



Measurements on Electric Drivetrains: Battery Tech Expo '23

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Making Sense with Sensors



STRAINSENSE

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QA-SGP001

General Overview

About Strainsense..

Established: 2002

Location: Milton Keynes HQ, plus external sales engineers, internal product specialists

Sensor and Data Acquisition solutions provider

Markets: include Automotive/Autosport, Crash, Military, Aerospace and Research facilities.

All of us, Internal Engineers, Product Specialists & External Sales focus our time providing application solutions using various sensing technologies within our extensive portfolio. Uniquely we can provide custom products, solutions and systems.

Accredited ISO9001:2015 & ISO14001:2015

Sensors and Data Acquisition:

Data Acquisition	Mobile, Test rigs, Power Analysers & analysis software
Pressure	General Industrial, High Temperature, Miniature/Dynamic
Force/Torque	Pancake, S-Beam, Low Profile, Multi-axis, Custom solutions
Position	Linear & Rotary, LVDT, Inclinometers, String Pots
Vibration	AC & DC coupled & Servo Accelerometers
Strain	Specialise in high temperature, gauging In-house, on site.
Inertial	Gyros, IMUs, INS & GPS
Current	Zero Flux & Rogowski coils, AC & DC coupled

Solutions to integrate all the above with signal conditioning, displays, cables & amplifiers



Making Sense with Sensors



Measurements on Electric Drivetrains

The requirement: to measure various parameters on an electric drivetrain – both in test cells and on-vehicle

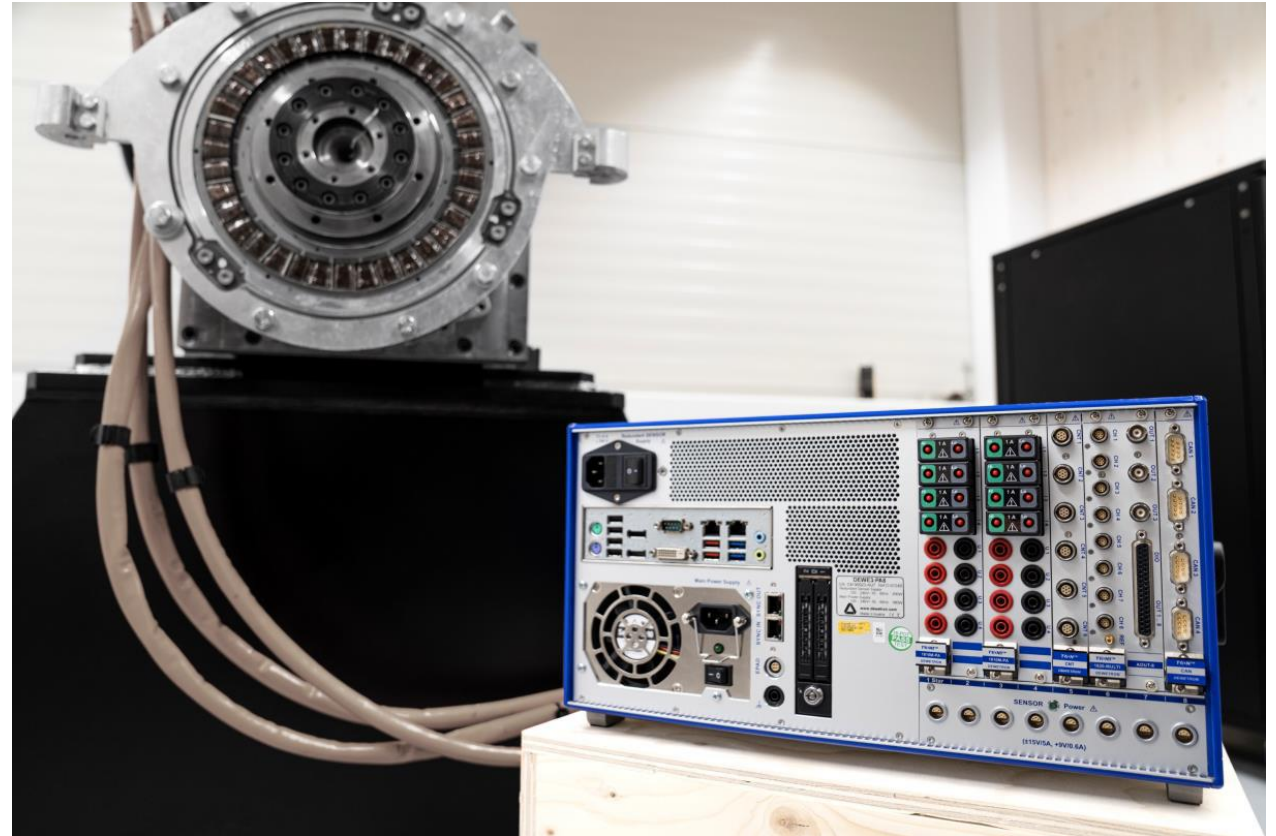
- Electrical power (DC and AC)
- Mechanical power (speed, torque)
- Efficiency – motor, inverter, total
- Harmonics
- Energy

The application:

- Steady state testing
- Run-ups, coast downs, different load steps
- Drive cycles

The challenges:

- Achieving high accuracy across wide operating frequency
- Simplifying efficiency mapping
- Analysing waveform data, order and DQ analysis
- Integrate with test cell controller



Measurements on Electric Drivetrains

The measurement solution: mixed signal power analyser – test cell

- Modular power analyser
- 4 channel POWER modules for HV and current
- 1kV RMS voltage inputs, 0.2 -20A RMS inputs for current sensors
- 10 MS/s sampling, 5MHz bandwidth, 18 bit resolution
- 0.03% measurement error (no range error)
- CAT IV 600V, CAT III 1kV category rating
- Accredited (ISO 17025) or traceable calibration
- Isolated modules for speed and torque (mechanical power)
- Isolated modules for other signals, e.g. NVH (IEPE)
- 8 channel current sensor power supply

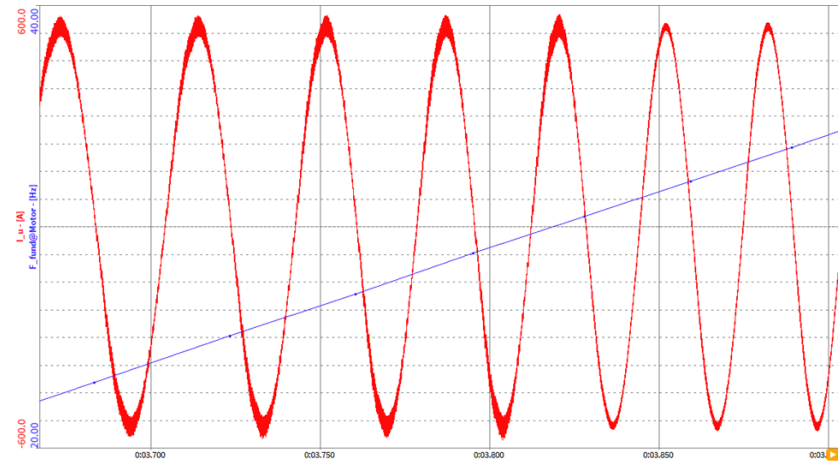
Test bed integration: integrate with test cell controller

- Transmit power data (low speed) and / or waveform data (high speed)
- Start / stop recording
- Load setup
- Automate test process

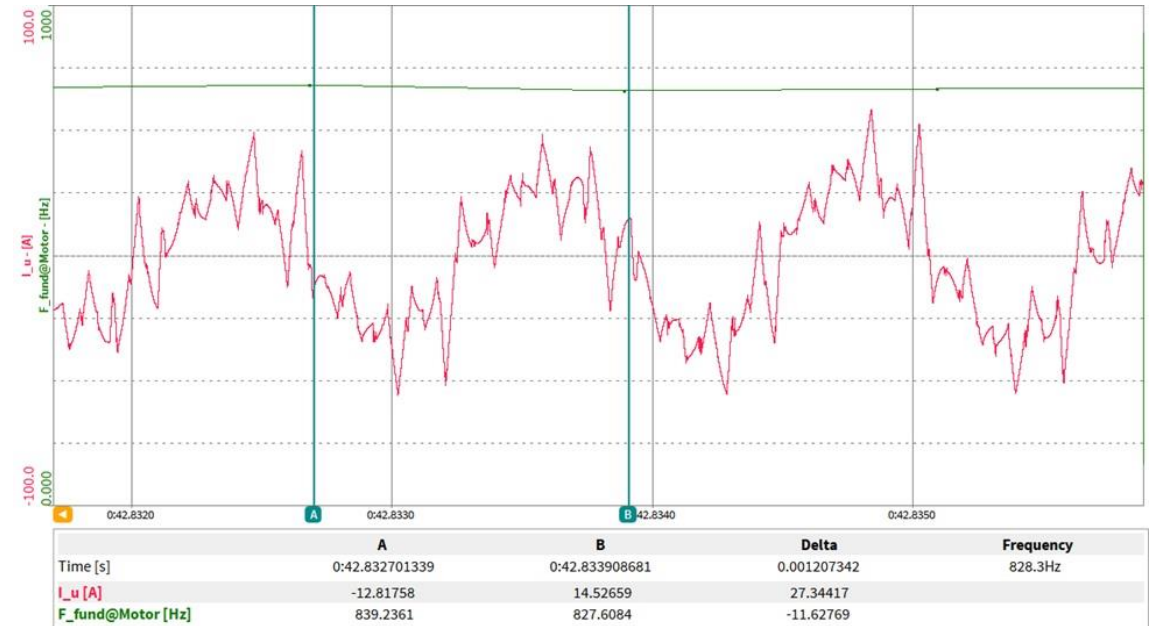
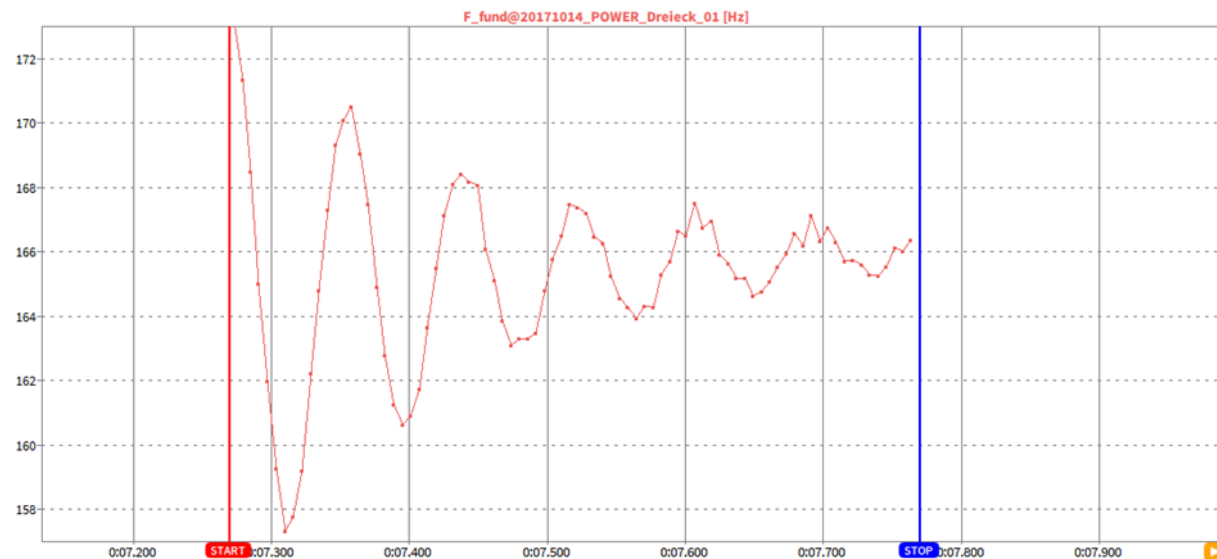


Measurements on Electric Drivetrains

Power analyser - automatic fundamental frequency detection



- Detect and visualize every single Zero-Crossing of the Fundamental



- Fundamental Frequency detection with highly distorted waveform
- Fundamental Frequency Trace of a Load Step, vibrations of 10 Hz can be clearly detected

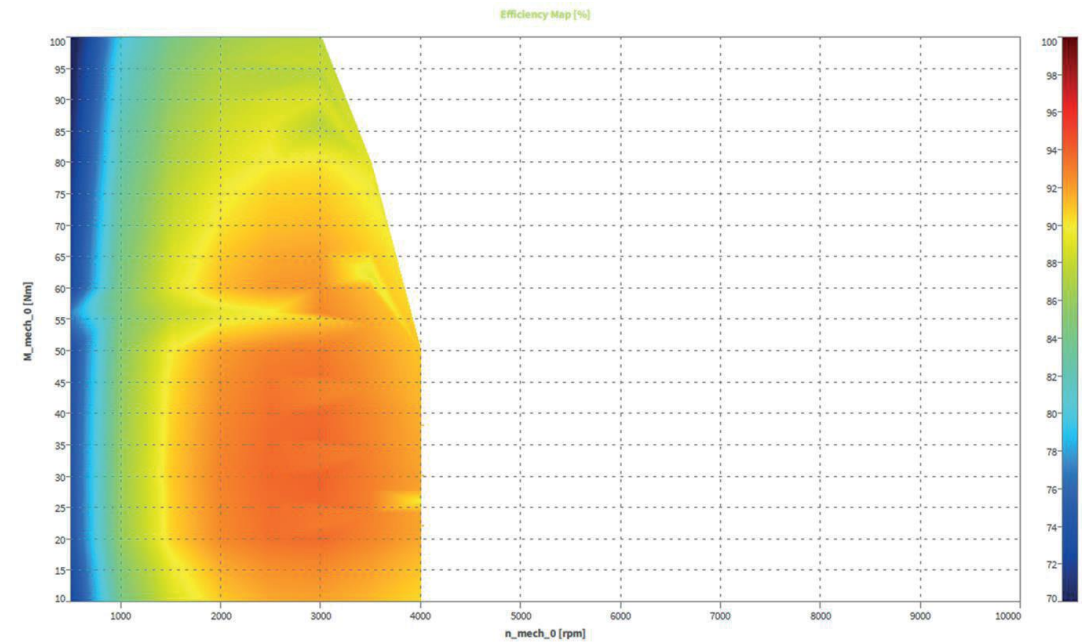
Measurements on Electric Drivetrains

Automation of efficiency mapping process

- Parallel calculation of motor, inverter and total efficiency at speed, torque set point
- 3D visualisation of speed, torque and efficiency
- Trigger measurement from test cell controller or manually
- Store burst of waveform data at set point
- Export efficiency map as PDF report at end of test

Advantages

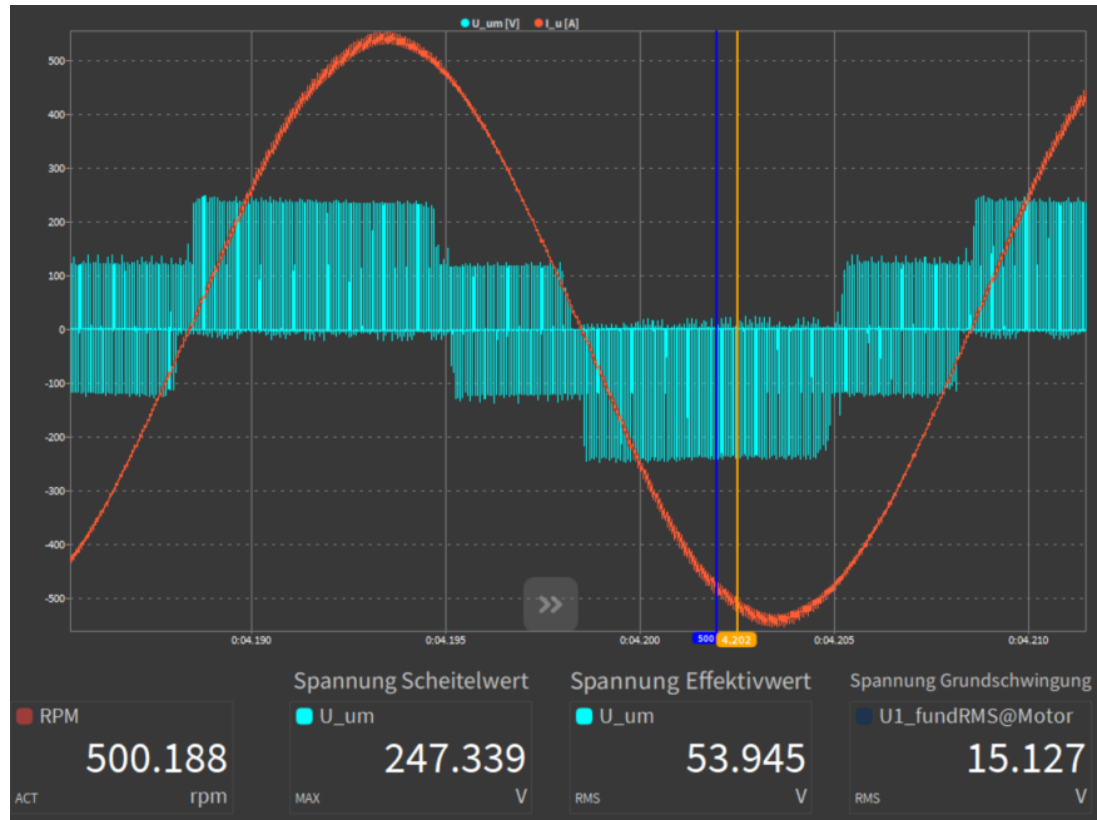
- Visualisation without post processing
- Freely definable visualisation of other parameters in 3D



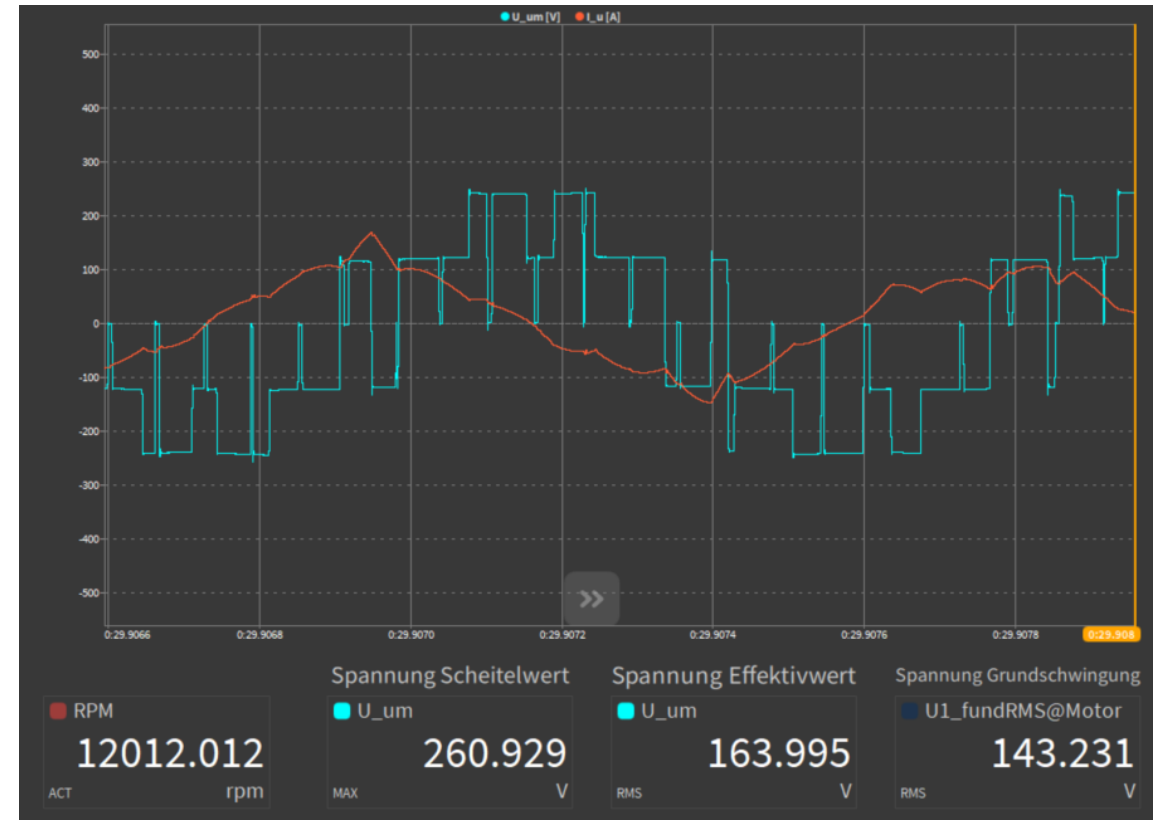
Measurements on Electric Drivetrains

Waveform recording to analyse power electronics in detail

- Use power analyser as a scope instrument



Current and voltage at the inverter output @500 RPM



Current and voltage at the inverter output @12000 RPM

Measurements on Electric Drivetrains

Test cell integration: integrate with test cell controller

- Transmit cyclic power data and / or waveform data
- Start & stop recording, trigger burst recording
- Load setup
- Store header data

Protocols:

- EtherCAT
- CAN/CAN-FD
- SCPI*
- Ethernet Highspeed Interface (Datastream)*
- XCP over Ethernet
- Ethernet Sender / Receiver
- RDP – Windows Remote Desktop

* LabView VI demonstration App available

Benefits:

- Automate the testing process, simplify the work flow



Measurements on Electric Drivetrains

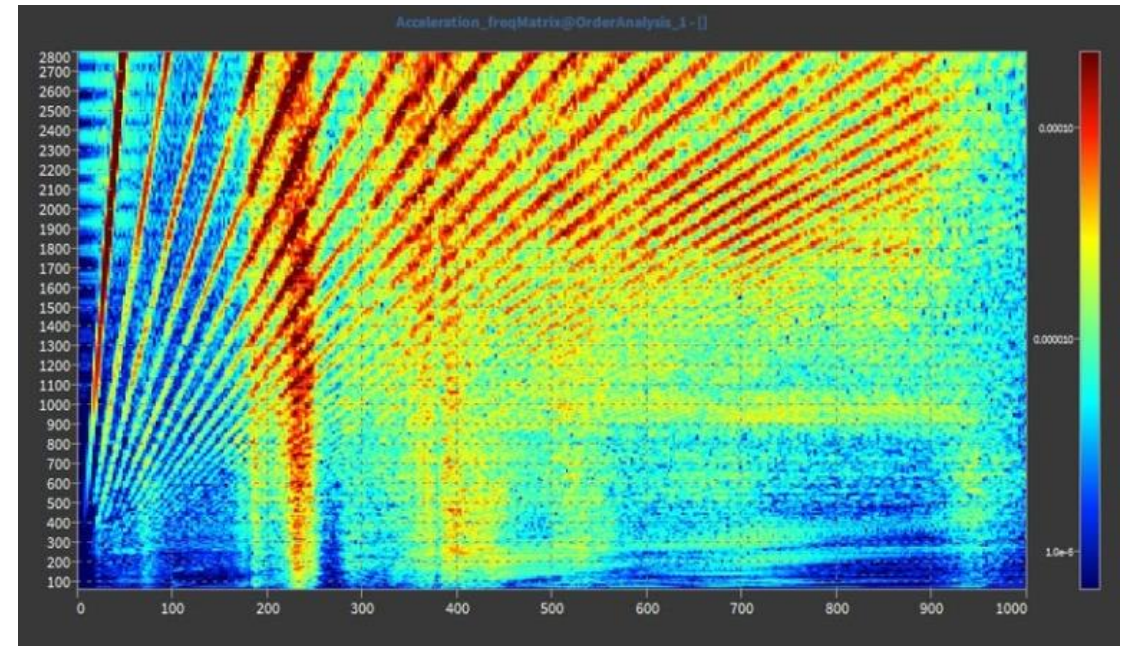
Order analysis

The challenge

- Determination of the vibration and noise emission of the motor in the frequency range and order range depending on motor speed
- Detection of critical operating points
- Fast and effective data collection and analysis

The solution

- Power analyser with additional isolated input channels
- Inputs for speed and angle measurement – encoder, resolver
- Analogue IEPE /ICP inputs for vibration or sound measurement



Measurements on Electric Drivetrains

DQ analysis

The challenge

- Analyse motor control function
- Check measured value against the set value from the motor controller

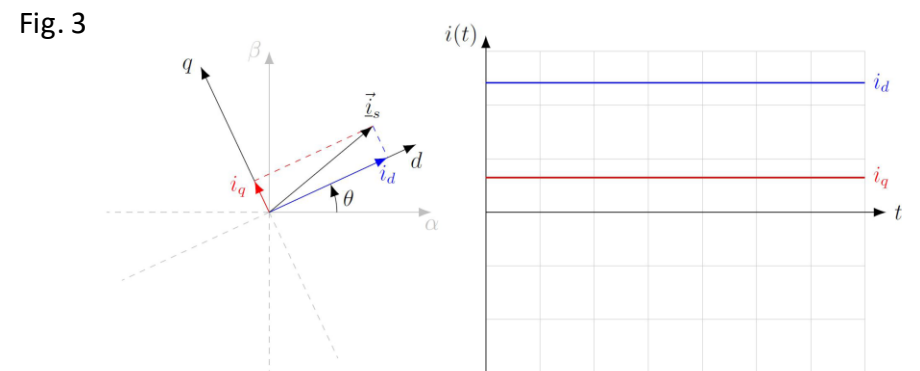
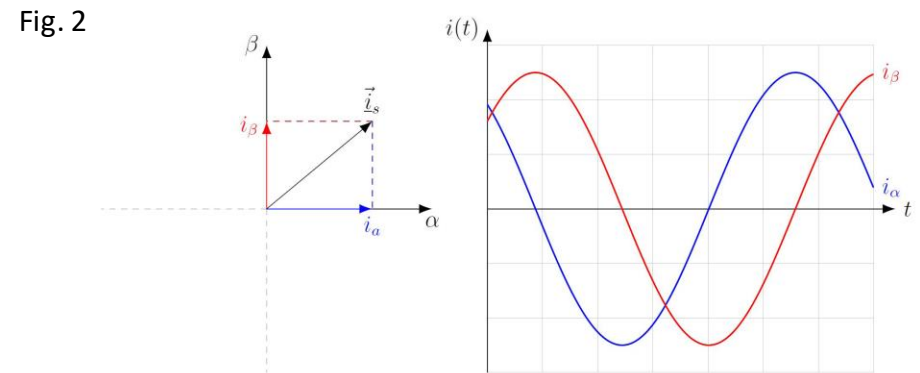
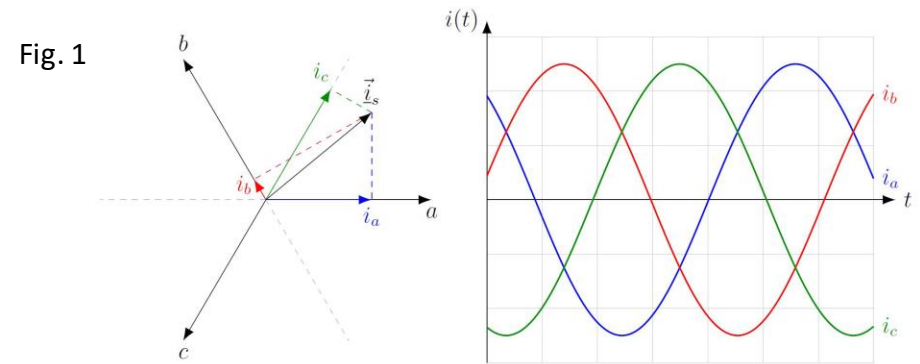
The solution

- Power analyser with real time DQ analysis
- Designed for use with 3-phase synchronous machine
- Park-Clarke transformation
- Performed with or without an angle signal
- Encoder, tape sensor and resolver inputs supported

Fig. 1: The abc-coordinate system

Fig. 2: The $\alpha\beta$ -coordinate system

Fig. 3: The dq-coordinate system



Measurements on Electric Drivetrains

The measurement solution: mixed signal power analyser – in-vehicle

- Portable power analyser
- Uses same module type for power measurement
- Input modules available for analogue / bridge, CAN, GPS, ADAS
- Video inputs
- External current sensor power supply box and battery pack

Advantages

- One hardware and software for test cell and on-vehicle test
- Simple to compare in-vehicle and test cell data



DEWE3-A4 with TRION-POWER module



Thank You –
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