Vincotech

V23990-P800-D30/-D40-PM

preliminary datasheet

flow PFC 0 — **500 V/ 2 x 14 A/ 200 kHz**

Features

- Clip-in housing
- Compact and low inductance design

flow 0 housing

Target Applications

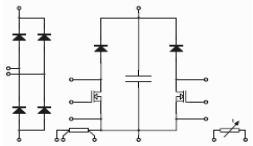
- PFC for welding
- PFC for SMPS
- PFC for motor drives
- PFC for UPS

Types

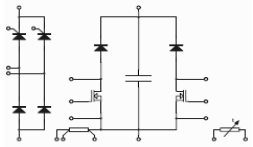
- V23990-P800-D30-PM without Thyristor
- V23990-P800-D40-PM with Thyristor

Schematic

P800-D30



P800-D40



Maximum Ratings

Parameter	Symbol	Condition		Value	Unit
Input Rectifier Diode					
Repetitive peak reverse voltage	V_{RRM}			1600	V
Forward current per diode	I_F	DC current $T_j=T_{jmax}$	T_h=80°C T_c=80°C	28	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25°C	200	A
I^2t-value	I^2t			200	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	T_h=80°C T_c=80°C	33	W
Maximum junction temperature	T_{jmax}			150	°C
Input Rectifier Thyristor					
Repetitive peak reverse voltage	V_{RRM}			1600	V
Forward current per Thyristor	I_F	DC current $T_j=T_{jmax}$	T_h=80°C T_c=80°C	35	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25°C	250	A
I^2t-value	I^2t			310	A^2s
Power dissipation per Thyristor	P_{tot}	$T_j=T_{jmax}$	T_h=80°C T_c=80°C	45	W
Maximum junction temperature	T_{jmax}			150	°C

Maximum Ratings

Parameter	Symbol	Condition	Value	Unit
PFC Transistor (MOSFET)-per leg				
Drain to source voltage	V_{DS}		500	V
DC drain current	I_d	$T_j=T_j$max T_h=80°C T_c=80°C	16	A
Pulsed drain current	I_{dpuls}	T_j=150°C T_h=80°C t_p limited by T_{jmax} T_c=80°C	96	A
Avalanche energy, single pulse	E_{AS}	I_D=10 A V_{DD}=50 V	1100	mJ
Avalanche energy, repetitive	E_{AR}	I_D=20A t_{AR} limited by Tjmax V_{DD}=50V	1	mJ
Avalanche current, repetitive	I_{AR}	t_p limited by Tjmax	20	A
Drain source voltage slope	dv/dt	I_D=32A V_{DS}=400V T_j=125°C	50	V/ns
Reverse diode dv/dt	dv/dt	I_D=32A V_{DS}=400V di/dt=100A/µs Tj=150°C	6	kV/µs
Power dissipation	P_{tot}	$T_j=T_{jmax}$ T_h=80°C T_c=80°C	63	W
Gate-source peak voltage	V_{GS}		20	V
Maximum junction temperature	T_{jmax}		150	°C
PFC Diode-per leg				
Peak repetitive reverse voltage	V_{RRM}		600	V
DC forward current	I_F	$T_j=T_{jmax}$ T_h=80°C T_c=80°C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by Tjmax T_h=80°C	64	A
Power dissipation	P_{tot}	$T_j=T_{jmax}$ T_h=80°C T_c=80°C	47	W
Maximum junction temperature	T_{jmax}		175	°C
PFC Shunt				
DC forward current	I_F	T_k=170°C T_k=Terminal temperature T_h=80°C	40	A
Power dissipation per Shunt	P_{tot}	T_k=170°C T_k=Terminal temperature T_h=80°C	17	W
Capacitor				
Max.DC voltage	V_{MAX}		500	V
Thermal properties				
Storage temperature	T_{stg}		-40…+125	°C
Operation temperature	T_{op}		-40…+125	°C
Insulation properties				
Insulation voltage	V_{is}	t=1min	4000	Vdc
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm

Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
			V_{GE}(V) or V_{GS}(V)	V_r(V) or V_{CE}(V) or V_{DS}(V)	I_C(A) or I_F(A) or I_D(A)	T(°C)	Min	Typ	Max	
Input Rectifier Bridge										
Forward voltage	V_F				30	Tj=25°C Tj=125°C		1,21 1,18	1,5	V
Threshold voltage (for power loss calc. only)	V_{to}				30	Tj=25°C Tj=125°C		0,93 0,79		V
Slope resistance (for power loss calc. only)	r_t				30	Tj=25°C Tj=125°C		0,009 0,013		Ohm
Reverse leakage current	I_r			1500		Tj=25°C Tj=150°C			0,01 1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						2,14		K/W
Input Rectifier Thyristor										
Forward voltage	V_F				30	Tj=25°C Tj=125°C		1,25 1,22	1,6	V
Threshold voltage (for power loss calc. only)	V_{to}				30	Tj=25°C Tj=125°C		0,93 0,82		V
Slope resistance (for power loss calc. only)	r_t				30	Tj=25°C Tj=125°C		0,011 0,014		Ohm
Reverse current	I_r			800		Tj=25°C Tj=125°C			0,05 2	mA
Gate controlled delay time	t_{gd}	Ig=0,5A dig/dt=0,5A/us		VD=1/2Vdrm		Tj=25°C			2	µs
Critical rate of rise of off-state voltage	$(dv/dt)_{cr}$			VD=2/3Vdrm		Tj=125°C			500	V/µs
Critical rate of rise of on-state current	$(di/dt)_{cr}$	Ig=0,2A f=50Hz		VD=2/3Vdrm	40	Tj=125°C			150	A/µs
Circuit-commutated turn-off time	t_q	VD=2/3Vdrm tp=200us		100	26	Tj=125°C		150		µs
Holding current	I_H	VD=6V				Tj=25°C			50	mA
Latching current	I_L	tp=10us Ig=0,2A				Tj=25°C			90	mA
Gate trigger voltage	V_{GT}	VD=6V				Tj=25°C Tj=-40°C			1,3 1,6	V
Gate trigger current	I_{GT}	VD=6V				Tj=25°C Tj=-40°C	11		28 50	mA
Gate non-trigger voltage	V_{GD}			VD=1/2Vdrm		Tj=125°C			0,2	V
Gate non-trigger current	I_{GD}			VD=1/2Vdrm		Tj=125°C			1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						1,57		K/W
PFC Transistor (MOSFET)-per leg										
Avalanche breakdown voltage	$V_{(BR)DS}$		0		0,0003	Tj=25°C	500			V
Static drain to source ON resistance	$R_{ds(on)}$		10		20	Tj=25°C Tj=125°C		0,11 0,24		Ohm
Gate threshold voltage	$V_{(GS)th}$		Vds		0,00018	Tj=25°C		3	3,9	V
Zero gate voltage drain current	I_{DSS}		0	500		Tj=25°C			2	µA
Gate to Source Leakage Current	I_{GSS}		20	0		Tj=25°C			150	nA
Turn On Delay Time	$t_{d(ON)}$	Rgon=4 Ohm Rgoff=4 Ohm	10	400	20	Tj=25°C Tj=125°C		21		ns
Rise Time	t_r					Tj=25°C Tj=125°C		5,4		ns
Turn off delay time	$t_{d(OFF)}$					Tj=25°C Tj=125°C		167,8		ns
Fall time	t_f					Tj=25°C Tj=125°C		13,9		ns
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		0,10		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		0,078		mWs
Total gate charge	Q_g		10	380	32	Tj=25°C		170		nC
Gate to source charge	Q_{gs}							15		nC
Gate to drain charge	Q_{gd}							90		nC
Input capacitance	C_{iss}	f=1MHz	0	25		Tj=25°C		4200		pF
Output capacitance	C_{oss}							1700		pF
Reverse transfer capacitance	C_{rss}							90		pF
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						1,12		K/W

Characteristic Values

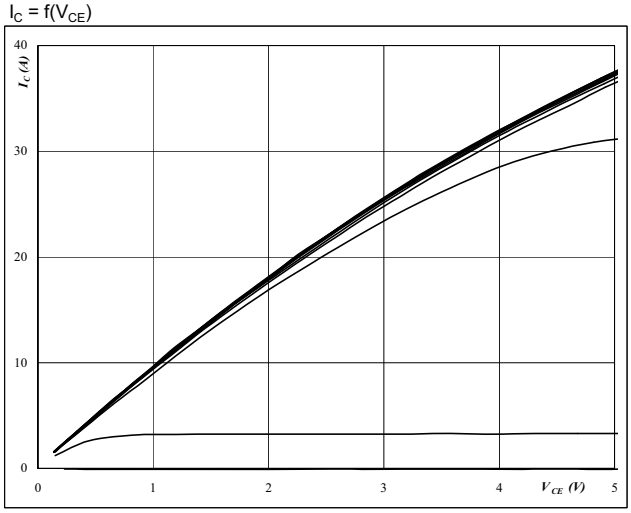
Parameter	Symbol	Conditions					Value			Unit
			V_{GE}(V) or V_{GS}(V)	V_r(V) or V_{CE}(V) or V_{DS}(V)	I_C(A) or I_F(A) or I_D(A)	T(°C)	Min	Typ	Max	
PFC Diode-per leg										
Forward voltage	V_F				16	Tj=25°C Tj=125°C		1,59 1,74	1,8	V
Reverse leakage current	I_r			600		Tj=25°C			400	uA
Peak reverse recovery current	I_{RRM}	Rgon=4 Ohm Rgoff=4 Ohm	10	400	20	Tj=25°C Tj=125°C		18,7		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		9,8		ns
Reverse recovery charge	Q_{rr}					Tj=25°C Tj=125°C		0,066		nC
Reverse recovered energy	E_{rec}					Tj=25°C Tj=125°C		0,0012		mWs
Peak rate of fall of reverse recovery current	di(rec)max /dt					Tj=25°C Tj=125°C		5444		A/µs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 0,61 W/mK						2,02		K/W
PFC Shunt										
R1 value	R					Tj=25°C	21,85	23,5	26,45	mOhm
Temperature coefficient	t_c	20°C to 60°C						< 30		ppm/K
Internal heat resistance	R_{thi}							<5		K/W
Inductance	L							< 3		nH
Capacitor										
C value	C					Tj=25°C	400	540	680	nF
NTC Thermistor										
Rated resistance	R_{25}	Tol. ±5%				Tj=25°C	20,9	22	23,1	kOhm
Deviation of R_{100}	ΔR/R	R_{100} = 1486 Ohm				Tj=100°C		5		%/K
Power dissipation	P_{25}					Tj=25°C		210		mW
B-value	$B_{(25/100)}$	Tol. ±3%						4000		K

PFC

Figure 1 PFC MOSFET

Typical output characteristics

$I_C = f(V_{CE})$

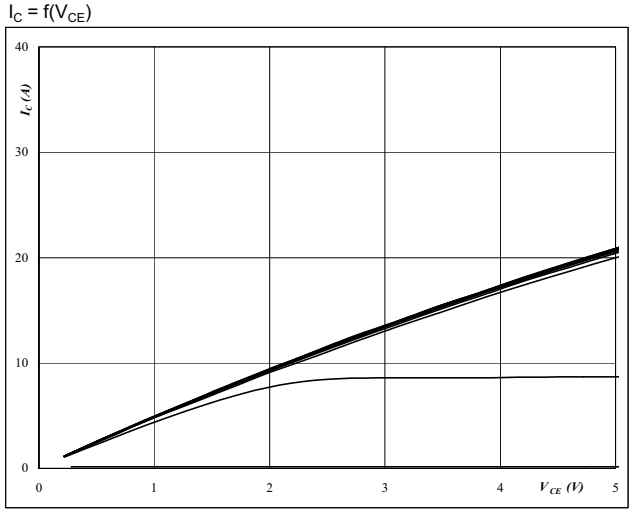


t_p = 250 µs
T_j = 25 °C
VGE from 3 V to 13 V in steps of 1 V

Figure 2 PFC MOSFET

Typical output characteristics

$I_C = f(V_{CE})$

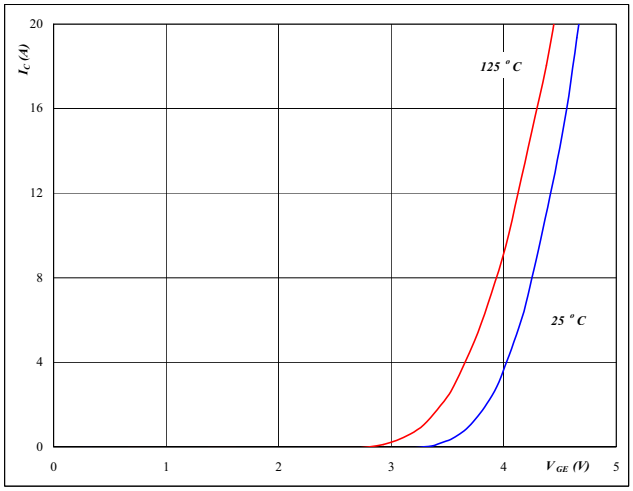


t_p = 250 µs
T_j = 125 °C
VGE from 3 V to 13 V in steps of 1 V

Figure 3 PFC MOSFET

Typical transfer characteristics

$I_C = f(V_{GE})$

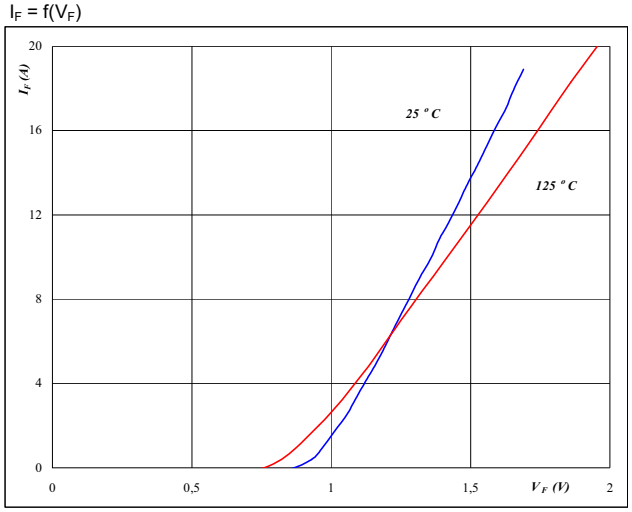


t_p = 250 µs
V_{CE} = 10 V

Figure 4 PFC FRED

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



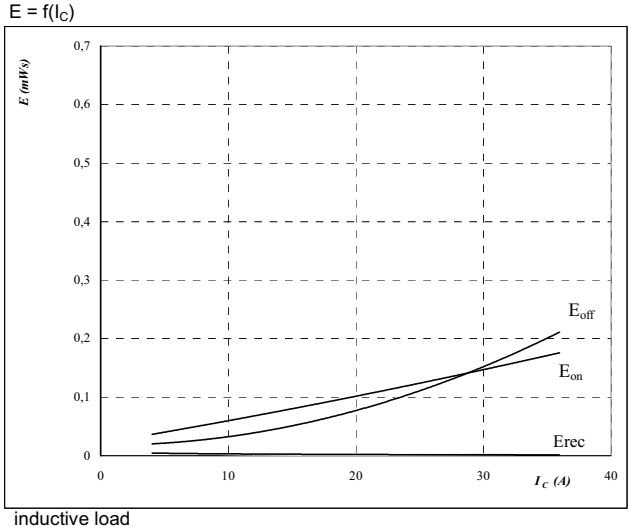
t_p = 250 µs

PFC

Figure 5 PFC MOSFET

Typical switching energy losses as a function of collector current

$E = f(I_C)$



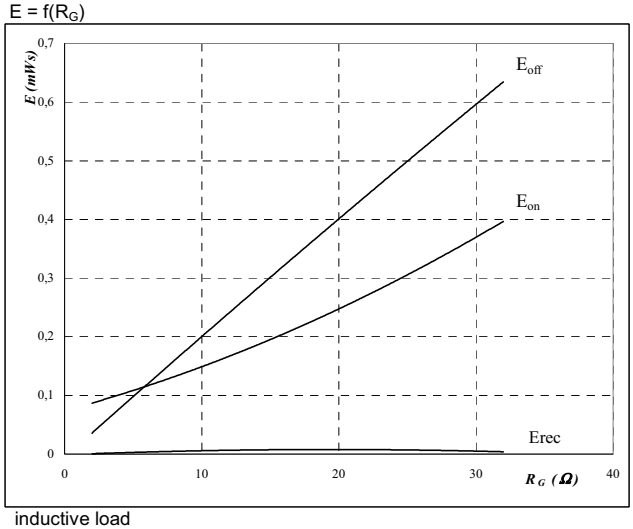
inductive load

T_j =	125	°C
V_{CE} =	400	V
V_{GE} =	10	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

Figure 6 PFC MOSFET

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



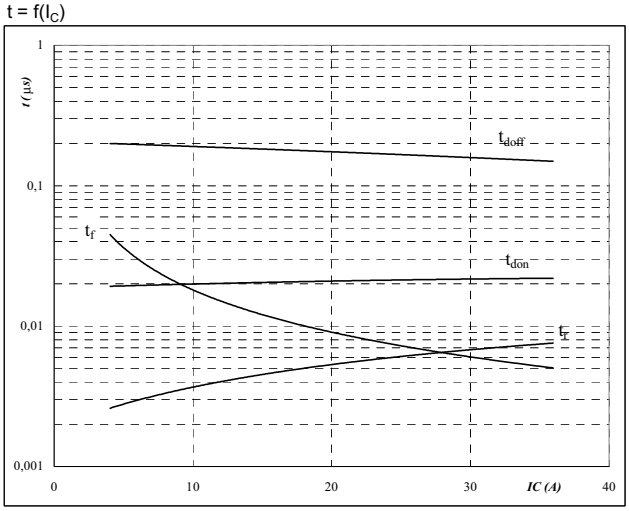
inductive load

T_j =	125	°C
V_{CE} =	400	V
V_{GE} =	10	V
I_C =	20	A

Figure 7 PFC MOSFET

Typical switching times as a function of collector current

$t = f(I_C)$



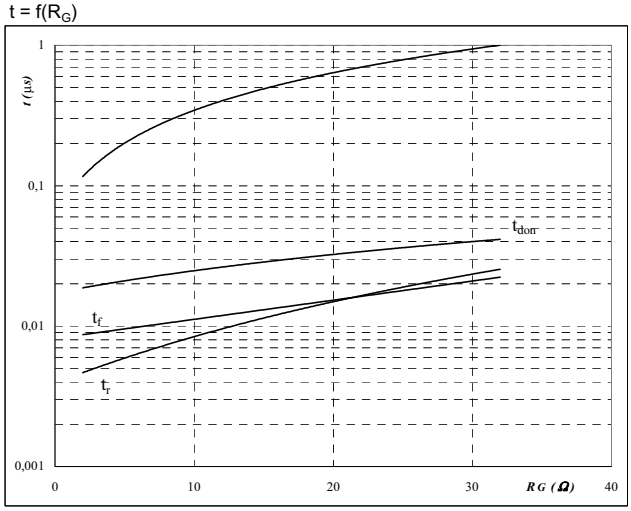
inductive load

T_j =	125	°C
V_{CE} =	400	V
V_{GE} =	10	V
R_{gon} =	4	Ω
R_{goff} =	4	Ω

Figure 8 PFC MOSFET

Typical switching times as a function of gate resistor

$t = f(R_G)$



inductive load

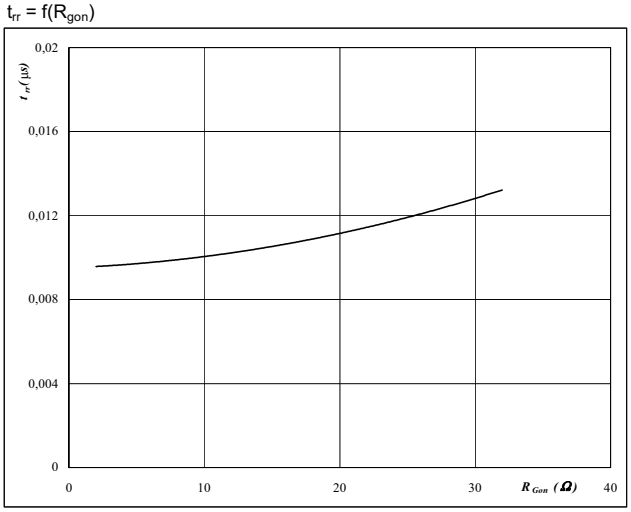
T_j =	125	°C
V_{CE} =	400	V
V_{GE} =	10	V
I_C =	20	A

PFC

Figure 9 PFC FRED diode

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

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

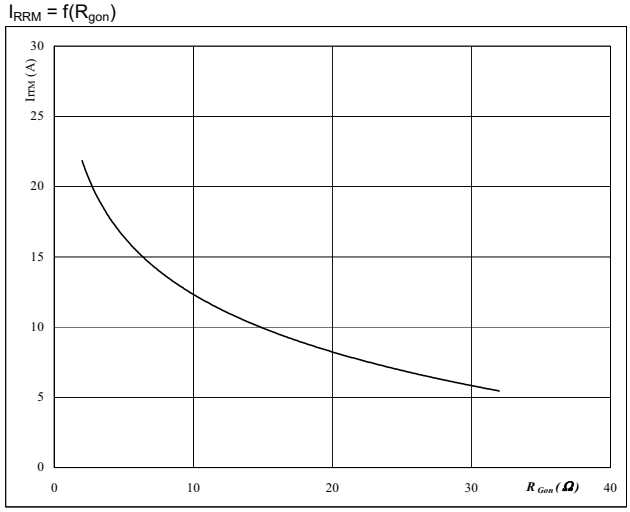


T_j =	125	°C
V_R =	400	V
I_F =	20	A
V_{GE} =	10	V

Figure 10 PFC FRED diode

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

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

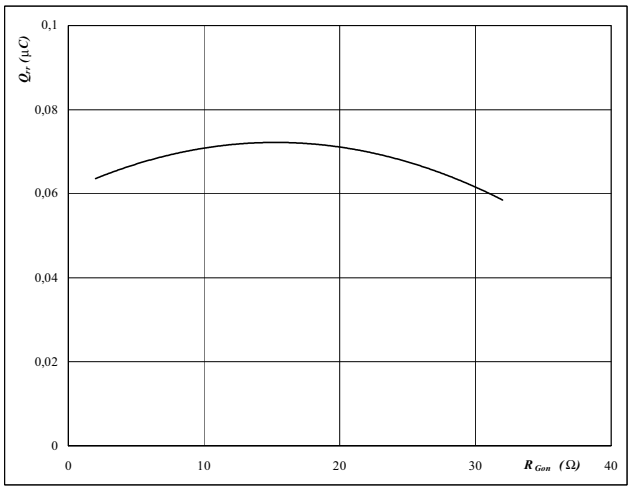


T_j =	125	°C
V_R =	400	V
I_F =	20	A
V_{GE} =	10	V

Figure 11 PFC FRED diode

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

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

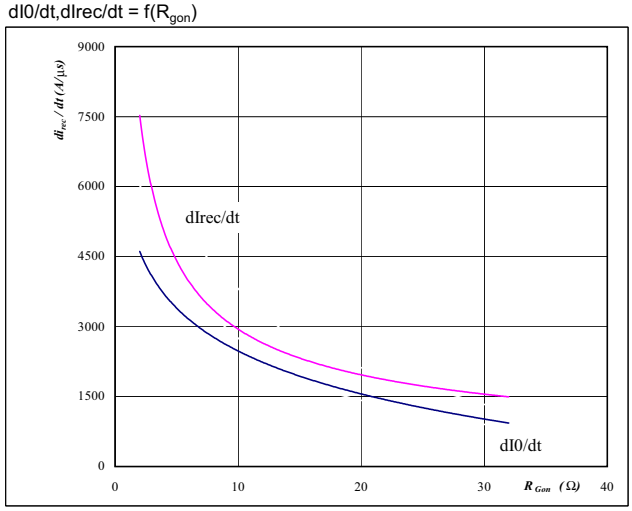


Tj =	125	°C
VR =	400	V
IF =	20	A
VGE =	10	V

Figure 12 PFC FRED diode

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

dI0/dt,dIrec/dt = $f(R_{gon})$

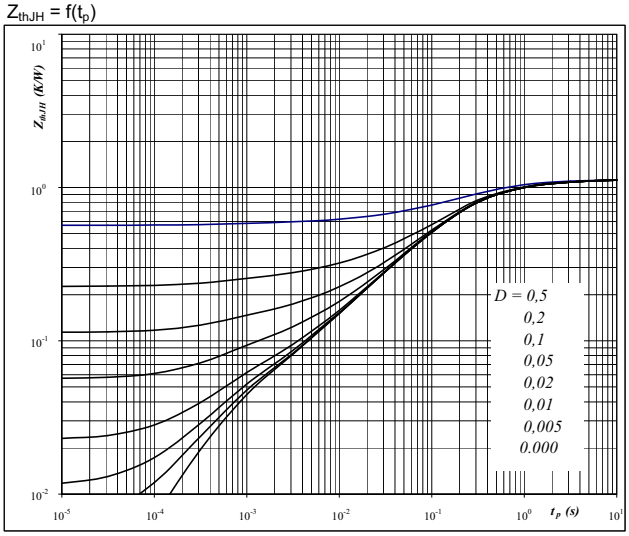


Tj =	125	°C
VR =	400	V
IF =	20	A
VGE =	10	V

PFC

Figure 13 PFC MOSFET

MOSFET transient thermal impedance
as a function of pulse width
$Z_{thJH} = f(t_p)$



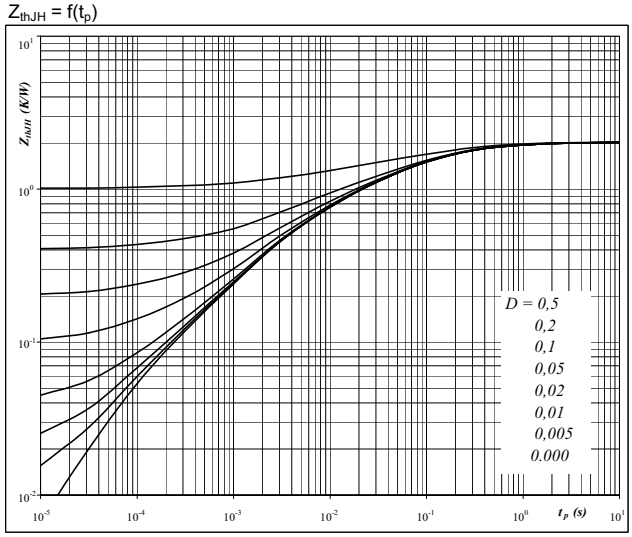
D = tp / T
R_{thJH} = 1,12 K/W

IGBT thermal model values

R (C/W)	Tau (s)
5,04E-02	9,74E+00
2,02E-01	1,14E+00
6,23E-01	2,01E-01
1,73E-01	3,65E-02
5,04E-02	5,53E-03
3,53E-02	6,12E-04

Figure 14 PFC FRED diode

FRED transient thermal impedance
as a function of pulse width
$Z_{thJH} = f(t_p)$



D = tp / T
R_{thJH} = 2,02 K/W

FRED thermal model values

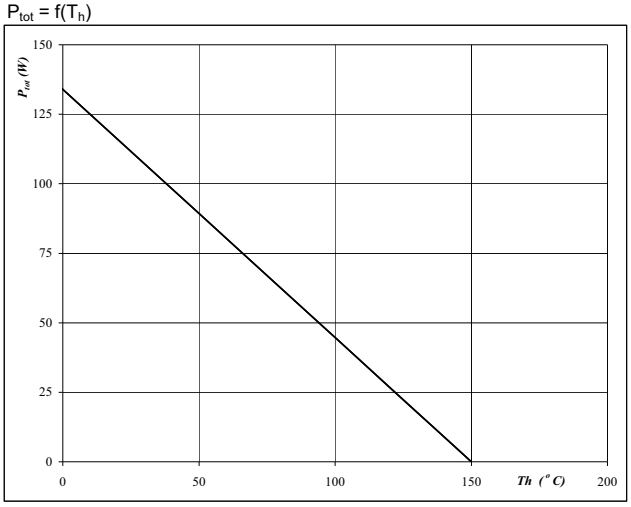
R (C/W)	Tau (s)
1,46E-01	1,52E+00
5,50E-01	1,86E-01
5,72E-01	4,49E-02
4,60E-01	8,20E-03
2,42E-01	1,49E-03
5,35E-02	1,16E-04

PFC

Figure 15 PFC MOSFET

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

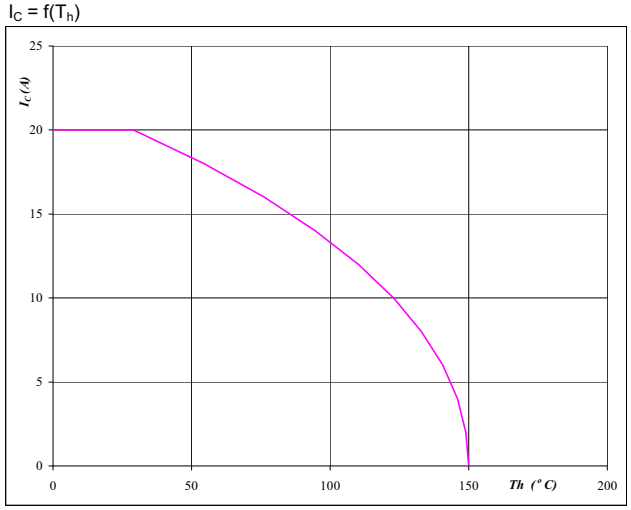


T_j = 150 °C

Figure 16 PFC MOSFET

Collector current as a function of heatsink temperature

$I_C = f(T_h)$

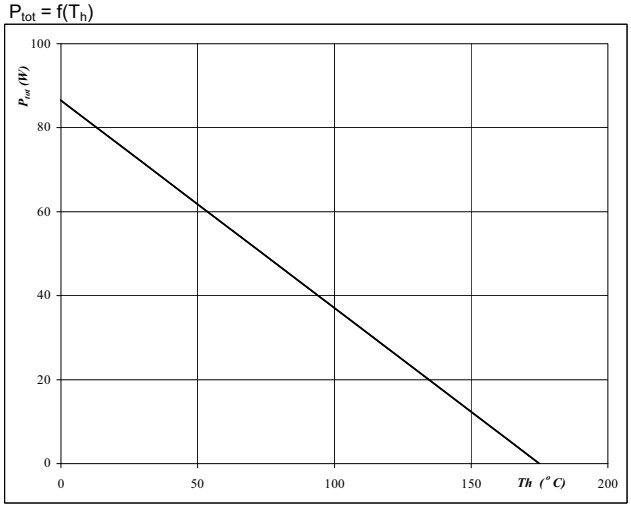


T_j = 150 °C
V_{GE} = 15 V

Figure 17 PFC FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

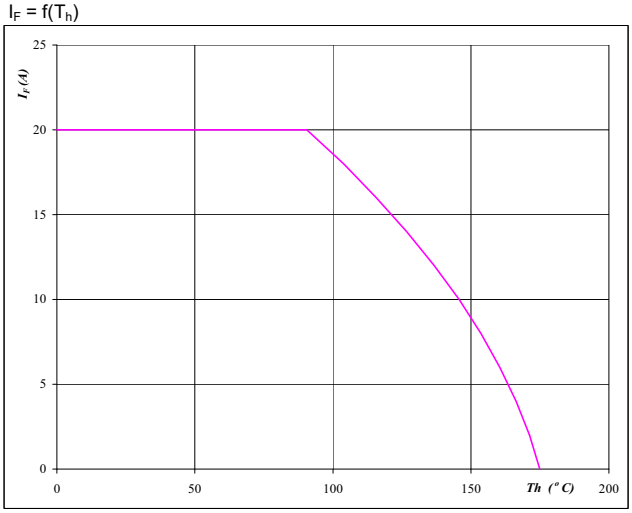


T_j = 175 °C

Figure 18 PFC FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



T_j = 175 °C

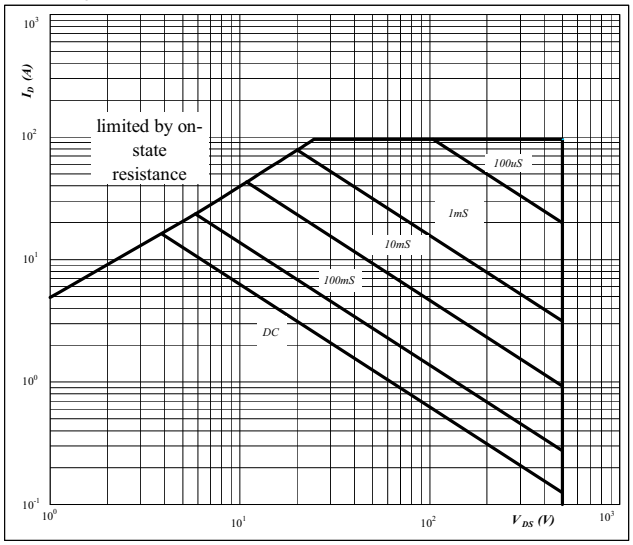
PFC

Figure 19 PFC MOSFET

Safe operating area function of drain-surce voltage

Output inverter MOSFET

$I_D = f(V_{DS})$



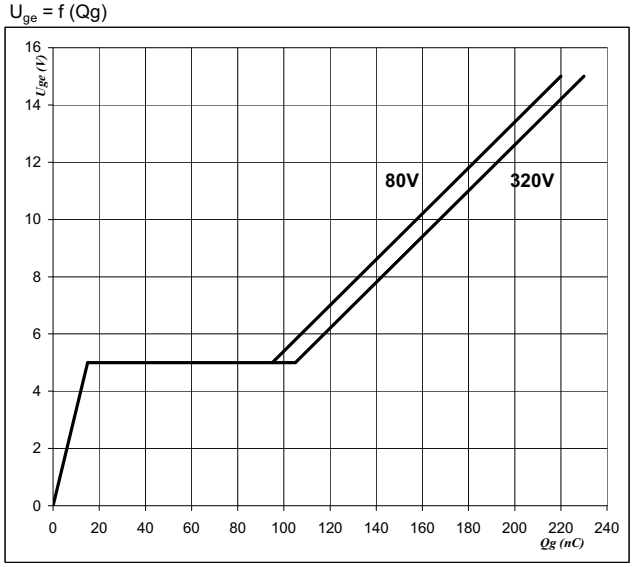
D =	0	
Th=	80	ºC
Vgs=	10	V
Tj=	125	ºC

Figure 20 PFC MOSFET

Gate voltage vs Gate charge

Output inverter MOSFET

$U_{ge} = f(Qg)$



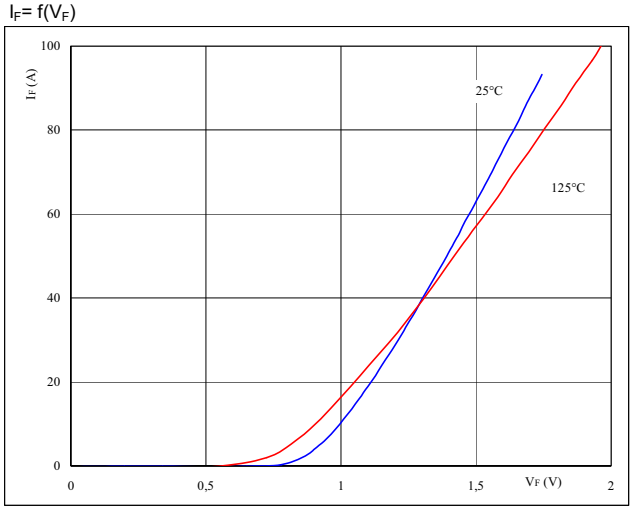
V_{GEoff} =	0	V
V_{GEon} =	10	V
V_C (100%) =	400	V
I_C (100%) =	20	A
Q_g =	131	nC

Input Rectifier Bridge

Figure 1 Rectifier diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

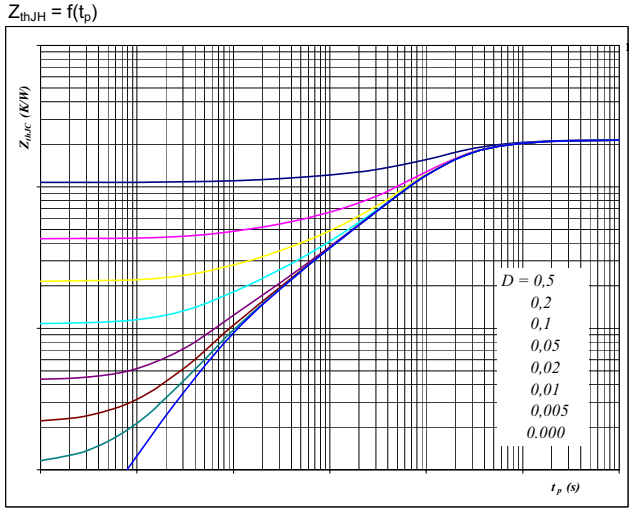


t_p = 250 µs

Figure 2 Rectifier diode

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



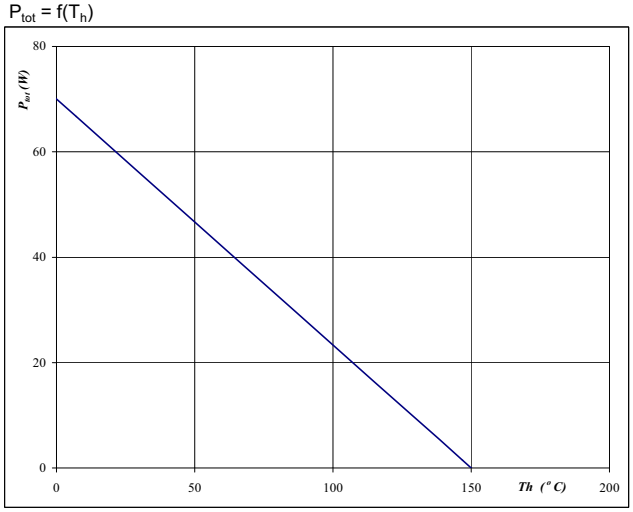
D = tp / T

R_{thJH} = 2,14 K/W

Figure 3 Rectifier diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

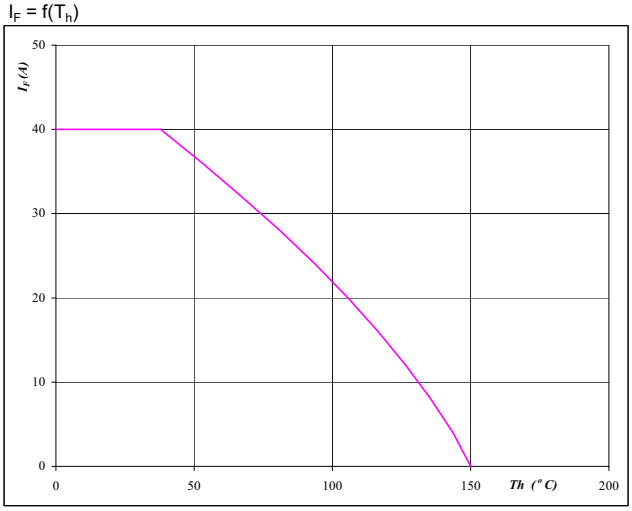


T_j = 150 °C

Figure 4 Rectifier diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



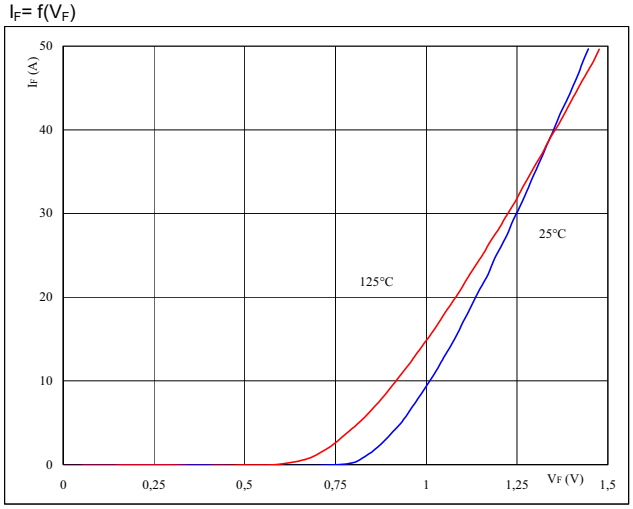
T_j = 150 °C

Thyristor

Figure 1 Thyristor

Typical thyristor forward current as a function of forward voltage

$I_F = f(V_F)$

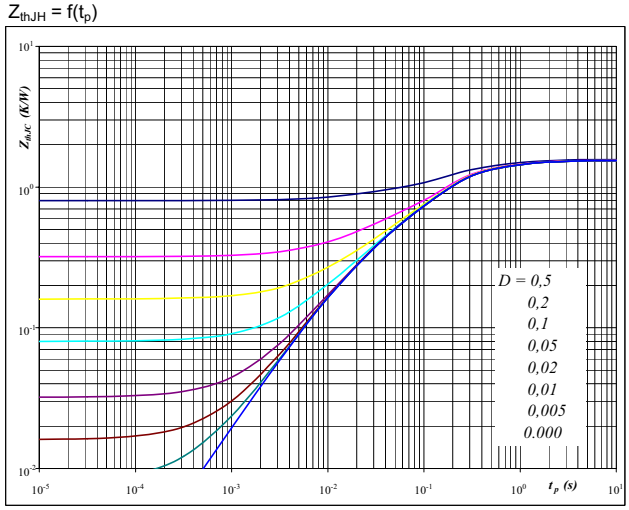


t_p = 250 µs

Figure 2 Thyristor

Thyristor transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



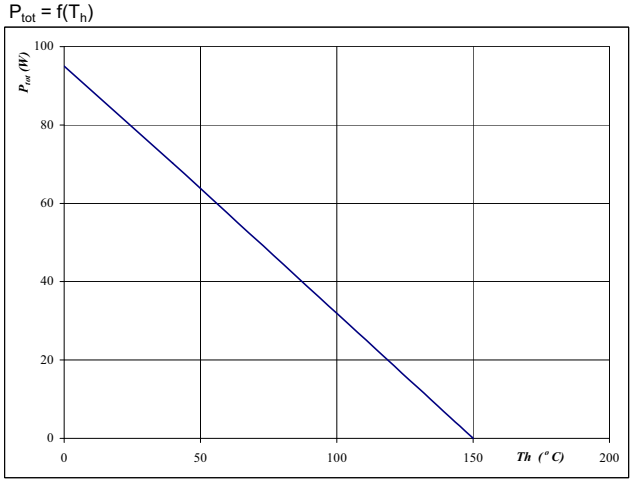
D = tp / T

R_{thJH} = 1,57 K/W

Figure 3 Thyristor

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

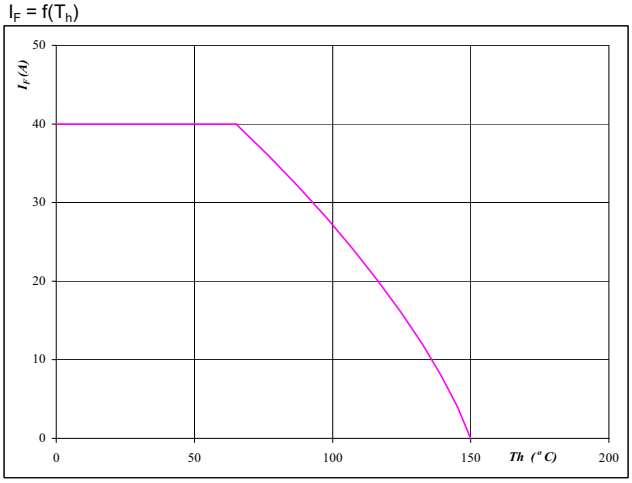


T_j = 150 °C

Figure 4 Thyristor

Forward current as a function of heatsink temperature

$I_F = f(T_h)$

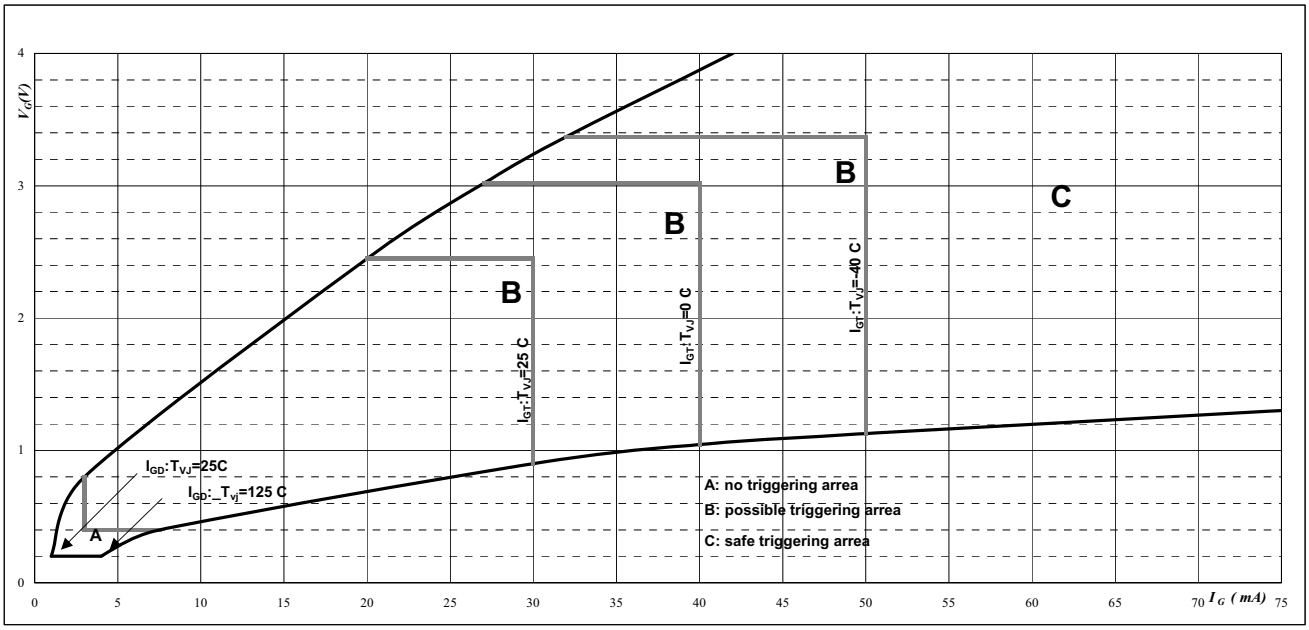


T_j = 150 °C

Thyristor

Figure 5 Thyristor

Gate trigger characteristics

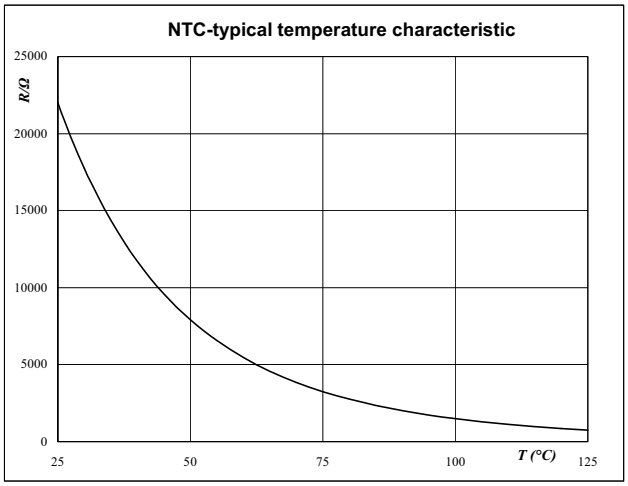


Thermistor

Figure 1 Thermistor

Typical NTC characteristic
as a function of temperature

$R_T = f(T)$



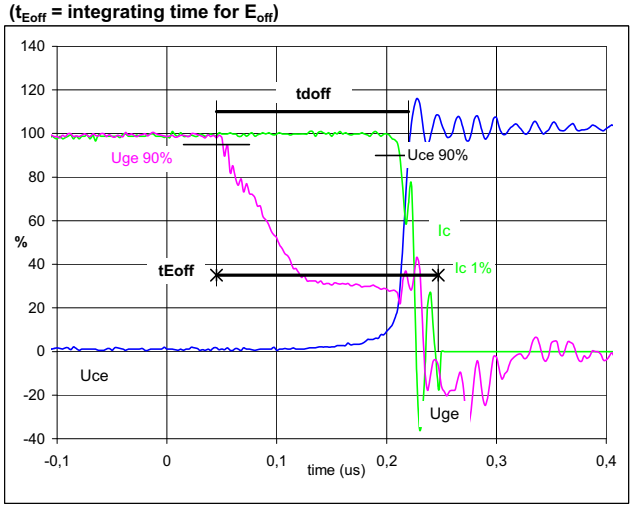
Switching Definitions PFC

General conditions

T_j	=	125 °C
R_{gon}	=	4 Ω
R_{goff}	=	4 Ω

Figure 1 PFC MOSFET

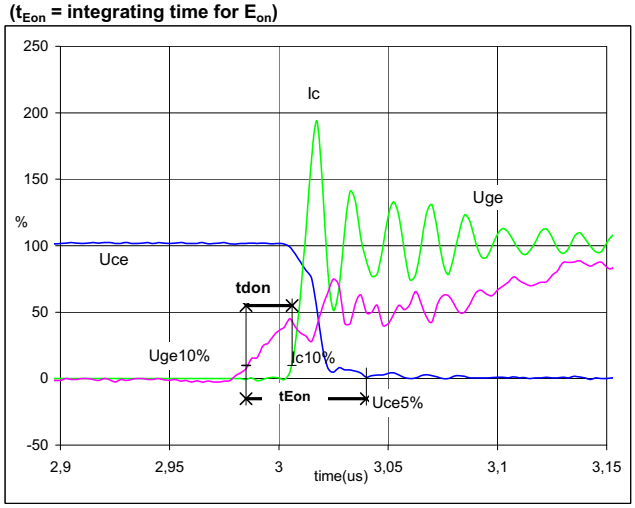
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	10	V
V_C (100%) =	400	V
I_C (100%) =	20	A
t_{doff} =	0,17	µs
t_{Eoff} =	0,20	µs

Figure 2 PFC MOSFET

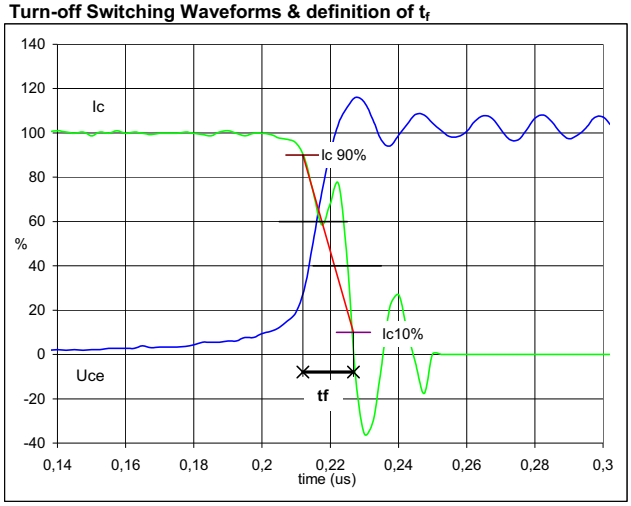
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	10	V
V_C (100%) =	400	V
I_C (100%) =	20	A
t_{don} =	0,021	µs
t_{Eon} =	0,055	µs

Figure 3 PFC MOSFET

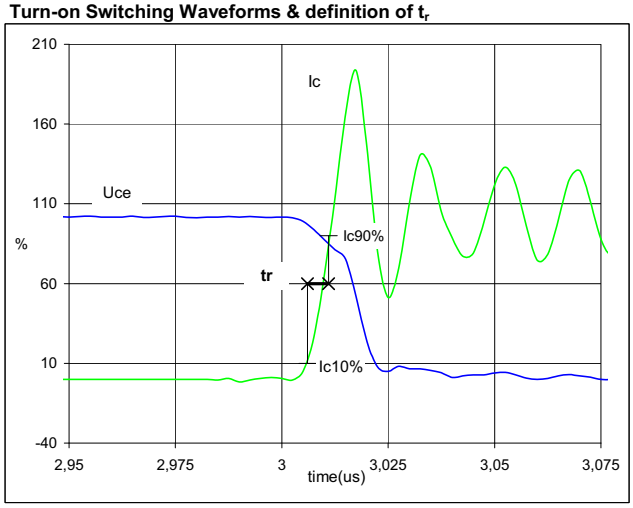
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	400	V
I_C (100%) =	20	A
t_f =	0,015	µs

Figure 4 PFC MOSFET

Turn-on Switching Waveforms & definition of t_r

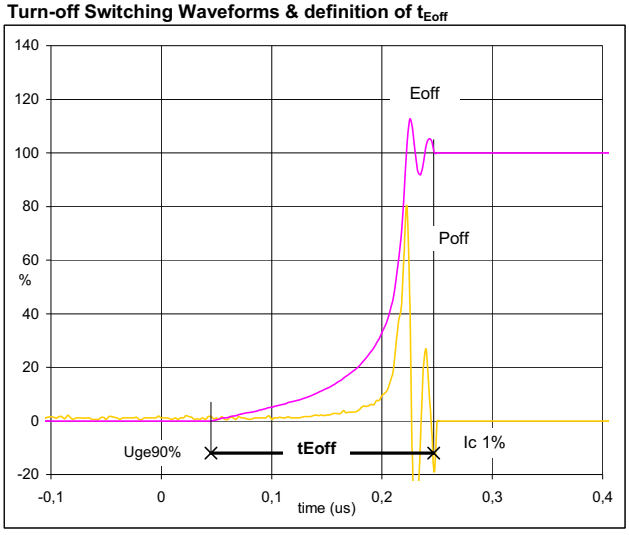


V_C (100%) =	400	V
I_C (100%) =	20	A
t_r =	0,005	µs

Switching Definitions PFC

Figure 5 PFC MOSFET

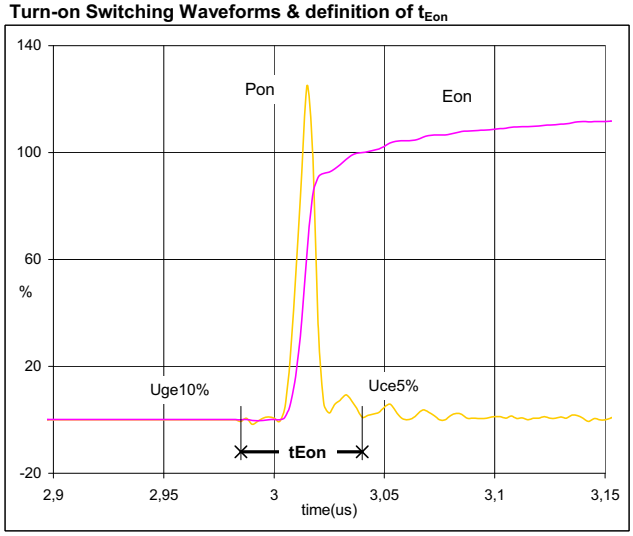
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	7,98	kW
E_{off} (100%) =	0,078	mJ
t_{Eoff} =	0,20	µs

Figure 6 PFC MOSFET

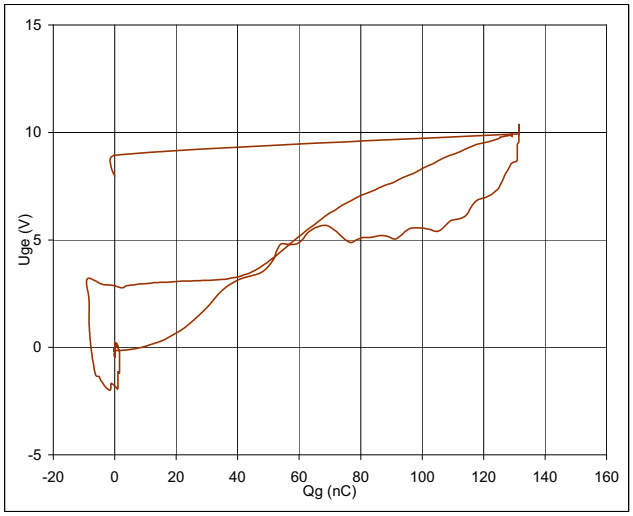
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	7,98	kW
E_{on} (100%) =	0,10	mJ
t_{Eon} =	0,055	µs

Figure 7 PFC MOSFET

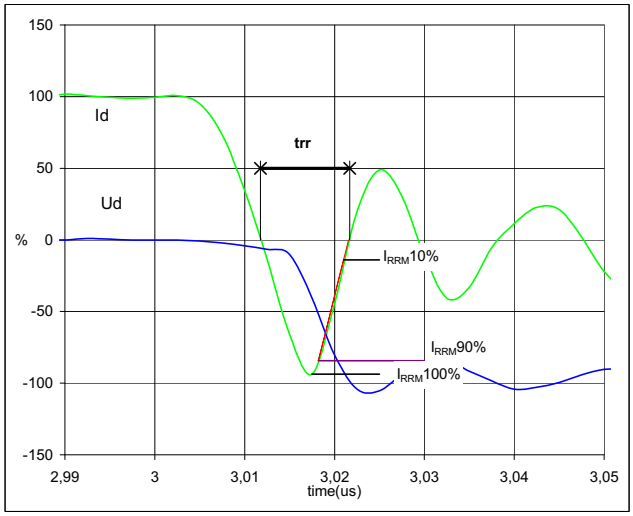
Gate voltage vs Gate charge



V_{GEoff} =	0	V
V_{GEon} =	15	V
V_C (100%) =	400	V
I_C (100%) =	20	A
Q_g =	131	nC

Figure 8 PFC FRED

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

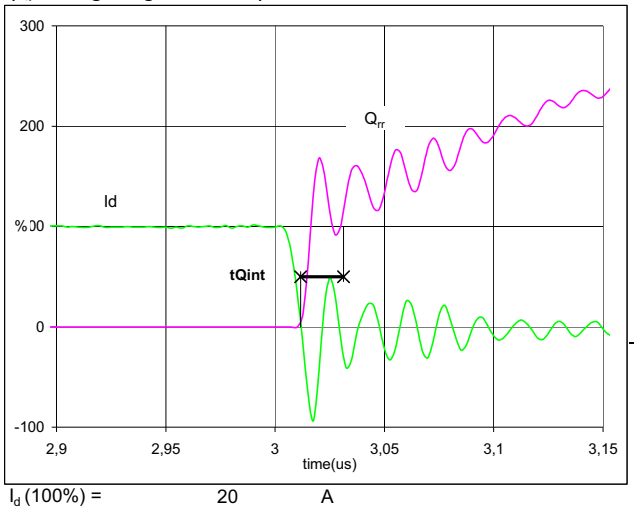


V_d (100%) =	400	V
I_d (100%) =	20	A
I_{RRM} (100%) =	19	A
t_{rr} =	0,01	µs

Switching Definitions PFC

Figure 9 PFC FRED

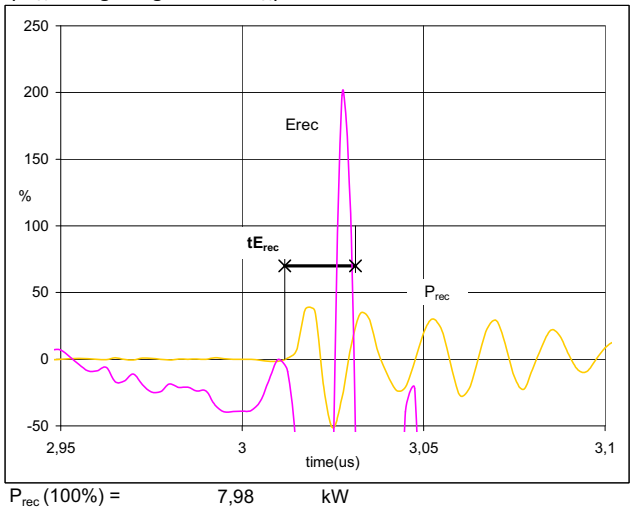
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	20	A
Q_{rr} (100%) =	0,066	µC
t_{Qint} =	0,019	µs

Figure 10 PFC FRED

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

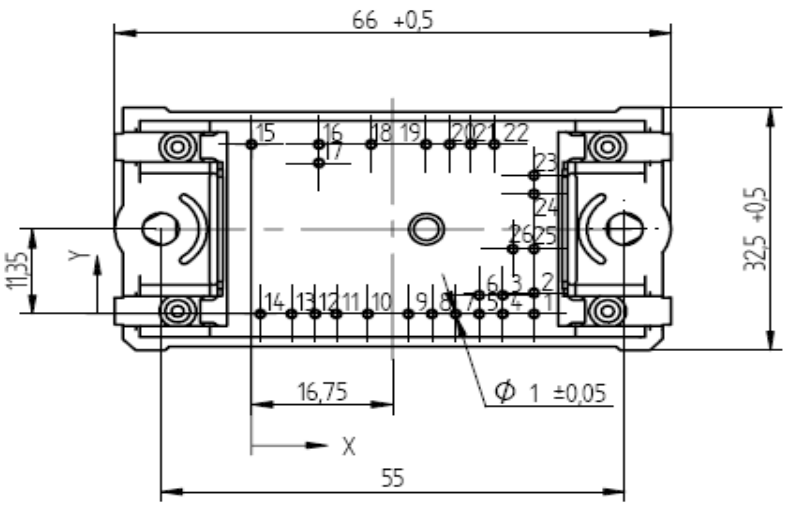


P_{rec} (100%) =	7,98	kW
E_{rec} (100%) =	0,001	mJ
t_{Erec} =	0,019	µs

Package Outline and Pinout

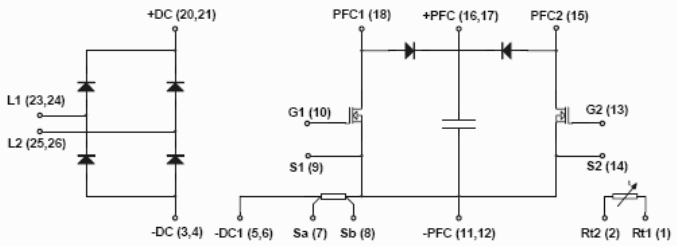
Outline

Pin Table		
Pin	X	Y
1	33,5	0
2	33,5	2,8
3	29,8	2,5
4	29,8	0
5	27	0
6	27	2,5
7	24,2	0
8	21,4	0
9	18,6	0
10	13,8	0
11	10,05	0
12	7,55	0
13	4,75	0
14	1,05	0
15	0	22,7
16	8	22,7
17	8	20,2
18	14,2	22,7
19	20,7	22,7
20	23,5	22,7
21	26	22,7
22	28,8	22,7
23	33,5	18,55
24	33,5	16,05
25	33,5	8,7
26	31	8,7

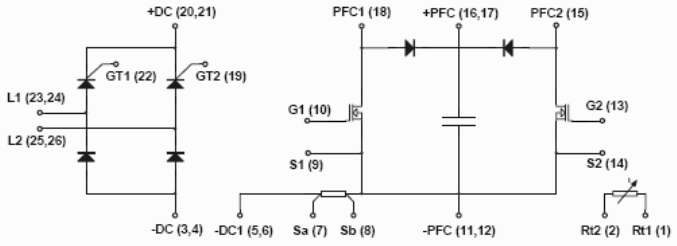


Pinout

P800-D30



P800-D40



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Datasheet Status	Product Status	Definition
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