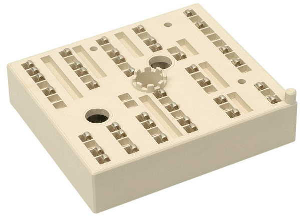
MiniSKiiP® 2 PIM — **600 V / 30 A**

Features

- Solderless interconnection
- Trench Fieldstop technology

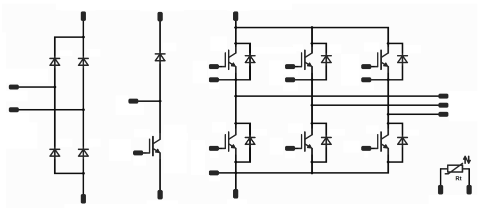
MiniSKiiP® 2 housing



Target Applications

- Industrial Motor Drives

Schematic



Types

- V23990-K222-B10-PM

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
D31,D32,D33,D34					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	$T_j = T_{jmax}$	T_s = 80°C	45	A
Surge forward current	I_{FSM}	t_p = 10ms, sin 180°		370	A
I²t-value	I^2t			370	A²s
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	56	W
Maximum Junction Temperature	T_{jmax}			150	°C
T11,T12,T13,T14,T15,T16					
Collector-emitter break down voltage	V_{CE}			600	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80°C	35	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		90	A
Turn off safe operating area		V_{CE} ≤ 600V, $T_j \le T_{op}$ max		60	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	70	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j ≤ 150°C V_{GE} = 15V		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
D11,D12,D13,D14,D15,D16					
Peak Repetitive Reverse Voltage	V_{RRM}			600	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80°C	28	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		60	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	45	W
Maximum Junction Temperature	T_{jmax}			175	°C
T27					
Collector-emitter break down voltage	V_{CE}			650	V
DC collector current	I_C	$T_j = T_{jmax}$	T_s = 80°C	47	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}		150	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	100	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	$T_j \leq$ 150°C V_{GE} = 15V		5 400	μs V
Maximum Junction Temperature	T_{jmax}			175	°C
D47					
Peak Repetitive Reverse Voltage	V_{RRM}			650	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80°C	20	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		30	A
Brake Inverse Diode	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	36	W
Maximum Junction Temperature	T_{jmax}			175	°C
D27					
Peak Repetitive Reverse Voltage	V_{RRM}			650	V
DC forward current	I_F	$T_j = T_{jmax}$	T_s = 80°C	44	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}		225	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$	T_s = 80°C	86	W
Maximum Junction Temperature	T_{jmax}			175	°C

Maximum Ratings

T_j=25°C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	°C
Operation temperature under switching condition	T_{op}			-40…+(T_{jmax} - 25)	°C
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 [°C]	Min	Typ	Max	
D31,D32,D33,D34										
Forward voltage	V_F				25	25 125	0,8	1,10 1,03	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}				25	25 125		0,90 0,77		V
Slope resistance (for power loss calc. only)	r_t				25	25 125		10 10		mΩ
Reverse current	I_r			1600		25 145			0,05 1,1	mA
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						1,25		K/W
T11,T12,T13,T14,T15,T16										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,00043	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		30	25 125	1	1,51 1,72	2,1	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	600		25			0,1	mA
Gate-emitter leakage current	I_{GES}		±25	0		25			350	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff}=16 Ω R_{gon}=16 Ω	±15	300	30	25 125		88 94		ns
Rise time	t_r					25 125		17 21		ns
Turn-off delay time	$t_{d(off)}$					25 125		137 155		ns
Fall time	t_f					25 125		73 95		ns
Turn-on energy loss	E_{on}					25 125		0,7 0,90		mWs
Turn-off energy loss	E_{off}					25 125		0,62 0,79		mWs
Input capacitance	C_{ies}	f=1MHz	0	25		25		1630		pF
Output capacitance	C_{oss}							108		pF
Reverse transfer capacitance	C_{rss}							50		pF
Gate charge	Q_G		15	480	30	25		167		nC
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						1,35		K/W
D11,D12,D13,D14,D15,D16										
Diode forward voltage	V_F				30	25 125	1	1,51 1,57	2,7	V
Peak reverse recovery current	I_{RRM}	R_{goff}=16 Ω	±15	300	30	25 125		26 28		A
Reverse recovery time	t_{rr}					25 125		212 356		ns
Reverse recovered charge	Q_{rr}					25 125		2,08 3,23		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		1257 854		A/μs
Reverse recovered energy	E_{rec}					25 125		0,42 0,69		mWs
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						2,11		K/W

Characteristic Values

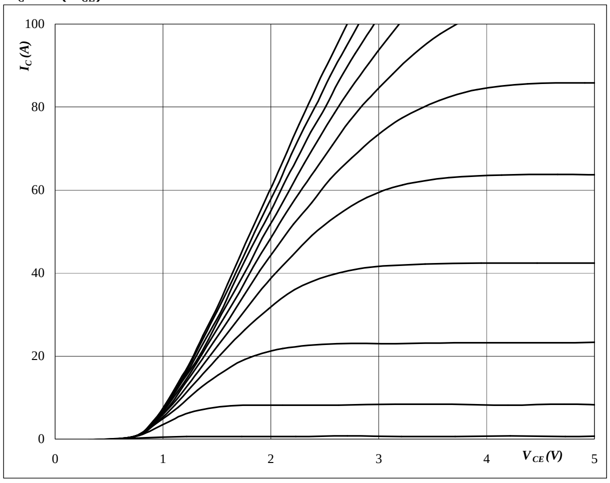
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] or V_{GS} [V]	V_r [V] or V_{CE} [V] or V_{DS} [V]	I_C [A] or I_F [A] or I_D [A]	T_j [°C]	Min	Typ	Max	
T27										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$			0,0008	25 125	4,2	5,1	5,6	V
Collector-emitter saturation voltage	V_{CEsat}		15		50	25 125	1	1,81 2,03	2,4	V
Collector-emitter cut-off incl diode	I_{CES}		0	650		25			0,01	mA
Gate-emitter leakage current	I_{GES}		20	0		25			300	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff}=8 Ω R_{gon}=8 Ω	±15	300	30	25 125		101 102		ns
Rise time	t_r					25 125		21 23		
Turn-off delay time	$t_{d(off)}$					25 125		140 173		
Fall time	t_f					25 125		7 28		
Turn-on energy loss	E_{on}					25 125		0,46 0,84		mWs
Turn-off energy loss	E_{off}					25 125		0,23 0,46		
Input capacitance	C_{ies}	f=1MHz	0	25		25		3100		pF
Output capacitance	C_{oss}							116		
Reverse transfer capacitance	C_{rss}							90		
Gate charge	Q_G		15	480	50	25		315		nC
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						0,95		K/W
D47										
Diode forward voltage	V_F				15	25 125	1	1,79 1,67	2	V
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						2,62		K/W
D27										
Diode forward voltage	V_F				50	25 125	1	2,50 2,19	2,8	V
Reverse leakage current	I_r			650		25			10	μA
Peak reverse recovery current	I_{RRM}	R_{goff}=8 Ω R_{goff}=8 Ω	±15	300	30	25 125		13 23		A
Reverse recovery time	t_{rr}					25 125		55 118		ns
Reverse recovered charge	Q_{rr}					25 125		0,33 1,59		μC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 125		1408 480		A/μs
Reverse recovery energy	E_{rec}					25 125		0,04 0,22		mWs
Thermal resistance chip to heatsink	$R_{th(j-s)}$	Thermal grease thickness≤50um λ = 1 W/mK						1,10		K/W
Thermistor										
Rated resistance	R					25		1000		Ω
Deviation of R100	$\Delta_{R/R}$	R_{100}=1670 Ω				100	-3		3	%
R100	R					25		1670,3125		Ω
A-value	$B_{(25/50)}$					25		$7{,}635 \cdot 10^{-3}$		1/K
B-value	$B_{(25/100)}$					25		$1{,}731 \cdot 10^{-5}$		1/K²
Vincotech NTC Reference									E	

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 1 T11,T12,T13,T14,T15,T16 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



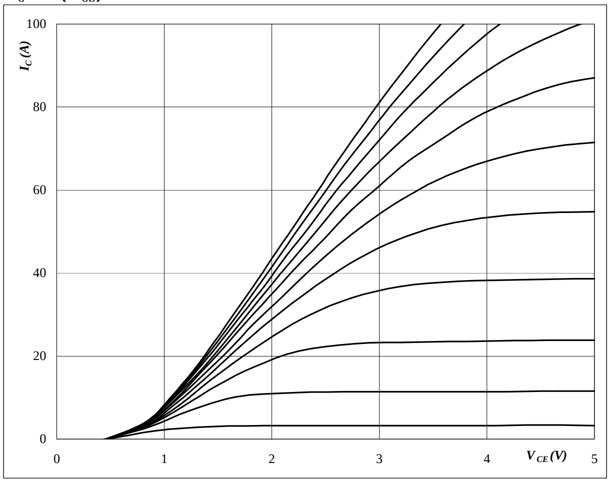
At

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

Figure 2 T11,T12,T13,T14,T15,T16 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



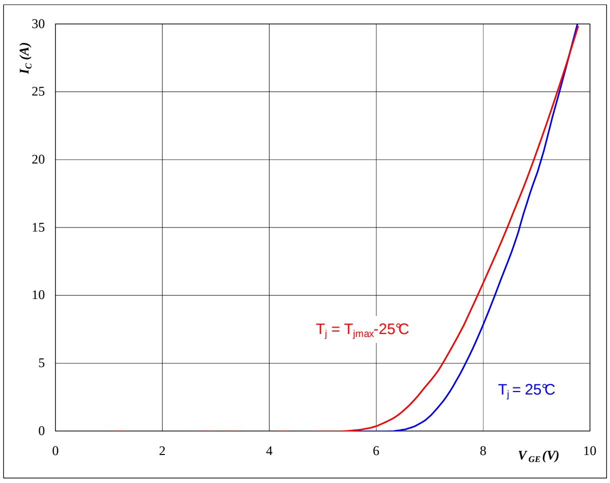
At

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

Figure 3 T11,T12,T13,T14,T15,T16 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



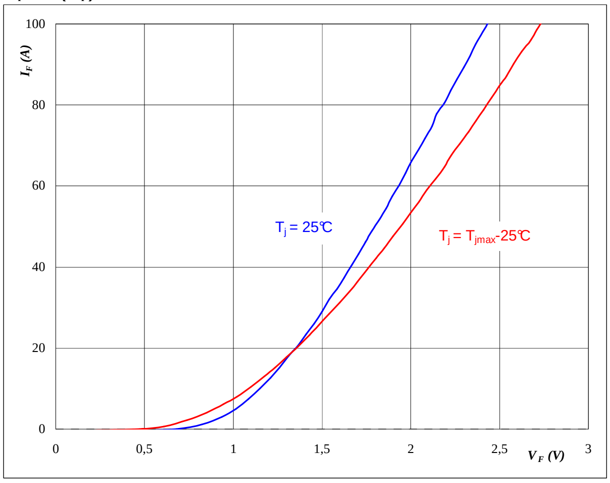
At

t_p =	250	μs
V_{CE} =	10	V

Figure 4 D11,D12,D13,D14,D15,D16 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

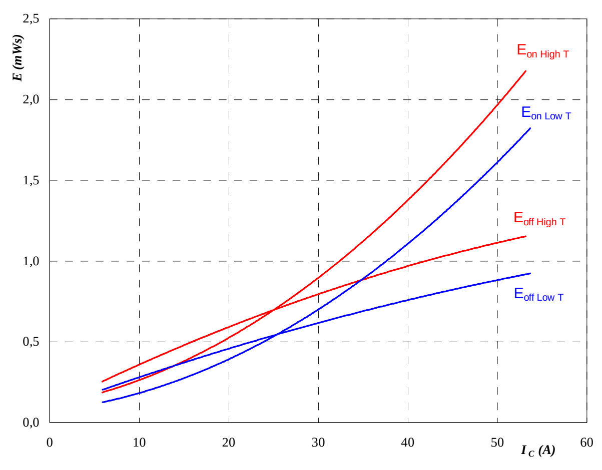
t_p =	250	μs

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 5 T11,T12,T13,T14,T15,T16 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



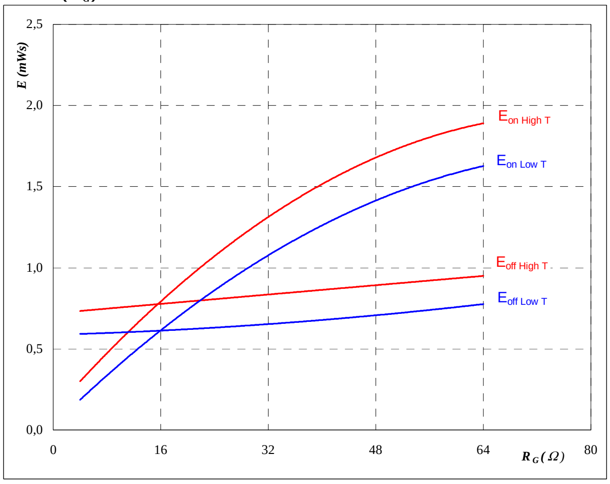
With an inductive load at

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

Figure 6 T11,T12,T13,T14,T15,T16 IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



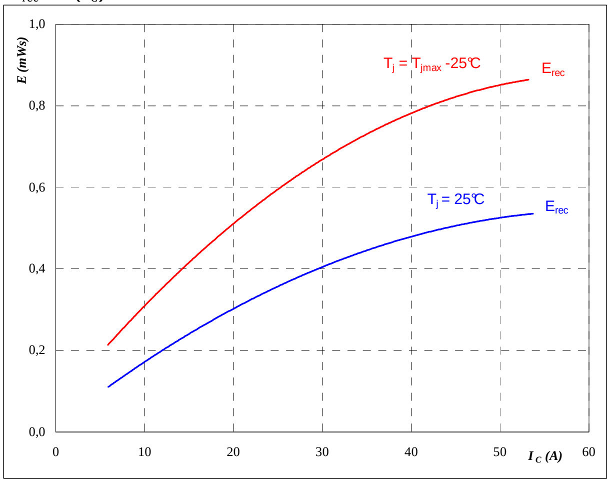
With an inductive load at

T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

Figure 7 T11,T12,T13,T14,T15,T16 IGBT

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



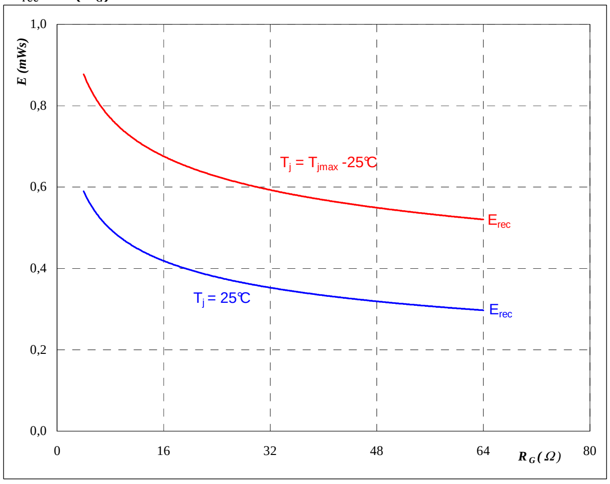
With an inductive load at

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

Figure 8 T11,T12,T13,T14,T15,T16 IGBT

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

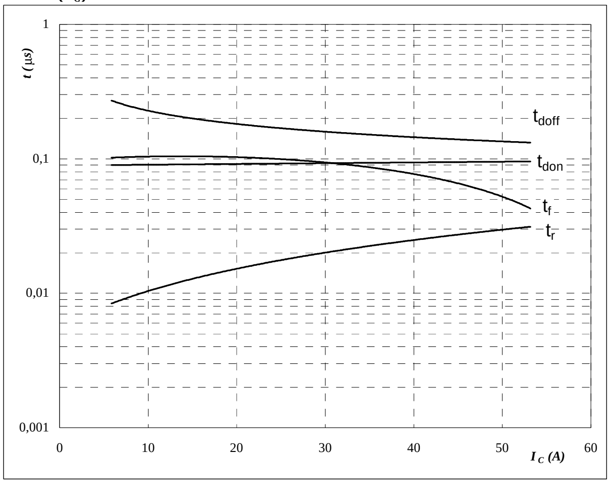
T_j =	25/125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 9 T11,T12,T13,T14,T15,T16 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



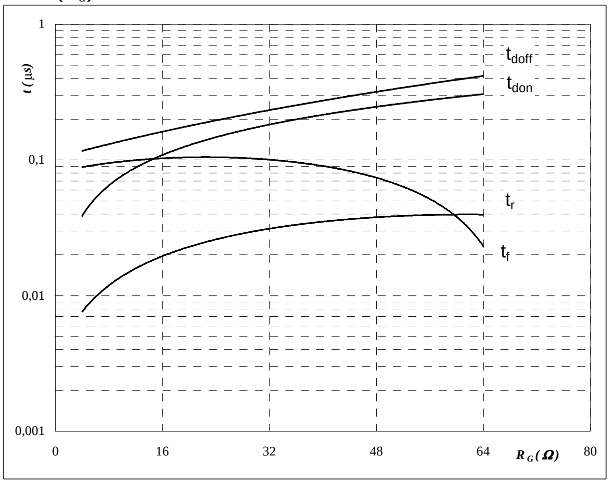
With an inductive load at

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

Figure 10 T11,T12,T13,T14,T15,T16 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



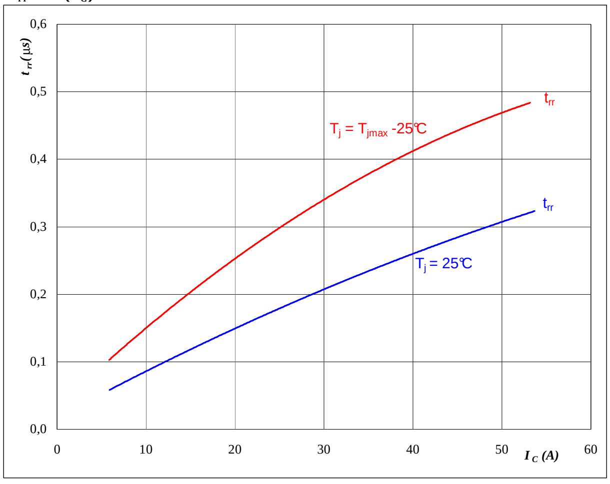
With an inductive load at

T_j =	125	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

Figure 11 D11,D12,D13,D14,D15,D16 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$



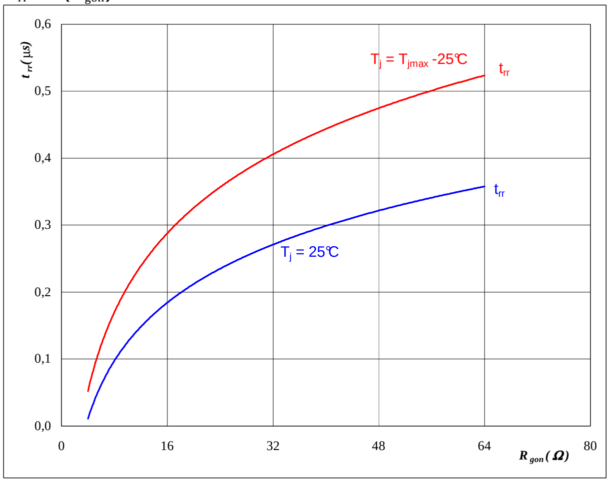
At

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

Figure 12 D11,D12,D13,D14,D15,D16 FWD

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

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



At

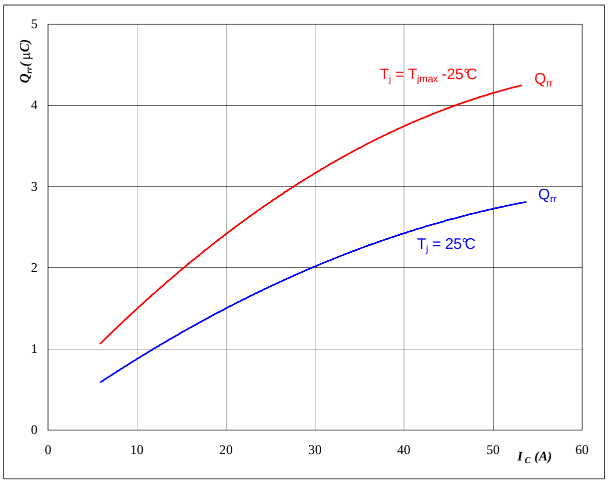
T_j =	25/125	°C
V_R =	300	V
I_F =	30	A
V_{GE} =	±15	V

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 13 D11,D12,D13,D14,D15,D16 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$



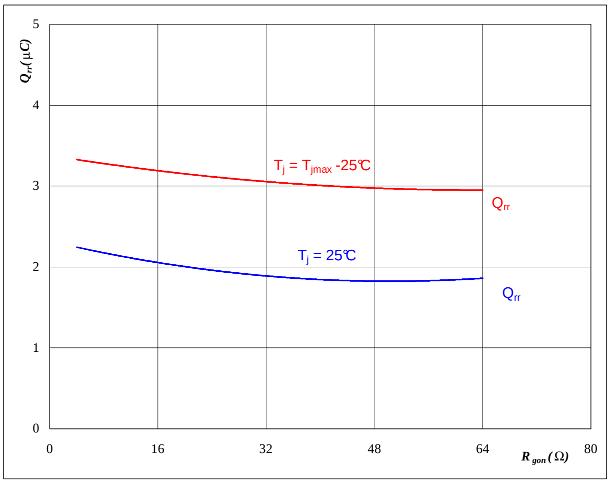
At

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

Figure 14 D11,D12,D13,D14,D15,D16 FWD

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

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



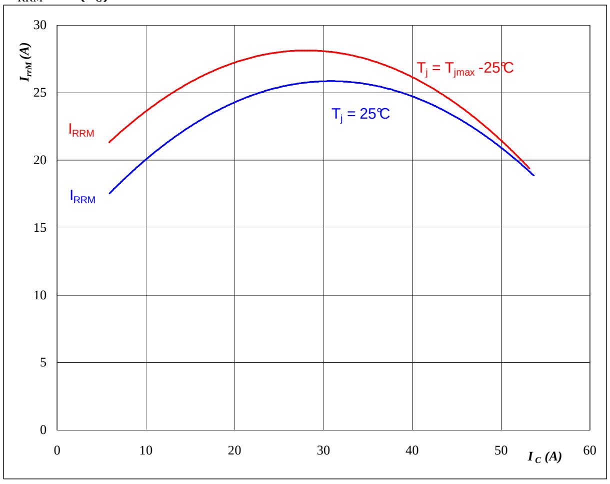
At

T_j =	25/125	°C
V_R =	300	V
I_F =	30	A
V_{GE} =	±15	V

Figure 15 D11,D12,D13,D14,D15,D16 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$



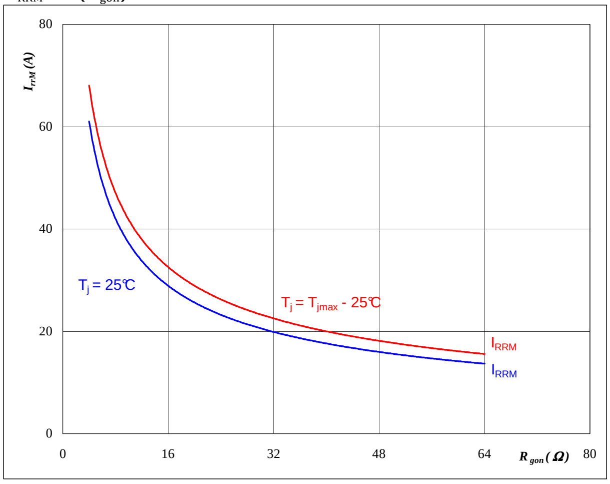
At

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

Figure 16 D11,D12,D13,D14,D15,D16 FWD

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

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



At

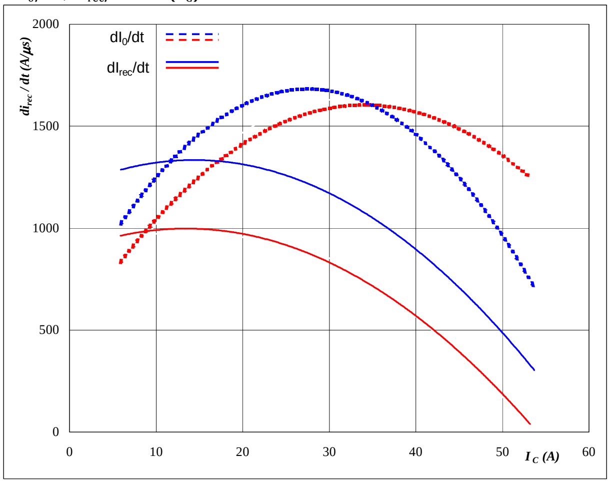
T_j =	25/125	°C
V_R =	300	V
I_F =	30	A
V_{GE} =	±15	V

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 17 D11,D12,D13,D14,D15,D16 FWD

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

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



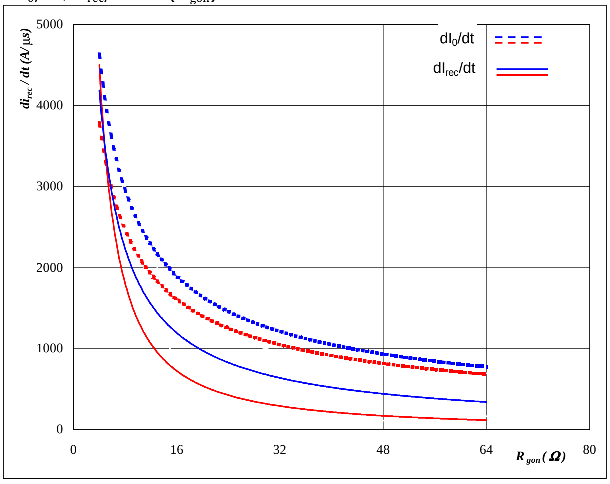
At

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

Figure 18 D11,D12,D13,D14,D15,D16 FWD

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

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



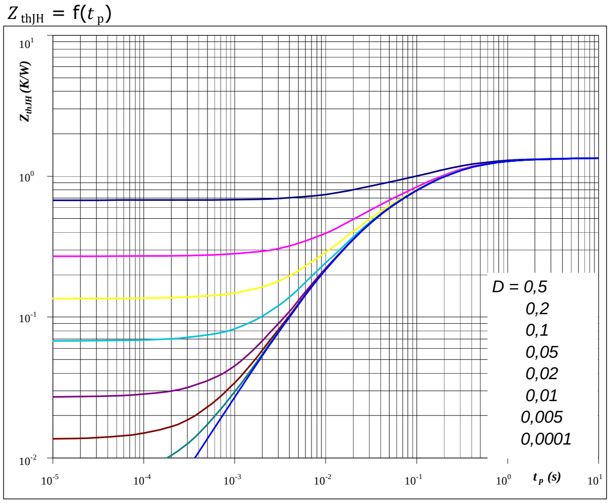
At

T_j =	25/125	°C
V_R =	300	V
I_F =	30	A
V_{GE} =	±15	V

Figure 19 T11,T12,T13,T14,T15,T16 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	1,35	K/W

IGBT thermal model values

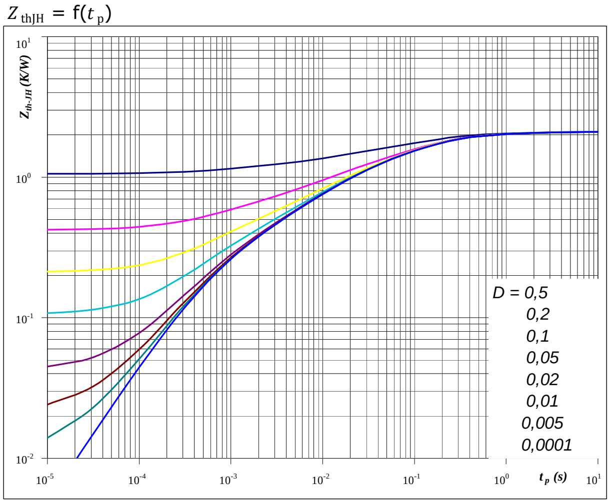
Thermal grease

R (K/W)	Tau (s)
0,05	4,4E+00
0,15	7,2E-01
0,54	1,9E-01
0,36	5,8E-02
0,26	1,4E-02

Figure 20 D11,D12,D13,D14,D15,D16 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

D =	t_p / T	
R_{thJH} =	2,11	K/W

FWD thermal model values

Thermal grease

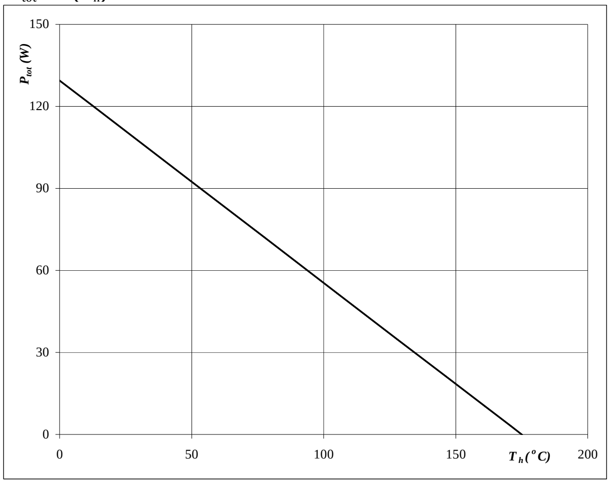
R (K/W)	Tau (s)
0,08	3,7E+00
0,27	4,4E-01
0,70	1,1E-01
0,44	2,6E-02
0,35	6,8E-03
0,19	1,2E-03

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 21 T11,T12,T13,T14,T15,T16 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



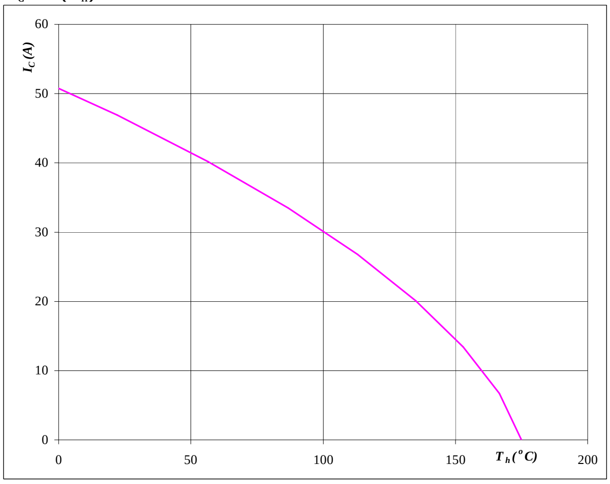
At

T_j = 175 °C

Figure 22 T11,T12,T13,T14,T15,T16 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

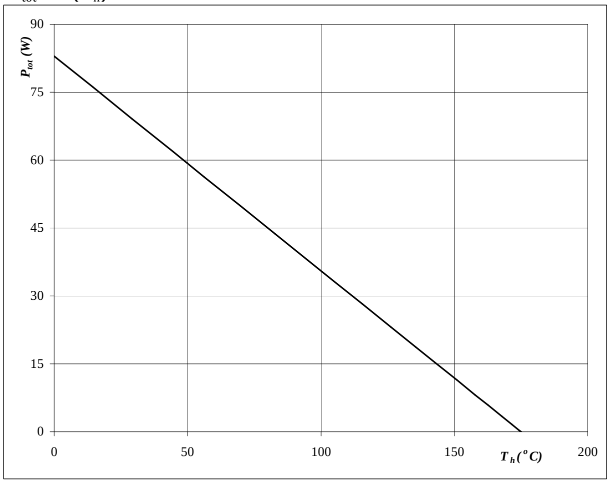
T_j = 175 °C

V_{GE} = 15 V

Figure 23 D11,D12,D13,D14,D15,D16 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



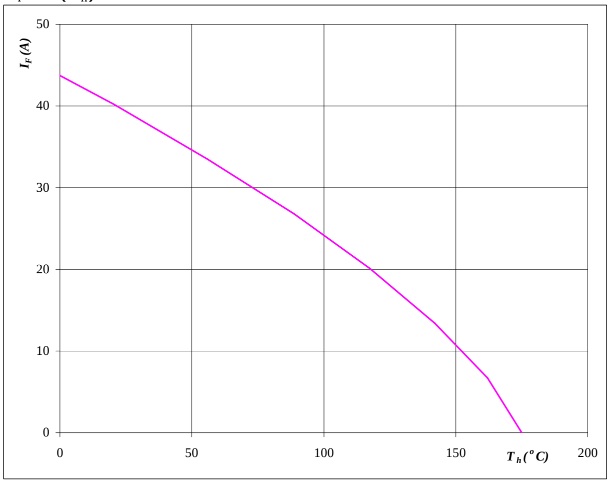
At

T_j = 175 °C

Figure 24 D11,D12,D13,D14,D15,D16 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

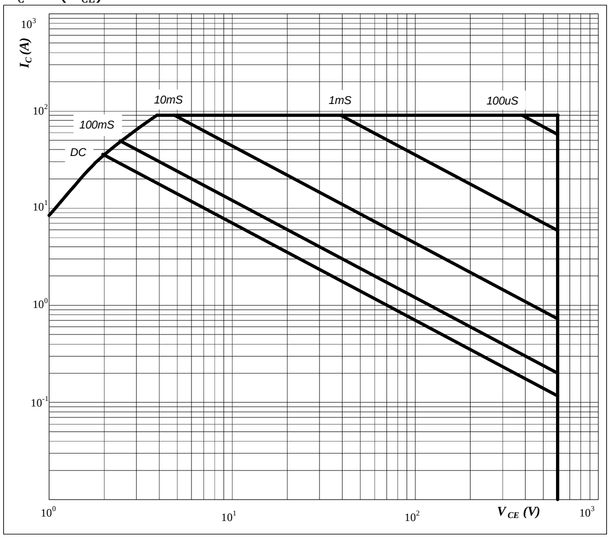
T_j = 175 °C

T11,T12,T13,T14,T15,T16 / D11,D12,D13,D14,D15,D16

Figure 25 T11,T12,T13,T14,T15,T16 IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



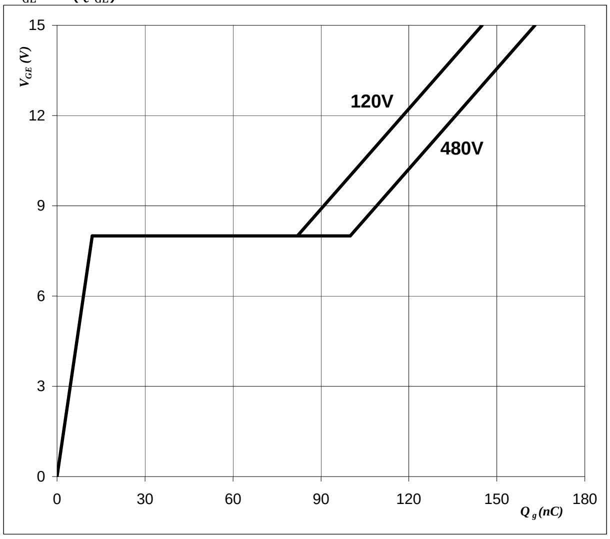
At

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

Figure 26 T11,T12,T13,T14,T15,T16 IGBT

Gate voltage vs Gate charge

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



At

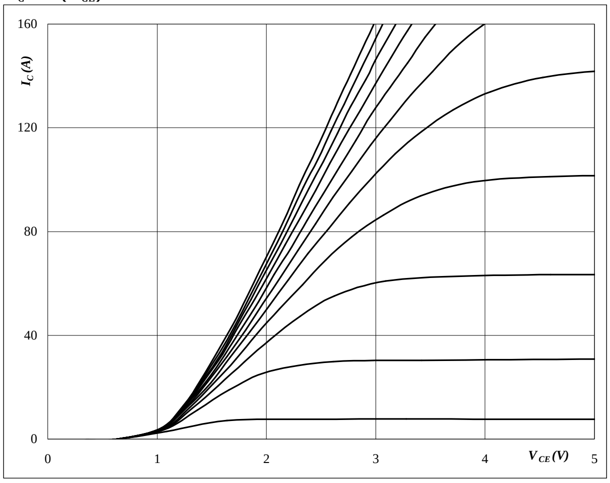
I_C =	30	A

T27 / D27

Figure 1 T27 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

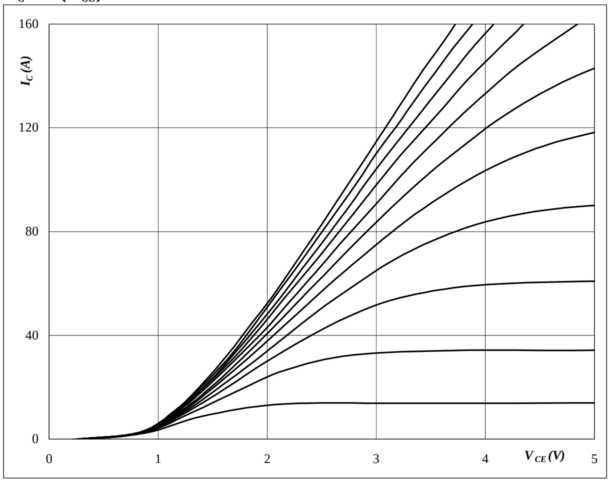
T_j = 25 °C

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

Figure 2 T27 IGBT

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

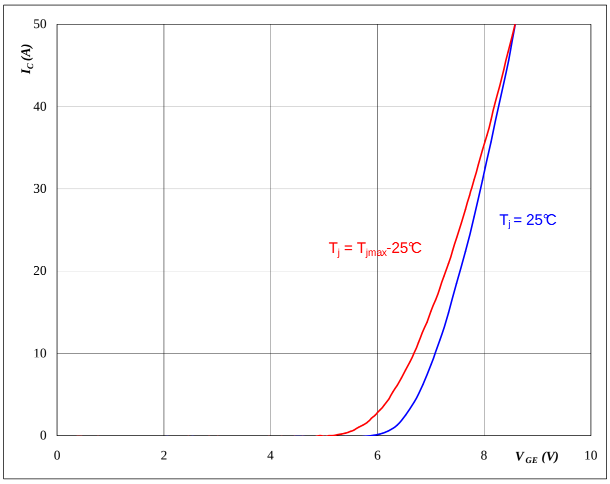
T_j = 149 °C

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

Figure 3 T27 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$



At

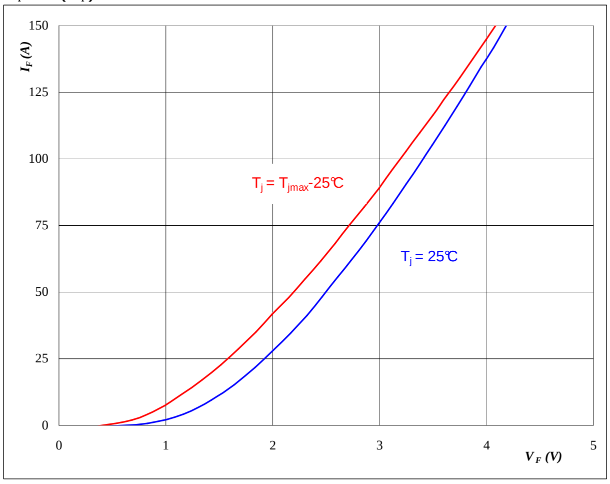
t_p = 250 µs

V_{CE} = 10 V

Figure 4 D27 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

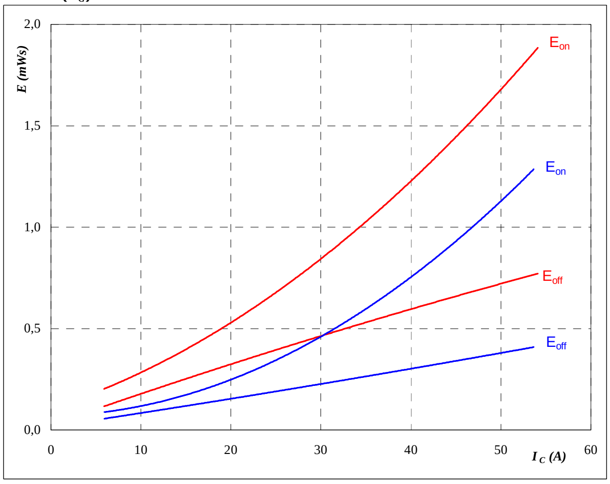
t_p = 250 µs

T27 / D27

Figure 5	T27 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



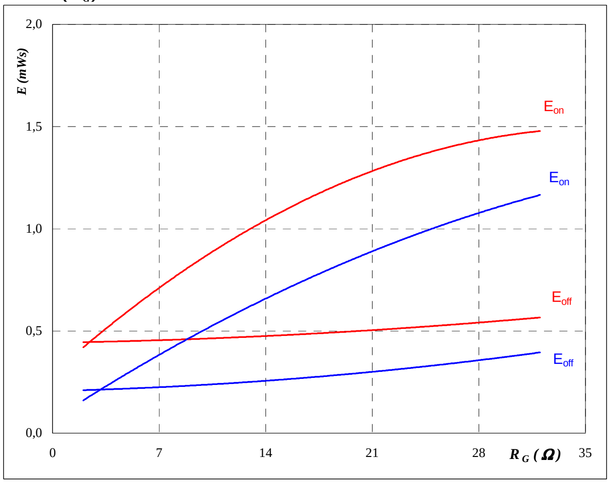
With an inductive load at

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 6	T27 IGBT

Typical switching energy losses as a function of gate resistor

$E = f(R_G)$



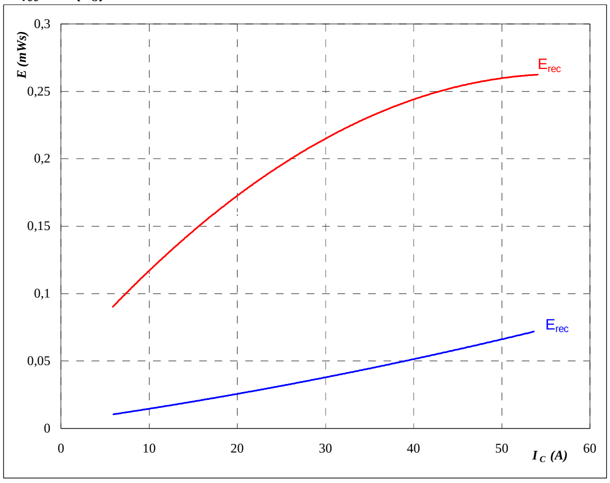
With an inductive load at

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

Figure 7	T27 IGBT

Typical reverse recovery energy loss as a function of collector current

$E_{rec} = f(I_C)$



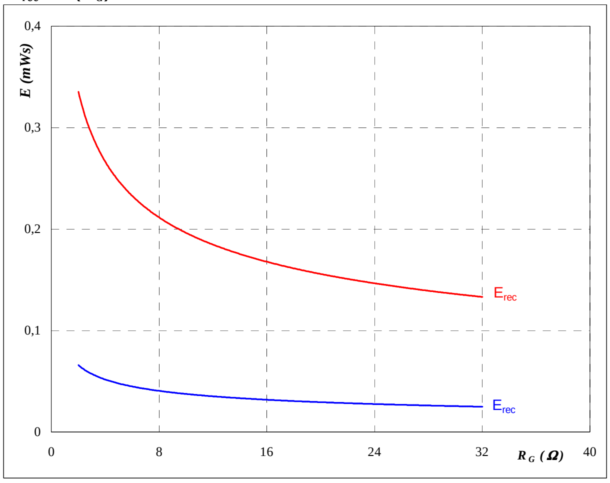
With an inductive load at

T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 8	T27 IGBT

Typical reverse recovery energy loss as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

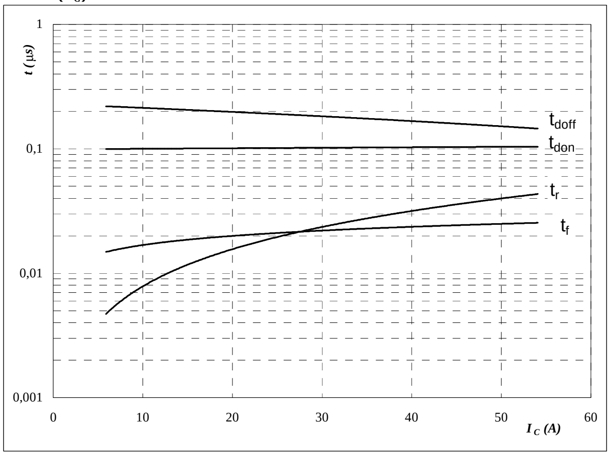
T_j =	25/150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

T27 / D27

Figure 9 T27 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



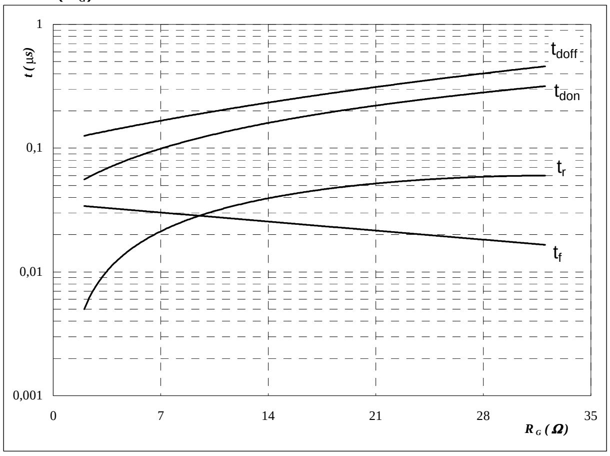
With an inductive load at

T_j =	150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 10 T27 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$



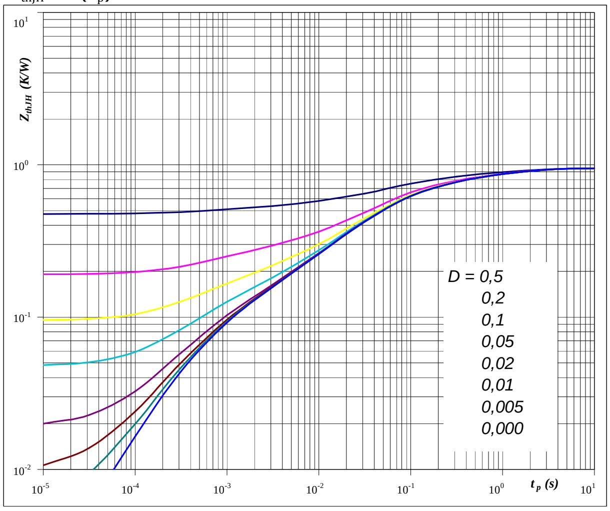
With an inductive load at

T_j =	150	°C
V_{CE} =	300	V
V_{GE} =	±15	V
I_C =	30	A

Figure 11 T27 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



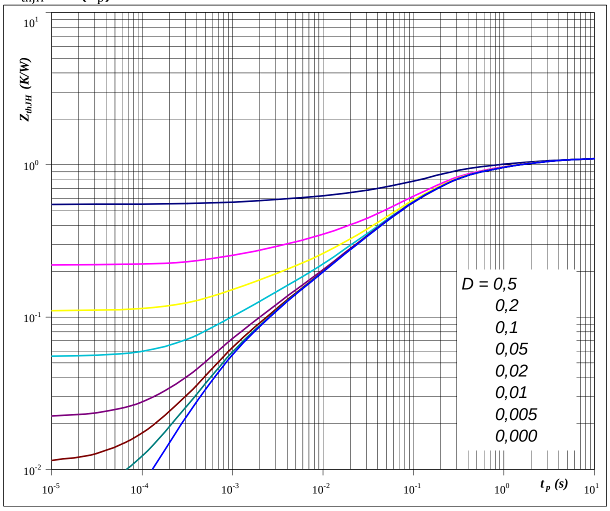
At

D =	t_p / T	
R_{thJH} =	0,95	K/W

Figure 12 D27 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

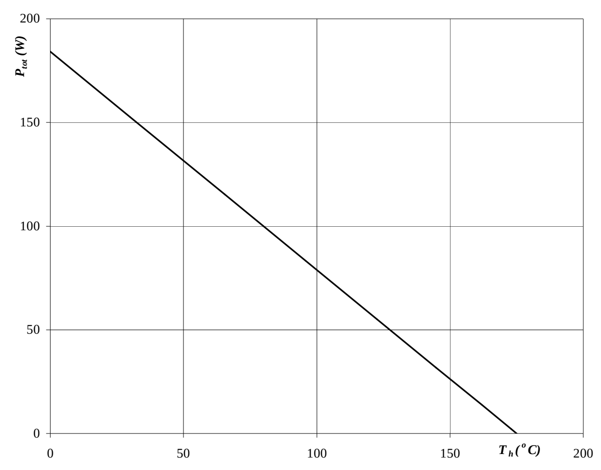
D =	t_p / T	
R_{thJH} =	1,10	K/W

T27 / D27

Figure 13 T27 IGBT

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



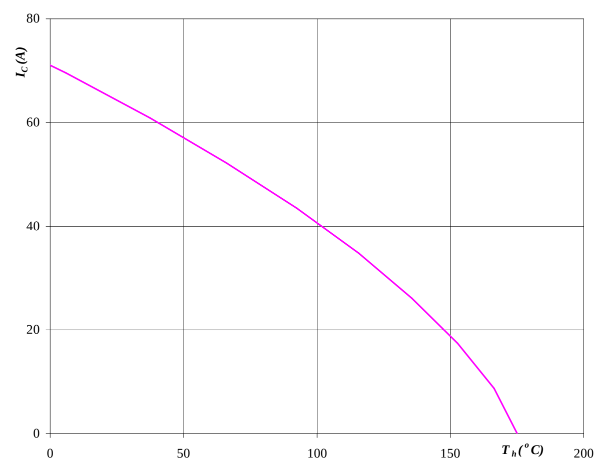
At

T_j = 175 ºC

Figure 14 T27 IGBT

Collector current as a function of heatsink temperature

$I_C = f(T_h)$



At

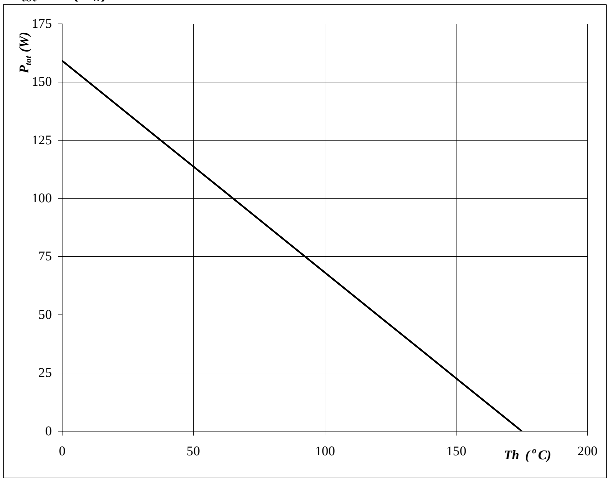
T_j = 175 ºC

V_{GE} = 15 V

Figure 15 D27 FWD

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



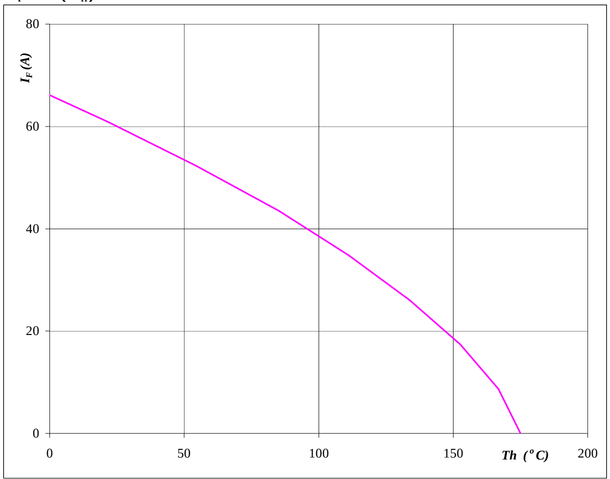
At

T_j = 175 ºC

Figure 16 D27 FWD

Forward current as a function of heatsink temperature

$I_F = f(T_h)$

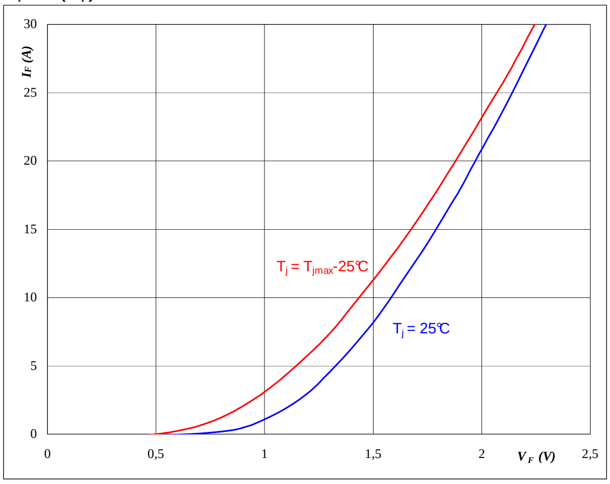


At

T_j = 175 ºC

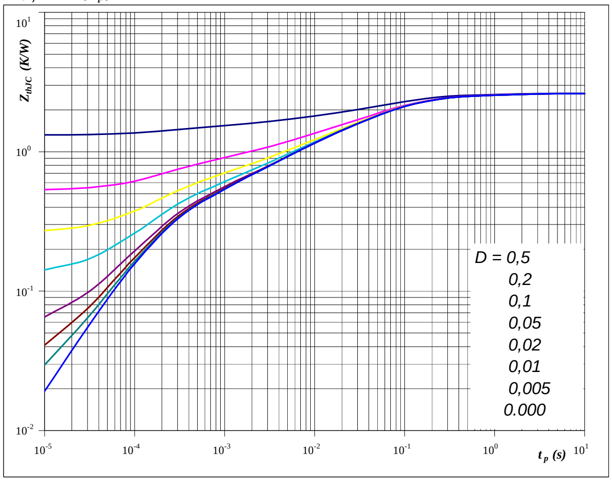
D47

Figure 1 D47 diode
Typical diode forward current as a function of forward voltage
$I_F = f(V_F)$



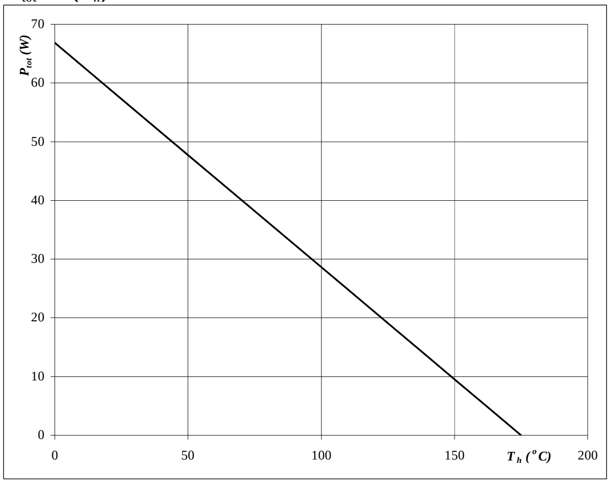
At
t_p = 250 µs

Figure 2 D47 diode
Diode transient thermal impedance as a function of pulse width
$Z_{thJH} = f(t_p)$



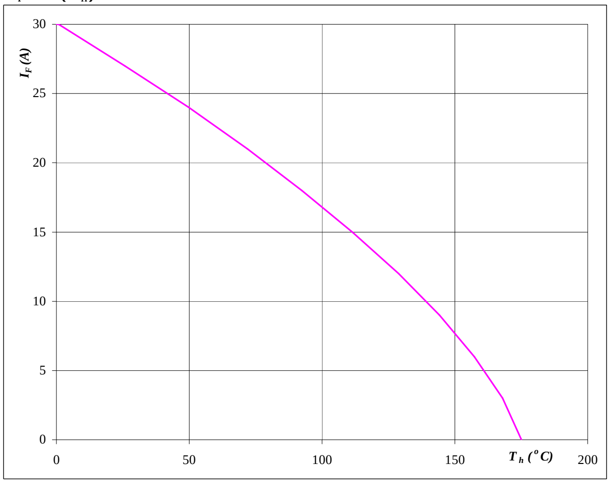
At
D = t_p / T
R_{thJH} = 2,62 K/W

Figure 3 D47 diode
Power dissipation as a function of heatsink temperature
$P_{tot} = f(T_h)$



At
T_j = 175 ºC

Figure 4 D47 diode
Forward current as a function of heatsink temperature
$I_F = f(T_h)$



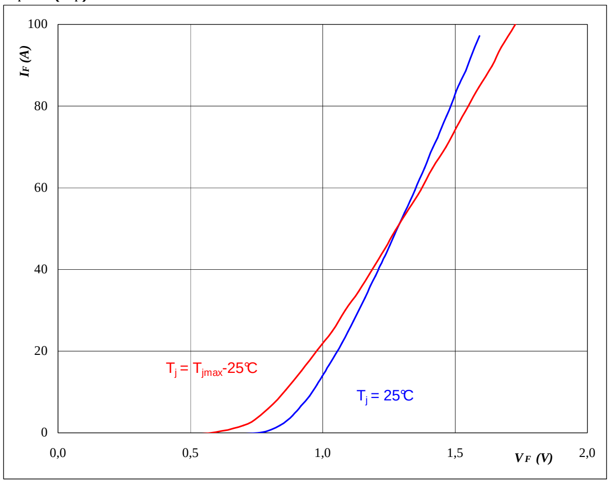
At
T_j = 175 ºC

D31,D32,D33,D34

Figure 1 D31,D32,D33,D34 diode

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



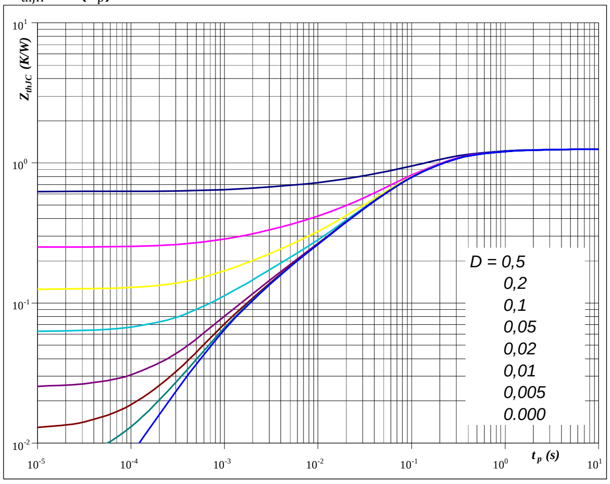
At

t_p = 250 μs

Figure 2 D31,D32,D33,D34 diode

Diode transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$



At

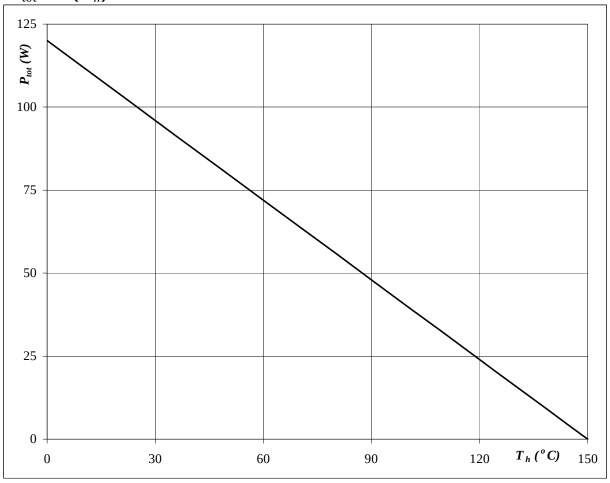
$D = t_p / T$

R_{thJH} = 1,25 K/W

Figure 3 D31,D32,D33,D34 diode

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_h)$



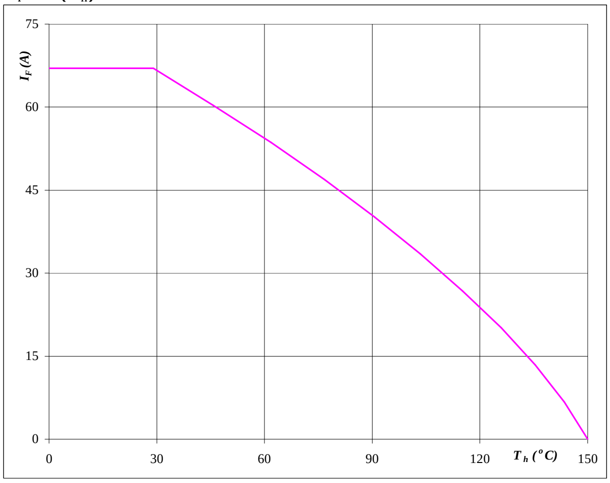
At

T_j = 150 ºC

Figure 4 D31,D32,D33,D34 diode

Forward current as a function of heatsink temperature

$I_F = f(T_h)$



At

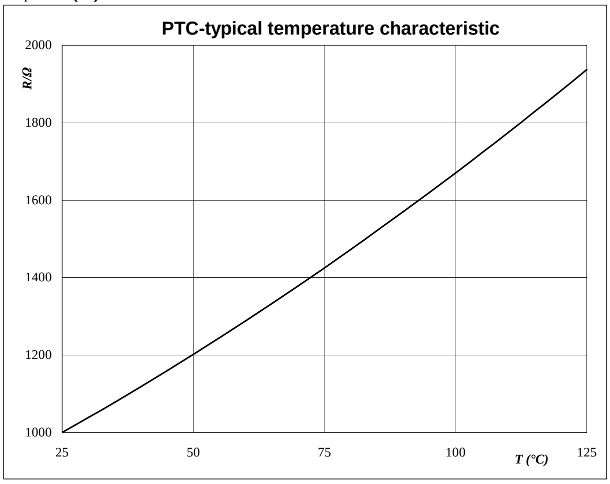
T_j = 150 ºC

Thermistor

Figure 1	Thermistor

Typical PTC characteristic
as a function of temperature

R_T = f(T)



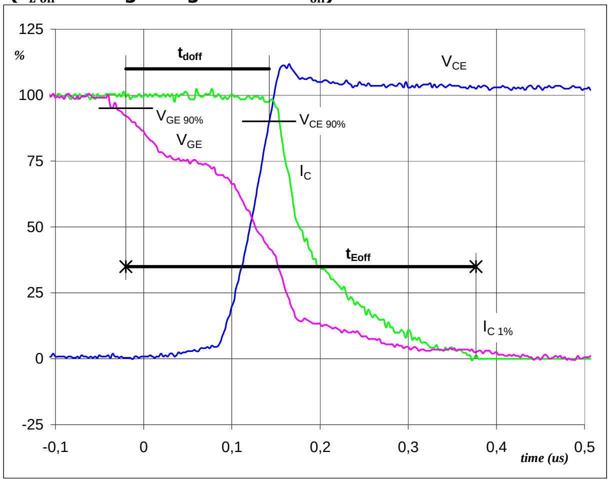
Inverter Switching Definitions

General conditions

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

Figure 1 Inverter IGBT

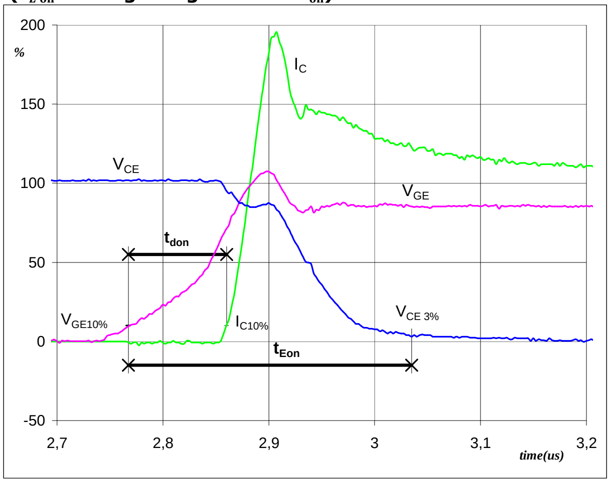
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	30	A
t_{doff} =	0,16	µs
$t_{E\,off}$ =	0,40	µs

Figure 2 Inverter IGBT

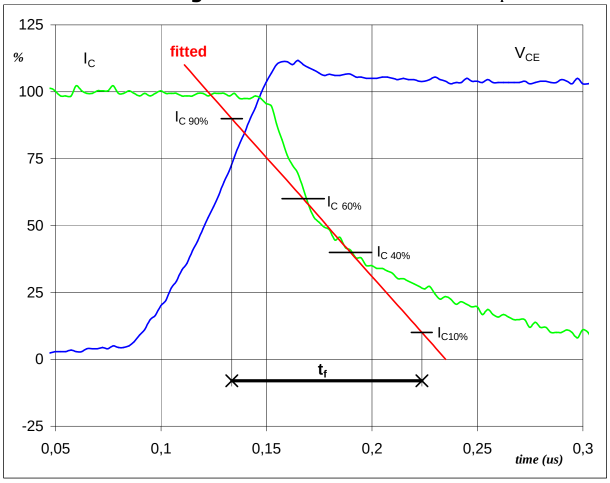
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	30	A
t_{don} =	0,09	µs
$t_{E\,on}$ =	0,27	µs

Figure 3 Inverter IGBT

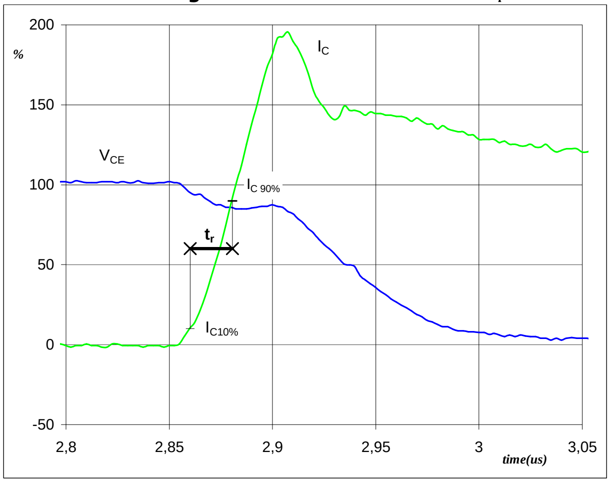
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	30	A
t_f =	0,09	µs

Figure 4 Inverter IGBT

Turn-on Switching Waveforms & definition of t_r

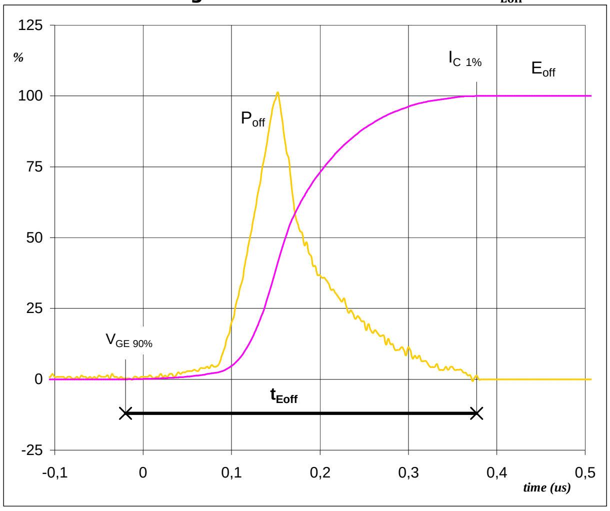


V_C (100%) =	300	V
I_C (100%) =	30	A
t_r =	0,02	µs

Inverter Switching Definitions

Figure 5 Inverter IGBT

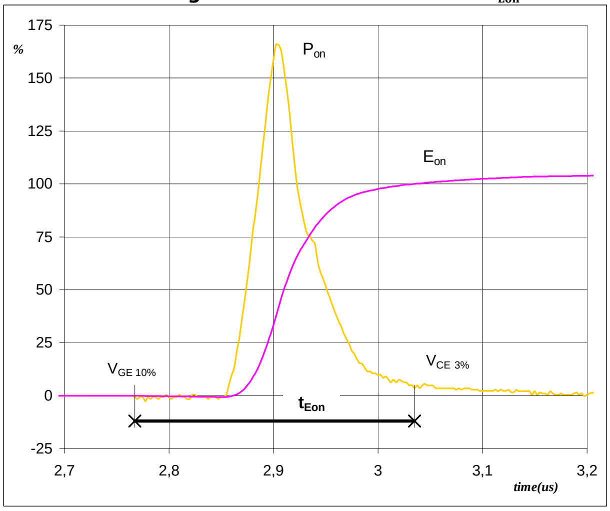
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	8,97	kW
E_{off} (100%) =	0,79	mJ
$t_{E\ off}$ =	0,40	μs

Figure 6 Inverter IGBT

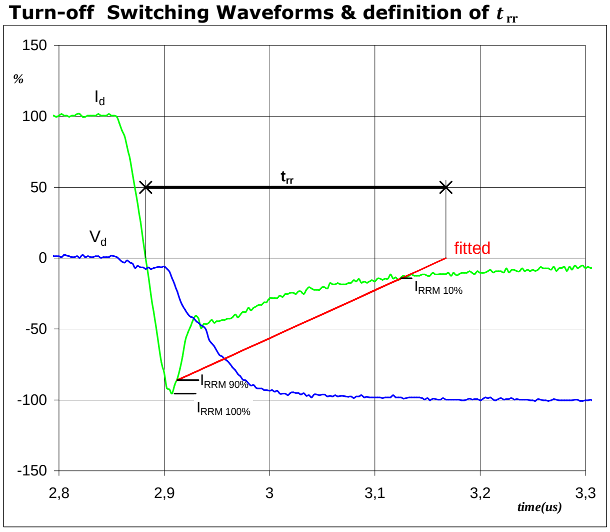
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	8,97	kW
E_{on} (100%) =	0,90	mJ
$t_{E\ on}$ =	0,27	μs

Figure 7 Inverter IGBT

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

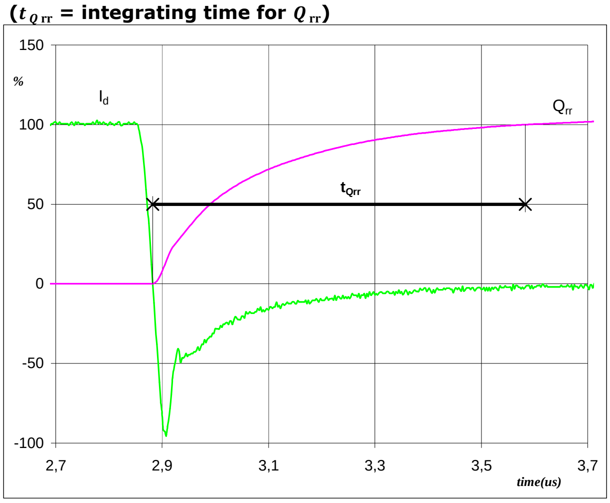


V_d (100%) =	300	V
I_d (100%) =	30	A
I_{RRM} (100%) =	28	A
t_{rr} =	0,36	μs

Inverter Switching Definitions

Figure 8 Inverter FWD

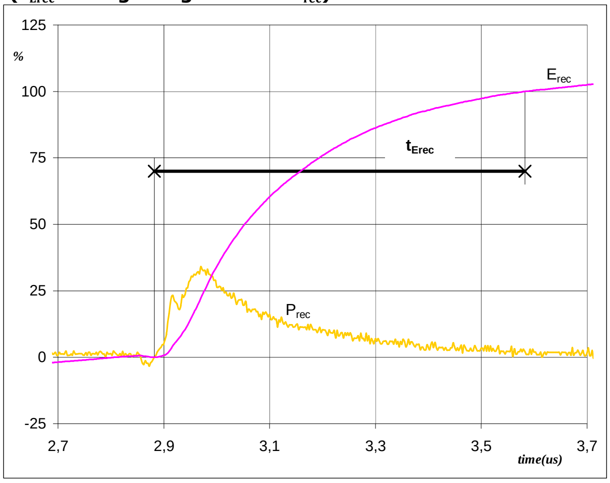
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	30	A
Q_{rr} (100%) =	3,23	μC
$t_{Q\,rr}$ =	0,70	μs

Figure 9 Inverter FWD

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



P_{rec} (100%) =	8,97	kW
E_{rec} (100%) =	0,69	mJ
$t_{E\,rec}$ =	0,70	μs

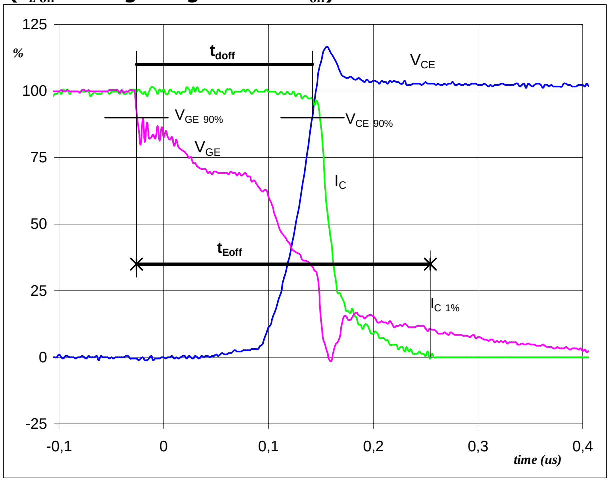
Brake Switching Definitions

General conditions

T_j	=	125 °C
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

Figure 1 Brake IGBT

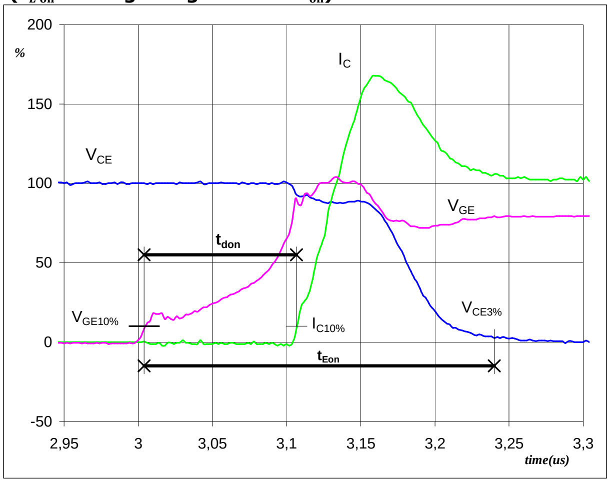
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	30	A
t_{doff} =	0,17	μs
$t_{E\,off}$ =	0,28	μs

Figure 2 Brake IGBT

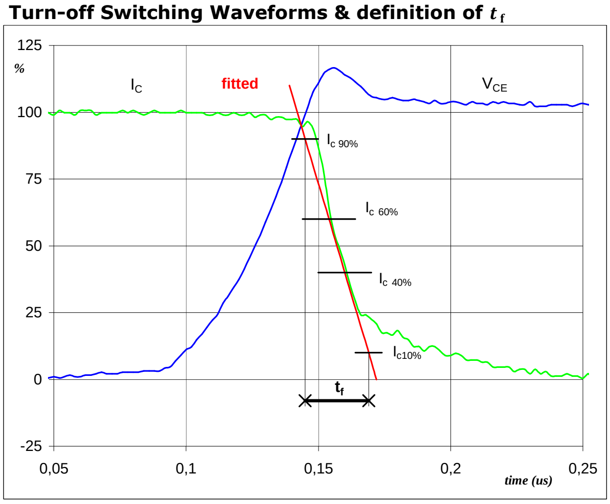
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	300	V
I_C (100%) =	30	A
t_{don} =	0,10	μs
$t_{E\,on}$ =	0,24	μs

Figure 3 Brake IGBT

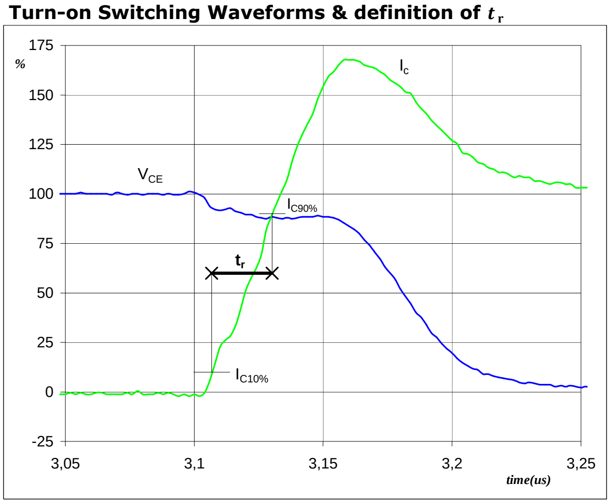
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	300	V
I_C (100%) =	30	A
t_f =	0,03	μs

Figure 4 Brake IGBT

Turn-on Switching Waveforms & definition of t_r

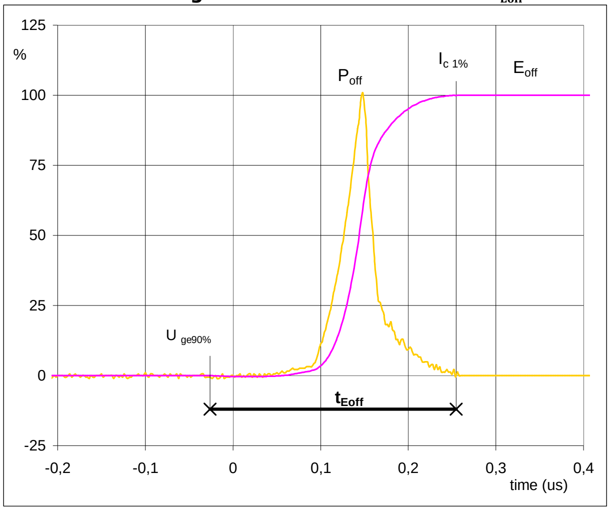


V_C (100%) =	300	V
I_C (100%) =	30	A
t_r =	0,02	μs

Brake Switching Definitions

Figure 5	Brake IGBT

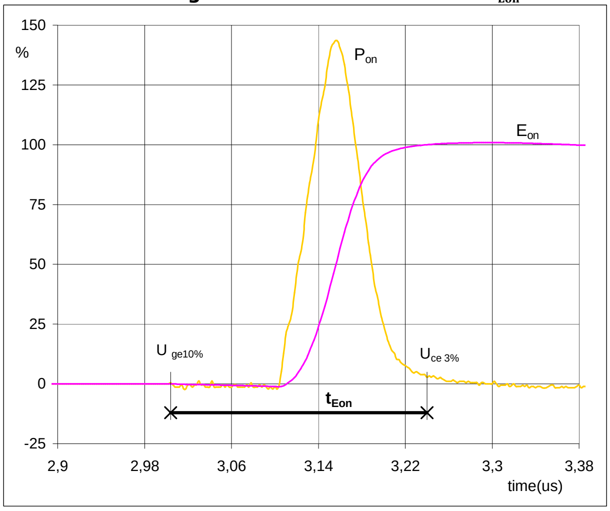
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	9,04	kW
E_{off} (100%) =	0,41	mJ
$t_{E\,off}$ =	0,28	μs

Figure 6	Brake IGBT

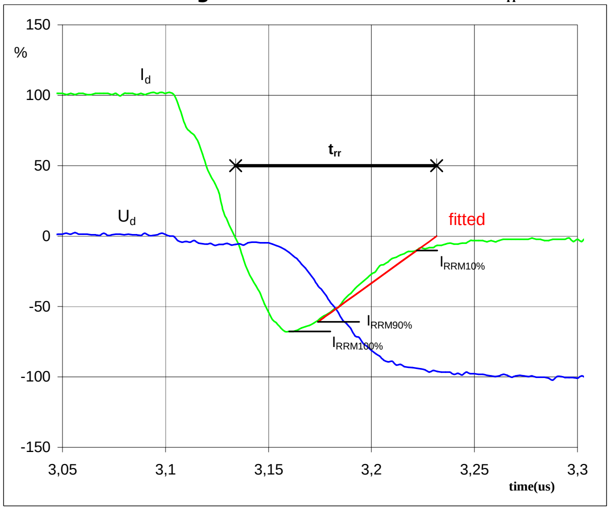
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	9,042	kW
E_{on} (100%) =	0,76	mJ
$t_{E\,on}$ =	0,236	μs

Figure 7	Brake FWD

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

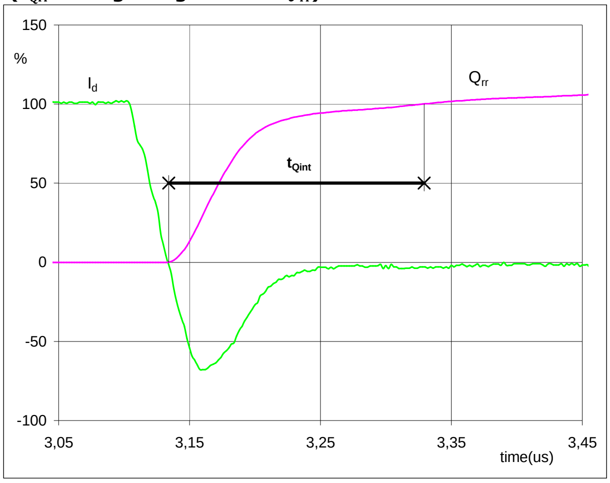


V_d (100%) =	300	V
I_d (100%) =	30	A
I_{RRM} (100%) =	-21	A
t_{rr} =	0,10	μs

Brake Switching Definitions

Figure 8 Brake FWD

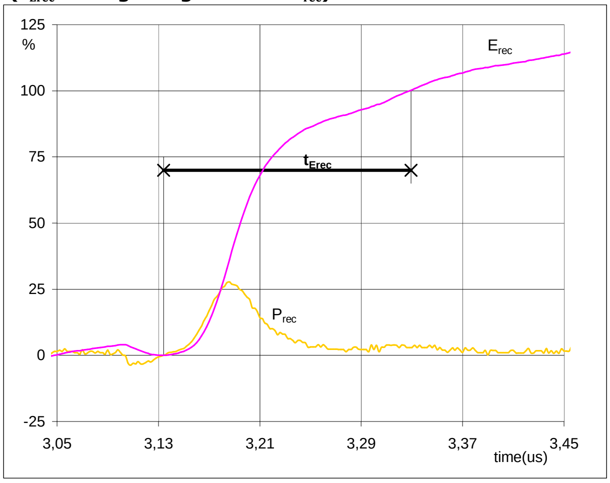
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr}= integrating time for Q_{rr})



I_d (100%) =	30	A
Q_{rr} (100%) =	1,18	μC
t_{Qint} =	0,20	μs

Figure 9 Brake FWD

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



P_{rec} (100%) =	9,04	kW
E_{rec} (100%) =	0,15	mJ
$t_{E\,rec}$ =	0,20	μs

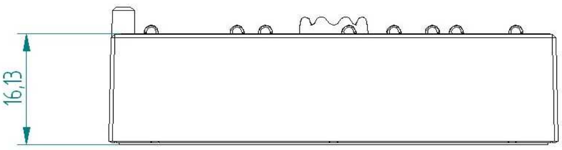
Ordering Code and Marking - Outline - Pinout

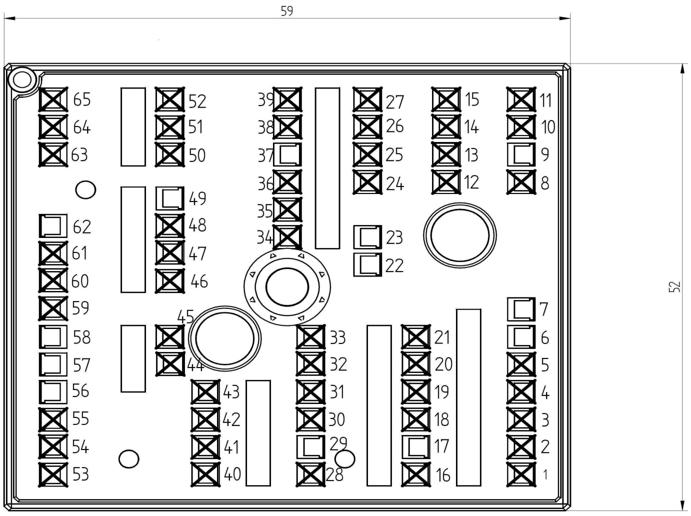
Ordering Code & Marking

Version	Ordering Code
with std lid (black V23990-K22-T-PM)	K222-B10-/0A/
with std lid (black V23990-K22-T-PM) and P12	K222-B10-/1A/
with thin lid (white V23990-K23-T-PM)	K222-B10-/0B/
with thin lid (white V23990-K23-T-PM) and P12	K222-B10-/1B/

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

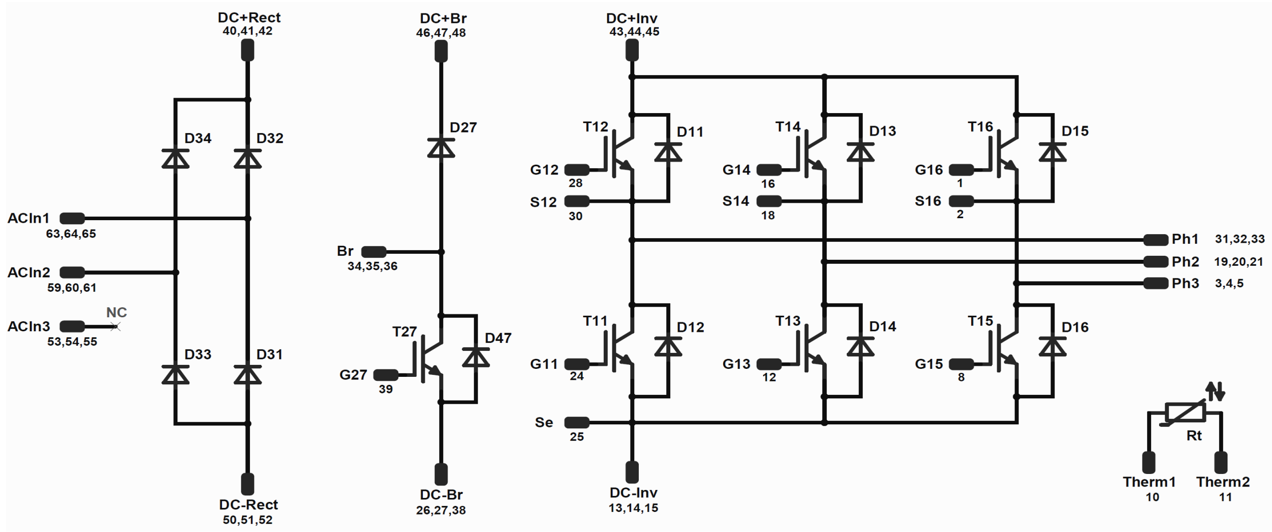




X = assembled pin position

Ordering Code and Marking - Outline - Pinout

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T11, T12, T13, T14, T15, T16	IGBT	600 V	30 A	Invertert Switch	
D11, D12, D13, D14, D15, D16	FWD	600 V	30 A	Inverter Diode	
T27	IGBT	650 V	50 A	Brake Switch	
D27	FWD	650 V	50 A	Brake Diode	
D47	Diode	650 V	15 A	Brake Protection Diode	
D31, D32, D33, D34	Diode	1600 V	25 A	Rectifier	
Therm1, Therm 2	NTC			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**198**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for MiniSkiiP® 0 packages see vincotech.com website.

Package data
Package data for MiniSkiiP® 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-K222-B10-PM-D4-14	23.03.2016	New Style, SOA value changed	All