



Vincotech

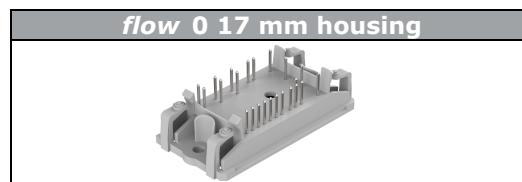
V23990-P541-A20-PM

datasheet

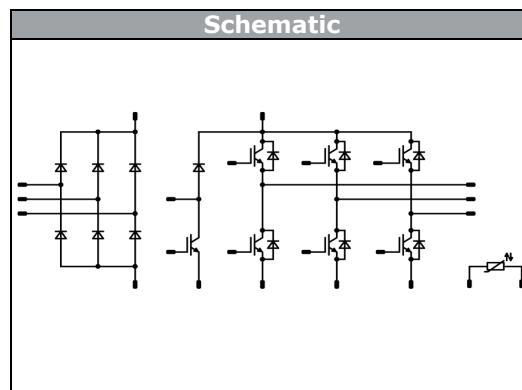
flow PIM 0

600 V / 6 A

Features
<ul style="list-style-type: none"> Clip-in housing Trench Fieldstop IGBT's for low saturation losses Optional w/o BRC



Target Applications
<ul style="list-style-type: none"> Industrial Drives Embedded Drives



Types
• V23990-P541-A20-PM

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Rectifier Diode				
Repetitive peak reverse voltage	V_{RRM}		1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$	32	A
Surge (non-repetitive) forward current	I_{FSM}	$t_p = 10 \text{ ms}$	200	A
I^2t -value	I^2t	$T_j = 150^\circ\text{C}$	200	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	43	W
Maximum Junction Temperature	T_{jmax}		150	$^\circ\text{C}$

Inverter Switch / Brake Switch

Collector-emitter breakdown voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$	12	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	18	A
Turn off safe operating area		$V_{CE} \leq 1200\text{V}$, $T_j \leq T_{op\ max}$	18	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	36	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq 150^\circ\text{C}$ $V_{GE} = 15\text{V}$	6 360	μs V
Maximum Junction Temperature	T_{jmax}		175	$^\circ\text{C}$

Maximum Ratings

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

Parameter	Symbol	Condition	Value	Unit
Inverter Diode / Brake Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		600	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80^\circ\text{C}$	12	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	12	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80^\circ\text{C}$	27	W
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...+($T_{jmax} - 25$)	$^\circ\text{C}$

Isolation Properties

Isolation voltage	V_{is}	$t = 2\text{ s}$	DC Test Voltage *	6000	V
		$t = 1\text{ min}$	AC Voltage	2500	V
Creepage distance				min 12,7	mm
Clearance				10,07	mm
Comparative tracking index	CTI			>200	

* 100% tested in production



Vincotech

V23990-P541-A20-PM

datasheet

Characteristic Values

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

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		145			1,1	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4 \text{ W/mK}$					1,61		K/W

Inverter Switch / Brake Switch

Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$		0,00009	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CESat}		15	6	25 150	1	1,52 1,7	2,1	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600	25			0,06	mA
Gate-emitter leakage current	I_{GES}		20	0	25			350	nA
Integrated Gate resistor	R_{gint}						none		Ω
Turn-on delay time	$t_{d(on)}$				25 150		12 10		
Rise time	t_r				25 150		8 11		ns
Turn-off delay time	$t_{d(off)}$	$R_{goff} = 16 \Omega$ $R_{gon} = 32 \Omega$	15	300	6	25 150	118 134		
Fall time	t_f				25 150		87 116		
Turn-on energy loss	E_{on}				25 150		0,07 0,10		
Turn-off energy loss	E_{off}				25 150		0,15 0,19		mWs
Input capacitance	C_{ies}						368		
Output capacitance	C_{oss}	$f = 1 \text{ MHz}$	0	25		25	28		pF
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 $\lambda = 3,4 \text{ W/mK}$					2,66		K/W

Inverter Diode / Brake Diode

Diode forward voltage	V_F			6	25 150	1	1,64 1,56	2,5	V
Peak reverse recovery current	I_{RRM}				25 150		8 8		A
Reverse recovery time	t_{rr}				25 150		73 163		ns
Reverse recovered charge	Q_{rr}	$R_{gon} = 32 \Omega$	15	300	6	25 150	0,23 0,43		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$				25 150		569 338		A/μs
Reverse recovered energy	E_{rec}				25 150		0,04 0,09		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material $\lambda = 3,4 \text{ W/mK}$					3,5		K/W

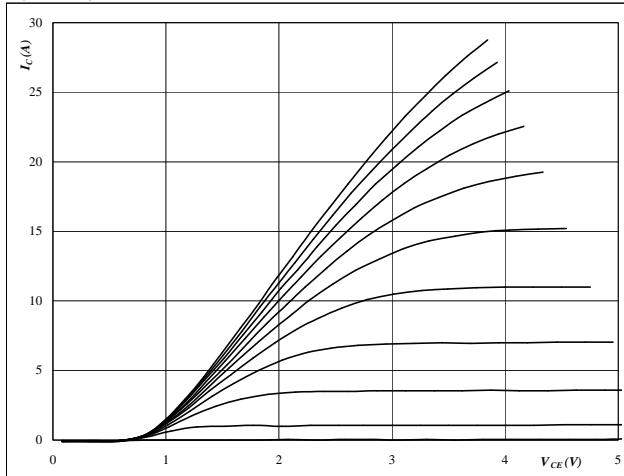
Thermistor

Rated resistance	R				25		22000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1484 \Omega$			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		

Inverter / Brake Characteristics

figure 1.**Typical output characteristics****IGBT**

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

**At**

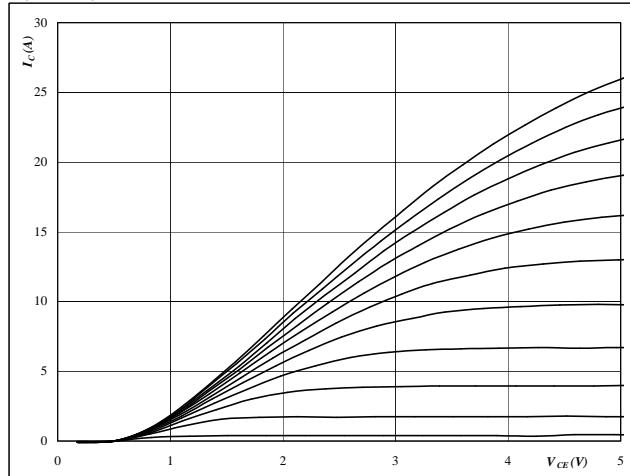
$$t_p = 250 \mu\text{s}$$

$$T_j = 25^\circ\text{C}$$

V_{GE} from 7 V to 17 V in steps of 1 V

figure 2.**Typical output characteristics****IGBT**

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

**At**

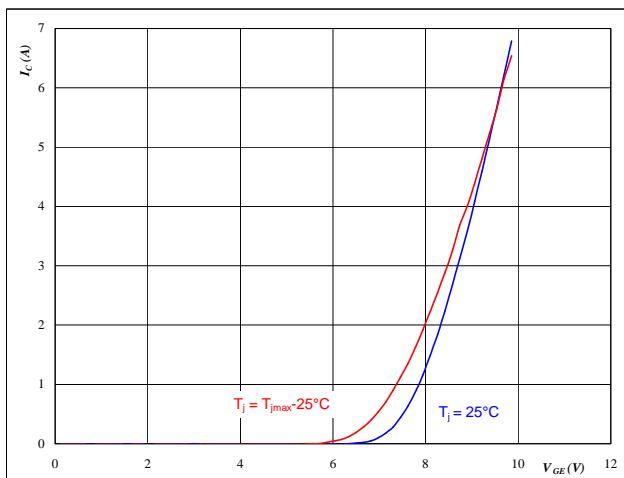
$$t_p = 250 \mu\text{s}$$

$$T_j = 125^\circ\text{C}$$

V_{GE} from 7 V to 17 V in steps of 1 V

figure 3.**Typical transfer characteristics****IGBT**

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

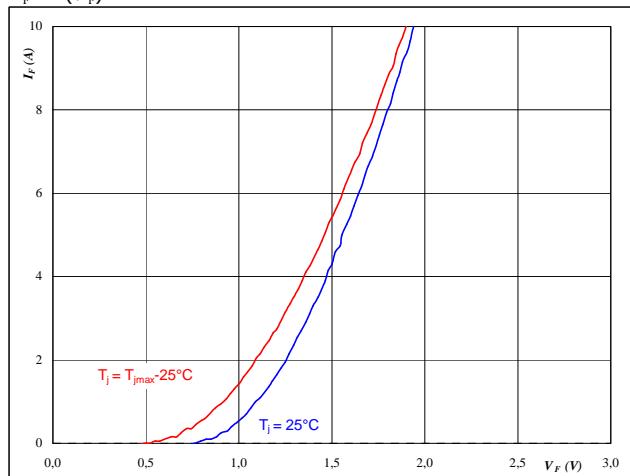
**At**

$$t_p = 250 \mu\text{s}$$

$$V_{CE} = 10 \text{ V}$$

figure 4.**Typical diode forward current as a function of forward voltage****FWD**

$$I_F = f(V_F)$$

**At**

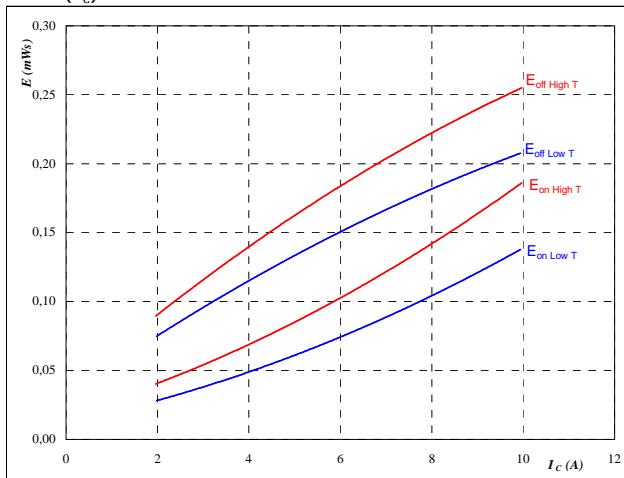
$$t_p = 250 \mu\text{s}$$

Inverter / Brake Characteristics

figure 5.

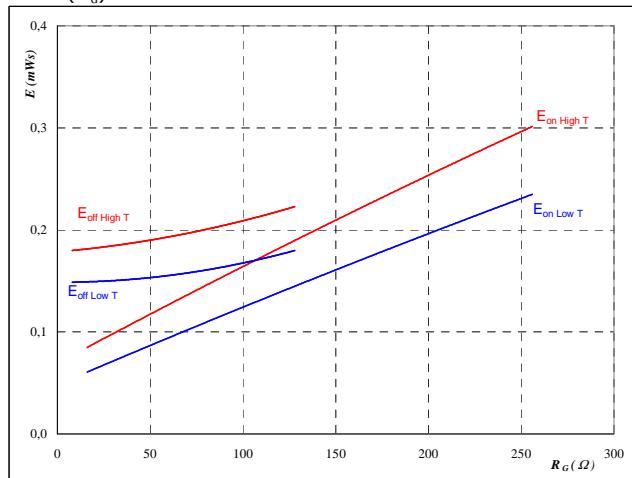
**Typical switching energy losses
as a function of collector current**

$$E = f(I_C)$$

**IGBT****figure 6.**

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

$$E = f(R_G)$$

**IGBT**

With an inductive load at

$$T_j = 25/125 \quad ^\circ\text{C}$$

$$V_{CE} = 300 \quad \text{V}$$

$$V_{GE} = 15 \quad \text{V}$$

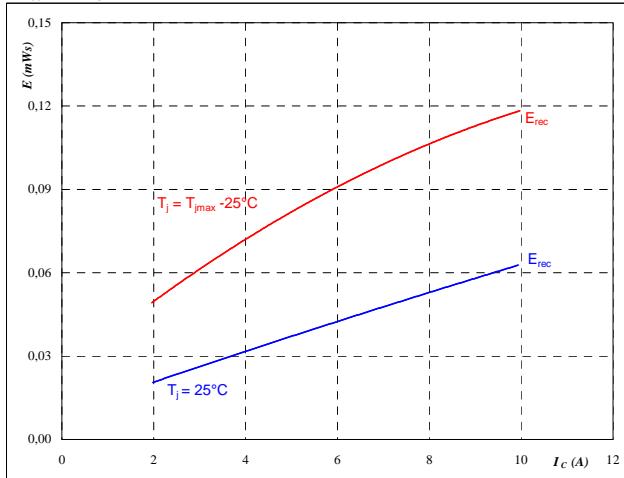
$$R_{gon} = 32 \quad \Omega$$

$$R_{goff} = 16 \quad \Omega$$

figure 7.

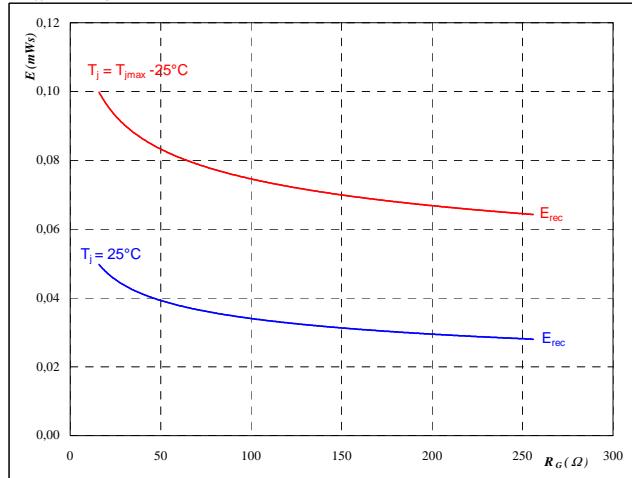
**Typical reverse recovery energy loss
as a function of collector current**

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

**FWD****figure 8.**

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

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

**FWD**

With an inductive load at

$$T_j = 25/125 \quad ^\circ\text{C}$$

$$V_{CE} = 300 \quad \text{V}$$

$$V_{GE} = 15 \quad \text{V}$$

$$R_{gon} = 32 \quad \Omega$$

With an inductive load at

$$T_j = 25/125 \quad ^\circ\text{C}$$

$$V_{CE} = 300 \quad \text{V}$$

$$V_{GE} = 15 \quad \text{V}$$

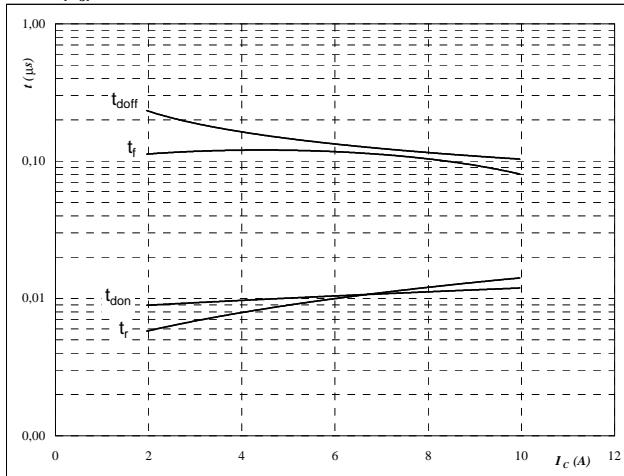
$$I_C = 6 \quad \text{A}$$

Inverter / Brake Characteristics

figure 9.

Typical switching times as a function of collector current

$$t = f(I_C)$$



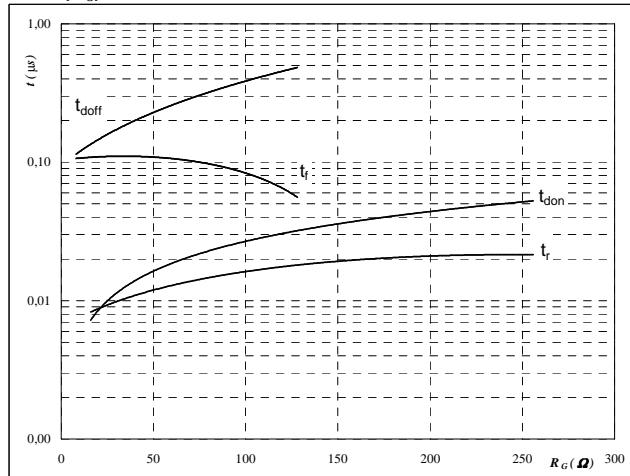
With an inductive load at

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

figure 10.

Typical switching times as a function of gate resistor

$$t = f(R_G)$$



With an inductive load at

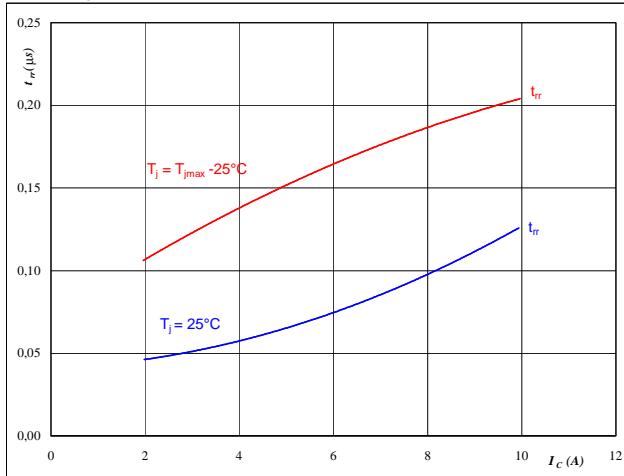
$T_j =$	125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$I_C =$	6	A

figure 11.

FWD

Typical reverse recovery time as a function of collector current

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



At

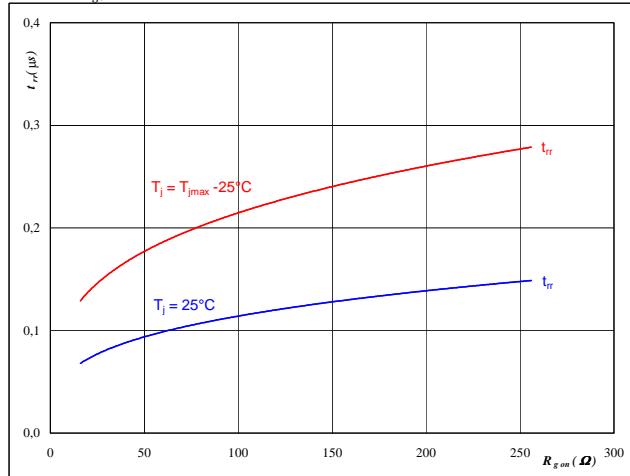
$T_j =$	25/125	°C
$V_{CE} =$	300	V
$V_{GE} =$	15	V
$R_{gon} =$	32	Ω

figure 12.

FWD

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

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



At

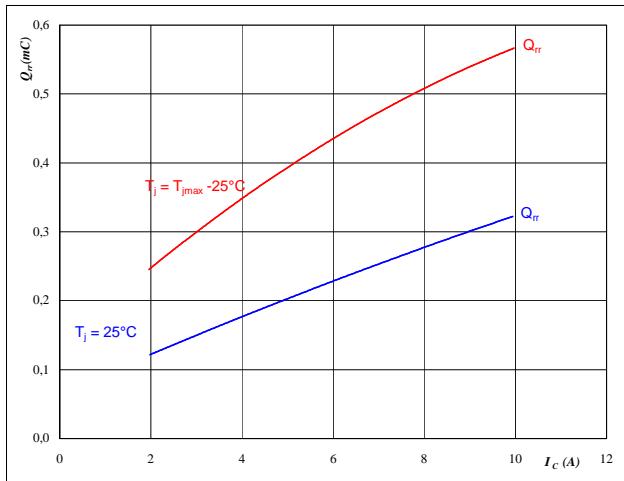
$T_j =$	25/125	°C
$V_R =$	300	V
$I_F =$	6	A
$V_{GE} =$	15	V

Inverter / Brake Characteristics

figure 13.**FWD**

Typical reverse recovery charge as a function of collector current

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

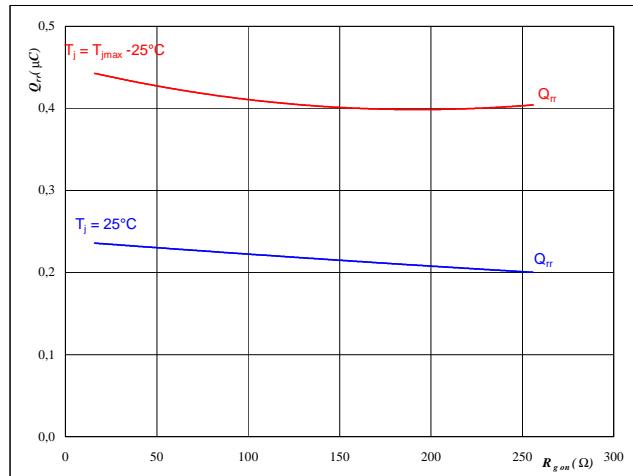
**At**

$T_j = 25/125 \quad ^\circ\text{C}$
 $V_{CE} = 300 \quad \text{V}$
 $V_{GE} = 15 \quad \text{V}$
 $R_{gon} = 32 \quad \Omega$

figure 14.**FWD**

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

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

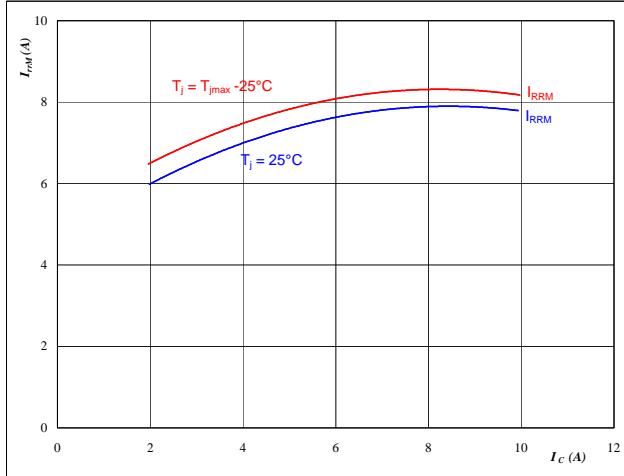
**At**

$T_j = 25/125 \quad ^\circ\text{C}$
 $V_R = 300 \quad \text{V}$
 $I_F = 6 \quad \text{A}$
 $V_{GE} = 15 \quad \text{V}$

figure 15.**FWD**

Typical reverse recovery current as a function of collector current

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

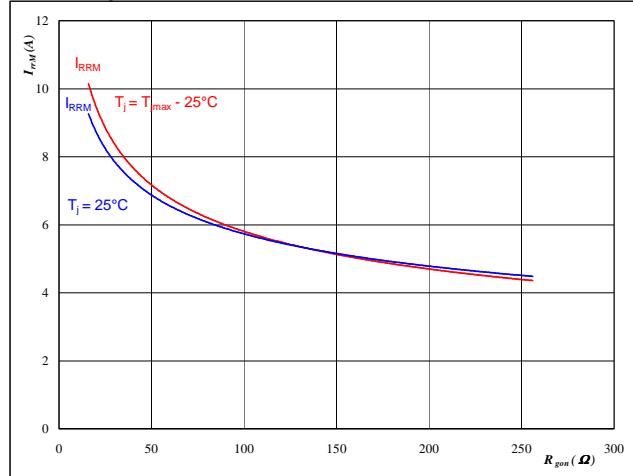
**At**

$T_j = 25/125 \quad ^\circ\text{C}$
 $V_{CE} = 300 \quad \text{V}$
 $V_{GE} = 15 \quad \text{V}$
 $R_{gon} = 32 \quad \Omega$

figure 16.**FWD**

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

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

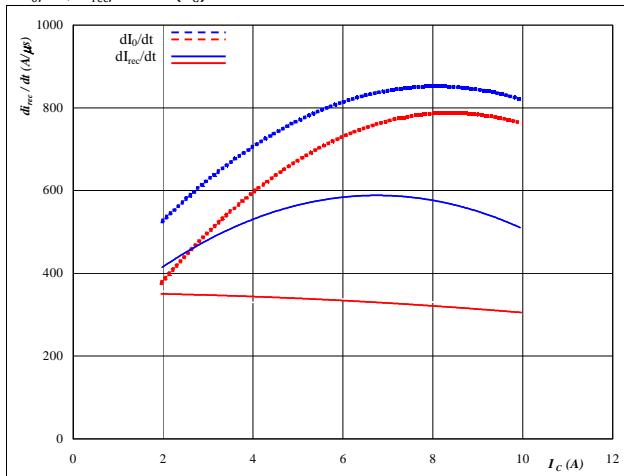
**At**

$T_j = 25/125 \quad ^\circ\text{C}$
 $V_R = 300 \quad \text{V}$
 $I_F = 6 \quad \text{A}$
 $V_{GE} = 15 \quad \text{V}$

Inverter / Brake Characteristics

figure 17.**FWD**

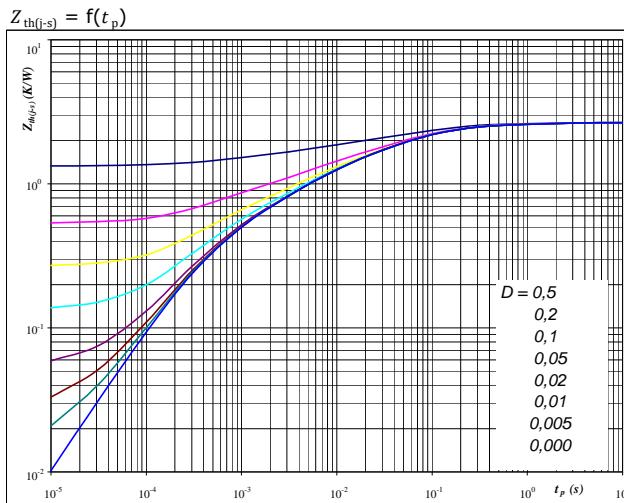
Typical rate of fall of forward and reverse recovery current as a function of collector current
 $dI_0/dt, dI_{rec}/dt = f(I_c)$

**At**

$T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_{CE} = 300 \text{ V}$
 $V_{GE} = 15 \text{ V}$
 $R_{gon} = 32 \Omega$

figure 19.**IGBT**

IGBT transient thermal impedance as a function of pulse width
 $Z_{th(j-s)} = f(t_p)$

**At**

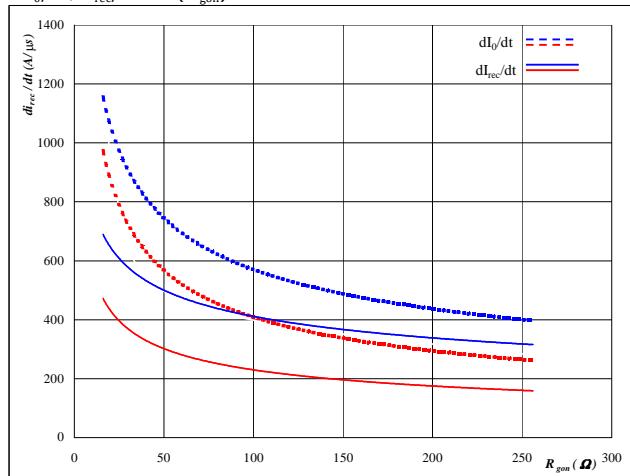
$D = t_p / T$
 $R_{th(j-s)} = 2,66 \text{ K/W}$

IGBT thermal model values

R (K/W)	Tau (s)
1,12E-01	1,79E+00
4,34E-01	1,79E-01
8,19E-01	4,95E-02
6,08E-01	9,45E-03
3,80E-01	2,26E-03
3,08E-01	3,96E-04

figure 18.**FWD**

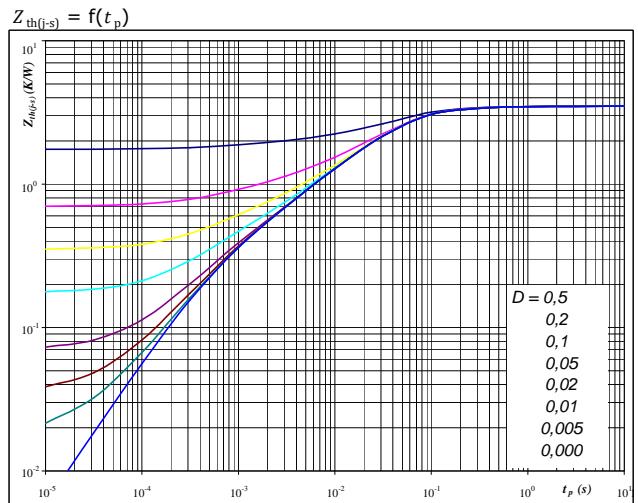
Typical rate of fall of forward and reverse recovery current as a function of IGBT turn on gate resistor
 $dI_0/dt, dI_{rec}/dt = f(R_{gon})$

**At**

$T_j = 25/125 \text{ } ^\circ\text{C}$
 $V_R = 300 \text{ V}$
 $I_F = 6 \text{ A}$
 $V_{GE} = 15 \text{ V}$

figure 20.**FWD**

FWD transient thermal impedance as a function of pulse width
 $Z_{th(j-s)} = f(t_p)$

**At**

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

FWD thermal model values

R (K/W)	Tau (s)
8,07E-02	1,31E+00
4,10E-01	1,54E-01
2,02E+00	3,86E-02
5,25E-01	9,91E-03
2,71E-01	2,43E-03
1,93E-01	5,12E-04

Inverter / Brake Characteristics

figure 21.

Power dissipation as a function of heatsink temperature

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

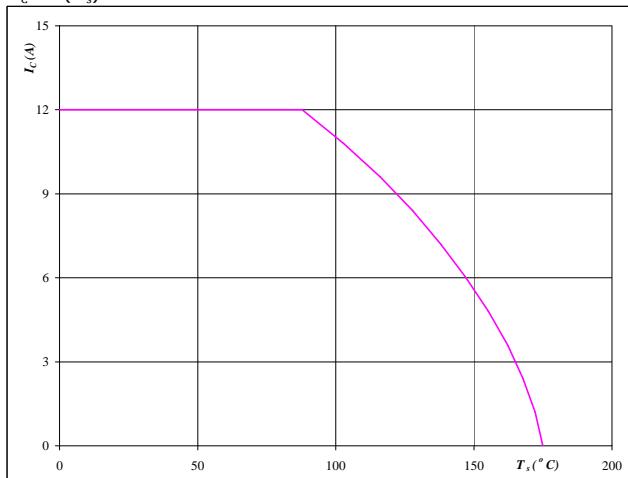
**At**

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

IGBT**figure 22.**

Collector current as a function of heatsink temperature

$$I_C = f(T_s)$$

**At**

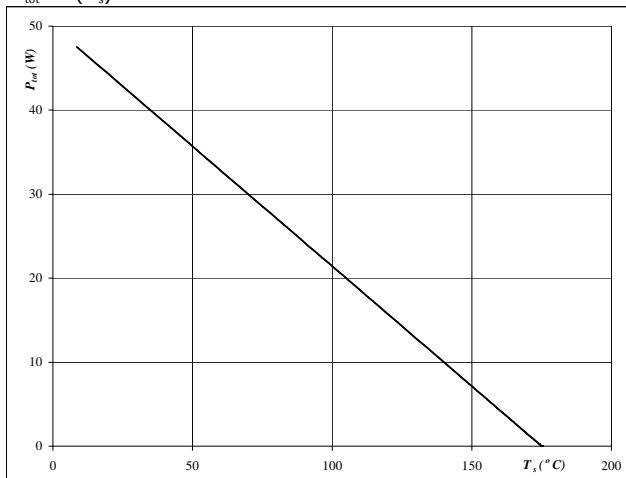
$$T_j = 175 \quad {}^\circ\text{C}$$

$$V_{\text{GE}} = 15 \quad \text{V}$$

figure 23.**FWD**

Power dissipation as a function of heatsink temperature

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

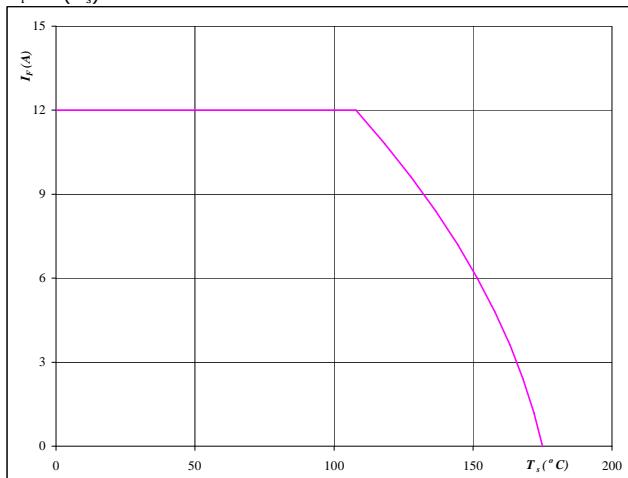
**At**

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

figure 24.**FWD**

Forward current as a function of heatsink temperature

$$I_F = f(T_s)$$

**At**

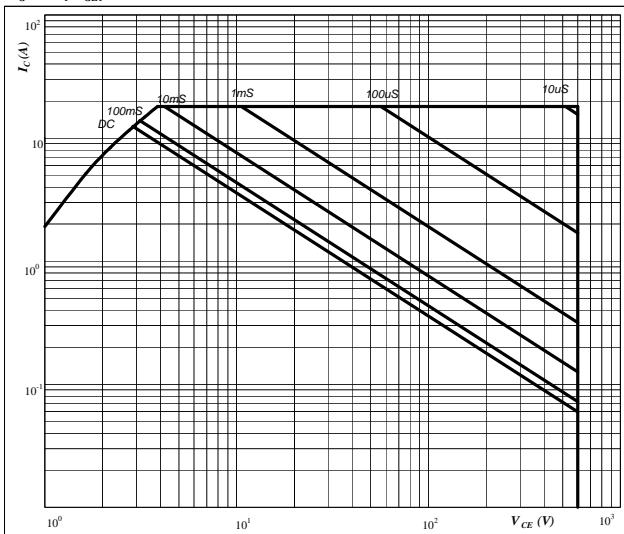
$$T_j = 175 \quad {}^\circ\text{C}$$

Inverter / Brake Characteristics

figure 25.

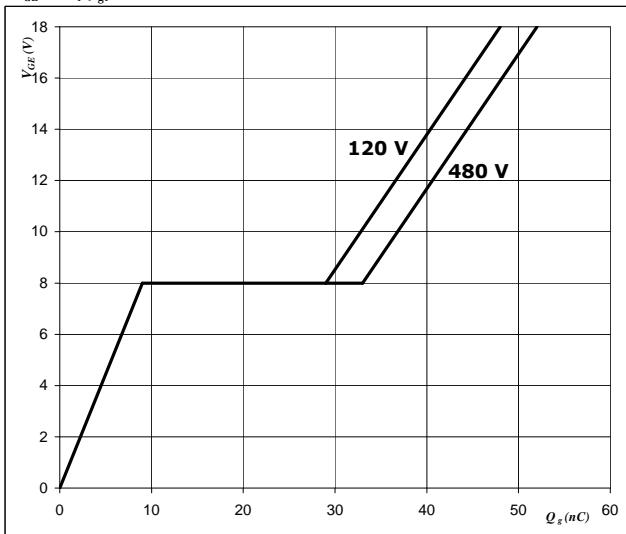
Safe operating area as a function of collector-emitter voltage

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


At
 $D = \text{single pulse}$
 $T_s = 80 \quad {}^\circ\text{C}$
 $V_{GE} = 15 \quad \text{V}$
 $T_j = T_{jmax}$
IGBT
figure 26.

Gate voltage vs Gate charge

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

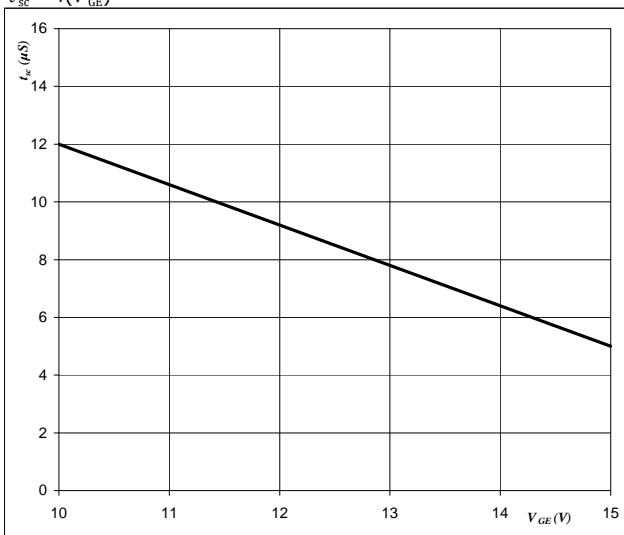

At

$I_C = 6 \quad \text{A}$

figure 27.
IGBT

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

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


At
 $V_{CE} = 600 \quad \text{V}$
 $T_j \leq 150 \quad {}^\circ\text{C}$
figure 28.
IGBT

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

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

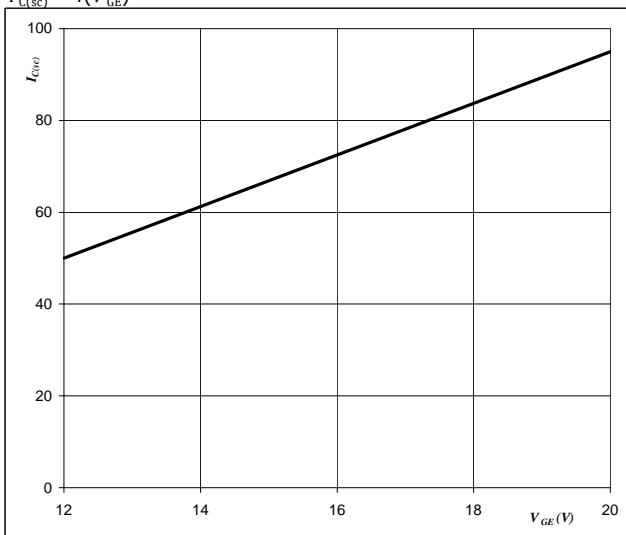
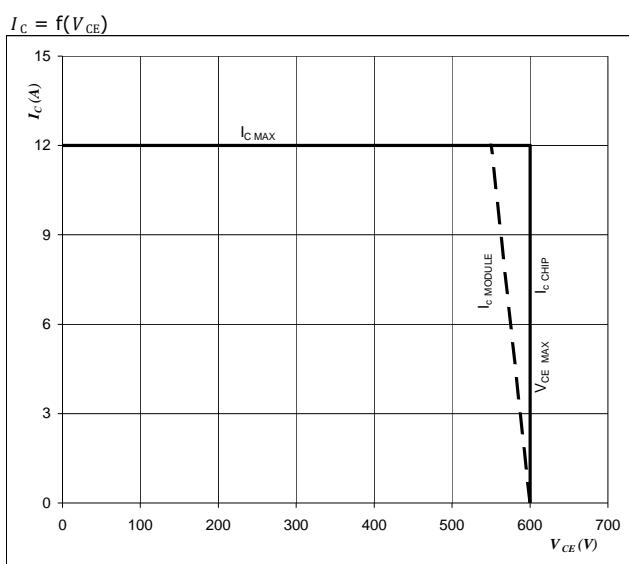

At
 $V_{CE} \leq 400 \quad \text{V}$
 $T_j = 150 \quad {}^\circ\text{C}$

figure 29.

IGBT

Reverse bias safe operating area

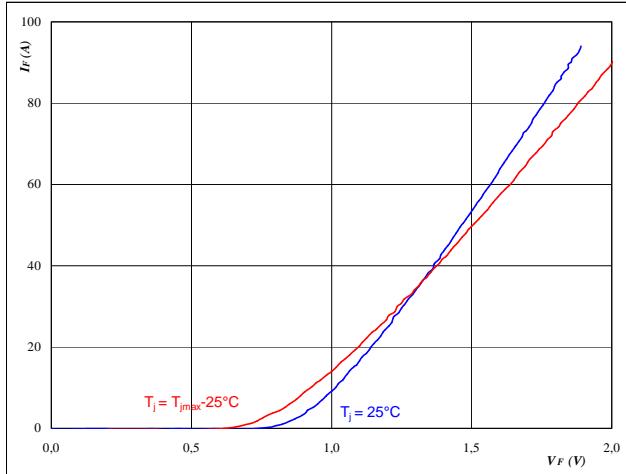
**At** $T_j = T_{jmax} - 25 \text{ } ^\circ\text{C}$

Rectifier Diode

figure 1.**Rectifier Diode**

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$

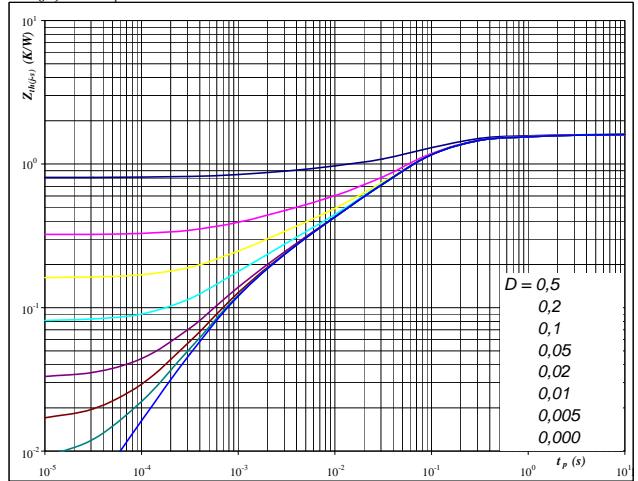
**At**

$$t_p = 250 \mu\text{s}$$

figure 2.**Rectifier Diode**

Diode transient thermal impedance as a function of pulse width

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

**At**

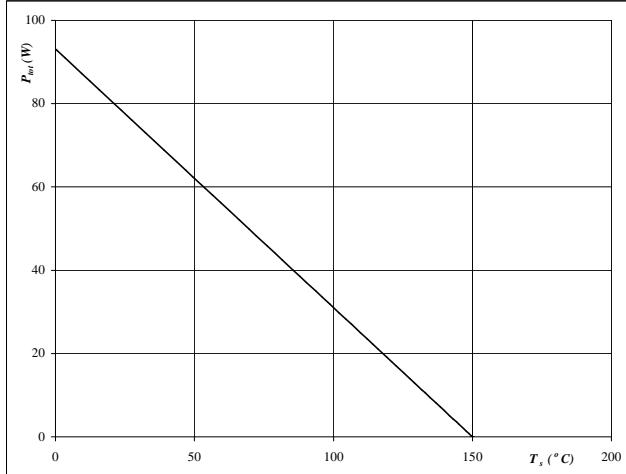
$$D = t_p / T$$

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

figure 3.**Rectifier Diode**

Power dissipation as a function of heatsink temperature

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

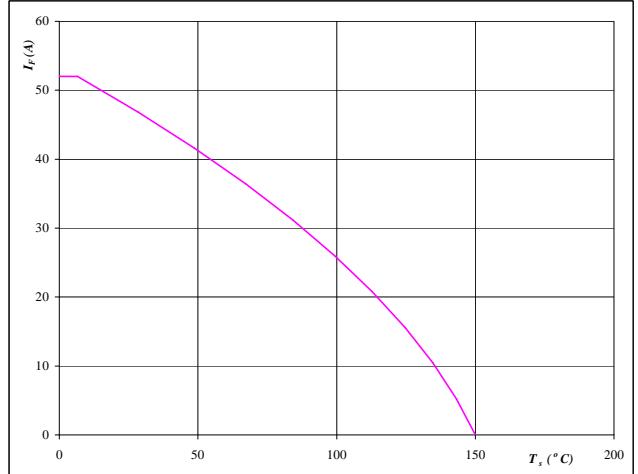
**At**

$$T_j = 150 \text{ }^{\circ}\text{C}$$

figure 4.**Rectifier Diode**

Forward current as a function of heatsink temperature

$$I_F = f(T_s)$$

**At**

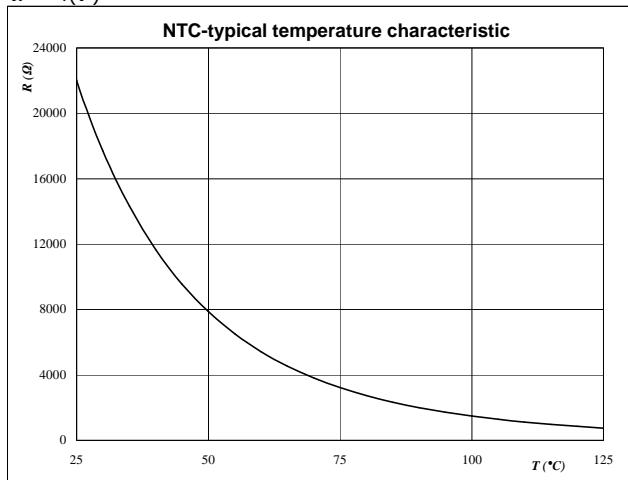
$$T_j = 150 \text{ }^{\circ}\text{C}$$

Thermistor

figure 1.**Thermistor**

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

$$R = f(T)$$



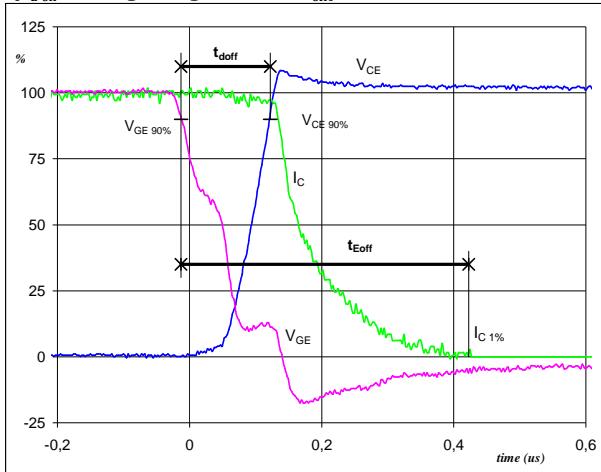
Switching Definitions Inverter

General conditions

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

figure 1.

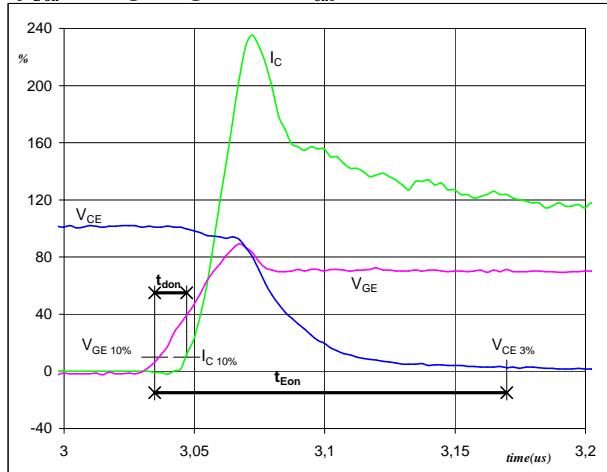
IGBT
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
 $(t_{Eoff} = \text{integrating time for } E_{off})$



$V_{GE}(0\%) = 0 \text{ V}$
 $V_{GE}(100\%) = 15 \text{ V}$
 $V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 6 \text{ A}$
 $t_{doff} = 0,13 \mu\text{s}$
 $t_{Eoff} = 0,44 \mu\text{s}$

figure 2.

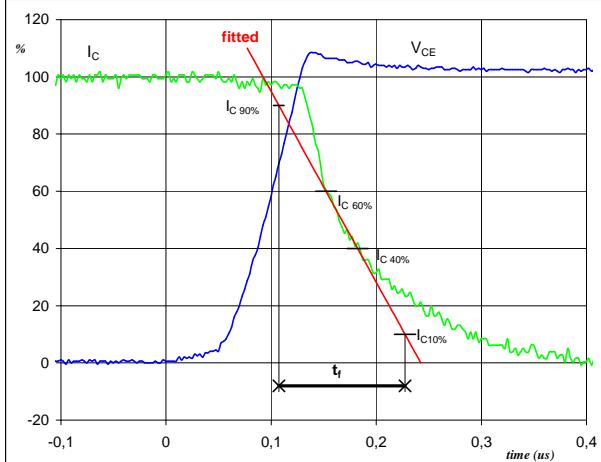
IGBT
Turn-on Switching Waveforms & definition of t_{don} , t_{Eon}
 $(t_{Eon} = \text{integrating time for } E_{on})$



$V_{GE}(0\%) = 0 \text{ V}$
 $V_{GE}(100\%) = 15 \text{ V}$
 $V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 6 \text{ A}$
 $t_{don} = 0,01 \mu\text{s}$
 $t_{Eon} = 0,13 \mu\text{s}$

figure 3.

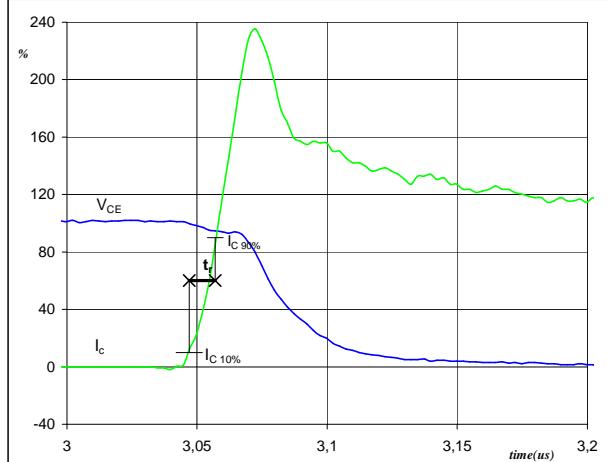
IGBT
Turn-off Switching Waveforms & definition of t_f



$V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 6 \text{ A}$
 $t_f = 0,12 \mu\text{s}$

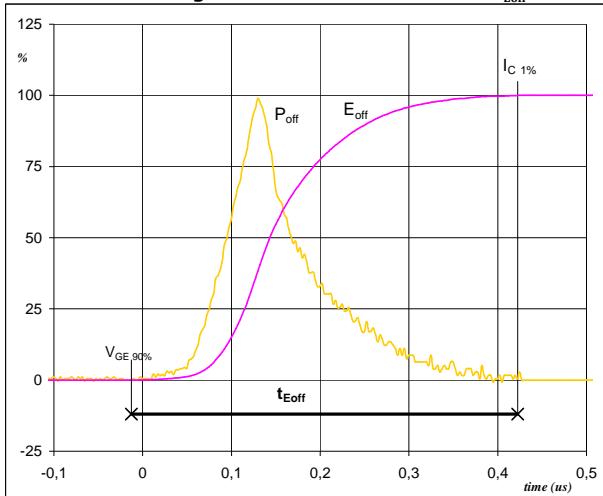
figure 4.

IGBT
Turn-on Switching Waveforms & definition of t_r

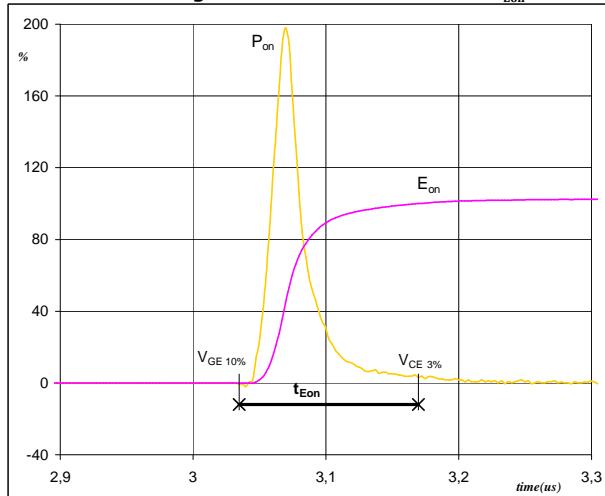


$V_C(100\%) = 300 \text{ V}$
 $I_C(100\%) = 6 \text{ A}$
 $t_r = 0,01 \mu\text{s}$

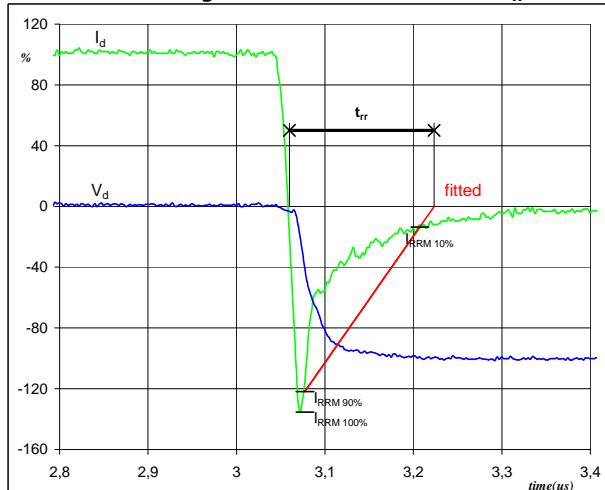
Switching Definitions Inverter

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

$P_{off} (100\%) = 1,79 \text{ kW}$
 $E_{off} (100\%) = 0,19 \text{ mJ}$
 $t_{Eoff} = 0,44 \mu\text{s}$

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

$P_{on} (100\%) = 1,79 \text{ kW}$
 $E_{on} (100\%) = 0,10 \text{ mJ}$
 $t_{Eon} = 0,13 \mu\text{s}$

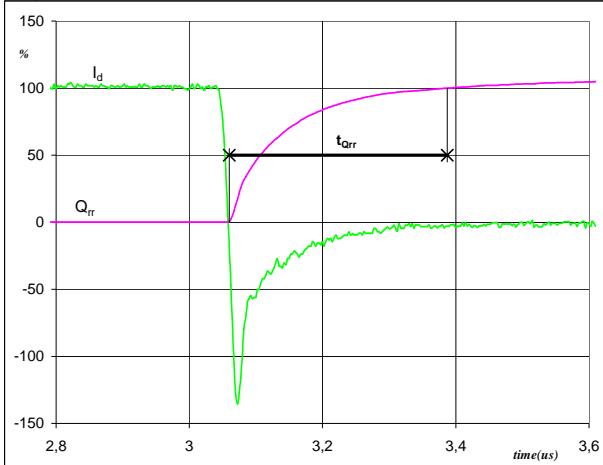
figure 7.**IGBT****Turn-off Switching Waveforms & definition of t_{rr}** 

$V_d (100\%) = 300 \text{ V}$
 $I_d (100\%) = 6 \text{ A}$
 $I_{RRM} (100\%) = 8 \text{ A}$
 $t_{rr} = 0,16 \mu\text{s}$

Switching Definitions Inverter

figure 8.**FWD**

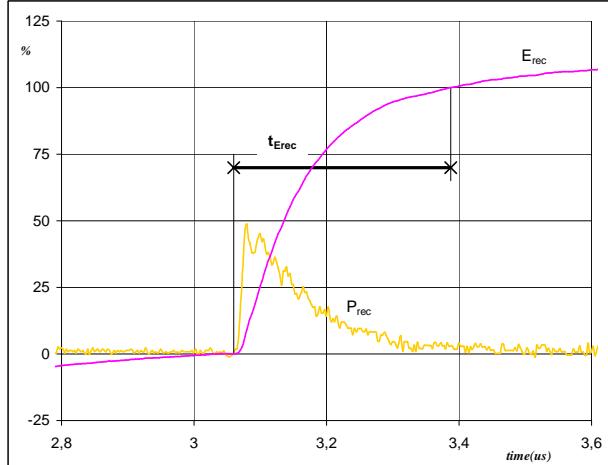
Turn-on Switching Waveforms & definition of t_{Qrr}
 $(t_{Qrr} = \text{integrating time for } Q_{rr})$



$I_d (100\%) = 6 \text{ A}$
 $Q_{rr} (100\%) = 0,43 \mu\text{C}$
 $t_{Qrr} = 0,33 \mu\text{s}$

figure 9.**FWD**

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



$P_{rec} (100\%) = 1,79 \text{ kW}$
 $E_{rec} (100\%) = 0,09 \text{ mJ}$
 $t_{Erec} = 0,33 \mu\text{s}$

Ordering Code & Marking

Version	Ordering Code					
without thermal paste 17 mm housing	V23990-P541-A20-PM					
Text	VIN	Date code	Name&Ver	UL	Lot	Serial
Datamatrix	VIN	WWYY	NNNNVV	UL	LLLLL	SSSS
	Type&Ver	Lot number	Serial	Date code		
	TTTTTWW	LLLLL	SSSS	WWYY		

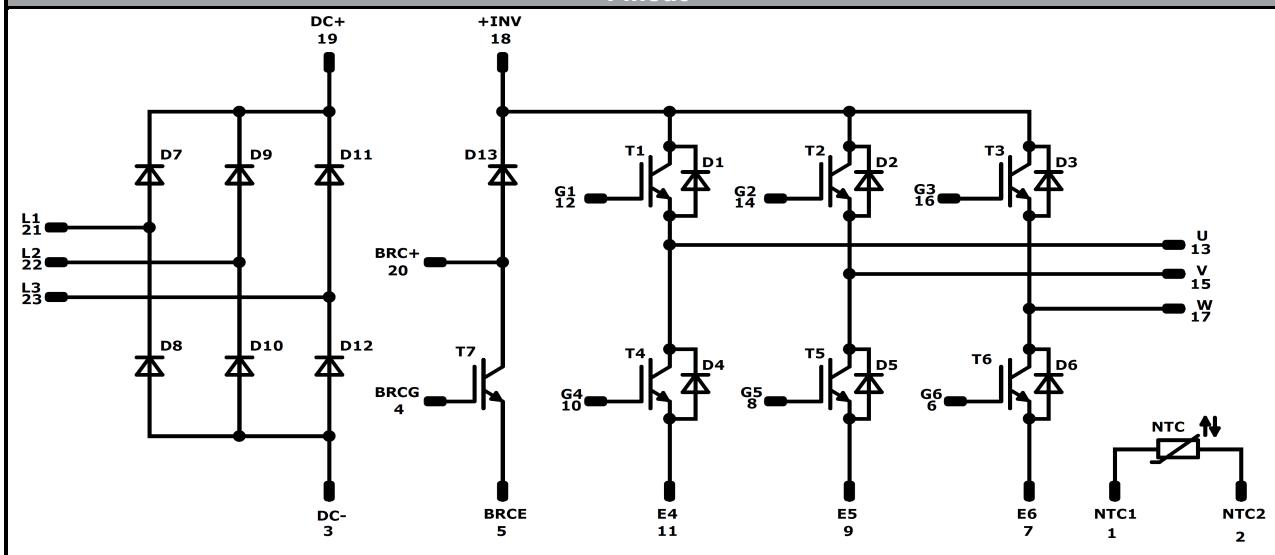
VIN WWYY
NNNNVV
UL
LLLLL SSSS

Outline

Pin table [mm]			
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

Tolerance of positions +05mm of the end of pins
Dimension of coordinate axis is only offset without tolerance

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	



Vincotech

V23990-P541-A20-PM

datasheet

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

Handling instruction
Handling instructions for <i>flow</i> 0 packages see vincotech.com website.

Package data
Package data for <i>flow</i> 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-A20-D3-14	10 Jul. 2017		

DISCLAIMER

The information, specifications, procedures, methods and recommendations herein (together "information") are presented by Vincotech to reader in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. Vincotech reserves the right to make any changes without further notice to any products to improve reliability, function or design. No representation, guarantee or warranty is made to reader as to the accuracy, reliability or completeness of said information or that the application or use of any of the same will avoid hazards, accidents, losses, damages or injury of any kind to persons or property or that the same will not infringe third parties rights or give desired results. It is reader's sole responsibility to test and determine the suitability of the information and the product for reader's intended use.

LIFE SUPPORT POLICY

Vincotech products are not authorised for use as critical components in life support devices or systems without the express written approval of Vincotech.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.