



<i>flow</i> PIM 0	600 V / 20 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Features</b></div> <ul style="list-style-type: none"> <li>Vincotech clip-in housing</li> <li>Trenchstop™ IGBT3 for low saturation losses</li> <li>Optional w/o BRC</li> </ul> <div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Target Applications</b></div> <ul style="list-style-type: none"> <li>Industrial drives</li> <li>Embedded drives</li> </ul> <div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Types</b></div> <ul style="list-style-type: none"> <li>V23990-P545-A28-PM</li> <li>V23990-P545-A29-PM</li> <li>V23990-P545-B28-PM</li> <li>V23990-P545-B128-PM</li> <li>V23990-P545-B129-PM</li> <li>V23990-P545-C29-PM</li> </ul>	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>flow 0 housing</b></div> <div style="display: flex; justify-content: space-around; align-items: center;"> </div> <div style="display: flex; justify-content: space-around; align-items: center;"> <span>12mm housing</span> <span>17mm housing</span> </div> <div style="background-color: #eee; padding: 2px; margin-top: 5px;"><b>Schematic</b></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	$I_{FAV}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	34	A
Surge (non-repetitive) forward current	$I_{FSM}$	$t_p = 10\text{ ms}$ 50 Hz half sine wave $T_j = 150\text{ °C}$	200	A
I <sup>2</sup> t-value	$I^2t$		200	A <sup>2</sup> s
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	43	W
Maximum Junction Temperature	$T_{jmax}$		150	°C
<b>Inverter Switch</b>				
Collector-emitter breakdown 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		$V_{CE} \leq 1200V, T_j \leq T_{op, max}$	60	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Gate-emitter peak voltage	$V_{GE}$		±20	V
Short circuit ratings	$t_{SC}$	$T_j \leq 150\text{ °C}$	6	µs
	$V_{CC}$	$V_{GE} = 15\text{ V}$	360	V
Maximum Junction Temperature	$T_{jmax}$		175	°C



## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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### Inverter Diode

Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	21	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	40	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	37	W
Maximum Junction Temperature	$T_{jmax}$		175	°C

### Brake Switch

Collector-emitter breakdown voltage	$V_{CE}$		600	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	21	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	45	A
Turn off safe operating area		$V_{CE} \leq 1200V, T_j \leq T_{op\ max}$	45	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	52	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	°C

### Brake Diode

Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	18	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	30	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	35	W
Maximum Junction Temperature	$T_{jmax}$		175	°C

### Thermal Properties

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

### Isolation Properties

Isolation voltage	$V_{is}$	$t = 2s$ DC voltage	4000	V
Creepage distance			min 12,7	mm
Clearance		12 mm / 17 mm housing	9,29 / min 12,7	mm
Comparative tracking index	CTI		>200	



Characteristic Values

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

**Rectifier Diode**

Forward voltage	$V_F$				25	25 125	0,8	1,22 1,20	1,45	V
Threshold voltage (for power loss calc. only)	$V_{to}$				25	25 125		0,95 0,81		V
Slope resistance (for power loss calc. only)	$r_t$				25	25 125		10 20		mΩ
Reverse current	$I_r$			1600		25 145			0,05 1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,61		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	25 125		1	1,55 1,75	2,2	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	$t_{d(on)}$	$R_{goff} = 8$ Ω $R_{gon} = 16$ Ω	+15/0	300	20	25			15		ns
Rise time	$t_r$					125			12		
Turn-off delay time	$t_{d(off)}$					25			198		
Fall time	$t_f$					125			212		
Turn-on energy loss	$E_{on}$					25			100		
Turn-off energy loss	$E_{off}$	125			104		0,31 0,43				mWs
Input capacitance	$C_{ies}$								1100		pF
Output capacitance	$C_{oss}$	$f = 1$ MHz	0	25		25			71		
Reverse transfer capacitance	$C_{rss}$								32		
Gate charge	$Q_G$		±15	480	20	25			120		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)							1,70		K/W

**Inverter Diode**

Diode forward voltage	$V_F$				20	25 125	1,25	1,81 1,76	1,95	V
Peak reverse recovery current	$I_{RRM}$	$R_{gon} = 16$ Ω	+15/0	300	20	25		19		A
Reverse recovery time	$t_{rr}$					125		21		
Reverse recovered charge	$Q_{rr}$					25		33		
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					125		192		
Reverse recovered energy	$E_{rec}$					25		0,45		
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,60		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]

**Brake Switch**

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	25 125	1,1	1,79 2,08	1,9	V
Collector-emitter cut-off incl diode	$I_{CES}$		0	600			25			0,00085	mA
Gate-emitter leakage current	$I_{GES}$		20	0			25			300	nA
Integrated Gate resistor	$R_{gint}$								none		$\Omega$
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 8 \Omega$ $R_{gon} = 16 \Omega$	+15/0	300	15	15	25			15	ns
Rise time	$t_r$						125			14	
Turn-off delay time	$t_{d(off)}$						25			11	
Fall time	$t_f$						125			14	
Turn-on energy loss	$E_{on}$						25			128	
Turn-off energy loss	$E_{off}$						125			145	
Input capacitance	$C_{ies}$	$f = 1 \text{ MHz}$	0	25		25			860		pF
Output capacitance	$C_{oss}$								55		
Reverse transfer capacitance	$C_{rss}$								24		
Gate charge	$Q_G$		$\pm 15$	480	15	25			87		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{monte} = 3,4 \text{ W/mK}$ (PSX)							1,83		K/W

**Brake Diode**

Diode forward voltage	$V_F$					15	25 125	1,25	1,86 1,75	1,95	V
Reverse leakage current	$I_r$			600			25			27	$\mu\text{A}$
Peak reverse recovery current	$I_{RRM}$	$R_{gon} = 16 \Omega$	+15/0	300	15	15	25		14		A
Reverse recovery time	$t_{rr}$						125			15	
Reverse recovered charge	$Q_{rr}$						25			128	
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						125			201	
Reverse recovery energy	$E_{rec}$						25			0,52	
							125			1,02	
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{monte} = 3,4 \text{ W/mK}$ (PSX)							0,10 0,21		mWs
									2,75		K/W

**Thermistor**

Rated resistance	$R$						25		22000		$\Omega$
Deviation of R100	$\Delta_{R/R}$	$R_{100} = 1484 \Omega$					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	

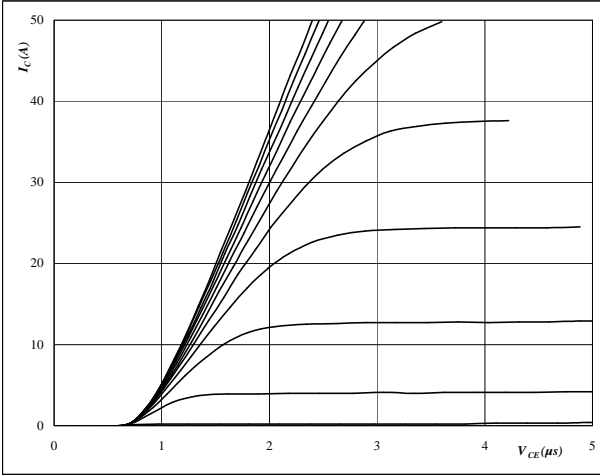


### Inverter Charateristics

**Figure 1** IGBT

Typical output characteristics

$I_C = f(V_{CE})$



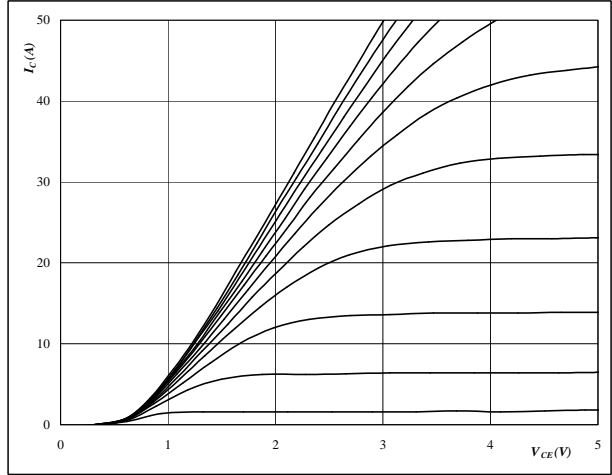
**At**

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

**Figure 2** IGBT

Typical output characteristics

$I_C = f(V_{CE})$



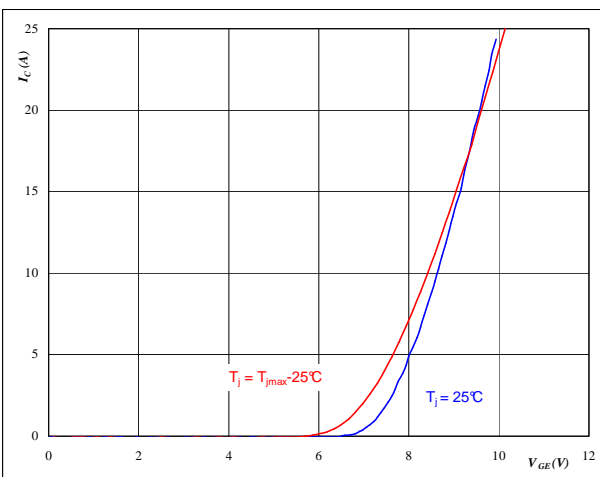
**At**

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

**Figure 3** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



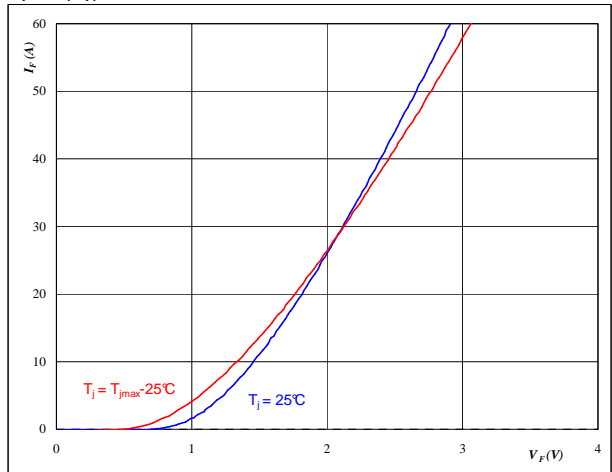
**At**

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

**Figure 4** FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



**At**

$t_p = 250 \mu s$

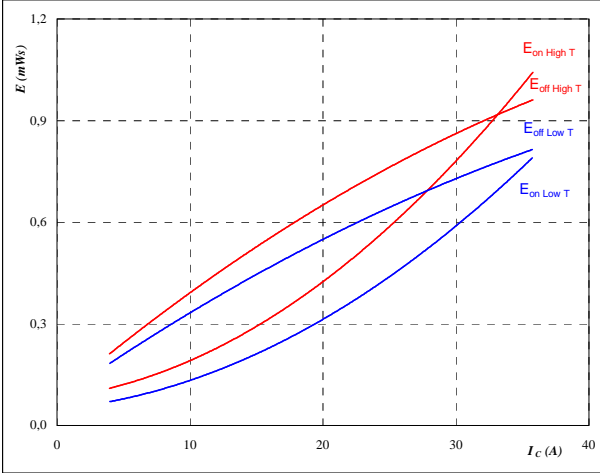


## Inverter Charateristics

**Figure 5** IGBT

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

$$E = f(I_C)$$



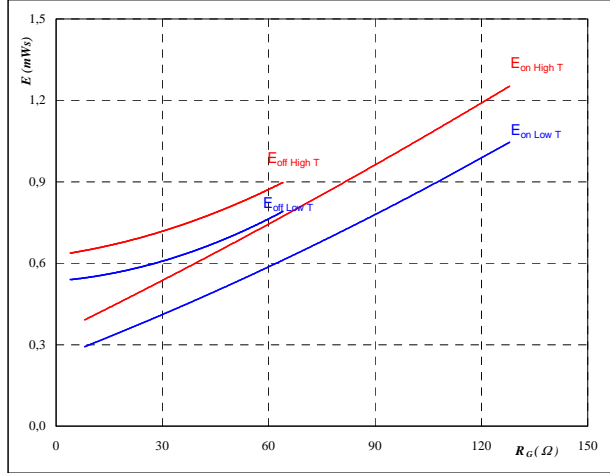
With an inductive load at

$T_j =$	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**

$$E = f(R_G)$$



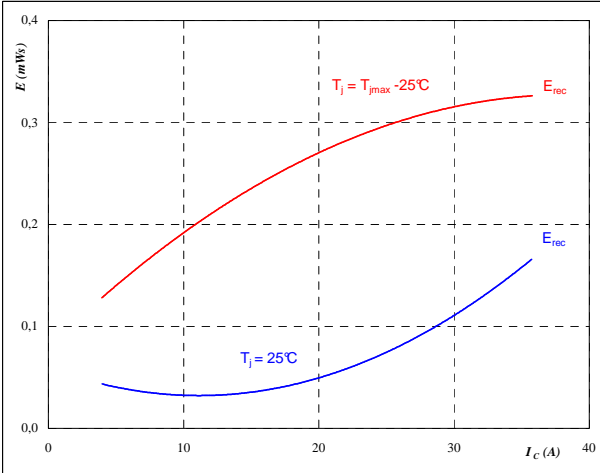
With an inductive load at

$T_j =$	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**

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



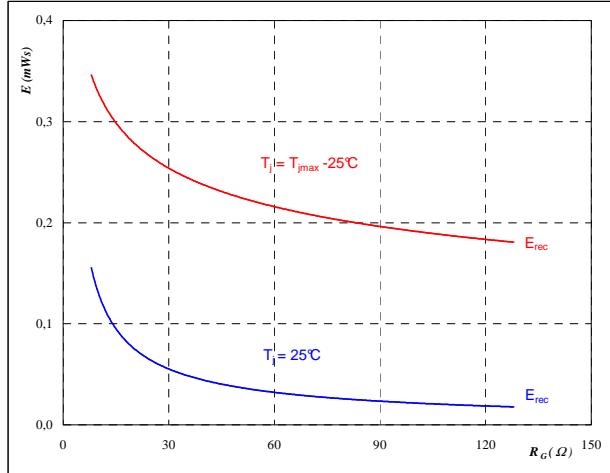
With an inductive load at

$T_j =$	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

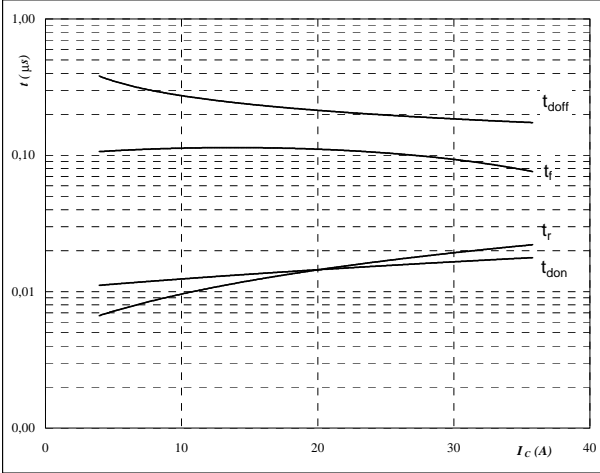


## Inverter Characteristics

**Figure 9** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



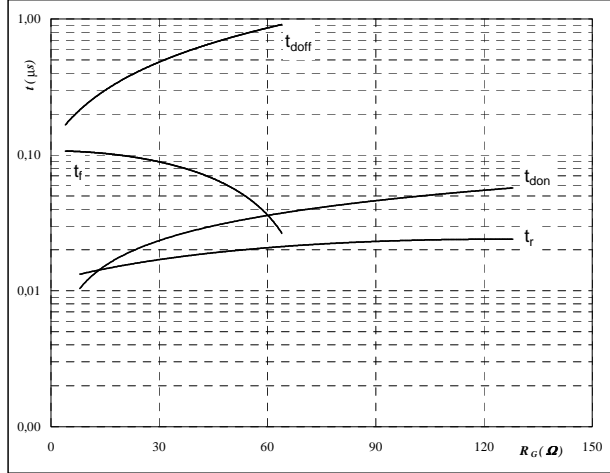
With an inductive load at

$T_j =$	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

$$t = f(R_G)$$



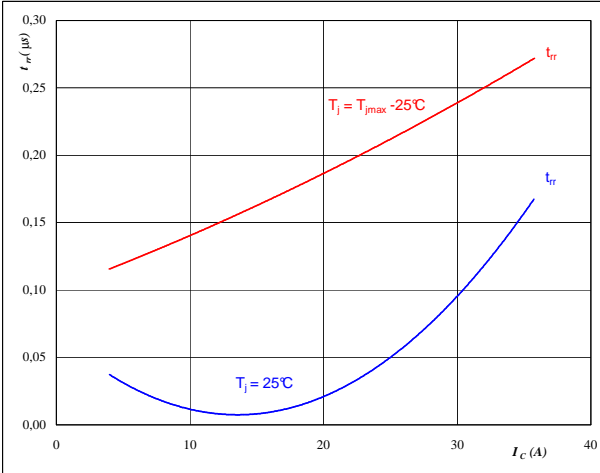
With an inductive load at

$T_j =$	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

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



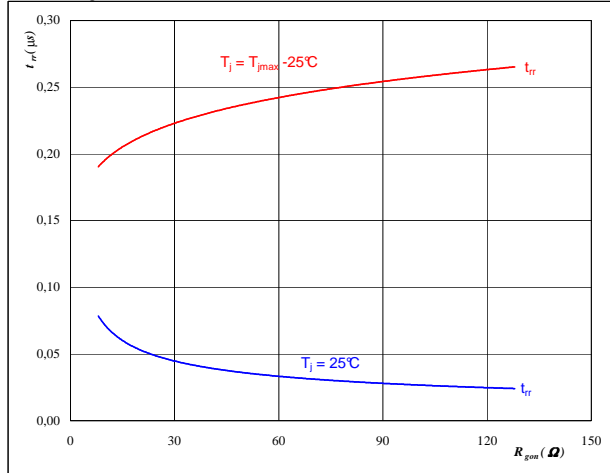
At

$T_j =$	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

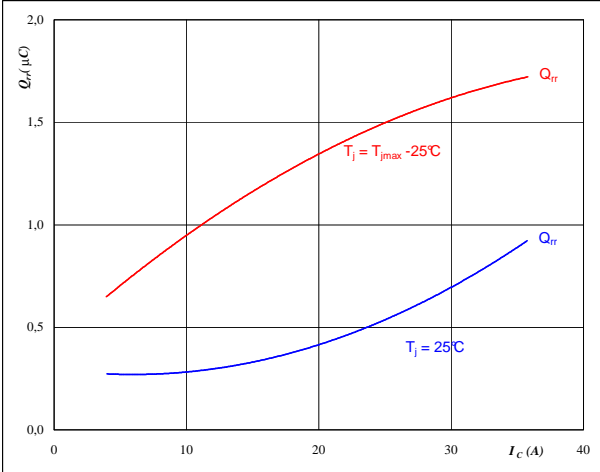


## Inverter Characteristics

**Figure 13** FWD

Typical reverse recovery charge as a function of collector current

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



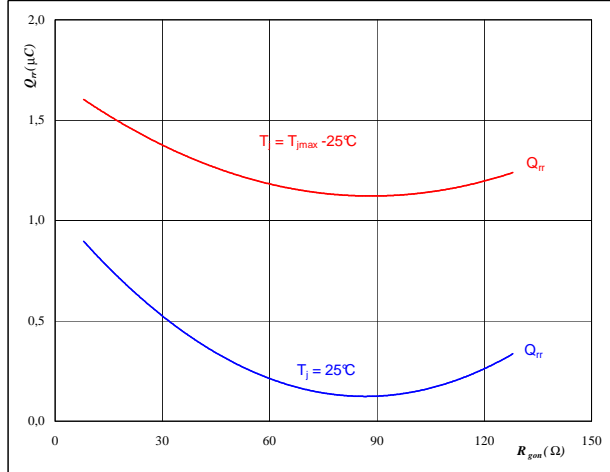
**At**

$T_j = 25/125$  °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

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



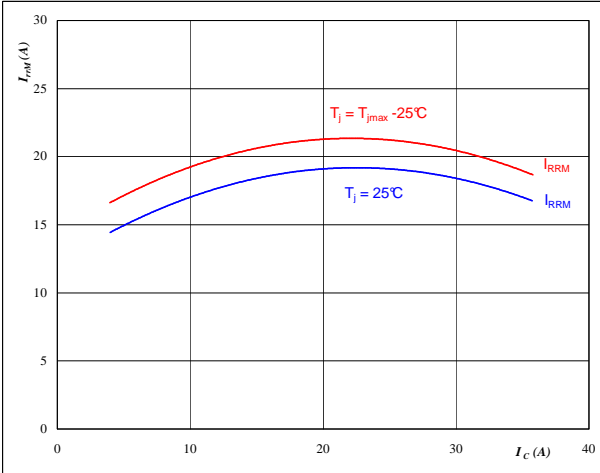
**At**

$T_j = 25/125$  °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

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



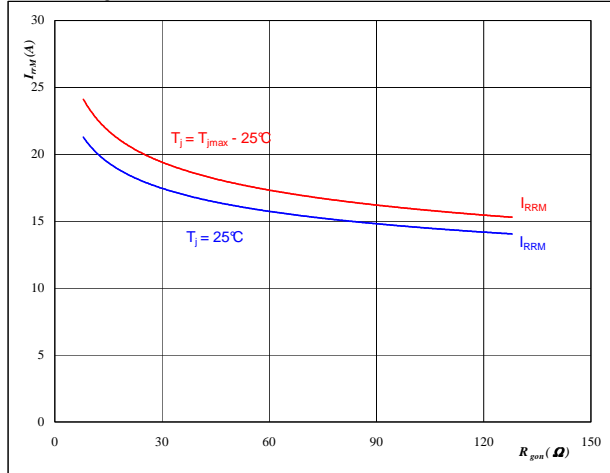
**At**

$T_j = 25/125$  °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



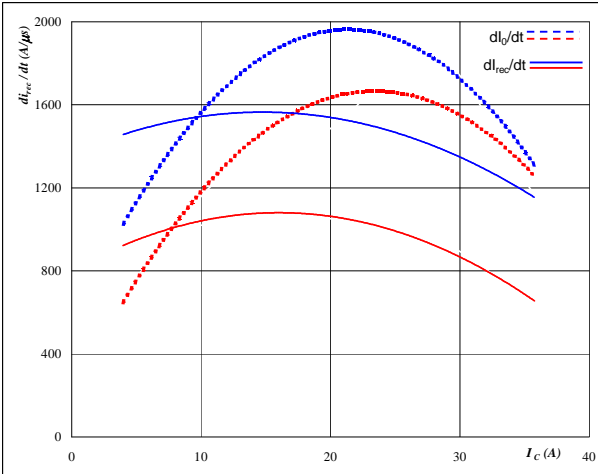


## Inverter Characteristics

**Figure 17** FWD

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

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

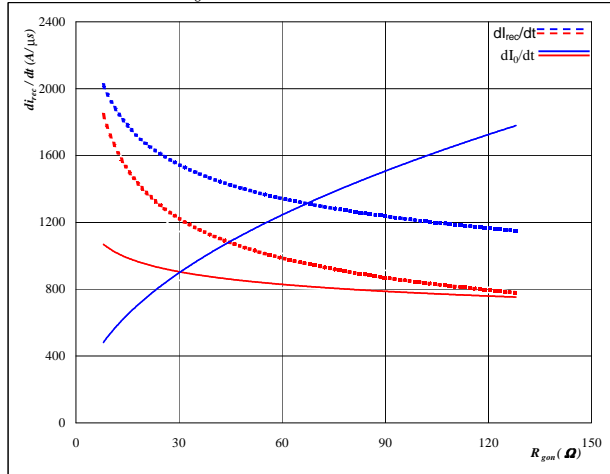


**At**  
 $T_j = 25/125$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = 15$  V  
 $R_{gon} = 16$  Ω

**Figure 18** FWD

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

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

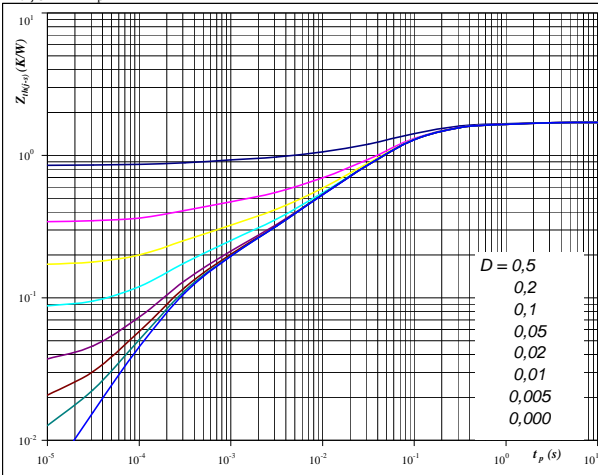


**At**  
 $T_j = 25/125$  °C  
 $V_R = 300$  V  
 $I_F = 20$  A  
 $V_{GE} = 15$  V

**Figure 19** IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{thj-s} = f(t_p)$$



**At**  
 $D = t_p / T$   
 $R_{thjH} = 1,70$  K/W

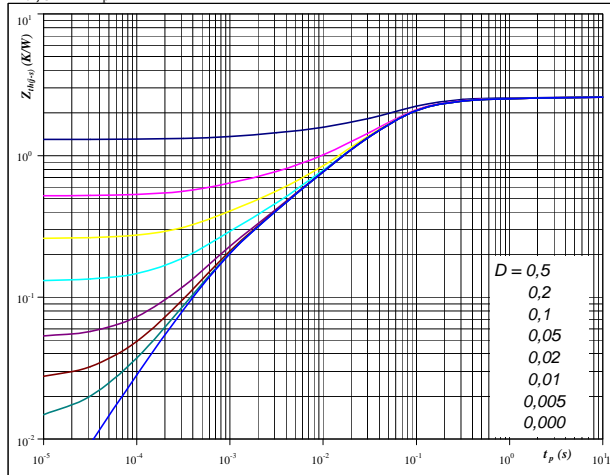
IGBT thermal model values

R (K/W)	Tau (s)
9,97E-02	1,34E+00
3,46E-01	1,70E-01
8,15E-01	5,34E-02
2,54E-01	7,74E-03
7,70E-02	1,33E-03
1,09E-01	2,63E-04

**Figure 20** FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{thj-s} = f(t_p)$$



**At**  
 $D = t_p / T$   
 $R_{thjH} = 2,60$  K/W

FWD thermal model values

R (K/W)	Tau (s)
6,56E-02	4,59E+00
1,58E-01	5,68E-01
8,97E-01	8,42E-02
1,05E+00	3,29E-02
2,75E-01	4,96E-03
1,51E-01	7,65E-04

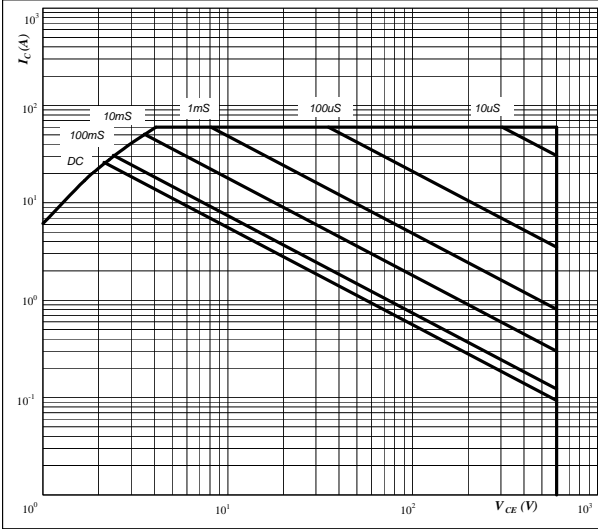


## Inverter Characteristics

**Figure 25** IGBT

Safe operating area as a function of collector-emitter voltage

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

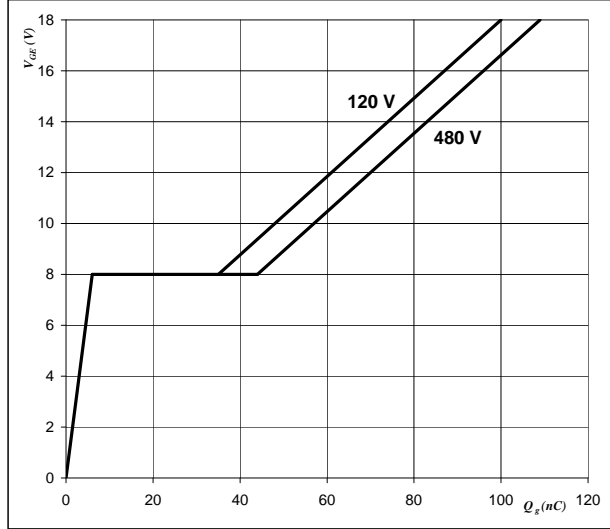


**At**  
 $D =$  single pulse  
 $T_s =$  80 °C  
 $V_{GE} =$  15 V  
 $T_j = T_{jmax}$

**Figure 26** IGBT

Gate voltage vs Gate charge

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

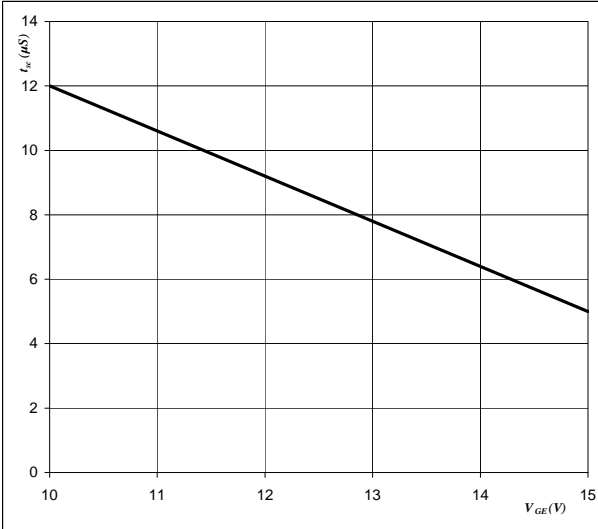


**At**  
 $I_C =$  20 A

**Figure 27** IGBT

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

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

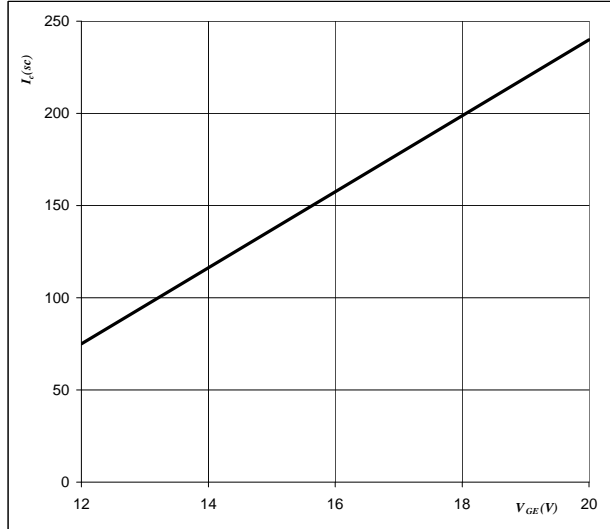


**At**  
 $V_{CE} =$  600 V  
 $T_j \leq$  175 °C

**Figure 28** IGBT

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

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



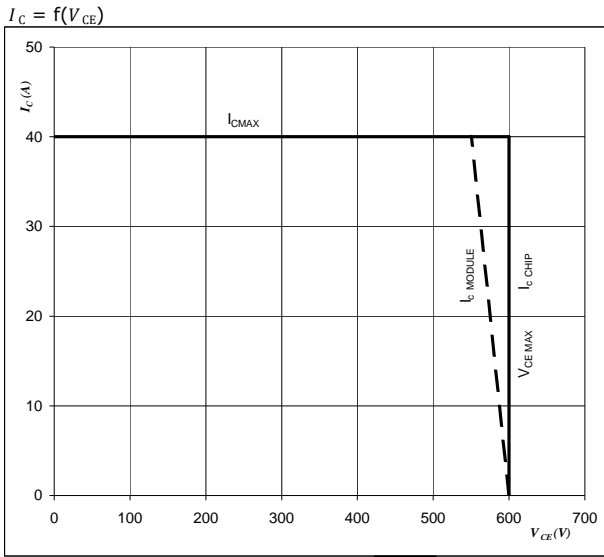
**At**  
 $V_{CE} \leq$  600 V  
 $T_j =$  175 °C



### Inverter Charateristics

**Figure 29** IGBT

Reverse bias safe operating area



**At**

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

Switching mode : 3phase SPWM

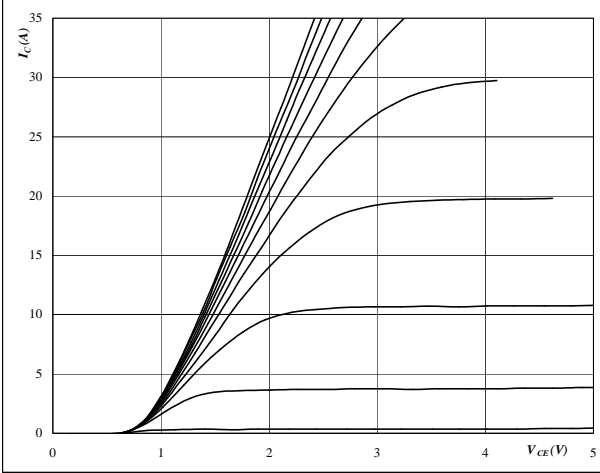


### Brake Characteristics

**Figure 1** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

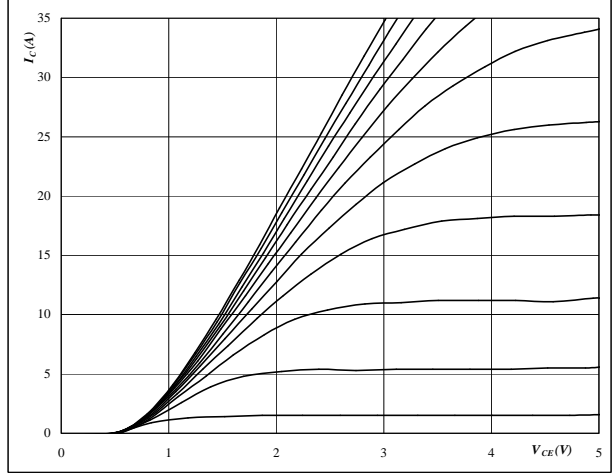


**At**  
 $t_p = 250 \mu s$   
 $T_j = 25 \text{ }^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**Figure 2** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

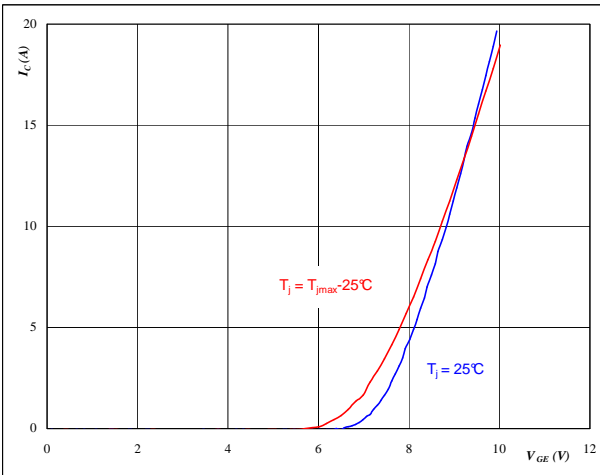


**At**  
 $t_p = 250 \mu s$   
 $T_j = 125 \text{ }^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**Figure 3** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

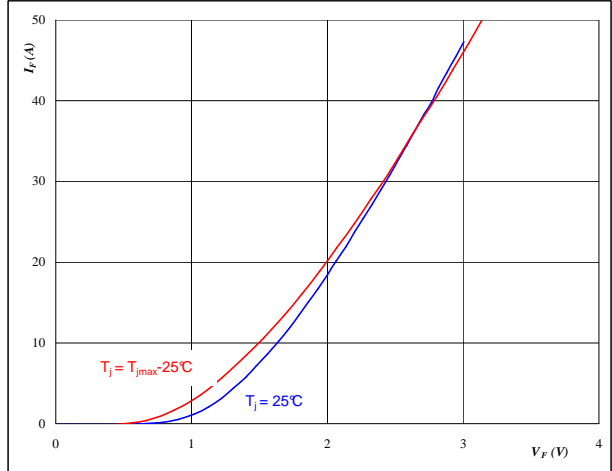


**At**  
 $t_p = 250 \mu s$   
 $V_{CE} = 10 V$

**Figure 4** IGBT

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



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

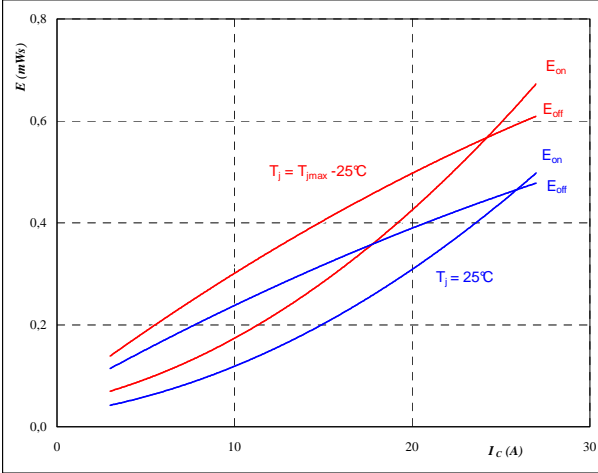


## Brake Characteristics

**Figure 5** IGBT

Typical switching energy losses  
as a function of collector current

$$E = f(I_C)$$



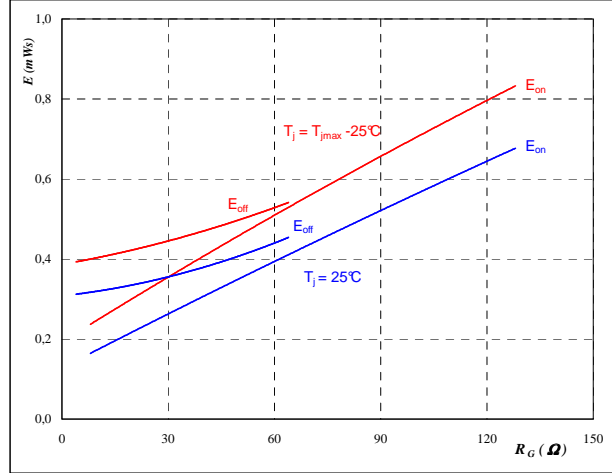
With an inductive load at

$T_j =$	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

$$E = f(R_G)$$



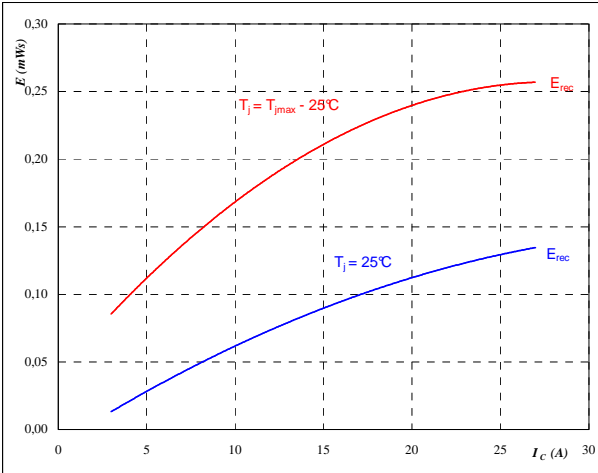
With an inductive load at

$T_j =$	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

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



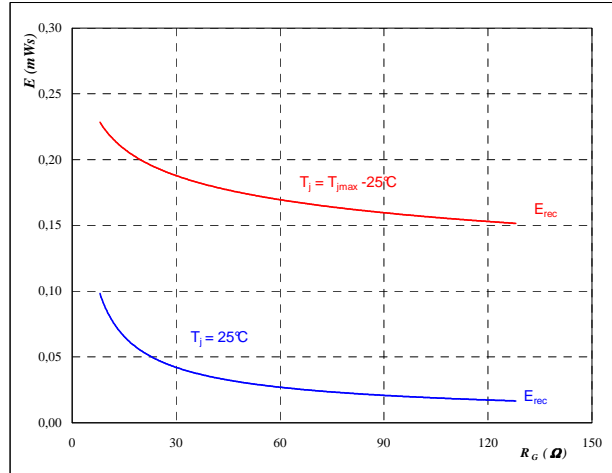
With an inductive load at

$T_j =$	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

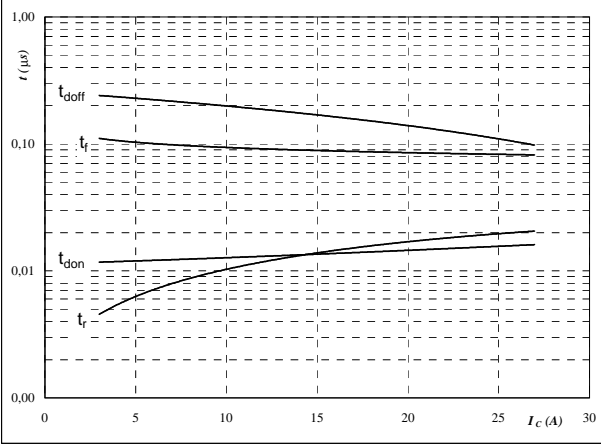


## Brake Characteristics

**Figure 9** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$

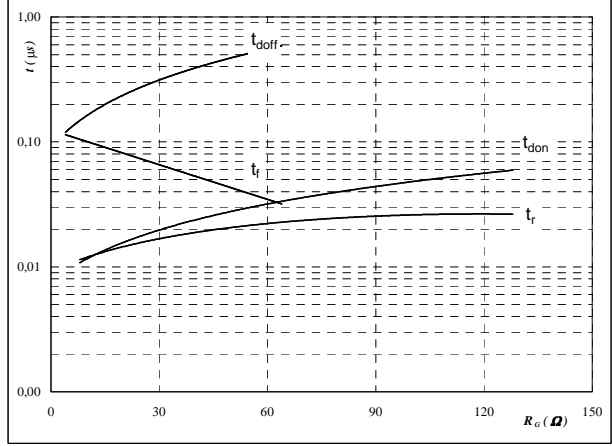


With an inductive load at  
 $T_j = 125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 300 \text{ V}$   
 $V_{GE} = 15 \text{ V}$   
 $R_{gon} = 16 \text{ } \Omega$   
 $R_{goff} = 8 \text{ } \Omega$

**Figure 10** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$

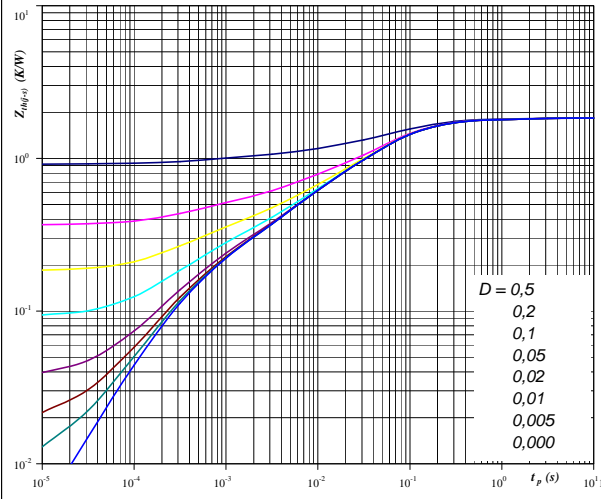


With an inductive load at  
 $T_j = 125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 300 \text{ V}$   
 $V_{GE} = 15 \text{ V}$   
 $I_C = 15 \text{ A}$

**Figure 11** IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{thj-s} = f(t_p)$$



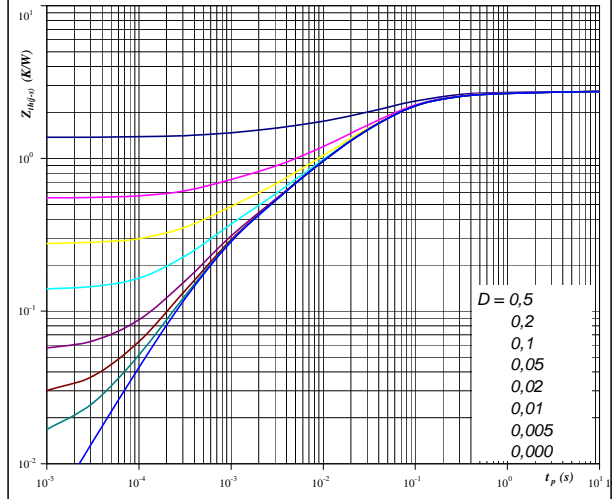
At  $D = t_p / T$

$R_{thjH} = 1,83 \text{ K/W}$

**Figure 12** FWD

FWD transient thermal impedance as a function of pulse width

$$Z_{thj-s} = f(t_p)$$



At  $D = t_p / T$

$R_{thjH} = 2,75 \text{ K/W}$

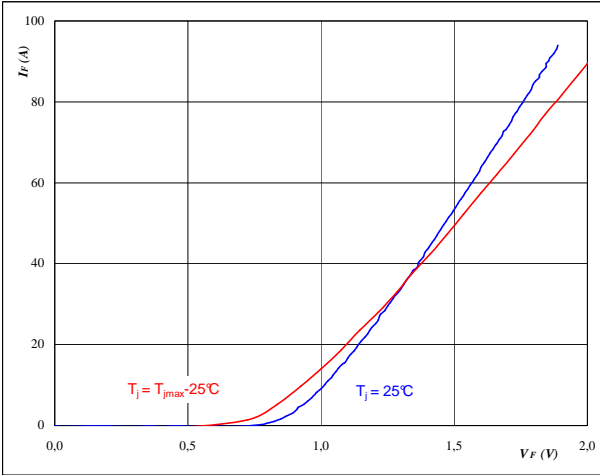


### Rectifier Diode Characteristics

**Figure 1** Diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



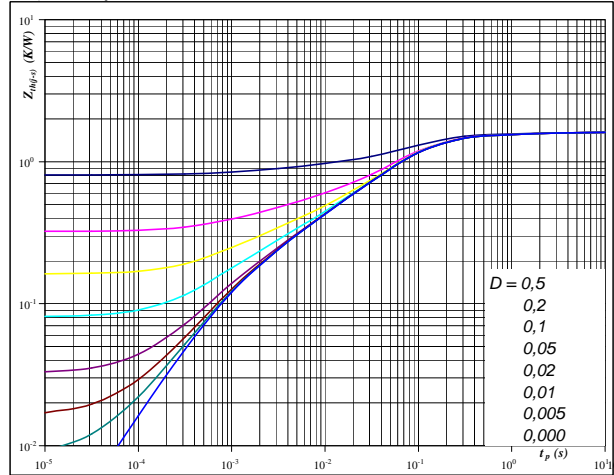
At

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

**Figure 2** Diode

Diode transient thermal impedance as a function of pulse width

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



At

$$D = t_p / T$$

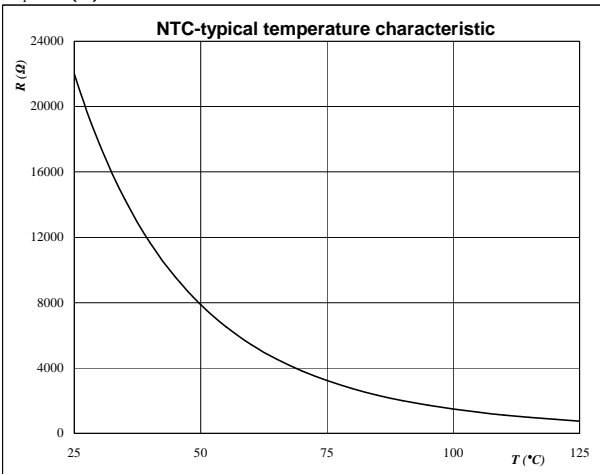
$$R_{th(j-H)} = 1,61 \text{ K/W}$$

### Thermistor

**Figure 1** Thermistor

Typical NTC characteristic as a function of temperature

$$R_T = f(T)$$





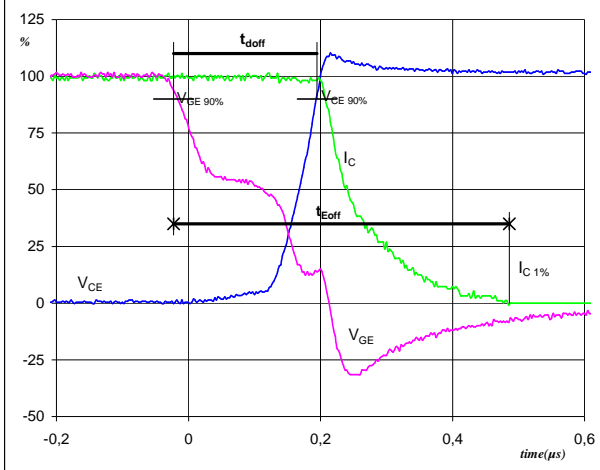
## Switching Definitions Inverter

### General conditions

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

**Figure 1** IGBT

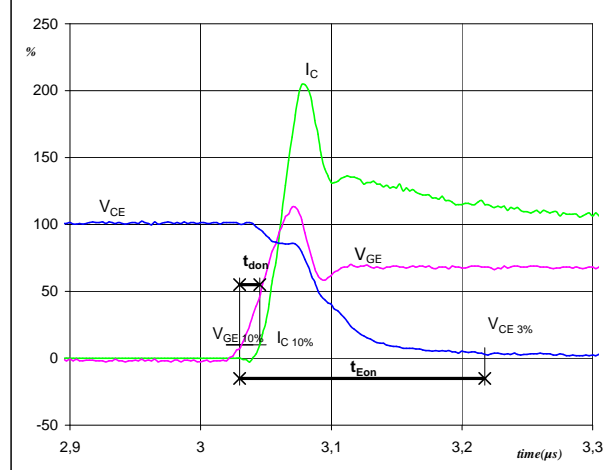
**Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$**   
 ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



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

**Figure 2** IGBT

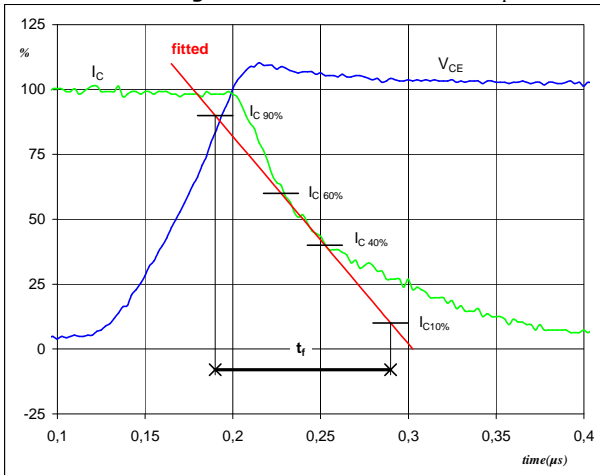
**Turn-on Switching Waveforms & definition of  $t_{donr}$ ,  $t_{Eon}$**   
 ( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{GE}$ (0%) =	0	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_{donr}$ =	0,01	$\mu$ S
$t_{Eon}$ =	0,19	$\mu$ S

**Figure 3** IGBT

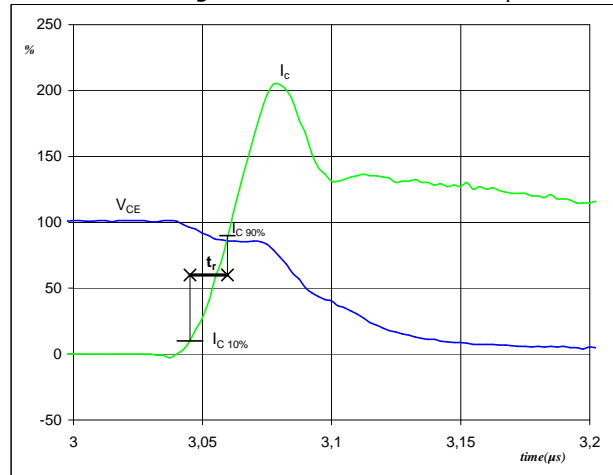
**Turn-off Switching Waveforms & definition of  $t_f$**



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

**Figure 4** IGBT

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



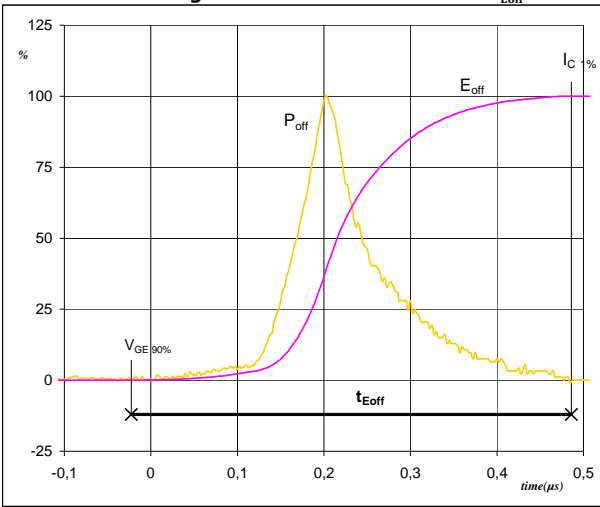
$V_C$ (100%) =	300	V
$I_C$ (100%) =	20	A
$t_r$ =	0,02	$\mu$ S





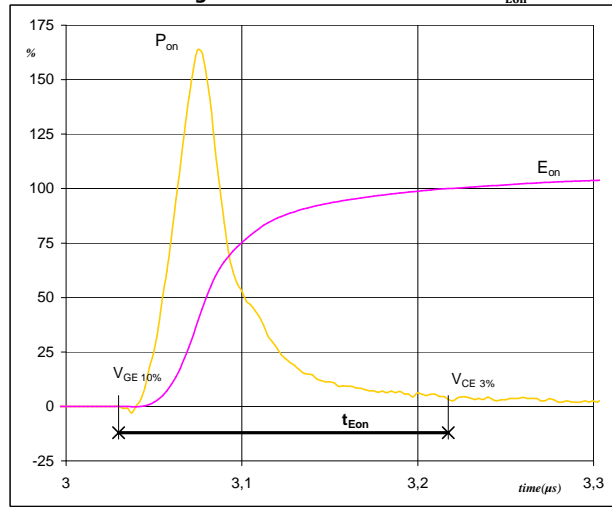
## Switching Definitions Inverter

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



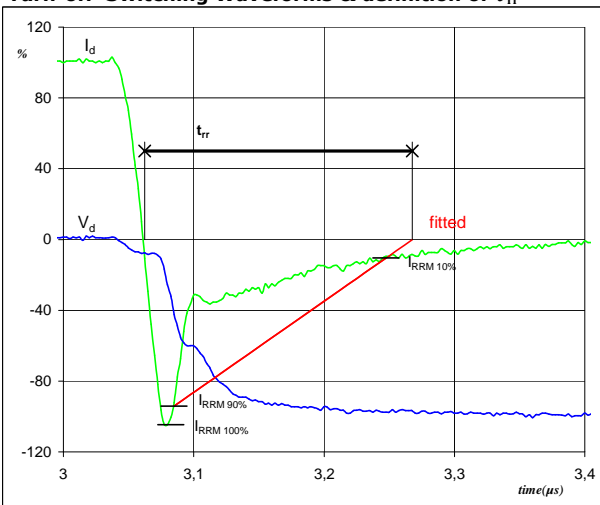
$P_{off} (100\%) = 5,99 \text{ kW}$   
 $E_{off} (100\%) = 0,65 \text{ mJ}$   
 $t_{Eoff} = 0,51 \text{ μs}$

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



$P_{on} (100\%) = 5,99 \text{ kW}$   
 $E_{on} (100\%) = 0,43 \text{ mJ}$   
 $t_{Eon} = 0,19 \text{ μs}$

**Figure 7** FWD  
**Turn-off Switching Waveforms & definition of  $t_{rr}$**



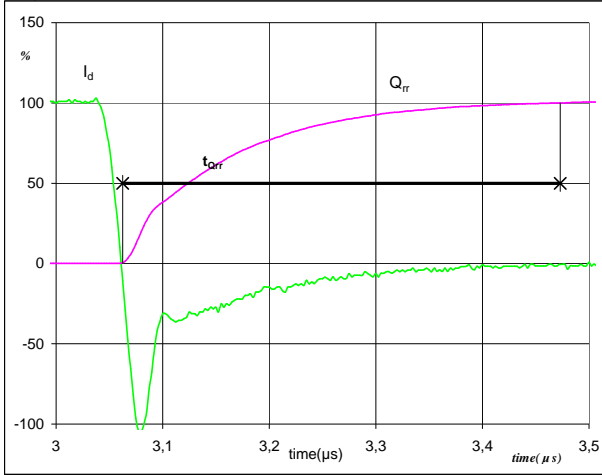
$V_d (100\%) = 300 \text{ V}$   
 $I_d (100\%) = 20 \text{ A}$   
 $I_{RRM} (100\%) = 21 \text{ A}$   
 $t_{rr} = 0,19 \text{ μs}$



## Switching Definitions Inverter

**Figure 8** FWD

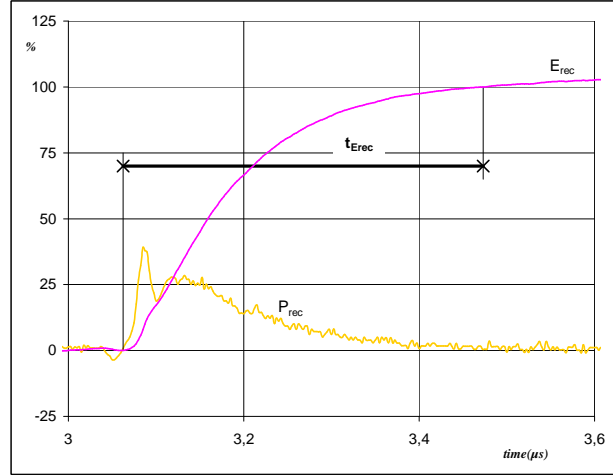
**Turn-on Switching Waveforms & definition of  $t_{Qrr}$**   
 ( $t_{Qrr}$  = integrating time for  $Q_{rr}$ )



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

**Figure 10** 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  $\mu$ s



## Ordering Code and Marking - Outline - Pinout

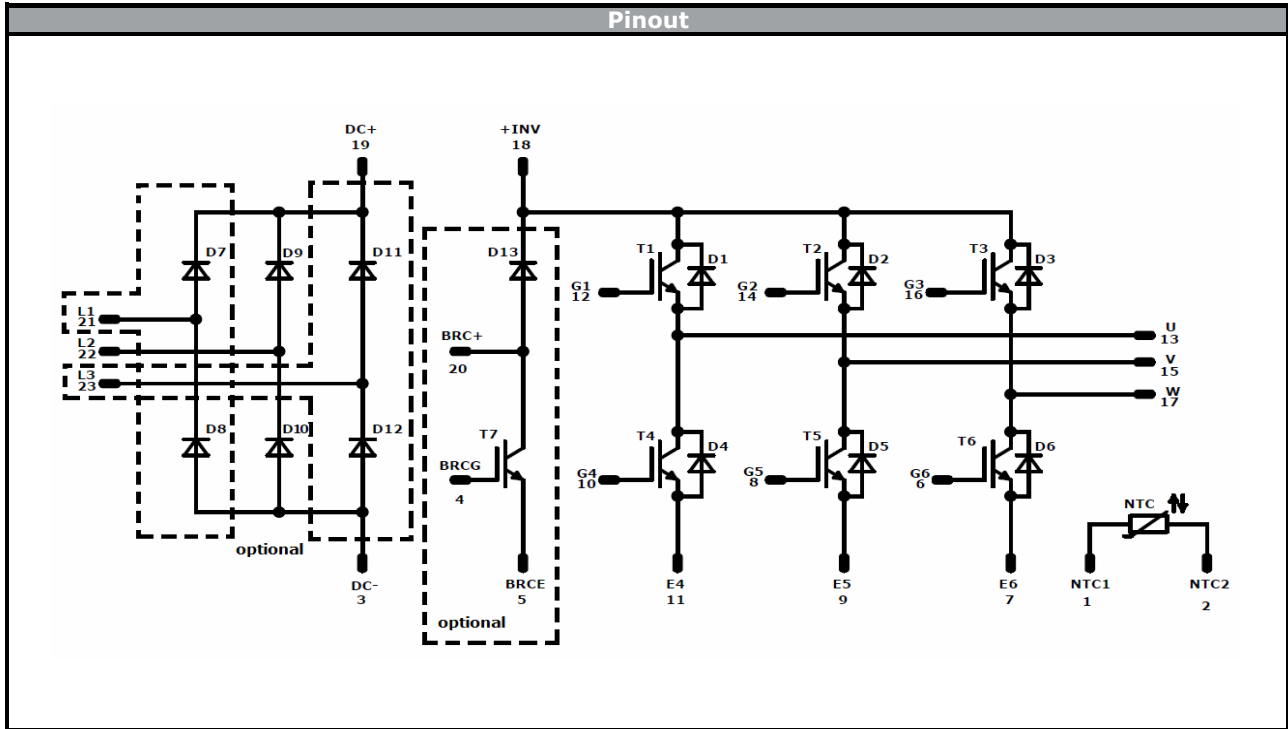
Ordering Code & Marking						
Version			Ordering Code			
without thermal paste 12mm housing with solder pins			V23990-P545-A28-PM			
with thermal paste 12mm housing with solder pins			V23990-P545-A28-/3/-PM			
without thermal paste 17mm housing with solder pins			V23990-P545-A29-PM			
without thermal paste 12mm housing 1 phase rectifier with solder pins			V23990-P545-B28-PM			
with thermal paste 12mm housing 1 phase rectifier with solder pins			V23990-P545-B28-/3/-PM			
with thermal paste 12mm housing 1 phase rectifier with solder pins			V23990-P545-B128-/3/-PM			
without thermal paste 17mm housing 1 phase rectifier with solder pins			V23990-P545-B129-PM			
with thermal paste 17mm housing 1 phase rectifier with solder pins			V23990-P545-B129-/3/-PM			
without thermal paste 17mm housing without brake with solder pins			V23990-P545-C29-PM			
	Text	VIN	Name&Ver	UL	Lot	Serial
		VIN	NNNNNNVV	UL	LLLLL	SSSS
Datamatrix	Name&Ver	Serial	Date Code			
	NNNNNNVV	SSSS	WWYY			

Pin table				Outline	
Pin	X	Y	Function	<p>17 mm housing</p>	
1	25,5	2,7	NTC1		
2	25,5	0	NTC2		
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	<p>12 mm housing</p>	
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		

Pinout variation	
Module subtype	Not assembled pins
V23990-P545-A28-PM	-
V23990-P545-A29-PM	-
V23990-P545-B28-PM	21
V23990-P545-B128-PM	23
V23990-P545-B129-PM	23
V23990-P545-C29-PM	4, 5, 20



## Ordering Code and Marking - Outline - Pinout




Identification					
ID	Component	Voltage	Current	Function	Comment
T1,T2,T3,T4,T5,T6	IGBT	600V	20A	Inverter Switch	
D1,D2,D3,D4,D5,D6	FWD	600V	20A	Inverter Diode	
T7	IGBT	600V	15A	Brake Switch	
D13	FWD	600V	15A	Brake Diode	
D7,D8,D9,D10,D11,D12	Diode	1600V	25A	Rectifier Diode	
NTC	NTC			Thermistor	



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

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

Package data
Package data for <i>flow</i> 0 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-x2x-D7-14	25 Nov. 2018	$R_{thr}$ $I_{max}$ $P_{tot}$ clearance values corrected	All

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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.