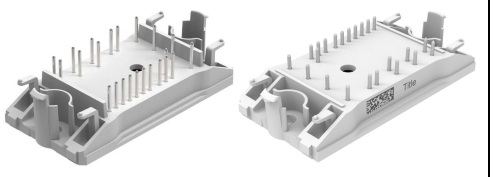
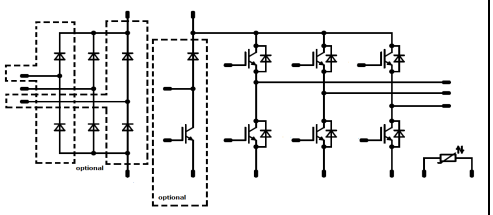
***flow* PIM 0** **600 V / 6 A**

Features
- Clip-in housing
- Trench Fieldstop IGBT's for low saturation losses
- Optional w/o BRC

Target Applications
- Industrial drives
- Embedded drives

Types
- V23990-P541-A28-PM
- V23990-P541-A29-PM
- V23990-P541-B28-PM
- V23990-P541-B129-PM
- V23990-P541-C29-PM
- V23990-P541-D28-PM
- V23990-P541-D129-PM

flow 0 housing

17mm housing 12mm housing

Schematic


Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Rectifier Diode					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	32 43	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms 50 Hz half sine wave	T_j = 25 °C	200	A
I2t-value	I^2t			200	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	43 66	W
Maximum Junction Temperature	T_{jmax}			150	°C
Inverter\Brake Switch					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	12 12	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		18	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80 °C T_c = 80 °C	36 54	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq$ 150 °C V_{GE} = 15 V		6 360	µs V
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter\Brake Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		600	V
DC forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C T_c = 80 °C	12 12	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	12	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C T_c = 80 °C	27 41	W
Maximum Junction Temperature	T_{jmax}		175	°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_{is}	t = 2 s DC voltage	4000	V
Creepage distance			min 12,7	mm
Clearance		17mm \ 12mm housing	min 12,7 \ 9,7	mm
Comparative tracking index	CTI		>200	

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	Max	
Rectifier Diode										
Forward voltage	V_F				25	25 125	0,8	1,20 1,17	1,45	V
Threshold voltage (for power loss calc. only)	V_{to}				25	25 125		0,88 0,76		V
Slope resistance (for power loss calc. only)	r_t				25	25 125		11 20		mΩ
Reverse current	I_r			1600		25 145			1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						1,61		K/W
Inverter\Brake Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,00009	25 125	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		6	25 125	1	1,52 1,7	2,1	V
Collector-emitter cut-off incl. Diode	I_{CES}		0	600		25 125			0,06	mA
Gate-emitter leakage current	I_{GES}		20	0		25 125			350	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 16 Ω R_{gon} = 32 Ω	±15	300	6	25 125		12 10		ns
Rise time	t_r					25 125		8 11		
Turn-off delay time	$t_{d(off)}$					25 125		118 134		
Fall time	t_f					25 125		87 116		
Turn-on energy loss	E_{on}					25 125		0,07 0,10		mWs
Turn-off energy loss	E_{off}					25 125		0,15 0,19		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		368		pF
Output capacitance	C_{oss}							28		
Reverse transfer capacitance	C_{rss}							11		
Gate charge	Q_G		±15	480	6	25		42		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						2,66		K/W
Inverter\Brake Diode										
Diode forward voltage	V_F				6	25 125	1	1,64 1,56	2,5	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 32 Ω		300	6	25 125		8 8		A
Reverse recovery time	t_{rr}					25 125		73 163		ns
Reverse recovered charge	Q_{rr}					25 125		0,23 0,43		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		569 338		A/µs
Reverse recovered energy	E_{rec}					25 125		0,04 0,09		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						3,5		K/W

Characteristic Values

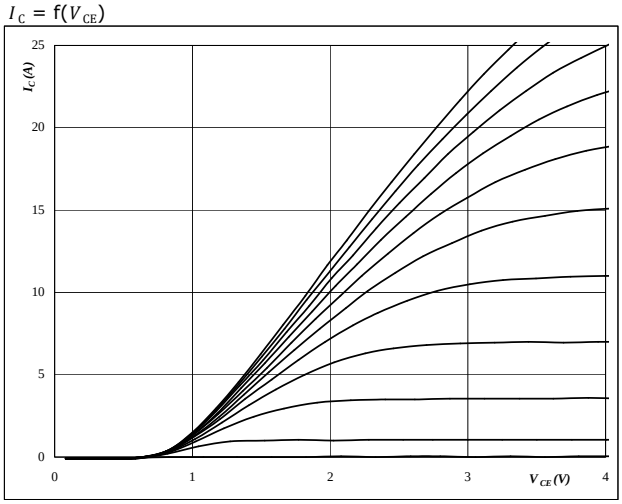
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	
Thermistor										
Rated resistance	R					25		22000		Ω
Deviation of R100	$\Delta_{R/R}$	R_{100} = 1486 Ω				100	-5		5	%
Power dissipation	P					25		210		mW
Power dissipation constant						25		3,5		mW/K
B-value	$B_{(25/50)}$	Tol. ±1%				25		3884		K
B-value	$B_{(25/100)}$	Tol. ±1%				25		3964		K
Vincotech NTC Reference						25			F	

Characteristics Inverter\Brake

Figure 1 **Inverter\Brake Switch**

Typical output characteristics

$I_C = f(V_{CE})$



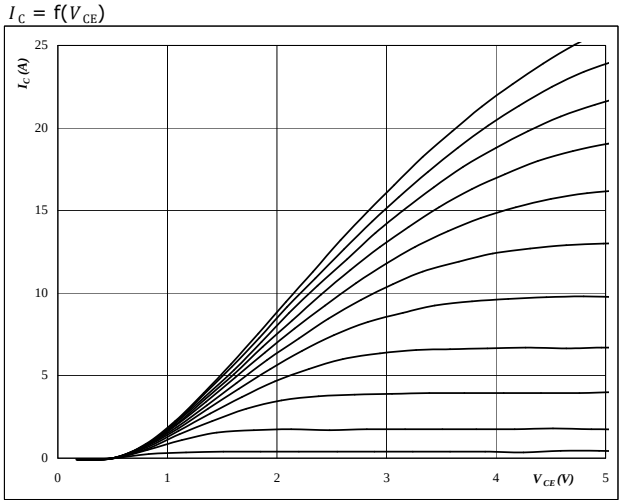
At

t_p =	250	µs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 2 **Inverter\Brake Switch**

Typical output characteristics

$I_C = f(V_{CE})$



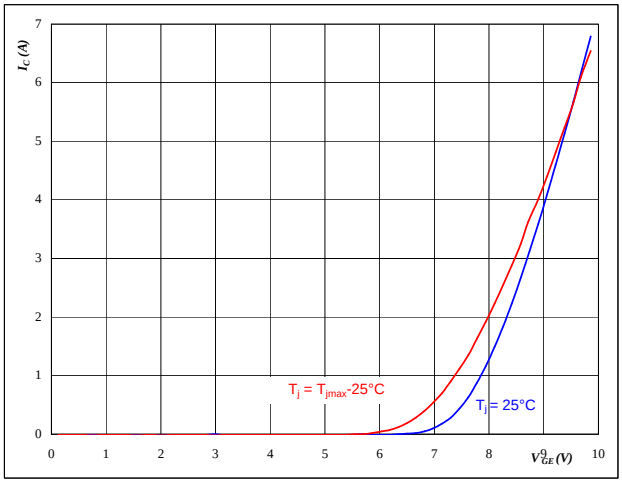
At

t_p =	250	µs
T_j =	125	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 3 **Inverter\Brake Switch**

Typical transfer characteristics

$I_C = f(V_{GE})$



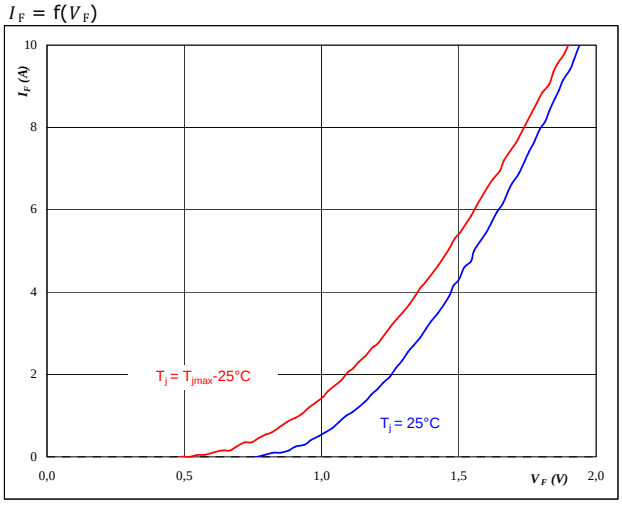
At

t_p =	250	µs
V_{CE} =	10	V

Figure 4 **Inverter\Brake Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

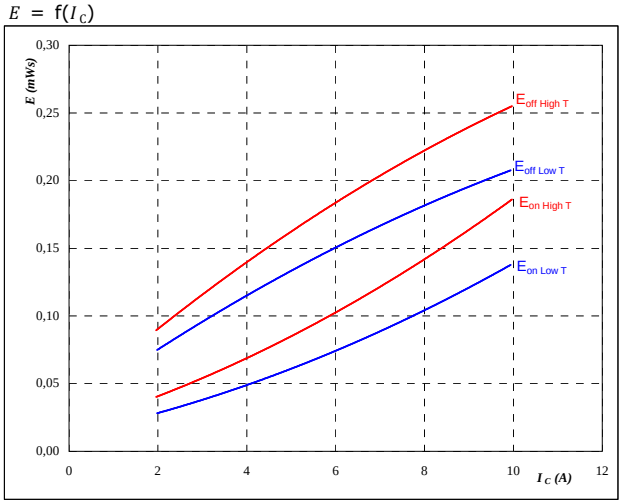
t_p =	250	µs

Characteristics Inverter\Brake

Figure 5 **Inverter\Brake Switch**

Typical switching energy losses as a function of collector current

$E = f(I_C)$



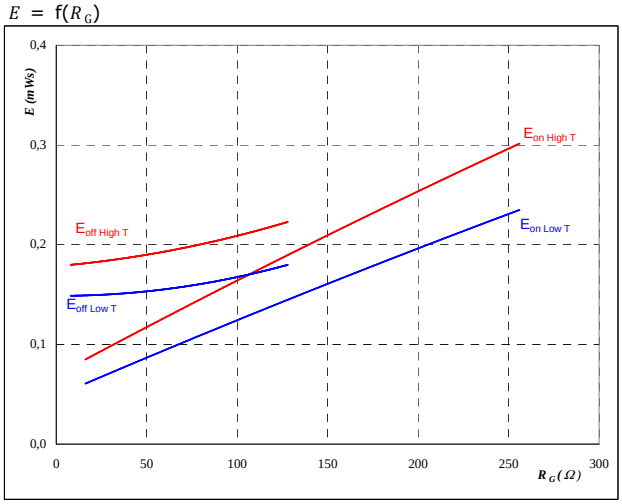
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω
R_{goff} =	16	Ω

Figure 6 **Inverter\Brake Switch**

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



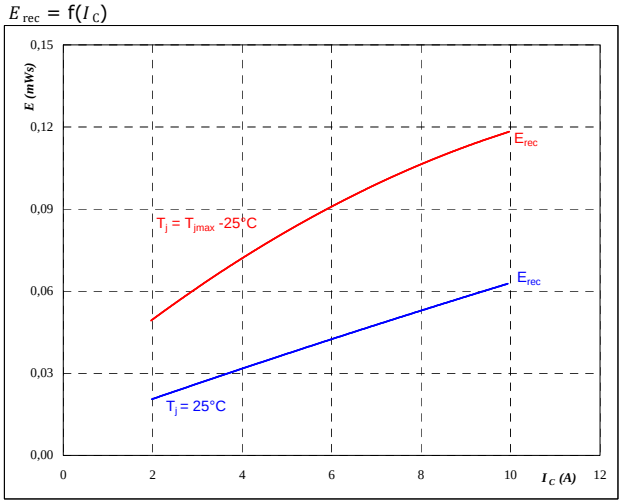
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	6	A

Figure 7 **Inverter\Brake Diode**

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



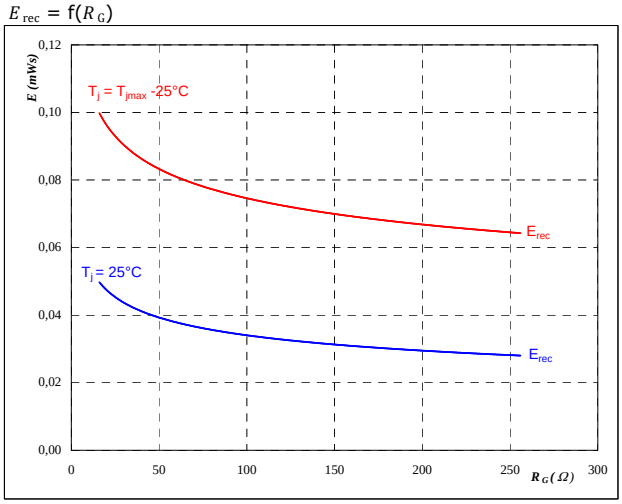
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

Figure 8 **Inverter\Brake Diode**

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

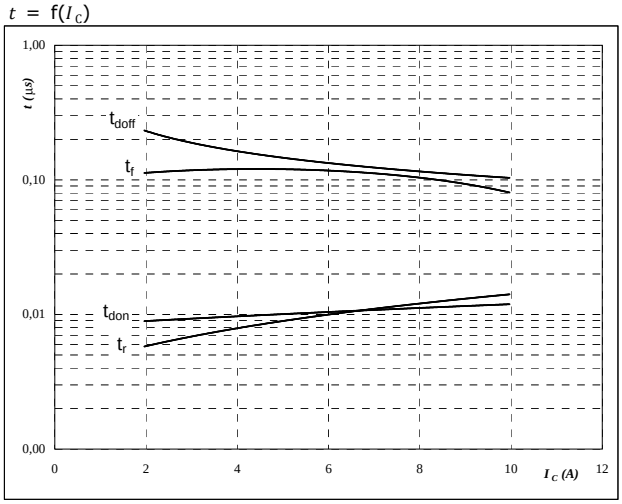
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	6	A

Characteristics Inverter\Brake

Figure 9 **Inverter\Brake Switch**

Typical switching times as a function of collector current

$t = f(I_C)$



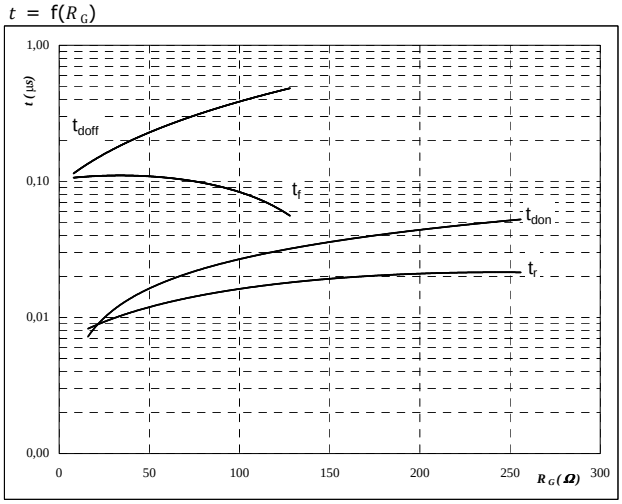
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω
R_{goff} =	16	Ω

Figure 10 **Inverter\Brake Switch**

Typical switching times as a function of gate resistor

$t = f(R_G)$



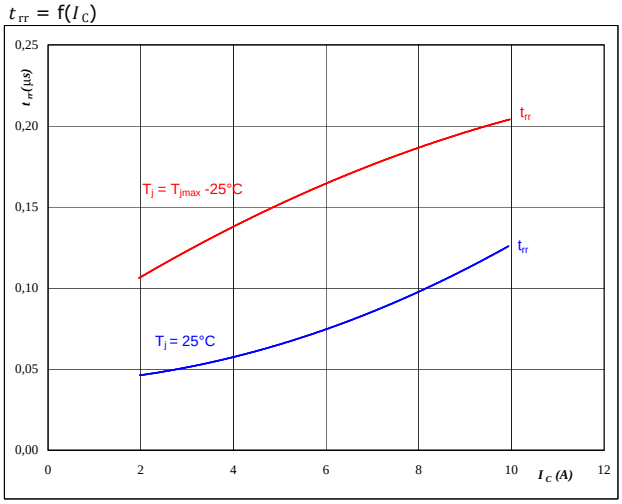
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	6	A

Figure 11 **Inverter\Brake Diode**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



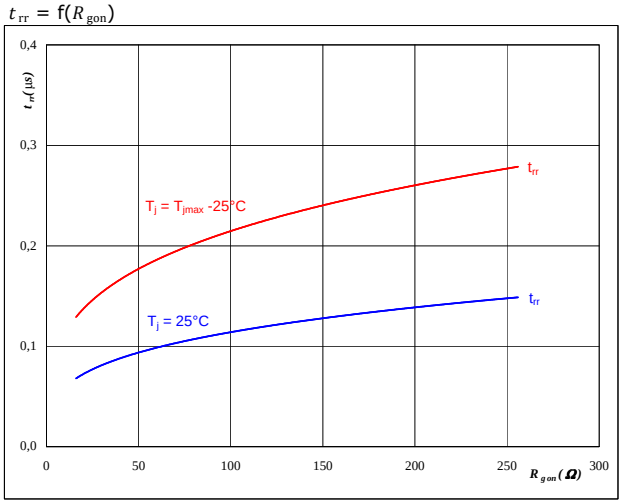
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

Figure 12 **Inverter\Brake Diode**

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

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



At

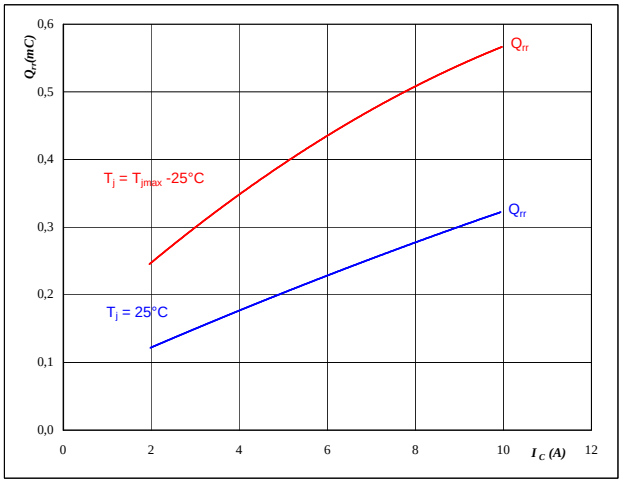
T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Characteristics Inverter\Brake

Figure 13 **Inverter\Brake Diode**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



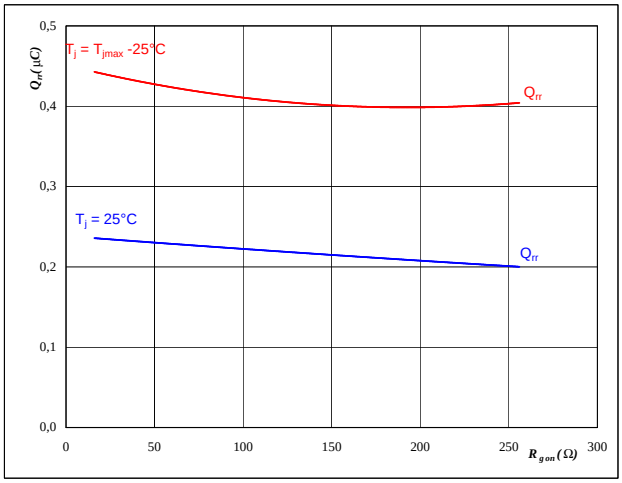
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

Figure 14 **Inverter\Brake Diode**

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

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



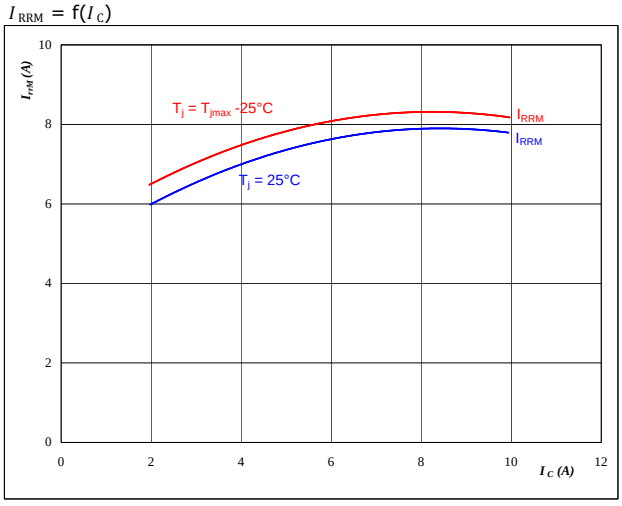
At

T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Figure 15 **Inverter\Brake Diode**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



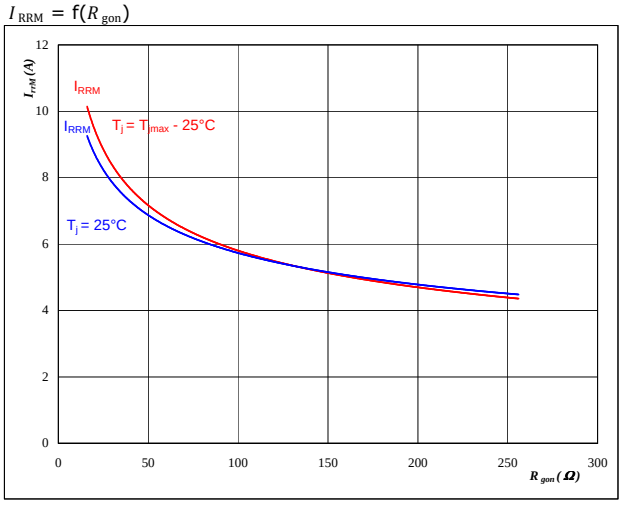
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

Figure 16 **Inverter\Brake Diode**

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

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



At

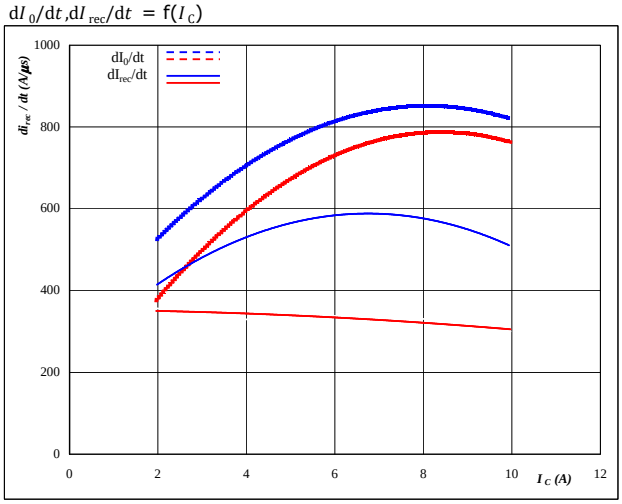
T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Characteristics Inverter\Brake

Figure 17 **Inverter\Brake Diode**

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

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



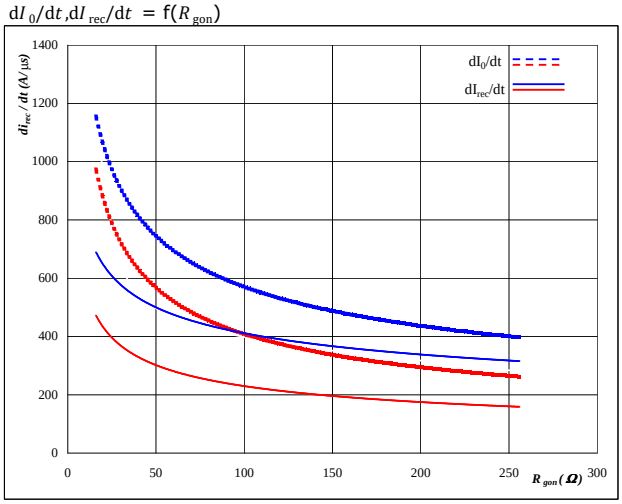
At

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
R_{gon} =	32	Ω

Figure 18 **Inverter\Brake Diode**

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

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



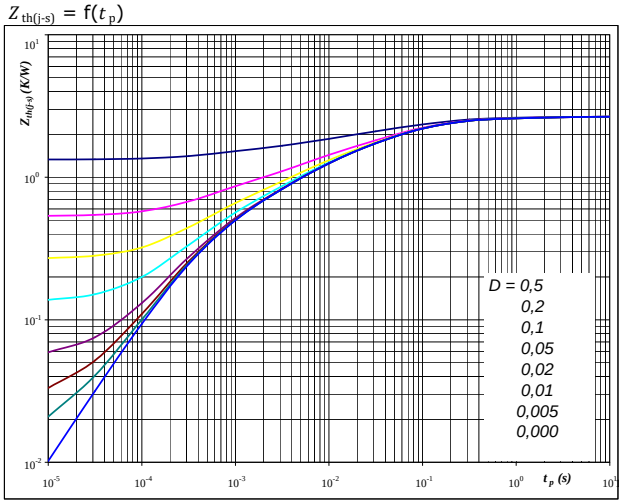
At

T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Figure 19 **Inverter\Brake Switch**

IGBT transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	2,66	K/W

IGBT thermal model values

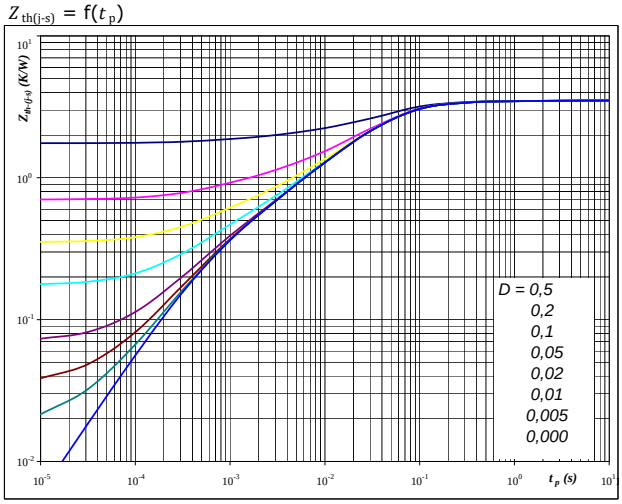
Phase change interface

R (K/W)	Tau (s)
0,11	1,8E+00
0,43	1,8E-01
0,82	4,9E-02
0,61	9,5E-03
0,38	2,3E-03
0,31	4,0E-04

Figure 20 **Inverter\Brake Diode**

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j-s)}$ =	3,50	K/W

FWD thermal model values

Phase change interface

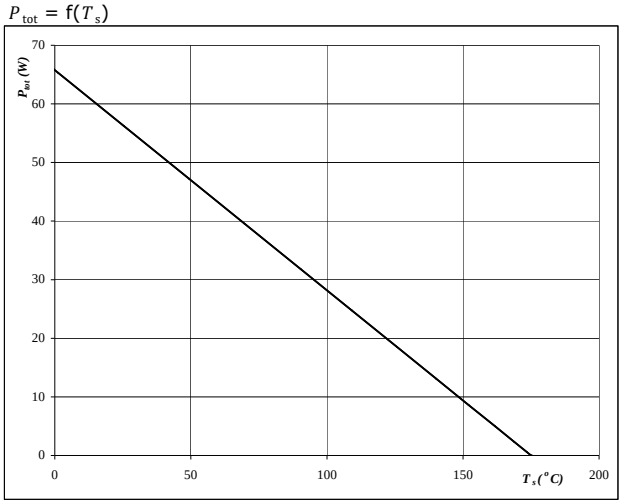
R (K/W)	Tau (s)
0,08	1,3E+00
0,41	1,5E-01
2,02	3,9E-02
0,53	9,9E-03
0,27	2,4E-03
0,19	5,1E-04

Characteristics Inverter\Brake

Figure 21 **Inverter\Brake Switch**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



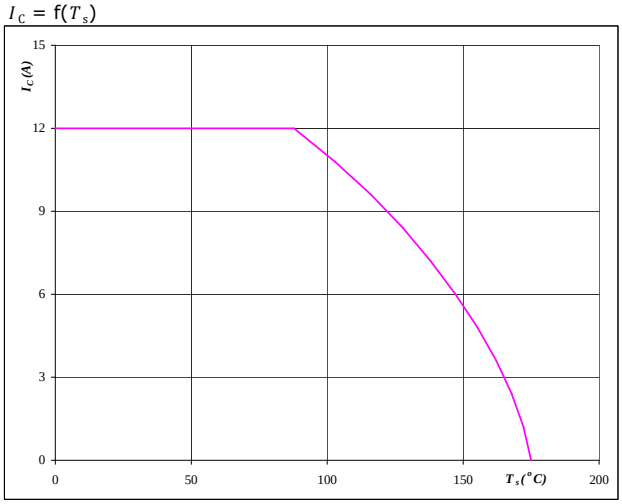
At

T_j = 175 °C

Figure 22 **Inverter\Brake Switch**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

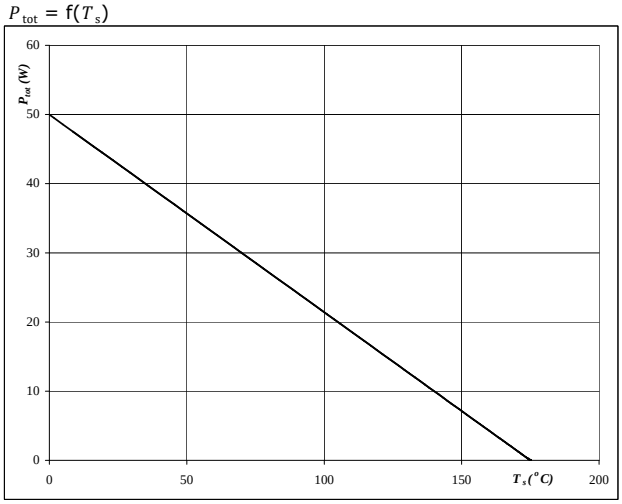
T_j = 175 °C

V_{GE} = 15 V

Figure 23 **Inverter\Brake Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



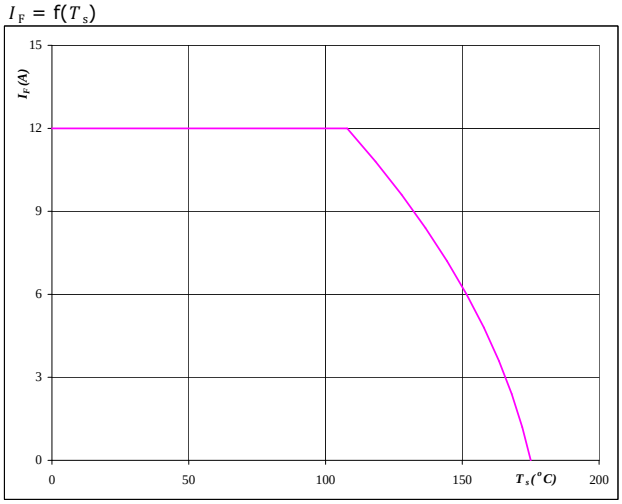
At

T_j = 175 °C

Figure 24 **Inverter\Brake Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

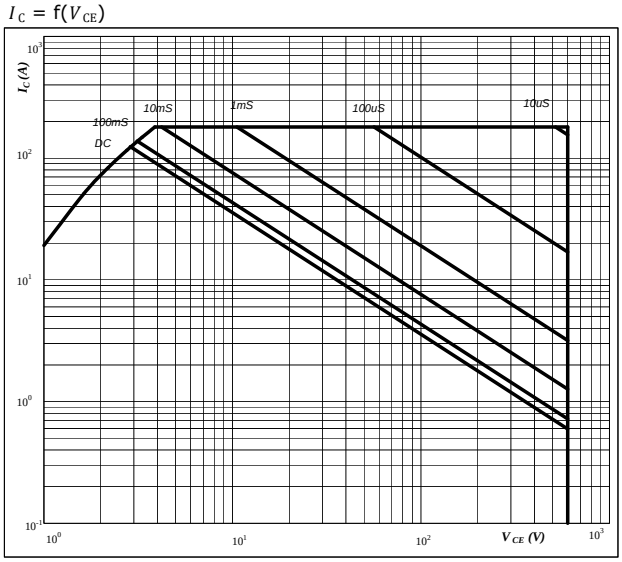
T_j = 175 °C

Characteristics Inverter\Brake

Figure 25 **Inverter\Brake Switch**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



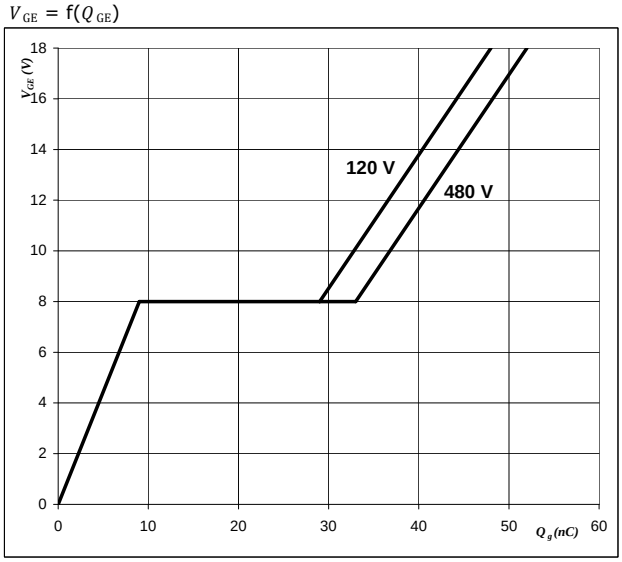
At

D =	single pulse	
T_h =	80	ºC
V_{GE} =	15	V
T_j =	T_{jmax}	ºC

Figure 26 **Inverter\Brake Switch**

Gate voltage vs Gate charge

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



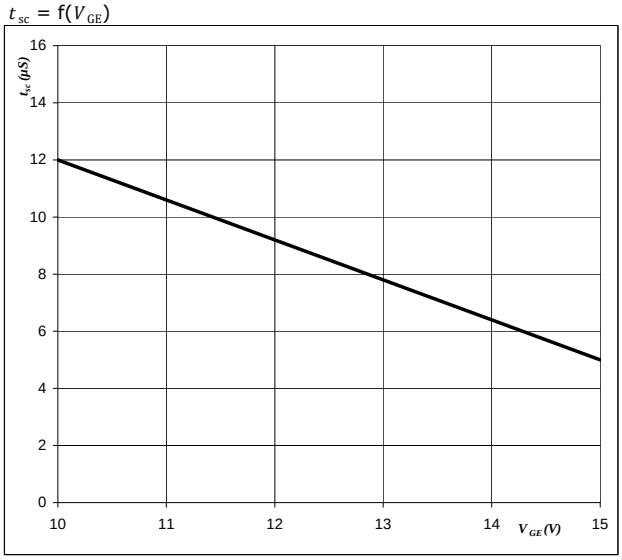
At

I_C =	6	A

Figure 27 **Inverter\Brake Switch**

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

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



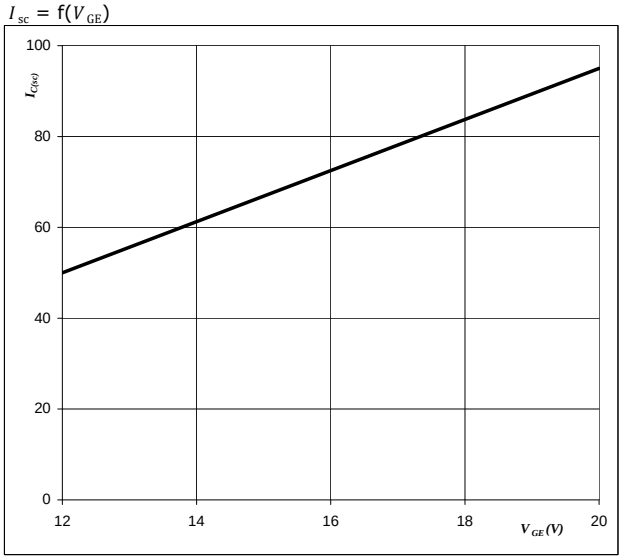
At

V_{CE} =	600	V
T_j ≤	150	ºC

Figure 28 **Inverter\Brake Switch**

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

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



At

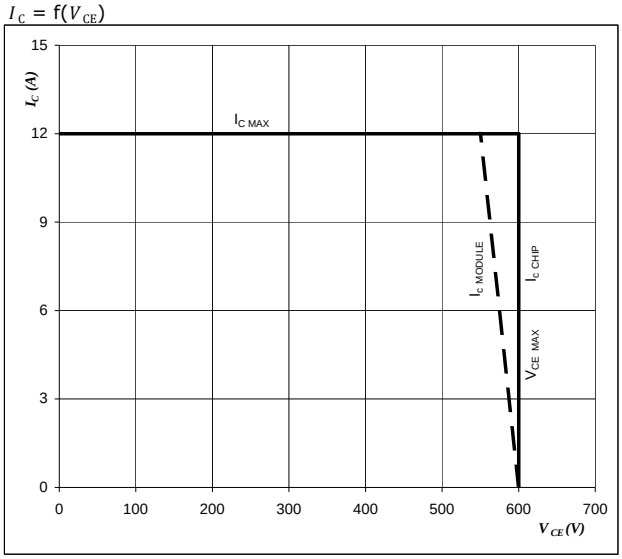
V_{CE} ≤	400	V
T_j =	150	ºC

Characteristics Inverter\Brake

Figure 29 **IGBT**

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

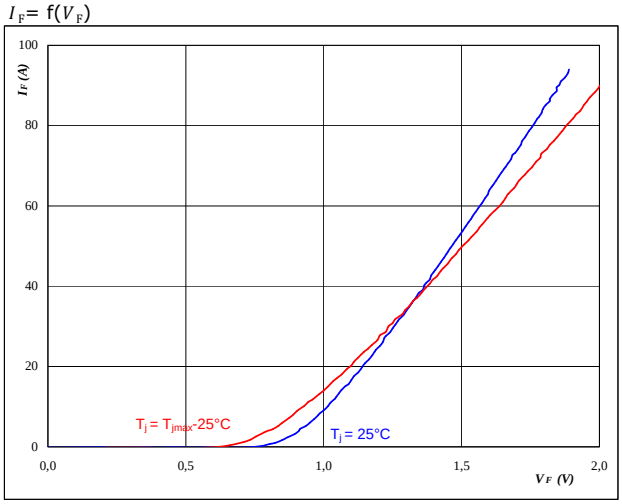
T_j = T_{jmax}-25 ºC

Rectifier Diode

Figure 1 **Rectifier diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



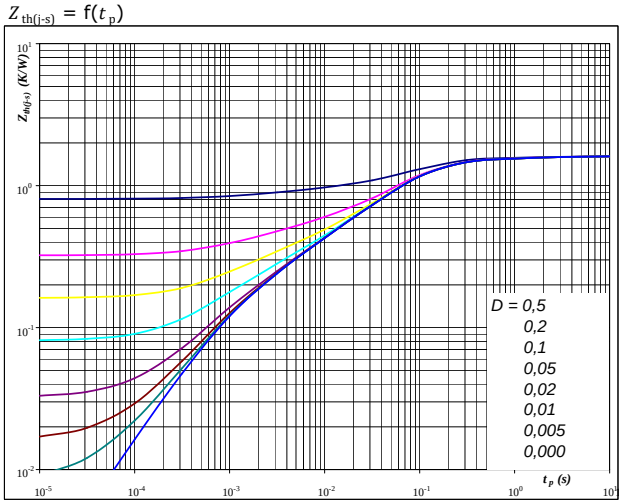
At

t_p = 250 µs

Figure 2 **Rectifier diode**

Diode transient thermal impedance as a function of pulse width

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



At

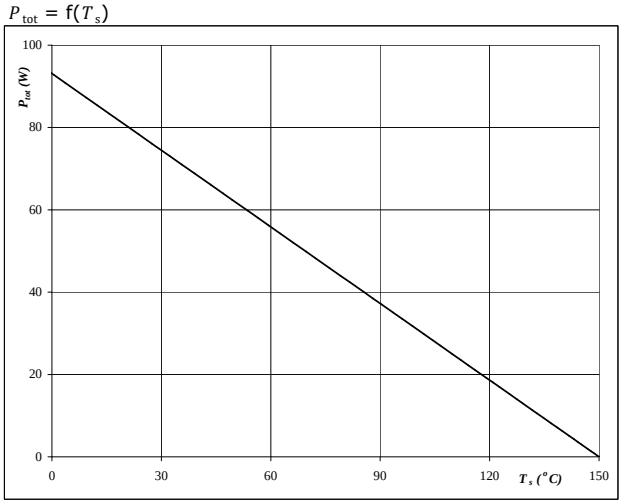
D = t_p / T

$R_{th(j-s)}$ = 1,61 K/W

Figure 3 **Rectifier diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



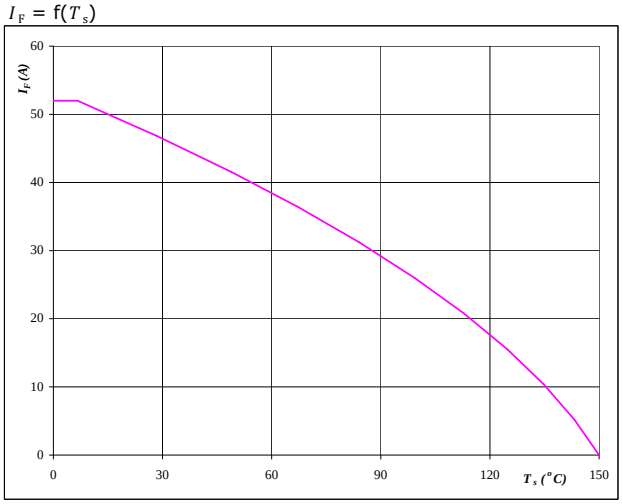
At

T_j = 150 ºC

Figure 4 **Rectifier diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

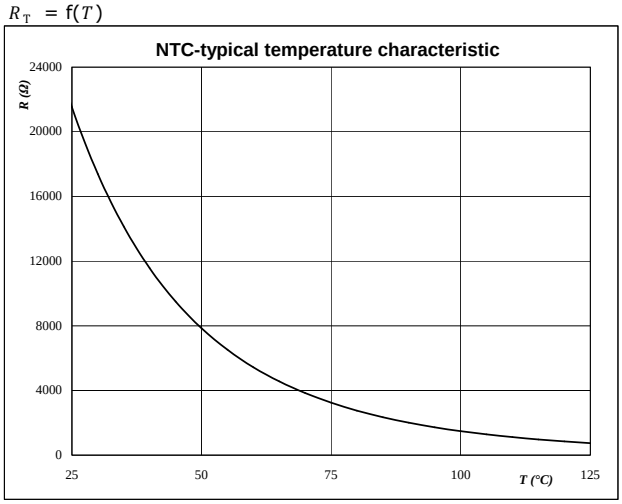
T_j = 150 ºC

Thermistor

Figure 1 **Thermistor**

Typical NTC characteristic as a function of temperature

$R_T = f(T)$



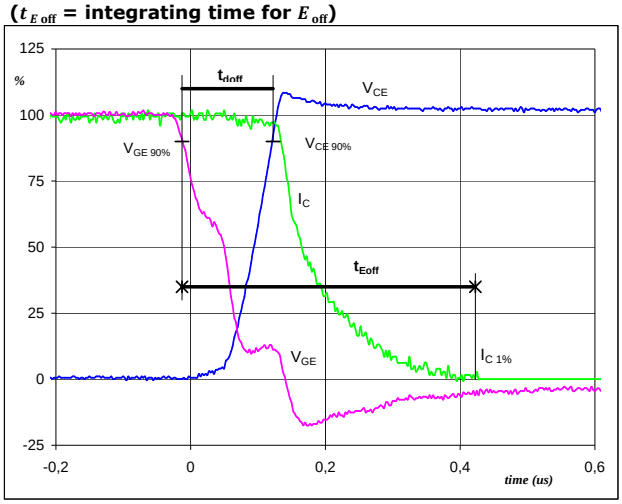
Switching Definitions Inverter

General conditions

T_j	=	125 °C
R_{gon}	=	32 Ω
R_{goff}	=	16 Ω

Figure 1 — **Inverter Switch**

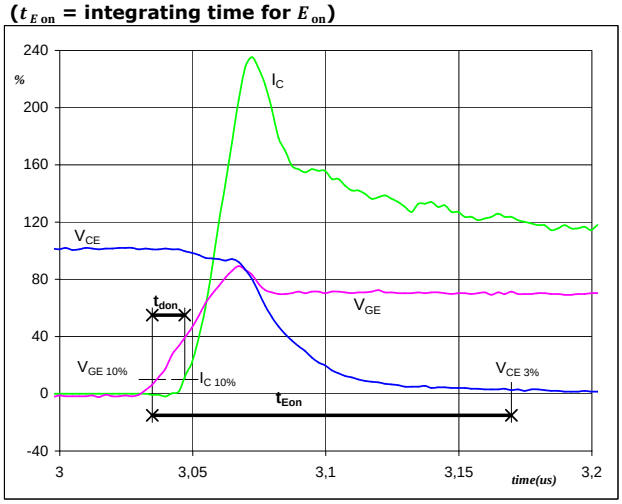
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	6	A
t_{doff} =	0,13	µs
$t_{E\,off}$ =	0,44	µs

Figure 2 — **Inverter Switch**

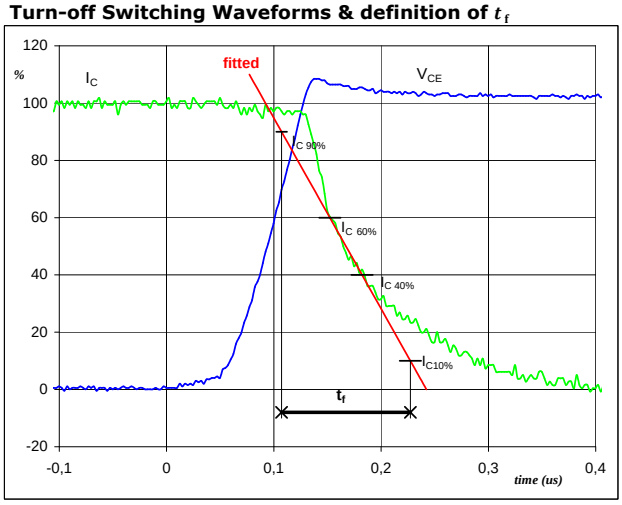
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	0	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	6	A
t_{don} =	0,01	µs
$t_{E\,on}$ =	0,13	µs

Figure 3 — **Inverter Switch**

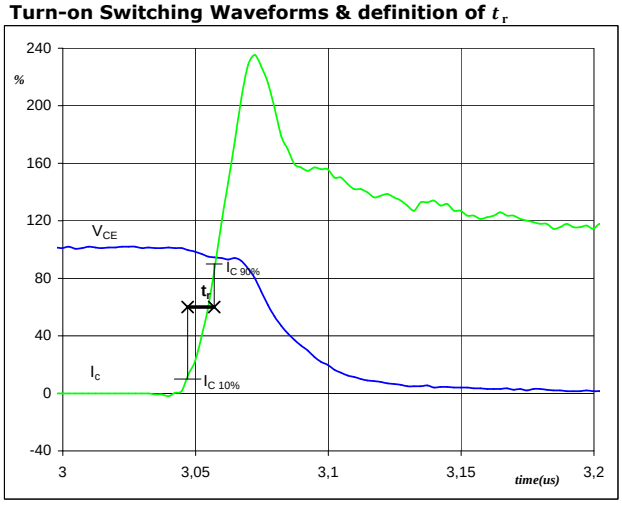
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	6	A
t_f =	0,12	µs

Figure 4 — **Inverter Switch**

Turn-on Switching Waveforms & definition of t_r

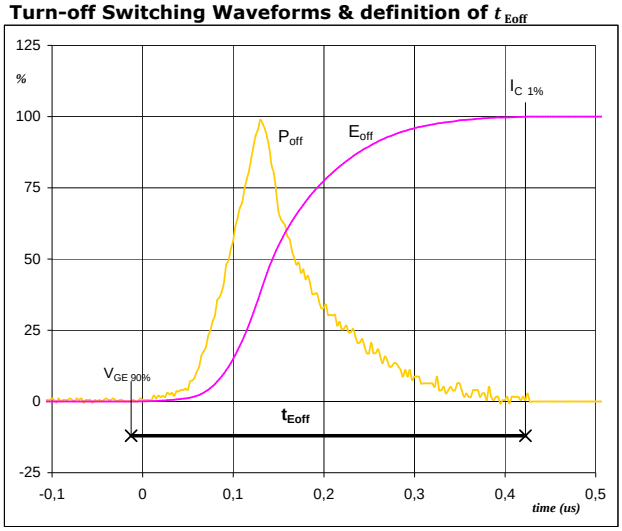


V_C (100%) =	300	V
I_C (100%) =	6	A
t_r =	0,01	µs

Switching Definitions Output Inverter

Figure 5 **Inverter Switch**

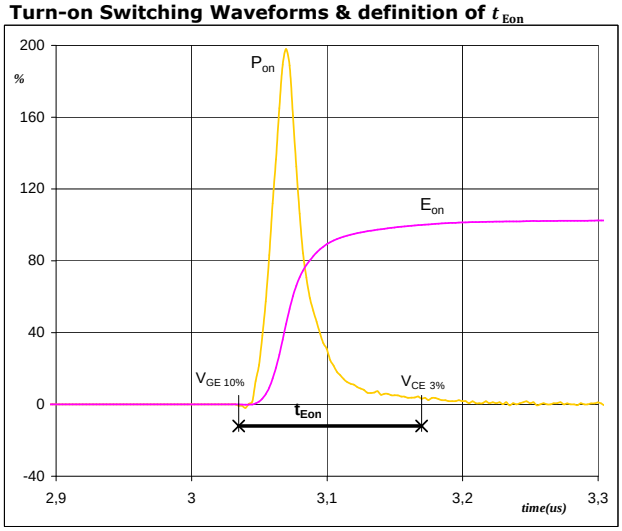
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	1,79	kW
E_{off} (100%) =	0,19	mJ
$t_{E\,off}$ =	0,44	µs

Figure 6 **Inverter Switch**

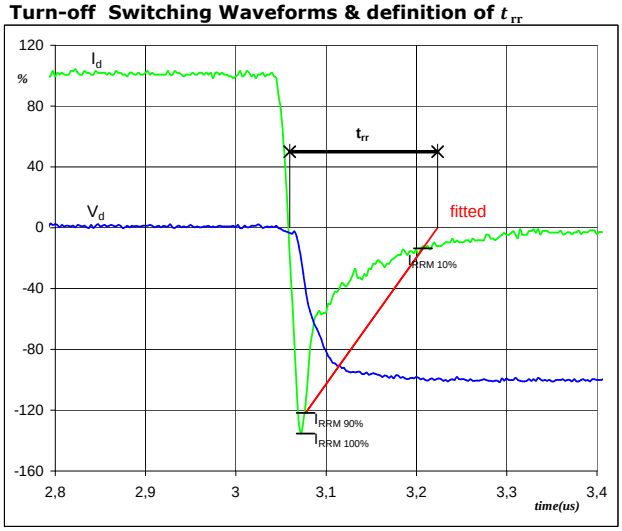
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	1,79	kW
E_{on} (100%) =	0,10	mJ
$t_{E\,on}$ =	0,13	µs

Figure 7 **Inverter Switch**

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

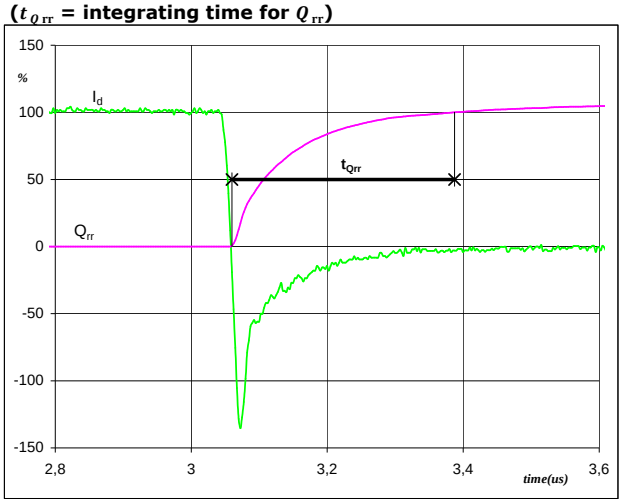


V_d (100%) =	300	V
I_d (100%) =	6	A
I_{RRM} (100%) =	8	A
t_{rr} =	0,16	µs

Switching Definitions Output Inverter

Figure 8 **Inverter Diode**

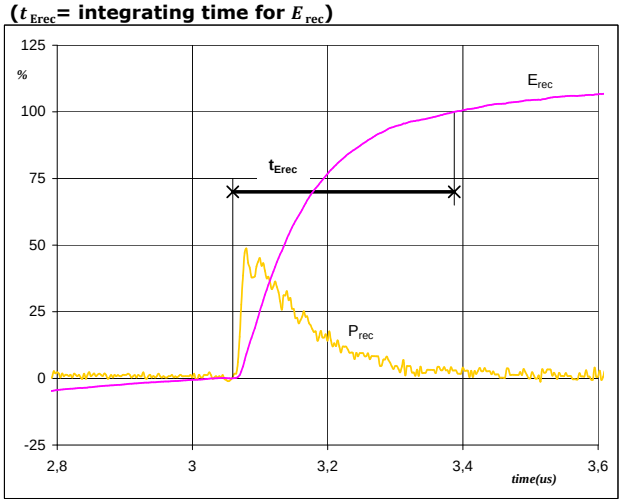
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	6	A
Q_{rr} (100%) =	0,43	µC
$t_{Q\,rr}$ =	0,33	µs

Figure 9 **Inverter Diode**

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



P_{rec} (100%) =	1,79	kW
E_{rec} (100%) =	0,09	mJ
$t_{E\,rec}$ =	0,33	µs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

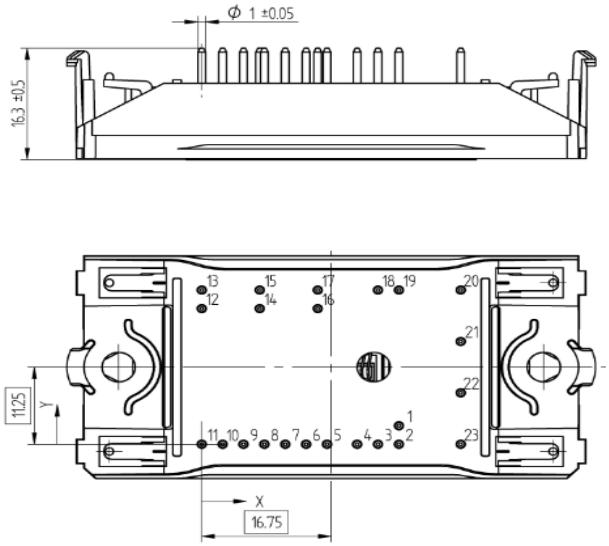
Version	Ordering Code
without thermal paste 12mm housing with solder pins	V23990-P541-A28-PM
without thermal paste 17mm housing with solder pins	V23990-P541-A29-PM
without thermal paste 12mm housing with solder pins with 1 phase Rectifier	V23990-P541-B28-PM
without thermal paste 17mm housing with solder pins with 1 phase Rectifier	V23990-P541-B129-PM
without thermal paste 17mm housing with solder pins w/o BRC	V23990-P541-C29-PM
without thermal paste 12mm housing with solder pins w/o BRC with 1 phase Rectifier	V23990-P541-D28-PM
without thermal paste 17mm housing with solder pins w/o BRC with 1 phase Rectifier	V23990-P541-D129-PM

Text	**VIN**	**Date code**	**Name&Ver**	**UL**	**Lot**	**Serial**
	VIN	WWYY	NNNNNNVV	UL	LLLLL	SSSS
Datamatrix	**Type&Ver**	**Lot number**	**Serial**	**Date code**		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

Outline

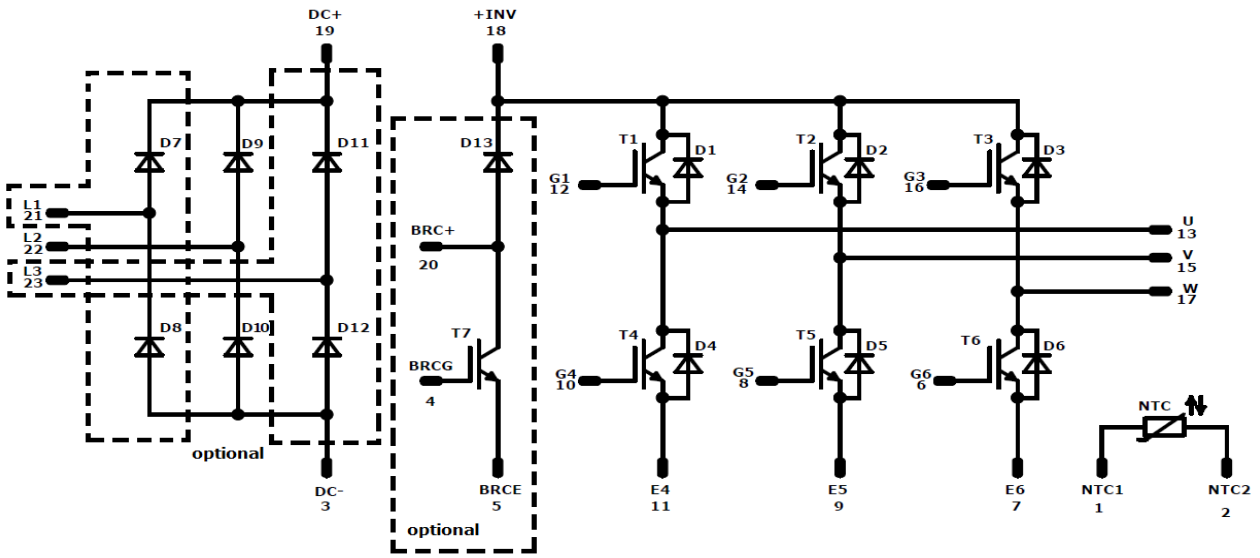
Pin table			
Pin	X	Y	Function
1	25,5	2,7	NTC1
2	25,5	0	NTC2
3	22,8	0	-DC
4	20,1	0	BRCG
5	16,2	0	BRCE
6	13,5	0	G6
7	10,8	0	E6
8	8,1	0	G5
9	5,4	0	E5
10	2,7	0	G4
11	0	0	E4
12	0	19,8	G1
13	0	22,5	U
14	7,5	19,8	G2
15	7,5	22,5	V
16	15	19,8	G3
17	15	22,5	W
18	22,8	22,5	+INV
19	25,5	22,5	+DC
20	33,5	22,5	BRC+
21	33,5	15	L1
22	33,5	7,5	L2
23	33,5	0	L3

Pinout variation	
Module subtype	Not assembled pins
P541-A28	-
P541-A29	-
P541-B28	21
P541-B129	23
P541-C29	4,5,20
P541-D28	4,5,20,21
P541-D129	4,5,20,23



Ordering Code and Marking - Outline - Pinout

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1-T6	IGBT	600 V	6 A	Inverter Switch	
D1-D6	FWD	600 V	6 A	Inverter Diode	
T7	IGBT	600 V	6 A	Brake Switch	
D13	FWD	600 V	6 A	Brake Diode	
D7-D12	Rectifier	1600 V	25 A	Rectifier Diode	
NTC	NTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**135**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for *flow* 0 packages see vincotech.com website.

Package data
Package data for *flow* 0 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
V23990-P541-x2x-D7-14	23 Apr. 2016		all