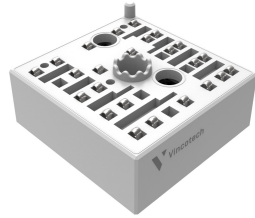
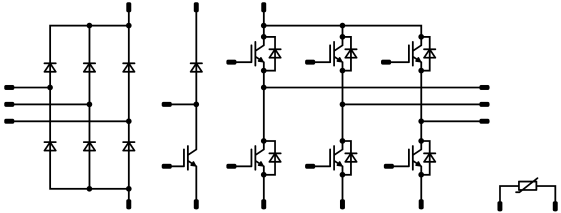




Vincotech

MiniSKiiP® 1 PIM	1200 V / 15 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Features</div> <ul style="list-style-type: none"> Solderless interconnection Trenchstop™ IGBT4 technology 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">MiniSkip® 1 housing</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Target applications</div> <ul style="list-style-type: none"> Industrial drives 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Schematic</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Types</div> <ul style="list-style-type: none"> V23990-K200-A41-PM 	

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter / Brake Switch				
Collector-emitter voltage	V_{CES}		1200	V
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
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	88	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$ $V_{CE} = 800\text{ V}$ $T_j = 150\text{ °C}$	10	μs
Maximum junction temperature	T_{jmax}		175	°C



Vincotech

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter / Brake Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	21	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave $t_p = 10\text{ ms}$ $T_j = 25\text{ °C}$	65	A
Surge current capability	I^2t		21	A ² s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	64	W
Maximum junction temperature	T_{jmax}		175	°C

Rectifier Diode

Peak repetitive reverse voltage	V_{RRM}		1600	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	49	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	270	A
Surge current capability	I^2t		370	A ² s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	64	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* $t_p = 2\text{ s}$	5500	V
		AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance		With std lid For more informations see handling instructions	6,3	mm
Clearance		With std lid For more informations see handling instructions	6,3	mm
Comparative Tracking Index	CTI		> 200	

*100 % tested in production



Vincotech

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 / Brake Switch

Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,0005	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CESat}		15		15	25 125 150	1,58	1,86 2,14 2,22	2,07	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		

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5 \text{ W/mK}$ (HPTP)						1,08		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \Omega$ $R_{goff} = 32 \Omega$	±15	600	15	25		102		ns
Rise time	t_r					150		102		
Turn-off delay time	$t_{d(off)}$					25		33		
Fall time	t_f					150		37		
Turn-on energy (per pulse)	E_{on}	$Q_{tFWD} = 1 \mu\text{C}$ $Q_{tFWD} = 2,3 \mu\text{C}$				25		0,986		mWs
Turn-off energy (per pulse)	E_{off}					150		1,53		
						25		0,904		
						150		1,47		



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 / Brake Diode

Static

Forward voltage	V_F				15	25 125		2,37 2,47	2,71	V
Reverse leakage current	I_R			1200		25 150			60 1800	μ A

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (HPTP)						1,48		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Dynamic

Peak recovery current	I_{RRM}					25 150		8 11		A
Reverse recovery time	t_{rr}					25 150		299 541		ns
Recovered charge	Q_r	$di/dt = 309$ A/ μ s $di/dt = 352$ A/ μ s	± 15	600	15	25 150		0,976 2,33		μ C
Reverse recovered energy	E_{rec}					25 150		0,381 0,966		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 150		73 47		A/ μ s

Rectifier Diode

Static

Forward voltage	V_F				35	25 125		1,17 1,13		V
Reverse leakage current	I_R			1600		25			50	μ A

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 2,5$ W/mK (HPTP)						1,10		K/W
-------------------------------------	---------------	--	--	--	--	--	--	------	--	-----

Thermistor

Rated resistance	R					25		1		k Ω
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1670$ Ω				100	-2		+2	%
R_{100}	R					100		1670		Ω
Power dissipation constant						25		0,76		mW/K
A-value	$A_{(25/50)}$					25		$7,635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1,731 \cdot 10^{-5}$		1/K ²
Vincotech PTC Reference									E	

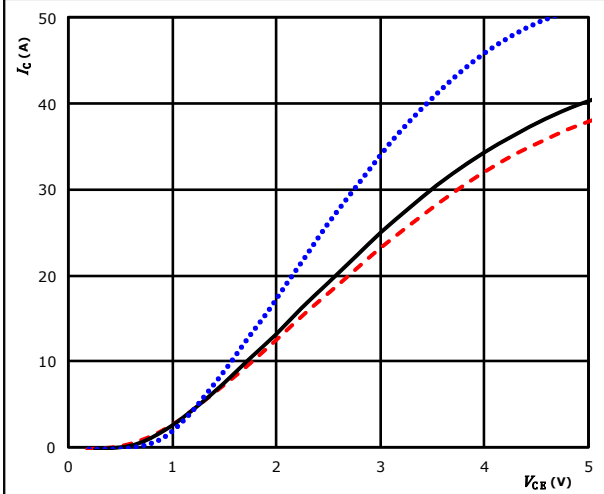


Inverter / Brake Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

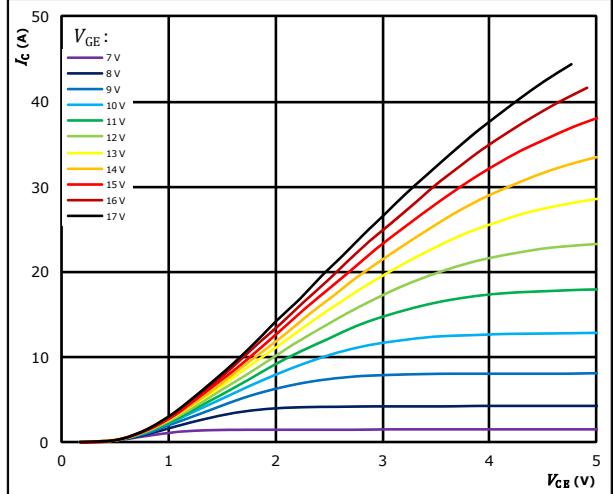


$t_p = 250 \mu\text{s}$ $V_{GE} = 15 \text{ V}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue)
 $T_j: 125 \text{ }^\circ\text{C}$ (solid black)
 $T_j: 150 \text{ }^\circ\text{C}$ (dashed red)

figure 2. IGBT

Typical output characteristics

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

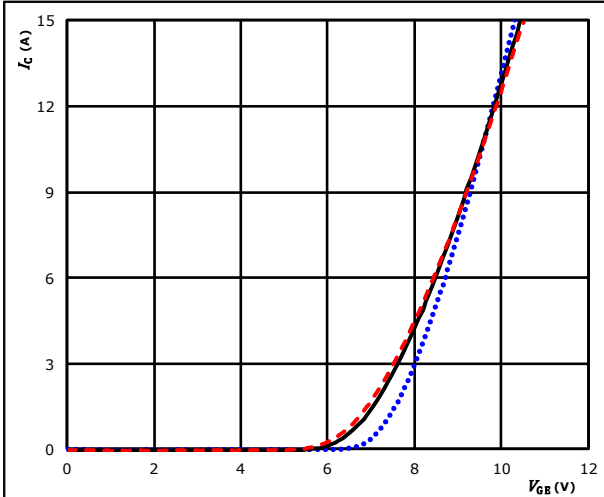


$t_p = 250 \mu\text{s}$ $T_j = 150 \text{ }^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

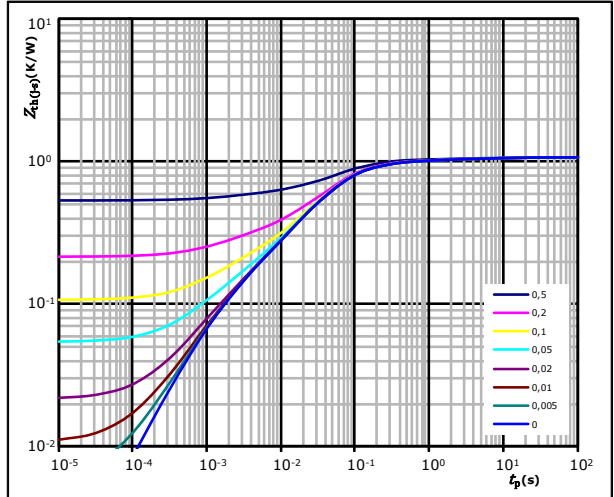


$t_p = 100 \mu\text{s}$ $V_{CE} = 10 \text{ V}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue)
 $T_j: 125 \text{ }^\circ\text{C}$ (solid black)
 $T_j: 150 \text{ }^\circ\text{C}$ (dashed red)

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 1,08 \text{ K/W}$

IGBT thermal model values

R (K/W)	τ (s)
4,02E-02	8,05E+00
7,53E-02	6,86E-01
2,00E-01	1,22E-01
5,79E-01	4,09E-02
1,08E-01	7,96E-03
7,24E-02	1,22E-03
4,99E-03	5,90E-04



Inverter / Brake Switch Characteristics

figure 5. IGBT

Gate voltage vs gate charge

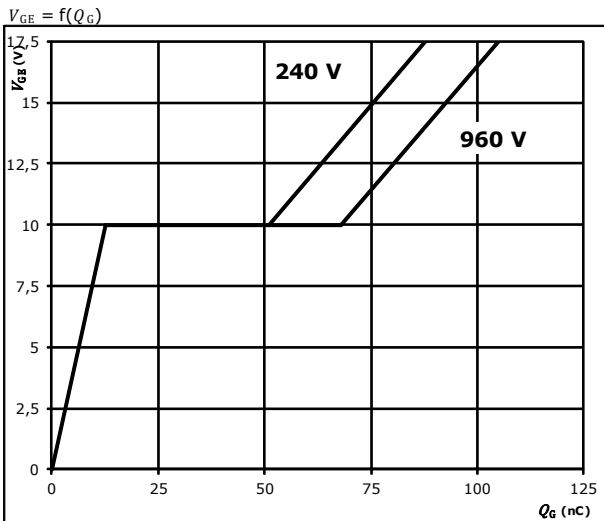
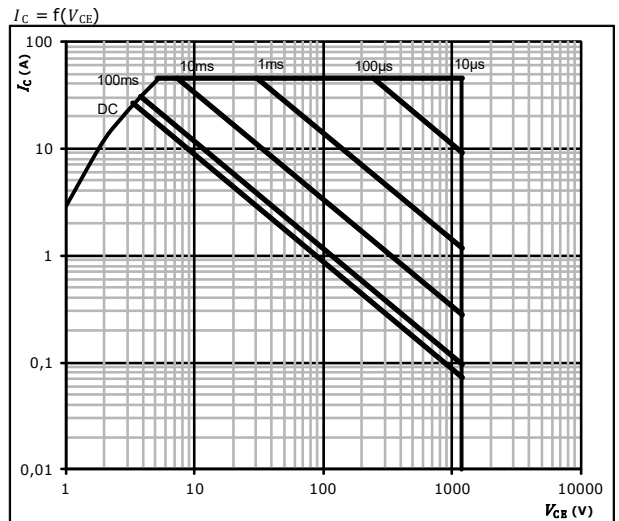


figure 6. IGBT

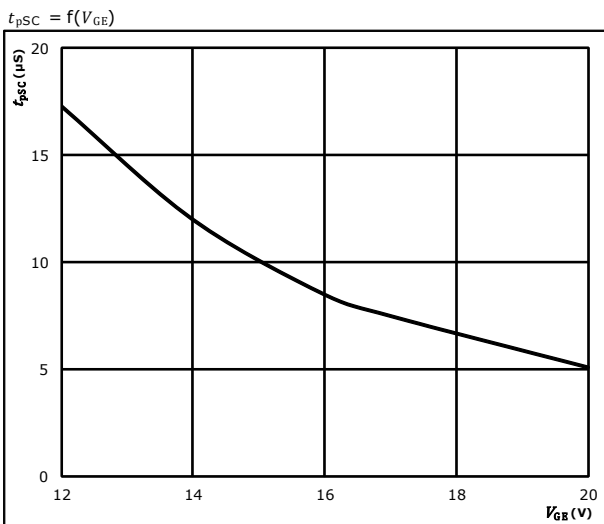
Safe operating area



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

figure 7. IGBT

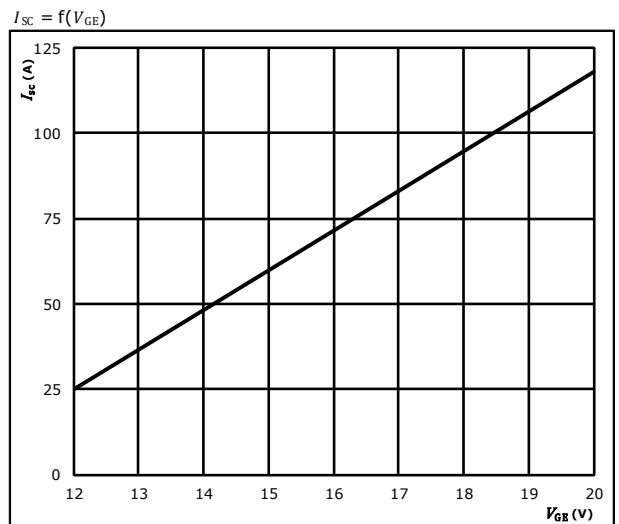
Short circuit duration as a function of V_{GE}



$V_{CE} = 600 \text{ V}$
 $T_j \leq 175 \text{ } ^\circ\text{C}$

figure 8. IGBT

Typical short circuit current as a function of V_{GE}



$V_{CE} \leq 600 \text{ V}$
 $T_j \leq 175 \text{ } ^\circ\text{C}$

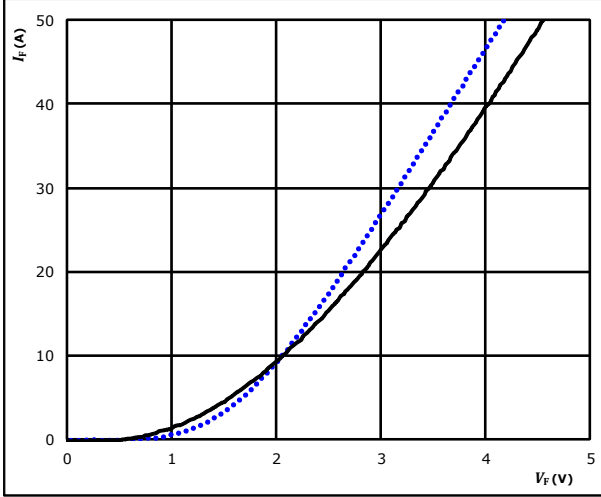


Inverter / Brake Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

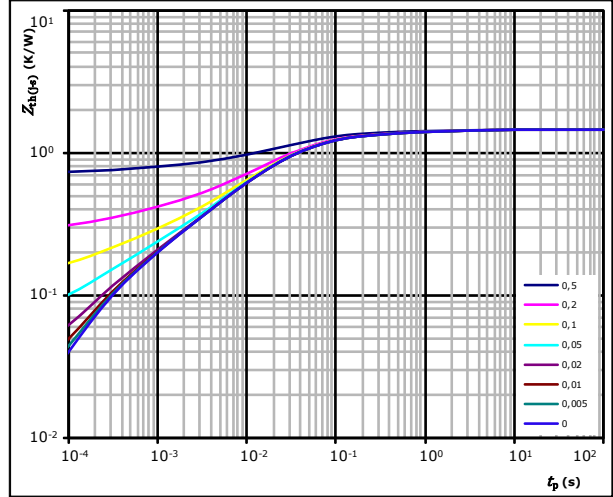


$t_p = 250 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (blue dotted line)
 $125 \text{ }^\circ\text{C}$ (black solid line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,44 \text{ K/W}$

FWD thermal model values

R (K/W)	τ (s)
6,32E-02	2,64E+00
1,25E-01	3,53E-01
4,72E-01	5,08E-02
4,73E-01	1,56E-02
2,06E-01	2,93E-03
1,06E-01	3,09E-04

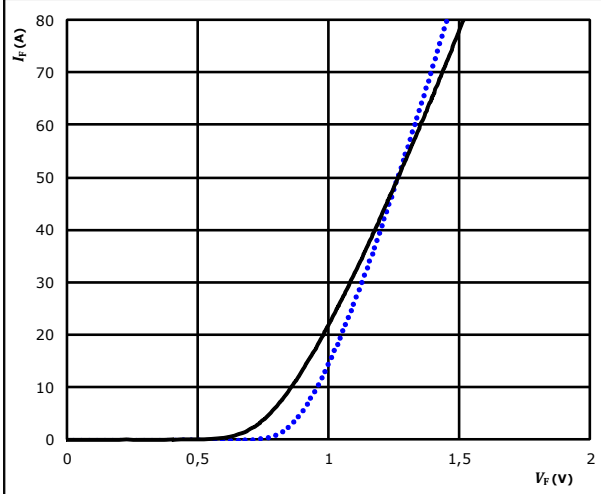


Rectifier Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

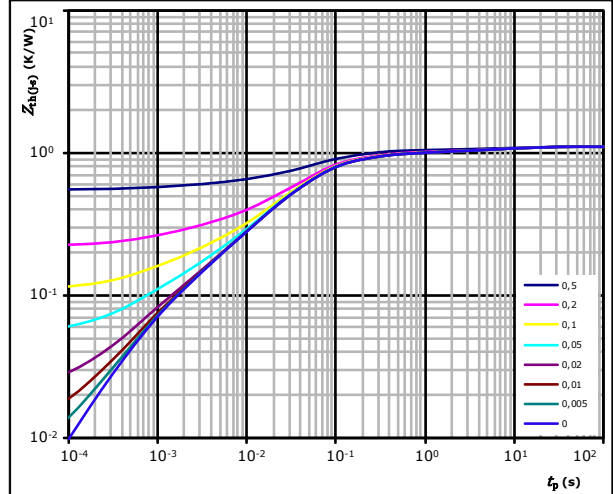


$t_p = 250 \mu s$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line) $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,10 \text{ K/W}$
 FWD thermal model values

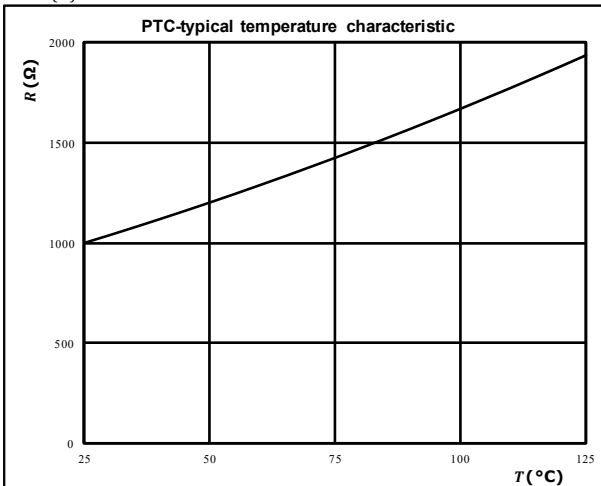
$R \text{ (K/W)}$	$\tau \text{ (s)}$
1,03E-01	7,04E+00
1,17E-01	3,94E-01
5,19E-01	5,87E-02
2,38E-01	2,15E-02
7,64E-02	3,49E-03
4,71E-02	6,93E-04

Thermistor Characteristics

figure 1. Thermistor

Typical PTC characteristic
as a function of temperature

$$R = f(T)$$



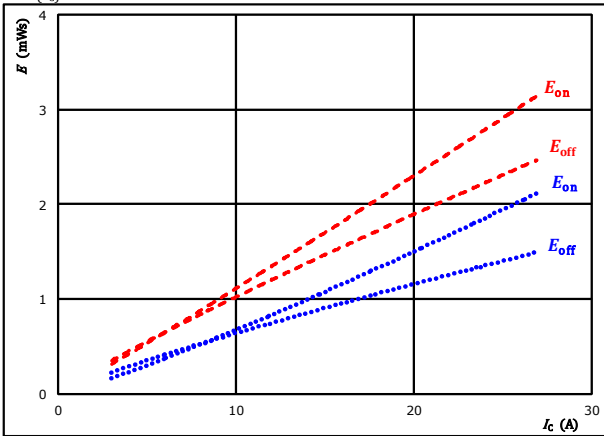


Inverter Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$



With an inductive load at

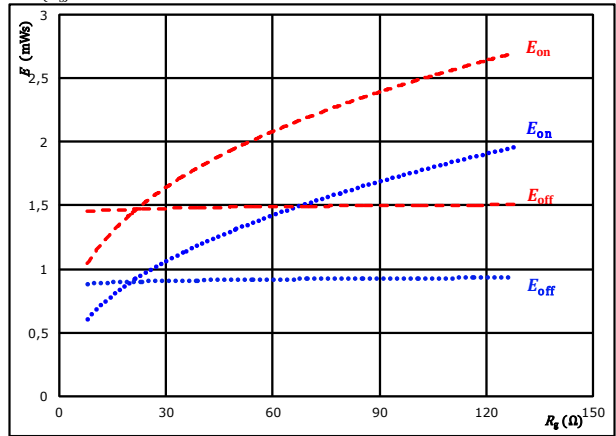
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω
 $R_{goff} = 32$ Ω

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(R_g)$$



With an inductive load at

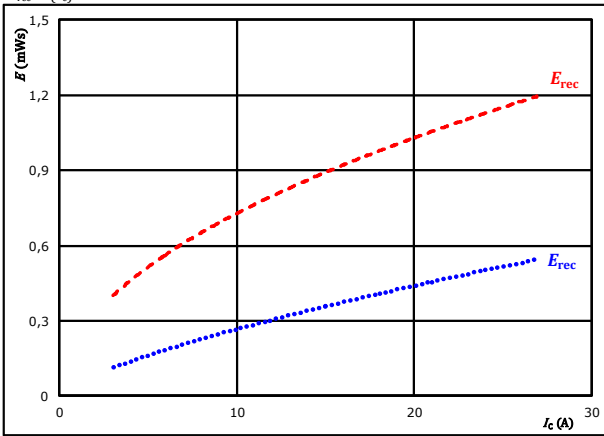
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

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



With an inductive load at

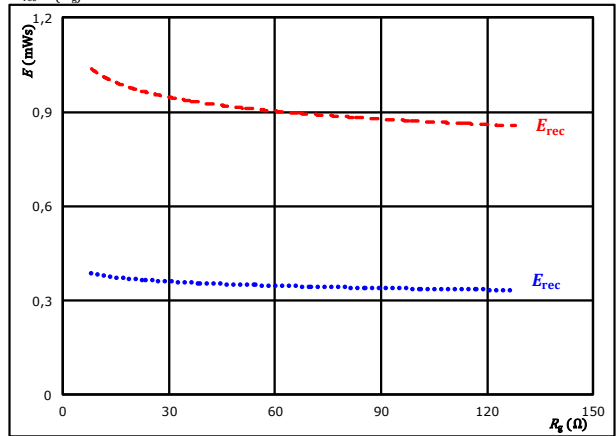
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 32$ Ω

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 4. 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 (blue dotted line)
150 °C (red dashed line)

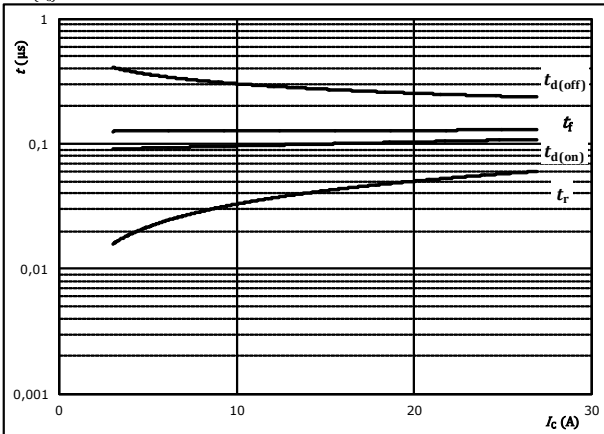


Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$$t = f(I_c)$$



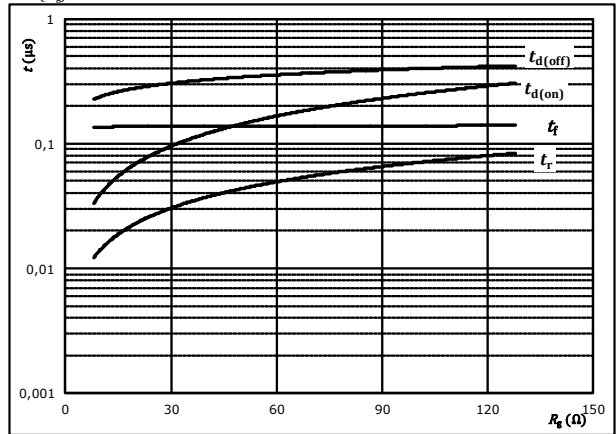
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	32	Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



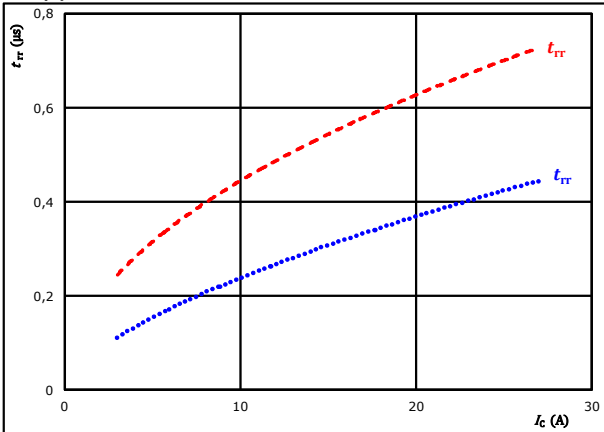
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_c =$	15	A

figure 7. FWD

Typical reverse recovery time as a function of collector current

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



With an inductive load at

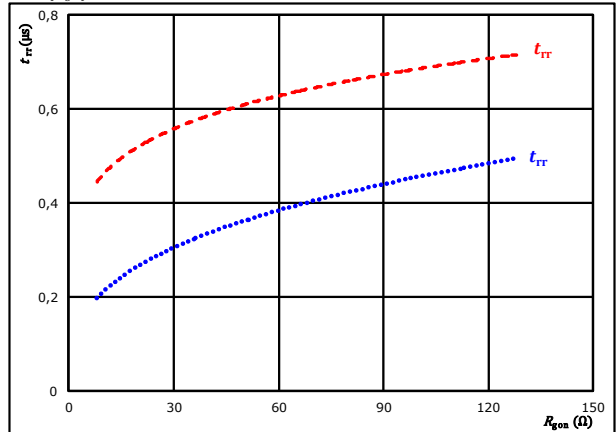
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	32	Ω

$T_j:$	25 °C
	150 °C	-----

figure 8. FWD

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

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



With an inductive load at

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

$T_j:$	25 °C
	150 °C	-----

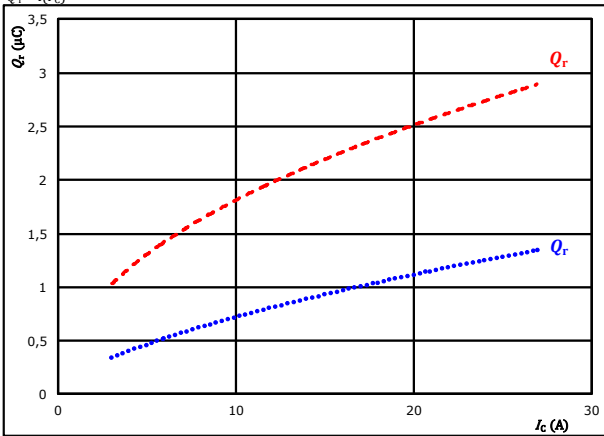


Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

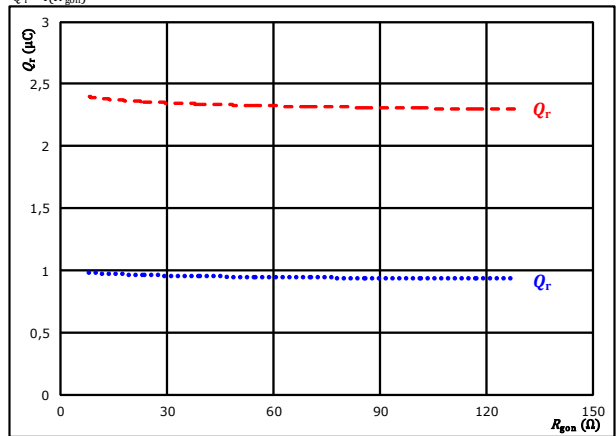
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{ggn} = 32$ Ω

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 10. FWD

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

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



With an inductive load at

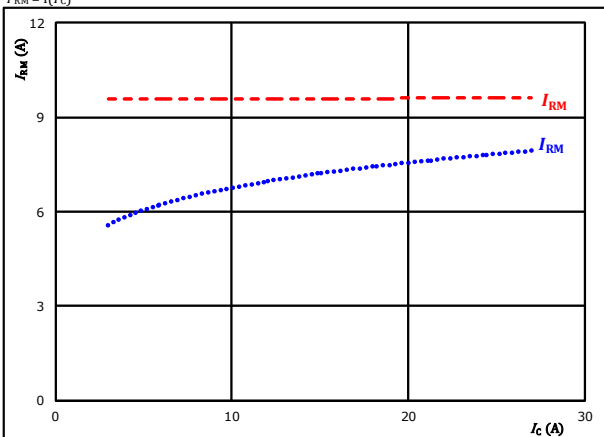
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 11. FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

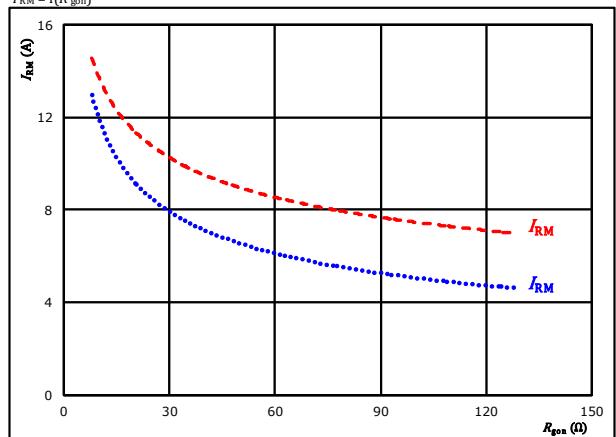
$V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{ggn} = 32$ Ω

T_j : 25 °C (blue dotted line)
150 °C (red dashed line)

figure 12. FWD

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

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



With an inductive load at

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

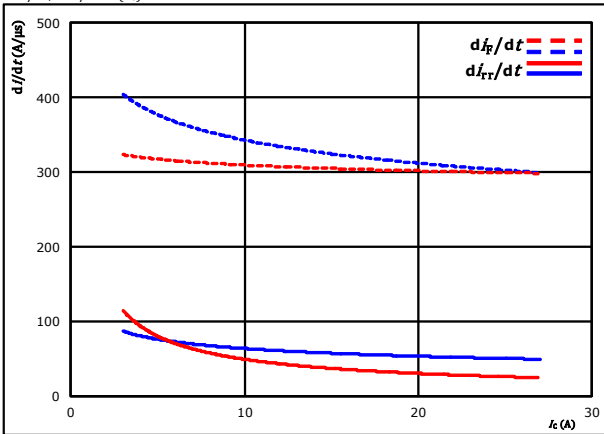
T_j : 25 °C (blue dotted line)
150 °C (red dashed line)



Inverter Switching Characteristics

figure 13. FWD

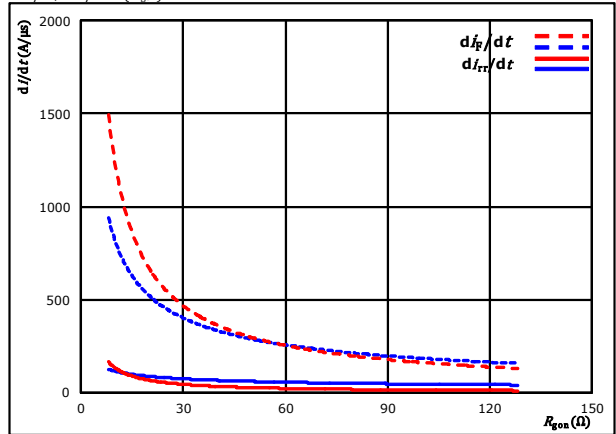
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_f/dt, di_{rr}/dt = f(I_c)$



With an inductive load at
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{g\text{on}} = 32 \text{ } \Omega$
 $T_j = 25 \text{ } ^\circ\text{C}$
 $150 \text{ } ^\circ\text{C}$

figure 14. FWD

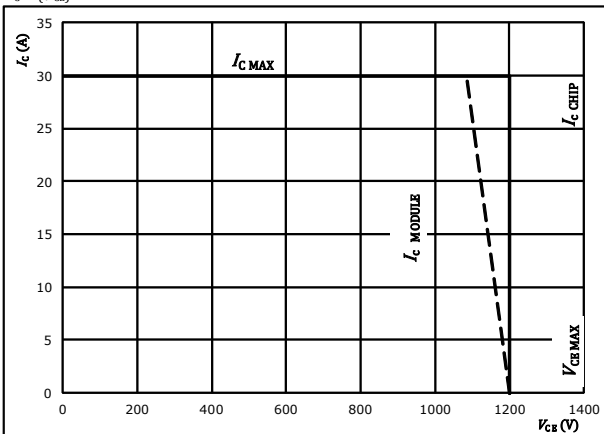
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $di_f/dt, di_{rr}/dt = f(R_{g\text{on}})$



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

figure 15. IGBT

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



At
 $T_j = 150 \text{ } ^\circ\text{C}$
 $R_{g\text{on}} = 32 \text{ } \Omega$
 $R_{g\text{off}} = 32 \text{ } \Omega$



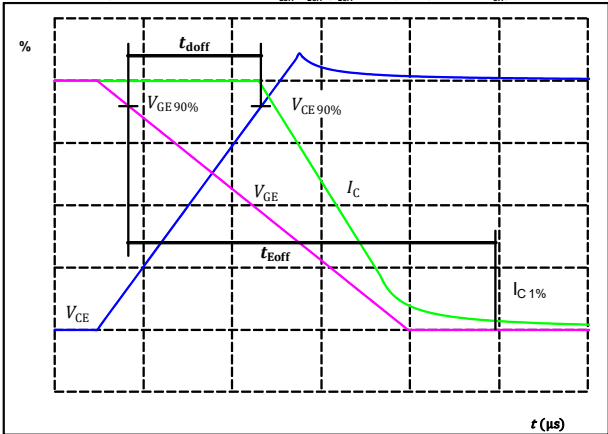
Inverter Switching Definitions

General conditions

T_j	=	125 °C
$R_{g\text{on}}$	=	32 Ω
$R_{g\text{off}}$	=	32 Ω

figure 1. IGBT

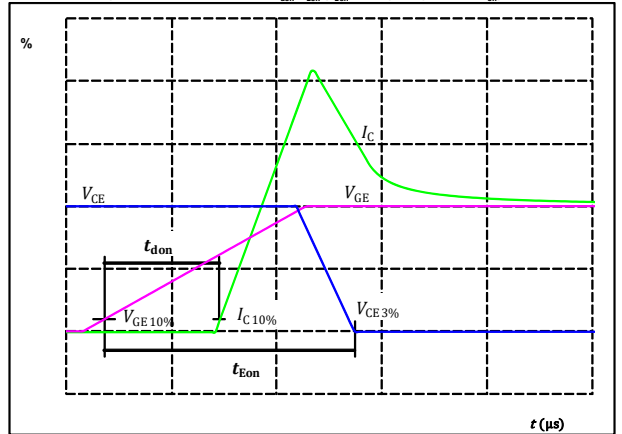
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{\text{CE}}(0\%) =$	-15	V
$V_{\text{GE}}(100\%) =$	15	V
$V_{\text{C}}(100\%) =$	600	V
$I_{\text{C}}(100\%) =$	15	A
$t_{\text{doff}} =$	284	ns

figure 2. IGBT

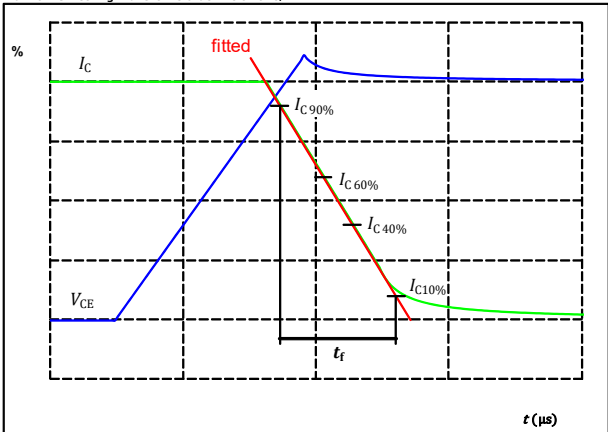
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{\text{CE}}(0\%) =$	-15	V
$V_{\text{GE}}(100\%) =$	15	V
$V_{\text{C}}(100\%) =$	600	V
$I_{\text{C}}(100\%) =$	15	A
$t_{\text{don}} =$	102	ns

figure 3. IGBT

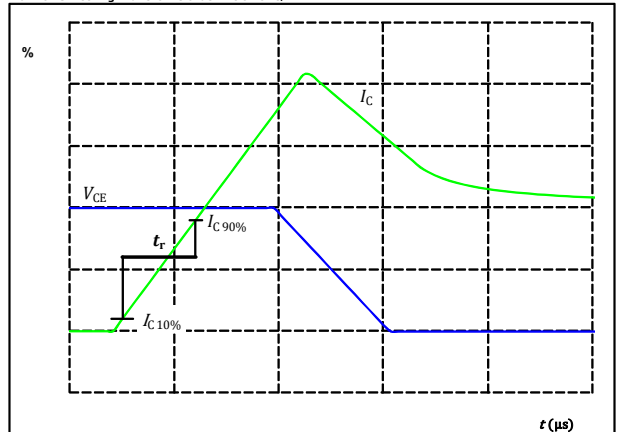
Turn-off Switching Waveforms & definition of t_r



$V_{\text{C}}(100\%) =$	600	V
$I_{\text{C}}(100\%) =$	15	A
$t_r =$	133	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r



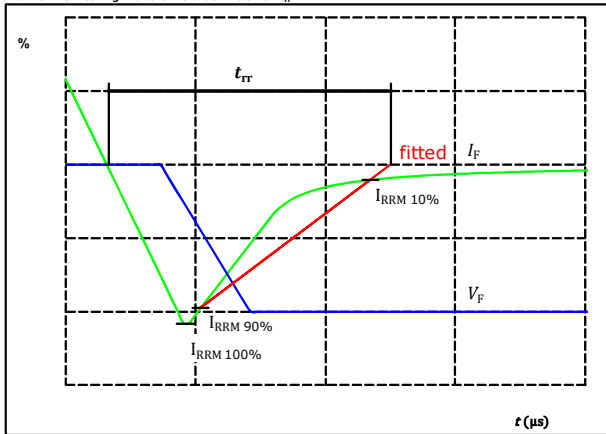
$V_{\text{C}}(100\%) =$	600	V
$I_{\text{C}}(100\%) =$	15	A
$t_r =$	37	ns



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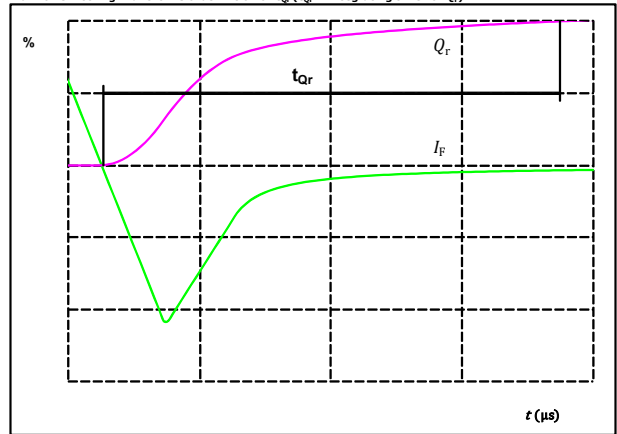
Inverter Switching Characteristics

figure 5. FWD
Turn-off Switching Waveforms & definition of t_{rr}



$V_F(100\%) =$	600	V
$I_F(100\%) =$	15	A
$I_{RRM}(100\%) =$	11	A
$t_{rr} =$	541	ns

figure 6. FWD
Turn-on Switching Waveforms & definition of t_{qr} ($t_{qr} =$ integrating time for Q_r)

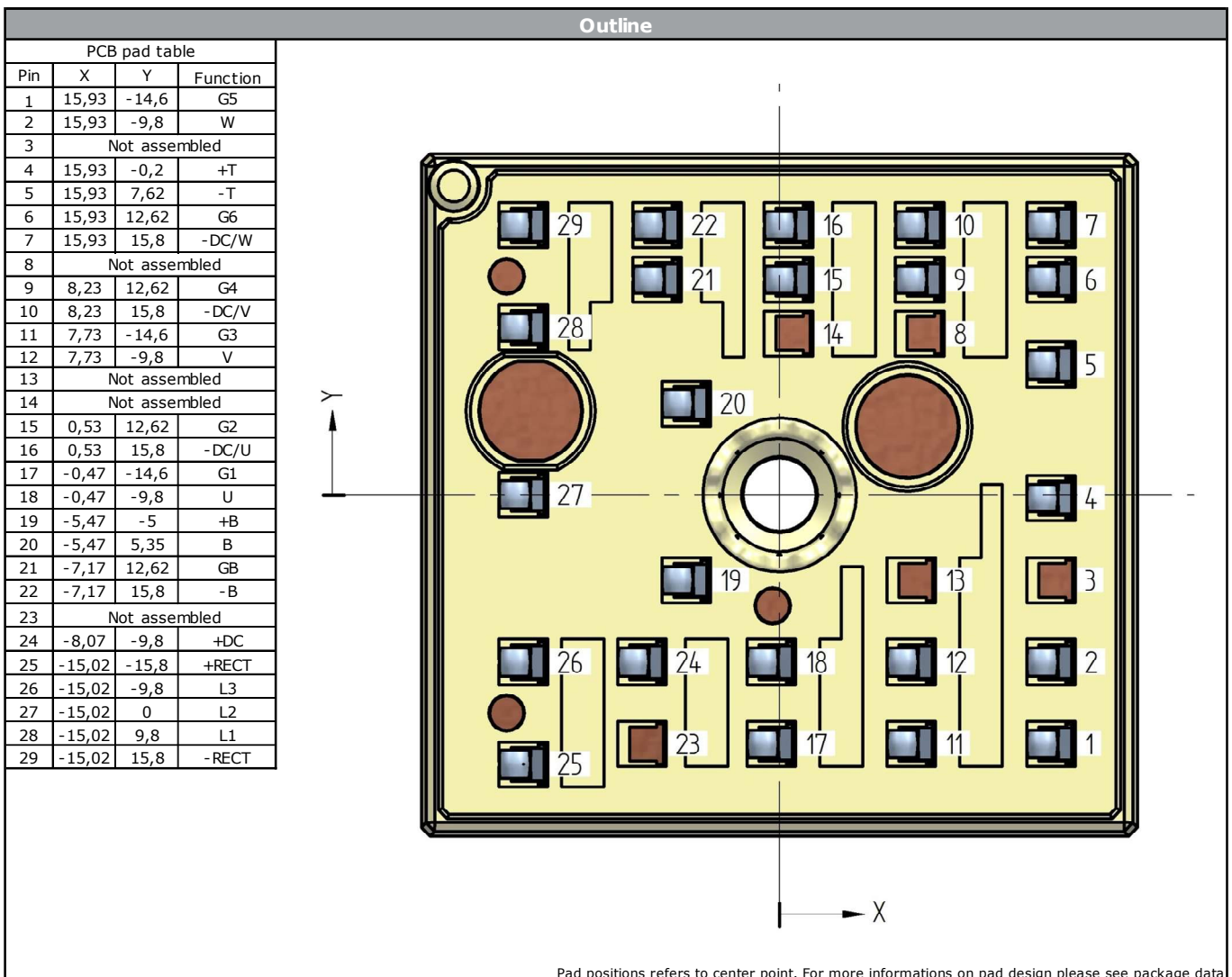


$I_F(100\%) =$	15	A
$Q_r(100\%) =$	2,33	μC



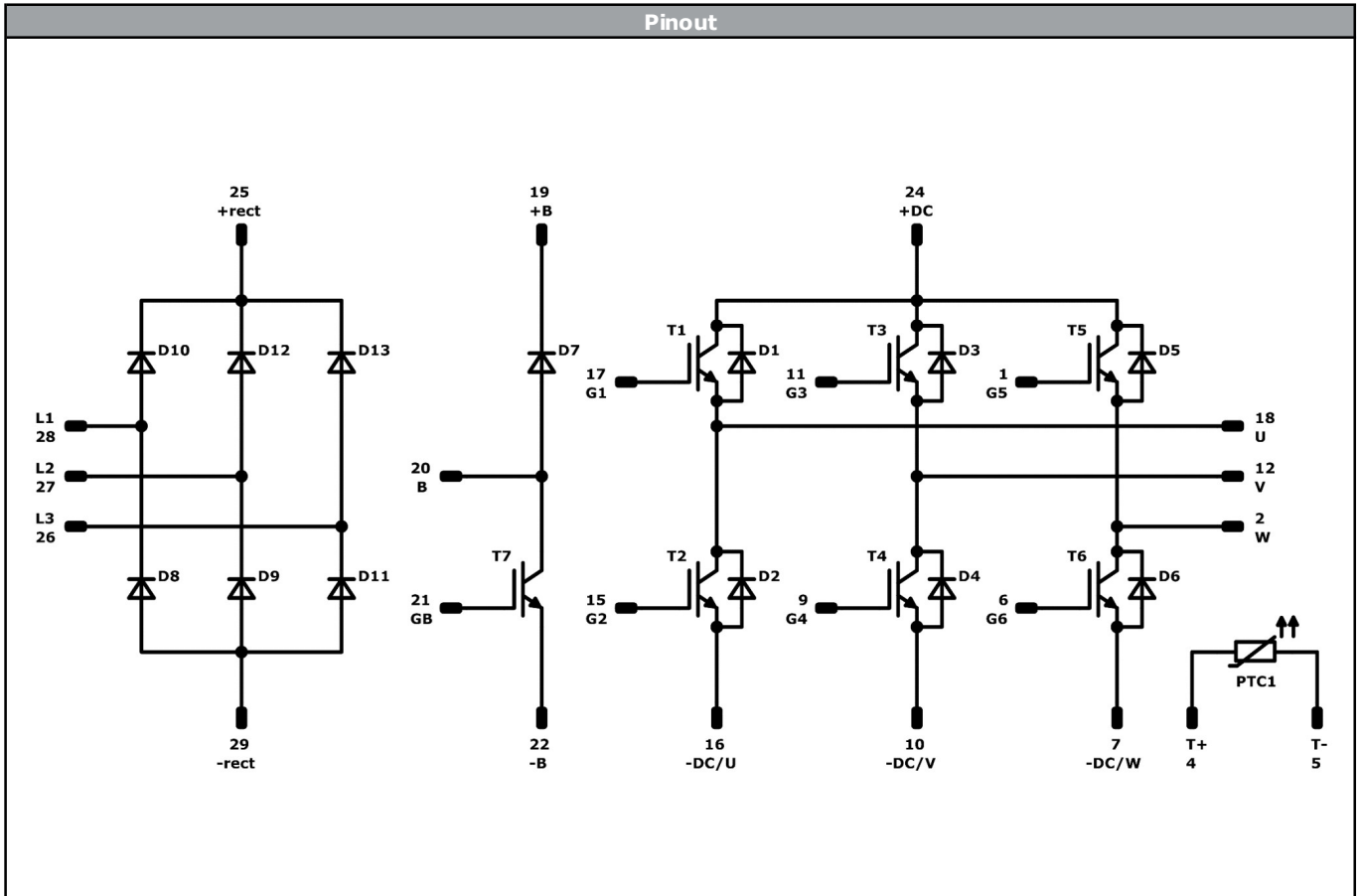
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Ordering Code & Marking									
Version				Ordering Code					
With std lid (6.5mm height) + no thermal grease				V23990-K200-A41-/0A/-PM					
With thin lid (2.8mm height) + no thermal grease				V23990-K200-A41-/0B/-PM					
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K200-A41-/1A/-PM					
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)				V23990-K200-A41-/1B/-PM					
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K200-A41-/4A/-PM					
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)				V23990-K200-A41-/4B/-PM					
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K200-A41-/5A/-PM					
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)				V23990-K200-A41-/5B/-PM					
VIN WWYY NNNNNNVV UL LLLL SSSS			Text	VIN	Date code	Name&Ver	UL	Lot	Serial
				VIN	WWYY	NNNNNNVV	UL	LLLLL	SSSS
			Datamatrix	Type&Ver	Lot number	Serial	Date code		
				NNNNNNVV	LLLLL	SSSS	WWYY		





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Identification					
ID	Component	Voltage	Current	Function	Comment
T1, T2, T3, T4, T5, T6, T7	IGBT	1200 V	15 A	Inverter / Brake Switch	
D1, D2, D3, D4, D5, D6, D7	FWD	1200 V	15 A	Inverter / Brake Diode	
D8, D9, D10, D11, D12, D13	Rectifier	1600 V	35 A	Rectifier Diode	
PTC1	PTC			Thermistor	




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Packaging instruction			
Standard packaging quantity (SPQ) 120	>SPQ	Standard	<SPQ Sample

Handling instruction
Handling instructions for MiniSkiiP® 1 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 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-K200-A41-D3-14	04 Jul. 2019	Correction of I _c /I _f values	1,2

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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.