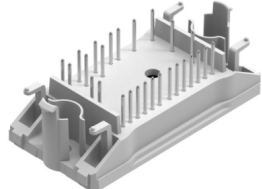

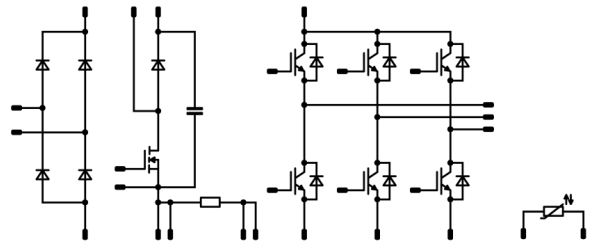




<i>flow PIM 0 + PFC</i>	600 V / 20 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Features</div> <ul style="list-style-type: none"> Clip in PCB mounting Trench Fieldstop IGBTs for low saturation losses Latest generation superjunction MOSFET for PFC 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><i>flow 0 17 mm housing</i></div> <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around; font-size: small;"> Solder pin Press-fit pin </div>
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Target applications</div> <ul style="list-style-type: none"> Embedded Drives Industrial Drives 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Schematic</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Types</div> <ul style="list-style-type: none"> 10-F006PPA020SB-M685B 10-P006PPA020SB-M685BY 	

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		1600	V
Continuous (direct) forward current	I_F		25	A
Surge (non-repetitive) forward current	I_{FSM}	50 Hz Single Half Sine Wave $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	200	A
Surge current capability	I_{Pt}		200	A^2s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	43	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}C$



Vincotech

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
PFC Switch				
Drain-source voltage	V_{DS}		600	V
Drain current	I_D		23	A
Peak drain current	I_{Dpulse}	t_p limited by T_{jmax}	159	A
Avalanche energy, single pulse	E_{AS}	$I_D = 9,3\text{ A}$ $V_{DD} = 50\text{ V}$	1135	mJ
Avalanche energy, repetitive	E_{AR}	$I_D = 9,3\text{ A}$ $V_{DD} = 50\text{ V}$	1,7	mJ
Avalanche current, repetitive	I_{AR}	t_p limited by T_{jmax} $P_{AV} = E_{AR} * f$	9,3	A
MOSFET dv/dt ruggedness	dv/dt	$V_{DS} = 0-480V$	50	V/ns
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	90	W
Gate-source voltage	V_{GS}		±20	V
Reverse diode dv/dt	dv/dt	$V_{DS} = 0-480V$	15	V/ns
Maximum Junction Temperature	T_{jmax}		150	°C

PFC Diode

Peak Repetitive Reverse Voltage	V_{RRM}		600	V
Continuous (direct) forward current	I_F		30	A
Surge (non-repetitive) forward current	I_{FSM}	60 Hz Single Half Sine Wave $t_p = 8,3\text{ ms}$	300	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	66	W
Maximum Junction Temperature	T_{jmax}		175	°C

Capacitor (PFC)

Maximum DC voltage	V_{MAX}		500	V
Operation Temperature	T_{op}		-55...+125	°C

PFC Shunt

DC forward current	I_F	terminal temperature $T_c \leq 90\text{ °C}$	22	A
Power dissipation	P_{tot}	terminal temperature $T_c \leq 90\text{ °C}$	5	W



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		20	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	53	W
Gate-emitter voltage	V_{GES}		± 20	V
Short circuit ratings	t_{SC}	$T_j \leq 150\text{ °C}$	6	μs
	V_{CC}	$V_{GE} = 15\text{V}$	360	V
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Inverter Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		600	V
Continuous (direct) forward current	I_F		30	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	61	W
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Module Properties

Thermal Properties				
Storage temperature	T_{stg}		-40...+125	$^{\circ}\text{C}$
Operation temperature under switching condition	T_{jop}		-40...($T_{jmax} - 25$)	$^{\circ}\text{C}$

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			min. 12,7	mm
Comparative Tracking Index	CTI		> 200	

*100 % tested in production



Characteristic Values

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

Rectifier Diode

Static

Forward voltage	V_F				25	25 125		1,22 1,21	1,75	V
Reverse leakage current	I_r			1600		25 145			50 1100	μA

Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,64		K/W
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Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
		V_{GS} [V]	V_{GE} [V] V_{GS} [V]	V_{DS} [V] V_F [V]	I_C [A] I_D [A] I_F [A]	T_j [°C]	Min	Typ	Max	
PFC Switch										
Static										
Drain-source on-state resistance	$r_{DS(on)}$		10		26	25 125		70 150	80	mΩ
Gate-source threshold voltage	$V_{GS(th)}$	$V_{GS} = V_{DS}$			0,00172	25	2,4	3	3,6	V
Gate to Source Leakage Current	I_{GSS}		20	0		25			100	nA
Zero Gate Voltage Drain Current	I_{DSS}		0	600		25			5	μA
Internal gate resistance	r_g	$f = 1\text{MHz}$	0	100		25		0,85		Ω
Gate charge	Q_g							170		nC
Gate to source charge	Q_{GS}		0/10	480	25,8	25		21		
Gate to drain charge	Q_{GD}							87		
Short-circuit input capacitance	C_{iss}							3800		pF
Short-circuit output capacitance	C_{oss}	$f = 1\text{MHz}$	0	100		25		215		
Reverse transfer capacitance	C_{rss}							35		
Thermal										
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4\text{ W/mK}$ (PSX)						0,78		K/W
Dynamic										
Turn-on delay time	$t_{d(on)}$					25 125 150		38 44 25		ns
Rise time	t_r	$R_{goff} = 8\ \Omega$ $R_{gon} = 8\ \Omega$				25 125 150		5 6 7		
Turn-off delay time	$t_{d(off)}$		10/-5	400	15	25 125 150		130 136 250		
Fall time	t_f					25 125 150		11 14 5		
Turn-on energy (per pulse)	E_{on}	$Q_{tFWD} = 0,3\ \mu\text{C}$ $Q_{tFWD} = 0,6\ \mu\text{C}$ $Q_{tFWD} = 0,8\ \mu\text{C}$				25 125 150		0,136 0,208 0,345		
Turn-off energy (per pulse)	E_{off}					25 125 150		0,042 0,053 0,120		mWs



Characteristic Values

Parameter	Symbol	Conditions					Value			Unit	
		V_{GE} [V]	V_{CE} [V]	I_C [A]	T_j [°C]	Min	Typ	Max			
PFC Diode											
Static											
Forward voltage	V_F			30	25 125 150		2,26 1,67 1,55	2,78		V	
Reverse leakage current	I_r		600		25			10		μA	
Thermal											
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK (PSX)}$						1,43			K/W
Dynamic											
Peak recovery current	I_{RRM}				25 125 150		29 43 45			A	
Reverse recovery time	t_{rr}				25 125 150		14 25 30			ns	
Recovered charge	Q_r	$di/dt = 2946 \text{ A/}\mu\text{s}$ $di/dt = 2625 \text{ A/}\mu\text{s}$ $di/dt = 2104 \text{ A/}\mu\text{s}$	10/-5	400	15	25 125 150	0,253 0,585 0,787			μC	
Reverse recovered energy	E_{rec}				25 125 150		0,046 0,185 0,125			mWs	
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$				25 125 150		8586 6089 4643			A/μs	
Capacitor (PFC)											
Capacitance	C						100			nF	
Tolerance							-10	+10		%	
PFC Shunt											
Resistance	R						10			mΩ	
Temperature coefficient	t_c				20 - 60			30		ppm/K	
Internal heat resistance	R_{thi}							10		K/W	



Characteristic Values

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

Inverter Switch

Static

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
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	1,52 1,75	1,9	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

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)							1,81		K/W

Dynamic

Parameter	Symbol	Conditions	V_{GS} [V]	V_{GE} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 16$ Ω $R_{gon} = 16$ Ω	±15	400	15			25	66		ns
Rise time	t_r							125	65		
Turn-off delay time	$t_{d(off)}$							25	20		
Fall time	t_f							125	21		
Turn-on energy (per pulse)	E_{on}	$Q_{rFWD} = 0,9$ μC $Q_{rFWD} = 1,8$ μC						25	0,450		mWs
Turn-off energy (per pulse)	E_{off}							125	0,667		
								25	0,385		
								125	0,523		



Characteristic Values

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

Inverter Diode

Static

Parameter	Symbol	V_{GS} [V]	V_{DS} [V]	I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Forward voltage	V_F			30	25 125		1,65 1,62	1,95	V
Reverse leakage current	I_r		600		25			200	μA

Thermal

Parameter	Symbol	Conditions	Value	Unit
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)	1,56	K/W

Dynamic

Parameter	Symbol	dI/dt	I_C	I_D	T_j [°C]	Min	Typ	Max	Unit
Peak recovery current	I_{RRM}	$dI/dt = 731$ A/μs $dI/dt = 708$ A/μs	±15	400	15	25	10		A
Reverse recovery time	t_{rr}					125	14		ns
Recovered charge	Q_r					25	0,883		μC
Reverse recovered energy	E_{rec}					125	1,790		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25	36		A/μs
		125	85						

Thermistor

Parameter	Symbol	Conditions	T_j [°C]	Min	Typ	Max	Unit
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	



Rectifier Diode Characteristics

figure 1. Rectifier
 Typical forward characteristics

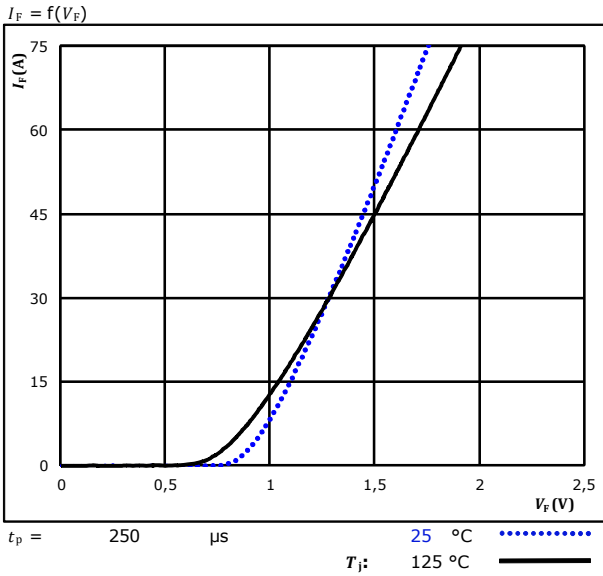
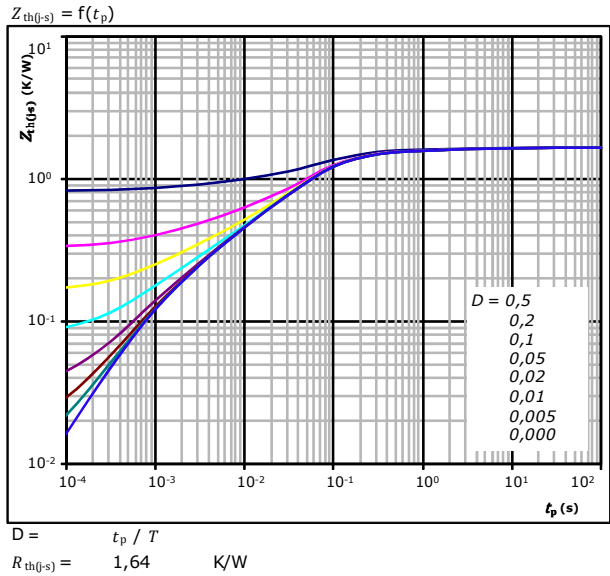


figure 2. Rectifier
 Transient thermal impedance as a function of pulse width



Diode thermal model values

R (K/W)	τ (s)
4,73E-02	6,99E+00
1,06E-01	9,98E-01
4,37E-01	1,30E-01
7,47E-01	4,61E-02
2,09E-01	5,25E-03
9,49E-02	8,85E-04
9,49E-02	8,85E-04

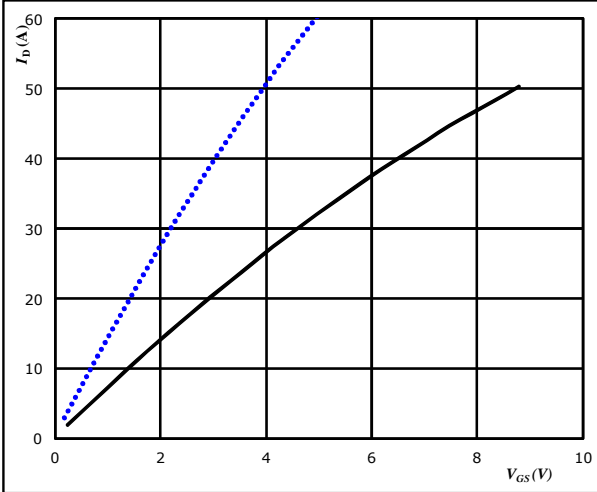


PFC Switch Characteristics

figure 1. MOSFET

Typical output characteristics

$I_D = f(V_{DS})$

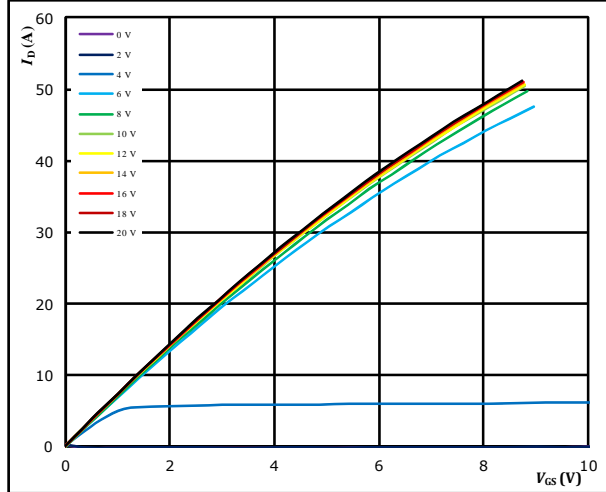


$t_p = 250 \mu s$ $25 \text{ }^\circ C$
 $V_{GS} = 10 \text{ V}$ $T_j: 125 \text{ }^\circ C$ ———

figure 2. MOSFET

Typical output characteristics

$I_D = f(V_{DS})$

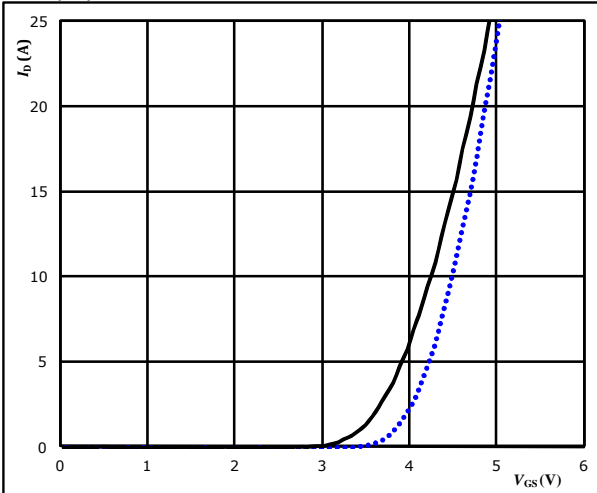


$t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GS} from 0 V to 20 V in steps of 2 V

figure 2. MOSFET

Typical transfer characteristics

$I_D = f(V_{DS})$

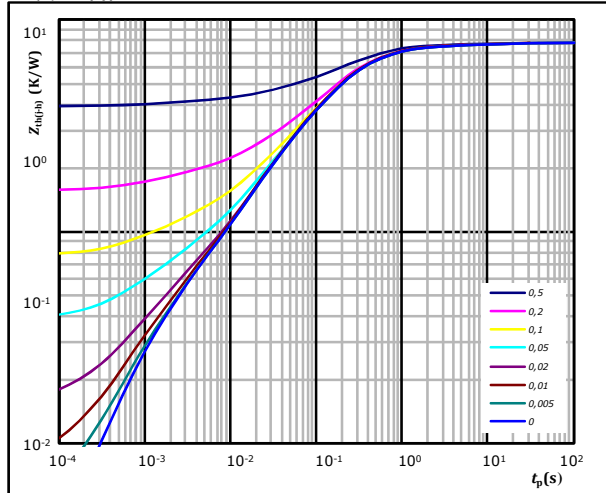


$t_p = 100 \mu s$ $25 \text{ }^\circ C$
 $V_{DS} = 10 \text{ V}$ $T_j: 125 \text{ }^\circ C$ ———

figure 4. MOSFET

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 0,78 \text{ K/W}$

R (K/W)	Tau (s)
2,79E-02	1,48E+01
9,18E-02	1,22E+00
4,16E-01	2,24E-01
1,49E-01	5,85E-02
6,36E-02	1,29E-02
3,14E-02	1,19E-03

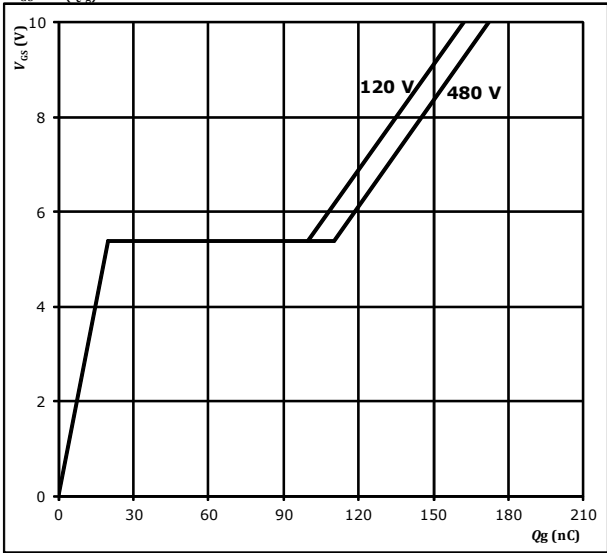


PFC Switch Characteristics

figure 5. MOSFET

Gate voltage vs Gate charge

$V_{GS} = f(Q_g)$



At

$I_D = 26$ A

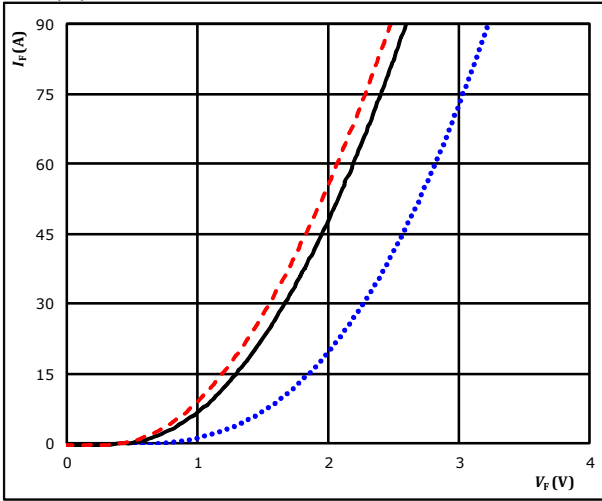


PFC Diode Characteristics

figure 1. FWD

Typical forward characteristics

$$I_F = f(V_F)$$



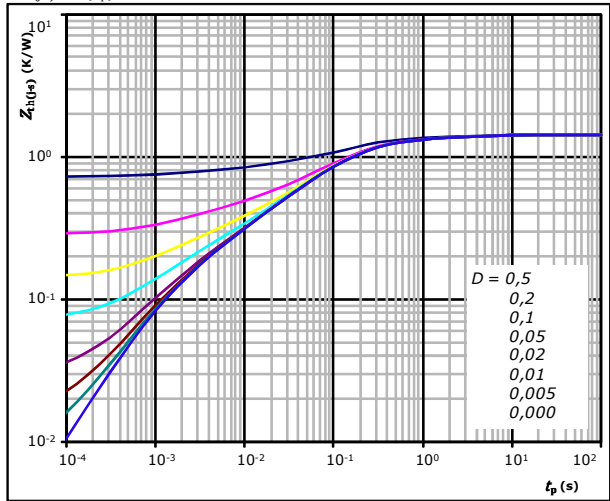
$t_p = 250 \mu\text{s}$

T_j : 25 °C (blue dotted line)
 125 °C (black solid line)
 150 °C (red dashed line)

figure 2. FWD

Transient thermal impedance as a function of pulse width

$$Z_{th(0-s)} = f(t_p)$$



$D = t_p / T$

$R_{th(0-s)} = 1,43 \text{ K/W}$

FWD thermal model values

R (K/W)	τ (s)
1,15E-01	3,33E+00
3,20E-01	3,63E-01
6,97E-01	8,76E-02
2,02E-01	9,87E-03
1,00E-01	1,27E-03

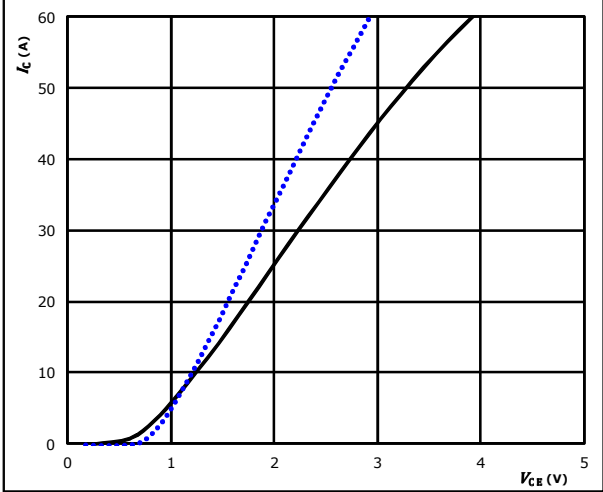


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

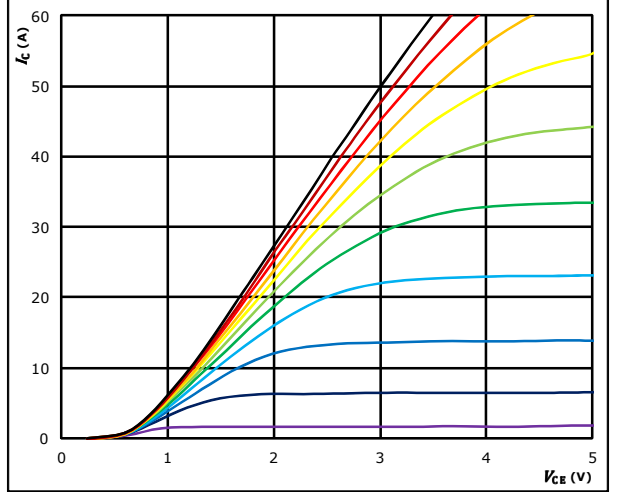


$t_p = 250 \mu s$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{GE} = 15 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 2. IGBT

Typical output characteristics

$I_C = f(V_{CE})$

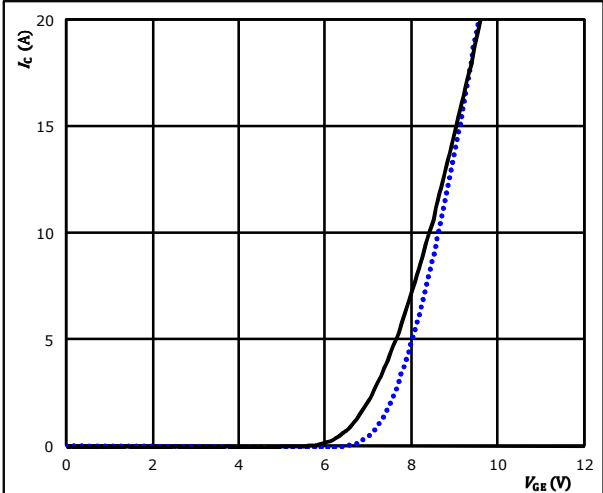


$t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

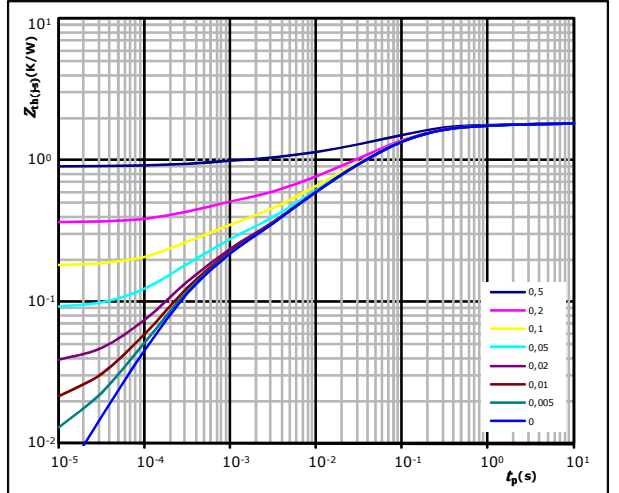


$t_p = 100 \mu s$ $T_j: 25 \text{ }^\circ\text{C}$ (dotted blue line)
 $V_{CE} = 10 \text{ V}$ $125 \text{ }^\circ\text{C}$ (solid black line)

figure 4. IGBT

Transient Thermal Impedance as function of Pulse duration

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



$D = t_p / T$
 $R_{th(j-s)} = 1,81 \text{ K/W}$
 IGBT thermal model values

$R \text{ (K/W)}$	$\tau \text{ (s)}$
6,63E-02	3,68E+00
1,83E-01	4,61E-01
8,24E-01	8,38E-02
3,93E-01	1,82E-02
1,96E-01	3,57E-03
1,49E-01	3,52E-04

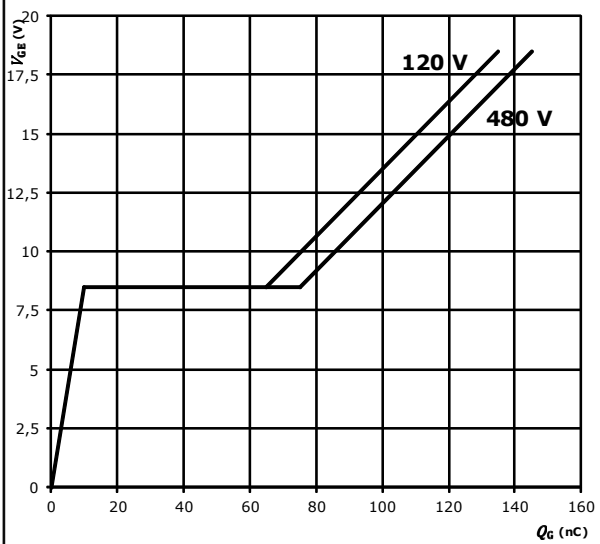


Inverter Switch Characteristics

figure 5. IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_G)$

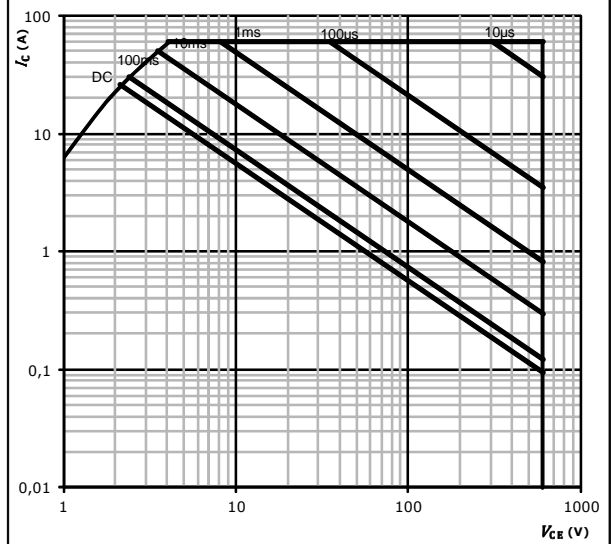


At
 $I_C = 20$ A

figure 6. IGBT

Safe operating area

$I_C = f(V_{CE})$

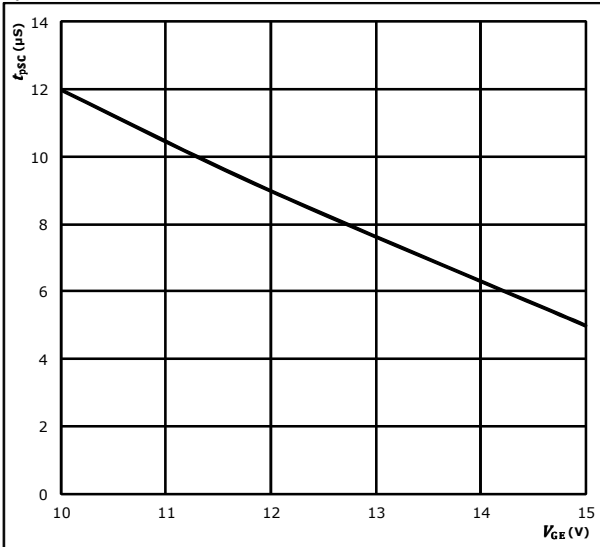


At
 $D =$ single pulse
 $T_s = 80$ °C
 $V_{GE} = \pm 15$ V
 $T_j = T_{jmax}$

figure 7. IGBT

Short circuit duration as a function of VGE

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

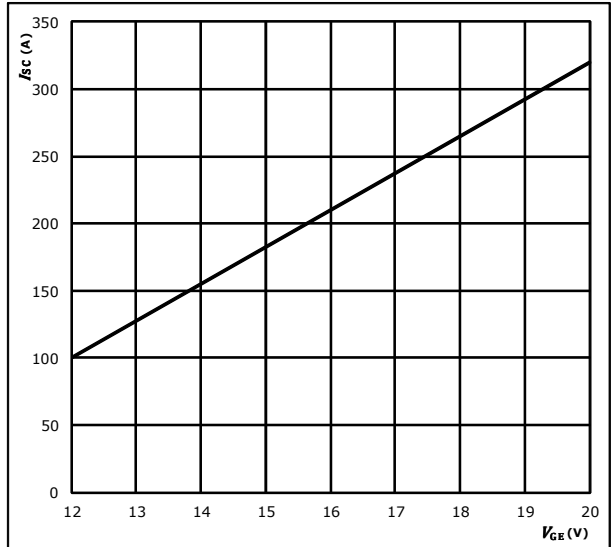


At
 $V_{CE} = 600$ V
 $T_j \leq 175$ °C

figure 8. IGBT

Typical short circuit current as a function of VGE

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



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



Inverter Diode Characteristics

figure 1. FWD
 Typical forward characteristics

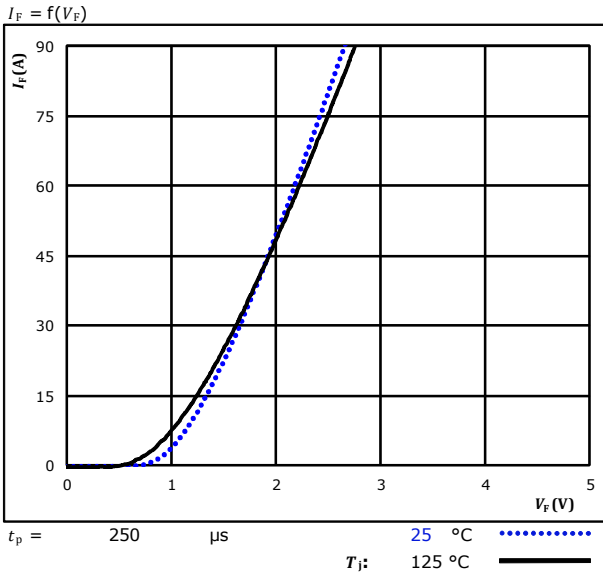
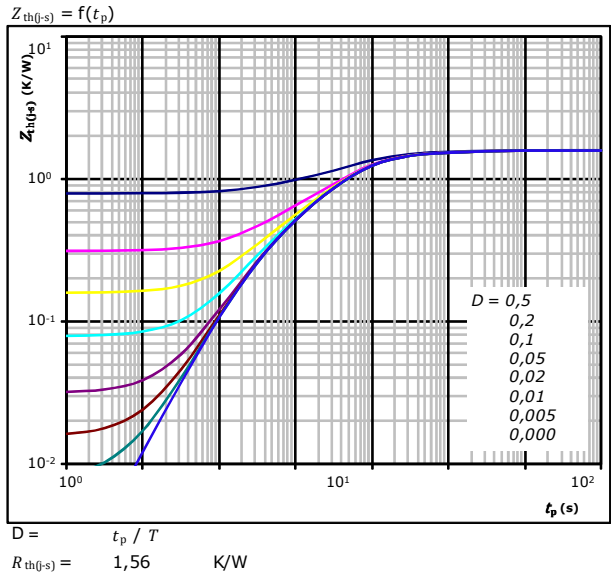


figure 2. FWD
 Transient thermal impedance as a function of pulse width



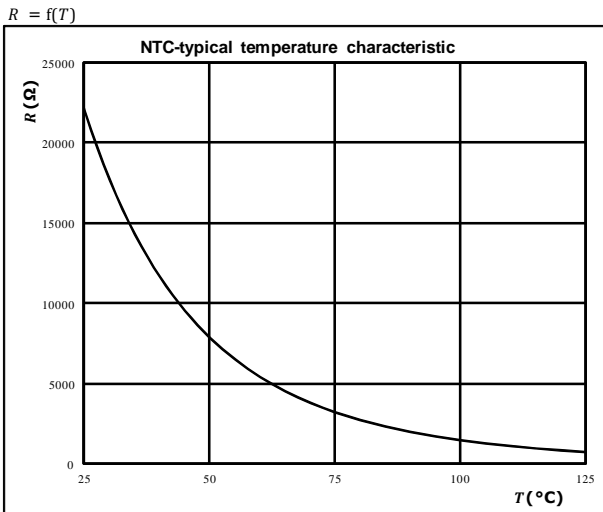
FWD thermal model values

R (K/W)	τ (s)
$9,10E-02$	$2,00E+00$
$3,45E-01$	$1,68E-01$
$7,17E-01$	$4,13E-02$
$2,97E-01$	$7,43E-03$
$1,15E-01$	$1,80E-03$



Thermistor Characteristics

figure 1. Thermistor
Typical NTC characteristic as a function of temperature





PFC Switching Characteristics

figure 1. MOSFET

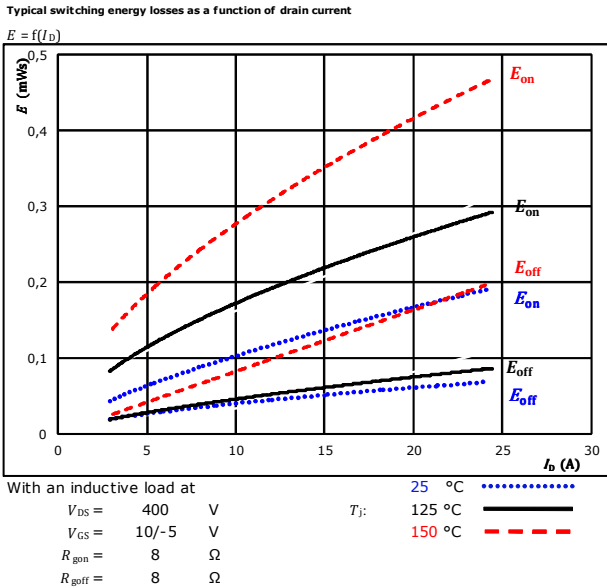


figure 2. MOSFET

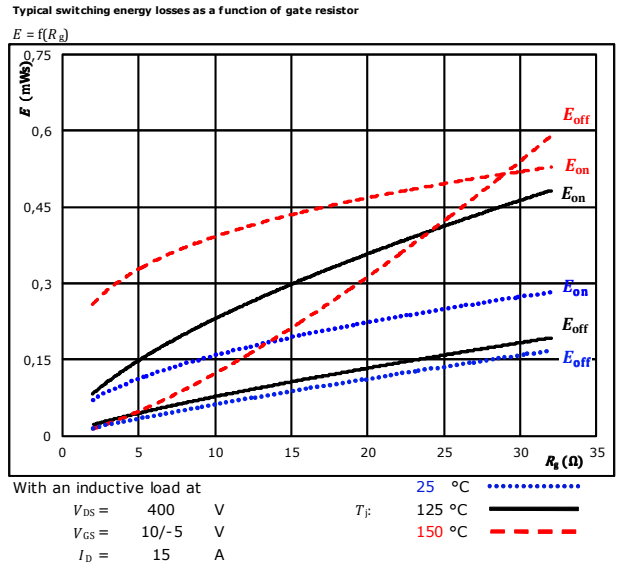


figure 3. FWD

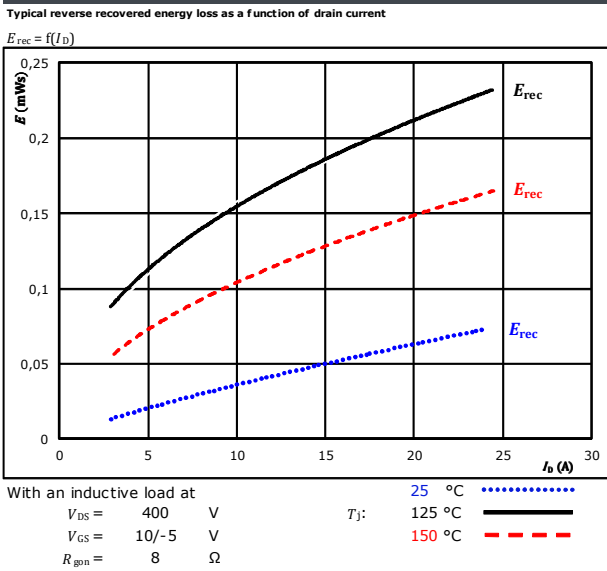
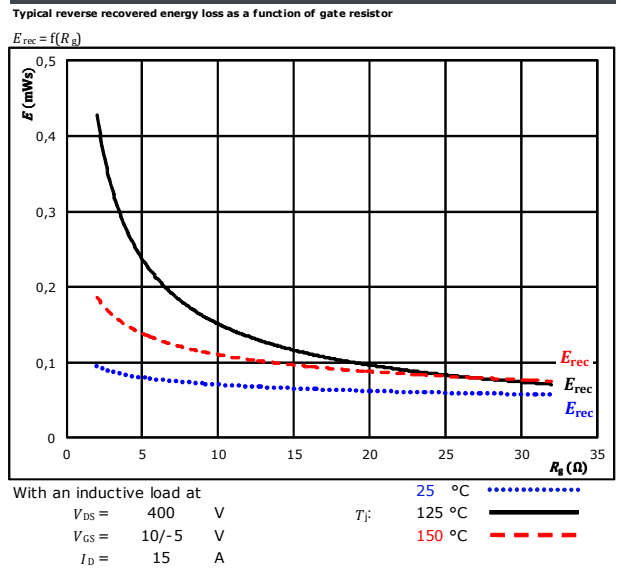


figure 4. FWD



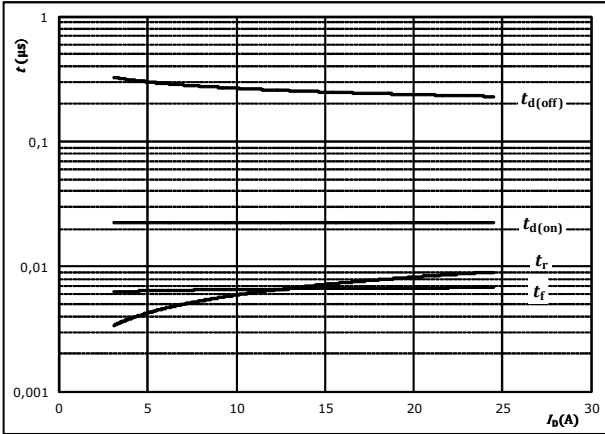


PFC Switching Characteristics

figure 5. MOSFET

Typical switching times as a function of drain current

$$t = f(I_D)$$



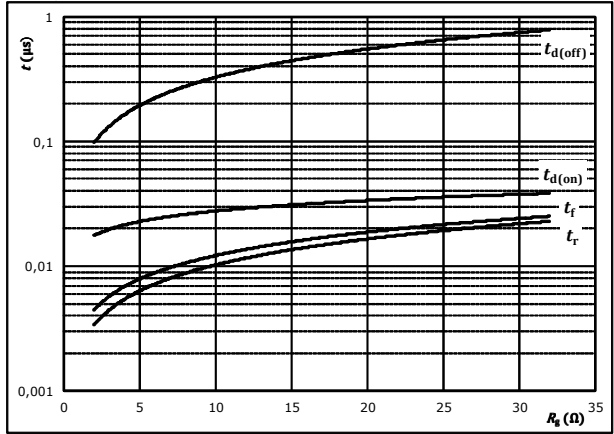
With an inductive load at

$T_J = 150 \text{ } ^\circ\text{C}$
 $V_{DS} = 400 \text{ V}$
 $V_{GS} = 10/-5 \text{ V}$
 $R_{g(on)} = 8 \text{ } \Omega$
 $R_{g(off)} = 8 \text{ } \Omega$

figure 6. MOSFET

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



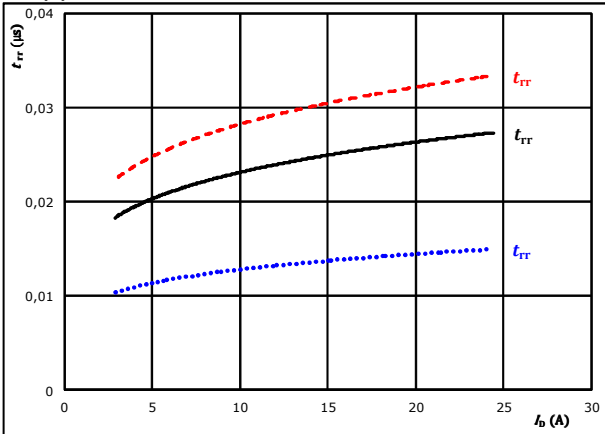
With an inductive load at

$T_J = 150 \text{ } ^\circ\text{C}$
 $V_{DS} = 400 \text{ V}$
 $V_{GS} = 10/-5 \text{ V}$
 $I_D = 15 \text{ A}$

figure 7. FWD

Typical reverse recovery time as a function of drain current

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

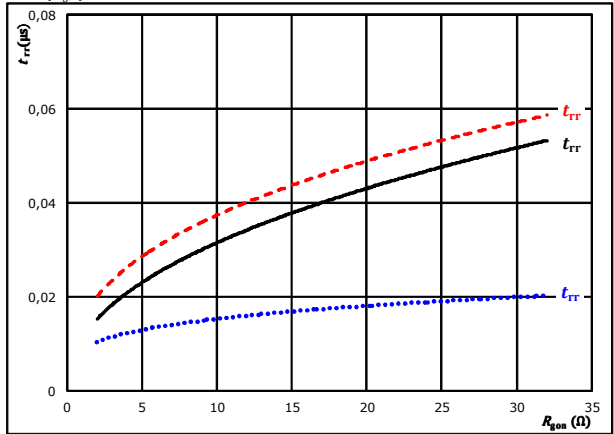


At $V_{DS} = 400 \text{ V}$
 $V_{GS} = 10/-5 \text{ V}$
 $R_{g(on)} = 8 \text{ } \Omega$
 $T_J: 25 \text{ } ^\circ\text{C}$ (dotted blue)
 $125 \text{ } ^\circ\text{C}$ (solid black)
 $150 \text{ } ^\circ\text{C}$ (dashed red)

figure 8. FWD

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

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



At $V_{DS} = 400 \text{ V}$
 $V_{GS} = 10/-5 \text{ V}$
 $I_D = 15 \text{ A}$
 $T_J: 25 \text{ } ^\circ\text{C}$ (dotted blue)
 $125 \text{ } ^\circ\text{C}$ (solid black)
 $150 \text{ } ^\circ\text{C}$ (dashed red)

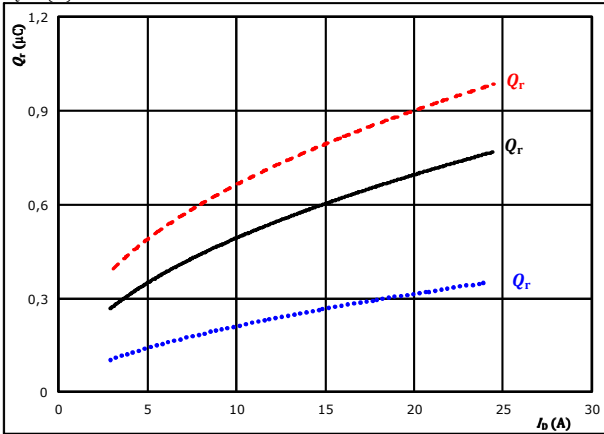


PFC Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of drain current

$$Q_r = f(I_D)$$

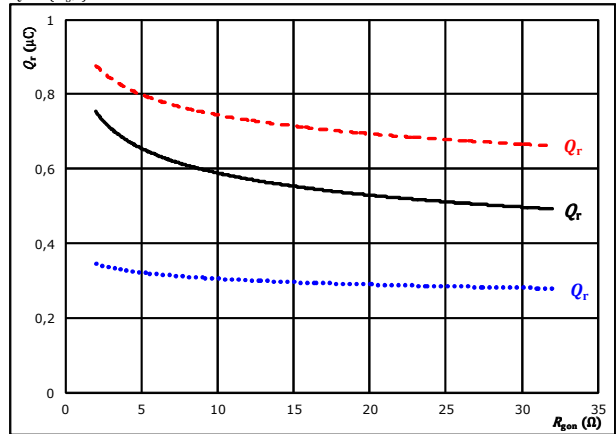


At $V_{DS} = 400$ V $T_j: 25$ °C
 $V_{GS} = 10/-5$ V $T_j: 125$ °C ———
 $R_{gson} = 8$ Ω $T_j: 150$ °C - - - - -

figure 10. FWD

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

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

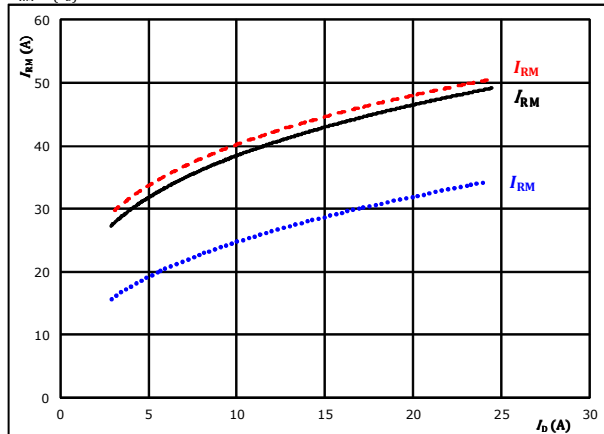


At $V_{DS} = 400$ V $T_j: 25$ °C
 $V_{GS} = 10/-5$ V $T_j: 125$ °C ———
 $I_D = 15$ A $T_j: 150$ °C - - - - -

figure 11. FWD

Typical peak reverse recovery current as a function of drain current

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

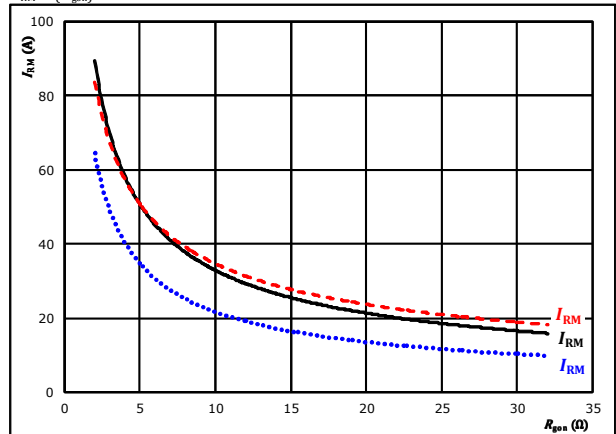


At $V_{DS} = 400$ V $T_j: 25$ °C
 $V_{GS} = 10/-5$ V $T_j: 125$ °C ———
 $R_{gson} = 8$ Ω $T_j: 150$ °C - - - - -

figure 12. FWD

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

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



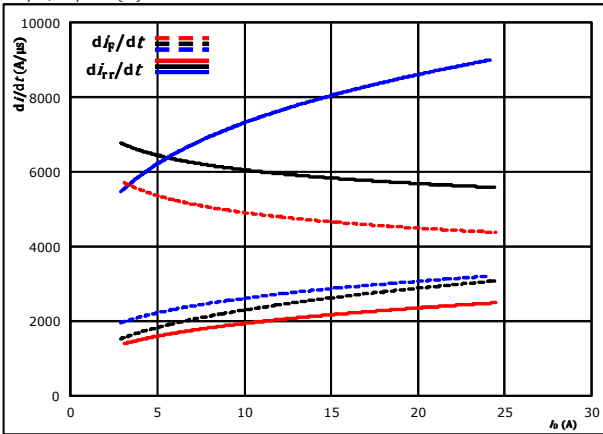
At $V_{DS} = 400$ V $T_j: 25$ °C
 $V_{GS} = 10/-5$ V $T_j: 125$ °C ———
 $I_D = 15$ A $T_j: 150$ °C - - - - -



PFC Switching Characteristics

figure 13. FWD

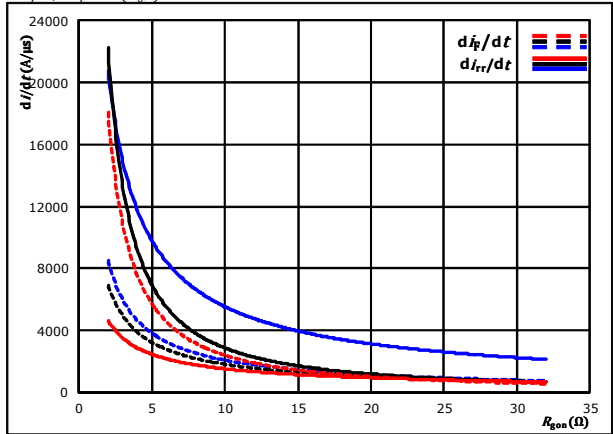
Typical rate of fall of forward and reverse recovery current as a function of drain current
 $di_f/dt, di_{rr}/dt = f(I_D)$



At $V_{DS} = 400$ V $T_j = 25$ °C
 $V_{GS} = 10/-5$ V $T_j = 125$ °C ———
 $R_{gon} = 8$ Ω $T_j = 150$ °C - - - - -

figure 14. FWD

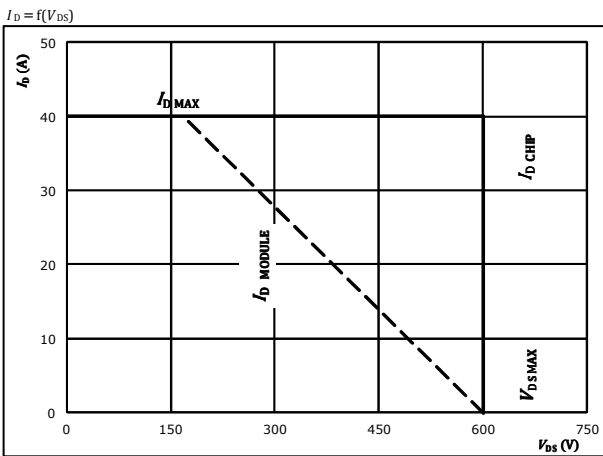
Typical rate of fall of forward and reverse recovery current as a function of MOSFET turn on gate resistor
 $di_f/dt, di_{rr}/dt = f(R_{gon})$



At $V_{DS} = 400$ V $T_j = 25$ °C
 $V_{GS} = 10/-5$ V $T_j = 125$ °C ———
 $I_D = 15$ A $T_j = 150$ °C - - - - -

figure 15. MOSFET

Reverse bias safe operating area



At $T_j = 150$ °C
 $R_{gon} = 8$ Ω
 $R_{goff} = 8$ Ω



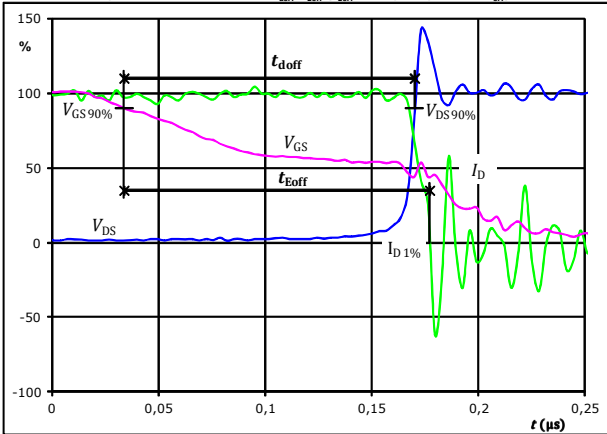
PFC Switching Definitions

General conditions

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

figure 1. MOSFET

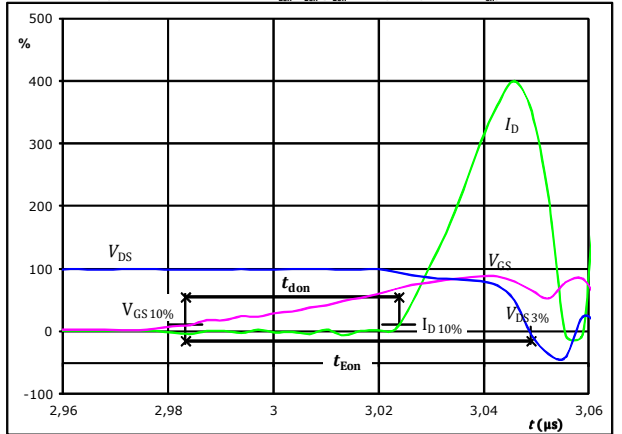
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



$V_{GS}(0\%) =$	10	V
$V_{GS}(100\%) =$	-5	V
$V_{DS}(100\%) =$	400	V
$I_D(100\%) =$	15	A
$t_{doff} =$	0,136	μs
$t_{Eoff} =$	0,143	μs

figure 2. MOSFET

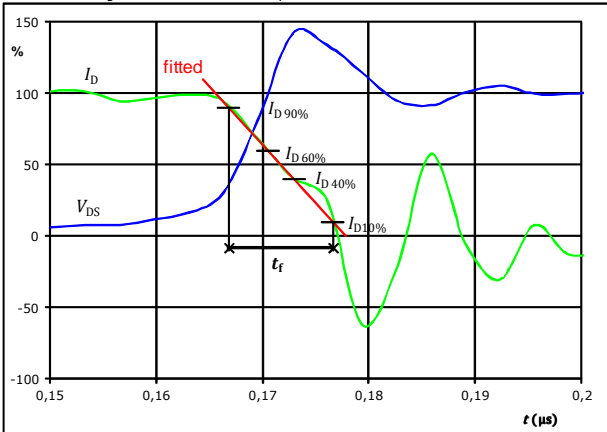
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



$V_{GS}(0\%) =$	10	V
$V_{GS}(100\%) =$	-5	V
$V_{DS}(100\%) =$	400	V
$I_D(100\%) =$	15	A
$t_{don} =$	0,044	μs
$t_{Eon} =$	0,066	μs

figure 3. MOSFET

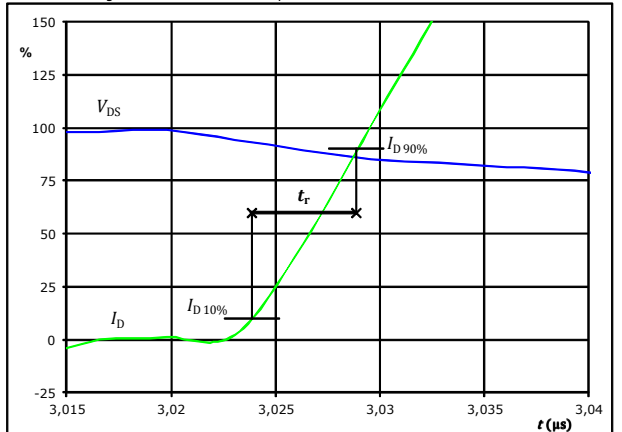
Turn-off Switching Waveforms & definition of t_f



$V_{DS}(100\%) =$	400	V
$I_D(100\%) =$	15	A
$t_f =$	0,014	μs

figure 4. MOSFET

Turn-on Switching Waveforms & definition of t_r

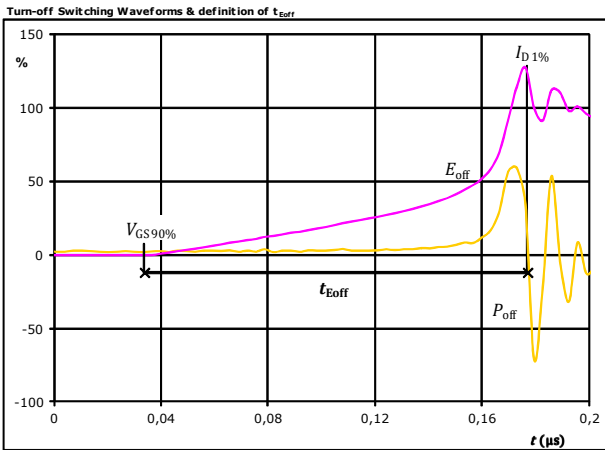


$V_{DS}(100\%) =$	400	V
$I_D(100\%) =$	15	A
$t_r =$	0,006	μs



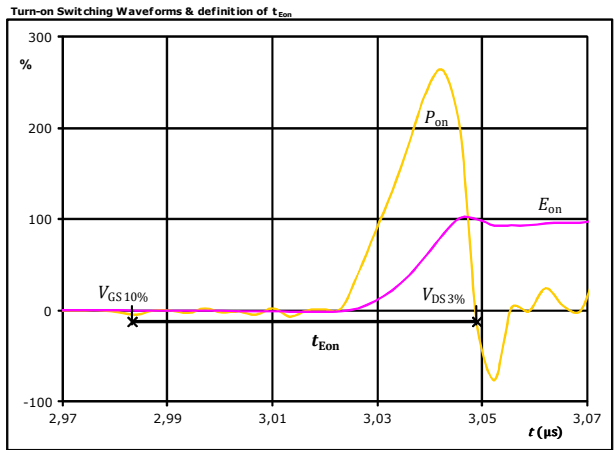
PFC Switching Characteristics

figure 5. MOSFET



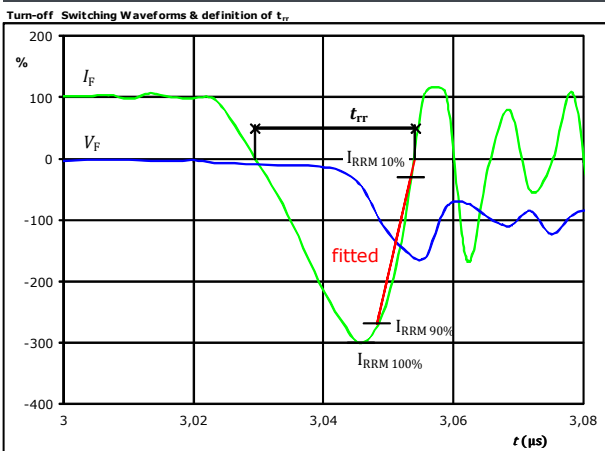
$P_{off}(100\%) = 6,02$ kW
 $E_{off}(100\%) = 0,05$ mJ
 $t_{Eoff} = 0,14$ μs

figure 6. MOSFET



$P_{on}(100\%) = 6,02$ kW
 $E_{on}(100\%) = 0,21$ mJ
 $t_{Eon} = 0,07$ μs

figure 7. FWD

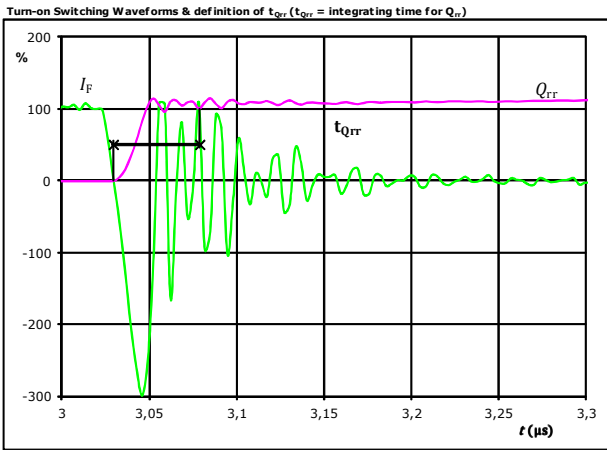


$V_F(100\%) = 400$ V
 $I_F(100\%) = 15$ A
 $I_{RRM}(100\%) = -43$ A
 $t_{rr} = 0,025$ μs



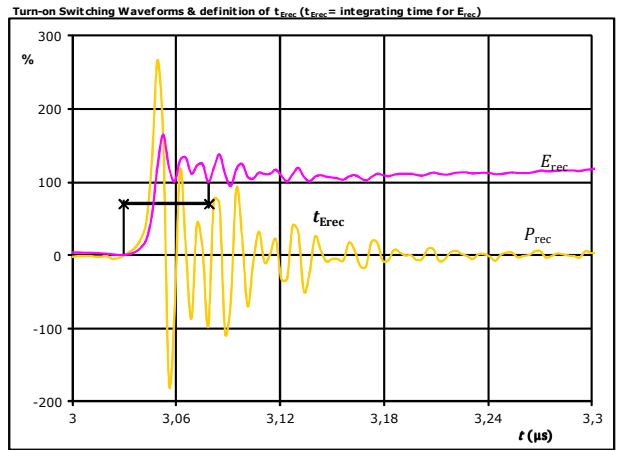
PFC Switching Characteristics

figure 8. FWD



I_F (100%) =	15	A
Q_{rr} (100%) =	0,59	μC
t_{Qrr} =	0,05	μs

figure 9. FWD



P_{rec} (100%) =	6,02	kW
E_{rec} (100%) =	0,19	mJ
t_{Erec} =	0,05	μs

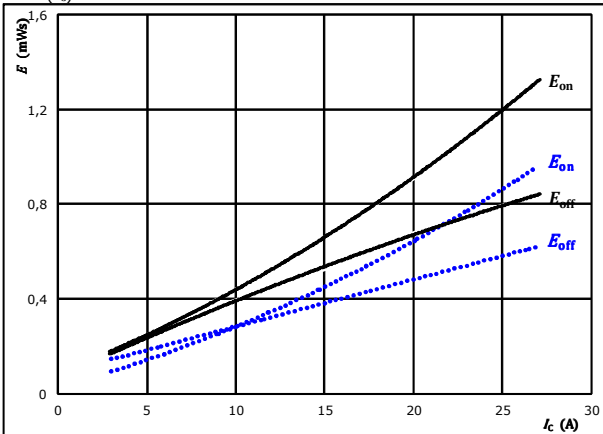


Inverter Switching Characteristics

figure 1. IGBT

Typical switching energy losses as a function of collector current

$$E = f(I_C)$$

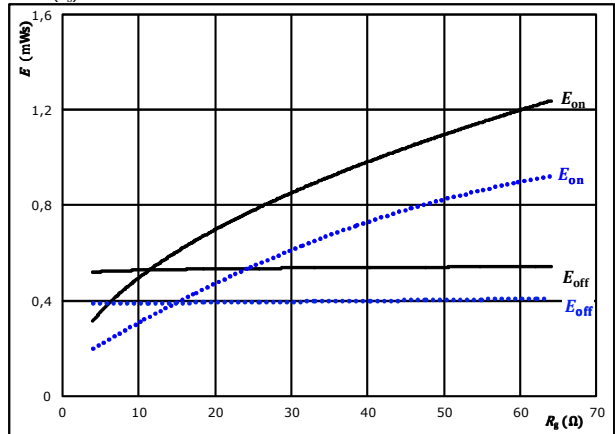


With an inductive load at
 $V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $R_{g\text{on}} = 16$ Ω
 $R_{g\text{off}} = 16$ Ω
 $T_j: 25$ $^{\circ}\text{C}$ (dotted blue line)
 $T_j: 125$ $^{\circ}\text{C}$ (solid black line)

figure 2. IGBT

Typical switching energy losses as a function of gate resistor

$$E = f(r_g)$$

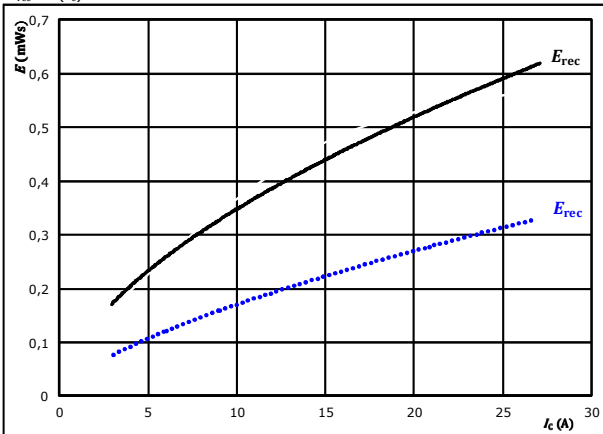


With an inductive load at
 $V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A
 $T_j: 25$ $^{\circ}\text{C}$ (dotted blue line)
 $T_j: 125$ $^{\circ}\text{C}$ (solid black line)

figure 3. FWD

Typical reverse recovered energy loss as a function of collector current

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

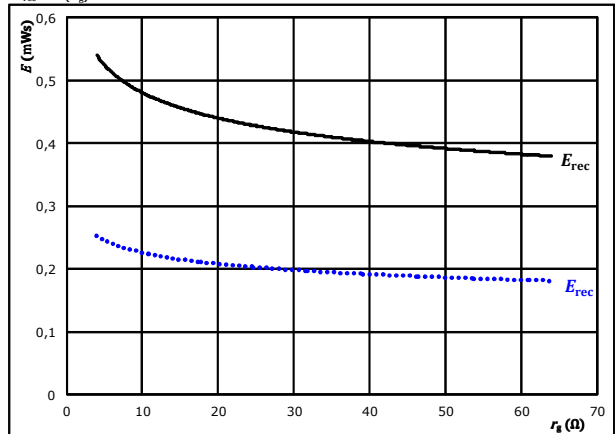


With an inductive load at
 $V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $R_{g\text{on}} = 16$ Ω
 $T_j: 25$ $^{\circ}\text{C}$ (dotted blue line)
 $T_j: 125$ $^{\circ}\text{C}$ (solid black line)

figure 4. FWD

Typical reverse recovered energy loss as a function of gate resistor

$$E_{\text{rec}} = f(r_g)$$



With an inductive load at
 $V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $I_C = 15$ A
 $T_j: 25$ $^{\circ}\text{C}$ (dotted blue line)
 $T_j: 125$ $^{\circ}\text{C}$ (solid black line)

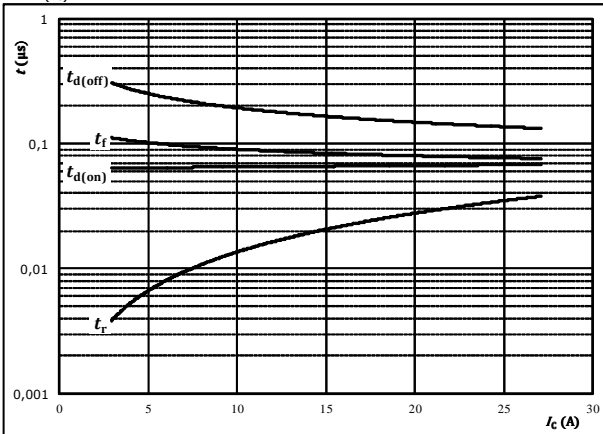


Inverter Switching Characteristics

figure 5. IGBT

Typical switching times as a function of collector current

$t = f(I_c)$



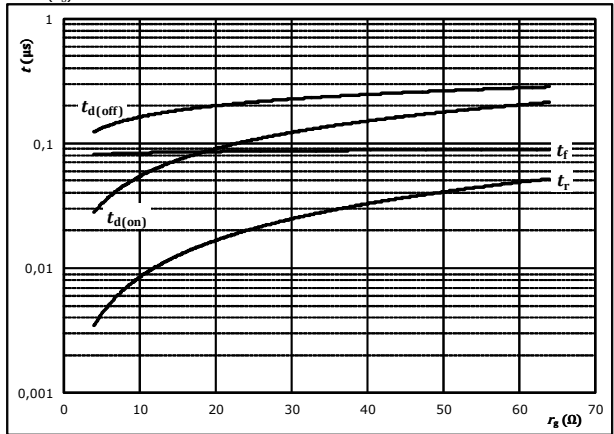
With an inductive load at

- $T_j = 125$ °C
- $V_{CE} = 400$ V
- $V_{GE} = \pm 15$ V
- $R_{gon} = 16$ Ω
- $R_{goff} = 16$ Ω

figure 6. IGBT

Typical switching times as a function of gate resistor

$t = f(r_g)$



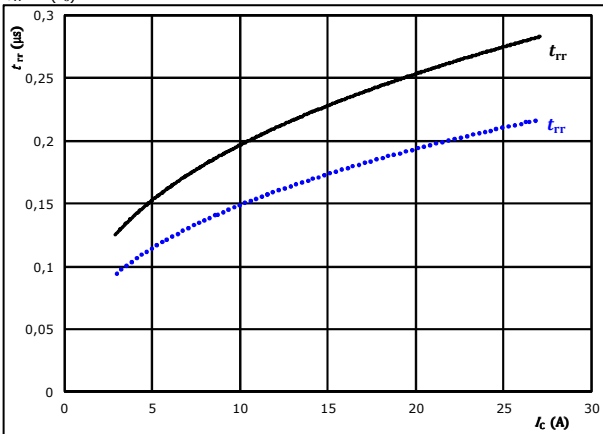
With an inductive load at

- $T_j = 125$ °C
- $V_{CE} = 400$ V
- $V_{GE} = \pm 15$ V
- $I_c = 15$ A

figure 7. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$

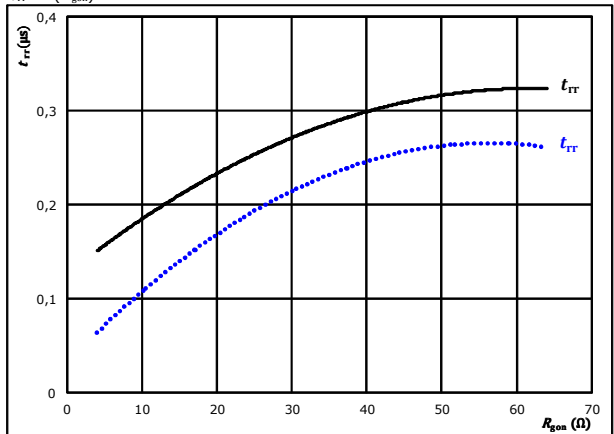


- At $V_{CE} = 400$ V $T_j: 25$ °C
 $V_{GE} = \pm 15$ V $T_j: 125$ °C ———
 $R_{gon} = 16$ Ω

figure 8. FWD

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

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



- At $V_{CE} = 400$ V $T_j: 25$ °C
 $V_{GE} = \pm 15$ V $T_j: 125$ °C ———
 $I_c = 15$ A

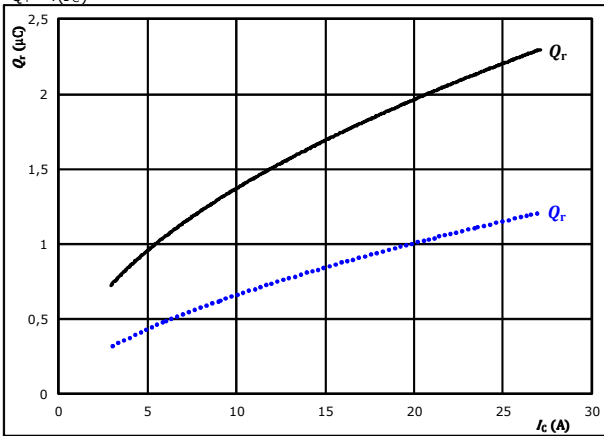


Inverter Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$

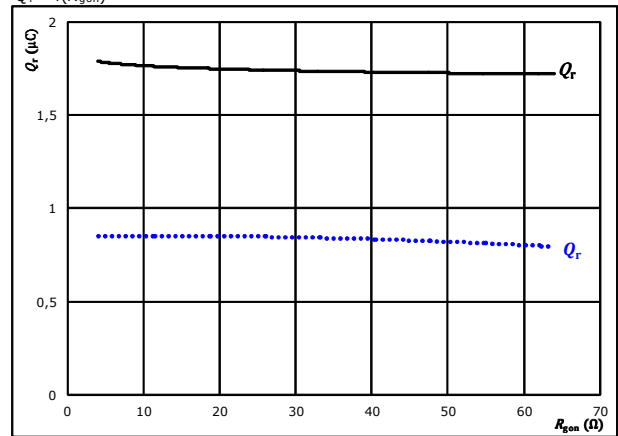


At $V_{CE} = 400$ V $T_j: 25^\circ\text{C}$
 $V_{GE} = \pm 15$ V $T_j: 125^\circ\text{C}$ ———
 $R_{gdn} = 16$ Ω

figure 10. FWD

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

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

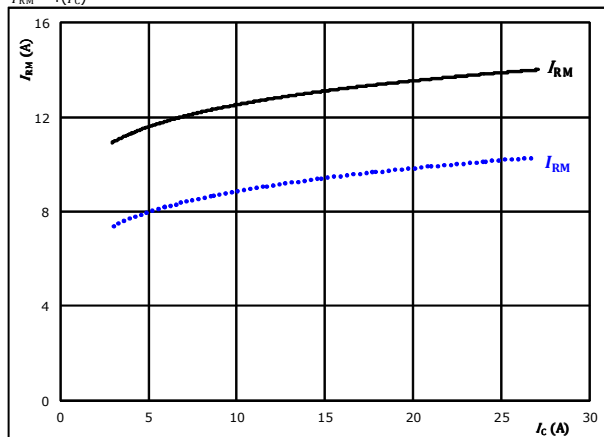


At $V_{CE} = 400$ V $T_j: 25^\circ\text{C}$
 $V_{GE} = \pm 15$ V $T_j: 125^\circ\text{C}$ ———
 $I_c = 15$ A

figure 11. FWD

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

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

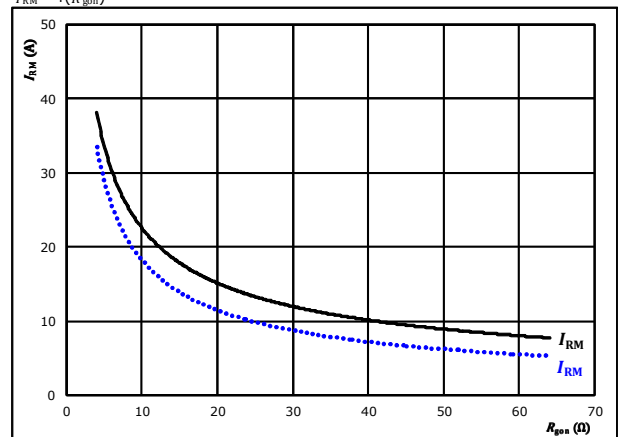


At $V_{CE} = 400$ V $T_j: 25^\circ\text{C}$
 $V_{GE} = \pm 15$ V $T_j: 125^\circ\text{C}$ ———
 $R_{gdn} = 16$ Ω

figure 12. FWD

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

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



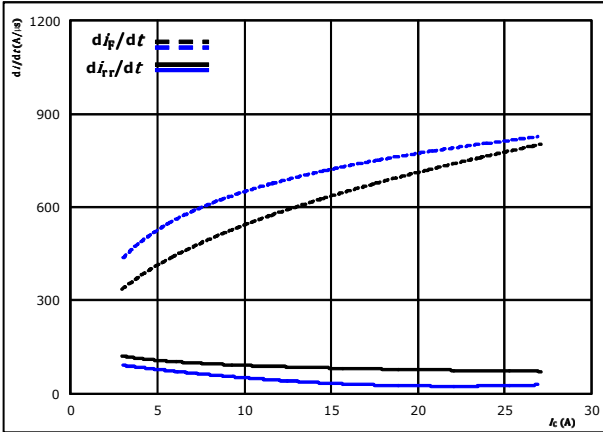
At $V_{CE} = 400$ V $T_j: 25^\circ\text{C}$
 $V_{GE} = \pm 15$ V $T_j: 125^\circ\text{C}$ ———
 $I_c = 15$ A



Inverter Switching Characteristics

figure 13. FWD

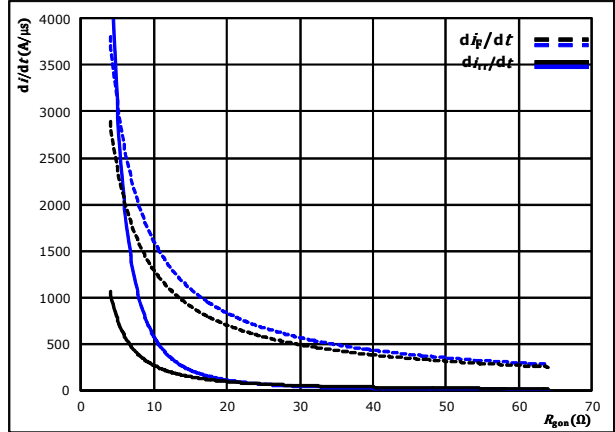
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $di_F/dt, di_{rr}/dt = f(I_c)$



At $V_{CE} = 400$ V $T_J: 25$ °C $R_{gpn} = 16$ Ω

figure 14. FWD

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

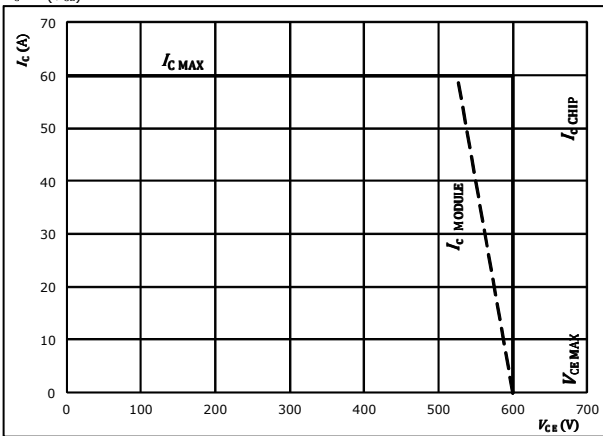


At $V_{CE} = 400$ V $T_J: 25$ °C $V_{GE} = \pm 15$ V $I_C = 15$ A $R_{gpn} = 16$ Ω

figure 15. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At $T_J = 175$ °C $R_{gpn} = 16$ Ω $R_{goff} = 16$ Ω



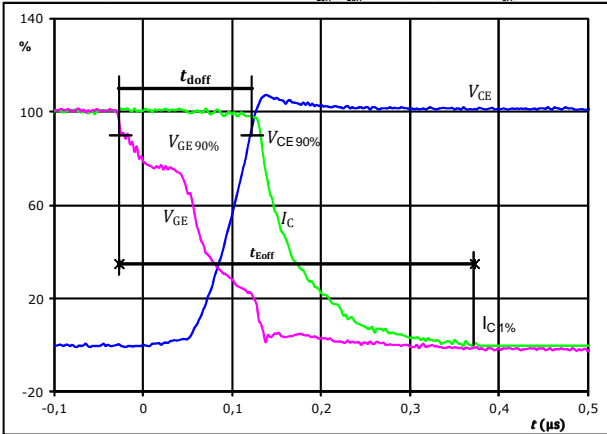
Inverter Switching Definitions

General conditions

T_j	=	125 °C
$R_{g\ on}$	=	16 Ω
$R_{g\ off}$	=	16 Ω

figure 1. IGBT

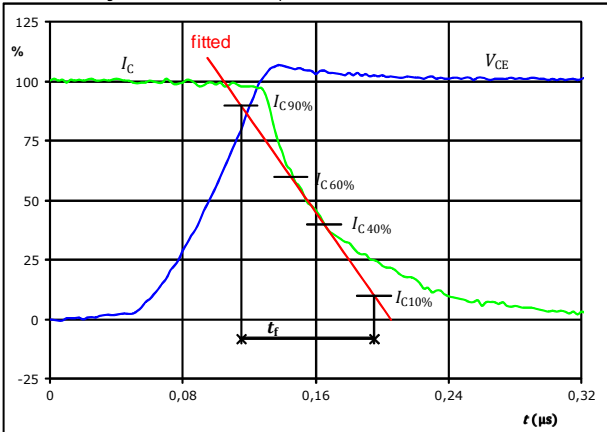
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	400	V
I_C (100%) =	21	A
t_{doff} =	0,145	μ s
t_{Eoff} =	0,400	μ s

figure 3. IGBT

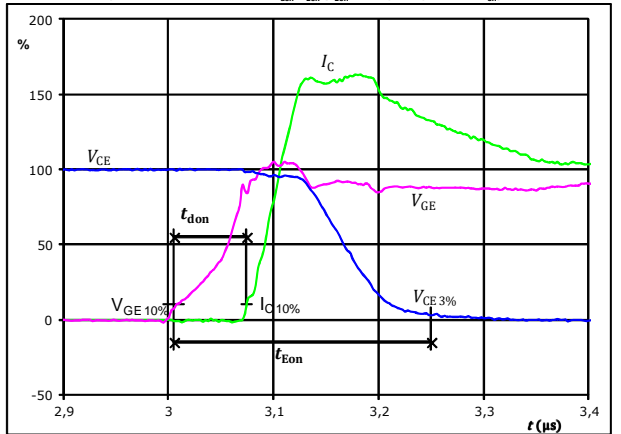
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	400	V
I_C (100%) =	21	A
t_f =	0,075	μ s

figure 2. IGBT

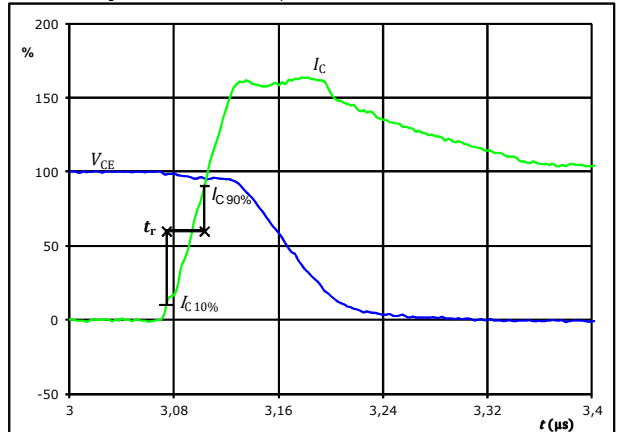
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	400	V
I_C (100%) =	21	A
t_{don} =	0,067	μ s
t_{Eon} =	0,245	μ s

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

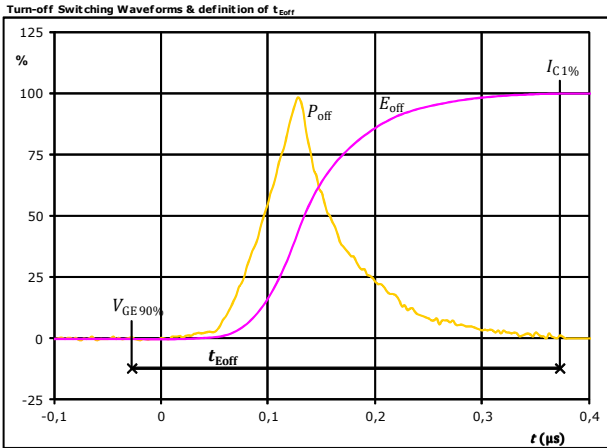


V_C (100%) =	400	V
I_C (100%) =	21	A
t_r =	0,029	μ s



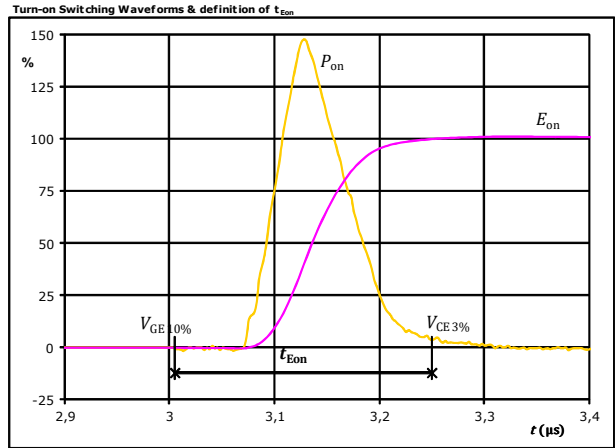
Inverter Switching Characteristics

figure 5. IGBT



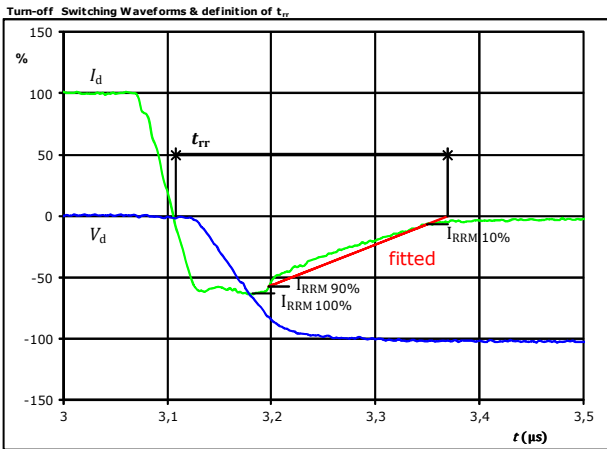
$P_{off} (100\%) = 8,37$ kW
 $E_{off} (100\%) = 0,71$ mJ
 $t_{Eoff} = 0,40$ μs

figure 6. IGBT



$P_{on} (100\%) = 8,37$ kW
 $E_{on} (100\%) = 0,96$ mJ
 $t_{Eon} = 0,24$ μs

figure 7. FWD

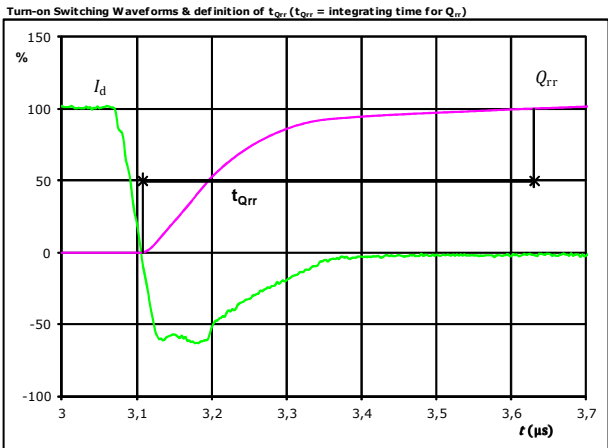


$V_d (100\%) = 400$ V
 $I_d (100\%) = 21$ A
 $I_{RRM} (100\%) = -13$ A
 $t_{rr} = 0,257$ μs



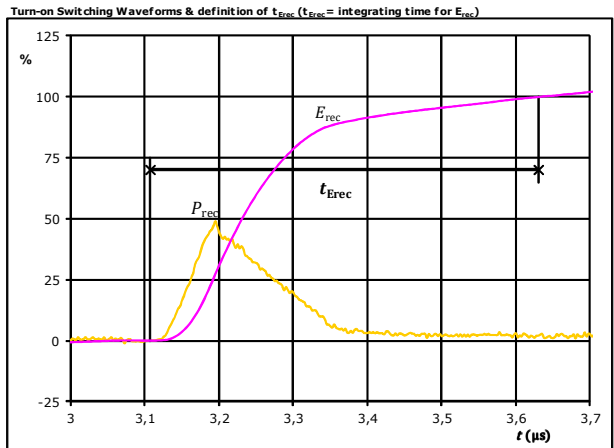
Inverter Switching Characteristics

figure 8. FWD



$I_d(100\%) =$	21	A
$Q_{rr}(100\%) =$	2,01	μC
$t_{Qrr} =$	0,52	μs

figure 9. FWD



$P_{rec}(100\%) =$	8,37	kW
$E_{rec}(100\%) =$	0,54	mJ
$t_{Erec} =$	0,52	μs



Ordering Code & Marking								
Version			Ordering Code					
without thermal paste 17 mm housing with solder pins			10-F006PPA020SB-M685B					
with thermal paste 17 mm housing with solder pins			10-F006PPA020SB-M685B-/3/					
without thermal paste 17 mm housing with press-fit pins			10-P006PPA020SB-M685BY					
with thermal paste 17 mm housing with press-fit pins			10-P006PPA020SB-M685BY-/3/					
NN-NNNNNNNNNNNN TTTTIV WWYY UL VIN LLLLL SSSS			Name		Date code	UL & VIN	Lot	Serial
			NN-NNNNNNNNNNNN-TTTTIV		WWYY	UL VIN	LLLLL	SSSS
			Type&Ver	Lot number	Serial	Date code		
Datamatrix		TTTTIV	LLLLL	SSSS	WWYY			

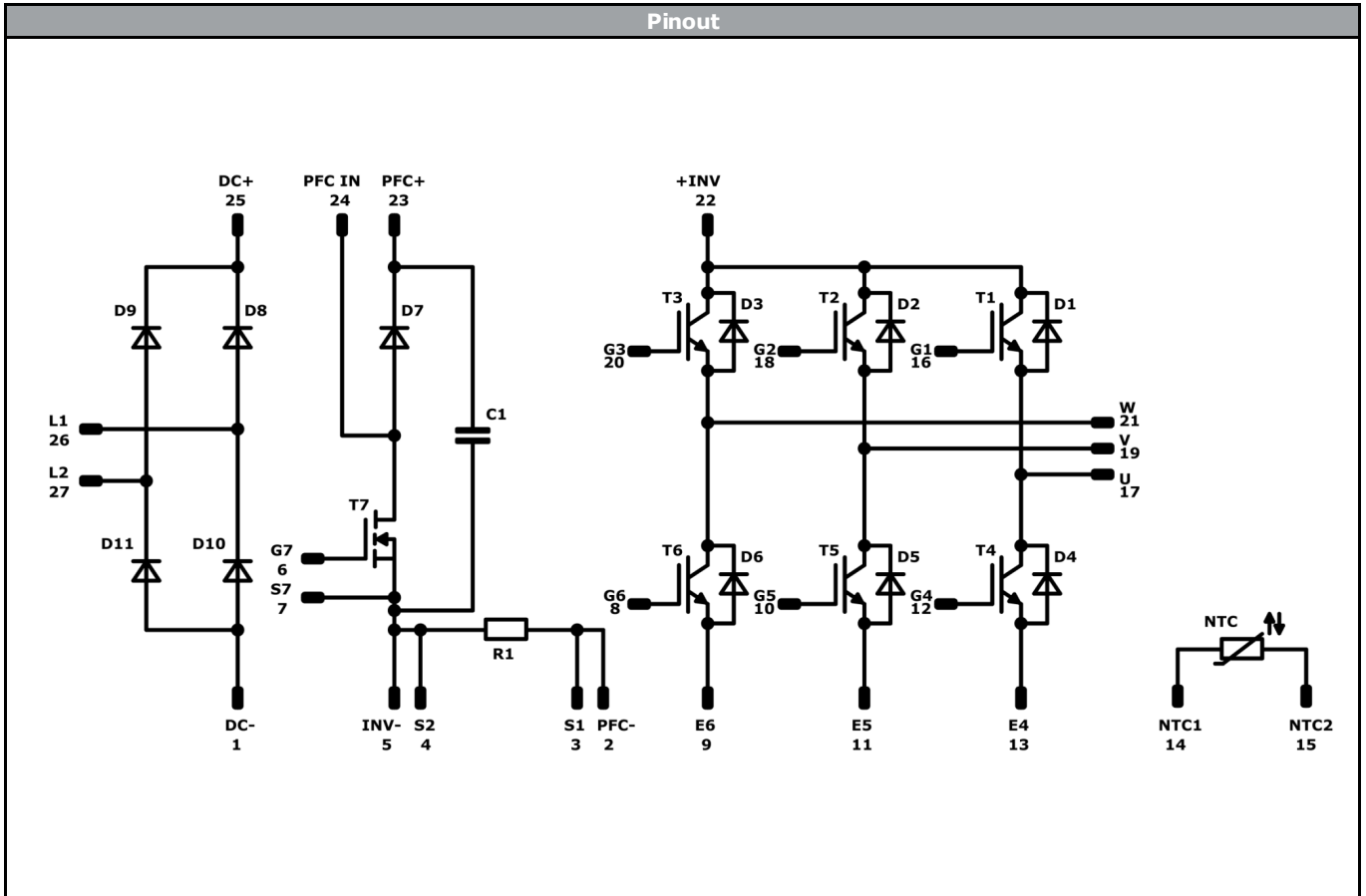
Pin table			
Pin	X	Y	Function
1	33,5	0	DC-
2	30,7	0	PFC-
3	28	0	S1
4	25,3	0	S2
5	22,6	0	INV-
6	19,9	0	G7
7	17,2	0	S7
8	13,5	0	G6
9	10,8	0	E6
10	8,1	0	G5
11	5,4	0	E5
12	2,7	0	G4
13	0	0	E4
14	0	8,6	NTC1
15	0	11,45	NTC2
16	0	19,8	G1
17	0	22,5	U
18	6	19,8	G2
19	6	22,5	V
20	12	19,8	G3
21	12	22,5	W
22	17,7	22,5	+INV
23	20,5	22,5	PFC+
24	26,5	22,5	PFC IN
25	33,5	22,5	DC+
26	33,5	15	L1
27	33,5	7,5	L2

Outline

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
D8, D9, D10, D11	Rectifier	1600 V	25 A	Rectifier	
T7	MOSFET	600 V	63 mΩ	PFC Switch	
D7	FWD	600 V	30 A	PFC Diode	
C1	Capacitor	500 V		Capacitor (PFC)	
R1	Shunt		22 A	PFC Shunt	
T1, T2, T3, T4, T5, T6	IGBT	600 V	20 A	Inverter Switch	
D1, D2, D3, D4, D5, D6	FWD	600 V	30 A	Inverter Diode	
NTC	NTC			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
10-x006PPA020SB-M685Bx-D3-14	05 Jun. 2019	Press-fit pin version is added	All

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.