Vincotech

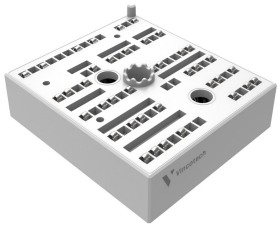
V23990-K229-A41
datasheet

MiniSKiiP®PIM 2 **1200 V / 25 A**

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology
- Enhanced input rectifier

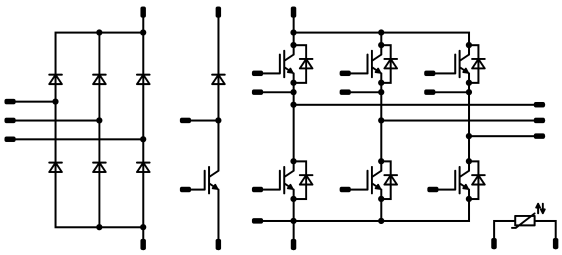
MiniSkiip®2 housing



Target applications

- Industrial Drives

Schematic



Types

- V23990-K229-A41

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	35	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	75	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	113	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC}	$T_j \leq$ 150 °C V_{GE} = 15 V Vcc = 800 V	10	µs
Maximum junction temperature	T_{jmax}		175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C	25	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms T_j = 150 °C	100	A
Surge current capability	I^2t		50	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	81	W
Maximum junction temperature	T_{jmax}		175	°C
Brake Switch				
Collector-emitter voltage	V_{CES}		1200	V
Collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	35	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	75	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	113	W
Gate-emitter voltage	V_{GES}		±20	V
Short circuit ratings	t_{SC}	$T_j \leq$ 150 °C V_{GE} = 15 V V_{CC} = 800 V	10	µs
Maximum junction temperature	T_{jmax}		175	°C
Brake Diode				
Peak repetitive reverse voltage	V_{RRM}		1200	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C	25	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms T_j = 150 °C	100	A
Surge current capability	I^2t		50	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	81	W
Maximum junction temperature	T_{jmax}		175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Peak repetitive reverse voltage	V_{RRM}		1600	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C	50	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave t_p = 10 ms T_j = 150 °C	490	A
Surge current capability	I^2t		1200	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	93	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 s	5500	V
		AC Voltage t_p = 1 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

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	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00085	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CEsat}		15		25	25 150	1,58	1,88 2,20	2,07	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			2,4	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 Mhz	0	25		25		1450		pF
Reverse transfer capacitance	C_{res}							50		
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,84		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 16 Ω R_{goff} = 16 Ω	±15	600	25	25 150		71 72		ns
Rise time	t_r					25 150		32 36		
Turn-off delay time	$t_{d(off)}$					25 150		199 270		
Fall time	t_f					25 150		90 135		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,5 µC Q_{rFWD} = 3,9 µC				25 150		1,607 2,462		mWs
Turn-off energy (per pulse)	E_{off}					25 150		1,527 2,498		

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 Diode										
Static										
Forward voltage	V_F				25	25 125 150		2,27 2,44 2,36	2,74	V
Reverse leakage current	I_R			1200		25 150			60 3300	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,17		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 690 A/µs di/dt = 578 A/µs	±15	600	25	25 150		12 17		A
Reverse recovery time	t_{rr}					25 150		277 580		ns
Recovered charge	Q_r					25 150		1,549 3,882		µC
Reverse recovered energy	E_{rec}					25 150		0,607 1,631		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		111 89		A/µs

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	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00085	25	5,3	5,8	6,3	V
Collector-emitter saturation voltage	V_{CEsat}		15		25	25 150	1,58	1,88 2,20	2,07	V
Collector-emitter cut-off current	I_{CES}		0	1200		25			2,4	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 Mhz	0	25		25		1450		pF
Reverse transfer capacitance	C_{res}							50		
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,84		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$	R_{gon} = 8 Ω R_{goff} = 8 Ω	0 / 15	700	25	25 125 150		63 59 57		ns
Rise time	t_r					25 125 150		68 68 69		
Turn-off delay time	$t_{d(off)}$					25 125 150		233 301 323		
Fall time	t_f					25 125 150		66 104 122		
Turn-on energy (per pulse)	E_{on}	Q_{rFWD} = 1,6 µC Q_{rFWD} = 3,2 µC Q_{rFWD} = 4 µC				25 125 150		2,061 2,791 3,095		mWs
Turn-off energy (per pulse)	E_{off}					25 125 150		1,655 2,633 2,978		

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				25	25 125 150		2,27 2,44 2,36	2,74	V
Reverse leakage current	I_R			1200		25 150			60 3300	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						1,17		K/W
Dynamic										
Peak recovery current	I_{RRM}	di/dt = 344 A/µs di/dt = 337 A/µs di/dt = 347 A/µs	0 / 15	700	25	25 125 150		14 18 19		A
Reverse recovery time	t_{rr}					25 125 150		292 473 550		ns
Recovered charge	Q_r					25 125 150		1,562 3,203 3,965		µC
Reverse recovered energy	E_{rec}					25 125 150		0,731 1,577 1,963		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125 150		286 139 138		A/µs
Rectifier Diode										
Static										
Forward voltage	V_F				50	25 125 150		1,14 1,08 1,07		V
Reverse leakage current	I_R			1600		25			50	µA
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	λ_{paste} = 2,5 W/mK (HPTP)						0,75		K/W

Characteristic Values

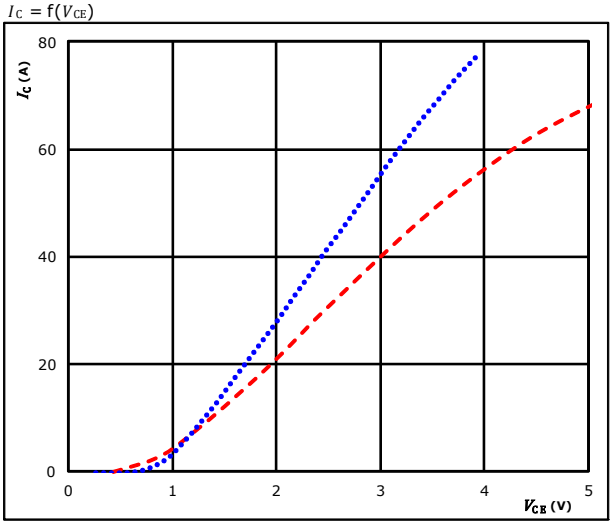
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_{CE} [V] V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
Thermistor										
Rated resistance	R					25		1		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω				100	-2		+2	%
R_{100}	R					100		1670		Ω
Power 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	

Inverter Switch Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

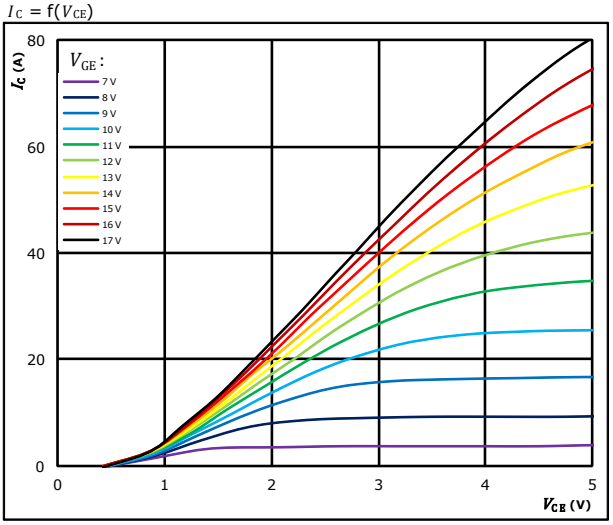


t_p =	250	µs	T_j:	25 °C	·····
V_{GE} =	15	V		150 °C	– – –

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

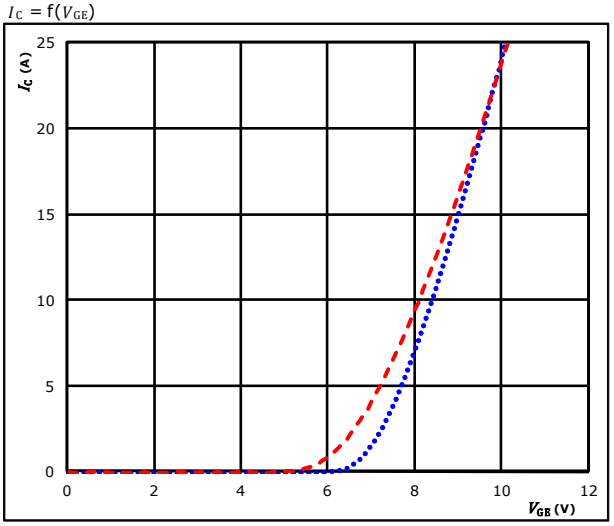


t_p =	250	µs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

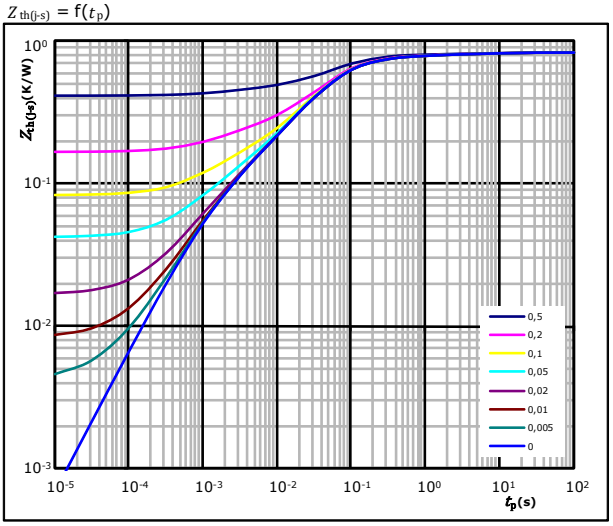


t_p =	100	µs	T_j:	25 °C	·····
V_{CE} =	10	V		150 °C	– – –

figure 4. **IGBT**

Transient thermal impedance as function of pulse duration

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



D =	t_p / T	
$R_{th(j-s)}$ =	0,84	K/W

IGBT thermal model values

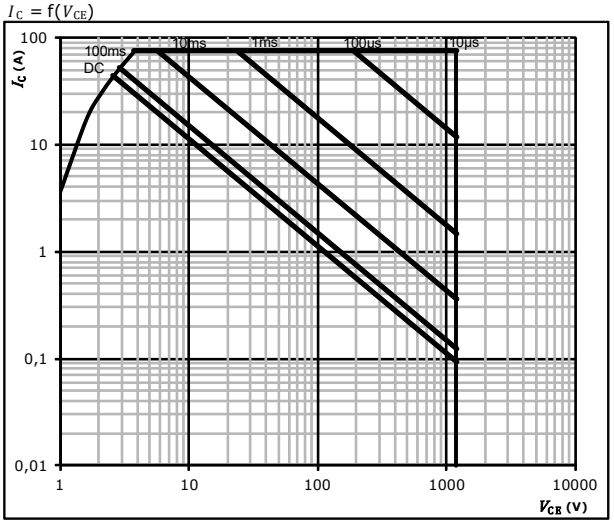
R (K/W)	τ (s)
3,13E-02	6,26E+00
5,86E-02	5,33E-01
1,55E-01	9,52E-02
4,50E-01	3,18E-02
8,39E-02	6,19E-03
5,63E-02	9,50E-04
3,88E-03	4,59E-04

Inverter Switch Characteristics

figure 5. **IGBT**

Safe operating area

$I_C = f(V_{CE})$



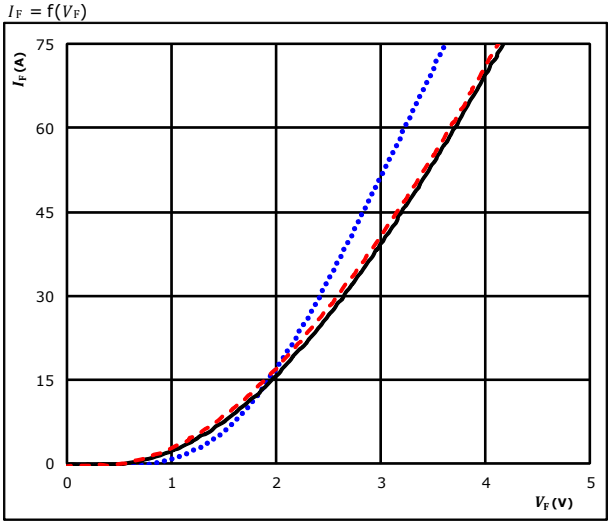
D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

Inverter Diode Characteristics

figure 1. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



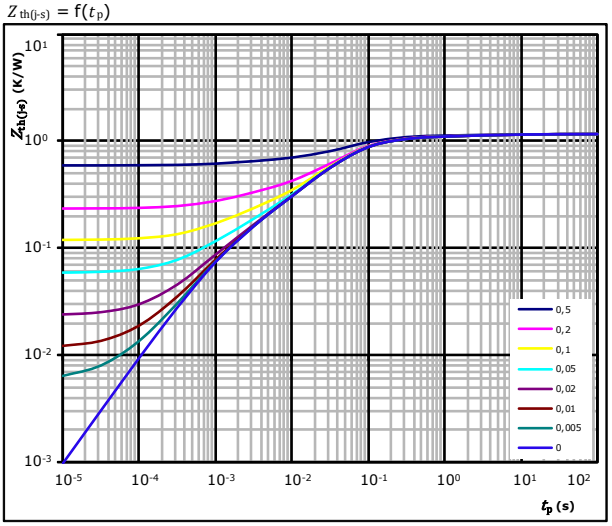
t_p = 250 µs

T_j: 25 °C
125 °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

$R_{th(j-s)}$ = 1,17 K/W

FWD thermal model values

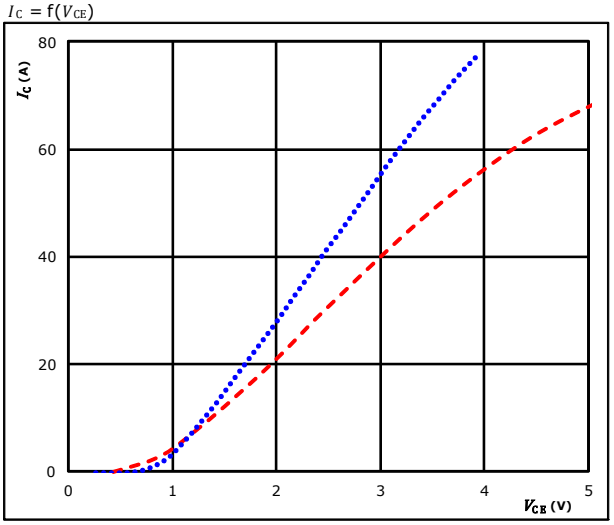
R (K/W)	τ (s)
4,37E-02	8,75E+00
8,19E-02	7,45E-01
2,17E-01	1,33E-01
6,29E-01	4,45E-02
1,17E-01	8,65E-03
7,87E-02	1,33E-03
5,43E-03	6,41E-04

Brake Switch Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

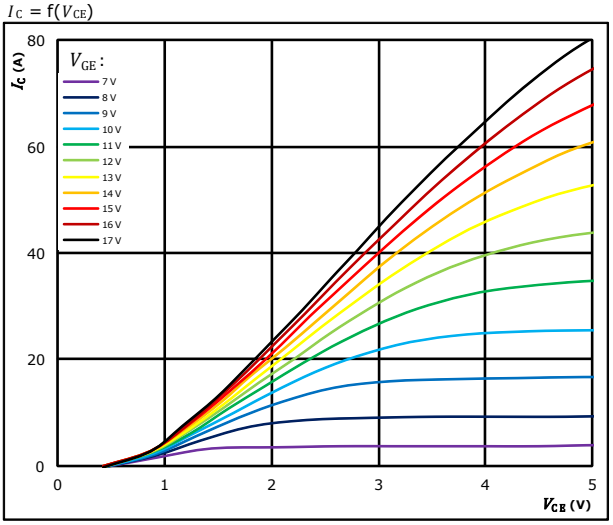


t_p =	250	µs	T_j:	25 °C	·····
V_{GE} =	15	V		150 °C	– – –

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$

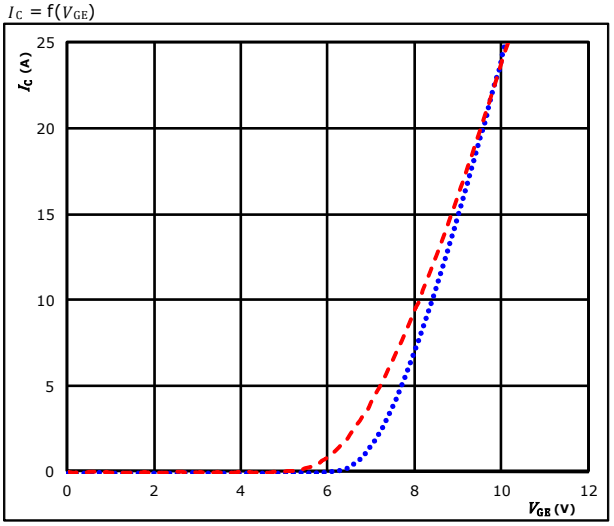


t_p =	250	µs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$

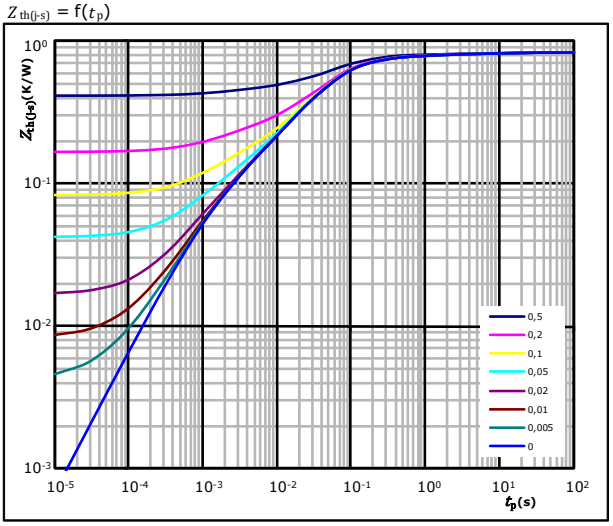


t_p =	100	µs	T_j:	25 °C	·····
V_{CE} =	10	V		150 °C	– – –

figure 4. **IGBT**

Transient thermal impedance as function of pulse duration

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



D =	t_p / T	
$R_{th(j-s)}$ =	0,84	K/W

IGBT thermal model values

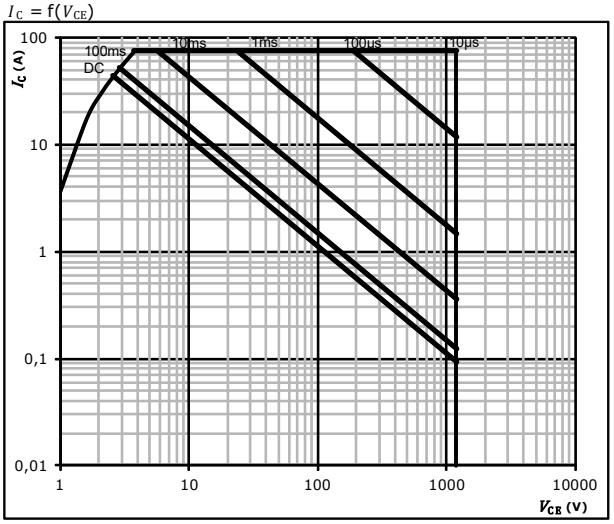
R (K/W)	τ (s)
3,13E-02	6,26E+00
5,86E-02	5,33E-01
1,55E-01	9,52E-02
4,50E-01	3,18E-02
8,39E-02	6,19E-03
5,63E-02	9,50E-04
3,88E-03	4,59E-04

Brake Switch Characteristics

figure 5. **IGBT**

Safe operating area

$I_C = f(V_{CE})$



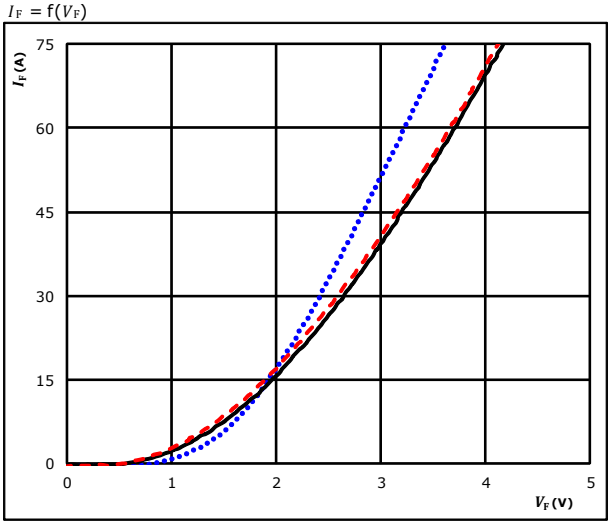
D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

Brake Diode Characteristics

figure 1. **FWD**

Typical forward characteristics

$I_F = f(V_F)$



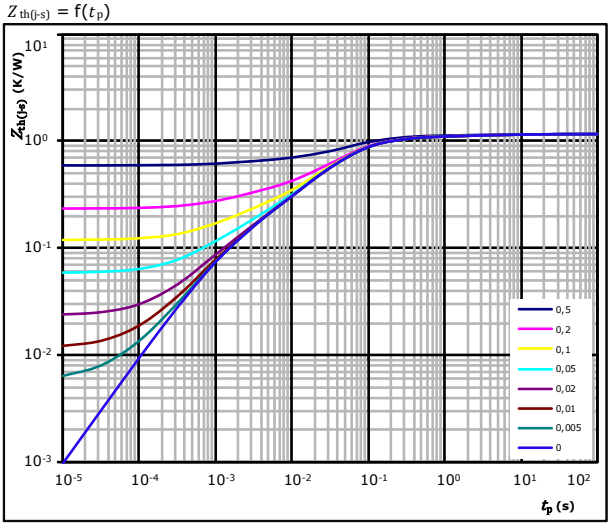
t_p = 250 µs

T_j: 25 °C
125 °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

$R_{th(j-s)}$ = 1,17 K/W

FWD thermal model values

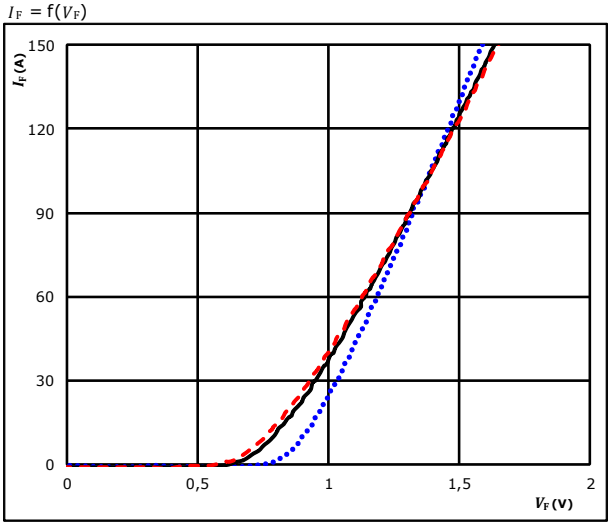
R (K/W)	τ (s)
4,37E-02	8,75E+00
8,19E-02	7,45E-01
2,17E-01	1,33E-01
6,29E-01	4,45E-02
1,17E-01	8,65E-03
7,87E-02	1,33E-03
5,43E-03	6,41E-04

Rectifier Diode Characteristics

figure 1. **Rectifier Diode**

Typical forward characteristics

$I_F = f(V_F)$



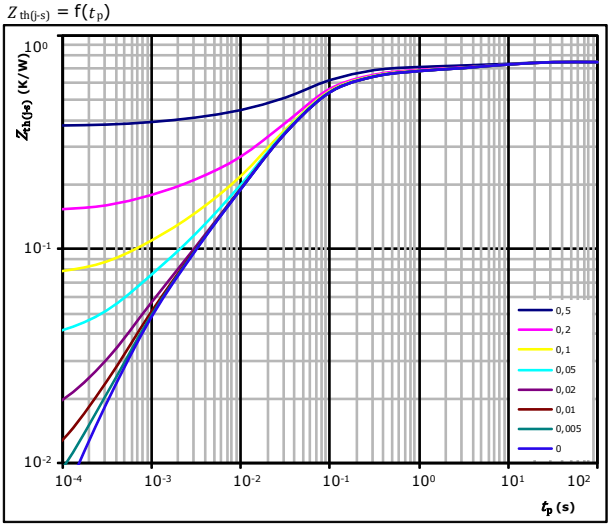
t_p = 250 µs

T_j: 25 °C
125 °C
150 °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

$R_{th(j-s)}$ = 0,75 K/W

Diode thermal model values

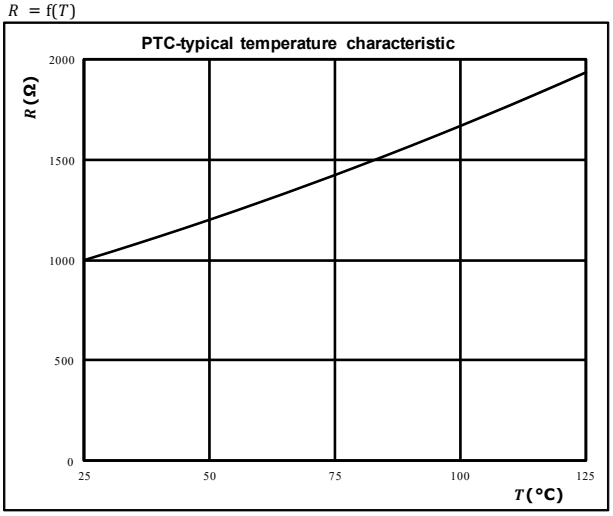
R (K/W)	τ (s)
6,99E-02	4,80E+00
7,97E-02	2,69E-01
3,54E-01	4,00E-02
1,62E-01	1,46E-02
5,21E-02	2,38E-03
3,21E-02	4,72E-04

Thermistor Characteristics

figure 1. **Thermistor**

Typical PTC characteristic
as a function of temperature

$R = f(T)$

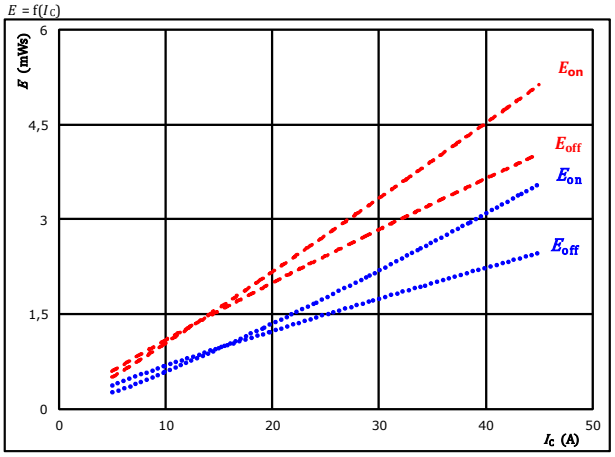


Inverter Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



With an inductive load at

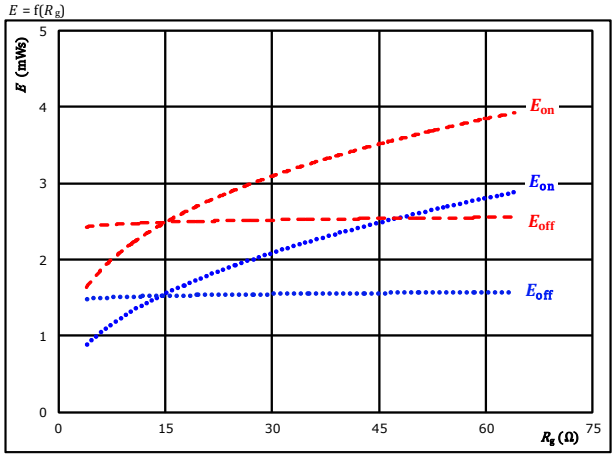
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

T_j: 25 °C, 150 °C

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



With an inductive load at

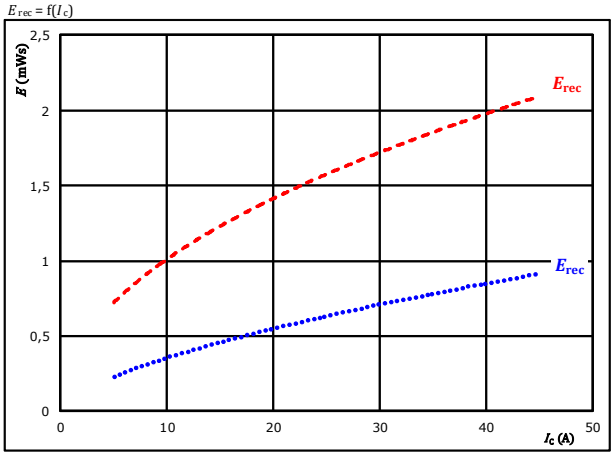
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	A

T_j: 25 °C, 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

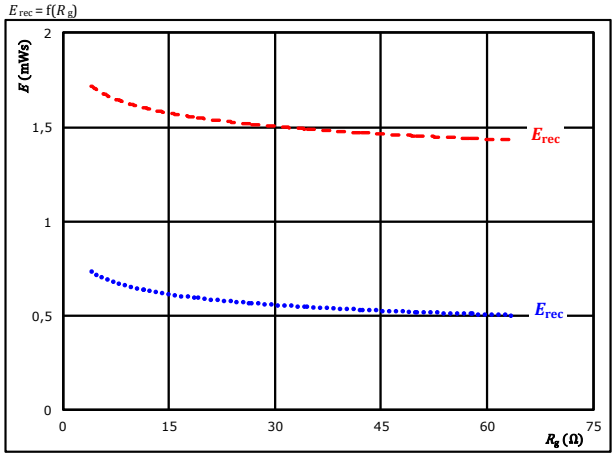
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

T_j: 25 °C, 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} =	600	V
V_{GE} =	±15	V
I_C =	25	A

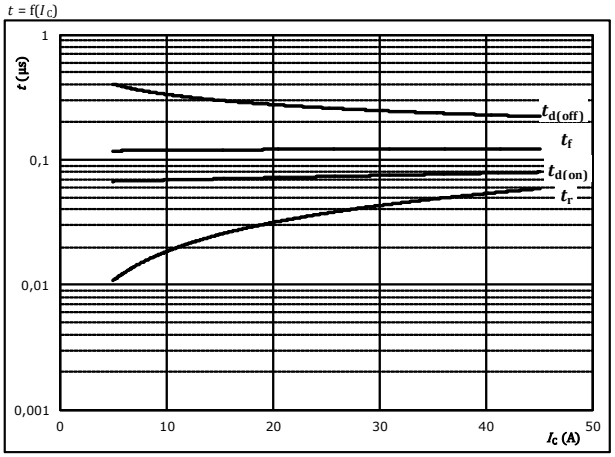
T_j: 25 °C, 150 °C

Inverter Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



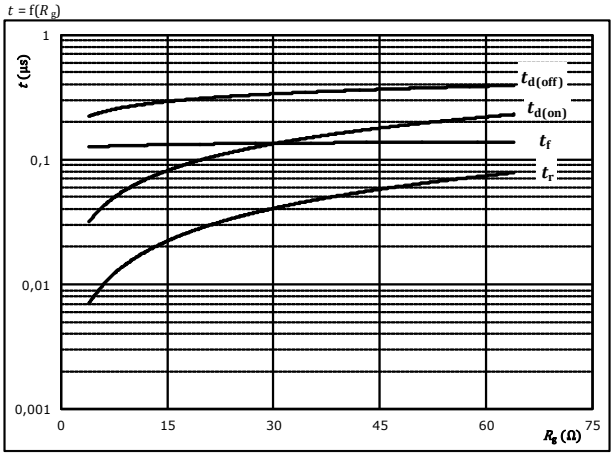
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



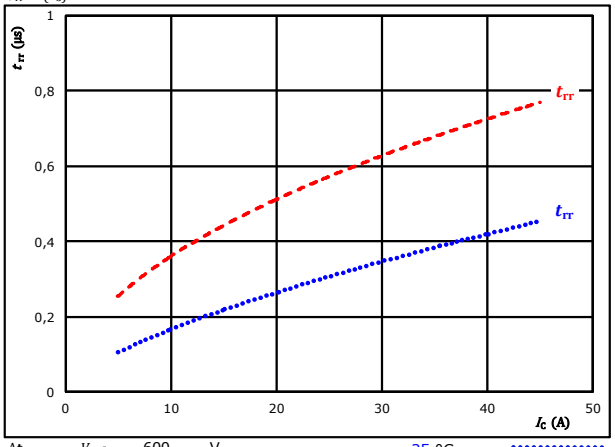
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	25	A

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



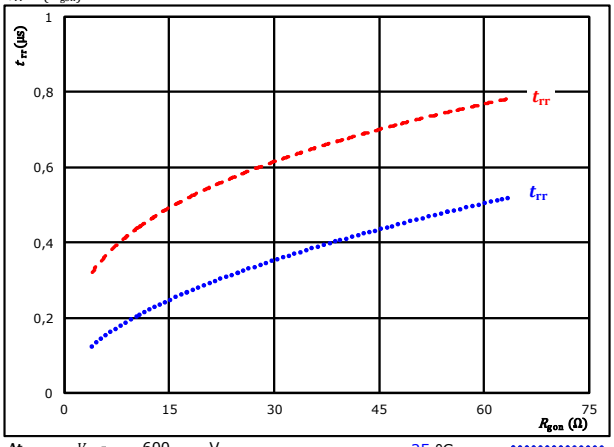
At

V_{CE} =	600	V	T_j:	25 °C	
V_{GE} =	±15	V		150 °C	
R_{gon} =	16	Ω			

figure 8. **FWD**

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

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



At

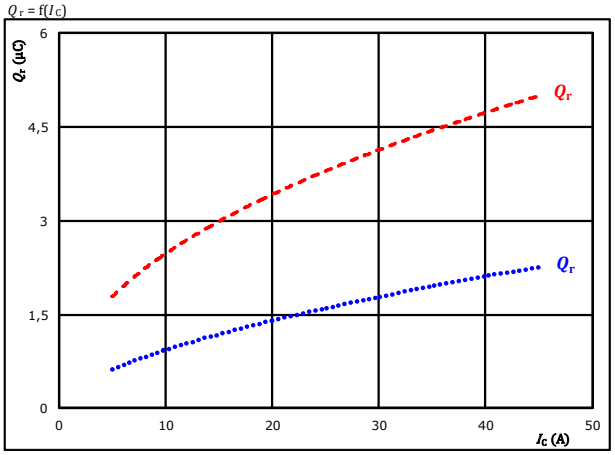
V_{CE} =	600	V	T_j:	25 °C	
V_{GE} =	±15	V		150 °C	
I_C =	25	A			

Inverter Switching Characteristics

figure 9. **FWD**

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

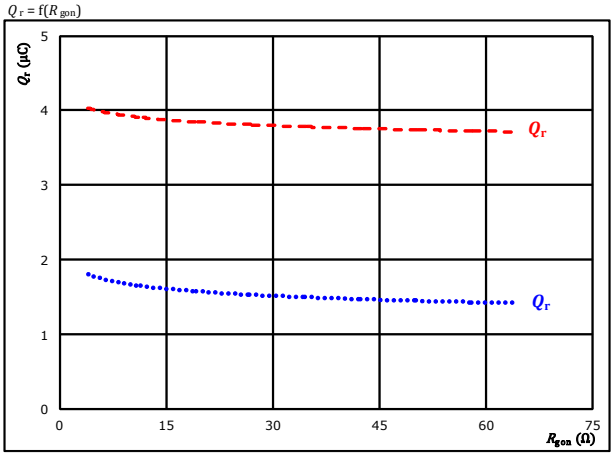


At						
	V_{CE} =	600	V	T_j:	25 °C	·····
	V_{GE} =	±15	V		150 °C	– – –
	R_{gon} =	16	Ω			

figure 10. **FWD**

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

$Q_r = f(R_{gon})$

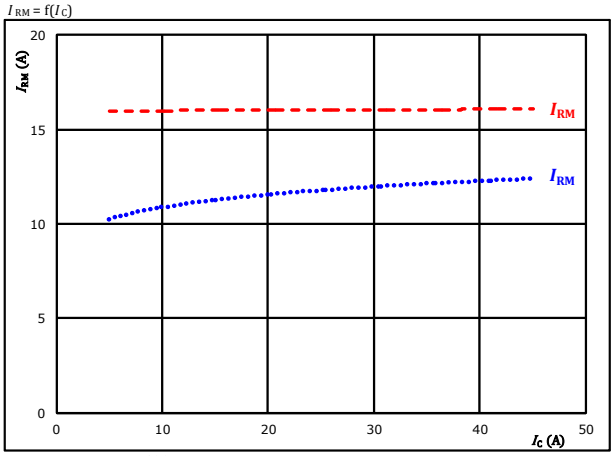


At						
	V_{CE}=	600	V	T_j:	25 °C	·····
	V_{GE} =	±15	V		150 °C	– – –
	I_C=	25	A			

figure 11. **FWD**

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

$I_{RM} = f(I_C)$

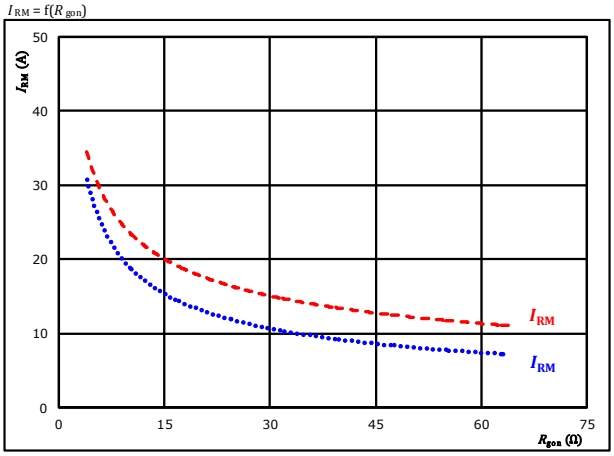


At						
	V_{CE}:	600	V	T_j:	25 °C	·····
	V_{GE} =	±15	V		150 °C	– – –
	R_{gon} =	16	Ω			

figure 12. **FWD**

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

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



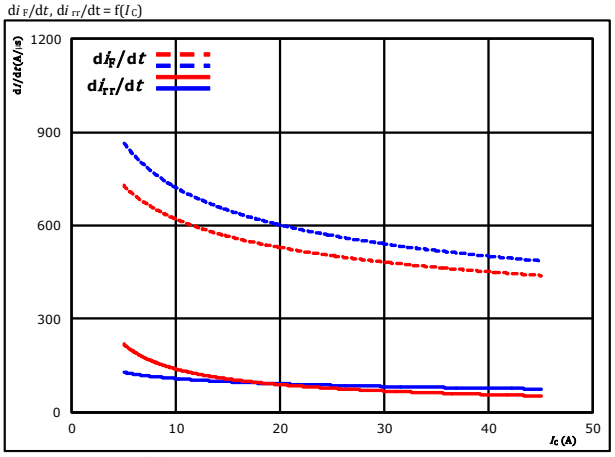
At						
	V_{CE} =	600	V	T_j:	25 °C	·····
	V_{GE} =	±15	V		150 °C	– – –
	I_C =	25	A			

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

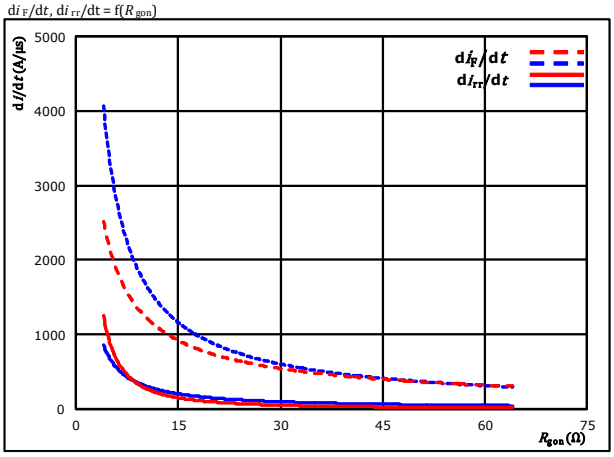


At						
	V_{CE}:	600	V		25	°C
	V_{GE} =	±15	V	T_j:	150	°C
	R_{gon} =	16	Ω			

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, $di_{rr}/dt = f(R_{gon})$

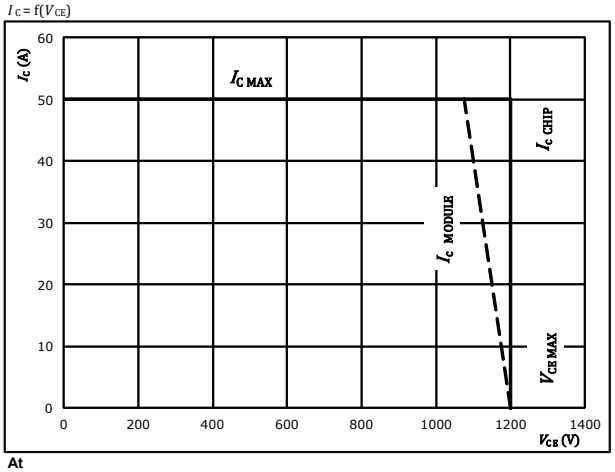


At						
	V_{CE} =	600	V		25	°C
	V_{GE} =	±15	V	T_j:	150	°C
	I_C=	25	A			

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At			
	T_j =	175	°C
	R_{gon} =	16	Ω
	R_{goff} =	16	Ω

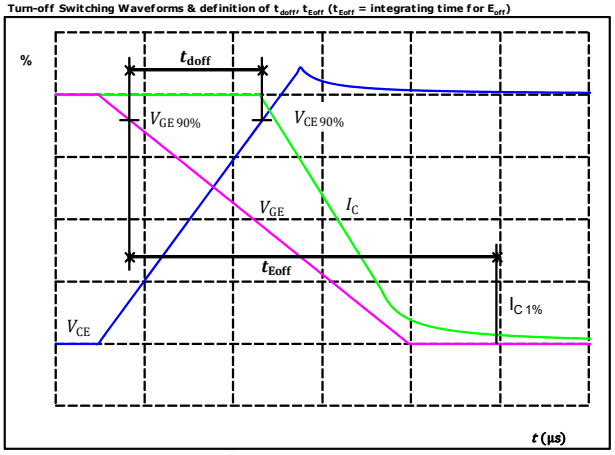
Inverter Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	16 Ω
R_{goff}	=	16 Ω

figure 1. IGBT

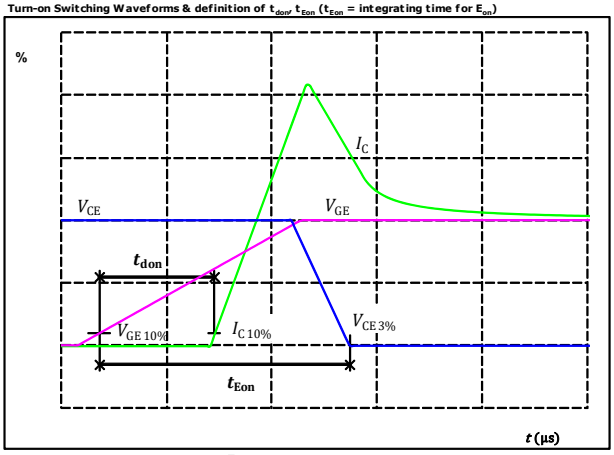
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_{doff} =	270	ns

figure 2. IGBT

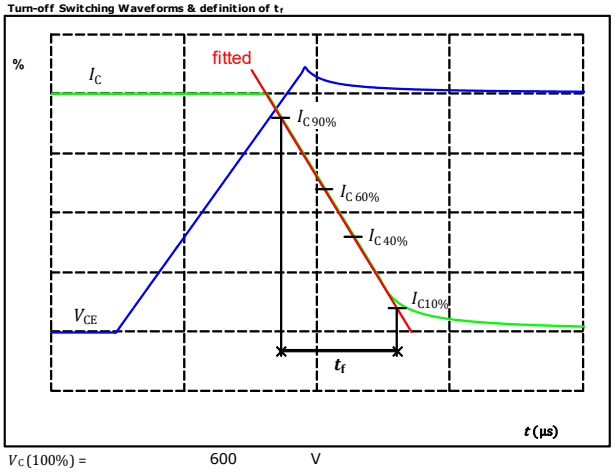
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	-15	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_{don} =	72	ns

figure 3. IGBT

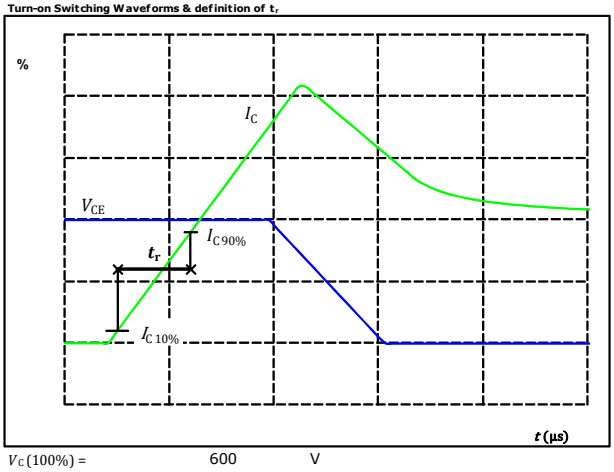
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_f =	135	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

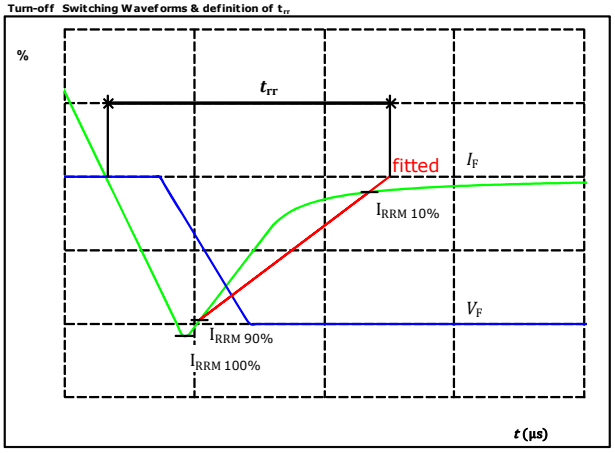


$V_C(100\%)$ =	600	V
$I_C(100\%)$ =	25	A
t_r =	36	ns

Inverter Switching Characteristics

figure 5. **FWD**

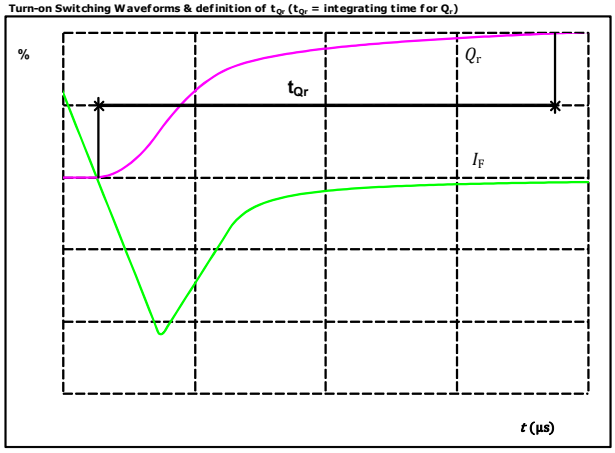
Turn-off Switching Waveforms & definition of t_{rr}



$V_F(100\%)$ =	600	V
$I_F(100\%)$ =	25	A
$I_{RRM}(100\%)$ =	17	A
t_{rr} =	580	ns

figure 6. **FWD**

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



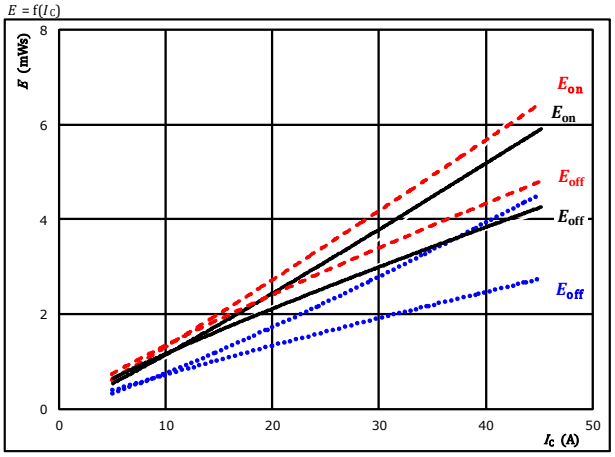
$I_F(100\%)$ =	25	A
$Q_r(100\%)$ =	3,88	µC

Brake Switching Characteristics

figure 1. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



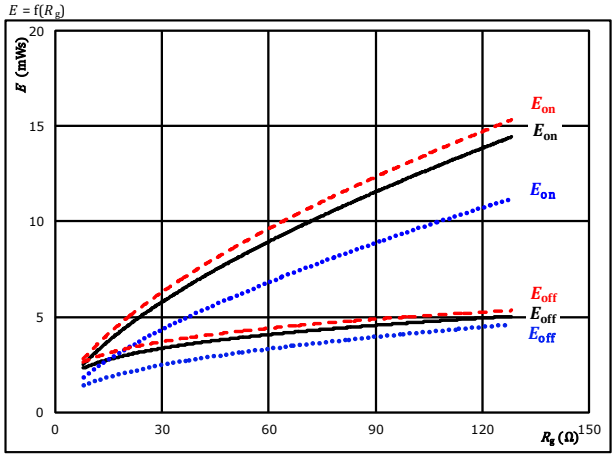
With an inductive load at

V_{CE} =	700	V	T_j:	25 °C
V_{GE} =	0 / 15	V		125 °C
R_{gon} =	8	Ω		150 °C
R_{goff} =	8	Ω		

figure 2. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_g)$



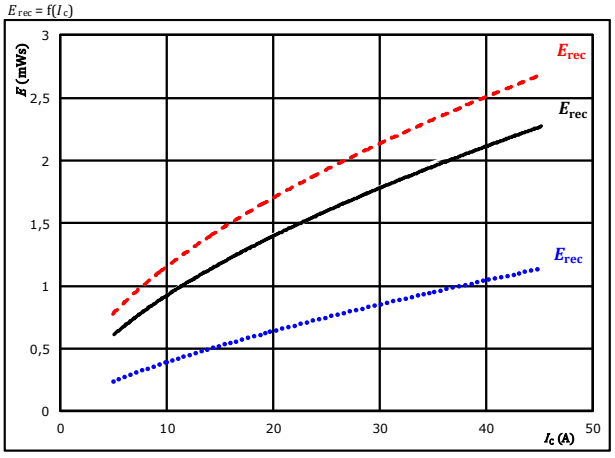
With an inductive load at

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

figure 3. **FWD**

Typical reverse recovered energy loss as a function of collector current

$E_{rec} = f(I_C)$



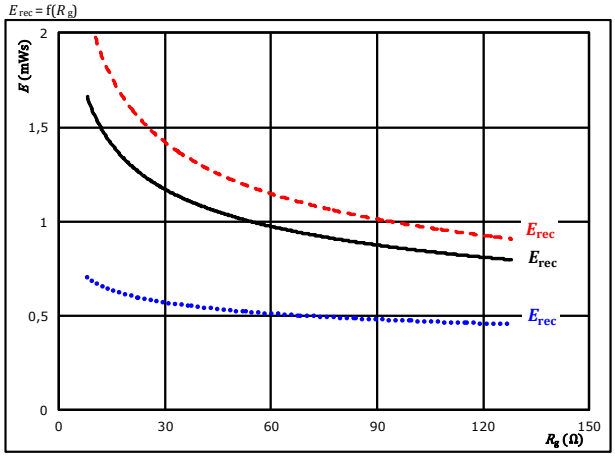
With an inductive load at

V_{CE} =	700	V	T_j:	25 °C
V_{GE} =	0 / 15	V		125 °C
R_{gon} =	8	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

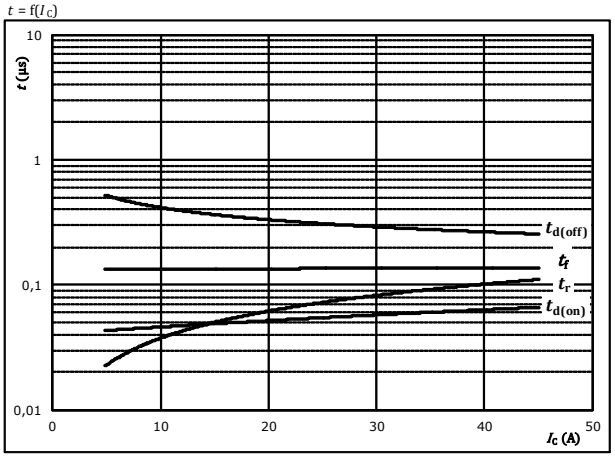
V_{CE} =	700	V	T_j:	25 °C
V_{GE} =	0 / 15	V		125 °C
I_C =	25	A		150 °C

Brake Switching Characteristics

figure 5. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



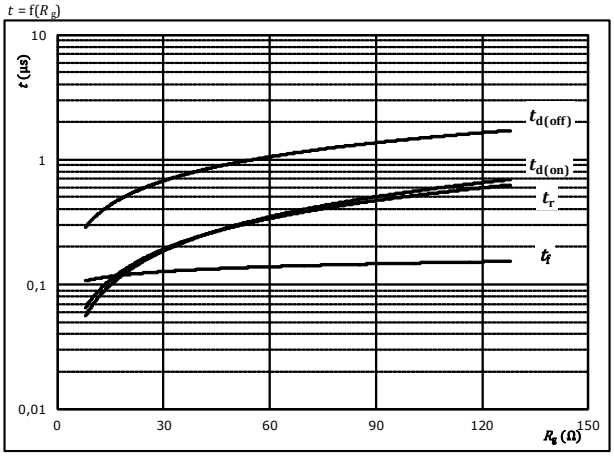
With an inductive load at

T_j =	150	°C
V_{CE} =	700	V
V_{GE} =	0 / 15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

figure 6. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_g)$



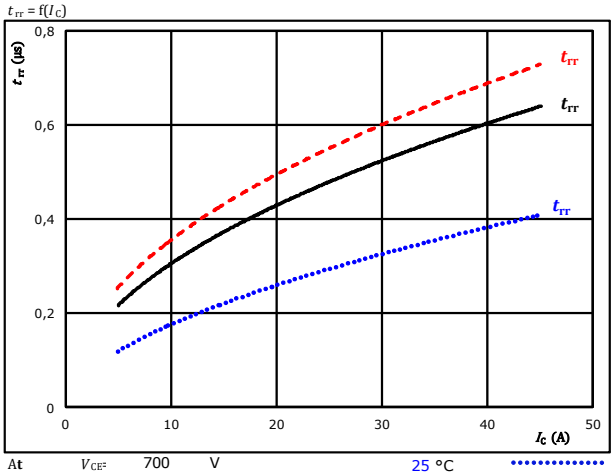
With an inductive load at

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

figure 7. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

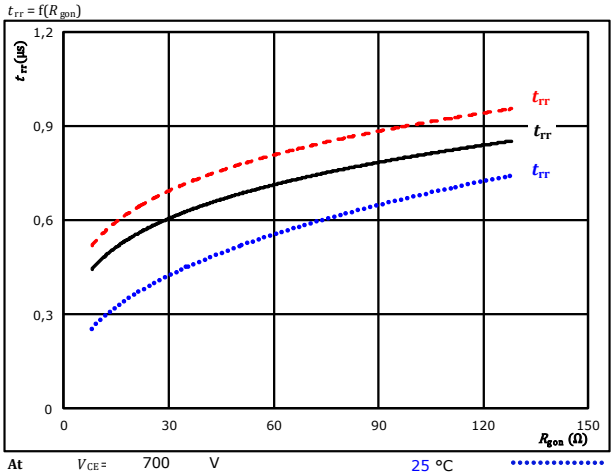


At					
V_{CE} =	700	V	T_j:	25 °C	
V_{GE} =	0 / 15	V		125 °C	
R_{gon} =	8	Ω		150 °C	

figure 8. **FWD**

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

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



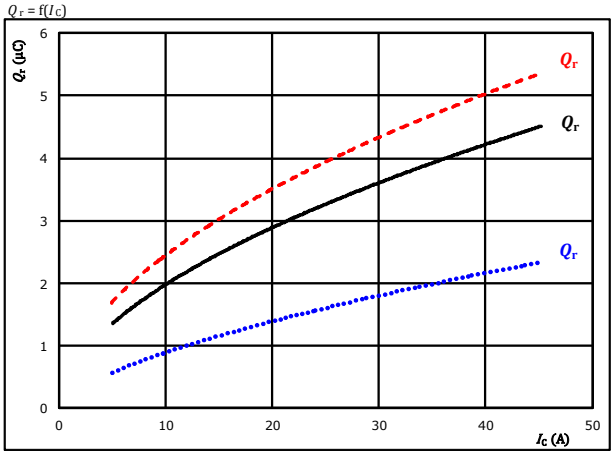
At					
V_{CE} =	700	V	T_j:	25 °C	
V_{GE} =	0 / 15	V		125 °C	
I_C =	25	A		150 °C	

Brake Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$Q_r = f(I_C)$

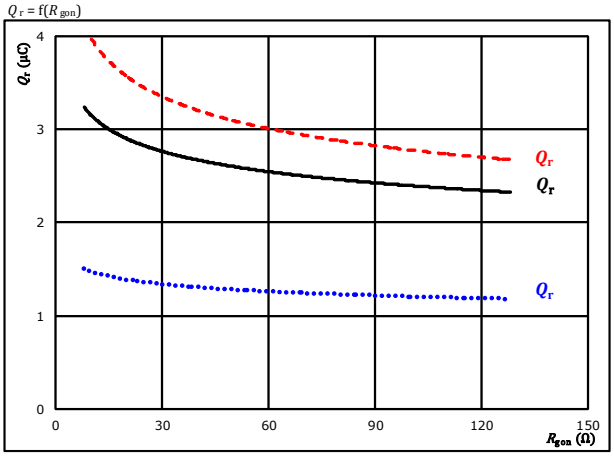


At					
V_{CE} =	700	V		25 °C	
V_{GE} =	0 / 15	V	T_j:	125 °C	
R_{gon} =	8	Ω		150 °C	

figure 10. FWD

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

$Q_r = f(R_{gon})$

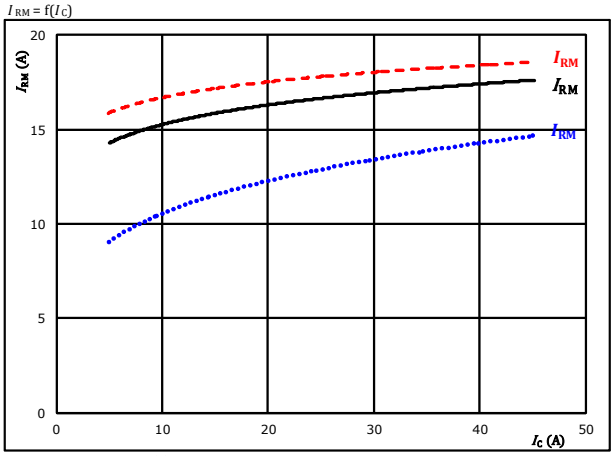


At					
V_{CE} =	700	V		25 °C	
V_{GE} =	0 / 15	V	T_j:	125 °C	
I_C =	25	A		150 °C	

figure 11. FWD

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

$I_{RM} = f(I_C)$

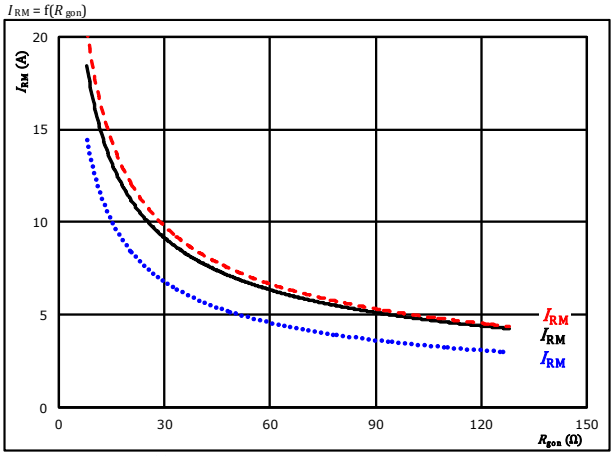


At					
V_{CE} =	700	V		25 °C	
V_{GE} =	0 / 15	V	T_j:	125 °C	
R_{gon} =	8	Ω		150 °C	

figure 12. FWD

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

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



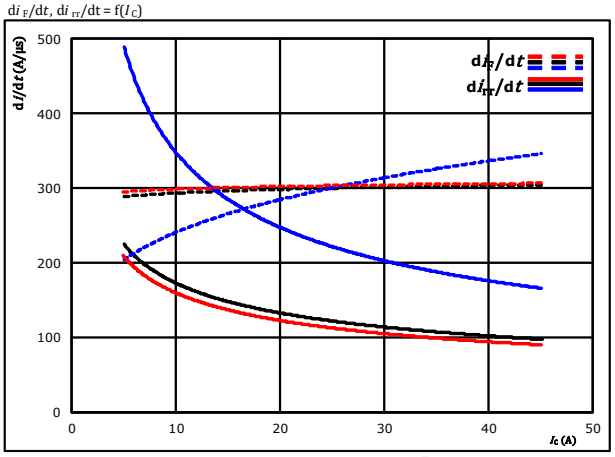
At					
V_{CE} =	700	V		25 °C	
V_{GE} =	0 / 15	V	T_j:	125 °C	
I_C =	25	A		150 °C	

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

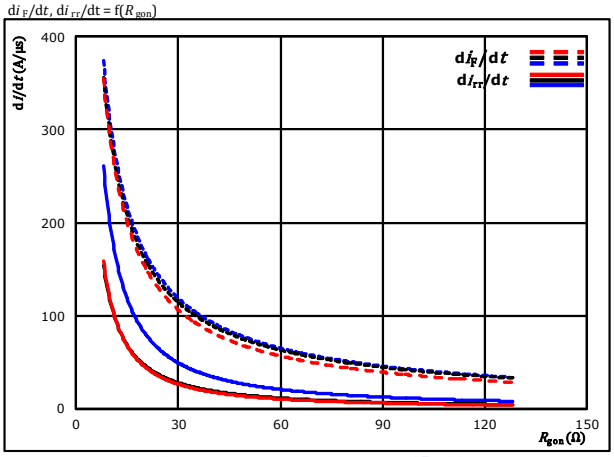


At						
	V_{CE}:	700	V		25	°C
	V_{GE} =	0 / 15	V	T_j:	125	°C
	R_{gon} =	8	Ω		150	°C

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, $di_{rr}/dt = f(R_{gon})$

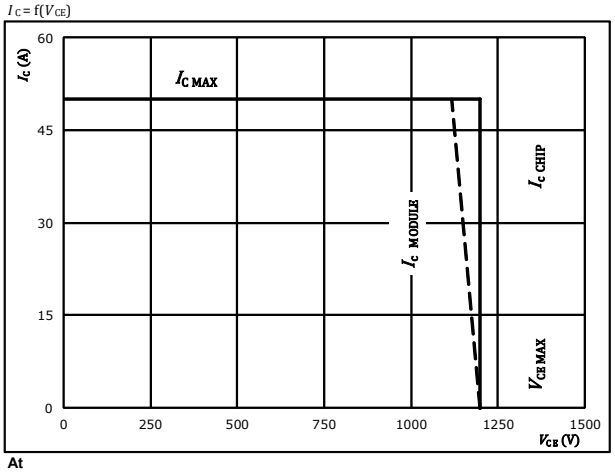


At						
	V_{CE} =	700	V		25	°C
	V_{GE} =	0 / 15	V	T_j:	125	°C
	I_C=	25	A		150	°C

figure 15. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j =	175	°C
R_{gon} =	8	Ω
R_{goff} =	8	Ω

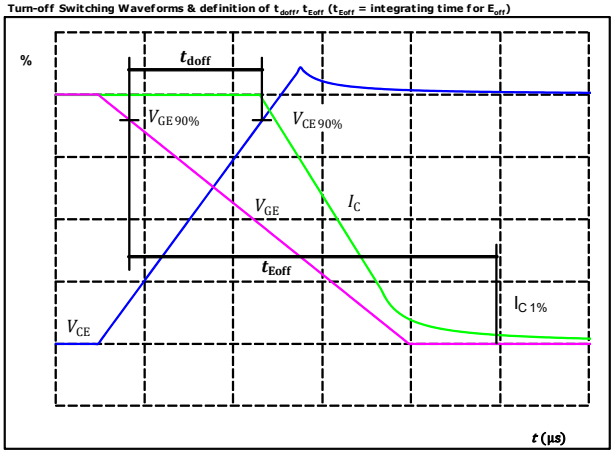
Brake Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

figure 1. IGBT

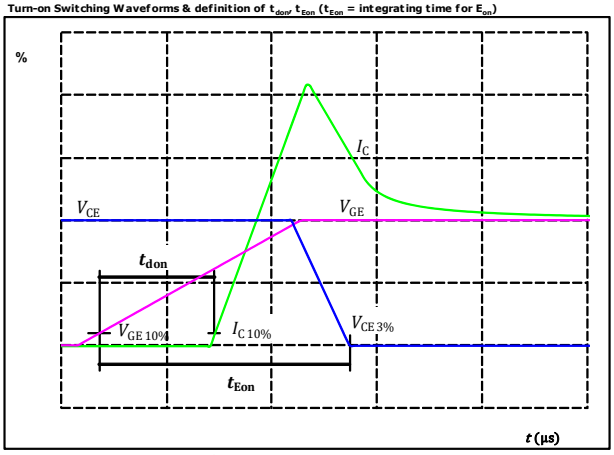
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GE}(0\%)$ =	0	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	25	A
t_{doff} =	301	ns

figure 2. IGBT

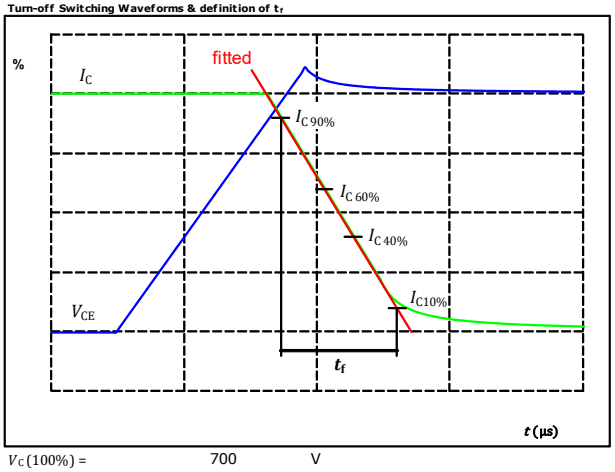
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GE}(0\%)$ =	0	V
$V_{GE}(100\%)$ =	15	V
$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	25	A
t_{don} =	59	ns

figure 3. IGBT

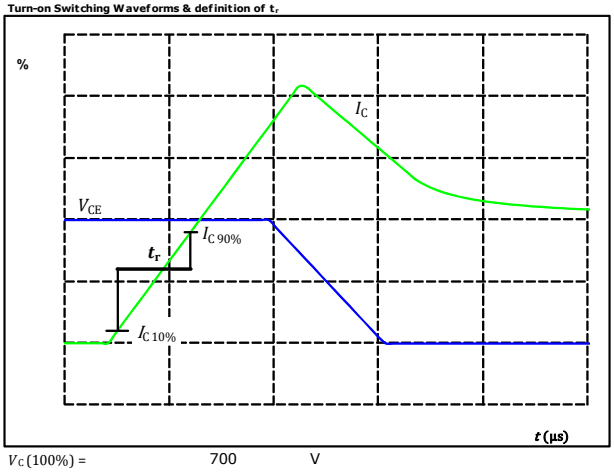
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	25	A
t_f =	104	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

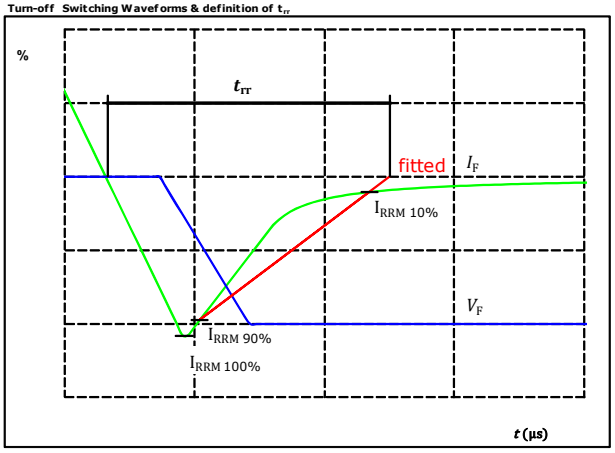


$V_C(100\%)$ =	700	V
$I_C(100\%)$ =	25	A
t_r =	68	ns

Brake Switching Characteristics

figure 5. **FWD**

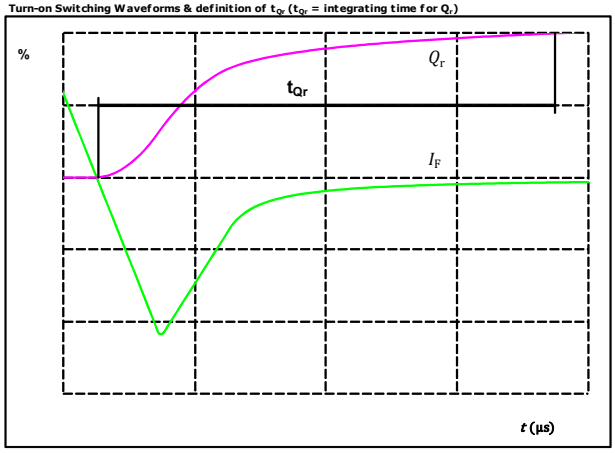
Turn-off Switching Waveforms & definition of t_{rr}



$V_F(100\%)$ =	700	V
$I_F(100\%)$ =	25	A
$I_{RRM}(100\%)$ =	18	A
t_{rr} =	473	ns

figure 6. **FWD**

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



$I_F(100\%)$ =	25	A
$Q_r(100\%)$ =	3,20	µC

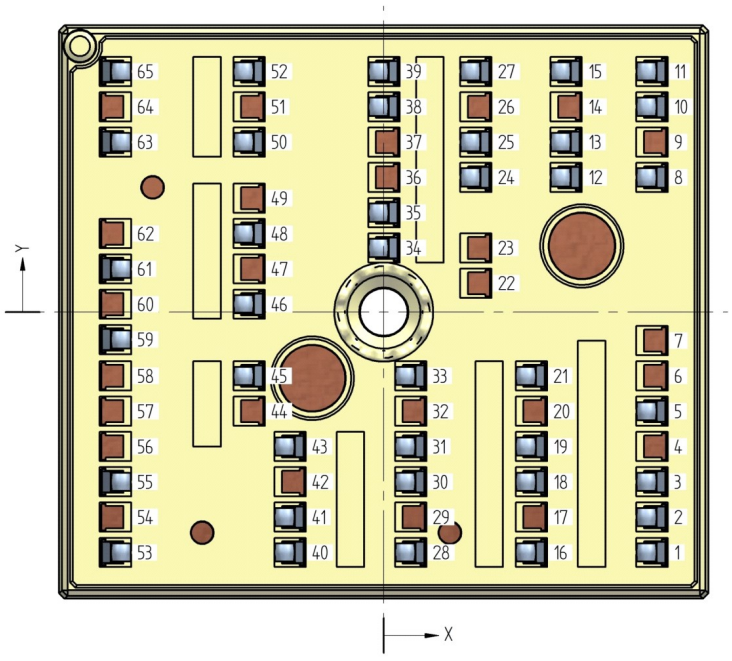
Ordering Code & Marking

Version	Ordering Code
With std lid (6.5mm height) + no thermal grease	V23990-K229-A41-/0A/
With thin lid (2.8mm height) + no thermal grease	V23990-K229-A41-/0B/
With std lid (6.5mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K229-A41-/1A/
With thin lid (2.8mm height) + thermal grease (0,8 W/mK, P12, silicone-based)	V23990-K229-A41-/1B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K229-A41-/4A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, TG20032, silicone-free)	V23990-K229-A41-/4B/
With std lid (6.5mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K229-A41-/5A/
With thin lid (2.8mm height) + thermal grease (2,5 W/mK, HPTP, silicone-based)	V23990-K229-A41-/5B/

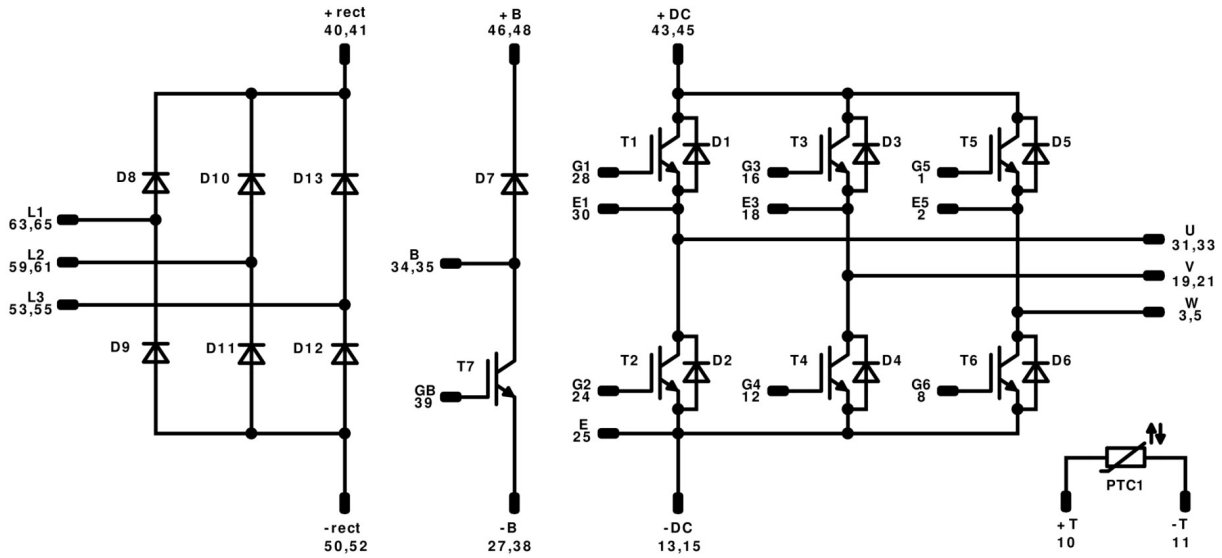
Text	**VIN**	**Date code**	**Name&Ver**	**UL**	**Lot**	**Serial**
	VIN	WWYY	NNNNNNNVV	UL	LLLLL	SSSS
Datamatrix	**Type&Ver**	**Lot number**	**Serial**	**Date code**		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

Outline

PCB pad table				PCB pad table			
Pin	X	Y	Function	Pin	X	Y	Function
1	24,38	-21,8	G5	45	-12,22	-5,8	+DC
2	24,38	-18,6	E5	46	-12,22	0,7	+B
3	24,38	-15,4	W	47	Not assembled		
4	Not assembled			48	-12,22	7,1	+B
5	24,38	-9	W	49	Not assembled		
6	Not assembled			50	-12,22	15,4	-rect
7	Not assembled			51	Not assembled		
8	24,38	12,2	G6	52	-12,22	21,8	-rect
9	Not assembled			53	-24,38	-21,8	L3
10	24,38	18,6	+T	54	Not assembled		
11	24,38	21,8	-T	55	-24,38	-15,4	L3
12	16,58	12,2	G4	56	Not assembled		
13	16,58	15,4	-DC	57	Not assembled		
14	Not assembled			58	Not assembled		
15	16,58	21,8	-DC	59	-24,38	-2,5	L2
16	13,42	-21,8	G3	60	Not assembled		
17	Not assembled			61	-24,38	3,9	L2
18	13,42	-15,4	E3	62	Not assembled		
19	13,42	-12,2	V	63	-24,38	15,4	L1
20	Not assembled			64	Not assembled		
21	13,42	-5,8	V	65	-24,38	21,8	L1
22	Not assembled						
23	Not assembled						
24	8,38	12,2	G2				
25	8,38	15,4	E				
26	Not assembled						
27	8,38	21,8	-B				
28	2,46	-21,8	G1				
29	Not assembled						
30	2,46	-15,4	E1				
31	2,46	-12,2	U				
32	Not assembled						
33	2,46	-5,8	U				
34	0,03	5,8	B				
35	0,03	9	B				
36	Not assembled						
37	Not assembled						
38	0,03	18,6	-B				
39	0,03	21,8	GB				
40	-8,5	-21,8	+rect				
41	-8,5	-18,6	+rect				
42	Not assembled						
43	-8,5	-12,2	+DC				
44	Not assembled						



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



Identification					
ID	**Component**	**Voltage**	**Current**	**Function**	**Comment**
T1, T2, T3, T4, T5, T6	IGBT	1200 V	25 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	1200 V	25 A	Inverter Diode	
T7	IGBT	1200 V	25 A	Brake Switch	
D7	FWD	1200 V	25 A	Brake Diode	
D8, D9, D10, D11, D12, D13	Rectifier	1600 V	50 A	Rectifier Diode	
PTC1	PTC			Thermistor	

Packaging instruction				
Standard packaging quantity (SPQ) 72	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 2 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 2 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-K229-A41-D6-14	01 Mar. 2019	Correction of I_c/I_f values	1,2,3