

flowPACK 0 3rd gen
600V/30A
Features

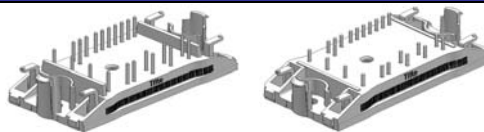
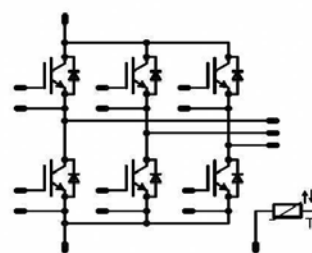
- 2 clip housing in 12mm and 17mm height
- Trench Fieldstop IGBT³ technology
- Compact and low inductance design
- Built-in NTC

Target Applications

- Motor Drives
- Power Generation
- UPS

Types

- V23990-P864-F49-PM: 17mm height
- V23990-P864-F48-PM: 12mm height

flow0 housing

Schematic


Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Transistor				
Collector-emitter voltage	V _{CE}		600	V
DC collector current	I _C	T _j =T _{jmax} T _h =80°C T _c =80°C	31	A
Repetitive peak collector current	I _{Cpulse}	t _p limited by T _{jmax}	90	A
Power dissipation per IGBT	P _{tot}	T _j =T _{jmax} T _h =80°C T _c =80°C	60	W
Gate-emitter peak voltage	V _{GE}		±20	V
Short circuit ratings*	t _{SC}	T _j ≤150°C	6	µs
	V _{CC}	V _{GE} =15V	360	V
Maximum Junction Temperature	T _{jmax}		175	°C

* It is recommended to not exceed 1000 short circuit situations in the lifetime of the module and to allow at least 1s between short circuits

Inverter Diode

Peak Repetitive Reverse Voltage	V _{RRM}	T _j =25°C	600	V
DC forward current	I _F	T _j =T _{jmax} T _h =80°C T _c =80°C	30	A
Repetitive peak forward current	I _{FRM}	t _p limited by T _{jmax}	60	A
Power dissipation per Diode	P _{tot}	T _j =T _{jmax} T _h =80°C T _c =80°C	46	W
Maximum Junction Temperature	T _{jmax}		175	°C

Thermal properties

Storage temperature	T _{stg}		-40.....+125	°C
Operation junction temperature	T _{op}		-40.....+T _{jmax} -25	°C

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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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

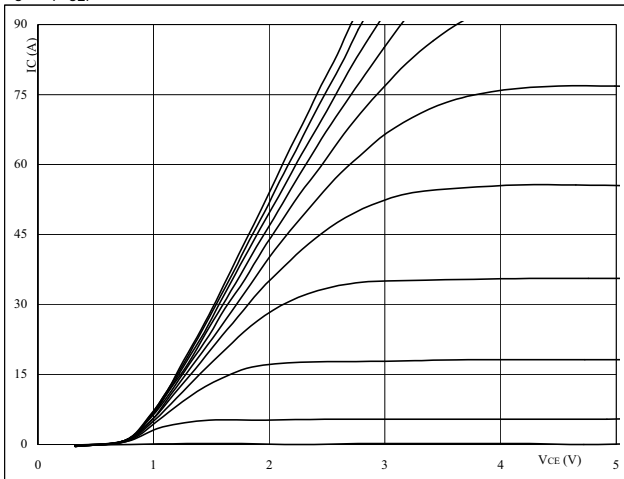
Parameter	Symbol	Conditions					Value			Unit
			$V_{GE} [V]$ or $V_{GS} [V]$	$V_r [V]$ or $V_{CE} [V]$ or $V_{DS} [V]$	$I_C [A]$ or $I_F [A]$ or $I_D [A]$	T_j	Min	Typ	Max	
Inverter Transistor										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,00043	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		30	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,57 1,79	2,15	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			200	μA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^{\circ}C$ $T_j=150^{\circ}C$			350	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon}=16\Omega$ $R_{goff}=16\Omega$	± 15	300	30	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		106 104		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		14 20		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		146 171		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		92 112		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		0,47 0,66		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		0,67 0,91		
Input capacitance	C_{ies}	$f=1MHz$	0	25		$T_j=25^{\circ}C$		1630		pF
Output capacitance	C_{oss}							108		
Reverse transfer capacitance	C_{rss}							50		
Gate charge	Q_{Gate}		15	480	30	$T_j=25^{\circ}C$		167		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 0,61 W/mK$						1,60		K/W
Inverter Diode										
Diode forward voltage	V_F				30	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,64 1,55	2,2	V
Peak reverse recovery current	I_{RRM}	$R_{gon}=16\Omega$	± 15	300	30	$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		27 34		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		146 253		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1,34 2,65		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=150^{\circ}C$		1752 815		A/ μs
Reverse recovered energy	E_{rec}					$T_j=150^{\circ}C$		0,57		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 0,61 W/mK$						2,08		K/W
Thermistor										
Rated resistance	R_{25}	Tol. $\pm 5\%$				$T_j=25^{\circ}C$	20,9	22	23,1	k Ω
Deviation of R100	$\Delta R/R$	$R_{100}=1486\Omega$				$T_j=100^{\circ}C$		2,9		%/K
Power dissipation	P					$T_j=25^{\circ}C$		210		mW
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				$T_j=25^{\circ}C$		4000		K

Output Inverter

Figure 1 Output inverter IGBT

Typical output characteristics

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

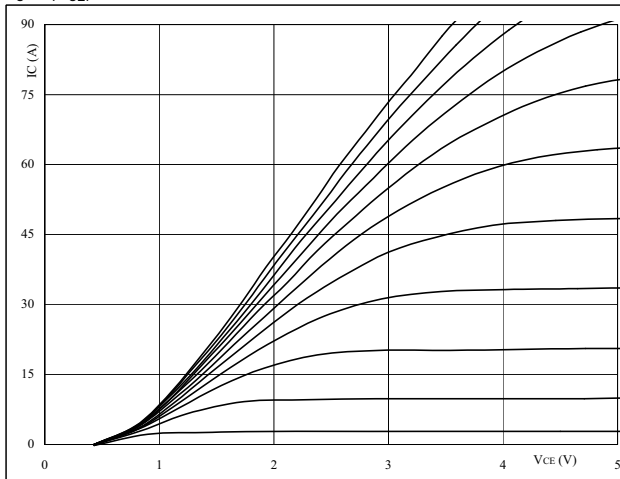


$t_p = 250 \mu s$
 $T_j = 25 ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 Output inverter IGBT

Typical output characteristics

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

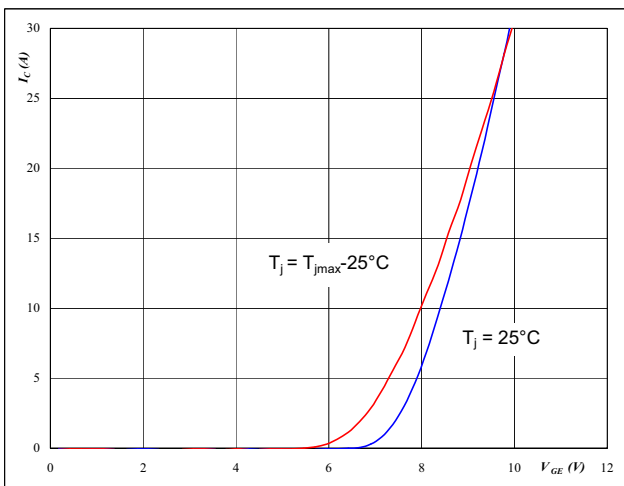


$t_p = 250 \mu s$
 $T_j = 150 ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 Output inverter IGBT

Typical transfer characteristics

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

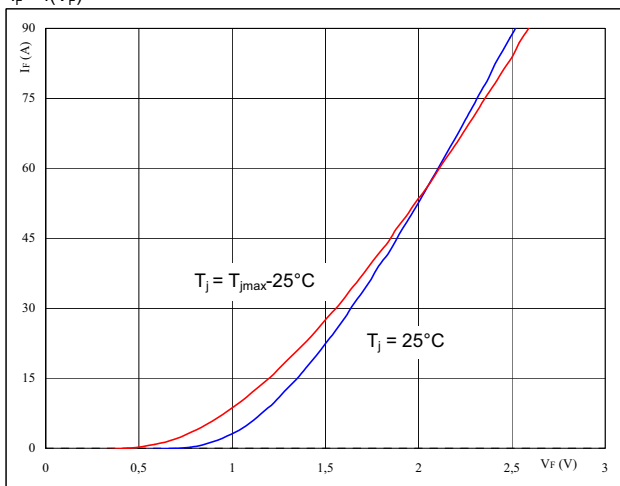


$t_p = 250 \mu s$
 $V_{CE} = 10 V$

Figure 4 Output inverter FRED

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



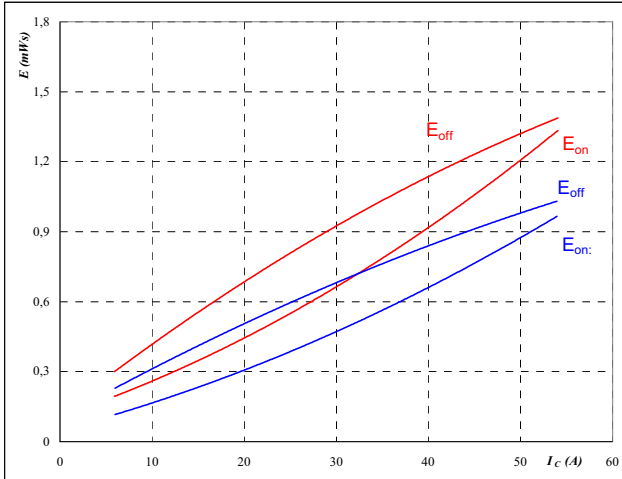
$t_p = 250 \mu s$

Output Inverter

Figure 5 Output inverter IGBT

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

$$E = f(I_C)$$



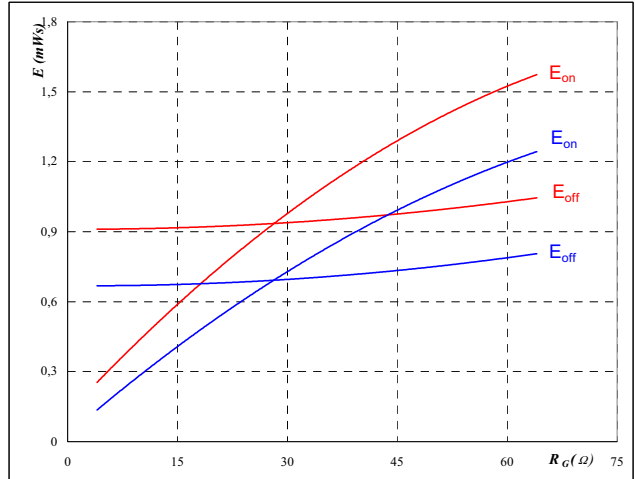
inductive load

$T_J =$	25/150	°C
$V_{CE} =$	300	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**

$$E = f(R_G)$$



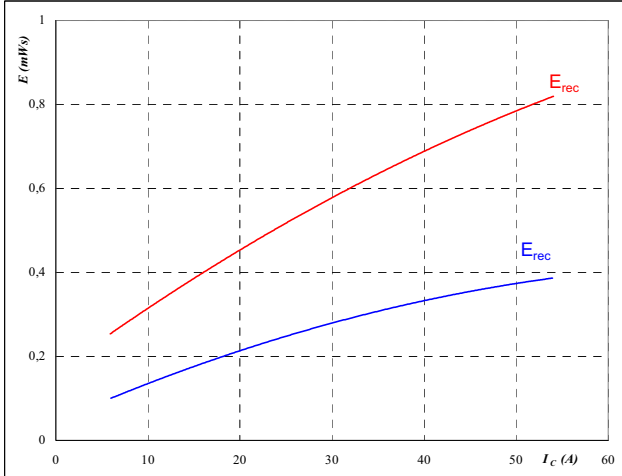
inductive load

$T_J =$	25/150	°C
$V_{CE} =$	300	V
$V_{GE} =$	±15	V
$I_C =$	30	A

Figure 7 Output inverter IGBT

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

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



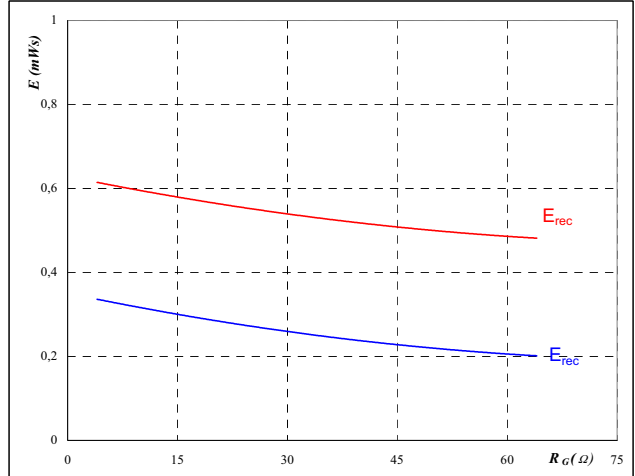
inductive load

$T_J =$	25/150	°C
$V_{CE} =$	300	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**

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



inductive load

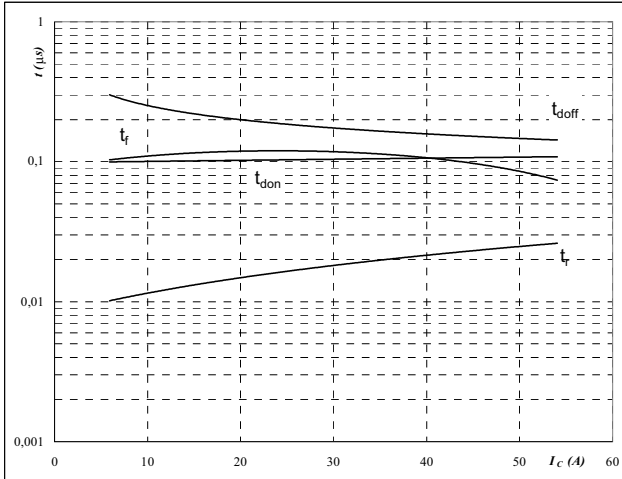
$T_J =$	25/150	°C
$V_{CE} =$	300	V
$V_{GE} =$	±15	V
$I_C =$	30	A

Output Inverter

Figure 9 Output inverter IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



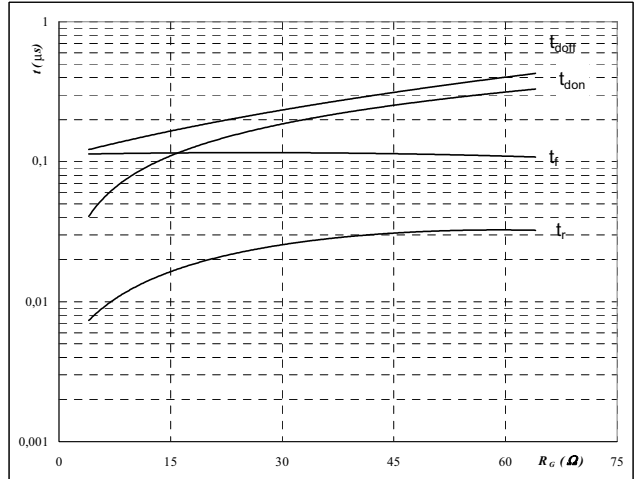
inductive load

$T_J =$	150	°C
$V_{CE} =$	300	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

$$t = f(R_G)$$



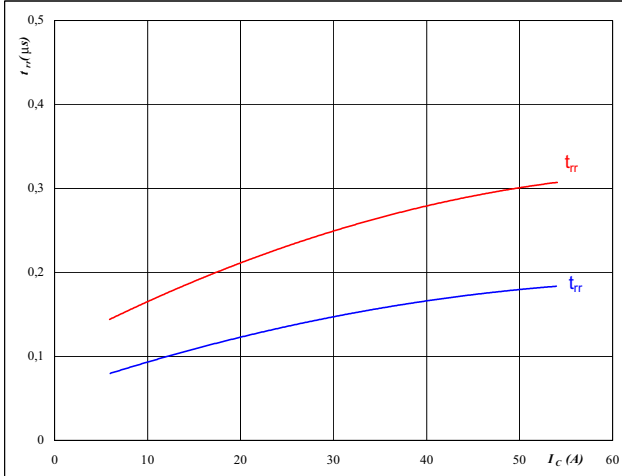
inductive load

$T_J =$	150	°C
$V_{CE} =$	300	V
$V_{GE} =$	±15	V
$I_C =$	30	A

Figure 11 Output inverter FRED

Typical reverse recovery time as a function of collector current

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

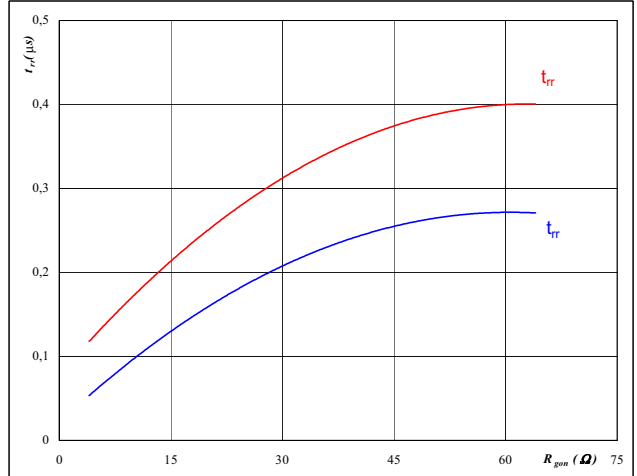


$T_J =$	25/150	°C
$V_{CE} =$	300	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω

Figure 12 Output inverter FRED

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

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



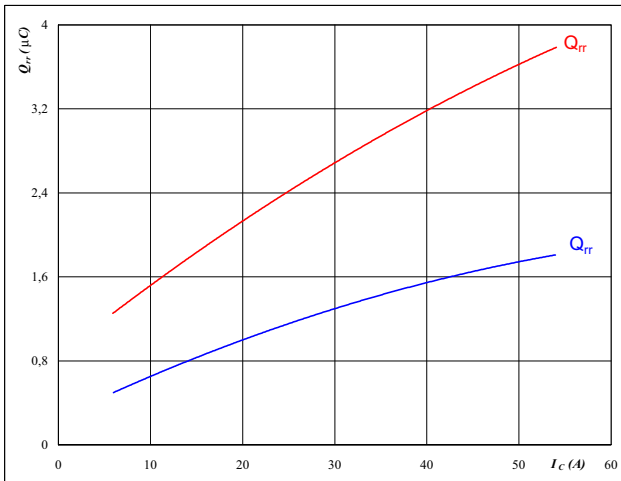
$T_J =$	25/150	°C
$V_R =$	300	V
$I_F =$	30	A
$V_{GE} =$	±15	V

Output Inverter

Figure 13 Output inverter FRED

Typical reverse recovery charge as a function of collector current

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

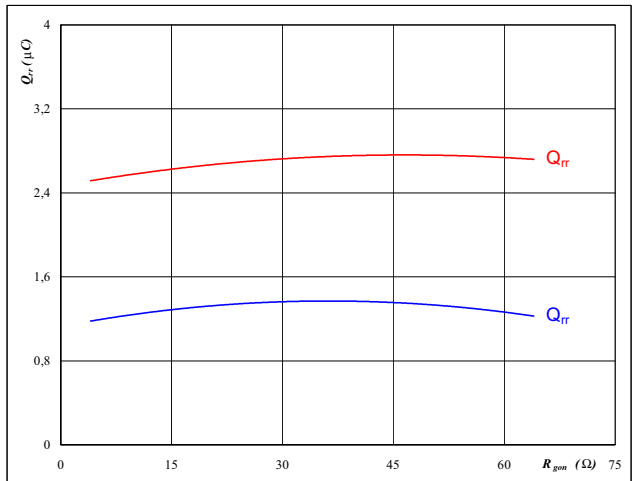


$T_J = 25/150$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 14 Output inverter FRED

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

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

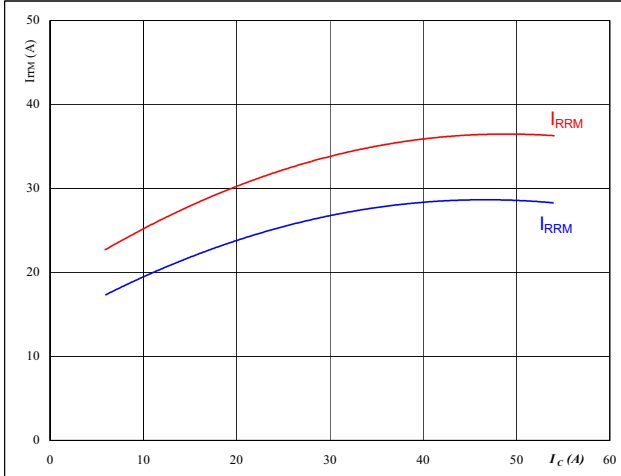


$T_J = 25/150$ °C
 $V_R = 300$ V
 $I_F = 30$ A
 $V_{GE} = \pm 15$ V

Figure 15 Output inverter FRED

Typical reverse recovery current as a function of collector current

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

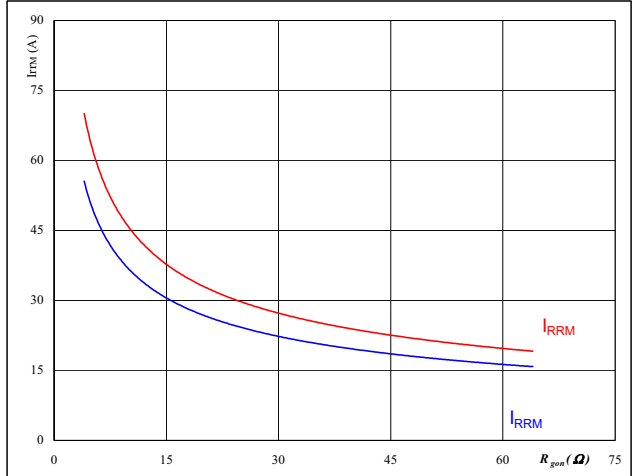


$T_J = 25/150$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 16 Output inverter FRED

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

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



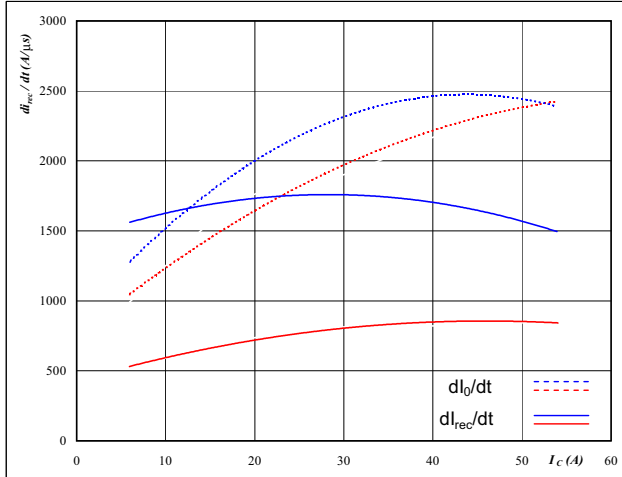
$T_J = 25/150$ °C
 $V_R = 300$ V
 $I_F = 30$ A
 $V_{GE} = \pm 15$ V

Output Inverter

Figure 17 Output inverter FRED

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

$$dI_o/dt, dI_{rec}/dt = f(I_c)$$

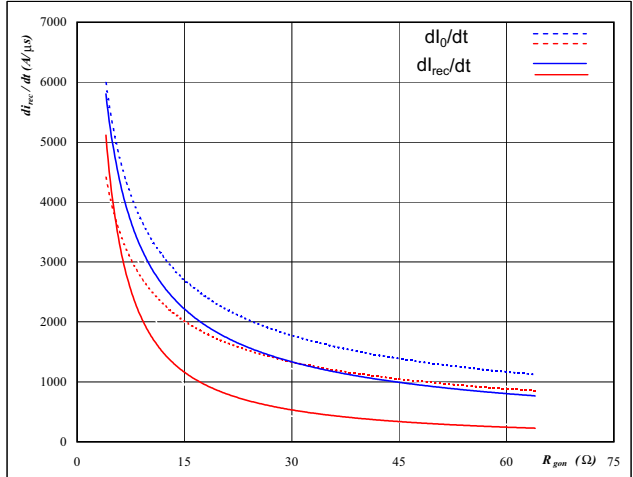


$T_j = 25/150$ °C
 $V_{CE} = 300$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

Figure 18 Output inverter FRED

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

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

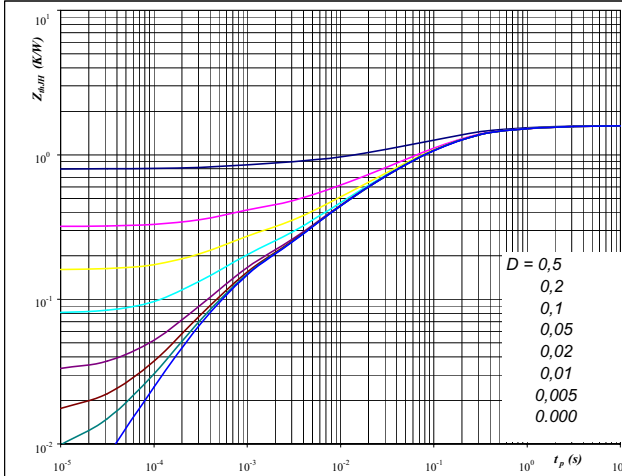


$T_j = 25/150$ °C
 $V_R = 300$ V
 $I_F = 30$ A
 $V_{GE} = \pm 15$ V

Figure 19 Output inverter IGBT

IGBT transient thermal impedance
as a function of pulse width

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



$D = t_p / T$
 $R_{thJH} = 1,60$ K/W

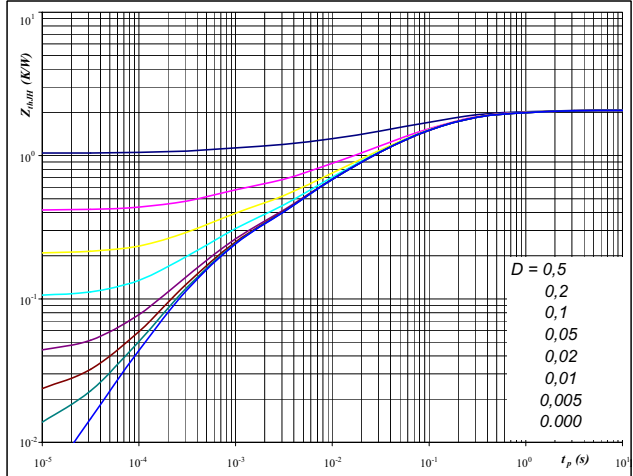
IGBT thermal model values

R (C/W)	Tau (s)
0,03	9,7E+00
0,16	9,7E-01
0,67	1,5E-01
0,40	3,3E-02
0,23	6,7E-03
0,12	5,5E-04

Figure 20 Output inverter FRED

FRED transient thermal impedance
as a function of pulse width

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



$D = t_p / T$
 $R_{thJH} = 2,08$ K/W

FRED thermal model values

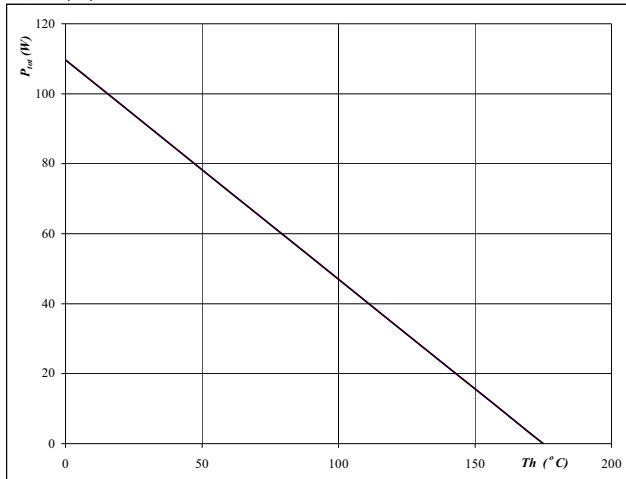
R (C/W)	Tau (s)
0,03	9,7E+00
0,19	8,1E-01
0,81	1,3E-01
0,57	2,7E-02
0,30	5,1E-03
0,18	4,7E-04

Output Inverter

Figure 21 Output inverter IGBT

Power dissipation as a function of heatsink temperature

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

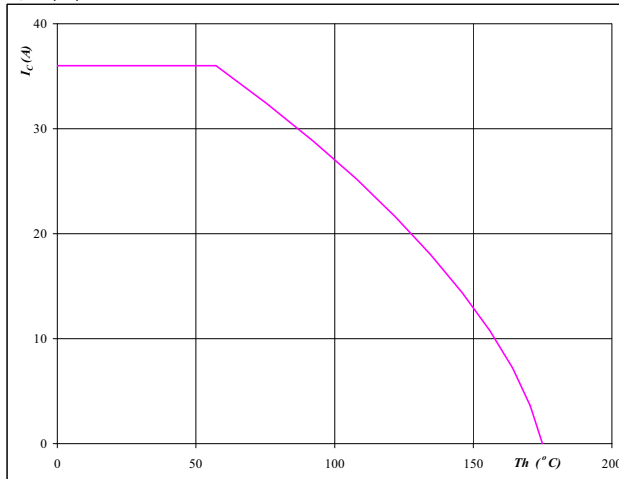


$T_J = 175$ °C

Figure 22 Output inverter IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

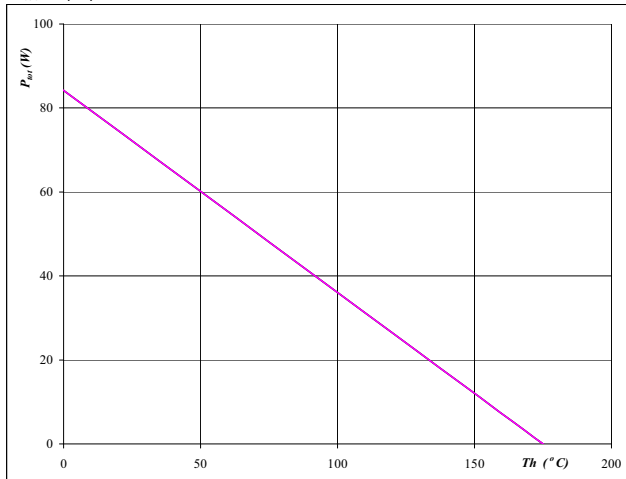


$T_J = 175$ °C
 $V_{GE} = 15$ V

Figure 23 Output inverter FRED

Power dissipation as a function of heatsink temperature

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

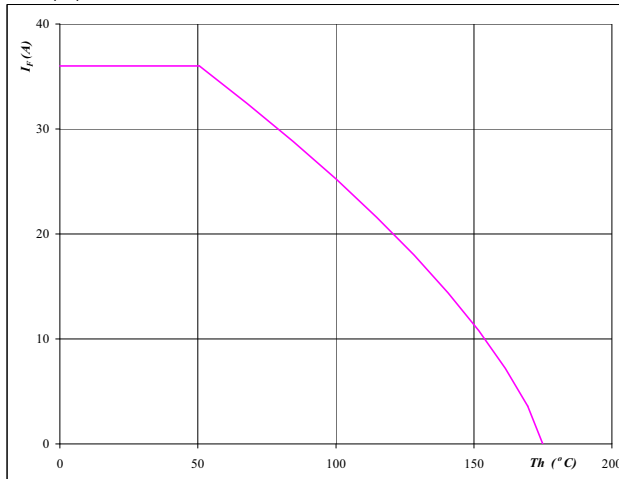


$T_J = 175$ °C

Figure 24 Output inverter FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



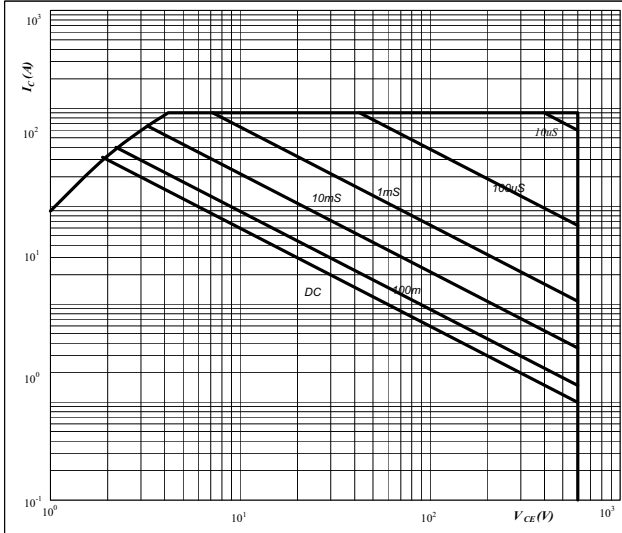
$T_J = 175$ °C

Output Inverter

Figure 25 Output inverter IGBT

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

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

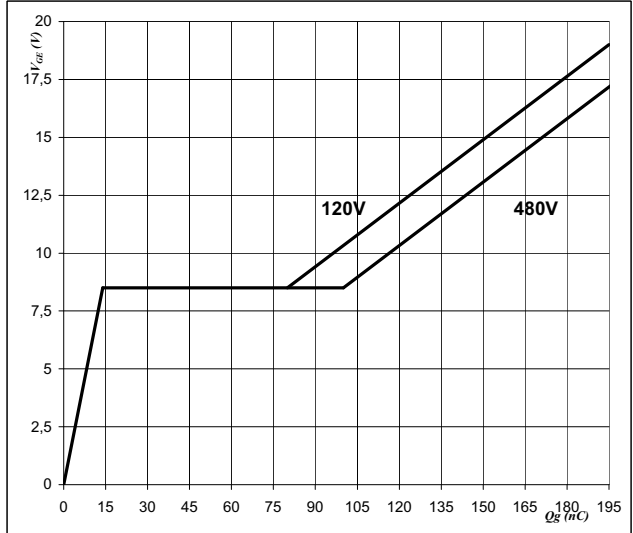


D = single pulse
T_h = 80 °C
V_{GE} = ±15 V
T_J = T_{Jmax} °C

Figure 26 Output inverter IGBT

Gate voltage vs Gate charge

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



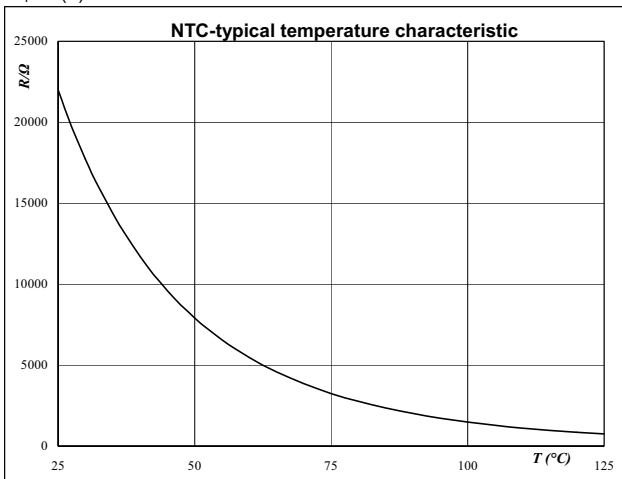
I_C = 30 A

Thermistor

Figure 1 Thermistor

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

$$R_T = f(T)$$



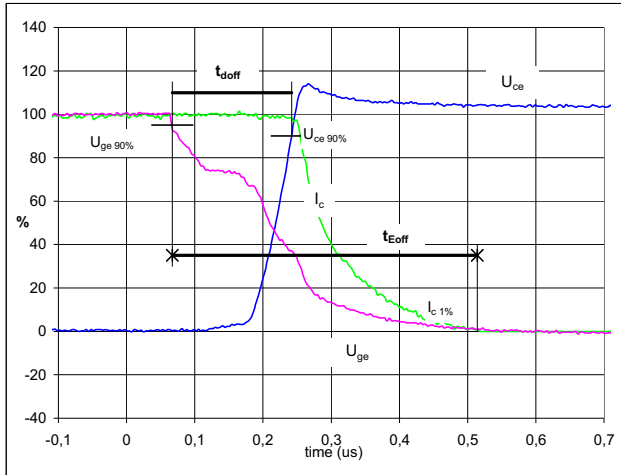
Switching Definitions Output Inverter

General conditions

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

Figure 1 Output inverter IGBT

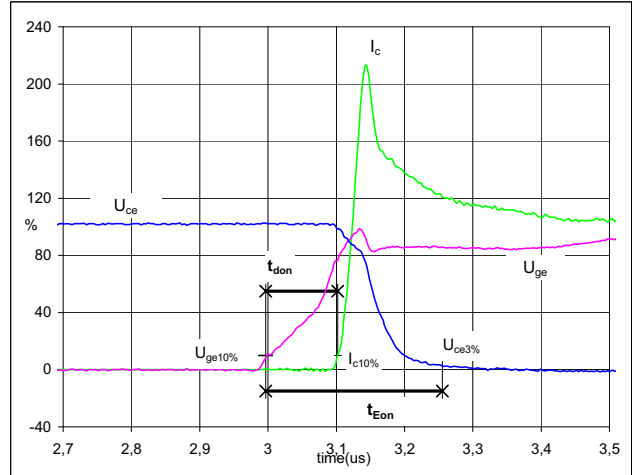
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	30	A
t_{doff}	=	0,17	μs
t_{Eoff}	=	0,45	μs

Figure 2 Output inverter IGBT

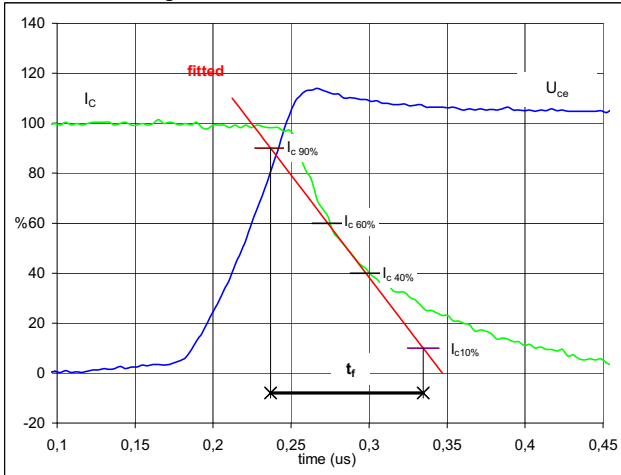
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
(t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$	=	-15	V
$V_{GE}(100\%)$	=	15	V
$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	30	A
t_{don}	=	0,10	μs
t_{Eon}	=	0,26	μs

Figure 3 Output inverter IGBT

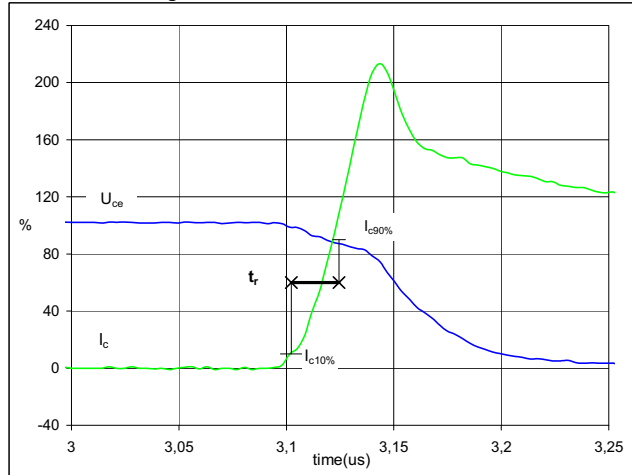
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	30	A
t_f	=	0,11	μs

Figure 4 Output inverter IGBT

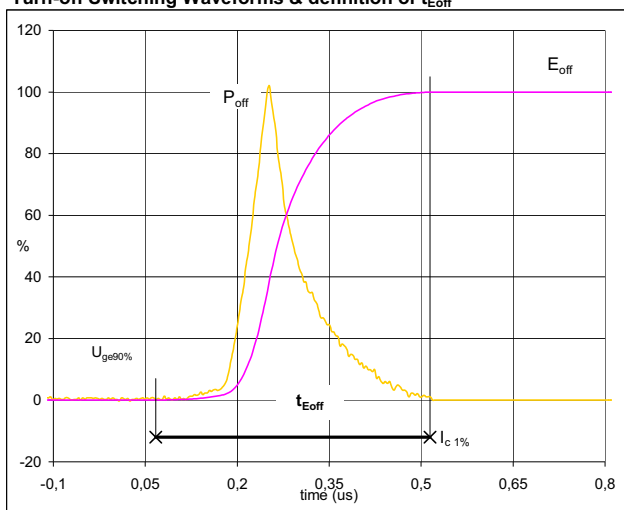
Turn-on Switching Waveforms & definition of t_r



$V_C(100\%)$	=	300	V
$I_C(100\%)$	=	30	A
t_r	=	0,02	μs

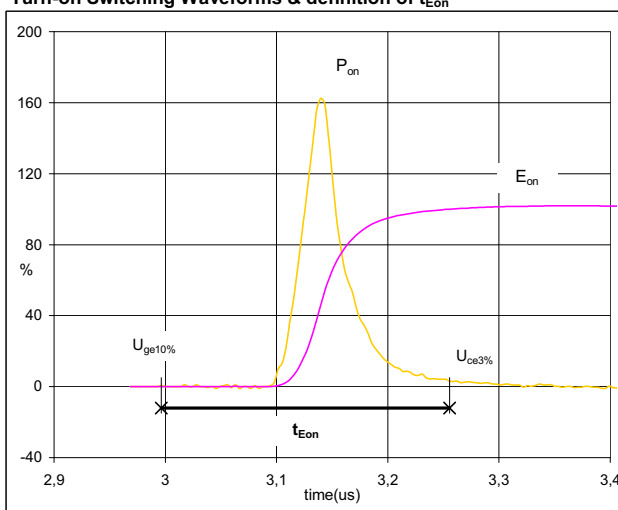
Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

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


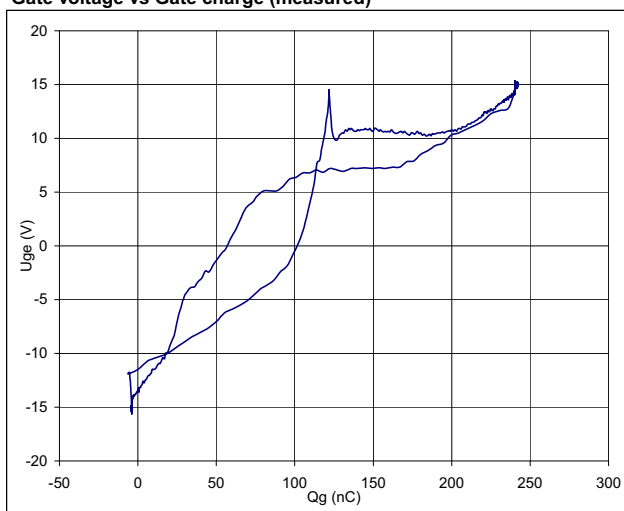
$P_{off} (100\%) = 9,01 \text{ kW}$
 $E_{off} (100\%) = 0,91 \text{ mJ}$
 $t_{Eoff} = 0,45 \text{ }\mu\text{s}$

Figure 6 Output inverter IGBT

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


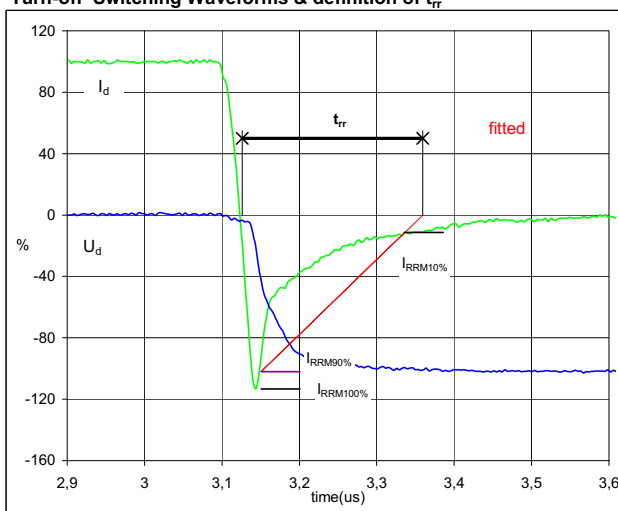
$P_{on} (100\%) = 9,01 \text{ kW}$
 $E_{on} (100\%) = 0,67 \text{ mJ}$
 $t_{Eon} = 0,26 \text{ }\mu\text{s}$

Figure 7 Output inverter FRED

Gate voltage vs Gate charge (measured)


$V_{GEoff} = -15 \text{ V}$
 $V_{GEon} = 15 \text{ V}$
 $V_C (100\%) = 300 \text{ V}$
 $I_C (100\%) = 30 \text{ A}$
 $Q_g = 1737 \text{ nC}$

Figure 8 Output inverter IGBT

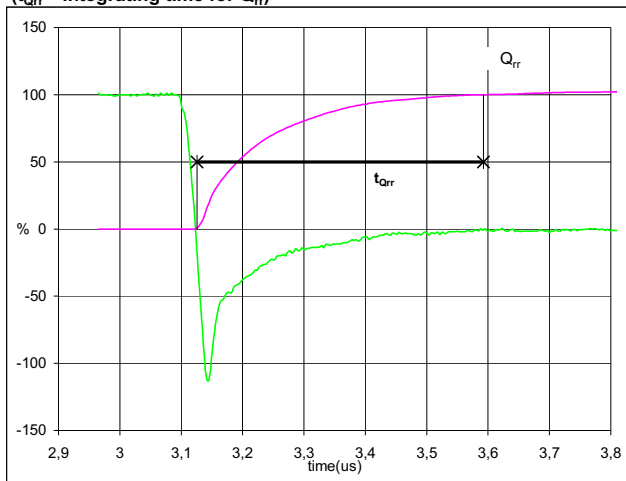
Turn-off Switching Waveforms & definition of t_{tr}


$V_d (100\%) = 300 \text{ V}$
 $I_d (100\%) = 30 \text{ A}$
 $I_{RRM} (100\%) = -34 \text{ A}$
 $t_{tr} = 0,25 \text{ }\mu\text{s}$

Switching Definitions Output Inverter

Figure 9 Output inverter FRED

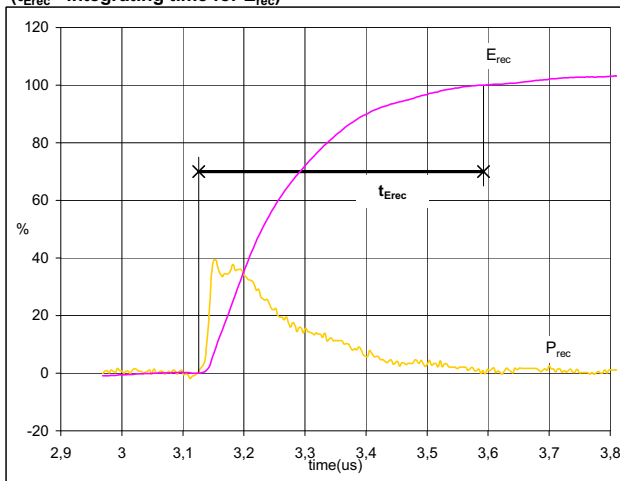
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 30 A
 Q_{rr} (100%) = 2,65 μ C
 t_{Qrr} = 0,47 μ s

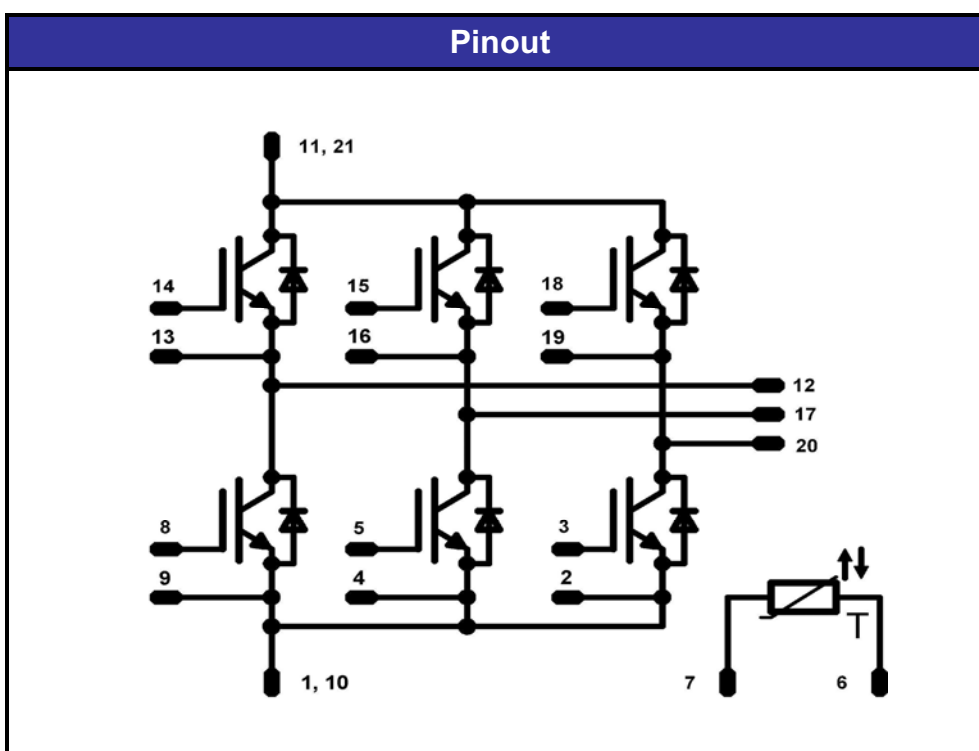
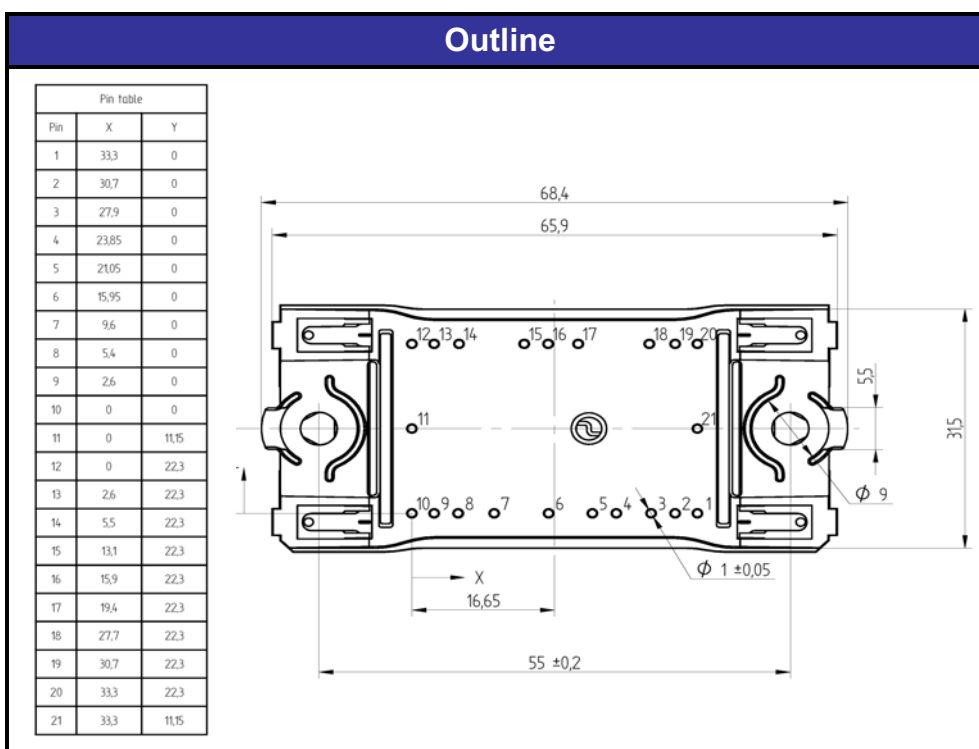
Figure 10 Output inverter FRED

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



P_{rec} (100%) = 9,01 kW
 E_{rec} (100%) = 0,57 mJ
 t_{Erec} = 0,47 μ s

Package Outline and Pinout



PRODUCT STATUS DEFINITIONS

Datasheet Status	Product Status	Definition
Target	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff.
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