Maximum Ratings / Höchstzulässige Werte — P723-F04 600V/60A

Parameter	Condition	Symbol	Datasheet values max.	Unit
DC link Capacitor **DC link Kondensator**				
Max.DC voltage Max. Gleichspannung	Tc=25°C	U_{MAX}	500	V
Transistor H-bridge(IGBT) **Transistor H-Brücke(IGBT)**				
Collector-emitter break down voltage Kollektor-Emitter-Sperrspannung		V_{CE}	600	V
DC collector current Kollektor-Dauergleichstrom	Tj=Tjmax Th=80°C, Tc=80°C	I_C	35	A
Repetitive peak collector current Periodischer Kollektorspitzenstrom	tp limited by Tj max	I_{cpuls}	224	A
Power dissipation per IGBT Verlustleistung pro IGBT	Tj=Tjmax Th=80°C Tc=80°C	P_{tot}	93	W
Gate-emitter peak voltage Gate-Emitter-Spitzenspannung		V_{GE}	±20	V
SC withstand time* Kurzschlußverhalten*	Tj=Tjmax VGE=15V VCC=360V	t_{SC}	6	us
max. Chip temperature max. Chiptemperatur		T_{jmax}	150	°C
Diode H-bridge **Diode H-Brücke**				
DC forward current Dauergleichstrom	Tj=Tjmax Th=80°C, Tc=80°C	I_F	34	A
Repetitive peak forward current Periodischer Spitzenstrom	tp limited by Tj max	I_{FRM}	150	A
Power dissipation per Diode Verlustleistung pro Diode	Tj=Tjmax Th=80°C Tc=80°C	P_{tot}	47	W
max. Chip temperature max. Chiptemperatur		T_{jmax}	150	°C

Maximum Ratings / Höchstzulässige Werte **P723-F04 600V/60A**

Parameter	Condition	Symbol	Datasheet values max.	Unit
Thermal properties **Thermische Eigenschaften**				
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:

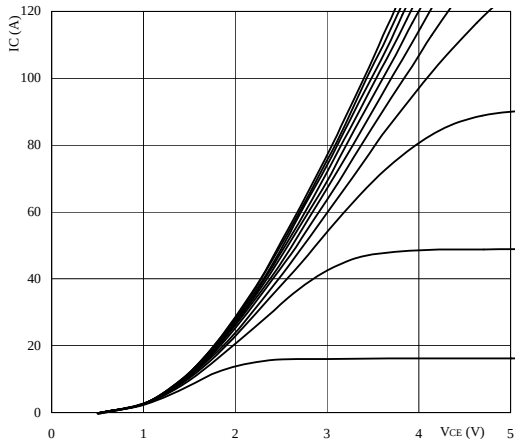
** Allowed number of short circuits must be less than 1000 times, and time duration between short circuits should be more than 1 second!*

Characteristic values/ Charateristische Werte **P723-F04**

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	
Capacitor										
Kondensator										
C value	C						216	270	324	nF
C Wert										
Transistor H-bridge(IGBT)										
Transistor H-Brücke(IGBT)										
Gate emitter threshold voltage	$V_{GE(th)}$	Tj=25°C	VCE=VGE			0.6m	3	4	5	V
Gate-Schwellenspannung		Tj=125°C								
Collector-emitter saturation voltage	$V_{CE(sat)}$	Tj=25°C		15		60		2,7	3,7	V
Kollektor-Emitter Sättigungsspannung		Tj=125°C						3,22		
Collector-emitter cut-off	I_{CES}	Tj=25°C		0	600				0,35	mA
Kollektor-Emitter Reststrom		Tj=125°C								
Gate-emitter leakage current	I_{GES}	Tj=25°C		20	0				300	nA
Gate-Emitter Reststrom		Tj=125°C								
Integrated Gate resistor	R_{gint}							none		Ω
Integrirter Gate Widerstand										
Turn-on delay time	$t_{d(on)}$	Tj=25°C	Rgoff=2 Ω							ns
Einschaltverzögerungszeit		Tj=125°C	Rgon=4 Ω	15	400	60		18		
Rise time	t_r	Tj=25°C	Rgoff=2 Ω							ns
Anstiegszeit		Tj=125°C	Rgon=4 Ω	15	400	60		16		
Turn-off delay time	$t_{d(off)}$	Tj=25°C	Rgoff=2 Ω							ns
Abschaltverzögerungszeit		Tj=125°C	Rgon=4 Ω	15	400	60		206		
Fall time	t_f	Tj=25°C	Rgoff=2 Ω							ns
Fallzeit		Tj=125°C	Rgon=4 Ω	15	400	60		12		
Turn-on energy loss per pulse	E_{on}	Tj=25°C	Rgoff=2 Ω							mWs
Einschaltverlustenergie pro Puls		Tj=125°C	Rgon=4 Ω	15	400	60		1,1		
Turn-off energy loss per pulse	E_{off}	Tj=25°C	Rgoff=2 Ω							mWs
Abschaltverlustenergie pro Puls		Tj=125°C	Rgon=4 Ω	15	400	60		0,96		
Input capacitance	C_{ies}	Tj=25°C	f=1MHz	0	25			3		nF
Eingangskapazität		Tj=125°C								
Output capacitance	C_{oss}	Tj=25°C	f=1MHz	0	25			0,3		nF
Ausgangskapazität		Tj=125°C								
Reverse transfer capacitance	Cies	Tj=25°C	f=1MHz	0	25			0,18		nF
Rückwirkungskapazität		Tj=125°C								
Thermal resistance chip to heatsink per chip	R_{thJH}		Thermal grease thickness≤50um					0,76		K/W
Wärmewiderstand Chip-Kühlkörper pro Chip			Wärmeleitpaste Dicke≤50um λ = 0,61 W/mK							
Diode H-bridge										
Diode H-Brücke										
Diode forward voltage	V_F	Tj=25°C				60	1,2	1,6	2,3	V
Durchlaßspannung		Tj=125°C						1,56		
Peak reverse recovery current	I_{RM}	Tj=25°C								A
Rückstromspitze		Tj=125°C	Rgon=4 Ω	15	400	60		100		
Reverse recovery time	t_{rr}	Tj=25°C								ns
Sperreverzögerungszeit		Tj=125°C	Rgon=4 Ω	15	400	60		126		
Reverse recovered charge	Q_{rr}	Tj=25°C								uC
Sperrverzögerungsladung		Tj=125°C	Rgon=4 Ω	15	400	60		4,5		
Reverse recovered energy	Erec	Tj=25°C								mWs
Sperrverzögerungsenergie		Tj=125°C	Rgon=4 Ω	15	400	60		1,32		
Thermal resistance chip to heatsink per chip										
Wärmewiderstand Chip-Kühlkörper pro Chip	R_{thJH}		Thermal grease thickness≤					1,49		K/W
Thermal resistance chip to case per chip										
Wärmewiderstand Chip-Gehause pro Chip	R_{thJC}		WarmeleitpasteDicke≤50u							
NTC-Thermistor										
NTC-Widerstand										
Rated resistance	R_{25}	Tj=25°C	Tol. ±5%				20,9	22	23,1	kOhm
Nennwiderstand										
Deviation of R100	$D_{R/R}$	Tc=100°C	R100=1503Ω					2,9		%/K
Abweichung von R100										
Power dissipation given Epcos-Typ	P	Tj=25°C						210		mW
Verlustleistung Epcos-Typ angeben										
B-value	$B_{(25/100)}$	Tj=25°C	Tol. ±3%					3980		K
B-Wert										

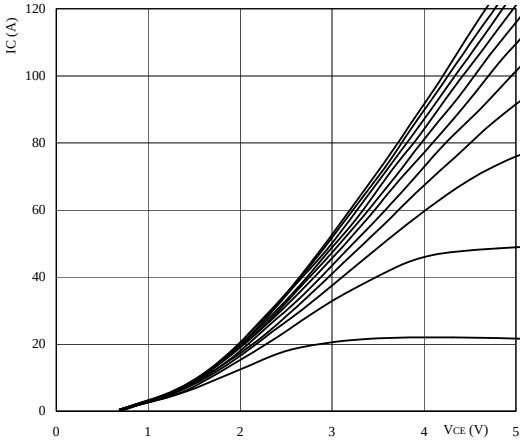
Output inverter

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



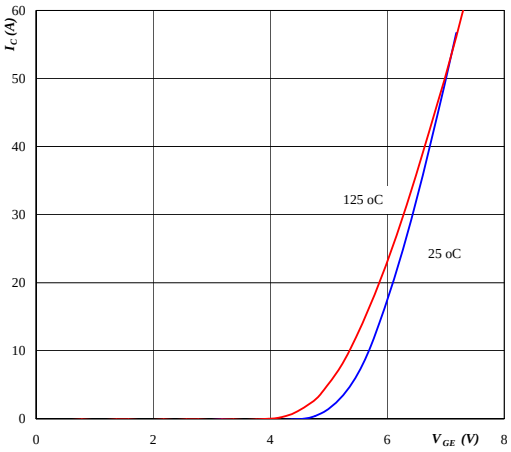
parameter: tp = 250 us Tj = 25 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

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



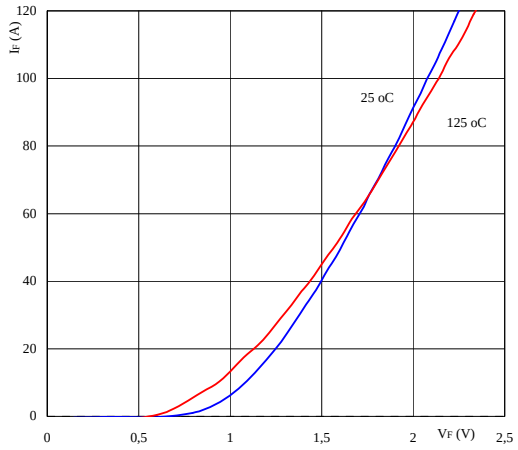
parameter: tp = 250 us Tj = 125 °C
VGE parameter: from: 6 V to 16 V
in 1 V steps

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



parameter: tp = 250 us VCE = 10 V

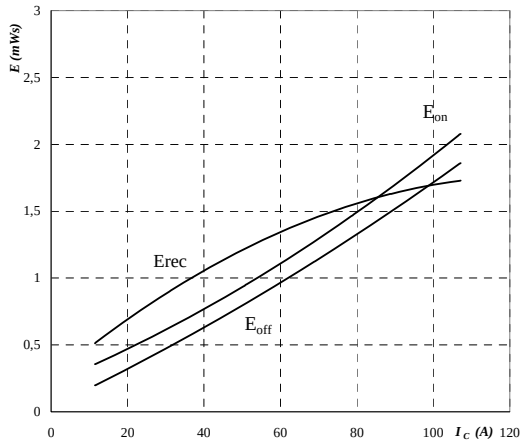
Figure 4. **Typical diode forward current as a function of forward voltage**
Output inverter FRED IF=f(VF)



parameter: tp = 250 us

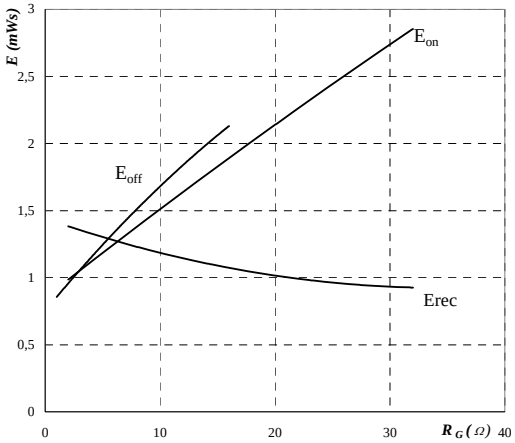
Output inverter

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



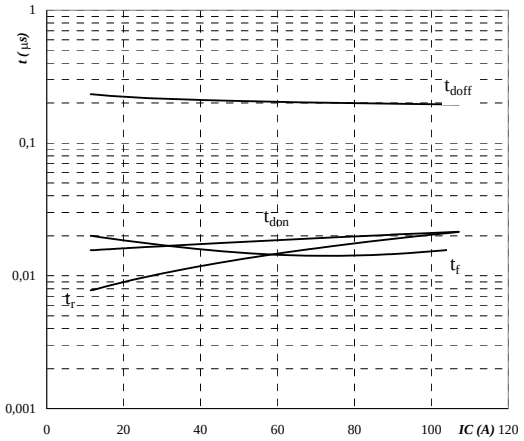
inductive load, Tj = 125 °C
VCE = 400 V
VGE= 15 V
Rgon= 4 Ω
Rgoff= 2 Ω

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



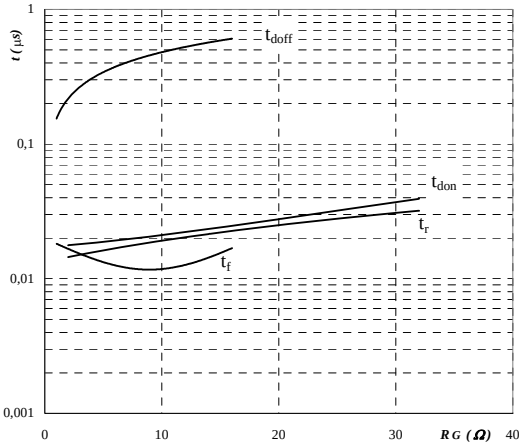
inductive load, Tj = 125 °C
VCE = 400 V
VGE= 15 V
Ic = 60 A

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



inductive load, Tj = 125 °C
VCE = 400 V
VGE= 15 V
Rgon= 4 Ω
Rgoff= 2 Ω

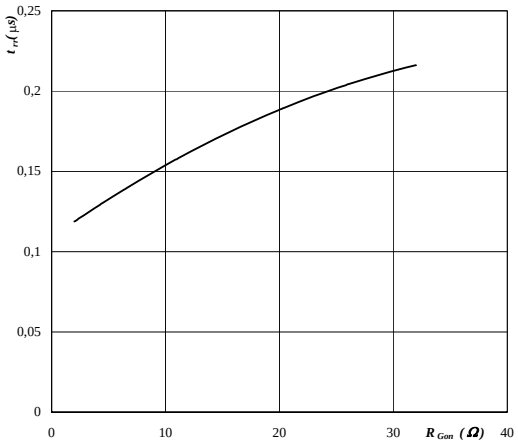
Figure 8. Typical switching times as a function of gate resistor
Output inverter IGBT
t = f (RG)



inductive load, Tj = 125 °C
VCE = 400 V
VGE= 15 V
Ic = 60 A

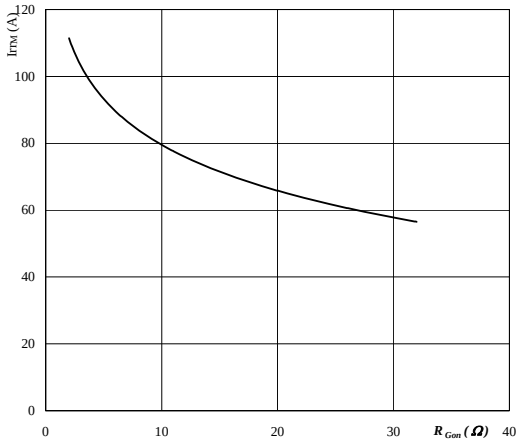
Output inverter

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



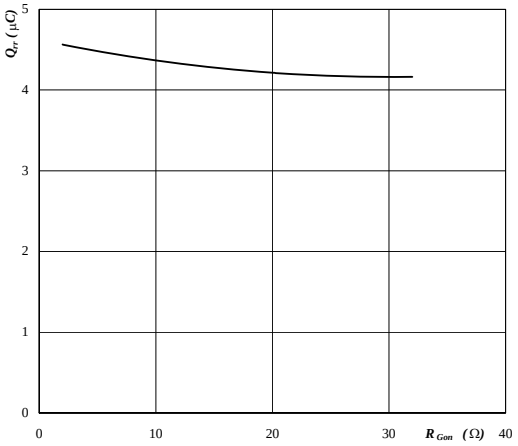
Tj = 125 °C
V_R = 400 V
I_F = 60 A
V_{GE} = 15 V

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



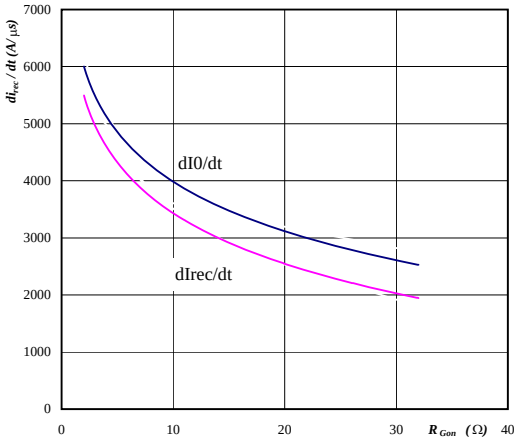
Tj = 125 °C
V_R = 400 V
I_F = 60 A
V_{GE} = 15 V

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 = 400 V
I_F = 60 A
V_{GE} = 15 V

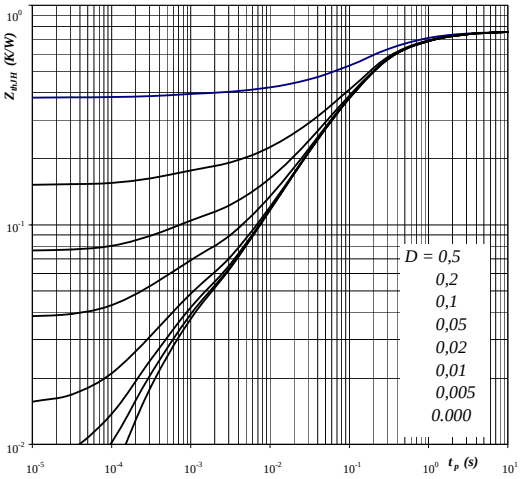
Figure 12. **Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor**
Output inverter FRED diode
dI0/dt,dIrec/dt= f (Rgon)



Tj = 125 °C
V_R = 400 V
I_F = 60 A
V_{GE} = 15 V

Output inverter

Figure 13. IGBT transient thermal impedance as a function of pulse width
$Z_{thJH} = f(tp)$

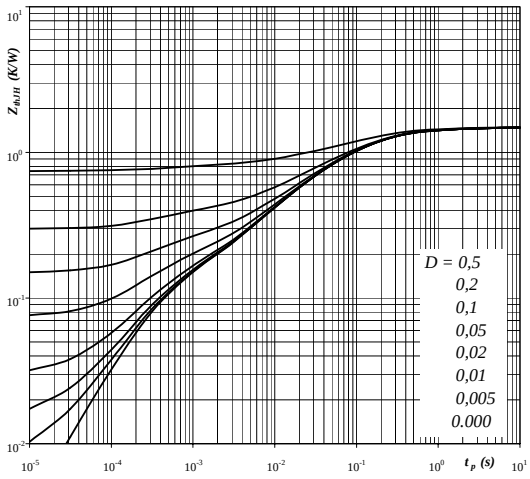


Parameter: D = tp / T RthJH= 0,76 K/W

IGBT thermal model values

R (C/W)	Tau (s)
0,04	4,9E+00
0,13	8,8E-01
0,41	1,7E-01
0,12	3,0E-02
0,03	4,9E-03
0,03	4,3E-04

Figure 14. FRED transient thermal impedance as a function of pulse width
$Z_{thJH} = f(tp)$



Parameter: D = tp / T RthJH= 1,49 K/W

FRED thermal model values

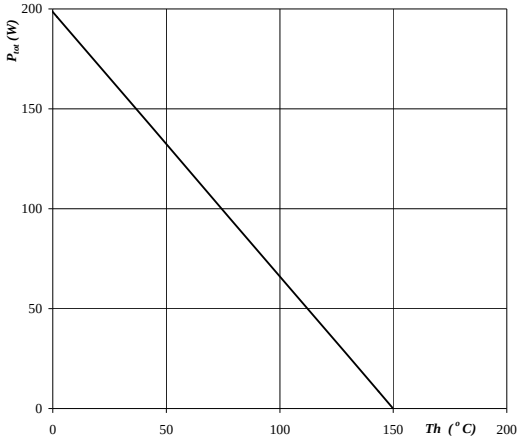
R (C/W)	Tau (s)
0,06	3,8E+00
0,20	5,1E-01
0,62	1,1E-01
0,39	2,2E-02
0,12	3,8E-03
0,10	3,3E-04

Output inverter

Figure 15. Power dissipation as a function of heatsink temperature

Output inverter IGBT

P_{tot} = f (Th)

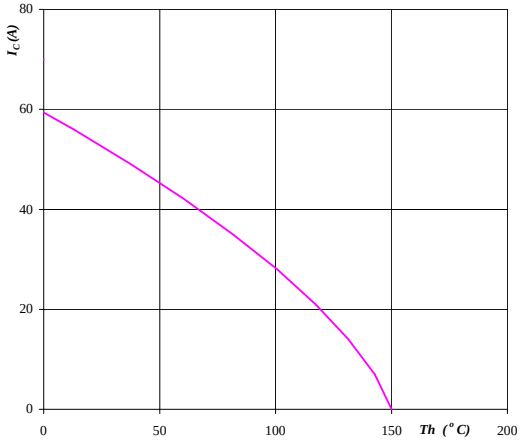


parameter: Tj = 150°C

Figure 16. Collector current as a function of heatsink temperature

Output inverter IGBT

I_C = f (Th)



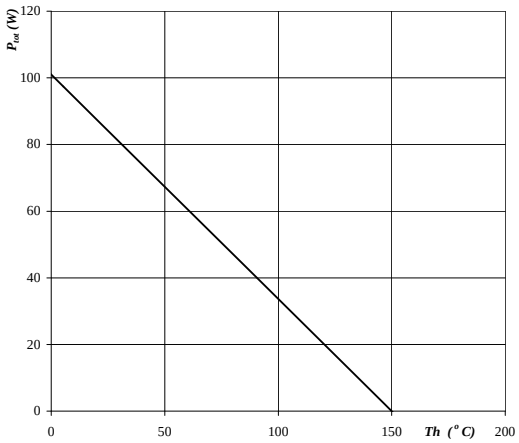
parameter: Tj = 150°C

V_{GE}= 15 V

Figure 17. Power dissipation as a function of heatsink temperature

Output inverter FRED

P_{tot} = f (Th)

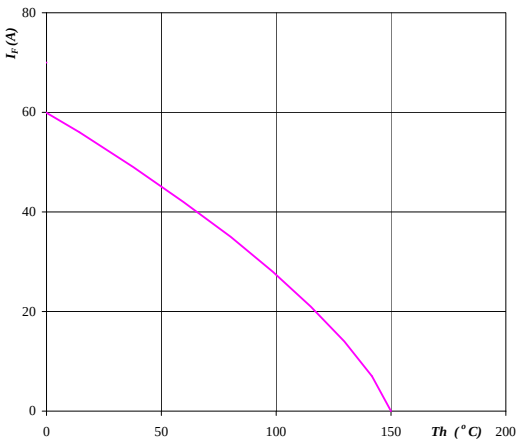


parameter: Tj = 150°C

Figure 18. Forward current as a function of heatsink temperature

Output inverter FRED

I_F = f (Th)

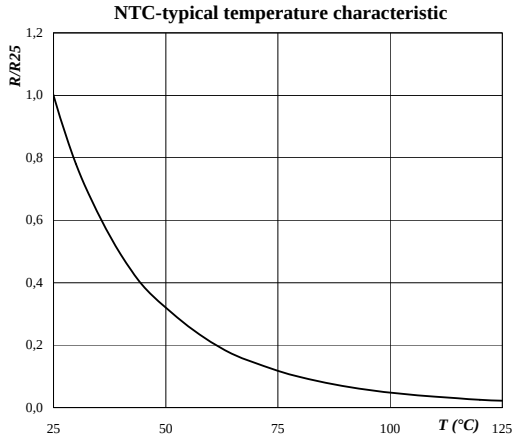


parameter: Tj = 150°C

Thermistor

Figure 1. Typical NTC characteristic as afunction of temperature

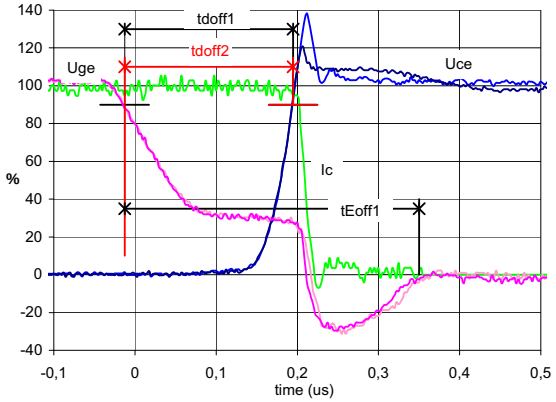
$R_T = f(T)$



Switching definitions

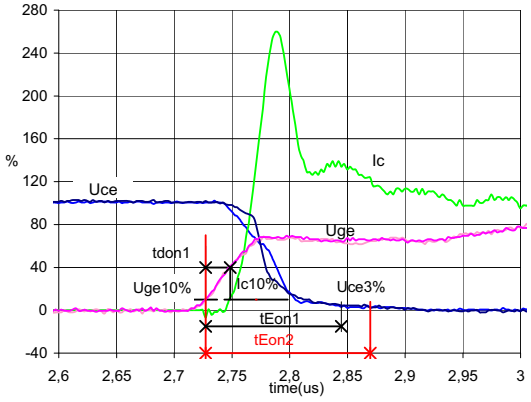
General conditions: Tj= 125 °C Rgon= 4 Ω Rgoff= 2 Ω

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



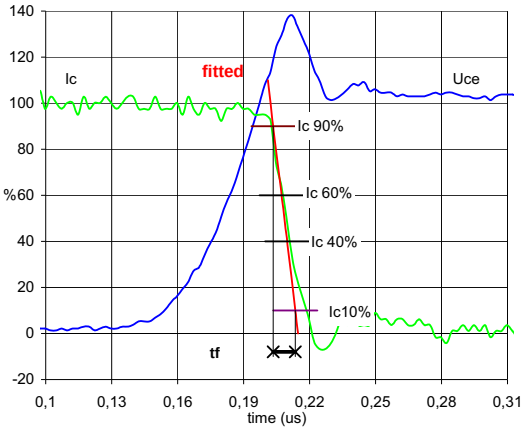
Uge(0%)= 0 V without capacitor (P623-F04)
Uge(100%)= 15 V with capacitor (P723-F04))
Uc(100%)= 400 V
Ic(100%)= 60 A
tdoff= 0,21 us
t_{Eoff}= 0,37 us

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



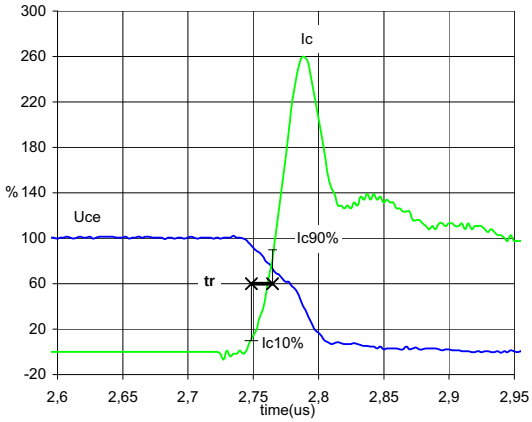
Uge(0%)= 0 V without capacitor
Uge(100%)= 15 V with capacitor
Uc(100%)= 400 V
Ic(100%)= 60 A
tdon= 0,02 us
t_{Eon}= 0,12 us

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



Uc(100%)= 400 V
Ic(100%)= 60 A
t_f= 0,013 us

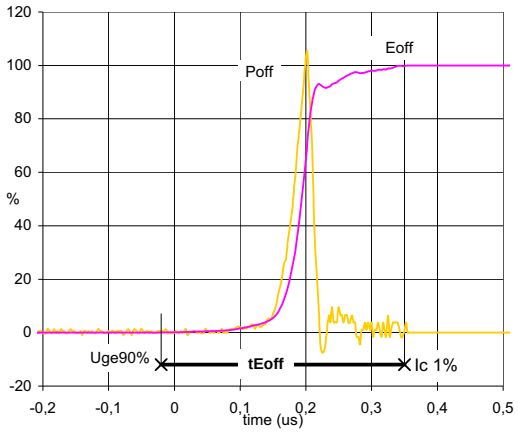
Figure 4. **Turn-on Switching Waveforms & definition of t_r**
Output inverter IGBT



Uc(100%)= 400 V
Ic(100%)= 60 A
t_r= 0,017 us

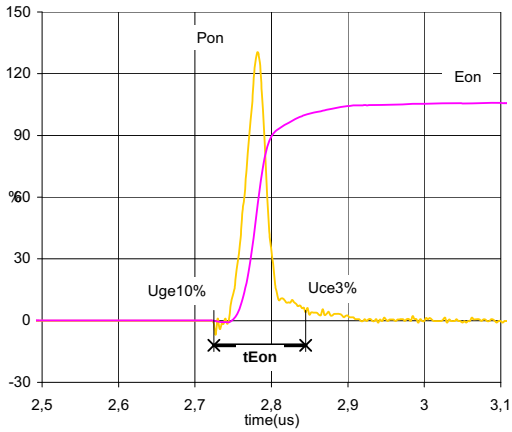
Switching definitions

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



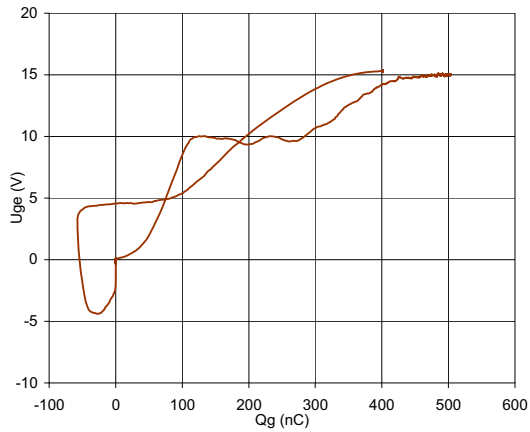
Poff(100%)= 23,96 kW
Eoff(100%)= 0,97 mJ
t_{Eoff}= 0,37 us

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



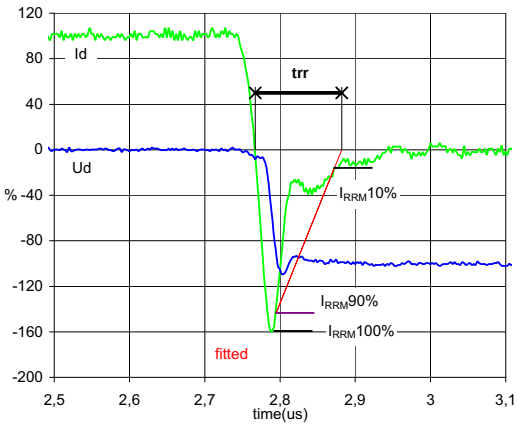
Pon(100%)= 24 kW
Eon(100%)= 1,06 mJ
t_{Eon}= 0,12 us

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



Ugeoff= 0 V
Ugeon= 15 V
Uc(100%)= 400 V
Ic(100%)= 60 A
Qg= 503,8 nC

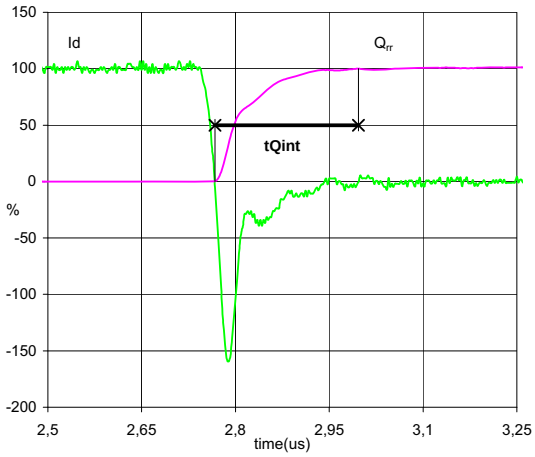
Figure 8. **Turn-off Switching Waveforms & definition of t_{rr}**
Output inverter FRED



Ud(100%)= 400 V
Id(100%)= 60 A
I_{RRM}(100%)= 96 A
trr= 0,11 us

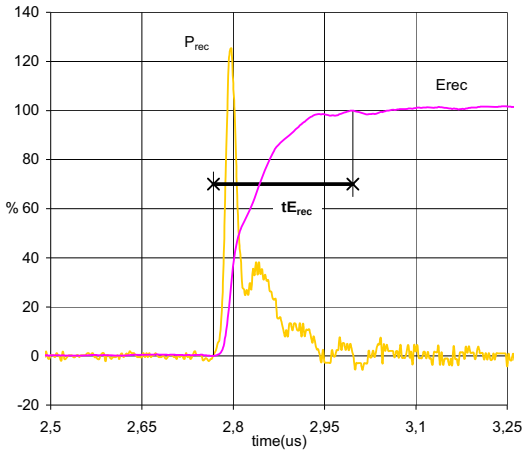
Switching definitions

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



Id(100%)= 60 A
Qrr(100%)= 4,211 uC
tQint= 0,23 us

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



Prec(100%)= 24 kW
Erec(100%)= 1,24 mJ
tErec= 0,23 us