# CONTACT

No. 15 MEASUREMENT • NEWS AUTUMN 2000

**Test & Measurement Division**

*Microwave measurements*

**Power Measurement & Control Division**

*Why and how should an energy measurement system be installed?*


**Temperature Measurement & Control**

*A review of temperature process control*

CHAUVIN ARNOUX

## CONTENTS




*Front cover :*
*Telecommunications relay*


TECHNICAL INFORMATION JOURNAL

Communication Dept.
190, rue Championnet
75876 PARIS Cedex 18
FRANCE

Tel: 33 1 44 85 44 85
Fax: 33 1 46 27 73 89
http://www.chauvin-arnoux.com
e-mail: info@chauvin-arnoux.com

Distributed free



AUTUMN 2000

PUBLISHING DIRECTOR
Claude GENTER

MANAGING EDITOR
Anaïde DER AGOBIAN

EDITOR
Olivier LOMBAERDE

CONTRIBUTORS
Didier BISAULT
Jean-Pierre CARITEY
Jean-Yves FABRE
Alain JOSSE
Pascal PERNIN
Laurence PETITGUYOT
Rachel OUTRAM

TRANSLATOR
Kevin WILLIAMS

GRAPHIC DESIGN AND LAYOUT
Pastelle Communication
Tel: 33 1 45 45 22 02


*For further information, contact your local agency, or our export departments in France*


TEST & MEASUREMENT DIVISION
Tel: 33 1 44 85 44 86 - Fax: 33 1 46 27 95 59
e-mail: export@chauvin-arnoux.fr

POWER MEASUREMENT & CONTROL DIVISION
Tel : 33 1 47 46 78 85 - Fax: 33 1 47 35 01 33
e-mail: info@enerdis.fr

TEMPERATURE MEASUREMENT & CONTROL DIVISION
Tel: 33 4 72 14 15 52 - Fax: 33 4 72 14 15 41
e-mail: export@pyro-controle.tm.fr



*To receive sales literature, fill out the Reader Service form between pages 12 and 13.*


## EDITORIAL

# STRONGER AND STRONGER LINKS WITH THE WORLD OF EDUCATION

A permanent feature of our policy, the ties which bind us to the world of education and teaching has just been strengthened by the creation of the Measuring Club (Club du Mesurage in French).

The Measuring Club's first meeting took place on 11 May this year in Annecy, the town in France where Metrix was founded and with which the company has always been associated, with 30 or so key figures from the French state education system present. This club, jointly organised and lead by teachers and Chauvin Arnoux's T & M Division, aims to become a real forum where the worlds of education and industry can exchange ideas and opinions. The results of the first round of exchanges will very soon be passed on to all teachers through a new periodical called the Cahiers de l'Instrumentation (Instrumentation Journal).

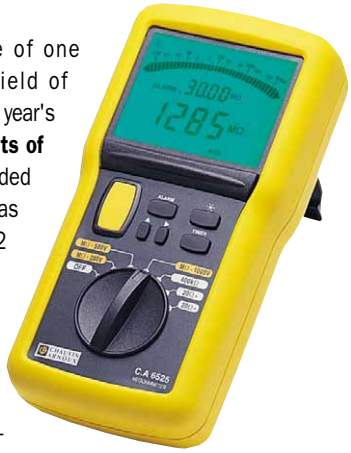
With ever more creativity and ever greater technical know-how, each of the three product divisions – T & M, Power M & C and Temperature M & C – design their appliances with the utmost concern for safety and user comfort. Therefore, these professional instruments are also perfect tools to use during training courses, not only for future technicians and engineers, but also for pupils in primary and secondary education.

Always striving to provide help to teachers, Chauvin Arnoux offers a number of teaching aids, among which are the new Metrix posters, technical data sheets, lab work media, but also dedicated educational measuring benches, in particular the latest to come out for energy metering and microwave measuring.

The increase in knowledge and the fact that this knowledge circulates truly expand and bolster creativity, and are sources of both individual and collective development. Contributing to greater wealth in the form of human capital is also one of Chauvin Arnoux's objectives, the company being aware that "the future is being built now" by accumulating and putting to use both past and present expertise. Consequently, we are proud of the role that we are able to take on within the world of teaching and education, which has been the case for several decades and will continue for a long time to come.

**Axel Arnoux**
**Vice-president**

# A medal in England



Every 2 years, in March, Birmingham is the venue of one of the most important British exhibitions in the field of electricity: **Electrex**. Chauvin Arnoux won renown during this year's show with a 50m² stand and by taking part in the **"Products of Imagination Awards" -** a competition where prizes are awarded to the best products exhibited, and which could be described as a "prize for innovation". Among the 64 products nominated, 12 were selected from the different fields linked to electricity (i.e. connectors, relays, etc.) and only 3 were awarded prizes in the measurements sector.
A prize was, once again, awarded to Chauvin Arnoux. This time, it was the megohmmeter **C.A 6525** *(photo opposite)* which hit the jackpot. Proof that, as regards insulation monitoring, there is general agreement as to the quality of Chauvin Arnoux's instruments.

# Manumesure in Belgium

**Manumesure,** the group's service company, is continuing to expand outside metropolitan France. In June of this year, it opened a new agency in **Brussels,** and it is **Mr Patrice Vigneron** who is in charge of running the agency.
Covering all of Belgium, this new structure will in particular be responsible for housing the group's after-sales service, as well as repairing, calibrating and carrying out maintenance work on professional electrical equipment of all brands.

*Mr Patrice Vigneron*

***Manumesure Brussels***
*Avenue Van Volxem 176 - 178*
*1190 Brussels 19*
*BELGIUM*
*Tel: 32 23 44 84 39*
*Fax: 32 23 44 87 92*

# EMC accredited by the COFRAC

At the beginning of this year, **the Electromagnetic Compatibility (EMC)** test laboratory on the premises of our **site in Annecy, France,** was awarded an **accreditation** by the Testing Section of the French Accreditation Committee **(COFRAC)** numbered **1-1036**.

This accreditation covers most immunity and emission tests currently required for marking in compliance with the following generic standards:

- NF EN 50081-1 of June 1992
- NF EN 50081-2 of December 1993
- NF EN 50082-1 of January 1998
- NF EN 50082-2 of June 1995

The test laboratory in Annecy carries out those electromagnetic compatibility tests which are necessary for developing new **Metrix and Chauvin Arnoux** brand appliances.

# Should anyone wish to meet us...

During the second half of this year, we will be taking part in the professional trade fairs and exhibitions shown below. An ideal time for listening and conversing, we will be happy to show you our very latest innovations and get your opinions in person.

| | | |
|---|---|---|
| 24/10 - 28/10 | MATELEC | Madrid - Spain |
| 07/11 - 11/11 | BIAS | Milan - Italy |
| 21/11 - 24/11 | ELECTRONICA | Munich - Germany |
| 22/11 - 26/11 | EDUCATEC | Paris Porte-de-Versailles - France |
| 11/12 - 15/12 | ELEC | Paris-Nord Villepinte - France |

# Trimaran 2 approved

**It is with much satisfaction that Chauvin Arnoux has received approval for the Trimaran 2, our new energy meter, from the Centre of Technical and Electrical Expertise belonging to EDF-GDF Services (EGS - French national electricity and gas companies).** The meter is currently being displayed in all EGS's regional centres.
Designed to meet the new requirements of the EDF's industrial customers, **Trimaran 2** makes implementation of the "Tarif Vert Émeraude" (Emerald Green Rate) possible, and offers a number of other possibilities.
One of the principle innovations of **Trimaran 2**, the 'prism concept', consists in dissociating the meter itself from the tariff application. In other words, a **Trimaran 2** meter is not fast-set in its possible uses and in the changes that can be made to it. Likewise, this principle makes it possible to offer a product suited to the globalisation of markets since it is open to all tariff changes. This product, available all over the world, is known as a **Prismeter** – the **Trimaran 2** being specific to the EDF.

*Reader service No. 1*

# Network analysis at the tip of a light pen

***Efficient and brand new, the C.A 8350 is a touch screen-type electricity network quality analyser, whose power and user-friendliness are similar to that of a portable computer. The latest in Chauvin Arnoux's range of power and interference testers, the C.A 8350 has already received the best possible reception from a technically highly specialised and particularly demanding client group.***

If you were looking for an appliance that is simple to use, user-friendly and capable of the best in terms of network analysis, in short an all-terrain and exceptionally gifted appliance, look no further! You have found it! Here is the first complete touch-type **interface three-phase analyser** (see box for the list of parameters measured).

## Parameters measured

**Voltage and current**
- Actual and average effective values
- Peak value and peak factor

**Power**
- Total active power and active power of the fundamental
- Total reactive power and reactive power of the fundamental
- Apparent power and power factor
- Harmonics: current, voltage, active and reactive power, and reactive distortion power

**Harmonic breakdown to the 50th order**
- Voltage: measurement of absolute Hn and of Hn / fundamental
- Current: measurement of absolute Hn and of Hn / fundamental
- Phase shift of each harmonic
- Overall and order-by-order THD (total rate of Hn distortion)
- Recognition of the direction of each harmonic order

**Spectral analysis of inter-harmonic frequencies**
- Active, reactive and apparent power
- System with positive phase sequence component, negative phase sequence component and zero-sequence component
- Phase shift
- Absolute value of voltage and current for the complete spectrum
- Voltage and current vector graphics

**Flicker**
- Measurements in compliance with EN 60868, EN 61000-3 and IEC 60868: Short (Pst) and long-term (Plt) flicker measurement
Average flicker on each phase
Max. instantaneous flicker

**HV network analysis**
- "Short-circuit" events recording (fault recorder)
- Voltage symmetry
- Power and frequency oscillation

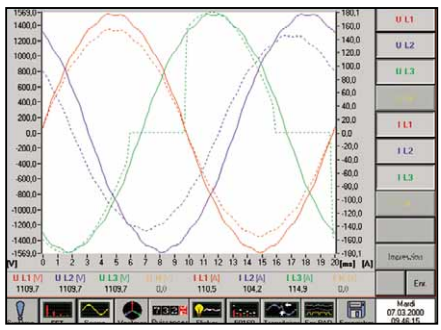
**And the whole analysis according to EN 50160**

## An abundance of functions

Built into a sturdy casing suitable for a building site, the **C.A 8350** is designed to be used out in the "theatre of operations". The safety terminal, on the right-hand side of the appliance, makes it possible to connect the different voltage and current leads (5 A direct input, 1,200 A clamp sensors or even 3,000 A **AmpFLEX**) and the power supply cable.

On the front panel, there is no switch to disconcert the user. Only a potentiometer allows the display contrast to be adjusted. The sober appearance of this face makes the lavish user interface stand out. As soon as the appliance is started up, and at any moment, all the functions available are displayed right at the bottom of the screen:

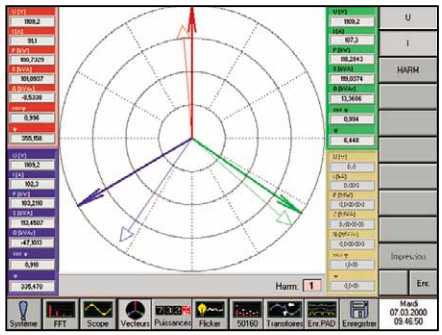
- General configuration
- Input connection and parameterisation
- Harmonic Analysis
- Oscilloscope mode (photo 1)
- Vector graphics (photo 2)
- Energy and power monitoring
- Flicker rate measurement
- Voltage monitoring
- EN 50160 summary chart
- Transients recording
- Data logging



**1. 8 trace oscilloscope**
***4 voltages and 4 currents automatic activation, automatic scaling***

## Simple and safe to use

Using this device is exceptionally intuitive. All programming and reading is carried out simply via the **touch screen**, within the user-friendly context of the Windows' operating system. To this end, a USB connector allows both a keyboard and a mouse to be connected. Data is stored in the internal memory and offers 6 months of autonomy. The software (delivered with the appliance, as is the USB cable) makes it possible to generate and edit reports on data analysed in chosen time windows in the language one chooses (English, French, German, Italian or Spanish). As far as safety is concerned, the **C.A 8350** also offers the best level of conformity with the IEC 61010-1 600V cat. III standard.



**2. Vector graphics: Voltage, current and harmonics. Automatic scale, connection and phase direction check, summary of measurements**

## And open-ended!

The basic configuration automatically includes the FFT analysis functions and oscilloscope mode. The other functions can be obtained as optional extras when the purchasing order is placed, or they could possibly be added later on as an open-ended requirementof the user. By the way, on the subject of it being "open-ended", we have not yet mentioned that the **C.A 8350** is designed to respond to the needs of tomorrow and the day after: there will be no problem in adapting it to future standards in the field of electricity network quality. As we said, it is an exceptionally gifted appliance!

*Reader service No. 2*

NEW PRODUCT

# Single, dual or triple output Laboratory power supply units

***With these 3 new power supply units, METRIX has added lightness, economy and a modern style to the widely acknowledged solidity of its previous models. The AX 501, AX 502 and AX 503 - with 1, 2 and 3 channels respectively, are indeed equipped with a high-efficiency ring-shaped transformer. This technology does not require installation of a ventilator, hence a sizeable gain in volume and above all in weight. Moreover, again thanks to this new technology, they produce a very low level of radiation.***

With particularly painstaking efforts taken with regard to safety, these power supply units are equipped with mechanisms which electronically limit current in the event of short circuits, and which control the temperature in the event of overloading and overheating. The outputs and mains are separated by double insulation, and the current is discharged via dual well-type safety terminals.

## As for performances...

These 3 new power supply units have either one or two 30 $V_{DC}$ / 2.5 A adjustable outputs.
As regards the additional output, available on the **AX 503,** its voltage can be adjusted between 2.7 V and 5.5 V with a fixed current of 5 A. Furthermore, for the two- and three- channel models, it is possible to couple the two main outputs in tracking ("slaved"), series or parallel modes. In this way, you can set up to 2.5 A in 60 V or 5 A in 30V depending on the coupling mode.

## Two colours for better visual interpretation

Thanks to their different colour displays, the user can tell the difference, with a single glance, between the currents and voltages of the two main outputs: the voltage levels are shown by the green LEDs and the current levels by the red LEDs, all of which are particularly luminous.
With their attractive and bright front panels, they will be a nice sight in your electronics laboratories.

*Reader service No. 3*

| Technical Characteristics | AX 503 | AX 502 | AX 501 |
|---|---|---|---|
| **Number of Outputs** | **3 outputs** | **2 outputs** | **1 output** |
| **Voltage regulation** | | | |
| Output 1 / Output 2 | 0 to 30 $V_{DC}$ / 0 to 30 $V_{DC}$ | 0 to 30 $V_{DC}$ / 0 to 30 $V_{DC}$ | 0 to 30 $V_{DC}$ / - |
| Resolution | 100 mV | 100 mV | 100 mV |
| Basic Accuracy | 0.5% rdg ± 1 pt | 0.5% rdg ± 1 pt | 0.5% rdg ± 1 pt |
| Residual ripple | < 1 mV RMS | < 1 mV RMS | < 1 mV RMS |
| Output 3 | 3 and 5 VDC (2.7 to 5.5 VDC) | - | - |
| **Current regulation** | | | |
| Output 1 / output 2 | 0 to 2.5 A / 0 2.5 A | 0 to 2.5 A / 0 2.5 A | 0 to 2.5 A / - |
| Resolution | 10 mA | 10 mA | 10 mA |
| Basic Accuracy | 0.5% rdg ± 1 pt | 0.5% rdg ± 1 pt | 0.5% rdg ± 1 pt |
| Output 3 | 5 A (fixed) | - | - |
| Protection | Short-circuits: electric current limitation, LEDs in channels 1,2 or 3 to indicate limits. Heating: temperature control | | |
| **Stability in case of variation** | | | |
| Mains of ± 10% | ±0.03% rdg + 2 mV | ±0.03% rdg + 2 mV | ±0.03% rdg + 2 mV |
| Load of 0% to 100% | ±0.02% rdg + 5 mV | ±0.02% rdg + 5 mV | ±0.02% rdg + 5 mV |
| **General Characteristics** | **AX 503** | **AX 502** | **AX501** |
| Displays | 3 digits – green (U) and red (I) LEDs – outputs 1 and 2 | | 3 digits – green (U) and red (I) LEDs |
| Coarse and fine adjustments | Outputs 1 and 2 | Outputs 1 and 2 | Output 1 |
| Wiring termination | Dual well-type safety terminals – Ground: male socket for safety yellow / green. | | |
| Power supplies | 110 $V_{AC}$ ± 10% / 60 Hz 230 $V_{AC}$ ± 10% / 50 Hz | | |
| Dimensions (L x H x D) | 225 x 120 x 270 mm | 225 x 120 x 270 mm | 225 x 120 x 270 mm |
| Weight | 6 kg | 4.5 kg | 4 kg |
| Safety | CEI 61010 – Class 1 – Pollution 2 | Output: Cat.1, 100 V | Power supply: Cat. II, 300V |

# An "all fire all flame" multimeter

***With the C.A 5260, the renowned Chauvin Arnoux C.A 5200 multimeter series is expanding again. This time, the multimeter in question is a dedicated one, specially developed to be used in climatic and environmental engineering. Heating engineers and specialists, self-employed qualified plumbers, boiler installers, laboratory technicians and those in charge of maintenance in the field of climatic and environmental engineering will be the people principally concerned by this new tool.***

Specially developed to be used in climatic and environmental engineering, the **C.A 5260** multimeter-cum-thermometer offers the best in multimeter measuring. Robust and efficient, this appliance has all the functions required for flame tests as well as for use in measuring temperature, voltage, current, continuity, resistance, capacity, etc. In short, a real multimeter designed for professionals, to use "when things are getting heated".

Its compact casing means that it offers a perfect grip and fits easily into your pocket. Handling errors are avoided due to the selection of the nominal ranges, which in this case is automatic. The large back-lit 4,000 count display is truly comfortable for your eyes to read. Connected to the flame detector of a gas-fired boiler, the **C.A 5260** enables combustion level setting to be fine-tuned *(see box)*. Via its adapter for a K-type thermocouple *(supplied with the appliance)*, the **C.A 5260** also enables temperatures between –40 and +1,000°C to be measured. The temperature is then read directly in °C or °F.

Owing to its numerous functions, the **C.A 5260** is both a multimeter and a thermometer, dedicated and at the same time multifunctional: voltage up to 600 V AC/DC, resistance up to 40 MΩ, capacity up to 4,000 µF, continuity test, diode test, min. and max. recording, HOLD key for keeping the value displayed on the screen, and, of course, compliance with the CEI 61010-1 CAT. III 600 V safety standard.

*Reader service No. 4*

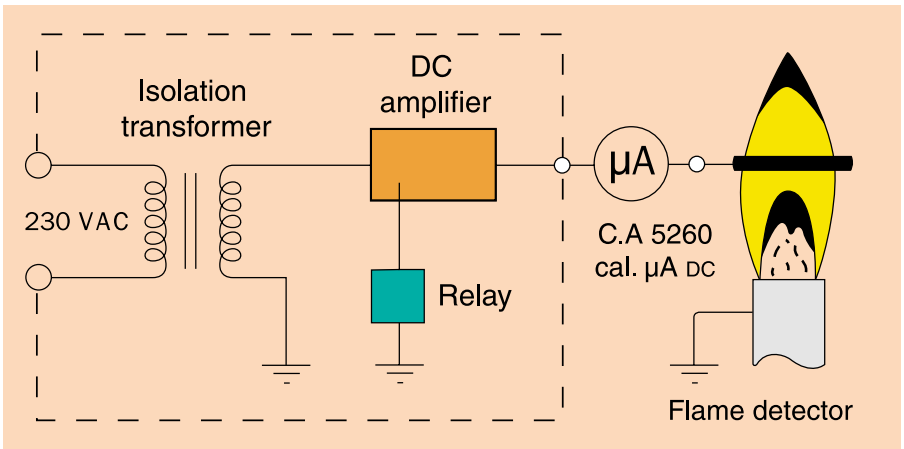
## Setting and adjusting the combustion level on a gas-fired boiler by means of an animating electrode

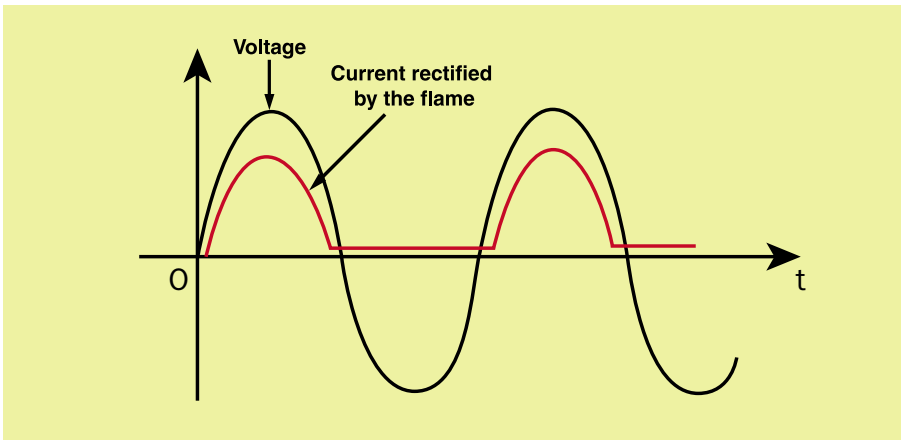
### *Principle*

**If a dipole formed by two electrodes with very different surfaces is placed in an ionised medium, such as a flame, the system will behave like a current rectifier. In that way, if this dipole is supplied with an alternating voltage, the circulating current becomes a single-alternation rectified current *(see graph)*. Application of this principle in a gas-fired boiler, with an amplifier controlling a relay, forms a device called a "flame relay".**

### *Handling*

**So, the C.A 5260, set to the µA DC measurement, should be connected to the flame detector and then an optimum combustion level setting corresponding to the maximum ionisation current should be fine-tuned.**



# Microwave measurements

***Omnipresent, microwaves are a part of our technological everyday life. With the exception of a few experts, they are, however, little known to many of us. Because of this, we deemed it necessary to write a special report on the subject. What is a microwave system, what quantities characterise it, and how do we measure these quantities? We will attempt to give these questions simple answers, even if it means being sometimes simplistic, in order to be understood by everybody.***

The rapid development of microwaves originated with radar. The latter was developed in the USA during the Second World War for military purposes, in order to locate the enemy plane squadrons as early as possible, and give them time to organise an effective defence. Today, microwaves are used in diverse and varied areas of activity. Here are the best-known:

- aeronautics, with radar and radio altimeter,
- telecommunications, with radio relay systems,
- cellular radiotelephony, with the mobile phone,
- security and safety, with alarms: detecting cases of overstepping and volumetric protection
- the food-processing industry, with microwave heating
- trading, with measurement of the degree of moisture carried out without the use of a contact element, a process also used in the pharmaceutical industry, the food industry and in food grain storage
- level or distance measurements carried out without the use of a contact element are other recent industrial applications.

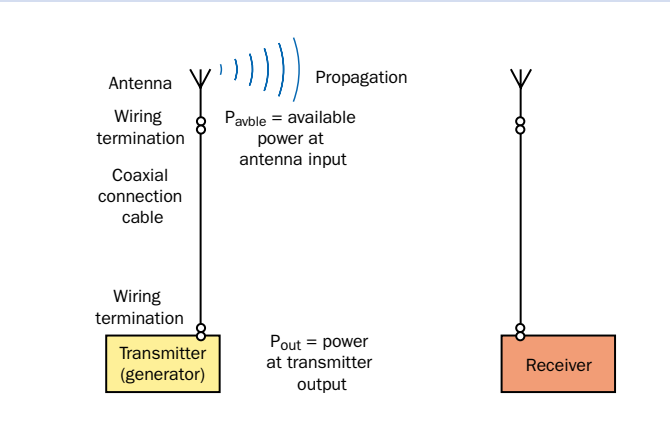
## Frequency plane

Microwaves correspond to a frequency range lying between those frequencies used by radio and those of infrared. They extend from about 300 MHz to approximately 300 GHz (see the diagram at the bottom of the page).
What makes microwaves remarkable is the fact that the weak value of their wavelengths (close to the visible spectrum), allows transmissions having a great degree of directivity to be achieved using rather small antennae. Therefore, beaming equipment is less sensitive to atmospheric or industrial interference. The limited range of microwaves is also an advantage which is widely used in cellular telephony (several distant relays use the same frequency to transmit various emissions).

## Standard constitution of a microwave system

A microwave system used in telecommunications is generally made up of the following main subassemblies

- a **transmitter** that generates the microwave energy needed to establish a link, i.e. the information medium frequency and power necessary to attain the desired range.
- a **connecting cable** used to carry microwave energy produced by the transmitter to...
- an **antenna,** which will beam it.




***Standard diagram of a microwave system. Ideal scenario: $P_{avble} = P_{out}$ (il y (there is maximum energy transfer)***

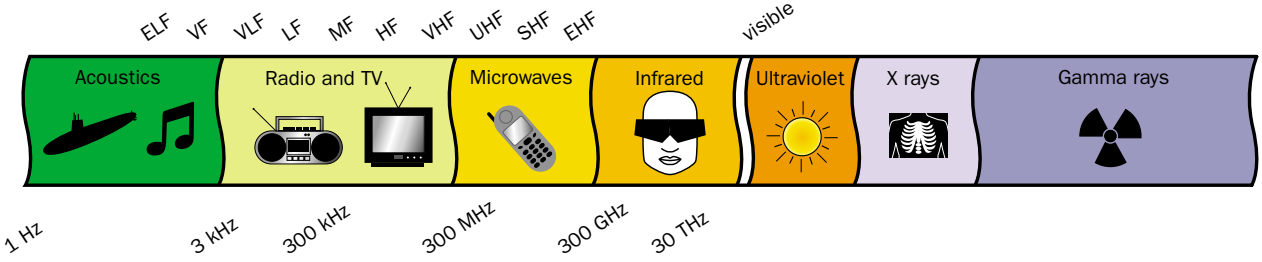
The microwave energy will then be propagated into free space, thus carrying the relevant information. At the other end of the information carrying chain, we generally find a symmetrical structure composed of:

- an **antenna** that will pick up the microwave information,
- then a **connection cable** which will carry it...
- to the **receiver**, which has to give back the relevant information (radar echo, digital or analog message, or otherwise an audible message such as one from a telephone, radio or television).

## Why it is necessary to carry out measurements

Why and when do we need to carry out measurements? As for any electronic system, the need to carry out measurements exists throughout the entire life of a microwave system, from its conception through to its reversal, namely:

- when the product is being thought up,
- when the product is qualified, to check its compliance with the specifications,
- when it is installed on the site on which it will be operated,
- when it receives technical acceptance,
- then for the whole of its operating life as part of normal maintenance procedure.

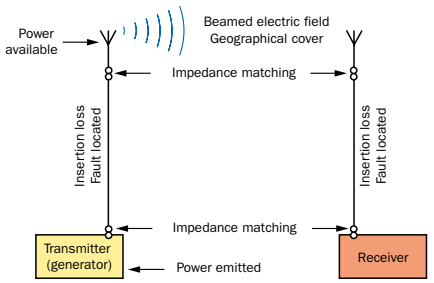



***Frequency plane***

## What are the measurements to be carried out?

In order to qualify a microwave system, depending on the circumstances, the following inspections will be performed:

- measurement of the power emitted by the generator
- measurement of the load's impedance matching (cable + antenna)
- measurement of the connecting cable's insertion loss
- fault location on the connecting cable
- measurement of the radiated electric field
- plot the geographical zone covered by the transmitter




***Qualification of a microwave system***

## Power metering

In order to check the compliance of a transmitter, we are led to measure the power that it provides. We can assess this by one of two methods.

### *A. Measurement by insertion.*

This method consists in **inserting** - in series, then - a measurement instrument in the form of a **wattmeter** or a **wattmeter-cum-reflectometer** between the transmitter output and its load circuit (cable, antenna). A directional coupler draws a portion of the energy circulating between the transmitter and its load. A detector is then used to deliver a voltage proportional to the power detected; this voltage and the coupling value make it possible to deduce the exact value of the power measured.

### *B. End point measurement*

This second method consists in **connecting a milliwattmeter**, coupled to a transducer in which the power supplied will be dissipated, to the generator output in place of the load circuit. Two types are generally used: the **diode transducer** and the **thermoelectric sensor**. In both these cases, the sensor is used as a load adapted to the end point of the measurement line.

a). **The diode transducer** detects amplitude by supplying a voltage proportional to the amplitude of the microwave signal to be measured; this voltage is then used to calculate the value of the power measured

b). **The thermoelectric** sensor supplies a data item which is proportional to the average power dissipated in the form of temperature in the load. Two variants coexist:

- ***The microwave thermistor,*** generally used in a branch of a Wheatstone bridge. The microwave power that is dissipated in the thermistor causes a change in its resistance which then unbalances the Wheatstone bridge. With the resistance variation of the thermistor being proportional to the average power to be measured, the information concerning the unbalance of the Wheatstone bridge is used to determine the value of this power. The thermistor used here is a very small component; its diameter is around 0.2 mm and its connecting wires around 20 µm.
- ***The microwave thermocouple,*** superposing two distinct functions. Firstly, a film which is resistive to the matched impedance and in which the power to be measured is dissipated, causing the temperature to rise. Then a **thin film thermocouple** superposed onto this load resistor, whose rise in temperature it measures, and which delivers a voltage proportional to the power to be measured. The microwave thermocouple is a component made of thin coats of metal that are in the region of a few hundred angströms thick.

***Thin-film microwave thermocouple. Actual diameter: approx. 30 mm.***

## Adaptation measurement

In any microwave system, it is of paramount importance to ensure that the load circuit produced by the generator actually has an impedance which is adapted to the impedance of the generator output. It is the essential requirement for there to be **maximum energy transfer** between the generator and the load circuit. This problem, which conditions the device's performance, has a direct effect on the operating costs.

In the field of microwaves, when a load circuit is not adapted, implying when its impedance does not correspond to the "conjugate impedance" of the generator, part of the energy produced by the generator is lost by reflection on the load impedance. The **energy reflected** by the load will disseminate into the transmission link, from the load to the generator, and meet the energy produced (called **incident**) and which disseminates in the opposite direction. These two energies, coming from the same generator, are coherent, and will therefore heterodyne and give rise to a "**standing wave**", made up of a succession of maxima and minima corresponding to the distribution composition in phase or in antiphase along the line of these two energies. The standing wave thus produced is characteristic of a level of impedance mismatch between generator and load circuit.

We are therefore naturally induced to carry out measurements on this standing wave in order to qualify the degree of impedance mismatch, which amounts to assessing the system's performance. The instruments used here are the **wattmeter-cum-reflectometer, analyser** or **scalar tester**.

### *A. Reflection coefficient*

We qualify impedance mismatches by the **Voltage Reflection Coefficient,** symbolised by the letter gamma, which corresponds to the ratio between the reflected voltage and the incidental voltage: $\Gamma_v = V_r / V_i$

It can also be expressed in terms of power $\Gamma_v = \sqrt{(P_r / P_i)}$ where $P_r$ and $P_i$ are respectively the reflected and incidental powers. $\Gamma_v$ is between 0 and 1

$\Gamma$ is often expressed in dB: $\Gamma_{(dB)} = 20 \log \Gamma_v$, in particular by the Anglo-Saxons, to whom it is known as "Return loss" (reflection loss).

### *B. The SWR*

The other essential measurement consists in determining the **Standing Wave Ratio**, abbreviated to SWR, whose value is between 1 et ∞.

If Vi and Vr represent respectively the incidental voltage and the reflected voltage, by definition, the SWR is given by the following equation:

$SWR = (V_i + V_r) / (V_i - V_r)$

The SWR can also be expressed based on the reflection coefficient:

$SWR = (1 + \Gamma_v) / (1 - \Gamma_v)$

| A few orders of magnitude | |
|---|---|
| SWR = 1.05 | Very good |
| SWR = 1.20 | Acceptable |
| SWR ≥ 2 | Poor |

## Insertion Loss

When we want to qualify a piece of microwave telecommunications equipment, it is worthwhile making sure that the connecting cable between the transmitter (or the receiver) and the associated antenna is in perfect condition, and that it will not prevent the transmission of energy. You must make sure that the cable does not generate a too considerable "**Insertion Loss**", out of consideration for the principle of "maximum energy transfer". As its name indicates, the Insertion Loss is a loss, a dissipation of the

transmitted produced energy, by insertion of the component concerned – in this case the connecting cable – between the generator and its use.
The equipment destined to carry out this measurement (milliwattmeter or scalar tester) proceed by comparison between the energy injected into the input of the cable to be tested and the energy available at the output.
If $P_{out}$ is the power injected into the input of the cable under scrutiny and the $P_{avble}$ is the power available at the other end of the same cable, then the Insertion Loss, symbolised by IL and measured in dB, is given by the following equation: $\mathbf{PI_{(dB)} = 10 \log (P_{avble} / P_{out})}$ (see block diagram on the first page of this article).
For a given cable, the value of the Insertion Loss is, of course, proportional to its length; for example, if it is 0.2 dB for 1 m, then it will attain 20 dB for 100 m.

## Locating a fault on a cable

Part of the microwave telecommunication installation is nearly always located outside, and this is often the case with coaxial connecting cables. This equipment, subject to attacks from external agents such as temperature variations, humidity, abnormal mechanic stress, etc., can become defective in the following ways:

- oxidation of the contact elements of a connector
- crushing of a cable,
- poor contact between the outer cable conductor and the connector
- connector short-circuited, etc.

*Antennae at a terrestrial radio relay station*

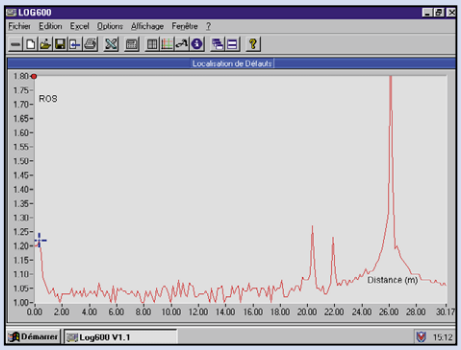
These different defects cause microwave signal transmission between the generator and the device radiating the signal to be impaired and interrupted are caused by the deterioration or interference of the microwave transmission signal, between generator and user, therefore causing major transmission failures. Now, these connecting cables which connect the transmitter to the transmitting antenna, or the reception antenna to the receiver, are often very long, because the antennae are generally placed on roofs or at the top of a pole several dozen meters high. It is, therefore, advisable to have a tool capable of locating the possible fault on the path of the cable to be tested. The standard instrument for these measurements is a fault locator; a function which the scalar tester also has.
Two measurement methods make it possible to locate a fault on the path of a coaxial cable with a known characteristic impedance. Both of them use the same characteristic physical features concerning the dissemination of microwave signals in the lines: the phase differences undergone by the microwave signals during their "forward-backward" journey passage along the length of a transmission line, varies depending on the frequency used.

### *A. Step method.*

This first method consists in injecting an excessively steep voltage step into the input of the cable being tested, i.e. with a very short equivalent build-up time; then in analysing the echo, i.e. the signal available on the return. The signal reflected by the cable's impedance discontinuity corresponds to the step emitted transformed by the impedance irregularity and the propagation time. However, this measurement method, which has the advantage of being quick, requires a subtle interpretation, and offers a mediocre measurement resolution.

### *B. Frequency response.*

This second method corresponds to the reflection coefficient frequency response measurement of the cable to be tested, a frequency response characteristic of the nature and position of the faults on the cable path. An algorithm, based on the "Inverse Fourier Transform" calculation, makes it possible to accurately determine the position, in terms of distance, of the impedance discontinuity sought.




***This cable shows a serious defect at 26 m from the outlet as well as two lesser defects at 20 m and 22 m, corresponding to connectors (measurement carried out using an ORITEL RO600 scalar tester)***

## Electric field measurement

The effective signal is remote transmitted thanks to propagation of the electromagnetic wave beamed by the antenna. It is worthwhile checking the validity of this propagation, to make sure that this link in the data transmission chain, between the transmitter and the receiver is not interrupted; for example by spurious reflections or by a blockage in the propagation.
It is also important to be able to check that an appliance does not radiate due to a too-high energy level, so as not to adversely affect the neighbouring electrical equipment (electromagnetic compatibility).
These measurements are carried out by **electric field measurers**. Their principle is based on the use of a great broadband reception antenna combined with a detector that delivers a voltage proportional to the electric field picked up. However, these instruments, which offer the advantage of working on a very broad frequency band, have the inconvenience of not knowing the frequency value of the signal measured.

## Electric field coverage

To determine the geographical zone covered by a transmitter, e.g. in order to forecast by simulation the reach of the calls expected to be made, the extent of GSM cellular radiotelephony coverage, we are led to **map out** the electric field around this transmitter. The equipment destined to carry out this measurement has to be very sensitive and enable a measurement to be carried out at a pre-determined frequency without being disrupted by those electric fields available on other frequencies.
The equipment intended to carry out this type of function are **selective receivers**, with several frequency changes, using the frequency-movable "Measurement Window " technique; a technique used in spectral analysis. These measurement receivers have, in addition to their capacity to carry out selective frequency measurements, a very great level dynamic measuring range, and a very high degree of sensitivity. It is fairly common to have a sensitivity in the region of –120 to –130 dBm, meaning that these receivers are capable of measuring signals in the region of 1fW ($10^{-15}$ W)!

# Microwaves: our measurement solutions

***All the different qualifying parameters in a microwave system, as those we have presented to you to on the preceding pages, can be measured with the appliances making up the "microwave" range of Chauvin Arnoux's Test and Measurement Division.***

## The Corresponding Measurement Instruments

The following table presents Chauvin Arnoux's measuring instruments that cover these types of measurement.

| | Power | | Impedance Adaptation | Insertion Loss | Fault Location | Electric Field | |
|---|---|---|---|---|---|---|---|
| | Insertion | Limit | | | | Radiation | Coverage |
| ORITEL MH600 | with associated coupler | ■ | with associated coupler | ■ | | | |
| ORITEL RO600 | | | ■ | ■ | ■ | | |
| ORITEL RW | ■ | with associated load | ■ | ■ | | | |
| C.A 41/C.A 43 | | | | | | ■ | |
| C.A 47 | | | | | | ■ | With accessories |

## ORITEL MH600 milliwattmeter

■ Power measurements are carried out by the ORITEL MH600 milliwattmeter that covers a frequency range of 100 kHz to 50 GHz, with a dynamic measuring range of 100 pW to a few W depending on the associated measuring probe.

*Reader service No. 5*

## C.A 41 and C.A 43 field measurers

■ The C.A 41 and C.A 43 field measurers, combined with their EF1 and EF2 probes, measure an electric field in a very extensive frequency domain: from 1 MHz to 3 GHz.

*Reader service No. 8*

## ORITEL RW500 series wattmeters-cum-relectometers

■ High power levels are measured using the wattmeters-cum-reflectometers in the ORITEL RW500 series. They produce incident and reflected powers of up to 1 KW between 2MHz and 2.7 GHz depending on the model; they also allow adaptations to be qualified.

*Reader service No. 6*

## C.A 47 RF receiver

■ For its part, the C.A 47 RF selective receiver measures the electric field picked up by an antenna, at any frequency chosen between 25 MHz and 2.5 GHz, on a very wide dynamic range extending from 100 µW / -10 dBm to 0.1 fW / -130 dBm.

*Reader service No. 9*

## ORITEL RO600 Scalar Tester

■ The ORITEL RO600 Scalar Tester, a field apparatus, measures the adaptation (SWR) and the insertion loss of a quadripole between 1 MHz and 2.7 GHz. This instrument also accurately locates the position of a fault corresponding to an impedance discontinuity on the path of a coaxial connecting cable.

*Reader service No. 7*

## Computer processing of data

**The C.A 43, C.A 47 and ORITEL RO600 can be used with software allowing measurements to be processed and archived on a microcomputer. These software packages are now available for use in a Windows™ 95, 98 or NT environment.**

# Transform your digital multimeter into a precision luxmeter

***Work regulations and quality standards applicable to the building industry define the minimum lighting levels required on public and business premises, as well as in all types of housing and accommodation. The instruments required for these measurements are luxmeters of high quality, accurate and reliable, but fairly expensive. At a lesser cost, the C.A 808 luxmetric cell enables your digital multimeter to be transformed into a high-performance and accurate luxmeter.***

Our human perception of good or bad lighting is quantified using a **luxmeter**, an instrument which measures **illumination,** i.e. the **quantity of light** received by a unit area. Illumination is assessed in **lux** (symbol lx). For example, under French regulations, the minimum lighting power for a draughtsman's work station is set at 300 lx. The AFNOR X 35-103 standard lays down the principles concerning the user's visual comfort which are to be applied with regard to lighting in the work place. For more information on this subject, we suggest you read issue **No. 46 of the Contact Measurement News magazine** (French version - article available only in French).

## A 'top of the range' cell

The **C.A 808** cell is designed around a selenium sensor (more sensitive than silicon), the spectral and spatial responses of which are corrected in accordance with the curve of "the international mean eye" set up by the International Lighting Committee. Capable of measuring up to 20,000 lx, it gives out a signal which is proportional to the lighting measured, at the rate of 1 mV for 100 lx. Thanks to its 2 meter-long shielded cord, it can easily be connected to all digital multimeters (2,000 counts minimum, rating 200 $mV_{DC}$) via two Ø 4 mm banana plugs.

## Some very practical details

Under the casing, a KODAK pitch-threaded insert enables it to be mounted on a tripod. Furthermore, an elastomer captive cover ensures the protection of the sensitive surface while it is in storage or being transported. When it is being used, the cell already has a protection rating 54 level of dust and watertightness.

Delivered either by itself as an accessory or in a complete fitted-out carrying case along with a multimeter and cords, the **C.A 808** cell is a reliable, precise and sensitive instrument, intended for professionals who are very demanding when it comes to the accuracy of their lighting measurements.

*Reader service No. 10*

NEW PRODUCT

# The user-comfort advantage of the remote temperature measuring gun

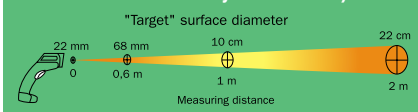
***As ergonomic as an instrument can possibly be imagined, the new C.A 878 and 880 infrared thermometers offer, in addition, measurement performances that will surprise you.***


Professional appliances for precision measurements, the C.A 878 and C.A 880 thermometers astonish with their prowess. Their "gun"-shaped casing makes them exceptionally easy to handle and gives them an extraordinary degree of user comfort. All functions (min, max, average, ΔT, emissivity and auto-hold) can be triggered using just one hand. The disengageable trigger can be locked in order to carry out measurements by scanning the target (scanner function). The laser sight, available on the C.A 880, offers perfect handling flexibility for aiming at the dead centre of any target whatsoever, with no possible error.

The rapid response time (300 ms), wide measurement range (-32°C to +500°C), adjustable emissivity (20% to 100%) and automatic back lighting are as many extra assets which make these thermometers essential tools.

*Reader service No. 11*

**The diameter of the surface targeted depends on how away far it is. The closer you get to the target, the smaller the surface is and the more accurate the measurement. This "distance from target / diameter of surface targeted" ratio is also called the measuring range. It has the shape of an elongated cone, with a diameter of 10 cm at a distance of 1m, and doubles with each meter (though this is only an approximation, chosen because it is easy to remember).**



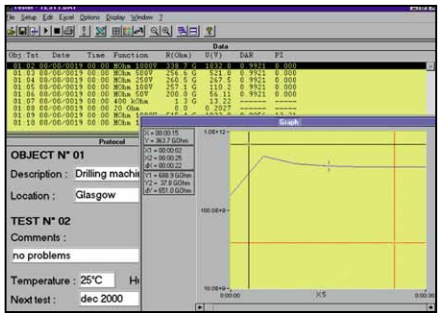
NEW PRODUCT

# Two new references for insulation testing

***Specialists in electrical safety measuring instruments, Chauvin Arnoux offer a new generation of insulation testers in a casing tailored for operations in the field. At the leading edge as regards technology and functionalities, these appliances have immediately begun to stand out as the new references in insulation testing at between 50V and 1kV.***

Controlled by a microprocessor, the **C.A 6541** and **C.A 6543** megohmmeters have very advanced functions for measuring insulation (up to 4 TΩ), AC/DC voltage (1,000 V), continuity (40Ω, with a current > 200 mA up to 20 Ω), resistance (400 kΩ) and capacity (5 µF).

The **C.A 6543** model also has a rechargeable battery and a built-in charger, a memory of 128 Kbytes, a RS232 connection allowing the appliance to be controlled entirely from a PC and making it possible to transfer data for computer processing by a specially developed software package (with display of the isolation trend curves, etc.)




## Reminders of the polarisation index (PI) and the dielectric absorption ratio (DAR).

| PI = $R_{10'}/R_{1'}$ | DAR = $R_{1'}/R_{30''}$ | Insulation quality |
|---|---|---|
| PI < 1 ou 2 | DAR < 1.25 | insufficient, even dangerous |
| 2 < PI < 4 | 1.25 < DAR < 1.6 | satisfactory |
| PI > 4 | DAR > 1.6 | excellent |

***For further information, we suggest you read the special report in Contact Measurement News No. 14.***

## The insulation experts

Among the many innovative functions which these new testers have, we can mention the following:

- **Automatic calculation of the PI and DAR coefficients** *(see box)*

So as not to be subject to the influence of parasitic currents which might pervert the insulation measurement, for example while testing a rotating machine, measurements must be carried out over a long period of time. The insulation value observed and recorded once the measurement has been performed, as well as those of the PI and DAR coefficients (irrespective of temperature), make it easier to judge the intrinsic quality of the insulants.

- **Programme test duration**

Insulation measurements sometimes take a good while to level off. Being able to perform measurements over a more or less long period of time and analyse the insulation trend curve according to the length of time the test voltage is applied leads to a better appreciation of the qualities of the different insulants.

- **R(t) curves plotting**

The user himself chooses the sampling rate at which the insulation measurements will be stored. These values will then be used for plotting the insulation trend curve depending on the length of time the test voltage is applied. With the **"MEGOHM VIEW"** software package for the **C.A 6543**, this profile is directly plotted on the PC screen.

- **Complete control of the appliance from a PC:** starting and stopping measurements, storing results, setting limits, etc.

- **Blocking access to the insulation test voltages** (so as to be able to entrust the appliance to less qualified people).

- **Programmable alarms**

- **Smoothing of measurements for display**

- **Remote triggering** via the remote control probe.

... and still many more that you will discover each time you use these high-performance products.

*Reader service No. 12*

# Electrical Energy: why and how should a management system be installed?

***A significant improvement in energy expenditure necessarily requires a better knowledge and control of one's consumption profile. Overall and centralised energy management brings with it quantitative and qualitative information on consumption. Periodically or selectively, all this information is exploited by the users.***

Industries, for whom energy expenditure represents between 15% and 50% of production costs, have a crucial need to know WHERE, WHEN, HOW and HOW MUCH energy is used. Moreover, the recent deregulation of the electrical energy market necessitates having accurate energy assessments in order to freely choose one's energy supplier on the basis of this specific and unquestionable data. Indeed, the choice of the best price scale is the customer's responsibility, for he is the only one who can know the possible rise or fall, in real time, of his requirements. Energy management systems meet this double requirement. There are now economic and open-ended solutions, suited to the most modest companies' budgets, and the cost of which will, moreover, very quickly be recouped through the savings made.

## Aims and principle

The aims of global and automated energy management are to make (direct or indirect) profits and/or implement a system of consumption management by analysis (cross-charging, breakdown per cost centre). The possible savings "reservoirs" can be of different kinds (reducing the energy bill, controlling the costs on products lacking in quality, preventive maintenance, awareness of energy expenditure, etc.). The advantage of energy management is to be able to quantify these "reservoirs". In order to do this, the operator must implement the following essential functions:

- **Measurement** of electrical values.
- **Metering** of active and reactive energy, pulses (water, gas, steam etc), overshooting subscribed power, etc.
- **History** making it possible to analyse changes in expenditure with regard to forecasts, break down consumption per sector and quantify corrective actions. Archive the events that have arisen on the network (overshooting thresholds, extreme values reached, etc).
- **Monitoring** sensitive electrical values (power factor, harmonics, etc.).
- **Detection** of abnormal incidences (overintensity, overvoltage etc.).

An Energy Management System is usually made up of **smart submeters** connected to an **industrial local network**. This network is used to transmit all the metering information, which will be organised and saved in a **database**, over long distances. This database will then be used by **an energy management software package** to draw up statistics, reports, judicious and periodic assessments etc, that are necessary to enable decisions to be made and corrective action to be carried out.

The flexibility and adaptability of good energy management enable information to be circulated selectively to the different people making up the company. Each person receives organised and directly usable data in personalised reports.

## The stages of good energy management

Attaining these objectives requires implementation of a real energy management policy, as well as the introduction of a plan of action which is generally broken down into several phases (analysis – assessment – diagnosis / accomplishment – follow-up).

### *Analysis of requirements*

The implementation of submetering procedures requires, beforehand, that the factory be split up into different parts according to functions. This split will establish consumption sectors which are common to the whole factory (boiler/furnace room, compressed air station, cold units for air conditioning, etc.) and the specific sectors (workshop, assembly line, department, etc.). If necessary, each sector could be further split into modules, in order, for example, to show up the share of the different operations involved in the manufacturing of a finished product. This analysis also applies to tertiary industry buildings, with the following sectors: offices, conference rooms, the staff canteen, leaseholders, common services, etc.

### *Assessment*

This stage consists in accurately determining exactly **where, when** and **how** the different energies are consumed, and **how much.** This assessment is drawn up from the periodic recording of power requests (power profile). These recordings, archived and used by a specific software package, enable reports, assessments and graphs to be drawn up in order to know the exact power requested and the consumption.

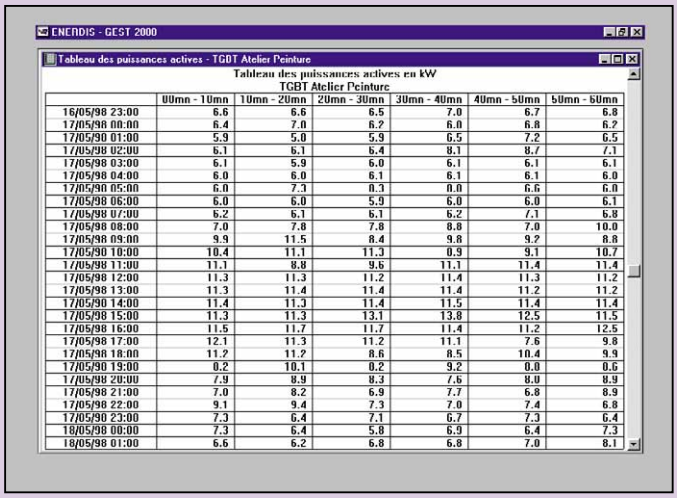
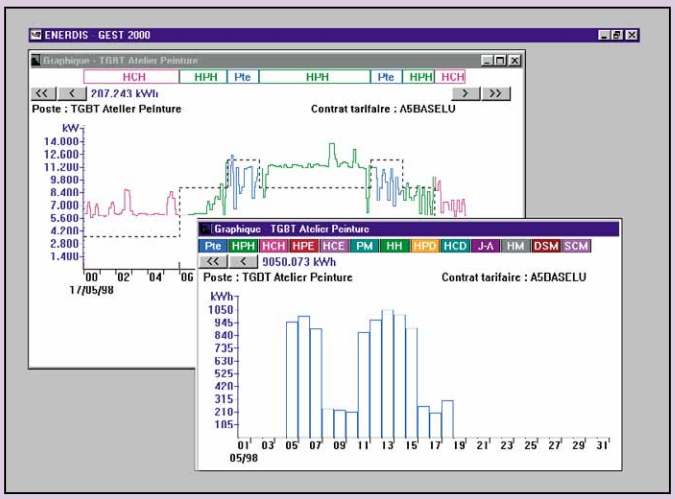



Tableau des puissances actives en kW
TGBT Atelier Peinture

| | 00mn - 10mn | 10mn - 20mn | 20mn - 30mn | 30mn - 40mn | 40mn - 50mn | 50mn - 60mn |
|---|---|---|---|---|---|---|
| 16/05/98 23:00 | 6.6 | 6.6 | 6.5 | 7.0 | 6.7 | 6.8 |
| 17/05/98 00:00 | 6.4 | 7.0 | 6.7 | 6.0 | 6.8 | 6.7 |
| 17/05/98 01:00 | 5.9 | 5.0 | 5.9 | 6.5 | 7.2 | 6.5 |
| 17/05/98 02:00 | 6.1 | 6.1 | 6.4 | 8.1 | 8.7 | 7.1 |
| 17/05/98 03:00 | 6.1 | 5.9 | 6.0 | 6.1 | 6.1 | 6.1 |
| 17/05/98 04:00 | 6.0 | 6.0 | 6.1 | 6.1 | 6.1 | 6.0 |
| 17/05/98 05:00 | 6.0 | 7.1 | 8.3 | 8.0 | 6.6 | 6.0 |
| 17/05/98 06:00 | 6.0 | 6.0 | 5.9 | 6.0 | 6.0 | 6.1 |
| 17/05/98 07:00 | 6.2 | 6.1 | 6.1 | 6.2 | 7.1 | 6.8 |
| 17/05/98 08:00 | 7.0 | 7.8 | 7.8 | 8.8 | 7.0 | 10.0 |
| 17/05/98 09:00 | 9.9 | 11.5 | 8.4 | 9.8 | 9.2 | 8.8 |
| 17/05/98 10:00 | 10.4 | 11.1 | 11.3 | 8.9 | 9.1 | 10.7 |
| 17/05/98 11:00 | 11.1 | 8.8 | 9.6 | 11.1 | 11.4 | 11.4 |
| 17/05/98 12:00 | 11.3 | 11.3 | 11.2 | 11.4 | 11.3 | 11.2 |
| 17/05/98 13:00 | 11.3 | 11.4 | 11.4 | 11.4 | 11.2 | 11.2 |
| 17/05/98 14:00 | 11.4 | 11.3 | 11.4 | 11.5 | 11.4 | 11.4 |
| 17/05/98 15:00 | 11.3 | 11.3 | 13.1 | 13.8 | 12.5 | 11.5 |
| 17/05/98 16:00 | 11.5 | 11.7 | 11.7 | 11.4 | 11.2 | 12.5 |
| 17/05/98 17:00 | 12.1 | 11.3 | 11.2 | 11.1 | 7.6 | 9.8 |
| 17/05/98 18:00 | 11.2 | 11.2 | 8.6 | 8.5 | 10.4 | 9.9 |
| 17/05/98 19:00 | 8.2 | 10.1 | 8.2 | 9.2 | 8.8 | 8.6 |
| 17/05/98 20:00 | 7.9 | 8.9 | 8.3 | 7.6 | 8.0 | 8.9 |
| 17/05/98 21:00 | 7.0 | 8.2 | 6.9 | 7.7 | 6.8 | 8.9 |
| 17/05/98 22:00 | 9.1 | 9.4 | 7.3 | 7.0 | 7.4 | 6.8 |
| 17/05/98 23:00 | 7.3 | 6.4 | 7.1 | 6.7 | 7.3 | 6.4 |
| 18/05/98 00:00 | 7.3 | 6.4 | 5.8 | 6.9 | 6.4 | 7.3 |
| 18/05/98 01:00 | 6.6 | 6.2 | 6.8 | 6.8 | 7.0 | 8.1 |

*Example: power profile recording of power requests at a metering point (Winthor software)*




*Example: graphic display of the powers requested and the energy consumed at one of the metering points (Winthor software)*

### *Diagnosis and Action*

Taking this energy assessment as a basis, those actions which are supposed to lead to energy savings are determined: renegotiation of the supply contract (version and power subscribed), installation of power cut-off mechanisms, capacitor batteries and anti-harmonics filters, modification of consumption habits, etc.

An order of investment priorities can be set up based on this calculated assessment.

### *Follow-up*

Following up the consumption records by means of an appropriate software package is the only way to measure the savings made, to make them into long-term savings and to initiate others. This follow-up will be daily, weekly, monthly and/or yearly, depending on the requirements expressed: monitoring excess demand, cross-charging and adjusting the supply contract.

## The advantages of an energy management system

There are many advantages in installing an energy management system and they are all very different. Principally, we can mention:

### *1. Automatic archiving of consumptions*

The automatic remote reading of meters brings speed, comfort and reliability. It avoids the necessity for repetitive and sometimes long routine inspections. All risk of error on the index readout is ruled out. Automatic data archiving allows more time to be devoted to studying and optimising consumption.

Recording the power profile of mean power levels, which makes it possible to carry out an exact follow-up of consumption over the course of time and to detect overshoots of subscribed power, requires a large number of data items to be archived (e.g. 1,152 values over 8 days, 59,904 over a year in 10-minute periods). Only an automatic remote reading of the information on the meter makes this follow-up possible.

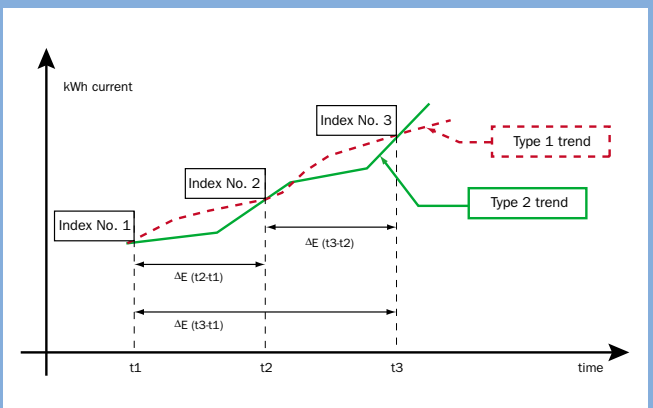
### *2. Technical and accounting analysis of consumption*

The periodic recording of consumption makes it possible:

- To draw up summary tables for each sector. These tables give an overall view of consumption in a factory, a company department, a production line or a cost centre, breaking it down into tariff brackets and calculating overshoots of subscribed power. The results will be expressed in energy units (kWh, kvarh, $m^3/h$) or in monetary units (euros, francs etc.).

## Method of energy consumption metering by index reading

***On a set date and at a set time, index reading, previously carried out by the routine inspectors, is automated. Time stamping enables consumption levels between two remote readings to be calculated.***

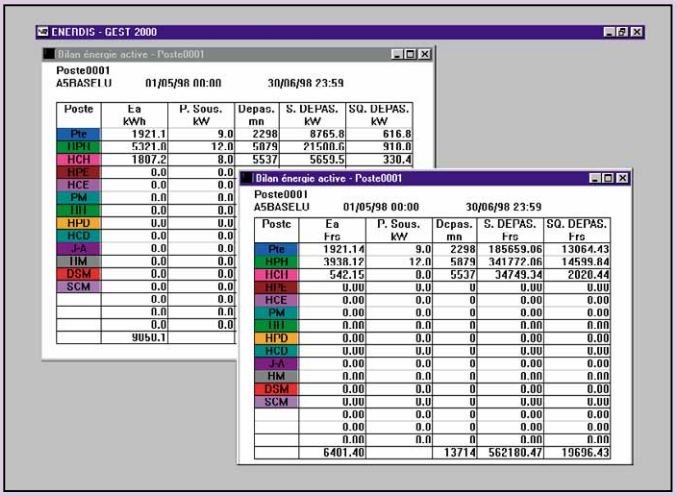



**The advantages:**

- Simple method for energy metering
- Little data to archive
- Reduced traffic on the local communication network
- All the indexes are read in a short time
- No error possible in the remote reading of the index values

**The disadvantages:**

- The consumption profile between 2 index readings (e.g. t1 and t2) is not known
- No continuous monitoring of power intakes
- Breaking consumption down into tariff brackets is tricky.




***Example: assessment showing, in figures, consumption at a given point of the site over two months (Winthor software)***

■ To draw up periodic energy assessments (daily, monthly, yearly, etc.) that in turn enable rapid identification of the "greediest" consumption points.

■ To rapidly identify the savings “reservoirs”, measure the influence that changing the characteristics of the supply contract (type of tariff, subscribed power, etc.) might have, and quickly locate cases of abnormal overconsumption.

■ To establish significant energy ratios or indicators (e.g. the quantity of electricity, water, steam or gas consumed / quantity of manufactured product, kWh/m$^2$, etc), in order to take into account the energy cost involved in manufacturing a finished product. Recording the power profiles enables the energy cost to be taken into account in the calculation of the ratios depending on the moment the power is consumed.

■ To supply reliable data and accurate energy diagnoses in order to rapidly establish the return on investment by quantifying the energy gains obtained. This accurate data affords precious help when it comes to making any decision regarding investment (new machine, cogeneration, etc.). It can be proven, by means of results which are accurate and expressed in figures, that energy is being purchased at the best price.

### *3. Optimising the supply contract*

Possible courses of action as regards the supply contract and consumption:

■ **Decrease the total amount of the fixed premium by lowering the values of the subscribed powers.** The fixed premium (or subscription) is proportional to the subscribed power. This premium often represents more than 35% of the total bill. Analysis of the load curves and notably that of the billing meter (green meter) makes it possible to display quickly and clearly whether or not the subscribed power is far beyond the power requests of one's electricity network.

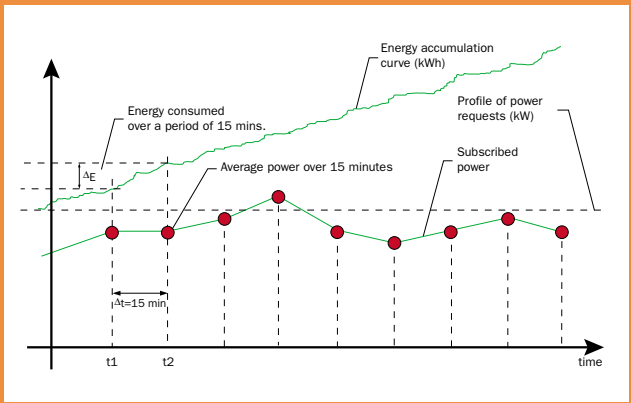
■ **Reduce overshoots of subscribed power.** In France, the fixed subscription premium is proportional to the subscribed power. Each overshoot of this power is billed at top price. Recording the load curve enables any overshoot to be displayed and quantified accurately. Analysing all the load curves in detail will show up the number of non-priority feeders to which power is likely to be cut off.

■ **Decrease active energy consumption by transferring consumption to the least expensive tariff periods.** All the data supplied by the energy management system (load curve, overshoots, kWh per tariff bracket, etc.) contributes to getting the “kWh” at the lowest cost, transferring consumption from peak time to day-tariff hours and from day-tariff hours to night-tariff hours.

■ Decrease the reactive energy consumption by monitoring and controlling the value of the tg φ.

## Method of energy consumption metering by load curve reading

***The values of the mean power levels are calculated on the basis of 15-minute consumption periods:***
***Pave (15') = 4x$\Delta$E (15').***
***This method enables the power request profile (kW requested depending on time).***




**The advantages:**

- **Accurate identification (value, moment, cost) of the subscribed power overshoots**
- **Calculation of the influence of modifications made to supply contract parameters**
- **Calculation of the influence of corrective action on consumption**
- **Determination of the "greediest" feeders and moments with regard to energy consumption**
- **Breakdown of consumption per sector or cost centre (analysis management)**
- **Breakdown of consumption per tariff bracket**

**The disadvantages:**

- **The quantity of data conveyed over the local network is considerable**
- **The number of data items to be archived and organised is bulky, and necessitates the use of high-performance computer equipment.**

### *4. Carrying out preventive maintenance on the network.*

Continuous analysis of all the events (tg φ, excess demands, extreme values, harmonics, abnormal consumption, etc.) reduces the number of critical interventions on the electricity network. Operating staff have accurate information in real time with which to optimise the use and increase the life span of the electricity network equipment.

# Energy Management: the solution put forward by the Power M and C Division

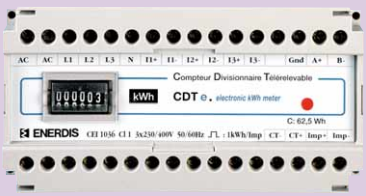
***Enerdis' offer as regards energy management revolves around the WinThor system, which combines measurement equipment (Remote-readable submeters, power monitors, etc.) and a supervisory software package that carries out the functions for automatic remote reading, archiving and handling of data.***

## CDT remote-readable submeters

The remote-readable submeters are LV metering modules in a DIN casing, for mounting on a DIN rail. Their function is one of multitariff metering in class 1 in accordance with the IEC 61036 standard, and they measure the parameters of a three-phase LV electricity network. Combined with the WinThor software, they monitor and manage electric energy.

The **32-bit CDTe** model is especially adapted for connection to a system (PC, PLC, centralised technical management, electricity technical management, construction technical management, etc.).

- 3 models: **CDTe "energy", CDTpr "power recorder", CDTpm "power monitor".**
- Measurement of more than 30 electrical quantities in instantaneous, average and maximum values.
- xx-minute (1 to 99 mm.) load curve storage (CDTpr, CDTpm).




- Threshold overshoot storage in U, I, P and PF.
- Metering pulse output.
- RS485 ModBus/Jbus digital output

## "recdigit NODUS" power monitors

Having a 96 x 96 compact size, **NODUS** has all the functions which are indispensable for monitoring LV three-phase electrical networks.

- Measurement of all the electrical values necessary for supervision
- 98 electrical values measured and accessible via RS485
- 32 parameters can be displayed on a LCD screen having a high degree of legibility, with automatic range and unit management


- Qualimetry: THD measurement (U and I), neutral current
- 4-quadrant metering as standard, for cogeneration applications
- Metrological accuracy: class 0.5 in measuring, class 1 in metering (IEC 61036)
- One alarm or pulse output (programmable)
- Plugs equally into a 1 A or a 5 A transformer
- Easy to operate by means of 4 direct access buttons
- Intuitive programming by means of a scroll-down menu in 4 languages (English, French, German and Spanish)
- Compact size, 96 x 96, 126 mm in depth, for all LV general switchboards (LGVS)

## recdigit POWER power monitors

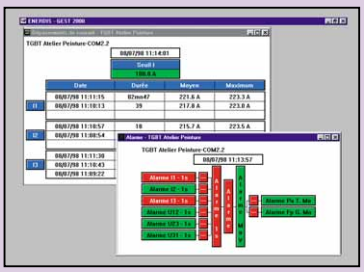
The **"recdigit POWER"** monitors enable up to 35 parameters of a three-phase LV, MV, HV network to be displayed on 3 high-readability display units. All the types of application are catered for by just 3 models: display, supervision and energy management. These monitors can be connected to a system (PC, PLC, construction general management, etc) via their analog, pulse or digital outputs.

- 3 dedicated models: Energy Display, Energy Quality, Energy Management
- High-level metrological characteristics: class 0.2 in measuring, class 1 in metering (IEC 61036).
- Displays 35 electrical quantities in instantaneous, average, minimum and maximum values.
- Automatic management of the ranges and units displayed
- Alarm relays as standard.
- Metering pulse and analog outputs as optional extras
- RS 485 ModBus/JBus digital output with a field memory studied for optimal integration into a supervisory system.

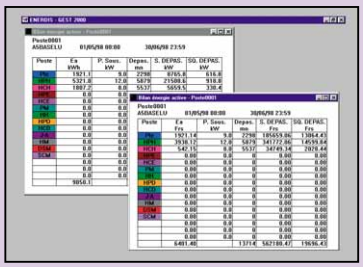
## WinThor supervisory software

This remote reading and energy management software, designed for a Windows PC environment, is made up of 3 menus: configuration, display and analysis.

- The Configuration menu serves to parameterise the system: transmission characteristics (direct or by modem), creation of fictional metering points (addition and/or subtraction of actual points), programming the automatic remote reading sessions, metering indexes and load curves, and tariff parameterisation (grid, contractual powers and different energy costs).
- The Display menu enables the electricity network to be monitored, thanks to the instantaneous display of all the parameters together (instantaneous, average, minimum and maximum values, meter indexes, etc.), display of alarms (remote threshold modifications), display and recording of chosen parameters, etc.

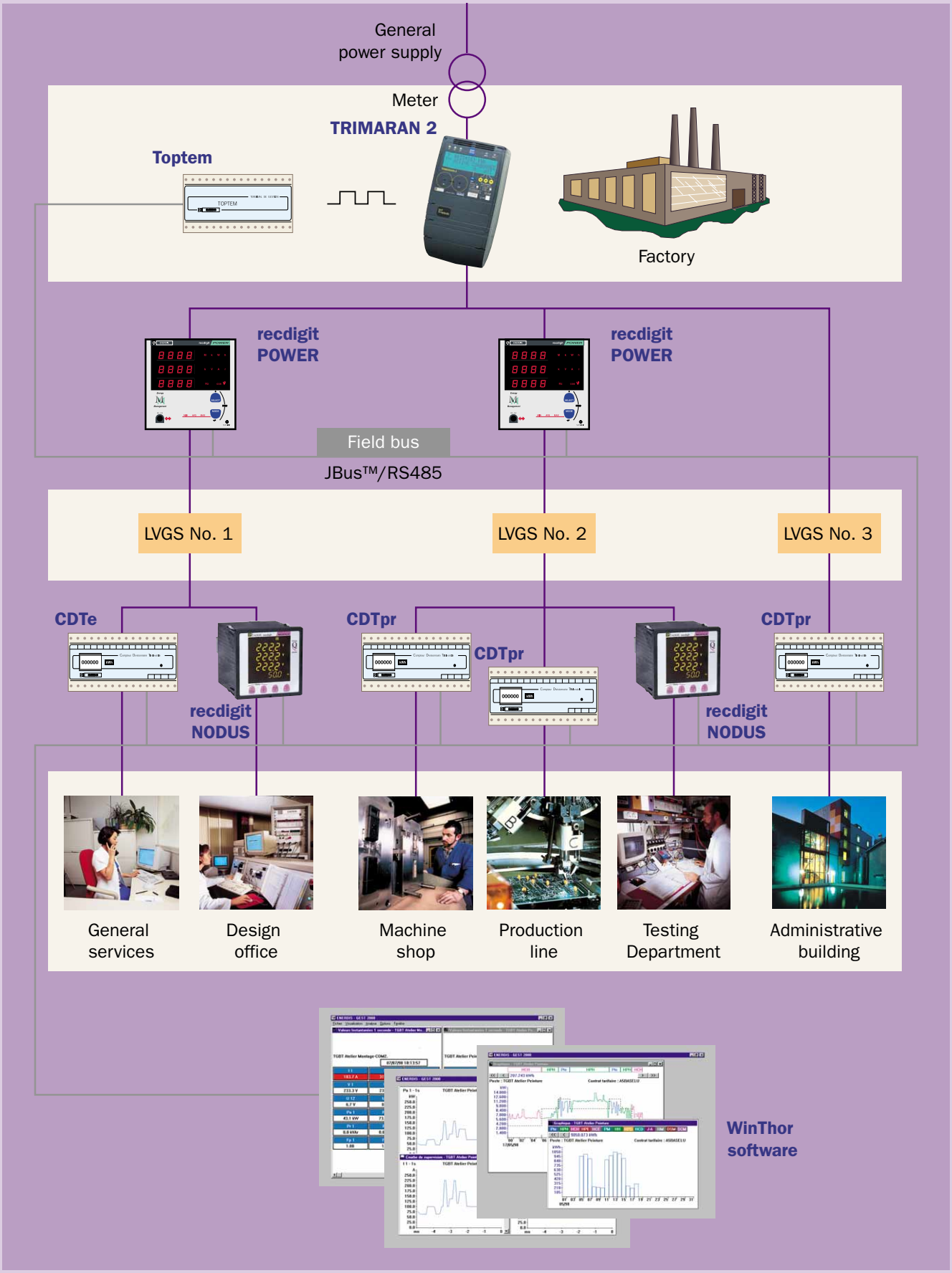


- The last menu enables energy consumption to be analysed quantitatively and qualitatively in several ways (tables, graphs, etc), and also consumption to be optimised through simulations depending on parameterisable criteria (tariff agreement, subscribed power, etc). Indeed, thanks to the remote reading of the load curves (15 min.) coming from the power monitors (recdigit POWER Energy Management) and the superimposition of the tariff agreement, the software is capable of automatically editing an electricity invoice. WinThor is therefore a specialised tool allowing comprehensive monitoring of the LV, MV or HV electricity networks as well as tariff simulations to be performed in the most rigorous way, i.e. in the same way as the official metering point.



*Reader service No. 13*

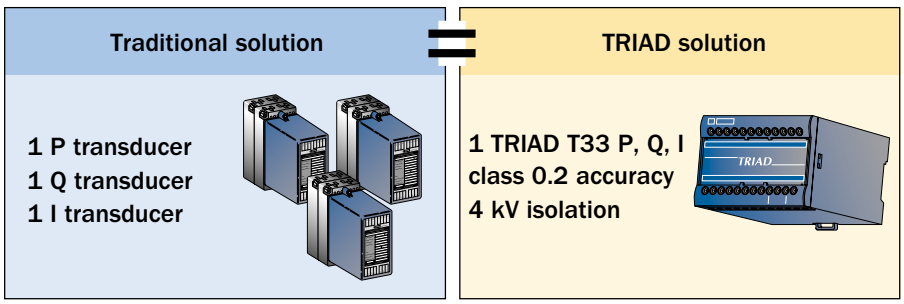
The range of communicating products for energy metering and management offer suitable and open-ended solutions adapted and developed for all electricity network monitoring as well as consumption control and optimisation applications. The whole of these products, connected to a field bus (RS485 ModBus/JBus), makes an overall and point-by-point analysis of the electricity network possible. Associated software such as WinThor – allows energy assessments to be carried out, tariff agreements to be optimised through an analysis of consumption profiles, and detailed simulations to be performed.



# TRIAD
# Electric quantities transducers


***Through its privileged contact with engineers in the electrical and industrial sectors, Enerdis is continually involved in the development and optimisation of measurement converters. More than 30 years of experience in this area have given us an excellent awareness of the applications and knowledge required for running electrical installations. The fruit borne of this know-how, TRIAD was the first in the range of multifunctional and configurable digital processing transducers, offering, what is more, an absolutely remarkable accuracy and level of isolation. Enerdis has obtained these performances notably by developing an ASIC integrated circuit, a truly accurate and reliable measuring centre, right in line with the reputation for quality and performance of the products of the previous generation.***

By developing an **ASIC** containing all its knowledge, **Enerdis** has equipped its range of **TRIAD** transducers with a digital measuring centre, the guarantee of an exceptional stability, with an accuracy of class 0.2 and compliance with electromagnetic compatibility standards. This technology allows the user, on the one hand, to convert "strong current" electric quantities to "low level" signals with an isolation of 4 kV and a response time of less than 300 ms, and, on the other hand, to group up to three functions in a single casing. On top of this, the ASIC has improved the product's configuration flexibility to the screw terminals with 6 mm² cables.
A single **TRIAD** transducer can replace one, two or three traditional transducers. For the user, the result is a gain on the overall purchasing price (reduced price for the appliance, reduced wiring and installation costs and a smaller number of measurement transformers). Thus for example, in an MV/LV (average voltage, low voltage) cell, there are three traditional transducers to supply remote measurements of electric quantities (active and reactive power and voltage) necessary in the context of MV network supervision. With **TRIAD,** a single transducer will suffice for this task.




which can, in a very short space of time, be adapted precisely to the characteristics of the installation (input transformation ratios, measuring ranges, transfer curves and output ranges). **TRIAD** is an extremely economical answer in terms of the purchasing and installation costs, especially since the programming can be done directly by the customer thanks to the TRIADJUST software. This range **complies with the IEC 60688 standard** and the European directives.

## A range full of advantages

**TRIAD** comes in the shape of DIN casings, 60 or 120 mm wide, which click on to a DIN rail or fix onto the back of a cabinet. It is connected directly

The **ASIC** circuit, besides its programming flexibility, also works under severe conditions, (temperature, humidity, interference), while at the same time guaranteeing a class 0.2 metrology (in accordance with the IEC 60688 standard). It offers better immunity against conducted and radiated EMC disturbances and, finally, does away with the need for periodic calibration operations.
The 0.2% accuracy and especially the 4 kV dielectric strength between the input, auxiliary power supply and output circuits, go towards making the electrical installations safer, just as they guarantee compliance with the international standards imposed by the major industries and electricity companies.

Each **TRIAD** is equipped with a switching power supply offering a broad dynamic rating allowing easy adaptation to the power supply values available on each site, in AC as in DC.

## Configurable products

The digital technology implemented in the heart of each **TRIAD** transducer enables it to be parameterised exactly to the requirements of each use. With the **TRIADJUST** configuration software, you can reduce even more the waiting period for, and the cost of, installation of your TRIAD transducers. Developed in order to simplify technological modifications during installation and to diminish the stocks of products assigned to maintenance, **TRIADJUST** is a high-performance tool for configuring the parameters of the transducer range in Windows™ how and as many times as you like. Equipped with a PC and the **TRIADJUST** module's infrared transmitter, you can interact with your **TRIADs** perfectly safely and without any specific electrical connection. You can thus act on the configuration of the transducers at any moment, on any site, for example to modify a current ratio on a **TRIAD** installed in a general switchboard, or even to adapt a **TRIAD** to the characteristics of the MV/LV cell that you are scheduled to deliver next week. In short, with **TRIADJUST**, you can rapidly and indefinitely access all the operating parameters of your transducers. Because it is so user-friendly, you can very easily modify inputs, measuring ranges, outputs, etc. of the transducers you install. You can even edit the characteristics and wiring diagram labels of the transducers parameterised in this way.

*Reader service No. 14*

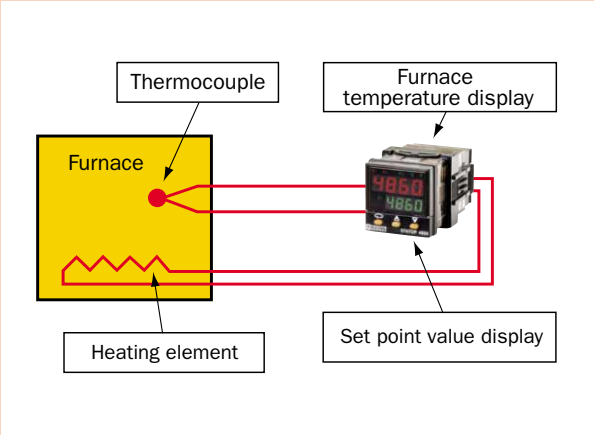
# A review of temperature process control

***Since the first temperature controller was manufactured by Chauvin Arnoux in 1934, the process control systems have developed considerably. Physical parameters which were still impossible to measure yesterday, are available today at a reasonable cost. This article offers you a clear insight into the current functions of temperature controller.***

In "process control", in the last ten years, many programmable controllers with built-in control loops have been set up on the production line. For a long time, we thought that the traditional switchboard controllers were doomed to slowly disappear. Now, in the last few months, we have once again been seeing sales rise for the big manufacturers of this type of product. Do the functions that they offer today suffice to explain this phenomenon?

## The principle of automatic control

Let us take the simple example of oven temperature control to define the key terms. The aim is to keep the oven's temperature at 200°C by varying the electric current in a resistor.




- The oven's temperature is the **controlled variable**
- The temperature fixed at 200°C is the **set point**
- The regulator's output variable is the **correcting variable**

## What is a controller?

A controller is an automatic process control device which enables quality, comfort and safety to be improved, and energy consumption to be minimised. The controller permanently compares the divergence between the controlled variable and the set point (which is called the measurement-set point divergence) and sends a signal aiming to offset it. The different sorts of automatic control can be arranged into 4 large technological families:

- Electromechanics
- Pneumatics and hydraulics
- Analog electronics
- Digital electronics

The choice of technology must be made strictly depending on the degree of automatic control being sought and the cost-in-use, as well as the dynamic and static behaviour of the processes concerned.

### *Electromechanics*

As a general rule, electromechanical controllers have only one function. They are suited to simple and standardised configurations. They convert a physical quantity into a mechanical movement aiming primarily to activate an electrical contact.

### *Pneumatics and Hydraulics*

This technology has the advantage of having a simple and quick element. Very often used in a dangerous environment, this type of controller enables motors, valves or cylinders to be actuated without any risk of sparks.

### *Analog electronics*

These controllers make it possible to carry out simple functions: detection, adjusting, displaying, and calculations. The forming of measuring chains is simplified by the standardisation of exchange signals. This technology can be bought at a very low cost.

### *Digital electronics*

This technology uses one or more microprocessors. It makes possible complex calculations in very short spaces of time, data storage, and data transmission via a field bus. The user-friendliness of the man-machine interface has become a determining factor.

### *Programmable controllers*

This type of product, originally designed for complex algorithms and to band together automatic operations, has progressively integrated new functionalities, like for example the control loops (PID action).

## What is a control mode?

For control to be optimal - meaning accurate, quick, insensitive to interference, and therefore stable - the operating mode of the control system has to be suited to the process. The automatic controller must not make its presence felt! Different modes solve all the automatic functioning problems in the various installations, depending on their static and dynamic characteristics, as well as the action range.

### *Cascade control*

The cascade system brings two control loops into play, with the first loop acting on the second. Its role is to "boost" reaction to the different disturbances which generate poor-quality controls.

### *Hot and cold control*

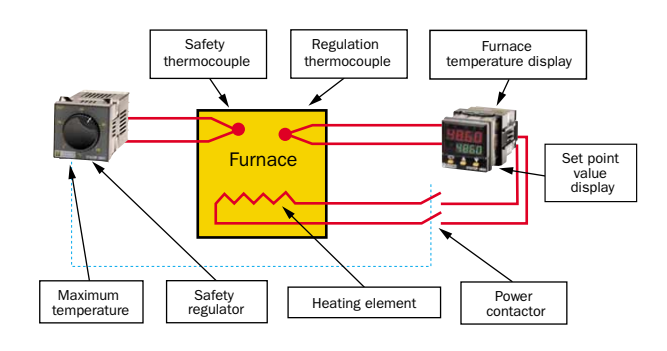
This is a single loop system but with two mutually opposed actions centered on the same control set point. Each action possesses its own PID parameterisation. Before the set point value is attained, the 'heating' action is set in motion; beyond that, the 'cooling action' takes over.

### *Ratio control*

The controller calculates the ratio between two values measured at the input. This ratio is kept constant by the control loop. It is most frequently used in quantitative analysing processes.

### *Protected control*

A second controller, functioning in on-off mode, protects the control loop by imposing a maximum temperature which should never be exceeded. This system provides a very high degree of safety for a very small cost.




### *"Feed forward" control*

The heating power calculated by the controller is corrected by another variable, for example the network fluctuation or the load variation due to the ageing of the heating elements. This function is sometimes integrated into power controllers equipped with well-made thyristors.

## Which outputs for electronic controllers?

### *On-off outputs*

This is the simplest and best-known, frequently used for simple systems when regulating quality is not very important (electric convectors, liquid level, etc.). If the measurement is lower than the set point, the controller's output is active, and vice versa. Oscillations of the controlled variable occur around the set point which are more or less considerable depending on the system's inertia, hence its use in systems that do not require much precision.

### *Modulated output*

The controller's output is modulated according to a fixed time period and a cyclic ratio (on/off) which will vary depending on a value calculated by the controller. The fixed time period will be a compromise between the wearout of the power element and the inertia of the process.

### *Direct current output*

The controller's output varies proportionally to the calculated value, generally got from a PID unit. The weaker the measurement-set point divergence, the weaker the output signal. It is useless when the controlled variable is equivalent to the set point.

## What are control parameters?

These enable the controllers to calculate the actions to be carried out in order to correct the divergences between the measurements and the set point.

### *The PID*

This is the combination and complementarity of the following 3 actions:

- **Proportional:** it suppresses the oscillations in the process at a value specific to it.
- **Integrated:** this corrective action adapts the speed of the controlling element so as to offset the measurement-set point divergence.
- **Derivative:** functions together with the integrated action. It is useful in cases of rapid and sudden disruptions in the process, and it cancels itself out when the divergence is once again close to zero.

All these actions are known as PID and are defined by:

- The user, according to the process which is to be controlled.
- The **Self-controlling** algorithm: the PID is automatically controlled by the controller, with the procedure being launched by the user.
- The **Self-adaptive** algorithm: the PID is adjusted to the process with each measurement-set point divergence observed by the controller. This is a dynamic function.

### *Fuzzy logic*

This algorithm calls on the "fuzzy" concept, which brings in subjective notions intended to be similar to human reasoning, for example: very cold, cold, warm, hot, very hot.
It is associated with the PID. This new hybrid system enables mathematical rigour to be combined with the flexibility of fuzzy logic.

## What is the situation as regards the temperature controller market?

As mentioned above, during the last few years we have observed an increase in demand for switchboard controllers, to the detriment of industrial programmable controller PID boards. How can we analyse this? The following 2 points will begin to provide an explanation.

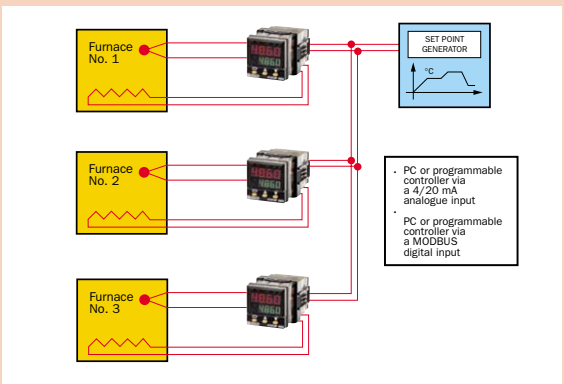
**1.** Control by programmable controller will never be as fine as with an automatic control, into which development teams have integrated all their professional know-how on the subject of control. Today, a precision of ±1°C is not easily achieved by a programmable controller, even one which is very sophisticated..

**2.** Industries which use continuous process manufacturing represent a mature market. Today, everybody is very aware of the place of each link in the chain and confusions are extremely rare. The tendency is to decentralise equipment, interlinking closely by means of field buses. The programmable controller has its place within the perspective of an integrated system, managing complex algorithms and **controlling separate elements.** In the event of a short "crash", these elements have to continue autonomously to monitor and control, to avoid production being destroyed. Thanks to that, the production teams will always be able to regain control in manual mode.
**This is why, in the Temperature M and C Division, we think that the future in industrial process applications lies in independent controllers controlled by a system or a programmable controller.**

## Developments to Chauvin Arnoux's range

Year after year, the range expands with new products, which enables you to continually improve the quality of your controlling for a more and more modest product cost. Before, we did not have a product in our catalogue whose set point could be controlled by a system (programmable controller, supervisor and set point generator). Today, it is done: to our great satisfaction, this product has just come to life in our factories - the **STATOP 4860.**
Among a great many other novel features, it enables the control set point to be remote modified by:

- either a 4 - 20 mA or 0 - 10 V fine control mechanism
- or a digital fine control mechanism in ModBus (RTU protocol)




We invite you to turn the page to learn about it in more detail

# A controller tailor-made for process applications


***With its set point input remote-controllable via an analog or digital link, its self-adjustment and self-adaptation functions as well as its two PID loops, the STATOP 4860 temperature controller is perfectly suited to industrial process applications. All the more so because its small DIN 48x48 format casing is totally impervious to dust and spraying with water (protection rating 65).***

As standard, the latest in the **STATOP** range is compatible with most of the control applications used in thermal processes. A word of reminder: by "process" we mean an uninterrupted industrial manufacturing process, like the production of glass, fibres, etc. Here, the slightest failure can bring the production chain to a complete halt, if not the entire factory. Therefore it is important that all equipment should have the safety mechanisms making it possible to offset any incident with the least possible loss in production. The **STATOP 4860** meets this requirement. But this product, one of the quickest on the market, (10 measurements per second), also has:

- A new algorithm: self-adaptive
- Two PIDs which are interchangeable via a logic input
- One factual input (logic)
- One load supervision input via a current transformer
- Completely insulated analog outputs
- The possible configuration by an external programming console (which makes it possible to save a configuration by downloading and to duplicate it onto other **STATOP 4860**s).
- A 20 V / 25 mA transmitter power supply

It is, therefore, a high-performance product, but one which is very simple to implement. No need to be an automatic control expert! The **STATOP 4860**s self-adjusting capability means that it can be used without specialised knowledge. The appliance itself determines the most suitable parameters for the process and automatically applies them. During the control operation, the self-adaptation capability continuously corrects the PID parameters. And fuzzy logic contributes to the remarkable control stability.

## Three inputs

**The main input,** for measuring the temperature or the controlled variable, is **configurable:** it accepts a number of different types of thermocouple, platinum probes and process signals, in voltage or current, coming from converters or programmable controllers *(table 1)*. When parameterising, the user will only have to indicate the signal used and, if need be, define a more restricted measuring range.

| Input | Maximum scale | Accuracy |
|---|---|---|
| ct J | -120 to 1000°C | ± 2°C |
| ct K | -200 to 1370°C | ± 2°C |
| ct T | -250 to 400°C | ± 2°C |
| ct E | -100 to 900°C | ± 2°C |
| ct B | 200 to 1820°C | ± 2°C |
| ct R | 0 to 1767.8°C | ± 2°C |
| ct S | -250 to 1300°C | ± 2°C |
| ct N | -250 to 1300°C | ± 2°C |
| ct L | -200 to 900°C | ± 2°C |
| Pt100 DIN | -210 to 700°C | ± 0.1°C |
| mV | -8 to 70 mV | ± 0.01 mV |
| mA | -3 to 27 mA | ± 0.005 mA |
| V | -1.3 to 11.5 V | ± 0.0015 V |

***Table 1: input type 1***

One of the numerous assets of the **STATOP 4860**, and not one of the lesser ones, is found in its **auxiliary input** for process signals *(table 2)*. This input allows analog remote control of the control set points or reading of a current coming from a current transformer (ct) to 1 A secondary. In this way, for example, load break detection can be monitored.

| Input | Scale | Accuracy |
|---|---|---|
| ct .../1A | 0 to 50.0 A | ± 2% |
| mA | -3 to 27mA | ±0.005 mA |
| V | -1.3 to 11.5 V | ±0.0015 V |

***Table 2: input type 2***

Lastly, a third input, this time **logic,** permits the configuration to be modified during process: choice of another set point defined beforehand, alarm cut-off or selection of a second group of PID control parameters.
It is even possible to act on one of the control outputs. This logic input is controlled at a very low safety voltage (VLSV): between –10 and +1 V are seen as "0" logic, and the "1" corresponds to a voltage between 2 and 10 V.

## Alarm or hot-cold outputs?

As standard, the **STATOP 4860** is equipped with two independent alarm relays. Entirely configurable (absolute alarm, deviation, symmetrical, time switch, suppressed at the first default latch and hold functions, etc), they can be adjusted over the whole measuring scale.
But the second alarm output can also be assigned to cold channel in the event of the **"Hot-Cold"** algorithm being chosen. Depending on the installation and heating element, you would choose -at the console- a logic or otherwise an analogue output, following the example of the first control output, which will then become the hot channel.

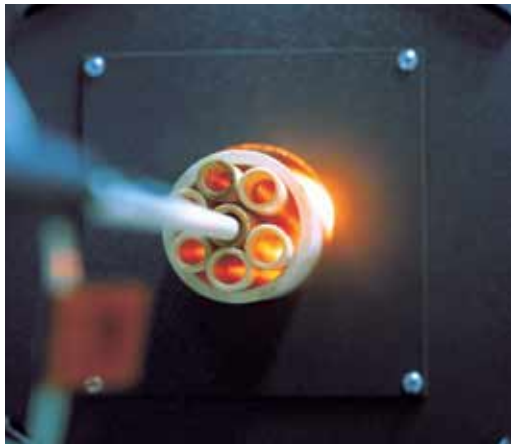
## RS485 ModBus communication

With the **RS485** digital transmission option, the **STATOP 4860** easily lends itself to the running of a supervised network in RTU ModBus protocol, with a turnover of 38.4 kbd. It will then be possible to record the measurements, direct the set points, cut off alarms, etc with standard software which can be bought from a shop.
Like the other DIN 48x48 models in the **STATOP range (4849 and 4850),** the **4860** enables a ramp to be introduced for temperature build-up, a timing function coupled to the alarms, and it is only slightly deep, which makes it easier for it to be recessed: only 75 mm.
It is, on the other hand, the only one of the three to have a power supply for transmitters (25 mA - 20 $V_{DC}$) and a programming menus access which is protected by microswitches.
The appliance is equipped with two 10,000-count LED displays, a red one to display the temperature measured, and a green one for the set point. The temperature values can be parameterised and displayed in degrees Celsius as well as in Fahrenheit. The power supply accepts from 90 to 261 $V_{AC}$, but the product can also be ordered in a mixed VLSV version: 11 to 26 $V_{AC}$ or $V_{DC}$.

*Reader service No. 15*

# Calibration materials and provisions

***Manufacturing products for - and supplying products to - industry, Pyro-Contrôle Chauvin Arnoux has a laboratory for calibrating temperature sensors and manufactures different calibration appliances and systems: standard sensors, fixed-point cells and calibration furnaces and baths.***



*The Pyro-Contrôle Chauvin Arnoux laboratory is accredited by the COFRAC - No. 2-1385 for calibration by comparison from -20°C to +1,550°C*

Two methods are commonly used to calibrate temperature sensors: the comparison method and the fixed-points method. It is not always easy to choose between the two of them.

When it is great accuracy that one is looking for, let us say equal to or more than 0.01°C for instance, then the fixed-points method is necessary. When there are a large number of sensors to be studied, or if there is a greater tolerance regarding accuracy, then the comparison method is preferable. However, even in this case, having one or several fixed-points enables reference sensors to be periodically checked and indicates when they need to undergo a complete re-calibration.

## The Comparison Method

Calibrating a sensor by comparison consists in placing it in an enclosure whose uniform and constant temperature is measured by means of a standard sensor, taken as a reference. This method has several advantages because it allows you to:

- Calibrate a large number of sensors simultaneously,
- Calibrate sensors having geometrically varied shapes,
- Calibrate at different temperatures.

However, it is often difficult to be sure that the sensors to be calibrated and the reference sensor are at the same temperature. Stable and uniform enclosures are difficult to achieve, especially at high temperatures, and the accuracy of the results is directly linked to the calibration and stability of the reference sensor.

**Pyro-Contrôle Chauvin Arnoux** manufactures reference thermocouples and a surface sensor calibrator device under licence from the **BNM-LNE.** (BNM: French National Metrology Office - LNE: French National Testing Laboratory)

C. Le Toquin / Studio Photo CNAM

*Gallium triple point: +29.7646°C. Impervious cell, closed in an argon atmosphere and fitted with a valve for achieving the triple point. Manufactured under licence from INM-BNM.*

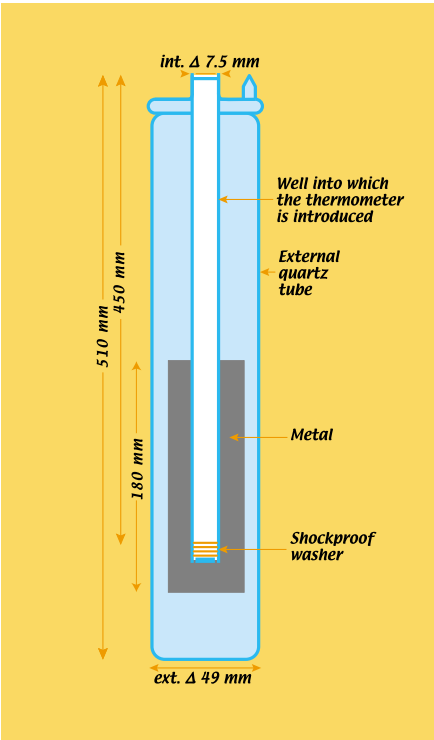
## Fixed-points method

Calibrating a sensor using the fixed-points method consists in placing it in an enclosure whose uniform and constant temperature is defined by the thermodynamic equilibrium between different phases of a pure substance.

**Principle:** A pure metal melts and solidifies at a temperature which is specific to that metal. When the environmental temperature conditions are correct and the quantity of metal used is sufficient, the latent heat absorbed or released during the change of phase maintains the metal mass, confined in the fixed-point cell, as well as the thermometer inserted into the well of the cell, at a constant temperature for several hours.

**Pyro-Contrôle Chauvin Arnoux** develops complete assemblies designed to achieve the ITS-90 fixed reference points. The sealed cells are manufactured under licence from the BNM-INM (INM = French National Metrology Institute).

| Fixed-point cell | Temperature |
|---|---|
| Gallium | +29.7646°C |
| Indium | +156.5985°C |
| Tin | +231.928°C |
| Zinc | +419.527°C |
| Aluminium | +660.323°C |
| Silver | +961.78°C |




*Principle of a fixed-point cell*

The main advantage of this method is that it provides a highly accurate calibration at a known temperature with great precision (accuracy in the region of a mK), without being reliant on the characteristics of a reference sensor, which are likely to drift with time. Let us not forget that this method is used for the International Temperature Scale (ITS-90).

The limitations of this method are:

- Calibration can only be performed at a certain number of pre-determined temperatures.
- During a change of phase, the number of sensors to be calibrated is limited depending on the duration of the temperature level.
- The sensors to be calibrated cannot have just any shape and configuration.

*Reader service No. 16*


## METRIX latest edition

On 32 colour pages, discover the essential products making up the **Metrix** ranges. Presented in tables indicating their main characteristics, appliances of the same type can easily be compared. Selecting a product takes no more than a few minutes. From the moment you know the name of the appliance, a name index also makes research easier.

Reader Service No.17


## All for one and one for four

"Because 80% of signals are periodic, analogue display remains the reference type". There is no denying that this quote deserved to be backed up by a specific and complete documentation. That now exists with this new 4-page brochure which portrays the whole **Metrix** analog oscilloscope range. Whether you work in the field of video technology, teaching or industry, you will find 1001 reasons for going analog.

Reader service No. 18

## All you need to know about your low voltage network

With the **NODUS** power monitor by **Enerdis**, dissect in minute detail up to 98 parameters of your electrical network. Measure, display, consult at a distance, keep a track on your energy consumption/production, monitor harmonic distortion and the current circulating in the neutral. A very high-performance product, having a small format (96 x 96), with a remarkably well developed interface for easy use. It is worth getting to know it by reading this brochure.


Reader service No. 19

## 144 x 144 mm power monitors

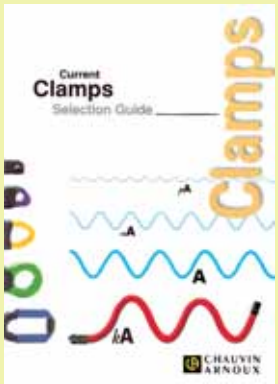
The 3 **Recdigit POWER** power monitors offer a graded solution to the requirements of LV, MV, HV network users: measurement (class 0.2) and display, monitoring and qualimetry, energy analyses. The powers (P, Q, and S) are measured in instantaneous, maximum or average values over a programmable length of time. Load curves and event storage (min., max., threshold) are other strong points of these communicating products.


Reader service No. 20


## Insulation in the palm of your hand

In this document, you will discover the complete range of **Chauvin Arnoux** insulation testers in a user-friendly casing: 3 appliances dedicated to electrical installations and equipment and 2 dedicated to low currents: telecommunications signals, electronics, home automation, etc.

Reader service No. 21




## Make your choice with the world leader!

The amperemetric clamp that you are looking for is inevitably in the **Chauvin Arnoux** catalogue. Here is a guidebook that summarises the characteristics of all the models to choose from. An impressive choice at that!

Reader service No. 22

## Temperature control problems overcome

Comletely electronic, the thyristor-equipped static power relays and regulators in the **THYRITOP** range guarantee a rapid and accurate load commutation, single- or three-phase, from 25 A to 1.9 kA. These 12 pages are richly illustrated.

Reader service No. 23


## Multimeters that are equal to anything

From the building site to the laboratory, **Chauvin Arnoux**'s 5200 digital multimeter series offers you the maximum in safety and comfort. From 2,000 counts to as high as 40,000 for the most accurate model (0.1% TRMS), their pocket size, combined with the shockproof sheath, provides a perfect handgrip.

Reader service No. 24

# We have the industrial answer to your electrical measurement needs

The electrician's profession has become more and more complex as a result of an increasingly technological environment. So whether it's test, control or general instrumentation equipment that you need, our distribution network brings our expertise straight to you. All of which helps you to go about your business, whether it's in installation, maintenance...

## Industrial maintenance

## Manutenzione industriale

## Industrielle Wartung

## Mantenimiento industrial

## Maintenance industrielle

**Electrical Installation Tester**
**C.A 6115**
Test electrical safety with a single instrument

**Megohmmeters**
**C.A 6521/23/25**
Insulation measurements have never been so easy

**Clamp-on power and harmonic meter**
**F27**
Analyse quality of electrical networks with ease

**Clamp-on earth resistance testers**
**C.A 6410/12/15**
Test earth loop resistance in a flash, from 0.1 Ω upwards

**Metrix Multimeters**
**MX Concept Series**
Need a TRMS multimeter?
A straightforward low-cost instrument?
Then choose metrix !

**Differential input oscilloscopes**
**OX 8062/8042/832/822**
Are you sure your measurements are earthed?
Got a single reference potential for both channels?
Happy with just 5 V/div?
Better think metrix differential oscilloscopes

Call us now for details !

*The best in measurement*

CHAUVIN ARNOUX

**Test & Measurement Division**
190, Rue Championnet - 75876 PARIS Cedex 18 - France
Tél. : 33 1 44 85 44 86 - Fax : 33 1 46 27 73 89
http://www.chauvin-arnoux.com

Reader service No. 25