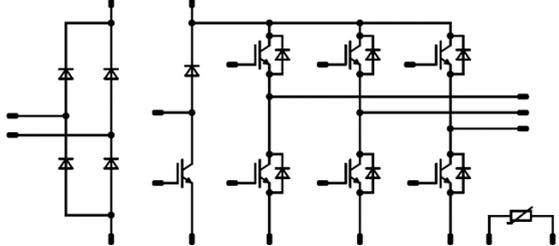




Vincotech

<i>flow PIM 0</i>	600 V / 20 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Features</div> <ul style="list-style-type: none"> Vincotech clip-in housing Trench Fieldstop IGBT's for low saturation losses Optional without brake 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><i>flow 0 12 mm housing</i></div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Target applications</div> <ul style="list-style-type: none"> Industrial drives Embedded 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-P545-B38-PM 	

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		600	V
Collector current	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	26	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	60	A
Turn off safe operating area		$V_{CE} \leq 600V, T_j \leq T_{op\ max}$	60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Gate-emitter voltage	V_{GES}		± 20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$ $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	μs
Maximum junction temperature	T_{jmax}		175	°C



Vincotech

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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Inverter Diode

Peak repetitive reverse voltage	V_{RRM}		600	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	21	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	40	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	37	W
Maximum junction temperature	T_{jmax}		175	°C

Brake Switch

Collector-emitter voltage	V_{CES}		600	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
Turn off safe operating area		$V_{CE} \leq 600V, T_j \leq T_{op\ max}$	45	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	52	W
Gate-emitter voltage	V_{GES}		± 20	V
Short circuit ratings	t_{SC}	$V_{GE} = 15\text{ V}$ $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	μs
Maximum junction temperature	T_{jmax}		175	°C

Brake Diode

Peak repetitive reverse voltage	V_{RRM}		600	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	18	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	30	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	35	W
Maximum junction temperature	T_{jmax}		175	°C

Rectifier Diode

Peak repetitive reverse voltage	V_{RRM}		1600	V
Continuous (direct) forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave $T_j = 150\text{ °C}$	270	A
Surge current capability	I^2t	$t_p = 10\text{ ms}$	370	A ² s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	56	W
Maximum junction temperature	T_{jmax}		150	°C



Vincotech

Maximum Ratings

$T_j = 25\text{ °C}$, 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_{top}		-40...(T _{max} - 25)	°C
Isolation Properties				
Isolation voltage	V_{isol}	DC Test Voltage* $t_p = 2\text{ s}$	6000	V
		AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			min 12,7	mm
Clearance			9,29	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	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00029	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		20	25 125	1	1,55 1,75	2,2	V
Collector-emitter cut-off current	I_{CES}		0	600		25			1,1	μA
Gate-emitter leakage current	I_{GES}		20	0		25			300	nA
Internal gate resistance	r_g							none		Ω
Input capacitance	C_{ies}							1100		pF
Output capacitance	C_{oes}	$f = 1$ Mhz	0	25		25		71		
Reverse transfer capacitance	C_{res}							32		
Gate charge	Q_g		±15	480	20	25		120		nC

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,70		K/W
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Dynamic

Turn-on delay time	$t_{d(on)}$					25 125		15 14		ns
Rise time	t_r	$R_{gon} = 16$ Ω $R_{goff} = 8$ Ω				25 125		12 16		
Turn-off delay time	$t_{d(off)}$		0 / 15	300	20	25 125		198 212		
Fall time	t_f					25 125		100 104		
Turn-on energy (per pulse)	E_{on}	$Q_{tFWD} = 0,5$ μC $Q_{tFWD} = 1,4$ μC				25 125		0,31 0,43		mWs
Turn-off energy (per pulse)	E_{off}					25 125		0,55 0,65		



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Characteristic Values

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

Inverter Diode

Static

Forward voltage	V_F				20	25 125	1,25	1,81 1,76	1,95	V
Reverse leakage current	I_R			600		25			27	μA

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,60		K/W
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Dynamic

Peak recovery current	I_{RRM}	$di/dt = 2170$ A/μs $di/dt = 1490$ A/μs	0 / 15	300	20	25 125		19 21		A
Reverse recovery time	t_{rr}					25 125		33 192		ns
Recovered charge	Q_r					25 125		0,45 1,35		μC
Reverse recovered energy	E_{rec}					25 125		0,06 0,27		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 125		1450 1050		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	$V_{GE(th)}$	$V_{GE} = V_{CE}$			0,00021	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		15	25 125	1,1	1,79 2,08	1,9	V
Collector-emitter cut-off current	I_{CES}		0	600		25			0,85	μA
Gate-emitter leakage current	I_{GES}		20	0		25			300	nA
Internal gate resistance	r_g							none		Ω
Input capacitance	C_{ies}	$f = 1$ Mhz	0	25		25		860		pF
Output capacitance	C_{oes}							55		
Reverse transfer capacitance	C_{res}							24		
Gate charge	Q_g		±15	480	15	25		87		nC

Thermal

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

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 16$ Ω $R_{goff} = 8$ Ω	0 / 15	300	15	25		15		ns
Rise time	t_r					125		14		
Turn-off delay time	$t_{d(off)}$					25		11		
Fall time	t_f					125		14		
						25		128		
Turn-on energy (per pulse)	E_{on}	$Q_{tFWD} = 0,5$ μC $Q_{tFWD} = 1$ μC				25		0,20	mWs	
Turn-off energy (per pulse)	E_{off}					125		0,28		
						25		0,32		
						125		0,40		



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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				15	25 125	1,25	1,86 1,75	1,95	V
Reverse leakage current	I_R			600		25			27	μA

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						2,75		K/W
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Dynamic

Peak recovery current	I_{RRM}	$di/dt = 1300$ A/μs $di/dt = 1220$ A/μs	0 / 15	300	15	25 125		14 15		A
Reverse recovery time	t_{rr}					25 125		128 201		ns
Recovered charge	Q_r					25 125		0,52 1,02		μC
Reverse recovered energy	E_{rec}					25 125		0,10 0,22		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 125		1310 657		A/μs

Rectifier Diode

Static

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

Thermal

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

Thermistor

Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1484$ Ω				100	-5		5	%
Power dissipation	P					25		5		mW
Power dissipation constant						25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1 %				25		3962		K
B-value	$B_{(25/100)}$	Tol. ±1 %				25		4000		K
Vincotech NTC Reference									I	

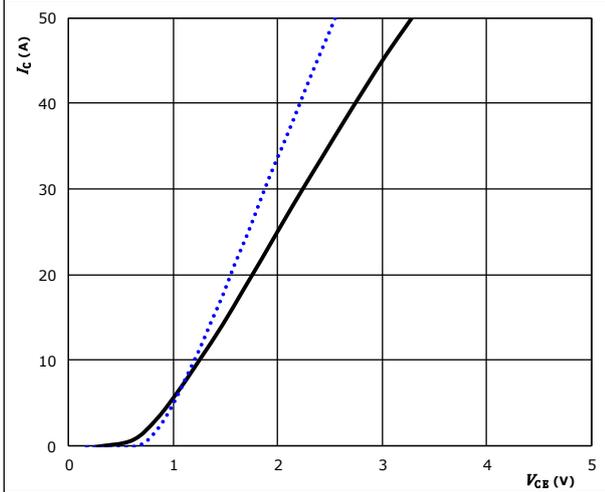


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

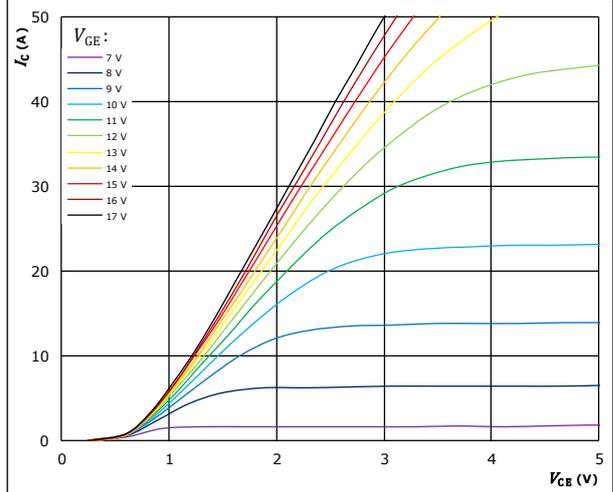


$t_p = 250 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{GE} = 15 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. IGBT

Typical output characteristics

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

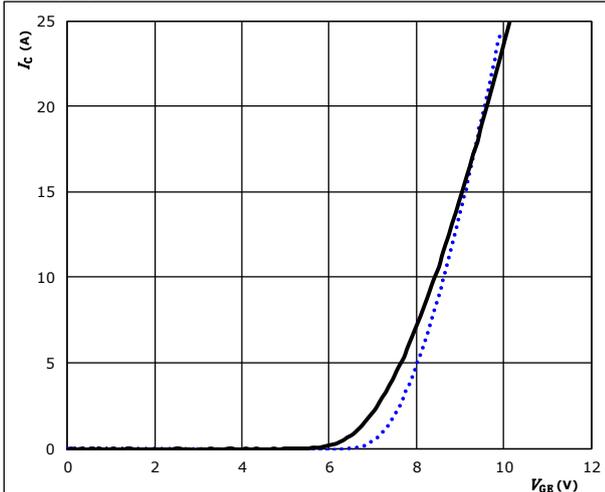


$t_p = 250 \mu\text{s}$
 $T_j = 125 \text{ }^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

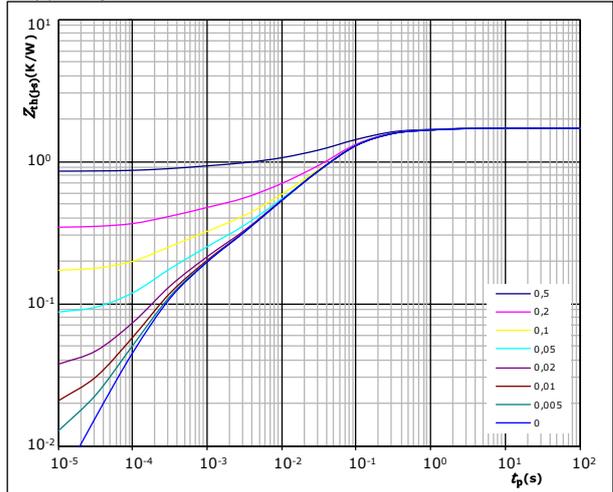


$t_p = 100 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{CE} = 10 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 1,70 \text{ K/W}$
 IGBT thermal model values

R (K/W)	τ (s)
9,97E-02	1,34E+00
3,46E-01	1,70E-01
8,15E-01	5,34E-02
2,54E-01	7,74E-03
7,70E-02	1,33E-03
1,09E-01	2,63E-04

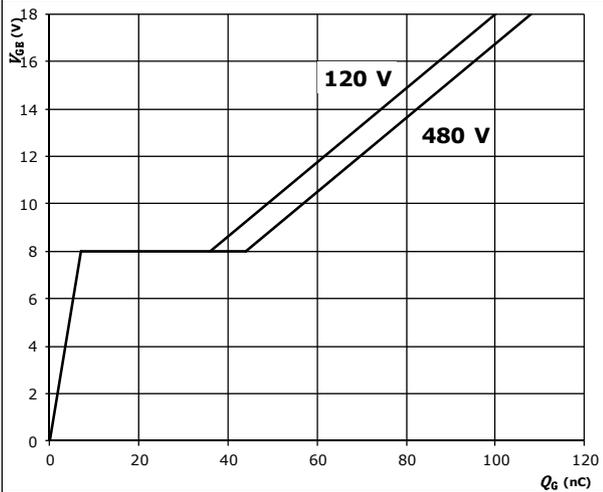


Inverter Switch Characteristics

figure 5. IGBT

Gate voltage vs gate charge

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

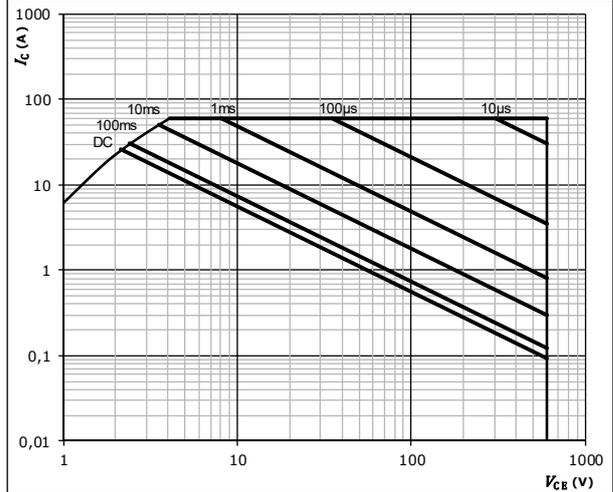


$I_C = 20$ A

figure 6. IGBT

Safe operating area

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

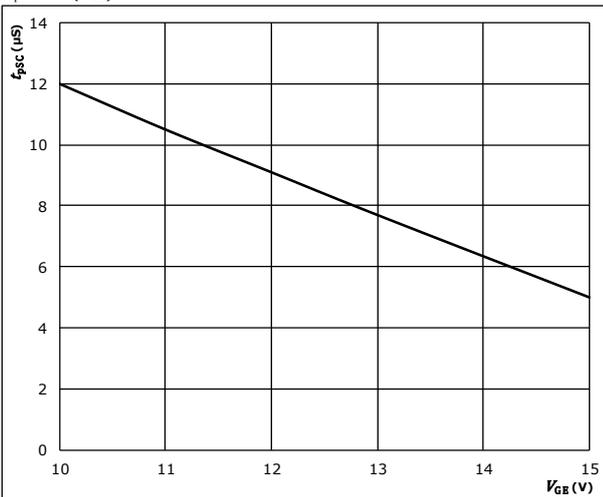


$D =$ single pulse
 $T_s = 80$ °C
 $V_{GE} = \pm 15$ V
 $T_j = T_{jmax}$

figure 7. IGBT

Short circuit duration as a function of V_{GE}

$$t_{pSC} = f(V_{GE})$$

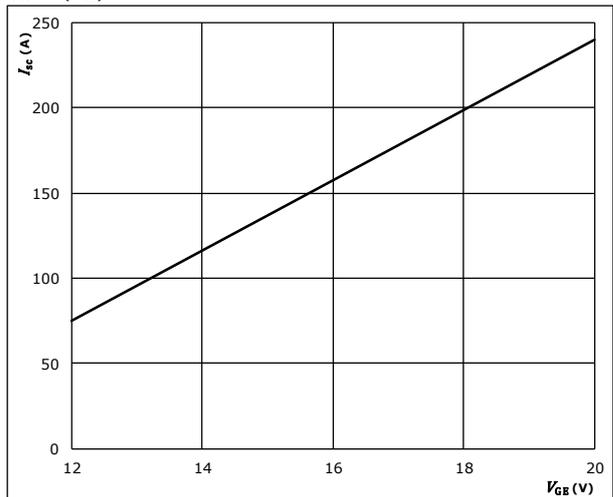


$V_{CE} = 600$ V
 $T_j \leq 175$ °C

figure 8. IGBT

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

$$I_{SC} = f(V_{CE})$$



$V_{CE} \leq 600$ V
 $T_j \leq 175$ °C

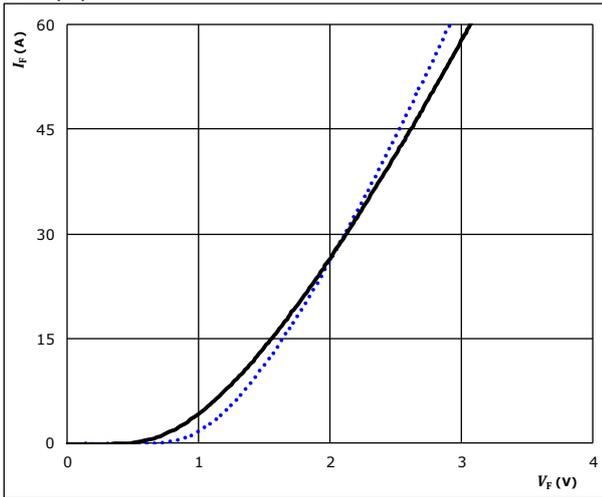


Inverter Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

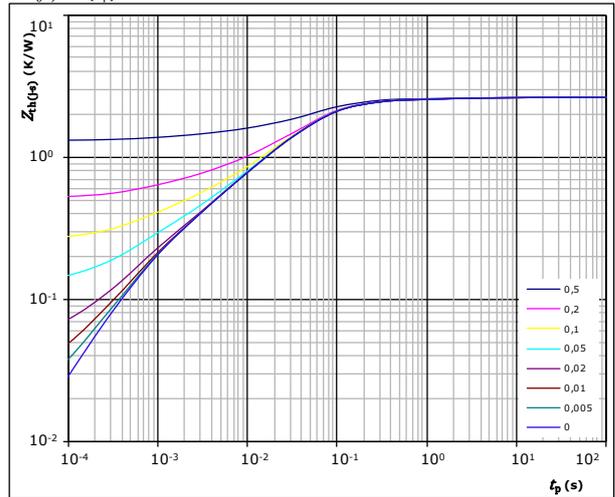


$t_p = 250 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line) $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 2,60 \text{ K/W}$

FWD thermal model values

R (K/W)	τ (s)
6,56E-02	4,59E+00
1,58E-01	5,68E-01
8,97E-01	8,42E-02
1,05E+00	3,29E-02
2,75E-01	4,96E-03
1,51E-01	7,65E-04

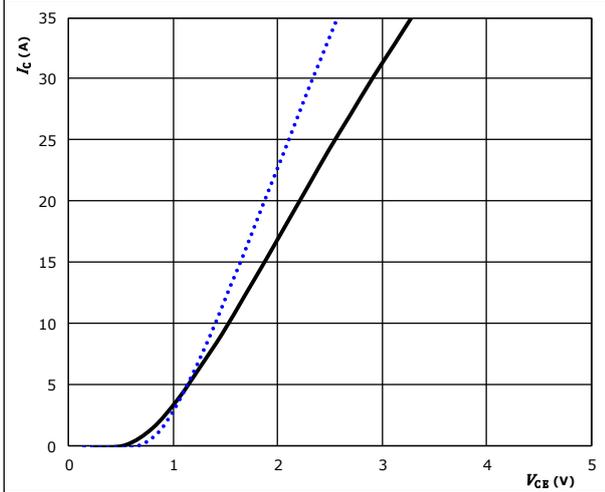


Brake Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

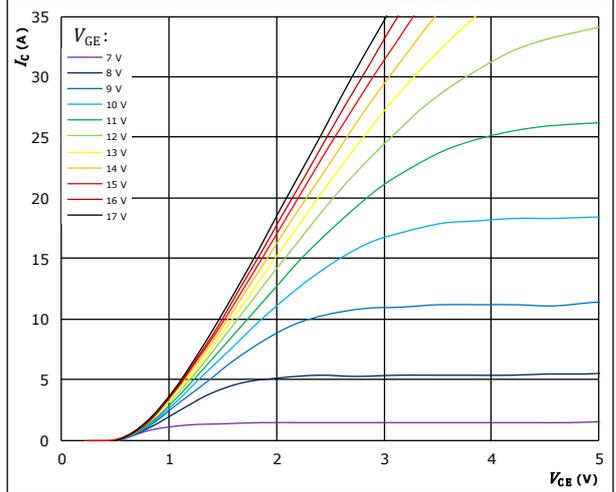


$t_p = 250 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{GE} = 15 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. IGBT

Typical output characteristics

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

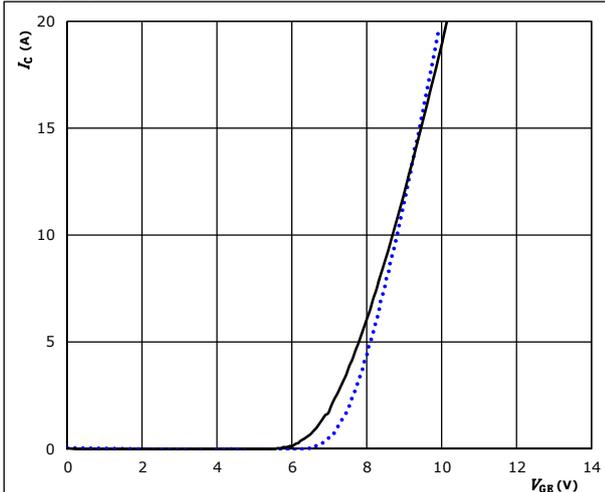


$t_p = 250 \mu\text{s}$
 $T_j = 125 \text{ }^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

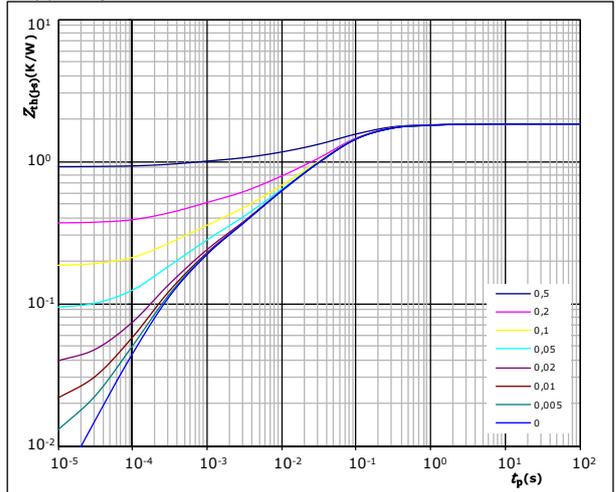


$t_p = 100 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{CE} = 10 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 4. IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 1,83 \text{ K/W}$
 IGBT thermal model values

R (K/W)	τ (s)
8,30E-02	1,29E+00
3,76E-01	1,56E-01
8,46E-01	5,15E-02
2,81E-01	8,16E-03
1,16E-01	2,04E-03
1,32E-01	3,43E-04



Vincotech

Brake Switch Characteristics

figure 5. IGBT

Safe operating area

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



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

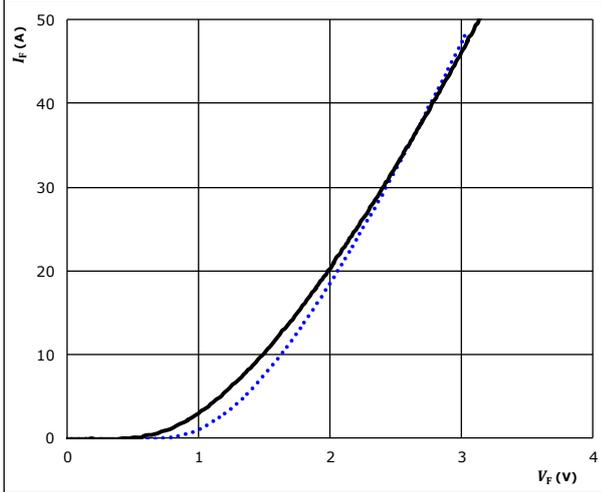


Brake Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

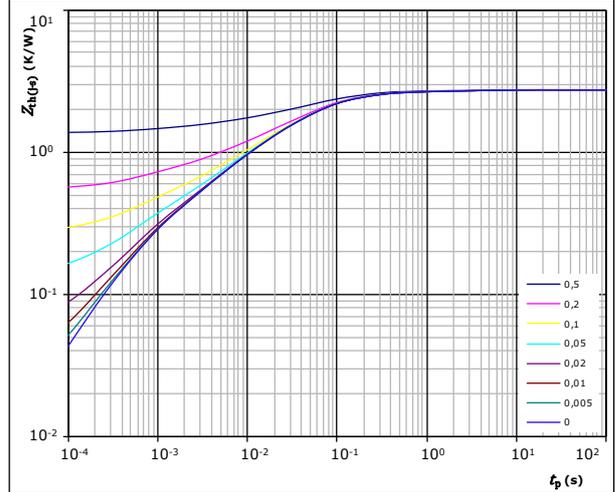


$t_p = 250 \mu\text{s}$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line), $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 2,75 \text{ K/W}$

FWD thermal model values

R (K/W)	τ (s)
1,03E-01	3,26E+00
3,03E-01	2,84E-01
1,23E+00	6,29E-02
5,94E-01	1,69E-02
3,18E-01	4,26E-03
2,02E-01	6,60E-04

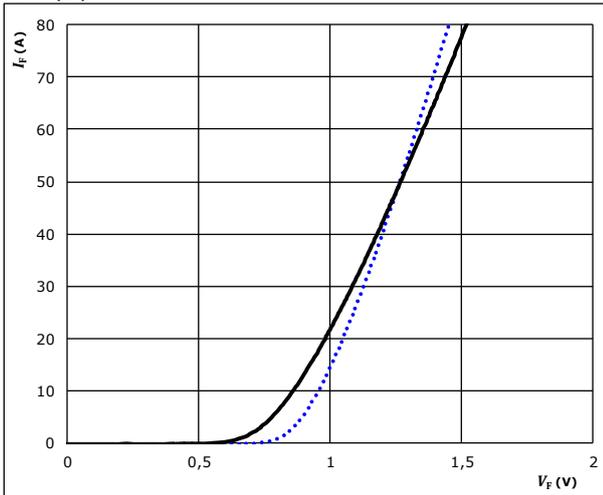


Rectifier Diode Characteristics

figure 1. Rectifier Diode

Typical forward characteristics

$$I_F = f(V_F)$$

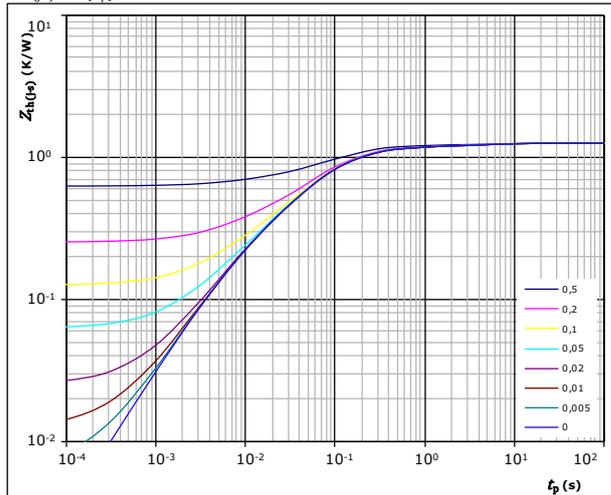


$t_p = 250 \mu s$
 $T_j: 25 \text{ } ^\circ\text{C}$ (dotted blue line)
 $125 \text{ } ^\circ\text{C}$ (solid black line)

figure 2. Rectifier Diode

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,25 \text{ K/W}$
Diode thermal model values

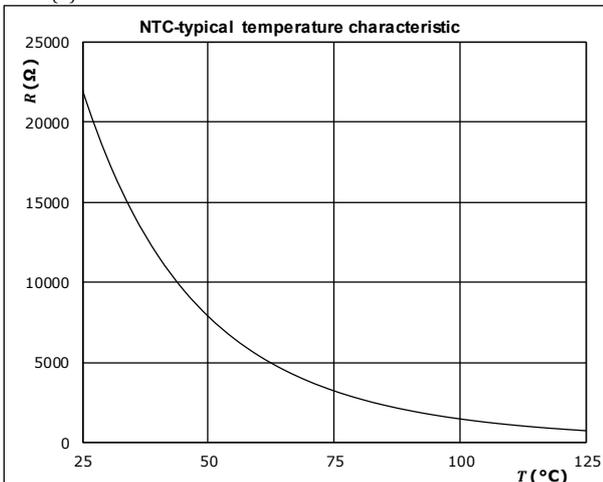
$R \text{ (K/W)}$	$\tau \text{ (s)}$
8,00E-02	5,22E+00
1,56E-01	4,18E-01
6,95E-01	8,82E-02
2,23E-01	3,07E-02
9,97E-02	5,99E-03

Thermistor Characteristics

figure 1. Thermistor

Typical NTC characteristic as a function of temperature

$$R = f(T)$$



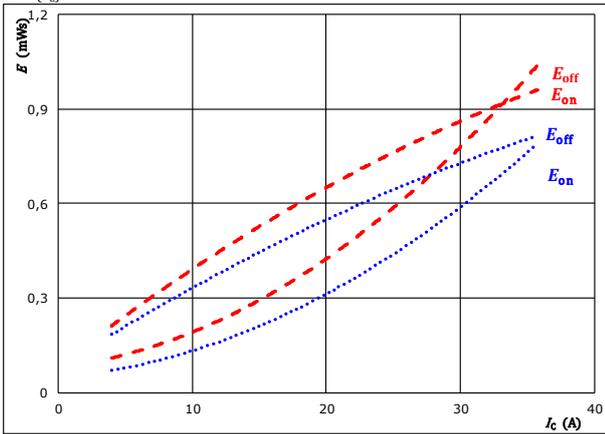


Inverter Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_c)$$



With an inductive load at

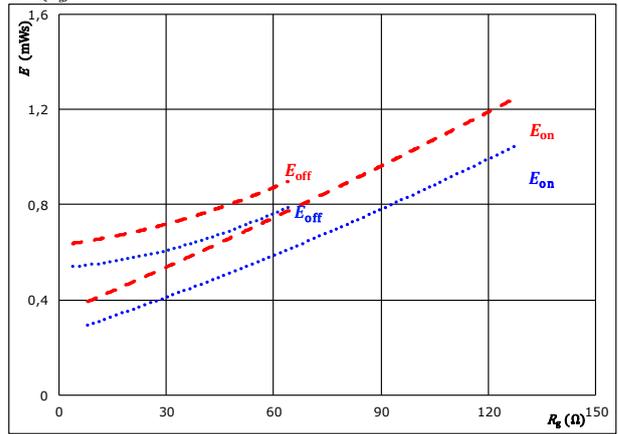
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω
 $R_{goff} = 8$ Ω

T_j : 25 °C (blue dotted line)
125 °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

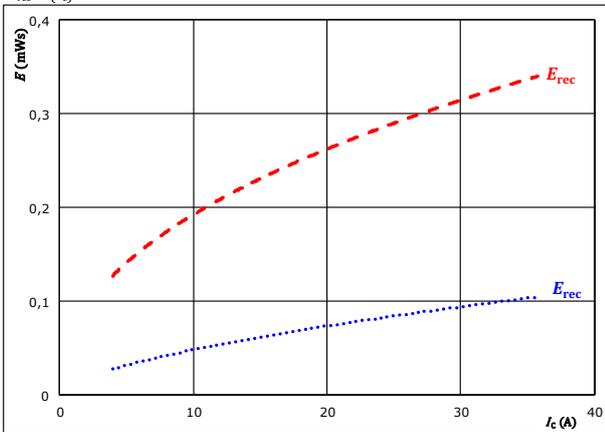
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 20$ A

T_j : 25 °C (blue dotted line)
125 °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

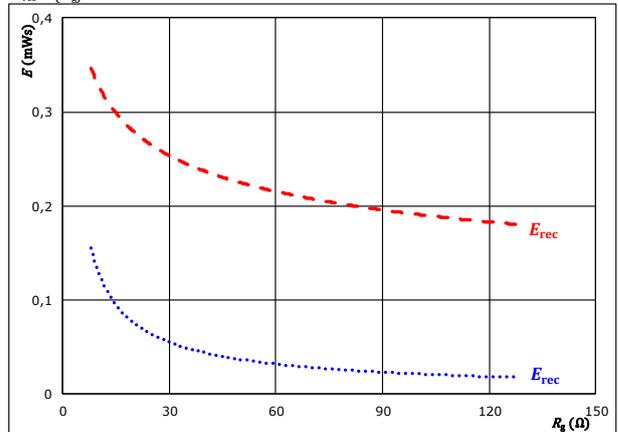
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω

T_j : 25 °C (blue dotted line)
125 °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

$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 20$ A

T_j : 25 °C (blue dotted line)
125 °C (red dashed line)

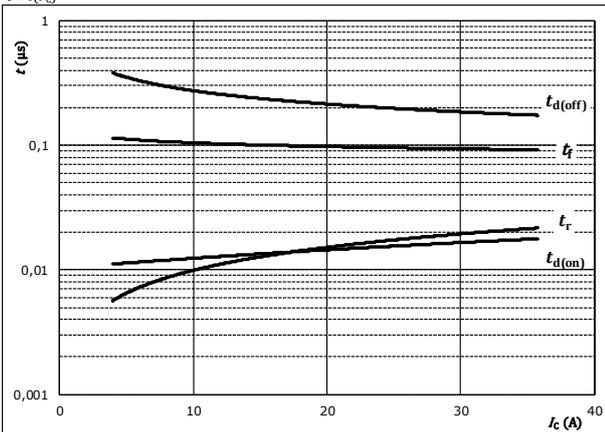


Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



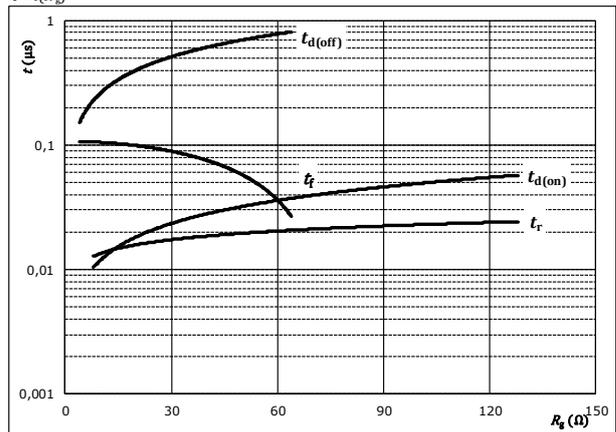
With an inductive load at

$T_j = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{g(on)} = 16$ Ω
 $R_{g(off)} = 8$ Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



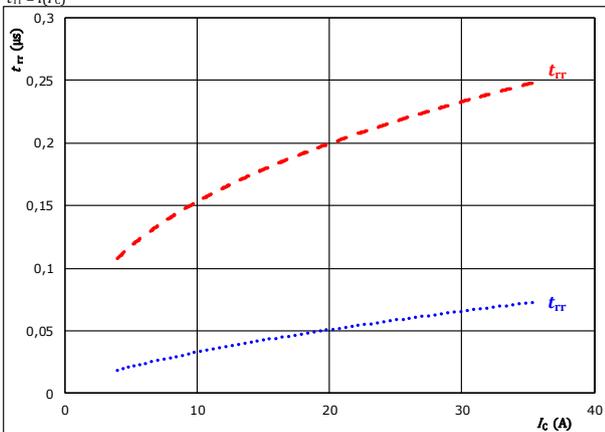
With an inductive load at

$T_j = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_C = 20$ A

figure 7. FWD

Typical reverse recovery time as a function of collector current

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



With an inductive load at

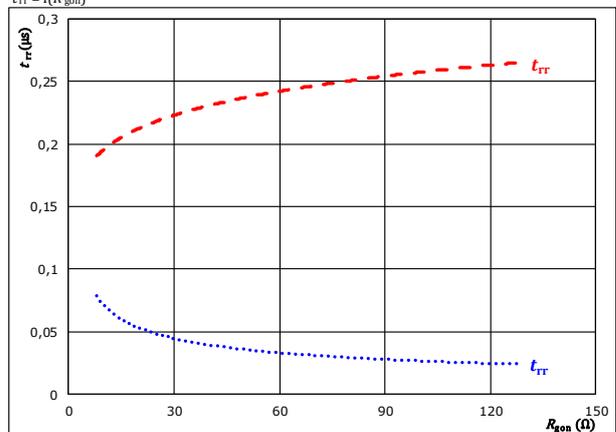
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{g(on)} = 16$ Ω

T_j : 25 °C (dotted line)
 125 °C (dashed line)

figure 8. FWD

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

$$t_{rr} = f(R_{g(on)})$$



With an inductive load at

$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_C = 20$ A

T_j : 25 °C (dotted line)
 125 °C (dashed line)

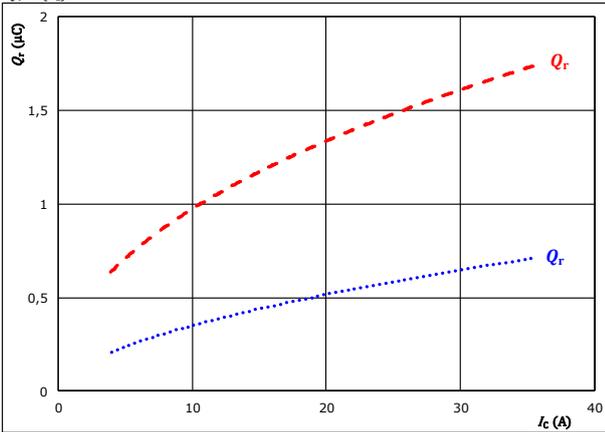


Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$

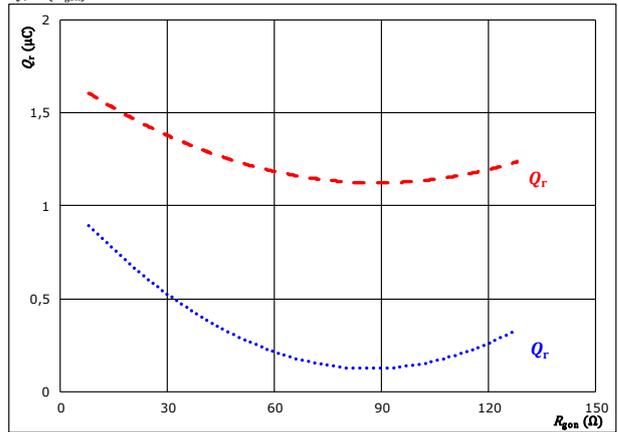


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω
 T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 10. FWD

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

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

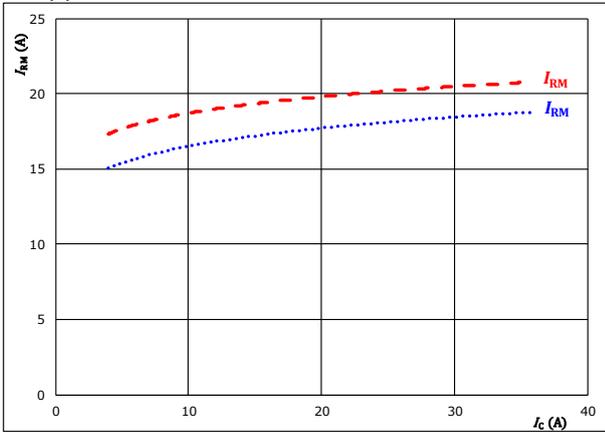


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 20$ A
 T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 11. FWD

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

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

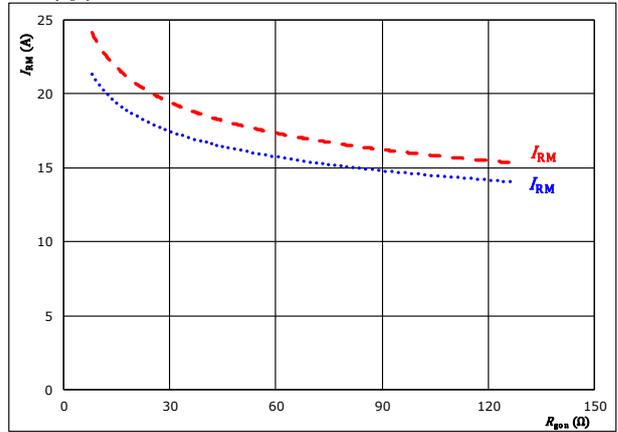


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω
 T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 12. FWD

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

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



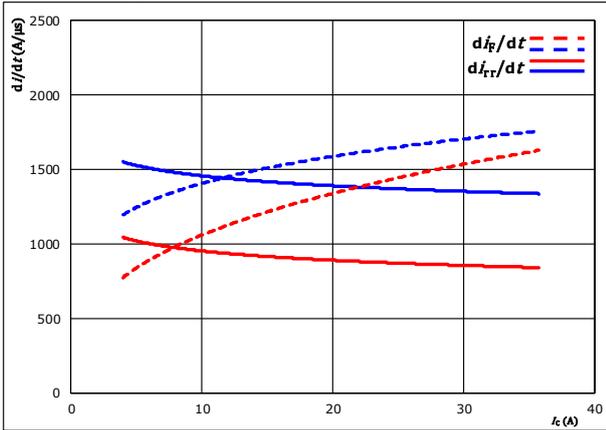
With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 20$ A
 T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)



Inverter Switching Characteristics

figure 13. FWD

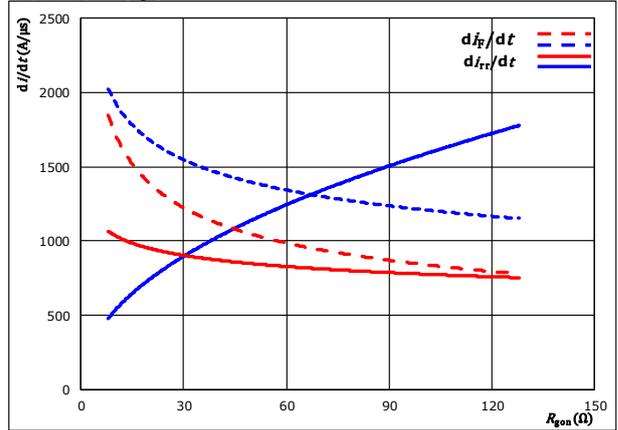
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_f/dt, di_{rr}/dt = f(I_c)$



With an inductive load at
 $V_{CE} = 300 \text{ V}$
 $V_{GE} = 0 / 15 \text{ V}$
 $R_{gon} = 16 \text{ } \Omega$
 $T_j: 25 \text{ } ^\circ\text{C}$
 $125 \text{ } ^\circ\text{C}$

figure 14. FWD

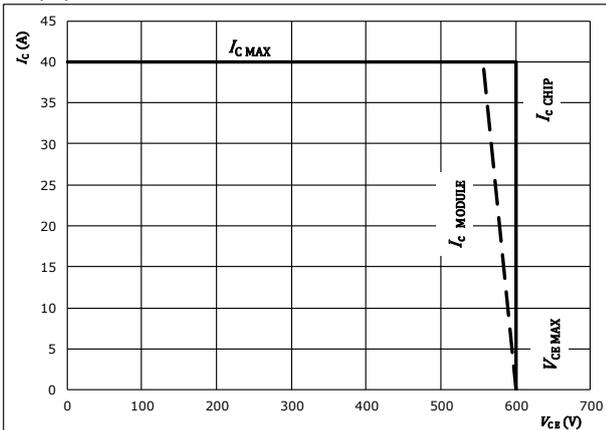
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $di_f/dt, di_{rr}/dt = f(R_{gon})$



With an inductive load at
 $V_{CE} = 300 \text{ V}$
 $V_{GE} = 0 / 15 \text{ V}$
 $I_c = 20 \text{ A}$
 $T_j: 25 \text{ } ^\circ\text{C}$
 $125 \text{ } ^\circ\text{C}$

figure 15. IGBT

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



At
 $T_j = 125 \text{ } ^\circ\text{C}$
 $R_{gon} = 16 \text{ } \Omega$
 $R_{goff} = 8 \text{ } \Omega$



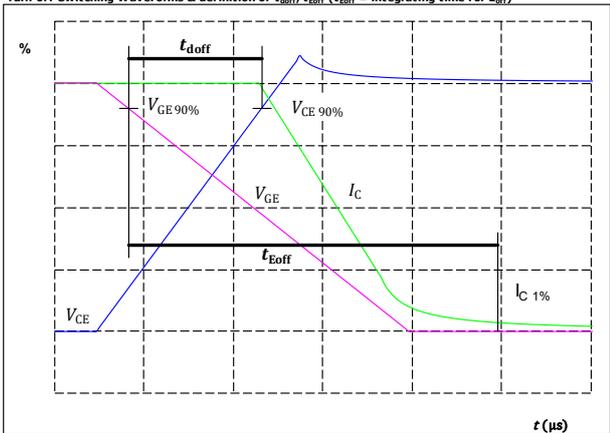
Inverter Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	16 Ω
R_{goff}	=	8 Ω

figure 1. IGBT

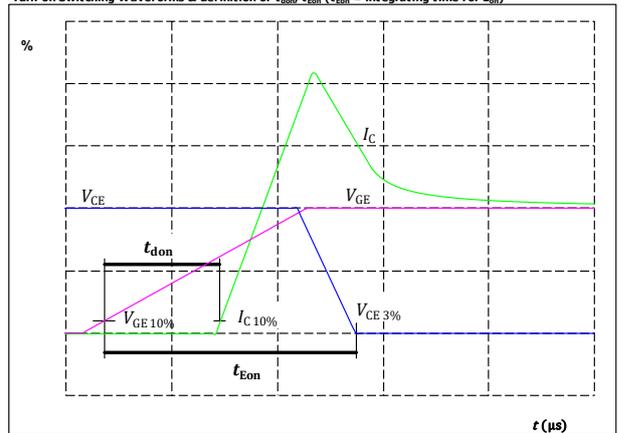
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{CE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	20	A
$t_{doff} =$	212	ns

figure 2. IGBT

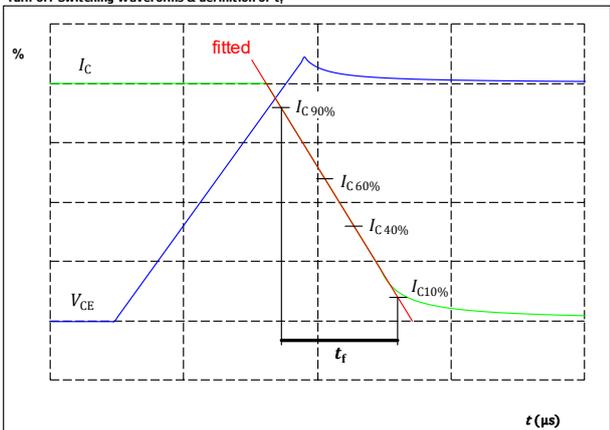
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{CE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	20	A
$t_{don} =$	14	ns

figure 3. IGBT

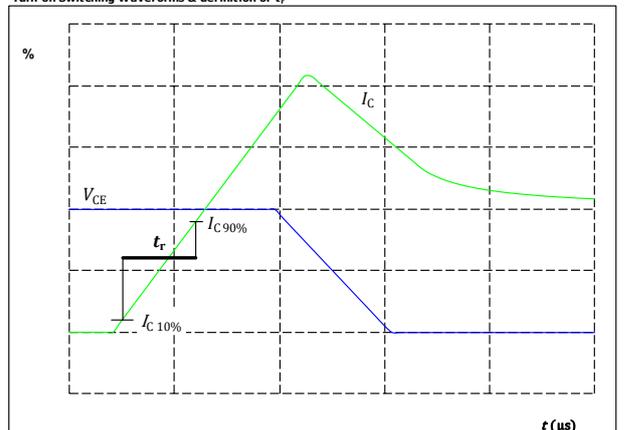
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) =$	300	V
$I_C(100\%) =$	20	A
$t_f =$	104	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r



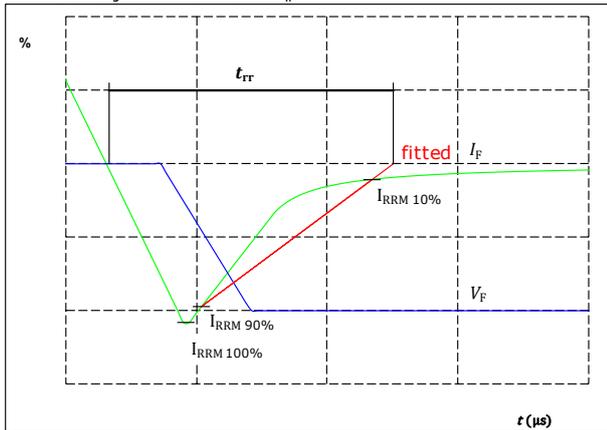
$V_C(100\%) =$	300	V
$I_C(100\%) =$	20	A
$t_r =$	16	ns



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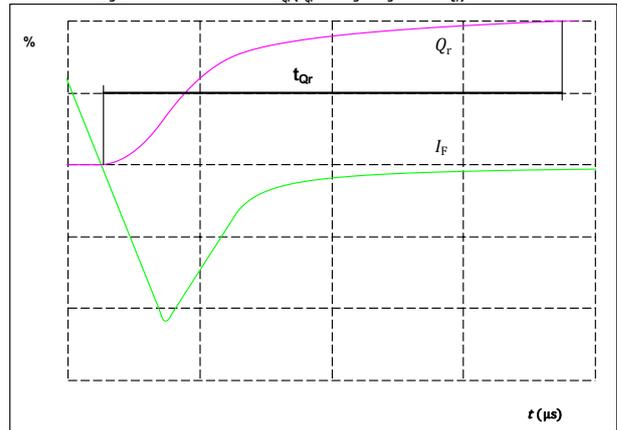
Inverter Switching Characteristics

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



$V_F(100\%) =$	300	V
$I_F(100\%) =$	20	A
$I_{RRM}(100\%) =$	21	A
$t_{rr} =$	192	ns

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



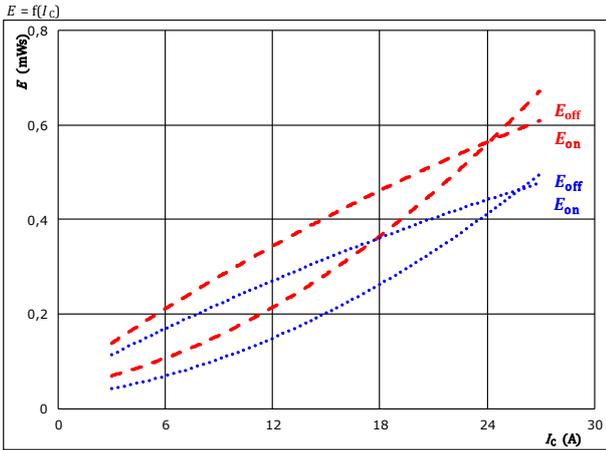
$I_F(100\%) =$	20	A
$Q_r(100\%) =$	1,35	μC



Brake Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

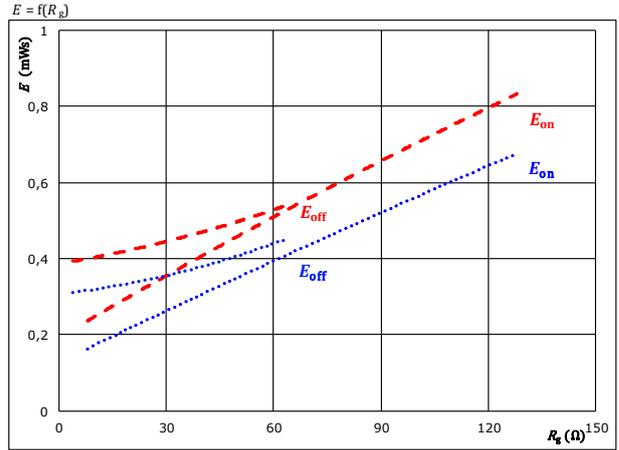


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω
 $R_{goff} = 8$ Ω

T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

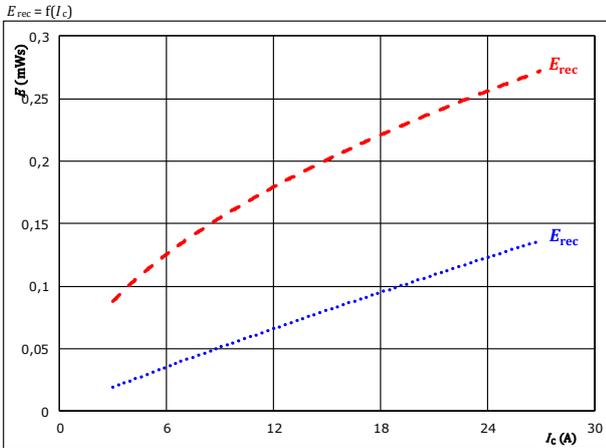


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 15$ A

T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

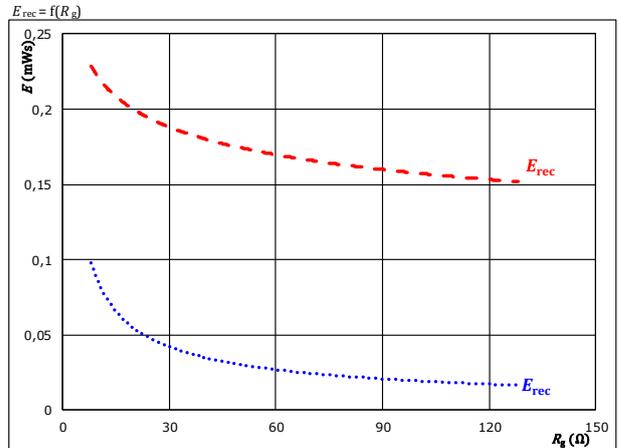


With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω

T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor



With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 15$ A

T_j : 25 °C (blue dotted line)
 125 °C (red dashed line)

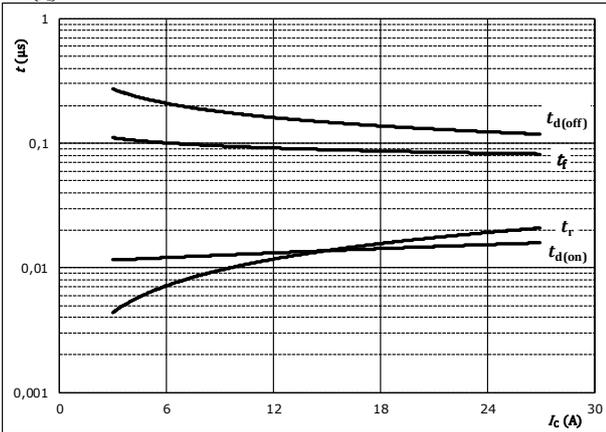


Brake Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



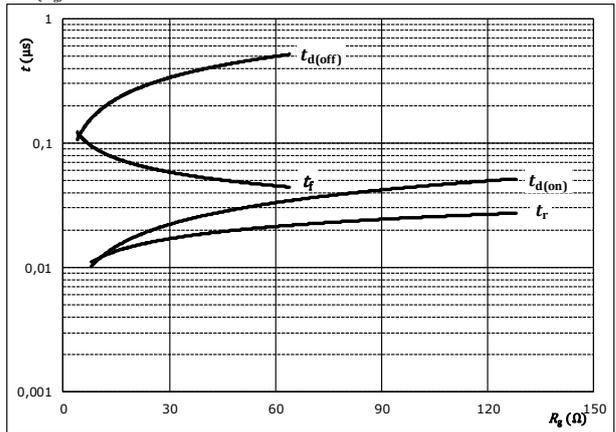
With an inductive load at

$T_j = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{g(on)} = 16$ Ω
 $R_{g(off)} = 8$ Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



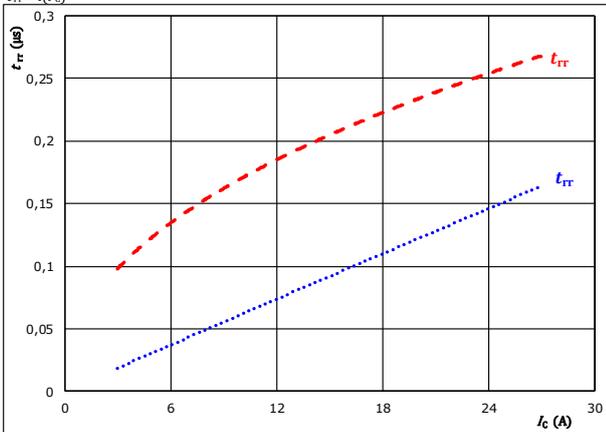
With an inductive load at

$T_j = 125$ °C
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ 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

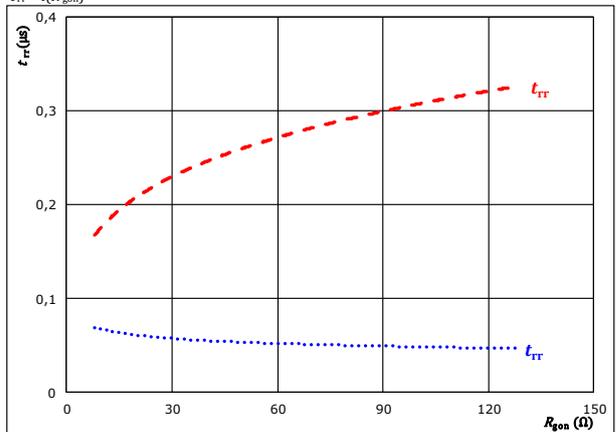
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{g(on)} = 16$ Ω

T_j : 25 °C (dotted blue)
 125 °C (dashed red)

figure 8. FWD

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

$$t_{rr} = f(R_{g(on)})$$



With an inductive load at

$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_C = 15$ A

T_j : 25 °C (dotted blue)
 125 °C (dashed red)

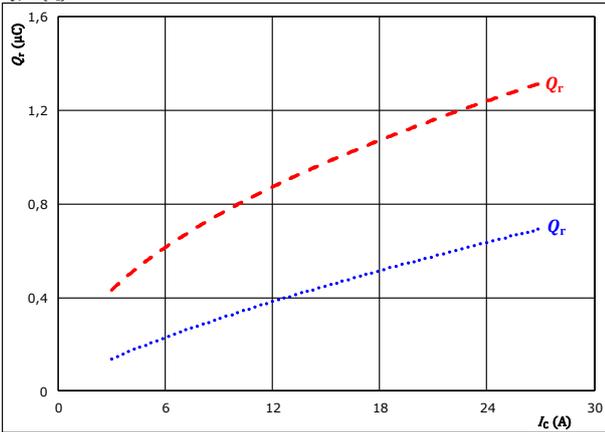


Brake Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

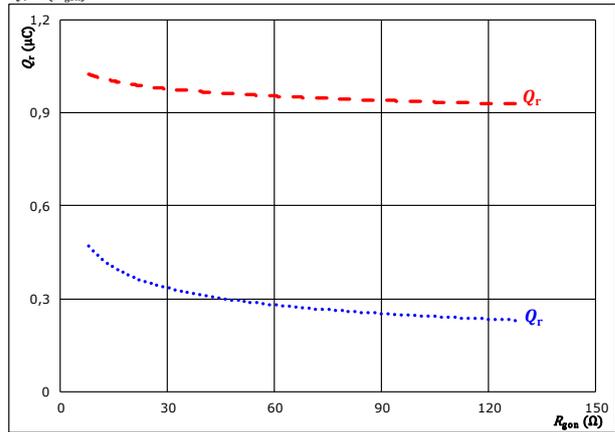
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω

T_j : 25 °C (blue dotted line)
125 °C (red dashed line)

figure 10. FWD

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

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



With an inductive load at

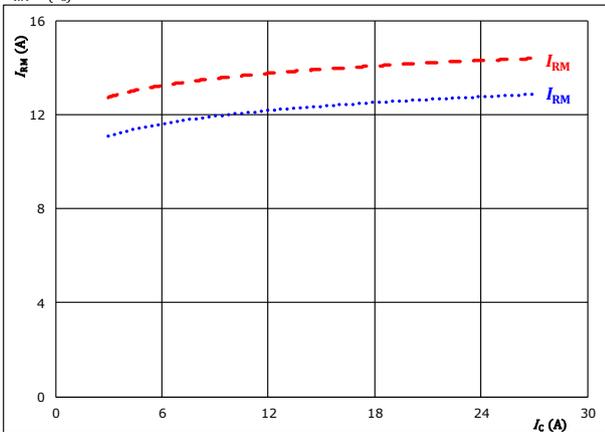
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 15$ A

T_j : 25 °C (blue dotted line)
125 °C (red dashed line)

figure 11. FWD

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

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



With an inductive load at

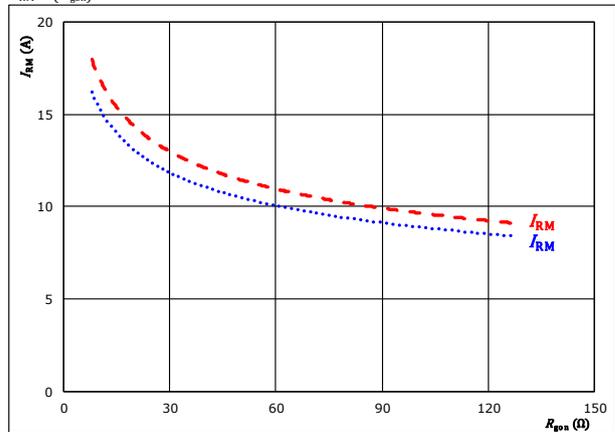
$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω

T_j : 25 °C (blue dotted line)
125 °C (red dashed line)

figure 12. FWD

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

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



With an inductive load at

$V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 15$ A

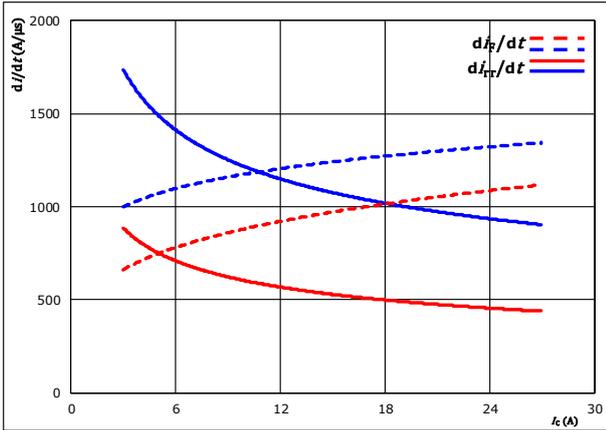
T_j : 25 °C (blue dotted line)
125 °C (red dashed line)



Brake Switching Characteristics

figure 13. FWD

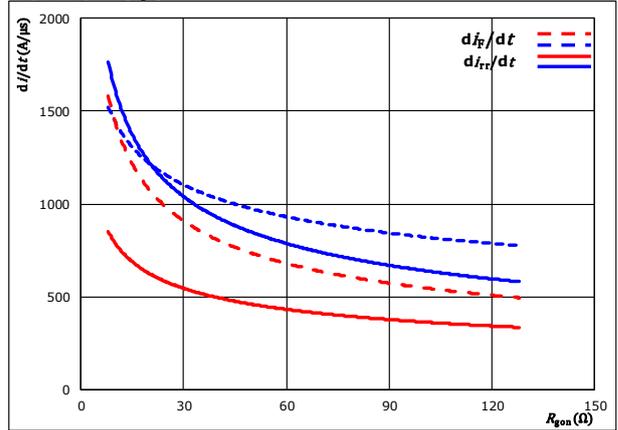
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_f/dt, di_{rr}/dt = f(I_c)$



With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $R_{gon} = 16$ Ω
 $T_j: 25$ °C
 125 °C

figure 14. FWD

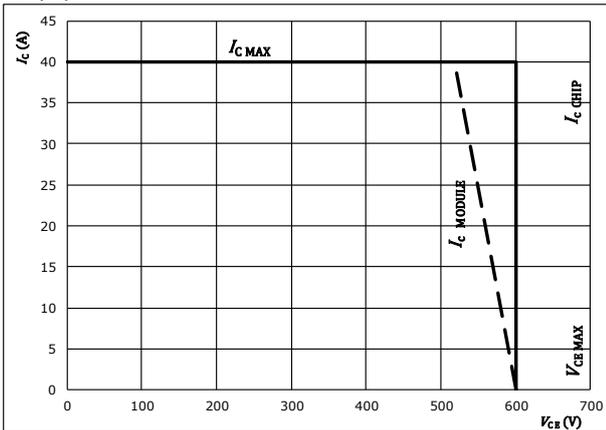
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $di_f/dt, di_{rr}/dt = f(R_{gon})$



With an inductive load at
 $V_{CE} = 300$ V
 $V_{GE} = 0 / 15$ V
 $I_c = 15$ A
 $T_j: 25$ °C
 125 °C

figure 15. IGBT

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



At
 $T_j = 125$ °C
 $R_{gon} = 16$ Ω
 $R_{goff} = 8$ Ω



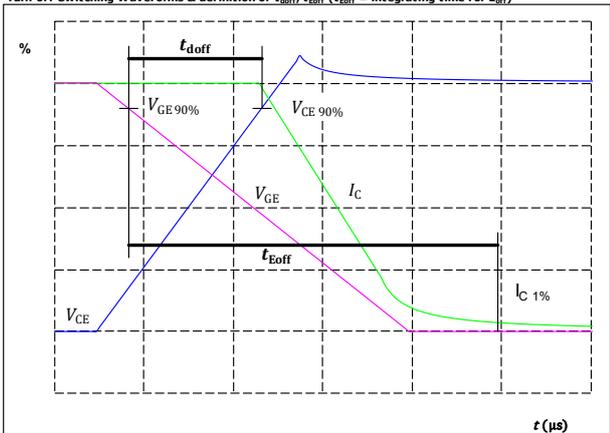
Brake Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	16 Ω
R_{goff}	=	8 Ω

figure 1. IGBT

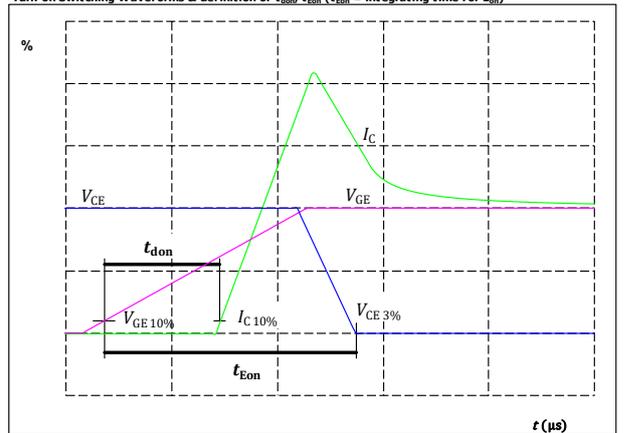
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{CE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	15	A
$t_{doff} =$	145	ns

figure 2. IGBT

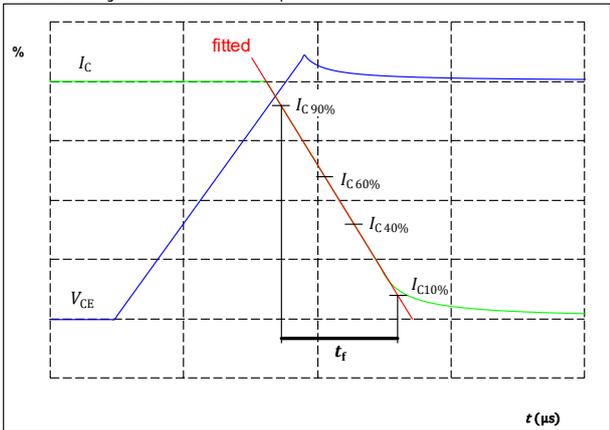
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{CE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	300	V
$I_C(100\%) =$	15	A
$t_{don} =$	14	ns

figure 3. IGBT

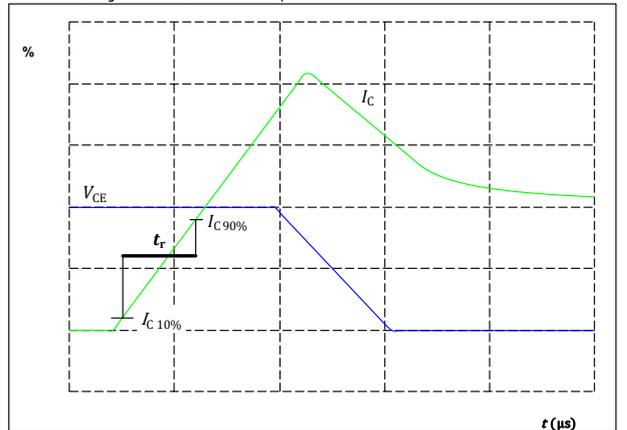
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) =$	300	V
$I_C(100\%) =$	15	A
$t_f =$	94	ns

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

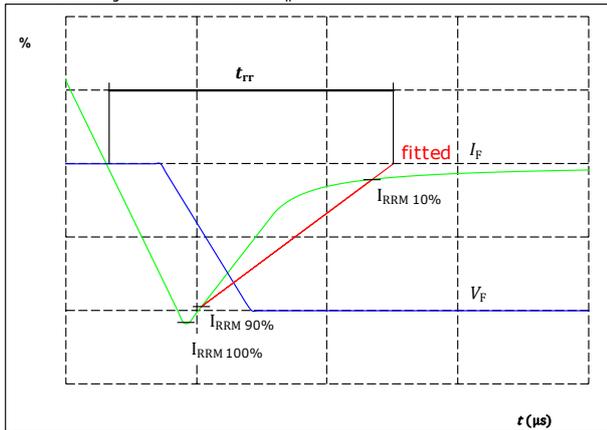


$V_C(100\%) =$	300	V
$I_C(100\%) =$	15	A
$t_r =$	14	ns



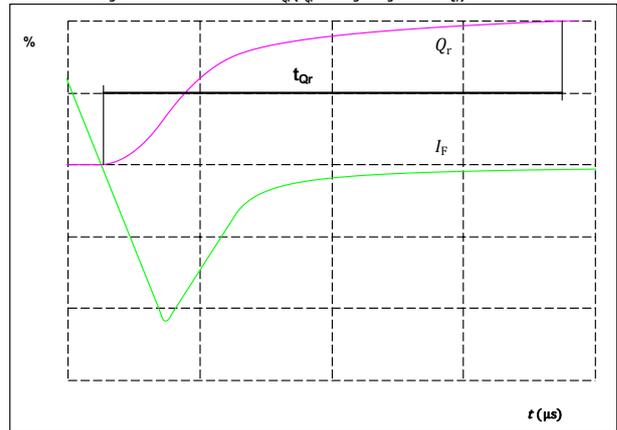
Brake Switching Characteristics

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



$V_F(100\%) =$	300	V
$I_F(100\%) =$	15	A
$I_{RRM}(100\%) =$	15	A
$t_{rr} =$	201	ns

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



$I_F(100\%) =$	15	A
$Q_r(100\%) =$	1,02	μC



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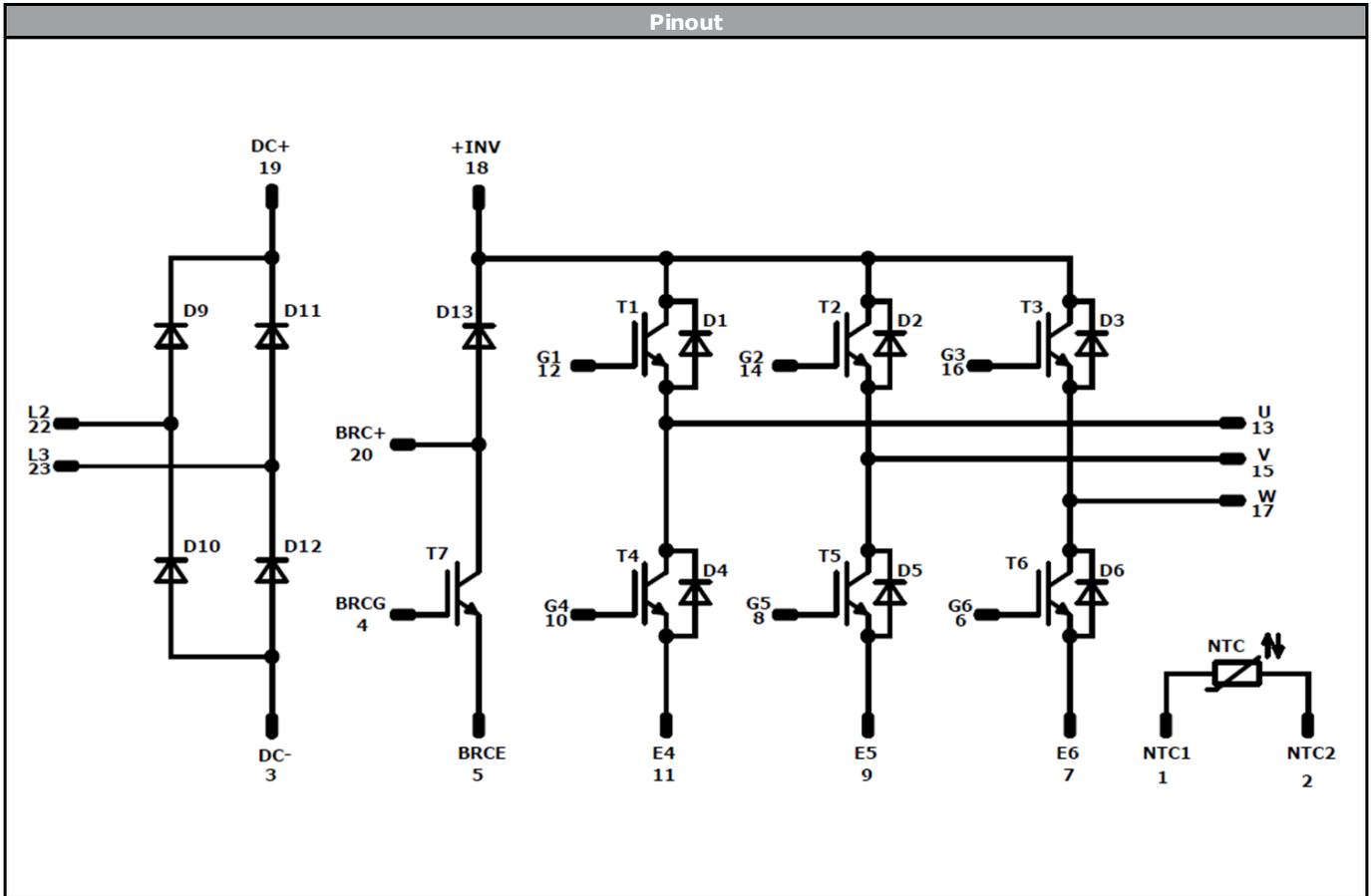
Ordering Code & Marking									
Version			Ordering Code						
without thermal paste			V23990-P545-B38-PM						
with thermal paste			V23990-P545-B38-/3/-PM						
VIN WWYY NNNNNNVV UL LLLLL SSSS			Text	VIN		Name&Ver	UL	Lot	Serial
				VIN		NNNNNNVV	UL	LLLLL	SSSS
			Datamatrix	Type&Ver	Lot number	Serial	Date code		
NNNNNNVV	LLLLL	SSSS		WWYY					

Pin table			
Pin	X	Y	Function
1	25,5	2,7	NTC1
2	25,5	0	NTC2
3	22,8	0	-DC
4	20,1	0	BRCG
5	16,2	0	BRCE
6	13,5	0	G6
7	10,8	0	E6
8	8,1	0	G5
9	5,4	0	E5
10	2,7	0	G4
11	0	0	E4
12	0	19,8	G1
13	0	22,5	U
14	7,5	19,8	G2
15	7,5	22,5	V
16	15	19,8	G3
17	15	22,5	W
18	22,8	22,5	+INV
19	25,5	22,5	+DC
20	33,5	22,5	BRC+
21	Not assembled		
22	33,5	7,5	L2
23	33,5	0	L3

Tolerance of pinpositions $\pm 0.5\text{mm}$ 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
T1, T2, T3, T4, T5, T6	IGBT	600 V	20 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	600 V	20 A	Inverter Diode	
T7	IGBT	600 V	15 A	Brake Switch	
D13	FWD	600 V	15 A	Brake Diode	
D9, D10, D11, D12	Rectifier	1600 V	35 A	Rectifier Diode	
NTC	Thermistor			Thermistor	



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Packaging instruction			
Standard packaging quantity (SPQ) 135	>SPQ	Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow 0</i> packages see vincotech.com website.

Package data
Package data for <i>flow 0</i> 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
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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.