



Vincotech

## V23990-P861-F49-PM

datasheet

flowPACK 0

600 V / 10 A

### Features

- Trench Fieldstop IGBT3 technology
- Compact and low inductance design
- Built-in NTC

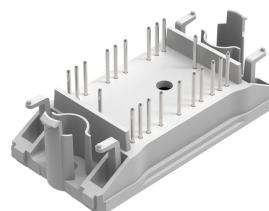
### Target applications

- Motor Drives
- Power Generation
- UPS

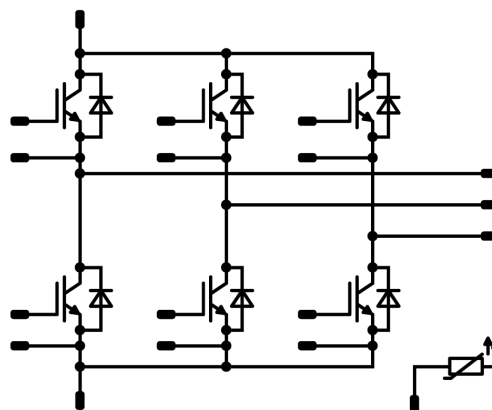
### Types

- V23990-P861-F49-PM

### flow 0 17 mm housing



### Schematic





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## Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter voltage	$V_{CES}$		600	V
Collector current (DC current)	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	17	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	30	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$	$V_{GE} = 15\text{ V}$ , $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	$\mu\text{s}$
Maximum junction temperature	$T_{jmax}$		175	°C

## Inverter Diode

Peak repetitive reverse voltage	$V_{RRM}$		600	V
Forward current (DC current)	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	16	A
Repetitive peak forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	20	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	32	W
Maximum junction temperature	$T_{jmax}$		175	°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* $t_p = 2\text{ s}$	6000	V
Isolation voltage	$V_{isol}$	AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			>12,7	mm
Clearance			>12,7	mm
Comparative Tracking Index	CTI		$\geq 200$	

\*100 % tested in production



## 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	

### Inverter Switch

#### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00015	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CEsat}$		15		10	25 150	1,1	1,5 1,8	1,9 <sup>(1)</sup>	V
Collector-emitter cut-off current	$I_{CES}$		0	600		25			0,6	µA
Gate-emitter leakage current	$I_{GES}$		20	0		25			300	nA
Internal gate resistance	$r_g$							None		Ω
Input capacitance	$C_{ies}$	$f = 1 \text{ Mhz}$	0	25		25		551		pF
Output capacitance	$C_{oes}$							40		pF
Reverse transfer capacitance	$C_{res}$							17		pF

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						2,15		K/W
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#### Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \text{ Ω}$ $R_{goff} = 32 \text{ Ω}$	±15	300	10	25 150		73,6 73,2		ns
Rise time	$t_r$					25 150		11,6 17,2		ns
Turn-off delay time	$t_{d(off)}$					25 150		109,4 129,4		ns
Fall time	$t_f$					25 150		100,24 118,41		ns
Turn-on energy (per pulse)	$E_{on}$					25 150		0,156 0,212		mWs
Turn-off energy (per pulse)	$E_{off}$					25 150		0,231 0,303		mWs



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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	

### Inverter Diode

#### Static

Forward voltage	$V_F$				10	25 150	1,25	1,61 1,56	1,95 <sup>(1)</sup>	V
Reverse leakage current	$I_R$	$V_r = 600$ V				25			27	μA

#### Thermal

Thermal resistance junction to sink <sup>(2)</sup>	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,99		K/W
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#### Dynamic

Peak recovery current	$I_{RRM}$	$di/dt=1006$ A/μs $di/dt=816$ A/μs	$\pm 15$	300	10	25 150		9,69 11,53		A
Reverse recovery time	$t_{rr}$					25 150		143,23 158,09		ns
Recovered charge	$Q_r$					25 150		0,485 0,905		μC
Reverse recovered energy	$E_{rec}$					25 150		0,104 0,195		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 150		401,89 120,39		A/μs



## 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	

## Thermistor

### Static

Rated resistance	$R$					25		22		kΩ
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1484 \Omega$				100	-5		5	%
Power dissipation	$P$							5		mW
Power dissipation constant	$d$					25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 1 \%$						3962		K
B-value	$B_{(25/100)}$	Tol. $\pm 1 \%$						4000		K
Vincotech Thermistor Reference									I	

<sup>(1)</sup> Value at chip level

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



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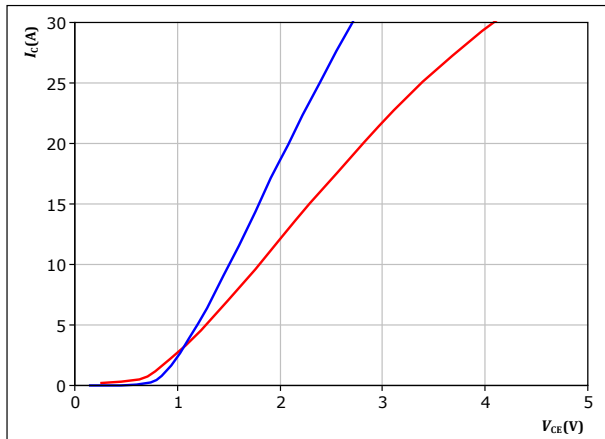
**V23990-P861-F49-PM**  
datasheet

## Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

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

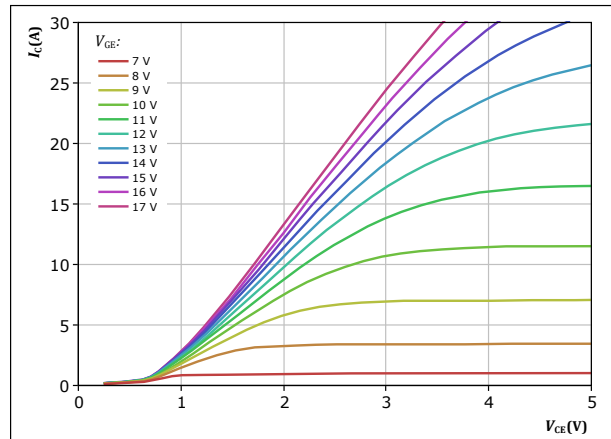


$t_p = 250 \mu s$   
 $V_{GE} = 15 V$   
 $T_J: 25 ^\circ C$   
 $150 ^\circ C$

**figure 2.** IGBT

Typical output characteristics

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

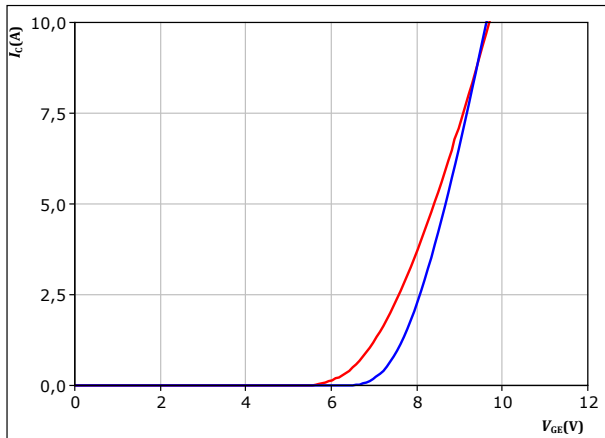


$t_p = 250 \mu s$   
 $T_J = 150 ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

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

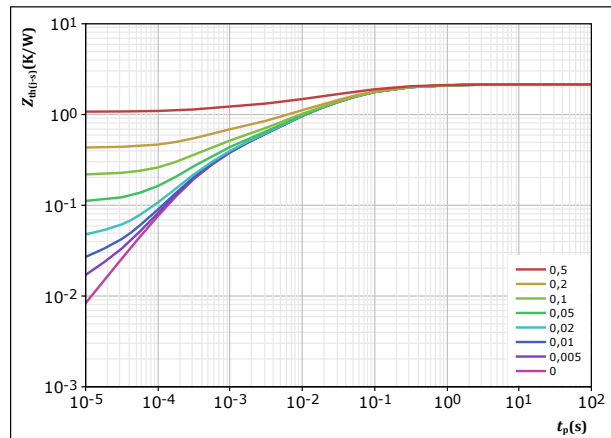


$t_p = 250 \mu s$   
 $V_{CE} = 10 V$   
 $T_J: 25 ^\circ C$   
 $150 ^\circ C$

**figure 4.** IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 2,149 K/W$   
IGBT thermal model values  

$R (K/W)$	$\tau (s)$
1,04E-01	1,37E+00
2,88E-01	2,01E-01
6,99E-01	5,27E-02
4,91E-01	1,22E-02
3,07E-01	2,97E-03
2,60E-01	3,80E-04



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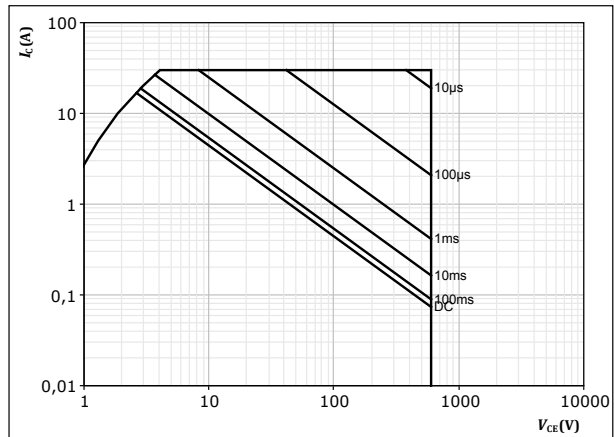
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datasheet

## Inverter Switch Characteristics

**figure 5.** IGBT

Safe operating area

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



$D =$  single pulse

$T_s = 80$  °C

$V_{GE} = 15$  V

$T_j = T_{jmax}$



## Inverter Diode Characteristics

figure 6. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

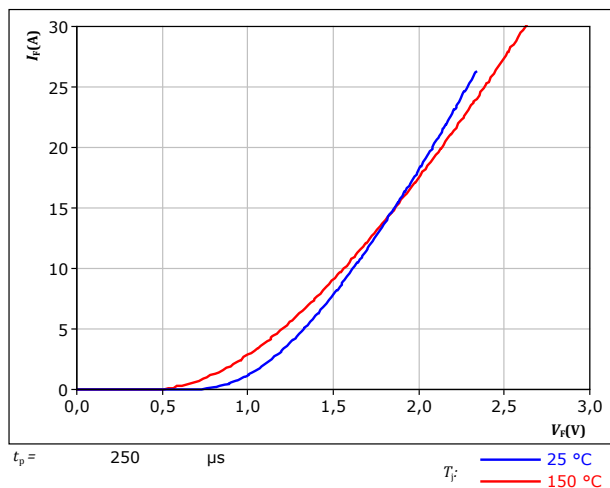
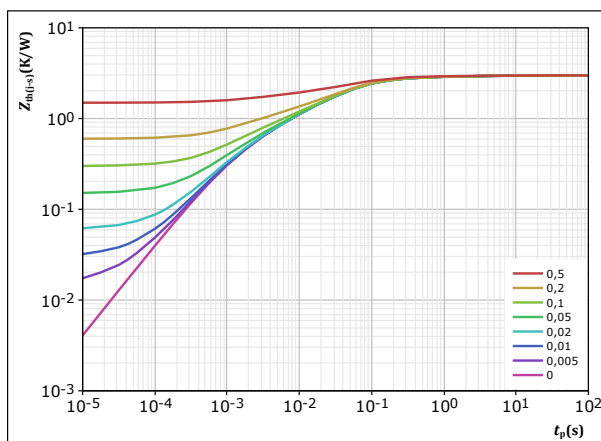


figure 7. FWD

Transient thermal impedance as a function of pulse width

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



$D =$	$t_p / T$	
$R_{th(j-s)} =$	2,988	K/W
FWD thermal model values		
$R$ (K/W)	$\tau$ (s)	
8,74E-02	5,59E+00	
2,41E-01	4,60E-01	
1,22E+00	6,53E-02	
6,89E-01	2,20E-02	
4,52E-01	5,14E-03	
2,99E-01	1,11E-03	



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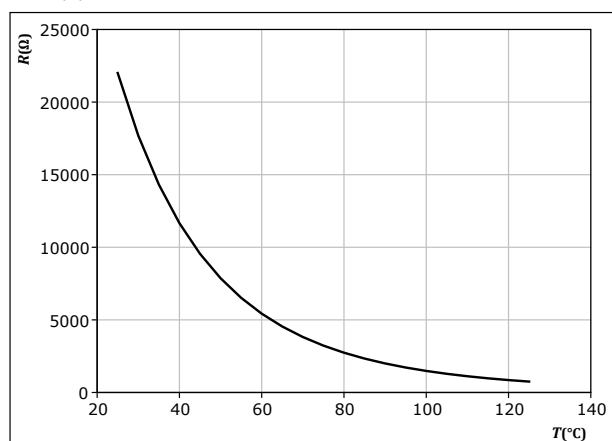
## Thermistor Characteristics

figure 8.

Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$





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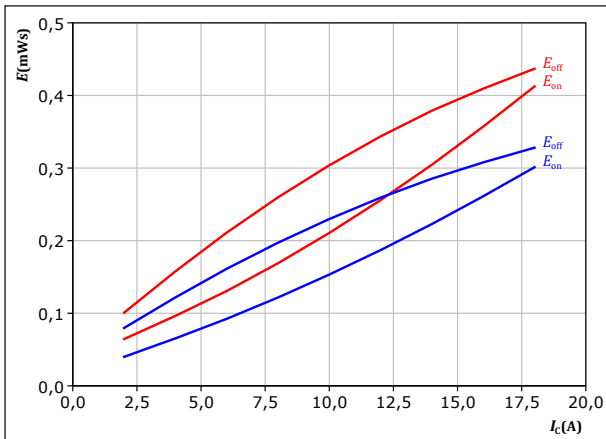
## Inverter Switching Characteristics

figure 9.

IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$   
 $R_{goff} = 32$   $\Omega$

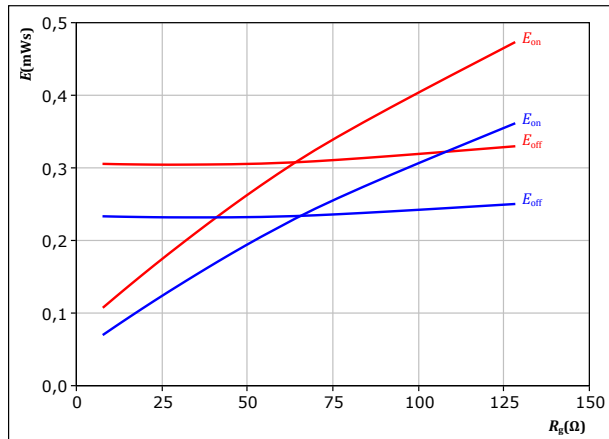
$T_j$ : — 25 °C  
— 150 °C

figure 10.

IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 10$  A

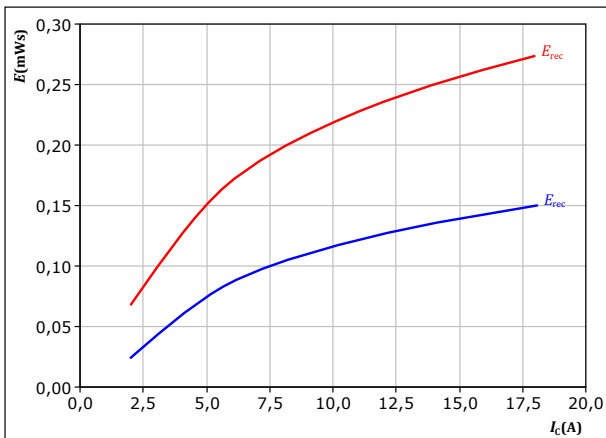
$T_j$ : — 25 °C  
— 150 °C

figure 11.

FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$

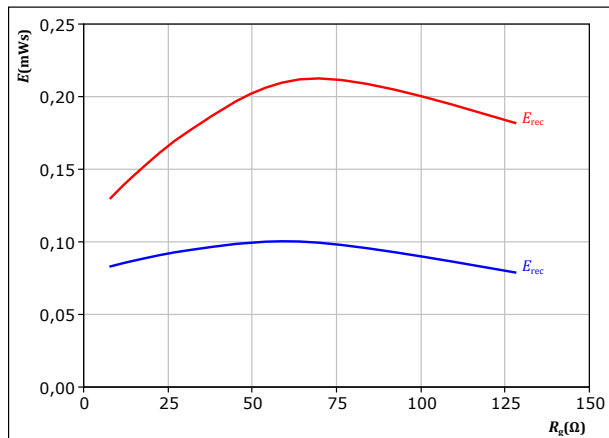
$T_j$ : — 25 °C  
— 150 °C

figure 12.

FWD

Typical reverse recovered energy loss as a function of gate resistor

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 10$  A

$T_j$ : — 25 °C  
— 150 °C



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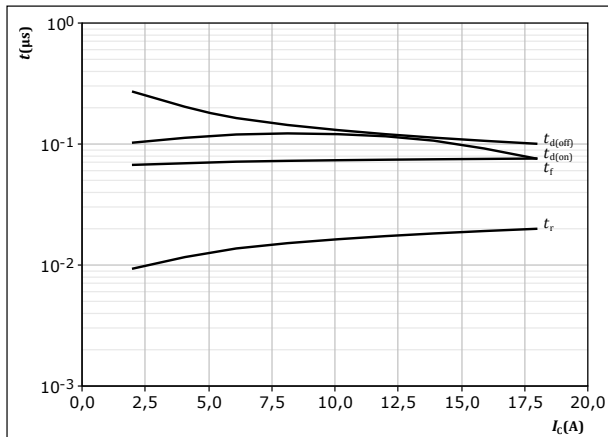
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datasheet

## Inverter Switching Characteristics

figure 13.

IGBT

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



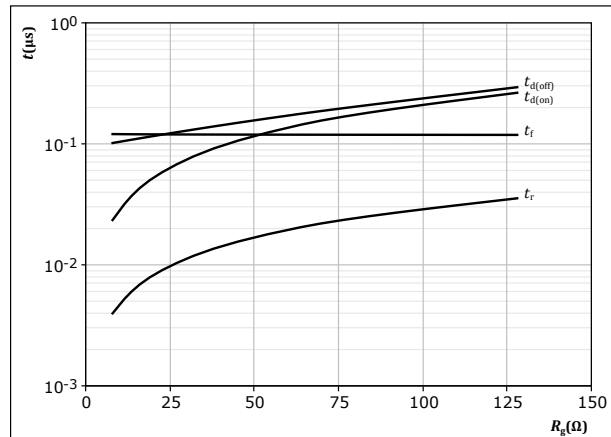
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω  
 $R_{goff} = 32$  Ω

figure 14.

IGBT

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



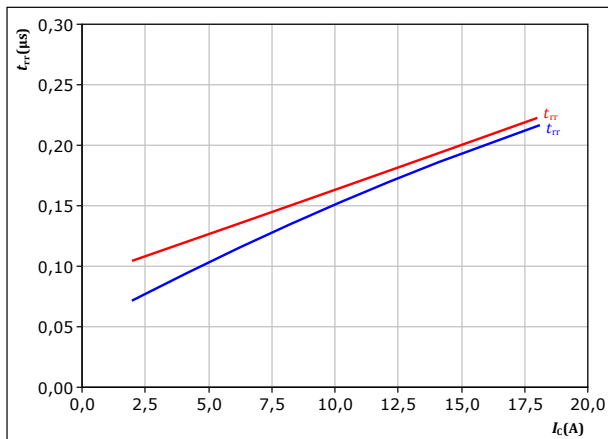
With an inductive load at

$T_j = 150$  °C  
 $V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 10$  A

figure 15.

FWD

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



With an inductive load at

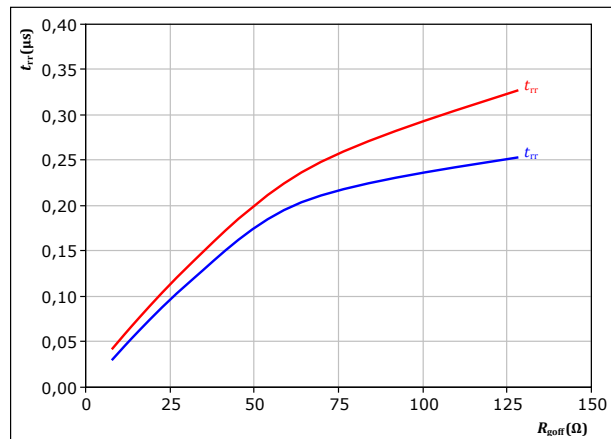
$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω

$T_j$ : — 25 °C  
— 150 °C

figure 16.

FWD

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 10$  A

$T_j$ : — 25 °C  
— 150 °C



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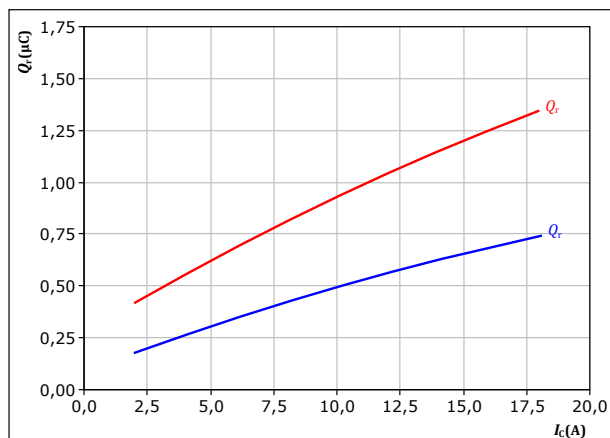
## Inverter Switching Characteristics

figure 17.

FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω

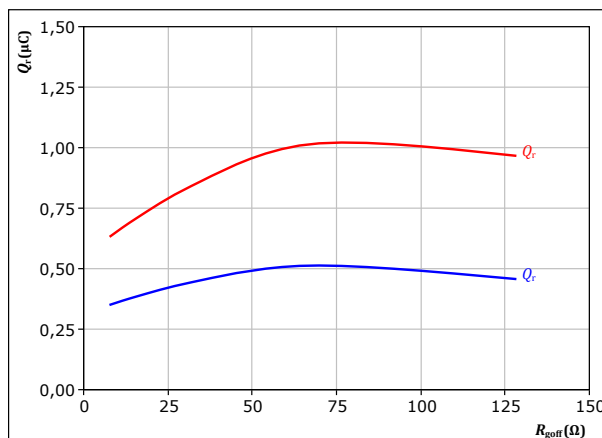
$T_j$ : — 25 °C  
— 150 °C

figure 18.

FWD

Typical recovered charge as a function of turn off gate resistor

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 10$  A

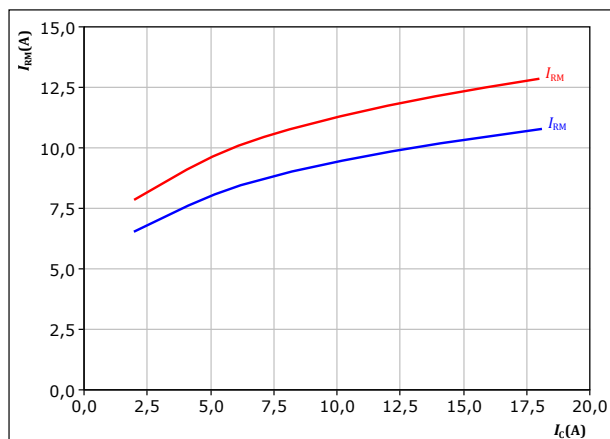
$T_j$ : — 25 °C  
— 150 °C

figure 19.

FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$  Ω

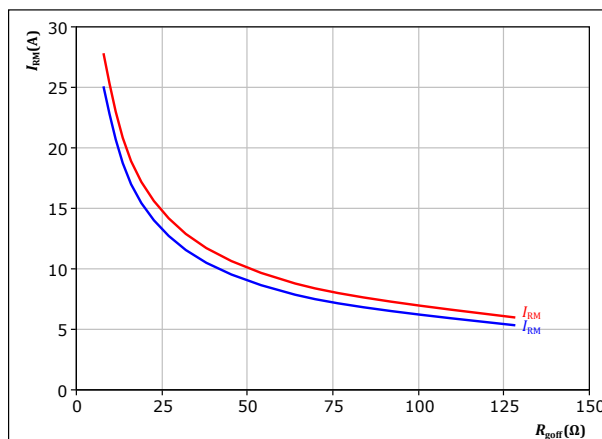
$T_j$ : — 25 °C  
— 150 °C

figure 20.

FWD

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

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



With an inductive load at

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_c = 10$  A

$T_j$ : — 25 °C  
— 150 °C



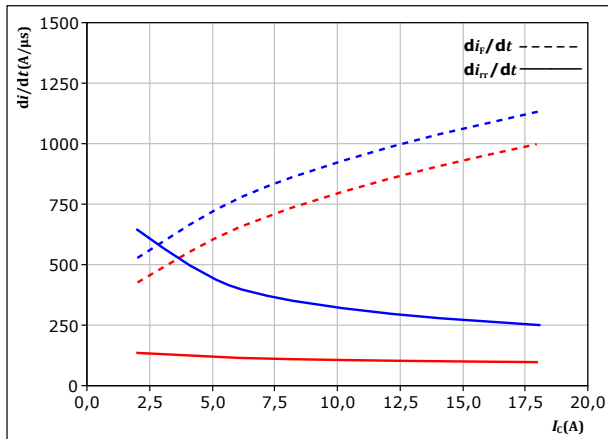
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## Inverter Switching Characteristics

**figure 21.** FWD

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



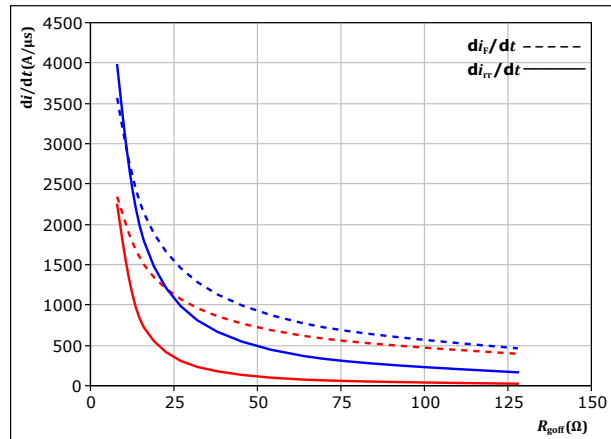
With an inductive load at

$V_{CE} = 300 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 32 \text{ } \Omega$

$T_j$ : — 25 °C  
 — 150 °C

**figure 22.** 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

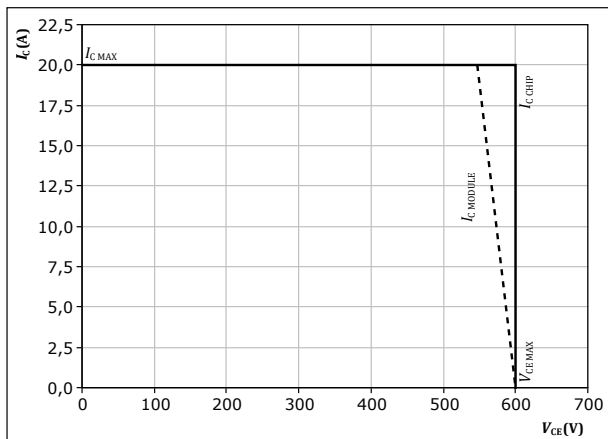
$V_{CE} = 300 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 10 \text{ A}$

$T_j$ : — 25 °C  
 — 150 °C

**figure 23.** IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At  $T_j = 150 \text{ } ^\circ\text{C}$   
 $R_{gon} = 32 \text{ } \Omega$   
 $R_{goff} = 32 \text{ } \Omega$



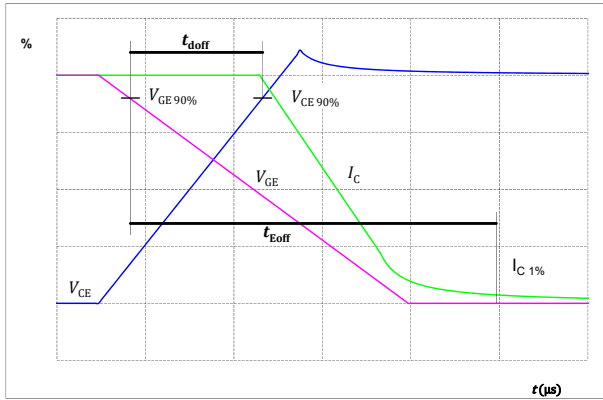
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## Inverter Switching Definitions

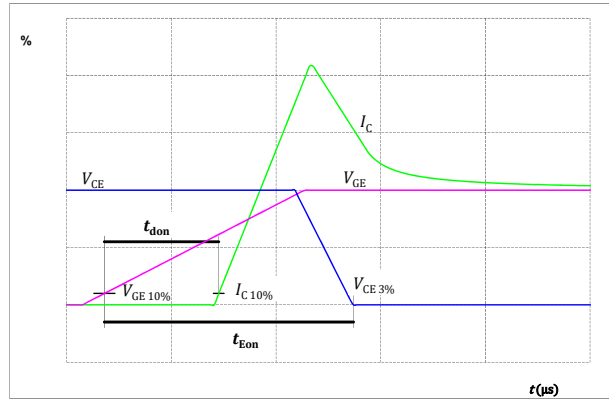
**figure 24.** IGBT

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



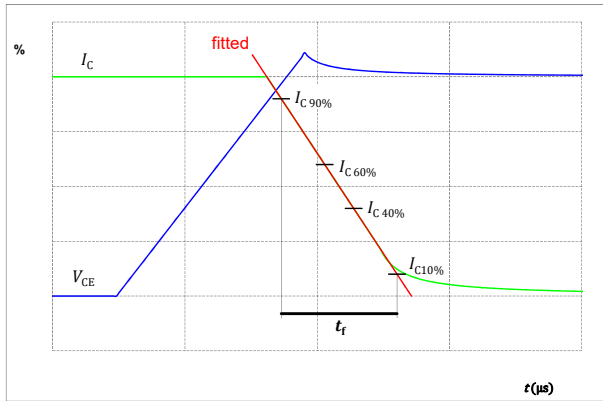
**figure 25.** IGBT

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



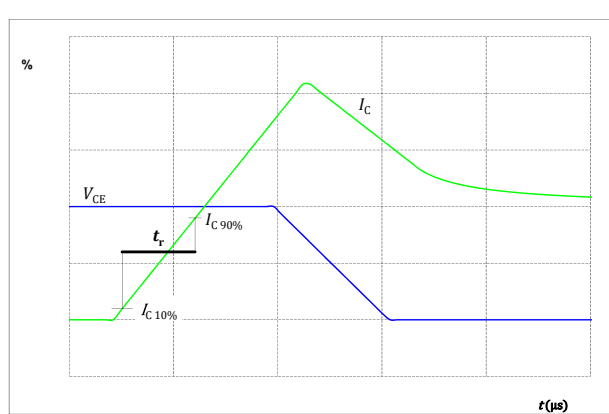
**figure 26.** IGBT

Turn-off Switching Waveforms & definition of  $t_f$



**figure 27.** IGBT

Turn-on Switching Waveforms & definition of  $t_r$





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## Inverter Switching Definitions

figure 28.

FWD

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

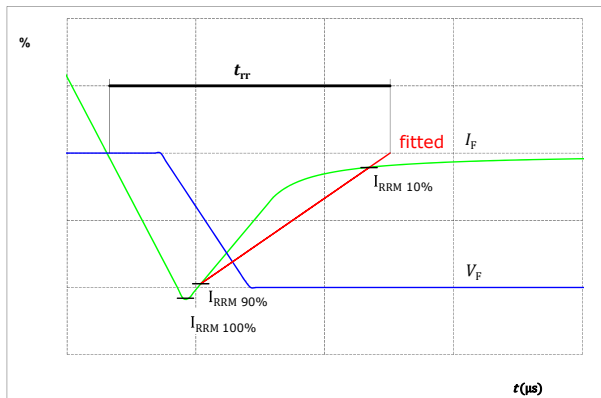
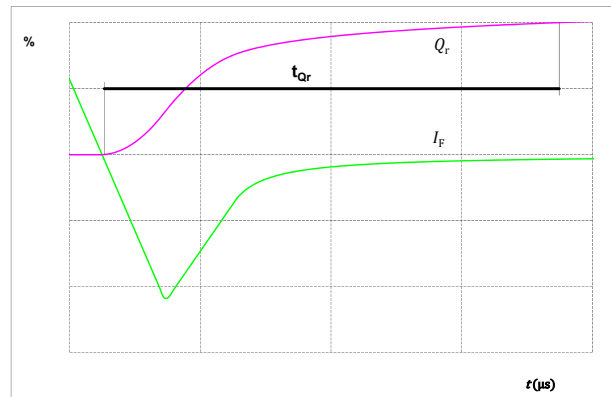


figure 29.

FWD


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





**V23990-P861-F49-PM**  
datasheet

Ordering Code	
Version	Ordering Code
Without thermal paste	V23990-P861-F49-PM
With thermal paste (5,2 W/mK, PTM6000HV)	V23990-P861-F49-/7/-PM
With thermal paste (3,4 W/mK, PSX-P7)	V23990-P861-F49-/3/-PM

Marking							
	Text	VIN	Date code	Type&Ver	UL	Lot	Serial
		VIN	WWYY	TTTTTTTV	UL	LLLL	SSSS
	Datamatrix	Type&Ver	Lot number	Serial	Date code		
		TTTTTTTV	LLLL	SSSS	WWYY		

### Pin table [mm]

Pin	X	Y	Function
1	33,3	0	-Vcc
2	30,7	0	S6
3	27,9	0	G6
4	23,85	0	S5
5	21,05	0	G5
6	15,95	0	NTC2
7	9,6	0	NTC1
8	5,4	0	G4
9	2,6	0	S4
10	0	0	-Vcc
11	0	11,15	+Vcc
12	0	22,3	U
13	2,6	22,3	U
14	5,5	22,3	G1
15	13,1	22,3	G2
16	15,9	22,3	V
17	19,4	22,3	V
18	27,7	22,3	G3
19	30,7	22,3	W
20	33,3	22,3	W
21	33,3	11,15	+Vcc

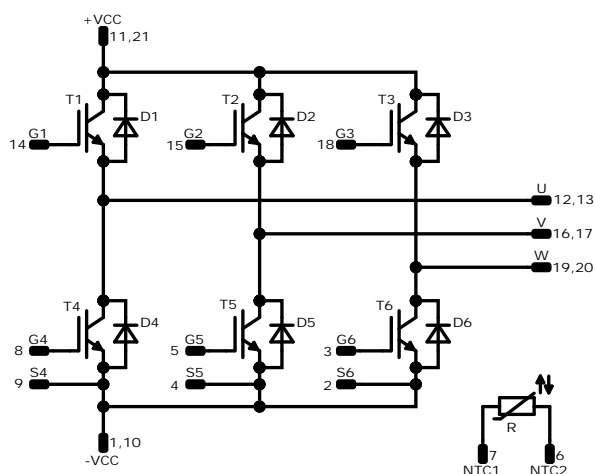
### Outline

The technical drawing shows the physical dimensions of the sensor module. The top view indicates a width of 110 mm and a length of 66.5 mm. Pin positions are numbered 1 through 21. The side view shows a height of 21.3 ± 0.5 mm and a pin diameter of φ 1 ± 0.05 mm.

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




Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T4, T1, T5, T2, T6, T3	IGBT	600 V	10 A	Inverter Switch	
D1, D4, D2, D5, D3, D6	FWD	600 V	10 A	Inverter Diode	
R	Thermistor			Thermistor	



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-P861-F49-PM-D4-14	10 Sep. 2021	Updated characteristic value of inverter switch and thermistor Introduce Rth values with PSX-P7 TIM Separate datasheet for 17 mm housing press-fit pin New datasheet format, module is unchanged	

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