

In-Space Power Electronics Building Blocks for Hybrid Power Systems

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- ❑ **In-Space Hybrid Power System Architecture**
 - Improved power-density, reliability, resilience,
 - High-voltage power electronics converters

- ❑ **Platforming Power Electronics**
 - Capable of performing any type of conversion (DC-DC, AC-DC, DC-AC, AC-AC)
 - Supporting high voltages (up to 10 kV)
 - High reliability
 - Radiation tolerant
 - Interchangeable boards
 - Optimizing spares, reduced component count
 - Reduced maintenance and long-duration in-space operation
 - Common control (plug & play)

- ❑ **Space Grade Intelligent Self-Sustained High-Voltage Power Electronics Building Blocks**
 - In-housed developed silicon carbide (SiC) switches supporting up to 10 kV
 - Multilevel neutral-point clamped topology

❑ A Common High-Voltage DC Bus

- ≥ 1000 V

❑ Energy Sources

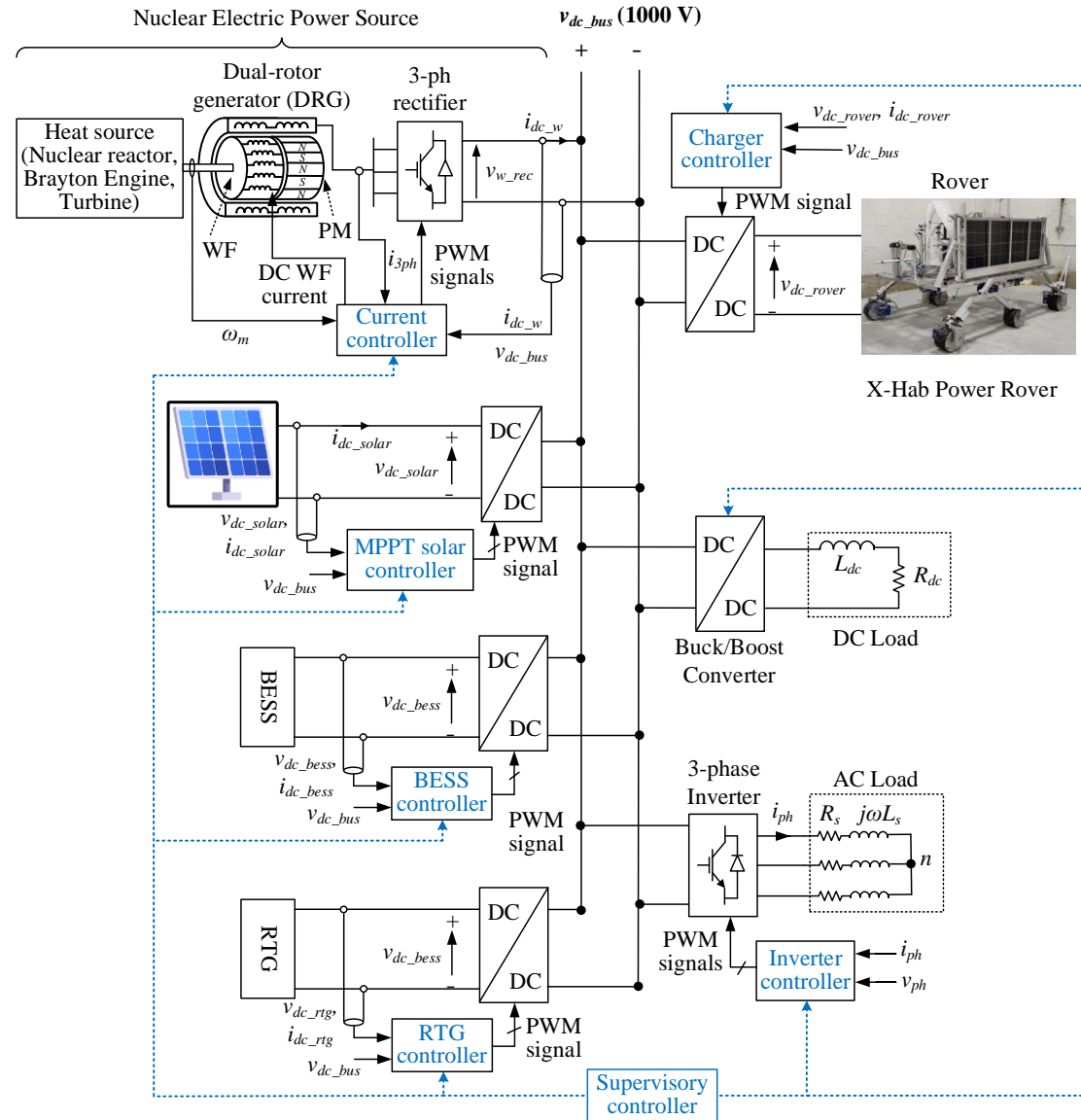
- Solar source interfaced to DC bus using DC-DC converter
- Nuclear electric power source interfaced to DC bus using an AC-DC converter (Rectifier)
- Battery energy storage (BESS) interfaced to DC bus using a bi-directional DC-DC converter
- RTG source interfaced to DC bus using DC-DC converter

❑ Loads

- Chargers interfaced to DC bus using DC-DC converter
- DC loads interfaced to DC bus using DC-DC converter
- 1-phase and/or 3-phase AC loads interfaced to DC bus using AC-DC active converter (Inverter)

❑ Controls & Monitoring

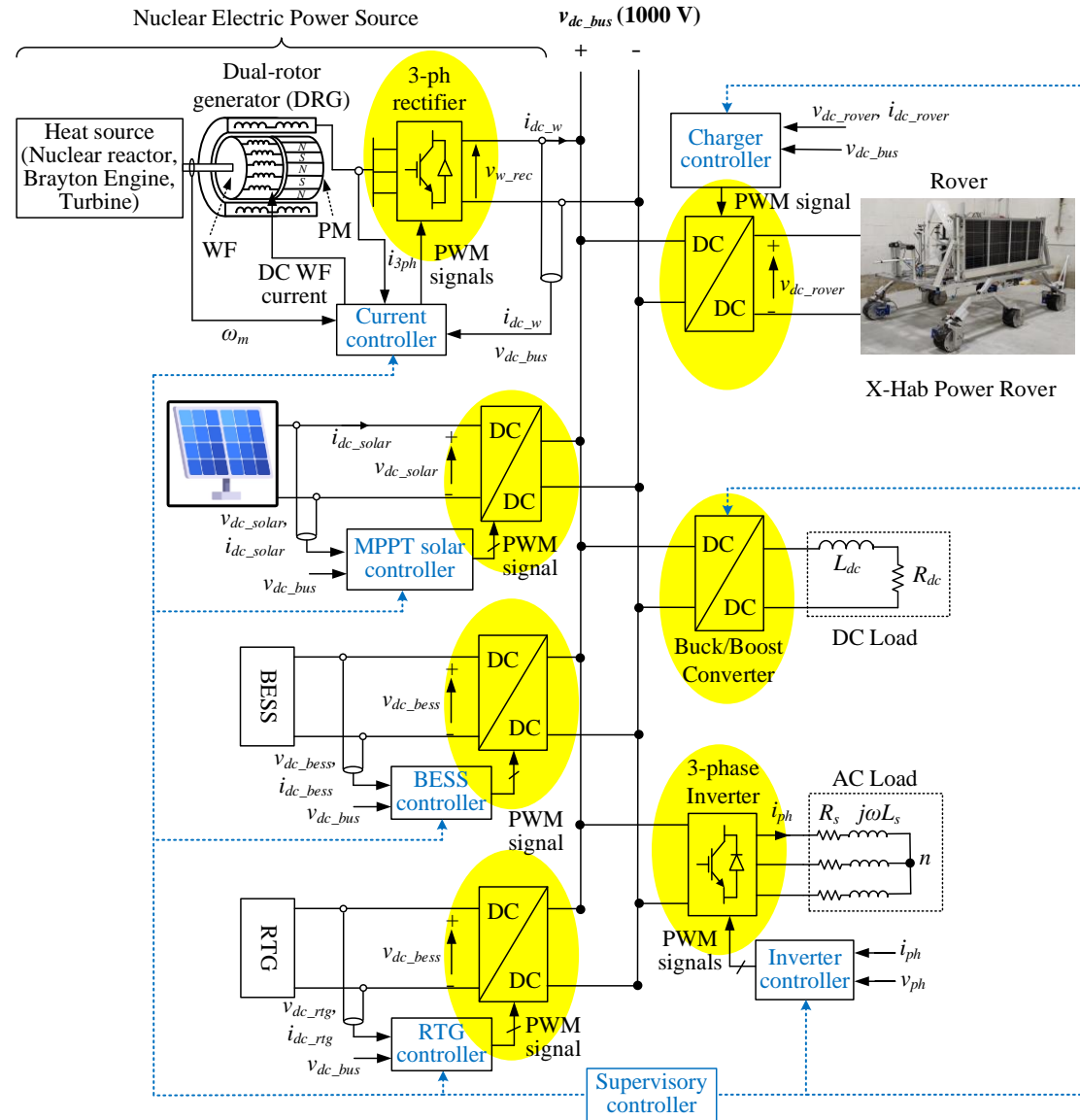
- Individual control for the source & load
- Supervisory control & monitoring for the entire system



Platforming Power Electronics

- Capable of performing any type of conversion (DC-DC, AC-DC, DC-AC, AC-AC)
- Supporting high voltages (up to 10 kV)
- High reliability
- Radiation tolerant
- Interchangeable boards
- Optimizing spares, reduced component count
- Reduced maintenance and long-duration in-space operation
- Common control (plug & play)

A Common Power Electronics Building Block is Highly Desired

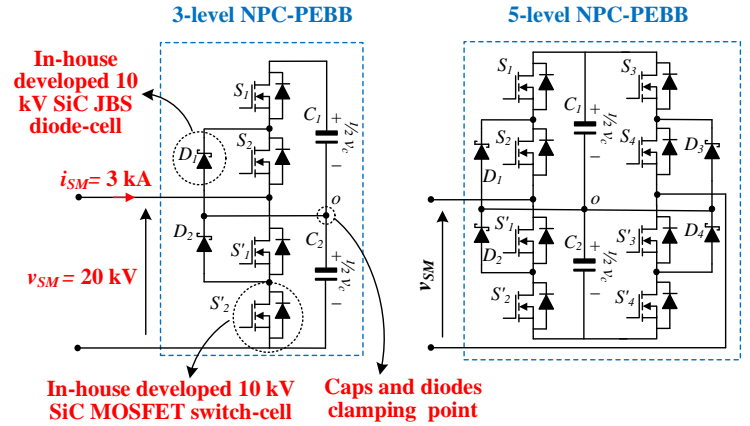


Space Grade Intelligent Self-Sustained High-Voltage Power Electronics Building Blocks

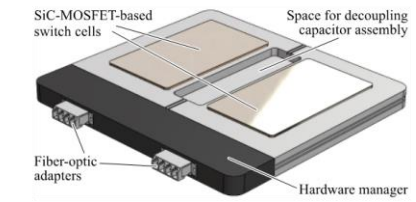
- A 3-level neutral-point clamped (NPC)-PEBB
- A 5-level NPC-PEBB

Features

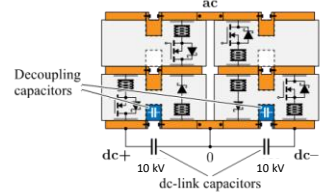
- Improved power-density (5%)
- Increased reliability (12%)
- Increased fault tolerance
- Increased energy accessibility over the converter lifetime
- In-house developed & packaged SiC switches (10 kV) for in-space environment (rad-hard, dust tolerant)
- Supporting voltages up to 20 kV at the converter terminal
- Stackable, interchangeable boards
- Bi-directional power flow (source to load & load to source)
- Supporting any conversion type (DC-DC, AC-DC, DC-AC and AC-DC)
- Intelligent self-sustained: PCB-based built-in overcurrent, overvoltage, and short-circuit protection; Bypass switch; local controller
- Built-in hardware manager: PCB-based current sensors; PCB-based voltage sensors
- A plug & play space vector modulation (SVM) control algorithm



(a) In-house developed 10 kV SiC MOSFET switch-cells



(b) 3-level NPC-PEBB stack with 20 kV (+10 kV) DC bus, four switch-cells, and two diode-cells



(c) Proposed SM: 3-level NPC-PEBB with Protection

