



flowPIM 0 + PFC

600 V / 20 A

Features

- Clip in PCB mounting
- Trench Fieldstop IGBTs for low saturation losses
- Latest generation superjunction MOSFET with SiC boost diode for PFC switching frequencies up to 200 kHz

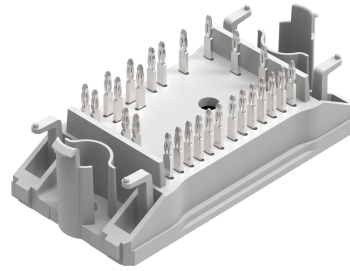
Target applications

- Embedded Drives
- Industrial Drives

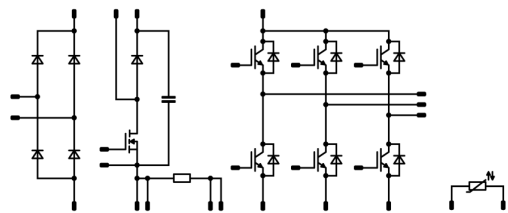
Types

- 10-P006PPA020SB01-M685B10Y

flow 0 17 mm housing



Schematic





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10-P006PPA020SB01-M685B10Y
datasheet

Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
Inverter Switch				
Collector-emitter voltage	V_{CES}		600	V
Collector current (DC 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
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	i_{SC}	$V_{GE} = 15\text{ V}$, $V_{CC} = 360\text{ V}$ $T_j = 150\text{ °C}$	6	μs
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$

Inverter Diode

Peak repetitive reverse voltage	V_{RRM}		600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	32	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	60	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	52	W
Maximum junction temperature	T_{jmax}		175	$^{\circ}\text{C}$



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Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
PFC Switch				
Drain-source voltage	V_{DSS}		600	V
Drain current (DC current)	I_D	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	24	A
Peak drain current	I_{DM}	t_p limited by T_{jmax}	159	A
Avalanche energy, single pulse	E_{AS}	$V_{DD} = 50\text{ V}$ $I_D = 9,3\text{ A}$	1135	mJ
Avalanche energy, repetitive	E_{AR}	$V_{DD} = 50\text{ V}$ $I_D = 9,3\text{ A}$	1,72	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	$V_{DS} = 480\text{ V}$ $T_s = 25\text{ °C}$	50	V/ns
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	90	W
Gate-source voltage	V_{GSS}		±20	V
Maximum Junction Temperature	T_{jmax}		150	°C

PFC Diode

Peak repetitive reverse voltage	V_{RRM}		650	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	29	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	105	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, $t_p = 8,3\text{ ms}$ $T_j = 150\text{ °C}$	75	A
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	52	W
Maximum junction temperature	T_{jmax}		175	°C



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Maximum Ratings

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

Parameter	Symbol	Conditions	Value	Unit
Rectifier Diode				
Peak repetitive reverse voltage	V_{RRM}		1600	V
Forward current (DC current)	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	33	A
Surge (non-repetitive) forward current	I_{FSM}	Single Half Sine Wave, $t_p = 10\text{ ms}$ $T_j = 150\text{ °C}$	200	A
Surge current capability	I^2t		200	A ² s
Total power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	44	W
Maximum junction temperature	T_{jmax}		150	°C

PFC Shunt

DC current	I	$T_c = 70\text{ °C}$	22	A
Power dissipation	P_{tot}	$T_c = 70\text{ °C}$	5	W
Operation Temperature	T_{op}		-55 ... 170	°C

Capacitor (PFC)

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

Module Properties

Thermal Properties

Storage temperature	T_{stg}		-40...+125	°C
Operation temperature under switching condition	T_{jop}		-40...+($T_{jmax} - 25$)	°C

Isolation Properties

Isolation voltage	V_{isol}	DC Test Voltage* $t_p = 2\text{ s}$	6000	V
Isolation voltage	V_{isol}	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



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Characteristic Values

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

Inverter Switch

Static

Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00029	25	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		20	25 125	1,1	1,55 1,75	1,9 ⁽¹⁾	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}	$f = 1 \text{ Mhz}$	0	25		25		71		pF
Reverse transfer capacitance	C_{res}							32		pF
Gate charge	Q_g	$V_{CC} = 480 \text{ V}$	0/15		20	25		120		nC

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)						1,7		K/W
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Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 16 \Omega$ $R_{goff} = 16 \Omega$	± 15	400	15	25		65,6		ns
						125		65,2		
Rise time	t_r					25		19,8		
						125		21		
Turn-off delay time	$t_{d(off)}$					25		141,8		
						125		167		
Fall time	t_f					25		76,33		
		125		86,36						
Turn-on energy (per pulse)	E_{on}	$Q_{tFWD} = 0,883 \mu\text{C}$ $Q_{tFWD} = 1,79 \mu\text{C}$				25		0,45		mWs
						125		0,667		
Turn-off energy (per pulse)	E_{off}					25		0,385		mWs
						125		0,523		



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Characteristic Values

Parameter	Symbol	Conditions					Values			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				30	25 125	1,25	1,65 1,61	1,95 ⁽¹⁾	V
Reverse leakage current	I_R	$V_i = 600$ V				25			27	μA

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,81		K/W
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Dynamic

Peak recovery current	I_{RRM}	$di/dt=731$ A/μs $di/dt=708$ A/μs	±15	400	15	25		10,06		A
						125		13,55		
Reverse recovery time	t_{rr}					25		173,99		
						125		233,08		
Recovered charge	Q_r					25		0,883		
		125		1,79						
Reverse recovered energy	E_{rec}	25		0,236						
		125		0,474						
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$	25		36,18						
		125		85,35						



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10-P006PPA020SB01-M685B10Y
datasheet

Characteristic Values

Parameter	Symbol	Conditions					Values			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		

PFC Switch

Static

Drain-source on-state resistance	$r_{DS(on)}$		10		25,8	25 125		70 144	70 ⁽¹⁾	mΩ
Gate-source threshold voltage	$V_{GS(th)}$		0		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							0,85		Ω
Gate charge	Q_g	$V_{DD} = 480 V$	10		25,8	25		170		nC
Short-circuit input capacitance	C_{iss}	$f = 1 Mhz$	0	100	0	25		3800		pF
Short-circuit output capacitance	C_{oss}							215		

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 W/mK$ (PSX)						0,78		K/W
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Dynamic

Turn-on delay time	$t_{d(on)}$	$R_{gon} = 8 \Omega$ $R_{goff} = 8 \Omega$	0/16	400	15	25		19,2		ns
Rise time	t_r					125		18,88		
						25		5,12		
Turn-off delay time	$t_{d(off)}$					25		292		
						125		310,72		
Fall time	t_f					25		28		
						125		44,28		
Turn-on energy (per pulse)	E_{on}	$Q_{rFWD}=0,092 \mu C$		25		0,022		mWs		
		$Q_{rFWD}=0,091 \mu C$		125		0,028				
Turn-off energy (per pulse)	E_{off}			25		0,081		mWs		
				125		0,095				



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Characteristic Values

Parameter	Symbol	Conditions					Values			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		

PFC Diode

Static

Forward voltage	V_F				24	25 125 150		1,37 1,55 1,63	1,55 ⁽¹⁾	V
Reverse leakage current	I_R	$V_T = 650$ V				25 150		4,8 72	480	μA

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,82		K/W
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Dynamic

Peak recovery current	I_{RRM}	$di/dt=4560$ A/μs $di/dt=4207$ A/μs	0/16	400	15	25		16,34		A
						125		15,7		
Reverse recovery time	t_{rr}					25		9,91		
						125		10,09		
Recovered charge	Q_r					25		0,092		
		125		0,091						
Reverse recovered energy	E_{rec}	25		0,068						
		125		0,064						
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$	25		4360						
		125		4238						



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Characteristic Values

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

Rectifier Diode

Static

Forward voltage	V_F				8	25 125		0,996 0,907	1,21 ⁽¹⁾ 1,1 ⁽¹⁾	V
Reverse leakage current	I_R	$V_i = 1600$ V				25			50	μA

Thermal

Thermal resistance junction to sink ⁽²⁾	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,59		K/W
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PFC Shunt

Static

Resistance	R							10		mΩ
Tolerance							-1		1	%
Temperature coefficient	tc								30	ppm/K

Capacitor (PFC)

Static

Capacitance	C	DC bias voltage = 0 V				25		100		nF
Tolerance							-10		10	%
Dissipation factor		$f = 1$ kHz				25		2,5		%



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Characteristic Values

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

Thermistor

Static

Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$A_{R/R}$	$R_{100} = 1484 \Omega$				100	-5		5	%
Power dissipation	P					25		130		mW
Power dissipation constant	d					25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 1 \%$						3962		K
B-value	$B_{(25/100)}$	Tol. $\pm 1 \%$						4000		K
Vincotech Thermistor Reference									I	

⁽¹⁾ Value at chip level

⁽²⁾ Only valid with pre-applied Vincotech thermal interface material.

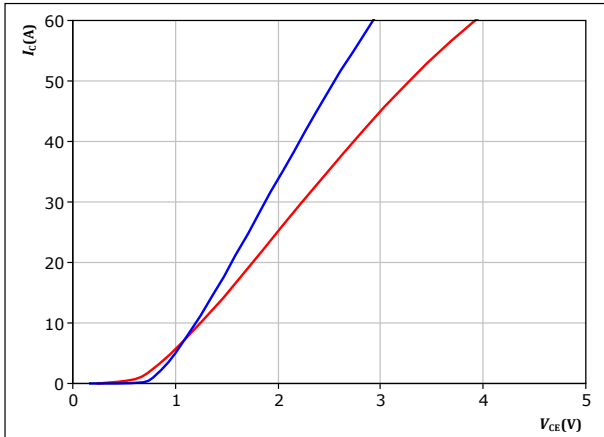


Inverter Switch Characteristics

figure 1. IGBT

Typical output characteristics

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

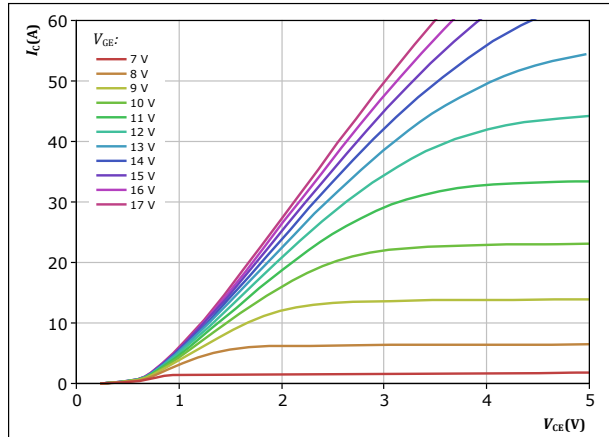


$t_p = 250 \mu\text{s}$
 $V_{GE} = 15 \text{ V}$
 $T_j: 25^\circ\text{C}$ (blue), 125°C (red)

figure 2. IGBT

Typical output characteristics

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

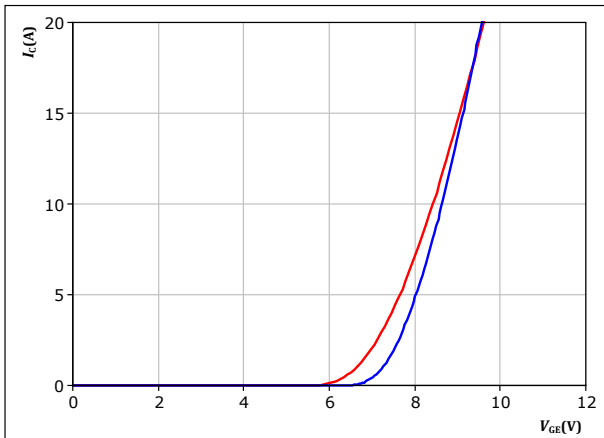


$t_p = 250 \mu\text{s}$
 $T_j = 125^\circ\text{C}$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3. IGBT

Typical transfer characteristics

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

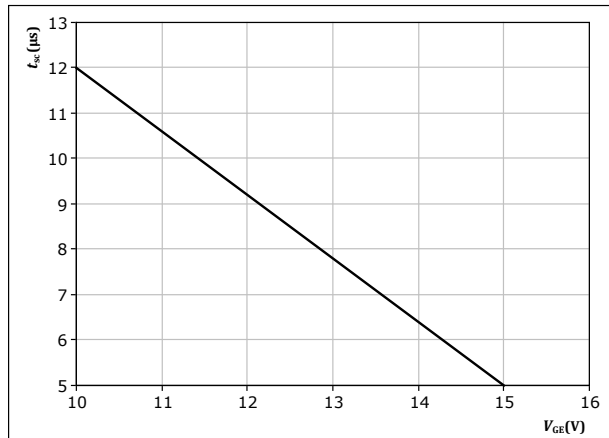


$t_p = 250 \mu\text{s}$
 $V_{CE} = 10 \text{ V}$
 $T_j: 25^\circ\text{C}$ (blue), 125°C (red)

figure 4. IGBT

Short circuit withstand time as a function of V_{GE}

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



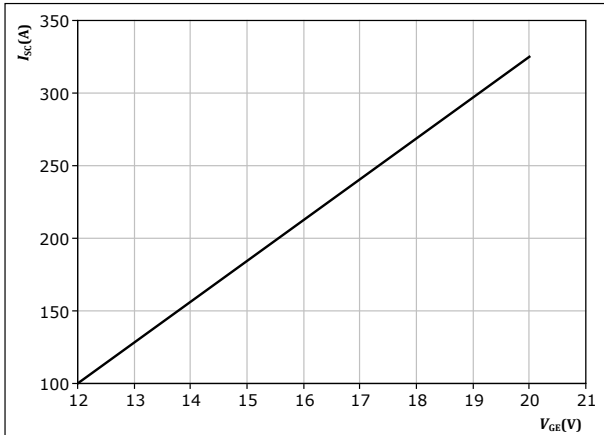
At $V_{CE} = 333 \text{ V}$
 $T_j \leq 333^\circ\text{C}$



Inverter Switch Characteristics

figure 5. IGBT

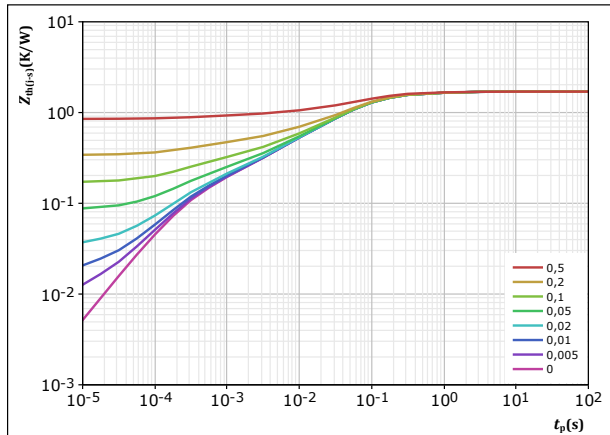
Typical short circuit current as a function of V_{GE}
 $I_{SC} = f(V_{GE})$



At $V_{CE} = 333$ V
 $T_j \leq 333$ °C

figure 6. IGBT

Transient thermal impedance as a function of pulse width
 $Z_{th(j-s)} = f(t_p)$

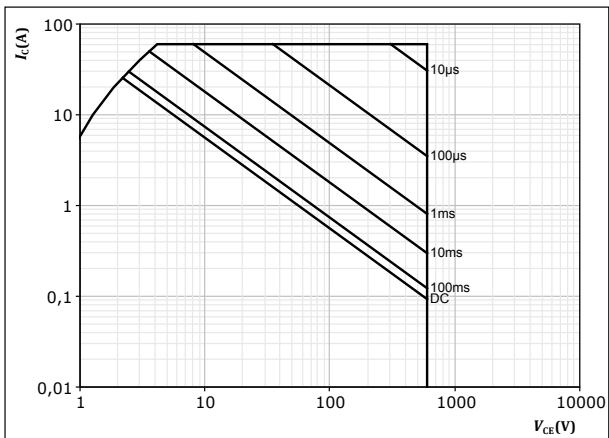


$D = t_p / T$
 $R_{th(j-s)} = 1,701$ K/W
IGBT thermal model values

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

figure 7. IGBT

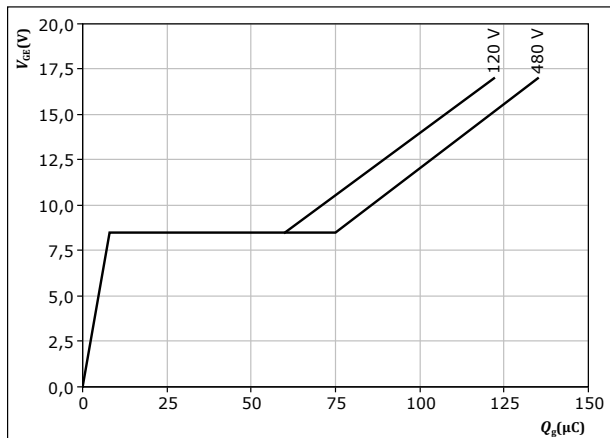
Safe operating area
 $I_C = f(V_{CE})$



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

figure 8. IGBT

Gate voltage vs gate charge
 $V_{GE} = f(Q_g)$



$I_C = 33$ A
 $T_j = 25$ °C

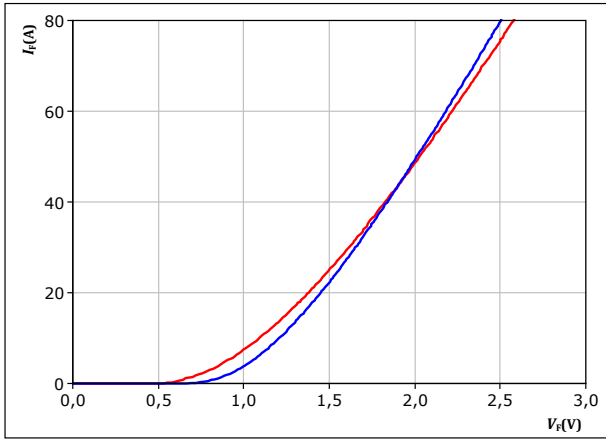


Inverter Diode Characteristics

figure 9. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

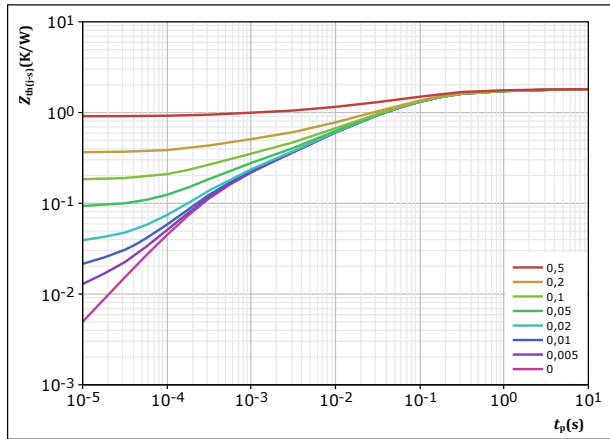


$t_p = 250 \mu s$
 $T_j: \text{---} 25 \text{ }^\circ\text{C}$
 $\text{---} 125 \text{ }^\circ\text{C}$

figure 10. FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,811 \text{ K/W}$
FWD thermal model values

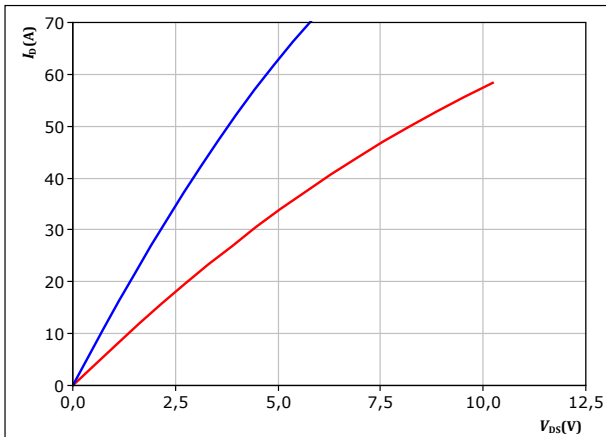
R (K/W)	τ (s)
8,35E-02	4,59E+00
2,01E-01	4,81E-01
7,60E-01	9,25E-02
4,22E-01	1,80E-02
2,13E-01	3,31E-03
1,40E-01	3,46E-04



PFC Switch Characteristics

figure 11. MOSFET

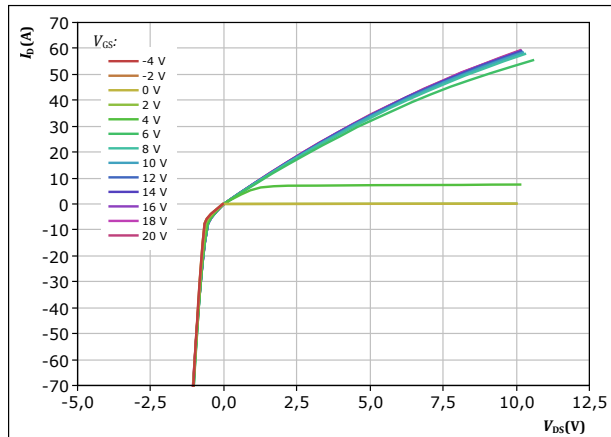
Typical output characteristics
 $I_D = f(V_{DS})$



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

figure 12. MOSFET

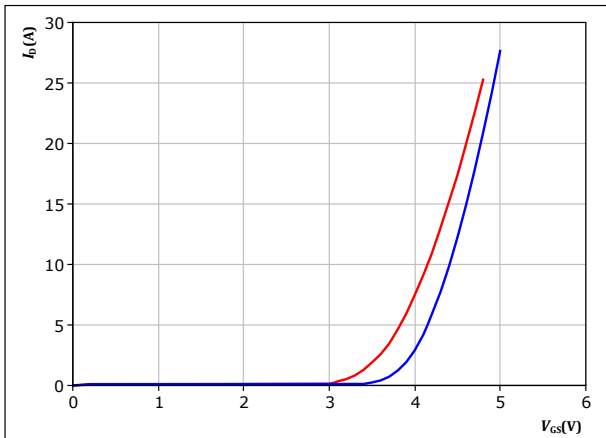
Typical output characteristics
 $I_D = f(V_{DS})$



$t_p = 250 \mu s$
 $T_j = 125^\circ C$
 V_{GS} from -4 V to 20 V in steps of 2 V

figure 13. MOSFET

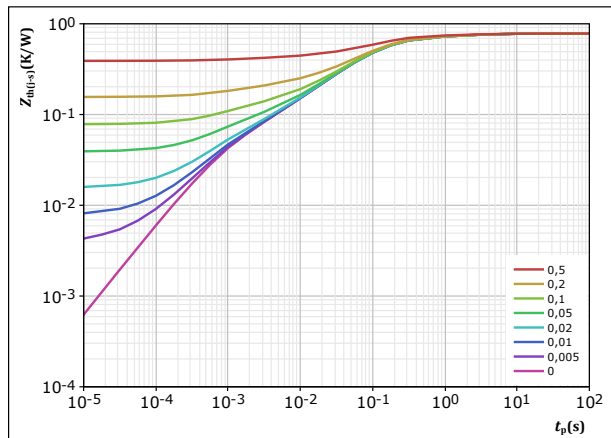
Typical transfer characteristics
 $I_D = f(V_{GS})$



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

figure 14. MOSFET

Transient thermal impedance as a function of pulse width
 $Z_{th(j-s)} = f(t_p)$



$D = t_p / T$
 $R_{th(j-s)} = 0,78 K/W$
MOSFET thermal model values

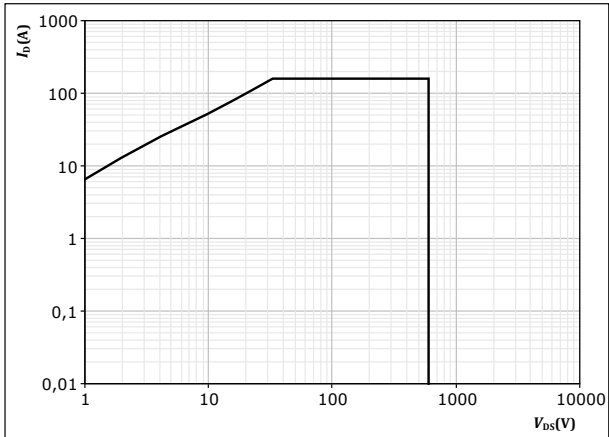
R (K/W)	τ (s)
4,90E-02	3,64E+00
1,03E-01	5,74E-01
4,25E-01	1,04E-01
1,20E-01	2,91E-02
4,27E-02	6,05E-03
4,10E-02	8,69E-04



PFC Switch Characteristics

figure 15. MOSFET

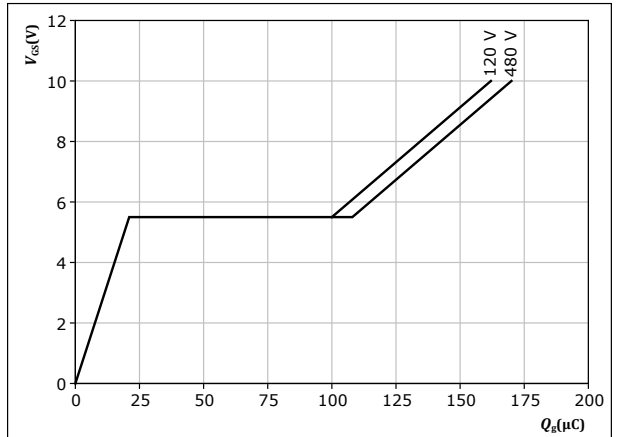
Safe operating area
 $I_D = f(V_{DS})$



$D =$ single pulse
 $T_s = 80$ °C
 $V_{GS} = 10$ V
 $T_j = T_{jmax}$

figure 16. MOSFET

Gate voltage vs gate charge
 $V_{GS} = f(Q_g)$



$I_D = 25.8$ A
 $T_j = 25$ °C



PFC Diode Characteristics

figure 17. FWD

Typical forward characteristics

$$I_F = f(V_F)$$

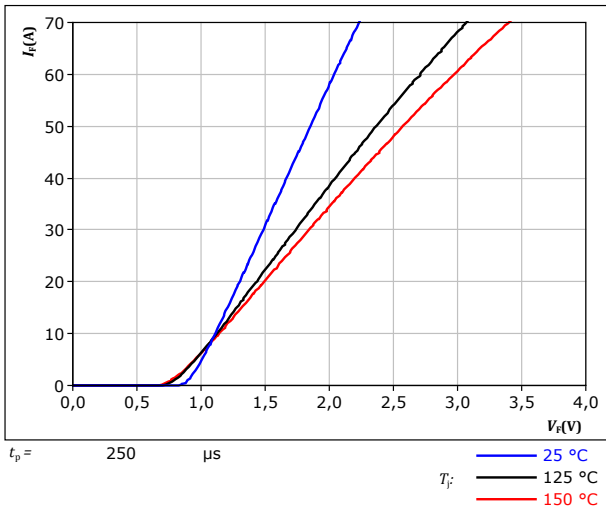
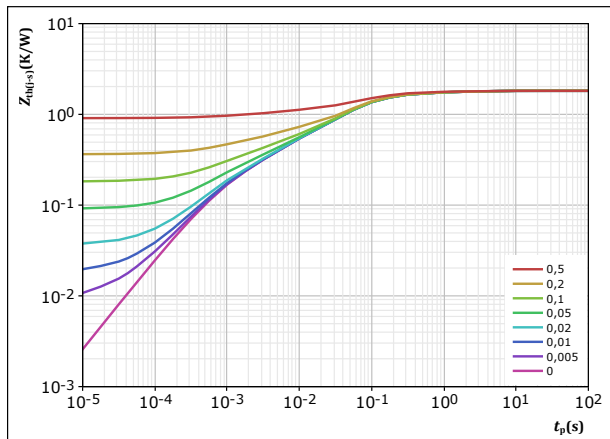


figure 18. FWD

Transient thermal impedance as a function of pulse width

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



$D =$	t_p / T	
$R_{th(j-s)} =$	1,817	K/W
FWD thermal model values		
R (K/W)	τ (s)	
9,99E-02	2,12E+00	
2,92E-01	2,34E-01	
1,04E+00	5,49E-02	
2,55E-01	4,86E-03	
1,35E-01	7,23E-04	



Rectifier Diode Characteristics

figure 19. Rectifier

Typical forward characteristics

$$I_F = f(V_F)$$

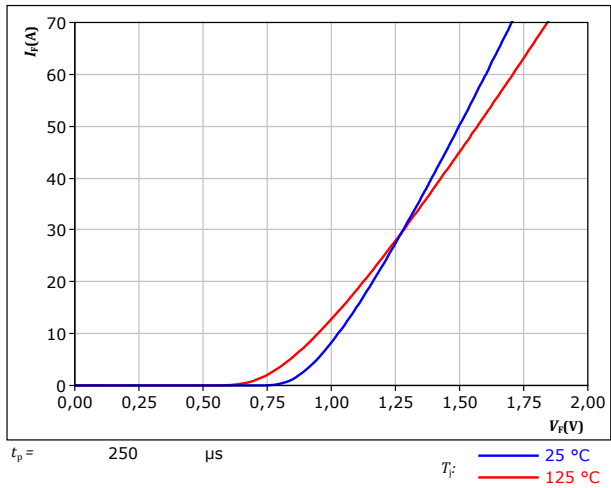
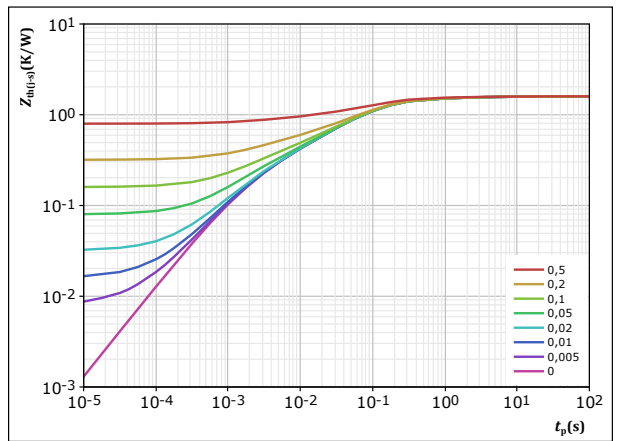


figure 20. Rectifier

Transient thermal impedance as a function of pulse width

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



$$D = \frac{t_p}{T}$$

$$R_{th(j-s)} = 1,594 \text{ K/W}$$

Rectifier thermal model values

R (K/W)	τ (s)
3,44E-02	9,66E+00
1,12E-01	1,22E+00
5,81E-01	1,45E-01
4,89E-01	5,05E-02
2,38E-01	9,26E-03
1,22E-01	1,79E-03
1,81E-02	7,88E-04

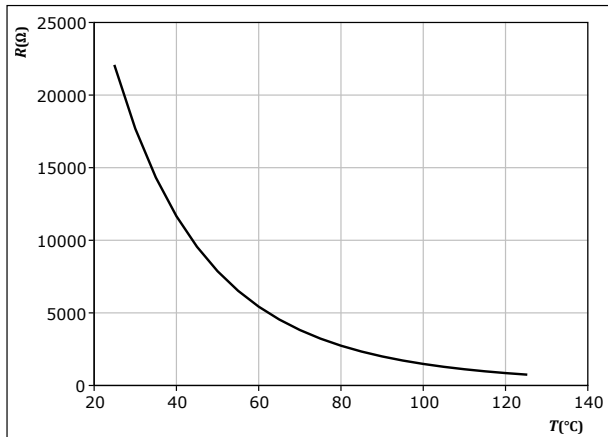


Thermistor Characteristics

figure 21. Thermistor

Typical NTC characteristic as function of temperature

$$R_T = f(T)$$

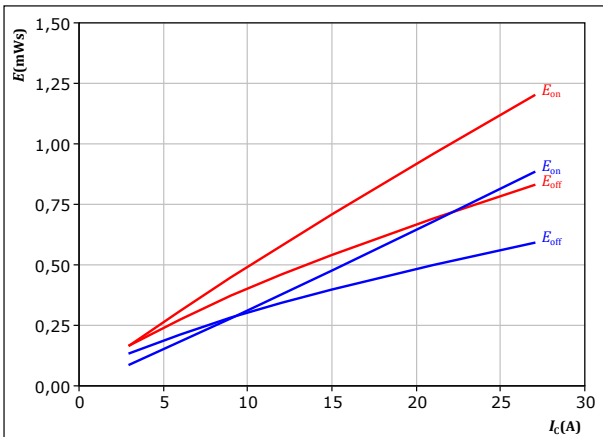




Inverter Switching Characteristics

figure 22. IGBT

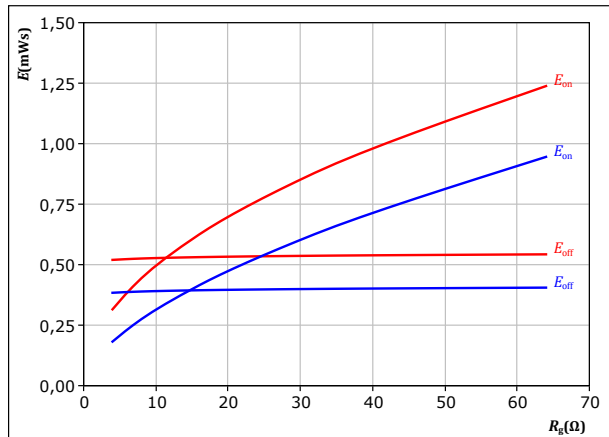
Typical switching energy losses as a function of collector current
 $E = f(I_c)$



With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 16 \text{ } \Omega$
 $R_{goff} = 16 \text{ } \Omega$
 T_j : — 25 °C
— 125 °C

figure 23. IGBT

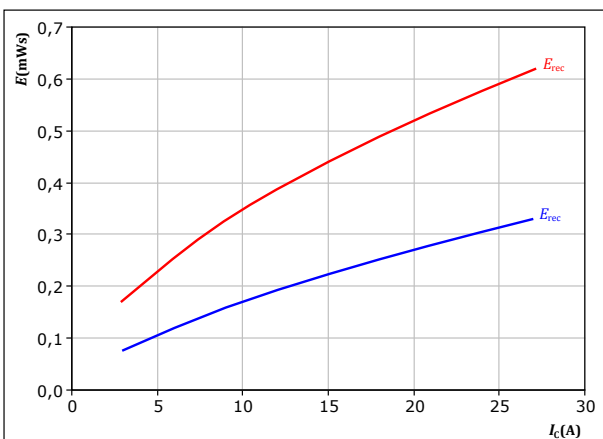
Typical switching energy losses as a function of gate resistor
 $E = f(R_g)$



With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$
 T_j : — 25 °C
— 125 °C

figure 24. FWD

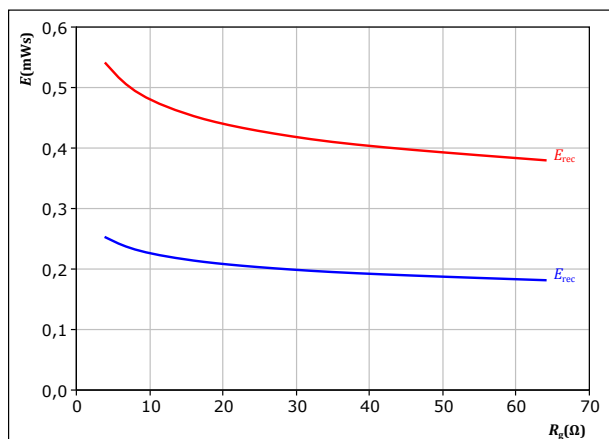
Typical reverse recovered energy loss as a function of collector current
 $E_{rec} = f(I_c)$



With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 16 \text{ } \Omega$
 T_j : — 25 °C
— 125 °C

figure 25. FWD

Typical reverse recovered energy loss as a function of gate resistor
 $E_{rec} = f(R_g)$



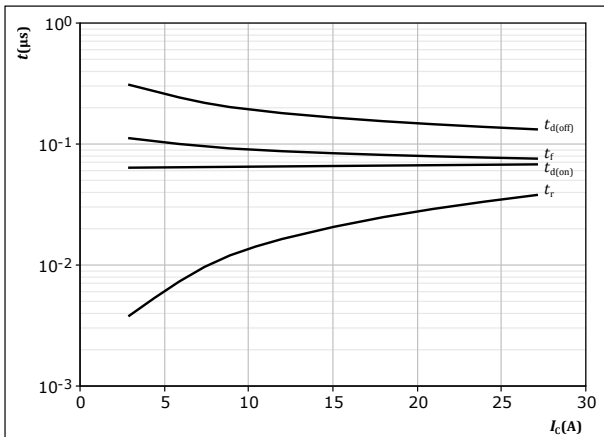
With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$
 T_j : — 25 °C
— 125 °C



Inverter Switching Characteristics

figure 26. IGBT

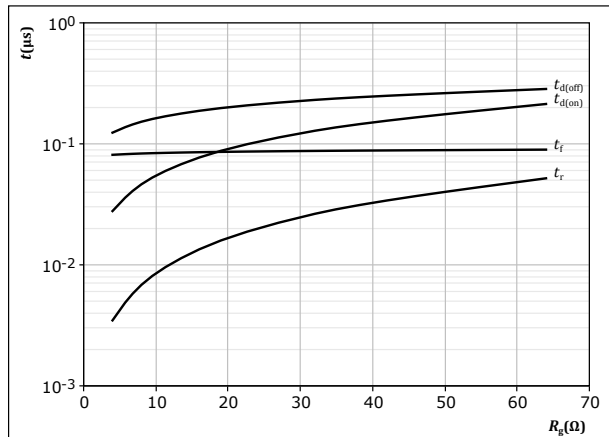
Typical switching times as a function of collector current
 $t = f(I_c)$



With an inductive load at
 $T_j = 125 \text{ } ^\circ\text{C}$
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{g(on)} = 16 \text{ } \Omega$
 $R_{g(off)} = 16 \text{ } \Omega$

figure 27. IGBT

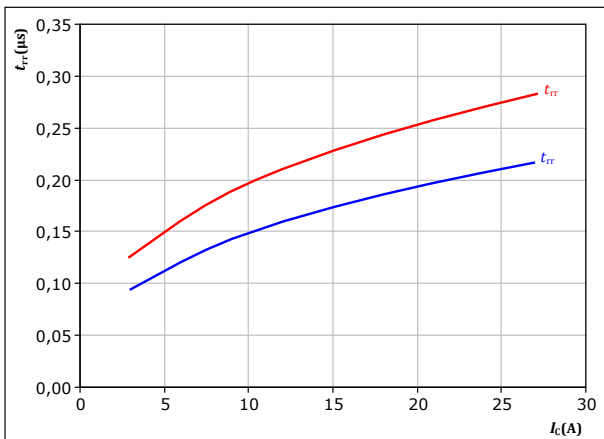
Typical switching times as a function of gate resistor
 $t = f(R_g)$



With an inductive load at
 $T_j = 125 \text{ } ^\circ\text{C}$
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$

figure 28. FWD

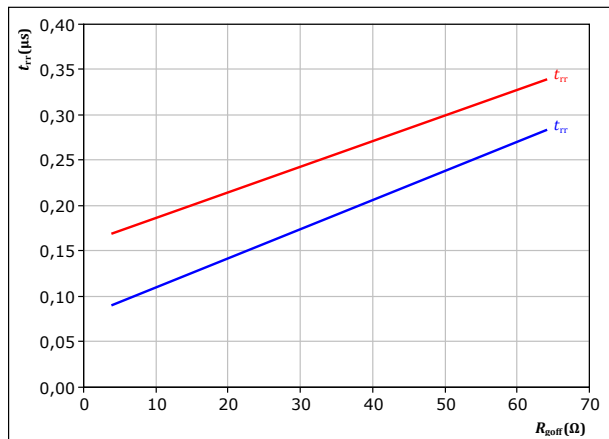
Typical reverse recovery time as a function of collector current
 $t_{rr} = f(I_c)$



With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{g(on)} = 16 \text{ } \Omega$
 T_j : — 25 °C
 — 125 °C

figure 29. FWD

Typical reverse recovery time as a function of IGBT turn off gate resistor
 $t_{rr} = f(R_{g(off)})$



With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$
 T_j : — 25 °C
 — 125 °C

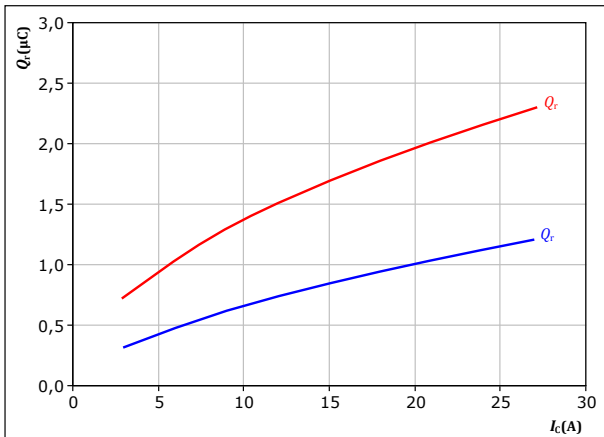


Inverter Switching Characteristics

figure 30. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$



With an inductive load at

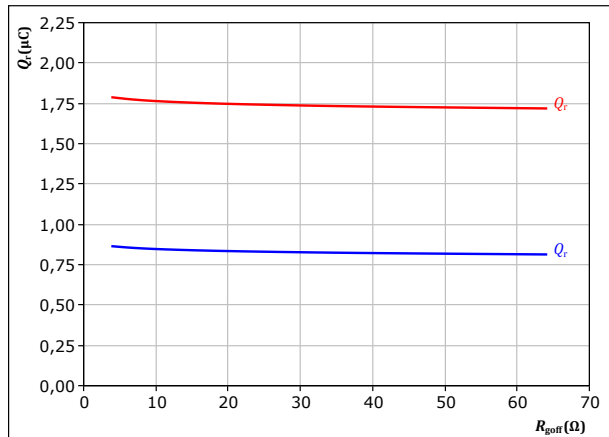
$V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $R_{goff} = 16$ Ω

T_j : — 25 °C
— 125 °C

figure 31. FWD

Typical recovered charge as a function of turn off gate resistor

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



With an inductive load at

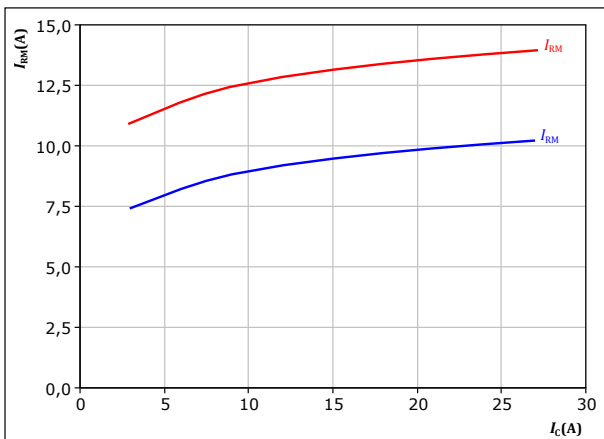
$V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

T_j : — 25 °C
— 125 °C

figure 32. FWD

Typical peak reverse recovery current as a function of collector current

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



With an inductive load at

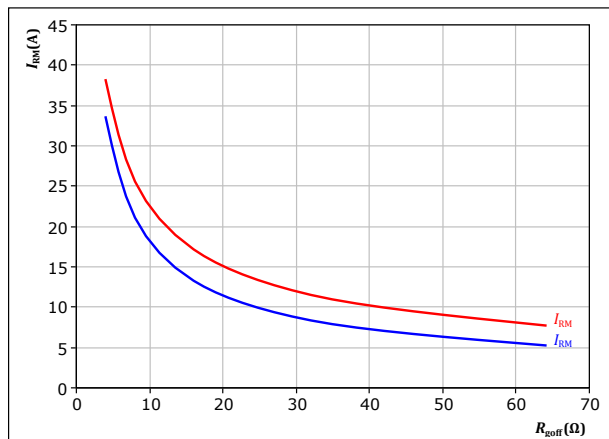
$V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $R_{goff} = 16$ Ω

T_j : — 25 °C
— 125 °C

figure 33. FWD

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

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



With an inductive load at

$V_{CE} = 400$ V
 $V_{GE} = \pm 15$ V
 $I_c = 15$ A

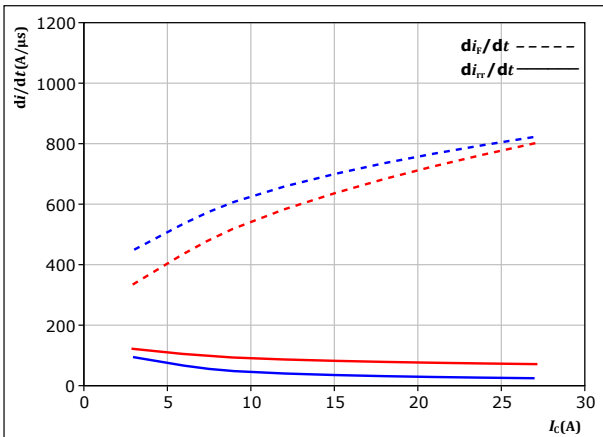
T_j : — 25 °C
— 125 °C



Inverter Switching Characteristics

figure 34. FWD

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

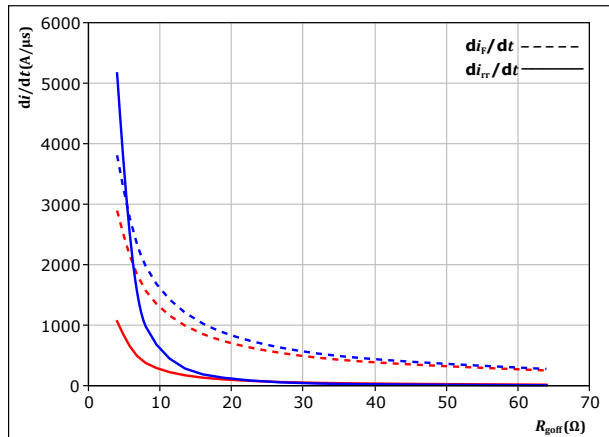


With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{goff} = 16 \text{ } \Omega$

T_j : — 25 °C
 — 125 °C

figure 35. FWD

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

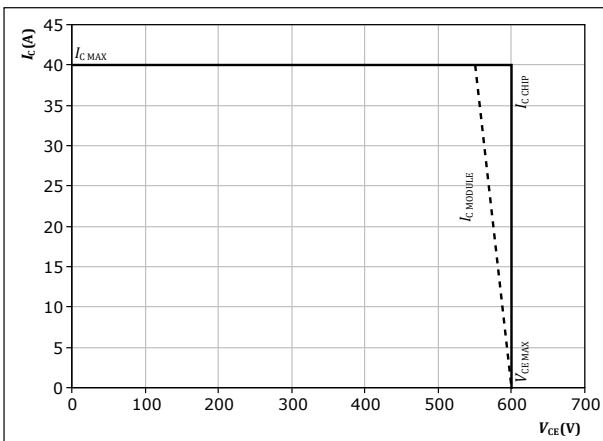


With an inductive load at
 $V_{CE} = 400 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $I_c = 15 \text{ A}$

T_j : — 25 °C
 — 125 °C

figure 36. IGBT

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



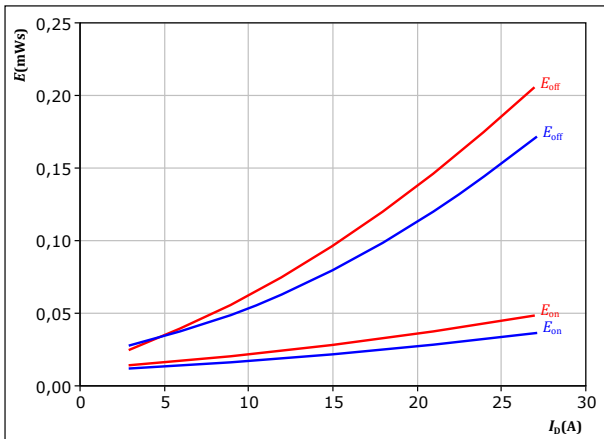
At $T_j = 125 \text{ } ^\circ\text{C}$
 $R_{goff} = 16 \text{ } \Omega$
 $R_{goff} = 16 \text{ } \Omega$



PFC Switching Characteristics

figure 37. MOSFET

Typical switching energy losses as a function of drain current
 $E = f(I_D)$



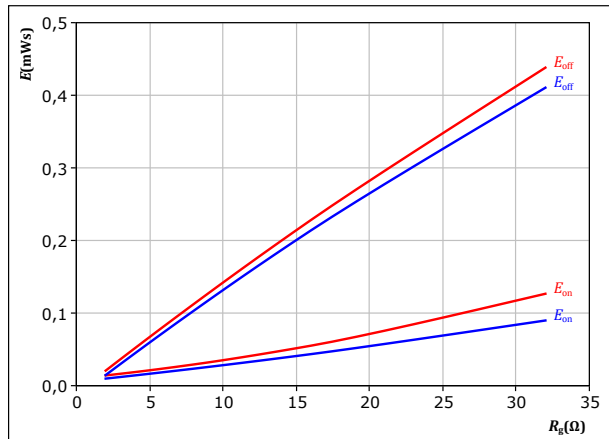
With an inductive load at

$V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $R_{gon} = 8$ Ω
 $R_{goff} = 8$ Ω

T_j : — 25 °C
 — 125 °C

figure 38. MOSFET

Typical switching energy losses as a function of gate resistor
 $E = f(R_g)$



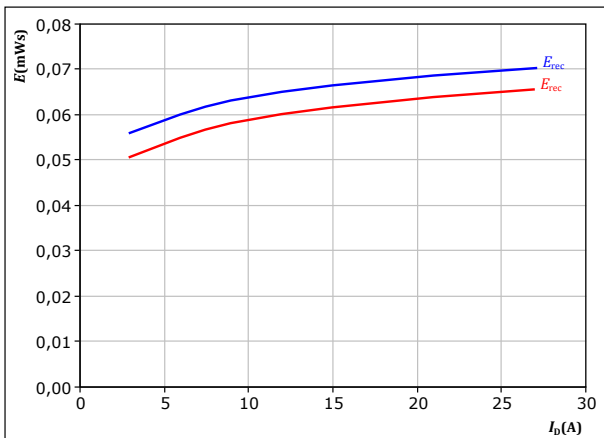
With an inductive load at

$V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $I_D = 15$ A

T_j : — 25 °C
 — 125 °C

figure 39. FWD

Typical reverse recovered energy loss as a function of drain current
 $E_{rec} = f(I_D)$



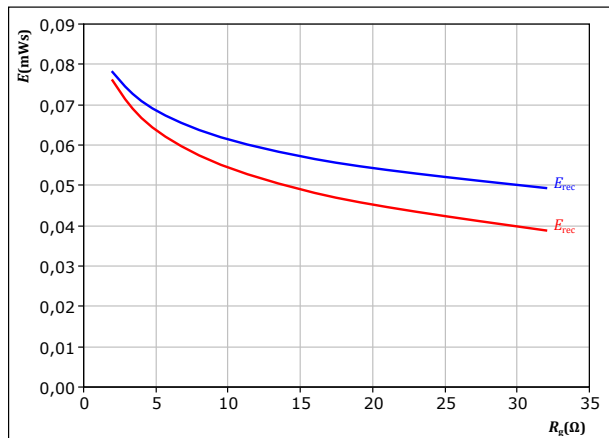
With an inductive load at

$V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $R_{gon} = 8$ Ω

T_j : — 25 °C
 — 125 °C

figure 40. FWD

Typical reverse recovered energy loss as a function of gate resistor
 $E_{rec} = f(R_g)$



With an inductive load at

$V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $I_D = 15$ A

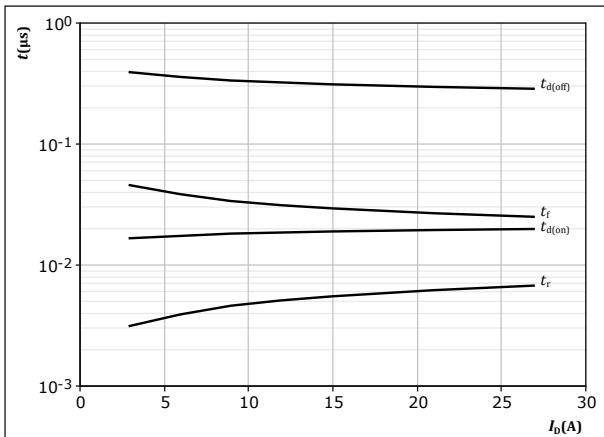
T_j : — 25 °C
 — 125 °C



PFC Switching Characteristics

figure 41. MOSFET

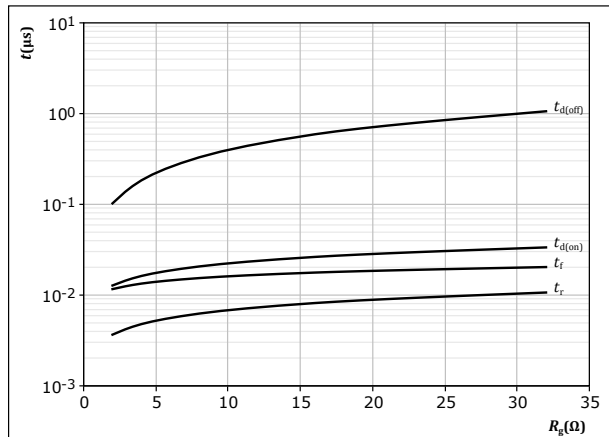
Typical switching times as a function of drain current
 $t = f(I_D)$



With an inductive load at
 $T_j = 125 \text{ }^\circ\text{C}$
 $V_{DS} = 400 \text{ V}$
 $V_{GS} = 0/16 \text{ V}$
 $R_{g\text{on}} = 8 \text{ } \Omega$
 $R_{g\text{off}} = 8 \text{ } \Omega$

figure 42. MOSFET

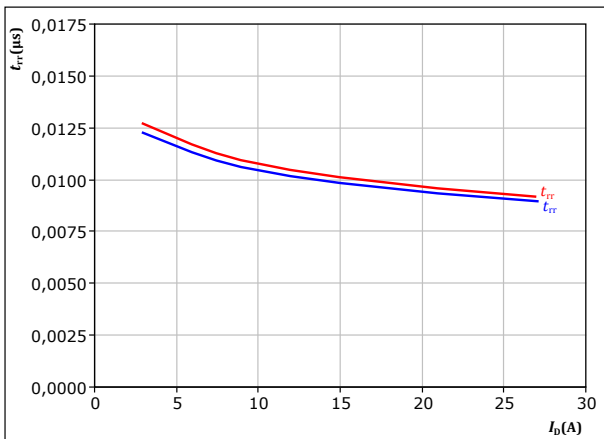
Typical switching times as a function of gate resistor
 $t = f(R_g)$



With an inductive load at
 $T_j = 125 \text{ }^\circ\text{C}$
 $V_{DS} = 400 \text{ V}$
 $V_{GS} = 0/16 \text{ V}$
 $I_D = 15 \text{ A}$

figure 43. FWD

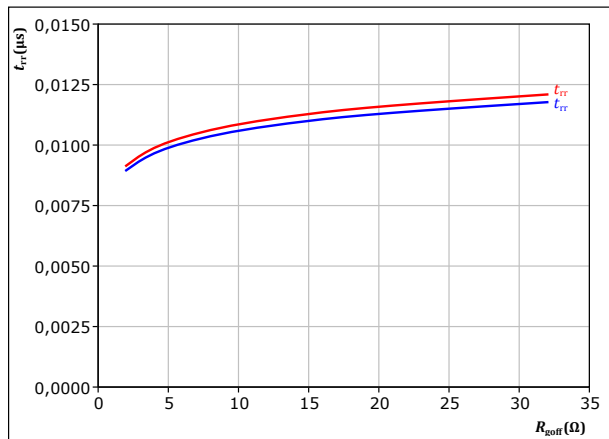
Typical reverse recovery time as a function of drain current
 $t_{rr} = f(I_D)$



At $V_{DS} = 400 \text{ V}$
 $V_{GS} = 0/16 \text{ V}$
 $R_{g\text{on}} = 8 \text{ } \Omega$
 T_j : — 25 °C
— 125 °C

figure 44. FWD

Typical reverse recovery time as a function of turn off gate resistor
 $t_{rr} = f(R_{g\text{off}})$



At $V_{DS} = 400 \text{ V}$
 $V_{GS} = 0/16 \text{ V}$
 $I_D = 15 \text{ A}$
 T_j : — 25 °C
— 125 °C

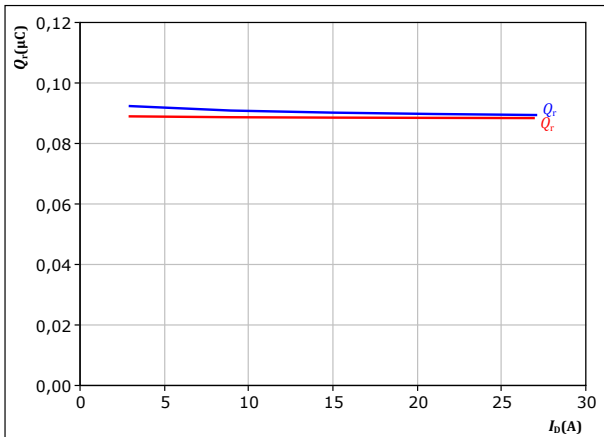


PFC Switching Characteristics

figure 45. FWD

Typical recovered charge as a function of drain current

$$Q_r = f(I_D)$$

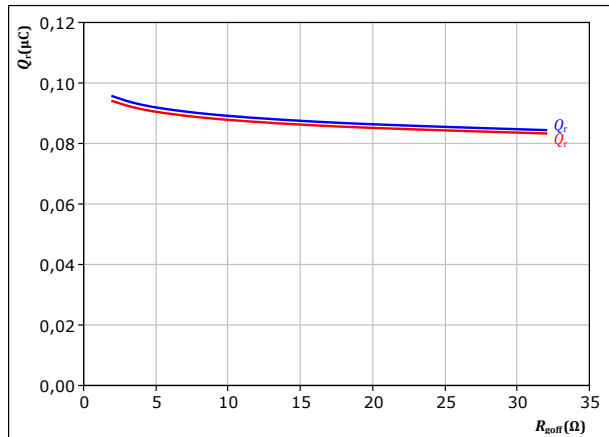


At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $R_{goff} = 8$ Ω
 T_j : — 25 °C
— 125 °C

figure 46. FWD

Typical recovered charge as a function of turn off gate resistor

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

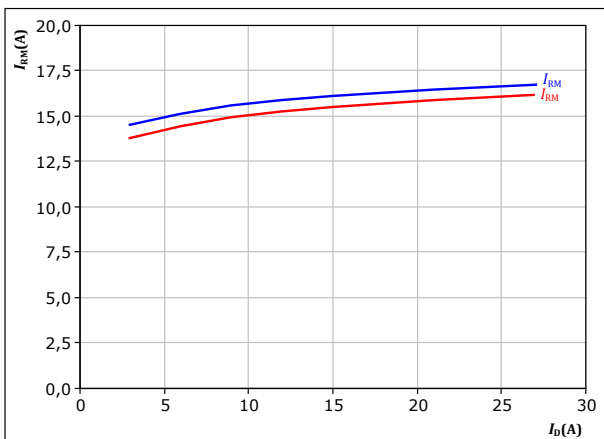


At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $I_D = 15$ A
 T_j : — 25 °C
— 125 °C

figure 47. FWD

Typical peak reverse recovery current as a function of drain current

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

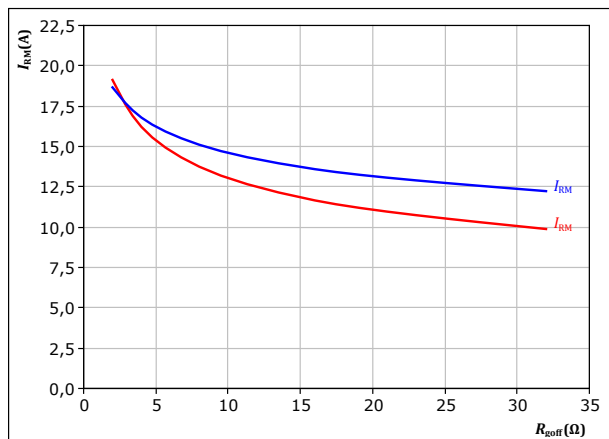


At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $R_{goff} = 8$ Ω
 T_j : — 25 °C
— 125 °C

figure 48. FWD

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

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



At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $I_D = 15$ A
 T_j : — 25 °C
— 125 °C

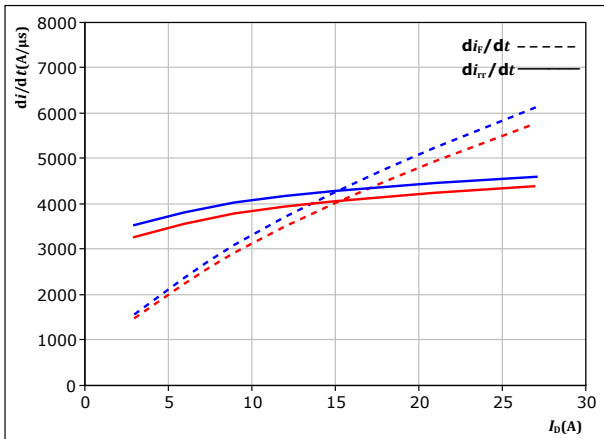


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PFC Switching Characteristics

figure 49. FWD

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

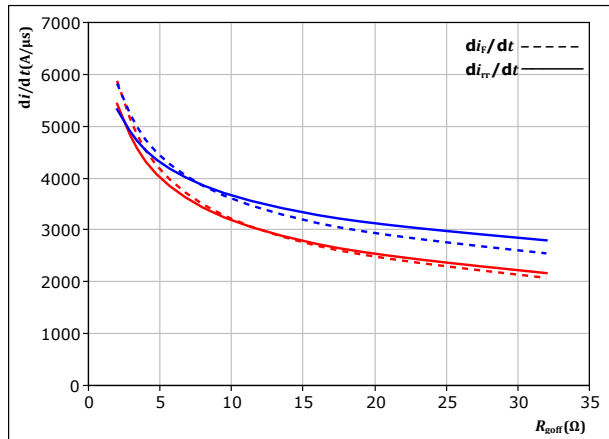


At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $R_{g(on)} = 8$ Ω

T_j : — 25 °C
- - - 125 °C

figure 50. FWD

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



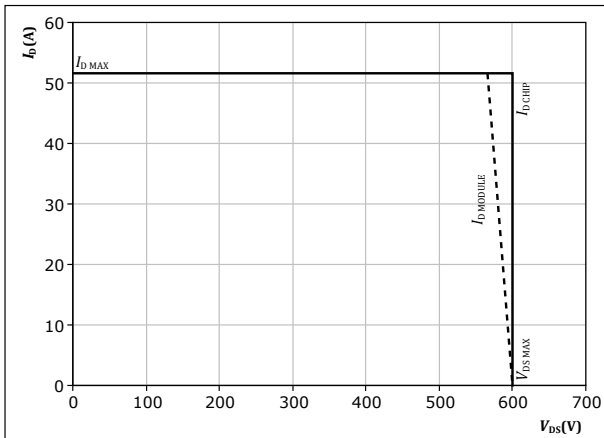
At $V_{DS} = 400$ V
 $V_{GS} = 0/16$ V
 $I_D = 15$ A

T_j : — 25 °C
- - - 125 °C

figure 51. MOSFET

Reverse bias safe operating area

$I_D = f(V_{DS})$



At $T_j = 125$ °C
 $R_{g(on)} = 8$ Ω
 $R_{g(off)} = 8$ Ω



Inverter Switching Definitions

figure 52. IGBT
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff} (t_{Eoff} = integrating time for E_{off})

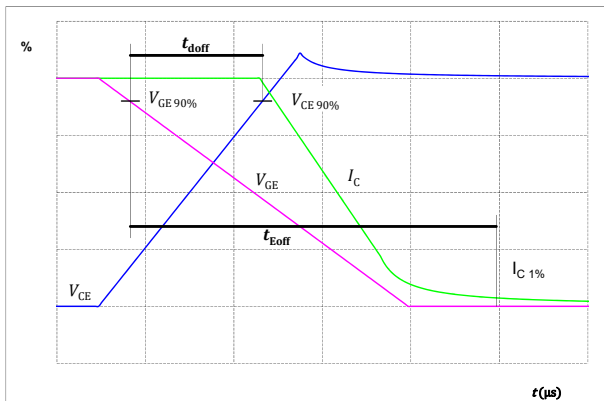


figure 53. IGBT
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon} (t_{Eon} = integrating time for E_{on})

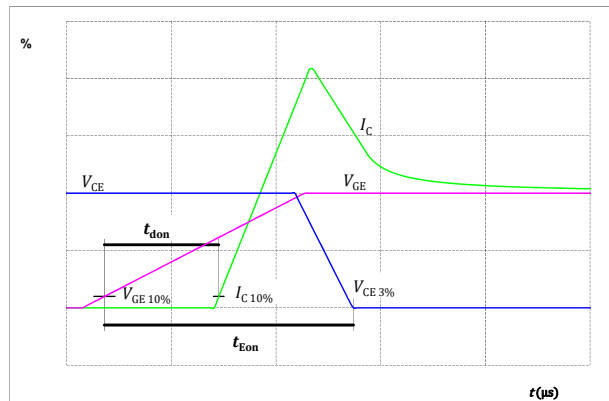


figure 54. IGBT
Turn-off Switching Waveforms & definition of t_f

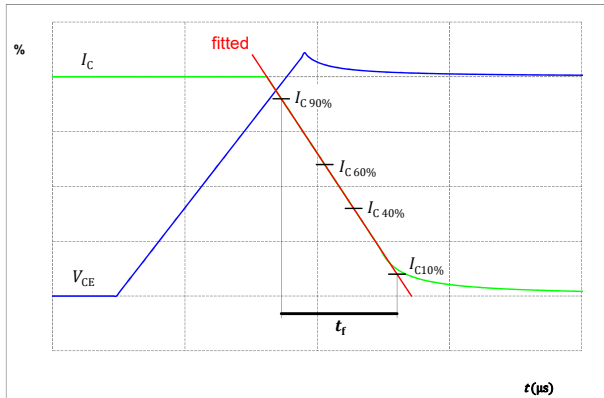
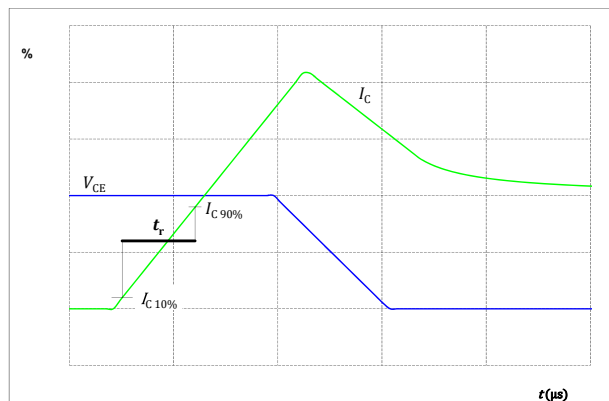


figure 55. IGBT
Turn-on Switching Waveforms & definition of t_r





Inverter Switching Definitions

figure 56. FWD

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

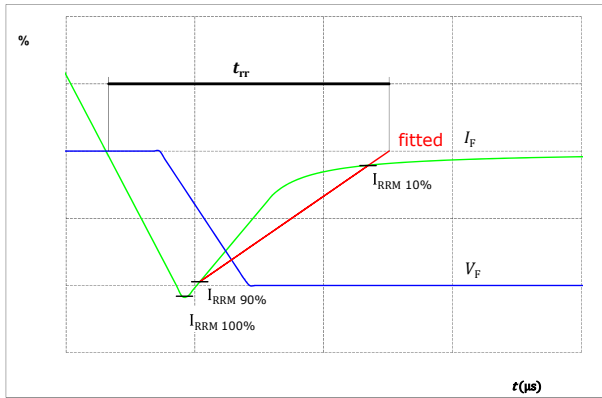
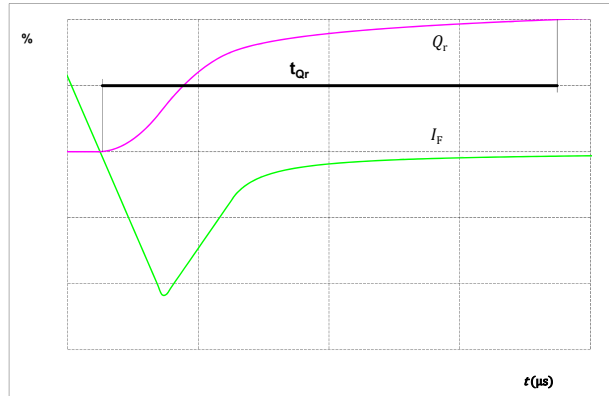


figure 57. FWD

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





PFC Switching Definitions

figure 52. MOSFET
Turn-off Switching Waveforms & definition of t_{doff} t_{Eoff} (t_{Eoff} = integrating time for E_{off})

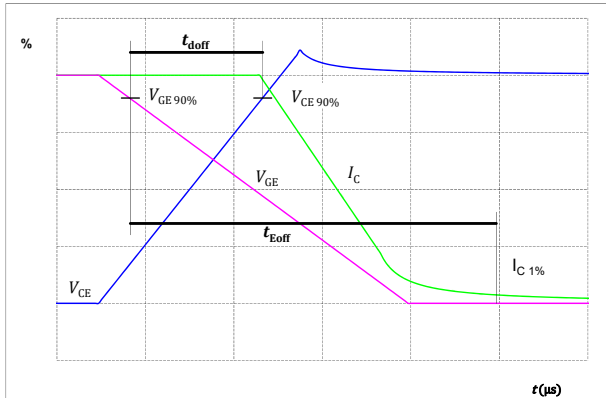


figure 53. MOSFET
Turn-on Switching Waveforms & definition of t_{don} t_{Eon} (t_{Eon} = integrating time for E_{on})

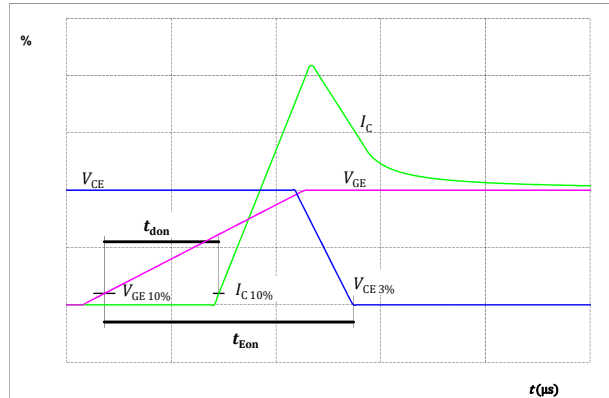


figure 54. MOSFET
Turn-off Switching Waveforms & definition of t_f

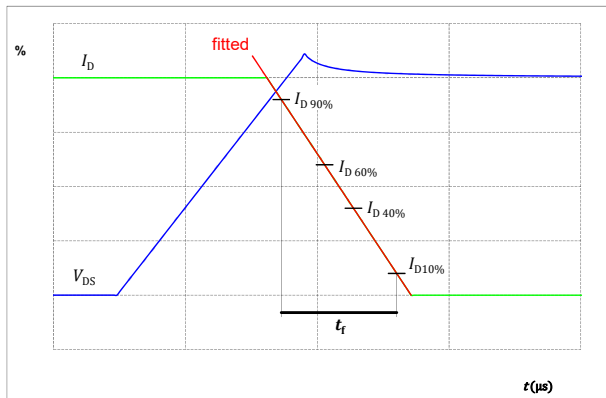
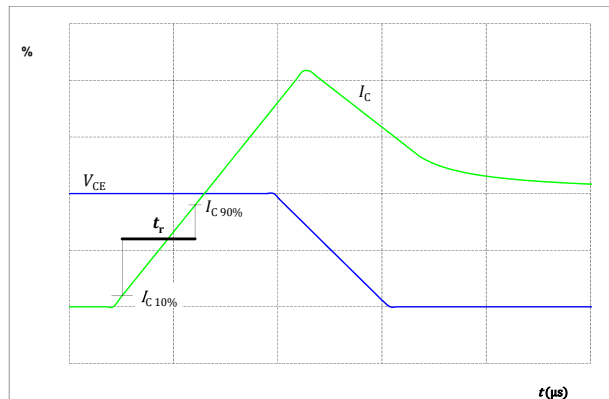


figure 55. MOSFET
Turn-on Switching Waveforms & definition of t_r





PFC Switching Definitions

figure 56. FWD

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

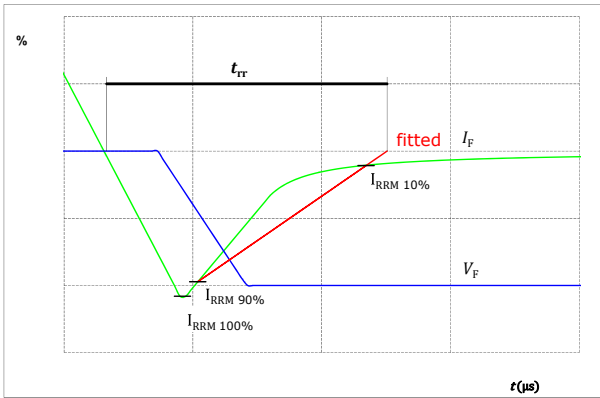


figure 57. FWD

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

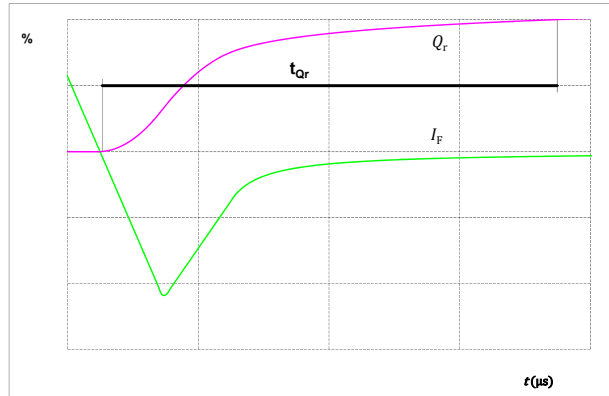
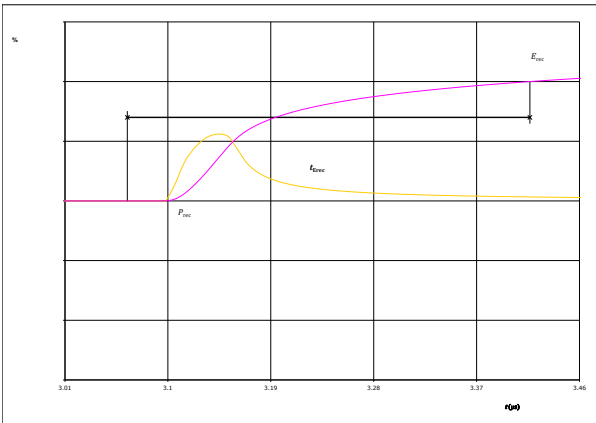


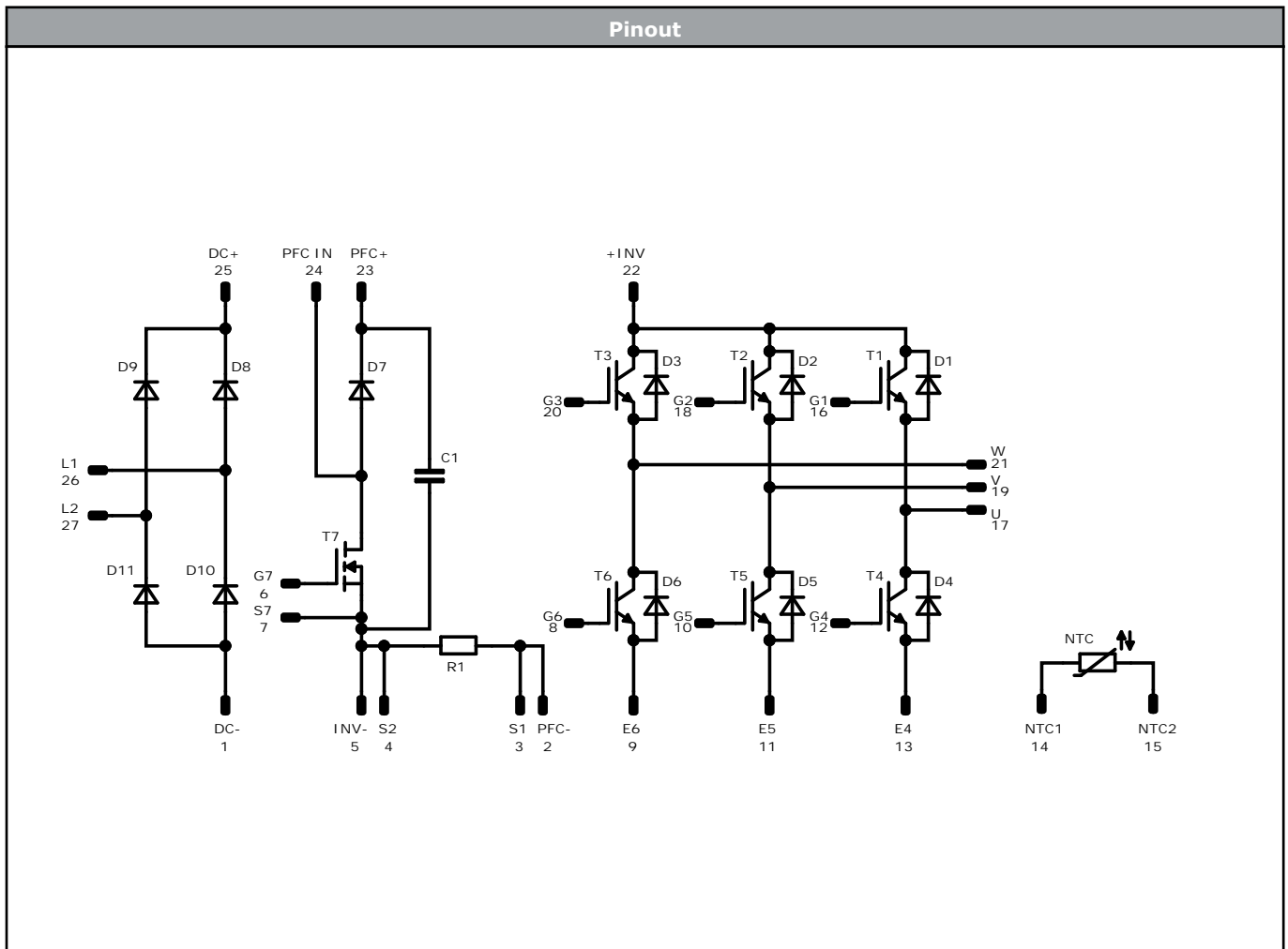
figure 58. FWD

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





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Identification					
ID	Component	Voltage	Current	Function	Comment
T6, T3, T5, T2, T4, T1	IGBT	600 V	20 A	Inverter Switch	
D3, D6, D2, D5, D1, D4	FWD	600 V	30 A	Inverter Diode	
T7	MOSFET	600 V	63 mΩ	PFC Switch	
D7	FWD	650 V	24 A	PFC Diode	
D11, D9, D10, D8	Rectifier	1600 V	25 A	Rectifier Diode	
R1	Shunt			PFC Shunt	
C1	Capacitor	500 V		Capacitor (PFC)	
NTC	Thermistor			Thermistor	




Vincotech

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.

Vincotech thermistor reference
See Vincotech thermistor reference table at 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-P006PPA020SB01-M685B10Y-D5-14	12 Jan. 2022	Update PFC (dynamic and Diode static values) according to PCN 15-2019	

DISCLAIMER

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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.