

Deep Space Avionics

SUPERNOVA HIGH POWER PCDU

Fault-Tolerant, Lightweight SmallSat Power Conditioning and Distribution Unit for LEO and Deep Space Applications up to 1.5 kW

The SuperNova PCDU is a 1.5 kW rated power conditioning and distribution unit capable of interfacing between 28V nominal Li-Ion batteries, up to 80 V solar array sections and a set of regulated and/or unregulated loads.

The unit is designed to be modular in input/output power capability, count and features by addition of generic modules in a plug-and-play manner. This way, the PCDU remains the best solution for a wide variety of mission profiles and spacecrafts.

The needs for high reliability, low mass and long lifetime of deep space missions are met by the SuperNova PCDU which is designed to operate for a TID up to 30 kRad under a proton-heavy environment. It is built to be single-failure-tolerant leading

to increased resilience against single events and other type of failures. Additionally, the unit offers a hardware based fail-safe "all off" hibernation mode and a controllable end-of charge voltage for increased protection during high energy particle events and reduction of battery fading during long transfer or idle times.

Eventually, the SuperNova PCDU also performs best-in-class on the power to size and weight metric for a wide range of power configuration.

All of this makes it the ideal candidate for deep space, high delta-v but also weight-, size- and reliability- sensitive LEO missions.

MAIN FEATURES

- Single unit covering solar array power harvesting, battery charge voltage and current regulation as well as protected distribution of regulated and unregulated power to loads. It can also directly interface towards Bradford ECAPS HPGP thruster (optional).
- Modular design for optimal, mission-specific performance.
- Best-in-class weight to power ratio optimized for high delta-v missions.
- High reliability and single failure tolerant architecture.
- Fail-safe pulsed-command controlled power cycling.
- Hibernation mode (timed shut-down) for improved resilience to radiation during high energy particle events.
- Triple redundant CC, CV battery charge controller with controllable end-of-charge voltage for reduced battery fading.
- Section-independent online MPPT highly facilitates the choice of section sizes and orientation.
- Extensive internal and external housekeeping (battery remote temperature/voltage, SA temperature, separation switch status).

BUDGETS

- Mass: < 1 kg (baseline config.).
- Volume (w x h x d): 60 x 120 x 135 mm (baseline config.).
- Power: up to 1.5 kW input (solar arrays) and output (distribution).

INTERFACES

- Battery bus: 22 V to 34 V unregulated, support for 2 x battery thermistors and remote voltage sensing.
- Solar Array: up to 1.5 kW with modular section count, support for one solar array thermistor per section.
- TM/TC: redundant CAN or RS485/422 and low level pulsed command controlled power cycling interface.
- Umbilical: trickle charge input with support of remote sensing, reverse polarity and short-circuit protection.
- Separation: 3 separation switches with 2 out of 3 separation logic.
- Distribution: up to 1.5 kW with modular output count, voltages and protection features.
- Thruster (optional): drive and telemetry support for 1N, 5N and 22N ECAPS HPGP thruster products with modular thruster count.

ENVIRONMENT

- Operational temperature range: -30 °C to +60 °C
- Non-operational temperature range: -40 °C to +70 °C
- Radiation: qualified up to 30 kRad total ionizing dose and for high energy protons.
- Lifetime: > 5 years.

READINESS

- Technology readiness: TRL 6 with expected TRL 7 by Q2 2022.

PCDU Performance and Specifications

Solar array power conversion

- V_{oc} , I_{sc} , P_{mpp} max per section: 80 V, 3 A, 100 W.
- Section count : 3 (baseline) extendable to any number.
- Conversion efficiency: up to 95 %.
- Conversion type: step down converter with hardware-based incremental conductance MPPT.
(DET, step up and step up+down on request).
- Filtering: common mode and differential mode filtered inputs.

Power distribution

- Unregulated output count and class: 15 LCL (baseline) extendable to any number. LCL class 0.5 A to 10 A.
- Regulated output count and class: 10 LCL (single RPD) extendable to any number. LCL class 0.5 A to 3 A.
- Regulated voltages and count: 2 distinct voltages (single RPD) customer-selectable between 3.3 V and 15 V, extendable to any number.
- LCL features: hardware arm-fire and retriggering features available on a set of LCLs.

Battery charge regulation

- Battery charge/discharge current max: +- 50 A
- EOCV levels: customer-selectable, 2-level EOCV.
- UVLO levels: customer-selectable UVLO in and out voltage.
- Trickle charge current max: 2 A.

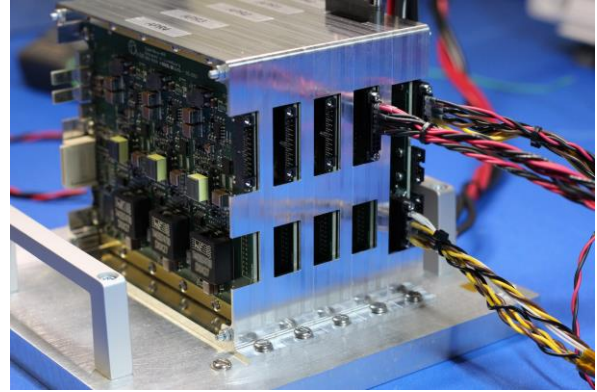


Figure 1: SuperNova electrical prototype

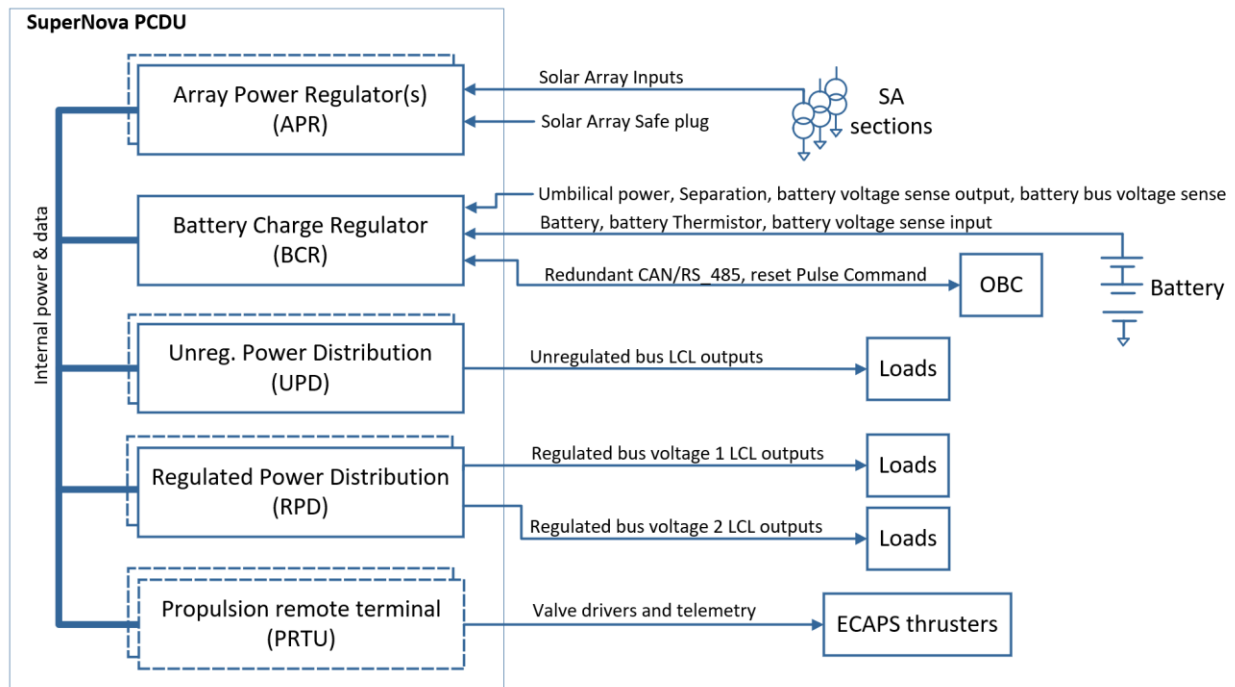


Figure 2: SuperNova typical configuration

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