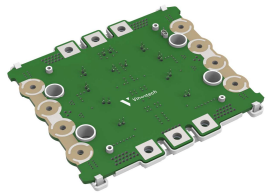
VINcoNPC X4 — 1500 V / 400 A

Features

- 1500 V NPC-topology
- High power screw interface
- Low inductive interface for external DC-capacitors and paralleling on component level
- Snubber diode for optional asymmetrical inductance
- High speed buck IGBT´s
- Temperature sensor

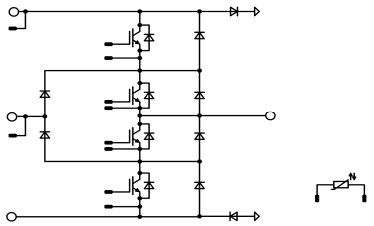
VINco X4 housing



Target Applications

- UPS
- Solar Inverters

Schematic



Types

- 70-W224NIA400SH-M400P

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Buck Switch					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	326	A
Pulsed collector current	I_{CRM}	t_p limited by T_{jmax}		1200	A
Turn off safe operating area		V_{CE} ≤ 1200 V, $T_j \leq T_{op\ max}$		800	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	881	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		10 800	μs V
Maximum Junction Temperature	T_{jmax}			175	°C
Buck Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	270	A
Repetitive peak forward current	I_{FRM}	t_p = 10 ms, sin 180°		800	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	565	W
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Boost Switch					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C	348	A
Pulsed collector current	I_{CRM}	t_p limited by T_{jmax}		1200	A
Turn off safe operating area		V_{CE} ≤ 1200 V, $T_j \leq T_{op\ max}$		800	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	826	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150 °C V_{GE} = 15 V		10 800	μs V
Maximum Junction Temperature	T_{jmax}			175	°C
Boost Inverse Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	242	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		600	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	423	W
Maximum Junction Temperature	T_{jmax}			175	°C
Boost Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			1200	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °C	257	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		600	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	452	W
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Snubber Diode					
Repetitive peak reverse voltage	V_{RRM}			1200	V
Forward average current	I_{FAV}	$T_j = T_{jmax}$	T_s = 80 °C	90	A
Surge forward current	I_{FSM}	t_p = 10 ms, sin 180°	T_j = 150 °C	540	A
I^2t-value	I^2t			730	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C	162	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
Insulation Properties					
Insulation voltage	V_{isol}	DC Test Volage*	t_p = 2 s	4000	V
		AC Voltage	t_p = 1 min	2500	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm
Comparative Tracking Index	CTI			>200	

*100 % tested in production

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	
Buck Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0136	25	5,2	5,8	6,4	V
Collector-emitter saturation voltage	V_{CEsat}		15		400	25 125	1,7	2,14 2,44		V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		25			0,048	mA
Gate-emitter leakage current	I_{GES}		20	0		25			960	nA
Integrated Gate resistor	R_{gint}							0,5		Ω
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 1\ \Omega$ $R_{gon} = 1\ \Omega$	±15	600	398	25 125		171 172		ns
Rise time	t_r					25 125		24 29		
Turn-off delay time	$t_{d(off)}$					25 125		238 290		
Fall time	t_f					25 125		21 38		
Turn-on energy loss per pulse	E_{on}					25 125		9,03 14,33		mWs
Turn-off energy loss per pulse	E_{off}					25 125		13,20 21,33		
Input capacitance	C_{ies}	$f = 1$ MHz	0	25		25		22160		pF
Output capacitance	C_{oss}							1520		
Reverse transfer capacitance	C_{rss}							1280		
Gate charge	Q_G		15	960	400	25		3040		nC
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,105		K/W
Buck Diode										
Diode forward voltage	V_F				400	25 125		2,34 2,38		V
Reverse leakage current	I_R			1200		25			480	µA
Peak reverse recovery current	I_{RRM}	R_{gon}=1 Ω	±15	600	398	25 125		506 624		A
Reverse recovery time	t_{rr}					25 125		86 117		ns
Reverse recovered charge	Q_{rr}					25 125		34,86 57,89		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		14614 15212		A/µs
Reverse recovered energy	E_{rec}					25 125		15,14 26,14		mWs
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,163		K/W

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	
Boost Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0152	25	5	5,80	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		400	25 125		1,91 2,14		V
Collector-emitter cut-off incl diode	I_{CES}		0	1200		25 125			0,052	mA
Gate-emitter leakage current	I_{GES}		20	0		25			2400	nA
Integrated Gate resistor	R_{gint}							1,875		Ω
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 1\ \Omega$ $R_{gon} = 1\ \Omega$	±15	600	398	25 125		233 242		ns
Rise time	t_r					25 125		44 49		
Turn-off delay time	$t_{d(off)}$					25 125		334 405		
Fall time	t_f					25 125		43 99		
Turn-on energy loss per pulse	E_{on}					25 125		15,2 21,5		mWs
Turn-off energy loss per pulse	E_{off}					25 125		24,2 37,6		
Input capacitance	C_{ies}	$f = 1$ MHz	0	25	398	25		24600		pF
Output capacitance	C_{oss}							1620		
Reverse transfer capacitance	C_{rss}							1380		
Gate charge	Q_G		±15	960	400	25		3200		nC
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,112		K/W
Boost Inverse Diode										
Diode forward voltage	V_F				300	25 125	1,35	1,90 1,84		V
Reverse leakage current	I_r			1200		25			56	μA
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,204		K/W
Boost Diode										
Diode forward voltage	V_F				300	25 125	1,35	1,90 1,84		V
Reverse leakage current	I_r			1200		25			56	μA
Peak reverse recovery current	I_{RRM}	$R_{gon} = 1\ \Omega$	±15	600	398	25 125		368 403		A
Reverse recovery time	t_{rr}					25 125		251 341		ns
Reverse recovered charge	Q_{rr}					25 125		34 59		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		3292 3343		A/μs
Reverse recovery energy	E_{rec}					125 125		13,60 24,53		mWs
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,204		K/W

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	
Snubber Diode										
Forward voltage	V_F				100	25 125		1,91 1,85		V
Reverse current	I_r			1200		25			0,12	mA
Thermal resistance chip to heatsink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						0,588		K/W
Thermistor										
Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1484 Ω				100	-5		+5	%
Power dissipation	P					25		5		mW
Power dissipation constant						25		1,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1%				25		3962		K
B-value	$B_{(25/100)}$	Tol. ±1%				25		4000		K
Vincotech NTC Reference									I	
Module Properties										
Module inductance (from chips to PCB)	$L_{sCE\ C\text{-}PCB}$	Buck						15		nH
		Boost						28		
Module inductance (from PCB to PCB using Intercon board)	$L_{sCE\ PCB\text{-}PCB}$							5		nH
Resistance of Intercon boards (from PCB to PCB using Intercon board)	$R_{cc'+EE'}$							1,5		mΩ
Weight	G								580	g

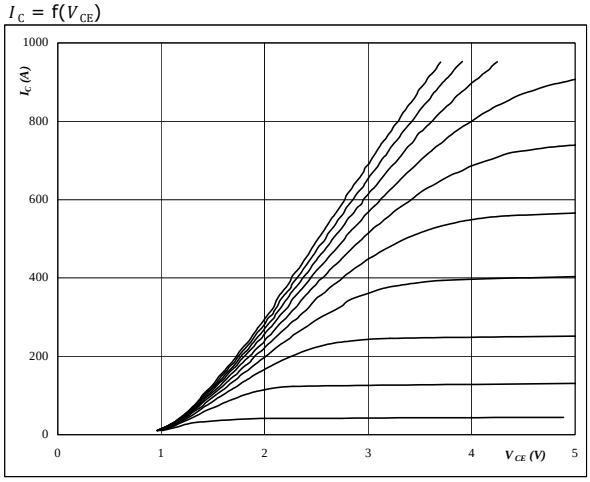
Buck

Buck IGBT and Buck FWD

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



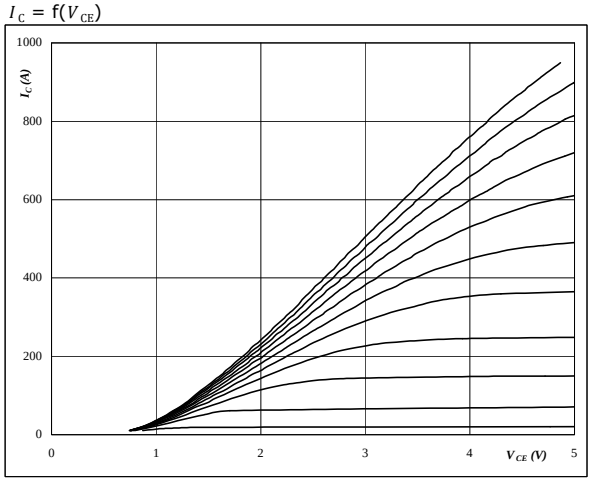
At

t_p =	350	µs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



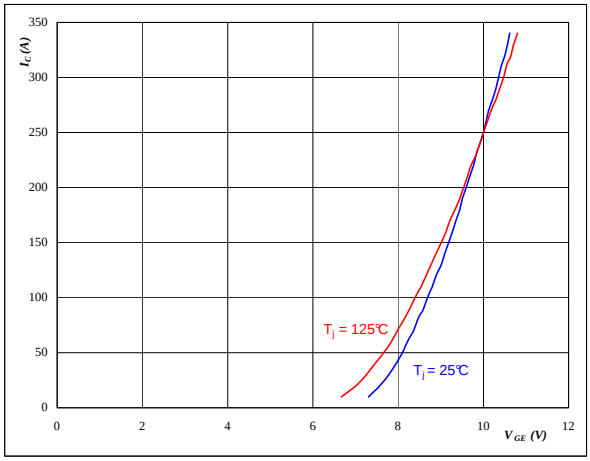
At

t_p =	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

$I_C = f(V_{GE})$



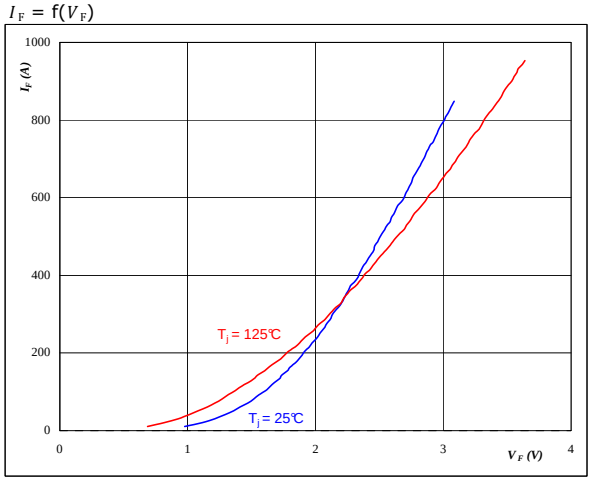
At

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

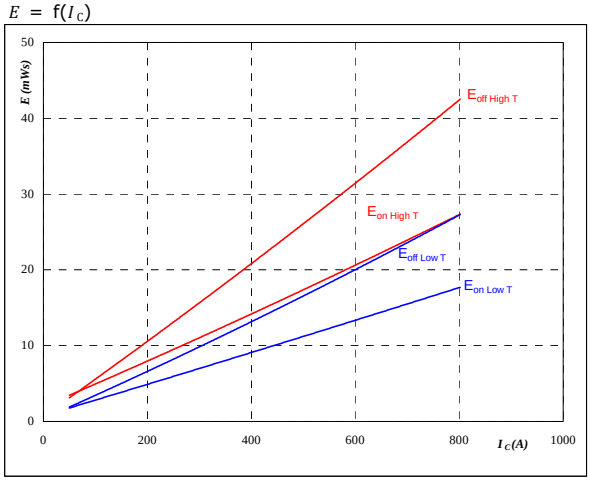
Buck

Buck IGBT and Buck FWD

figure 5. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



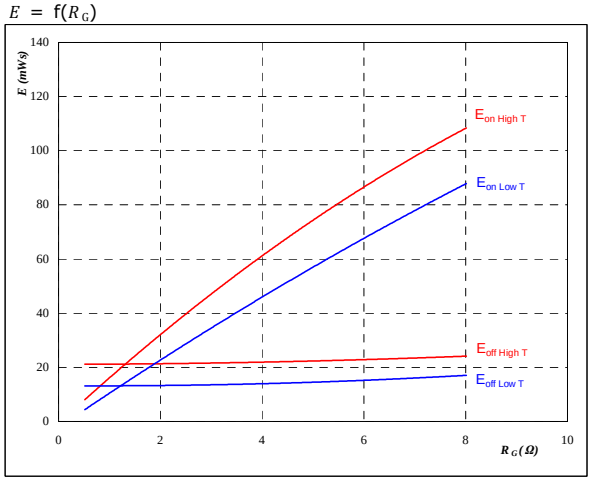
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1	J
R_{goff} =	1	J

figure 6. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



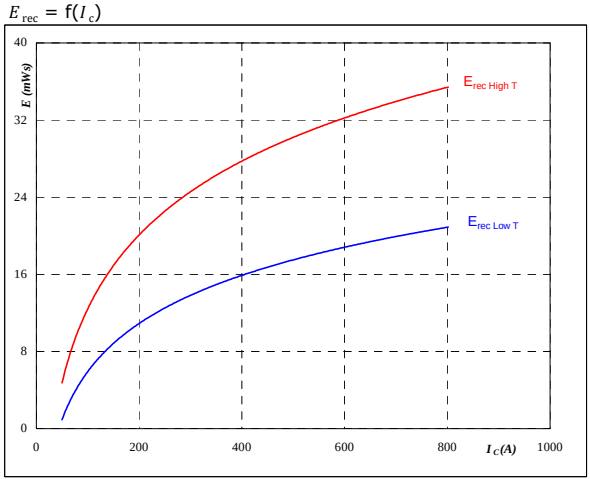
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	398	A

figure 7. **FWD**

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_c)$



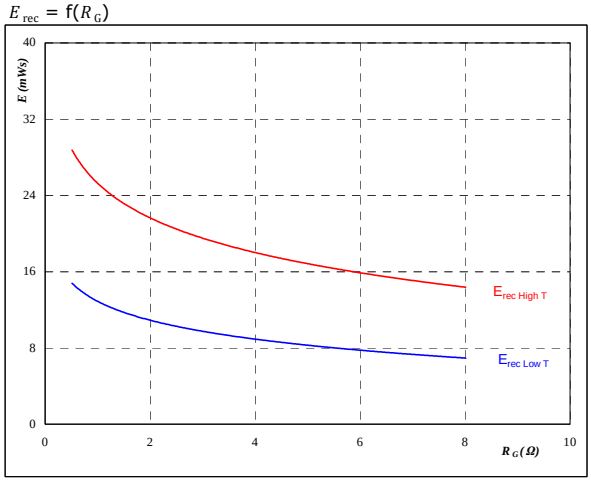
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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} =	600	V
V_{GE} =	±15	V
I_C =	398	A

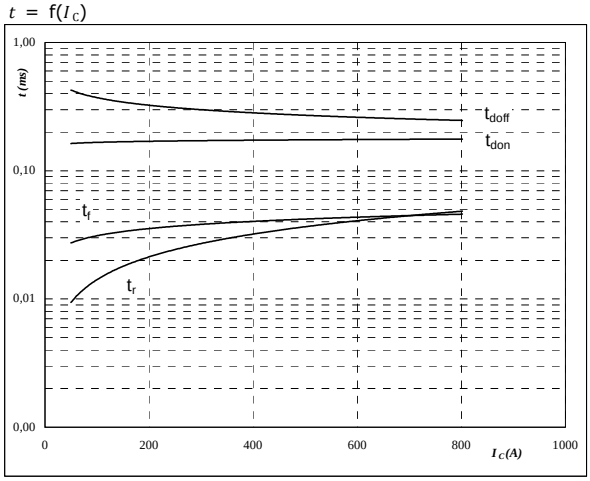
Buck

Buck IGBT and Buck FWD

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



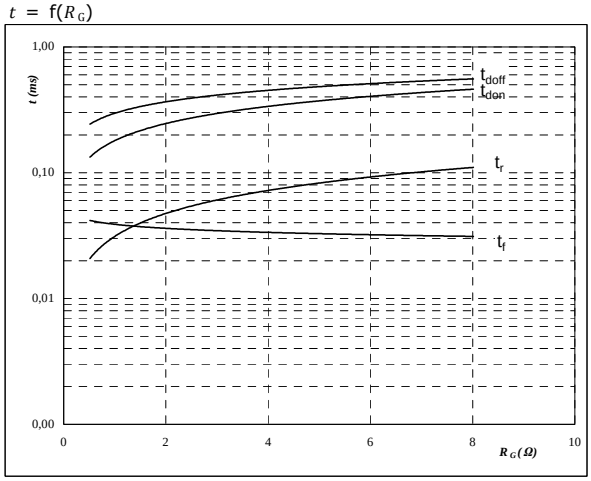
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1	J
R_{goff} =	1	J

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



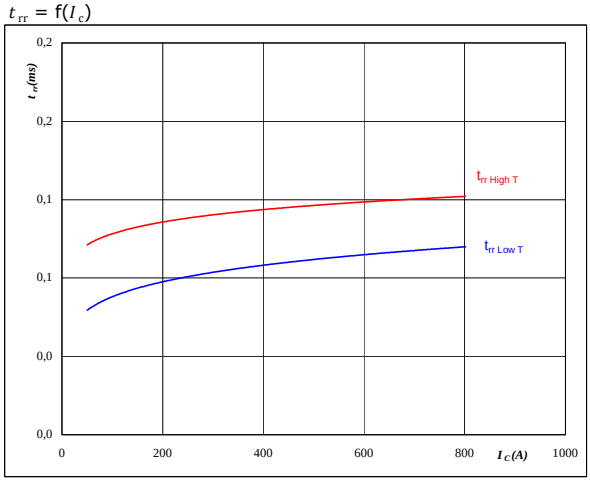
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	398	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$



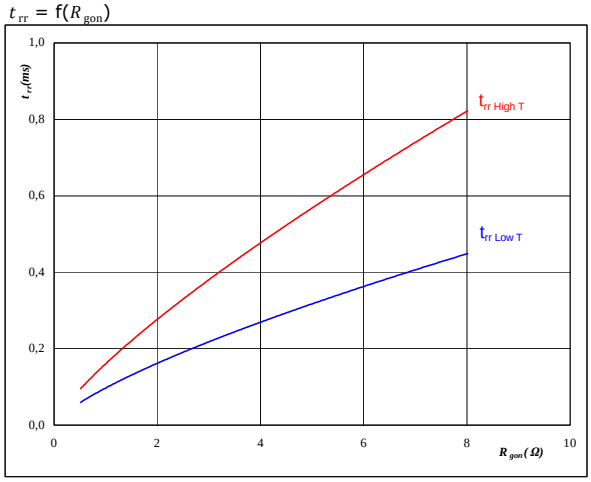
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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 =	600	V
I_F =	398	A
V_{GE} =	±15	V

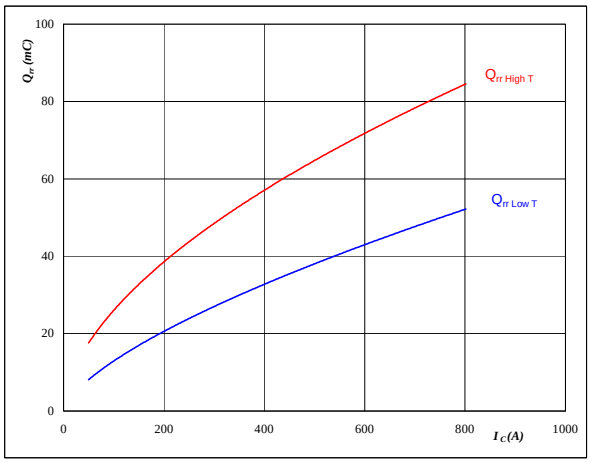
Buck

Buck IGBT and Buck FWD

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



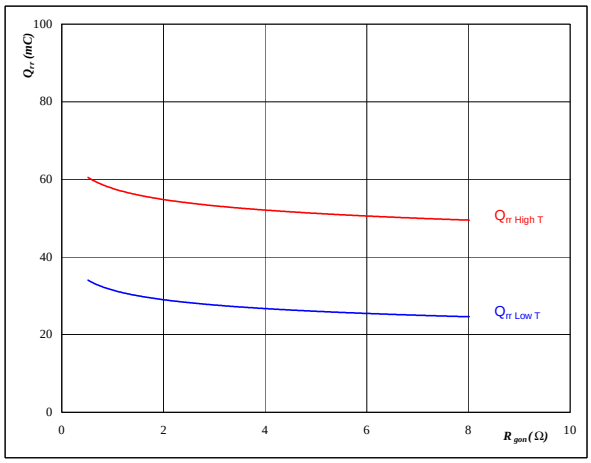
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

figure 14. **FWD**

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

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



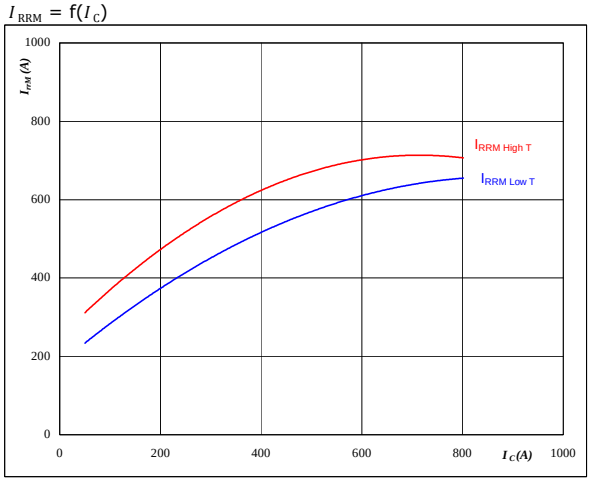
At

T_j =	25/125	°C
V_R =	600	V
I_F =	398	A
V_{GE} =	±15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



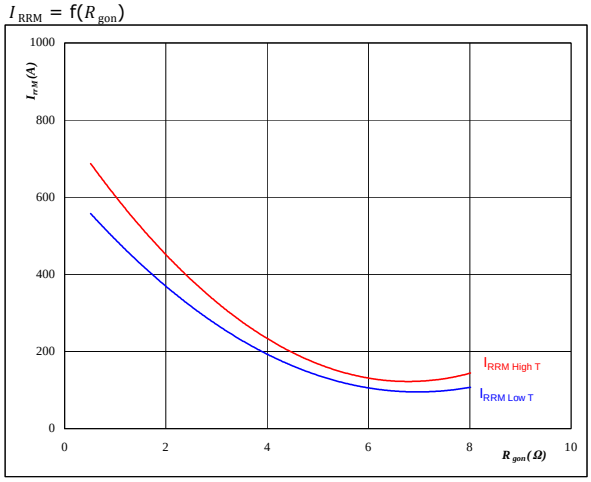
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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	°C
V_R =	600	V
I_F =	398	A
V_{GE} =	±15	V

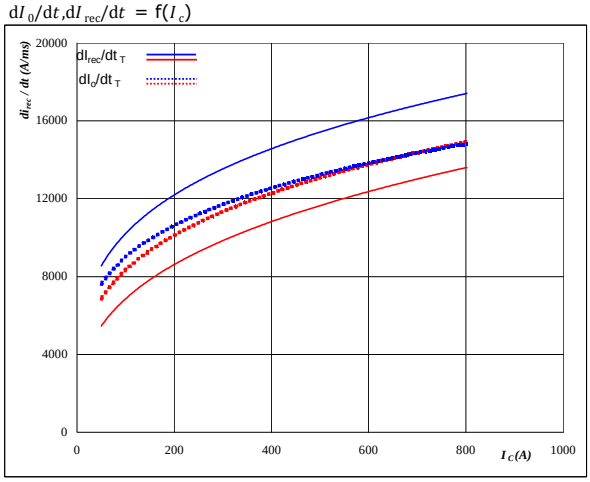
Buck

Buck IGBT and Buck FWD

figure 17. **FWD**

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

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



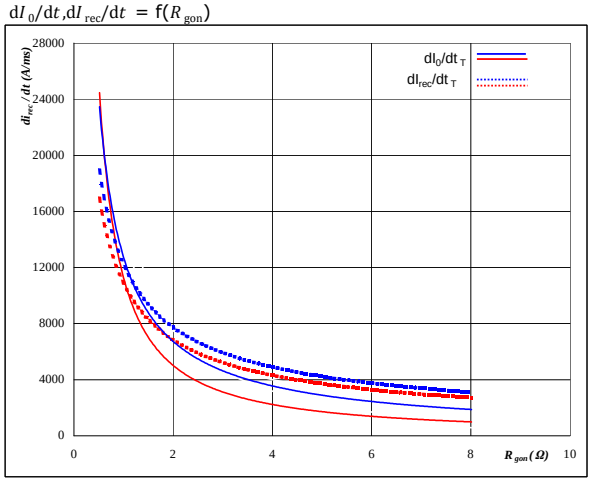
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

figure 18. **FWD**

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

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



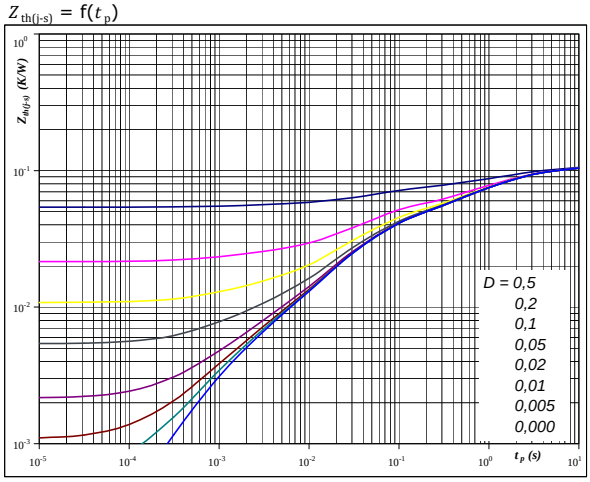
At

T_j =	25/125	°C
V_R =	600	V
I_F =	398	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	
$R_{th(j-s)}$ =	0,105	K/W

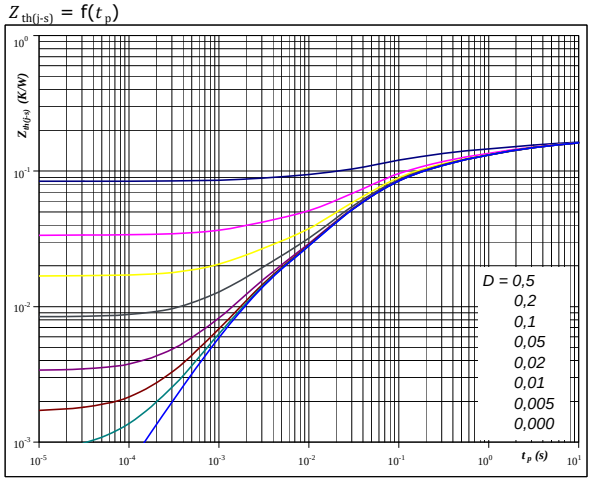
IGBT thermal model values

With phase change material	
R (K/W)	Tau (s)
1,04E-02	5,24E+00
3,34E-02	1,19E+00
2,40E-02	2,95E-01
2,73E-02	3,03E-02
6,18E-03	7,56E-03
3,33E-03	7,59E-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	
$R_{th(j-s)}$ =	0,163	K/W

FWD thermal model values

With phase change material	
R (K/W)	Tau (s)
1,77E-02	7,43E+00
3,03E-02	1,59E+00
3,09E-02	2,90E-01
4,17E-02	6,32E-02
3,22E-02	2,05E-02
1,01E-02	1,83E-03

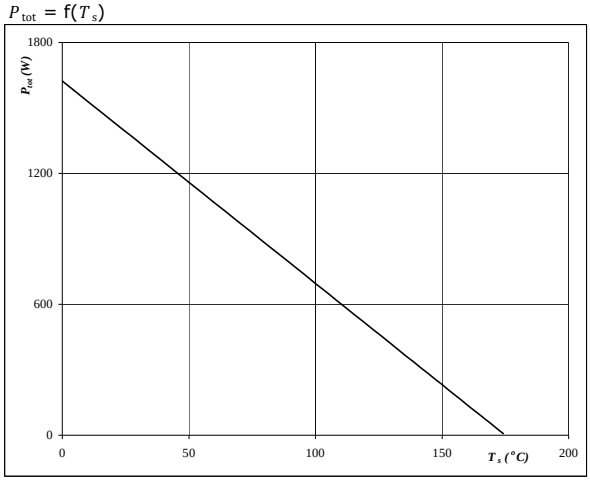
Buck

Buck IGBT and Buck FWD

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



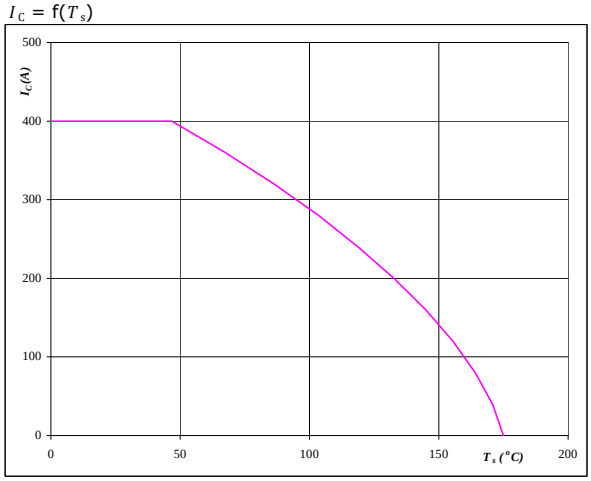
At

T_j = 175 °C

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

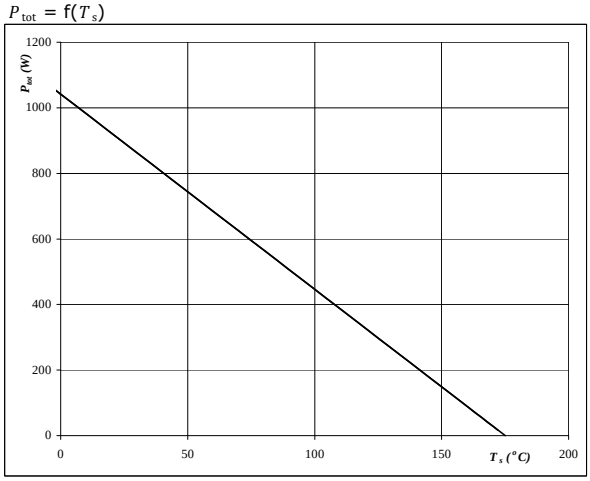
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



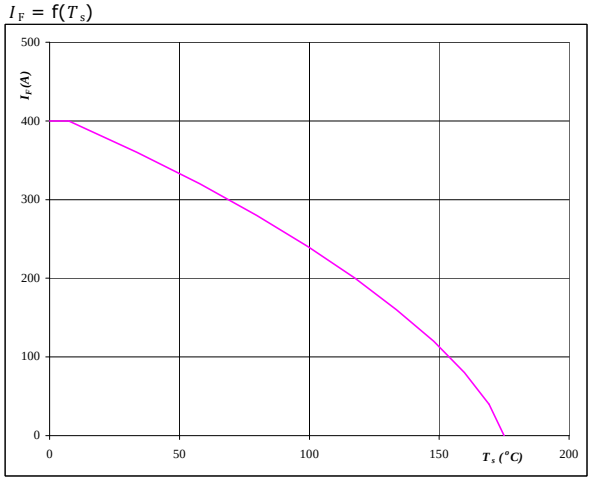
At

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

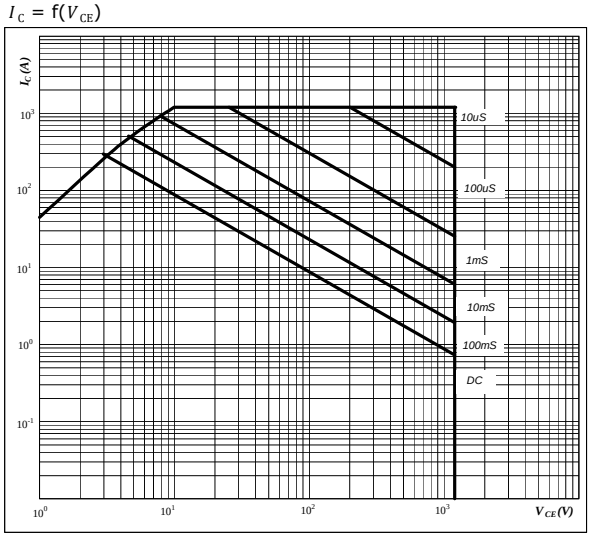
Buck

Buck IGBT and Buck FWD

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



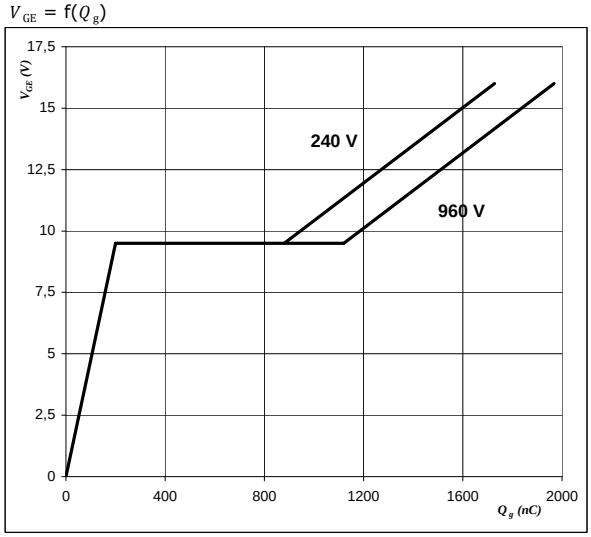
At

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

figure 26. **IGBT**

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



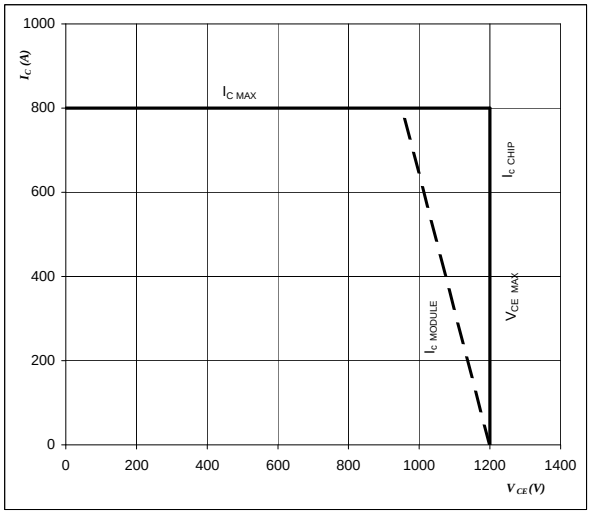
At

I_C = 400 A

figure 27. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

$U_{ccminus} = U_{ccplus}$

Switching mode : 3 level switching

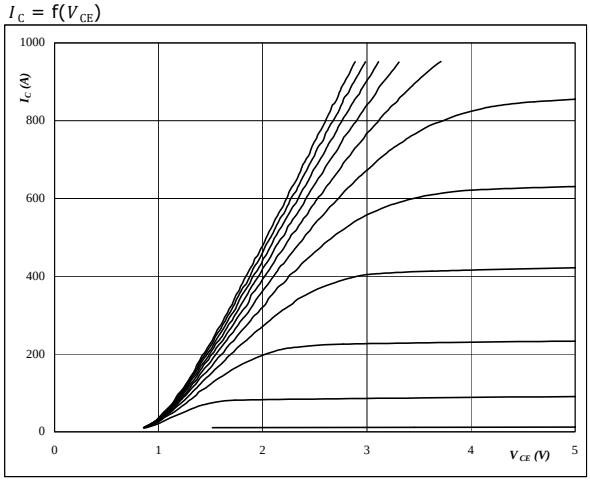
Boost

Boost IGBT and Boost FWD

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



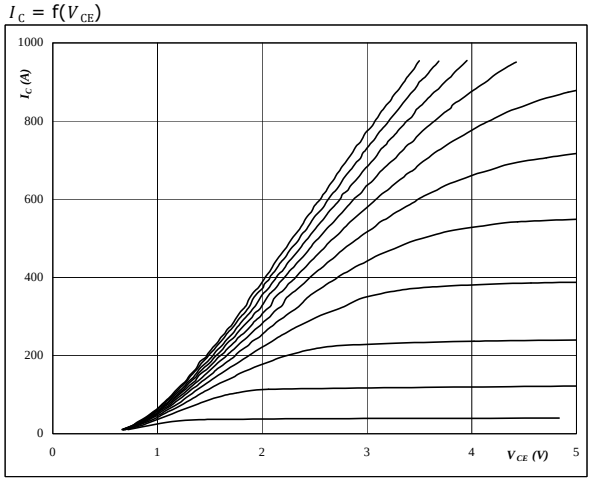
At

t_p =	350	µs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



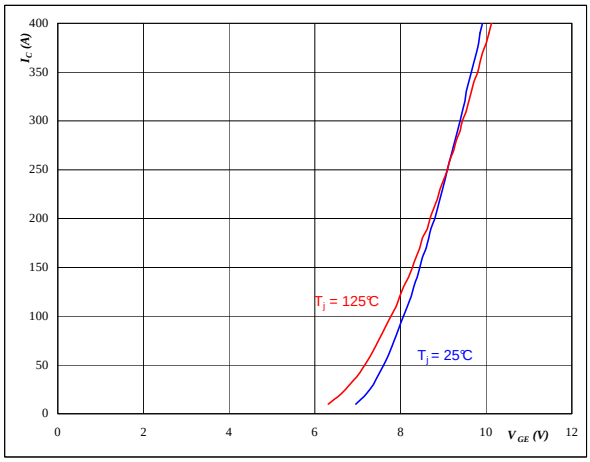
At

t_p =	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

$I_C = f(V_{GE})$



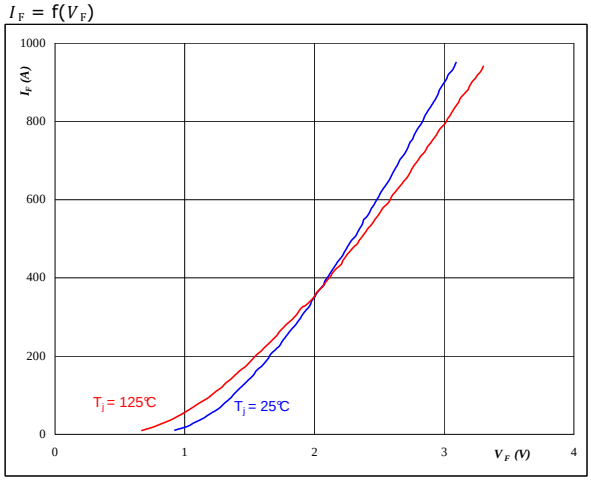
At

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

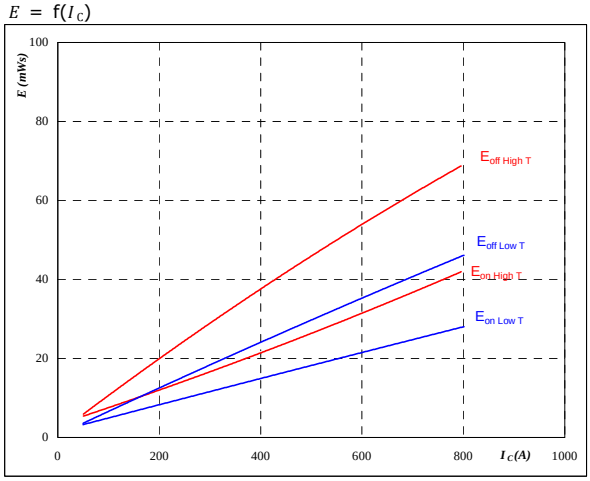
Boost

Boost IGBT and Boost FWD

figure 5. **IGBT**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



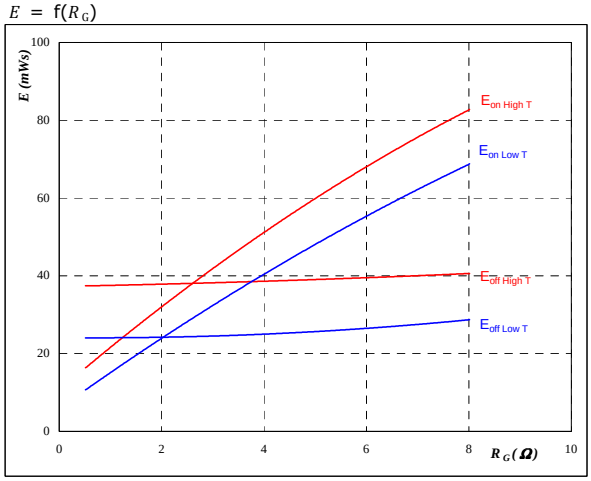
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J
R_{goff} =	1,0	J

figure 6. **IGBT**

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



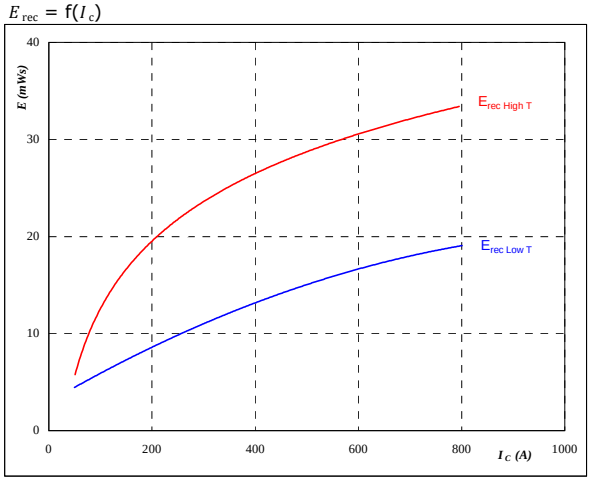
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	398	A

figure 7. **FWD**

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_c)$



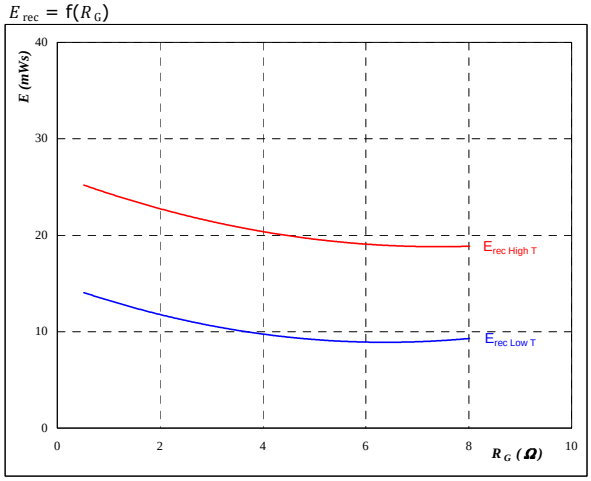
With an inductive load at

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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} =	600	V
V_{GE} =	±15	V
I_C =	398	A

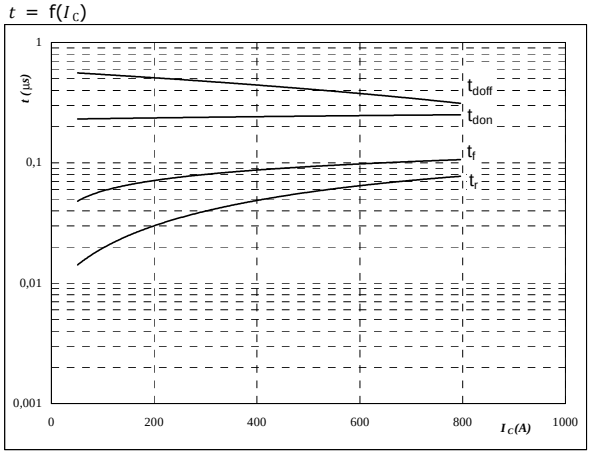
Boost

Boost IGBT and Boost FWD

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



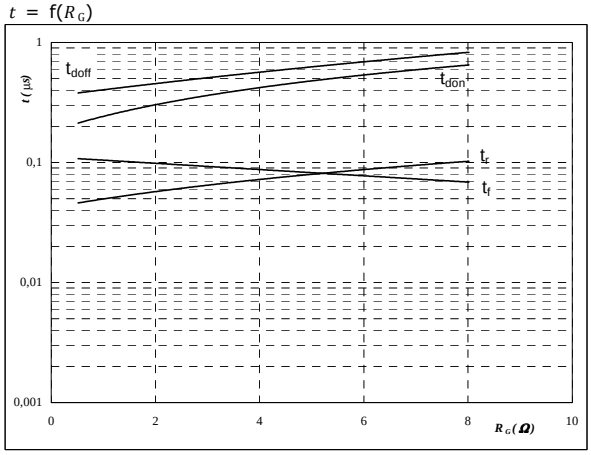
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J
R_{goff} =	1,0	J

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



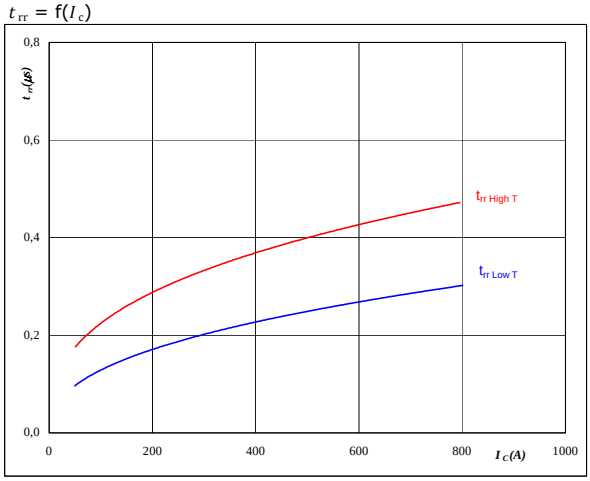
With an inductive load at

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	398	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$



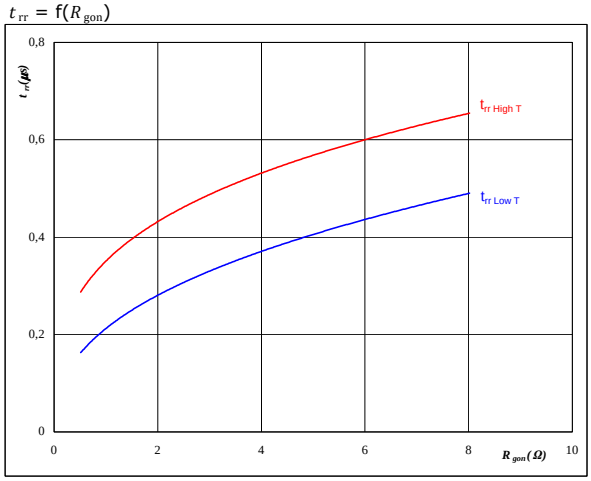
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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 =	600	V
I_F =	398	A
V_{GE} =	±15	V

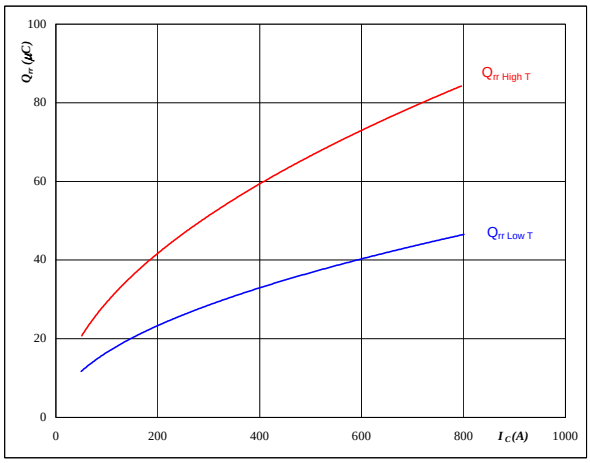
Boost

Boost IGBT and Boost FWD

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



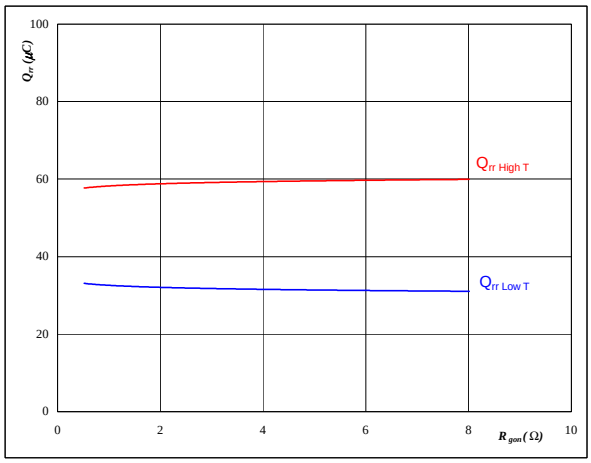
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

figure 14. **FWD**

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

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



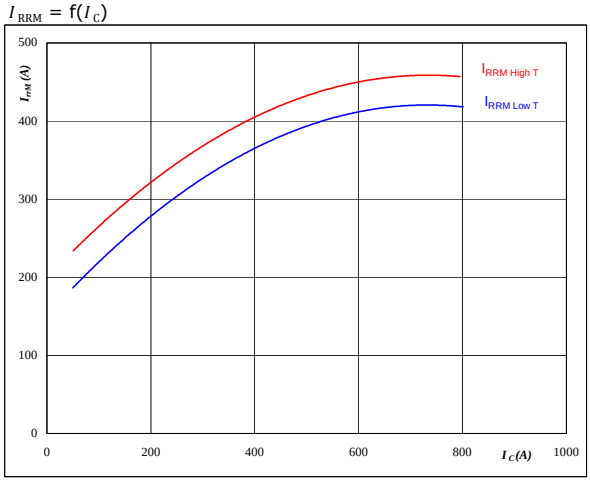
At

T_j =	25/125	°C
V_R =	600	V
I_F =	398	A
V_{GE} =	±15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



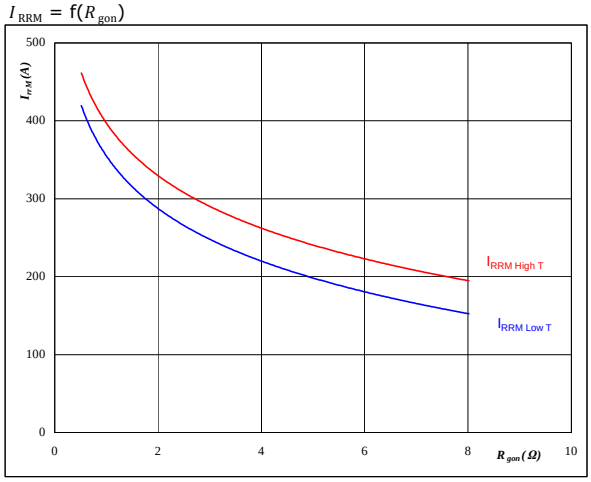
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

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	°C
V_R =	600	V
I_F =	398	A
V_{GE} =	±15	V

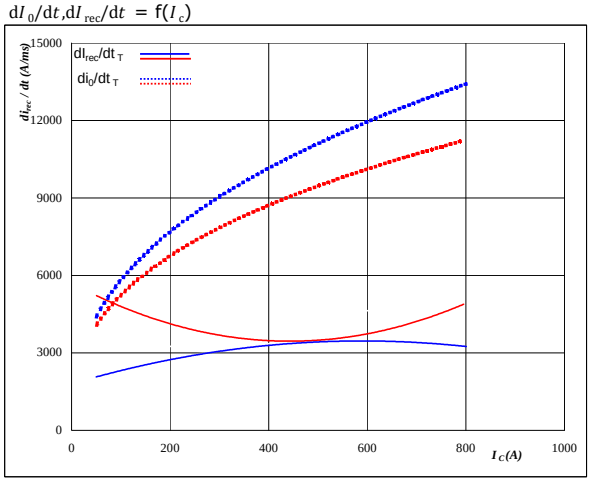
Boost

Boost IGBT and Boost FWD

figure 17. **FWD**

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

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



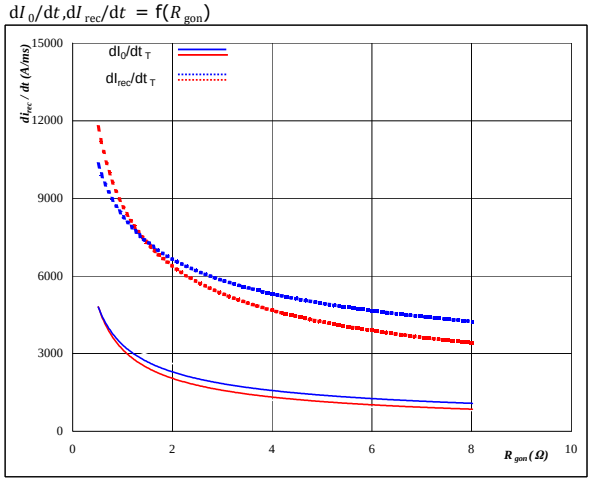
At

T_j =	25/125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	1,0	J

figure 18. **FWD**

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

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



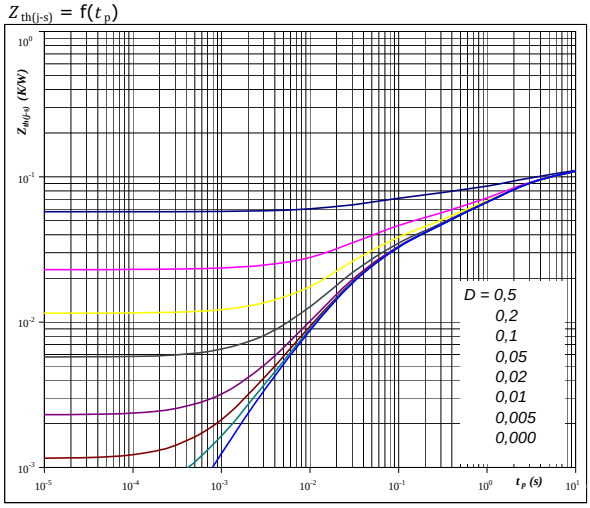
At

T_j =	25/125	°C
V_R =	600	V
I_F =	398	A
V_{GE} =	±15	V

figure 19. **IGBT**

IGBT transient thermal impedance as a function of pulse width

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



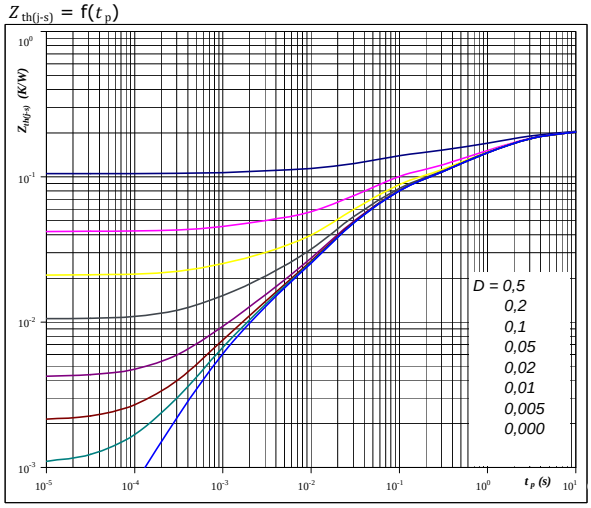
At

D =	t_p / T	
$R_{th(j-s)}$ =	0,112	K/W

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	
$R_{th(j-s)}$ =	0,204	K/W

IGBT thermal model values

With phase change material

R (K/W)	Tau (s)
1,16E-02	6,35E+00
4,61E-02	1,77E+00
2,00E-02	3,94E-01
1,28E-02	8,72E-02
1,94E-02	1,94E-02
1,72E-03	2,24E-03

FWD thermal model values

With phase change material

R (K/W)	Tau (s)
2,03E-02	5,24E+00
6,52E-02	1,19E+00
4,67E-02	2,95E-01
5,32E-02	3,03E-02
1,20E-02	7,56E-03
6,49E-03	7,59E-04

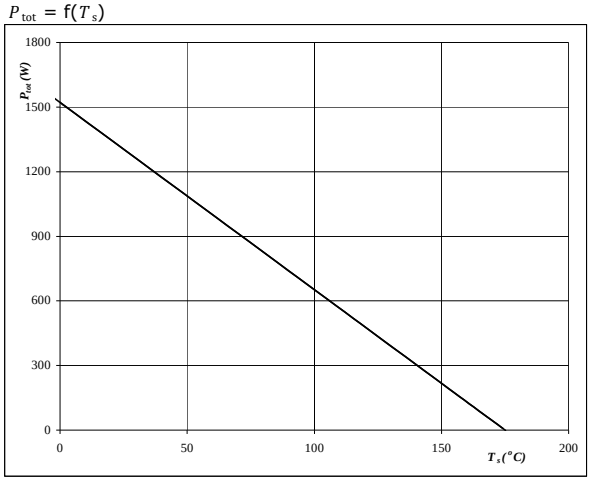
Boost

Boost IGBT and Boost FWD

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



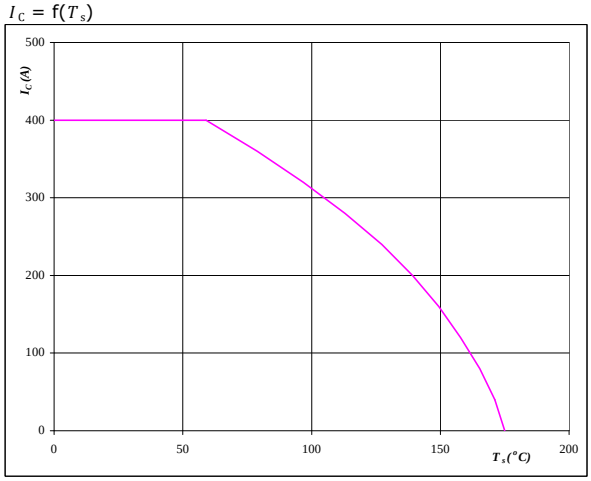
At

T_j = 175 ºC

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

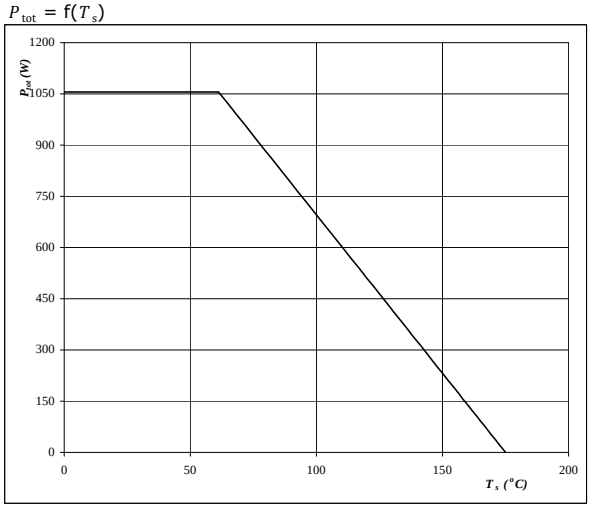
T_j = 175 ºC

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



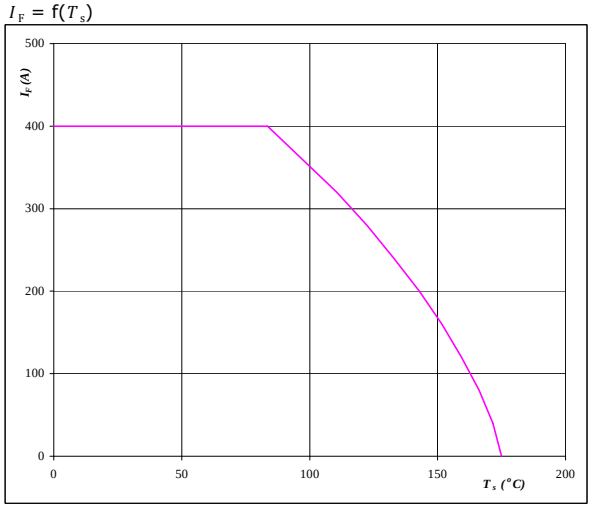
At

T_j = 175 ºC

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

T_j = 175 ºC

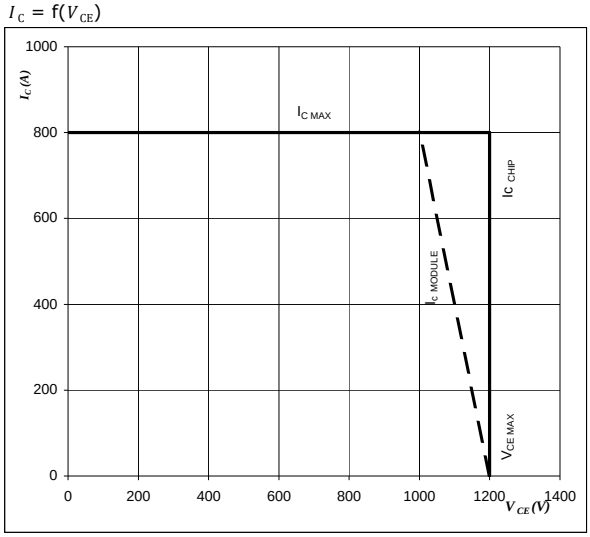
Boost

Boost IGBT

figure 25. **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

$U_{ccminus} = U_{ccplus}$

$L_s =$ 12 nH

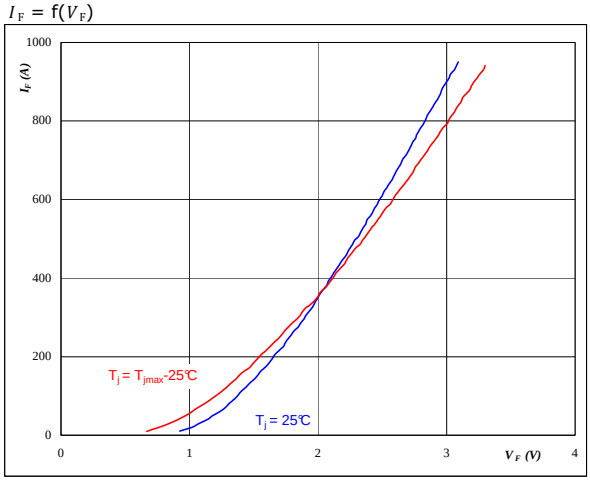
Switching mode : 3 level switching

Boost Inverse Diode

figure 25. **Boost Inverse Diode**

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$



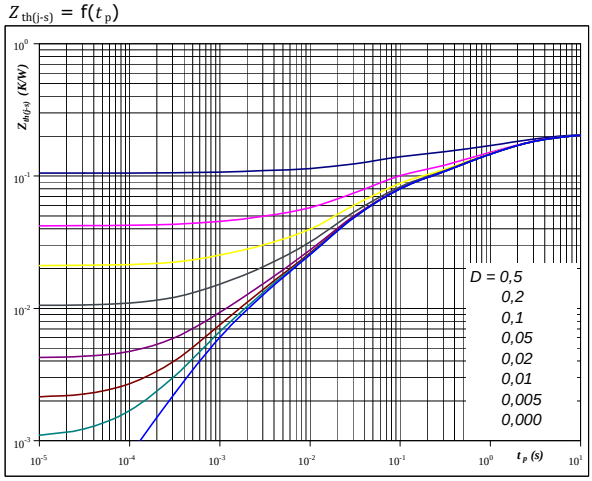
At

t_p = 250 µs

figure 26. **Boost Inverse Diode**

FWD transient thermal impedance as a function of pulse width

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



At

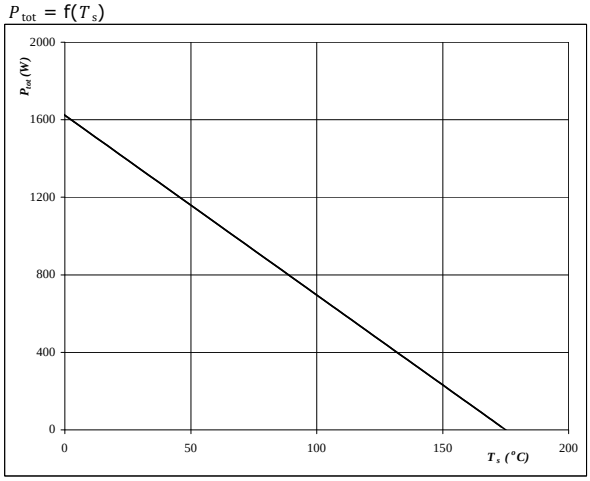
D = t_p / T

$R_{th(j-s)}$ = 0,204 K/W

figure 27. **Boost Inverse Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



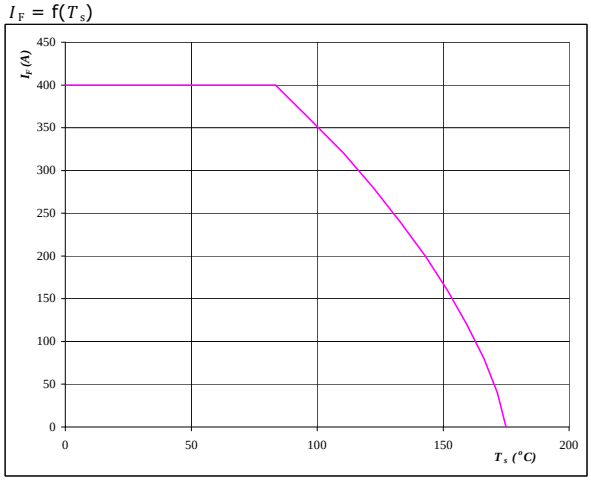
At

T_j = 175 ºC

figure 28. **Boost Inverse Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

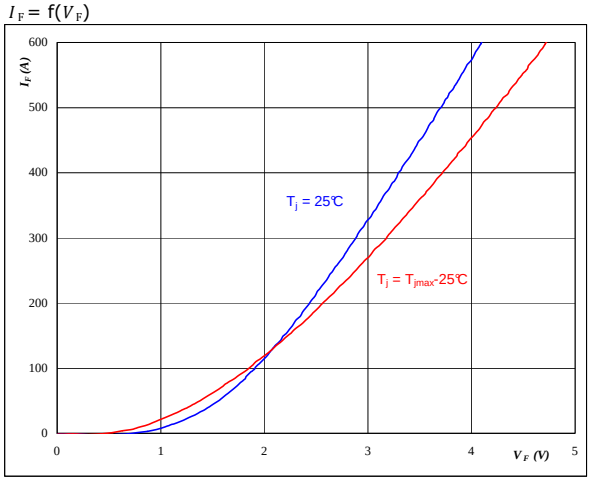
T_j = 175 ºC

Snubber Diode

figure 1. **Snubber Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



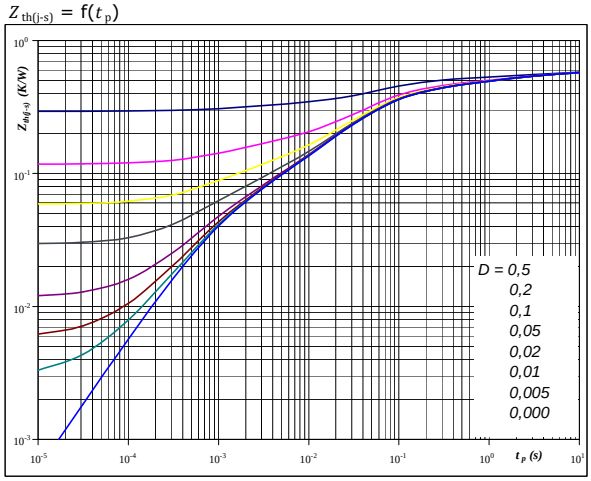
At

t_p = 250 µs

figure 2. **Snubber Diode**

Diode transient thermal impedance as a function of pulse width

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



At

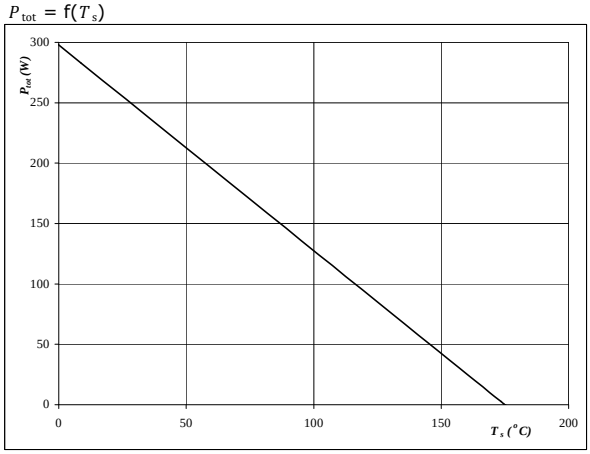
D = t_p / T

$R_{th(j-s)}$ = 0,588 K/W

figure 3. **Snubber Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



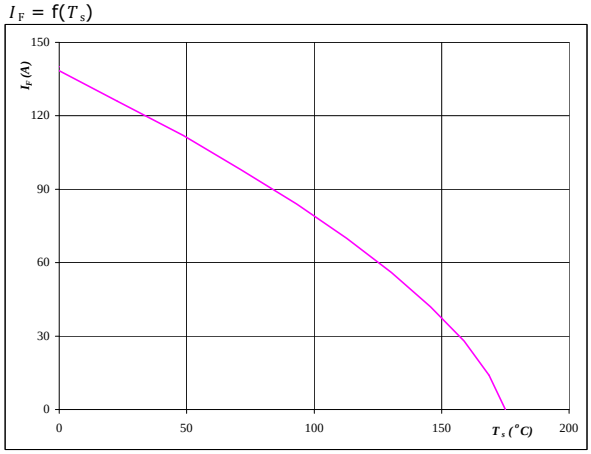
At

T_j = 175 ºC

figure 4. **Snubber Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



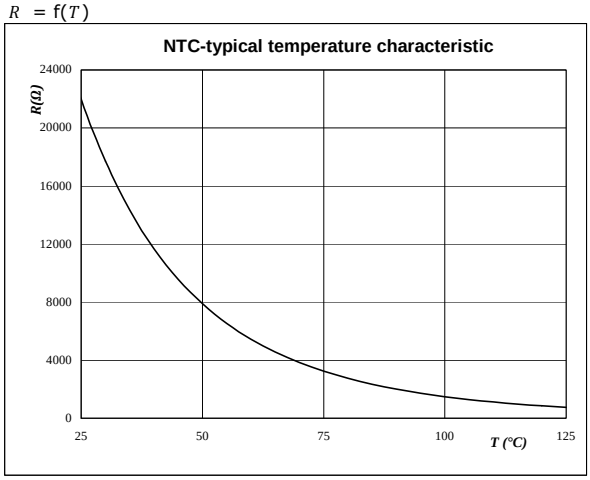
At

T_j = 175 ºC

Thermistor

figure 1. **Thermistor**

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



Switching Definitions Buck

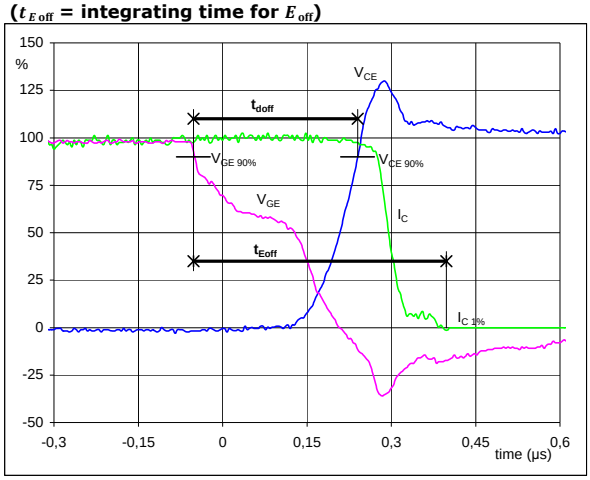
General conditions

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

Test setup inductance: 9 nH

figure 1. **IGBT**

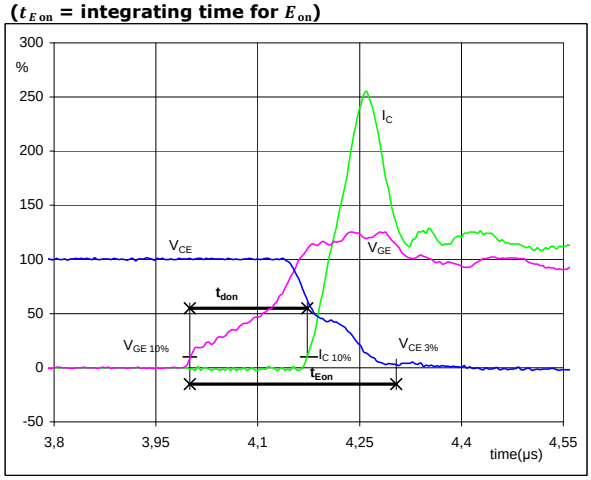
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	402	A
t_{doff} =	0,29	µs
$t_{E\,off}$ =	0,45	µs

figure 2. **IGBT**

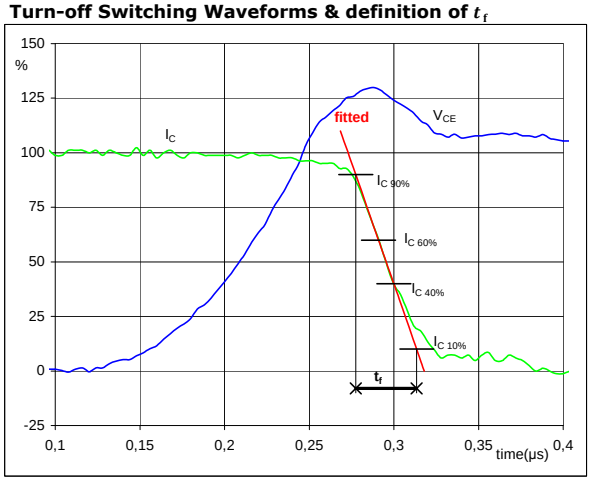
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	402	A
t_{don} =	0,17	µs
$t_{E\,on}$ =	0,30	µs

figure 3. **IGBT**

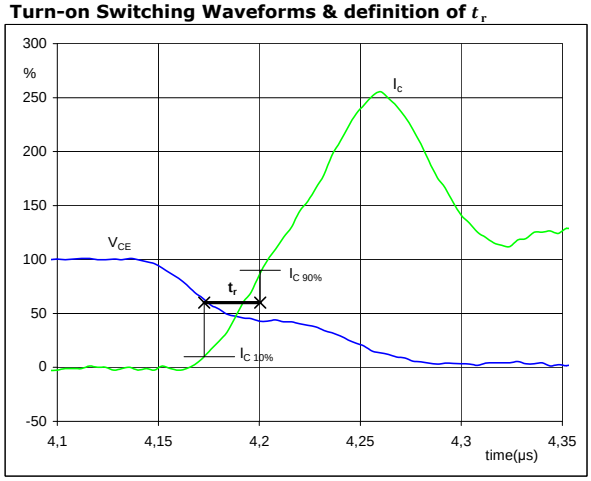
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	402	A
t_f =	0,04	µs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

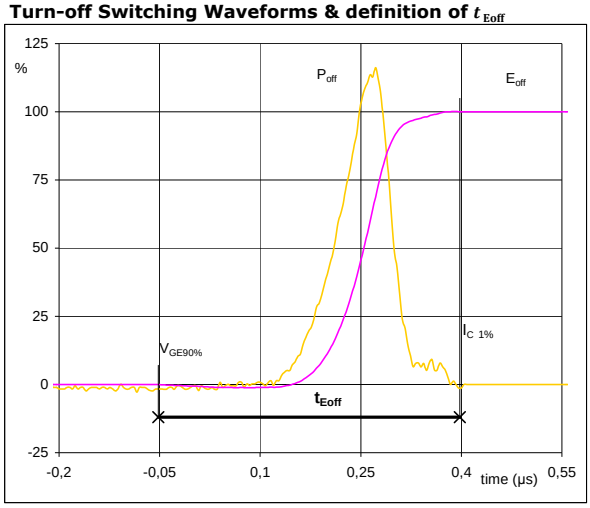


V_C (100%) =	600	V
I_C (100%) =	402	A
t_r =	0,03	µs

Switching Definitions Buck

figure 5. **IGBT**

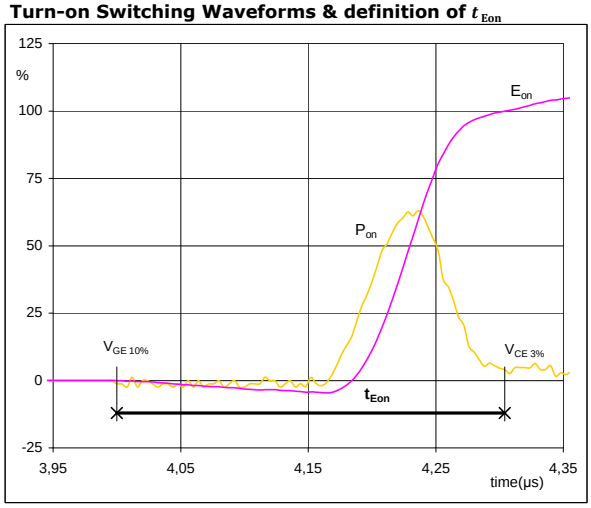
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	241,06	kW
E_{off} (100%) =	21,33	mJ
$t_{E\,off}$ =	0,45	µs

figure 6. **IGBT**

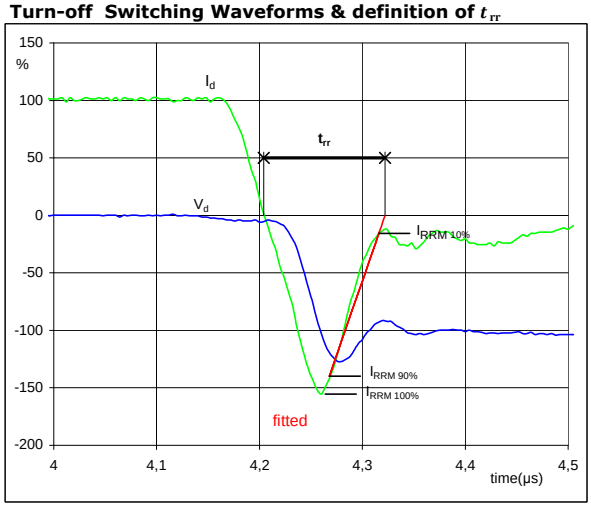
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	241,06	kW
E_{on} (100%) =	14,33	mJ
$t_{E\,on}$ =	0,30	µs

figure 7. **FWD**

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

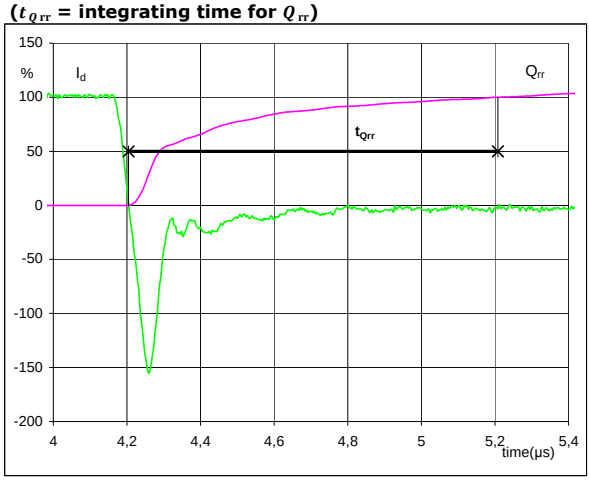


V_d (100%) =	600	V
I_d (100%) =	402	A
I_{RRM} (100%) =	-624	A
t_{rr} =	0,12	µs

Switching Definitions Buck

figure 8. **FWD**

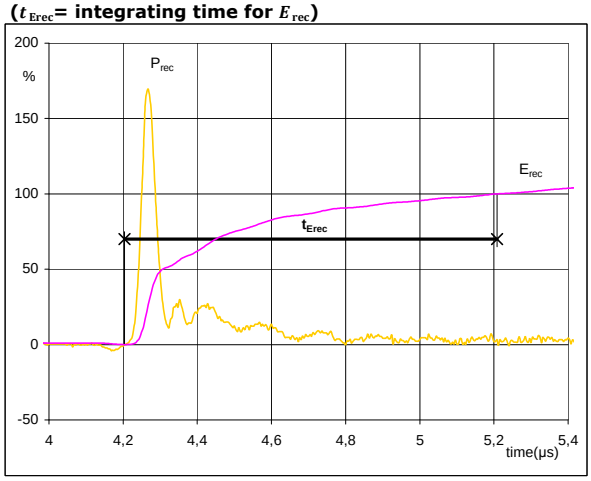
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	402	A
Q_{rr} (100%) =	57,89	µC
t_{Qrr} =	1,00	µs

figure 10. **FWD**

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



P_{rec} (100%) =	241,06	kW
E_{rec} (100%) =	26,14	mJ
t_{Erec} =	1,00	µs

Switching Definitions Boost

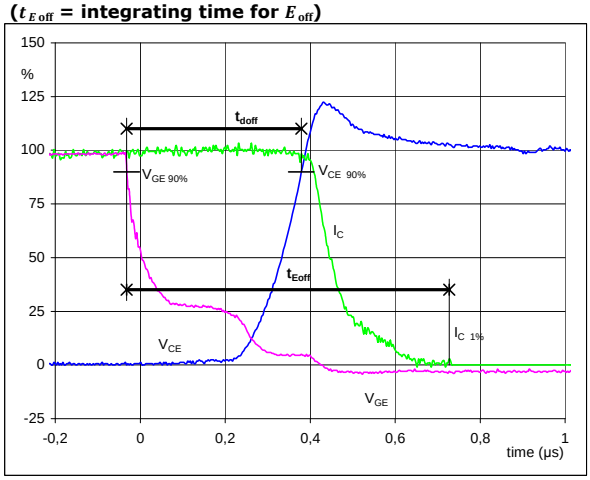
General conditions

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

Test setup inductance: 9 nH

figure 1. **Boost IGBT**

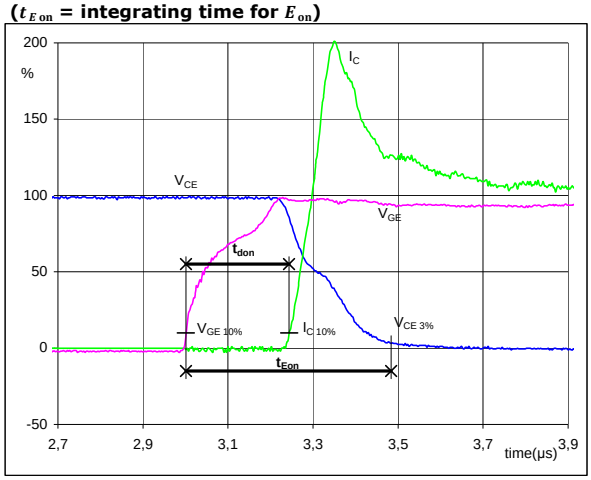
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	398	A
t_{doff} =	0,40	µs
$t_{E\,off}$ =	0,76	µs

figure 2. **Boost IGBT**

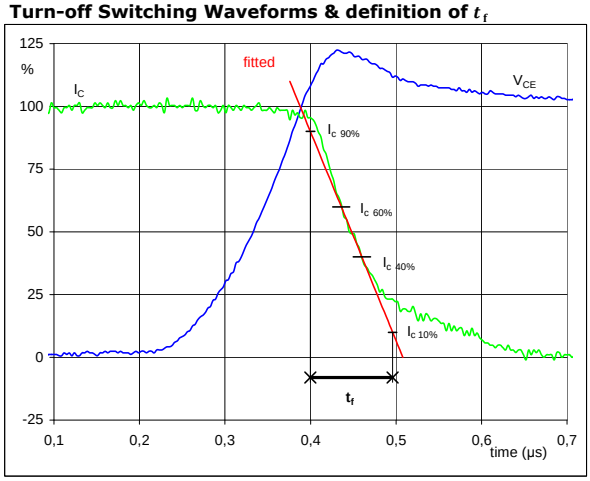
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	398	A
t_{don} =	0,24	µs
$t_{E\,on}$ =	0,48	µs

figure 3. **Boost IGBT**

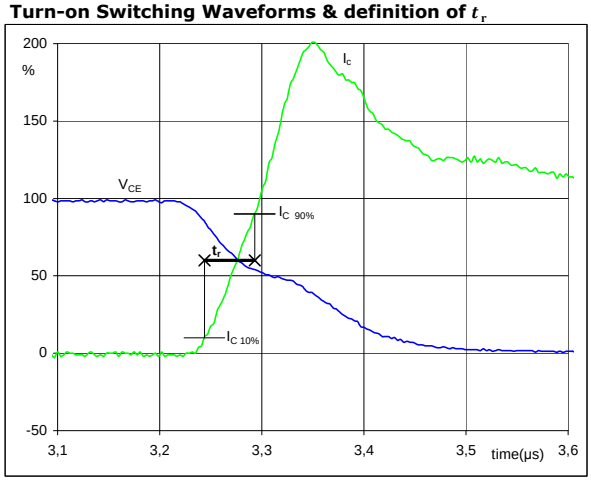
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	398	A
t_f =	0,099	µs

figure 4. **Boost IGBT**

Turn-on Switching Waveforms & definition of t_r

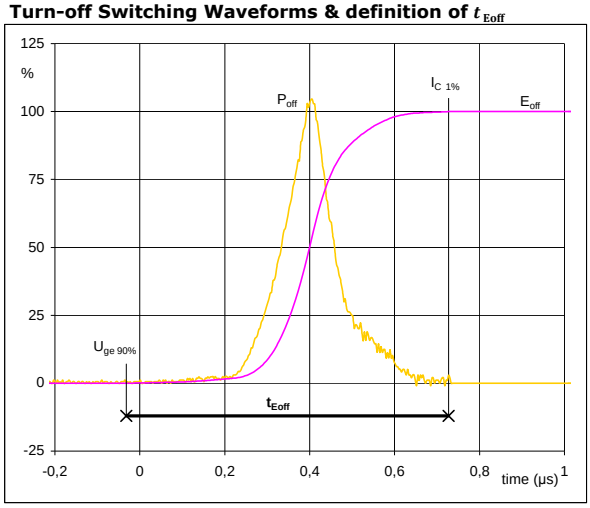


V_C (100%) =	600	V
I_C (100%) =	398	A
t_r =	0,049	µs

Switching Definitions Boost

figure 5. **Boost IGBT**

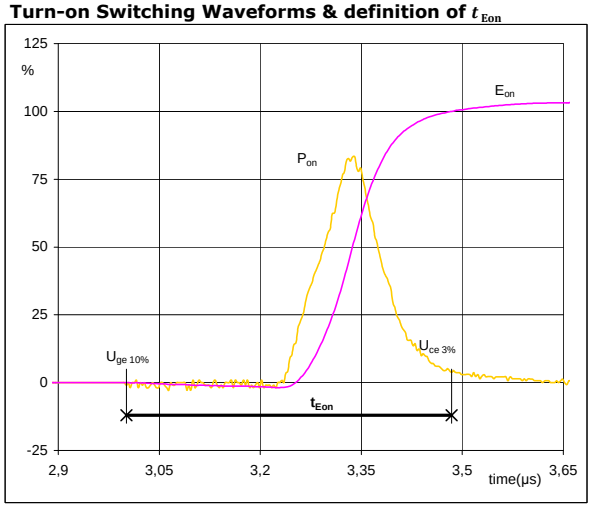
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	238,67	kW
E_{off} (100%) =	37,62	mJ
$t_{E\,off}$ =	0,76	µs

figure 6. **Boost IGBT**

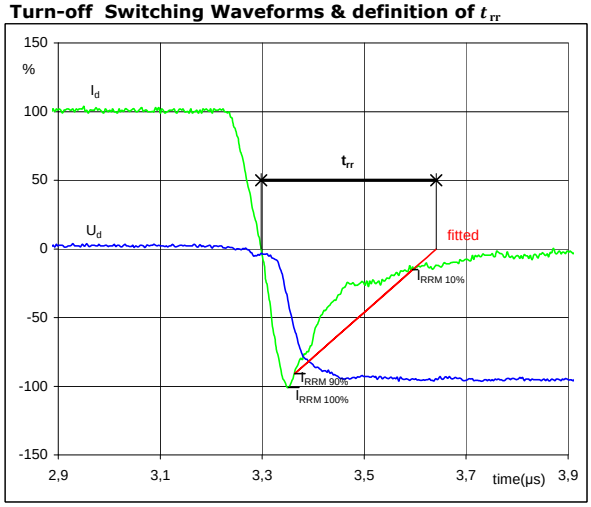
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	238,672	kW
E_{on} (100%) =	13,39	mJ
$t_{E\,on}$ =	0,48	µs

figure 7. **Boost FWD**

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

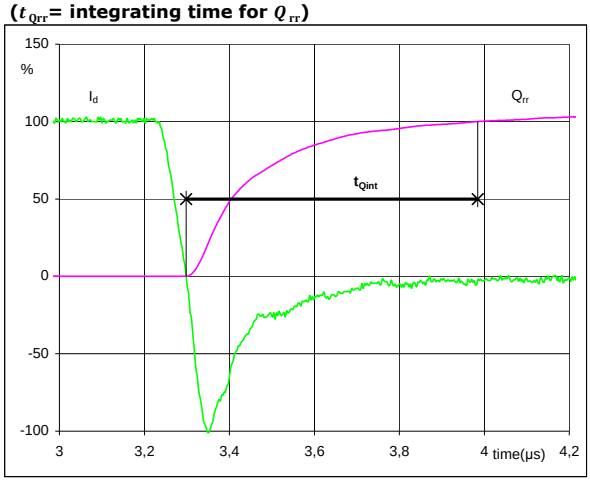


V_d (100%) =	600	V
I_d (100%) =	398	A
I_{RRM} (100%) =	-403	A
t_{rr} =	0,34	µs

Switching Definitions Boost

figure 8. **Boost FWD**

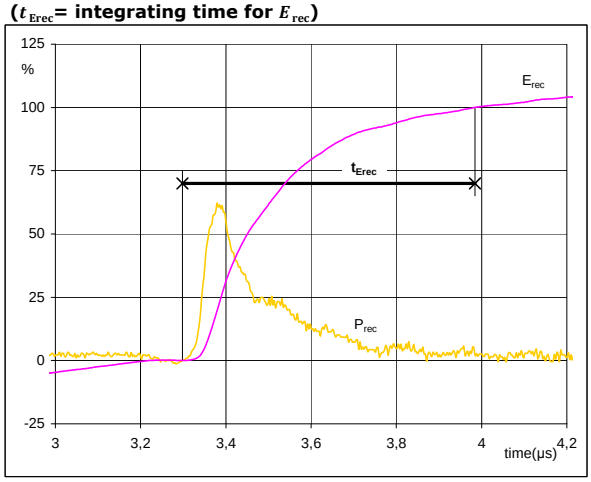
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	398	A
Q_{rr} (100%) =	58,83	µC
t_{Qint} =	0,69	µs

figure 9. **Boost FWD**

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



P_{rec} (100%) =	238,67	kW
E_{rec} (100%) =	24,53	mJ
t_{Erec} =	0,69	µs

Ordering Code & Marking

Version	Ordering Code
without thermal paste	70-W224NIA400SH-M400P
with thermal paste	70-W224NIA400SH-M400P-/3/

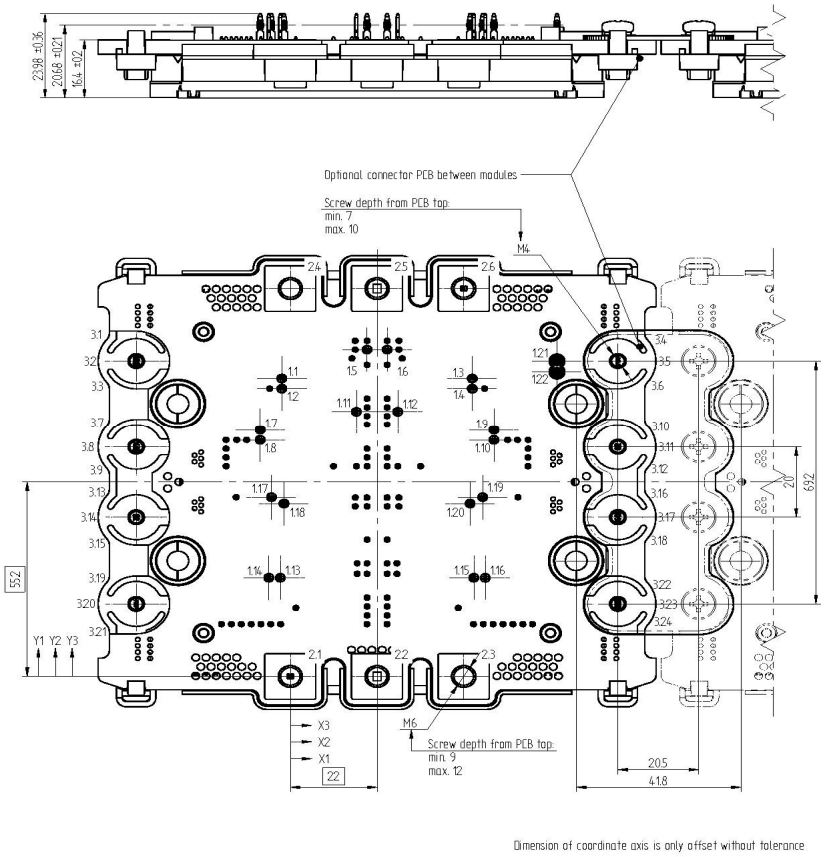
Name
Date code
Lot
Serial
Vincotech UL

Text	**Name**		**Date code**	**UL & Vinco**	**Lot**	**Serial**
	NN-NNNNNNNNNNNNNN-NNNNNNNN		WWYY	UL VIN	LLLLL	SSSS
Datamatrix	**Type&Ver**	**Lot number**	**Serial**	**Date code**		
	TTTT-TTT	LLLLL	SSSS	WWYY		

Outline

Pin table [mm]

Pin	X	Y	Function	Group
1.1	-2,15	84,85	G1-1	T1
1.2	-2,15	81,95	E1-1	T1
1.3	46,15	84,85	G1-2	T1
1.4	46,15	81,95	E1-2	T1
1.5	19,45	93,05	DC+ desat	T1
1.6	24,55	93,05	DC+ desat	T1
1.7	-7,65	70,05	G2-1	T2
1.8	-7,65	67,15	E2-1	T2
1.9	51,65	70,05	G2-2	T2
1.10	51,65	67,15	E2-2	T2
1.11	16,75	75,35	GND desat	D5
1.12	27,25	75,35	GND desat	D5
1.13	-2,55	28	G3-1	T3
1.14	-5,45	28	E3-1	T3
1.15	46,55	28	G3-2	T3
1.16	49,45	28	E3-2	T3
1.17	-4,8	50,85	G4-1	T4
1.18	-1,6	49,05	E4-1	T4
1.19	48,8	50,85	G4-2	T4
1.20	45,6	49,05	E4-2	T4
1.21	67,65	89,8	NTC1	
1.22	67,65	86,7	NTC2	



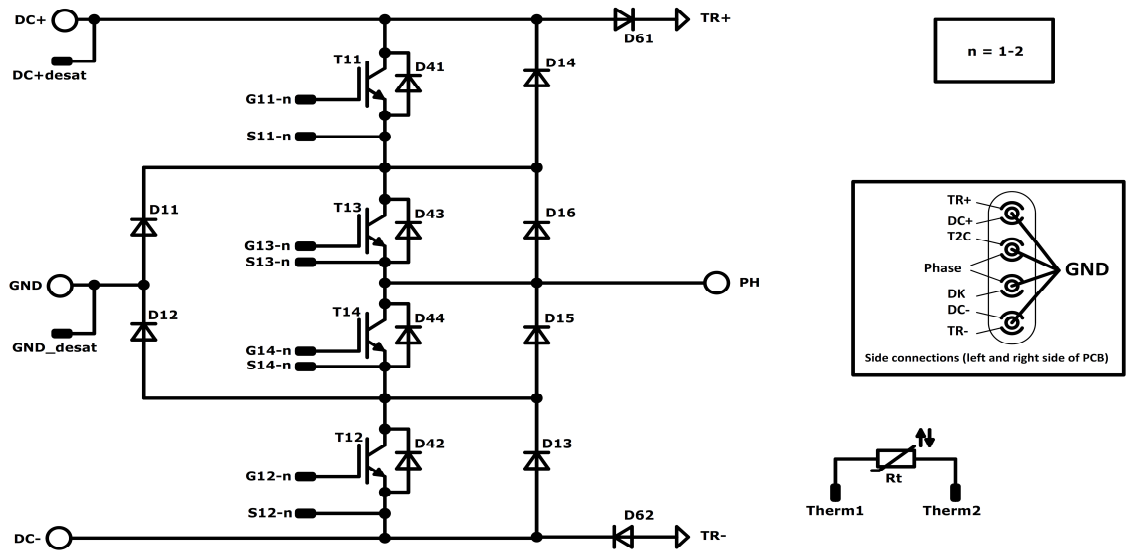
Low current connections

M4 screw	X3	Y3	Function
3.1	-39,1	89,8	TR+
3.2	-39,1	89,8	GND
3.3	-39,1	89,8	DC+
3.4	83,1	89,8	TR+
3.5	83,1	89,8	GND
3.6	83,1	89,8	DC+
3.7	-39,1	65,2	T2C
3.8	-39,1	65,2	GND
3.9	-39,1	65,2	Phase
3.10	83,1	65,2	T2C
3.11	83,1	65,2	GND
3.12	83,1	65,2	Phase
3.13	-39,1	45,2	Phase
3.14	-39,1	45,2	GND
3.15	-39,1	45,2	DK
3.16	83,1	45,2	Phase
3.17	83,1	45,2	GND
3.18	83,1	45,2	DK
3.19	-39,1	20,6	DC-
3.20	-39,1	20,6	GND
3.21	-39,1	20,6	TR-
3.22	83,1	20,6	DC-
3.23	83,1	20,6	GND
3.24	83,1	20,6	TR-

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	GND
2.6	44	110,4	DC-

Pinout



NOTE: Driver pins for parallel devices are not connected inside the module!

Identification

ID	Component	Voltage	Current	Function	Comment
T11, T12	IGBT	1200 V	400 A	Buck Switch	
D11, D12	FWD	1200 V	400 A	Buck Diode	
T13, T14	IGBT	1200 V	400 A	Boost Switch	
D15, D16	FWD	1200 V	300 A	Boost Inverse Diode	
D13, D14	FWD	1200 V	300 A	Boost Diode	
D61, D62	FWD	1200 V	50 A	Snubber Diode	
Rt	NTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**8**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for VINco X4 packages see vincotech.com website.

Package data
Package data for VINco X4 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
70-W224NIA400SH-M400P-D7-14	10 Jul. 2019	Marketing application voltage modified	1