flowNPC 0 — 600V/50A & 45A PS*

Features

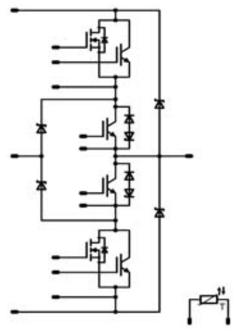
- *PS: 45A parallel switch (40A PT and 99mΩ)
- neutral point clamped inverter
- reactive power capability
- low inductance layout

flow0 12mm housing

Target Applications

- solar inverter
- UPS

Schematic



Types

- FZ06NPA045FP01

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Buck 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	31 41	A
Repetitive peak collector current	I_{Cpulse}	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	54 82	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150°C V_{GE}=15V		3 390	µs V
Maximum Junction Temperature	$T_j$max			150	°C
Buck Diode					
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	21 29	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max	T_c=100°C	120	A
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80°C T_c=80°C	41 62	W
Maximum Junction Temperature	$T_j$max			150	°C

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Buck MOSFET					
Drain to source breakdown voltage	V_{DS}			600	V
DC drain current	I_D	$T_j=T_j$max	T_h=80°C T_c=80°C	16 21	A
Pulsed drain current	I_{Dpulse}	t_p limited by $T_j$max	Tc=25°C	93	A
Power dissipation	P_{tot}	$T_j=T_j$max	T_h=80°C T_c=80°C	54 97	W
Gate-source peak voltage	Vgs			±20	V
Maximum Junction Temperature	$T_j$max			150	°C
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	50 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	15 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

Maximum Ratings

Tj=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
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					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	
Buck IGBT *										
Gate emitter threshold voltage	$V_{GE(th)}$	VCE=VGE			0.00025	Tj=25°C Tj=125°C	4.5	5.5	7	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		45	Tj=25°C Tj=125°C		2.21 2.21	3 2.6	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		Tj=25°C Tj=125°C			250	mA
Gate-emitter leakage current	I_{GES}		±20	0		Tj=25°C Tj=125°C			300	nA
Integrated Gate resistor	R_{gint}							none		Ω
Input capacitance **	C_{ies}							2,2+4,7		nF
Output capacitance	C_{oss}	f=1MHz	0	25		Tj=25°C		150		pF
Reverse transfer capacitance	C_{rss}							80		
Gate charge **	Q_{Gate}		15	300	20	Tj=25°C		142+70		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1.30		K/W

* see dinamic characteristic at **Buck MosFET**
**additional value stands for built-in capacitor

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				30	Tj=25°C Tj=125°C		3.18 2.37	3.3	V
Peak reverse recovery current	I_{RRM}					Tj=25°C Tj=125°C		75 84		A
Reverse recovery time	t_{rr}					Tj=25°C Tj=125°C		12.3 20.0		ns
Reverse recovered charge	Q_{rr}	Rgon=8 Ω	±15	350	30	Tj=25°C Tj=125°C		0.43 0.99		μC
Peak rate of fall of recovery current	di(rec)max/dt					Tj=25°C Tj=125°C		22562 15818		A/μs
Reverse recovered energy	Erec					Tj=25°C Tj=125°C		0.11 0.18		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1.72		K/W
Buck MOSFET										
Static drain to source ON resistance	$R_{ds(on)}$		15		15	Tj=25°C Tj=125°C		109 219		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			10	uA
Turn On Delay Time	$t_{d(ON)}$					Tj=25°C Tj=125°C		104 99		
Rise Time	t_r					Tj=25°C Tj=125°C		8 8		ns
Turn off delay time	$t_{d(OFF)}$	Rgon=8 Ω ** Rgoff=8 Ω **	±15	350	30	Tj=25°C Tj=125°C		250 258		
Fall time	t_f					Tj=25°C Tj=125°C		18 4		
Turn-on energy loss per pulse	E_{on}					Tj=25°C Tj=125°C		0.08 0.24		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		0.06 0.12		
Total gate charge	Q_g							60	80	
Gate to source charge	Q_{gs}		±15	350	30	Tj=25°C		14		nC
Gate to drain charge	Q_{gd}							20		
Input capacitance	C_{iss}	f=1MHz	0	100		Tj=25°C		2800		pF
Output capacitance	C_{oss}							130		
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1.29		K/W

** see schematic of the Gate-complex at characteristic figures

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	Value Min	Typ	Max	Unit
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		45	Tj=25°C Tj=125°C	1	1.28 1.31	1.9	V
Collector-emitter cut-off incl diode	I_{CES}		0	600		Tj=25°C Tj=125°C			0.03	mA
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		0.72 0.96		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25°C Tj=125°C		0.85 1.16		
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	2.61 2.16	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	±15	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

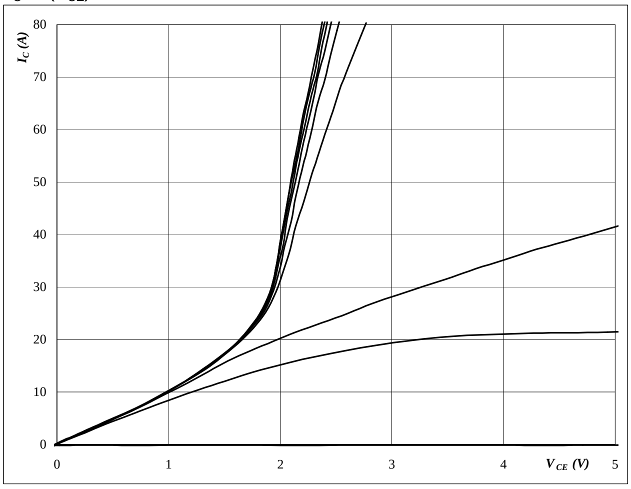
* see details on **Thermistor** charts on ***Figure 2.***

Buck

Figure 1 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$



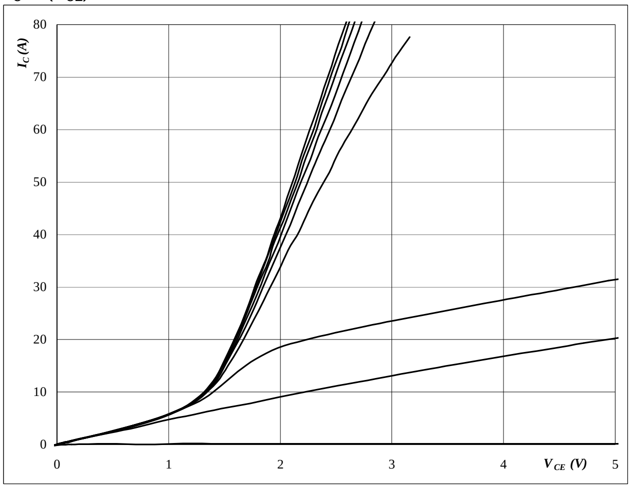
At

t_p =	250	μs
T_j =	25	°C
V_{GE} from	3 V to 19 V in steps of 2 V	

Figure 2 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$



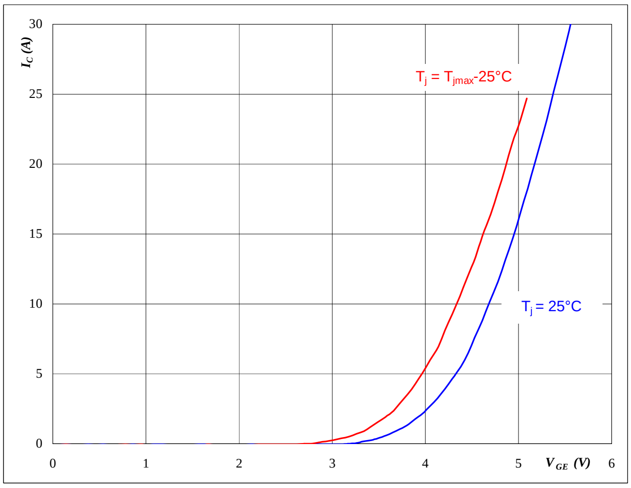
At

t_p =	250	μs
T_j =	125	°C
V_{GE} from	3 V to 19 V in steps of 2 V	

Figure 3 MOSFET

Typical transfer characteristics

$I_C = f(V_{GE})$



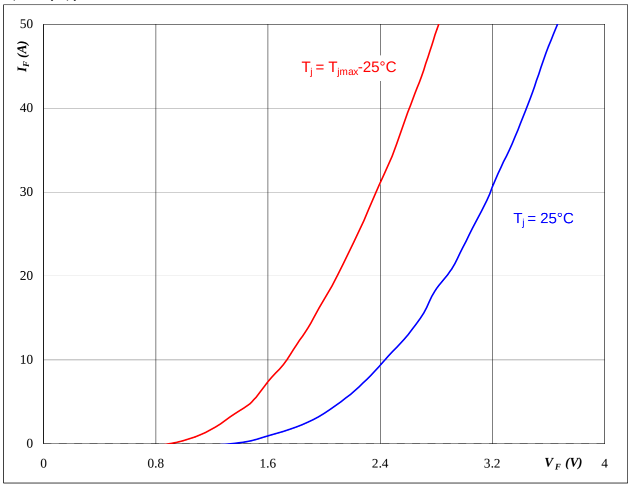
At

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

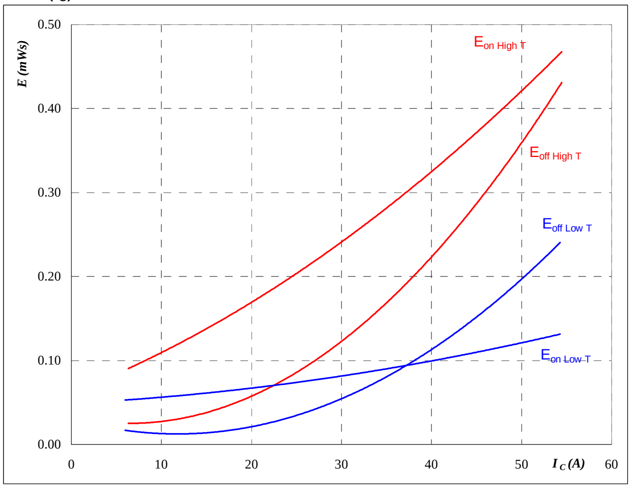
t_p =	250	μs

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

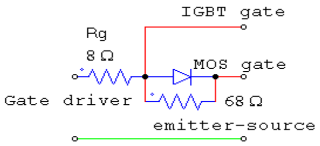
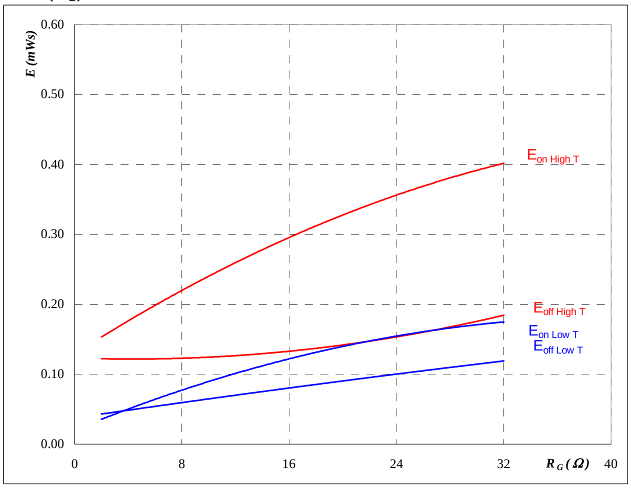


Figure 6 MOSFET

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

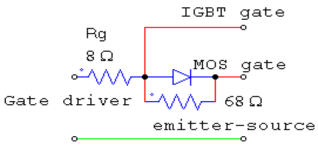
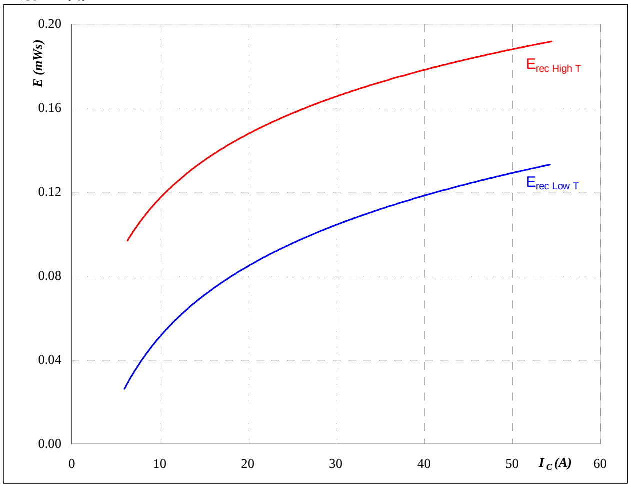


Figure 7 FRED

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

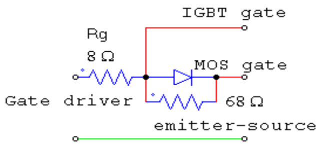
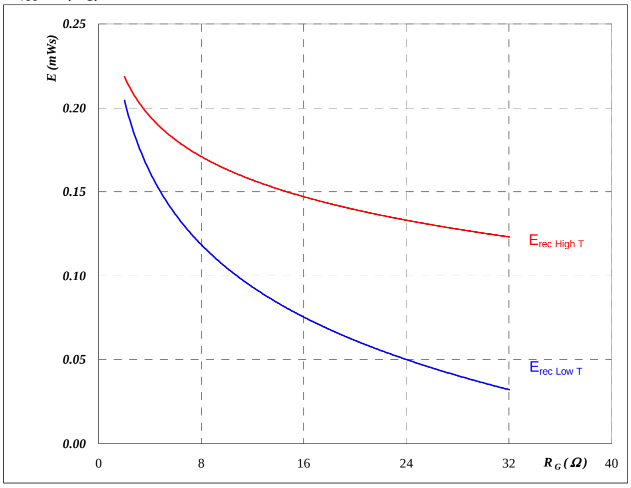


Figure 8 FRED

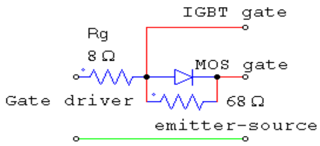
Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

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

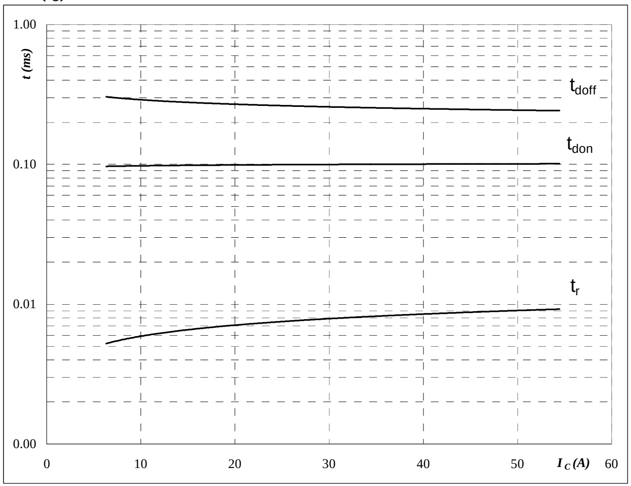


Buck

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

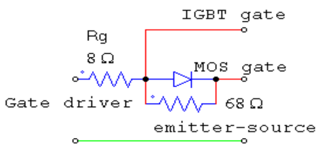
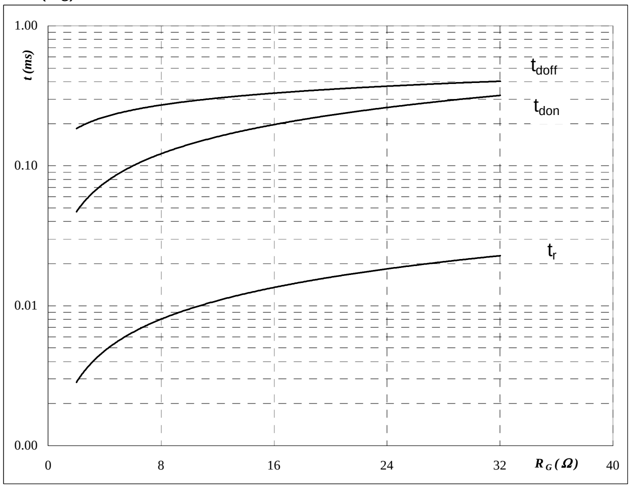


Figure 10 — MOSFET

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

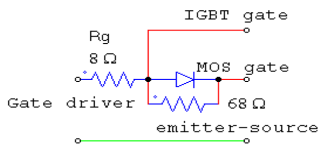
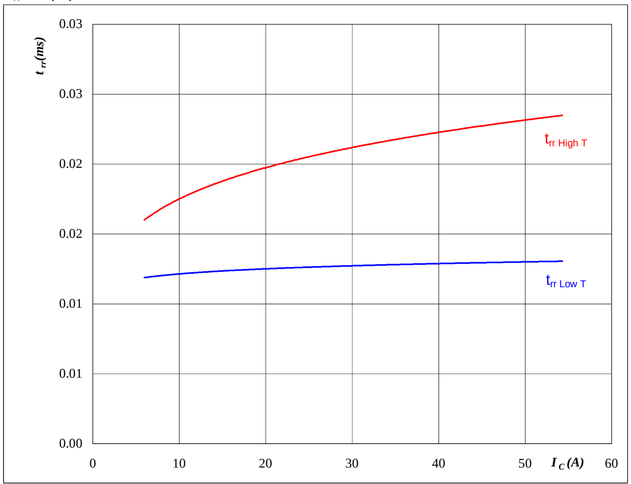


Figure 11 — FRED

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

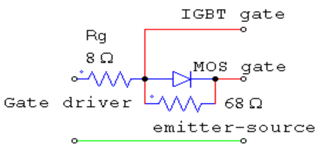
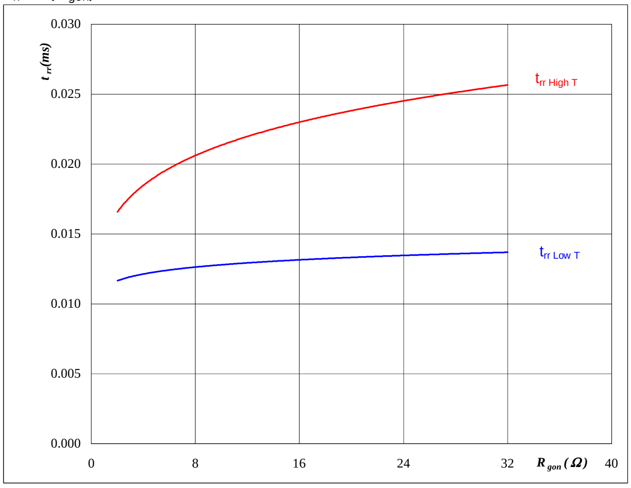


Figure 12 — FRED

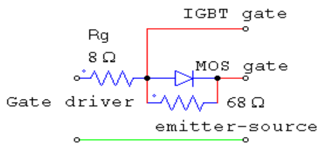
Typical reverse recovery time as a function of IGBT turn on gate resistor

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



At

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

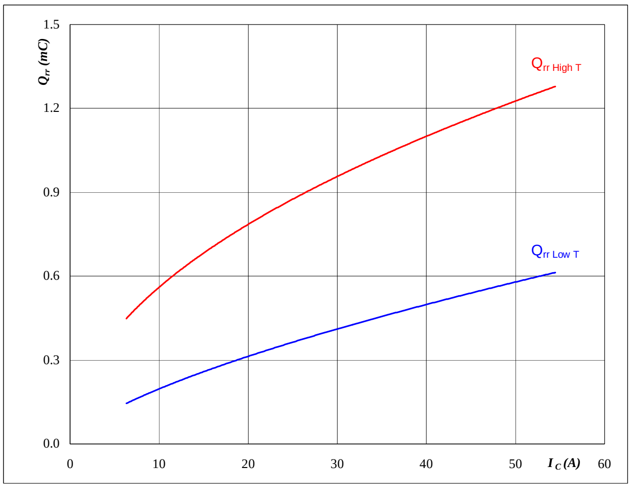


Buck

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

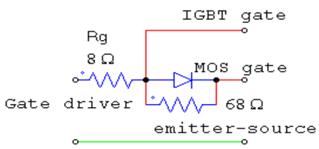
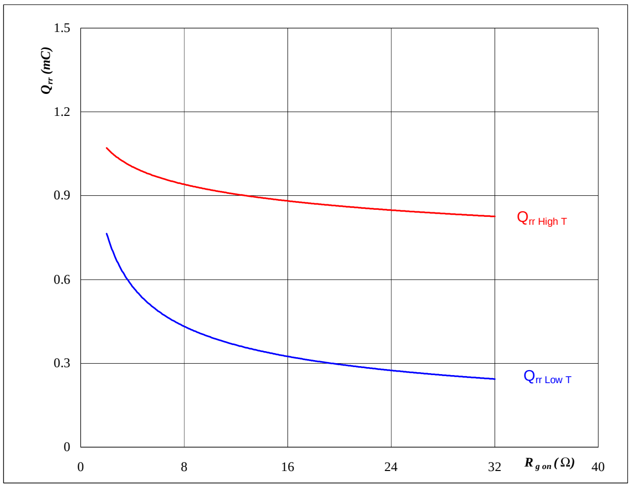


Figure 14 FRED

Typical reverse recovery charge as a function of 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

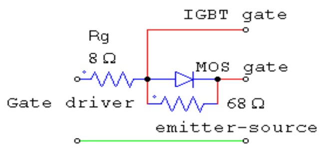
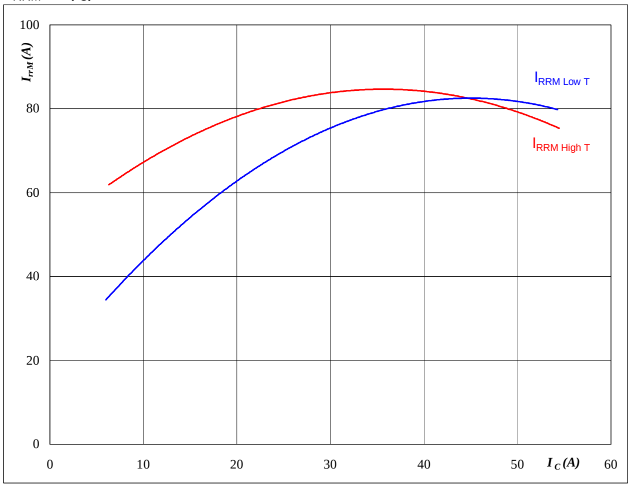


Figure 15 FRED

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

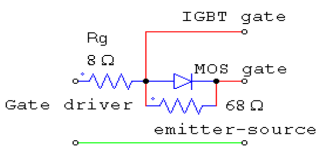
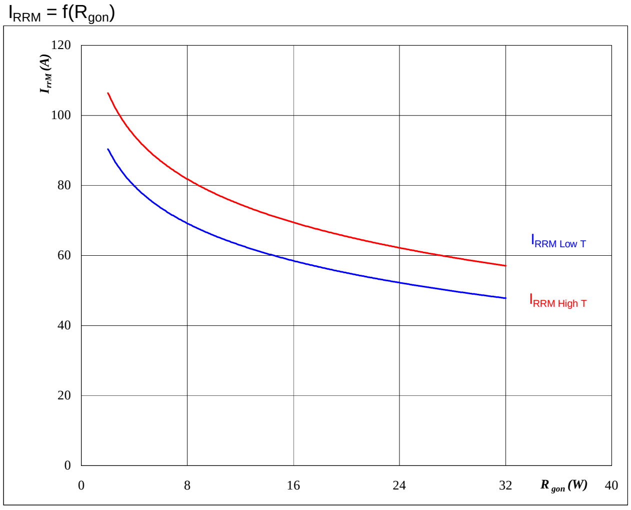


Figure 16 FRED

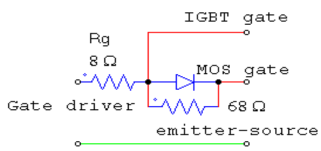
Typical reverse recovery current as a function of IGBT turn on gate resistor

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



At

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

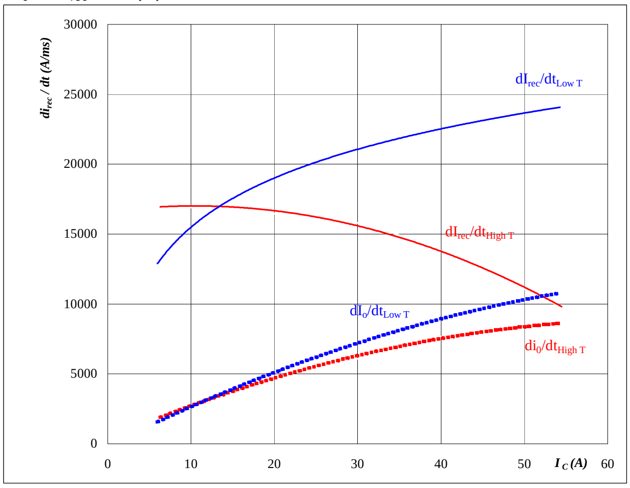


Buck

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

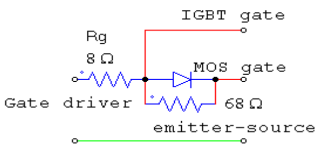
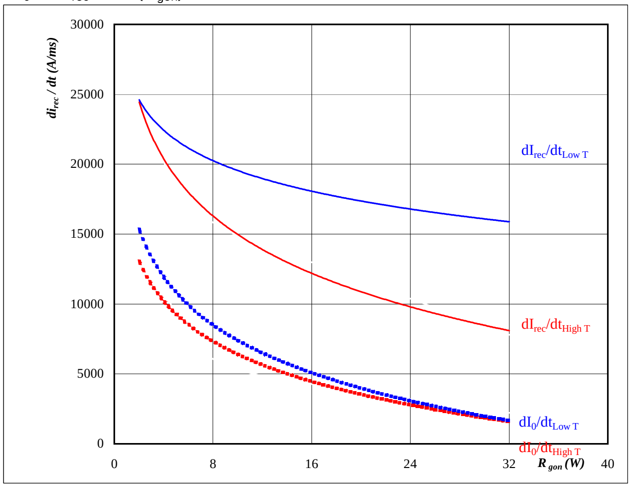


Figure 18 FRED

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

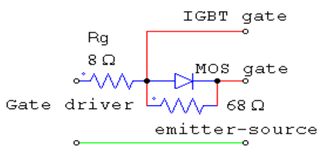
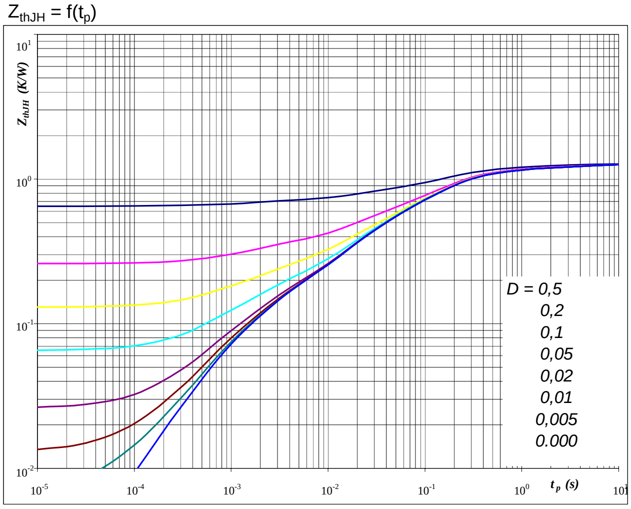


Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	1.30	K/W

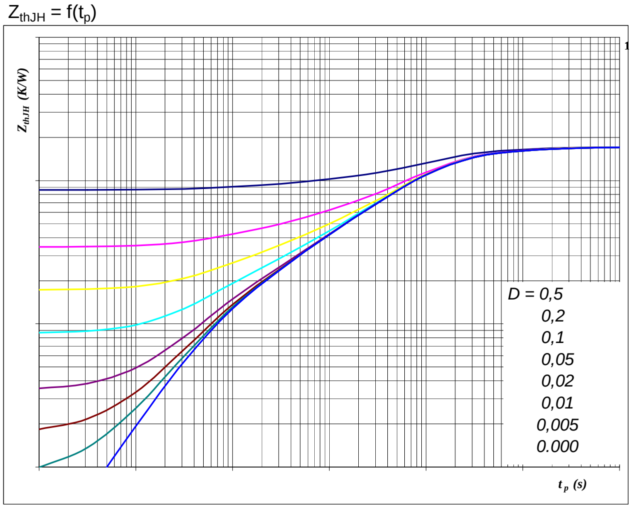
IGBT thermal model values

R (C/W)	Tau (s)
0.11	9.8E+00
0.22	6.3E-01
0.63	1.2E-01
0.24	1.8E-02
0.10	1.3E-03

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} =	1.72	K/W

FRED thermal model values

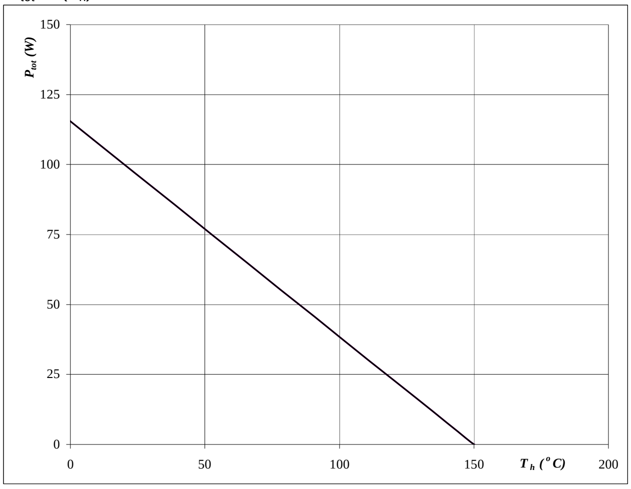
R (C/W)	Tau (s)
0.04	7.9E+00
0.21	8.8E-01
0.82	1.3E-01
0.39	3.0E-02
0.17	4.1E-03
0.09	6.3E-04

Buck

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



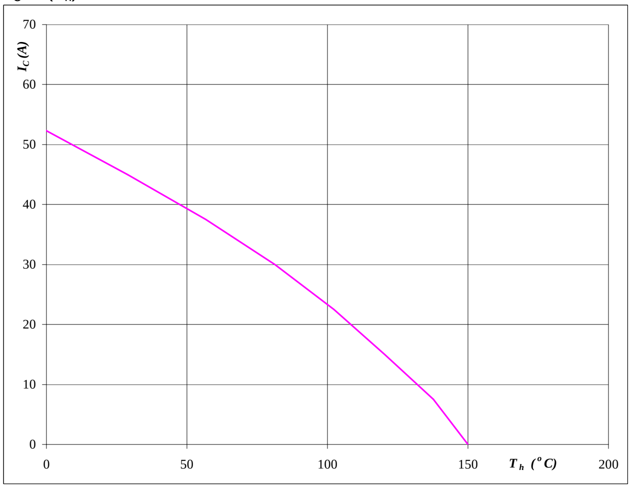
At

T_j = 150 °C

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

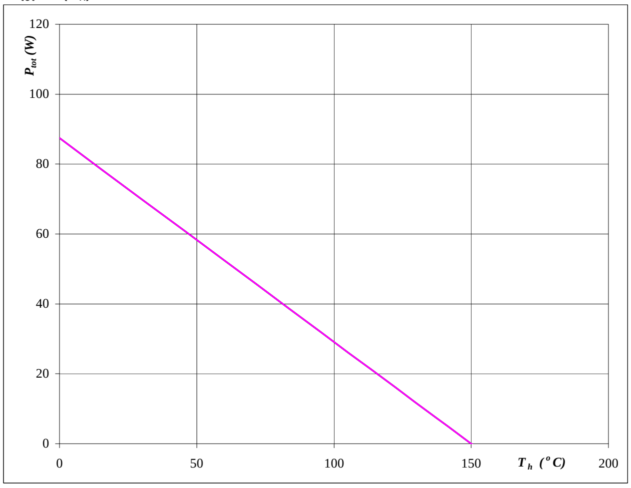
T_j = 150 °C

V_{GE} = 15 V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



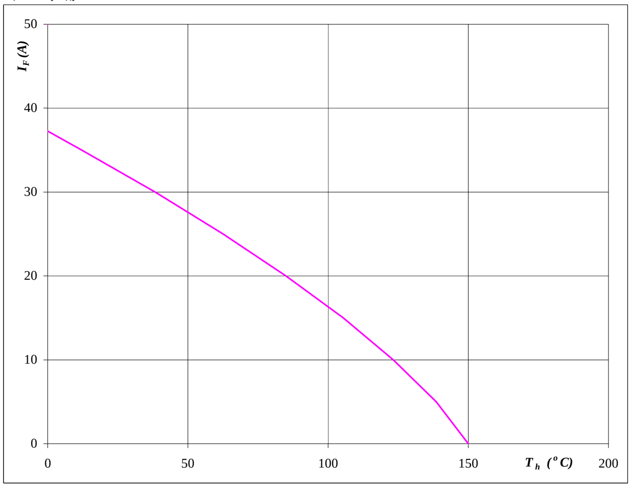
At

T_j = 150 °C

Figure 24 FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

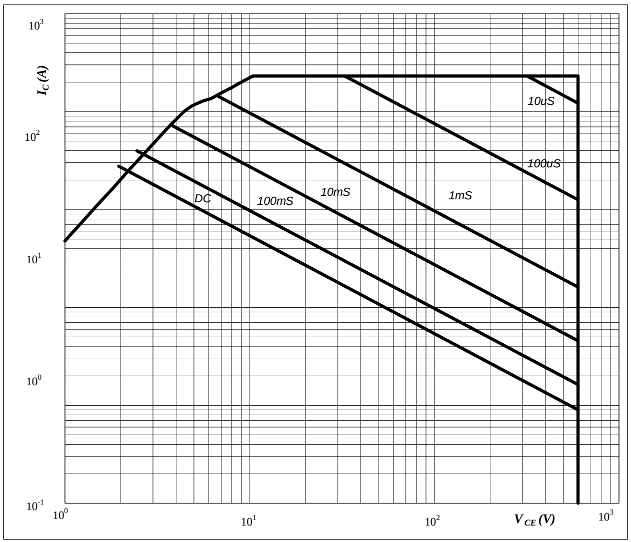
T_j = 150 °C

Buck

Figure 25 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



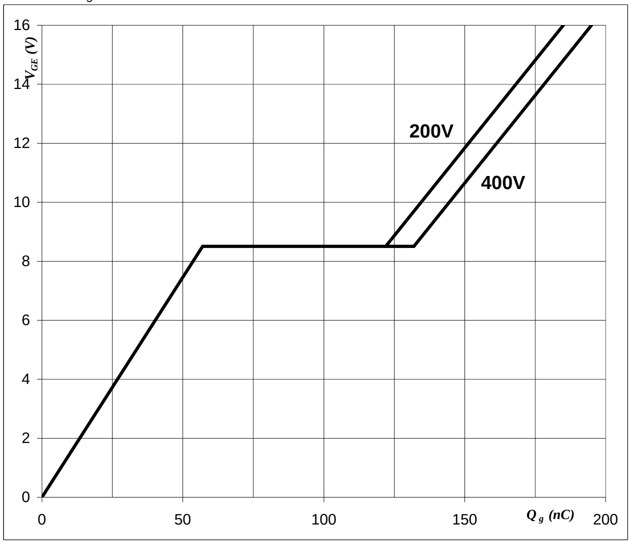
At

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

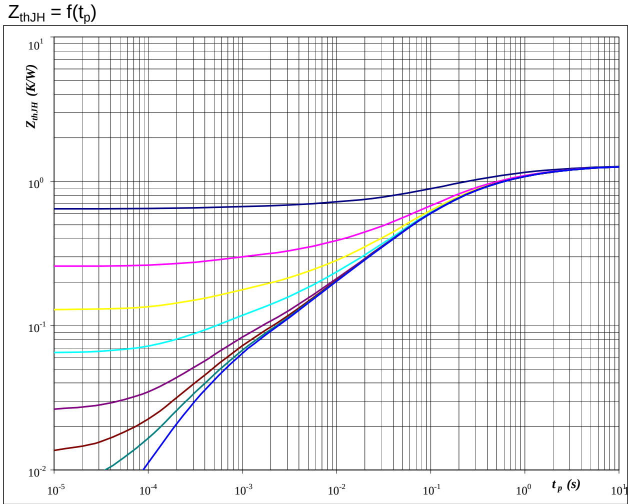
$I_{G(REF)}$=1mA, R_L=15Ω

Figure 27 MOSFET

MOSFET transient thermal impedance

as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	1.29	K/W

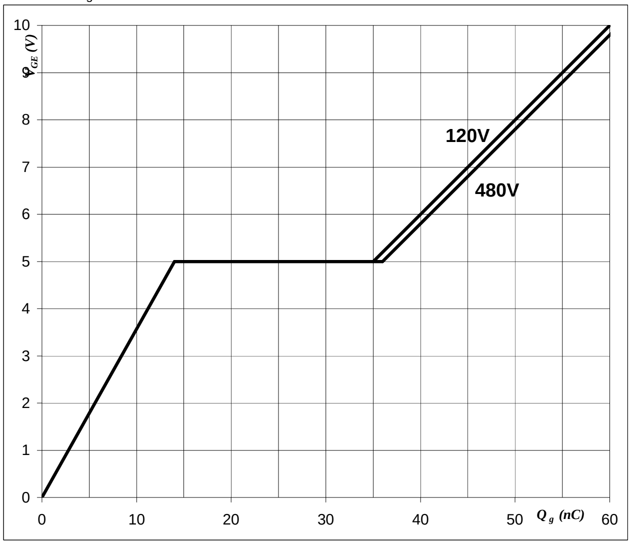
MOSFET thermal model values

R (C/W)	Tau (s)
0.09	9.2E+00
0.27	1.3E+00
0.53	2.1E-01
0.27	4.0E-02
0.08	4.8E-03
0.05	4.7E-04

Figure 28 MOSFET

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



At

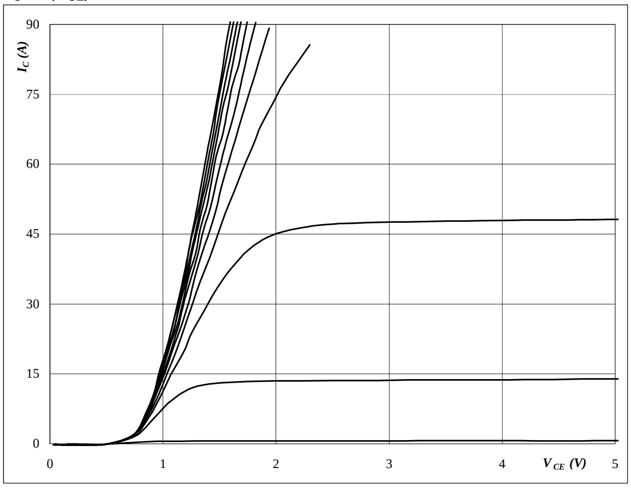
I_C =	18	A

Boost

Figure 1 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



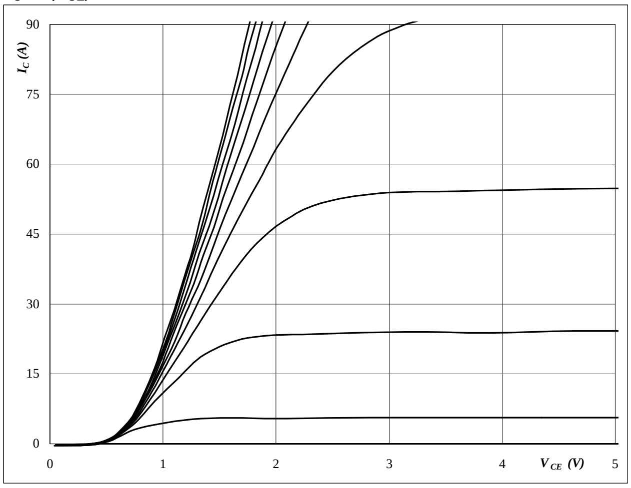
At

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

$I_C = f(V_{CE})$



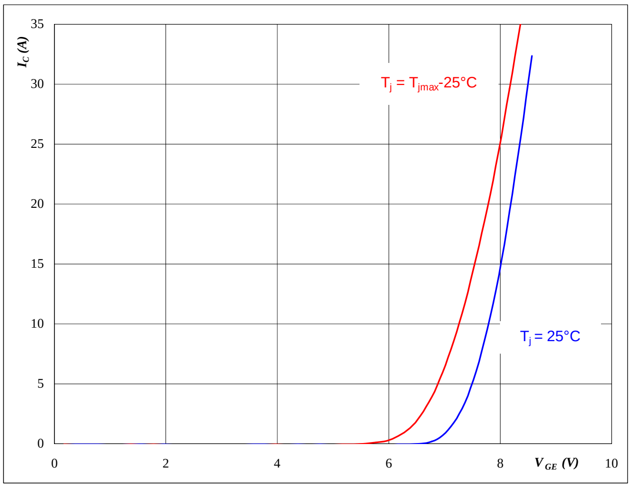
At

t_p =	250	μs
T_j =	125	°C
V_{GE} from	6 V to 16 V in steps of 1 V	

Figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



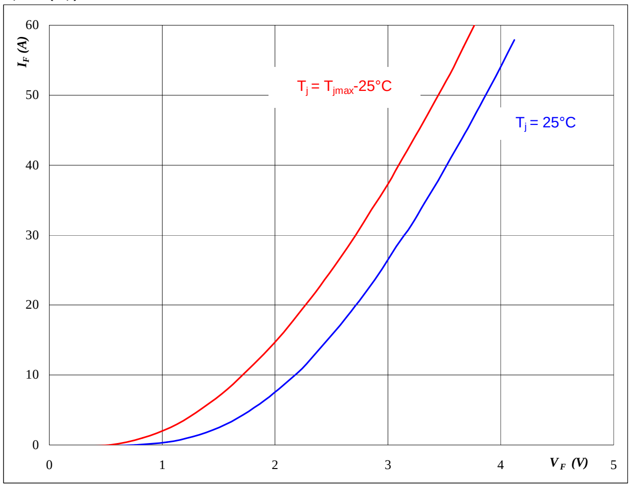
At

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

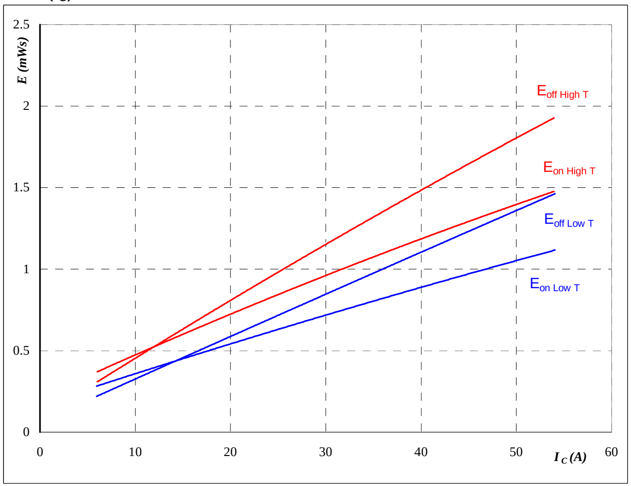
t_p =	250	μs

Boost

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



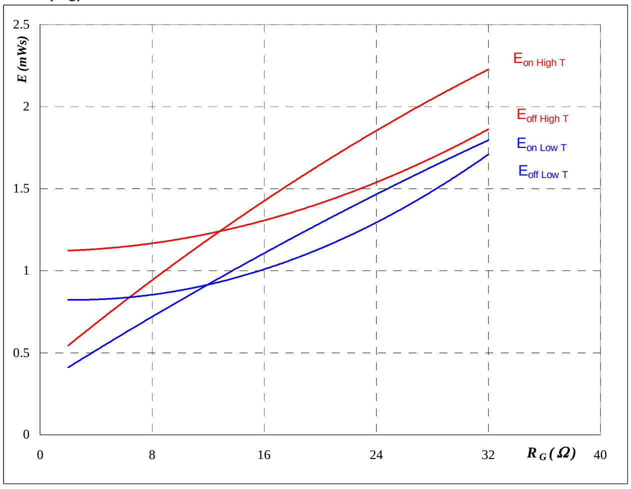
With an inductive load at

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

$E = f(R_G)$



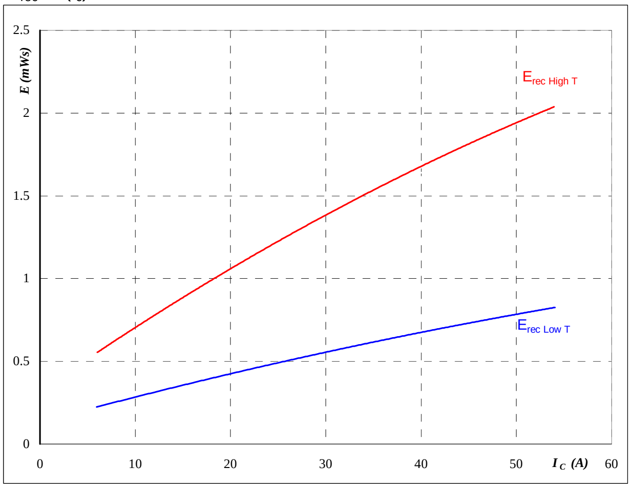
With an inductive load at

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

Figure 7 IGBT

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_c)$



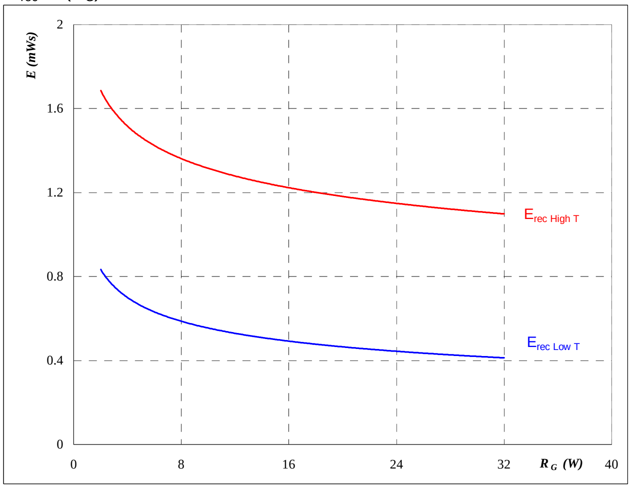
With an inductive load at

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

Figure 8 IGBT

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

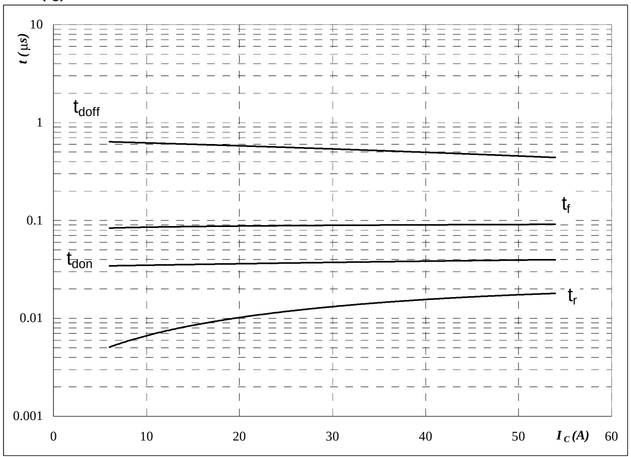
T_j =	25/125	°C
V_{CE} =	350	V
V_{GE} =	15	V
I_C =	30	A

Boost

Figure 9 IGBT

Typical switching times as a function of collector current

t = f(I_C)



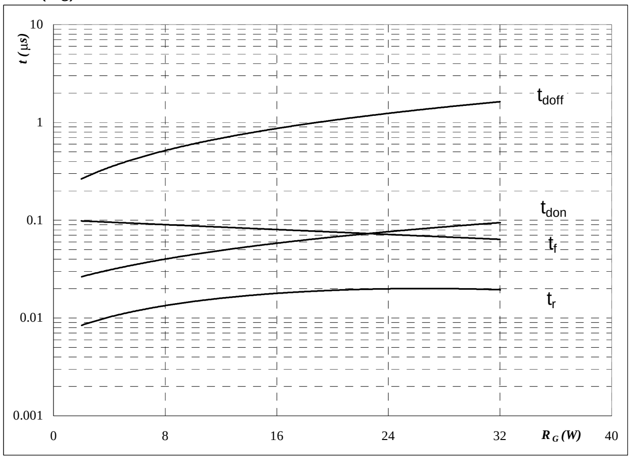
With an inductive load at

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)



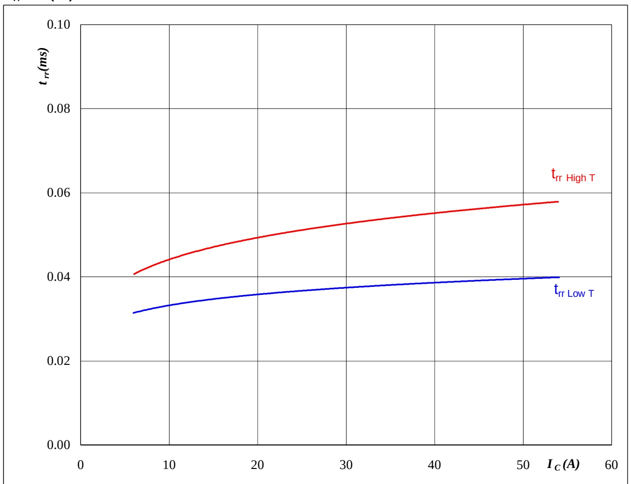
With an inductive load at

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)



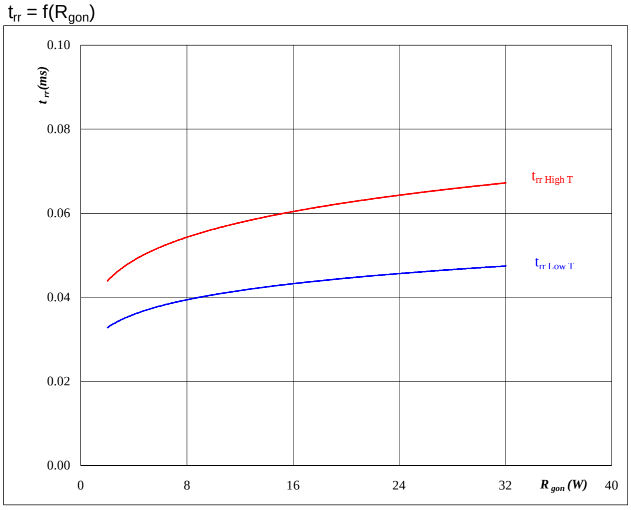
At

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

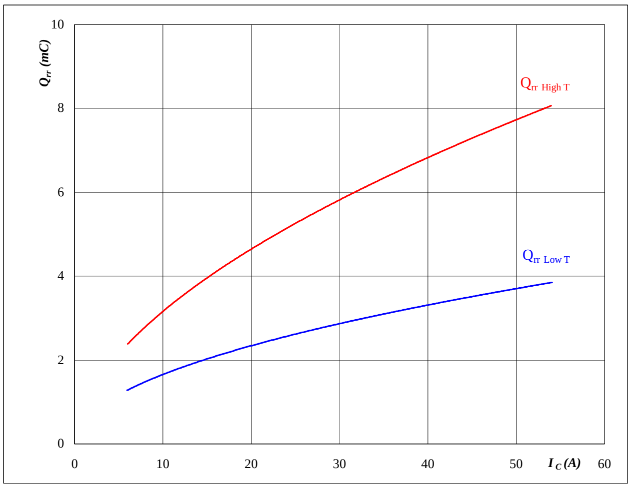
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Boost

Figure 13 FRED

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



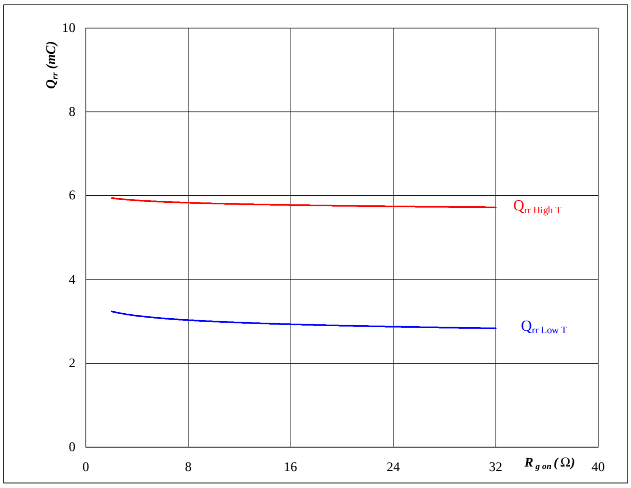
At

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

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



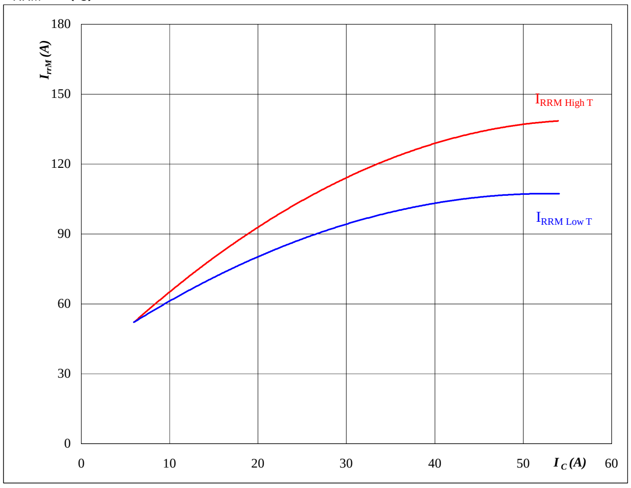
At

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

$I_{RRM} = f(I_C)$



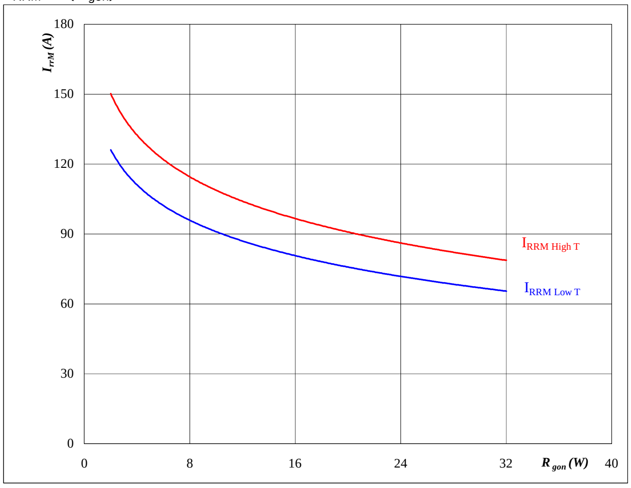
At

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

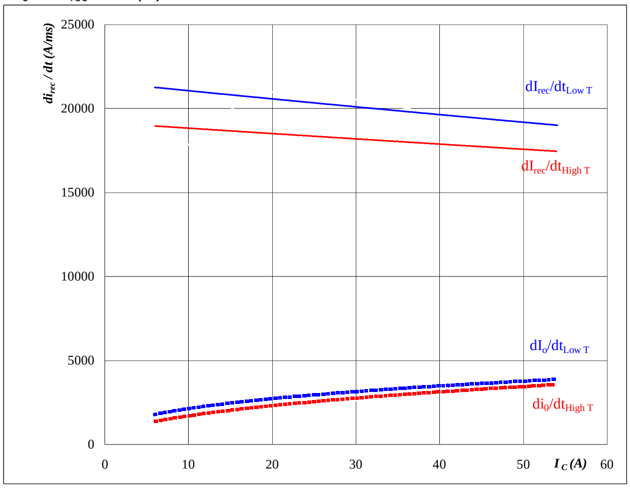
T_j =	25/125	°C
V_R =	350	V
I_F =	30	A
V_{GE} =	15	V

Boost

Figure 17 FRED

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

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



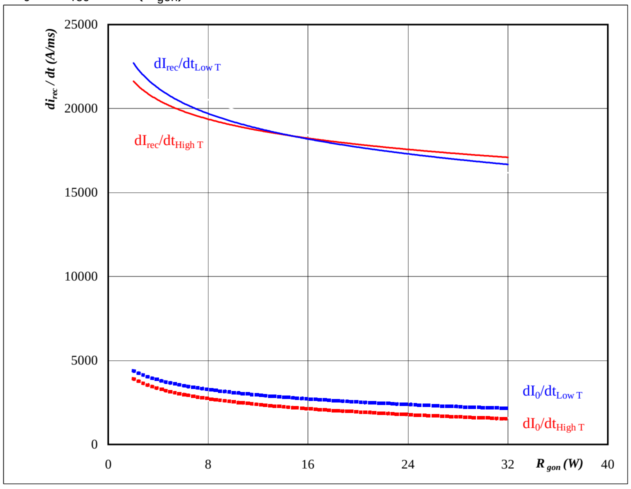
At

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 and reverse recovery current

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



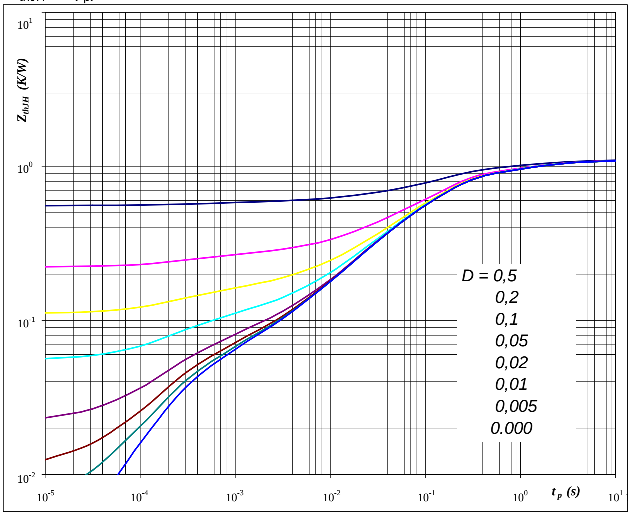
At

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

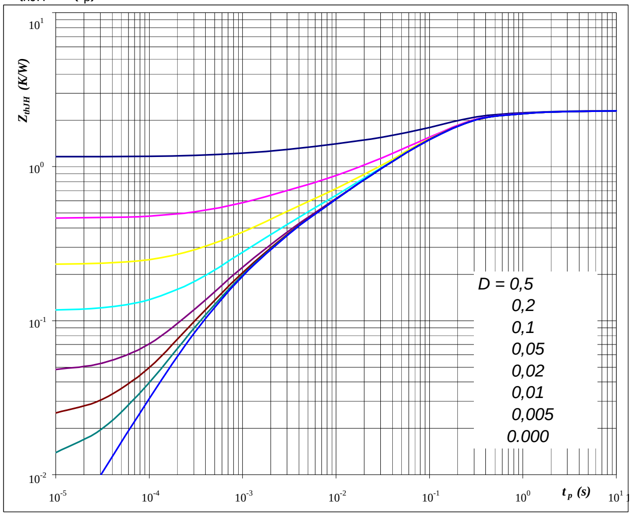
IGBT thermal model values

R (C/W) Tau (s)

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

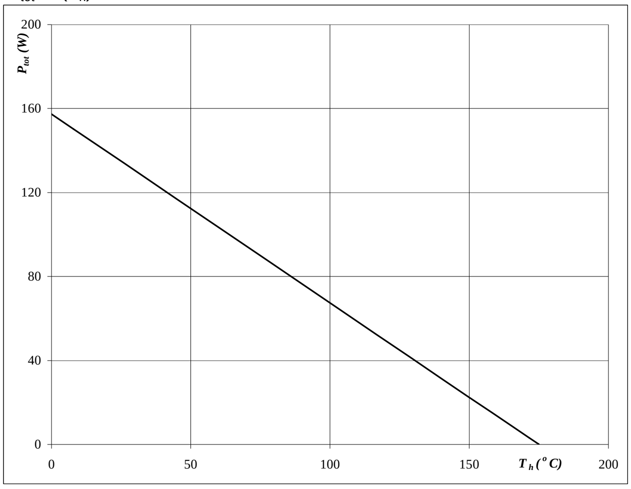
R (C/W) Tau (s)

Boost

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



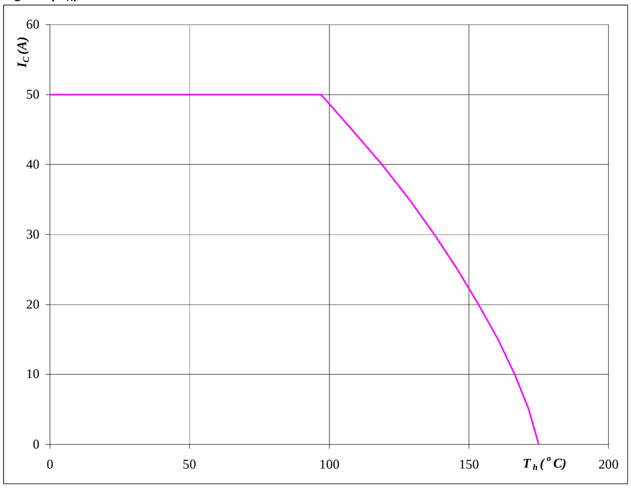
At

T_j = 175 ºC

Figure 22 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

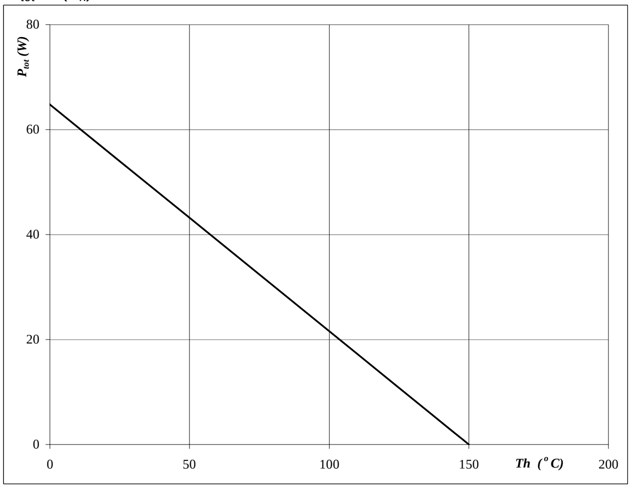
T_j = 175 ºC

V_{GE} = 15 V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



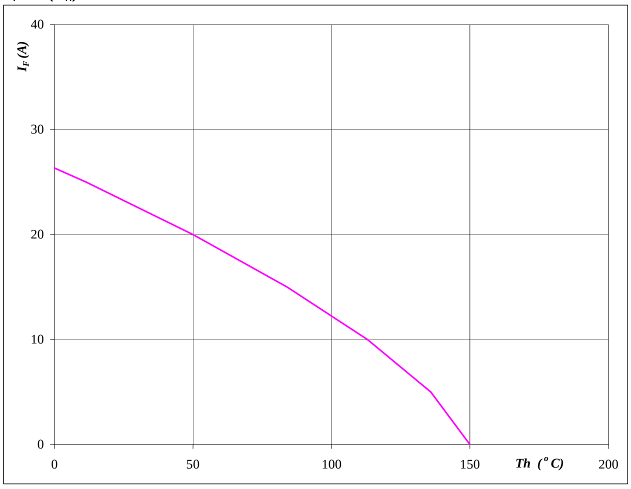
At

T_j = 150 ºC

Figure 24 FRED

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

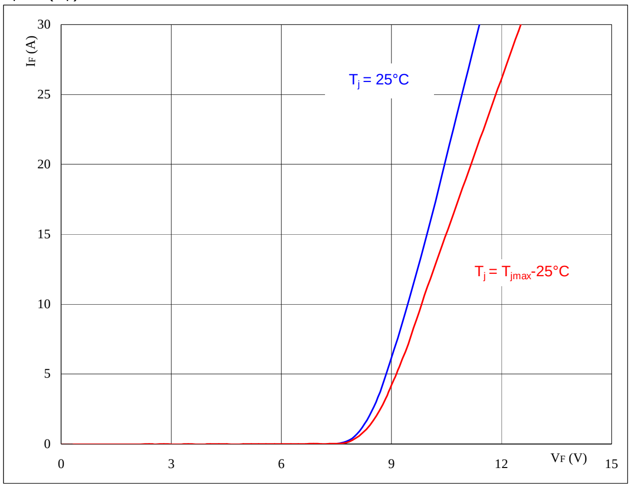
T_j = 150 ºC

Boost

Figure 25 Boost Inverse Diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



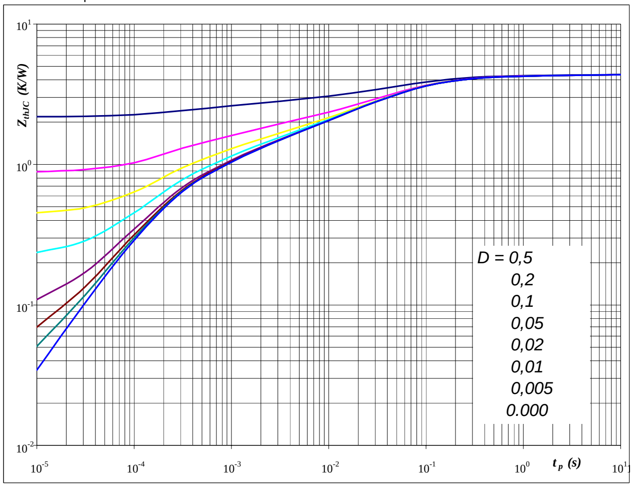
At

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

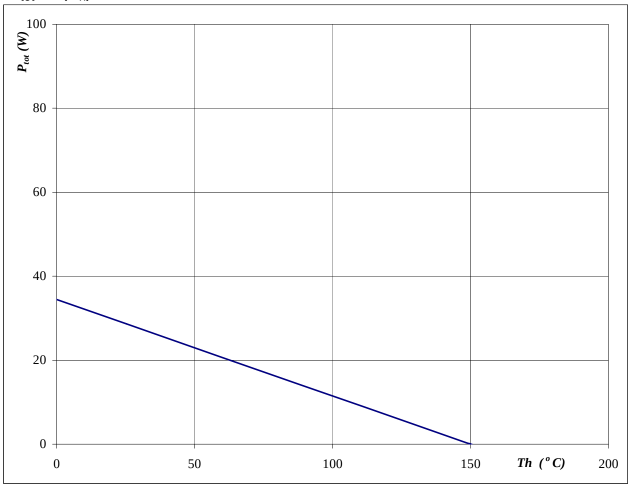
D = tp / T

R_{thJH} = 4.36 K/W

Figure 27 Boost Inverse Diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



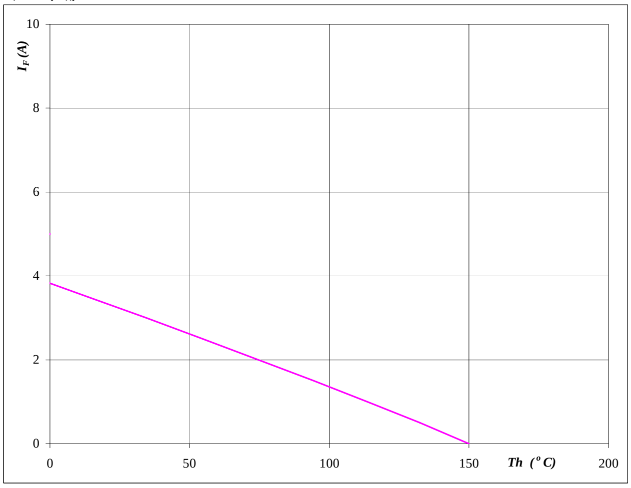
At

T_j = 150 ºC

Figure 28 Boost Inverse Diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

T_j = 150 ºC

Thermistor

Figure 1 Thermistor

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

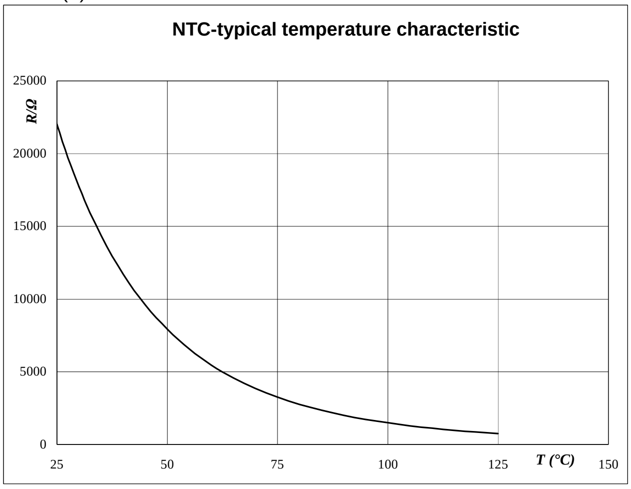


Figure 2 Thermistor

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

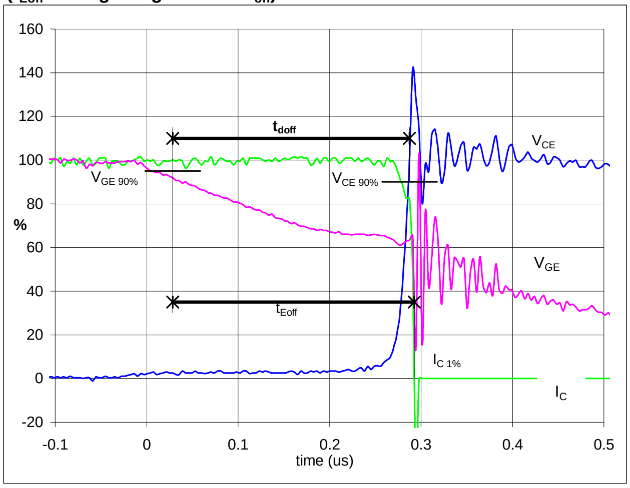
Switching Definitions BUCK MOSFET

General conditions

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

Figure 1 Output inverter IGBT

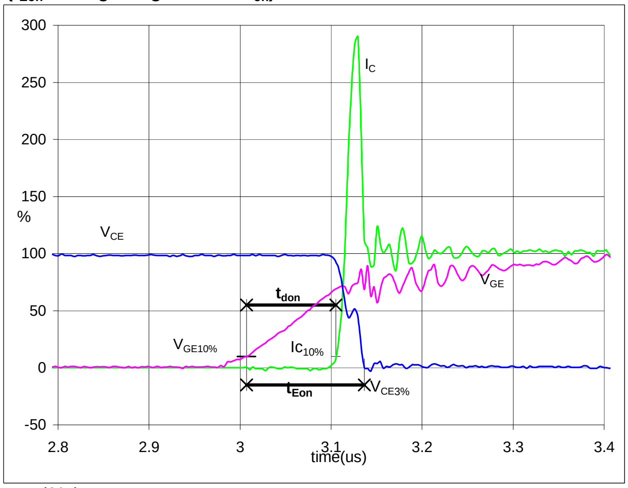
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
(t_{Eoff} = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	42	A
t_{doff} =	0.25	µs
t_{Eoff} =	0.26	µs

Figure 2 Output inverter IGBT

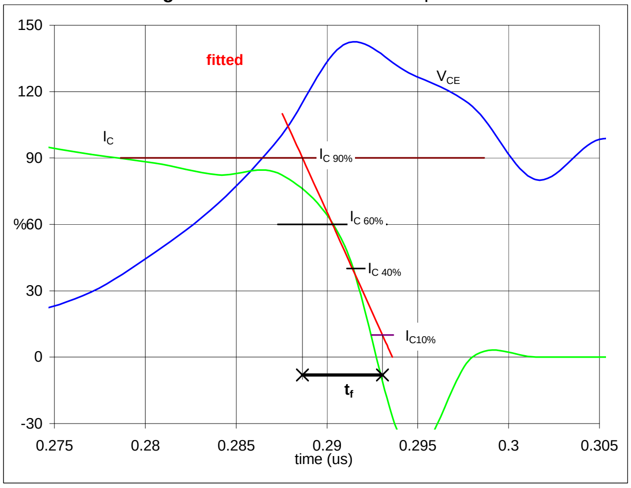
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
(t_{Eon} = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	350	V
I_C (100%) =	42	A
t_{don} =	0.10	µs
t_{Eon} =	0.13	µs

Figure 3 Output inverter IGBT

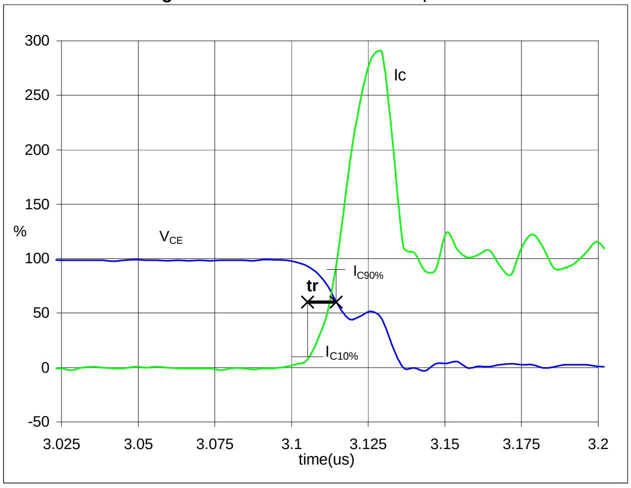
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	350	V
I_C (100%) =	42	A
t_f =	0.004	µs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

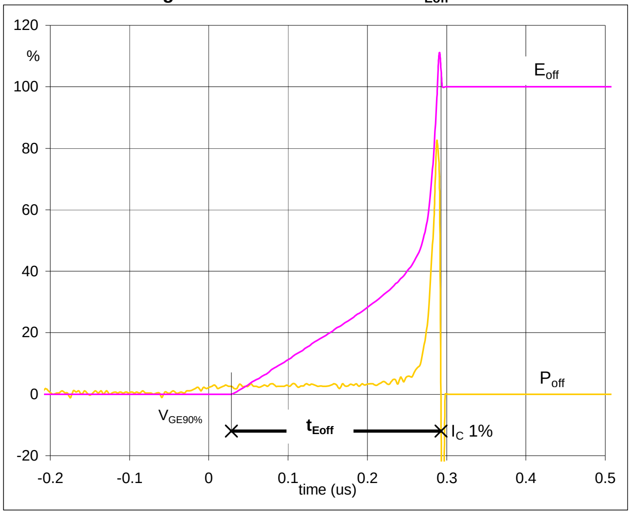


V_C (100%) =	350	V
I_C (100%) =	42	A
t_r =	0.01	µs

Switching Definitions BUCK MOSFET

Figure 5 Output inverter IGBT

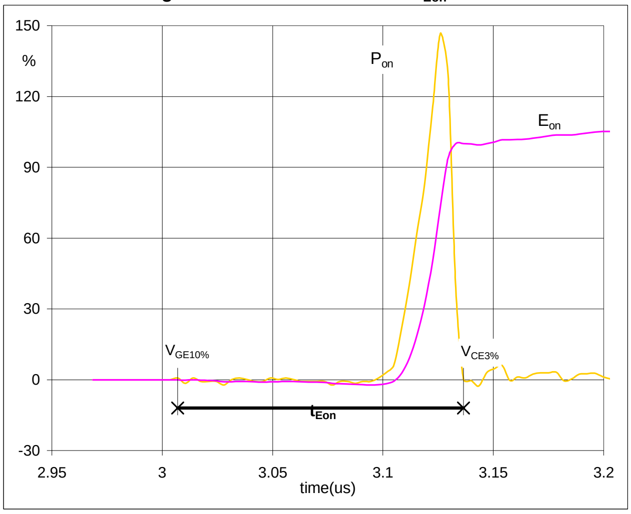
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	14.63	kW
E_{off} (100%) =	0.24	mJ
t_{Eoff} =	0.26	μs

Figure 6 Output inverter IGBT

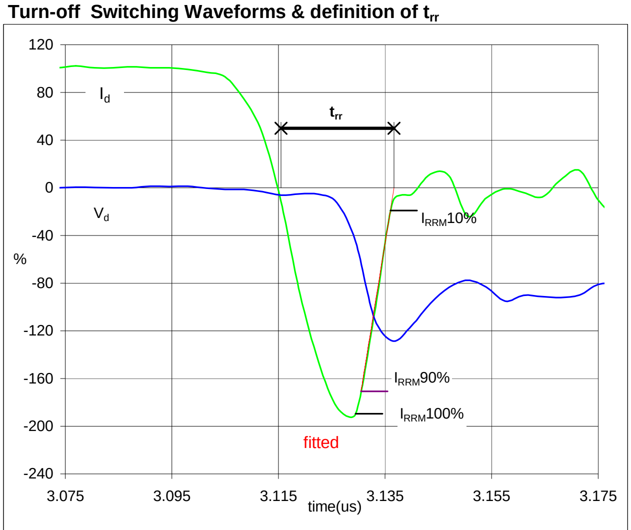
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	14.63	kW
E_{on} (100%) =	0.34	mJ
t_{Eon} =	0.13	μs

Figure 7 Output inverter IGBT

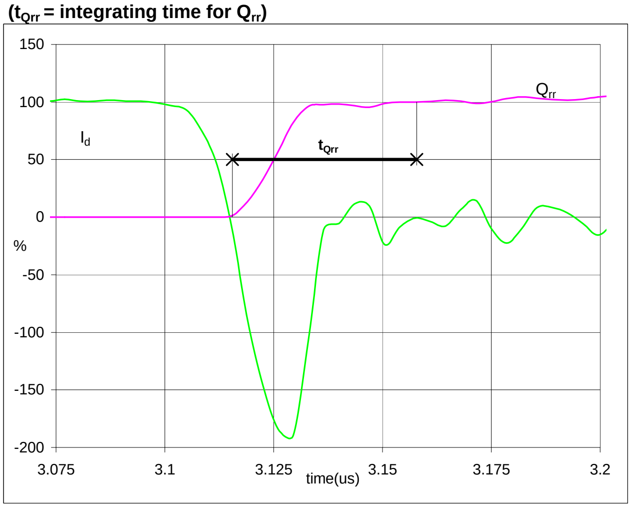
Turn-off Switching Waveforms & definition of t_{rr}



V_d (100%) =	350	V
I_d (100%) =	42	A
I_{RRM} (100%) =	-81	A
t_{rr} =	0.02	μs

Figure 8 Output inverter FRED

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

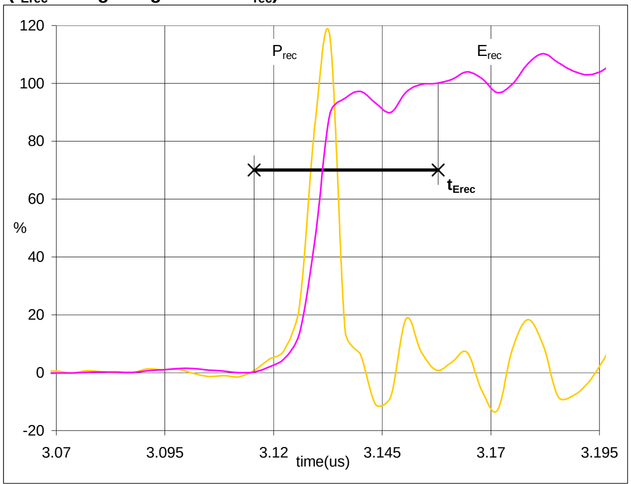


I_d (100%) =	42	A
Q_{rr} (100%) =	1.10	μC
t_{Qrr} =	0.04	μs

Switching Definitions BUCK MOSFET

Figure 9 Output inverter FRED

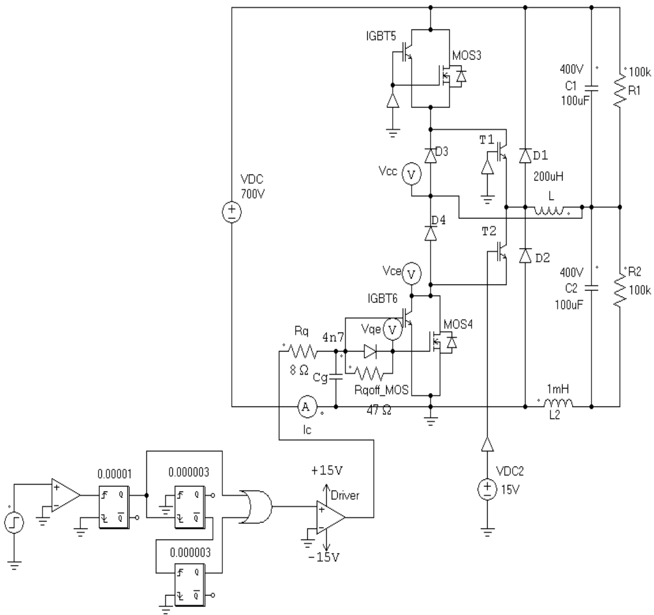
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	14.63	kW
E_{rec} (100%) =	0.18	mJ
t_{Erec} =	0.04	μs

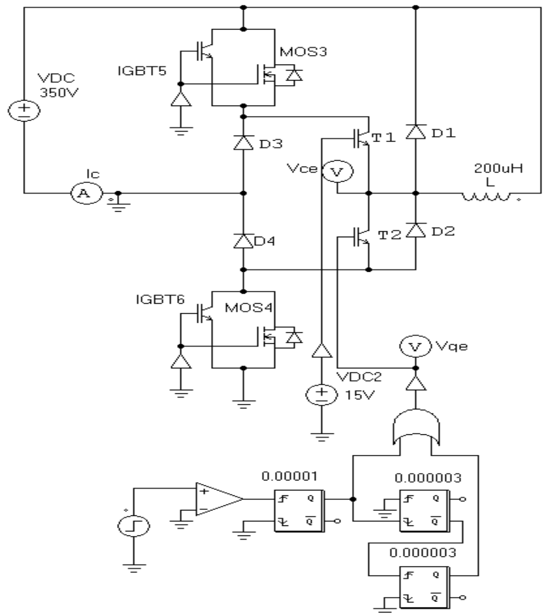
Measurement circuits

Figure 11
BUCK stage switching measurement circuit



Cg is included in the module

Figure 12
BOOST stage switching measurement circuit



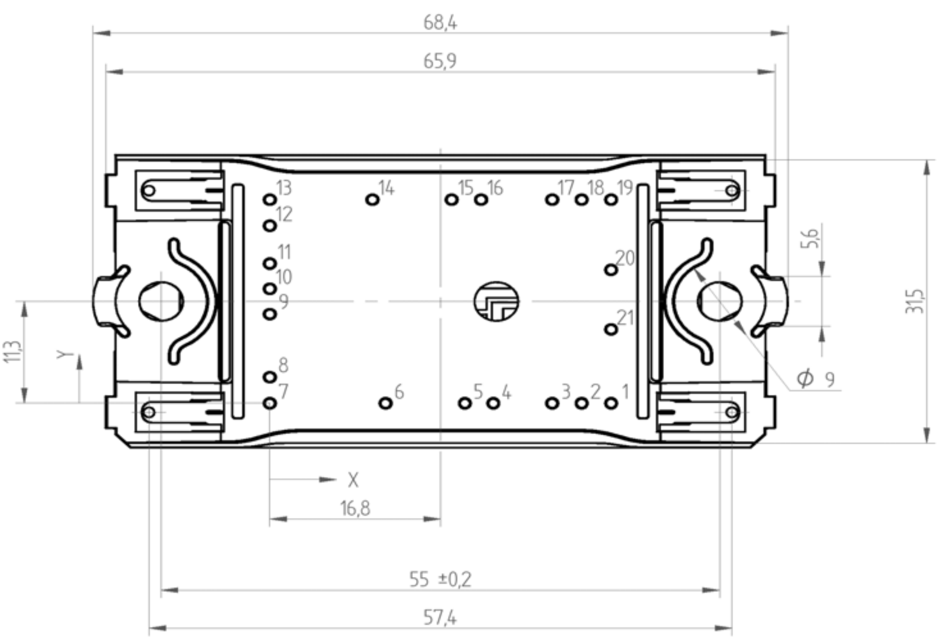
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

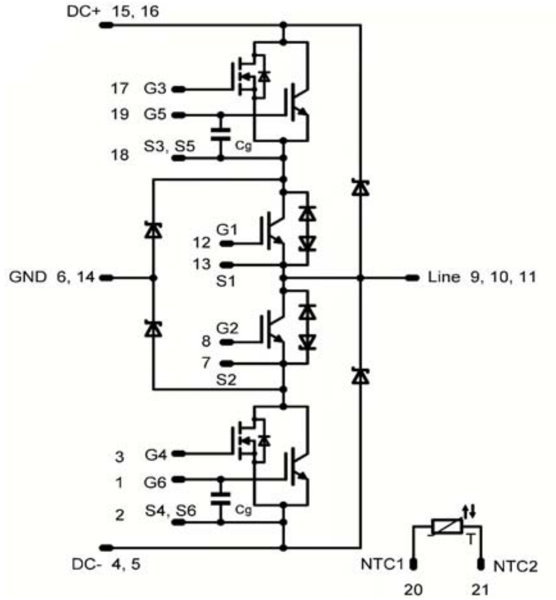
Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste 12mm housing	10-FZ06NPA045FP01-P967F10	P967F10	P967F10

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.