Rotor Position Sensors for Hybrid Drives and Electric Drives

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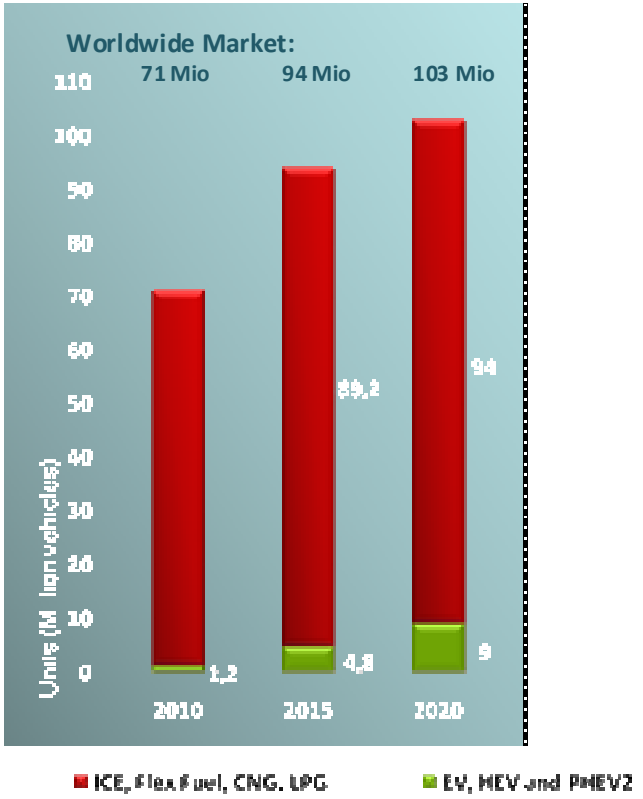
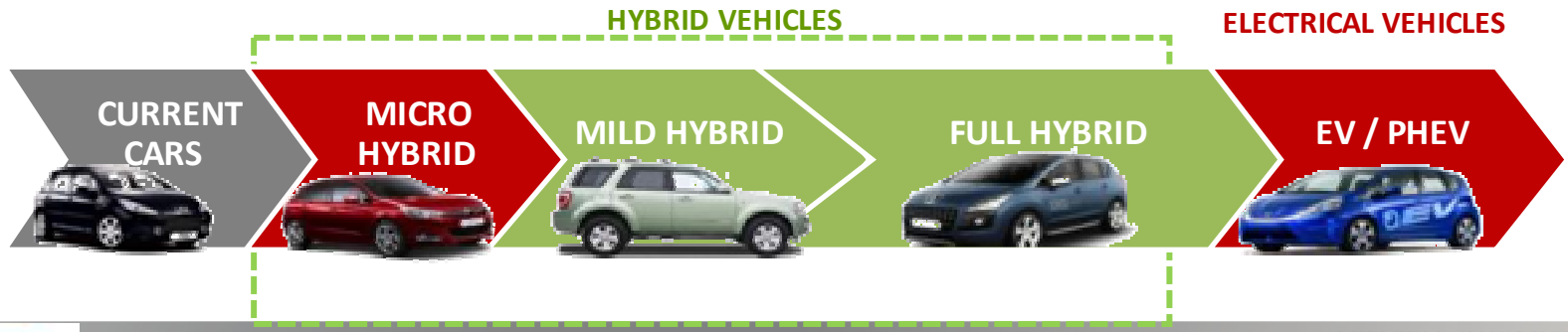
1

Introduction

Electric motor for vehicles

- Estimated **9** million vehicles by 2020
  - Europe (CAFE): **95 g CO_2/km**
  - US (Government): **110 g CO_2/km**
- **1,x e-motors per vehicles**
- **Rising market looking for high volume cost effective & high performance solutions**





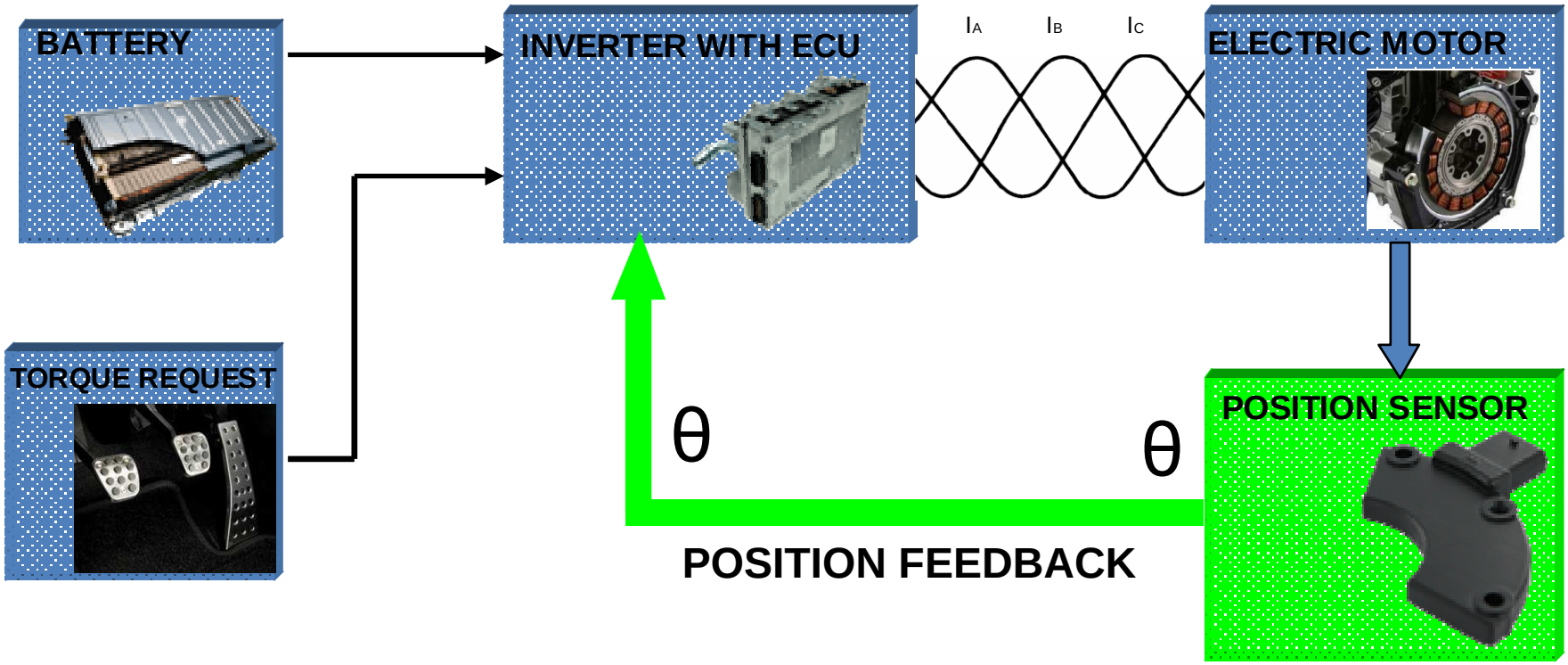
Electric motors for HEV / Plug-in HEV / EV

- **Asynchronous electrical motors:**
  - Advantages:
    - Relative mature technology
    - no magnet, low cost
  - Drawbacks:
    - Low power density
    - Difficult torque control

- **Synchronous electrical motors:**
  - Advantages:
    - High power density
    - High efficiency
  - Drawbacks:
    - Higer cost
    - magnet aeging @ high temperature

1.3 Position Sensor for Synchronous Motor Control

- The control system of **synchronous motors** needs position feedback in order to calculate the phase currents necessary for obtaining the desired torque with maximum efficiency.



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Rotary Position Sensors

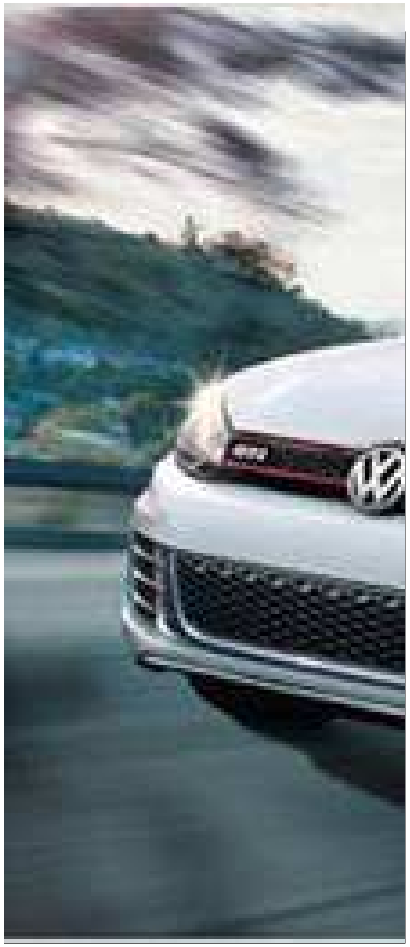
2.1 Resolvers

Provide two AC analog signals representing sine and cosine of θ.

- Advantages
  - Absolute position information at power on
  - Robustness
  - High temperature range
  - Not sensitive to pollution
  - High accuracy

- Drawbacks
  - Potential interference with magnetic stray fields
  - Requires high excitation currents
  - Analog output signals
  - Needs external conditioning circuit
  - Requires precise positioning of the stator
  - High cost

2.2 Electric Motor POsition Sensor = EMPOS



- The ideal Rotary Position Sensor for electric motors would have high accuracy and robustness like resolvers, combined with additional features like:

- ✔ Improved immunity to magnetic stray fields
- ✔ Flexible design
- ✔ High compactness
- ✔ Reduced cost
- ✔ High accuracy
- ✔ Digital signal

EMPOS is a **new generation rotary position sensor**, based on eddy current measurement, that was designed to meet these requirements

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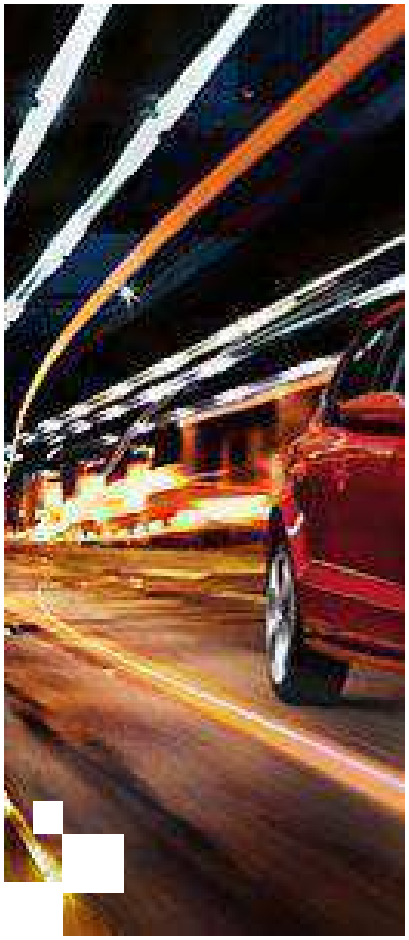
EMPOS Design

3.1 Working Principle



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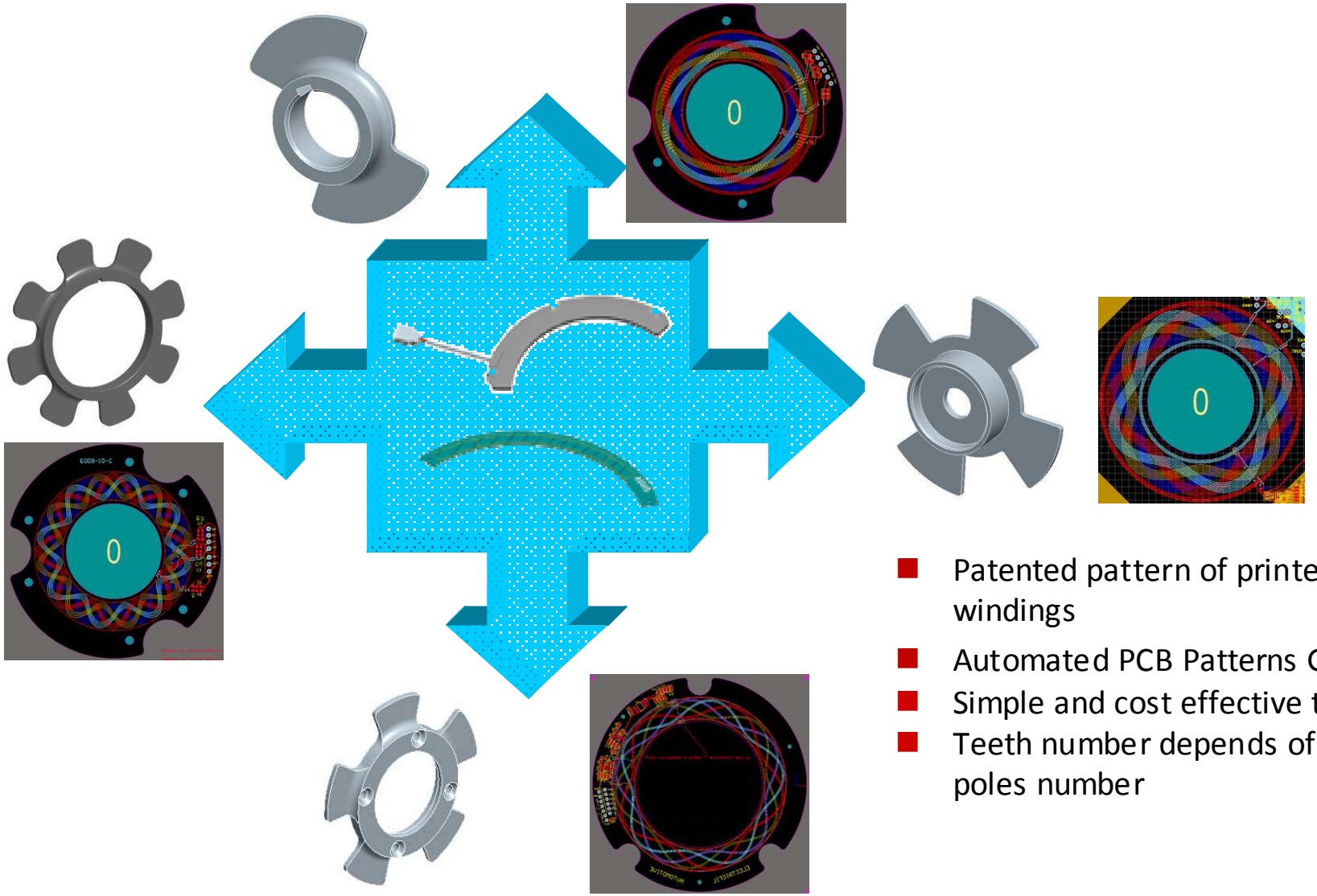
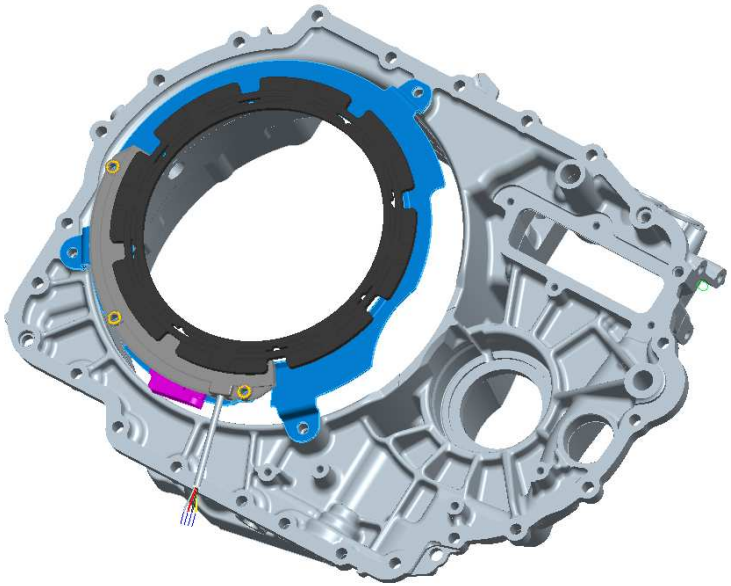
Mechanical & Electrical interfaces

4.1 Product Customisation



- Patented pattern of printed coil windings
- Automated PCB Patterns Generation
- Simple and cost effective target
- Teeth number depends of motor poles number

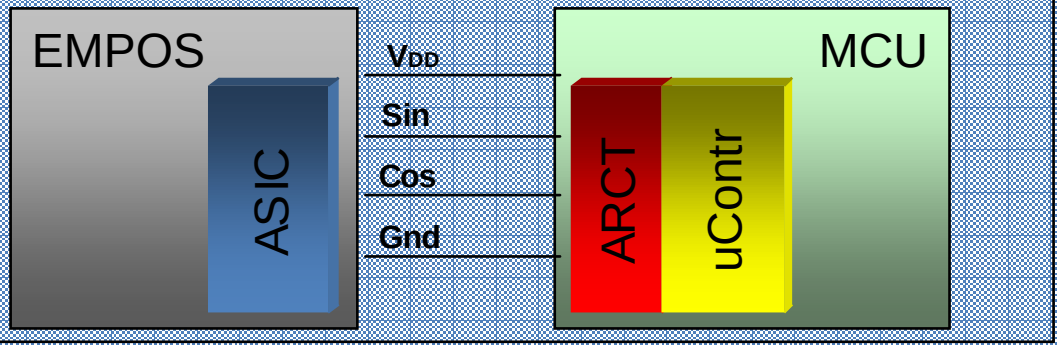
4.2 Assembly on Electric motor



- Possible fixation on metallic support without influence on measurement
- Robust to harsh environments of elec. motors and gear boxes
- TW thickness depend on vibrational constraints

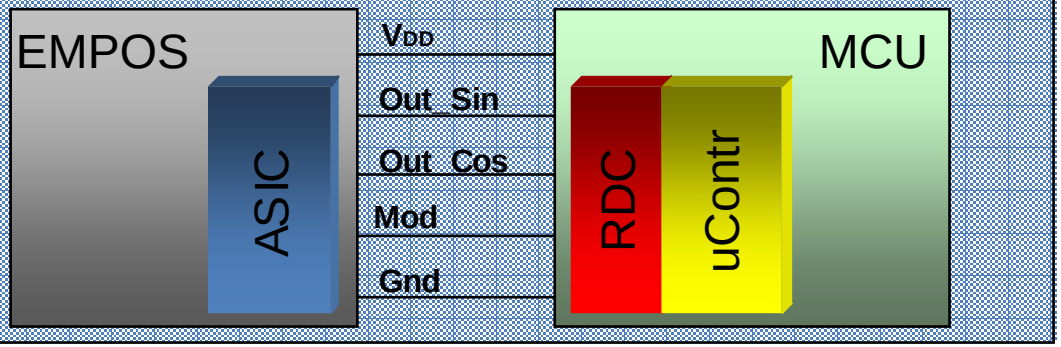
3 OPTIONS

Analog interface without carrier signal



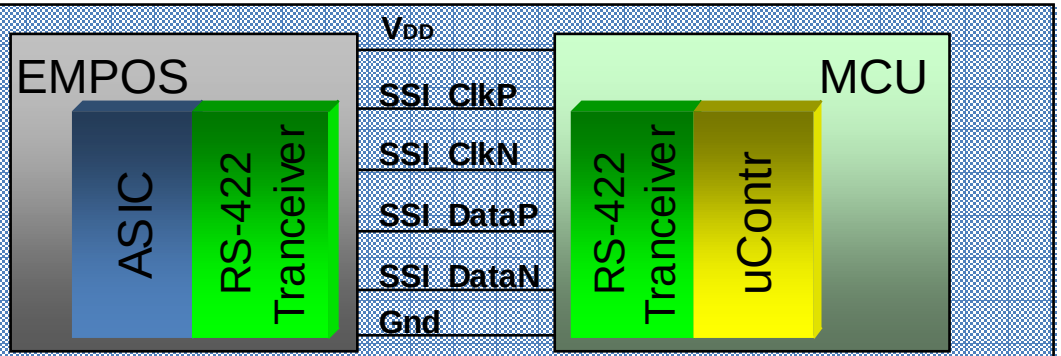
Analog interface with carrier signal:

- Improved noise immunity
- Standard RDC



Digital Serial Interface SSI++:

- EMC Immunity
- No RDC needed, cost saving



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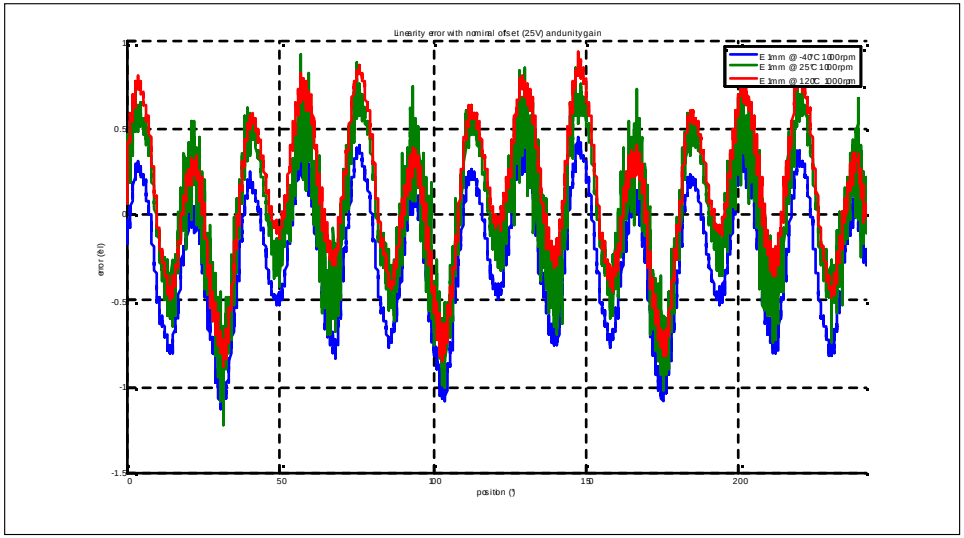
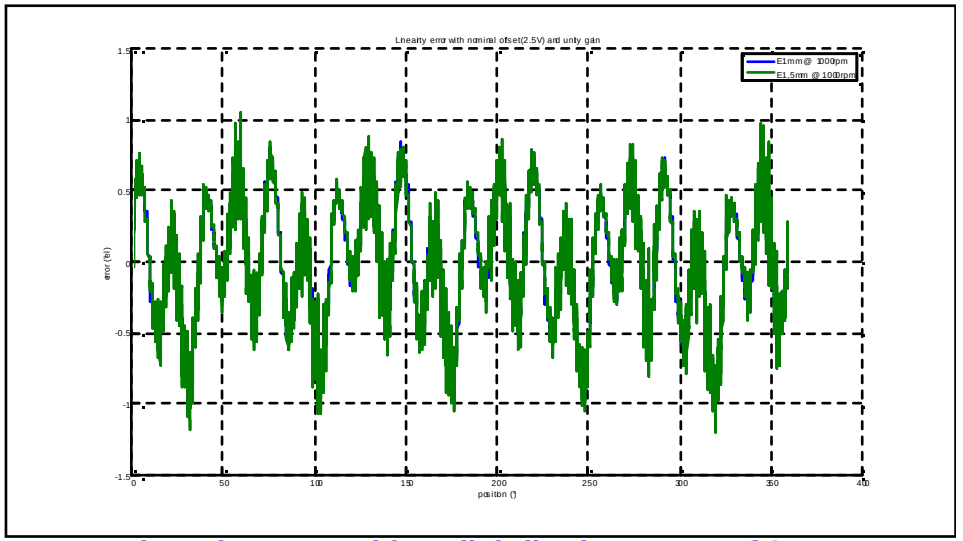
Performances

5.1 Sensor accuracy @ low speed

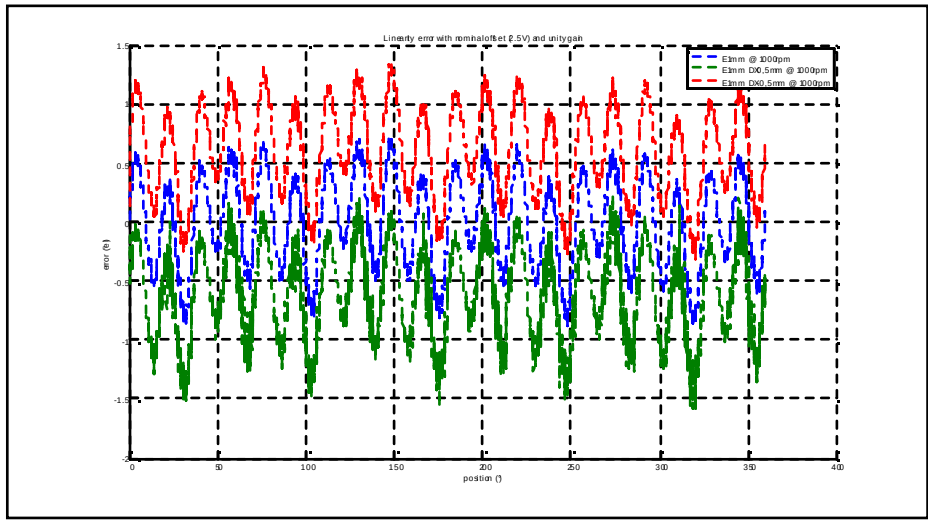
Linearity error with temperature change



Linearity error with axial displacement of 0,5 mm

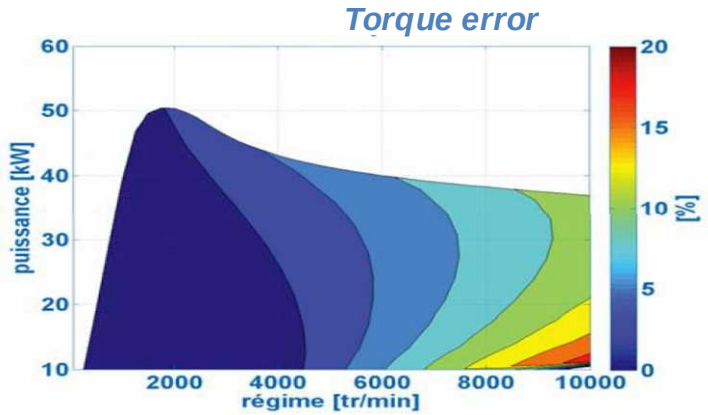


Linearity error with radial displacement of 0.5mm

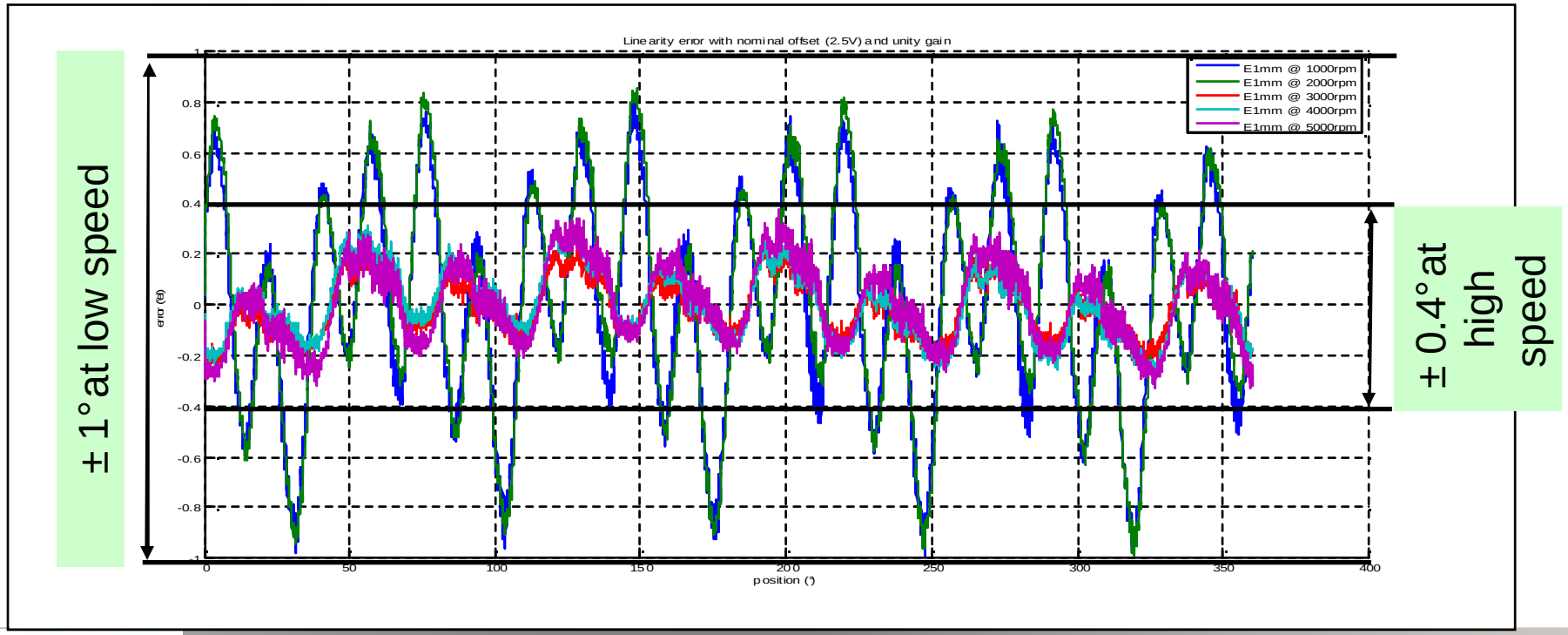


- ***All effect cumulated linearity error < 1° electrical***
  - *.Temperature*
  - *. Assembly tolerances*

5.2 High speed performance optimisation



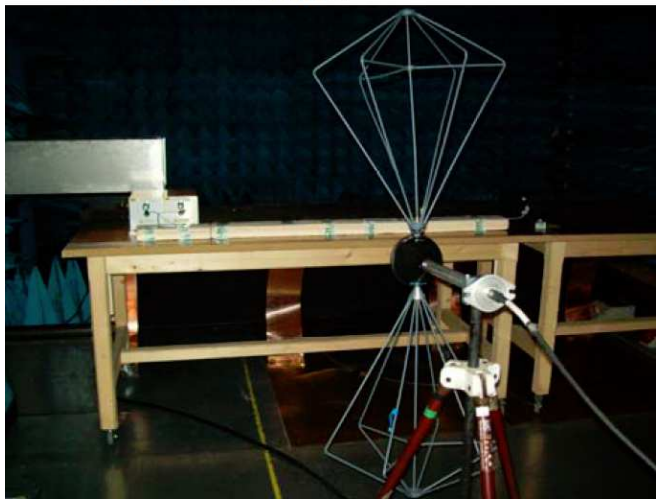
- Sensor errors influence increase @ high speed



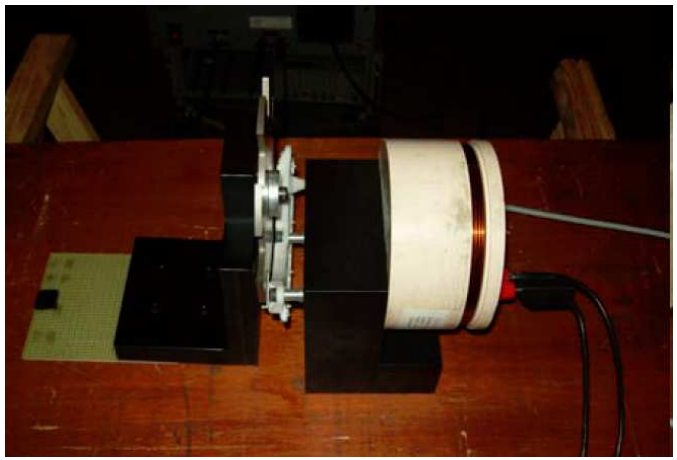
5.3 EMC Performances

- EMISSION
  - 150kHz – 2GHz
  - CISPR 25 – 48 to 25 dB µV/m
  - compliant

30MHz – 300MHz



- IMMUNITY
  - RF (200-3000MHz):
    - 70V/m to 140V/m
    - ISO 11452-2
  - AF (15Hz-30kHz):
    - 300A/m to 10A/m
    - ISO 11452-8
  - compliant



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Conclusion

6.1 Conclusion

Their is a high demand in High performance sensor for Synchronous motor

EMPOS is an innovative sensor based on eddy current technology

It offer flexible and easy mechanical integration

It is compatible with 3 electrical interfaces, analog and digital

The performance has been improved at high speed for Optimum power efficiency