



<i>flow</i> PACK 2	1200V/100A
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; margin: 0;"><b>Features</b></p> <ul style="list-style-type: none"> <li>High power flow2 housing</li> <li>Trench Fieldstop Technology IGBT4</li> <li>Compact and low inductive design</li> </ul> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; margin: 0;"><b>Target Applications</b></p> <ul style="list-style-type: none"> <li>Motor Drive</li> <li>Power Generation</li> <li>UPS</li> </ul> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; margin: 0;"><b>Types</b></p> <ul style="list-style-type: none"> <li>V23990-P689-F</li> </ul> </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; margin: 0;"><i>flow</i> 2 17mm housing</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; margin: 0;"><b>Schematic</b></p> </div>

## Maximum Ratings

$T_j = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter break down voltage	$V_{CE}$		1200	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	100	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	300	A
Power dissipation per IGBT	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	270	W
Gate-emitter peak voltage	$V_{GE}$		±20	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	10 900	μs V
Maximum Junction Temperature	$T_{jmax}$		175	°C
<b>Inverter Diode</b>				
Peak Repetitive Reverse Voltage	$V_{RRM}$		1200	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	85	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	200	A
Power dissipation per Diode	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	160	W
Maximum Junction Temperature	$T_{jmax}$		175	°C



## Maximum Ratings

$T_i = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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### Modul Properties

#### Thermal Properties

Storage temperature	$T_{stg}$		-40...+125	°C
Operation temperature under switching condition	$T_{op}$		-40...+( $T_{jmax} - 25$ )	°C

#### Insulation Properties

Insulation voltage	$V_{is}$	DC Test Voltage* $t_p = 2\text{ s}$	4000	V
		AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm
Competative tracking index	CTI		>200	

\* 100 % tested in production



### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit	
		$V_{GE}$ [V]	$V_{GS}$ [V]	$V_r$ [V]	$V_{CE}$ [V]	$V_{DS}$ [V]	$I_C$ [A]	$I_F$ [A]	$I_D$ [A]		$T_j$ [°C]

#### Inverter Switch

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$				0,0034	25		5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CESat}$		15			100	25 150		1,5	1,94 2,35	2,5	V
Collector-emitter cut-off current incl. Diode	$I_{CES}$		0	1200			25				0,025	mA
Gate-emitter leakage current	$I_{GES}$		20	0			25				700	nA
Integrated Gate resistor	$R_{gint}$									2		Ω
Turn-on delay time	$t_{d(on)}$						25 150			104 108		ns
Rise time	$t_r$						25 150			18 23		
Turn-off delay time	$t_{d(off)}$	$R_{gon} = 8 \Omega$	$\pm 15$	600	100		25 150			219 293		
Fall time	$t_f$	$R_{goff} = 8 \Omega$					25 150			72 111		
Turn-on energy loss per pulse	$E_{on}$						25 150			4,04 6,73		mWs
Turn-off energy loss per pulse	$E_{off}$						25 150			5,25 8,77		
Input capacitance	$C_{ies}$									5540		pF
Output capacitance	$C_{oss}$	$f = 1 \text{ MHz}$	0	25			25			410		
Reverse transfer capacitance	$C_{rss}$									320		
Gate charge	$Q_G$	$V_{cc}=960$	$\pm 15$			100	25			480		nC
Thermal resistance chip to heatsink per chip	$R_{th(j-s)}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1 \text{ W/mK}$								0,35		K/W

#### Inverter Diode

Diode forward voltage	$V_F$					100	25 150		1	1,99 2,01	2,5	V
Peak reverse recovery current	$I_{RRM}$						25 150			164 187		A
Reverse recovery time	$t_{rr}$						25 150			130 294		ns
Reverse recovered charge	$Q_{rr}$	$R_{gon} = 8 \Omega$	$\pm 15$	600	100		25 150			9,32 18,66		μC
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						25 150			8743 3702		A/μs
Reverse recovered energy	$E_{rec}$						25 150			3,87 7,96		mWs
Thermal resistance chip to heatsink per chip	$R_{th(j-s)}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1 \text{ W/mK}$								0,60		K/W

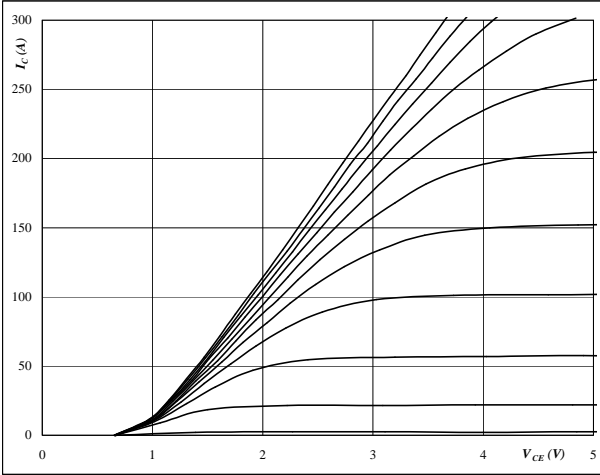


# Inverter

**Figure 1** Inverter IGBT

Typical output characteristics

$I_C = f(V_{CE})$



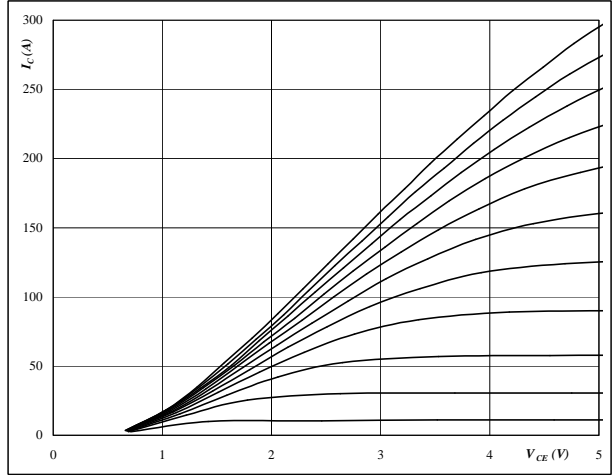
At

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

**Figure 2** Inverter IGBT

Typical output characteristics

$I_C = f(V_{CE})$



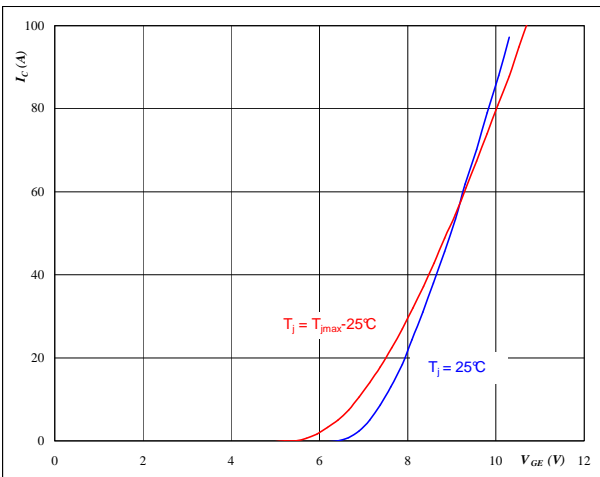
At

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

**Figure 3** Inverter IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



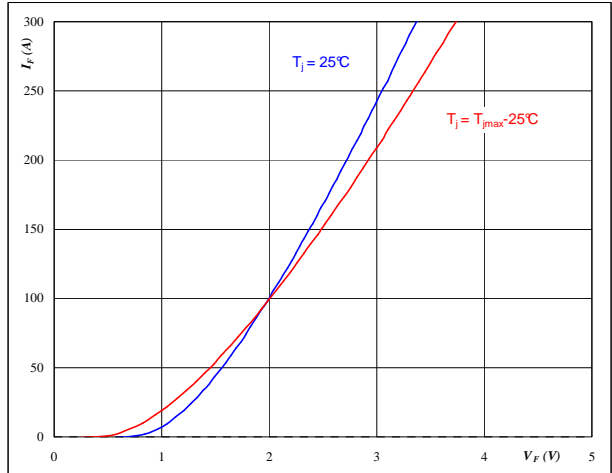
At

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

**Figure 4** Inverter FRED

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

$t_p = 250 \mu s$

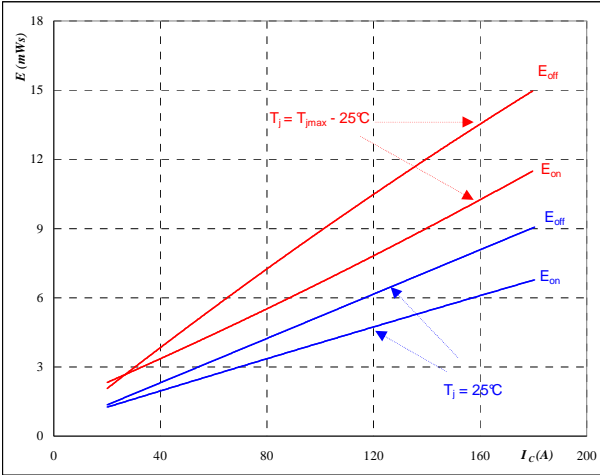


# Inverter

**Figure 5** Inverter IGBT

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

$E = f(I_C)$



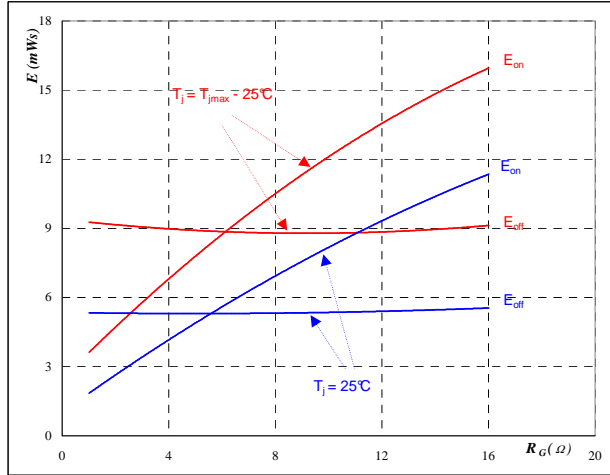
With an inductive load at

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4 \text{ } \Omega$
- $R_{goff} = 4 \text{ } \Omega$

**Figure 6** Inverter IGBT

**Typical switching energy losses as a function of gate resistor**

$E = f(R_G)$



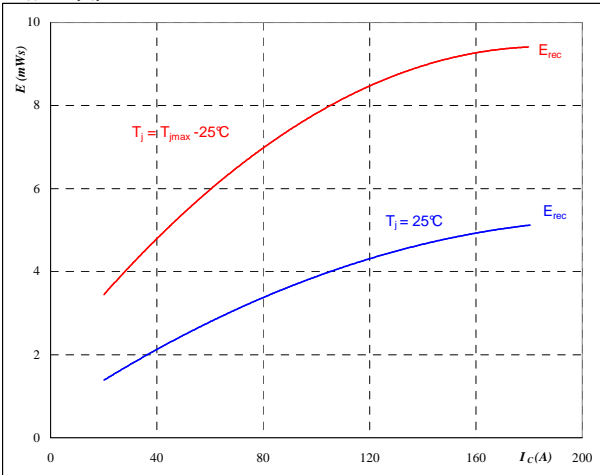
With an inductive load at

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $I_C = 100 \text{ A}$

**Figure 7** Inverter IGBT

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

$E_{rec} = f(I_C)$



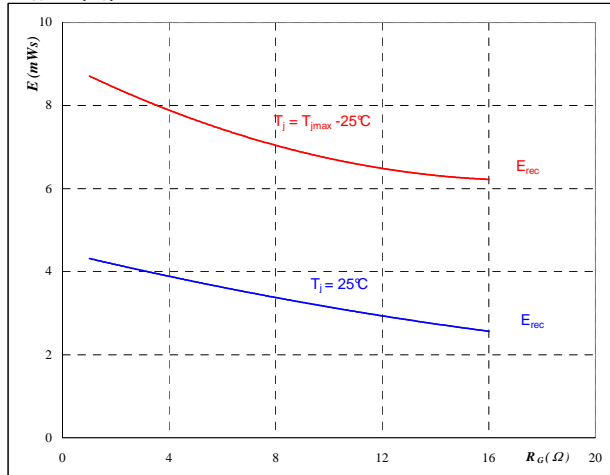
With an inductive load at

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4 \text{ } \Omega$

**Figure 8** Inverter IGBT

**Typical reverse recovery energy loss as a function of gate resistor**

$E_{rec} = f(R_G)$



With an inductive load at

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $I_C = 100 \text{ A}$

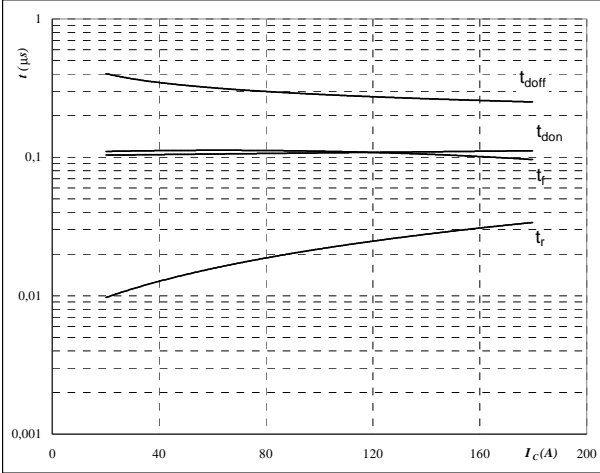


# Inverter

**Figure 9** Inverter IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



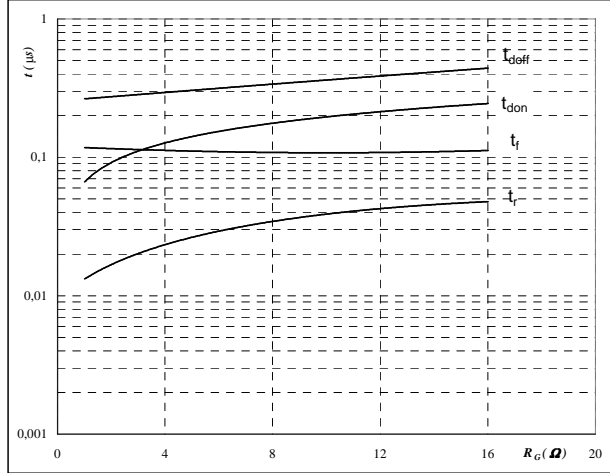
With an inductive load at

- $T_j = 150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4 \text{ } \Omega$
- $R_{goff} = 4 \text{ } \Omega$

**Figure 10** Inverter IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



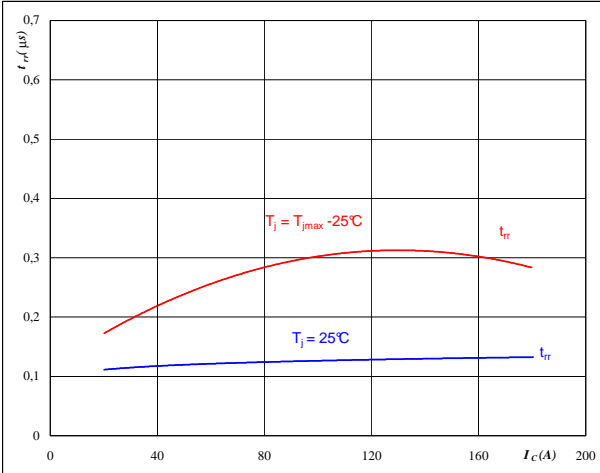
With an inductive load at

- $T_j = 150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $I_C = 100 \text{ A}$

**Figure 11** Inverter FRED

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



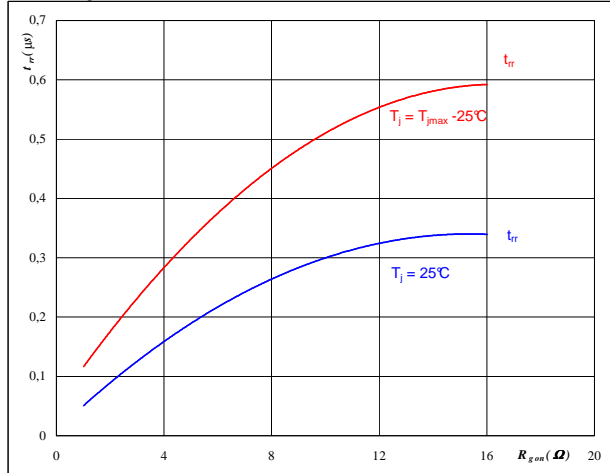
At

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_{CE} = 600 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4 \text{ } \Omega$

**Figure 12** Inverter FRED

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

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



At

- $T_j = 25/150 \text{ } ^\circ\text{C}$
- $V_R = 600 \text{ V}$
- $I_F = 100 \text{ A}$
- $V_{GE} = \pm 15 \text{ V}$

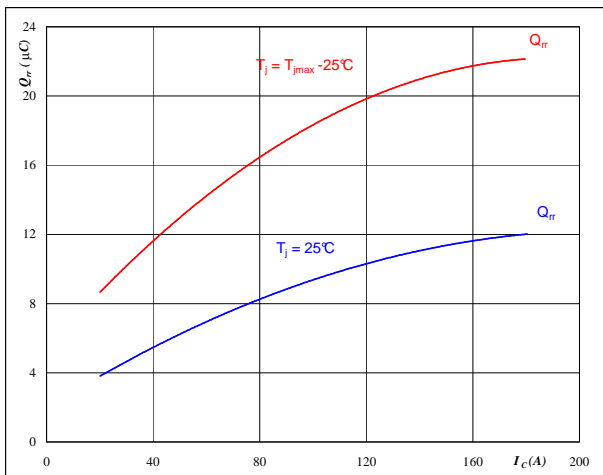


# Inverter

**Figure 13** Inverter FRED

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



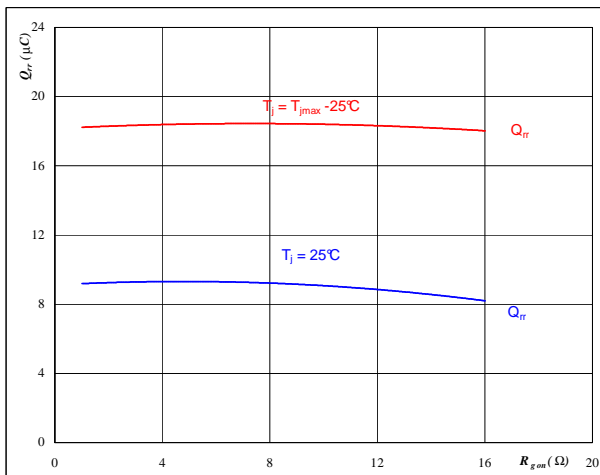
**At**

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	4	Ω

**Figure 14** Inverter FRED

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

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



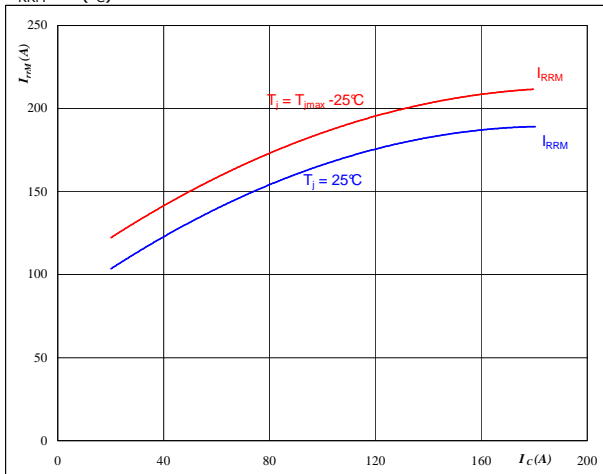
**At**

$T_j =$	25/150	°C
$V_R =$	600	V
$I_F =$	100	A
$V_{GE} =$	±15	V

**Figure 15** Inverter FRED

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



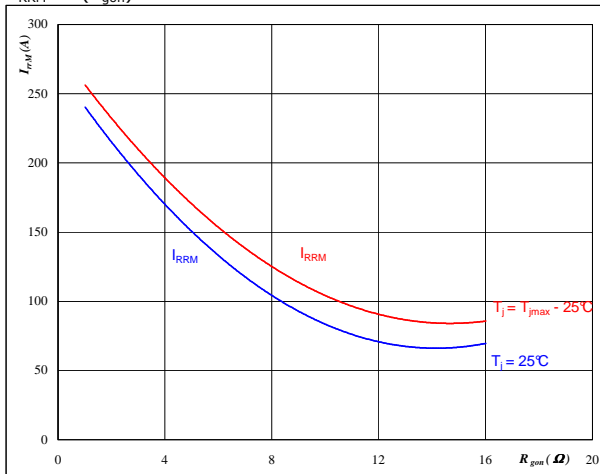
**At**

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	4	Ω

**Figure 16** 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
$I_F =$	100	A
$V_{GE} =$	±15	V

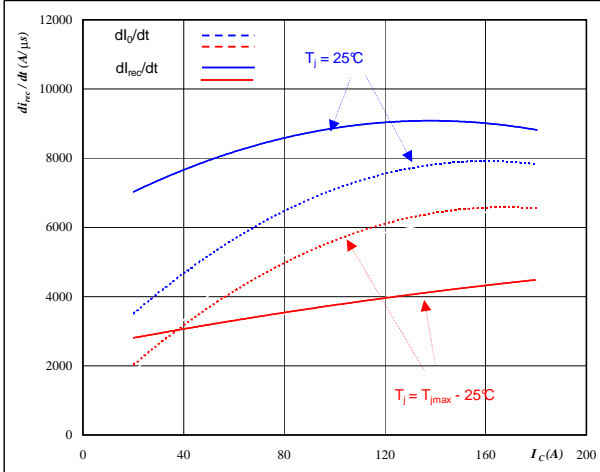


# Inverter

**Figure 17** Inverter FRED

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

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

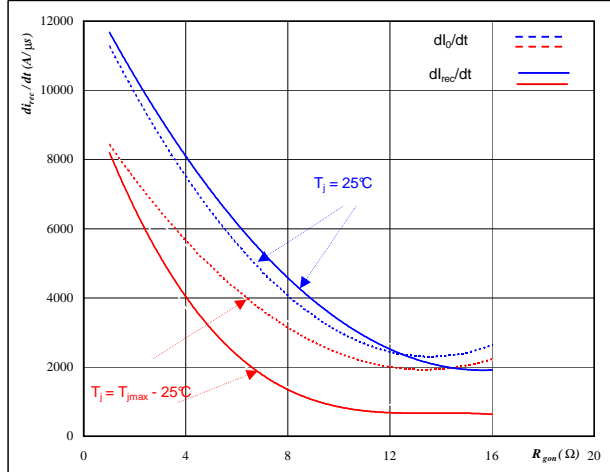


**At**  
 $T_j = 25/150 \text{ } ^\circ\text{C}$   
 $V_{CE} = 600 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$

**Figure 18** Inverter FRED

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

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

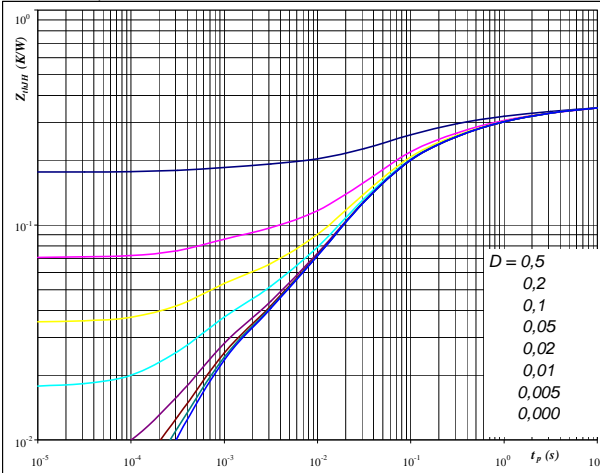


**At**  
 $T_j = 25/150 \text{ } ^\circ\text{C}$   
 $V_R = 600 \text{ V}$   
 $I_F = 100 \text{ A}$   
 $V_{GE} = \pm 15 \text{ V}$

**Figure 19** Inverter IGBT

**IGBT transient thermal impedance as a function of pulse width**

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



**At**  
 $D = t_p / T$   
 $R_{thJH} = 0,35 \text{ K/W}$

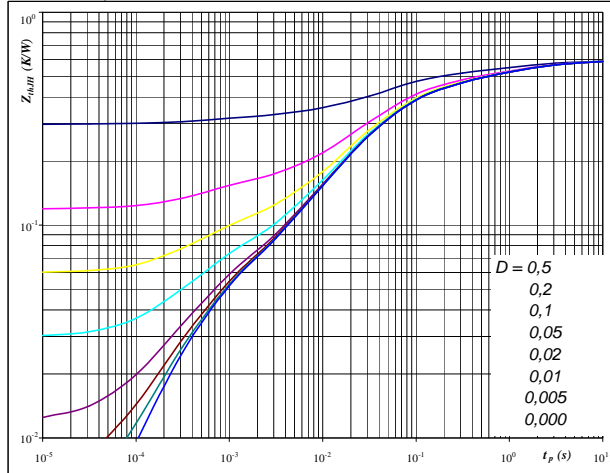
IGBT thermal model values

R (C/W)	Tau (s)
0,06	3,1E+00
0,09	4,1E-01
0,14	6,1E-02
0,05	1,2E-02
0,02	7,0E-04

**Figure 20** Inverter FRED

**FRED transient thermal impedance as a function of pulse width**

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



**At**  
 $D = t_p / T$   
 $R_{thJH} = 0,60 \text{ K/W}$

FRED thermal model values

R (C/W)	Tau (s)
0,03	9,1E+00
0,10	1,3E+00
0,14	1,7E-01
0,25	3,1E-02
0,04	4,4E-03
0,04	4,5E-04



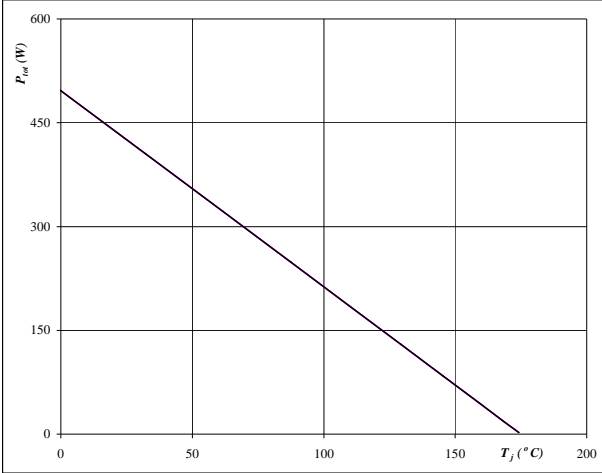


# Inverter

**Figure 21** Inverter IGBT

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_j)$

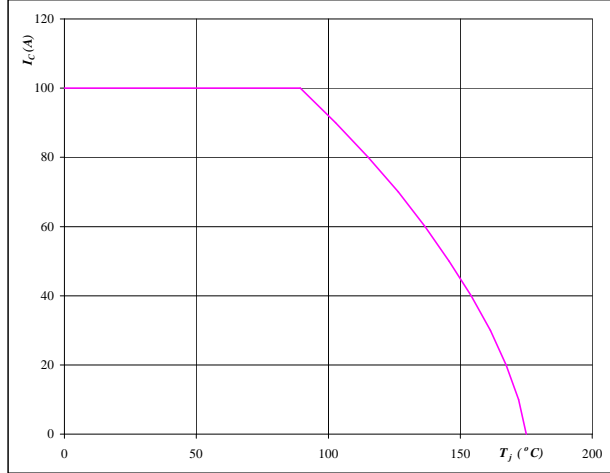


**At**  
T<sub>j</sub> = 175 °C

**Figure 22** Inverter IGBT

**Collector current as a function of heatsink temperature**

$I_C = f(T_j)$

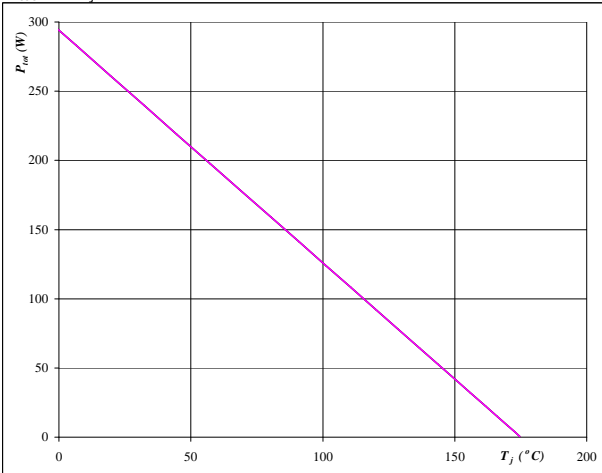


**At**  
T<sub>j</sub> = 175 °C  
V<sub>GE</sub> = 15 V

**Figure 23** Inverter FRED

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_j)$

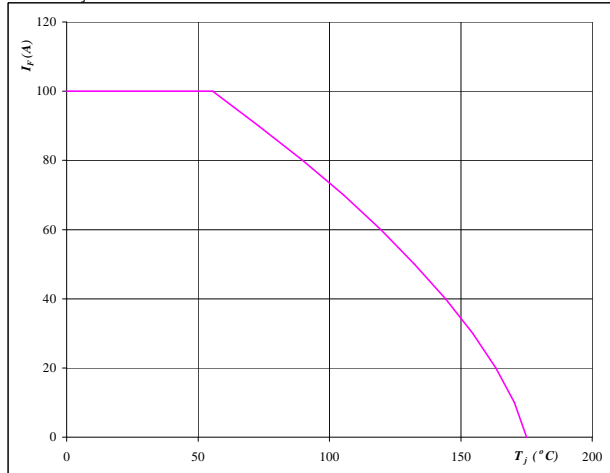


**At**  
T<sub>j</sub> = 175 °C

**Figure 24** Inverter FRED

**Forward current as a function of heatsink temperature**

$I_F = f(T_j)$



**At**  
T<sub>j</sub> = 175 °C

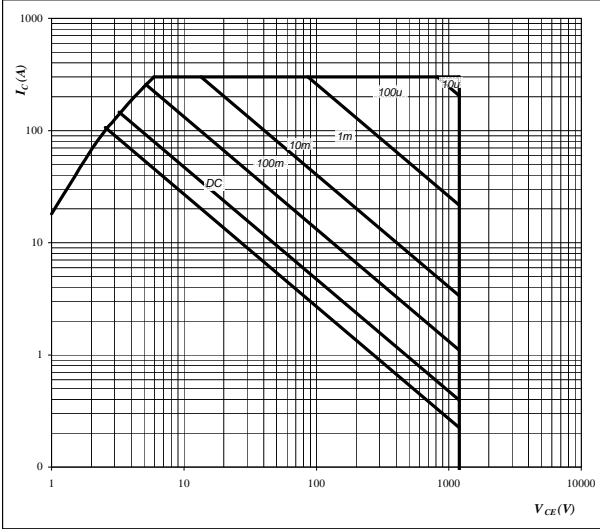


# Inverter

**Figure 25** Inverter IGBT

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

$I_C = f(V_{CE})$

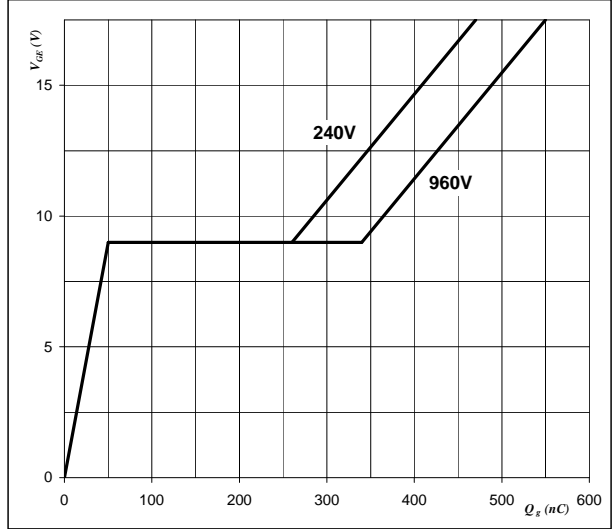


**At**  
 D = single pulse  
 Th = 80 °C  
 V<sub>GE</sub> = ±15 V  
 T<sub>j</sub> = T<sub>jmax</sub>

**Figure 26** Inverter IGBT

**Gate voltage vs Gate charge**

$V_{GE} = f(Q_g)$



**At**  
 I<sub>C</sub> = 100 A



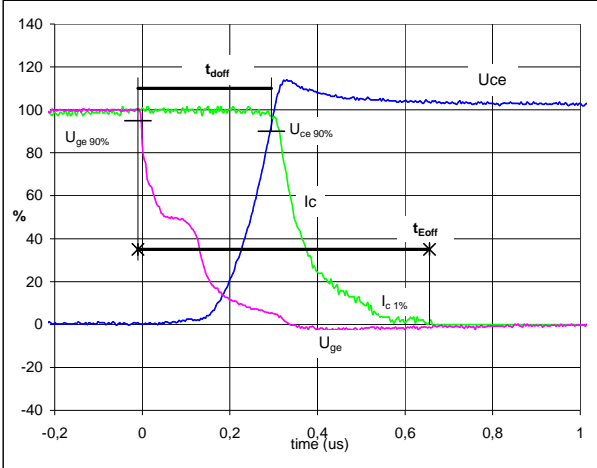
## Switching Definitions Inverter

### General conditions

$T_j$	=	150 °C
$R_{gon}$	=	4 $\Omega$
$R_{goff}$	=	4 $\Omega$

**Figure 1** Inverter IGBT

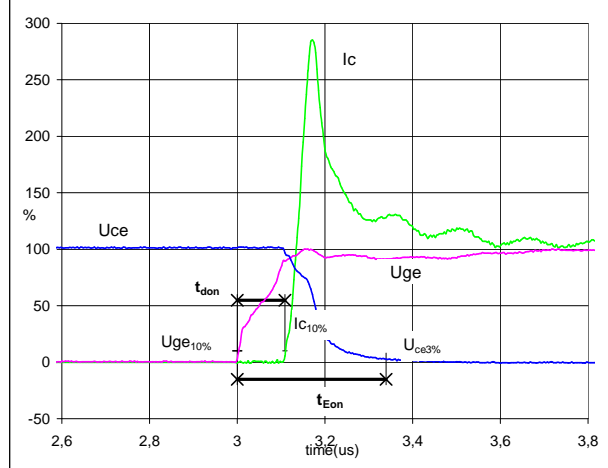
**Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$**   
( $t_{Eoff}$  = integrating time for  $E_{off}$ )



$V_{GE} (0\%)$	=	-15	V
$V_{GE} (100\%)$	=	15	V
$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	100	A
$t_{doff}$	=	0,29	$\mu s$
$t_{Eoff}$	=	0,67	$\mu s$

**Figure 2** Inverter IGBT

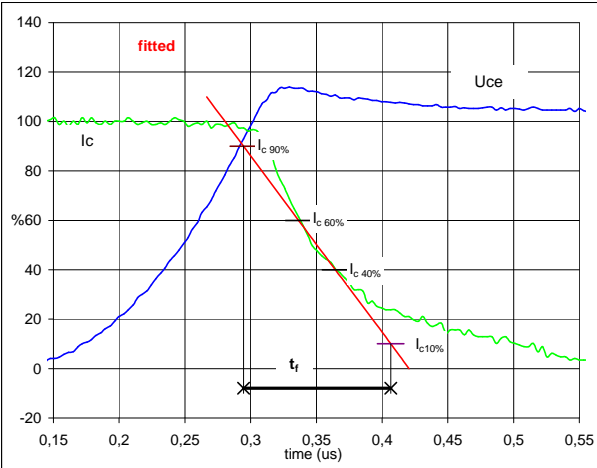
**Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$**   
( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{GE} (0\%)$	=	-15	V
$V_{GE} (100\%)$	=	15	V
$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	100	A
$t_{don}$	=	0,11	$\mu s$
$t_{Eon}$	=	0,34	$\mu s$

**Figure 3** Inverter IGBT

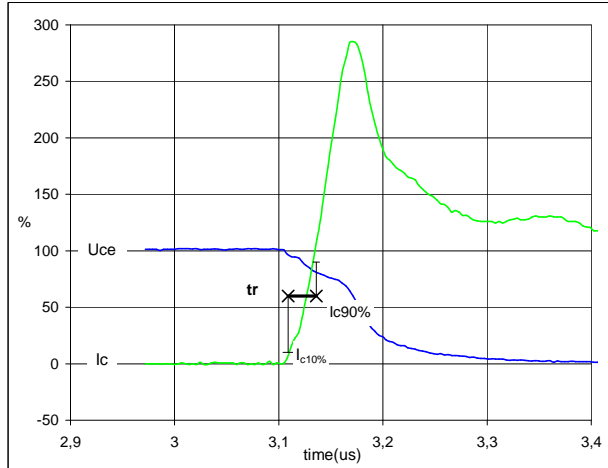
**Turn-off Switching Waveforms & definition of  $t_f$**



$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	100	A
$t_f$	=	0,11	$\mu s$

**Figure 4** Inverter IGBT

**Turn-on Switching Waveforms & definition of  $t_r$**

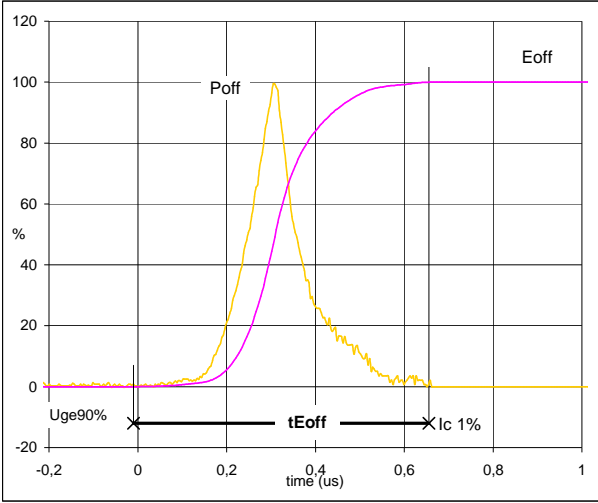


$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	100	A
$t_r$	=	0,02	$\mu s$



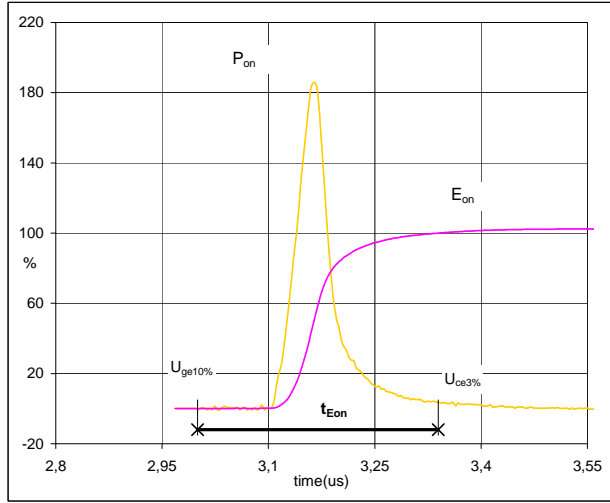
## Switching Definitions Inverter

**Figure 5** Inverter IGBT  
Turn-off Switching Waveforms & definition of  $t_{Eoff}$



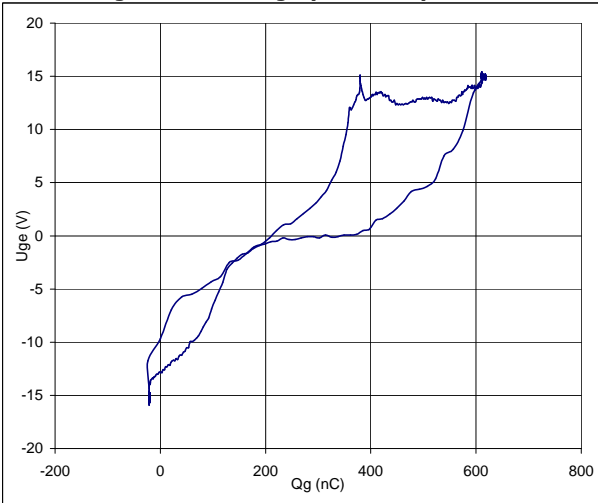
$P_{off} (100\%) = 60,25 \text{ kW}$   
 $E_{off} (100\%) = 8,77 \text{ mJ}$   
 $t_{Eoff} = 0,67 \text{ } \mu\text{s}$

**Figure 6** Inverter IGBT  
Turn-on Switching Waveforms & definition of  $t_{Eon}$



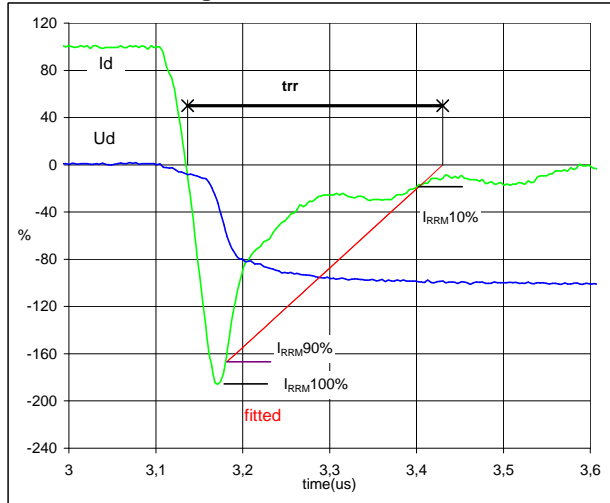
$P_{on} (100\%) = 60,25 \text{ kW}$   
 $E_{on} (100\%) = 6,73 \text{ mJ}$   
 $t_{Eon} = 0,34 \text{ } \mu\text{s}$

**Figure 7** Inverter FRED  
Gate voltage vs Gate charge (measured)



$V_{GEoff} = -15 \text{ V}$   
 $V_{GEon} = 15 \text{ V}$   
 $V_C (100\%) = 600 \text{ V}$   
 $I_C (100\%) = 100 \text{ A}$   
 $Q_g = 4658,95 \text{ nC}$

**Figure 8** Inverter IGBT  
Turn-off Switching Waveforms & definition of  $t_{rr}$



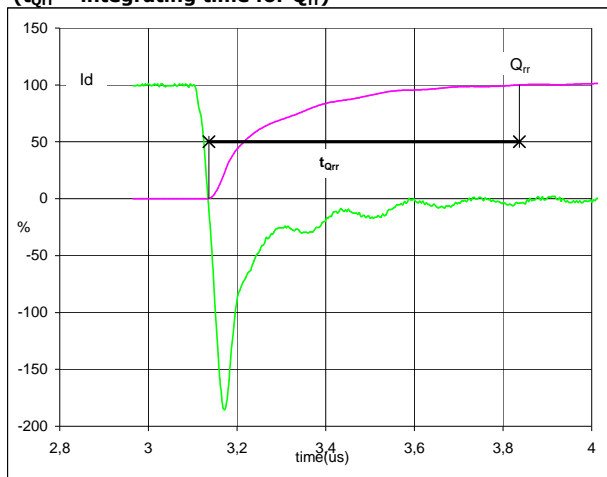
$V_d (100\%) = 600 \text{ V}$   
 $I_d (100\%) = 100 \text{ A}$   
 $I_{RRM} (100\%) = -187 \text{ A}$   
 $t_{rr} = 0,29 \text{ } \mu\text{s}$



### Switching Definitions Inverter

**Figure 9** Inverter FRED

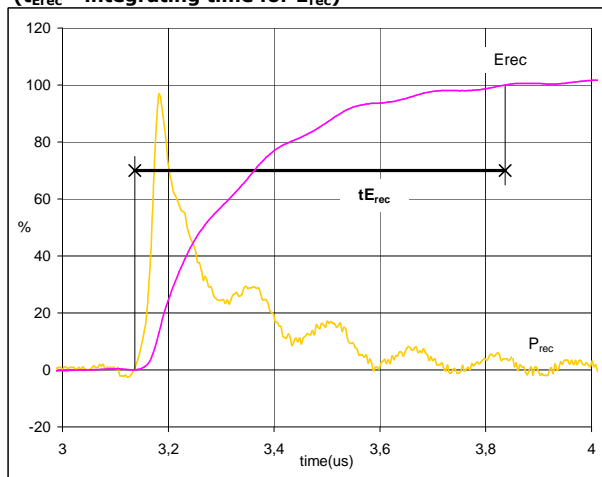
Turn-on Switching Waveforms & definition of  $t_{Qrr}$   
( $t_{Qrr}$  = integrating time for  $Q_{rr}$ )



$I_d$ (100%) =	100	A
$Q_{rr}$ (100%) =	18,66	$\mu\text{C}$
$t_{Qrr}$ =	0,70	$\mu\text{s}$

**Figure 10** Inverter FRED

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



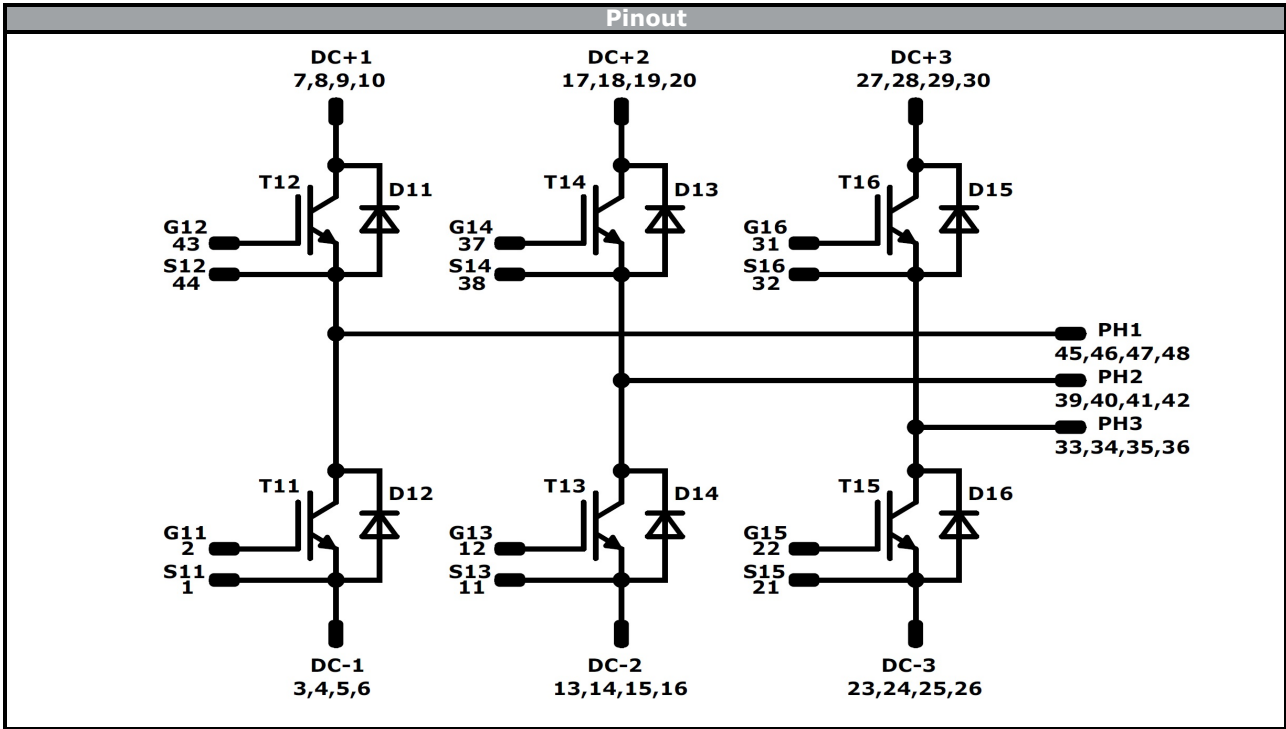
$P_{rec}$ (100%) =	60,25	kW
$E_{rec}$ (100%) =	7,96	mJ
$t_{Erec}$ =	0,70	$\mu\text{s}$



Ordering Code & Marking									
<b>Version</b>			<b>Ordering Code</b>						
without thermal paste 17mm housing			V23990-P689-F						
with thermal paste 17mm housing			V23990-P689-F-/3/						
			<b>Text</b>	<b>VIN</b>	<b>Date code</b>	<b>Name&amp;Ver</b>	<b>UL</b>	<b>Lot</b>	<b>Serial</b>
				VIN	WWYY	NNNNNNVV	UL	LLLLL	SSSS
			<b>Datamatrix</b>	<b>Type&amp;Ver</b>	<b>Lot number</b>	<b>Serial</b>	<b>Date code</b>		
				TTTTTTVV	LLLLL	SSSS	WWYY		

Outline							
Pin table [mm]				Pin table [mm]			
Pin	X	Y	Function	Pin	X	Y	Function
1	1,2	0	S11	25	57,2	0	DC-3
2	1,2	2,7	G11	26	57,2	2,7	DC-3
3	3,9	0	DC-1	27	65,8	0	DC+3
4	3,9	2,7	DC-1	28	65,8	2,7	DC+3
5	6,6	0	DC-1	29	68,5	0	DC+3
6	6,6	2,7	DC-1	30	68,5	2,7	DC+3
7	15,2	0	DC+1	31	64,1	36	G16
8	15,2	2,7	DC+1	32	61,4	36	S16
9	17,9	0	DC+1	33	58,7	36	Ph3
10	17,9	2,7	DC+1	34	56	36	Ph3
11	26,5	0	S13	35	53,3	36	Ph3
12	26,5	2,7	G13	36	50,6	36	Ph3
13	29,2	0	DC-2	37	38,8	36	G14
14	29,2	2,7	DC-2	38	36,1	36	S14
15	31,9	0	DC-2	39	33,4	36	Ph2
16	31,9	2,7	DC-2	40	30,7	36	Ph2
17	40,5	0	DC+2	41	28	36	Ph2
18	40,5	2,7	DC+2	42	25,3	36	Ph2
19	43,2	0	DC+2	43	13,5	36	G12
20	43,2	2,7	DC+2	44	10,8	36	S12
21	51,8	0	S15	45	8,1	36	Ph1
22	51,8	2,7	G15	46	5,4	36	Ph1
23	54,5	0	DC-3	47	2,7	36	Ph1
24	54,5	2,7	DC-3	48	0	36	Ph1

Tolerance of positions: ±0.05mm at the end of pins  
Direction of coordinate axis is only offset without tolerance



**Identification**

ID	Component	Voltage	Current	Function	Comment
T11 - T16	IGBT	1200	100	Inverter Switch	
D11 - D16	FWD	1200	100	Inverter Diode	

**Packaging instruction**

Standard packaging quantity (SPQ)	<b>36</b>	>SPQ	Standard	<SPQ	Sample
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**Handling instruction**

Handling instructions for *flow 2* packages see vincotech.com website.

**Package data**

Package data for *flow 2* packages see vincotech.com website.

**UL recognition and file number**

This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.



Document No.:	Date:	Modification:	Pages
V23990-P689-F-D2-14	27 Jun. 2017	Logo corrected, SPQ changed	All

**Product status definition****DISCLAIMER**

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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.