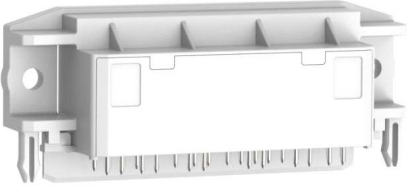
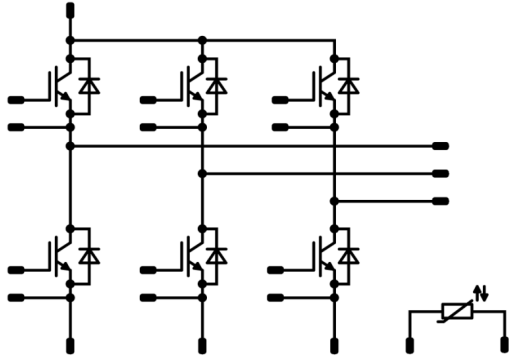




# Vincotech

<i>flow 90PACK 1</i>	<b>600 V / 30 A</b>
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Features</b></div> <ul style="list-style-type: none"> <li>IGBT3 (600 V) technology for low saturation losses</li> <li>Supports designs with 90° mounting angle</li> <li>Clip-in PCB mounting</li> </ul>	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><i>flow 90 1 housing</i></div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Target applications</b></div> <ul style="list-style-type: none"> <li>Industrial</li> </ul>	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Schematic</b></div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Types</b></div> <ul style="list-style-type: none"> <li>V23990-P704-F-PM</li> </ul>	

## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter voltage	$V_{CES}$		600	V
Collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	35	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	90	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	70	W
Gate-emitter voltage	$V_{GES}$		±20	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	6 360	μs V
Maximum junction temperature	$T_{jmax}$		175	°C



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## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Inverter Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		600	V
Continuous (direct) forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	34	A
Repetitive peak forward current	$I_{FRM}$		60	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	50	W
Maximum junction temperature	$T_{jmax}$		175	°C

## Module Properties

### Thermal Properties

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

### Isolation Properties

Isolation voltage	$V_{isol}$	DC Test Voltage $t_p = 2\text{ s}$	4000	V
Creepage distance			min. 12,7	mm
Clearance			11,84	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] $V_F$ [V]	$I_C$ [A] $I_D$ [A] $I_F$ [A]	$T_j$ [°C]	Min	Typ	Max		

### Inverter Switch

#### Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{CE}$			0,00043	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CEsat}$		15		30	25 125	1,1	1,54 1,71	1,9	V
Collector-emitter cut-off current	$I_{CES}$		0	600		25			1,6	μA
Gate-emitter leakage current	$I_{GES}$		20	0		25			300	nA
Internal gate resistance	$r_g$							none		Ω
Input capacitance	$C_{ies}$							1630		pF
Output capacitance	$C_{oes}$	$f = 1$ MHz	0	25		25		108		
Reverse transfer capacitance	$C_{res}$							50		

#### Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4$ W/mK						1,36		K/W
-------------------------------------	---------------	-----------------------------------------------	--	--	--	--	--	------	--	-----

#### Dynamic

Turn-on delay time	$t_{d(on)}$					25 125		91 95		ns
Rise time	$t_r$	$R_{goff} = 16$ Ω $R_{gon} = 16$ Ω				25 125		17 19		
Turn-off delay time	$t_{d(off)}$		±15	300	30	25 125		138 159		
Fall time	$t_f$					25 125		65 83		
Turn-on energy (per pulse)	$E_{on}$	$Q_{tFWD} = 1,4$ μC $Q_{tFWD} = 2,3$ μC				25 125		0,372 0,496		mWs
Turn-off energy (per pulse)	$E_{off}$					25 125		0,667 0,823		



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## Characteristic Values

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

### Inverter Diode

#### Static

Parameter	Symbol	$V_{GS}$ [V]	$V_{DS}$ [V]	$I_D$ [A]	$I_F$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Forward voltage	$V_F$			30		25 125		1,47 1,44	1,95	V
Reverse leakage current	$I_R$		600			25			27	μA

#### Thermal

Parameter	Symbol	Conditions	Value	Unit
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4$ W/mK	1,88	K/W

#### Dynamic

Parameter	Symbol	$dI/dt$	$I_D$	$I_F$	$T_j$ [°C]	Min	Typ	Max	Unit
Peak recovery current	$I_{RRM}$	$dI/dt = 3643$ A/μs $dI/dt = 2533$ A/μs	±15	300	30	25	37		A
Reverse recovery time	$t_{rr}$					125	41		ns
Recovered charge	$Q_r$					25	1,429		μC
Reverse recovered energy	$E_{rec}$					125	2,304		mWs
Peak rate of fall of recovery current	$(dI_{rr}/dt)_{max}$					25	0,306		mWs
		125	0,509		A/μs				

### Thermistor

Parameter	Symbol	Conditions	$T_j$ [°C]	Min	Typ	Max	Unit
Rated resistance	R		25		22		kΩ
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1484$ Ω	100	-5		5	%
Power dissipation	P		25		5		mW
Power dissipation constant			25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1 %	25		3962		K
B-value	$B_{(25/100)}$	Tol. ±1 %	25		4000		K
Vincotech NTC Reference						I	

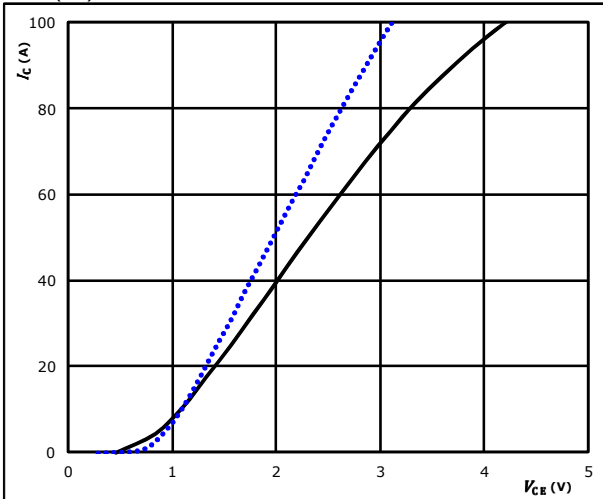


## Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

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

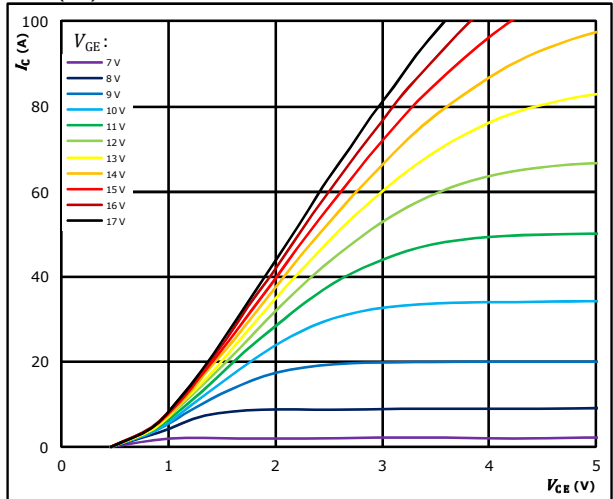


$t_p = 250 \mu s$   $T_j: 25 \text{ }^\circ C$  (dotted blue line)  
 $V_{GE} = 15 V$   $T_j: 125 \text{ }^\circ C$  (solid black line)

**figure 2.** IGBT

Typical output characteristics

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

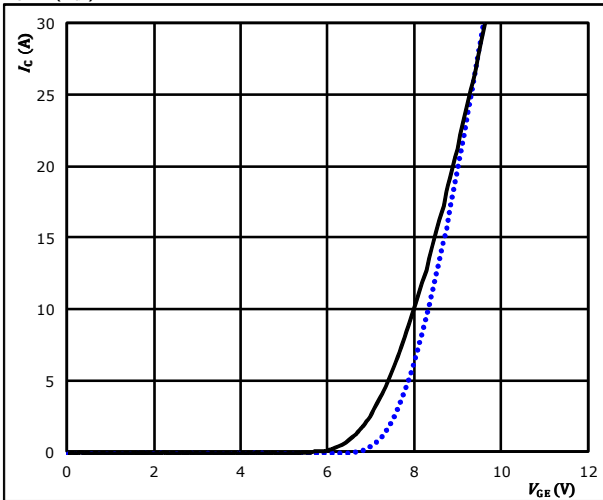


$t_p = 250 \mu s$   
 $T_j = 125 \text{ }^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

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

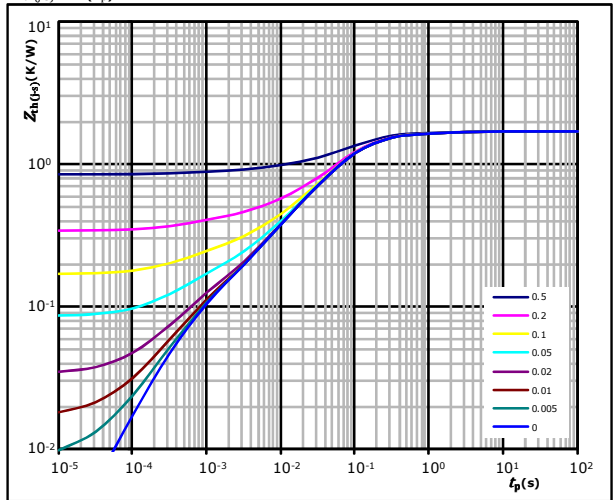


$t_p = 100 \mu s$   $T_j: 25 \text{ }^\circ C$  (dotted blue line)  
 $V_{CE} = 10 V$   $T_j: 125 \text{ }^\circ C$  (solid black line)

**figure 4.** IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,36 \text{ K/W}$

IGBT thermal model values

$R$ (K/W)	$\tau$ (s)
6,35E-02	3,01E+00
1,66E-01	4,76E-01
1,09E+00	7,92E-02
2,16E-01	1,94E-02
9,88E-02	4,23E-03
7,00E-02	5,06E-04

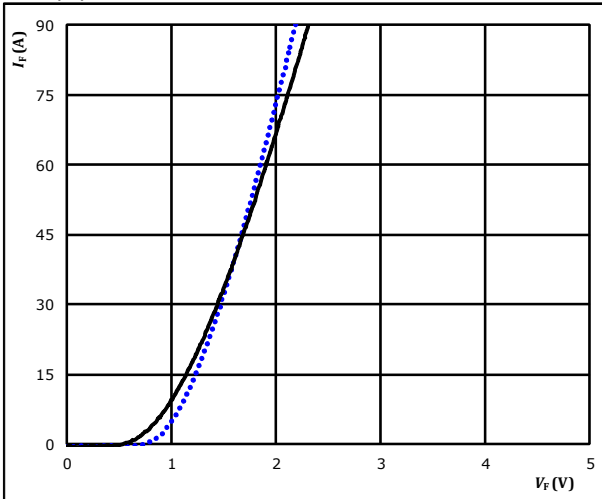


## Inverter Diode Characteristics

**figure 1.** FWD

Typical forward characteristics

$$I_F = f(V_F)$$

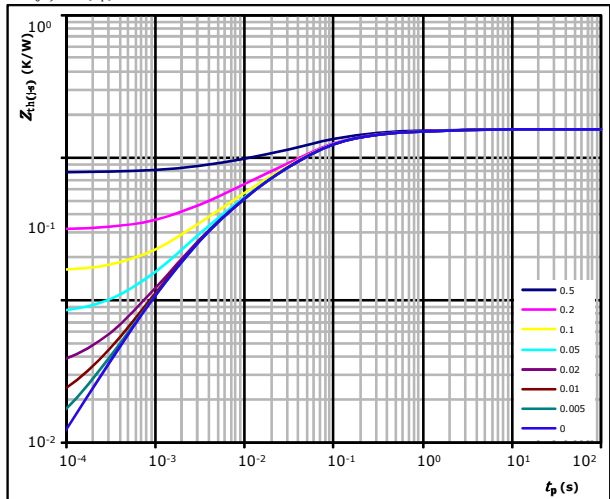


$t_p = 250 \mu s$   $T_j: 25 \text{ } ^\circ\text{C}$  (dotted blue line)  $125 \text{ } ^\circ\text{C}$  (solid black line)

**figure 2.** FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,88 \text{ K/W}$   
 FWD thermal model values

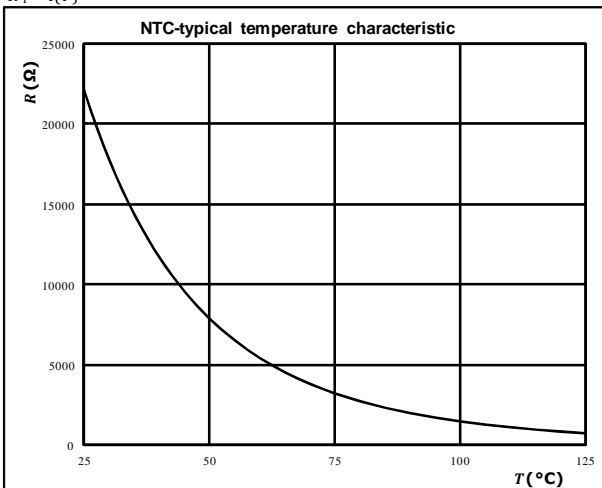
$R \text{ (K/W)}$	$\tau \text{ (s)}$
9,10E-02	2,00E+00
3,45E-01	1,68E-01
7,17E-01	4,13E-02
2,97E-01	7,43E-03
1,15E-01	1,80E-03

## Thermistor Characteristics

Thermistor typical temperature characteristic

Typical NTC characteristic  
as a function of temperature

$$R_T = f(T)$$

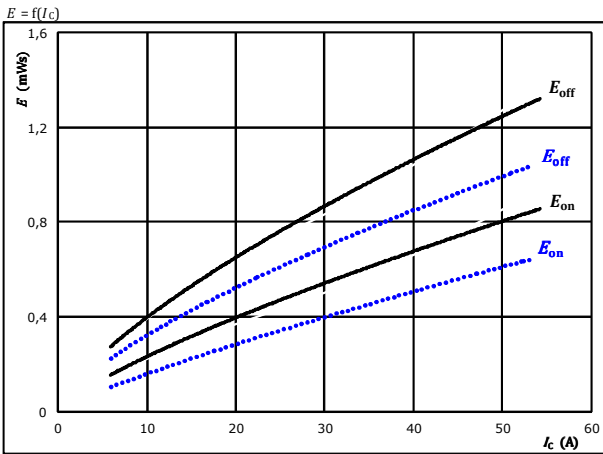




## Inverter Switching Characteristics

**figure 1.** IGBT

Typical switching energy losses as a function of collector current

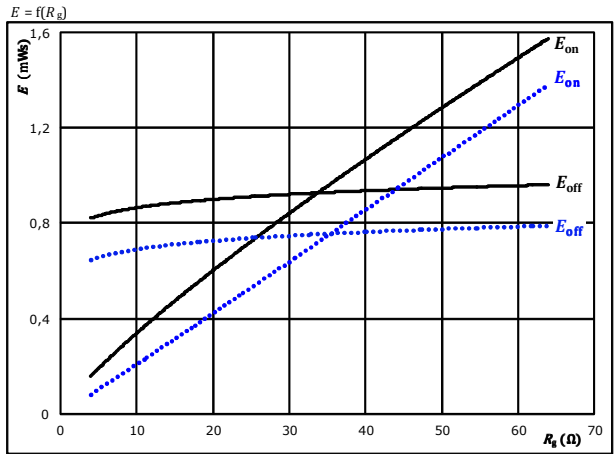


With an inductive load at  $T_j$ : 25 °C (dotted blue), 125 °C (solid black)

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 16$   $\Omega$   
 $R_{goff} = 16$   $\Omega$

**figure 2.** IGBT

Typical switching energy losses as a function of gate resistor

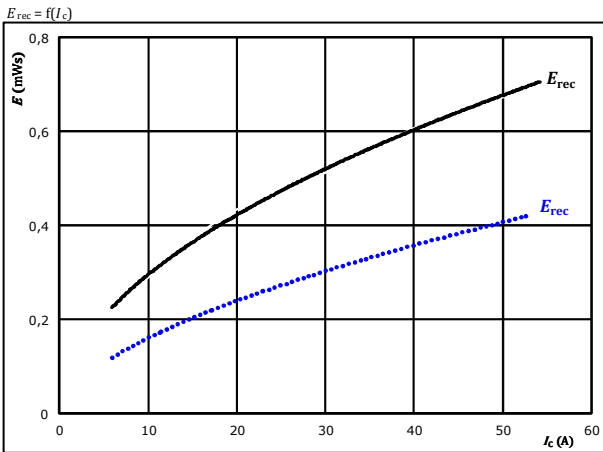


With an inductive load at  $T_j$ : 25 °C (dotted blue), 125 °C (solid black)

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 30$  A

**figure 3.** FWD

Typical reverse recovered energy loss as a function of collector current

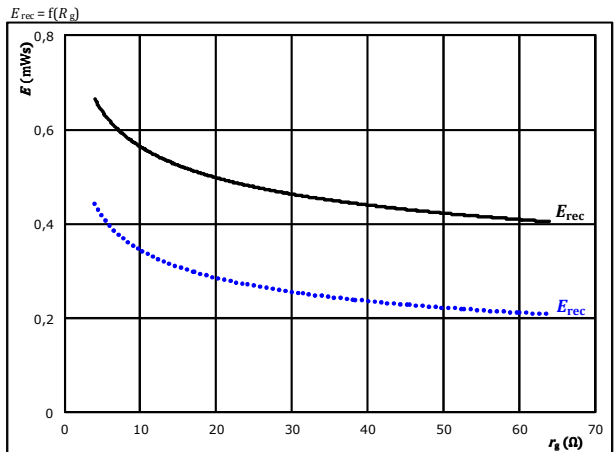


With an inductive load at  $T_j$ : 25 °C (dotted blue), 125 °C (solid black)

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 16$   $\Omega$

**figure 4.** FWD

Typical reverse recovered energy loss as a function of gate resistor



With an inductive load at  $T_j$ : 25 °C (dotted blue), 125 °C (solid black)

$V_{CE} = 300$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 30$  A

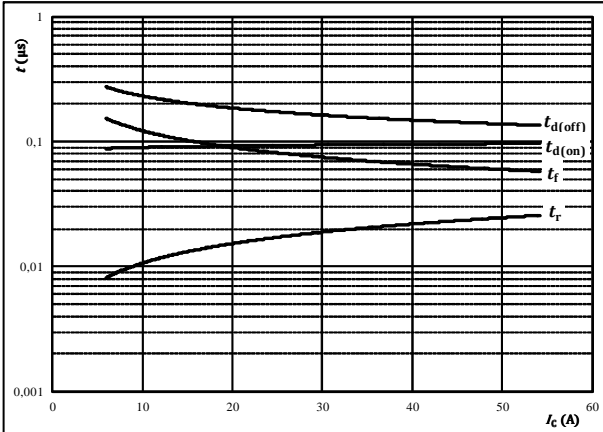


## Inverter Switching Characteristics

**figure 5.** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



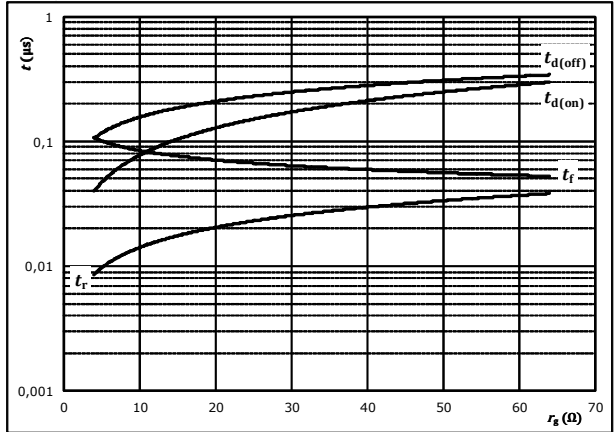
With an inductive load at

$T_j =$	125	$^{\circ}C$
$V_{CE} =$	300	V
$V_{GE} =$	$\pm 15$	V
$R_{gon} =$	16	$\Omega$
$R_{goff} =$	16	$\Omega$

**figure 6.** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



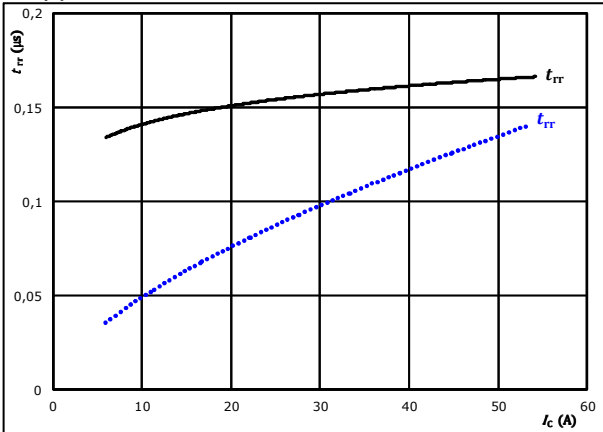
With an inductive load at

$T_j =$	125	$^{\circ}C$
$V_{CE} =$	300	V
$V_{GE} =$	$\pm 15$	V
$I_C =$	30	A

**figure 7.** FWD

Typical reverse recovery time as a function of collector current

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

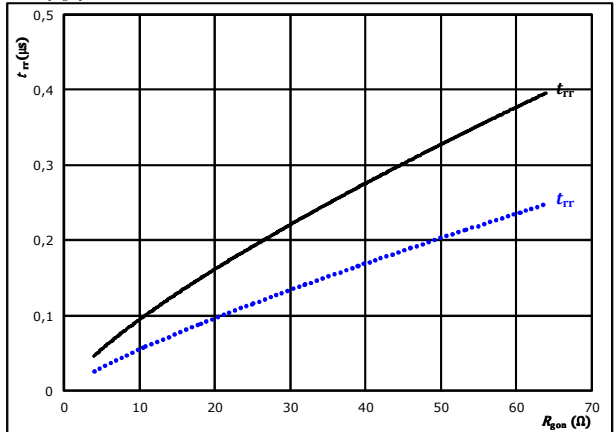


At	$V_{CE} =$	300	V	$T_j =$	25 $^{\circ}C$	.....
	$V_{GE} =$	$\pm 15$	V		125 $^{\circ}C$	————
	$R_{gon} =$	16	$\Omega$			

**figure 8.** FWD

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

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



At	$V_{CE} =$	300	V	$T_j =$	25 $^{\circ}C$	.....
	$V_{GE} =$	$\pm 15$	V		125 $^{\circ}C$	————
	$I_C =$	30	A			



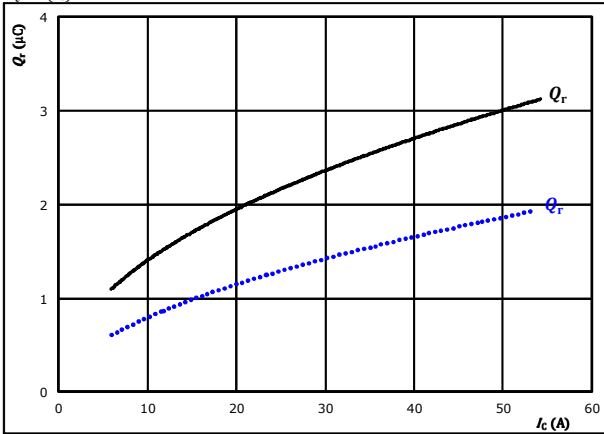


## Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$

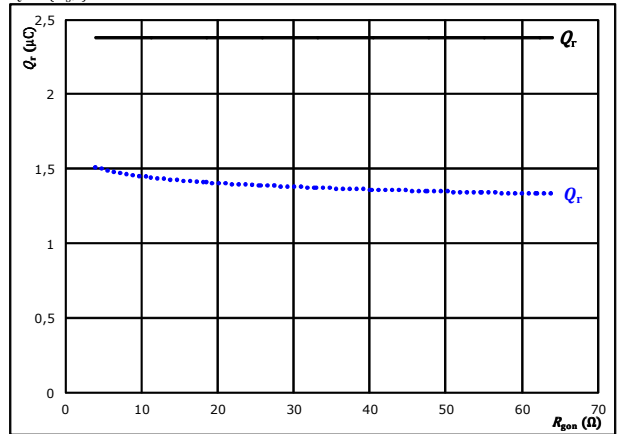


At  $V_{CE} = 300$  V  $T_j = 25\text{ °C}$  (dotted blue line)  
 $V_{GE} = \pm 15$  V  $T_j = 125\text{ °C}$  (solid black line)  
 $R_{gpn} = 16\ \Omega$

figure 10. FWD

Typical recovered charge as a function of IGBT turn on gate resistor

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

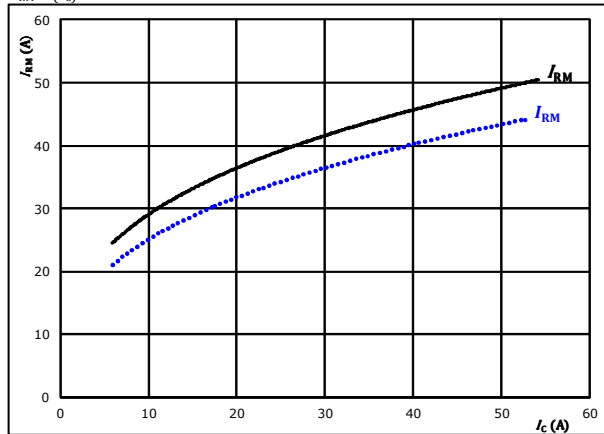


At  $V_{CE} = 300$  V  $T_j = 25\text{ °C}$  (dotted blue line)  
 $V_{GE} = \pm 15$  V  $T_j = 125\text{ °C}$  (solid black line)  
 $I_c = 30$  A

figure 11. FWD

Typical peak reverse recovery current as a function of collector current

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

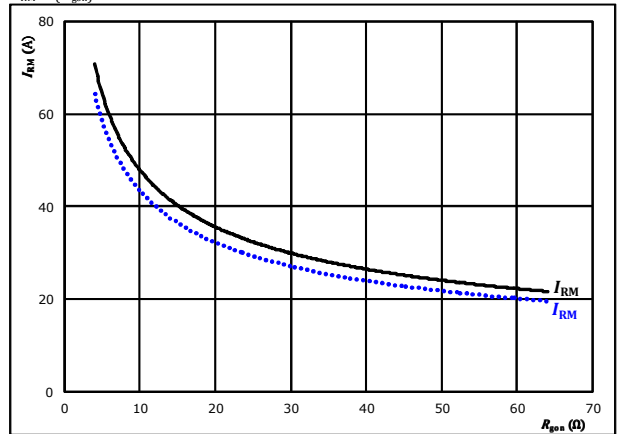


At  $V_{CE} = 300$  V  $T_j = 25\text{ °C}$  (dotted blue line)  
 $V_{GE} = \pm 15$  V  $T_j = 125\text{ °C}$  (solid black line)  
 $R_{gpn} = 16\ \Omega$

figure 12. FWD

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

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



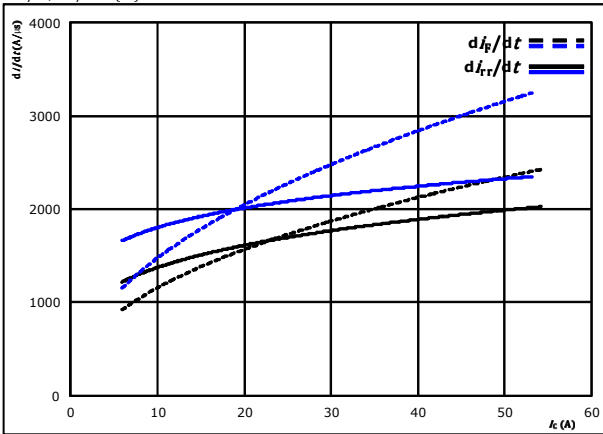
At  $V_{CE} = 300$  V  $T_j = 25\text{ °C}$  (dotted blue line)  
 $V_{GE} = \pm 15$  V  $T_j = 125\text{ °C}$  (solid black line)  
 $I_c = 30$  A



## Inverter Switching Characteristics

figure 13. FWD

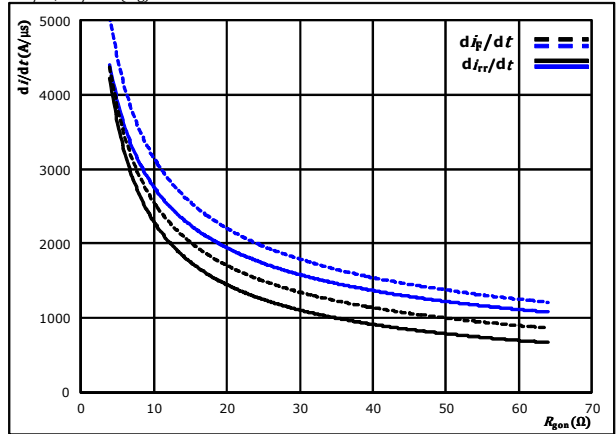
Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_{rr}/dt = f(I_c)$



At  $V_{CE} = 300$  V  $T_j = 25$  °C (dotted line)  
 $V_{GE} = \pm 15$  V  $T_j = 125$  °C (solid line)  
 $R_{g(on)} = 16$  Ω

figure 14. FWD

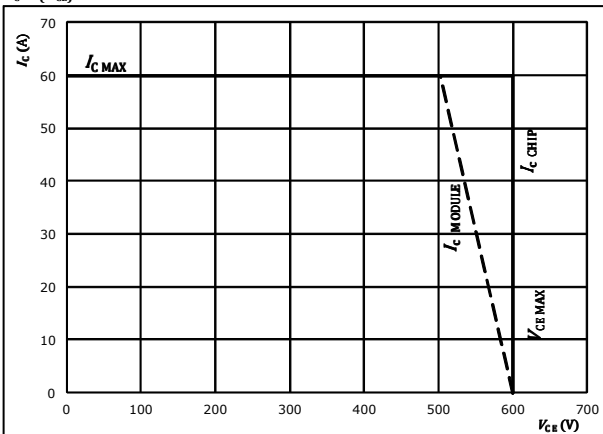
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor  
 $di_f/dt, di_{rr}/dt = f(R_{g(on)})$



At  $V_{CE} = 300$  V  $T_j = 25$  °C (dotted line)  
 $V_{GE} = \pm 15$  V  $T_j = 125$  °C (solid line)  
 $I_c = 30$  A

figure 15. IGBT

Reverse bias safe operating area  
 $I_c = f(V_{CE})$



At  $T_j = 175$  °C  
 $R_{g(on)} = 16$  Ω  
 $R_{g(off)} = 16$  Ω

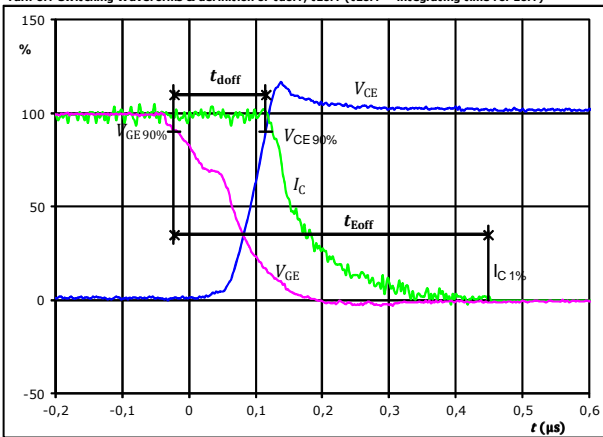


## Inverter Switching Definitions

**General conditions**

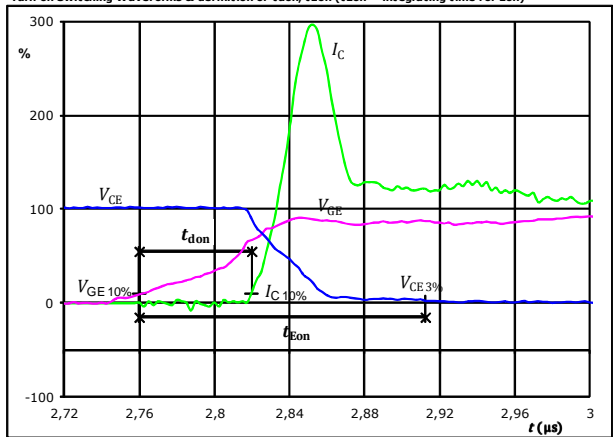
$T_j$	=	125 °C
$R_{gon}$	=	8 $\Omega$
$R_{goff}$	=	8 $\Omega$

**figure 1.** IGBT  
Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$  ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



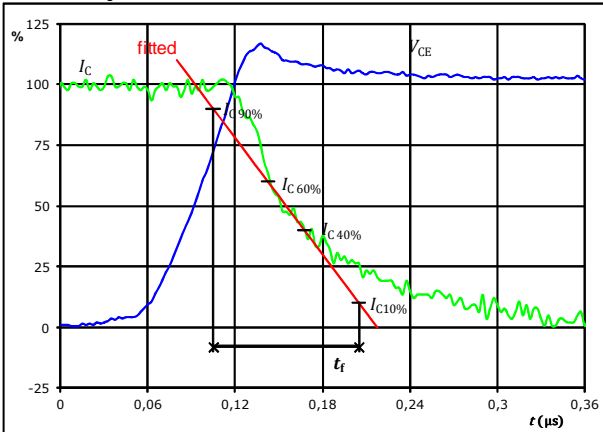
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	30	A
$t_{doff} =$	0,133	$\mu s$
$t_{Eoff} =$	0,471	$\mu s$

**figure 2.** IGBT  
Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$  ( $t_{Eon}$  = integrating time for  $E_{on}$ )



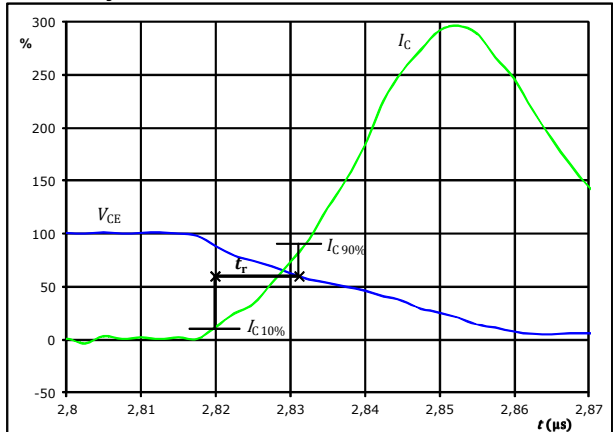
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	30	A
$t_{don} =$	0,058	$\mu s$
$t_{Eon} =$	0,152	$\mu s$

**figure 3.** IGBT  
Turn-off Switching Waveforms & definition of  $t_f$



$V_C(100\%) =$	300	V
$I_C(100\%) =$	30	A
$t_f =$	0,114	$\mu s$

**figure 4.** IGBT  
Turn-on Switching Waveforms & definition of  $t_r$



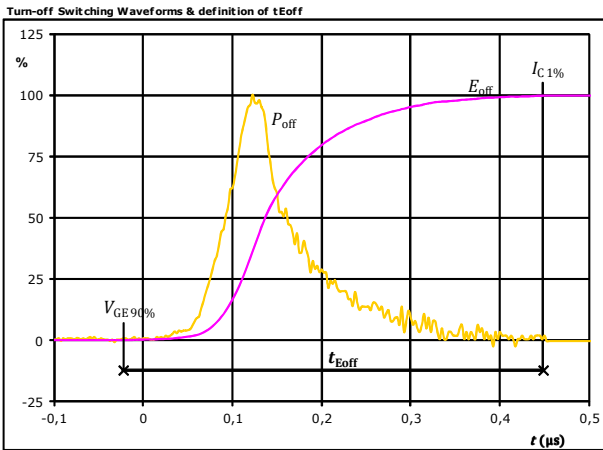
$V_C(100\%) =$	300	V
$I_C(100\%) =$	30	A
$t_r =$	0,012	$\mu s$



Vincotech

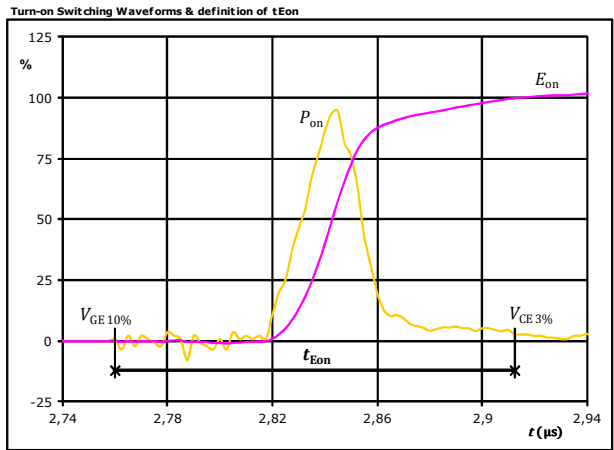
## Inverter Switching Definitions

figure 5. IGBT



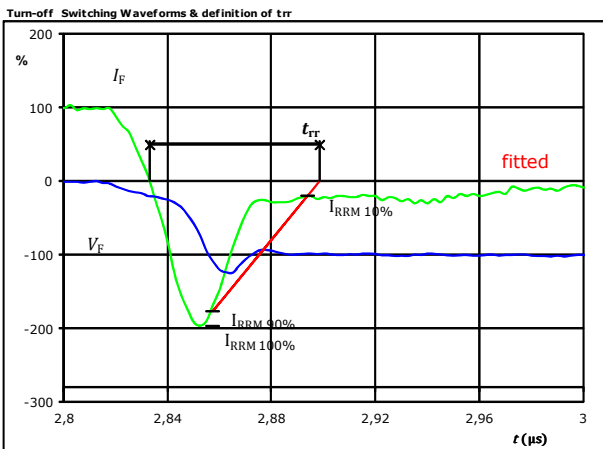
$P_{off}(100\%) = 8,97$  kW  
 $E_{off}(100\%) = 0,87$  mJ  
 $t_{Eoff} = 0,47$  μs

figure 6. IGBT



$P_{on}(100\%) = 8,97$  kW  
 $E_{on}(100\%) = 0,24$  mJ  
 $t_{Eon} = 0,15$  μs

figure 7. FWD

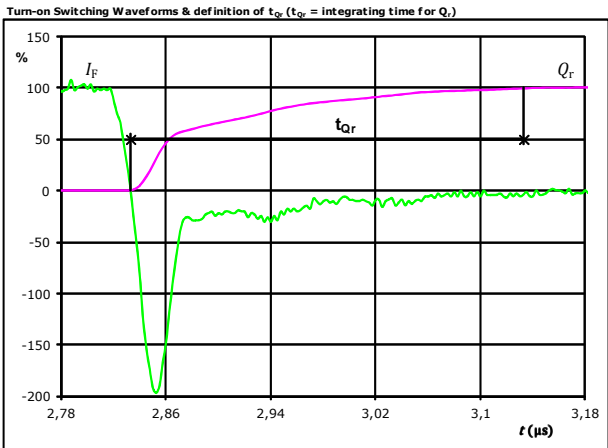


$V_F(100\%) = 300$  V  
 $I_F(100\%) = 30$  A  
 $I_{RRM}(100\%) = 59$  A  
 $t_{rr} = 0,071$  μs



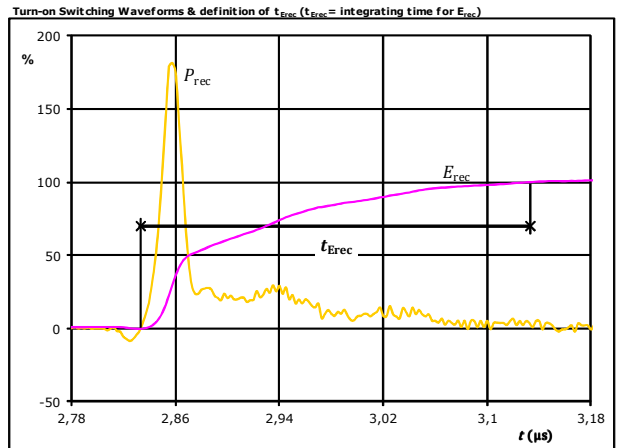
## Inverter Switching Definitions

figure 8. FWD



$I_F$  (100%) = 30 A  
 $Q_r$  (100%) = 2,38  $\mu\text{C}$   
 $t_{Qr}$  = 0,30  $\mu\text{s}$

figure 9. FWD



$P_{rec}$  (100%) = 8,97 kW  
 $E_{rec}$  (100%) = 0,62 mJ  
 $t_{Erec}$  = 0,30  $\mu\text{s}$



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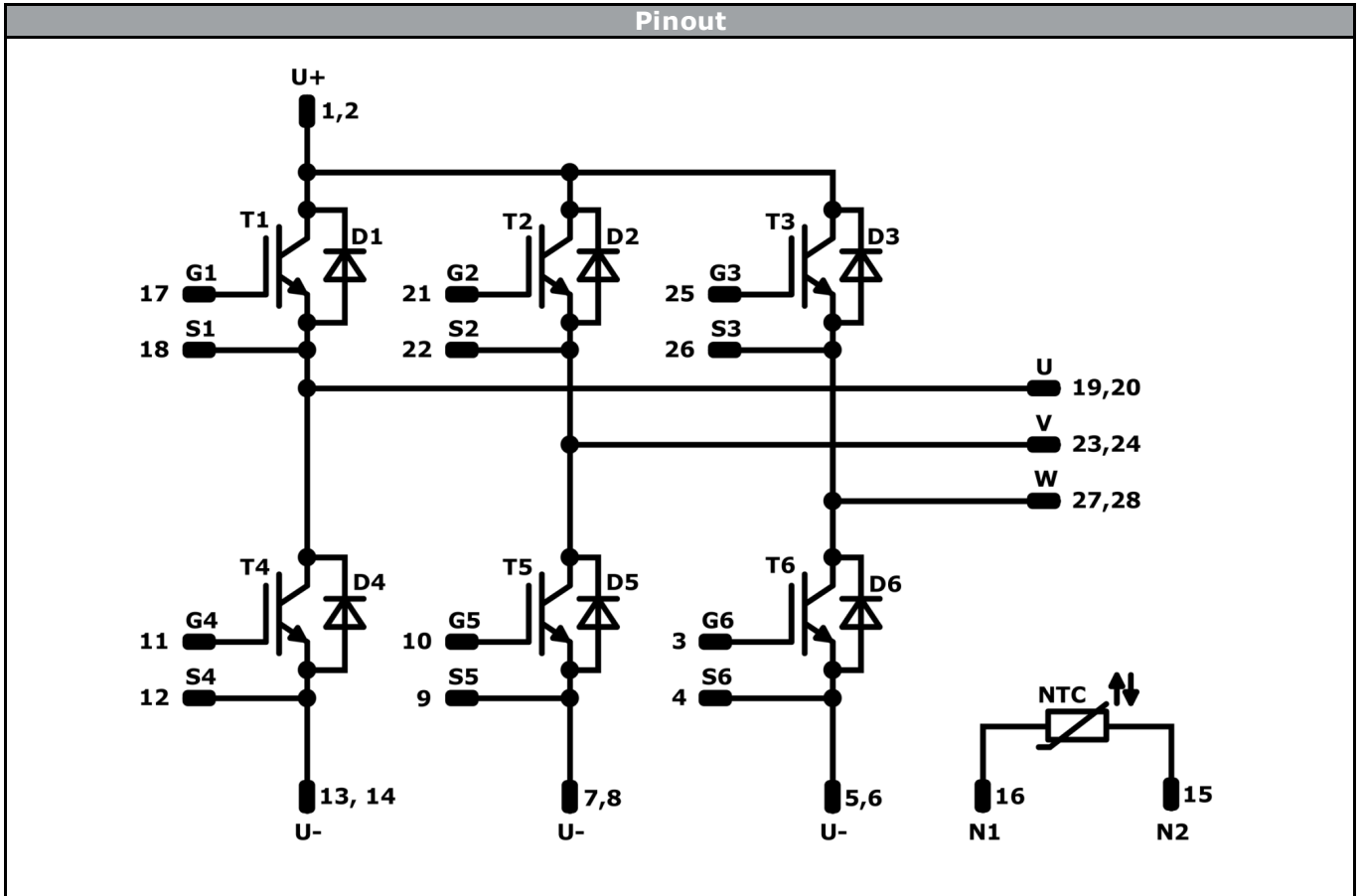
Ordering Code & Marking							
Version				Ordering Code			
without thermal paste housing with solder pins				V23990-P704-F-PM			
with thermal paste housing with solder pins				V23990-P704-F-/3/-PM			
Text	VIN	Date code	Name&Ver	UL	Lot	Serial	
	VIN	WWYY	NNNNNNNVV	UL	LLLLL	SSSS	
Datamatrix	Type&Ver	Lot number	Serial	Date code			
	TTTTTTTVV	LLLLL	SSSS	WWYY			

Pin table [mm]				Outline	
Pin	X	Y	Function		
1	53	0	U+		
2	50	0	U+		
3	43	0	G6		
4	40	0	S6		
5	37	0	U-		
6	34,1	0	U-		
7	31	0	U-		
8	28,1	0	U-		
9	24,05	0	S5		
10	21,05	0	G5		
11	17	0	G4		
12	12,95	0	S4		
13	8,9	0	U-		
14	6	0	U-		
15	3	0	N2		
16	0	0	N1		
17	0	7	G1		
18	3	7	S1		
19	7,2	7	U		
20	10,2	7	U		
21	17,2	7	G2		
22	20,2	7	S2		
23	29,75	7	V		
24	32,75	7	V		
25	39,75	7	G3		
26	42,75	7	S3		
27	47	7	W		
28	50	7	W		

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



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<b>Identification</b>					
ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	30 A	Inverter Switch	
D1-D6	FWD	600 V	30 A	Inverter Diode	
NTC	Thermistor			Thermistor	




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Packaging instruction			
Standard packaging quantity (SPQ) 80	>SPQ	Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow</i> 90 1 packages see vincotech.com website.

Package data
Package data for <i>flow</i> 90 1 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-P704-F-D2-14	30 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.