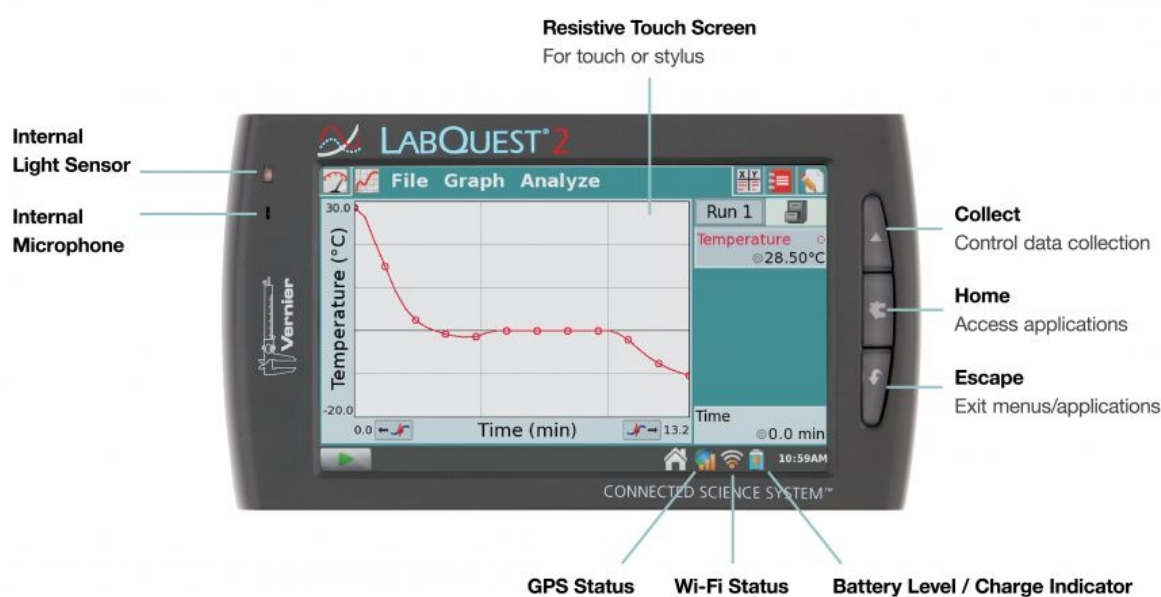


1 Merilne naprave

Pri fizikalnih eksperimentih pogosto uporabljamo merilne naprave, s katerimi želimo potrditi teoretične principe in fizikalne pojave. V šolskem prostoru najpogosteje uporabljamo Vernier-jevo merilno napravo LabQuest Hardware "LabQuest® Hardware and Specifications | Vernier", ki nam omogoča raznovrstne meritve.

1.1 Vernier's DAQs



Slika 1: Vernier-jeva merilna naprava LabQuest2

Poglejmo si nekaj podatkov o napravi:

- **Display**

- 11.2 cm x 6.7 cm (13.1 cm diagonal) screen
- 800 x 480 pixel color display at 188 dpi
- LED backlight
- portrait or landscape screen orientation
- high-contrast mode for outdoor visibility

- **Processor**

- 800 MHz Application Processor
- **Connectivity**
 - Wi-Fi 802.11 b/g/n @ 2.4GHz
 - Bluetooth Smart for WDSS and Go Wireless Sensors
- **User Interface**
 - Resistive touch screen
 - Touch and stylus navigation for efficiency and precision
- **Data Acquisition**
 - 100,000 samples per second
 - 12-bit resolution
 - Built-in GPS, 3-axis accelerometer, ambient temperature, light, and microphone
- **Environmental Durability**
 - Operating Temperature: 0 + 45°C
 - Storage Temperature: -30 + 60°C
 - Splash resistant
 - Rugged enclosure designed to withstand a fall from lab bench
- **Size and Weight**
 - Size: 8.8 cm x 15.4 cm x 2.5 cm
 - Weight: 350 g
- **Ports**
 - 5 sensor channels
 - USB port for sensors, flash drives, and peripherals
 - USB mini port
 - DC power jack
 - MicroSD/MMC slot
 - Audio in and out
- **Storage**
 - 200 MB
 - Expandable with MicroSD and USB flash drive
- **Power**
 - Rechargeable, high-capacity battery

- DC charging/powering through external adapter (included)

- **cena:**

- \$455

Seveda pa morate dokupiti še senzorje, ki tudi niso cenovno ugodni, saj se njihova cena giblje od \$30 ... naprej.

1.2 Arduino Data Acquisition System

On the market we can find different DAQ systems which are hi-end products and often expensive (from 100 € .. n k€). Buy we can use Arduino (Uno, nano, ...) as low-cost data acquisition system if we do not need scientific accurate data (for pedagogical purposes).

<- [Parts of DAQ](#)[[NationalInstruments]] ->

Na plošči vsebuje mikrokontrolnik **Atmega328**, ki lahko opravi podobne naloge, kot smo jih opisali v poglavju **Merilne naprave**.

Poglejmo si nekaj karakteristik tega mikrokontrolnika (Atmel 2017):

- **Advanced RISC Architecture**

- 131 Powerful Instructions
- Most Single Clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 20 MIPS Throughput at 20MHz
- On-chip 2-cycle Multiplier

- **High Endurance Non-volatile Memory Segments**

- 32KBytes of In-System Self-Programmable Flash program Memory
- 1KBytes EEPROM
- 2KBytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data Retention: 20 years at 85°C/100 years at 25°C(1)
- Optional Boot Code Section with Independent Lock Bits
 - * In-System Programming by On-chip Boot Program
 - * True Read-While-Write Operation
- Programming Lock for Software Security

- **Atmel® QTouch® Library Support**

- Capacitive Touch Buttons, Sliders and Wheels
- QTouch and QMatrix® Acquisition
- Up to 64 sense channels

- **Peripheral Features**

- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- ADC
 - * 8-channel 10-bit ADC in TQFP and QFN/MLF package
 - * Temperature Measurement
 - * 6-channel 10-bit ADC in PDIP Package
 - * 10-bit Resolution
 - * 0.5 LSB Integral Non-Linearity
 - * ± 2 LSB Absolute Accuracy
 - * 13 - 260us Conversion Time
 - * Up to 76.9kSPS (Up to 15kSPS at Maximum Resolution)
 - * Six Multiplexed Single Ended Input Channels
 - * Two Additional Multiplexed Single Ended Input Channels (TQFP and VFQFN Package only)
 - * Temperature Sensor Input Channel
 - * Optional Left Adjustment for ADC Result Readout
 - * 0 - VCC ADC Input Voltage Range
 - * Selectable 1.1V ADC Reference Voltage
 - * Free Running or Single Conversion Mode
 - * Interrupt on ADC Conversion Complete
 - * Sleep Mode Noise Canceler
- Two Master/Slave SPI Serial Interface
- One Programmable Serial USART
- One Byte-oriented 2-wire Serial Interface (Philips I2C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- One On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

- **Special Microcontroller Features**

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator

- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

- **I/O and Packages**

- 23 Programmable I/O Lines
- 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF

- **Operating Voltage:**

- 1.8 - 5.5V

- **Temperature Range:**

- -40°C to 105°C

- **Speed Grade:**

- 0 - 4MHz @ 1.8 - 5.5V
- 0 - 10MHz @ 2.7 - 5.5V
- 0 - 20MHz @ 4.5 - 5.5V

- **Power Consumption at 1MHz, 1.8V, 25°C**

- Active Mode: 0.2mA
- Power-down Mode: 0.1uA
- Power-save Mode: 0.75uA (Including 32kHz RTC)

1.3 Requirements

(Checked is required, unchecked is optional)

Hardware:

- Computer
- Arduino board ([Arduino UNO](#), [Arduino LEONARDO](#), [Arduino NANO](#), [clone products](#))
- basic electronics components for sensors
- arduino set starter [for example use this kit](#)
- arduino sensors set [for example use this kit](#)

Software:

- Arduino IDE [download here](#)
- Python (>=3.0)
- pyserial
- Ms Excel

1.4 Pros & Cons

Pros	Cons
+ Price (Arduino ~3€, sensors ~2-5€)	- work in progress
+ Accessibility	- no plug&play solutions
+ Versatility	- DIY project
+ Easy importing data into MS Excel	- low sampling rate ~6kHz
+ točne časovne meritve	- 10-bi resolutuin

More about DAQ you can read in further reading...

Kaj ko bi si lahko naredili svojo merilno napravo?

V ta namen smo ustvarili nekaj vsebin na portalu [GitHub](#)...

Atmel. 2017. "ATMEGA328P." 2017. http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf.

"LabQuest® Hardware and Specifications | Vernier." <https://www.vernier.com/products/interfaces/labq/hardware/>.