



<i>flow PIM 0</i>	600 V / 20 A
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #ccc; margin: 0;"><b>Features</b></p> <ul style="list-style-type: none"> <li>Vincotech clip-in housing</li> <li>Trench Fieldstop IGBT's for low saturation losses</li> <li>Optional w/o BRC</li> </ul> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #ccc; margin: 0;"><b>Target Applications</b></p> <ul style="list-style-type: none"> <li>Industrial Drives</li> <li>Embedded Generation</li> </ul> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #ccc; margin: 0;"><b>Types</b></p> <ul style="list-style-type: none"> <li>V23990-P545-A21-PM</li> <li>V23990-P545-C21-PM</li> </ul> </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #ccc; margin: 0;"><i>flow 0 17mm housing</i></p> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #ccc; margin: 0;"><b>Schematic</b></p> </div>

## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Rectifier Diode</b>				
Repetitive peak reverse voltage	$V_{RRM}$		1600	V
DC forward current	$I_{FAV}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	A
Surge (non-repetitive) forward current	$I_{FSM}$	$t_p = 10\text{ ms}$ $T_j = 25\text{ °C}$	250	A
$I^2t$ -value	$I^2t$		310	$A^2s$
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Maximum Junction Temperature	$T_{jmax}$		150	°C
<b>Inverter Switch</b>				
Collector-emitter break down voltage	$V_{CE}$		600	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	26	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	60	A
Turn off safe operating area		$V_{CE} \leq 600\text{ V}$ , $T_j \leq T_{op\ max}$	60	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	57	W
Gate-emitter peak voltage	$V_{GE}$		±20	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	6 360	$\mu s$ V
Maximum Junction Temperature	$T_{jmax}$		175	°C
<b>Inverter Diode</b>				
Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	28	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	40	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	W
Maximum Junction Temperature	$T_{jmax}$		175	°C

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

Parameter	Symbol	Condition	Value	Unit
<b>Brake Switch</b>				
Collector-emitter break down voltage	$V_{CE}$		600	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	20	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	45	A
Turn off safe operating area		$V_{CE} \leq 600\text{ V}$ , $T_j \leq T_{op\ max}$	45	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	51	W
Gate-emitter peak voltage	$V_{GE}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	6 360	$\mu\text{s}$ V
Maximum Junction Temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

**Brake Diode**

Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	19	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	30	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	36	W
Maximum Junction Temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

**Thermal Properties**

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

**Isolation Properties**

Isolation voltage	$V_{is}$	$t = 2\text{ s}$ DC voltage	4000	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm
Comparative tracking index	CTI		>200	



### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
		$V_{GE}$ [V]	$V_r$ [V]	$I_C$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Rectifier Diode

Forward voltage	$V_F$				30	25 125	0,8	1,14 1,11	1,6	V
Threshold voltage (for power loss calc. only)	$V_{to}$				30	25 125		0,92 0,78		V
Slope resistance (for power loss calc. only)	$r_t$				30	25 125		8 11		mΩ
Reverse current	$I_r$			1500		25 150			0,05 1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	phase change material $\lambda = 3,4$ W/mK						1,25		K/W

#### Inverter Switch

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00029	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		20	25 150	1,1	1,55 1,75	1,9	V
Collector-emitter cut-off current incl. Diode	$I_{CES}$		0	600		25			0,0011	mA
Gate-emitter leakage current	$I_{GES}$		20	0		25			300	nA
Integrated Gate resistor	$R_{gint}$							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{goff} = 16 \Omega$	$\pm 15$	300	20	25		15		ns
Rise time	$t_r$					150		14		
Turn-off delay time	$t_{d(off)}$					25		16		
Fall time	$t_f$					150		198		
Turn-on energy loss	$E_{on}$					25		212		
Turn-off energy loss	$E_{off}$	150		100						
Input capacitance	$C_{ies}$	$f = 1$ MHz	0	25	25			1100		pF
Output capacitance	$C_{oss}$							71		
Reverse transfer capacitance	$C_{rss}$							32		
Gate charge	$Q_G$		15	480	20	25		120		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	phase change material $\lambda = 3,4$ W/mK						1,68		K/W

#### Inverter Diode

Diode forward voltage	$V_F$				20	25 150	1,25	1,81 1,76	1,95	V
Peak reverse recovery current	$I_{RRM}$	$R_{gon} = 16 \Omega$	$\pm 15$	300	20	25		19		A
Reverse recovery time	$t_{rr}$					150		21		
Reverse recovered charge	$Q_{rr}$					25		33		
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					150		192		
Reverse recovered energy	$E_{rec}$					25		0,45		
Thermal resistance junction to sink	$R_{th(j-s)}$	phase change material $\lambda = 3,4$ W/mK						2,16		K/W



### Characteristic Values

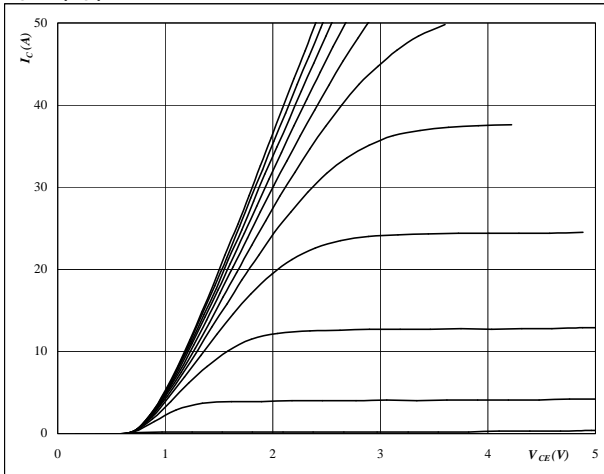
Parameter	Symbol	Conditions					Value			Unit
		$V_{GE}$ [V] $V_{GS}$ [V]	$V_r$ [V] $V_{CE}$ [V] $V_{DS}$ [V]	$I_C$ [A] $I_F$ [A] $I_D$ [A]	$T_j$ [°C]	Min	Typ	Max		
<b>Brake Switch</b>										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00021	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CESat}$		15		15	25 150	1,1	1,64 1,86	1,9	V
Collector-emitter cut-off incl diode	$I_{CES}$		0	600		25			0,0011	mA
Gate-emitter leakage current	$I_{GES}$		20	0		25			300	nA
Integrated Gate resistor	$R_{gint}$							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{gon} = 16 \Omega$	$\pm 15$	300	15	25		15		ns
Rise time	$t_r$					150		14		
Turn-off delay time	$t_{d(off)}$					25		11		
Fall time	$t_f$					150		14		
Turn-on energy loss	$E_{on}$					25		128		
Turn-off energy loss	$E_{off}$					150		145		
Input capacitance	$C_{ies}$					25		91		
Output capacitance	$C_{oss}$					150		94		
Reverse transfer capacitance	$C_{rss}$					25		0,20		
Gate charge	$Q_G$					150		0,28		
Thermal resistance junction to sink	$R_{th(j-s)}$	phase change material $\lambda = 3,4 \text{ W/mK}$				25		0,32		mWs
						150		0,40		mWs
								860		pF
		$f = 1 \text{ MHz}$	0	25		25		55		pF
								24		pF
			$\pm 15$	480	15	25		87		nC
								1,88		K/W
<b>Brake Diode</b>										
Diode forward voltage	$V_F$				15	25 150	1,25	1,86 1,75	1,95	V
Reverse leakage current	$I_r$	$R_{gon} = 16 \Omega$		600		25			27	μA
Peak reverse recovery current	$I_{RRM}$	$R_{gon} = 16 \Omega$	$\pm 15$	300	15	25		14		A
Reverse recovery time	$t_{rr}$					150		15		
Reverse recovered charge	$Q_{rr}$					25		128		
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					150		201		
Reverse recovery energy	$E_{rec}$					25		0,52		
Thermal resistance junction to sink	$R_{th(j-s)}$					150		1,02		
		phase change material $\lambda = 3,4 \text{ W/mK}$				25		1307		A/μs
						25		657		A/μs
						150		0,10		mWs
						150		0,21		mWs
								2,65		K/W
<b>Thermistor</b>										
Rated resistance	$R$					25		22000		Ω
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1486 \Omega$				100	-5		5	%
Power dissipation	$P$					25		210		mW
Power dissipation constant						25		3,5		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 3\%$				25				K
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				25		4000		K
Vincotech NTC Reference						25			A	

## Inverter Characteristics

**figure 1. IGBT**

**Typical output characteristics**

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



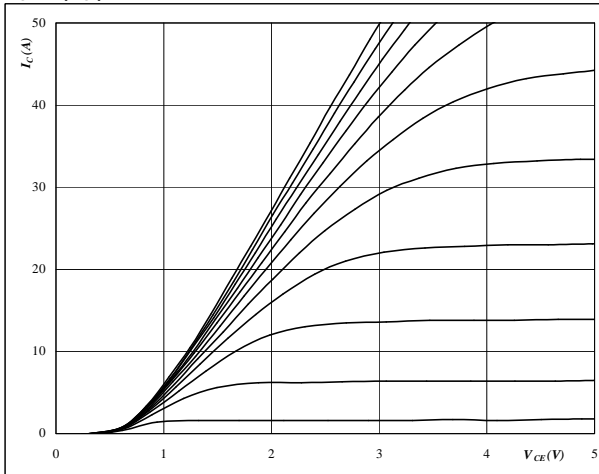
**At**

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

**figure 2. IGBT**

**Typical output characteristics**

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



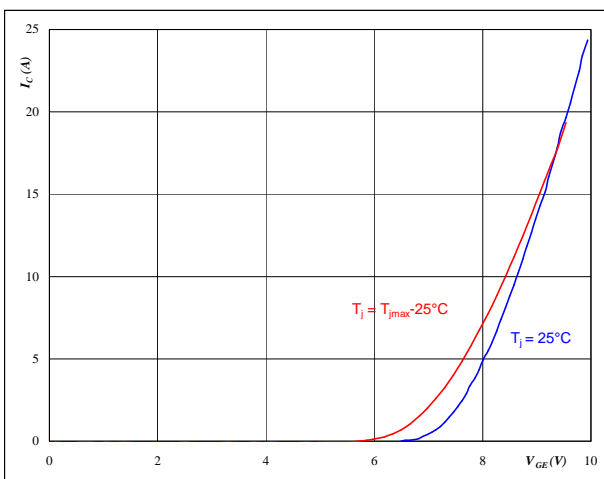
**At**

$t_p = 250 \mu\text{s}$   
 $T_j = 125 \text{ }^\circ\text{C}$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3. IGBT**

**Typical transfer characteristics**

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



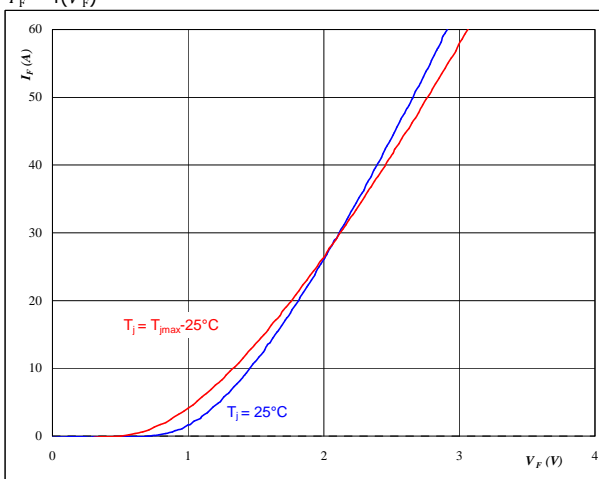
**At**

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

**figure 4. FWD**

**Typical diode forward current as a function of forward voltage**

$$I_F = f(V_F)$$



**At**

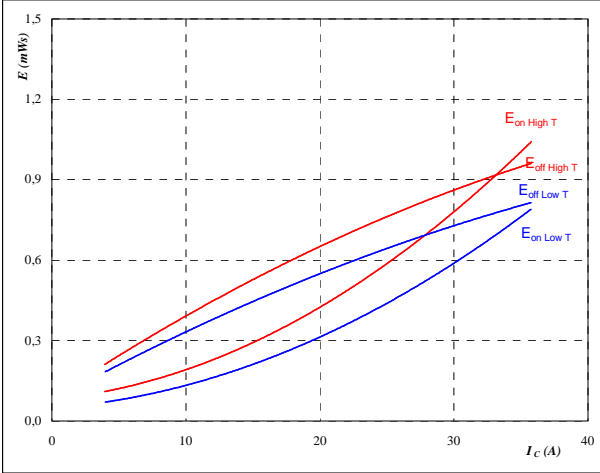
$t_p = 250 \mu\text{s}$

## Inverter Characteristics

**figure 5. IGBT**

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

$E = f(I_C)$



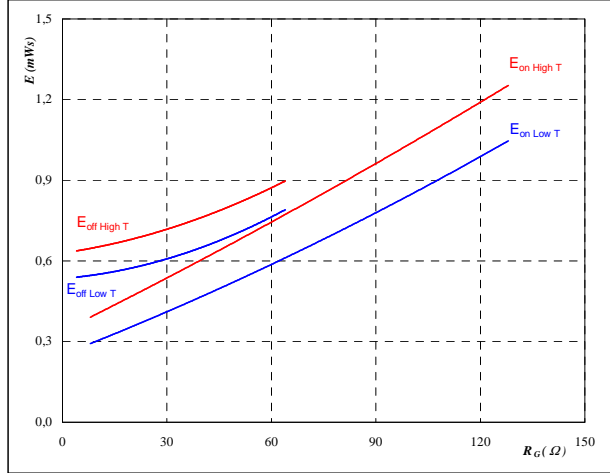
With an inductive load at

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	8	Ω

**figure 6. IGBT**

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

$E = f(R_G)$



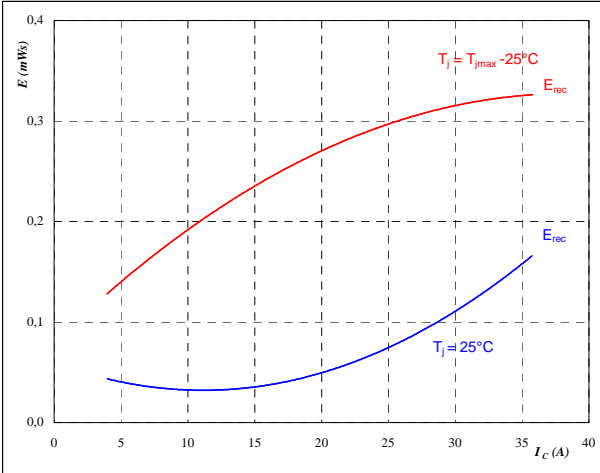
With an inductive load at

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	20	A

**figure 7. FWD**

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

$E_{rec} = f(I_C)$



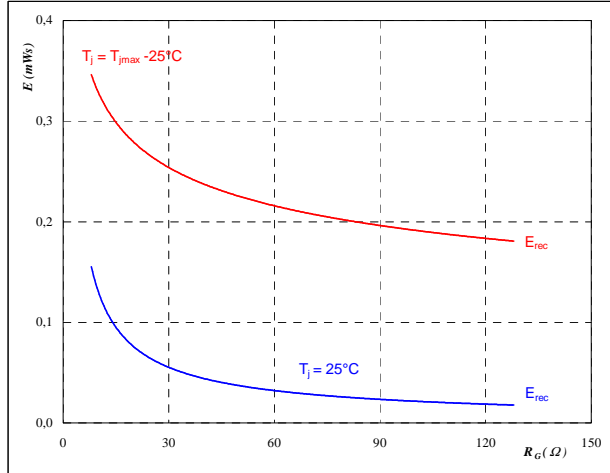
With an inductive load at

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	16	Ω

**figure 8. FWD**

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

$E_{rec} = f(R_G)$



With an inductive load at

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	20	A

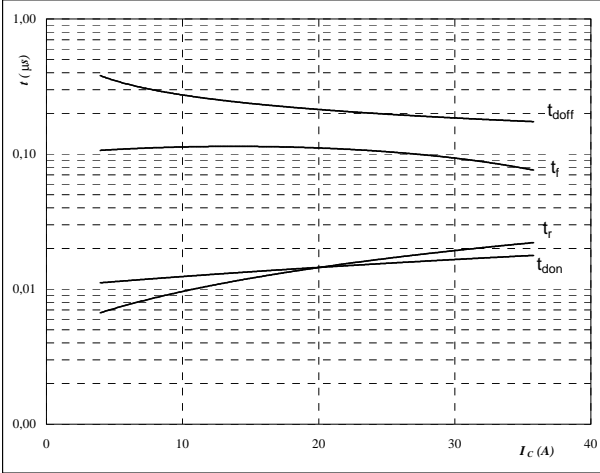


### Inverter Characteristics

**figure 9. IGBT**

Typical switching times as a function of collector current

$$t = f(I_C)$$



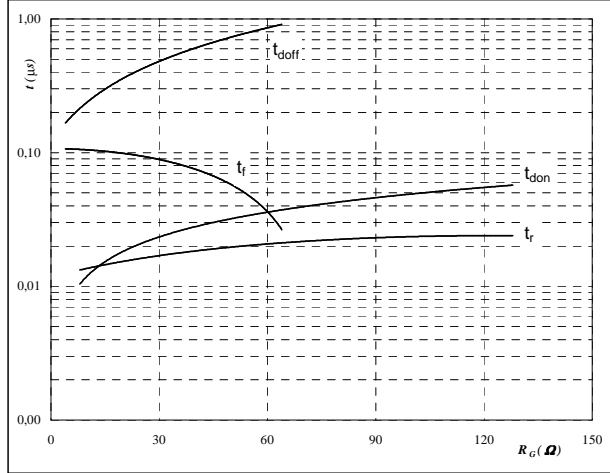
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	8	Ω

**figure 10. IGBT**

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



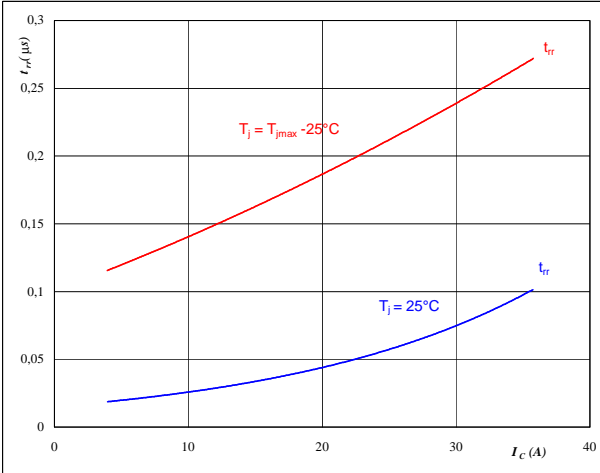
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	20	A

**figure 11. FWD**

Typical reverse recovery time as a function of collector current

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



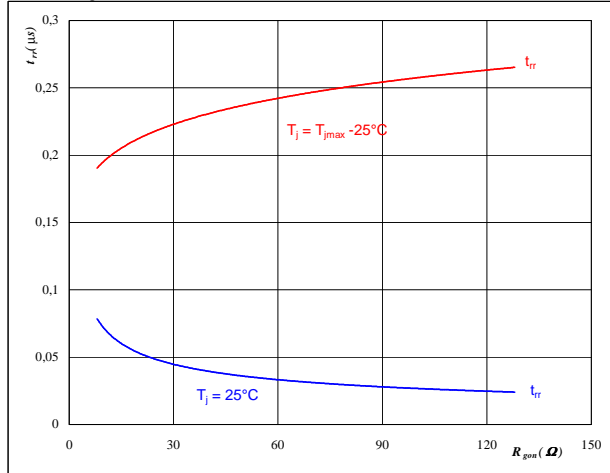
At

$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	16	Ω

**figure 12. FWD**

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

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



At

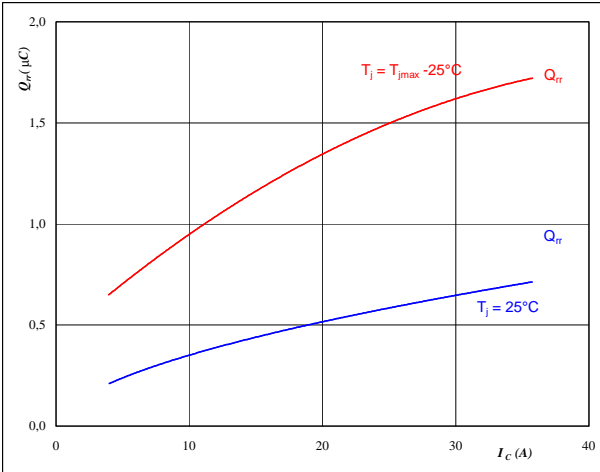
$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	20	A
$V_{GE} =$	15	V

## Inverter Characteristics

**figure 13.** FWD

Typical reverse recovery charge as a function of collector current

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

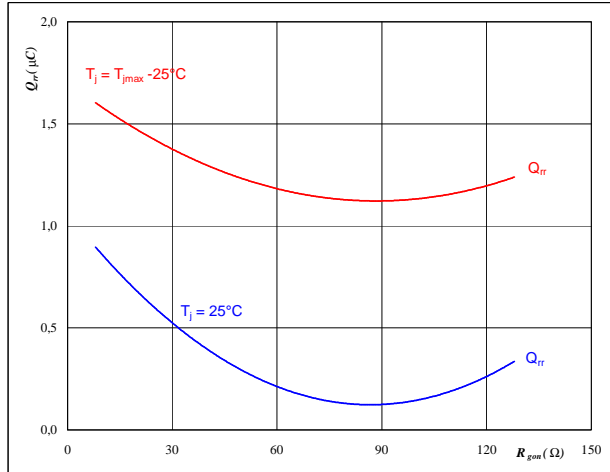


**At**  
 $T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω

**figure 14.** FWD

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

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

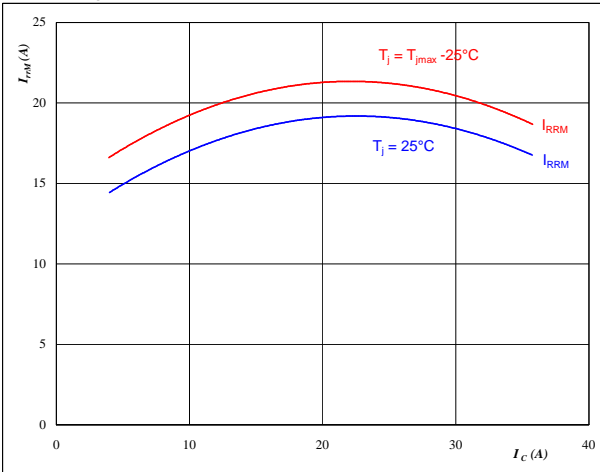


**At**  
 $T_j = 25/125$  °C  
 $V_R = 300$  V  
 $I_F = 20$  A  
 $V_{GE} = 15$  V

**figure 15.** FWD

Typical reverse recovery current as a function of collector current

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

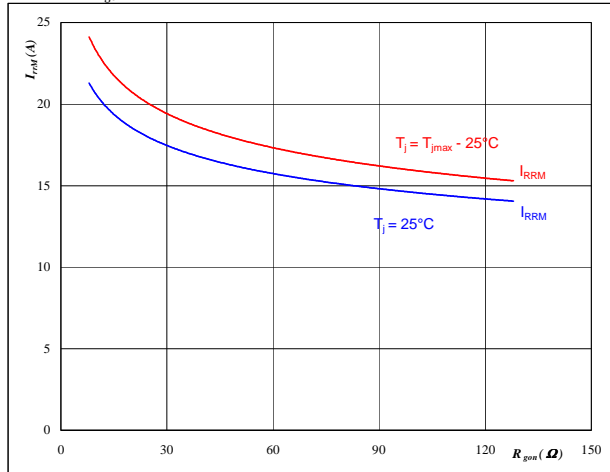


**At**  
 $T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω

**figure 16.** FWD

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

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



**At**  
 $T_j = 25/125$  °C  
 $V_R = 300$  V  
 $I_F = 20$  A  
 $V_{GE} = 15$  V



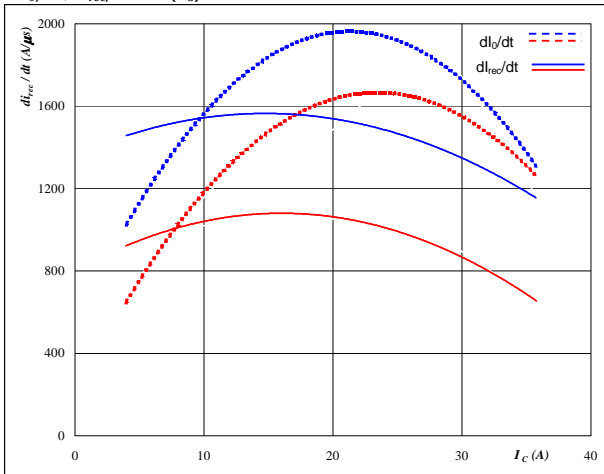


### Inverter Characteristics

**figure 17.** FWD

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

$$dI_0/dt, dI_{rec}/dt = f(I_C)$$

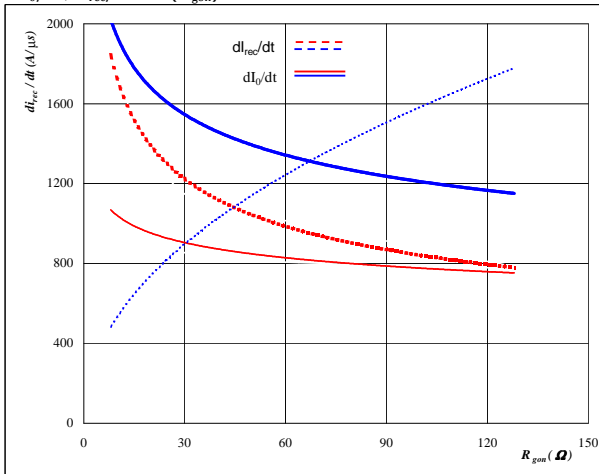


**At**  
 $T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω

**figure 18.** FWD

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

$$dI_0/dt, dI_{rec}/dt = f(R_{gon})$$

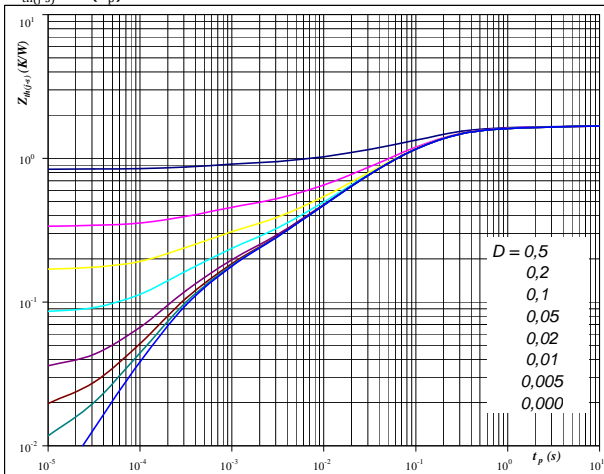


**At**  
 $T_j = 25/125$  °C  
 $V_R = 300$  V  
 $I_F = 20$  A  
 $V_{GE} = 15$  V

**figure 19.** IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 1,68$  K/W

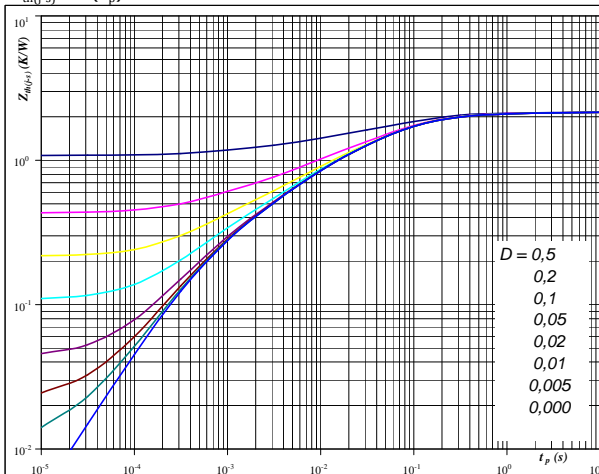
IGBT thermal model values

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

**figure 20.** FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 2,16$  K/W

FWD thermal model values

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

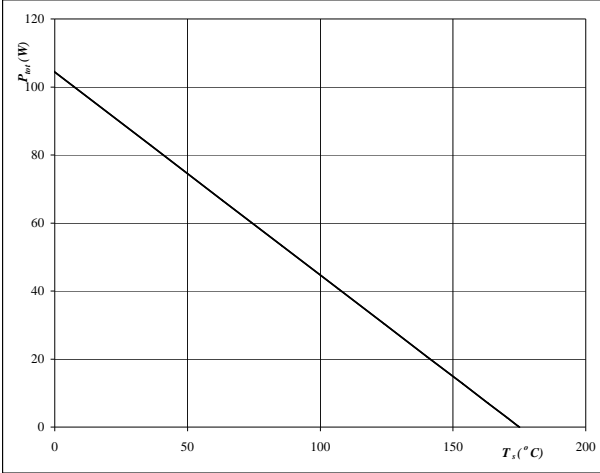


### Inverter Characteristics

**figure 21. IGBT**

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

$$P_{tot} = f(T_s)$$

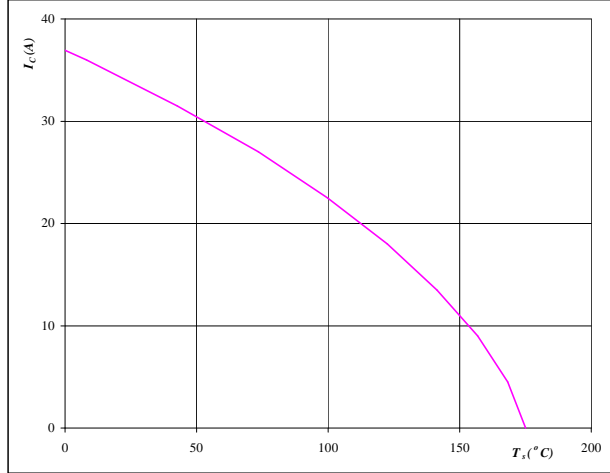


**At**  
 $T_j = 175 \text{ } ^\circ\text{C}$

**figure 22. IGBT**

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

$$I_c = f(T_s)$$

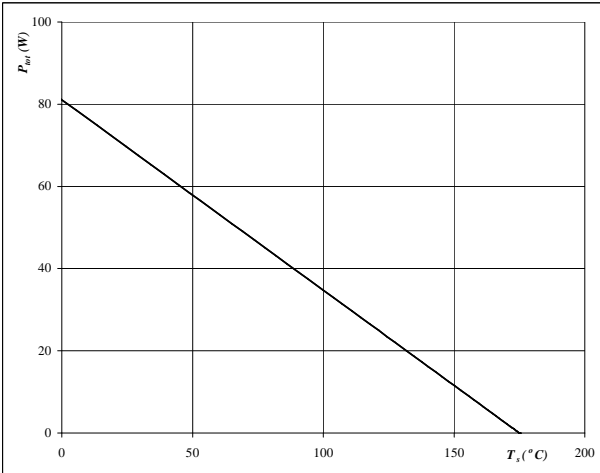


**At**  
 $T_j = 175 \text{ } ^\circ\text{C}$   
 $V_{GE} = 15 \text{ V}$

**figure 23. FWD**

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

$$P_{tot} = f(T_s)$$

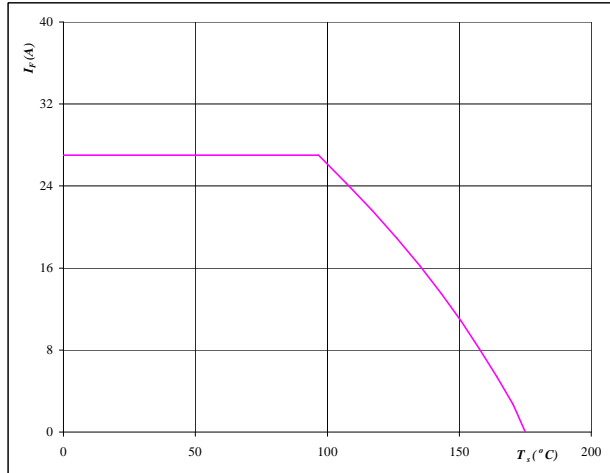


**At**  
 $T_j = 175 \text{ } ^\circ\text{C}$

**figure 24. FWD**

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

$$I_F = f(T_s)$$



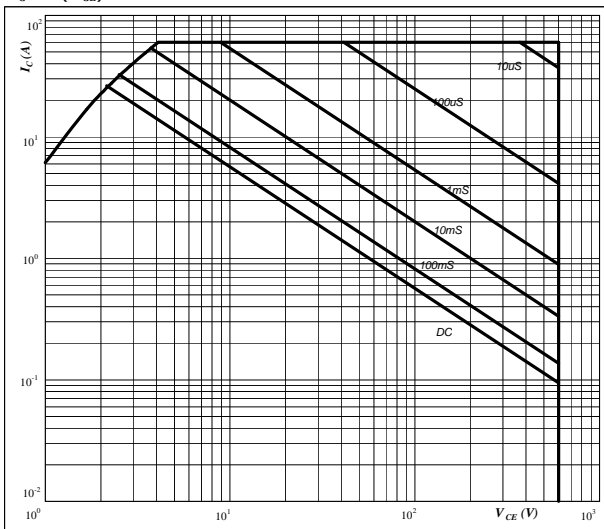
**At**  
 $T_j = 175 \text{ } ^\circ\text{C}$

## Inverter Characteristics

**figure 25. IGBT**

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

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



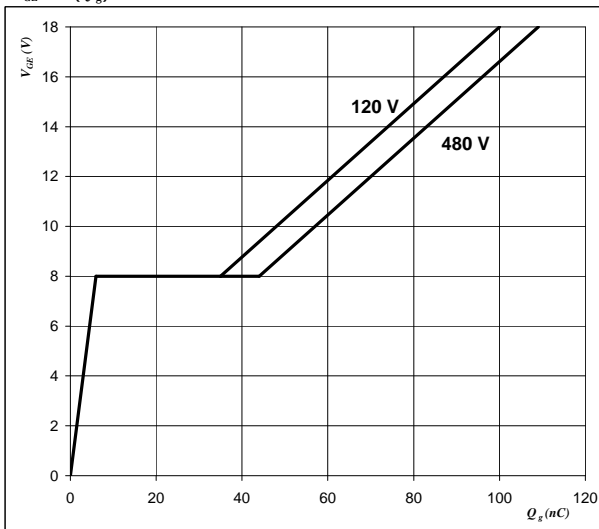
**At**

$D =$  single pulse  
 $T_s =$  80 °C  
 $V_{GE} =$  15 V  
 $T_j = T_{jmax}$

**figure 26. IGBT**

**Gate voltage vs Gate charge**

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



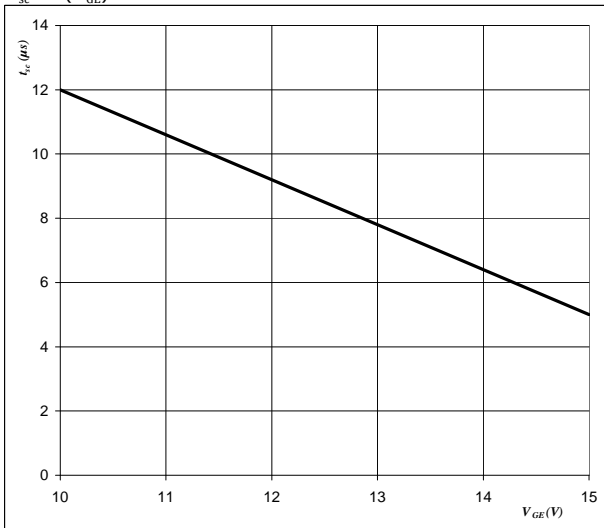
**At**

$I_C =$  20 A

**figure 27. IGBT**

**Short circuit withstand time as a function of gate-emitter voltage**

$$t_{sc} = f(V_{GE})$$



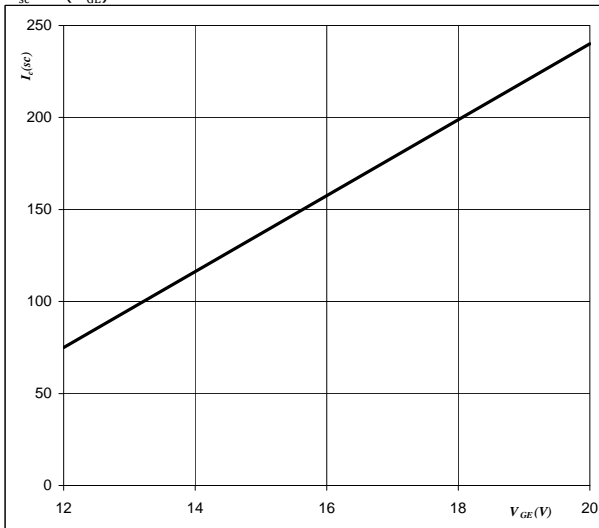
**At**

$V_{CE} =$  600 V  
 $T_j \leq$  175 °C

**figure 28. IGBT**

**Typical short circuit collector current as a function of gate-emitter voltage**

$$I_{sc} = f(V_{GE})$$



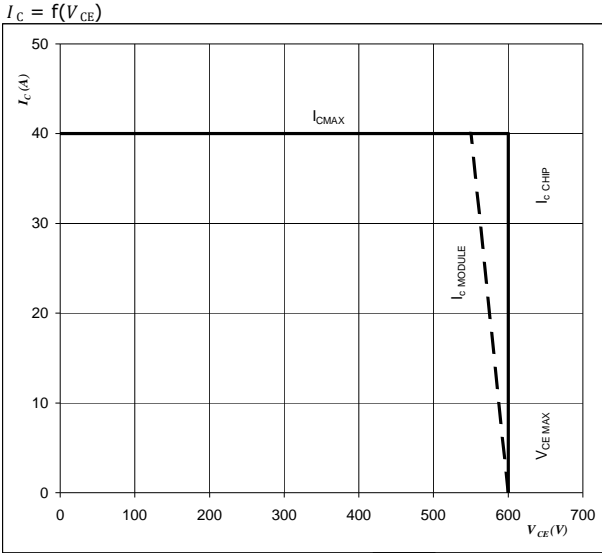
**At**

$V_{CE} \leq$  600 V  
 $T_j =$  175 °C



### Inverter Characteristics

**figure 29.** IGBT  
**Reverse bias safe operating area**



**At**

$T_j = T_{j\text{max}} - 25 \text{ } ^\circ\text{C}$

Switching mode : 3phase SPWM

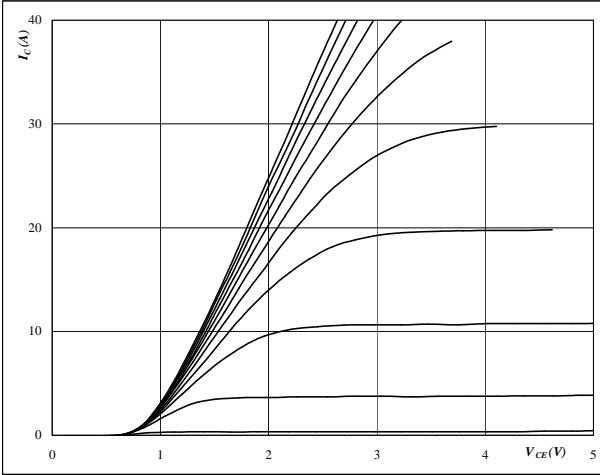


### Brake Characteristics

**figure 1. IGBT**

**Typical output characteristics**

$I_C = f(V_{CE})$



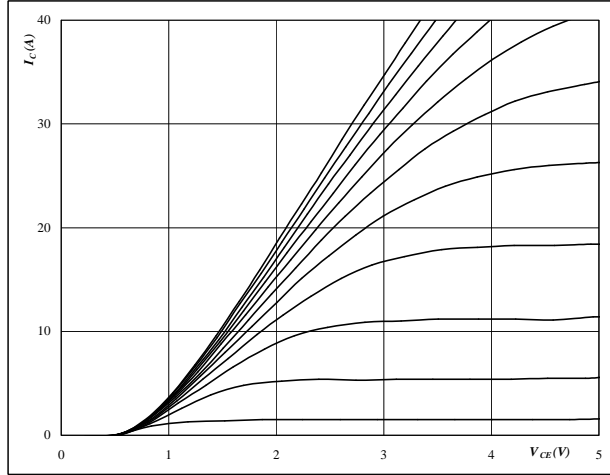
**At**

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

**figure 2. IGBT**

**Typical output characteristics**

$I_C = f(V_{CE})$



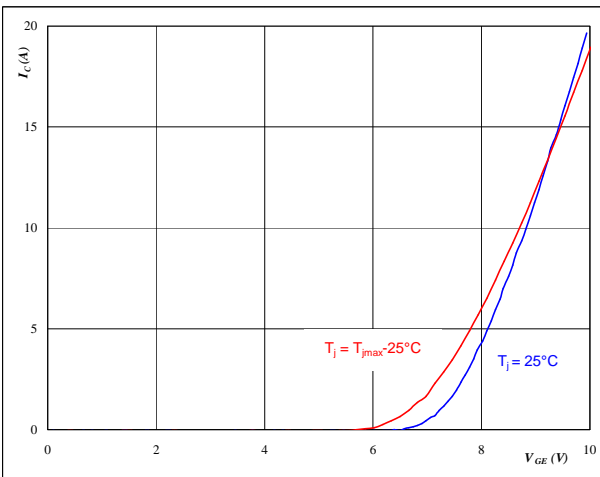
**At**

$t_p = 250 \mu s$   
 $T_j = 125 \text{ } ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3. IGBT**

**Typical transfer characteristics**

$I_C = f(V_{GE})$



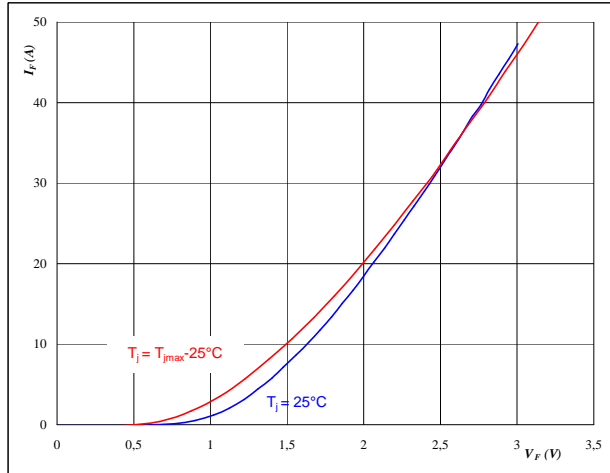
**At**

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

**figure 4. FWD**

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$



**At**

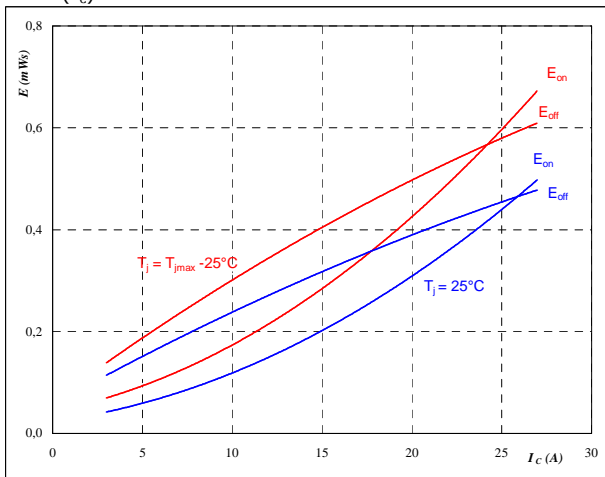
$t_p = 250 \mu s$

### Brake Characteristics

**figure 5. IGBT**

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

$E = f(I_C)$



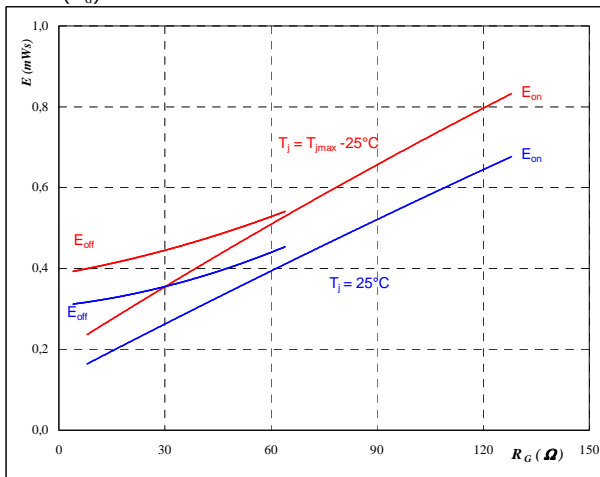
With an inductive load at

$T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω  
 $R_{goff} = 8$  Ω

**figure 6. IGBT**

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

$E = f(R_G)$



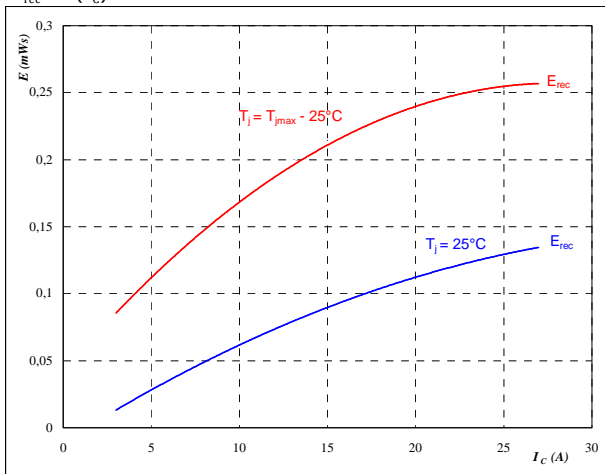
With an inductive load at

$T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $I_C = 15$  A

**figure 7. FWD**

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

$E_{rec} = f(I_C)$



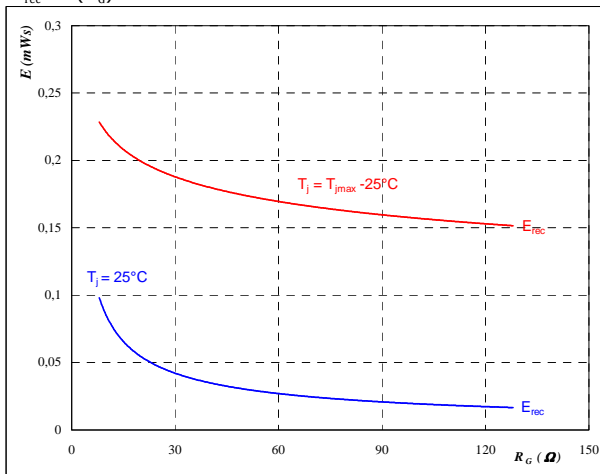
With an inductive load at

$T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω

**figure 8. FWD**

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

$E_{rec} = f(R_G)$



With an inductive load at

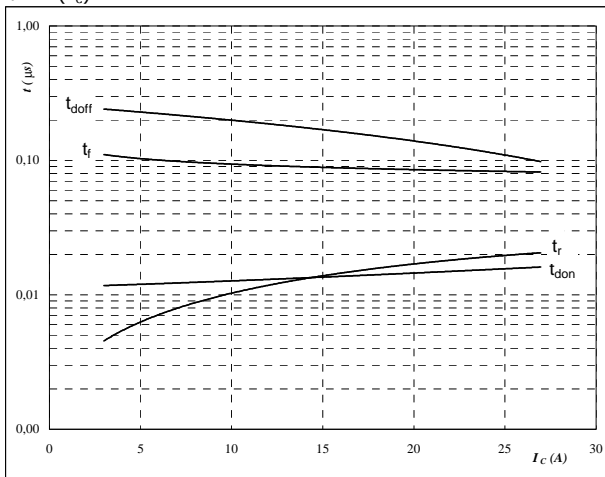
$T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $I_C = 15$  A

### Brake Characteristics

**figure 9.** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



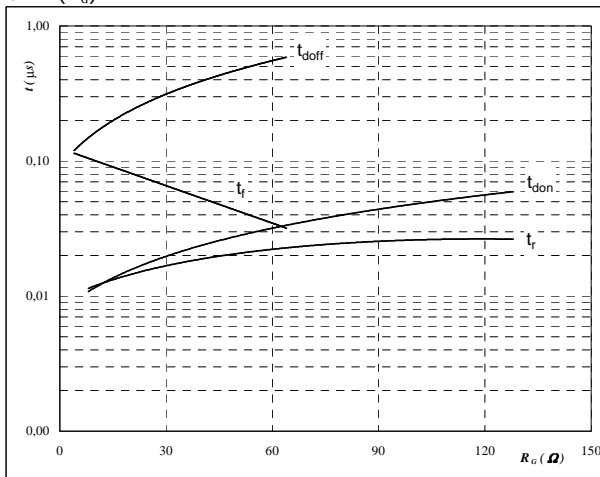
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	16	Ω
$R_{goff} =$	8	Ω

**figure 10.** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



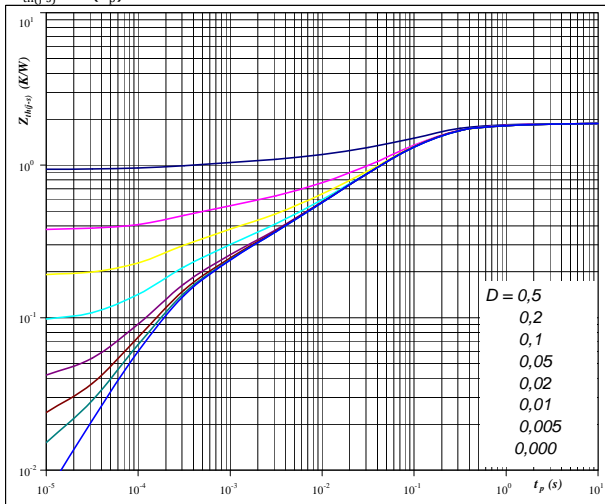
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	15	A

**figure 11.** IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



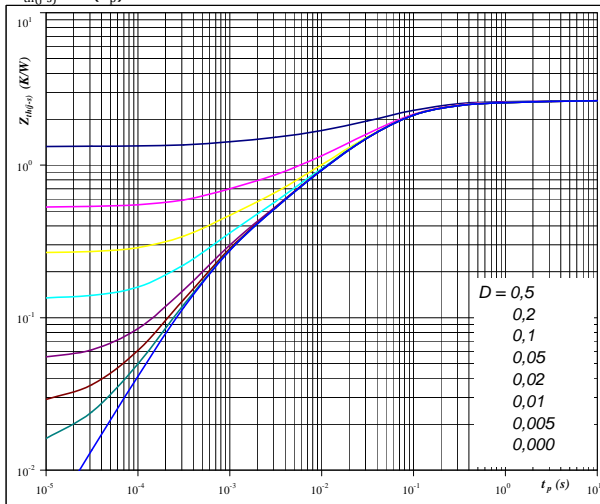
At

$D =$	$t_p / T$
$R_{th(j-s)} =$	1,88 K/W

**figure 12.** FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{th(j-s)} = f(t_p)$$



At

$D =$	$t_p / T$
$R_{th(j-s)} =$	2,65 K/W

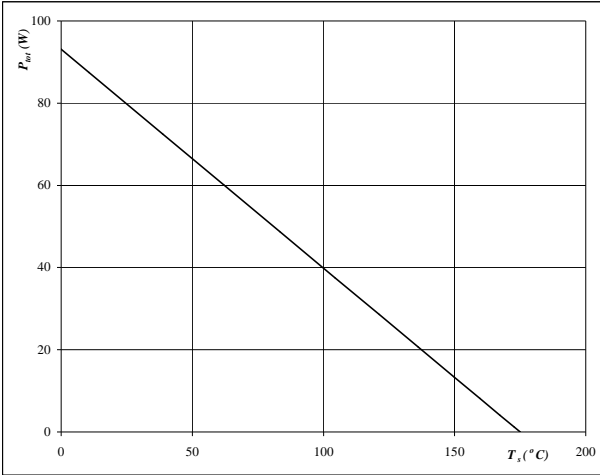


### Brake Characteristics

**figure 13.** IGBT

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

$$P_{tot} = f(T_s)$$

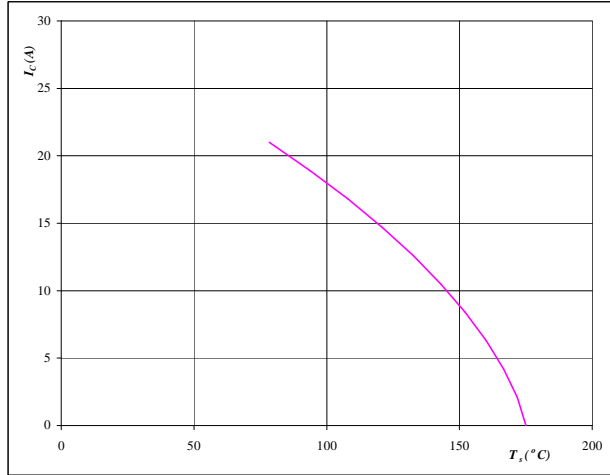


**At**  
T<sub>j</sub> = 175 °C

**figure 14.** IGBT

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

$$I_C = f(T_s)$$

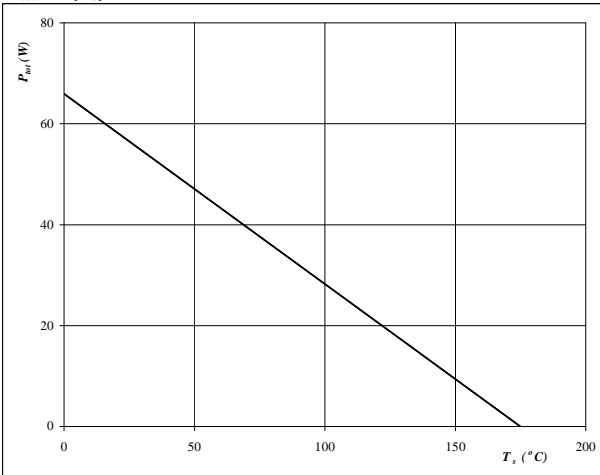


**At**  
T<sub>j</sub> = 175 °C  
V<sub>GE</sub> = 15 V

**figure 15.** FWD

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

$$P_{tot} = f(T_s)$$

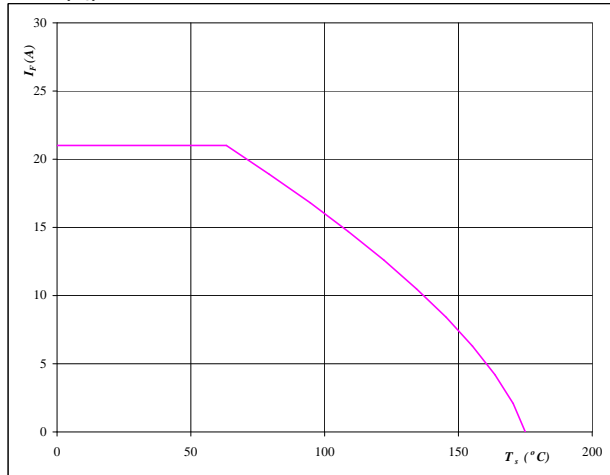


**At**  
T<sub>j</sub> = 175 °C

**figure 16.** FWD

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

$$I_F = f(T_s)$$



**At**  
T<sub>j</sub> = 175 °C



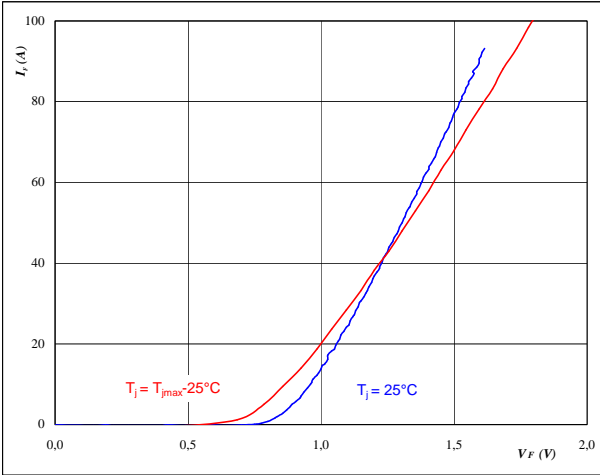


### Rectifier Diode Characteristics

**figure 1. Rectifier Diode**

**Typical diode forward current as a function of forward voltage**

$I_F = f(V_F)$

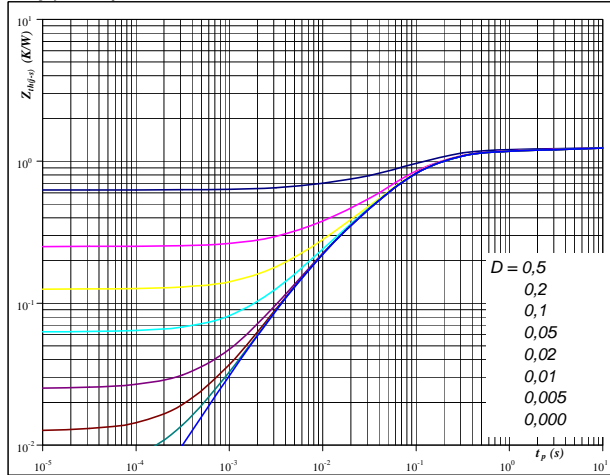


**At**  
 $t_p = 250 \mu s$

**figure 2. Rectifier Diode**

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

$Z_{th(j-s)} = f(t_p)$

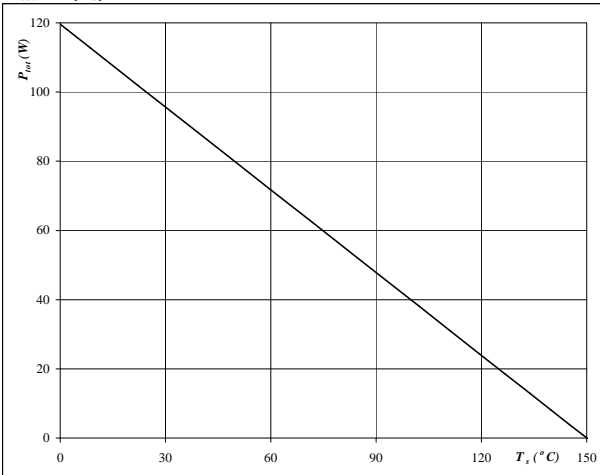


**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 1,25 \text{ K/W}$

**figure 3. Rectifier Diode**

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

$P_{tot} = f(T_s)$

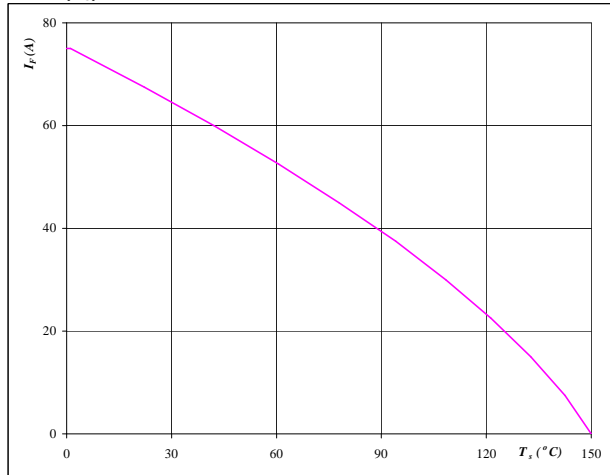


**At**  
 $T_j = 150 \text{ °C}$

**figure 4. Rectifier Diode**

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

$I_F = f(T_s)$



**At**  
 $T_j = 150 \text{ °C}$

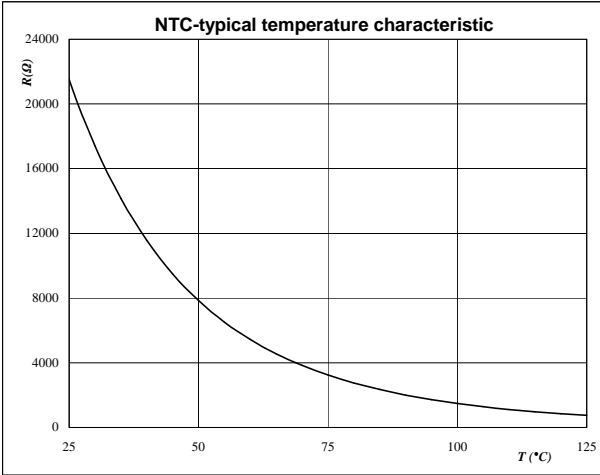


# Thermistor

**figure 1. Thermistor**

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

$$R_T = f(T)$$



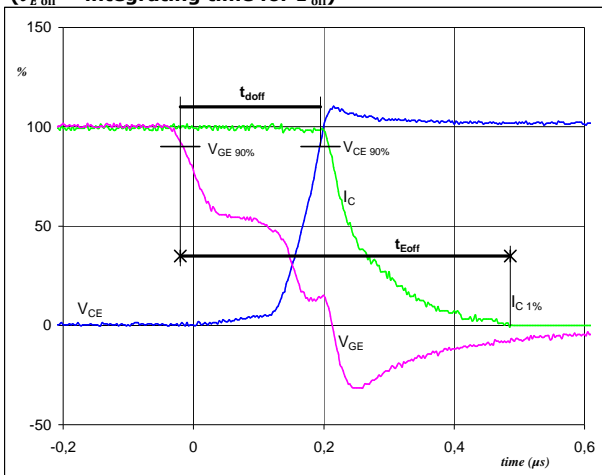
## Switching Definitions Inverter

### General conditions

$T_j$	=	125 °C
$R_{gon}$	=	16 Ω
$R_{goff}$	=	8 Ω

**figure 1. IGBT**

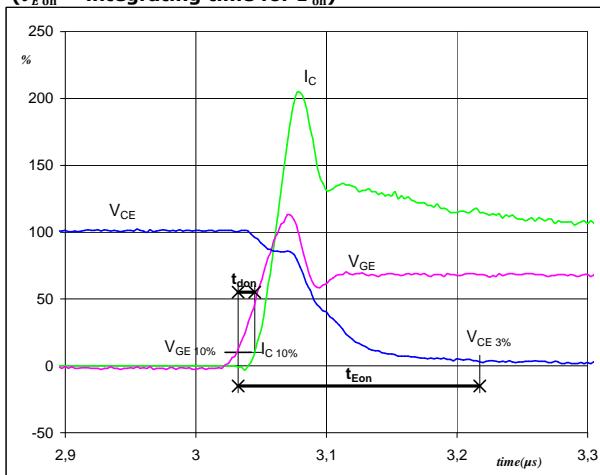
**Turn-off Switching Waveforms & definition of  $t_{doff}$   $t_{Eoff}$**   
 ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



$V_{GE}$ (0%) =	0	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_{doff}$ =	0,21	μs
$t_{Eoff}$ =	0,51	μs

**figure 2. IGBT**

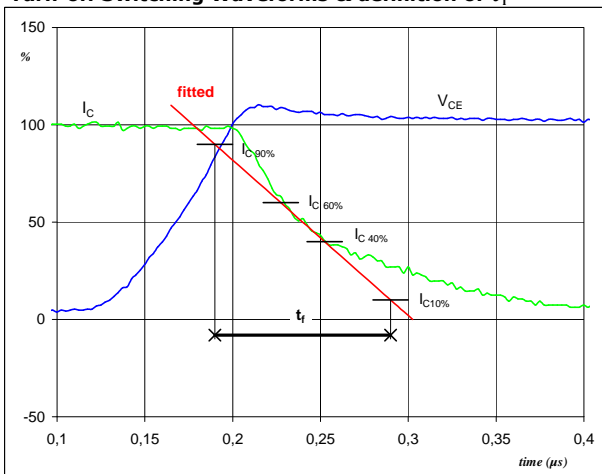
**Turn-on Switching Waveforms & definition of  $t_{don}$   $t_{Eon}$**   
 ( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{GE}$ (0%) =	0	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_{don}$ =	0,01	μs
$t_{Eon}$ =	0,18	μs

**figure 3. IGBT**

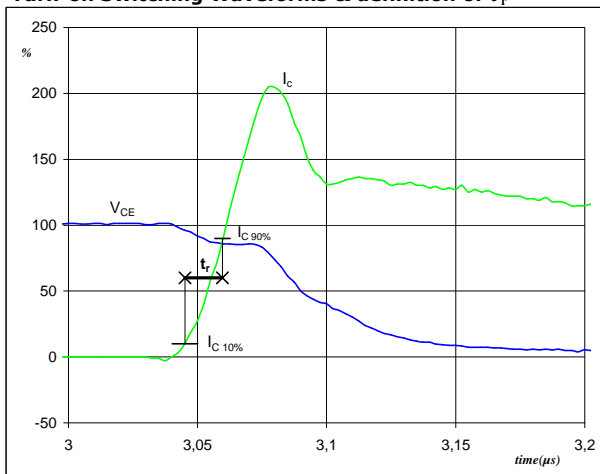
**Turn-off Switching Waveforms & definition of  $t_f$**



$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_f$ =	0,10	μs

**figure 4. IGBT**

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



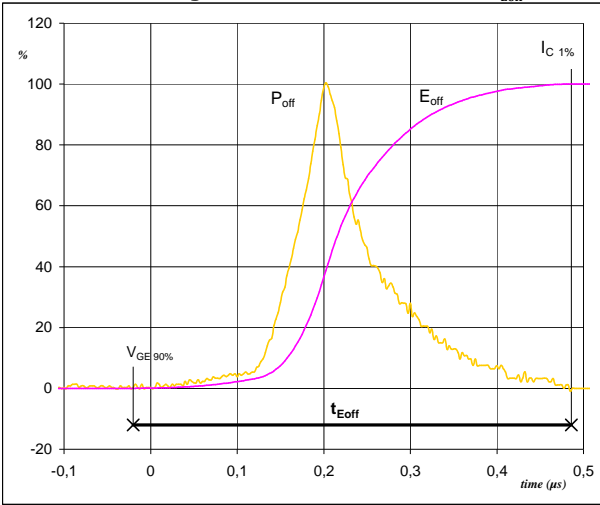
$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_r$ =	0,02	μs



# Switching Definitions Inverter

**figure 5. IGBT**

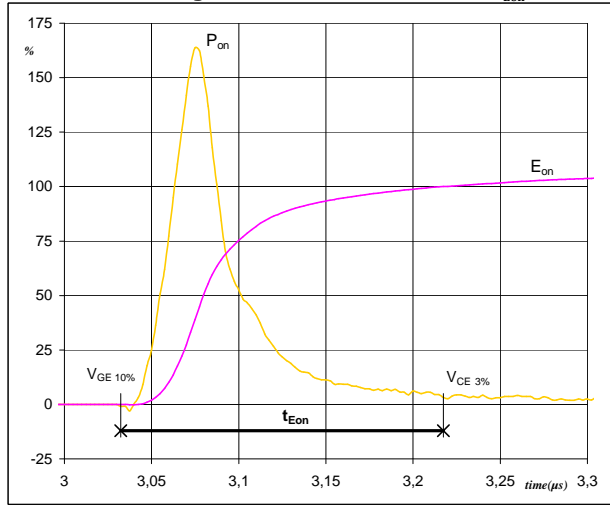
**Turn-off Switching Waveforms & definition of  $t_{Eoff}$**



$P_{off} (100\%) = 5,99 \text{ kW}$   
 $E_{off} (100\%) = 0,65 \text{ mJ}$   
 $t_{Eoff} = 0,51 \text{ μs}$

**figure 6. IGBT**

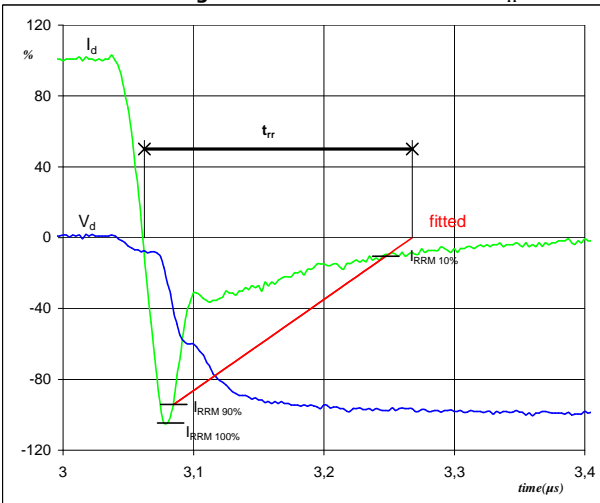
**Turn-on Switching Waveforms & definition of  $t_{Eon}$**



$P_{on} (100\%) = 5,99 \text{ kW}$   
 $E_{on} (100\%) = 0,43 \text{ mJ}$   
 $t_{Eon} = 0,18 \text{ μs}$

**figure 7. FWD**

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

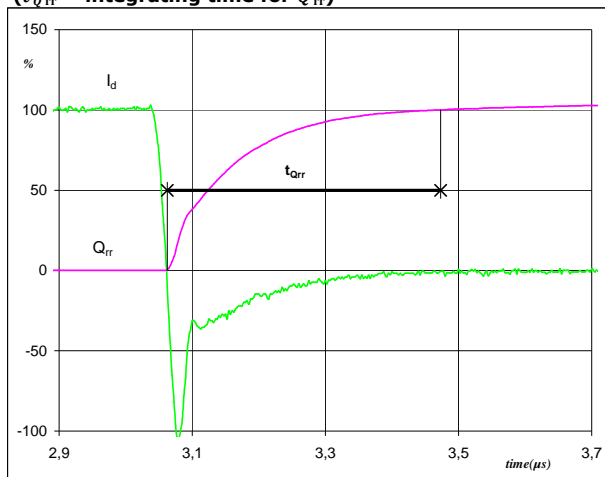


$V_d (100\%) = 300 \text{ V}$   
 $I_d (100\%) = 20 \text{ A}$   
 $I_{RRM} (100\%) = 21 \text{ A}$   
 $t_{rr} = 0,19 \text{ μs}$

## Switching Definitions Inverter

**figure 8. FWD**

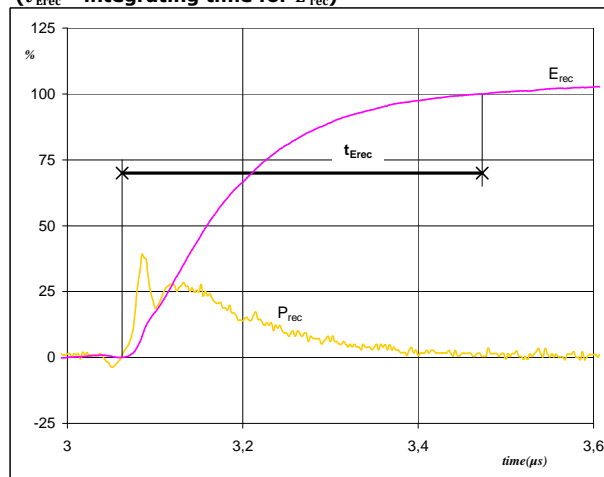
**Turn-on Switching Waveforms & definition of  $t_{Qrr}$**   
 ( $t_{Qrr}$  = integrating time for  $Q_{rr}$ )



$I_d$ (100%) =	20	A
$Q_{rr}$ (100%) =	1,35	$\mu\text{C}$
$t_{Qrr}$ =	0,41	$\mu\text{s}$


**figure 9. FWD**

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

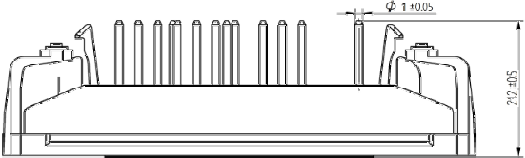
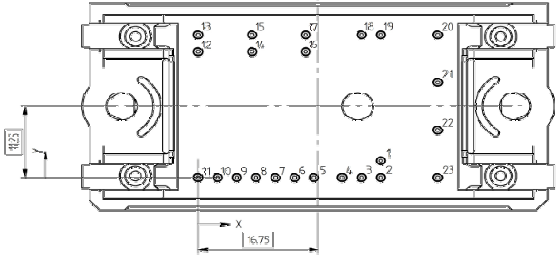


$P_{rec}$ (100%) =	5,99	kW
$E_{rec}$ (100%) =	0,27	mJ
$t_{Erec}$ =	0,41	$\mu\text{s}$

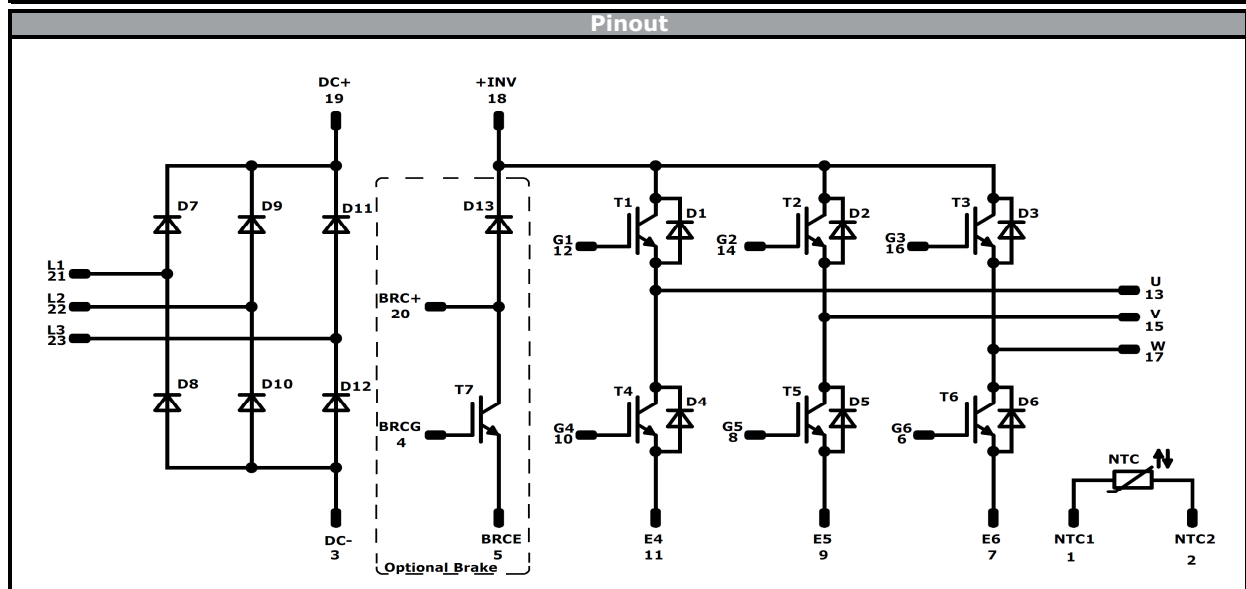
## Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking							
Version				Ordering Code			
without thermal paste 17mm housing with solder pins				V23990-P545-A21-PM			
with thermal paste 17mm housing with solder pins				V23990-P545-A21-/3/-PM			
without thermal paste 17mm housing with solder pins without BRC				V23990-P545-C21-PM			
	Text	VIN	Date code	Name&Ver	UL	Lot	Serial
		VIN	WYYY	NNNNNVV	UL	LLLL	SSSS
	Datamatrix	Name&Ver	Lot number	Serial	Date code		
		NNNNNVV	LLLL	SSSS	WYYY		

Outline						
Pin table			Pinout variation			
Pin	X	Y	Function	Modul subtype	Not assembled pins	
1	25,5	2,7	NTC1	P545-A21	-	
2	25,5	0	NTC2	P545-C21	4,5,20	
3	22,8	0	-DC			
4	20,1	0	BRCG			
5	16,2	0	BRCE			
6	13,5	0	G6			
7	10,8	0	E6			
8	8,1	0	G5			
9	5,4	0	E5			
10	2,7	0	G4			
11	0	0	E4			
12	0	19,8	G1			
13	0	22,5	U			
14	7,5	19,8	G2			
15	7,5	22,5	V			
16	15	19,8	G3			
17	15	22,5	W			
18	22,8	22,5	+INV			
19	25,5	22,5	+DC			
20	33,5	22,5	BRC+			
21	33,5	15	L1			
22	33,5	7,5	L2			
23	33,5	0	L3			

Tolerance of pinpositions: ±0.5mm at the end of pins  
Dimension of coordinate axis is only offset without tolerance




Identification						
ID	Component	Voltage	Current	Function	Comment	
T1-T6	IGBT	600 V	20 A	Inverter Switch		
D1-D6	FWD	600 V	20 A	Inverter Diode		
T7	IGBT	600 V	15 A	Brake Switch		
D13	FWD	600 V	15 A	Brake Diode		
D7-D12	Rectifier	1600 V	35 A	Rectifier Diode		
NTC	Thermistor			Thermistor		



Packaging instruction			
Standard packaging quantity (SPQ)	<b>135</b>	>SPQ Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow 0</i> packages see vincotech.com website.

Package data
Package data for <i>flow 0</i> 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-P545-x21-D5-14	24 Jun. 2016		

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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.