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# Leading the way in high-precision power measurement

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## Colophon

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## Yokogawa Europe –the world's first non-governmental ISO 17025 Accreditation for power calibration up to 100 kHz.

As more and more innovation focuses on energy efficiency and the use of renewable energy resources, engineers are increasingly demanding accuracy and precision from their power measurements. At the same time, new standards such as IEC 62301 Ed2.0 and EN 50564:2011, covering standby power consumption, and the SPEC guidelines,

covering power consumption in data centres, demand more precise and accurate testing to ensure compliance. To meet these challenges, R&D teams are increasingly confronted with the need for new levels of precision in power measurement, that can only be achieved if the measuring instruments are properly calibrated with reference to national and international standards.

Therefore, we are proud to announce that Yokogawa's European Calibration Laboratory has become the world's first non-governmental facility to receive full ISO 17025 Accreditation for power measurements at up to 100 kHz. This is in addition to its established capability for providing high-accuracy calibration at 50 Hz, especially at very low power factors (down to 0.0001) and at high currents.

The recognition offered by this accreditation is objective proof that the knowledge of our personnel and the quality of our instruments are world-leading. For customers working with tight tolerances, ISO 17025 accredited calibration of the measurement is vital to major critical measuring projects and provides the high level of quality assurance that our customers need.

Without high-quality in-house calibration facilities, instrument manufacturers cannot provide the sort of evidence that is available to Yokogawa to show that their instruments perform within their specifications. We can honestly say, for example, that our WT3000E power analyser is the most accurate power analyser in the world, with proof provided by its accreditation certificate.

Please see the article on page 4 for more information on high-frequency power measurements.

**Erik Kroon**  
Yokogawa Calibration Laboratory Manager

- Former auditor for ISO 17025 for the Dutch Council of Accreditation (RvA) Technical committee member for the Dutch Council of Accreditation
- Member of the users committee for the EU Power and Energy project
- Member of the users committee for the EU Smart Power project
- VSL Dutch Metrology Institute (8 years)



# Ensuring accuracy

## in high-frequency power measurements

By Clive Davis, Marketing Manager & Erik Kroon, Calibration Laboratory Manager

The increasing use of devices such as switch-mode power supplies, electronic lighting ballasts, soft starters and frequency converters has created a growing demand for power measurement at high frequencies. Unfortunately, the calibration of high-frequency power measurements has lagged behind the development of power meters to address these applications, and few national laboratories can provide traceability up to 100 kHz: the frequency at which instruments have to be calibrated to provide accurate results in these application sectors.

There are a number of other parameters involved in power measurements that determine the performance of an instrument in a particular application. It is no longer sufficient merely to list voltage and current specifications: today’s power environment needs to address variables such as phase shift, power factor and the effects of distorted waveforms.

### ‘Real-world’ conditions

It is also important to calibrate the instrument under the right conditions. Many test houses still use pure sine waves at only 50 Hz to calibrate power meters, which renders the results virtually useless for users carrying out tests under ‘real world’ conditions.

It is therefore important for users of power measuring instruments to look at the actual ‘calibrated’ performance of different manufacturers’ products rather than just comparing specifications. This is the key thinking behind

Yokogawa’s policy of having its own European Standards Laboratory with minimal uncertainties and capabilities which are second to none: as confirmed by the fact that it has become the world’s first non-governmental facility to receive full ISO 17025 accreditation for power measurements at up to 100 kHz.



### Guaranteed specifications

The specifications of test instruments will often include terms such as “guaranteed” and “typical” values. Some product manufacturers use typical values in their published data, and this is something that can often mislead customers. Typical values are usually a reference value based on what a manufacturer expects from their product, but these values are not usually 100% guaranteed. This is the reason why many manufacturers’ specifications for typical values are much better than the guaranteed values – and is also why Yokogawa power analysers, when calibrated, provide accuracies which

are five to ten times better than the published product specifications. In fact, Yokogawa is the only manufacturer of power meters that guarantees the power measurement uncertainties published in their data sheets.

## An ISO17025 accredited calibration proves the measurement accuracy

### Precisely specified measurement ranges

Another factor that is often inadequately specified in manufacturers’ data is measurement range. This is an important point because the uncertainty of a power measurement varies depending on

the measurement range, and so the accuracy value should specify the range over which it is valid. For example the power accuracy of the Yokogawa WT3000E – the >>>>





**WT3000E** The world's most accurate and stable power analyser

>>>> world's most accurate power analyser - is valid from 1% to 130% of the measurement range. Without specifying the measurement range, a user will find it difficult to know whether the accuracy values are valid only at a single point or at a few points of measurement range. Again, Yokogawa is the only power analyser manufacturer to specify the measurement range for its products.

**High-precision harmonics measurement**

Harmonic measurement is another area where it is important to specify the accuracy in the context of the application. Every Yokogawa power analyser has an additional oscillator dedicated to phase-locked loop (PLL) measurement which provides high-precision harmonic measurement. With the help of this dedicated oscillator and powerful digital signal processing, the frequency spectrum can be analysed up to the 500th order (depending on the instrument) harmonics simultaneously with the normal measurement. In addition, because of this dedicated circuit, it is possible for Yokogawa to specify the accuracy of the harmonic analysis – something that is not the case with many other manufacturers.

**Maximum accuracy**

Other parameters that need to be taken into account in considering measurement accuracy include crest factor, defined as the ratio of the peak value to the effective RMS value of the waveform; the confusing use of peak and RMS

measurements in some specifications (Yokogawa uses RMS values for both measurement range setting and tolerance calculation); phase error and common-mode rejection ratio (both specified in detail by Yokogawa); and temperature effects (again specified precisely by Yokogawa).

The specified 45-65 Hz accuracy for Yokogawa's most accurate instrument, the WT3000E, is 0.01% of reading plus 0.03% of range. As indicated above, these figures are based on RMS values rather than waveform peak values, confirming the superiority of the instrument. Because power ranges are the multiple of the voltage and current ranges, the actual power measurement error due to an uncertainty of 0.03% of range in a WT3000E is less than 0.01% of range for a power meter based on peak values.

Users can also mix 30 A and 2 A input current elements, allowing them to test the compliance of their products with harmonics, flicker and standby power standards in a single instrument.

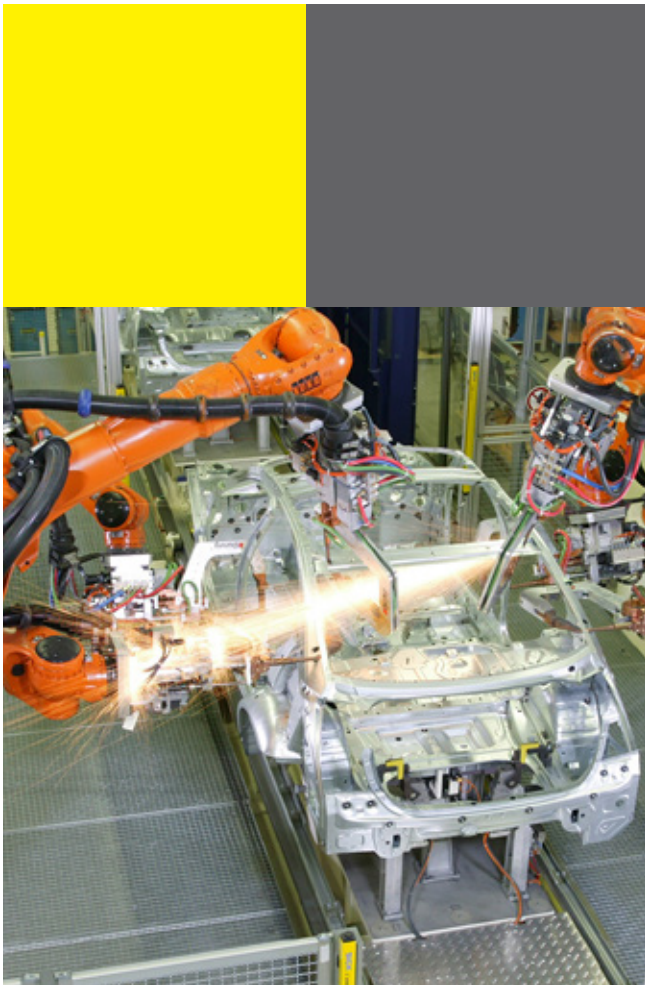
For more information on calibration, visit:  
[www.tmi.yokogawa.com/calibration](http://www.tmi.yokogawa.com/calibration)

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Precision Power Scope  
**Helps KUKA Systems minimise robots' energy consumption**

by Yokogawa Europe Product Marketing & KUKA Systems GmbH Augsburg/Deutschland



**The Yokogawa PX8000 Precision Power Scope is playing a key part in tests being carried out by KUKA Systems as part of a programme designed to minimise the energy consumption of the latest generation of industrial robots. >>>**



KUKA robots

>>> As a subsidiary of robotics and plant engineering company KUKA AG, KUKA Systems plans and implements automated production and assembly lines. A key focus of the company is the provision of complete solutions, including robots, for joining, assembly and handling operations in the automotive and other industries.

Energy consumption is becoming a key aspect in robotics, and KUKA is participating with around 50 other companies in a project supported by the German Ministry of Education & Research with the aim of achieving a 50% reduction of energy usage in the production of car bodies.

In order to assess the effectiveness of these measures, detailed information on the energy consumption of the components used in the production line and different robot activities are required. Some of these data are provided by the manufacturers of the system components while others are determined by appropriate measurements which allow KUKA to capture the actual energy consumption and try out various optimisation options. These tests include handling processes and spot welding, both of which involve very different movements.

In addition, KUKA takes into account the times when the robot is inactive, such as at night-time, by switching everything to “hibernate mode”, a state similar to the standby mode of consumer PCs, which can reduce consumption by 90%.

Each robot usually has a motor for each of the six axes, each controlled by a three-phase inverter. In the resting position a robot consumes about 700 W, which after 20 seconds at a standstill is automatically reduced to only 200 W. In the “hibernate” mode, the power consumption

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Matthias Paukner and Tobias Zimmermann (center, both KUKA Systems) show Klaus Thalheimer (left, Yokogawa) and Johann Mathä (right, Yokogawa) how to control the robot with the controlling panel.

of the overall system is about 18 W, and in full operation it rises to peaks of about 60 kW. Added to this is the power consumption of the tools.

For measurements on the robots and other equipment KUKA Systems uses Yokogawa’s PX8000 Precision Power Scope with current clamps on all three phases on the power input of the controller. In addition to measuring power directly from the current and voltage waveforms, the instrument is also used to measure other signals.

“We deliberately chose this instrument because we wanted to capture very short pulses and spikes which typically occur in spot welding and during braking or acceleration processes”, says Matthias Paukner: “We also need to cover an enormous range, from a few thousand amperes during welding to quiescent currents of a few milliamps in hibernate mode. When searching for a suitable solution, we first used simple handheld power meters, then tried an oscilloscope and experimented with a modular system, but



Tobias Zimmermann (KUKA Systems) measures the power consumption of the robot with the Yokogawa PX8000 Precision Power Scope.

none of these solutions offered the combination of accuracy and versatility that we required.”

The PX8000 has proved particularly useful in demonstrating the effectiveness of certain measures that KUKA Systems has developed including special control programs that perform predetermined movements. In particular, the PX8000

has the ability to both record data and carry out subsequent analysis. This allows the measured values to be transmitted to a database containing data for a variety of movement profiles from many different components of a production line. Currently

about 300 different values are stored for each robot type. The measured power values then form the basis for the simulation of the energy consumption of an entire production hall.

“Our goal for energy savings is in the double-digit percentage range. The investment for the measures required for this purpose should be amortised within two to three years”, says project manager Matthias Paukner.

### PX8000 Precision Power Scope

Like a power analyser, a precision power scope is capable of accurately measuring steady-state power and related variables, since they share the same input techniques and measurement principles. However, as it also shares characteristics of oscilloscopes and ScopeCorders, it is capable of capturing and measuring the power arbitrarily over any part of the power waveform using start and stop cursors. This is particularly useful for examining transient phenomena and in the design of periodically controlled equipment. The trigger functionality helps to set various trigger conditions based on the analysis of the transient phenomena to understand the behaviour of the system under test.

For more information on PX8000 Precision Power Scope, visit [www.tmi.yokogawa.com/px8000](http://www.tmi.yokogawa.com/px8000)





# A grating-based optical spectrum analyser

with a gas purging feature for higher performance

by Paolo Magni, Product Marketing Manager, Optical T&M Instruments

The new Yokogawa AQ6375B is an optical spectrum analyser operating in the short-wavelength infrared (SWIR) region and covering wavelengths from 1200 to 2400 nm.



Successor of the renowned AQ6375, the new analyser mounts a totally new monochromator which incorporates a number of new features including a built-in gas purging circuit and a cut-off filter. The AQ6375B combines high measurement performance with ease of operation, thanks to the new data-logging capabilities, a double-speed mode, and support for Windows file sharing. The new gas purging function is designed to minimise the influence of water-vapour absorption on spectral measurements carried out in the SWIR region.

By continuously supplying a pure purge gas such as nitrogen to the monochromator through the dedicated connectors on the back panel, these absorption effects are significantly reduced, leading to a more accurate measurement of the optical signal under test.

The AQ6375B, thanks to its design based on diffraction grating technology, offers high wavelength accuracy of  $\pm 0.05$  nm (1520 to 1580 nm)  $\pm 0.50$  nm (full range) and high wavelength resolution of 0.05 nm, a wide close-in dynamic range of 55 dB, and a wide measurement level range from +20 dBm to -70 dBm. The use of an advanced monochromator design helps to separate spectral signals in close proximity to one another, and improves the dynamic range by reducing the influence of stray light.

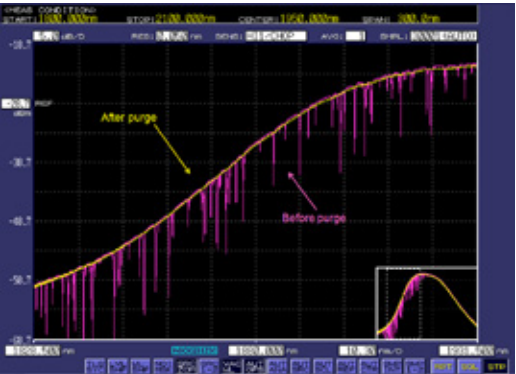
In conjunction with new high-speed circuitry and noise reduction techniques, the monochromator also enables the AQ6375B to achieve a high measurement speed: up to 0.5 sec/100 nm. The double-speed mode makes it possible to measure an optical signal in half the time compared with the conventional mode, with only a 2 dB penalty over the standard sensitivity value.

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Purge gas ports on the Yokogawa AQ6375B optical spectrum analyser



Effect of purging (dry-air, 1 hour) water vapour absorptions around 1900 nm.

A free-space optical input makes it possible to connect multimode and single-mode fibres with PC or APC connectors to the same input with no need for an adaptor. It also provides a low and stable insertion loss for multimode fibres, which helps to maintain the excellent measurement efficiency as well as increasing measurement repeatability.

Also included is a built-in cut-off filter for the high-order diffracted light generated by the monochromator at wavelengths equal to integral multiples of the input wavelength. By cutting incoming light below 1150 nm with the built-in filter, the AQ6375B reduces the influence of secondary diffracted light on the measurement by 50 dB or more at wavelengths up to about 2300 nm.

A new data-logging function is available on the AQ6375B for recording analysis results such as distributed feedback laser diode (DFB-LD) analysis and multi-peak measurements at up to 10,000 points per channel with time stamps. Recorded data can be displayed in table and graphical formats.

For transferring acquired data for subsequent analysis, a Windows file sharing function is available in addition to the existing Ethernet, GPIB and USB interfaces. Applications for the AQ6375B cover the analysis of telecommunication devices and systems operating in single-mode transmission in all the windows of optical communications, from the beginning of the O-band at 1260 nm to the end of the U-band at 1675 nm.

The AQ6375B is also suitable for measurements in other areas such as environmental monitoring - including the sensing of gases such as NO<sub>x</sub> and CO<sub>2</sub> - atmospheric observation, and the medical and biomedical sector for virus sensing and checking surgical equipment. This includes manufacturers of optical devices in these sectors using the AQ6375B for both R&D and production testing.

## Gas purging minimises the influence of water vapour absorptions

For more information on Yokogawa optical instruments, visit [www.tmi.yokogawa.com](http://www.tmi.yokogawa.com)

# New ScopeCorder modules add flexibility

by Peter Schutte, Product Marketing Manager, Automotive & Transportation

**Three new models have been added to the range of plug-in measurement modules for Yokogawa's DL850E/DL850EV ScopeCorder family.**



DL850E modules

The new modules are designed to enhance the performance and versatility of the ScopeCorder family in applications including power systems, transportation and mechatronics.

Applications for the 720211 high-speed (100 MS/s) 12-bit isolation module are in the electric power and energy sectors, including the testing and evaluation of inverter, motor and power devices where multichannel measurements with isolation up to 1000 V are becoming a fundamental requirement.

The 720243 SENT monitor module (available only for the DL850EV Vehicle

Edition ScopeCorder) will find use in development and production testing for SENT (Single Edge Nibble Transmission) applications in the automotive sector.

The 720254 4-channel 1 MS/s 16-bit isolation module increases the maximum channel count of a ScopeCorder and is suited to a wide range of multichannel measurement applications, but particularly for isolated high-voltage measurements and the long-term monitoring of power generators or multi-output power supplies.

For more information on ScopeCorders, visit [www.tmi.yokogawa.com/DL850E](http://www.tmi.yokogawa.com/DL850E)

## Upcoming events

### EIS Instrumentation Analysis and Testing Exhibition 2016

15 March 2016  
Silverstone, UK

### LED & Lighting Design

8 & 9 March 2016  
Oxford & Cambridge, UK

### PCIM Europe 2016

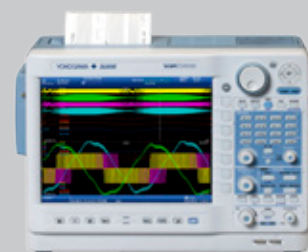
10 - 12 May 2016  
Nuremberg, Germany

### EPE 2016 - ECCE Europe

18th European Conference on Power Electronics and Applications  
5- 9 September 2016  
Karlsruhe, Germany

## What is a ScopeCorder?

A ScopeCorder is a modular, multichannel measuring instrument that can be configured for a wide variety of applications. It combines the benefits of a high-speed oscilloscope and those of a traditional data acquisition recorder in a single portable instrument.



DL850E

### As an oscilloscope

- Capture events using an extensive set of triggers
- Easily measure waveform parameters
- Perform channel calculations in real-time and trigger on the results
- Isolated input channels (up to 1 kVrms input)

### As a data acquisition recorder

- Combine electrical, sensor based and CAN/LIN/SENT bus measurements.
- Capture detail with 16 bit A/D converters
- Improve measurement accuracy using sensor-specific signal conditioning
- Measure from less than a microsecond up to 200 days

### Who should use a ScopeCorder?

A ScopeCorder is a solution for any company working on (power) electronics & electro-mechanical applications with a multitude of different signals and sensors. It enables evaluation of your application in real-time in order to make quick adjustments and save development time.

Download here the "10 reasons to choose a ScopeCorder"  
[www.tmi.yokogawa.com/10reasons](http://www.tmi.yokogawa.com/10reasons)