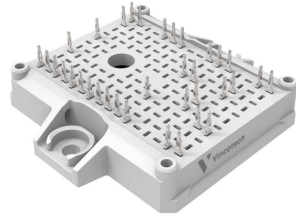
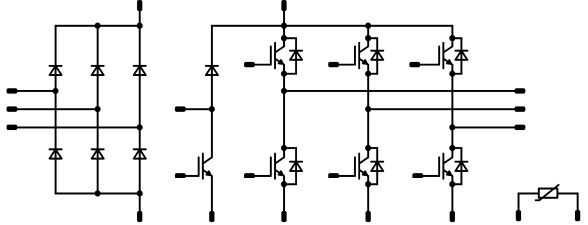




Vincotech

<i>flowPIM E2</i>	1200 V / 15 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Features</b></div> <ul style="list-style-type: none"> <li>IGBT M7 with low <math>V_{CEsat}</math> and improved EMC behavior</li> <li>Standard industrial housing</li> <li>Optimized <math>R_{th(j-s)}</math> with Phase Change Material</li> <li>Built-in NTC</li> </ul>	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>flow E2 12 mm housing</b></div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Target applications</b></div> <ul style="list-style-type: none"> <li>Industrial Drives</li> </ul>	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Schematic</b></div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;"><b>Types</b></div> <ul style="list-style-type: none"> <li>10-EY12PMA015M7-L186A78T</li> </ul>	

## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Inverter Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current	$I_C$		15	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	30	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	64	W
Gate-emitter voltage	$V_{GES}$		$\pm 20$	V
Maximum junction temperature	$T_{jmax}$		175	°C



Vincotech

## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
<b>Inverter Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Continuous (direct) forward current	$I_F$		15	A
Repetitive peak forward current	$I_{FRM}$	$T_j$ limited by $T_{jmax}$	30	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	51	W
Maximum junction temperature	$T_{jmax}$		175	°C
<b>Brake Switch</b>				
Collector-emitter voltage	$V_{CES}$		1200	V
Collector current	$I_C$		15	A
Repetitive peak collector current	$I_{CRM}$	$t_p$ limited by $T_{jmax}$	30	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	64	W
Gate-emitter voltage	$V_{GES}$		±20	V
Maximum junction temperature	$T_{jmax}$		175	°C
<b>Brake Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1200	V
Continuous (direct) forward current	$I_F$		10	A
Repetitive peak forward current	$I_{FRM}$	$T_j$ limited by $T_{jmax}$	20	A
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	43	W
Maximum junction temperature	$T_{jmax}$		175	°C
<b>Rectifier Diode</b>				
Peak repetitive reverse voltage	$V_{RRM}$		1600	V
Continuous (direct) forward current	$I_F$		35	A
Surge (non-repetitive) forward current	$I_{FSM}$	50 Hz Single Half Sine Wave $T_j = 150\text{ °C}$	270	A
Surge current capability	$I^2t$	$t_p = 10\text{ ms}$	370	A <sup>2</sup> s
Total power dissipation	$P_{tot}$	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	58	W
Maximum junction temperature	$T_{jmax}$		150	°C



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## Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
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### Module Properties

#### Thermal Properties

Storage temperature	$T_{stg}$		-40...+125	°C
Operation temperature under switching condition	$T_{top}$		-40...(T <sub>max</sub> - 25)	°C

#### Isolation Properties

Isolation voltage	$V_{isol}$	DC Test Voltage* $t_p = 2\text{ s}$	6000	V
		AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			min. 12,7	mm
Clearance			8,83	mm
Comparative Tracking Index	CTI		≥ 600	

\*100 % tested in production



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## Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
		$V_{GS}$ [V]	$V_{GE}$ [V]	$V_{DS}$ [V]	$I_D$ [A]	$T_j$ [°C]	Min	Typ	Max	

### Inverter Switch

#### Static

Parameter	Symbol	$V_{GS}$ [V]	$V_{GE}$ [V]	$V_{DS}$ [V]	$I_D$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Gate-emitter threshold voltage	$V_{GE(th)}$		10		0,0015	25	5,4	6,0	6,6	V
Collector-emitter saturation voltage	$V_{CESat}$	15			15	25 125 150		1,70 1,95 2,01	2,15	V
Collector-emitter cut-off current	$I_{CES}$	0		1200		25			60	μA
Gate-emitter leakage current	$I_{GES}$	20	0			25			500	nA
Internal gate resistance	$r_g$							none		Ω
Input capacitance	$C_{ies}$							2900		pF
Output capacitance	$C_{oes}$	0		10		25		120		
Reverse transfer capacitance	$C_{res}$							34		
Gate charge	$Q_g$		15	600	15	25		110		nC

#### Thermal

Parameter	Symbol	Value	Unit
Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4 \text{ W/mK}$ (PSX)	K/W

#### Dynamic

Parameter	Symbol	$R_{gon}$	$R_{goff}$	$V_{GS}$ [V]	$V_{GE}$ [V]	$V_{DS}$ [V]	$I_D$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Turn-on delay time	$t_{d(on)}$	$R_{gon} = 32 \Omega$ $R_{goff} = 32 \Omega$		±15	600	15			25	196		ns
Rise time	$t_r$								125	191		
Turn-off delay time	$t_{d(off)}$								150	190		
Fall time	$t_f$								25	60		
Turn-on energy (per pulse)*	$E_{on}$								25	1,69		mWs
Turn-off energy (per pulse)*	$E_{off}$								125	2,11		
									150	2,21		
									25	0,987		
									125	1,33		
									150	1,41		

\*  $L_s = 10 \text{ nH}$



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## Characteristic Values

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

### Inverter Diode

#### Static

Forward voltage	$V_F$				15	25 125 150		1,63 1,74 1,73	2,1	V
Reverse leakage current	$I_R$			1200		25			30	μA

#### Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,88		K/W
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#### Dynamic

Peak recovery current	$I_{RRM}$					25 125 150		9 11 11		A
Reverse recovery time	$t_{rr}$					25 125 150		286 422 471		ns
Recovered charge	$Q_r$	$di/dt = 181$ A/μs $di/dt = 205$ A/μs $di/dt = 175$ A/μs	±15	600	15	25 125 150		1,50 2,46 2,68		μC
Reverse recovered energy	$E_{rec}$					25 125 150		0,497 0,913 1,00		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$					25 125 150		77 49 44		A/μs



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## Characteristic Values

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

### Brake Switch

#### Static

Gate-emitter threshold voltage	$V_{GE(th)}$			10	0,0015	25	5,4	6,0	6,6	V
Collector-emitter saturation voltage	$V_{CEsat}$	15			15	25 125 150		1,70 1,95 2,01	2,15	V
Collector-emitter cut-off current	$I_{CES}$	0		1200		25			60	μA
Gate-emitter leakage current	$I_{GES}$	20		0		25			500	nA
Internal gate resistance	$r_g$							none		Ω
Input capacitance	$C_{ies}$							2900		pF
Output capacitance	$C_{oes}$	0		10		25		120		
Reverse transfer capacitance	$C_{res}$							34		
Gate charge	$Q_g$	15		600	15	25		110		nC

#### Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)						1,49		K/W
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#### Dynamic

Turn-on delay time	$t_{d(on)}$					25 125 150		300 262 253		ns
Rise time	$t_r$	$R_{gon} = 32$ Ω $R_{goff} = 32$ Ω				25 125 150		194 205 209		
Turn-off delay time	$t_{d(off)}$					25 125 150		388 428 438		
Fall time	$t_f$		0 / 15	600	15	25 125 150		67 87 89		
Turn-on energy (per pulse)	$E_{on}$	$Q_{tFWD} = 1,1$ μC $Q_{tFWD} = 1,8$ μC $Q_{tFWD} = 2$ μC				25 125 150		2,50 3,01 3,19		mWs
Turn-off energy (per pulse)	$E_{off}$					25 125 150		1,12 1,44 1,54		



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### Characteristic Values

Parameter	Symbol	Conditions					Value			Unit
		$V_{GE}$ [V]	$V_{CE}$ [V]	$I_C$ [A]	$T_j$ [°C]	Min	Typ	Max		

#### Brake Diode

##### Static

Parameter	Symbol	$V_{GE}$ [V]	$V_{CE}$ [V]	$I_C$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Forward voltage	$V_F$			10	25 125 150		1,61 1,69 1,69	2,1	V
Reverse leakage current	$I_R$		1200		25			25	μA

##### Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)					2,19		K/W
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##### Dynamic

Parameter	Symbol	$V_{GE}$ [V]	$V_{CE}$ [V]	$I_C$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Peak recovery current	$I_{RRM}$				25 125 150		6 7 7		A
Reverse recovery time	$t_{rr}$				25 125 150		317 473 542		ns
Recovered charge	$Q_r$	$di/dt = 74$ A/μs $di/dt = 65$ A/μs $di/dt = 62$ A/μs	0 / 15	600	15	25 125 150	1,11 1,78 2,04		μC
Reverse recovered energy	$E_{rec}$				25 125 150		0,368 0,644 0,753		mWs
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$				25 125 150		40 28 24		A/μs

#### Rectifier Diode

##### Static

Parameter	Symbol	$V_{GE}$ [V]	$V_{CE}$ [V]	$I_C$ [A]	$T_j$ [°C]	Min	Typ	Max	Unit
Forward voltage	$V_F$			35	25 125		1,17 1,13		V
Reverse leakage current	$I_R$		1600		25			50	μA

##### Thermal

Thermal resistance junction to sink	$R_{th(j-s)}$	$\lambda_{paste} = 3,4$ W/mK (PSX)					1,20		K/W
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Vincotech

## Characteristic Values

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

### Thermistor

Rated resistance	$R$					25		5		kΩ
Deviation of $R_{100}$	$\Delta_{R/R}$	$R_{100} = 493 \Omega$				100	-5		+5	%
Power dissipation	$P$					25		245		mW
Power dissipation constant						25		1,4		mW/K
B-value	$B_{(25/50)}$	Tol. $\pm 2 \%$				25		3375		K
B-value	$B_{(25/100)}$	Tol. $\pm 2 \%$				25		3437		K
Vincotech NTC Reference									K	

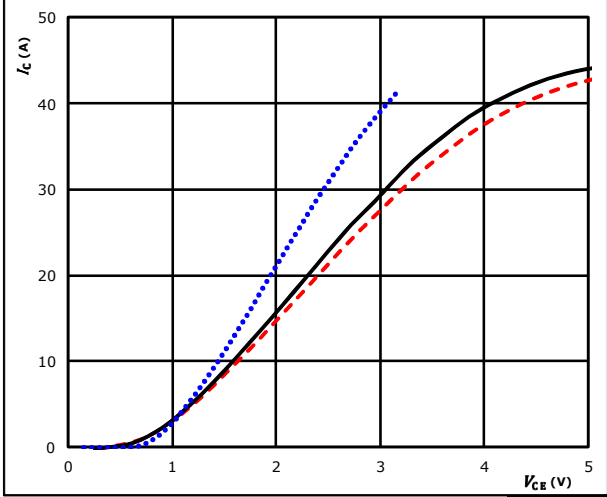


### Inverter Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

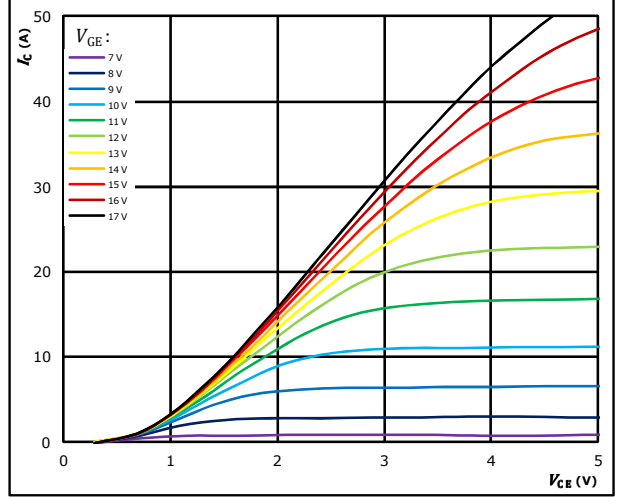


$t_p = 250 \mu s$   $T_j: 25 \text{ }^\circ C$  .....  
 $V_{GE} = 15 V$   $T_j: 125 \text{ }^\circ C$  ———  
 $T_j: 150 \text{ }^\circ C$  - - - -

**figure 2.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

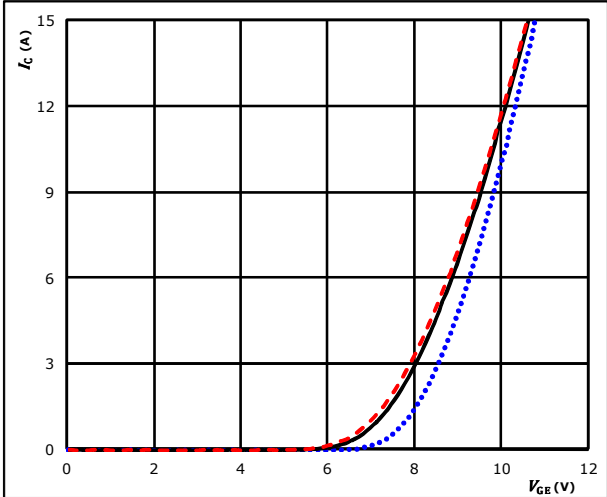


$t_p = 250 \mu s$   
 $T_j = 150 \text{ }^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

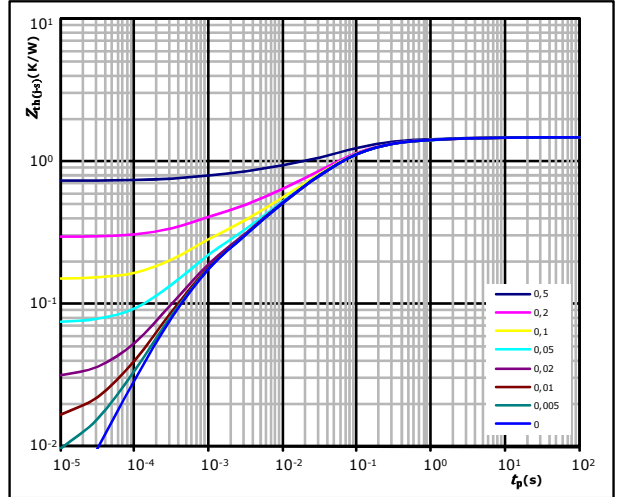


$t_p = 100 \mu s$   $T_j: 25 \text{ }^\circ C$  .....  
 $V_{CE} = 10 V$   $T_j: 125 \text{ }^\circ C$  ———  
 $T_j: 150 \text{ }^\circ C$  - - - -

**figure 4.** IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,49 \text{ K/W}$

IGBT thermal model values

R (K/W)	$\tau$ (s)
4,90E-02	3,61E+00
1,10E-01	6,54E-01
4,70E-01	1,09E-01
4,98E-01	2,97E-02
2,21E-01	4,73E-03
1,37E-01	5,51E-04

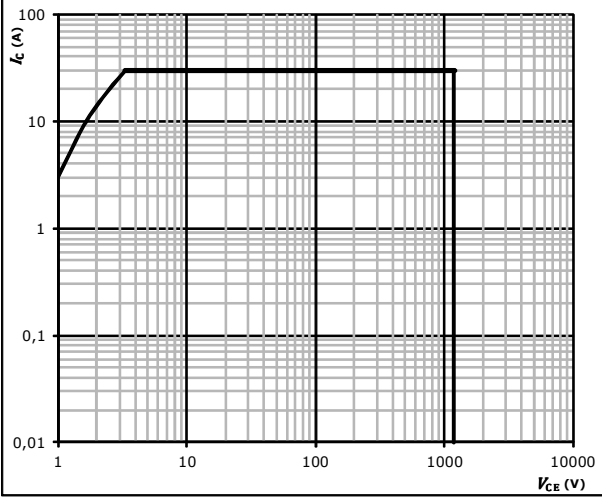


### Inverter Switch Characteristics

figure 5. IGBT

Safe operating area

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



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

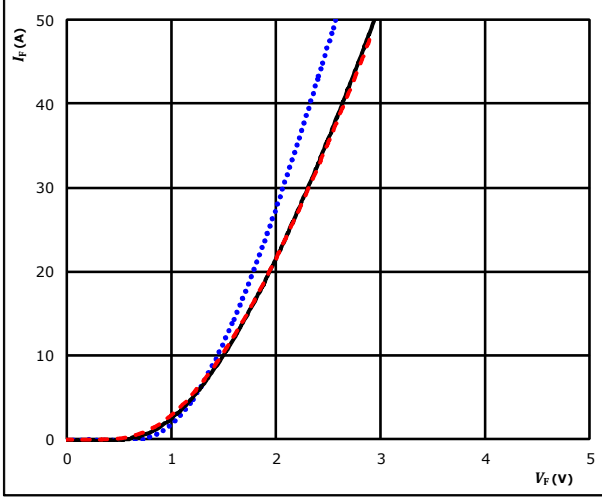


### Inverter Diode Characteristics

**figure 1.** FWD

Typical forward characteristics

$$I_F = f(V_F)$$

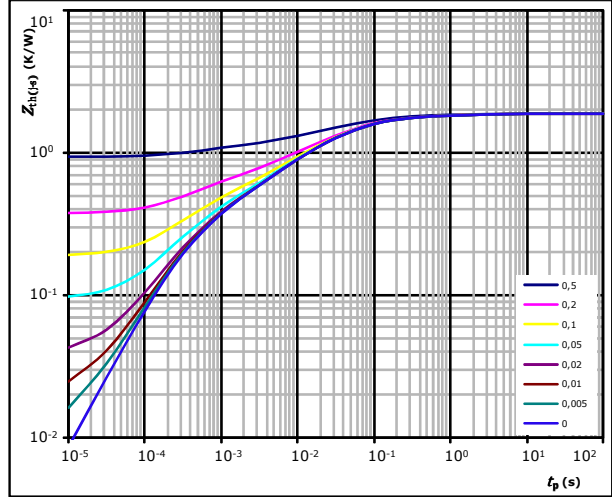


$t_p = 250 \mu s$   
 $T_j$ : 25 °C .....  
 125 °C ———  
 150 °C - - - -

**figure 2.** FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,88 \text{ K/W}$

FWD thermal model values

R (K/W)	$\tau$ (s)
7,31E-02	2,45E+00
1,93E-01	2,55E-01
6,27E-01	4,97E-02
4,83E-01	1,15E-02
2,56E-01	2,33E-03
2,42E-01	3,41E-04

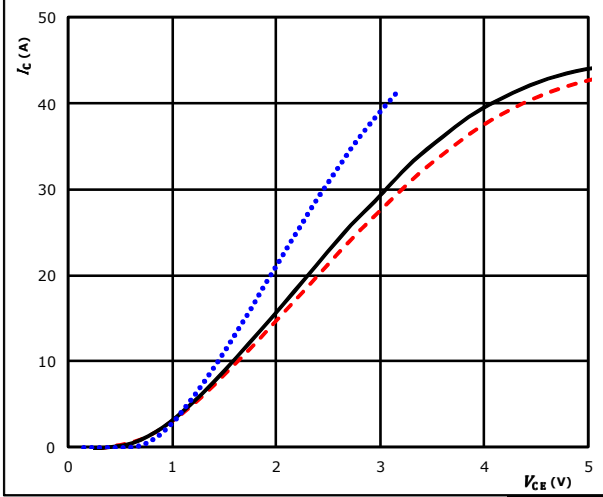


### Brake Switch Characteristics

**figure 1.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

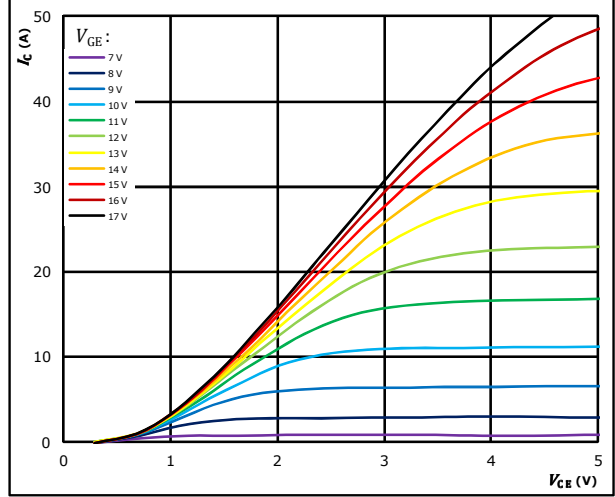


$t_p = 250 \mu s$   $T_j: 25 \text{ }^\circ C$  .....  
 $V_{GE} = 15 \text{ V}$   $T_j: 125 \text{ }^\circ C$  ———  
 $T_j: 150 \text{ }^\circ C$  - - - - -

**figure 2.** IGBT

Typical output characteristics

$I_C = f(V_{CE})$

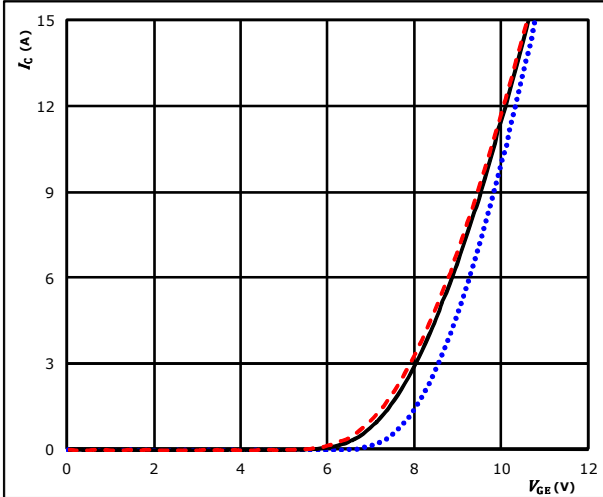


$t_p = 250 \mu s$   
 $T_j = 150 \text{ }^\circ C$   
 $V_{GE}$  from 7 V to 17 V in steps of 1 V

**figure 3.** IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

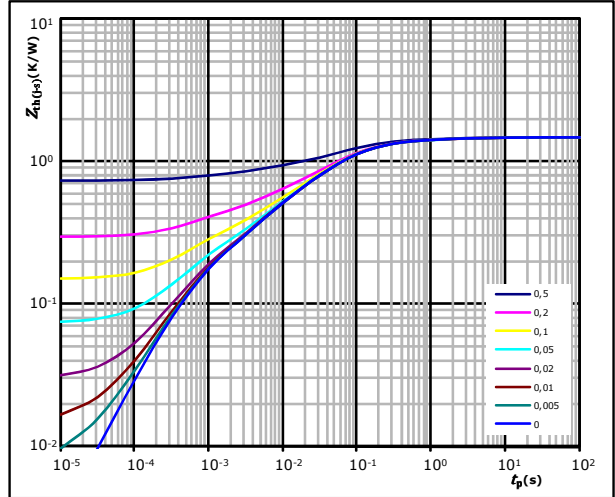


$t_p = 100 \mu s$   $T_j: 25 \text{ }^\circ C$  .....  
 $V_{CE} = 10 \text{ V}$   $T_j: 125 \text{ }^\circ C$  ———  
 $T_j: 150 \text{ }^\circ C$  - - - - -

**figure 4.** IGBT

Transient thermal impedance as function of pulse duration

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,49 \text{ K/W}$   
 IGBT thermal model values

R (K/W)	$\tau$ (s)
4,90E-02	3,61E+00
1,10E-01	6,54E-01
4,70E-01	1,09E-01
4,98E-01	2,97E-02
2,21E-01	4,73E-03
1,37E-01	5,51E-04



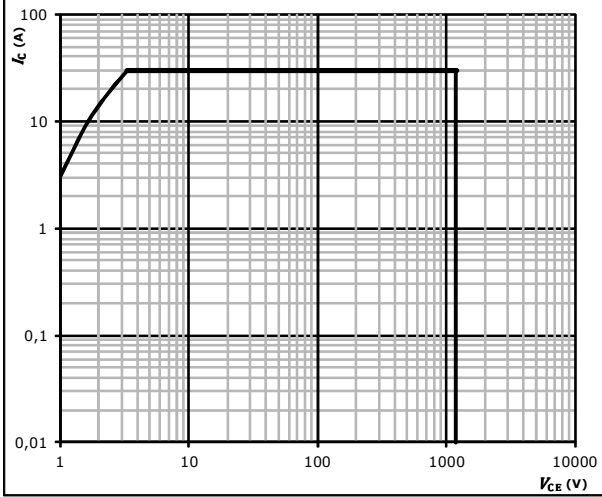
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## Brake Switch Characteristics

figure 5. IGBT

Safe operating area

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



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

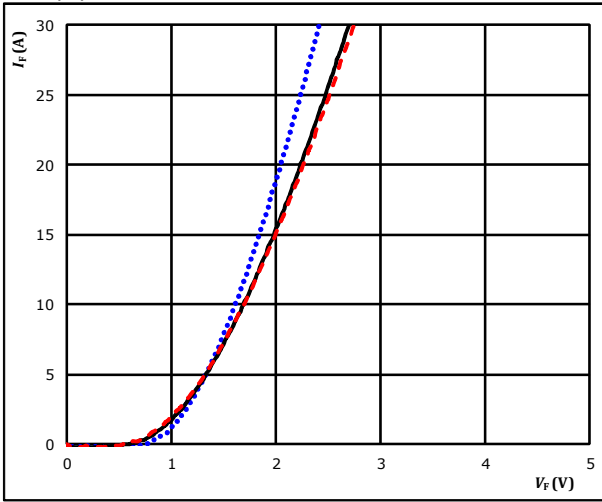


### Brake Diode Characteristics

**figure 1.** FWD

Typical forward characteristics

$$I_F = f(V_F)$$



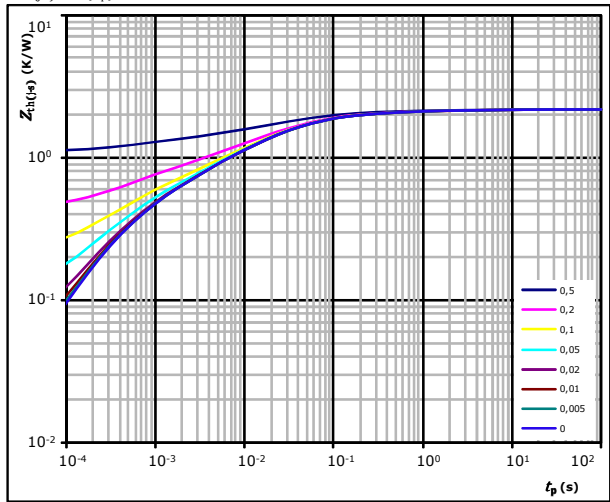
$t_p = 250 \mu s$

$T_j:$  25 °C .....  
125 °C ———  
150 °C - - - -

**figure 2.** FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$

$R_{th(j-s)} = 2,19 \text{ K/W}$

FWD thermal model values

$R$ (K/W)	$\tau$ (s)
8,09E-02	3,20E+00
2,08E-01	2,82E-01
6,85E-01	4,41E-02
5,92E-01	1,02E-02
3,27E-01	2,02E-03
2,95E-01	3,64E-04

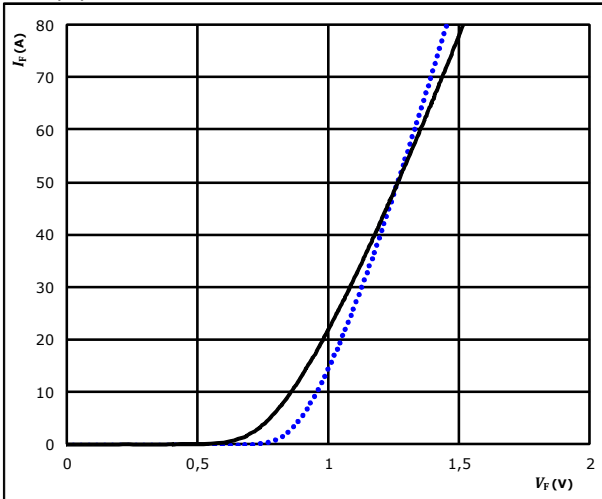


## Rectifier Diode Characteristics

**figure 1.** FWD

Typical forward characteristics

$$I_F = f(V_F)$$

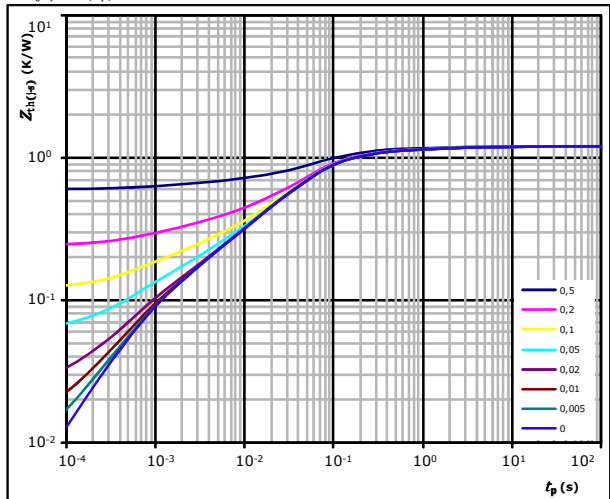


$t_p = 250 \mu s$   $T_j: 25 \text{ }^\circ\text{C}$  (dotted blue line)  $125 \text{ }^\circ\text{C}$  (solid black line)

**figure 2.** FWD

Transient thermal impedance as a function of pulse width

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



$D = t_p / T$   
 $R_{th(j-s)} = 1,20 \text{ K/W}$   
 FWD thermal model values

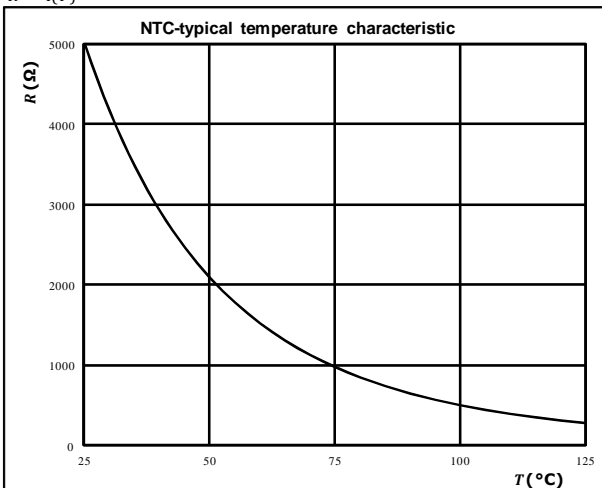
$R \text{ (K/W)}$	$\tau \text{ (s)}$
3,54E-02	9,31E+00
8,09E-02	9,99E-01
2,12E-01	1,71E-01
6,76E-01	4,85E-02
1,19E-01	5,88E-03
7,98E-02	8,33E-04

## Thermistor Characteristics

**figure 1.** Thermistor

Typical NTC characteristic  
as a function of temperature

$$R = f(T)$$

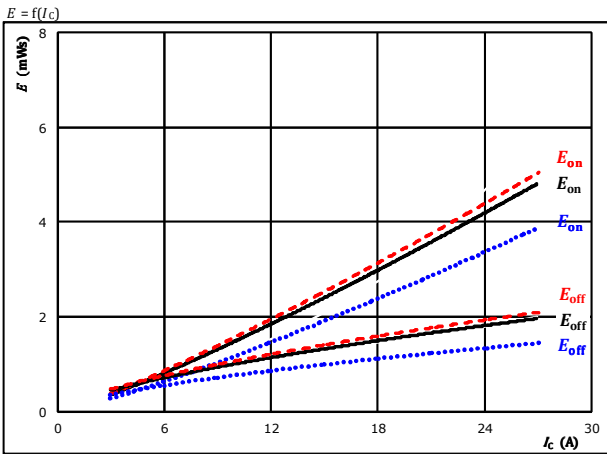




## Inverter Switching Characteristics

**figure 1.** IGBT

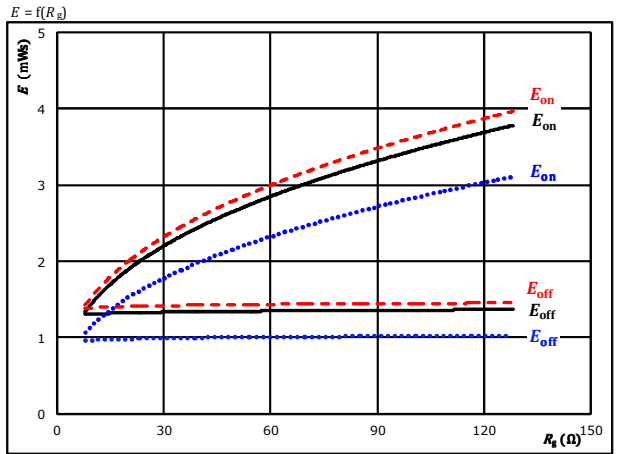
Typical switching energy losses as a function of collector current



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$   
 $R_{goff} = 32$   $\Omega$   
 $T_j: 25$   $^{\circ}\text{C}$  (dotted blue)  
 $125$   $^{\circ}\text{C}$  (solid black)  
 $150$   $^{\circ}\text{C}$  (dashed red)

**figure 2.** IGBT

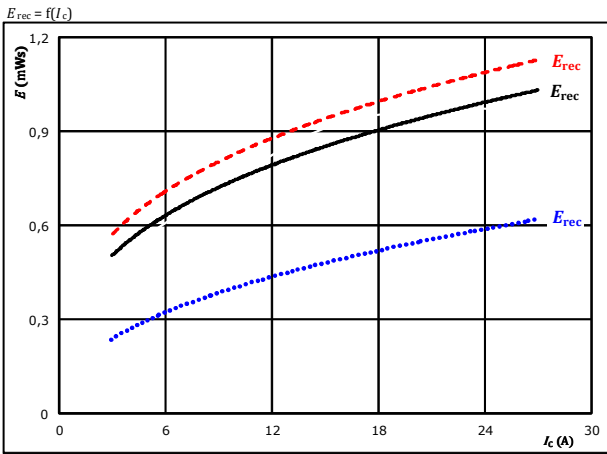
Typical switching energy losses as a function of gate resistor



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 15$  A  
 $T_j: 25$   $^{\circ}\text{C}$  (dotted blue)  
 $125$   $^{\circ}\text{C}$  (solid black)  
 $150$   $^{\circ}\text{C}$  (dashed red)

**figure 3.** FWD

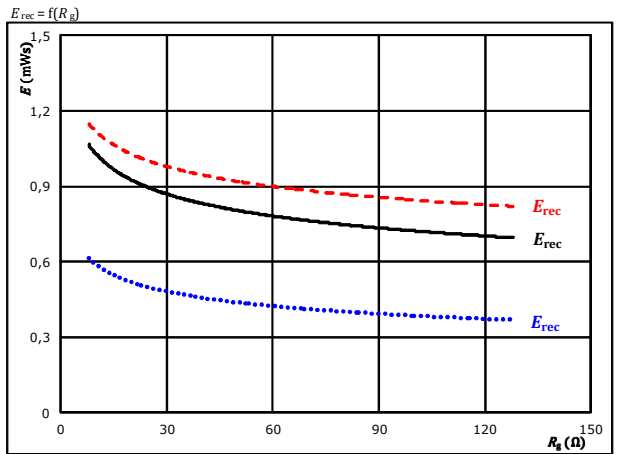
Typical reverse recovered energy loss as a function of collector current



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $R_{gon} = 32$   $\Omega$   
 $T_j: 25$   $^{\circ}\text{C}$  (dotted blue)  
 $125$   $^{\circ}\text{C}$  (solid black)  
 $150$   $^{\circ}\text{C}$  (dashed red)

**figure 4.** FWD

Typical reverse recovered energy loss as a function of gate resistor



With an inductive load at  
 $V_{CE} = 600$  V  
 $V_{GE} = \pm 15$  V  
 $I_C = 15$  A  
 $T_j: 25$   $^{\circ}\text{C}$  (dotted blue)  
 $125$   $^{\circ}\text{C}$  (solid black)  
 $150$   $^{\circ}\text{C}$  (dashed red)

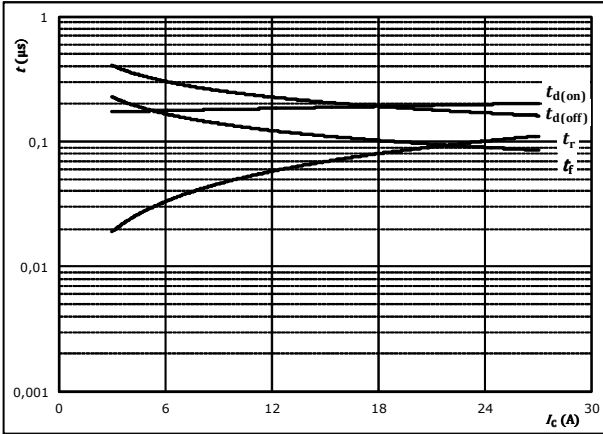


## Inverter Switching Characteristics

**figure 5.** IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



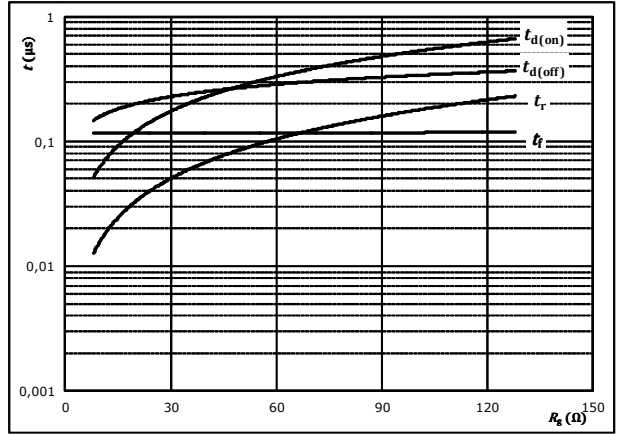
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	32	Ω

**figure 6.** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



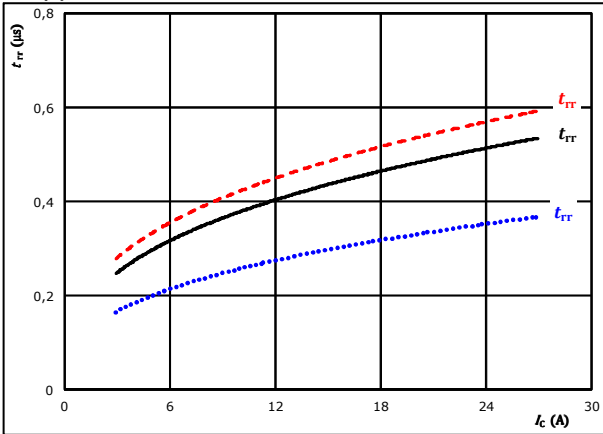
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	15	A

**figure 7.** FWD

Typical reverse recovery time as a function of collector current

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

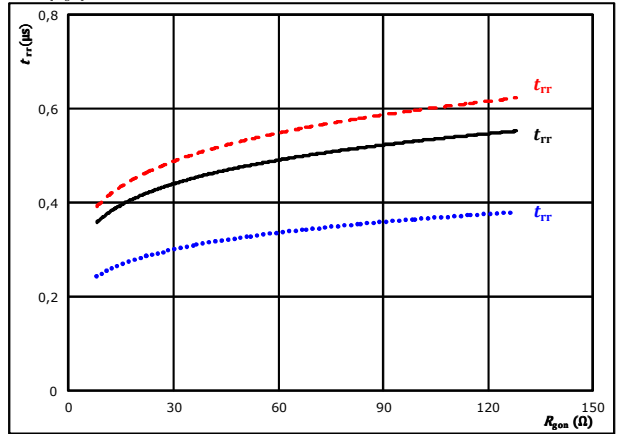


At	$V_{CE} =$	600	V	$T_j:$	25 °C	.....
	$V_{GE} =$	±15	V		125 °C	————
	$R_{gon} =$	32	Ω		150 °C	-----

**figure 8.** FWD

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

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

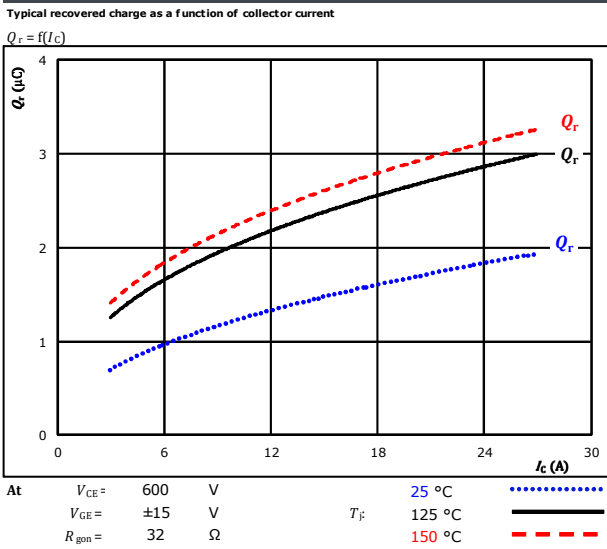


At	$V_{CE} =$	600	V	$T_j:$	25 °C	.....
	$V_{GE} =$	±15	V		125 °C	————
	$I_C =$	15	A		150 °C	-----

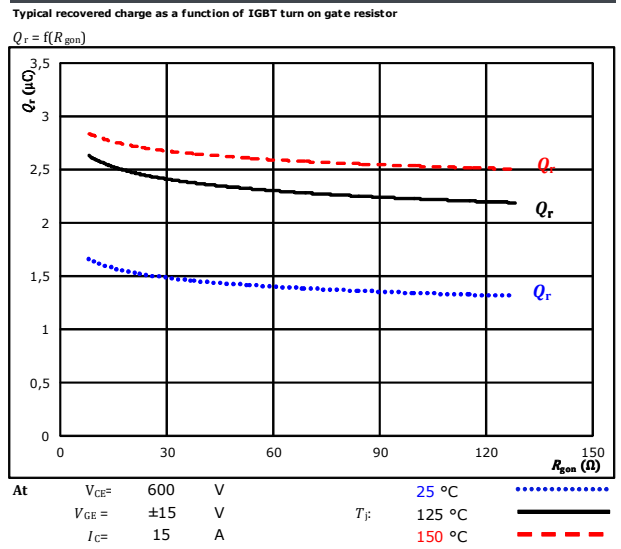


## Inverter Switching Characteristics

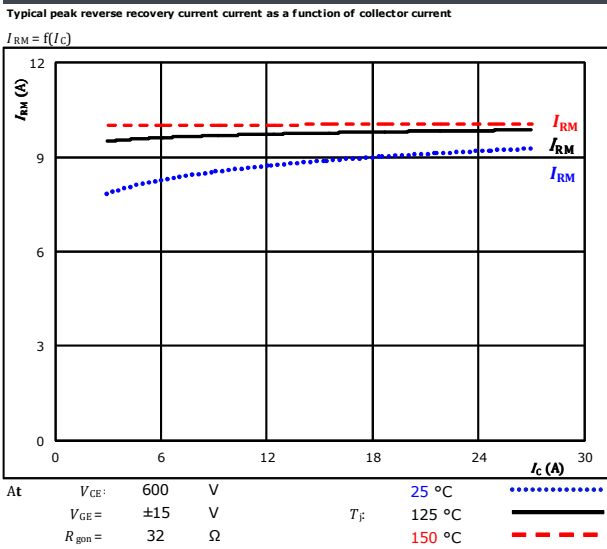
**figure 9.** FWD



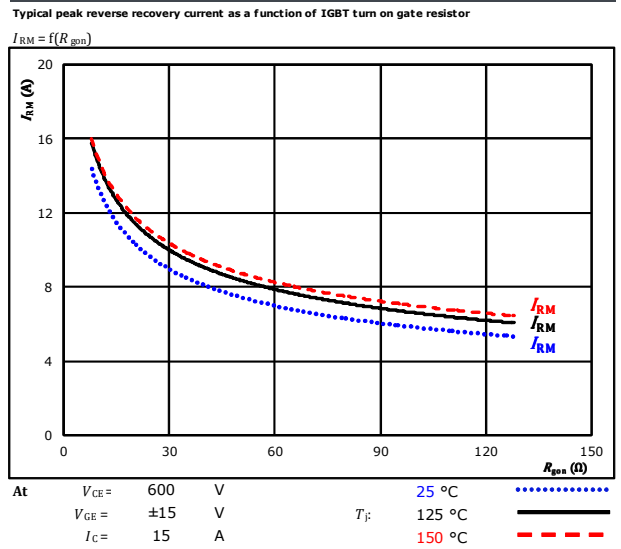
**figure 10.** FWD



**figure 11.** FWD



**figure 12.** FWD

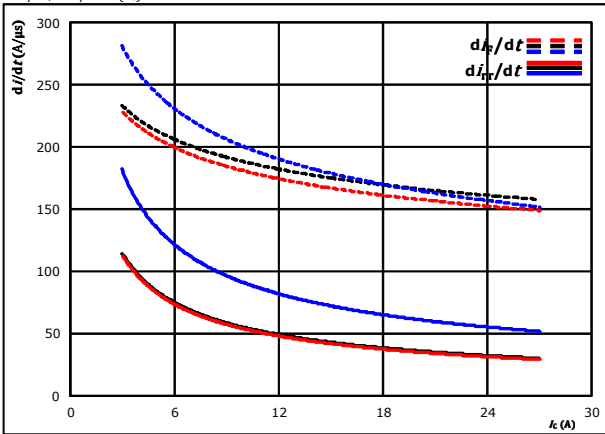




## Inverter Switching Characteristics

**figure 13.** FWD

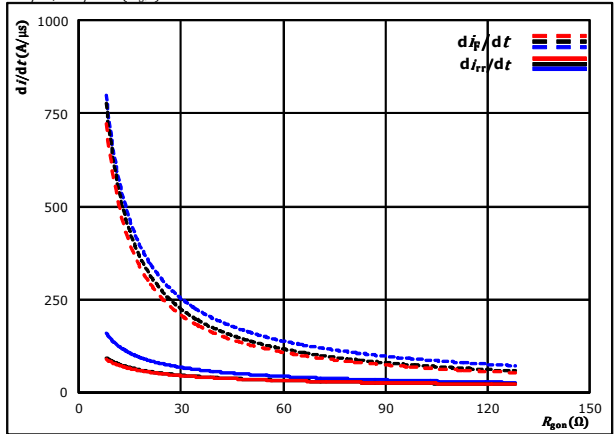
Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_{rr}/dt = f(I_c)$



At  $V_{CE} = 600$  V  $T_j = 25$  °C  
 $V_{GE} = \pm 15$  V  $T_j = 125$  °C  
 $R_{g(on)} = 32$  Ω  $T_j = 150$  °C

**figure 14.** FWD

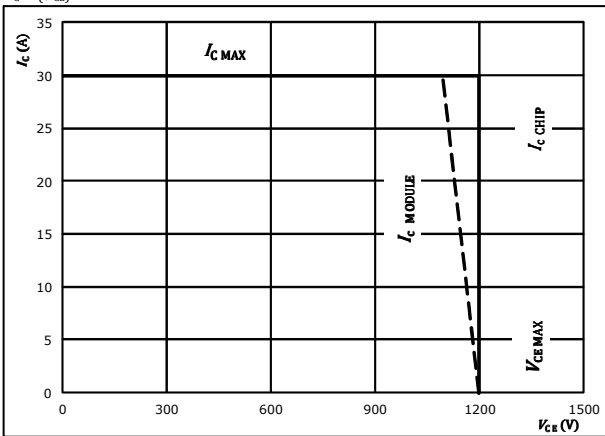
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor  
 $di_f/dt, di_{rr}/dt = f(R_{g(on)})$



At  $V_{CE} = 600$  V  $T_j = 25$  °C  
 $V_{GE} = \pm 15$  V  $T_j = 125$  °C  
 $I_c = 15$  A  $T_j = 150$  °C

**figure 15.** IGBT

Reverse bias safe operating area  
 $I_c = f(V_{CE})$



At  $T_j = 175$  °C  
 $R_{g(on)} = 32$  Ω  
 $R_{g(off)} = 32$  Ω



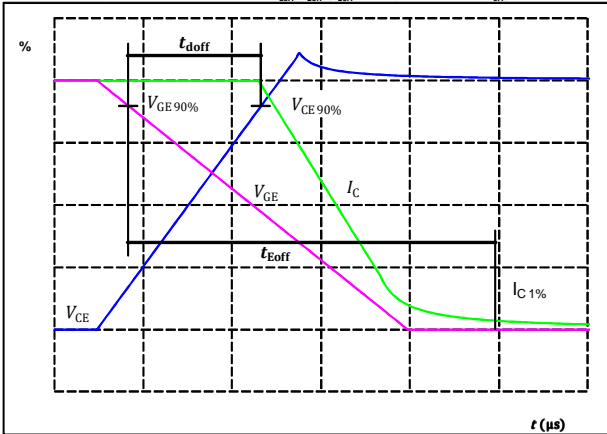
## Inverter Switching Definitions

**General conditions**

$T_j$	=	125 °C
$R_{gon}$	=	32 $\Omega$
$R_{goff}$	=	32 $\Omega$

**figure 1.** IGBT

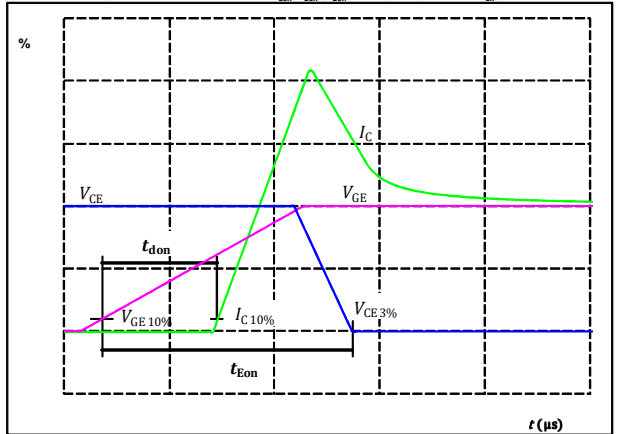
Turn-off Switching Waveforms & definition of  $t_{doff}$ ,  $t_{Eoff}$  ( $t_{Eoff}$  = integrating time for  $E_{off}$ )



$V_{CE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{doff} =$	206	ns

**figure 2.** IGBT

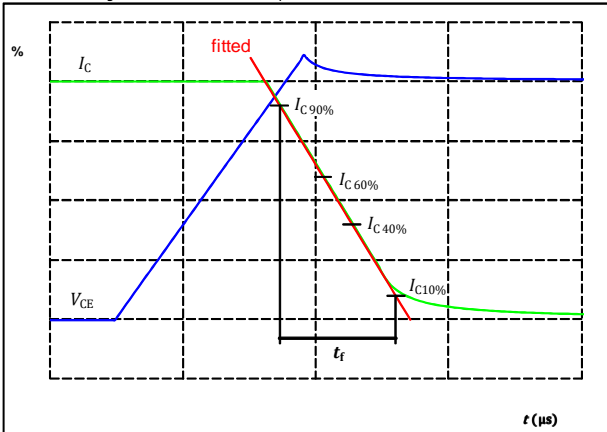
Turn-on Switching Waveforms & definition of  $t_{don}$ ,  $t_{Eon}$  ( $t_{Eon}$  = integrating time for  $E_{on}$ )



$V_{CE}(0\%) =$	-15	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{don} =$	191	ns

**figure 3.** IGBT

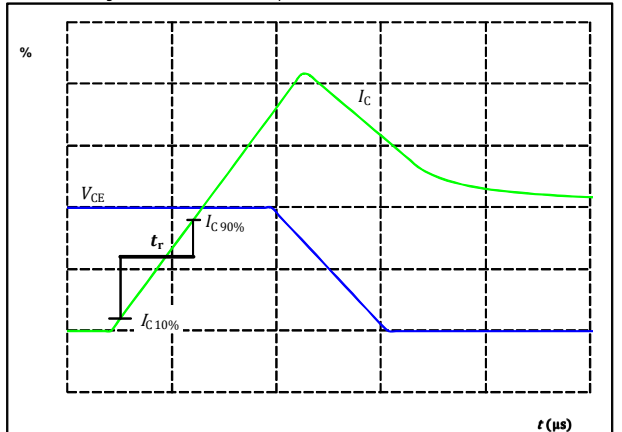
Turn-off Switching Waveforms & definition of  $t_r$



$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_r =$	113	ns

**figure 4.** IGBT

Turn-on Switching Waveforms & definition of  $t_r$



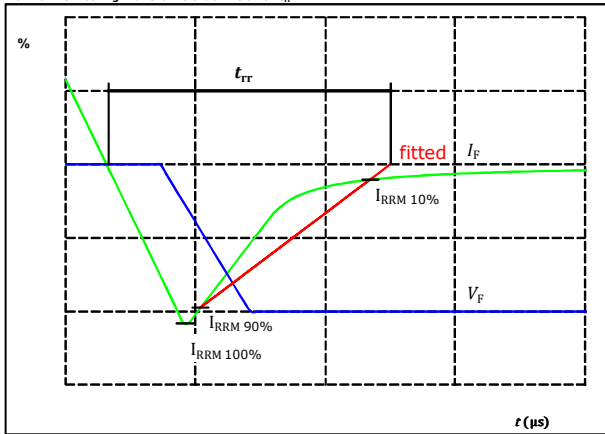
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_r =$	63	ns



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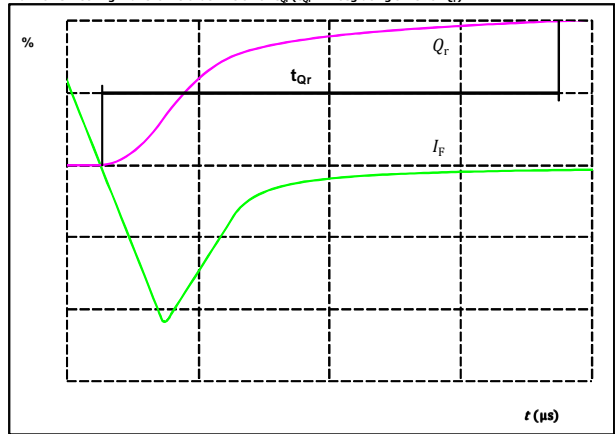
## Inverter Switching Characteristics

figure 5. FWD  
Turn-off Switching Waveforms & definition of  $t_{rr}$



$V_F(100\%) =$	600	V
$I_F(100\%) =$	15	A
$I_{RRM}(100\%) =$	11	A
$t_{rr} =$	422	ns

figure 6. FWD  
Turn-on Switching Waveforms & definition of  $t_{qr}$  ( $t_{qr} =$  integrating time for  $Q_r$ )

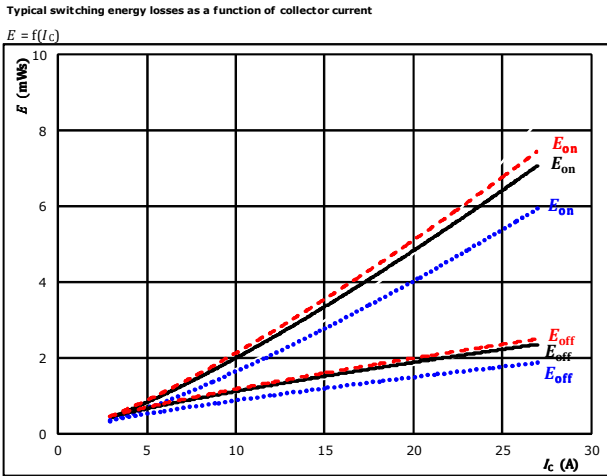


$I_F(100\%) =$	15	A
$Q_r(100\%) =$	2,46	$\mu\text{C}$



## Brake Switching Characteristics

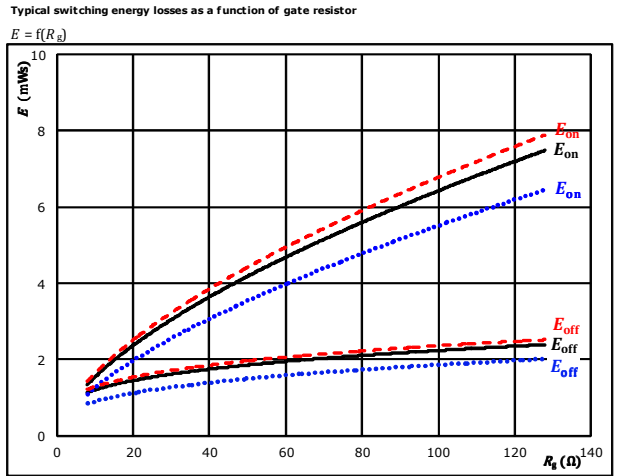
**figure 1.** IGBT



With an inductive load at

$V_{CE} = 600$ V	$T_j = 25$ °C	.....
$V_{GE} = 0 / 15$ V	$T_j = 125$ °C	————
$R_{gon} = 32$ Ω	$T_j = 150$ °C	-----
$R_{goff} = 32$ Ω		

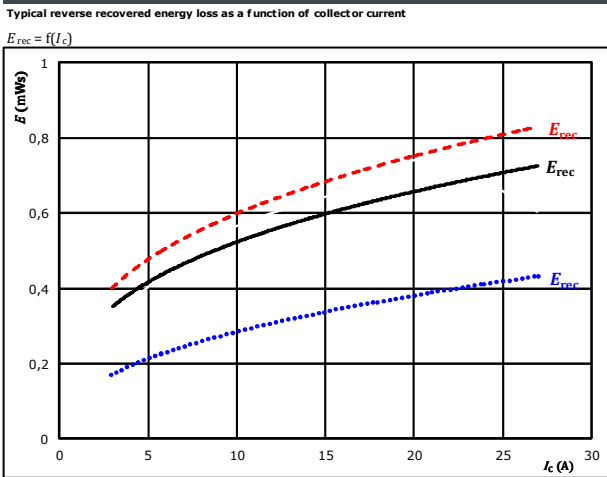
**figure 2.** IGBT



With an inductive load at

$V_{CE} = 600$ V	$T_j = 25$ °C	.....
$V_{GE} = 0 / 15$ V	$T_j = 125$ °C	————
$I_c = 15$ A	$T_j = 150$ °C	-----

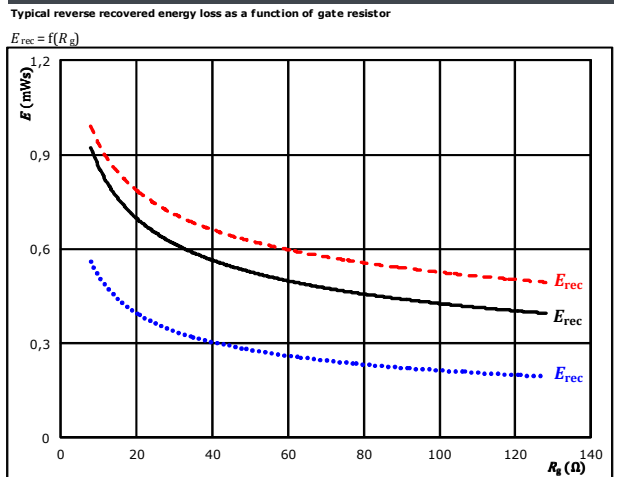
**figure 3.** FWD



With an inductive load at

$V_{CE} = 600$ V	$T_j = 25$ °C	.....
$V_{GE} = 0 / 15$ V	$T_j = 125$ °C	————
$R_{gon} = 32$ Ω	$T_j = 150$ °C	-----

**figure 4.** FWD



With an inductive load at

$V_{CE} = 600$ V	$T_j = 25$ °C	.....
$V_{GE} = 0 / 15$ V	$T_j = 125$ °C	————
$I_c = 15$ A	$T_j = 150$ °C	-----

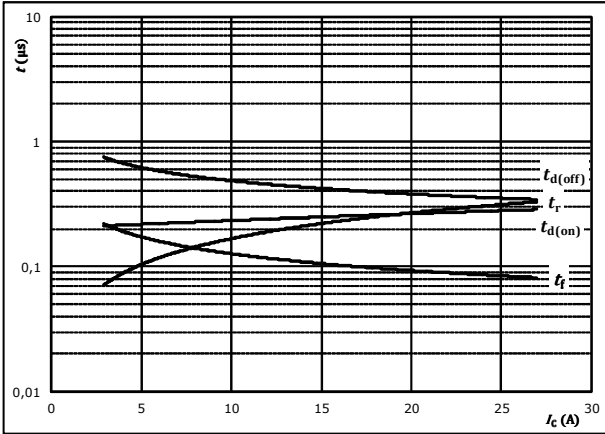


## Brake Switching Characteristics

**figure 5.** IGBT

Typical switching times as a function of collector current

$$t = f(I_c)$$



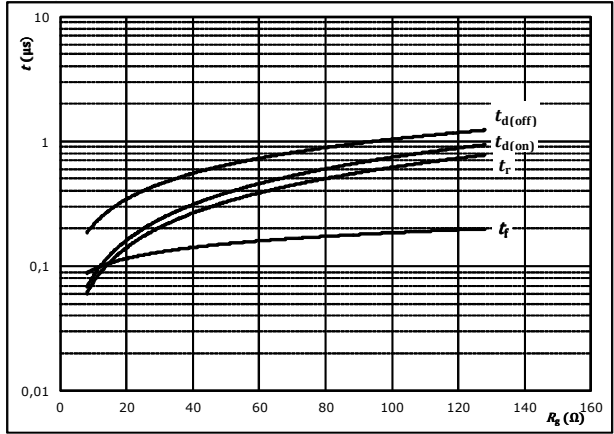
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	0 / 15	V
$R_{gon} =$	32	Ω
$R_{goff} =$	32	Ω

**figure 6.** IGBT

Typical switching times as a function of gate resistor

$$t = f(R_g)$$



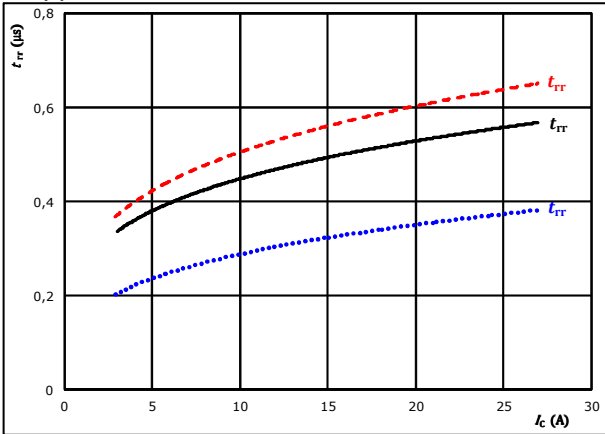
With an inductive load at

$T_j =$	150	°C
$V_{CE} =$	600	V
$V_{GE} =$	0 / 15	V
$I_c =$	15	A

**figure 7.** FWD

Typical reverse recovery time as a function of collector current

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

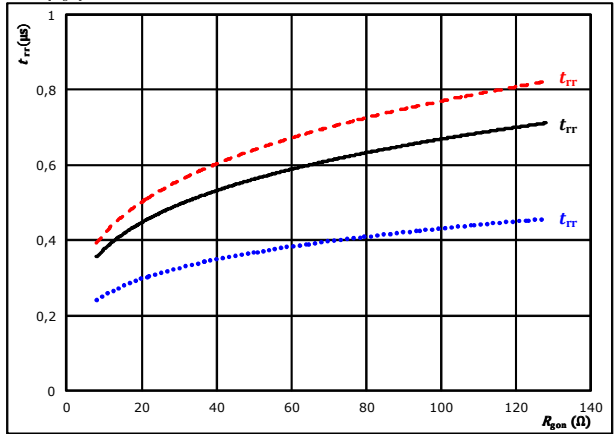


At	$V_{CE} =$	600	V	$T_j:$	25 °C	.....
	$V_{GE} =$	0 / 15	V		125 °C	————
	$R_{gon} =$	32	Ω		150 °C	- - - -

**figure 8.** FWD

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

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



At	$V_{CE} =$	600	V	$T_j:$	25 °C	.....
	$V_{GE} =$	0 / 15	V		125 °C	————
	$I_c =$	15	A		150 °C	- - - -

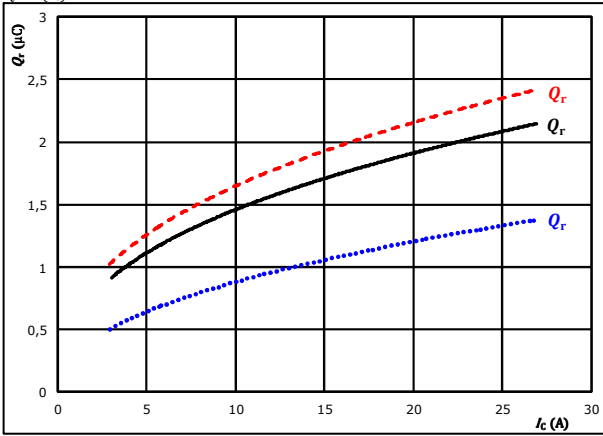


## Brake Switching Characteristics

figure 9. FWD

Typical recovered charge as a function of collector current

$$Q_r = f(I_c)$$

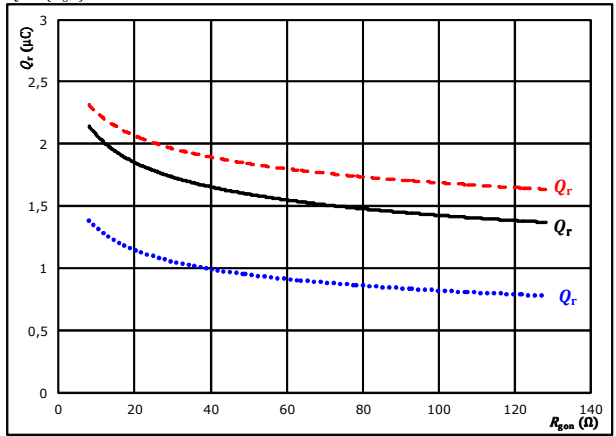


At  $V_{CE} = 600$  V  $T_j = 25$  °C (dotted blue)  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C (solid black)  
 $R_{ggn} = 32$  Ω  $T_j = 150$  °C (dashed red)

figure 10. FWD

Typical recovered charge as a function of IGBT turn on gate resistor

$$Q_r = f(R_{ggn})$$

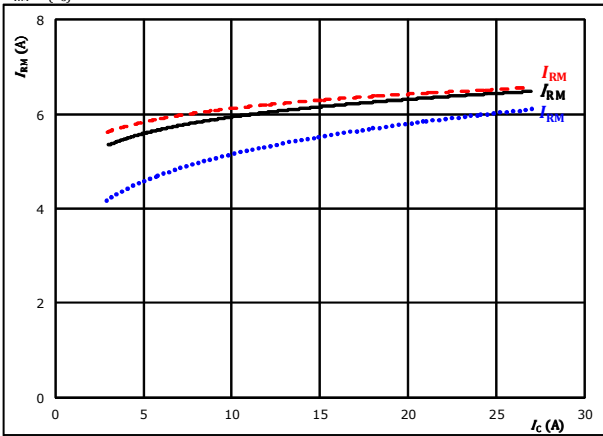


At  $V_{CE} = 600$  V  $T_j = 25$  °C (dotted blue)  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C (solid black)  
 $I_c = 15$  A  $T_j = 150$  °C (dashed red)

figure 11. FWD

Typical peak reverse recovery current as a function of collector current

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

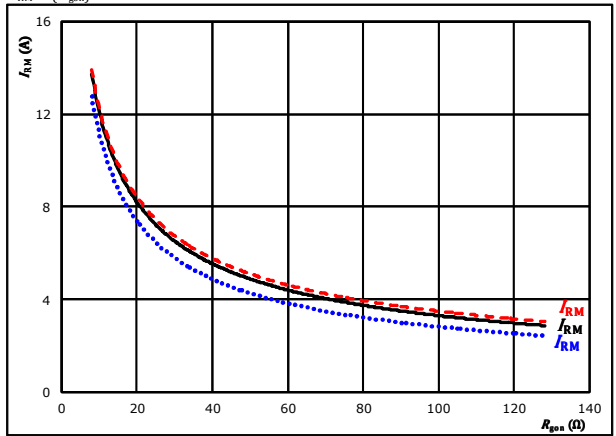


At  $V_{CE} = 600$  V  $T_j = 25$  °C (dotted blue)  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C (solid black)  
 $R_{ggn} = 32$  Ω  $T_j = 150$  °C (dashed red)

figure 12. FWD

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

$$I_{RM} = f(R_{ggn})$$



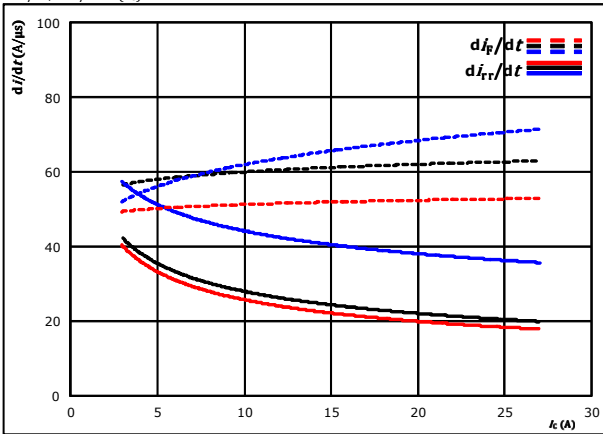
At  $V_{CE} = 600$  V  $T_j = 25$  °C (dotted blue)  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C (solid black)  
 $I_c = 15$  A  $T_j = 150$  °C (dashed red)



## Brake Switching Characteristics

**figure 13.** FWD

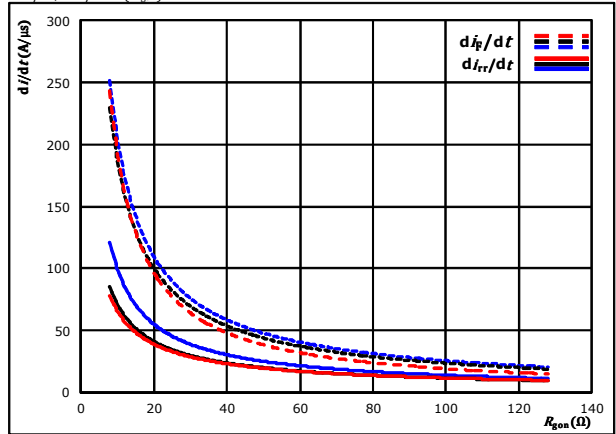
Typical rate of fall of forward and reverse recovery current as a function of collector current  
 $di_f/dt, di_{rr}/dt = f(I_c)$



At  $V_{CE} = 600$  V  $T_j = 25$  °C  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C  
 $R_{g(on)} = 32$  Ω  $T_j = 150$  °C

**figure 14.** FWD

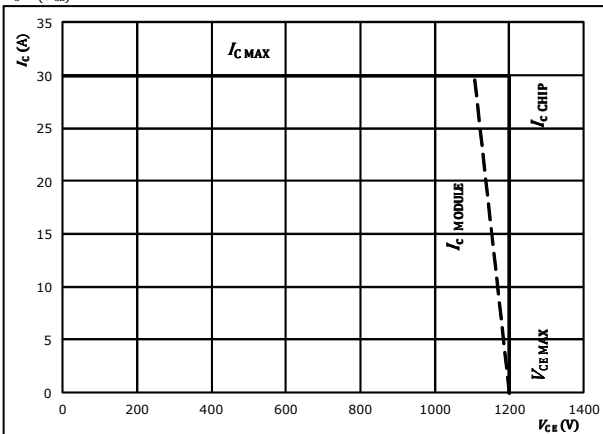
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor  
 $di_f/dt, di_{rr}/dt = f(R_{g(on)})$



At  $V_{CE} = 600$  V  $T_j = 25$  °C  
 $V_{GE} = 0 / 15$  V  $T_j = 125$  °C  
 $I_c = 15$  A  $T_j = 150$  °C

**figure 15.** IGBT

Reverse bias safe operating area  
 $I_c = f(V_{CE})$



At  $T_j = 125$  °C  
 $R_{g(on)} = 32$  Ω  
 $R_{g(off)} = 32$  Ω

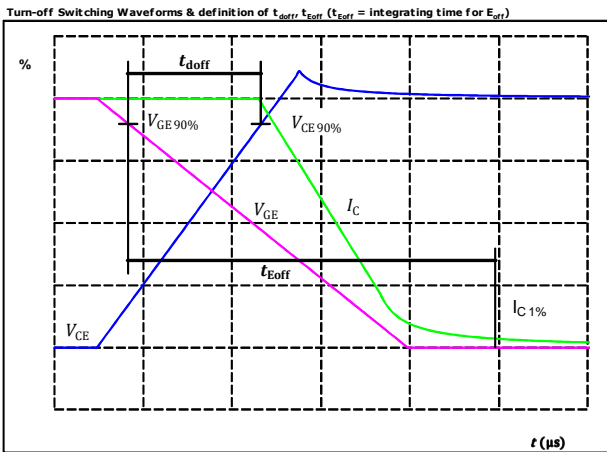


## Brake Switching Definitions

**General conditions**

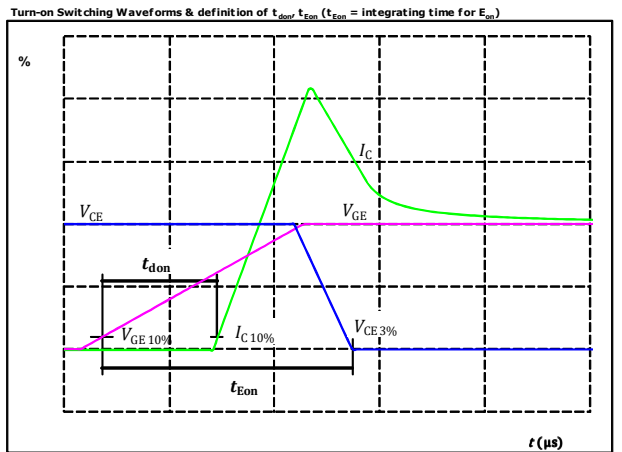
$T_j$	=	125 °C
$R_{gon}$	=	32 $\Omega$
$R_{goff}$	=	32 $\Omega$

**figure 1.** IGBT



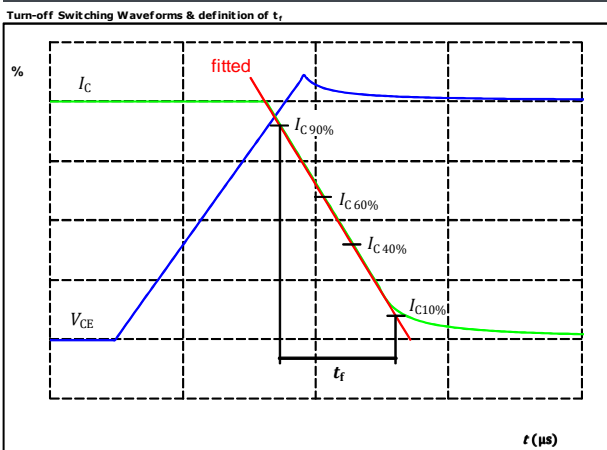
$V_{GE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{doff} =$	428	ns

**figure 2.** IGBT



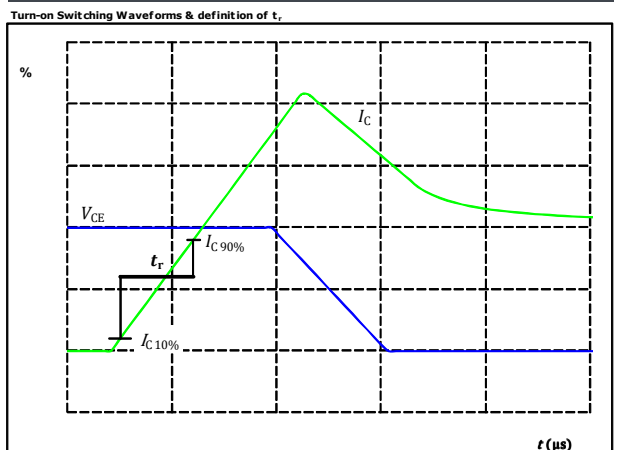
$V_{GE}(0\%) =$	0	V
$V_{GE}(100\%) =$	15	V
$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_{don} =$	262	ns

**figure 3.** IGBT



$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_f =$	87	ns

**figure 4.** IGBT

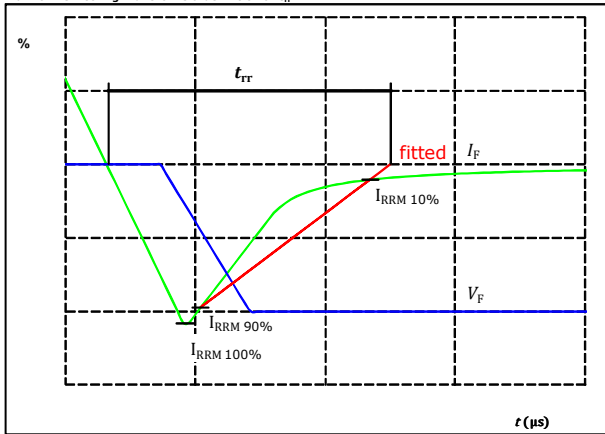


$V_C(100\%) =$	600	V
$I_C(100\%) =$	15	A
$t_r =$	205	ns



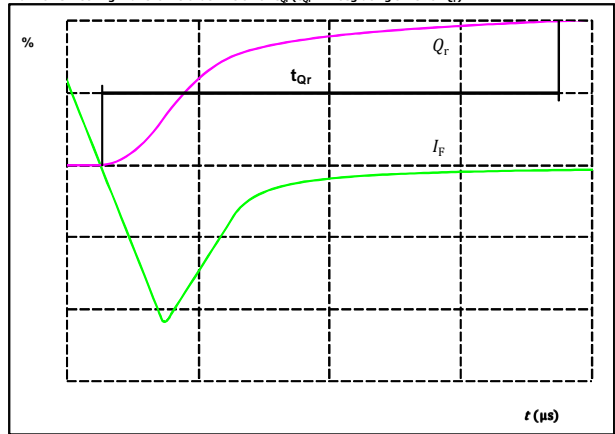
### Brake Switching Characteristics

figure 5. FWD  
Turn-off Switching Waveforms & definition of  $t_{rr}$



$V_F(100\%) =$	600	V
$I_F(100\%) =$	15	A
$I_{RRM}(100\%) =$	7	A
$t_{rr} =$	473	ns

figure 6. FWD  
Turn-on Switching Waveforms & definition of  $t_{qr}$  ( $t_{qr} =$  integrating time for  $Q_r$ )



$I_F(100\%) =$	15	A
$Q_r(100\%) =$	1,78	$\mu\text{C}$



Vincotech

Ordering Code & Marking								
<b>Version</b>			<b>Ordering Code</b>					
without thermal paste 12 mm housing with press-fit pins			10-EY12PMA015M7-L186A78T					
with thermal paste 12 mm housing with press-fit pins			10-EY12PMA015M7-L186A78T-/3/					
NN-NNNNNNNNNNNN TTTTWW WWYY UL VIN LLLL SSSS			<b>Text</b>	<b>Name</b>	<b>Date code</b>	<b>UL &amp; VIN</b>	<b>Lot</b>	<b>Serial</b>
			<b>Datamatrix</b>	<b>Type&amp;Ver</b>	<b>Lot number</b>	<b>Serial</b>	<b>Date code</b>	

Pin table			
Pin	X	Y	Function
1	25,6	6,4	ACIn2
2	22,4	6,4	ACIn2
3	16	9,6	ACIn1
4	12,8	9,6	ACIn1
5	9,6	0	DC+Rect
6	9,6	3,2	DC+Rect
7	0	0	DC-Rect
8	0	3,2	DC-Rect
9	0	16	G27
10	0	19,2	DC-Br
11	0	22,4	G11
12	0	25,6	DC-1
13	0	28,8	DC-1
14	0	32	G13
15	0	35,2	DC-2
16	0	38,4	DC-2
17	0	41,6	G15
18	0	44,8	DC-3
19	0	48	DC-3
20	9,6	48	Therm1
21	19,2	48	Therm2
22	28,8	48	G16
23	32	48	Ph3
24	32	44,8	Ph3
25	32	35,2	G14
26	32	32	Ph2
27	32	28,8	Ph2
28	32	19,2	G12
29	32	16	Ph1
30	32	12,8	Ph1
31	32	3,2	ACIn3
32	32	0	ACIn3
33	22,4	19,2	DC+Inv
34	22,4	16	DC+Inv
35	9,6	19,2	Br

**Outline**

center of press-fit pinhead  
for connection parameter see the handling instruction

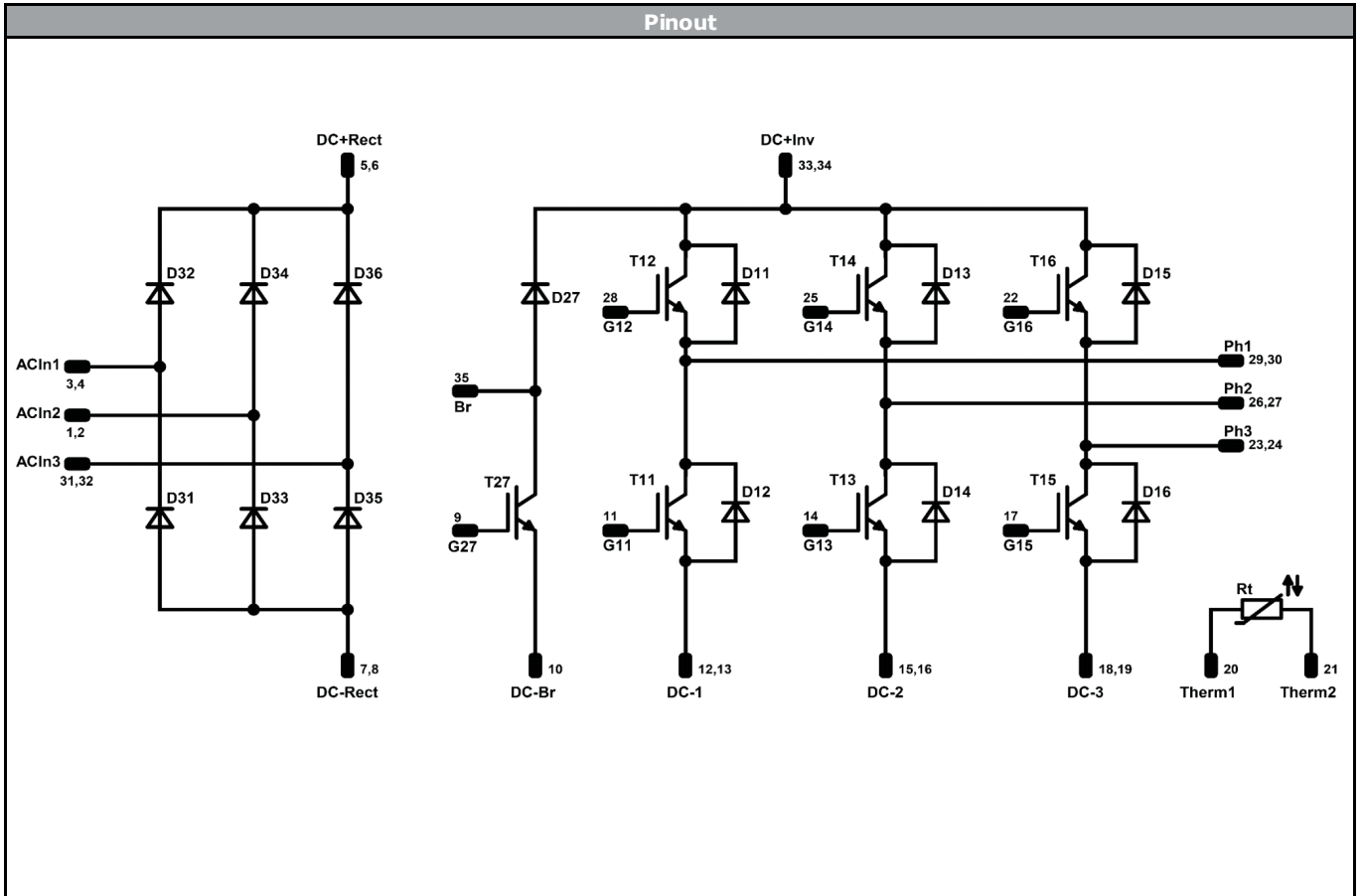
13.08 ±0.1  
16.4 ±0.5

24  
Y  
X  
16

Tolerance of pinpositions: ±0.4mm at the end of pins  
Dimension of coordinate axis is only offset without tolerance



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<b>Identification</b>					
<b>ID</b>	<b>Component</b>	<b>Voltage</b>	<b>Current</b>	<b>Function</b>	<b>Comment</b>
T11, T12, T13, T14, T15, T16	IGBT	1200 V	15 A	Inverter Switch	
D11, D12, D13, D14, D15, D16	FWD	1200 V	15 A	Inverter Diode	
T27	IGBT	1200 V	15 A	Brake Switch	
D27	FWD	1200 V	10 A	Brake Diode	
D31, D32, D33, D34, D35, D36	Rectifier	1600 V	35 A	Rectifier Diode	
Rt	NTC			Thermistor	




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Packaging instruction			
Standard packaging quantity (SPQ) 100	>SPQ	Standard	<SPQ Sample

Handling instruction
Handling instructions for <i>flow</i> E2 packages see vincotech.com website.

Package data
Package data for <i>flow</i> E2 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
10-EY12PMA015M7-L186A78T-D1-14	17 May. 2018		

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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.