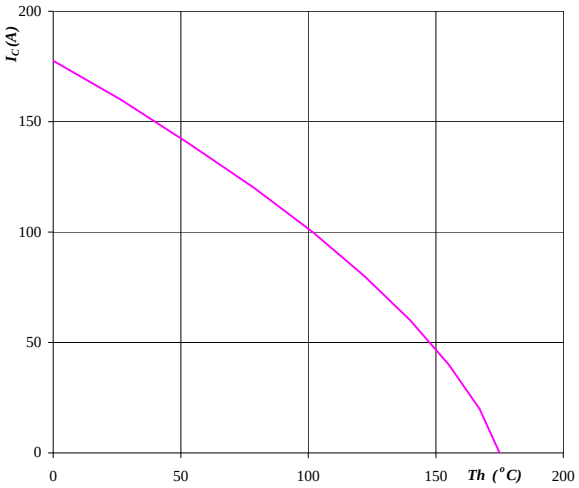


parameter: Tj= 175 ºC

Figure 16. Collector current as a function of heatsink temperature

Output inverter IGBT

I_C = f (Th)



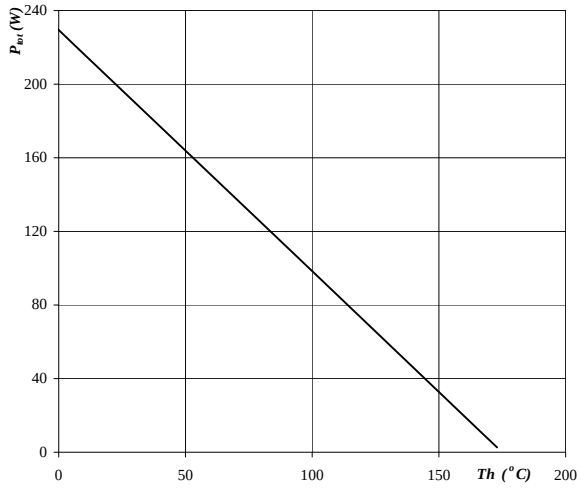
parameter: Tj= 175 ºC

V_{GE}= 15 V

Figure 17. Power dissipation as a function of heatsink temperature

Output inverter FRED

P_{tot} = f (Th)

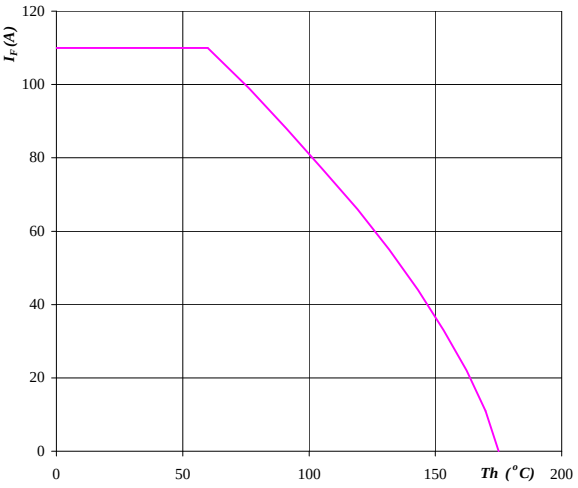


parameter: Tj= 175 ºC

Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED

I_F = f (Th)



parameter: Tj= 175 ºC