



flowCON 0

1600 V / 105 A

**Features**

- modular Input Rectifier & BRC-Circuit for 30kW Motor Drive
- 1 or 3 phase rectifier (optional half controlled)
- 3 phase rectifier with breake
- compatible with 3 x flow PHASE 0

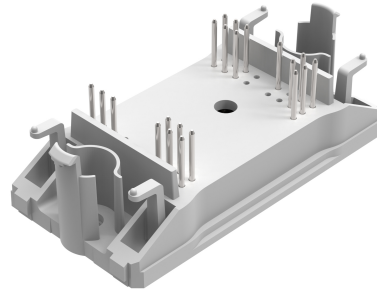
**Target applications**

- Industrial Drives

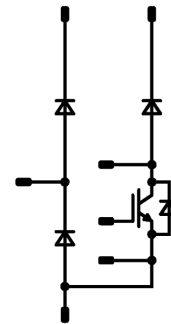
**Types**

- V23990-P600-I09-PM

**flow 0 17 mm housing**



**Schematic**



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

Parameter	Symbol	Conditions	Value	Unit
<b>Brake Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	80	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	225	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	174	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 900\text{ V}$ $T_j = 125\text{ °C}$	10	$\mu\text{s}$
Maximum junction temperature	$T_{jmax}$		175	$^{\circ}\text{C}$

**Brake Diode**

Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	43	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	100	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	75	W
Maximum junction temperature	$T_{jmax}$		150	$^{\circ}\text{C}$

**Brake Sw. Protection Diode**

Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	15	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	15	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	32	W
Maximum junction temperature	$T_{jmax}$		150	$^{\circ}\text{C}$



## Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
<b>Rectifier Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	109	A
Surge (non-repetitive) forward current	$I_{FSM}$	Single Half Sine Wave, $t_p = 10\text{ ms}$ $T_j = 125\text{ °C}$	1380	A
Surge current capability	$I^2t$		9520	A <sup>2</sup> s
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	139	W
Maximum junction temperature	$T_{jmax}$		150	°C

## Module Properties

### Thermal Properties

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

### Isolation Properties

Isolation voltage	$V_{isol}$	DC Test Voltage* $t_p = 2\text{ s}$	4000	V
Creepage distance			>12,7	mm
Clearance			>12,7	mm
Comparative Tracking Index	CTI		≥ 200	

\*100 % tested in production



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### Characteristic Values

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

#### Brake Switch

##### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,003	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		75	25 125	1,4	1,71 1,97	2,1 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	1200		25			10,1	μA
Gate-emitter leakage current	$I_{GES}$		20	0		25			600	nA
Internal gate resistance	$r_g$							10		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	20		25		5345		pF
Reverse transfer capacitance	$C_{res}$									
Gate charge	$Q_g$		15		0	25		700		nC

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						0,55		K/W
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##### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 4 \Omega$ $R_{goff} = 4 \Omega$	0/15	700	75	25		62,08		ns
Rise time	$t_r$					125		62,08		ns
						25		27,84		ns
Turn-off delay time	$t_{d(off)}$					125		30,72		ns
						25		631,36		ns
Fall time	$t_f$					125		756,16		ns
						25		58,98		ns
Turn-on energy (per pulse)	$E_{on}$	125		153,87		mWs				
		25		6,07		mWs				
Turn-off energy (per pulse)	$E_{off}$	125		8,03		mWs				
		25		5,77		mWs				
						9,42				



### Characteristic Values

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

#### Brake Diode

##### Static

Forward voltage	$V_F$				50	25 125	1,23	1,85 1,89	1,95 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 1200$ V				25			27	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						0,93		K/W
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##### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=3083$ A/μs $di/dt=2859$ A/μs	0/15	700	75	25 125		66,32 81,03		A
Reverse recovery time	$t_{rr}$					25 125		285,17 430,61		ns
Recovered charge	$Q_r$					25 125		6,03 10,78		μC
Reverse recovered energy	$E_{rec}$					25 125		2,64 4,98		mWs
Peak rate of fall of recovery current	$(di_r/dt)_{max}$					25 125		2221 1483		A/μs

#### Brake Sw. Protection Diode

##### Static

Forward voltage	$V_F$				7,5	25 125	1,23	1,66 1,62	1,97 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 1200$ V				25			27	μA

##### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,2		K/W
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Vincotech

### Characteristic Values

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

### Rectifier Diode

#### Static

Forward voltage	$V_F$				77	25 125		1,2 1,11	1,21 <sup>(1)</sup> 1,1 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 1600$ V				25			50	μA

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						0,5		K/W
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<sup>(1)</sup> Value at chip level

<sup>(2)</sup> Only valid with pre-applied Vincotech thermal interface material.

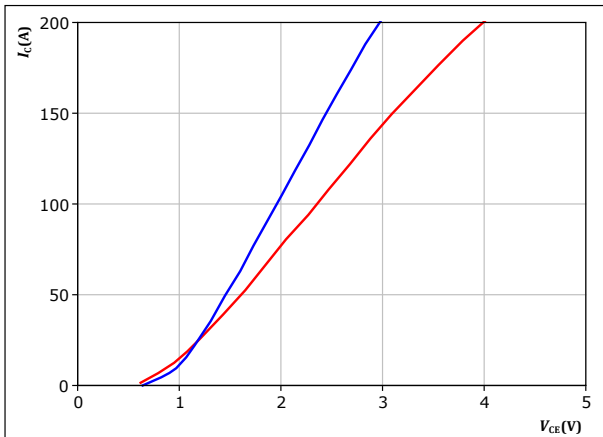


## Brake Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

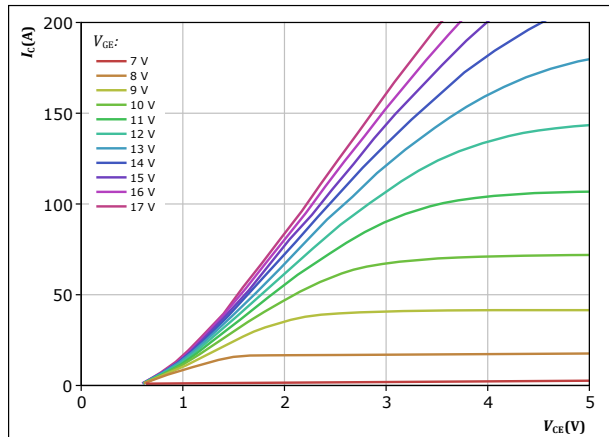


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_j: 25^\circ C$  (blue line)  
 $125^\circ C$  (red line)

figure 2. IGBT

Typical output characteristics

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

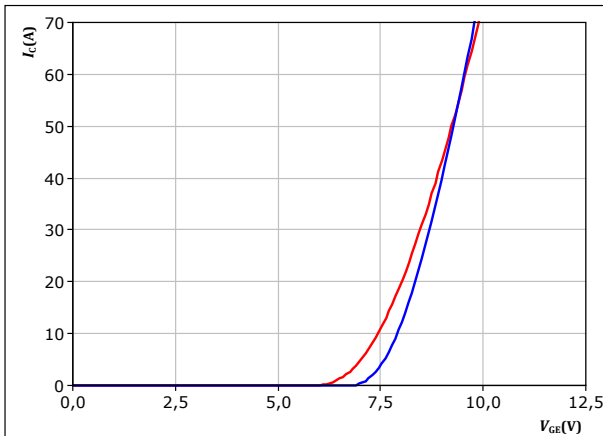


$t_p = 250 \mu s$   
 $T_j = 125^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

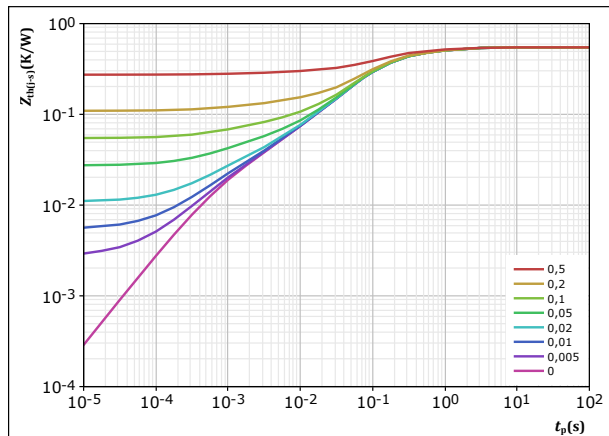


$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_j: 25^\circ C$  (blue line)  
 $125^\circ C$  (red line)

figure 4. IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 0,547 K/W$   
IGBT thermal model values  

R (K/W)	$\tau$ (s)
7,87E-02	1,38E+00
1,57E-01	2,43E-01
2,74E-01	7,84E-02
2,46E-02	4,30E-03
1,24E-02	6,52E-04

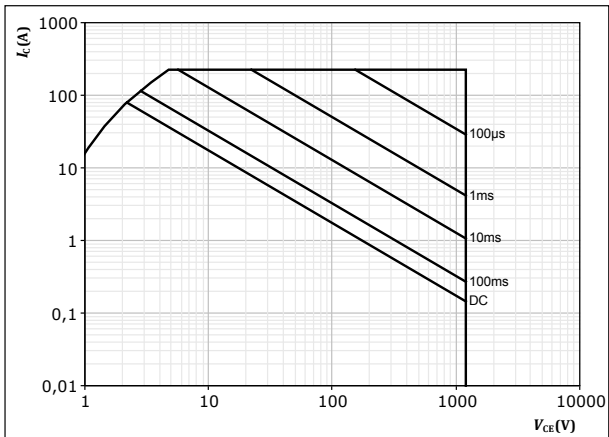


### Brake Switch Characteristics

figure 5. IGBT

Safe operating area

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



$D =$  single pulse  
 $T_s = 80 \text{ } ^\circ\text{C}$   
 $V_{CE} = 15 \text{ V}$   
 $T_j = T_{jmax}$





## Brake Diode Characteristics

figure 6. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

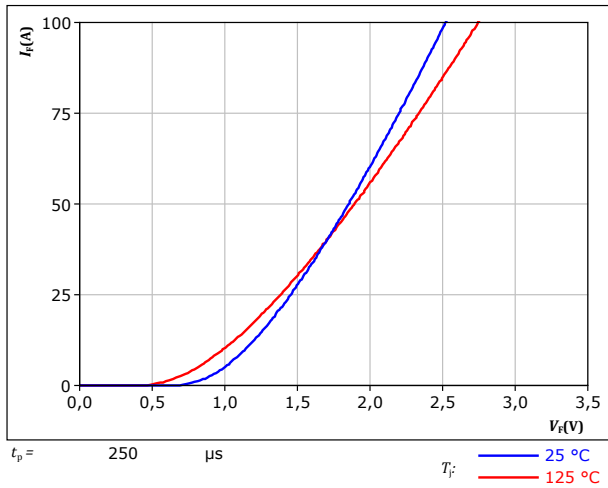
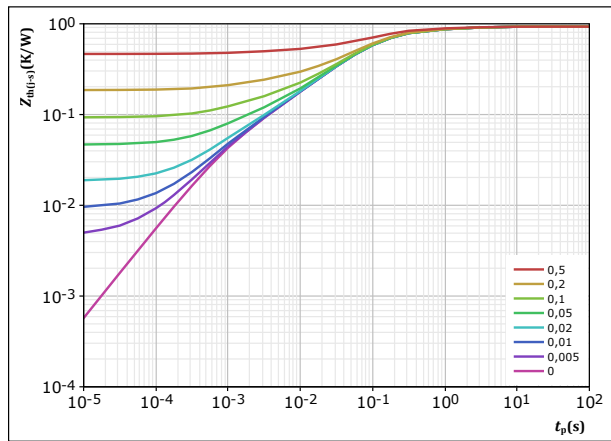


figure 7. FWD

Transient thermal impedance as a function of pulse width

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



$D = \frac{t_p}{T}$   
 $R_{th(j-s)} = 0,93 \text{ K/W}$   
 FWD thermal model values

$R$ (K/W)	$\tau$ (s)
5,72E-02	2,80E+00
1,20E-01	5,37E-01
4,66E-01	1,06E-01
1,66E-01	3,81E-02
7,82E-02	8,59E-03
4,25E-02	1,08E-03

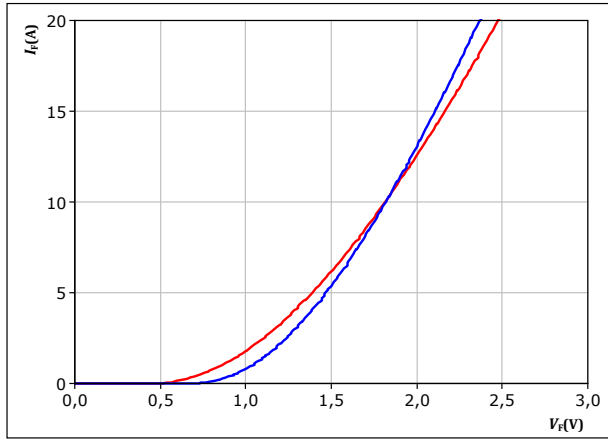


## Brake Sw. Protection Diode Characteristics

figure 8. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

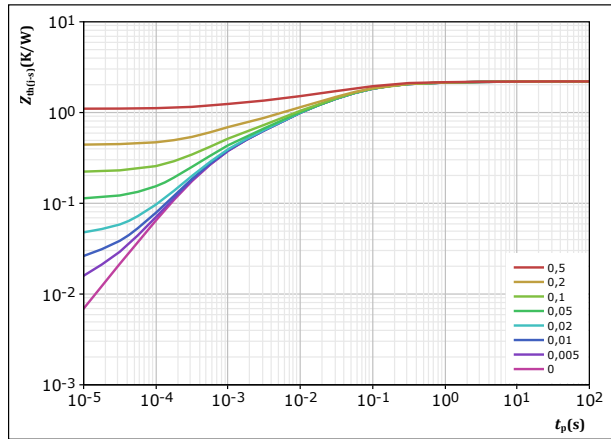


$t_p = 250\ \mu\text{s}$   
 $T_j:$  — 25 °C  
 — 125 °C

figure 9. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 2,202\ \text{K/W}$   
 FWD thermal model values

$R$ (K/W)	$\tau$ (s)
4,63E-02	5,76E+00
1,60E-01	5,24E-01
7,96E-01	7,03E-02
5,50E-01	1,58E-02
3,61E-01	3,60E-03
2,88E-01	5,25E-04

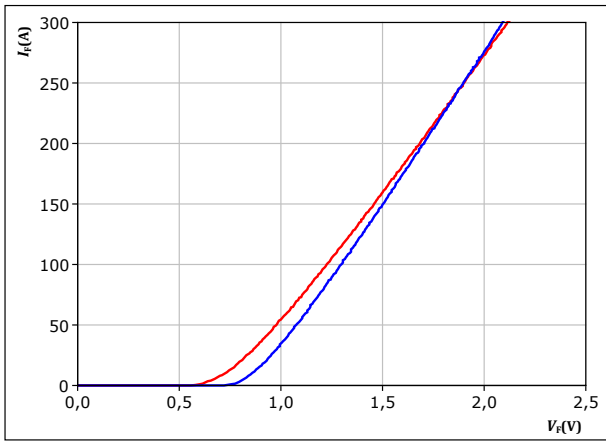


## Rectifier Diode Characteristics

figure 10. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$



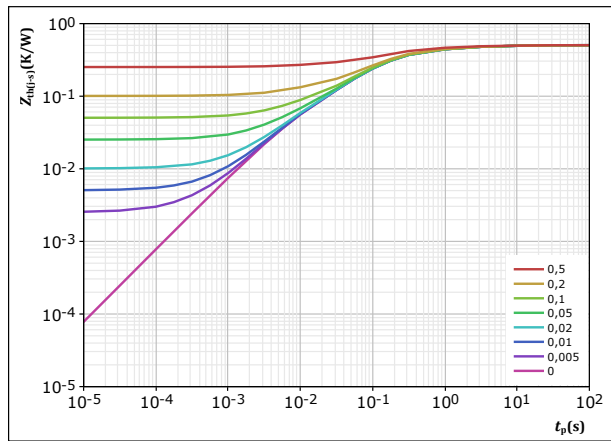
$t_p = 250 \mu s$

$T_j$ : — 25 °C  
— 125 °C

figure 11. Rectifier

Transient thermal impedance as a function of pulse width

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



$$D = t_p / T$$

$$R_{th(j-s)} = 0,504 \text{ K/W}$$

Rectifier thermal model values

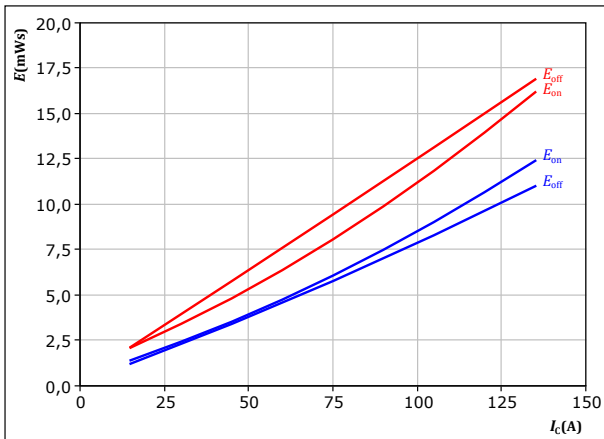
R (K/W)	$\tau$ (s)
2,79E-02	9,21E+00
7,78E-02	1,20E+00
1,49E-01	2,49E-01
2,15E-01	8,46E-02
3,51E-02	7,65E-03



## Brake Switching Characteristics

**figure 12.** IGBT

Typical switching energy losses as a function of collector current  
 $E = f(I_c)$



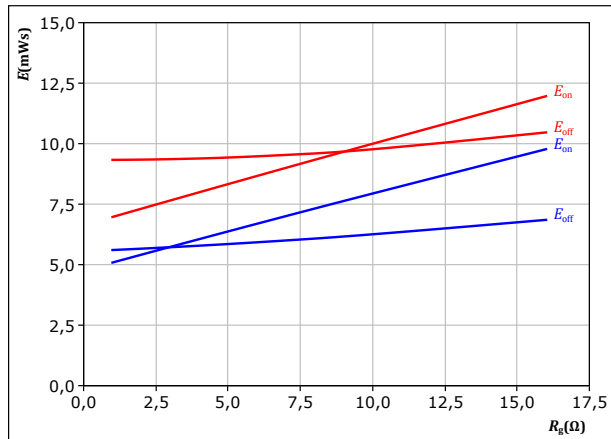
With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 4$   $\Omega$   
 $R_{goff} = 4$   $\Omega$

$T_j$ : — 25 °C  
— 125 °C

**figure 13.** IGBT

Typical switching energy losses as a function of gate resistor  
 $E = f(R_g)$



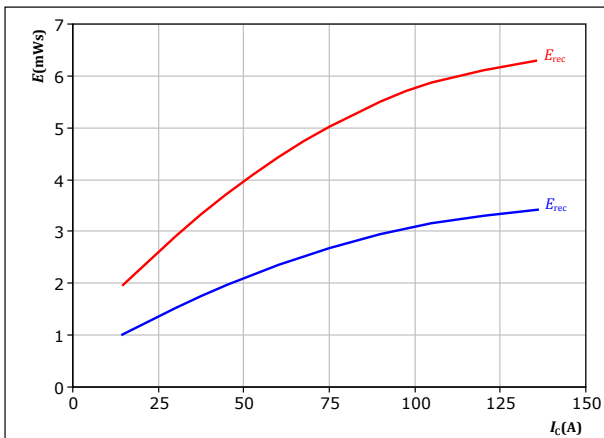
With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 75$  A

$T_j$ : — 25 °C  
— 125 °C

**figure 14.** FWD

Typical reverse recovered energy loss as a function of collector current  
 $E_{rec} = f(I_c)$



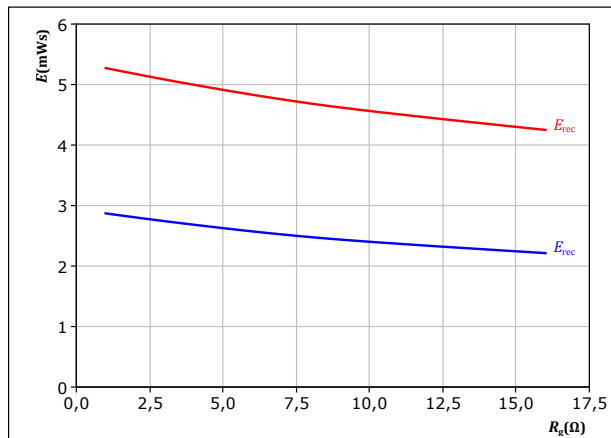
With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 4$   $\Omega$

$T_j$ : — 25 °C  
— 125 °C

**figure 15.** FWD

Typical reverse recovered energy loss as a function of gate resistor  
 $E_{rec} = f(R_g)$



With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 75$  A

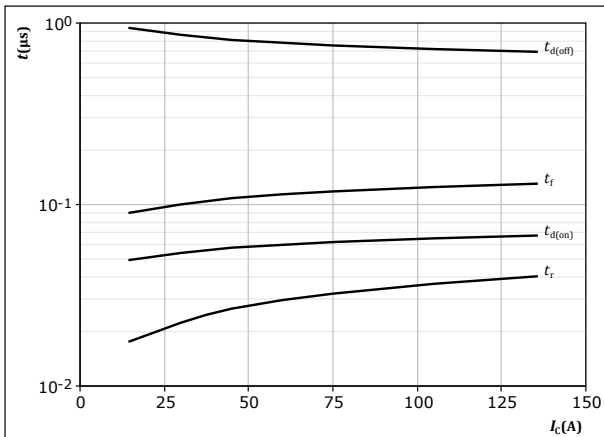
$T_j$ : — 25 °C  
— 125 °C



## Brake Switching Characteristics

**figure 16.** IGBT

Typical switching times as a function of collector current  
 $t = f(I_C)$

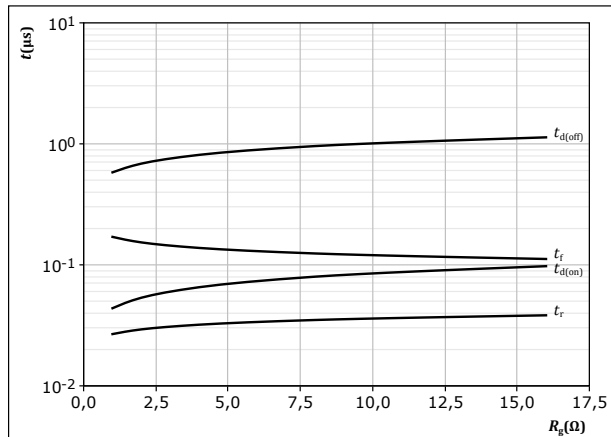


With an inductive load at

$T_j = 125$  °C  
 $V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 4$  Ω  
 $R_{goff} = 4$  Ω

**figure 17.** IGBT

Typical switching times as a function of gate resistor  
 $t = f(R_g)$

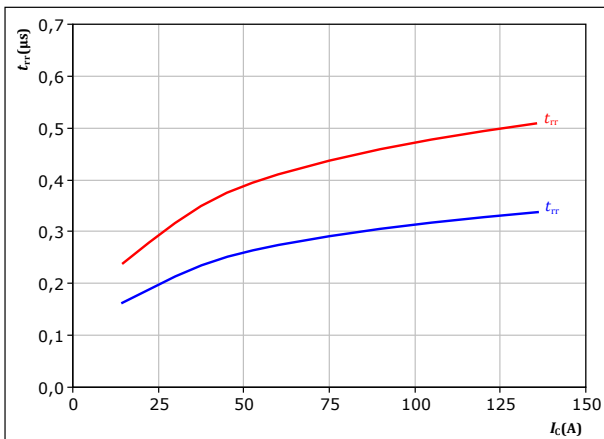


With an inductive load at

$T_j = 125$  °C  
 $V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_C = 75$  A

**figure 18.** FWD

Typical reverse recovery time as a function of collector current  
 $t_{rr} = f(I_C)$



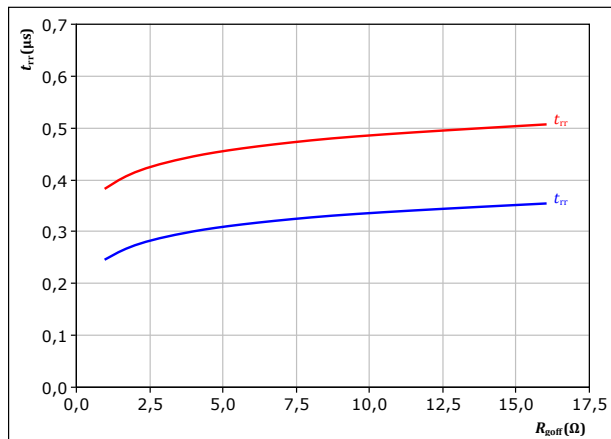
With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{gon} = 4$  Ω

$T_j$ : — 25 °C  
— 125 °C

**figure 19.** FWD

Typical reverse recovery time as a function of IGBT turn off gate resistor  
 $t_{rr} = f(R_{goff})$



With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_C = 75$  A

$T_j$ : — 25 °C  
— 125 °C

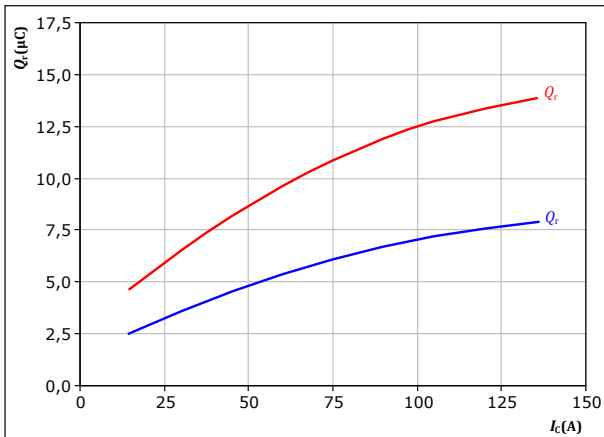


## Brake Switching Characteristics

**figure 20.** FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

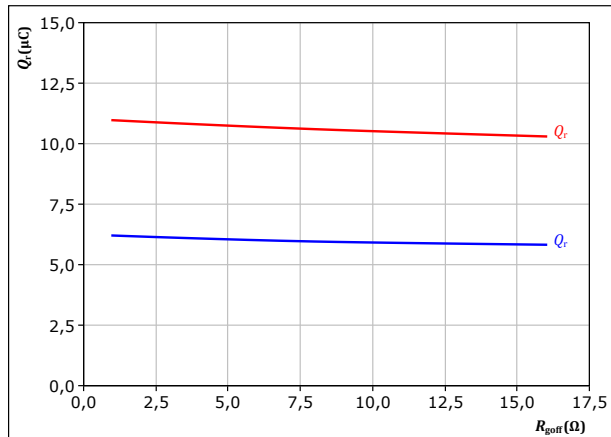
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{goff} = 4$  Ω

$T_j$ : — 25 °C  
— 125 °C

**figure 21.** FWD

Typical recovered charge as a function of turn off gate resistor

$$Q_r = f(R_{goff})$$



With an inductive load at

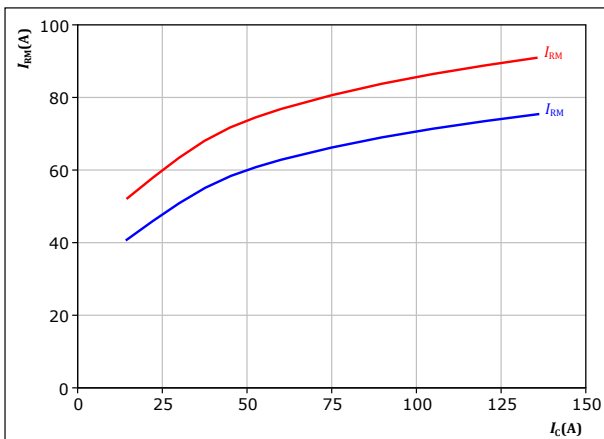
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 75$  A

$T_j$ : — 25 °C  
— 125 °C

**figure 22.** FWD

Typical peak reverse recovery current as a function of collector current

$$I_{RM} = f(I_c)$$



With an inductive load at

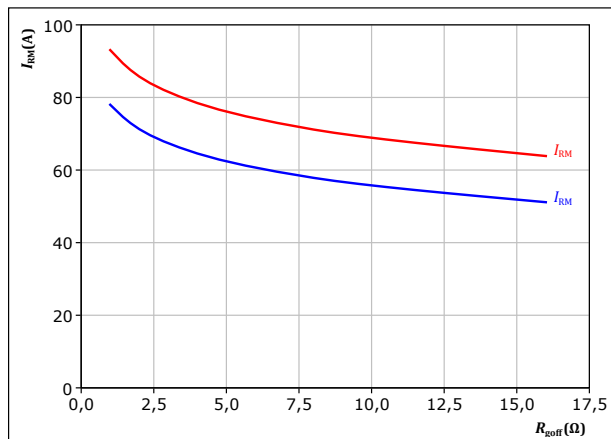
$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $R_{goff} = 4$  Ω

$T_j$ : — 25 °C  
— 125 °C

**figure 23.** FWD

Typical peak reverse recovery current as a function of turn off gate resistor

$$I_{RM} = f(R_{goff})$$



With an inductive load at

$V_{CE} = 700$  V  
 $V_{GE} = 0/15$  V  
 $I_c = 75$  A

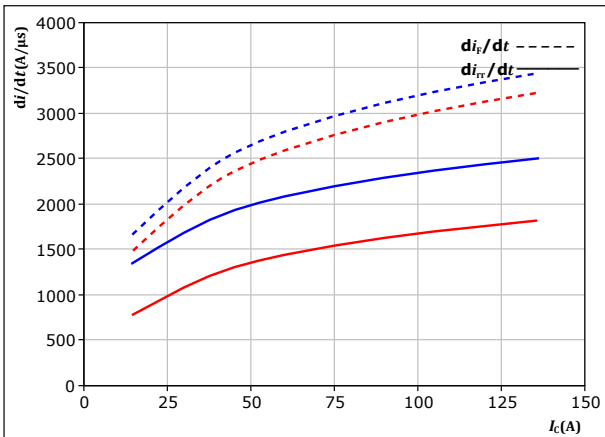
$T_j$ : — 25 °C  
— 125 °C



## Brake Switching Characteristics

**figure 24.** FWD

Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_r/dt = f(I_c)$



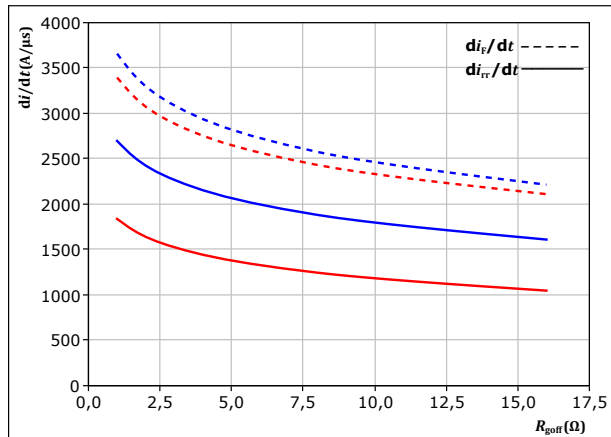
With an inductive load at

$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $R_{goff} = 4 \text{ } \Omega$

$T_j$ : — 25 °C  
 — 125 °C

**figure 25.** FWD

Typical rate of fall of forward and reverse recovery current as a function of turn off gate resistor  
 $di_f/dt, di_r/dt = f(R_{goff})$



With an inductive load at

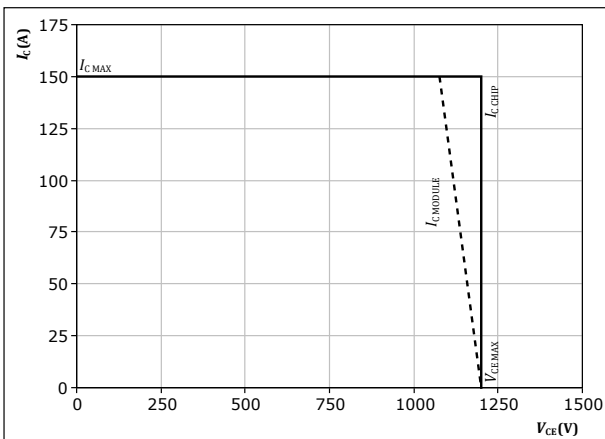
$V_{CE} = 700 \text{ V}$   
 $V_{GE} = 0/15 \text{ V}$   
 $I_c = 75 \text{ A}$

$T_j$ : — 25 °C  
 — 125 °C

**figure 26.** IGBT

Reverse bias safe operating area

$I_c = f(V_{CE})$



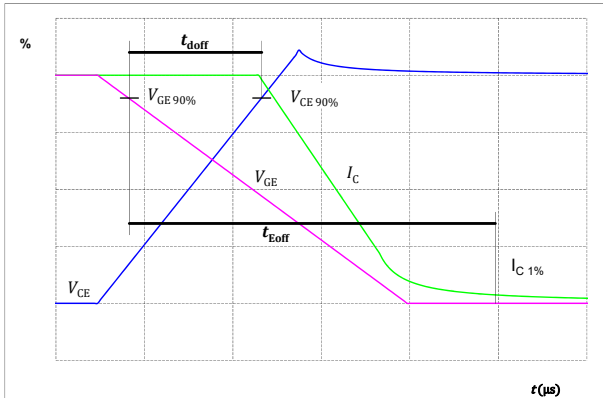
At  $T_j = 125 \text{ } ^\circ\text{C}$   
 $R_{goff} = 4 \text{ } \Omega$   
 $R_{goff} = 4 \text{ } \Omega$



## Brake Switching Definitions

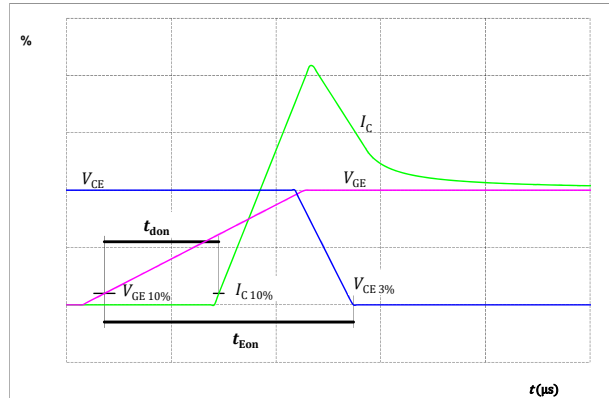
**figure 27.** IGBT

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



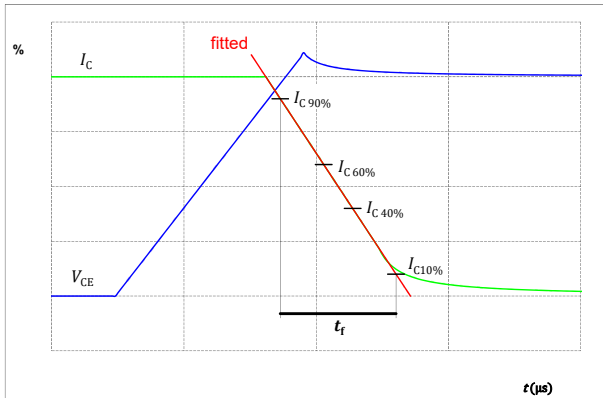
**figure 28.** IGBT

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



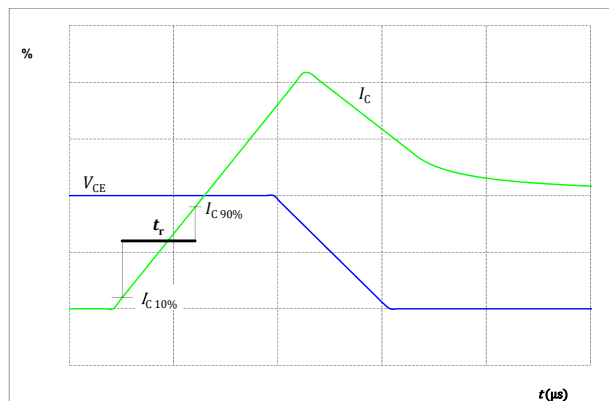
**figure 29.** IGBT

Turn-off Switching Waveforms & definition of  $t_f$



**figure 30.** IGBT

Turn-on Switching Waveforms & definition of  $t_r$







### Brake Switching Definitions

figure 31. FWD

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

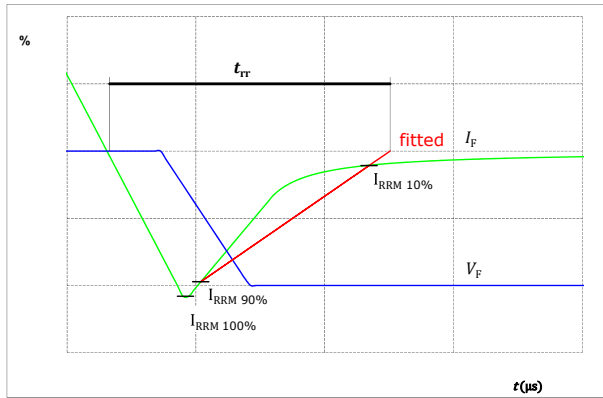
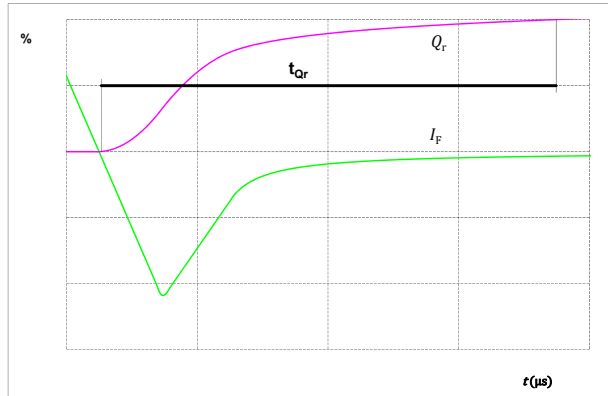


figure 32. FWD

Turn-on Switching Waveforms & definition of  $t_{Qr}$  ( $t_{Qr}$  = integrating time for  $Q_r$ )





Vincotech

**V23990-P600-I09-PM**  
datasheet

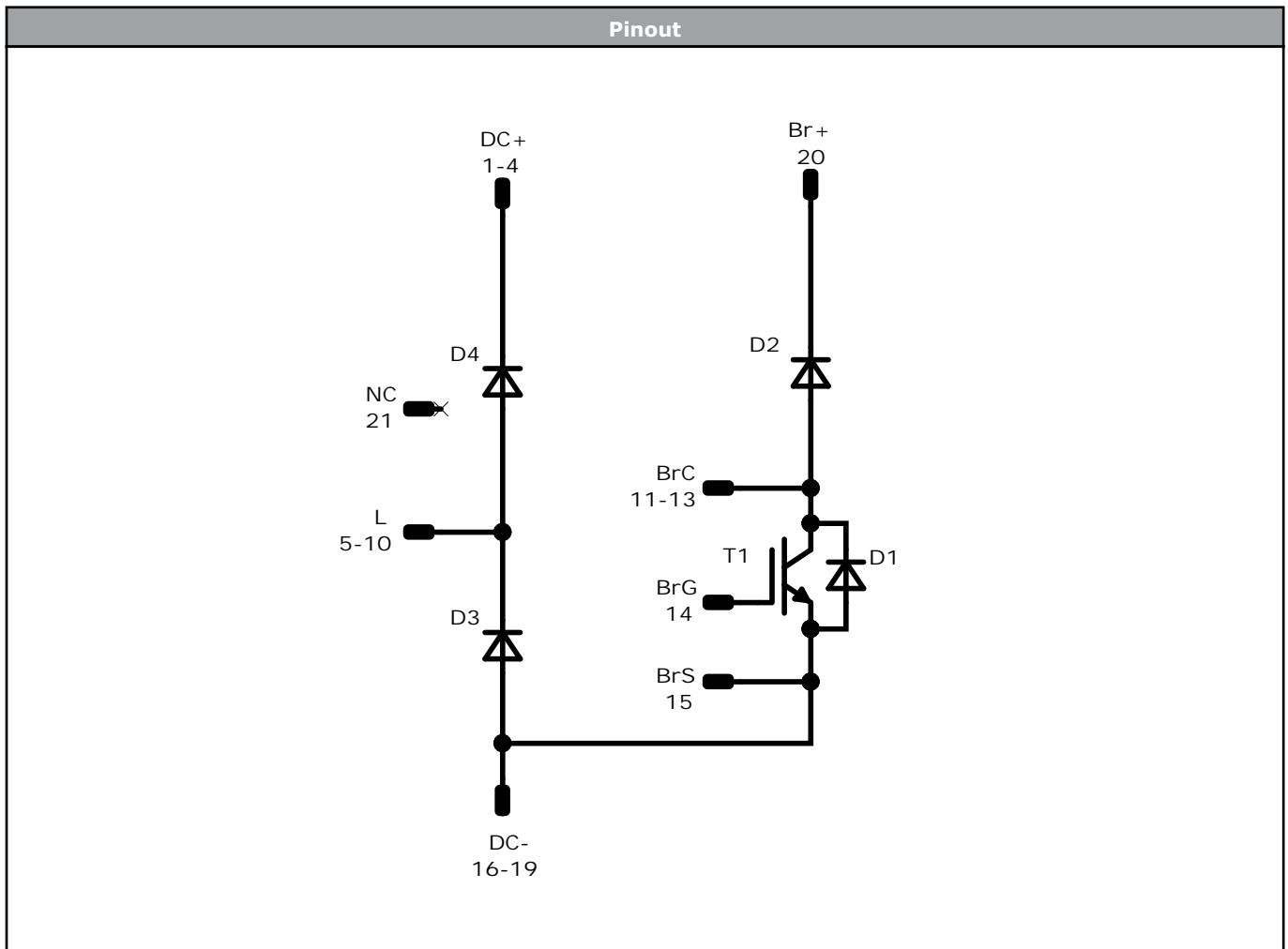
Ordering Code	
<b>Version</b>	<b>Ordering Code</b>
Without thermal paste	V23990-P600-I09-PM
With thermal paste (5,2 W/mK, PTM6000HV)	V23990-P600-I09-/7/-PM
With thermal paste (3,4 W/mK, PSX-P7)	V23990-P600-I09-/3/-PM

Marking							
	<b>Text</b>	<b>VIN</b>	<b>Date code</b>	<b>Type&amp;Ver</b>	<b>UL</b>	<b>Lot</b>	<b>Serial</b>
		VIN	WWYY	TTTTTTVV	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	X	Y	Function	
1	33,3	2,8	DC+	
2	33,3	0	DC+	
3	30,5	0	DC+	
4	28,1	0	DC+	
5	2,4	5,6	L	
6	2,4	2,8	L	
7	2,4	0	L	
8	0	0	L	
9	0	2,8	L	
10	0	5,6	L	
11	0	16,6	BrC	
12	0	19,4	BrC	
13	0	22,2	BrC	
14	30,5	22,2	BrG	
15	30,5	19,4	BrS	
16	33,3	22,2	DC-	
17	33,3	19,4	DC-	
18	33,3	16,6	DC-	
19	30,5	16,6	DC-	
20	33,3	8,4	Br+	
21	30,5	2,8	NC	

Technical drawings showing side and top views of the component. The side view shows a height of 213 ±0,5 mm and a pin diameter of  $\phi 1 \pm 0,05$  mm. The top view shows a width of 16,65 mm and a height of 11 mm. Coordinate axes X and Y are indicated.

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	IGBT	1200 V	75 A	Brake Switch	
D2	FWD	1200 V	50 A	Brake Diode	
D1	FWD	1200 V	7,5 A	Brake Sw. Protection Diode	
D3, D4	Rectifier	1600 V	140 A	Rectifier Diode	




Packaging instruction				
Standard packaging quantity (SPQ) 135	>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.

Vincotech thermistor reference
See Vincotech thermistor reference table at 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-P600-I09-PM-D3-14	18 Sep. 2021	New Datasheet format, module is unchanged Separate datasheet for BRC version Update Dynamic measurements	

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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.