

AVL



AVL List GmbH (Headquarters)

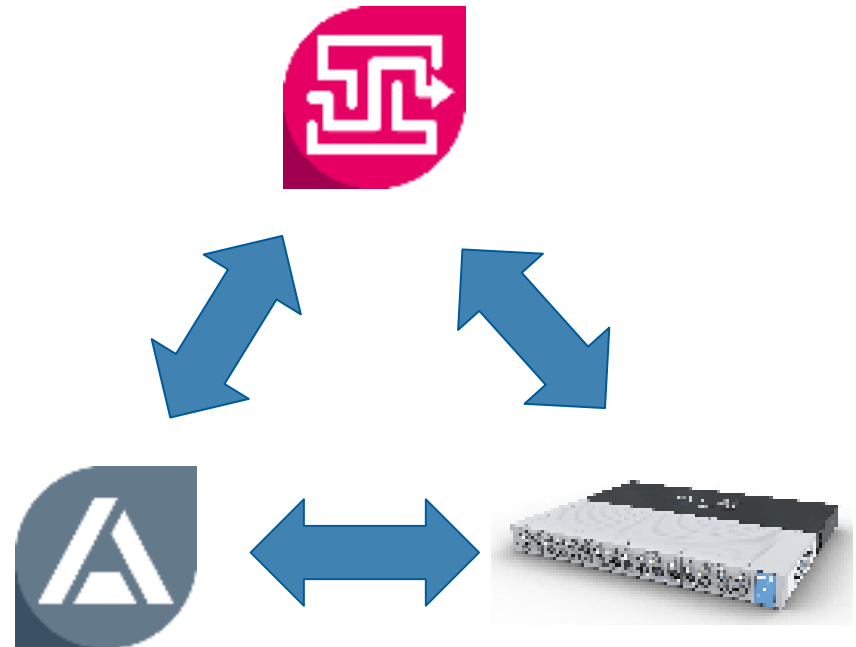


E-Drive Calibration

Automatic E-Drive calibration with
AVL E-Drive Test System

E-Drive Calibration

- Cameo
- Puma
- X-ion



Customer problem / Benefits

Actual Problem:

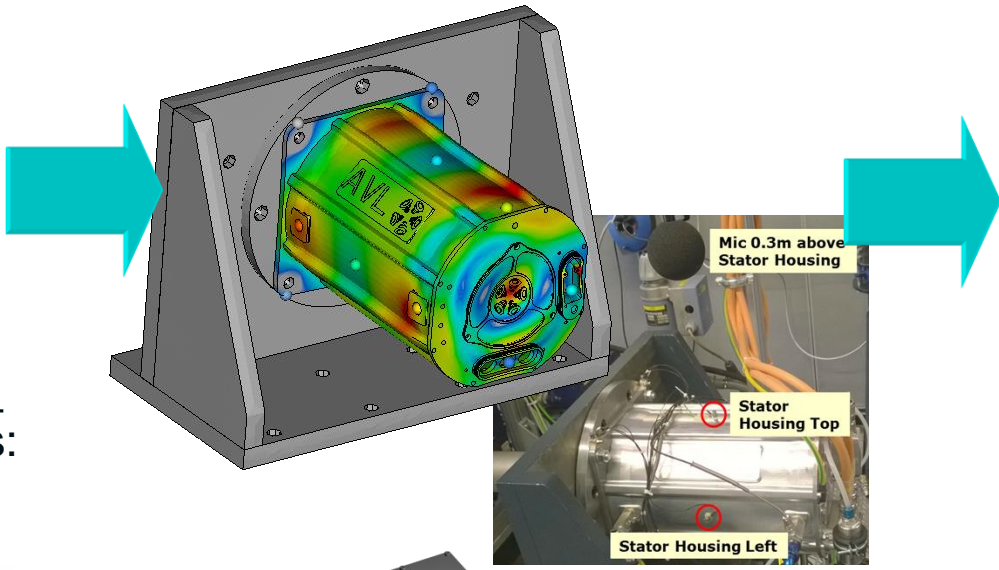
Manual calibration → **very high time effort!**

Benefits:

- **Higher Quality** due to advanced calibration methodology
- **60% Reduction** of development time and cost
 - Unattended, automated test runs over night
 - Less manpower

Challenge → Calibration

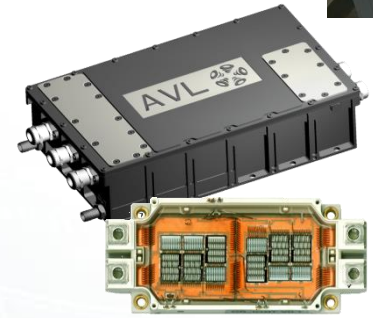
Input Parameters:
High amount of Variables



Target:
Maximum efficiency
At constraint Back EMF and Temperature limits

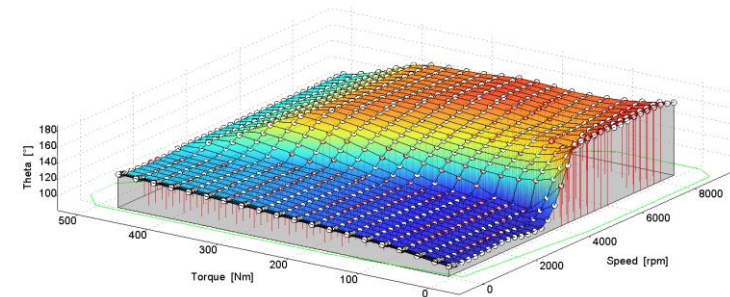
Base calibration:
Theta influences:

- I_d
- I_q
- L_d
- L_q
- Psi_m



ECU

→ How to effectively find the improved calibration?



Theta Map = Application Label



AVL PVL COOLANT CONDITIONING SYSTEM

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CURRENT TRANSDUCER 80A

AVL

AVL

AVL

AVL STORAGE BATTERY

AVL

AVL

AVL

AVL

X-FEM "Universal"
Comm. Sensors, NVH,...

X-FEM "e-Power"
Current, Voltage → BEV

X-ion Basis Rack (1HU x 19")

X-FEM "Indi"
cylinder pressure
ICE or Hybrid (HEV)



X-ion Front-End Modules (X-FEMs)

Rack cascadable
6 Racks up to 96 Channels!

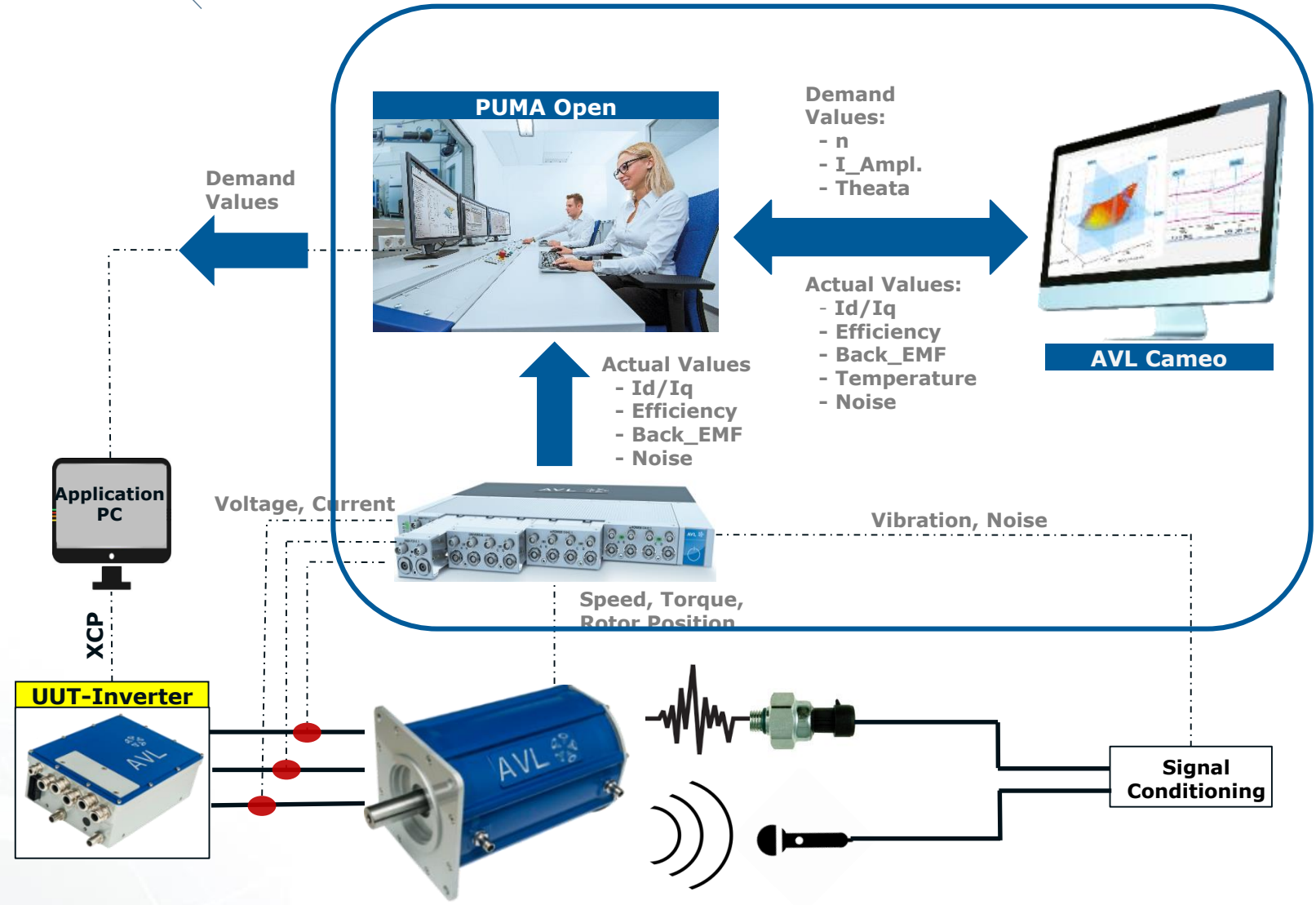
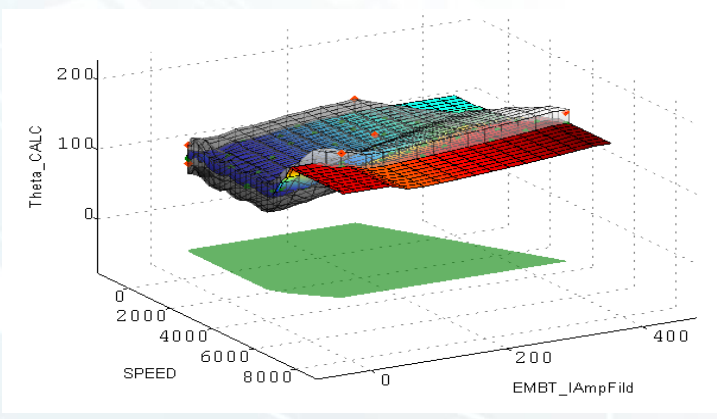
- ✓ Acquisition rate: **2 MS/s**
- ✓ Resolution: **18 bit**
- ✓ Bandwidth: **1000 kHz**

Solution - Automated E-Drive Calibration

Teamply Software:

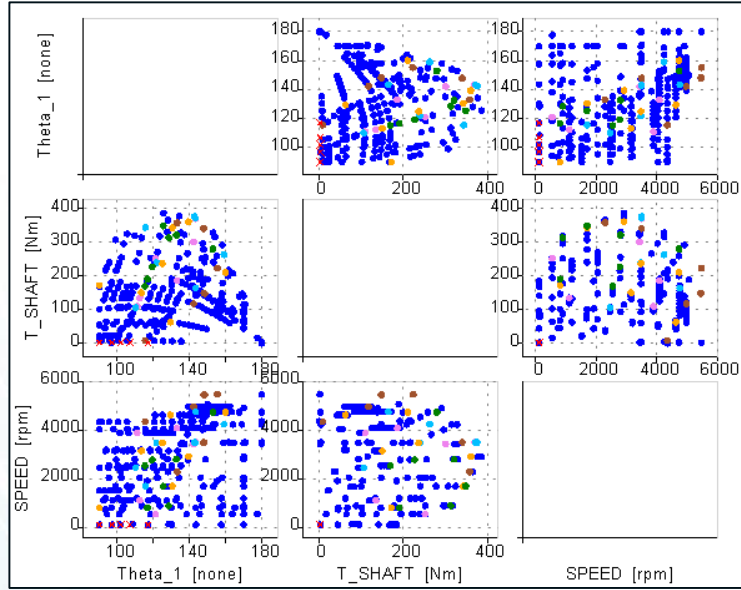
- Puma
- Cameo
- X-ion

Cameo - Active DoE

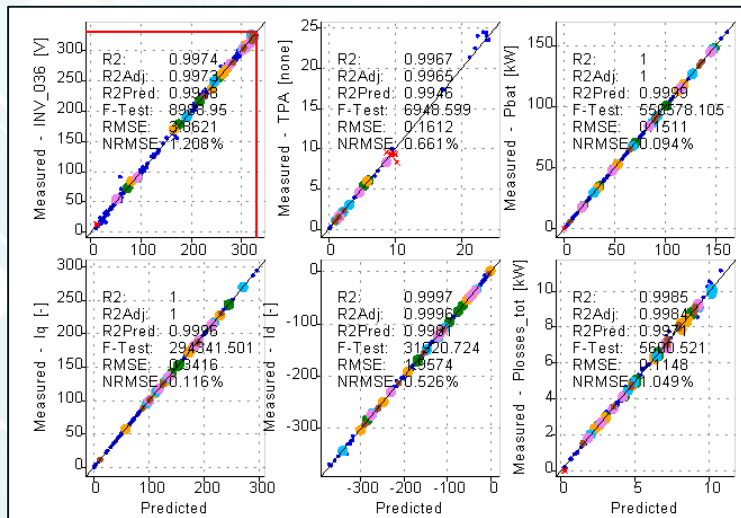


Rawdata plausibilization and Model building

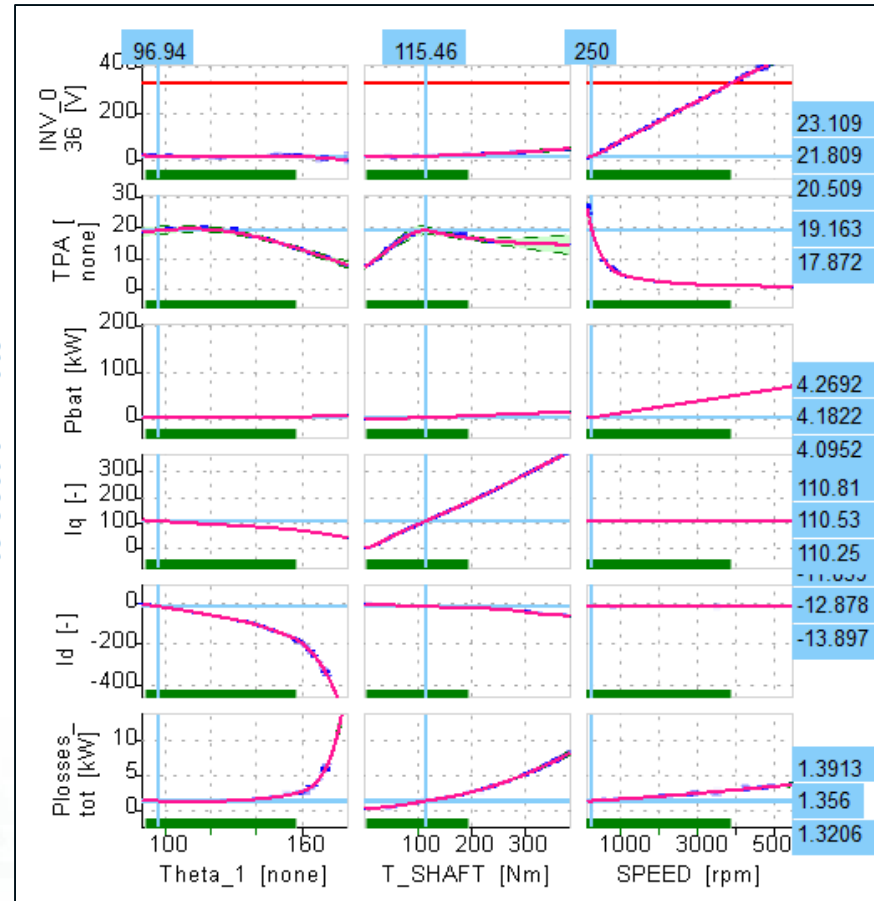
Variation vs Variation design space



Measured vs Predicted

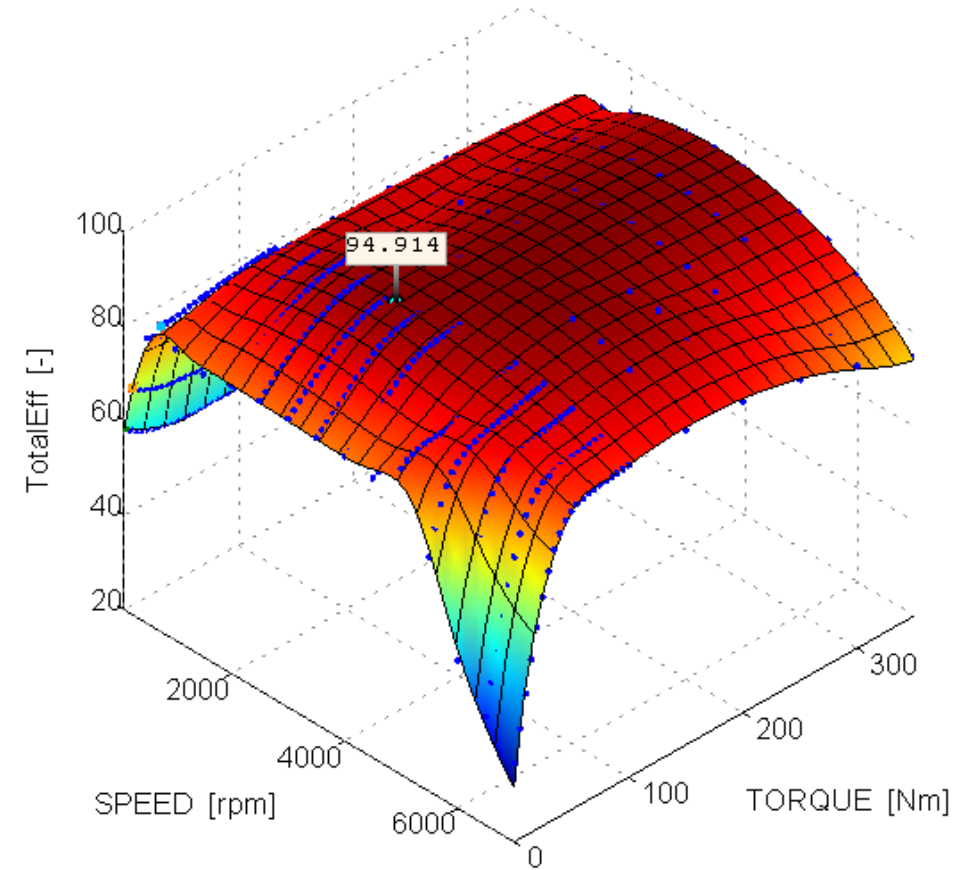
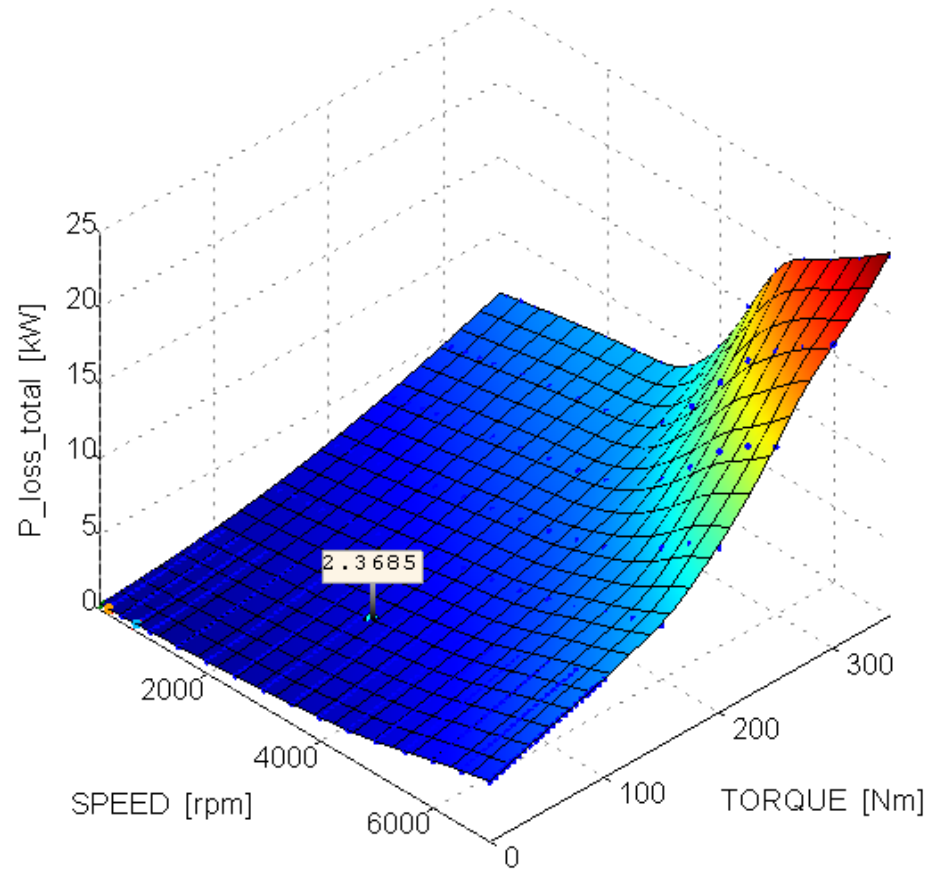


Intersection Plots



- Plausibilization of raw data
- Global Model using averaged measurements as function of (Theta, T_Shift, Speed)
- Empirical Models allow a prediction at every operating point

Result: Minimized Losses, Total Efficiency



Advanced Calibration of E-motor & Inverter on E-Drive Testbed



In order to maximize the electric range of vehicles an optimized calibration of E-motor & Inverter is essential. AVL developed a toolchain for highly efficient and accurate testing, calibration and validation on an E-drive testbed.

AVL PUMA OPEN 2™

AVL CAMEO™

AVL X-ion™

Battery Simulator

Theta

Efficiency

Multi Parameter Optimization

Proven Benefits

<p>Reduction of development and testing time</p>	<ul style="list-style-type: none"> Up to 80% time reduction in calibration process compared to manual approach Seamless tool chain integration on the testbed assures maximum testing efficiency
<p>Reduction of cost</p>	<ul style="list-style-type: none"> Minimized UUT & testbed occupation time. Reduction of measurement effort due to consequent DOE utilization Quantification of your specific commercial benefits
<p>Increased product quality</p>	<ul style="list-style-type: none"> High repeatability of measurement results Higher traceability of results Multi-parameter optimization in the whole operating range Optimized efficiency of E-drive increases the electric range

Thank You



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