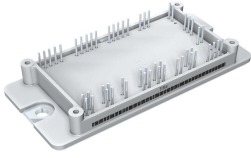
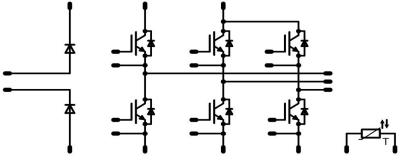


<p>flowPACK 2</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #003366; color: white; margin: 0;">Features</p> <ul style="list-style-type: none"> Inverter, blocking diodes Built-in thermistor IGBT4 technology for low saturation losses </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #003366; color: white; margin: 0;">Target Applications</p> <ul style="list-style-type: none"> Power Regeneration </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #003366; color: white; margin: 0;">Types</p> <ul style="list-style-type: none"> 30-F212R6A150SC-M440E 30-F212R6A150SC01-M440E10 </div>	<p style="text-align: right;">1200 V/150 A</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; background-color: #003366; color: white; margin: 0;">flow 2 housing</p>  </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center; background-color: #003366; color: white; margin: 0;">Schematic</p>  </div>
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Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
D7a,b-D8a,b				
Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}	$T_j=T_{jmax}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	154 208	A
Surge forward current	I_{FSM}	$t_p=10\text{ms}$ $T_j=25^\circ\text{C}$	1270	A
I^2t -value	I^2t		2400	A^2s
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	189 287	W
Maximum Junction Temperature	T_{jmax}		150	$^\circ\text{C}$
T1a-b,T2a-b,T3a-b,T4a-b,T5a-b,T6a-b				
Collector-emitter break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_{jmax}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	110 110	A
Pulsed collector current	I_{Cpulse}	t_p limited by T_{jmax}	450	A
Turn off safe operating area		$V_{CE} \leq 1200\text{V}$, $T_j \leq T_{op max}$	300	A
Power dissipation per IGBT	P_{tot}	$T_j=T_{jmax}$ $T_h=80^\circ\text{C}$ $T_c=80^\circ\text{C}$	400 606	W
Gate-emitter peak voltage	V_{GE}		± 20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^\circ\text{C}$ $V_{GE}=15\text{V}$	10 960	μs V
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit	
D1,D2,D3,D4,D5,D6					
Peak Repetitive Reverse Voltage	V_{RRM}		1200	V	
DC forward current	I_F	$T_j=T_{jmax}$	$T_h=80^{\circ}\text{C}$	64	A
			$T_c=80^{\circ}\text{C}$	84	
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	100	A	
Power dissipation per Diode	P_{tot}	$T_j=T_{jmax}$	$T_h=80^{\circ}\text{C}$	127	W
			$T_c=80^{\circ}\text{C}$	192	
Maximum Junction Temperature	T_{jmax}		175	$^{\circ}\text{C}$	

Thermal Properties

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

Insulation Properties

Insulation voltage	V_{is}	$t=2\text{s}$ DC voltage	4000	V
Creepage distance			min 12,7	mm
Clearance			min 12,7	mm
Comparative tracking index	CTI		>200	

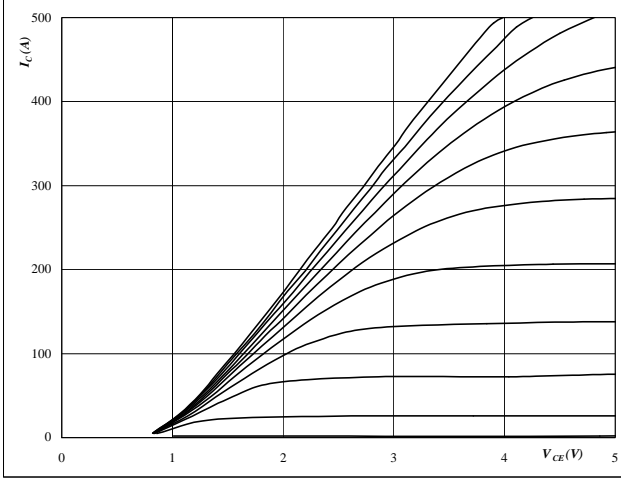
Characteristic Values

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		
D7a,b-D8a,b										
Forward voltage	V_F				100	$T_j=25^\circ C$ $T_j=125^\circ C$	1,12 1,07	1,21		V
Threshold voltage (for power loss calc. only)	V_{to}				100	$T_j=25^\circ C$ $T_j=125^\circ C$	0,89 0,76			V
Slope resistance (for power loss calc. only)	r_t				100	$T_j=25^\circ C$ $T_j=125^\circ C$	2 3			m Ω
Reverse current	I_r			1600		$T_j=25^\circ C$ $T_j=125^\circ C$		0,05		mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Phase-Change Material						0,37		K/W
Thermal resistance chip to heatsink per chip	R_{thJC}							0,24		
T1a-b,T2a-b,T3a-b,T4a-b,T5a-b,T6a-b										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0051	$T_j=25^\circ C$ $T_j=150^\circ C$	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		150	$T_j=25^\circ C$ $T_j=150^\circ C$		1,93 2,31	2,4	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		$T_j=25^\circ C$ $T_j=150^\circ C$			0,02	mA
Gate-emitter leakage current	I_{GES}		20	0		$T_j=25^\circ C$ $T_j=150^\circ C$			1200	nA
Integrated Gate resistor	R_{gint}							1,33		Ω
Turn-on delay time	$t_{d(on)}$	$R_{goff}=2 \Omega$ $R_{gon}=2 \Omega$	± 15	600	150	$T_j=25^\circ C$ $T_j=150^\circ C$		106 110		ns
Rise time	t_r					$T_j=25^\circ C$ $T_j=150^\circ C$		20 23		
Turn-off delay time	$t_{d(off)}$					$T_j=25^\circ C$ $T_j=150^\circ C$		227 307		
Fall time	t_f					$T_j=25^\circ C$ $T_j=150^\circ C$		53 112		
Turn-on energy loss per pulse	E_{on}					$T_j=25^\circ C$ $T_j=150^\circ C$		3,8 5,66		
Turn-off energy loss per pulse	E_{off}	$T_j=25^\circ C$ $T_j=150^\circ C$		8,27 15,32						
Input capacitance	C_{ies}							8310		pF
Output capacitance	C_{oss}	$f=1MHz$	0	25		$T_j=25^\circ C$		615		
Reverse transfer capacitance	C_{rss}							480		
Gate charge	Q_{Gate}		± 15	960	150	$T_j=25^\circ C$		720		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Phase-Change Material						0,24		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,16		
D1,D2,D3,D4,D5,D6										
Diode forward voltage	V_F				50	$T_j=25^\circ C$ $T_j=150^\circ C$	1,1	1,74 1,77	2,3	V
Peak reverse recovery current	I_{RRM}					$T_j=25^\circ C$ $T_j=150^\circ C$		168,76 183,3		A
Reverse recovery time	t_{rr}	$R_{gon}=2 \Omega$	± 15	600	150	$T_j=25^\circ C$ $T_j=150^\circ C$		109,9 129,9		ns
Reverse recovered charge	Q_{rr}					$T_j=25^\circ C$ $T_j=150^\circ C$		10,1 15,84		
Peak rate of fall of recovery current	$di(rec)max/dt$					$T_j=25^\circ C$ $T_j=150^\circ C$		6851 4547		
Reverse recovered energy	E_{rec}	$T_j=25^\circ C$ $T_j=150^\circ C$		4,72 7,42		mWs				
Thermal resistance chip to heatsink per chip	R_{thJH}	Phase-Change Material						0,75		K/W
Thermal resistance chip to case per chip	R_{thJC}							0,49		
Thermistor										
Rated resistance	R					$T_j=25^\circ C$		22000		Ω
Deviation of R100	$\Delta R/R$	R100=1486 Ω				T=100 $^\circ C$	-12		14	%
Power dissipation	P					Tc=100 $^\circ C$		200		mW
Power dissipation constant						$T_j=25^\circ C$		2		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 3\%$				$T_j=25^\circ C$		3950		K
B-value	$B_{(25/100)}$	Tol. $\pm 3\%$				$T_j=25^\circ C$		3998		K
Vincotech NTC Reference						$T_j=25^\circ C$			B	

T1a,b,c-T6a,b,c/D1-D6
Figure 1 T1a,b,c-T6a,b,c IGBT

Typical output characteristics

$I_C = f(V_{CE})$

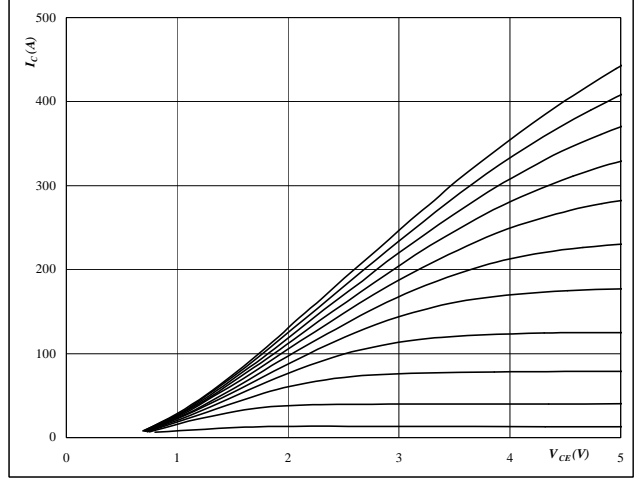


At
 $t_p = 250 \mu s$
 $T_j = 25 \text{ } ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 2 T1a,b,c-T6a,b,c IGBT

Typical output characteristics

$I_C = f(V_{CE})$

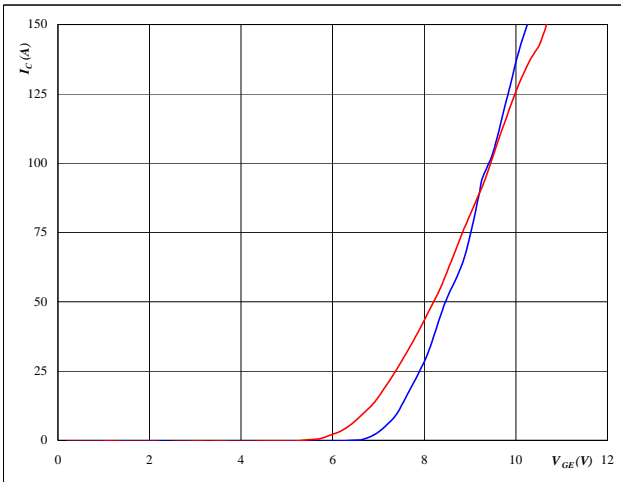


At
 $t_p = 250 \mu s$
 $T_j = 150 \text{ } ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

Figure 3 T1a,b,c-T6a,b,c IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

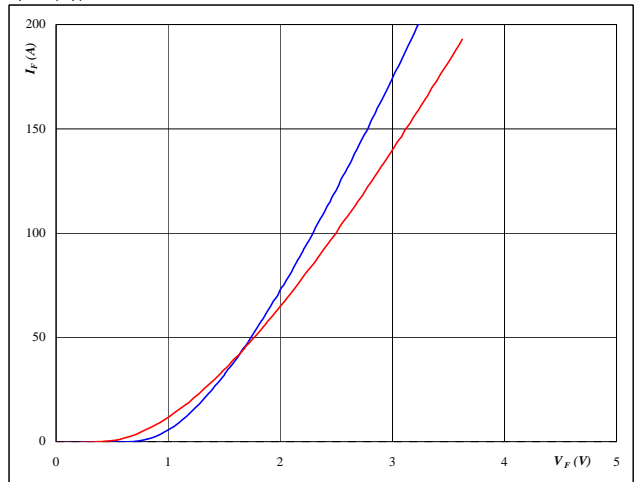


At
 $T_j = 25/150 \text{ } ^\circ C$
 $t_p = 250 \mu s$
 $V_{CE} = 10 \text{ V}$

Figure 4 D1-D6 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$

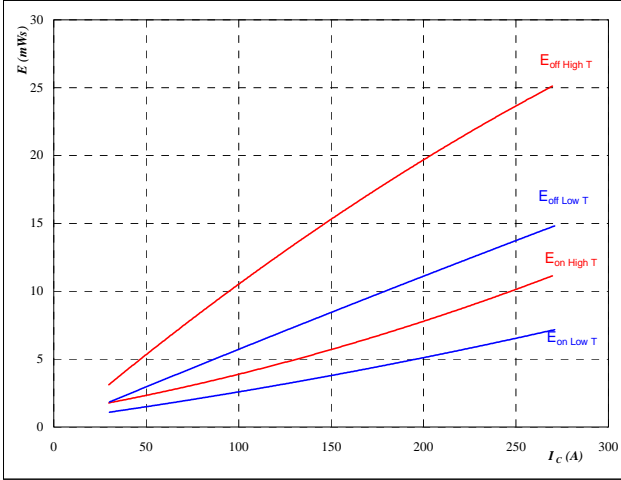


At
 $T_j = 25/150 \text{ } ^\circ C$
 $t_p = 250 \mu s$

T1a,b,c-T6a,b,c/D1-D6
Figure 5 T1a,b,c-T6a,b,c IGBT

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

$E = f(I_C)$



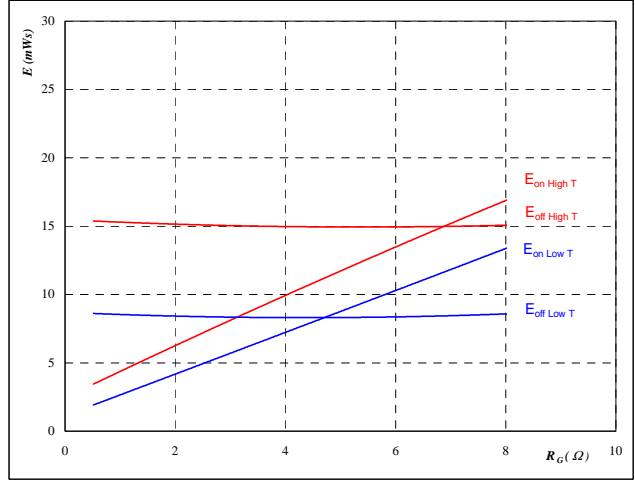
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	2	Ω
$R_{goff} =$	2	Ω

Figure 6 T1a,b,c-T6a,b,c IGBT

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

$E = f(R_G)$



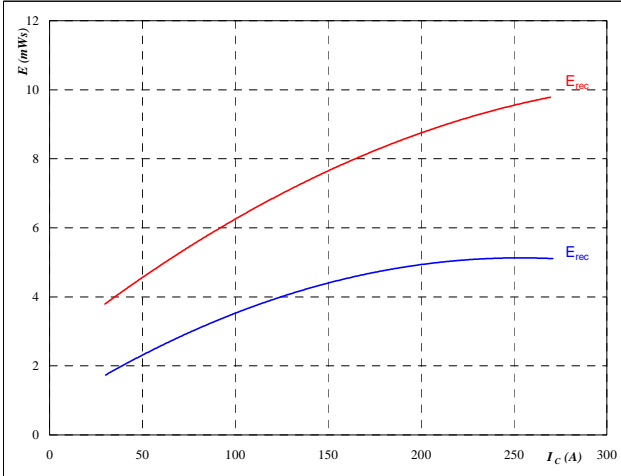
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	149	A

Figure 7 D1-D6 FWD

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

$E_{rec} = f(I_C)$



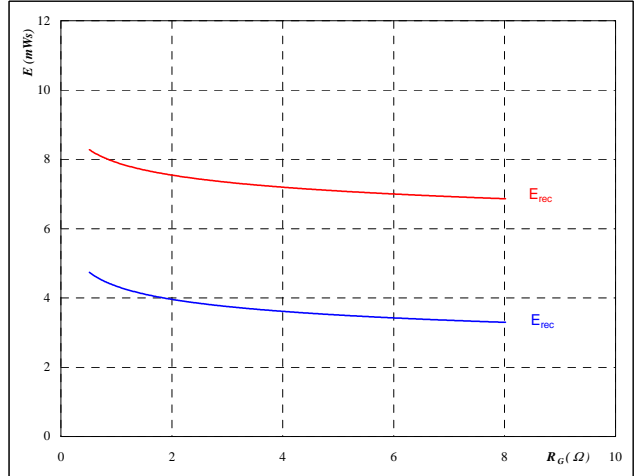
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	2	Ω

Figure 8 D1-D6 FWD

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

$E_{rec} = f(R_G)$



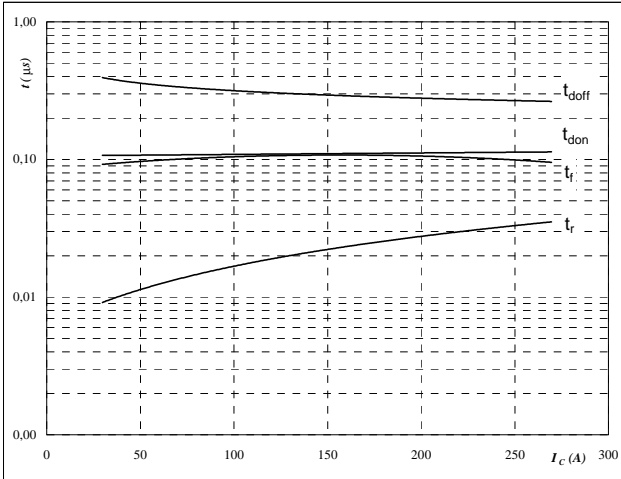
With an inductive load at

$T_J =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	149	A

T1a,b,c-T6a,b,c/D1-D6
Figure 9 T1a,b,c-T6a,b,c IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



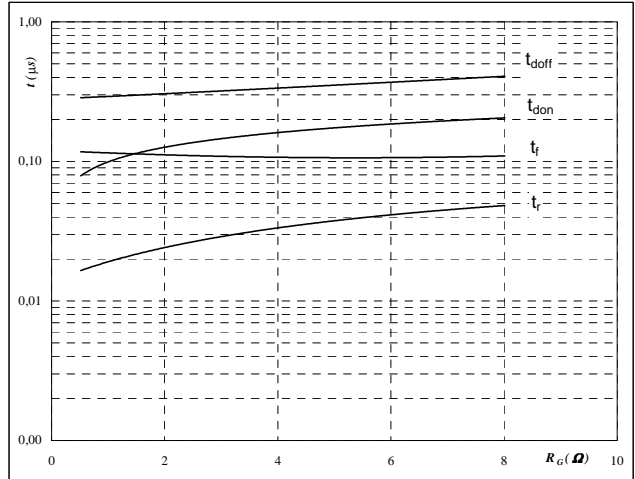
With an inductive load at

$T_J =$	150	$^{\circ}C$
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$R_{gon} =$	2	Ω
$R_{goff} =$	2	Ω

Figure 10 T1a,b,c-T6a,b,c IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



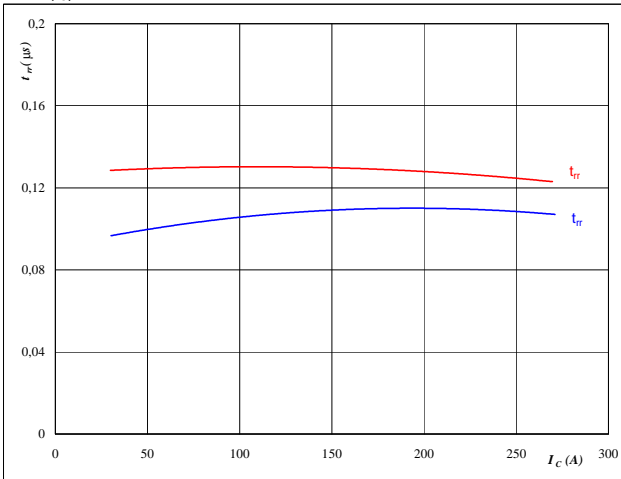
With an inductive load at

$T_J =$	150	$^{\circ}C$
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$I_C =$	149	A

Figure 11 D1-D6 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

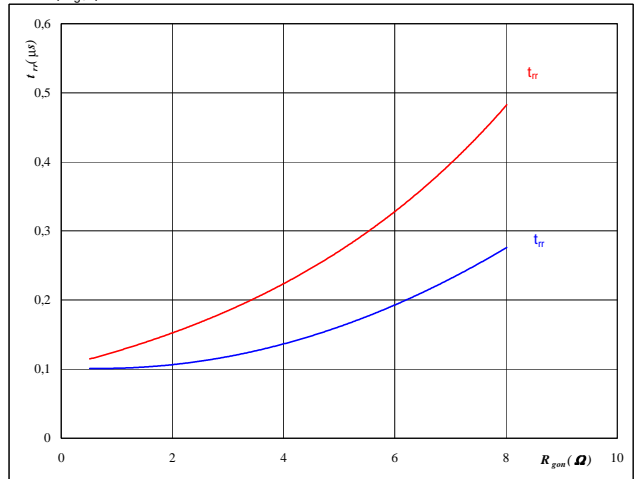

At

$T_J =$	25/150	$^{\circ}C$
$V_{CE} =$	600	V
$V_{GE} =$	± 15	V
$R_{gon} =$	2	Ω

Figure 12 D1-D6 FWD

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

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

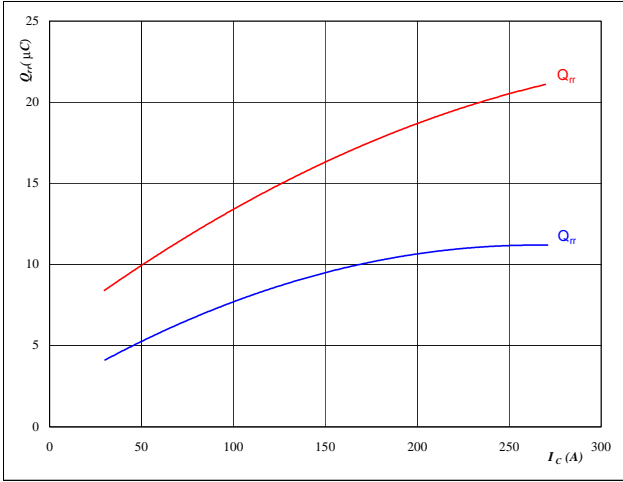

At

$T_J =$	25/150	$^{\circ}C$
$V_R =$	600	V
$I_F =$	149	A
$V_{GE} =$	± 15	V

T1a,b,c-T6a,b,c/D1-D6
Figure 13 D1-D6 FWD

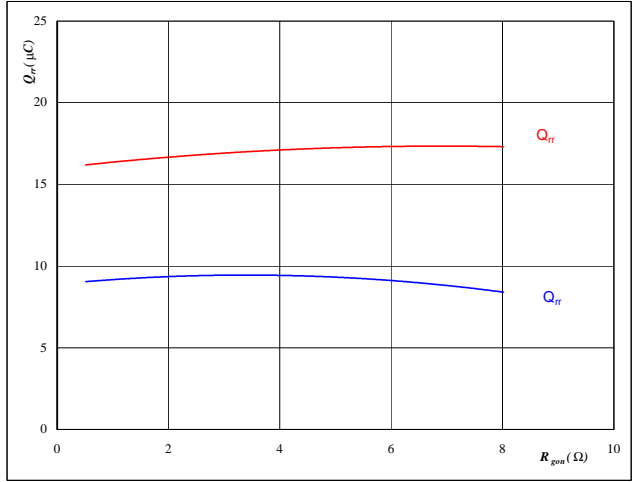
Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$


At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 2 \text{ } \Omega$
Figure 14 D1-D6 FWD

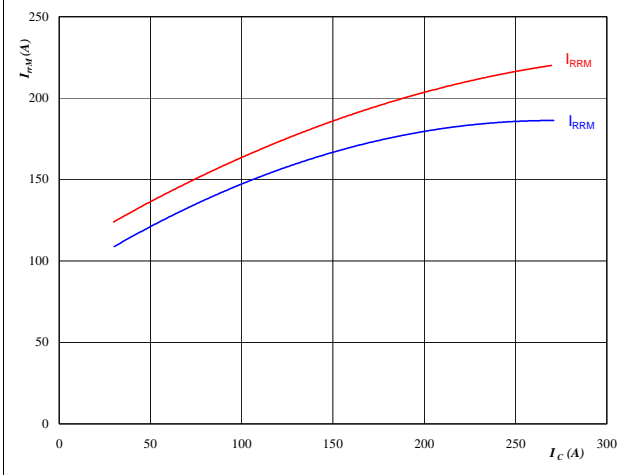
Typical reverse recovery charge as a function of IGBT turn on gate resistor

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


At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_R = 600 \text{ V}$
 $I_F = 149 \text{ A}$
 $V_{GE} = \pm 15 \text{ V}$
Figure 15 D1-D6 FWD

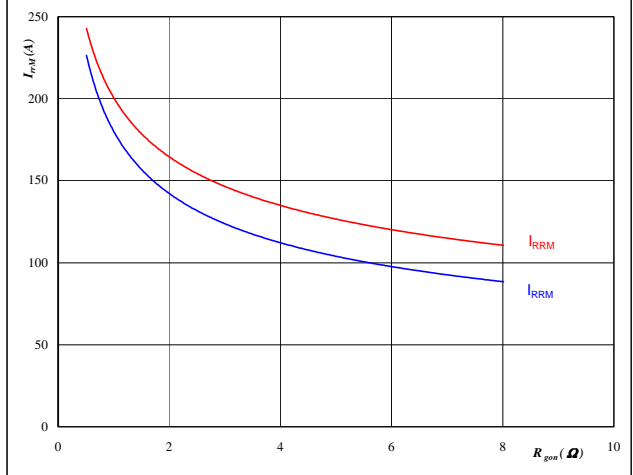
Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$


At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 2 \text{ } \Omega$
Figure 16 D1-D6 FWD

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

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

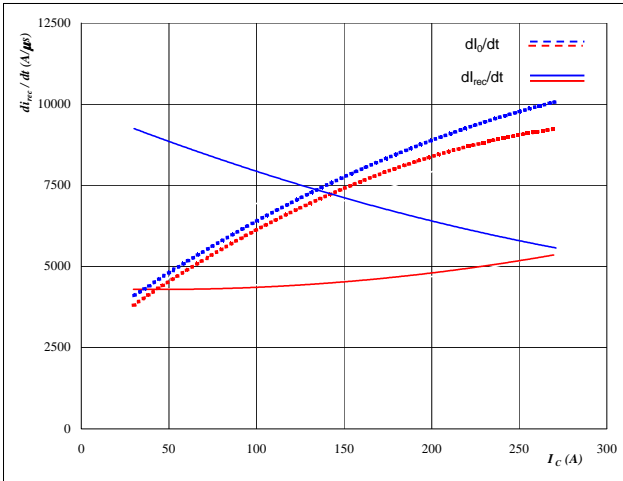

At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_R = 600 \text{ V}$
 $I_F = 149 \text{ A}$
 $V_{GE} = \pm 15 \text{ V}$

T1a,b,c-T6a,b,c/D1-D6

Figure 17 D1-D6 FWD

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

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

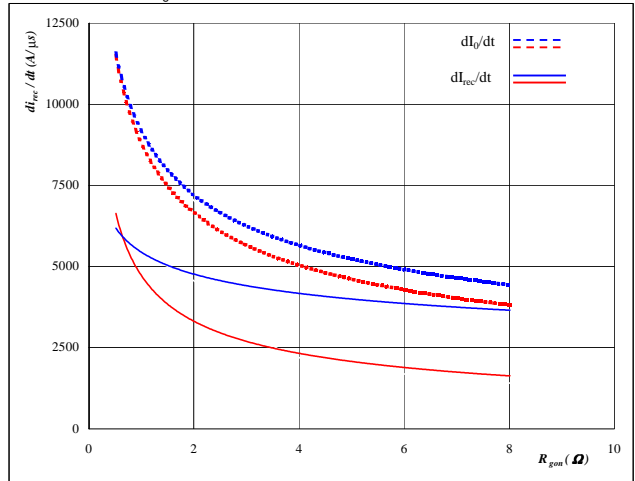


At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 2 \text{ } \Omega$

Figure 18 D1-D6 FWD

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

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

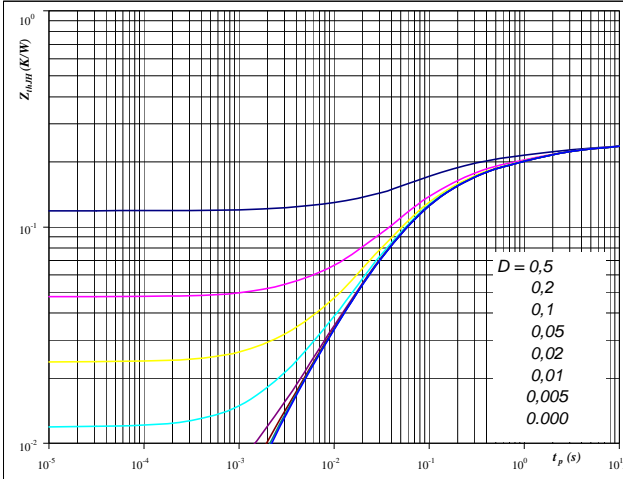


At
 $T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_R = 600 \text{ V}$
 $I_F = 149 \text{ A}$
 $V_{GE} = \pm 15 \text{ V}$

Figure 19 T1a,b,c-T6a,b,c IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At
 $D = t_p / T$
 $R_{thJH} = 0,24 \text{ K/W}$ $R_{thJH} = 0,23 \text{ K/W}$

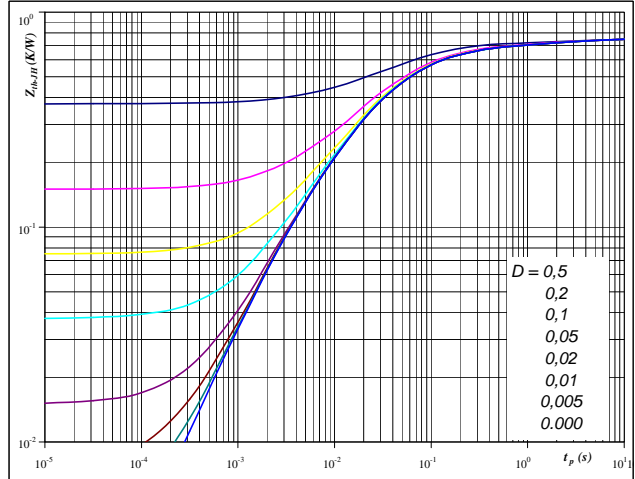
IGBT thermal model values

Phase-Change Material	R (C/W)	Tau (s)
	0,04	2,9E+00
	0,04	6,2E-01
	0,08	1,3E-01
	0,07	3,3E-02
	0,01	4,2E-03

Figure 20 D1-D6 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At
 $D = t_p / T$
 $R_{thJH} = 0,75 \text{ K/W}$ $R_{thJH} = 0,73 \text{ K/W}$

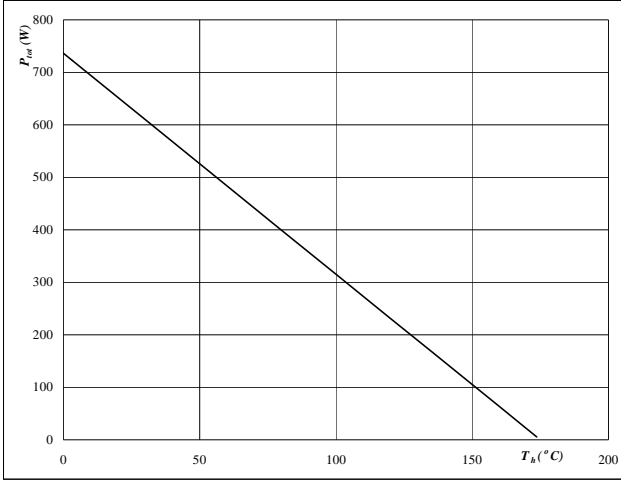
FWD thermal model values

Phase-Change Material	R (C/W)	Tau (s)
	0,04	3,6E+00
	0,07	6,2E-01
	0,25	8,6E-02
	0,32	2,1E-02
	0,06	3,5E-03

T1a,b,c-T6a,b,c/D1-D6
Figure 21 T1a,b,c-T6a,b,c IGBT

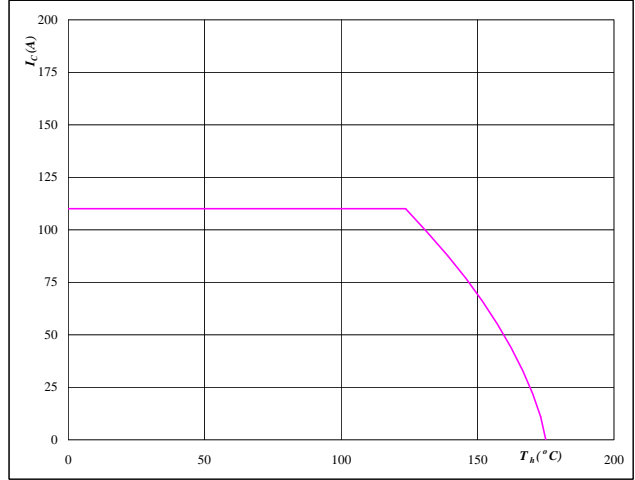
Power dissipation as a function of heatsink temperature

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


At
 $T_j = 175 \text{ } ^\circ\text{C}$
Figure 22 T1a,b,c-T6a,b,c IGBT

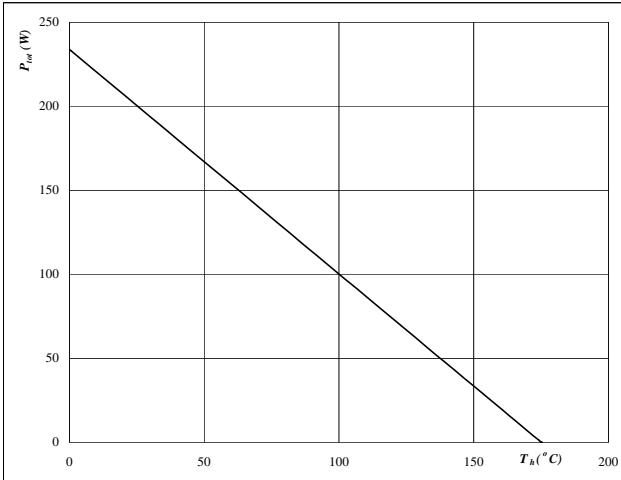
Collector current as a function of heatsink temperature

$$I_C = f(T_h)$$


At
 $T_j = 175 \text{ } ^\circ\text{C}$
 $V_{GE} = 15 \text{ V}$
Figure 23 D1-D6 FWD

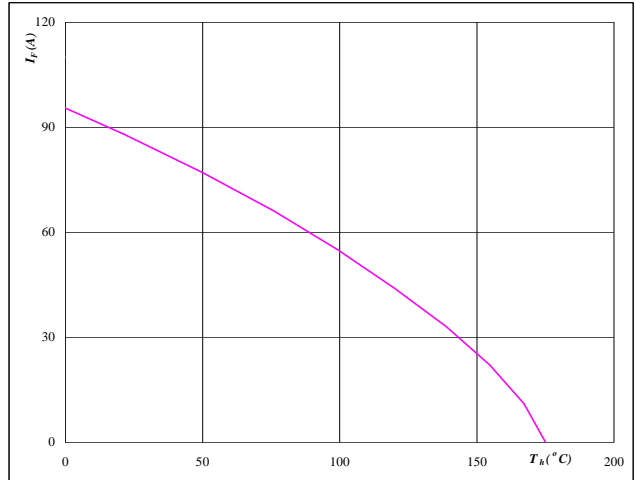
Power dissipation as a function of heatsink temperature

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

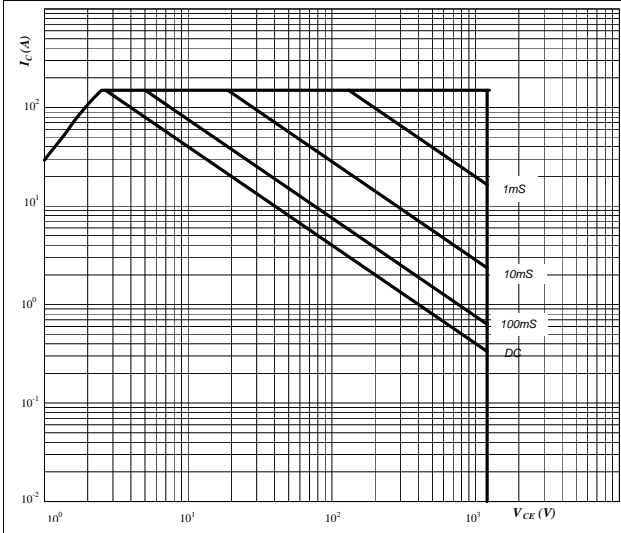

At
 $T_j = 175 \text{ } ^\circ\text{C}$
Figure 24 D1-D6 FWD

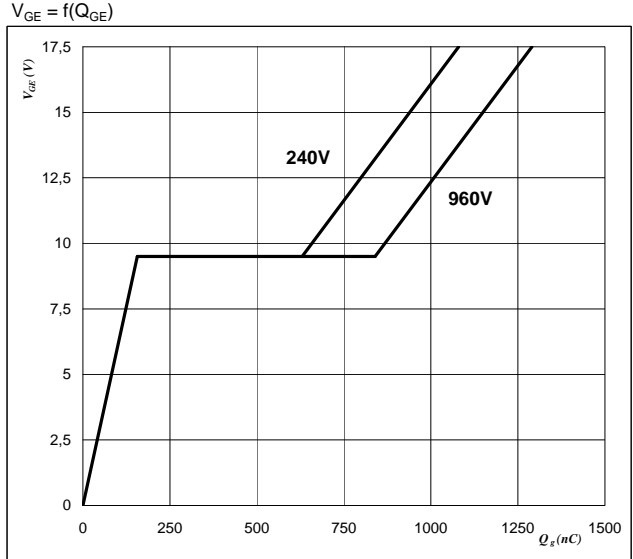
Forward current as a function of heatsink temperature

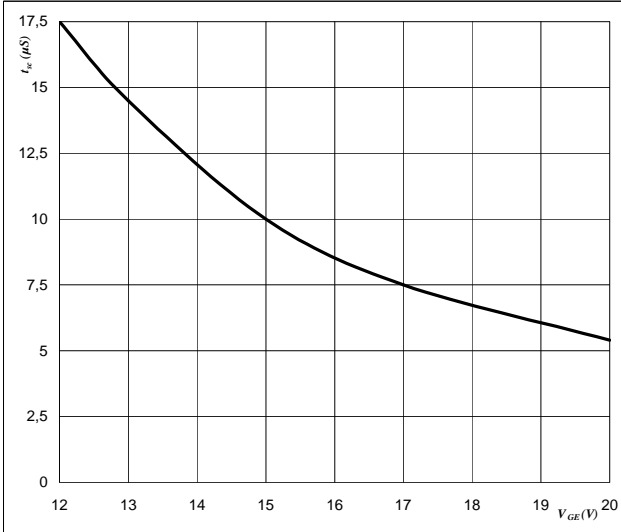
$$I_F = f(T_h)$$


At
 $T_j = 175 \text{ } ^\circ\text{C}$

T1a,b,c-T6a,b,c/D1-D6
Figure 25 T1a,b,c-T6a,b,c IGBT

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

At
 D = single pulse
 $T_h = 80 \text{ } ^\circ\text{C}$
 $V_{GE} = \pm 15 \text{ V}$
 $T_j = T_{jmax} \text{ } ^\circ\text{C}$
Figure 26 T1a,b,c-T6a,b,c IGBT

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

At
 $I_C = 149 \text{ A}$
Figure 27 T1a,b,c-T6a,b,c IGBT

Short circuit withstand time as a function of gate-emitter voltage
 $t_{sc} = f(V_{GE})$

At
 $V_{CE} = 1200 \text{ V}$
 $T_j \leq 175 \text{ } ^\circ\text{C}$
Figure 28 T1a,b,c-T6a,b,c IGBT

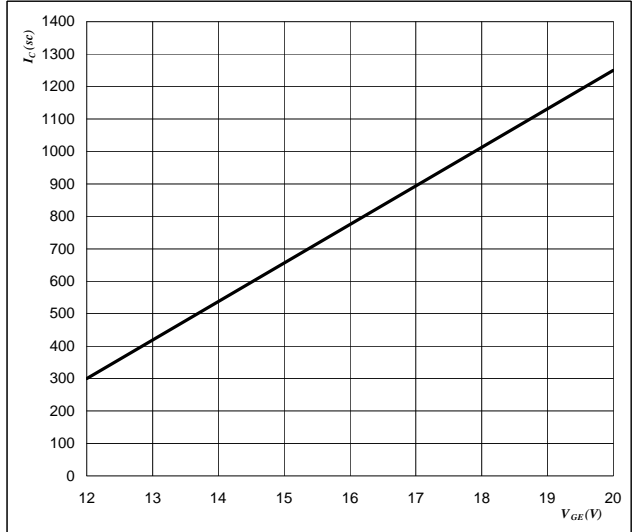
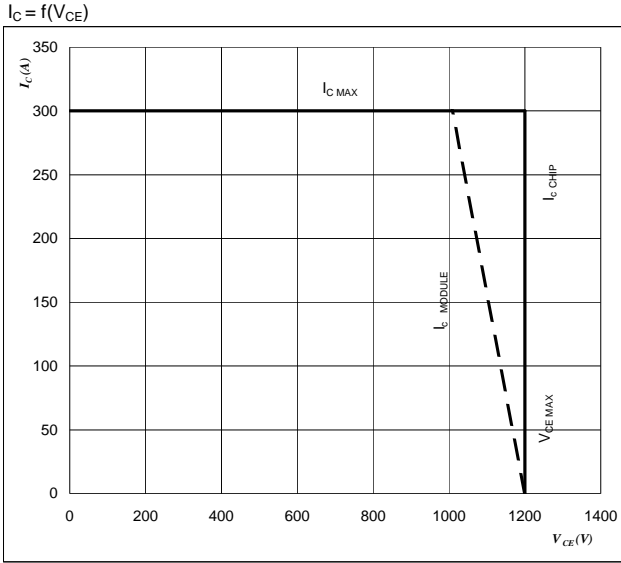
Typical short circuit collector current as a function of gate-emitter voltage
 $V_{GE} = f(Q_{GE})$

At
 $V_{CE} \leq 1200 \text{ V}$
 $T_j = 175 \text{ } ^\circ\text{C}$

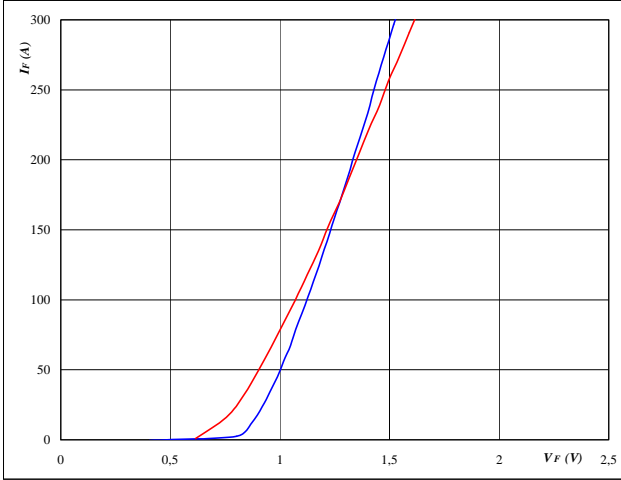
Figure 29 T1a,b,c-T6a,b,c IGBT

Reverse bias safe operating area

At
 $T_J = 150\ ^\circ\text{C}$
 $R_{gon} = 2\ \Omega$
 $R_{goff} = 2\ \Omega$

D7a,b-D8a,b
Figure 1 D7a,b-D8a,b

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

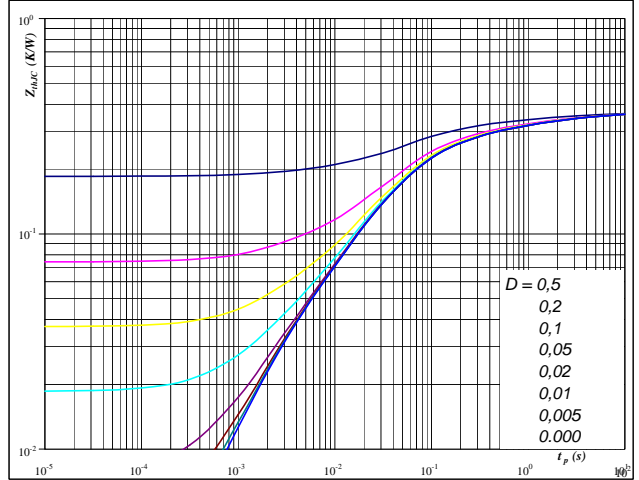


At
 $T_j = 25/125$ °C
 $t_p = 250$ μs

Figure 2 D7a,b-D8a,b

Diode transient thermal impedance as a function of pulse width

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

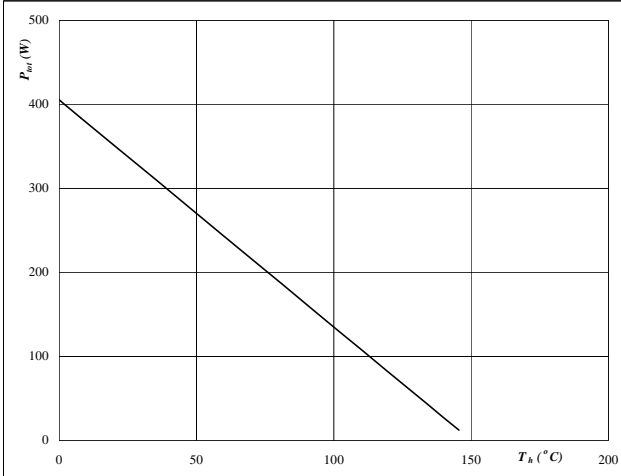


At
 $D = t_p / T$
 $R_{thJH} = 0,37$ K/W

Figure 3 D7a,b-D8a,b

Power dissipation as a function of heatsink temperature

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

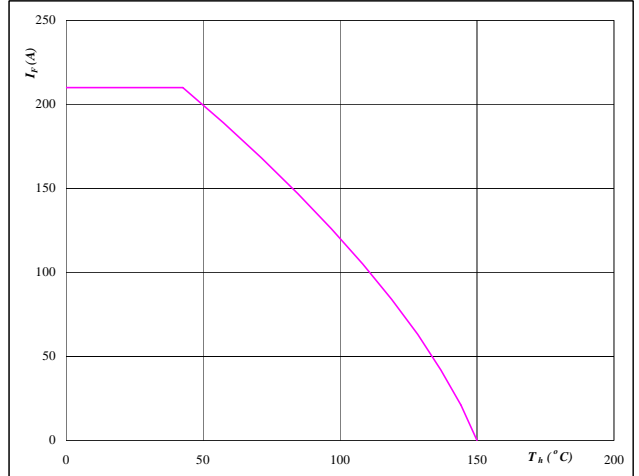


At
 $T_j = 150$ °C

Figure 4 D7a,b-D8a,b

Forward current as a function of heatsink temperature

$$I_F = f(T_h)$$



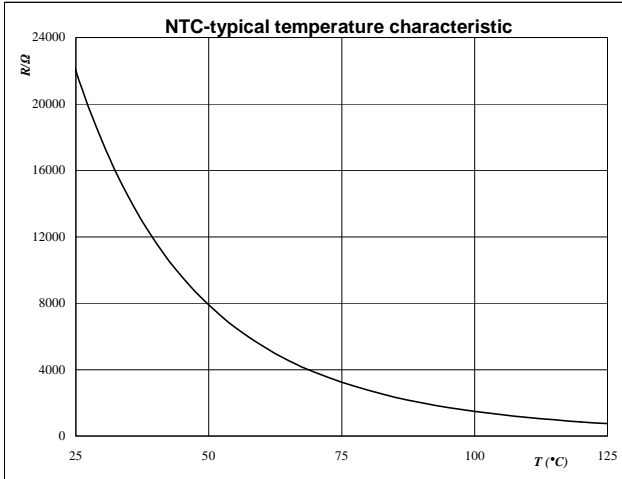
At
 $T_j = 150$ °C

Thermistor

Figure 1 Thermistor

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

$$R_T = f(T)$$

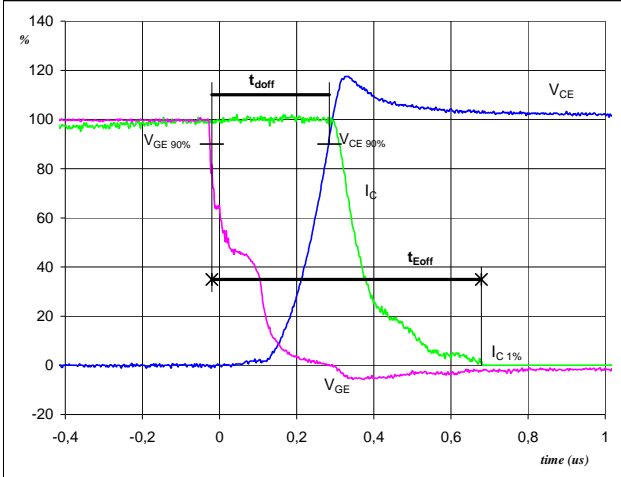


Switching Definitions Output Inverter

General conditions

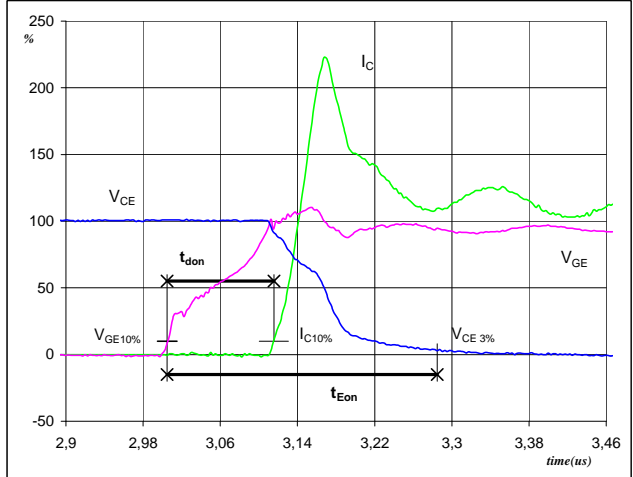
T_j	=	150 °C
R_{gon}	=	2 Ω
R_{goff}	=	2 Ω

Figure 1 T1a,b,c-T6a,b,c IGBT

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


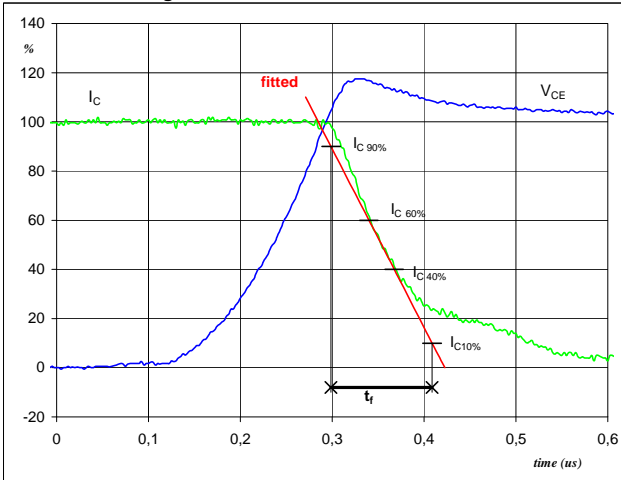
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	149	A
$t_{doff} =$	0,31	μs
$t_{Eoff} =$	0,70	μs

Figure 2 T1a,b,c-T6a,b,c IGBT

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


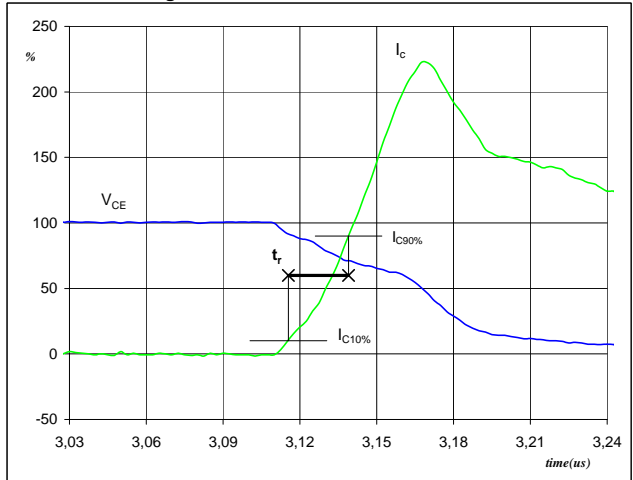
$V_{GE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	149	A
$t_{don} =$	0,11	μs
$t_{Eon} =$	0,28	μs

Figure 3 T1a,b,c-T6a,b,c IGBT

Turn-off Switching Waveforms & definition of t_f


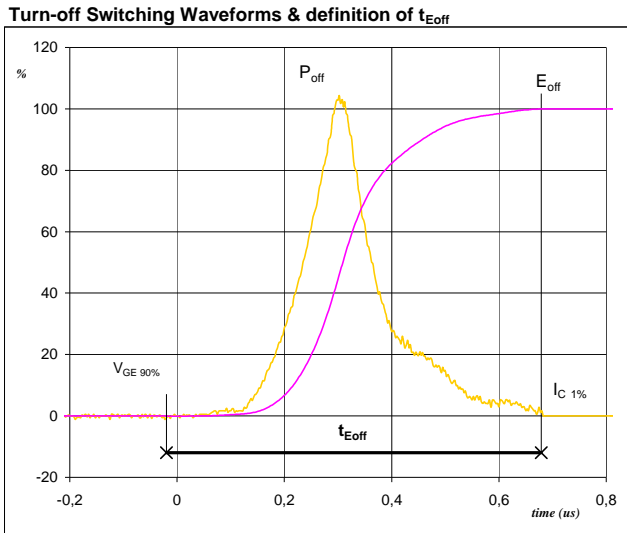
$V_C(100\%) =$	600	V
$I_C(100\%) =$	149	A
$t_f =$	0,11	μs

Figure 4 T1a,b,c-T6a,b,c IGBT

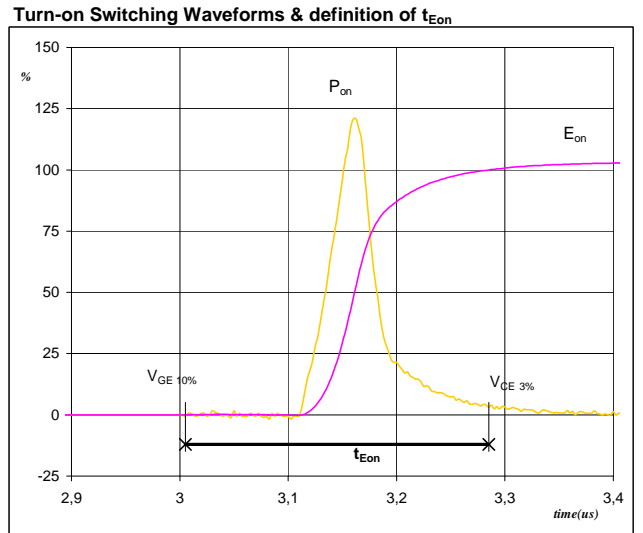
Turn-on Switching Waveforms & definition of t_r


$V_C(100\%) =$	600	V
$I_C(100\%) =$	149	A
$t_r =$	0,02	μs

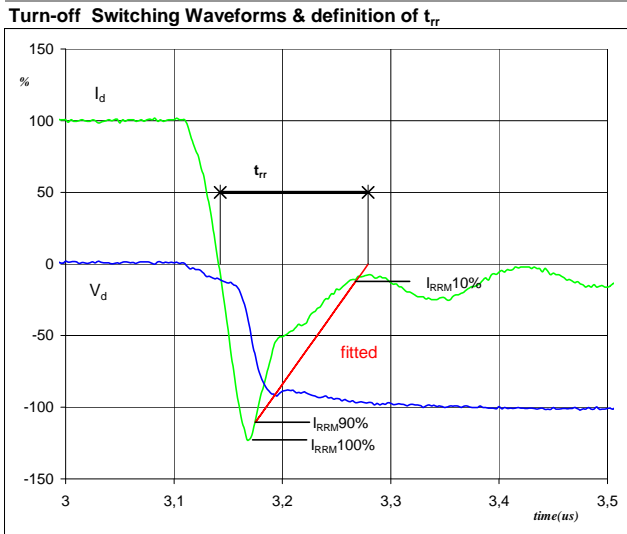
Switching Definitions Output Inverter

Figure 5 T1a,b,c-T6a,b,c IGBT


$P_{off}(100\%) = 89,22 \text{ kW}$
 $E_{off}(100\%) = 15,32 \text{ mJ}$
 $t_{Eoff} = 0,70 \text{ }\mu\text{s}$

Figure 6 T1a,b,c-T6a,b,c IGBT


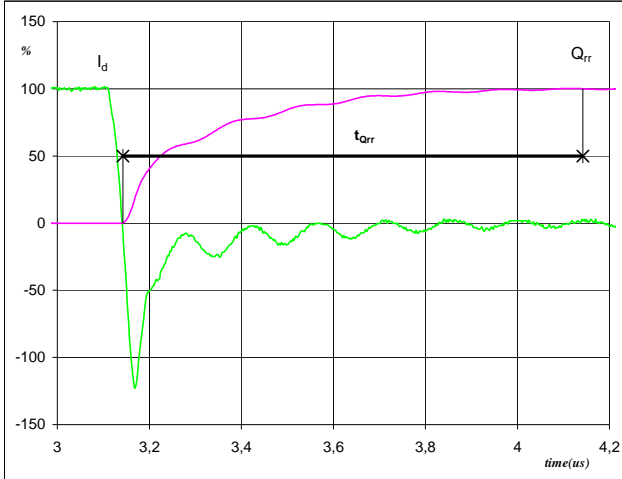
$P_{on}(100\%) = 89,22 \text{ kW}$
 $E_{on}(100\%) = 5,66 \text{ mJ}$
 $t_{Eon} = 0,28 \text{ }\mu\text{s}$

Figure 7 D1,D2,D3,D4,D5,D6 FWD


$V_d(100\%) = 600 \text{ V}$
 $I_d(100\%) = 149 \text{ A}$
 $I_{RRM}(100\%) = -183 \text{ A}$
 $t_{rr} = 0,13 \text{ }\mu\text{s}$

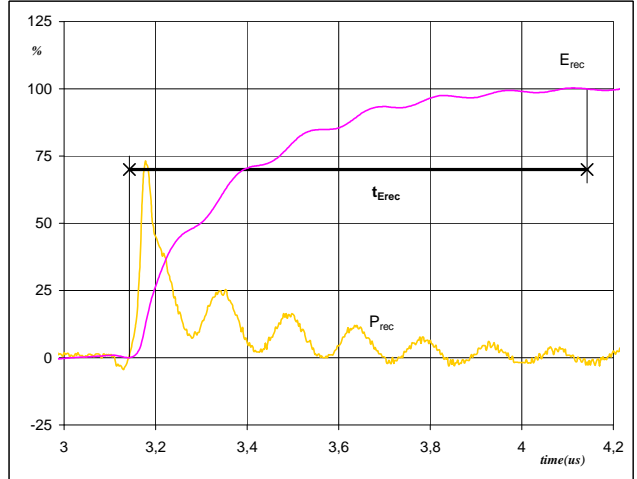
Switching Definitions Output Inverter

Figure 8 D1,D2,D3,D4,D5,D6 FWD

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


I_d (100%) =	149	A
Q_{rr} (100%) =	15,84	μC
t_{Qrr} =	1,00	μs

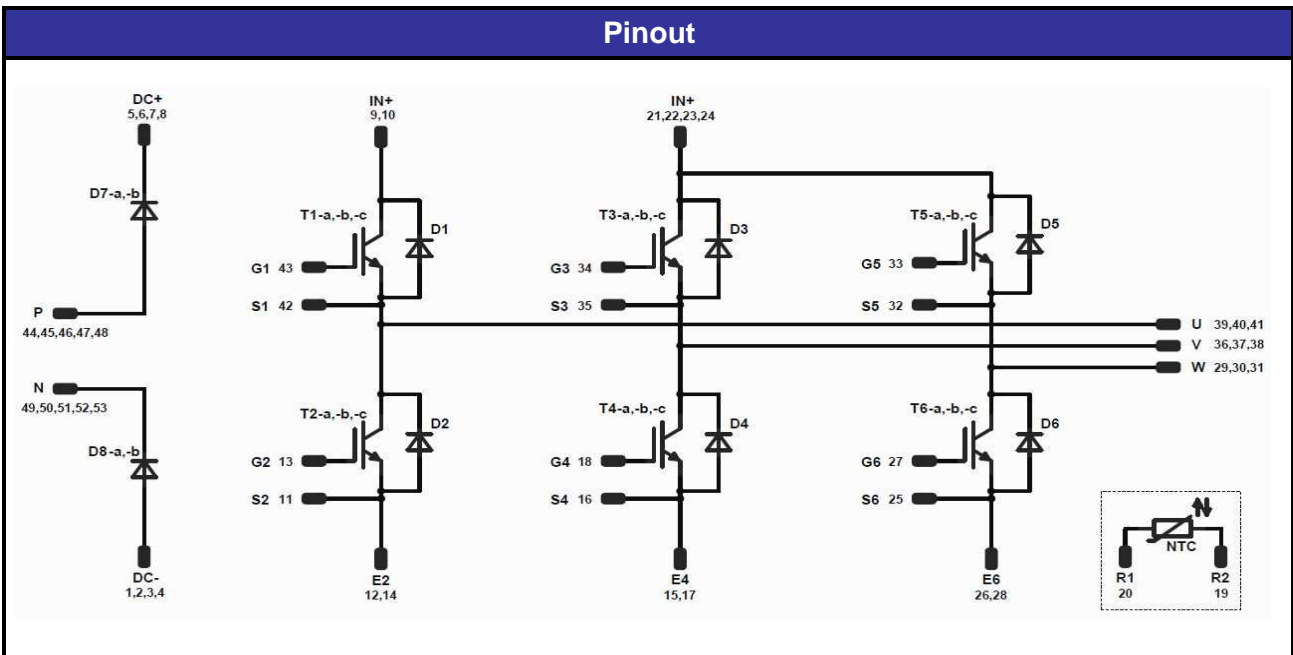
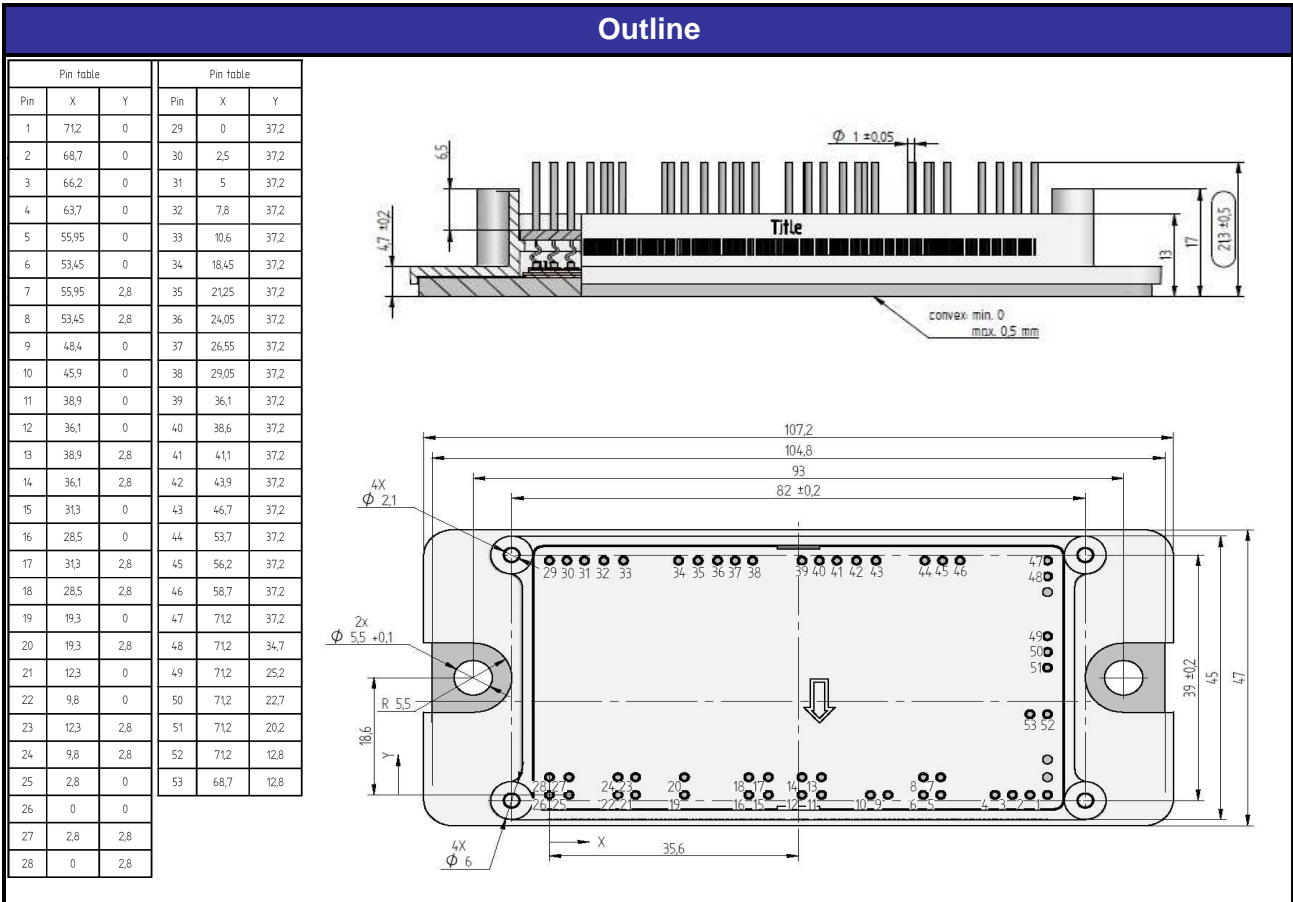
Figure 9 D1,D2,D3,D4,D5,D6 FWD

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


P_{rec} (100%) =	89,22	kW
E_{rec} (100%) =	7,42	mJ
t_{Erec} =	1,00	μs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking			
Version	Ordering Code	in DataMatrix as	in packaging barcode as
17mm housing	30-F212R6A150SC-M440E	M440-E	M440-E
17mm housing, without thermistor	30-F212R6A150SC01-M440E10	M440-E10	M440-E10



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