VINcoMNPC X4 — 1200 V/400 A

Features

- Mixed voltage NPC
- Low inductive
- High power screw interface
- Integrated DC-snubber capacitors

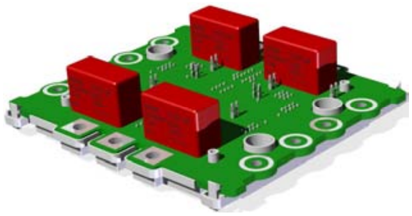
Target Applications

- Solar inverter
- UPS
- High speed motor drive

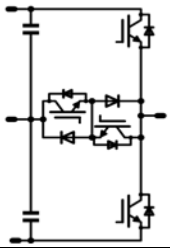
Types

- 70-W212NMA400SC-M209P

VINco X4 housing



Schematic



Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
half bridge IGBT (T1 , T4)					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	$T_j=T_j max$	$T_h=80°C$ $T_c=80°C$	338 439	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j max$		1200	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j max$	$T_h=80°C$ $T_c=80°C$	729 1104	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \le 150°C$ $V_{GE}=15V$		10 800	µs V
Turn off safe operating area (RBSOA)	I_{cmax}	$V_{CE\ max}$ = 1200V $T_{vj\ max}$= 150°C		800	A
Maximum Junction Temperature	$T_j max$			175	°C
neutral point FWD (D2 , D3)					
Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25°C$		600	V
DC forward current	I_F	$T_j=T_j max$	$T_h=80°C$ $T_c=80°C$	309 415	A
Surge forward current	I_{FSM}	t_p = 10 ms, sine halfwave	T_{vj} < 150°C	890	A
I2t-value	I^2t			3960	A^2s
Repetitive peak forward current	I_{FRM}	t_P = 1 ms	T_{vj} < 150°C	800	A
Power dissipation per FWD	P_{tot}	$T_j=T_j max$	$T_h=80°C$ $T_c=80°C$	421 637	W
Maximum Junction Temperature	$T_j max$			175	°C

Maximum Ratings

Tj=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
neutral point IGBT (T2 , T3)					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j=T_jmax$	T_h=80℃ T_c=80℃	329 430	A
Repetitive peak 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℃ T_c=80℃	574 870	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V		6 360	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)					
Peak Repetitive Reverse Voltage	V_{RRM}	T_j=25℃		1200	V
DC forward current	I_F	$T_j=T_jmax$	T_h=80℃ T_c=80℃	270 356	A
Surge forward current	I_{FSM}	t_p=10ms , sin 180°	T_j=150℃	2200	A
I2t-value	I^2t	t_p=10ms , sin 180°	T_j=150℃	6052	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℃ T_c=80℃	540 818	W
Maximum Junction Temperature	T_jmax			175	℃
DC link Capacitor					
Max.DC voltage	V_{MAX}		Tc=100℃	630	V
General Module Properties					
Material of module baseplate				Cu	
Material of internal isulation				Al_2O_3	
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					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 IGBT (T1 , T4)										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0152	Tj=25℃ Tj=150℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		400	Tj=25℃ Tj=150℃	1,5	1,97 2,23	2,4	V
Collector-emitter cut-off current incl. FWD	I_{CES}		0	1200		Tj=25℃ Tj=150℃			0,6	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=150℃			3000	nA
Integrated Gate resistor	R_{gint}							1,88		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=1 Ω Rgon=1 Ω	±15	350	400	Tj=25℃ Tj=150℃		235 247		ns
Rise time	t_r					Tj=25℃ Tj=150℃		46 55		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=150℃		292 354		
Fall time	t_f					Tj=25℃ Tj=150℃		55 92		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=150℃		7,95 12,30		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=150℃		13,25 22,08		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		24600		pF
Output capacitance	C_{oss}							1620		
Reverse transfer capacitance	C_{rss}							1380		
Gate charge	Q_{Gate}		±15	960	400	Tj=25℃		2030		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,13		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,09		
neutral point FWD (D2 , D3)										
FWD forward voltage	V_F				400	Tj=25℃ Tj=150℃	1,2	1,67 1,56	2,2	V
Peak reverse recovery current	I_{RRM}	Rgon=1 Ω	±15	350	400	Tj=25℃ Tj=150℃		204 262		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=150℃		183 295		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=150℃		17 33		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=150℃		3129 1705		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=150℃		3,78 7,44		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,23		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,15		
neutral point IGBT (T2 , T3)										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0064	Tj=25℃ Tj=150℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		400	Tj=25℃ Tj=150℃	1	1,56 1,80	2,2	V
Collector-emitter cut-off incl FWD	I_{CES}		0	600		Tj=25℃ Tj=150℃			0,1	mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=150℃			3000	nA
Integrated Gate resistor	R_{gint}							0,5		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=1 Ω Rgon=1 Ω	±15	350	400	Tj=25℃ Tj=150℃		201 204		ns
Rise time	t_r					Tj=25℃ Tj=150℃		29 32		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=150℃		248 272		
Fall time	t_f					Tj=25℃ Tj=150℃		71 88		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=150℃		3,93 5,61		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=150℃		10,49 14,07		
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℃		2480		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,17		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,11		

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)										
FWD forward voltage	V_F				400	Tj=25℃ Tj=150℃	1	2,29 2,37	3	V
Reverse leakage current	I_r			1200		Tj=25℃ Tj=150℃			480	µA
Peak reverse recovery current	I_{RRM}	Rgon=1 Ω	±15	350	400	Tj=25℃ Tj=150℃		410 521		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=150℃		63 149		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=150℃		24 49		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=150℃		18915 15110		A/µs
Reverse recovery energy	E_{rec}					Tj=25℃ Tj=150℃		5,79 12,71		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,18		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,12		
DC link Capacitor										
C value	C							2 * 0,68		µF
Stray inductance of on board capacitors	ESL							26/2		nH
Series resistance of on board capacitors	ESR							14/2		mΩ
Thermistor										
Rated resistance	R					Tj=25℃		22000		Ω
Deviation of R_{100}	ΔR/R	R100=1486 Ω				Tj=100℃	-5		5	%
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						Tj=25℃			B	
Module Properties										
Module inductance (from chips to PCB)	L_{sCE}							5		nH
Module inductance (from PCB to PCB using Intercon board)	L_{sCE}							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

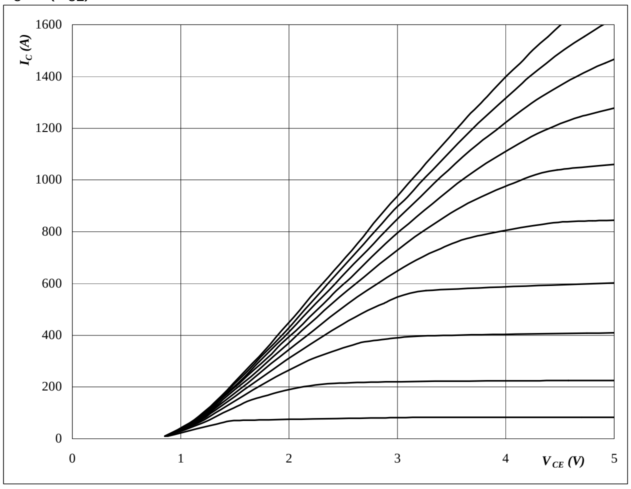
Buck

half bridge IGBT and neutral point FWD

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



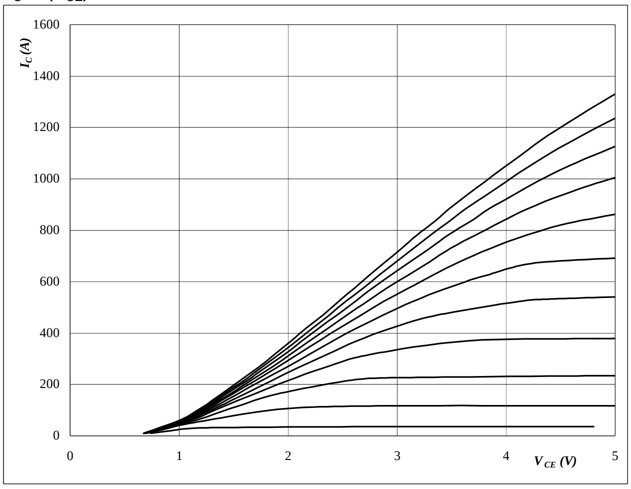
At

t_p =	350	µs
T_j =	25	°C
V_{GE} from	8 V to 17 V in steps of 1 V	

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



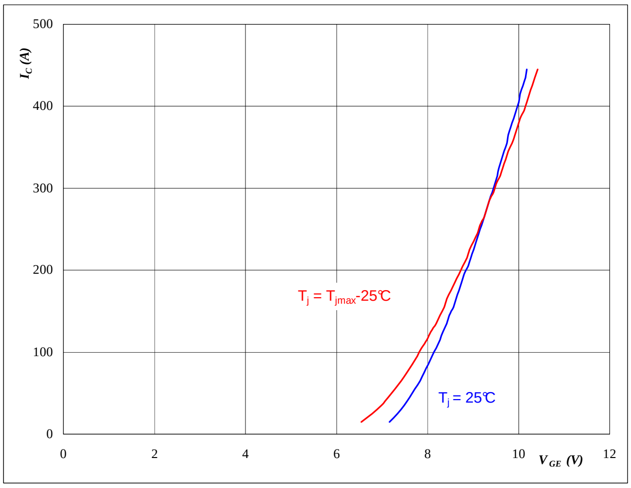
At

t_p =	350	µs
T_j =	125	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



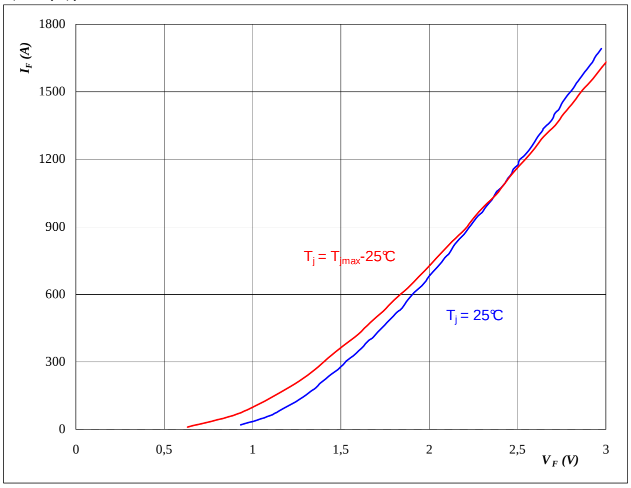
At

t_p =	350	µs
V_{CE} =	10	V

Figure 4 FWD

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$



At

t_p =	350	µs

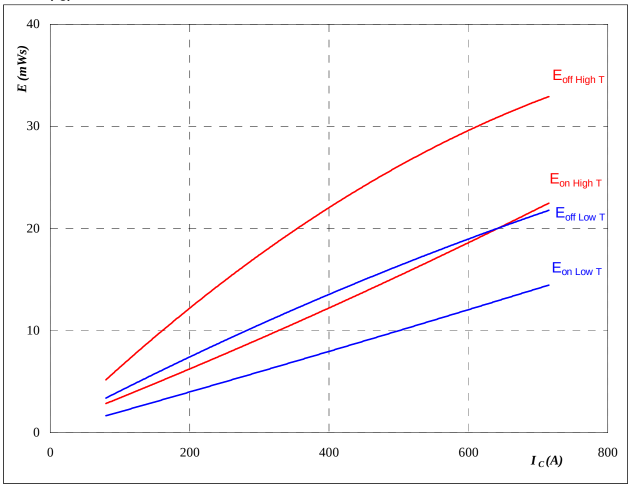
Buck

half bridge IGBT and neutral point FWD

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



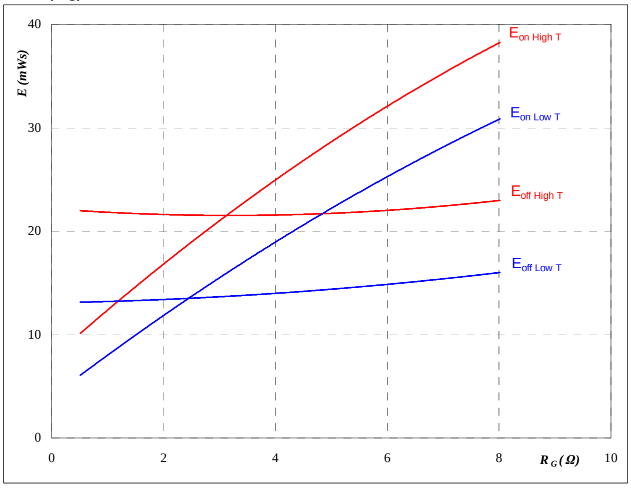
With an inductive load at

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

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



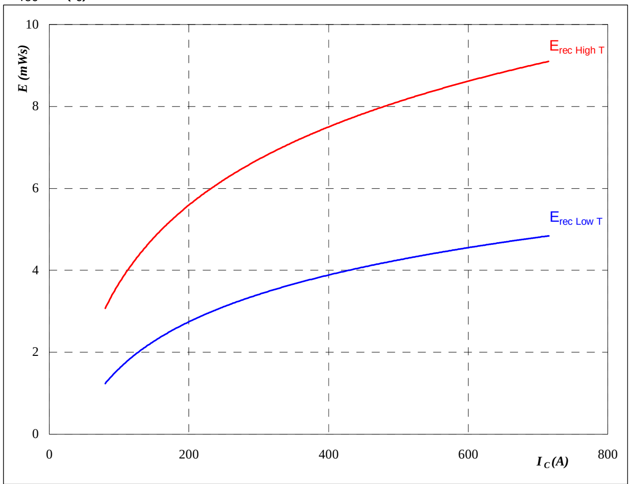
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

Figure 7 FWD

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_c)$



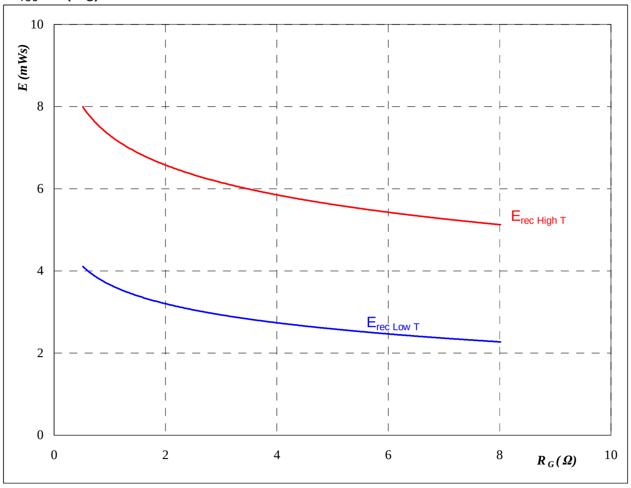
With an inductive load at

T_j =	25/125	°C
V_{CE} =	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	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

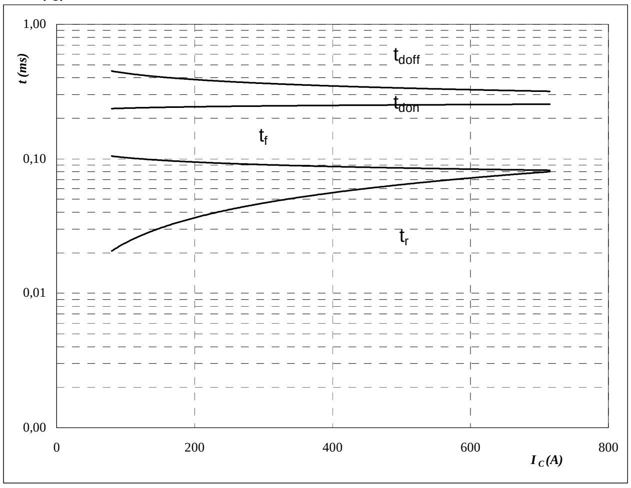
Buck

half bridge IGBT and neutral point FWD

Figure 9 IGBT

Typical switching times as a function of collector current

t = f(I_C)



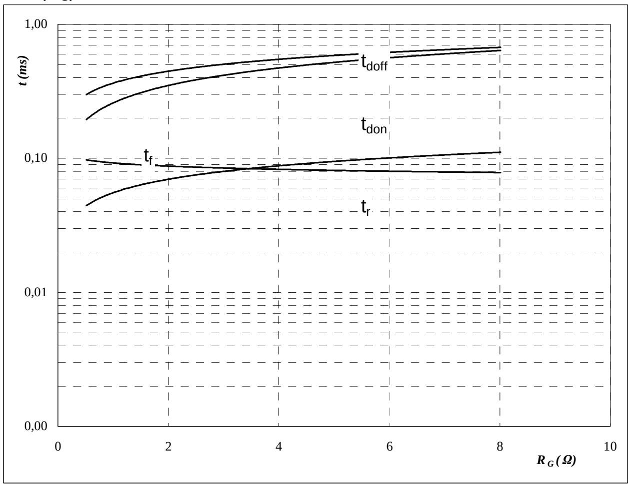
With an inductive load at

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

Figure 10 IGBT

Typical switching times as a function of gate resistor

t = f(R_G)



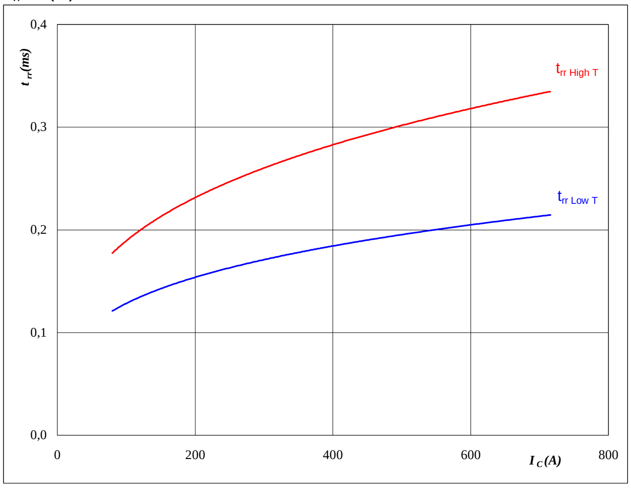
With an inductive load at

T_j =	125	°C
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

t_{rr} = f(Ic)



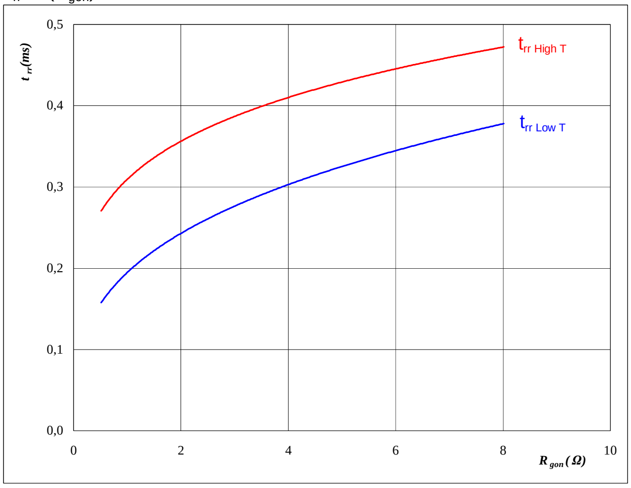
At

T_j =	25/125	°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	°C
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

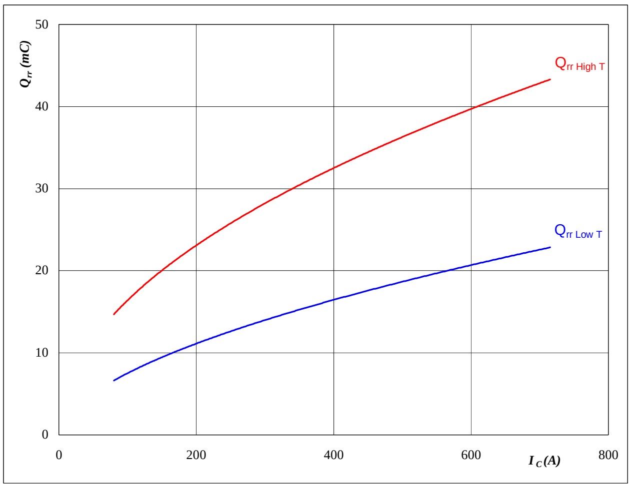
Buck

half bridge IGBT and neutral point FWD

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



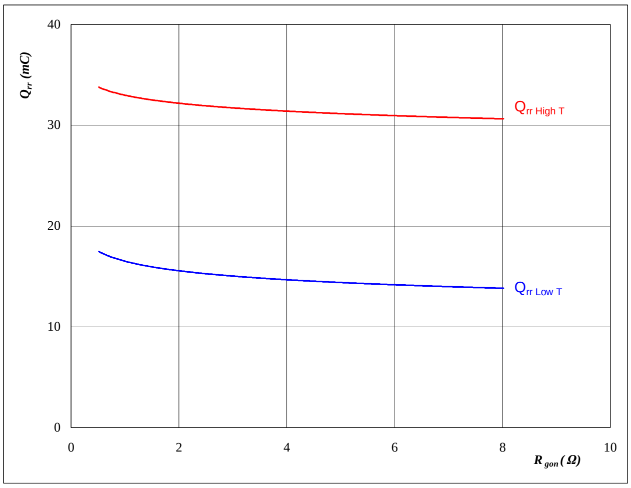
At

T_j =	25/125	℃
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

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



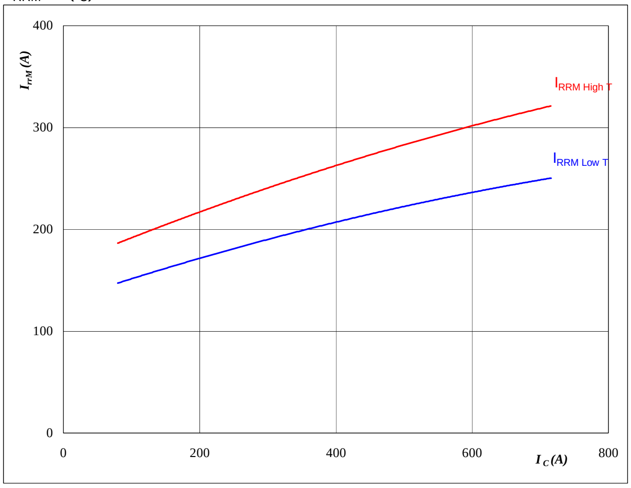
At

T_j =	25/125	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



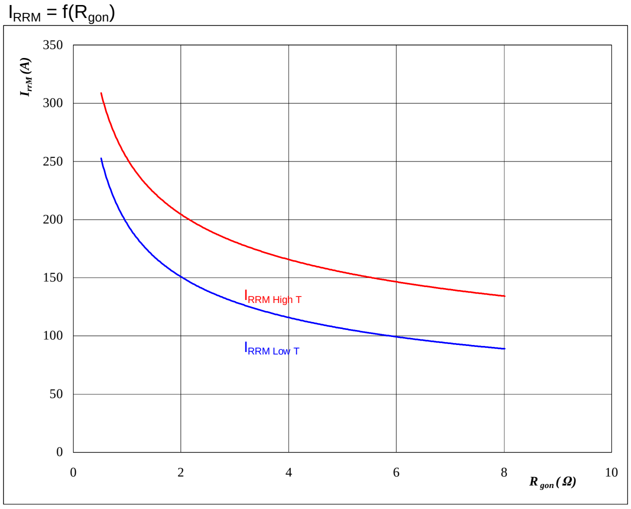
At

T_j =	25/125	℃
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	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

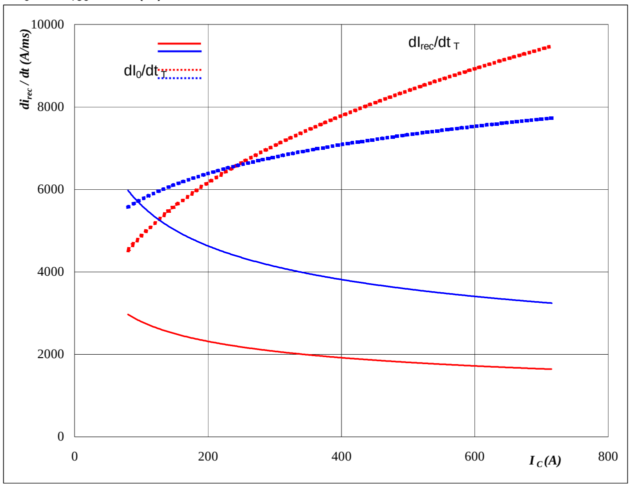
Buck

half bridge IGBT and neutral point FWD

Figure 17 FWD

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

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



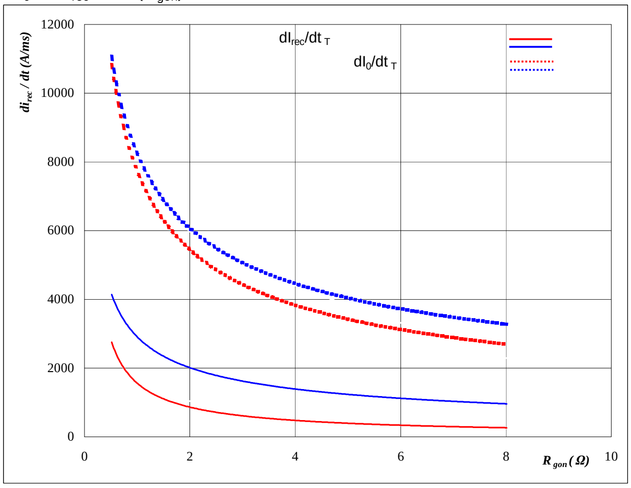
At

T_j =	25/125	℃
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

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



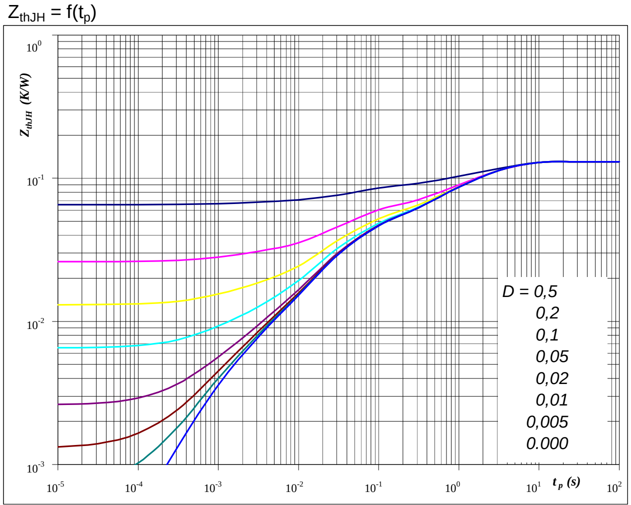
At

T_j =	25/125	℃
V_R =	350	V
I_F =	400	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	
R_{thJH} =	0,13	K/W

IGBT thermal model values

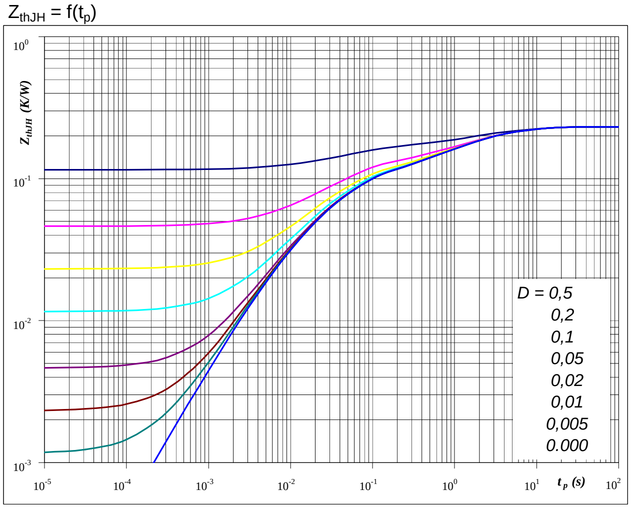
Thermal grease

R (C/W)	Tau (s)
0,06	2,5E+00
0,03	4,7E-01
0,03	3,9E-02
0,01	1,2E-02
0,00	1,2E-03

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	0,23	K/W

FWD thermal model values

Thermal grease

R (C/W)	Tau (s)
0,05	5,2E+00
0,07	1,1E+00
0,02	2,0E-01
0,06	4,6E-02
0,02	1,7E-02

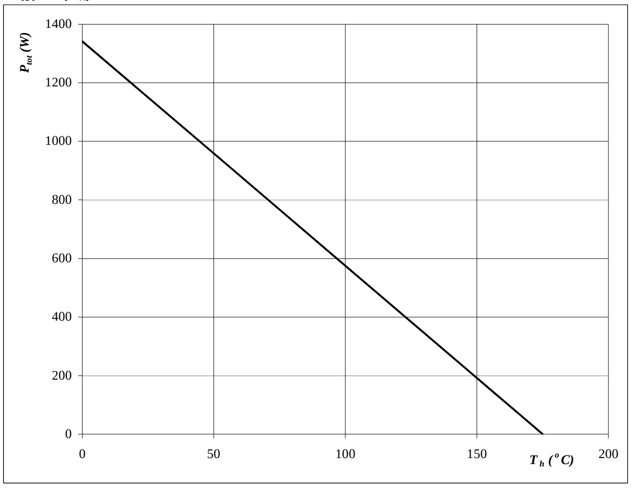
Buck

half bridge IGBT and neutral point FWD

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



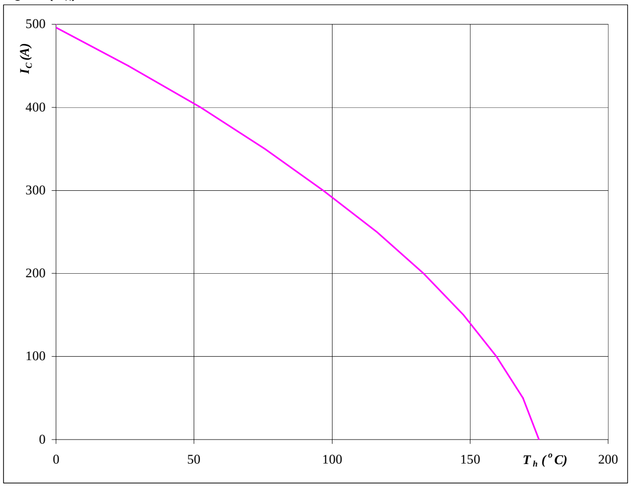
At

T_j = 175 ℃

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

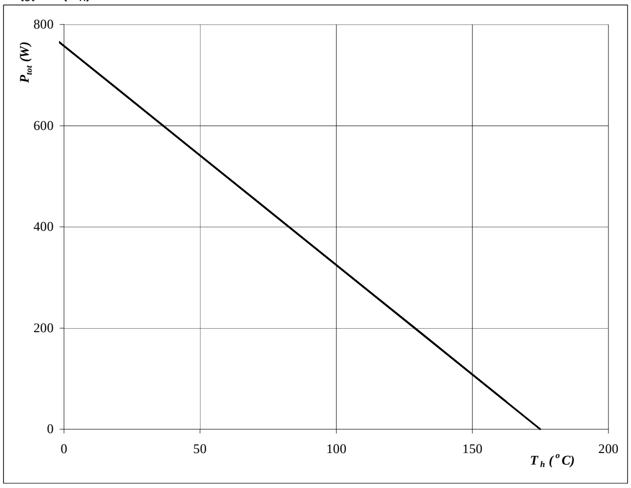
T_j = 175 ℃

V_{GE} = 15 V

Figure 23 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



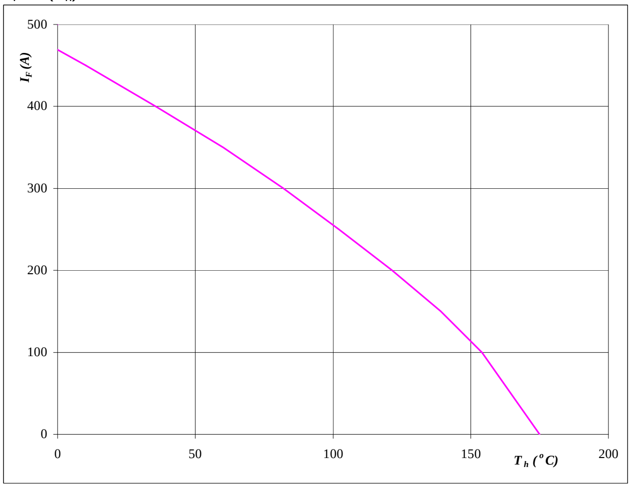
At

T_j = 175 ℃

Figure 24 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

T_j = 175 ℃

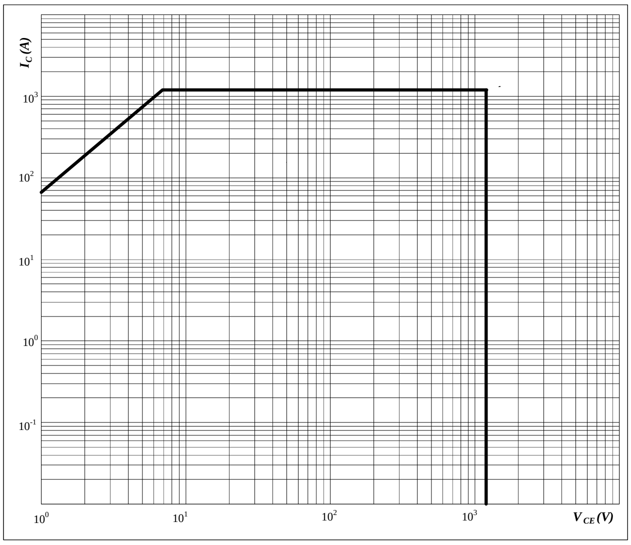
Buck

half bridge IGBT and neutral point FWD

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



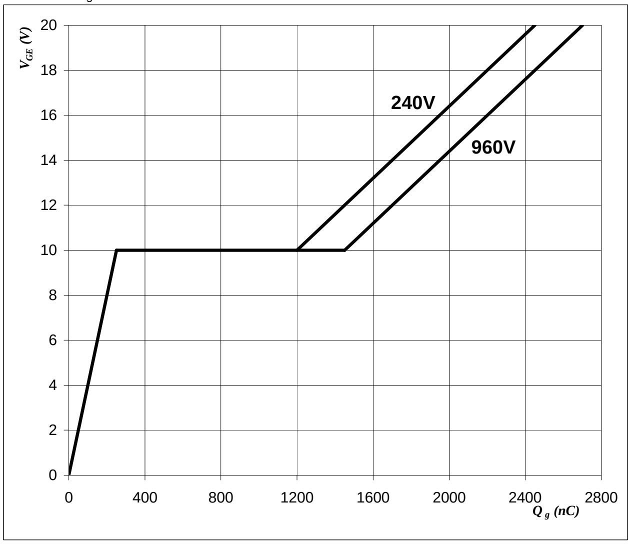
At

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

Figure 26 IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



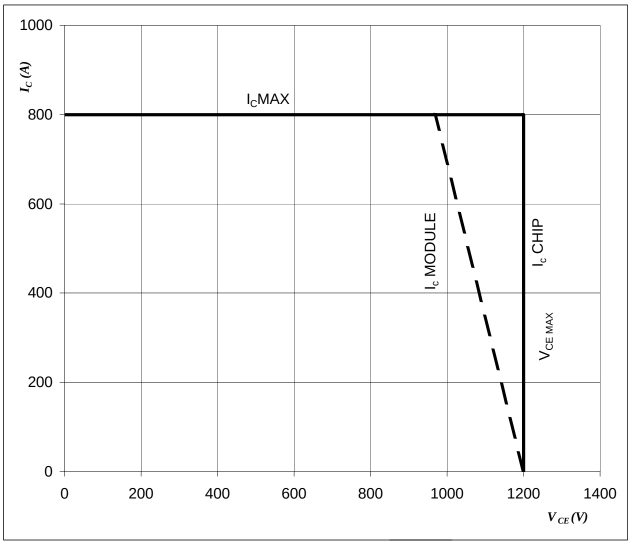
At

I_C =	400	A

Figure 27 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j =	T_{jmax}-25	ºC
$U_{ccminus}$=U_{ccplus}		
Switching mode :	3 level switching	

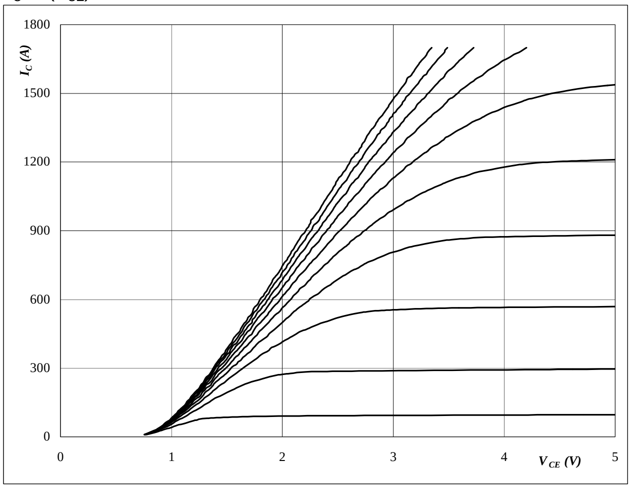
Boost

neutral point IGBT and half bridge FWD

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



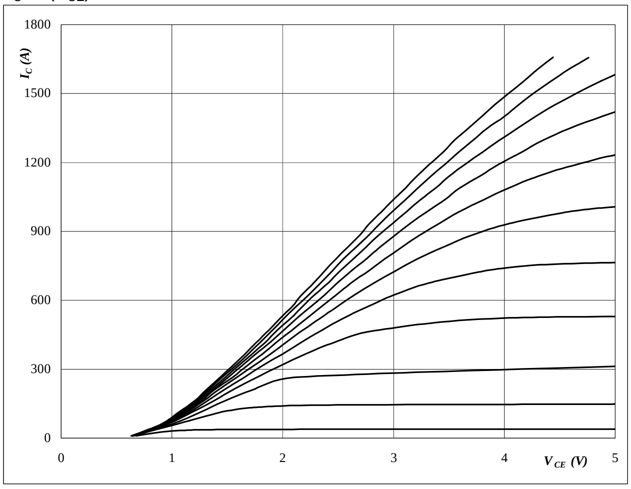
At

t_p =	350	μs
T_j =	25	℃
V_{GE} from	8 V to 17 V in steps of 1 V	

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



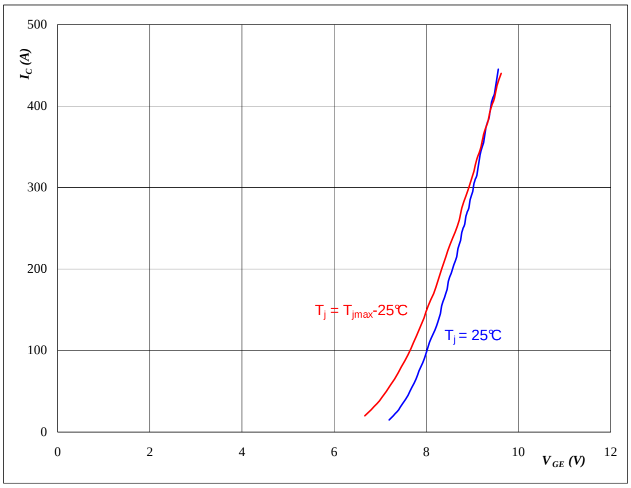
At

t_p =	350	μs
T_j =	125	℃
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

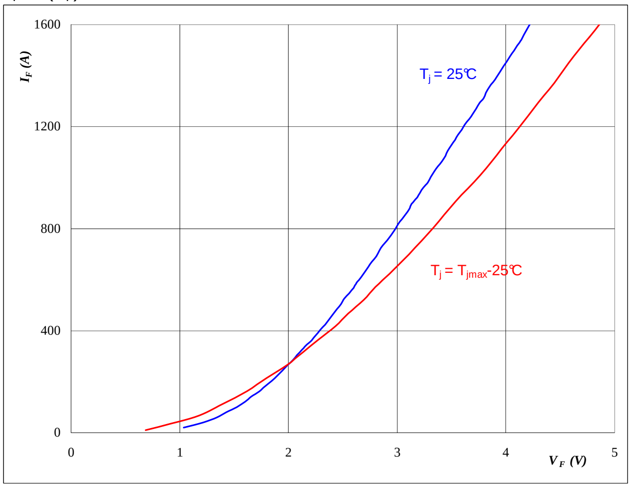
t_p =	350	μs
V_{CE} =	0	V

Figure 4 FWD

Typical FWD forward current as

a function of forward voltage

$I_F = f(V_F)$



At

t_p =	350	μs

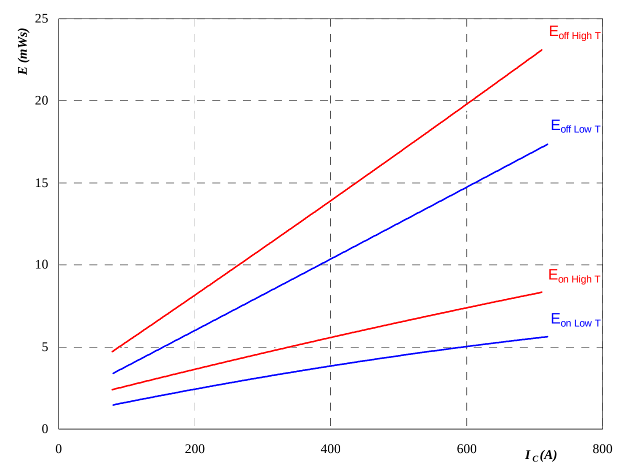
Boost

neutral point IGBT and half bridge FWD

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

E = f(I_C)



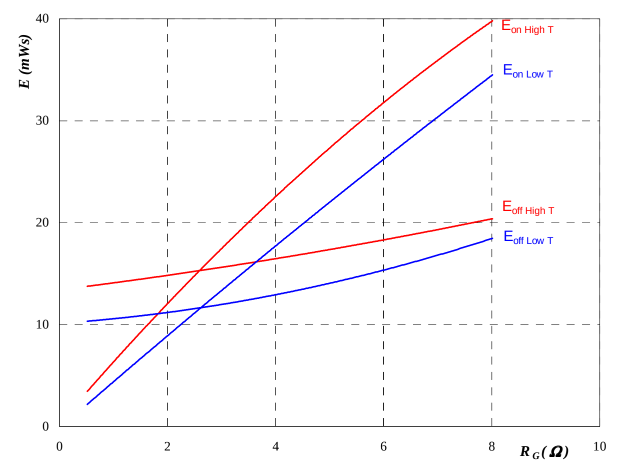
With an inductive load at

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

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor

E = f(R_G)



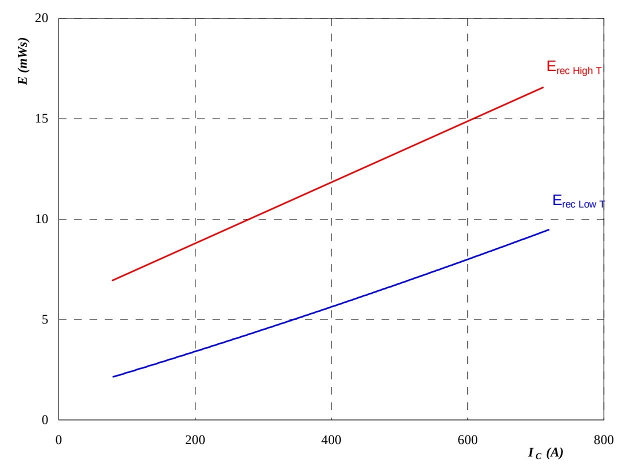
With an inductive load at

T_j =	25/125	℃
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

Figure 7 FWD

Typical reverse recovery energy loss
as a function of collector current

E_{rec} = f(I_c)



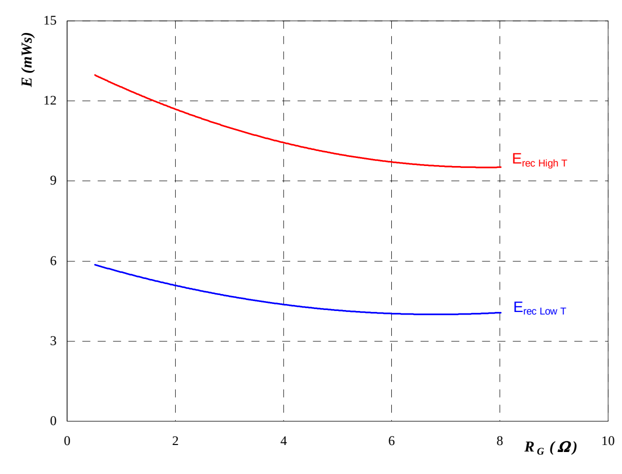
With an inductive load at

T_j =	25/125	℃
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	℃
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

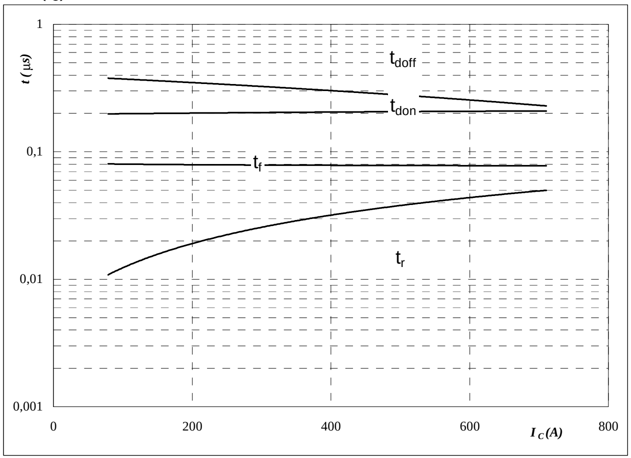
Boost

neutral point IGBT and half bridge FWD

Figure 9 IGBT

Typical switching times as a function of collector current

t = f(I_C)



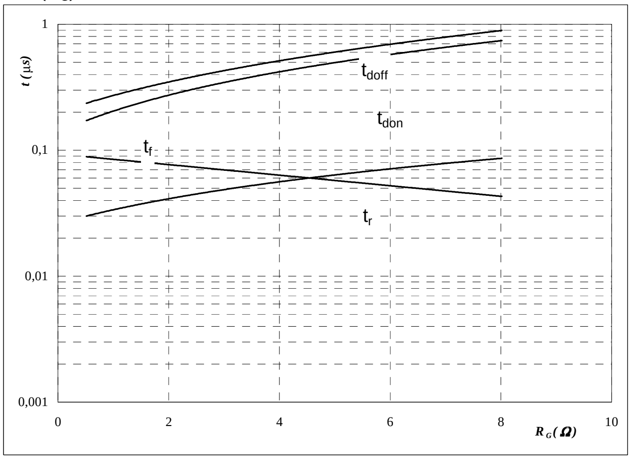
With an inductive load at

T_j =	125	℃
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)



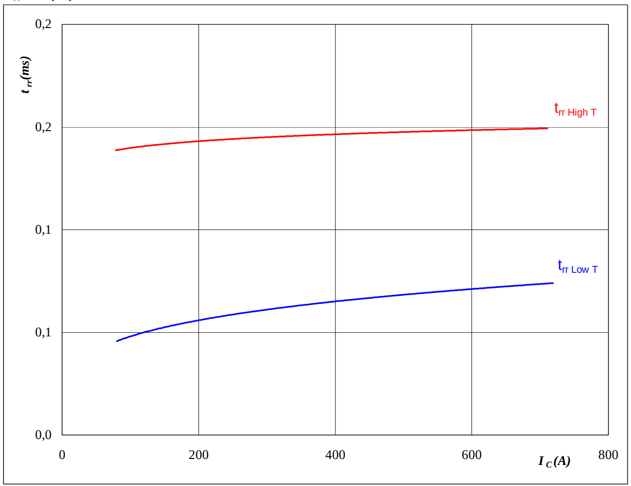
With an inductive load at

T_j =	125	℃
V_{CE} =	350	V
V_{GE} =	±15	V
I_C =	400	A

Figure 11 FWD

Typical reverse recovery time as a function of collector current

t_{rr} = f(Ic)



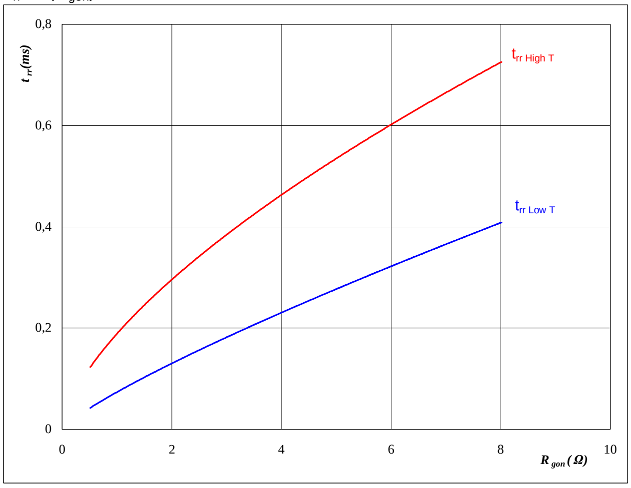
At

T_j =	25/125	℃
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	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

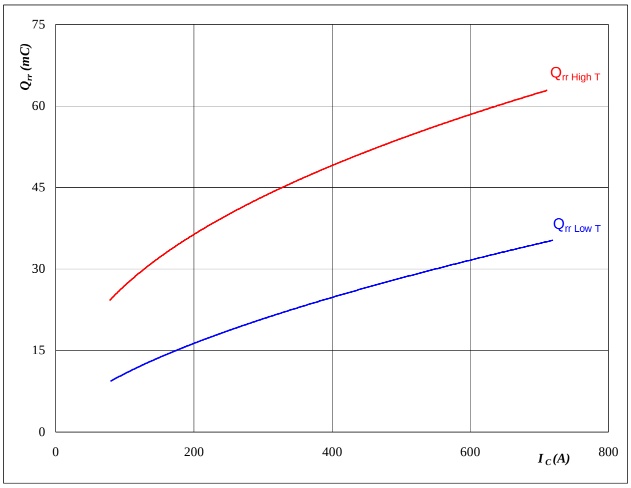
Boost

neutral point IGBT and half bridge FWD

Figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



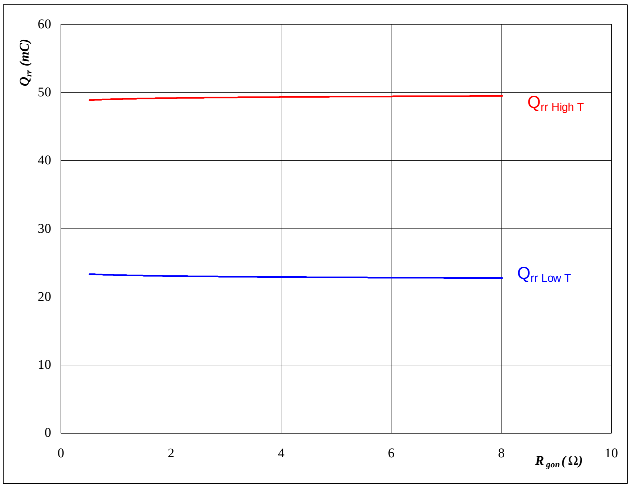
At

T_j =	25/125	℃
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

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



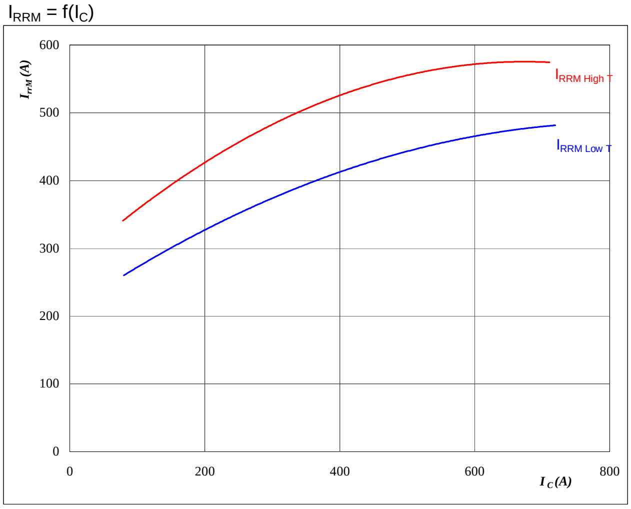
At

T_j =	25/125	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

Figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



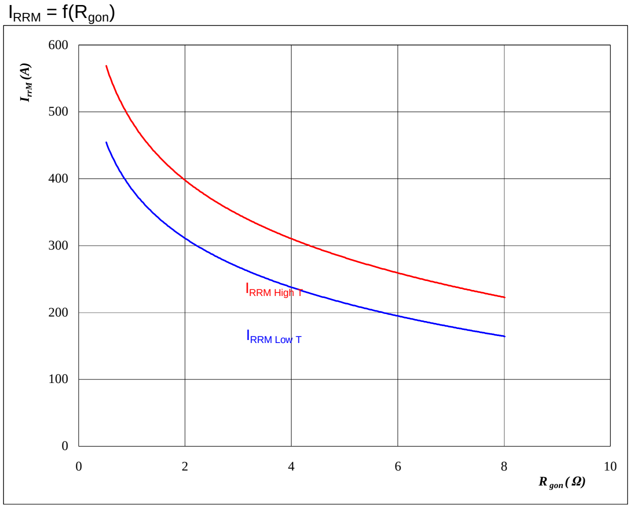
At

T_j =	25/125	℃
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	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

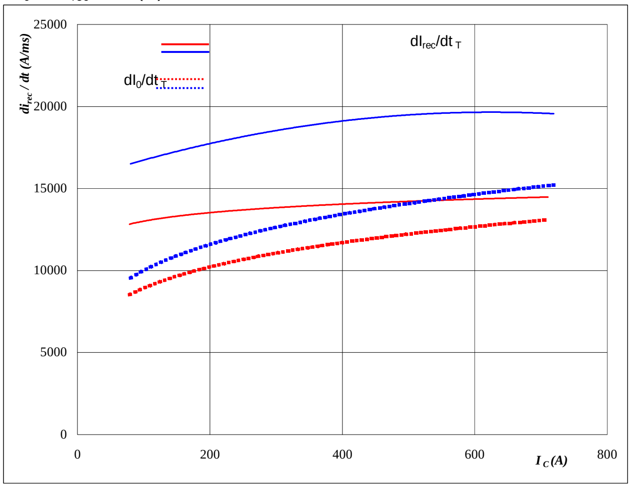
Boost

neutral point IGBT and half bridge FWD

Figure 17 FWD

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

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



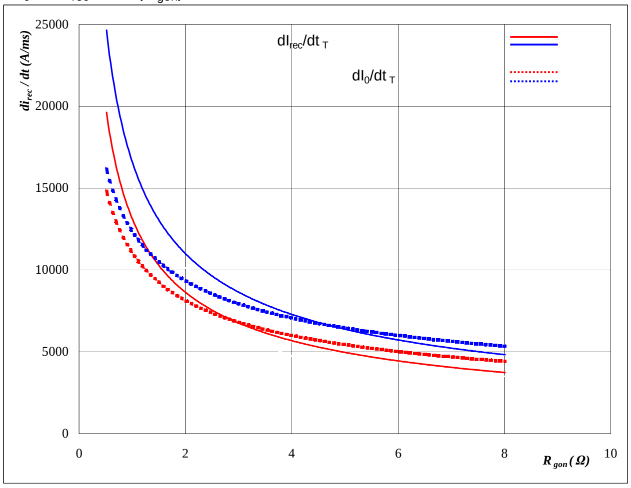
At

T_j =	25/125	℃
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

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



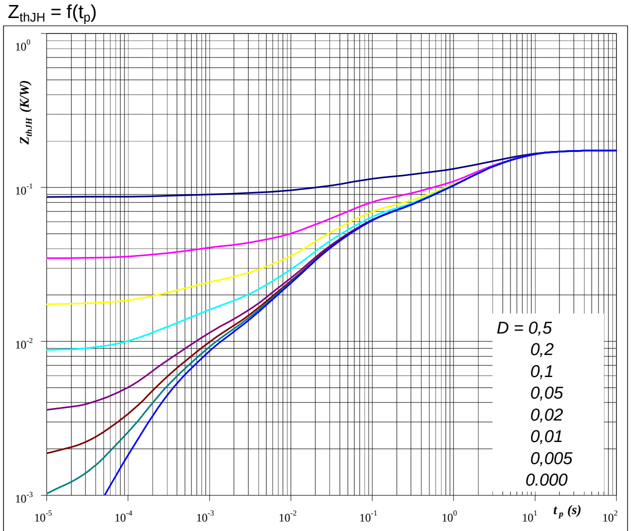
At

T_j =	25/125	℃
V_R =	350	V
I_F =	400	A
V_{GE} =	±15	V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



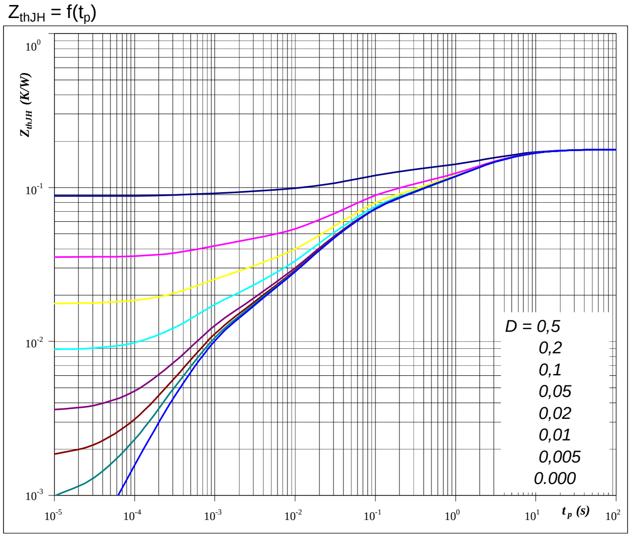
At

D =	tp / T	
R_{thJH} =	0,17	K/W

Figure 20 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	tp / T	
R_{thJH} =	0,18	K/W

IGBT thermal model values

IGBT thermal model values

R (C/W)	Tau (s)
0,03	8,9E+00
0,07	2,2E+00
0,02	3,7E-01
0,04	4,3E-02
0,01	1,1E-02
0,00	1,9E-03

FWD thermal model values

FWD thermal model values

R (C/W)	Tau (s)
0,02	9,8E+00
0,05	2,5E+00
0,03	6,5E-01
0,03	8,1E-02
0,03	2,7E-02
0,01	4,1E-03

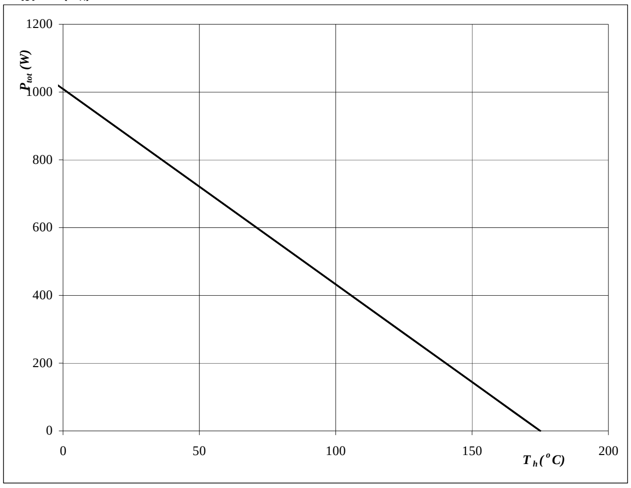
Boost

neutral point IGBT and half bridge FWD

Figure 21	IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

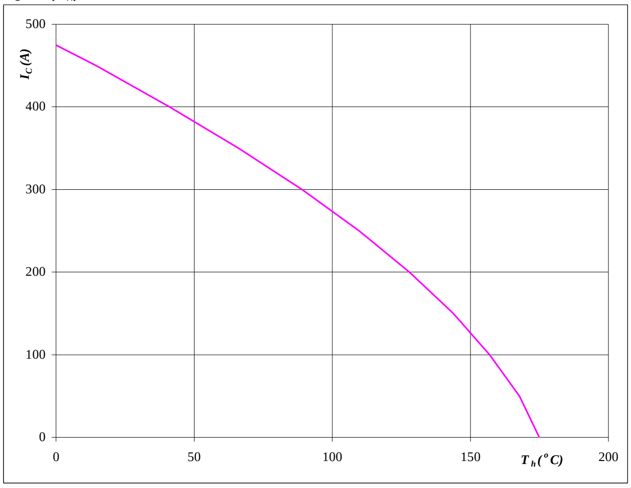


At
T_j = 175 ºC

Figure 22	IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$

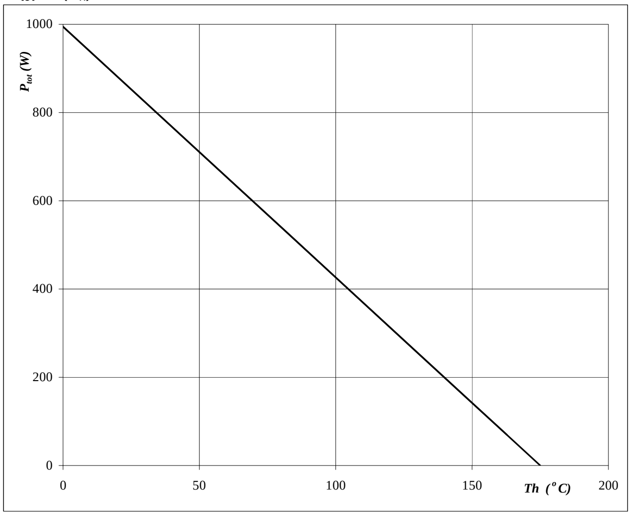


At
T_j = 175 ºC
V_{GE} = 15 V

Figure 23	FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$

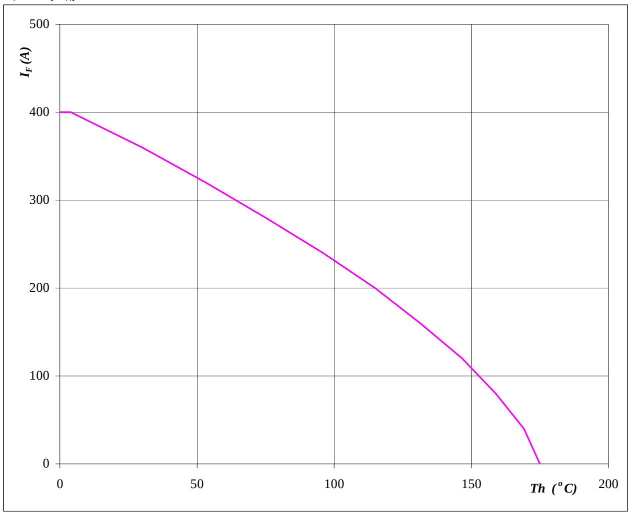


At
T_j = 175 ºC

Figure 24	FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At
T_j = 175 ºC

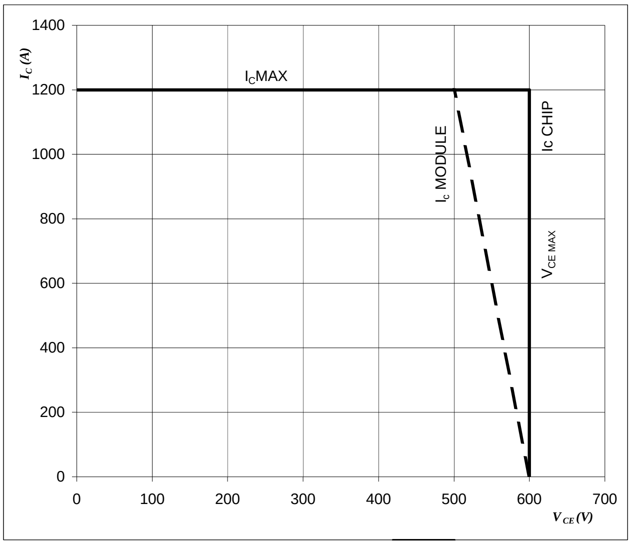
Boost

neutral point IGBT

Figure 25 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j = T_{jmax}-25 ºC

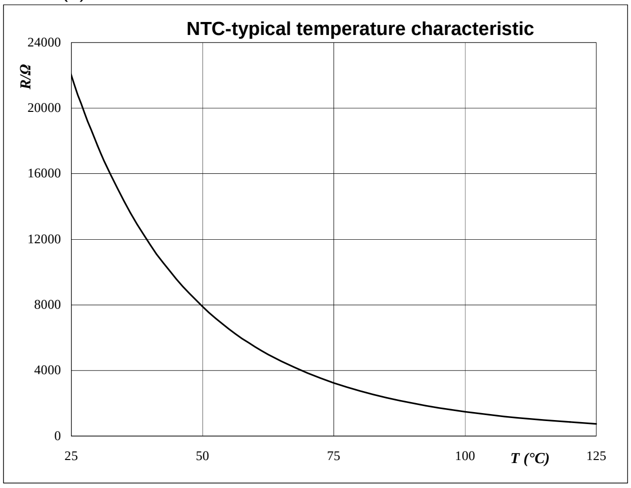
$U_{ccminus}$=U_{ccplus}

Switching mode : 3 level switching

Thermistor

Figure 1	Thermistor

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



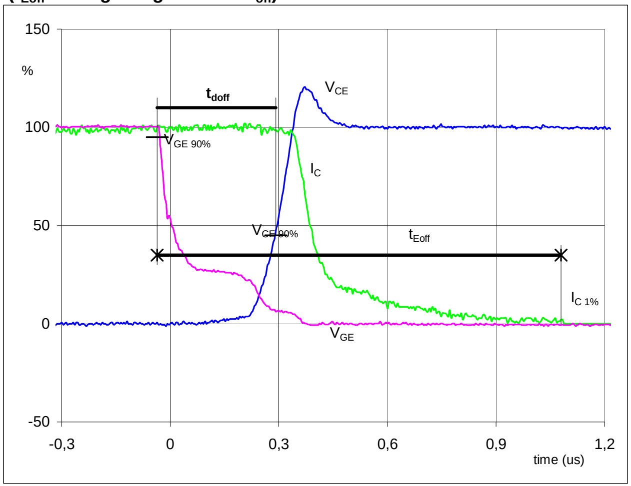
Switching Definitions half bridge IGBT

General conditions

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

Figure 1 half bridge IGBT

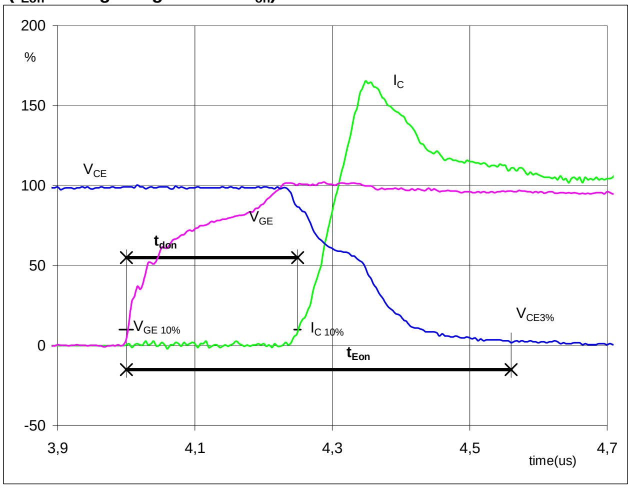
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	400	A
t_{doff} =	0,35	μs
t_{Eoff} =	1,12	μs

Figure 2 half bridge IGBT

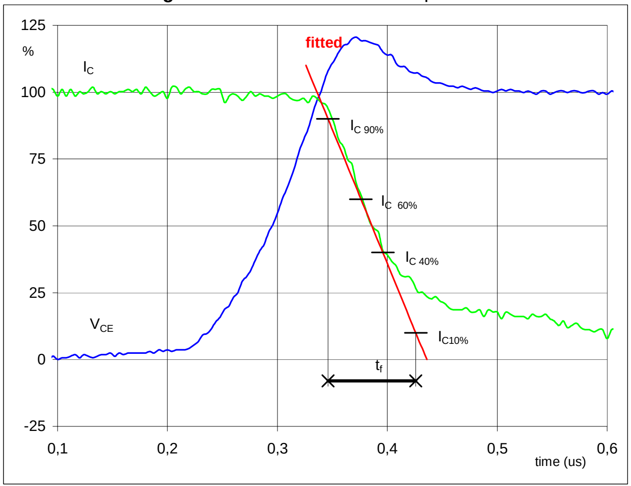
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	400	A
t_{don} =	0,25	μs
t_{Eon} =	0,56	μs

Figure 3 half bridge IGBT

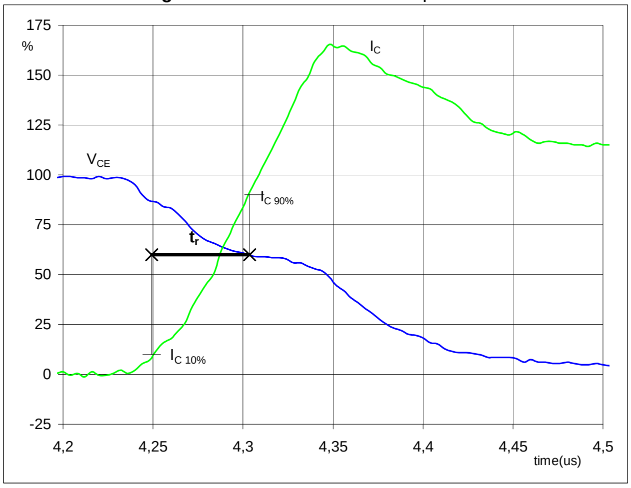
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	400	A
t_f =	0,09	μs

Figure 4 half bridge IGBT

Turn-on Switching Waveforms & definition of t_r

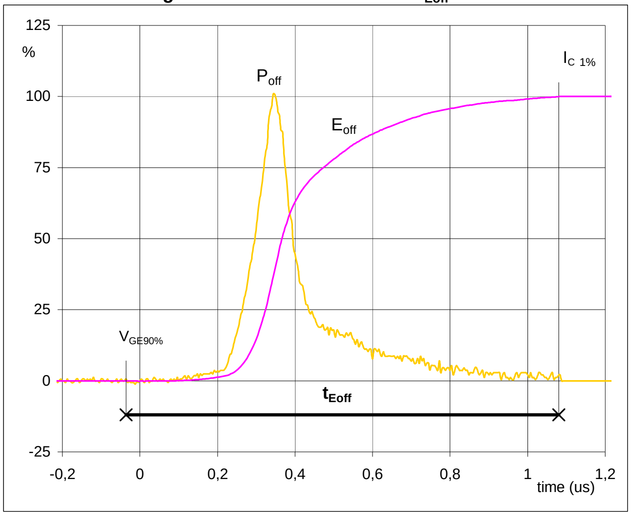


V_C (100%) =	350	V
I_C (100%) =	400	A
t_r =	0,06	μs

Switching Definitions half bridge IGBT

Figure 5 half bridge IGBT

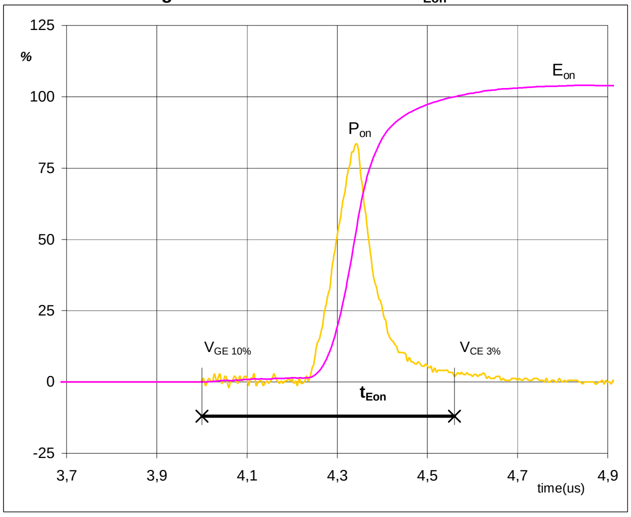
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	140,00	kW
E_{off} (100%) =	22,08	mJ
t_{Eoff} =	1,12	µs

Figure 6 half bridge IGBT

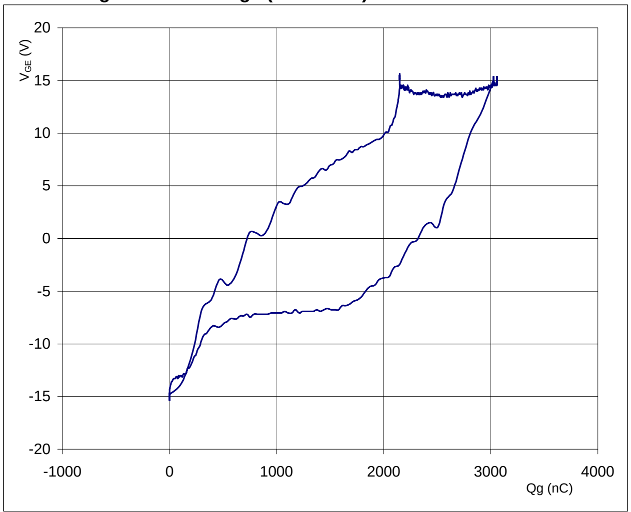
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	140,00	kW
E_{on} (100%) =	12,30	mJ
t_{Eon} =	0,56	µs

Figure 7 half bridge IGBT

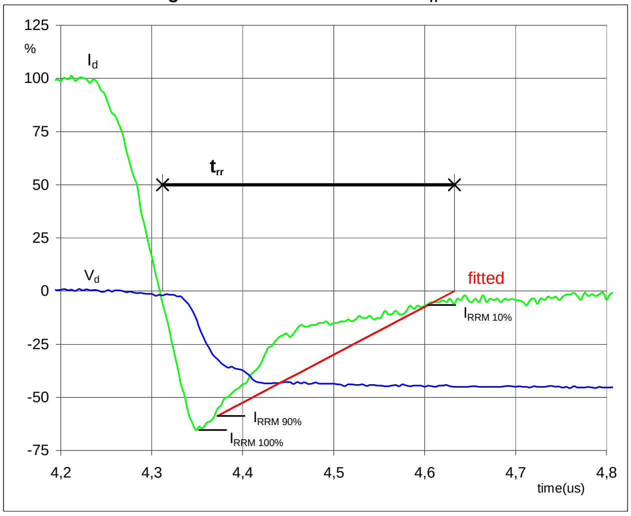
Gate voltage vs Gate charge (measured)



V_{GEoff} =	-15	V
V_{GEon} =	15	V
V_C (100%) =	350	V
I_C (100%) =	400	A
Q_g =	3059	nC

Figure 8 neutral point FWD

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

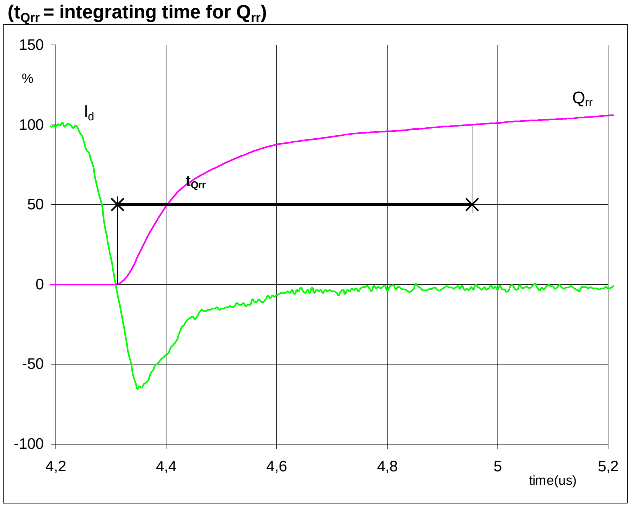


V_d (100%) =	350	V
I_d (100%) =	400	A
I_{RRM} (100%) =	-262	A
t_{rr} =	0,30	µs

Switching Definitions half bridge IGBT

Figure 9	neutral point FWD

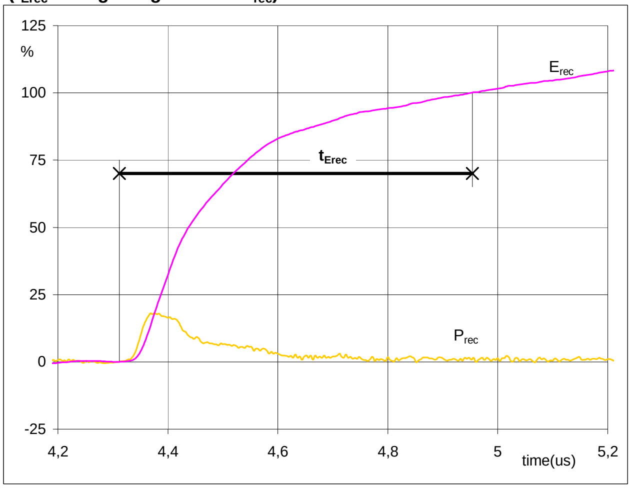
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	400	A
Q_{rr} (100%) =	33,04	µC
t_{Qrr} =	0,64	µs

Figure 10	neutral point FWD

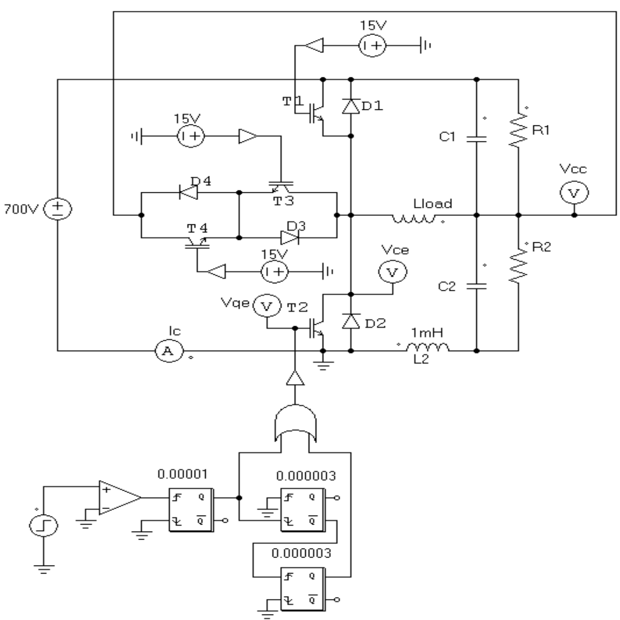
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	140,00	kW
E_{rec} (100%) =	7,44	mJ
t_{Erec} =	0,64	µs

half bridge IGBT switching measurement circuit

Figure 11

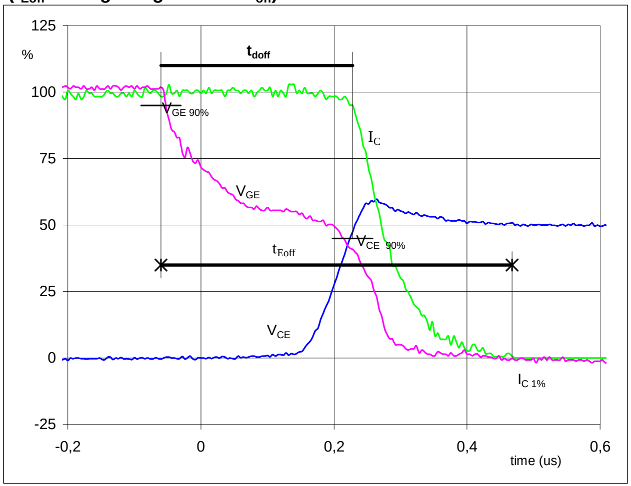


Switching Definitions neutral point IGBT

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

Figure 1 neutral point IGBT

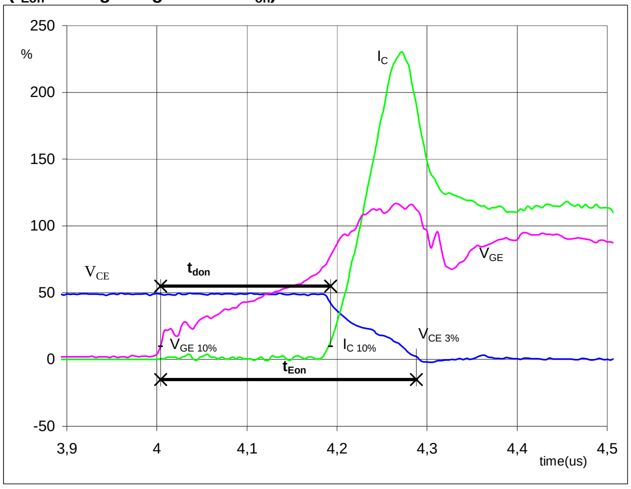
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	700	V
I_C (100%) =	400	A
t_{doff} =	0,23	μs
t_{Eoff} =	0,58	μs

Figure 2 neutral point IGBT

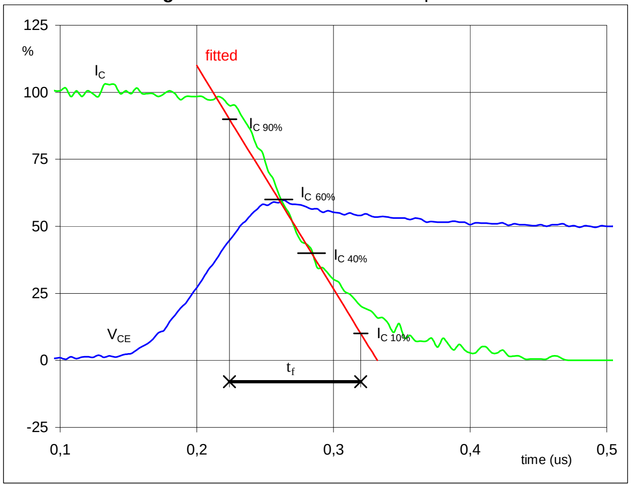
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	700	V
I_C (100%) =	400	A
t_{don} =	0,20	μs
t_{Eon} =	0,38	μs

Figure 3 neutral point IGBT

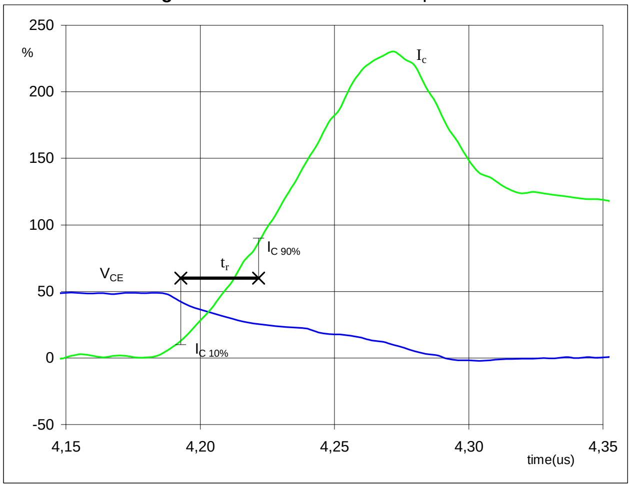
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	700	V
I_C (100%) =	400	A
t_f =	0,088	μs

Figure 4 neutral point IGBT

Turn-on Switching Waveforms & definition of t_r

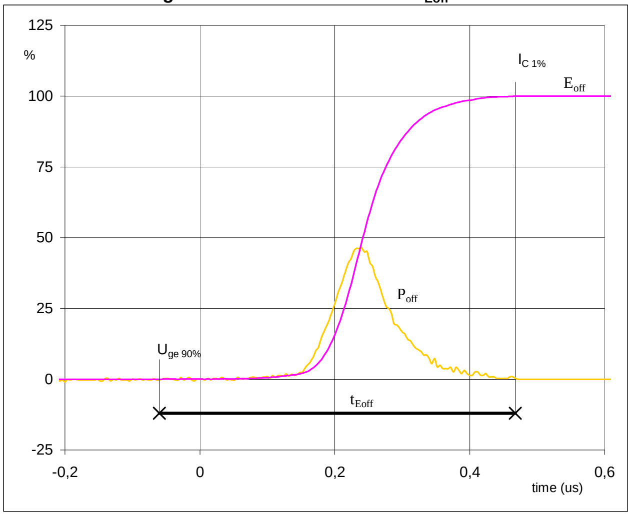


V_C (100%) =	700	V
I_C (100%) =	400	A
t_r =	0,032	μs

Switching Definitions neutral point IGBT

Figure 5 — neutral point IGBT

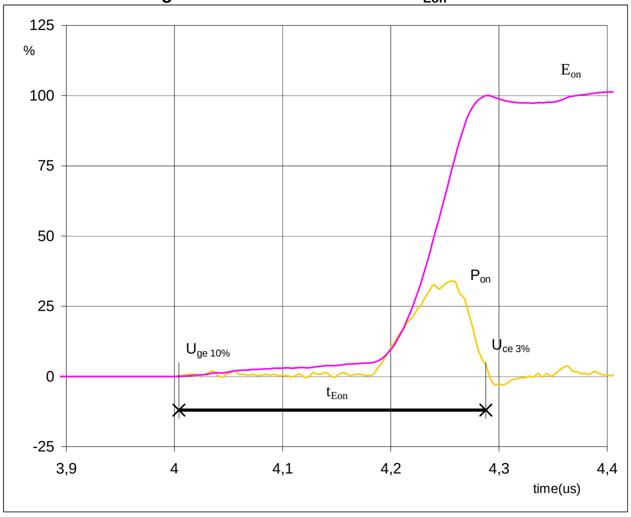
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	280,22	kW
E_{off} (100%) =	14,07	mJ
t_{Eoff} =	0,58	μs

Figure 6 — neutral point IGBT

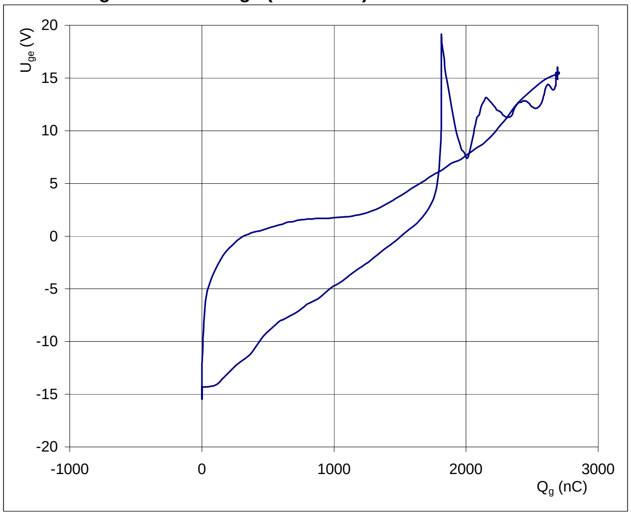
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	280,2184	kW
E_{on} (100%) =	13,39	mJ
t_{Eon} =	0,38	μs

Figure 7 — neutral point IGBT

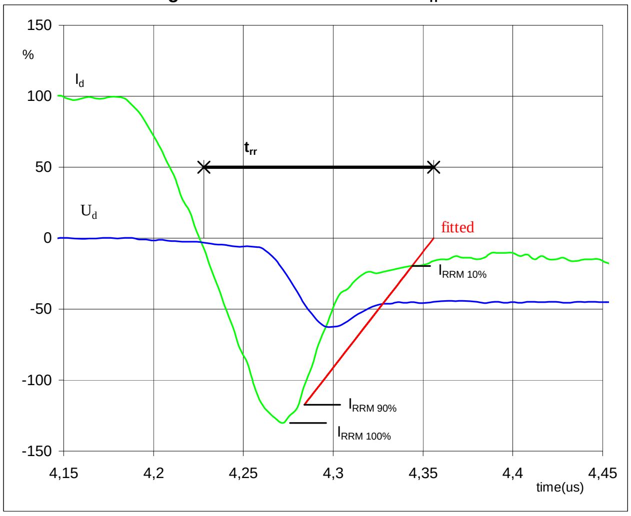
Gate voltage vs Gate charge (measured)



V_{GEoff} =	-15	V
V_{GEon} =	15	V
V_C (100%) =	700	V
I_C (100%) =	400	A
Q_g =	3442	nC

Figure 8 — half bridge FWD

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

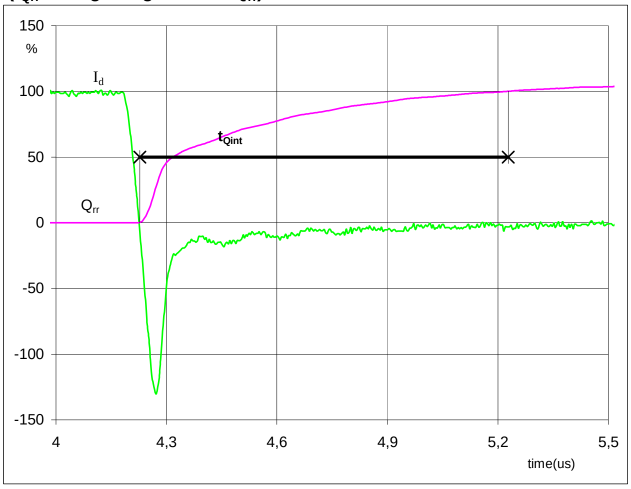


V_d (100%) =	700	V
I_d (100%) =	400	A
I_{RRM} (100%) =	-521	A
t_{rr} =	0,15	μs

Switching Definitions neutral point IGBT

Figure 9 half bridge FWD

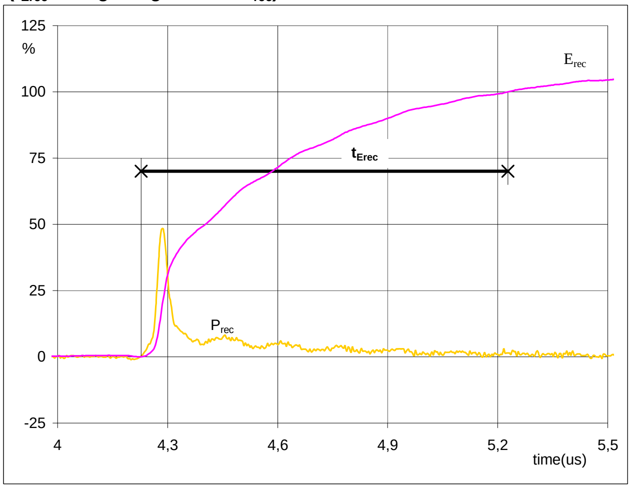
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	400	A
Q_{rr} (100%) =	49,18	µC
t_{Qint} =	0,33	µs

Figure 10 half bridge FWD

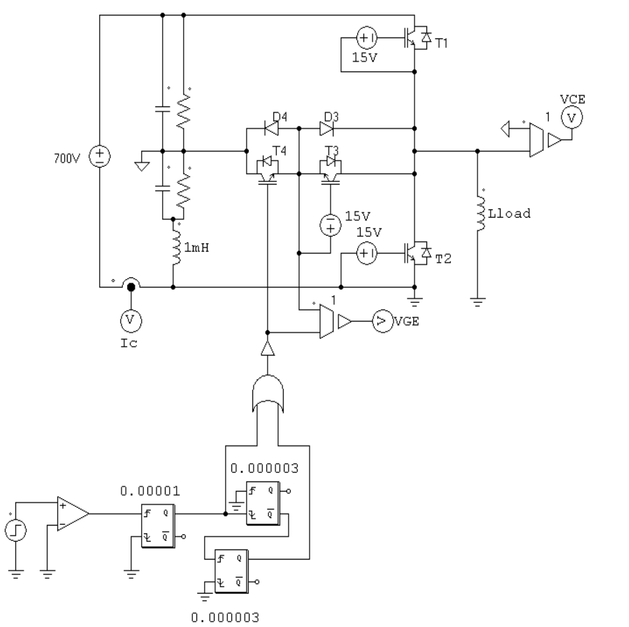
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	280,22	kW
E_{rec} (100%) =	12,71	mJ
t_{Erec} =	0,33	µs

neutral point IGBT switching measurement circuit

Figure 11



Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

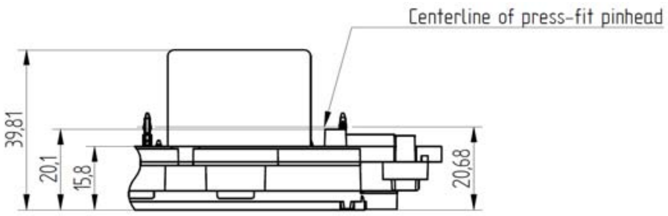
Version	Ordering Code	in DataMatrix as	in packaging barcode as
Standard	70-W212NMA400SC-M209P	M209P	M209P

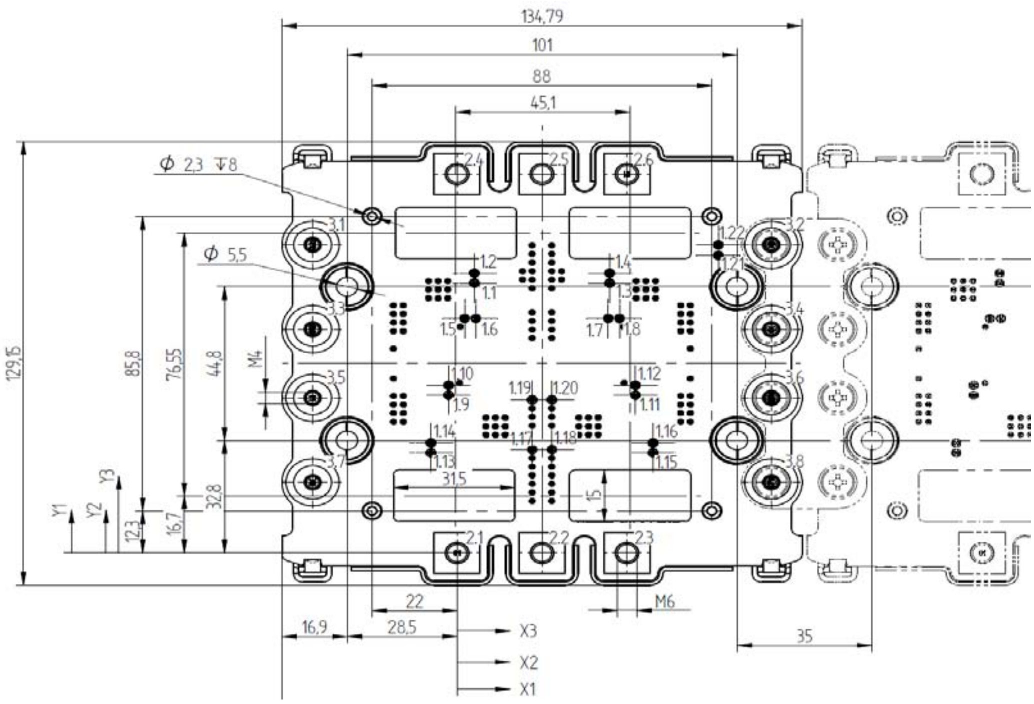
Outline

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	

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-

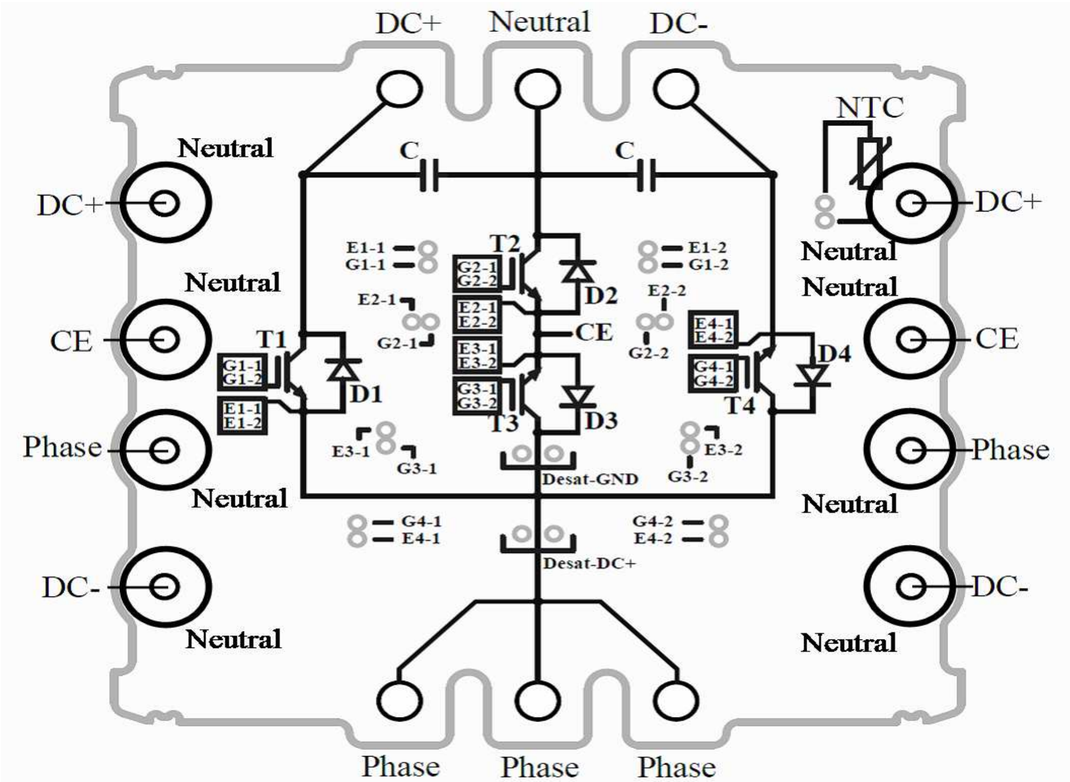
Low current connections			
M4 screw	X3	Y3	Function
3.1	-37,4	89,8	DC+
3.2	81,4	89,8	DC+
3.3	-37,4	65,2	CE
3.4	81,4	65,2	CE
3.5	-37,4	45,2	Phase
3.6	81,4	45,2	Phase
3.7	-37,4	20,6	DC-
3.8	81,4	20,6	DC-





Ordering Code and Marking - Outline - Pinout

Pinout



<u>**NOTE: Driver pins for parallel devices are not connected inside the module!**</u>
Gx-1 to Gx-2 and Ex-1 to Ex2 shall be connected on customer PCB!
Where x = 1 to 4

DISCLAIMER

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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.