MiniSKiiP® 2 PACK

1200V/35A

Features

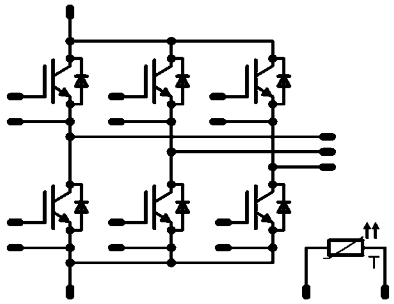
- Solder less interconnection
- Temperature sensor
- Standard (6.5mm) and thin (2.8mm) lids,16mm housing
- Optional with pre-applied thermal grease

MiniSKiiP® 2 housing

Target Applications

- Industrial Motor Drives
- Power Generation
- UPS

Schematic



Types

- V23990-K238-F-PM

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
T1,T2,T3,T4,T5,T6				
Collector-emitter break down voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j=T_j$max T_h=80℃ T_c=80℃	40 53	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j$max	105	A
Turn off safe operating area		VCE ≤ 1200V, Tj ≤ Top max	105	A
Power dissipation per IGBT	P_{tot}	$T_j=T_j$max T_h=80℃ T_c=80℃	93 141	W
Gate-emitter peak voltage	V_{GE}		20	V
Short circuit ratings	t_{SC} V_{CC}	T_j≤150℃ V_{GE}=15V	10 600	µs V
Maximum Junction Temperature	$T_j$max		150	℃
D1,D2,D3,D4,D5,D6				
Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F	$T_j=T_j$max T_h=80℃ T_c=80℃	24 31	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max	47	A
Power dissipation per Diode	P_{tot}	$T_j=T_j$max T_h=80℃ T_c=80℃	47 71	W
Maximum Junction Temperature	$T_j$max		150	℃

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	℃
Operation temperature under switching condition	T_{op}			-40…+125	℃
Insulation Properties					
Insulation voltage	V_{is}	t=2s	DC voltage	4000	V
Creepage distance				min 12,7	mm
Clearance				min 12,7	mm

Characteristic Values

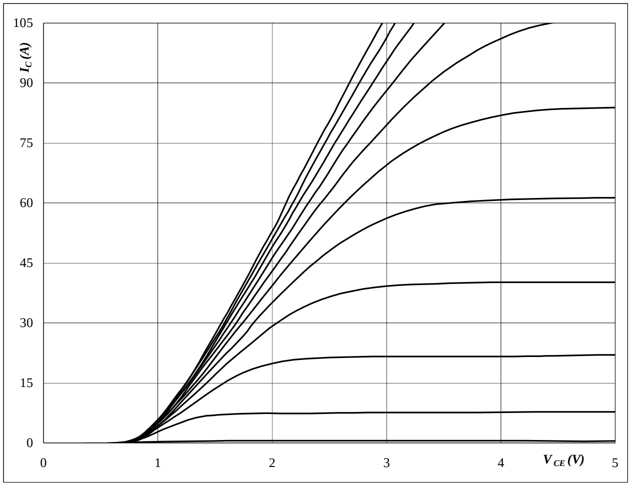
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j	Min	Typ	Max	
T1,T2,T3,T4,T5,T6										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0015	Tj=25℃ Tj=125℃	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$		15		35	Tj=25℃ Tj=125℃	1,4	1,71 1,93	2,1	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		Tj=25℃ Tj=125℃		0,4 4		mA
Gate-emitter leakage current	I_{GES}		20	0		Tj=25℃ Tj=125℃		300		nA
Integrated Gate resistor	R_{gint}							6		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=28 Ω Rgon=28 Ω	±15	600	35	Tj=25℃ Tj=125℃		73		ns
Rise time	t_r					Tj=25℃ Tj=125℃		20		
Turn-off delay time	$t_{d(off)}$					Tj=25℃ Tj=125℃		566		
Fall time	t_f					Tj=25℃ Tj=125℃		165		
Turn-on energy loss per pulse	E_{on}					Tj=25℃ Tj=125℃		2,53		mWs
Turn-off energy loss per pulse	E_{off}					Tj=25℃ Tj=125℃		2,28		
Input capacitance	C_{ies}	f=1MHz	0	25		Tj=25℃		2500		pF
Output capacitance	C_{oss}							132		
Reverse transfer capacitance	C_{rss}							110		
Gate charge	Q_{Gate}		±15	960	40	Tj=25℃		203		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						0,75		K/W
D1,D2,D3,D4,D5,D6										
Diode forward voltage	V_F				20	Tj=25℃ Tj=125℃		1,46 1,5	1,77	V
Peak reverse recovery current	I_{RRM}	Rgoff=28 Ω	0	600	20	Tj=25℃ Tj=125℃		51,3		A
Reverse recovery time	t_{rr}					Tj=25℃ Tj=125℃		380,7		ns
Reverse recovered charge	Q_{rr}					Tj=25℃ Tj=125℃		6,52		µC
Peak rate of fall of recovery current	di(rec)max /dt					Tj=25℃ Tj=125℃		1832		A/µs
Reverse recovered energy	Erec					Tj=25℃ Tj=125℃		2,64		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50um λ = 1 W/mK						1,5		K/W
Thermistor										
Rated resistance	R					T=25℃		1000		Ω
Deviation of R100	ΔR/R	R100=1670 Ω				T=100℃	-3		3	%
R100	P					T=100℃		1670,313		Ω
A-value	$B_{(25/50)}$	Tol. %				T=25℃		7,635*10-3		1/K
B-value	$B_{(25/100)}$	Tol. %				T=25℃		1,731*10-5		1/K²
Vincotech NTC Reference									E	

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 1 T1,T2,T3,T4,T5,T6 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 μs

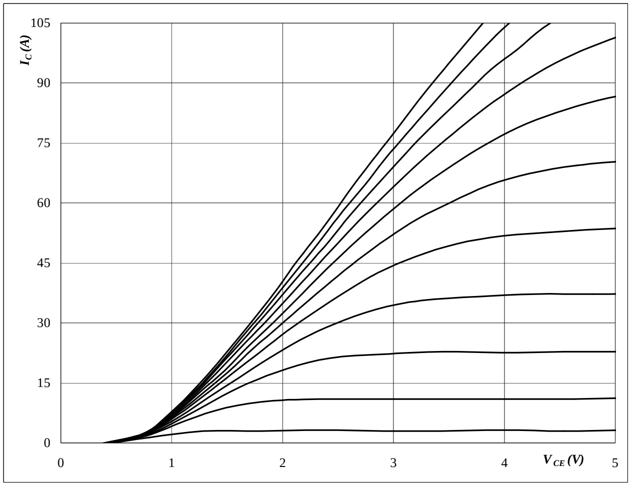
T_j = 25 ℃

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

Figure 2 T1,T2,T3,T4,T5,T6 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 μs

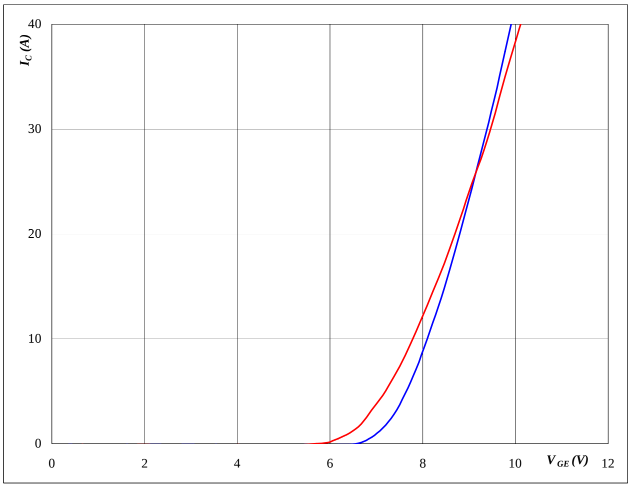
T_j = 125 ℃

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

Figure 3 T1,T2,T3,T4,T5,T6 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



At

Tj = 25/125 ℃

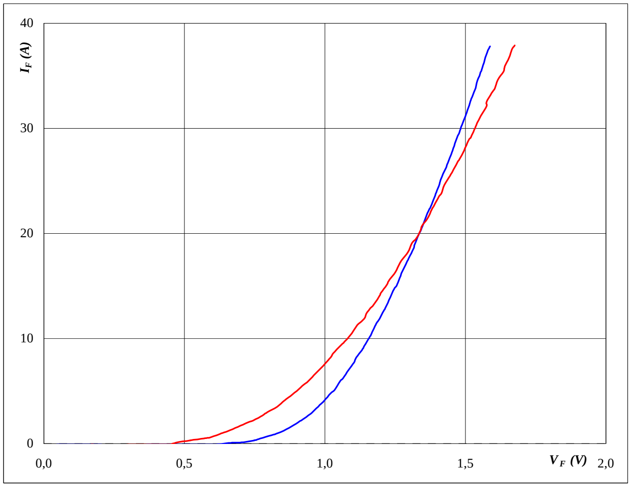
t_p = 250 μs

V_{CE} = 10 V

Figure 4 D1,D2,D3,D4,D5,D6 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



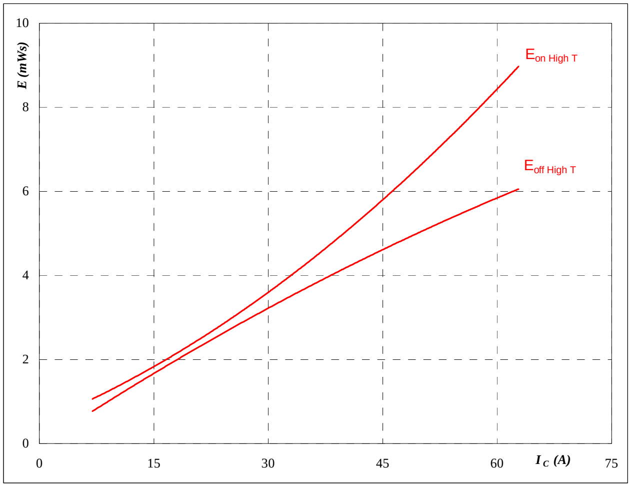
At

t_p = 250 μs

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 5 T1,T2,T3,T4,T5,T6 IGBT

Typical switching energy losses
as a function of collector current
$E = f(I_C)$

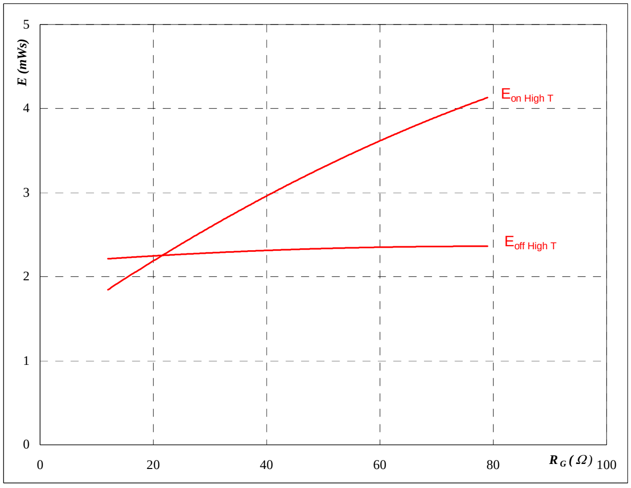


With an inductive load at

T_j = 125 ℃
V_{CE} = 600 V
V_{GE} = ±15 V
R_{gon} = 28 Ω
R_{goff} = 28 Ω

Figure 6 T1,T2,T3,T4,T5,T6 IGBT

Typical switching energy losses
as a function of gate resistor
$E = f(R_G)$

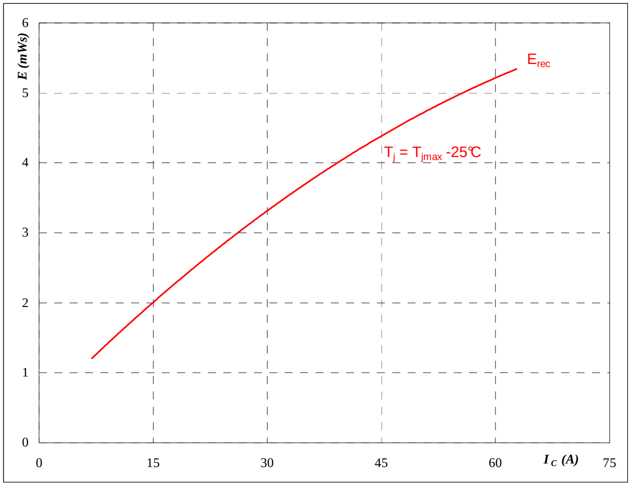


With an inductive load at

T_j = 125 ℃
V_{CE} = 600 V
V_{GE} = ±15 V
I_C = 21 A

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

Typical reverse recovery energy loss
as a function of collector current
$E_{rec} = f(I_C)$

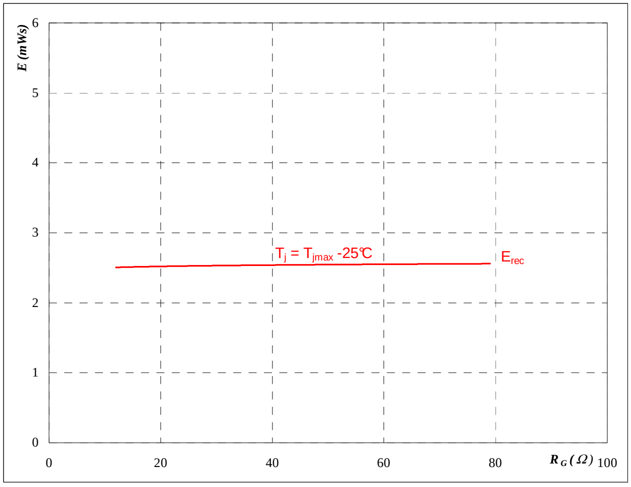


With an inductive load at

T_j = 125 ℃
V_{CE} = 600 V
V_{GE} = ±15 V
R_{gon} = 28 Ω

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

Typical reverse recovery energy loss
as a function of gate resistor
$E_{rec} = f(R_G)$



With an inductive load at

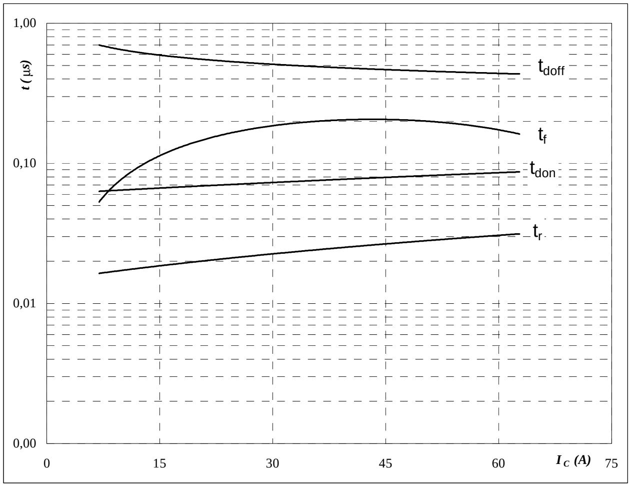
T_j = 125 ℃
V_{CE} = 600 V
V_{GE} = ±15 V
I_C = 21 A

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 9 T1,T2,T3,T4,T5,T6 IGBT

Typical switching times as a function of collector current

t = f(I_C)



With an inductive load at

T_j = 125 ℃

V_{CE} = 600 V

V_{GE} = ±15 V

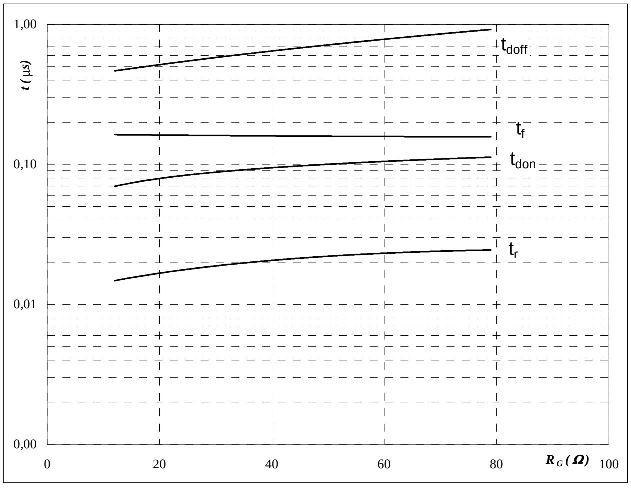
R_{gon} = 28 Ω

R_{goff} = 28 Ω

Figure 10 T1,T2,T3,T4,T5,T6 IGBT

Typical switching times as a function of gate resistor

t = f(R_G)



With an inductive load at

T_j = 125 ℃

V_{CE} = 600 V

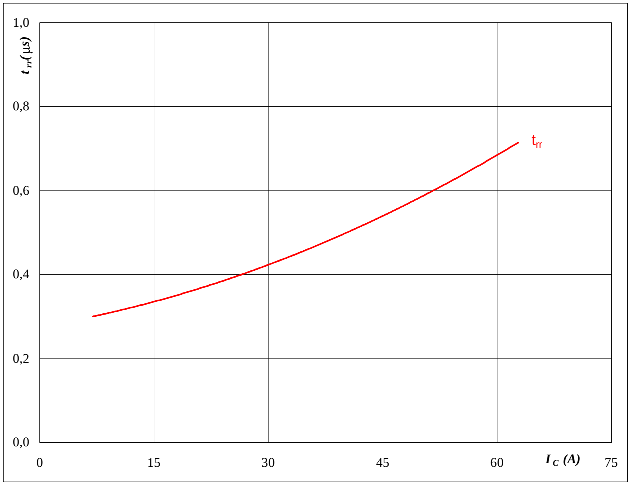
V_{GE} = ±15 V

I_C = 21 A

Figure 11 D1,D2,D3,D4,D5,D6 FWD

Typical reverse recovery time as a function of collector current

t_{rr} = f(I_C)



At

T_j = 125 ℃

V_{CE} = 600 V

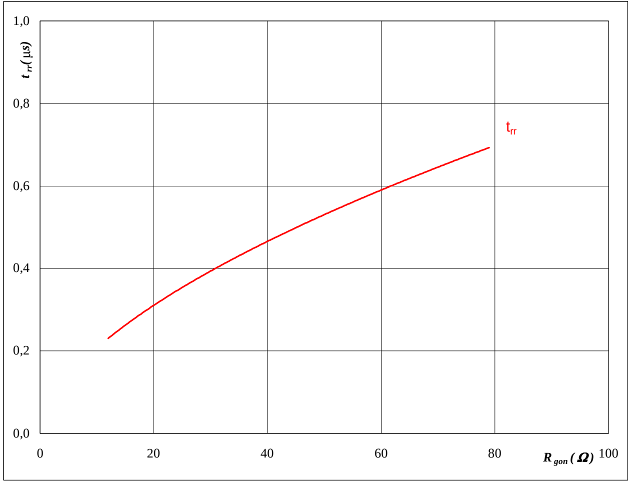
V_{GE} = ±15 V

R_{gon} = 28 Ω

Figure 12 D1,D2,D3,D4,D5,D6 FWD

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

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



At

T_j = 125 ℃

V_R = 600 V

I_F = 21 A

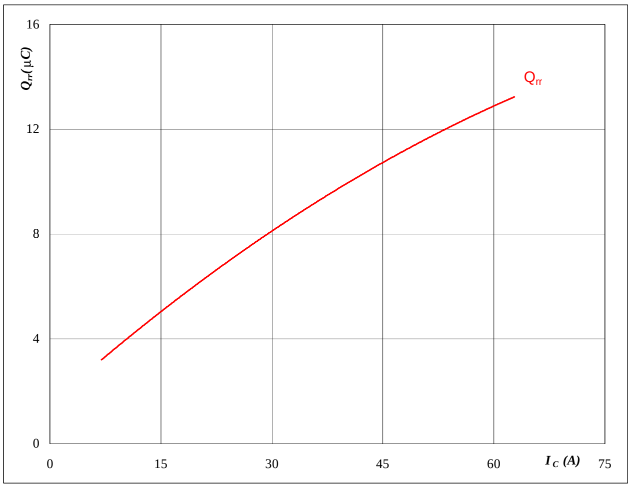
V_{GE} = ±15 V

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 13 D1,D2,D3,D4,D5,D6 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



At

T_j = 125 ℃

V_{CE} = 600 V

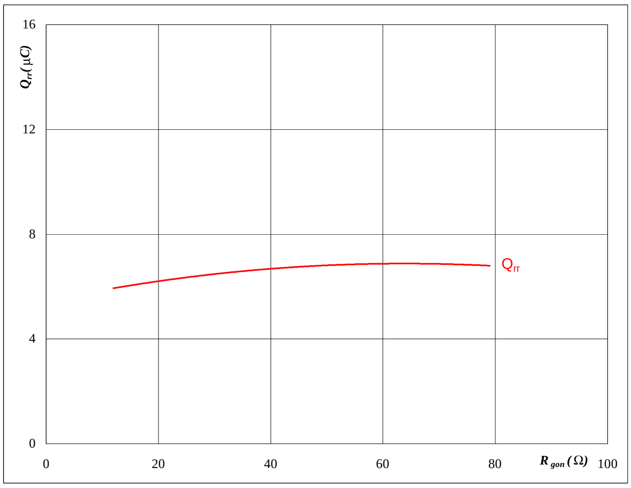
V_{GE} = ±15 V

R_{gon} = 28 Ω

Figure 14 D1,D2,D3,D4,D5,D6 FWD

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

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



At

T_j = 125 ℃

V_R = 600 V

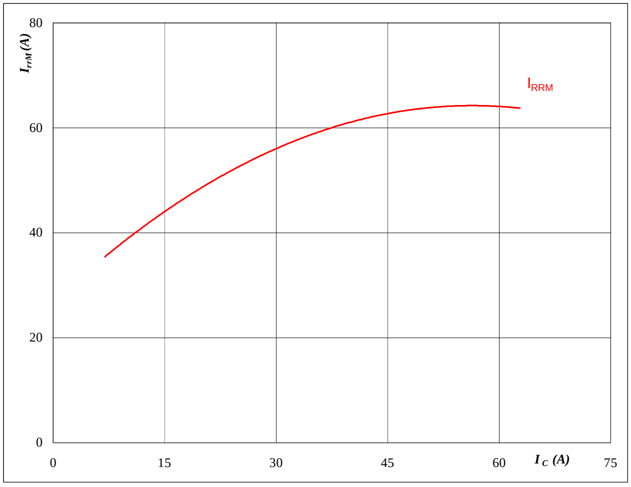
I_F = 21 A

V_{GE} = ±15 V

Figure 15 D1,D2,D3,D4,D5,D6 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



At

T_j = 125 ℃

V_{CE} = 600 V

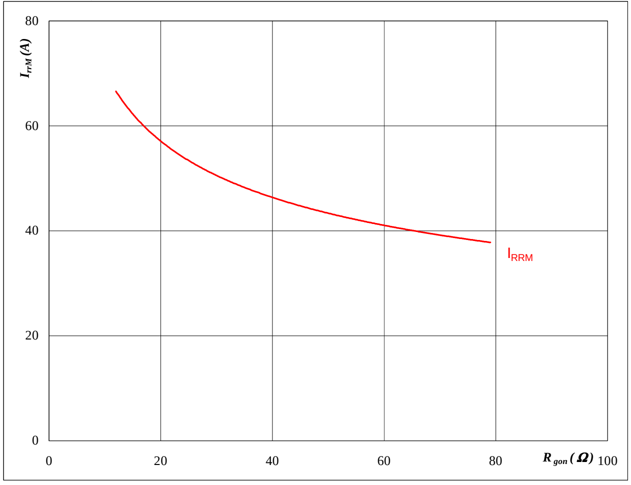
V_{GE} = ±15 V

R_{gon} = 28 Ω

Figure 16 D1,D2,D3,D4,D5,D6 FWD

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

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



At

T_j = 125 ℃

V_R = 600 V

I_F = 21 A

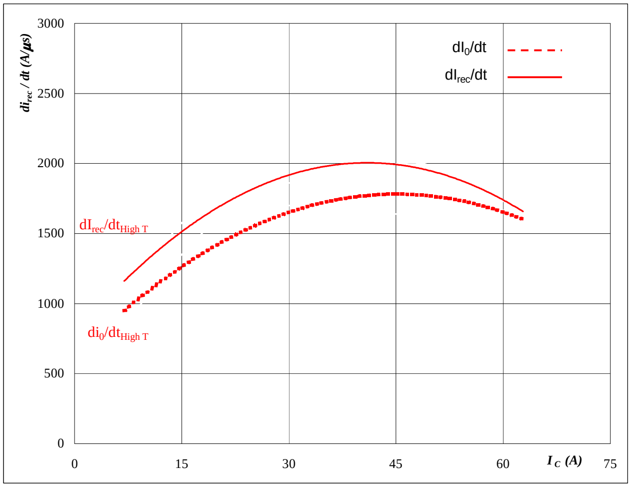
V_{GE} = ±15 V

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 17 D1,D2,D3,D4,D5,D6 FWD

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

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



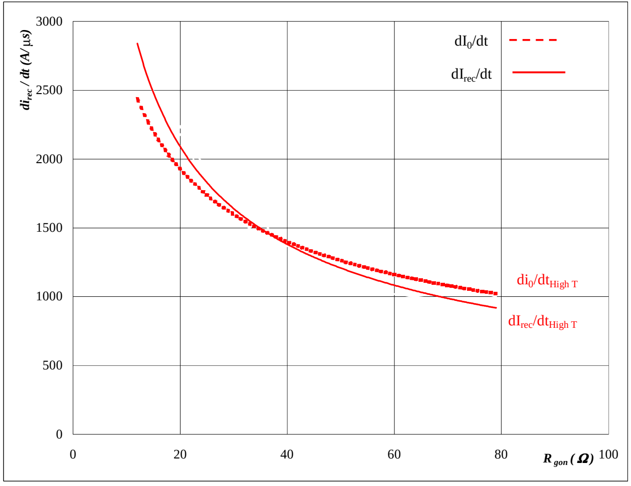
At

T_j =	125	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	28	Ω

Figure 18 D1,D2,D3,D4,D5,D6 FWD

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

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



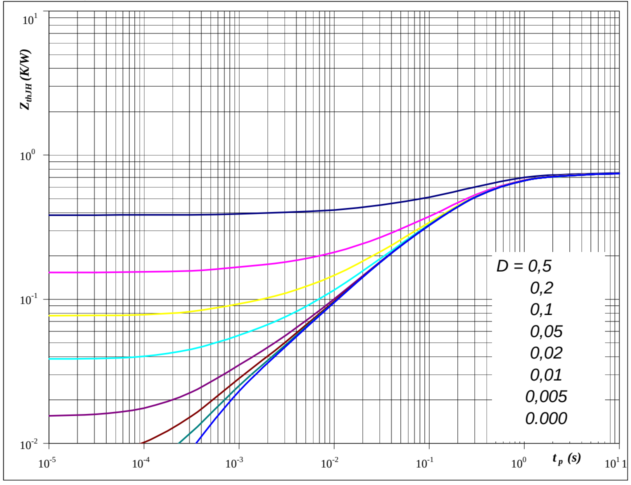
At

T_j =	125	°C
V_R =	600	V
I_F =	21	A
V_{GE} =	±15	V

Figure 19 T1,T2,T3,T4,T5,T6 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	0,75	K/W

IGBT thermal model values

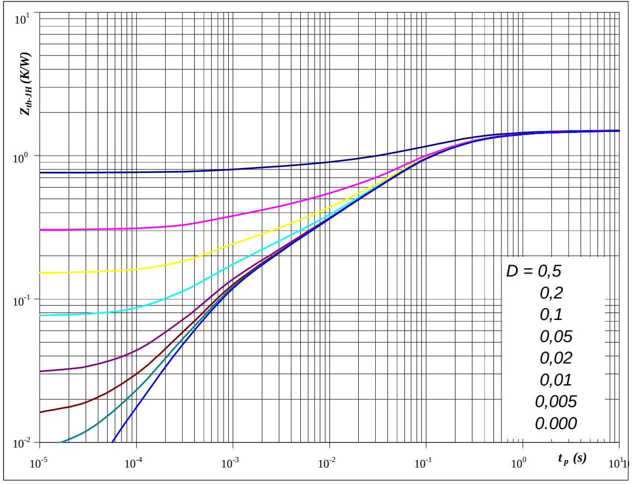
Thermal grease

R (C/W)	Tau (s)
0,04	2,2E+01
0,09	1,6E+00
0,34	3,5E-01
0,21	8,5E-02
0,07	1,1E-02
0,02	8,7E-04

Figure 20 D1,D2,D3,D4,D5,D6 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	1,50	K/W

FWD thermal model values

Thermal grease

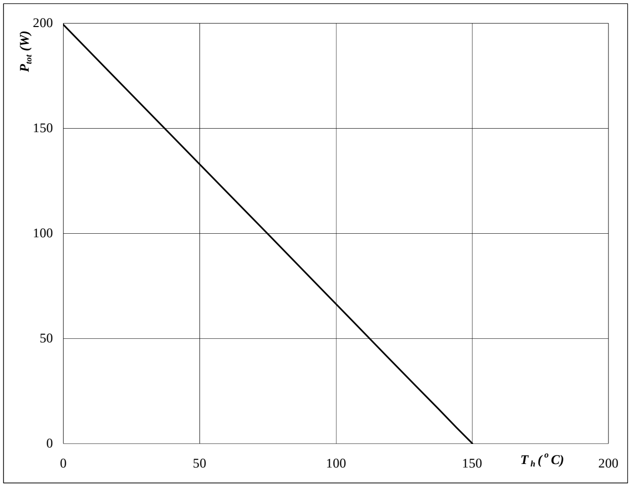
R (C/W)	Tau (s)
0,04	6,4E+01
0,12	1,8E+00
0,44	2,4E-01
0,62	6,3E-02
0,19	7,6E-03
0,12	7,8E-04

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 21 T1,T2,T3,T4,T5,T6 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



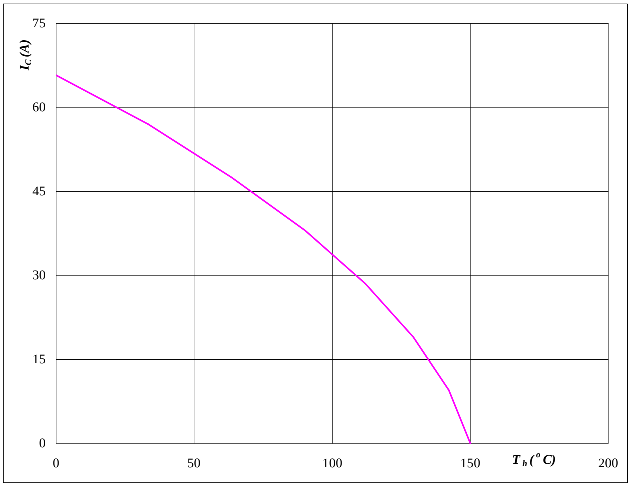
At

T_j = 150 ℃

Figure 22 T1,T2,T3,T4,T5,T6 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

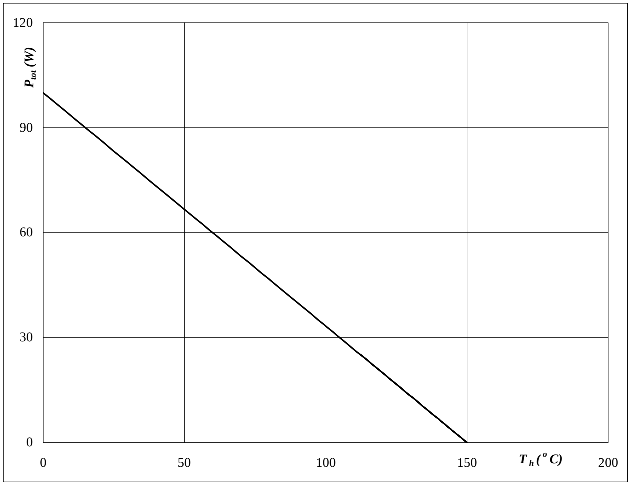
T_j = 150 ℃

V_{GE} = 15 V

Figure 23 D1,D2,D3,D4,D5,D6 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



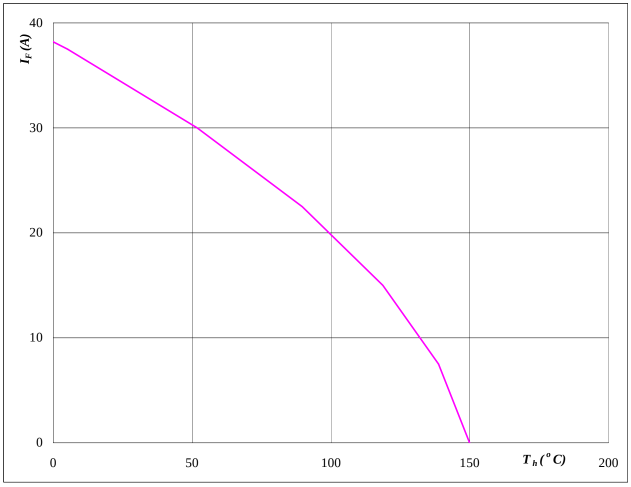
At

T_j = 150 ℃

Figure 24 D1,D2,D3,D4,D5,D6 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

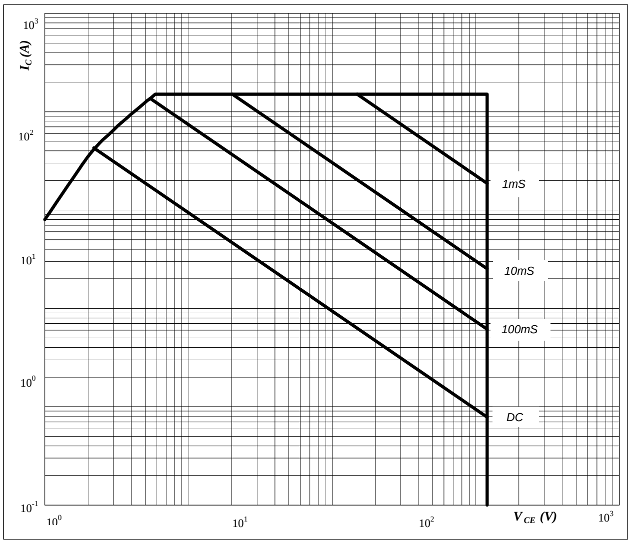
T_j = 150 ℃

T1,T2,T3,T4,T5,T6/D1,D2,D3,D4,D5,D6

Figure 25 T1,T2,T3,T4,T5,T6 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



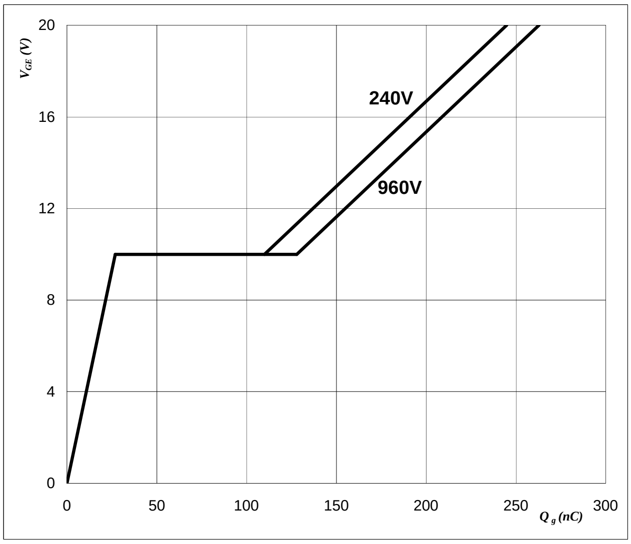
At

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

Figure 26 T1,T2,T3,T4,T5,T6 IGBT

Gate voltage vs Gate charge

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



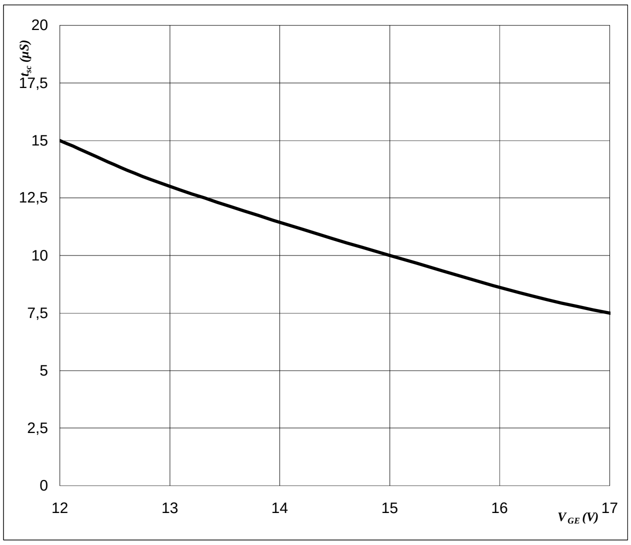
At

I_C =	21	A

Figure 27 T1,T2,T3,T4,T5,T6 IGBT

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

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



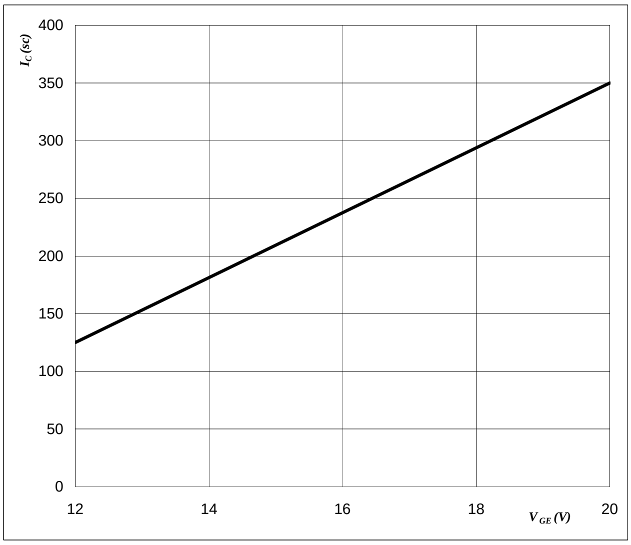
At

V_{CE} =	1200	V
T_j ≤	150	ºC

Figure 28 T1,T2,T3,T4,T5,T6 IGBT

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

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



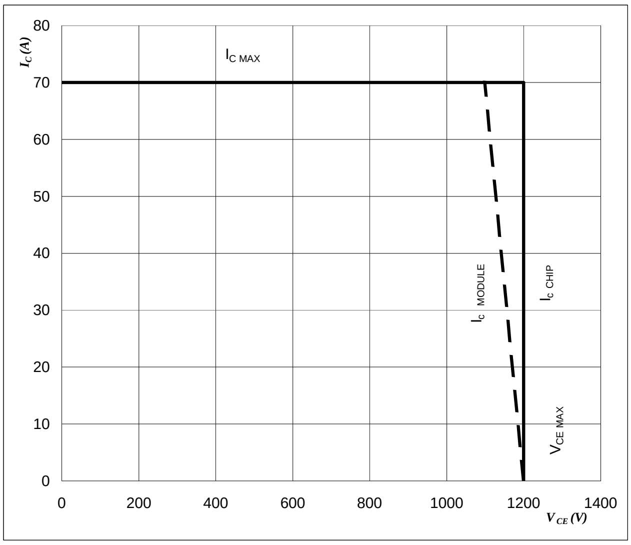
At

V_{CE} ≤	1200	V
T_j =	150	ºC

Figure 29 T1,T2,T3,T4,T5,T6 IGBT

Reverse bias safe operating area

$I_C = f(V_{CE})$



At

T_j = 125 ℃

Rgon = 28 Ω

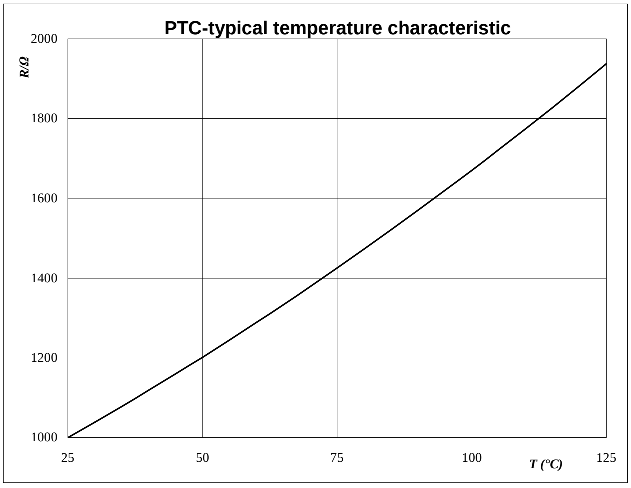
Rgoff = 28 Ω

Thermistor

Figure 1 Thermistor

Typical PTC characteristic
as a function of temperature

$R_T = f(T)$



Switching Definitions Output Inverter

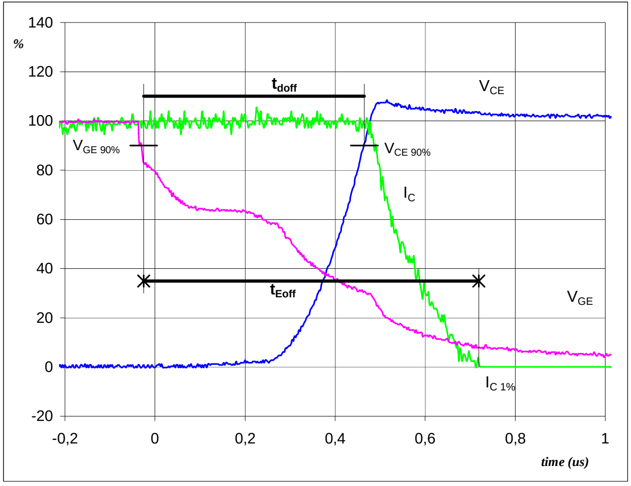
General conditions

T_j	=	125 ℃
R_{gon}	=	28 Ω
R_{goff}	=	28 Ω

Figure 1 Output inverter IGBT

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

(t_{Eoff} = integrating time for E_{off})

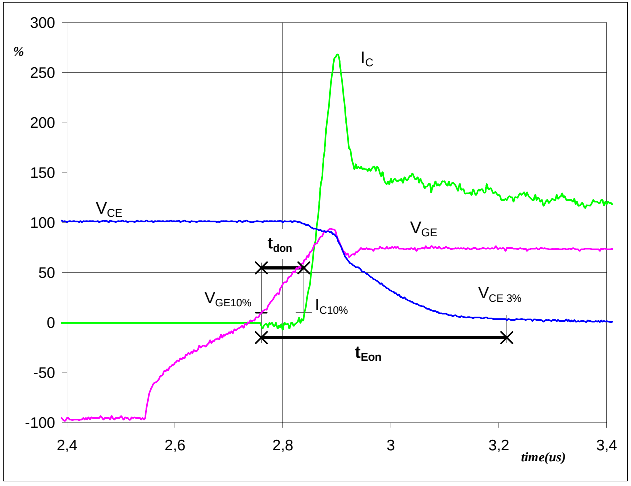


V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	34	A
t_{doff} =	0,50	µs
t_{Eoff} =	0,74	µs

Figure 2 Output inverter IGBT

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

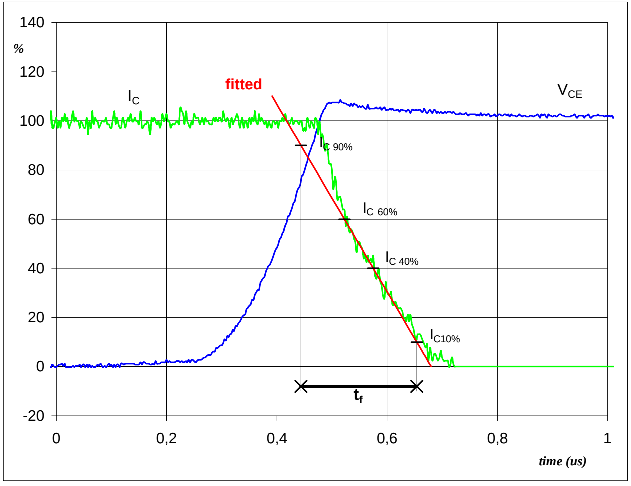
(t_{Eon} = integrating time for E_{on})



V_{GE} (-100%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	34	A
t_{don} =	0,08	µs
t_{Eon} =	0,45	µs

Figure 3 Output inverter IGBT

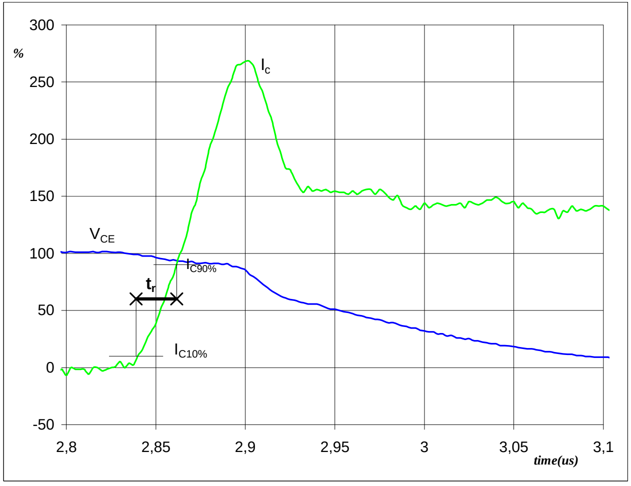
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	34	A
t_f =	0,20	µs

Figure 4 Output inverter IGBT

Turn-on Switching Waveforms & definition of t_r

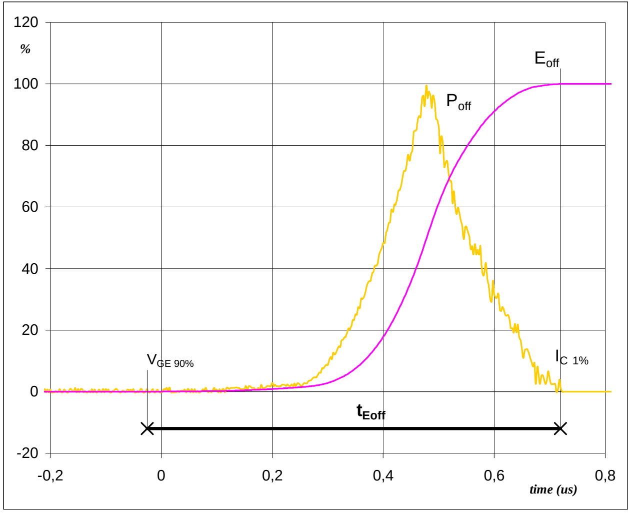


V_C (100%) =	600	V
I_C (100%) =	34	A
t_r =	0,02	µs

Switching Definitions Output Inverter

Figure 5 Output inverter IGBT

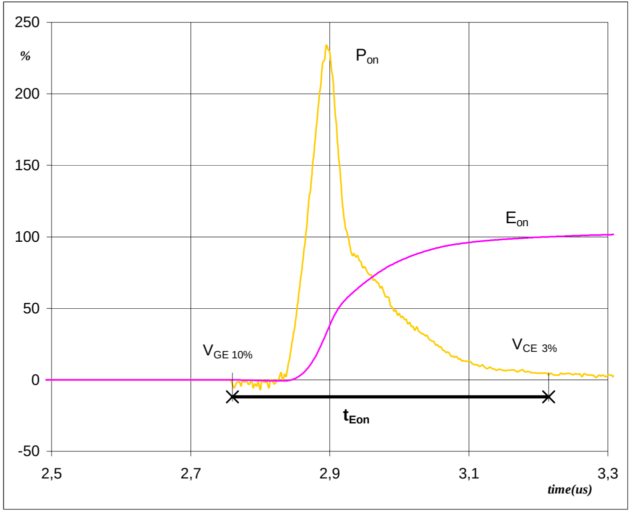
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	20,50	kW
E_{off} (100%) =	3,64	mJ
t_{Eoff} =	0,74	μs

Figure 6 Output inverter IGBT

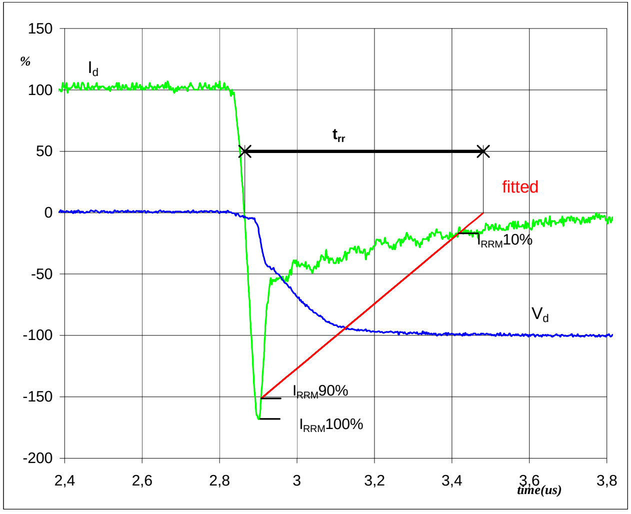
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	20,50	kW
E_{on} (100%) =	4,20	mJ
t_{Eon} =	0,45	μs

Figure 7 Output inverter FWD

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



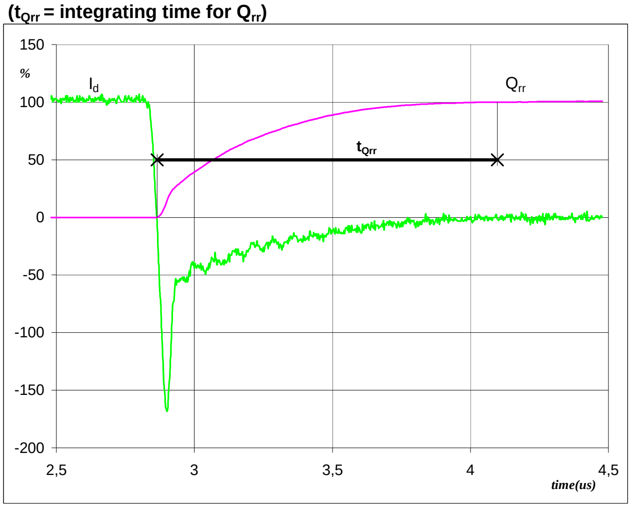
V_d (100%) =	600	V
I_d (100%) =	34	A
I_{RRM} (100%) =	56	A
t_{rr} =	0,47	μs

Switching Definitions Output Inverter

Figure 8 Output inverter FWD

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

(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) = 34 A

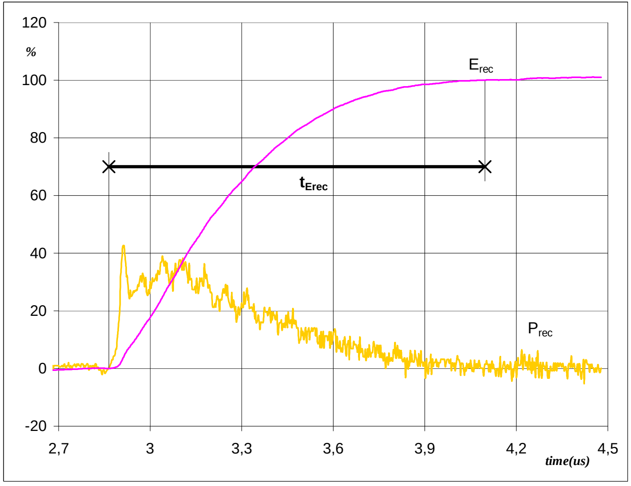
Q_{rr} (100%) = 9,01 µC

t_{Qrr} = 1,23 µs

Figure 9 Output inverter FWD

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

(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) = 20,50 kW

E_{rec} (100%) = 3,70 mJ

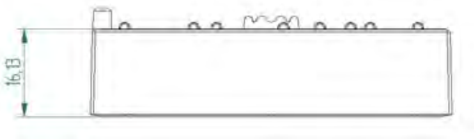
t_{Erec} = 1,23 µs

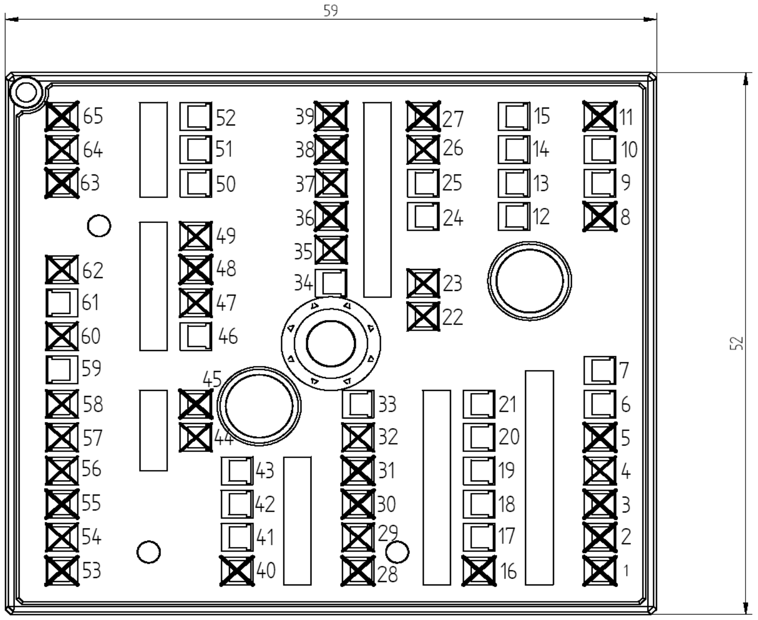
Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

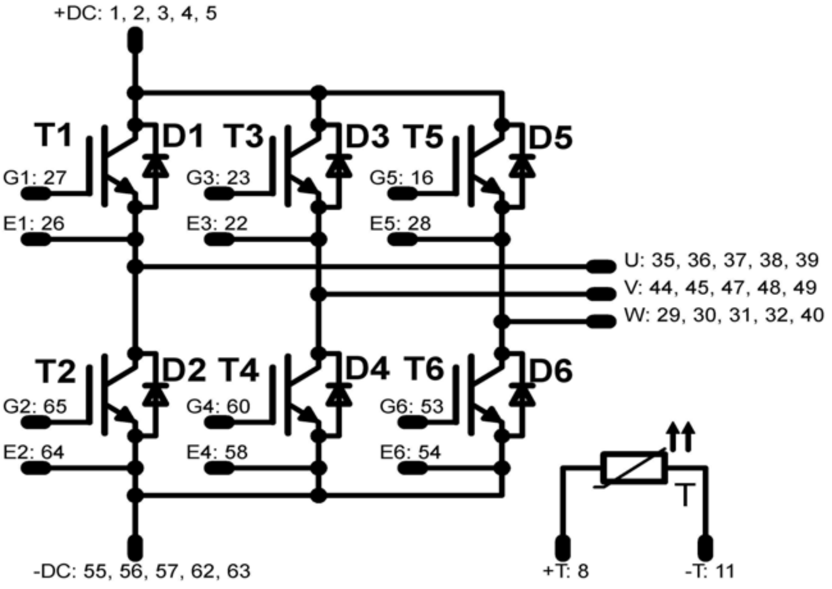
Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K22-T-PM)	V23990-K238-F-/0A/-PM	K238F	K238F-/0A/
with std lid (black V23990-K22-T-PM) and P12	V23990-K238-F-/1A/-PM	K238F	K238F-/1A/
with thin lid (white V23990-K23-T-PM)	V23990-K238-F-/0B/-PM	K238F	K238F-/0B/
with thin lid (white V23990-K23-T-PM) and P12	V23990-K238-F-/1B/-PM	K238F	K238F-/1B/

Outline





Pinout



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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.