

ROTAX

NEXT GEN E-POWER UNIT

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BRP-ROTAX E-DRIVE TECHNOLOGIES



CONTENT

01

Diversity of Applications

02

Motivation for Electrification

03

Comparison to Passenger cars

04

Power Unit Architecture

05

Integration Level

06

Advantages

07

Results

DIVERSITY OF MOBILITY



POWER UNIT FAMILIES

Mid-Size Vehicles

100kW peak

HV



Small Vehicles

35kW peak

HV



Micro Vehicles

1kW peak

LV



WHY ELECTRIC ?



VISION

New vehicle types



THRUST

Power delivery
Acceleration



PRECISION

Efficiency
Elegance



ROBUSTNESS

No maintenance



NOISE

Powerful sound
No noise



SMELL

No stench
No poison gases

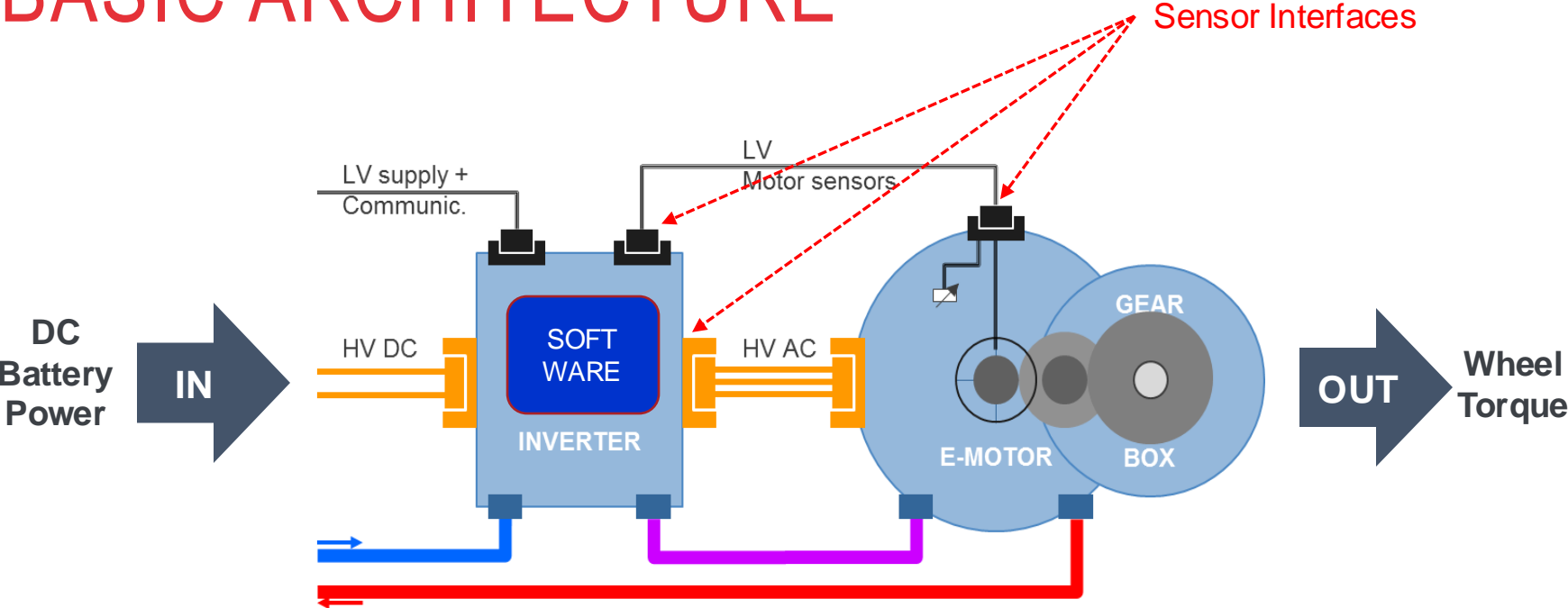
AUTOMOTIVE VS. POWERSPORTS



Torque
Speed
Power
Efficiency
Functional Safety
Cyber Security
Robustness
Package
NVH
EMC

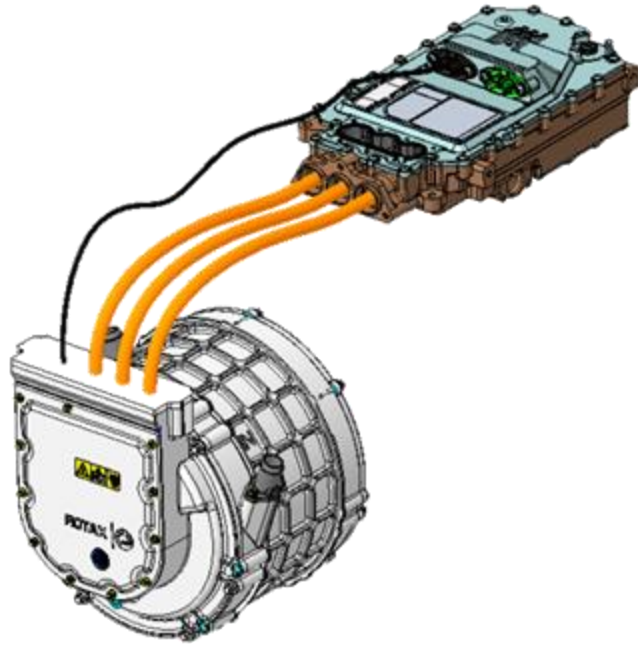


BASIC ARCHITECTURE

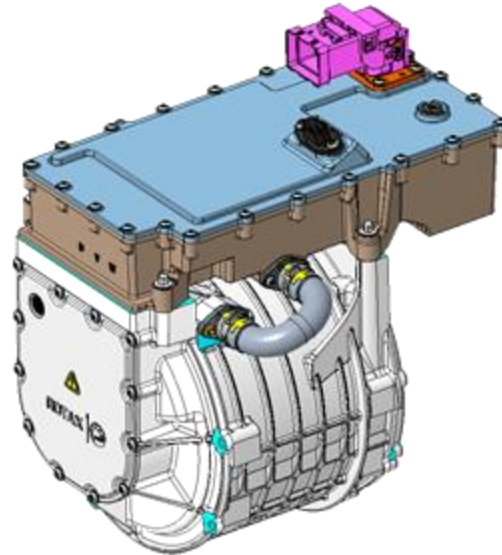


Mechatronic System with a Variety of Interfaces

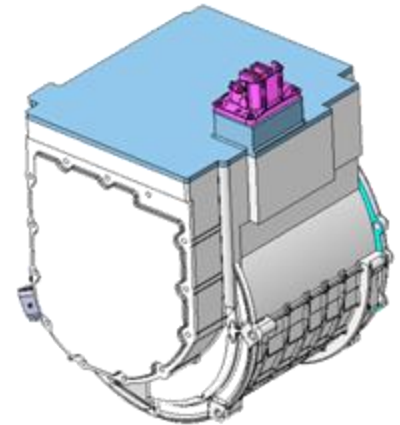
WHICH TOPOLOGY IS THE RIGHT ONE?



**Separated
Inverter**

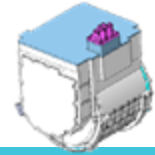
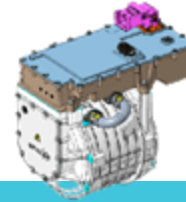
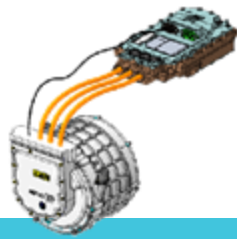


**Attached
Inverter**



**Integrated
Inverter**

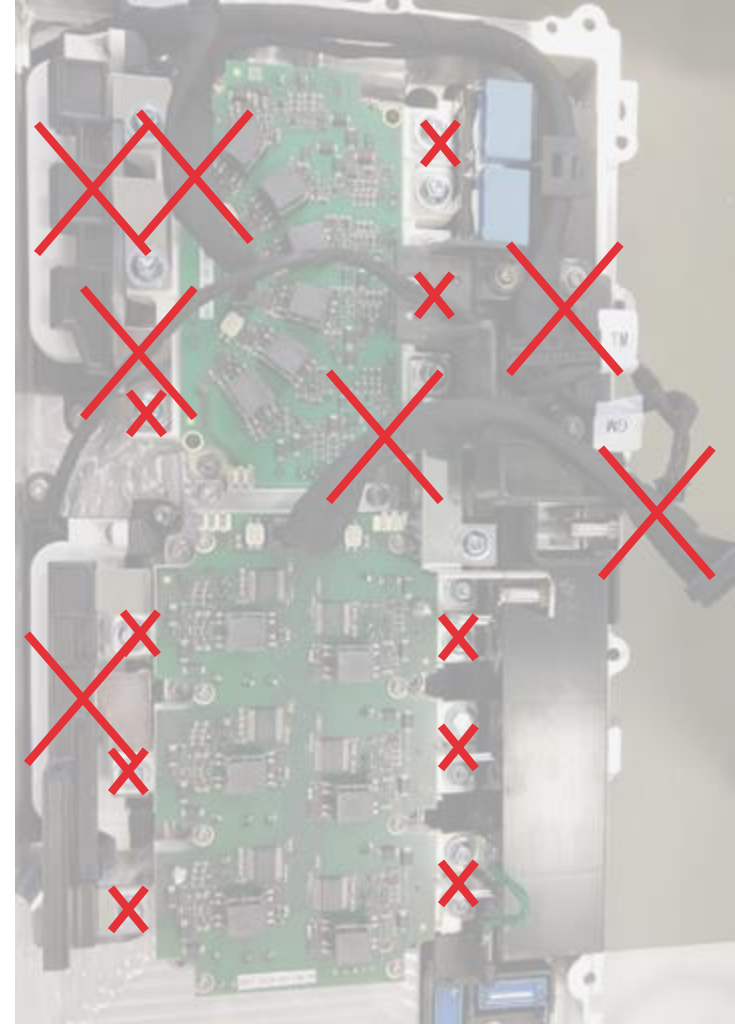
COMPARISON

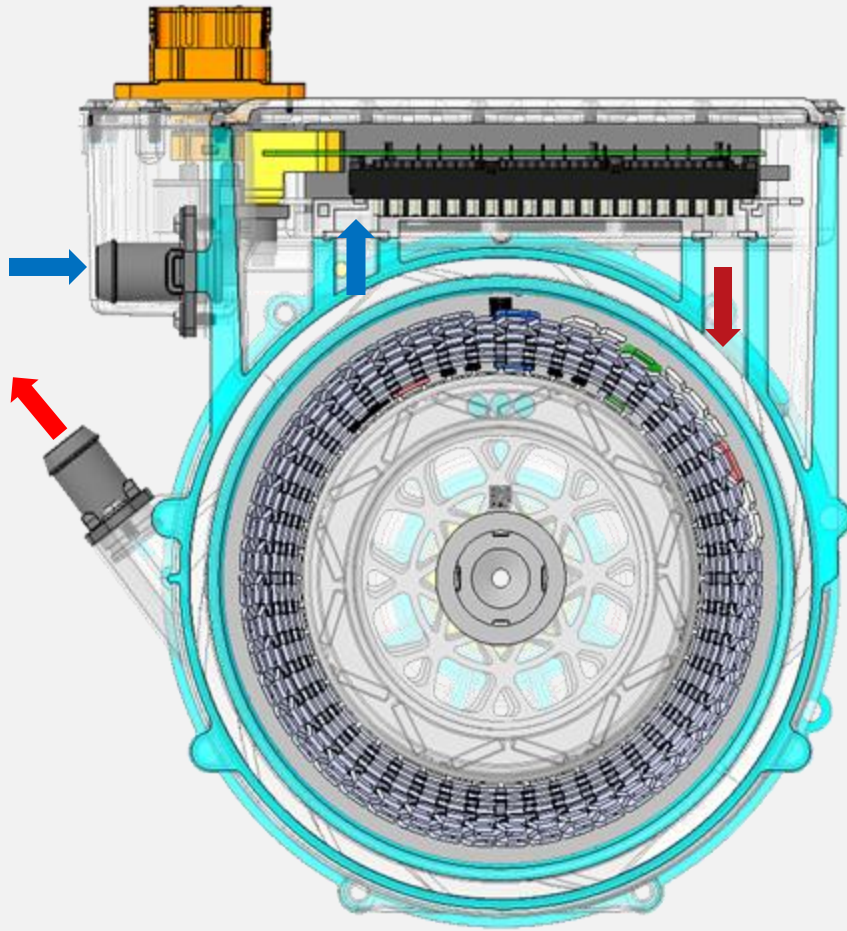


	Separated	Attached	Integrated
Modularity	+	-	-
Package	-	-	+++
Robustness	-	+	+++
Vehicle Integration	+	-	+
EMC	-	+	+++
Efficiency	-	+	+
Weight	-	+	+++
System costs	-	+	+++

GENERAL GUIDELINE

- **“Everything that is not there cannot fail”**
 - To reduce components to a minimum number
 - To reduce number of contact pins and flying wires
 - To make the product more robust
 - To reduce the cost structure
- **Antoine de Saint-Exupéry :**
„**Perfection** is achieved,
not when there is **nothing more to add**,
but when there is **nothing left to take away.** “

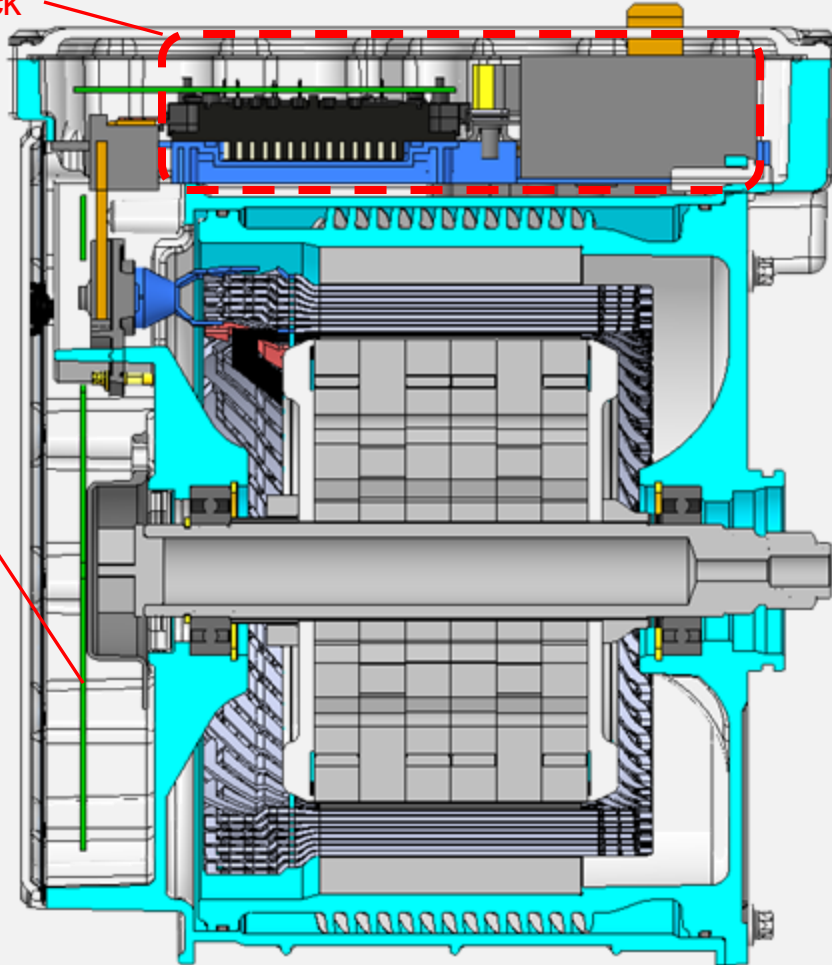




EPU with integrated inverter

- Peak Power 100kW
- Continuous Power 60kW
- 3-phase Permanent Magnet Synchronous Motor
- Power module on top
- Joint liquid cooling

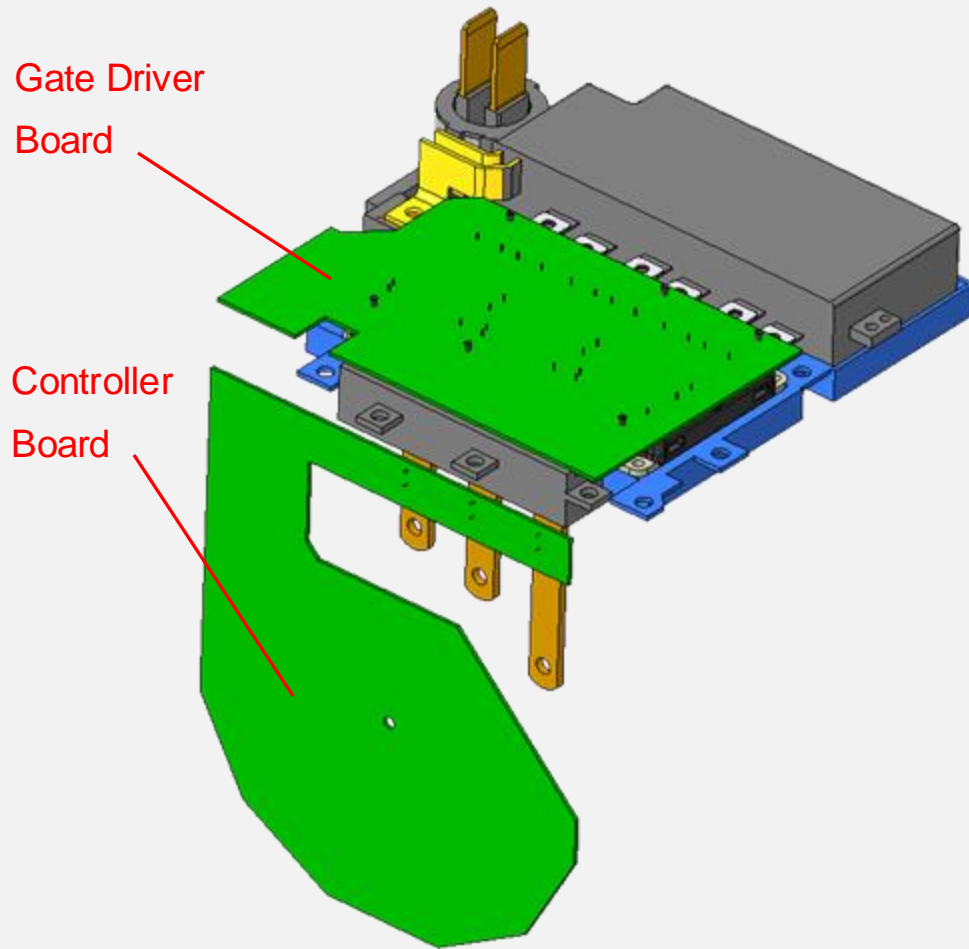
Power Stack



Controller
Board

ARCHITECTURE

- Power stack on top in common carrier
- Controller Board on B-side of E-Motor
- **ADVANTAGE:** Sensors on Controller Board
 - **Rotor Position Sensor**
 - **AC Current Sensors**
 - **Motor Temperature Sensor**



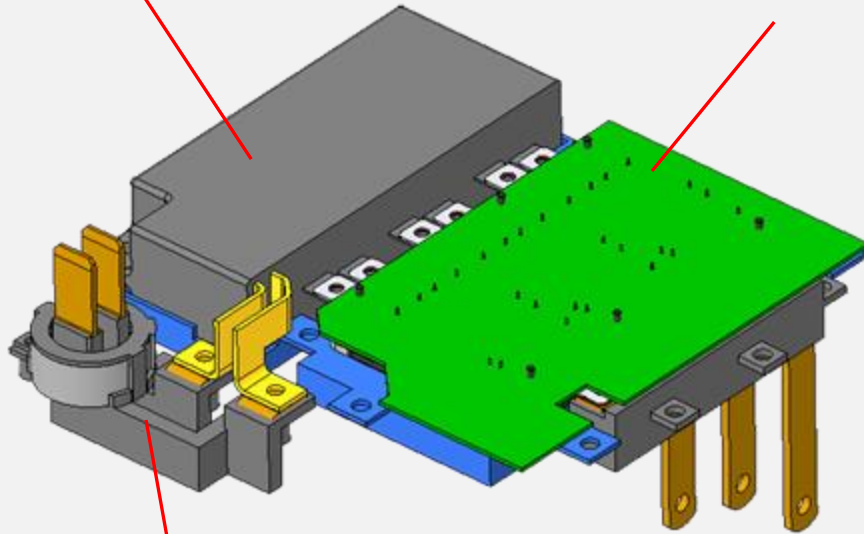
DISTRIBUTED INVERTER

- Controller Board on B-side of E-Motor
- Gate Driver Board pressed in on Power Module
- Wiring connection between Gate Driver Board and Controller Board
 - PWM signals
 - Diagnosis signals

POWER STACK

DC Link Capacitor

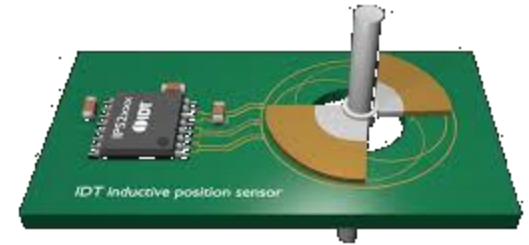
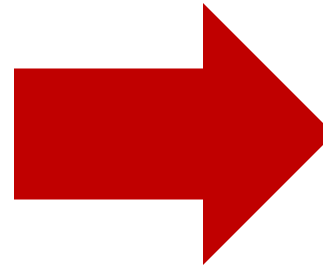
Gate Driver Board



HV DC Filter

- Power stack is one single sub assembly
 - Can be tested separately
 - Can be inserted and mounted easily
 - Prepared for bolting and laser welding

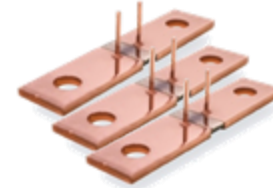
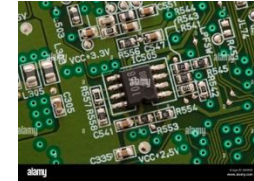
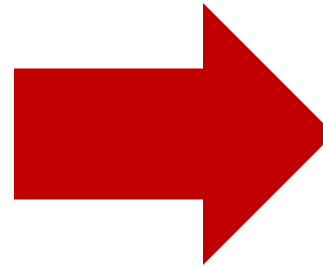
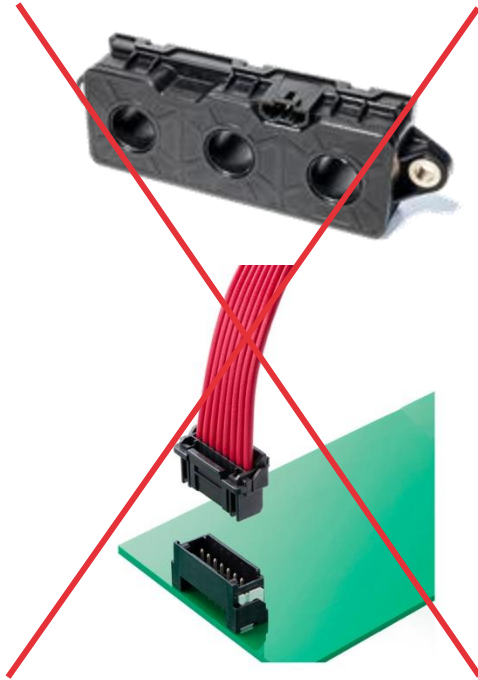
ADVANTAGE #1: ROTOR POSITION SENSOR



- Target wheel on motor shaft
- Electronics on Controller Board
- No connectors
- No wiring harness

Images are only symbolic

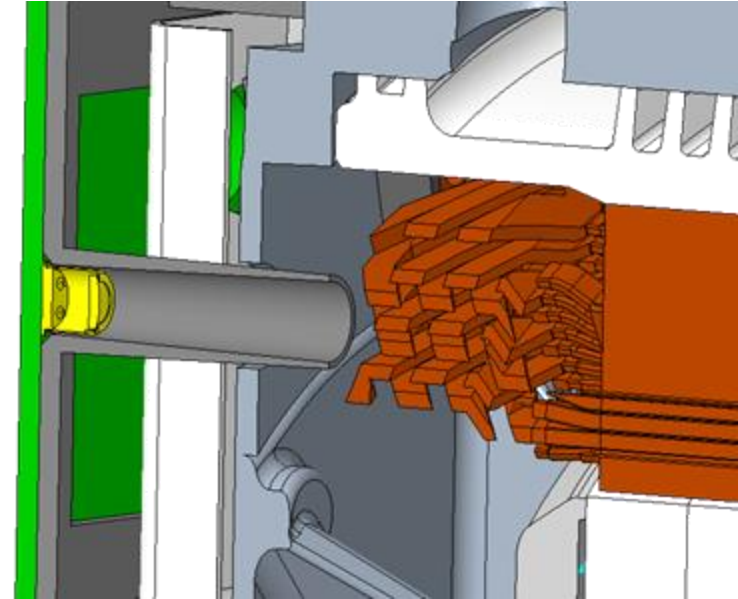
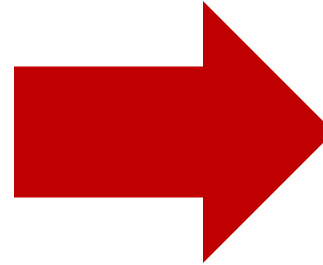
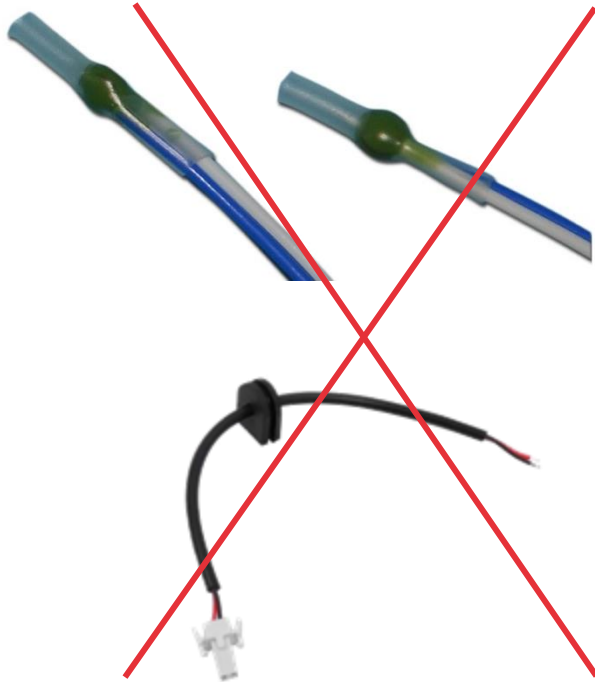
ADVANTAGE #2: CURRENT MEASUREMENT



- Shunts integrated in busbars
- Electronics on Controller Board
- No wiring harness

Images are only symbolic

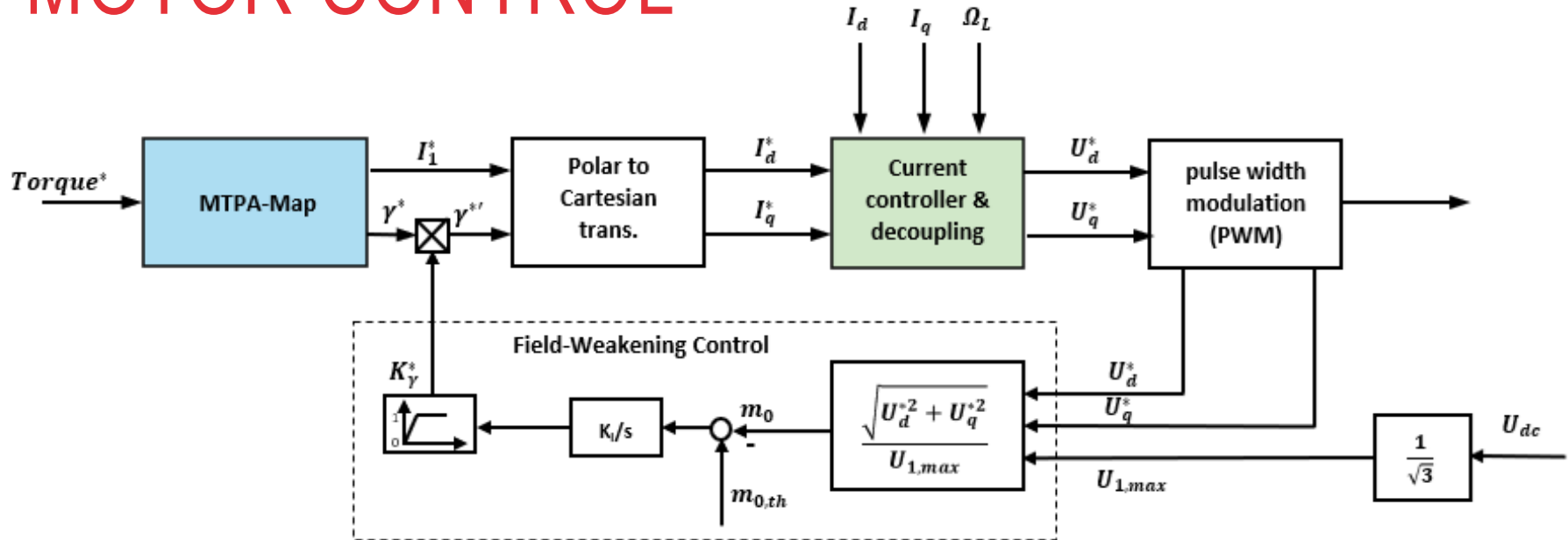
ADVANTAGE #3: TEMPERATURE SENSOR



- Infrared sensor & light pipe
- Electronics on Controller Board
- No wiring harness

Images are only symbolic

MOTOR CONTROL



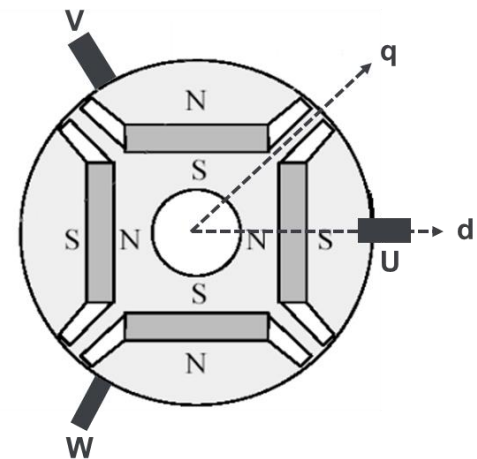
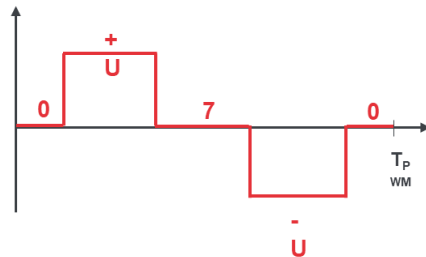
- Field-Oriented Control
- MTPA-Map
- Field-Weakening Controller

USING SOFTWARE INSTEAD OF HARDWARE

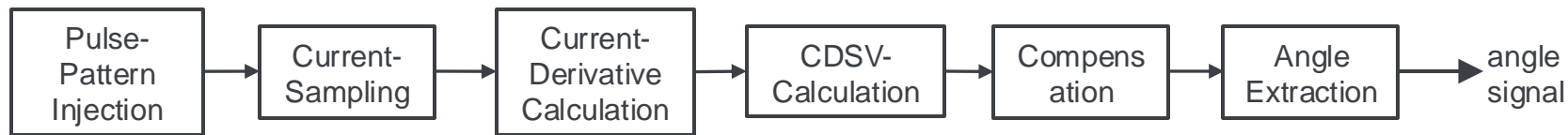
Transient Pulse Injection

Pulse-Pattern:

Voltage time multiple of zero.

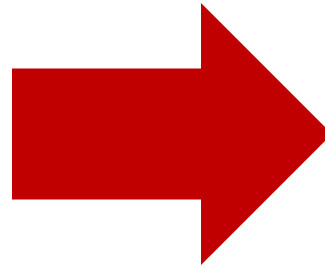


SW-Implementation:



CDSV... Current Derivative Space-Vector

ADVANTAGE: ROTOR POSITION BY SOFTWARE



```
);  
s->rule_exists( $resource_details['id'], $role  
$access = false ) {  
  / Remove the rule as there is currently no need  
  details['access'] = !$access;  
  this->_sql->delete( 'acl_rules', $details );  
  e {  
  / Update the rule with the new access value  
  this->_sql->update( 'acl_rules', array( 'access'  
ch( $this->rules as $key=>$rule ) {  
  ( $details['role_id'] == $rule['role_id'] &&  
  if ( $access == false ) {  
    unset( $this->rules[ $key ] );  
  } else {  
    $this->rules[ $key ]['access'] = $access  
  }  
}
```

- No hardware anymore

Images are only symbolic

RESULT: NEXT GEN POWER UNIT



Very compact electric power unit thanks to high level integration



Reduced number of parts, especially connectors and wiring harnesses



Reduced cost structure



Increased reliability



ROTAX

THANKS FOR
YOUR ATTENTION

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