PrimeSTACK

Documentation and Operating Instructions

Product:	PrimeSTACK
Application:	Converters and Inverters
Revision:	Rev. 2.3 30 October 2008

CONTENTS

1 Introduction

This is the documentation for the PrimeSTACK product family. It describes the products

- PrimeSTACK,
- PrimeSTACK IPM and
- PrimeSTACK System

with regard to their technical features and thus gives all application relevant references and descriptions for the design-in, for the safe installation and the operation of the PrimeSTACK in an explanatory form. Further technical information can be found on the datasheet of the individual PrimeSTACK. This takes precedence over this document.

The documentation begins with the question what the PrimeSTACK is in general. Then, building on the technical descriptions and the associated application options of the PrimeSTACK, all relevant details in dealing with the product family are described.

Contained are:

- Descriptions and circuit diagrams of the PrimeSTACK electronics (interface, protection and monitoring electronics)
- The optional assemblies (electrical and mechanical)
- The Standards and certifications in use which where referenced for the development of the PrimeSTACK
- Description of the correct PrimeSTACK system integration and the EMC concept
- Technical drawings

Please read this documentation completely before using the PrimeSTACK. Only in this way can a flawless and safe application be warranted. Also observe all safety notes (especially section 4 and 5).

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2 The PrimeSTACK overview

This section introduces the PrimeSTACK product family. Fundamental features of the PrimeSTACK, its construction and possible fields of application are described. For technical details please read section 3 “The PrimeSTACK in detail”.

2.1 PrimeSTACK – what is it?

PrimeSTACK is a modularly constructed power electronic unit from Infineon (Figure 1). Its core are standardised base elements which may be omitted or added according to requirement. The attainable product spectrum extends from a straightforward single phase converter with simple functions for a few kW all the way to a complete water-cooled 4-quadrant 3-phase inverter in MW size with complex protection logic.

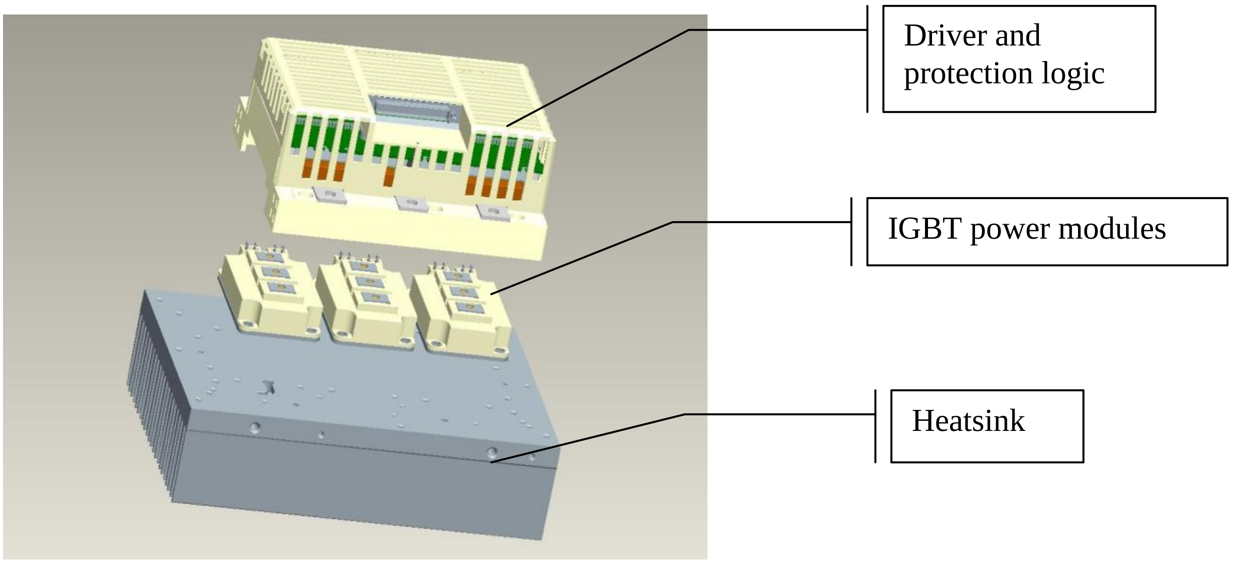
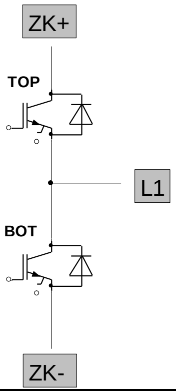


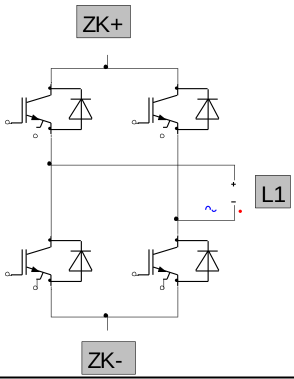
Figure 1: Construction of a standard PrimeSTACK with the three base elements: driver - power modules - heatsink

A PrimeSTACK consists of the following logical and physical components:

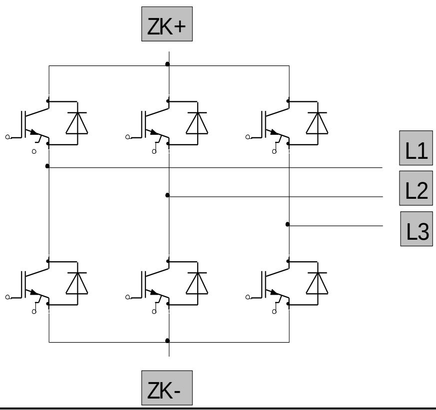
- **Circuit topology of the power section.** See also Table 1. The power section consists of Infineon 62mm IGBT modules. These are clearly categorised according to the power to be controlled and the circuit topology required. With the voltage classes 600V, 1200V and 1700V and module nominal currents up to 1600A per PrimeSTACK the following topologies are available:
  - ½ B2I → simple half-bridge
  - B2I → single phase bridge
  - B6I → three-phase bridge with/without break-chopper
- **Control of the power section.** The IGBTs are driven by the Infineon EiceDRIVER™ integrated into the PrimeSTACK electronics. The electronics is adapted in accordance with the selected circuit topology of the power section and the implemented IGBT modules.

<table>
<tr><th>Circuit topology</th><th>Description</th></tr>
<tr><td>
</td><td>½B2I half-bridge

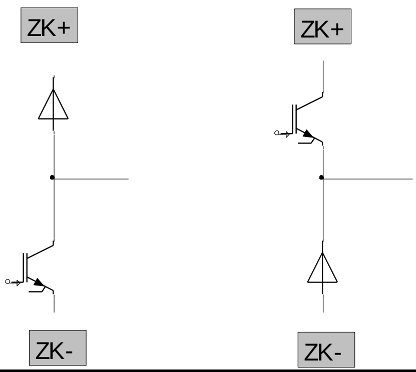
According to the required power the following options exist:

→ 2, 3 or 4 IGBT modules paralleled in one PrimeSTACK
→ for more power still: several paralleled PrimeSTACKs</td></tr>
<tr><td>
</td><td>B2I single phase full bridge

Two fundamentally different versions:

→ 2 or 4 IGBT modules in one PrimeSTACK, where one each or two parallel modules are operated as individual half-bridges
→ 2 individual PrimeSTACKs each as a half-bridge circuit together acting as a B2I bridge</td></tr>
<tr><td>
</td><td>B6I three-phase full bridge

2 versions:

→ one PrimeSTACK with 3 integrated IGBT modules where each is acting as an individual half-bridge
→ three individual PrimeSTACKs each in half-bridge circuit and each with 2, 3 or 4 paralleled IGBT modules</td></tr>
<tr><td>
</td><td>Brake chopper

2 versions: IGBT on DC+ or DC-:

→ as a fourth module in a PrimeSTACK in B6I topology, where the other 3 IGBT modules each act as a half-bridge
→ on request: as a separate PrimeSTACK with 2,3 or 4 paralleled chopper modules for high brake loads</td></tr>
</table>

Table 1: Overview of the PrimeSTACK circuit topologies

- **Protection of the system.** According to requirements optional protection components are available in addition to the basic provision of standard self protection. The following physical parameters are monitored and/or measured in real time and are provided with “safe separation” as an analogue voltage value at the PrimeSTACK electronics interface:
    - Load current monitoring of each logical output phase (standard)
    - Bridge short circuit monitoring (standard)
    - Temperature monitoring with over-temperature protection (standard)
    - Monitoring of under-voltage supply of the controller; serves the safe switching of the IGBTs (standard)
    - Monitoring of DC-bus voltage incl. turn-off at over-voltage (optional)
    - Simulation of the junction temperatures of the IGBTs at hardware level to protect from transient over-temperature (optional)
- **Cooling.** According to application and power requirements:
    - Heatsink with forced air cooling (standard)
    - Water cooling
- **DC-bus construction.** Especially for the PrimeSTACK a DC-bus construction has been developed which requires a minimum of space whilst assuring the best possible electrical and thermal design. It consists of these components:
    - Capacitor box (incl. busbar)
    - Electrolytic capacitors
    - Snubber capacitors
    - Voltage sharing resistors
- **Kit-set concept.** If the power requirement exceeds that of a single PrimeSTACK then several PrimeSTACKs may be paralleled with or without DC-bus section. Optionally available is a specifically developed parallel interface as well as a DC-busbar to connect the individual DC-busses.

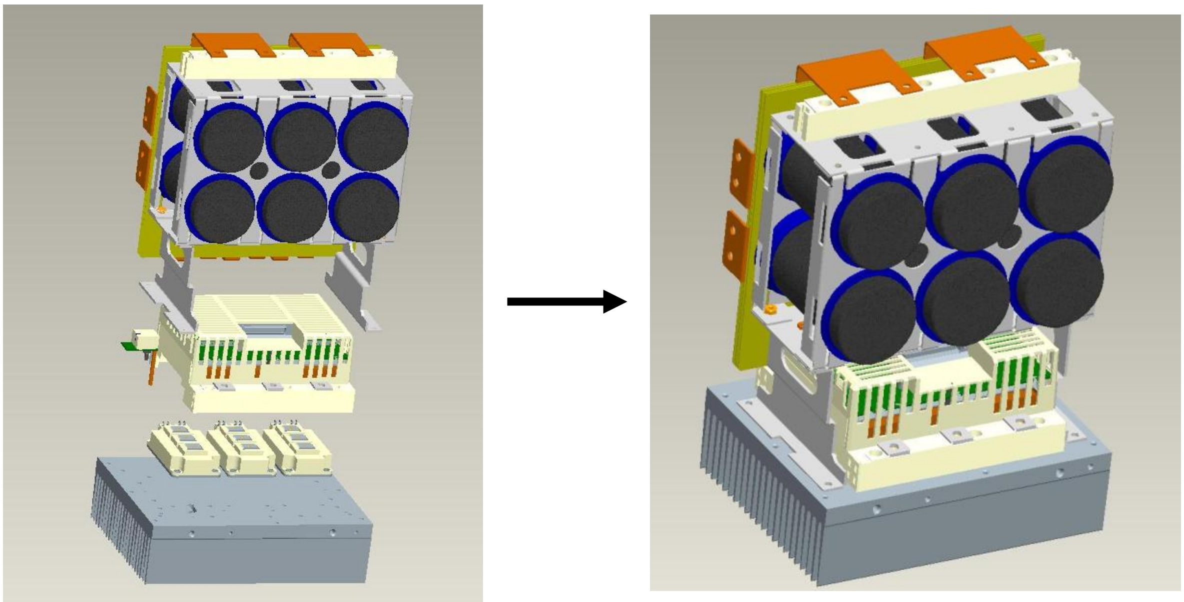


Figure 2: The PrimeSTACK kit-set concept

The PrimeSTACK and all its components are UL certified and designed and built under strict adherence to the relevant Standards.

2.2 The right PrimeSTACK for each purpose

According to requirements the PrimeSTACK product family is suitably divided into three family members.

1. PrimeSTACK
2. PrimeSTACK IPM – head of the family and
3. PrimeSTACK System – the complete system solution

Each of these family members consists of standard production components. Like kit-set, required components are added or omitted. Further, PrimeSTACKs are available as standard and traction versions. If not mentioned otherwise, reference is made to the standard version hereafter.

2.2.1 PrimeSTACK components

- **PrimeSTACK Basic**. This component is elementary to each PrimeSTACK. Only the requirements in power and circuit topology result in specific versions. The elements are:
    - EiceDRIVER™
    - PrimeSTACK electronics (wide range power supply, fault logic, protection logic) (see also section 3.3)
    - Standard protection concept (load current monitoring, temperature monitoring, bridge short circuit protection, monitoring of under-voltage supply of the electronics)
- **PrimeSTACK Basic add-on.** These components too are part of the standard PrimeSTACK, however, they vary with regard to numbers, voltage class and nominal current as well as application.
    - 62mm IGBT modules
    - Heatsink
- **PrimeSTACK add-on.** Encompasses all optionally available electronic assemblies or power components:
    - Temperature simulation
    - DC-bus voltage monitoring
    - Snubber capacitors
    - Brake chopper
- **PrimeSTACK System add-on.** Optional components with which a PrimeSTACK System is made from a PrimeSTACK:
    - DC-bus capacitor box
    - DC-bus capacitors
    - Voltage sharing resistors
    - Parallel interface

2.2.2 PrimeSTACK

This family member is the corner stone of the entire PrimeSTACK product family. Each PrimeSTACK consists of the following three elementary components:

- **Control section (PrimeSTACK Basic) with integrated protection logic.** The driver is formed by the EiceDRIVER™ developed by Infineon. It is embedded in the partially standard and partially optionally available protection logic of the electronics (PrimeSTACK add-on).

- **Power modules** (PrimeSTACK Basic add-on) always two, three or four power modules per PrimeSTACK. Design: Infineon 62mm IGBT modules always as a half-bridge. The final topology results from the interconnection of the individual 62mm modules.
- **Heatsinks** (PrimeSTACK Basic add-on) generally either air cooling or water cooling.

Figure 1 shows a PrimeSTACK in standard configuration consisting of driver with integrated protection logic, three 62mm IGBT modules each implemented as a half-bridge and the standard heatsink for forced air cooling. The application determines the interconnection of the IGBT modules as well as the additional protection option, an optical controller interface or the implementation of external ancillary circuitry (see section: “The PrimeSTACK in detail”).

2.2.3 PrimeSTACK IPM

IPM means Intelligent Power Module. It covers the same requirements as the PrimeSTACK described above. The supply, however, is without heatsink. This assures a maximum adaptation to the application.
In short:

PrimeSTACK IPM = PrimeSTACK **minus** heatsink.

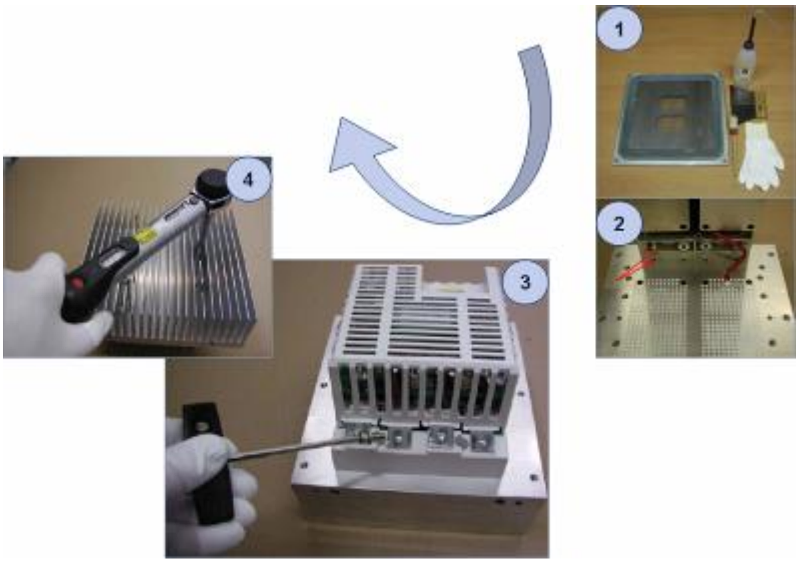


Figure 3: PrimeSTACK IPM heatsink mounting

The PrimeSTACK IPM is mounted on the heatsink by customer. Support is provided by the Application Note AN2006-07 which describes this process and section 3.5.7 of this PrimeSTACK product documentation.

2.2.4 PrimeSTACK System

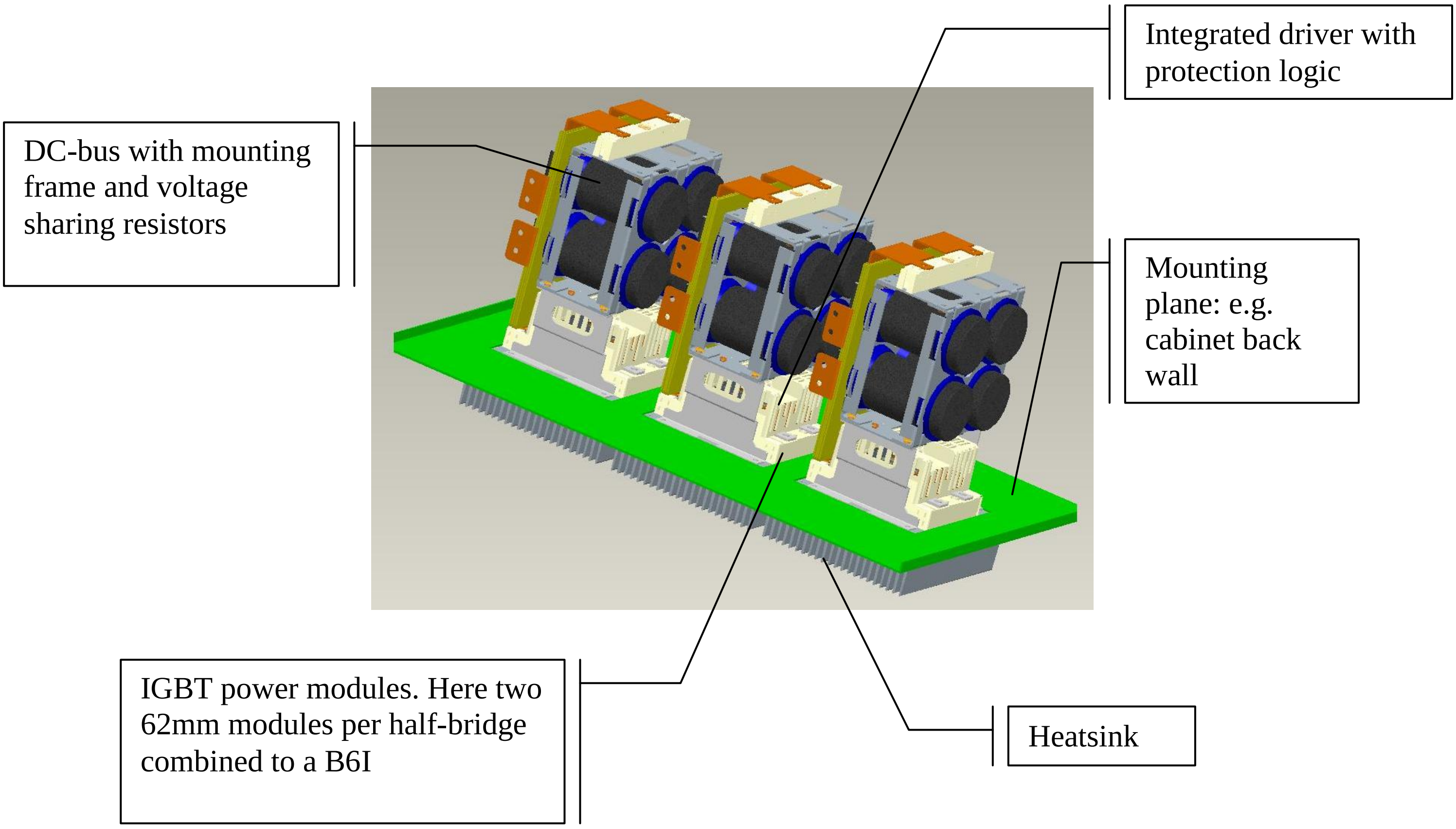


Figure 4: Example of a PrimeSTACK System

The PrimeSTACK product family is completed by the PrimeSTACK System. It supplements the PrimeSTACK according to requirements with a DC-bus construction and/or a parallel interface (PrimeSTACK System add-ons) for parallel configurations with several PrimeSTACKs.

The PrimeSTACK System depicted in Figure 4 as an example consists of three individual PrimeSTACKs with two power modules each in half-bridge configuration, heatsink, driver with monitor and protection electronics plus the DC-bus construction. Together the three individual half-bridges make up a powerful B6I three phase bridge with excellently matched components.

2.3 PrimeSTACK system integration

The integration of the PrimeSTACK into the surrounding system comprises the termination of control and power leads to standardised terminals:

- **Control signals** are accepted by the PrimeSTACK in CMOS standard or via fibre optic cable (optional). For the standard galvanic coupling the use of the SUB-D connectors assures a better EMC immunity compared to the IDC connector system. Both connector versions are compatible.

- **On the power side** robust screw terminals assure solid support for the DC and AC busbars. Per power module used in the PrimeSTACK an M8 bolt is required for the AC terminals and an M6 bolt for both the DC+ and DC- terminals. Other than in a pressure contact inside the power section the AC and DC power terminals are

mechanically non-critical and may be stressed liberally in the x-, y- and z-axis (see section 4.3.2 “Connecting the power terminals”). The PrimeSTACK is hence suitable for mechanically stressed as well as mostly immobile applications.

- The PrimeSTACK is designed **within an EMC concept**. This EMC concept, which is adhered to consequently, assures fault-free operation (see section 4.1 “EMC concept”).

2.4 Appropriate use

According to IEC 61800-5-1 the PrimeSTACK is a “converter section” of a “basic drive module (BDM)”. All members of the PrimeSTACK product family (PrimeSTACK, PrimeSTACK IPM and PrimeSTACK System) are open frame systems with a protection rating of IP00. They are designed for use in closed mobile or immobile installations. For their operation a user supply with suitable contactor arrangement and a controller are required. The PrimeSTACK is supplied without a fan as standard. The infrastructure required for cooling during operation has to exist in the switchboard. Please observe the safety notifications and installation and commissioning notes in section 4 and 5.

The PrimeSTACK can be implemented universally. Typical applications are:

- Converter / inverter in immobile drive systems
- Wind and solar energy plants
- Traction
- UPS systems / flywheel storage

The PrimeSTACK may only be operated within the operating and safety conditions (section 5) listed in the datasheet and explained in this document. Further, mounting and commissioning notes (section 4) are to be observed. For damages resulting from ignoring these, solely the user is responsible.

3 The PrimeSTACK in detail

This section describes the technical details of the PrimeSTACK which are necessary to understand the implemented functions and for a design-in.

3.1 PrimeSTACK type designation

The type designation gives a defined name for each PrimeSTACK variant. The most important electrical and mechanical data of the individual PrimeSTACK can be derived from it. Two type designations are differentiated:

- For PrimeSTACK System ➔ analogous to the ModSTACK™ product family (see also www.eupec.com).
- For PrimeSTACK and PrimeSTACK IPM ➔ **described here:**

All data is listed continuously without a space. For improved readability a hyphen separates the basic electrical data – to the left – from all standard or optional ancillary circuitry – to the right -. Options or customised modifications are listed at the end of the type designation in the same sequence and with a custom specific number. The sequence can be seen in Table 2.

The type designation is explained with a sample PrimeSTACK of the type “2PS0600R12DLC-3G” with some added options. This is a forced air cooled PrimeSTACK in half-bridge configuration consisting of three paralleled IGBT half-bridges. The module nominal currents sum up to 600A. The chip generation is IGBT2.

Full name	**2PS0600R12DLC-3G01C1VTB1IOM**									
Segregated name	2	PS	0600	R	12	DLC	-	3	G01	C1VTB1IOM
Place designation	A	B	C	D	E	F	G	H	I	J

Position	**For example**	**Meaning**	**Further possible data**
A	2	Circuit topology of the power section. The given number is the number of switches; here: 2 switches, thus half-bridge	6 (for B**6**I)
B	PS	Type designation of the PrimeSTACK product family	-
C	0600	Installed nominal current of the power modules contained. Meaning here: 600A	Specifically graded values between 0100 and 1600
D	R	R=“reverse conducting“, i.e. each circuit has an antiparallel diode	-
E	12	12=1200V maximum blocking voltage divided through 100	06 (for 600V) 17 (for 1700V)
F	DLC	Generation of the IGBTs used. Meaning here: Infineon low loss IGBTs of the second generation with Emitter Controlled Diode	KE3, KT3 (Trench Fieldstop) KS4, DN2 (NPT)
G	-	Hyphen – separates visually the basic electrical data from the additional information	-

H	3	Sizes (see PrimeSTACK sizes); the number shows, how many IGBT modules can be used in a PrimeSTACK, and thus defines its mechanical dimensions	2 or 4
I	G01	Cooling method. G=air cooler; 01=customised code	F (fan supplied) W (water cooler)
J		**Meaning of the options indicated with “J“**	
G		Standard cooler for forced air cooling, fan is not included	
Gxx		Air cooling with customised heatsink, xx = 01, 02 etc.	
F		Standard air cooling, fan is included	
W		Water cooler (W) made of aluminium	
WC		Water cooler (W) with copper pipes (C)	
WS		Water cooler (W) with stainless steel pipes (S)	
Wxx		Water cooler (W) according to customised design (xx, e.g. 01, 02 etc.)	
M		Parallel interface	
IO		Optical interface	
B1		Cooler is sealed with sealing ring	
B3		Mounting platform	
V		Voltage option for measurement and output of the DC-bus voltage	
T		Temperature option for real time simulation of the chip temperature	
Cxx		DC-bus construction (C) for 600, 1200, 1700V, customised (xx e.g. 01)	
D	1	Integrated chopper, IGBT as BOT switch (between AC and DC-)	
	2	Integrated chopper, IGBT as TOP switch (between AC and DC+)	
	3	As D1, only without integrated chopper driver and on-off controller	
	4	As D2, only without integrated chopper driver and on-off controller	

Table 2: The PrimeSTACK type designation

3.2 PrimeSTACK datasheet

This section describes the layout and contents of the PrimeSTACK datasheet. The exact physical explanations can be found as an index in the appendix.

3.2.1.1 Structure and composition

All PrimeSTACK datasheets are composed the same. They contain individual blocks with special functional contents assigned. According to PrimeSTACK type the contents and extent can vary. The following blocks may be contained:

- Cover sheet: Basic information about the PrimeSTACK such as circuit topology, monitoring options and applied Standards.
- Electrical data: Defines the permissible minimal, typical and maximum parameters on the power side.
- Controller interface: Specifies the limit values for the controller
- Heatsink: Parameter to be fulfilled to be able to achieve the values listed under “Electrical data”
- Environmental conditions: Defines permissible environmental conditions which affect the PrimeSTACK externally. Also contained are the weight and the external dimensions.
- Mechanical drawing: The technical drawing depicting the PrimeSTACK in three different perspectives
- Circuit diagram: PrimeSTACK conceptual block diagram with all control and power in- and outputs.

- Conditions of use and safety notices.

The following describes the composition of the datasheet with the example of a PrimeSTACK 2PS1600R12KE3-4G and the parameters and values contained.

3.2.1.2 Headline

The headline can be found on each page of the datasheet.

Technical Information

PrimeSTACK™ 2PS1600R12KE3-4G

1

1. - Technical information points out that the document is a datasheet. This specifies technical data for the correct use.
   - PrimeSTACK defines which product family is concerned (related product families: ModSTACK™, BipSTACK)
   - Data from the type designation (see also section "PrimeSTACK type designation")

3.2.1.3 Cover sheet

Key data
1x 717A AC at 400V AC, forced air (fan not implemented)

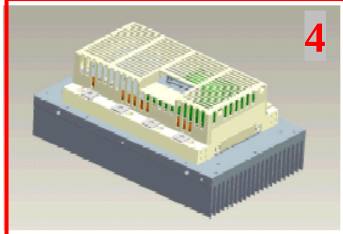
1

General information for:
Stacks for various inverter application. Semiconductors, heat sinks, drivers and sensors included.
These are only technical data!
Please read carefully the complete documentation and maintain the proper design environment!
Especially note the EMC environment and the controller's functionality.

2

Topology		1/2 B2I
Application / Modulation		Inverter / Sine
Load type		resistive, inductive
Cooling		forced air (fan not implemented)
Market		common industrial, drives, power supply
Monitors		current, temperature
Semicond. (Unit 1)		none
DC Link		none
Semicond. (Unit 2)	IGBT	4x FF400R12KE3
Interface IGBT		electrical CMOS
Standards		EN50178, UL94, prepared for UL508C
Product ID (eupec)		26571
Mechanical drawing number		38000031
Electrical drawing number		2PS-C4-V

3



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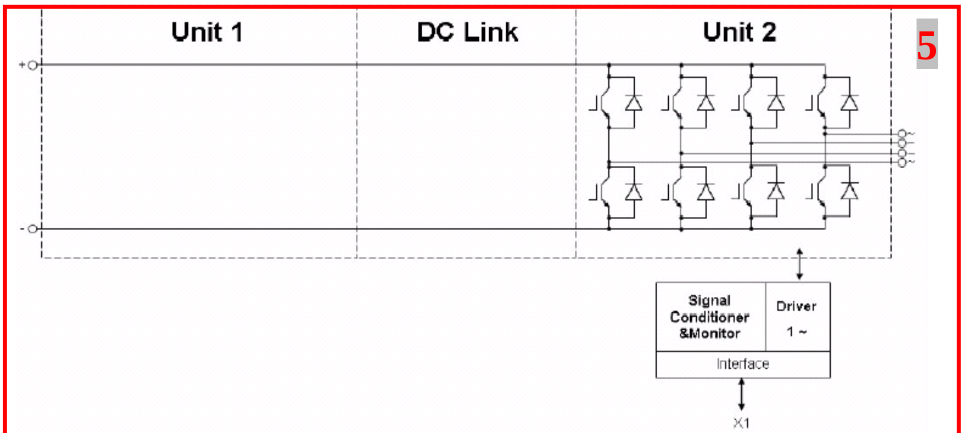


5

1. Maximum steady state electrical corner data for permanent operation at the reference operating point (see Electrical data); cooling type.

2. Characterisation of the PrimeSTACK. Note of the technical character of the datasheet.
3. - Details regarding the circuit topology of the power section (B6I, ½B2I or sim.)
   - Permissible load type: resistive - inductive load
   - Cooling type: forced air cooling
   - Possible field of application
   - Monitoring of current and temperature
   - Module (unit 2): listing of the 62mm IGBT modules which make up the power section of the PrimeSTACK. (Number of modules) x (Type of modules used)
   - Standard for the PWM signal interface to the PrimeSTACK. Here: CMOS. Optionally - an optical interface is available.
   - Which Standards and regulations does the PrimeSTACK fulfil.
4. 3D-pictureof the PrimeSTACK type described in this data sheet.
5. Block diagram of the PrimeSTACK. The designations (e.g. Unit 2) can be found under Electrical data.

3.2.1.4 Electrical data

Electrical data

DC Link			min	typ	max	unit
Voltage		V_{DC}		650	850	V **1**

Unit 2 AC			min	typ	max	unit
Voltage	depending on controller	V_{Unit2}		400		V_{RMS} **2**
Continuous current	V_{Unit2} = 400V_{RMS}, V_{DC} = 650V, T_{inlet} = 40°C, $T_J \leq$ 125°C, f_{Unit2} = 50Hz, f_{sw2} = 5000Hz, cos(phi) = 0,85	I_{Unit2}			717	A_{RMS}
Continuous current overload cap.	T_{inlet} = 40°C, for overload capability 150% for 60s			527		A_{RMS}
Short time current	T_{inlet} = 40°C, 10s, every 180s, initial load = 644A_{RMS}	I_{Unit2}			805	A_{RMS}
DC current	no rotating field, T_{inlet} = 40°C	$I_{Unit2\ DC}$			346,0	A_{av}
Overcurrent shutdown	within 15µs			2500		A_{peak}
Switching frequency		f_{sw2}			6000	Hz
Power losses	V_{Unit2} = 400V, V_{DC} = 650V, T_{inlet} = 40°C, $T_J \leq$ 125°C, f_{Unit2} = 50Hz, f_{sw2} = 5000Hz, cos(phi) = 0,85, I_{Unit2} = 717A_{RMS}	P_{loss2}		2300		W
Power factor		$cos(phi)_{Unit2}$	-1,00		1,00	

General data				min	typ	max	unit
Power losses (PCB)			$P_{loss\ aux}$			t.b.d.	W **3**
EMC test	according to IEC61800-3 at named interfaces	power	V_{Burst}		2		kV
		control	V_{Burst}		1		kV
		aux (24V)	V_{Surge}		1		kV
Insulation management is designed for			V_{Line}		500		V_{RMS}
Insulation test voltage	according to EN50178, f = 50Hz, t = 60s		V_{isol}		1,8		kV_{RMS}

1. Permissible operating conditions on the DC side
   Usually this will be the value for the permissible voltages of the DC-bus.
2. Permissible operating conditions on the AC side
   What permanent current at what voltage (both AC and DC) is permissible, what overload current and what switching frequencies are possible, what surge current will affect a shut-down and what losses will be generated by the power section when operating at nominal conditions.

3. General values associated with electrical data
   Value of the maximum losses generated by the control unit of the PrimeSTACK. Very important data in this block make reference to the values and parameters of EMC and insulation structure. These values may not be exceeded under any circumstances.

3.2.1.5 Controller interface

This section describes the conditions necessary for the reliable operation of the controller (see also section 3.3).

1. Supply voltage of the wide range power supply and power loss of the controller
2. Main elements of the PrimeSTACK controller interface (see also section 6.2 “Further associated documentation”)
3. - Acceptable voltage limits of the digital inputs and outputs.
   - Monitoring of current and temperature (optionally also DC-bus voltage monitoring). The voltage given equates the parameter defined to the left (e.g. the controller gives out a voltage of typically 3.10V_{DC}, when the current measured at the AC terminals is 717A).
4. Data for time management (see section 3.3.7)

Controller interface data			min	typ	max	units	
Auxiliary voltage		V_{aux}	13	24	30	V_{a}	1
Auxiliary power requirement	V_{aux} = 24V_{av}	P_{aux}		40		W	
Driver and interface board	see separate technical information			DR240			2
Driver core				EiceDRIVER 2ED300C17-S			
Digital input level	resistor to GND 10,0kΩ, capacitor to GND 1nF	V_{in}	0,0		15,0	V	3
Digital output level	open collector, low = ok, max 15mA	V_{out}	0,0		30,0	V	
Analog current outputs Unit 2	load max 5mA; at 717A	$V_{ana\ out}$	2,83	2,89	2,95	V	
Analog temperature output	load max 5mA; at T_{NTC} = 80°C correspond to T_j = 125°C	$V_{T\ out}$	9,57	9,77	9,97	V	
Overvoltage shutdown reaction time	after overvoltage message by PrimeSTACK interface				50	µs	4
Overcurrent shutdown reaction time	after overvoltage message by PrimeSTACK interface				10	µs	

3.2.1.6 Heatsink

Heat sink air cooled / Thermal data			min	typ	max	units	
Airflow	T_{Air} = 20°C, Pair = 1013hPa, dry- and dust free, measured on side of heat sink. according to DIN 41882	$\Delta V/\Delta t_{Air}$	500			m³/h	1
Air pressure drop		Δp_{Air}		180		Pa	
Cooling air inlet temperature	T_{inlet} > 40°C derating necessary		-40	40	70	°C	

Heat sink water cooled / Thermal data			min	typ	max	units	
Water flow	according cooling water specification from eupec	$\Delta V/\Delta t_{Water}$	12			dm³/m...	2
Water pressure drop		Δp_{Water}		t.b.d.		mbar	
Water pressure					t.b.d.	bar	
Cooling water inlet temperature		T_{inlet}	t.b.d.		60	°C	
Water connection				1/2		in	

Two basically different heatsinks exist: air cooled and water cooled. Depending on the cooling method used for the PrimeSTACK, only one of the heatsinks and datasheet blocks will appear which is explained as follows.

1. Air cooling: The values given define the operating point airflow/pressure drop as the intersection of the fan and heatsink characteristics in the permissible temperature

range of -40 to +70°C. These values have to be adhered to for safe operation, as it is detailed in the block “Electrical data”.
2. Water cooling: The values given here correspond with those of air cooling. As an additional value the connection of water in and out is specified.

3.2.1.7 Ambient conditions

This block gives all those environmental parameters important for the safe operation of the PrimeSTACK. The individual terms are mostly self explanatory.

1. Required natural climatic conditions and/or caused by forced air with regard to temperature, humidity and installation level (height above sea level) during operation and storage.
2. - permissible mechanical stresses through vibration, shock of the entire PrimeSTACK and bolt torque at the AC and DC terminals
   - IP protection class and permissible pollution
3. mechanical dimensions and weight

Environmental conditions			min	typ	max	units	
Storage temperature		T_{stor}	-40		85	°C	1
Ambient temperature (PCB)		T_{amp}	-25		55	°C	
Operating temperature	see chapter Heat sink air cooled / Thermal data						
Cooling air velocity (PCB)		$V_{Air\ PCB}$	0,3			m/s	
Air pressure	standard atmosphere	p_{Air}	900		1100	Pa	
Humidity	no condensation	Rel. F	5		85	%	
Installation height			0		1000	m	
Vibration	according to IEC60721				5	m/s²	
Shock	according to IEC60721				40	m/s²	2
Protection degree				IP00			
Pollution degree				2			
Torque at DC Terminals		M_{DC}	6,0		10,0	Nm	
Torque at AC Terminals		M_{AC}	16,0		20,0	Nm	
Dimensions	width × depth × height		216	360	167	mm	
Weight with heat sink	approximation			11,8		kg	3
Weight without heat sink	approximation			3,8		kg	

3.3 PrimeSTACK electronics

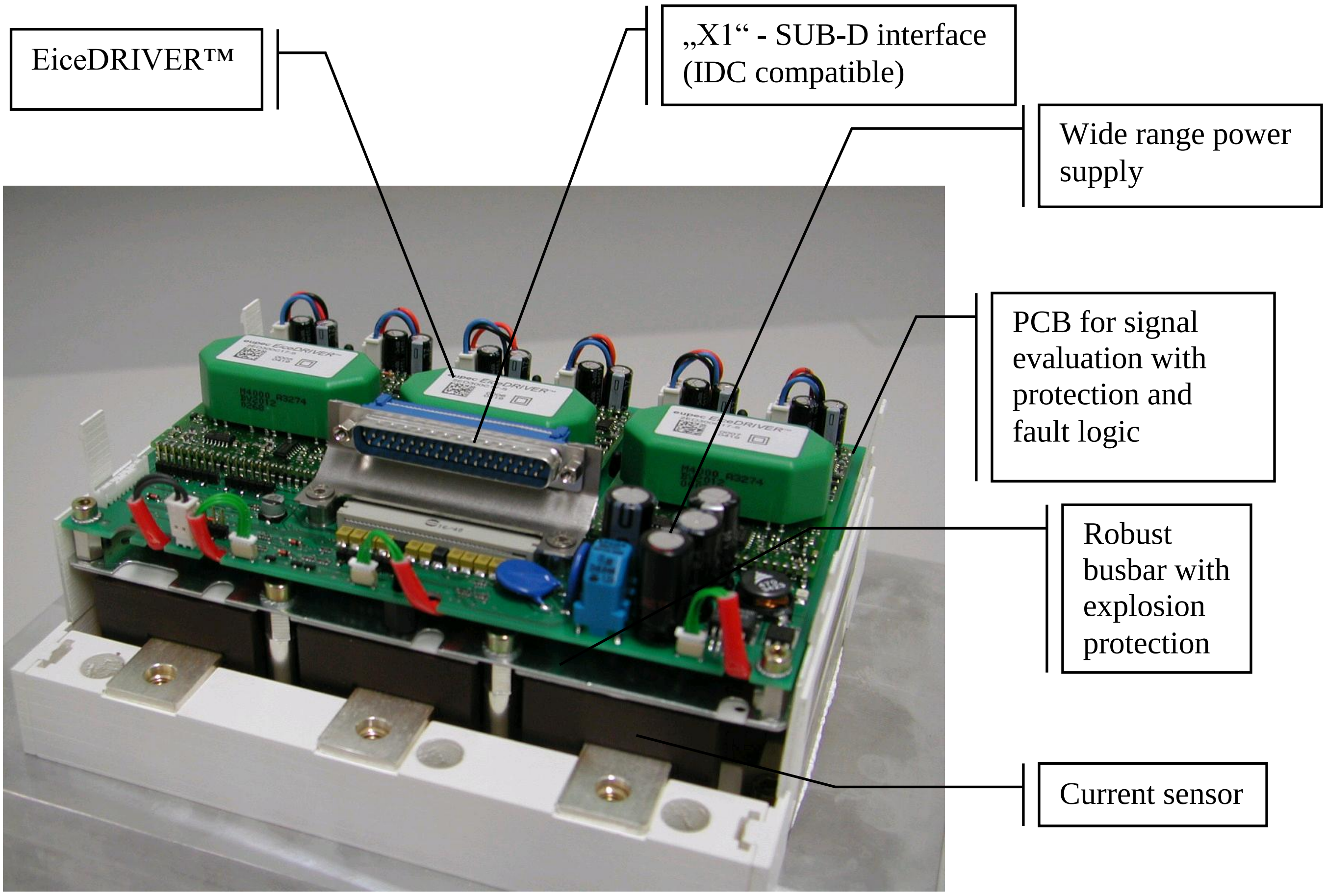


Figure 5: PrimeSTACK electronics

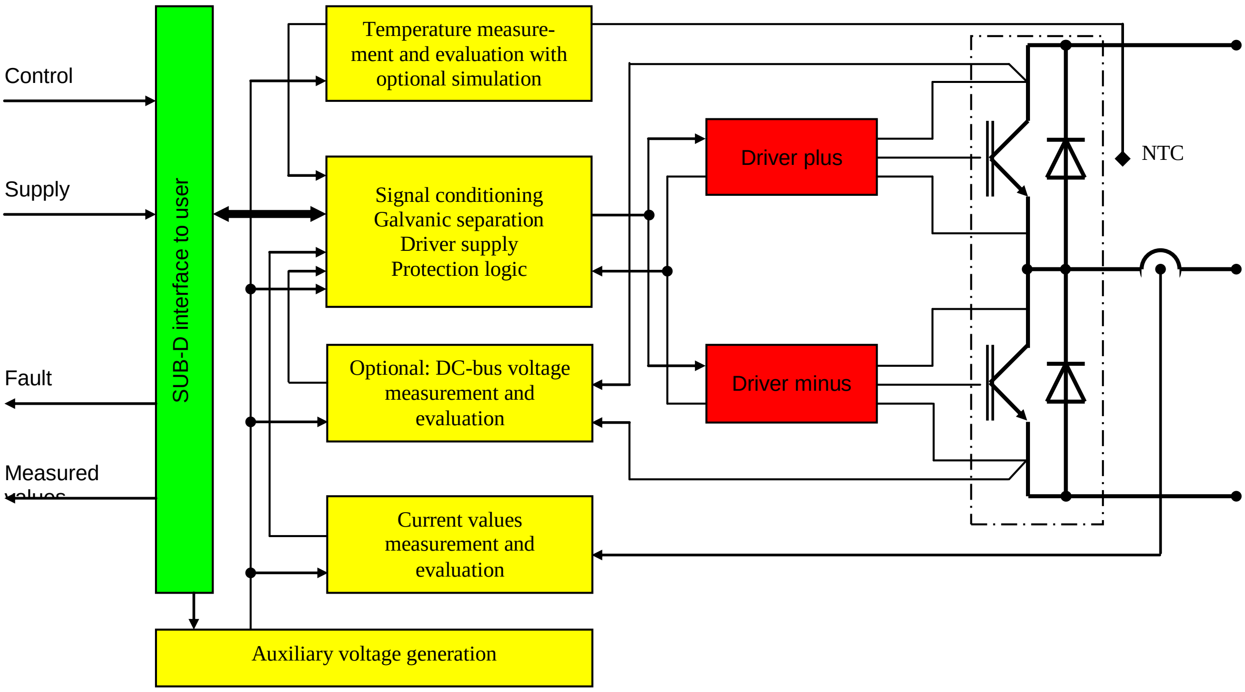


Figure 6: PrimeSTACK block diagram

The PrimeSTACK electronics comprises the following elements and functions:

- User interface X1 (SUB-D),
- Driver for the IGBTs (EiceDRIVER™),
- Auxiliary voltage generation
- Protection and fault logic
- Evaluation and processing of the measured values
- Uniform EMC concept

Figure 6 depicts a simplified block diagram detailing the co-operation of the controller with the rest of the system, in particular with the control and protection of the IGBTs.

3.3.1 User interface and pin-out

Depending on the circuit topology of the power section, the following pin numbers apply:

1. Half-bridge 25-pin
2. Three phase bridge B6I 37-pin

B6I with/without chopper				**Half-bridge**		
Pin IDC	Pin SUB -D	I/O	Signal	Pin SUB-D	I/O	Signal
1	1	---	Shield (TE)	1	---	Shield (TE)
2	20	IN	Half-bridge A IGBT minus	14	IN	IGBT minus
3	2	OUT	Half-bridge A Fault	2	OUT	Fault
4	21	IN	Half-bridge A IGBT plus	15	IN	IGBT plus
5	3	IN	Half-bridge B IGBT minus	3	OUT	Over-temperature
6	22	OUT	Half-bridge B Fault	16	IN	Supply +13…30V DC
7	4	IN	Half-bridge B IGBT plus	4	IN	Supply +13…30V DC
8	23	IN	Half-bridge C IGBT minus	17	OUT	+15V DC / 50mA
9	5	OUT	Half-bridge C Fault	5	OUT	+15V DC / 50mA
10	24	IN	Half-bridge C IGBT plus	18	IN	Supply GND
11	6	OUT	Over-temperature	6	IN	Supply GND
12	25	OUT	GND digital	19	OUT	Temperature analogue
13	7	OUT	V_{ZK} ($V_{DC\text{-}bus}$) analogue	7	OUT	GND analogue
14	26	IN	Supply +13…30V DC	20	OUT	I analogue out
15	8	IN	Supply +13…30V DC	8	OUT	GND analogue
16	27	OUT	+15V DC / 50mA	21	OUT	V_{ZK} ($V_{DC\text{-}bus}$) analogue (optional)
17	9	OUT	+15V DC / 50mA	9	OUT	GND analogue
18	28	IN	Supply GND	22	OUT	Overvoltage (optional)
19	10	IN	Supply GND	10	---	NC
20	29	OUT	Temperature analogue	23	---	NC
21	11	OUT	GND analogue	11	---	NC
22	30	OUT	I analogue out half-bridge A	24	---	NC
23	12	OUT	GND analogue	12	---	NC
24	31	OUT	I analogue out half-bridge B	25	OUT	GND digital
25	13	OUT	GND analogue	13	OUT	GND digital
26	32	OUT	I analogue out half-bridge C			
---	14	---	NC			
---	33	IN	Chopper IGBT ON external			
---	15	OUT	Chopper Fault			
---	34	IN	Chopper Reset			
---	16	OUT	Overvoltage (optional)			
---	35	---	NC			
---	17	---	NC			
---	36	---	NC			
---	18	---	NC			
---	37	OUT	GND digital			
---	19	OUT	GND digital			

Table 3: Pin-out of the PrimeSTACK controller interface for IDC and SUB-D connectors

The user interface, connecting the controller with the PrimeSTACK electronics, is implemented as a male SUB-D connector with bolt lock (UNC4/40 thread) compatible to IDC plug connectors. For superior EMC properties of the signal link we recommend the use of a round shielded cable. All signal cables provide “reinforced isolation”.

SUB-D connector (male)

SUB-D for IDC-ribbon cable

IDC system

3.3.2 Power supply of the electronics

The PrimeSTACK features a wide voltage range power supply. This allows operation from an unregulated supply voltage within the following limits[1]:

$$V_{CC\text{-}min}=13V < V_{CC} < V_{CC\text{-}max}=30V$$

The supply voltage for a PrimeSTACK in B6I topology is connected to pin 26 or 8, in case of a half-bridge this is pin 16 or 4. Both pins are shorted internally. Theoretically it would therefore be sufficient to connect to one pin each[2]. For the ground potential we recommend to use the pins 28 and 10 for B6I or 18 and 6 for simple half-bridge especially provided for the supply to improve the EMC immunity (see also section 4.1 “EMC concept”).
Stabilisation and regulation of the supply voltage is done internally. The regulated voltage is $V_{CC\text{-}intern}$=15V and is present at the interface. The maximum permissible load of this terminal is I_{max}=50mA. If the input voltage drops below 13V the PrimeSTACK turns off. A voltage-low fault occurs (see section 3.3.6 “Fault output and reset”). This serves the protection of the IGBTs, as, once the supply voltage drops below 13V, the gate voltage of +/-15V for safe switching on and off of the IGBTs can no longer be guaranteed.

3.3.3 The digital inputs

Digital inputs (internal circuit see Figure 7) are those connector pins of the SUB-D plug at which the PWM signal or generally the digital turn-on and turn-off signal for the IGBTs is connected. The inputs are CMOS compatible. Therefore, the following applies to a signal at a digital input (in the range of 0…+15V):

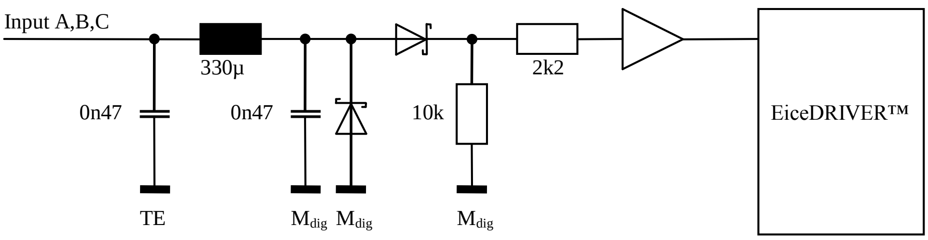


Figure 7: Internal input circuit of the digital inputs of the PrimeSTACK electronics

[1] The values given in the window are referenced to the measured voltages directly at X1 (see Figure 5: “PrimeSTACK electronics”). Long leads may cause significant voltage drop between the cable ends.
[2] We recommend to use as many spare leads as possible for the power supply (incl. ground). This increases the conductor square section and reduces parasitic influences (e.g. unintentional voltage drop)

- low < 4.0V IGBT = Off → turn-off command for IGBT; V_{GE}=-15V
- high > 11.5V IGBT = On → turn-on command for IGBT; V_{GE}=+15V

The digital inputs use a common ground with the digital outputs. This ground potential is solely reserved for digital signals and is decoupled from other ground potentials by LC-filters.

The digital inputs may be fed a maximum switching frequency shown in Figure . The limits are valid for the permissible temperature area.

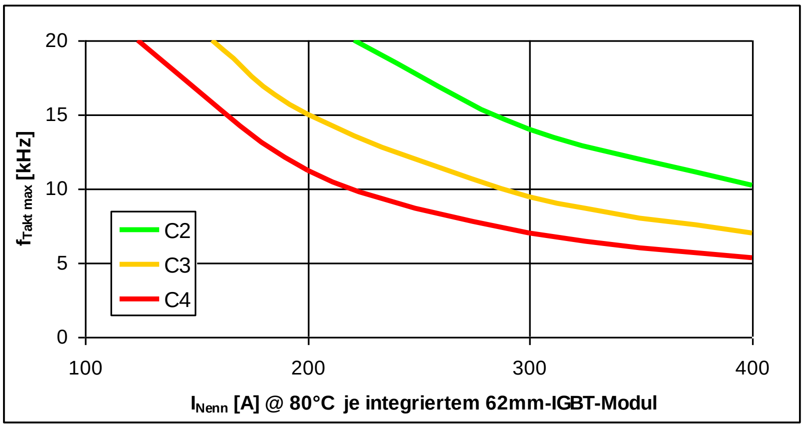


Figure 8: Maximum permissible PrimeSTACK switching frequency referred to module rated currents. Parameter: size (C2,3,4)

3.3.4 The digital outputs

All digital outputs ("**half-bridge A, B, C fault; over-temperature; over-voltage; chopper fault**") are open collector outputs according to Figure 9. This means that a transistor is turned on internally of which the emitter (source) is at ground potential and the collector (drain) is open, hence not connected. In a fault situation the transistor is in blocking mode. The drain has to be pulled up to the required High potential by an external resistor.

Limit values are:

- V_{max}=30V
- I_{max}=15mA

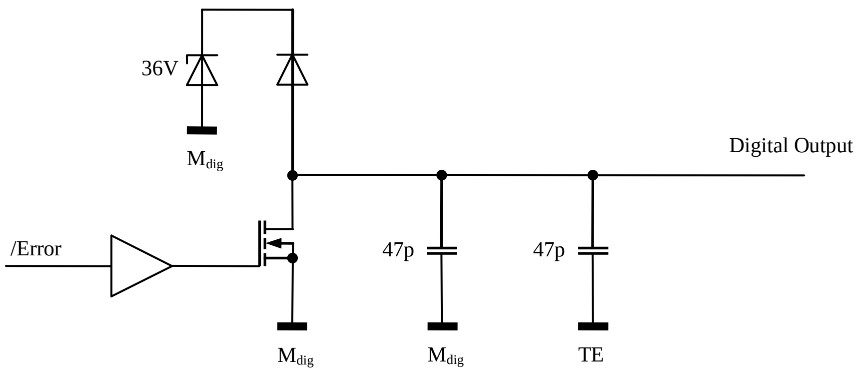


Figure 9: Internal circuit of the digital outputs of the PrimeSTACK electronics

The output current of maximum15mA limited by the external pull-up resistor should preferably be used to its full extend for good EMC performance. The digital outputs are

referenced to a common potential "GND digital". No other signals should be referenced to this ground.

3.3.5 The analogue outputs

Analogue are those outputs which carry processed measurement data (**"VDC-bus analogue; temperature analogue; I analogue out half-bridge A, B, C"**). All analogue outputs are referenced to a separate ground. Thus measured values are not disturbed by other signals. The load of the analogue outputs must not exceed 5mA.

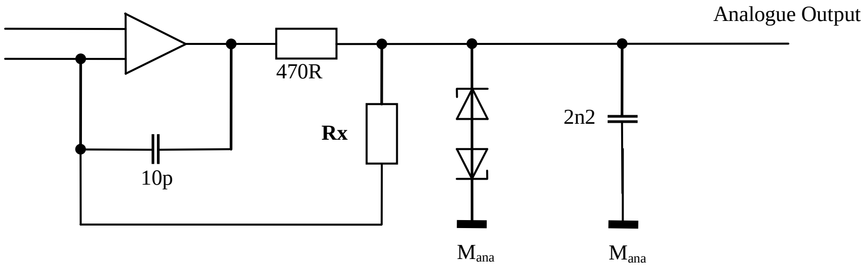


Figure 10: Internal circuit of the analogue outputs of the PrimeSTACK electronics

According to the individual analogue output value an adjustment of the resistor Rx is done (Figure 10, Figure 9 and Table 4). Further explanations in section "PrimeSTACK protection concept".

Analogue output	Resistor value Rx
Temperature	10kΩ
DC-bus voltage	24kΩ
Load current	47kΩ

Table 4: Adaptation of the analogue output by variable resistor values

3.3.6 Fault output and reset

All fault outputs from the PrimeSTACK electronics are digital outputs (see section "The digital outputs"). The fault interfaces build a fault matrix. This is depicted in Table 5 and Table 6.

Fault type	Fault (Pin2)	Voltage fault (Pin22)	Temperature fault (Pin22)
Driver fault	●		
Overcurrent	●		
DC-bus overvoltage	●	●	
electronics power supply voltage low	●	●	
Over-temperature of the power section	●		●
Over-temperature of the electronics	●		●

Table 5: PrimeSTACK fault matrix for ½B2I half-bridge

Fault type	Half-bridge A fault (pin2)	Half-bridge B fault (pin22)	Half-bridge C fault (pin5)	Voltage fault (Pin16)	Temperature fault (Pin6)
Driver fault half-bridge A	●				
Driver fault half-bridge B		●			
Driver fault half-bridge C			●		
Overcurrent	●	●	●		
DC-bus overvoltage	●	●	●	●	
Electronics power supply voltage low	●	●	●	●	
Over-tempe-rature of the power section	●	●	●		●
Over-tempe-rature of the controller	●	●	●	●	●

Table 6: PrimeSTACK fault matrix for B6I full bridge

A bullet point in one of the table cells means that a fault is present at this output. In this case the open collector transistor of the individual fault output is blocked. The external pull-up resistor brings the output to HIGH potential. If no fault is present, however, then the open collector transistor is turned on. Then the fault output shows the logic level ZERO or LOW.

If a fault is set the PrimeSTACK electronics ignores incoming PWM control signals and the power section is turned off. The fault is registered (saved). If operation is to continue, the following conditions have to exist:

1. There must not be a status present which causes the generation of a fault condition
2. All inputs of the controller have to be at LOW level for a minimum of 9µs

3.3.7 Time management

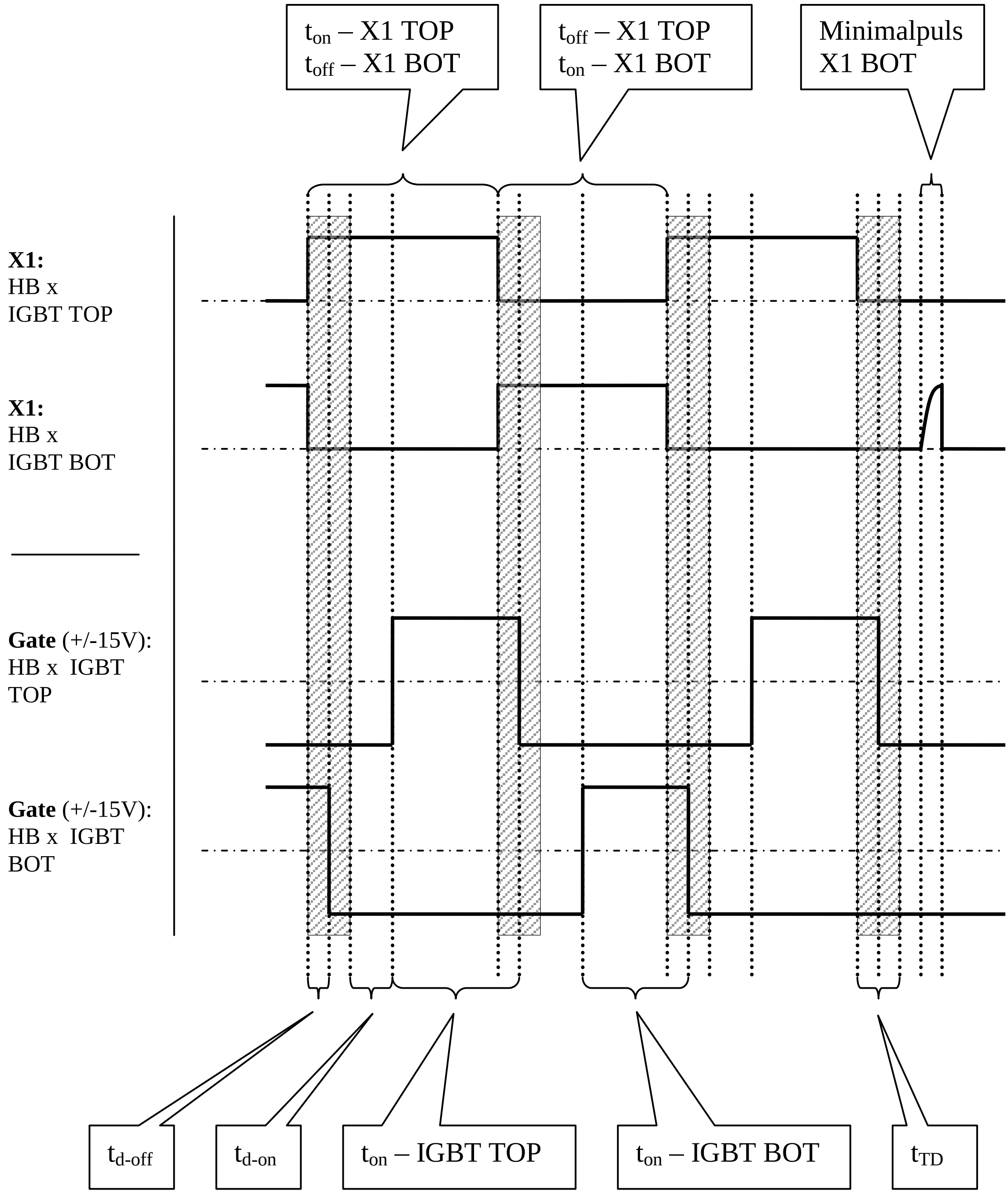


Figure 11: Time management of the PrimeSTACK electronics:

Size	$t_{on\text{-}min}$ recommended	$t_{d\text{-}on}$ typical	$t_{d\text{-}off}$ typical	t_{TD} typical	t_{md} typical
value / µs	5	1.8	2.0	3.8	0.5

Table 7: Time management of the PrimeSTACK electronics:

- X1
  Controller interface of the PrimeSTACK. SUB-D socket

- Minimum turn-on time (t_{on-min})
  recommended approximate value. If this falls below, the switch rise times of VCE and IC can increase significantly and produce increased switching overvoltages accordingly.

- Transition time for turn-on pulse (t_{d-on})
  defines the processing time of the turn-on signal of an IGBT. Measured between the terminal X1 (SUB-D connector of the PrimeSTACK) and the output of the driver (gate of the IGBT). Identical times for TOP- (connected to DC+) and BOT (connected and DC-) IGBT.

- Signal time for turn-off pulse (t_{d-off})
  Definition analogue t_{d-on}, however, with regard to the turn-off control pulse of an IGBT.

- Bridge interlock time (t_{TD})
  Control signal interlock between each other set on the driver site, referred to one individual half-bridge. As soon as one of both inputs is turned off, t_{TD} starts. While t_{TD} is active, a turn-on signal on the other channel is blocked. Only at the end of t_{TD} it will be passed to the gate.

- Minimum pulse suppression (t_{md})
  is filtering out signals coupled into the control cable; otherwise they can be misinterpreted by the PrimeSTACK as control signals. The indicated time is valid both for turn-on and -off pulses.

- Response time of the electronics (t_A)
  Response time interval measured from the beginning of the incident (e.g. overcurrent, over-voltage etc.) to the beginning of an action.

Fault type	**t_A maximum**
Over-voltage	50µs
Over-current	10µs
Bridge short circuit	10µs

Table 8: Response times of the PrimeSTACK electronics in the case of fault

3.3.8 The EiceDRIVER™

The EiceDRIVER™ is a power driver. It is, embedded in the electronics, an essential part of the PrimeSTACK and serves the control of the implemented IGBTs inside the 62mm modules. It has been developed and designed especially for modern Infineon IGBT generations. Each EiceDRIVER™ can control two logic switches where a maximum gate current of 30A is possible. Depending on the circuit topology a PrimeSTACK contains one (½B2I half-bridge), two (B2I single phase bridge) or three (B6I three phase bridge) EiceDRIVER™.

Figure 12: EiceDRIVER™

The EiceDRIVER™ is characterised by the following features:

- Reincorced isolation according to EN50178 (surge voltage test: 9.6kV)
- "Soft shut down" during short circuits for especially low over-voltages
- Maximum gate current or power per channel: +/-30A or 4W
- Maximum switching frequency: 60kHz
- For IGBTs up to 1.7kV blocking voltage or 1600A nominal current.

Note:
The EiceDRIVER™ can be purchased both individually as well as integrated into a PrimeSTACK. A separate datasheet and separate application notes exist (see section 6.2 "Further associated documentation").

3.4 PrimeSTACK protection concept

To protect the PrimeSTACK and its surrounding installation against damage, the PrimeSTACK protection concept has been developed. Data from the sensors are monitored in real time, processed, transferred via the analogue controller interface and compared with internal set values. If one of the measured values exceeds its internal maximum set value the PrimeSTACK turns itself off (with or without an interlock delay time). Additionally a fault signal is given out matching the reason for turn-off (see Table 5 and Table 6). The protection concept includes:

1. **Monitoring the load current**
    - Standard: Current measurement at each AC terminal with analogue actual value output in real time

      → Overcurrent trip individually adapted (see datasheet)
2. **Protection against bridge shorts**
    - Standard: Permanent monitoring of the collector-emitter voltage of the IGBTs.
      → Trip occurs within 10µs, when $dV_{CE}/dt \neq 0$, without a switching process being sensed, while the IGBTs are in On-state.

3. **Monitoring the DC-bus voltage**
    - Optional: Voltage measurement with analogue actual value output in real time
      → Trip occurs application specific (see datasheet)

4. **Monitoring the temperature**

- o Standard: Temperature measurement via the NTC directly below the power module with analogue actual value output in real time
  → Trip occurs at 80…85°C heatsink temperature (or 60…65°C for water coolers). This corresponds to a chip temperature of approx. 125°C in steady state thermal condition
- o Standard: Temperature measurement via NTC on the PrimeSTACK electronics
  → Monitoring of the immediate ambient temperature during operation. If the ambient temperature exceeds 75°C the PrimeSTACK turns off.
- o Optional: Temperature simulation of the chip temperature
  → In case of short term overload the temperature at the NTC can not immediately follow the actual chip temperature due to thermal capacity. To protect the chip from undetectable over-temperature, the actual chip temperature is simulated based on measurable values such as load current. If the calculated chip temperature exceeds 125°C the PrimeSTACK is turned off.

3.4.1 Monitoring the load current

The acquisition of the load current at the PrimeSTACK AC terminals serves two purposes. Firstly, the PrimeSTACK is protected against overcurrents by processing of the current measurement via the internal electronics. Secondly, an exact, processed, linear and current-proportional voltage signal of each AC terminal is provided at the controller interface.

The current sensor employed makes use of the compensation principle. A current signal produced through induction is represented with a voltage and compensated to zero with the sensor electronics. The magnitude of the compensation voltage is directly proportional to the load current. A standardised current sensor is used in all PrimeSTACKs. The adaptation of the current-proportional voltage signal is done with burden resistors. According to the model, referencing of the nominal current is thus achieved to the datasheet voltage value. Independently of that, turn-off always occurs at

$$I_{analog\ Out}=10V$$

By the model dependent value of the analogue output signal at nominal current a model specific adjustment for overload is possible. Overload trip may therefore vary between 150% and 300% of the PrimeSTACK nominal current.

<u>Relevant data of the current sensor:</u>

- Insulation: Reinforced isolation according to EN50178
  Test voltage: burst 5kV/50Hz/1s; surge 12kV/1.5/50µs
- Accuracy @ 25°C: <|+/-0.5|%
- Linear error < 0.1% for I<300A
- Temperature drift of the measured value = 0.01% / K referenced to I=300A
- Response time up to 30A: <1µs
- Response time for 30…270A: <0.5µs
- Frequency range: 0Hz (DC)…100kHz
- Temperature range: -40…85°C

Due to its linearity, the high temperature stability and the high frequency range the current-proportional voltage signal is well suited for the use in control loops e.g. as set value or also as feedback signal (see Figure 13).

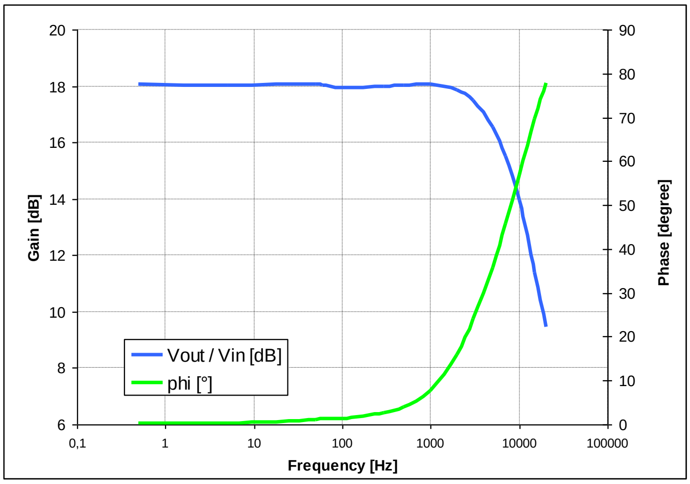


Figure 13: Transfer characteristics of the PrimeSTACK current sensor versus the frequency of the load current

Depending on the circuit topologies of the PrimeSTACK power section differences exist in the analogue output of the current-proportional voltage signal:

- **Simple half-bridge:** Only one connection pin of the controller exists for the analogue output: Independently of the frame sizes (see 3.6 "PrimeSTACK sizes") the AC currents of each 62mm module are individually measured, however, only the summed total current is brought out as a current-proportional voltage signal.
- **B6I full bridge:** A connected pin exists for each of the output phases of the power section at the PrimeSTACK controller interface. Each phase current is measured individually and given out as a current-proportional voltage signal.

3.4.2 Monitoring of the IGBT saturation voltage

If both the IGBTs on the DC+ and DC- rail in a half-bridge are conducting, the positive and negative potential of the DC-bus is short circuited. Such bridge shorts are actively inhibited by the EiceDRIVER™ by interlocking the upper IGBT (collector on DC+) against the lower IGBT (emitter on DC-). If a bridge short still occurs it can not be detected by the AC current sensors. Whilst the IGBTs actively limit the short circuit current, this current, however, combined with the DC-bus voltage, generates enormous losses at the conducting IGBT.

To recognise bridge shorts V_{CE} voltage monitoring is used on the IGBTs. This is permanently active and monitors all IGBTs. If the collector-emitter voltage V_{CE} on one IGBT suddenly rises without a control signal to turn off is present, then this is recognised as a short circuit. The "Soft Shut Down" integrated in the PrimeSTACK is activated. This affects, compared with other turn-off processes, a slow switching off of the short. Too high turn-off voltages generated otherwise by a high turn-off di/dt, which may exceed the blocking capability of the IGBT, are thus avoided.

3.4.3 Monitoring the DC-bus voltage (V option)

With this optionally available assembly the DC-bus voltage is measured and potential separated given out as an analogue bus-voltage proportional voltage signal to the PrimeSTACK controller interface.
Firstly the DC-bus voltage is divided by the resistance ratio of the measuring resistor bridge. This value is then potential separated and via burden resistors normalised to 10V for the PrimeSTACK specific voltage class available at the V_{ZK} ($V_{DC\text{-}bus}$) analogue output.

Depending on the voltage class, the following reference levels apply:

- …06… → 600V PrimeSTACK: $V_{ZKanalog}$=10V → V_{ZK}=444V
- …12… → 1200V PrimeSTACK: $V_{ZKanalog}$=10V → V_{ZK}=1000V
- …17… → 1700V PrimeSTACK: $V_{ZKanalog}$=10V → V_{ZK}=1333V

The threshold at which the PrimeSTACK turns off due to overvoltage is 9V as standard at the analogue output. The turn-off time is 5ms. However, these values may vary specifically to application. The valid values can be taken from the PrimeSTACK datasheet.

3.4.4 Temperature measurement

The PrimeSTACK features two independently working NTC temperature sensors as standard: one - for monitoring the chip temperature, the other one - for monitoring the ambient temperature.

Monitoring the chip temperature
The temperature is measured by means of an NTC (characteristic see Figure 14) beneath the baseplate of a power module and given out in real time as a temperature proportional voltage signal. It has to be differentiated between the implementation of a water cooler and that of an air cooler:

- **Air cooler:** The trip level at T_{NTC} = 80…85°C
- **Water cooler** The trip level due to the better thermal resistance of the cooler at T_{NTC} = 60…65°C

In both cases this corresponds to a chip temperature of approx. 125°C. The analogue temperature output is affected by a certain inertia due to the thermal capacities. To equalise and counteract this time step in transient processes, such as high temporary overload, an optional assembly for temperature simulation is available (see section "Temperature simulation (T option)".

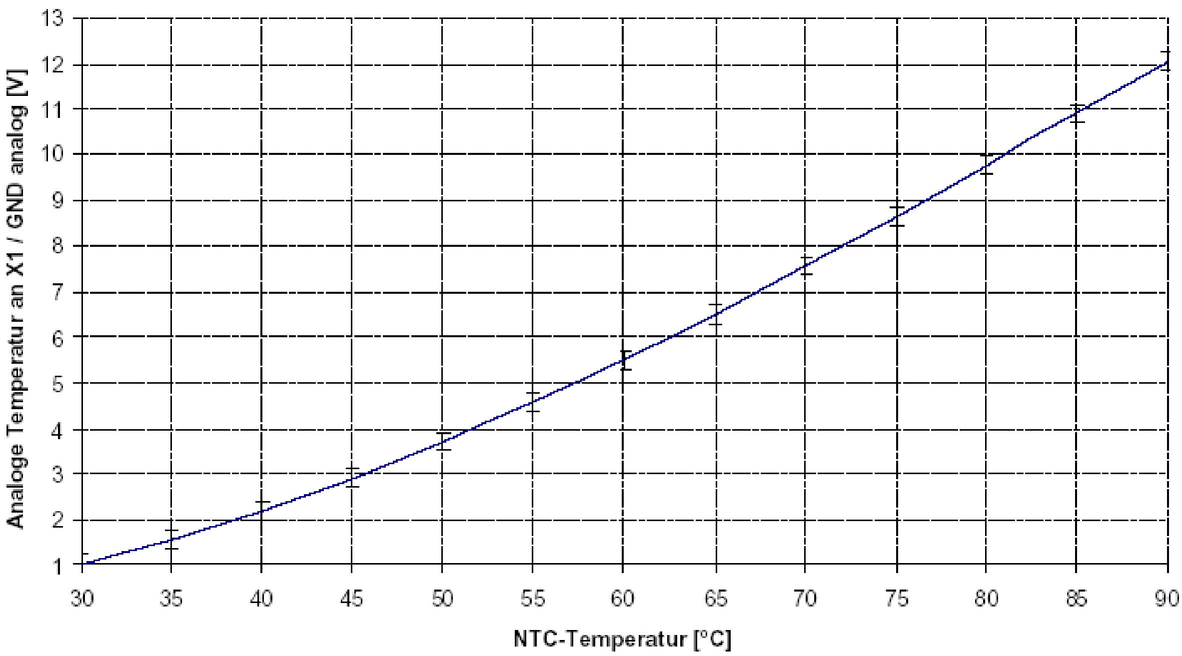


Figure 14: Characteristics of the temperature monitor signal at the analogue output → measured temperature beneath the module

Note
Please note, that for temperature lower than described in Figure 14 negative voltages can occur at analogue output.

Monitoring the ambient temperature
During operation the electronics of the PrimeSTACK heats up to a certain temperature level above the ambient. In order to protect the electronics from over heating and damage arising from this, the PrimeSTACK is turned off at an electronics ambient temperature of 75°C. This is measured with an NTC which is situated on the PrimeSTACK electronics. The measured value is not given out. Instead an over temperature fault is generated.

3.4.5 Temperature simulation (T option)

If the PrimeSTACK is operated with high transient overloads, the chip junction temperatures of the IGBTs increase faster than the temperature rise at the NTC is recognised and registered. The reason for this is the time lag of the system due to "charging" of the thermal capacities. To close this protection gap the optional temperature simulation was developed. This is recommended in particular if varying overload situations are regularly encountered and the PrimeSTACK is to be used safely and to its limits.

Basis for the temperature simulation is the knowledge of the thermal parameters of the PrimeSTACK. The following values are included in the calculation of the simulated chip temperature:

1. RMS value of the load current
2. DC-bus voltage
3. NTC temperature
4. Switching frequency

As soon as the calculation has reached a value greater than 125°C chip temperature, regardless of the reason, an over-temperature fault is given out to the PrimeSTACK controller interface. The fault output through simulated over-temperature is identical with that of the measured over-temperature. An analogue output of the simulated temperature is not provided. The temperature simulation is permanently active.

3.5 PrimeSTACK ancillaries and add-ons

This section describes the PrimeSTACK (System) add-ons available. These are sensible electronic assemblies or power assemblies.

3.5.1 DC-bus circuits (C-option)

Selection of the DC-bus is application specific. Voltage, current and ambient conditions are vital design criteria. The PrimeSTACK DC-bus circuits are referenced to these criteria and to some extent use standard assemblies (e.g. capacitors, voltage sharing resistors) and partially components designed specifically for the PrimeSTACK (e.g. capacitor box, busbar).

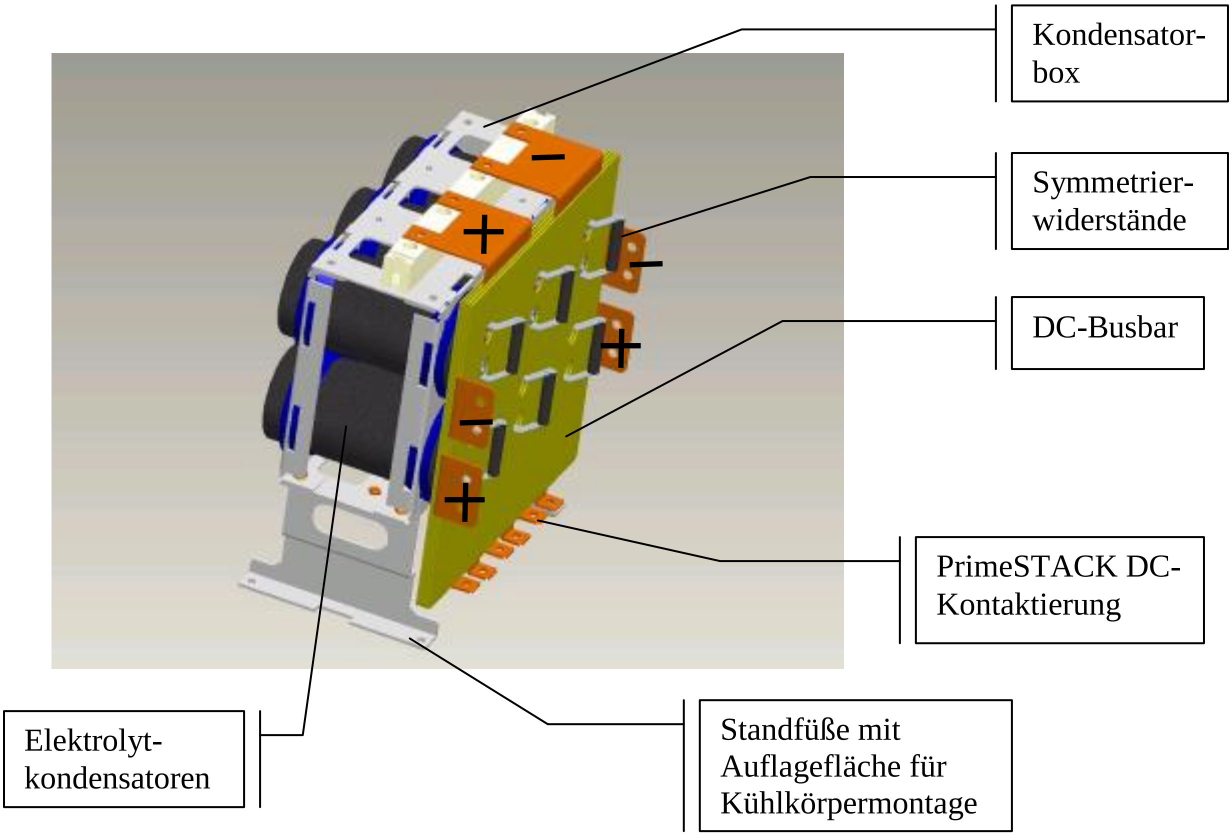


Figure 15: PrimeSTACK DC-bus construction (here 1200V PrimeSTACK in size C3)

Design criteria:

- **Electrically and thermally** the DC-bus is designed for the required currents and a minimal inductance. The capacitors are selected in a way that for the nominal load of the application no thermal over-stressing of the capacitors will occur and even overload conditions can be handled. The specifically integrated high temperature resistors take care of a symmetric division of the DC-bus voltage over the seriesed electrolytic capacitors and a discharge of the capacitors within a defined time period after turn-off.
- **Mechanically** the construction is both robust and stable and constructed matching the PrimeSTACK DC-terminals**.** Several possibilities to connect a DC-feed exist which can be freely selected according to the existing infrastructure.

The assembly is carried out in the depicted position (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The construction is placed over the PrimeSTACK onto the heatsink. Robust feet for the bolts are positioned at the contact faces; this acts as the direct contact to the heatsink. The link to the DC-terminals is also done with bolt connections (see “Table 14: Recommended nominal and fastening torques”). All bolt connections feature good mechanical stability.

Note

Part of the PrimeSTACK DC-bus construction are also the snubbers to dampen turn-off over-voltages as described in section “**Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.**”.

Mounting
Aluminium is characterised by high conductivity and low weight. It is thus extremely well suited as a busbar in DC-bus constructions. DC busbars in the PrimeSTACK systems consist of Al99.5 with a conductivity of approx. $35m/(\Omega mm^2)$. The surface of this high-purity aluminium forms an oxide and thus a comparatively high contact resistance which can lead to high temperatures spots due to the resistive power losses there.
In order to prevent this, we recommend, before the galvanic connection of any individual electric circuit with the PrimeSTACK busbar, the pre-treatment of the junction or contact points as following:

1. Roughen or brush the contact point in order to remove the oxide from the aluminium surface.
2. Apply contact grease for example Klüber's Wolfracoat C in a thin layer onto the roughed, oxide free surface.
3. Make the connection

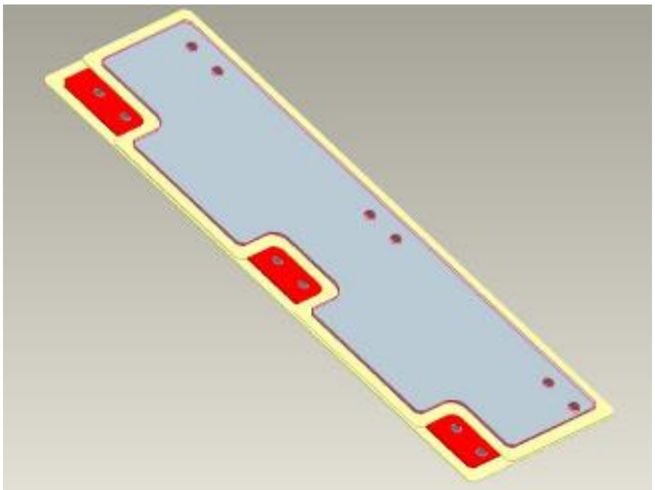


Figure 16: Two layer aluminium sheet to connect three individual PrimeSTACK DC-buses to a single DC-bus system

Note:
The formation of the oxides on a A199.5 surface takes place rapidly. We recommend, therefore, carrying out step 2 immediately after step 1. Figure 16 shows a layer, as it can be used in order to connect individual PrimeSTACK DC-buses. Basis forms the PrimeSTACK system shown in Figure 4. Copper bars for connecting several DC-buses with each other are possible but they are not recommended due to their comparatively high inductance.

3.5.2 Fans (F-Option)

Fan type	Manufacturer	F [Hz]	V [V]	Free blowing air flow [m³/h]	P [W]	$T_{amb\text{-}max}$ [°C]
D2E133AM4723	ebm-papst	50	230	685	190	45
D2E133AM4701		60	230	510	200	40
D2E133DM4701		60	230	600	195	40
D2E146AP4702		60	230	690	330	35

Table 9: Recommended fans for PrimeSTACK air cooling where a PrimeSTACK standard heatsink is used

Air-cooled PrimeSTACKs are designed for forced air cooling as a standard. The fan itself is optionally available. It is important to operate the fan correctly. Only with correct air flow and air current (exact values see each fan datasheet) the PrimeSTACK may be operated under nominal conditions.

3.5.3 Paralleling interface PD100 (M-Option)

The parallel interface serves the parallel operation of several identical PrimeSTACKs. This is of interest in particular when the power of one individual PrimeSTACK does not suffice and two or more PrimeSTACKs are to be connected in parallel. The following functions are implemented:

- **Splitting of the PWM control signals** The PWM signal from the controller designated for each logical switch is split by the parallel interface into two identical PWM signals.
- **Analogue output:** Analogue values measured in the parallel PrimeSTACKs are conceptually combined. The following analogue signals are given out at the PrimeSTACK parallel interface:
    - **Load current** → generation of the average value of the individual PrimeSTACK currents
    - **Temperature** → output of the highest individual NTC temperature
    - **DC-bus voltage V_{ZK}** → output the highest individual measured DC-bus voltage (V_{ZK}) where not necessarily each PrimeSTACK has to be equipped with the V option, in particular when the same DC-bus is used
- **Fault management:** Each PrimeSTACK protects itself to a large extend by the protection mechanism described and turns itself off. In case of a fault the generated fault signal is given out to the parallel interface. This immediately blocks the PWM signals for the remaining paralleled PrimeSTACKs and turns them off.

Figure 17: The parallel interface PD100 for the parallel operation of two PrimeSTACKs

3.5.4 Optical Interface OEA240 (IO-Option)

The optical interface OEA240 serves to control a PrimeSTACK in half-bridge configuration with optical timing signals. The following functions are implemented:

- **2 optical inputs.** For each the IGBTs on plus (top) and minus (bottom)
- **1 to 3 optical outputs.**
    - Combined fault (standard)

- Over-temperature fault (optional)
    - Over-voltage fault (optional)
- **Sub-D connector for the remaining, non optical signals**

If an OEA240 is used, the feeding of the supply voltage of the PrimeSTACK occurs via the OEA240. The required controlled internal operating voltage of +15V is fed back from the PrimeSTACK into the OEA240. This is part of the EMC concept (see section 4.1).

Note:
For the OEA240 individual documentation is available on request.

Figure 18: Optical interface OEA240

3.5.5 Chopper driver DR220 (D-option)

The chopper driver DR220 serves to control 62mm modules with circuit variants shown in Figure 19. It is optionally available as an additional component of a PrimeSTACK in B6I configuration (6PS…). The mechanical size of the PrimeSTACK increases here from C3 (three integrated 62mm modules) to C4 (four 62mm modules).

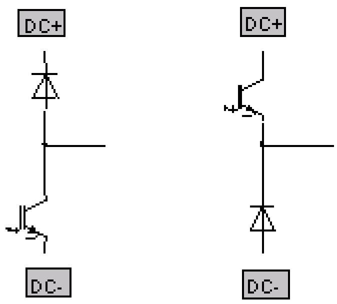


Figure 19: Boost-/buck converter and chopper

The DR220 has following characteristics:

- 2 control modes:
  → Control via external switching signal or
  → Control by internal on-off controller
- Maximum switching frequency: $f_{Takt\ max} = 5kHz$

- $V_{CE\ sat}$ monitoring
- Temperature monitoring with additional NTC under the module baseplate

The control with external switching signal occurs similarly compared with the control of the other IGBTs through the customer controller. The internal on-off controller, however, offers the possibility to have this task done by the PrimeSTACK. As a standard, the following on-off controller switching thresholds are fixed:

	Version 1:	**Version 2:**
Overvoltage fault	730V	860V
Turn-on threshold	681V	802V
Turn-off threshold	667V	786V

Table 10: Switching thresholds for PrimeSTACK chopper (DR220)

Application note
The brake resistor is to be connected in such a way that the parasitic inductance is minimized and the resistive characteristic of the brake still exists. The maximum length of the cable is to be chosen according to:

- Braking current (preferably RMS instead of peak current)
- Cross section of the cable
- Parasitic inductance of the brake resistor

This length must not be exceeded. The use multi-core cable is preferred.

3.5.6 Snubber capacitors

Snubber capacitors serve the reduction of turn-off overvoltages of the IGBT. They are connected to the PrimeSTACK DC-terminals. If snubbers are used, then always all of the 62mm power modules of the individual PrimeSTACK should be equipped with a snubber capacitor. Apart from the selecting the correct capacitance for the snubber capacitors it is important to determine their adequacy for the respective application. The latter is not a part of the specification:

- $C_{Snubber}$ too low: Snubber capacitors ineffective:
- $C_{Snubber}$ too high: long decay time
- $C_{Snubber}$ correct: Correct dampening of the turn-off overvoltage

We recommend the following metallised-dielectric capacitors in conjunction with the PrimeSTACK:

Capacitor type number	Manufacturer	$C_{Snubber}$ [µF]	V_{max} [V]	Appropriate for
B32654-S0474-K566	Epcos	0.47	1000	1200V – PrimeSTACK (…R12…)
B32654-A7224-K		0.22	1250	1700V – PrimeSTACK (…R17…)

Table 11: Recommended snubber capacitors

3.5.7 Heatsink (G-, W-option)

Two basically different heatsinks exist: air cooled and water cooled. When using air coolers the PrimeSTACK standard is forced air cooling. For air cooled systems the capability is usually limited by the heatsink. If a water cooler is to be used in the application, wider prospects exist regarding power density.

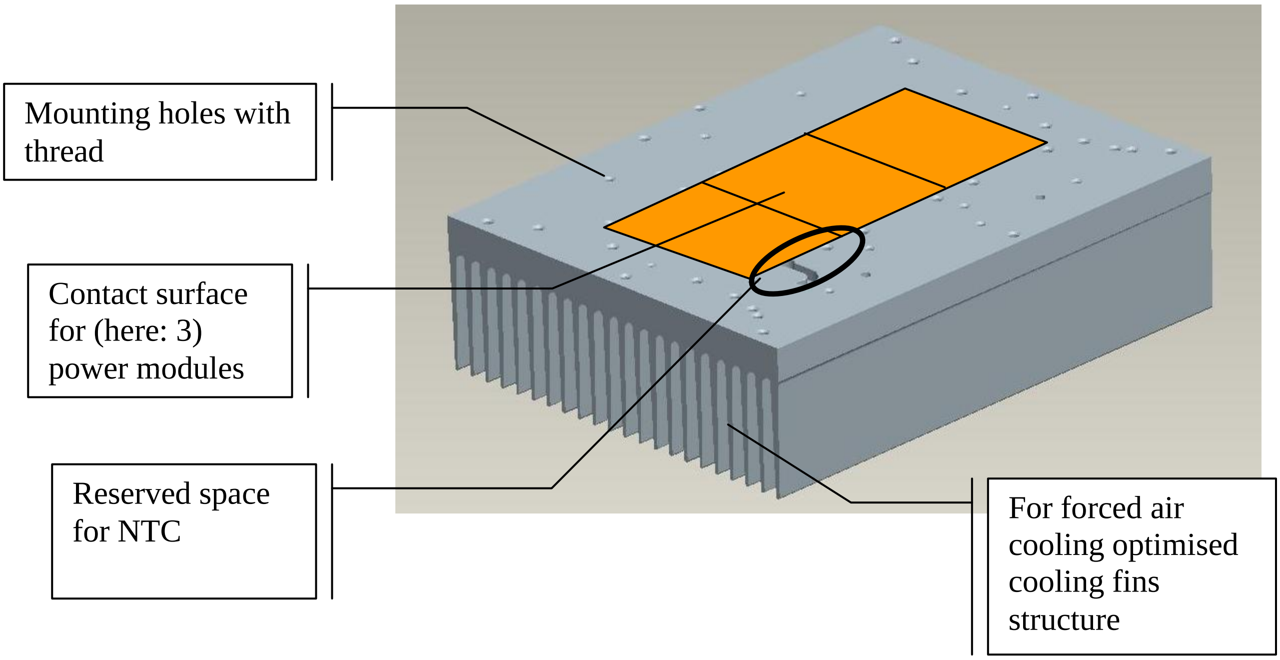


Figure 20: PrimeSTACK standard heatsink (forced air cooling) of a C3 PrimeSTACK

Figure shows the standard heatsink for forced air cooling of a PrimeSTACK size C3 (three 62mm IGBT modules integrated). The arched groove on the top site of the depicted heatsink is the space reserved for the NTC temperature sensor. All other holes feature M5- or M6-threads to mount the standard and optional PrimeSTACK components.

Note for water coolers

An in- and outlet of the cooling liquid exists for each water cooler (see Figure 30: Technical drawing PrimeSTACK in size C3 with water cooler”). Positioning these is possible in five different positions (designated with A…E in the technical drawing). By default these are positioned in B and C).

Please note the dimension of the mechanical connection. As a standard this is a pipe thread of the size “G ½” according to the DIN ISO 228 T1.

Customised heatsinks (for example for PrimeSTACK IPM) have to have the necessary mounting holes and the groove required of the NTC. Technical drawings for production of such heatsinks are available on request. Further information can be taken from the Application Note AN2006-07.

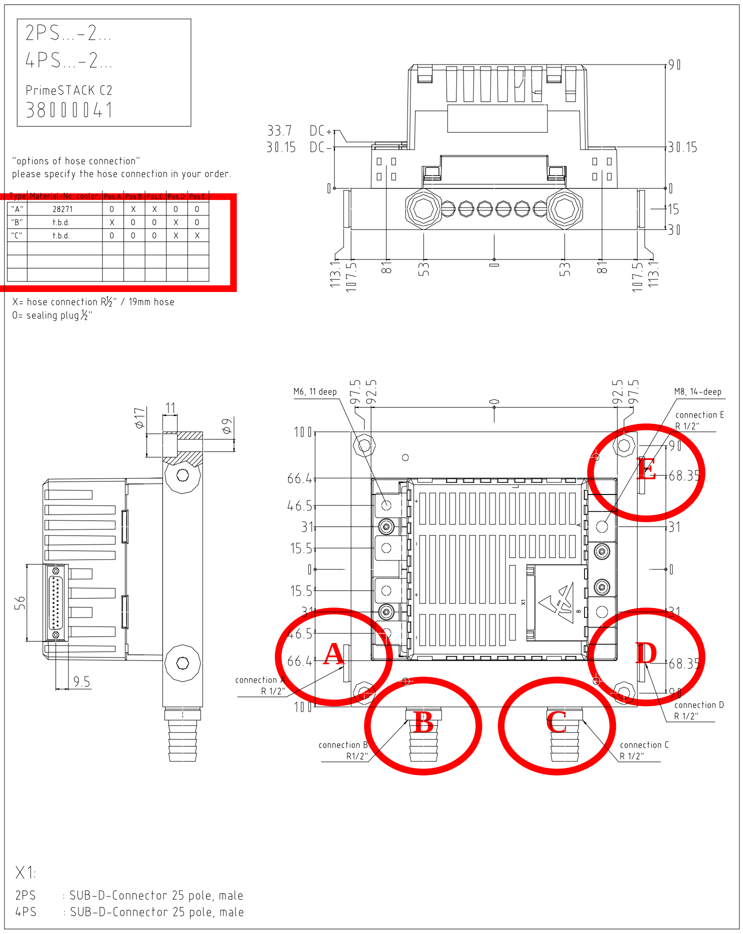


Figure 21: Optional position of the water in and outlets

3.6 PrimeSTACK sizes

The term "sizes" refers to the mechanical dimensions of the various PrimeSTACKs. The entire portfolio is based on three sizes: "C2", "C3" and "C4". The number after the "C" refers to the number of integrated 62mm power modules within a PrimeSTACK. This number is also found in the type designation immediately after the hyphen (see section 3.1 "PrimeSTACK type designation").

Connecting both electrically and mechanically equal sizes of PrimeSTACKs will result in an extension of the range:

Size	Component	1/2B2I	B2I	B6I	B6I + Brake
C2	Basic PrimeSTACK in C2	800A	---	---	---
C3	Basic PrimeSTACK in C3	1200A	400A	400A	---
C4	Basic PrimeSTACK in C4	1600A	800A	---	400A
CA	2 units C2 on one heatsink	1600A	---	---	---
CB	2 units C3 on one heatsink	2400A	---	---	---
CC	2 units C4 on one heatsink	3200A	---	---	---
CD	3 units C2 on one heatsink		---	800A	---
CE	3 units C3 on one heatsink		---	1200A	---
CF	3 units C4 on one heatsink		---	1600A	---

Table 12: Relationship between the sizes and the configurations and currents (IGBT nominal current). Notice: B6I and B2I circuits can be realised by 3 or 2 individual 1/2B2I respectively

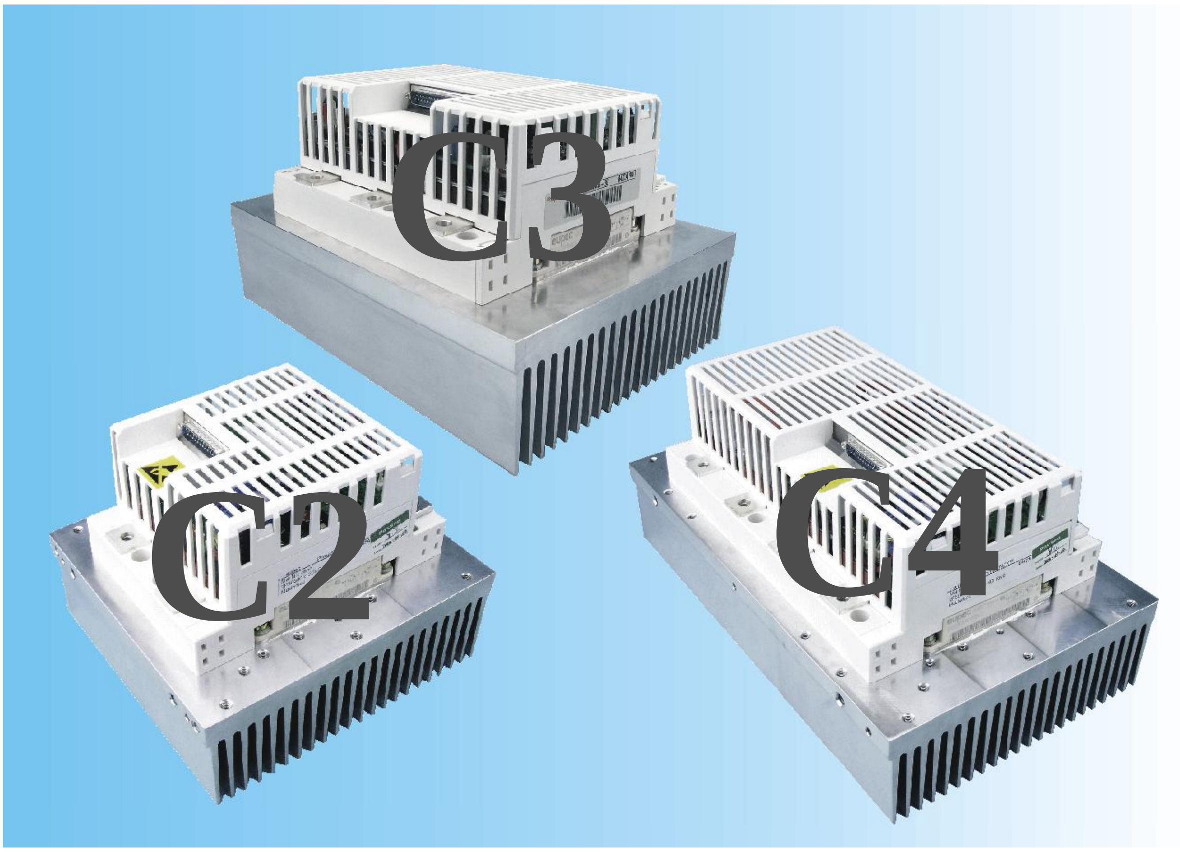


Figure 22: Standard PrimeSTACK sizes C2, C3 and C4

PrimeSTACK traction

Traction as an operating field - depending on the respective application – makes for very different requirements of the PrimeSTACK in many respects. These requirements are defined in many regulations.

The PrimeSTACK complies with many traction regulations. However, the subject areas dew-point, humidity and condensation should be checked thoroughly with regard to each application case. If using appropriate switchboards or cases the PrimeSTACK can be used in vehicles. However, according to the required insulating clearance, not entire bandwidth of installation sites (e.g. wheel housing) is available.

In order to asses the traction suitability in each case, the following categories must be known:

a.) Overvoltage category OV1 to OV4
b.) Pollution level PD1 to PD4 (A,B)
c.) Rated insulation voltage

4 PrimeSTACK system integration

This section describes the integration of the PrimeSTACK into the surrounding system. Hints are given for installation and commissioning, regarding the permissible limits of operation and the maintenance of the PrimeSTACK.

4.1 EMC concept

A solid EMC concept strictly adhered to assures operating of the PrimeSTACK free of EMC-disturbances and, of course, also of the system into which the PrimeSTACK is integrated. Such a concept mainly consists of:

1. **Introduction of different grounds**
    - **PE-ground** → current conducting earth (return currents from motors, earthing of switchboard cabinets etc.), solid construction, voltage differences of 50…100V induced by high current pulses can occur within the PE-ground
    - **TE-ground** → electronics shield (connected with PE at one place only; strictly separated otherwise. Entering the switchboard insulated from the cabinet walls). Not designed for high currents, only to evade disturbances by generating a ground shield.
    - **Signal / supply ground** (further separated according to requirements)
      → Supply ground for the electronics (V_{24}) (least sensitive)
      → Reference ground for digital signals (moderately sensitive)
      → Reference ground for analogue signals (most sensitive)

2. **Correct earthing** of the ground connections and connecting the grounds to each other
    - TE is galvanically connected to PE at exactly one spot only. This position should be as close as possible to the PE-connection, e.g. the factory hall to the outside world. Several connections may lead to circulating currents and should be avoided.
    - Signal / supply ground V_{24} is to be connected with TE only, under no circumstances with PE. A connection may be made at several positions (capacitively and/or via a varistor and/or hard galvanic etc.)
    - Usually the controller, which drives the PrimeSTACK, is supplied with this V_{24}. Inside this controller the digital and analogue grounds should be separated internally.

3. **Consistent shielding**
    - Signal leads anywhere should be shielded with the screen to the TE-ground (shielded cable).
    - SUB-D plugs should be used in preference over IDC connectors. Appropriately shielded plugs can be purchased through your stack supplier.

Figure 23 depicts this concept. The entire system is divided into several zones indicated here with circles. Each zone has its own ground. From a steady state point of view i.e. very low frequencies (ideal DC), these zones are shorted to each other. Dynamically, however, they are separated from each other by a specially designed de-coupling circuit. Thereby transient voltage drops or voltage variations, due to current pulses on parasitic inductances of earth leads, are kept away from freely defined sub-systems. The influence of the EMC disturbance described as an example is thus limited to one circle. These circles may be freely defined and should then be strictly adhered to.

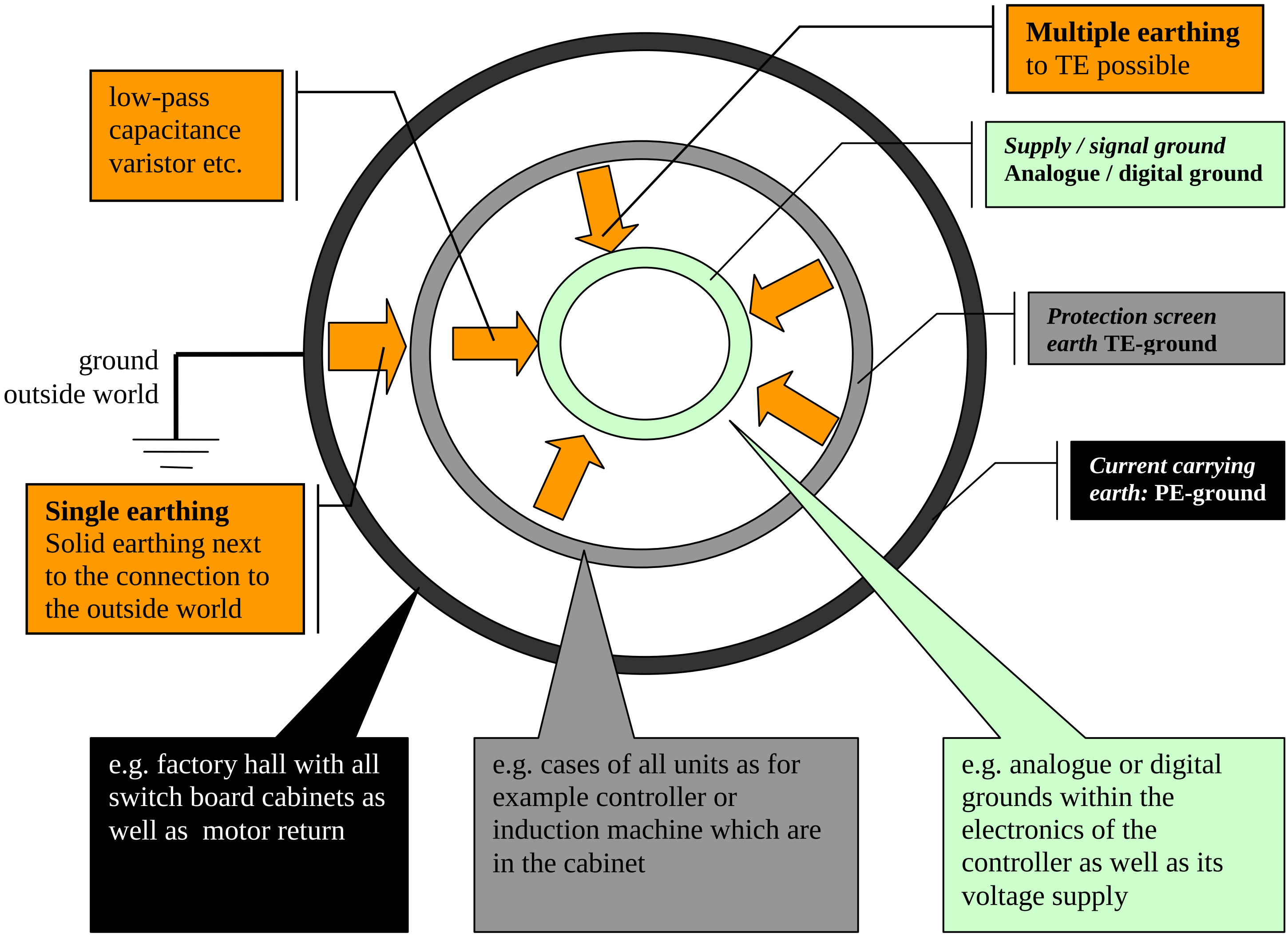


Figure 23: Example of an EMC concept

4.2 Checklist for system integration

The following shows a checklist to integrate the PrimeSTACK into the system. This checklist is only meant as a brief set of instructions. Make sure that all points of the list have been followed before commissioning. Please also read the sections referred to in the checklist.

1. Check the delivery
2. Read the safety notes carefully (section 5)
3. Make sure the required space for the PrimeSTACK is available and the permissible ambient conditions are observed.
4. Check for rating and safe connections of the DC supply wiring
5. Check for rating and safe connections of the AC supply wiring
6. Check for rating and safe connection of the break chopper wiring (if existing)
7. In case of parallel connection of several PrimeSTACKs to one PrimeSTACK system, check the rating and the safe connection of the DC-bus wiring.
8. Check the rating and the safe fit of the control cable(s). Make sure, that no cables have been mixed up.

9. Make sure, that the rules of the EMC concept have been observed.
10. Follow the commissioning instructions
11. The PrimeSTACK is now ready for operation.

4.3 Installation and commissioning

Prior to installation and commissioning of your PrimeSTACK, the safety instructions and the frame conditions in section 4 and 5 described by Standards have to be read! It is important to observe the required distance of the PrimeSTACK to other components. We recommend a minimal distance of 15 to 20mm between the plastic housing of the PrimeSTACK electronics and other components.

4.3.1 Connecting the controller

See also section 3.3.

We recommend to use a round shielded cable for the control connection. The shield must be connected EMC-suitably on both sides (SUB-D case according to telecom Standard). The correct pin-out can be taken from section 3.3.1 "User interface and pin-out". For EMC-suitable connection we recommend the use of a SUB-D plug instead of an IDC connector. The pin-outs are compatible with each other (see Table 3).

The purpose of the control unit (not part of the PrimeSTACK) is to drive the PrimeSTACK and to evaluate the analogue and digital signals of the PrimeSTACK. We recommend to supply the PrimeSTACK with 24V. A supply voltage below 13V is not permitted.

Notices for layout of cables
Machine and line cables are to be run separately and at a distance to control cables. Avoid long parallel runs to line or machine cables. Should a parallel run to a line be unavoidable, following distances have to be observed in order to avoid RF-interference:

Cable distance [m]	Screened cable length [m]
0.3	<50
1	<200

Table 13: Recommended cable lengths for controller connection

4.3.2 Connecting the power terminals

Cables and fuses are not part of the PrimeSTACK and have to be rated according to the nominal current. The temperature on the PrimeSTACK power terminals may not exceed 120°C. However, local regulations have to be observed. Power cables, in particular line and machine cables have to cross other cables perpendicularly. Make sure that line and machine cables are not swapped. The cable must not run over sharp corners or edges. After connection, check again that the power cables are fixed properly on the terminals. Please also use appropriately designed dV/dt-filters.

Please also observe both the recommended fastening torques of the power terminals as well as their maximum permissible load through external forces. To achieve the quoted fastening torques, bolts of the material class 8.8 are necessary. To secure the bolts, we recommend lock washers in S form in M6 and M8.

Terminal	Thread	M_{max} [Nm]	M_{nom} [Nm]	T
DC at the DC-bus[3]	M8	20	17	+/-10%
AC				
DC at the PrimeSTACK	M6	10	8	+/-10%

Table 14: Recommended nominal and fastening torques for the power terminals

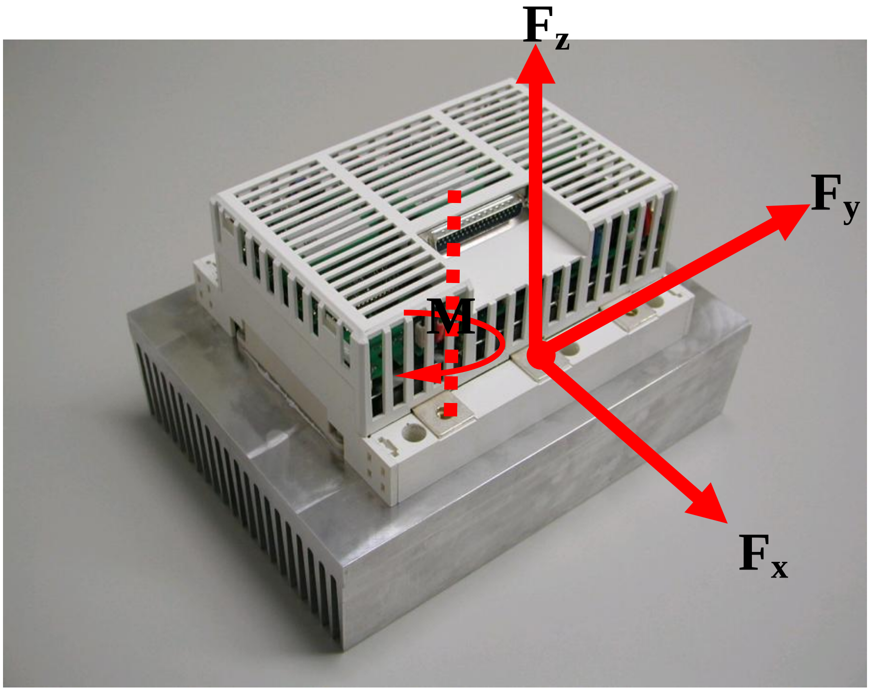


Figure 24: Spatial definition of the maximum permissible forces and recommended fastening torques

	Force (pull and push)	Size C2	Size C3	Size C4
DC terminal	F_{x-max} [N]	200	135	100
	F_{y-max} [N]	250	250	200
	F_{z-max} [N]	375	250	185
AC terminal	F_{x-max} [N]	400	250	200
	F_{y-max} [N]	500	500	375
	F_{z-max} [N]	750	500	375

Table 15: Maximum permissible forces per power terminal

The maximum permissible forces have been derived by a type test and contain an appropriately high safety margin.

M_{nom} → Nominal fastening torque
M_{max} → Maximum fastening torque
T → Permissible tolerance regarding the quoted torques
$F_{x,y,z}$ → Maximum permissible force F in +/-x-, +/-y- or +/-z-direction (see Figure 24) per power terminal.

[3] Only for PrimeSTACK system with DC-bus construction

4.3.3 Earthing

In accordance with section 4.1 the correct earthing of a PrimSTACK is illustrated here with a figure.

The main components, controller, 24V supply for the PrimeSTACK driver and the PrimeSTACK itself should to be connected to TE and PE as shown in figure 25.

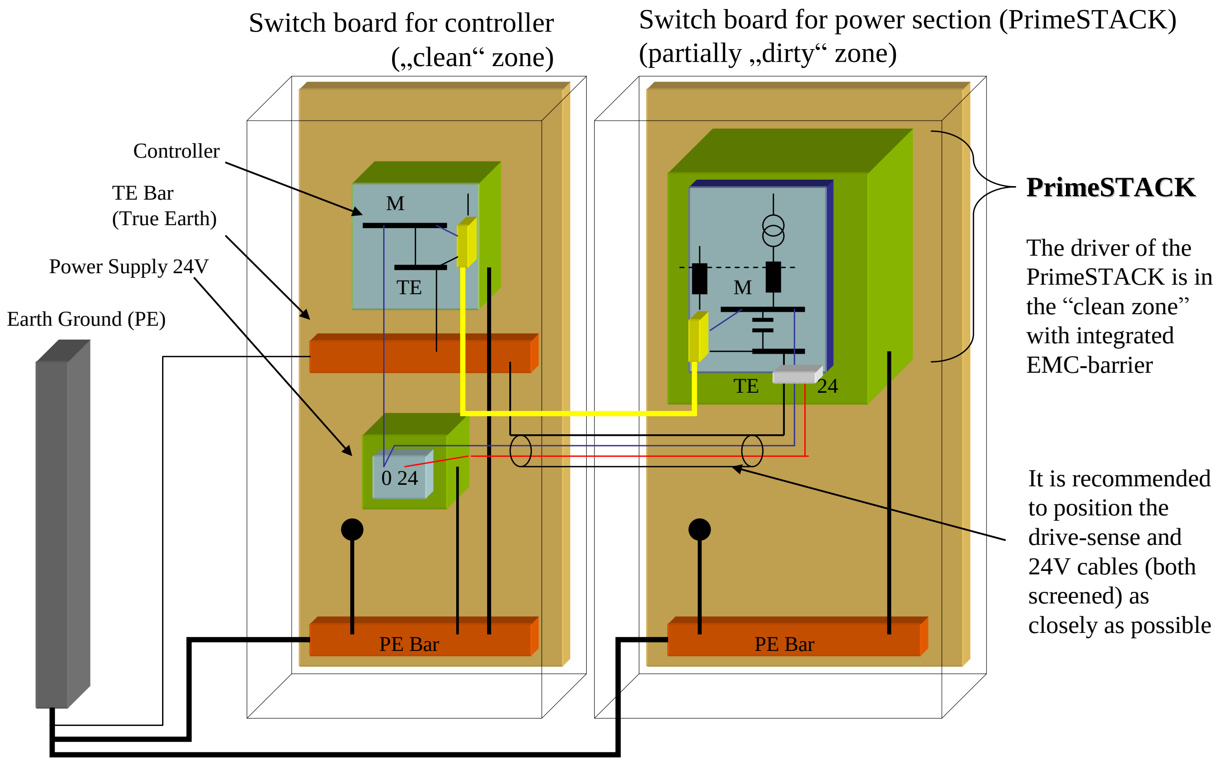


Figure 25: Example of the correct earthing for a PrimeSTACK

4.4 Maintenance and repair on site

4.4.1 Maintenance

Basically the PrimeSTACK is designed for maintenance free operation. Within appropriate intervals it should be made sure, however, that the defined ambient conditions regarding operation and storage (see section 5) are observed. The PrimeSTACK itself does not cause contamination by its operation. If, however, other contamination occurs e.g. of the heatsink, this should be removed regularly. Before maintaining the PrimeSTACK, make sure you have read the safety instructions in section 4 and 5!

4.4.2 Repair on site

If a fault occurs on the PrimeSTACK itself, it is possible in principle to repair on site. This includes all components used in the PrimeSTACK. It the fault is located, the defective component can be repaired or replaced.

Among others:

- Cases
- Driver board

- Sensors
- IGBT modules
- as well as all DC-bus components

can be replaced individually. Intact and still working components can remain in the PrimeSTACK for further use.

The possibility of the repair on site is a key advantage that helps to keep MTTR[3] and costs as low as possible. Instructions and documentation for repair on site is available on request.

4.5 Insulation concept

The PrimeSTACK insulation concept features consistent observance of "reincorced isolation". All signals available to the user from the PrimeSTACK controller interface are safely separated. For this, the Standard IEC 61800-3 has been consistently applied and both the rated voltages as well as the clearance and creepage distances according to IEC 60664-1 have been observed. In addition, the PrimeSTACK is UL listed.

Earth-free mains

The PrimeSTACK can basically be used in earth-free mains as long as the voltages occurring thereby do not exceed the values specified in the Standards IEC 61800 and IEC60664 which are relevant for the design rating. Control electronics and sensors accessible to the user at X1 (see also "User interface and pin-out") are potential separated from the power section.
Additionally, the peak voltages occurring in earth-free mains due to the parasitic capacitances are to be taken into consideration

4.6 IP class of protection

The PrimeSTACK complies with class of protection IP00. Except for the accessible life power terminals (DC+/- and AC) IP20 is complied with. The case is designed accordingly.

4.7 Permissible environmental conditions

4.7.1 Operation

The PrimeSTACK is designed for operation according to the Standard IEC 60721-3-3. In most cases the PrimeSTACK is integrated into installations which themselves are housed in a switchboard cabinet. The operating conditions defined under this Standard and the values specified in the datasheet may not be violated.

The following environmental ratings are valid for operation according to the Standard IEC 60721-3-3:

- Climatic **3K3**
    - Air pressure 90kPa to 103kPa
    - Temperature heatsink air in -40°C… +70°C
    - Ambient temperature PrimeSTACK -25°C…+55°C (+85°C)
- Biological **3B1**
- Chemical active substances **3C2**, no salty air, however

[3] Mean Time To Repair

- Mechanical active substances **3S1**
- Mechanical **3M2**

The main values are as follows:

- Temperature range
  - cooling air drawn in: -40°C…+70°C
  - Ambient of the PrimeSTACK electronics: -25°C…+55°C
  - For electronics: Design temperature of +85°C minimum needs to be observed
- Temperature drift 0.5K/min
- Relative humidity 5%...85%, no condensation
- Air pressure
  - 90kPa= 1000m level of installation
  - 103kPa= 0m= normal air pressure
  - Power derating at installation levels above 1000m
- Forced air cooling: Minimum 1m/s
- Negligible biological strain
- No salty ambient air
- Sine-wave vibration
  - 1.5mm @ 2Hz - 9Hz and
  - 5m/s² @ 9Hz - 200Hz
- Shock
  - Type L
  - 40m/s²

Note:

The terms ambient temperature and design temperature have different meanings and are hence not identical. The design temperature (sometimes called operating temperature) defines permissible operating temperatures given by the manufacturers of the components themselves, whilst ambient temperatures (room temperature, temperature inside the switchboard cabinets etc.) are quoted at some distance to the individual component (PrimeSTACK). Therefore, design temperatures are usually rated at higher levels than the permissible ambient temperatures.

4.7.2 Transport

The following technical specifications have to be observed additionally to the quoted safety regulations for a safe transport. This is based on the assumption that the transport of the PrimeSTACK takes place in the packaging supplied. The following environmental ratings are valid for transporting the PrimeSTACK according to the Standard IEC 60721-3-2:

- Climatic **2K2,** however, temperature -40°C…+85°C
- Biological **2B1**
- Chemical active substances **2C2**, no salty air, however
- Mechanical active substances **2S1**
- Mechanical **2M2**

The main values are as follows:

- Temperature range -40°C…+85°C
- Relative humidity 75% at 30°C, not in conjunction with fast temperature drift
- Negligible biological strain
- No salty ambient air
- Sine-wave vibration
    - 3.5mm @ 2Hz - 9Hz and
    - 10m/s² @ 9Hz - 200Hz
    - 15m/s² @ 200Hz - 500Hz
- Shock
    - Type I
    - 100m/s²

4.7.3 Storage

For storage without packaging please observe additionally to the safety regulations quoted under 4.7.1 the following limits. The environmental ratings are given in IEC 60721-3-1.

- Climatic **1K2,** however, temperature -40°C…+85°C
- Biological **1B1**
- Chemical active substances **1C2**, no salty air, however
- Mechanical active substances **1S1**
- Mechanical **1M2**

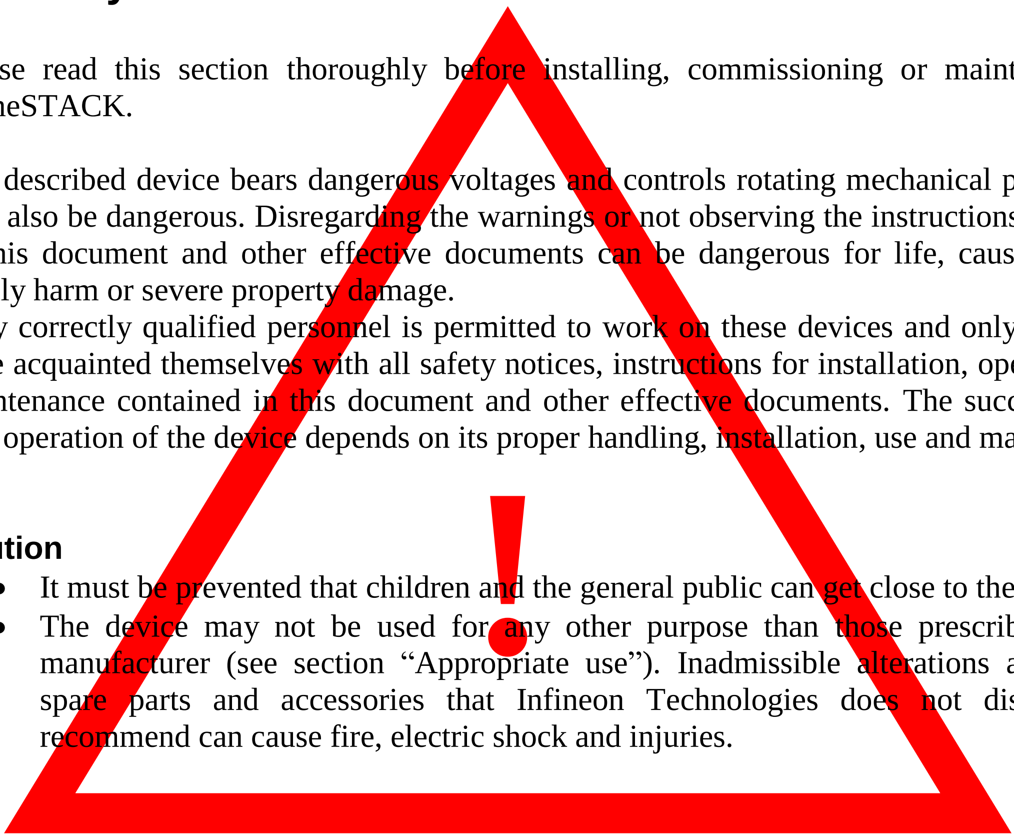
The main values are as follows:

- Temperature range -40°C…+85°C
- Temperature drift 0.5K/min
- Relative humidity 5%...85%
- no condensation
- Negligible biological strain
- No salty ambient air
- Sine-wave vibration
    - 1.5mm @ 2Hz - 9Hz
    - 5m/s² @ 9Hz - 200Hz
- Shock
    - Type L
    - 40m/s²

5 Safety notices

Please read this section thoroughly before installing, commissioning or maintaining the PrimeSTACK.

The described device bears dangerous voltages and controls rotating mechanical parts which may also be dangerous. Disregarding the warnings or not observing the instructions contained in this document and other effective documents can be dangerous for life, cause grievous bodily harm or severe property damage.
Only correctly qualified personnel is permitted to work on these devices and only after they have acquainted themselves with all safety notices, instructions for installation, operation and maintenance contained in this document and other effective documents. The successful and safe operation of the device depends on its proper handling, installation, use and maintenance.



Caution

- It must be prevented that children and the general public can get close to the device!
- The device may not be used for any other purpose than those prescribed by the manufacturer (see section “Appropriate use”). Inadmissible alterations and use of spare parts and accessories that Infineon Technologies does not distribute or recommend can cause fire, electric shock and injuries.

Notes:

- This document has to be kept well accessible near the device and placed at the disposal of all users.
- When measurements or tests have to be performed on life equipment, the regulations according to **BGV A3** are to be observed. Suitable electronic devices are to be used.
- Before installation and commissioning please read thoroughly these safety instructions and warnings as well as all warning signs attached to the device. Make sure that warning signs remain in a legible condition and missing or damaged signs are replaced.

5.1 Transport and storage

- Correct transport (see section 4.7.2 “Transport”) and storage (see section 4.7.3 “Storage”), mounting and installation as well as careful use and maintenance are important for the proper and safe operation of the device.

Caution

- During transport and storage the PrimeSTACK has to be protected against mechanical shocks and vibration with values exceeding given in the datasheet and in this document. Protection against water (rain) and inadmissible temperatures is also mandatory.

5.2 Commissioning

- Work on the device and/or system carried out by **unqualified** personnel and/or not observing the warnings can be **dangerous for life, cause grievous bodily harm or serious material damage**. Work on the device and/or system may only be carried out by suitably qualified personnel, with regard to the setting-up, installation, commissioning and operation of the product.

- During the removal of the protective cover and the work with electric parts of the PrimeSTACK, ESD protective measures have to be taken.
- Only hardwired AC/DC – terminals are permitted. **The device has to be earthed.** We recommend to ground the heatsink.
- Should a residual current device (RCD) be used, it has to be of **type B**.
- Machines with three-phase electric power supply equipped with EMC-filters may not be connected to the mains via an earth fault protective switch (see EN 50178).
- The AC and DC terminals can bear dangerous voltages even when the PrimeSTACK is not running!

Caution

- The connection of the cables for mains supply, motor and control on the inverter has to be carried out as described in section 4 “PrimeSTACK system integration” to prevent inductive and capacitive disturbances interfering with the proper functions of the inverter.

5.3 Operation

- The PrimeSTACK works with high and dangerous voltages.
- During operation of electric devices it is inevitable that dangerous voltages are born on certain parts of the devices.
- Equipment for emergency stop has to remain operative in all operating states of the controller. A reset of the emergency stop must not lead to uncontrolled or undefined restart.
- In such cases when short circuits in the controller can lead to considerable property damage or even to grievous bodily harm and death (i.e. potentially dangerous short circuits), additional external measures or equipment have to be provided in order to guarantee or force safe operation even if a short circuit occurs (e.g. independent limit switches, mechanical interlocks, etc.).
- Certain parameter adjustments may result in the automatic start of the PrimeSTACK after an interruption of the mains voltage.
- The device must not be used as “Equipment for emergency stop” (see EN 60204).

Please note that for installation higher than 1000m above sea level a derating of the load current will be necessary!

5.4 Maintenance

- Repairs on the device may only be carried out by Infineon repair centres, service facilities accredited by Infineon or by qualified personnel thoroughly acquainted with all warnings and operating procedures in this manual.
- Work on the PrimeSTACK (installation and removal of subassemblies, mechanical work etc.) may only be carried out with sufficient ESD-protective measures. As minimal protection, the person doing this job must be connected by an ESD-wristband with earth potential.
- Any defective parts or components must be replaced by parts from the corresponding spare parts list.
- Remove the electric power supply before opening of the device.

6 Appendix

6.1 Technical drawings

6.1.1 PrimeSTACK with air cooler

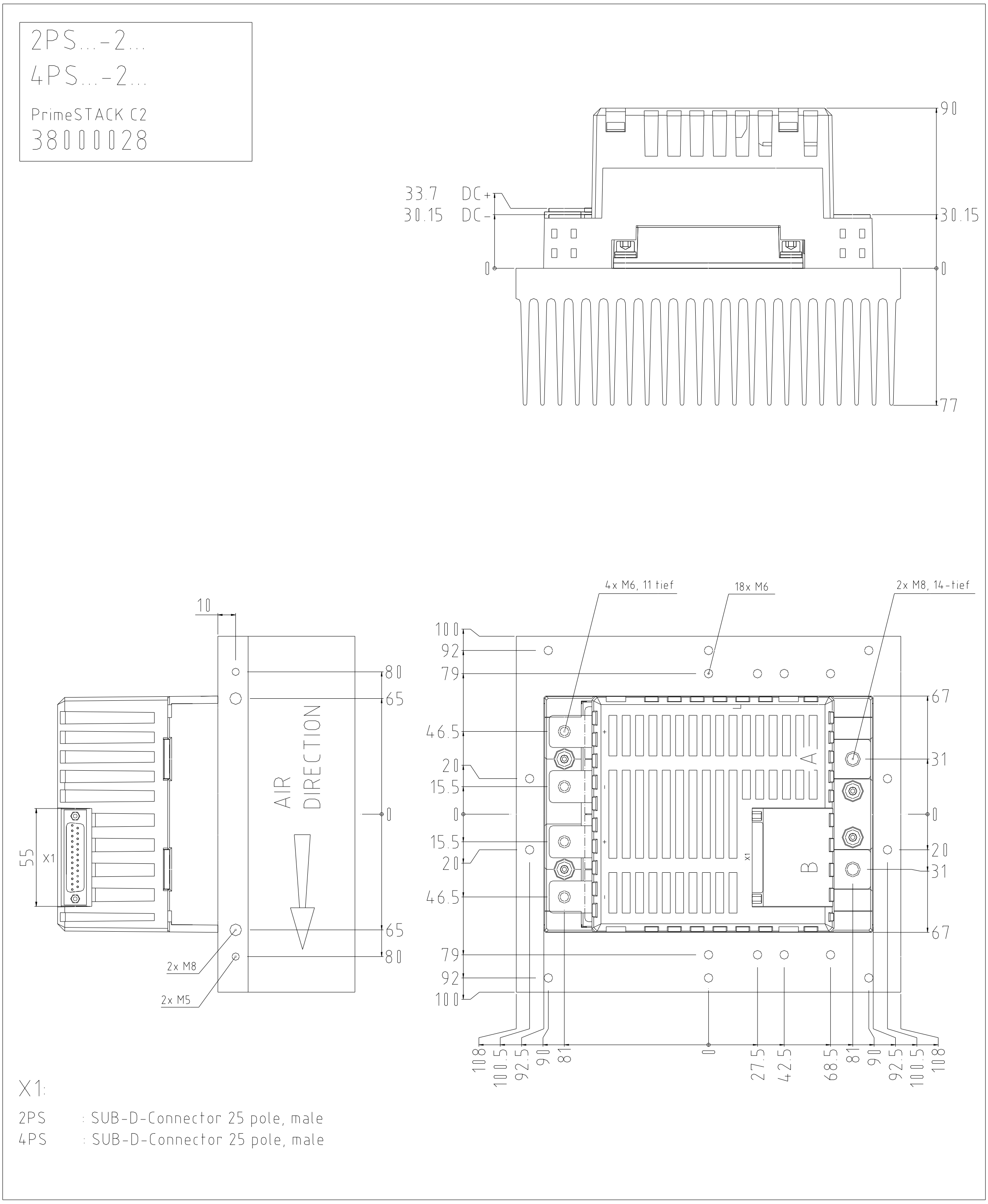


Figure 26: Technical drawing PrimeSTACK in size C2 with air cooler

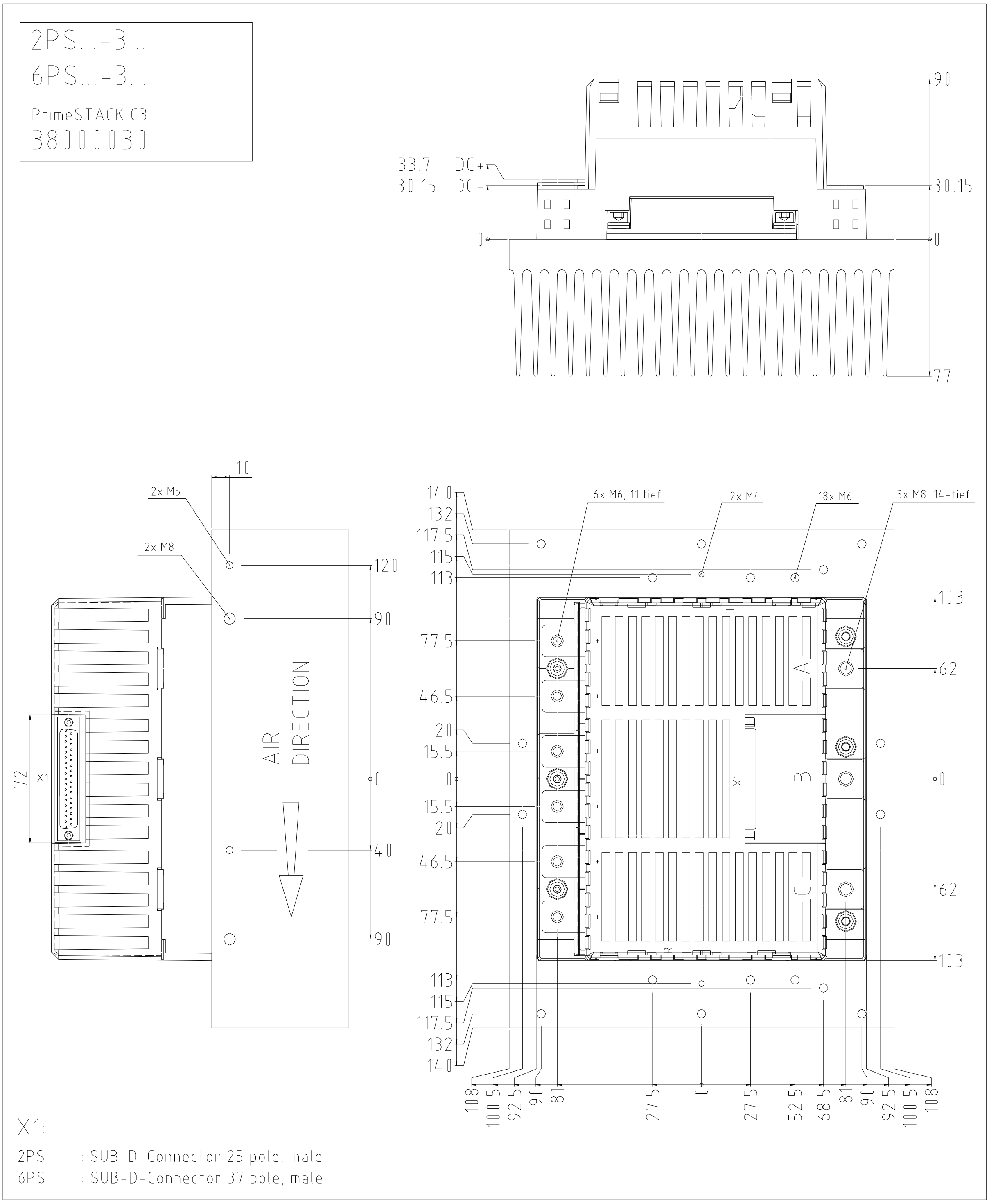


Figure 27: Technical drawing PrimeSTACK in size C3 with air cooler

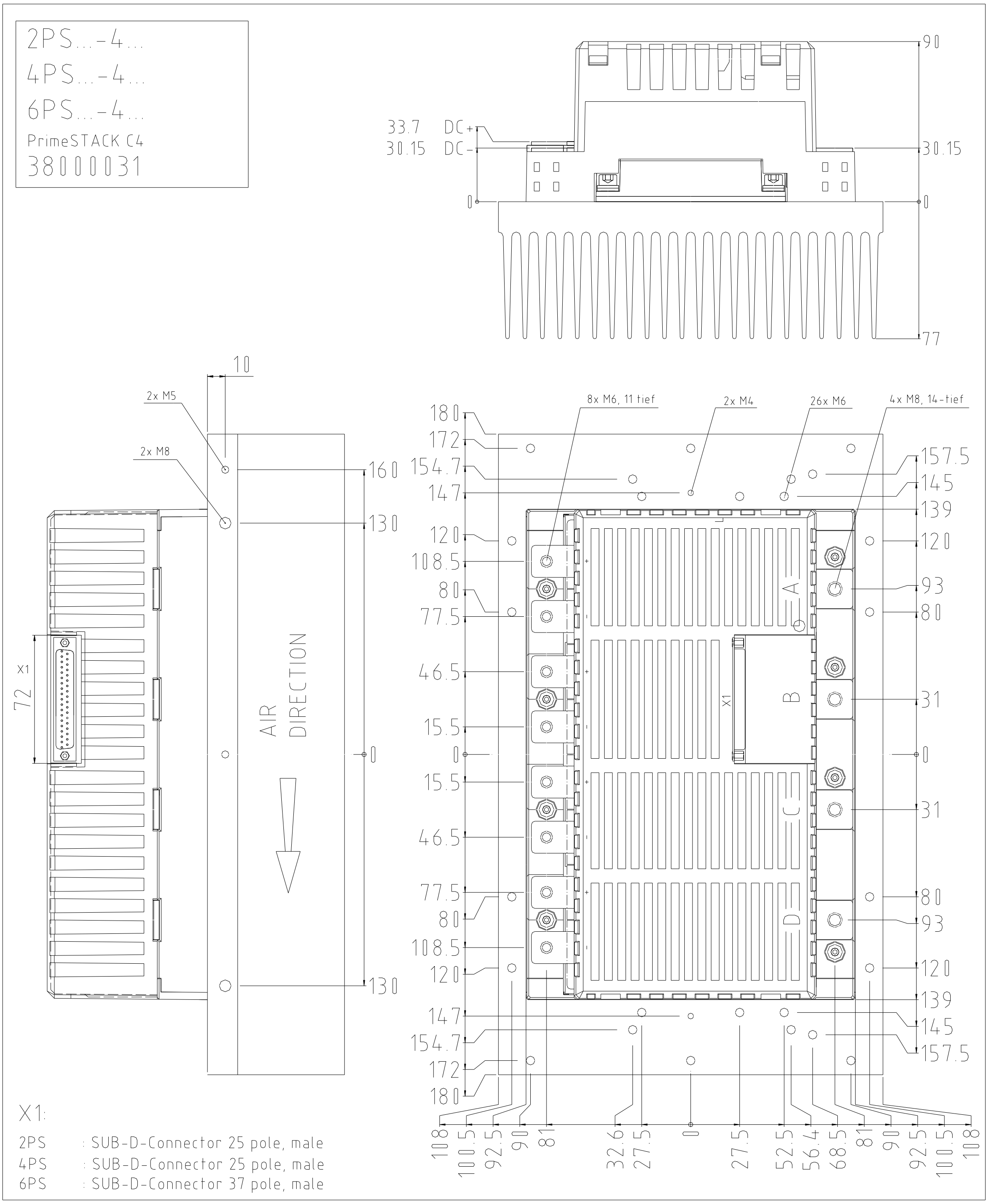
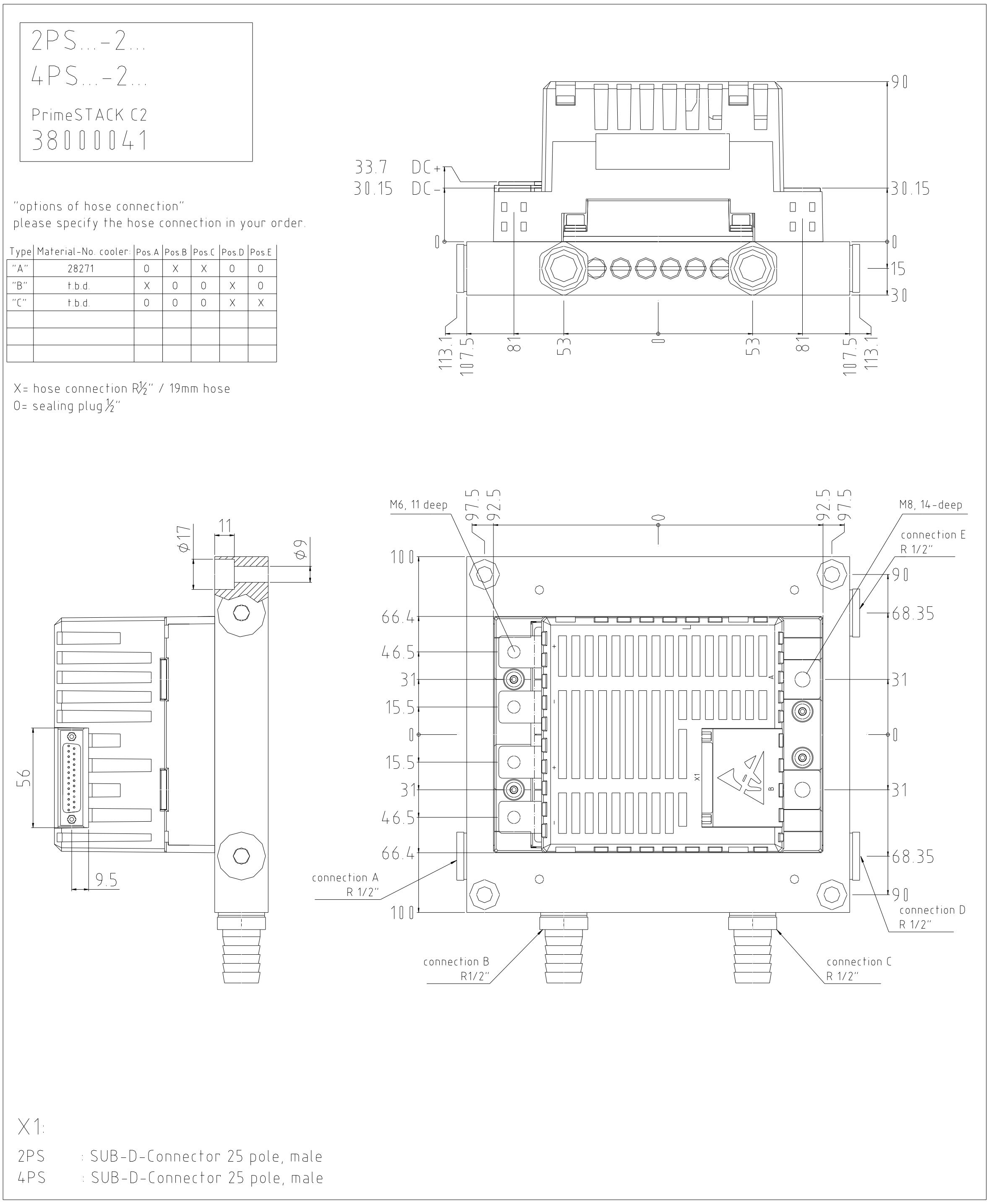


Figure 28: Technical drawing PrimeSTACK in size C4 with air cooler

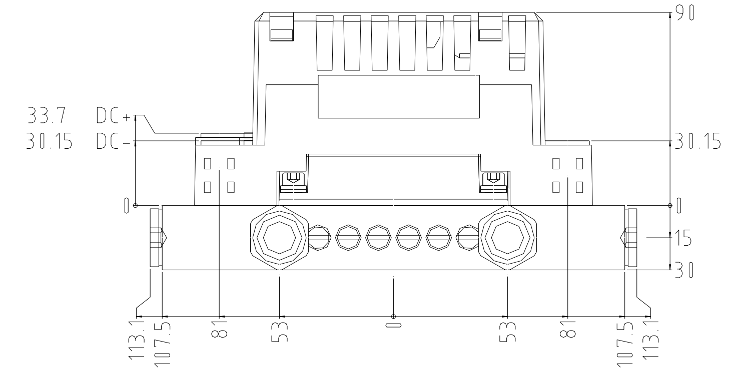
6.1.2 PrimeSTACK with water cooler



Type	Material-No. cooler:	Pos.A	Pos.B	Pos.C	Pos.D	Pos.E
"A"	28271	O	X	X	O	O
"B"	t.b.d.	X	O	O	X	O
"C"	t.b.d.	O	O	O	X	X

Figure 29: Technical drawing PrimeSTACK in size C2 with water cooler

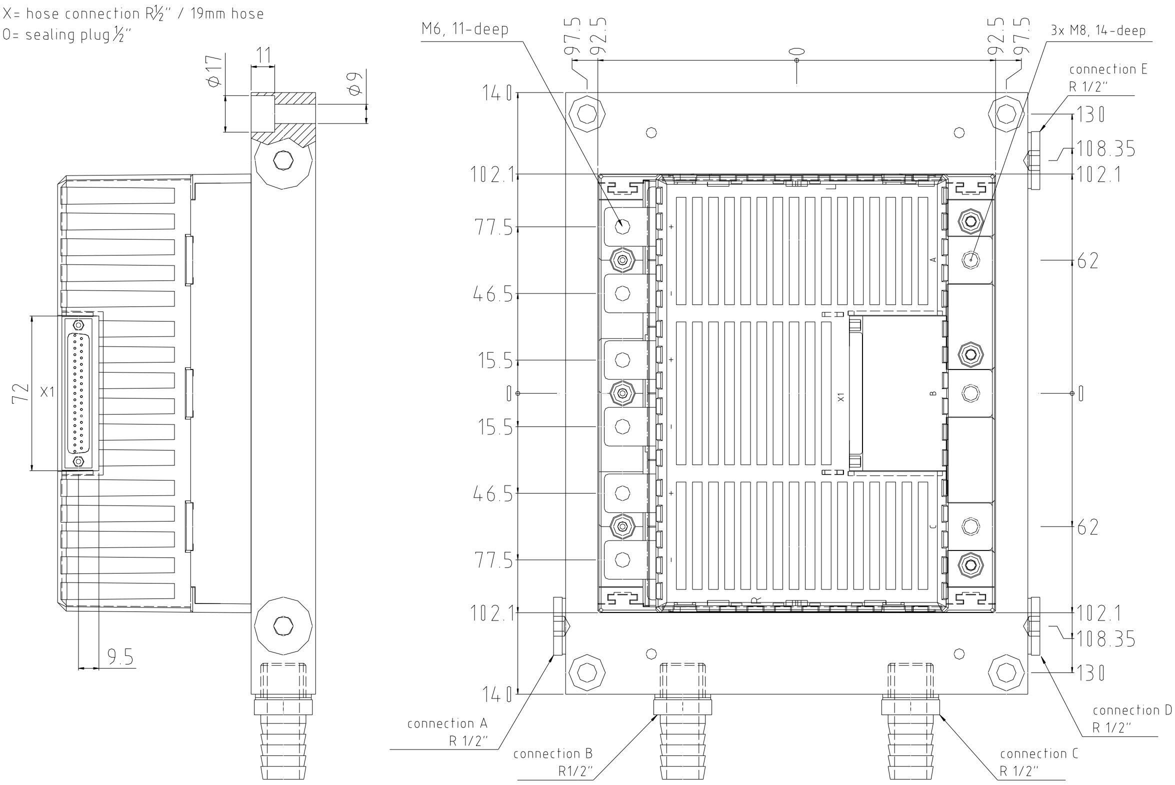
2PS...-3...
6PS...-3...
PrimeSTACK C3
38000039



"options of hose connection"
please specify the hose connection in your order.

Type	Material-No. cooler:	Pos.A	Pos.B	Pos.C	Pos.D	Pos.E
"A"	27723	0	X	X	0	0
"B"	t.b.d.	X	0	0	X	0
"C"	t.b.d.	0	0	0	X	X

X= hose connection R½" / 19mm hose
0= sealing plug ½"



X1:
2PS : SUB-D-Connector 25 pole, male
6PS : SUB-D-Connector 37 pole, male

Figure 30: Technical drawing PrimeSTACK in size C3 with water cooler

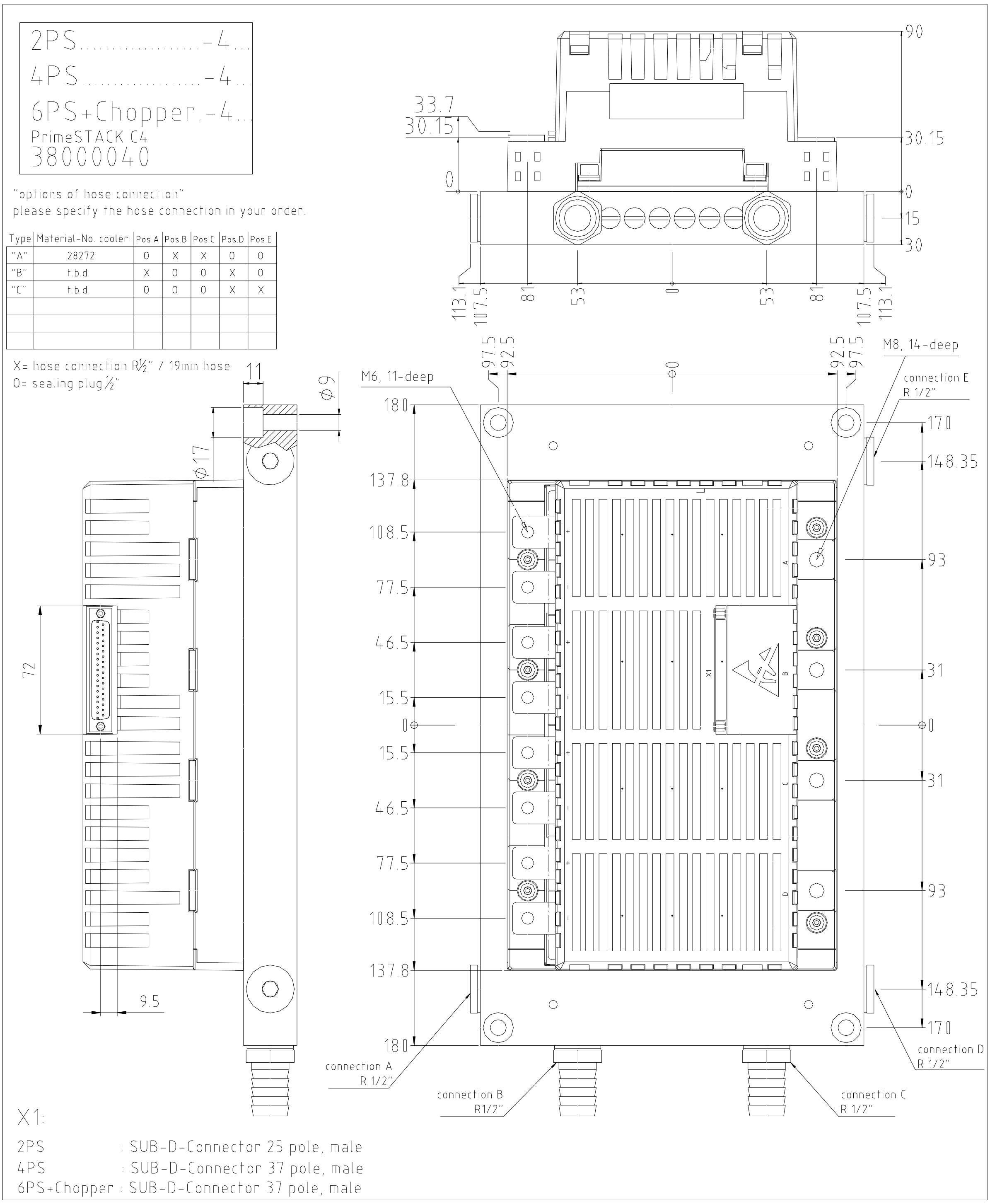


Figure 31: Technical drawing PrimeSTACK in size C4 with water cooler

6.1.3 PrimeSTACK capacitor box

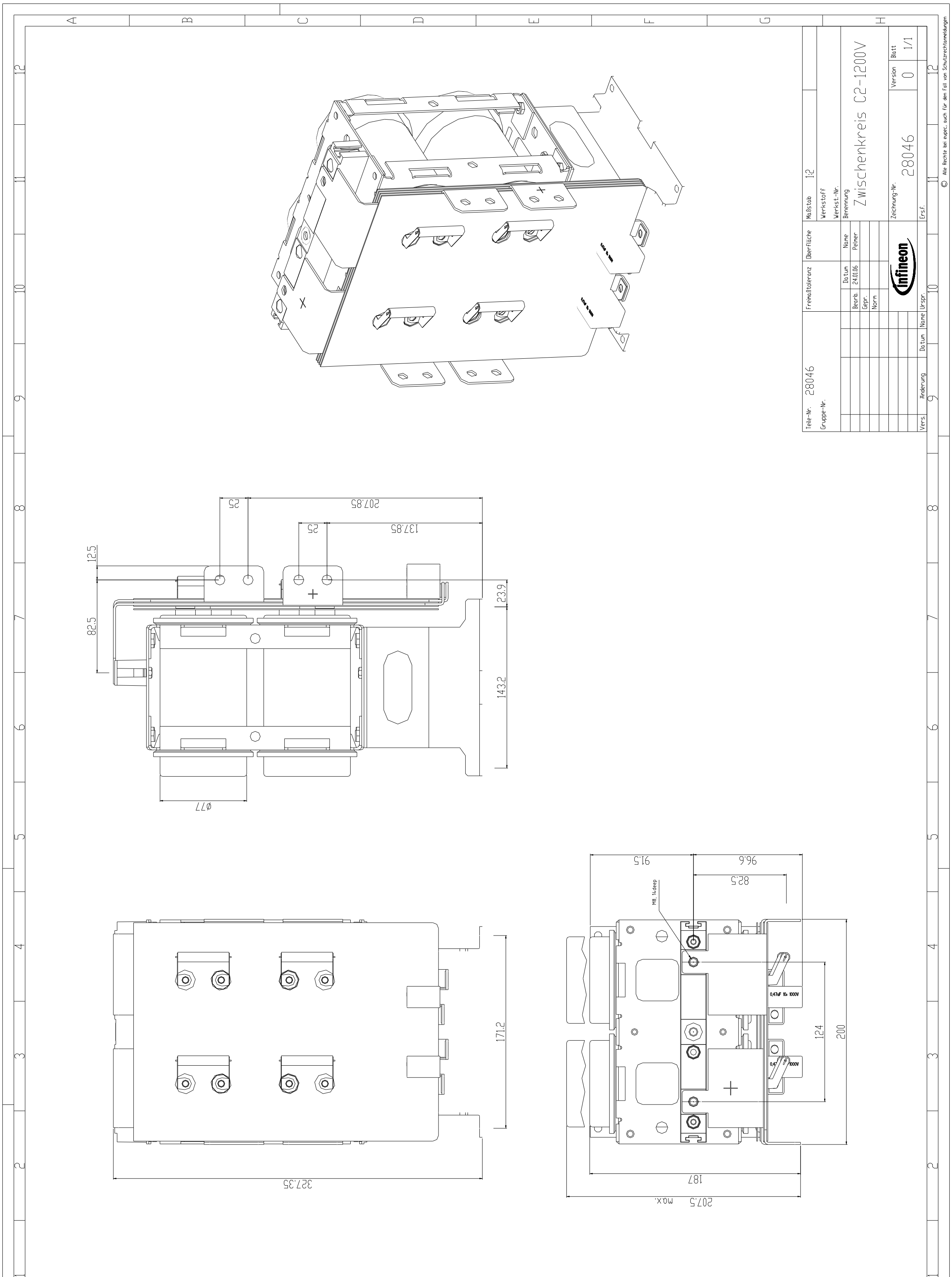


Figure 32: Technical drawing PrimeSTACK DC-bus assembly (here: for size C2)

6.1.4 Examples of PrimeSTACK systems

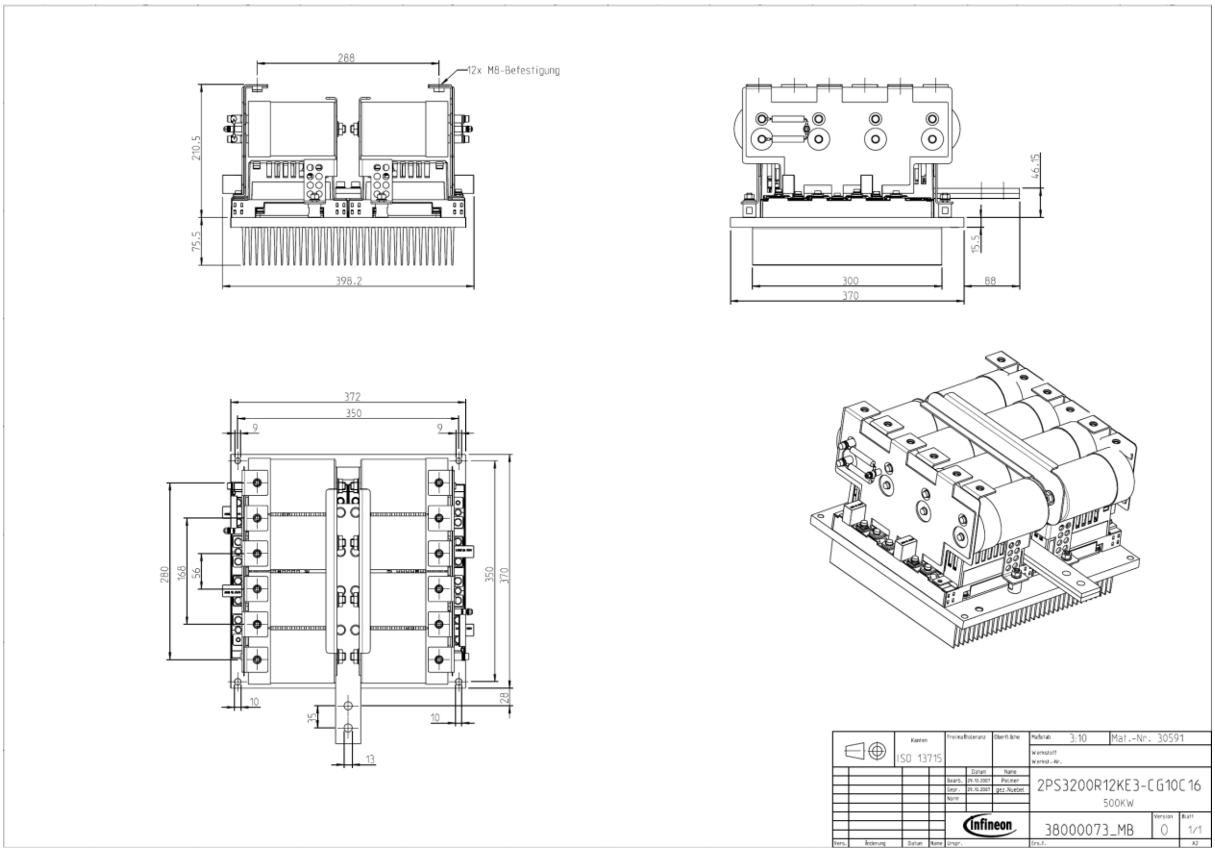


Figure 33: PrimeSTACK size CC with DC-bus. Very compact IGBT half-bridge with 3200A nominal chip current

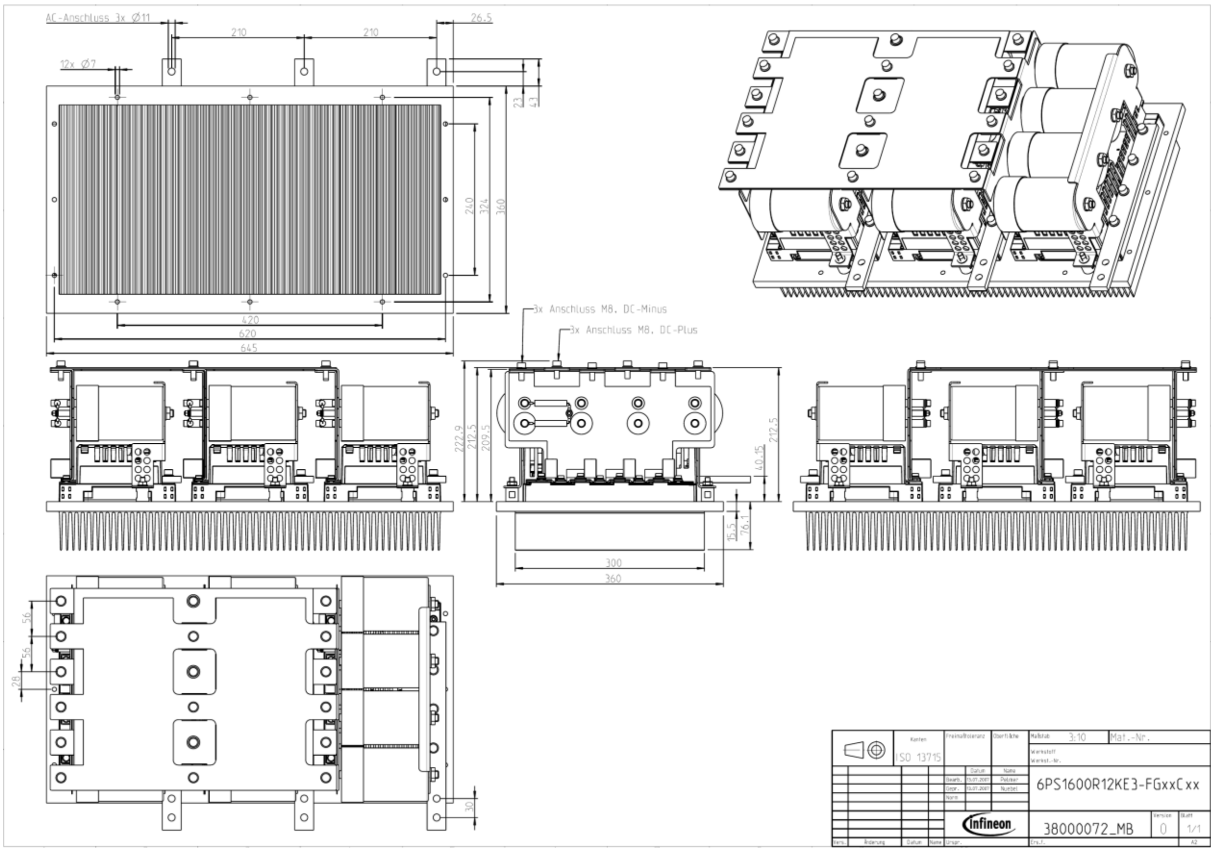


Figure 34: PrimeSTACK size CF with DC-bus. Very compact B6I with 1600A nominal chip current per half-bridge.

6.2 Further associated documentation

The documents listed below are effective in parallel to this PrimeSTACK product family documentation. All information can be found either on the Internet www.infineon.com or please contact us directly. We are pleased to give advice regarding all information recorded in the current documents. You find our contact address in the appendix of this document.

- **PrimeSTACK datasheet**
- **EiceDRIVER™ datasheet** The EiceDRIVER™ is an essential component of the PrimeSTACK.
- **PrimeSTACK datasheet glossary of terms**
  → Explanations to the abbreviations, symbols and parameters used in the PrimeSTACK datasheets (contained also in the appendix of this document)
- **Application Notes** All application notes published by Infineon at the time of application of the PrimeSTACK are valid:
  - PrimeSTACK especially:
    - AN2006-03
    - AN2006-07
  - EiceDRIVER™ and
  - other relevant components of the PrimeSTACK (e.g. heatsink)
- **STACK-Optimizer**
  Detailed customised calculation with regard to one or several operating points of the PrimeSTACK. This also includes calculation of the live time of the DC-bus capacitors (for PrimeSTACK System)

- **CE declaration of conformity regarding PrimeSTACK**

6.3 CE – declaration of conformity

Regarding disturbances caused and immunity against disturbances of all PrimeSTACK family members with or without additional components the relevant requirements are observed. In particular, these are the current Standard in combination with the directives:

- EMC - directive → 89/336/EEC
- Low voltage directive → 73/23/EEC

Infineon Technologies, therefore, confirms CE conformity of the products:

- PrimeSTACK
- PrimeSTACK IPM
- PrimeSTACK System

The CE- declaration of conformity regarding the PrimeSTACK is available as a separate document (see also section 6.2 “Further associated documentation”).

6.4 PrimeSTACK portfolio

The following list features the PrimeSTACK portfolio at the time of this revision. The following information can be found.

V_{ZKmax}	Type	Topology	phase current RMS	Size Case	Cooling
see	section 3.1	section 2 section 6.1	section 3.2	section 3.6 section 6.1	section 3.5

Tabelle 16: Reference section for information regarding the portfolio

Further explanations can be found in the sections referred to.

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
600V KE3 Chips	4PS0400R06KE3-3G	B2I	300	C3	Air cooling
	6PS0200R06KE3-3G	B6I	197	C3	Air cooling
	6PS0300R06KE3-3G	B6I	243	C3	Air cooling
	6PS0400R06KE3-3G	B6I	400	C3	Air cooling
	2PS0800R06KE3-3G	1/2B2I	630	C2	Air cooling
	2PS1200R06KE3-3G	1/2B2I	870	C3	Air cooling
	2PS1600R06KE3-3G	1/2B2I	1032	C4	Air cooling

Table 17: PrimeSTACK portfolio of 600V types on standard heatsinks

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
1200V KS4 Chips	4PS0300R12KS4-3G	B2I	183	C3	Air cooling
	6PS0300R12KS4-3G	B6I	170	C3	Air cooling
	2PS0600R12KS4-2G	½ B2I	366	C2	Air cooling
	2PS0900R12KS4-4G	½ B2I	500	C4	Air cooling
	2PS1200R12KS4-4G	½ B2I	610	C4	Air cooling

Table 18: PrimeSTACK Portfolio of 1200V types on standard heatsinks, IGBT2 short tail (KS4-Chips)

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
1200V KE3 Chips	6PS0150R12KE3-3G	B6I	134	C3	Air cooling
	6PS0300R12KE3-3G	B6I	181	C3	Air cooling
	6PS0400R12KE3-3G	B6I	210	C3	Air cooling
	6PS1600R12KE3-FG	B6I	850	CF	Air cooling
	2PS0400R12KE3-2G	½ B2I	311	C2	Air cooling
	2PS0600R12KE3-2G	½ B2I	360	C2	Air cooling
	2PS0800R12KE3-2G	½ B2I	445	C2	Air cooling
	2PS0900R12KE3-3G	½ B2I	500	C3	Air cooling
	2PS1200R12KE3-3G	½ B2I	569	C3	Air cooling
	2PS1600R12KE3-4G	½ B2I	717	C4	Air cooling

Table 19: PrimeSTACK portfolio of 1200V types on standard heatsinks, IGBT3 Trench Fieldstop (KE3-Chips)

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
1200V KE3 Chips	6PS0200R12KE3-3GH	B6I	172	C3	Air cooling
	6PS0400R12KE3-3GH	B6I	237	C3	Air cooling
	6PS1600R12KE3-FGH	B6I	950	CF	Air cooling
	2PS0800R12KE3-2GH	1/2B2I	490	C2	Air cooling
	2PS1200R12KE3-3GH	1/2B2I	720	C3	Air cooling
	2PS1600R12KE3-4GH	1/2B2I	850	C4	Air cooling

Table 20: PrimeSTACK portfolio of 1200V types on high efficiency heatsinks, IGBT3 Trench Fieldstop (KE3-Chips)

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
1700V KE3-Chip	4PS0300R17KE3-3G	B2I	165	C3	Air cooling
	6PS0300R17KE3-3G	B6I	145	C3	Air cooling
	2PS0400R17KE3-2G	½ B2I	276	C2	Air cooling
	2PS0600R17KE3-2G	½ B2I	325	C2	Air cooling
	2PS0900R17KE3-3G	½ B2I	422	C3	Air cooling
	2PS0800R17KE3-4G	½ B2I	482	C4	Air cooling
	2PS1200R17KE3-4G	½ B2I	571	C4	Air cooling

Table 21: PrimeSTACK portfolio of 1700V types, IGBT3 Trench Fieldstop (KE3-Chips)

V_{ZKmax}	Type	Topology	$I_{Last\ RMS}$ [A]	Size Case	Cooling
1700V KE3-Chip	6PS0300R17KE3-3GH	B6I	176	C3	Forced Air
	2PS0600R17KE3-2GH	½ B2I	375	C2	Forced Air
	2PS0900R17KE3-3GH	½ B2I	550	C3	Forced Air
	2PS1200R17KE3-3GH	½ B2I	650	C3	Water
	2PS1200R17KE3-4GH	½ B2I	650	C4	Forced Air
	2PS1200R17KE3-4W	½ B2I	788	C4	Water

6.5 Indices

6.5.1 Index of terms

6.5.2 List of figures

6.5.3 List of tables

6.6 Conditions of use

The data contained in this product information is exclusively intended for technically trained staff. You or your technical departments will have to evaluate the suitability of the described products for the intended application and the completeness of the product data provided with respect to such application.

This product documentation describes those features which are warranted by us under the delivery contract. Such a warranty references back exclusively to the regulations contained in the individual delivery contract. No guarantee of any kind will be given for the product or its properties.

Should you require product information in addition to the contents of this product information which concerns the specific application and use of this product, please contact the sales office which is responsible for your area. For those interested we may provide application notes.

Due to technical requirements our products may contain substances which can endanger your health. For information regarding the substances contained in the specific product please also contact the sales office responsible for your area.

Should you intend to use the products in aviation applications or in uses where health or life is endangered or in life support, please contact Infineon. Please note that for any such application we strongly recommend

- to jointly perform a risk and quality assessment;
- to draw up a quality assurance agreement,
- to establish joint measures for ongoing product monitoring and that delivery of product may depend on such measures.

If, and to the extent necessary, please forward equivalent notices to your customers.

Changes to this product documentation are reserved.

6.7 Contact

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