

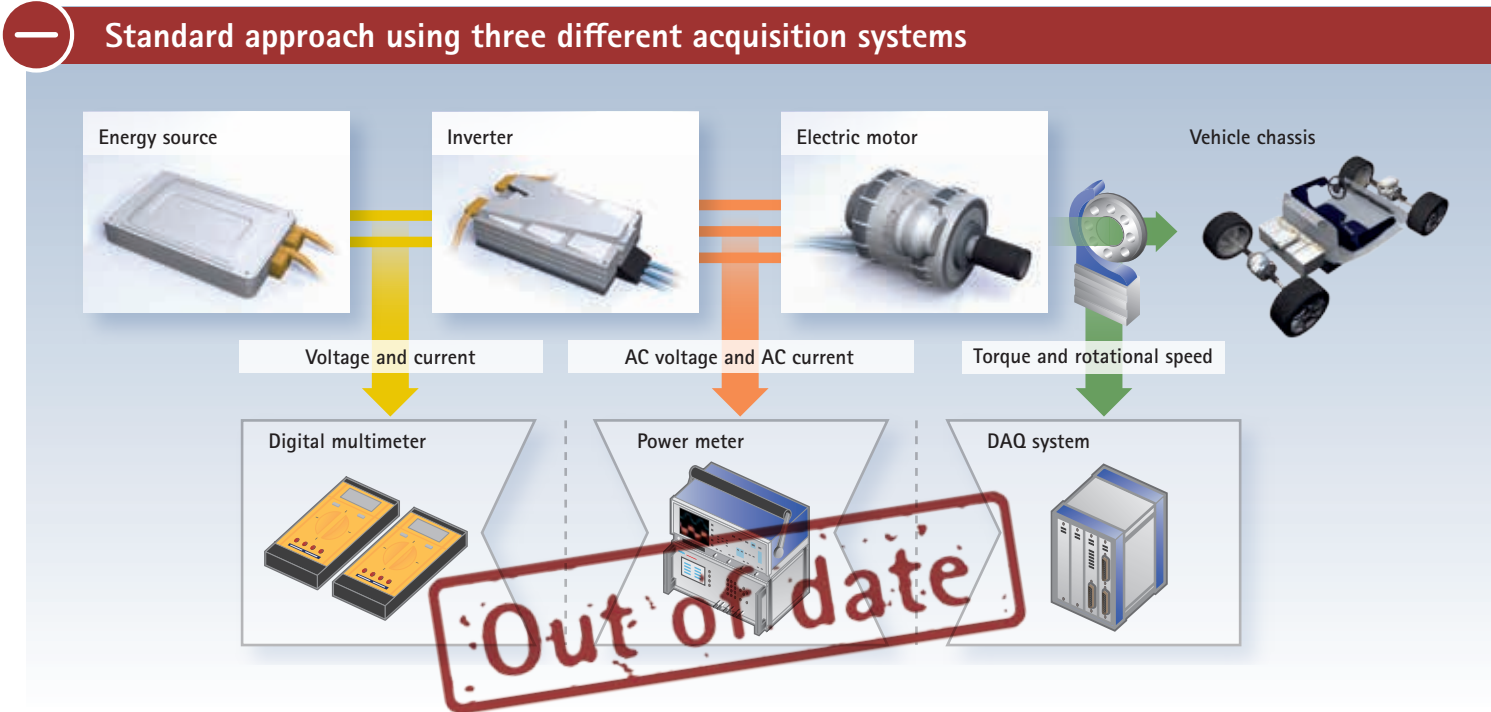


## Optimized testing of electric drives



# Facing challenges: with the standard method?

Improving the efficiency of inverter, motor and the entire drive train is a central task for the manufacturers of electric or hybrid drives. The standard method is not intended for the simultaneous, continuous and dynamic acquisition of mechanical and electrical parameters.



## Major drawbacks:

- Time synchronization between different systems is difficult
- Data storage in three different systems and data formats
- No continuous raw data acquisition
- Slow calculation cycles of the power meters
- Inadequate documentation of the algorithms for power analysis

Many customers report:

*"With our existing set-up we sometimes measure efficiencies larger than 1, which is obviously wrong. But we can't investigate any further as there is no raw data."*

**Have you had similar experiences?**

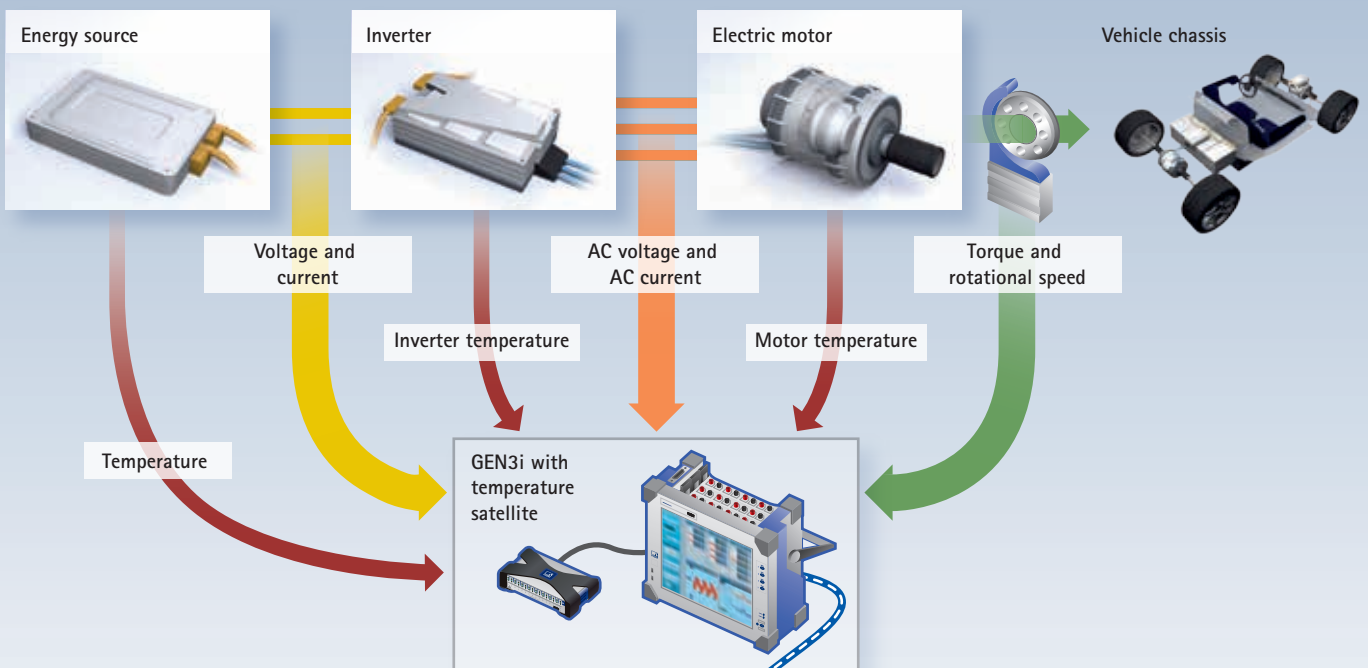
Take a closer look at our solution:

It meets all your requirements for the testing of electric drives.

# With the new, integral solution!

The new all-in-one solution from HBM Test & Measurement helps you to better understand the inverter and the electric motor and thus to make conversion and regenerative braking more efficient. Our integral system offers perfectly matched components from a single source, covering electrical signals up to 1000 V, mechanical signals and temperatures. It uses the best-in-class torque transducer and comes with software specifically developed for this application.

## + New HBM testing concept - one integral system



### Advantages of the new system:

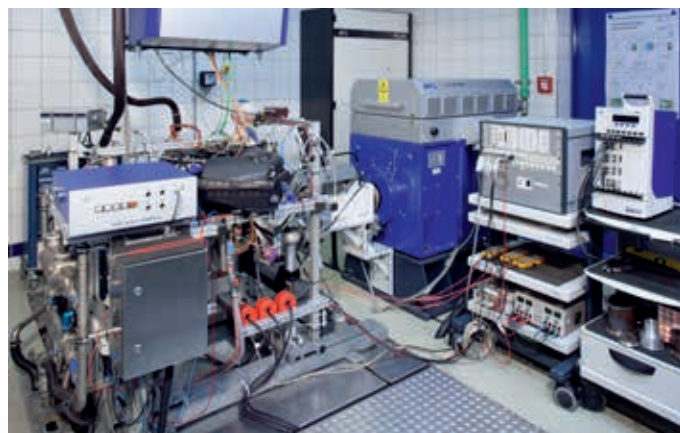
- + Continuous storage of all raw data for verification and analysis
- + Synchronous acquisition of all data
- + Storage of all data in a standardized system
- + Live power calculation per half cycle
- + Live oscilloscope and FFT display
- + Channel count can be increased, e.g. for strain gauges or acceleration transducers

# One solution for all your requirements



The time-consuming and error-prone synchronization of different measuring instruments is now a thing of the past. Measurement data acquisition with Genesis HighSpeed products is perfectly matched to our digital torque transducers.

This combination enables you to perform highly dynamic and precise tests on inverters and electric motors. Continuous measurements of up to an hour with a maximum of two million measurements per second per channel are not a problem.



HBM test and measurement equipment in a test bench for hybrid motors at Darmstadt Technical University, Institute for Combustion Engines and Vehicle Drive Systems (Institut für Verbrennungskraftmaschinen und Fahrzeugantriebe (vkm)).



All-in-one solution including the GEN3i data recorder with MX1609B temperature satellite and T40B torque transducer

# HBM's all-in-one system for measurements on electric motors and generators

The data recorders of the Genesis HighSpeed family provide maximum sampling rates and continuous direct-to-disk storage at up to 200 MB/s. Based on a modular platform the system can easily be configured to meet your specific needs - whether for 3, 6, 12 or 18 current/voltage channels or, alternatively, with an additional temperature measurement module.

While GEN3i rather has been developed for interactive or mobile use, GEN3t, which comes without a display, is mainly integrated in measurement cabinets and operated via an external computer.

The MX1609B temperature satellite provides 16 channels for thermocouples and can be connected to both mainframes (GEN3i and GEN3t).



## Voltage and current measurements

- 2 MS/s per channel continuous storage
- Unlimited recording length
- Isolated inputs from  $\pm 20$  mV to  $\pm 1,000$  V
- Measurement of phase-to-phase voltage or phase voltage
- Direct connection of current clamps or current transformers (via shunt)
- Scaling of the current sensors through database with calibration values
- One torque/speed input each per board

**2 MS/s**  
PER CHANNEL

**Genesis**  
HIGH SPEED



## Torque and rotational speed measurement with recognition of direction

- Direct connection of T12 or T40B
- Digital measurement eliminating analog errors
- Reference accuracy up to 0.03 %
- High bandwidth up to 6 kHz
- Reference pulse for identification of the rotor position

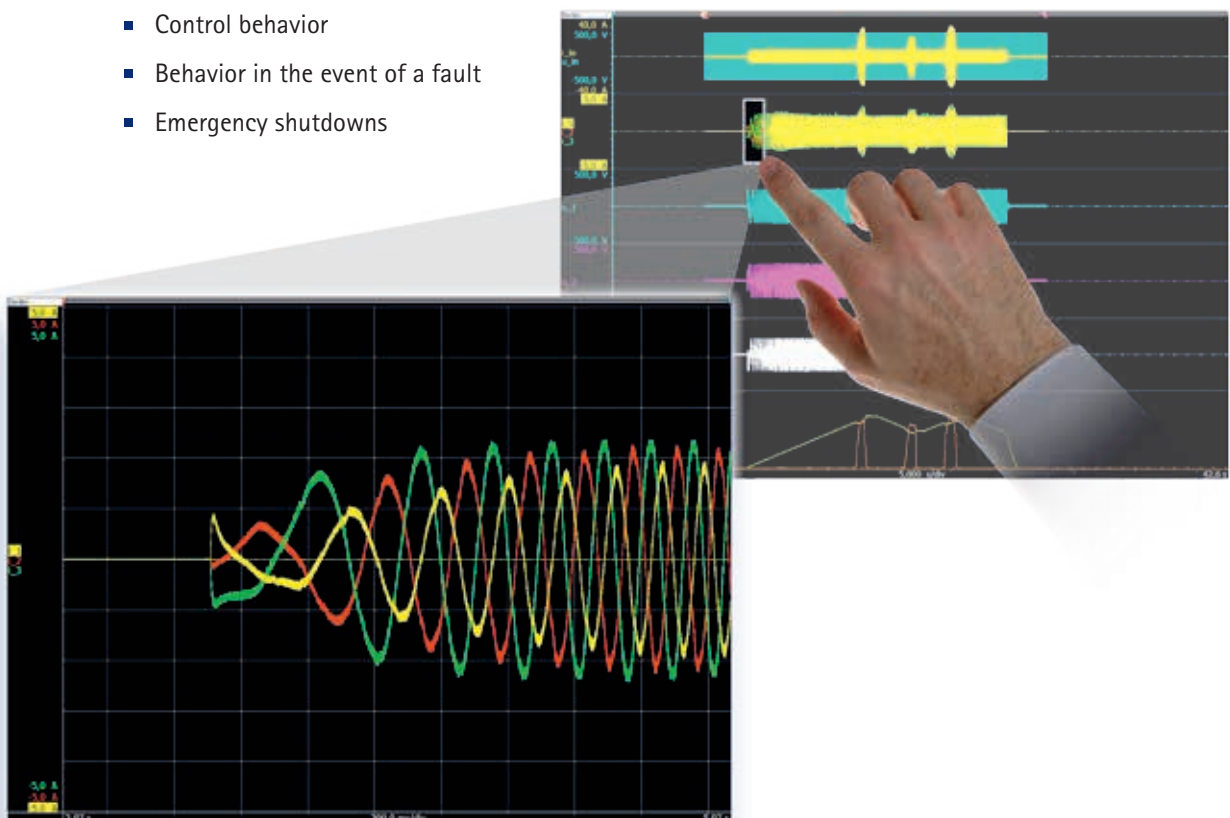
# Measurement data analysis at any time thanks to raw data storage

In contrast to power meters, the data recorders of the Genesis HighSpeed family continuously record all raw data. Therefore, calculated results such as RMS values or efficiencies can be verified at any time later. Moreover, the direct acquisition of raw data allows a detailed analysis of inverter and electric motor.

Detailed analysis of the drive train is possible thanks to continuous acquisition of raw data.

## Measurement, storage and analysis of:

- Dynamic load cycles
- Starting currents
- Control behavior
- Behavior in the event of a fault
- Emergency shutdowns



*Recording of all measurement data allows later playback, verification and further analyses.*

# Award-winning user interface

All data recorders of the Genesis HighSpeed family are intuitive to use via Perception software. Award-winning.

A special, application-oriented user interface has been developed for measurements on electric drives or generators. Therefore, no experience with the measuring instrument or the software is required. No familiarization is needed nor are there any problems with wiring or setup; you get your measurement results more quickly and reliably.



*The Setup menu simulates your measurement task and is visualized in the function blocks of an electric drive. You select, for example, power supply, type of connection, current sensors used and the sampling rate - done.*

*One click on the respective channel shows where and what signals are connected.*

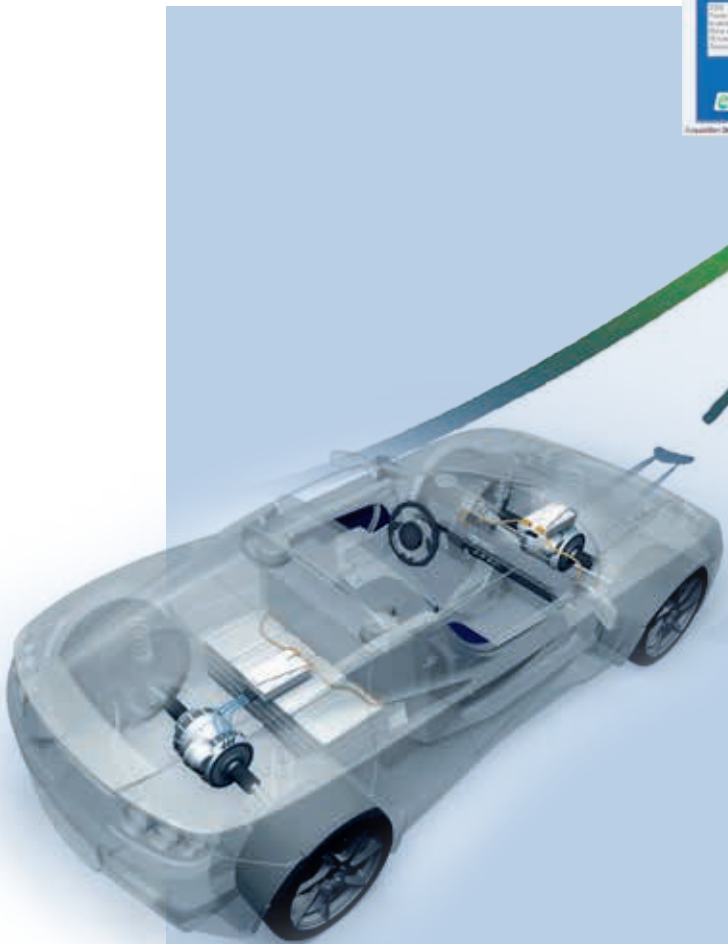
*There is no faster and easier way to do this.*

# Immediately see the result

Values computed from electrical and mechanical parameters are displayed live already during measurement with Genesis HighSpeed data acquisition systems.

Apart from these numerical results, live oscilloscope and FFT displays are possible. All LIVE result values can be directly entered into an Excel spreadsheet at the touch of a button.

A software interface enables import of the displayed LIVE values into third-party software for automated analyses.



## LIVE calculation results

- RMS values of current, voltage and fundamental frequency
- Active, apparent and reactive power
- Torque and rotation speed
- Mechanical power
- Power factor and efficiency
- and many other results ...



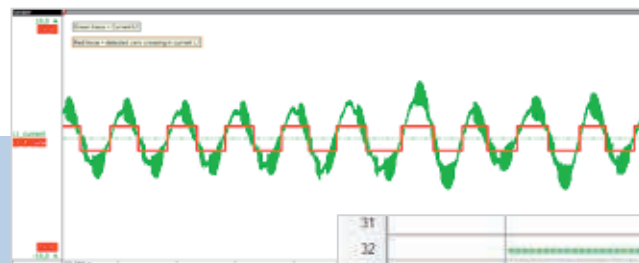
# Analysis with guaranteed precision

## Requirements

- Computing the RMS value requires that the individual signal cycles are clearly identified.
- This cycle detection needs to work reliably even with difficult signals such as phased currents.
- Further analysis needs to provide all important electrical and mechanical parameters per cycle.

## Solution

Perception software detects all zero crossings using special algorithms and can display the result of this cycle detection for verification. The software simultaneously generates a plausibility signal enabling instant feedback to be given. It enables all calculation steps from cycle detection through to the final computation, for example, of the motor's efficiency to be individually kept track of and verified.



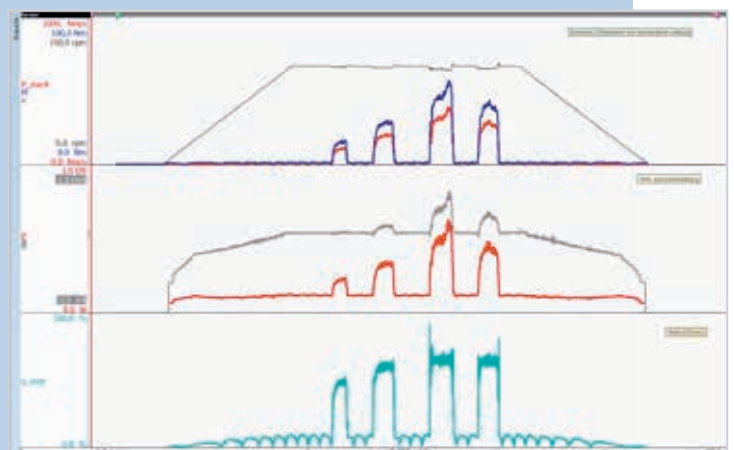
*Cycle detection and display in the reference current channel*

31	
32	
33	START of Computing the True RMS current signals
34	L1_A_rms @CycleRMS ( Formula L1_current: 1, Formula L1_A_cycle )
35	L2_A_rms @CycleRMS ( Formula L2_current: 1, Formula L1_A_cycle )
36	L3_A_rms @CycleRMS ( Formula L3_current: 1, Formula L1_A_cycle )
37	END of Computing the True RMS current signals
38	
39	

*RMS value calculation of the three phase currents*

## Measurement and analysis options

- Phase-phase and phase-star measurements
- RMS values of current and voltage per phase
- Cumulative RMS values
- Active, apparent and reactive power per phase and in total
- Mechanical power
- Power factor and efficiency
- Fundamental frequency



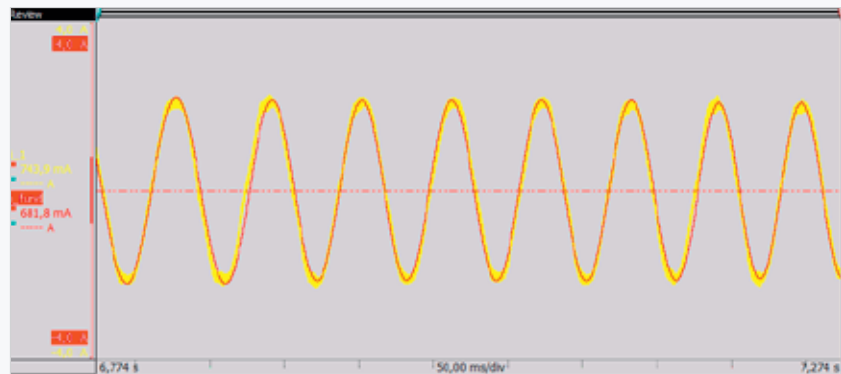
*Mechanical power, electrical active and apparent power as well as motor efficiency in the event of dynamic load cycles*

# Detailed inverter and motor analyses

The formula editor integrated with Perception software is a powerful toolbox that enables even highly complex calculations to be performed. Over 200 mathematical functions are available that can be combined as required and used even for huge data sets in the gigabyte range.

## Sample analyses on the inverter:

- Frequency and amplitude of the fundamental
- Switching frequency
- THD of current and voltage
- Cumulative power
- Control behavior
- Modulation method

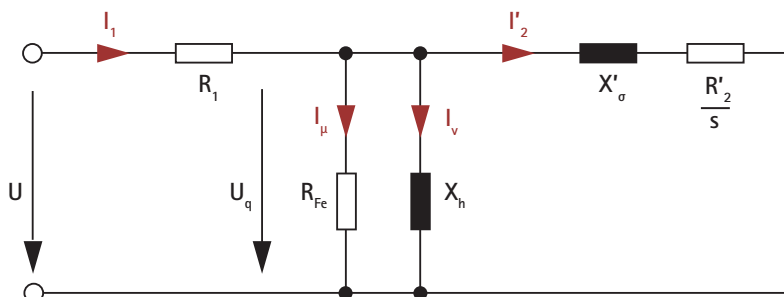


Current curve and computed fundamental

## Sample analyses on the electric motor:

- |   |                      |                                     |
|---|----------------------|-------------------------------------|
| ▪ Equivalent circuit diagram of the motor | ▪ Main inductance    | ▪ Rotating magnetic field frequency |
| ▪ Starting currents                       | ▪ Saturation effects | ▪ Slip                              |
| ▪ Armature currents                       | ▪ Residual currents  | ▪ Torque ripple                     |
| ▪ Iron loss resistance                    | ▪ Air-gap moment     | ▪ Cogging torque                    |

### Simplified equivalent circuit diagram of an asynchronous motor's fundamental



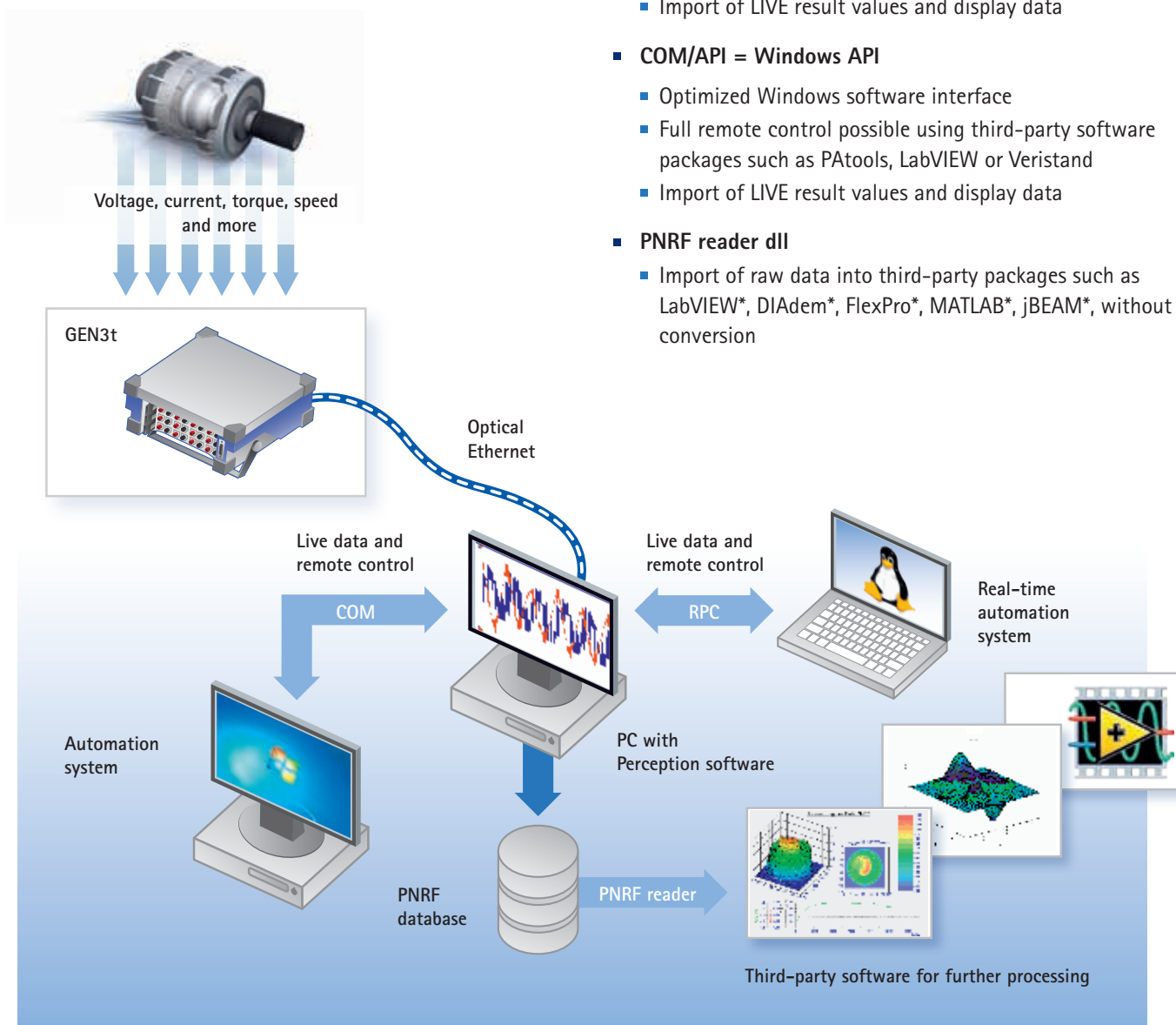
The equivalent circuit diagram of the motor can be determined from the short circuit and no-load measurement.

# Integration with your software

GEN3i/GEN3t can be easily integrated with third-party software or automation environments. Data can be transferred to many analysis programs directly and without conversion.

## Hardware interfaces:

- **Optical Ethernet interface for remote control**
  - Reliable electrical isolation
  - Safe operation of the measuring instrument in the test stand from the control room



## Software interfaces:

- **RPC = Remote Procedure Calls that are independent of the platform**
  - For Windows\*, Linux, Android, MacOS\*, etc.
  - Full remote control possible using third-party software packages such as LabVIEW\* or Veristand\*
  - Import of LIVE result values and display data
- **COM/API = Windows API**
  - Optimized Windows software interface
  - Full remote control possible using third-party software packages such as PAtools, LabVIEW or Veristand
  - Import of LIVE result values and display data
- **PNRF reader dll**
  - Import of raw data into third-party packages such as LabVIEW\*, DIAdem\*, FlexPro\*, MATLAB\*, jBEAM\*, without conversion

\*Trademarks are the property of the respective trademark holders

[www.hbm.com](http://www.hbm.com)

**HBM Test and Measurement**

Tel. +49 6151 803-0

Fax +49 6151 803-9100

[info@hbm.com](mailto:info@hbm.com)

measure and predict with confidence

