

ATR100

500 W Bidirectional 4-Switch Buck-Boost DC-DC Converter with Isolated USB-C Digital Configuration



12–85V INPUT	1–85V OUTPUT	500W MAX POWER
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Black anodized aluminum enclosure · top-mounted forced-air cooling fan · side ventilation slots · pluggable screw-terminal power connectors

FEATURES

- **Bidirectional 4-switch buck-boost topology** — regulates output whether V_{in} is above, below, or equal to V_{out}
- **Wide input range:** 12–85V DC
- **Fully adjustable output:** 1–85V DC
- **Constant-current / constant-voltage (CC/CV)** regulation with digital soft-start ramp
- **Digital control core** — firmware-driven digital power controller executes the CC/CV loop, soft-start, and telemetry
- **Isolated Hall-effect current sensing** for both input and output current loops (automotive-grade sensor)
- **USB-C configuration & monitoring interface** — enumerates as a standard USB HID device, no driver installation required
- **Galvanically isolated configuration interface** — isolated I²C link decouples host PC ground from converter power ground
- **Forced-air cooled aluminum heatsink** with top-side thermal interface to primary switches
- **Black anodized aluminum enclosure** with side ventilation and top-mounted forced-air cooling fan

APPLICATIONS

- Battery charging / discharging across mismatched voltage domains (e.g., 24V ↔ 48V systems)
- Bench and ATE power delivery requiring programmable CC/CV setpoints
- Solar / battery hybrid energy routing
- Motor drive and industrial DC bus regulation
- Lab and educational power electronics platforms

DESCRIPTION

The ATR100 is a 500 W bidirectional DC-DC converter built around a 4-switch buck-boost power stage, allowing it to regulate its output continuously across input and output voltages that overlap — without the mode-switching discontinuities of a simple buck or boost design. An onboard digital power controller closes the CC/CV control loop in firmware, executes a soft-start ramp on power-up, and exposes live telemetry and setpoint control over an isolated USB-C interface that presents to a host PC as a standard HID device — no drivers to install.

Current in both the input and output paths is measured with isolated Hall-effect sensors, and power switching is handled by parallel N-channel MOSFETs driven through dedicated per-device gate resistors to control switch-node ringing. Primary switch heat is extracted through a top-side thermal pad into a finned aluminum heatsink under forced air, with side ventilation slots supporting airflow through the enclosure.

FUNCTIONAL BLOCK DIAGRAM

Fig. 1 — ATR100 simplified functional block diagram. Isolation boundary applies to the USB-C configuration path only.

Note: Design and BOM parameters below are confirmed from engineering records; values marked TBD are pending bench validation (efficiency, ripple, thermal derating, EMC, and mechanical outline) and will be published as testing completes.

ABSOLUTE MAXIMUM RATINGS

Parameter	Value	Notes
Input voltage, VIN	−0.3 to 90 V	Referenced to power GND
Output voltage, VOUT	−0.3 to 90 V	Referenced to power GND
Continuous output power	500 W	With forced-air cooling
Primary switch VDSS	150 V	Automotive-grade power MOSFETs
USB-C interface voltage	0 to 5.5 V	Isolated from power stage
Operating ambient, TA	TBD	Pending thermal validation
Storage temperature	TBD	

Stresses beyond Absolute Maximum Ratings may cause permanent damage. Functional operation at these limits is not implied.

ELECTRICAL CHARACTERISTICS

Parameter	Value	Conditions
Input voltage range	12–85 V	
Output voltage range	1–85 V	Digitally set via USB-C
Maximum output power	500 W	
Regulation modes	CC / CV	Firmware-selectable
Soft-start	Digital ramp	Programmable
Peak efficiency	TBD	Bench characterization pending
Switching frequency	TBD	
Line / load regulation	TBD	
Output ripple & noise	TBD	
Current sense accuracy	TBD	Isolated Hall-effect sensing

PROTECTION FEATURES

- **Overcurrent protection** — independent isolated Hall-effect sensing on input and output current loops
- **Over-temperature protection** — controller-supervised thermal cutback / shutdown
- **Configuration-interface isolation** — USB host ground is decoupled from power ground via I²C isolation barrier
- Additional protections (UVLO, OVP, reverse-polarity) implemented at design level; thresholds TBD

POWER STAGE & CONTROL

Function	Implementation
Control architecture	Fully digital
Power topology	4-switch bidirectional buck-boost
Primary switches	Automotive-grade N-channel MOSFETs
Gate drive	Dedicated high/low-side drivers
Current sensing	Isolated Hall-effect, input & output
Host interface	USB-C, HID class
Interface isolation	Digital isolator on config link
Auxiliary supply	Isolated flyback bias rail
Power inductor	Custom-spec'd flat-wire inductor

CONSTRUCTION

Parameter	Value
Enclosure	Black anodized aluminum
Cooling	Finned aluminum heatsink, forced air
Cooling fan	Top-mounted, 30×30×10 mm
Ventilation	Side vent slots, front/rear intake
Dimensions (L×W×H)	TBD
Weight	TBD

INTERFACES & CONNECTORS

Interface	Description
V_IN	DC power input, 12–85V — 2-position pluggable screw terminal
V_OUT	DC power output, 1–85V, 500W max — 2-position pluggable screw terminal
USB-C	Isolated HID configuration & telemetry, plug-and-play

Terminal block wire gauge and torque rating published at production release.

ORDERING INFORMATION

Part Number	Description	Package
ATR100	500W bidirectional buck-boost DC-DC converter	Enclosed module

MSRP target: \$199. Sold FBM via Amazon and direct from Aatrral Industries LLC.