APEC 2020 - Hybrid Aluminum Electrolytic Capacitors
High energy density and low ESR for eMobility
ESR versus high ripple current capability
The path to high energy density!

What you get with conventional capacitor

Limited $I_{AC}$

High ESR

Big (bulky) components

What you really want

High $I_{AC}$

Low ESR

More compact design, higher flexibility for integration

ESR must be minimized to achieve highest ripple current capability
How to understand the ESR of an Aluminum Electrolytic Capacitor?

$$\text{ESR} = \text{ESR oxide} + \text{ESR cathode (electrolyte, polymer, paper)} + \text{ESR structure} + \text{ESR aluminium}$$

Our challenge is to minimize metal and cathode ESR!
World’s first axial-lead hybrid polymer aluminum electrolytic capacitors
TDK’s Axial-lead HP Design – the Best of Two Worlds

New materials and processes

- Improved electrolyte composition and structure
  - Reinforced electrolyte structure
  - New liquid electrolytes

New design

- Axial-lead hybrid polymer design with optimized winding construction for
  - Lowest ESR
  - Lowest thermal resistance

Patented process and hybrid electrolyte structure

Different mechanical designs allowing design flexibility

Unique advantages

- Lowest ESR for full temperature range ➔ highest ripple current
- Lowest thermal resistance ➔ high thermal dissipation performance
- Stable thermal connection during useful life ➔ mechanical robustness
New HP al caps offer strong application benefits

Equivalent ripple current performance under heat-sink operation

Advantages

- Replaces multiple components with a single, smaller capacitor
- Smaller footprint, volume and weight
- Over dimensioning of capacitance not necessary
TDK focus product – 48V boardnet
More power density = higher power rating

Axial hybrid-polymer cap

Axial Alu cap

B41687 / 787
63V
125°C rated
150 °C max.

✓ lower thermal resistance series

✓ B41789L8827Q001
820µF – 18x35mm
Max. 17.2 A at 125°C

✓ B41787A8827Q001
820µF 63V - 18x35 mm
Max. 19.9 A at 125°C

Axial-lead
B40640
Soldering Star
B40740

Rated voltage 63 V
Rated capacitance 390 to 680 µF
Rated temperature 125 °C (150 °C max.)
ESR typ. 2.5 to 4.0 mΩ
Ripple current capability 18 to 25 A / 4000 h / 125 °C
Useful life 4000 h / 125 °C
2000 h / 150 °C
Dimensions 14 x 25 to 16 x 30 mm (d x h)

✓ B40740A8537Q001
530µF 63V – \text{16x25 mm}
Max. 22.9 A at 125°C
On Board Charger (OBC) – e.g. module topology

- System power typically 11 kW with 1 module per phase with 3.7 kW each
- Capacitance requirement 1 - 1.5 mF in DC link stage, operation voltage typically below 450 V
- 2 to 3 Large size capacitors per module / phase (6 to 9 for the overall unit)
On Board Charger (OBC) – Product roadmap

**OBC application – Large size capacitors**

- **B43268**
  - Compact design 680 µF in 35 x 55 mm
  - Qualification based on AEC-Q200 available

- **B43649**
  - Ultra Compact design
    - 680 µF in 35 x 45 mm
    - Qualification based on AEC-Q200 available

- **B43654**
  - Long useful life at 5000h
    - 680 µF in 35 x 55 mm
    - Qualification based on AEC-Q200 available

**Expanding product range**

- **B436xx**
  - Side vent design feature for forced cooling
    - Target 680 µF in 35 x 50 mm
    - AEC-Q200 qualified design available

- **B43504**
  - High vibration stability up to 40 g
    - Qualification based on AEC-Q200 available

✓ Option for the customer to use the browser based Useful Life Calculation tool

Thanks for your attention!

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