VINcoMNPC X4	1200 V/600 A

Features

- Mixed voltage NPC
- Low inductive
- High power screw interface

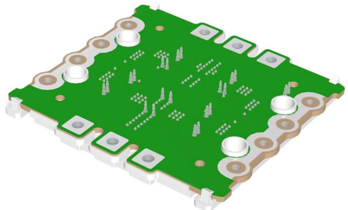
Target Applications

- Solar inverter
- UPS
- High speed motor drive

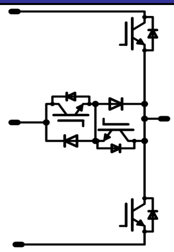
Types

- 70-W212NMA600NB02-M200P62

VINco X4 housing



Schematic



Maximum Ratings

Tj=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
half bridge IGBT (T1, T4) (T1 , T4)					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	T_j=$T_j$max	T_h=80℃	517	A
Pulsed collector current	I_{Cpulse}	t_p limited by $T_j$max		1200	A
Power dissipation per IGBT	P_{tot}	T_j=$T_j$max	T_h=80℃	1051	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V		10 850	µs V
Maximum Junction Temperature	$T_j$max			175	℃
neutral point FWD (D2, D3) (D2 , D3)					
Peak Repetitive Reverse Voltage	V_{RRM}			650	V
DC forward current	I_F	T_j=$T_j$max	T_h=80℃	254	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms	T_{vj} < 150℃	800	A
Power dissipation per FWD	P_{tot}	T_j=$T_j$max	T_h=80℃	354	W
Maximum Junction Temperature	$T_j$max			175	℃

Maximum Ratings

Tj=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
neutral point IGBT (T2, T3) (T2 , T3)					
Collector-emitter break down voltage	V_{CE}			650	V
DC collector current	I_C	$T_j=T_jmax$	T_h=80℃	344	A
Pulsed collector current	I_{Cpuls}	t_p limited by T_jmax		1200	A
Power dissipation per IGBT	P_{tot}	$T_j=T_jmax$	T_h=80℃	629	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V		10 360	µs V
Turn off safe operating area (RBSOA)	I_{cmax}	$V_{CE\ max}$ = 1200V $T_{vj\ max}$= 150℃		800	A
Maximum Junction Temperature	T_jmax			175	℃
half bridge FWD (D1, D4) (D1 , D4)					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	$T_j=T_jmax$	T_h=80℃	272	A
Surge forward current	I_{FSM}	t_p=10ms , sin 180°	T_j=150℃	1100	A
I2t-value	I^2t			3026	A^2s
Repetitive peak forward current	I_{FRM}	t_p limited by T_jmax		1200	A
Power dissipation per FWD	P_{tot}	$T_j=T_jmax$	T_h=80℃	596	W
Maximum Junction Temperature	T_jmax			175	℃

Maximum Ratings

Tj=25℃, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
General Module Properties				
Material of module baseplate			Cu	
Material of internal isulation			Al2O3	
Thermal Properties				
Storage temperature	T_{stg}		-40…+125	℃
Operation temperature under switching condition	T_{op}		-40…+(Tjmax - 25)	℃
Insulation Properties				
Insulation voltage	V_{is}	t=2s DC 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] 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_j	Min	Typ	Max	Unit
half bridge IGBT (T1, T4) (T1 , T4)										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,03	Tj=25℃ Tj=125℃	5,4	6	6,6	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		600	Tj=25℃ Tj=125℃		1,86 2,11		V
Collector-emitter cut-off current incl. FWD	I_{CES}		0	1200		Tj=25℃ Tj=125℃			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=125℃			1500	nA
Integrated Gate resistor	R_{gint}							3,25		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=0,5 Ω Rgon=0,5 Ω	±15	350	600	Tj=25℃ Tj=125℃		323 340		ns
Rise time	t_r					Tj=25℃ Tj=125℃		73 91		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=125℃		234 274		
Fall time	t_f					Tj=25℃ Tj=125℃		48 66		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=125℃		23 34		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=125℃		18 26		
Input capacitance	C_{ies}	f=1MHz	0	10		Tj=25℃			60000	pF
Output capacitance	C_{oss}								12000	
Reverse transfer capacitance	C_{rss}								1000	
Thermal resistance chip to heatsink per chip	R_{thJH}	100um preapplied PCM						0,09		K/W
Thermal resistance chip to heatsink per chip	R_{thJH}	100um grease 1W/mK						0,11		K/W
neutral point FWD (D2, D3) (D2 , D3)										
FWD forward voltage	V_F				400	Tj=25℃ Tj=125℃		1,66 1,60		V
Peak reverse recovery current	I_{RRM}	Rgon=0,5 Ω	±15	350	600	Tj=25℃ Tj=125℃		158 192		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=125℃		281 417		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=125℃		18 35		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=125℃		2050 827		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=125℃		3 7		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	100um preapplied PCM						0,27		K/W
Thermal resistance chip to heatsink per chip	R_{thJH}	100um grease 1W/mK						0,31		K/W
neutral point IGBT (T2, T3) (T2 , T3)										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0032	Tj=25℃ Tj=125℃	5,1	5,8	6,4	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		400	Tj=25℃ Tj=125℃		1,60 1,86		V
Collector-emitter cut-off incl FWD	I_{CES}		0	650		Tj=25℃ Tj=125℃			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=125℃			1500	nA
Integrated Gate resistor	R_{gint}							1		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=1 Ω Rgon=1 Ω	±15	350	600	Tj=25℃ Tj=125℃		209 213		ns
Rise time	t_r					Tj=25℃ Tj=125℃		44 49		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=125℃		250 265		
Fall time	t_f					Tj=25℃ Tj=125℃		79 106		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=125℃		6 9		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=125℃		21 28		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		24640		pF
Output capacitance	C_{oss}							1536		
Reverse transfer capacitance	C_{rss}							732		
Gate charge	Q_{Gate}		15	480	400	Tj=25℃		2507		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	100um preapplied PCM						0,15		K/W
Thermal resistance chip to heatsink per chip	R_{thJH}	100um grease 1W/mK						0,17		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_j	Min	Typ	Max	
half bridge FWD (D1, D4) (D1 , D4)										
FWD forward voltage	V_F				400	Tj=25℃ Tj=125℃		2,19 2,47		V
Reverse leakage current	I_r			1200		Tj=25℃ Tj=125℃			48	µA
Peak reverse recovery current	I_{RRM}					Tj=25℃ Tj=125℃		448 568		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=125℃		70 138		ns
Reverse recovered charge	Q_{rr}	Rgon=1 Ω	±15	350	600	Tj=25℃ Tj=125℃		19 53		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=125℃		20142 14965		A/µs
Reverse recovery energy	E_{rec}					Tj=25℃ Tj=125℃		4 13		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	100um preapplied PCM						0,16		K/W
Thermal resistance chip to case per chip	R_{thJH}	100um grease 1W/mK						0,18		K/W
Thermistor										
Rated resistance	R					Tj=25℃		22000		Ω
Deviation of R_{100}	ΔR/R	R100=1486 Ω				Tj=100℃	-12		+14	%
Power dissipation	P					Tj=25℃		200		mW
Power dissipation constant						Tj=25℃		2		mW/K
B-value	$B_{(25/50)}$	Tol. ±3%				Tj=25℃		3950		K
B-value	$B_{(25/100)}$	Tol. ±3%				Tj=25℃		3996		K
Vincotech NTC Reference									B	
Module Properties										
Module inductance (from chips to PCB)	$L_{sCE\ C\text{-}PCB}$							5		nH
Module inductance (from PCB to PCB using Intercon board)	$L_{sCE\ PCB\text{-}PCB}$							3		nH
Resistance of Intercon boards (from PCB to PCB using Intercon board)	$Rcc_{'1+EE'}$	Tc=25℃, per switch						1,5		mΩ
Mounting torque	M	Screw M4 - mounting according to valid application note FSWB1-4TY-M-*-HI					2		2,2	Nm
Mounting torque	M	Screw M5 - mounting according to valid application note FSWB1-4TY-M-*-HI					4		6	Nm
Terminal connection torque	M	Screw M6 - mounting according to valid application note FSWB1-4TY-M-*-HI					2,5		5	Nm
Weight	G								710	g

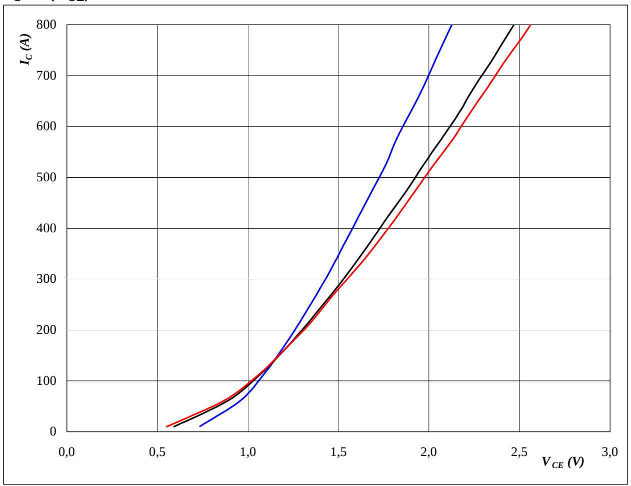
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 1 IGBT

Typical output characteristics Vge=15V

$I_C = f(V_{CE})$



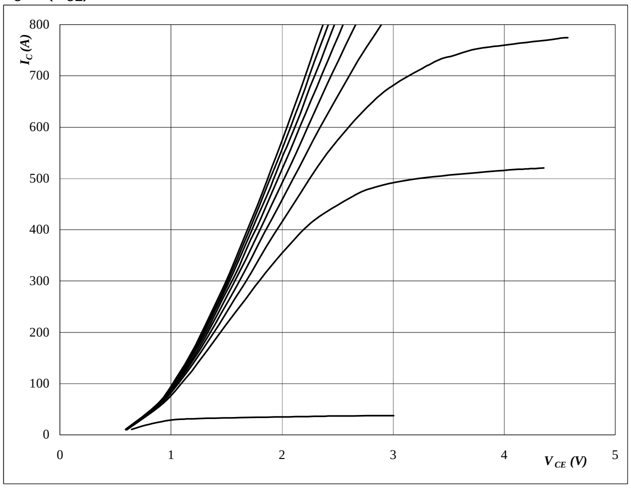
At

t_p =	350	μs
T_j =	25/125/150	℃
$V_{GE=}$	15	V

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



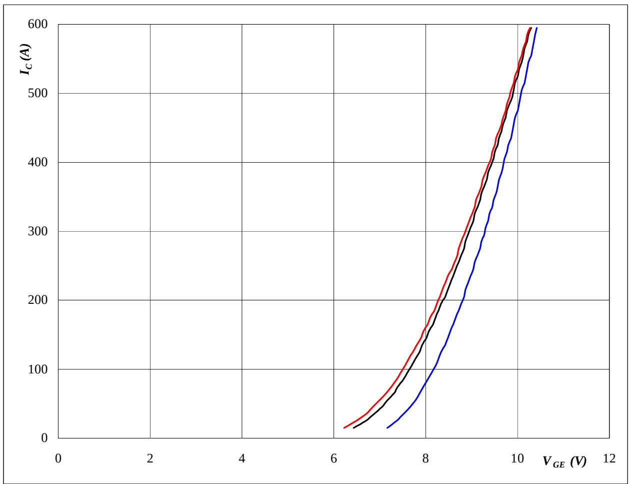
At

t_p =	350	μs
T_j =	150	℃
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



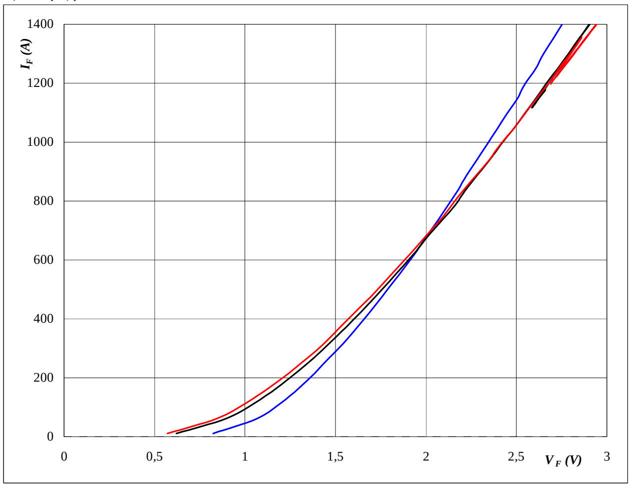
At

t_p =	350	μs
V_{CE} =	350	V
Tj=	25/125/150	℃

Figure 4 FWD

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$



At

t_p =	350	μs
Tj=	25/125/150	℃

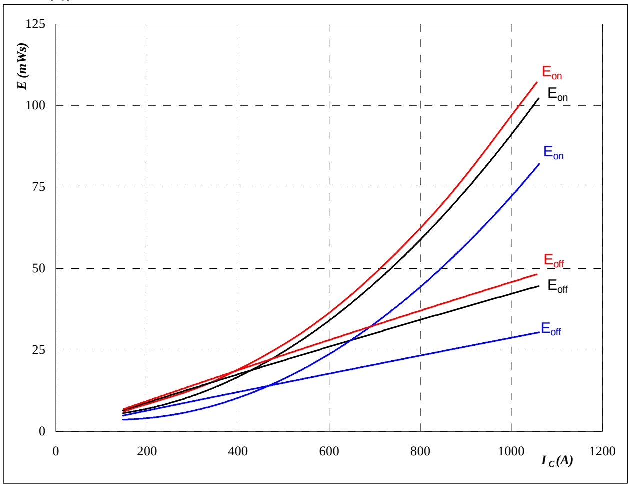
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 5 IGBT

Typical switching energy losses as a function of collector current

E = f(I_C)



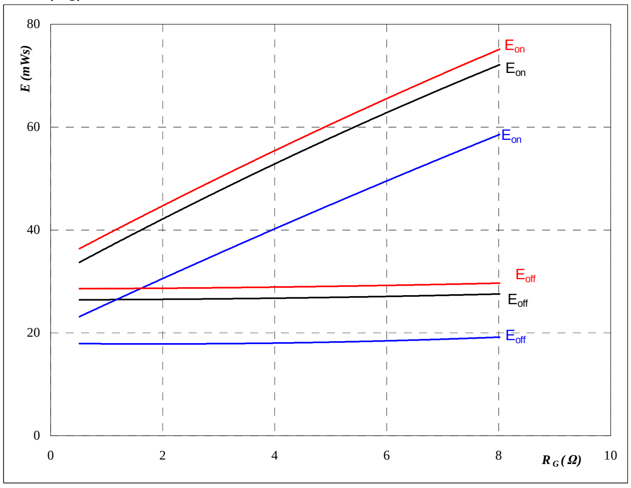
With an inductive load at

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	Ω
R_{goff} =	0,5	Ω

Figure 6 IGBT

Typical switching energy losses as a function of gate resistor

E = f(R_G)



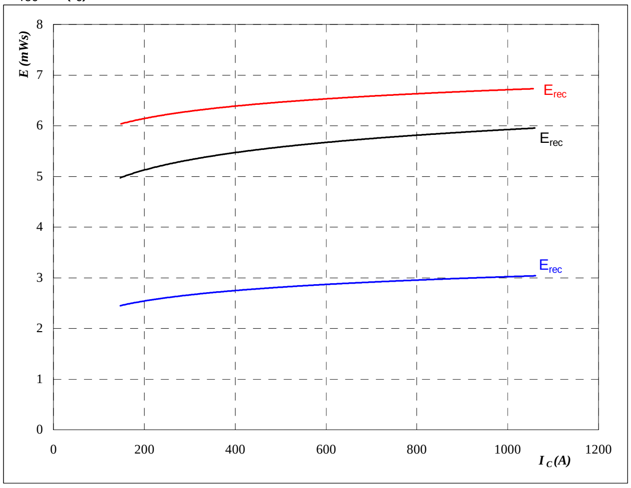
With an inductive load at

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	601	A

Figure 7 FWD

Typical reverse recovery energy loss as a function of collector current

E_{rec} = f(I_c)



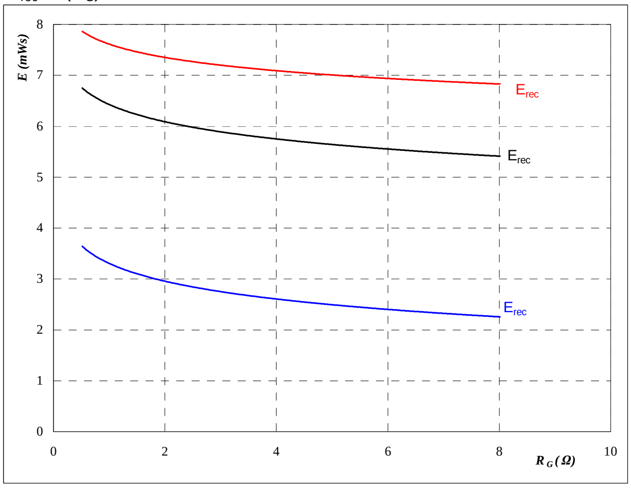
With an inductive load at

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	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 =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	601	A

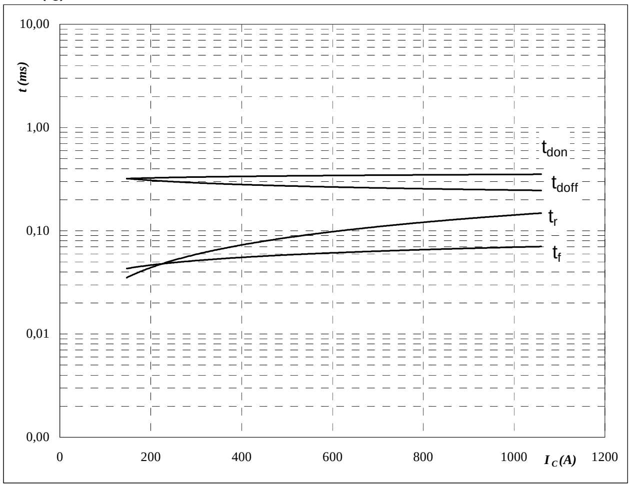
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 9 IGBT

Typical switching times as a function of collector current

t = f(I_C)



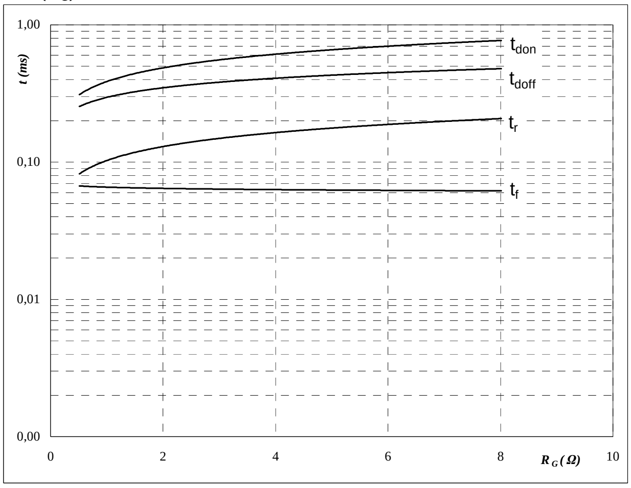
With an inductive load at

T_j =	125	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	Ω
R_{goff} =	0,5	Ω

Figure 10 IGBT

Typical switching times as a function of gate resistor

t = f(R_G)



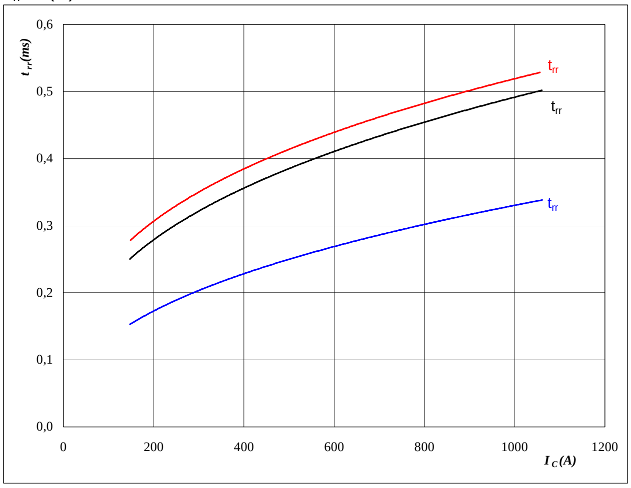
With an inductive load at

T_j =	125	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	601	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

t_{rr} = f(Ic)



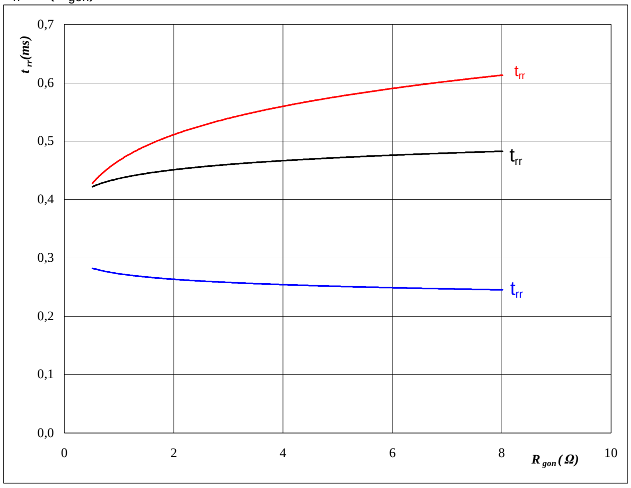
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	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 =	25/125/150	°C
V_R =	350	V
I_F =	601	A
V_{GE} =	±15	V

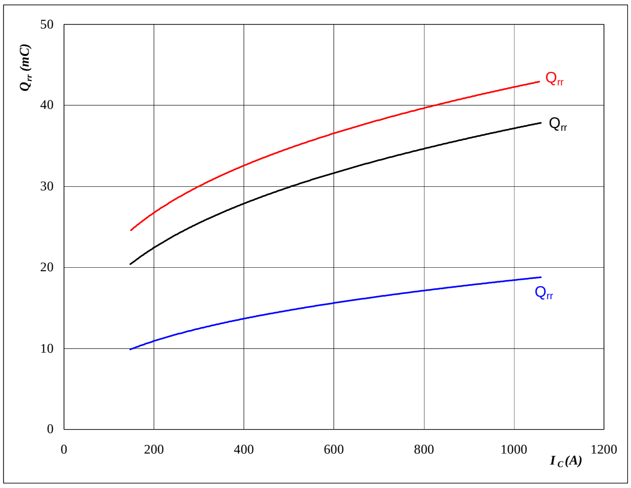
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



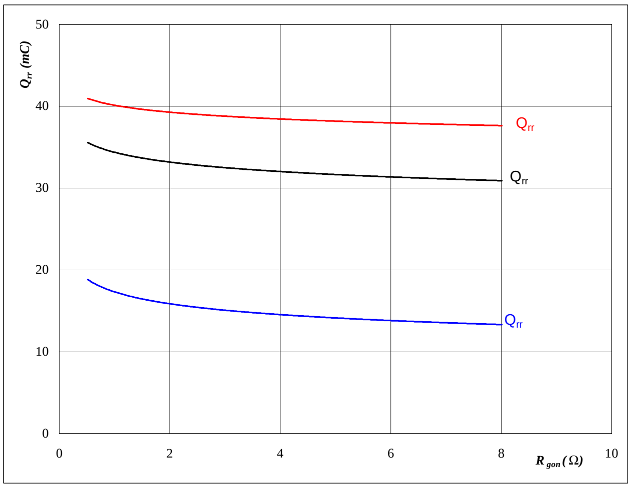
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	Ω

Figure 14 FWD

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

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



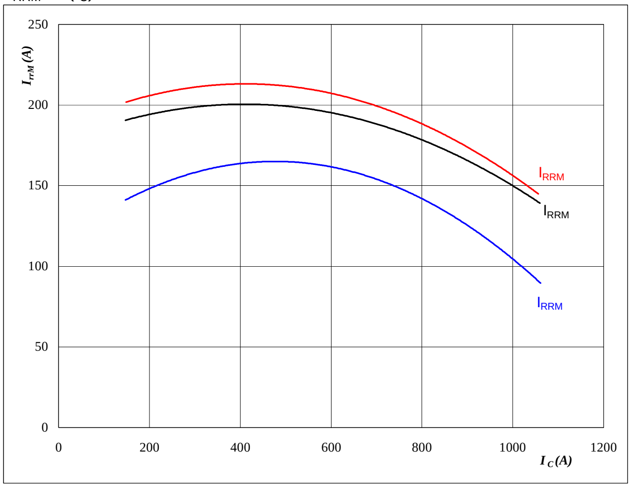
At

T_j =	25/125/150	°C
V_R =	350	V
I_F =	601	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



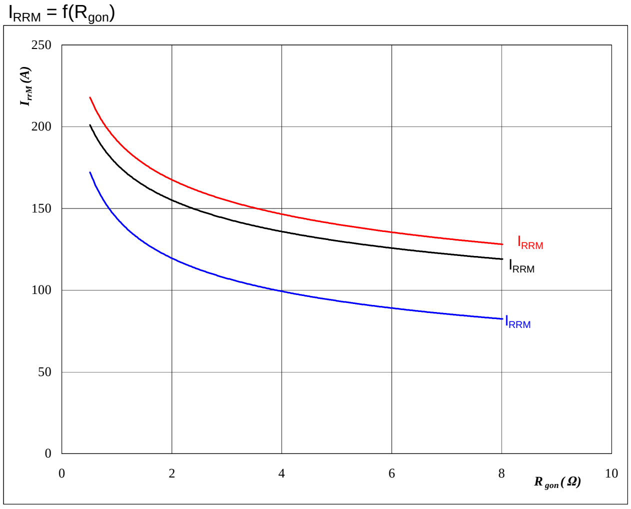
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	0,5	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 =	25/125/150	°C
V_R =	350	V
I_F =	601	A
V_{GE} =	±15	V

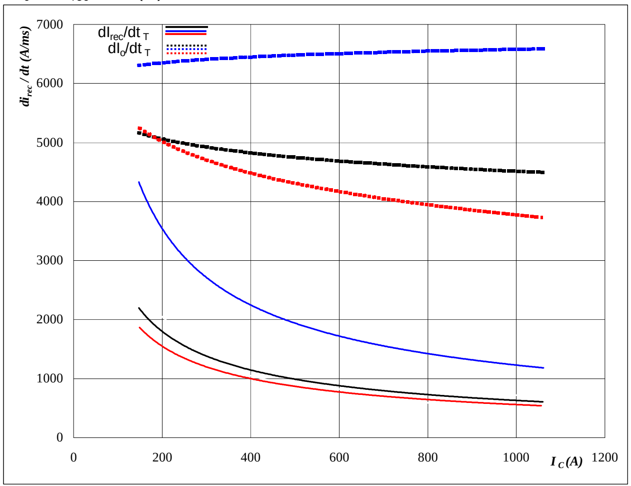
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 17 FWD

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

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



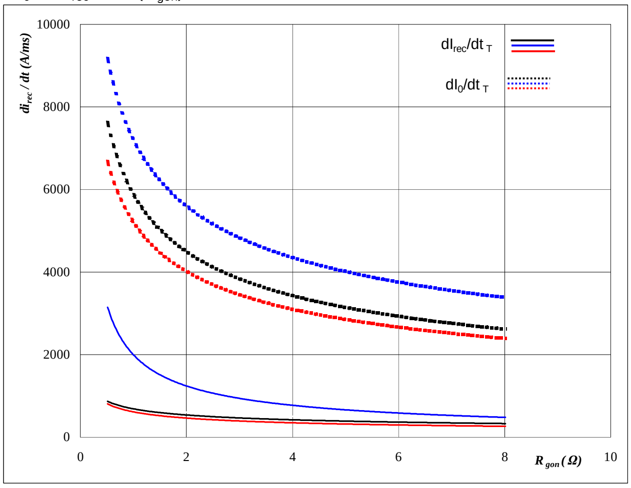
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1,0	Ω

Figure 18 FWD

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

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



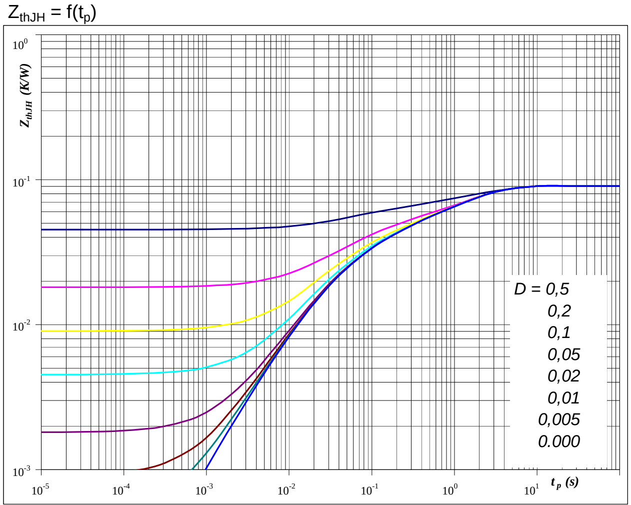
At

T_j =	25/125/150	°C
V_R =	350	V
I_F =	601	A
V_{GE} =	±15	V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

$D = t_p / T$

Preapplied PCM			Thermal grease		
R_{thJH} =	0,09	K/W	R_{thJH} =	0,11	K/W

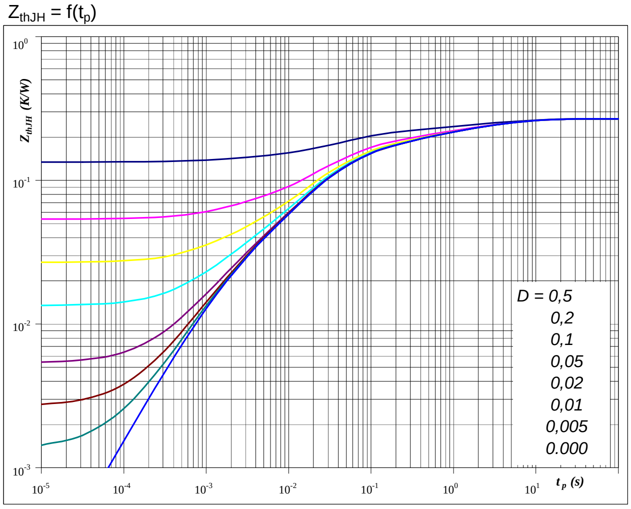
IGBT thermal model values

100um preapplied PCM		100um grease 1W/mK (P12)	
R (C/W)	Tau (s)	R (C/W)	Tau (s)
0,042	1,916	0,051	1,916
0,024	0,234	0,030	0,234
0,023	0,035	0,028	0,035
0,002	0,006	0,002	0,006

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

$D = t_p / T$

Preapplied PCM			Thermal grease		
R_{thJH} =	0,27	K/W	R_{thJH} =	0,31	K/W

FWD thermal model values

100um preapplied PCM		100um grease 1W/mK (P12)	
R (C/W)	Tau (s)	R (C/W)	Tau (s)
0,040	5,632	0,047	5,632
0,044	1,073	0,051	1,073
0,044	0,202	0,051	0,202
0,087	0,041	0,100	0,041
0,038	0,012	0,044	0,012

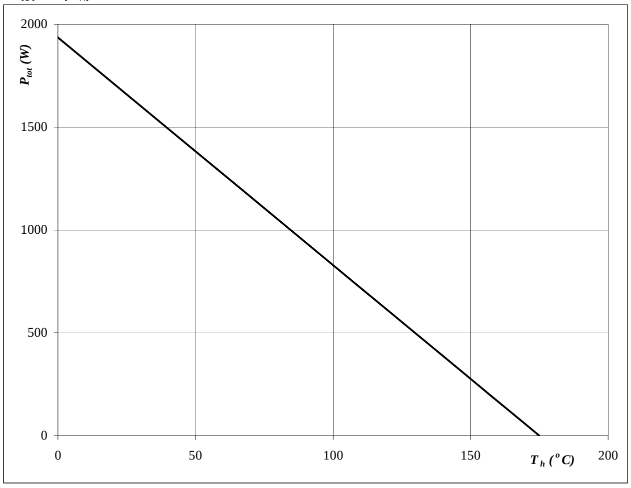
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



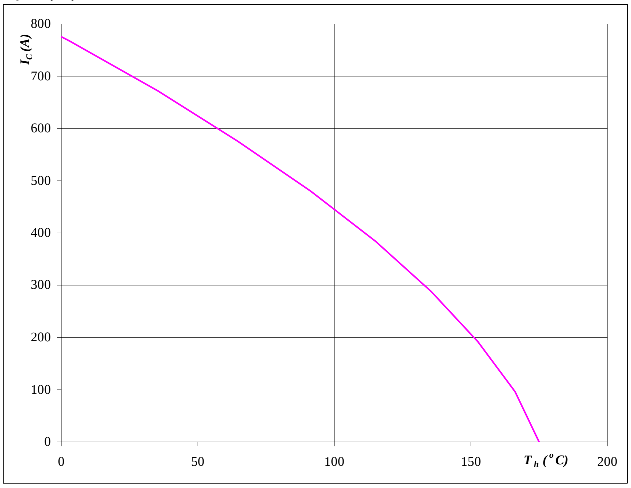
At

$T_j =$ 175 ℃

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

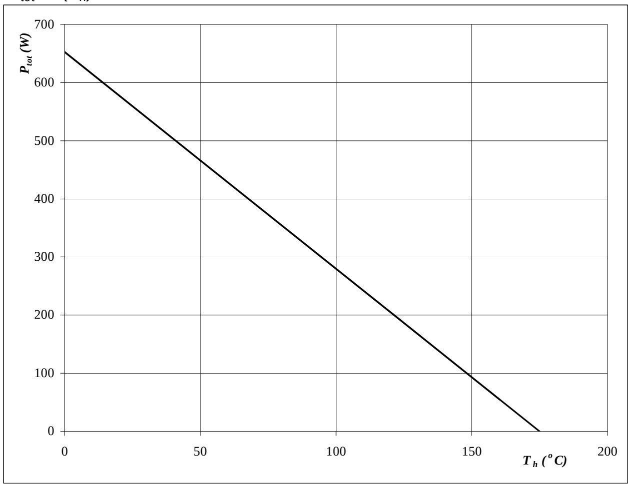
$T_j =$ 175 ℃

$V_{GE} =$ 15 V

Figure 23 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



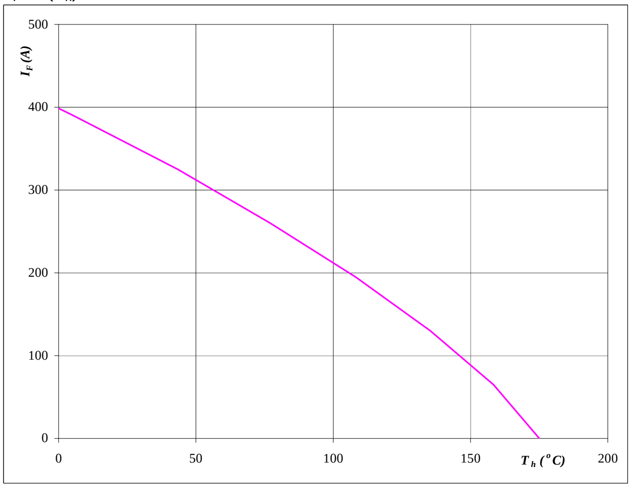
At

$T_j =$ 175 ℃

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

$T_j =$ 175 ℃

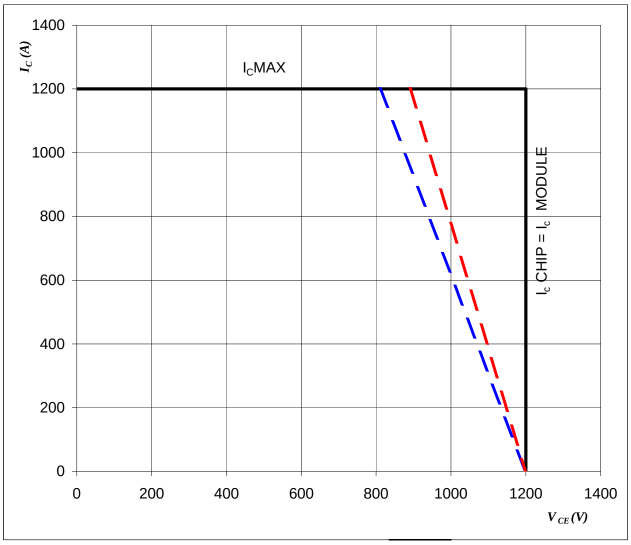
Buck operation

Half Bridge IGBT (T1,T4) and Neutral Point FWD (D2,D3)

Figure 21 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j =	25,150	ºC	
$U_{ccminus}$=U_{ccplus}=U_{cc}/2			
V_{GE} =	±15	V	
R_{gon} =	1	Ω	
Switching mode:		3 level	cont
		2 level	dashed

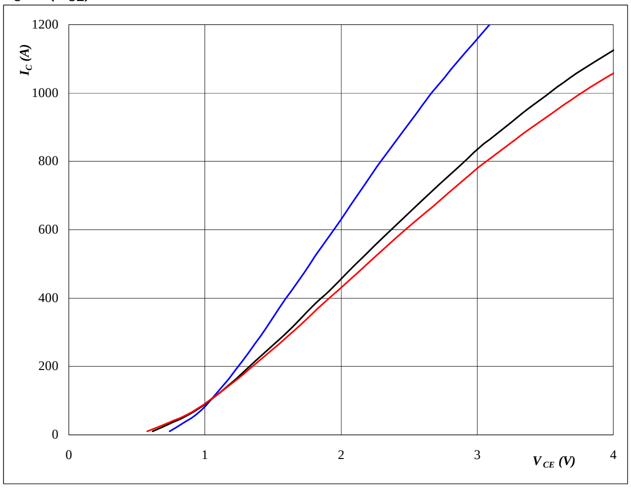
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 1	IGBT

Typical output characteristics Vge=15V

$I_C = f(V_{CE})$



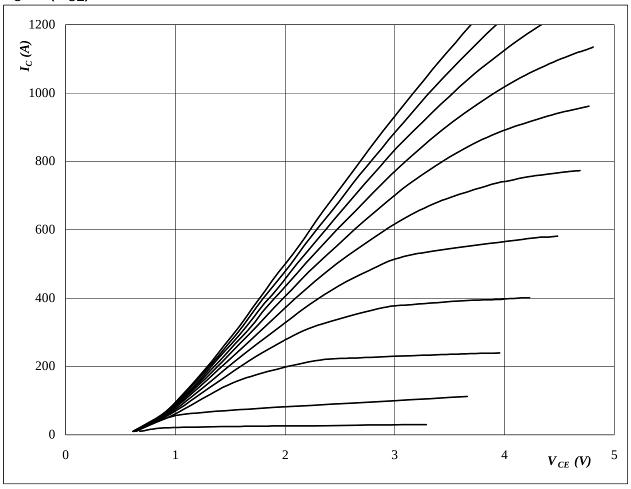
At

t_p =	350	μs
T_j =	25/125/150	℃
$V_{GE=}$	15	V

Figure 2	IGBT

Typical output characteristics

$I_C = f(V_{CE})$



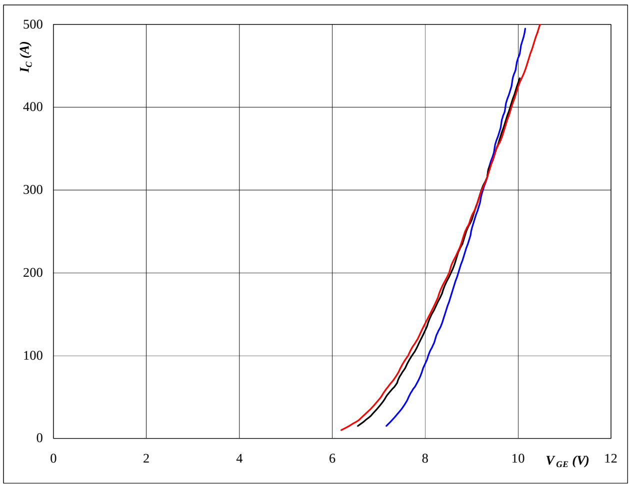
At

t_p =	350	μs
T_j =	151	℃
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

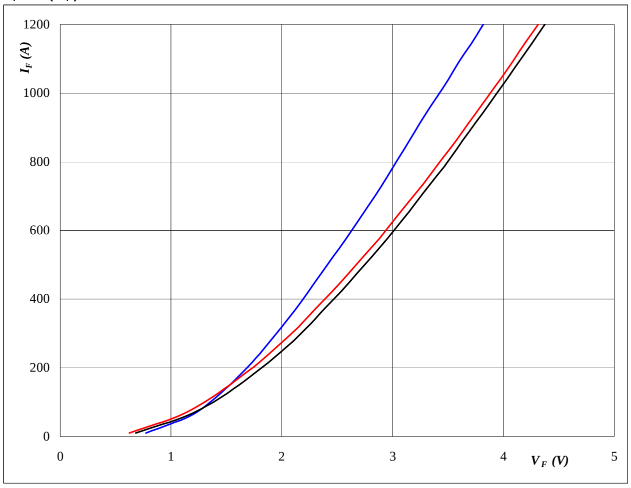
t_p =	350	μs
V_{CE} =	350	V
T_j =	25/125/150	℃

Figure 4	FWD

Typical FWD forward current as

a function of forward voltage

$I_F = f(V_F)$



At

t_p =	350	μs
T_j =	25/125/150	℃

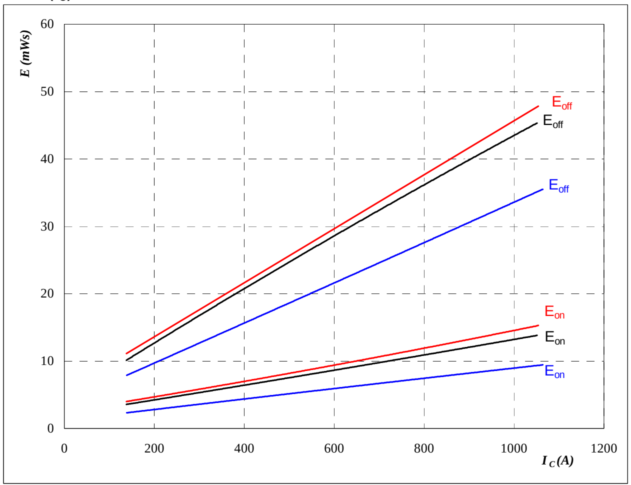
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



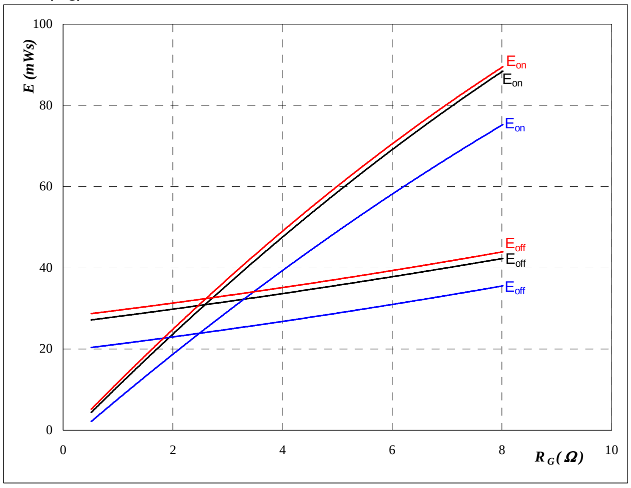
With an inductive load at

T_j =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1,0	Ω
R_{goff} =	1	Ω

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



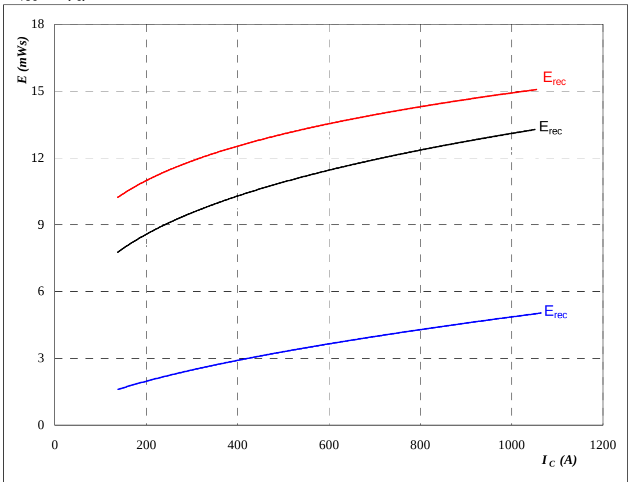
With an inductive load at

T_j =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	600	A

Figure 7 FWD

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_c)$



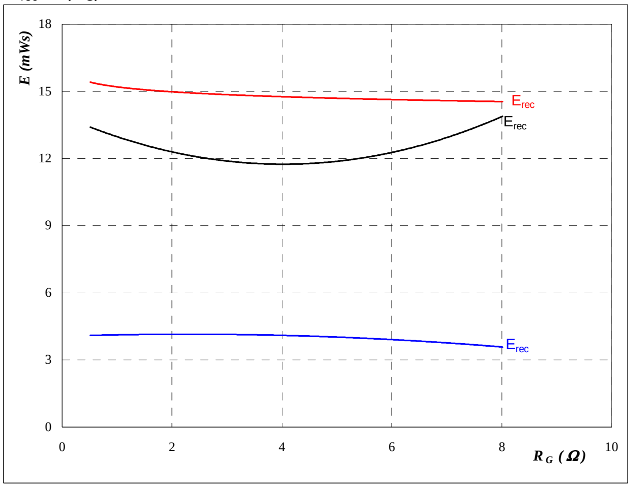
With an inductive load at

T_j =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	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 =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	600	A

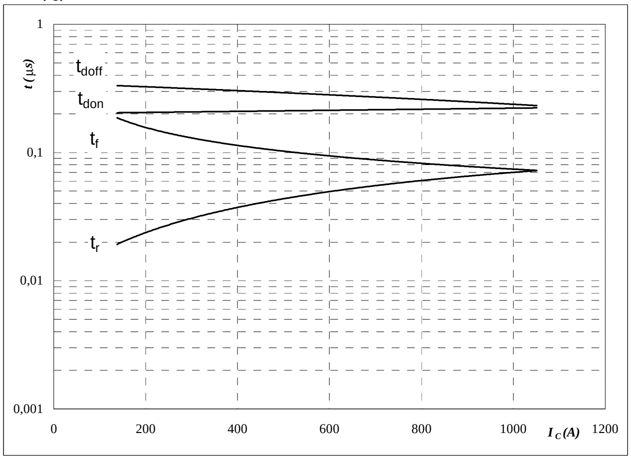
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 9 IGBT

Typical switching times as a function of collector current

t = f(I_C)



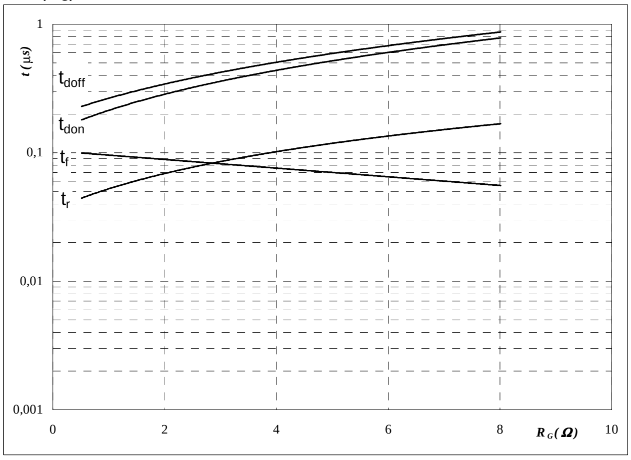
With an inductive load at

T_j =	126	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	Ω
R_{goff} =	1	Ω

Figure 10 IGBT

Typical switching times as a function of gate resistor

t = f(R_G)



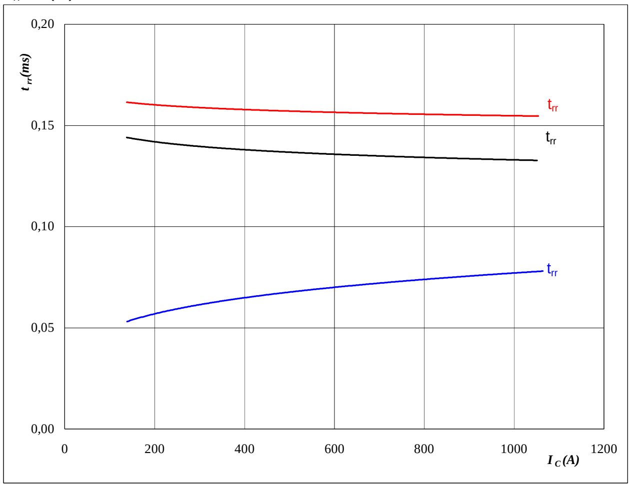
With an inductive load at

T_j =	126	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	600	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

t_{rr} = f(Ic)



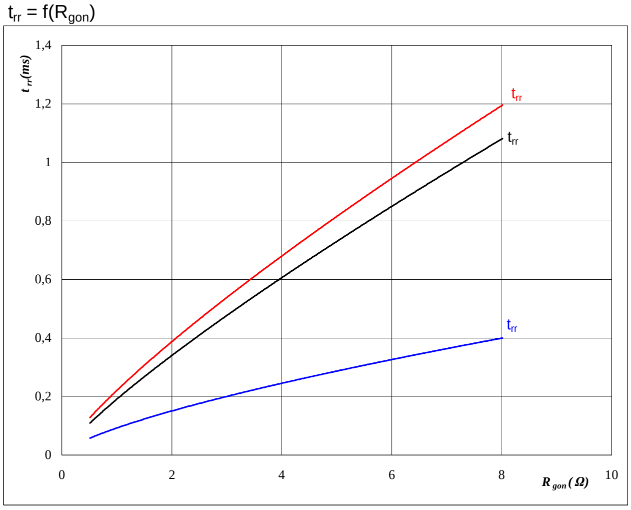
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	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 =	25/125/150	°C
V_R =	350	V
I_F =	600	A
V_{GE} =	±15	V

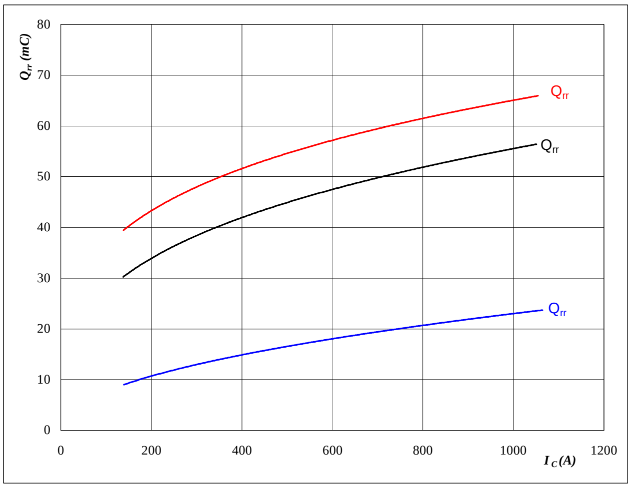
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



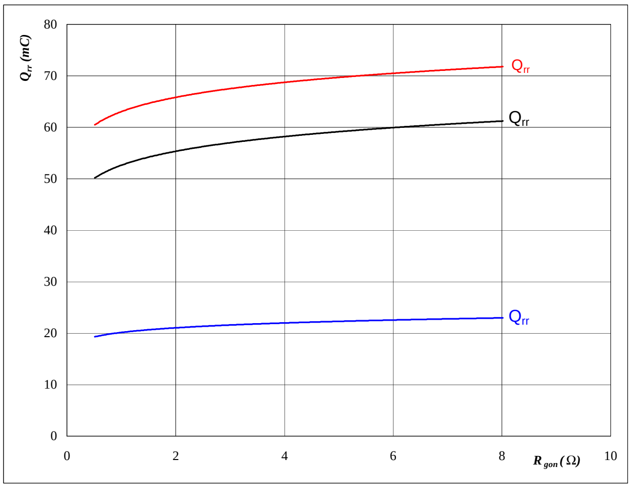
At

T_j =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	Ω

Figure 14 FWD

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

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



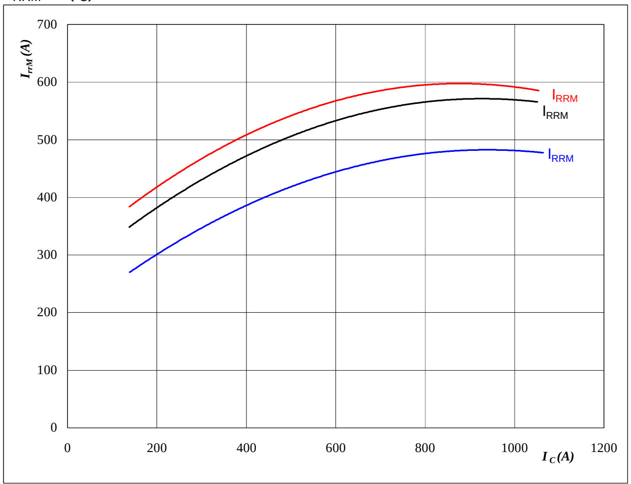
At

T_j =	25/125/150	℃
V_R =	350	V
I_F =	600	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



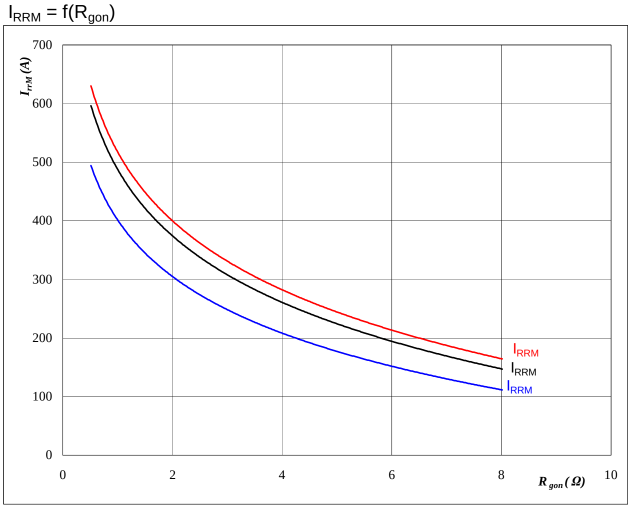
At

T_j =	25/125/150	℃
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	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 =	25/125/150	℃
V_R =	350	V
I_F =	600	A
V_{GE} =	±15	V

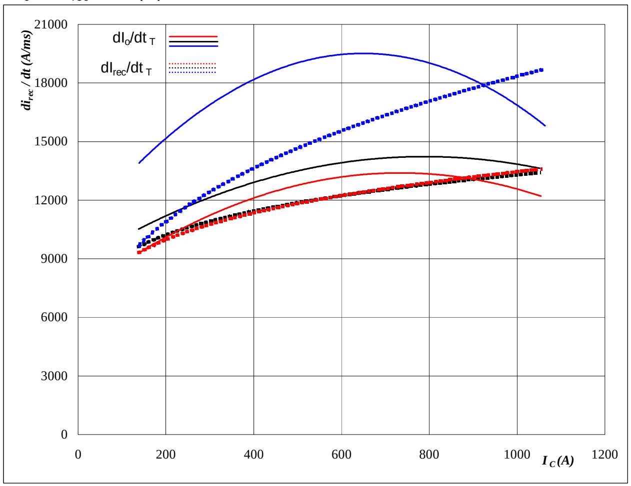
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 17 FWD

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

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



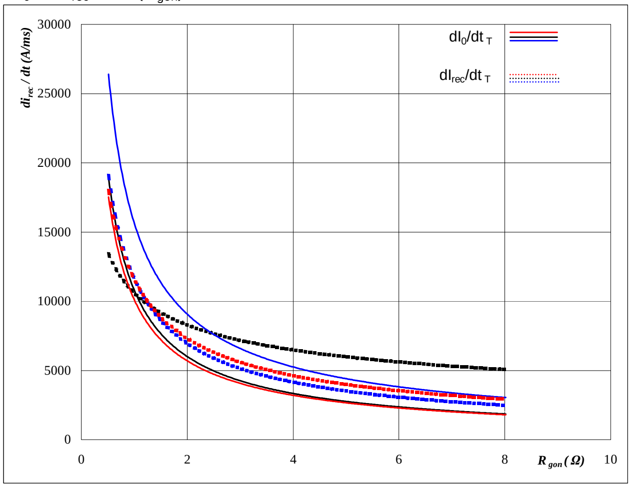
At

T_j =	25/125/150	°C
V_{CE} =	350	V
V_{GE} =	±15	V
R_{gon} =	1	Ω

Figure 18 FWD

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

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



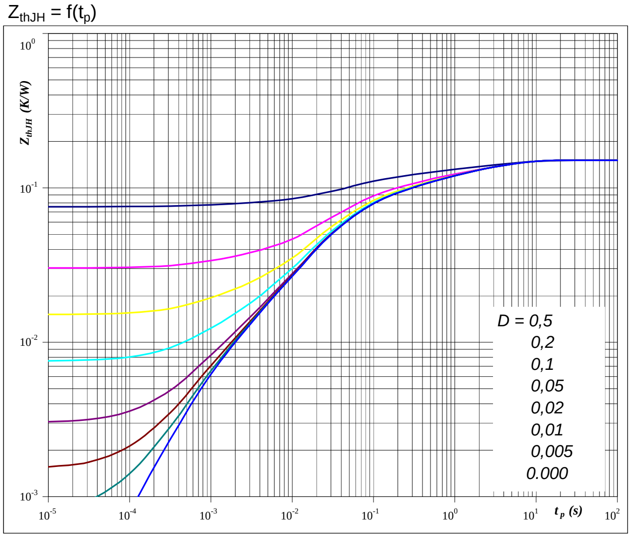
At

T_j =	25/125/150	°C
V_R =	350	V
I_F =	600	A
V_{GE} =	±15	V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D = tp / T

Preapplied PCM			Thermal grease		
R_{thJH} =	0,15	K/W	R_{thJH} =	0,17	K/W

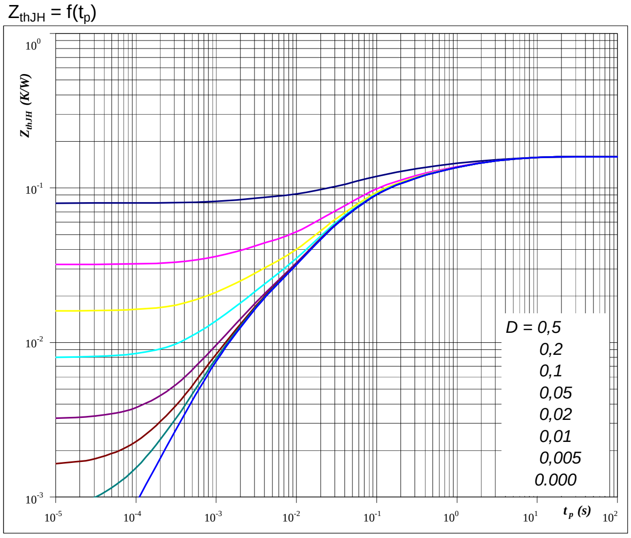
IGBT thermal model values

100um preapplied PCM		100um grease 1W/mK (P12)	
R (C/W)	Tau (s)	R (C/W)	Tau (s)
0,029	2,074	0,033	2,074
0,027	0,416	0,030	0,416
0,030	0,086	0,034	0,086
0,048	0,018	0,054	0,018
0,011	0,005	0,012	0,005

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D = tp / T

Preapplied PCM			Thermal grease		
R_{thJH} =	0,16	K/W	R_{thJH} =	0,18	K/W

FWD thermal model values

100um preapplied PCM		100um grease 1W/mK (P12)	
R (C/W)	Tau (s)	R (C/W)	Tau (s)
0,015	5,007	0,0165	5,007
0,026	1,172	0,0296	1,172
0,033	0,251	0,0377	0,251
0,052	0,054	0,0590	0,054
0,022	0,015	0,0252	0,015

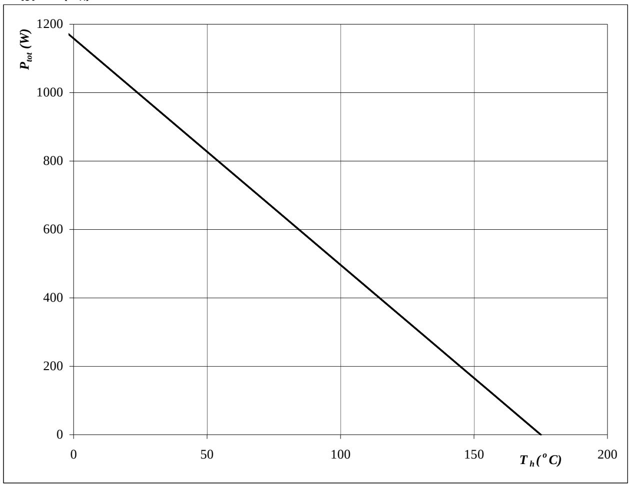
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



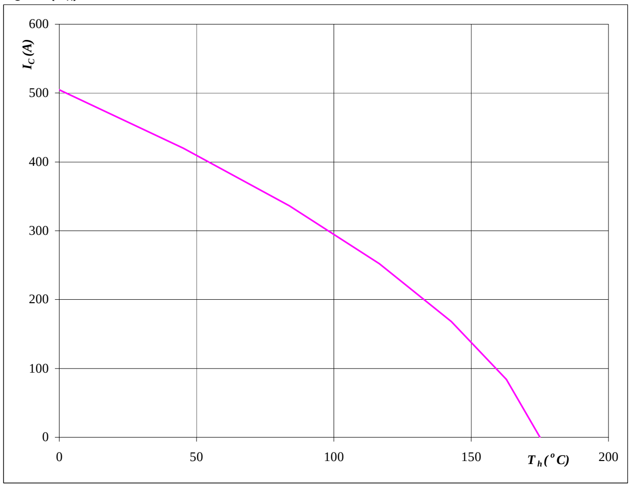
At

T_j = 175 ºC

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

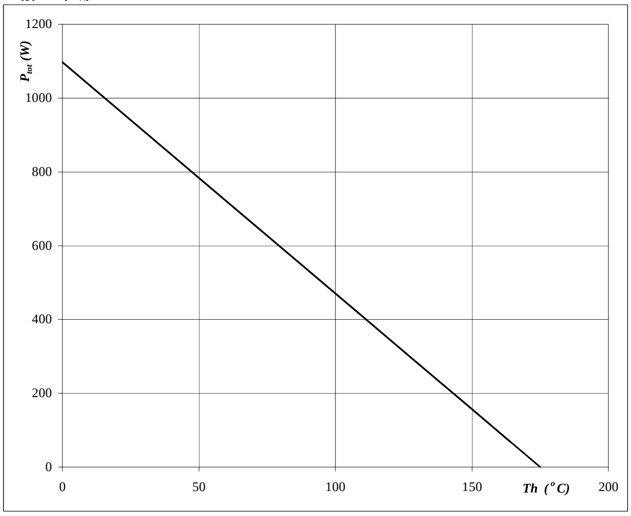
T_j = 175 ºC

V_{GE} = 15 V

Figure 23 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



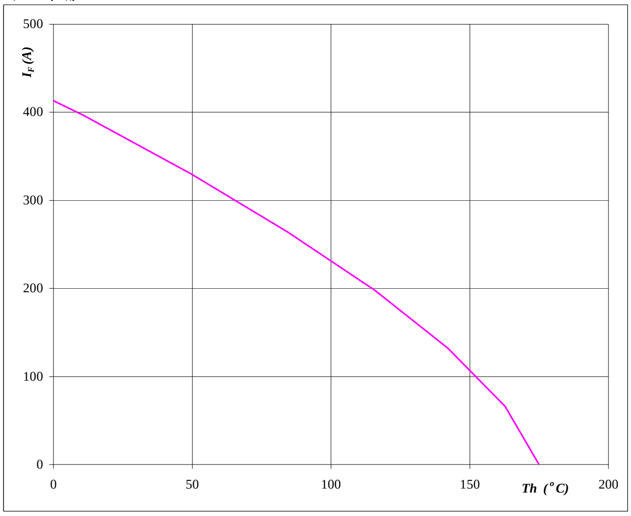
At

T_j = 175 ºC

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

T_j = 175 ºC

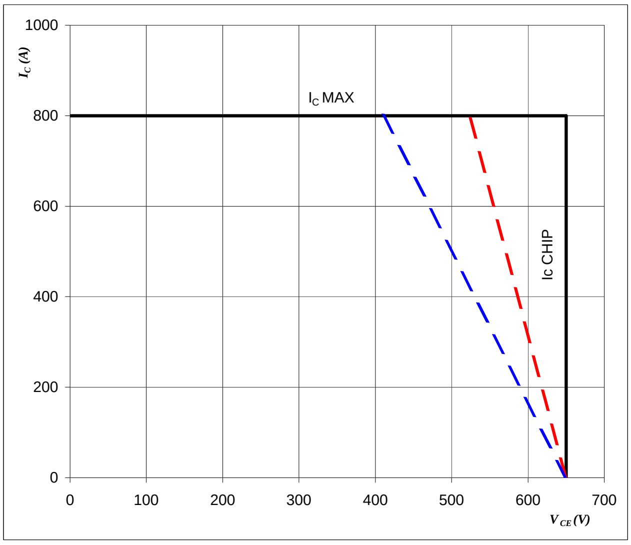
Boost operation

neutral point IGBT (T2,T3) and half bridge FWD (D1,D4)

Figure 25 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



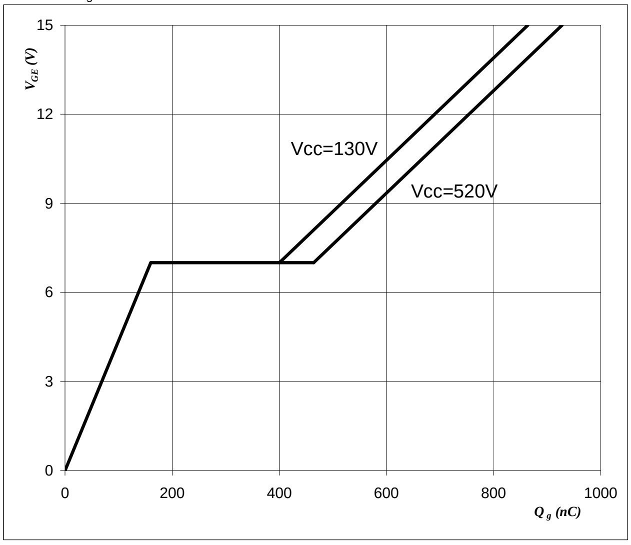
At

T_j =	25\150	ºC
$U_{ccminus}$=$U_{ccplus=}$$Uc_c$/2		
VGE =	±15	V
Rgon =	1	Ω

Figure 22 IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



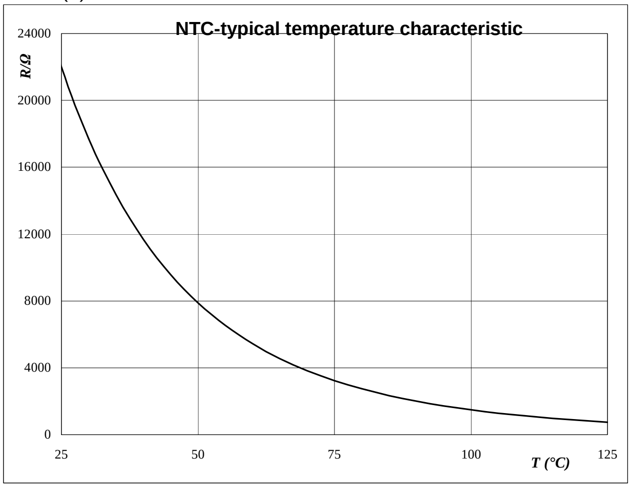
At

I_C =	400	A

Thermistor

Figure 1	Thermistor

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



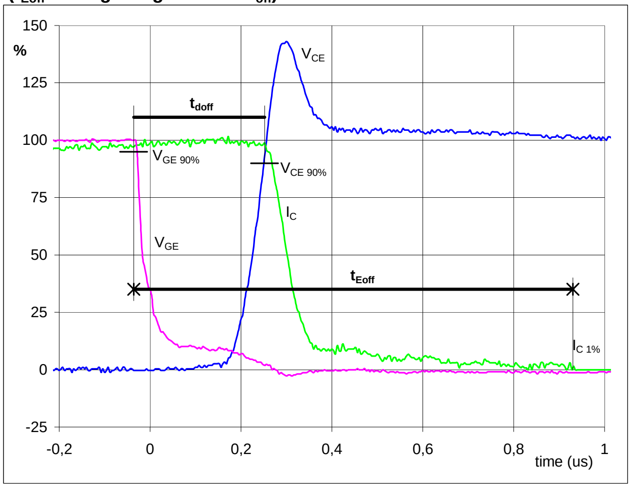
Switching Definitions Half Bridge

General conditions

T_j	=	125 °C
R_{gon}	=	0,5 Ω
R_{goff}	=	0,5 Ω

Figure 1 Half Bridge IGBT

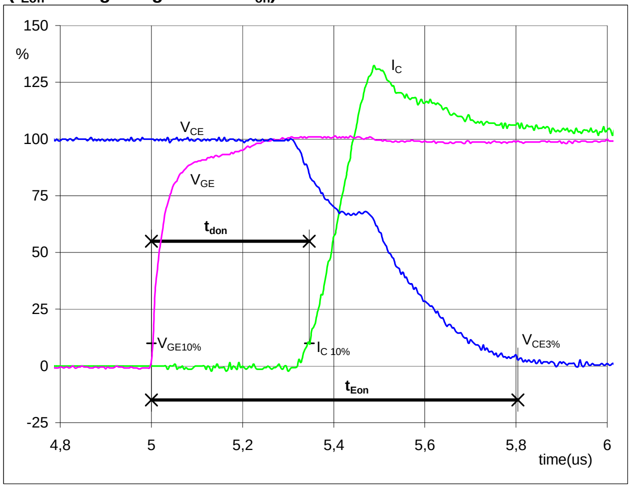
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	599	A
t_{doff} =	0,27	µs
t_{Eoff} =	0,97	µs

Figure 2 Half Bridge IGBT

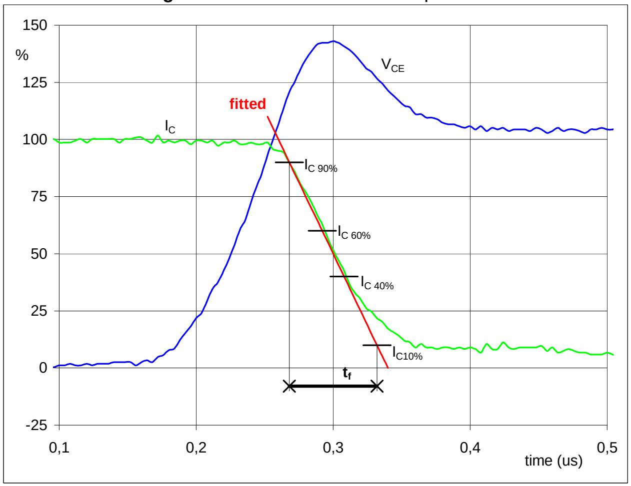
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	599	A
t_{don} =	0,34	µs
t_{Eon} =	0,80	µs

Figure 3 Half Bridge IGBT

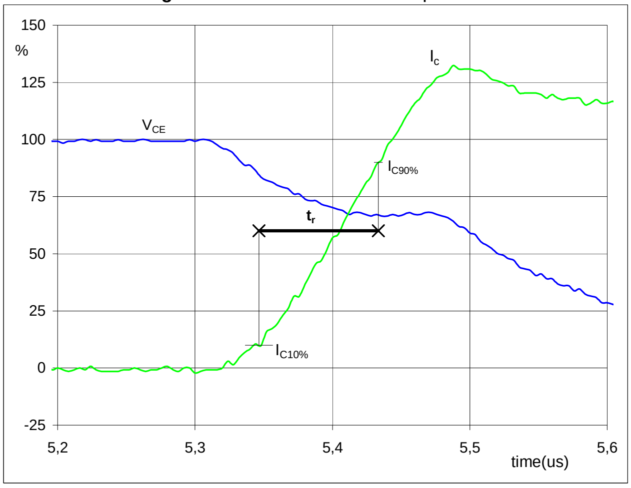
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	599	A
t_f =	0,07	µs

Figure 4 Half Bridge IGBT

Turn-on Switching Waveforms & definition of t_r

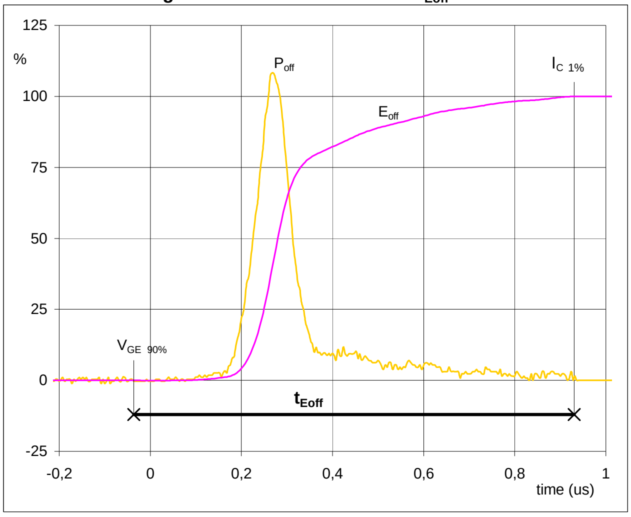


V_C (100%) =	350	V
I_C (100%) =	599	A
t_r =	0,09	µs

Switching Definitions Half Bridge

Figure 5 Half Bridge IGBT

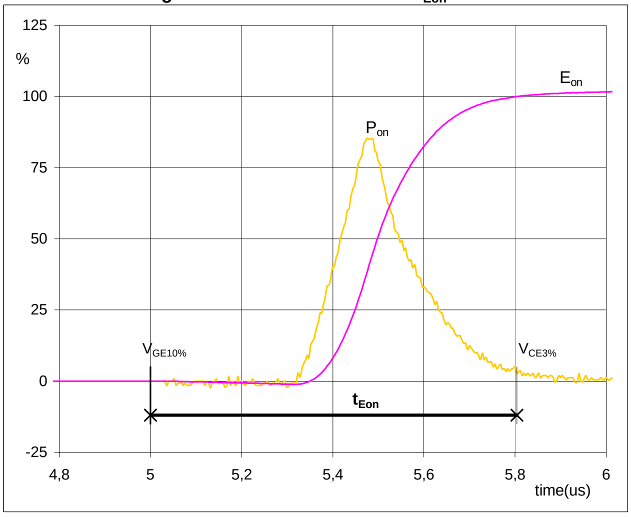
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	209,70	kW
E_{off} (100%) =	26,34	mJ
t_{Eoff} =	0,97	μs

Figure 6 Half Bridge IGBT

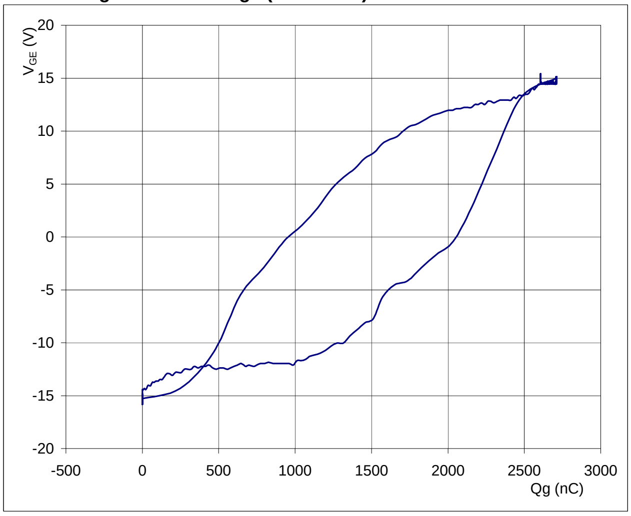
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	209,70	kW
E_{on} (100%) =	33,64	mJ
t_{Eon} =	0,80	μs

Figure 7 Half Bridge IGBT

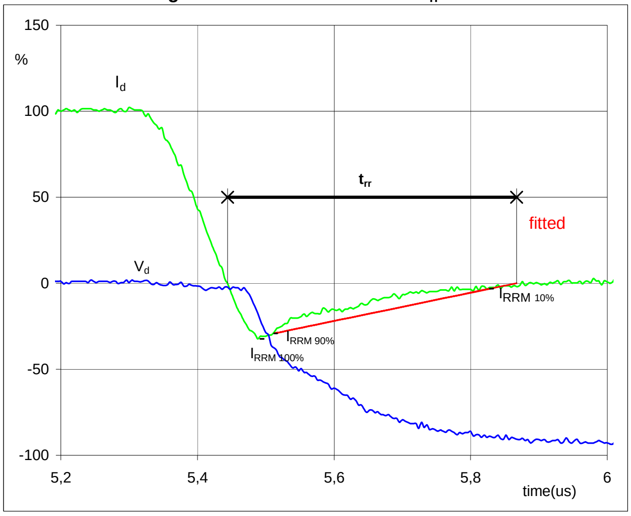
Gate voltage vs Gate charge (measured)



V_{GEoff} =	-15	V
V_{GEon} =	15	V
V_C (100%) =	350	V
I_C (100%) =	599	A
Q_g =	2710,20	nC

Figure 8 Neutral Point FWD

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

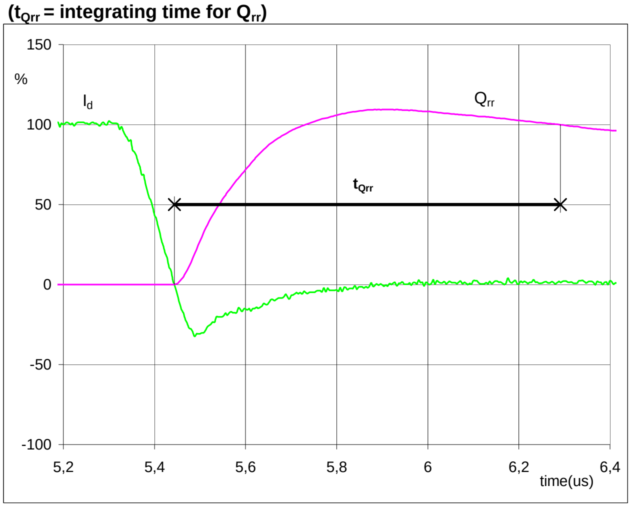


V_d (100%) =	350	V
I_d (100%) =	599	A
I_{RRM} (100%) =	-192	A
t_{rr} =	0,42	μs

Switching Definitions Half Bridge

Figure 9 Neutral Point FWD

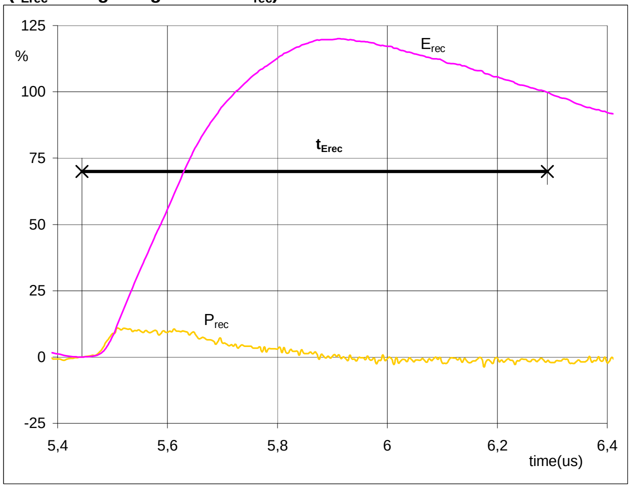
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	599	A
Q_{rr} (100%) =	34,86	µC
t_{Qrr} =	0,85	µs

Figure 10 Neutral Point FWD

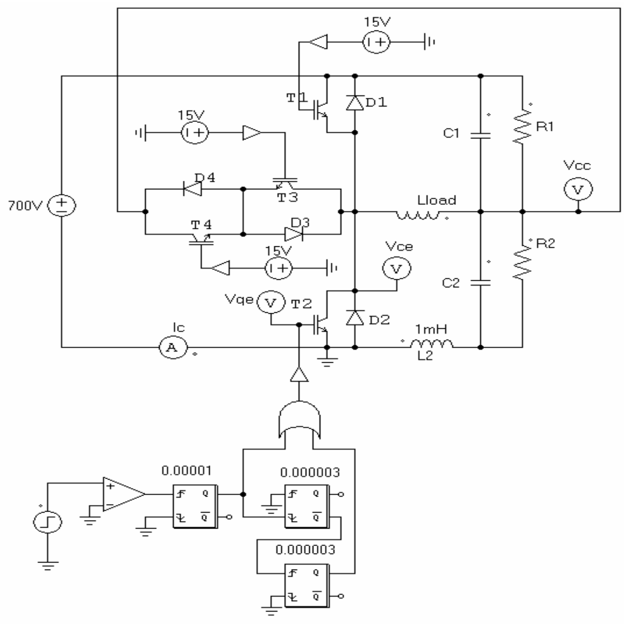
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	209,70	kW
E_{rec} (100%) =	6,58	mJ
t_{Erec} =	0,85	µs

Half Bridge switching measurement circuit

Figure 11



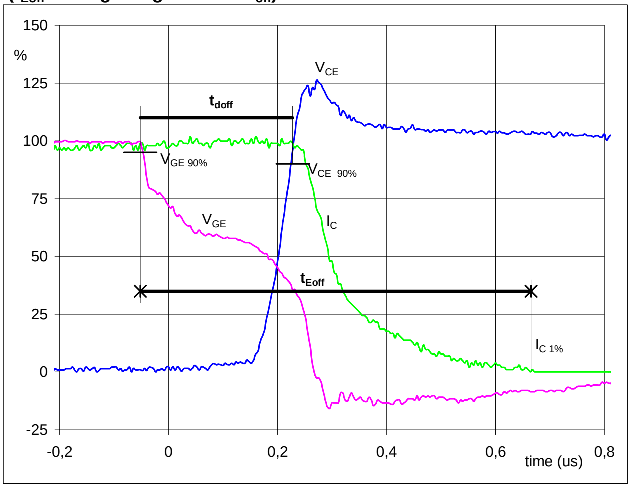
Switching Definitions Neutral Point

General conditions

T_j	=	125 °C
R_{gon}	=	1 Ω
R_{goff}	=	1 Ω

Figure 1 Neutral Point IGBT

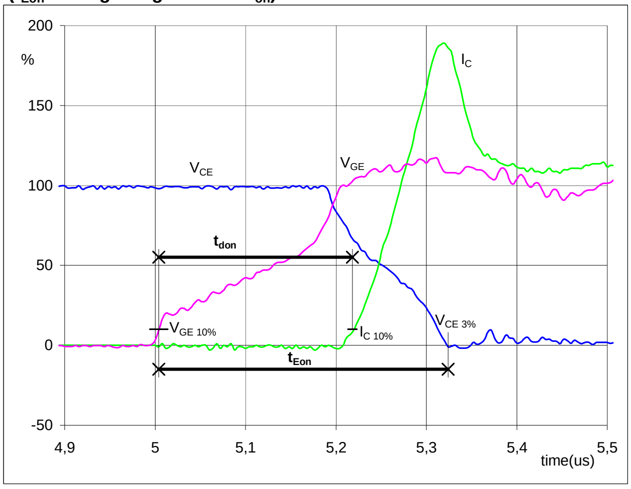
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	601	A
t_{doff} =	0,23	μs
t_{Eoff} =	0,58	μs

Figure 2 Neutral Point IGBT

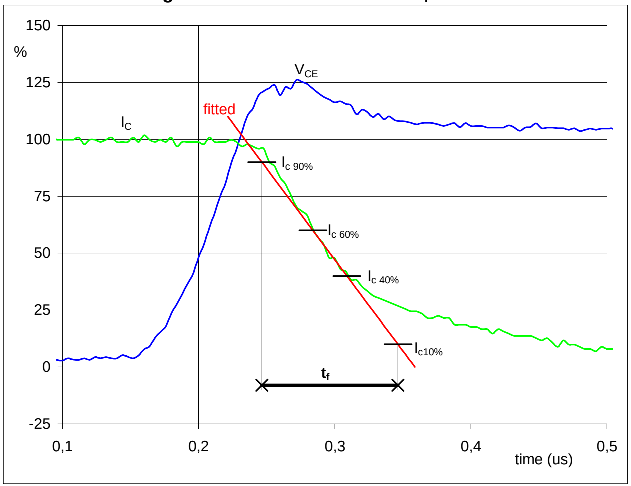
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	601	A
t_{don} =	0,21	μs
t_{Eon} =	0,38	μs

Figure 3 Neutral Point IGBT

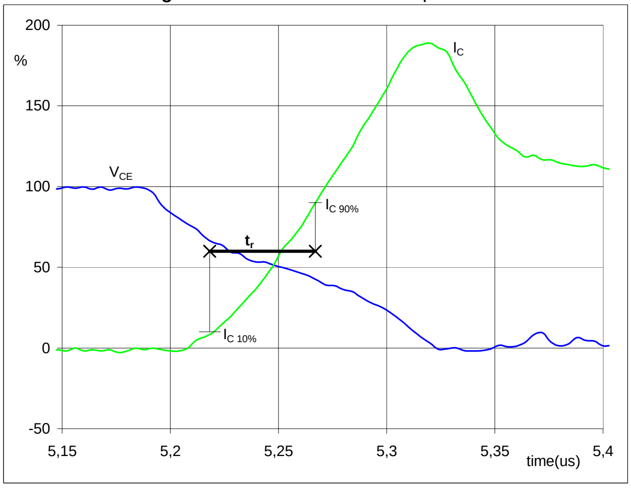
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	601	A
t_f =	0,106	μs

Figure 4 Neutral Point IGBT

Turn-on Switching Waveforms & definition of t_r

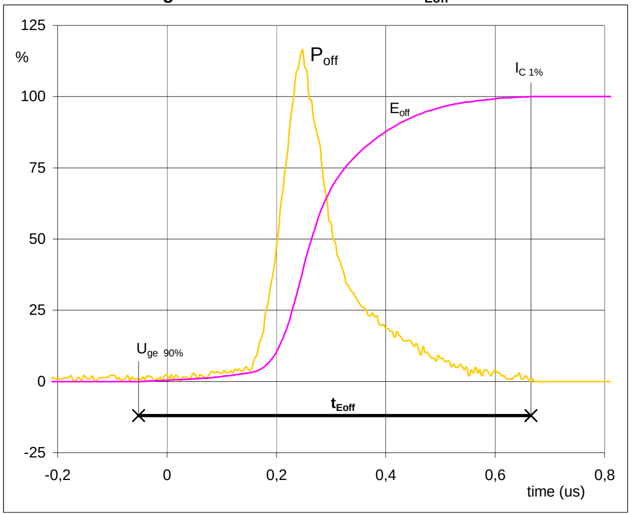


V_C (100%) =	350	V
I_C (100%) =	601	A
t_r =	0,049	μs

Switching Definitions Neutral Point

Figure 5 Neutral Point IGBT

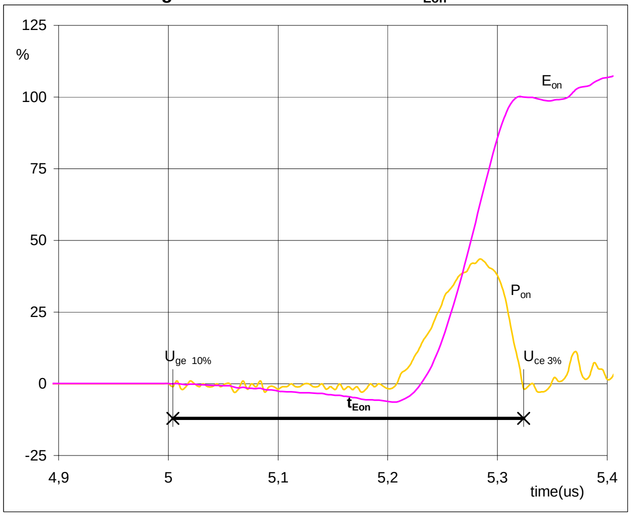
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	210,20	kW
E_{off} (100%) =	27,94	mJ
t_{Eoff} =	0,58	μs

Figure 6 Neutral Point IGBT

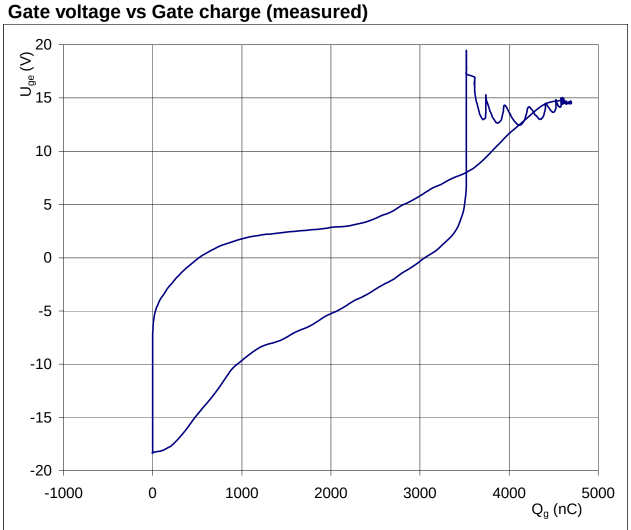
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	210,20405	kW
E_{on} (100%) =	13,39	mJ
t_{Eon} =	0,38	μs

Figure 7 Neutral Point IGBT

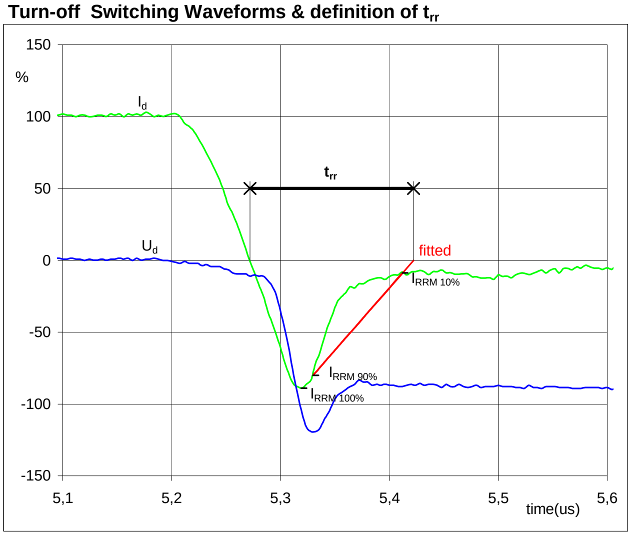
Gate voltage vs Gate charge (measured)



V_{GEoff} =	-15	V
V_{GEon} =	15	V
V_C (100%) =	350	V
I_C (100%) =	601	A
Q_g =	3441,54	nC

Figure 8 Half Bridge FWD

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

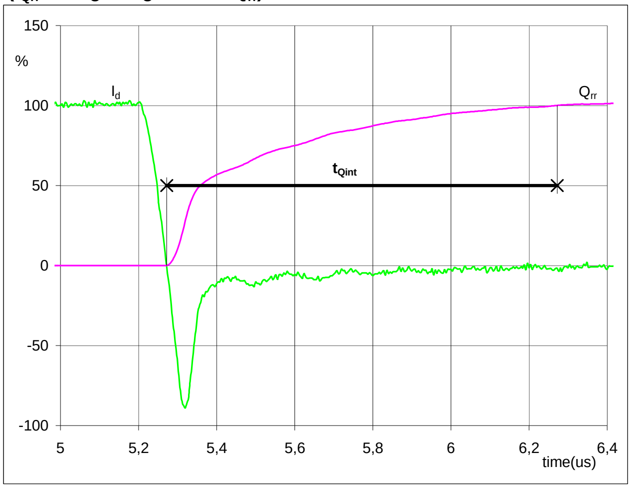


V_d (100%) =	350	V
I_d (100%) =	601	A
I_{RRM} (100%) =	-540	A
t_{rr} =	0,14	μs

Switching Definitions Neutral Point

Figure 9 Half Bridge FWD

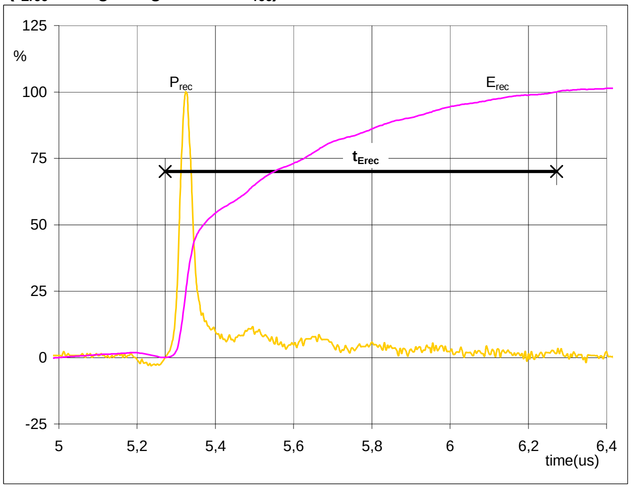
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	601	A
Q_{rr} (100%) =	51,60	μC
t_{Qint} =	0,33	μs

Figure 10 Half Bridge FWD

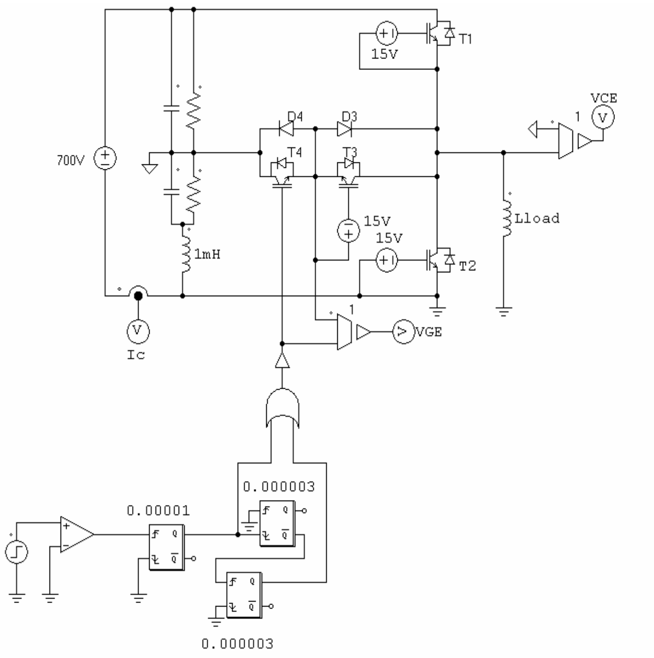
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	210,20	kW
E_{rec} (100%) =	12,97	mJ
t_{Erec} =	0,33	μs

Neutral Point switching measurement circuit

Figure 11



Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
without PCM	70-W212NMA600NB02-M200P62	M200P62	M200P62
with PCM	70-W212NMA600NB02-M200P62-/3/	M200P62	M200P62-/3/

Outline

Driver pins

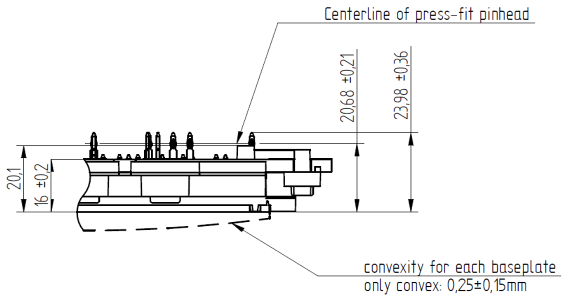
Pin	X1	Y1	Function	Group
1.1	4,5	78,65	G1-1	T1
1.2	4,5	81,55	E1-1	T1
1.3	39,5	78,65	G1-2	T1
1.4	39,5	81,55	E1-2	T1
1.5	1,95	68,4	E2-1	T2
1.6	4,85	68,4	G2-1	T2
1.7	39,15	68,4	G2-2	T2
1.8	42,05	68,4	E2-2	T2
1.9	-2,2	46	G3-1	T3
1.10	-2,2	48,9	E3-1	T3
1.11	46,2	46	G3-2	T3
1.12	46,2	48,9	E3-2	T3
1.13	-6,75	29,2	E4-1	T4
1.14	-6,75	32,1	G4-1	T4
1.15	50,75	29,2	E4-2	T4
1.16	50,75	32,1	G4-2	T4
1.17	19,45	30,15	Desat-DC+	
1.18	24,55	30,15	Desat-DC+	
1.19	19,45	44,65	Desat-GND	
1.20	24,55	44,65	Desat-GND	
1.21	67,65	86,7	NTC	
1.22	67,65	89,8	NTC	

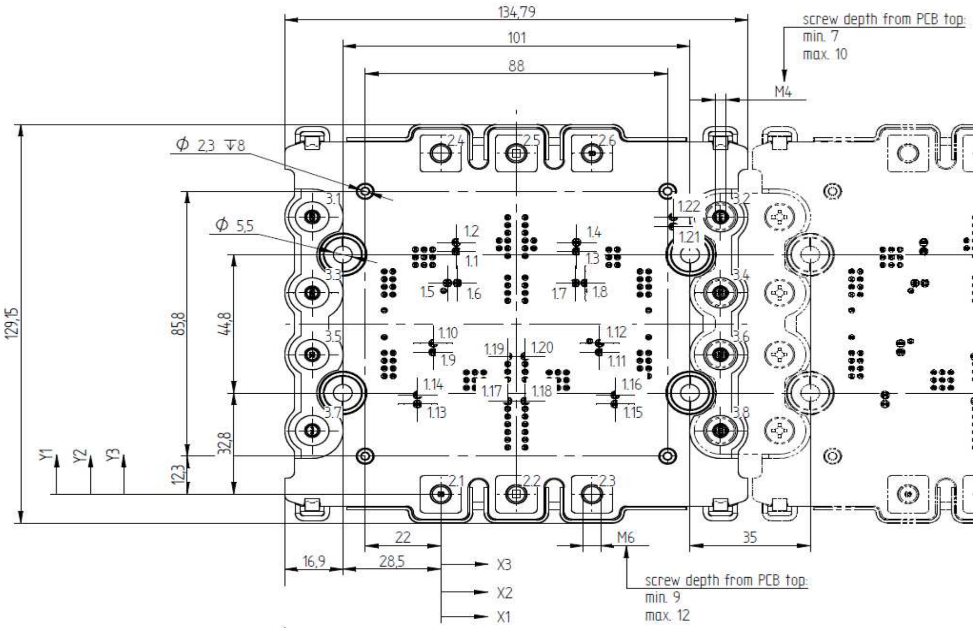
Low current connections

M4 screw	X3	Y3	Function
3.1	-37,4	89,8	DC+
3.2	81,4	89,8	DC+
3.3	-37,4	65,2	CE
3.4	81,4	65,2	CE
3.5	-37,4	45,2	Phase
3.6	81,4	45,2	Phase
3.7	-37,4	20,6	DC-
3.8	81,4	20,6	DC-

Power connections

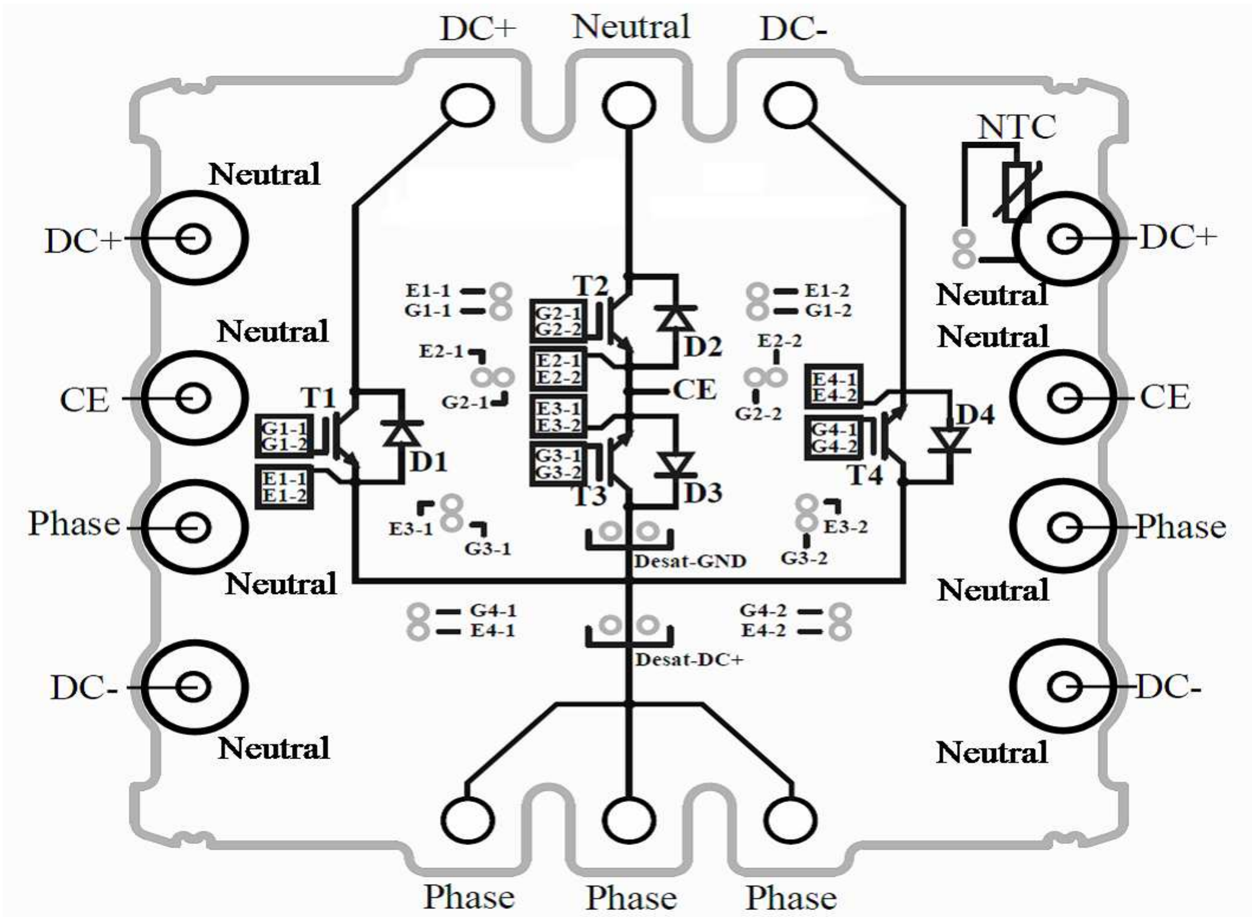
M6 screw	X2	Y2	Function
2.1	0	0	Phase
2.2	22	0	Phase
2.3	44	0	Phase
2.4	0	110,4	DC+
2.5	22	110,4	Neutral
2.6	44	110,4	DC-





Ordering Code and Marking - Outline - Pinout

Pinout



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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.