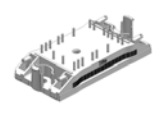
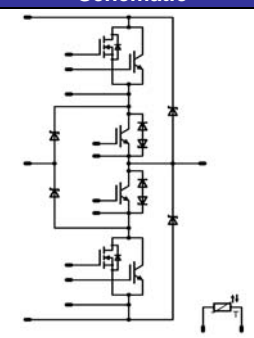


flowNPC 0	600V/50A & 45A PS*
<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Features</p> <ul style="list-style-type: none"> *PS: 45A parallel switch (40A PT and 99mΩ) neutral point clamped inverter reactive power capability SiC buck diode low inductance layout </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Target Applications</p> <ul style="list-style-type: none"> solar inverter UPS </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Types</p> <ul style="list-style-type: none"> FZ06NPA045FP </div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">flow0 12mm housing</p>  </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #000080; color: white; margin: 0;">Schematic</p>  </div>

Maximum Ratings

T_j=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 _{jmax} T _h =80°C T _c =80°C	30 41	A
Repetitive peak collector current	I _{Cpulse}	t _p limited by T _{jmax}	225	A
Power dissipation per IGBT	P _{tot}	T _j =T _{jmax} 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 ≤125°C V _{GE} =15V	3 390	μs V
Maximum Junction Temperature	T _{jmax}		150	°C
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	21 27	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	44 66	W
Maximum Junction Temperature	T _{jmax}		175	°C

Maximum Ratings

 $T_j=25^{\circ}\text{C}$, unless otherwise specified

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

Boost IGBT

Collector-emitter break down voltage	V_{CE}		600	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	50 50	A
Repetitive peak collector current	I_{Cpuls}	t_p limited by T_{jmax}	225	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	85 129	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^{\circ}\text{C}$ $V_{GE}=15\text{V}$	6 360	μs V
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$

Boost Inverse Diode

Peak Repetitive Reverse Voltage	V_{RRM}	$T_c=25^{\circ}\text{C}$	600	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	2	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	21	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Boost Diode

Peak Repetitive Reverse Voltage	V_{RRM}	$T_j=25^{\circ}\text{C}$	1200	V
DC forward current	I_F	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	15 21	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	36	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	30 46	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Maximum Ratings

$T_j=25^{\circ}\text{C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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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_{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_b [A]	T_j	Min	Typ	Max		
Buck IGBT *										
Gate emitter threshold voltage	$V_{GE(th)}$	VCE=VGE			0.00025	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	4.5	5.5	7	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		45	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		2.21 2.21	3 2.6	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			250	μA
Gate-emitter leakage current	I_{GES}		± 20	0		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			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		$T_j=25^\circ\text{C}$		150		pF
Reverse transfer capacitance	C_{rss}							80		
Gate charge **	Q_{Gate}		15	300	20	$T_j=25^\circ\text{C}$		142+70		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1 \text{ W/mK}$						1.30		K/W

 * see dynamic characteristic at **Buck MosFET**

**additional value stands for built-in capacitor

Buck Diode

Diode forward voltage	V_F				16	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1	1.55 1.66	1.8	V
Peak reverse recovery current	I_{RRM}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		39 32		A
Reverse recovery time	t_{rr}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		8 8		ns
Reverse recovered charge	Q_{rr}	$R_{gon}=8 \Omega$	± 15	350	30	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0.10 0.09		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		13751 10591		A/ μs
Reverse recovered energy	E_{rec}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0.010 0.010		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1 \text{ W/mK}$						2.18		K/W

Buck MOSFET

Static drain to source ON resistance	$R_{ds(on)}$		10		15	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		109 219		$\text{m}\Omega$
Gate threshold voltage	$V_{(GS)th}$		$V_{DS}=V_{GS}$		0.003	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	2.1	3	3.9	V
Gate to Source Leakage Current	I_{gss}		20	0		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			200	nA
Zero Gate Voltage Drain Current	I_{dss}		0	600		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			5	μA
Turn On Delay Time	$t_{d(ON)}$					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		67 70		ns
Rise Time	t_r					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		3.8 4.2		
Turn off delay time	$t_{d(OFF)}$	$R_{gon}=8 \Omega$ ** $R_{goff}=8 \Omega$ **	± 15	350	30	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		237 249		
Fall time	t_f					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		12 6.2		mWs
Turn-on energy loss per pulse	E_{on}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0.05 0.06		
Turn-off energy loss per pulse	E_{off}					$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		0.08 0.16		
Total gate charge	Q_g							60	80	nC
Gate to source charge	Q_{gs}		± 15	350	30	$T_j=25^\circ\text{C}$		14		
Gate to drain charge	Q_{gd}							20		
Input capacitance	C_{iss}	f=1MHz	0	100		$T_j=25^\circ\text{C}$		2800		pF
Output capacitance	C_{oss}							130		
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1 \text{ W/mK}$						1.29		K/W

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

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_b [A]	T_j	Min	Typ	Max		
Boost IGBT										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0.0012	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	5	5.8	6.5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		45	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1	1.28 1.31	1.9	V
Collector-emitter cut-off incl diode	I_{CES}		0	600		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			0.03	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			650	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	$R_{gon}=8\ \Omega$ $R_{goff}=8\ \Omega$	± 15	350	30	$T_j=25^\circ\text{C}$		40		ns
Rise time	t_r					$T_j=125^\circ\text{C}$		37		
Turn-off delay time	$t_{d(off)}$					$T_j=25^\circ\text{C}$		10		
Fall time	t_f					$T_j=125^\circ\text{C}$		13		
Turn-on energy loss per pulse	E_{on}					$T_j=25^\circ\text{C}$		454		
Turn-off energy loss per pulse	E_{off}		502							
Input capacitance	C_{ies}					$T_j=25^\circ\text{C}$		64		mWs
Output capacitance	C_{oss}	$f=1\text{MHz}$	0	25		$T_j=25^\circ\text{C}$		87		
Reverse transfer capacitance	C_{rss}							0.72		
Gate charge	Q_{Gate}		15	480	75	$T_j=25^\circ\text{C}$		0.96		
Thermal resistance chip to heatsink per chip	$R_{th,JH}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1\ \text{W/mK}$						0.85		
								1.16		
								4620		
								288		pF
								137		
								470		nC
								1.11		K/W
Boost Inverse Diode										
Diode forward voltage	V_F				20	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$		9.07 9.43		V
Thermal resistance chip to heatsink per chip	$R_{th,JH}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1\ \text{W/mK}$						4.36		K/W
Boost Diode										
Diode forward voltage	V_F				18	$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$	1.5	2.61 2.16	3.5	V
Reverse leakage current	I_r			1200		$T_j=25^\circ\text{C}$ $T_j=125^\circ\text{C}$			100	μA
Peak reverse recovery current	I_{RRM}	$R_{gon}=8\ \Omega$	± 15	350	30	$T_j=25^\circ\text{C}$		92		A
Reverse recovery time	t_{rr}					$T_j=125^\circ\text{C}$		112		
Reverse recovered charge	Q_{rr}					$T_j=25^\circ\text{C}$		37.1		
Peak rate of fall of recovery current	$di(rec)/dt$					$T_j=125^\circ\text{C}$		51.9		
Reverse recovery energy	E_{rec}					$T_j=25^\circ\text{C}$		2.8		
			5.7							
			20796							
			20514							
			0.54							
			1.39							
Thermal resistance chip to heatsink per chip	$R_{th,JH}$	Thermal grease thickness $\leq 50\mu\text{m}$ $\lambda = 1\ \text{W/mK}$						2.32		K/W
Thermistor										
Rated resistance*	R_{25}	Tol. $\pm 13\%$				$T_j=25^\circ\text{C}$	19.1	22	24.9	k Ω
	R_{100}	Tol. $\pm 5\%$				$T_j=100^\circ\text{C}$	1411	1486	1560	Ω
Power dissipation	P					$T_j=25^\circ\text{C}$		210		mW
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				$T_j=25^\circ\text{C}$		4000		K

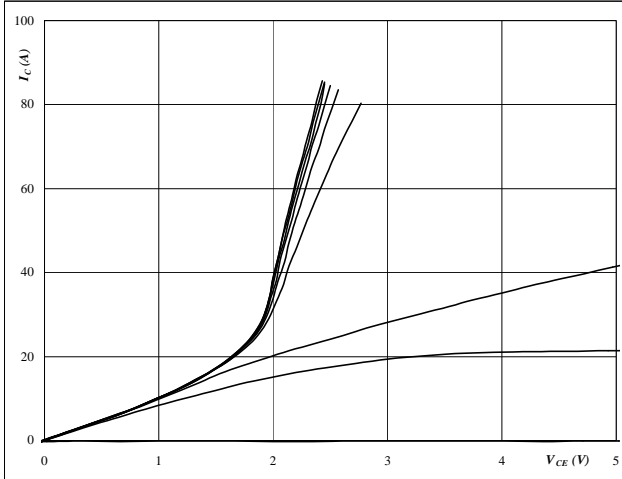
* see details on Thermistor charts on Figure 2.

Buck

Figure 1 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$

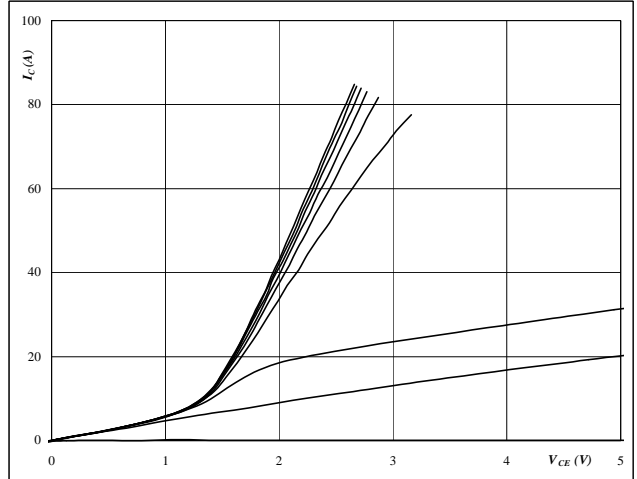


At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ }^\circ C$
 V_{GE} from 3 V to 19 V in steps of 2 V

Figure 2 MOSFET

Typical output characteristics

$I_C = f(V_{CE})$

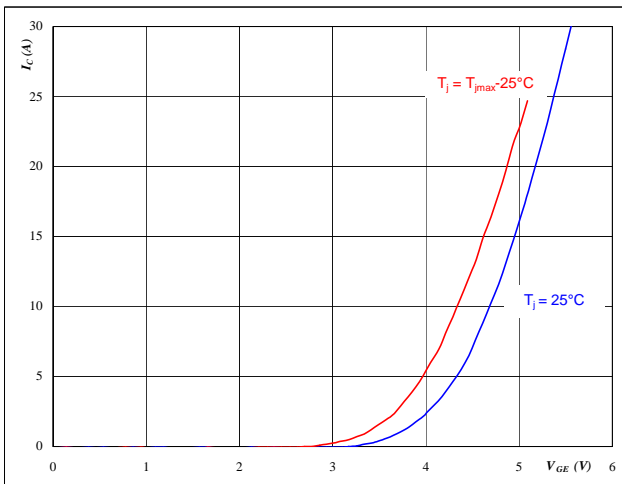


At
 $t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GE} from 3 V to 19 V in steps of 2 V

Figure 3 MOSFET

Typical transfer characteristics

$I_C = f(V_{GE})$

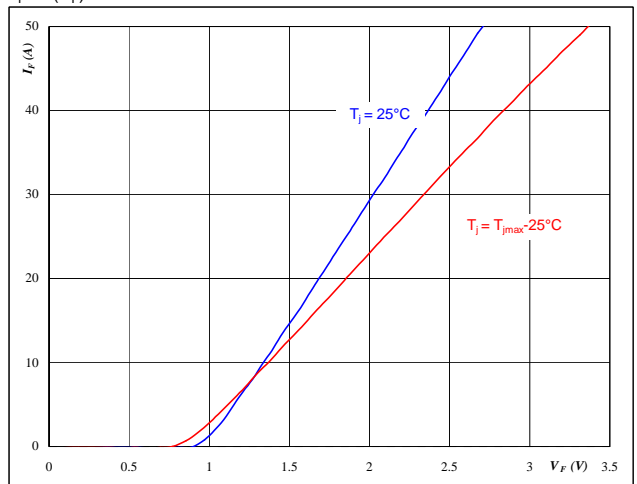


At
 $t_p = 250 \mu s$
 $V_{CE} = 10 V$

Figure 4 FRED

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

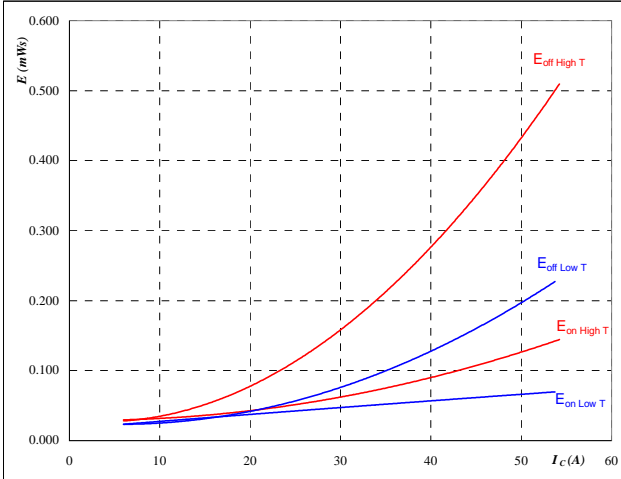


At
 $t_p = 250 \mu s$

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
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω
 $R_{goff} = 8$ Ω

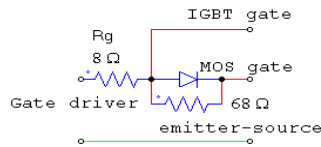
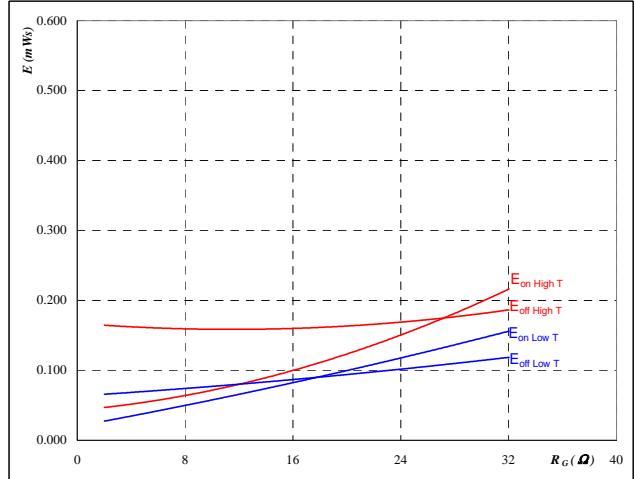


Figure 6 MOSFET

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
 $V_{GE} = \pm 15$ V
 $I_C = 30$ A

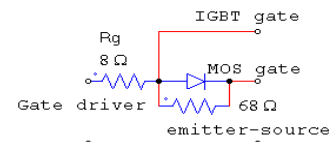
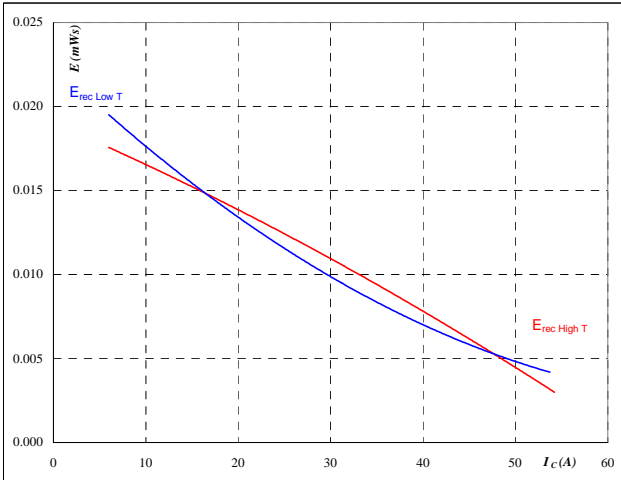


Figure 7 FRED

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
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

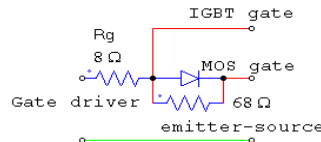
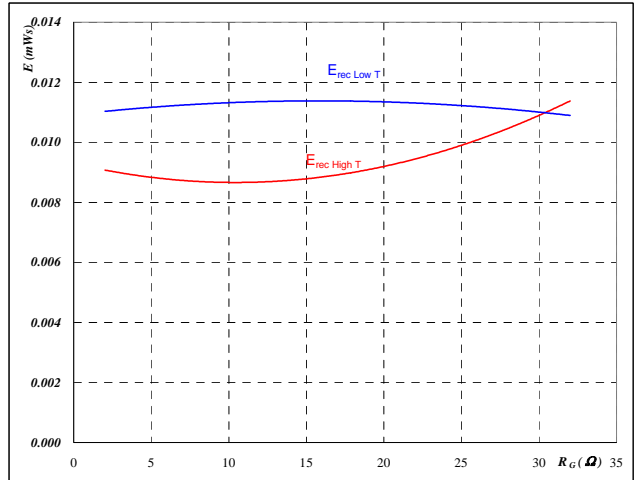


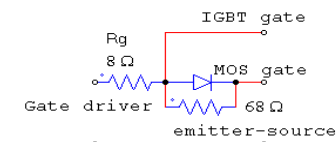
Figure 8 FRED

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



With an inductive load at

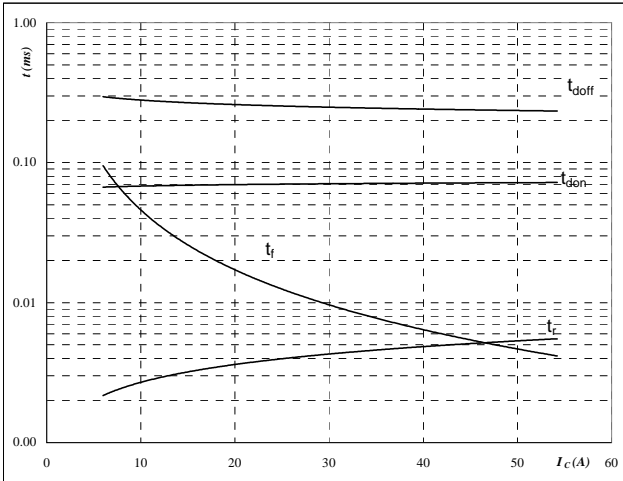
$T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = \pm 15$ V
 $I_C = 30$ A



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
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω
 $R_{goff} = 8$ Ω

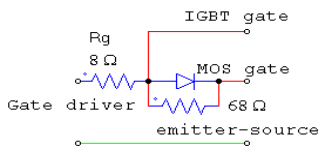
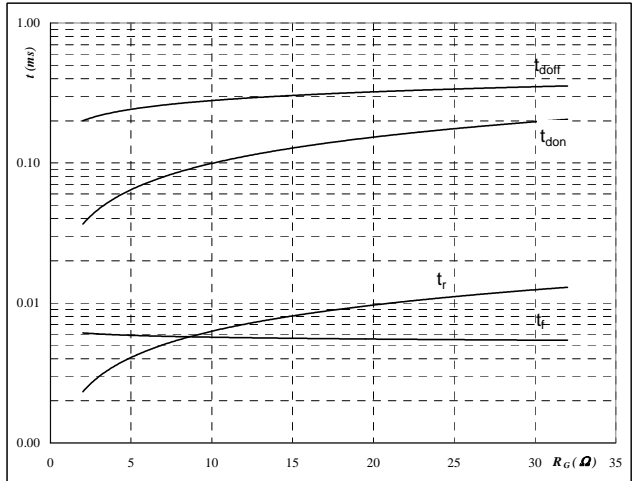


Figure 10 MOSFET

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
 $V_{GE} = \pm 15$ V
 $I_C = 30$ A

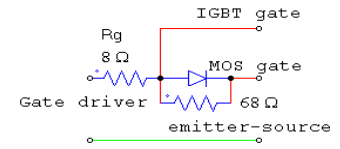
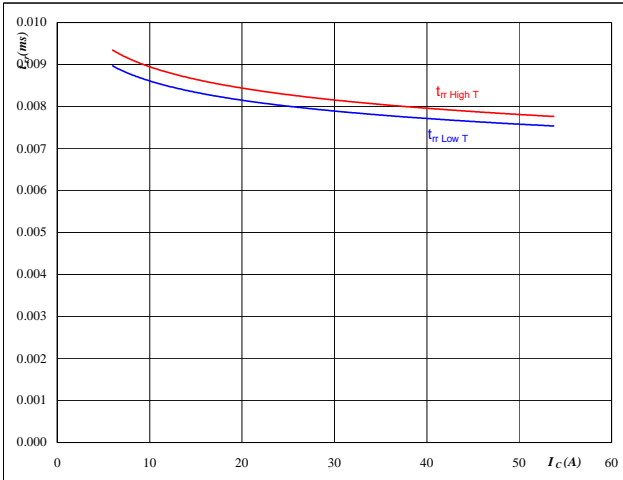


Figure 11 FRED

Typical reverse recovery time as a function of collector current
 $t_{rr} = f(I_C)$



At

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

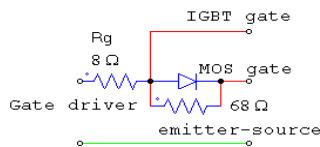
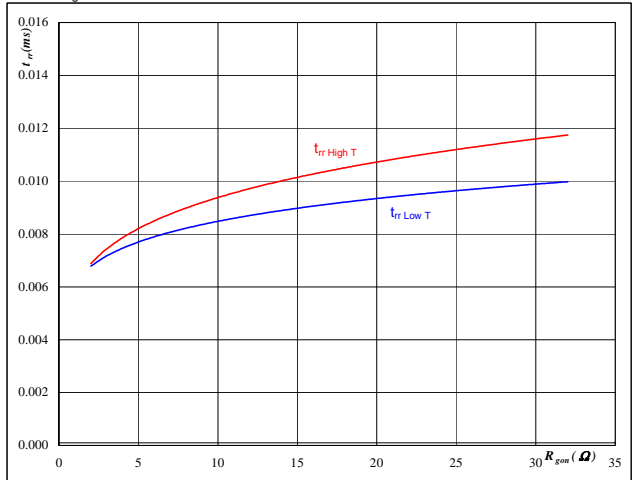


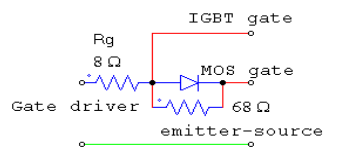
Figure 12 FRED

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
 $V_{GE} = \pm 15$ V

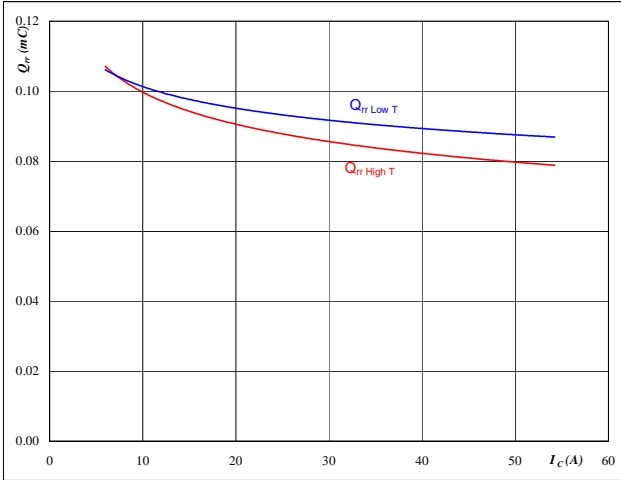


Buck

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
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

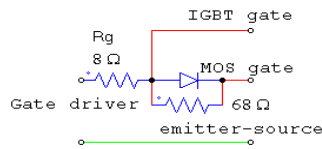
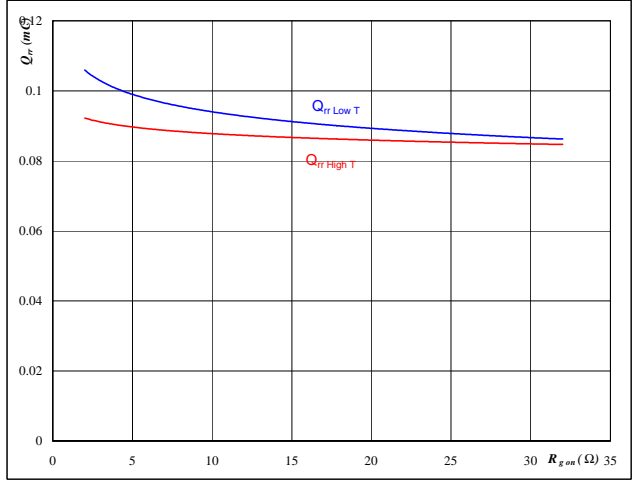


Figure 14 FRED

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
 $V_{GE} = \pm 15$ V

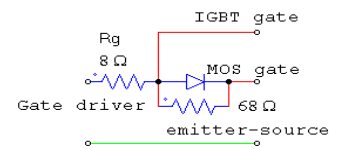
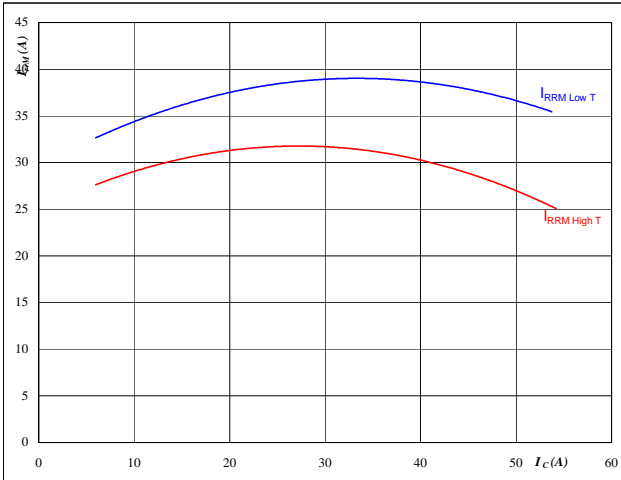


Figure 15 FRED

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
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

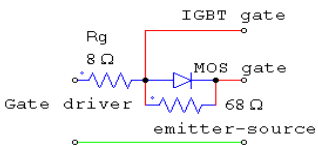
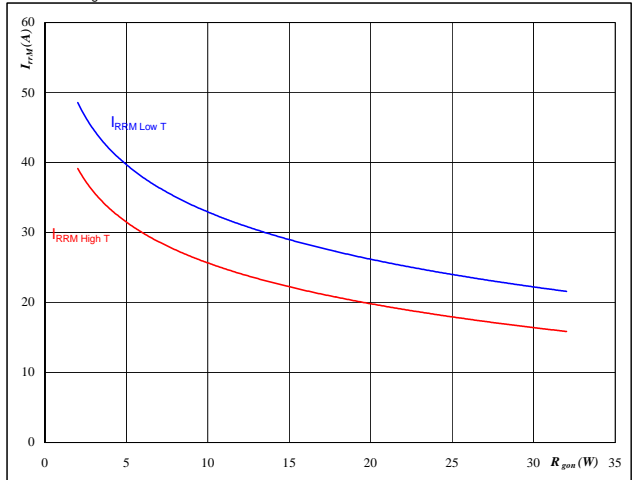


Figure 16 FRED

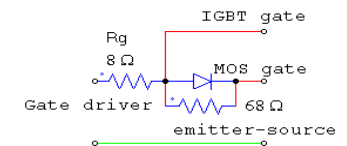
Typical reverse recovery current as a function of IGBT turn on gate resistor

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



At

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

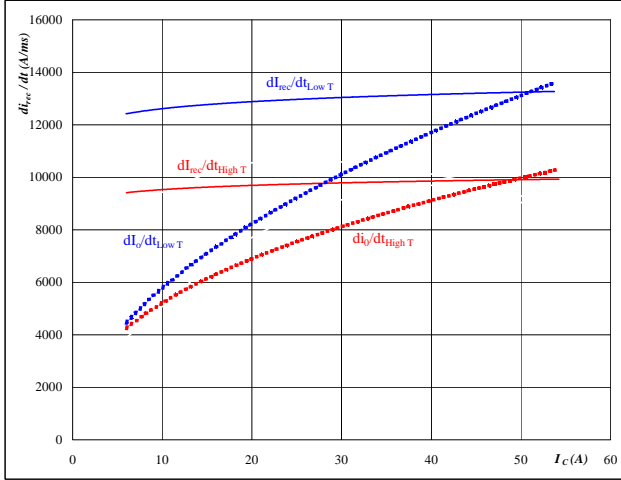


Buck

Figure 17 FRED

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

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



At

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

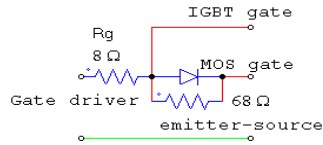
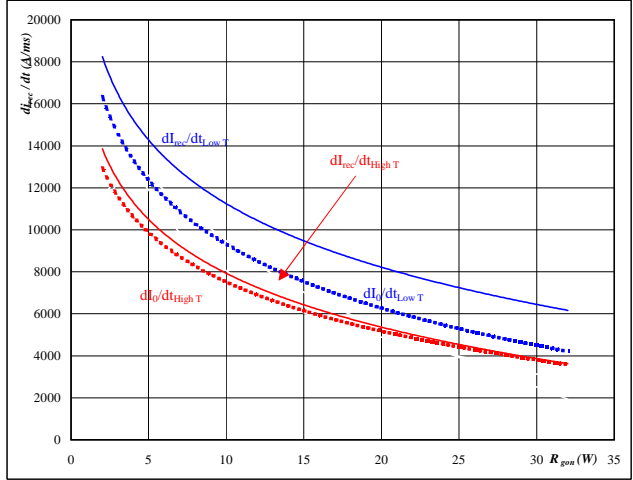


Figure 18 FRED

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

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



At

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

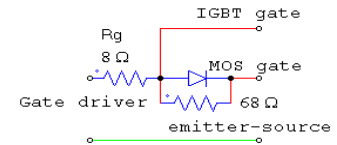
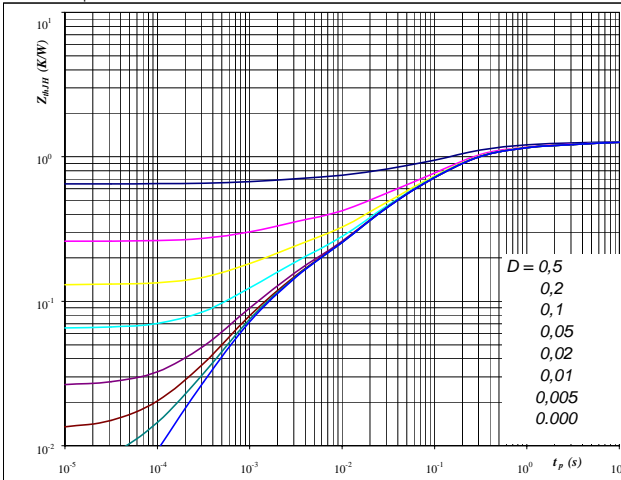


Figure 19 IGBT

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

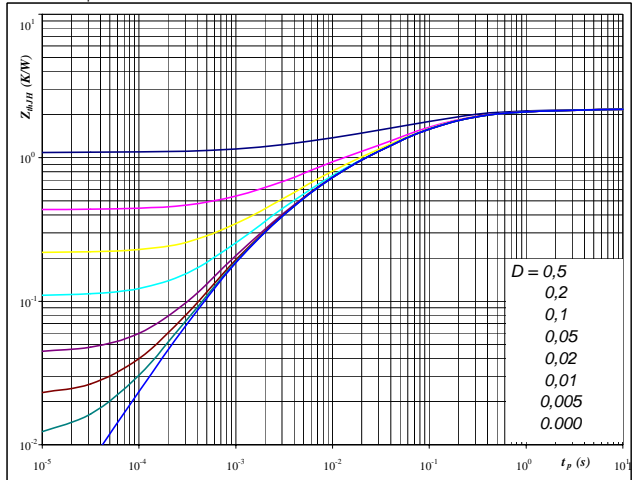
IGBT thermal model values

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

$D = t_p / T$
 $R_{thJH} = 2.18$ K/W

FRED thermal model values

R (C/W)	Tau (s)
0.13	2.4E+00
0.43	2.6E-01
0.90	6.2E-02
0.55	7.7E-03
0.18	1.2E-03

Buck

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

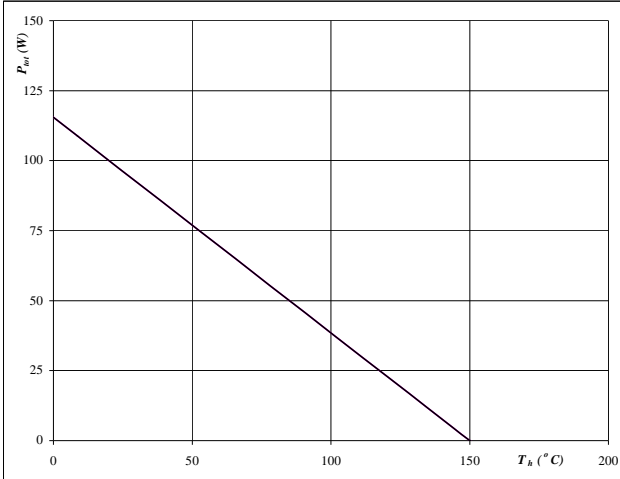

At
 $T_j = 150$ °C

Figure 22 IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

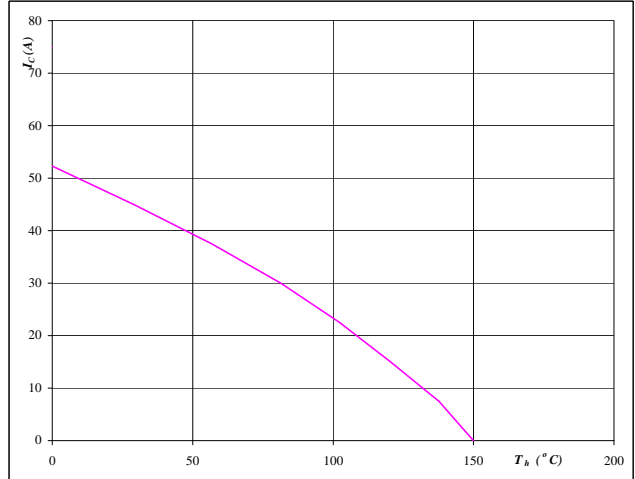

At
 $T_j = 150$ °C
 $V_{GE} = 15$ V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

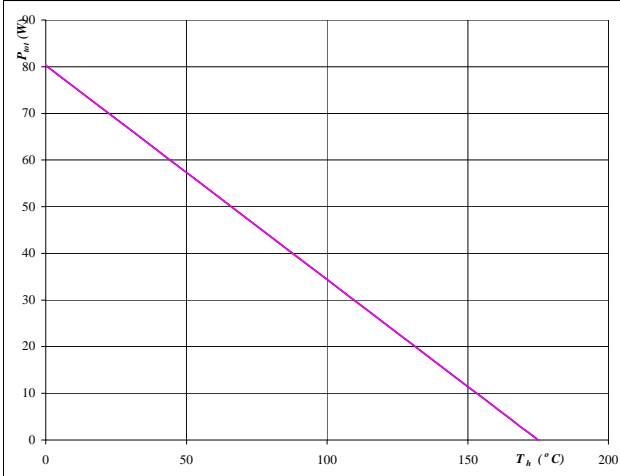
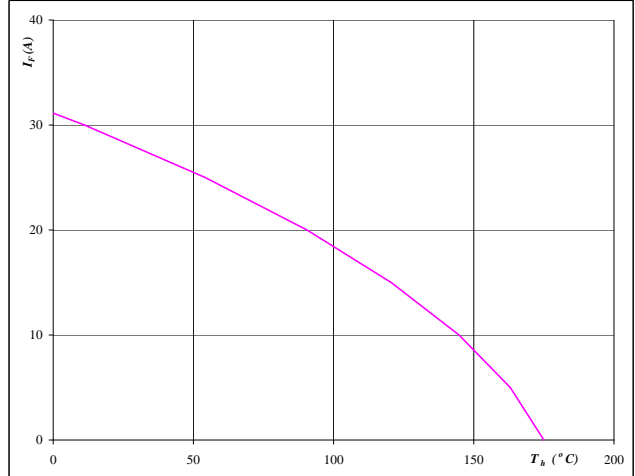

At
 $T_j = 175$ °C

Figure 24 FRED

Forward current as a function of heatsink temperature

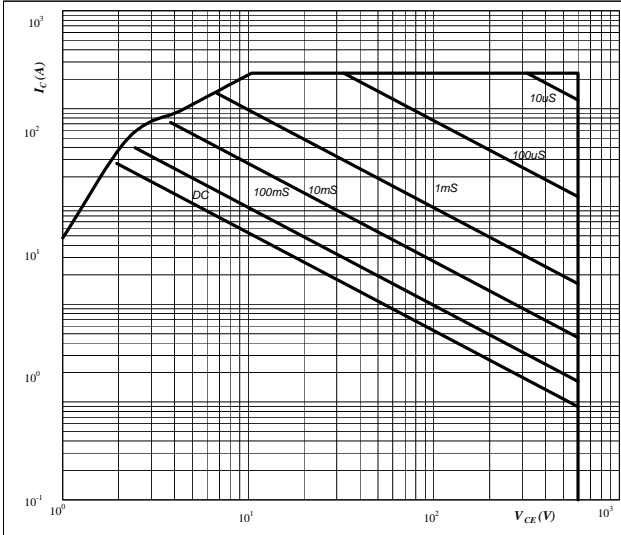
$$I_F = f(T_h)$$


At
 $T_j = 175$ °C

Buck

Figure 25 IGBT

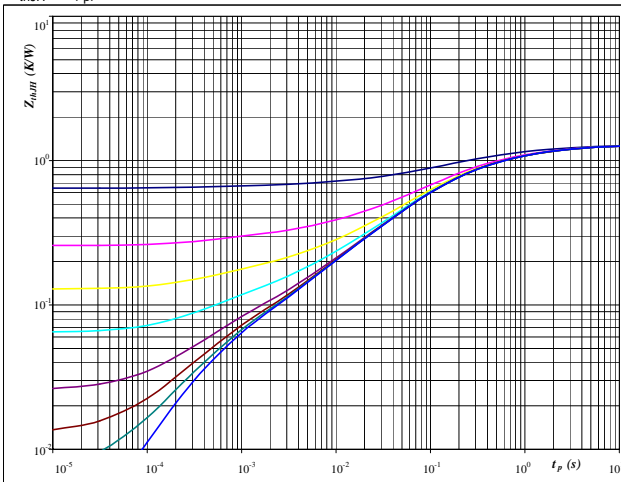
Safe operating area as a function of collector-emitter voltage
 $I_C = f(V_{CE})$



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

Figure 27 MOSFET

MOSFET transient thermal impedance as a function of pulse width
 $Z_{thJH} = f(t_p)$



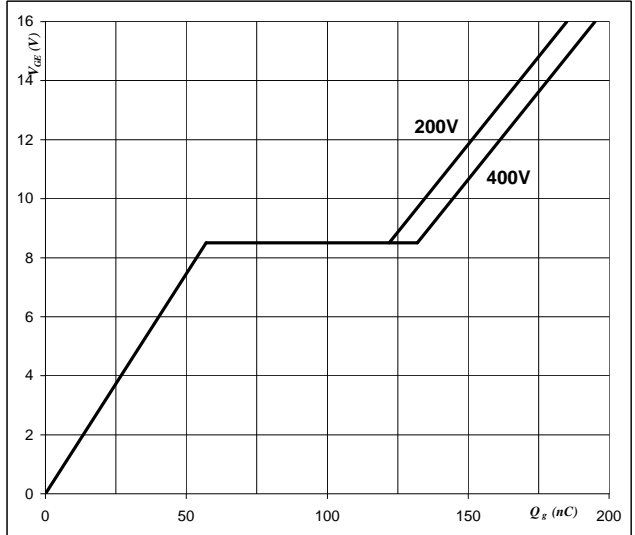
At
D = t_p / T
R_{thJH} = 1.29 K/W

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 26 IGBT

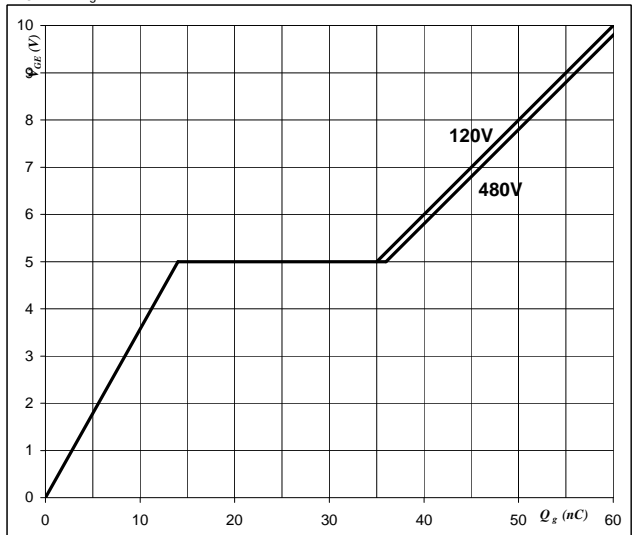
Gate voltage vs Gate charge
 $V_{GE} = f(Q_g)$



At
I_{G(REF)} = 1mA, R_L = 15Ω

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

$I_C = f(V_{CE})$

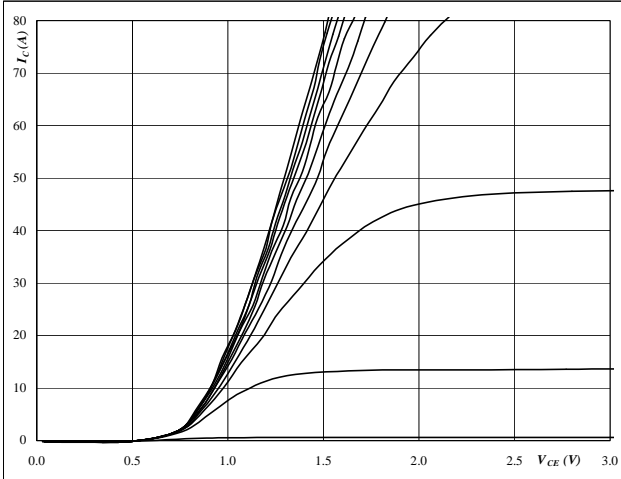

At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ }^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

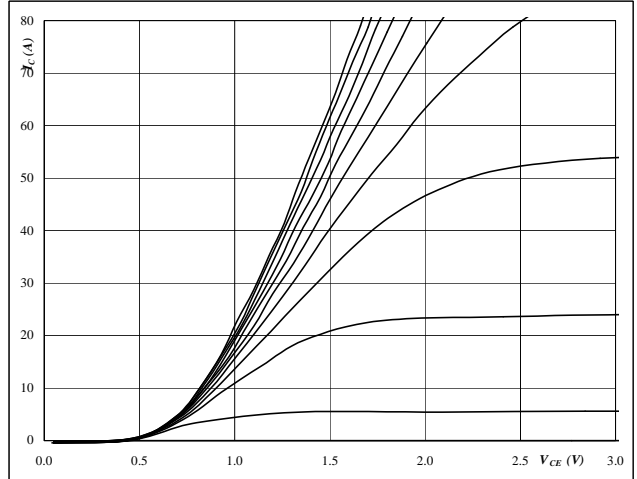
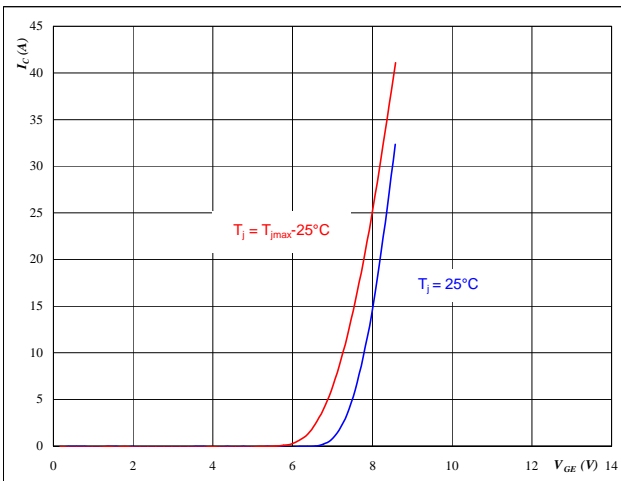

At
 $t_p = 250 \mu s$
 $T_j = 125 \text{ }^\circ C$
 V_{GE} from 6 V to 16 V in steps of 1 V

Figure 3 IGBT

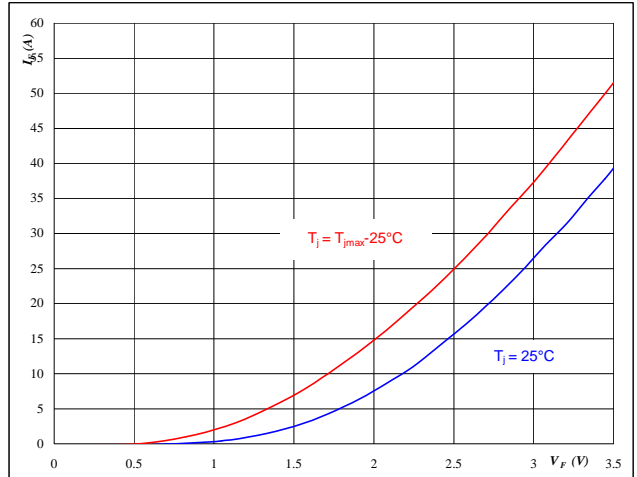
Typical transfer characteristics

$I_C = f(V_{GE})$


At
 $t_p = 250 \mu s$
 $V_{CE} = 10 V$
Figure 4 FRED

Typical diode forward current as a function of forward voltage

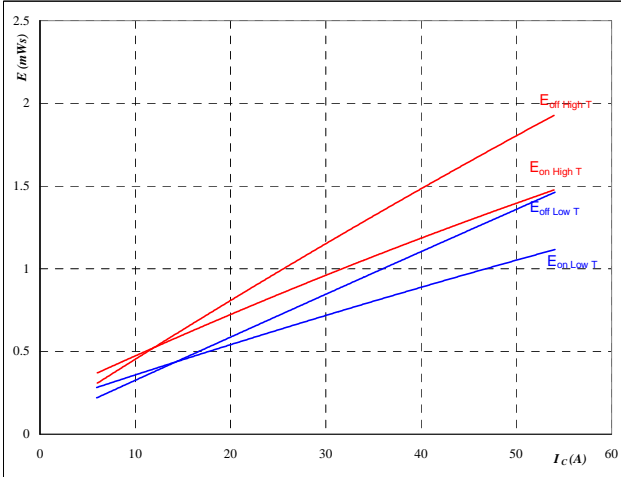
$I_F = f(V_F)$


At
 $t_p = 250 \mu s$

Boost

Figure 5 IGBT

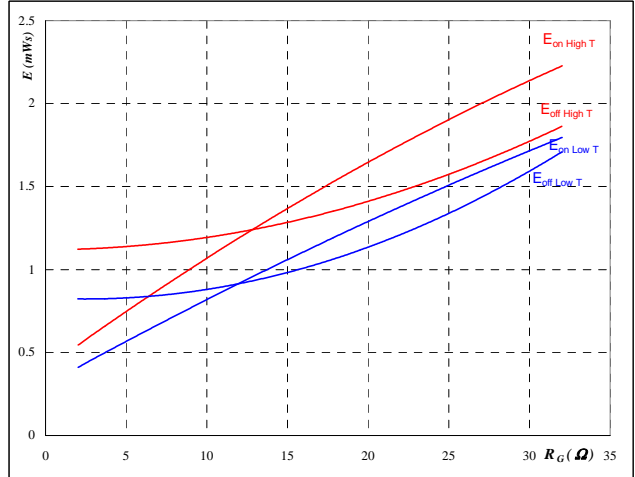
Typical switching energy losses
 as a function of collector current
 $E = f(I_C)$



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

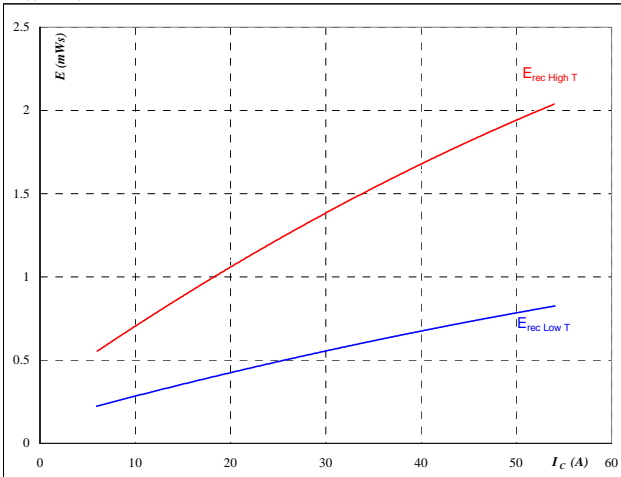
Typical switching energy losses
 as a function of gate resistor
 $E = f(R_G)$



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

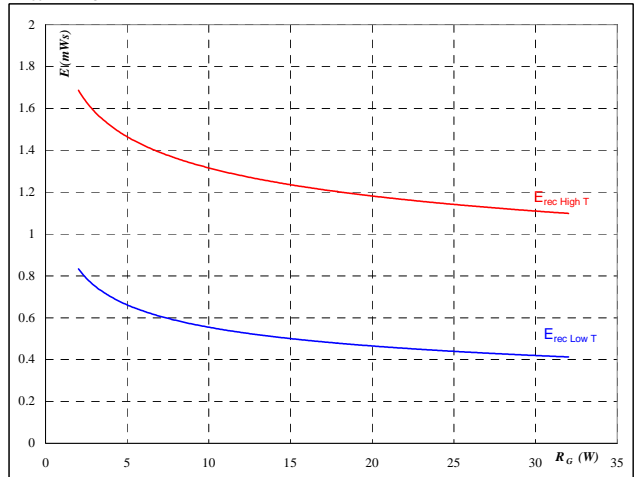
Typical reverse recovery energy loss
 as a function of collector current
 $E_{rec} = f(I_C)$



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
 $E_{rec} = f(R_G)$

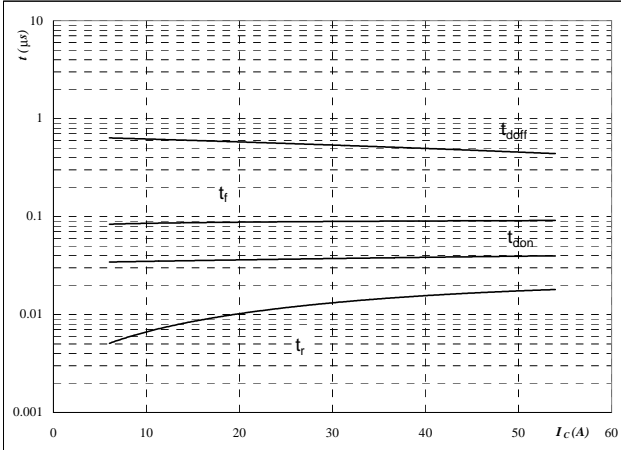


With an inductive load at
 $T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $I_C = 30$ A

Boost

Figure 9 IGBT

Typical switching times as a function of collector current
 $t = f(I_C)$

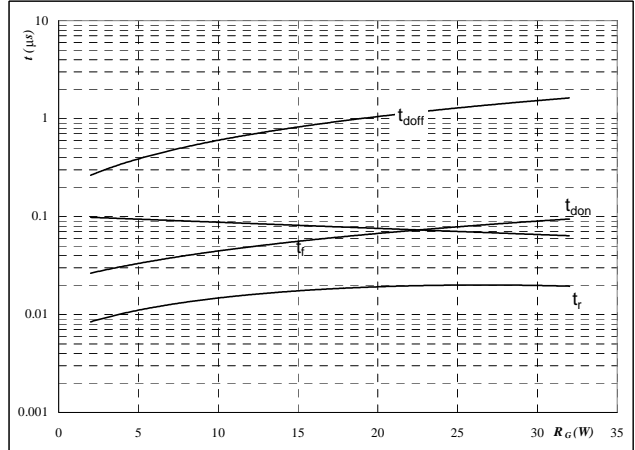


With an inductive load at

$T_j =$	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
 $t = f(R_G)$

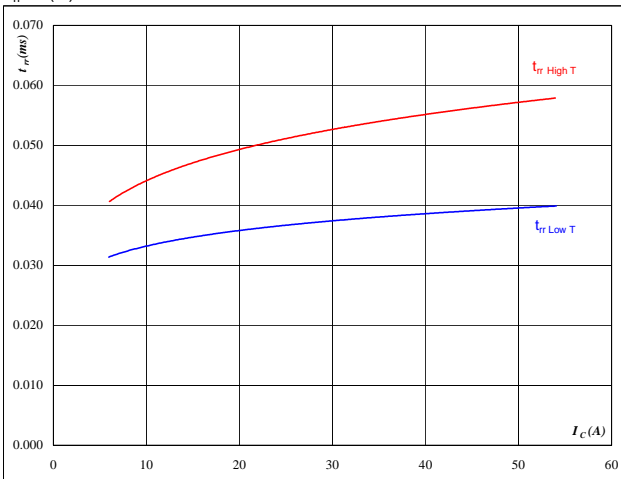


With an inductive load at

$T_j =$	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
 $t_{rr} = f(I_C)$

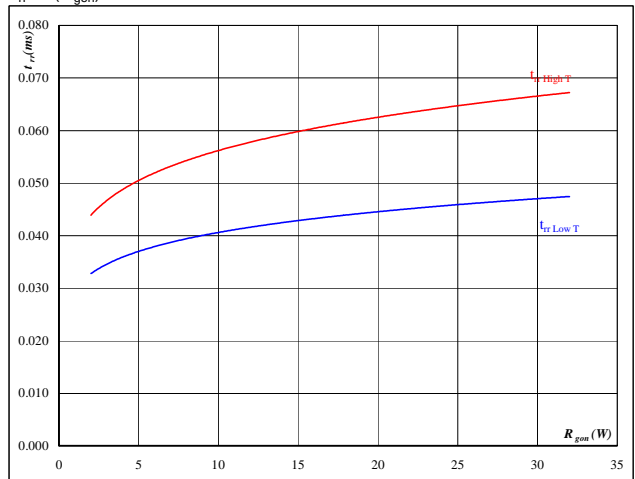


At

$T_j =$	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

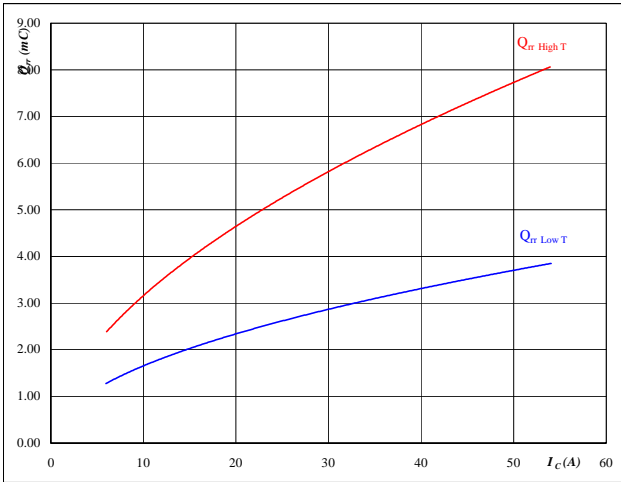
$T_j =$	25/125	°C
$V_R =$	350	V
$I_F =$	30	A
$V_{GE} =$	15	V

Boost

Figure 13 FRED

Typical reverse recovery charge as a function of collector current

$$Q_{rr} = f(I_C)$$

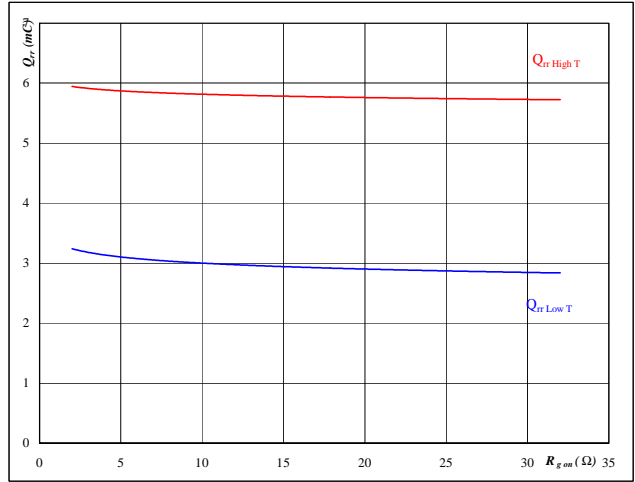


At
 $T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 14 FRED

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

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

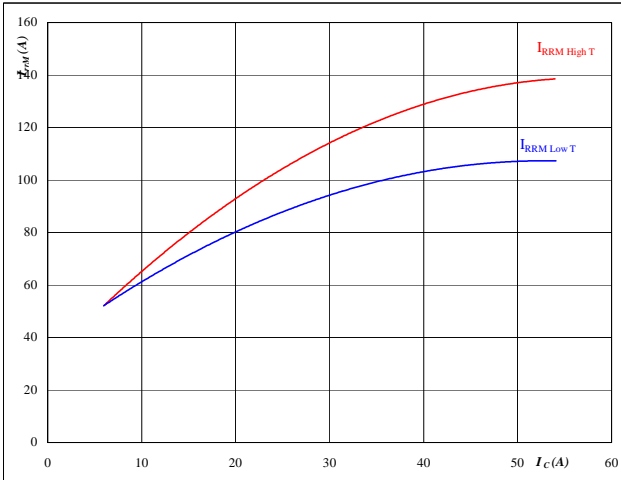


At
 $T_j = 25/125$ °C
 $V_R = 350$ V
 $I_F = 30$ A
 $V_{GE} = 15$ V

Figure 15 FRED

Typical reverse recovery current as a function of collector current

$$I_{RRM} = f(I_C)$$

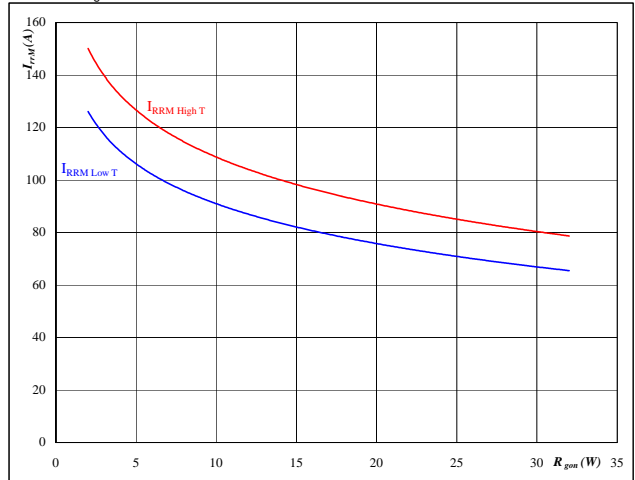


At
 $T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 16 FRED

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

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



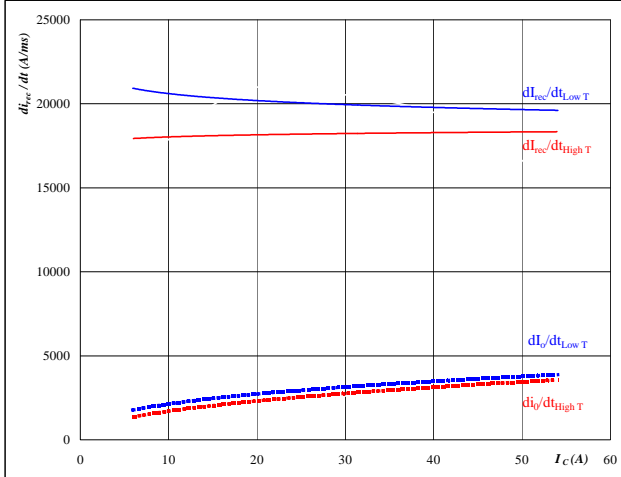
At
 $T_j = 25/125$ °C
 $V_R = 350$ V
 $I_F = 30$ A
 $V_{GE} = 15$ V

Boost

Figure 17 FRED

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

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

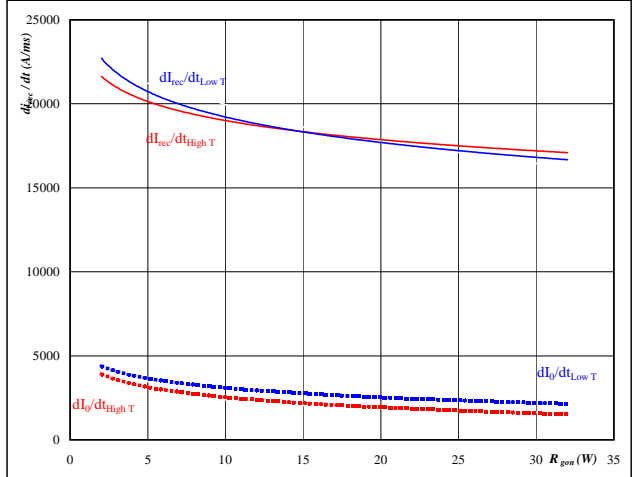


At
 $T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 18 FRED

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

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

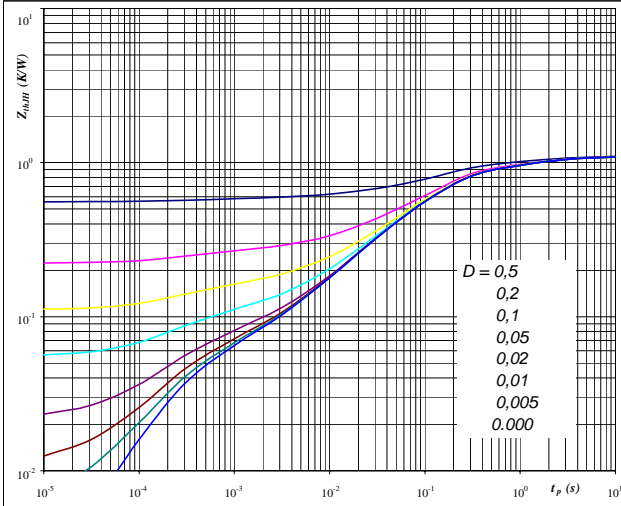


At
 $T_j = 25/125$ °C
 $V_R = 350$ V
 $I_F = 30$ A
 $V_{GE} = 15$ V

Figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



At
 $D = t_p / T$
 $R_{thJH} = 1.11$ K/W

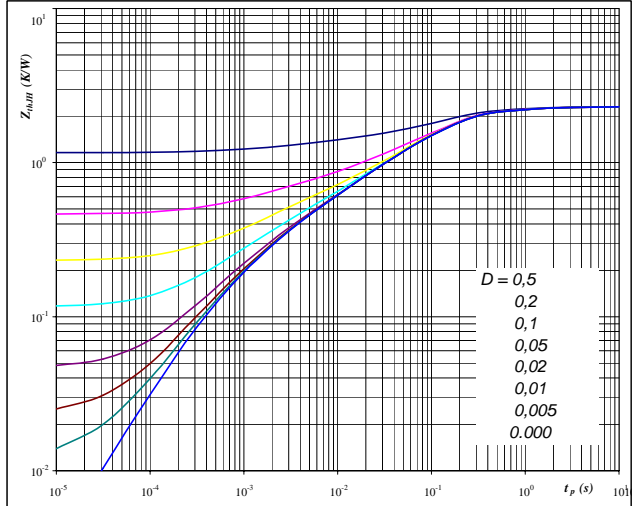
IGBT thermal model values

R (C/W) Tau (s)

Figure 20 FRED

FRED transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$



At
 $D = t_p / T$
 $R_{thJH} = 2.32$ K/W

FRED thermal model values

R (C/W) Tau (s)

Boost

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

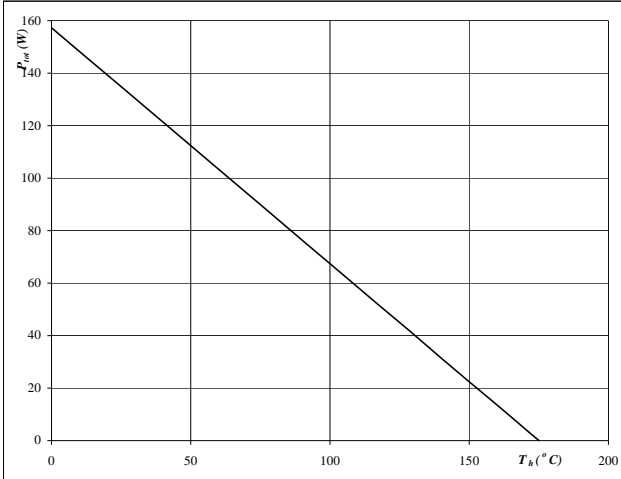

At
 $T_j = 175$ °C

Figure 22 IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

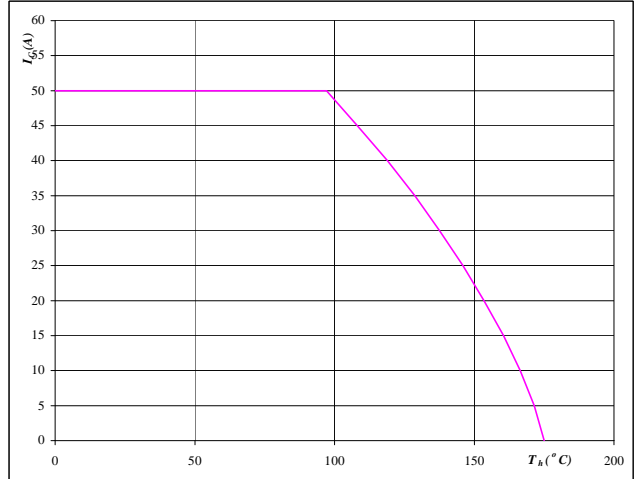

At
 $T_j = 175$ °C
 $V_{GE} = 15$ V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$

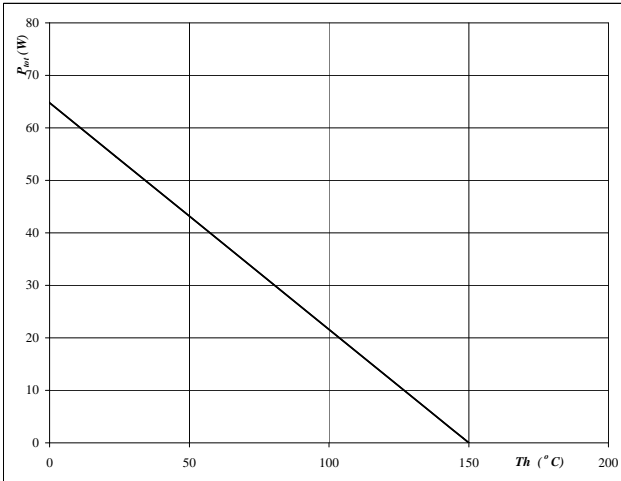
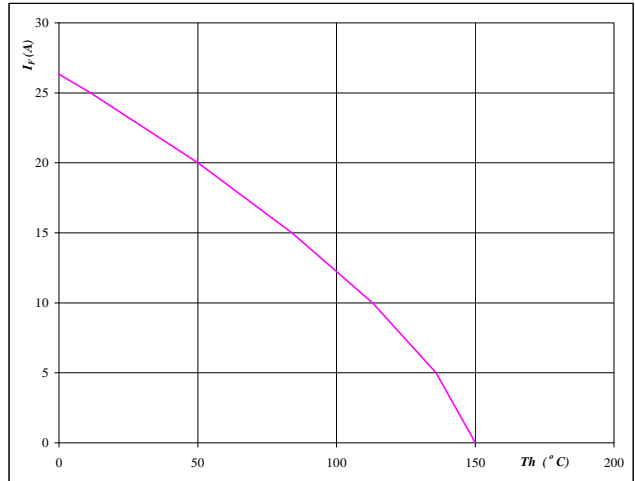

At
 $T_j = 150$ °C

Figure 24 FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$

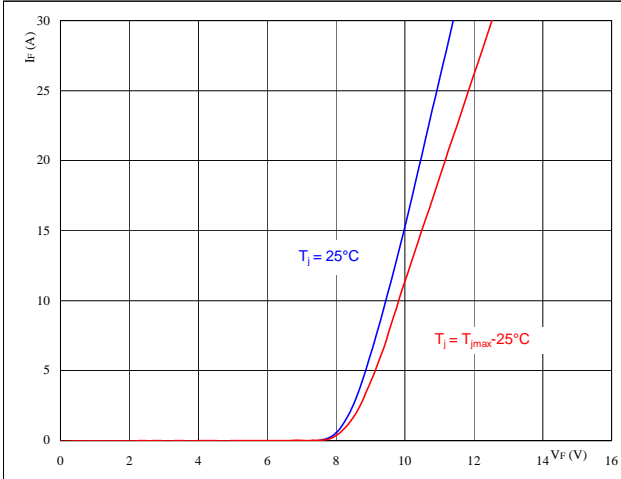

At
 $T_j = 150$ °C

Boost

Figure 25 Boost Inverse Diode

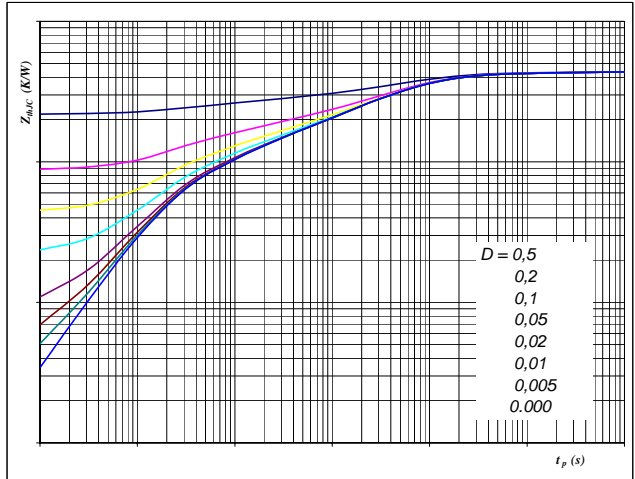
Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$


At
 $t_p = 250 \mu s$
Figure 26 Boost Inverse Diode

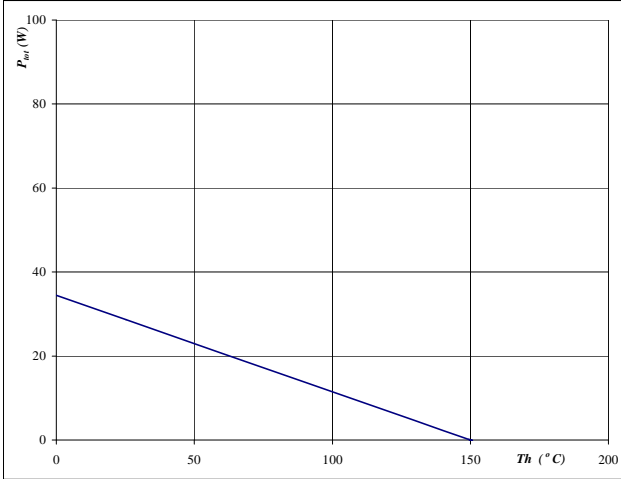
Diode transient thermal impedance as a function of pulse width

$$Z_{thJH} = f(t_p)$$


At
 $D = t_p / T$
 $R_{thJH} = 4.36 \text{ K/W}$
Figure 27 Boost Inverse Diode

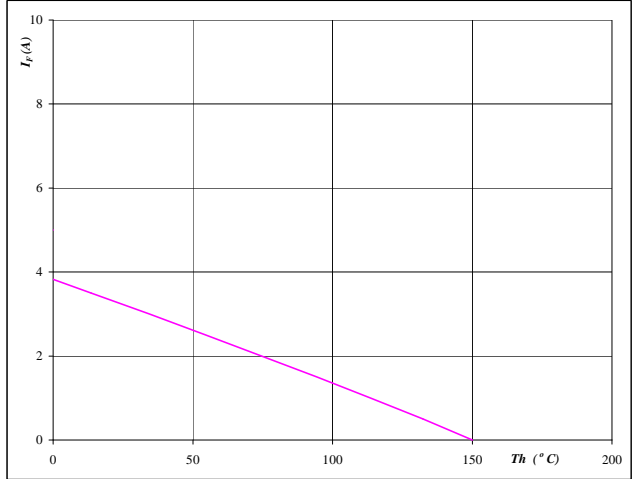
Power dissipation as a function of heatsink temperature

$$P_{tot} = f(T_h)$$


At
 $T_j = 150 \text{ }^\circ C$
Figure 28 Boost Inverse Diode

Forward current as a function of heatsink temperature

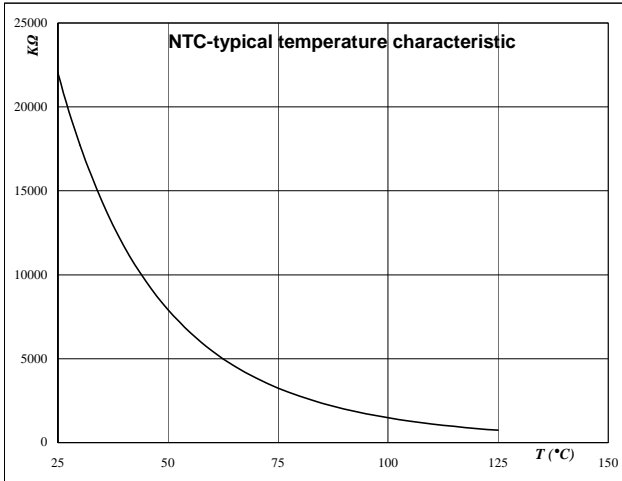
$$I_F = f(T_h)$$


At
 $T_j = 150 \text{ }^\circ C$

Thermistor

Figure 1 Thermistor

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


Figure 2 Thermistor

Typical NTC resistance values

$$R(T) = R_{25} \cdot e^{\left(B_{25100} \left(\frac{1}{T} - \frac{1}{T_{25}} \right) \right)} \quad [\Omega]$$

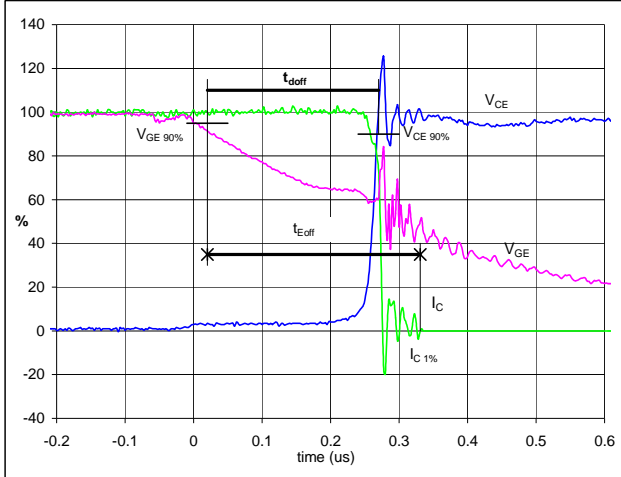
T [°C]	R _{nom} [Ω]	R _{min} [Ω]	R _{max} [Ω]	ΔR/R [±%]
-55	2089434,5	1506495,4	2672373,6	27,9
0	71804,2	59724,4	83884	16,8
10	43780,4	37094,4	50466,5	15,3
20	27484,6	23684,6	31284,7	13,8
25	22000	19109,3	24890,7	13,1
30	17723,3	15512,2	19934,4	12,5
60	5467,9	4980,6	5955,1	8,9
70	3848,6	3546	4151,1	7,9
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

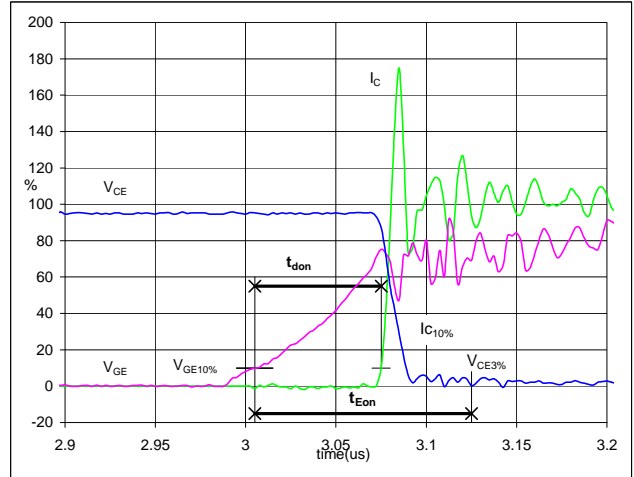
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
 (t_{Eoff} = integrating time for E_{off})



$V_{GE} (0\%) =$	-15	V
$V_{GE} (100\%) =$	15	V
$V_C (100\%) =$	350	V
$I_C (100\%) =$	42	A
$t_{doff} =$	0.24	μs
$t_{Eoff} =$	0.31	μs

Figure 2 Output inverter IGBT

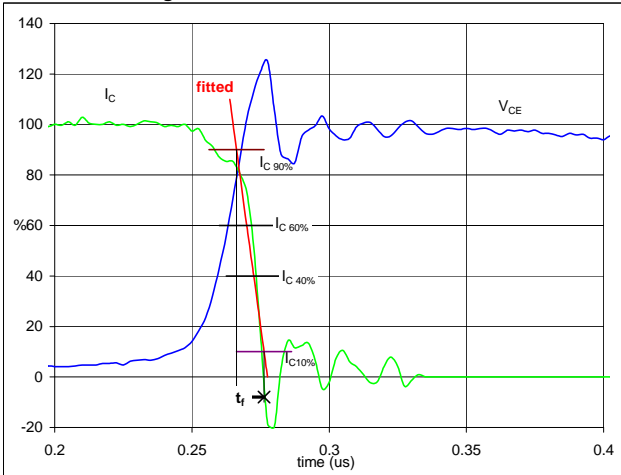
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
 (t_{Eon} = integrating time for E_{on})



$V_{GE} (0\%) =$	-15	V
$V_{GE} (100\%) =$	15	V
$V_C (100\%) =$	350	V
$I_C (100\%) =$	42	A
$t_{don} =$	0.07	μs
$t_{Eon} =$	0.12	μs

Figure 3 Output inverter IGBT

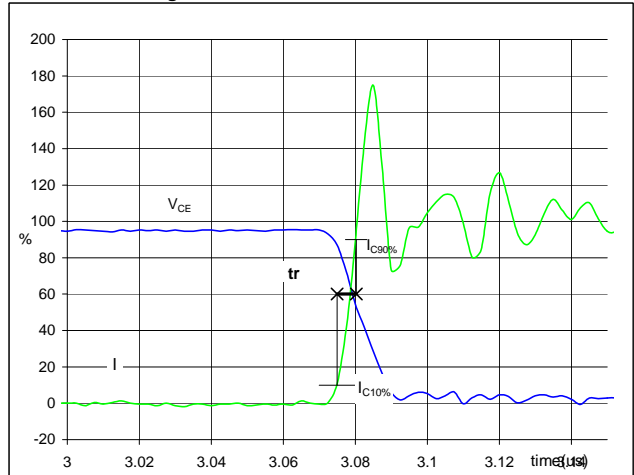
Turn-off Switching Waveforms & definition of t_f



$V_C (100\%) =$	350	V
$I_C (100\%) =$	42	A
$t_f =$	0.006	μs

Figure 4 Output inverter IGBT

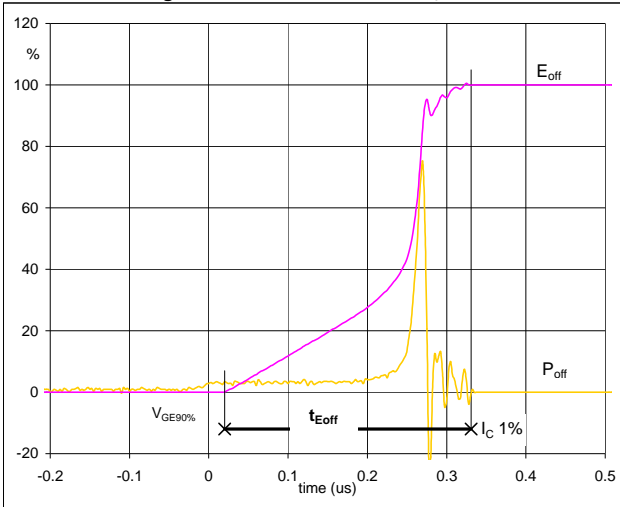
Turn-on Switching Waveforms & definition of t_r



$V_C (100\%) =$	350	V
$I_C (100\%) =$	42	A
$t_r =$	0.005	μs

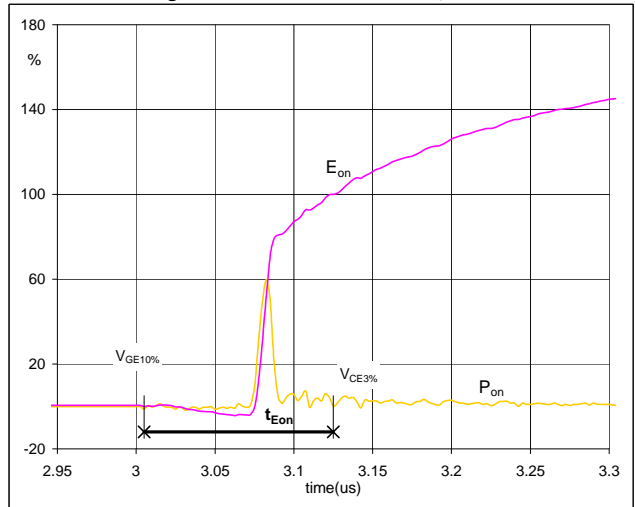
Switching Definitions BUCK MOSFET

Figure 5 Output inverter IGBT

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


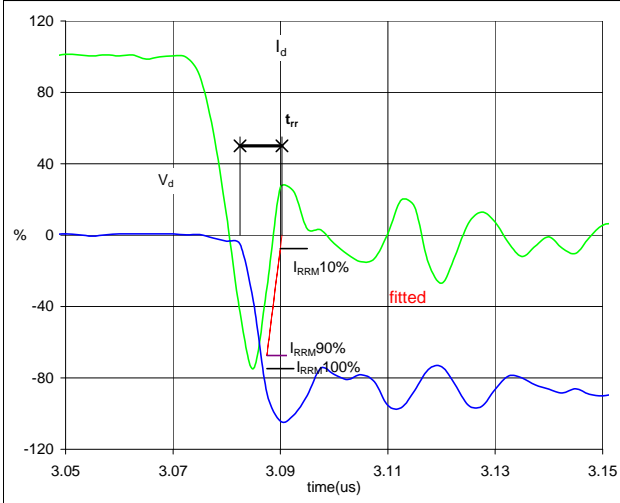
$P_{off}(100\%) =$	14.72	kW
$E_{off}(100\%) =$	0.31	mJ
$t_{Eoff} =$	0.31	μs

Figure 6 Output inverter IGBT

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


$P_{on}(100\%) =$	14.72	kW
$E_{on}(100\%) =$	0.11	mJ
$t_{Eon} =$	0.12	μs

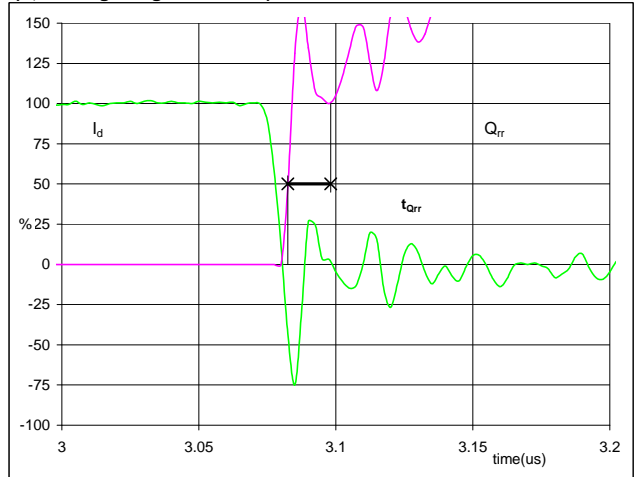
Figure 7 Output inverter IGBT

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


$V_d(100\%) =$	350	V
$I_d(100\%) =$	42	A
$I_{RRM}(100\%) =$	-31	A
$t_{rr} =$	0.008	μs

Figure 8 Output inverter FRED

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

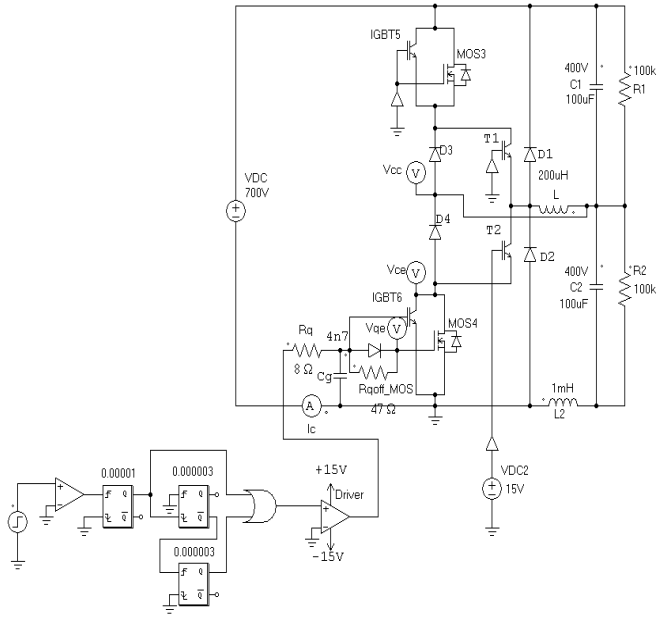
 ($t_{Qrr} =$ integrating time for Q_{rr})


$I_d(100\%) =$	42	A
$Q_{rr}(100\%) =$	0.09	μC
$t_{Qrr} =$	0.02	μs

Measurement circuits

Figure 11

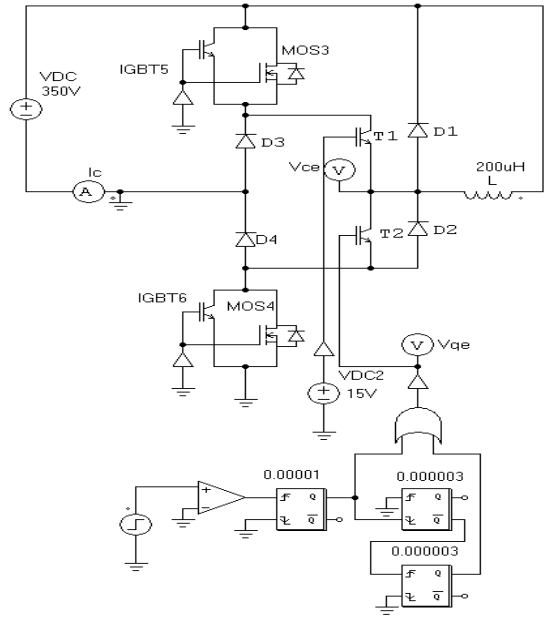
BUCK stage switching measurement circuit



Cg is included in the module

Figure 12

BOOST stage switching measurement circuit

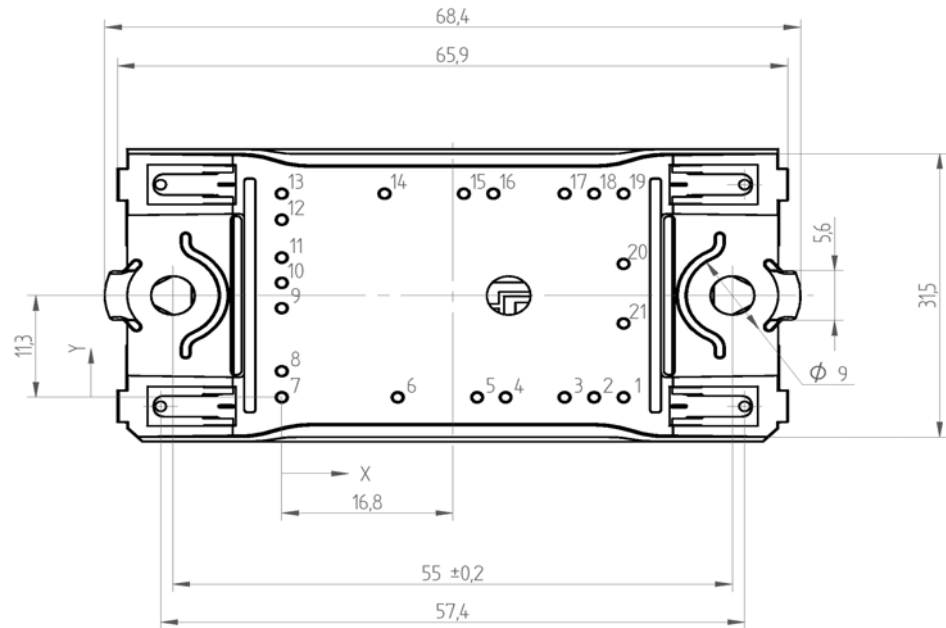
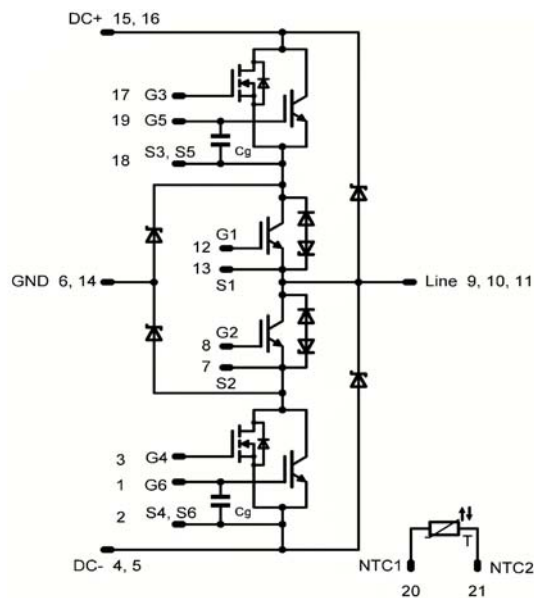


Ordering Code and Marking - Outline - Pinout
Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste 12mm housing	10-FZ06NPA045FP-P967F	P967F	P967F

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.
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