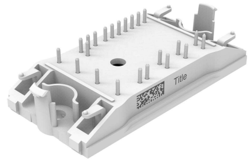
flow PIM 0 — 600 V / 6 A

Features

- Trench Fieldstop IGBTs for low saturation losses
- Compact and low inductive design
- built in NTC
- Optional w/o BRC
- Enhanced rectifier

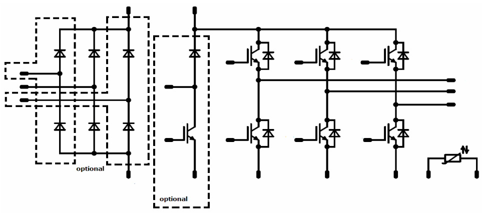
flow 0 12 mm housing



Target Applications

- Industrial drives
- Embedded drives

Schematic



Types

- V23990-P541-A38-PM
- V23990-P541-B138-PM
- V23990-P541-C38-PM
- V23990-P541-D138-PM

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	33	A
Surge (non-repetitive) forward current	I_{FSM}	t_p = 10 ms 50Hz half sine wave T_s = 150 °C	270	A
I^2t-value	I^2t		370	A^2s
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	37	W
Maximum Junction Temperature	T_{jmax}		150	°C
Inverter Switch / Brake Switch				
Collector-emitter break down voltage	V_{CE}		600	V
DC collector current	I_C	$T_j = T_{jmax}$ T_s = 80 °C	12	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	18	A
Turn off safe operating area		$V_{CE} \leq$ 600V, $T_j \leq T_{op}$ max	18	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	36	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 Diode / Brake Diode					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80 °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 °C	27	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 Test Voltage*	6000	V
		t = 1 min	AC Voltage	2500	V
Creepage distance				min 12,7	mm
Clearance				9,29	mm
Comparative tracking index	CTI			>200	

* 100% tested in production

Characteristic Values

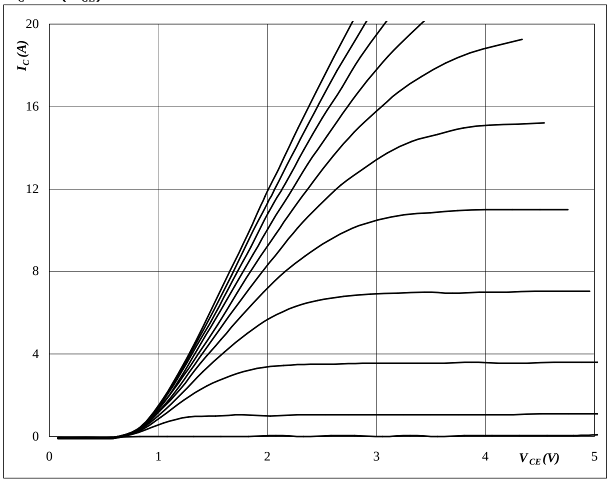
Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	Unit
Rectifier Diode										
Forward voltage	V_F				30	25 125	0,8	1,16 1,13	1,6	V
Threshold voltage (for power loss calc. only)	V_{to}				30	25 125		0,90 0,78		V
Slope resistance (for power loss calc. only)	r_t				30	25 125		8 11		mΩ
Reverse current	I_r			1500		150			2	mA
Thermal resistance junction to sink	$R_{th(j-s)}$	phase-change material λ = 3,4 W/mK						1,25		K/W
Inverter 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	$t_{d(on)}$	R_{goff} = 16 Ω R_{gon} = 32 Ω	15	300	6	25 150		12 10		ns
Rise time	t_r					25 150		8 11		
Turn-off delay time	$t_{d(off)}$					25 150		118 134		
Fall time	t_f					25 150		87 116		
Turn-on energy loss	E_{on}					25 150		0,07 0,10		mWs
Turn-off energy loss	E_{off}					25 150		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 Diode										
Diode forward voltage	V_F				6	25 150	1	1,64 1,56	2,5	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 32 Ω	15	300	6	25 150		8 8		A
Reverse recovery time	t_{rr}					25 150		73 163		ns
Reverse recovered charge	Q_{rr}					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 λ = 3,4 W/mK						3,5		K/W
Thermistor										
Rated resistance	R					25		22000		Ω
Deviation of R_{100}	$\Delta_{R/R}$	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. ±3%				25				K
B-value	$B_{(25/100)}$	Tol. ±3%				25		4000		K
Vincotech NTC Reference									A	

Inverter / Brake Characteristics

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

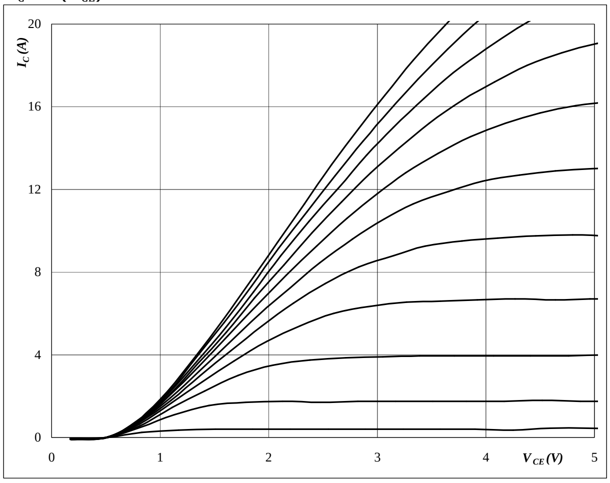
T_j = 25 °C

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

figure 2. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

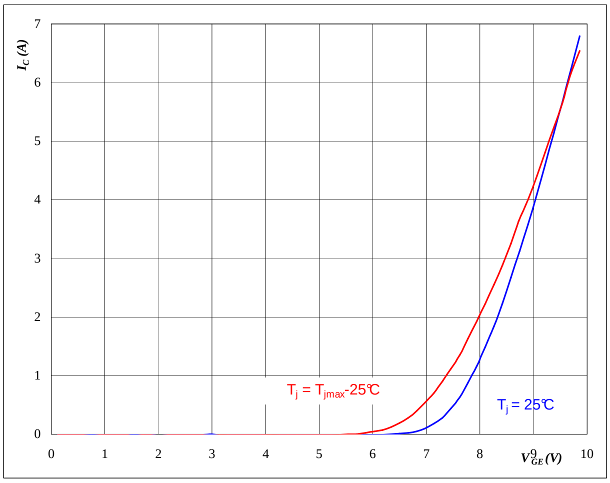
T_j = 125 °C

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

figure 3. **IGBT**

Typical transfer characteristics

$I_C = f(V_{GE})$



At

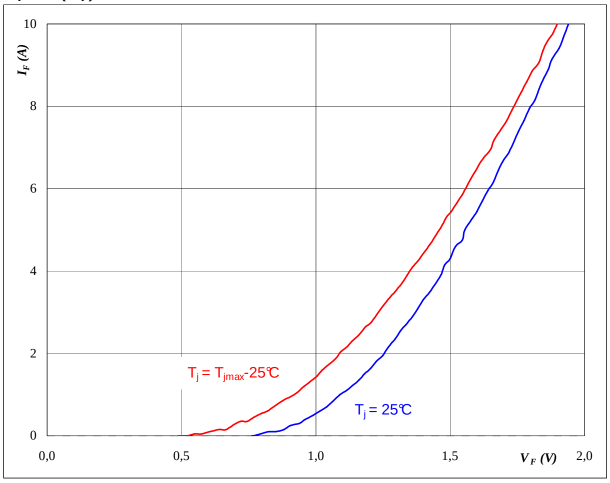
t_p = 250 µs

V_{CE} = 10 V

figure 4. **FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

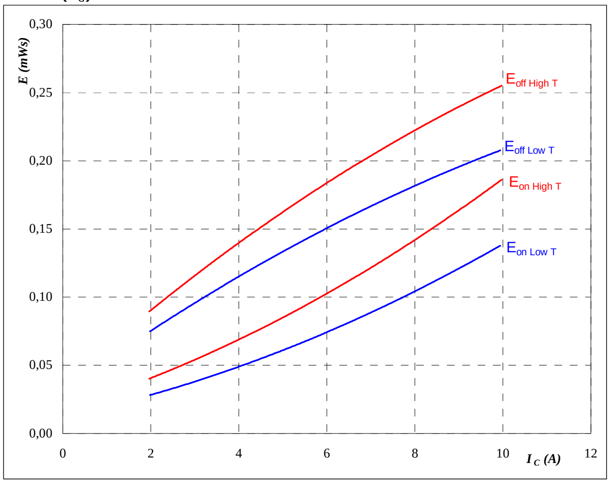
t_p = 250 µs

Inverter / Brake Characteristics

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_C)$



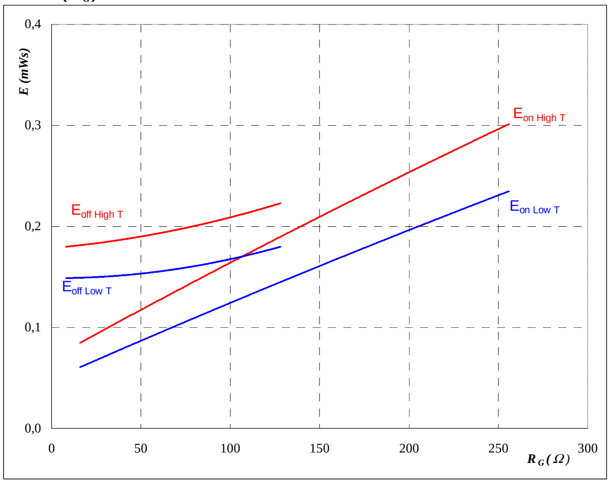
With an inductive load at

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

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



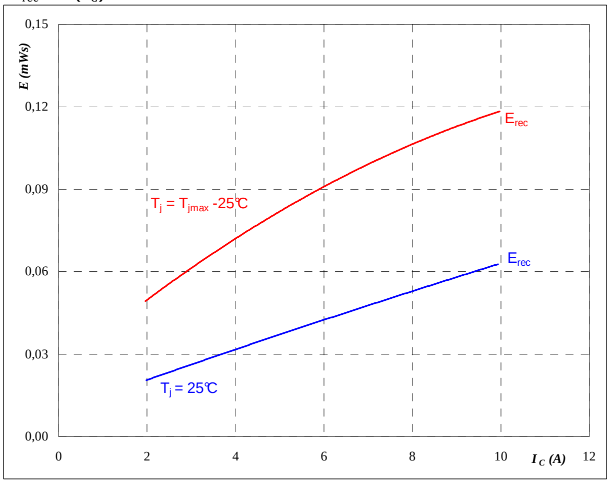
With an inductive load at

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

figure 7. **FWD**

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_C)$



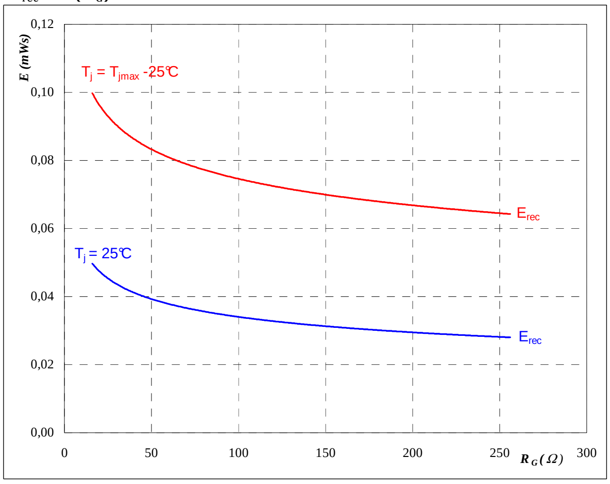
With an inductive load at

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

figure 8. **FWD**

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

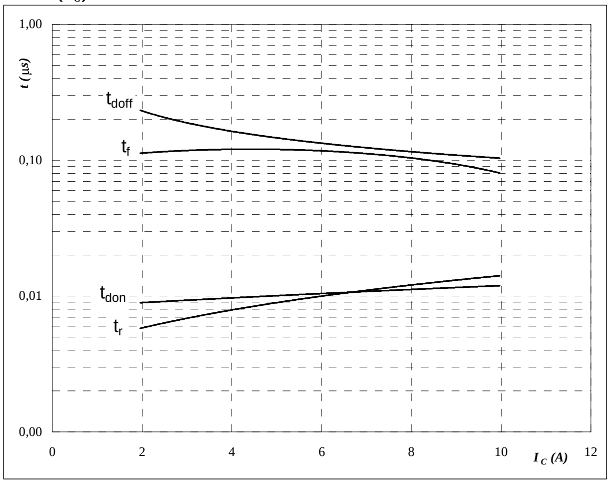
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	15	V
I_C =	6	A

Inverter / Brake Characteristics

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



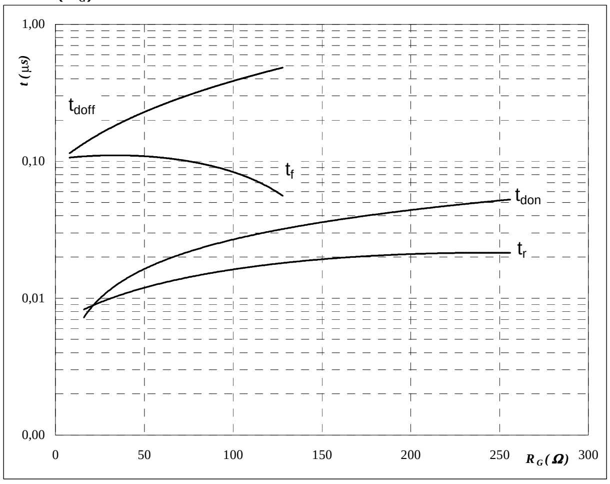
With an inductive load at

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

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



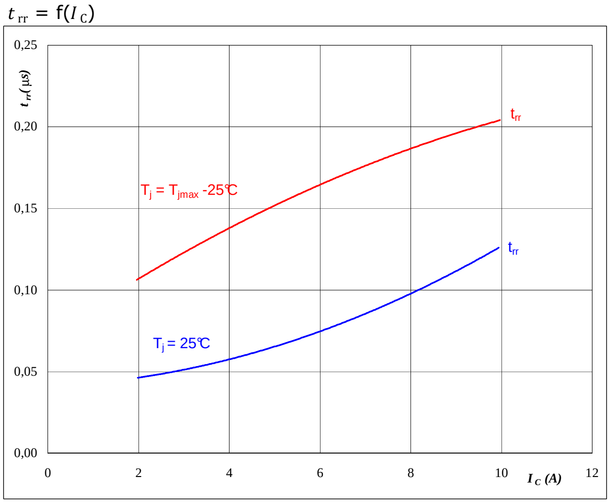
With an inductive load at

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

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



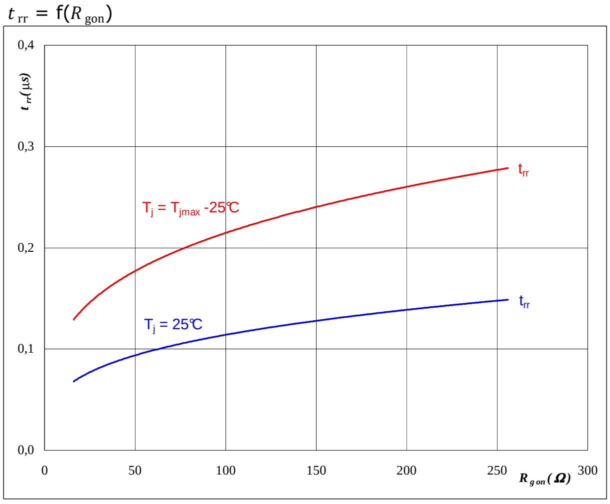
At

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

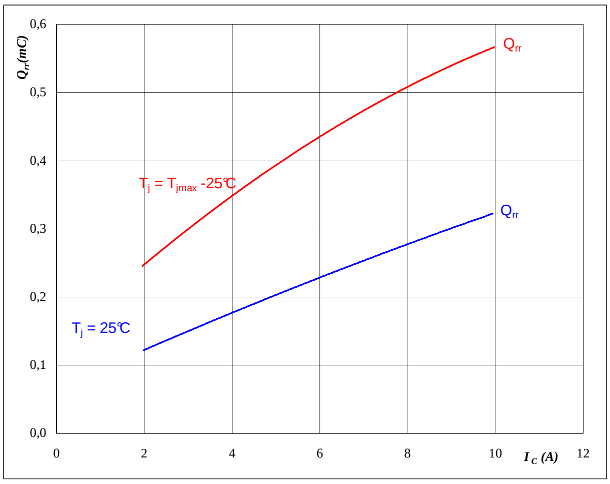
T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Inverter / Brake Characteristics

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



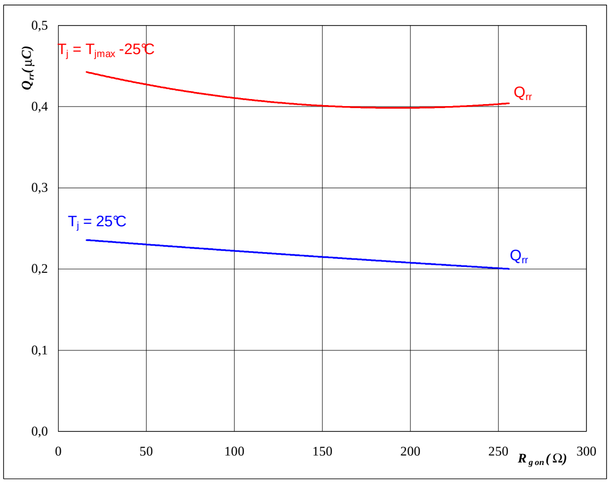
At

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

figure 14. **FWD**

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

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



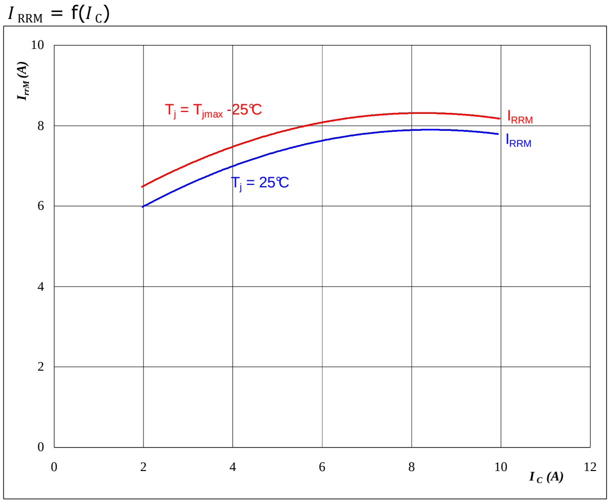
At

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

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



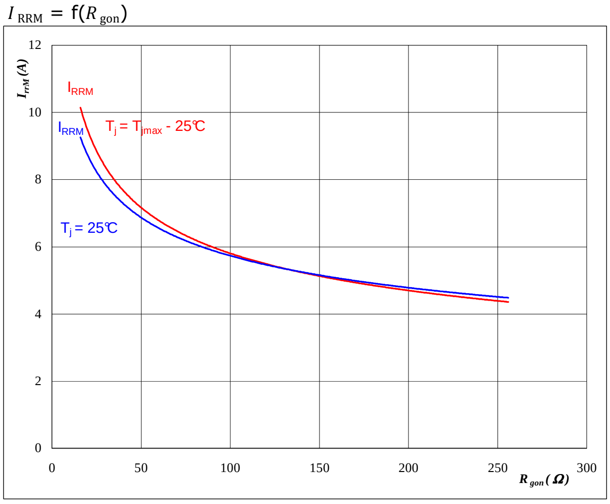
At

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

figure 16. **FWD**

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

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



At

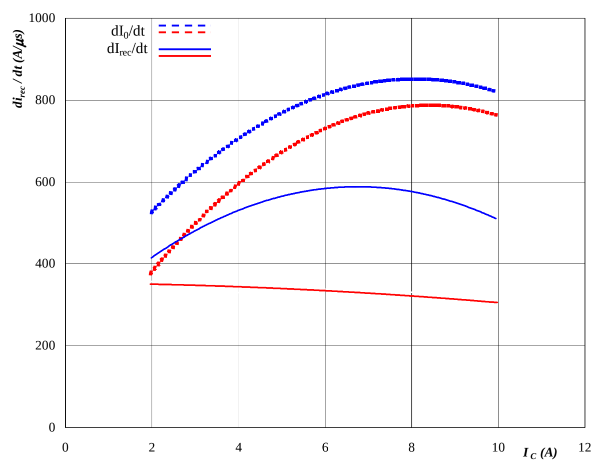
T_j =	25/125	°C
V_R =	300	V
I_F =	6	A
V_{GE} =	15	V

Inverter / Brake Characteristics

figure 17. **FWD**

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

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



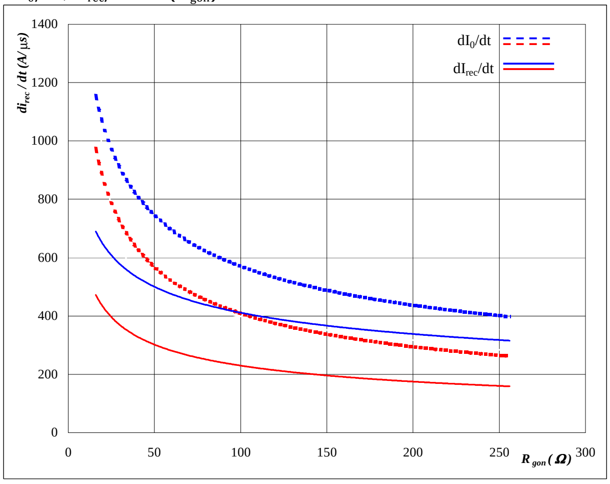
At

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

figure 18. **FWD**

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

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



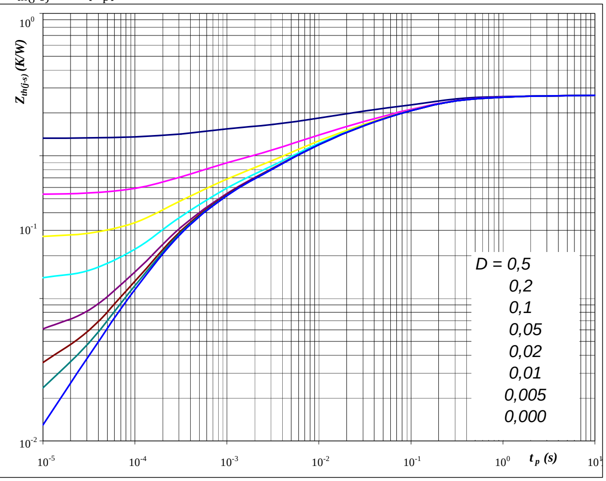
At

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

figure 19. **IGBT**

IGBT transient thermal impedance as a function of pulse width

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



At

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

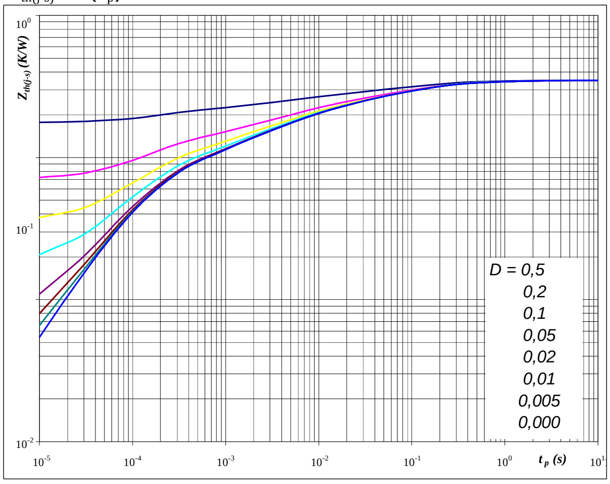
IGBT thermal model values

R (K/W)	Tau (s)
7,05E-02	3,27E+00
3,24E-01	3,78E-01
8,86E-01	8,30E-02
6,07E-01	1,30E-02
4,23E-01	2,64E-03
3,49E-01	3,19E-04

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	
$R_{th(j-s)}$ =	3,49	K/W

FWD thermal model values

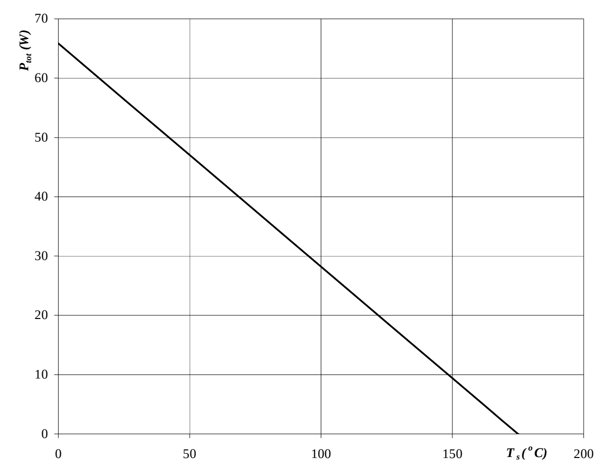
R (K/W)	Tau (s)
4,22E-02	1,41E+01
1,90E-01	7,04E-01
8,32E-01	1,16E-01
6,58E-01	1,99E-02
7,36E-01	4,07E-03
4,19E-01	7,32E-04

Inverter / Brake Characteristics

figure 21.	IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



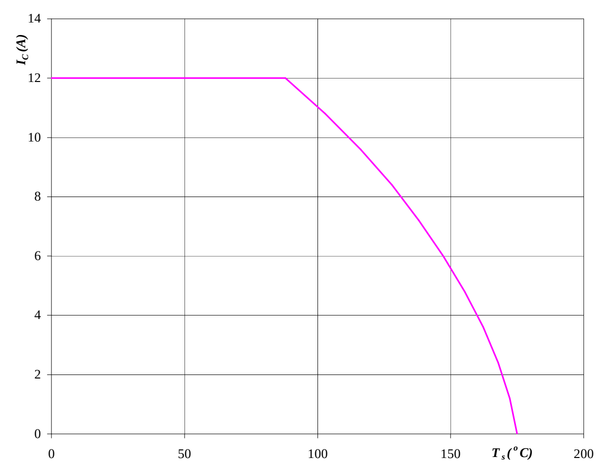
At

T_j = 175 °C

figure 22.	IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

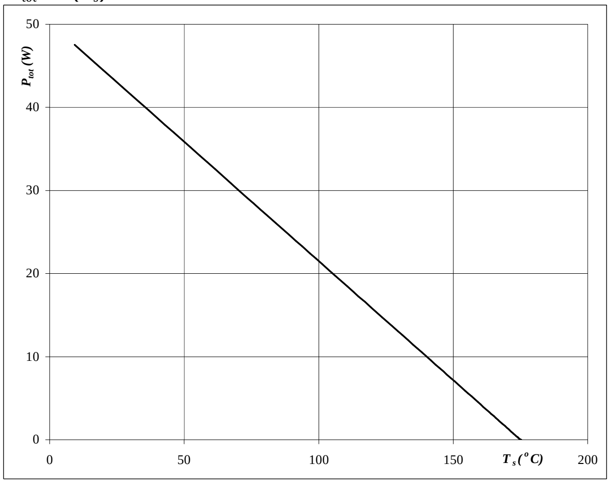
T_j = 175 °C

V_{GE} = 15 V

figure 23.	FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



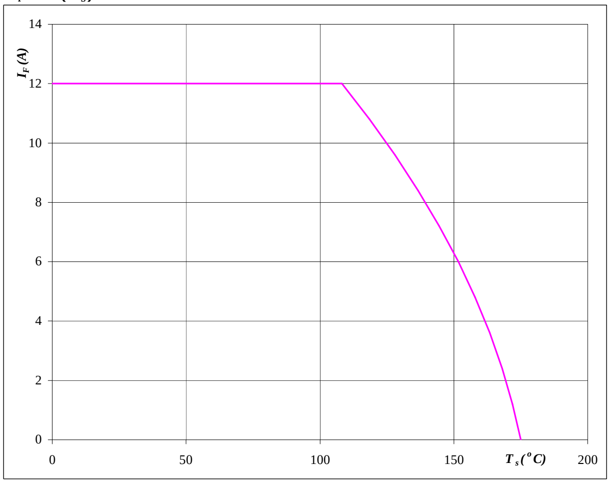
At

T_j = 175 °C

figure 24.	FWD

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

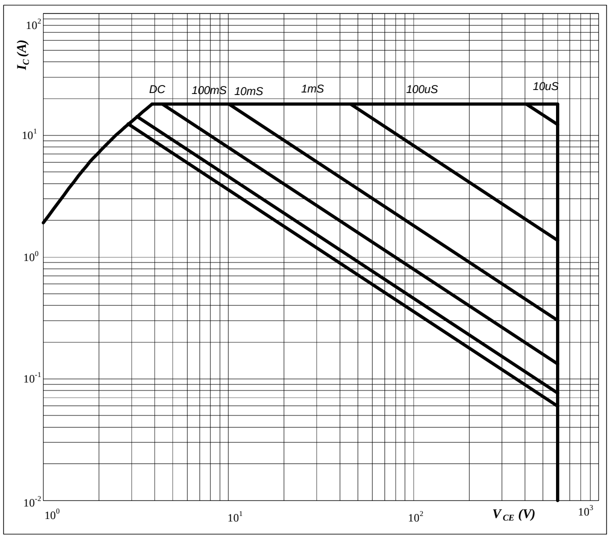
T_j = 175 °C

Inverter / Brake Characteristics

figure 25. **IGBT**

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



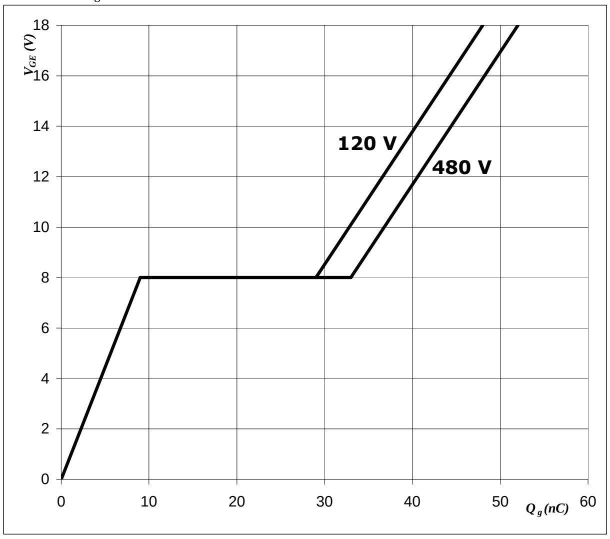
At

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

figure 26. **IGBT**

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



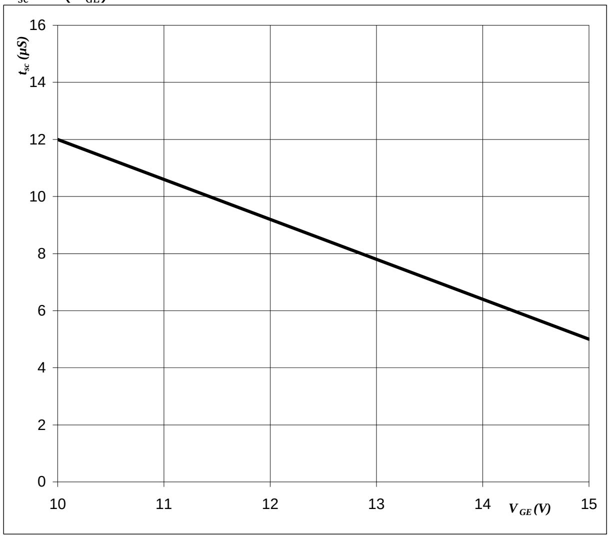
At

I_C =	6	A

figure 27. **IGBT**

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

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



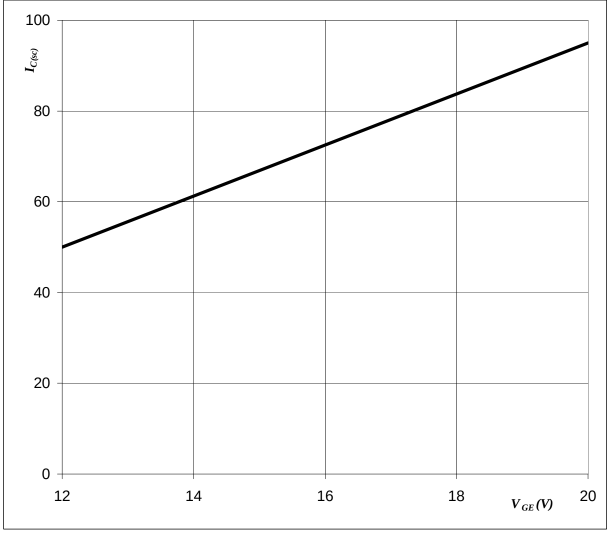
At

V_{CE} =	600	V
T_j ≤	150	ºC

figure 28. **IGBT**

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

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



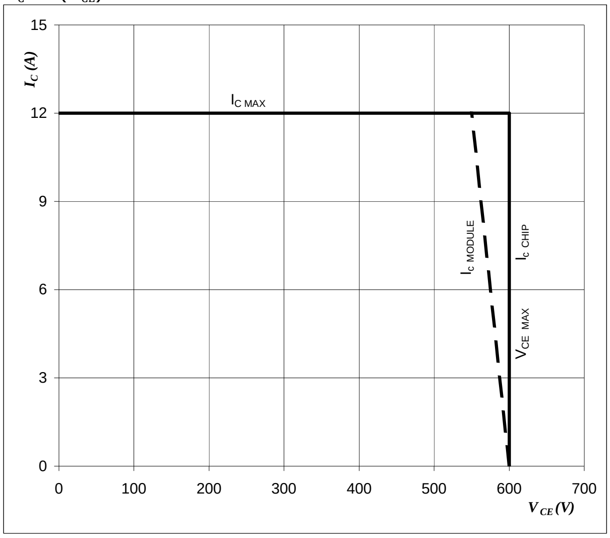
At

V_{CE} ≤	400	V
T_j =	150	ºC

figure 29.	IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

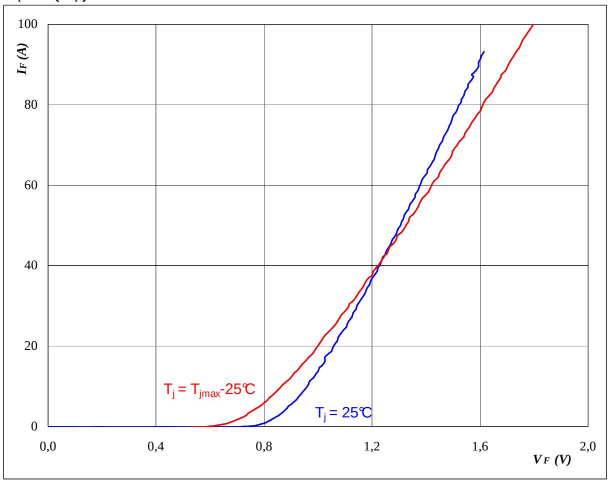
T_j = T_{jmax}-25 ºC

Rectifier Diode Characteristics

figure 1. **Rectifier Diode**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



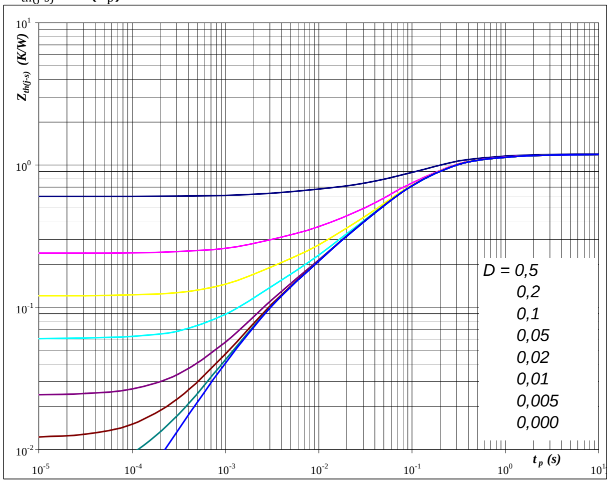
At

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

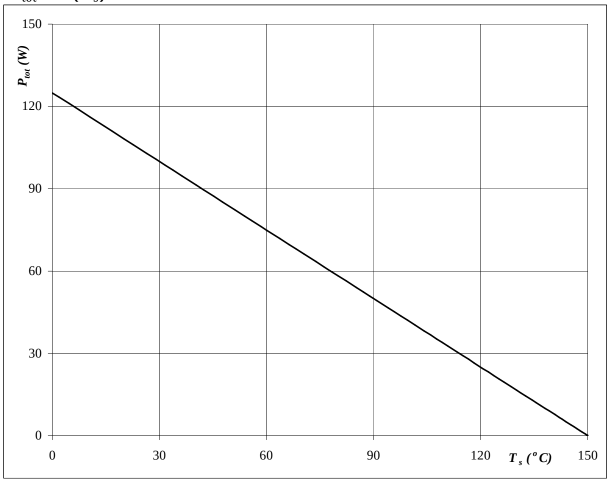
D = t_p / T

$R_{th(j-s)}$ = 1,25 K/W

figure 3. **Rectifier Diode**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



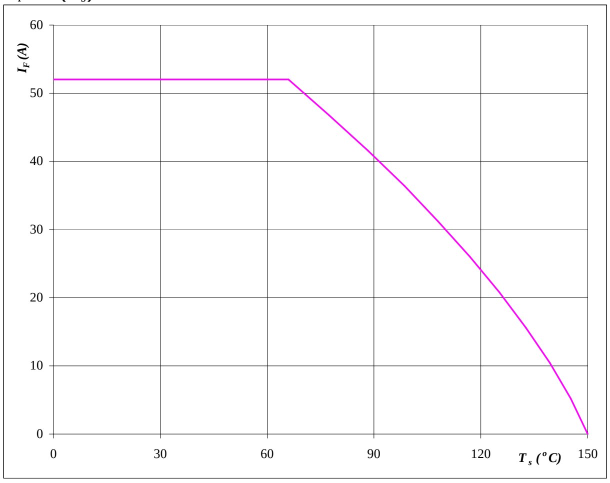
At

T_j = 150 ºC

figure 4. **Rectifier Diode**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



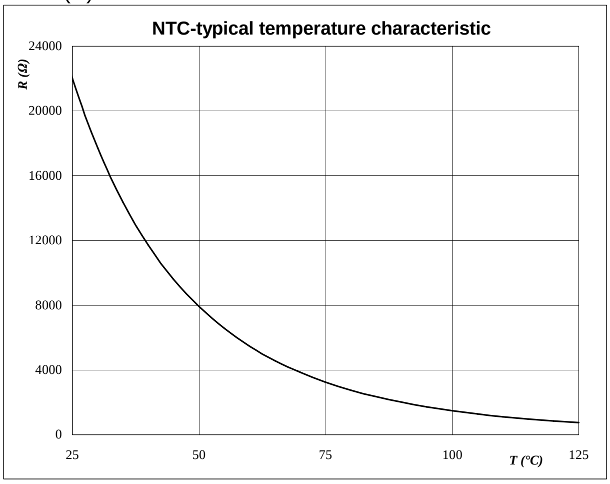
At

T_j = 150 ºC

Thermistor Characteristics

figure 1.	Thermistor

Typical NTC characteristic
as a function of temperature
$R = f(T)$



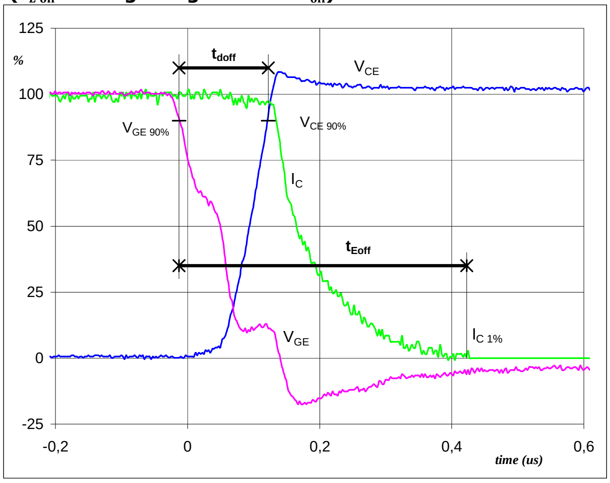
Switching Definitions

General conditions

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

figure 1. **IGBT**

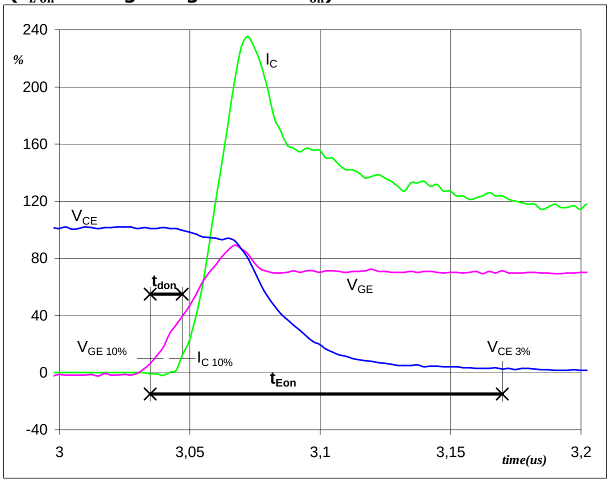
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



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. **IGBT**

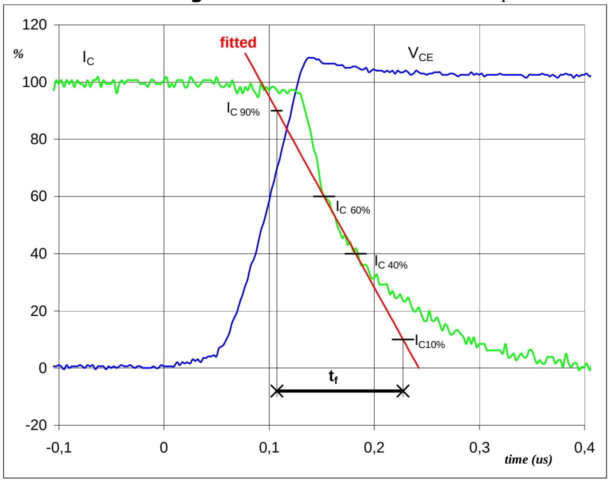
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



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. **IGBT**

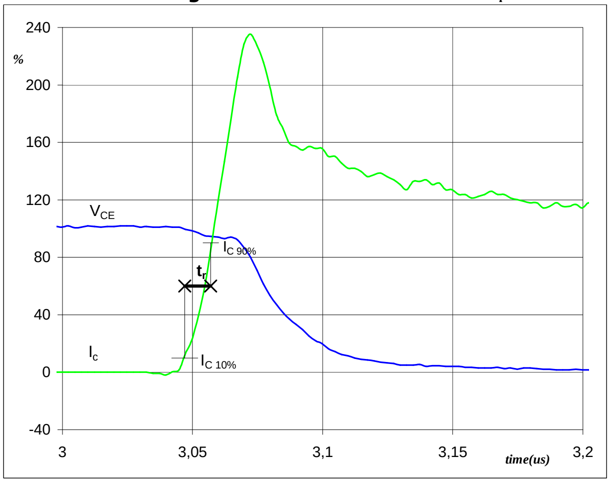
Turn-off Switching Waveforms & definition of t_f



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

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

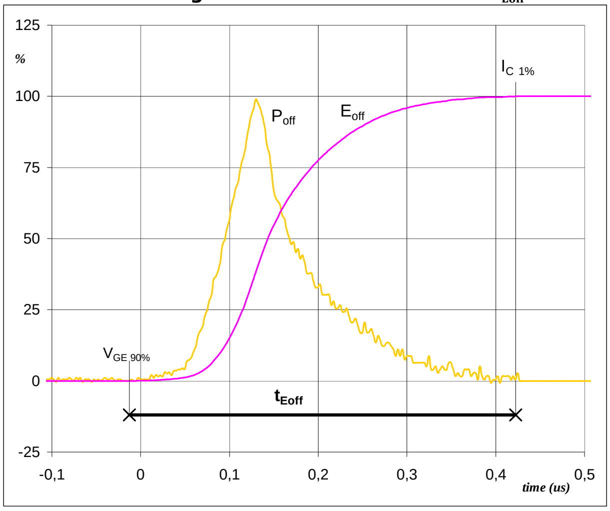


V_C (100%) =	300	V
I_C (100%) =	6	A
t_r =	0,01	μs

Switching Definitions

figure 5. **IGBT**

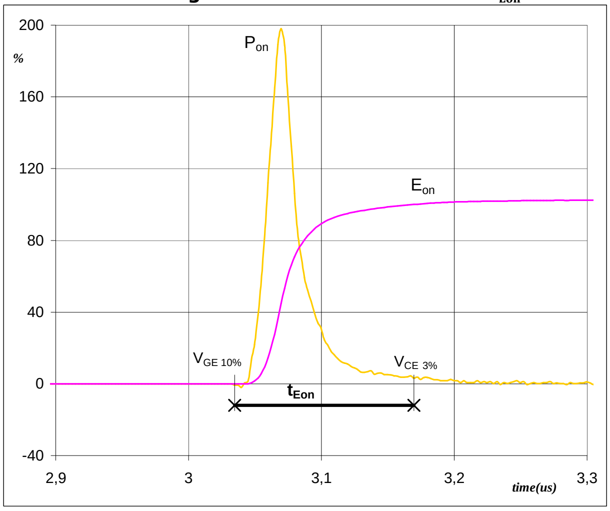
Turn-off Switching Waveforms & definition of t_{Eoff}



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

figure 6. **IGBT**

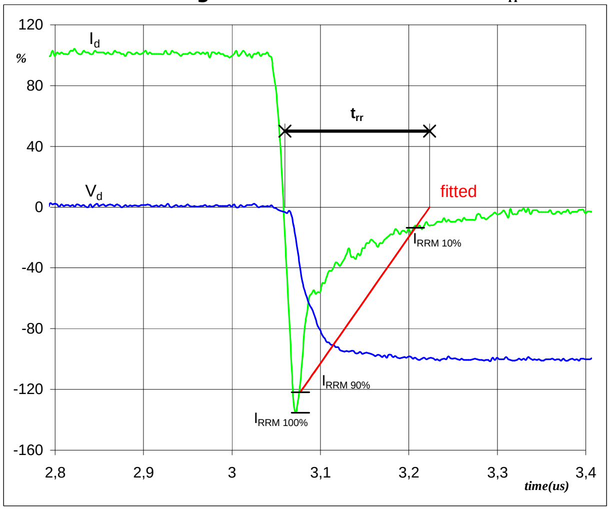
Turn-on Switching Waveforms & definition of t_{Eon}



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

figure 7. **IGBT**

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

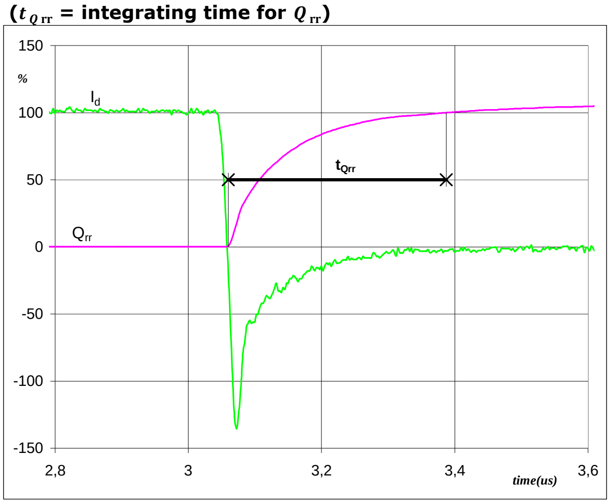


V_d (100%) = 300 V
I_d (100%) = 6 A
I_{RRM} (100%) = 8 A
t_{rr} = 0,16 µs

Switching Definitions

figure 8. **FWD**

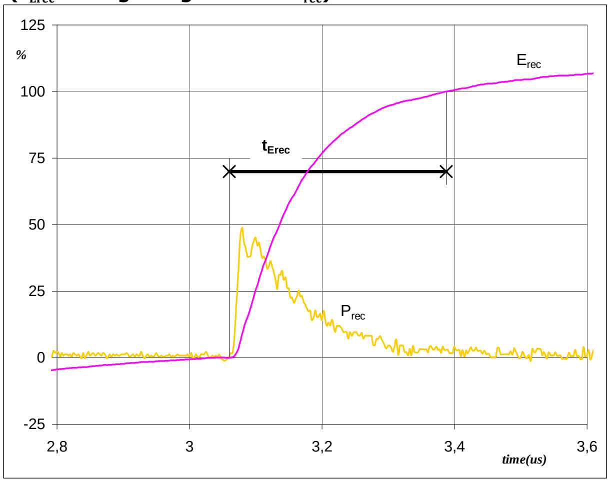
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



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

figure 9. **FWD**

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_{Erec} =	0,33	µs

Ordering Code and Marking - Features - Outline - Pinout

Ordering Code & Marking

Version	Ordering Code
without thermal paste 12 mm housing	V23990-P541-A38-PM
with thermal paste 12 mm housing	V23990-P541-A38-/3/-PM
without thermal paste 12 mm housing with one-phase rectifier	V23990-P541-B138-PM
with thermal paste 12 mm housing with one-phase rectifier	V23990-P541-B138-/3/-PM
without thermal paste 12 mm housing without brake	V23990-P541-C38-PM
with thermal paste 12 mm housing without brake	V23990-P541-C38-/3/-PM
without thermal paste 12 mm housing without brake with one-phase rectifier	V23990-P541-D138-PM
with thermal paste 12 mm housing without brake with one-phase rectifier	V23990-P541-D138-/3/-PM

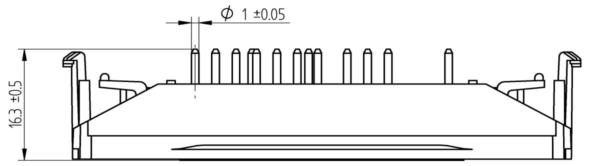
Outline

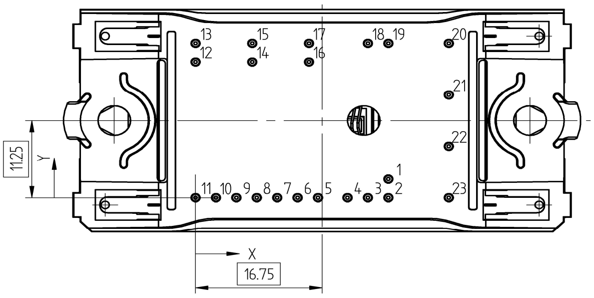
Pin Table

Pin	X	Y
1	25,5	2,7
2	25,5	0
3	22,8	0
4	20,1	0
5	16,2	0
6	13,5	0
7	10,8	0
8	8,1	0
9	5,4	0
10	2,7	0
11	0	0
12	0	19,8
13	0	22,5
14	7,5	19,8
15	7,5	22,5
16	15	19,8
17	15	22,5
18	22,8	22,5
19	25,5	22,5
20	33,5	22,5
21	33,5	15
22	33,5	7,5
23	33,5	0

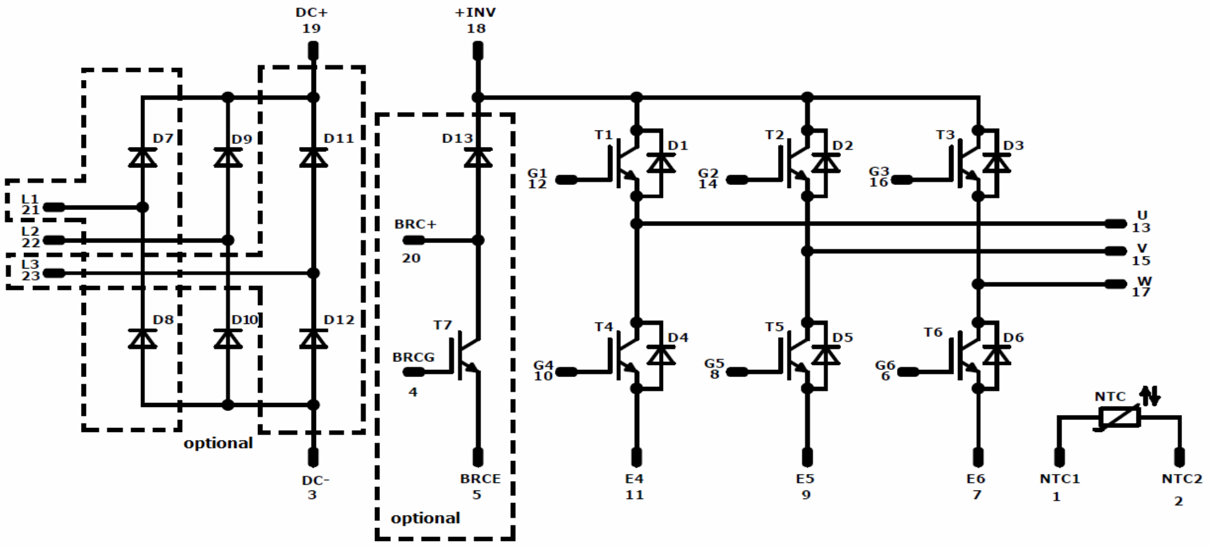
Pinout variation

N/A Pins	Module subtype
-	V23990-P541-A38-PM
23	V23990-P541-B138-PM
4,5,20	V23990-P541-C38-PM
4,5,20,23	V23990-P541-D138-PM





Pinout



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-x3x-D6-14	05 Feb. 2019	corrected characteristic values	3