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# Modular and Hybrid Implementation of DC-DC Converter, FCL and LCL.

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## DC-DC converter requirements

- Determined by internal needs:
- 60% of internal production <20W with unregulated 20-43V power bus
- Multioutputs.
- DM and CM filter.
- Inrush-current limiter and ON/OFF function.
- Solid State Power Controller at Power Bus I/F.
- Undervoltage protection.
- Overvoltage protection.
- Input polarity inversion protection.
- Fault tolerant Synchronisation Circuitry.

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## Key issues

- Final goal was cost optimisation, reduced time to market, and better performances.
- Three possible approaches:
  1. Standard product
  2. Ad hoc design
  3. Building blocks
- The last one has been chosen as best compromise between flexibility and low cost, short time to market and high performances.

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## Alenia Spazio Laben hybrid converter

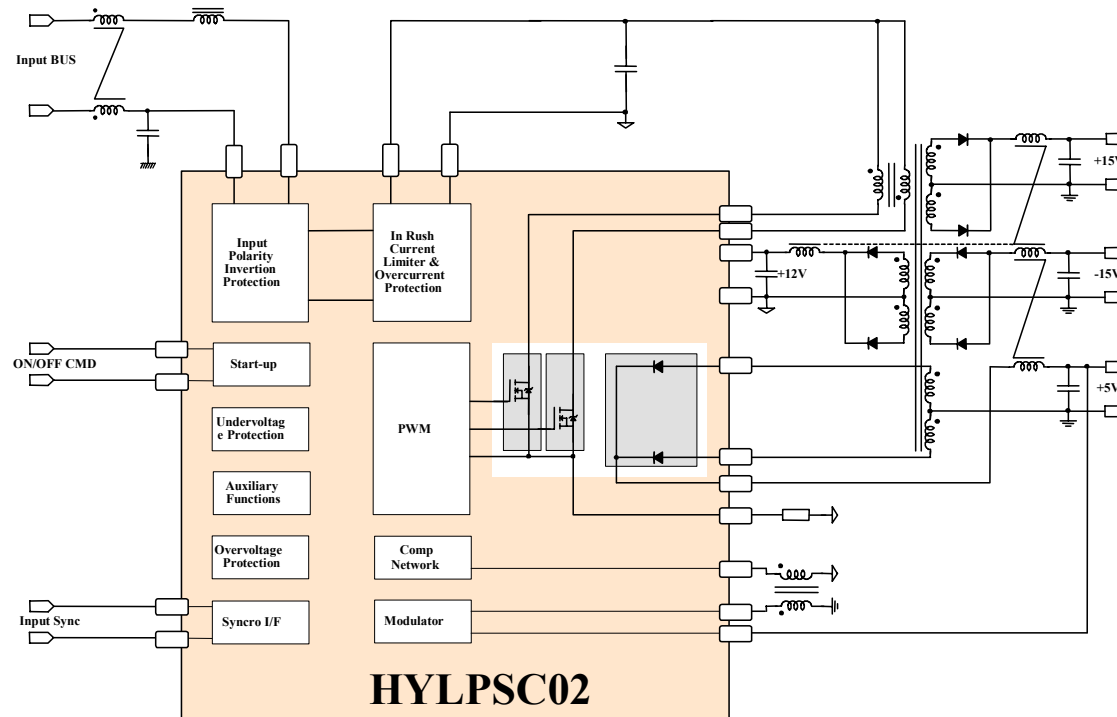
- All silicon parts (diodes, mosfets, transistors, I.C. and low power passive components) integrated in a power hybrid.
- Input-output filters and power transformer PCB mounted with the hybrid.
- The hybrid is an off the shelf component which remains unchanged whatever are the output voltages (number, type ecc.).

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## Advantages

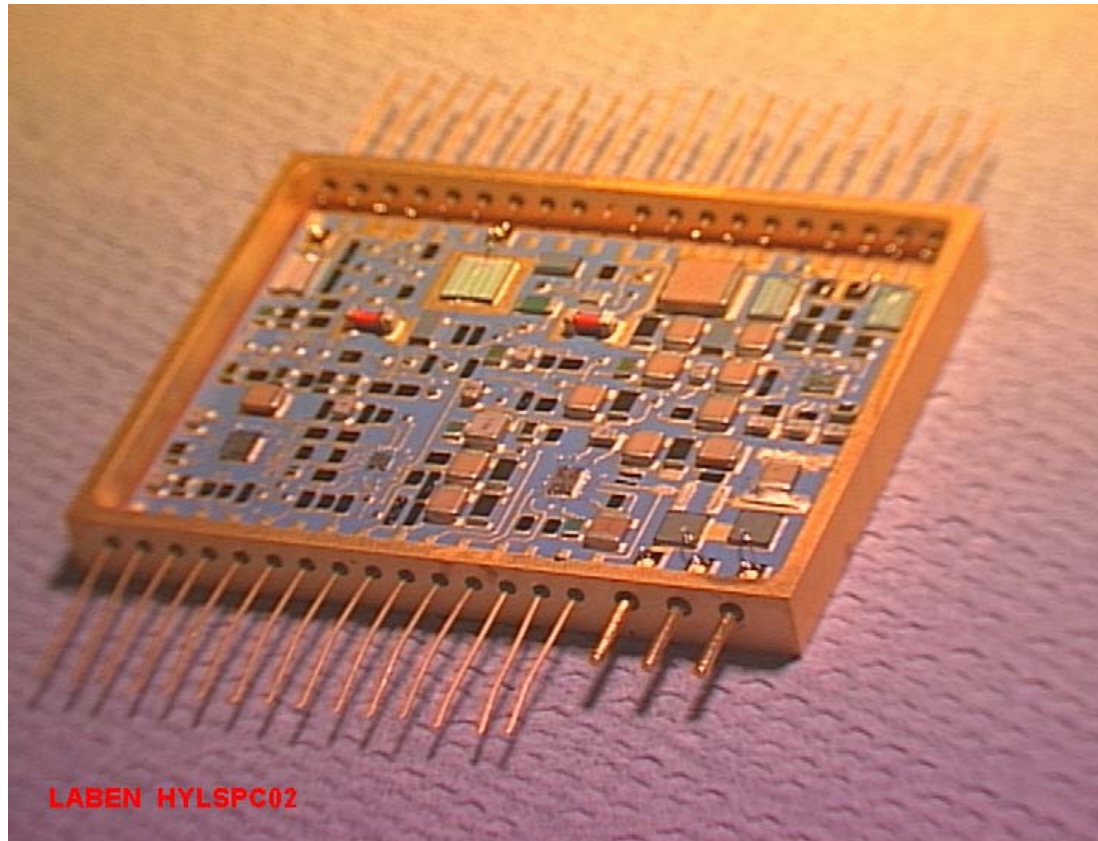
- High flexibility both electrical and mechanical
- DC-DC converter design is greatly simplified. Design Engineer has to focus only on the power transformer and output filters.
- Short design phase because all protections and additional features are incorporated into the hybrid.
- Low implementation risk.
- No delay due to components procurement.

# Converter Block Diagram



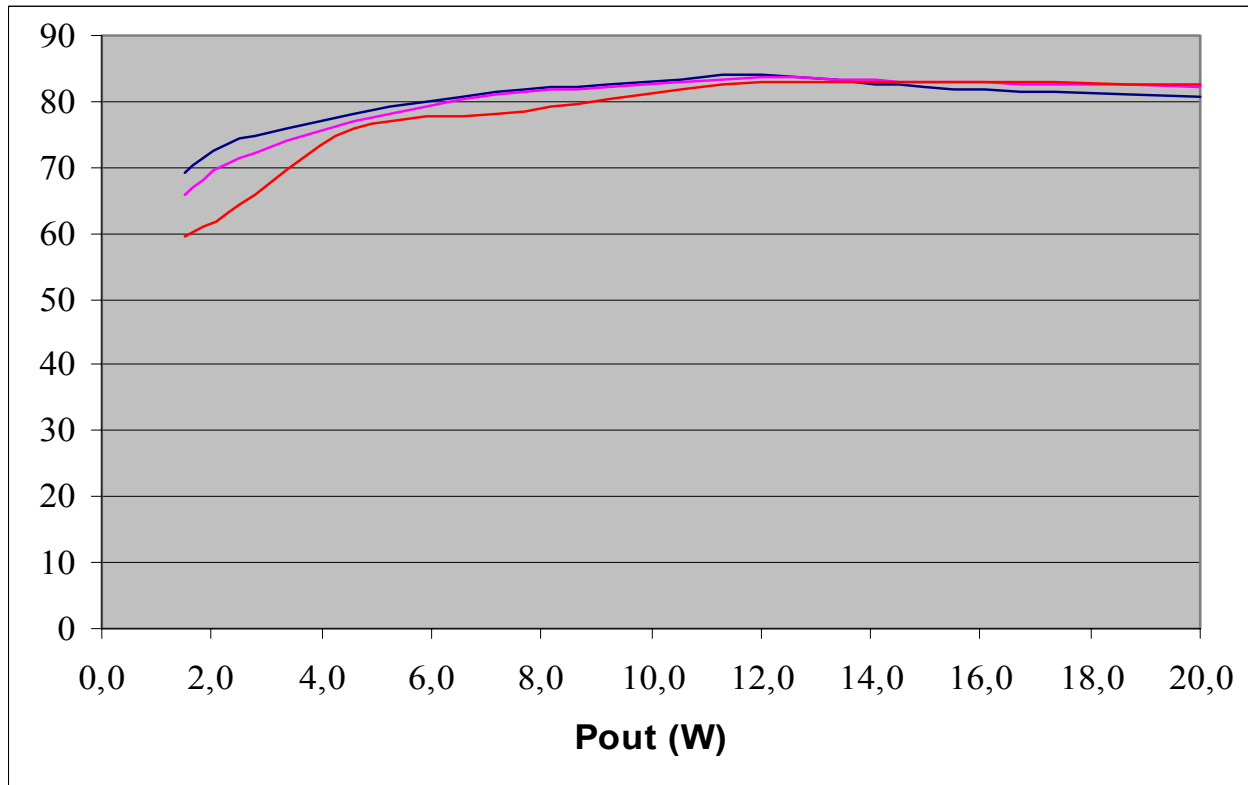
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# Power hybrid



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## Efficiency vs. output power and input voltage



Vin= 20 (blue), 28 (red) and 43V (orange)



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## Electrical implementation

- So far a number of DC-DC converters has been manufactured and tested based on the above hybrid.
- Number of outputs vary from 1 to 8.
- Output voltage range from 2.2V to 28V.
- The hybrid can be easily used in Self Driving Synchronous Rectification for low voltage application (2.2V, 8A with 80% efficiency).
- Output noise (filter) can be easily adapted to customer needs.

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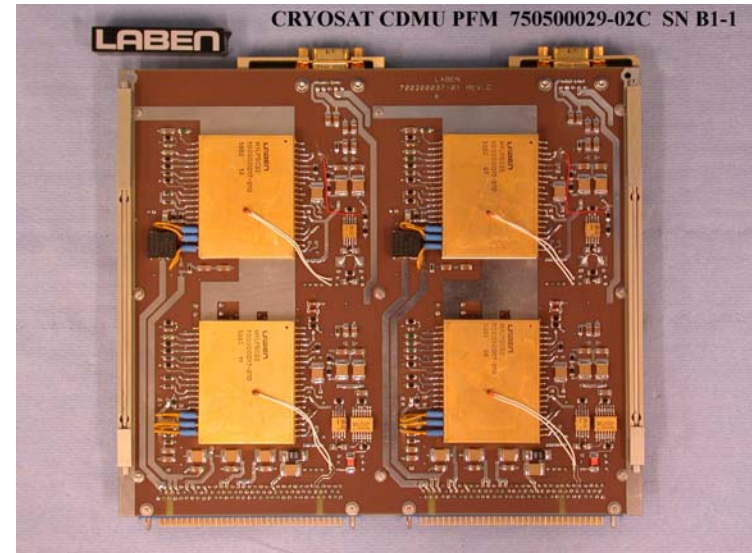
## Mechanical implementation

- DC-DC converters has been housed in standard board (up to three converter in a S.E.), or in ad hoc aluminium box.
- Mass can range from 130 to 250 gr, depending on number of outputs, output noise requirement, electrical mechanical interfaces ...
- Volume between 120 and 180 cm<sup>3</sup>.



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# Example of Mechanical Implementation



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# LCL/OV protection for secondary power lines

- Reasons for the need of secondary lines LCL/OV
  - 1) Powering multiple users from the same DC-DC converter
  - 2) Failure propagation control through the interfaces
  - 3) Powering new components/technologies subjected to latch-up

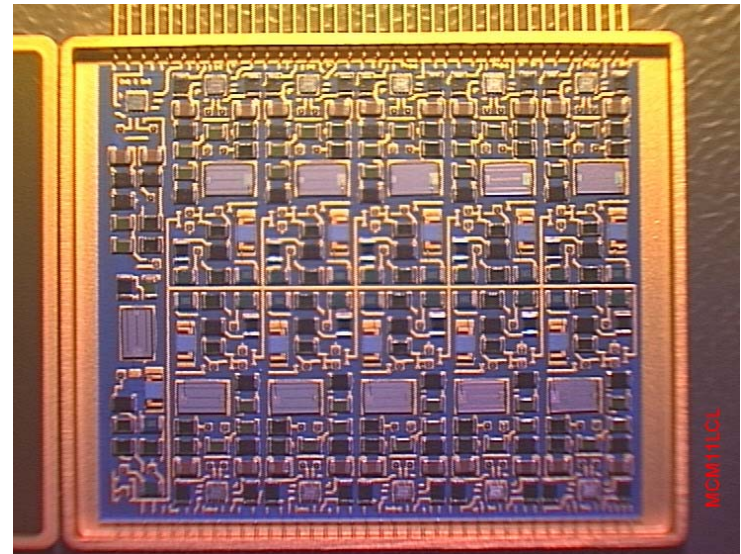
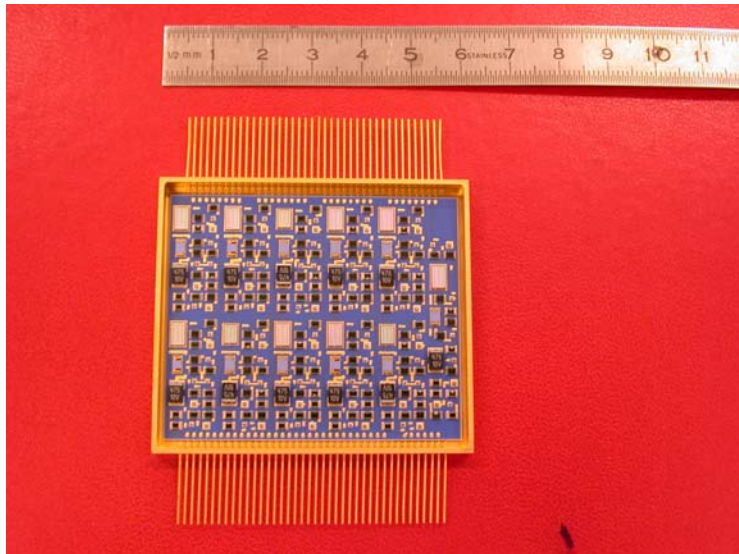
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# LCL/OV protection hybrids main features

- 11 channels (3xP3.6V, 4xP6V, 3xN6, 1xP15V )
- Current limitation between 0.1-0.4A
- OVP at 110% of nominal voltage
- Trip-off time 30msec (both protections)
- Reaction time 1 usec
- Protection reset by power recycling
- 11 channels (11x3.3V )
- Current limitation between 0.25A
- ON/OFF commands
- Status monitors
- Trip-off time 1msec
- Reaction time 1 usec
- Protection reset by OFF/ON sequence

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# LCL/OV protection hybrids



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## New possible developments

- New version of DC/DC converter for 20-55V power bus, while reducing of 30% the overall mass.
- General purpose 4 channels (3.3V, 5V +15V and -15V adjustable) low drop series regulator and LCL.
- Primary power bus (20-60V or 80-120V) LCL with active input filter.
- Voltage Regulator Module for low voltage (1.5-3.3V) high (and pulsed) current digital loads.