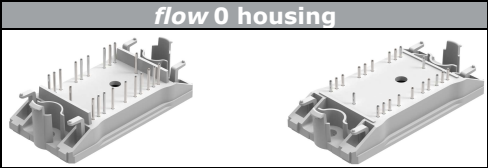
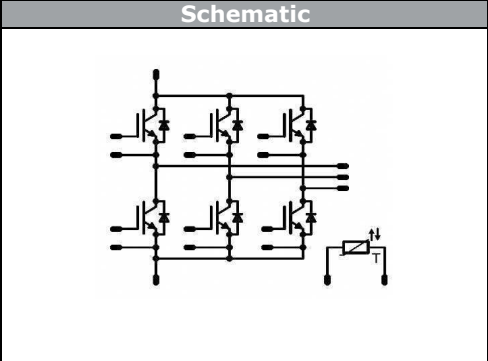




<i>flow</i> PACK 0	1200 V / 35 A
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Features</div> <ul style="list-style-type: none"> 2 clip housing in 12 mm and 17 mm height Trench Fieldstop IGBT⁴ technology Compact and low inductance design Built-in NTC 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">flow 0 housing</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Target Applications</div> <ul style="list-style-type: none"> Motor Drives Power Generation UPS 	<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Schematic</div> 
<div style="background-color: #eee; padding: 2px; margin-bottom: 5px;">Types</div> <ul style="list-style-type: none"> V23990-P860-F49-PM V23990-P860-F48-PM 	

Maximum Ratings

$T_j = 25\text{ °C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Inverter Transistor				
Collector-emitter voltage	V_{CE}		1200	V
DC collector current	I_C	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	34	A
Repetitive peak collector current	I_{CRM}	t_p limited by T_{jmax}	105	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	80	W
Gate-emitter peak voltage	V_{GE}		±20	V
Short circuit ratings*	t_{SC}	$T_j \leq 150\text{ °C}$	10	µs
	V_{CC}	$V_{GE} = 15\text{ V}$	800	V
Maximum Junction Temperature	T_{jmax}		175	°C

* It is recommended to not exceed 1000 short circuit situations in the lifetime of the module and to allow at least 1s between short circuits

Inverter Diode				
Peak Repetitive Reverse Voltage	V_{RRM}		1200	V
DC forward current	I_F	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	35	A
Repetitive peak forward current	I_{FRM}	t_p limited by T_{jmax}	70	A
Power dissipation	P_{tot}	$T_j = T_{jmax}$ $T_s = 80\text{ °C}$	61	W
Maximum Junction Temperature	T_{jmax}		175	°C

Thermal properties				
Storage temperature	T_{stg}		-40.....+125	°C
Operation junction temperature	T_{op}		-40.....+ T_{jmax} -25	°C



Maximum Ratings

$T_i = 25\text{ °C}$, unless otherwise specified

Parameter	Symbol	Condition	Value	Unit
Insulation properties				
Insulation voltage	V_{isol}	DC Test Voltage* $t_p = 2\text{ s}$	6000	V
		AC Voltage $t_p = 1\text{ min}$	2500	V
Creepage distance			min.12,7	mm
Clearance			9,22	mm
			min.12,7	mm
Comparative Tracking Index	CTI		>200	

*100% tested in production



Characteristic Values

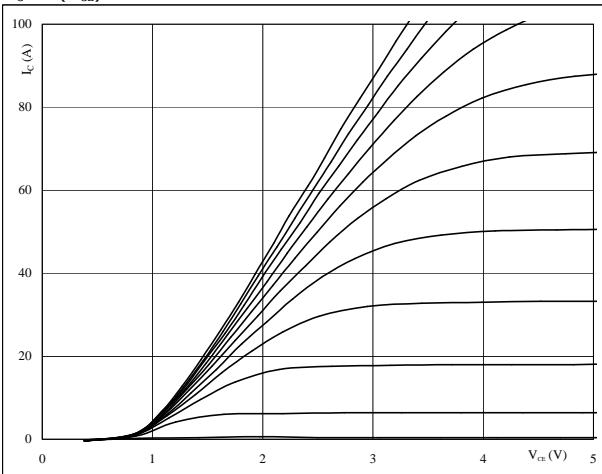
Parameter	Symbol	Conditions					Value			Unit					
		V_{GE} [V]	V_{GS} [V]	V_r [V]	V_{CE} [V]	V_{DS} [V]	I_C [A]	I_F [A]	I_D [A]		T_j [°C]	Min	Typ	Max	
Inverter Transistor															
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$				0,0012	25			5	5,8	6,5	V		
Collector-emitter saturation voltage	$V_{CE(sat)}$		15			35	25 150				1,9 2,33	2,3	V		
Collector-emitter cut-off current incl. Diode	I_{CES}		0	1200			25					15	µA		
Gate-emitter leakage current	I_{GES}		20	0			25					200	nA		
Integrated Gate resistor	R_{gint}										none		Ω		
Turn-on delay time	$t_{d(on)}$	$R_{gon} = 16 \Omega$ $R_{goff} = 16 \Omega$	± 15	600	35		25				85		ns		
Rise time	t_r						150				22				26
Turn-off delay time	$t_{d(off)}$						25				199				259
Fall time	t_f						150				73				115
Turn-on energy loss per pulse	E_{on}						25				2,48				3,71
Turn-off energy loss per pulse	E_{off}						150				1,83				2,9
Input capacitance	C_{ies}	$f = 1 \text{ MHz}$	0	25			25				1950		pF		
Output capacitance	C_{oss}										155				
Reverse transfer capacitance	C_{rss}										115				
Gate charge	Q_G		15	960	35	25					197		nC		
Thermal resistance chip to heatsink	$R_{th(j-s)}$	$\lambda_{paste} = 0,8 \text{ W/mK}$ (P12)									1,19		K/W		
Inverter Diode															
Diode forward voltage	V_F					35	25 150				1,79 1,76	2,3	V		
Peak reverse recovery current	I_{RRM}	$R_{gon} = 16 \Omega$	± 15	600	35		25				30,4		A		
Reverse recovery time	t_{rr}						150				298				34,5
Reverse recovered charge	Q_{rr}						25				493				
Peak rate of fall of recovery current	$(di_{rr}/dt)_{max}$						150				3,79				7,00
Reverse recovered energy	E_{rec}						25				122				105
Thermal resistance chip to heatsink	$R_{th(j-s)}$	$\lambda_{paste} = 0,8 \text{ W/mK}$ (P12)									1,55		K/W		
Thermistor															
Rated resistance	R						25				22		kΩ		
Deviation of R_{100}	$\Delta_{R/R}$	$R_{100} = 1486 \Omega$					100		-5		+5		%		
Power dissipation	P						25				210		mW		
Power dissipation constant							25				4,4		mW/K		
B-value	$B_{(25/50)}$	Tol. -13,1%					25				3940		K		
B-value	$B_{(25/100)}$	Tol. +11,6%					25				4000		K		
Vincotech NTC Reference												A			

Output Inverter

figure 1 IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

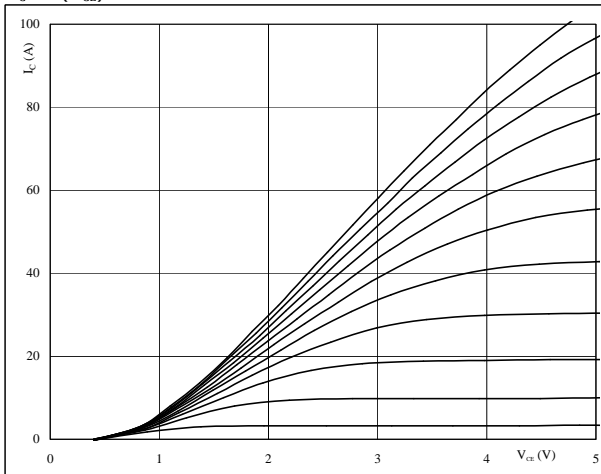


$t_p = 250 \mu s$
 $T_j = 25 \text{ } ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 2 IGBT

Typical output characteristics

$$I_C = f(V_{CE})$$

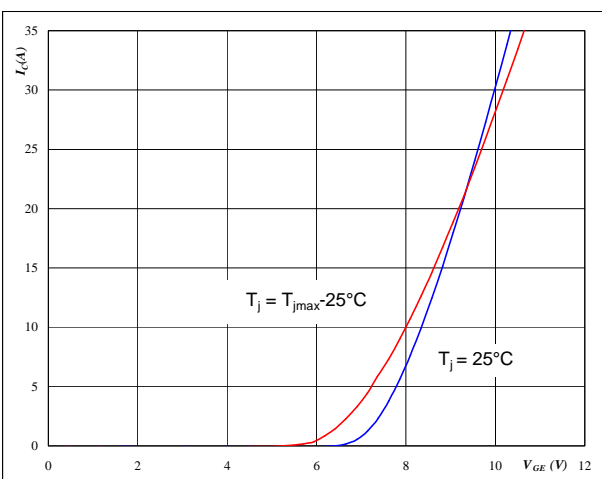


$t_p = 250 \mu s$
 $T_j = 150 \text{ } ^\circ C$
 V_{GE} from 7 V to 17 V in steps of 1 V

figure 3 IGBT

Typical transfer characteristics

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

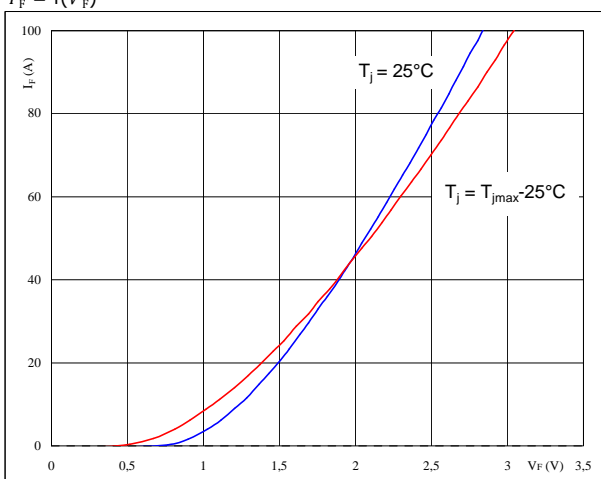


$t_p = 250 \mu s$
 $V_{CE} = 10 \text{ V}$

figure 4 FWD

Typical diode forward current as a function of forward voltage

$$I_F = f(V_F)$$



$t_p = 250 \mu s$

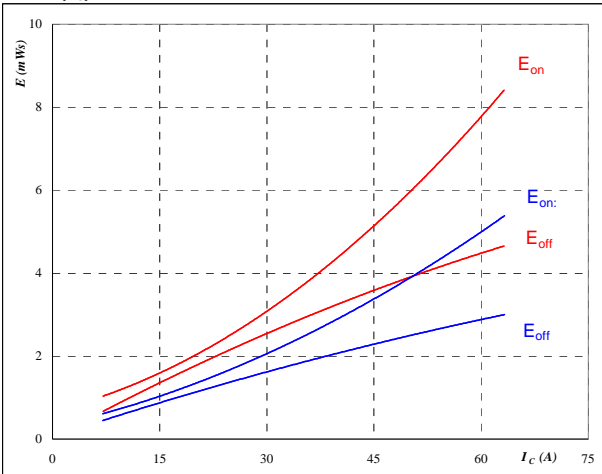


Output Inverter

figure 5 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



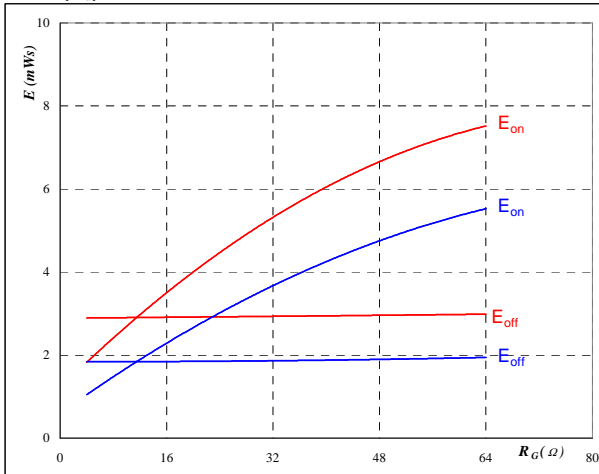
inductive load

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

$E = f(R_G)$



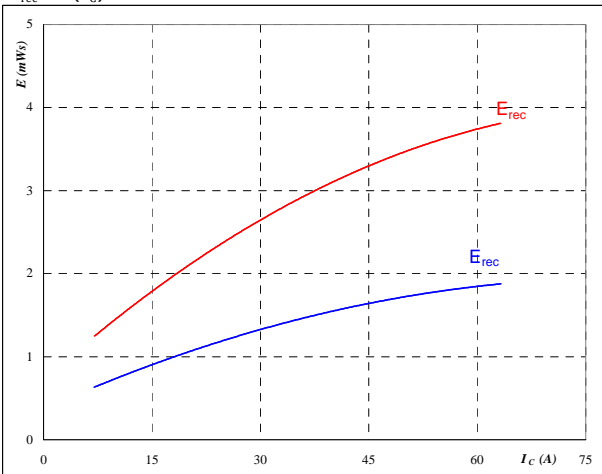
inductive load

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

$E_{rec} = f(I_C)$



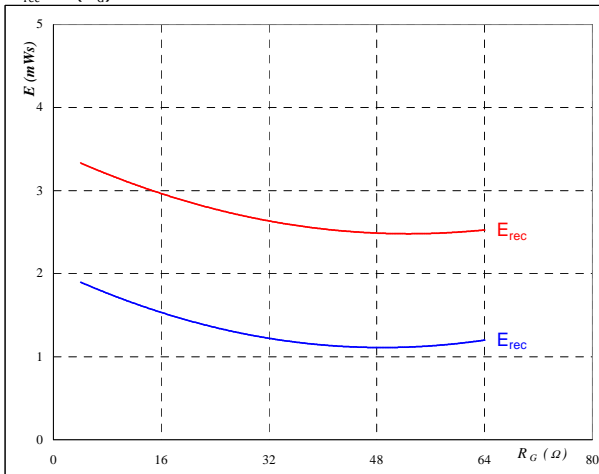
inductive load

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

$E_{rec} = f(R_G)$



inductive load

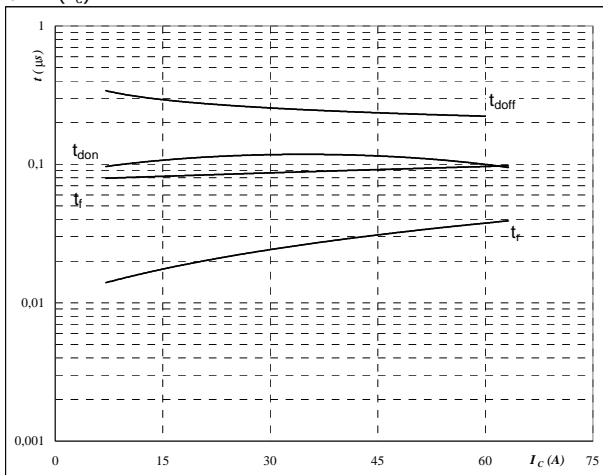
T _j =	25/150	°C
V _{CE} =	600	V
V _{GE} =	±15	V
I _C =	35	A

Output Inverter

figure 9 IGBT

Typical switching times as a function of collector current

$$t = f(I_C)$$



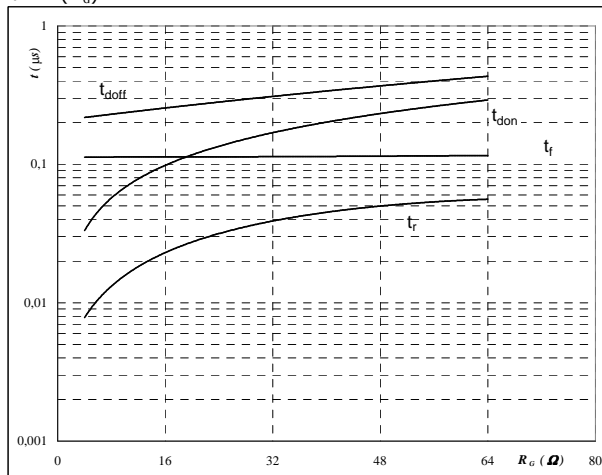
inductive load

$T_j =$	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

$$t = f(R_G)$$



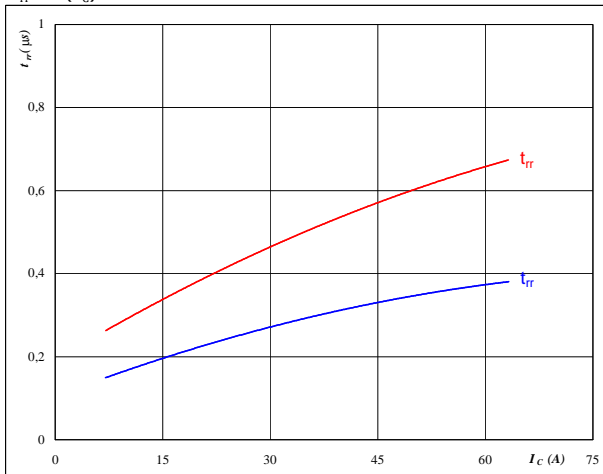
inductive load

$T_j =$	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

$$t_{rr} = f(I_C)$$

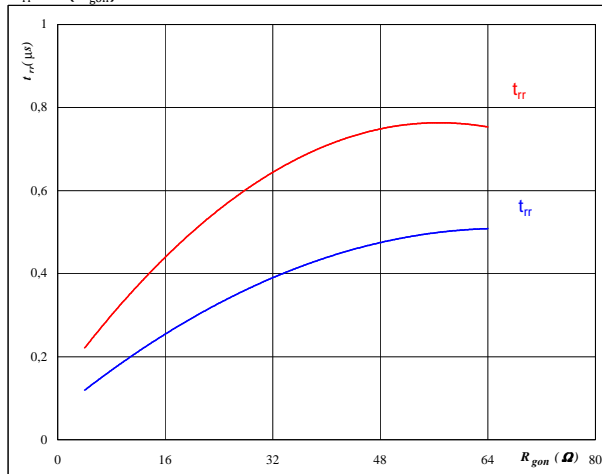


$T_j =$	25/150	°C
$V_{CE} =$	600	V
$V_{GE} =$	±15	V
$R_{gon} =$	16	Ω

figure 12 FWD

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

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



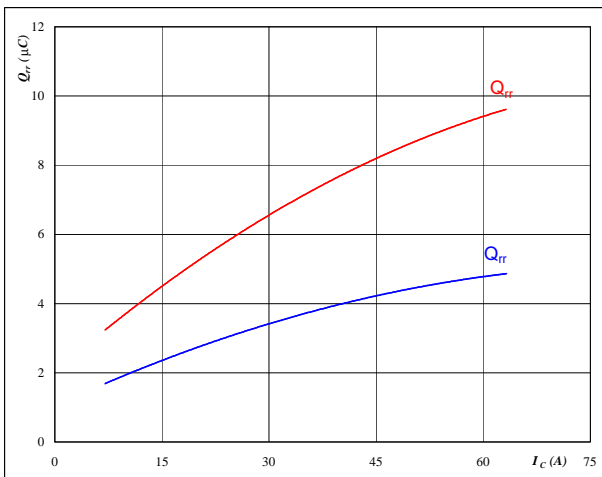
$T_j =$	25/150	°C
$V_R =$	600	V
$I_F =$	35	A
$V_{GE} =$	±15	V

Output Inverter

figure 13 FWD

Typical reverse recovery charge as a function of collector current

$$Q_{rr} = f(I_c)$$

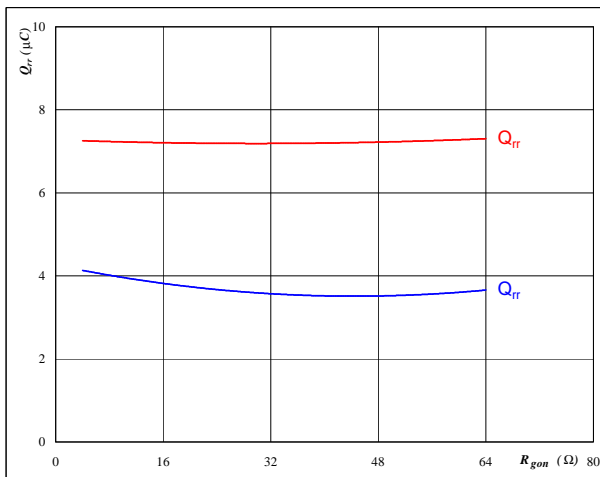


$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

figure 14 FWD

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

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

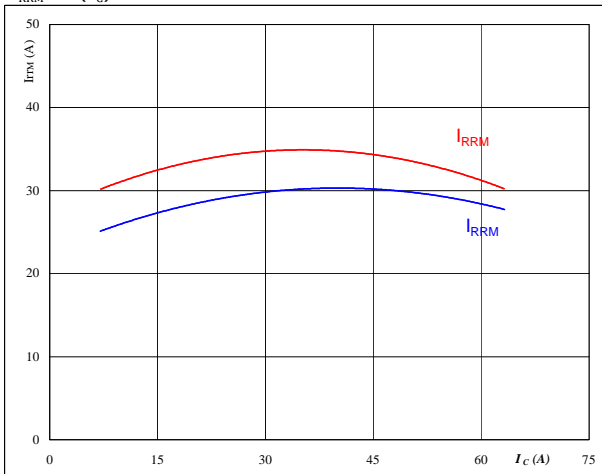


$T_j = 25/150$ °C
 $V_R = 600$ V
 $I_F = 35$ A
 $V_{GE} = \pm 15$ V

figure 15 FWD

Typical reverse recovery current as a function of collector current

$$I_{RRM} = f(I_c)$$

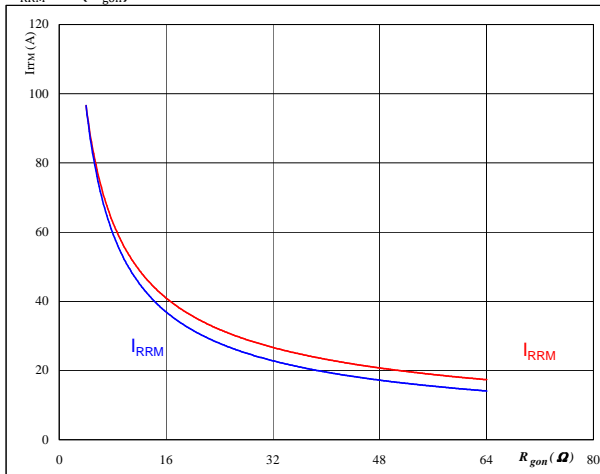


$T_j = 25/150$ °C
 $V_{CE} = 600$ V
 $V_{GE} = \pm 15$ V
 $R_{gon} = 16$ Ω

figure 16 FWD

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

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



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

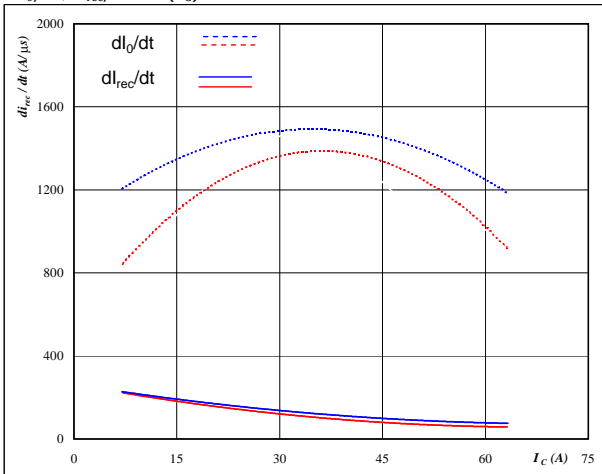


Output Inverter

figure 17 FWD

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

$$di_o/dt, di_{rec}/dt = f(I_c)$$

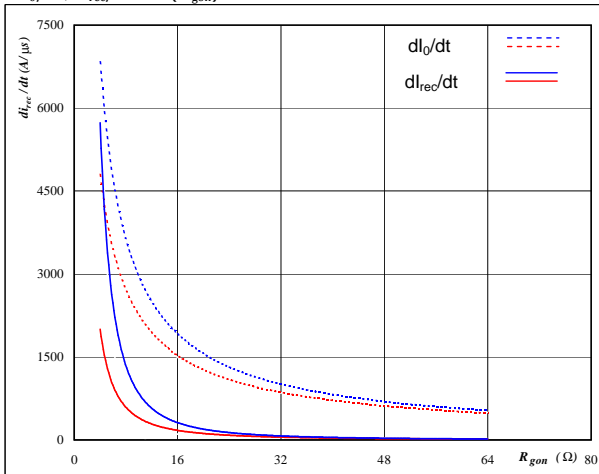


$T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_{CE} = 600 \text{ V}$
 $V_{GE} = \pm 15 \text{ V}$
 $R_{gon} = 16 \text{ } \Omega$

figure 18 FWD

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

$$di_o/dt, di_{rec}/dt = f(R_{gon})$$

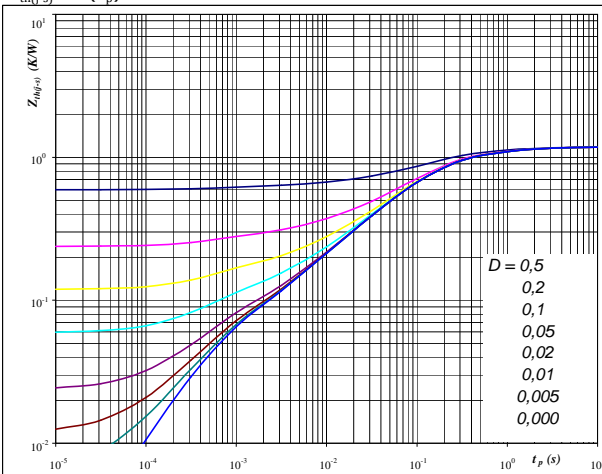


$T_j = 25/150 \text{ } ^\circ\text{C}$
 $V_R = 600 \text{ V}$
 $I_F = 35 \text{ A}$
 $V_{GE} = \pm 15 \text{ V}$

figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,19 \text{ K/W}$

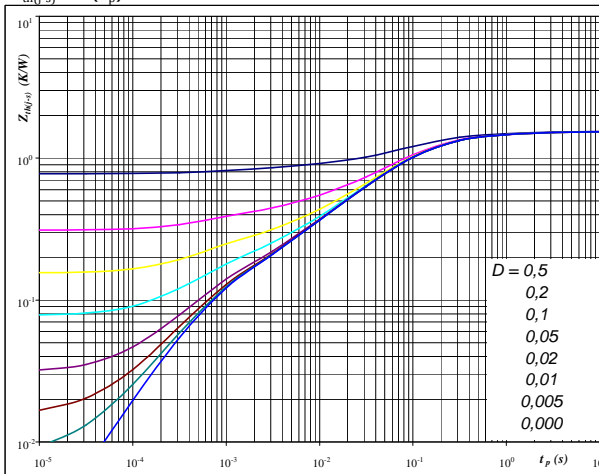
IGBT thermal model values

R (K/W)	Tau (s)
3,38E-02	6,78E+00
1,63E-01	9,97E-01
5,97E-01	1,60E-01
2,53E-01	3,98E-02
8,72E-02	7,05E-03
5,35E-02	5,91E-04

figure 20 FWD

FWD transient thermal impedance as a function of pulse width

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



$D = t_p / T$
 $R_{th(j-s)} = 1,55 \text{ K/W}$

FWD thermal model values

R (K/W)	Tau (s)
3,30E-02	9,78E+00
1,60E-01	9,82E-01
6,46E-01	1,42E-01
4,66E-01	4,00E-02
1,39E-01	6,02E-03
1,05E-01	6,16E-04

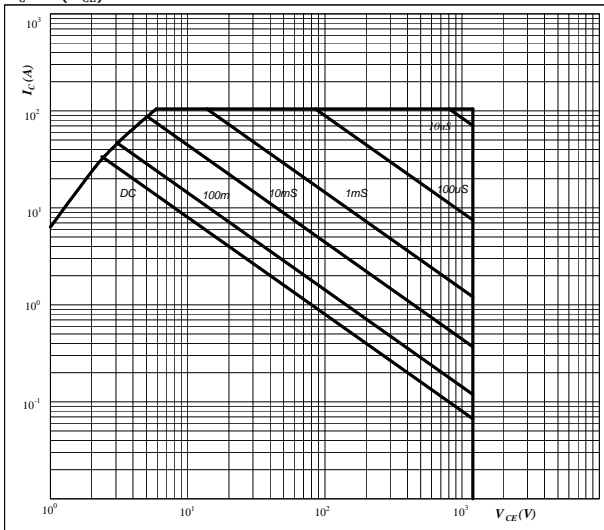


Output Inverter

figure 21 IGBT

Safe operating area as a function of collector-emitter voltage

$$I_C = f(V_{CE})$$

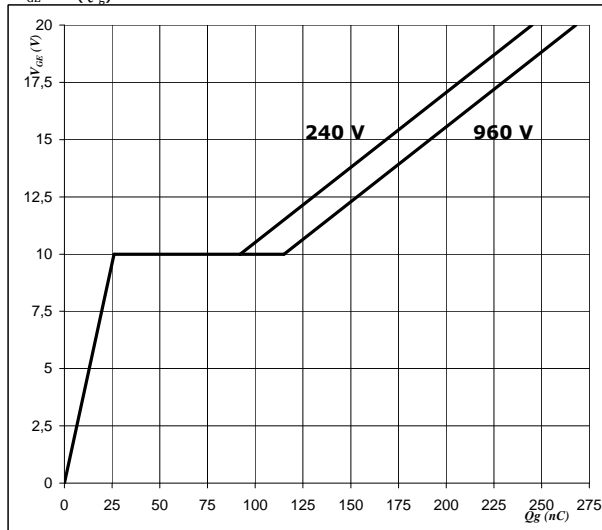


$D =$ single pulse
 $T_s =$ 80 °C
 $V_{GE} =$ ±15 V
 $T_j = T_{jmax}$

figure 22 IGBT

Gate voltage vs Gate charge

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



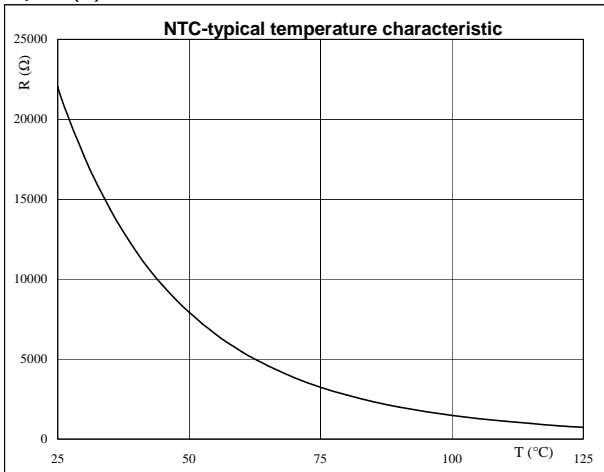
$I_C =$ 35 A

Thermistor

figure 1 Thermistor

Typical NTC characteristic as a function of temperature

$$R_T = f(T)$$





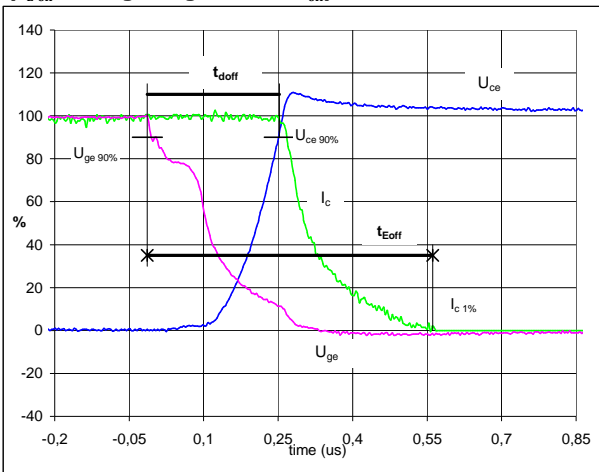
Switching Definitions Output Inverter

General conditions

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

Figure 1 IGBT

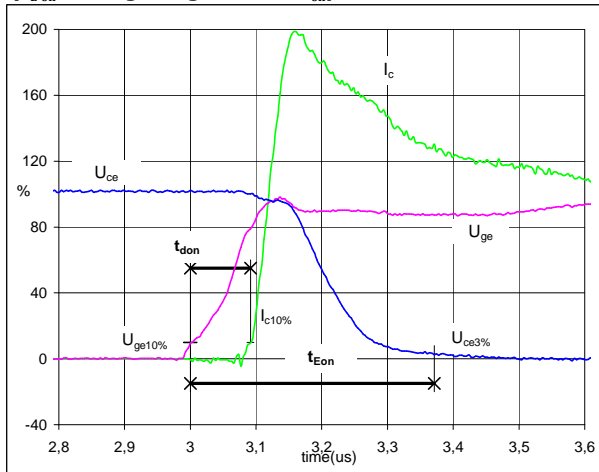
Turn-off Switching Waveforms & definition of t_{doff} , t_{Eoff}
 (t_{Eoff} = integrating time for E_{off})



$V_{GE} (0\%)$	=	-15	V
$V_{GE} (100\%)$	=	15	V
$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	35	A
t_{doff}	=	0,26	μ s
t_{Eoff}	=	0,57	μ s

Figure 2 IGBT

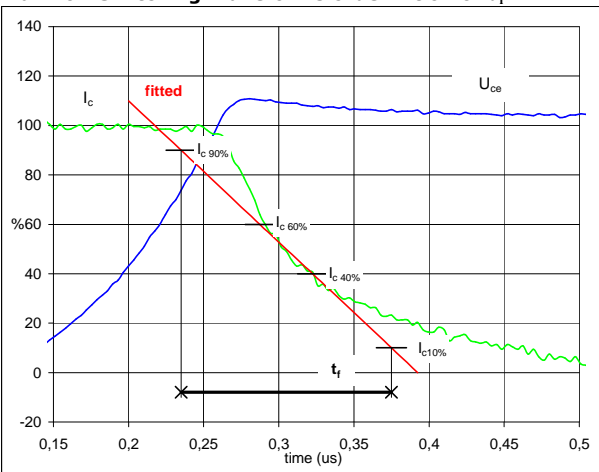
Turn-on Switching Waveforms & definition of t_{donr} , t_{Eon}
 (t_{Eon} = integrating time for E_{on})



$V_{GE} (0\%)$	=	-15	V
$V_{GE} (100\%)$	=	15	V
$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	35	A
t_{donr}	=	0,09	μ s
t_{Eon}	=	0,37	μ s

Figure 3 IGBT

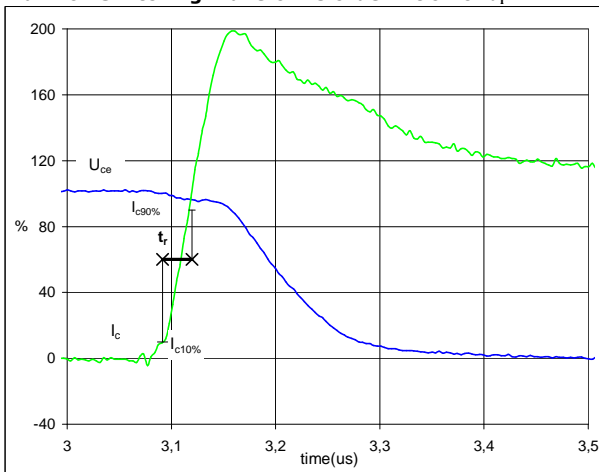
Turn-off Switching Waveforms & definition of t_f



$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	35	A
t_f	=	0,12	μ s

Figure 4 IGBT

Turn-on Switching Waveforms & definition of t_r



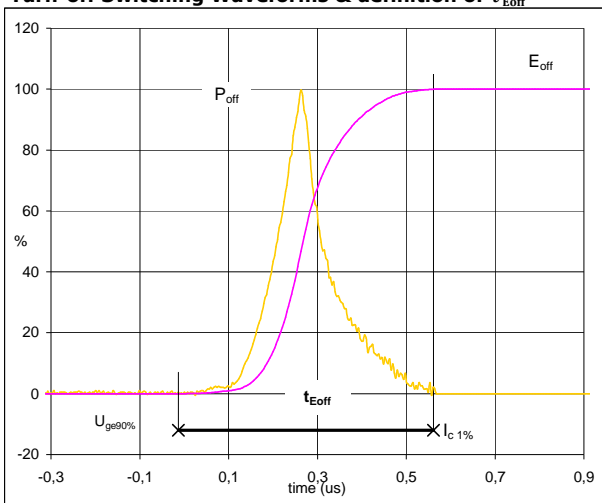
$V_C (100\%)$	=	600	V
$I_C (100\%)$	=	35	A
t_r	=	0,03	μ s



Switching Definitions Output Inverter

Figure 5 IGBT

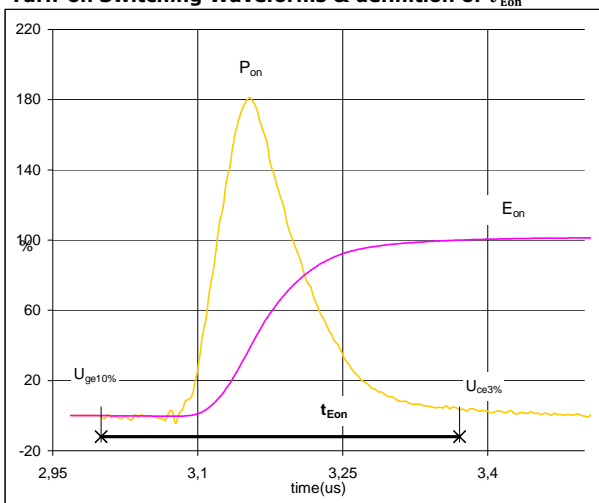
Turn-off Switching Waveforms & definition of t_{Eoff}



$P_{off} (100\%) =$	21,08	kW
$E_{off} (100\%) =$	2,91	mJ
$t_{Eoff} =$	0,57	μ s

Figure 6 IGBT

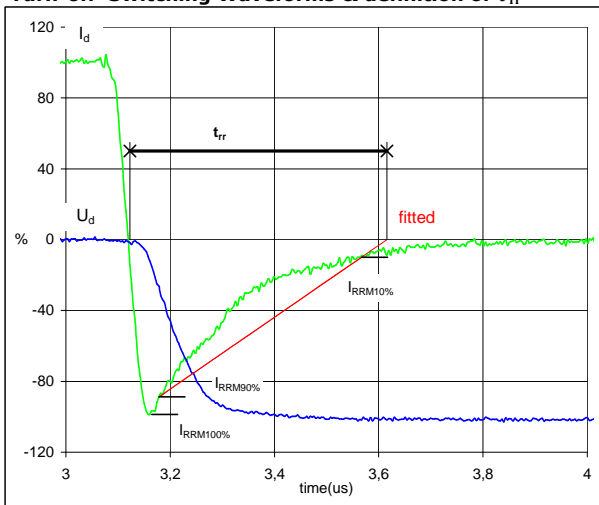
Turn-on Switching Waveforms & definition of t_{Eon}



$P_{on} (100\%) =$	21,08	kW
$E_{on} (100\%) =$	3,71	mJ
$t_{Eon} =$	0,37	μ s

Figure 7 FWD

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



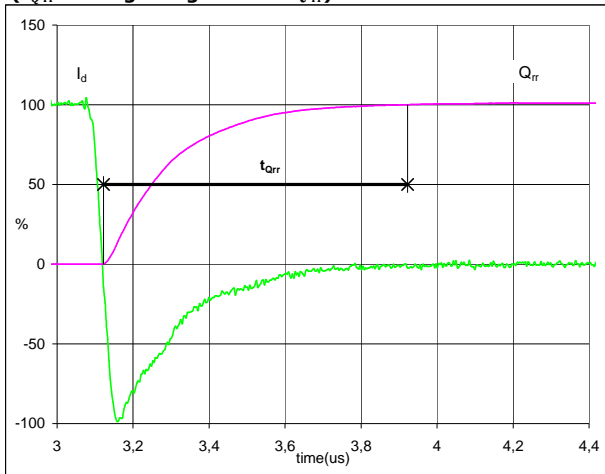
$V_d (100\%) =$	600	V
$I_d (100\%) =$	35	A
$I_{RRM} (100\%) =$	-34	A
$t_{rr} =$	0,49	μ s



Switching Definitions Output Inverter

Figure 8 FWD

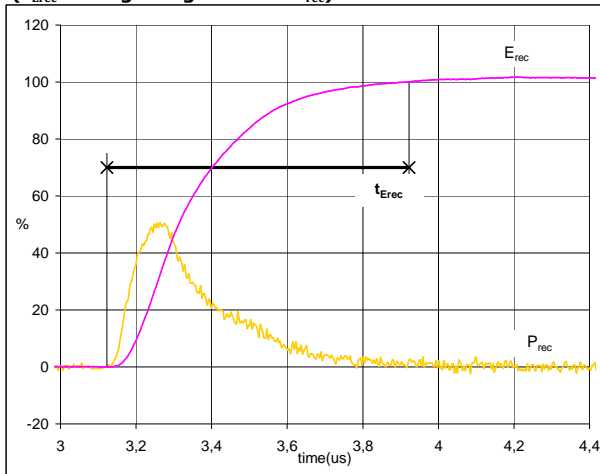
Turn-on Switching Waveforms & definition of t_{Qrr}
(t_{Qrr} = integrating time for Q_{rr})



I_d (100%) =	35	A
Q_{rr} (100%) =	7,00	μC
t_{Qrr} =	0,80	μs

Figure 9 FWD

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

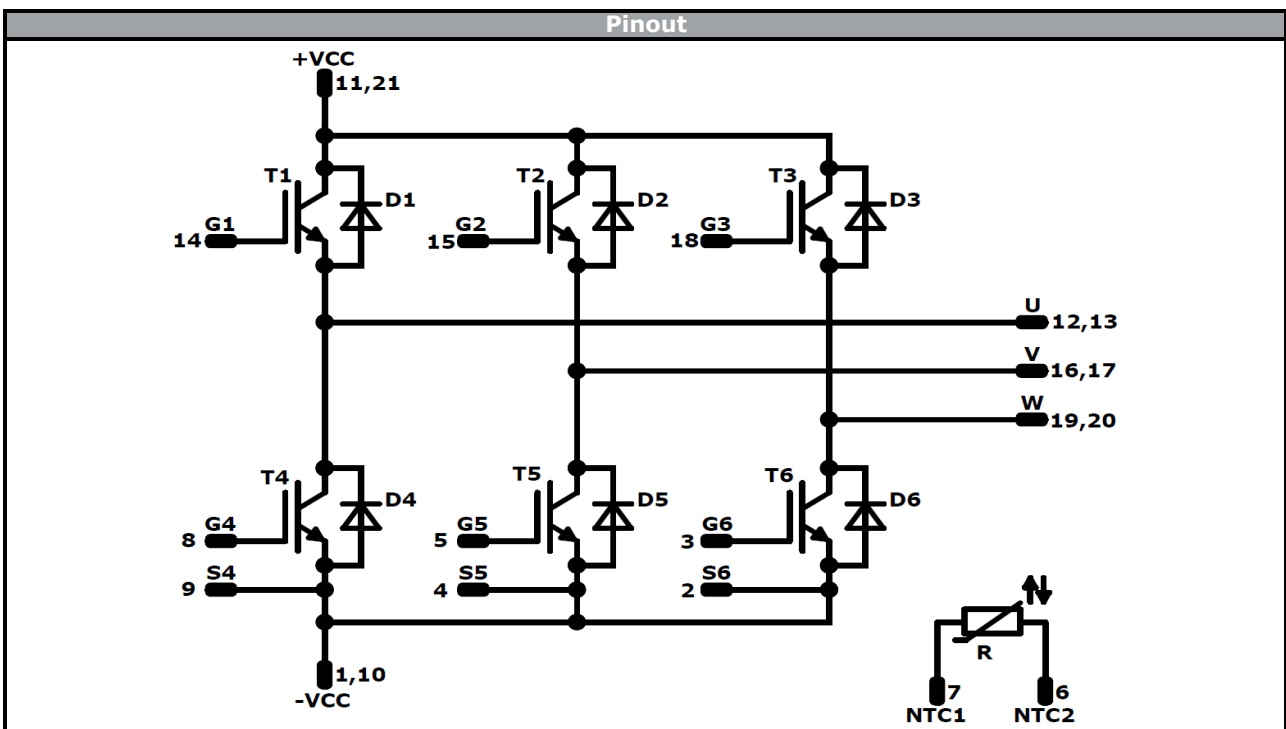


P_{rec} (100%) =	21,08	kW
E_{rec} (100%) =	2,81	mJ
t_{Erec} =	0,80	μs



Ordering Code & Marking							
Version				Ordering Code			
without thermal paste 12 mm housing				V23990-P860-F48-PM			
without thermal paste 17 mm housing				V23990-P860-F49-PM			
	Text	VIN	Date code	Name&Ver	UL	Lot	Serial
		VIN	WWYY	NNNNVVV	UL	LLLLL	SSSS
	Datamatrix	Type&Ver	Lot number	Serial	Date code		
		TTTTTTVV	LLLLL	SSSS	WWYY		

Pin table [mm]				Outline	
Pin	X	Y	Function		17 mm housing
1	33,3	0	-Vcc		
2	30,7	0	S6		12 mm housing
3	27,9	0	G6		
4	23,85	0	S5	<p>Tolerance of pinpositions: $\pm 0.5\text{mm}$ at the end of pins Dimension of coordinate axis is only offset without tolerance</p>	
5	21,05	0	G5		
6	15,95	0	NTC2		
7	9,6	0	NTC1		
8	5,4	0	G4		
9	2,6	0	S4		
10	0	0	-Vcc		
11	0	11,15	+Vcc		
12	0	22,3	U		
13	2,6	22,3	U		
14	5,5	22,3	G1		
15	13,1	22,3	G2		
16	15,9	22,3	V		
17	19,4	22,3	V		
18	27,7	22,3	G3		
19	30,7	22,3	W		
20	33,3	22,3	W		
21	33,3	11,15	+Vcc		



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

**Packaging instruction**

Standard packaging quantity (SPQ)	135	>SPQ	Standard	<SPQ	Sample
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Handling instruction

Handling instructions for *flow* 0 packages see vincotech.com website.

Package data

Package data for *flow* 0 packages see vincotech.com website.

UL recognition and file number

This device is certified according to UL 1557 standard, UL file number E192116. For more information see vincotech.com website.



Document No.:	Date:	Modification:	Pages
V23990-P860-F4x-D3-14	28 Jan. 2018		

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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.