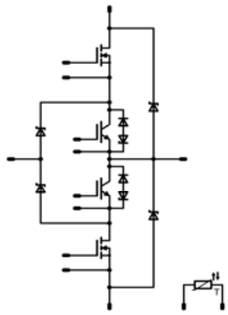
flowNPC 0 — 600V/30A

Features
- neutral point clamped inverter
- reactive power capability
- SiC buck diode
- clip-in pcb mounting
- low inductance layout

flow0 12mm housing

Target Applications
- solar inverter
- UPS

Schematic



Types
- FZ06NRA045FH

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Buck Diode					
Peak Repetitive Reverse Voltage	V_{RRM}	T_j=25°C		600	V
DC forward current	I_F	$T_j=T_jmax$	T_h=80°C T_c=80°C	20 26	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_jmax	T_c=100°C	70	A
Power dissipation per Diode	P_{tot}	$T_j=T_jmax$	T_h=80°C T_c=80°C	40 61	W
Maximum Junction Temperature	T_jmax			175	°C
Buck MOSFET					
Drain to source breakdown voltage	V_{DS}			600	V
DC drain current	I_D	$T_j=T_jmax$	T_h=80°C T_c=80°C	36 44	A
Pulsed drain current	I_{Dpulse}	t_p limited by T_jmax	Tc=25°C	230	A
Power dissipation	P_{tot}	$T_j=T_jmax$	T_h=80°C T_c=80°C	125 189	W
Gate-source peak voltage	Vgs			±20	V
Maximum Junction Temperature	T_jmax			150	°C

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Boost IGBT					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j=T_j$max	T_h=80°C T_c=80°C	47 50	A
Repetitive peak collector current	I_{Cpuls}	t_p limited by $T_j$max		225	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j$max	T_h=80°C T_c=80°C	85 129	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150°C V_{GE}=15V		6 360	μs V
Maximum Junction Temperature	$T_j$max			175	°C
Boost Inverse Diode					
Peak Repetitive Reverse Voltage	V_{RRM}	T_c=25°C		600	V
DC forward current	I_F	$T_j=T_j$max	T_h=80°C T_c=80°C	2	A
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	T_h=80°C T_c=80°C	21	W
Maximum Junction Temperature	$T_j$max			150	°C
Boost Diode					
Peak Repetitive Reverse Voltage	V_{RRM}	T_j=25°C		1200	V
DC forward current	I_F	$T_j=T_j$max	T_h=80°C T_c=80°C	16 21	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max		36	A
Power dissipation per Diode	P_{tot}	$T_j=T_j$max	T_h=80°C T_c=80°C	30 46	W
Maximum Junction Temperature	$T_j$max			150	°C
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+(Tjmax - 25)	°C
Insulation Properties					
Insulation voltage	V_{is}	t=2s	DC voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm

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
Buck Diode										
Diode forward voltage	V_F				16	Tj=25°C Tj=125°C	1	1,55 1,66	1,8	V
Peak reverse recovery current	I_{RRM}	Rgon=8 Ω		350	30	Tj=25°C Tj=125°C		25 23		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		9,9 10,7		ns
Reverse recovered charge	Q_{rr}					Tj=25°C Tj=125°C		0,108 0,113		μC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25°C Tj=125°C		7192 5586		A/μs
Reverse recovered energy	Erec					Tj=25°C Tj=125°C		0,007 0,010		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						2,36		K/W
Buck MOSFET										
Static drain to source ON resistance	$R_{ds(on)}$		10		44	Tj=25°C Tj=125°C		42 83		mΩ
Gate threshold voltage	$V_{(GS)th}$		V_{DS}=V_{GS}		0,003	Tj=25°C Tj=125°C	2,1	3	3,9	V
Gate to Source Leakage Current	I_{gss}		20	0		Tj=25°C Tj=125°C			200	nA
Zero Gate Voltage Drain Current	I_{dss}		0	600		Tj=25°C Tj=125°C			25	μA
Turn On Delay Time	$t_{d(ON)}$	Rgon=8 Ω Rgoff=8 Ω	15	350	30	Tj=25°C Tj=125°C		33 31		ns
Rise Time	t_r					Tj=25°C Tj=125°C		7 8		
Turn off delay time	$t_{d(OFF)}$					Tj=25°C Tj=125°C		278 298		
Fall time	t_f					Tj=25°C Tj=125°C		4 6		
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		0,095 0,108		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		0,064 0,091		
Total gate charge	Q_g		15	350	30	Tj=25°C		150	190	nC
Gate to source charge	Q_{gs}							34		
Gate to drain charge	Q_{gd}							51		
Input capacitance	C_{iss}	f=1MHz	0	100		Tj=25°C		6800		pF
Output capacitance	C_{oss}							320		
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,56		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	
Boost IGBT										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0012	Tj=25°C Tj=125°C	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		30	Tj=25°C Tj=125°C	1	1,14 1,19	1,8	V
Collector-emitter cut-off incl diode	I_{CES}		0	600		Tj=25°C Tj=125°C			30	μA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25°C Tj=125°C			650	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	Rgon=8 Ω Rgoff=8 Ω	15	350	30	Tj=25°C Tj=125°C		40 37		ns
Rise time	t_r					Tj=25°C Tj=125°C		10 13		
Turn-off delay time	$t_{d(off)}$					Tj=25°C Tj=125°C		454 502		
Fall time	t_f					Tj=25°C Tj=125°C		64 87		
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		0,719 0,959		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		0,854 1,163		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25°C		4620		pF
Output capacitance	C_{oss}							288		
Reverse transfer capacitance	C_{rss}							137		
Gate charge	Q_{Gate}		15	480	75	Tj=25°C		470		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1,11		K/W
Boost Inverse Diode										
Diode forward voltage	V_F				20	Tj=25°C Tj=125°C		9,07 9,43		V
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						4,36		K/W
Boost Diode										
Diode forward voltage	V_F				18	Tj=25°C Tj=125°C	1,5	3,14 2,71	3,5	V
Reverse leakage current	I_r			1200		Tj=25°C Tj=125°C			100	μA
Peak reverse recovery current	I_{RRM}	Rgon=8 Ω		350	30	Tj=25°C Tj=125°C		92 112		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		37,1 51,9		ns
Reverse recovered charge	Q_{rr}					Tj=25°C Tj=125°C		2,8 5,7		μC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25°C Tj=125°C		20796 20514		A/μs
Reverse recovery energy	E_{rec}					Tj=25°C Tj=125°C		0,54 1,39		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						2,32		K/W
Thermistor										
Rated resistance*	R_{25}	Tol. ±13%				Tj=25°C	19,1	22	24,9	kΩ
	R_{100}	Tol. ±5%				Tj=100°C	1411	1486	1560	Ω
Power dissipation	P					Tj=25°C		210		mW
B-value	$B_{(25/100)}$	Tol. ±3%				Tj=25°C		4000		K

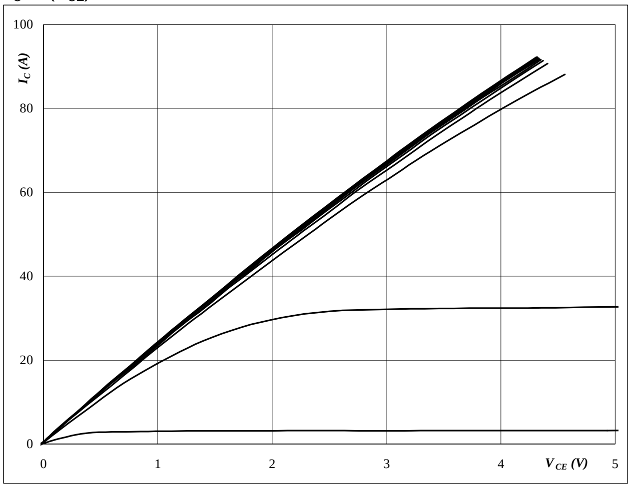
* see details on **Thermistor** charts on ***Figure 2.***

Buck

Figure 1 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$



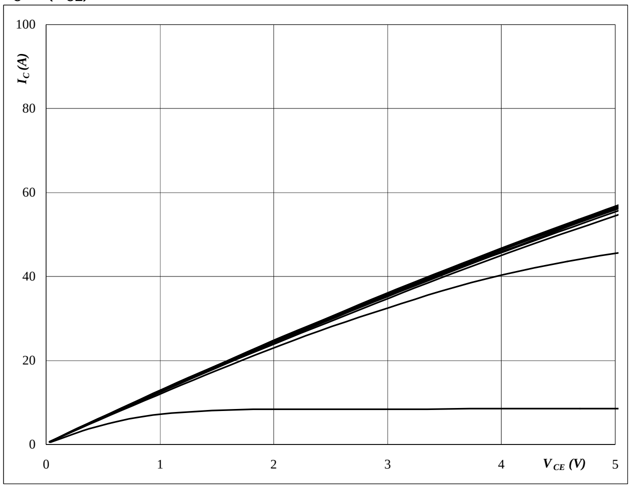
At

t_p =	250	μs
T_j =	25	°C
V_{GE} from	4 V to 14 V in steps of 1 V	

Figure 2 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$



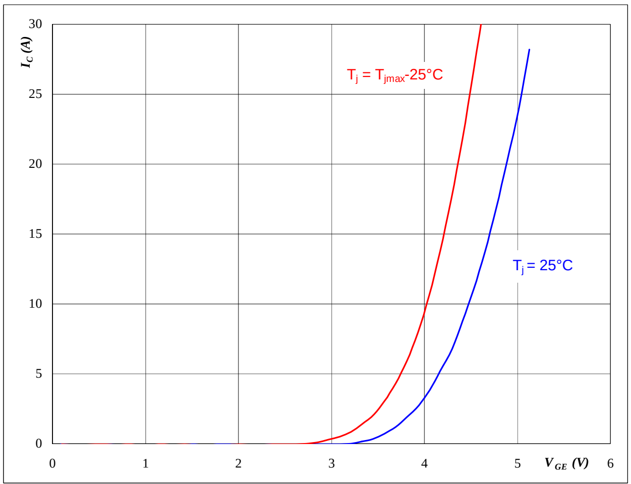
At

t_p =	250	μs
T_j =	125	°C
V_{GE} from	4 V to 14 V in steps of 1 V	

Figure 3 MOSFET

Typical transfer characteristics

$I_C = f(V_{GE})$



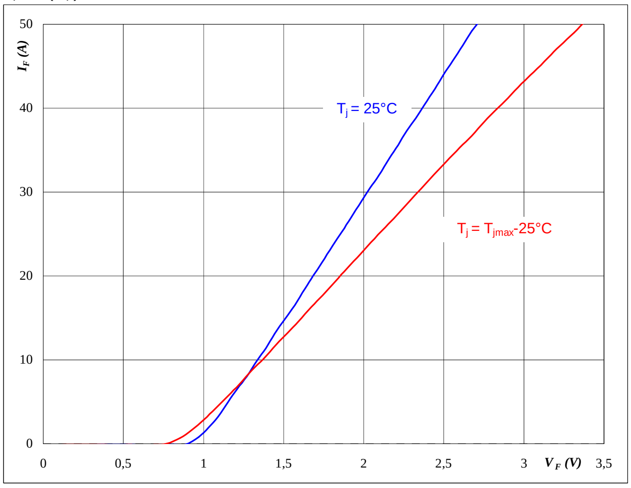
At

t_p =	250	μs
V_{CE} =	10	V

Figure 4 FRED

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

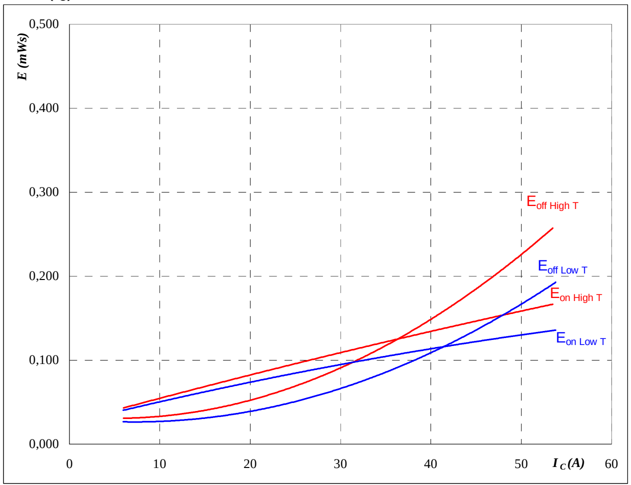
t_p =	250	μs

Buck

Figure 5 MOSFET

Typical switching energy losses
as a function of collector current

E = f(I_C)



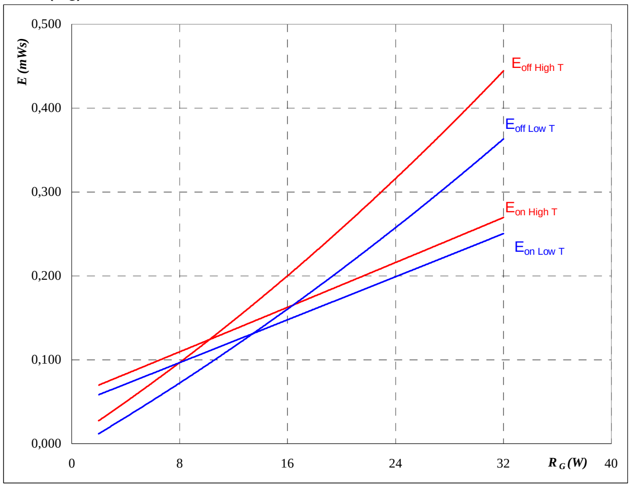
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 6 MOSFET

Typical switching energy losses
as a function of gate resistor

E = f(R_G)



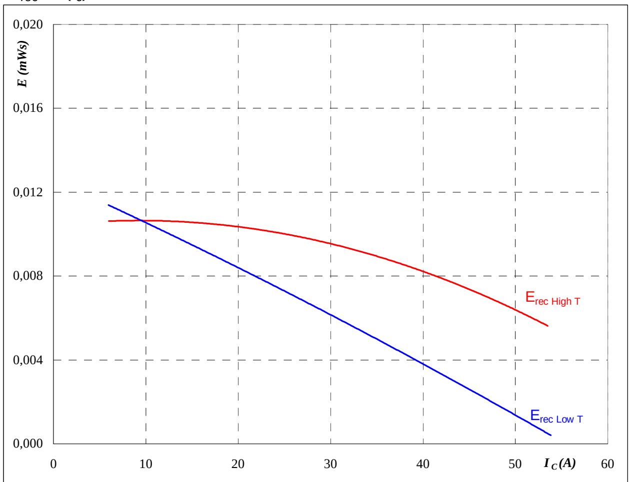
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Figure 7 FRED

Typical reverse recovery energy loss
as a function of collector current

E_{rec} = f(I_c)



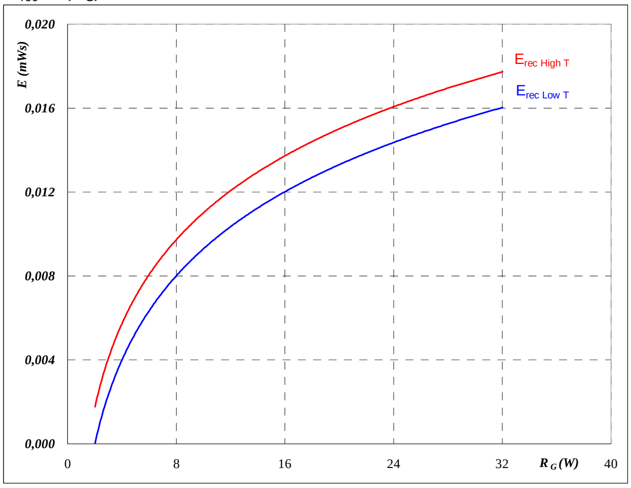
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 8 FRED

Typical reverse recovery energy loss
as a function of gate resistor

E_{rec} = f(R_G)



With an inductive load at

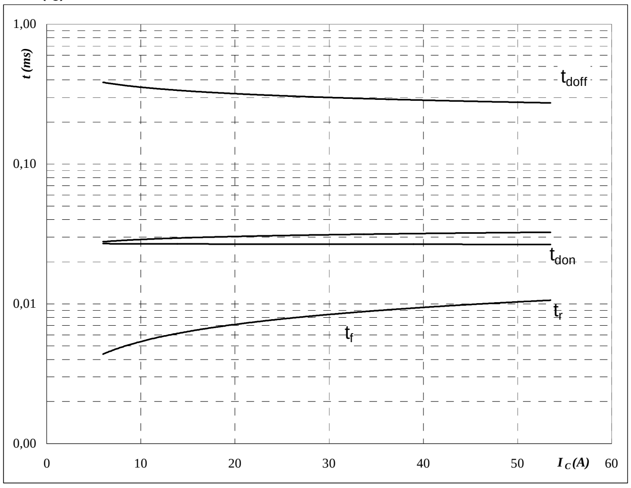
T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Buck

Figure 9 MOSFET

Typical switching times as a function of collector current

t = f(I_C)



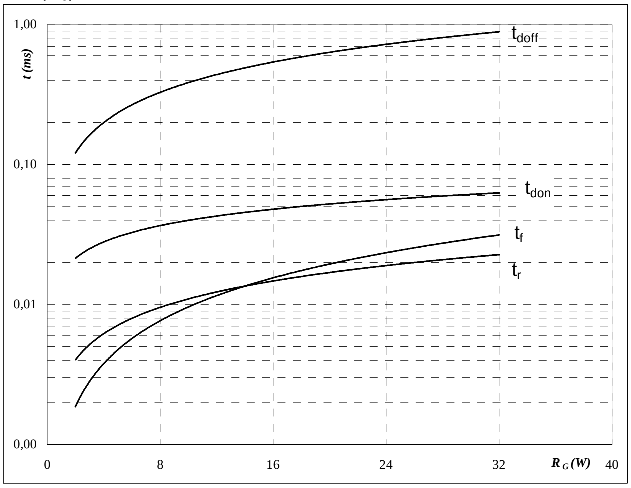
With an inductive load at

T_j =	125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 10 MOSFET

Typical switching times as a function of gate resistor

t = f(R_G)



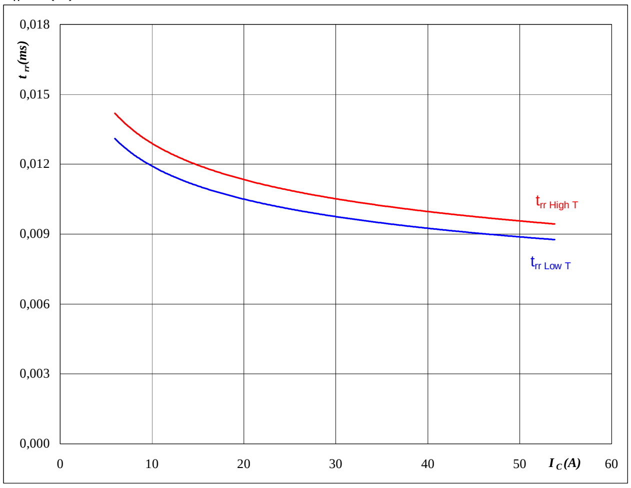
With an inductive load at

T_j =	125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Figure 11 FRED

Typical reverse recovery time as a function of collector current

t_{rr} = f(Ic)



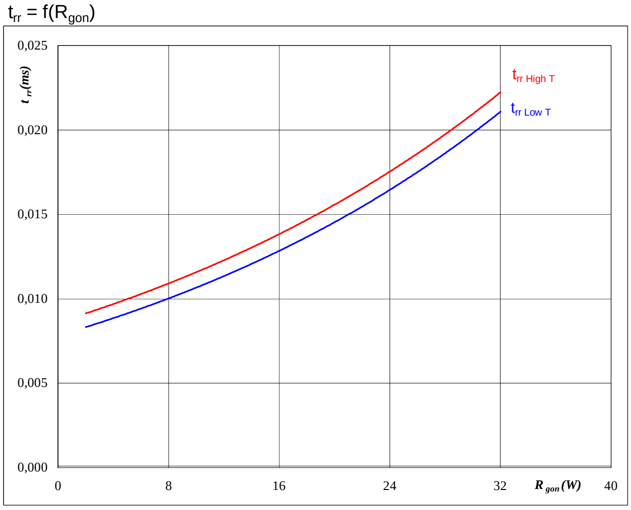
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 12 FRED

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

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



At

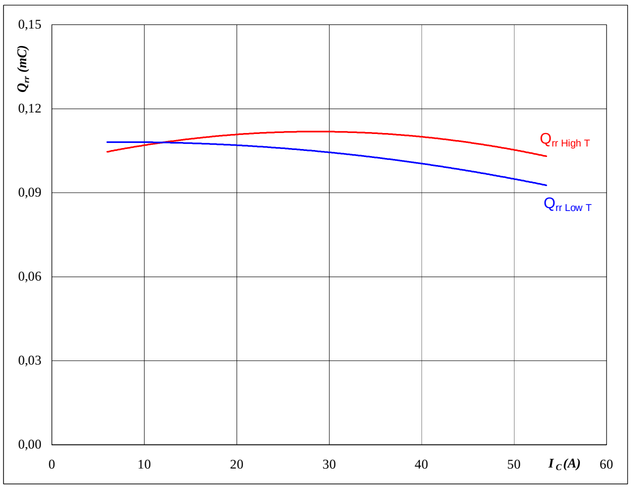
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Buck

Figure 13 FRED

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



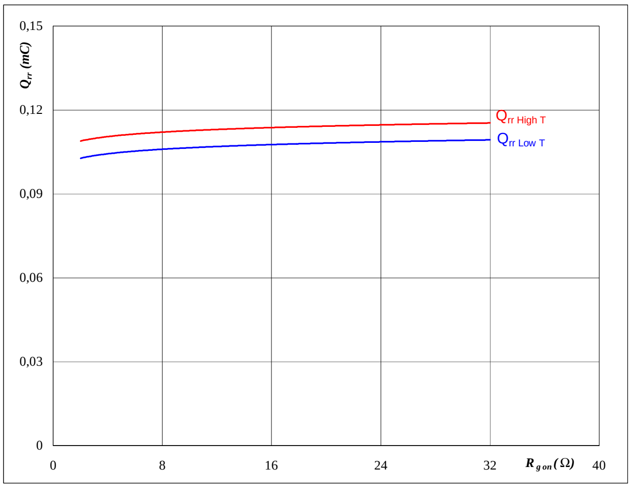
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 14 FRED

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

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



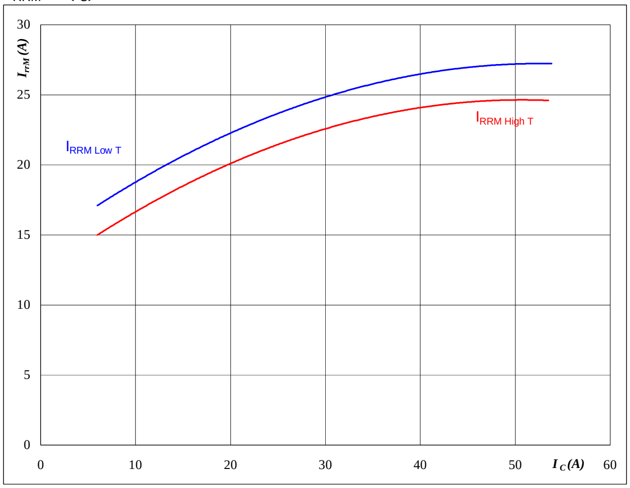
At

T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Figure 15 FRED

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



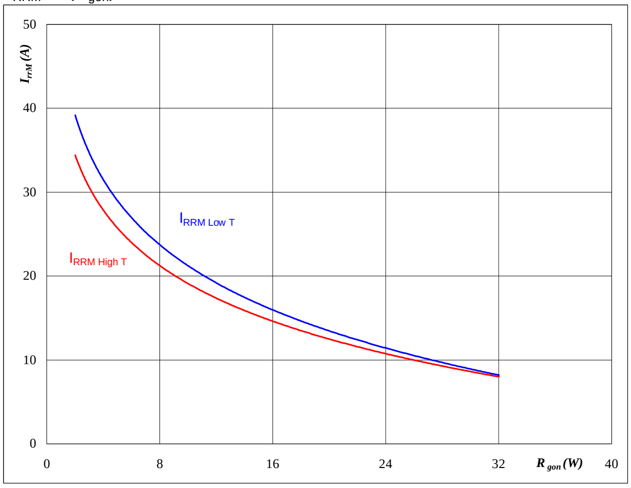
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 16 FRED

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

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



At

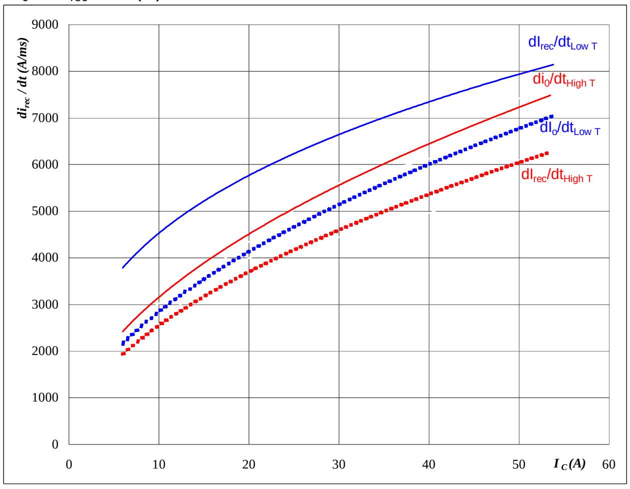
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Buck

Figure 17	FRED

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

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



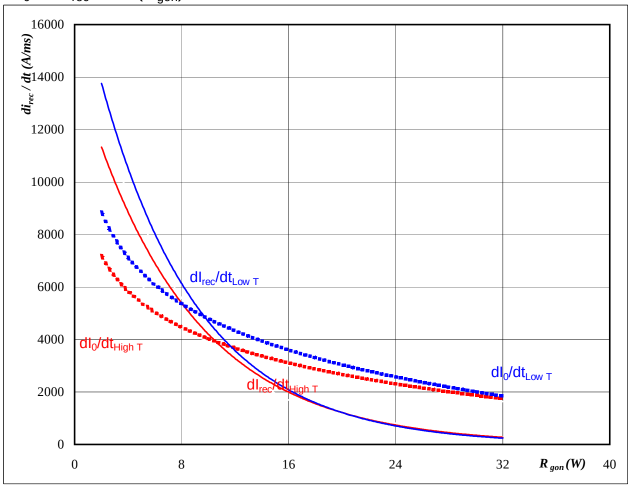
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 18	FRED

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

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



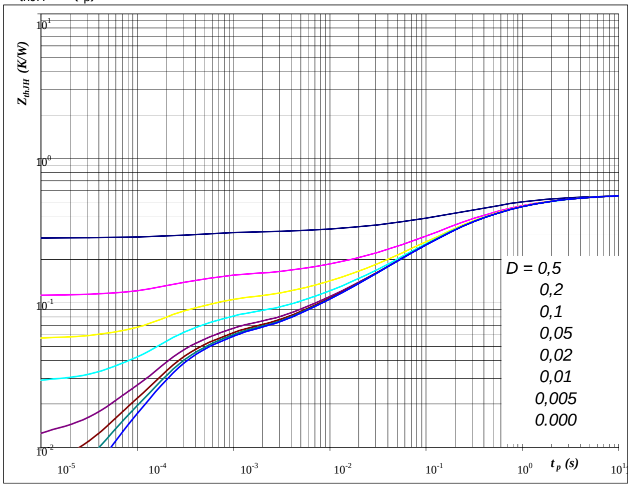
At

T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Figure 19	MOSFET

MOSFET transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	0,56	K/W

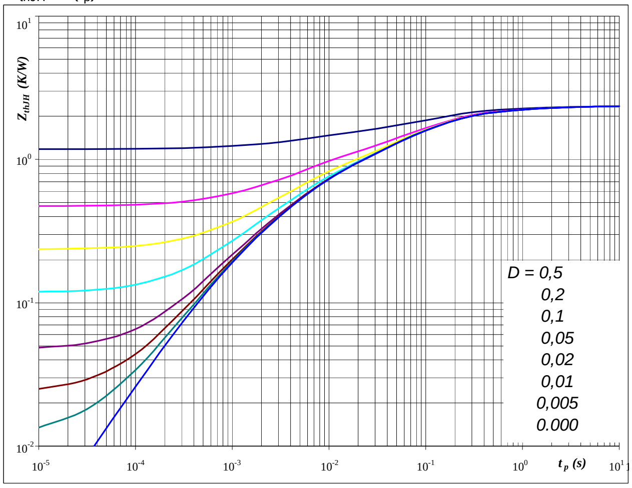
IGBT thermal model values

R (C/W)	Tau (s)
0,04	8,6E+00
0,13	1,4E+00
0,23	2,2E-01
0,09	3,6E-02
0,03	5,0E-03
0,05	2,6E-04

Figure 20	FRED

FRED transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	2,36	K/W

FRED thermal model values

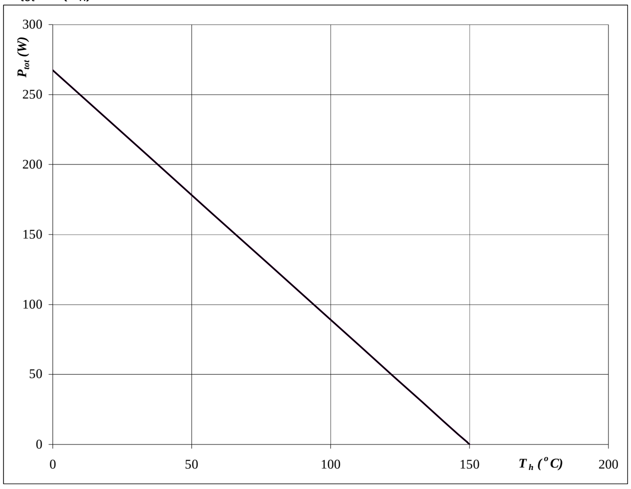
R (C/W)	Tau (s)
0,07	5,2E+00
0,25	8,9E-01
0,97	1,3E-01
0,54	2,8E-02
0,45	4,1E-03
0,08	6,2E-04

Buck

Figure 21 MOSFET

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



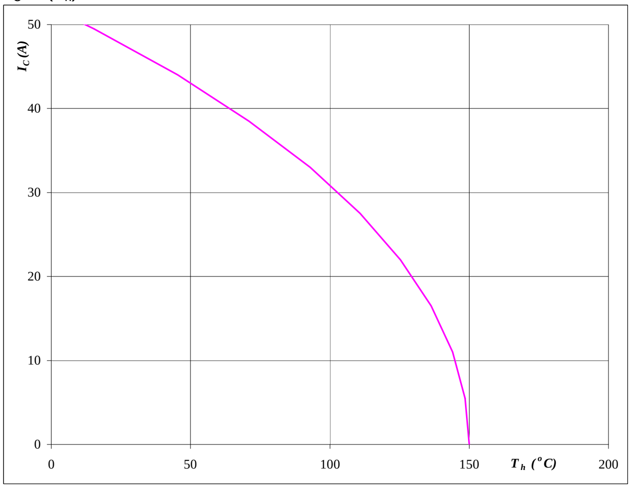
At

T_j = 150 °C

Figure 22 MOSFET

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

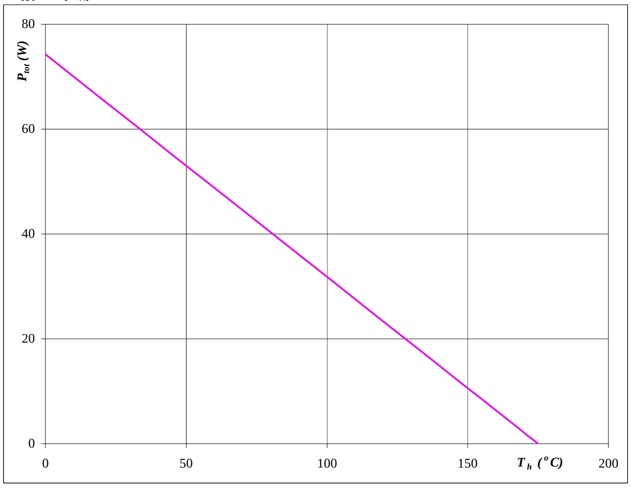
T_j = 150 °C

V_{GE} = 15 V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



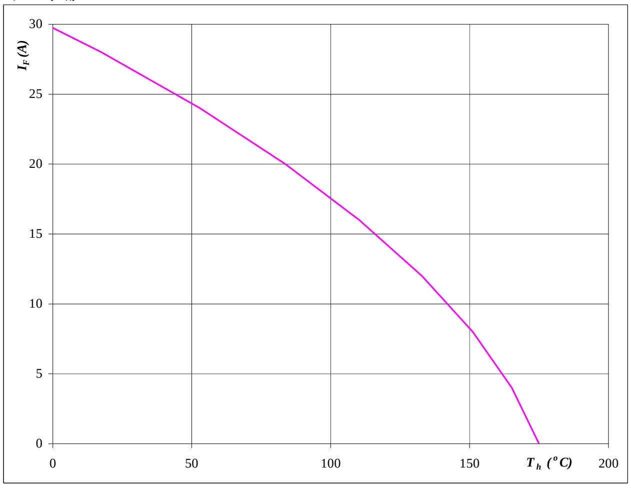
At

T_j = 175 °C

Figure 24 FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

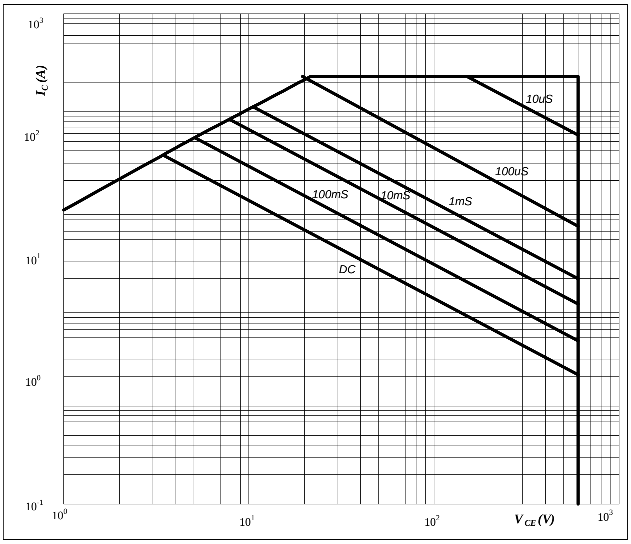
T_j = 175 °C

Buck

Figure 25 MOSFET

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



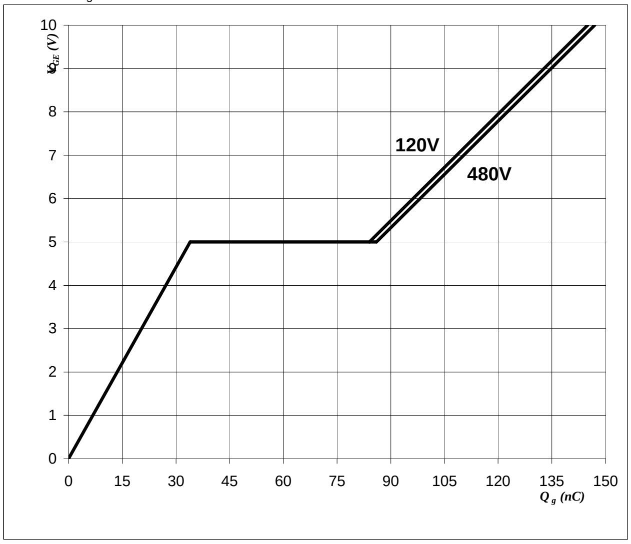
At

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

Figure 26 MOSFET

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



At

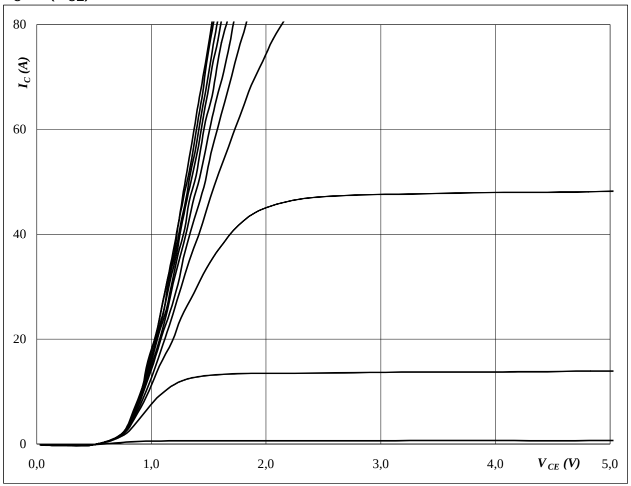
I_C =	44	A

Boost

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

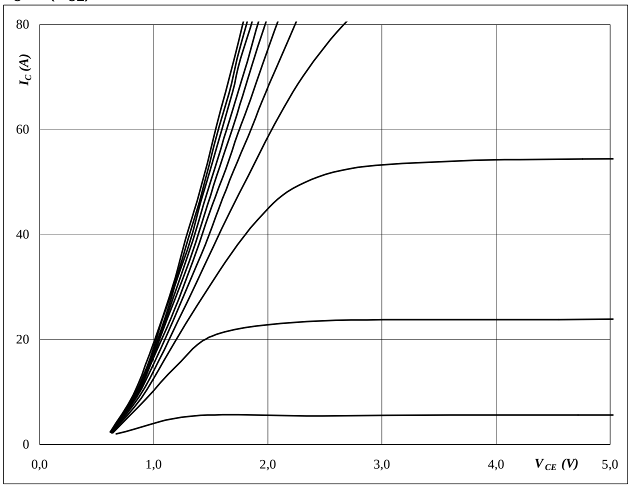
T_j = 25 °C

V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

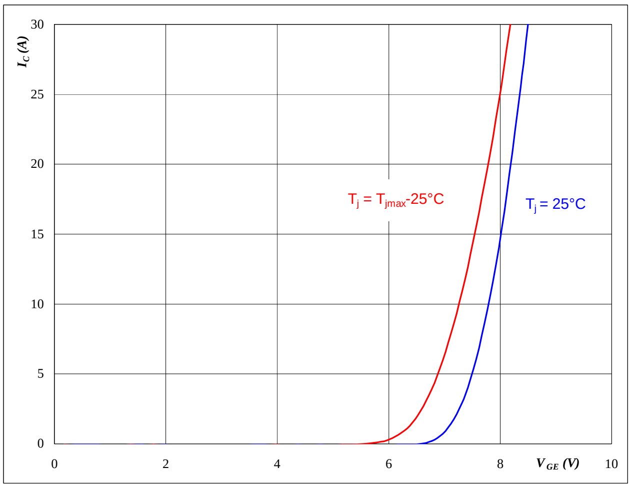
T_j = 125 °C

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

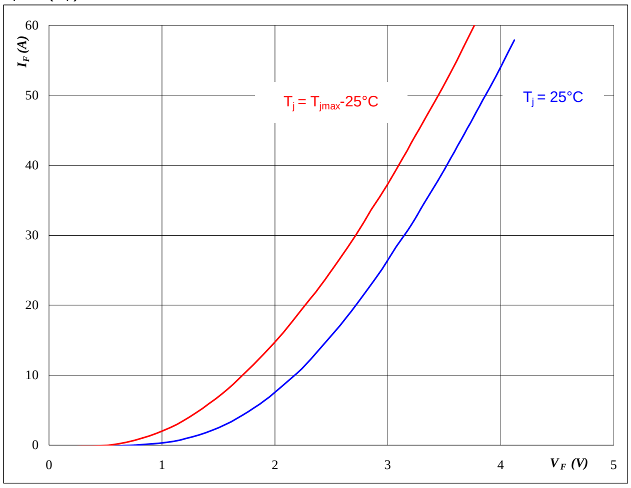
t_p = 250 µs

V_{CE} = 10 V

Figure 4 FRED

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



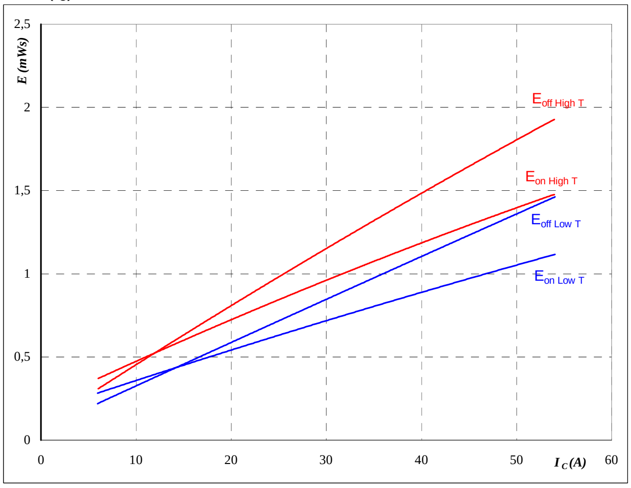
At

t_p = 250 µs

Boost

Figure 5 IGBT

Typical switching energy losses
as a function of collector current
E = f(I_C)

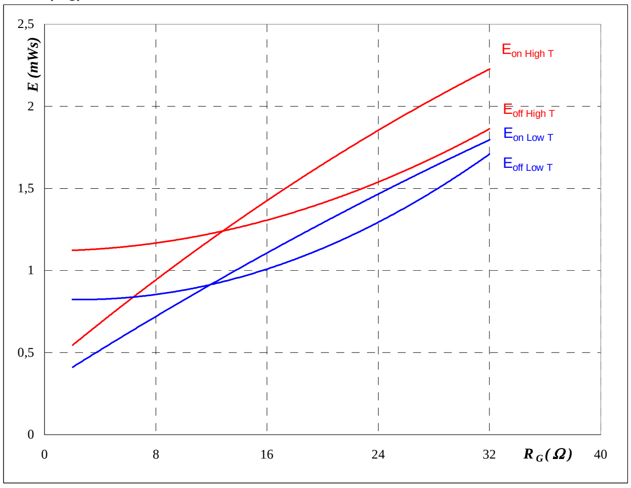


With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 6 IGBT

Typical switching energy losses
as a function of gate resistor
E = f(R_G)

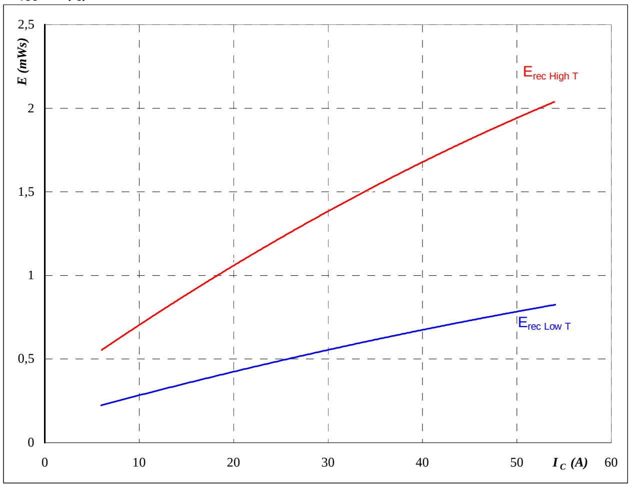


With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Figure 7 FRED

Typical reverse recovery energy loss
as a function of collector current
E_{rec} = f(I_c)

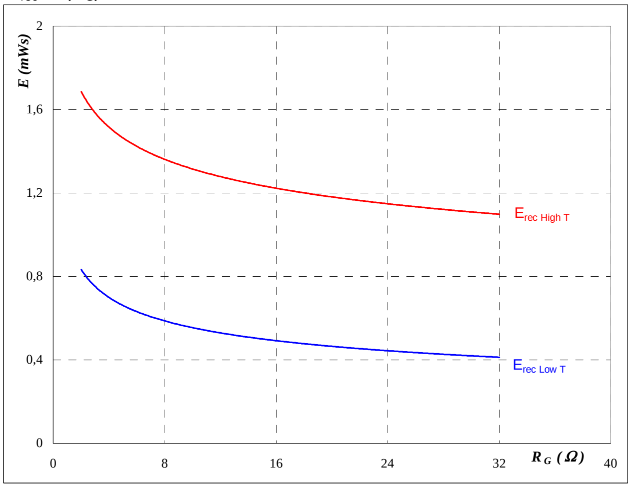


With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 8 FRED

Typical reverse recovery energy loss
as a function of gate resistor
E_{rec} = f(R_G)



With an inductive load at

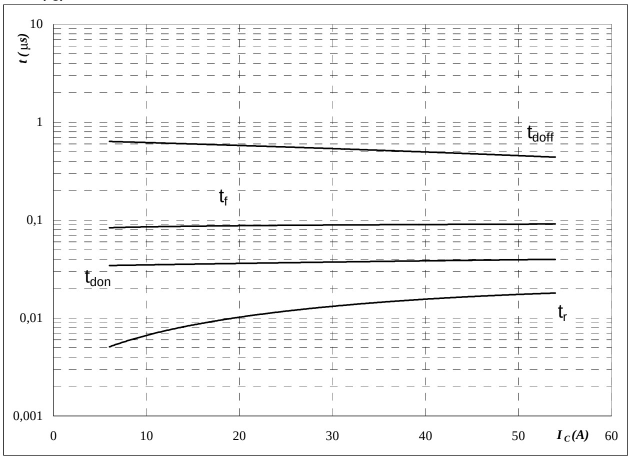
T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Boost

Figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



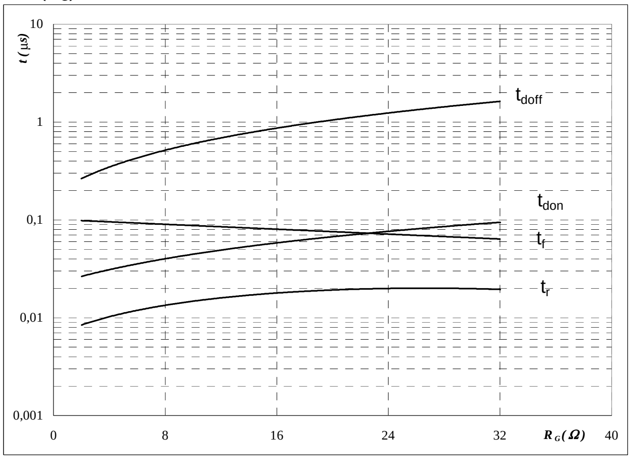
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 10 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



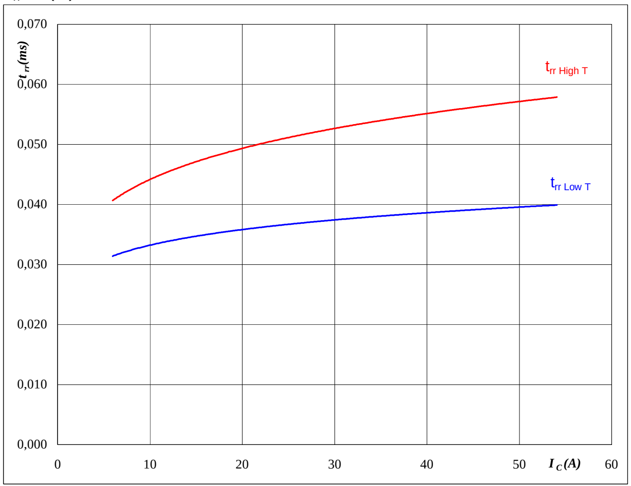
With an inductive load at

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Figure 11 FRED

Typical reverse recovery time as a function of collector current

$t_{rr} = f(Ic)$



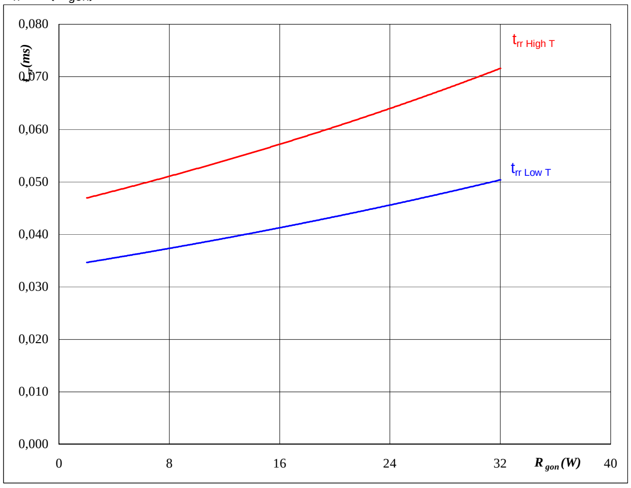
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 12 FRED

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

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



At

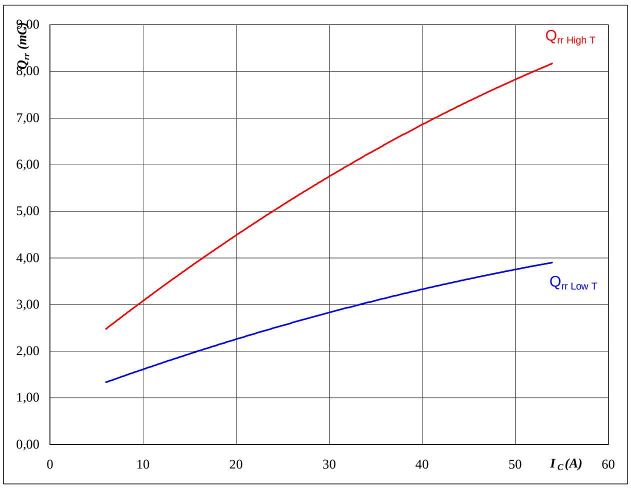
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Boost

Figure 13 FRED

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



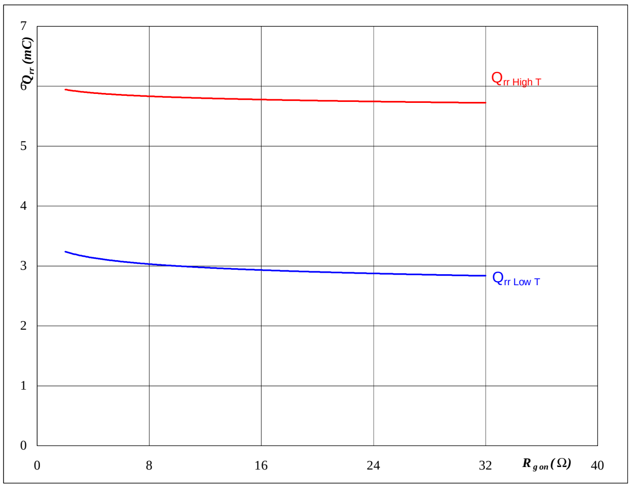
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 14 FRED

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

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



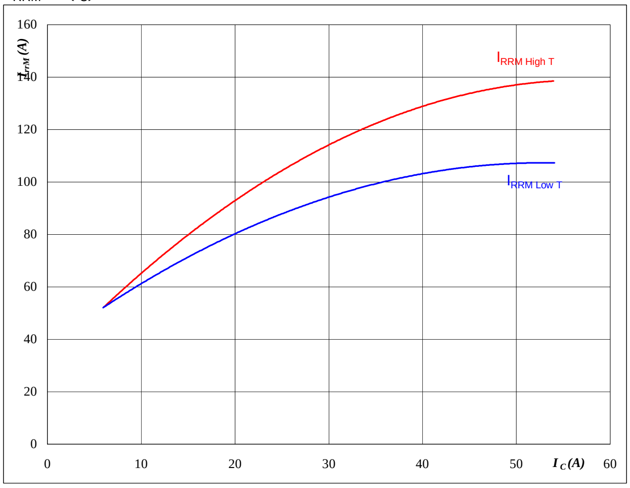
At

T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Figure 15 FRED

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



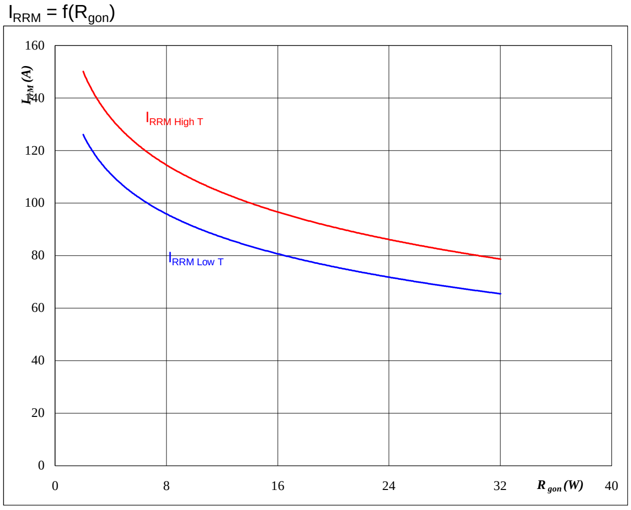
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 16 FRED

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

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



At

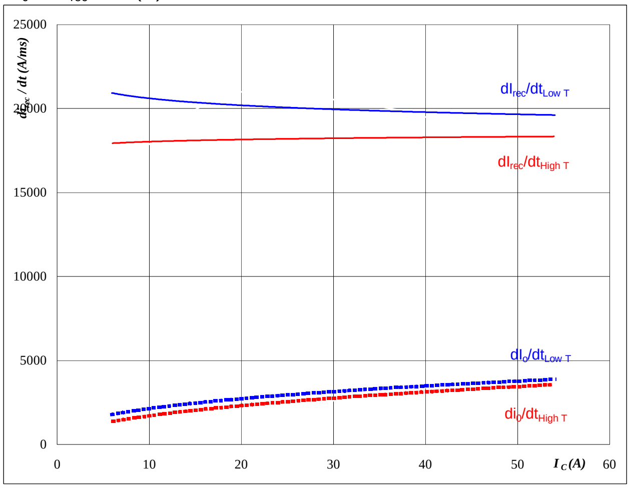
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Boost

Figure 17	FRED

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

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



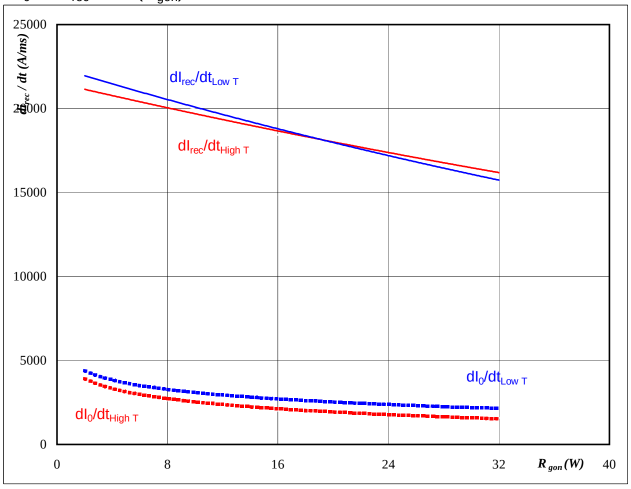
At

T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
R_{gon} =	8	Ω

Figure 18	FRED

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

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



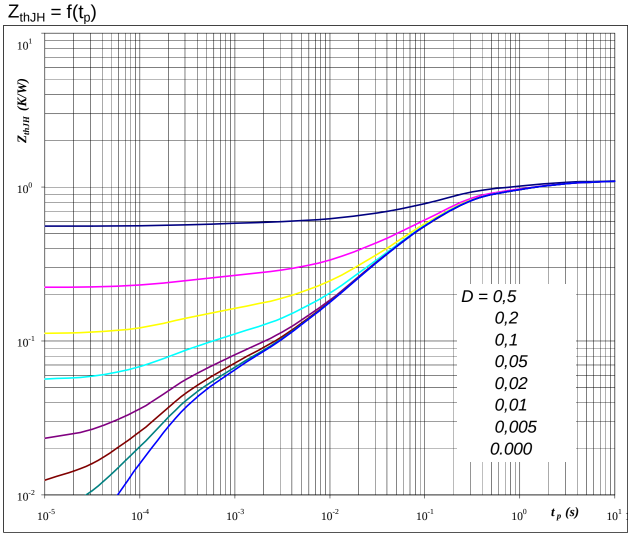
At

T_j =	25/125	°C
V_R =	350	V
I_F =	30	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} =	1,11	K/W

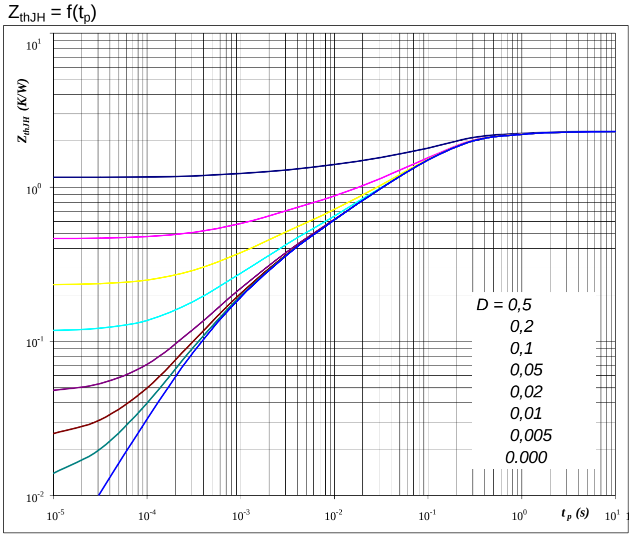
IGBT thermal model values

R (C/W)	Tau (s)
0,06	9,9E+00
0,22	1,2E+00
0,59	1,4E-01
0,17	2,2E-02
0,03	2,7E-03
0,04	2,7E-04

Figure 20	FRED

FRED transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	tp / T	
R_{thJH} =	2,32	K/W

FRED thermal model values

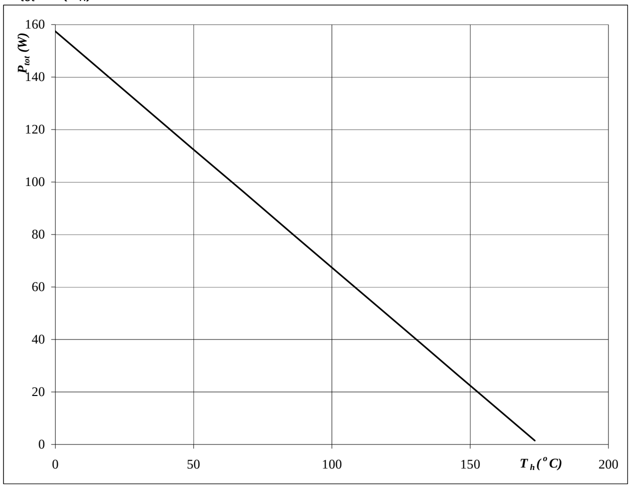
R (C/W)	Tau (s)
0,04	9,8E+00
0,25	7,7E-01
1,24	1,2E-01
0,44	2,0E-02
0,25	2,6E-03
0,09	4,3E-04

Boost

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



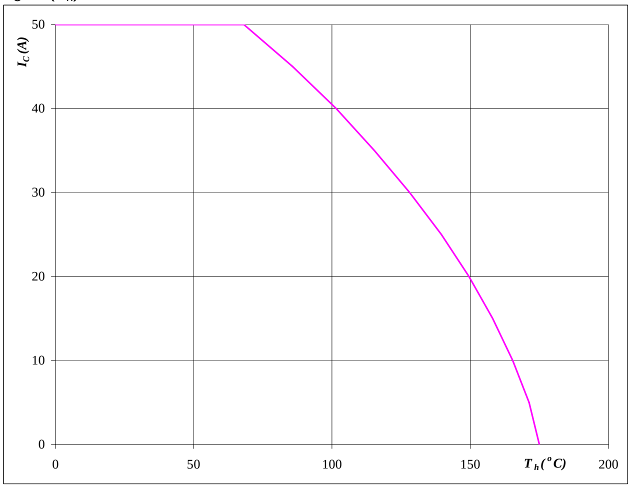
At

T_j = 175 ºC

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

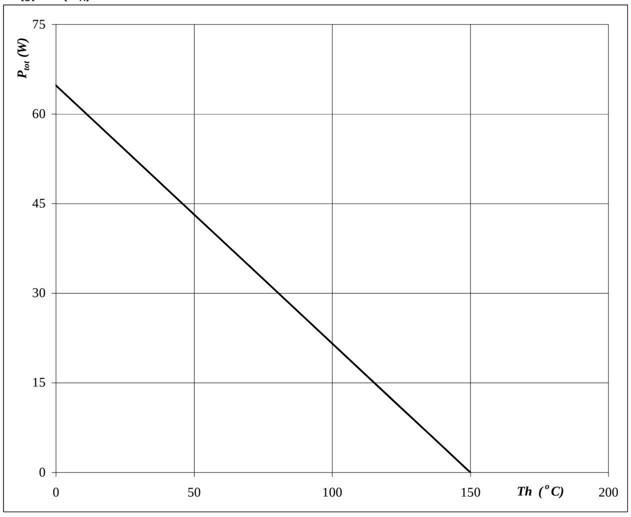
T_j = 175 ºC

V_{GE} = 15 V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



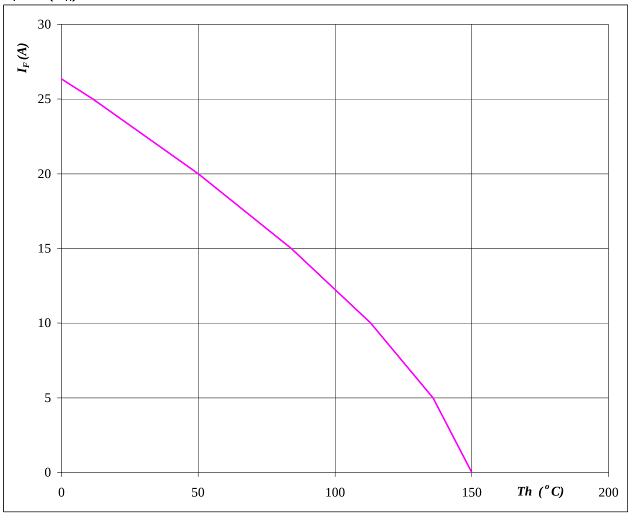
At

T_j = 150 ºC

Figure 24 FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

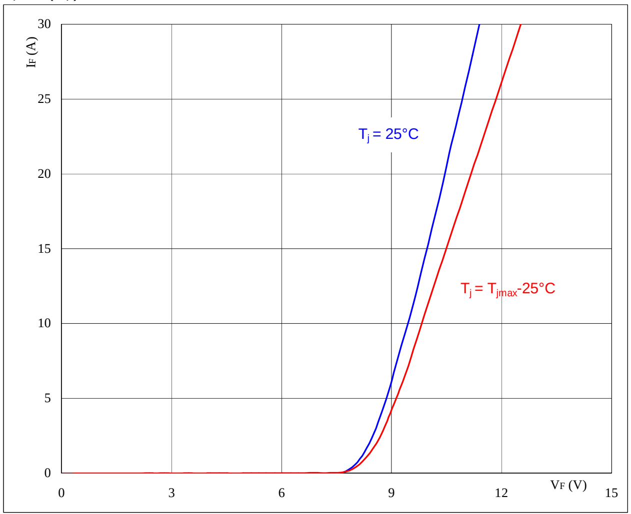
T_j = 150 ºC

Boost

Figure 25 Boost Inverse Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



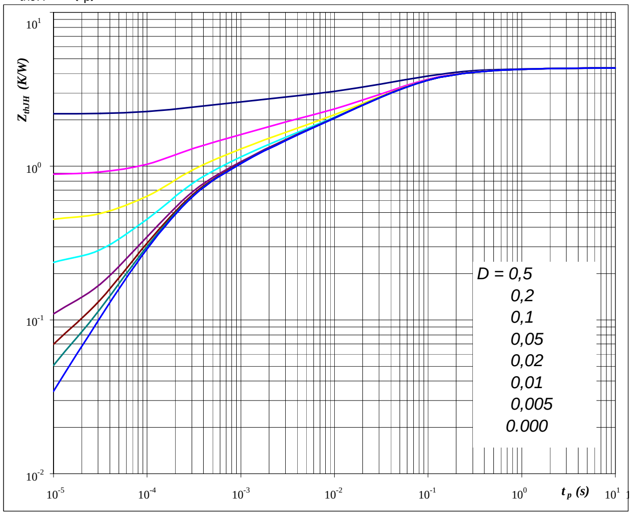
At

t_p = 250 µs

Figure 26 Boost Inverse Diode

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D = tp / T

R_{thJH} = 4,36 K/W

Thermistor

Figure 1 Thermistor

Typical NTC characteristic
as a function of temperature

$R_T = f(T)$

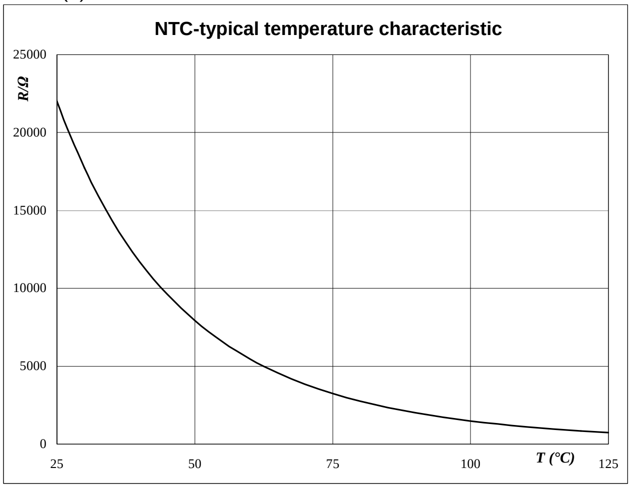


Figure 2 Thermistor

Typical NTC resistance values

$$R(T) = R_{25} \cdot e^{\left(B_{25/100} \cdot \left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right)} \quad [\Omega]$$

T [°C]	R_soll [Ω]	R_min [Ω]	R_max [Ω]	△R/R [+-%]
-50	1458070,6	1069249,3	1846891,9	26,7
0	71804,2	59724,4	83884	16,8
10	43780,4	37094,4	50466,5	15,3
20	27484,6	23684,6	31284,7	13,8
25	22000	19109,3	24890,7	13,1
30	17723,3	15512,2	19934,4	12,5
60	5467,9	4980,6	5955,1	8,9
70	3848,6	3546	4151,1	7,9
80	2757,7	2568,2	2947,1	6,9
90	2008,9	1889,7	2128,2	5,9
100	**1486,1**	**1411,8**	**1560,4**	**5**
150	400,2	364,8	435,7	8,8

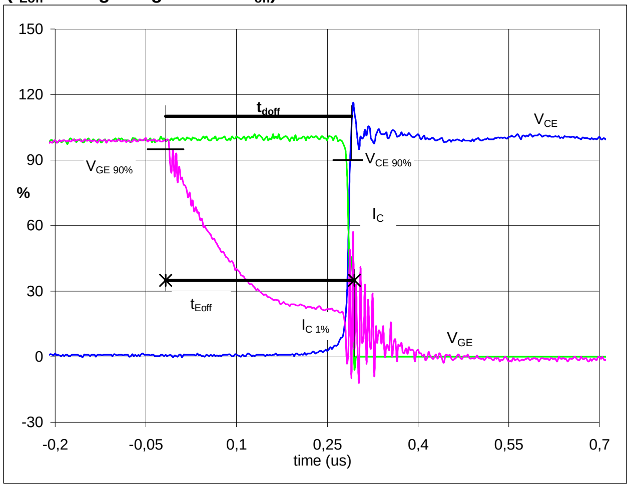
Switching Definitions BUCK MOSFET

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

Figure 1 BUCK MOSFET

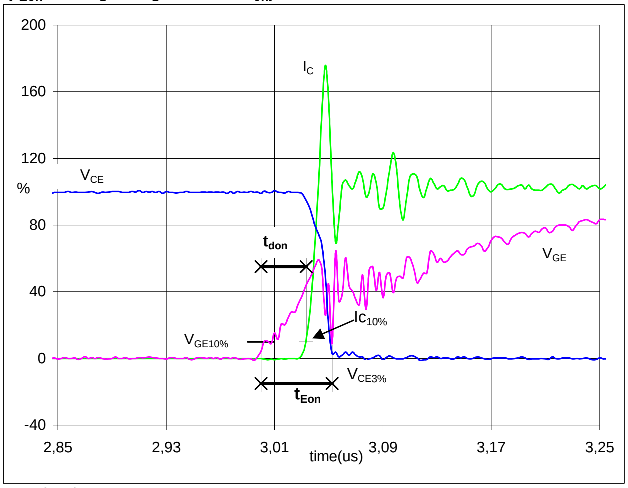
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
t_{doff} =	0,30	μs
t_{Eoff} =	0,31	μs

Figure 2 BUCK MOSFET

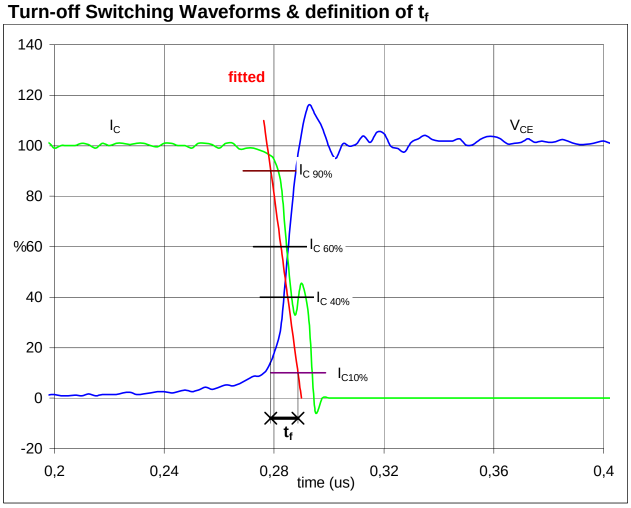
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
t_{don} =	0,03	μs
t_{Eon} =	0,05	μs

Figure 3 BUCK MOSFET

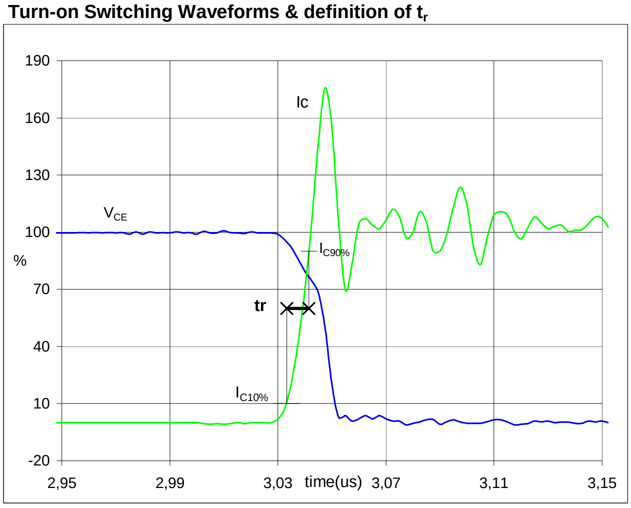
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	30	A
t_f =	0,01	μs

Figure 4 BUCK MOSFET

Turn-on Switching Waveforms & definition of t_r

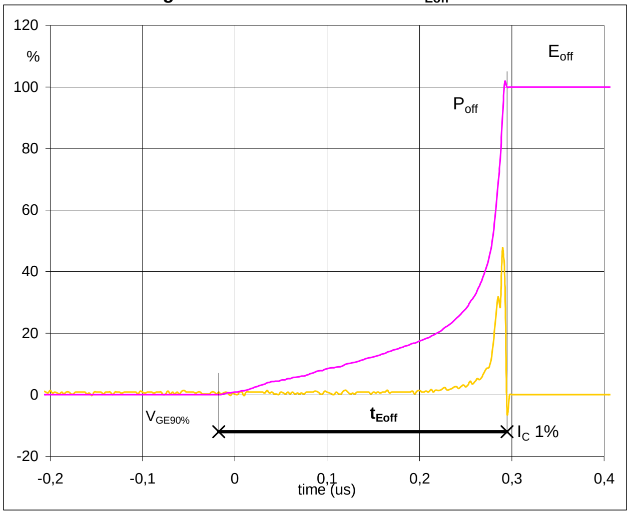


V_C (100%) =	350	V
I_C (100%) =	30	A
t_r =	0,01	μs

Switching Definitions BUCK MOSFET

Figure 5 BUCK MOSFET

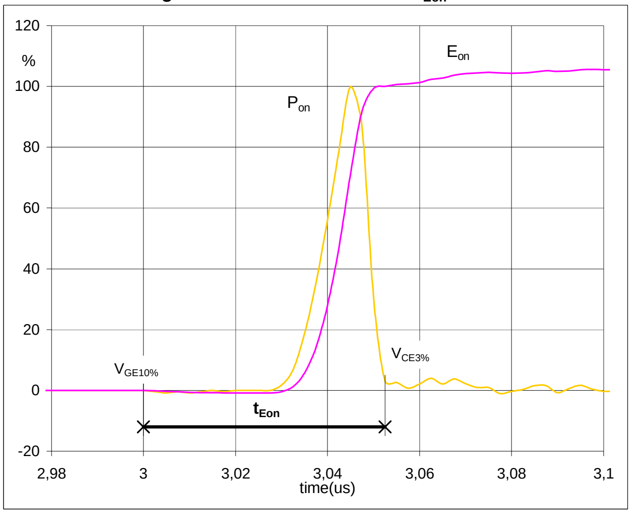
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	10,43	kW
E_{off} (100%) =	0,09	mJ
t_{Eoff} =	0,31	μs

Figure 6 BUCK MOSFET

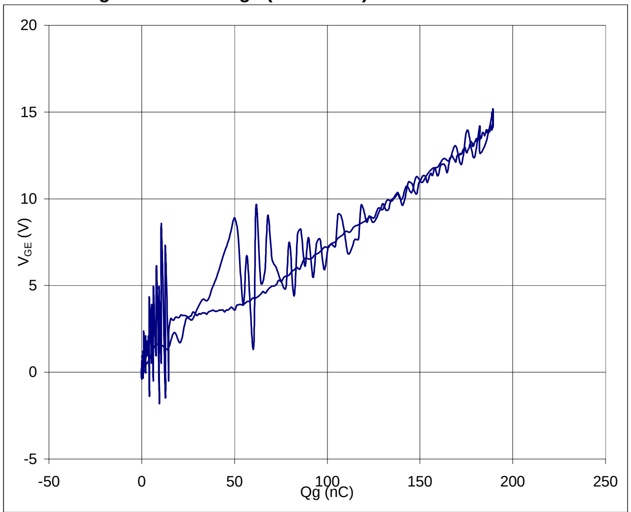
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	10,43	kW
E_{on} (100%) =	0,11	mJ
t_{Eon} =	0,05	μs

Figure 7 BUCK MOSFET

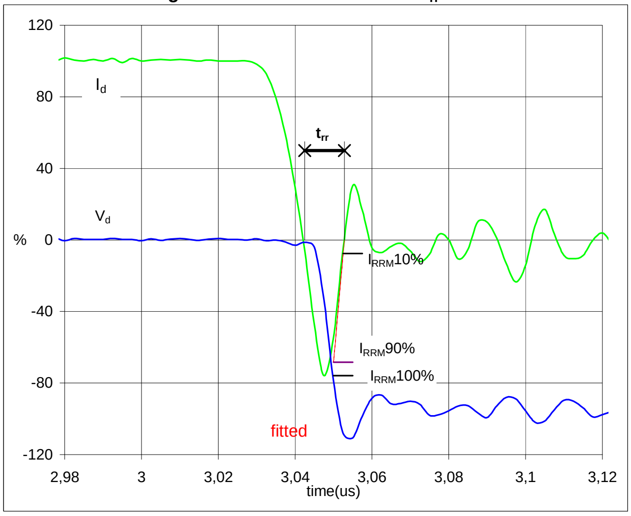
Gate voltage vs Gate charge (measured)



V_{GEoff} =	0	V
V_{GEon} =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
Q_g =	189,26	nC

Figure 8 BUCK FRED

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

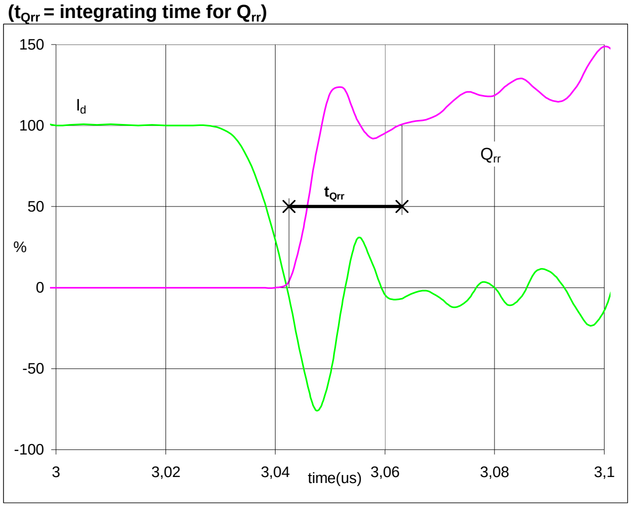


V_d (100%) =	350	V
I_d (100%) =	30	A
I_{RRM} (100%) =	-23	A
t_{rr} =	0,01	μs

Switching Definitions BUCK MOSFET

Figure 9 BUCK FRED

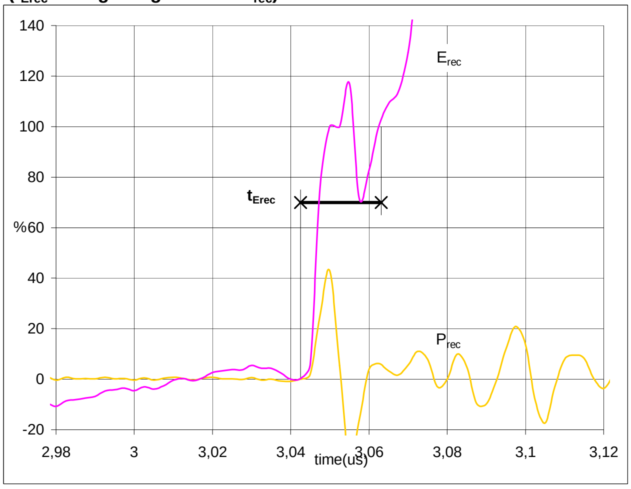
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	30	A
Q_{rr} (100%) =	0,11	μC
t_{Qrr} =	0,02	μs

Figure 10 BUCK FRED

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



P_{rec} (100%) =	10,43	kW
E_{rec} (100%) =	0,01	mJ
t_{Erec} =	0,02	μs

Measurement circuits

Figure 11

BUCK stage switching measurement circuit

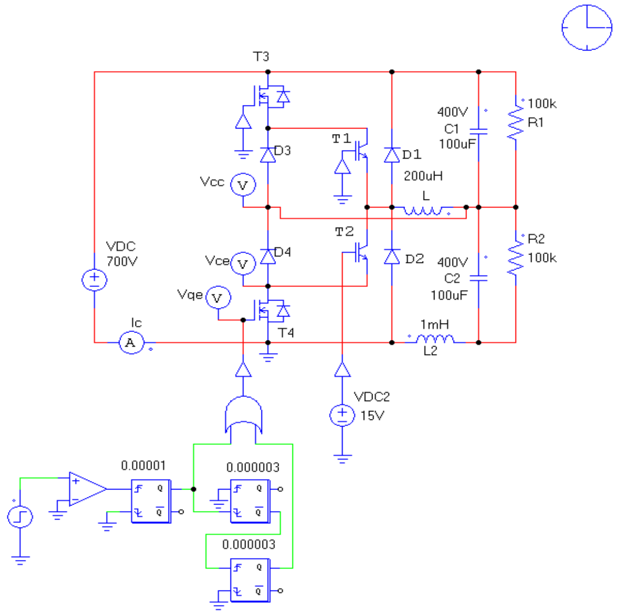
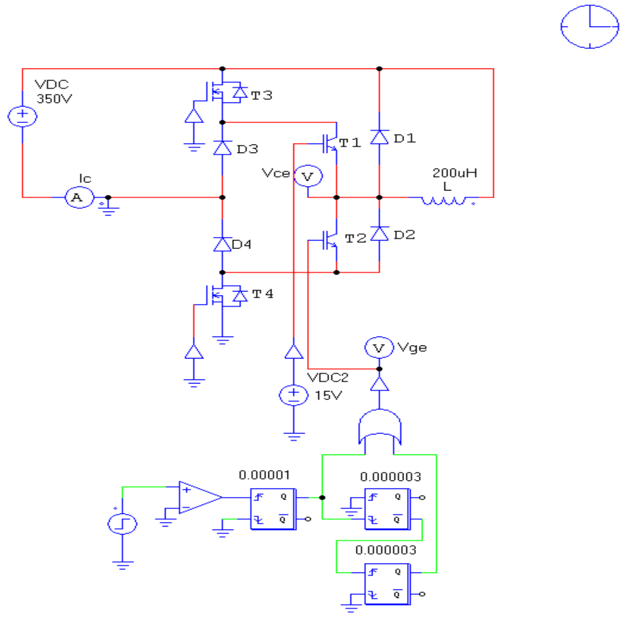


Figure 12

BOOST stage switching measurement circuit



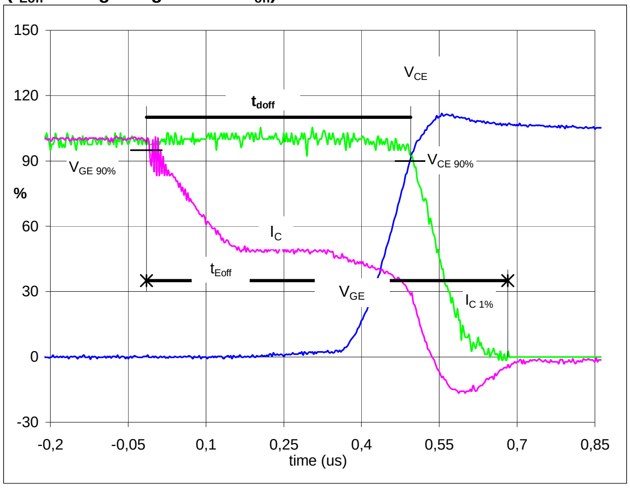
Switching Definitions Boost IGBT

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

Figure 1 BOOST IGBT

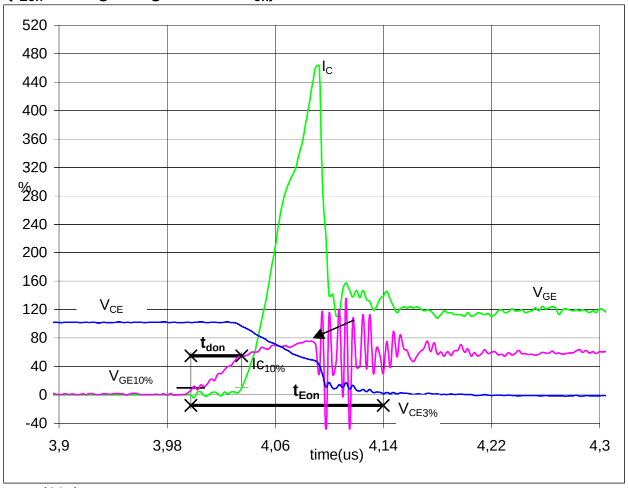
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
t_{doff} =	0,50	μs
t_{Eoff} =	0,70	μs

Figure 2 BOOST IGBT

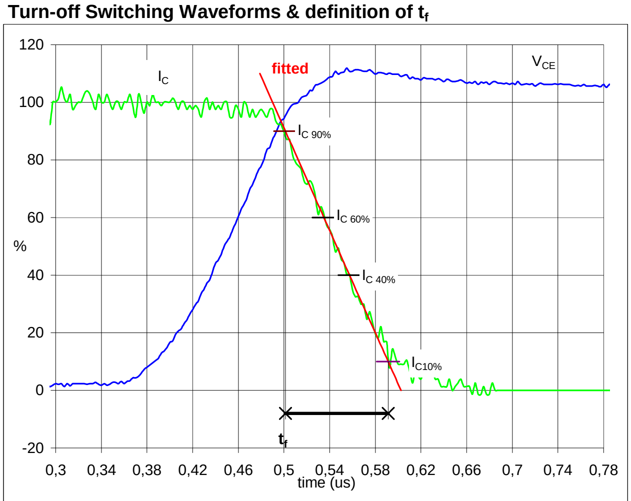
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
t_{don} =	0,04	μs
t_{Eon} =	0,14	μs

Figure 3 BOOST IGBT

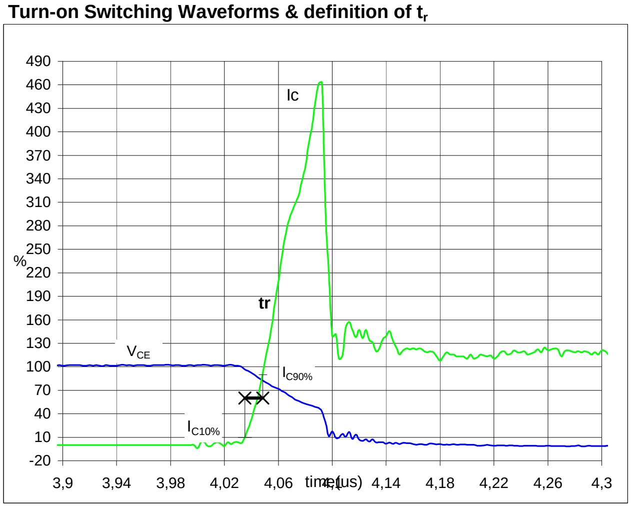
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	30	A
t_f =	0,09	μs

Figure 4 BOOST IGBT

Turn-on Switching Waveforms & definition of t_r

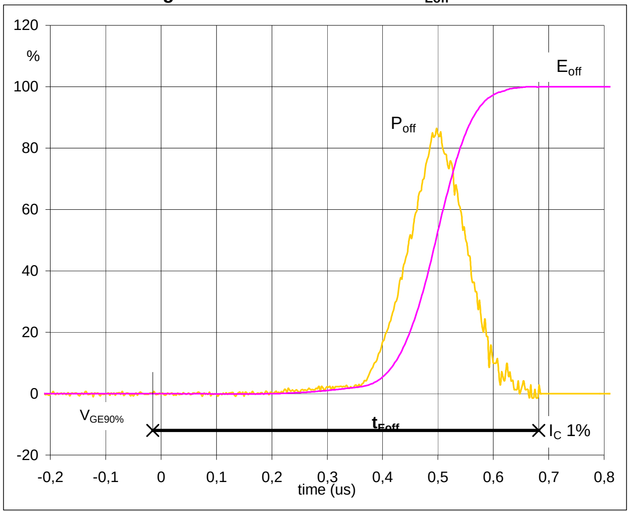


V_C (100%) =	350	V
I_C (100%) =	30	A
t_r =	0,01	μs

Switching Definitions Boost IGBT

Figure 5 BOOST IGBT

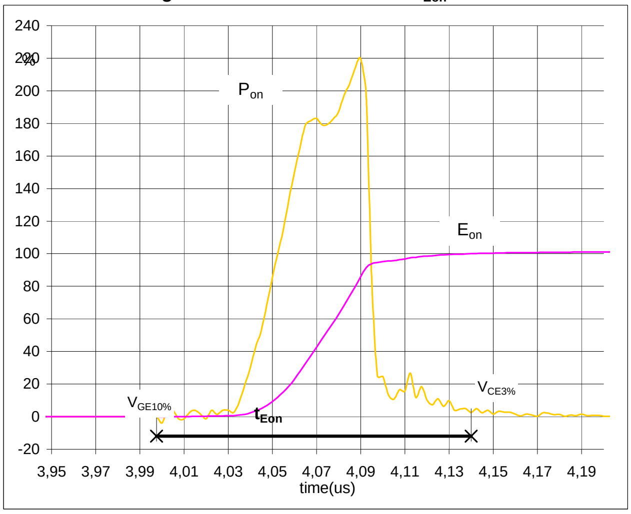
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	10,55	kW
E_{off} (100%) =	1,16	mJ
t_{Eoff} =	0,70	μs

Figure 6 BOOST IGBT

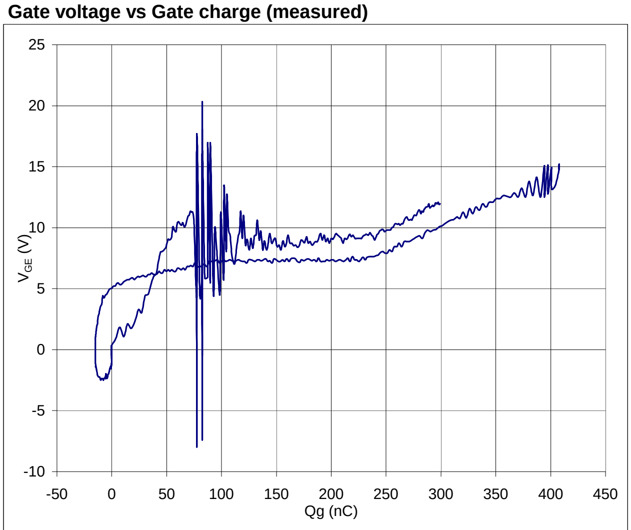
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	10,55	kW
E_{on} (100%) =	0,96	mJ
t_{Eon} =	0,14	μs

Figure 7 BOOST IGBT

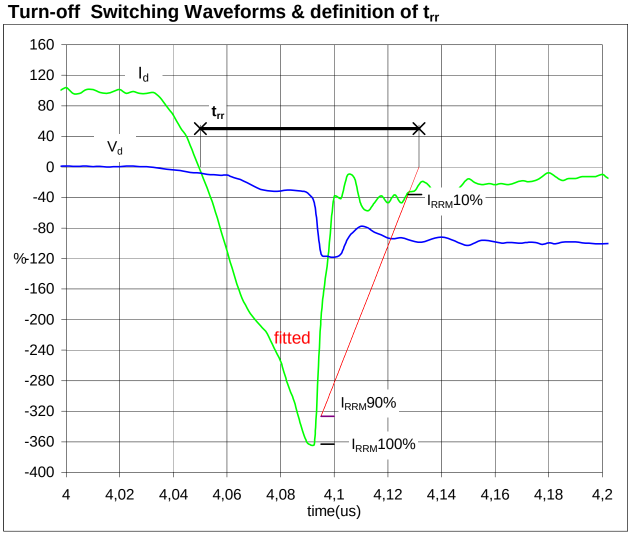
Gate voltage vs Gate charge (measured)



V_{GEoff} =	0	V
V_{GEon} =	15	V
V_C (100%) =	350	V
I_C (100%) =	30	A
Q_g =	407,76	nC

Figure 8 BOOST FRED

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

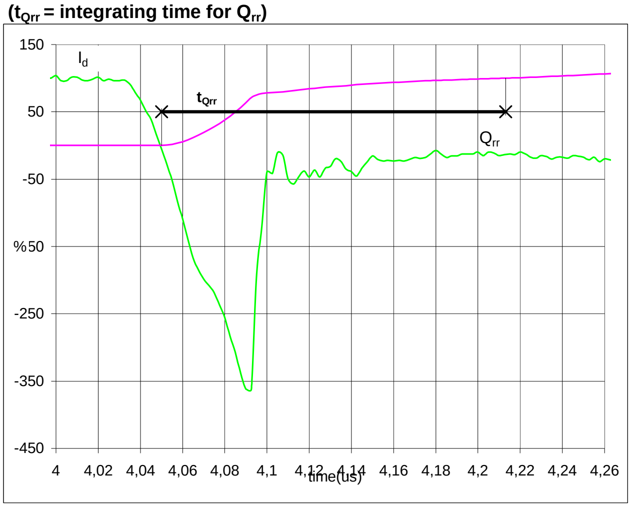


V_d (100%) =	350	V
I_d (100%) =	30	A
I_{RRM} (100%) =	-112	A
t_{rr} =	0,05	μs

Switching Definitions Boost IGBT

Figure 9 BOOST FRED

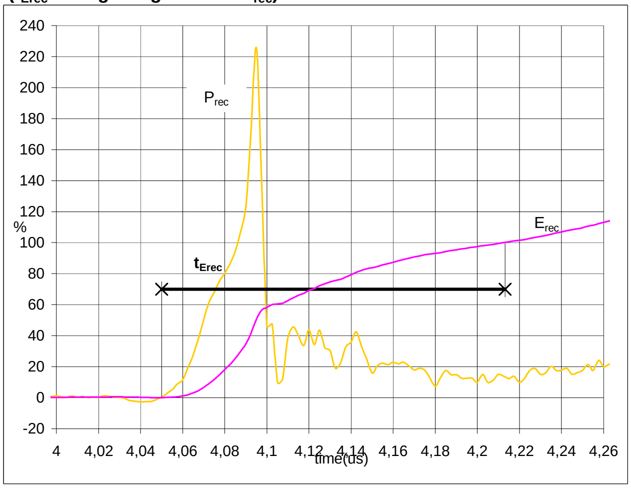
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	30	A
Q_{rr} (100%) =	5,74	µC
t_{Qrr} =	0,16	µs

Figure 10 BOOST FRED

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



P_{rec} (100%) =	10,55	kW
E_{rec} (100%) =	1,39	mJ
t_{Erec} =	0,16	µs

Measurement circuits

Figure 11

BUCK stage switching measurement circuit

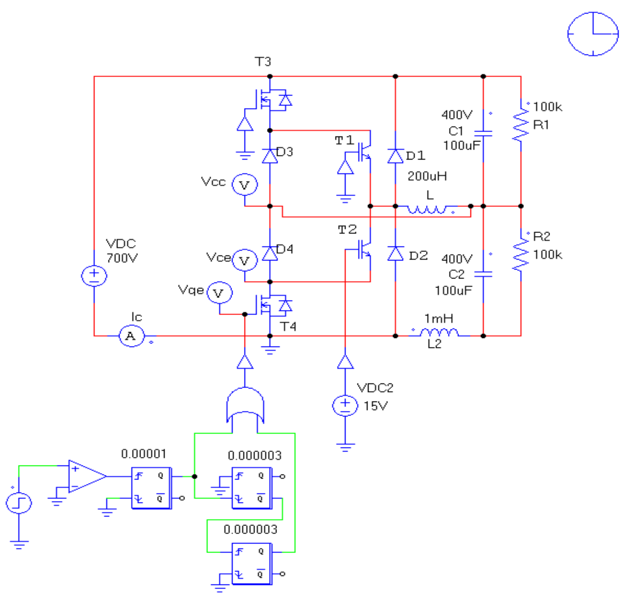
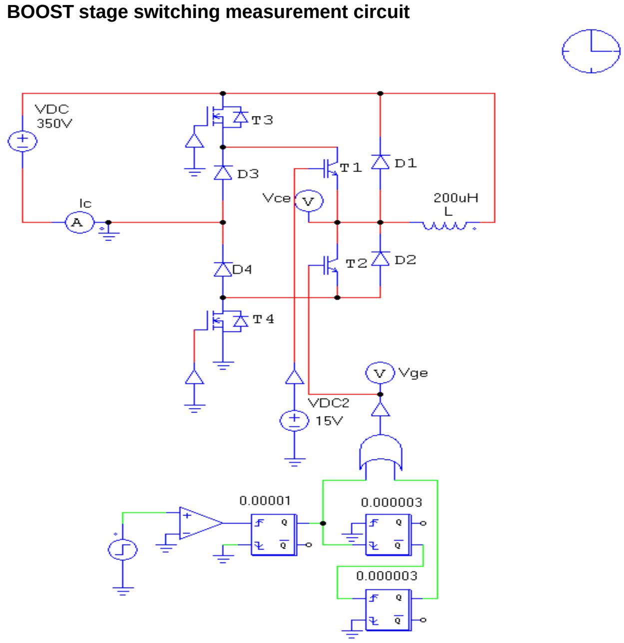


Figure 12

BOOST stage switching measurement circuit



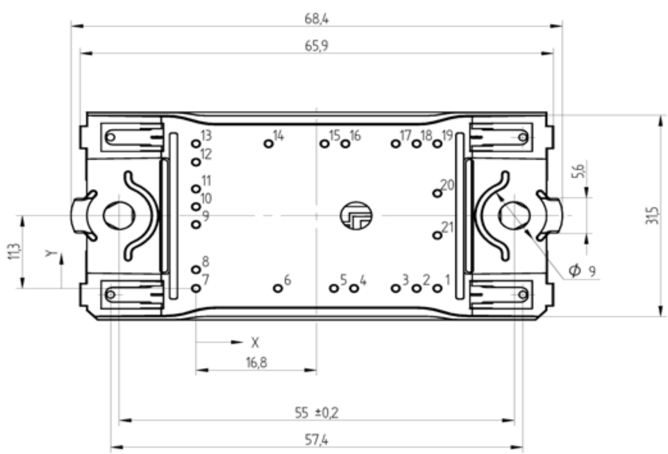
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

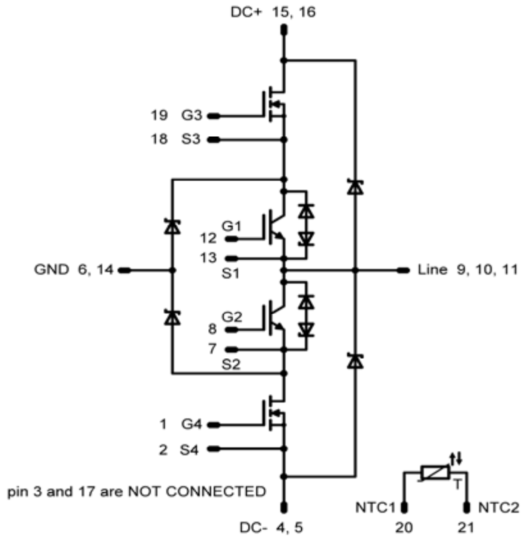
Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste 12mm housing	10-FZ06NRA045FH-P965F	P965F	P965F

Outline

Pin table		
Pin	X	Y
1	33,6	0
2	30,7	0
3	27,8	0
4	22	0
5	19,2	0
6	11,4	0
7	0	0
8	0	2,9
9	0	9,9
10	0	12,7
11	0	15,5
12	0	19,7
13	0	22,6
14	10,1	22,6
15	17,9	22,6
16	20,8	22,6
17	27,8	22,6
18	30,7	22,6
19	33,6	22,6
20	33,6	14,8
21	33,6	8,2



Pinout



PRODUCT STATUS DEFINITIONS

Datasheet Status	Product Status	Definition
Target	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice. The data contained is exclusively intended for technically trained staff.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data may be published at a later date. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.
Final	Full Production	This datasheet contains final specifications. Vincotech reserves the right to make changes at any time without notice in order to improve design. The data contained is exclusively intended for technically trained staff.

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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.