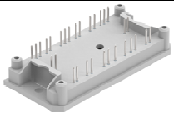
flow **PACK 1**	**1200 V / 35 A**

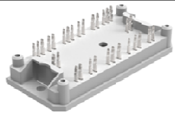
Features

- Compact flow1 housing
- Trench Fieldstop IGBT4 Technology
- Compact and Low Inductance Design
- AlN substrate for improved performance
- Built-in NTC

flow1 housing



solder pin

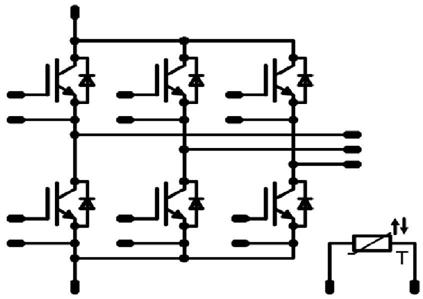


Press-fit pin

Target Applications

- Motor Drive
- Power Generation
- UPS

Schematic



Types

- V23990-P828-F-PM
- V23990-P828-FY-PM

Maximum Ratings

T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Switch				
Collector-emitter breakdown voltage	V_{CE}		1200	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}	105	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	158	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	10 800	μs V
Maximum Junction Temperature	T_{jmax}		175	°C
Inverter Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F	$T_j = T_{jmax}$ T_s = 80 °C	35	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	70	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ T_s = 80 °C	125	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…+150	°C
Isolation Properties					
Isolation voltage	V_{is}	t = 2 s	DC Test Voltage	4000	V
Creepage distance				min 12,7	mm
Clearance			solder pin / Press-fit pin	12,64 / min 12,7	mm

Characteristic Values

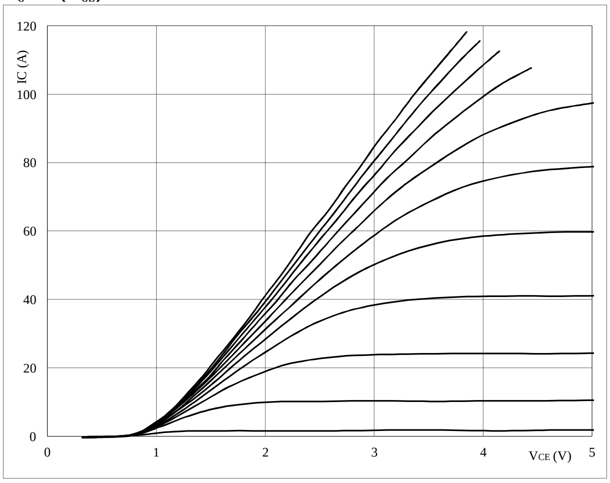
Parameter	Symbol	Conditions	V_{GE} [V] V_{GS} [V]	V_{r} [V] V_{CE} [V] V_{DS} [V]	I_{C} [A] I_{F} [A] I_{D} [A]	T_{j} [°C]	Min	Typ	Max	Unit
Inverter Switch										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0012	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		15		35	25 150	1,3	1,92 2,39	2,3	V
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200		25			0,015	mA
Gate-emitter leakage current	I_{GES}		20	0		25			200	nA
Integrated Gate resistor	R_{gint}							none		Ω
Turn-on delay time	$t_{d(on)}$	R_{goff} = 16 Ω R_{gon} = 16 Ω	±15	600	35	25 150		91 94		ns
Rise time	t_{r}					25 150		19 23		
Turn-off delay time	$t_{d(off)}$					25 150		204 264		
Fall time	t_{f}					25 150		72 109		
Turn-on energy loss	E_{on}					25 150		2,02 3,09		mWs
Turn-off energy loss	E_{off}					25 150		1,76 2,81		
Input capacitance	C_{ies}	f = 1 MHz	0	25		25		1950		pF
Output capacitance	C_{oss}							155		
Reverse transfer capacitance	C_{rss}							115		
Gate charge	Q_{G}		±15		35	25		180		nC
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal foil thickness=76um Kunze foil KU-ALF5						0,60		K/W
Inverter Diode										
Diode forward voltage	V_{F}				35	25 150	1,35	1,80 1,77	2,35	V
Peak reverse recovery current	I_{RRM}	R_{gon} = 16 Ω	±15	600	35	25 150		48 53		A
Reverse recovery time	t_{rr}					25 150		251 353		ns
Reverse recovered charge	Q_{rr}					25 150		3,56 6,93		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		2000 390		A/µs
Reverse recovered energy	E_{rec}					25 150		1,38 2,83		mWs
Thermal resistance junction to sink	$R_{th(j-s)}$	Thermal foil thickness=76um Kunze foil KU-ALF5						0,76		K/W
Thermistor										
Rated resistance	R_{25}	Tol. ±5%				25	4,2	4,7	5,8	kΩ
Deviation of R_{100}	$D_{R/R}$	R_{100} = 435 Ω				100		2,6		%/K
Power dissipation given Epcos-Typ	P					25		210		mW
B-value	$B_{(25/100)}$	Tol. ±3%				25		3530		K

Output Inverter

figure 1. **IGBT**

Typical output characteristics

$I_C = f(V_{CE})$



At

t_p = 250 µs

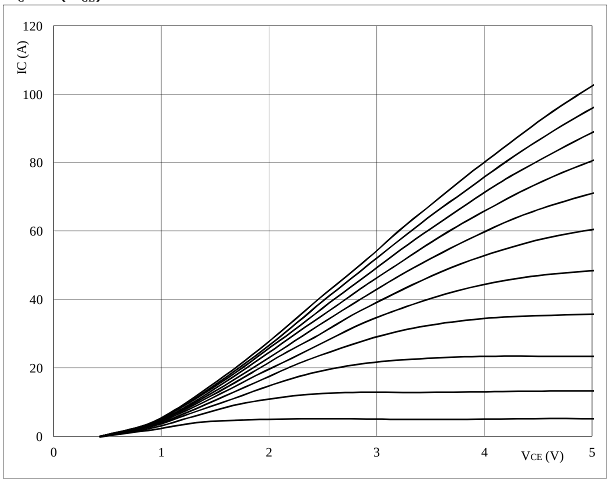
T_j = 25 °C

VGE 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

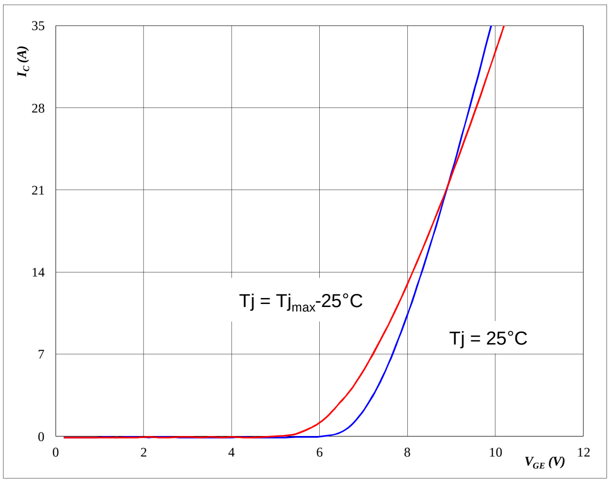
T_j = 150 °C

VGE from 7 V to 17 V in steps of 1 V

figure 3. **IGBT**

Typical transfer characteristics

$I_c = f(V_{GE})$



At

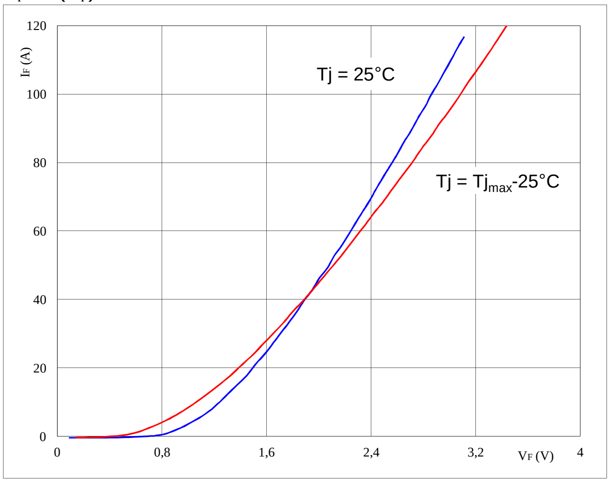
t_p = 250 µs

V_{CE} = 10 V

figure 4. **FWD**

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



At

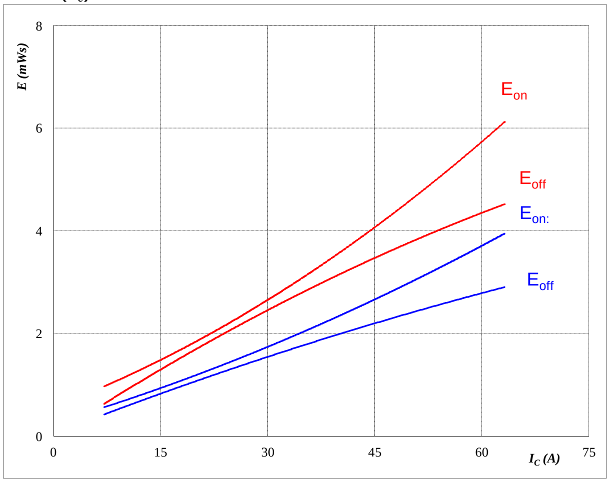
t_p = 250 µs

Output Inverter

figure 5. **IGBT**

Typical switching energy losses
as a function of collector current

$E = f(I_c)$



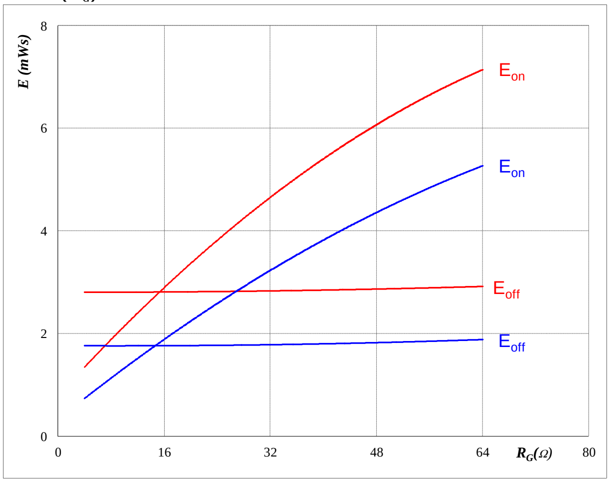
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 6. **IGBT**

Typical switching energy losses
as a function of gate resistor

$E = f(R_G)$



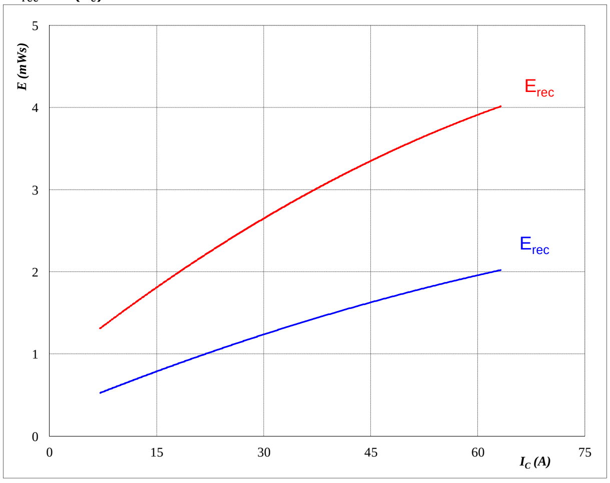
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

figure 7. **IGBT**

Typical reverse recovery energy loss
as a function of collector current

$E_{rec} = f(I_c)$



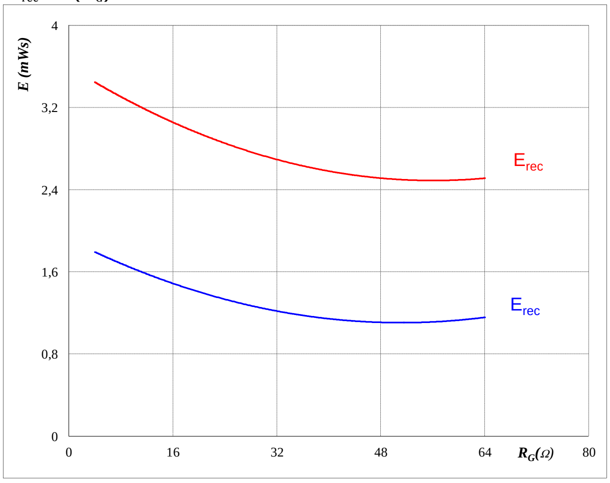
With an inductive load at

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 8. **IGBT**

Typical reverse recovery energy loss
as a function of gate resistor

$E_{rec} = f(R_G)$



With an inductive load at

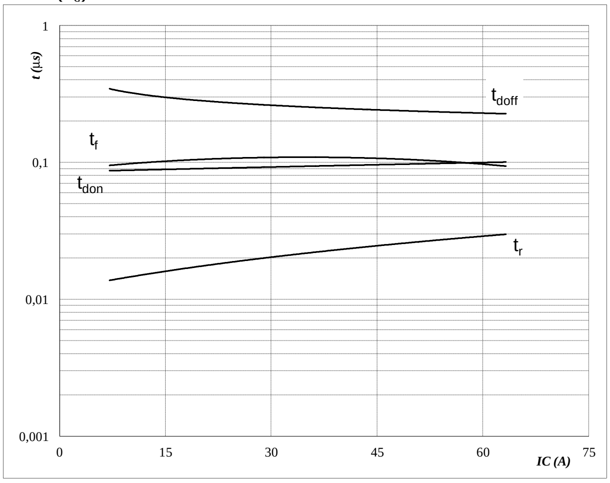
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

Output Inverter

figure 9. **IGBT**

Typical switching times as a function of collector current

$t = f(I_C)$



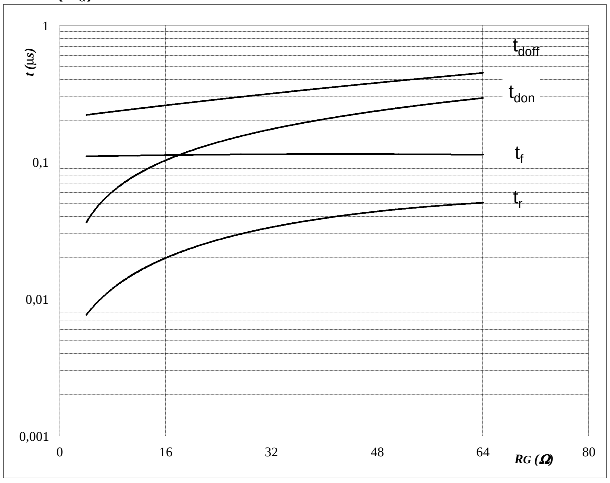
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω
R_{goff} =	16	Ω

figure 10. **IGBT**

Typical switching times as a function of gate resistor

$t = f(R_G)$



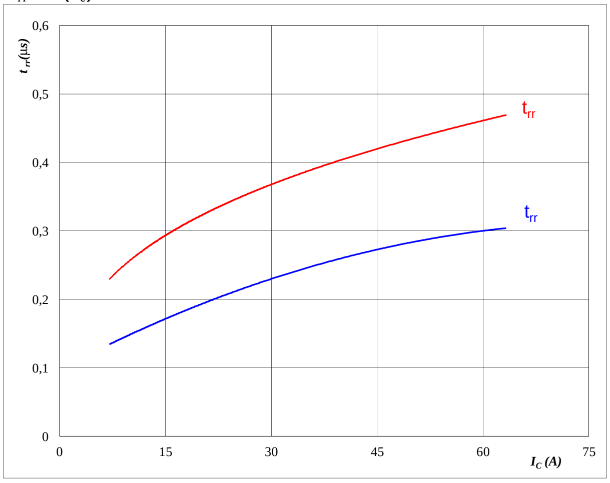
With an inductive load at

T_j =	150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

figure 11. **FWD**

Typical reverse recovery time as a function of collector current

$t_{rr} = f(I_c)$



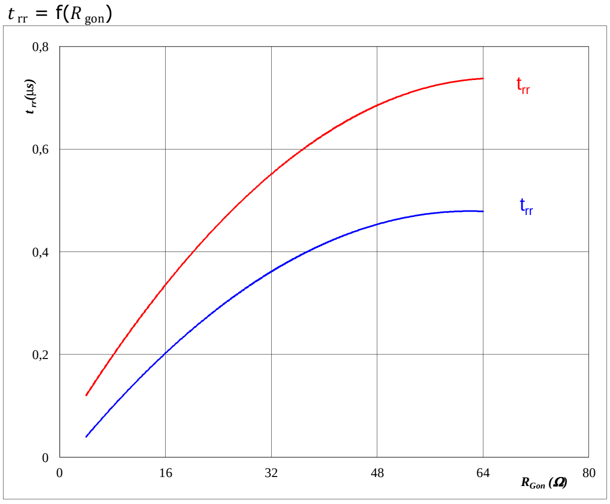
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 12. **FWD**

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

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



At

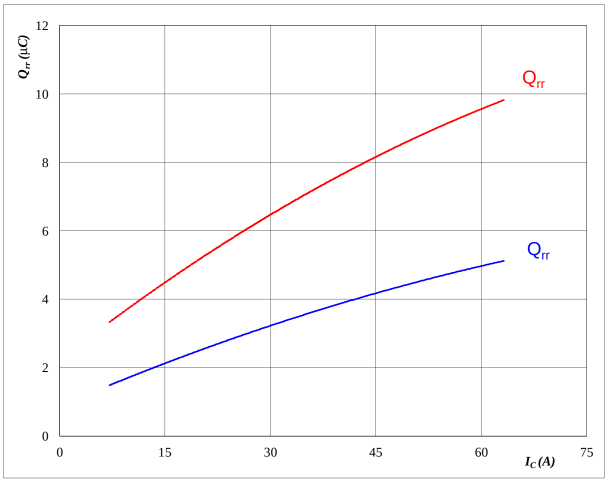
T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

Output Inverter

figure 13. **FWD**

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_c)$



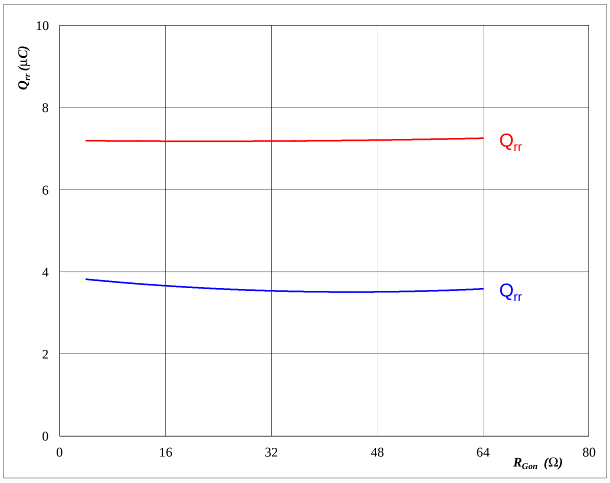
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 14. **FWD**

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

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



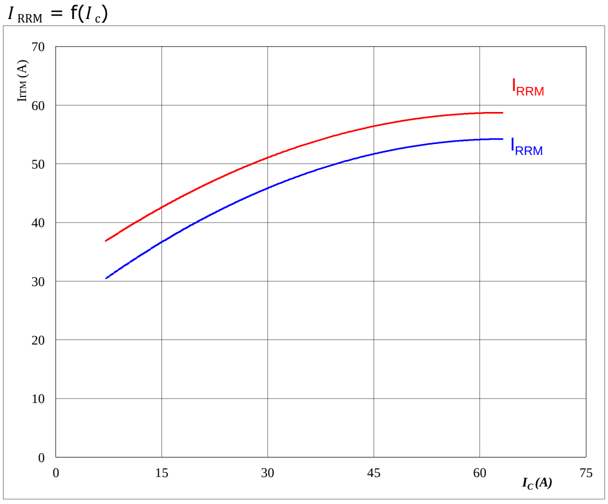
At

T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

figure 15. **FWD**

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_c)$



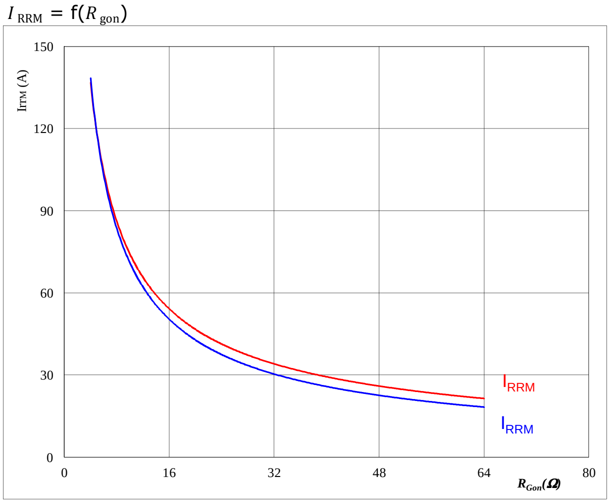
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 16. **FWD**

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

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



At

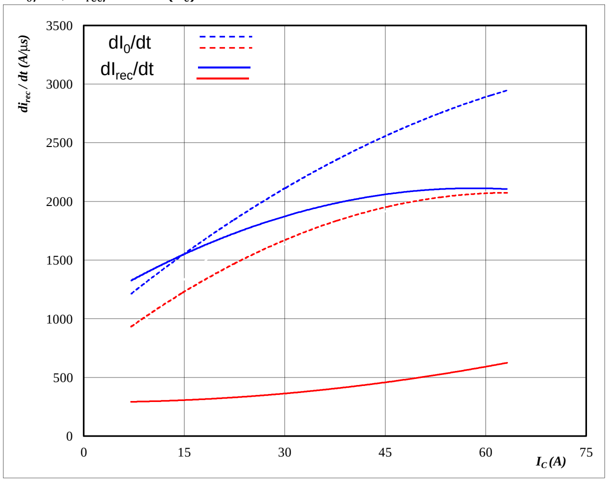
T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

Output Inverter

figure 17. FWD

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

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



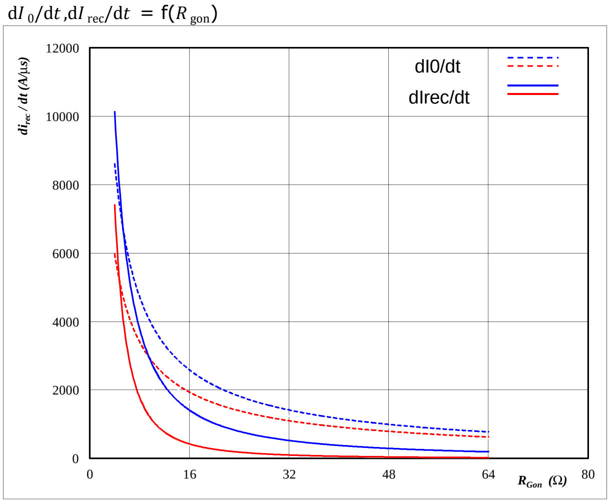
At

T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 18. FWD

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

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



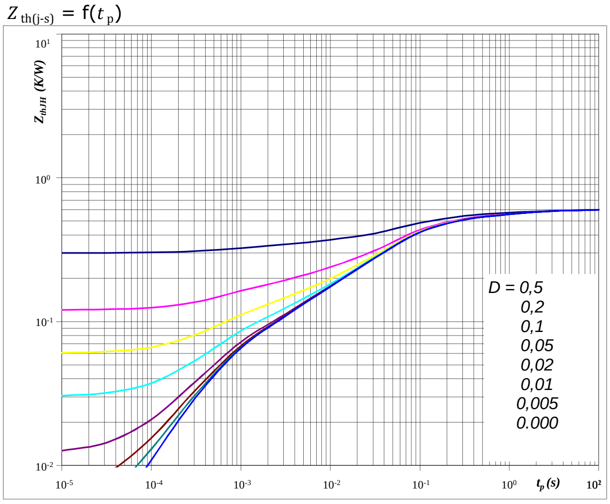
At

T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

figure 19. IGBT

IGBT transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,60	K/W

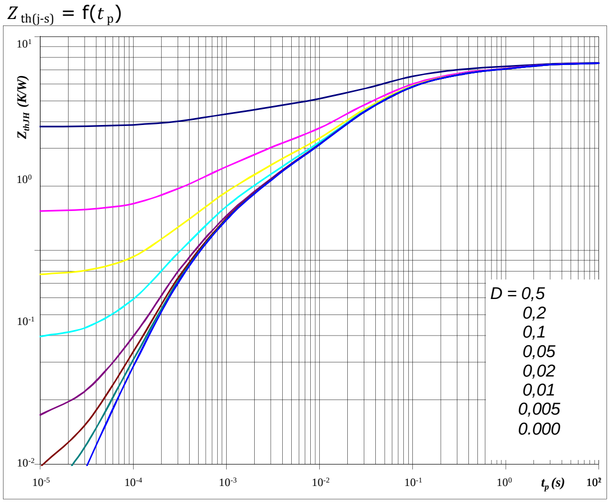
IGBT thermal model values

R (K/W)	Tau (s)
7,47E-02	1,72E+00
1,46E-01	1,85E-01
2,60E-01	4,38E-02
6,55E-02	4,17E-03
5,41E-02	5,70E-04

figure 20. FWD

FWD transient thermal impedance as a function of pulse width

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



At

D =	t_p / T	
$R_{th(j\text{-}s)}$ =	0,76	K/W

FWD thermal model values

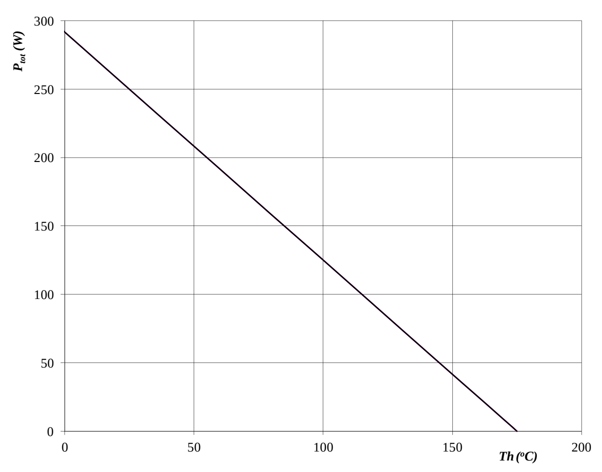
R (K/W)	Tau (s)
1,74E-02	9,51E+00
8,57E-02	1,11E+00
1,74E-01	1,20E-01
2,75E-01	2,41E-02
1,18E-01	2,22E-03
8,80E-02	3,47E-04

Output Inverter

figure 21. **IGBT**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



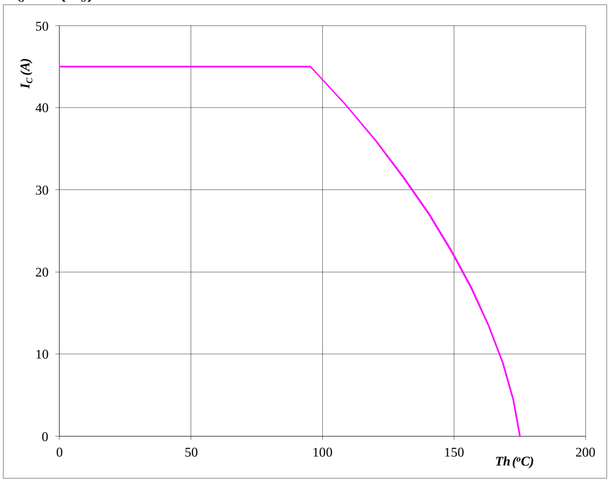
At

T_j = 175 °C

figure 22. **IGBT**

Collector current as a function of heatsink temperature

$I_C = f(T_s)$



At

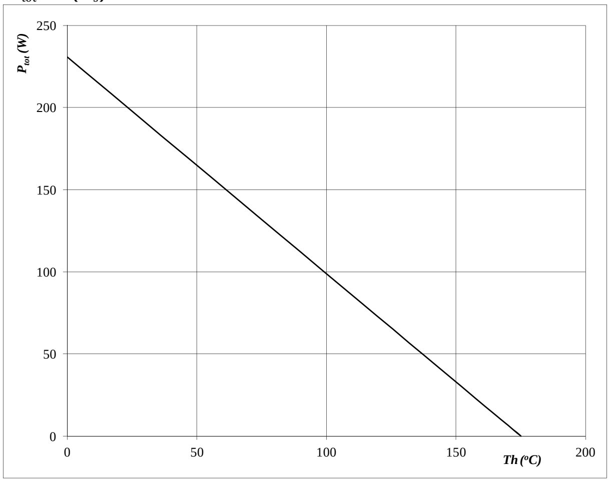
T_j = 175 °C

V_{GE} = 15 V

figure 23. **FWD**

Power dissipation as a function of heatsink temperature

$P_{tot} = f(T_s)$



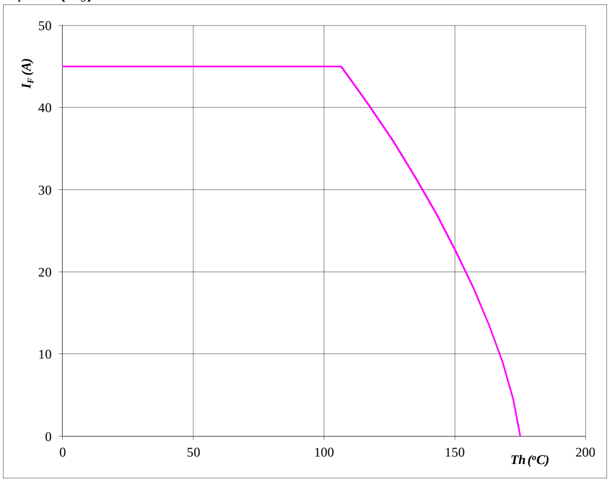
At

T_j = 175 °C

figure 24. **FWD**

Forward current as a function of heatsink temperature

$I_F = f(T_s)$



At

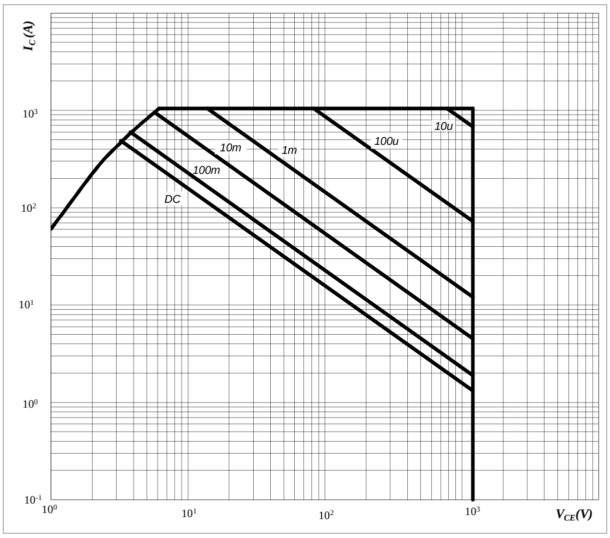
T_j = 175 °C

Output Inverter

figure 25.	IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$



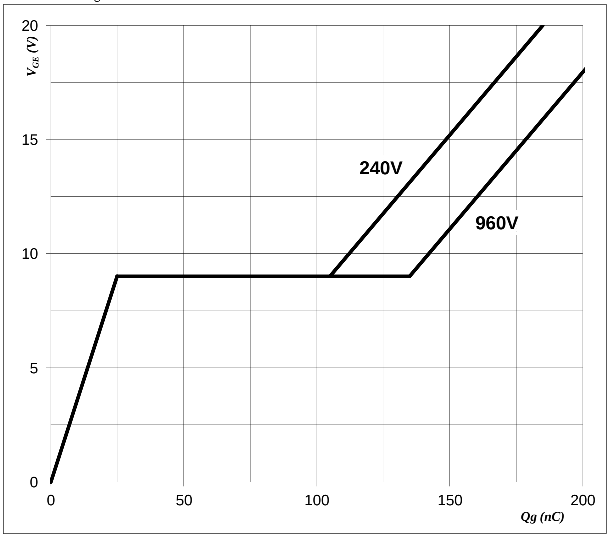
At

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

figure 26.	IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



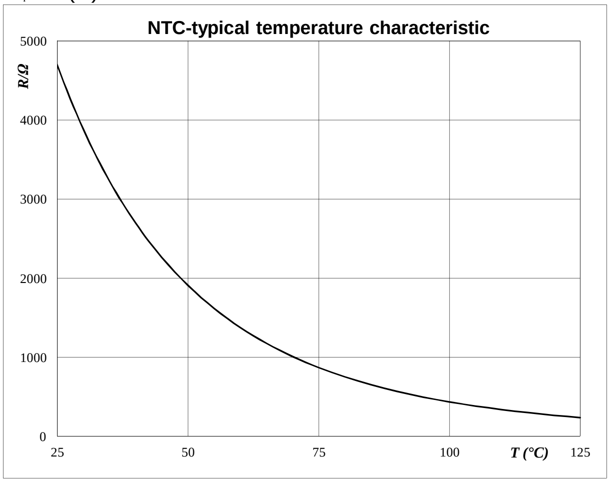
At

I_C =	35	A

Thermistor

figure 1.	Thermistor

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



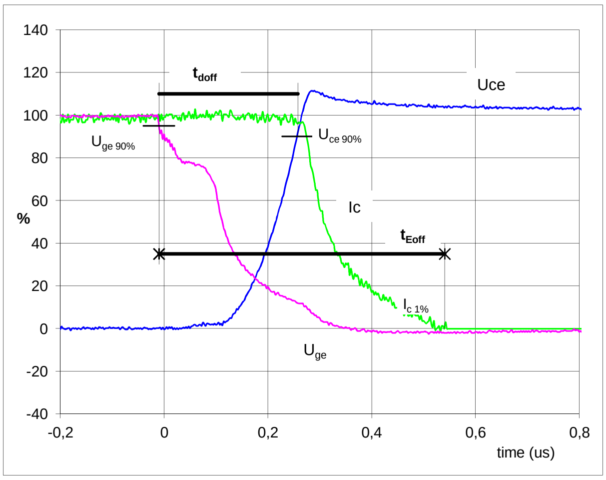
Switching Definitions Output Inverter

General conditions

T_j	=	150 °C
R_{gon}	=	16 Ω
R_{goff}	=	16 Ω

figure 1. **IGBT**

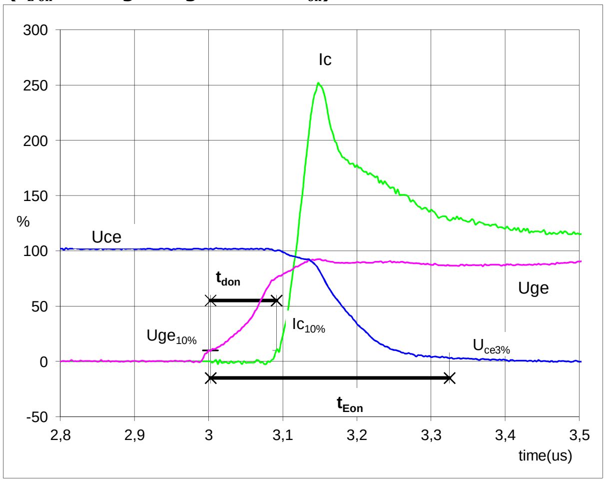
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	35	A
t_{doff} =	0,26	μs
$t_{E\,off}$ =	0,55	μs

figure 2. **IGBT**

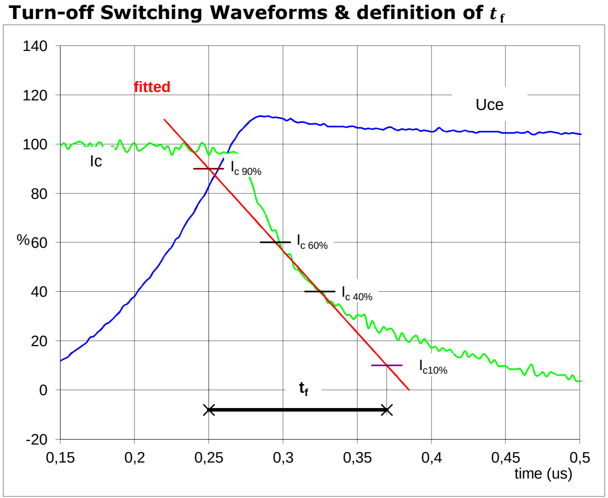
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



V_{GE} (0%) =	-15	V
V_{GE} (100%) =	15	V
V_C (100%) =	600	V
I_C (100%) =	35	A
t_{don} =	0,09	μs
$t_{E\,on}$ =	0,32	μs

figure 3. **IGBT**

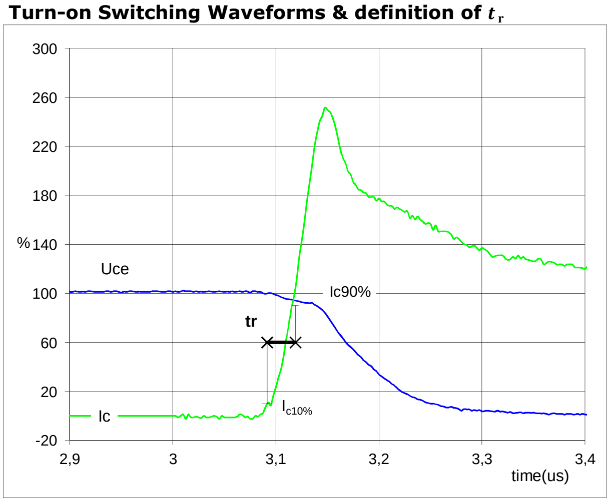
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	35	A
t_f =	0,11	μs

figure 4. **IGBT**

Turn-on Switching Waveforms & definition of t_r

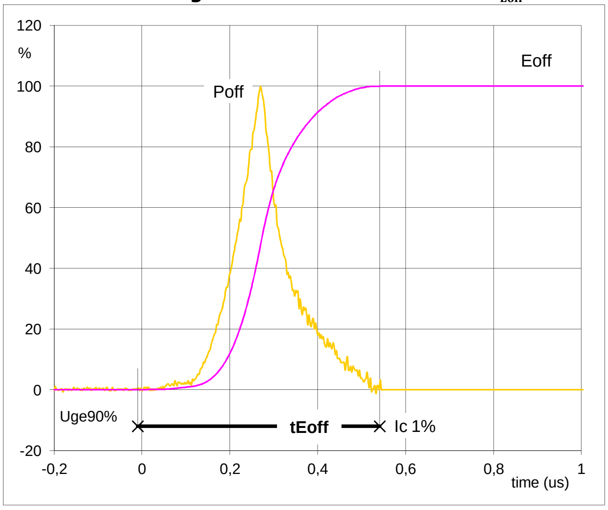


V_C (100%) =	600	V
I_C (100%) =	35	A
t_r =	0,02	μs

Switching Definitions Output Inverter

figure 5. **IGBT**

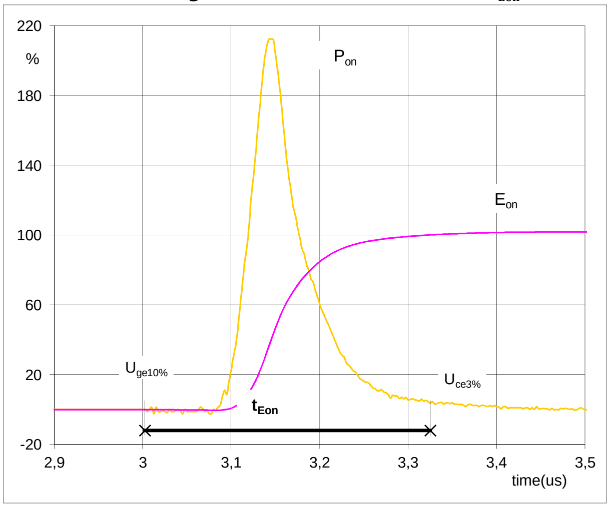
Turn-off Switching Waveforms & definition of t_{Eoff}



P_{off} (100%) =	20,98	kW
E_{off} (100%) =	2,81	mJ
$t_{E\,off}$ =	0,55	μs

figure 6. **IGBT**

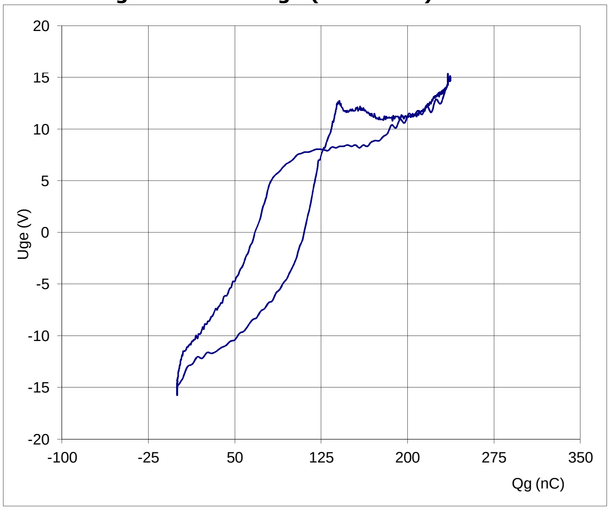
Turn-on Switching Waveforms & definition of t_{Eon}



P_{on} (100%) =	20,98	kW
E_{on} (100%) =	3,09	mJ
$t_{E\,on}$ =	0,32	μs

figure 7. **FWD**

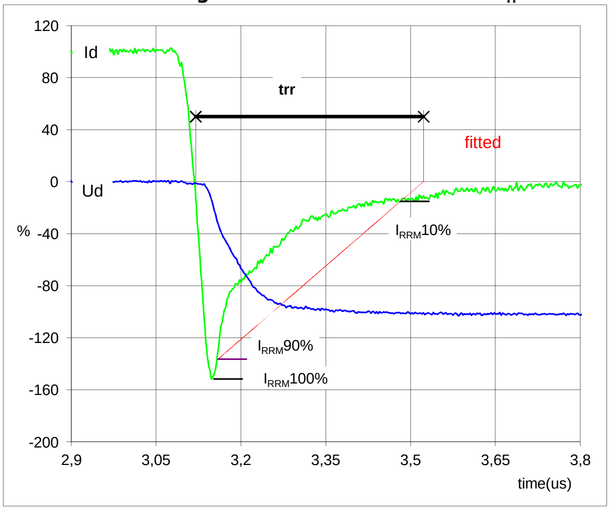
Gate voltage vs Gate charge (measured)



$V_{GE\,off}$ =	-15	V
$V_{GE\,on}$ =	15	V
V_C (100%) =	600	V
I_C (100%) =	35	A
Q_g =	236,86	nC

figure 8. **IGBT**

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

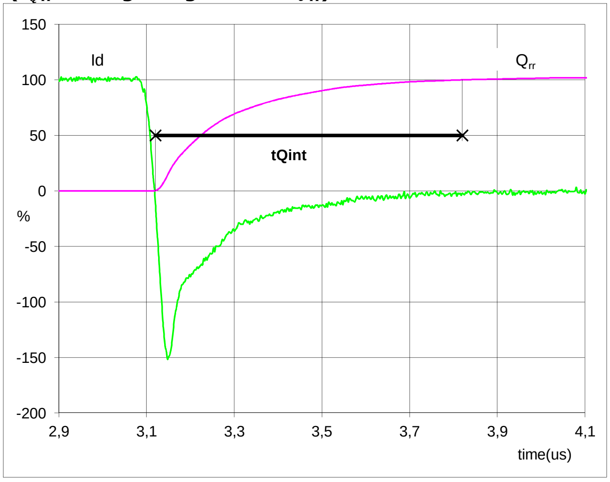


V_d (100%) =	600	V
I_d (100%) =	35	A
I_{RRM} (100%) =	-53	A
t_{rr} =	0,35	μs

Switching Definitions Output Inverter

figure 9. **FWD**

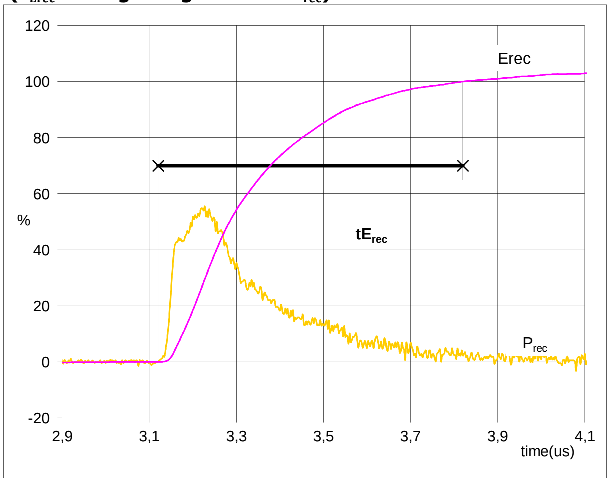
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



I_d (100%) =	35	A
Q_{rr} (100%) =	6,93	μC
t_{Qint} =	0,70	μs

figure 10. **FWD**

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



P_{rec} (100%) =	20,98	kW
E_{rec} (100%) =	2,83	mJ
$t_{E\,rec}$ =	0,70	μs

Ordering Code & Marking

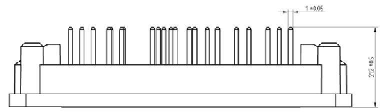
Version	Ordering Code
without thermal paste 17mm housing with solder pin	V23990-P828-F-PM
with thermal paste 17mm housing with solder pin	V23990-P828-F-/3/-PM
without thermal paste 17mm housing with Press-fit pin	V23990-P828-FY-PM
with thermal paste 17mm housing with Press-fit pin	V23990-P828-FY-/3/-PM

	VIN	Date code	Name&Ver	UL	Lot	Serial
Text	VIN	WWYY	NNNNNNNVV	UL	LLLLL	SSSS
	Type&Ver	Lot number	Serial	Date code		
Datamatrix	TTTTTTTVV	LLLLL	SSSS	WWYY		

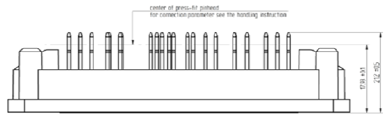
Outline

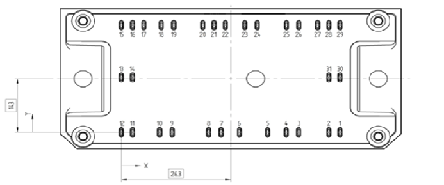
Pin table [mm]				Pin table [mm]			
Pin	X	Y	Function	Pin	X	Y	Function
1	52,6	0	DC-	20	19,6	28,6	V
2	49,9	0	DC-	21	22,3	28,6	V
3	42,65	0	G6	22	25	28,6	V
4	39,65	0	S6	23	29,7	28,6	S3
5	35,15	0	NTC1	24	32,7	28,6	G3
6	28,4	0	NTC2	25	39,7	28,6	S5
7	24	0	G4	26	42,7	28,6	G5
8	21	0	S4	27	47,2	28,6	W
9	12,2	0	G2	28	49,9	28,6	W
10	9,2	0	S2	29	52,6	28,6	W
11	2,7	0	DC-	30	52,6	14,65	DC+
12	0	0	DC-	31	49,9	14,65	DC+
13	0	14,65	DC+				
14	2,7	14,65	DC+				
15	0	28,6	U				
16	2,7	28,6	U				
17	5,4	28,6	U				
18	9,6	28,6	S1				
19	12,6	28,6	G1				

solder pin



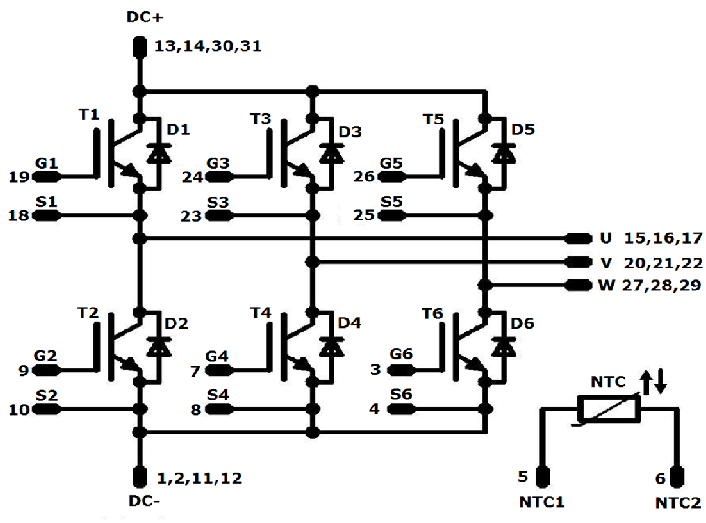
Press-fit pin





Tolerance of pinpositions: ±0,5mm at the end of pins
Dimension of coordinate axis is only offset without tolerance

Pinout



Identification

ID	Component	Voltage	Current	Function	Comment
T1,T2,T3,T4,T5,T6	IGBT	1200 V	35 A	Inverter Switch	
D1,D2,D3,D4,D5,D6	FWD	1200 V	35 A	Inverter Diode	
NTC	Thermistor			Thermistor	

Packaging instruction					
Standard packaging quantity (SPQ)	**100**	>SPQ	Standard	<SPQ	Sample

Handling instruction
Handling instructions for *flow* 1 packages see vincotech.com website.

Package data
Package data for *flow* 1 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-P828-Fx-D3-14	27 Oct. 2016	New brand, Press-fit version added	all

LIFE SUPPORT POLICY

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

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in labelling can be reasonably expected to result in significant injury to the user.

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