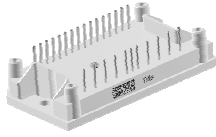
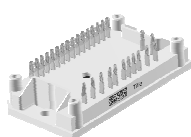
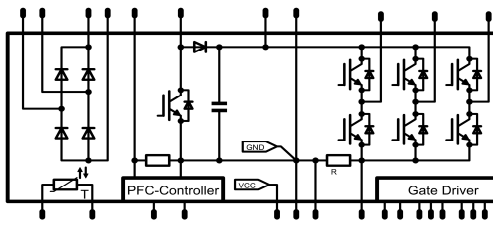




<i>flow</i> IPM 1B	600 V / 4 A
<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Features</p> <ul style="list-style-type: none"> • Input Rectifier, PFC-Boost with integrated PFC-Shunt, PFC-Controller and DC-capacitor • 3 phase inverter with integrated DC Shunt, gate driver circuit incl. bootstrap circuit and over current protection • Sense output of DC-current • Temperature sensor • Conclusive Power Flow, all power connections on one side, no input output X-ing </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Target Applications</p> <ul style="list-style-type: none"> • Low Power Industrial Drives • Motor Integrated Fans and Pumps • AirCon • Electrical Tools </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Types</p> <ul style="list-style-type: none"> • 20-1B06IPB004RC-P952A40 • 20-PB06IPB004RC-P952A40Y </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">flow 1B housing</p> <div style="display: flex; justify-content: space-around;">   </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> solder pins Press-fit pins </div> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Schematic</p>  </div>

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Input Rectifier Diode				
Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$ $T_s = 80\text{ }^\circ\text{C}$	13	A
Surge (non-repetitive) forward current	I_{FSM}	$t_p = 10\text{ ms}$ 50 Hz half sine wave $T_j = 45\text{ }^\circ\text{C}$	130	A
I^2t -value	I^2t		80	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ }^\circ\text{C}$	15	W
Maximum Junction Temperature	T_{jmax}		150	$^\circ\text{C}$
PFC IGBT				
Collector-emitter breakdown voltage	V_{CE}		650	V
DC collector current	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ }^\circ\text{C}$	8	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	45	A
Turn off safe operating area		$V_{CE} \leq 650\text{V}$, $T_j \leq T_{op\ max}$	45	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ }^\circ\text{C}$	16	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$



Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
PFC Inverse Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		650	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	6	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	12	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	10	W
Maximum Junction Temperature	T_{jmax}		175	°C

PFC Diode

Peak Repetitive Reverse Voltage	V_{RRM}		650	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	9	A
Surge (non-repetitive) forward current	I_{FSM}	$t_p = 8,3\text{ms}$	100	A
I^2t -value	I^2t	60 Hz half sine wave	40	A ² s
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	30	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	15	W
Maximum Junction Temperature	T_{jmax}		175	°C

Inverter Transistor

Collector-emitter breakdown voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	4	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	12	A
Turn off safe operating area		$V_{CE} \leq 600\text{V}$, $T_j \leq T_{jmax}$	8	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	12	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	8 400	µs V
Maximum Junction Temperature	T_{jmax}		175	°C



Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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Inverter Diode

Peak Repetitive Reverse Voltage	V_{RRM}		600	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	5	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	8	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	9	W
Maximum Junction Temperature	T_{jmax}		175	°C

PFC Shunt

DC forward current	I_F	$T_c = 25\text{ °C}$	10	A
Power dissipation	P_{tot}	$T_c = 25\text{ °C}$	9	W

PFC Controller*

VCC supply voltage	V_{CC}	V_{CC} common with gate driver I_c	26	V
VSENSE voltage	V_{VSENSE}		26	V
Vsense Current	I_{VSENSE}		800	μA
FREQ pin voltage	V_{FREQ}		5,3	V
Maximum Junction Temperature	T_{jmax}		125	°C

* for more information see Infineon's datasheet ICE3PCS02

DC - Shunt

DC forward current	I_F	$T_c = 25\text{ °C}$	8	A
Power dissipation	P_{tot}	$T_c = 25\text{ °C}$	3,2	W

DC link Capacitor

Max.DC voltage	V_{MAX}	$T_c = 25\text{ °C}$	500	V
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Gate Driver*

Supply voltage	V_{CC}	V_{CC} common with PFC driver	20	V
Input voltage (LIN, HIN, EN)	U_{IN}		10	V
Output voltage (FAULT)	U_{OUT}		$V_{CC} + 0.5$	V

* for more information see infineon's datasheet 6ED003L02-F2



Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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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}	$t = 2\text{ s}$ 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					Value			Unit
		V_{GE} [V]	V_r [V]	I_C [A]	T_j [°C]	Min	Typ	Max		

Input Rectifier Diode

Parameter	Symbol	Conditions	Value	Unit
Forward voltage *	V_F	V_{GE} [V] V_{GS} [V]	7 25 125	V
Threshold voltage (for power loss calc. only)	V_{th}		25 125	V
Slope resistance (for power loss calc. only)	r_t		25 125	mΩ
Reverse current	I_r	1600	25 125	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$	4,56	K/W

* chip data

PFC IGBT

Parameter	Symbol	Conditions	Value	Unit		
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{GE} = V_{CE}$	0,0004 25	V		
Collector-emitter saturation voltage*	V_{CEsat}	15	6 25 150	V		
Collector-emitter cut-off	I_{CES}	0 650	25	mA		
Rise time	t_r	$U_{cc} = 15V$ 400	25 150	ns		
Turn-off delay time **	$t_{d(off)}$		25 150			
Fall time	t_f		25 150			
Turn-on energy loss	E_{on}		25 150		mWs	
Turn-off energy loss	E_{off}	25 150				
Input capacitance	C_{ies}	$f = 1\text{ MHz}$ 0	25	25	930	pF
Output capacitance	C_{oss}				24	
Reverse transfer capacitance	C_{rss}				4	
Gate charge	Q_G	±15 520	15 25	38	nC	
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$	5,80	K/W		

* chip data

PFC Inverse Diode

Parameter	Symbol	Conditions	Value	Unit
Diode forward voltage	V_F		6 25 125	V
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$	9,56	K/W

PFC Diode

Parameter	Symbol	Conditions	Value	Unit
Forward voltage *	V_F		6 25 150	V
Peak recovery current	I_{RRM}	$U_{cc}=15V$ 400	25 150	A
Reverse recovery time	t_{rr}		25 150	ns
Reverse recovery charge	Q_{rr}		25 150	μC
Reverse recovered energy	E_{rec}		25 150	mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$		25 150	A/μs
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$	7,19	K/W

* chip data

PFC Shunt

Parameter	Symbol	Value	Unit
R1 value	R	100	mΩ



Characteristic Values

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

Inverter Transistor

Parameter	Symbol	Conditions	V_{GE} [V]	V_r [V]	I_C [A]	T_j [°C]	Min	Typ	Max	Unit
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,000075	25	4,4	5	5,6	V
Collector-emitter saturation voltage*	$V_{CE(sat)}$		15		4	25 150	1,7	2,20 2,29	2,8	v
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		25			120	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time **	$t_{d(on)}$	$U_{ce}=15V$ $V_{in}=5V$	400	4	4	25		586		ns
Rise time	t_r					150		635		
Turn-off delay time **	$t_{d(off)}$					25		21		
Fall time	t_f					150		30		
Turn-on energy loss	E_{on}					25		666		
Turn-off energy loss	E_{off}					150		749		
Input capacitance	C_{ies}	$f = 1 \text{ MHz}$	0	25	25	25		305		pF
Output capacitance	C_{oss}					150		18		
Reverse transfer capacitance	C_{rss}					25		9		
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$						8,93		K/W

* chip data
 ** including gate driver

Inverter Diode

Parameter	Symbol	Conditions	V_{GE} [V]	V_r [V]	I_C [A]	T_j [°C]	Min	Typ	Max	Unit
Diode forward voltage *	V_F				4	25 150	1,5	2,08 1,92	2,6	V
Peak reverse recovery current	I_{RRM}	$U_{ce}=15V$ $V_{in}=5V$	400	4	4	25		2		A
Reverse recovery time	t_{rr}					150		3		
Reverse recovered charge	Q_{rr}					25		166		
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					150		254		
Reverse recovered energy	E_{rec}					25		0,18		
Thermal resistance junction to sink	$R_{th(j-s)}$					150		0,35		
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4W/mK$						10,05		K/W

* chip data

DC - Shunt

Parameter	Symbol	Conditions	V_{GE} [V]	V_r [V]	I_C [A]	T_j [°C]	Min	Typ	Max	Unit
R2 value	R					25		50		$m\Omega$

DC link Capacitor

Parameter	Symbol	Conditions	V_{GE} [V]	V_r [V]	I_C [A]	T_j [°C]	Min	Typ	Max	Unit
C value	C							100		nF



Characteristic Values

Parameter	Symbol	Conditions				Value			Unit
		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]	Min	Typ	Max	
Gate Driver									
Supply voltage	V_{CC}				25 125	13	15	17,5	V
Quiescent Vcc supply current	IQCC	VLIN=0V; VHIN=3,3V			25 125		1,3	2	mA
Input voltage (LIN, HIN, EN)	VIN	$V_{CC} = 15V$			25 125	0		5	V
Input voltage (GATE)	VGATE		25 125	0		15			
Logic "0" input voltage (LIN, HIN)	VIH		25 125	1,7	2,1	2,4			
Logic "1" input voltage (LIN, HIN)	VIL		25 125	0,7	0,9	1,1			
Positive going threshold voltage (EN)	VEN, TH+		25 125	1,9	2,1	2,3			
Negative going threshold voltage (EN)	VEN, TH-		25 125	1,1	1,3	1,5			
Input clamp voltage (LIN, HIN, EN)	VIN, CLAMP		IIN = 4mA	25 125	9	10,3	12		
ITRIP positive going threshold	VIT, TH+		25 125	380	445	510	mV		
Input bias current LIN high	I_{iIN+}	VLIN = 3,3V	25 125		70	100	μA		
Input bias current LIN low	I_{iIN-}	VLIN = 0V	25 125		110	200			
Input bias current HIN high	I_{iHIN+}	VHIN = 3,3V	25 125		70	100			
Input bias current HIN low	I_{iHIN-}	VHIN = 0V	25 125		110	200			
Input bias current EN high	IEN+	VHIN = 3,3V	25 125		45	120			
Output voltage (FAULT)	V_{rLT}		25 125	0		V_{CC}		V	
Low on resistor of pull down trans. (FAULT)	RON, FLT	$V_{rFAULT} = 0.5 V$	25 125		45	100	Ω		
Pulse width for ON or OFF	tIN		25 125	1			μs		
Turn-on propagation delay (LIN, HIN)	tON	VLIN/HIN = 0V or 3,3V	25 125	400	530	800	ns		
Turn-off propagation delay (LIN, HIN)	tOFF	VLIN/HIN = 0V or 3,3V	25 125	360	490	760			
FAULT reset time	tRST		25 125		4		ms		
Fixed deadtime between high and low side	tDT	VLIN/HIN = 0V & 3,3V	25 125	150	310		ns		



Characteristic Values

Parameter	Symbol	Conditions				Value			Unit
		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]	Min	Typ	Max	

Thermistor

Rated resistance	R		25		22000		Ω
Deviation of R_{100}	$\Delta R/R$		100	-12		12	%
Power dissipation	P		25		200		mW
Power dissipation constant			25		2		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 3\%$	25		3950		K
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$	25		3998		K
Vincotech NTC Reference			25			B	

PFC Controller

Supply voltage*	V_{CC}		25	15		26	V	
VCC turn-on threshold	V_{CCon}			11,5	12,0	12,9	V	
VCC turn-off threshold	V_{CCUvLO}			10,5	11,0	11,9	V	
Operating current with active GATE	I_{CCHG}	$C_L = 1nF$			6,4	8,5	mA	
Operating current during standby	I_{CCstby}				3,5	4,7	mA	
PFC switching frequency	F_{SWnom}	Set with an internal resistor $R_{FREQ} = 220k\Omega^{**}$			20		kHz	
PFC disable threshold	$V_{dis PFC}$	pull Vsense higher than $V_{dis PFC}$ to disable PFC operation			14		V	
DC link voltage	DC2+	Set with an internal resistor divider***			325	410	V	
DC link threshold (OVP1) low to high	$V_{OVP1L2H}$	relative to output voltage OVP1 values varies with external resistor Feedback voltage $V_{DClink}/130$ can be measured at VSENSE pin			108		%	
DC link threshold (OVP1) high to low	$V_{OVP1H2L}$				100		%	
Blanking time for OVP1	t_{OVP1}				12		μs	
DC link threshold (OVP1) hysteresis	V_{OVP1_HYS}			6	8	11	%	
DC link threshold (OVP2) low to high	V_{OVP2_L2H}	relative to OVP2			428	443	460	V
DC link threshold (OVP2) high to low	V_{OVP2_H2L}					92		%
Blanking time for OVP2	t_{OVP2}				12		μs	

*recommended supply voltage range: 15-18 V

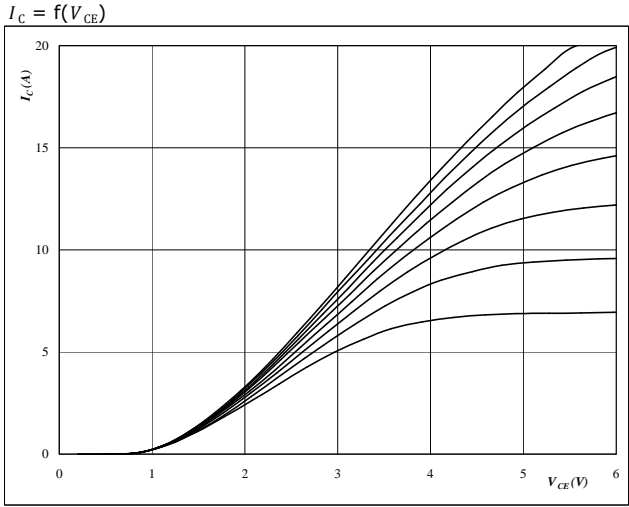
**switching frequency is settable by an external resistor between pins 14-16 (see figure on page30 for values)

***DC link voltage is settable by an external resistor between pins 14-15 (see figure on page30 for values)



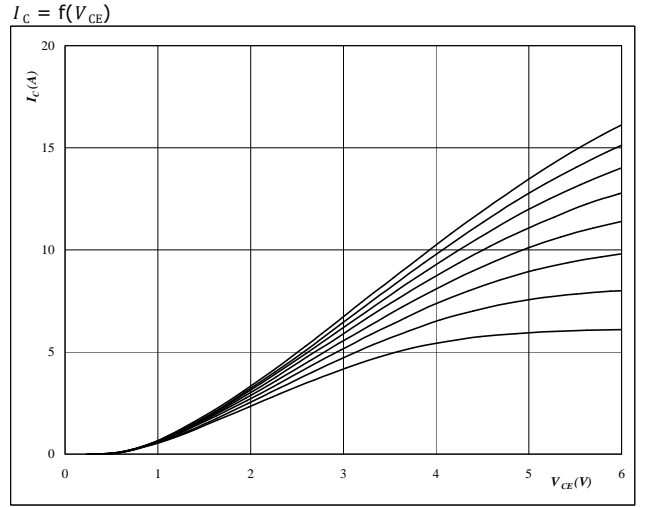
Output Inverter

figure 1. IGBT
Typical output characteristics



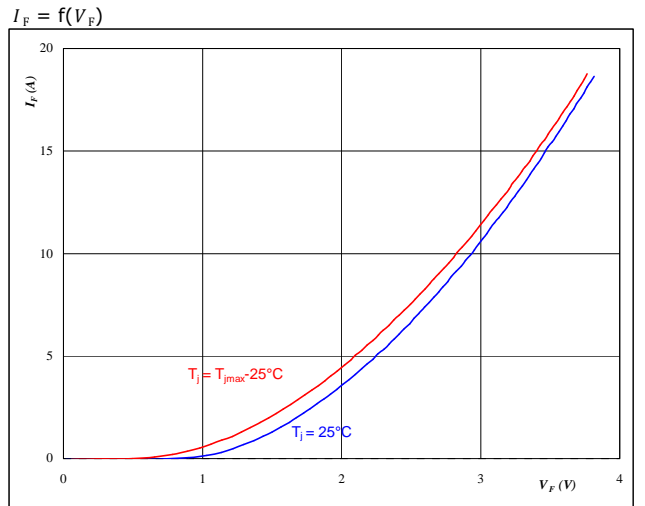
At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ } ^\circ C$
 U_{CC} from 10 V to 17V in steps of 1V

figure 2. IGBT
Typical output characteristics



At
 $t_p = 250 \mu s$
 $T_j = 125 \text{ } ^\circ C$
 U_{CC} from 10 V to 17V in steps of 1V

figure 3. FWD
Typical diode forward current as a function of forward voltage



At
 $t_p = 250 \mu s$

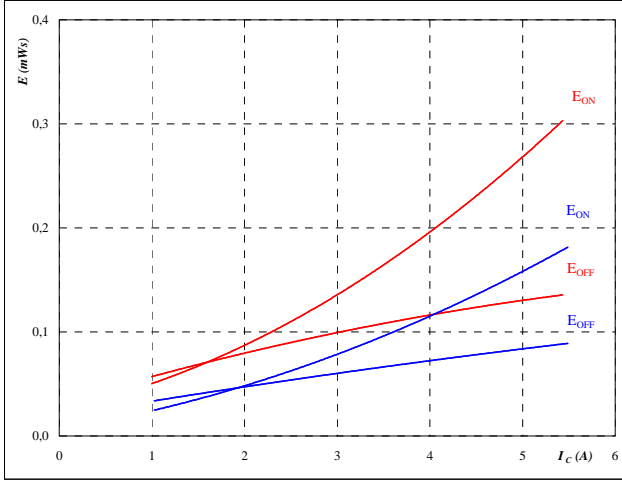


Output Inverter

figure 4. IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



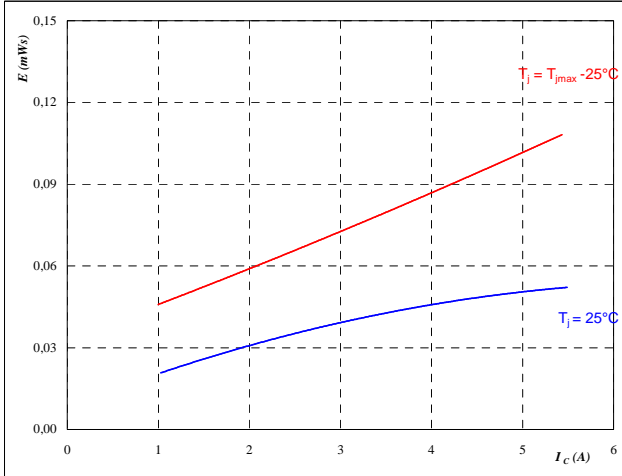
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 400 \text{ V}$
 $U_{CC} = 15 \text{ V}$

figure 5. FWD

Typical reverse recovery energy loss
as a function of collector current

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



With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 400 \text{ V}$
 $U_{CC} = 15 \text{ V}$

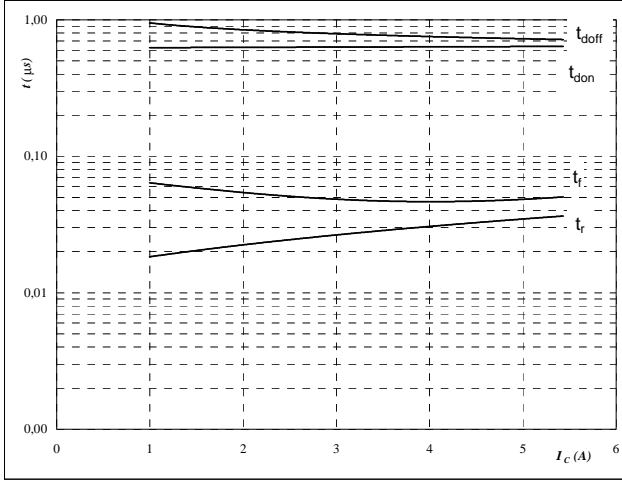


Output Inverter

figure 6. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



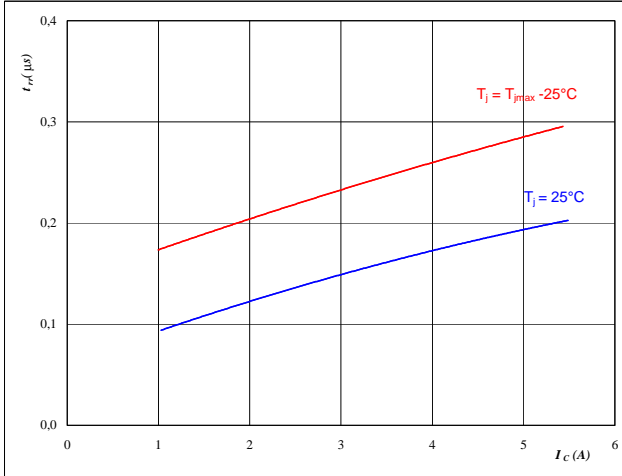
With an inductive load at

- $T_j = 125 \text{ } ^\circ\text{C}$
- $V_{CE} = 400 \text{ V}$
- $U_{CC} = 15 \text{ V}$

figure 7. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



At

- $T_j = 25/125 \text{ } ^\circ\text{C}$
- $V_{CE} = 400 \text{ V}$
- $U_{CC} = 15 \text{ V}$

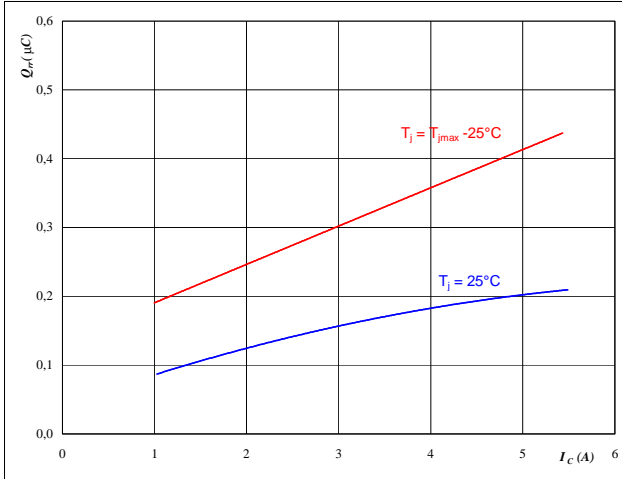


Output Inverter

figure 8. FWD

Typical reverse recovery charge as a function of collector current

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



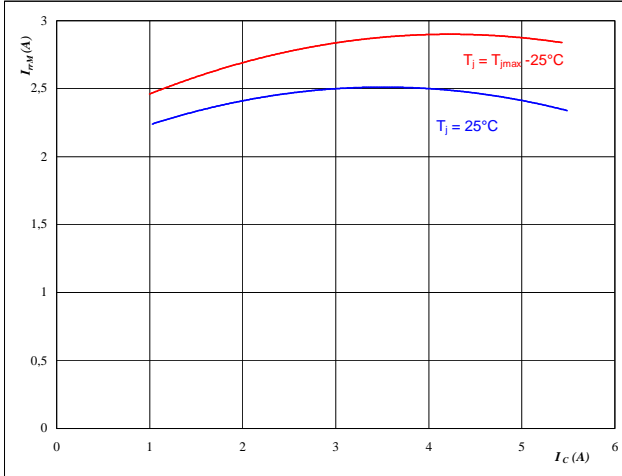
At

T _j =	25/125	°C
V _{CE} =	400	V
U _{CC} =	15	V

figure 9. FWD

Typical reverse recovery current as a function of collector current

$$I_{RRM} = f(I_C)$$



At

T _j =	25/125	°C
V _{CE} =	400	V
U _{CC} =	15	V

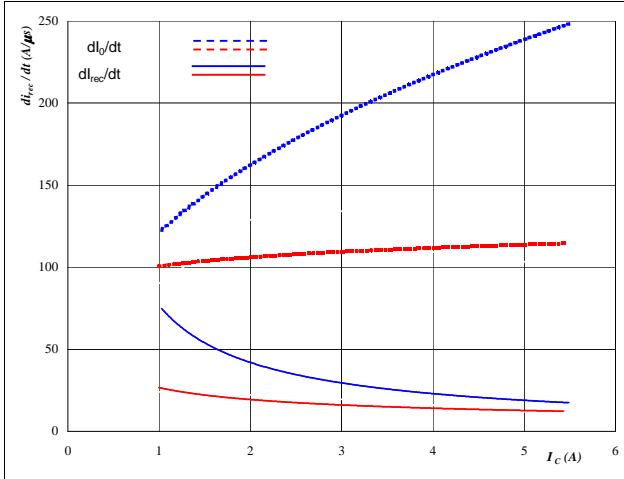


Output Inverter

figure 10. FWD

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

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

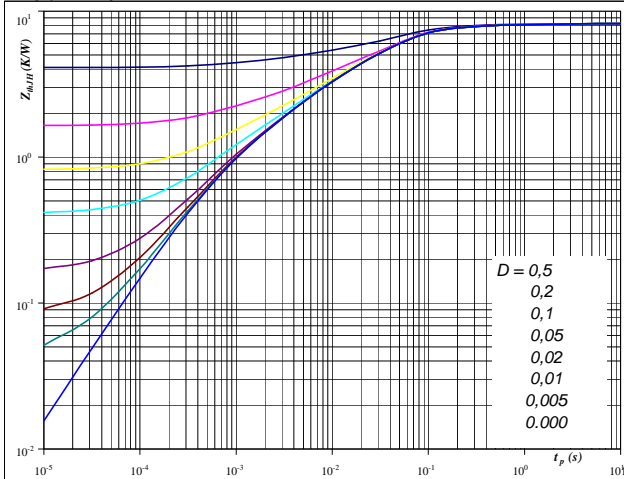


At
 $T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 400 \text{ V}$
 $U_{CC} = 15 \text{ V}$

figure 11. IGBT

IGBT transient thermal impedance as a function of pulse width

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



At
 $D = t_p / T$
 $R_{th(j-s)} = 8,20 \text{ K/W}$

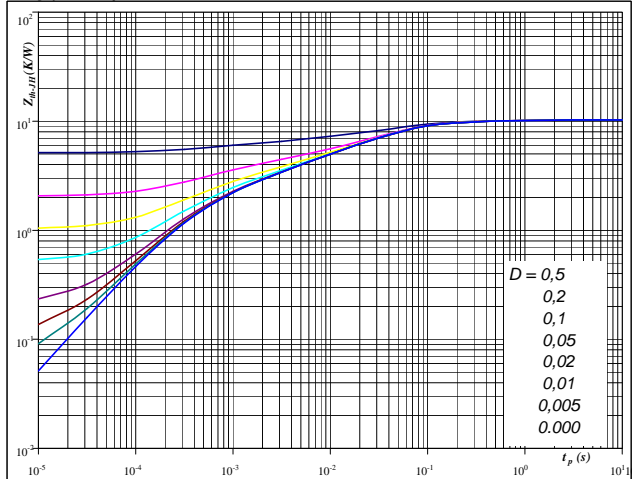
IGBT thermal model values

R (K/W)	Tau (s)
2,49E-01	1,64E+00
9,97E-01	1,59E-01
4,55E+00	3,81E-02
1,65E+00	5,10E-03
6,64E-01	7,96E-04
9,00E-02	3,11E-04

figure 12. FWD

FWD transient thermal impedance as a function of pulse width

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



At
 $D = t_p / T$
 $R_{th(j-s)} = 10,24 \text{ K/W}$

FWD thermal model values

R (K/W)	Tau (s)
5,43E-01	6,92E-01
3,81E+00	5,93E-02
2,56E+00	1,81E-02
1,83E+00	2,58E-03
1,50E+00	3,50E-04

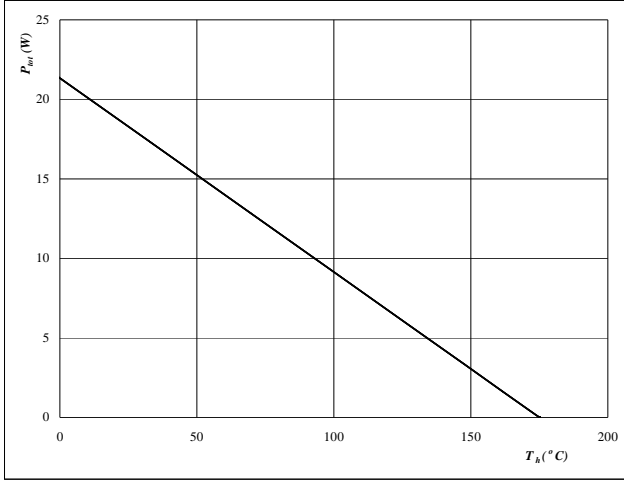


Output Inverter

figure 13. IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

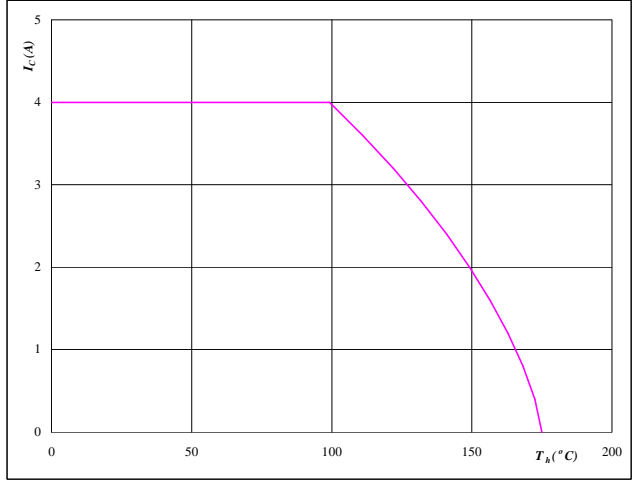


At
 $T_j = 175$ °C

figure 14. IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At
 $T_j = 175$ °C
 $U_{CC} = 15$ V

figure 15. FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

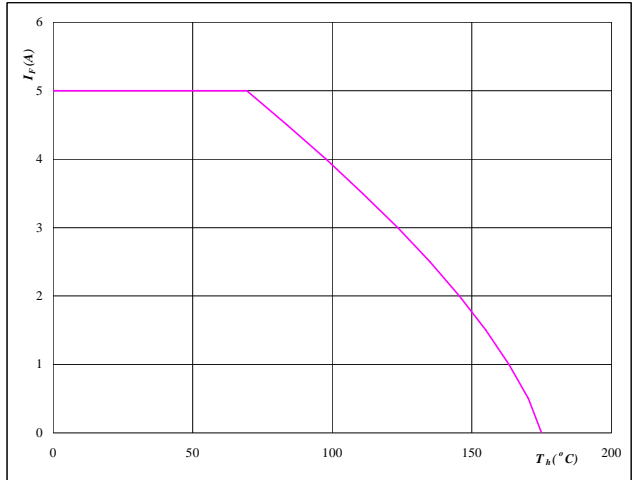


At
 $T_j = 175$ °C

figure 16. FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At
 $T_j = 175$ °C

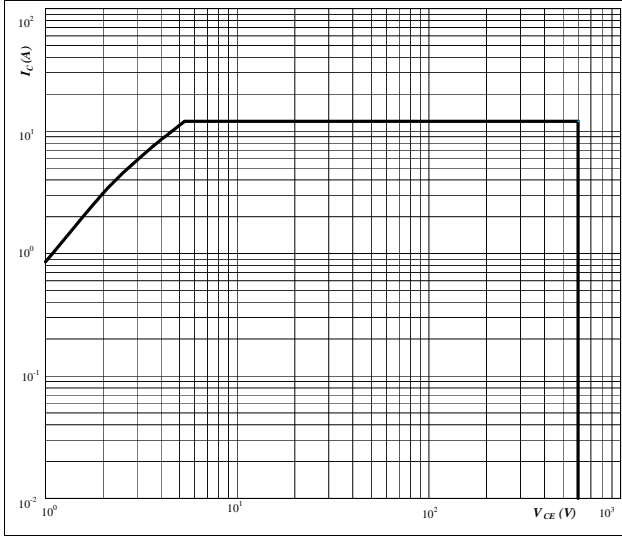


Output Inverter

figure 17. IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$

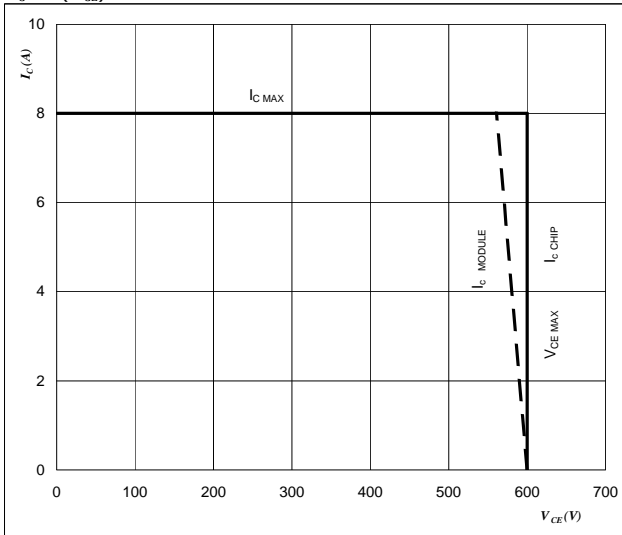


At
 $T_j \leq T_{jmax}$ °C
 $U_{CC} = 15$ V

figure 18. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$

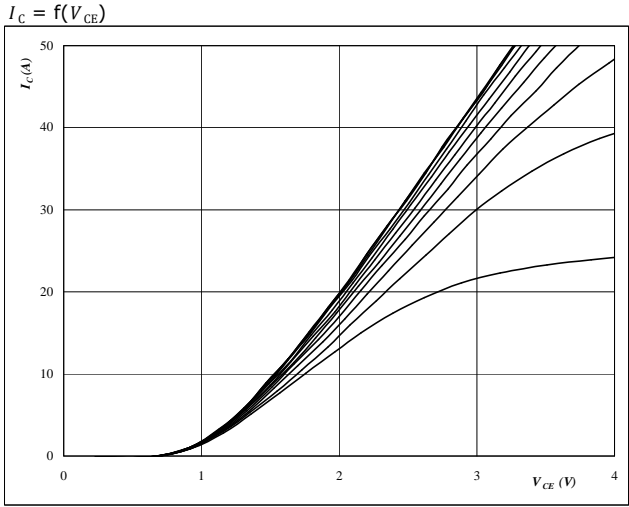


At
 $T_j = T_{jmax} - 25$ °C



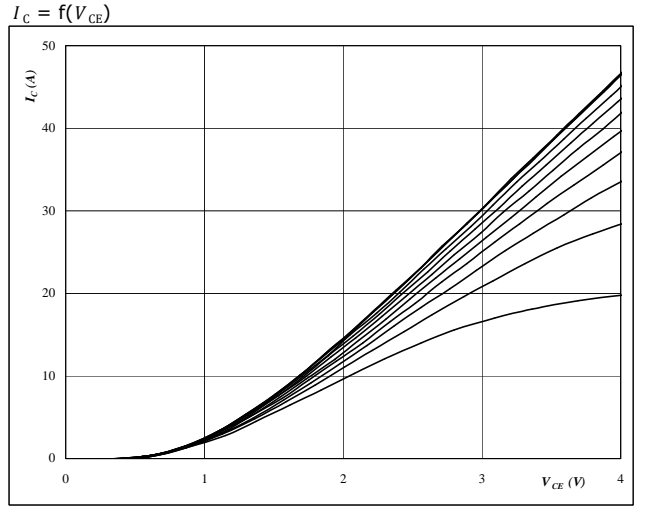
PFC

figure 1. IGBT
Typical output characteristics



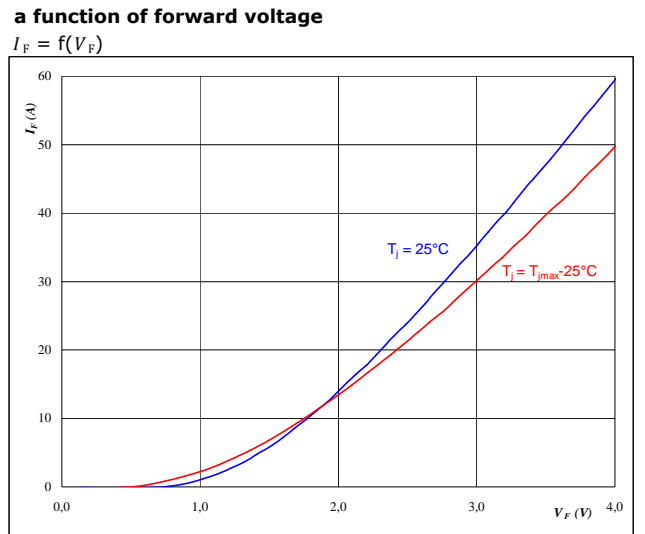
At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ } ^\circ C$
 U_{CC} from 7 V to 17V in steps of 1V

figure 2. IGBT
Typical output characteristics



At
 $t_p = 250 \mu s$
 $T_j = 150 \text{ } ^\circ C$
 U_{CC} from 7 V to 17V in steps of 1V

figure 3. FWD
Typical diode forward current as a function of forward voltage



At
 $t_p = 250 \mu s$

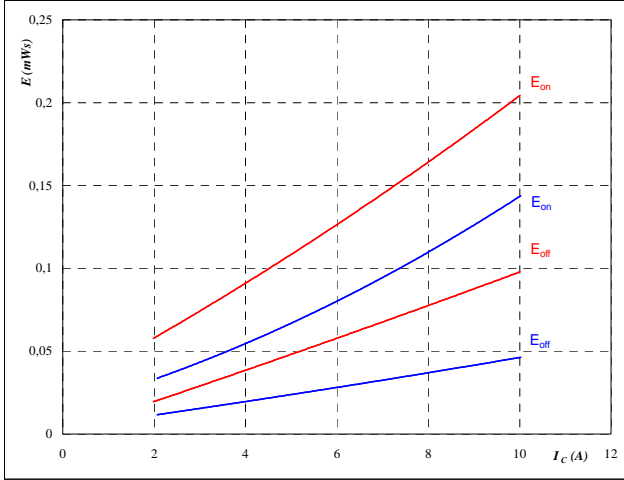


PFC

figure 4. IGBT

Typical switching energy losses
as a function of collector current

$E = f(I_c)$



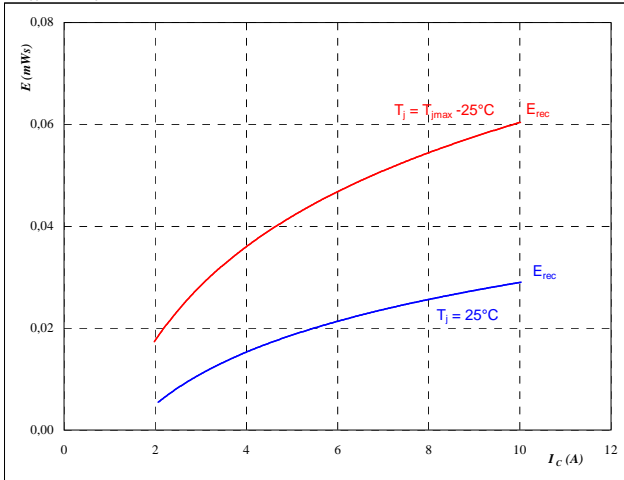
With an inductive load at

- $T_j = 25/125$ °C
- $V_{CE} = 400$ V
- $U_{CC} = 15$ V

figure 5. IGBT

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
- $V_{CE} = 400$ V
- $U_{CC} = 15$ V

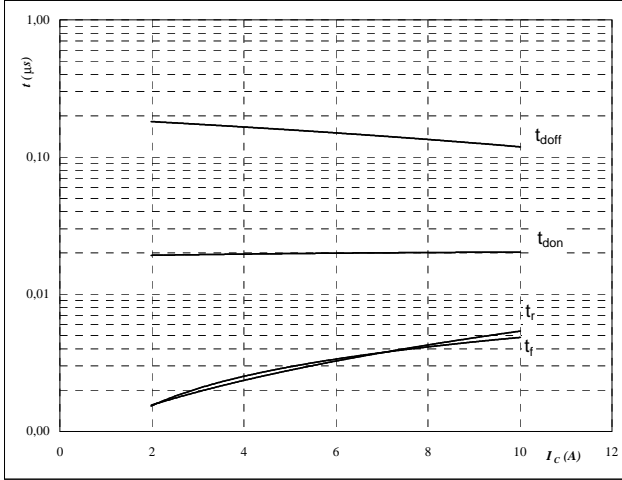


PFC

figure 6. IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



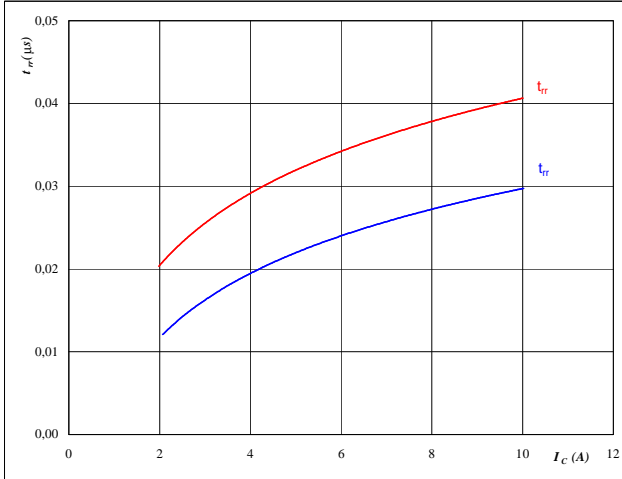
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	400	V
$U_{CC} =$	15	V

figure 7. FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



At

$T_j =$	25/125	°C
$V_{CE} =$	400	V
$U_{CC} =$	15	V

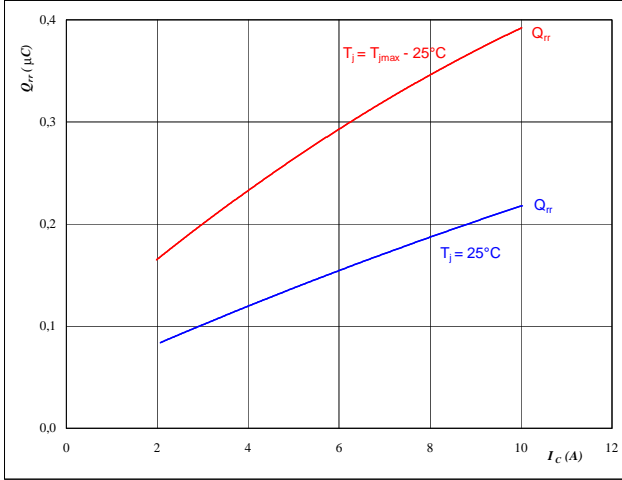


PFC

figure 8. FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



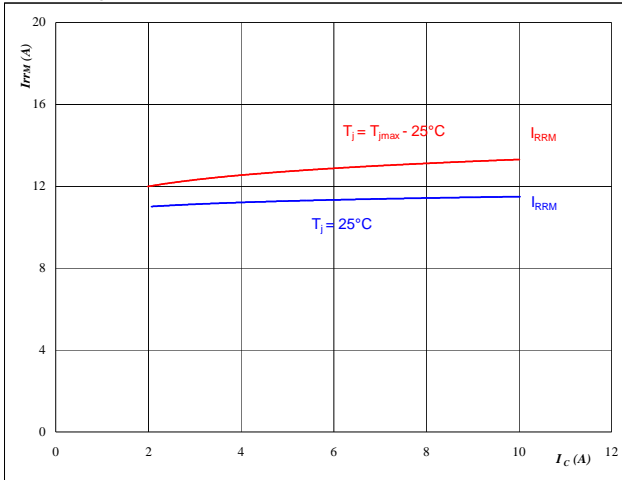
At

$T_j =$	25/125	°C
$V_{CE} =$	400	V
$U_{CC} =$	15	V

figure 9. FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



At

$T_j =$	25/125	°C
$V_{CE} =$	400	V
$U_{CC} =$	15	V

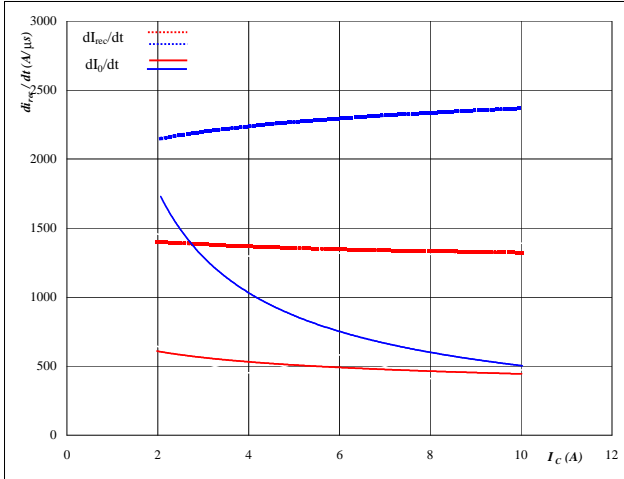


PFC

figure 10. FWD

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

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

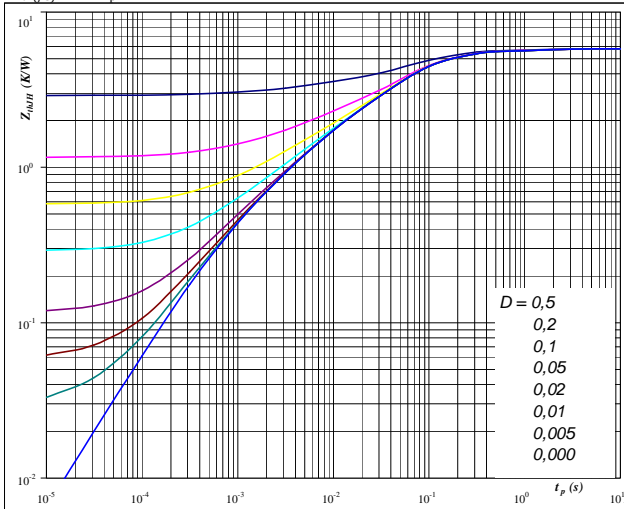


At
 $T_j = 25/125$ °C
 $V_{CE} = 400$ V
 $U_{CC} = 15$ V

figure 11. IGBT

IGBT transient thermal impedance as a function of pulse width

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



At
 $D = t_p / T$
 $R_{th(j-s)} = 5,80$ K/W

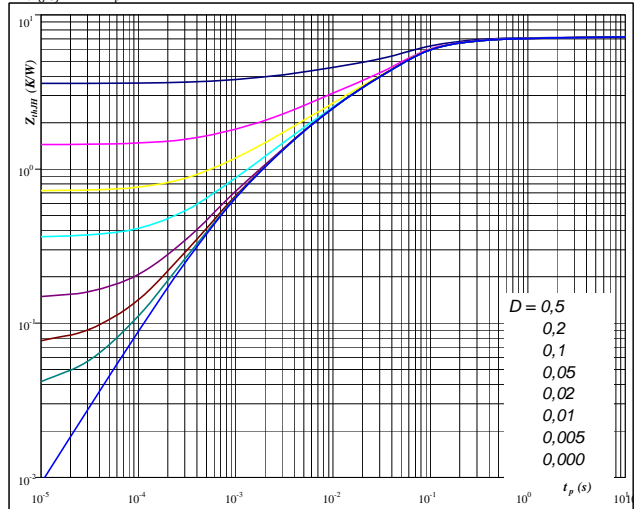
IGBT thermal model values

R (C/W)	Tau (s)
8,85E-02	4,38E+00
3,12E-01	8,32E-01
1,99E+00	1,12E-01
2,31E+00	3,80E-02
8,99E-01	4,25E-03
	5,94E-04

figure 12. FWD

FWD transient thermal impedance as a function of pulse width

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



At
 $D = t_p / T$
 $R_{th(j-s)} = 7,19$ K/W

FWD thermal model values

R (C/W)	Tau (s)
2,22E-01	2,69E+00
6,61E-01	2,71E-01
4,47E+00	4,89E-02
1,43E+00	5,11E-03
4,13E-01	7,51E-04

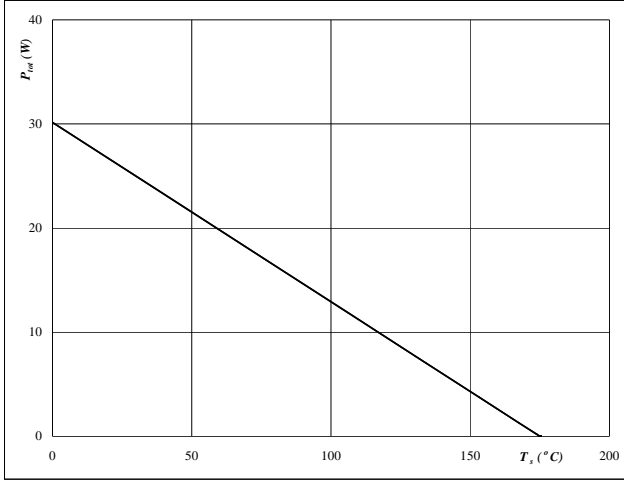


PFC

figure 13. IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

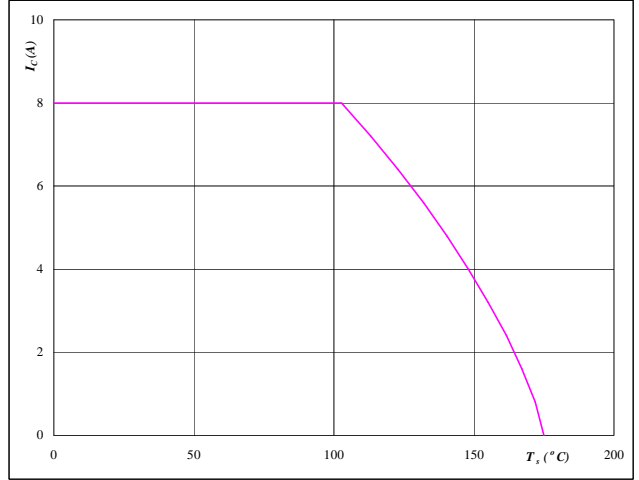


At
T_j = 175 °C

figure 14. IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_s)$

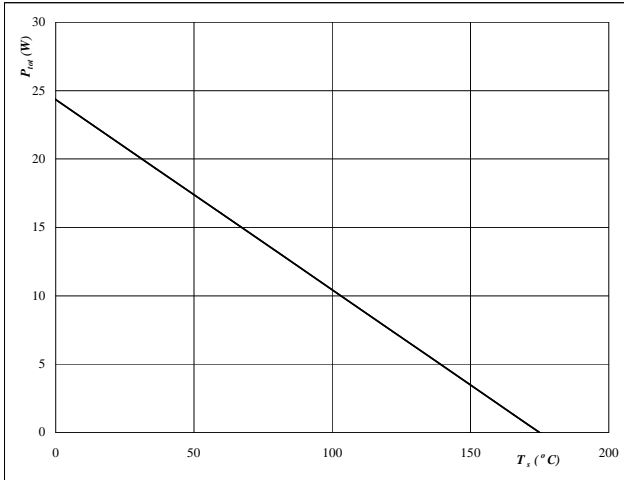


At
T_j = 175 °C
U_{CC} = 15 V

figure 15. FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

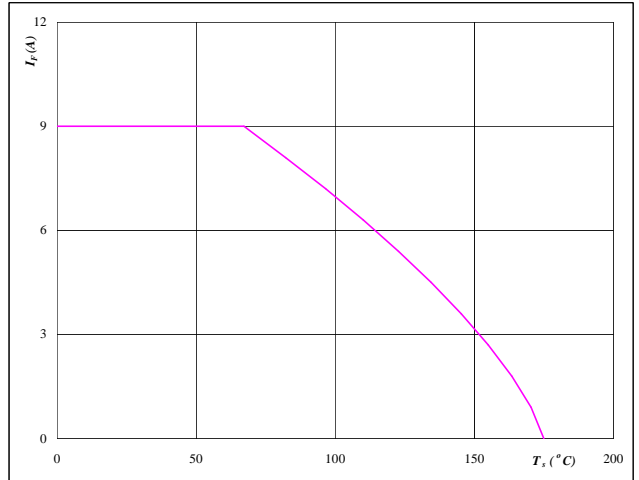


At
T_j = 175 °C

figure 16. FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At
T_j = 175 °C

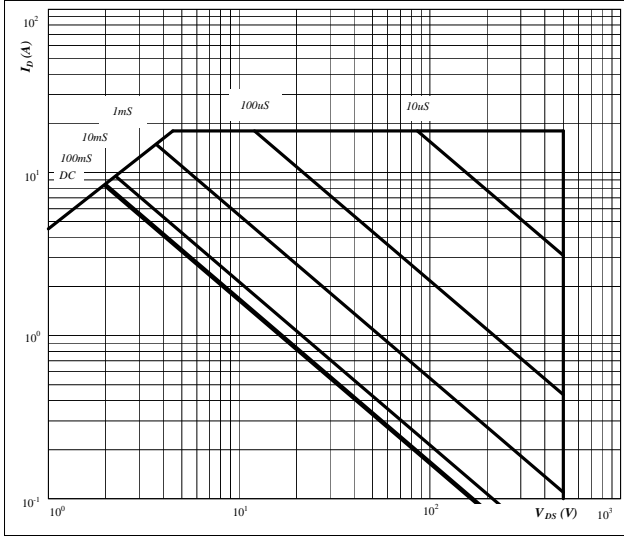


PFC

figure 17. IGBT

Safe operating area as a function of collector-emitter voltage

$I_D = f(V_{DS})$

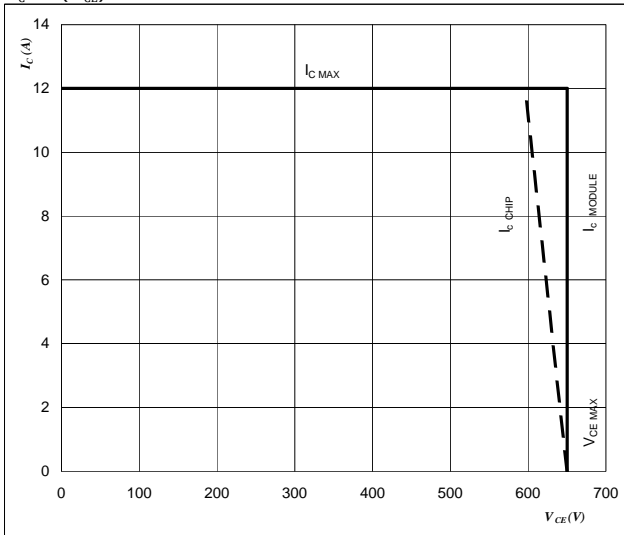


At
 $D =$ single pulse
 $T_s =$ 80 °C
 $U_{CC} =$ 15 V
 $T_j = T_{jmax}$ °C

figure 18. IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At
 $T_j = T_{jmax} - 25$ °C

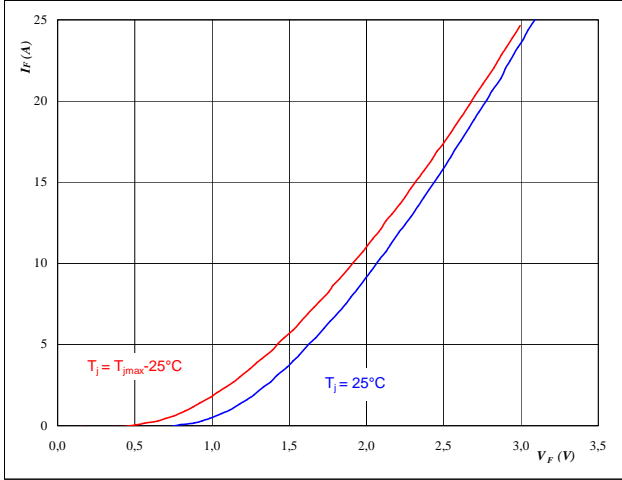


PFC Inverse.Diode

Figure 1 PFC Inverse.Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

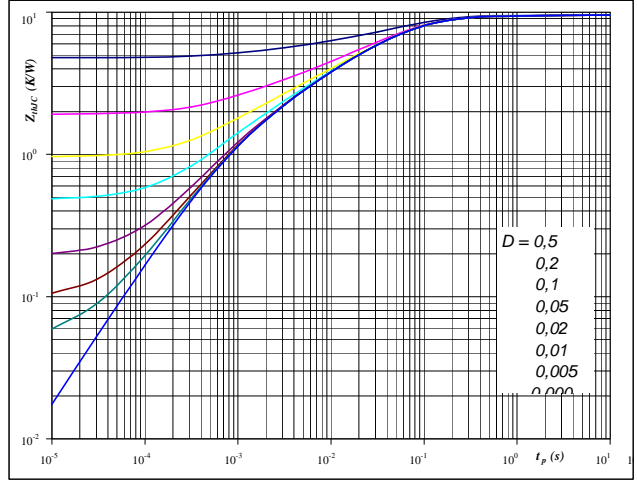


At
 $t_p = 250 \mu s$

Figure 2 PFC Inverse.Diode

Thyristor transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$

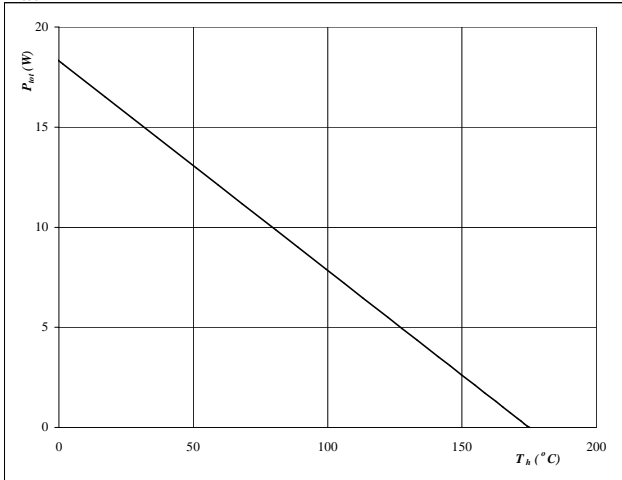


At
Thermal grease
 $R_{thJH} = 9,56 \text{ K/W}$

Figure 3 PFC Inverse.Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

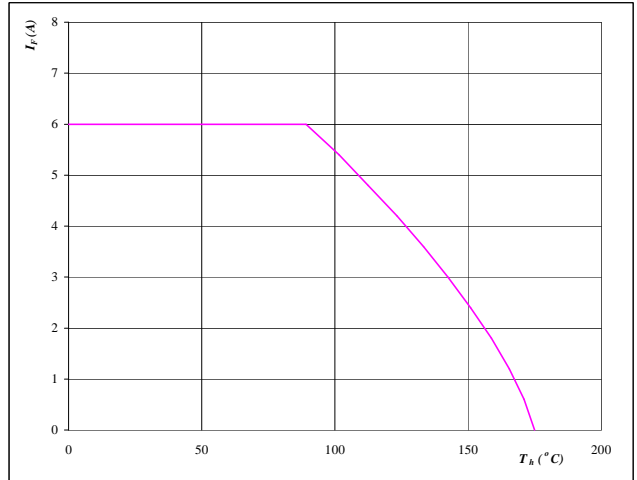


At
 $T_j = 175 \text{ °C}$

Figure 4 PFC Inverse.Diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At
 $T_j = 175 \text{ °C}$

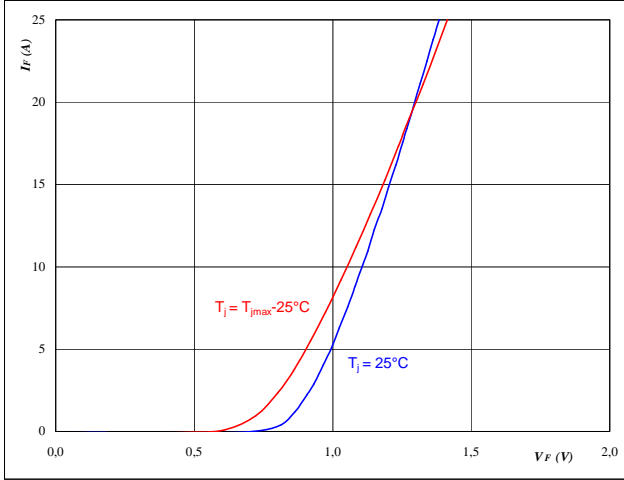


Input Rectifier Diode

figure 1. Rectifier Diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

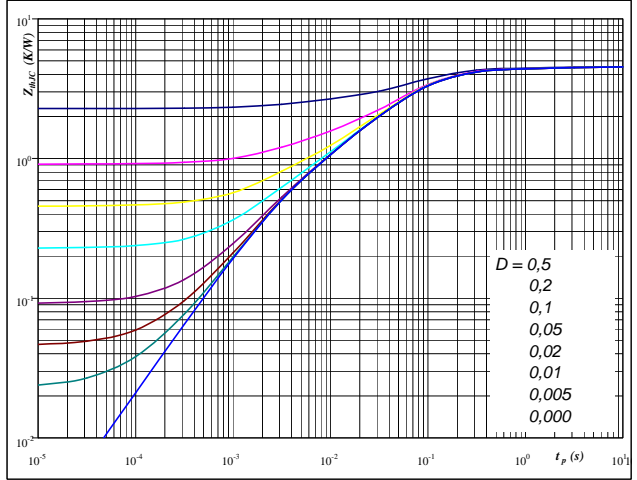


At
 $t_p = 250 \mu s$

figure 2. Rectifier Diode

Diode transient thermal impedance as a function of pulse width

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

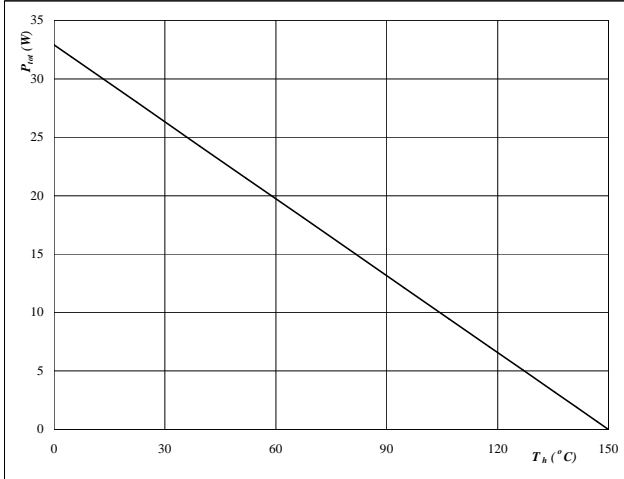


At
 $D = t_p / T$
 $R_{th(f-s)} = 4,56 \text{ K/W}$

figure 3. Rectifier Diode

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_s)$$

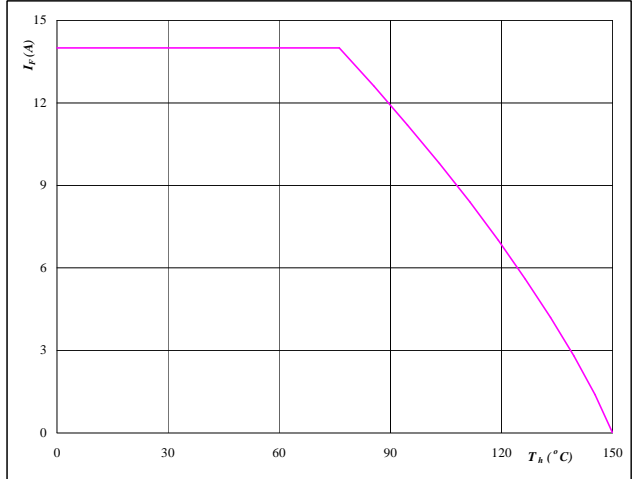


At
 $T_j = 150 \text{ °C}$

figure 4. Rectifier Diode

Forward current as a function of heatsink temperature

$$I_F = f(T_s)$$

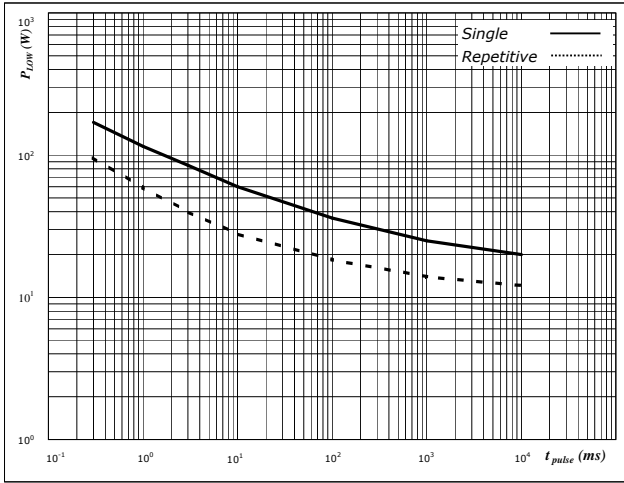


At
 $T_j = 150 \text{ °C}$



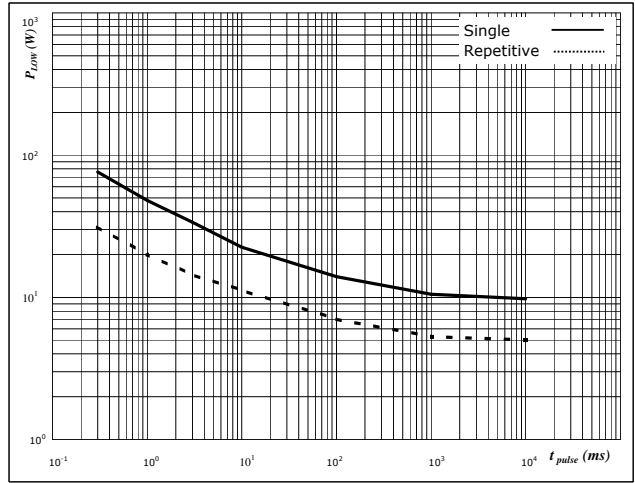
Shunt

figure 1. PFC Shunt
Pulse Power R1



————— $dR/R_0 < 5\%$ after 1 pulse
 $dR/R_0 < 5\%$ after 10.000 cycles; duty cycle < 0,1%

figure 2. DC Shunt
Pulse Power R2



————— $dR/R_0 < 1\%$ after 1 pulse
 $dR/R_0 < 1\%$ after 10.000 cycles; duty cycle < 0,1%

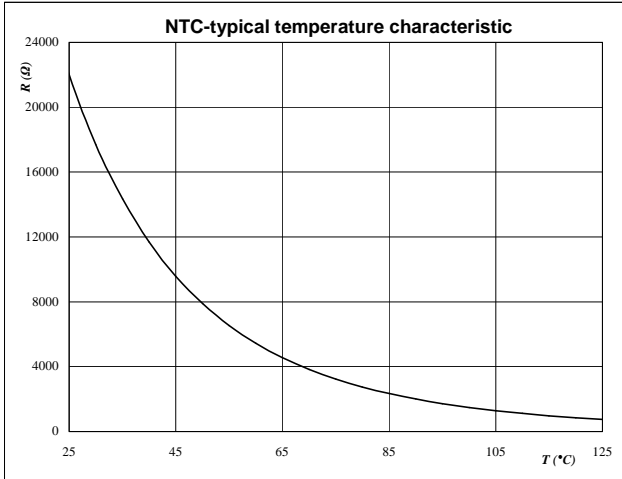


Thermistor

figure 1. Thermistor

**Typical NTC characteristic
as a function of temperature**

$$R_T = f(T)$$





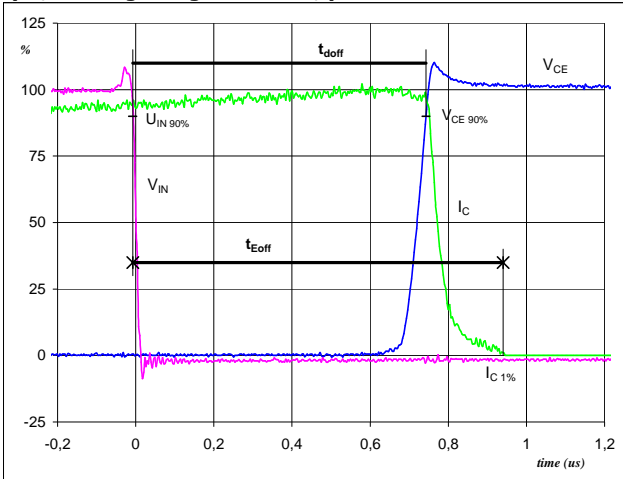
Switching Definitions Output Inverter

General conditions

T_j	=	125 °C
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figure 1. IGBT

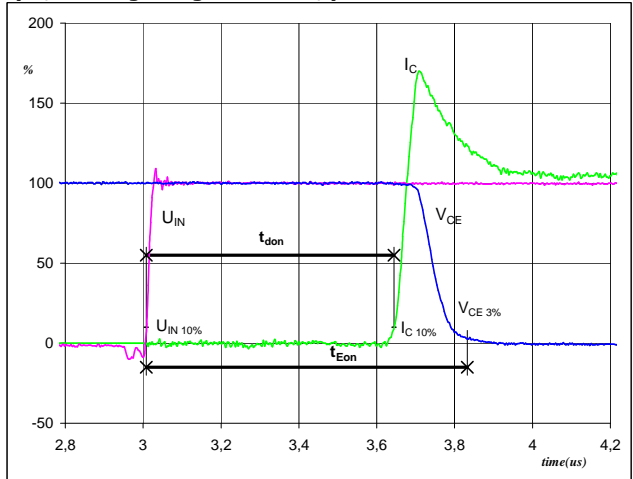
Turn-off Switching Waveforms & definition of t_{doff} t_{Eoff}
 (t_{Eoff} = integrating time for E_{off})



$U_{IN} (0\%) =$	0	V
$U_{IN} (100\%) =$	5	V
$V_C (100\%) =$	400	V
$I_C (100\%) =$	4	A
$t_{doff} =$	0,75	μ s
$t_{Eoff} =$	0,95	μ s

figure 2. IGBT

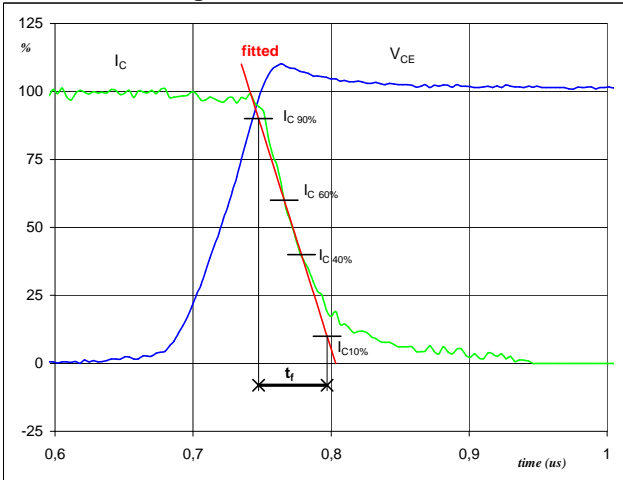
Turn-on Switching Waveforms & definition of t_{don} t_{Eon}
 (t_{Eon} = integrating time for E_{on})



$U_{IN} (0\%) =$	0	V
$U_{IN} (100\%) =$	5	V
$V_C (100\%) =$	400	V
$I_C (100\%) =$	4	A
$t_{don} =$	0,64	μ s
$t_{Eon} =$	0,82	μ s

figure 3. IGBT

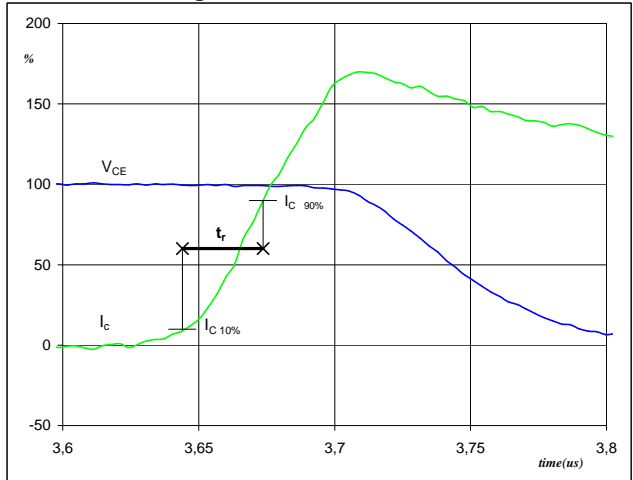
Turn-off Switching Waveforms & definition of t_f



$V_C (100\%) =$	400	V
$I_C (100\%) =$	4	A
$t_f =$	0,05	μ s

figure 4. IGBT

Turn-on Switching Waveforms & definition of t_r

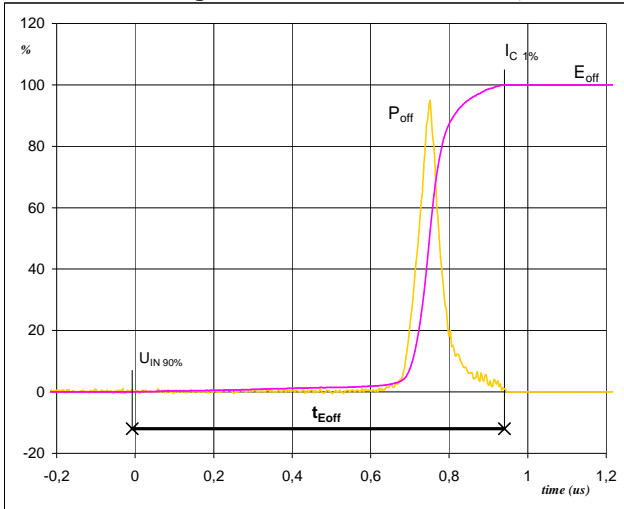


$V_C (100\%) =$	400	V
$I_C (100\%) =$	4	A
$t_r =$	0,03	μ s



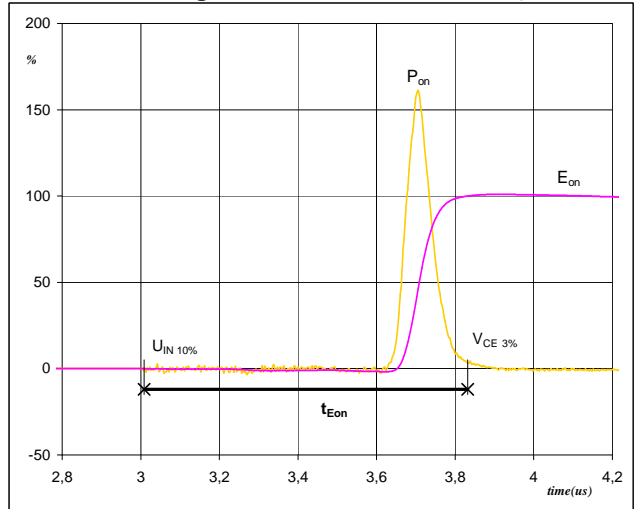
Switching Definitions Output Inverter

figure 5. IGBT
Turn-off Switching Waveforms & definition of t_{Eoff}



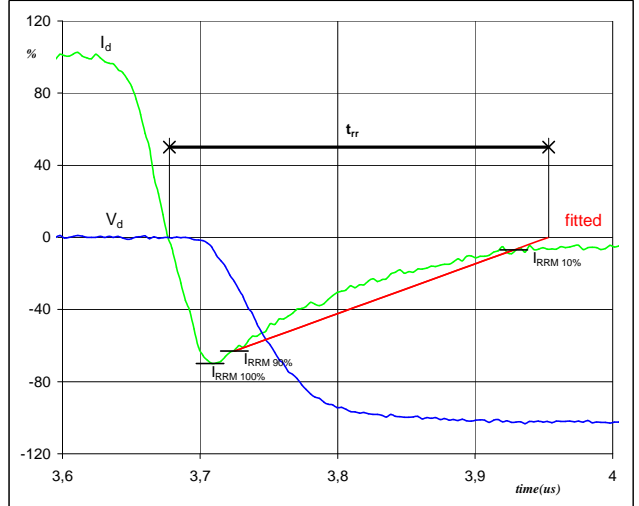
$P_{off} (100\%) = 1,61 \text{ kW}$
 $E_{off} (100\%) = 0,12 \text{ mJ}$
 $t_{Eoff} = 0,95 \text{ } \mu\text{s}$

figure 6. IGBT
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on} (100\%) = 1,61 \text{ kW}$
 $E_{on} (100\%) = 0,20 \text{ mJ}$
 $t_{Eon} = 0,82 \text{ } \mu\text{s}$

figure 7. FWD
Turn-off Switching Waveforms & definition of t_{rr}



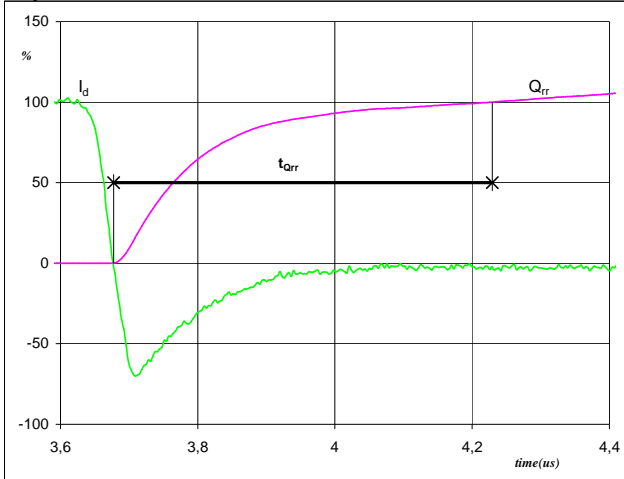
$V_d (100\%) = 400 \text{ V}$
 $I_d (100\%) = 4 \text{ A}$
 $I_{RRM} (100\%) = -3 \text{ A}$
 $t_{rr} = 0,25 \text{ } \mu\text{s}$



Switching Definitions Output Inverter

figure 8. FWD

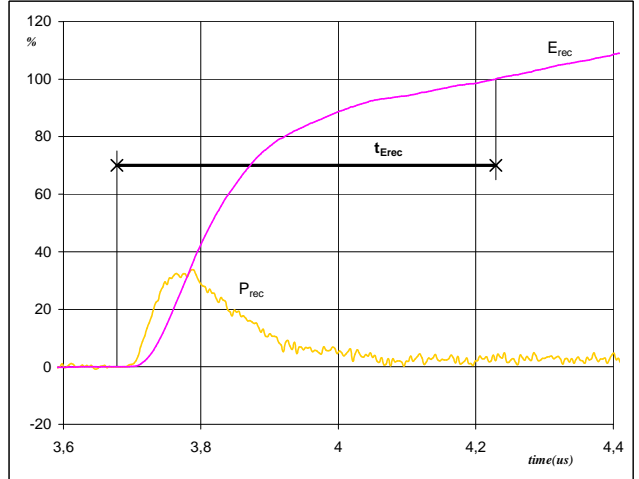
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	4	A
Q_{rr} (100%) =	0,35	μC
t_{Qrr} =	0,55	μs

figure 9. FWD

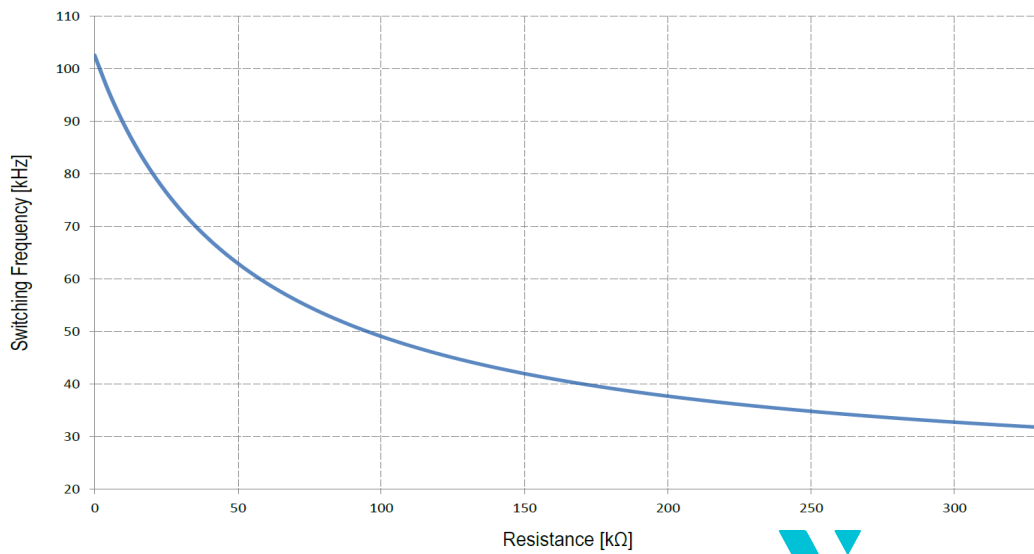
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec} = integrating time for E_{rec})



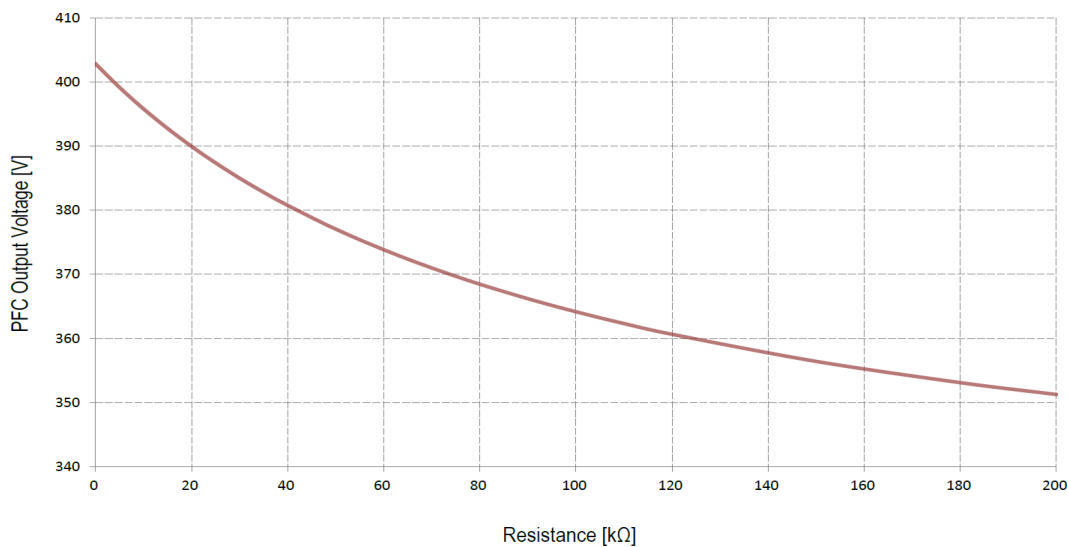
P_{rec} (100%) =	1,61	kW
E_{rec} (100%) =	0,09	mJ
t_{Erec} =	0,55	μs

Application data

Static logic function table							
VCC	VBS	RCIN	ITRIP	ENABLE	FAULT	LO1,2,3	HO1,2,3
<V _{CCUV-}	X	X	X	X	0	0	0
15V	<V _{BSUV-}	X	0	3.3V	High imp	/LIN1,2,3	0
15V	15V	<3.2V↓	0	3.3V	0	0	0
15V	15V	X	> V _{IT,TH+}	3.3V	0	0	0
15V	15V	> V _{RCIN,TH}	0	3.3V	High imp	/LIN1,2,3	/HIN1,2,3
15V	15V	> V _{RCIN,TH}	0	0	High imp	0	0



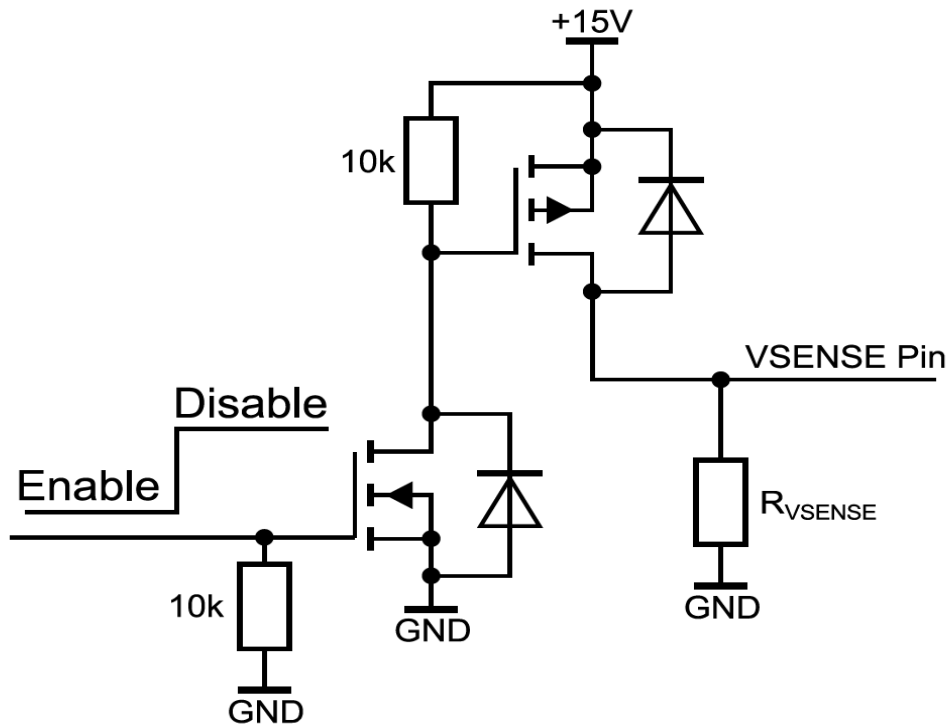
Resistance on f _{set}	Switching Frequency
0Ω	102.6kHz
5.1kΩ	95.5kHz
10.0kΩ	89.7kHz
15.0kΩ	84.7kHz
20.0kΩ	80.3kHz
24.0kΩ	77.2kHz
30.0kΩ	73.2kHz
36.0kΩ	69.6kHz
39.0kΩ	68.0kHz
47.0kΩ	64.3kHz
51.0kΩ	62.6kHz
56.0kΩ	60.7kHz
62.0kΩ	58.6kHz
68.0kΩ	56.7kHz
75.0kΩ	54.7kHz
82.0kΩ	52.9kHz
91.0kΩ	50.9kHz
100.0kΩ	49.1kHz
110.0kΩ	47.3kHz
120.0kΩ	45.8kHz
150.0kΩ	42.0kHz
180.0kΩ	39.2kHz
200.0kΩ	37.7kHz



Resistance on V _{set}	Output Voltage
0Ω	402.9V
5.1kΩ	399.2V
10.0kΩ	395.9V
15.0kΩ	392.8V
20.0kΩ	390.0V
24.0kΩ	387.9V
30.0kΩ	385.0V
36.0kΩ	382.4V
39.0kΩ	381.2V
47.0kΩ	378.1V
51.0kΩ	376.7V
56.0kΩ	375.1V
62.0kΩ	373.3V
68.0kΩ	371.5V
75.0kΩ	369.7V
82.0kΩ	368.0V
91.0kΩ	366.0V
100.0kΩ	364.2V
110.0kΩ	362.3V
120.0kΩ	360.6V
150.0kΩ	356.4V
180.0kΩ	353.1V
200.0kΩ	351.3V



PFC enable circuit



Pin Descriptions

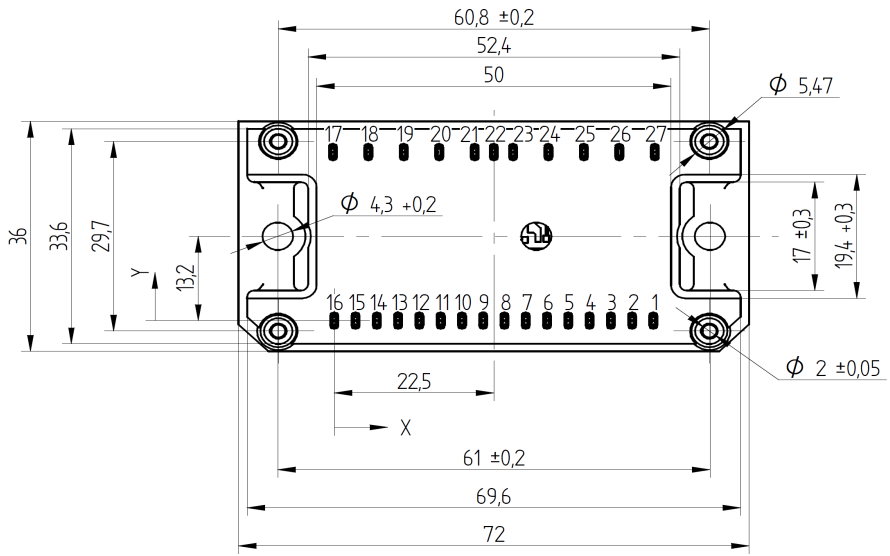
Pin #	Pin Name	Pin Description
1	NTC2	Temperature sensor connector 1
2	NTC1	Temperature sensor connector 2
3	InvS +	Inverter sense resistor high-side
4	InvS -	Inverter sense resistor low-side
5	EN	Enable I/O functionality
6	¬Fault	Fault output, indicates over current or under voltage (negative)
7	¬LIN3	Signal input for low-side W phase
8	¬LIN2	Signal input for low-side V phase
9	¬LIN1	Signal input for low-side U phase
10	¬HIN3	Signal input for high-side W phase
11	¬HIN2	Signal input for high-side V phase
12	¬HIN1	Signal input for high-side U phase
13	V _{CC}	Driver circuit supply voltage
14	GND2	Inverter ground
15	VSENSE	PFC Bulk voltage sense
16	FREQ	PFC Switching frequency adjust
17	AC1	Rectifier input
18	AC2	Rectifier input
19	DC1 + (coil)	Rectifier output DC +
20	PFC + (coil)	PFC coil connector
21	DC1 -	Rectifier output DC -
22	PFC -	PFC return
23	DC2 -	Inverter input DC -
24	DC2 +	Inverter input DC +
25	W	Output for W phase
26	V	Output for V phase
27	U	Output for U phase



Ordering Code & Marking - Outline - Pinout

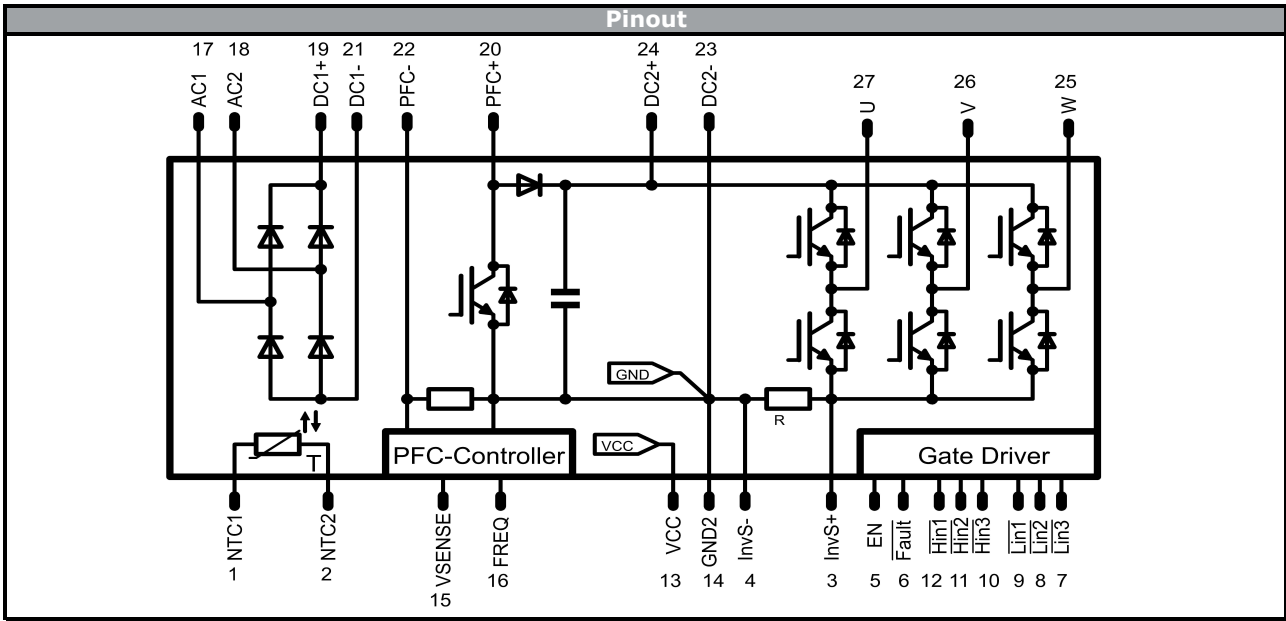
Ordering Code & Marking							
Version			Ordering Code				
without thermal paste, solder pins			20-1B06IPB004RC-P952A40				
with thermal paste, solder pins			20-1B06IPB004RC-P952A40-/3/				
without thermal paste, press fit pins			20-PB06IPB004RC-P952A40Y				
with thermal paste, press fit solder pins			20-PB06IPB004RC-P952A40Y-/3/				
NN-NNNNNNNNNNNNNN TTTTIVVWWYY UL VIN LLLL SSSS		Text	Name	Date code	UL & VIN	Lot	Serial
			NN-NNNNNNNNNNNN- TTTTIVV	WWYY	UL VIN	LLLL	SSSS
Datamatrix			Type&Ver	Lot number	Serial	Date code	
			TTTTIVV	LLLL	SSSS	WWYY	

Pin table [mm]				Outline
Pin	X	Y	Function	
1	45	0	NTC2	
2	42	0	NTC1	
3	39	0	Inv_S+	
4	36	0	Inv_S-	
5	33	0	EN	
6	30	0	FAULT	
7	27	0	LIN3	
8	24	0	LIN2	
9	21	0	LIN1	
10	18	0	HIN3	
11	15	0	HIN2	
12	12	0	HIN1	
13	9	0	VCC	
14	6	0	GND2	
15	3	0	VSENSE	
16	0	0	FREQ	
17	-0,2	26,4	AC1	
18	4,8	26,4	AC2	
19	9,8	26,4	DC1+	
20	14,8	26,4	PFC+	
21	19,8	26,4	DC1-	
22	22,5	26,4	PFC-	
23	25,2	26,4	DC2-	
24	30,2	26,4	DC2+	
25	35,2	26,4	W	
26	40,2	26,4	V	
27	45,2	26,4	U	





Ordering Code & Marking - Outline - Pinout




Identification					
ID	Component	Voltage	Current	Function	Comment
T1,T2,T3,T4,T5,T6	IGBT	600 V	4 A	Inverter Transistor	
T7	IGBT	650 V	15 A	PFC IGBT	
D12	FWD	650 V	15 A	PFC Diode	
D11	FWD	650 V	6 A	PFC inverse Diode	
R3	Resistor			PFC Shunt	
D7,D8,D9,D10	Rectifier	1600 V	12 A	Input Rectifier Diode	
R2	Resistor			DC - Shunt	
C1	Capacitor	500 V		DC link Capacitor	
T	Thermistor			Thermistor	



Packaging instruction			
Standard packaging quantity (SPQ)	100	>SPQ Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow</i> 1B packages see vincotech.com website.

Package data
Package data for <i>flow</i> 1B 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
20-xB06IPB004RC-P952A40x-D4-14	08 Apr. 2017	Page number correction	8

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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.

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