

FASTER AND MORE ACCURATE CONTROL OF SWITCHED RELUCTANCE ELECTRIC MOTORS USING ZYNQ SOC



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- Punch Powertrain
- ARMEVA
- Design workflow
- SR motor technology
- Matlab workflow
- Results













Punch Powertrain intends to become the leading independent provider of innovative clean

powertrain technologies for car manufacturers.



Punch Powertrain: double digit growth

past

2006-2015 (10 yrs of double digit growth)

2016



In 2015 the domestic Chinese OEMs adopt:

- 71% of all their CVTs from Punch
- 11% of all their ATs as Punch CVTs



Customers & Applications

Demand rises also from other regions

- Wider spread of applications
- Design for global market coverage



2006: few apps/30 kupa VT2

2016: 60 apps/400kupa VT2/3

Products & Product Development







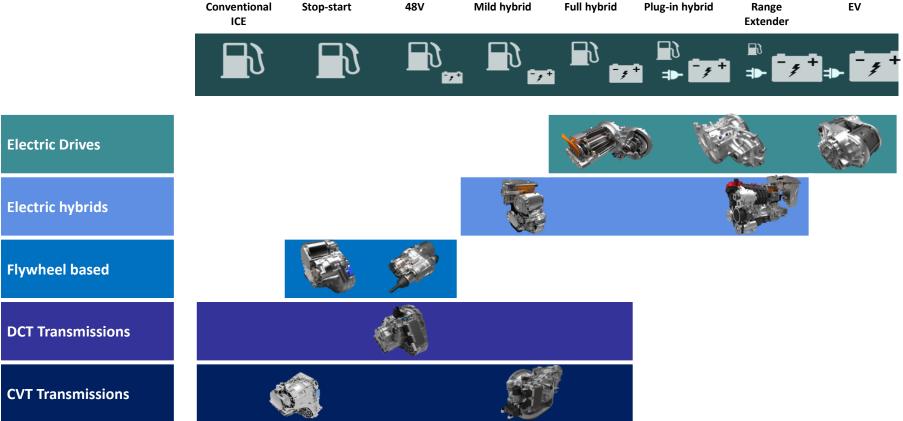
VT5



DT1



Market requirements and solutions









Goal:

To develop a new generation of rare-earth free electric motors based on magnetic reluctance.

punch powertrain Gase up for the Atture	Punch Powertrain N.V.	Belgium
SIEMENS	Siemens SISW	Belgium
TU/e Statement of theoretic R. Statement of	Technische Universiteit Eindhoven	Netherlands
PRODRIVE	Prodrive B.V.	Netherlands
○ Te K s h i f t	TeKshift GmbH	Germany
UNIVERSITATEA TEHNICĂ	Universitatea Tehnica din Cluj-Napoca	Romania
SIEMENS	Siemens SISW	France





Content Electric Drive System including:

- Motors
- Power Electronics
- Controls

Focus

- power density increase
- Increased efficiency
- Smart packaging

Impact

EV with increased efficiency at lower cost



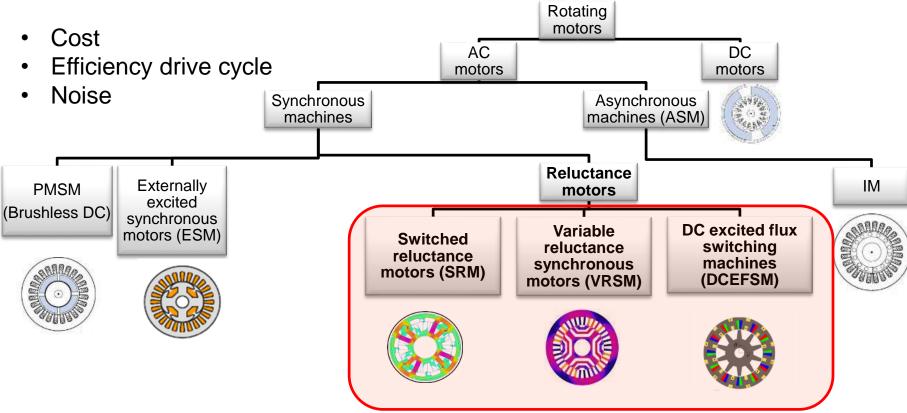




Vehicle requirements Vehicle Optimize 3 motors Test bench E-drive requirements Sensitivity analyses Final board HIL test **Architecture Design Eval Board** HIL test Eval board desk test Module Design MIL **Implementation**









Switched Reluctance motor characteristics

Basic Principle: Magnetic Reluctance

Advantages

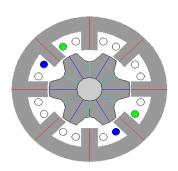
- Simple, robust construction
- No permanent magnets
- High efficiency
- High speed capability
- Low cost
- Safe Operation

Challenges:

- Torque Ripple
- Controls
- Electronics
- Acoustics





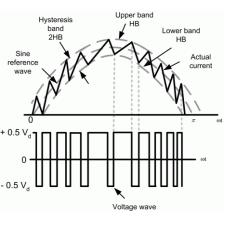






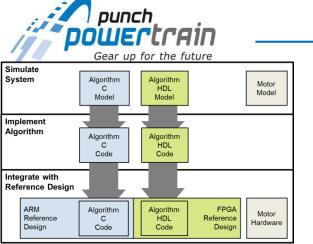


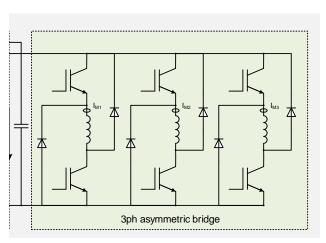




- Higher speed: 20 000rpm
- Less inductance: 8000A/ms
- Delay of 1µs -> error of 8A
- Interrupt based current hysteresis control in processor 14µs minimum
- New closed loop control strategies with fast and heavy calculations
- -> SoC device: Zynq 7045 device
- No FPGA knowledge within Punch

MATLAB workflow





- Zynq 7045 device
- Fixed point workflow
- Embedded coder / HDL coder
- Vivado

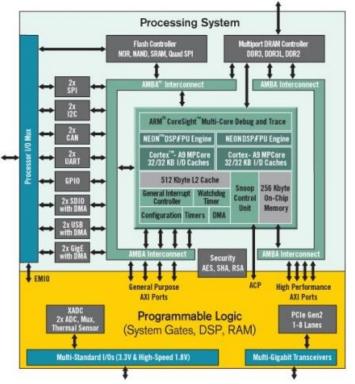




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Our experience workflow





- Easy to split SW architecture for μproc and FPGA
- Reuse of legacy code
- Automatic communication HW-SW
- Ecosystem Zynq for more specialized drivers not available: CAN
- Fixed point conversion not yet push button
- Vivado workflow fully automated



Development workflow part 2



Vehicle requirements

E-drive requirements

Final board

Vehicle

Test bench

Architecture Design

Module Design

Reuse models from left leg for validation

Design Eval board desk test

MIL

Implementation



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HIL test

Eval Board HIL test





- Integrated E-drive:
 - motor, PE and SW
- 4 different control strategies
 - 1,5 years with 2FTE's
- Models reusable for production
- Smooth integration and validation due to development process
 - Validation before electronics are produced
 - Do not loose critical test bench time





Growth in:

- Products
- Staff

- Time to market
- Quality
- Cost



Thank you for your attention!

For more info about us, please visit our website www.punchpowertrain.com

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