


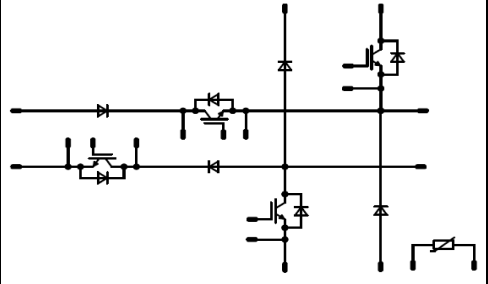
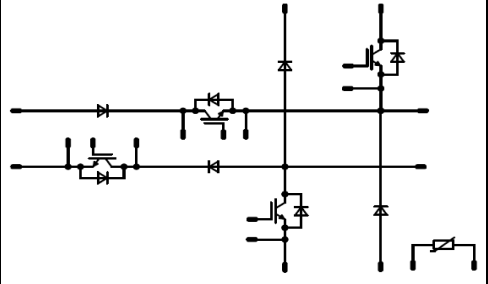
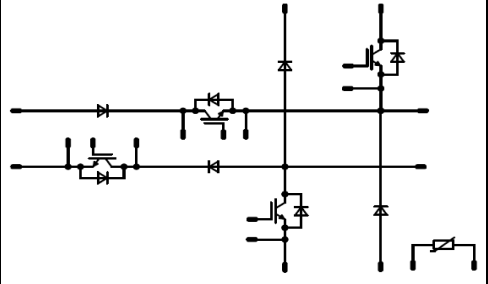




Vincotech

<i>flow 2 MNPC</i>	1200 V / 160 A				
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## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Buck Inverse Diode</b>				
Repetitive peak reverse voltage	$V_{RRM}$		1200	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	7	A
Maximum repetitive forward current	$I_{FRM}$	$t_p = 10\text{ ms}$	14	A
$I^2t$ -value	$I^2t$	$T_j = T_{jmax}$	40	$A^2s$
Power dissipation	$P_{tot}$	$T_s = 80\text{ °C}$	40	W
Maximum Junction Temperature	$T_{jmax}$		150	°C
<b>Buck Switch</b>				
Collector-emitter breakdown voltage	$V_{CE}$		1200	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	157	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	480	A
Turn off safe operating area		$V_{CE}max = 1200V, T_{vj} \leq 150\text{ °C}$	320	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	398	W
Gate-emitter peak voltage	$V_{GE}$		±20	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	10 800	$\mu s$ V
Maximum Junction Temperature	$T_{jmax}$		175	°C

**Maximum Ratings** $T_j = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
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**Buck Diode**

Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	96	A
Non-repetitive Peak Surge Current	$I_{FSM}$	$t_p$ limited by $T_{jmax}$	1200	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	110	W
Maximum Junction Temperature	$T_{jmax}$		150	°C

**Boost Switch**

Collector-emitter breakdown voltage	$V_{CE}$		600	V
DC collector current	$I_C$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	91	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	300	A
Turn off safe operating area		$V_{CE} \leq 600V, T_j \leq 175\text{ °C}$	300	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	174	W
Gate-emitter peak voltage	$V_{GE}$		$\pm 20$	V
Short circuit ratings	$t_{SC}$ $V_{CC}$	$T_j \leq 150\text{ °C}$ $V_{GE} = 15\text{ V}$	6 360	$\mu\text{s}$ V
Maximum Junction Temperature	$T_{jmax}$		175	°C

**Boost Inverse Diode**

Peak Repetitive Reverse Voltage	$V_{RRM}$		600	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	38	A
Maximum repetitive forward current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$	60	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	65	W
Maximum Junction Temperature	$T_{jmax}$		175	°C

**Boost Diode**

Peak Repetitive Reverse Voltage	$V_{RRM}$		1200	V
DC forward current	$I_F$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	50	A
Nonrepetitive peak surge current	$I_{FRM}$	$t_p$ limited by $T_{jmax}$ (Halfwave 1 Phase 60Hz)	650	A
Power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	94	W
Maximum Junction Temperature	$T_{jmax}$		150	°C

**Thermal Properties**

Storage temperature	$T_{stg}$		-40...+125	°C
Operation temperature under switching condition	$T_{op}$		-40...+( $T_{jmax} - 25$ )	°C

**Isolation Properties**

Isolation voltage	$V_{isol}$	DC voltage*	$t_p = 2\text{ s}$	4000	V
		AC voltage	$t_p = 1\text{ min}$	min 12,7	V
Creepage distance				min 12,7	mm
Clearance				>200	mm
Comparative Tracking Index	CTI				

\* 100 % tested in production



### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit			
		$V_{GE}$ [V]	$V_{GS}$ [V]	$V_r$ [V]	$V_{CE}$ [V]	$V_{DS}$ [V]	$I_C$ [A]	$I_F$ [A]	$I_D$ [A]		$T_j$ [°C]	Min	Typ
<b>Buck Inverse Diode</b>													
Forward voltage	$V_F$					7	25 125			1	1,97 1,65	3,4	V
Threshold voltage (for power loss calc. only)	$V_{to}$					7	25 125				1,33 1,01		V
Slope resistance (for power loss calc. only)	$r_t$					7	25 125				91 91		mΩ
Reverse current	$I_r$					1200				25		0,25	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm $\lambda = 1$ W/mK									1,77		K/W
<b>Buck Switch</b>													
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$				0,006	25			5,2	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CESat}$		15			160	25 125			2	2,02 2,37	2,4	V
Collector-emitter cut-off current incl. Diode	$I_{CES}$		0	1200			25					0,02	mA
Gate-emitter leakage current	$I_{GES}$		20	0			25					480	nA
Integrated Gate resistor	$R_{gint}$										none		Ω
Turn-on delay time	$t_{d(on)}$						25 125				133 135		ns
Rise time	$t_r$						25 125				20 23		
Turn-off delay time	$t_{d(off)}$	$R_{goff} = 4 \Omega$	±15	700	100		25 125				225 276		
Fall time	$t_f$	$R_{gon} = 4 \Omega$					25 125				38 64		
Turn-on energy loss	$E_{on}$						25 125				1,80 3,18		mWs
Turn-off energy loss	$E_{off}$						25 125				2,52 4,03		
Input capacitance	$C_{ies}$										9200		pF
Output capacitance	$C_{oss}$	$f = 1$ MHz	0	25							920		
Reverse transfer capacitance	$C_{rss}$										540		
Gate charge	$Q_G$		15	960	160						740		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm $\lambda = 1$ W/mK									0,24		K/W



### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit	
		$V_{GE}$ [V]	$V_{GS}$ [V]	$V_r$ [V]	$V_{CE}$ [V]	$V_{DS}$ [V]	$I_C$ [A]	$I_F$ [A]	$I_D$ [A]		$T_j$ [°C]

#### Buck Diode

Diode forward voltage	$V_F$					120	25 125		1,47 1,29	1,7		V
Peak reverse recovery current	$I_{RRM}$	$R_{gon} = 4 \Omega$	$\pm 15$	700	100		25		127			A
							125		151			
Reverse recovery time	$t_{rr}$						25		40			ns
							125		81			
Reverse recovered charge	$Q_{rr}$						25		3,02			$\mu C$
		125		7,13								
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						25		12386			A/ $\mu s$
							125		3767			
Reverse recovered energy	$E_{rec}$						25		0,31			mWs
							125		1,01			
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness $\leq 50 \mu m$ $\lambda = 1 W/mK$							0,64			K/W

#### Boost Switch

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$				0,0016	25		5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CESat}$		15			100	25 125		1,05	1,58 1,8	1,85	V
Collector-emitter cut-off incl diode	$I_{CES}$		0	600			25				0,0052	mA
Gate-emitter leakage current	$I_{GES}$		20	0			25				1200	nA
Integrated Gate resistor	$R_{gint}$									none		$\Omega$
Turn-on delay time	$t_{d(on)}$	$R_{goff} = 4 \Omega$ $R_{gon} = 4 \Omega$	$\pm 15$	700	100		25			103		ns
							125		103			
Rise time	$t_r$						25		17			
							125		19			
Turn-off delay time	$t_{d(off)}$						25		158			
		125		179								
Fall time	$t_f$	25		44								
		125		64								
Turn-on energy loss	$E_{on}$	25		1,06		$\mu Ws$						
		125		1,52								
Turn-off energy loss	$E_{off}$	25		2,48		$\mu Ws$						
		125		3,32								
Input capacitance	$C_{ies}$									6280		pF
Output capacitance	$C_{oss}$	$f = 1 MHz$	0	25						400		
Reverse transfer capacitance	$C_{rss}$					25				186		
Gate charge	$Q_G$		15	480	100					620		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness $\leq 50 \mu m$ $\lambda = 1 W/mK$								0,54		K/W

#### Boost Inverse Diode

Diode forward voltage	$V_F$					30	25 125		1,00	1,64 1,55	1,95	V
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness $\leq 50 \mu m$ $\lambda = 1 W/mK$								1,45		K/W



### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit			
		$V_{GE}$ [V]	$V_{GS}$ [V]	$V_r$ [V]	$V_{CE}$ [V]	$V_{DS}$ [V]	$I_C$ [A]	$I_F$ [A]	$I_D$ [A]		$T_j$ [°C]	Min	Typ
<b>Boost Diode</b>													
Diode forward voltage	$V_F$					60	25 125			1,50	2,47 2,11	3,30	V
Reverse leakage current	$I_r$			1200			25					200	µA
Peak reverse recovery current	$I_{RRM}$						25 125				107 142		A
Reverse recovery time	$t_{rr}$						25 125				51 69		ns
Reverse recovered charge	$Q_{rr}$	$R_{gon} = 4 \Omega$	±15	700	100		25 125				6 13		µC
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						25 125				5985 2890		A/µs
Reverse recovery energy	$E_{rec}$						25 125				1,71 3,61		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal grease thickness ≤ 50µm $\lambda = 1 \text{ W/mK}$									0,74		K/W
<b>Thermistor</b>													
Rated resistance	$R$						25				22000		Ω
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 1486 \Omega$					100		-5			+5	%
Power dissipation	$P$						25				200		mW
Power dissipation constant							25				2		mW/K
B-value	$B_{(25/50)}$	Tol. ±3%					25				3950		K
B-value	$B_{(25/100)}$	Tol. ±3%					25				3998		K
Vincotech NTC Reference												B	



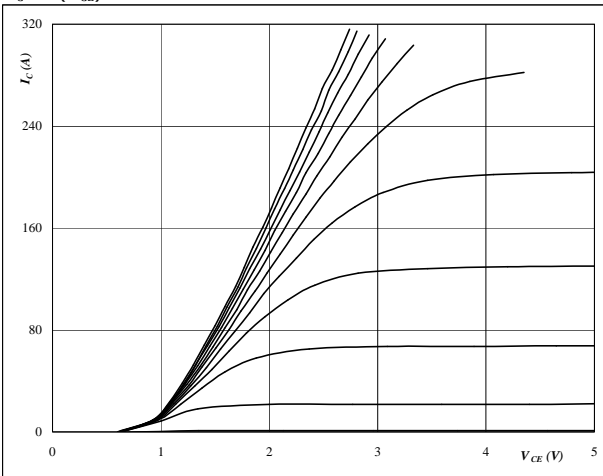
# Buck Switch

Buck IGBT and Buck FWD

**figure 1.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$



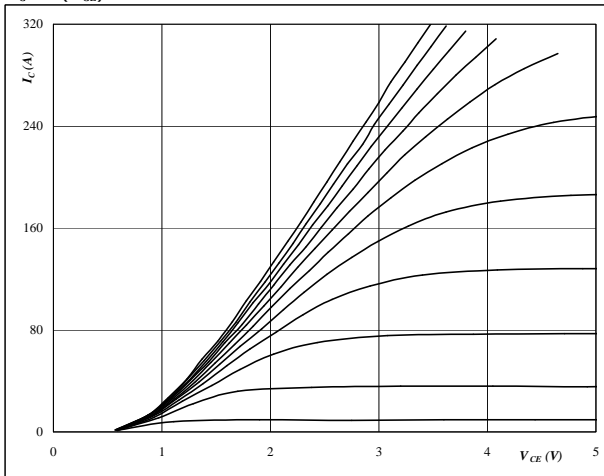
At

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

**figure 2.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$



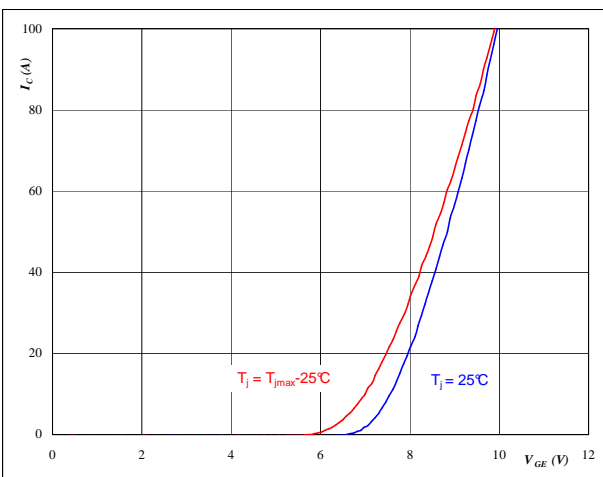
At

$t_p = 250 \mu s$   
 $T_j = 125 \text{ } ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



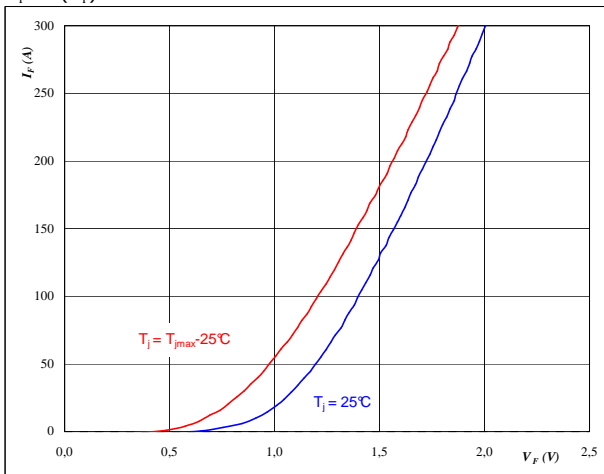
At

$t_p = 250 \mu s$   
 $V_{CE} = 10 \text{ V}$   
 $T_j = 25/150 \text{ } ^\circ C$

**figure 4.** FWD

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$



At

$t_p = 250 \mu s$   
 $T_j = 25/150 \text{ } ^\circ C$



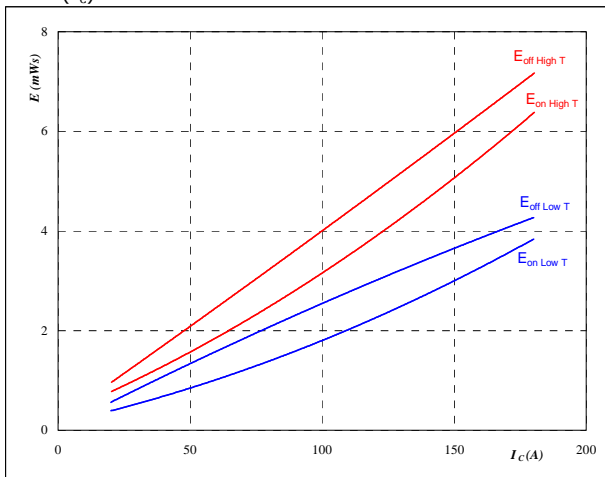
## Buck Switch

Buck IGBT and Buck FWD

**figure 5.** IGBT

**Typical switching energy losses as a function of collector current**

$E = f(I_C)$



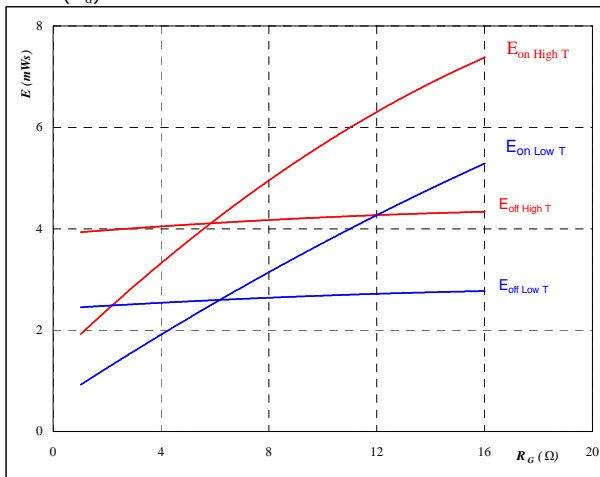
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$   
 $R_{goff} = 4 \text{ } \Omega$

**figure 6.** IGBT

**Typical switching energy losses as a function of gate resistor**

$E = f(R_G)$



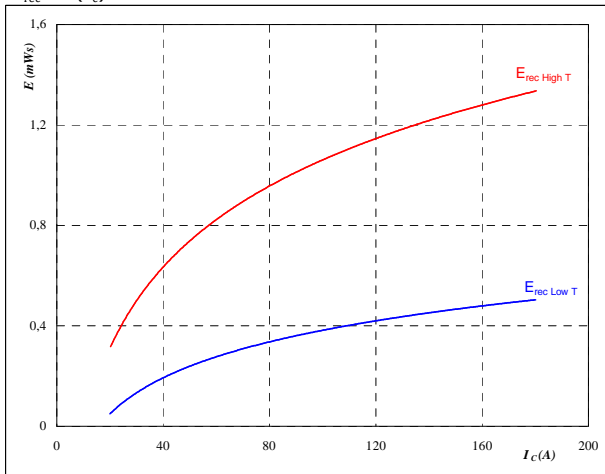
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 100 \text{ A}$

**figure 7.** FWD

**Typical reverse recovery energy loss as a function of collector current**

$E_{rec} = f(I_C)$



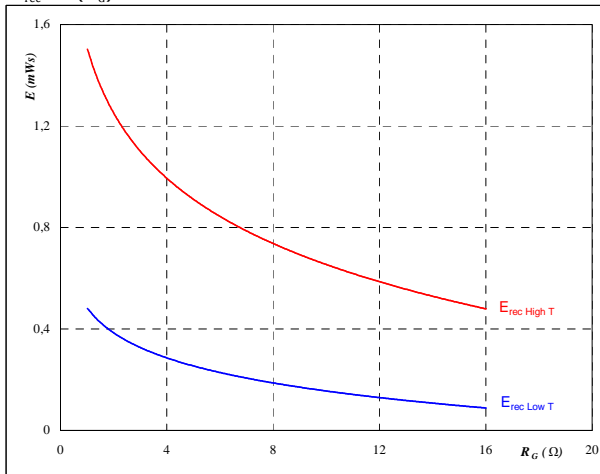
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$

**figure 8.** FWD

**Typical reverse recovery energy loss as a function of gate resistor**

$E_{rec} = f(R_G)$



With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 100 \text{ A}$



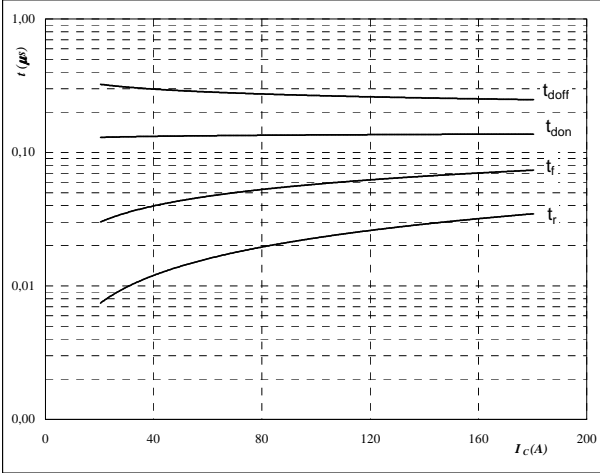
## Buck Switch

Buck IGBT and Buck FWD

**figure 9.** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



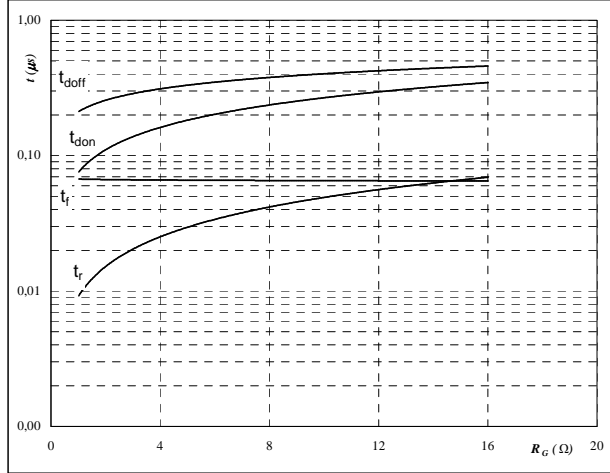
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$R_{gon} =$	4	Ω
$R_{goff} =$	4	Ω

**figure 10.** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



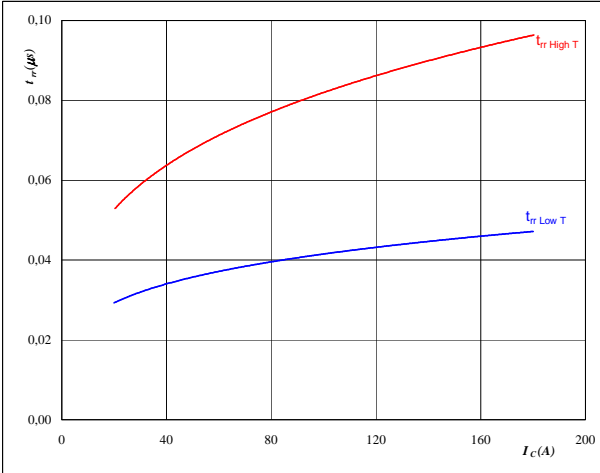
With an inductive load at

$T_j =$	125	°C
$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$I_C =$	100	A

**figure 11.** FWD

Typical reverse recovery time as a function of collector current

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



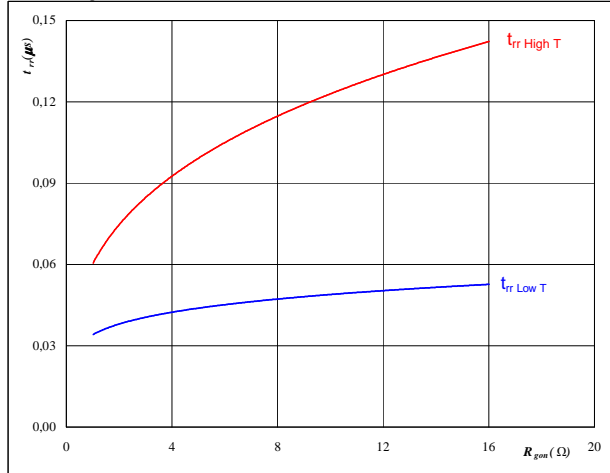
At

$T_j =$	25/125	°C
$V_{CE} =$	350	V
$V_{GE} =$	±15	V
$R_{gon} =$	4	Ω

**figure 12.** FWD

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

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



At

$T_j =$	25/125	°C
$V_R =$	350	V
$I_F =$	100	A
$V_{GE} =$	±15	V





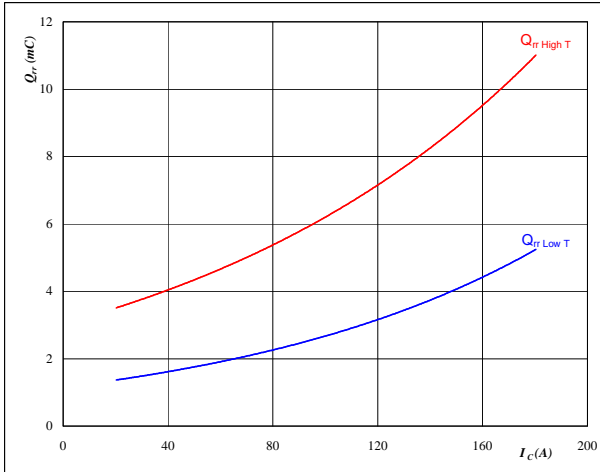
## Buck Switch

### Buck IGBT and Buck FWD

**figure 13.** FWD

Typical reverse recovery charge as a function of collector current

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

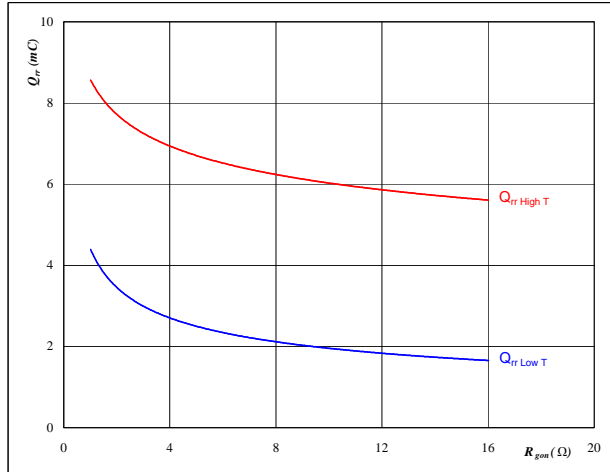
**At**

$T_j$	=	25/125	°C
$V_{CE}$	=	350	V
$V_{GE}$	=	±15	V
$R_{gon}$	=	4	Ω

**figure 14.** FWD

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

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

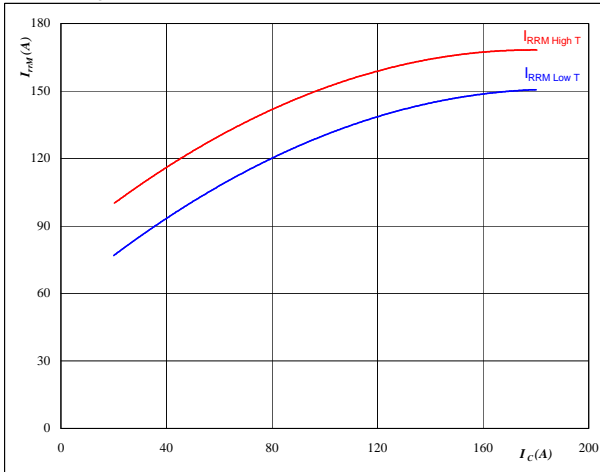
**At**

$T_j$	=	25/125	°C
$V_R$	=	350	V
$I_F$	=	100	A
$V_{GE}$	=	±15	V

**figure 15.** FWD

Typical reverse recovery current as a function of collector current

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

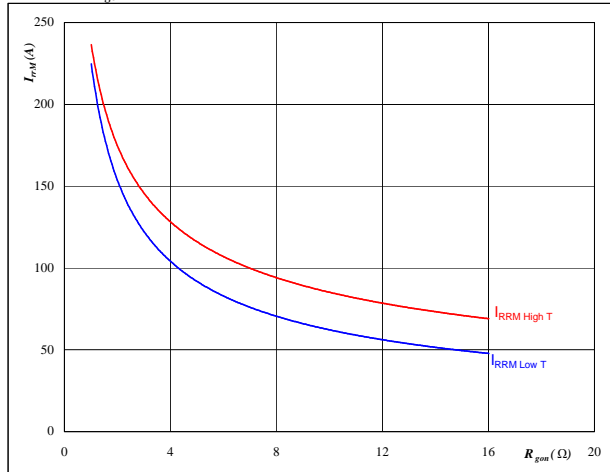
**At**

$T_j$	=	25/125	°C
$V_{CE}$	=	350	V
$V_{GE}$	=	±15	V
$R_{gon}$	=	4	Ω

**figure 16.** FWD

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

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

**At**

$T_j$	=	25/125	°C
$V_R$	=	350	V
$I_F$	=	100	A
$V_{GE}$	=	±15	V



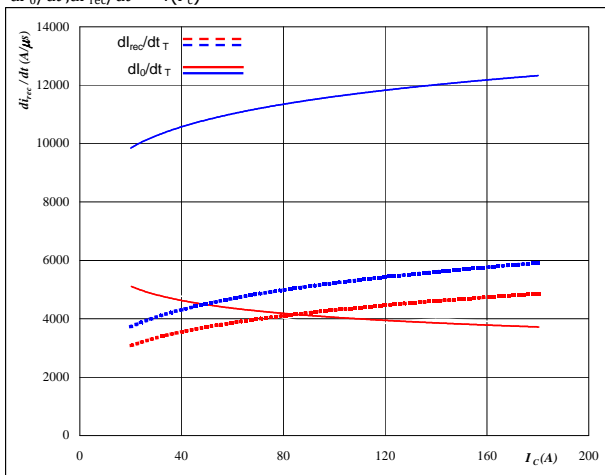
# Buck Switch

Buck IGBT and Buck FWD

**figure 17.** FWD

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

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

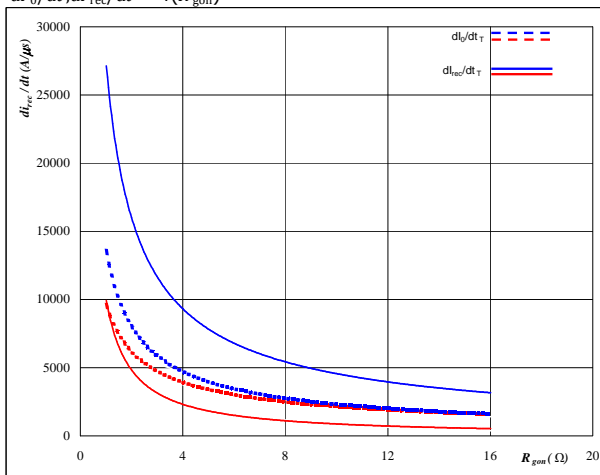


**At**  
 $T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$

**figure 18.** FWD

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

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

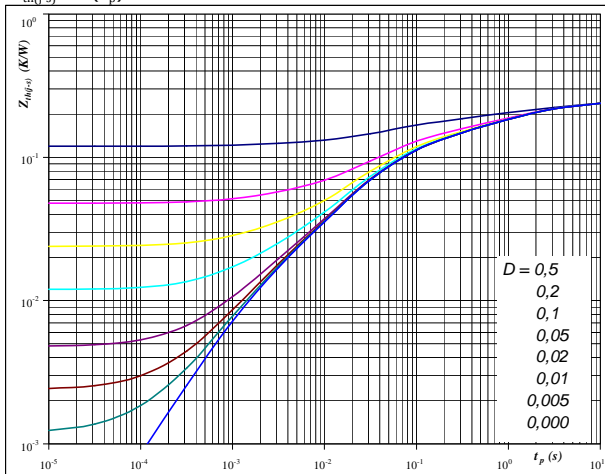


**At**  
 $T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_R = 350 \text{ V}$   
 $I_F = 100 \text{ A}$   
 $V_{GE} = \pm 15 \text{ V}$

**figure 19.** IGBT

IGBT transient thermal impedance as a function of pulse width

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



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 0,24 \text{ K/W}$

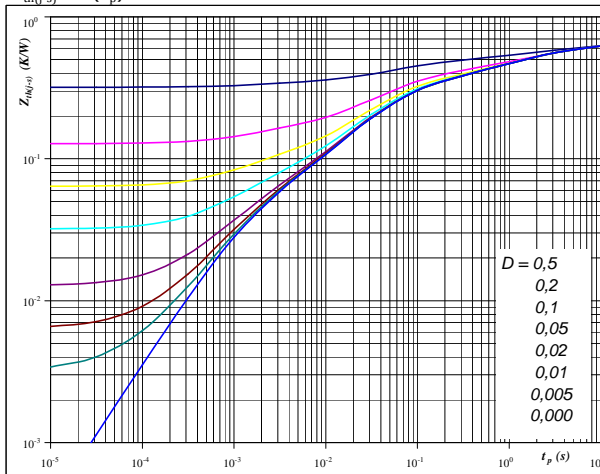
IGBT thermal model values

R (K/W)	Tau (s)
8,15E-02	2,26E+00
5,67E-02	2,93E-01
7,19E-02	4,58E-02
2,05E-02	1,26E-02
7,97E-03	1,53E-03

**figure 20.** FWD

FWD transient thermal impedance as a function of pulse width

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



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 0,64 \text{ K/W}$

FWD thermal model values

R (K/W)	Tau (s)
1,73E-01	3,90E+00
1,15E-01	8,45E-01
8,15E-02	1,79E-01
1,95E-01	4,20E-02
3,86E-02	9,89E-03
3,49E-02	1,28E-03



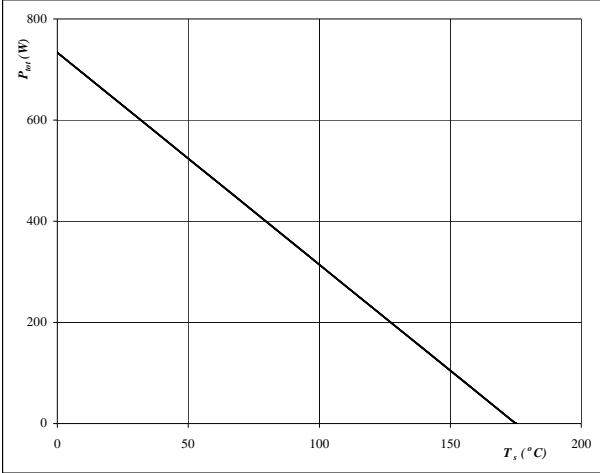
# Buck Switch

Buck IGBT and Buck FWD

**figure 21.** IGBT

**Power dissipation as a function of heatsink temperature**

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

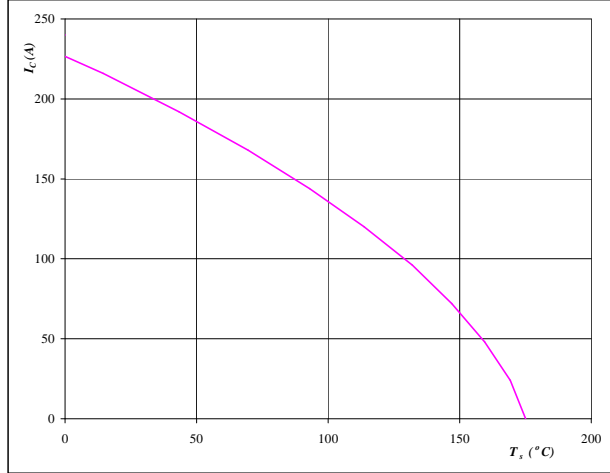


**At**  
T<sub>j</sub> = 175 °C

**figure 22.** IGBT

**Collector current as a function of heatsink temperature**

$$I_C = f(T_s)$$

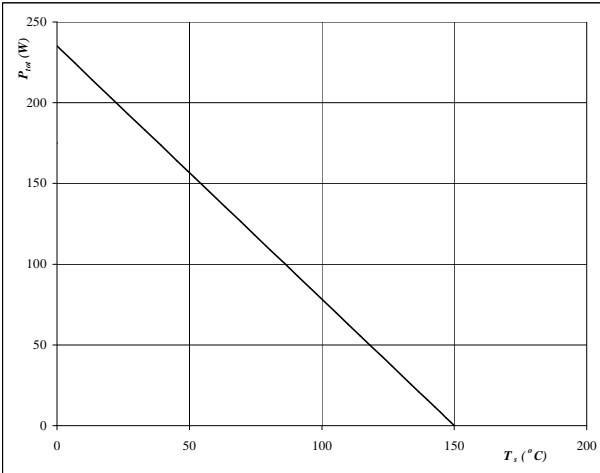


**At**  
T<sub>j</sub> = 175 °C  
V<sub>GE</sub> = 15 V

**figure 23.** FWD

**Power dissipation as a function of heatsink temperature**

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

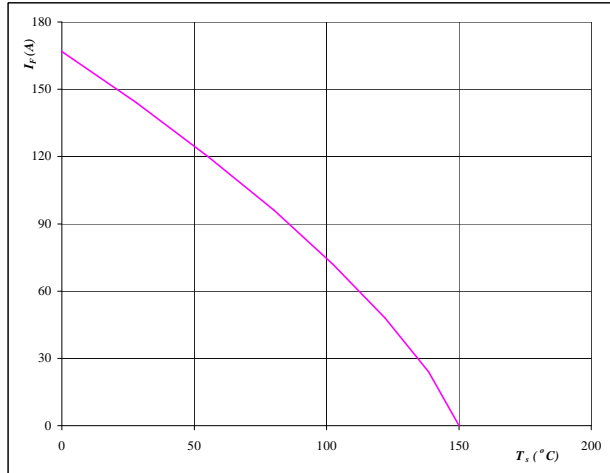


**At**  
T<sub>j</sub> = 150 °C

**figure 24.** FWD

**Forward current as a function of heatsink temperature**

$$I_F = f(T_s)$$



**At**  
T<sub>j</sub> = 150 °C



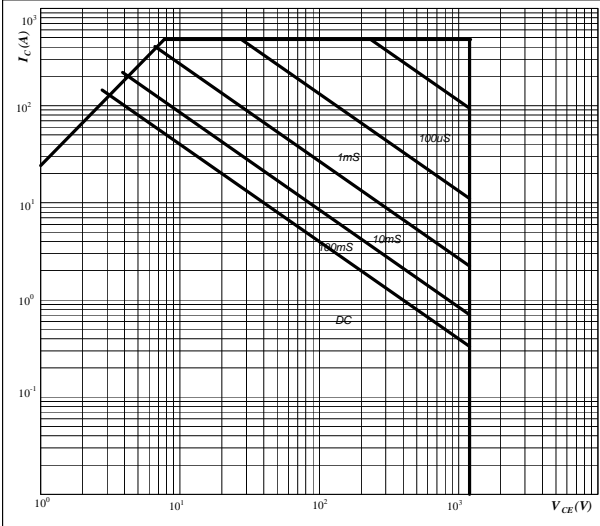
## Buck Switch

Buck IGBT and Buck FWD

**figure 25. IGBT**

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

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

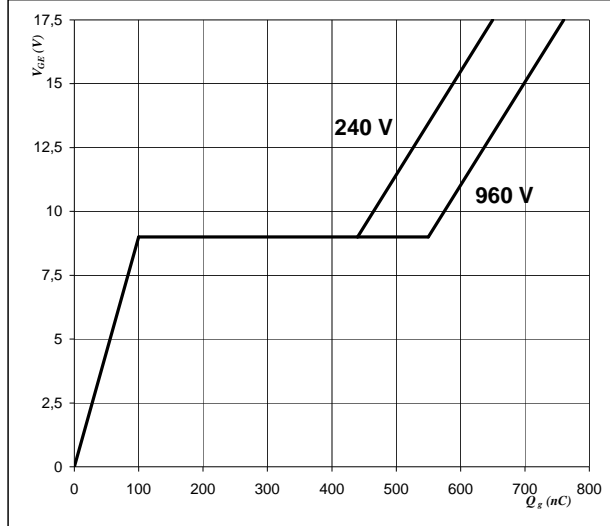


**At**  
 $D =$  single pulse  
 $T_s =$  80 °C  
 $V_{GE} =$  ±15 V  
 $T_j = T_{jmax}$

**figure 26. IGBT**

**Gate voltage vs Gate charge**

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

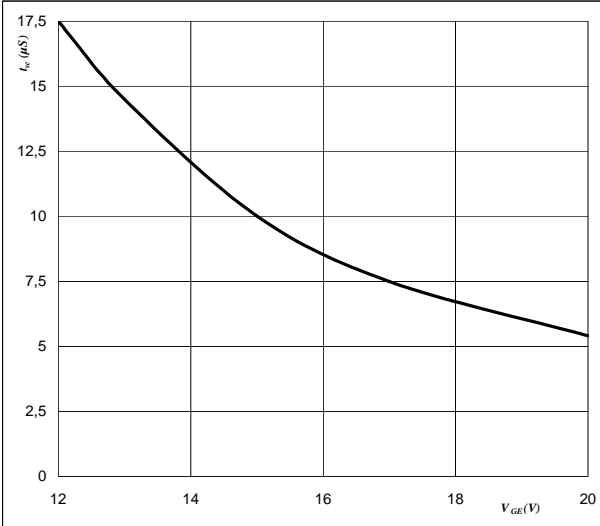


**At**  
 $I_D =$  160 A  
 $T_j =$  25 °C

**figure 27. IGBT**

**Short circuit withstand time as a function of gate-emitter voltage**

$$t_{sc} = f(V_{GE})$$

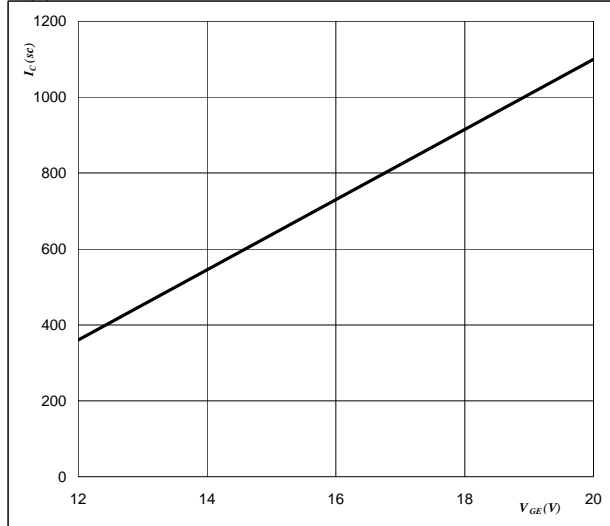


**At**  
 $V_{CE} =$  1200 V  
 $T_j \leq$  175 °C

**figure 28. IGBT**

**Typical short circuit collector current as a function of gate-emitter voltage**

$$I_{C(sc)} = f(V_{GE})$$



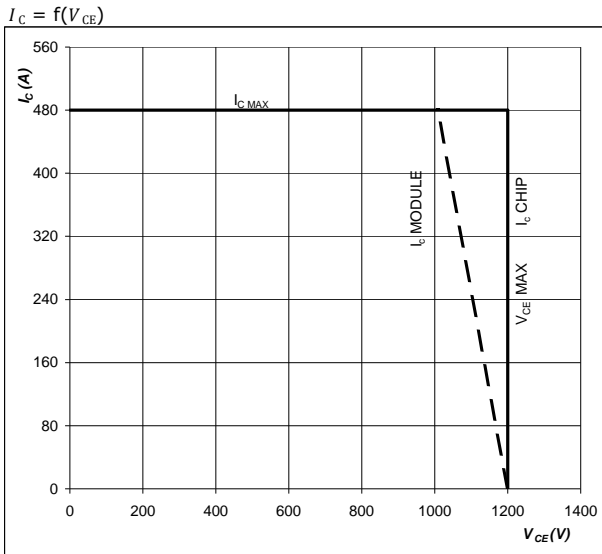
**At**  
 $V_{CE} \leq$  1200 V  
 $T_j =$  175 °C



## Buck Switch

Buck IGBT and Buck FWD

**figure 29.** IGBT  
**Reverse bias safe operating area**



**At**

$$T_j = T_{jmax} - 25 \text{ } ^\circ\text{C}$$

$$U_{ccminus} = U_{ccplus}$$

Switching mode : 3 level switching



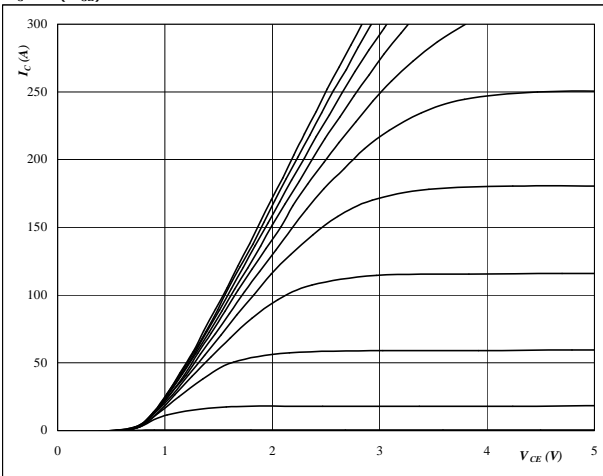
# Boost Switch

Boost IGBT and Boost FWD

**figure 1. IGBT**

**Typical output characteristics**

$I_C = f(V_{CE})$



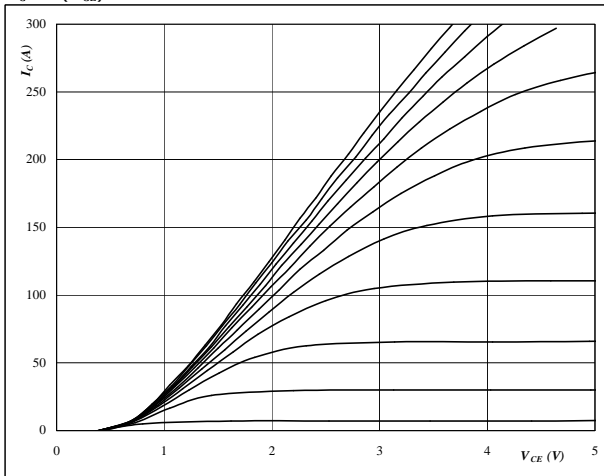
**At**

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

**figure 2. IGBT**

**Typical output characteristics**

$I_C = f(V_{CE})$



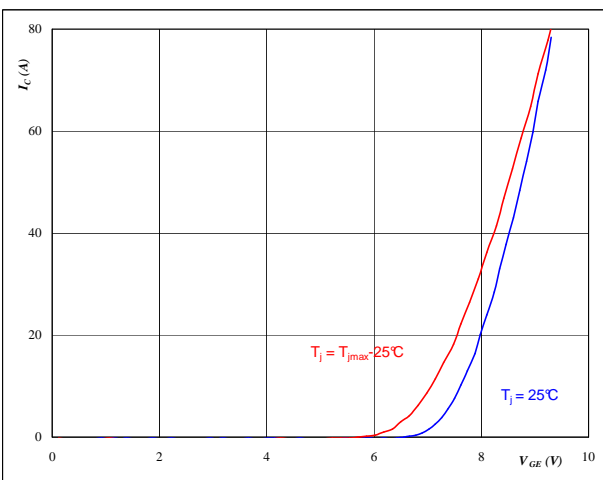
**At**

$t_p = 250 \mu s$   
 $T_j = 150 \text{ } ^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3. IGBT**

**Typical transfer characteristics**

$I_C = f(V_{GE})$



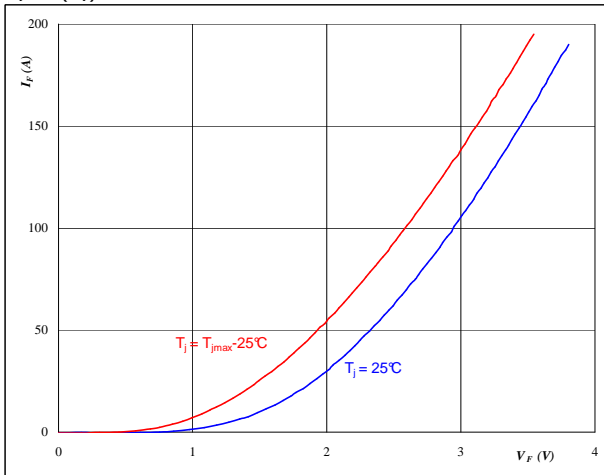
**At**

$t_p = 250 \mu s$   
 $V_{CE} = 10 \text{ V}$   
 $T_j = 25/150 \text{ } ^\circ C$

**figure 4. FWD**

**Typical FWD forward current as a function of forward voltage**

$I_F = f(V_F)$



**At**

$t_p = 250 \mu s$   
 $T_j = 25/150 \text{ } ^\circ C$



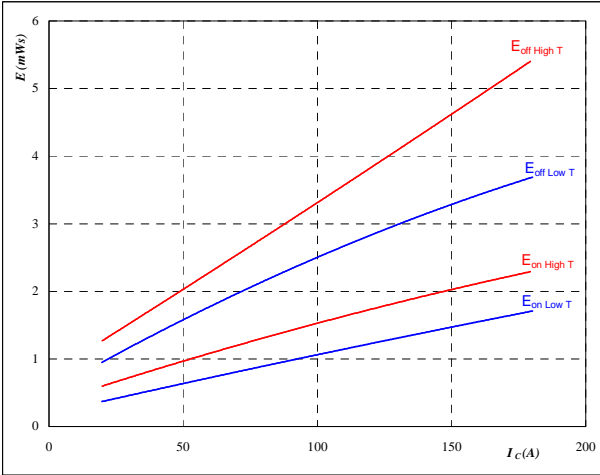
## Boost Switch

Boost IGBT and Boost FWD

**figure 5.** IGBT

Typical switching energy losses  
as a function of collector current

$$E = f(I_C)$$



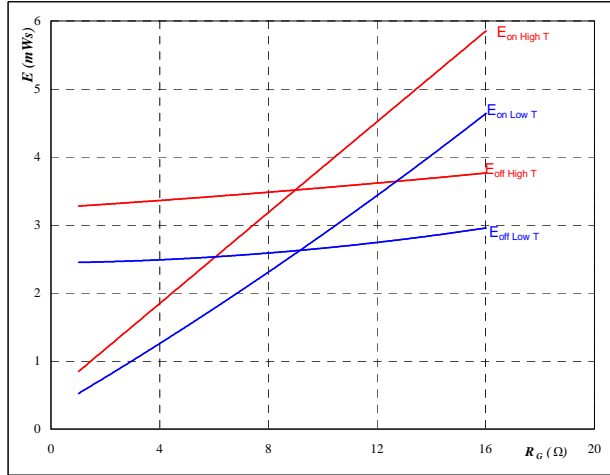
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$   
 $R_{goff} = 4 \text{ } \Omega$

**figure 6.** IGBT

Typical switching energy losses  
as a function of gate resistor

$$E = f(R_G)$$



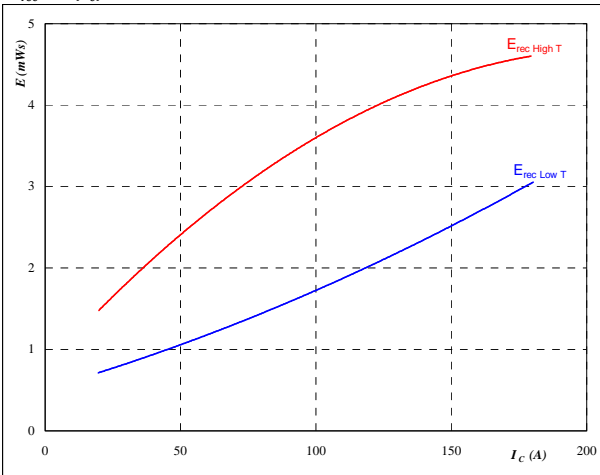
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 100 \text{ A}$

**figure 7.** FWD

Typical reverse recovery energy loss  
as a function of collector current

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



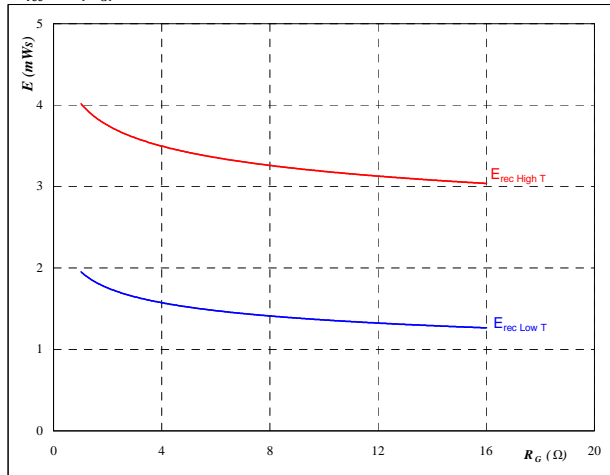
With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $R_{gon} = 4 \text{ } \Omega$

**figure 8.** FWD

Typical reverse recovery energy loss  
as a function of gate resistor

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



With an inductive load at

$T_j = 25/125 \text{ } ^\circ\text{C}$   
 $V_{CE} = 350 \text{ V}$   
 $V_{GE} = \pm 15 \text{ V}$   
 $I_C = 100 \text{ A}$



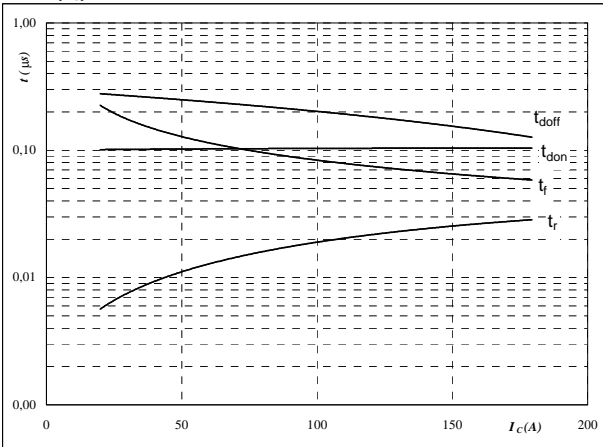
### Boost Switch

Boost IGBT and Boost FWD

**figure 9. IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



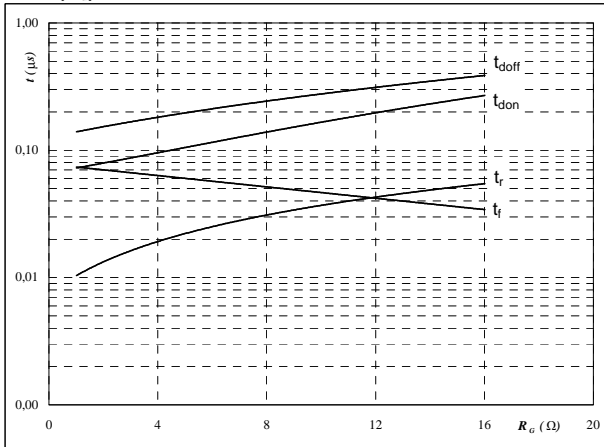
With an inductive load at

- $T_j = 125 \text{ } ^\circ\text{C}$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4 \text{ } \Omega$
- $R_{goff} = 4 \text{ } \Omega$

**figure 10. IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



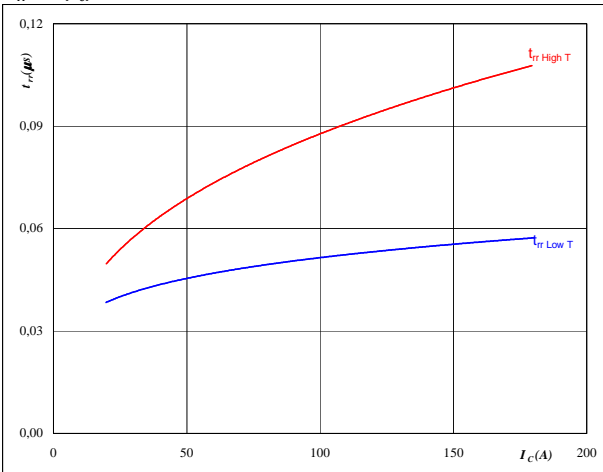
With an inductive load at

- $T_j = 125 \text{ } ^\circ\text{C}$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $I_C = 100 \text{ A}$

**figure 11. FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



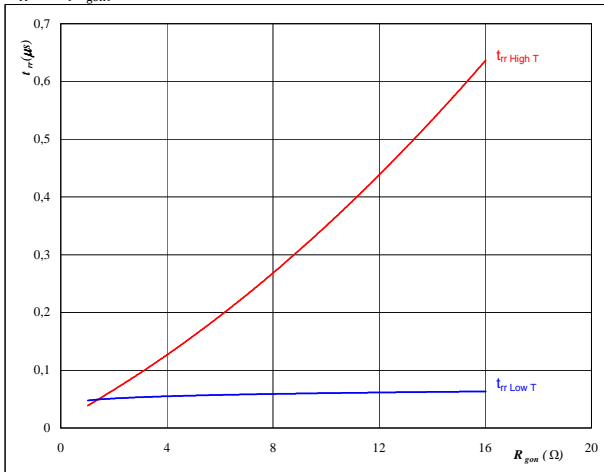
At

- $T_j = 25/125 \text{ } ^\circ\text{C}$
- $V_{CE} = 350 \text{ V}$
- $V_{GE} = \pm 15 \text{ V}$
- $R_{gon} = 4,0 \text{ } \Omega$

**figure 12. FWD**

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

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



At

- $T_j = 25/125 \text{ } ^\circ\text{C}$
- $V_R = 350 \text{ V}$
- $I_F = 100 \text{ A}$
- $V_{GE} = \pm 15 \text{ V}$





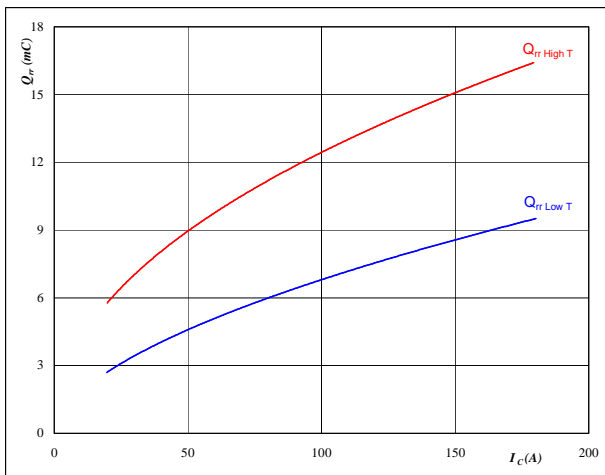
## Boost Switch

Boost IGBT and Boost FWD

**figure 13.** FWD

Typical reverse recovery charge as a function of collector current

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



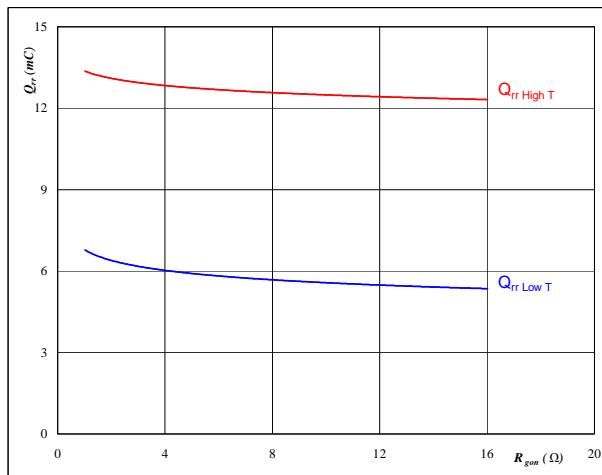
At

$T_j = 25/125$  °C  
 $V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 4$  Ω

**figure 14.** FWD

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

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



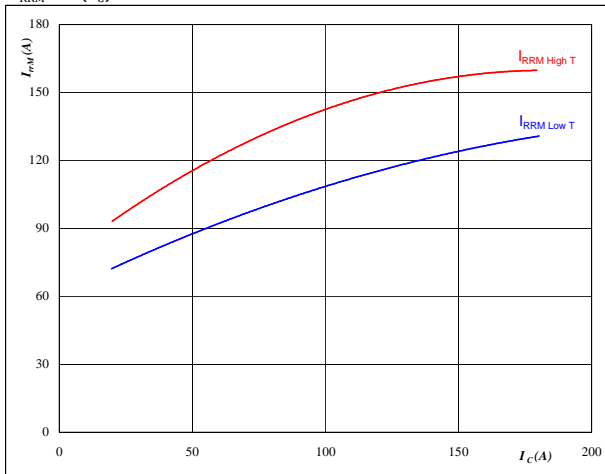
At

$T_j = 25/125$  °C  
 $V_R = 350$  V  
 $I_F = 100$  A  
 $V_{GE} = \pm 15$  V

**figure 15.** FWD

Typical reverse recovery current as a function of collector current

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



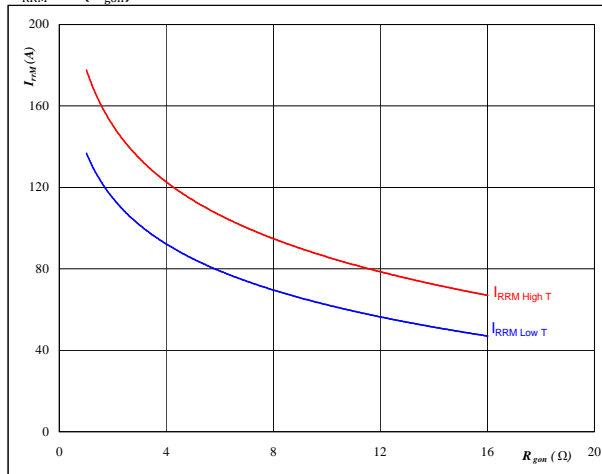
At

$T_j = 25/125$  °C  
 $V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 4$  Ω

**figure 16.** FWD

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

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



At

$T_j = 25/125$  °C  
 $V_R = 350$  V  
 $I_F = 100$  A  
 $V_{GE} = \pm 15$  V



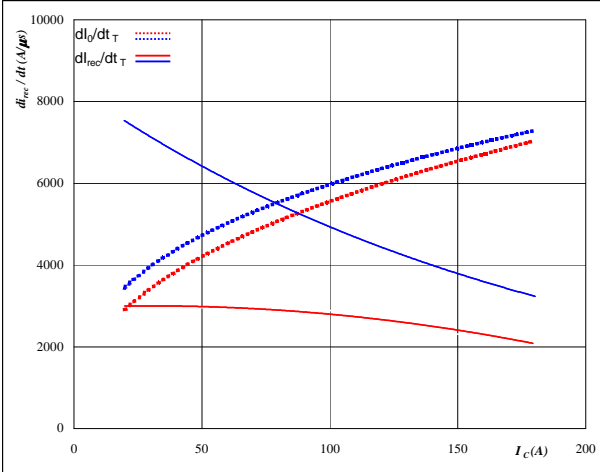
### Boost Switch

Boost IGBT and Boost FWD

**figure 17.** FWD

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

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

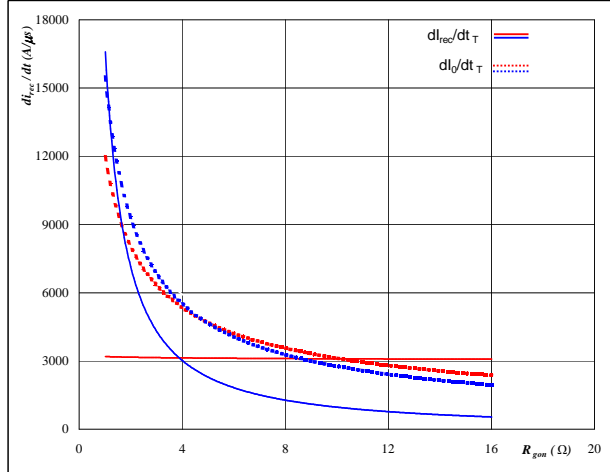


**At**  
 $T_j = 25/125$  °C  
 $V_{CE} = 350$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 4$  Ω

**figure 18.** FWD

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

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

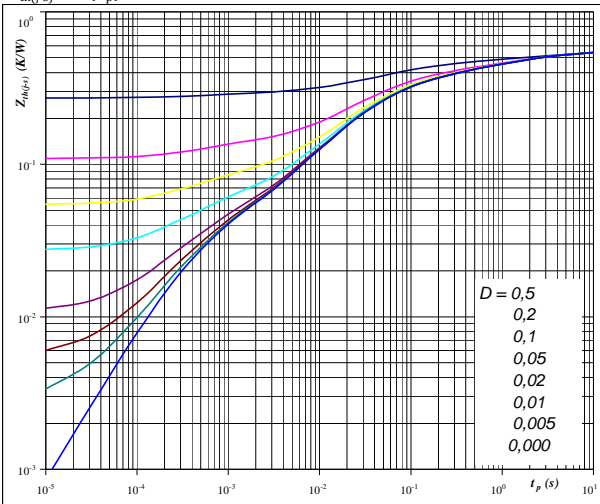


**At**  
 $T_j = 25/125$  °C  
 $V_R = 350$  V  
 $I_F = 100$  A  
 $V_{GE} = \pm 15$  V

**figure 19.** IGBT

**IGBT transient thermal impedance as a function of pulse width**

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



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 0,54$  K/W

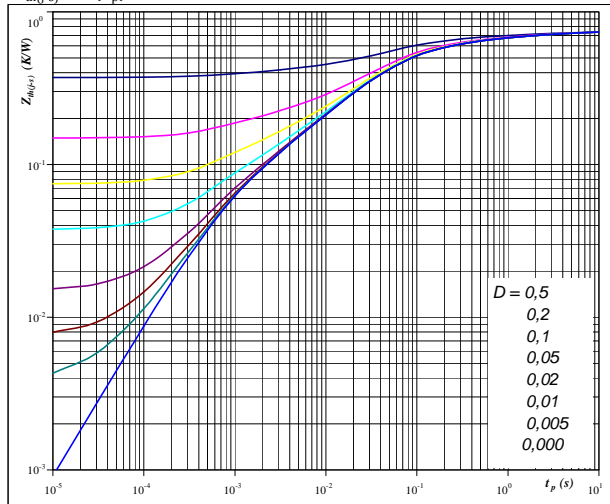
IGBT thermal model values

R (K/W)	Tau (s)
1,12E-01	2,87E+00
8,79E-02	4,59E-01
1,16E-01	9,51E-02
1,70E-01	2,49E-02
3,03E-02	4,36E-03

**figure 20.** FWD

**FWD transient thermal impedance as a function of pulse width**

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



**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 0,74$  K/W

FWD thermal model values

R (K/W)	Tau (s)
6,78E-02	3,67E+00
1,00E-01	5,41E-01
1,97E-01	9,81E-02
2,56E-01	2,84E-02
6,83E-02	4,90E-03



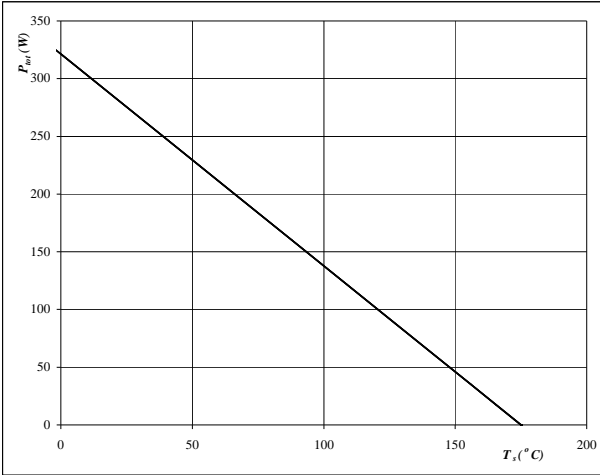
### Boost Switch

Boost IGBT and Boost FWD

**figure 21. IGBT**

**Power dissipation as a function of heatsink temperature**

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

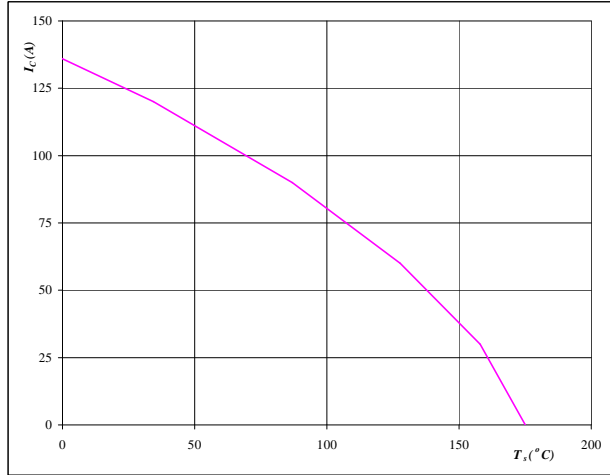


**At**  
 $T_j = 175$  °C

**figure 22. IGBT**

**Collector current as a function of heatsink temperature**

$$I_C = f(T_s)$$

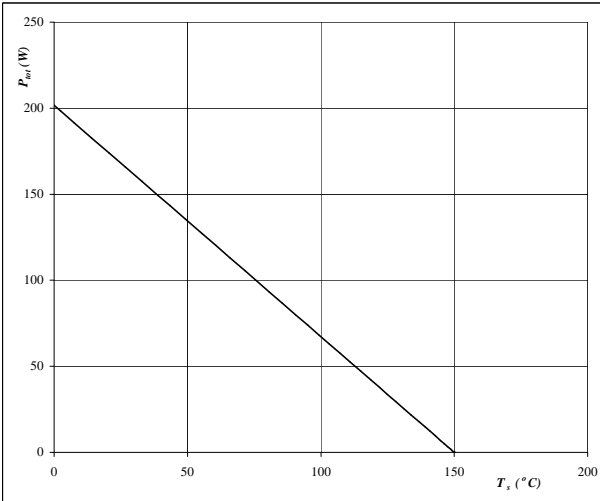


**At**  
 $T_j = 175$  °C  
 $V_{GE} = 15$  V

**figure 23. FWD**

**Power dissipation as a function of heatsink temperature**

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

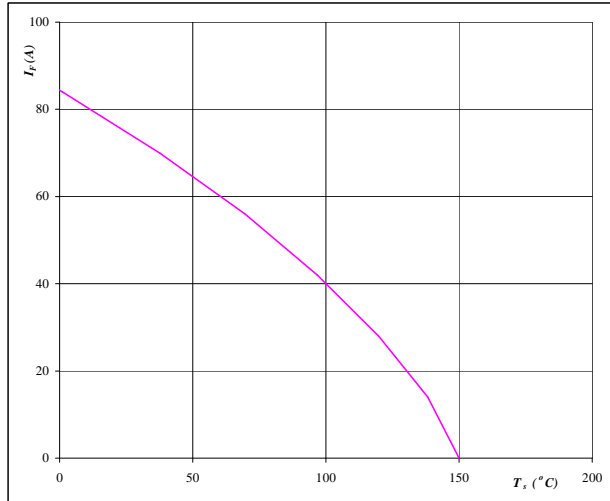


**At**  
 $T_j = 150$  °C

**figure 24. FWD**

**Forward current as a function of heatsink temperature**

$$I_F = f(T_s)$$



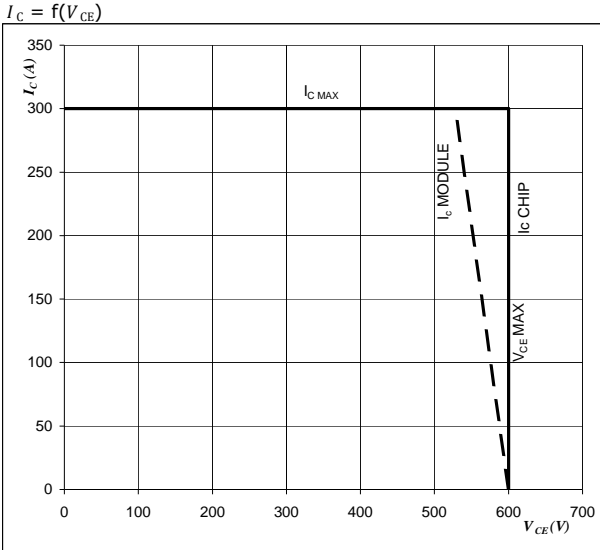
**At**  
 $T_j = 150$  °C



## Boost Switch

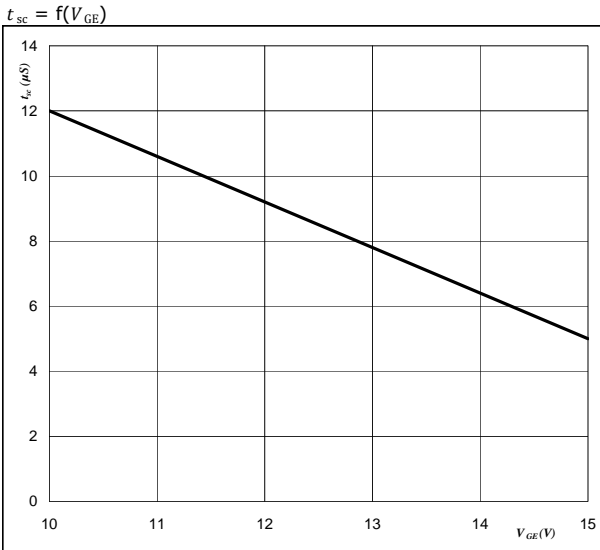
Boost IGBT

**figure 25.** IGBT  
**Reverse bias safe operating area**



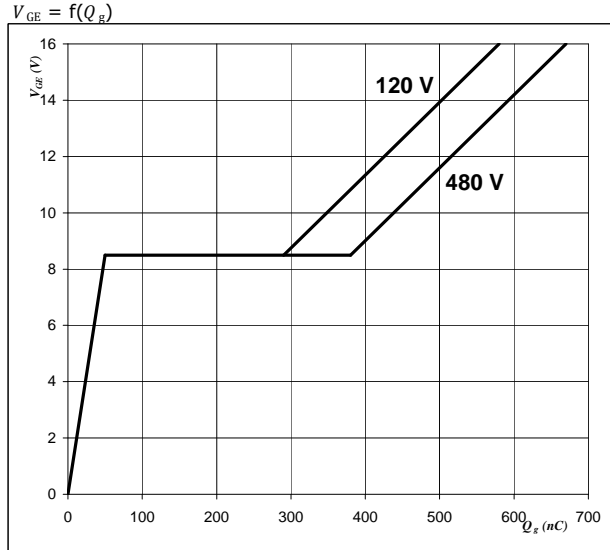
**At**  
 $T_j = T_{jmax} - 25 \text{ } ^\circ\text{C}$   
 $U_{ccminus} = U_{ccplus}$   
 Switching mode : 3 level switching

**figure 27.** IGBT  
**Short circuit withstand time as a function of gate-emitter voltage**



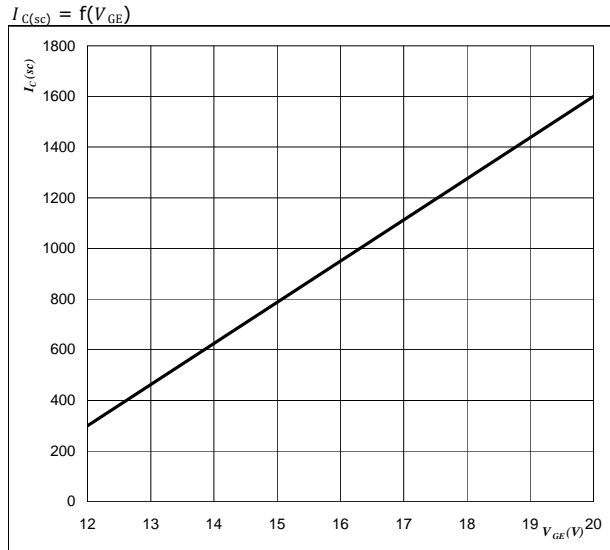
**At**  
 $V_{CE} = 600 \text{ V}$   
 $T_j \leq 150 \text{ } ^\circ\text{C}$

**figure 26.** IGBT  
**Gate voltage vs Gate charge**



**At**  
 $I_D = 100 \text{ A}$   
 $T_j = 25 \text{ } ^\circ\text{C}$

**figure 28.** IGBT  
**Typical short circuit collector current as a function of gate-emitter voltage**



**At**  
 $V_{CE} \leq 400 \text{ V}$   
 $T_j = 125 \text{ } ^\circ\text{C}$

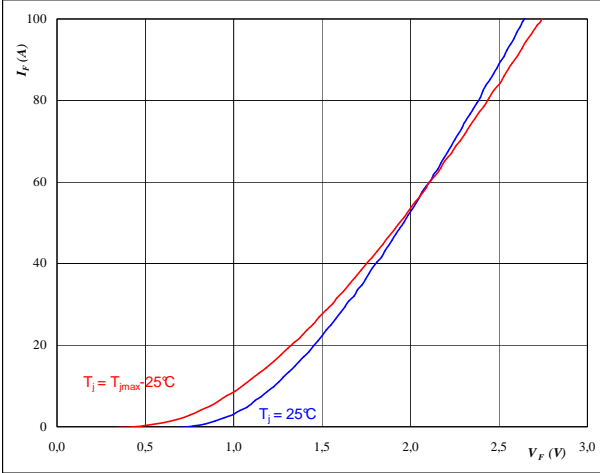


### Boost Inverse Diode

**figure 25. Boost Inverse Diode**

**Typical FWD forward current as a function of forward voltage**

$I_F = f(V_F)$

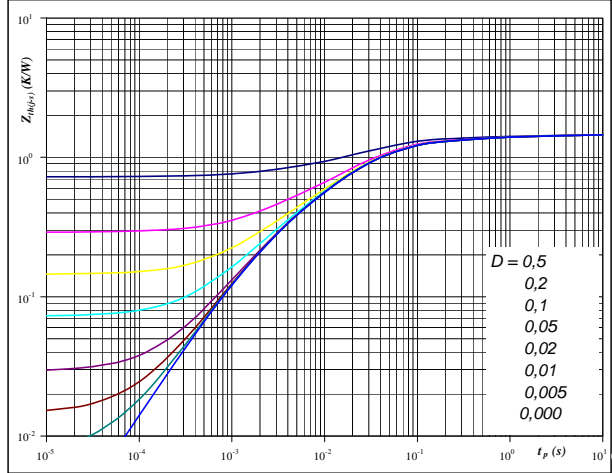


**At**  
 $t_p = 250 \mu s$

**figure 26. Boost Inverse Diode**

**FWD transient thermal impedance as a function of pulse width**

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

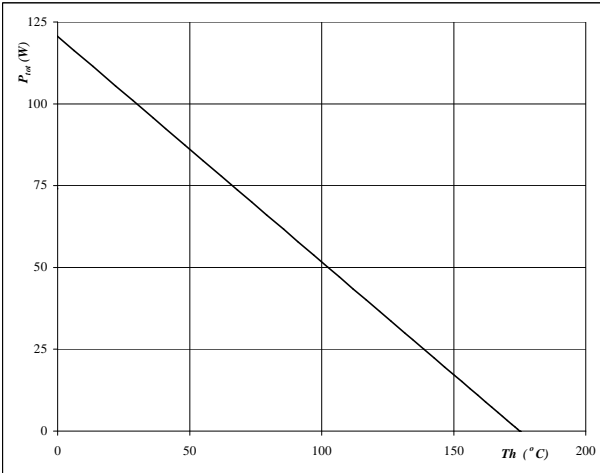


**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 1,45 K/W$

**figure 27. Boost Inverse Diode**

**Power dissipation as a function of heatsink temperature**

$P_{tot} = f(T_s)$

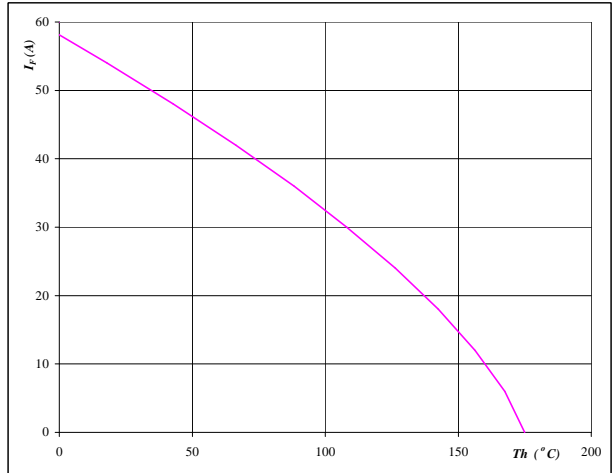


**At**  
 $T_j = 175 °C$

**figure 28. Boost Inverse Diode**

**Forward current as a function of heatsink temperature**

$I_F = f(T_s)$



**At**  
 $T_j = 175 °C$

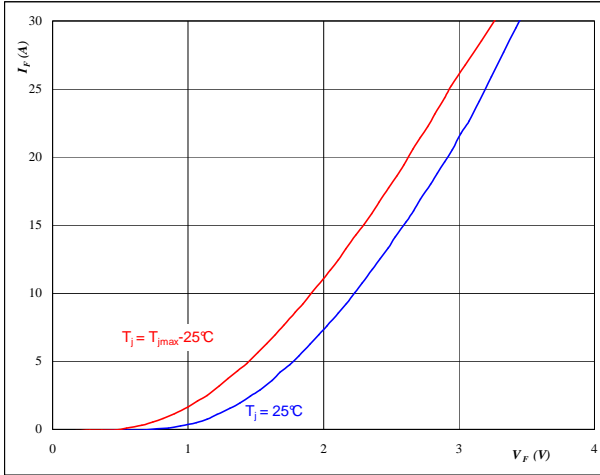


### Buck Inverse Diode

**figure 1. Buck Inverse Diode**

Typical FWD forward current as a function of forward voltage

$I_F = f(V_F)$

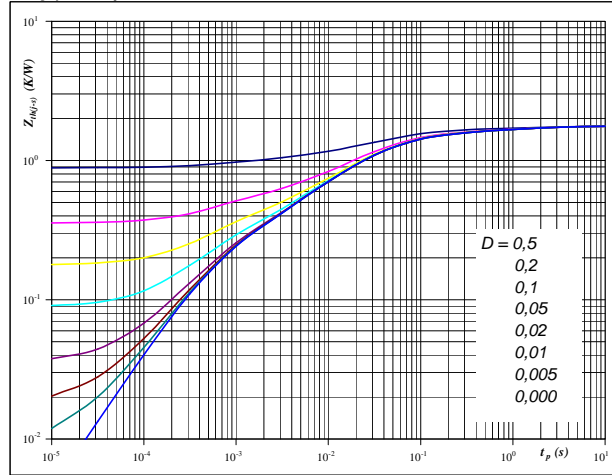


**At**  
 $t_p = 250 \mu s$

**figure 2. Buck Inverse Diode**

FWD transient thermal impedance as a function of pulse width

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

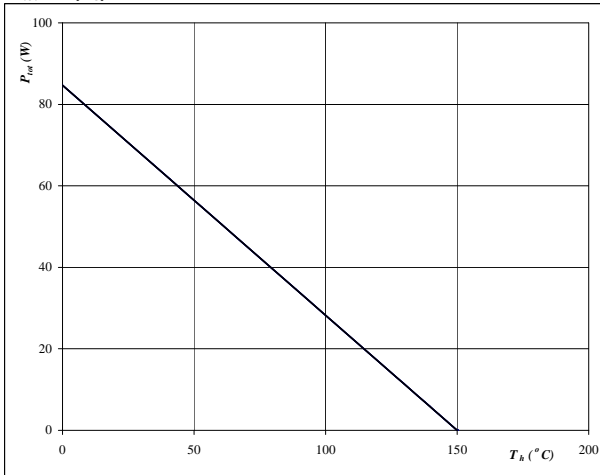


**At**  
 $D = t_p / T$   
 $R_{th(j-s)} = 1,77 \text{ K/W}$

**figure 3. Buck Inverse Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$

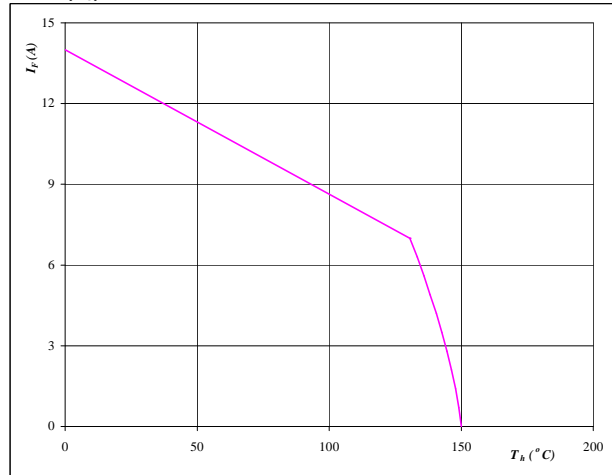


**At**  
 $T_j = 150 \text{ °C}$

**figure 4. Buck Inverse Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



**At**  
 $T_j = 150 \text{ °C}$

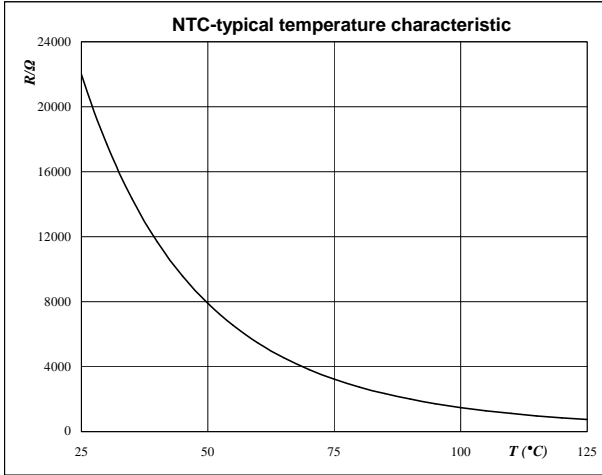


# Thermistor

**figure 1. Thermistor**

**Typical NTC characteristic  
as a function of temperature**

$$R_T = f(T)$$





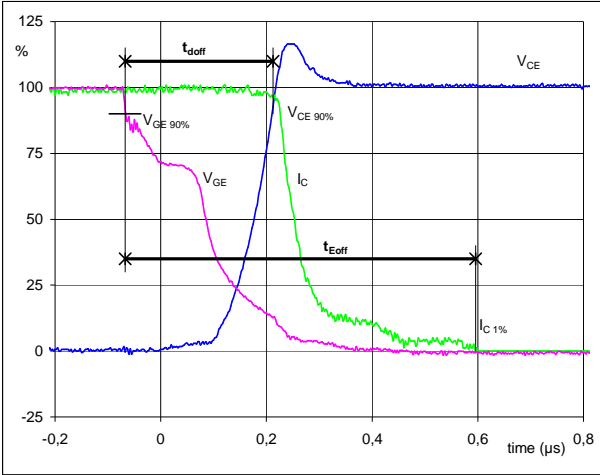
### Switching Definitions Buck

**General conditions**

$T_j$	=	125 °C
$R_{gon}$	=	4 Ω
$R_{goff}$	=	4 Ω

**figure 1. Buck IGBT**

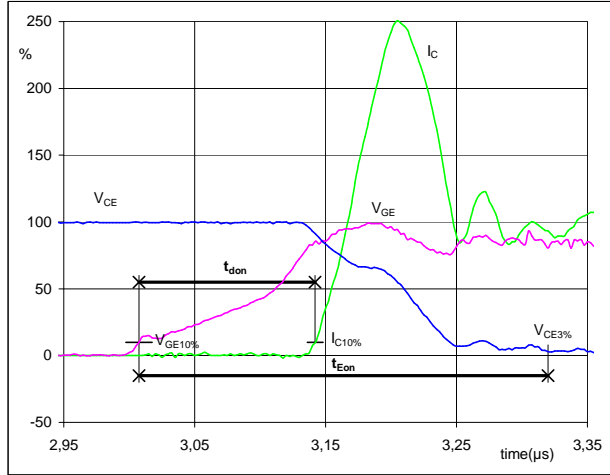
**Turn-off Switching Waveforms & definition of  $t_{doff}$   $t_{Eoff}$**   
( $t_{Eoff}$  = integrating time for  $E_{off}$ )



$V_{GE}$ (0%) =	-15	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_{doff}$ =	0,28	μs
$t_{Eoff}$ =	0,66	μs

**figure 2. Buck IGBT**

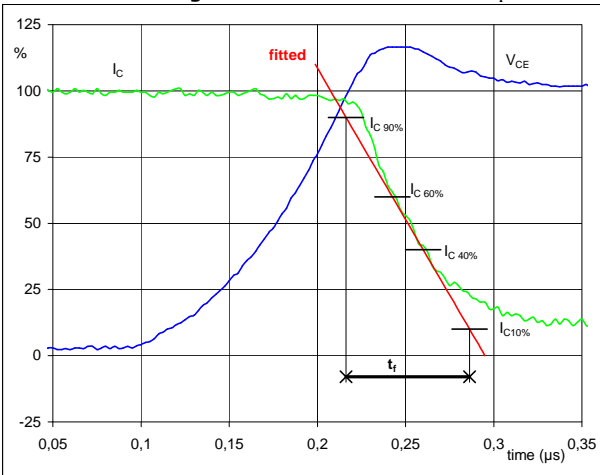
**Turn-on Switching Waveforms & definition of  $t_{don}$   $t_{Eon}$**   
( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{GE}$ (0%) =	-15	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_{don}$ =	0,14	μs
$t_{Eon}$ =	0,31	μs

**figure 3. Buck IGBT**

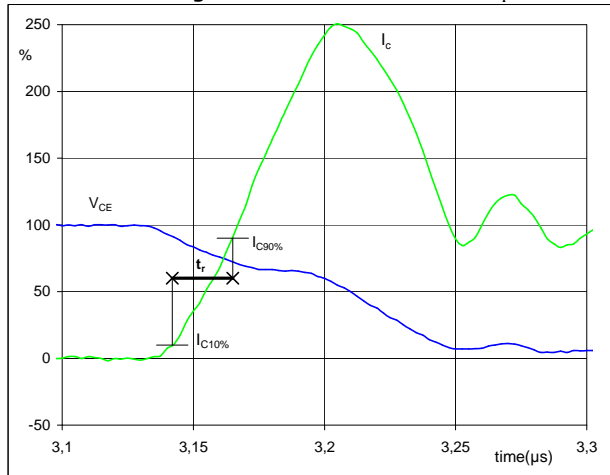
**Turn-off Switching Waveforms & definition of  $t_f$**



$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_f$ =	0,06	μs

**figure 4. Buck IGBT**

**Turn-on Switching Waveforms & definition of  $t_r$**



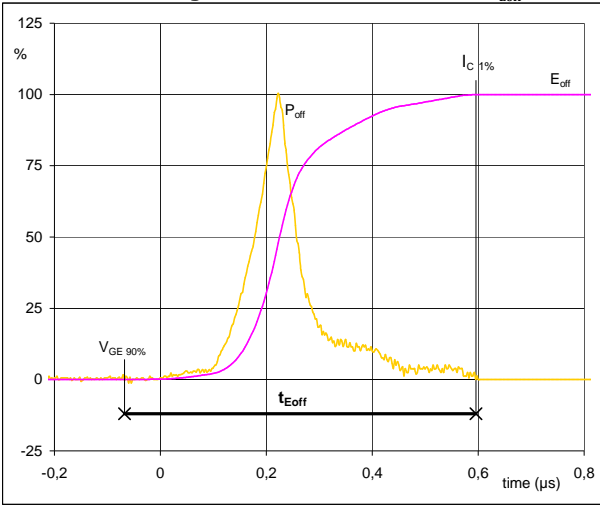
$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_r$ =	0,02	μs





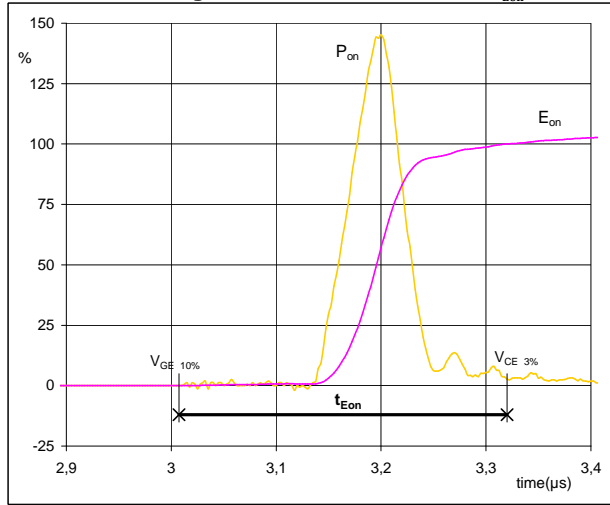
### Switching Definitions Buck

**figure 5. Buck IGBT**  
**Turn-off Switching Waveforms & definition of  $t_{Eoff}$**



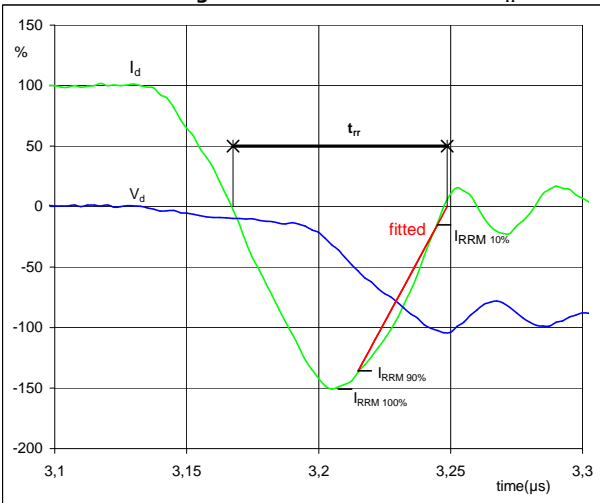
$P_{off} (100\%) = 70,22 \text{ kW}$   
 $E_{off} (100\%) = 4,03 \text{ mJ}$   
 $t_{Eoff} = 0,66 \text{ }\mu\text{s}$

**figure 6. Buck IGBT**  
**Turn-on Switching Waveforms & definition of  $t_{Eon}$**



$P_{on} (100\%) = 70,22 \text{ kW}$   
 $E_{on} (100\%) = 3,18 \text{ mJ}$   
 $t_{Eon} = 0,31 \text{ }\mu\text{s}$

**figure 7. Boost FWD**  
**Turn-off Switching Waveforms & definition of  $t_{tr}$**



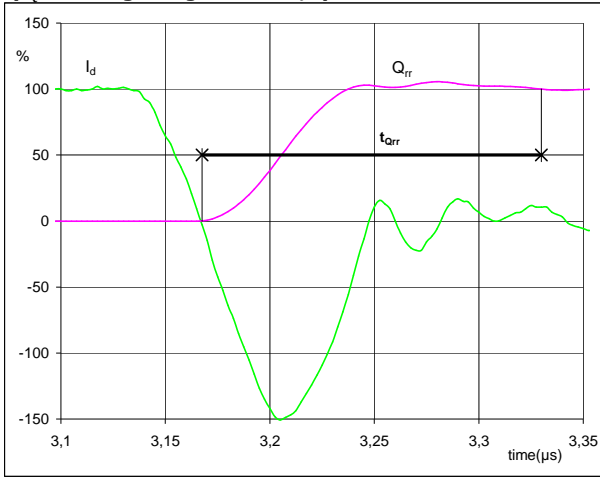
$V_d (100\%) = 700 \text{ V}$   
 $I_d (100\%) = 100 \text{ A}$   
 $I_{RRM} (100\%) = -151 \text{ A}$   
 $t_{tr} = 0,08 \text{ }\mu\text{s}$



## Switching Definitions Buck

**figure 8. Boost FWD**

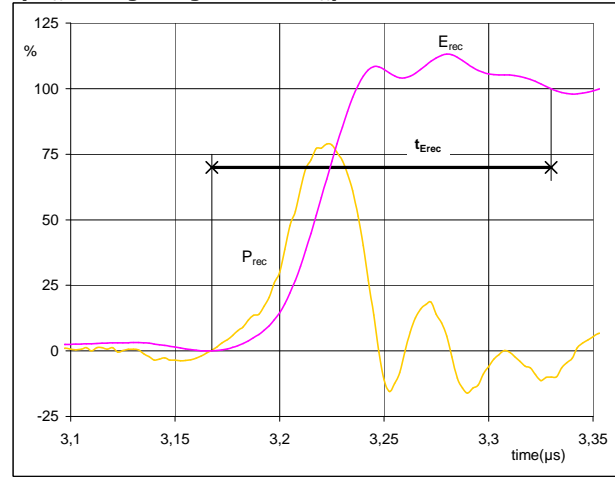
**Turn-on Switching Waveforms & definition of  $t_{Qrr}$**   
( $t_{Qrr}$  = integrating time for  $Q_{rr}$ )



$I_d$ (100%) =	100	A
$Q_{rr}$ (100%) =	7,13	$\mu\text{C}$
$t_{Qrr}$ =	0,16	$\mu\text{s}$

**figure 9. Boost FWD**

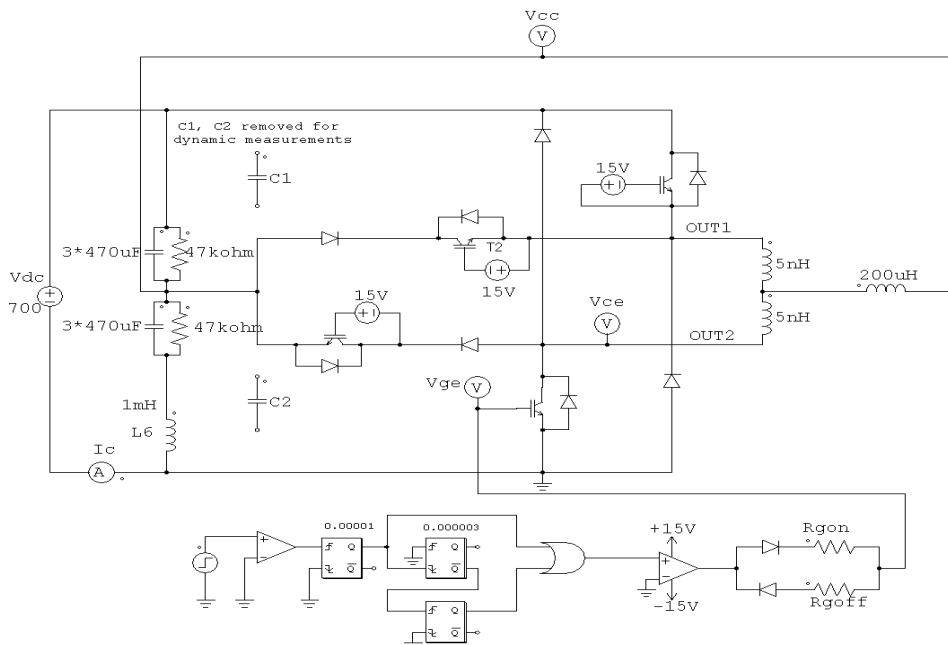
**Turn-on Switching Waveforms & definition of  $t_{Erec}$**   
( $t_{Erec}$  = integrating time for  $E_{rec}$ )



$P_{rec}$ (100%) =	70,22	kW
$E_{rec}$ (100%) =	1,01	mJ
$t_{Erec}$ =	0,16	$\mu\text{s}$

## Buck switching measurement circuit

**figure 10.**





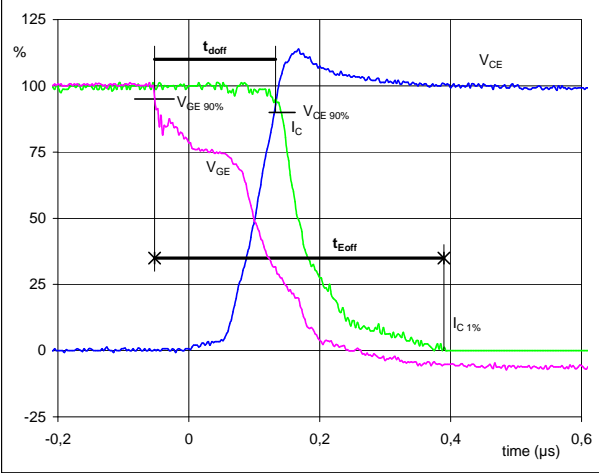
### Switching Definitions Boost

**General conditions**

$T_j$	=	125 °C
$R_{gon}$	=	4 Ω
$R_{goff}$	=	4 Ω

**figure 1. Boost IGBT**

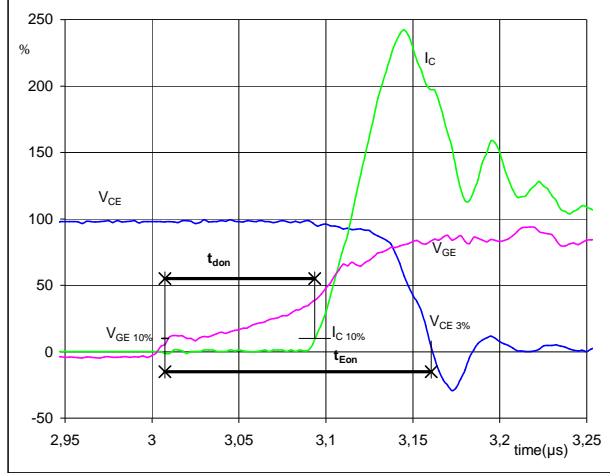
**Turn-off Switching Waveforms & definition of  $t_{doff}$   $t_{Eoff}$**   
( $t_{Eoff}$  = integrating time for  $E_{off}$ )



$V_{GE}$ (0%) =	-15	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_{doff}$ =	0,18	μs
$t_{Eoff}$ =	0,44	μs

**figure 2. Boost IGBT**

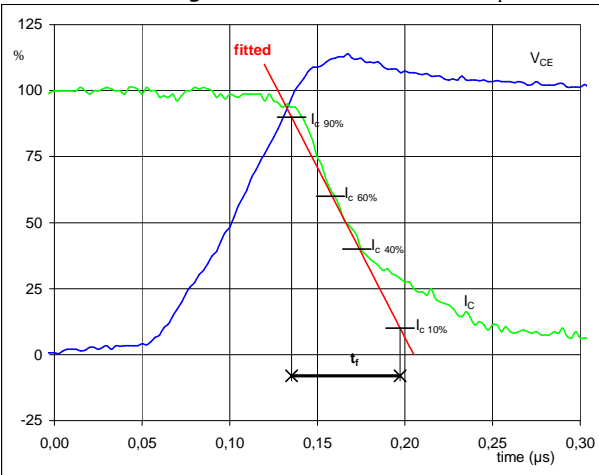
**Turn-on Switching Waveforms & definition of  $t_{don}$   $t_{Eon}$**   
( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{GE}$ (0%) =	-15	V
$V_{GE}$ (100%) =	15	V
$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_{don}$ =	0,10	μs
$t_{Eon}$ =	0,15	μs

**figure 3. Boost IGBT**

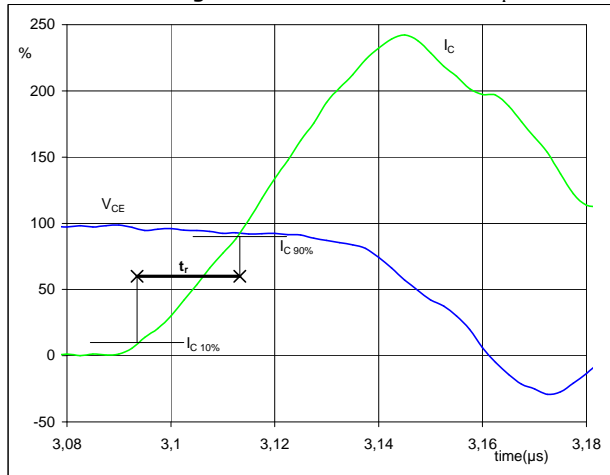
**Turn-off Switching Waveforms & definition of  $t_f$**



$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_f$ =	0,064	μs

**figure 4. Boost IGBT**

**Turn-on Switching Waveforms & definition of  $t_r$**

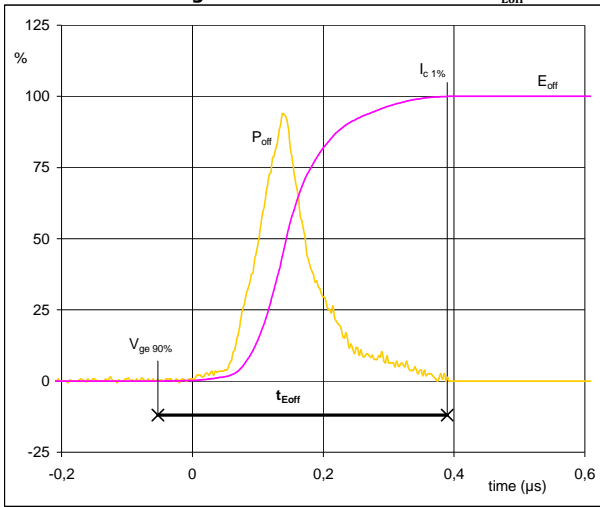


$V_C$ (100%) =	700	V
$I_C$ (100%) =	100	A
$t_r$ =	0,019	μs



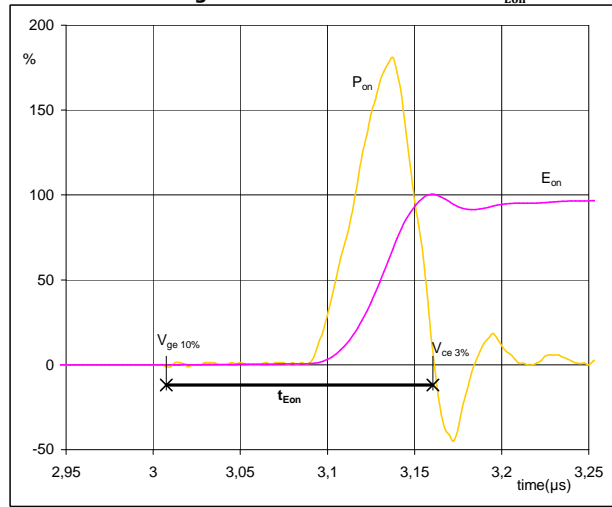
### Switching Definitions Boost

**figure 5. Boost IGBT**  
**Turn-off Switching Waveforms & definition of  $t_{Eoff}$**



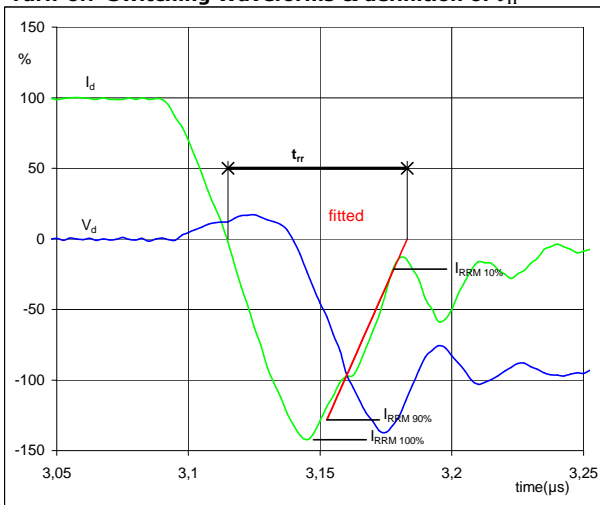
$P_{off} (100\%) = 69,93 \text{ kW}$   
 $E_{off} (100\%) = 3,32 \text{ mJ}$   
 $t_{Eoff} = 0,44 \text{ } \mu\text{s}$

**figure 6. Boost IGBT**  
**Turn-on Switching Waveforms & definition of  $t_{Eon}$**



$P_{on} (100\%) = 69,9279 \text{ kW}$   
 $E_{on} (100\%) = 1,52 \text{ mJ}$   
 $t_{Eon} = 0,18 \text{ } \mu\text{s}$

**figure 7. Buck FWD**  
**Turn-off Switching Waveforms & definition of  $t_{tr}$**

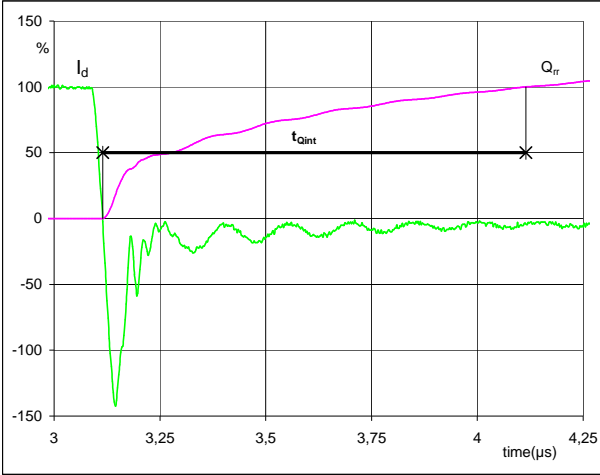


$V_d (100\%) = 700 \text{ V}$   
 $I_d (100\%) = 100 \text{ A}$   
 $I_{RRM} (100\%) = -142 \text{ A}$   
 $t_{tr} = 0,07 \text{ } \mu\text{s}$



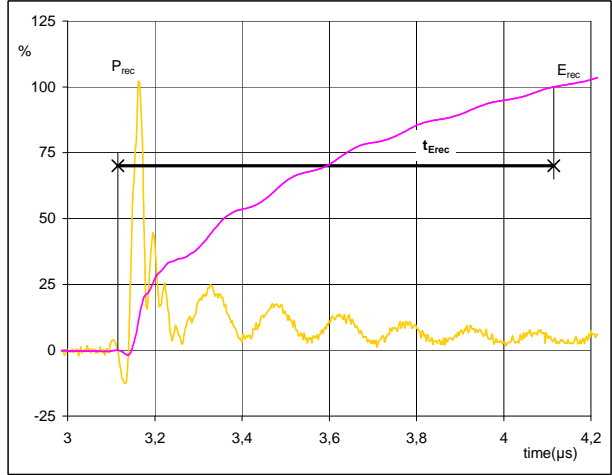
### Switching Definitions Boost

**figure 8. Buck FWD**  
**Turn-on Switching Waveforms & definition of  $t_{Qrr}$**   
( $t_{Qrr}$  = integrating time for  $Q_{rr}$ )



$I_d$ (100%) =	100	A
$Q_{rr}$ (100%) =	12,71	$\mu\text{C}$
$t_{Qint}$ =	1,00	$\mu\text{s}$

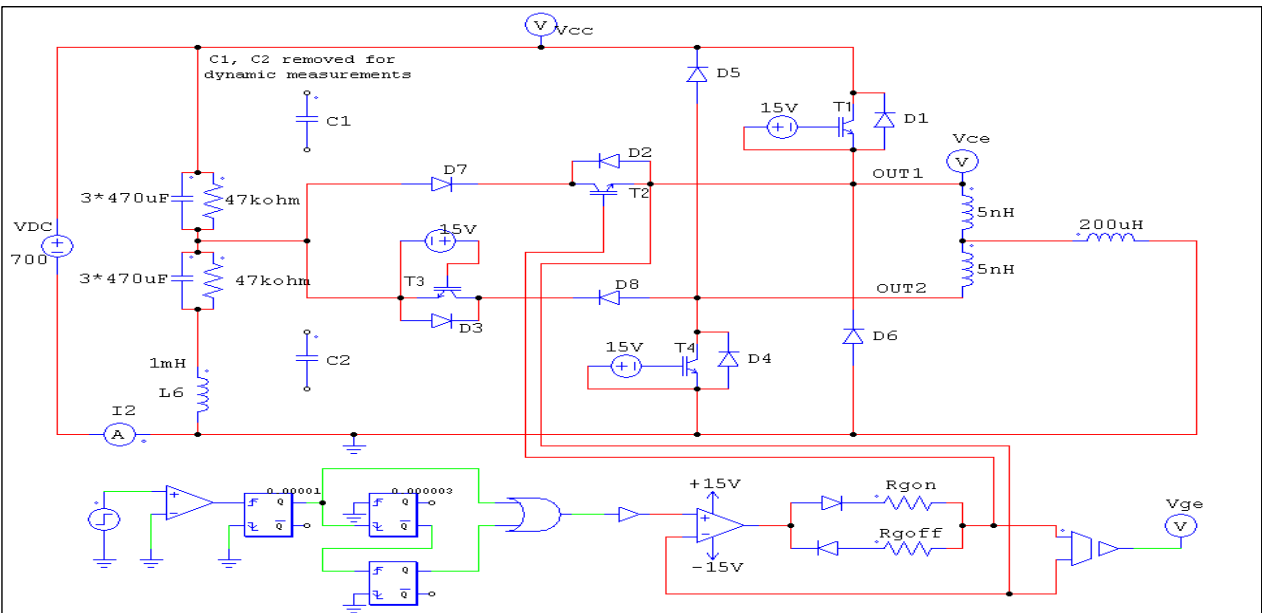
**figure 9. Buck FWD**  
**Turn-on Switching Waveforms & definition of  $t_{Erec}$**   
( $t_{Erec}$  = integrating time for  $E_{rec}$ )



$P_{rec}$ (100%) =	69,93	kW
$E_{rec}$ (100%) =	3,61	mJ
$t_{Erec}$ =	1,00	$\mu\text{s}$

### Boost switching measurement circuit

**figure 10.**





Ordering Code & Marking						
<b>Version</b>			<b>Ordering Code</b>			
without thermal paste 13mm housing			30-FT12NMA160SH-M669F08			
	<b>Text</b>	<b>Name</b>	<b>Date code</b>	<b>UL &amp; VIN</b>	<b>Lot</b>	<b>Serial</b>
		NN-NNNNNNNNNNNNNN-TTTTTVV	WWYY	UL VIN	LLLLL	SSSS
	<b>Datamatrix</b>	<b>Type&amp;Ver</b>	<b>Lot number</b>	<b>Serial</b>	<b>Date code</b>	
		TTTTTVV	LLLLL	SSSS	WWYY	

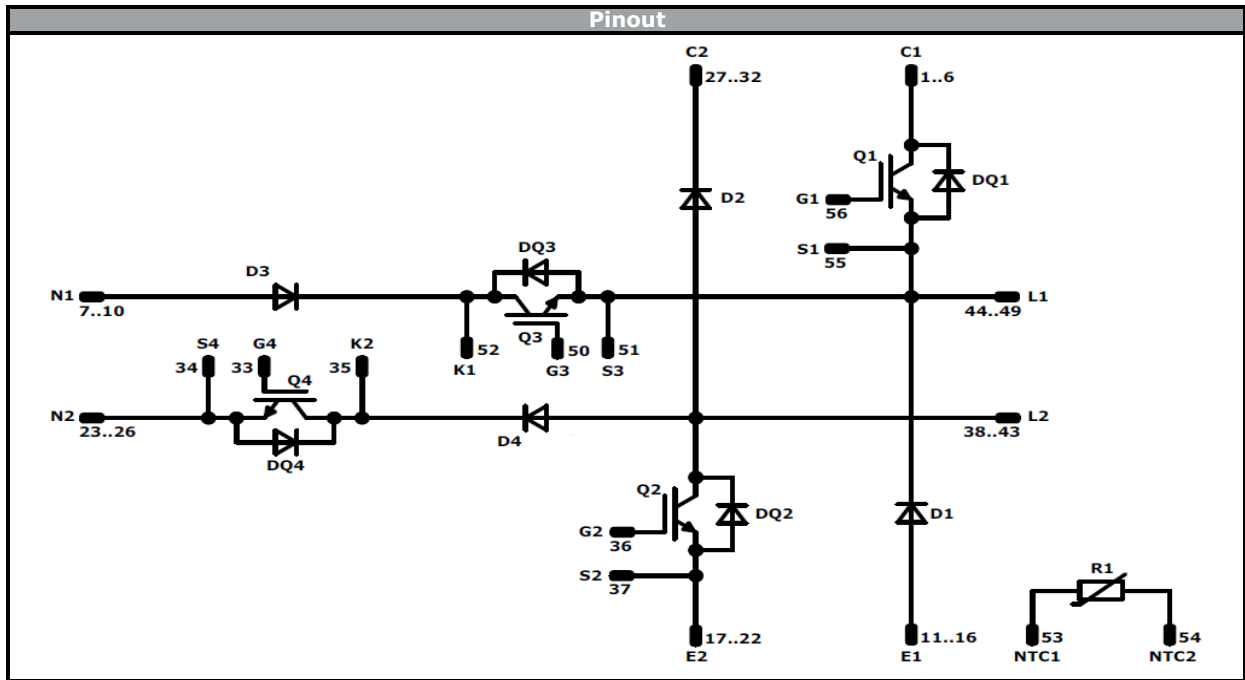
Outline							
Pin table [mm]				Pin table [mm]			
Pin	X	Y	Function	Pin	X	Y	Function
1	70	3	C1	29	2,5	3	C2
2	70	0	C1	30	2,5	0	C2
3	67,5	0	C1	31	0	3	C2
4	65	0	C1	32	0	0	C2
5	62,5	0	C1	33	5,75	19,45	G4
6	60	0	C1	34	5,75	22,45	S4
7	52,75	3	N1	35	12,1	22,7	K2
8	52,75	0	N1	36	19,25	22,85	G2
9	50,25	3	N1	37	17,85	19,85	S2
10	50,25	0	N1	38	2	36	L2
11	43	3	E1	39	4,5	36	L2
12	43	0	E1	40	7	36	L2
13	40,5	3	E1	41	9,5	36	L2
14	40,5	0	E1	42	12	36	L2
15	38	3	E1	43	14,5	36	L2
16	38	0	E1	44	38	36	L1
17	32	3	E2	45	40,5	36	L1
18	32	0	E2	46	43	36	L1
19	29,5	3	E2	47	45,5	36	L1
20	29,5	0	E2	48	48	36	L1
21	27	3	E2	49	50,5	36	L1
22	27	0	E2	50	49,9	32	G3
23	19,75	0	N2	51	52,9	32	S3
24	17,25	0	N2	52	52	18,1	K1
25	14,75	0	N2	53	64,2	36,6	NTC
26	12,25	0	N2	54	70,6	36,55	NTC
27	5	3	C2	55	70	18,9	S1
28	5	0	C2	56	68,55	15,9	G1

Tolerance of pinpositions: ±0.5mm of the end of pins  
Dimension of coordinate axis is only offset without tolerance



Vincotech




<b>Identification</b>					
ID	Component	Voltage	Current	Function	Comment
Q1,Q2	IGBT	1200 V	160 A	Buck Switch	
DQ1,DQ2	FWD	1200 V	7 A	Buck Inverse Diode	
D3,D4	FWD	600 V	120 A	Buck Diode	
Q3,Q4	IGBT	600 V	120 A	Boost Switch	
D1,D2	FWD	1200 V	60 A	Boost Diode	
DQ3,DQ4	FWD	600 V	50 A	Boost Inverse Diode	
R1	NTC			Thermistor	



Packaging instruction			
Standard packaging quantity (SPQ)	36	>SPQ Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow 2</i> packages see vincotech.com website.

Package data
Package data for <i>flow 2</i> packages see vincotech.com website.

UL recognition and file number
This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website. 

Document No.:	Date:	Modification:	Pages
30-FT12NMA160SH-M669F08-D4-14	13 Jun. 2017	New design, packing unit number	All

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.