

flowNPC 0
600V/75A & 70A PS*
Features

- *PS: 70A parallel switch (60A PT and 99mΩ)
- neutral point clamped inverter
- reactive power capability
- SiC buck diode
- low inductance layout

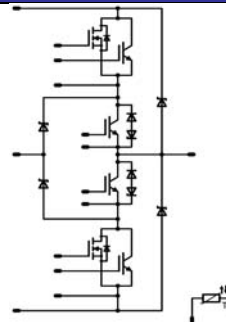
Target Applications

- solar inverter
- UPS

Types

- FZ06NPA070FP

flow0 12mm housing

Schematic


Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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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	44 59	A
Repetitive peak collector current	I _{Cpulse}	t _p limited by T _{jmax}	240	A
Power dissipation per IGBT	P _{tot}	T _j =T _{jmax} T _h =80°C T _c =80°C	71 108	W
Gate-emitter peak voltage	V _{GE}		±20	V
Short circuit ratings	t _{SC} V _{CC}	T _j ≤150°C V _{GE} =15V	5 390	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	27 37	A
Repetitive peak forward current	I _{FRM}	t _p limited by T _{jmax} T _c =100°C	105	A
Power dissipation per Diode	P _{tot}	T _j =T _{jmax} T _h =80°C T _c =80°C	50 75	W
Maximum Junction Temperature	T _{jmax}		175	°C

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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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	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	57 75	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	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	20 28	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	70	A
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^{\circ}\text{C}$ $T_c=80^{\circ}\text{C}$	34 52	W
Maximum Junction Temperature	T_{jmax}		150	$^{\circ}\text{C}$

Maximum Ratings

T_j=25°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	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0.00025	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	4.5	5.2	7	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		70	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1	2.32 2.09	2.9	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			250	uA
Gate-emitter leakage current	I_{GES}		±20	0		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			300	nA
Integrated Gate resistor	R_{gint}							none		Ω
Input capacitance **	C_{ies}	f=1MHz	0	25		$T_j=25^{\circ}C$		4+4,7		nF
Output capacitance	C_{oss}							400		pF
Reverse transfer capacitance	C_{rss}							200		pF
Gate charge **	Q_{Gate}		±15			$T_j=25^{\circ}C$		225+70		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um $\lambda = 1 \text{ W/mK}$						0.99		K/W
* see dynamic characteristic at Buck MosFET **additional value stands for built-in capacitor										
Buck Diode										
Diode forward voltage	V_F				24	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1	1.48 1.58	1.8	V
Peak reverse recovery current	I_{RRM}	$R_{gon}=8 \Omega$		350	40	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		42 34		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		9 9		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.121 0.121		μC
Peak rate of fall of recovery current	$di(rec)/max /dt$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		13108 10427		A/μs
Reverse recovered energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.011 0.012		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um $\lambda = 1 \text{ W/mK}$						1.91		K/W
Buck MOSFET										
Static drain to source ON resistance	$R_{ds(on)}$		10		18	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		109 219		mΩ
Gate threshold voltage	$V_{(GS)th}$			$V_{DS}=V_{GS}$	0.001	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	2.1	3	3.6	V
Gate to Source Leakage Current	I_{gss}		20	0		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			200	nA
Zero Gate Voltage Drain Current	I_{dss}		0	600		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			60	uA
Turn On Delay Time	$t_{d(ON)}$	$R_{gon}=8 \Omega$ ** $R_{goff}=8 \Omega$ **	±15	350	40	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		92 101		ns
Rise Time	t_r					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		6 6		
Turn off delay time	$t_{d(OFF)}$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		208 210		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		9 5		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.066 0.096		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.100 0.225		
Total gate charge	Q_g		±15	350	40	$T_j=25^{\circ}C$		60	80	nC
Gate to source charge	Q_{gs}							14		
Gate to drain charge	Q_{gd}							20		
Input capacitance	C_{iss}	f=1MHz	0	100		$T_j=25^{\circ}C$		2800		pF
Output capacitance	C_{oss}							130		
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um $\lambda = 1 \text{ W/mK}$						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 $V_{BS} [V]$	$I_c [A]$ 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	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	5	5.8	6.5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		70	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1	1.49 1.6	2.1	V
Collector-emitter cut-off incl diode	I_{CES}		0	600		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			0.03	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			650	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	Rgon=8 Ω Rgoff=8 Ω	± 15	350	40	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		37 35		ns
Rise time	t_r					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		13 16		
Turn-off delay time	$t_{d(off)}$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		459 500		
Fall time	t_f					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		83 106		
Turn-on energy loss per pulse	E_{on}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.81 1.11		mWs
Turn-off energy loss per pulse	E_{off}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		1.35 1.71		
Input capacitance	C_{ies}	f=1MHz	0	25		$T_j=25^{\circ}C$		4620		pF
Output capacitance	C_{oss}							288		
Reverse transfer capacitance	C_{rss}							137		
Gate charge	Q_{Gate}		15	480	75	$T_j=25^{\circ}C$		470		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 \text{ W/mK}$						1.11		K/W
Boost Inverse Diode										
Diode forward voltage	V_F				20	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		9.07 9.43		V
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 \text{ W/mK}$						4.36		K/W
Boost Diode										
Diode forward voltage	V_F				30	$T_j=25^{\circ}C$ $T_j=125^{\circ}C$	1.5	2.44 2.01	3.5	V
Reverse leakage current	I_r			1200		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$			100	μA
Peak reverse recovery current	I_{RRM}	Rgon=8 Ω	350	40		$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		80 100		A
Reverse recovery time	t_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		33 109		ns
Reverse recovered charge	Q_{rr}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		2.7 6		μC
Peak rate of fall of recovery current	$di(rec)_{max}/dt$					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		11226 8793		A/ μs
Reverse recovery energy	E_{rec}					$T_j=25^{\circ}C$ $T_j=125^{\circ}C$		0.61 1.52		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness $\leq 50\mu m$ $\lambda = 1 \text{ W/mK}$						2.04		K/W
Thermistor										
Rated resistance*	R_{25}	Tol. $\pm 13\%$				$T_j=25^{\circ}C$	19.1	22	24.9	k Ω
	R_{100}	Tol. $\pm 5\%$				$T_j=100^{\circ}C$	1411	1486	1560	Ω
Power dissipation	P					$T_j=25^{\circ}C$		210		mW
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				$T_j=25^{\circ}C$		4000		K

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

Buck

Figure 1 MOSFET

Typical output characteristics

$$I_C = f(V_{CE})$$

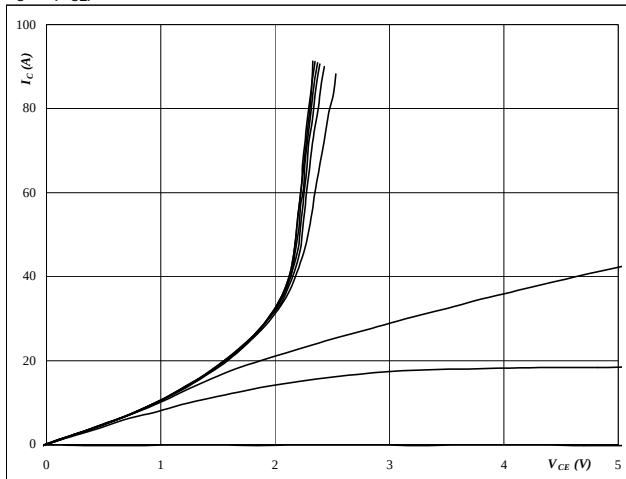

At
 $t_p = 250 \mu s$
 $T_J = 25 ^\circ C$
 V_{GE} from 3 V to 19 V in steps of 2 V

Figure 2 MOSFET

Typical output characteristics

$$I_C = f(V_{CE})$$

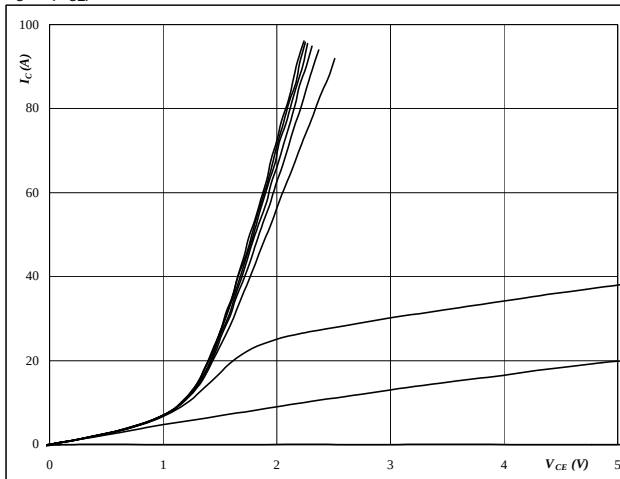
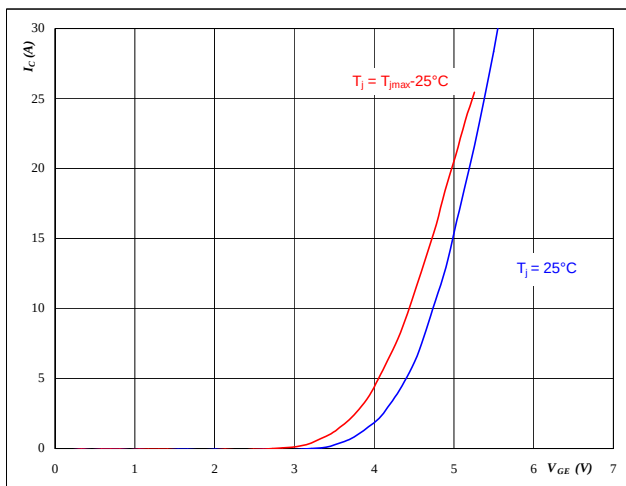

At
 $t_p = 250 \mu s$
 $T_J = 125 ^\circ C$
 V_{GE} from 3 V to 19 V in steps of 2 V

Figure 3 MOSFET

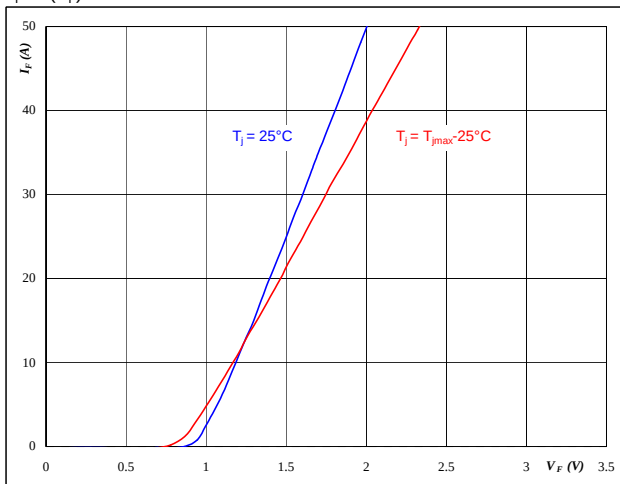
Typical transfer characteristics

$$I_C = f(V_{GE})$$


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

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

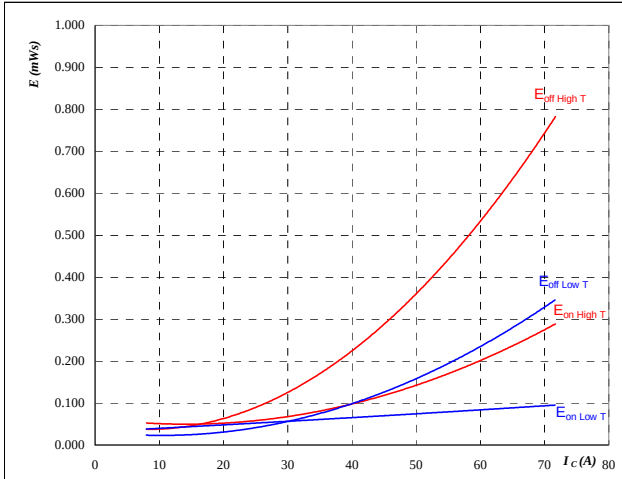

At
 $t_p = 250 \mu s$

Buck

Figure 5 MOSFET

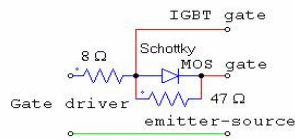
Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



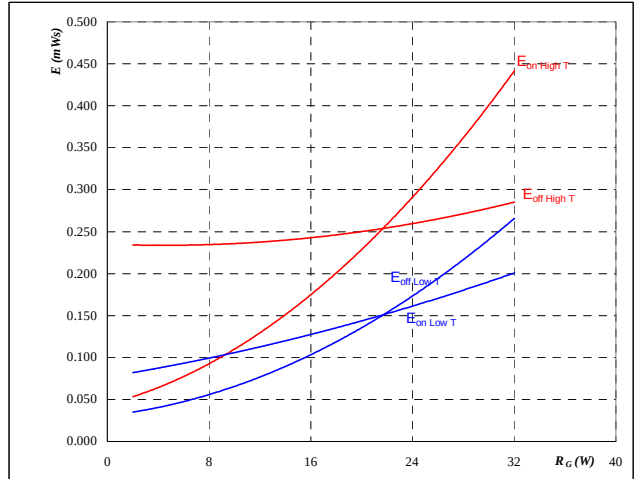
With an inductive load at

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


Figure 6 MOSFET

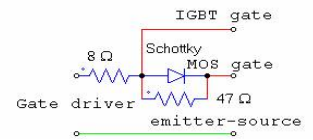
Typical switching energy losses
as a function of IGBT gate resistor

$$E = f(R_G)$$



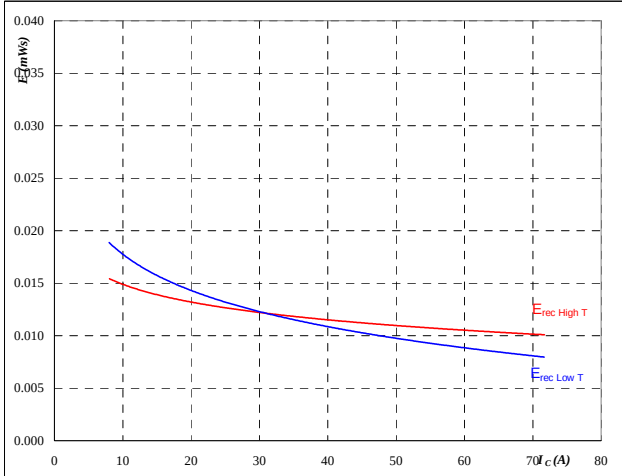
With an inductive load at

$T_J = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = \pm 15$ V
 $I_C = 40$ A


Figure 7 FRED

Typical reverse recovery energy loss
as a function of collector current

$$E_{rec} = f(I_C)$$



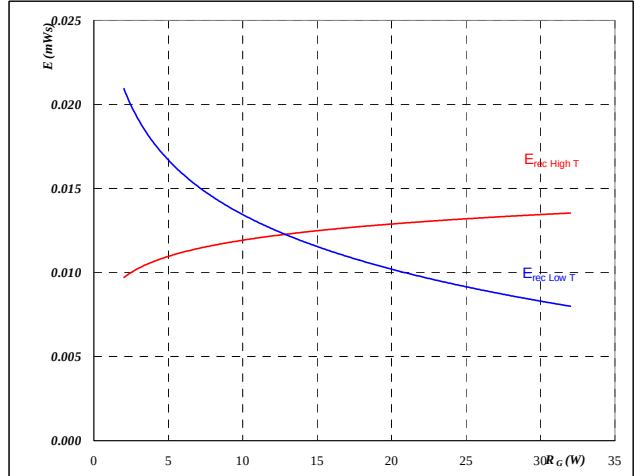
With an inductive load at

$T_J = 25/125$ °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

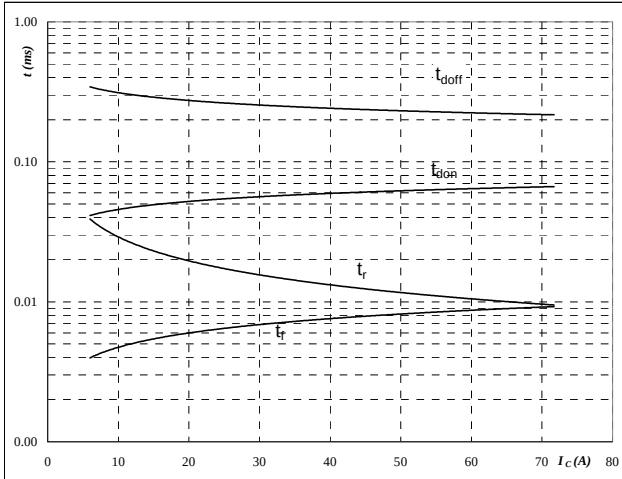
$T_J = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = \pm 15$ V
 $I_C = 40$ A

Buck

Figure 9 MOSFET

Typical switching times as a function of collector current

$$t = f(I_C)$$



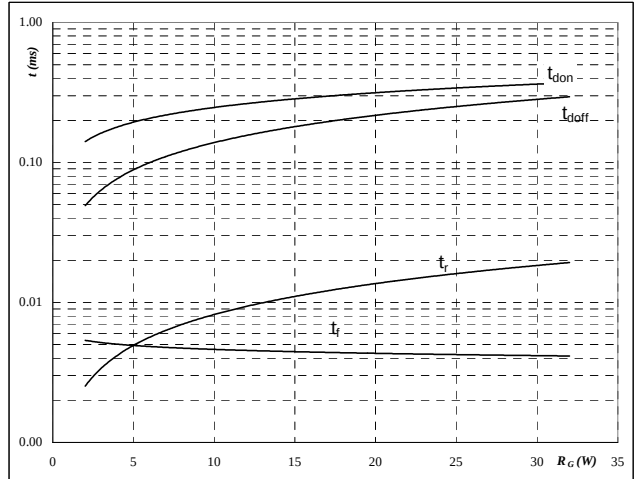
With an inductive load at

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

$$t = f(R_G)$$



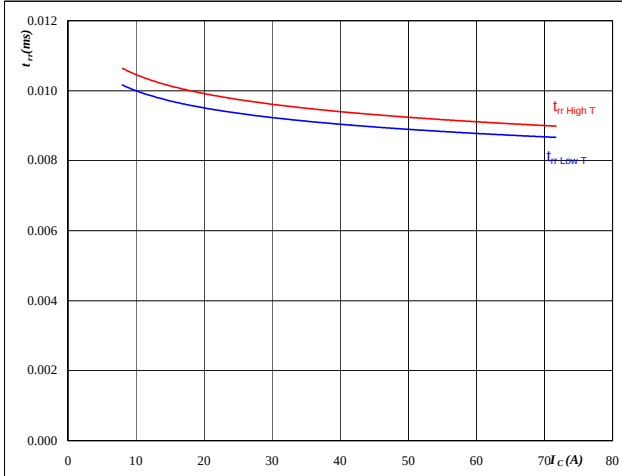
With an inductive load at

T _J =	125	°C
V _{CE} =	350	V
V _{GE} =	±15	V
I _C =	40	A

Figure 11 FRED

Typical reverse recovery time as a function of collector current

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



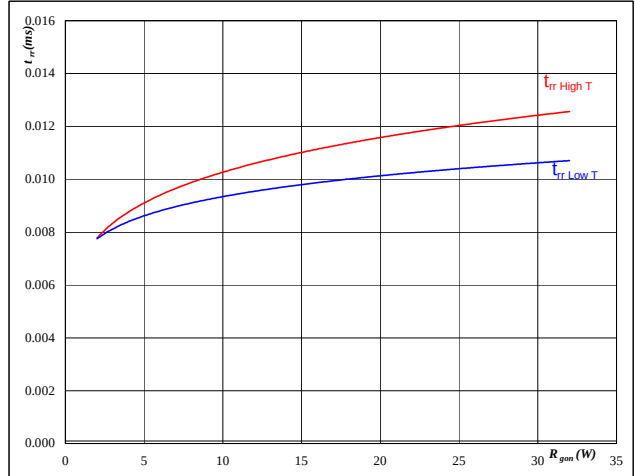
At

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 =	40	A
V _{GE} =	±15	V

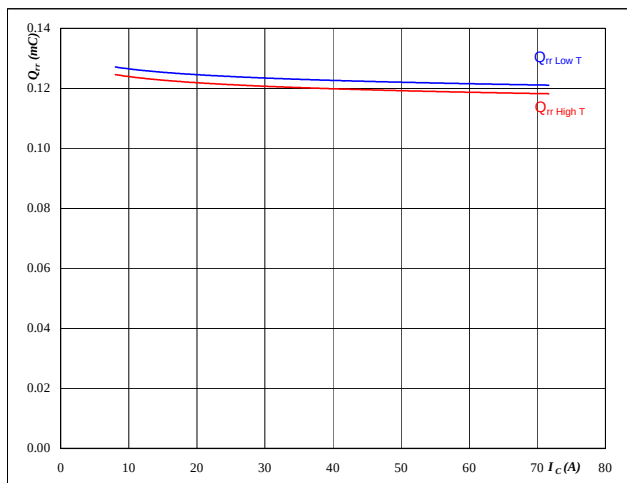
Buck

Figure 13

FRED

Typical reverse recovery charge as a function of collector current

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


At

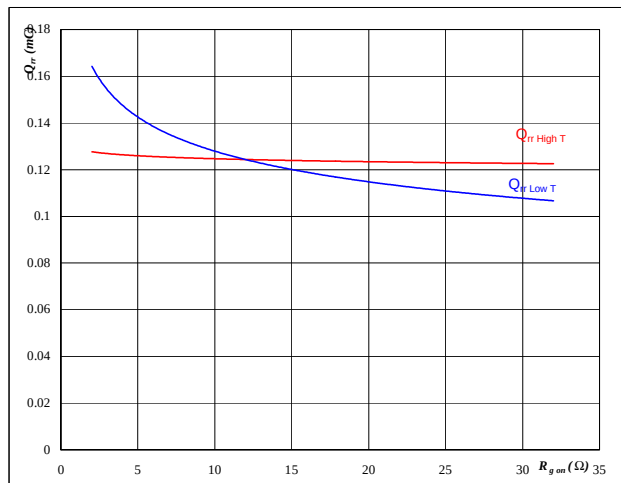
$T_J = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

Figure 14

FRED

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

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


At

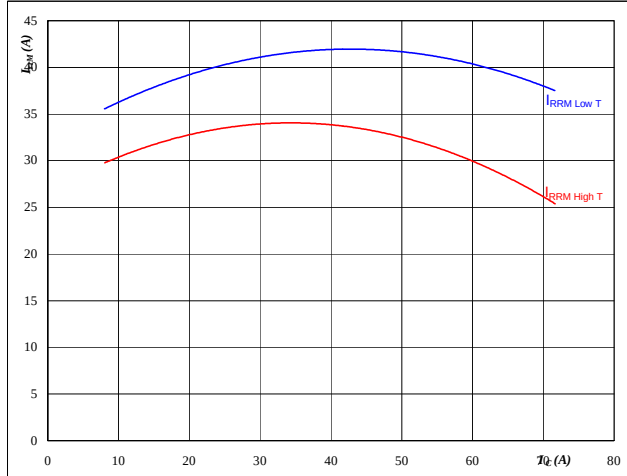
$T_J = 25/125$ °C
 $V_R = 350$ V
 $I_F = 40$ A
 $V_{GE} = \pm 15$ V

Figure 15

FRED

Typical reverse recovery current as a function of collector current

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


At

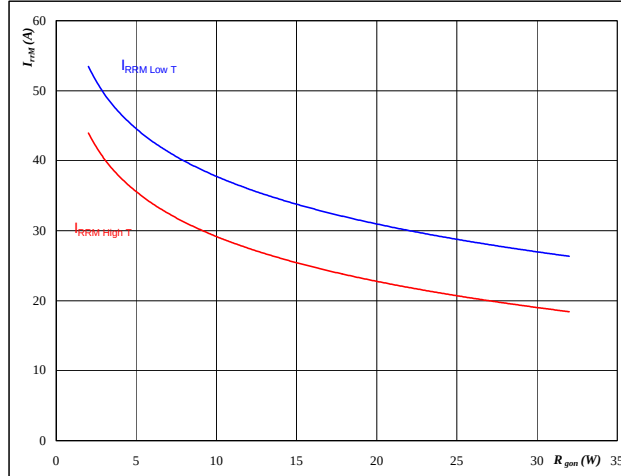
$T_J = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 8$ Ω

Figure 16

FRED

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

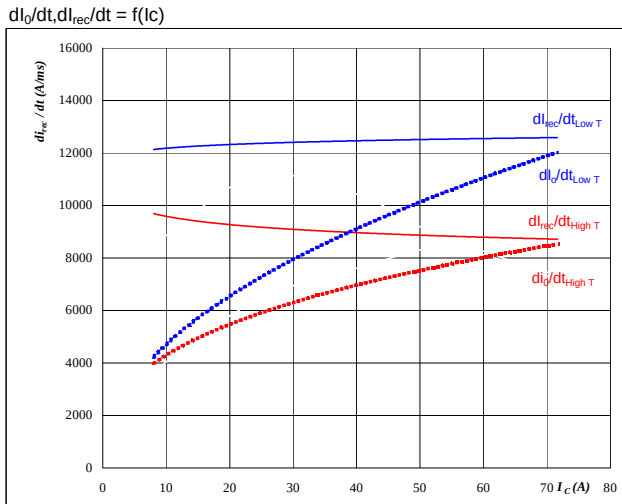
$$I_{RRM} = f(R_{gon})$$


At

$T_J = 25/125$ °C
 $V_R = 350$ V
 $I_F = 40$ A
 $V_{GE} = \pm 15$ V

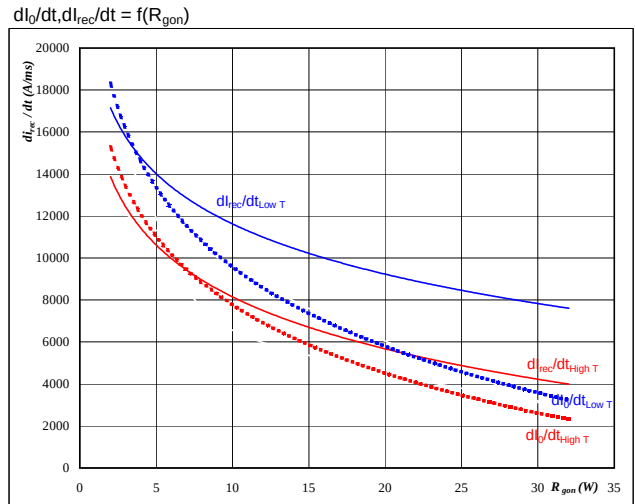
Buck

Figure 17 FRED
 Typical rate of fall of forward and reverse recovery current
 as a function of collector current



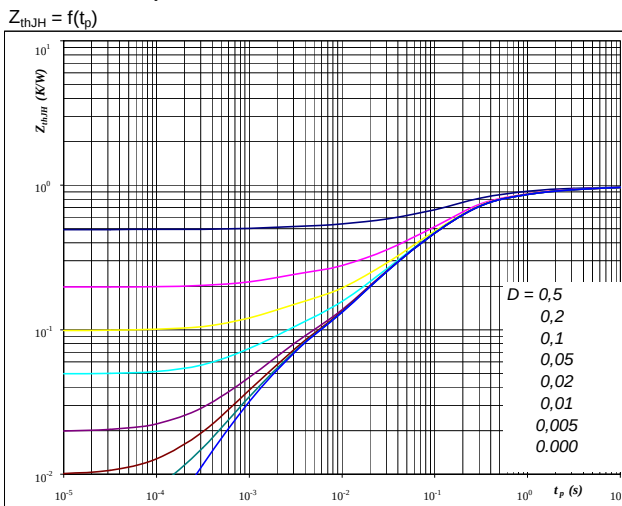
At
 $T_J = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 350 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 8 \text{ } \Omega$

Figure 18 FRED
 Typical rate of fall of forward and reverse recovery current
 as a function of IGBT turn on gate resistor



At
 $T_J = 25/125 \text{ } ^\circ\text{C}$
 $V_R = 350 \text{ V}$
 $I_F = 40 \text{ A}$
 $V_{GE} = \pm 15 \text{ V}$

Figure 19 IGBT
 IGBT transient thermal impedance
 as a function of pulse width

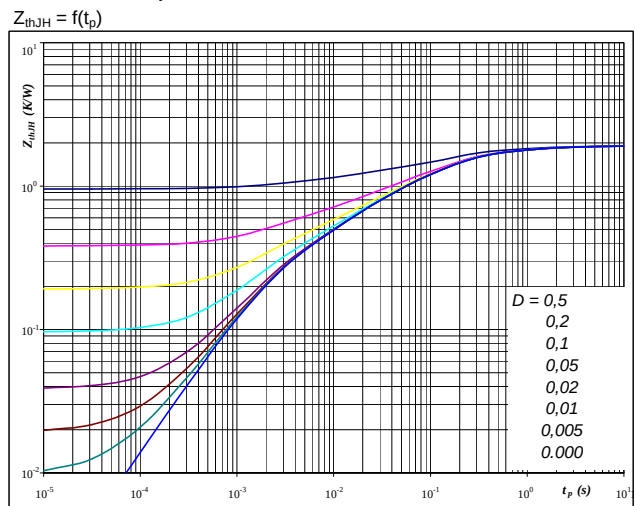


At
 $D = t_p / T$
 $R_{thJH} = 0.99 \text{ K/W}$

IGBT thermal model values

R (C/W)	Tau (s)
0.06	9.7E+00
0.18	9.9E-01
0.56	1.6E-01
0.14	2.4E-02
0.05	1.6E-03

Figure 20 FRED
 FRED transient thermal impedance
 as a function of pulse width



At
 $D = t_p / T$
 $R_{thJH} = 1.91 \text{ K/W}$

FRED thermal model values

R (C/W)	Tau (s)
0.10	3.8E+00
0.32	5.7E-01
0.91	1.0E-01
0.38	1.4E-02
0.21	2.0E-03

Buck

Figure 21

IGBT

Power dissipation as a function of heatsink temperature

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

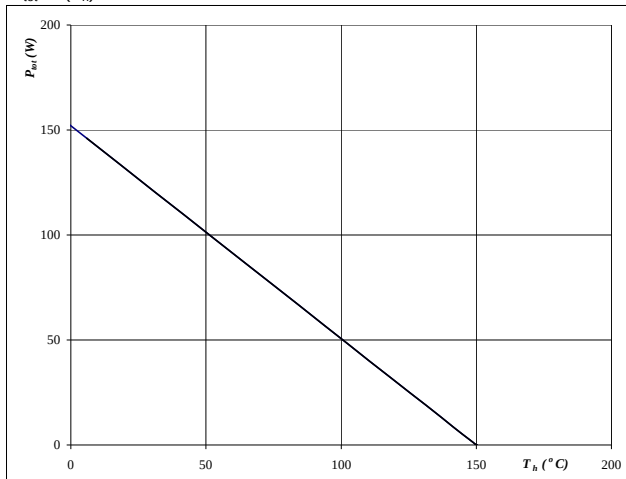

At
 $T_j = 150$ °C

Figure 22

IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

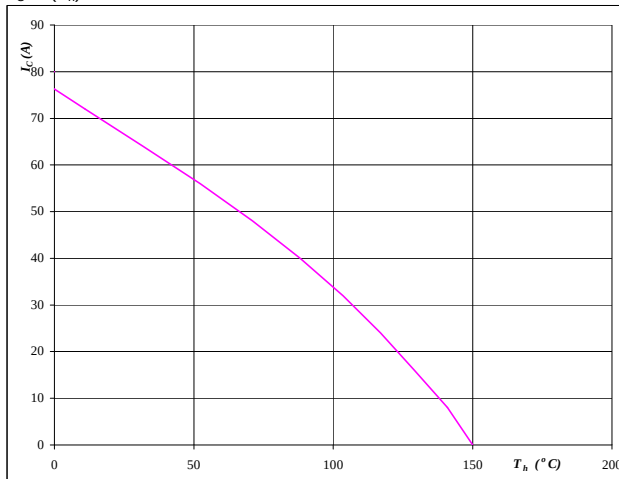

At
 $T_j = 150$ °C
 $V_{GE} = 15$ V

Figure 23

FRED

Power dissipation as a function of heatsink temperature

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

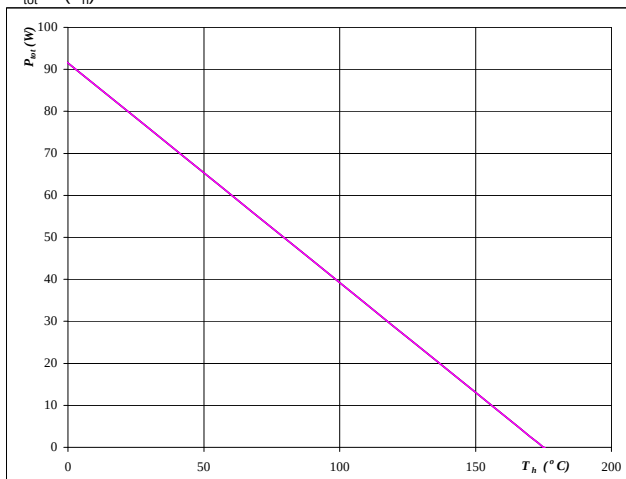
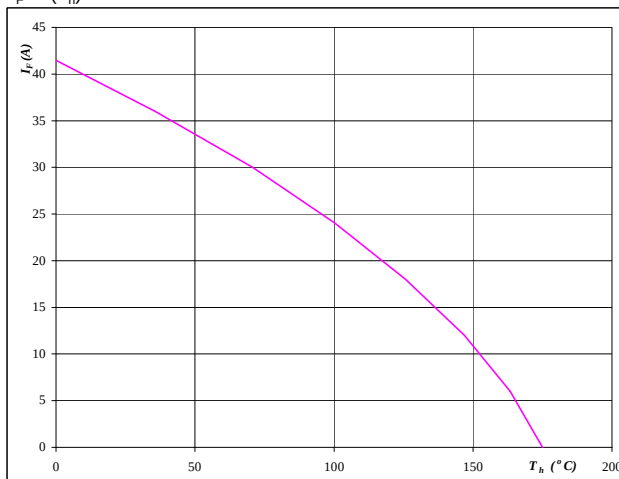

At
 $T_j = 175$ °C

Figure 24

FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$


At
 $T_j = 175$ °C

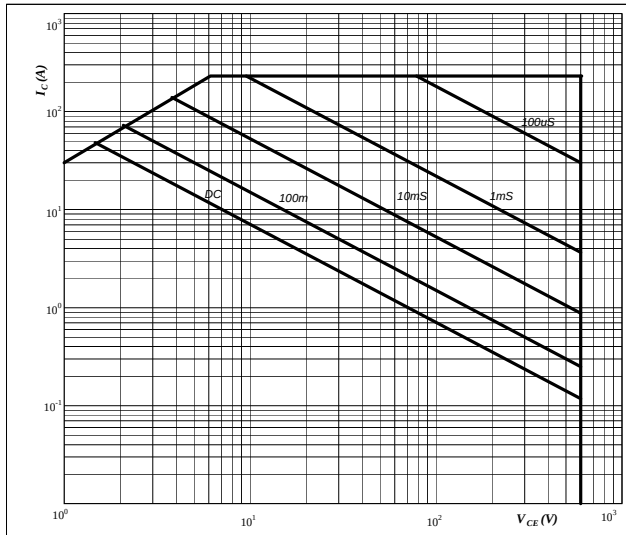
Buck

Figure 25

IGBT

**Safe operating area as a function
of collector-emitter voltage**

$$I_C = f(V_{CE})$$


At

D = single pulse

 T_h = 80 °C

 V_{GE} = ±15 V

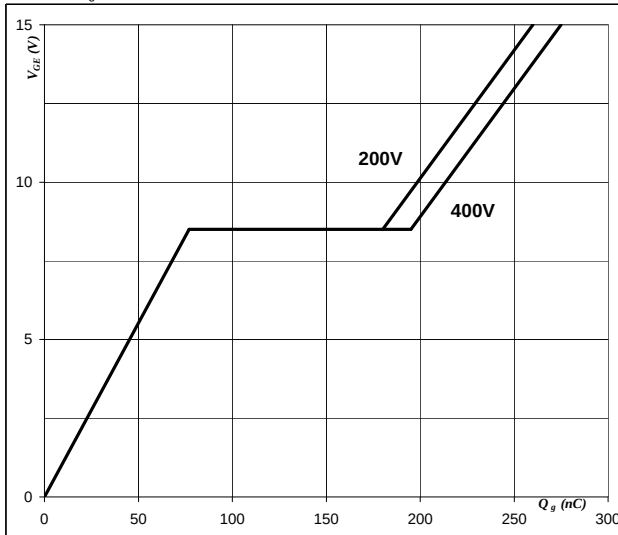
 T_j = T_{jmax} °C

Figure 26

IGBT

Gate voltage vs Gate charge

$$V_{GE} = f(Q_g)$$


At

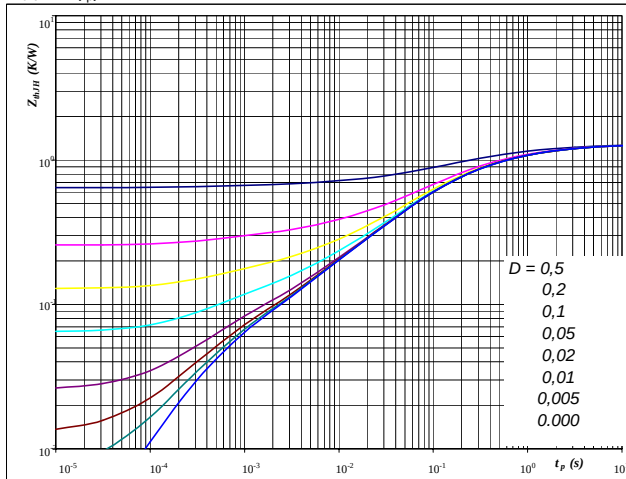
 I_{G(REF)} = 1mA, R_L = 15Ω

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

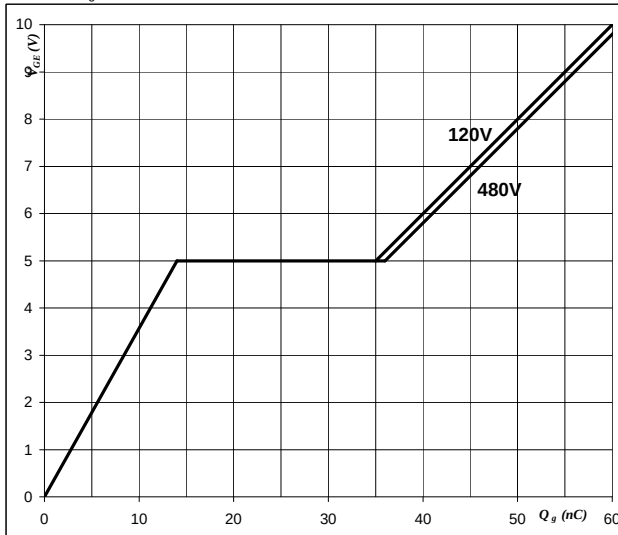
R (C/W)	Tau (s)
0.09	9.2E+00
0.27	1.3E+00
0.53	2.1E-01
0.27	4.0E-02
0.08	4.8E-03
0.05	4.7E-04

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

$$I_C = f(V_{CE})$$

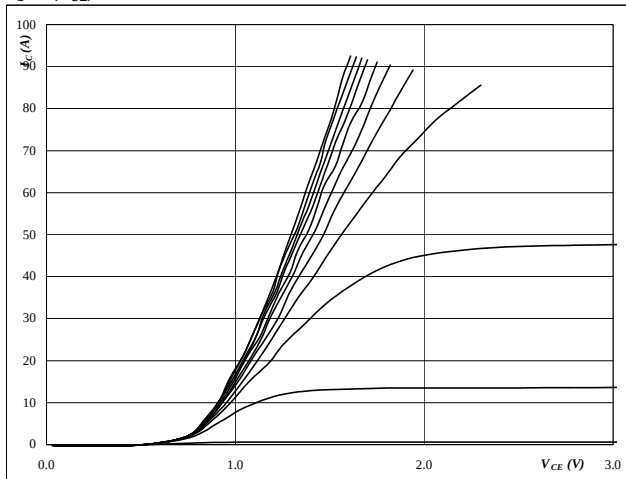

At
 $t_p = 250 \mu s$
 $T_J = 25^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

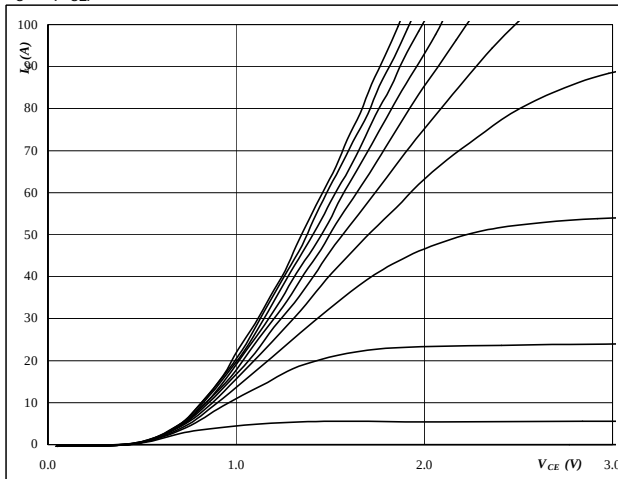
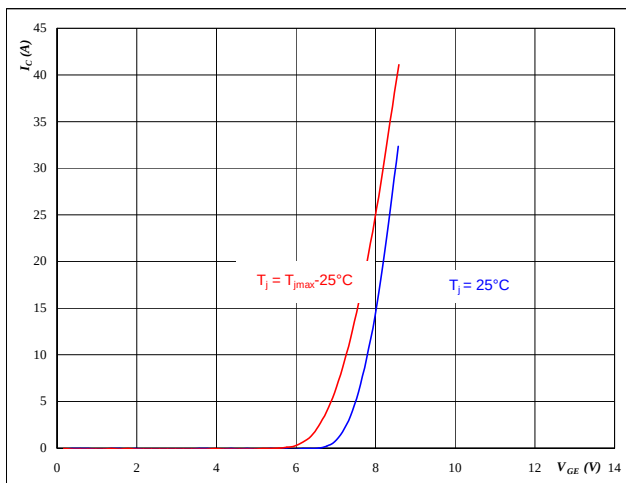

At
 $t_p = 250 \mu s$
 $T_J = 125^\circ C$
 V_{GE} from 6 V to 16 V in steps of 1 V

Figure 3 IGBT

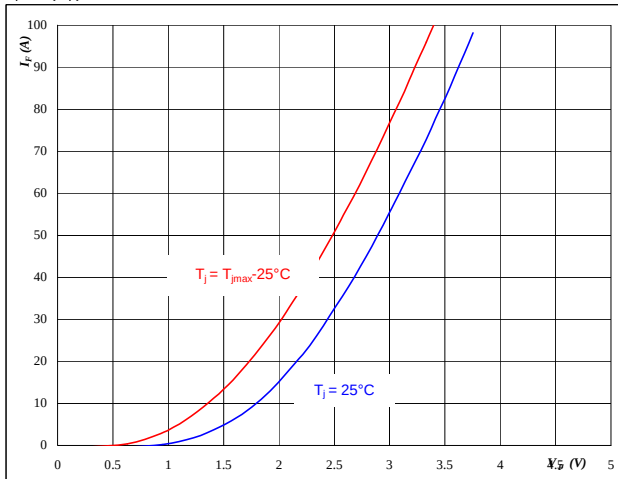
Typical transfer characteristics

$$I_C = f(V_{GE})$$


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

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

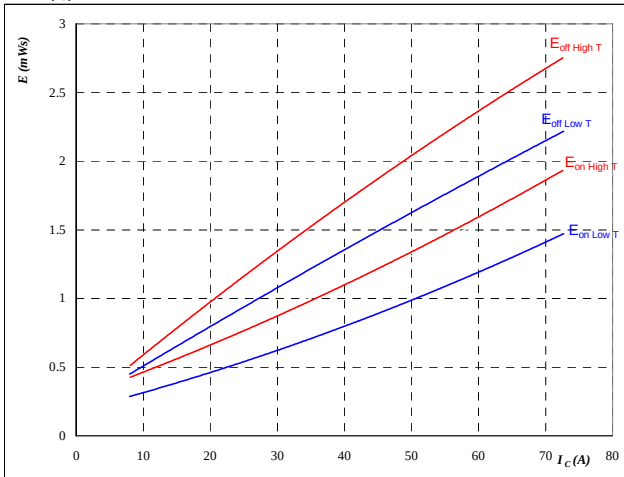

At
 $t_p = 250 \mu s$

Boost

Figure 5 IGBT

Typical switching energy losses
as a function of collector current

$$E = f(I_C)$$



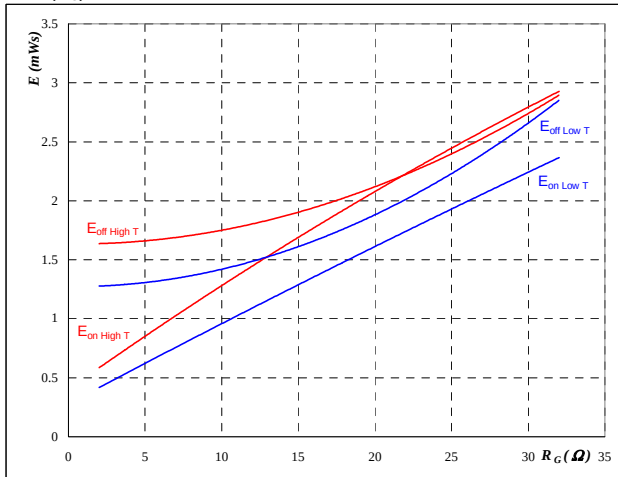
With an inductive load at

$T_J =$	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

$$E = f(R_G)$$



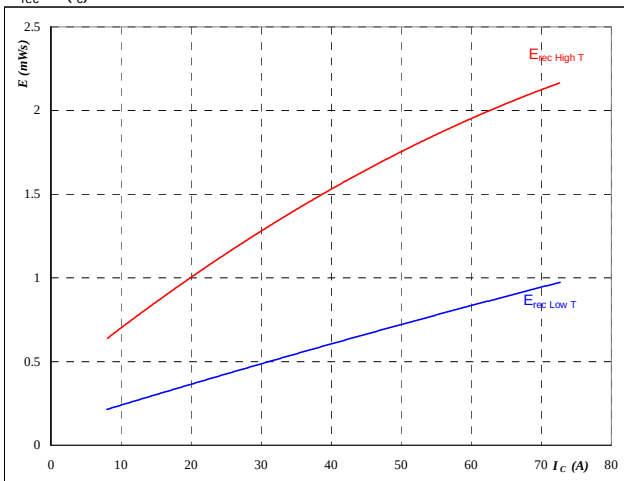
With an inductive load at

$T_J =$	25/125	°C
$V_{CE} =$	350	V
$V_{GE} =$	15	V
$I_C =$	40	A

Figure 7 IGBT

Typical reverse recovery energy loss
as a function of collector current

$$E_{rec} = f(I_C)$$



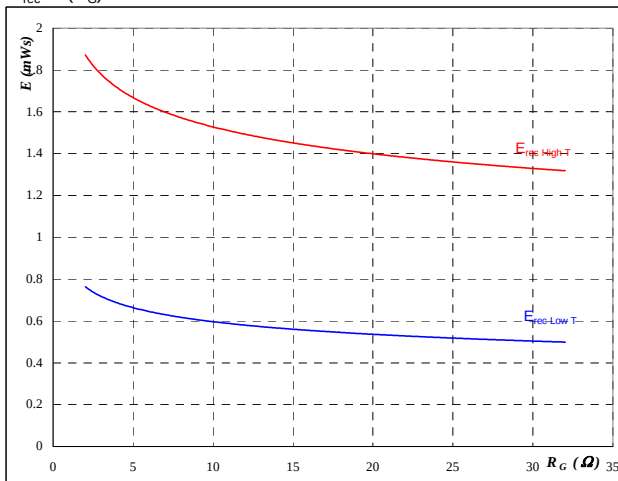
With an inductive load at

$T_J =$	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

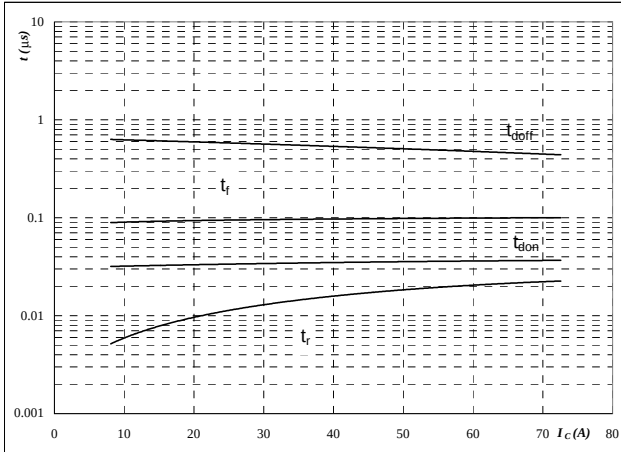
$T_J =$	25/125	°C
$V_{CE} =$	350	V
$V_{GE} =$	15	V
$I_C =$	40	A

Boost

Figure 9 IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



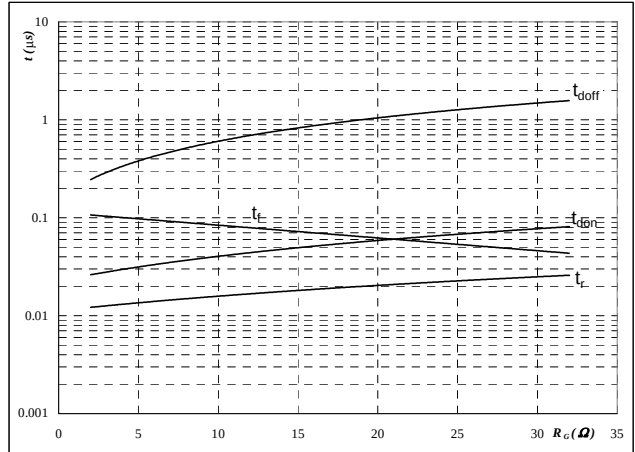
With an inductive load at

$T_J =$	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

$$t = f(R_G)$$



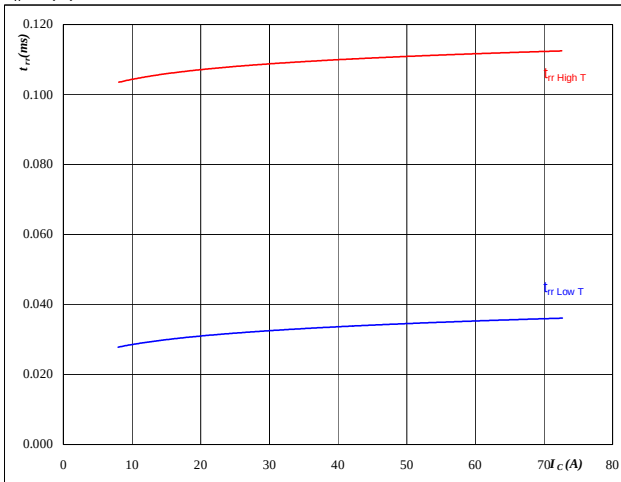
With an inductive load at

$T_J =$	125	°C
$V_{CE} =$	350	V
$V_{GE} =$	15	V
$I_C =$	40	A

Figure 11 FRED

Typical reverse recovery time as a function of collector current

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



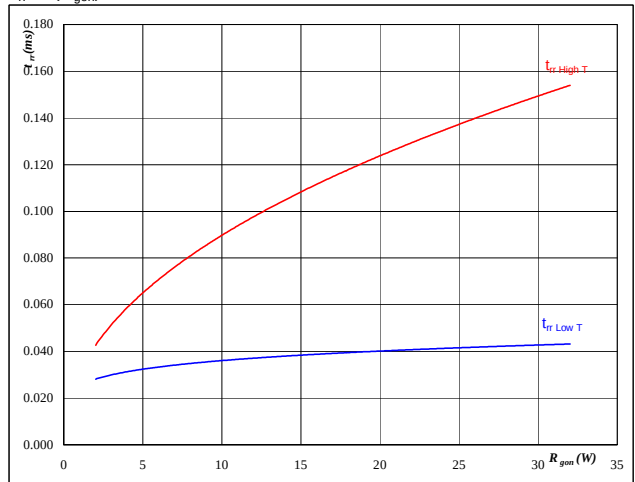
At

$T_J =$	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
$I_F =$	40	A
$V_{GE} =$	15	V

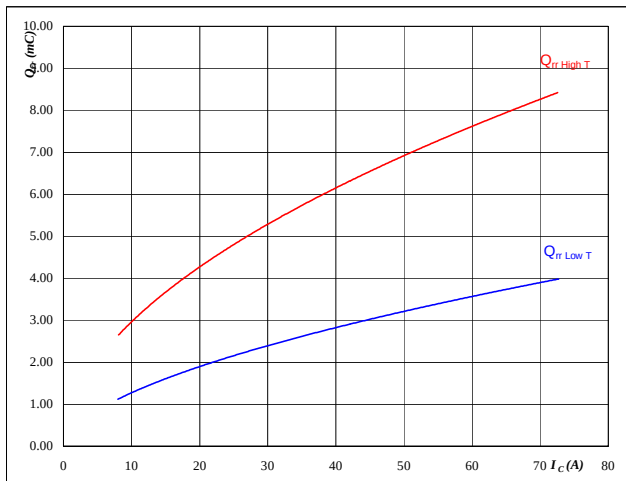
Boost

Figure 13

FRED

Typical reverse recovery charge as a function of collector current

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


At

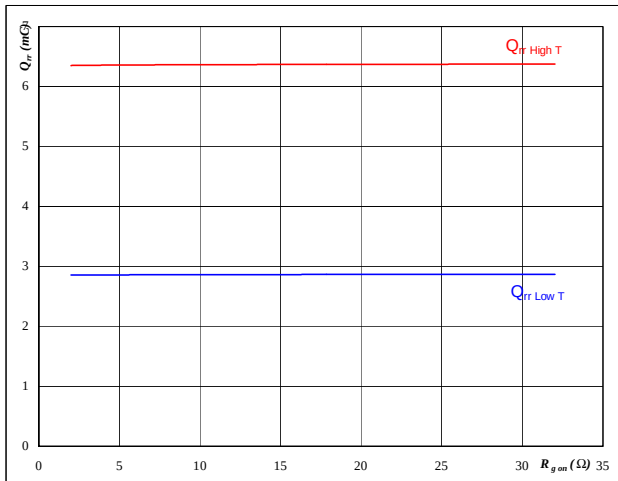
$T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 14

FRED

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

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


At

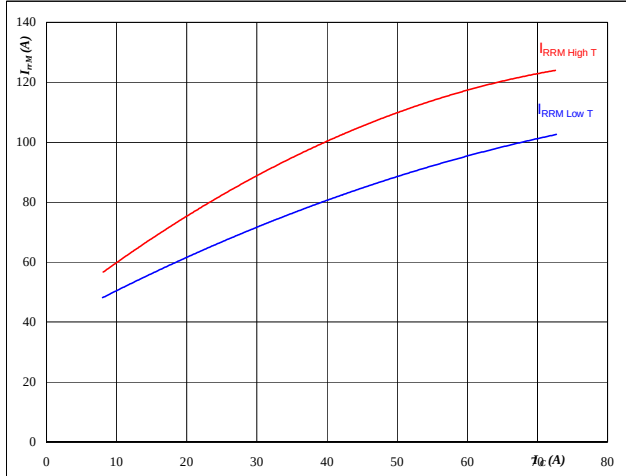
$T_j = 25/125$ °C
 $V_R = 350$ V
 $I_F = 40$ A
 $V_{GE} = 15$ V

Figure 15

FRED

Typical reverse recovery current as a function of collector current

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


At

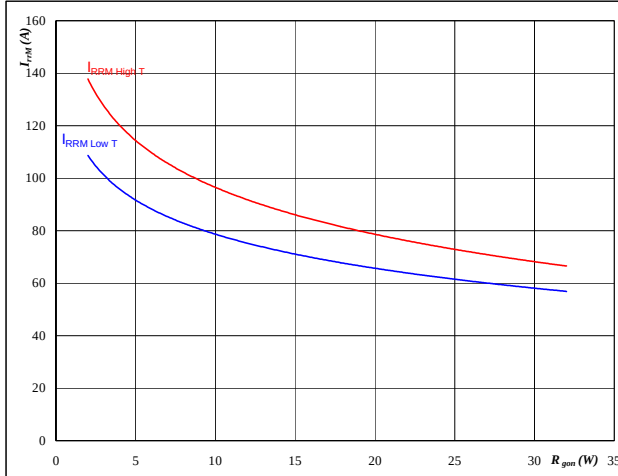
$T_j = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 16

FRED

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

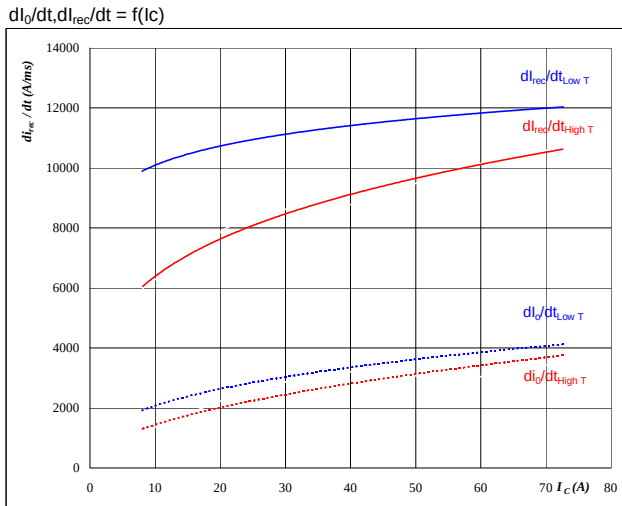
$$I_{RRM} = f(R_{gon})$$


At

$T_j = 25/125$ °C
 $V_R = 350$ V
 $I_F = 40$ A
 $V_{GE} = 15$ V

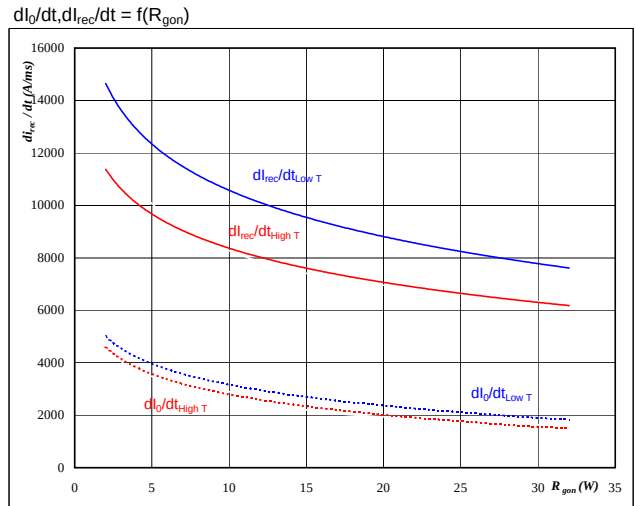
Boost

Figure 17 FRED
 Typical rate of fall of forward and reverse recovery current
 as a function of collector current



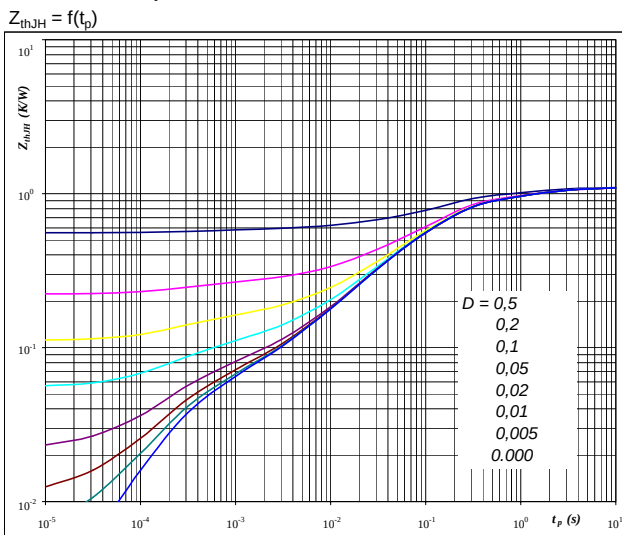
At
 $T_J = 25/125$ °C
 $V_{CE} = 350$ V
 $V_{GE} = 15$ V
 $R_{gon} = 8$ Ω

Figure 18 FRED
 Typical rate of fall of forward and reverse recovery current
 as a function of IGBT turn on gate resistor



At
 $T_J = 25/125$ °C
 $V_R = 350$ V
 $I_F = 40$ A
 $V_{GE} = 15$ V

Figure 19 IGBT
 IGBT transient thermal impedance
 as a function of pulse width

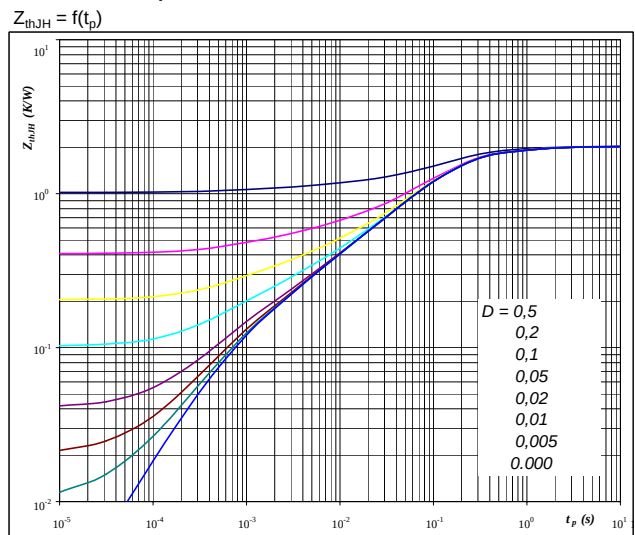


At
 $D = t_p / T$
 $R_{thJH} = 1.11$ K/W

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



At
 $D = t_p / T$
 $R_{thJH} = 2.04$ K/W

FRED thermal model values

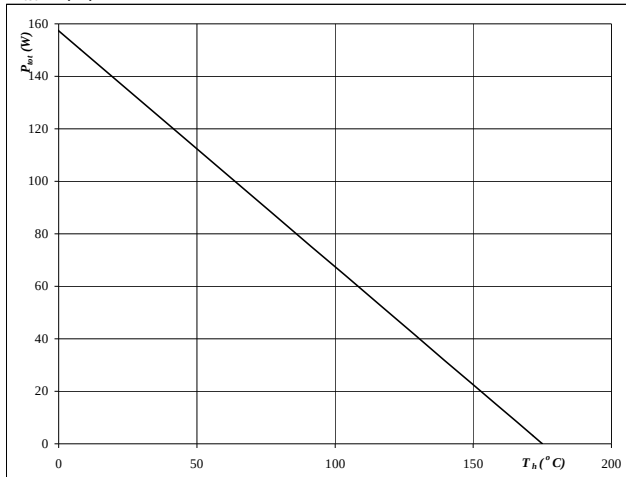
R (C/W)	Tau (s)
0.04	9.8E+00
0.21	1.0E+00
1.12	1.5E-01
0.42	3.7E-02
0.17	4.4E-03
0.08	6.1E-04

Boost

Figure 21 IGBT

Power dissipation as a function of heatsink temperature

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

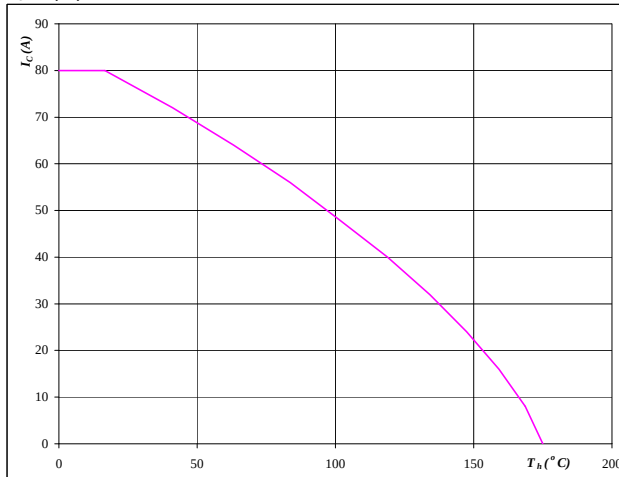


At
 $T_j = 175$ °C

Figure 22 IGBT

Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$

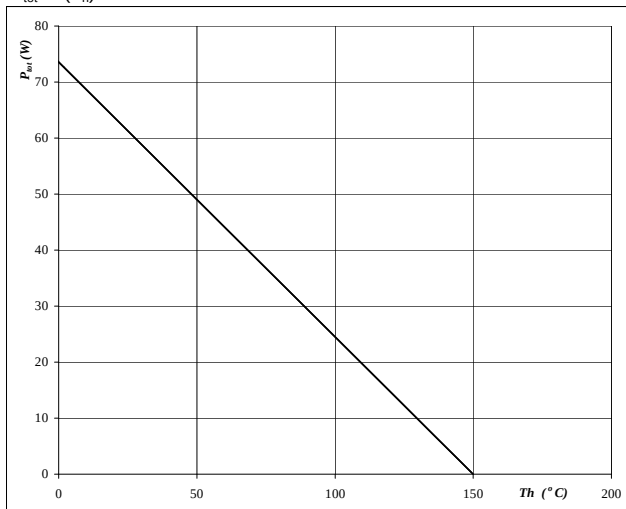


At
 $T_j = 175$ °C
 $V_{GE} = 15$ V

Figure 23 FRED

Power dissipation as a function of heatsink temperature

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

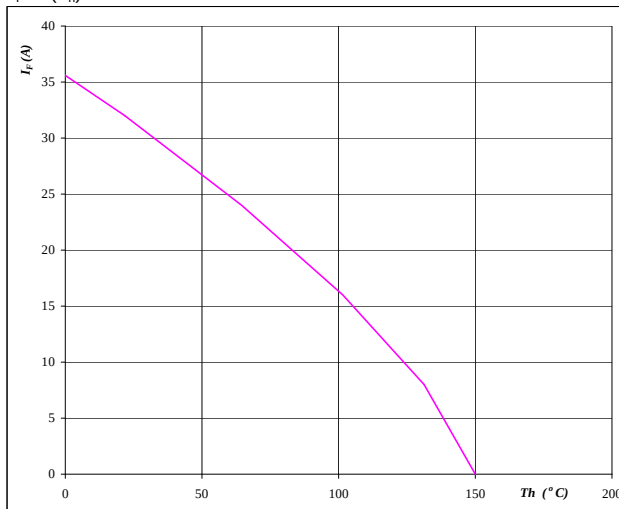


At
 $T_j = 150$ °C

Figure 24 FRED

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



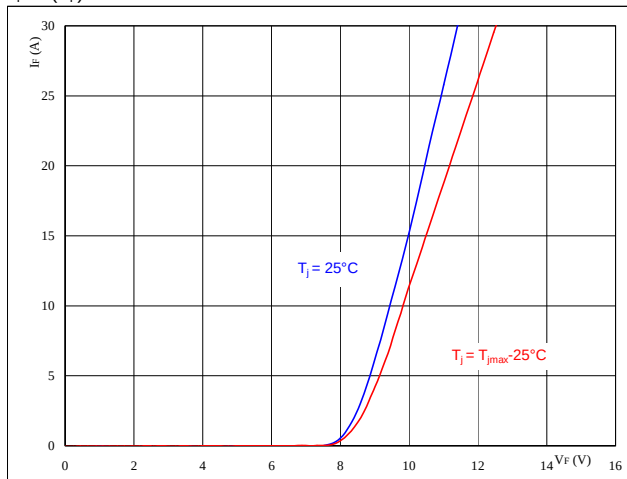
At
 $T_j = 150$ °C

Boost

Figure 25 Boost Inverse Diode

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

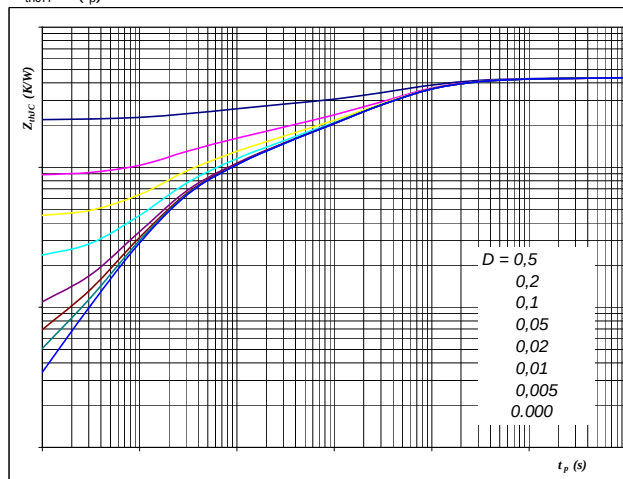


At
 $t_p = 250 \mu s$

Figure 26 Boost Inverse Diode

Diode transient thermal impedance as a function of pulse width

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

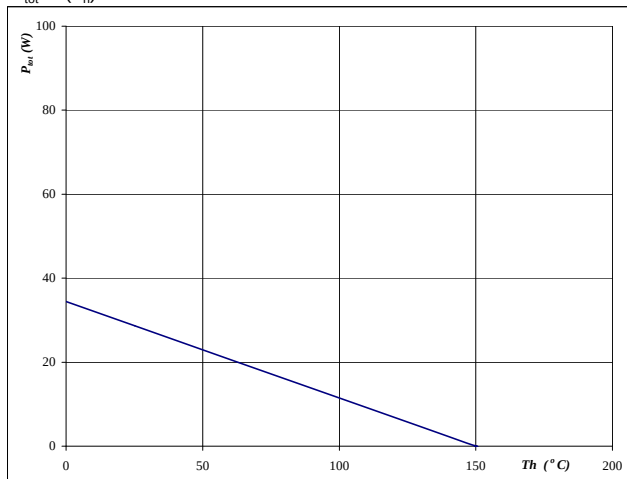


At
 $D = t_p / T$
 $R_{thJH} = 4.36 \text{ K/W}$

Figure 27 Boost Inverse Diode

Power dissipation as a function of heatsink temperature

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

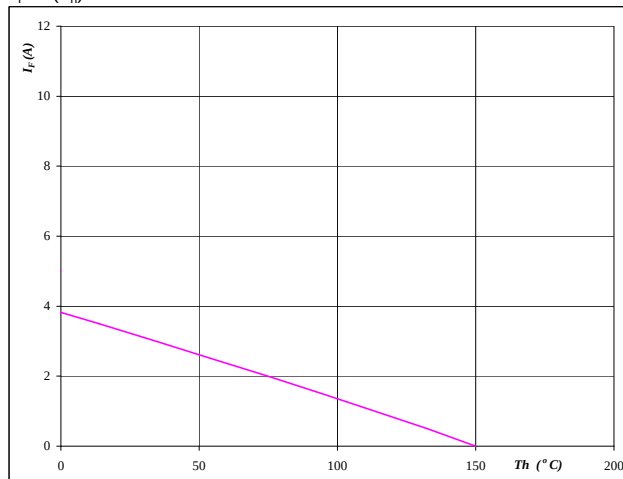


At
 $T_J = 150 \text{ °C}$

Figure 28 Boost Inverse Diode

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



At
 $T_J = 150 \text{ °C}$

Thermistor

Figure 1 Thermistor

Typical NTC characteristic
as a function of temperature

$R_T = f(T)$

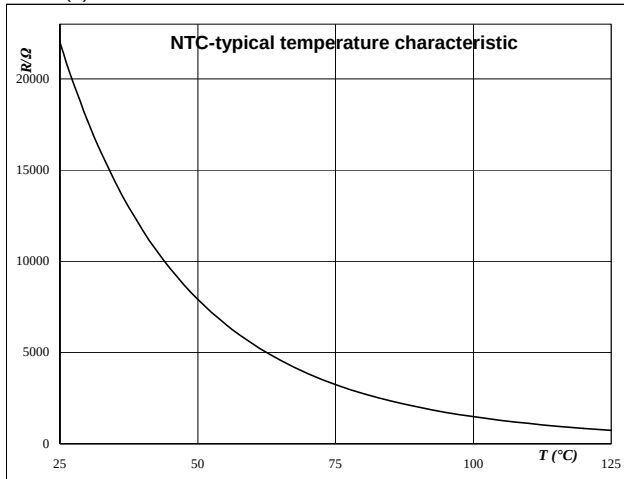


Figure 2 Thermistor

Typical NTC resistance values

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

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

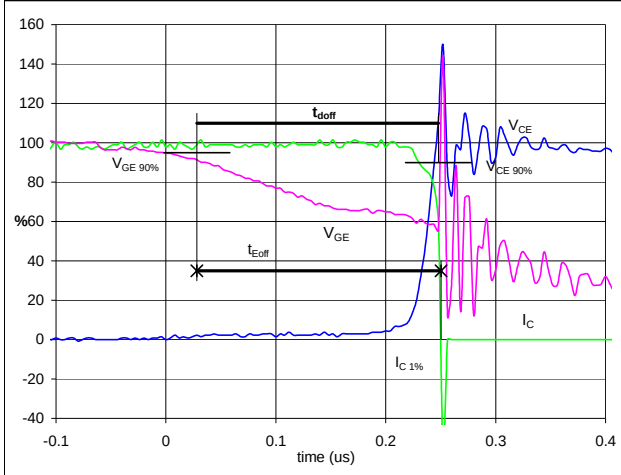
General conditions

$R_{gon\ IGBT}$	=	8 Ω	T_j	=	125 $^{\circ}\text{C}$	$R_{gon\ MOSFET}$	=	0 Ω
$R_{goff\ IGBT}$	=	8 Ω				$R_{goff\ MOSFET}$	=	47 Ω

Figure 1 Output inverter IGBT

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

(t_{Eoff} = integrating time for E_{off})

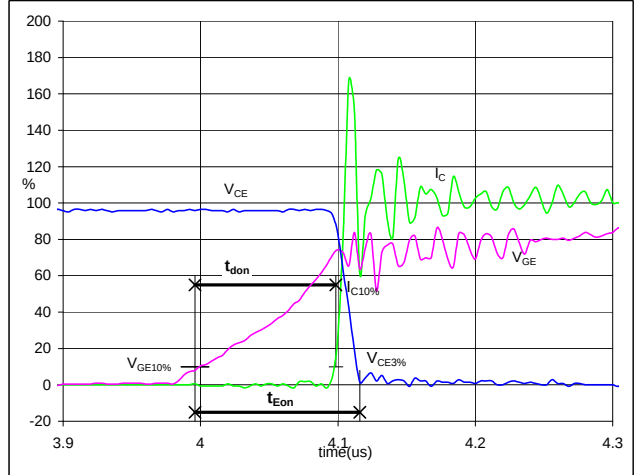


$V_{GE} (0\%) =$	-15	V
$V_{GE} (100\%) =$	15	V
$V_C (100\%) =$	700	V
$I_C (100\%) =$	40	A
$t_{doff} =$	0.21	μs
$t_{Eoff} =$	0.22	μs

Figure 2 Output inverter IGBT

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

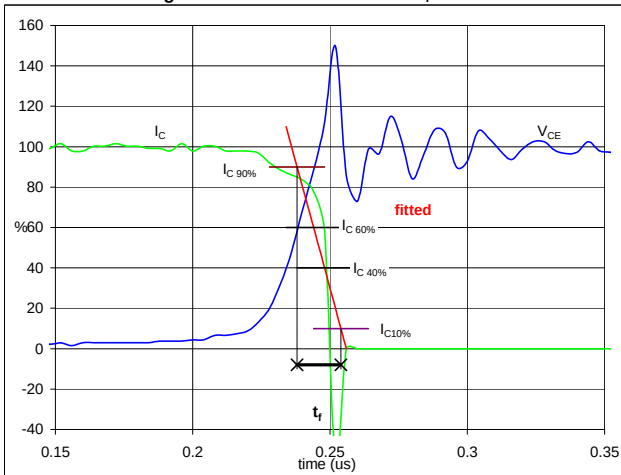
(t_{Eon} = integrating time for E_{on})



$V_{GE} (0\%) =$	-15	V
$V_{GE} (100\%) =$	15	V
$V_C (100\%) =$	700	V
$I_C (100\%) =$	40	A
$t_{don} =$	0.10	μs
$t_{Eon} =$	0.12	μs

Figure 3 Output inverter IGBT

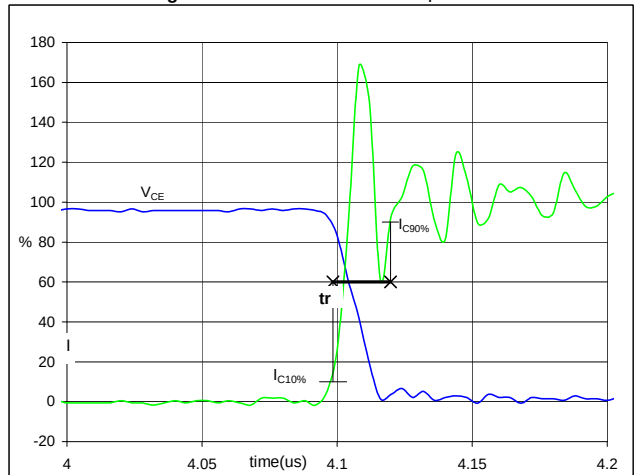
Turn-off Switching Waveforms & definition of t_f



$V_C (100\%) =$	700	V
$I_C (100\%) =$	40	A
$t_f =$	0.01	μs

Figure 4 Output inverter IGBT

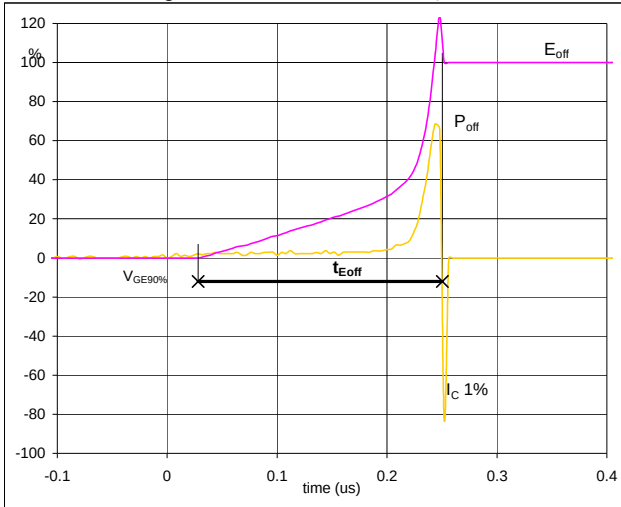
Turn-on Switching Waveforms & definition of t_r



$V_C (100\%) =$	700	V
$I_C (100\%) =$	40	A
$t_r =$	0.01	μs

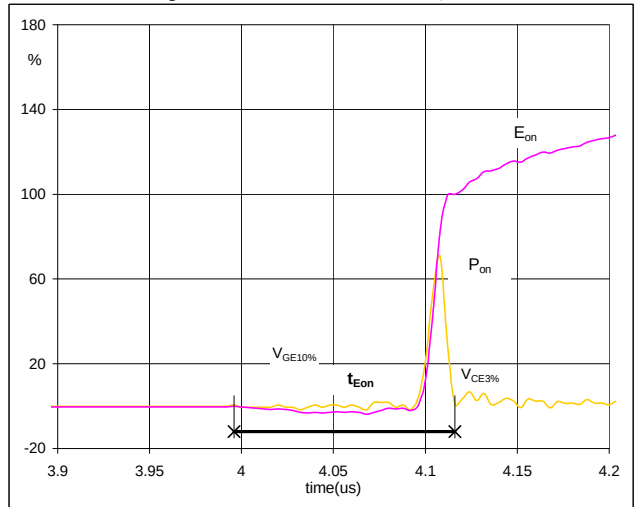
Switching Definitions BUCK MOSFET

Figure 5 Output inverter IGBT

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


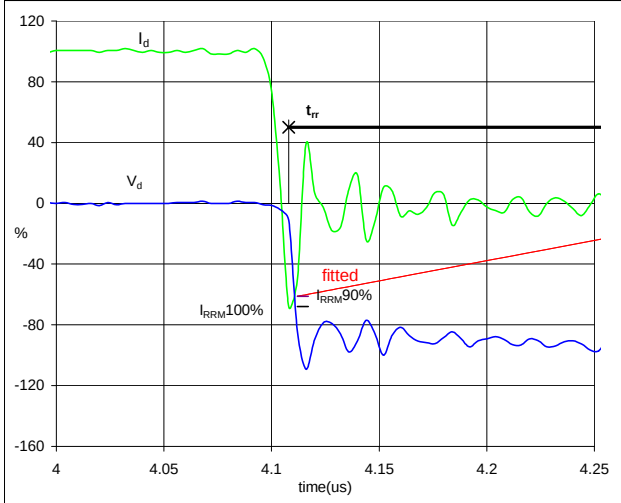
$P_{off}(100\%) = 28.08$ kW
 $E_{off}(100\%) = 0.23$ mJ
 $t_{Eoff} = 0.22$ μ s

Figure 6 Output inverter IGBT

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


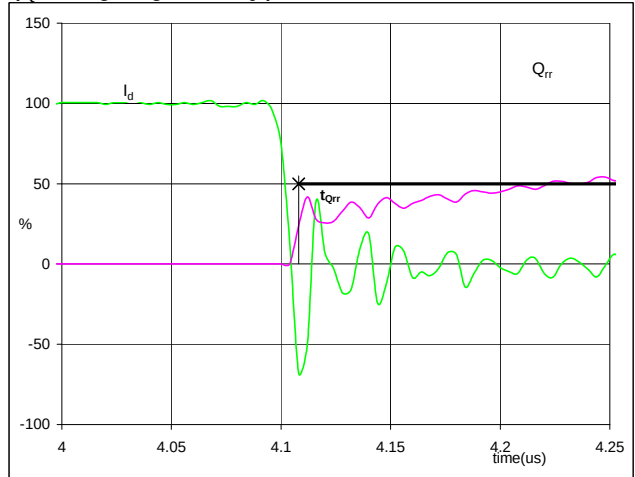
$P_{on}(100\%) = 28.08$ kW
 $E_{on}(100\%) = 0.10$ mJ
 $t_{Eon} = 0.12$ μ s

Figure 7 Output inverter IGBT

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


$V_d(100\%) = 700$ V
 $I_d(100\%) = 40$ A
 $I_{RRM}(100\%) = -34$ A
 $t_{rr} = 0.01$ μ s

Figure 8 Output inverter FRED

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


$I_d(100\%) = 40$ A
 $Q_{rr}(100\%) = 0.12$ μ C
 $t_{Qrr} = 0.47$ μ s

Figure 9 Output inverter FRED

(t_{Erec} = integrating time for E_{rec})



Figure 11

Figure 12

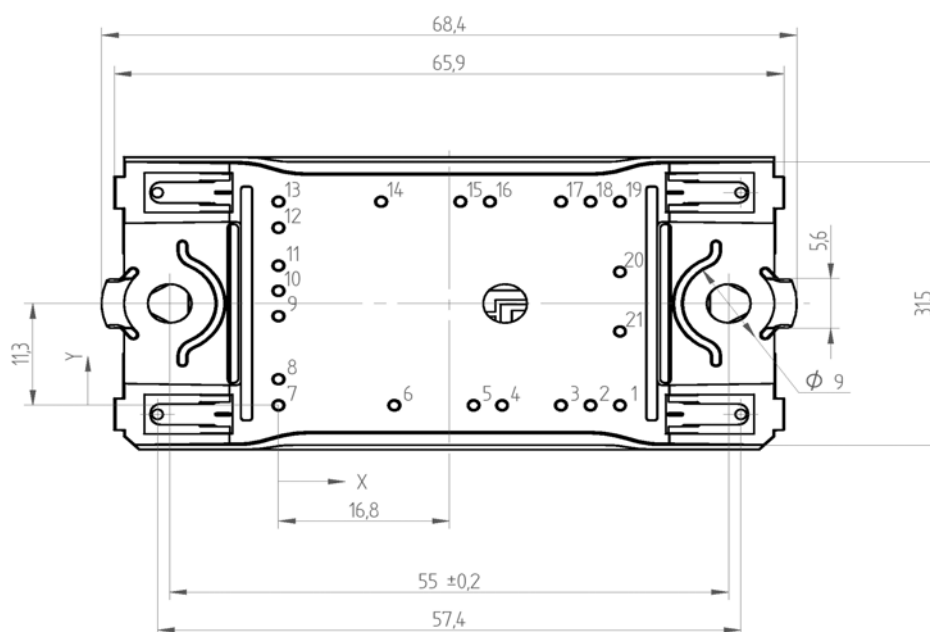
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

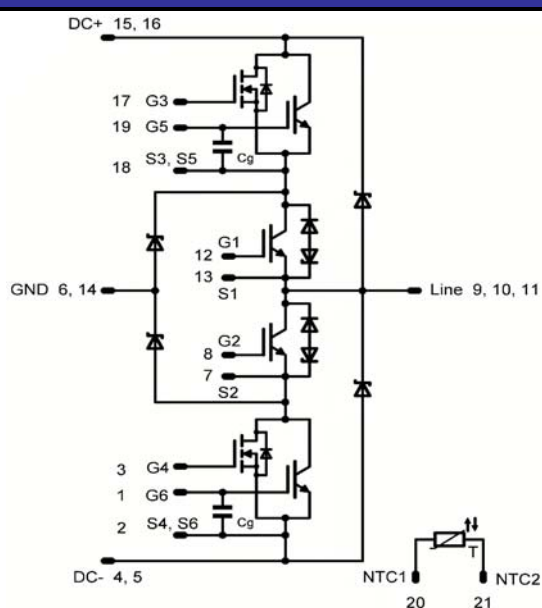
Version	Ordering Code	in DataMatrix as	in packaging barcode as
without thermal paste 12mm housing	10-FZ06NPA070FP-P969F	P969F	P969F

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.
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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.
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.