

electric power testing

# eDrive Power Analyzer Family

BEST IN CLASS ACCURACY FOR ANALYZING ELECTRIC DRIVE SYSTEMS

**HBK**   
HOTTINGER BRÜEL & KJÆR



# A complete solution ...

## SENSORS

### Current

HBM offers world class zero flux current transducers with highest accuracy and bandwidth. The full aluminium body ensures perfect EMC immunity critical in inverter based drive environments. They are a perfect fit for eDrive applications and offered with optional connection cables and power supply, a range from 50 A to 1200 A and bandwidths from 400 kHz to 1 MHz.



### Voltage

For different voltage levels, HBM offers different solutions. Certified connection cables with high CAT rating, or HV probes with a unique safety concept to allow high accuracy measurements up to 5 kV rms. For even higher voltages, the isolated digitizers allow safe measurements to virtually any voltage level, be it 10 kV or 10 MV.

### Torque and Speed

HBM torque sensors are the standard in the market not only for outstanding accuracy, but also for the unique Flexrange capabilities, the optional speed measurement systems and the high bandwidth to observe torque ripple. When seamlessly integrated in the eDrive solution, unmatched accuracy in both electrical and mechanical measurements is achieved.



## POWER ANALYZER

### Power Analyzer Card

The GN310B power analyzer card offers the best accuracy, the highest input range and the best safety class on the market. Combine as many cards as you need as computing power is fully scalable due to on-board DSPs. Digital cycle detection allows true dynamic power calculation needed for run up tests or WLTP drive cycles.



### Mainframes

Select a mainframe with the appropriate number of slots, stand-alone or with integrated PC. Combine mainframes to increase your system size.

PC integrated systems are best for bench top and portable use; tethered systems are optimized for rack and test rig integration.



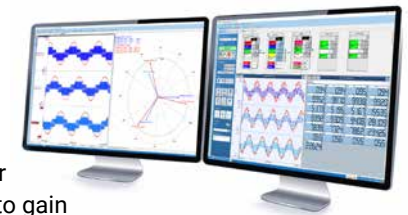
### Options for NVH, Temperatures, and CAN bus

Expandability is a key feature of the HBM solution. You want to add accelerometers or temp channels to correlate with other measurements? No problem, just select the proper card. Or add a scope card with 250 MS/s into the power analyzer. CAN FD and EtherCAT interfaces are available as well.

## PERCEPTION SOFTWARE

### ePower suite

Dedicated Windows® software allows basic power measurements out of the box. Scope, FFT and Phazor displays are available to gain more insights. And user programmable formulas in real time or post process analysis branch out for drive calibration or reverse engineering.



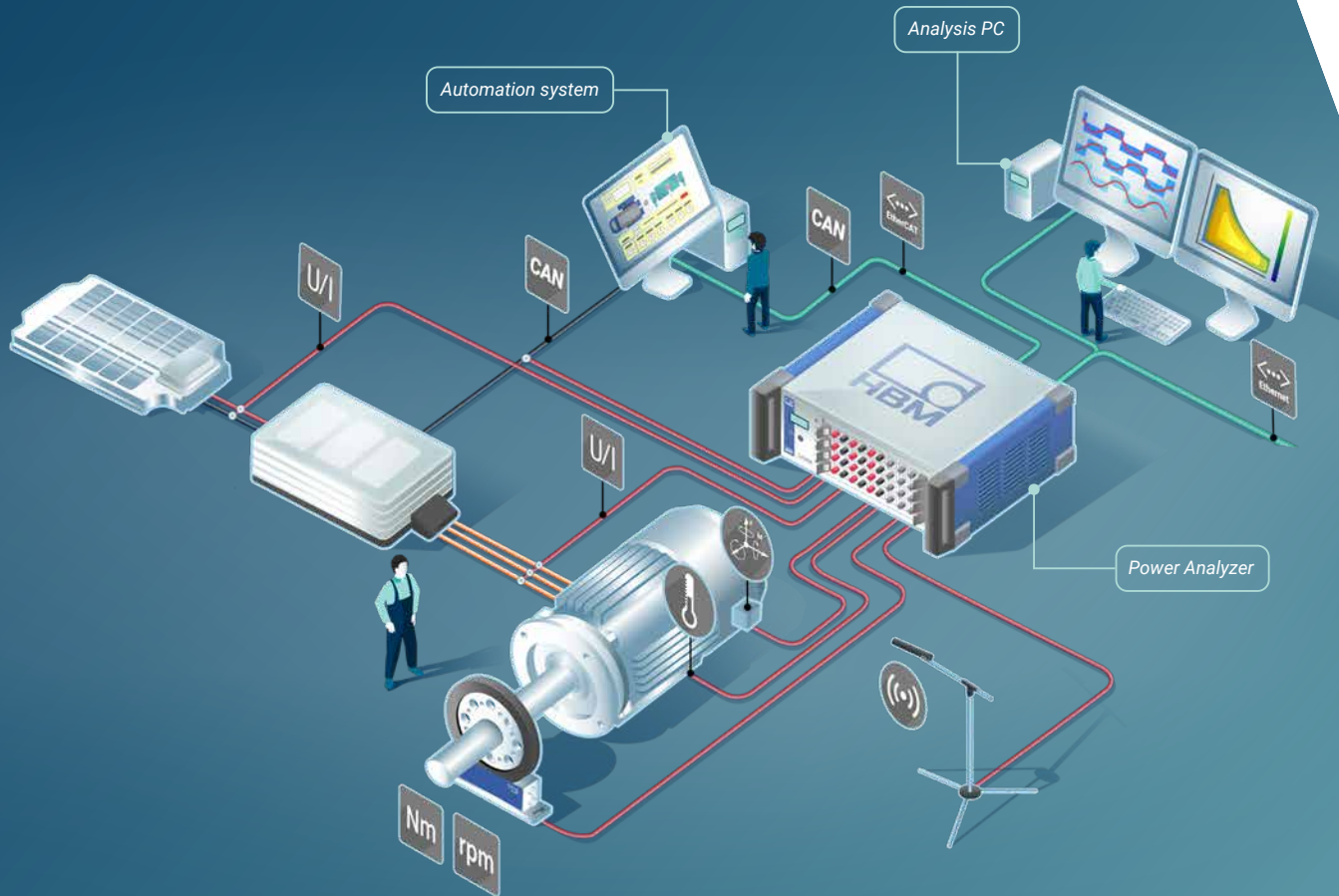
## KNOW HOW

### Training, Engineering Services and Consultancy

Be it product training, classroom style introduction to electrical testing or advanced analysis, or having an HBM expert on site to help improve measurement uncertainty or NVH behaviour: be assured HBM offers you all these services from its world class staff of electrical drive experts. We not only sell products; we can help you to maximize the return of investment by guiding you through all stages of electric motor testing.



# ... for electrical and mechanical signals



The HBM eDrive Power Analyzers cover the entire measurement chain from high-precision sensors to powerful instruments and intuitive software. And they simultaneously acquire electrical signals like voltage and current, mechanical signals like torque, speed, temperatures or vibration and bus signals like CAN based control commands or test rig parameters. They help engineers to analyze their drive better, faster and more accurately than ever before.

- Highest power **accuracy 0.015% reading + 0.02% range**
- **Sample rate of 2 MS/s** with 1 MHz bandwidth (per channel)
- Voltage inputs up to **+/- 1500 V**, with 1000 V CAT IV safety
- Programmable input ranges and **AUTO-Range** to minimize measurement uncertainty
- Packages from 3 to 9 power channels, **expandable to 51**
- Up to **12 torque / speed frequency-inputs** with exceptional accuracy of 0.004%
- Real time power calculation with **transparent formulas**, and unlimited user defined computations
- Digital cycle detection for accurate power measurements in **dynamic load changes** like WLTP drive cycles
- Optional inputs for **temperatures, accelerometers, microphones, CAN bus** and more
- **Continuous raw data** storage at full sample rate for analysis and review
- **Flexible recording modes** with triggers to store results only, raw data or both
- **Powerful analysis** like fundamentals, space vectors, dq0 transformation, torque ripple, harmonics, back EMF and much more
- **Easy test rig integration** using TTL, CAN, EtherCAT, or software API

# Seven different packages

## SELECT THE MAINFRAME WHICH BEST MEETS YOUR REQUIREMENTS:

- “i” mainframes feature an integrated PC and are best for portable use or when an instrument-type Power Analyzer is desired.
- “t” mainframes are connected to a PC but can work stand alone as well. They are best for test rig integration, in-car use or if an existing PC is used.

All systems come standard with Perception Enterprise ePower suite, a built-in SSD, an artificial star adapter and a signal splitter to connect torque/speed sensors.

### Overall specifications

- Board modular mainframe
- Mix Power Analyzer cards and other inputs for temperature, acceleration or CAN FD
- Continuous, full sample rate streaming
  - 100 MB/s to PC
  - 200 / 350 MB/s to internal SSD
- 500 GB or 1 TB SSD
- Real time result transfer via API, CAN FD or EtherCAT
- Remote control via API, TTL or CAN FD
- Stand alone operation without PC/Perception



## PRECONFIGURED EDRIVE POWER ANALYZERS

	PC-tethered Power Analyzer					Instrument-style Power Analyzer	
Description							
Part number	1-EDRV-3P-2T	1-EDRV-6P-2T	1-EDRV-6P-4T	1-EDRV-9P-4T	1-EDRV-6P-7T	1-EDRV-6P-3I	1-EDRV-6P-7I
Mainframe	GEN2tB	GEN2tB	GEN4tB	GEN4tB	GEN7tA	GEN3iA	GEN7iA
# of power channels	3	6	6	9	6	6	6
Max # of power channels	6	6	12	12	21	9	21
Software	ePower suite running on external PC					ePower suite running on built-in PC	
Base power accuracy	0.015 % of reading + 0.02 % of range						
Integrated Windows PC	x	x	x	x	x	Intel i3, 4 GB, 17" TFT	Intel i5, 8 GB, 17" TFT
SSD capacity	500 GB	500 GB	500 GB / 1 TB	500 GB / 1 TB	960 GB RAID	480 GB (in PC)	960 GB (in PC)
Streaming rate	200 MB/s	200 MB/s	350 / 200 MB/s	350 / 200 MB/s	350 MB/s	200 MB/s	350 MB/s
Open slots for expansion	1	–	2	1	5	1	5
Sample rate / channel	2 MS/s						
Torque / speed inputs	2+2	4+4	4+4	6+6	4+4	4+4	6+6
System integration	Good	Good	Best	Best	Best	Limited, slow	
EtherCat output option	x	x	✓	✓	✓	x	x
CAN FD option	✓	✓	✓	✓	✓	x	x
GEN DAQ hardware API	✓	✓	✓	✓	✓	limited, read only	limited, read only
Perception API	✓	✓	✓	✓	✓	✓	✓

Note: More detailed specifications can be found in the datasheets of the individual mainframes

# GN310B Power Analyzer Card

## ACCURATE AND DYNAMIC POWER MEASUREMENTS

The GN310B card is the base of all systems and plug & play with all mainframes, as plain Power Analyzer or paired with mechanical input cards as power and NVH data recorder. Unmatched accuracy and a hardware-based concept enable unlimited scalability, dynamic power measurement and real time streaming to SSD. Best in class accuracy for both electrical and mechanical power measurements and highest overvoltage categories allowing worry free use at levels up to 1500 V.

### Overall specifications

- 3 power channels, base accuracy **0.015% reading + 0.02% range**
- 4 frequency inputs for torque and speed, accuracy better than **0.004%**
- Scalable, hardware-based power calculations: RMS, P, Q, S,  $\eta$ ,  $\lambda$ ,  $\cos\phi$ ,  $\alpha$ ,  $\beta$ -vectors, for full signal or fundamentals only
- Results per half cycle with 2000 results/s maximum
- Unlimited user formulas with over 70 operators
- 2 MS/s sampling rate per channel with 18-bit resolution
- Digital cycle detectors for dynamic power measurement
- Cycle based recording for accelerated motor mapping

### Voltage input specifications

- 5 ranges  $\pm 50$  V,  $\pm 100$  V,  $\pm 500$  V,  $\pm 1000$  V,  $\pm 1500$  V, AUTO
- Bandwidth > 1 MHz
- Highest overvoltage category on the market: 1500 V DC, 1000 V CAT IV

### Current input specifications

- 7 ranges  $\pm 0.075$  A,  $\pm 0.15$  A,  $\pm 0.3$  A,  $\pm 0.6$  A,  $\pm 1.0$  A,  $\pm 1.2$  A,  $\pm 2.0$  A, AUTO
- Bandwidth > 1 MHz
- 2 built-in burden resistors 100 m $\Omega$ , 330 m $\Omega$
- Switchable to voltage for current clamps, 9 ranges  $\pm 50$  mV to  $\pm 20$  V

### Power accuracy

For $0.5 < PF \leq 1$	Reading error	Range error	Measurement Uncertainty Contribution
DC	0.015 %	0.02 %	0.015 %
100 Hz	0.019 %	0.02 %	0.016 %
10 kHz	0.415 %	0.02 %	0.25 %
100 kHz	1.015 %	0.02 %	0.59 %

### Torque accuracy

- Direct frequency input
  - Accuracy 5 - 360 kHz (T12/T40B range):
    - With 500 values/s: <0.004%
    - With 50 values/s: <0.0005%
  - "DualTorque" computation delivers both high accuracy torque for efficiency and high dynamic torque for torque ripple analysis

### Speed accuracy

- Direct frequency input with quadrature encoder and direction
  - Reference pulse input for angle measurement
  - Accuracy > 60 rpm (T40B with 1024 pulses/rev):
    - With 500 values/s: < 0.004%
    - With 50 values/s: < 0.0005%

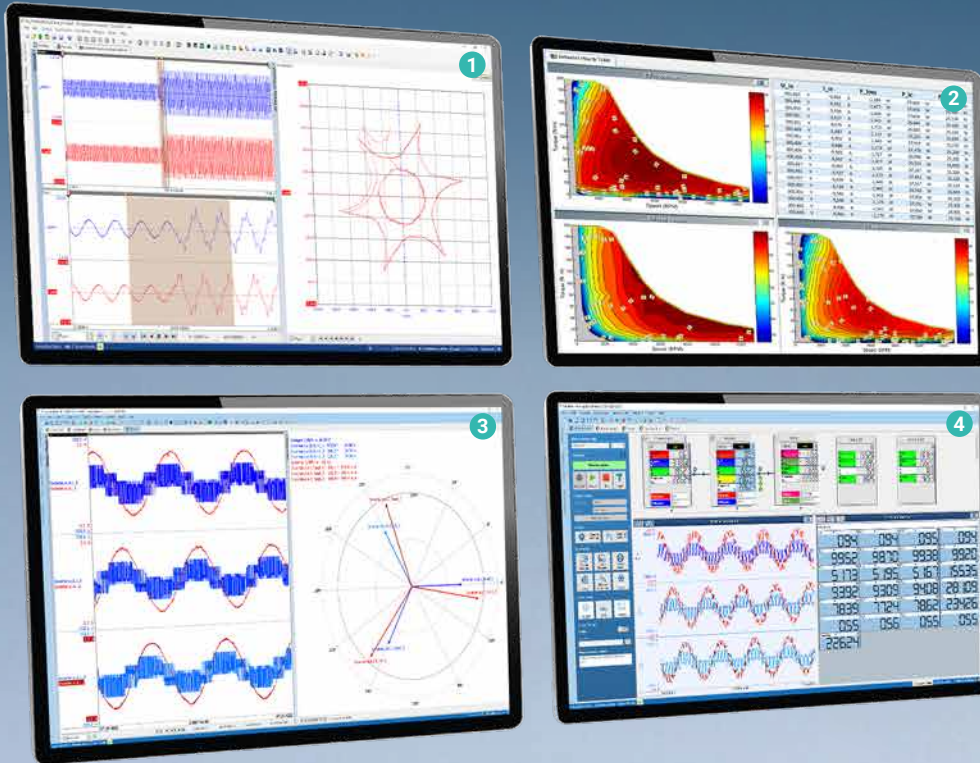
*Note: The Measurement Uncertainty Contribution here is achieved according to GUM guidelines at reference conditions and full scale. More detailed specifications can be found in the GN310B Power Analyzer datasheet*



*Each GN310B Power Analyzer card features three power channels and two torque/speed inputs.*

# Perception ePower suite

SET UP YOUR POWER ANALYZER AND USE POWERFUL DISPLAYS TO UNDERSTAND YOUR DRIVE



## Analysis and display features

- 1 Space vectors in time and xy domain to understand modulation
- 2 Multiple efficiency maps for motor / inverter / drive in real time
- 3 Vectorscope for amplitudes and phases in 3ph systems
- 4 Live scope displays for raw data
- 5 User definable system maps to automatically generate formulas and displays for complex configurations like hybrid drives
- 6 Meters can be freely configured and arranged



The Perception ePower software allows to operate the power analyzer with just a few mouseclicks. And it also turns the device into a scope, an FFT analyzer and into a DAQ for raw data. With the ability to analyze in real time with predefined and user defined formulas, to re-analyze in post process for verification and certification, and to transfer the data into other packages like Matlab or LabVIEW. And the multi monitoring capabilities allow you to show all of this information on as many monitors as your PC supports.

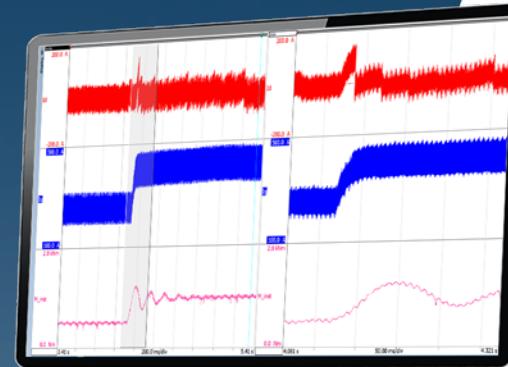
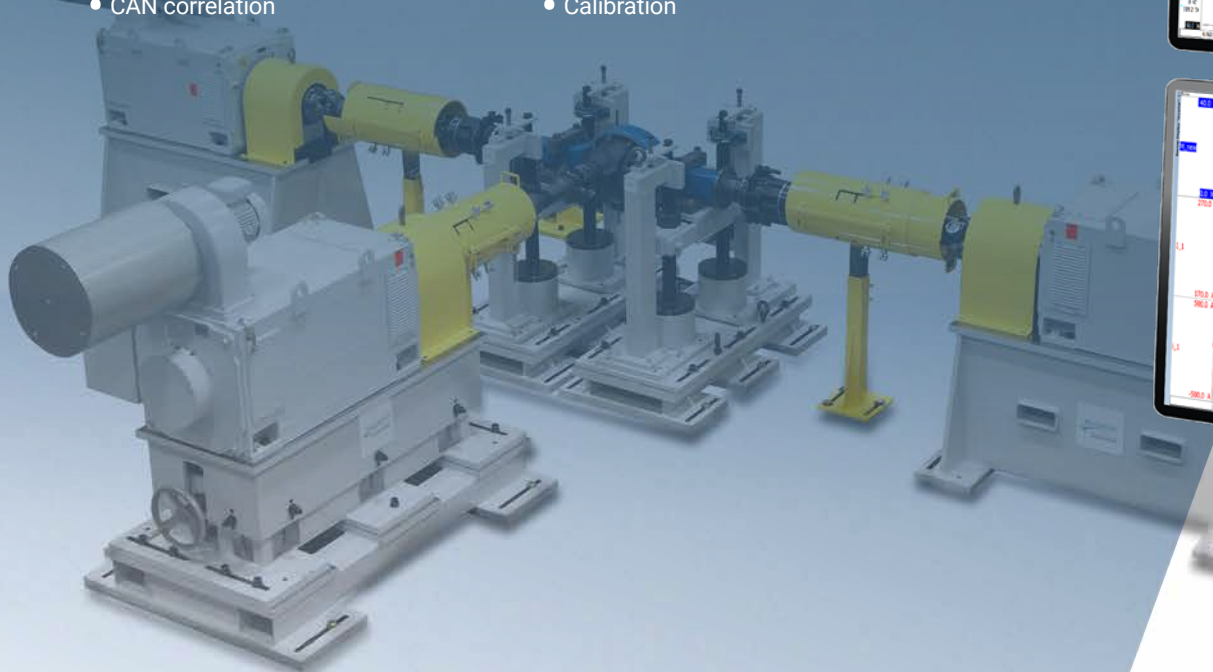
# Advanced analysis

## GAIN INSIGHTS IN YOUR DRIVE WITH TRACEABLE RESULTS

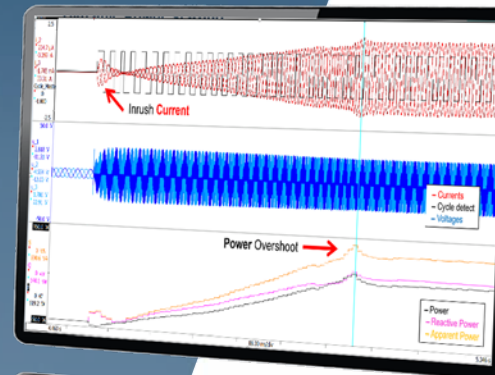
With recorded data and more than 100 analysis functions to create your own formulas, you can learn more about your machine and inverter than ever before. Show computed results live as scope traces so you can get intuition to your signals while doing power analysis. Batch processing allows you to reanalyze your test with the recorded data saving you the time and effort of redoing a test.

### Analysis examples

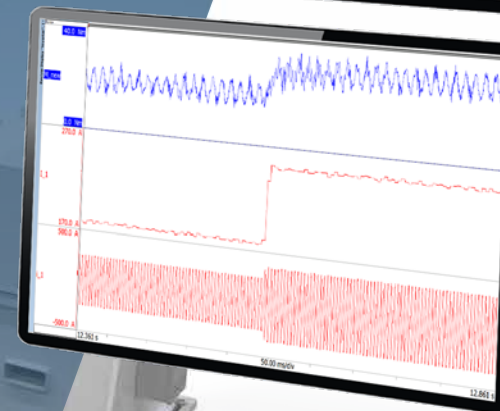
- dq0 transformation
- Torque ripple
- Cogging torque
- Back EMF
- Motor parameter testing
- Modulation method evaluation
- CAN correlation
- Electromechanical testing
- NVH
- Dynamic power and transient torque
- Flux calculation and flux maps
- Airgap torque
- Range determination and drive cycles
- Calibration



**dq0 calculations** allow you to validate models. These signals are calculated in real time and can be viewed as a scope trace with CAN, torque, or any other signal.












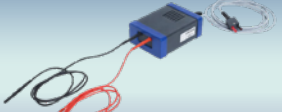
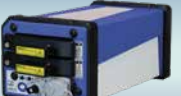

To maximize the efficiency of an electric motor it needs to be tuned for its real world and **dynamic drive cycle**. Recorded data and accurate power measurements on the half cycle allow engineers to analyze real world **dynamic power**.



Engineers go to great lengths to analyze **torque ripple**, but it is simple to look at torque ripple and dynamic torque with the HBM **DualTorque** system. It allows you to look at high accuracy torque for power and full bandwidth torque for ripple analysis at the same time.

# Options and Accessories

## EVERYTHING YOU NEED TO GET STARTED AND TO EXPAND YOUR SYSTEM

					
<p><b>Torque / speed transducer</b></p>	<p><b>CAN FD interface</b></p>	<p><b>Universal/temperature input card</b></p>	<p><b>Voltage cables</b></p>	<p><b>GEN DAQ API / Perception API</b></p>	<p><b>PNRF reader toolkit</b></p>
<p>Best accuracy with the T12HP, or best value for money with the T40B: HBM is the market leader in torque. With highest accuracy for efficiency measurements and high bandwidth to obtain torque ripple simultaneously.</p>	<p>Enables user to read data from and to transmit results to CAN bus, and basic remote control like Start/Stop/Trigger. <i>Available for all "t" mainframes.</i></p>	<p>8 or 16 channel universal input card for various sensors like Thermocouples or PTxx, accelerometer, strain gages and more; 50 V isolation, 500 kS/s @ 24 bit.</p>	<p>Low capacitance, shielded voltage cables with high over-voltage ratings up to 1500 V DC CAT III and 1000 V CAT IV. <i>Available in different lengths with 3 wires and shield</i></p>	<p>Programmers interfaces, example libraries and help files to control GEN DAQ hardware or Perception software from 3rd party programs like LabVIEW or from automation systems.</p>	<p>Programmers interfaces, example libraries and help file to read PNRF files into 3rd party software like MATLAB. <i>Various 3rd party software can read PNRF files.</i></p>
					
<p><b>Current transducer</b></p>	<p><b>EtherCAT interface</b></p>	<p><b>HighSpeed input cards</b></p>	<p><b>5 kV<sub>rms</sub> differential probe</b></p>	<p><b>Isolated digitizers 6600</b></p>	<p><b>Perception software</b></p>
<p>Best in class zero flux current sensors from 50 A to 1200 A with bandwidths up to 1 MHz and 1 or 2 ppm accuracy. With all cables and a 1U rack mountable power supply. <i>CT's up to 11 kA on request.</i></p>	<p>Enables transmitting results to EtherCAT in real time, with a latency &lt; 1 ms. Transfer speed 1000 result blocks/s. <i>Available for GEN4tB, GEN7tA and GEN17tA mainframes .</i></p>	<p>8 channel "scope" input card with 25 / 100 / 250 MS/s sample rate @ 14 bit resolution; 8 GByte RAM. +/-10 mV to +/-100 V, 1 MΩ or 50 Ω input for probe usage.</p>	<p>High accuracy, differential voltage probe for the GN310B with certified safety concept; impedance 10 MΩ, accuracy 0.2%, usable frequency range 100 kHz (&lt; 0.5 dB).</p>	<p>Fibre-optic front end for safe measurements in medium and high voltage; battery operated or 10 kV isolated power supply; typically used with HILO or RITZ dividers.</p>	<p>From the free viewer version to display and export data and results, to the floating network license: Perception is available in a lot of different flavours to meet your needs.</p>

\* LabVIEW is a registered trademark of National Instruments Corporation.

\*\* MATLAB is a registered trademark of MathWorks.



FOR MORE INFORMATION, PLEASE SEE



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

**HBK – Hottinger, Brüel & Kjær**

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

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

**Denmark**

Hottinger Brüel & Kjær A/S

DK-2850 Nærum, Denmark

Telephone +45 77 41 20 00

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

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

**Germany**

Hottinger Brüel & Kjaer GmbH

D-64293 Darmstadt, Germany

Telephone +49 6151 803 0

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

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