



Temperature Variation According to electricity Consumption

Temperature monitoring is a key factor for industrial sectors using blast furnaces and for the coolers used in the agri-food sector. The temperature has a direct impact on electricity consumption in these industries. Blast furnaces need electricity to heat up, while coolers need it to drive their compressors.

By analysing the temperature as a function of electricity consumption, it is possible to detect any malfunctions leading to excessive consumption.

In the case studied here, the aim is to record the temperature of a domestic appliance (a refrigerator in this case) and its electricity consumption in order to analyse the link between the two.

This Case Study uses a simple example involving the Recorder mode of a Scopix® portable oscilloscope.

Monitoring

Analysis

Thermistor

Thermocouple

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Step 1

Choosing the sensor

The first step is to choose the temperature sensor. There are several available which vary according to their technology, the type of sensor, the material used, the application and constraints, etc.

Scopix® is equipped with two Probix® adapters for temperature sensors: the HX0035 adapter for K thermocouples and the HX0036 for Pt100 sensors. Further details of this equipment are provided on the last page. The connection technology of the Probix® adapters is standard, ensuring compatibility with a large number of sensors.

Pt100 sensors:

Platinum-wire resistor wound round an insulating core: the core is usually ceramic. The operating ranges are from -100 °C to +500 °C. These features are appreciated for their **high accuracy** and **high stability**.

Other materials such as copper and nickel obey the same laws in terms of temperature characteristics, but Pt100 sensors are increasingly preferred because of their **high accuracy** and **wide operating range**.

Thermocouple sensors:

These sensors are the most widely used in industry. There are various different types of thermocouples: J, K, etc.

Scopix® is only compatible with K thermocouples. Formed by a junction of two materials, a thermocouple's operating range depends directly on the materials used. For this reason, it is important to review the various existing couples in order to choose the most suitable for the application. The measurements may range from a few degrees to several thousand. Although they are relatively inexpensive, they also suffer from limited accuracy: it is difficult to obtain measurements with an error below 0.1 °C or even 0.2 °C.



We choose the Pt100 probe for its accuracy in the required range.



Pyrocontrole manufactures temperature sensors and has a comprehensive catalogue of sensors compatible with the Scopix® and the HX0035 and HX0036 adapters. For further information: **+33 4 72 14 15 40**

Step 2

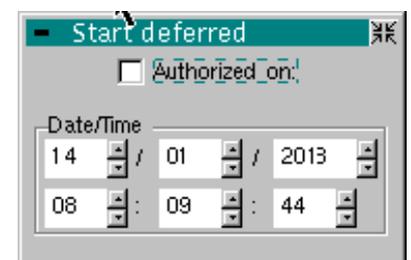
Data acquisition

The Scopix® oscilloscope is equipped with the Recorder mode, without the 50 kB extended memory option.

Before you start recording, you have to choose the recording duration and the vertical sensitivity of each sensor to ensure that the data can be viewed properly. Once recording has started, it is no longer possible to change these parameters. The sampling interval is linked to the recording duration and also depends on whether the "Acquisition memory extension" option is present or not.

Horizontal scale	SCOPIX III 2.5 Gs/s – RECORDER mode												
Recording duration	2 s	10 s	30 s	60 s	10 mn	30 mn	60 mn	12 h	24 h	48 h	7 j	31 jours	
Sampling interval	800 µs	4 ms	12 ms	24 ms	240 ms	720 ms	1,440 s	17,28 s	34,56 s	1 mn 09 s	4 mn 02 s	17 mn 51 s	2,5 kpts
Sampling interval	40 µs	200 µs	600 µs	1,2 ms	12 ms	36 ms	72 ms	864 ms	1,728 s	3,456 s	12,10 s	53,57 s	50 kpts

In the trigger menu, it is possible to defer recording activation, without any time limit.



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Two recording modes are available. The default mode records all the data over a **predefined time**, with the possibility of triggering and halting recording if a fault occurs. The other mode is the **"Fault Capture"** mode in which several triggers are possible after the occurrence of several faults. A maximum of 10 fault triggers is possible, but this limit is raised to 100 if the Scopix is equipped with the HX0077 "acquisition memory extension" option.

If no stop trigger is programmed, acquisition does not stop automatically, so the user must stop it by pressing the RUN/HOLD button. The first recorded data will be overwritten by the last data. This also applies to the "Fault capture" mode, with only the latest faults being stored in the memory.

Caution:
the oscilloscopes in the Scopix® range are designed for use between 0 °C and +40 °C, so the instrument must not be placed in an area outside these limits or it may not function properly.

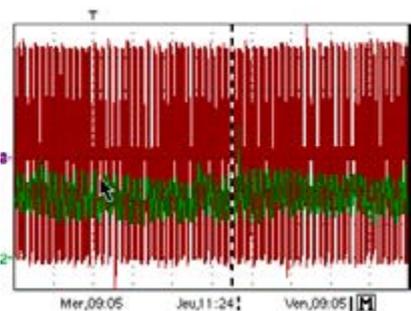


Fig. 1

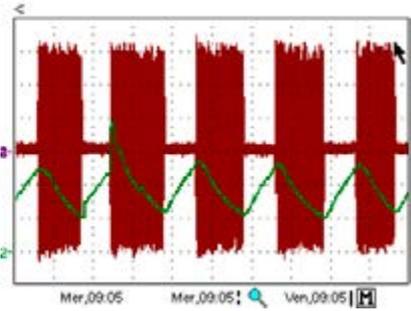


Fig. 2

This application begins with a temperature measurement inside a refrigerator by means of an HX0036 Pt100 adapter and measurement of its electricity consumption with the Probix HX0034 current clamp. As the recording duration is 48 hours, the graphs obtained are particularly condensed and do not allow effective visual analysis (fig. 1). It is necessary to zoom on the curve to see the real temperature trends (fig. 2).

The current curve is red. It indicates the consumption of the compressor.

The temperature curve is linked to activation of the compressor: when the compressor is operating, the temperature falls to 2.5 °C before stopping. The compressor only starts up when the temperature is above 7 °C. These two plateaux change according to the thermostat setting. At certain points on the curve, the temperature "jumps". This occurs when the refrigerator door is opened (fig 3).

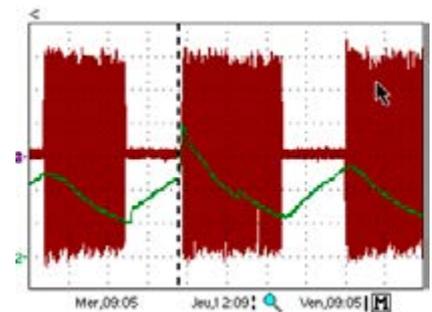


Fig. 3

Step 3

Recording the data

After stopping recording, it is possible to save the traces obtained in two different ways, depending on what you wish to do with them. If you want to redisplay the traces on the oscilloscope, you should save them in binary format in a "*.rec" file. The SX-Metro software can also analyse this type of file. The other possibility is to save them as a "*.txt" file which contains the position of each point as a function of time in alphanumeric form.

The two types of files can be imported into Excel. This procedure is explained in detail in the note "Processing of Recorder mode data", available on the www.chauvin-arnoux.com website.

It is possible to save the files in the internal storage of the oscilloscope, on a micro-SD card or on an FTP server.



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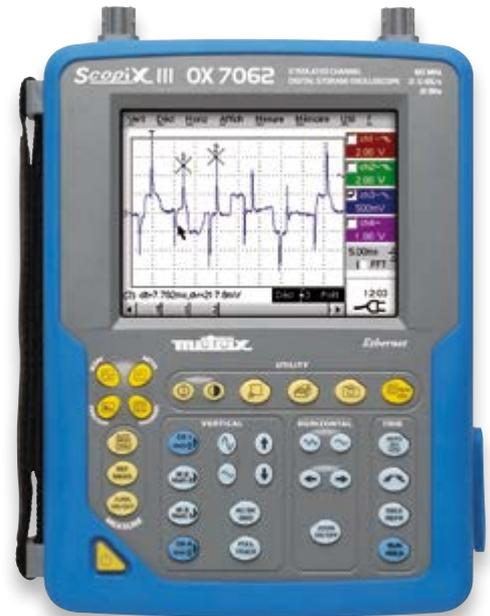
Scopix III

Available in various versions with two or four channels and bandwidth from 40 MHz to 200 MHz, Scopix III is a versatile tool grouping five instruments in one: oscilloscope, multimeter, FFT analyser, recorder and harmonic analyser.

The patented Probix® system of plug-and-play accessories ensures quick and above all error-free implementation. The coefficients, scales and units of the sensors and the configuration of the channels are managed automatically, while the sensors and adapters are recognized immediately when they are connected.

The Ethernet network interface with web server enables users to operate the instrument remotely and to transfer curves or screenshots without additional software. An FTP server/client communication mode is also available.

The Recorder mode described in this case study is capable of recording up to four signals for a duration ranging from a few seconds to one month. Remote control via internet also allows users to monitor the instrument wherever it is located, on a PC or on an Android™ tablet or smartphone with the application available from Google store.



Probix adapters

The HX0035 accessory is an adapter used to linearize the temperature measurements from a K thermocouple. The ratio, cold-junction compensation and unit are managed automatically by the Scopix.

The HX0036 is used to perform temperature measurements with a Pt100 platinum sensor. As with the HX0035, the ratio and measurement unit are managed automatically.



Model	HX0035	HX0036
Measurement range	-40 °C to +1,250 °C	-100 °C to +500 °C
Accuracy	± 1 % ± 3.5 °C	± 1 % ± 1.5 °C
Electrical safety	30 V CAT I	30 V CAT I



The HX0034 current clamp, equipped with a Hall-effect cell, can be used to measure DC or AC currents without disconnecting the device to be analysed.

Its internal electronics are powered by the oscilloscope, so no batteries are required. The DC offset is compensated by pressing a button. The measurement coefficient is applied automatically by Probix®, so no adjustments are necessary on the oscilloscope.

The measurement output is entirely isolated and is equipped with two buttons for remote control of the oscilloscope. The action caused by these buttons can be parameterized by the user.

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