



flowPIM 1

1200 V / 15 A

Features

- Three-phase rectifier, optional BRC, Inverter, NTC
- Very compact housing, easy to route
- IGBT4 / EmCon4 technology for low saturation losses and improved EMC behavior

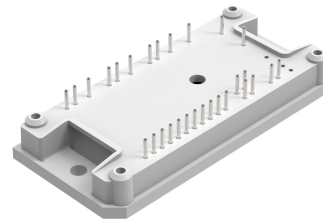
Target applications

- Industrial drives
- Embedded drives

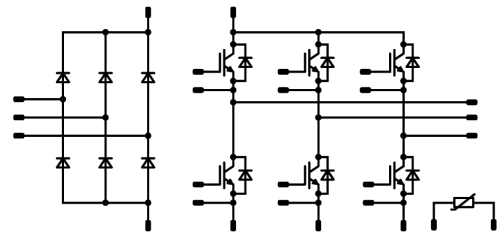
Types

- V23990-P588-C418-PM

flow 1 12 mm housing



Schematic





Vincotech

Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current (DC current)	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	23	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	45	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	71	W
Gate-emitter voltage	V_{GES}		± 20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$, $V_{CC} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	μs
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$
Inverter Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	23	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	30	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	52	W
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$
Rectifier Diode				
Peak repetitive reverse voltage	V_{RRM}		1600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	46	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	270	A
Surge current capability	I^2t		370	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Maximum junction temperature	T_{jmax}		150	$^{\circ}\text{C}$



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Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
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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			7,91	mm
Comparative Tracking Index	CTI		≥ 200	

*100 % tested in production



Characteristic Values

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

Inverter Switch

Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0005	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		15	25 150	1,58	1,84 2,24	2,07 ⁽¹⁾	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			2	µA
Gate-emitter leakage current	I_{GES}		20	0		25			120	nA
Internal gate resistance	r_g							None		Ω
Input capacitance	C_{ies}	$f = 1 \text{ Mhz}$	0	25		25		890		pF
Reverse transfer capacitance	C_{res}							30		pF
Gate charge	Q_g		20		0	25		120		nC

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						1,35		K/W
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Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \Omega$ $R_{goff} = 32 \Omega$	± 15	600	15	25		85,2		ns
Rise time	t_r					150		84,8		ns
						25		17		ns
Turn-off delay time	$t_{d(off)}$					150		200,8		ns
						150		264,2		ns
Fall time	t_f					25		82,07		ns
						150		123,1		ns
Turn-on energy (per pulse)	E_{on}	$Q_{rFWD} = 1,34 \mu\text{C}$		25		0,817		mWs		
		$Q_{rFWD} = 2,98 \mu\text{C}$		150		1,25		mWs		
Turn-off energy (per pulse)	E_{off}			25		0,878		mWs		
				150		1,36		mWs		



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				15	25 150	1,35	1,86 1,79	2,05 ⁽¹⁾	V
Reverse leakage current	I_R	$V_r = 1200$ V				25			3,5	μA

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,83		K/W
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Dynamic

Peak recovery current	I_{RRM}	$di/dt=1293$ A/μs $di/dt=949$ A/μs	±15	600	15	25		24,57		A
Reverse recovery time	t_{rr}					150		25,93		
						25		152,87		ns
Recovered charge	Q_r					150		312,55		
						25		1,34		μC
Reverse recovered energy	E_{rec}	150		2,98						
		25		0,518		mWs				
Peak rate of fall of recovery current	$(di_r/dt)_{max}$	150		1700						
		25		776,27		A/μs				

Rectifier Diode

Static

Forward voltage	V_F				13	25 125		0,988 0,899	1,21 ⁽¹⁾ 1,1 ⁽¹⁾	V
Reverse leakage current	I_R	$V_r = 1600$ V				25			50	μA

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,25		K/W
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Vincotech

Characteristic Values

Parameter	Symbol	Conditions					Values			Unit
		V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	V_{CE} [V]	T_j [°C]	Min	Typ	Max	

Thermistor

Static

Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$A_{R/R}$	$R_{100} = 1486 \Omega$				100	-12		14	%
Power dissipation	P							200		mW
Power dissipation constant	d					25		2		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 3 \%$						3950		K
B-value	$B_{(25/100)}$	Tol. $\pm 3 \%$						3998		K
Vincotech Thermistor Reference									B	

⁽¹⁾ Value at chip level

⁽²⁾ Only valid with pre-applied Vincotech thermal interface material.

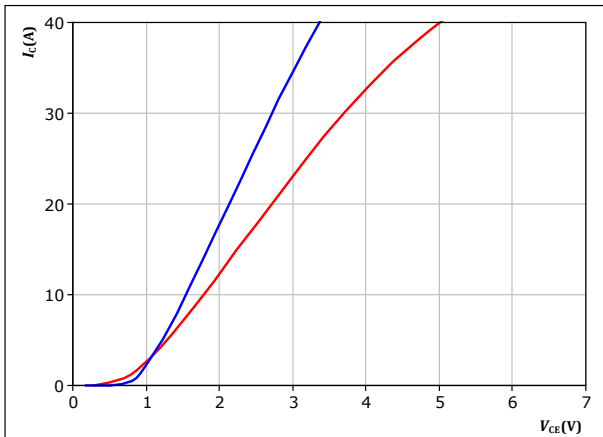


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

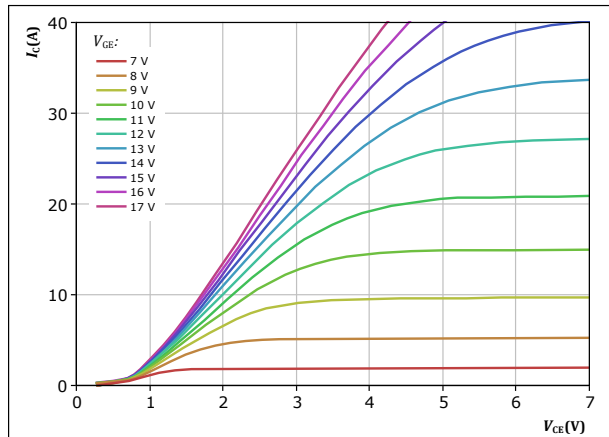


$t_p = 250 \mu s$
 $V_{GE} = 15 V$
 $T_j:$ — 25 °C
— 150 °C

figure 2. IGBT

Typical output characteristics

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

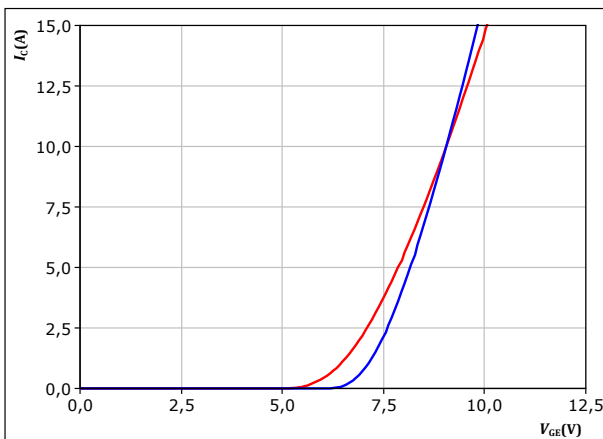


$t_p = 250 \mu s$
 $T_j = 150 \text{ °C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

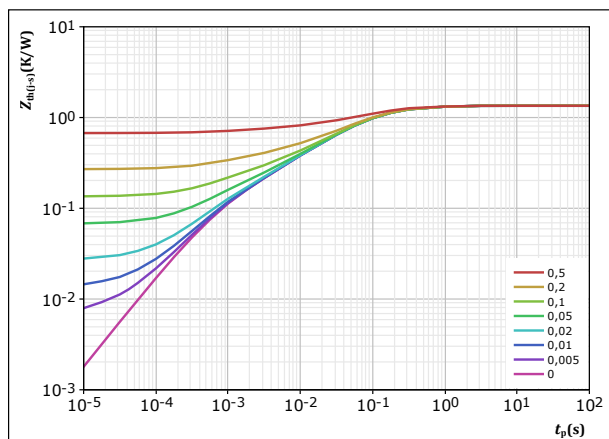


$t_p = 250 \mu s$
 $V_{CE} = 10 V$
 $T_j:$ — 25 °C
— 150 °C

figure 4. IGBT

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,347 \text{ K/W}$

IGBT thermal model values

R (K/W)	τ (s)
1,62E-01	5,85E-01
6,34E-01	9,42E-02
2,82E-01	2,85E-02
1,64E-01	6,73E-03
8,75E-02	9,43E-04
1,75E-02	3,79E-04

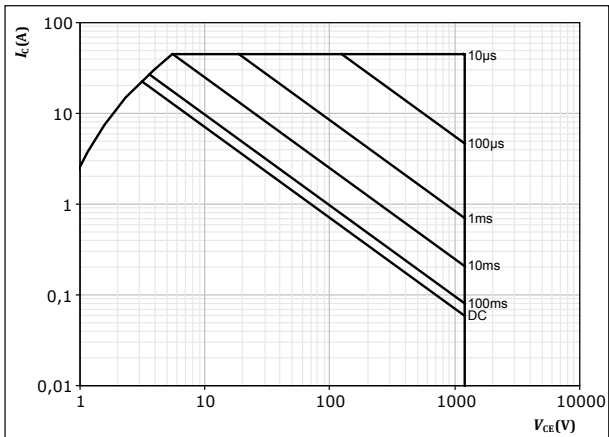


Inverter Switch Characteristics

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

$$I_F = f(V_F)$$

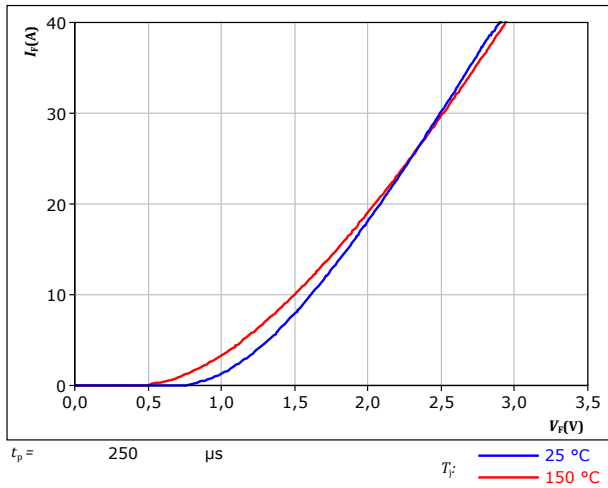
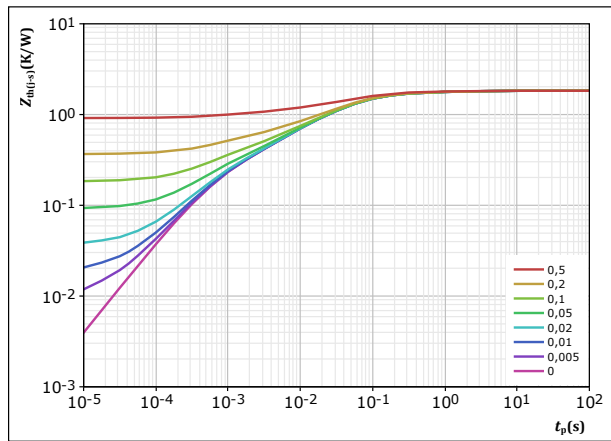


figure 7. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)} = 1,829 \text{ K/W}$

FWD thermal model values

R (K/W)	τ (s)
6,16E-02	2,79E+00
1,40E-01	3,93E-01
7,06E-01	6,76E-02
4,97E-01	1,96E-02
2,49E-01	4,04E-03
1,76E-01	5,86E-04



Rectifier Diode Characteristics

figure 8. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

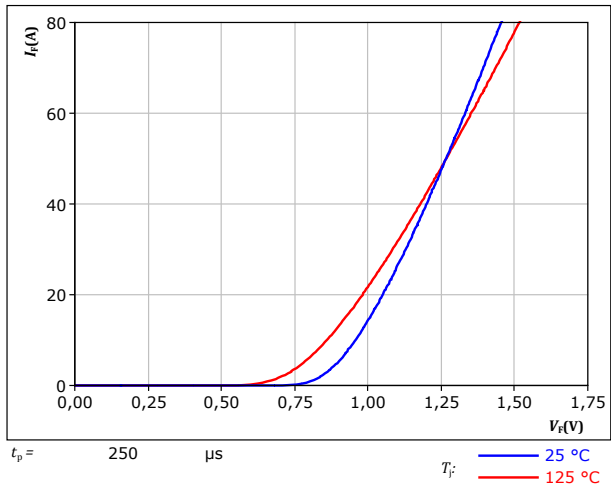
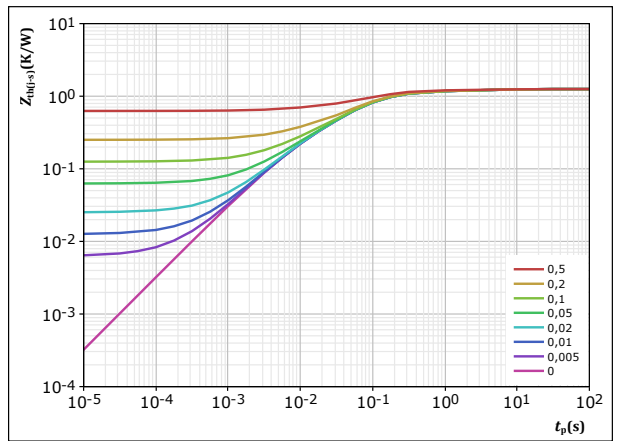


figure 9. Rectifier

Transient thermal impedance as a function of pulse width

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



$D = \frac{t_p}{T}$

$R_{th(j-s)} = 1,254 \text{ K/W}$

Rectifier thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
8,00E-02	5,22E+00
1,56E-01	4,18E-01
6,95E-01	8,82E-02
2,23E-01	3,07E-02
9,97E-02	5,99E-03

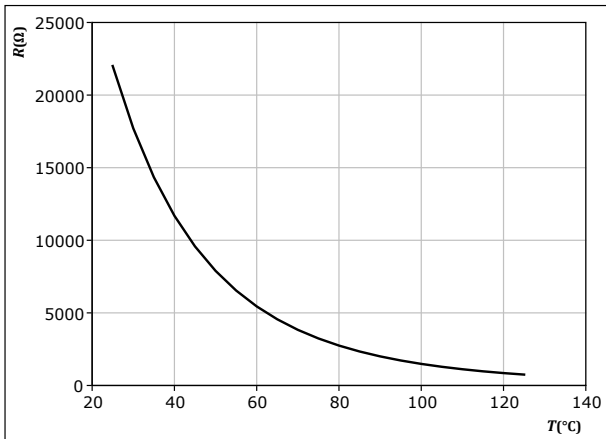


Thermistor Characteristics

figure 10. Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$

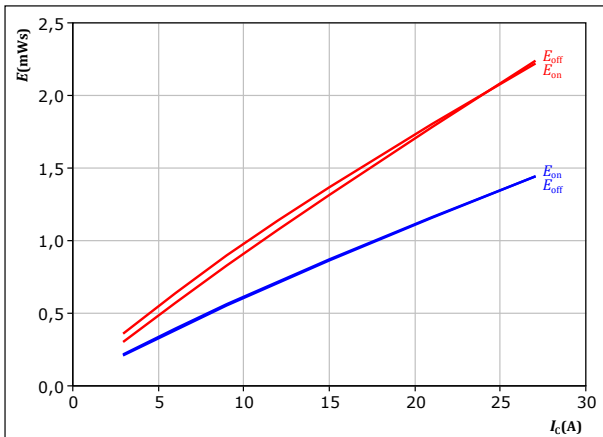




Inverter Switching Characteristics

figure 11. IGBT

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



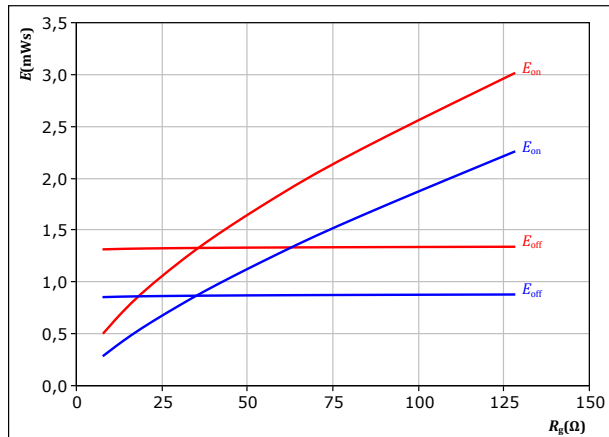
With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 32$ Ω

T_j : — 25 °C
 — 150 °C

figure 12. IGBT

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



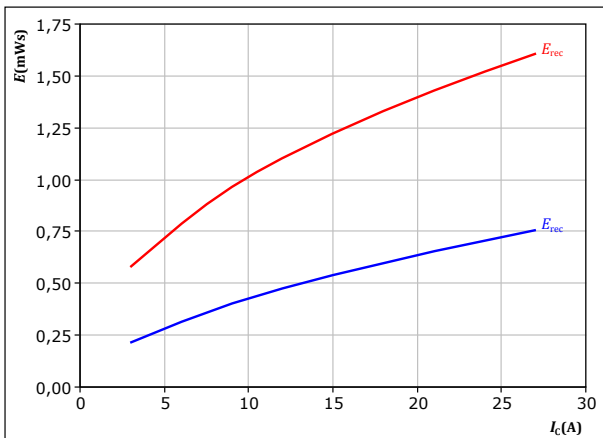
With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j : — 25 °C
 — 150 °C

figure 13. FWD

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



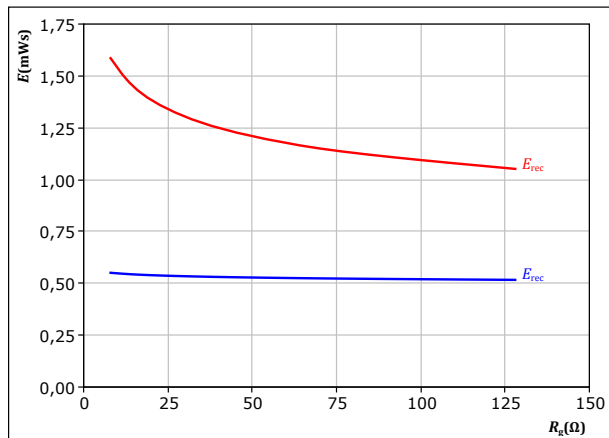
With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω

T_j : — 25 °C
 — 150 °C

figure 14. FWD

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



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

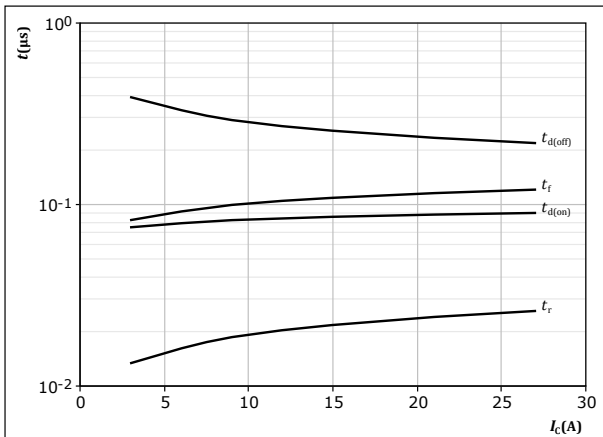
T_j : — 25 °C
 — 150 °C



Inverter Switching Characteristics

figure 15. IGBT

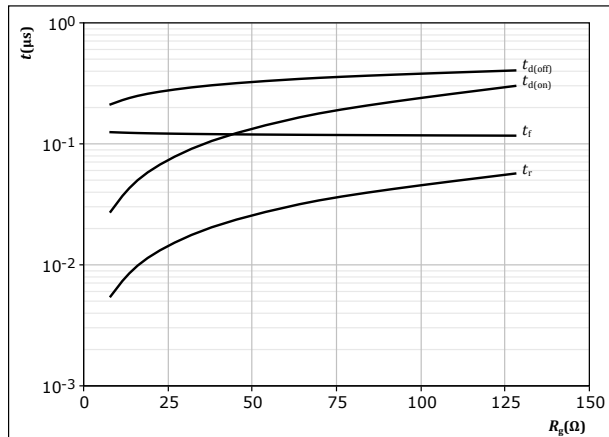
Typical switching times as a function of collector current
 $t = f(I_c)$



With an inductive load at
 $T_j = 150 \text{ }^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{g(on)} = 32 \text{ } \Omega$
 $R_{g(off)} = 32 \text{ } \Omega$

figure 16. IGBT

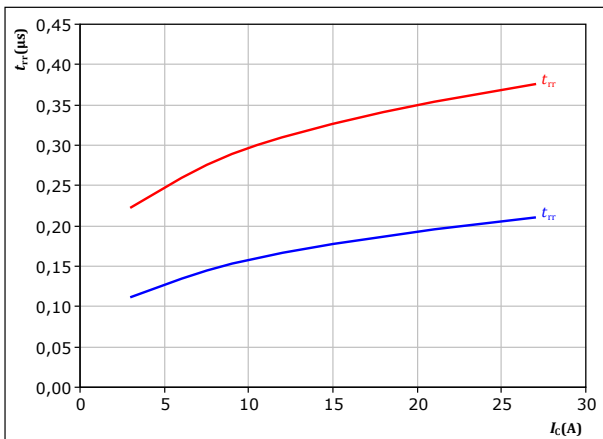
Typical switching times as a function of gate resistor
 $t = f(R_g)$



With an inductive load at
 $T_j = 150 \text{ }^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$

figure 17. FWD

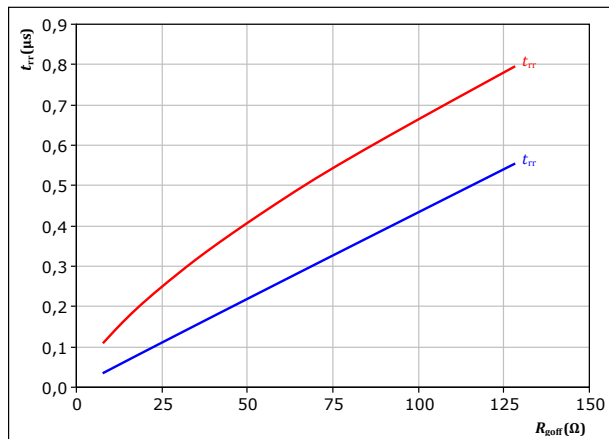
Typical reverse recovery time as a function of collector current
 $t_{rr} = f(I_c)$



With an inductive load at
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{g(on)} = 32 \text{ } \Omega$
 T_j : — 25 °C
— 150 °C

figure 18. FWD

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



With an inductive load at
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$
 T_j : — 25 °C
— 150 °C

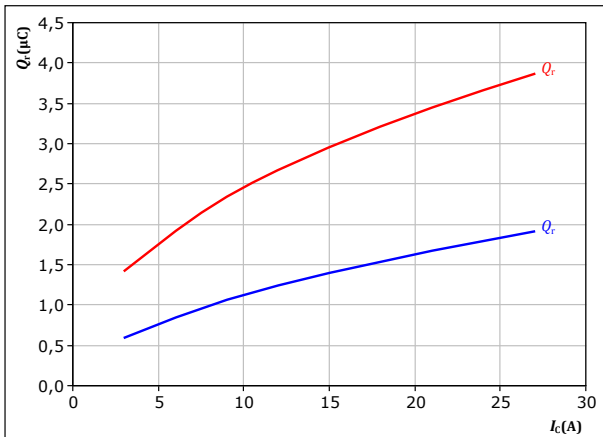


Inverter Switching Characteristics

figure 19. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

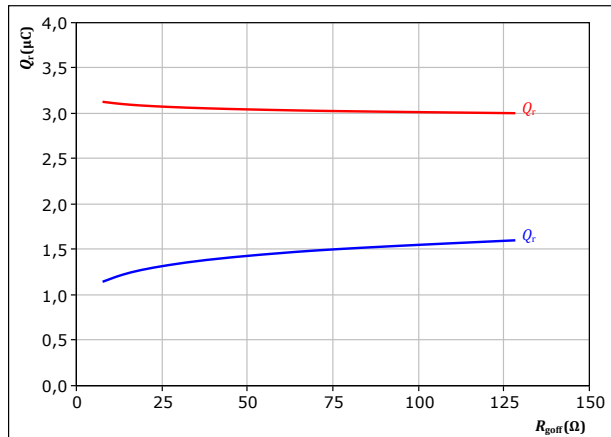
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{goff} = 32$ Ω

T_j : — 25 °C
— 150 °C

figure 20. FWD

Typical recovered charge as a function of turn off gate resistor

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



With an inductive load at

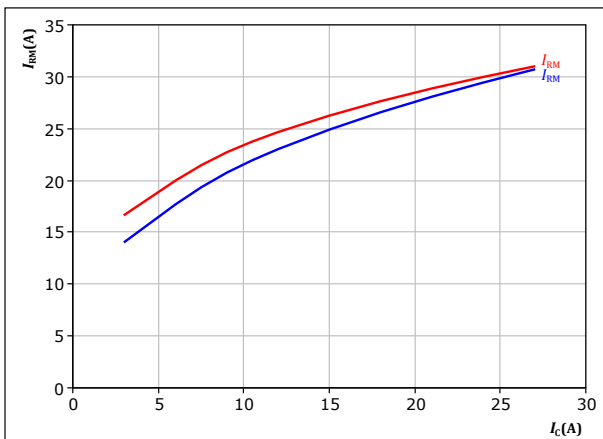
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j : — 25 °C
— 150 °C

figure 21. FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

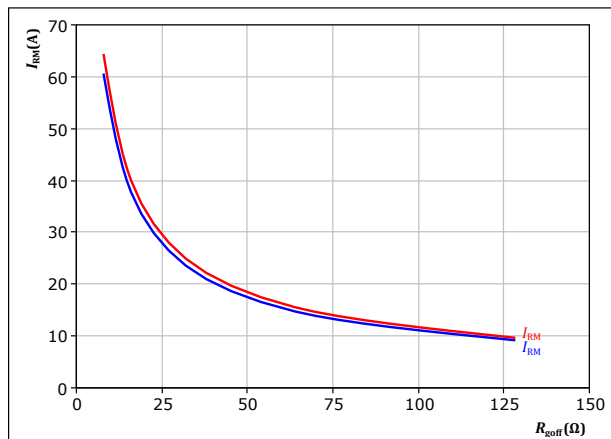
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{goff} = 32$ Ω

T_j : — 25 °C
— 150 °C

figure 22. FWD

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

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



With an inductive load at

$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

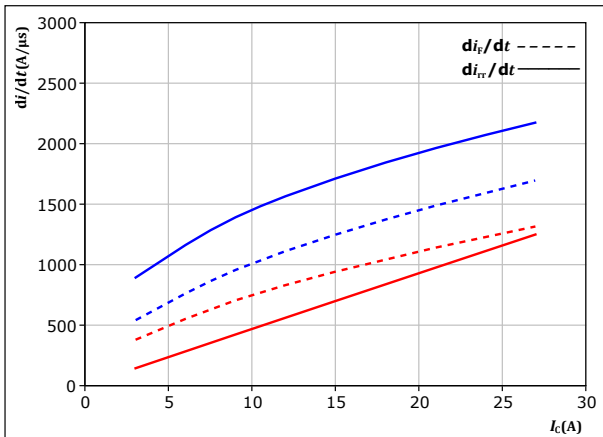
T_j : — 25 °C
— 150 °C



Inverter Switching Characteristics

figure 23. FWD

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



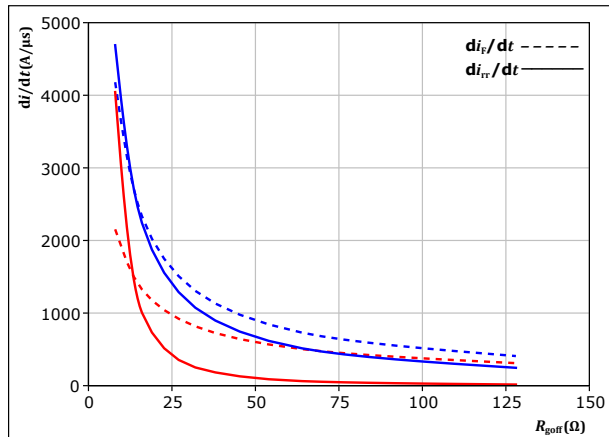
With an inductive load at

$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{goff} = 32 \ \Omega$

T_j : — 25 °C
 — 150 °C

figure 24. FWD

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



With an inductive load at

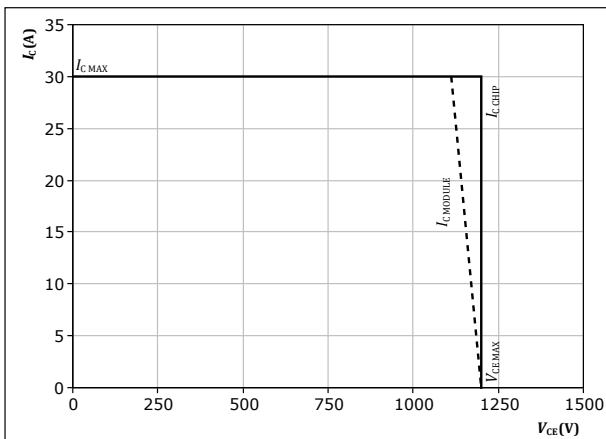
$V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_C = 15 \text{ A}$

T_j : — 25 °C
 — 150 °C

figure 25. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At $T_j = 150 \text{ °C}$
 $R_{goff} = 32 \ \Omega$
 $R_{goff} = 32 \ \Omega$



Inverter Switching Definitions

figure 26. IGBT

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

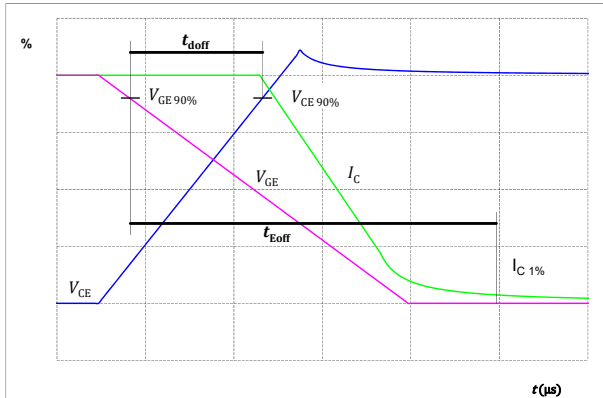


figure 27. IGBT

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

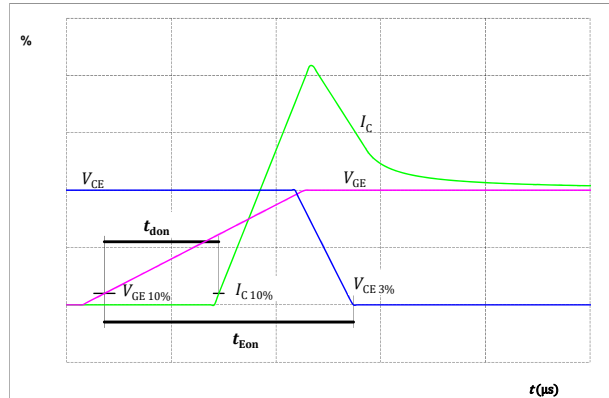


figure 28. IGBT

Turn-off Switching Waveforms & definition of t_f

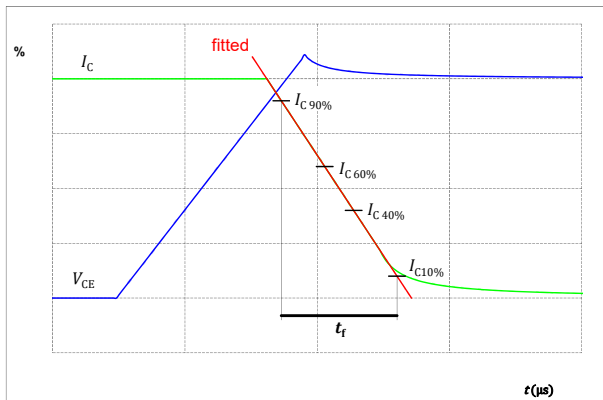
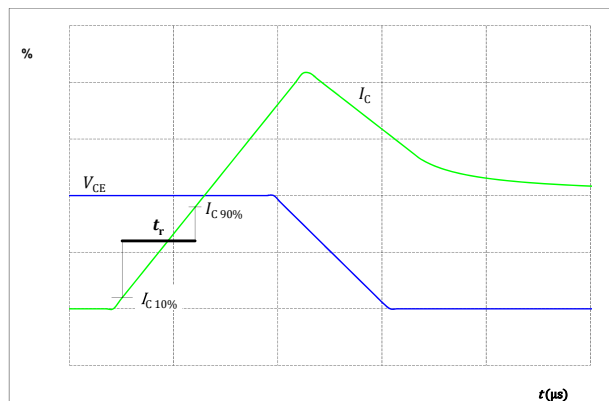


figure 29. IGBT

Turn-on Switching Waveforms & definition of t_r





Inverter Switching Definitions

figure 30. FWD

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

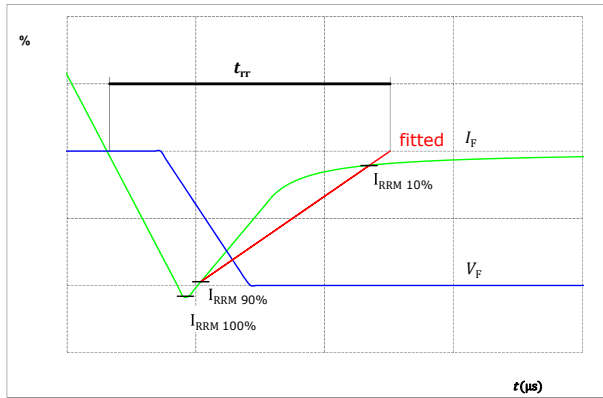
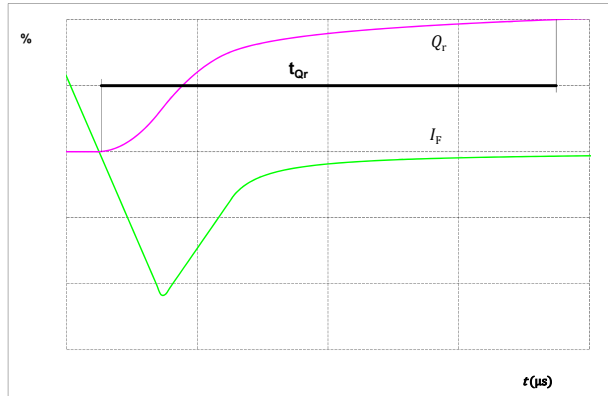


figure 31. FWD

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





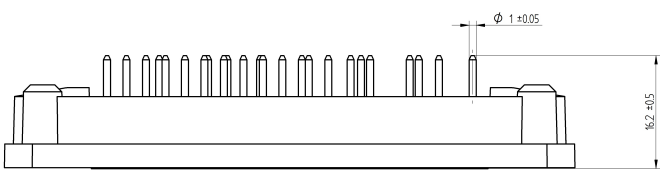
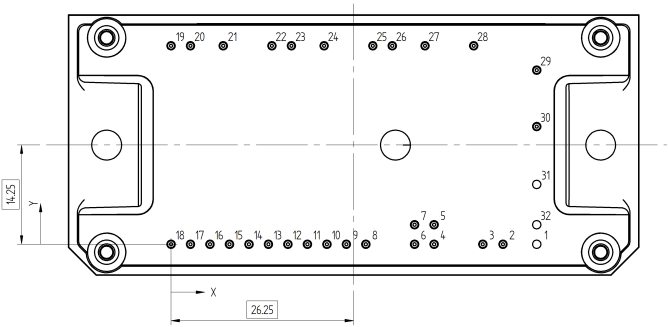
Vincotech

V23990-P588-C418-PM
datasheet

Ordering Code	
Version	Ordering Code
Without thermal paste	V23990-P588-C418-PM
With thermal paste (5,2 W/mK, PTM6000HV)	V23990-P588-C418-/7/-PM
With thermal paste (3,4 W/mK, PSX-P7)	V23990-P588-C418-/3/-PM

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

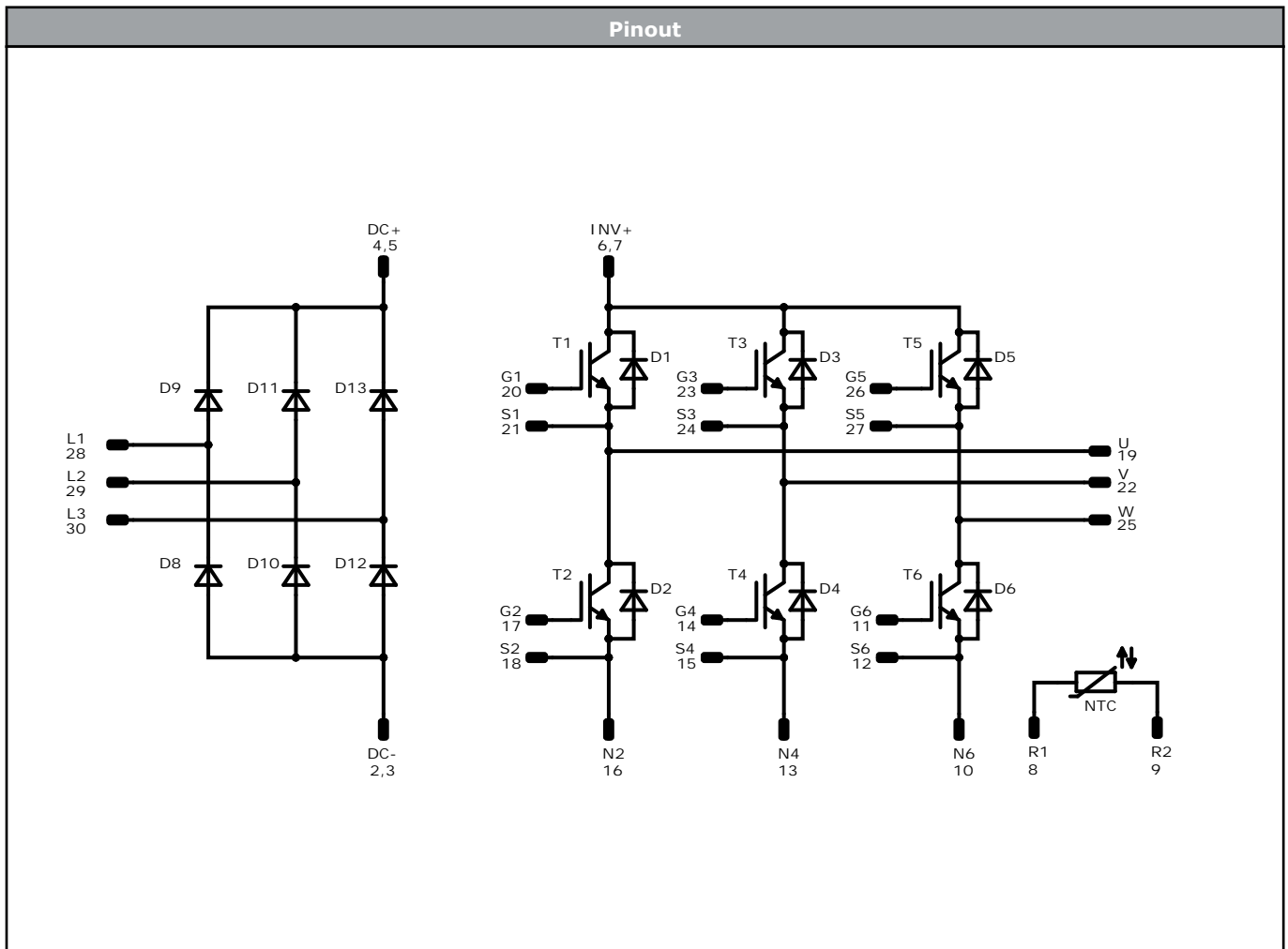
Outline				
Pin table [mm]				
Pin	X	Y	Function	
1	not assembled			
2	47,7	0	DC-	
3	44,8	0	DC-	
4	37,8	0	DC+	
5	37,8	2,8	DC+	
6	35	0	Inv+	
7	35	2,8	Inv+	
8	28	0	R1	
9	25,2	0	R2	
10	22,4	0	N6	
11	19,6	0	G6	
12	16,8	0	S6	
13	14	0	N4	
14	11,2	0	G4	
15	8,4	0	S4	
16	5,6	0	N2	
17	2,8	0	G2	
18	0	0	S2	
19	0	28,5	U	
20	2,8	28,5	G1	
21	7,5	28,5	S1	
22	14,5	28,5	V	
23	17,3	28,5	G3	
24	22	28,5	S3	
25	29	28,5	W	
26	31,8	28,5	G5	
27	36,5	28,5	S5	
28	43,5	28,5	L1	
29	52,55	25	L2	
30	52,55	16,9	L3	
31	not assembled			
32	not assembled			

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



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Identification					
ID	Component	Voltage	Current	Function	Comment
T2, T1, T4, T3, T6, T5	IGBT	1200 V	15 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	15 A	Inverter Diode	
D9, D8, D11, D10, D13, D12	Rectifier	1600 V	35 A	Rectifier Diode	
Rt	Thermistor			Thermistor	




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Packaging instruction				
Standard packaging quantity (SPQ) 100	>SPQ	Standard	<SPQ	Sample

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

Package data
Package data for <i>flow 1</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-P588-C418-PM-D7-14	22 Sep. 2021	Rectifier maximum ratings is updated Characteristic values are updated Separated datasheet New datasheet format, module is unchanged	

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