

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.





**Customers
&
Applications**



In 2015 the domestic Chinese OEMs adopt:

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



Demand rises also from other regions

- Wider spread of applications
- Design for global market coverage




**Products
&
Product
Development**



VT3



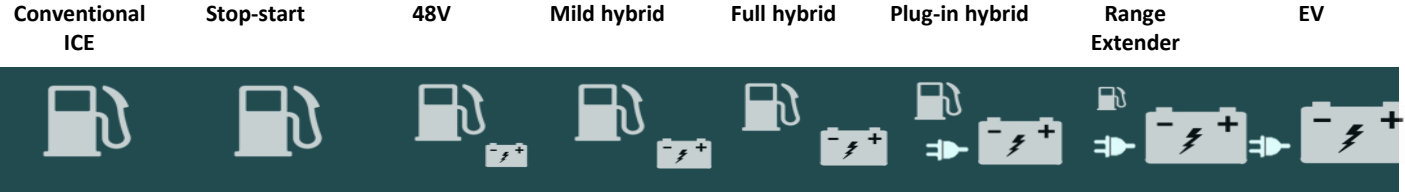
HS2



VT5



DT1



Electric Drives



Electric hybrids



Flywheel based



DCT Transmissions









CVT Transmissions





Goal:

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

	Punch Powertrain N.V.	Belgium
	Siemens SISW	Belgium
	Technische Universiteit Eindhoven University of Technology	Netherlands
	Prodrive B.V.	Netherlands
	TeKshift GmbH	Germany
	Universitatea Tehnica din Cluj-Napoca	Romania
	Siemens SISW	France



Content

Electric Drive System including:

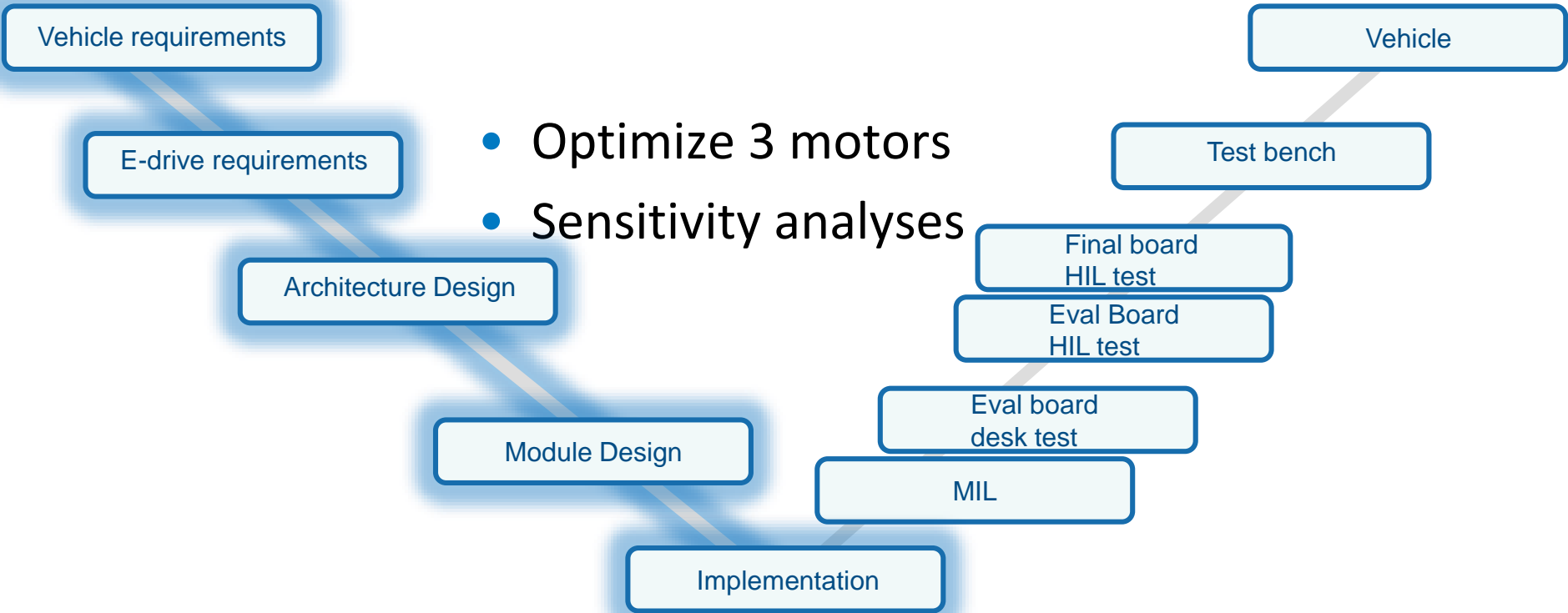
- Motors
- Power Electronics
- Controls

Focus

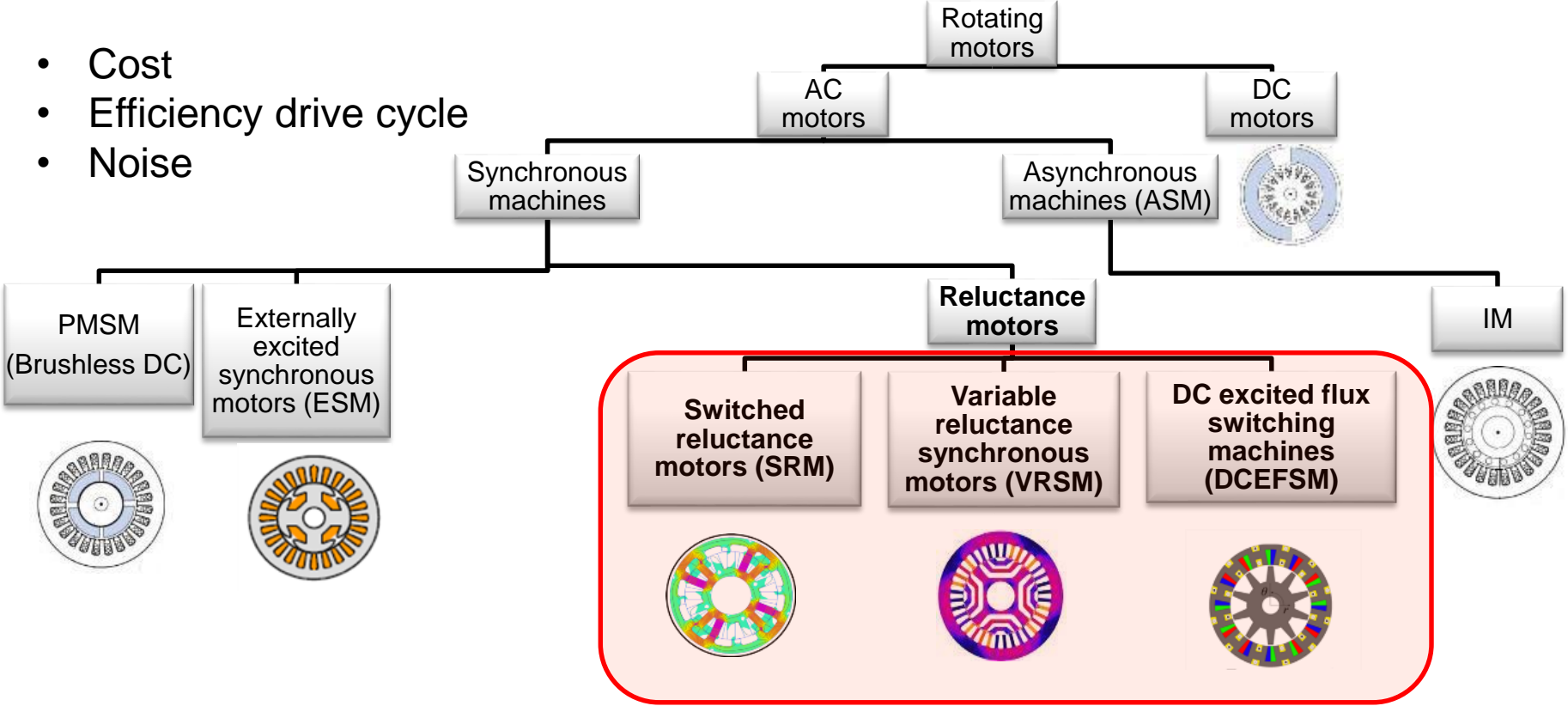
- power density increase
- Increased efficiency
- Smart packaging

Impact

- EV with increased efficiency at lower cost



- Cost
- Efficiency drive cycle
- Noise



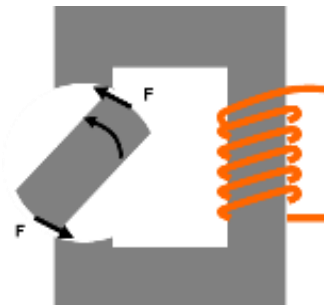
Basic Principle: Magnetic Reluctance

Advantages

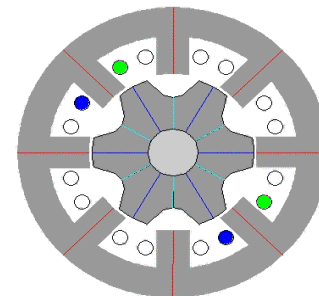
- Simple, robust construction
- No permanent magnets
- High efficiency
- High speed capability
- Low cost
- Safe Operation

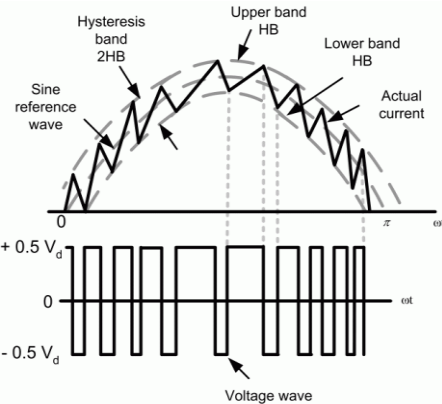
Challenges:

- Torque Ripple
- Controls
- Electronics
- Acoustics

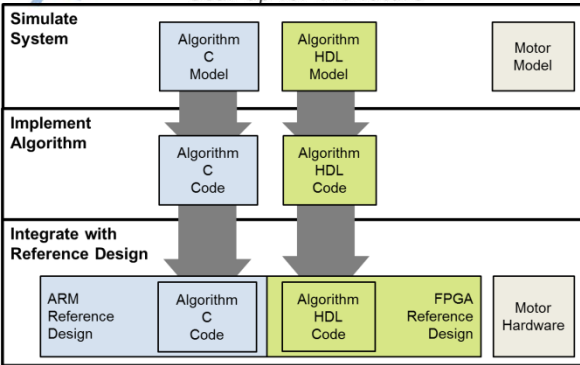


SWITCHED-RELUCTANCE MOTOR

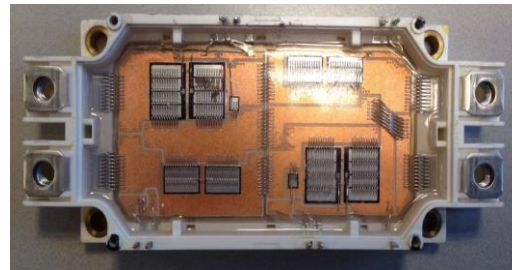
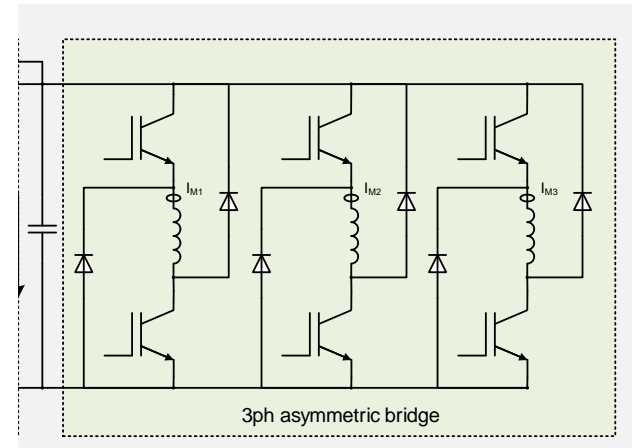


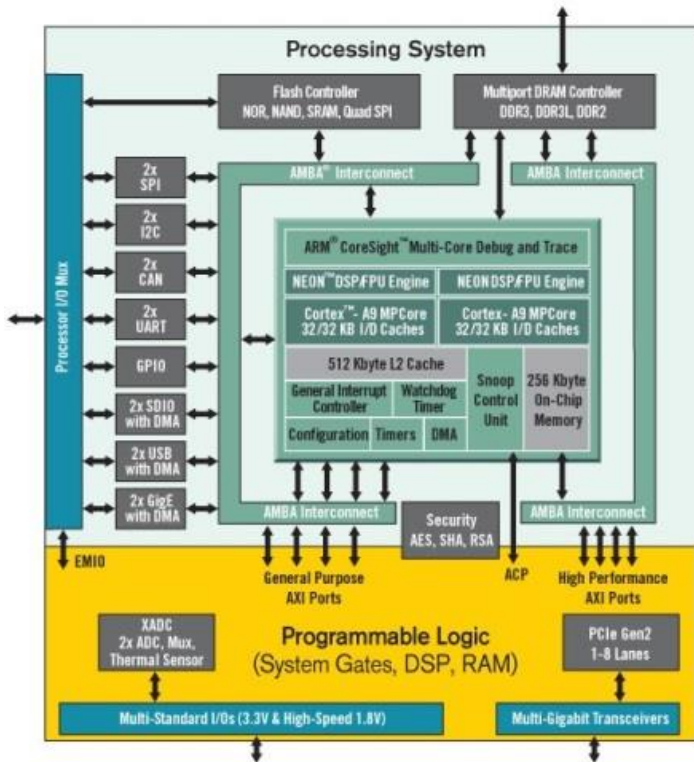


- Higher speed: 20 000rpm
- Less inductance: 8000A/ms
- Delay of $1\mu\text{s}$ \rightarrow error of 8A
- Interrupt based current hysteresis control in processor $14\mu\text{s}$ minimum
- New closed loop control strategies with fast and heavy calculations
- \rightarrow SoC device: Zynq 7045 device
-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



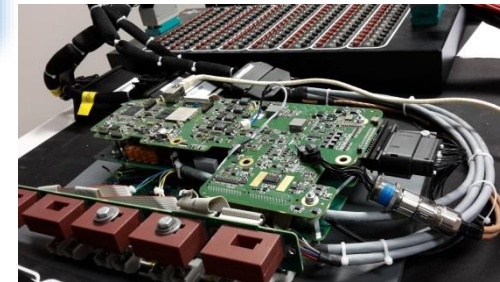
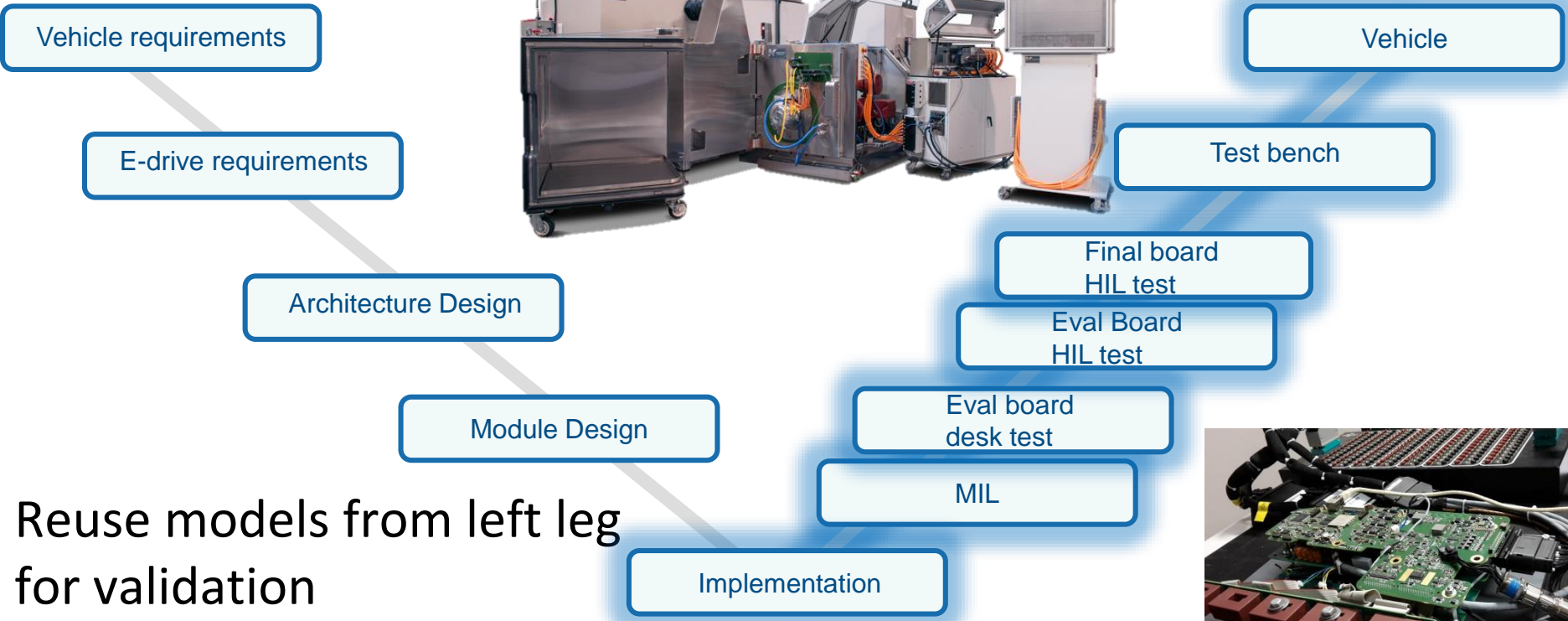
- Zynq 7045 device
- Fixed point workflow
- Embedded coder / HDL coder
- Vivado



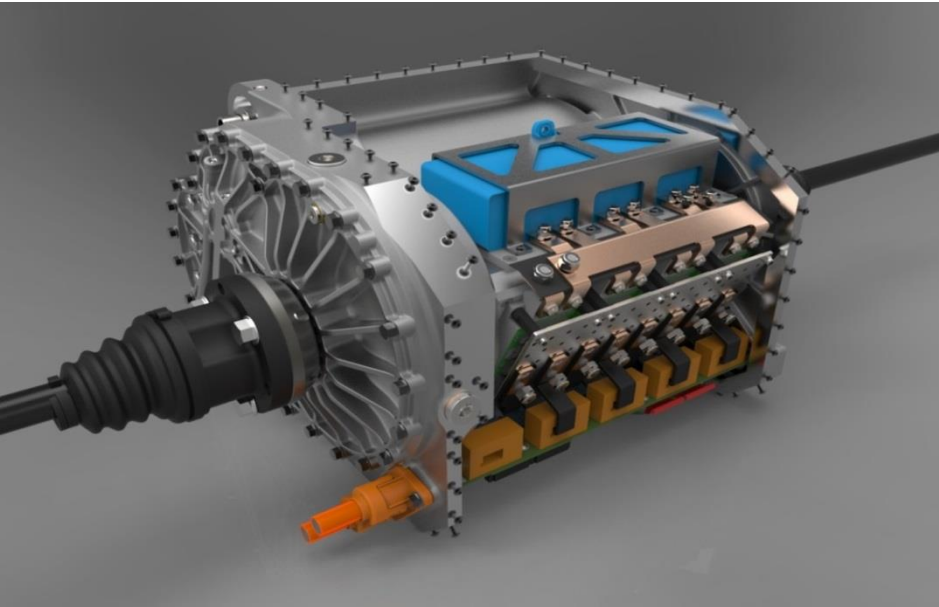


- Easy to split SW architecture for μ proc and FPGA
- Reuse of legacy code
- Automatic communication HW-SW
- Ecosystem Zynq for more specialized drivers not available: CAN
- Fixed point conversion not yet push button
- Vivado workflow fully automated

Development workflow part 2



Reuse models from left leg for validation



- 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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