IGBT Stacks

- ModSTACK™
- ModSTACK™-HD
- PrimeSTACK™
IGBT Stacks – Present & New

Present

ModSTACK

PrimeSTACK

New

ModSTACK-HD
IGBT Stack – Concept

PWM      Control

Interface

Signal Management

Drivers

Sensors

IGBT Modules

DC-link Capacitors

Heatsink

+DC-  ~AC

~AC

Air

Water

Air

Water
IGBT Stack – Brief

- **IGBT Modules**
  - All dual-switch modules (“FF”)
  - 62mm, IHM, PrimePACK
  - 600V, 1200V, 1700V

- **Main Circuit Topology**
  - Half-bridge (1/2B2I)
  - H-bridge (B2I)
  - 3-phase bridge (B6I)
  - Back-to-back converter (B6I+B6I)

- **Functionality**
  - Gate driving
  - Sensing
  - Protection

- **DC-link capacitors**
  - Electrolytic capacitors
  - Foil capacitors

- **Heatsink**
  - Water cooled
  - Forced-air cooled

- **Interface**
  - Electrical
  - Optical
  - Paralleling
ModSTACK™
ModSTACK™ - Main Components

- Driver PCB (DR110)
- Optical Interface* (OEA101)
- Paralleling Interface* (SAD101)
- DC-link Capacitors
- DC +/- Terminals
- IGBT Module (IHM)
- Heatsink
- Voltage Sensors* (LV25-1000)
- Current Sensors (LEM HAT)
- AC Power Terminals
ModSTACK™ - Main Topology

- ModSTACKs use **IHM 140x130 Dual-switch** modules. FF-; **1200V, 1700V**; 600A-800A-1200A

- ModSTACK™3 can use maximally 6 IHMs, which can form a back-to-back converter topology or 3-phase converter topology by paralleling of 2 IHMs.
ModSTACK™ - Functional Boards

FLOW DIAGRAM

LOAD

DC-Link

Voltage-transformer

LOAD

MA1xx

MA1xx

MA1xx

NT

LV25

MA1xx

MA1xx

MA1xx

Temperature

DC-Voltage

Current U, V, W

Power Supply

Signal management

DR XXX

SAD XXX

to other paralleled STACKs

X4

X2

X3

X4_1

X2_1

X3_1

X4

X2

X3

X4_1

X2_1

X3_1

X4

X2

X3

Convert the signals fibre optics

Controller

Input PWM & fault Output

Monitor

ModSTACK™ - Functions

Gate Driving
- EiceDRIVER™ 2ED300C17-S, one for each half-bridge
- Adaptor board on each module

Sensing
- AC current on each phase
- Temperature on heatsink
- DC-link voltage (optional)

Protection
- Short Circuit: via Vcesat monitoring with EiceDRIVER™
- Over Current: via current sensor
- Over Voltage: via voltage sensor (optional)
- Over Temperature: via NTC & chip temperature simulation

Signal Input & Output
- PWM Inputs (Digital) – electrical or optical
- Fault Outputs (Digital) – electrical or optical
- Analog Current/Temperature/Voltage Outputs (Analog)
ModSTACK™ – Cooling

Forced Air Cooling

Water Cooling (Al-tube or Cu-tube)
ModSTACK™3 – Size & Capacitor Layout

<table>
<thead>
<tr>
<th>Size</th>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>L = 1090mm</td>
<td>Foil or Electrolytic</td>
</tr>
<tr>
<td>D = 396mm</td>
<td>Max. 10 paralleled</td>
</tr>
<tr>
<td>1 Row</td>
<td>2 Rows</td>
</tr>
</tbody>
</table>

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<th>Size</th>
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</thead>
<tbody>
<tr>
<td>L = 1090mm</td>
<td>Foil or Electrolytic</td>
</tr>
<tr>
<td>D = 496mm</td>
<td>Max. 20 paralleled</td>
</tr>
<tr>
<td>2 Rows</td>
<td></td>
</tr>
</tbody>
</table>

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<th>Size</th>
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</tr>
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<tbody>
<tr>
<td>L = 1090mm</td>
<td>Foil or Electrolytic</td>
</tr>
<tr>
<td>D = 596mm</td>
<td>Max. 30 paralleled</td>
</tr>
<tr>
<td>3 Rows</td>
<td></td>
</tr>
</tbody>
</table>
ModSTACK™ – Options for Customization

Module
- IHM standard modules (FFxxxxRxxKE3)
- IHM traction modules (FFxxxxRxxKE3_B2)

Capacitor (for ModSTACK3)
- Electrolytic Capacitors
  2 rows (max. 20 pcs) or 3 rows (max. 10 pcs)
- Foil capacitors
  1 row (max. 10 pcs), 2 rows (max. 20 pcs) or 3 rows (max. 10 pcs)

Depth
- 396mm (for foil capacitors in 1 row)
- 496mm (for foil/electrolytic capacitors in 2 rows)
- 596mm (for foil/electrolytic capacitors in 3 rows or 2 rows)

Heatsink
- Air cooled (with fans or without fans)
- Water cooled (Al-tube or Cu-tube, front-side or back-side water connection)

DC +/- Terminals
- On the same side (right or left)
- One right & one left
ModSTACK™ – Type Designation

6 MS 2400R17KE3 - 3 W C H – IO V

- B6I
- ModSTACK
- 2x FF1200R17KE3(B2) per phase
- MS3
- Water Cooling
- Copper Tube
- High Efficiency Heatsink
- Optical Interface
- Voltage Sensor
With the paralleling interface, it is possible to parallel maximally four ModSTACKs.
ModSTACK™ – Paralleling
ModSTACK™ – Applications

Example 1:
- 1.5MW Wind-power Direct Drive Converter
- DC-link 1100V
- 2x B6I units paralleled for grid side; 2 for rotor side.

Example 2:
- 2MW Wind-power Double-feed Converter
- DC-link 1100V
- 1x B6I unit for grid side & rotor side each

Example 3:
- 1500A Drive @ 690Vac
- DC Link 1000...1100V
- 4 parallel B6I Units
- Water Cooling
- Cabinet Base 800x600
- Application: Heavy Drive Units for Oil and Gas Down Drilling
ModSTACK方案举例：2.5MW直驱式风电变流器
ModSTACK™ HD

ModSTACK™ High Density with PrimePACK™

The evolution for the well known ModSTACK™ packages

All data are target data
ModSTACK™ HD halfbridge stack based on PrimePACK™3

Package MS2W B10
ModSTACK™ HD - Phase Module

- Up to
  - 3 PrimePACK 2 or 3
  - 9 MP capacitors, alternative electrolytic capacitors (needs an additional capacitor box)
- 690V rms
- 1100V DC nominal
- 1700A rms (target)
- Driver DR240 for one phase unit, alternative DR110 for three phase unit (EiceDRIVER™ included)
- Water-cooled heatsink with copper or aluminium tubes
- Designed for a mounting frame for up to 3 phase modules.
  - Dimensions comparable to to ModSTACK 3 package
ModSTACK™ HD with PrimePACK™

- Special features
  - Based on the dimensions of the ModSTACK family
    - Please read also the ModSTACK Product Presentation
  - High temperature of module allowed
  - Flexible adaption of power terminals
  - Limited heat flow from module to capacitors
  - Dynamic Active Clamping (optionally)
  - Back to back mounting possible
    - Less copperbars for back to back converter
ModSTACK™ HD Evolution
Based on PrimePACK™ 3, increased power range for several applications

- Current package: MS3W
  (also available)
- 6* IH2 (FF1200R17KE3)
  - 3*1100 Arms
  - 3*690 Vrms
- 1.3 MVA Inverter

- Improved package: MS3W B10
  (B10 -> HD concept)
- 9* PP3 (FF1000R17IE4)
  - 3*1700 Arms
  - 3*690 Vrms
- 2 MVA Inverter (+54%)
ModSTACK HD in B6I+B6I configuration (asymmetric)

- Package: MS3W B10
- 9* PP3 (FF1000R17IE4)
- 3*1150 Arms
- 3* 560 Arms
- 3* 690 Vrms

For Wind Power Systems based on DFIG
ModSTACK™ HD B6CI+B6CI stack based on PrimePACK™, vertically mounted

- **Package**: MS6W B10
- **18* PP3 (FF1000R17IE4)**
- **2*3*1700 Arms**
- **3* 690 Vrms**
- **2 MVA Full Inverter**
  e.g. for Wind Power Systems based on Synchronous Generator
## Planned package range (water cooled)

<table>
<thead>
<tr>
<th>Package</th>
<th>Circuit</th>
<th>Suitable PrimePACK™</th>
<th>Weight</th>
<th>Dimensions w<em>d</em>h [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS2WB10</td>
<td>B6I</td>
<td>3* PP2 or PP3</td>
<td>32 kg</td>
<td>400<em>596</em>370</td>
</tr>
<tr>
<td>MS3WB10</td>
<td>B6I+B6I</td>
<td>9* PP2 or PP3</td>
<td>100 kg</td>
<td>1090<em>596</em>370</td>
</tr>
<tr>
<td>MS2WB10</td>
<td>1/2B2I</td>
<td>3* PP2 or PP3</td>
<td>32 kg</td>
<td>400<em>596</em>370</td>
</tr>
<tr>
<td>MS3WB10</td>
<td>B2I</td>
<td>9* PP2 or PP3</td>
<td>100 kg</td>
<td>1090<em>596</em>370</td>
</tr>
<tr>
<td>MS3WB10</td>
<td>B6I</td>
<td>9* PP2 or PP3</td>
<td>125 kg</td>
<td>1090<em>596</em>370</td>
</tr>
<tr>
<td>MS6WB10</td>
<td>B6I+B6I</td>
<td>18* PP2 or PP3</td>
<td>270 kg</td>
<td>1090<em>596</em>850</td>
</tr>
</tbody>
</table>

**All data are target data**
# Planned type range (water cooled)

<table>
<thead>
<tr>
<th>Current *)</th>
<th>Type</th>
<th>Circuit</th>
<th>Package</th>
<th>Included PrimePACK™</th>
</tr>
</thead>
<tbody>
<tr>
<td>3*560</td>
<td>6MS1000R17IE4-2WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS2WB10</td>
<td>3*FF1000R17IE4</td>
</tr>
<tr>
<td>2<em>3</em>560</td>
<td>12MS1000R17IE4-3WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS3WB10</td>
<td>6*FF1000R17IE4</td>
</tr>
<tr>
<td>3*1150A</td>
<td>12MS2000R17IE4-3WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS3WB10</td>
<td>9*FF1000R17IE4</td>
</tr>
<tr>
<td>3*560A</td>
<td>12MS2000R17IE4-3WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS3WB10</td>
<td>9*FF1000R17IE4</td>
</tr>
<tr>
<td>1*1700</td>
<td>2MS3000R17IE4-2WAHCxB10</td>
<td>1/2B2I</td>
<td>MS2WB10</td>
<td>3*FF1000R17IE4</td>
</tr>
<tr>
<td>2*1700</td>
<td>4MS3000R17IE4-3WAHCxB10</td>
<td>B2I</td>
<td>MS3WB10</td>
<td>6*FF1000R17IE4</td>
</tr>
<tr>
<td>3*1150</td>
<td>6MS2000R17IE4-3WAHCxB10</td>
<td>B6I</td>
<td>MS3WB10</td>
<td>6*FF1000R17IE4</td>
</tr>
<tr>
<td>3*1700</td>
<td>6MS3000R17IE4-3WAHCxB10</td>
<td>B6I</td>
<td>MS3WB10</td>
<td>9*FF1000R17IE4</td>
</tr>
<tr>
<td>2<em>3</em>1150</td>
<td>12MS2000R17IE4-6WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS6WB10</td>
<td>12*FF1000R17IE4</td>
</tr>
<tr>
<td>2<em>3</em>1700</td>
<td>12MS3000R17IE4-6WAHCxB10</td>
<td>B6I+B6I</td>
<td>MS6WB10</td>
<td>18*FF1000R17IE4</td>
</tr>
</tbody>
</table>

Basic stacks, others on request

*) typical output current (preliminary) at VDC=1100V, fsw=2 kHz, VAC=690V, f_0=50Hz, cos_phi=0,85, Ta=40°C, Tjmax=Tjop

All data are target data
Type Designation

Example: 6MS3000R17IE4-3XXX

- **6**: Circuit Topology of the power section (amount of switches, here: six switches 3x plus, 3x minus => 2, 4, 6, 12)
- **MS**: Stack family ModSTACK
- **3000**: Installed nominal current of the IGBT’s
- **R**: “Reverse conducting“, i.e. each circuit has an antiparallel diode
- **17**: Maximum blocking voltage (here 1700V)
- **IE4**: Generation of the IGBT -Chip
- **-3**: Package => 1=MS1, 2= MS2, 3=MS3, 4=MS4
- **XXX**: Description several extension options (amount of IGBT modules, Cooling method, mechanical dimension, Option Key, etc.)
PrimeSTACK™
PrimeSTACK™ – Frame Sizes

PrimeSTACK™2
2× 62mm modules

PrimeSTACK™3
3× 62mm modules

PrimeSTACK™4
4× 62mm modules
PrimeSTACK™ – Topologies

2pack

4pack

6pack

6pack + chopper
PrimeSTACK™ - Product Range

Implemented Chip Current per Phase Leg @ $T_c=80$°C [A]

- **1200V IGBT**: 2-pack, 4-pack, 6-pack, 4-pack, 2-pack
- **1700V IGBT**: 2-pack, 4-pack, 6-pack, 4-pack, 6+1 pack

C2, C3, C4
PrimeSTACK™ - Functional Diagram

OEA240 (if optical)

- Temperature monitoring
- Signal management, safe isolation
- Opt.: DC-link monitoring
- Current monitoring
- Aux.-voltage generation

Driver +

DR240

Driver -

2ED300C17-S

PWM

Supply

Fault Output

Analog Output

X1

VAC

Safe Isolation

NTC
PrimeSTACK™ - Functions

Gate Driving
- EiceDRIVER™ 2ED300C17-S, one for each half-bridge
- Adaptor board on each module

Sensing
- AC current on each module
- Temperature on heatsink and PCB (ambient)
- DC-link voltage (optional)

Protection
- Short Circuit: via Vcesat monitoring with EiceDRIVER™
- Over Current: via current sensor
- Over Voltage: via voltage sensor (optional)
- Over Temperature: via NTC & chip temperature simulation (optional)

Signal Input & Output
- PWM Inputs (Digital) – electrical or optical
- Fault Outputs (Digital) – electrical or optical
- Analog Current/Temperature/Voltage Outputs (Analog)
PrimeSTACK™ – Cooling Method

- Forced Air Cooling
- Water Cooling
PrimeSTACK™ – Basic Set & Add-on

- Basic
- ex. Module ex.
- Heatsink
- xPSxxxxRxxxxx-3x

+ Basic Add-on
- IGBT Modules

Add-on
- DC Voltage Sensor
  (Installed Inside)

Basic Add-on
- Heatsink

PrimeSTACK™ Basic
with Basic Add-on
- IGBT Modules
PrimeSTACK™ System

- Capacitors
- Capacitor box for C2, C3, C4
- Symmetry Resistor
- Individuell connection to DC+/-
- Ultra low inductive DC - bus bar
- Connection (+/-) to PrimeSTACK
PrimeSTACK™ System

**Complete DC-link (3x)**
- Capacitors,
- Sym. Resistors
- Snubber
- Box

**DC-link layer**

**Electronic (3x)**
- Driver
- Monitoring
- Analog output
- EMC concept
- Protection

**Mounting Plate**

**Heat Sinks**
Air or water

**62mm IGBT modules**
PrimeSTACK™ - Type Designation

Example 2 PS 1200R17KE3 - 4 WH - IO

1/2B2I (Half-bridge)
PrimeSTACK
1200A (4x300A), 1700V KE3 Module
Frame Size (C4)
Water Cooling
High-efficiency Heatsink
Optical Interface
Example: Paralleling of PrimeSTACKs for 1.5MVA Wind Power Applications
PrimeSTACK方案举例：2.5MW直驱式风电变流器

- 套件型号：2PS1200R17KE3-4WH-CxVTIO
- 发电机侧：9个套件，每3个套件并联为一个半桥
- 电网侧：9个套件，每3个套件并联为一个半桥
- 即：一个系统共用18个套件
UL approved PrimeSTACK variants for high power applications (solar, drive, wind) (250kW to 1500kW)
PrimeSTACK System for Half-bridge, package “CG”
(up to 1470Arms)
Three phase system based on 3x package “CG”
(up to 3x1470Arms)
### 500kW solar application
*(Parameter based on 1200V IGBT)*

- **Type:** 3*2PS3200R12KE3-CGHCxVB1B3
- **DC Link Voltage:** 350 to 900Vav
- **AC Voltage:** 250 V AC
- **AC Current:** 3*1470 Arms
- **Cooling air temperature:** 50°C

- **IGBT modules:** 24*FF400R12KE3 (62mm)
- **DC Link capacitor:** 24*415µF/1100V MP
- **Current sensor:**
- **DC link voltage sensor:**
- **Temperature sensor:**
- **Driver board:** DR240 with EiceDRIVER 2ED300C17

- **Dimensions (w*d*h):** 1142*468*313mm
- **Weight:** About 100kg

- **UL approved**
1500 kW drive application
(Parameter based on 1700V IGBT)

- Type: 3*2PS2400R17KE3-CGHCxVB1B3
- Current: 3*1250 Arms
- Line voltage: 3*690 Vrms
- Apparent power: 1,5 MVA
- DC Link Voltage nom: 975 Vav
- Cooling air temperature: 40°C

- IGBT modules: 24*FF300R17KE3 (62mm)
- DC Link capacitor: 24*415µF/1100V MP
- Current sensor:
- DC link voltage sensor:
- Temperature sensor:
- Driver board: DR240 with EiceDRIVER 2ED300C17

- Dimensions (w*d*h): 1142*468*313mm
- Weight: About 100kg

- UL approved
PrimeSTACK System based on package “CF” (up to 3*735Arms)
250kW solar application
(Parameter based on 1200V IGBT)

- Type: 6PS1600R12KE3-FGHCxVB1
- DC Link Voltage: 350 to 900Vav
- AC Voltage: 250 V AC
- AC Current: 3*735 Arms
- Cooling air temperature: 50°C

- IGBT modules: 12*FF400R12KE3 (62mm)
- DC Link capacitor: 12*415µF/1100V MP
- Current sensor:
- DC link voltage sensor:
- Temperature sensor:
- Driver board: DR240 with EiceDRIVER 2ED300C17

- Dimensions (w*d*h): 571*468*313mm
- Weight: About 50kg

- UL approved
We commit.
We innovate.
We partner.
We create value.