OPEN SOURCE DATA ACQUISITION SYSTEMS

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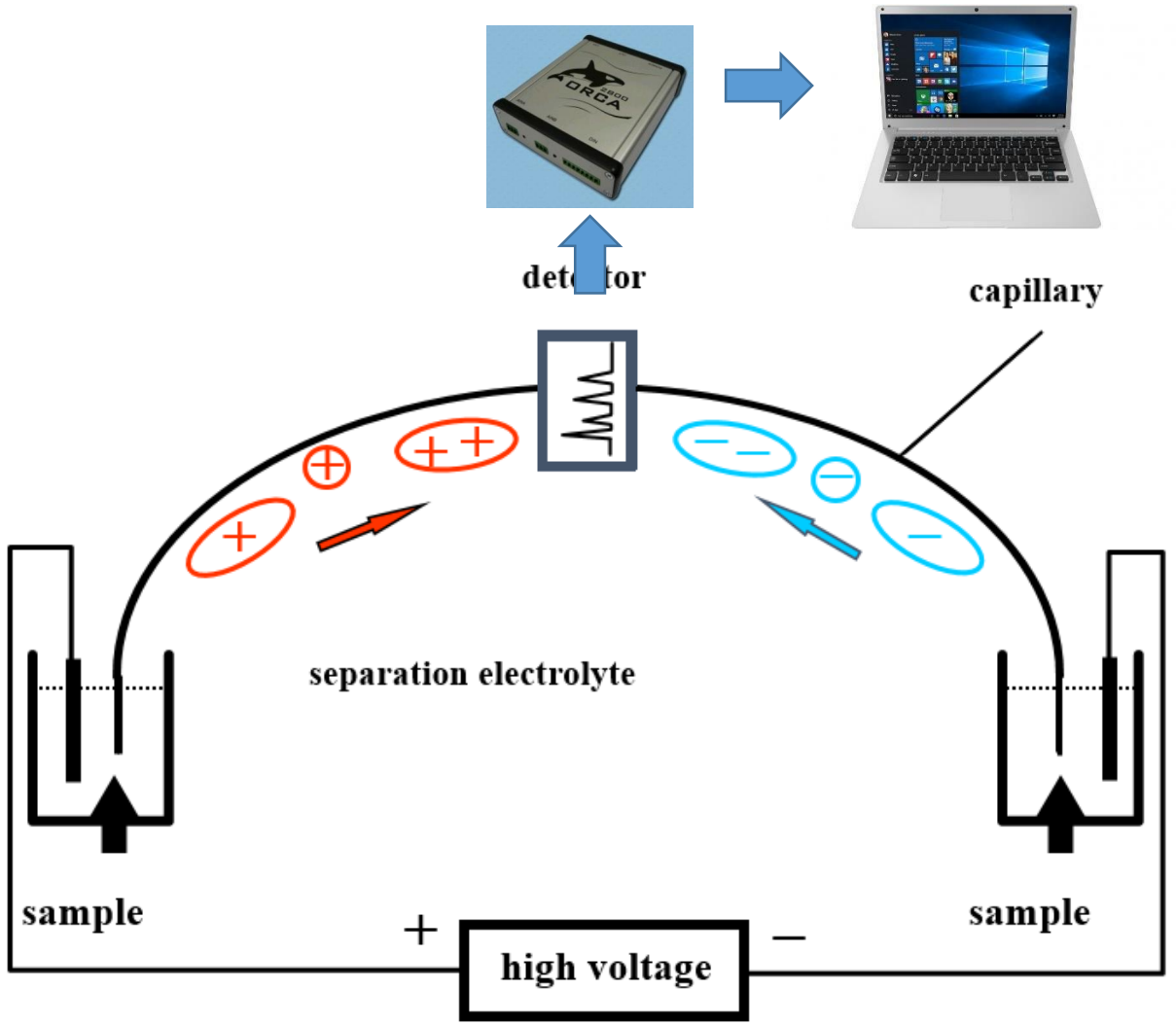
DATA ACQUISITION SYSTEMS



ese signals into digital form for analysis
rders, or communications networks

and integrity is the

DATA ACQUISITION SYSTEMS

12 –bit

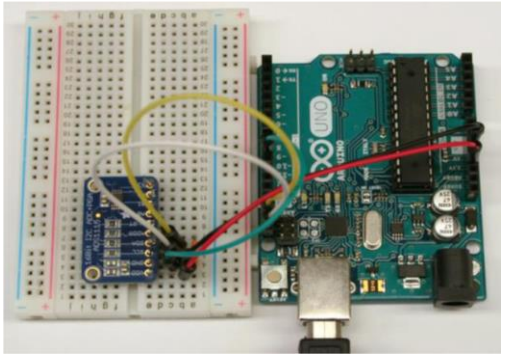
69 USD

24 –bit

1000 USD

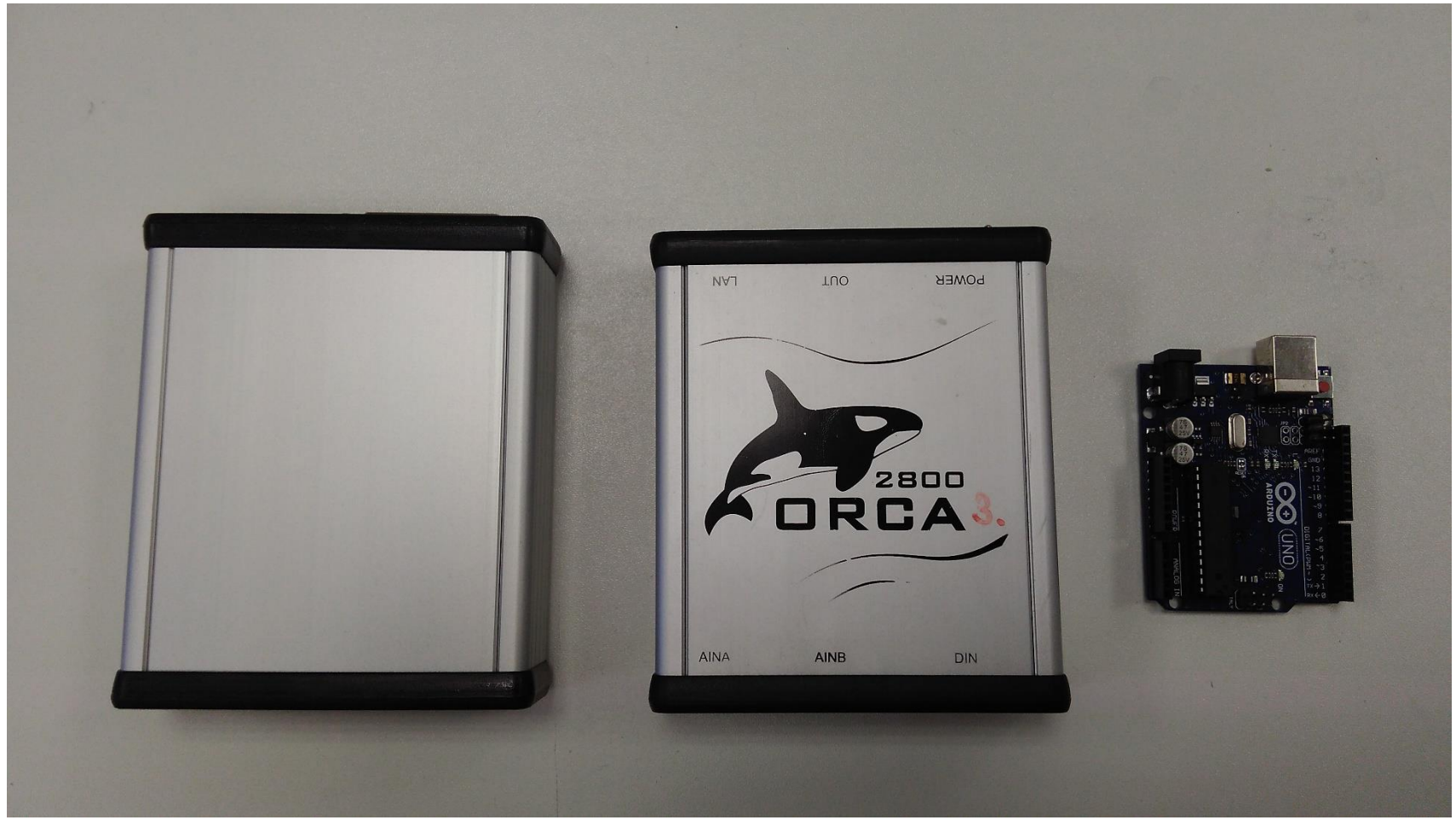
24 –bit

500 USD



16 –bit

50 USD


LAN
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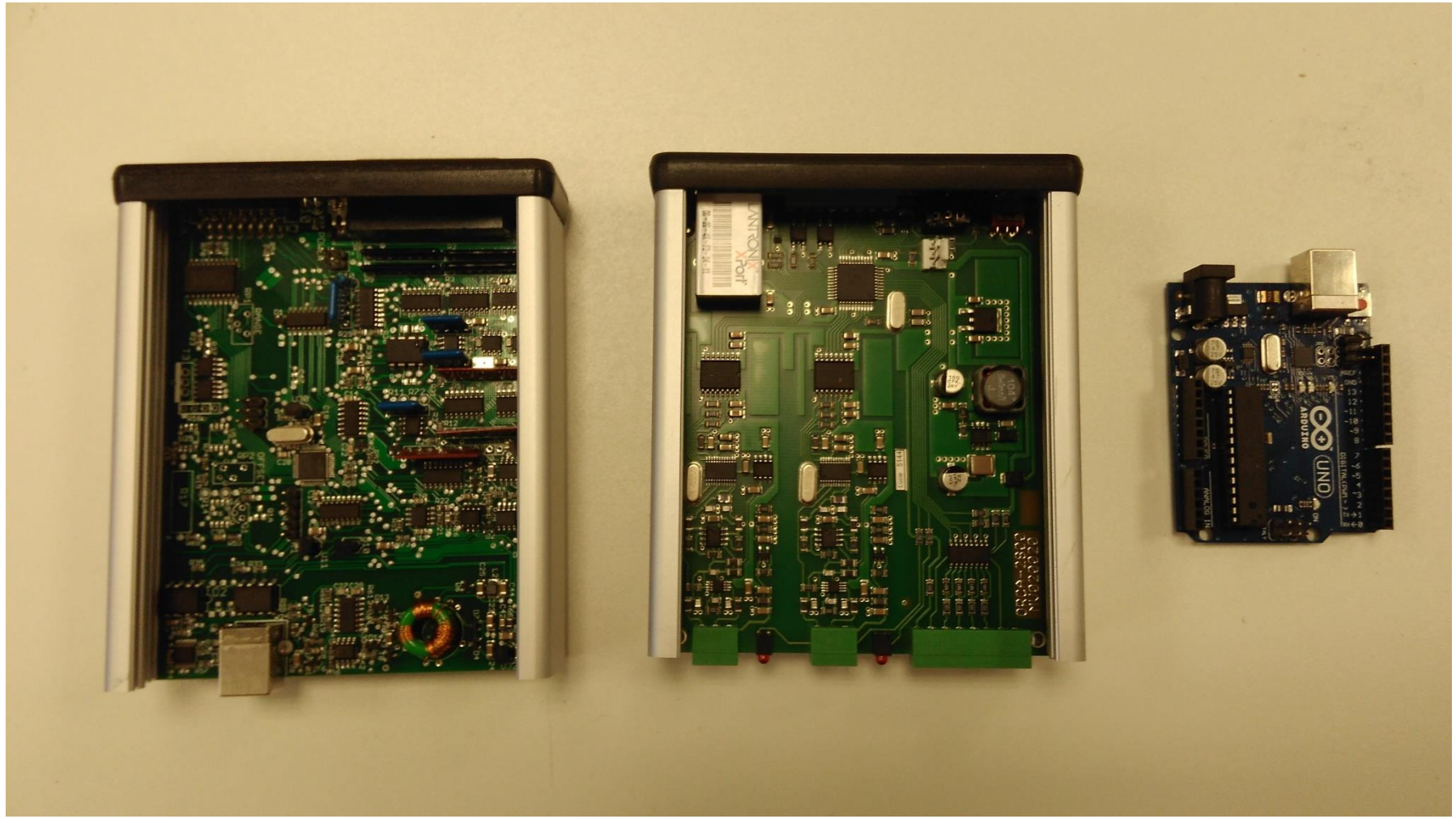
ARDUINO
UNO


ARDUINO
UNO

Application Report

SBAA051A–January 1994–Revised April 2015

Principles of Data Acquisition and Conversion

http://www.ti.com/lit/an/sbaa051a/sbaa051a.pdf

AN1636
APPLICATION NOTE

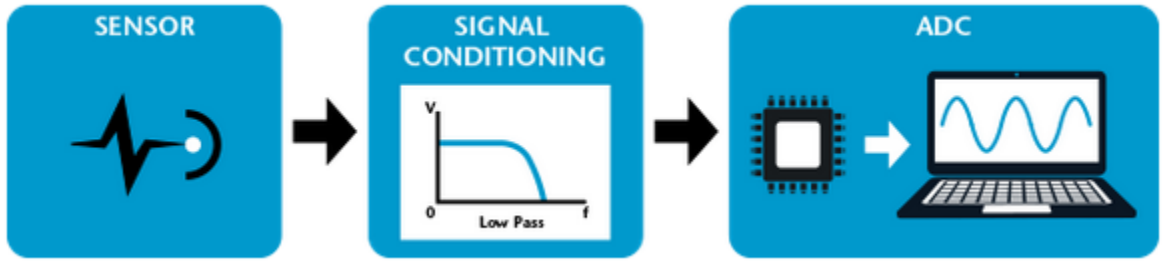
UNDERSTANDING AND MINIMISING ADC CONVERSION ERRORS

By Microcontroller Division Applications

https://www.st.com/content/ccc/resource/technical/document/application_note/9d/56/66/74/4e/97/48/93/CD00004444.pdf/files/CD00004444.pdf/jcr:content/translations/en.CD00004444.pdf

DATA ACQUISITION

Process of acquiring analog signals and converting these signals into digital form



Parameters of DAQ device to consider

Sampling frequency
Bit resolution
Voltage Range

SIGNAL DISTORTION DURING DATA ACQUISITION

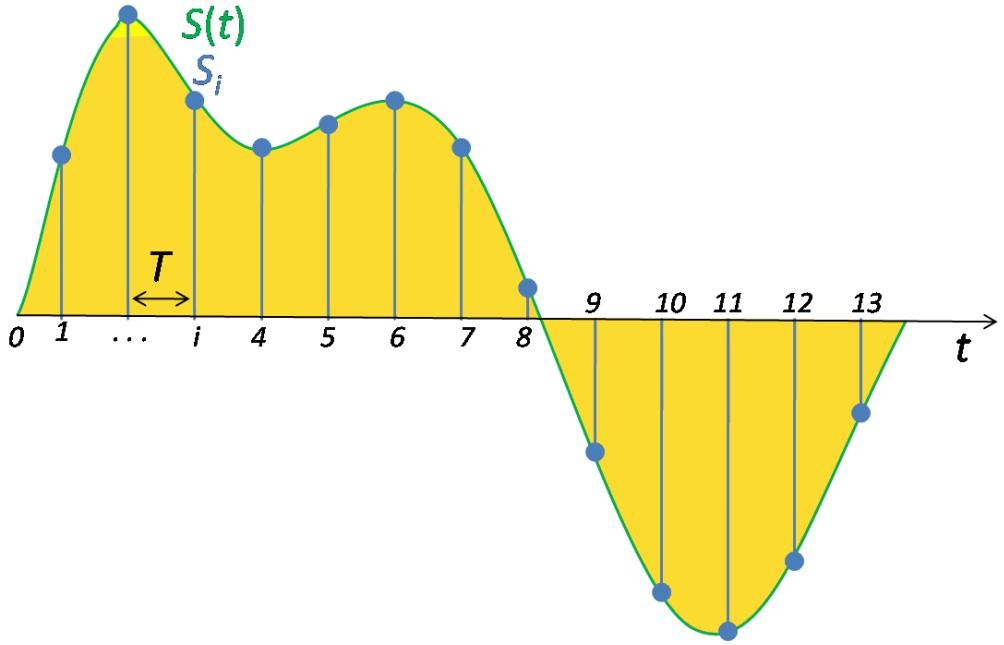
- Aliasing
- Aperture error
- Jitter
- Noise
- Slew rate limit error
- Quantization error
- Error due to other non-linear effects of the mapping of input voltage to converted output value (in addition to the effects of quantization).

SAMPLING FREQUENCY / RATE

Nyquist–Shannon sampling theorem

It establishes a sufficient condition for a sample rate that permits a discrete sequence of *samples* to capture all the information from a continuous-time signal of finite bandwidth.

The conversion involves quantization of the input, so it necessarily introduces a small amount of error or noise.



SAMPLING FREQUENCY / RATE

The highest frequency component in an analog signal determines the bandwidth of that signal.

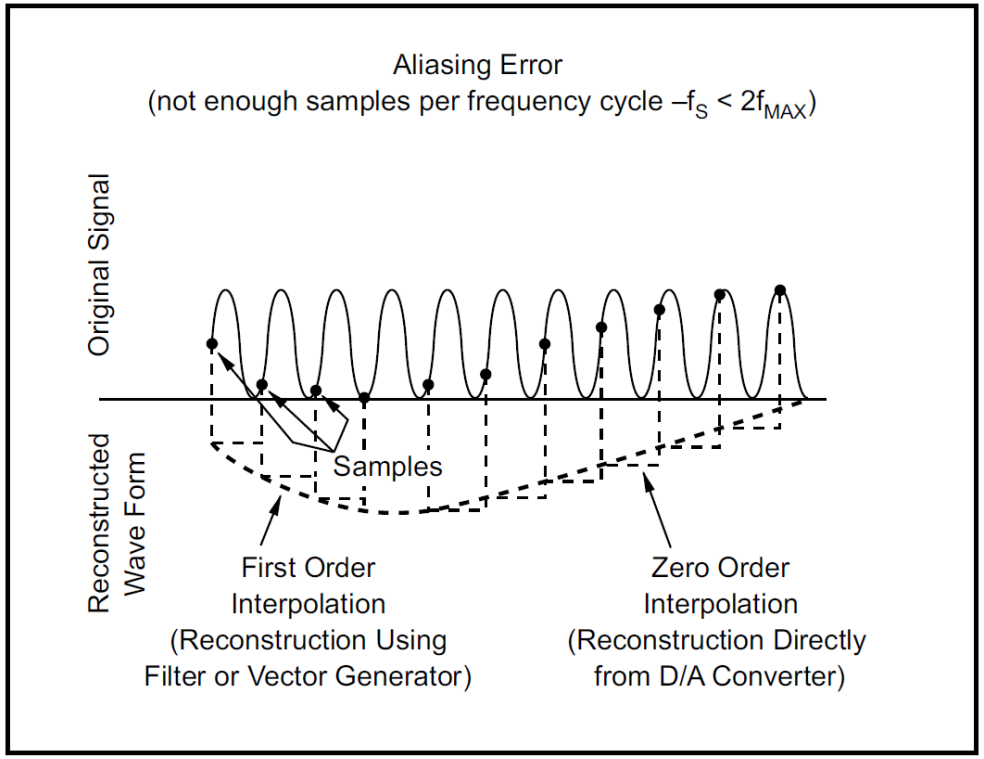
According to the Nyquist Theorem, the sampling rate must be at least $2f_{max}$, or twice the highest analog frequency component.

When such a digital signal is converted back to analog form by a digital-to-analog converter, false frequency components appear that were not in the original analog signal. This undesirable condition is a form of distortion called aliasing.

ALIASING ERROR

From the Nyquist sampling theorem, a minimum of two samples per cycle of the data bandwidth is required in an ideal sampled data system to reproduce sampled data with no loss of information.

aliasing error caused from an insufficient number of samples per cycle of data bandwidth



DATA RECONSTRUCTION

2 samples per cycle of sinusoidal data are taken, and the data is reconstructed directly from an unfiltered D/A converter (zero order reconstruction)

The average error between the reconstructed data and the original signal

32% for zero order data, and 14% for first order reconstruction

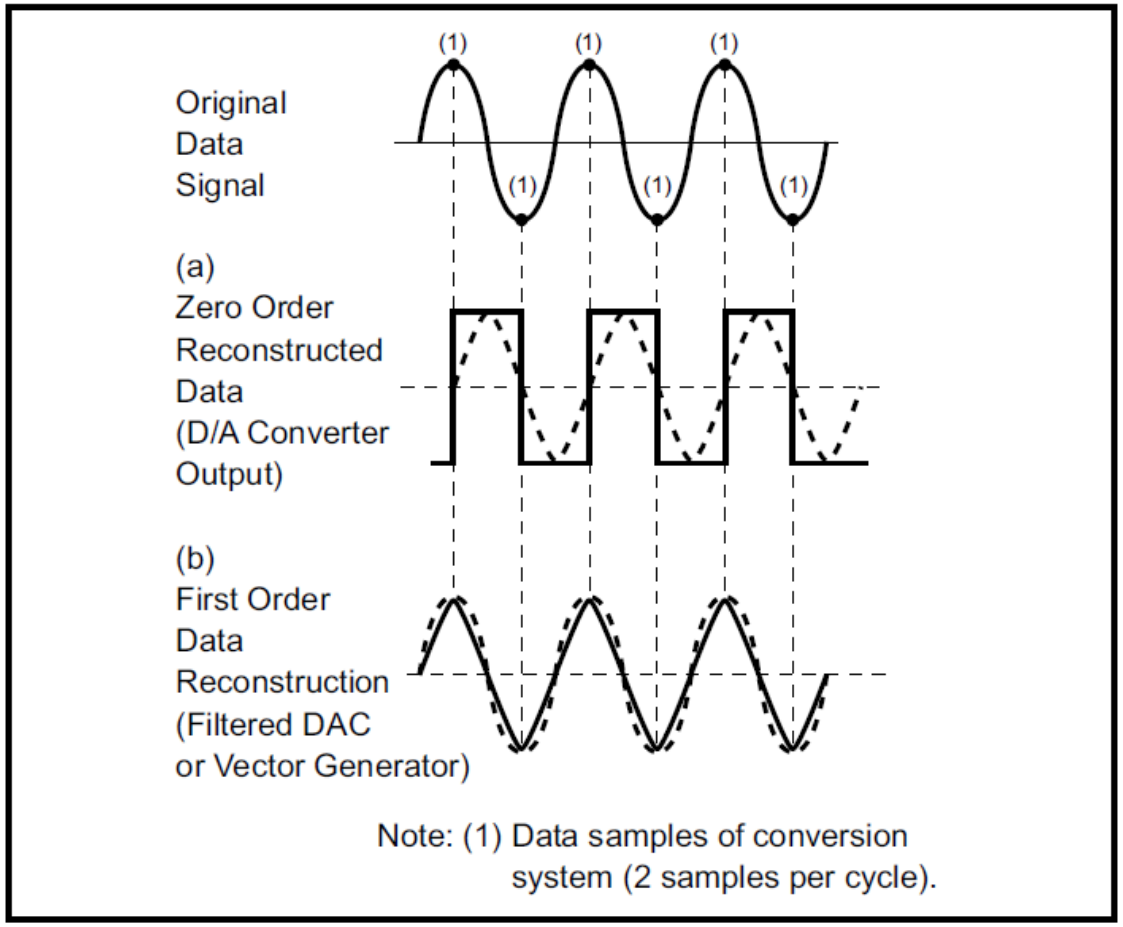


Figure 3. Reconstruction of Sampled Data Where $f_s = 2f_{MAX}$

DATA RECONSTRUCTION ACCURACY

The improvement in average accuracy of sampled data is dramatic with only a slight increase in the number of samples per cycle

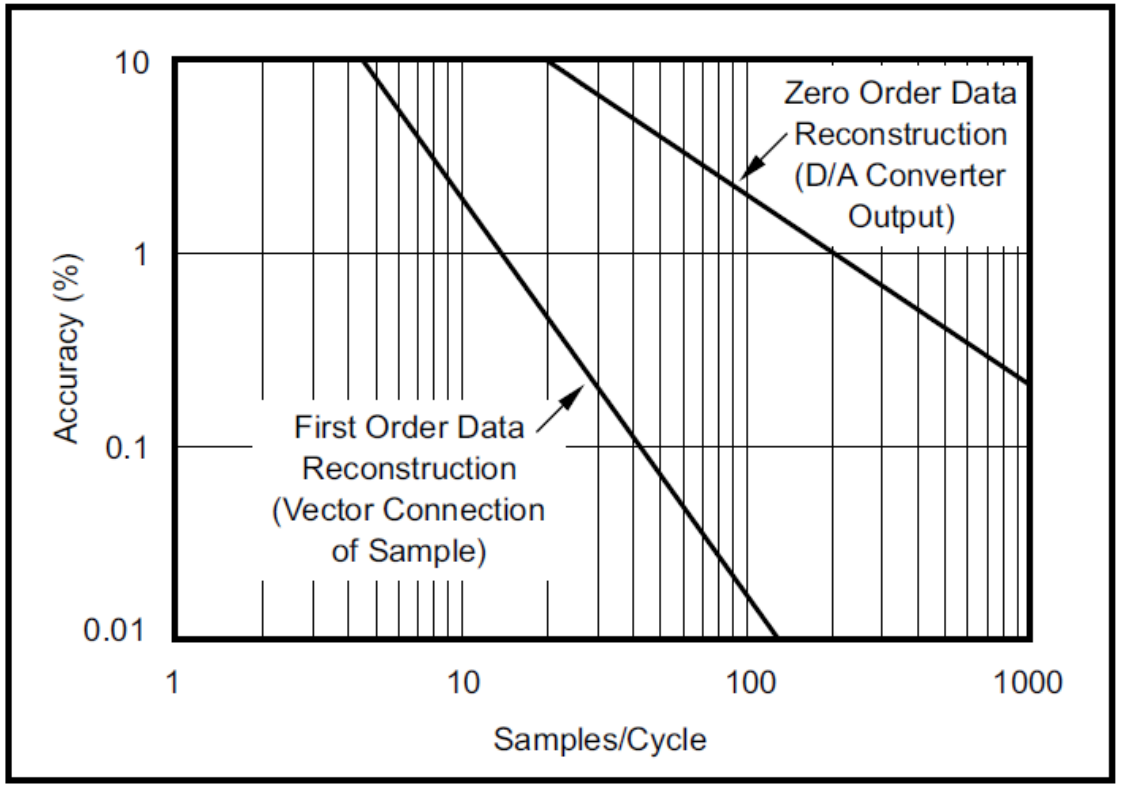
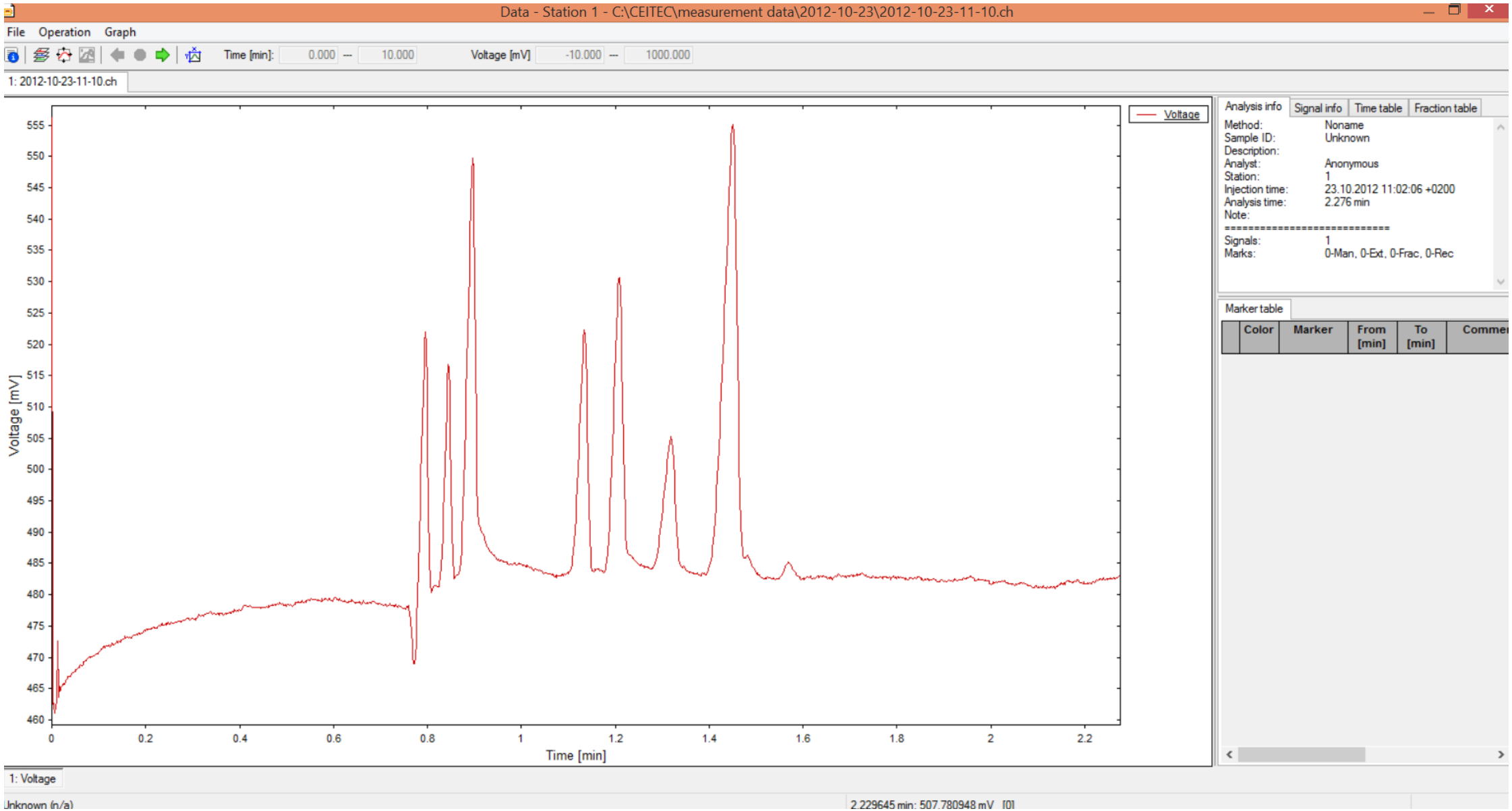
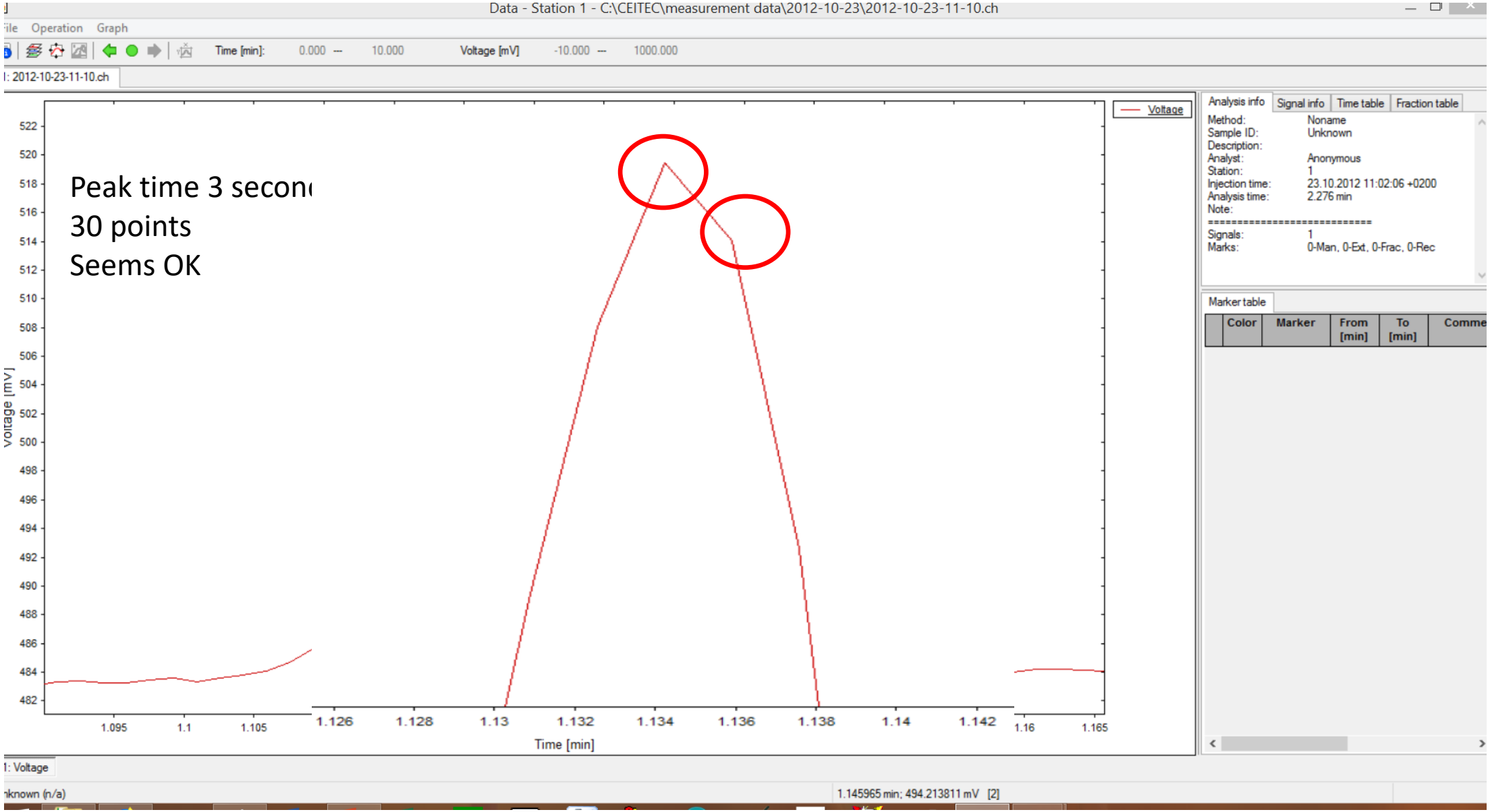


Figure 4. Reconstruction Accuracy vs Number of Samples Per Cycle

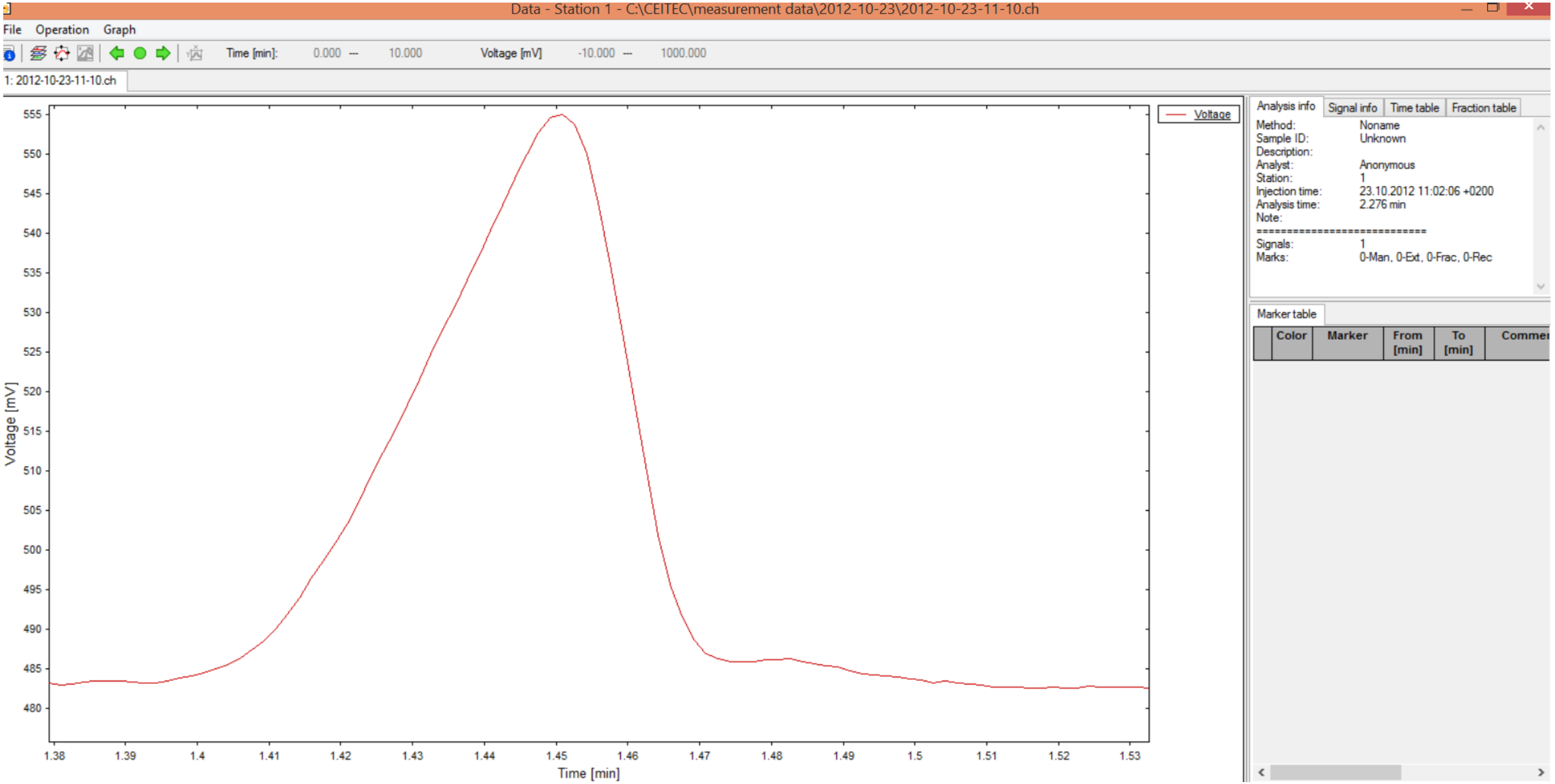
ANION ANALYSIS BY CE C4D, sampling frequency 10 Hz



ANION ANALYSIS BY CE C4D, sampling frequency 10 Hz formate peak



ANION ANALYSIS BY CE C4D, sampling frequency 10 Hz acetate peak



BIT RESOLUTION

The resolution of the converter indicates the number of discrete values it can produce over the range of analog values.

The resolution determines the magnitude of the quantization error and therefore determines the maximum possible average signal-to-noise ratio for an ideal ADC without the use of oversampling.

For example, an ADC with a resolution of 8 bits can encode an analog input to one in 256 different levels ($2^8 = 256$). The values can represent the ranges from 0 to 255 (i.e. unsigned integer) or from −128 to 127 (i.e. signed integer), depending on the application.

1-bit	0 , 1	2 signal levels
2-bit	00, 01, 10, 11	4 signal levels
3-bit	000, 001, 010, 011, 100, 101, 110, 111	8 signal levels
x x x x x		
10-bit		1024 levels
12-bit		4096 levels
16-bit		65536 levels
20-bit		1 048 576 levels
24-bit		16 777 216 levels

Voltage	2-Bit Digital Representation
0 to 2.5	00
2.5 to 5	01
5 to 7.5	10
7.5 to 10	11

MINIMUM DETECTABLE SIGNAL CHANGE in 0-1V range

10-bit converter	1000/1024 mV	1 mV
16-bit converter	1000/65536 mV	0.015 mV
24-bit converter	1000/16 777 216	60 nV

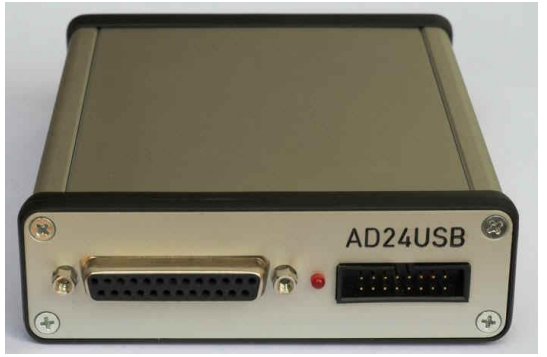
WHICH ONE WOULD YOU CHOOSE ?

12 –bit

69 USD

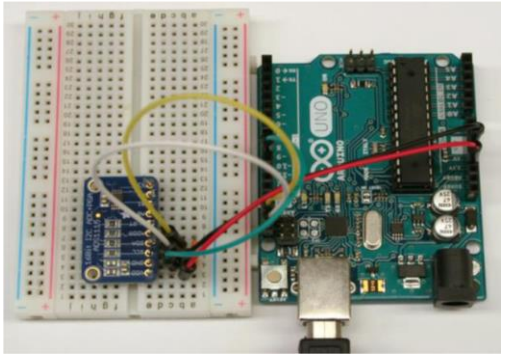
24 –bit

1000 USD



24 –bit

500 USD



16 –bit

50 USD

Model DI-1100

- Four ±10 V Differential Analog Inputs
- 12-bit Resolution
- High sample rates per channel (dependent on the number of channels enabled):
  - 40 kHz, 1 enabled channel
  - 30 kHz, 2 enabled channels
  - 24 kHz, 3 enabled channels
  - 20 kHz, 4 enabled channels

Includes a DI-1100 instrument, a 6-foot USB cable, a screwdriver for signal connections, and downloadable WinDaq software

$59.00

Qty: 1

Add to Cart

Availability: In Stock

Order before 3PM ET for Same Day Shipping

Condition: New

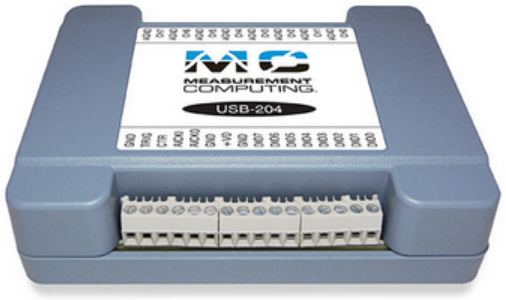
Model DI-1120	•14-bit analog-to-digital resolution •160 kHz sample throughput rate	$178.00
Model DI-2108	•Up to 16-bit analog-to-digital resolution •Up to 220 kHz sample throughput rate (160 kHz throughput for analog channels)	$259.00

MEASUREMENT COMPUTING™

https://www.mccdaq.com/

USB-200 Series ★★★★½ REVIEWS (54)

Single Gain Multifunction USB Devices



Product Data Sheets - (PDF printable)

Software and Driver Downloads

RoHS CE

KEY HIGHLIGHTS

The USB-200 Series of USB data acquisition (DAQ) devices provide higher sampling speeds compared to similarly priced 12-bit DAQ devices. Each device provides analog input, digital, and counter functions, and up to two analog outputs. OEM versions are available for embedded applications.

ANALOG INPUT		
CHANNELS	RESOLUTION	MAX SAMPLE RATE
Up to 8 SE	12-bit	Up to 500 kS/s
SAMPLING	RANGES	ISOLATION
Multiplexed	±10 V	—

ANALOG OUTPUT		
CHANNELS	RESOLUTION	SPEED
2	12-bit	Up to 250 S/s

DIGITAL I/O		
CHANNELS	COUNTER/TIMERS	ENCODER
Up to 8	Up to 1	—

SOFTWARE		POWER
OS SUPPORT	DRIVERS	POWER
Windows®, Android™, and Linux®	Universal Library™ SW Suite	Bus powered

PRICE 99 USD

USB-230 Series ★★★★½ REVIEWS (7)

Multifunction USB Devices

Product Data Sheets - (PDF printable)

Software and Driver Downloads

RoHS

KEY HIGHLIGHTS

The USB-230 Series of USB data acquisition (DAQ) devices provide improved cost/performance compared to our similarly priced 16-bit DAQ devices. Each device provides analog input and output along with digital and counter functions. OEM versions are available for embedded applications.

ANALOG INPUT		
CHANNELS	RESOLUTION	MAX SAMPLE RATE
8 SE/4 DIFF	16-bit	Up to 100 kS/s
SAMPLING	RANGES	ISOLATION
Multiplexed	±10 V	—

ANALOG OUTPUT		
CHANNELS	RESOLUTION	SPEED
2	16-bit	5 kS/s

DIGITAL I/O		
CHANNELS	COUNTER/TIMERS	ENCODER
8	1	—

SOFTWARE		POWER
OS SUPPORT	DRIVERS	POWER
Windows®	Universal Library™ SW Suite	Bus powered

PRICE 260 USD

USB-TEMP and TC Series ★★★★½ REVIEWS (61)

Low-Speed Temperature and Voltage USB Devices

Product Data Sheets - (PDF printable)

Software and Driver Downloads

KEY HIGHLIGHTS

The USB-TEMP and TC Series USB data acquisition (DAQ) devices provide highly accurate temperature measurements. Each device provides analog input along with digital and counter functions, and cold junction compensation (CJC). Available with support for thermocouple, RTD, thermistor, and semiconductor sensors.

ANALOG INPUT

CHANNELS	RESOLUTION	MAX SAMPLE RATE	SAMPLING
Up to 8 DIFF	24-bit	2 S/s/ch	Multiplexed

RANGES	ISOLATION
Varies by sensor type	500 V ch-host

SENSOR

THERMOCOUPLE	RTD	THERMISTOR	VOLTAGE
All	USB-TEMP USB-TEMP-AI	USB-TEMP USB-TEMP-AI	USB-TEMP-AI USB-TC-AI

ANALOG OUTPUT

CHANNELS	RESOLUTION	SPEED
—	—	—

DIGITAL I/O

CHANNELS	COUNTER/TIMERS	ENCODER
8	1/—	—

SOFTWARE | **POWER**

OS SUPPORT	DRIVERS	POWER
Windows®, Android™, and Linux®	Universal Library™ SW Suite	Bus powered

PRICE 375 USD

USB-2408 Series

REVIEWS (17)

High Precision Thermocouple, Voltage USB Devices

Product Data Sheets - (PDF printable)

Software and Driver Downloads

RoHS

KEY HIGHLIGHTS

The USB-2408 Series of USB data acquisition (DAQ) devices have 24-bit resolution for highly accurate measurements. Features include thermocouple or voltage configuration per channel along with digital and counter functions. Up to two analog outputs are available.

ANALOG INPUT			
CHANNELS	RESOLUTION	MAX SAMPLE RATE	SAMPLING
16 SE/8 DIFF	24-bit	1 kS/s	Multiplexed
RANGES		ISOLATION	
±10 V, ±5 V, ±2.5 V, ±1.25 V, ±625 mV, ±312.5 mV, ±156.25 mV, ±78.125 mV		500 VDC ch-host	

SENSOR			
THERMOCOUPLE	RTD	THERMISTOR	VOLTAGE
Yes	—	—	Yes

ANALOG OUTPUT		
CHANNELS	RESOLUTION	SPEED
Up to 2	16-bit	Up to 1 kS/s

DIGITAL I/O		
CHANNELS	COUNTER/TIMERS	ENCODER
8	2/—	—

SOFTWARE		POWER
OS SUPPORT	DRIVERS	POWER
Windows® and Linux®	Universal Library™ SW Suite	Bus powered

PRICE 630 USD

DAQami™ v4.2.1 ★★★★½ REVIEWS (32)

Data Acquisition Companion Software for Acquiring Data and Generating Signals

Quick Start Guide - (PDF printable)

Product Data Sheets - (PDF printable)

KEY HIGHLIGHTS

DAQami provides an intuitive drag-and-drop interface for users to quickly and easily become familiar with the features of a data acquisition (DAQ) device, acquire data, and generate signals. DAQami is ideal for interactive testing, data logging, and developing applications that run for minutes or days.

Learn how to acquire data and generate signals with DAQami: Click here to view this video on YouTube.

- **Out-of-the-box data acquisition companion software for supported USB, Ethernet, and Bluetooth® DAQ devices**
- **Easy-to-use drag-and-drop interface**
- **Supports multiple devices for concurrent data input and output applications**
- **Acquire and log virtually unlimited samples from analog, digital, and counter input channels**
- **Generate signals from analog, digital, and counter/timer output channels**
- **Export acquired data to a .csv file for use in Microsoft® Excel® or MATLAB®**
- **English, Chinese, and German language support**
- **Supported Operating Systems: Windows® 10/8/7/Vista®, 32-bit or 64-bit**
- **View supported MCC hardware**

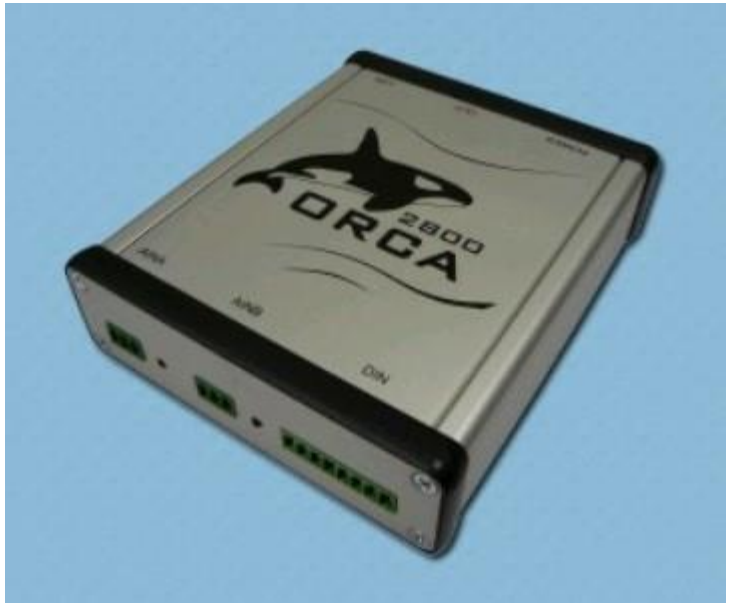
Try DAQami for 30 Days

Download and install DAQami and try the fully-functional software for 30 days. After 30 days, all features except for data logging and data export will continue to be available. Data logging and data export features can be unlocked by purchasing the software.

PRICE 49 USD

ORCA 2800 ECOM s.r.o

http://www.ecomsro.com/en/s40-product/sw-hw/c283-hw/p632-orca-2800-ad-converter



two channels **24bit** A/D converter with two analog and four digital inputs

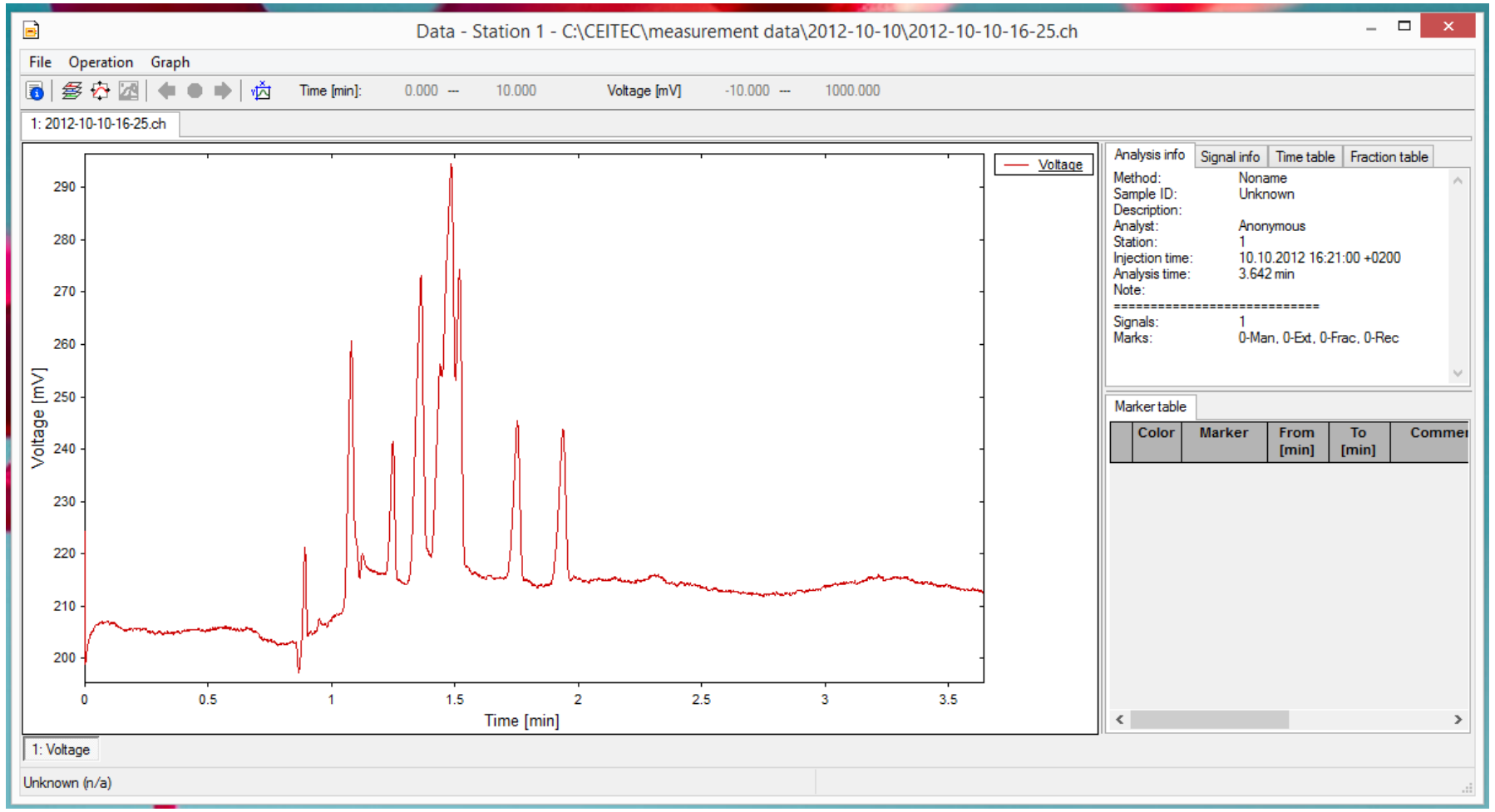
Sampling rates: 2, 5, 10, 20, 50, 60, 100, 200, 400, 800 sps

Voltage ranges ± 250mV, ± 2V, ± 20V

PRICE 800 EUR

SOFTWARE

http://www.ecomsro.com/en/s124-detail/special/c262-ecomac



JANAS CARD

http://www.janascard.cz/aHome.html

data acquisition module with high resolution up to 26 bits

sampling rate 3 samples/s

resolution from 22 to 26 bits with galvanic isolation from USB

sampling rate from 80 to 3 samples/s

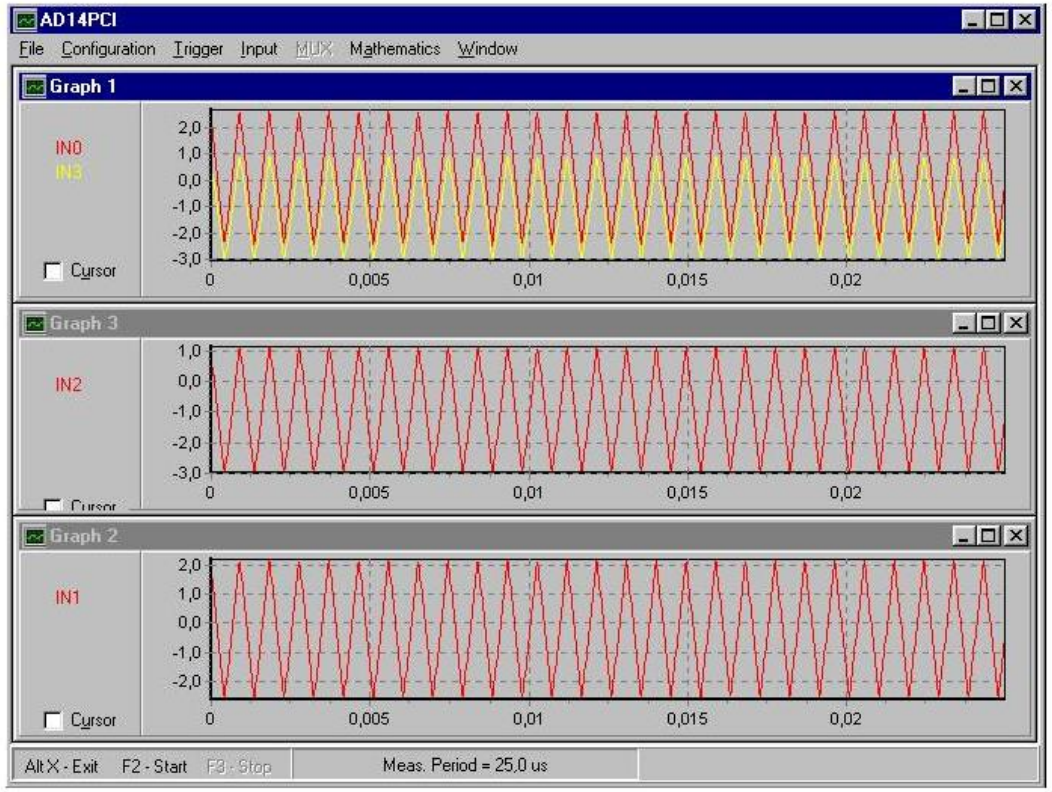
input range 10 V/ +-5 V, programmable gain 1 to 128

PRICE 400 EUR

SOFTWARE

Software ADcontrol

is powerful and user-friendly software running under Windows XP/Vista/7 for **AD14ETH** and its simplified version (without FFT and digital filtering) comes with **AD24USB/AD24ETH** and **AD16USB**.



Features:
graphical data displaying, zoom, cursors, graph copy to other applications

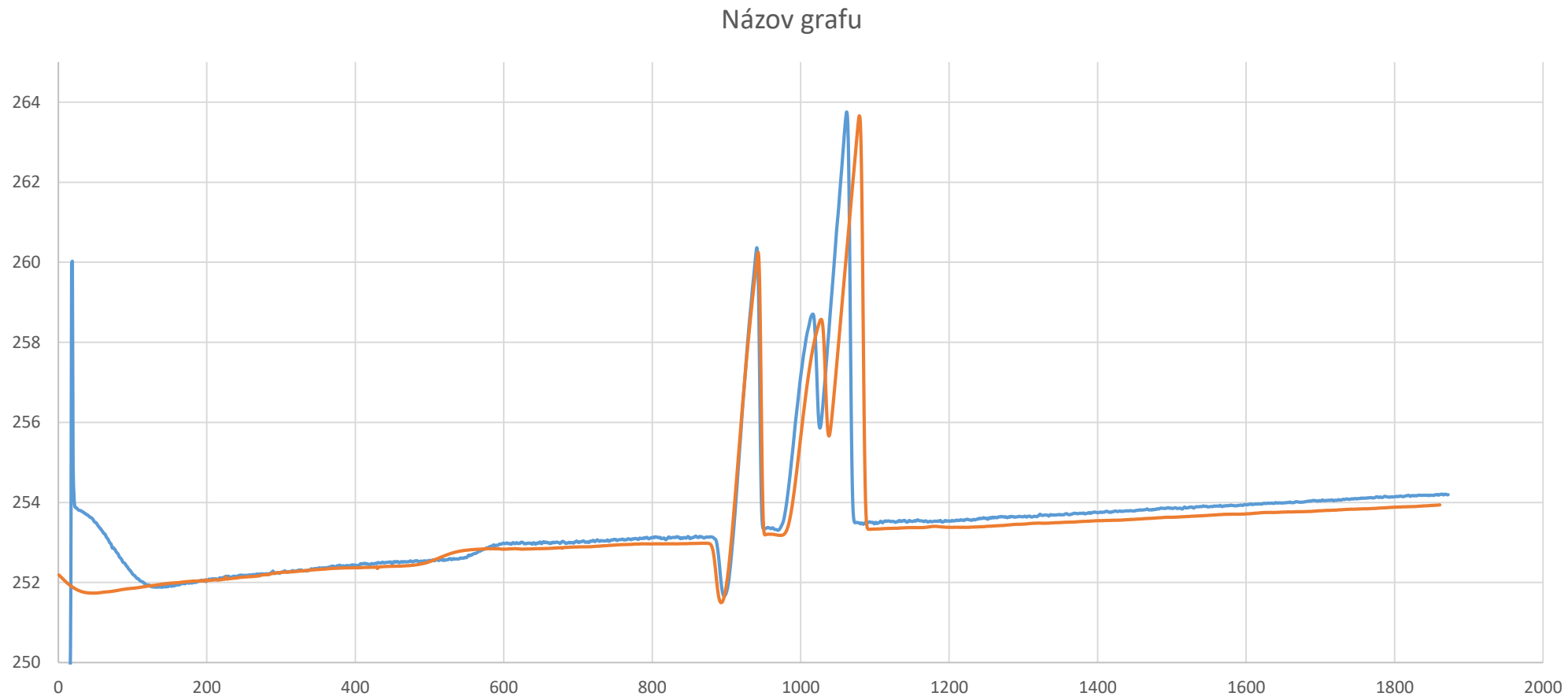
FFT with length up to 128 k samples

digital filters, filter type Butterworth, Chebychev, Bessel, max filter order 8, low pass, high pass, band pass, band stop

temperature measurement with Pt100, thermocouples

store data in binary and ASCII format - can be simply read in EXCEL, Matlab etc.

the software is optimised for work with a large amount data - up to 100 000 000 samples.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262
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1600
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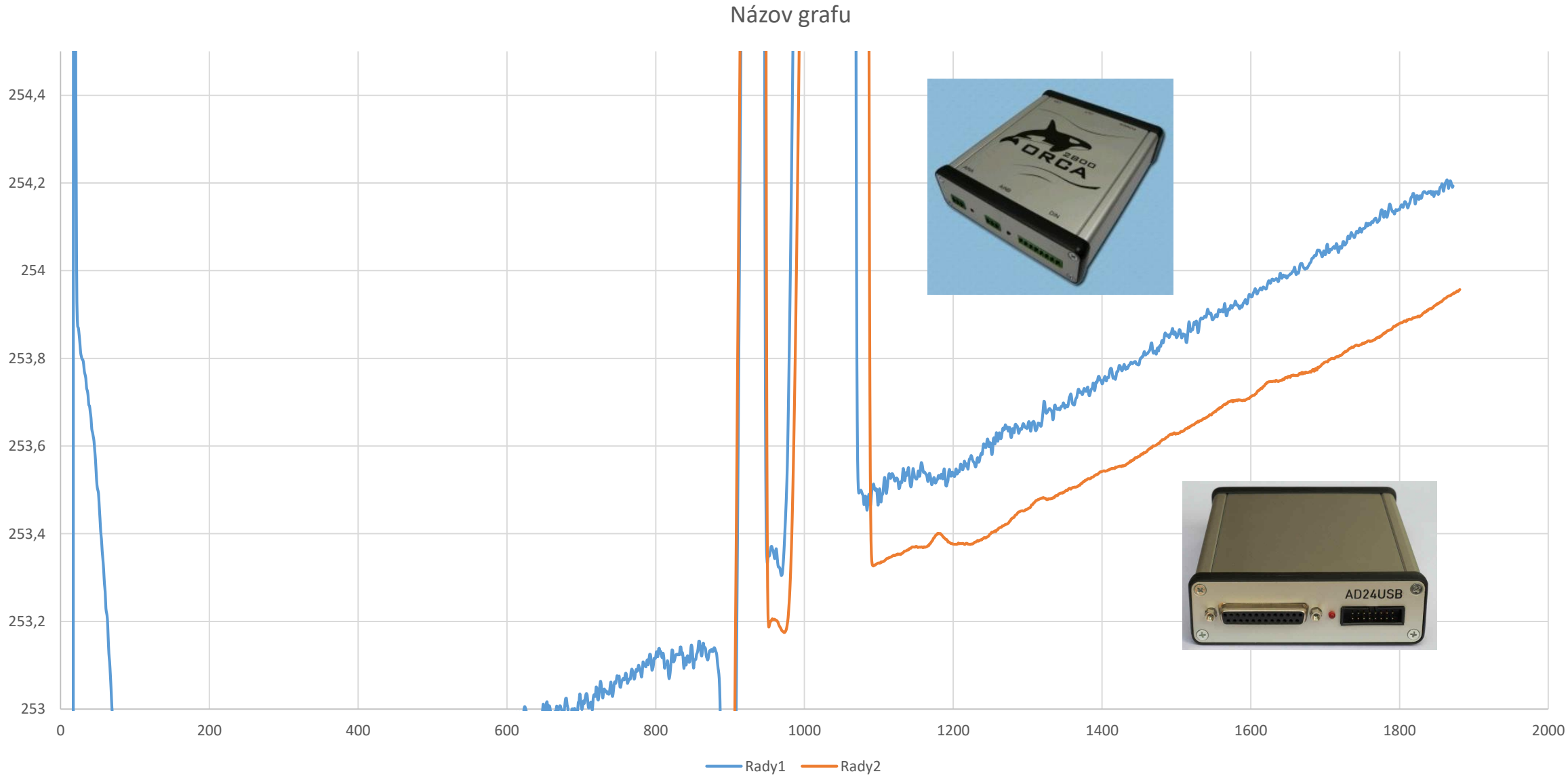
2000

BOTH 24-BIT DAQ



OPEN SOURCE DAQ BASED ON ARDUINO

https://playground.arduino.cc/uploads/Main/arduino_notebook_v1-1.pdf

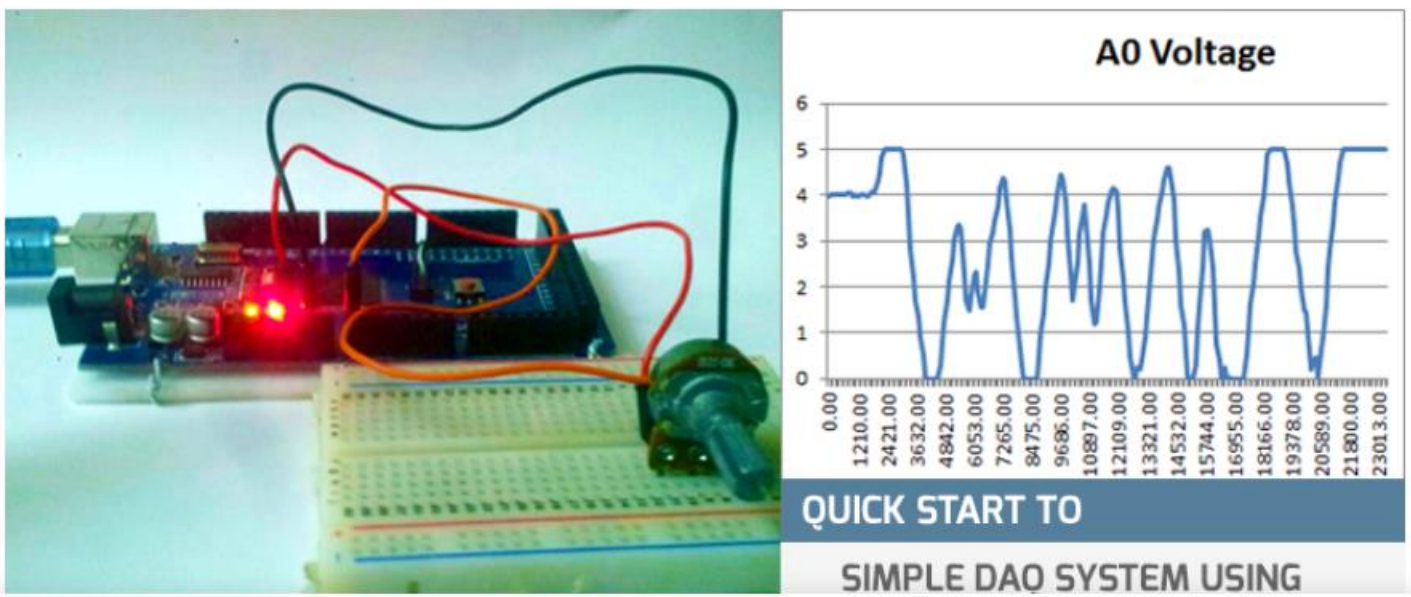
https://www.arduino.cc/en/Tutorial/ReadAnalogVoltage

```
/*
  ReadAnalogVoltage

  Reads an analog input on pin 0, converts it to voltage, and prints the result to the Serial Monitor.
  Graphical representation is available using Serial Plotter (Tools > Serial Plotter menu).
  Attach the center pin of a potentiometer to pin A0, and the outside pins to +5V and ground.

  This example code is in the public domain.

  http://www.arduino.cc/en/Tutorial/ReadAnalogVoltage
*/

// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);
  // Convert the analog reading (which goes from 0 - 1023) to a voltage (0 - 5V):
  float voltage = sensorValue * (5.0 / 1023.0);
  // print out the value you read:
  Serial.println(voltage);
}
```

https://medium.com/@islamnegm/quick-start-to-simple-daq-system-using-plx-daq-excel-arduino-d2457773384b

Islam Negm (Mr.Bit) Follow
Electrical Engineer totally passionate about (Programming Embedded Systems, Electronics, Electrical Machines, UI and UX Design).
Jul 16, 2016 · 5 min read

Quick Start to Simple DAQ System using PLX-DAQ Excel & Arduino



https://www.parallax.com/downloads/plx-daq

PLX-DAQ

Download Summary

Parallax Data Acquisition tool (PLX-DAQ) software add-in for Microsoft Excel acquires up to 26 channels of data from any Parallax microcontrollers and drops the numbers into columns as they arrive. PLX-DAQ provides easy spreadsheet analysis of data collected in the field, laboratory analysis of sensors and real-time equipment monitoring.

File Name	Size	Upload Date
PLX-DAQ.zip	1.96 MB	Tue, 2014-02-18 14:42

Download Version & Details

PLX-DAQ Features

PLX-DAQ is a Parallax microcontroller data acquisition add-on tool for Microsoft Excel. Any of our microcontrollers connected to any sensor and the serial port of a PC can now send data directly into Excel. PLX-DAQ has the following features:

- Plot or graph data as it arrives in real-time using Microsoft Excel
- Record up to 26 columns of data
- Mark data with real-time (hh:mm:ss) or seconds since reset
- Read/Write any cell on a worksheet
- Read/Set any of 4 checkboxes on control the interface
- Example code for the BS2, SX (SX/B) and Propeller available
- Baud rates up to 128K
- Supports Com1-15

A CHILD'S GUIDE TO DIRECT DATALOGGING WITH EXCEL

http://homepages.ihug.com.au/~npyner/Arduino/GUIDE_2PLX.pdf

A CHILD'S GUIDE TO DIRECT DATALOGGING WITH EXCEL

version 5 (All brickbats and bouquets gladly received - on the Arduino forum)

This is an aide memoire for the PLX-DAQ macro for Excel. Parallax do not address the use of their freebie with Arduino.

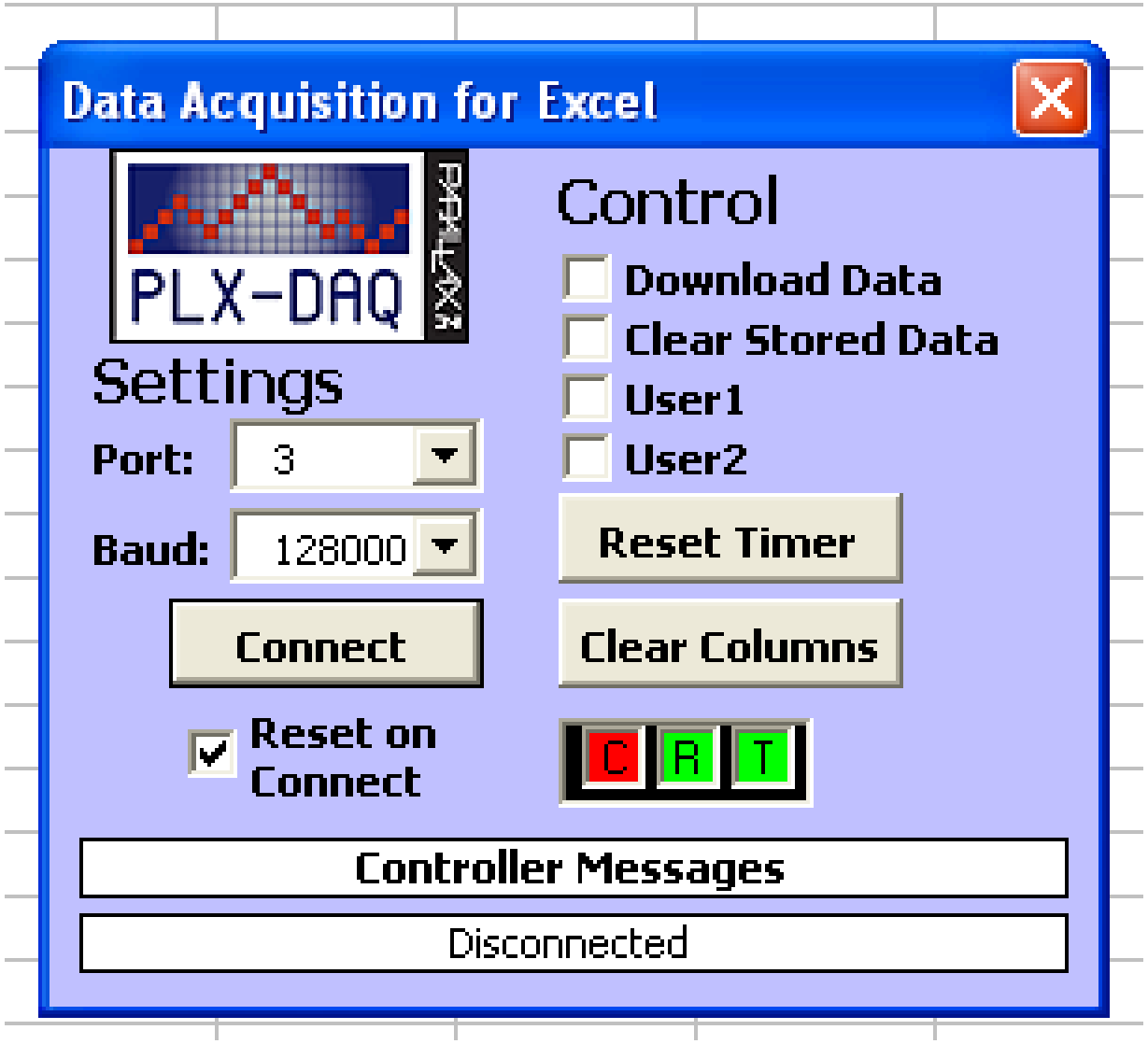
The objective is to use this macro in order to feed data direct from Arduino to Excel. Essentially, the macro enables Excel to work just like any other terminal programme but has the advantage of producing direct input into where you really want it, and it can give you live graphs as well as a data file. I'm sure you can get pretty sophisticated with the Excel commands, but this start might be all you need.

1. MINIMUM REQUIREMENTS

Hardware: Any Arduino capable of serial output to a PC
Software: Microsoft Office 2000, Windows XP
The PLX-DAQ macro for Excel. This available for free from

http://www.parallax.com/downloads/plx-daq

Note that there may be a "maximum requirement". I know that PLX is OK with Excel 2007 under Windows 7, but I'm not sure about later versions. It costs nothing to try it.
Note also that there is a limit to the number of COM ports that PLX can address which, for me, precludes the use of Bluetooth.


Data Acquisition for Excel
PLX-DAQ
Settings
Port:
3
Baud:
128000
Connect
Reset on Connect
Control
Download Data
Clear Stored Data
User1
User2
Reset Timer
Clear Columns
C
R
T
Controller Messages
Disconnected

```
unsigned long int milli_time;    //variable to hold the time

float voltage;         //variable to hold the voltage form A0

void setup() {
  Serial.begin(128000);               //Fastest baudrate
  Serial.println("CLEARDATA");        //This string is defined as a
                                      // commmand for the Excel VBA
                                      // to clear all the rows and
columns
  Serial.println("LABEL,Computer Time,Time (Milli Sec.),Volt");
                                      //LABEL command creates label
for
                                      // columns in the first row
with bold font
}

void loop() {
  milli_time = millis();
  voltage = 5.0 * analogRead(A0) / 1024.0;
  Serial.print("DATA,TIME,");
  Serial.print(milli_time);
  Serial.print(",");
  Serial.println(voltage);

  delay(100);                   //Take samples every one second
}
```

Chart Area

	A	B	C
1	Computer Time	Time (Milli Sec.)	Volt
2	20:43:34	0.00	2.45
3	20:43:34	100.00	2.52
4	20:43:34	201.00	2.53
5	20:43:34	302.00	2.53
6	20:43:34	402.00	2.45
7	20:43:34	503.00	2.32
8	20:43:34	604.00	2.16
9	20:43:34	704.00	2.03
10	20:43:34	805.00	1.87
11	20:43:35	906.00	1.72
12	20:43:35	1006.00	1.6
13	20:43:35	1107.00	1.52
14	20:43:35	1208.00	1.47
15	20:43:35	1308.00	1.47
16	20:43:35	1410.00	1.56
17	20:43:35	1510.00	1.7
18	20:43:35	1610.00	1.83
19	20:43:35	1712.00	1.95
20	20:43:35	1812.00	2.09
21	20:43:36	1913.00	2.19
22	20:43:36	2014.00	2.29
23	20:43:36	2114.00	2.31
24	20:43:36	2215.00	2.31
25	20:43:36	2316.00	2.21
26	20:43:36	2416.00	2.08
27	20:43:36	2518.00	1.93
28	20:43:36	2618.00	1.8
29	20:43:36	2719.00	1.64
30	20:43:36	2820.00	1.51
31	20:43:37	2920.00	1.37
32	20:43:37	3021.00	1.34
33	20:43:37	3122.00	1.3
34	20:43:37	3222.00	1.36
35	20:43:37	3323.00	1.46

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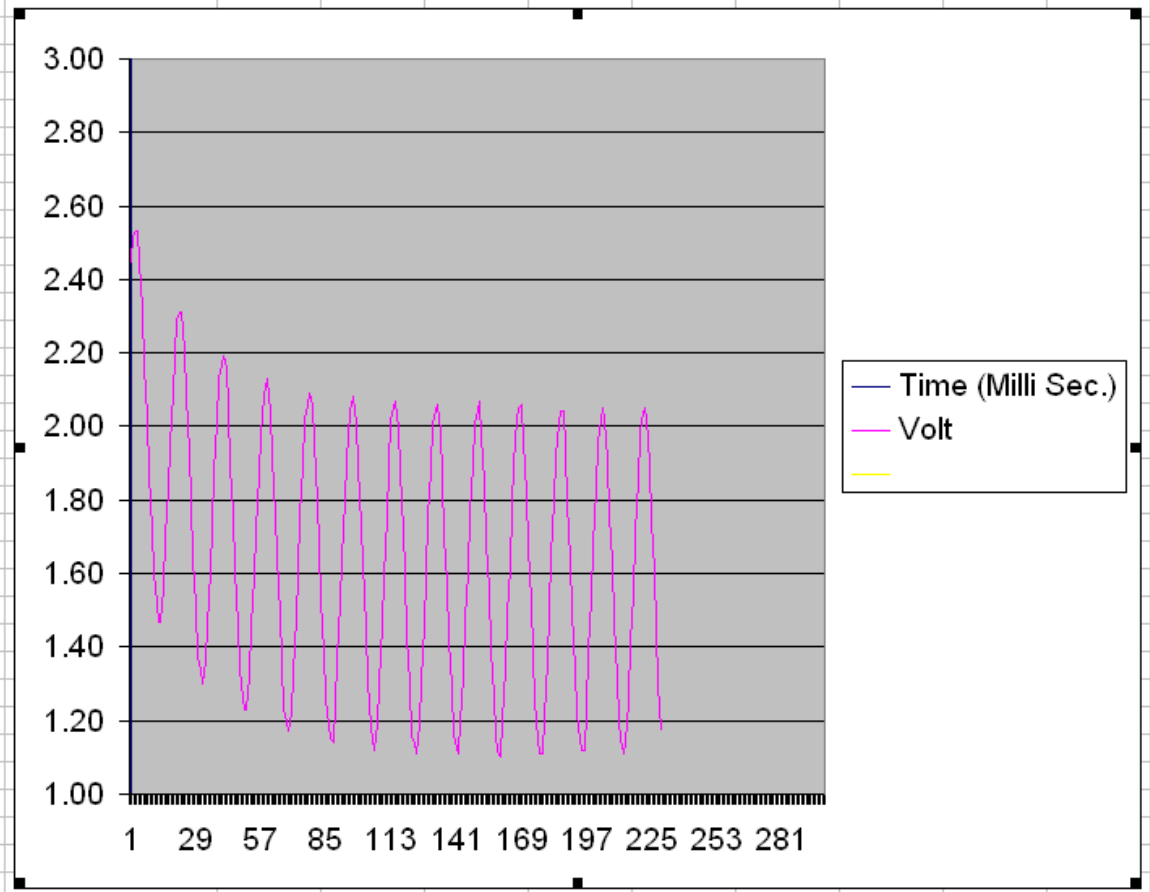

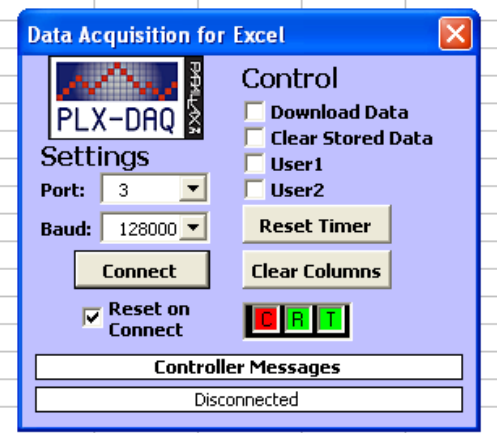

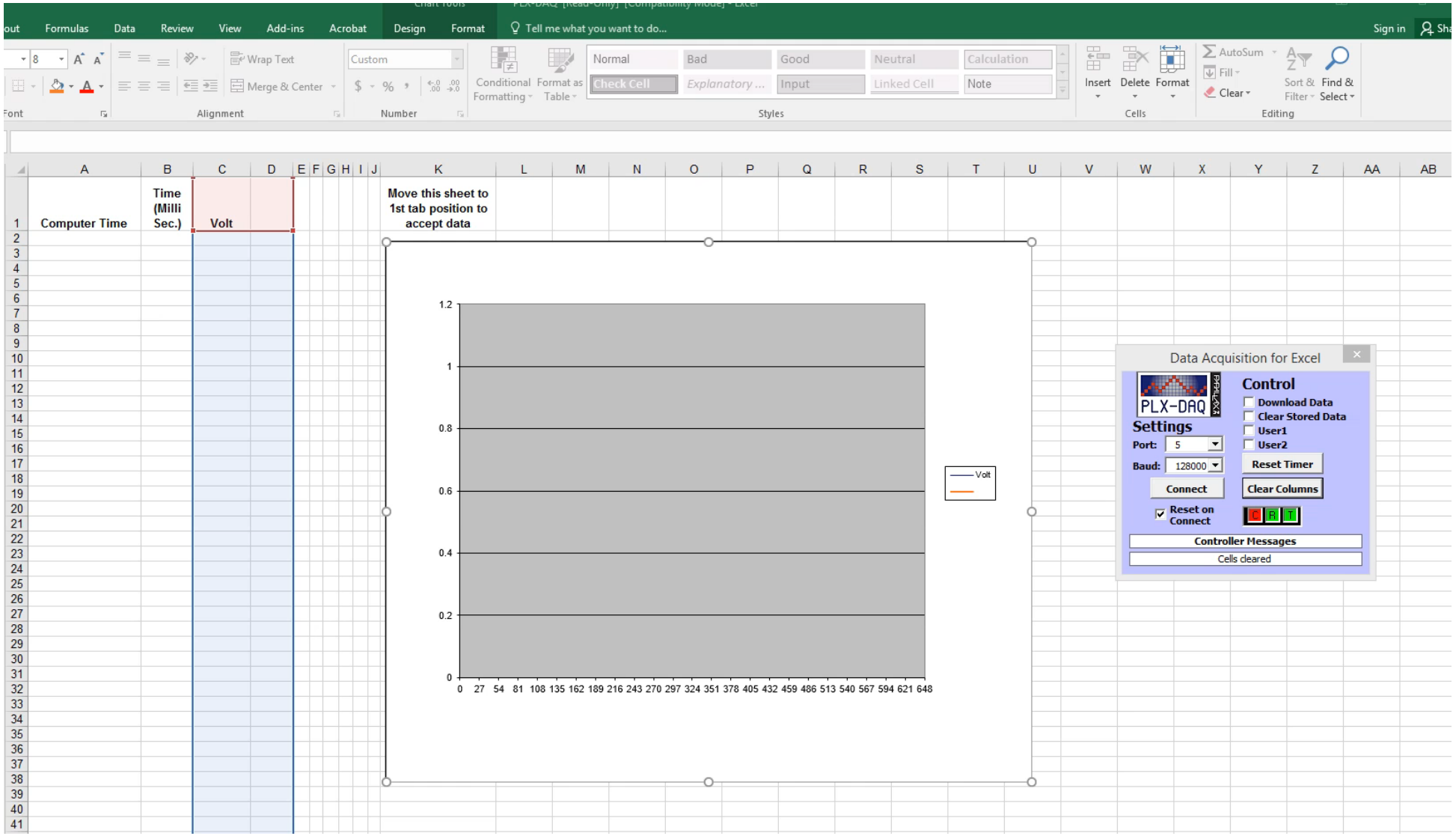
Formulas
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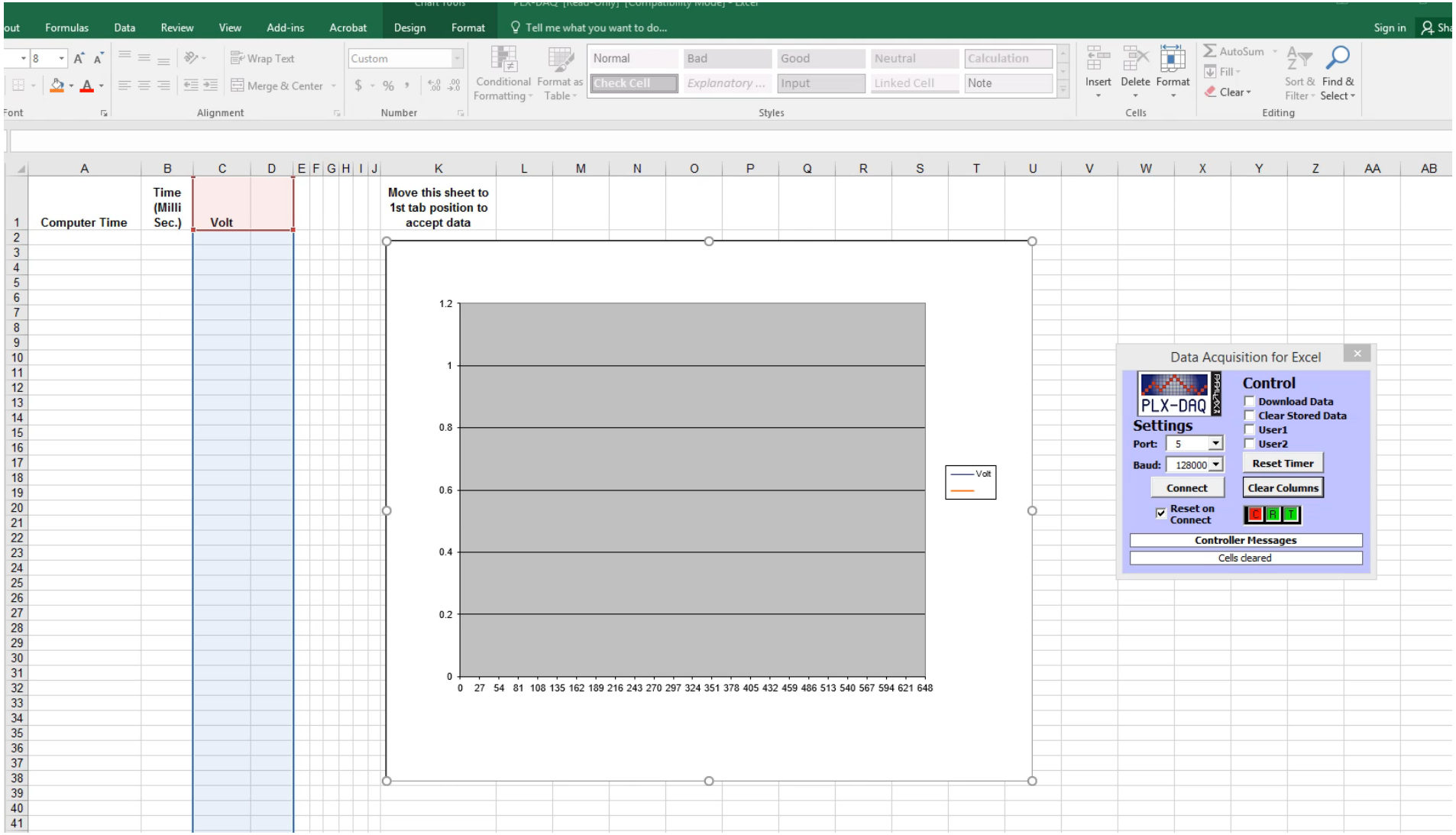
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Controller Messages
Cells cleared

JOURNAL OF CHEMICAL EDUCATION

Technology Report

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An Inexpensive, Open-Source USB Arduino Data Acquisition Device for Chemical Instrumentation

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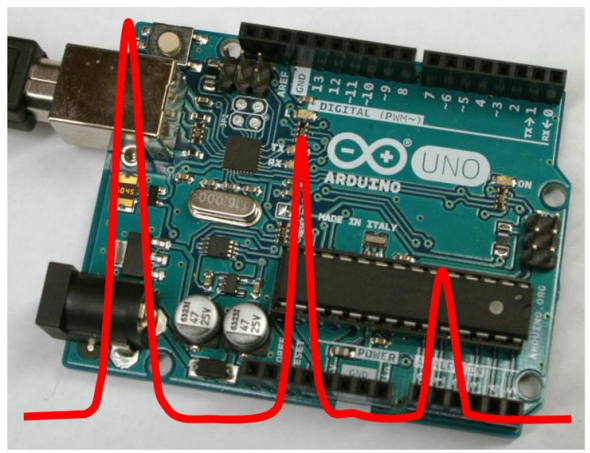
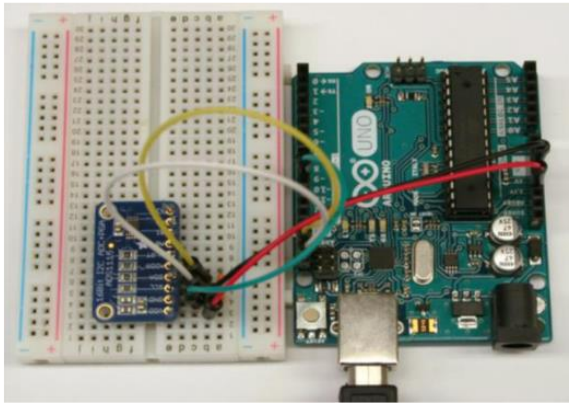


ARDUINO and ADS1115 16-bit DAC



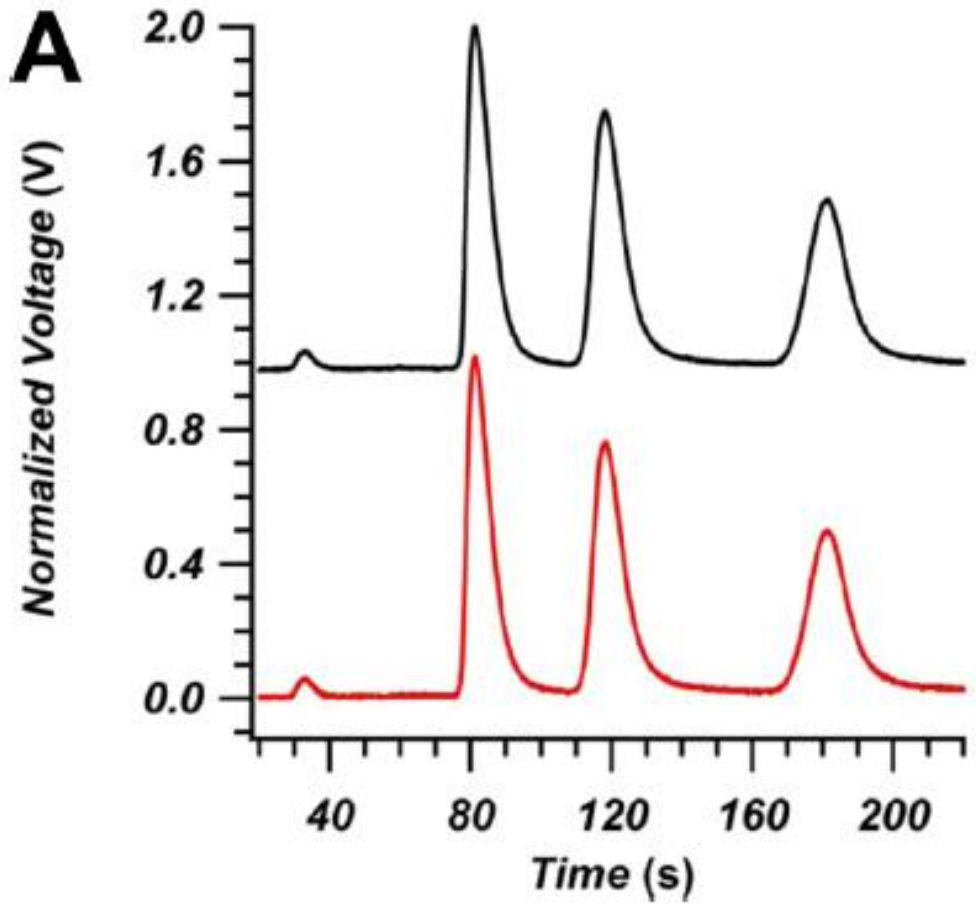
PARTS LIST

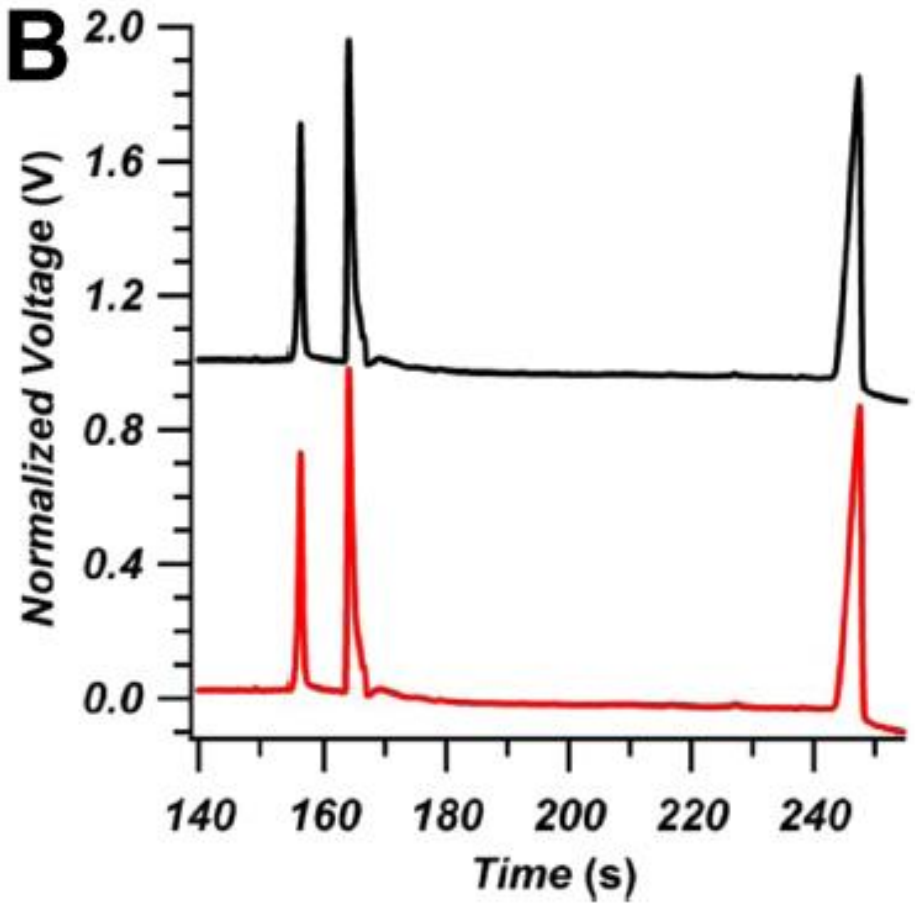
Component	Vendor	Part Number	Cost[1]
Arduino Uno Rev3[2]	Adafruit	50	$24.95
ADS 1115 Breakout Board	Adafruit	1085	$14.95
USB Type A-to-Type B Cable	Newark	96K1696	$1.12
Jumper Wire Assortment[3]	Newark	99W1758	$3.29
Solderless Breadboard	Newark	99W1759	$2.51
		Total:	$46.82

[1] Costs are based on website access at Adafruit (www.adafruit.com) and Newark (www.newark.com) in March 2016.

[2] Price list built from official components. Arduino Uno clones with cables can typically be found on eBay for approximately $5, bringing the total cost closer to $20.

[3] Wire assortment has 65 pieces, but only 8 are required for this design, so actual cost is closer to $0.41.





ARDUINO

INSTRUMENT

HPLC

CE

Electrophoresis 2018, 0, 1–14

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Review

Open source capillary electrophoresis

Open source paradigm is becoming widely accepted in scientific communities and open source hardware is finding its steady place in chemistry research. In this review article, we provide the reader with the most up-to-date information on open source hardware and software resources enabling the construction and utilization of an "open source capillary electrophoresis instrument". While CE is still underused as a separation technique, it offers unique flexibility, low-cost, and high efficiency and is particularly suitable for open source instrumental development. We overview the major parts of CE instruments, such as high voltage power supplies, detectors, data acquisition systems, and CE software resources with emphasis on availability of the open source information on the web and in the scientific literature. This review is the first of its kind, revealing accessible blueprints of most parts from which a fully functional open source CE system can be built. By collecting the extensive information on open source capillary electrophoresis in this review article, the authors aim at facilitating the dissemination of knowledge on CE within and outside the scientific community, fosters innovation and inspire other researchers to improve the shared CE blueprints.

Keywords:
Capillary electrophoresis / Open source hardware / Open source software / Review

DOI 10.1002/elps.201800304

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CONCLUSIONS

Wide range of products available, prices 70 to 1000 USD

Important parameters: bit resolution
sampling frequency
range setup

DYI Arduino based DAQ are an interesting option, price as low as 20-50 USD

True comparison of various devices would be needed to show their performance

Importance of the data storage and further analysis (integration, display)

Importance of sharing information