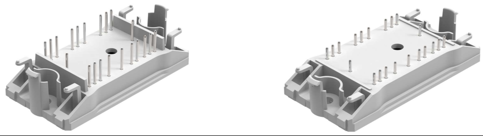
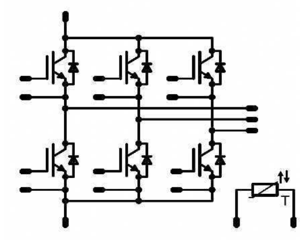
***flow* PACK 0** | **1200 V / 35 A**

Features
- 2 clip housing in 12 mm and 17 mm height
- Trench Fieldstop IGBT4 technology
- Compact and low inductance design
- Built-in NTC

flow 0 housing


Target Applications
- Motor Drives
- Power Generation
- UPS

Schematic


Types
- V23990-P860-F49-PM
- V23990-P860-F48-PM

Maximum Ratings

T_j = 25 °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 °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 °C	80	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

* 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

Parameter	Symbol	Condition		Value	Unit
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	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_j = 25 °C, unless otherwise specified

Parameter	Symbol	Condition		Value	Unit
Insulation properties					
Insulation voltage	V_{isol}	DC Test Voltage*	t_p = 2 s	6000	V
		AC Voltage	t_p = 1 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

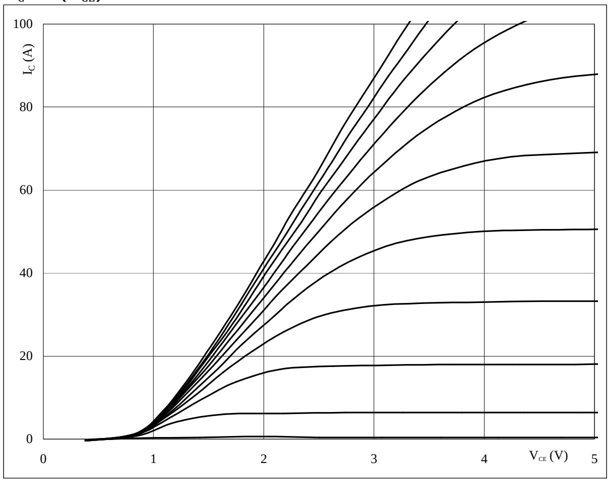
Parameter	Symbol	Conditions					Value			Unit
			V_{GE} [V] V_{GS} [V]	V_r [V] V_{CE} [V] V_{DS} [V]	I_C [A] I_F [A] I_D [A]	T_j [°C]	Min	Typ	Max	
Inverter Transistor										
Gate emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}$			0,0012	25	5	5,8	6,5	V
Collector-emitter saturation voltage	V_{CEsat}		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 Ω R_{goff} = 16 Ω	±15	600	35	25 150		85 88		ns
Rise time	t_r					25 150		22 26		
Turn-off delay time	$t_{d(off)}$					25 150		199 259		
Fall time	t_f					25 150		73 115		
Turn-on energy loss per pulse	E_{on}					25 150		2,48 3,71		mWs
Turn-off energy loss per pulse	E_{off}					25 150		1,83 2,9		
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	960	35	25		197		nC
Thermal resistance chip to heatsink	$R_{th(j-s)}$	λ_{paste} = 0,8 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 Ω	±15	600	35	25 150		30,4 34,5		A
Reverse recovery time	t_{rr}					25 150		298 493		ns
Reverse recovered charge	Q_{rr}					25 150		3,79 7,00		µC
Peak rate of fall of recovery current	$(di_{rf}/dt)_{max}$					25 150		122 105		A/ms
Reverse recovered energy	E_{rec}					150		2,81		mWs
Thermal resistance chip to heatsink	$R_{th(j-s)}$	λ_{paste} = 0,8 W/mK (P12)						1,55		K/W
Thermistor										
Rated resistance	R					25		22		kΩ
Deviation of R_{100}	$\Delta_{R/R}$	R_{100} = 1486 Ω				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

$I_C = f(V_{CE})$

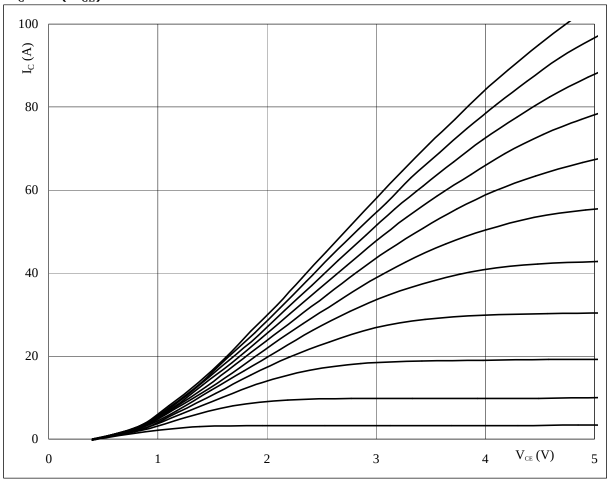


t_p =	250	μs
T_j =	25	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 2 IGBT

Typical output characteristics

$I_C = f(V_{CE})$

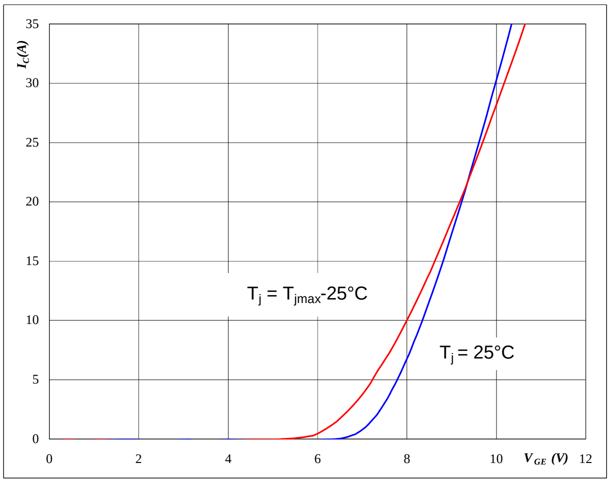


t_p =	250	μs
T_j =	150	°C
V_{GE} from	7 V to 17 V in steps of 1 V	

figure 3 IGBT

Typical transfer characteristics

$I_C = f(V_{GE})$

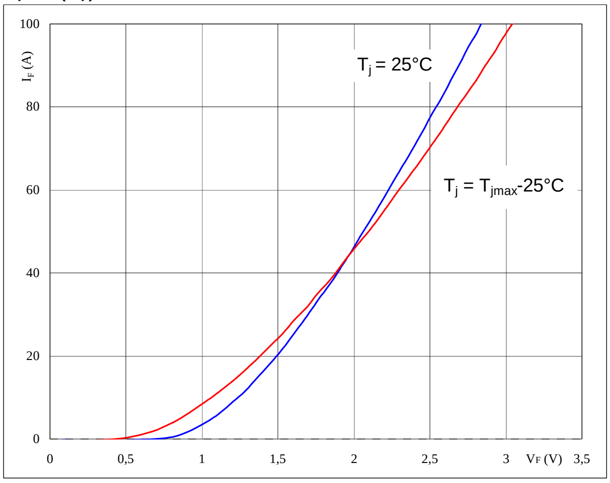


t_p =	250	μs
V_{CE} =	10	V

figure 4 FWD

Typical diode forward current as a function of forward voltage

$I_F = f(V_F)$



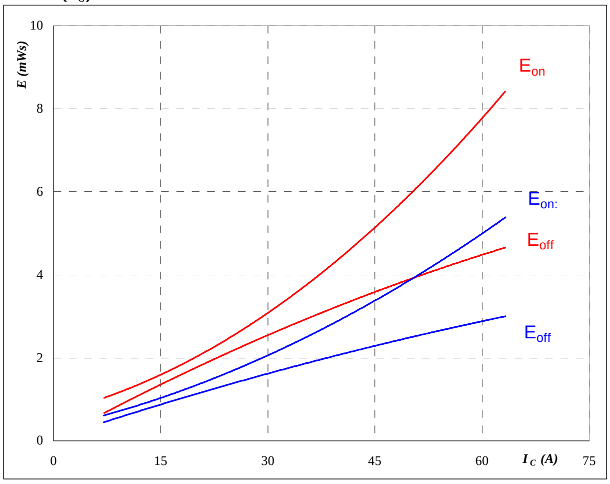
t_p =	250	μs

Output Inverter

figure 5 IGBT

Typical switching energy losses as a function of collector current

$E = f(I_C)$



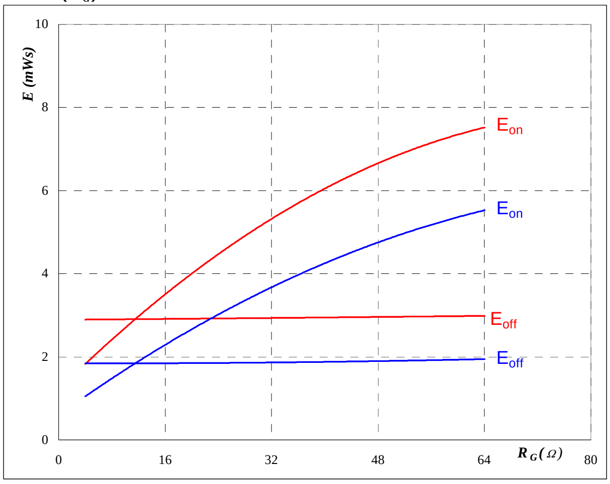
inductive load

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

$E = f(R_G)$



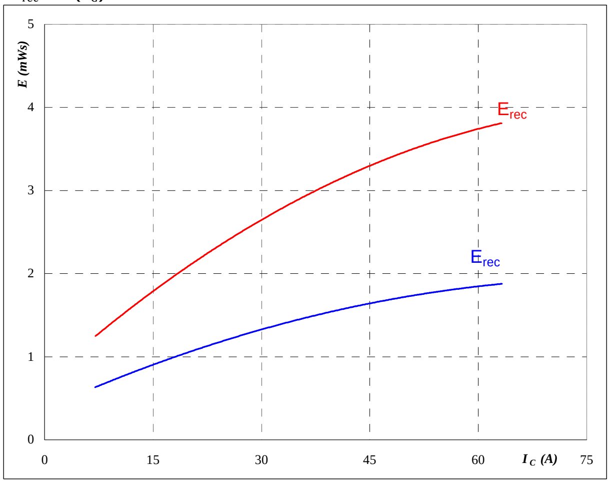
inductive load

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

$E_{rec} = f(I_C)$



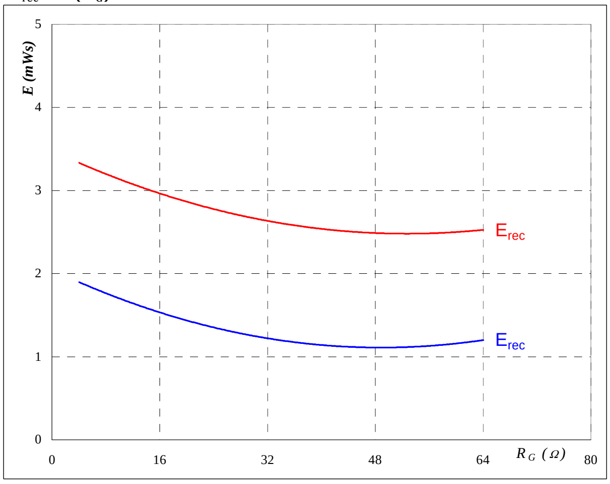
inductive load

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

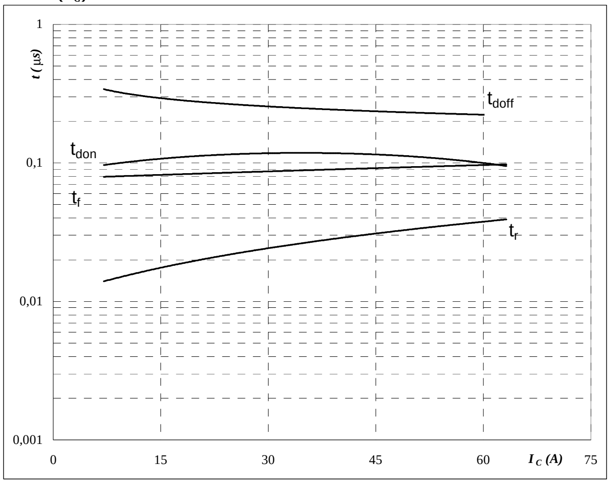
T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
I_C =	35	A

Output Inverter

figure 9 IGBT

Typical switching times as a function of collector current

$t = f(I_C)$



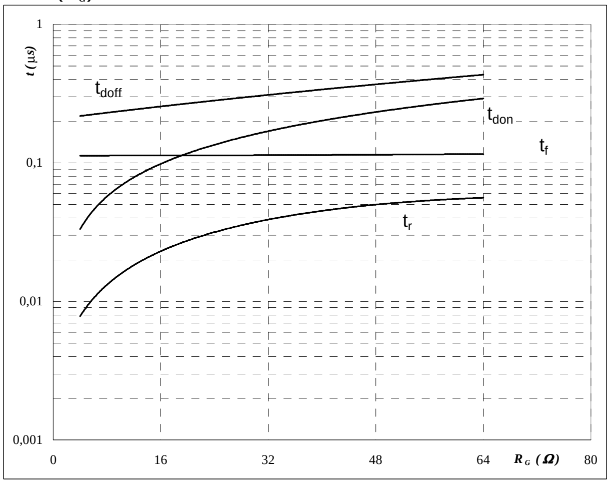
inductive load

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

$t = f(R_G)$



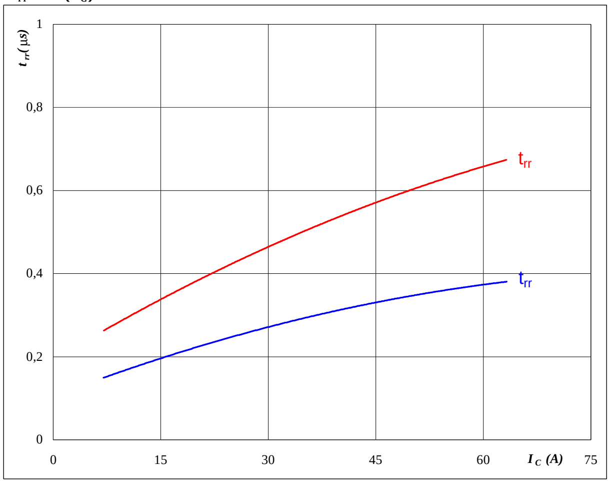
inductive load

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

$t_{rr} = f(I_C)$

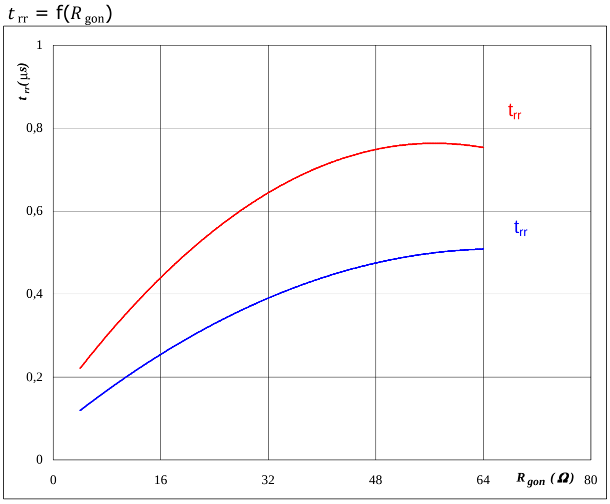


T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 12 FWD

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

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



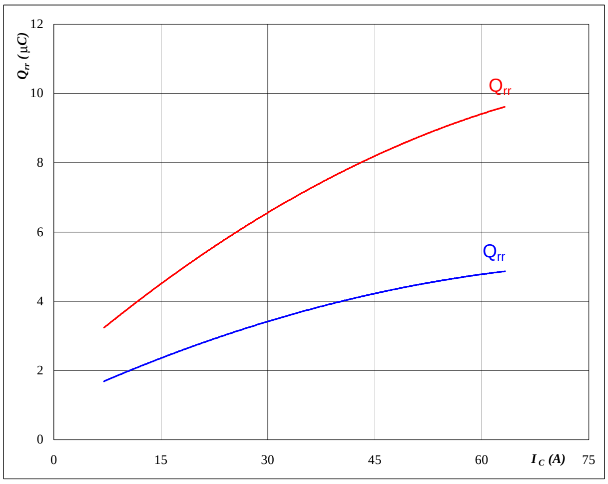
T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

Output Inverter

figure 13 FWD

Typical reverse recovery charge as a function of collector current

$Q_{rr} = f(I_C)$

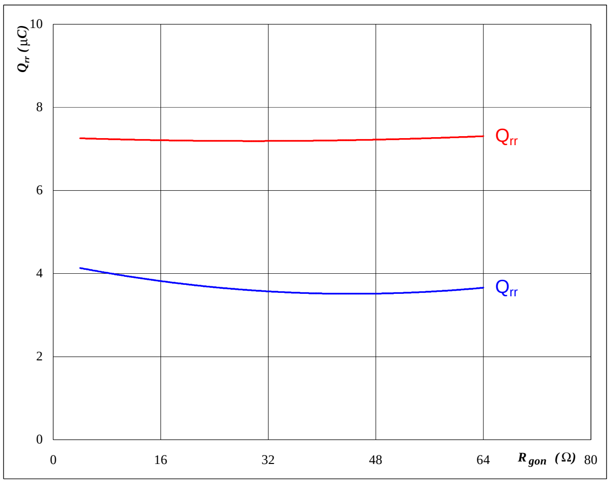


T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 14 FWD

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

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

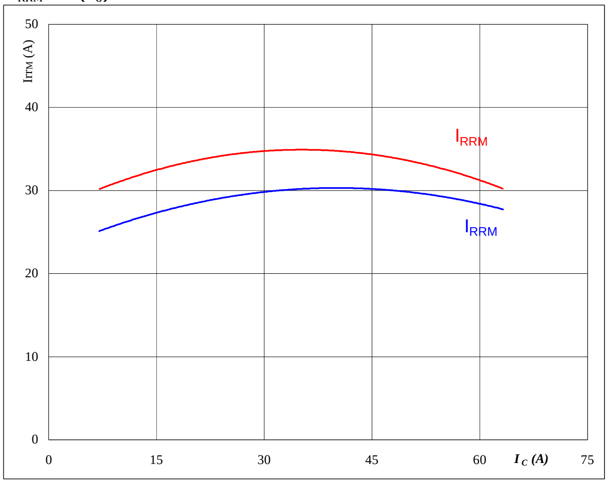


T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

figure 15 FWD

Typical reverse recovery current as a function of collector current

$I_{RRM} = f(I_C)$

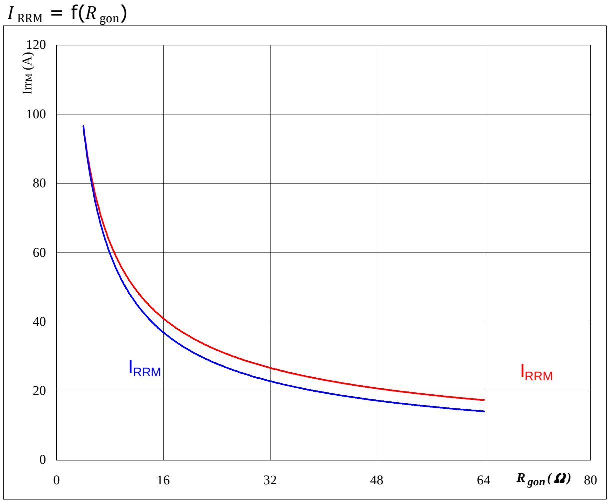


T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 16 FWD

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

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



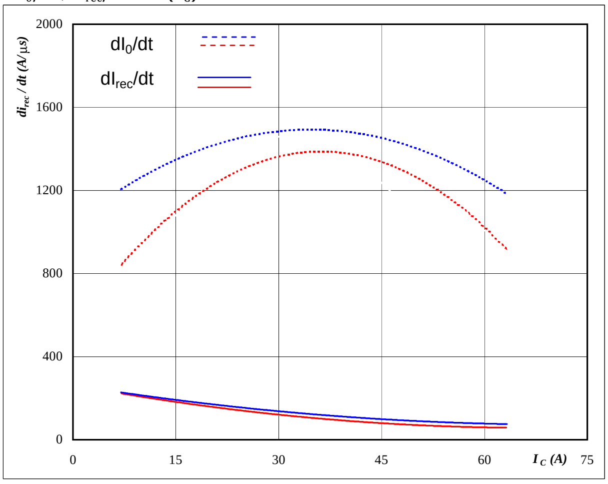
T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

Output Inverter

figure 17 FWD

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

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

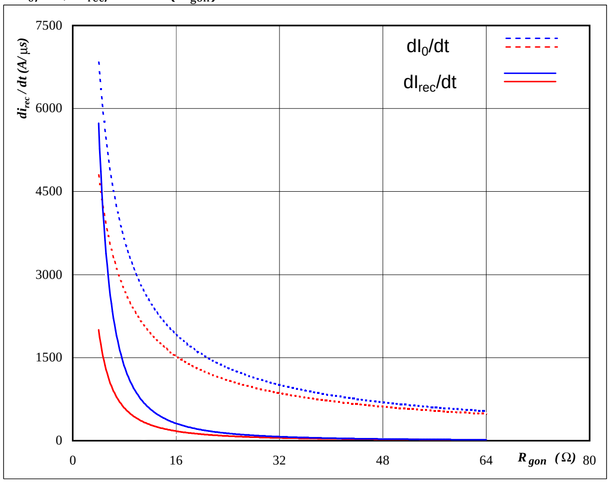


T_j =	25/150	°C
V_{CE} =	600	V
V_{GE} =	±15	V
R_{gon} =	16	Ω

figure 18 FWD

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

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

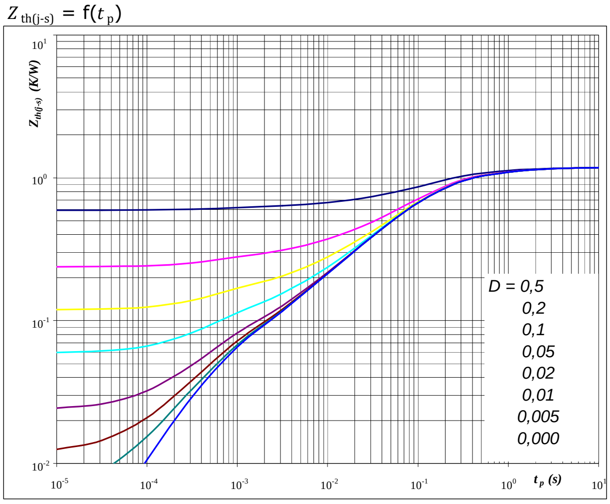


T_j =	25/150	°C
V_R =	600	V
I_F =	35	A
V_{GE} =	±15	V

figure 19 IGBT

IGBT transient thermal impedance as a function of pulse width

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



D = t_p / T

$R_{th(j-s)}$ = 1,19 K/W

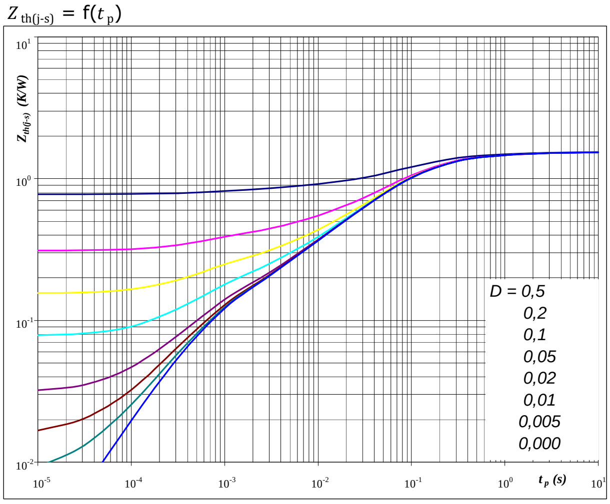
IGBT thermal model values

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 K/W

FWD thermal model values

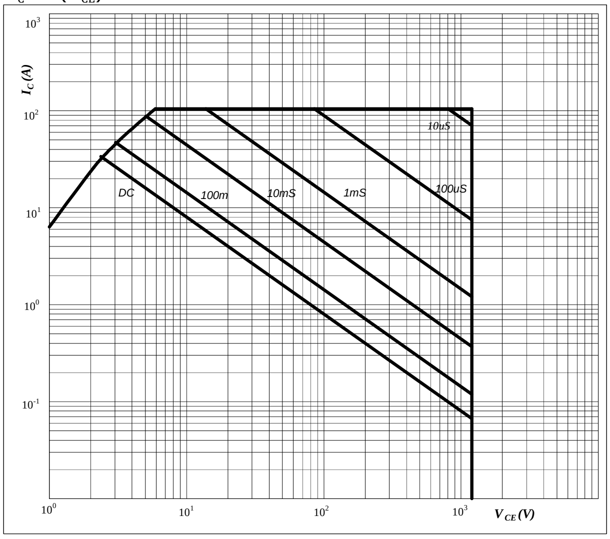
R (K/W)	Tau (s)
3,30E-02	9,78E+00
1,60E-01	9,82E-01
6,46E-01	1,42E-01
4,66E-01	4,00E-02
1,39E-01	6,02E-03
1,05E-01	6,16E-04

Output Inverter

figure 21	IGBT

Safe operating area as a function of collector-emitter voltage

$I_C = f(V_{CE})$

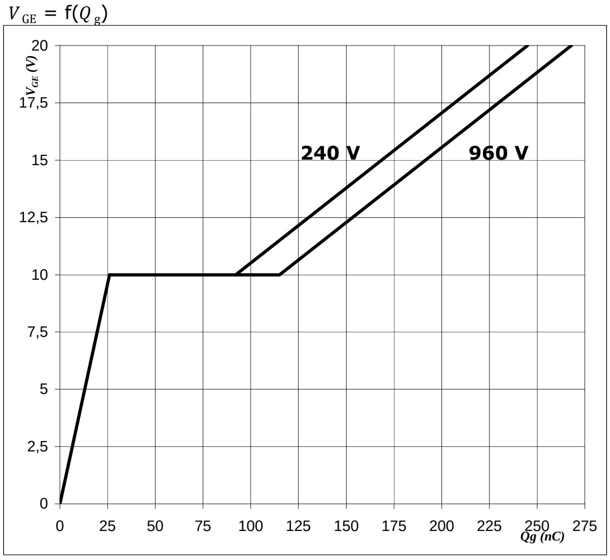


D =	single pulse	
T_s =	80	ºC
V_{GE} =	±15	V
T_j =	T_{jmax}	

figure 22	IGBT

Gate voltage vs Gate charge

$V_{GE} = f(Q_g)$



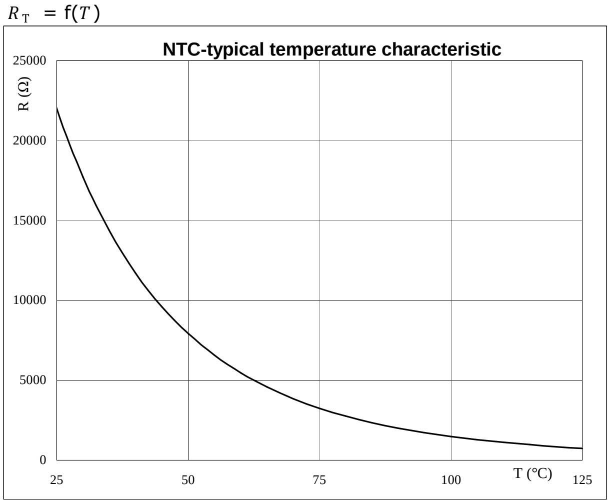
I_C =	35	A

Thermistor

figure 1	Thermistor

Typical NTC characteristic as a function of temperature

$R_T = f(T)$



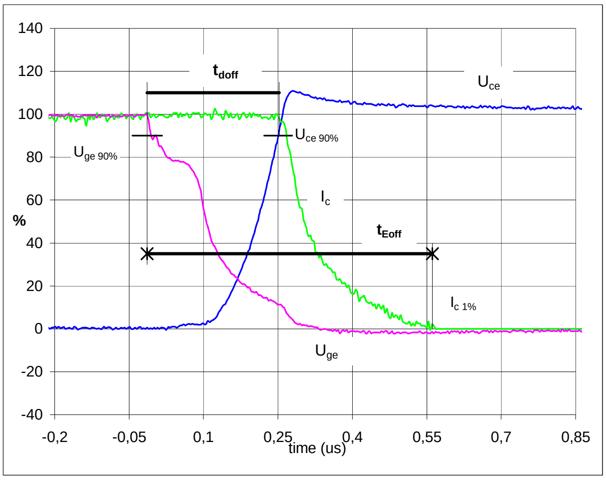
Switching Definitions Output Inverter

General conditions

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

Figure 1 IGBT

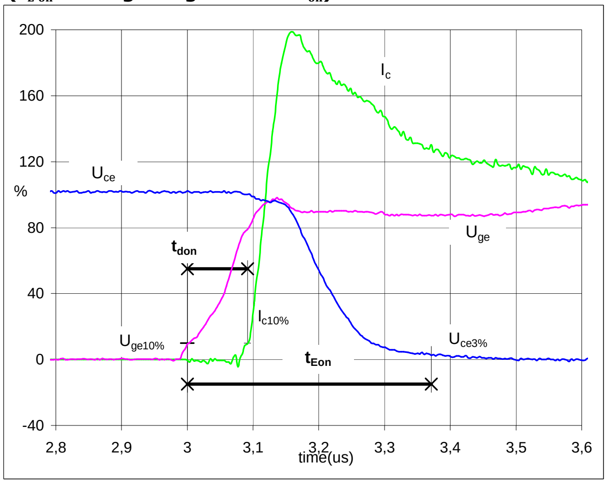
Turn-off Switching Waveforms & definition of t_{doff}, t_{Eoff}
($t_{E\,off}$ = integrating time for E_{off})



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
$t_{E\,off}$ =	0,57	µs

Figure 2 IGBT

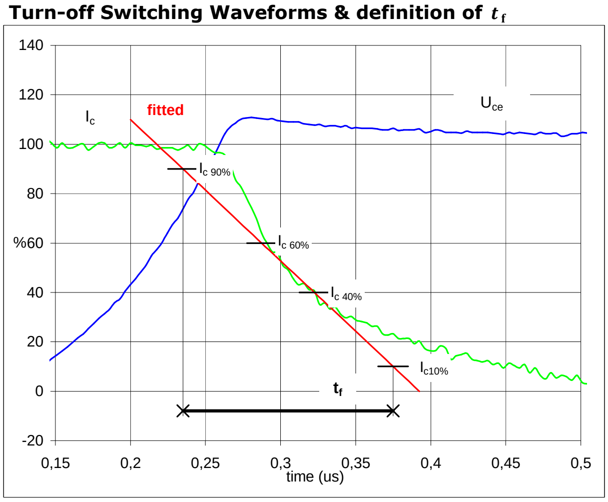
Turn-on Switching Waveforms & definition of t_{don}, t_{Eon}
($t_{E\,on}$ = integrating time for E_{on})



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
$t_{E\,on}$ =	0,37	µs

Figure 3 IGBT

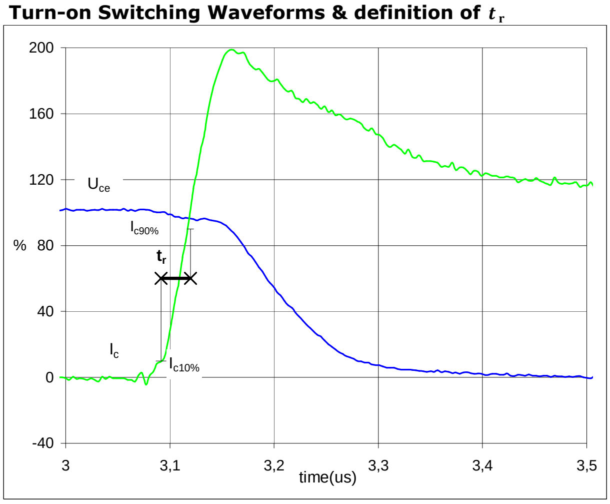
Turn-off Switching Waveforms & definition of t_f



V_C (100%) =	600	V
I_C (100%) =	35	A
t_f =	0,12	µs

Figure 4 IGBT

Turn-on Switching Waveforms & definition of t_r

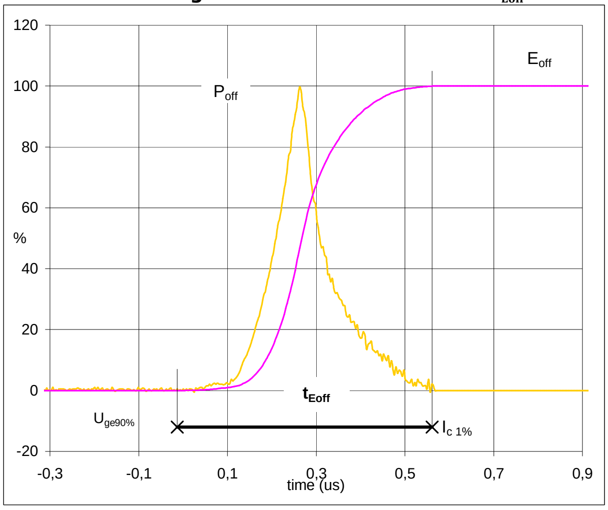


V_C (100%) =	600	V
I_C (100%) =	35	A
t_r =	0,03	µs

Switching Definitions Output Inverter

Figure 5 IGBT

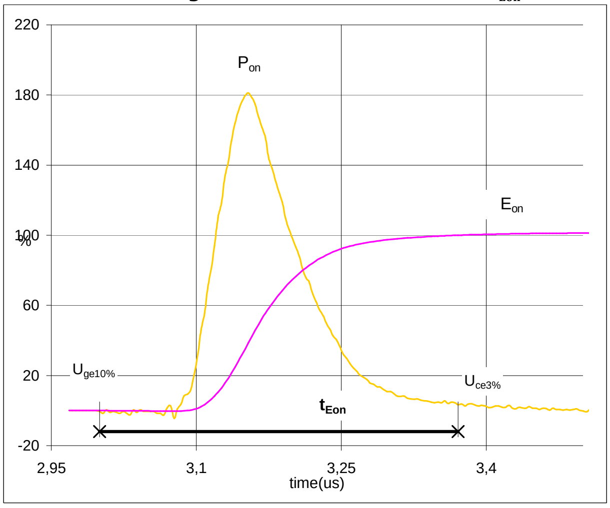
Turn-off Switching Waveforms & definition of t_{Eoff}



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

Figure 6 IGBT

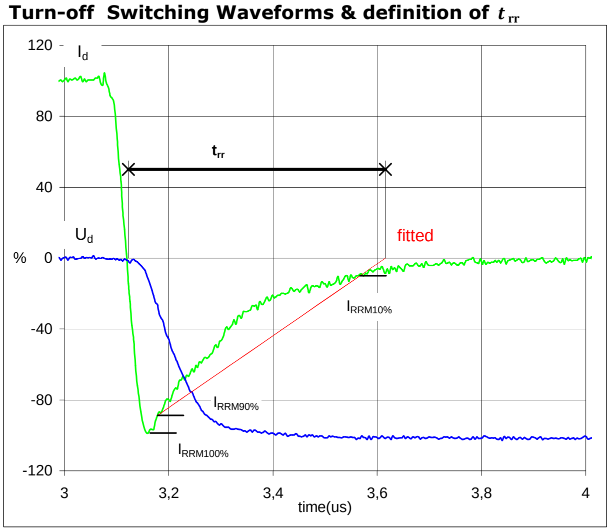
Turn-on Switching Waveforms & definition of t_{Eon}



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

Figure 7 FWD

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

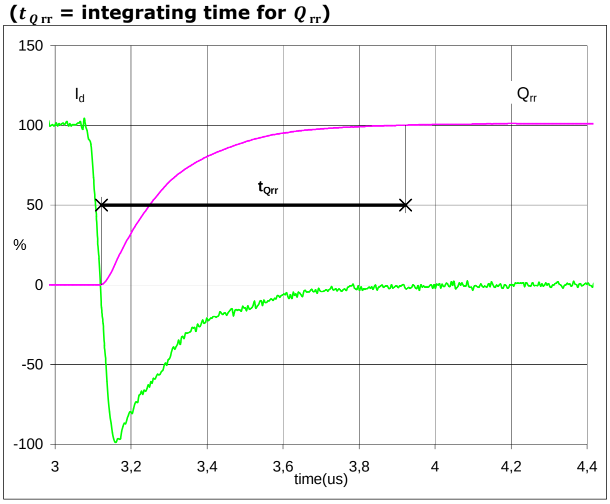


V_d (100%) =	600	V
I_d (100%) =	35	A
I_{RRM} (100%) =	-34	A
t_{rr} =	0,49	μs

Switching Definitions Output Inverter

Figure 8 FWD

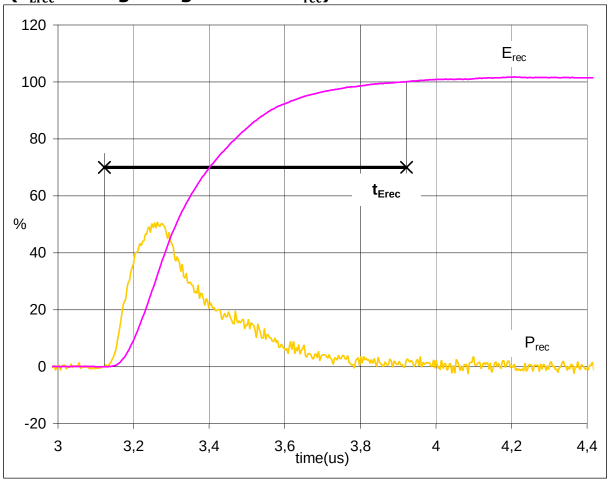
Turn-on Switching Waveforms & definition of t_{Qrr}
($t_{Q\,rr}$ = integrating time for Q_{rr})



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

Figure 9 FWD

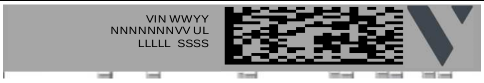
Turn-on Switching Waveforms & definition of t_{Erec}
(t_{Erec}= integrating time for E_{rec})



P_{rec} (100%) =	21,08	kW
E_{rec} (100%) =	2,81	mJ
$t_{E\,rec}$ =	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

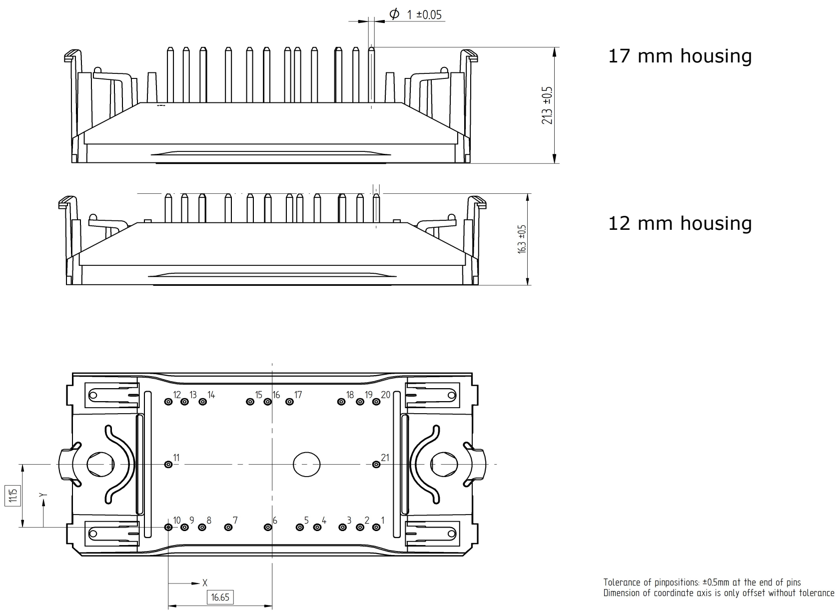


Text	VIN	Date code	Name&Ver	UL	Lot	Serial
	VIN	WWYY	NNNNNNVV	UL	LLLLL	SSSS
Datamatrix	Type&Ver	Lot number	Serial	Date code		
	TTTTTTTVV	LLLLL	SSSS	WWYY		

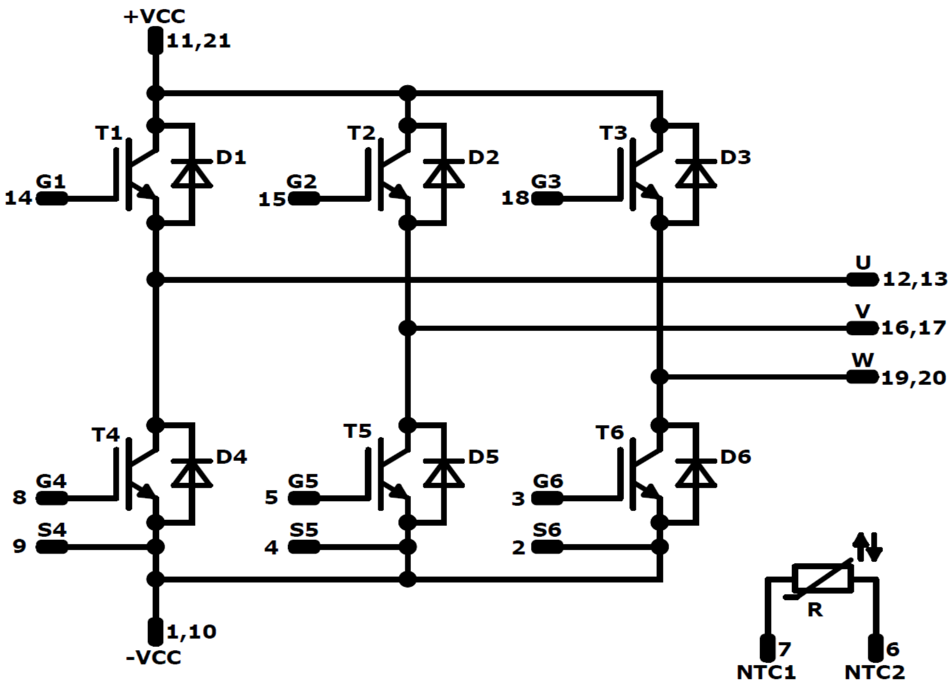
Outline

Pin table [mm]

Pin	X	Y	Function
1	33,3	0	-Vcc
2	30,7	0	S6
3	27,9	0	G6
4	23,85	0	S5
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



Pinout



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

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		