Vincotech

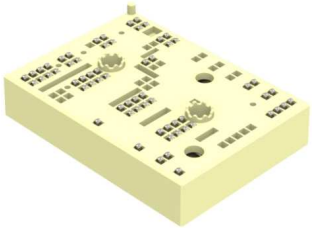
80-M3166BA140SC02-K489G40
datasheet

MiniSKiiP®CON 3 — **1600 V / 140 A**

Features

- Three-phase input Rectifier with Brake
- Solderless interconnection
- Trench Fieldstop IGBT 4 technology

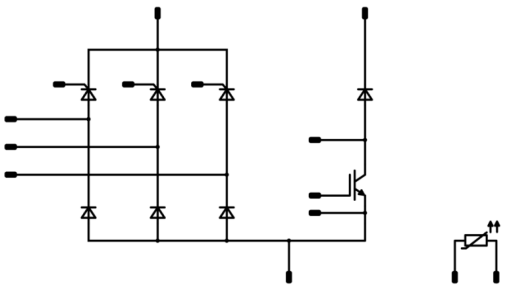
MiniSkiip®3 housing



Target applications

- Motor Drivers
- Servo Drivers
- UPS

Schematic



Types

- 80-M3166BA140SC02-K489G40

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Brake Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	169	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	450	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	452	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq$ 150 °C V_{GE} = 15 V	10 800	µs V
Maximum Junction Temperature	T_{jmax}		175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Brake Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C	112	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms T_j = 150 °C	900	A
Surge current capability	I^2t		4050	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	244	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 °C	127	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms T_j = 150 °C	1380	A
Surge current capability	I^2t		9520	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	171	W
Maximum junction temperature	T_{jmax}		150	°C
Rectifier Thyristor				
Repetitive peak reverse voltage	V_{RRM}		1600	V
Forward average current	I_{FAV}	sine, d = 0,5 $T_j = T_{jmax}$ T_s = 80 °C	139	A
Surge forward current	I_{FSM}	t_p = 10 ms T_j = 130 °C	1250	A
I^2t value	I^2t		7810	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	152	W
Maximum Junction Temperature	T_{jmax}		130	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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 s	5500	V
		AC Voltage t_p = 1 min	2500	V
Creepage distance			min. 12,7	mm
Clearance			min. 12,7	mm
Comparative Tracking Index	CTI		> 200	

*100 % tested in production

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	
Brake Switch										
Static										
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,0052	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CEsat}		15		150	25 150	1,58	1,93 2,39	2,07	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			2	µA
Gate-emitter leakage current	I_{GES}		20	0		25			240	nA
Internal gate resistance	r_g							5		Ω
Input capacitance	C_{ies}	f= 1 MHz	0	25		25		8600		pF
Reverse transfer capacitance	C_{res}							320		
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease λ = 2,5 W/mK (Silicone-based)						0,21		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{goff} = 4 Ω R_{gon} = 4 Ω	15/0	700	149	25 125 150		64 65 66		ns
Rise time	t_r					25 125 150		71 71 70		
Turn-off delay time	$t_{d(off)}$					25 125 150		597 681 708		
Fall time	t_f					25 125 150		28 45 90		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 9,6 µC Q_{rFWD} = 19,7 µC Q_{rFWD} = 24,5 µC				25 125 150		26,612 35,580 38,379		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		11,669 16,842 18,783		

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	
Brake Diode										
Static										
Forward voltage	V_F				150	25 150		2,50 2,53	2,7	V
Reverse leakage current	I_R			1200		25 150			180 28000	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease λ = 2,5 W/mK (Silicone-based)						0,39		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 800 A/µs di/dt = 1170 A/µs di/dt = 1197 A/µs	15/0	700	149	25 125 150		41 54 61		A
Reverse recovery time	t_{rr}					25 125 150		461 625 713		ns
Recovered charge	Q_r					25 125 150		9,606 19,735 24,477		µC
Reverse recovered energy	E_{rec}					25 125 150		3,568 7,410 9,263		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		98 61 66		A/µs
Rectifier Diode										
Static										
Forward voltage	V_F				140	25 125		1,46 1,41		V
Reverse leakage current	I_R			1600		25 150			50 1100	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease λ = 2,5 W/mK (Silicone-based)						0,41		K/W

Characteristic Values

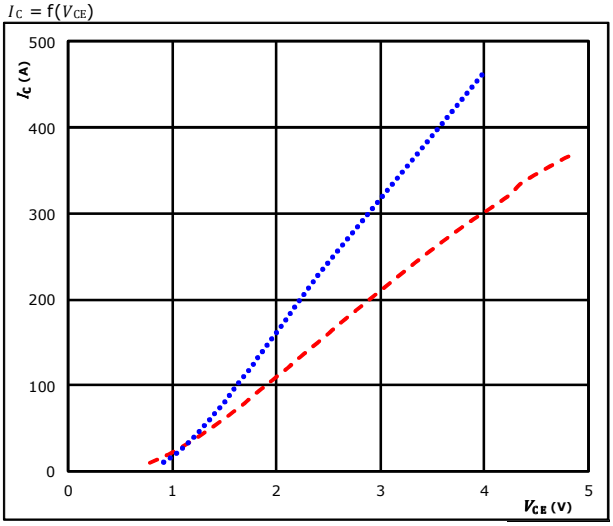
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
Rectifier Thyristor										
Static										
Forward voltage	V_F				125	25 125		1,11 1,06	1,2	V
Threshold voltage (for power loss calc. only)	V_{to}					130			0,85	V
Slope resistance (for power loss calc. only)	r_t					130			3,2	mΩ
Critical rate of rise of off-state voltage	$(dv/dt)_{cr}$					130			1000	V/µs
Critical rate of rise of on-state current	$(di/dt)_{cr}$					130			100	A/µs
Circuit commutated turn-off time	t_q					130		150		µs
Holding current	I_H					25			220	mA
Latching current	I_L					25			550	mA
Gate trigger voltage	V_{GT}					25			1,98	V
Gate trigger current	I_{GT}					25			100	mA
Gate non-trigger voltage	V_{GD}					130	0,25			V
Gate non-trigger current	I_{GD}					115	6			mA
Thermal										
Thermal resistance chip to sink	$R_{th(j-s)}$	Thermal grease λ = 2,5 W/mK (Silicone-based)						0,33		K/W
Thermistor										
Rated resistance	R					25		1		kΩ
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		$7,635*10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1,731*10^{-5}$		1/K²
Vincotech PTC Reference									E	

Brake Switch Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

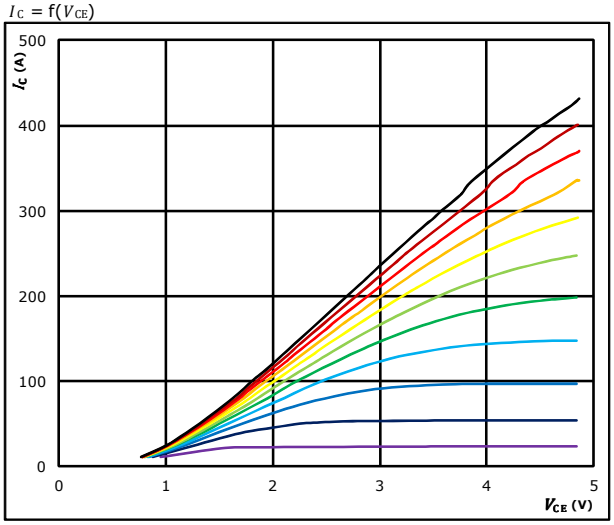


t_p =	250	µs		25 °C	•••••••••
V_{GE} =	15	V	T_j:	150 °C	— — —

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

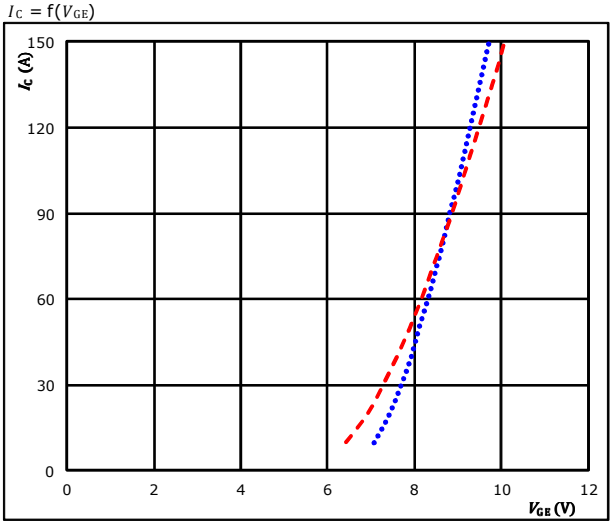


t_p =	250	µs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

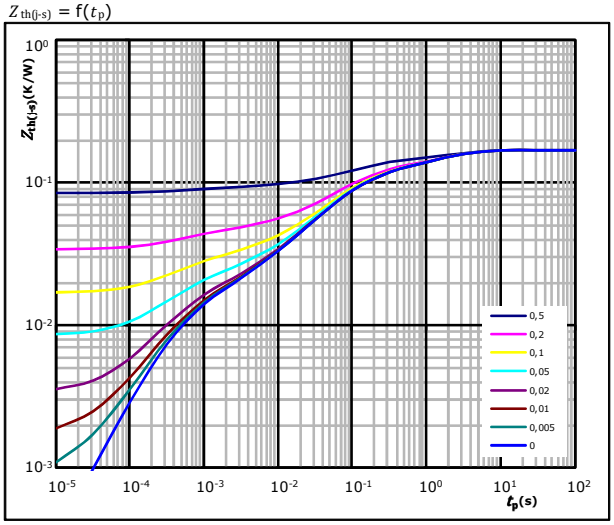


t_p =	100	µs		25 °C	•••••••••
V_{CE} =	10	V	T_j:	150 °C	— — —

figure 4. **IGBT**

Transient Thermal Impedance as function of Pulse duration

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



D =	t_p / T	
$R_{th(j-s)}$ =	0,17	K/W

IGBT thermal model values

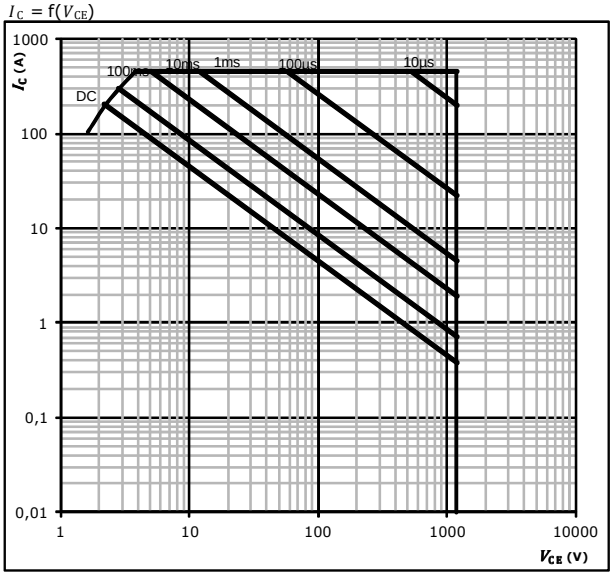
R (K/W)	τ (s)
4,70E-02	1,97E+00
2,42E-02	3,38E-01
6,55E-02	7,73E-02
1,51E-02	1,74E-02
7,58E-03	2,43E-03
1,07E-02	3,85E-04

Brake Switch Characteristics

figure 5. **IGBT**

Safe operating area

$I_C = f(V_{CE})$



At

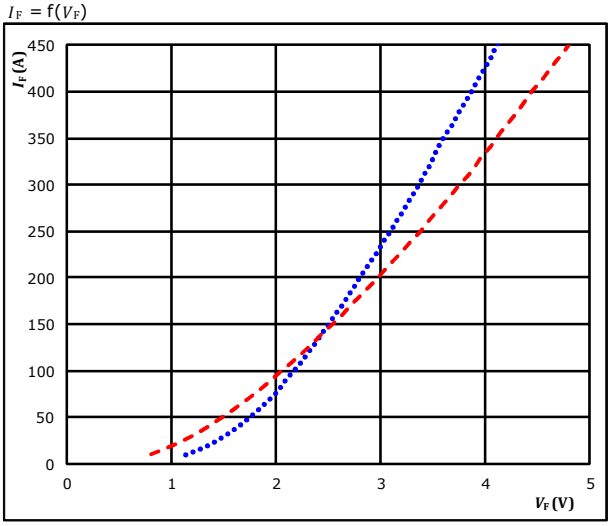
D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

Brake Diode Characteristics

figure 1. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



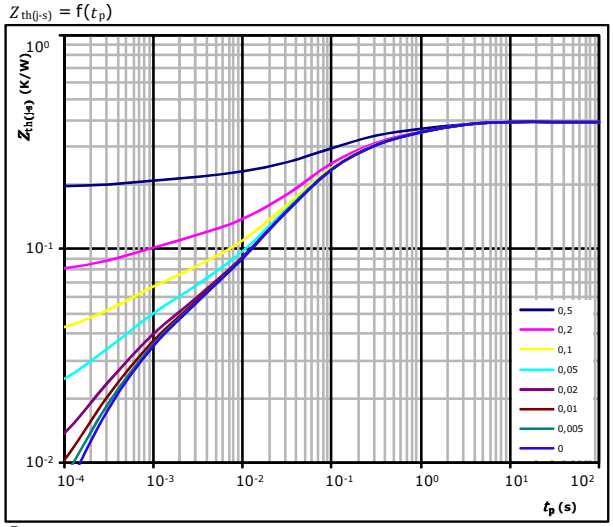
t_p = 250 µs

T_j: 25 °C, 150 °C

figure 2. **FWD**

Transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 0,39 K/W

FWD thermal model values

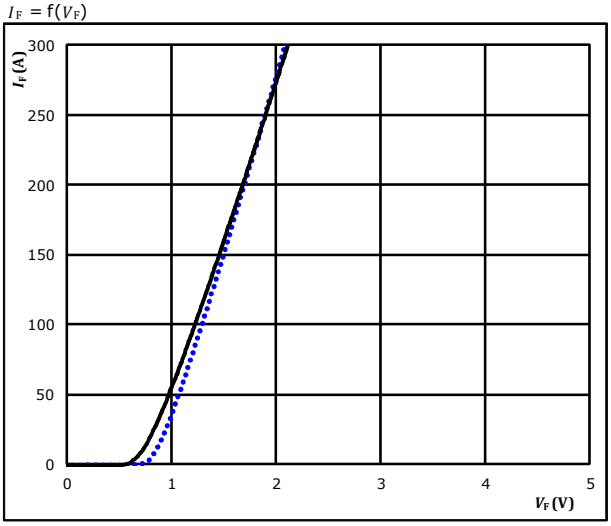
R (K/W)	τ (s)
7,06E-02	1,62E+00
7,14E-02	3,07E-01
1,65E-01	6,80E-02
3,93E-02	1,30E-02
2,25E-02	1,79E-03
2,09E-02	3,53E-04

Rectifier Diode Characteristics

figure 1. **Rectifier Diode**

Typical forward characteristics

$I_F = f(V_F)$



t_p = 250 µs

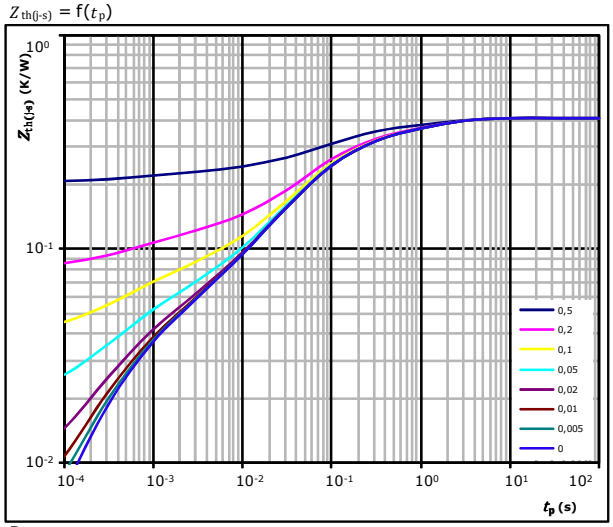
T_j: 25 °C

125 °C

figure 2. **Rectifier Diode**

Transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 0,41 K/W

Diode thermal model values

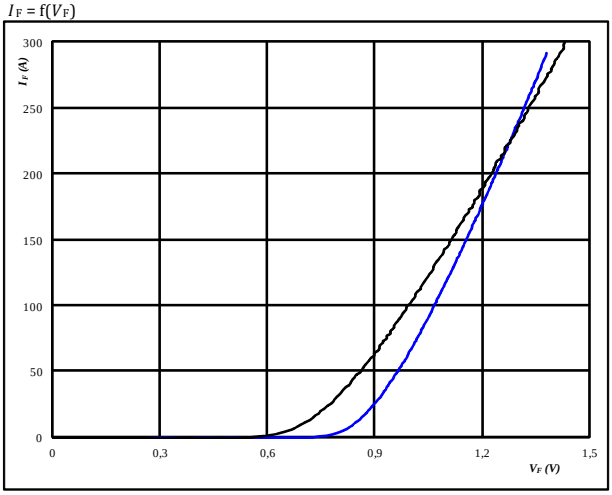
R (K/W)	τ (s)
7,42E-02	1,62E+00
7,50E-02	3,07E-01
1,74E-01	6,80E-02
4,13E-02	1,30E-02
2,37E-02	1,79E-03
2,19E-02	3,53E-04

Rectifier Thyristor Characteristics

figure 1. **Thyristor**

Typical forward characteristics

$I_F = f(V_F)$

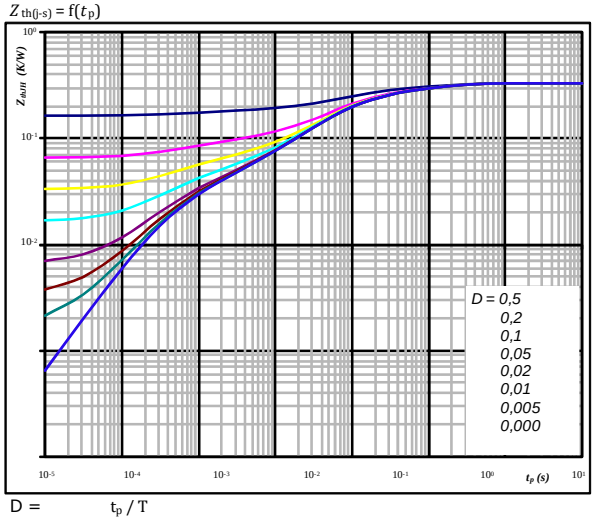


t_p =	250	µs
T_j =	25, 125	°C

figure 2. **Thyristor**

Transient thermal impedance as a function of pulse width

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



D =	t_p / T	
$R_{th(j-s)}$ =	0,33	K/W

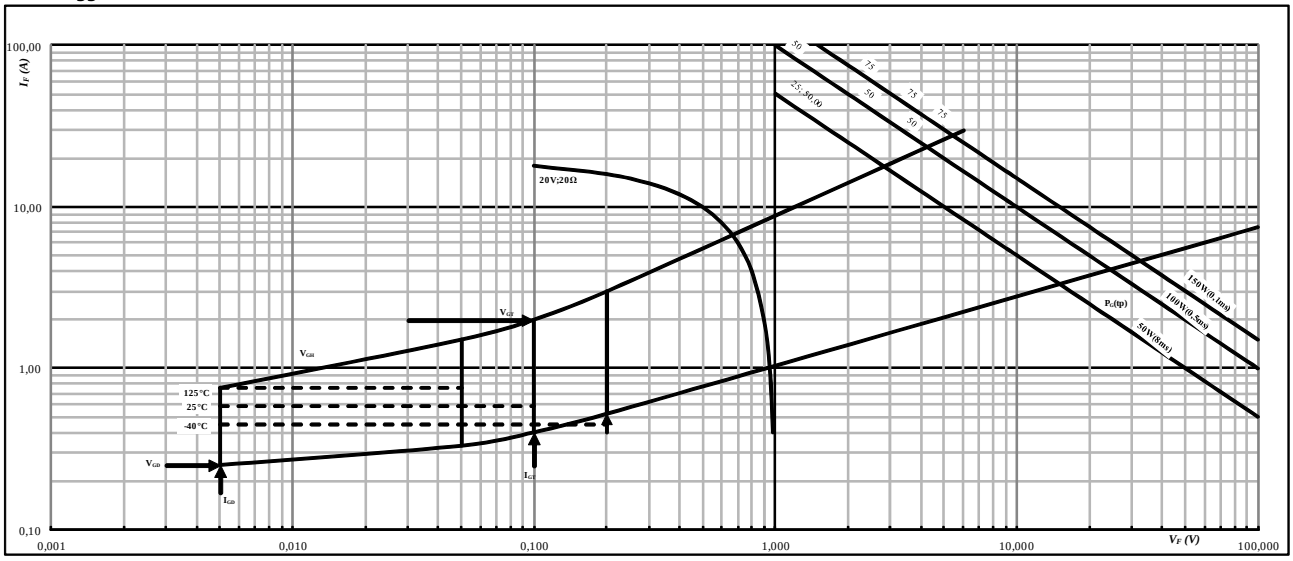
FWD thermal model values

R (K/W)	Tau (s)
6,07E-02	1,62E+00
6,14E-02	3,07E-01
1,42E-01	6,80E-02
3,38E-02	1,30E-02
1,94E-02	1,79E-03

Rectifier Thyristor Characteristics

figure 3. **Thyristor**

Gate trigger characteristics

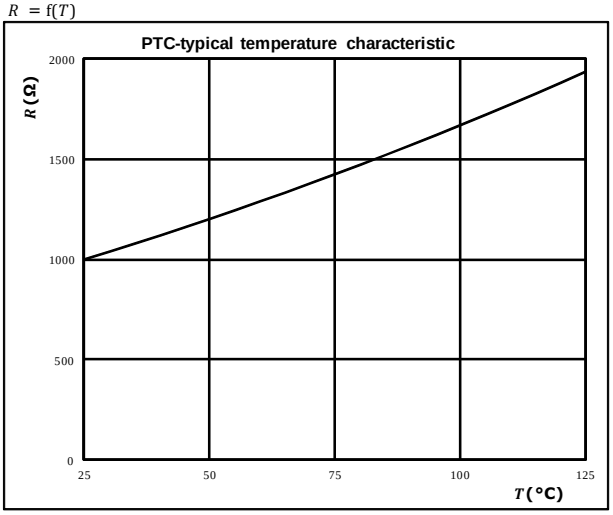


PTC Characteristics

figure 1. **Thermistor**

Typical PTC characteristic as a function of temperature

$R = f(T)$

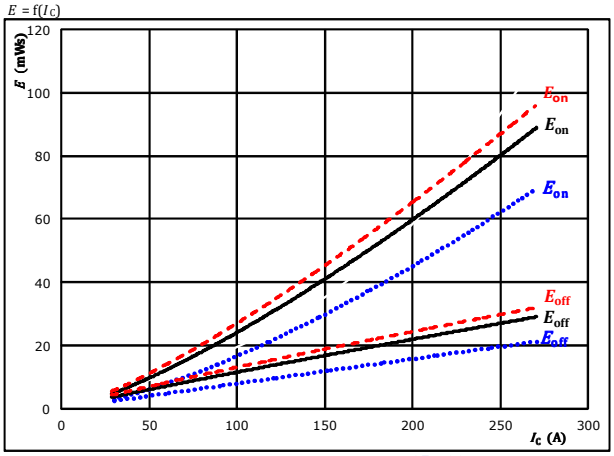


Brake Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



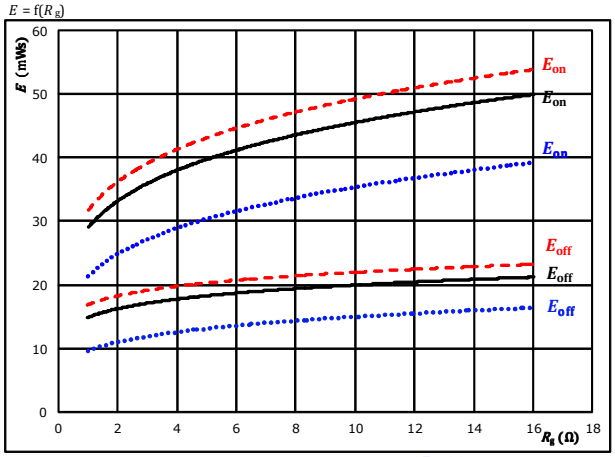
With an inductive load at

V_{CE} =	700	V	T_J:	25 °C	·····
V_{GE} =	15/0	V		125 °C	———
R_{gon} =	4	Ω		150 °C	- - -
R_{goff} =	4	Ω			

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



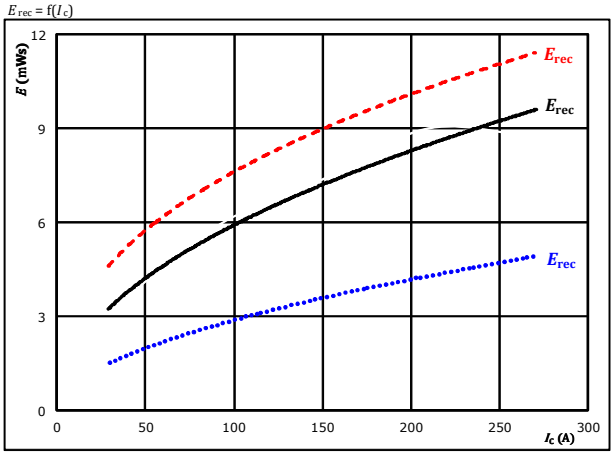
With an inductive load at

V_{CE} =	700	V	T_J:	25 °C	·····
V_{GE} =	15/0	V		125 °C	———
I_C =	149	A		150 °C	- - -

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_C)$



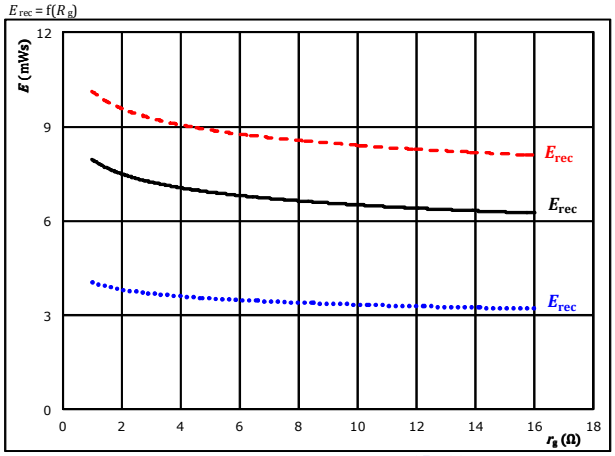
With an inductive load at

V_{CE} =	700	V	T_J:	25 °C	·····
V_{GE} =	15/0	V		125 °C	———
R_{gon} =	4	Ω		150 °C	- - -

figure 4. **FWD**

Typical reverse recovered energy loss as a function of gate resistor

$E_{rec} = f(R_g)$



With an inductive load at

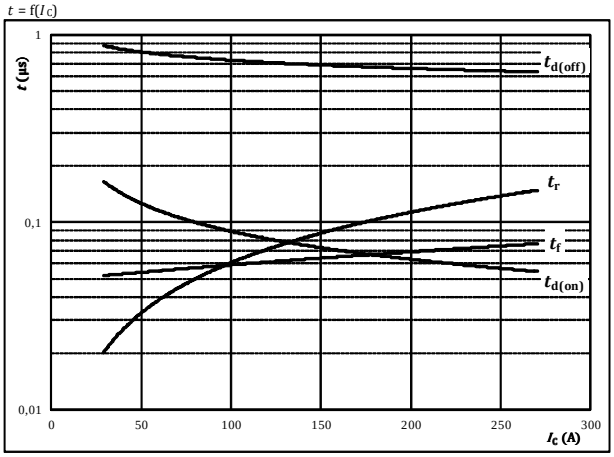
V_{CE} =	700	V	T_J:	25 °C	·····
V_{GE} =	15/0	V		125 °C	———
I_C =	149	A		150 °C	- - -

Brake Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



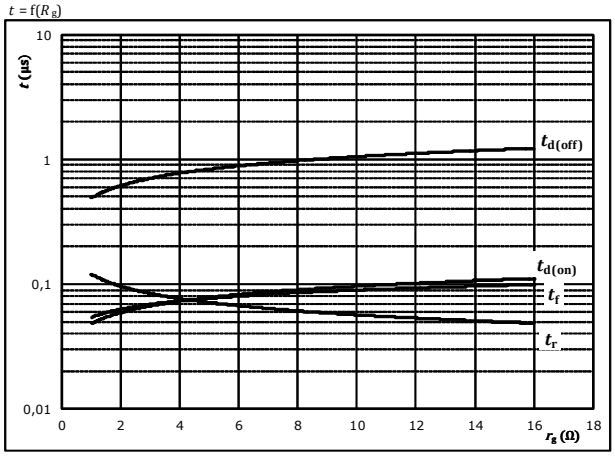
With an inductive load at

T_j =	150	°C
V_{CE} =	700	V
V_{GE} =	15/0	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



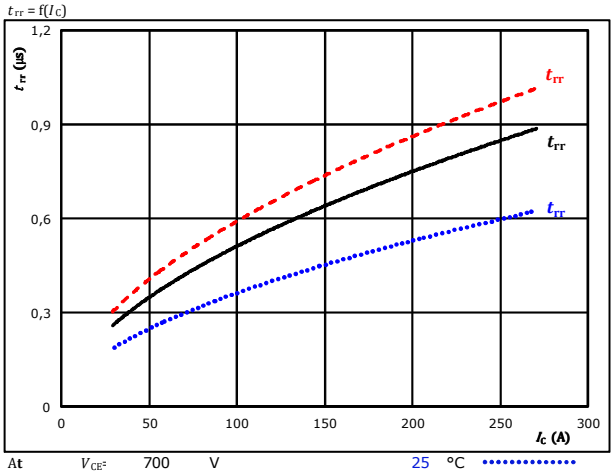
With an inductive load at

T_j =	150	°C
V_{CE} =	700	V
V_{GE} =	15/0	V
I_C =	149	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

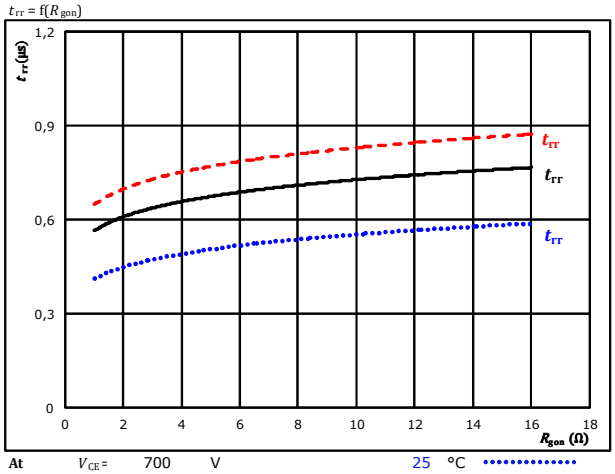


At					
	V_{CE} =	700	V		25 °C
	V_{GE} =	15/0	V	T_j:	125 °C
	R_{gon} =	4	Ω		150 °C

figure 8. **FWD**

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

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



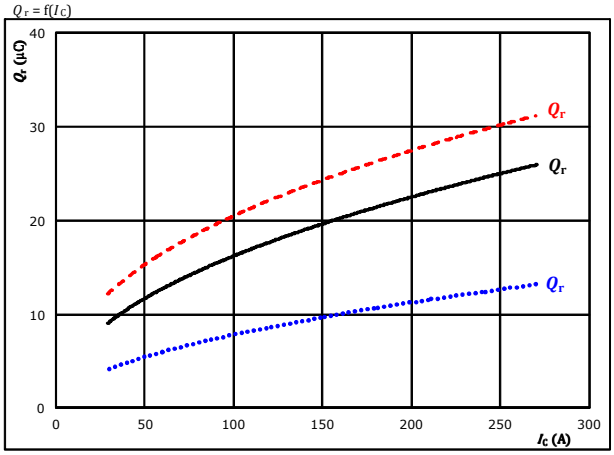
At					
	V_{CE} =	700	V		25 °C
	V_{GE} =	15/0	V	T_j:	125 °C
	I_C =	149	A		150 °C

Brake Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

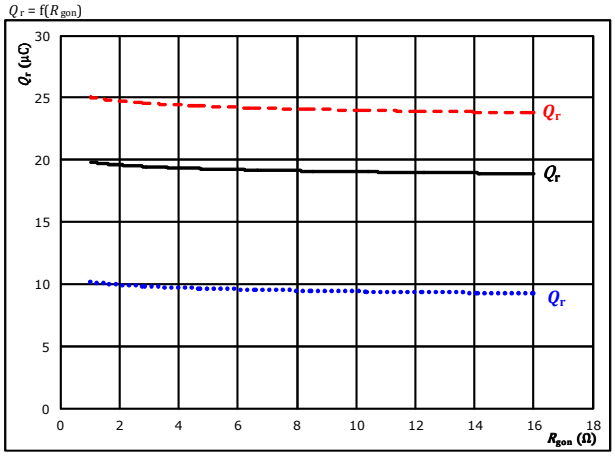


At						
	V_{CE} =	700	V		25 °C	
	V_{GE} =	15/0	V	T_j:	125 °C	
	R_{gon} =	4	Ω		150 °C	

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

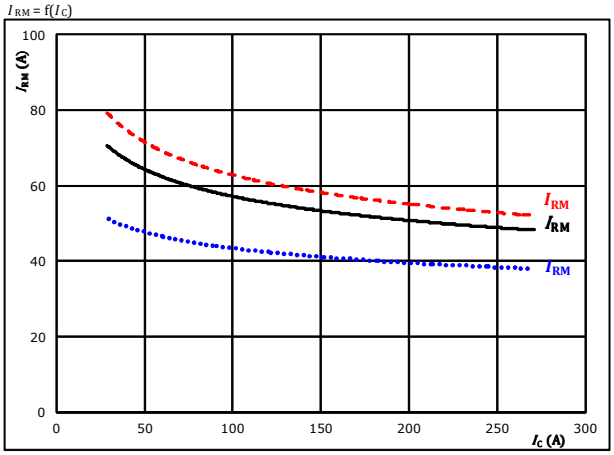


At						
	V_{CE}=	700	V		25 °C	
	V_{GE} =	15/0	V	T_j:	125 °C	
	I_C=	149	A		150 °C	

figure 11. **FWD**

Typical peak reverse recovery current current as a function of collector current

$I_{RM} = f(I_C)$

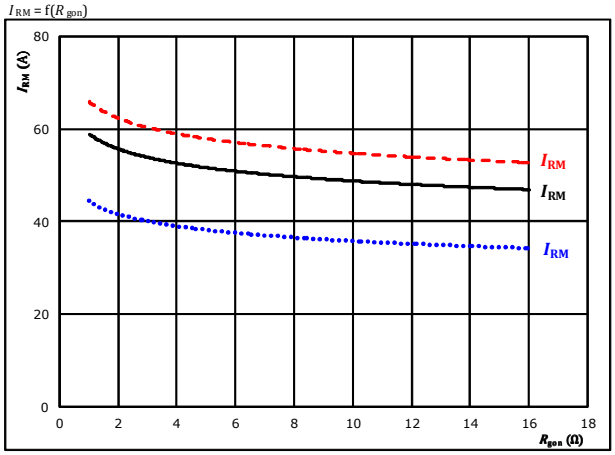


At						
	V_{CE}:	700	V		25 °C	
	V_{GE} =	15/0	V	T_j:	125 °C	
	R_{gon} =	4	Ω		150 °C	

figure 12. **FWD**

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

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



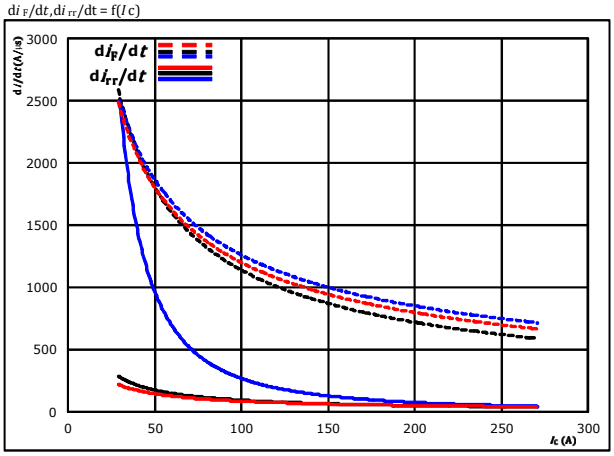
At						
	V_{CE} =	700	V		25 °C	
	V_{GE} =	15/0	V	T_j:	125 °C	
	I_C =	149	A		150 °C	

Brake Switching Characteristics

figure 13. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of collector current

$di_F/dt, di_{rr}/dt = f(I_C)$

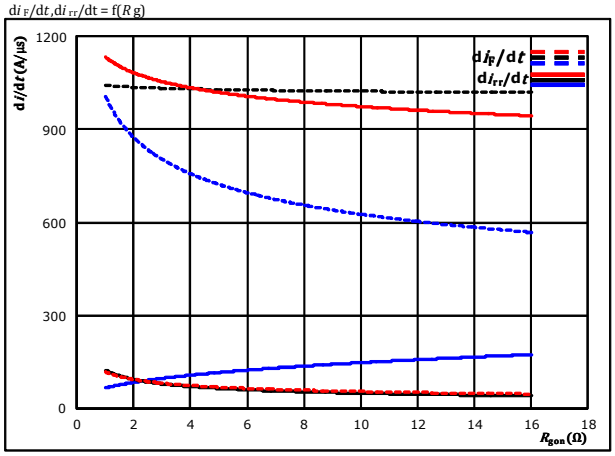


At	V_{CE} =	700	V	T_j:	25 °C	
	V_{GE} =	15/0	V		125 °C	
	R_{gon} =	4	Ω		150 °C	

figure 14. **FWD**

Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor

$di_F/dt, di_{rr}/dt = f(R_g)$

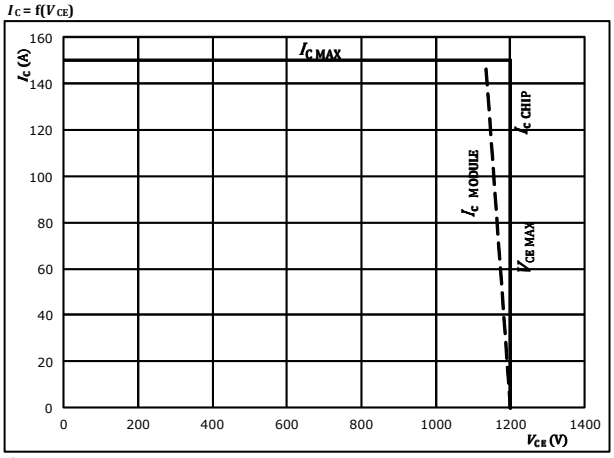


At	V_{CE} =	700	V	T_j:	25 °C	
	V_{GE} =	15/0	V		125 °C	
	I_C =	149	A		150 °C	

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j =	175	°C	
R_{gon} =	4	Ω	
R_{goff} =	4	Ω	

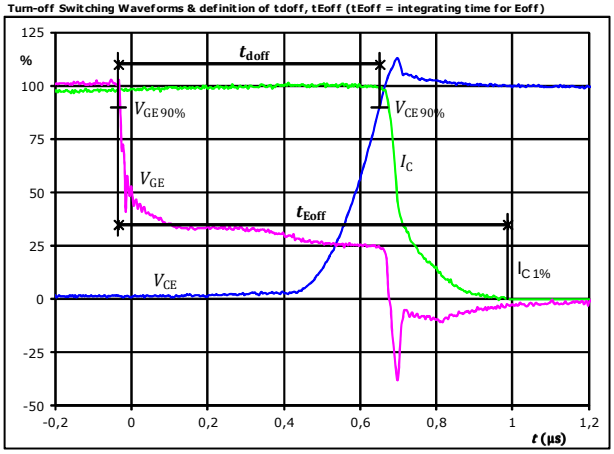
Brake Switching Definitions

General conditions

T_j	=	**125 °C**
R_{gon}	=	**4 Ω**
R_{goff}	=	**4 Ω**

figure 1. IGBT

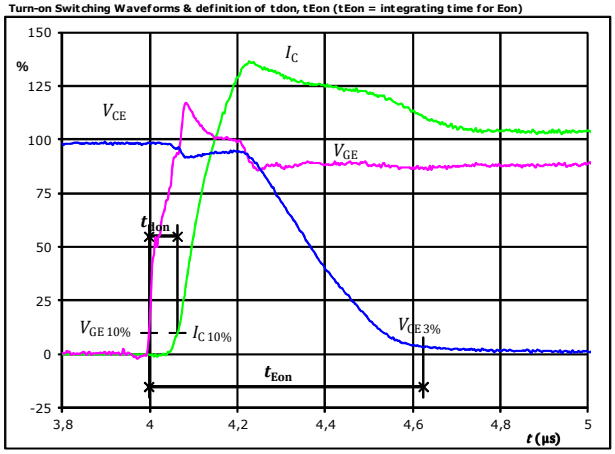
Turn-off Switching Waveforms & definition of tdoff, tEoff (tEoff = integrating time for Eoff)



$V_{GE}(0\%)$ =	0	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	151	A
t_{doff} =	0,681	µs
t_{Eoff} =	1,021	µs

figure 2. IGBT

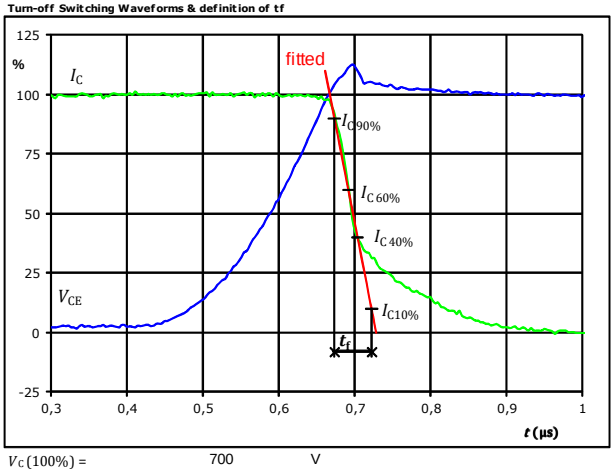
Turn-on Switching Waveforms & definition of tdon, tEon (tEon = integrating time for Eon)



$V_{GE}(0\%)$ =	0	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	151	A
t_{don} =	0,065	µs
t_{Eon} =	0,626	µs

figure 3. IGBT

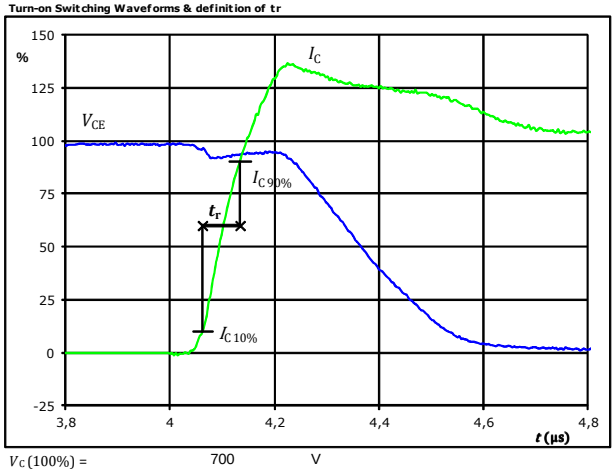
Turn-off Switching Waveforms & definition of tf



$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	151	A
t_f =	0,045	µs

figure 4. IGBT

Turn-on Switching Waveforms & definition of tr

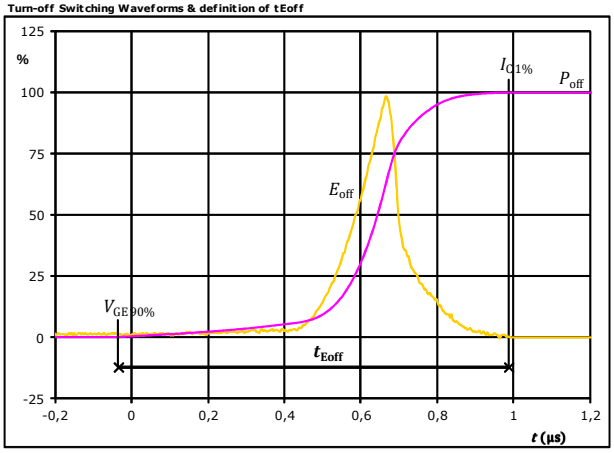


$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	151	A
t_r =	0,071	µs

Brake Switching Characteristics

figure 5. **IGBT**

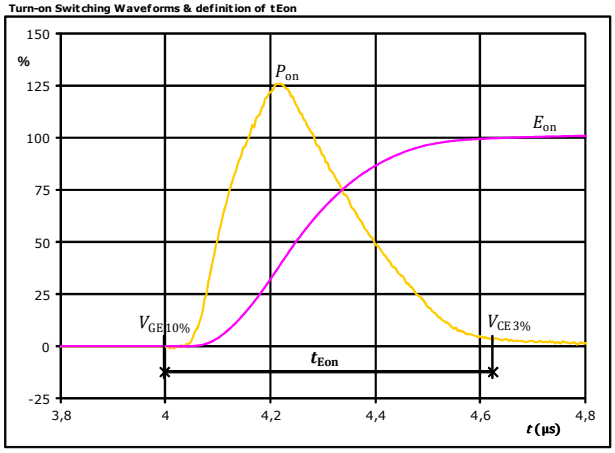
Turn-off Switching Waveforms & definition of tEoff



$P_{off}(100\%)$ =	105,38	kW
$E_{off}(100\%)$ =	16,84	mJ
t_{Eoff} =	1,02	µs

figure 6. **IGBT**

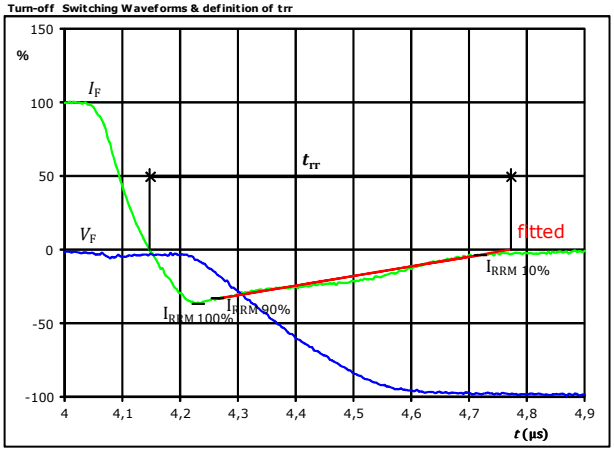
Turn-on Switching Waveforms & definition of tEon



$P_{on}(100\%)$ =	105,38	kW
$E_{on}(100\%)$ =	35,58	mJ
t_{Eon} =	0,63	µs

figure 7. **FWD**

Turn-off Switching Waveforms & definition of trr

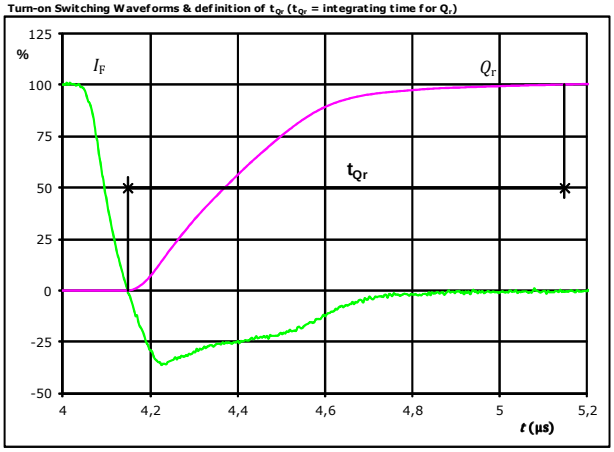


$V_F(100\%)$ =	700	V
$I_F(100\%)$ =	151	A
$I_{RRM}(100\%)$ =	-54	A
t_{rr} =	0,625	µs

Brake Switching Characteristics

figure 8. **FWD**

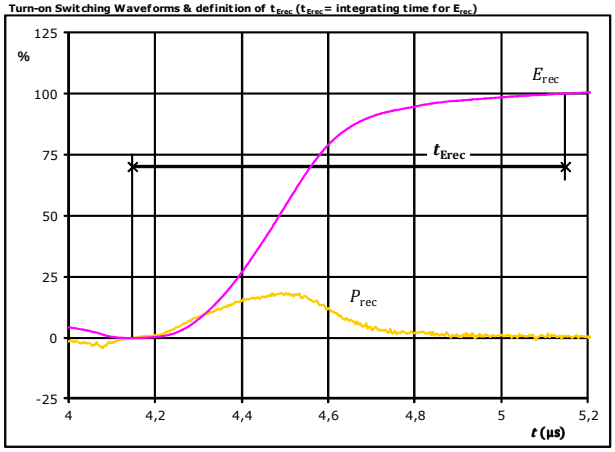
Turn-on Switching Waveforms & definition of t_{Qr} (t_{Qr} = integrating time for Q_r)



I_F (100%) =	151	A
Q_r (100%) =	19,74	µC
t_{Qr} =	1,00	µs

figure 9. **FWD**

Turn-on Switching Waveforms & definition of t_{Erec} (t_{Erec} = integrating time for E_{rec})



P_{rec} (100%) =	105,38	kW
E_{rec} (100%) =	7,41	mJ
t_{Erec} =	1,00	µs

Vincotech

Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K32-T-2-PM)	80-M3166BA140SC02-K489G40-/0A/
with std lid (black V23990-K32-T-2-PM)+thermal grease	80-M3166BA140SC02-K489G40-/5A/

Text	Name		Date code	UL & VIN	Lot	Serial
	NN-NNNNNNNNNNNNNN-TTTTTTVV		WWYY	UL VIN	LLLLL	SSSS
Datamatrix	**Type&Ver**	**Lot number**	**Serial**	**Date code**		
	TTTTTTVV	LLLLL	SSSS	WWYY		

Outline

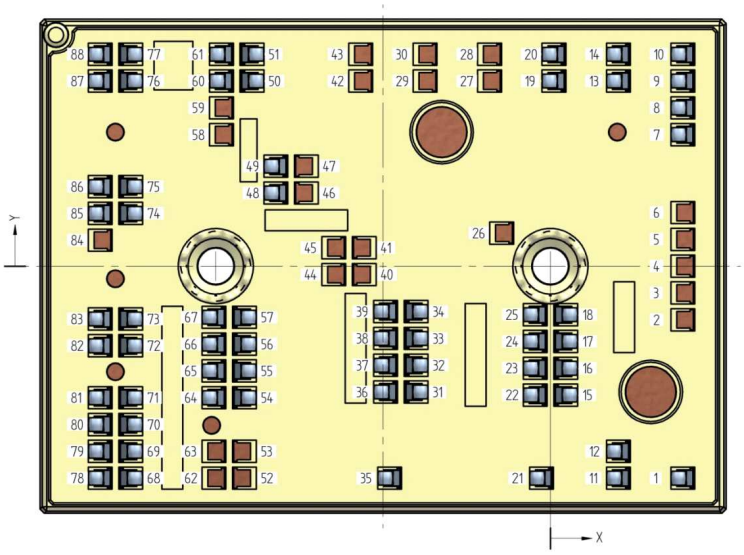
PCB pad table

Pin	X	Y	Function
1	15,83	-25,3	G36
2	Not assembled		
3	Not assembled		
4	Not assembled		
5	Not assembled		
6	Not assembled		
7	15,83	15,7	DC-
8	15,83	18,9	DC-
9	15,83	22,1	DC-
10	15,83	25,3	DC-
11	8,13	-25,3	Therm1
12	8,13	-22,1	Therm2
13	8,13	22,1	DC-
14	8,13	25,3	DC-
15	41,82	-15,38	ACIn3
16	41,82	-12,18	ACIn3
17	41,82	-8,98	ACIn3
18	41,82	-5,79	ACIn3
19	0,43	22,1	DC-
20	0,43	25,3	DC-
21	-1,07	-25,3	G34
22	-1,82	-15,38	ACIn3
23	-1,82	-12,18	ACIn3
24	-1,82	-8,98	ACIn3
25	-1,82	-5,79	ACIn3
26	Not assembled		
27	Not assembled		
28	Not assembled		
29	Not assembled		
30	Not assembled		
31	23,95	-15,02	ACIn2
32	23,95	-11,82	ACIn2
33	23,95	-8,63	ACIn2
34	23,95	-5,42	ACIn2
35	-19,22	-25,3	G32
36	-19,7	-15,02	ACIn2
37	-19,7	-11,82	ACIn2
38	-19,7	-8,62	ACIn2
39	-19,7	-5,42	ACIn2
40	Not assembled		
41	Not assembled		
42	Not assembled		
43	Not assembled		
44	Not assembled		
45	Not assembled		
46	Not assembled		
47	Not assembled		
48	-32,82	8,74	S27
49	-32,82	11,94	G27
50	4,32	22,1	Br
51	4,32	25,3	Br

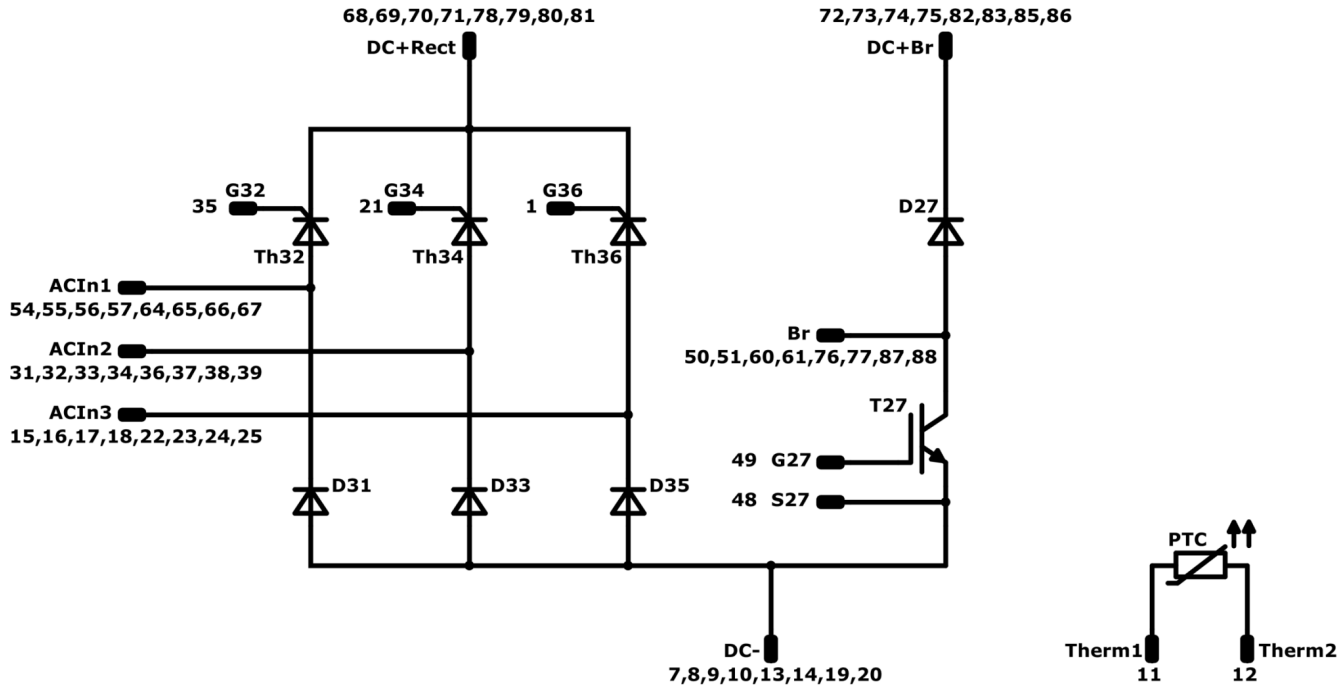
PCB pad table

Pin	X	Y	Function
52	Not assembled		
53	Not assembled		
54	3,42	-15,7	ACIn1
55	3,42	-12,5	ACIn1
56	3,42	-9,3	ACIn1
57	3,42	-6,1	ACIn1
58	Not assembled		
59	Not assembled		
60	-39,32	22,1	Br
61	-39,32	25,3	Br
62	Not assembled		
63	Not assembled		
64	-40,22	-15,7	ACIn1
65	-40,22	-12,5	ACIn1
66	-40,22	-9,3	ACIn1
67	-40,22	-6,09	ACIn1
68	-10,18	-25,3	DC+Rect
69	-10,18	-22,1	DC+Rect
70	-10,18	-18,9	DC+Rect
71	-10,18	-15,7	DC+Rect
72	-10,18	-9,5	DC+Br
73	-10,18	-6,3	DC+Br
74	-10,18	6,3	DC+Br
75	-10,18	9,5	DC+Br
76	-10,18	22,1	Br
77	-10,18	25,3	Br
78	-53,82	-25,3	DC+Rect
79	-53,82	-22,1	DC+Rect
80	-53,82	-18,9	DC+Rect
81	-53,82	-15,7	DC+Rect
82	-53,82	-9,5	DC+Br
83	-53,82	-6,3	DC+Br
84	Not assembled		
85	-53,82	6,3	DC+Br
86	-53,82	9,5	DC+Br
87	-53,82	22,1	Br
88	-53,82	25,3	Br

Pad positions refers to center point. For more informations on pad design please see package data.



Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T27	IGBT	1200 V	150 A	Brake Switch	
D27	FWD	1200 V	150 A	Brake Diode	
D31, D33, D35	Rectifier	1600 V	140 A	Rectifier Diode	
Th32, Th34, Th36	Thyristor	1600 V	125 A	Rectifier Thyristor	
PTC	PTC			Thermistor	

Packaging instruction				
Standard packaging quantity (SPQ) 48	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 3 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 3 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
80-M3166BA140SC02-K489G40-D2-14	10 Aug. 2017		