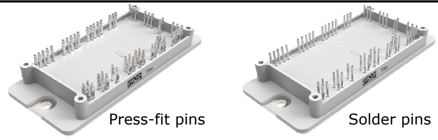
flow PIM 2 — 1200 V / 50 A

Features

- Three-phase rectifier, Inverter, NTC
- Very Compact housing, easy to route
- IGBT4/ EmCon4 technology for low saturation losses and improved EMC behavior

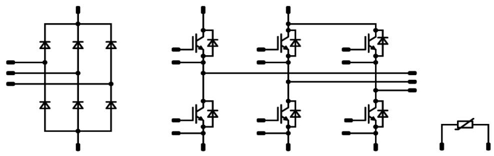
flow 2 17mm housing



Target Applications

- Motor Drives
- Power Generation

Schematic



Types

- V23990-P768-C-PM
- V23990-P768-CY-PM

Maximum Ratings

T_j=25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Input Rectifier Diode				
Repetitive peak reverse voltage	V_{RRM}		1600	V
Forward current	I_{FAV}		50	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms T_j = 150 °C	490	A
I^2t-value	I^2t		1200	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	95	W
Maximum Junction Temperature	T_{jmax}		150	°C
Inverter Switch				
Collector-emitter breakdown voltage	V_{CE}		1200	V
DC collector current	I_C		50	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	150	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	163	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \le$ 150 °C V_{GE} = 15 V	10 900	μs V
Maximum Junction Temperature	T_{jmax}		175	°C

Maximum Ratings

T_j=25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F		50	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	100	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	114	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}	DC test Voltage* t = 2 s	4000	V
		Ac Voltage t = 1 min	2500	V
Creepage distance			min 12,7	mm
Clearance		with Press-fit pins / with Solder pins	11,58 / 11,82	mm
Comparative Tracking Index	CTI		>200	

*100% tested in production

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]	Min	Typ	Max	Unit
Input Rectifier Diode										
Forward voltage	V_F				50	25 125		1,1 1,05	1,7	V
Threshold voltage (for power loss calc. only)	V_{to}					25 125		0,89 0,78		V
Slope resistance (for power loss calc. only)	r_t					25 125		0,004 0,006		Ω
Reverse current	I_r			1600		25 145			0,05 1,1	mA
Thermal resistance junction to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50μm λ = 1 W/mK						0,74		K/W
Thermal resistance junction to case	$R_{th(j-c)}$							0,49		
Inverter Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0017	25 150	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		50	25 150		1,86 2,3	2,3	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		25 150			0,02	mA
Gate-emitter leakage current	I_{GES}		20	0		25 150			200	nA
Integrated Gate resistor	R_{gint}							4		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 8 Ω R_{gon} = 8 Ω	±15	600	50	25 150		104 100		ns
Rise time	t_r					25 150		19 23,8		
Turn-off delay time	$t_{d(off)}$					25 150		220 295		
Fall time	t_f					25 150		78 118		
Turn-on energy loss	E_{on}					25 150		2,86 4,5		mWs
Turn-off energy loss	E_{off}					25 150		2,69 4,48		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		2770		pF
Output capacitance	C_{oss}							205		
Reverse transfer capacitance	C_{rss}							160		
Gate charge	Q_G		±15	960		25		290		nC
Thermal resistance junction to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50μm λ = 1 W/mK						0,58		K/W
Thermal resistance junction to case	$R_{th(j-c)}$							0,38		
Coupled thermal resistance transistor-transistor	R_{thJH}T-T							0,1		
Coupled thermal resistance diode-transistor	R_{thJH}D-T							0,13		
Inverter Diode										
Diode forward voltage	V_F				50	25 150		1,75 1,71	2,2	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 8 Ω	±15	600	50	25 150		65 82		A
Reverse recovery time	t_{rr}					25 150		162 313		ns
Reverse recovered charge	Q_{rr}					25 150		4,62 9,95		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		2298 1106		A/μs
Reverse recovered energy	E_{rec}					25 150		1,92 3,98		mWs
Thermal resistance junction to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50μm λ = 1 W/mK						0,83		K/W
Thermal resistance junction to case	$R_{th(j-c)}$							0,55		
Coupled thermal resistance transistor-diode	R_{thJH}T-D							0,12		

Characteristic Values

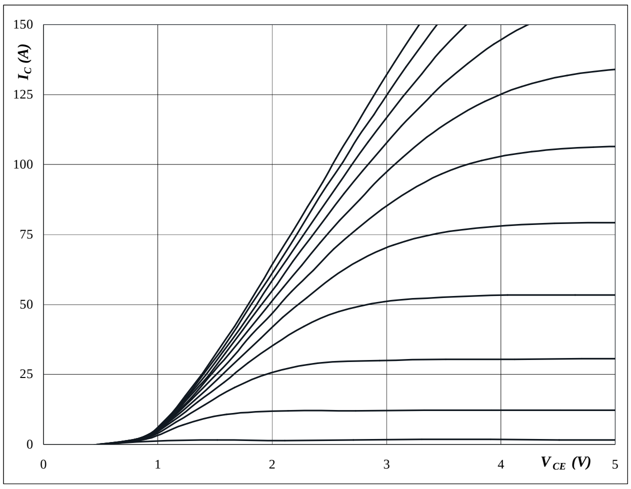
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	
Thermistor										
Rated resistance	R_{25}					25		22		kΩ
Deviation of R_{100}	$\boldsymbol{D}_{R/R}$	R_{100} = 1486 Ω				Tj = 100	-12		12	%
Power dissipation	P					25		200		mW
Power dissipation constant						25		2		mW/K
B-value	$B_{(25/50)}$	Tol. ±3%				25		3950		K
B-value	$B_{(25/100)}$	Tol. ±3%				25		3998		K
Vincotech NTC Reference									B	

Output Inverter

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

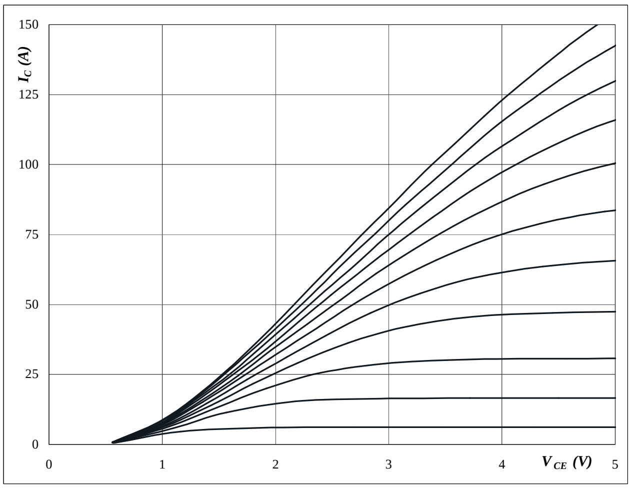
T_j = 25 °C

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

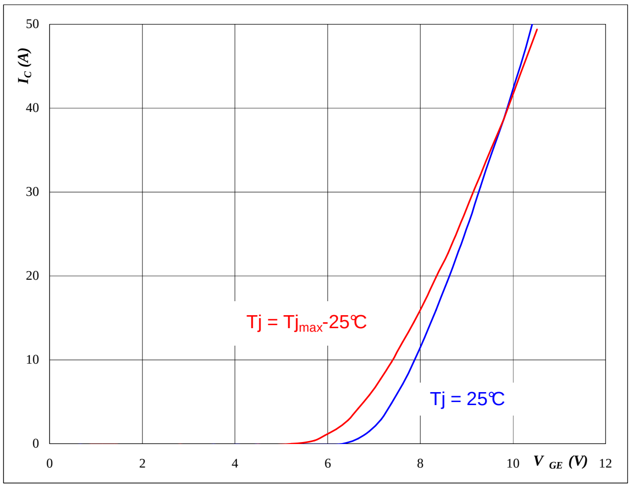
T_j = 150 °C

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

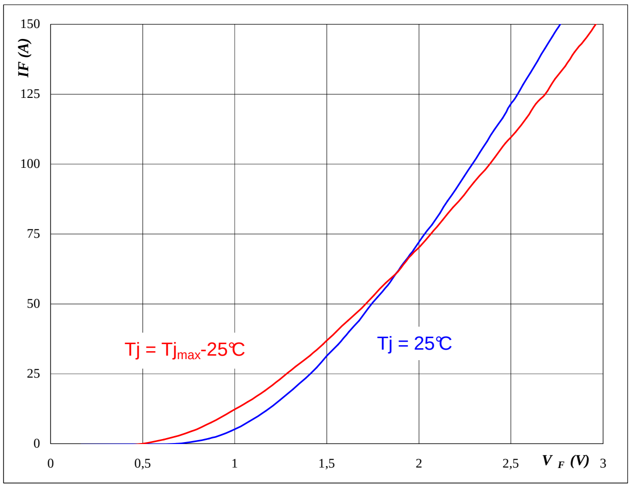
t_p = 250 µs

V_{CE} = 10 V

figure 4. **FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

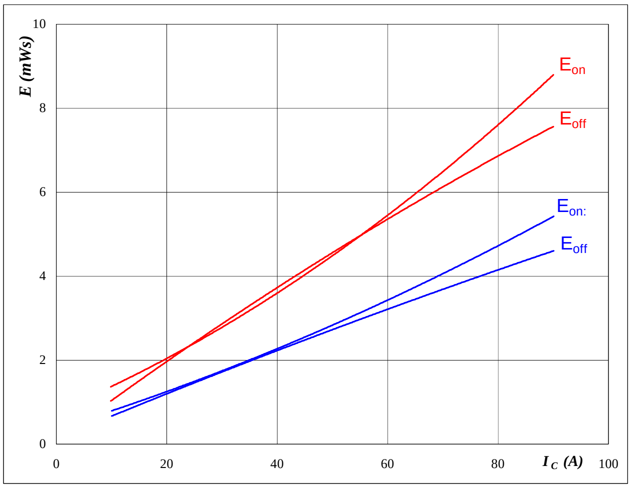
t_p = 250 µs

Output Inverter

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



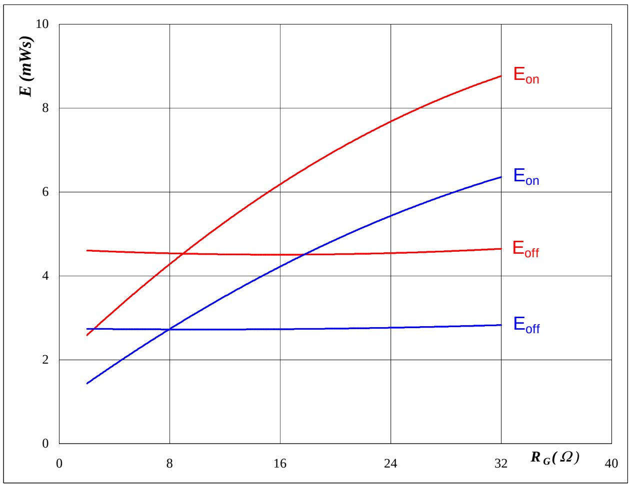
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



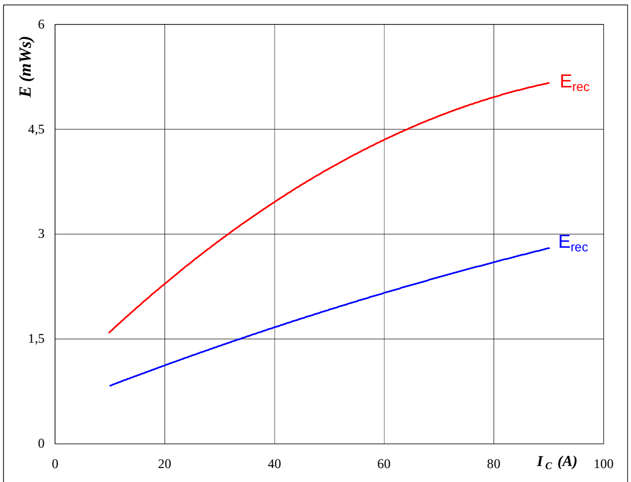
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

figure 7. **IGBT**

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_C)$



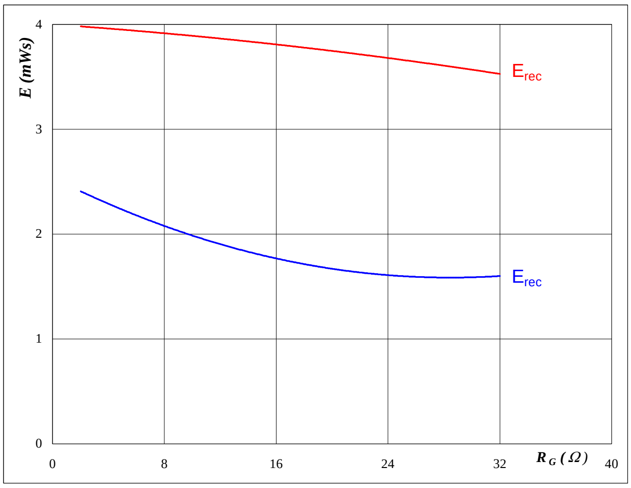
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

figure 8. **IGBT**

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

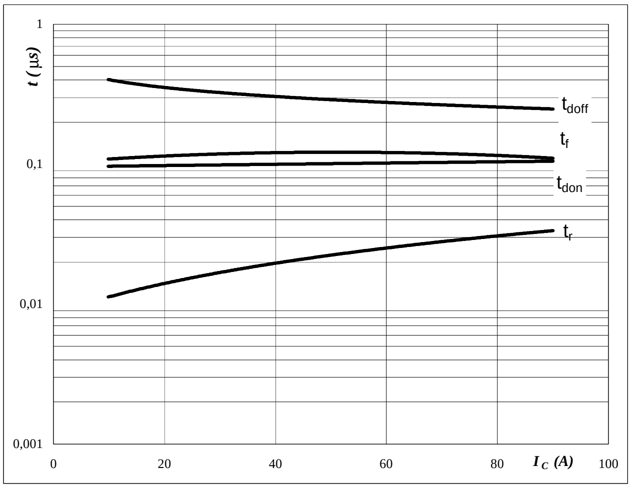
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Output Inverter

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



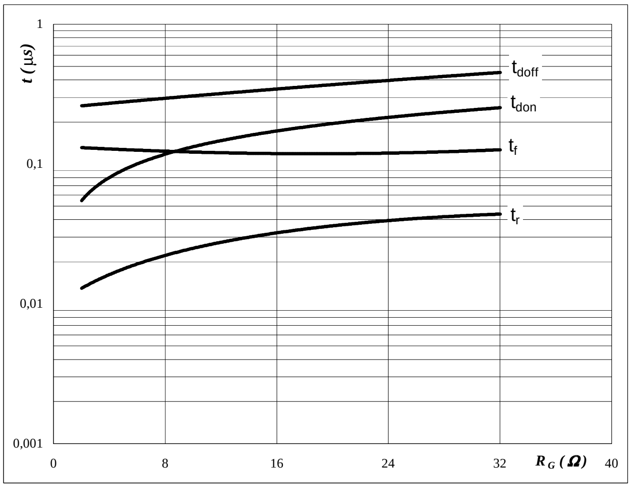
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



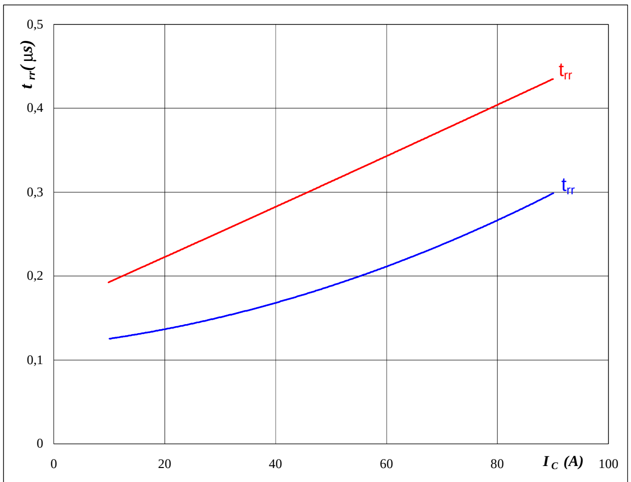
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$



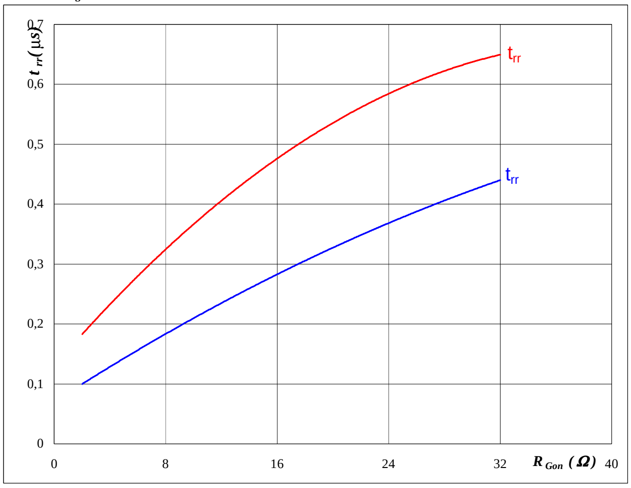
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

figure 12. **FWD**

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

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



At

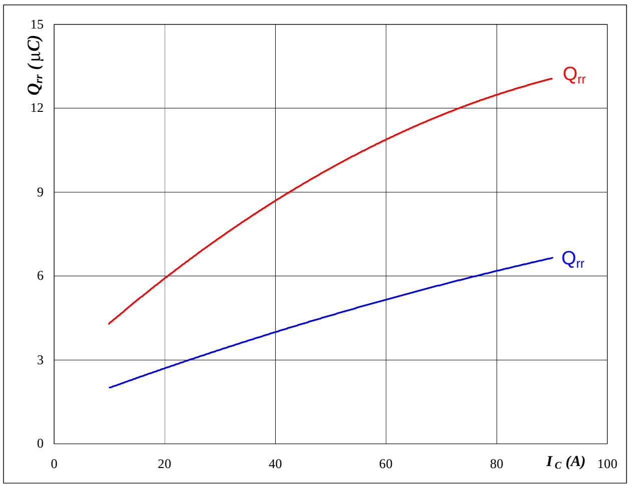
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Output Inverter

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_c)$



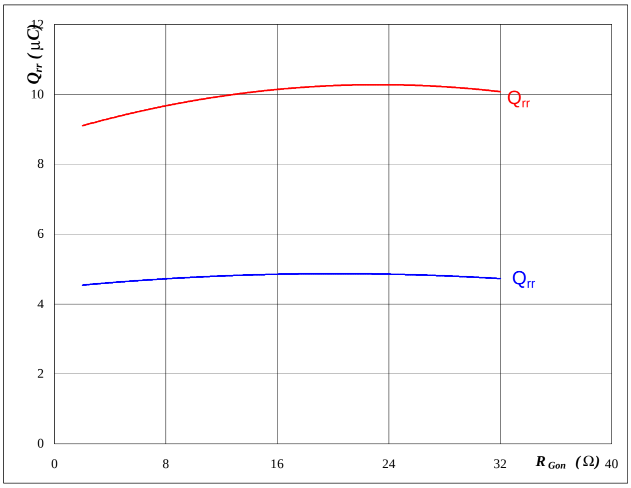
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

figure 14. **FWD**

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

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



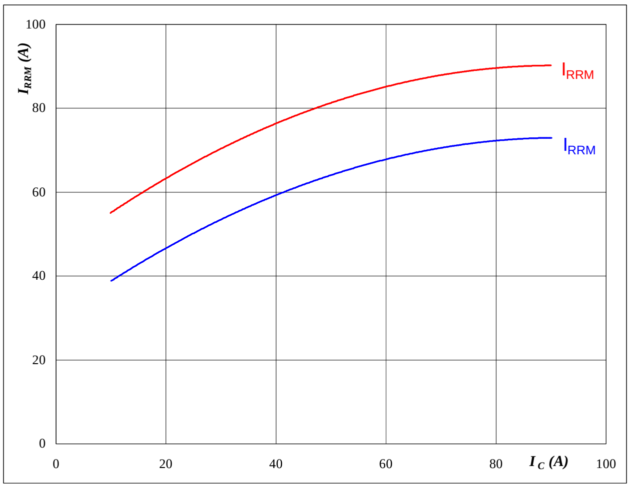
At

T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_c)$



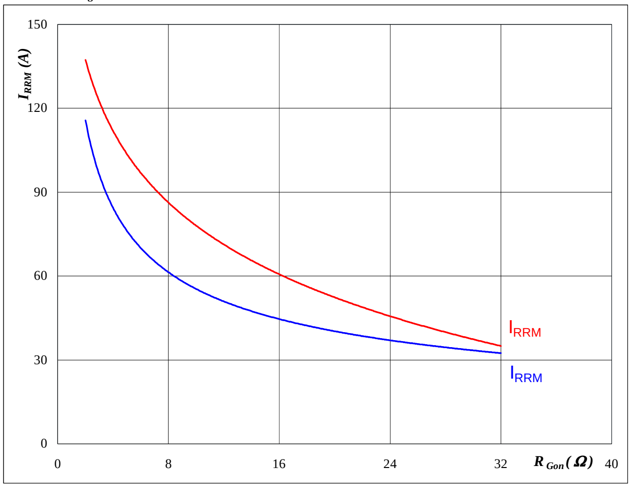
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

figure 16. **FWD**

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

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



At

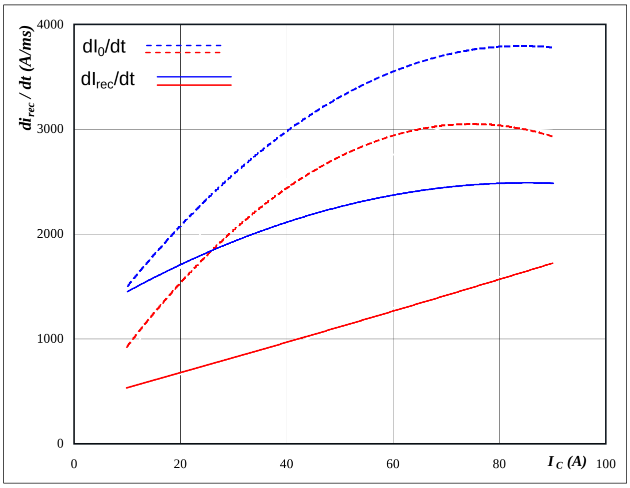
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

Output Inverter

figure 17. **FWD**

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

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



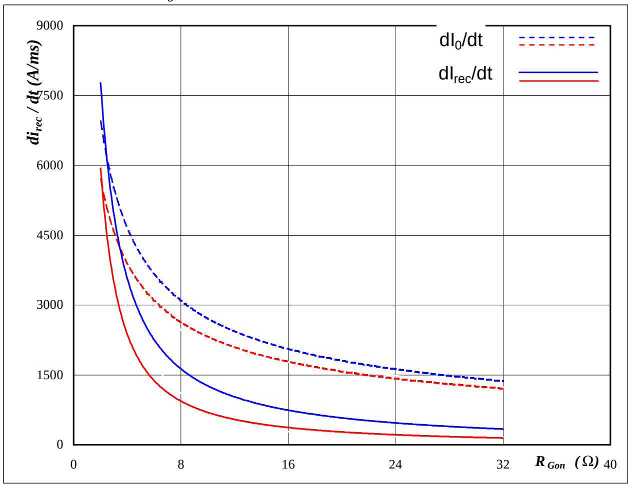
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

figure 18. **FWD**

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

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



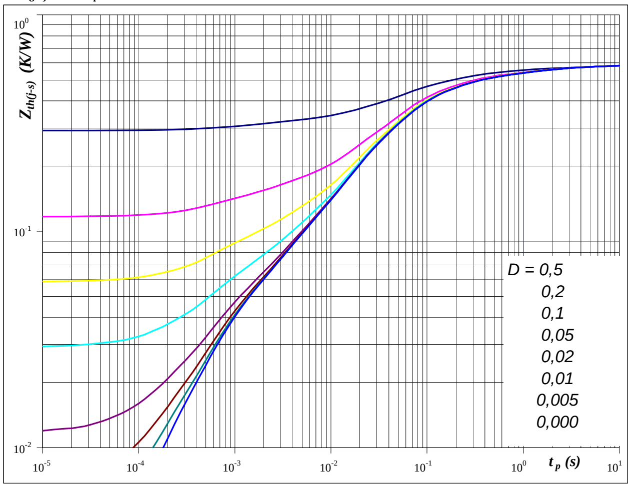
At

T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±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

$R_{th(j-s)}$ =	0,583	K/W	$R_{th(j-s)}$ =	0,68	K/W
Single device heated			All devices heated		

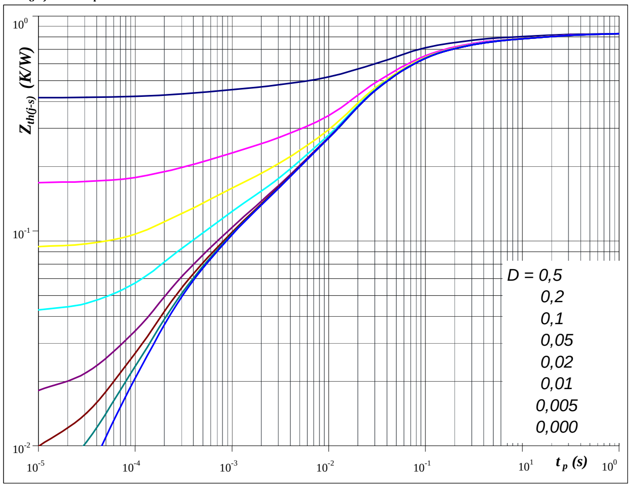
IGBT thermal model values

R (K/W)	Tau (s)	R (K/W)	Tau (s)
6,70E-02	2,10E+00	1,68E-01	2,10E+00
1,25E-01	2,43E-01	1,25E-01	2,43E-01
2,70E-01	5,10E-02	2,70E-01	5,10E-02
7,97E-02	1,21E-02	7,97E-02	1,21E-02
4,11E-02	8,63E-04	4,11E-02	8,63E-04

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

$R_{th(j-s)}$ =	0,83	K/W	$R_{th(j-s)}$ =	0,83	K/W
Single device heated			All devices heated		

FWD thermal model values

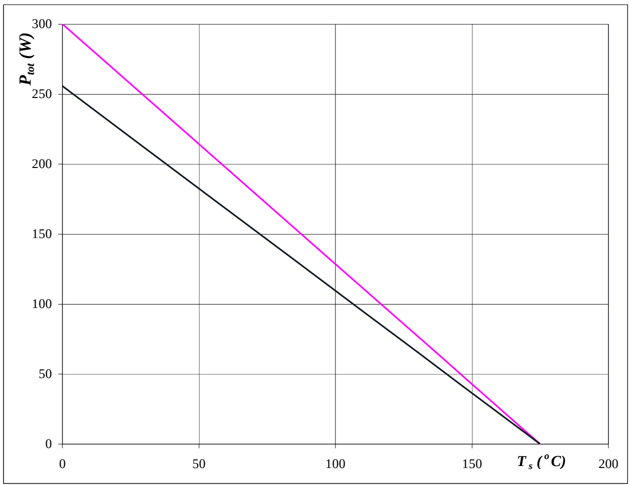
R (K/W)	Tau (s)	R (K/W)	Tau (s)
2,00E-02	9,74E+00	2,00E-02	9,74E+00
7,74E-02	1,11E+00	7,74E-02	1,11E+00
2,22E-01	1,27E-01	2,22E-01	1,27E-01
3,93E-01	2,45E-02	3,93E-01	2,45E-02
6,96E-02	1,97E-03	6,96E-02	1,97E-03
5,24E-02	2,88E-04	5,24E-02	2,88E-04

Output Inverter

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



At

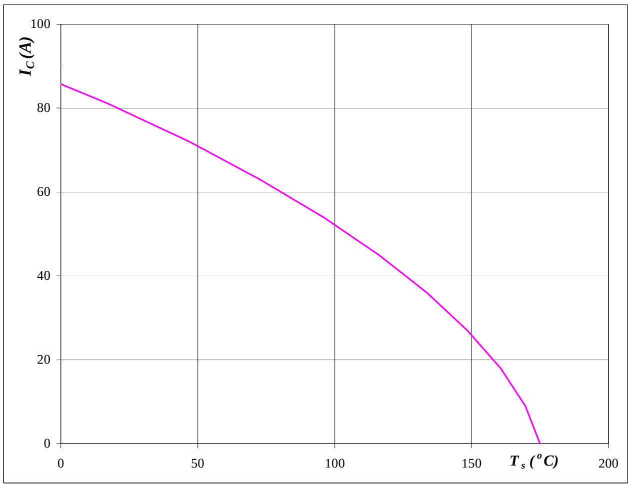
T_j = 175 °C

single heating
overall heating

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

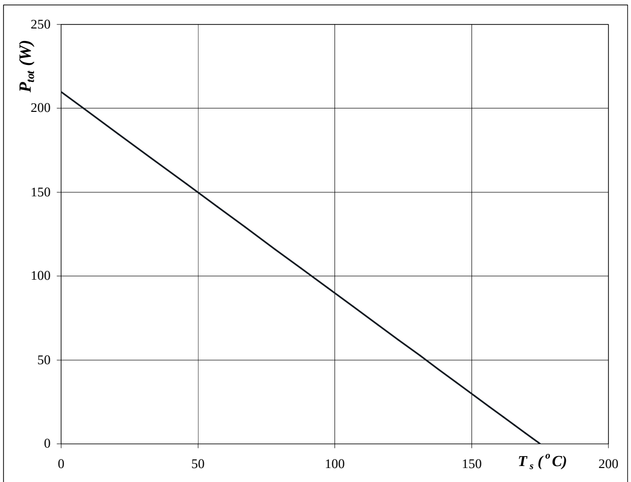
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



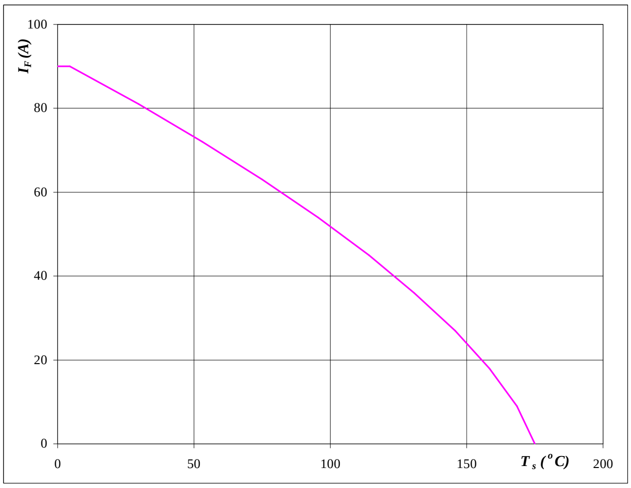
At

T_j = 175 °C

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

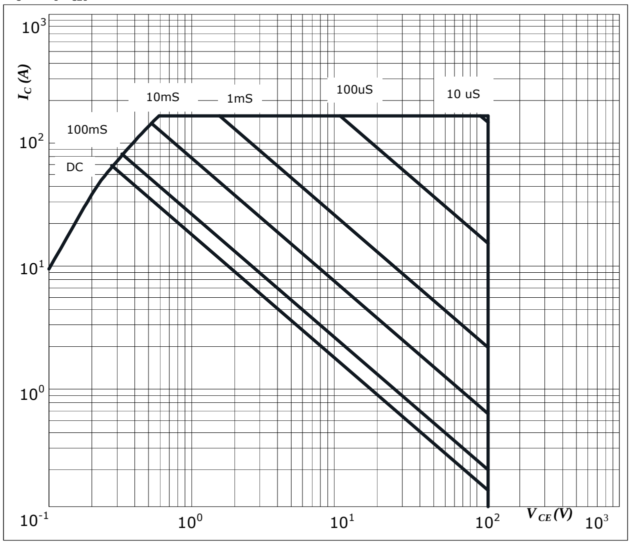
T_j = 175 °C

Output Inverter

figure 25.	IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



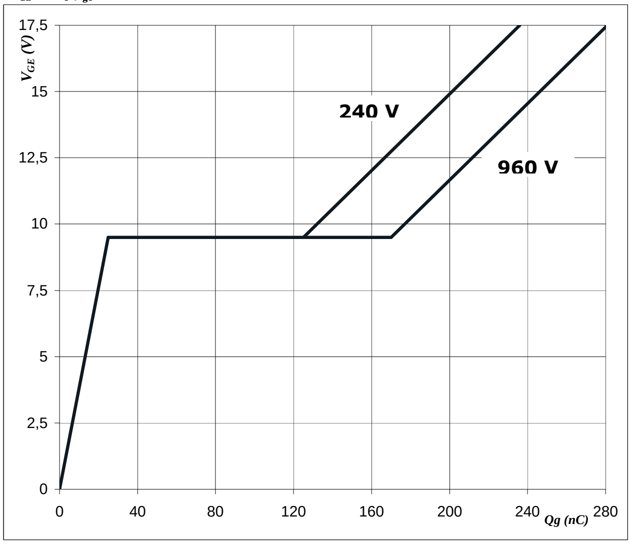
At

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

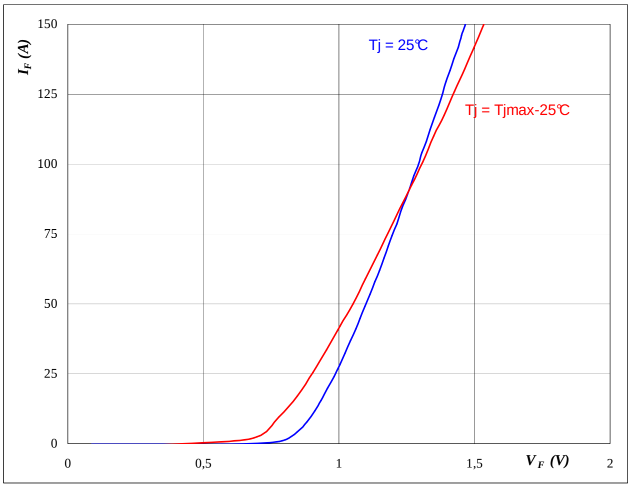
I_C =	50	A

Input Rectifier Bridge

figure 1. **Rectifier Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



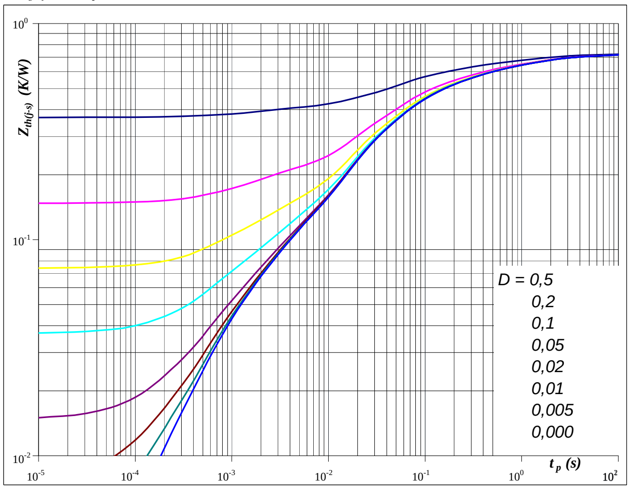
At

t_p = 250 μs

figure 2. **Rectifier Diode**

Diode transient thermal impedance as a function of pulse width

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



At

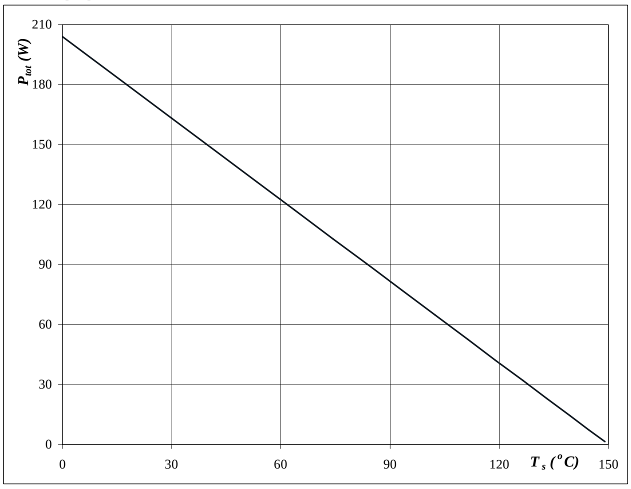
D = t_p / T

$R_{th(j-s)}$ = 0,74 K/W

figure 3. **Rectifier Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



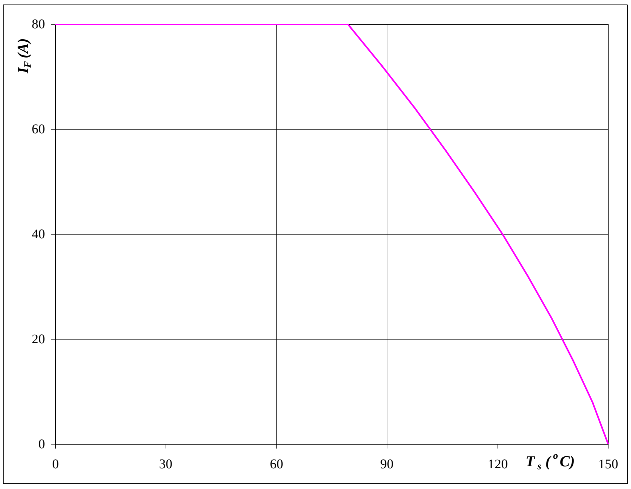
At

T_j = 150 ºC

figure 4. **Rectifier Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



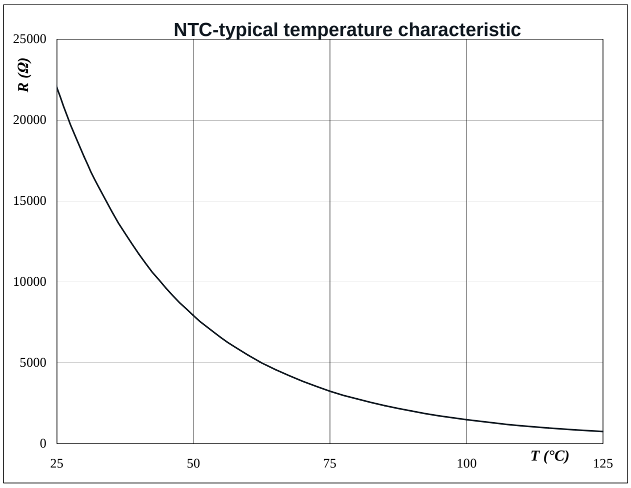
At

T_j = 150 ºC

Thermistor

figure 1.	Thermistor

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



Switching Definitions Output Inverter

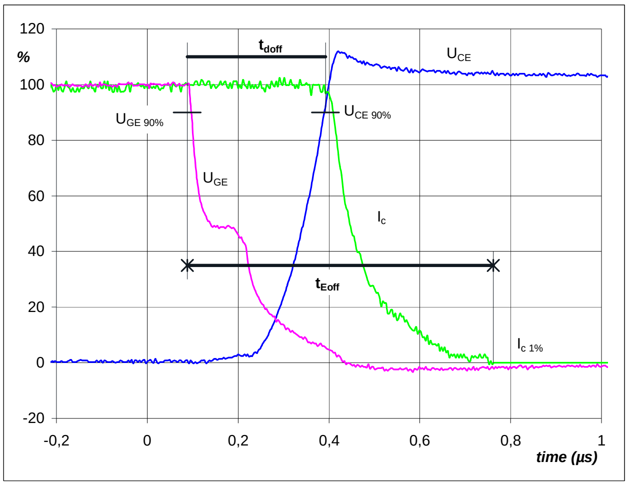
General conditions

T_j	=	150 °C
R_{gon}	=	8 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})

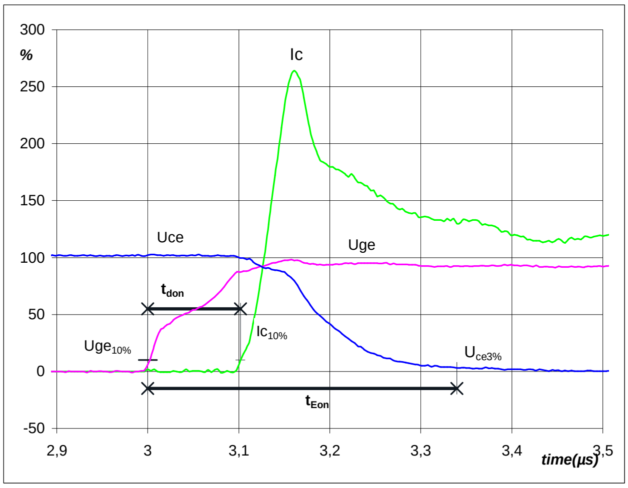


V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{doff} =	0,30	µs
$t_{E\,off}$ =	0,67	µs

figure 2. **IGBT**

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

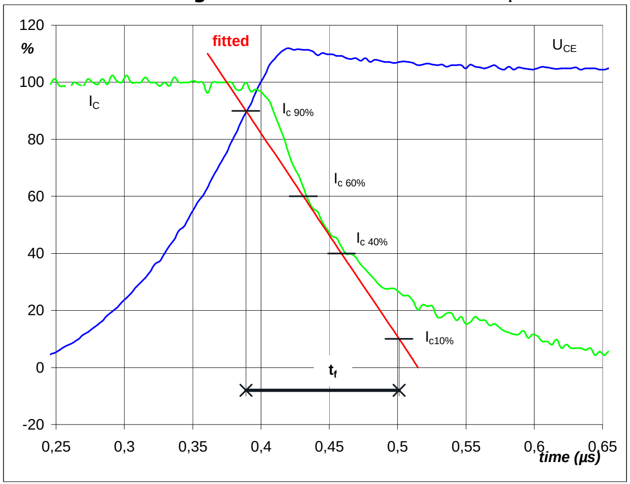
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{don} =	0,10	µs
$t_{E\,on}$ =	0,34	µs

figure 3. **IGBT**

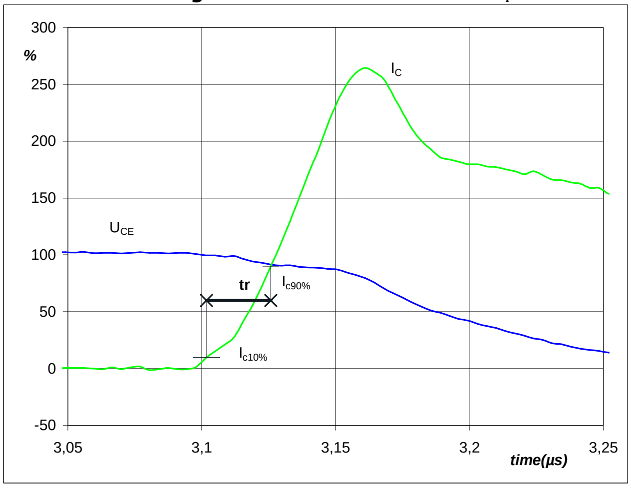
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	50	A
t_f =	0,12	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

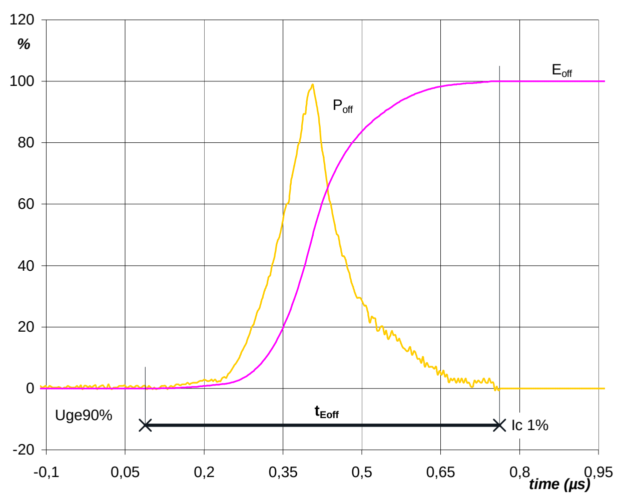


V_C (100%) =	600	V
I_C (100%) =	50	A
t_r =	0,02	µs

Switching Definitions Output Inverter

figure 5. **IGBT**

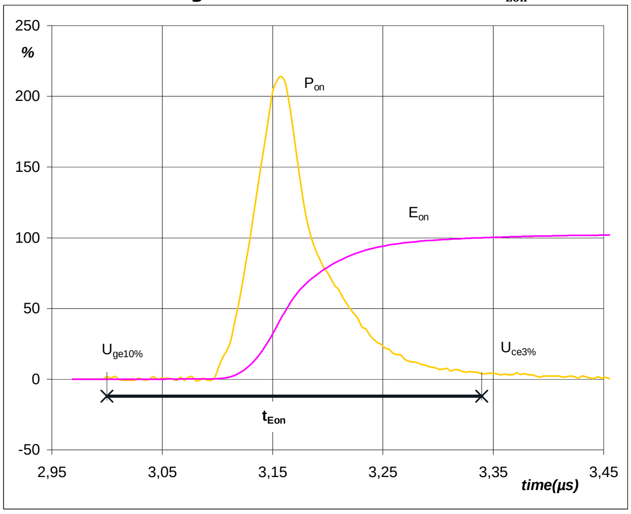
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	29,95	kW
E_{off} (100%) =	4,48	mJ
$t_{E\,off}$ =	0,67	µs

figure 6. **IGBT**

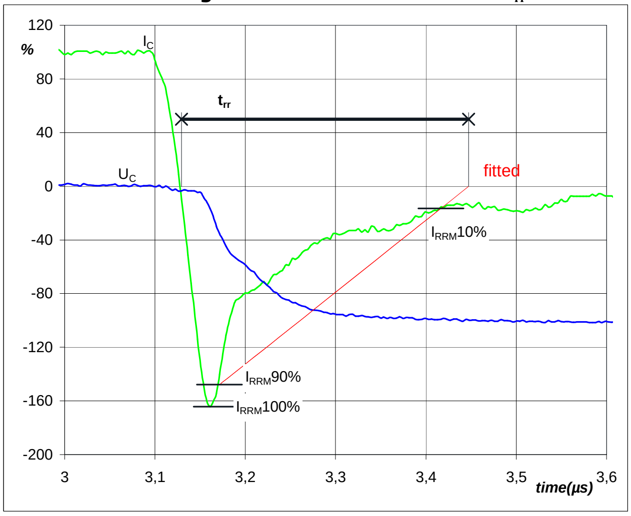
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	29,95	kW
E_{on} (100%) =	4,50	mJ
$t_{E\,on}$ =	0,34	µs

figure 7. **FWD**

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

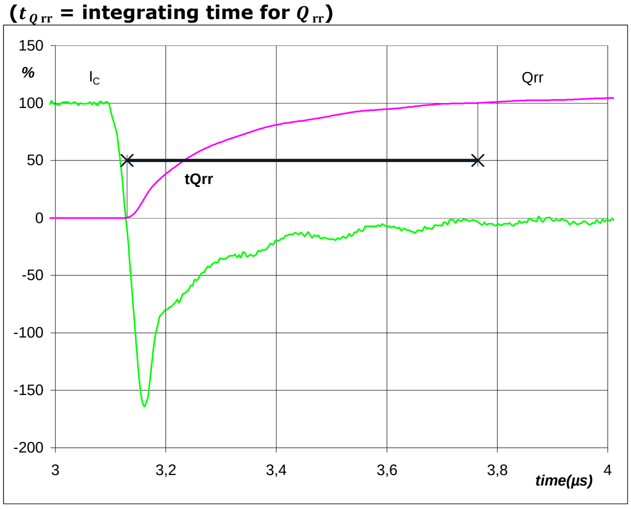


V_C (100%) =	600	V
I_C (100%) =	50	A
I_{RRM} (100%) =	-82	A
t_{rr} =	0,31	µs

Switching Definitions Output Inverter

figure 8. **FWD**

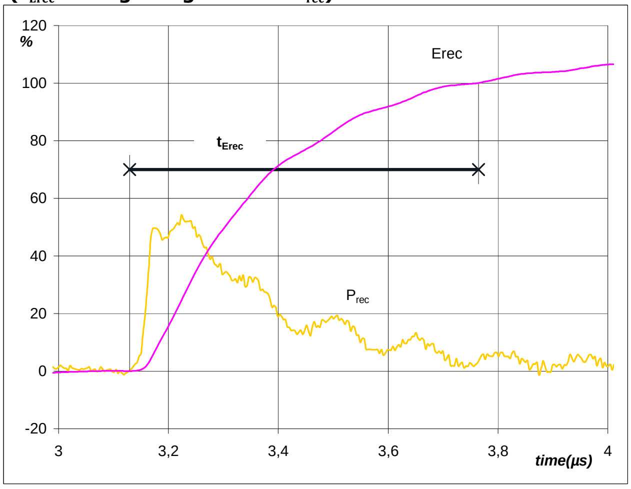
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_C (100%) =	50	A
Q_{rr} (100%) =	9,95	µC
t_{Qint} =	0,64	µs

figure 9. **FWD**

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



P_{rec} (100%) =	29,95	kW
E_{rec} (100%) =	3,98	mJ
$t_{E\,rec}$ =	0,64	µs

Ordering Code and Marking - Outline - Pinout

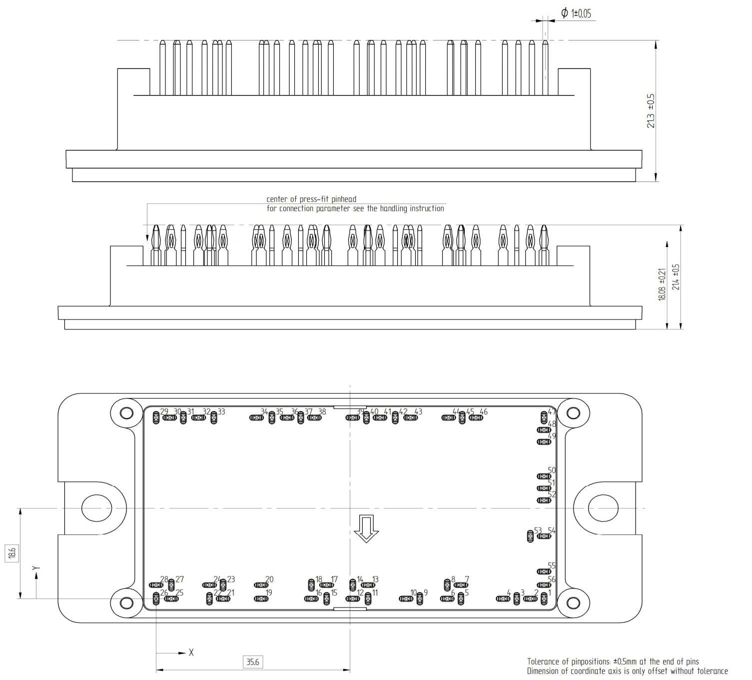
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste with Solder pins	V23990-P768-C-PM	P768C	P768C
without thermal paste with Press-fit pins	V23990-P768-CY-PM	P768CY	P768CY
with thermal paste with Solder pins	V23990-P768-C-/3/-PM	P768C	P768C-/3/
with thermal paste with Press-fit pins	V23990-P768-CY-/3/-PM	P768CY	P768CY-/3/

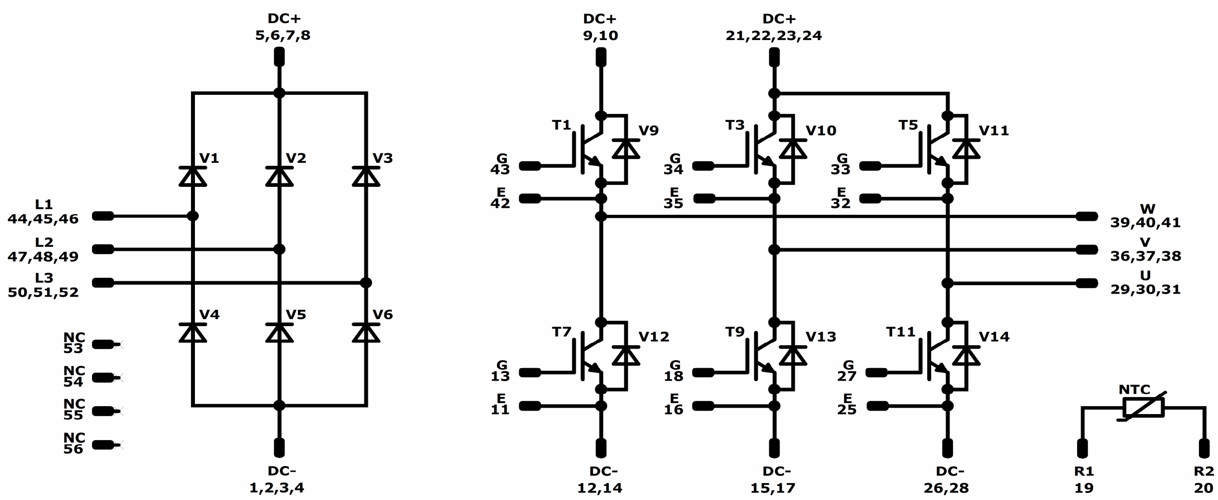
Outline

Pin table

Pin	Function	X	Y	Pin	Function	X	Y
1	DC-	71,2	0	29	U	0	37,2
2	DC-	68,7	0	30	U	2,5	37,2
3	DC-	66,2	0	31	U	5	37,2
4	DC-	63,7	0	32	E	7,8	37,2
5	DC+	55,95	0	33	G	10,6	37,2
6	DC+	53,45	0	34	G	18,45	37,2
7	DC+	55,95	2,8	35	E	21,25	37,2
8	DC+	53,45	2,8	36	V	24,05	37,2
9	DC+	48,4	0	37	V	26,55	37,2
10	DC+	45,9	0	38	V	29,05	37,2
11	E	38,9	0	39	W	36,1	37,2
12	DC-	36,1	0	40	W	38,6	37,2
13	G	38,9	2,8	41	W	41,1	37,2
14	DC-	36,1	2,8	42	E	43,9	37,2
15	DC-	31,3	0	43	G	46,7	37,2
16	E	28,5	0	44	L1	53,7	37,2
17	DC-	31,3	2,8	45	L1	56,2	37,2
18	G	28,5	2,8	46	L1	58,7	37,2
19	R1	19,3	0	47	L2	71,2	37,2
20	R2	19,3	2,8	48	L2	71,2	34,7
21	DC+	12,3	0	49	L2	71,2	32,2
22	DC+	9,8	0	50	L3	71,2	25,2
23	DC+	12,3	2,8	51	L3	71,2	22,7
24	DC+	9,8	2,8	52	L3	71,2	20,2
25	E	2,8	0	53	NC	71,2	12,8
26	DC-	0	0	54	NC	68,7	12,8
27	G	2,8	2,8	55	NC	71,2	5,6
28	DC-	0	2,8	56	NC	71,2	2,8



Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1,T3,T5,T7,T9,T11	IGBT	1200 V	50 A	Inverter Switch	
V9,V10,V11, V12,V13,V14	FWD	1200 V	50 A	Inverter Diode	
V1,V2,V3,V4,V5,V6	Rectifier	1600 V	50 A	Rectifier	
NTC	NTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**36**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for *flow* 2 packages see vincotech.com website.

Package data
Package data for *flow* 2 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-P768-C-D1-14	07 Dec. 2017		