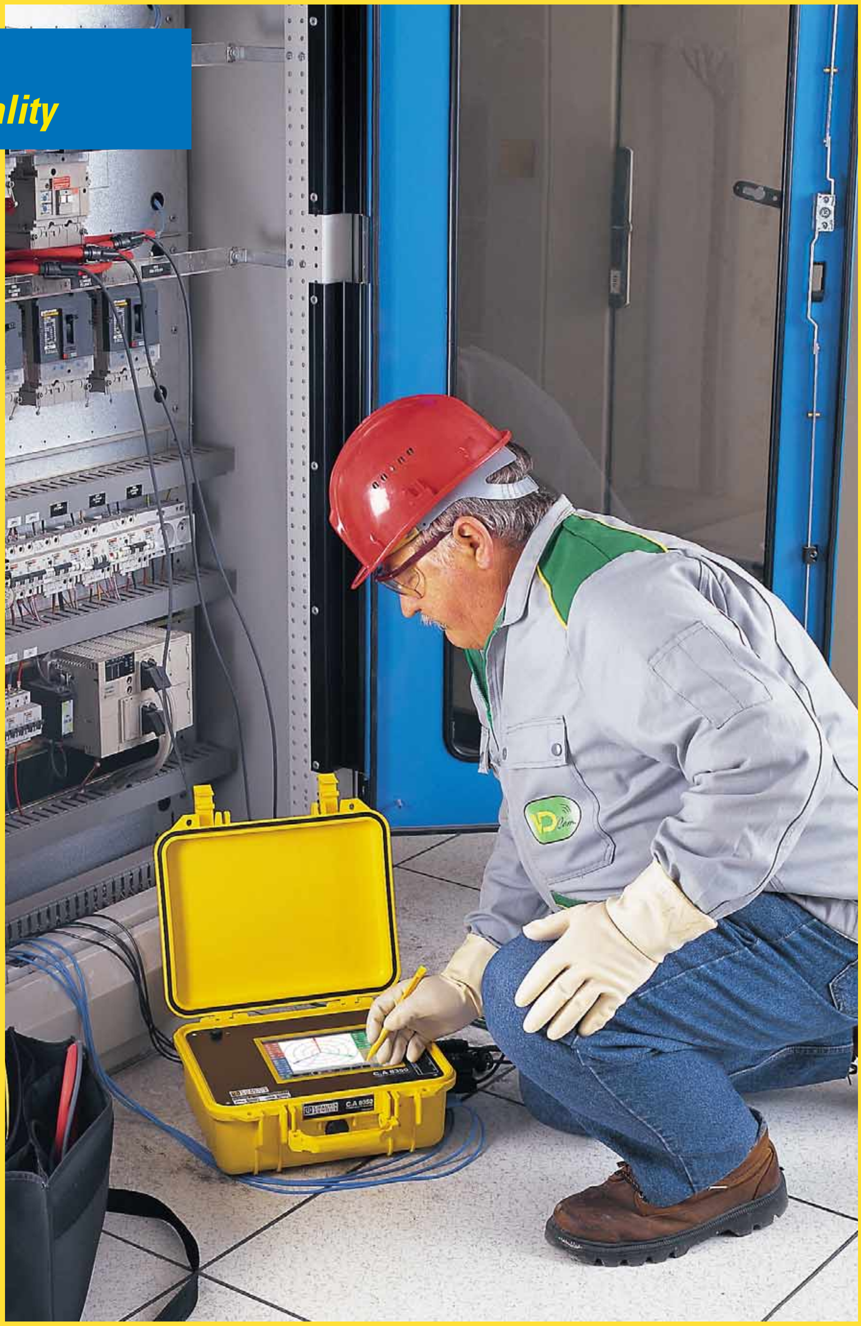
CONTACT

No. 16 MEASUREMENT • NEWS SPRING 2001

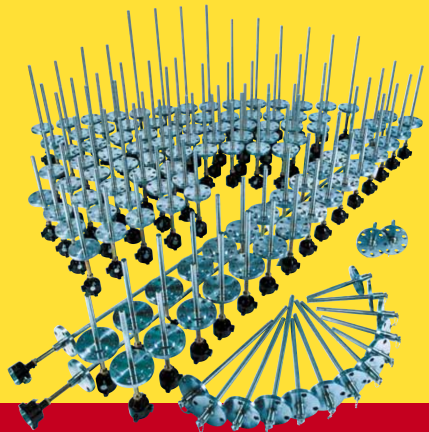


Test & Measurement

LF disturbance and voltage quality

Power Measurement & Control

Continuous monitoring of your electricity networks



Temperature Measurement & Control

Pt 100 Ω sensors and insertion pyrometers

CHAUVIN ARNOUX

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Cover photo:
Electrical Network Measurement Campaign using analyser C.A 8350

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To receive sales literature, fill out the Reader Service form between pages 14 and 15.

EDITORIAL

CHAUVIN ARNOUX & ITS SUBSIDIARIES

Chauvin Arnoux, Europe's largest Electrical Test & Measurement Equipment Company recently celebrated its 107th birthday. Unusually, in today's frantic and ever changing business environment, Chauvin Arnoux is still a family owned and managed company. This independence and continuity has allowed values and operating principles more associated with smaller companies to be vigorously maintained, demonstrating an on-going practical commitment to the environment, education establishments, organisations and the people it serves. Extremely important issues of customer care, product quality and electrical safety are paramount in the daily activities of our company, and essential to our present and future successes. Chauvin Arnoux is committed to producing and developing quality products, suited to the needs of their customers, at a realistic and competitive price.

Our customers are our most important and valuable assets.

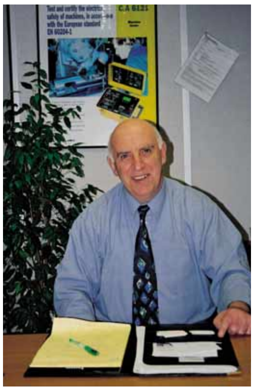
We at Chauvin Arnoux (UK), Maidenhead, Berkshire are one example of the many global subsidiaries reporting into France.

Maidenhead is a very busy subsidiary, staffed by friendly, dedicated and professional people, who try their very best to offer our customers a service of excellence. We attempt to emulate those values and operating principals established and evolved by Chauvin Arnoux over its 107 year history. We have a large and varied product stocking policy enabling us to offer fast delivery. Our customers and products are supported by our own direct external technical sales force, internal customer care team, calibration and service facilities based in our offices at Maidenhead. Chauvin Arnoux's quality procedures, product and operating controls conform to the many and various ISO, EMC, EN and IEC directives, rules and regulations.

Please do not hesitate in contacting us, either by telephone or by email, or in visiting the Chauvin Arnoux group's website at www.chauvin-arnoux.com.

Ken Ballinger
General Manager
Chauvin Arnoux UK

A new Sales Manager is welcomed into the fold



Peter Hills is the newly appointed Sales office Manager of **Chauvin Arnoux UK.** He joined the group in November 2000 as part of the continuing expansion taking place within the United Kingdom.

Peter is responsible for the day-to-day running of our sales office, of which part of his role is to maintain regular contact with the French parent company.

This means that we all benefit due to his ability to speak some French.

A new address for our American subsidiary

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Foxborough, MA 02035 - USA
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The RO600 takes off

Recently marketed *(see Contact No. 15)*, the **RO600 scalar multimeter** wins its spurs by shining in two invitations to tender from prestigious institutions:

- In France, an order for 150 units by the Gendarmerie
- In Germany, an order for 51 units from the Air Force

Ideal for operation in the field as well as in the laboratory, the **RO600** is designed to measure the adaptation, the insertion loss or the gain of a microwave component between 1 MHz and 2.7 GHz. Its "fault location" function, highly appreciated for the maintenance of radio telecommunication or relay sites, determines with accuracy where an anomaly is on a coaxial cable between transmitter/receiver and antenna.

The use of scroll menus making the configurations implicit means that the **RO600** is a very user-friendly instrument.
Its excellent value for money and the remarkable simplicity of the man/machine interface make it the choice of demanding customers, ahead of those of the competition.

Reader Service No. 1

New director for the T & M division

Mr. Philippe WEIL, a specialist in Measurement and Industrial Inspection with twenty years' experience, arrived at the company in June 2000 and was put in charge of the **Marketing Department of the Test & Measurement Division** for the Chauvin Arnoux group.

He will therefore be responsible for managing products marketed under the 2 brands (Chauvin Arnoux and Metrix) and supporting their international development.

We wish him the best of luck in his new mission.

Should anyone wish to meet us...

Throughout the first half of the year 2001, we will be taking part in various of the main European professional trade fairs and exhibitions; as shown below.

As many will agree, this is an ideal opportunity for listening and conversing, for being shown our latest additions to the **Chauvin Arnoux** product line and also for giving us your opinions in person.

13/03 – 15/03	EMV	Ausburg - Germany
19/03 – 21/03	Cigré	Tripoli - Libya
23/04 – 28/04	Industrie	Hanover - Germany
23/05 – 27/05	INTEL	Milan - Italy
18/06 – 21/06	CIRED	Amsterdam
20/06 – 22/06	ELTEC	Nürnberg - Germany

ISO 9001 for AMRA SpA

Since the merger of our Italian subsidiary **AMRA–CHAUVIN ARNOUX** and **MTI**, former subsidiary of the ITT Canon group, the activities of the two companies were reorganised and grouped at the end of December 1999 on the same site, in Macherio near Milan. Independent since the end of the 70s, MTI makes **electromagnetic relays** complementary to those made by AMRA.
Today, the new company site is home to two relay manufacturing lines. This site was audited by the certification company **DNV**, which recognised its Quality Assurance system as compliant with the requirements of **ISO 9001**.
This certification applied to production activities as well as commercial activities selling electrical and electronic equipment.

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Measurement of electrical power

Instantaneous, mean, active, reactive and apparent electrical power, power factor, etc.
We would like to remind you about these basic parameters in electronics and about three-phase measurement methods.

Definition of electrical power

At a given moment, when a current **i** travels from generator **G** to receiver **R** in the direction defined by the voltage **v** delivered by the generator *(figure 1)*, the **instantaneous power** supplied to the receiver R is equal to **product v.i.**

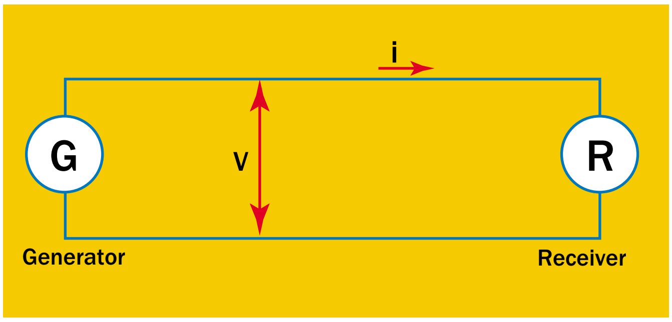


figure 1

If the voltage and current are DC, the mean power V·I is equal to the instantaneous power v·i.
If the voltage and current are **sinusoidal AC**, there is generally a **phase shift** φ between the voltage and the current *(figure 2)*.
The **instantaneous values** of voltage **v** and current **i** have the form:
$v = V_{max} \cos \omega t$
$i = I_{max} \cos (\omega t - \varphi)$
Where ω, the pulse, is proportional to the frequency F (ω = 2πF).

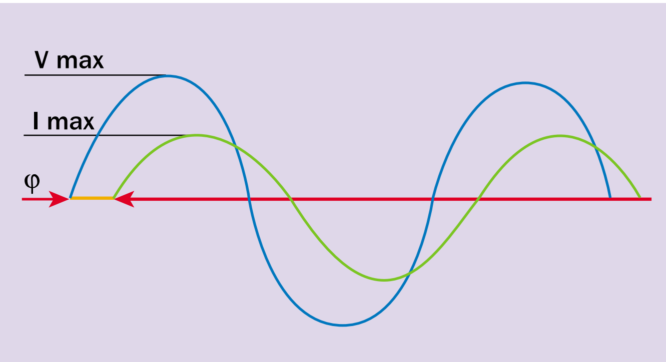


figure 2

The **phase shift** φ is, conventionally, counted as positive when the current is delayed in relation to the voltage.

The **instantaneous power** has a value of: $V_{max} \cdot I_{max} \cdot \cos \omega \cdot \cos (\omega t - \varphi)$.
You must take the average value of this product during a period to obtain the expression of the power provided by generator G to receiver R. This power is called the **active power** and is expressed by the formula:

$$P = \frac{V_{max} \cdot I_{max}}{\sqrt{2}} \cos \varphi = V_{eff} \cdot I_{eff} \cdot \cos \varphi$$

The **wattmeters** provide the expression of this product, either by causing a deviation of the pointer in the case of a device with an electrodynamic or ferrodynamic moving coil, or by supplying a DC current or a voltage proportional to the product in the case of electronic wattmeters; this current or this voltage is then applied to an analogue or digital display.

The existence of a phase shift φ between the current and the voltage leads, for AC currents, to the introduction of 3 additional quantities:

- **The apparent power** $S = V_{eff} \cdot I_{eff}$, in VA (volt-amperes), defining the voltage V_{eff} not to be exceeded (insulator breakdown, increase in core loss) and the intensity I_{eff} circulating in the receivers.

- **The power factor:**
$$\cos \varphi = \frac{P}{S} = \frac{P}{V_{eff} \cdot I_{eff}}$$
when the current and voltage are sinusoidal quantities.

- **The reactive power** $Q = V_{eff} \cdot I_{eff} \cdot \sin \varphi$, in rva (reactive volt-amperes). The latter may be directly measured by a wattmeter if for voltage $V_{max} \cdot \cos \omega t$ we substitute a phase-shifted voltage of π/2, i.e. $V_{max} \times \cos (\omega t - \pi/2)$.

The mean product measured will be

$V_{max} \cdot I_{max} \cdot \cos (\omega t - \pi/2) \times \cos (\omega t - \varphi)$ which is expressed by:
$$Q = \frac{V_{max} \cdot I_{max}}{\sqrt{2}} \cos (\pi/2 - \varphi) = V_{eff} \cdot I_{eff} \cdot \sin \varphi$$

Knowing P and Q, we can calculate the apparent power and the power factor:

Apparent power: $S = \sqrt{P^2 + Q^2}$

Power factor: $PF = P/S = P/\sqrt{P^2 + Q^2}$

Knowing the parameters defined above: active power, reactive power, apparent power, power factor, is fundamental in electrical engineering and enables accurate calculation of the characteristics of the equipment used: yield, load, cos φ, utilisation limits. The wattmeters used for these measurements are classified in three major families: electrodynamic, ferrodynamic and electronic.

Measurement of active power

4-wire balanced three-phase measurement (3 phases + neutral)

The intensities circulating in the three phases are equal in terms of rms values $I_1 = I_2 = I_3$ and show the same phase shift φ in relation to the respective voltages of the 3 phases.

If U_{1N} is the simple voltage measured between phase 1 and neutral, power P_1 supplied by phase 1 will be obtained by connecting a wattmeter as shown in figure 3.

Its value will be: $P_1 = U_{1N} \cdot I_1 \cdot \cos \varphi$
The total power supplied P will be equal to 3 P_1.

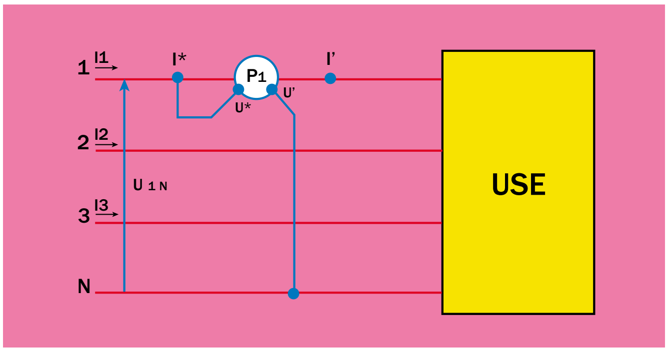


figure 3

Note: The expression $P_1 = U_{1N} \cdot I_1 \cdot \cos\varphi$ in the scalar product of the 2 vectors $\vec{U}_{1N}$ and $\vec{I}_1$ which enables use of the notation

$P_1 = \vec{U}_{1N} \cdot \vec{I}_1$

and in three-phase:

$P = \vec{U}_{1N} \cdot \vec{I}_1 + \vec{U}_{2N} \cdot \vec{I}_2 + \vec{U}_{3N} \cdot \vec{I}_3$

Measurement in 3-wire balanced three-phase (3 phases no neutral)

The intensities circulating in the three phases are equal $I_1 = I_2 = I_3$.
An artificial neutral is created using three resistors R, R et R'. The sum R' + r must be equal to R (r is the resistance of the voltage circuit of the unit).

This returns us to the previous case with U_{1N} between phase 1 and the artificial neutral *(figure 4).*

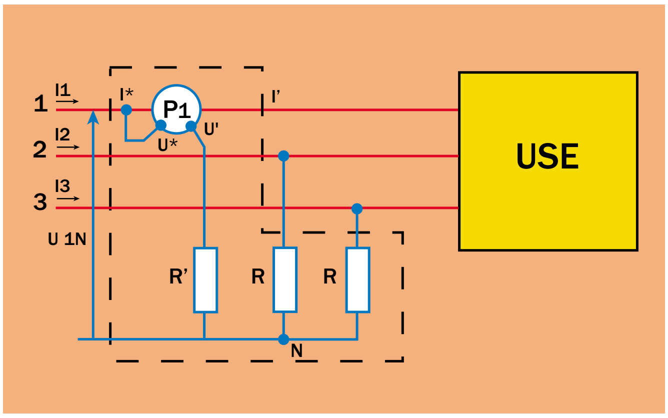


figure 4

P_1 = Power supplied on phase 1

Totale P supplied = $3\,U_{1N} \cdot I_1 \cdot \cos\varphi = 3P_1$.

With many wattmeters, the balanced three-phase measurements (3 phases no neutral) are performed directly; the artificial neutral point recreated by the resistors R, R and R' is included in the instrument (astatic wattmeter, CdA 778 wattmeter, for example). This design is shown in the diagram by the dotted section.

Measurement in 3-wire unbalanced three-phase (3 phases no neutral) - method using two wattmeters.

Whether the circuit is **balanced** or **not in the absence of a neutral, there remains $I_1 + I_2 + I_3 = 0$.**

In this case, the general expression of the power given above is simplified

$P = (\vec{U}_{1N} - \vec{U}_{3N}) \cdot \vec{I}_1 + (\vec{U}_{2N} - \vec{U}_{3N}) \cdot \vec{I}_2$

so $P = \vec{U}_{13} \cdot \vec{I}_1 + \vec{U}_{23} \cdot \vec{I}_2$

and the measurement of the total power may be carried out using two wattmeters *(figure 5).*

U_{13} and U_{23} are the phase-to-phase voltages measured respectively between phase 1 and phase 3 and then between phase 2 and phase 3.

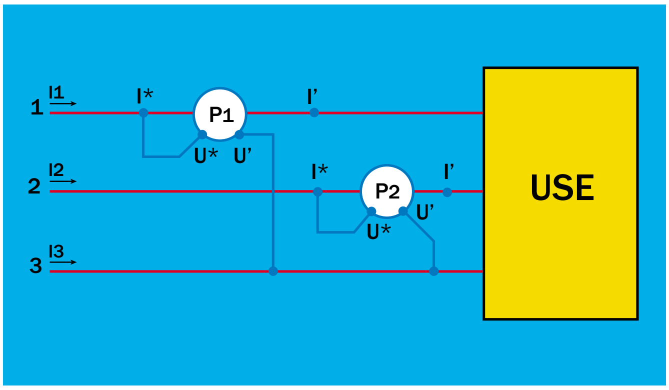


figure 5

Two cases may arise:

a) $P_1 \geq 0$ and $P_2 \geq 0$, then $P_{total} = P_1 + P_2$

b) one wattmeter deviates to the right and the other is as far as it will go to the left. To read the second; transfer the feed wires to the voltage circuit: U*-U' becomes U'-U*.
The value will be considered negative and we will obtain: $P_{total} = P_1 - P_2$

If it is a digital wattmeter we will add together the algebraic values displayed.

Note: it is possible to use a single wattmeter successively connected to 2 positions, using an inverter switch. This type of switch contains auxiliary contacts ensuring short-circuiting of the unused contacts.

Measurement in 4-wire balanced three-phase (3 phases + neutral)

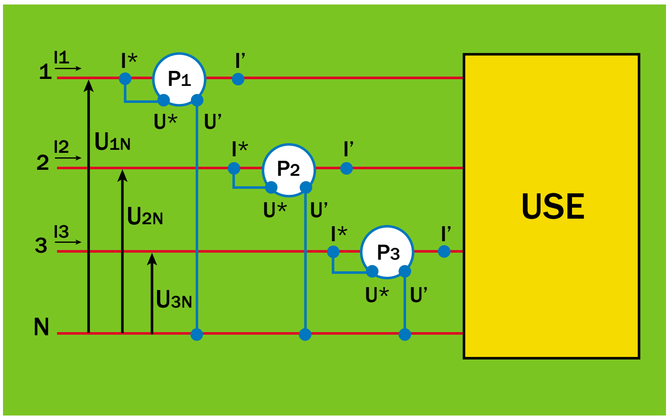


figure 6

We obtain $P_{total} = P_1 + P_2 + P_3$ *(figure 6).*

In this case, we must use 3 wattmeters and add the readings together. If the measurement is stable, we can successively carry out 3 measurements with a single wattmeter. Caution: it is recommended to use a system preventing the intensity circuits from being cut off during switching.

A new wattmeter concept, the “powermeter”

The wattmeter, at least in its single function version, was long resistant to digital technology.
Today, it would be unfortunate to be deprived of the possibilities of this technology, especially when the improvements made are not more expensive but cheaper!

Given their large measurement range and their sensitivity, the **METRIX** instruments **PX 120** and **PX 110** are designed for general or technical secondary schools, installers and industrial maintenance services. More specifically, their ability to measure **RMS values in AC + DC** enables them to take measurements in all 4 quadrants on signals disturbed and polluted by harmonics. Both instruments are suited for field and laboratory measurements. The only difference between the two models: the **PX 120** measures power in 3-wire balanced three-phase (T3FE) systems, while the **PX 110** is reserved for single-phase systems.

Implementation and robustness

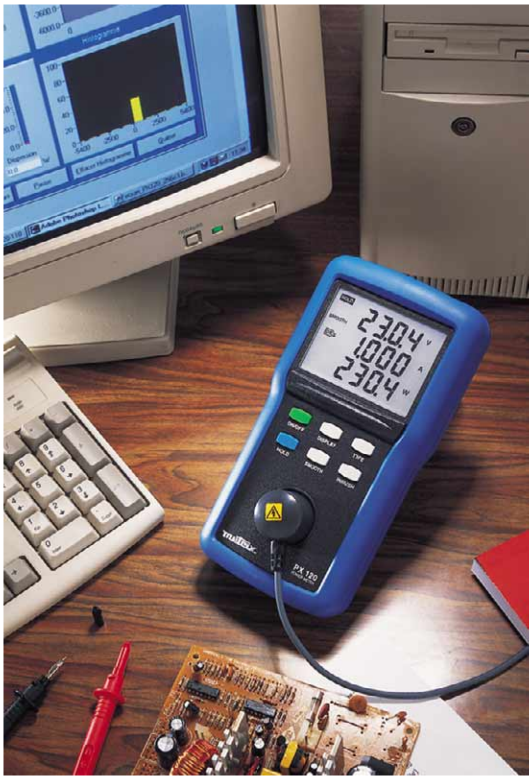
Though providing advanced functions, the **PX 120** and **PX 110** are very simple to use. Each of the five (PX 110) or six keys (PX 120) corresponds to a single clearly identifiable function. The function is directly accessible simply by pressing. Finally, the automatic range change function frees the user from adjustments.

The moulded elastomer casing gives these devices excellent handling characteristics and outstanding robustness. For table use, a stand raises the unit to 30°, making it easier to read the results. This stand can be clipped to the bottom during on-site measurements.

Inrush currents and unstable measurements

There are certain loads, such as motors, heating resistors and lighting systems, which draw large amounts of current when switched on. These currents, although short-lived, may trigger safety systems or even damage an installation.
The **PX 120** and **PX 110** are equipped with the **INRUSH** function to deal with this problem. It involves measuring the maximum value of the samples during a half-period.
This value is automatically maintained until a new, higher value is measured.

The PX 120 and 110 are compliant with safety standard EN 61010 Ed 99, Category III, 600 V - Class 2.



The **SMOOTH** function is very useful when the measurement is unstable. It filters the measurements using a time constant of approximately 3 seconds. The display stability then changes from 5 counts to 2 counts.
The user can then take full advantage of the exceptional readability of these units: a particularly large digit size (14 mm), a display capacity of 9999 counts (4 digits) on three lines, simultaneous display of three values, etc. Only two different tables are required to display all the quantities measured by the units.

Communication, the cutting edge!

The word digital also means communications options! These new wattmeters are also distinguished by their infrared **transmission mode**. The days of faulty contacts are past! The link is established using a magnetised optical head positioned simply on the front panel of the unit. A **software processing** system displays the different quantities on a **PC** screen, prints screens or transfers measurement files to a spreadsheet for storage.
Finally, given their possibilities, the **PX 120** and **110** are much more than simple wattmeters.
They herald a new concept: that of the **“powermeters”**.

Reader Service No. 2

LF disturbance: voltage quality is something that can be measured

For several years, we have been observing an increase in so-called "non-linear" loads on networks linked to electronic data processing and power electronics equipment. Now, these loads play a part in deteriorating supply voltage. They are also detrimental when it comes to operating electrotechnical equipment and material at maximum capacity. In this report, we will endeavour to set out the main types of disturbance encountered, their causes, the measures to be taken as well as certain clearly defined limits, bearing in mind that the results of the measurements must be recorded over a period of at least one week.

For an electric energy distributor, it is of paramount importance to deliver a top-quality product, meaning a balanced three-phase sinusoidal 50 Hz voltage at a rated value. By doing so, he is being consistent with the invoice sent out to the user customer.

The relevant standards

In order to help distributors and users in their steps to monitoring and improving the quality of electricity networks, several standards have been instituted or are in the course of being drawn up.

The **NF EN 50160** standard was established so as to characterise the quality of the voltage supplied. This standard sets out the various types of voltage disturbance observed at the customer's delivery location, depending on the waveform, voltage level as well as the frequency and imbalance of the three-phase system. It thus lists the parameters to be monitored and the length of time during which they should be monitored.

The standard which is currently undergoing preparation, **IEC/EN 61000-4-30**, defines the measuring methods for each parameter along with the measuring conditions and procedures.

Two standards, **IEC 61000-2-2** for LV networks and **IEC 61000-2-12** for AV networks, define the so-called acceptable "compatibility" levels for each parameter.

Slow variations: voltage troughs, overvoltages and outages

The amplitude of the voltage is a crucial factor for the quality of electricity. It generally constitutes the energy distributor's prime contractual engagement. Combined with the unknown factors in transmission and distribution network management (such as power monitor adjustments, dispatching and automatic protection systems), it is subjected to abnormal variations and can even collapse to a level bordering on zero. To characterise these events, two parameters are commonly used: the amplitude and the length of time the variation lasts.

Several types of defects are defined: **overvoltage**, **voltage trough** and **outage**. The nominal variation range for the network voltage is fixed by the energy distributor, generally speaking at ± 10% of the phase-to-phase voltage. The overvoltages are measured in amplitude and duration when the upper threshold of the nominal range is overshot. The voltage troughs are counted when the voltage is lower than the lower threshold of the nominal range *(see figure 1)*. Most commonly, these variations last less than 0.2 seconds in AV and HV. Over a period of one year, the number of voltage troughs can go from a few dozen to around a thousand.

In normal conditions, the number of very short outages can vary from a few dozen to several hundred per year and not last longer than 1 second.

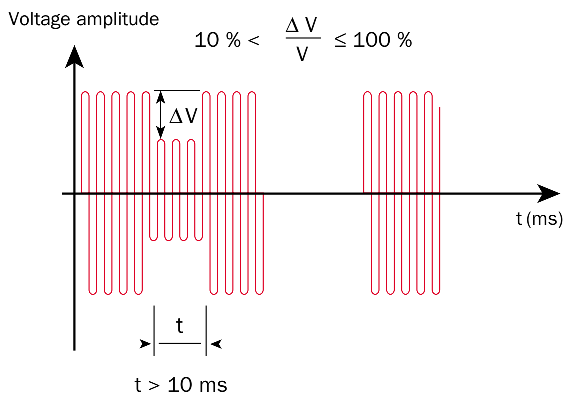


Figure 1: voltage troughs

Several types of phenomena can be seen to cause the voltage variations. When they arise at producer level, it is always a question of uncertain phenomena such as lightning or accidental short circuits (defective insulation, fissure in a cable, branches falling on overhead electricity lines, etc.) which are to blame. At consumer level, it is essentially the installation itself which is at fault. Therefore, connecting up heavy loads can bring about variations in voltage if the short-circuit power at a delivery point is of too low capacity. High-power engines, transformers and capacitor assemblies are the loads which most commonly give rise to voltage variations. The effects of such loads can increase considerably when a large number of customers are connected to the same branch. In the case of a rotary engine, the variations can have a dramatic influence on the engine itself. Therefore, when a defect appears, all those customers connected at the same level on the network are affected by the voltage variations.

The major difficulty consists in measuring the duration and amplitude of these voltage variations very accurately, especially when the variation in voltage appears on all the three phases with different durations and amplitudes. It has become a necessity to use so-called "three-phase" network analysers in order to analyse the three phases simultaneously.

Rapid variations: transient overvoltages

Those overvoltages lasting less than 10 ms are known as **"transient overvoltages"** *(figure 2)*. These overvoltages are caused by atmospheric phenomena (lightning) or, more frequently, by electrical equipment being operated (more or less inductive load commutations producing transient overvoltages at high frequency).

These transient phenomena can also arise when two thyristors are commutated, prompting a very short-lived short circuit between the two phases. The rise time can vary from less than a few microseconds to several milliseconds. These LV overvoltages generally remain below 800 V, but they can go over 1,000 V subsequent to a fuse melting.

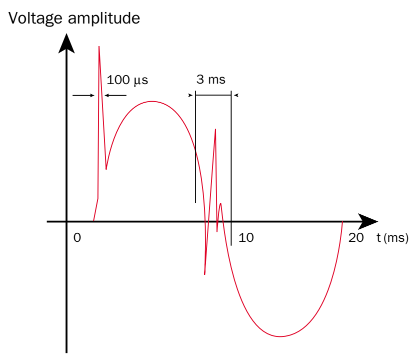
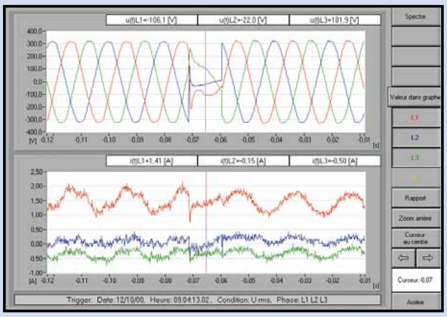


Figure 2: transient overvoltages

Measuring transient overvoltages requires specific analysers using digital technology and a high sampling frequency.



Triggering a contactor causes a current peak to appear, the effect of which is a voltage drop (on either side of the cursor, shown here in pink).

Flicker or rapid voltage fluctuations

The discomfort felt by the human optical system when variations of light intensity occur, what we call **"flickering"**, is measured by the value of the flicker. Its main effects on a human being can be headache, irritability and sometimes even epilepsy.

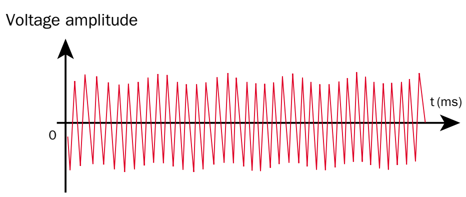
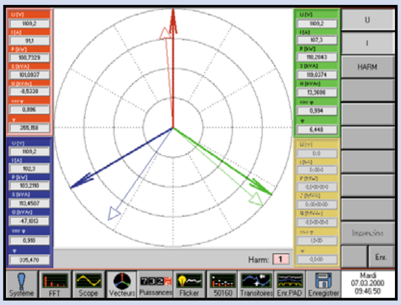


Figure 3: rapid variations in voltage

The flicker is in reality a statistical calculation, defined by the **EN IEC 61000-4-15** standard and obtained from measuring the rapid variations in voltage. These rapid variations in voltage *(figure 3)* are, generally speaking, caused by variable loads such as arc furnaces, laser printers, micro-wave ovens or air conditioning systems being started up.
The method of measurement must be representative of the discomfort felt and take into account the mechanisms of vision. To achieve that, the flicker must be assessed over a sufficiently long period of time. Moreover, due to the uncertain nature of the flicker, caused only by certain loads, its instantaneous level can vary considerably and unpredictably during this period.
A 10-minute space of time has been deemed to be a good compromise for assessing what is called the short-term flicker, or **"Pst"**. It is long enough to avoid granting too much importance to isolated voltage variations. It is also long enough to allow an inexperienced person to notice the disturbance and its persistence. At the same time, it is short enough to enable a piece of disruptive equipment with a long operating cycle to be finely characterised.
The period of 10 minutes on which the assessment of the short-term flicker severity has been based is valid for assessing the disturbances caused by individual sources such as rolling mills, heat pumps or electric household appliances.
In cases in which the combined effect of several disruptive loads operating in an uncertain manner (e.g. welding units or engines) has to be taken into account, or when the flicker sources in question are ones with a long or variable operating cycle (e.g. electric arc furnace), the disturbance thus created is required to be assessed over a longer period. Measuring is set to last 2 hours, a duration considered appropriate to the operating cycle of the load or one during which an observer can perceive the long-term flicker. The long-term flicker, or **"Plt"**, will be calculated from the short-term flicker values. This is a standard function on certain network analysers.



Measuring the severity of the short- and long-term flicker

Harmonics and interharmonics

In numerous cases, the current consumed by the loads no longer has a pure sinusoidal shape. Current distortion implies a voltage distortion which also depends on the source impedance.
The so-called **"harmonic"** disturbances are caused by non-linear loads such as pieces of equipment with integrated power electronics (variators, inverters, static converters, dimmers, welding units, etc.) being introduced onto the network. More generally, all the materials incorporating rectifiers and chopping electronics distort the currents and create voltage fluctuations on the low-voltage distribution network. It is the concentration of numerous harmonics "polluters" which generates a huge amount of disturbance on the network.

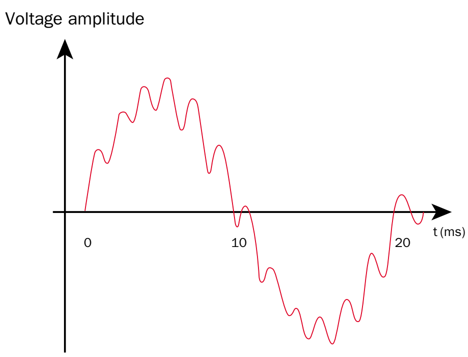
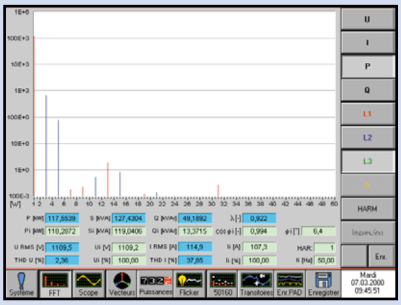


Figure 4: harmonics

What we call **harmonic** is the superposition on the 50 Hz fundamental wave of other waves which are also sinusoidal but which have frequencies that are multiples of the fundamental *(figure 4)*. In order to measure the "current" or "voltage" harmonics, we use the Fourier transform making it possible to break a periodic signal down into a sum of sinusoidal signals that are

multiples of the fundamental frequency. When the signal has a component which is superposed onto the fundamental wave (50 Hz) and which is not a multiple of the fundamental (e.g. 175 Hz), we speak of **interharmonics**. The level of the interharmonics is also on the increase due to the development of power converters, speed variators and other similar command control equipment.
All these harmonics can be added up, with the result being the **THD** (total harmonics distortion). The frequency range which corresponds to the study of harmonics is generally between 100 and 2,000 Hz, meaning from order 2 to order 40 harmonic. The maximum levels, order by order, are defined in the **IEC 61000-2-2** standard for LV and the **IEC 61000-2-12** standard for AV. Present-day measuring instruments must be capable of performing this harmonic analysis order by order and also overall, so as to carry out a finely detailed diagnosis of the installation.
The consequences of these harmonics can be instantaneous on certain electronic appliances and instruments: functional disorders (synchronisation, commutation), ill-timed trip-outs, measurement errors on energy meters, etc.



Voltage, current and power harmonics spectrum

The additional induced temperature rises can, in the medium term, reduce the life span of rotating machines, capacitors, power transformers and neutral conductors.

Imbalance

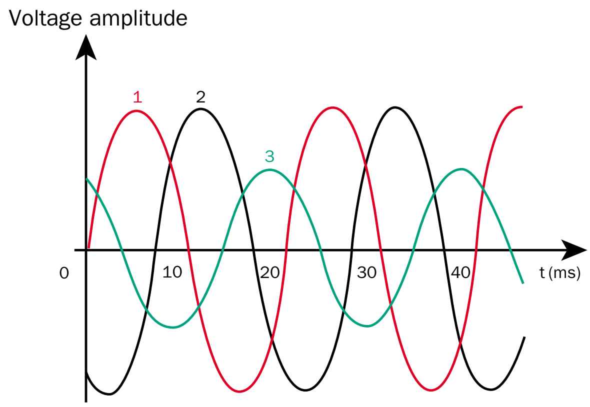
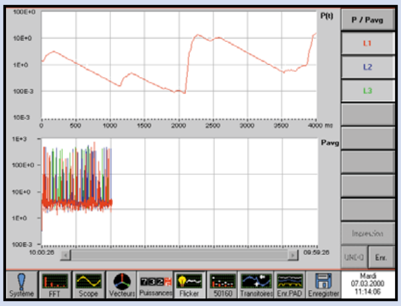


Figure 5: voltage imbalance

An unbalanced three-phase electric receiver or unbalanced single-phase receivers energized by a balanced three-phase network can lead to voltage imbalances between phases (figure 5).
These imbalances are due to the circulation of unbalanced currents through the network impedances.
Voltage can be broken down by a method known as "of symmetrical, direct, negative phase sequence or homopolar components".
It is well known that the negative phase sequence component causes cases of spurious braking torque and additional temperature rises in alternating current rotating machines.

The imbalance and its three components are given by the network analyser offering the Imbalance function.
It is generally agreed that no problem can arise with an imbalance of less than 2%.



Visual display of the imbalance on the analyser by means of the Fresnel graph

Frequency

Frequency fluctuations are most often observed on networks which are not interconnected, as is the case with Corsica, or networks powered by generator sets. Under normal operating conditions, the average value of the fundamental frequency should be in the 50 Hz ± 1% range *(figure 6)*.

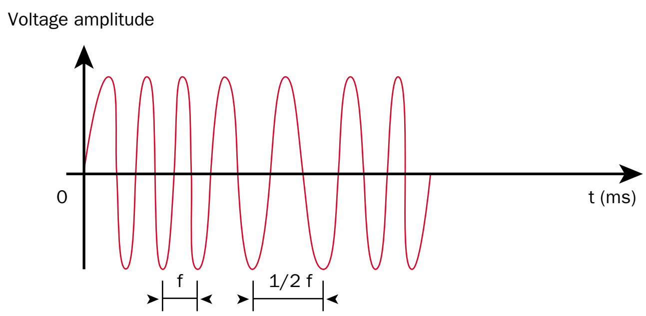


Figure 6: frequency fluctuations

Conclusion

Problems of voltage troughs and outages are becoming more and more an everyday topic owing to the high level of sensitivity of certain pieces of equipment to these phenomena. Unfortunately, these problems will persist despite all the improvements made by the distributor to his networks.
In France, the Emerald Contract (Contrat Émeraude - green tariff) is applied to those industrial customers using the EDF (national electricity company - translator's note) distribution network. It includes a contractual undertaking with regard to troughs and outages depending on the geographical area, and a personalised undertaking with regard to harmonics, flicker and imbalance.
Voltage disturbances come from the increasing installation by users of so-called "fluctuating" loads.
It should therefore be stressed that the quality of electric energy depends not only on the supplier but also on the end user. Checking the quality of the electricity supply requires the use of effective tools which enable all the parameters described above to be checked. The new three-phase network analysers allow a complete analysis of the network quality parameters, a diagnosis and an assessment of the problems observed on the network.

Electrical systems: the full analysis with the C.A 8350

The new C.A 8350 electrical system quality analyser, is a product of development and complies with the latest standards in the field, in particular EN 50160. It provides access to all measurements for complete analysis: power, harmonics, flicker, transients etc. The touch-sensitive screen makes it remarkably simple and intuitive to use and program. The operating software, Windows ™, handles data formatting in the form of tables or colour graphics and printing of analysis campaign reports.

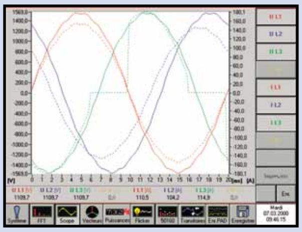
To supplement the article published on this product in our previous issue, we present here the various measurement options for electric and qualimetric parameters, the theory of which we broached in the 3 previous pages.

Harmonics analysis

FFT representation of the voltage and current
Representation of harmonics (to 50th order) and inter-harmonics
Recognition of harmonic current direction (input or output)
Statistical analysis

Oscilloscope Mode

Wave form display:
4 voltages and 4 currents
Automatic triggering
Phase imbalance measurement
Automatic Scaling



8-trace Oscilloscope

"Flicker" rate measurement

Graphic time representation
Short-term "flicker" rate
Long-term "flicker" rate

Energy and power monitoring

Representation of voltage, current, power and energy values in the form of tables Monitoring of mini, maxi and average values
Display of power profiles

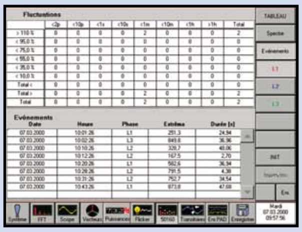
Power and energy analysis

Vector representation

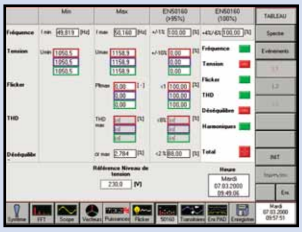
Voltage, currents and harmonics
Automatic Scaling
Verification of connection and phase rotation
Summary of different measurements on each phase

Voltage Monitoring

Representation of voltage fluctuations with ratio of non-standard values
Monitoring according to standard **EN 50160**
Statistical analysis and sorting



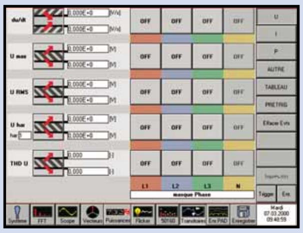
Voltage fluctuation analysis



Summary table EN 50160

Recording of transients

Monitoring - Trigger selection
Pre/post triggering
Summary event table
Time and date stamping and event duration



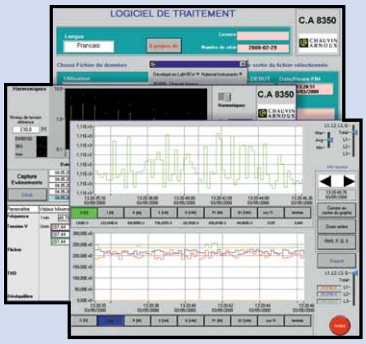
Recording of transient thresholds (40 µs in single phase)

Data recorder

Analogue and digital inputs
Meter inputs
Connection on **USB** port of **C.A 8350**

PC software

The software, delivered as standard with the C.A 8350, can be used to analyse data, make a diagnosis and generate and print out clear, detailed data reports in the selected language very simply.
Processing of data
Printing of reports
Printing of graphs and tables
Export of data to spreadsheet



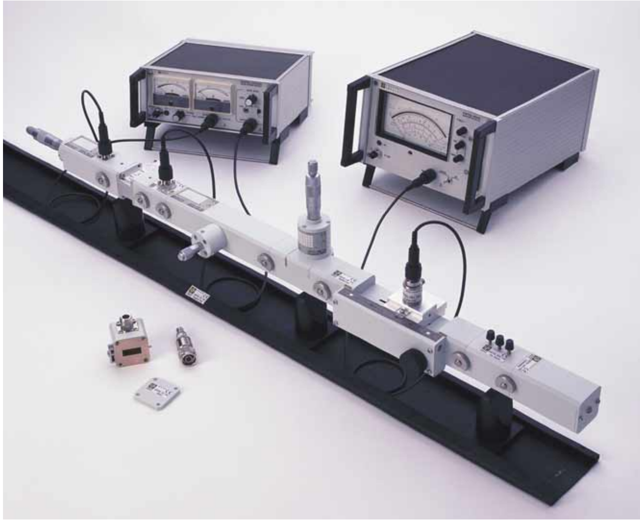
A4 printing of data reports analysed on selected time windows

An instrument with many advantages

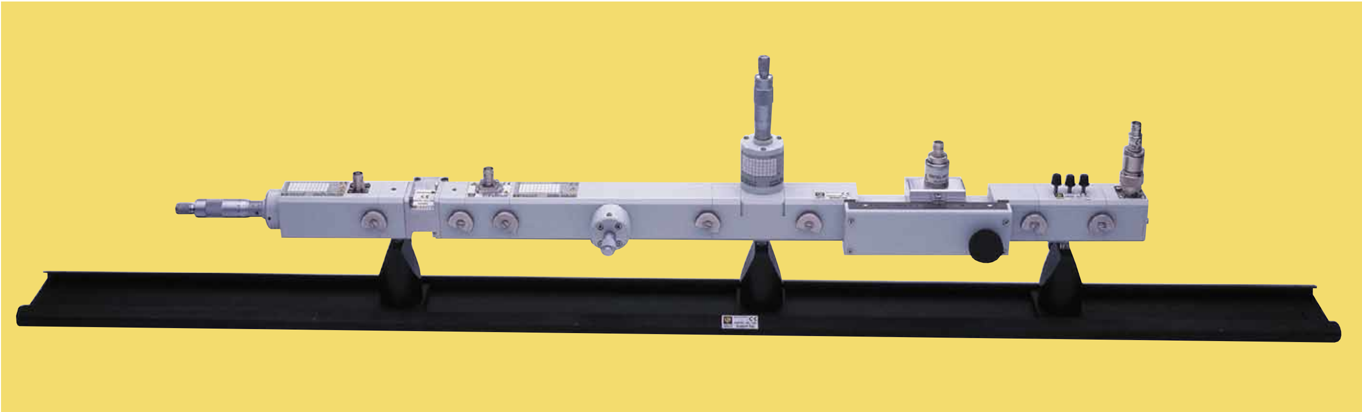
Remarkably intuitive in its use, all the programming and reading of the **C.A 8350** is carried out by pressing its touch-sensitive screen, in a particularly user-friendly **Windows™ environment**. With a memory of 6 Gb, long measurement campaigns are possible. All the parameters can be displayed instantaneously and simultaneously.
In its basic version, the unit possesses **FFT analysis** functions and the **oscilloscope mode** for curve display. Then, each user customises his unit by adding the option(s) he needs: power analysis and "vectorscope" mode, flicker and EN 50160 standard analysis, transient recording and data recording. All these functions are available simultaneously to facilitate operation.

Reader Service No. 3

Microwave training bench 8.5 to 9.6 GHz



To meet the requirements of teaching and adult training in both civilian and military contexts, the ORITEL BDH R100 bench can be used for many basic experiments using microwaves.



This training bench uses the "rectangular wave guide" technique as per standard R100/WR90. It covers a frequency range of 8.5 to 9.6 GHz. This frequency range, with a wavelength of 3 cm, was chosen because of the important developments observed therein and also for the small dimensions of the components.

The **ORITEL BDH R100** bench consists of a robust set of components and shows great ease of use because of the ingenious EASYFIX™ assembly system (Chauvin Arnoux registered trade mark). Each component is fitted with the EASYFIX™ fast attachment system: 1/4 turn knob and failsafe system. In a few minutes, the wave guide configuration required for experimentation is assembled; the three supports screw on under the guide and the assembly slides under the ruler.

ORITEL LAF 100 test track is fitted, like each component, with the EASYFIX™ fast attachment system.

Basic bench composition:

The bench consists of 11 microwave components and 3 guide supports, with the operating manual and detailed practical exercises for each experiment, all included in a carrying case.

Components:

- Gunn diode oscillator,
- ferrite isolator,
- Pin diode modulator,
- variable attenuator,
- curve-type wavemeter,
- measurement line,
- impedance adapter
- guide-coaxial transition,
- coaxial sensor,
- adapted load,
- short-circuit

Other components are available optionally: star coupler, hoghorn antenna etc.

The related measuring instruments (SWR indicator, Gunn power supply, microwave milliwattmeter, oscilloscope, etc.) are delivered as options.

Experiments

The main basic microwave experiments, which can be conducted using this training bench, are:

- Gunn oscillator analysis
- wavelength measurement
- standing wave ratio measurement
- impedance measurement
- frequency measurement
- reading of the quadratic law of a detector

Teaching aids and detailed practical exercises complete the operating manual.

Reader Service No. 4

NEW PRODUCT

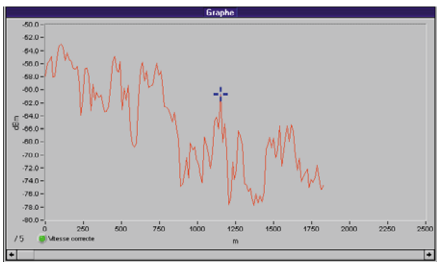
Electric field mapping within arm's reach

In order to determine a transmitter's geographical coverage, so as to estimate the range of communications, the electric field around this transmitter needs to be mapped. The C.A 47 receiver, combined with an odometer and a GPS, meets this requirement. In addition to its aptitude for performing selective frequency measurements, it has a very high level of sensitivity and a very wide dynamic measuring range (between -10 and -130 dBm).

Portable instrument designed for the field, the C.A 47 selective RF receiver has an autonomy of a minimum of 3 hours.

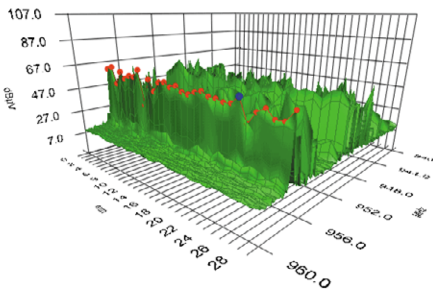
The **C.A 47** measures the electric field picked up by an antenna, at a determined frequency between 25 MHz and 2.5 GHz, and over a very wide dynamic measuring range of between -10 dBm (100 µW) and -130 dBm (0.1 fW).
On principle, this type of **selective receiver** carries out the measurement at a determined frequency without being disturbed by the electric fields which are present on other frequencies. Indeed, it has a selectivity that can be configured between 1 kHz and 1 MHz (5 analysis filters: 1 kHz, 8.5 kHz, 16 kHz, 120 kHz, 1 MHz) and can be used over its whole frequency range (25 MHz to 2.5 GHz).
This technique known as the "measuring window" (this window can be moved within the frequency range) is the technique used in spectral analysis. The following can also be configured: the measuring rate (between 0.1 and 165 measurements per second); the choice of peak, quasi-peak or average detection mode; the amplitude (AM) or frequency (FM) demodulation which can be heard on the built-in loudspeaker*.

**WARNING! In France, under article R.226 of the Penal Code, this demodulation option can only be used after authorisation has been granted by the Ministry of Defence.*



Evolution of the electric field in relation to the distance, at a determined frequency. Measurements carried out in a vehicle with the odometer accessory and the LOG 47 software.

Its large backlit liquid crystal display (LCD) indicates all the configuration parameters as well as, at the same time, the value measured and the dBm or dBmV unit. The possible configurations are clearly indicated in the form of menus and in the language of the selected messages (English, French, German, Spanish or Italian).
The configuration parameters can be adjusted by means of a rotary control knob and a numeric keypad, or via a RS 232 link.

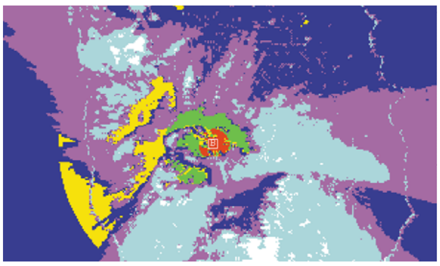


Monitoring function with LOG 47 software. Observing changes to the levels picked up on a frequency range according to time.

The **C.A 47 selective receiver** has an internal memory which can store 5 configuration registers and 96,000 measurements as well as a RS 232 interface for programming and editing results.
Its **LOG 47 systems software**, available as an optional extra, enables the measurements to be processed and archived onto a microcomputer with a choice from among five languages for reading the messages.
Designed to be used in the field, this receiver has an autonomy of more than 3 hours and can be powered at 12 V (from the socket of a cigar lighter in a car) or with a 230 V mains network (115 V as an optional extra).

Mapping applications

In these applications, the **C.A 47**, combined with a microcomputer which is in turn equipped with the **LOG 47** software, is taken on board a vehicle. **Two accessories** are required in this case: an **odometer** and a **GPS**.
The odometer, fitted to one of the wheels of the vehicle, controls the setting of the length of time between two measurements proportionally to the speed of the vehicle.
As for the GPS (Global Positioning System), this positions the signal received into geographical coordinates, i.e. according to latitude, longitude and altitude.
Radiocommunications operators use mapping software so as to be able to simulate network coverage. The **C.A 47**, equipped with its accessories, enables the gaps in the advance data to be filled in by incorporating the field level values observed and recorded in the field. The map thus drawn gives the geographical area actually covered around a transmitter as well as its different ranges.



Example of an electric field map plotted by means of specialised software, based on readings from the C.A 47. The measurements were carried out in a vehicle using the GPS and odometer accessories which come with the LOG 47 software.

Reader Service No. 5

Microwave wattmeter-reflectometers

The ORITEL RW series of wattmeters for civilian and military applications is designed for efficiency: its aim is to verify microwave transmission/reception installations simply and rapidly without investing in sophisticated and costly equipment.

For SSB transmissions from 2 to 30 MHz: the ORITEL RW 511 wattmeter

On the transmission assembly (transmitter, wiring and antenna), these wattmeters are used to verify that the installation meets expected performance.
Implementation requires no special technical know-how. Measurements are carried out directly by the assembly team who set up the installation. For maintenance during system operation, the same applies and the measurements are simple and quick.
The parameters measured are the incident and reflected powers of up to 1 kW between 2 MHz and 2.7 GHz, depending on the model. Each wattmeter in the series operates in a wide bandwidth (see table) and requires no special accessories to do so.

With their small size and portable carrying bags, these mulitmeters were designed mainly for use in the field. Their metal casings are especially robust. They are also perfectly suited to use in the laboratory.

Two models are referenced by **NATO**:
- **RW 306**, part number 6625-14-472-7790,
- **RW 521**, part number 6625-14-441-7702,

Measurement principle

The measurement method involves setting up the wattmeter-reflectometer in series – between the output of the transmitter and its operating circuit (cable, antenna). These test units are fitted with “N female” input and output connectors.
The main component is a wide band bi-directional coupler which samples and detects simultaneously a fraction of the incident power and a fraction of the reflected power.

For FM and TV networks from 25 to 1300 MHz: the ORITEL RW 501 wattmeter

The voltage provided by the detectors on the bi-coupler branches (voltage proportional to the detected power) is used after amplification to provide the power measured on a galvanometer graduated in watts or in dBm *(see table)*.

Reader Service No. 6

Military Special

The ORITEL RW 306 wattmeter is rainproof, robust and takes up little space. It can be fitted to any vehicle, using the powerful magnet on the back of the unit.
NATO part number:
6625-14-472-7790.

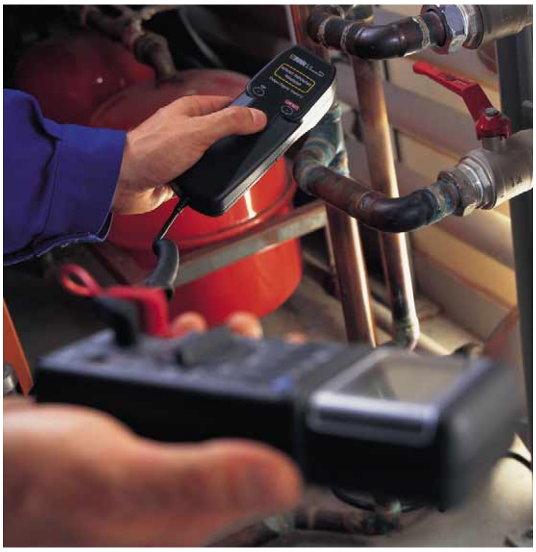
Model	Frequency	Power	Utilisation
ORITEL RW 511	2 at 30 MHz	3 W to 1 kW	transmission SSB (Single Side Band)
ORITEL RW 306	26 at 90 MHz	100 mW to 100 W	frequency-hopping transmitter-receivers
ORITEL RW 5012	25 at 500 MHz	100 mW to 300 W	police, DDE, DDSIS networks
ORITEL RW 501	25 at 1 300 MHz	100 mW to 300 W	radio FM, TV networks
ORITEL RW TDI	800 at 1 300 MHz	30 W to 1 kW (1)	TACAN, DME, IFF transmission
ORITEL RW 521	1 300 at 2 700 MHz	3 mW to 10 W (2)	Rural UHF networks

(1): wattmeter graduation in dBm, from +45 to +60 dBm. (2): wattmeter graduation in dBm, from +5 to +40 dBm

NEW PRODUCT

PHYSICS Line: your testers for physical measurements

Nine testers for easy measurement of temperature, relative humidity and lighting.
The entire range was designed in a new, light ergonomic casing, fitted with an anti- shock sheath for greater robustness.



Temperature measurement with no contact using C.A 874 infrared probe

C.A 870 and C.A 872 infrared thermometers

Using these two thermometers, there is no risk of touching a hot surface because the infrared measurements are made remotely, from -50 to +260°C.

The **C.A 872** is also fitted with a laser sighting system to aim at the hot spots more accurately.

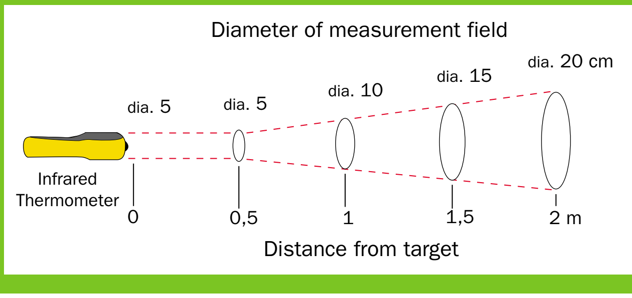
Characteristics:

- 2000-count digital display
- resolution 1°C
- accuracy ±2% reading or 3°C
- response time 1 s
- fixed emissivity 0.95
- aiming field 10/1

They are fitted with functions for **Auto-Hold, back-lighting** of the display and display in °C or °F.

Infrared distance to target

The diameter of the targeted area depends on its distance. The closer the target, the smaller the area and the better the measurement. This "target distance/targeted area diameter" ratio is also called the measurement field.



Infrared measurement principle

All objets whose temperature is higher than absolute zero (-273.15°C) emit infrared energy. This energy radiates in all directions at the speed of light.

When the C.A 870 is aimed at an object, its lens captures this energy and focuses it on an infrared sensor. This detector reacts by generating a voltage proportional to the amount of energy received, which means that it is proportional to the object's temperature.

Certain objects not only emit infrared energy but also reflect it. Unlike matt surfaces, shiny or highly-polished surfaces tend to reflect energy. This reflection is represented by a factor called the emissivity coefficient which may vary from 0.1 for a highly reflective object to 1 for a theoretical "black body".

For the C.A 870 thermometer, the emissivity coefficient is pre-set to 0.95. This corresponds to the most common value which covers more than 90% of applications.

C.A 874 infrared probe

This infrared temperature probe can adapt to any multimeter with an input impedance of 10 MΩ.

It provides 10 mV per °C, output on standard banana plugs via its extension cord.

Its measurement range, -20 to +260°C, and its technical characteristics are identical to the C.A 870 thermometer.

It is equipped with a **battery indicator** and an **Auto-Hold** function.

The infrared C.A 874 temperature probe adapts to any multimeter.

K type couple thermometers
C.A 861 - single K type couple input
C.A 863 - dual K type couple input

Two K type couple thermometers with **2000-count** digital display and **backlighting**. Many K type couple sensors are available for measurements from -40 to +1350°C using the **C.A 861** and from -50 to +1300°C using the **C.A 863**, with ΔT difference measurement on the latter. They are equipped with **Max., Hold** and **°C or °F display functions.**

Characteristics:

- resolution 1°C or 0.1°C
- response time 400 ms
- accuracy ±0.1% reading ±1°C for the C.A 861 and ±0.3% reading ±1°C for the C.A 863

The C.A 863 is delivered with 2 flexible K couple sensors and the C.A 861 is delivered with one sensor.

C.A 865 Thermometer with Pt100 probe

This thermometer with a platinum probe offers excellent accuracy over a measurement range of -50 to +200°C.

Its **2000-count** digital display is equipped with **backlighting**.

Many Pt 100 sensors for special uses are available optionally. It is equipped with **Max., Hold** and **display in °C or °F functions.**

Characteristics:

- accuracy ±0.5°C
- resolution 0.1°C
- response time 400 ms

The C.A 865 is delivered with a general-purpose Pt 100 sensor.

C.A 846 thermo-hygrometer

Perfectly suited to environmental measurements, this thermo-hygrometer gives the temperature and percentage of humidity in the air: -20 to +60°C and 0 to 95% RH.

It is fitted with a **Pt 1000** Ω temperature sensor **at 0°C** and its humidity sensor is a fast-reaction capacitive sensor. It is equipped with **Max, Hold** and **°C or °F display functions.**

Its **2000-count** digital display has **backlighting**.

Characteristics:

- resolution 0.1°C and 0.1% RH
- temperature accuracy ±0.5°C from 0 to +60°C and ±1°C from -20 to 0°C
- accuracy for relative humidity ±2.5% from 10 to 90% RH and ±5% from 0 to 10 and 90 to 100% RH

C.A 811 and C.A 813 light meters

Two digital light meters for light measurements with a **silicon photodiode sensor.** Measuring range: from 20 to 20 klx for the **C.A 811** and 20 to 200 klx for the **C.A 813.** The sensor is capable of **spectral correction** and **incidence correction.**

They are fitted with the **Auto-hold** function, **max.** value for the **C.A 811** and **peak** value for the **C.A 813.**

Their 2000-count digital display is backlit with a function for **display in lx** (lux) or in **fc** (foot-candle).

Characteristics:

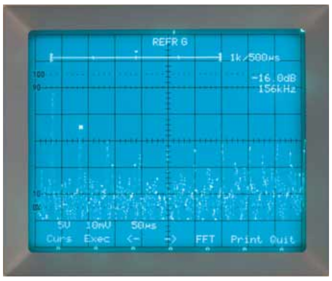
- resolution 0.01 lx
- accuracy ±3% reading ±10 counts

Sensor with protective cover and extension cord to facilitate measurement.

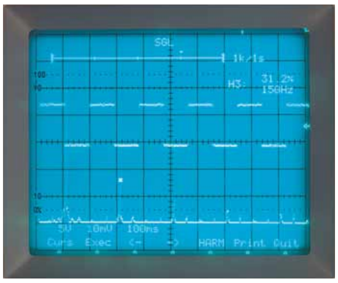
Reader Service No. 7

FFT and harmonic analysis: a major advance!

It is clear that with digital technology, the number of functions potentially available in instruments is exploding. It even makes you wonder sometimes whether these functions serve any real purpose. In general, the answer is yes! In-depth analysis of customer applications and habits indicates new requirements. This is exactly what has happened with oscilloscopes, with the FFT and harmonic analysis functions we propose.



In harmonics mode, the cursor automatically jumps from one overtone to the next, indicating the number of the overtone, its amplitude as a percentage of the fundamental and its frequency. This representation of the harmonics is richer than a conventional bar display. In particular, it even works on MLI-type signals.



In FFT mode, the cursor follows all the signal points, each time indicating the amplitude (in Volts or dB) and the frequency.

The oscilloscope is an outstanding display tool. As such, it may be considered the perfect quality control tool. With digital technology, it has become possible to progress even more. The various possibilities for acquisition as well as measurement enable the oscilloscope to be used not only for verification, but also as a genuine diagnostic or survey tool. In other words, the user first qualitatively checks the operation of the installation or system by displaying its signal and can then determine the cause of the malfunction or anomaly using measurement tools, all with the same instrument. Among these tools, advanced functions have appeared, such as **harmonic analysis** or **FFT** (Fast Fourier Transform).

The reason for this choice?

For harmonic analysis, the answer is simple. The pollution of networks and the problems this causes for the operation of an electrical installation and the devices connected to it represent a highly topical subject *(see page 7)*. Before carrying exhaustive, precise analysis using dedicated instruments, it is useful to quickly and simply assess the source of the pollution and the characteristics of the incriminated equipment.
The oscilloscope, a standard tool, can do this.

The second, FFT, involves analysing complex signals or checking noise levels. Using this function, it is possible to assess a noise level or determine clearly the frequency components of a given signal. Furthermore, this function has a very interesting educational aspect since it becomes possible to display on the same screen the form of a characteristic signal and its breakdown into Fourier series.
Of course, a more accurate measurement may require the use of a dedicated instrument such as a spectrum analyser, but the cost of such an instrument is not always justified! In the end, isn't the oscilloscope confirming in its maturity that it remains the universal instrument par excellence?

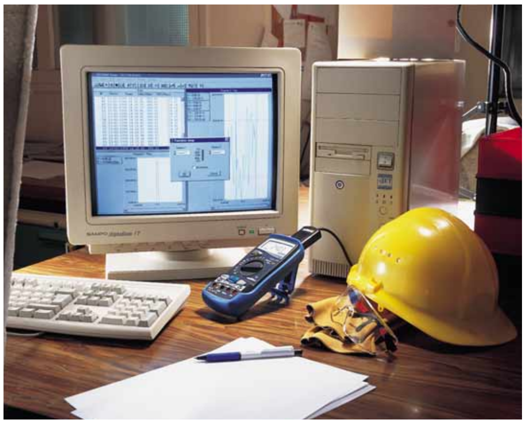
Reader Service No. 8

Metrix proposes Harmonic Analysis functions and FFT on several of its oscilloscopes:

	OX 8100	OX 8050	OX 8062	OX 8042
Operation	Digital and Analogue	Digital and Analogue	Digital and Analogue	Digital and Analogue
Input Type	Conventional	Conventional	Differential CAT II - 600 V	Differential CAT II - 600 V
Digital bandwidth	100 MHz	60 MHz	60 MHz	40 MHz
Vertical Amplitude	2 mV to 5 V/div.	5 mV to 20 V/div.	10 mV to 200 V/div.	10 mV to 200 V/div.
Sampling frequency: Single sweep ETS	 100 Msam/sec 20 Gsam/sec	 100 Msam/sec 20 Gsam/sec	 100 Msam/sec 20 Gsam/sec	 100 Msam/sec 20 Gsam/sec
Signal Analysis Function	FFT and standard harmonics analysis Dynamic 50 dB, linear or logarithmic scales (volts or dB) Hamming, Hanning, Blackman, or Rectangle windowing Cursor Amplitude/Frequency slave to the curve			

NEW PRODUCT

Measure and process your signals regardless of their form



METRIX is completing its range of MX Concept multimeters with a True RMS 100 kHz unit, fitted with an infrared digital link.

The latest product in the **MX Concept** line, the **MX 26** is a 5000-count multimeter at home in the field, but also in the lab.

In the field...

Users will appreciate its measurement capabilities, and its ability to measure voltages and currents even with interference. Because the **MX 26** is not only an **RMS AC+DC** unit (see box) but also has a 100-kHz bandwidth which enables it to take harmonics into account. Furthermore, its **"V low Z"** function (low impedance) avoids measuring spurious voltages, often a cause of error, and its

"Peak" function traps 1 ms positive or negative interference.

Its display characteristics are also an advantage for field work: the backlighting facilitates readings in conditions where there is little light and the bargraph instantaneously indicates trends.

Finally, it benefits from the compact, robust casing which characterizes the line and is responsible for its success with, in particular, easy access to the batteries and even safer fuses.

In the lab...

Its communications capabilities will delight users. Because of its infrared digital output, the **MX 26** can be connected directly to a computer. The user can then acquire data, record it and display it in graphical form using advanced software **(SX-DMMC).**

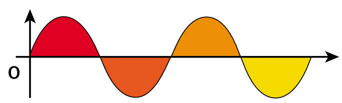
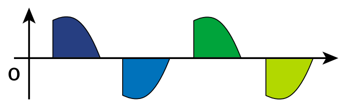
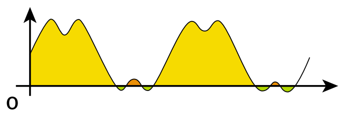
Later, the user will even be able to calibrate the unit without opening it and print a record of the corrections made to the unit using special software.

Its multifunction Elastomer sheath is useful in any environment: on site, it is used to attach the probes; on a table, its stand keeps the unit in an inclined position.

Reader Service No. 9

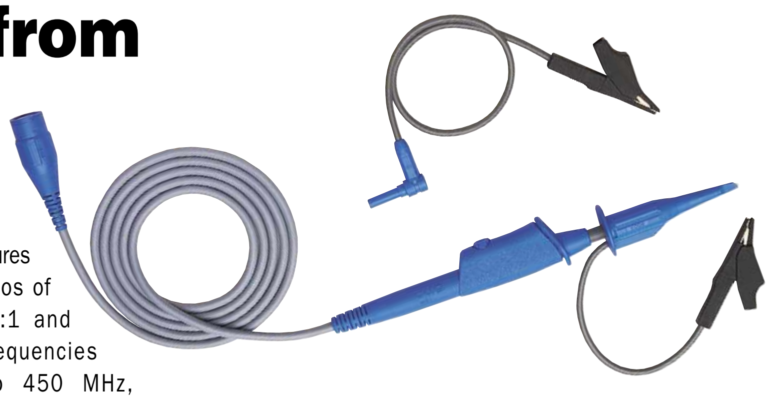
TECHNICAL CHARACTERISTICS	MX 26
Voltage DC	0.5 - 5 - 50 - 500 - 1000 V
Voltage AC	0.5 - 5 - 50 - 500 - 750 V
Current DC	500 mA / 10 A
Current AC	500 mA / 10 A
Other measurements	Ω, continuity, diode test, capacity, Frequency
Display	5,000-count / Bargraph / Backlighting
Functions	MIN/MAX, AVG, MEM, AUTO MEM, PEAK
IEC 61010 safety	CAT III - 600 V - Pol.2

Choose the right instrument for the type of signal to be measured:

	U_{AVG} Multimeter$_R$ x 1,1	RMS Multimeter (AC)	RMS Multimeter (AC+DC)*
Sinusoidal signal with no DC component 	Correct	Correct	Correct
Distorted AC signals with no DC component 	Default error capable of reaching 30 to 50%	Correct	Correct
Distorted AC signals with DC component 	Default error capable of reaching 30 to 50%	Default error (depending on the UDC value)	Correct

* RMS multimeters (AC+DC), are also called TRMS (True RMS) units.

4 voltage probes from 150 to 450 MHz for oscilloscopes



With its new generation of **HX** voltage probes, **METRIX** is launching a family of advanced, uniform accessories with an unequalled level of safety. Its design, common to the entire line, is ergonomically thought out: a guard positions the fingers naturally and the sleeve, whose colour changes depending on the model, is retractable, which facilitates direct grounding connection of the accessories. Identified by full markings, each model is factory-adjusted for HF compensation; no need for a screwdriver to perform LF compensation.

The series features fixed filter ratios of 10:1 to 100:1 and covers the frequencies 150 MHz to 450 MHz, with voltages of up to 5 kV. With this level of performance, these four models are the perfect answer to industrial needs, as emphasised by connection accessories such as "hook-type" and "crocodile clip" probes.

In terms of safety, all models are compliant with standard EN 61010-2-31.

Three of them even qualify for Category III - 600 V/ Category II - 1000 V.

So get the best out of your oscilloscopes with the new **METRIX** voltage probes!

NEW PRODUCT

When aesthetics rhymes with measurement!

Combining the functions of an AC/DC multimeter and ammeter clamp, the METRIX MX 655 and 650 feature the essential functions that every electrician needs. As such, for high currents and voltages (up to 1000 A and 750 VAC / 1000 VDC), they complement the MX 355 and 350.

The new clamp-on multimeters, **MX 655** and **MX 650**, are distinguished by their technology. The first is a **Hall-effect** clamp which can measure AC and DC currents. Also, it features

an **RMS** converter for AC currents and voltages. The MX 650 uses the principle of measurement by transformer so it is intended for measurement of **AC currents only**.

Both are particularly ergonomic; they feature excellent handling and their displays are large and clear. A 42-segment bargraph instantly shows all signal variations, complementing the 4000-count display. The units symbol and a battery level indicator are also included.

Complementary functions

The **MX 655 and 650** are fitted with a **HOLD** key to freeze the display and facilitate reading, regardless of access or light conditions. There is a also "**Peak**" function, capable of capturing 1 ms signals, a "**Min Max**" function, and a "**Rel**" function for relative measurements. This feature will be particularly appreciated for compensating cable resistance.

Another of their advantages is their price, particularly since it includes the measuring leads, the batteries and a carrying bag well as the clamp.

Reader Service No. 10

TECHNICAL SPECIFICATIONS	MX 655	MX 650
AC current	0.05 to 1000 A **RMS** (3 calibres)	0.05 to 1000 A (3 calibres)
DC current	0.1 to 1000 A (3 calibres)	-
AC Voltage	0.5 to 750 V **RMS** (2 calibres)	0.5 to 750 V (2 calibres)
DC Voltage	0.2 to 1000 V (2 calibres)	0.2 to 1000 V (2 calibres)
Resistance	0.2 Ω to 4 kΩ (2 calibres)	0.2 Ω to 4 kΩ (2 calibres)
Frequency (current)	20 Hz to 10 kHz (2 calibres)	20 Hz to 10 kHz (2 calibres)
Frequency (Voltage)	10 Hz to 10 kHz (2 calibres)	10 Hz to 10 kHz (2 calibres)
Diode test and sound continuity	Yes	Yes
Clamping dia.	40 mm	36 mm
EN 61010-1 safety	CAT III - 600 V - Pol.2	CAT III - 600 V - Pol.2

Continuous monitoring of the quality of your electrical networks

This article follows on from the previous Special Report entitled Electrical Energy: why and how should a management system be installed? In which we explained the principles of such a system in detail and ran through the advantages it brings regarding remote index reading, consumption data reduction, results analysis and the "reserves" of corrective action. However, we could not finish without taking up the various closely related functionalities offered by power monitor networks. Monitoring the quality of your electricity is also one of their purposes.

Setting up an energy management system on an industrial or service sector site generally brings a very quick return on investment (often in less than two years). The cases of waste identified, re-assignment of certain activities which require a high level of energy consumption to other and more advantageous time slots, cutting-off of non-critical load, renegotiation of the supply contract and limitation of the number of cases of excess demand immediately generate cost savings for the structure. What is more, the benefits of an energy management system lie in the simplification of tasks, since all data - energy metered, values measured and installation parameters - are collected via a local network, formatted and then stored at a central point. The management and analysis software enables the consumption of each workstation where a metering point has been installed (modular meter or power monitor) to be studied in detail.

But, above and beyond the legitimacy of investing in such energy consumption management equipment, those operating will be able to take advantage of numerous extra functions which make possible to monitor the quality of the network in its entirety and at the most critical points of the site. In other words, the energy management system will contribute to greater **SAFETY** of the installation through detection and recording of abnormal phenomena or technical problems, with the responsibility for solving them remaining with specialised technical teams or even automated devices controlled by dedicated software.

In addition to the metering of the active, reactive and apparent energies consumed, here are the main quantities measured by a power monitor. These measurements can be performed on instantaneous, average, maximum and minimum values:

- **3 x V: single phase-neutral voltages (V)**
- **3 x U: compound phase-neutral voltages (V)**
- **3 x I: currents per phase (A)**
- **Ineutral: neutral current (A)**
- **3 x P: active powers per phase (W)**
- **Ptot: total active power (W)**
- **3 x Q: reactive powers per phase (var)**
- **Qtot: total reactive power (var)**
- **3 x S: apparent powers per phase (VA)**
- **Stot: total apparent power (VA)**
- **F: frequency (Hz)**
- **3 x PF: power factor per phase (0 < PF < 1)**
- **PFtot: overall power factor**
- **THD-U and THD-I: total harmonic distortion in voltage or current, per phase or overall (%)**

These alarm and monitoring functions are an integral part of power monitors. Thanks to high-performance built-in electronics, these instruments display and memorise dozens of parameters on the MV or LV feeders and switch cabinets.

For a consumer who installs power monitors to manage his electrical resources, there is an extra benefit: "Each monitor installed guarantees that any accidental event which may happen will be recorded, and offers the possibility of operating alarms in order to be informed in real time of the quality defects affecting your electricity." More precisely, the power monitor has the following advantages:

- Since the monitor is a unit permanently connected to the network, monitoring is carried out 24 hours a day, 7 days a week and 52 weeks a year (unlike with a portable monitor installed following a suspected or intermittent defect). The phenomenon will automatically be taken into account.

- Installing power monitors on the most sensitive branches of the network actively contributes to increase the safety of the most critical workstations or departments of the plant. (monitoring in this case to be carried out at carefully chosen points).

- The default recorded locally by the monitor will be collected through the local network to the supervisory unit (which manages energy and allocates consumption), but they will also be indicated locally by the monitor itself, which can remain on standby for a manual alarm acknowledgement. In that way, the intelligence remains local too, which is the case with any good centralised system.

Where must the quality of the network be continuously monitored?

In what we shall refer to here as the "company", whether the site in question is an industrial or service sector one, there are numerous nerve centres where continuous monitoring is perfectly justified, either because of the value of the equipment and machines or because of the need to ensure non-stop service.

Those industries working on the basis of continuous production and processing (agri-food, chemicals, petrochemicals, iron and steel, glass-making, etc., to mention only a few) are already particularly aware of the need for systems which monitor the continuity of production in the event of a defect of any type. The fact that the systems currently available are easy to implement and not expensive means that companies of a more modest size or ones whose line of business is more diversified, or even sites occupied by several independent entities, can enjoy the use of their own system. For them, a centralised form of energy management based on power monitors, which in addition offer network quality monitoring functions, is perfectly justifiable. Here are a few examples:

On average voltage outputs:

- upstream monitoring of the different MV loops,
- monitoring of expensive engines connected to MV (compressors, grinders and crushers, centrifuges, pumps, submerged pumps, ventilators and wind tunnels, rolling mills, dockside lifting cranes, etc.).

On the most critical low voltage outputs:

- production lines working round the clock (process),
- computer rooms, clean rooms, telephone switchboards, etc.,
- refrigerating sets, compressors, freezing water generators,
- operating theatres, recovery rooms, etc.
- back-up and energy production equipment such as stand-by generator sets and cogeneration installations, etc.

The philosophy of the monitoring system

As we have just seen, this system is made up of light pieces of "slave" equipment, namely modular energy meters and power monitors, communicating with the "master" (the supervisory unit station) via a local network. The different slaves do not intercommunicate. Therefore, each of them separately monitors the network continuously and records the phenomena locally. The whole set of data is transmitted (remote reading) to the supervisory unit at a later time upon request from the master.

Therefore:

- the intelligence and the memory remain permanently at the measuring point itself,
- there is no real-time monitoring of the quality of the network by the supervisory unit; the latter centralises all the defects which have occurred on the network,
- real-time monitoring is performed at the measuring point.

Recording minimum and maximum values

The power monitor continuously determines and stocks the true rms values of all the parameters measured on the network loop: voltages, currents, frequency, powers (active, reactive, apparent), power factor (cos φ) and the overall rates of harmonic distortion (THD-U and THD-I). It memorises in its registers the minimum and maximum values attained for each of these parameters and constantly updates them. Certain power monitors are equipped with a "real time" internal clock which enables them to "time-and date-stamp" all the events they record.

A few examples of applications using the min./max. data:

Monitoring the quality of the voltage supplied or produced. Before incriminating a particular piece of equipment or a particular point in the installation, it is common sense to make sure that the defect does not come from the energy supplier.

The minimum and maximum values recorded upstream of the installation, as near as possible to the delivery point, must normally remain within the tolerances set by the producer (normally +6% to -10% of the rated voltage). Moreover, a minimum zero value will reveal a more or less brief cut in supply, and its time and date stamping will make it possible to determine the exact moment when the cut occurred.

Testing the capability of the network to stand up to power surges. Should a voltage drop be observed on one of the power monitors, the maximum values recorded for intensity will have to be checked either overall or phase by phase. The simultaneous recording of a $U_{min.}$ and an $I_{max.}$ is proof of an incapability to absorb the load. If there is no synchronism between the $U_{min.}$ and the $I_{max.}$, the problem may be one of voltage supply upstream.

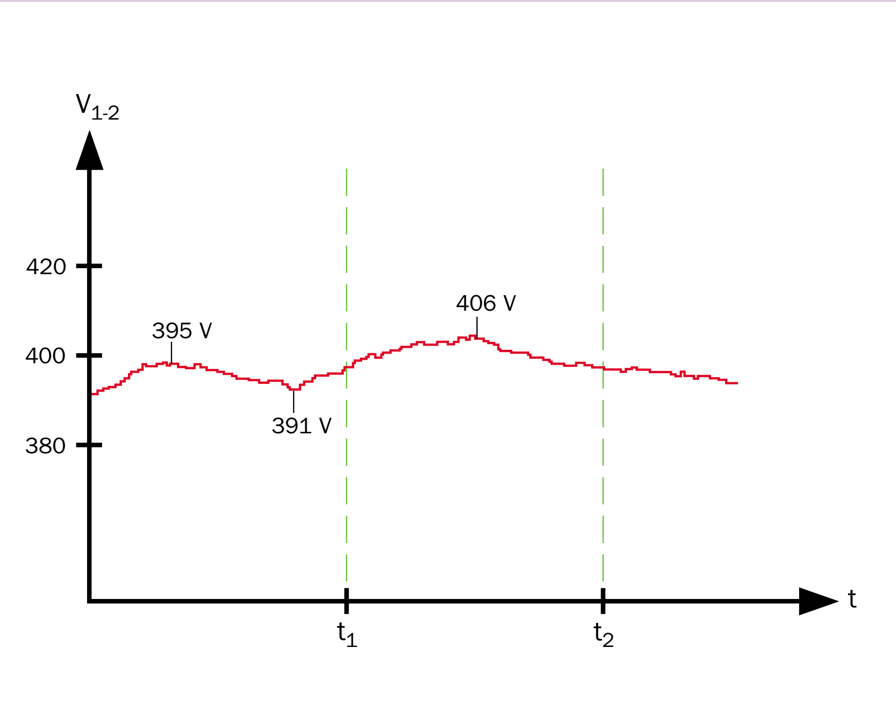
Changes to the load on a loop over the long term. Studying the $I_{min.}$ and $I_{max.}$ over a lengthy period of time will enable underused outputs to be detected. If, for example, we have an $I_{max.}$ of 60 A and an $I_{min.}$ of 15 A for an LV output of 100 A nominal, we will have identified a potentially usable reserve in the context of future dispositions. Should no change be planned, it would perhaps be worthwhile downgrading the equipment (i.e. reduce its nominal range).

Phase unbalance detection. Considerable differences between the $P_{max.}$ of each of the phases attest to a network unbalance.

The installation will be analysed in detail so as to detect the source/sources of this unbalance and re-assign the single-phase loads.

Circuit breaker triggering analysis. Knowing the $I_{max.}$ on each phase will allow you to know if untimely triggering of the circuit breaker is due to an overload on the three phases or else to a defect on one of the phases.

Verifying the appropriateness of the range to the electrical phenomena encountered. By monitoring the $P_{max.}$ on each phase and overall, you will be able to make sure that the transformers, circuit breakers, cables, etc. are correctly calibrated in order to limit the overload and therefore their overheating, the latter being conducive to premature ageing of the transformer.

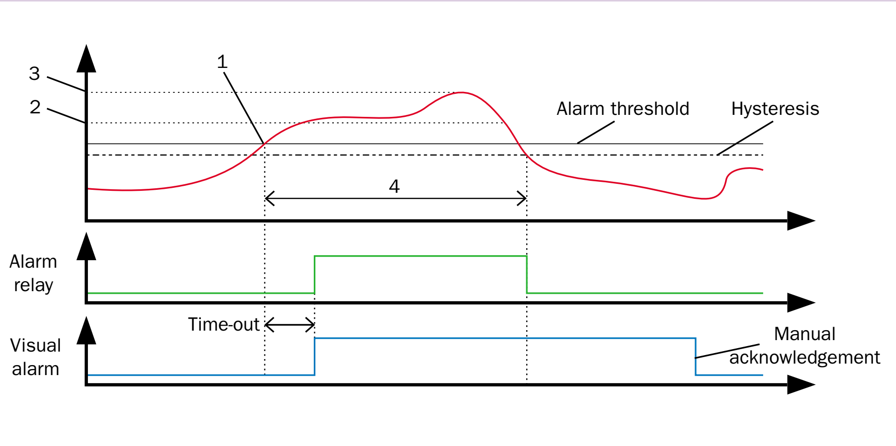


Example of the recording of minimum and maximum voltage values between two phases. If the power monitor is queried at the moment t_1, the subsequent read-out will show an instantaneous voltage of 395 V, a maximum voltage of 398 V and a minimum voltage of 391 V. At the moment t_2, the maximum value indicated by the monitor has moved up to 406 V whereas the minimum value has remained at 391 V.

Detecting no-load running on rotating machines. A too high reactive power ($Q_{max.}$) by phase or overall reveals an engine which is not sufficiently loaded or is running idle.

Order 3 harmonic detection. A current circulating in the neutral conductor reveals the presence of an order 3 harmonic. The minimum and maximum values of $I_{neutral}$ will bring such a phenomenon to the fore if they are strongly discordant.

Harmonics level monitoring. By monitoring the $THD_{min.}$ and $THD_{max.}$, on both voltages and currents, you will reveal the true level of distortions to which the network is subjected in the short or medium term. This will help you to decide whether or not to purchase filtering equipment.



Example of an intensity threshold overshoot on a recdigit POWER power monitor.
1 • date and time recording of the beginning of the event
2 • recording of the average value of the quantity during the overshoot
3 • recording of the maximum value of the quantity during the overshoot
4 • recording of the duration of the overshoot
(enabling the date and time of the end of the overshoot to be determined)

Testing that the compensation batteries for re-phasing are in correct working order.
The minimum and maximum values of the power factor (PF) will be interesting when it comes to regularly making sure of the effectiveness of the capacitor bank when the company has to correct its consumption of reactive energy. Indeed, sometimes a few elements break down, thus weakening the correction. Such a problem may also be due to the presence of harmonics, which cause the capacitors to resonate before being destroyed by rupture. For example, a $P_{min.}$ of 0.75 instead of the usual 0.90 - if it is synchronous with a THD-U peak - is certainly the result of such a phenomenon. The necessary measures will have to be taken in that case to limit the harmonics, or at least their effects.

Programmable alarms

In addition to continuously recording minimum and maximum values, power monitors enable alarm set-points to be introduced on one or more quantities recorded locally. When the quantity exceeds the threshold attributed to it, it will cause a relay contact to open and the event will be recorded with notification of the supervisory unit. The alarm relay can be used to control an audible or visual signalling facility, or to provide data to a PLC or a centralised technical management unit, which will undertake the corrective actions (disconnection of the re-phasing capacitors when the maximum threshold in voltage of the total harmonic distortion is detected in order to limit the risk of these capacitors rupturing, or shutting down a piece of equipment in the event of an alarm on V or U).

A well-designed power monitor will thus be able to record up to the last five overshoots of each quantity. This functionality will be very useful for analysing an output on which you wish to increase the power rating or change the voltage ratio. To do so, a set-point will be introduced on the root mean square values of the current. A set-point could also be defined so as to see the presence of reactive energy as well as the duration of this presence in order to isolate the equipment in question.

Monitoring and prevention

The monitoring functions offered by power monitors connected to the network provide real data, both local and centralised, for the teams whose job it is to carry out the maintenance work on the electrical installation as well as for the people in the company who are in charge of energy. These functions, which can be seen as an added advantage in an overall energy management system, quickly become indispensable. The management system, more or less centralised, can then use them as a support to keep a close watch on a submetering point in the event of an anomaly being observed. Over and above the remote reading of powers of ten and energy metering, the power monitor constitutes a real tool for initial diagnosis. The fact that it is installed permanently in one place means that it can guarantee its user continuous availability of data (e.g. date-and-time-stamped minima and maxima).
The simplicity with which it can be used and the signal sampling frequency correspond to the reality of monitoring a network, and thus make it accessible to most electricians without any particularly specialised knowledge being required. We are still talking about working out in the field here. From the moment the problems become too specialised, it will perhaps be necessary to conduct a series of measurements using a high-performance three-phase network portable analyser, such as those available from the Test and Measurement division of Chauvin Arnoux *(see page 10)*.

A few reminders:

Active power, in watts: $P = U \times I \times \cos\varphi$

Reactive power, in var: $Q = \sqrt{S^2 - P^2}$

Apparent power, in volt-amperes: $S = U \times I$

Power factor $PF = P / S$

CAUTION: It is only in the case of pure signals, i.e. non-distorted sine curves, that the PF is equivalent to the current-voltage phase shift cosine ($\cos\varphi$).

Overall total harmonic distortion (THD), in %:

$THD = \sqrt{H2^2 + H3^2 + \ldots + Hn^2} / H1$

H1 designates the fundamental and Hn the n order harmonic. If H2, H3, ...Hn designate current harmonics, we talk of THD-I, and if they designate voltage harmonics, we talk of THD-U.

ULYS, a new line of energy meters

ULYS meters immediately joined the front ranks of the market. In addition to offering class-1 metrological accuracy, they comply in full with IEC standard 61036, both electrically and mechanically. Finally, the ULYS models are distinguished by their original, contemporary casing design. In other words, a line in harmony with its high-tech performance, using the best that technology has to offer.

The new line of **ULYS** electronic meters provides a simple, fast and economic solution to all submetering requirements. It consists of **6 models** covering every metering need for LV or MV:

- single-phase, double tariff, direct input 90 A under 230 V
- 3-phase, single tariff, direct input 90 A under 100 V to 400 V
- 3-phase, single tariff, direct input on CT .../1 A or 5 A under 100 to 400 V
- 3-phase, single tariff, direct input on CT .../1 A or 5 A under 100 to 400 V
- 3-phase, double tariff, insulated input on CT .../1 A or 5 A under 100 to 400 V
- 3-phase, active and reactive power, insulated input on CT .../1 A or 5 A under 100 to 400 V

4 DIN modules for the "single" model versus 7 for the "3-phase"

Total compliance with IEC 61036

Each of the six models provides class-1 metering accuracy, as per the requirements of standard **IEC 61036** regarding **"static active energy meters"**. Above all, they comply with all the specifications of this standard, which covers not only metrological performance, but also electrical and mechanical meter design. These devices are **self-supplied** by the energy they meter, and even with two phases faulty out of three, metering continues. In mechanical terms, in addition to **direct DIN rail attachment**, the **ULYS** meters are designed to fit perfectly into cabinets and modular home, industrial or service panels. Above all, the screw-type terminal strips are fitted with **terminal covers** designed to receive a "seal" to prevent meter tampering.

A comprehensive interface

The liquid crystal display, **backlit** on the five "3-phase" models, is very easy to read. Instantaneous energy or power are displayed directly over 9 large digits, with the corresponding measurement unit. Several pictograms and one or two metrology LED(s) fully inform the user. The phases present are indicated and a pictogram is displayed in case of wrong connection. Another animated pictogram permanently indicates the metering and the appropriate symbol signals the transmission of a metering pulse to the relay provided for this in the standard set-up *(see further)*.

One important characteristic: the display has a battery power **reserve for reading** the **registers** and **configuring** the meter when it is **not powered**.

For the models intended for 3-phase networks, the KP power ratio, which takes into account the voltage and current transformation ratios, can be entered into the unit directly without having to trigger microswitches.

For example, for 3-phase metering on a station equipped with voltage transformers (VT) 9000/100 V, for a nominal current of 200 A (CT of 200/5 A):

Kp = VT x CT = 9000/100 x 200/5 = 3600

Once this coefficient is parameterised, ULYS will display the energy consumed directly, for a corresponding nominal power:

$P = \sqrt{3 \times U \times I \times \cos\varphi}$,

i.e. $\sqrt{3} \times 9000 \times 200 \times 1 = 3.1$ MW.

Of course, access to the parameterising menu is blocked by the terminal covers sealed under normal operating conditions.

With the standard configuration, you've got it all!

The display does not just indicate total energy consumption. **ULYS** also features a **partial metering mode**, similar to a car odometer. The consumption recorded in Partial mode will be useful in many ways: direct display of consumption between the departure and arrival of a customer (camping, seasonal rentals etc.), periodic consumption of service or industrial customers (reinvoicing of energy in shopping centres, ports, airports etc.), or reassignment of one department's energy charges in the proportion to actual consumption, etc. The word PART will be displayed when in this partial metering mode.

Upon request, **ULYS** will display the instantaneous active power. This function will be welcomed, for example, for verifying the consequences of connection of a new load to the network loop. **ULYS** also keeps in non-volatile storage the maximum value reached by the instantaneous power. On the ETAR model (index of active and reactive energies), display of the instantaneous reactive power and its maximum value reached will also be provided.

Each **ULYS** has a pulse output as standard equipment. The length of this pulse may be parameterised, between 50 ms and 0.5 seconds, so that it can be used on various devices (pulse concentrators , PLC, GTC etc.).

Another special feature: this pulse may be defined before or after the transformation, i.e. weighted or not by the KP coefficient. For a pulse defined on the primary, you can program a load of 10 Wh, 100 Wh, 1, 10 or 100 kWh. If defined on the secondary, the loads will be 0.1 or 0.2 Wh, then 1 and 10 Wh.

Characteristics of the ULYS line

- Total compliance with IEC 61036
- Active energy metering: class 1
- Reactive energy metering: class 2 according to IEC 61268
- 90 A direct input or by transformer, secondary 1 or 5 A on the same model
- Programmable transformation ratio
- Backlit LCD display (on “3-phase” meters)
- Self-supplied, with battery operating reserve for display (5000 x 10 s)
- Configuration and index saved in non-volatile memory
- Pulse output(s) for active (and reactive) energy
- Attachment on symmetrical DIN rail
- Sealable terminal covers
- IP 51 Sealing
- Space requirements: 7 17.5 mm modules (4 DIN modules for the “single” model)
- Pulse: parameterisable weight, either in relation to the primary power of the transformers, or in relation to the secondary power.
  Pulse width adjustable from 50 to 500 ms (by 50 ms steps).
- Standard products, kept in stock, with no accessory or option.
- Pulse output on static relay 100 mA / 230 V_{AC} or 325 V_{DC}

Reader Service No. 11

NEW PRODUCT

Measurement and display stations for three-phase LV electrical networks

Let us welcome the latest member to the family of Enerdis recdigit measurement and display stations. Called NODUS Energy Display, it inherits much from its elder, NODUS Energy Quality, which we have presented many times. NODUS Energy Display is an entry-level product, especially intended for display functions, as its name indicates.

On its clearly readable LCD screen, the **recdigit NODUS “Energy Display”** station provides a permanent display of 22 basic parameters of the installation: energy consumed (active, reactive and apparent), single and compound voltages, intensities, frequency, active, reactive and apparent power, power factor, and the maximum intensities and active power. The perfect product, in both technical and economic terms, for effectively replacing the meters and indicators for a power distribution cabinet or a low voltage feeder. But that is not all! **NODUS ED** is also a smart sensor, capable of informing an energy management system such as **WinThor** via an RS 485 field bus.

In its small 96 x 96 mm casing, only 110 mm deep, **NODUS ED** measures and records some 75 parameters. This information will be transmitted to supervision via the **ModBus/JBus protocol**, on the local network. And on large industrial or service sites, such as hospitals, shopping centres, ports and airports etc. whenever measurement or metering supervision is necessary, **NODUS ED** is the ideal product for consumption monitoring in real time or reinvoicing of energy to the different consumers on the site.
Furthermore, the station is fitted with a **pulse transmitter** to transfer the consumption information to centralised technical management.

For user-friendliness also, **NODUS** takes the prize. Programming – like operation – is easy using the 4 keys on the front panel. And instructions are displayed clearly in the language chosen by the operator: French, English, German or Spanish. Implementation is simple too: connection to screw-type terminal boards, “current” inputs designed both for CTs with 5 A and with 1 A secondaries (selection during programming).
The spring-leaf type clamps, integrated in the casing and coupled to a play take up system, ensure instant, perfect fastening, without even requiring a screwdriver, in a small square standardised DIN cutout.
An entry-level product with no options, **NODUS ED** will be a welcome addition to your electrical panel. And, for more complex needs, its elder cousin the **recdigit NODUS “Energy Quality”** station is available with the following additional functions:

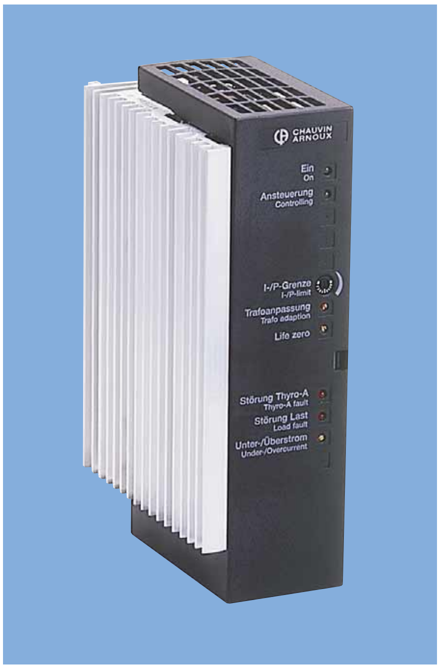
- four-quadrant active/reactive metering (versus two for NODUS ED)
- 98 parameters measured, 32 displayed
- qualimetric measurements: THD-U, THD-I, neutral current
- relay alarm output
- amber backlit display

Reader Service No. 12

A much more constant heating temperature

With the THYRITOP 3 "QTM" thyristor-equipped power controller, companies which use heating resistors with a very low degree of inertia - such as those in infrared lamps - will find an undoubted advantage in this new product: the perfect balancing of useful heat emissions.

The infrared lamps used for drying paints require very constant heating power control.



An installation assistance service and specific on-site training are offered for the Thyritop 3 "QTM".

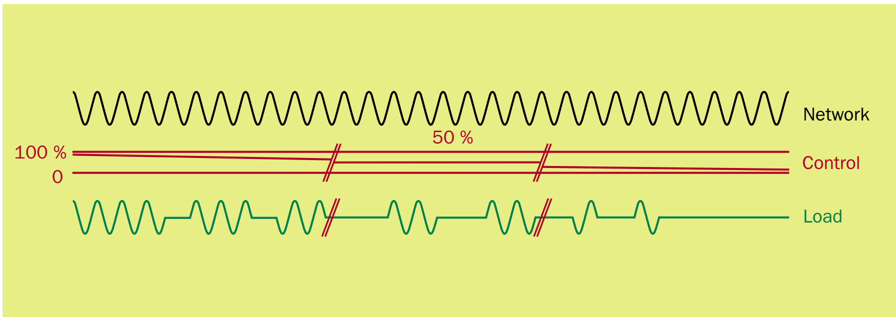
First of all, a reminder about the **Thyritop 3**: this static controller commutates the high powers necessary for industrial processes: from 30 A to 280 A for resistive and inductive loads, in single-phase and three-phase operating modes, interruption of 2 or 3 phases, at 230 V, 400 V or 500 V.
It has numerous functions: U_2, I_2 and P controls; I, U and P limitations; synchronisation; alarms; etc. The **Thyritop 3**, in its various existing versions, operates in syncopated wave train mode (Takt mode) or by phase angle (Var mode).

QTM, a new operating mode

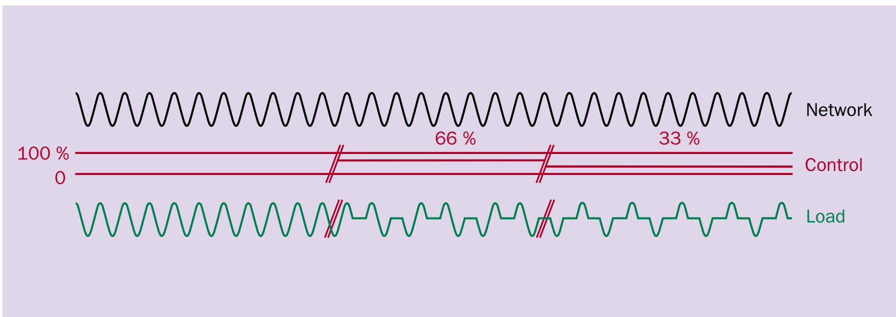
The **Thyritop 3 "QTM"** has a new operating mode, the **QTM** (or **Quick Takt Mode**). This mode enables loads with low degrees of inertia, such as infrared lamps, to be controlled while perfectly balancing useful heat emissions. It is very similar to the "phase angle" mode minus the drawbacks of the latter, since commutation is carried out at voltage zero and no DC component is generated.
The principle consists in commutating 10 ms half-alternations according to a cycle time which is twice as quick as the Takt mode, which has a time base calculated on a full 20 ms alternation; and this goes for the whole set-point range from 0 to 100%.
Consequently, the temperature of the heating element is much more constant. And for the user, there is an improved degree of comfort, with the glittering of the infrared lamps becoming practically imperceptible to the eye.
Very obviously, this controller - which is equipped with a microprocessor - prohibits the presence of the DC component by adjusting the same number of positive as negative alternations over a set calculating period.

An algorithm built into this controller enables the variations in useful heat caused by amplitude variations in the electricity network to be eliminated.
Lastly, it is important to be able to "intersynchronise" several **Thyritop 3s**, thereby avoiding too strong inrush currents. This function (with synchronisation of up to 16 controllers) is available as standard on the **Thyritop 3"QTM".**

Reader Service No. 13



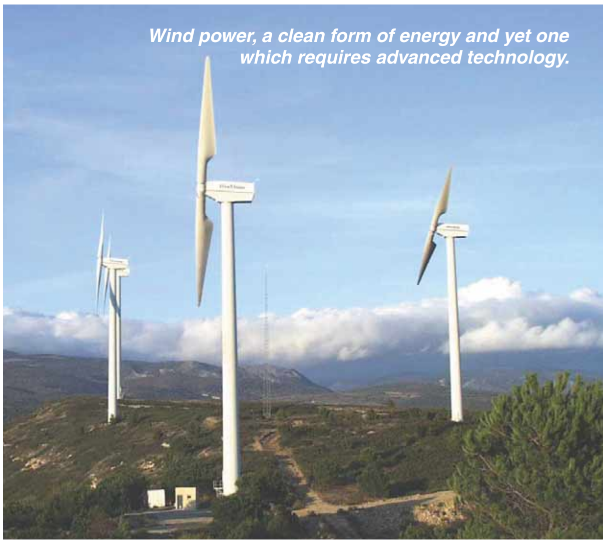
Syncopated wave train operating mode or Takt mode



Syncopated wave train operating mode or QTM mode

Power control gets a breath of fresh air

Pyro-Contrôle Chauvin Arnoux has developed an innovative solution for controlling an assembly made up of a wind turbine, a battery charger and a water tank heating system.



Wind power, a clean form of energy and yet one which requires advanced technology.

This equipment which nowadays equips low-power wind turbines (approx. 10 kW) was developed in collaboration with the metering division of EDF (the French national electricity company) in Carcassonne.
This wind turbine drives an alternator which, after rectification, provides current for charging a battery made up of thirty-two 1.5 V cells, i.e. 48 V. An inverter then transforms this energy into a 230 V (50 Hz) specific local network, destined for a remote farm, for example. When the battery is full, the small built-in automaton switches the electric energy to a hot water tank resistor; this is the so-called "overflow" function.
The energy used to be switched very suddenly, "on-off", this has the major drawback of straining the wind turbine's mechanics. With the solution developed, the heating resistor is now energized progessively and the quantity of energy applied (5 heating speeds) is proportional to the wind speed.

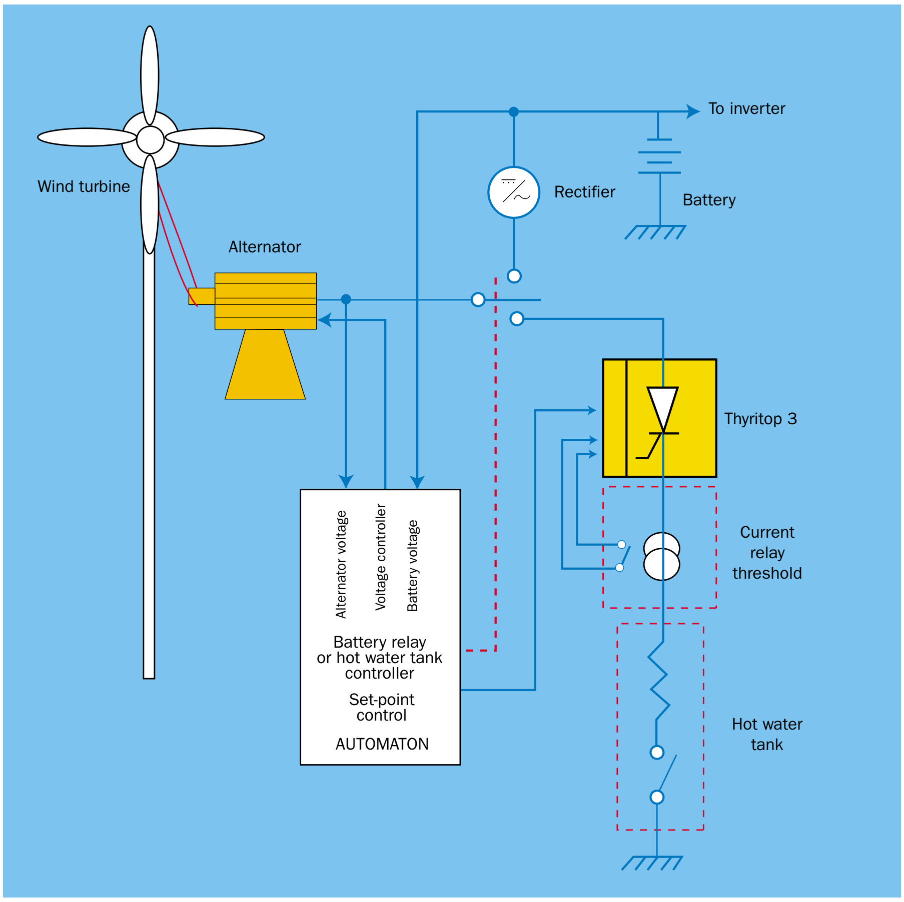
Problem posed

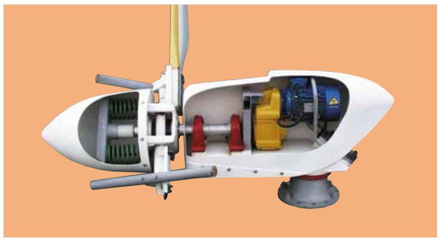
This wind turbine activates an alternator which supplies current to charge the battery. This device already possesses advanced functions owing to the small automaton which manages the different parameters. There are two possible cases in which the wind turbine can operate:

- **Case 1:** there is some wind; the battery is not full, so it charges itself. The speed at which it gets charged depends on the wind speed and the charging level.
- **Case 2:** there is some wind; the battery is fully charged, and the electric energy is then re-directed to heating the water tank. The drawback of this system is that the water heating operation takes place on an "on-off" basis (2 kW or nothing), with a switch in a very short space of time, and therefore a sudden strain for the wind turbine's mechanical components. Moreover, it is impossible to anticipate the restart of the tank's safety thermostat, meaning another operation taking place on an all-or-nothing basis.

Expected improvements

Have several heating speeds which will be determined by the wind speed. The automaton will deal with calculating the deciding factors for commutating one of these speeds. The changeover between two heating speeds should happen very gradually. Integrating the heating set-point should take several seconds.
At the moment of engaging a restart after the power supply to the heating resistor has been cut off by the safety thermostat, the set-point will imperatively have to be forced to 0% of heating, then gradually increased until reaching the requested value. This system should be able to operate in a "phase angle" mode.





Cross-section of a wind turbine from left to right: blade feathering (spring system), rotary axis, reducer and alternator.

The chosen solution

Two **Chauvin Arnoux** products meet the expected criteria and represent a reliable solution for optimising this wind turbine's energy production. These products are:

- a **Thyritop 3**, a power controller equipped with thyristors - special wind turbine version - with a single-phase 230 V power supply for a gradual control of the heating resistor.
- a **RMPI current relay**, mounted in the threshold detector, to check whether or not the heating relay is being powered and the set-point is forced to 0% when a restart is engaged.

Pt 100s and insertion pyrometers for chemical processes

Pt 100 sensors used in conditions of high pressure.

Because of the temperature ranges they require, chemical and pharmaceutical processes authorise the use of Pt 100s. The chemical transformations most often take place between 0 and +200°C, less often between +200 and +400°C, and rarely beyond. Pt 100s are preferred to thermocouples since they are less sensitive to deviation and more accurate.

The special requirements of processing industries, in particular those involving chemicals, often require the use of Pt 100s in process pyrometers for temperature measurement.

The city of Lyon's historical position as a chemical centre favoured the development of such know-how at **Pyro-Contrôle Chauvin Arnoux.** This article explains the principle of measurement using Pt 100s and its implementation in process pyrometers.

Pt 100 temperature measurement

A. Platinum resistance thermometer

Pure platinum has an electrical resistance which varies according to temperature. This law is expressed in the form: $\mathbf{R = Ro.(1 + At + Bt^2)}$.

Measuring the resistance of a platinum wire is thus a way of finding out its temperature and therefore the temperature of its environment.

In practice, most platinum resistance thermometers are made to obtain a nominal resistance of 100 Ω at 0°C; for that reason and for convenience they are called Pt 100s.

The IEC 751 standard defines the characteristic temperature/resistance relations the components must conform to. It also defines a scope going from -200°C to +850°C. But in practice, the operating conditions are very often lower than 450°C. Over 450°C, special assembly precautions must be observed in order to prevent any pollution of the platinum filaments.

B. Interchangeability class

Resistance thermometers must observe a maximum deviation in relation to the standard.

- For **class A**,
  maximum difference of **0.15°C +0.002.T**
  (where T is the measured temperature)
- For **class B**,
  maximum difference of **0.30°C +0.005.T**

C. Connection

To measure the resistance of a Pt 100, it must be connected to a measuring instrument.

This instrument must be very sensitive because resistance variations are low (40 mΩ for 0.1°C).

There are three types of connection.

- 2 wires: in practice, 2-wire connections are avoided since they degrade the class of the sensor.
- 3 wires: measurement by Wheatstone bridge.
- 4 wires: 2 wires for voltage measurement, 2 wires for current measurement.

The insulating resistance between each output and the outer metal sheath of the sensor must be higher than 10 MΩ for a operating temperature between 100 and 300°C.

D. Technology

To make the Pt 100, two technologies are currently used. In the first, a platinum filament is wound around a ceramic core and assembled inside a cylindrical ceramic body. The external dimensions include diameters of 1 to 4.5 mm, for lengths of 10 to 40 mm.

In the second, a platinum film is deposited on a ceramic substrate, using a vacuum deposition technique. The thicknesses are approximately 1 mm, for a length and width of about 2 x 8 mm.

E. Accuracy

The Pt 100s are very accurate and are less subject to deviation than thermocouples.

Process pyrometers

If the Pt 100 is used to measure temperature, the assembly into which it is integrated is designed to protect and transmit the value of its resistance to a zone where the measurement will be analysed.

A process pyrometer is generally made up of three components.

- First, a **protector**, most often a **thermo-well drilled** into the material. The metal and the dimensions of the protector are determined in accordance with the requirements of resistance to corrosion, abrasion and mechanical resistance to pressure.
- Then, a **sensitive element** which ensures the connection of the Pt 100 to the terminals or the transmitter in the connection head. Often this sensitive element is removable, to simplify maintenance
- Finally, there is a packing gland for connecting the installation instrumentation cables.

Depending on the type of atmosphere, explosive or not, the assembly may be assembled in accordance with the “Intrinsic safety”, “Explosive safety” or “Extended safety” standards.

The pyrometer is connected to the process by sealed threading or by flange. When measuring a temperature gradient, for example in a chemical reactor, multipoint pyrometers are used: several sensitive elements are stacked then connected to an external casing *(photo below).*

Authorised multipoint pyrometer casing Intrinsic safety

Reader Service No. 14

Extremely simple to operate

Tailer-made for process applications, the **STATOP 4860** temperature controller comes with a self-adaptive/self-adjusting PID and fuzzy logic. As a standard, this latest addition to the STATOP range meets most of the control applications in thermal processes.

Reader Service No. 15

Take temperatures from a distance

It's possible with these new **infrared thermometers.** Aim, press the trigger, and get the required information in an instant: mean temperature, maxi, mini, relative ect. Model **C.A 880**, with its visible laser sight, provides perfect handling flexibility. All the characteristics are detailed in this two-page leaflet.

Reader Service No. 16

Three compact laboratory power supplies

This colour recto-verso shows up all the characteristics of these three **Metrix** power supplies, the **AX 503, 502 and 501**, respectively 3, 2 and 1 outputs (2x30 V/2.5 A - 1x5 V/5 A). It explains how their exclusive feature, a high-yield ring transformer, avoids the need for a fan, resulting in a substantial gain in volume and weight, with very low radiation.

Reader Service No. 17

Winthor energy management system

The **Enerdis** communicating product line offers solutions suited and adaptable for all applications for supervision of electrical networks, for control and optimisation of consumption. The **WinThor** system, using an RS 485 ModBus/JBus field bus is capable of overall and point by point analysis of the electrical network. This 6-page document, presents the advantages of the system.

Reader Service No. 18

Reader Service No. 19

Electrical safety: know how to insulate yourself!

With the **C.A 6541** and **6543** controllers, discover the comfort, safety and thoroughness of a new generation of **megohmmeters** designed for demanding campaigns in the field, that you can analyse on your computer. Discover in this document the many possibilities of dielectric insulation measurement analysis, indispensable for your safety and the operation of your machines.

Reader Service No. 20

In the heart of the flame

With the **C.A 5260**, take advantage of a device specially designed for climate engineering specialists. Its µA calibre optimises the ionisation current during adjustment of gas boilers. The unit is delivered standard with a K couple sensor, for temperature measurements from –40 to 1000°C. Two indispensable pages to know everything on this digital multimeter-thermometer.

Temperature calibration equipment and services

In this 12-page brochure, discover the "calibration" proposal by the Chauvin Arnoux **Temperature M & C Division** calibration sensors, fixed-point cells, calibration ovens and baths, and an authorised Cofrac temperature laboratory for calibration of your sensors and temperature measurement instruments.

Reader Service No. 21

All for one and one for four! (contd.)

After the range of **analogue oscilloscopes**, here come the digital and mixed units. Four devices, with bandwidths of 40 to 150 MHz, are presented in this new 6-page document. This means you can assess their performance: up to 200 Msam/s sampling in a single sweep; input 1 mV at 20 V/div...but also additional functions, such as FFT, harmonic analysis or communication options.

Reader Service No. 22

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Reader Service No. 23

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