Vincotech

MiniSKiiP® 3 PIM	1200V / 50A

Features

- Solderless interconnection
- Trench Fieldstop IGBT4 technology

MiniSKiiP® 3 housing

Target Applications

- Industrial Drives

Schematic
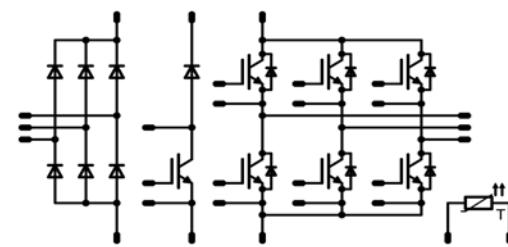
Types

- V23990-K428-A40-PM

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
D8,D9,D10,D11,D12,D13					
Repetitive peak reverse voltage	V_{RRM}			1600	V
DC forward current	I_{FAV}	T_j=$T_j$max	T_h=80℃	69	A
Surge forward current	I_{FSM}	t_p=10ms	T_j=25℃	450	A
I^2t-value	I^2t			1020	A^2s
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80℃	77	W
Maximum Junction Temperature	$T_j$max			150	℃
T1,T2,T3,T4,T5,T6,T7					
Collector-emitter break down voltage	V_{CE}			1200	V
DC collector current	I_C	T_j=$T_j$max	T_h=80℃	52	A
Repetitive peak collector current	I_{Cpulse}	t_p limited by $T_j$max		150	A
Power dissipation per IGBT	P_{tot}	T_j=$T_j$max	T_h=80℃	133	W
Gate-emitter peak voltage	V_{GE}			±20	V
Short circuit ratings	t_{SC} V_{CC}	T_j=150℃ V_{GE}=15V		10 800	µs V
Maximum Junction Temperature	$T_j$max			175	℃

Maximum Ratings

T_j=25℃, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
D1,D2,D3,D4,D5,D6,D7					
Repetitive peak reverse voltage	V_{RRM}			1200	V
DC forward current	I_F	T_j=$T_j$max	T_h=80℃	46	A
Repetitive peak forward current	I_{FRM}	t_p limited by $T_j$max		335	A
Power dissipation per Diode	P_{tot}	T_j=$T_j$max	T_h=80℃	100	W
Maximum Junction Temperature	$T_j$max			175	℃
Thermal Properties					
Storage temperature	T_{stg}			-40…+125	℃
Operation temperature under switching condition	T_{op}			-40…+(Tjmax - 25)	℃
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	
D8,D9,D10,D11,D12,D13									
Forward voltage	V_F			35	Tj=25°C / Tj=125°C	0,8	1,1 / 1,02	1,35	V
Threshold voltage (for power loss calc. only)	V_{to}				Tj=25°C / Tj=125°C		0,9 / 0,74		V
Slope resistance (for power loss calc. only)	r_t				Tj=25°C / Tj=125°C		0,004 / 0,006		Ω
Reverse current	I_r		1500		Tj=25°C / Tj=125°C			0,1 / 1,1	mA
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK					0,90		K/W
T1,T2,T3,T4,T5,T6,T7									
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE}=V_{GE}$		0,0017	Tj=25°C / Tj=150°C	5	5,8	6,5	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	15		50	Tj=25°C / Tj=150°C	1,6	1,91 / 2,39	2,4	V
Collector-emitter cut-off current incl. Diode	I_{CES}		1200		Tj=25°C / Tj=150°C			0,06	mA
Gate-emitter leakage current	I_{GES}	20	0		Tj=25°C / Tj=150°C			600	nA
Integrated Gate resistor	R_{gint}						4		Ω
Turn-on delay time	$t_{d(on)}$	Rgoff=8Ω Rgon=8Ω	600	50	Tj=25°C / Tj=150°C		106 / 111		ns
Rise time	t_r				Tj=25°C / Tj=150°C		18 / 25		
Turn-off delay time	$t_{d(off)}$	±15			Tj=25°C / Tj=150°C		228 / 298		
Fall time	t_f				Tj=25°C / Tj=150°C		84 / 125		
Turn-on energy loss per pulse	E_{on}				Tj=25°C / Tj=150°C		2,66 / 4,46		mWs
Turn-off energy loss per pulse	E_{off}				Tj=25°C / Tj=150°C		2,78 / 4,58		
Input capacitance	C_{ies}						2770		
Output capacitance	C_{oss}	f=1MHz / 0	25		Tj=25°C		205		pF
Reverse transfer capacitance	C_{rss}						160		
Gate charge	Q_{Gate}	±15			Tj=25°C		380		nC
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK					0,71		K/W
D1,D2,D3,D4,D5,D6,D7									
Diode forward voltage	V_F			50	Tj=25°C / Tj=150°C	1,5	2,19 / 2,21	2,9	V
Peak reverse recovery current	I_{RRM}				Tj=25°C / Tj=150°C		61,3 / 70,7		A
Reverse recovery time	t_{rr}	Rgon=8Ω	600	50	Tj=25°C / Tj=150°C		144 / 312		ns
Reverse recovered charge	Q_{rr}	±15			Tj=25°C / Tj=150°C		3,74 / 8,8		µC
Peak rate of fall of recovery current	di(rec)max /dt				Tj=25°C / Tj=150°C		3494 / 950		A/µs
Reverse recovered energy	Erec				Tj=25°C / Tj=150°C		1,38 / 3,48		mWs
Thermal resistance chip to heatsink per chip	R_{thJH}	Thermal grease thickness≤50µm λ=1W/mK					0,95		K/W
Thermistor									
Rated resistance	R				T=25°C		1000		Ω
Deviation of R100	ΔR/R	R100=1670 Ω			T=100°C	-3		3	%
R100	P				T=100°C		1670,313		Ω
Power dissipation constant					T=25°C				mW/K
A-value	B(25/50)	Tol. %			T=25°C		7,635*10-3		1/K
B-value	B(25/100)	Tol. %			T=25°C		1,731*10-5		1/K²
Vincotech NTC Reference								E	

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 1	T1,T2,T3,T4,T5,T6,T7 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

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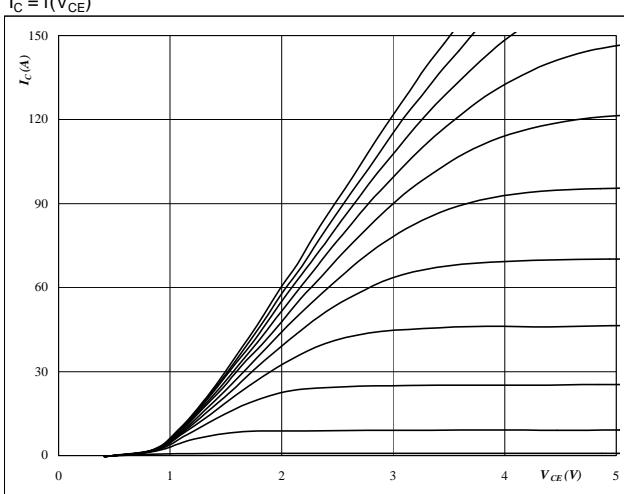
$t_p =$	250	µs
$T_j =$	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 2	T1,T2,T3,T4,T5,T6,T7 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

At
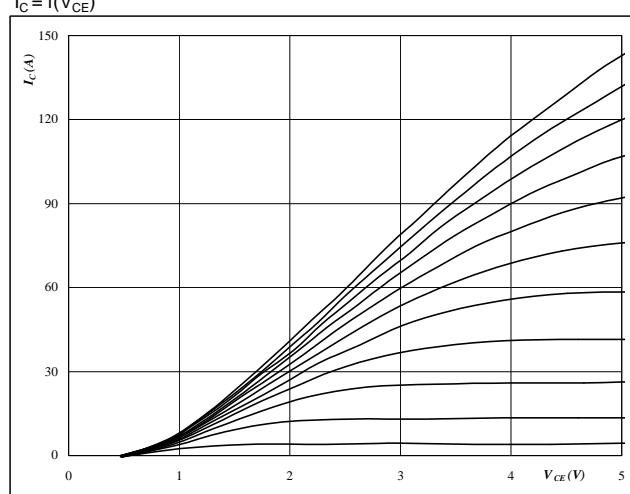
$t_p =$	250	µs
$T_j =$	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

Figure 3	T1,T2,T3,T4,T5,T6,T7 IGBT

Typical transfer characteristics

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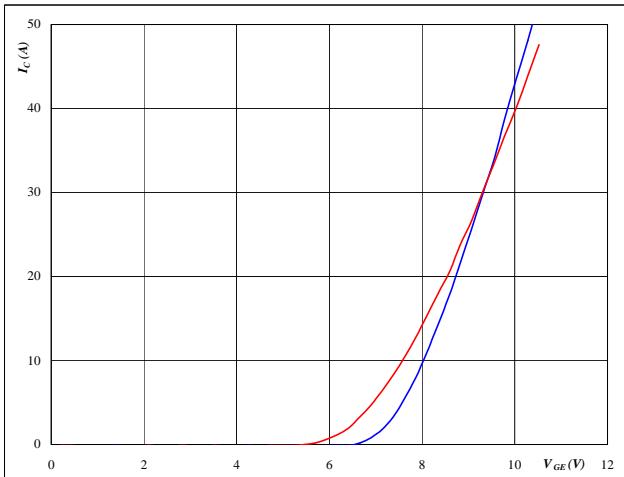
At

$T_j =$	25/150	°C
$t_p =$	250	µs
$V_{CE} =$	10	V

Figure 4	D1,D2,D3,D4,D5,D6,D7 FWD

**Typical diode forward current as
a function of forward voltage**

$I_F = f(V_F)$

At
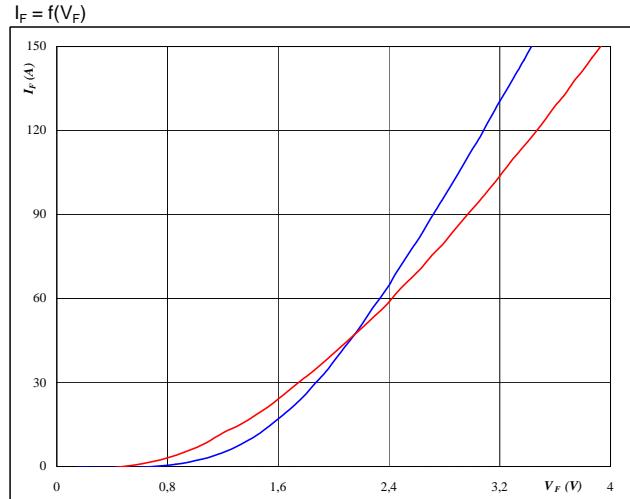
$T_j =$	25/150	°C
$t_p =$	250	µs

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 5	T1,T2,T3,T4,T5,T6,T7 IGBT

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

$E = f(I_C)$
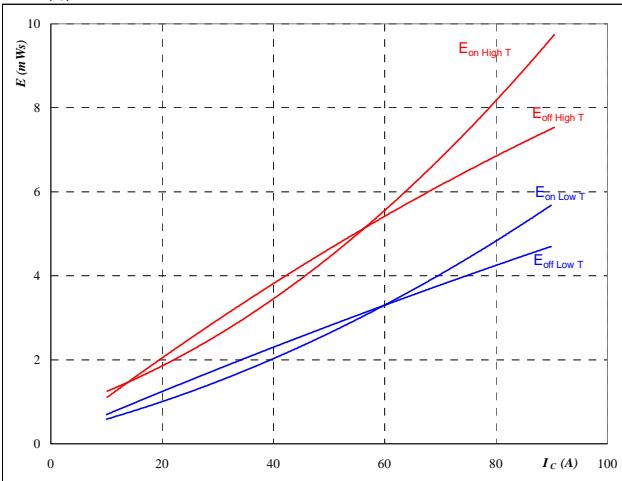
With an inductive load at

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω
$R_{goff} =$	8	Ω

Figure 6	T1,T2,T3,T4,T5,T6,T7 IGBT

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

$E = f(R_G)$
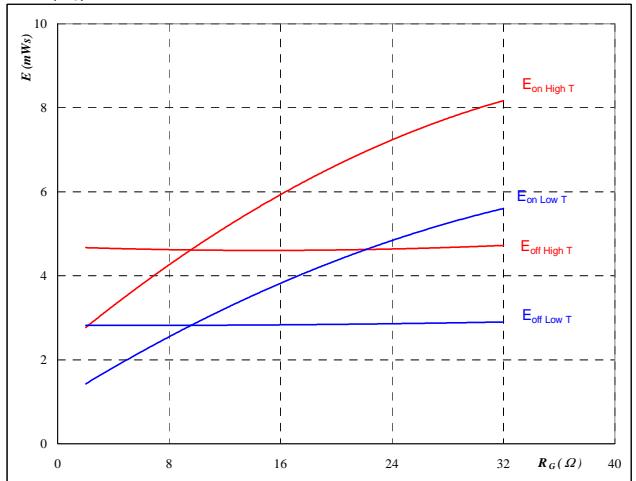
With an inductive load at

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	50	A

Figure 7	D1,D2,D3,D4,D5,D6,D7 FWD

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

$E_{rec} = f(I_C)$
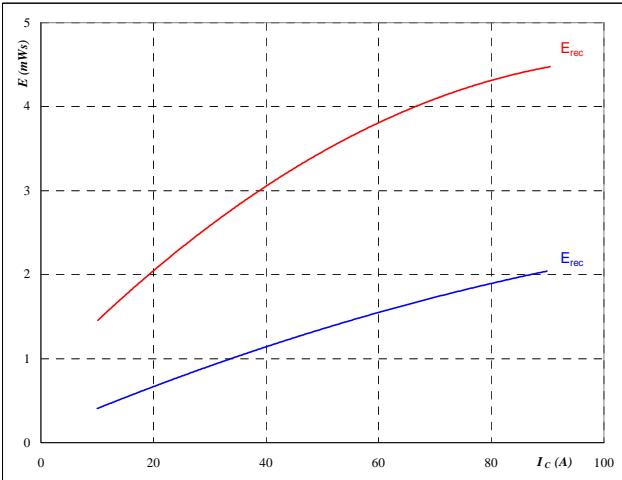
With an inductive load at

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω

Figure 8	D1,D2,D3,D4,D5,D6,D7 FWD

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

$E_{rec} = f(R_G)$
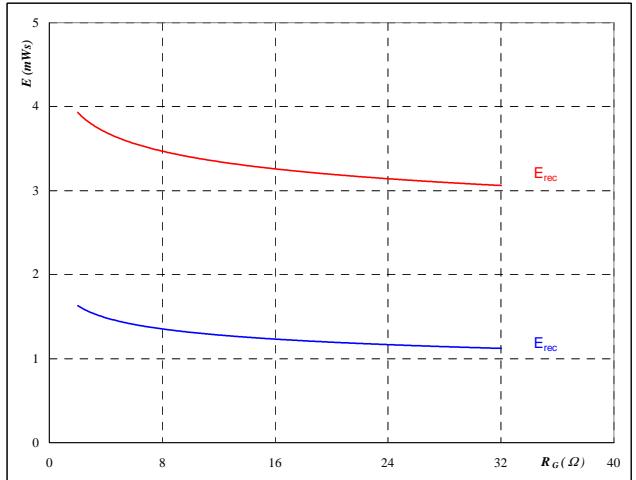
With an inductive load at

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$I_C =$	50	A

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 9	T1,T2,T3,T4,T5,T6,T7 IGBT

**Typical switching times as a function of collector current**

$t = f(I_C)$
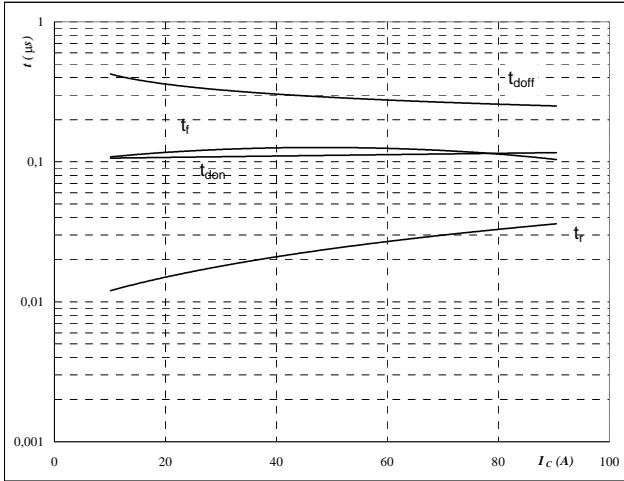
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω
R_{goff} =	8	Ω

Figure 10	T1,T2,T3,T4,T5,T6,T7 IGBT

Typical switching times as a function of gate resistor

$t = f(R_G)$
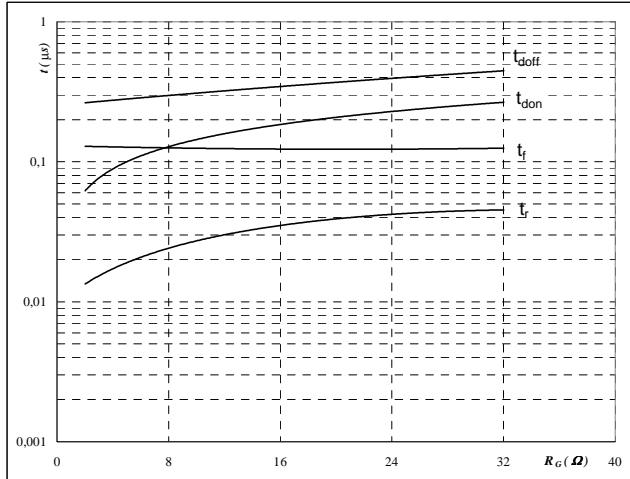
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	50	A

Figure 11	D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_C)$

At
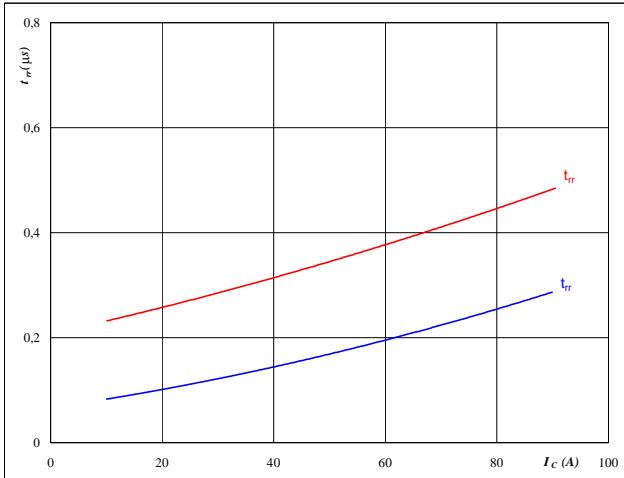
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	8	Ω

Figure 12	D1,D2,D3,D4,D5,D6,D7 FWD

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

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

At
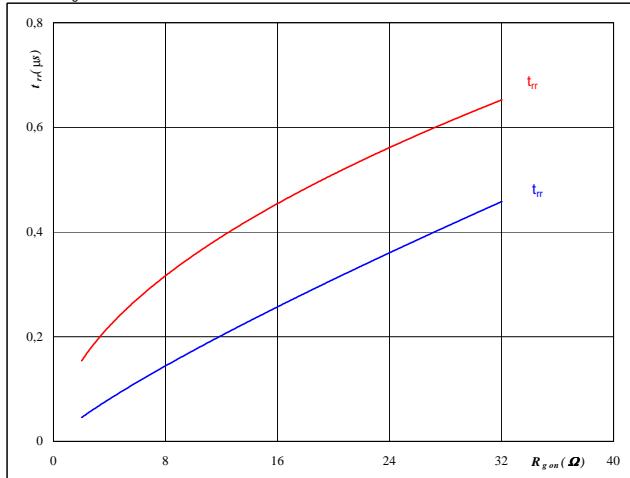
T_j =	25/150	°C
V_R =	600	V
I_F =	50	A
V_{GE} =	±15	V

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 13	D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$

At

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω
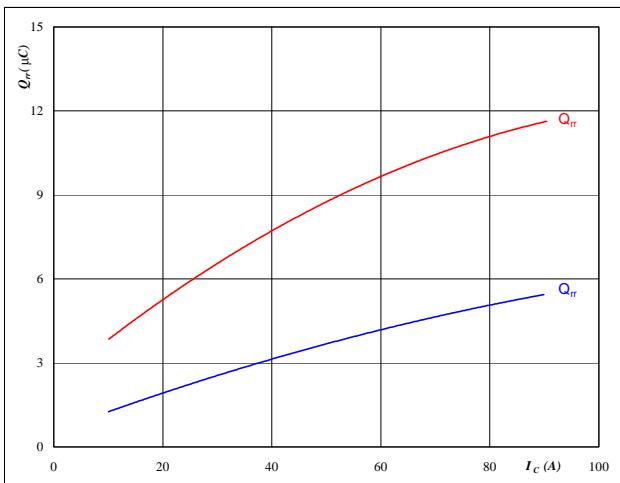
Figure 14	D1,D2,D3,D4,D5,D6,D7 FWD

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

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

At
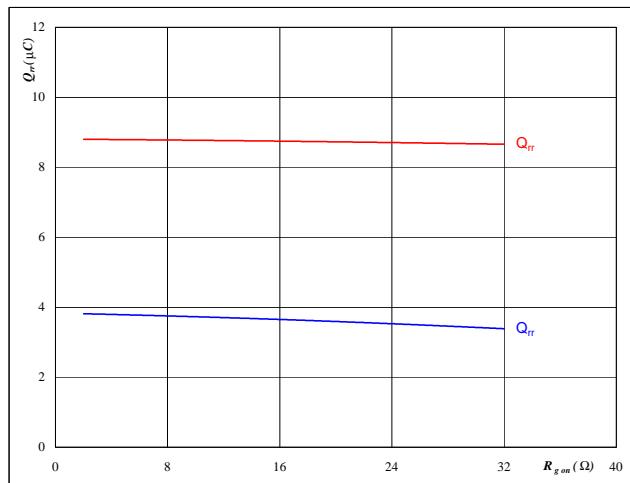
$T_j =$	25/150	°C
$V_R =$	600	V
$I_F =$	50	A
$V_{GE} =$	±15	V

Figure 15	D1,D2,D3,D4,D5,D6,D7 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$

At

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω
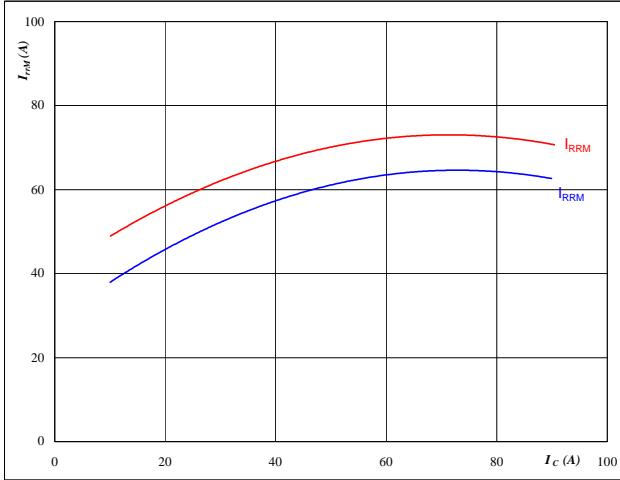
Figure 16	D1,D2,D3,D4,D5,D6,D7 FWD

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

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

At
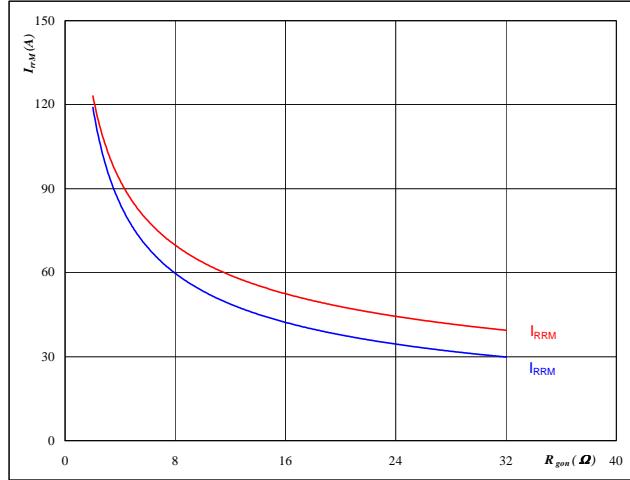
$T_j =$	25/150	°C
$V_R =$	600	V
$I_F =$	50	A
$V_{GE} =$	±15	V

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 17	D1,D2,D3,D4,D5,D6,D7 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

$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	8	Ω

Figure 18	D1,D2,D3,D4,D5,D6,D7 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
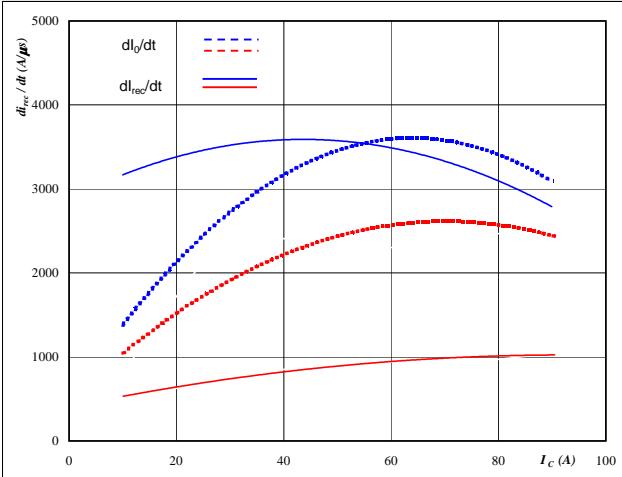
$T_j =$	25/150	°C
$V_R =$	600	V
$I_F =$	50	A
$V_{GE} =$	±15	V

Figure 19	T1,T2,T3,T4,T5,T6,T7 IGBT

IGBT transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$
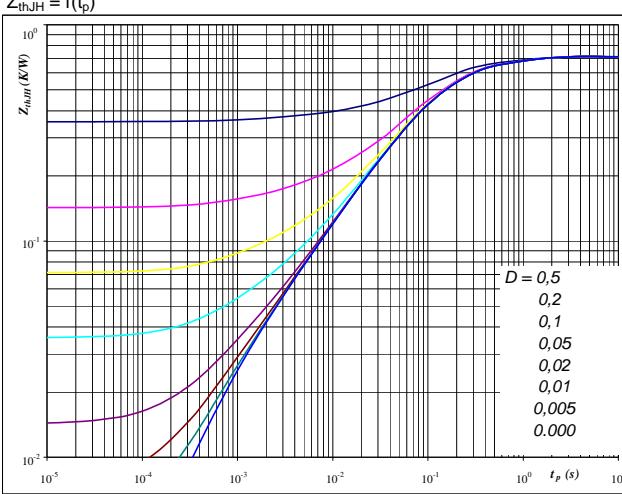
At

D =	t_p / T	
$R_{thJH} =$	0,71	K/W

IGBT thermal model values

R (C/W)	Tau (s)
0,11	7,7E-01
0,36	1,3E-01
0,16	4,6E-02
0,06	8,2E-03
0,02	1,1E-03
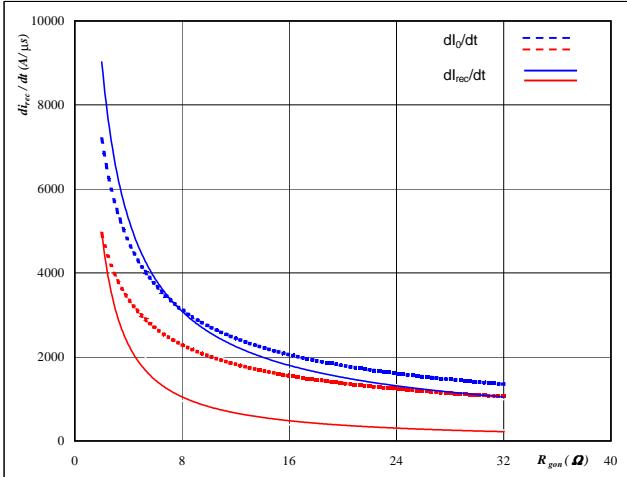
Figure 20	D1,D2,D3,D4,D5,D6,D7 FWD

FWD transient thermal impedance as a function of pulse width

$Z_{thJH} = f(t_p)$
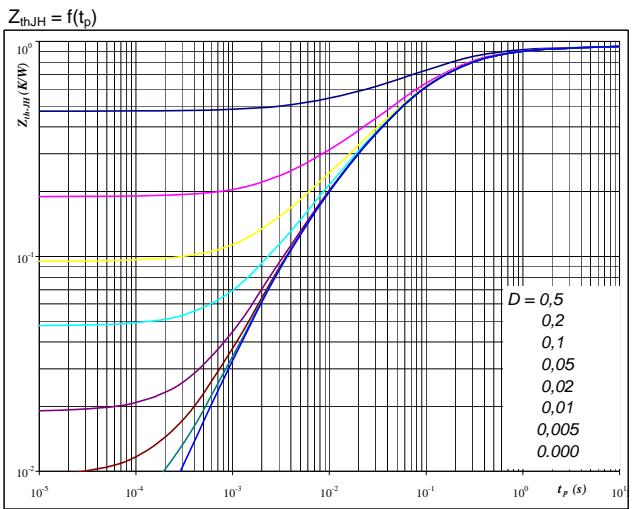
At

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

FWD thermal model values

R (C/W)	Tau (s)
0,06	2,5E+00
0,21	3,5E-01
0,44	7,8E-02
0,17	1,7E-02
0,07	3,6E-03

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 21	T1,T2,T3,T4,T5,T6,T7 IGBT

**Power dissipation as a**
function of heatsink temperature
$P_{tot} = f(T_h)$

At

$T_j =$ 175   °C

Figure 22	T1,T2,T3,T4,T5,T6,T7 IGBT

Collector current as a
function of heatsink temperature
$I_C = f(T_h)$
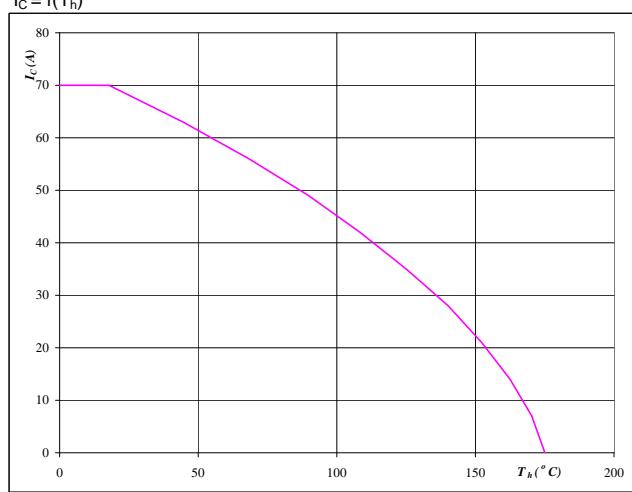
At

$T_j =$ 175   °C
$V_{GE} =$ 15   V

Figure 23	D1,D2,D3,D4,D5,D6,D7 FWD

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

At
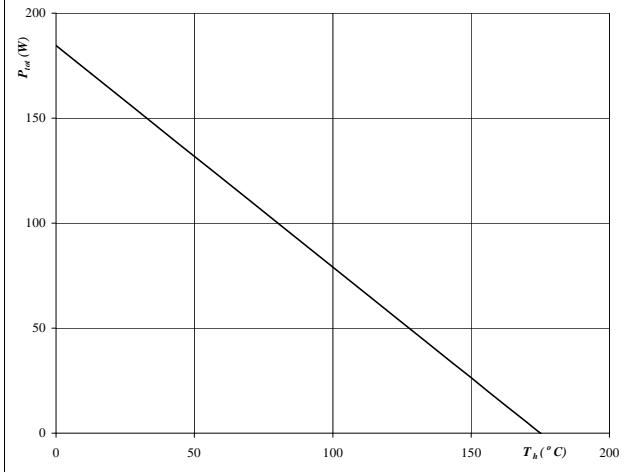
$T_j =$ 175   °C

Figure 24	D1,D2,D3,D4,D5,D6,D7 FWD

Forward current as a
function of heatsink temperature
$I_F = f(T_h)$

At
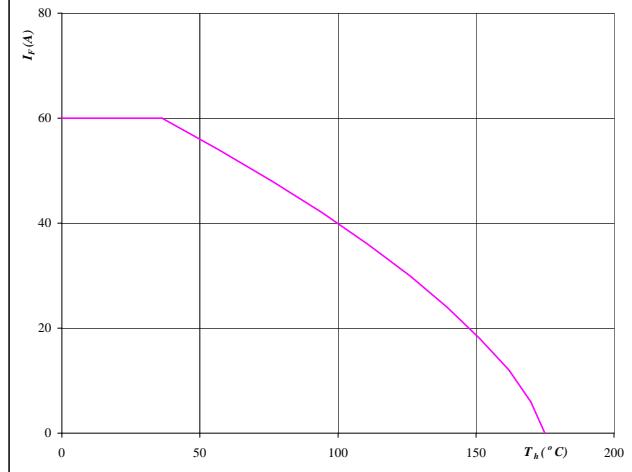
$T_j =$ 175   °C

T1,T2,T3,T4,T5,T6,T7/D1,D2,D3,D4,D5,D6,D7

Figure 25	T1,T2,T3,T4,T5,T6,T7 IGBT

**Safe operating area as a function
of collector-emitter voltage**
$I_C = f(V_{CE})$
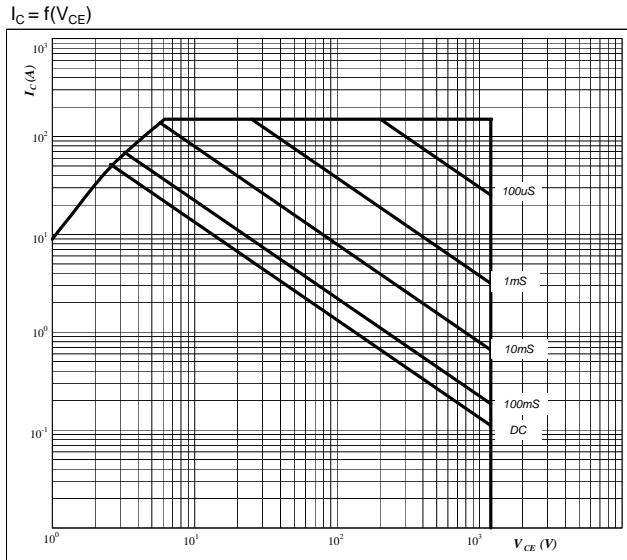
At

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

Figure 26	T1,T2,T3,T4,T5,T6,T7 IGBT

Gate voltage vs Gate charge

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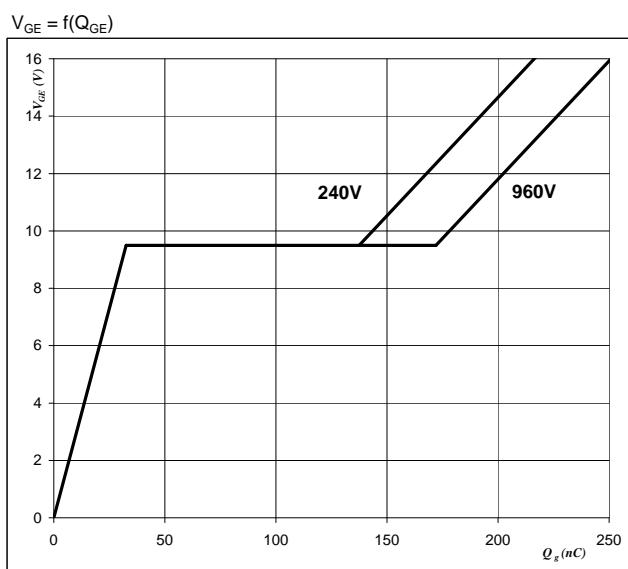
At

I_C =	50	A

D8,D9,D10,D11,D12,D13

Figure 1	D8,D9,D10,D11,D12,D13

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

At

Tj = 25/125 ℃

t_p = 250 µs
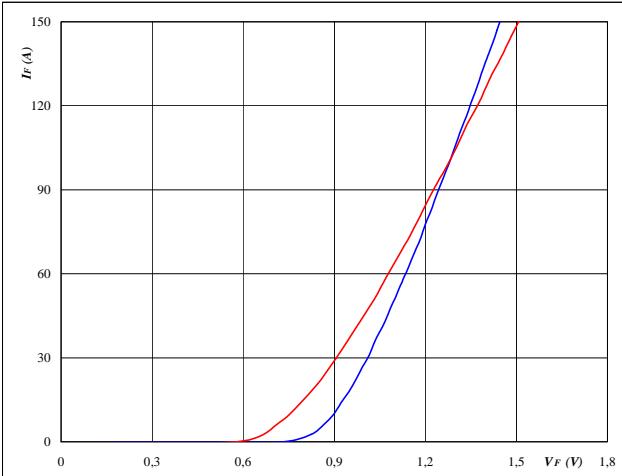
Figure 2	D8,D9,D10,D11,D12,D13

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

$D = 0,5$
$0,2$
$0,1$
$0,05$
$0,02$
$0,01$
$0,005$
0.000

At
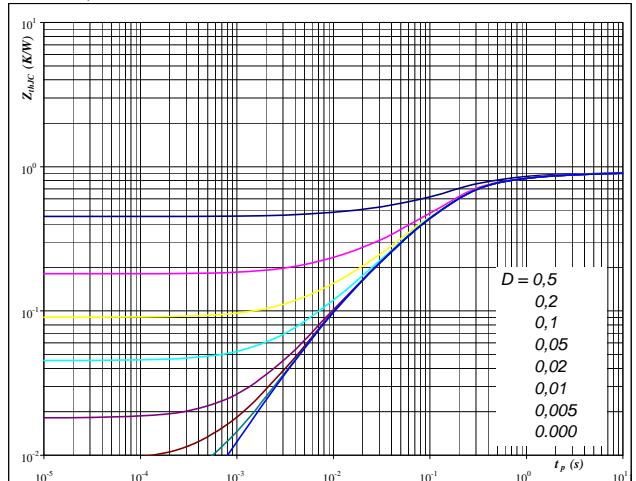
D = t_p / T

R_{thJH} = 0,9 K/W

Figure 3	D8,D9,D10,D11,D12,D13

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

At
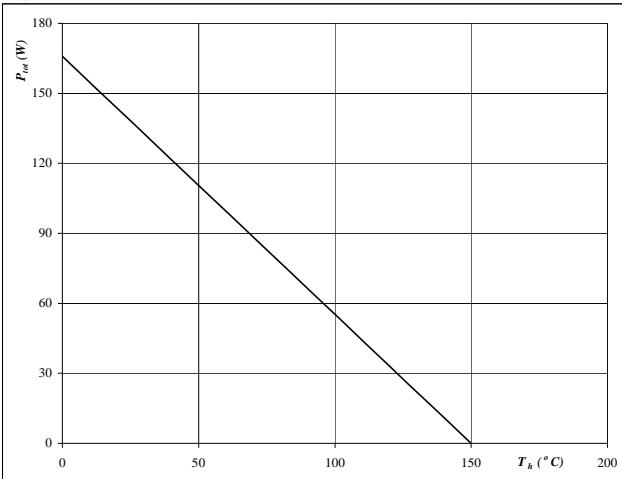
T_j = 150 ºC

Figure 4	D8,D9,D10,D11,D12,D13

Forward current as a
function of heatsink temperature
$I_F = f(T_h)$

At
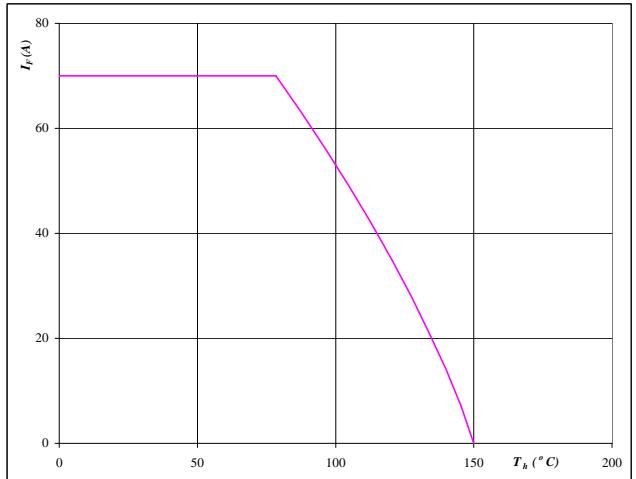
T_j = 150 ºC

Thermistor

Figure 1   Thermistor

Typical PTC characteristic
**as a function of temperature**
R_T = f(T)

PTC-typical temperature characteristic
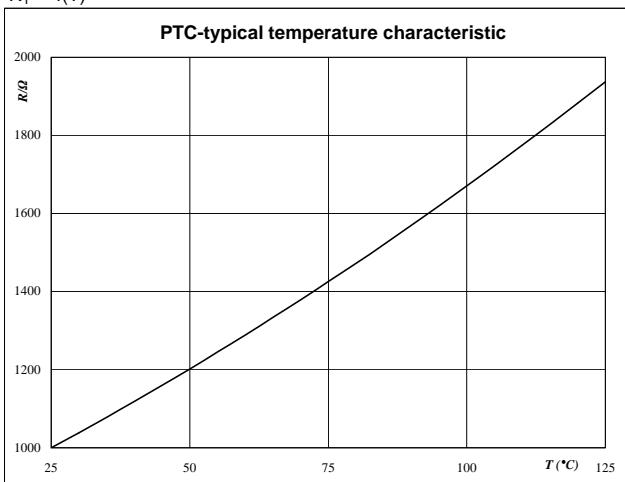
Switching Definitions Output Inverter

General conditions

T_j	=	150 ℃
R_{gon}	=	8 Ω
R_{goff}	=	8 Ω

**Figure 1**   T1,T2,T3,T4,T5,T6,T7 IGBT

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

(t_{Eoff} = integrating time for E_{off})
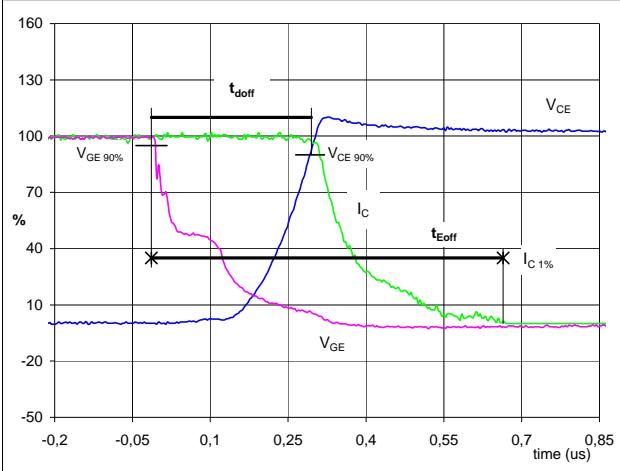
V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{doff} =	0,30	µs
t_{Eoff} =	0,68	µs

Figure 2   T1,T2,T3,T4,T5,T6,T7 IGBT

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

(t_{Eon} = integrating time for E_{on})
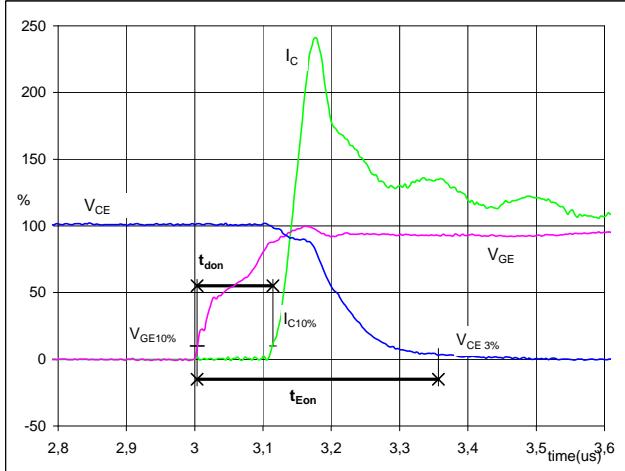
V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	50	A
t_{don} =	0,11	µs
t_{Eon} =	0,35	µs

Figure 3   T1,T2,T3,T4,T5,T6,T7 IGBT

Turn-off Switching Waveforms & definition of t_f
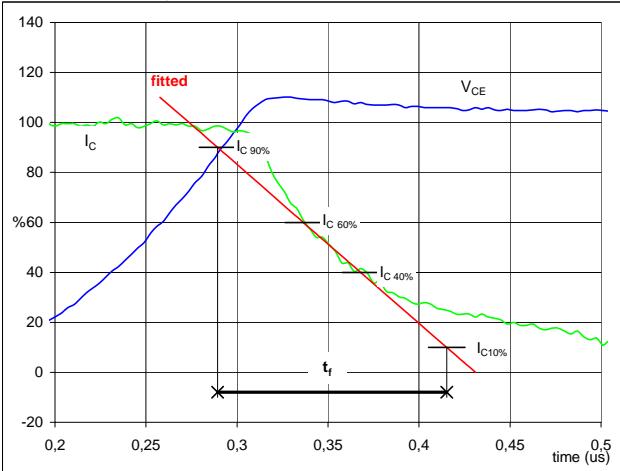
V_C (100%) =	600	V
I_C (100%) =	50	A
t_f =	0,13	µs

Figure 4   T1,T2,T3,T4,T5,T6,T7 IGBT

Turn-on Switching Waveforms & definition of t_r
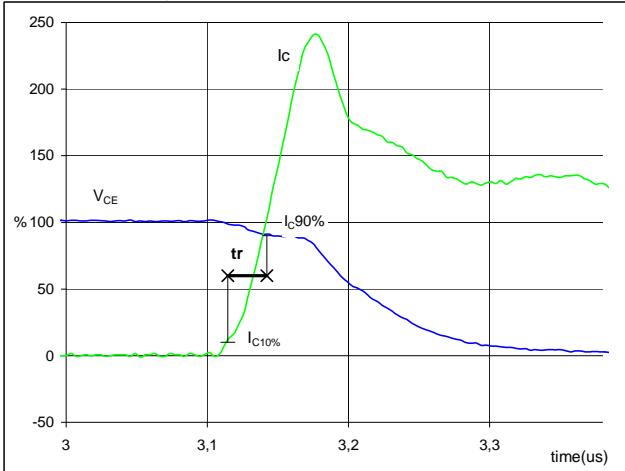
| V_C (100%) =	600	V
I_C (100%) =	50	A
t_r =	0,03	µs

Switching Definitions Output Inverter

Figure 5 — T1,T2,T3,T4,T5,T6,T7 IGBT

Turn-off Switching Waveforms & definition of t_{Eoff}
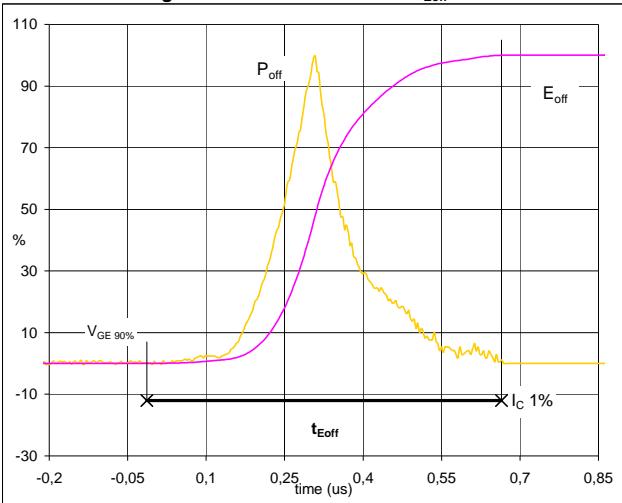
P_{off} (100%) =	29,95	kW
E_{off} (100%) =	4,58	mJ
t_{Eoff} =	0,68	µs

Figure 6 — T1,T2,T3,T4,T5,T6,T7 IGBT

Turn-on Switching Waveforms & definition of t_{Eon}
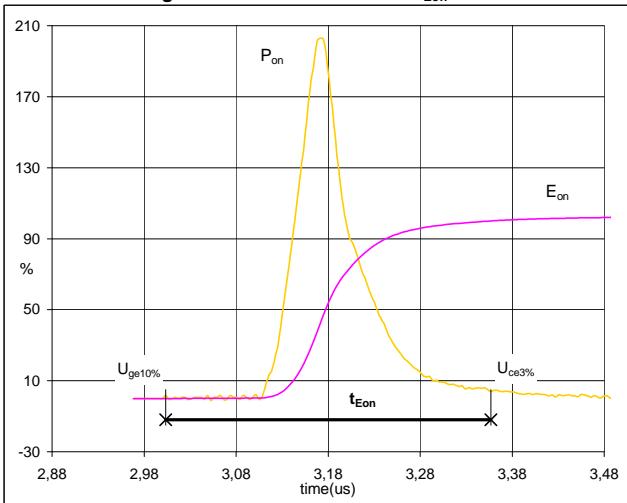
P_{on} (100%) =	29,95	kW
E_{on} (100%) =	4,46	mJ
t_{Eon} =	0,35	µs

Figure 78 — D1,D2,D3,D4,D5,D6,D7 FWD

Turn-off Switching Waveforms & definition of t_{rr}
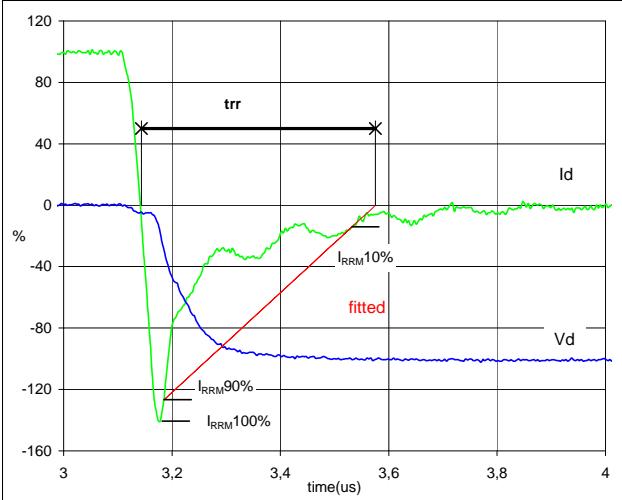
V_d (100%) =	600	V
I_d (100%) =	50	A
I_{RRM} (100%) =	-71	A
t_{rr} =	0,31	µs

Switching Definitions Output Inverter

Figure 8	D1,D2,D3,D4,D5,D6,D7 FWD

Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})
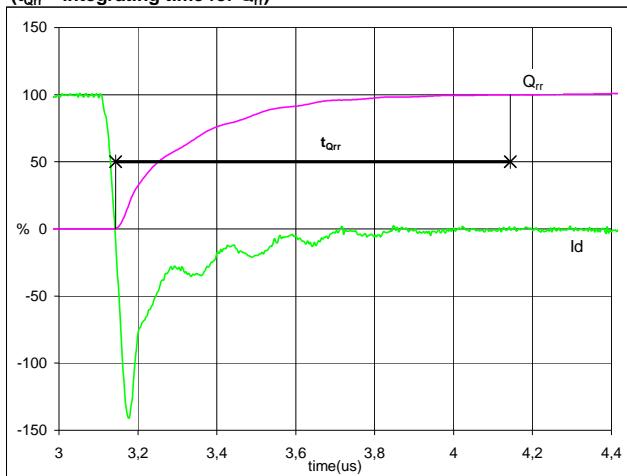
I_d (100%) =	50	A
Q_{rr} (100%) =	8,80	µC
t_{Qrr} =	1,00	µs

Figure 9	D1,D2,D3,D4,D5,D6,D7 FWD

Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec} = integrating time for E_{rec})
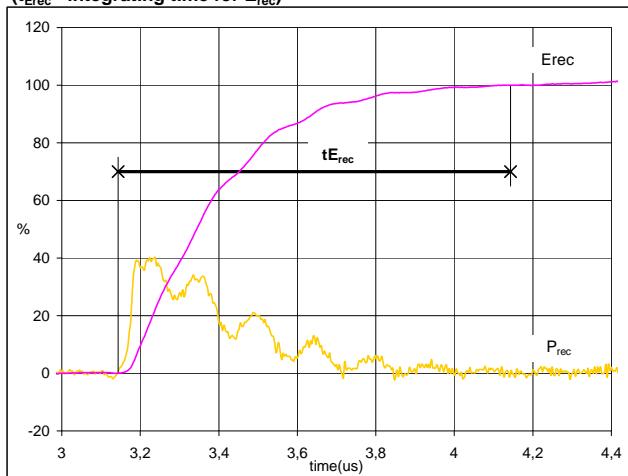
P_{rec} (100%) =	29,95	kW
E_{rec} (100%) =	3,48	mJ
t_{Erec} =	1,00	µs

Ordering Code and Marking - Outline - Pinout

Ordering Code & Marking

Version	Ordering Code	in DataMatrix as	in packaging barcode as
with std lid (black V23990-K32-T-PM)	V23990-K428-A40-/0A/-PM	K428A40	K428A40-/0A/
with std lid (black V23990-K32-T-PM) and P12	V23990-K428-A40-/1A/-PM	K428A40	K428A40-/1A/
with thin lid (white V23990-K33-T-PM)	V23990-K428-A40-/0B/-PM	K428A40	K428A40-/0B/
with thin lid (white V23990-K33-T-PM) and P12	V23990-K428-A40-/1B/-PM	K428A40	K428A40-/1B/

Outline
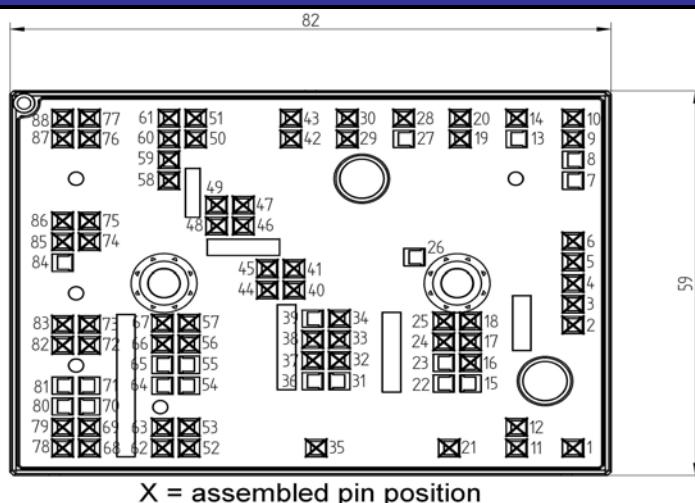
X = assembled pin position
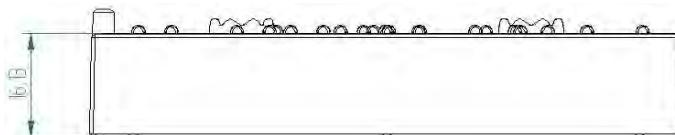
Pinout
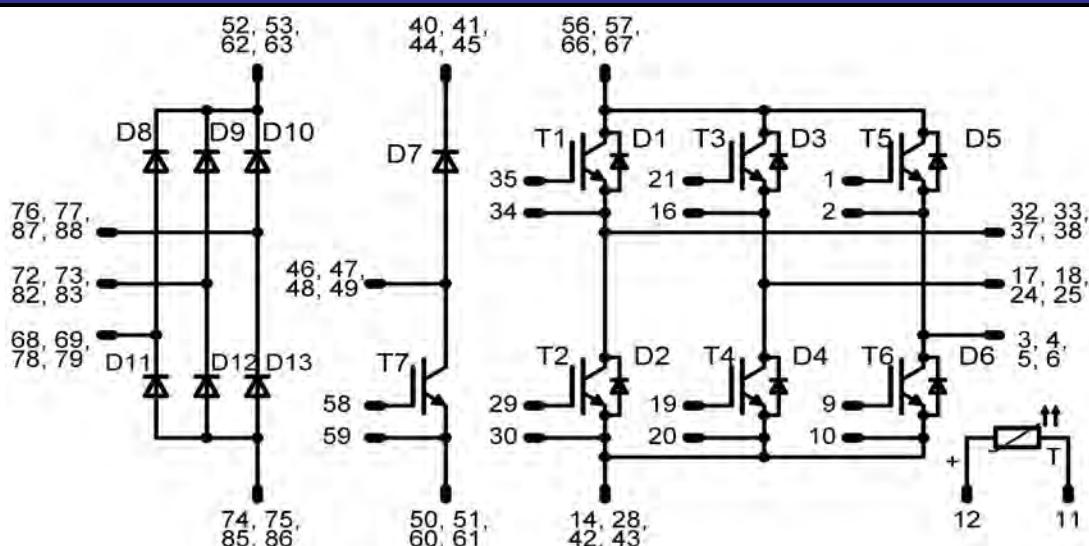
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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.