MiniSKiiP® 1 PIM + PFC — 600 V / 15 A

Features

- Solderless interconnection
- IGBT Trench 3 technology

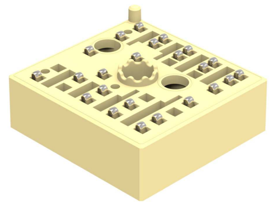
Target Applications

- Industrial drives

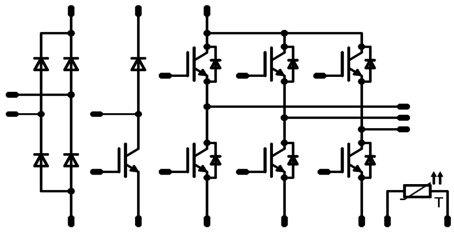
Types

- V23990-K203-B10-PM

MiniSKiiP® 1 housing



Schematic



Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Rectifier Diode					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$	T_s = 80 °C	30	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms	T_j=150°C	200	A
I2t-value	I^2t			200	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	46	W
Maximum Junction Temperature	T_{jmax}			150	°C
PFC Switch					
Collector-emitter breakdown voltage	V_{CE}			650	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	26	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		90	A
Turn off safe operating area		V_{CE} ≤ 650V, $T_j \leq T_{op}$ max		60	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	68	W
Gate-emitter peak voltage	V_{GE}			20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		5 400	μs V
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
PFC Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			650	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	37	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		90	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	67	W
Maximum Junction Temperature	T_{jmax}			175	°C
Inverter Switch					
Collector-emitter breakdown voltage	V_{CE}			600	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	21	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		45	A
Turn off safe operating area		V_{CE} ≤ 600V, $T_j \le T_{op}$ max		30	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	53	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		6 360	μs V
Maximum Junction Temperature	T_{jmax}			175	°C
Inverter Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		40	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	38	W
Maximum Junction Temperature	T_{jmax}			175	°C
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+(T_{jmax} - 25)	°C
Isolation Properties					
Isolation voltage	V_{is}	t = 2 s	DC Test Voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative tracking index	CTI			>200	

Characteristic Values

Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Value Min	Value Typ	Value Max	Unit
Rectifier Diode										
Forward voltage	V_F				25	25 125	1	1,51 1,42	1,75	V
Threshold voltage (for power loss calc. only)	V_{to}				25	25 125		0,86 0,79		V
Slope resistance (for power loss calc. only)	r_t				25	25 125		26 25		mΩ
Reverse current	I_r			1600		25 125			0,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,51		K/W
PFC Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00043	25 125	4,2	5,1	5,6	V
Collector-emitter saturation voltage	V_{CEsat}		15		30	25 125	1	2,1 2,3	2,6	V
Collector-emitter cut-off	I_{CES}		0	650		25 125			0,01	mA
Gate-emitter leakage current	I_{GES}		20	0		25 125			400	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 16 Ω	±15	300	15	25 125		22 21		ns
Rise time	t_r					25 125		28,2 27,8		
Turn-off delay time	$t_{d(off)}$					25 125		197 222		
Fall time	t_f					25 125		6 37		
Turn-on energy loss	E_{on}					25 125		0,278 0,507		mWs
Turn-off energy loss	E_{off}					25 125		0,15 0,228		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		1630		pF
Output capacitance	C_{oss}							108		
Reverse transfer capacitance	C_{rss}							50		
Gate charge	Q_G		±15	480	30	25		167		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,40		K/W
PFC Diode										
Forward voltage	V_F				30	25 125	1	2,1 1,83	2,9	V
Reverse leakage current	I_{rm}			650		25 125			10	µA
Peak recovery current	I_{RRM}	R_{gon} = 16 Ω	±15	300	15	25 125		8,06 14,94		A
Reverse recovery time	t_{rr}					25 125		94,2 128,9		ns
Reverse recovery charge	Q_{rr}					25 125		0,31 1,11		µC
Reverse recovered energy	E_{rec}					25 125		0,05 0,16		mWs
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		526 195		A/µs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,42		K/W

Characteristic Values

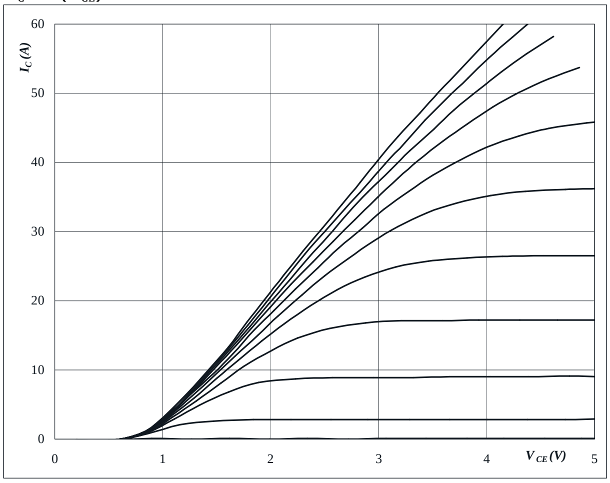
Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Value Min	Value Typ	Value Max	Unit
Inverter Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00021	25 125	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		15	25 125	1,1	1,73 1,87	2,2	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25 125			0,05	mA
Gate-emitter leakage current	I_{GES}		20	0		25 125			300	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 16 Ω	±15	300	15	25 125		17,8 17,8		ns
Rise time	t_r					25 125		18,2 22,5		
Turn-off delay time	$t_{d(off)}$					25 125		135 155		
Fall time	t_f					25 125		100 103		
Turn-on energy loss	E_{on}					25 125		0,39 0,5		mWs
Turn-off energy loss	E_{off}					25 125		0,35 0,45		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		860		pF
Output capacitance	C_{oss}							55		
Reverse transfer capacitance	C_{rss}							24		
Gate charge	Q_G		±15	480	15	25		87		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						1,81		K/W
Inverter Diode										
Diode forward voltage	V_F				20	25 125	0,8	1,8 1,86	2,1	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 16 Ω	±15	300	15	25 125		8,25 10,6		A
Reverse recovery time	t_{rr}					25 125		217,5 332,1		ns
Reverse recovered charge	Q_{rr}					25 125		0,81 1,45		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		43 63		A/µs
Reverse recovered energy	E_{rec}					25 125		0,15 0,29		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50um λ = 1 W/mK						2,51		K/W
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1670 Ω				100	-3		3	%
Power dissipation	P					100		1670,3125		Ω
Power dissipation constant						25				mW/K
B-value	$B_{(25/50)}$					25		$7,635*10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1,731*10^{-5}$		1/K²
Vincotech NTC Reference									E	

Inverter Characteristics

figure 1.	**IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



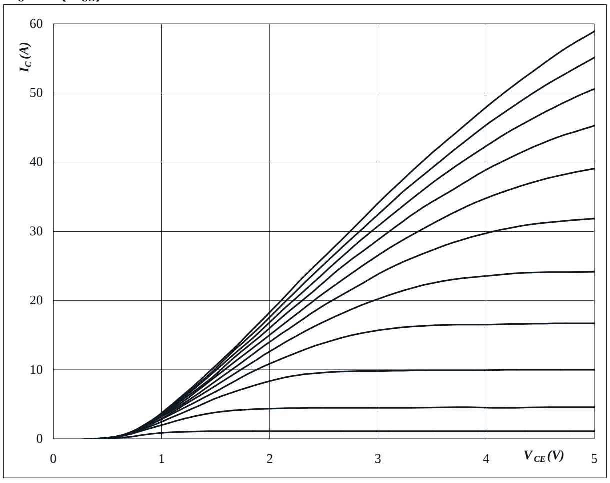
At

t_p =	250	µs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 2.	**IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



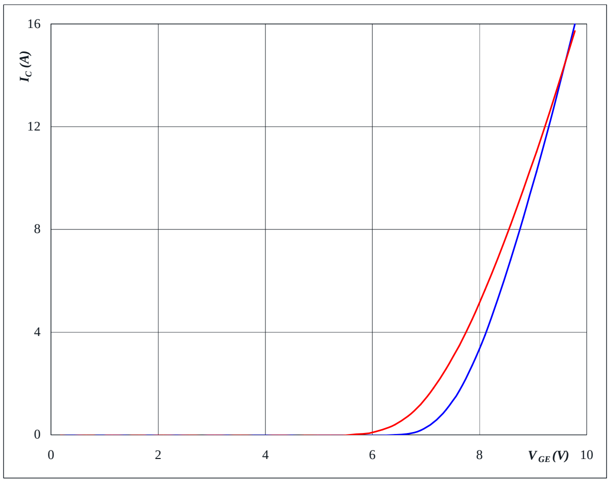
At

t_p =	250	µs
T_j =	125	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3.	**IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$



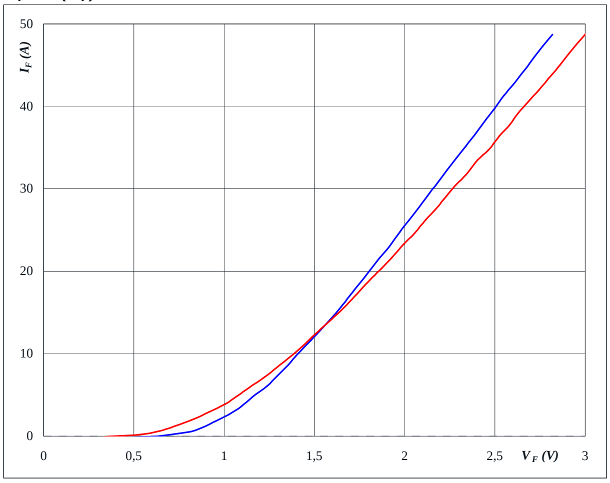
At

T_j =	25/125	°C
t_p =	250	µs
V_{CE} =	10	V

figure 4.	**FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

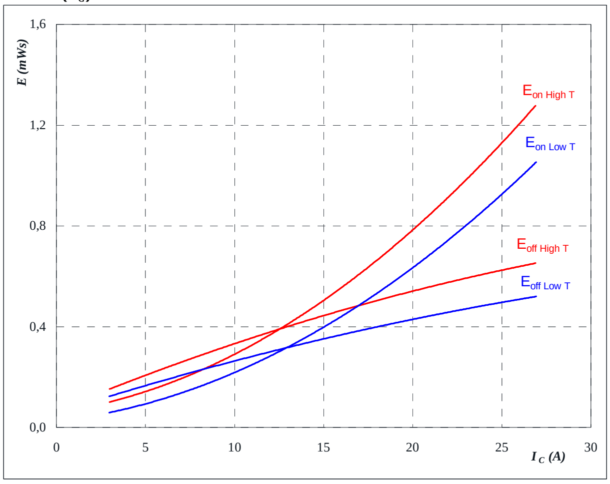
T_j =	25/125	°C
t_p =	250	µs

Inverter Characteristics

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



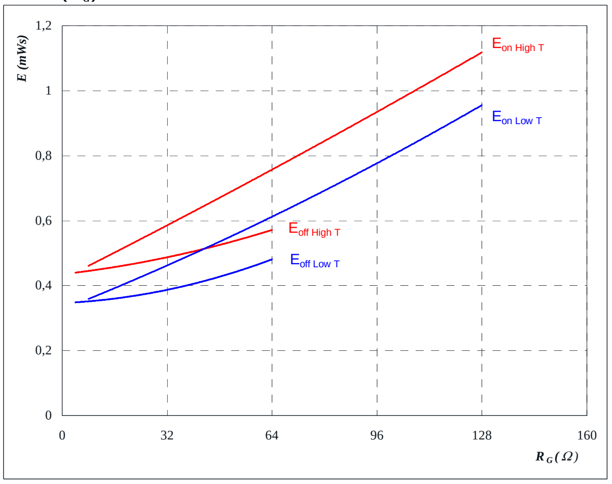
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω
R_{goff} =	8	Ω

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



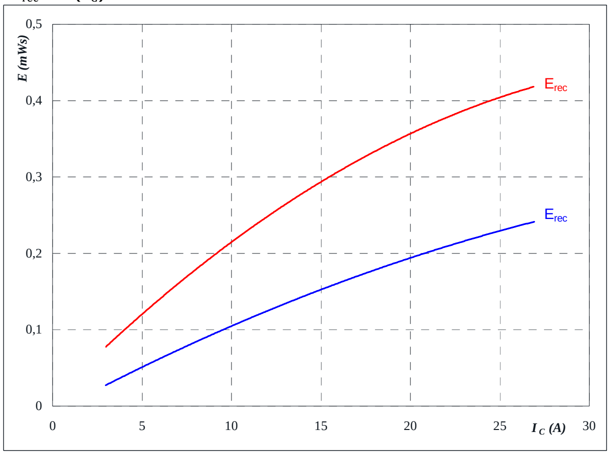
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

figure 7. **FWD**

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_C)$



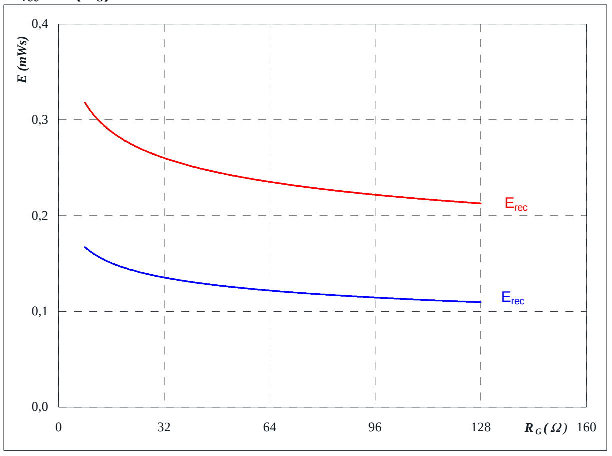
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 8. **FWD**

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

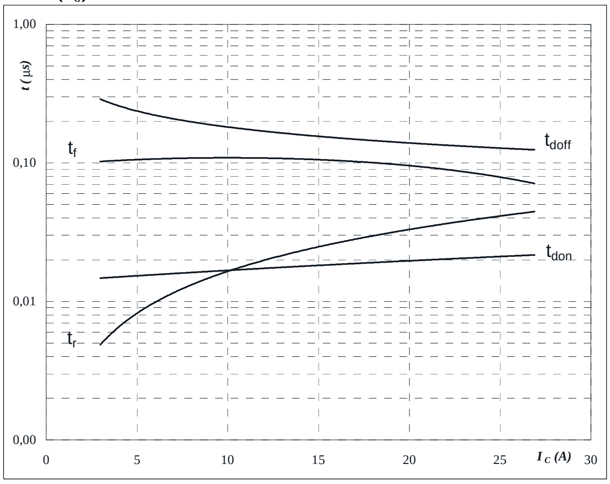
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

Inverter Characteristics

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



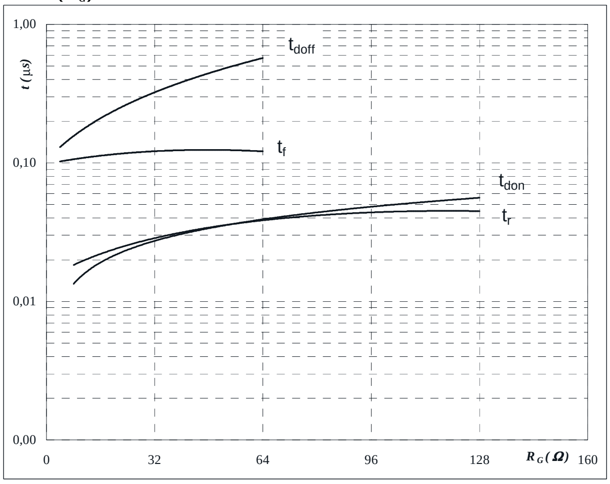
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω
R_{goff} =	8	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



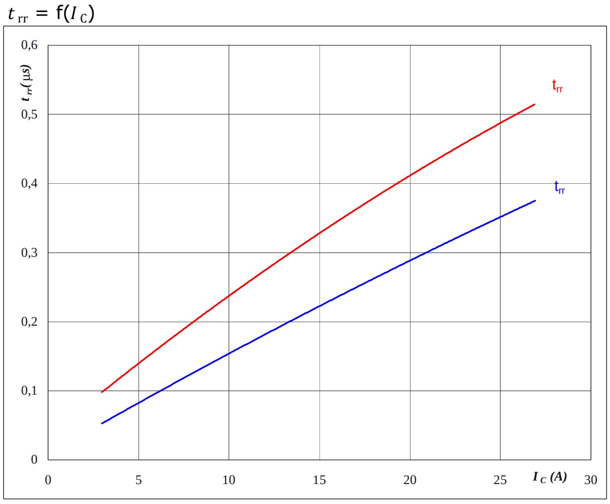
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



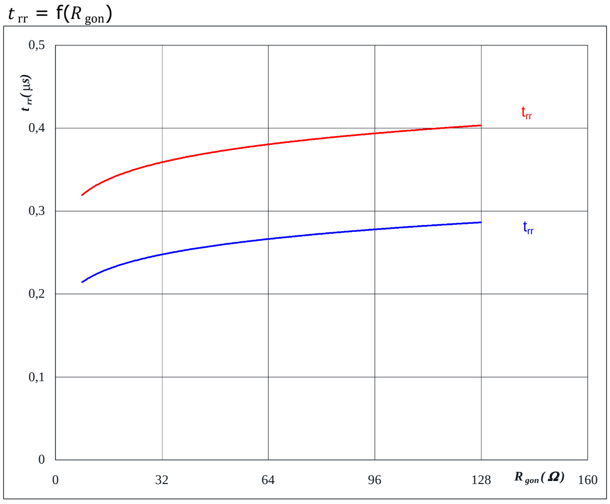
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 12. **FWD**

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

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



At

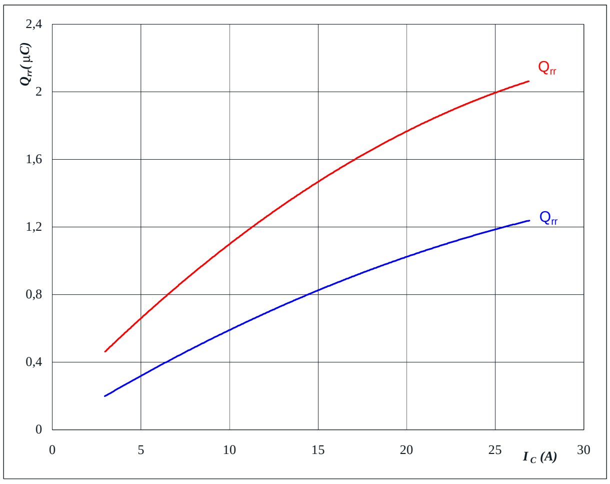
T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GE} =	15	V

Inverter Characteristics

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



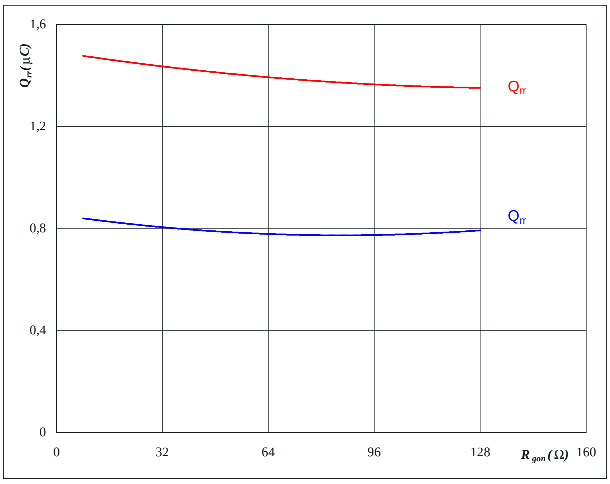
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 14. **FWD**

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

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



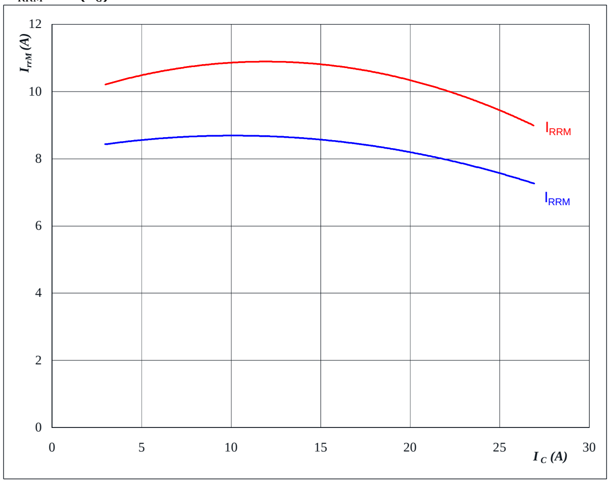
At

T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GE} =	15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



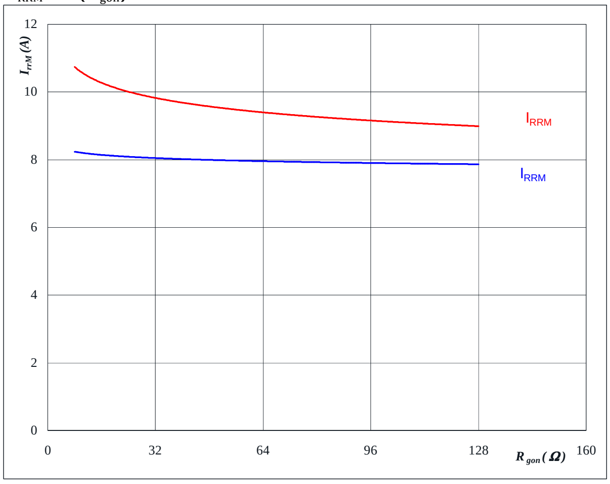
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 16. **FWD**

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

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



At

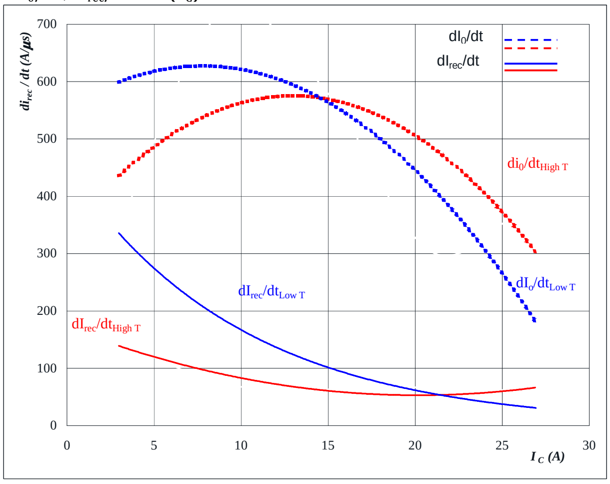
T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GE} =	15	V

Inverter Characteristics

figure 17. **FWD**

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

$dI_0/dt, dI_{rec}/dt = f(I_C)$



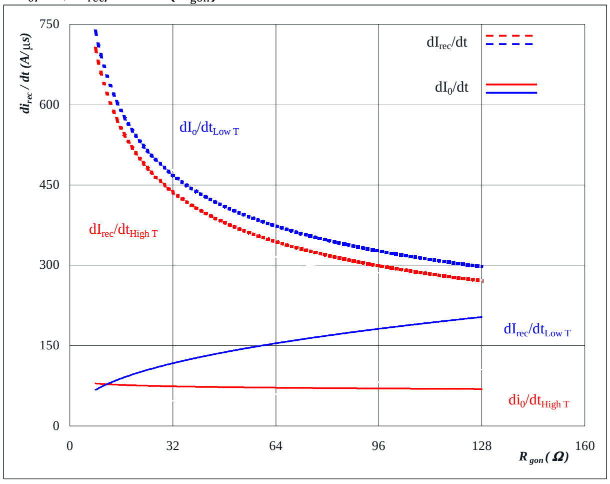
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 18. **FWD**

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

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



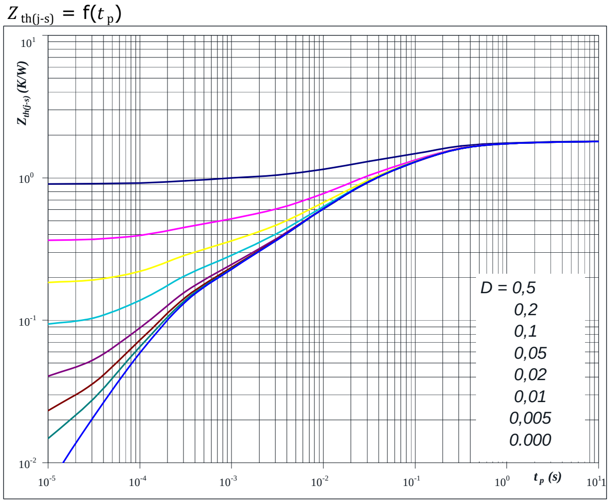
At

T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GE} =	15	V

figure 19. **IGBT**

IGBT transient thermal impedance as a function of pulse width

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



At

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

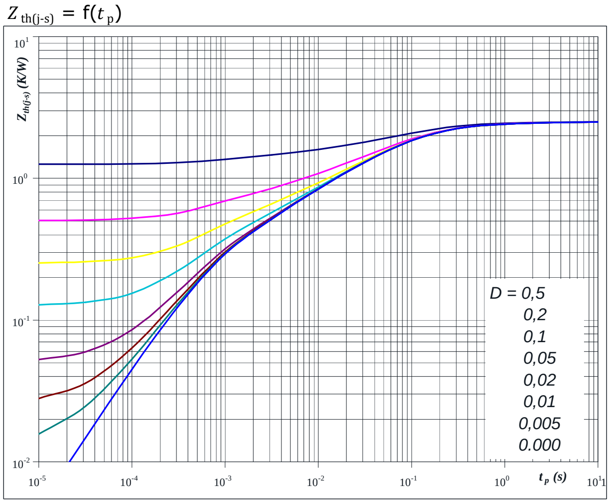
IGBT thermal model values

R (K/W)	Tau (s)
4,79E-02	6,42E+00
2,09E-01	5,50E-01
7,40E-01	1,07E-01
5,03E-01	1,63E-02
1,67E-01	2,67E-03
1,40E-01	2,31E-04

figure 20. **FWD**

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	2,51	K/W

FWD thermal model values

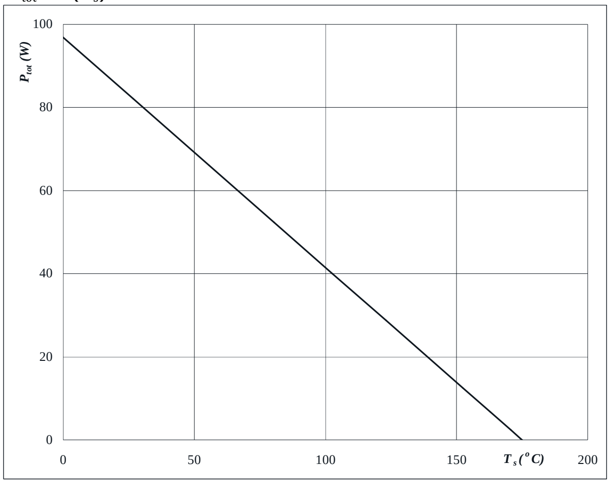
R (K/W)	Tau (s)
5,06E-02	9,02E+00
2,53E-01	6,56E-01
8,83E-01	1,18E-01
7,35E-01	2,86E-02
3,35E-01	4,82E-03
2,57E-01	6,88E-04

Inverter Characteristics

figure 21.	IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



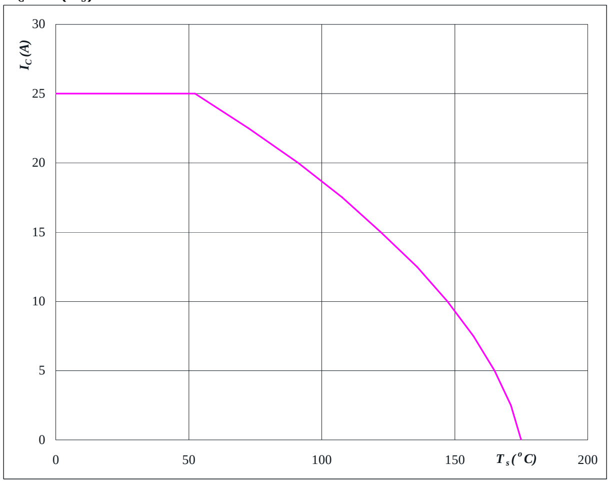
At

T_j = 175 °C

figure 22.	IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

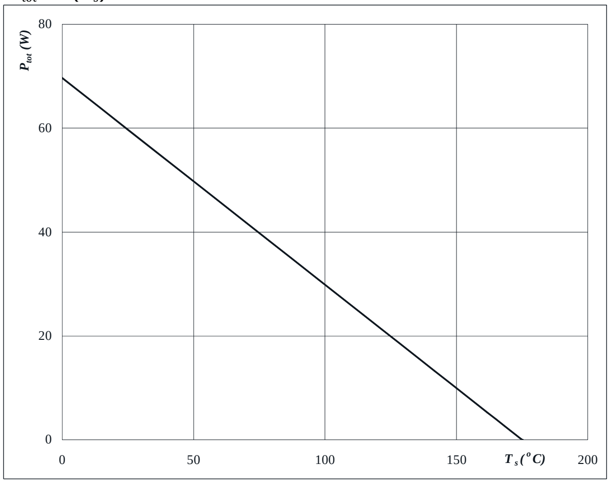
T_j = 175 °C

V_{GE} = 15 V

figure 23.	FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



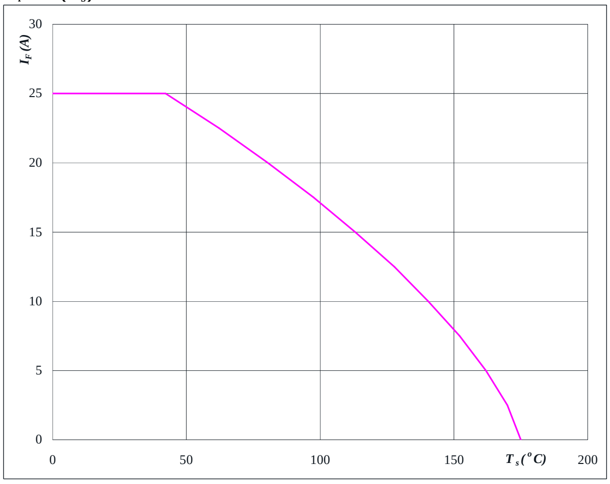
At

T_j = 175 °C

figure 24.	FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

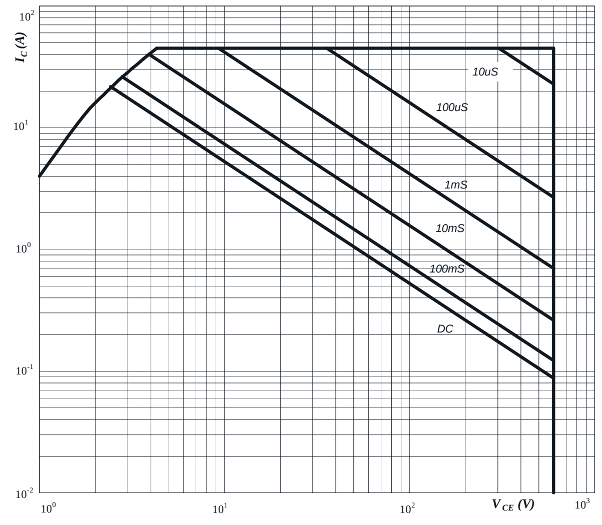
T_j = 175 °C

Inverter Characteristics

figure 25.	IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



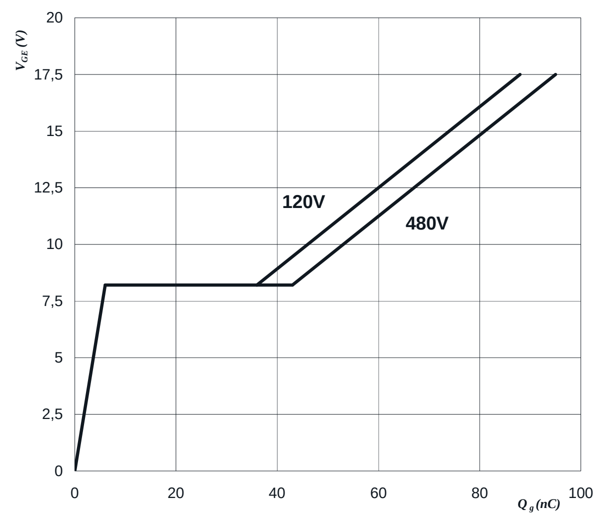
At

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

figure 26.	IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



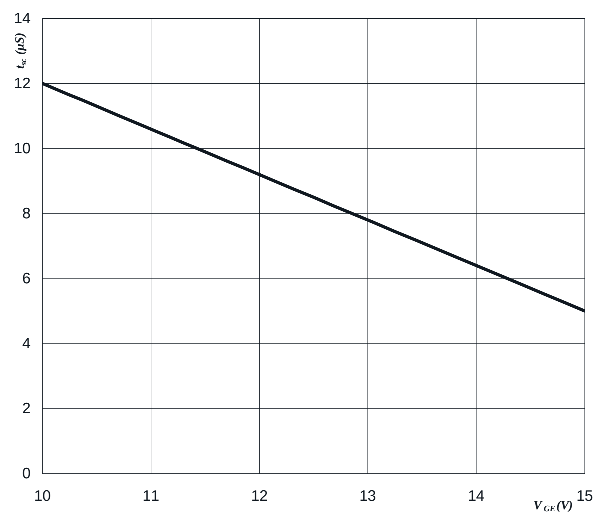
At

I_C =	15	A

figure 27.	IGBT

Short circuit withstand time as a function of gate-emitter voltage

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



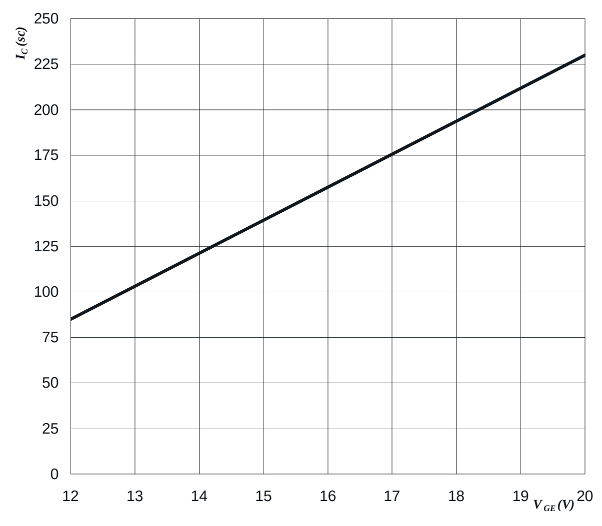
At

V_{CE} =	600	V
T_j ≤	175	ºC

figure 28.	IGBT

Typical short circuit collector current as a function of gate-emitter voltage

$I_{C(sc)} = f(V_{GE})$



At

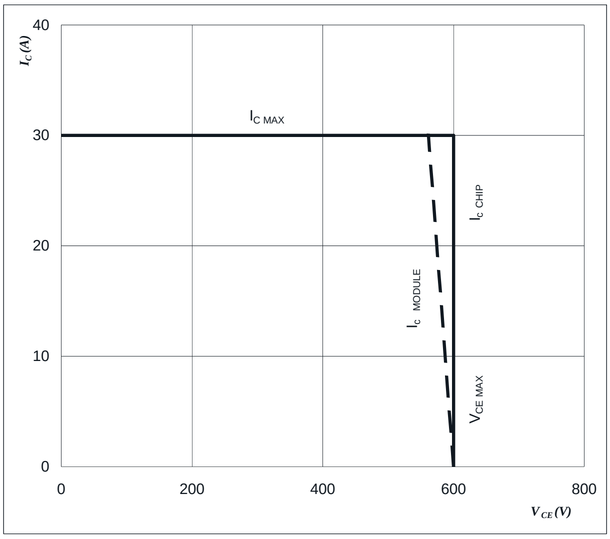
V_{CE} ≤	600	V
T_j =	175	ºC

Inverter Characteristics

figure 29.	IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

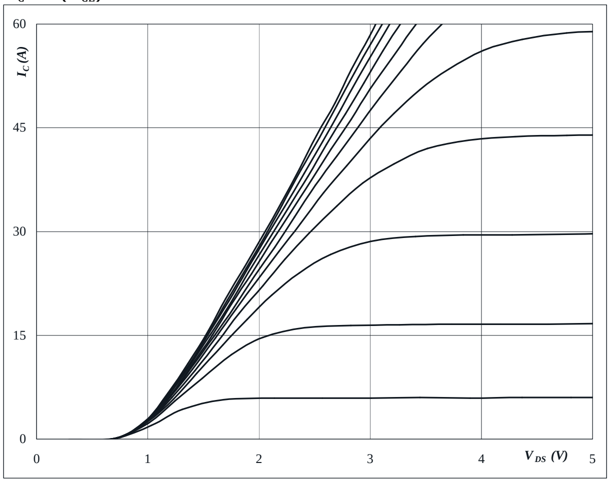
T_j = 125 °C
R_{gon} = 16 Ω
R_{goff} = 8 Ω

PFC Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

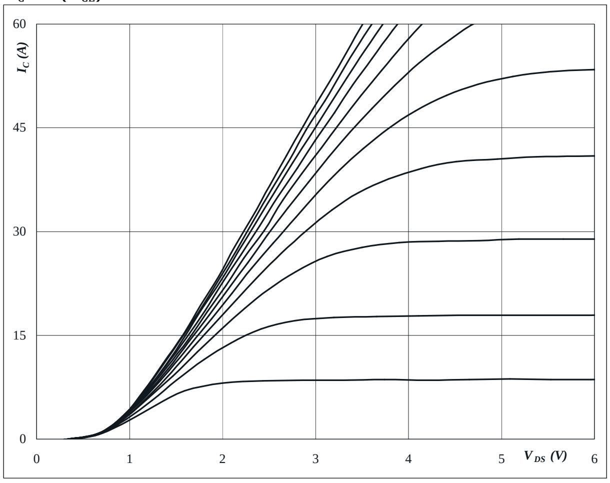
T_j = 25 °C

V_{CE} from 7 V to 17 V in steps of 1 V

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

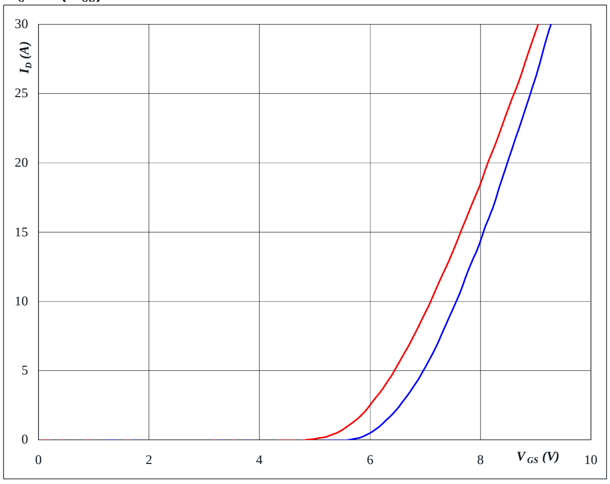
T_j = 126 °C

V_{CE} from 7 V to 17 V in steps of 1 V

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{CE})$



At

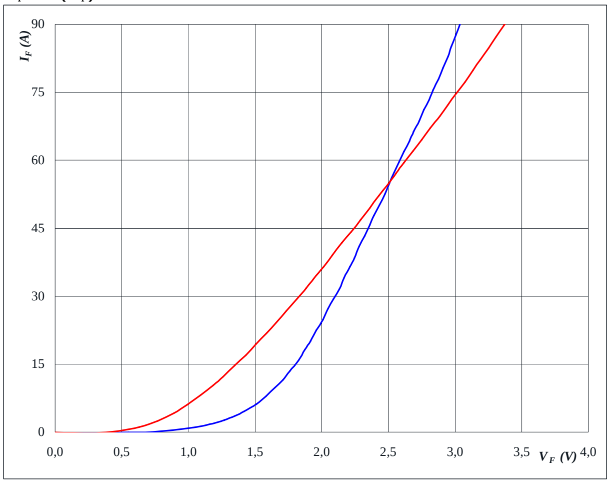
t_p = 250 µs T_j = 25/125 °C

V_{CE} = 10 V

figure 4. **FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

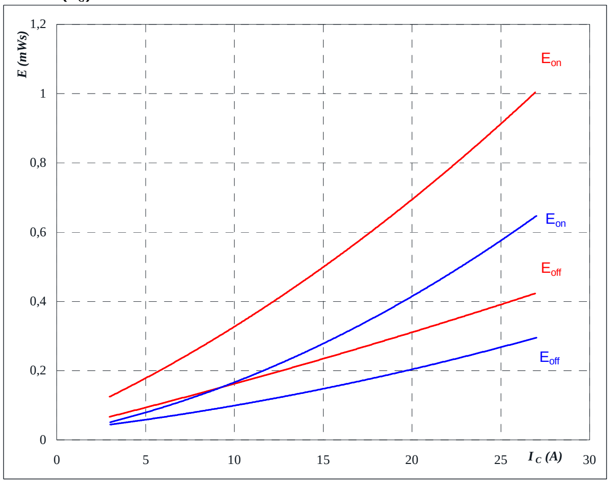
t_p = 250 µs T_j = 25/125 °C

PFC Characteristics

figure 5. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



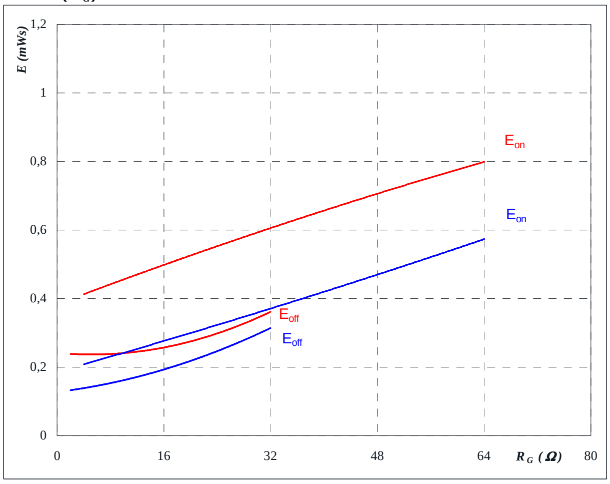
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω
R_{goff} =	8	Ω

figure 6. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



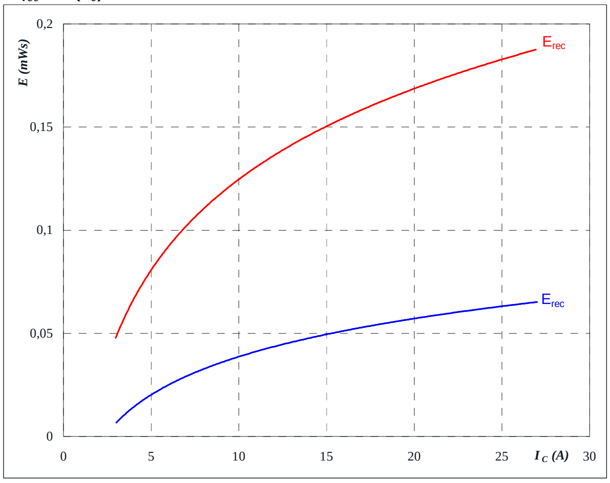
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

figure 7. **FWD**

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_c)$



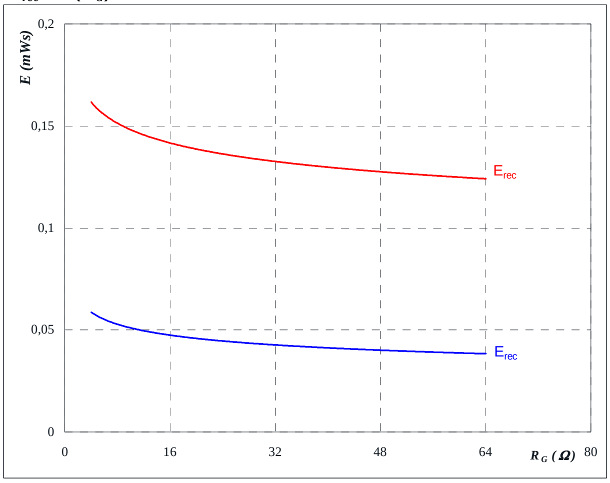
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω
R_{goff} =	8	Ω

figure 8. **FWD**

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

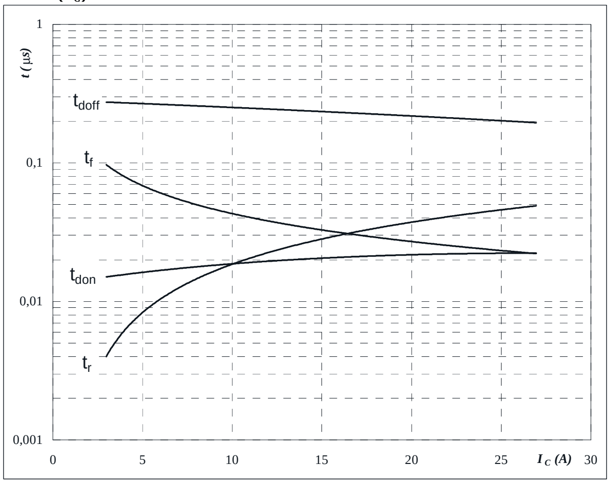
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

PFC Characteristics

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



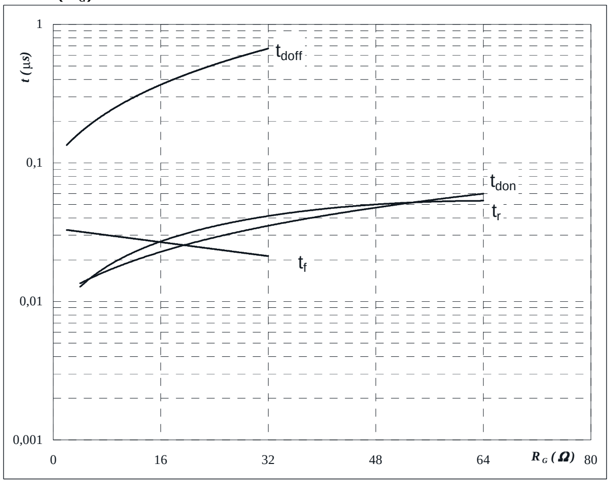
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω
R_{goff} =	8	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



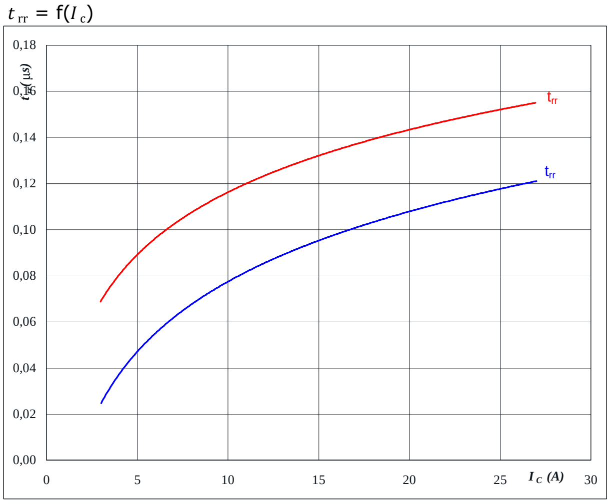
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	15	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$



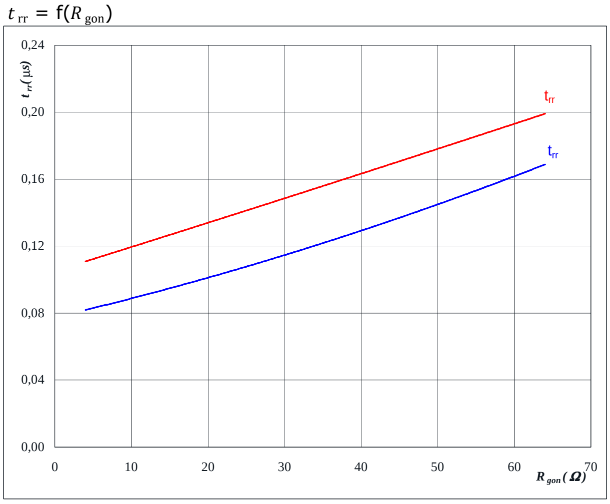
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 12. **FWD**

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

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



At

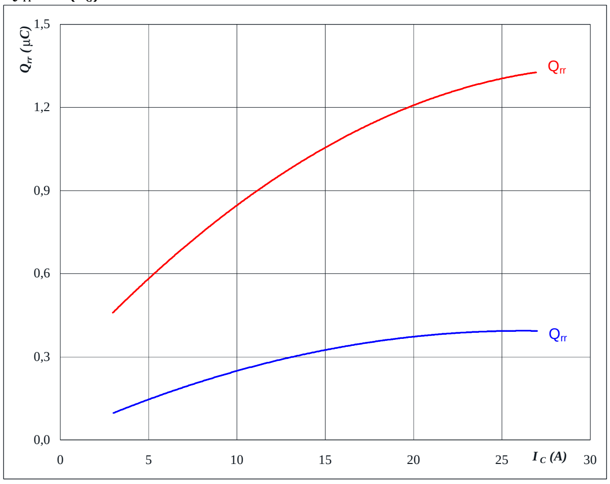
T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GS} =	15	V

PFC Characteristics

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



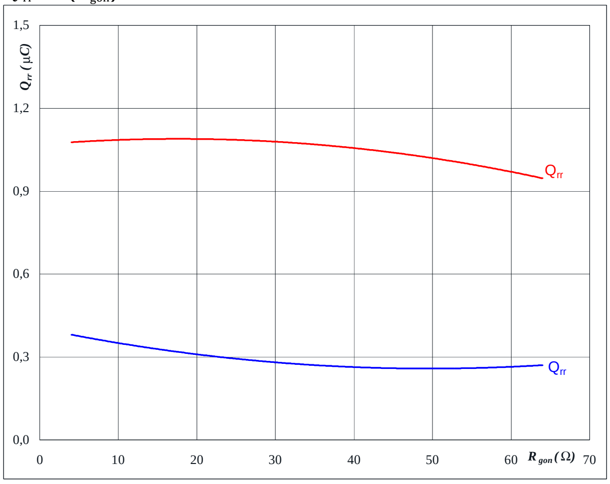
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 14. **FWD**

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

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



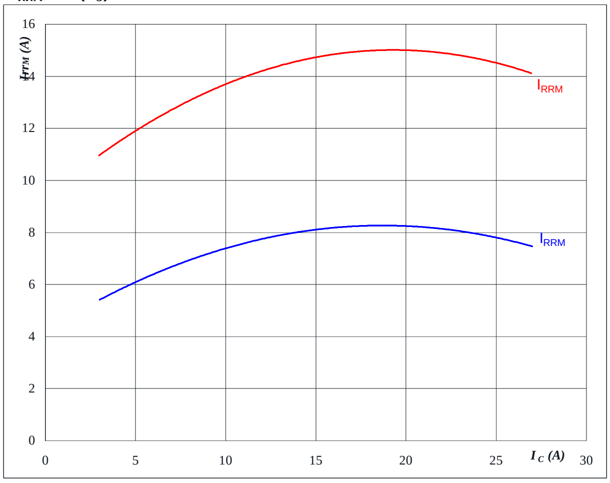
At

T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GS} =	15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



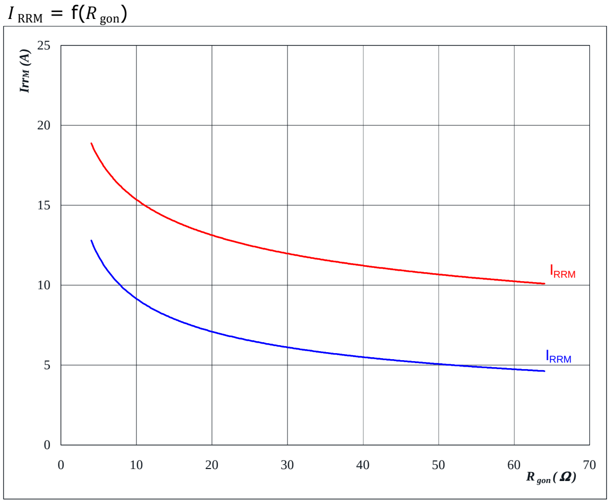
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 16. **FWD**

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

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



At

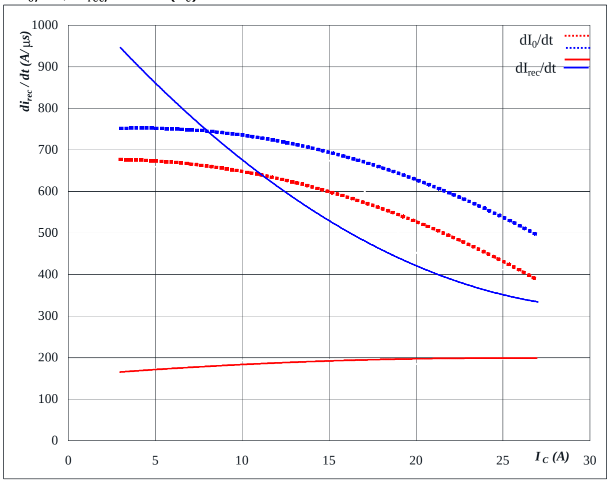
T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GS} =	15	V

PFC Characteristics

figure 17. **FWD**

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

$dI_0/dt, dI_{rec}/dt = f(I_c)$



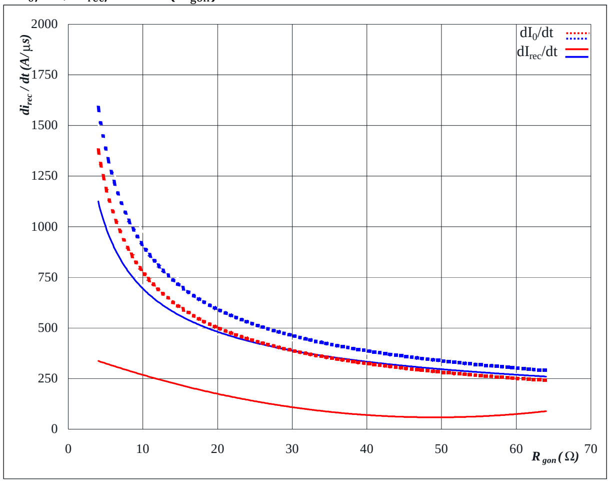
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	16	Ω

figure 18. **FWD**

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

$dI_0/dt, dI_{rec}/dt = f(R_{gon})$



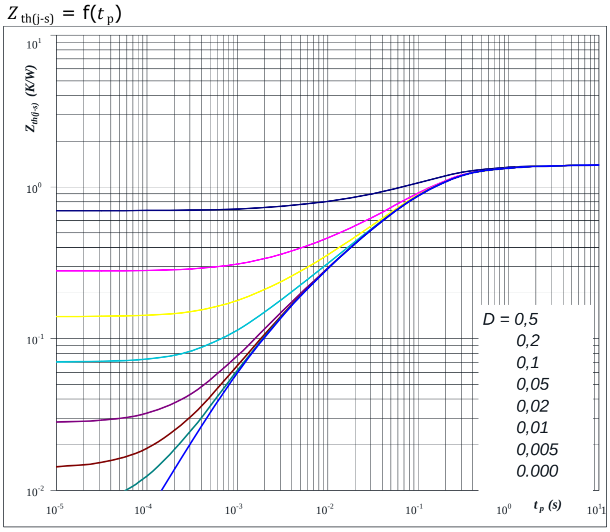
At

T_j =	25/125	°C
V_R =	300	V
I_F =	15	A
V_{GS} =	15	V

figure 19. **IGBT**

IGBT transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	1,40	K/W

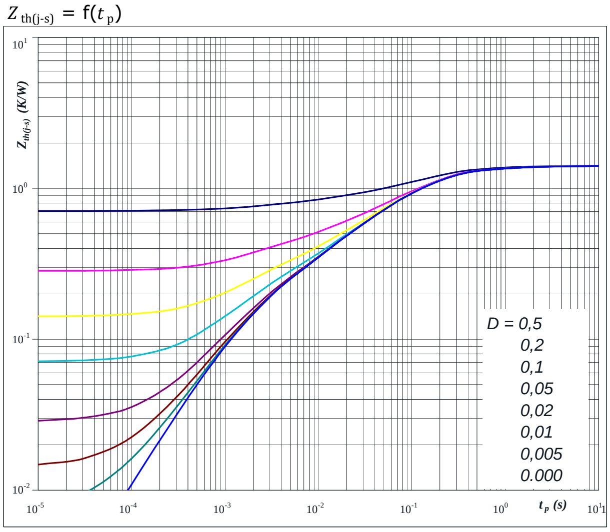
IGBT thermal model values

R (K/W)	Tau (s)
7,09E-02	2,80E+00
2,04E-01	4,27E-01
6,77E-01	1,13E-01
2,25E-01	3,41E-02
1,65E-01	8,19E-03
5,35E-02	1,40E-03

figure 20. **FWD**

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	1,42	K/W

FWD thermal model values

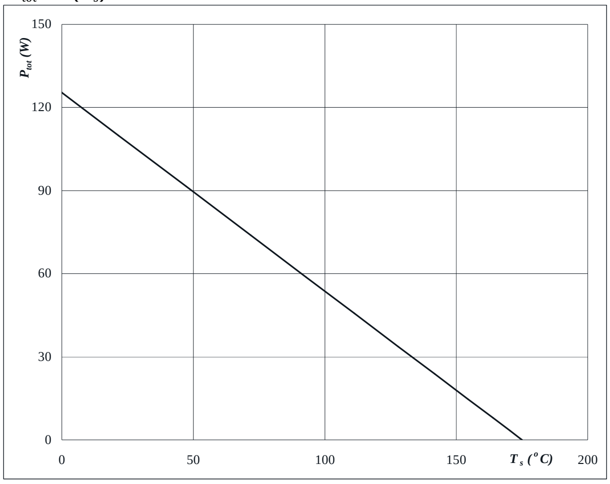
R (K/W)	Tau (s)
2,89E-02	8,41E+00
1,06E-01	9,99E-01
6,58E-01	1,49E-01
3,38E-01	4,10E-02
1,58E-01	8,96E-03
1,27E-01	1,55E-03

PFC Characteristics

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



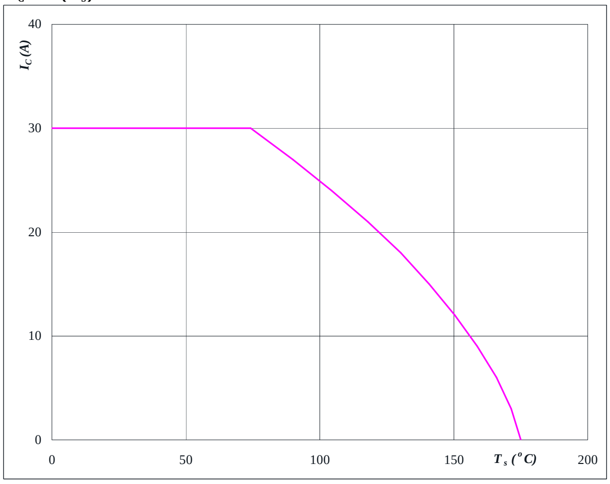
At

T_j =	175	ºC

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



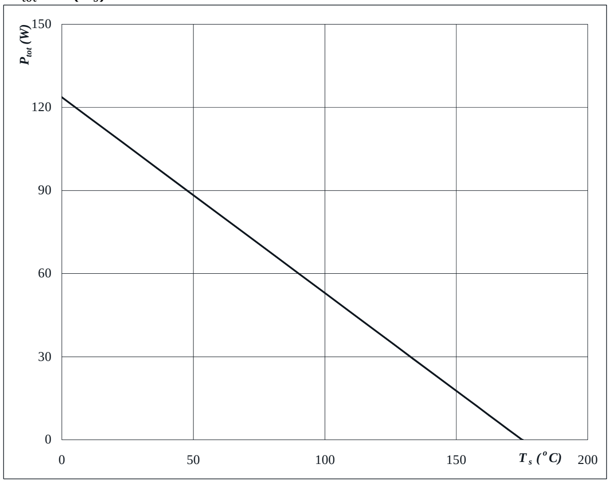
At

T_j =	175	ºC
V_{GE} =	15	V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



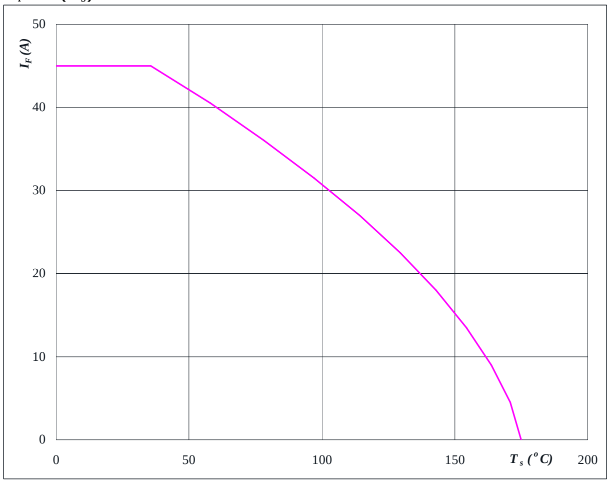
At

T_j =	175	ºC

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

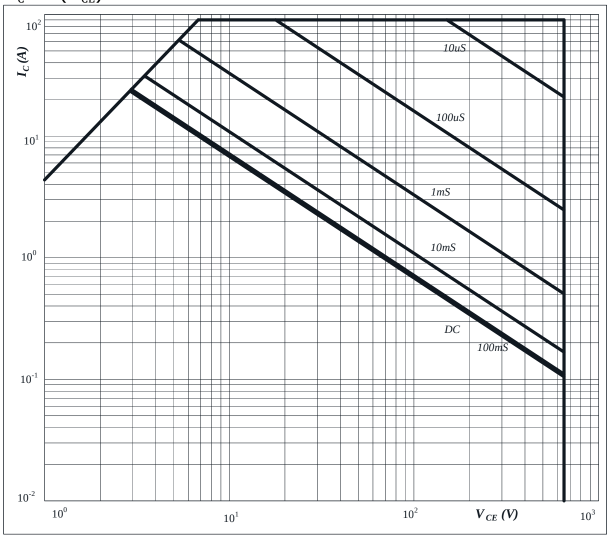
T_j =	175	ºC

PFC Characteristics

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



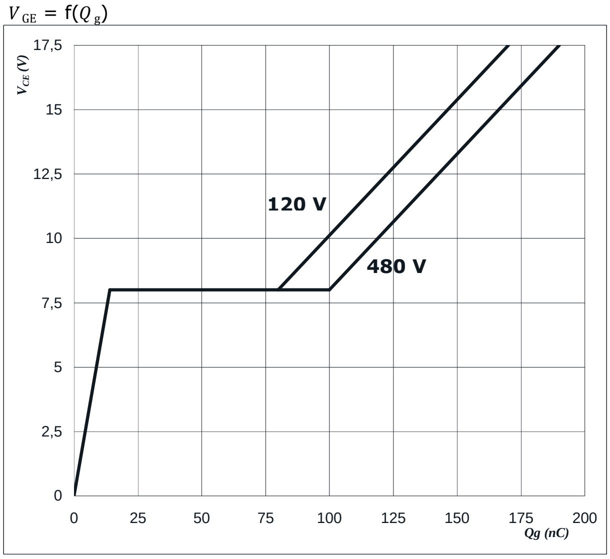
At

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

figure 26. **IGBT**

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



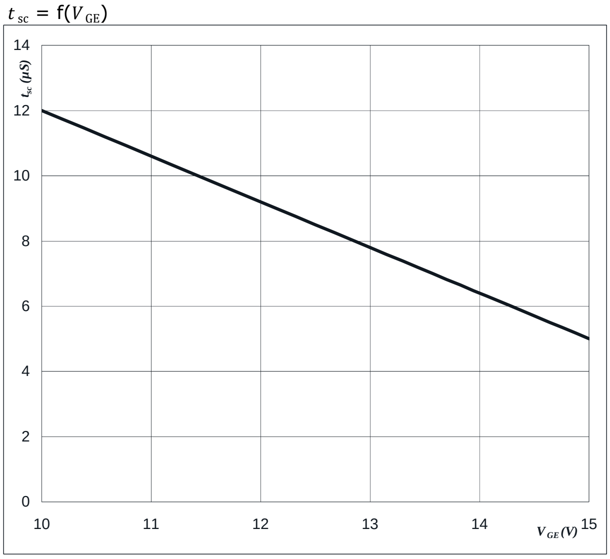
At

I_C =	15	A

figure 27. **IGBT**

Short circuit withstand time as a function of gate-emitter voltage

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



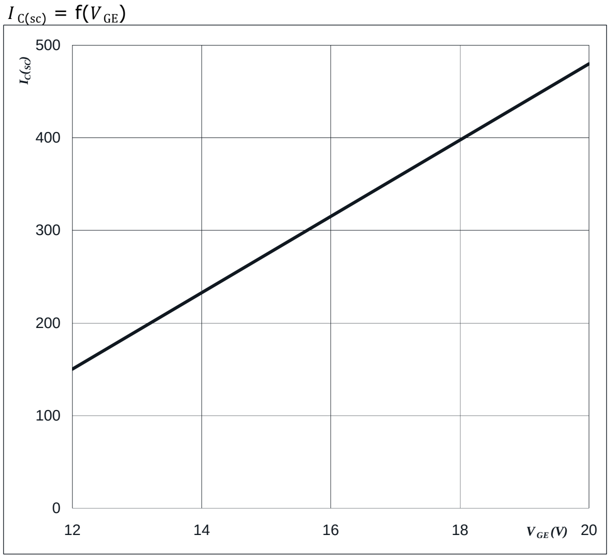
At

V_{CE} =	600	V
T_j ≤	175	ºC

figure 28. **IGBT**

Typical short circuit collector current as a function of gate-emitter voltage

$I_{C(sc)} = f(V_{GE})$



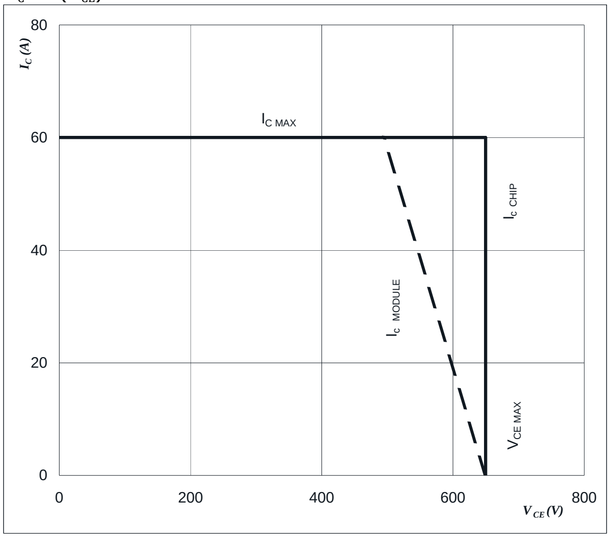
At

V_{CE} ≤	600	V
T_j =	175	ºC

figure 29. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

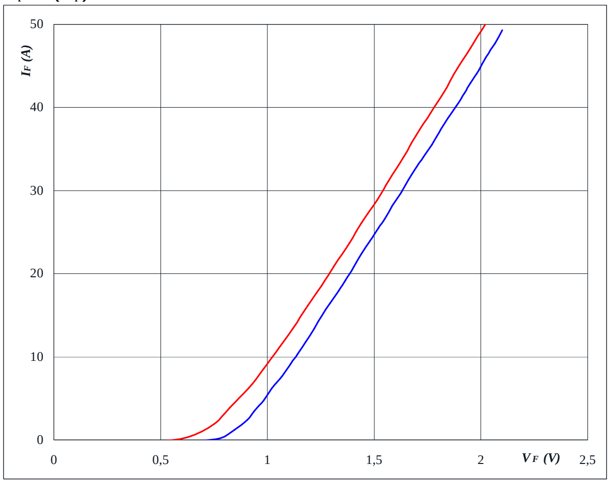
T_j =	125 °C
R_{gon} =	16 Ω
R_{goff} =	8 Ω

Rectifier Diode Characteristics

figure 1.	Rectifier Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

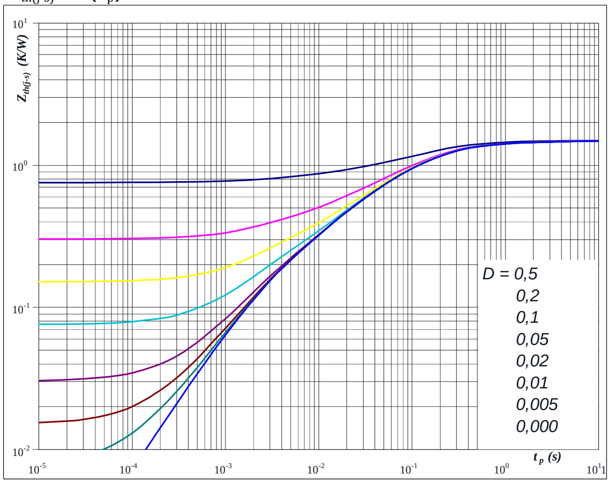
T_j = 25/125 °C

t_p = 250 μs

figure 2.	Rectifier Diode

Diode transient thermal impedance as a function of pulse width

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



At

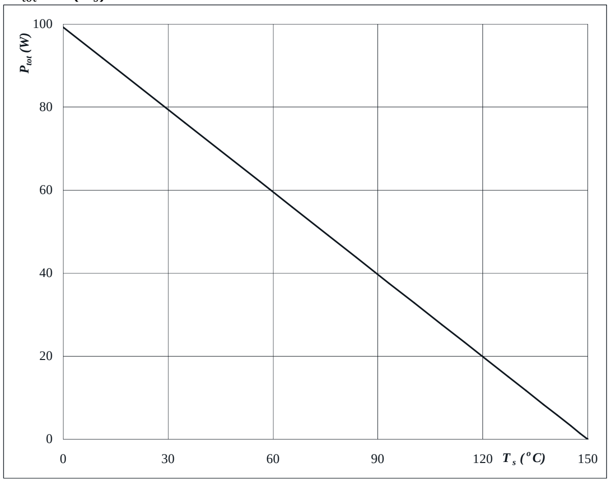
D = t_p / T

$R_{th(j\text{-}s)}$ = 1,51 K/W

figure 3.	Rectifier Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



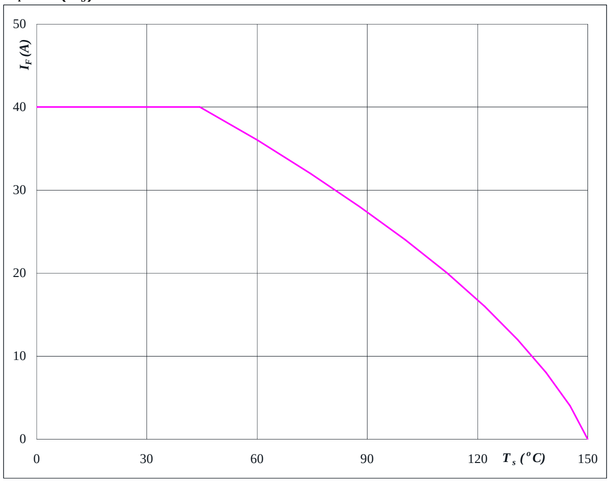
At

T_j = 150 ºC

figure 4.	Rectifier Diode

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



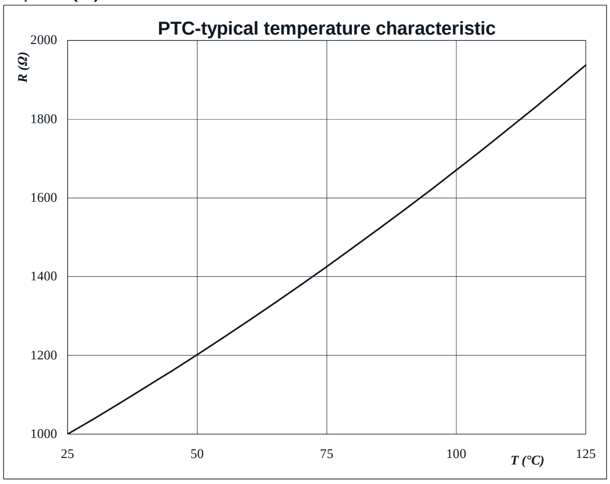
At

T_j = 150 ºC

Thermistor

figure 1.	Thermistor

Typical PTC characteristic
as a function of temperature
$R_T = f(T)$



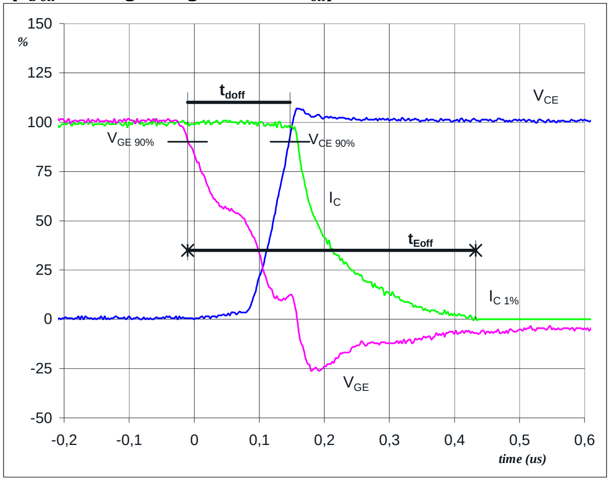
Switching Definitions Inverter

General conditions

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

figure 1. **IGBT**

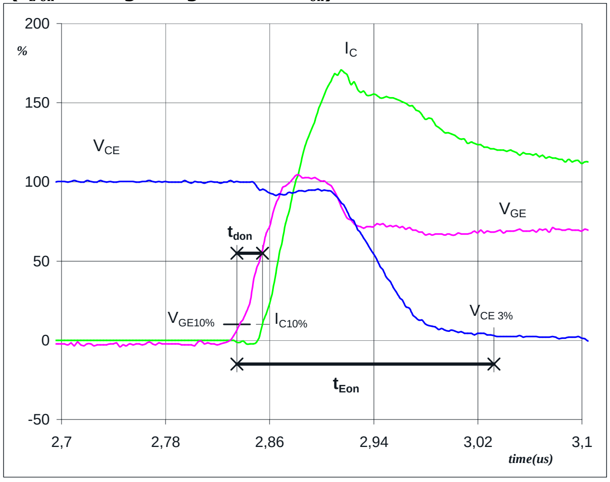
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	15	A
t_{doff} =	0,15	µs
t_{Eoff} =	0,44	µs

figure 2. **IGBT**

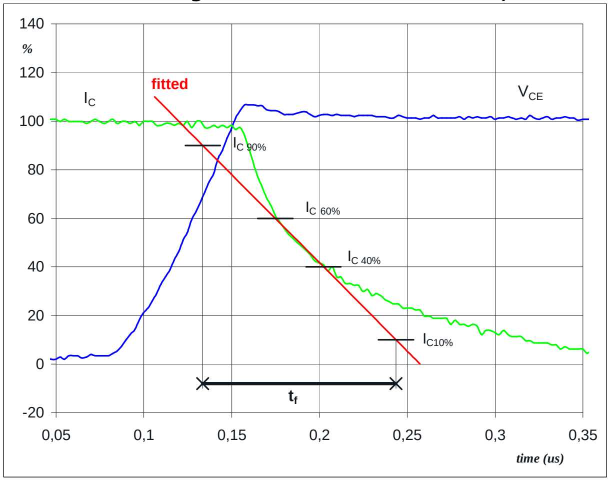
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	15	A
t_{don} =	0,02	µs
t_{Eon} =	0,20	µs

figure 3. **IGBT**

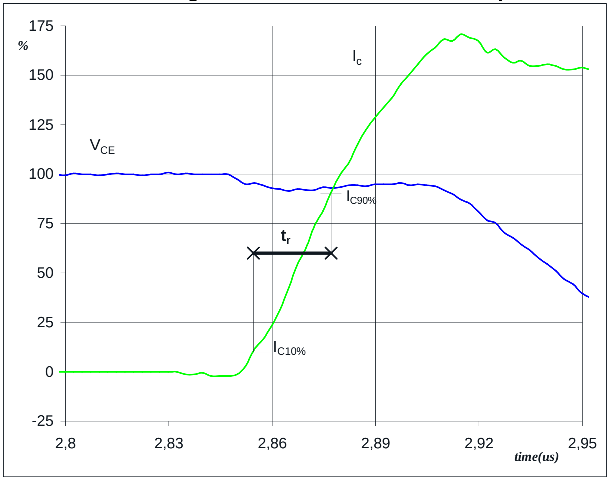
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	15	A
t_f =	0,10	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

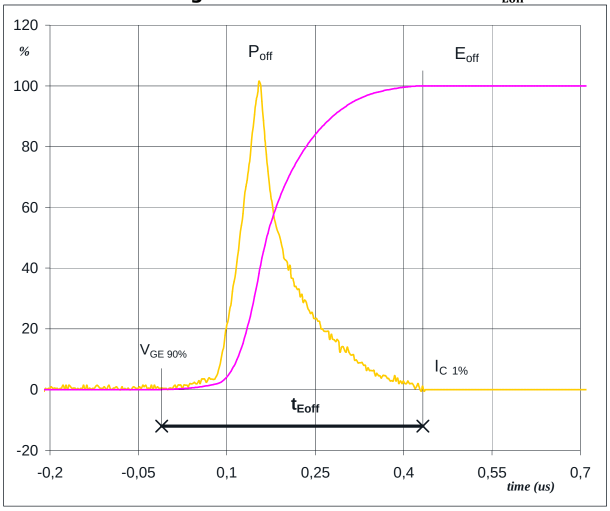


V_C (100%) =	300	V
I_C (100%) =	15	A
t_r =	0,02	µs

Switching Definitions Inverter

figure 5. **IGBT**

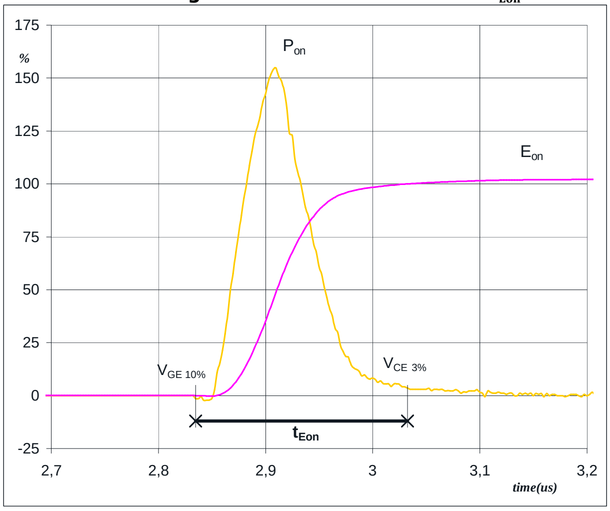
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	4,50	kW
E_{off} (100%) =	0,45	mJ
$t_{E\,off}$ =	0,44	μs

figure 6. **IGBT**

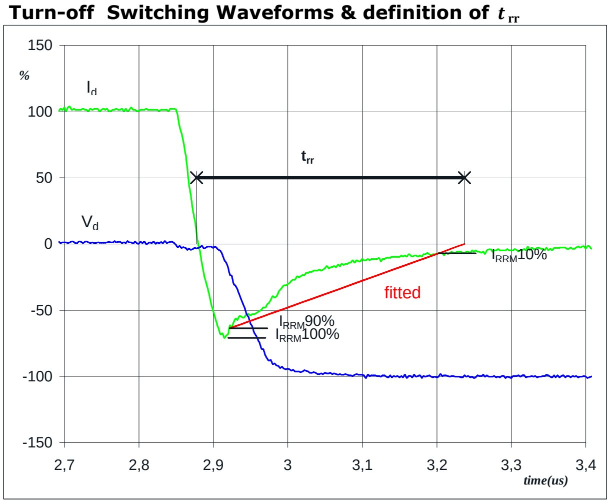
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	4,50	kW
E_{on} (100%) =	0,50	mJ
$t_{E\,on}$ =	0,20	μs

figure 7. **FWD**

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

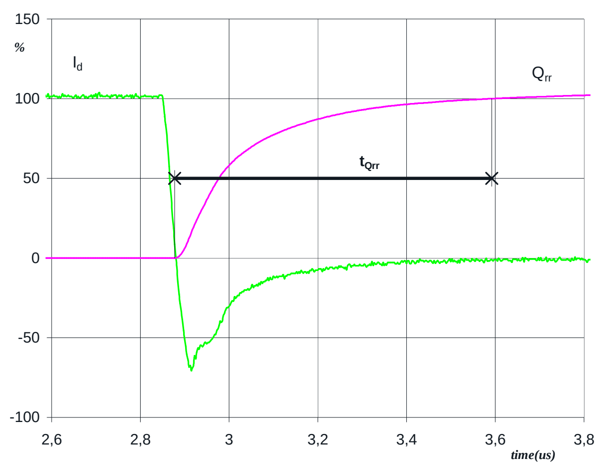


V_d (100%) =	300	V
I_d (100%) =	15	A
I_{RRM} (100%) =	11	A
t_{rr} =	0,33	μs

Switching Definitions Inverter

figure 8. **FWD**

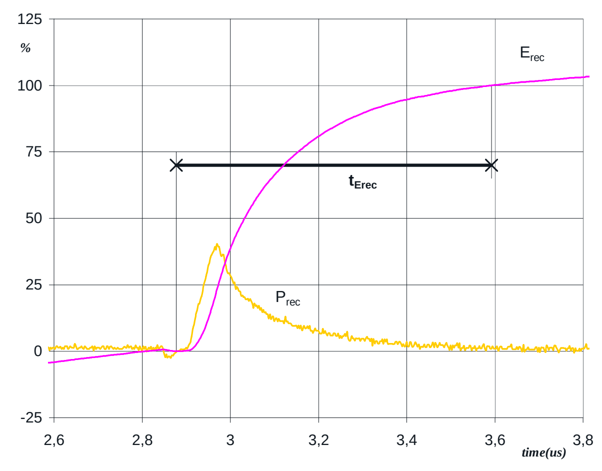
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	15	A
Q_{rr} (100%) =	1,45	µC
t_{Qrr} =	0,71	µs

figure 9. **FWD**

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



P_{rec} (100%) =	4,50	kW
E_{rec} (100%) =	0,29	mJ
t_{Erec} =	0,71	µs

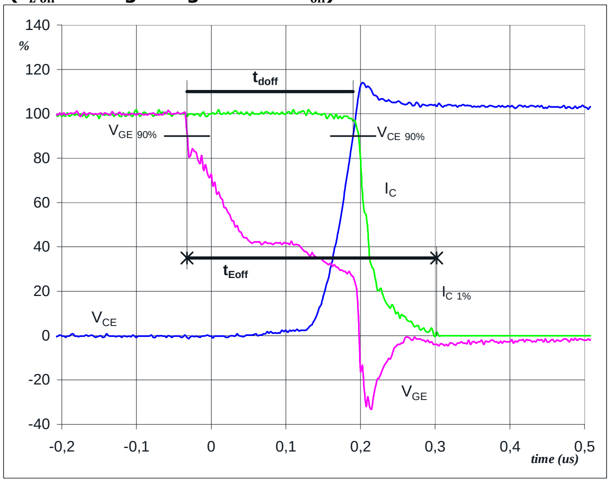
Switching Definitions PFC

General conditions

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

figure 1. **IGBT**

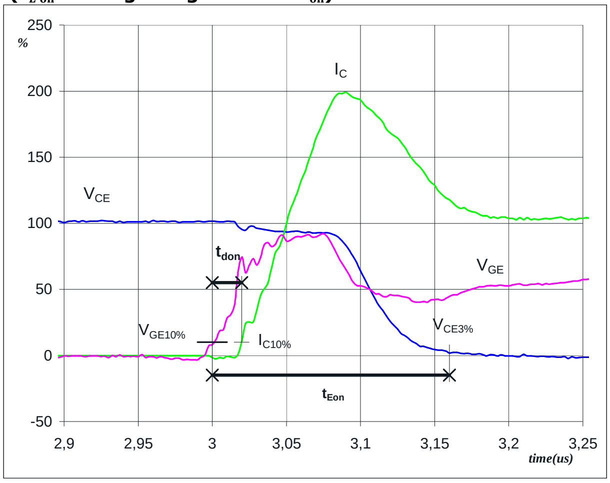
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) = 0 V
V_{GE} (100%) = 15 V
V_C (100%) = 300 V
I_C (100%) = 15 A
t_{doff} = 0,22 μs
$t_{E\,off}$ = 0,33 μs

figure 2. **IGBT**

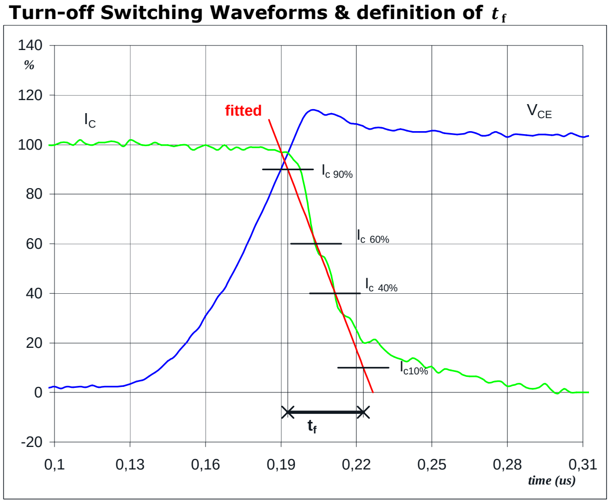
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) = 0 V
V_{GE} (100%) = 15 V
V_C (100%) = 300 V
I_C (100%) = 15 A
t_{don} = 0,02 μs
$t_{E\,on}$ = 0,16 μs

figure 3. **IGBT**

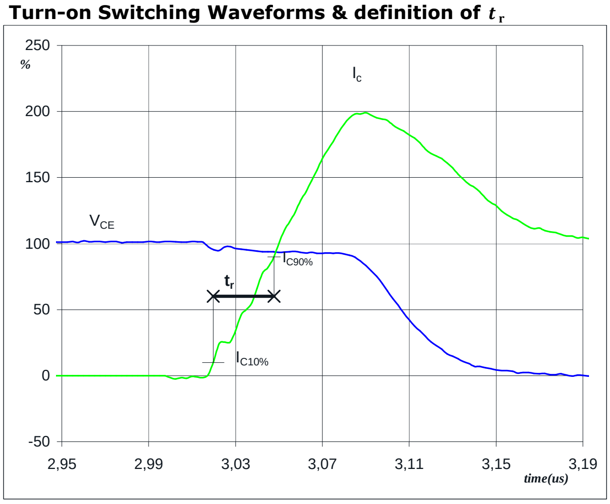
Turn-off Switching Waveforms & definition of t_f



V_C (100%) = 300 V
I_C (100%) = 15 A
t_f = 0,04 μs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

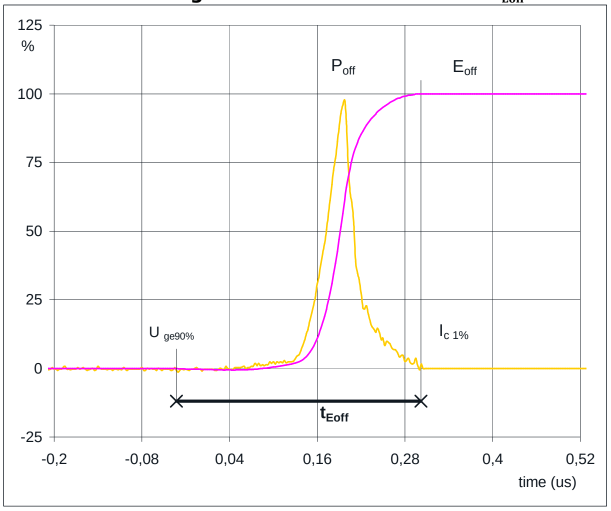


V_C (100%) = 300 V
I_C (100%) = 15 A
t_r = 0,03 μs

Switching Definitions PFC

figure 5. **IGBT**

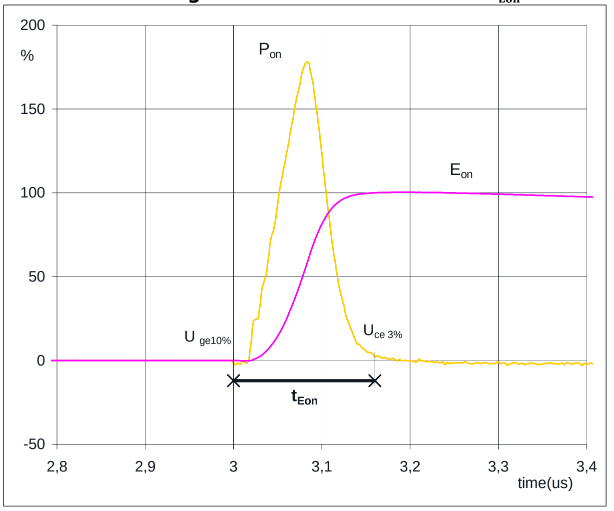
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	4,52	kW
E_{off} (100%) =	0,23	mJ
$t_{E\ off}$ =	0,33	µs

figure 6. **IGBT**

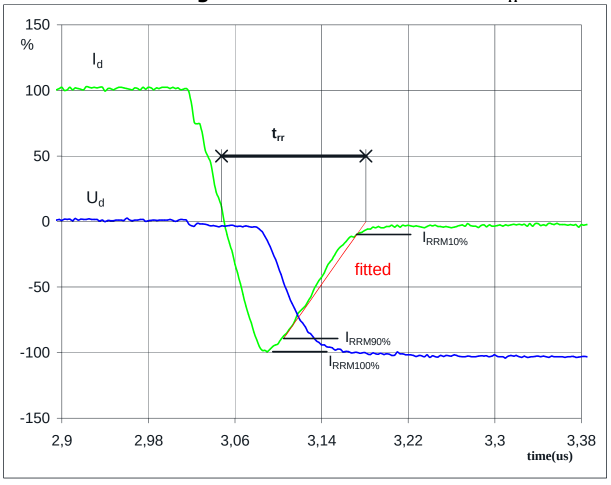
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	4,5177	kW
E_{on} (100%) =	0,51	mJ
$t_{E\ on}$ =	0,16	µs

figure 7. **FWD**

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

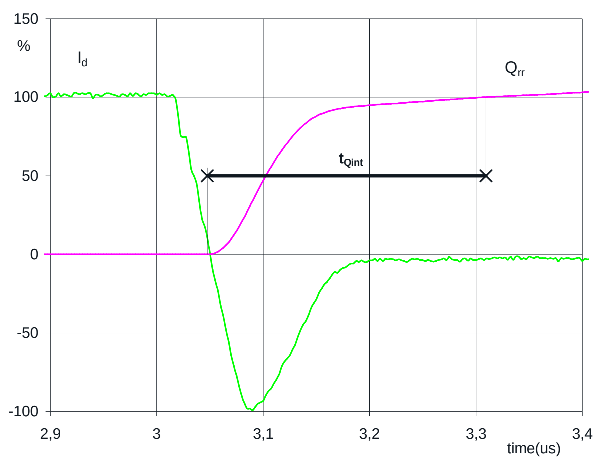


V_d (100%) =	300	V
I_d (100%) =	15	A
I_{RRM} (100%) =	-15	A
t_{rr} =	0,13	µs

Switching Definitions PFC

figure 8. **FWD**

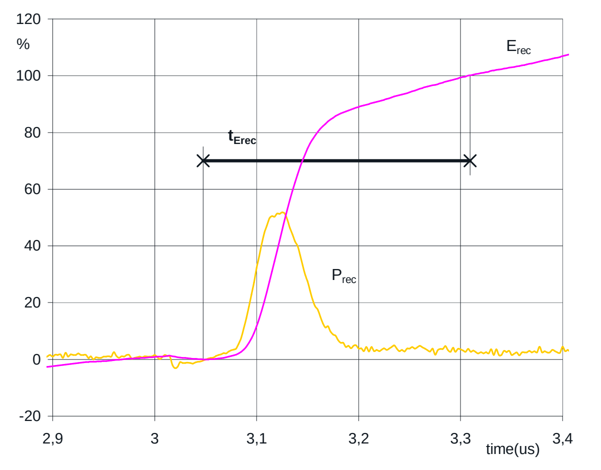
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	15	A
Q_{rr} (100%) =	1,11	μC
t_{Qint} =	0,26	μs

figure 9. **FWD**

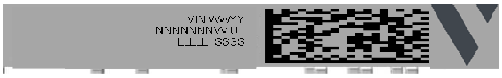
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	4,52	kW
E_{rec} (100%) =	0,16	mJ
$t_{E\,rec}$ =	0,26	μs

Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K12-T-PM)	V23990-K203-B10-/0A/-PM
with std lid (black V23990-K12-T-PM) and P12	V23990-K203-B10-/1A/-PM
with thin lid (white V23990-K13-T-PM)	V23990-K203-B10-/0B/-PM
with thin lid (white V23990-K13-T-PM) and P12	V23990-K203-B10-/1B/-PM



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

Outline

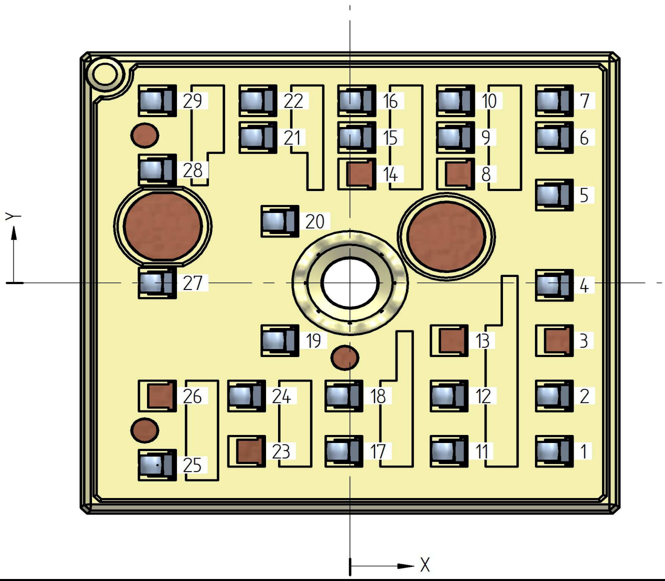
PCB pad table

Pad	X	Y	Function
1	15,93	-14,6	G5
2	15,93	-9,8	W
3	Not assembled		
4	15,93	-0,2	+T
5	15,93	7,62	-T
6	15,93	12,62	G6
7	15,93	15,8	-DC/W
8	Not assembled		
9	8,23	12,62	G4
10	8,23	15,8	-DC/V
11	7,73	-14,6	G3
12	7,73	-9,8	V
13	Not assembled		
14	Not assembled		
15	0,53	12,62	G2
16	0,53	15,8	-DC/U
17	-0,47	-14,6	G1
18	-0,47	-9,8	U
19	-5,47	-5	+B

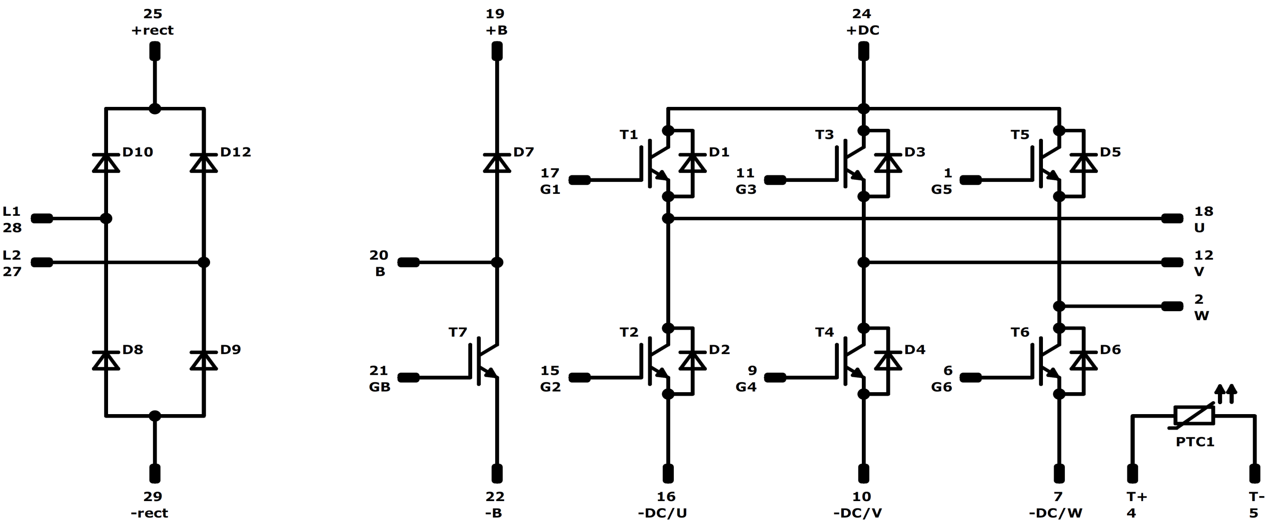
PCB pad table

Pad	X	Y	Function
20	-5,47	5,35	B
21	-7,17	12,62	GB
22	-7,17	15,8	-B
23	Not assembled		
24	-8,07	-9,8	+DC
25	-15,02	-15,8	+RECT
26	Not assembled		
27	-15,02	0	L2
28	-15,02	9,8	L1
29	-15,02	15,8	-RECT

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



Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	15 A	Inverter Switch	
T7	IGBT	650 V	30 A	PFC Switch	
D1-D6	FWD	600 V	10 A	Inverter Diode	
D7	FWD	650 V	30 A	PFC Diode	
D8, D9, D10, D12	Rectifier	1600 V	25 A	Rectifier Diode	
PTC1	PTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**198**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 0 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 0 packages see vincotech.com website.

UL recognition and file number
This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.

Document No.:	Date:	Modification:	Pages
V23990-K203-B10-D4-14	19 Jul. 2016		