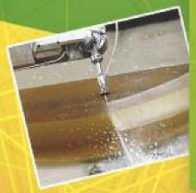
ERM AUTOMATISMES

Didactique I Robotique I Fab&Test I Energies

Equipment and solutions for technical education and vocational training

CATALOGUE 2017



ERM AUTOMATISMES
Didactique | Robotique | Fab&Test | Energies

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About us

ERM provides technical systems and services in the fields of education, robotics, manufacturing laboratories (FabLabs), energy and industry. Founded in 1990 in southern France, ERM first focused on industrial automation. Overtaken by its educational culture, ERM quickly became the precursor of introducing industrial production lines within technical training institutions. Upon request by these educational institutions, ERM then extended its offer to other areas, such as electronics, electrical engineering, power engineering and renewable energy.

Today, ERM has become a market leader in didactic solutions and systems for technological and vocational training in France, and is developing its export markets.

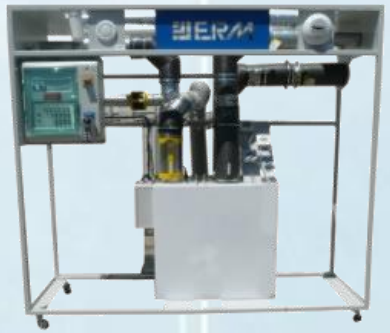
More than 1500 academic institutions are equipped with ERM technical teaching equipment in France: Secondary schools for vocational training, Vocational training centers, Universities, Universities of Technology, Major engineering schools, etc.

Abroad, many vocational training institutions are using our systems:

- French overseas territories: Guadeloupe, Guyana, Reunion, Martinique, Mayotte, New Caledonia, French Polynesia, Wallis & Futuna
- Africa : Algeria, Burkina, Cameroun, Gabon, Ivory Coast, Morocco, Mauritania, Senegal, Tunisia, …
- Asia : Vietnam, Korea…
- America : Mexico, Colombia…
- Europe : Belgium, Luxembourg, Romania, Hungary, Slovakia, Switzerland…

Engineering science

NAO Humanoid Robot
& training modules



Double flow Controlled
Mechanical Ventilation system

Drinking water control
and distribution

Aerial imaging gimbal

KNX eco-energy

TangoKit

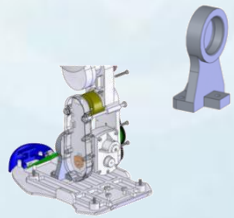
Instruments, tools and data acquisition : See pages I1 to I9

NAO Humanoid Robot

In partnership with ALDEBARAN SoftBank Group

➢ *Features:*

- **Audio** (4 microphones and 2 loudspeakers)
- **Video** (2 HD cameras 1200 x 960)
- **Inertial unit** (3-axis accelerometer, and 2-axis gyrometer) and **Sonars**
- **Sensors (p**ressure FSR, bumpers, tactile)
- Servo-motors (**coreless motors** with **hall effect sensors)**
- Grip (prehensile hands with 3 operable fingers)
- Intel Atom 1.6 GHz CPU with 1 GB RAM and 8 GB Micro SDHC (**text-to-speech, Image and voice recognition**…)
- **WiFi** and **Ethernet** modules
- Lithium-ion battery (90 minutes autonomy)



➢ *Training activities:*

- History and development of robotics, present and future applications
- NAO technical specifications, Functional analysis and Heuristic diagram, Patents
- **Kinematic, electronic and software architecture**
- Materials and processes (NAO shell)
- **Spatial and voice localizations, organ motion, gripping, balance, means of communication**
- Ergonomics and **design**
- **Controllers** on NAO
- **Localization algorithms** (with sonar)
- **Use of 8 pressure FSR pressure sensors** for NAO balancing
- **Development and testing of new algorithms** (eg: sight, balance…) within the NAO community
- Project: Develop applications for NAO, **invent missions for NAO**
- Project: Design **software architecture** for activities (eg: NAO monitors a room)
- Project: **Creation of behaviors** with Choregraphe software or SDK for complex behaviors
- Project: **Create a vehicle for NAO** (using the Vehicle Kit with Bluetooth communication)

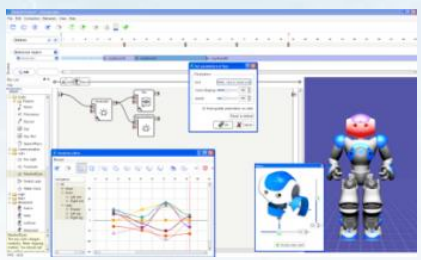
python

➢ *Key points:*

- Motivating and fun for students, and a **medium of communication** for the institution
- Open environment (Software suite for programming and data logging...)

➢ *Reference:* **AR//H25-EA:** NAO humanoid Robot with SDK, Choregraphe, Monitor, 10 licenses - **AR//SW-WNAO:** Webots software for NAO, 1 license - **NA10**: Accessory kit for training activities (weights, ultrasonic sensors, Wi-Fi router, IR Remote control...) - **NA11**: Training system for NAO Foot + Ankle control - **NA12**: "Foot + Ankle" mechanical set - **AR//SW-CSDK-U**: Software suite Choregraphe, Monitor, SDK, site license - **AR//SW-WNAO10**: Webots software for NAO, 10 licenses

Webots 3D simulation software



Choregraphe programming software

MATLAB SIMULINK

LabVIEW

Training system for NAO Foot + Ankle control

Ankle

Training bench with accessories

➢ *Features:*

- **Mechanical transmissions** (gears, gear reducer…)
- Motors (**DC motors**)
- Sensors (**magnetic position sensors**)
- **SPI electronic bus**

➢ *Training activities:*

- Studying a **DC / DC static converter**
- Studying **correctors** and frictions
- Friction identification
- Influence of a **PI corrector**
- **Model of pitch behavior**
- Impact of **sensor position on control**
- Studying **inertia** and **pitch dynamics**
- **Model analysis** and **balance concept**
- **Kinematics**: is the NAO ankle anthropomorphous ?
- LTI system: **identification of step responses**, optimizing a PID corrector
- **Dynamics**: dynamic optimization of a kick

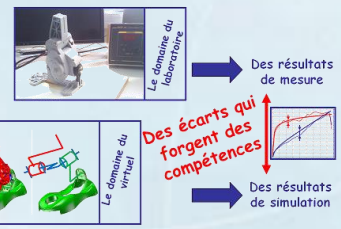
➢ *Key points:*

- Ideal resource to teach about design and **servo control for biaxial systems**
- **Labview/Matlab/Sinusphy** models to **compare simulations with real measurements**
- **Disturbance accessories are supplied (weights, slopes)**
- **Viewer Software** for **communication with and control from a PC**
- **Solidworks 3D Model** and **electronic diagrams** to study constructive and practical solutions

Compatible with the "Motors & Motion Lab" bench

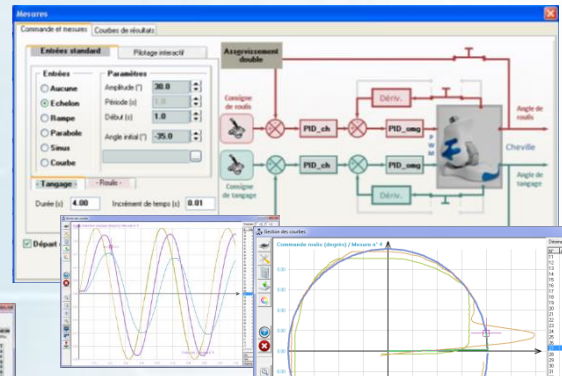
Page H6

➢ *Reference:* **NA11**: Training system for NAO "Foot + Ankle" control - **PR09**: USB Logic Analyzer (to see the frames running on the SPI electronic bus) – **AQ10**: USB Data Logger

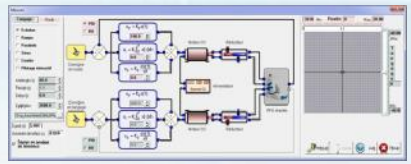


Engineering procedure

Viewer



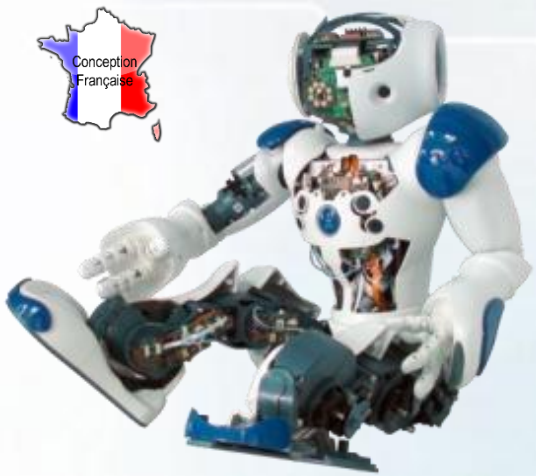
Frequency study (with Kp variable)



Labview / Matlab / SinusPhy models

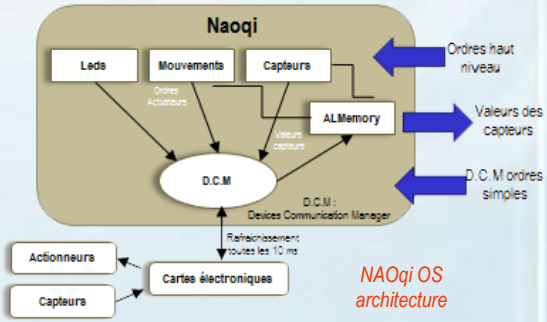
Trajectory follow-up

NAOtronics - Exploration of technology solutions implemented in the NAO robot



➢ *Three training modules:*
- **NAOtronics Detection**
- **NAOtronics Motorization**
- **NAOtronics Communication**

Resources for projects



NAOqi OS architecture

➢ *Key points:* Ideal training support for studying multi-physics technology solutions and developing skills and knowledge in a training module.

NAOtronics Detection – Platform for the study of electronic detection technologies implemented in the NAO humanoid robot

➢ *Features:*
- **FSR** (Force Sensor Resistor) **pressure** sensors
- **MRE** (Magnetic Rotary Encoder) **position** sensors
- **Inertial measurement unit** (3-axis accelerometer / 3-axis gyroscope)
- **Ultrasonic** (sonar) sensors
- **Infrared** (remote control command) sensors
- **Mechanical contact** (shock) sensors
- **Capacitive** (touch) sensors
- **Sound** (microphone) sensors
- Arduino UNO development pack

➢ *Training activities:*
- **Analysis of sensors in an inertial measurement unit: accelerometer and gyroscope** (experimental initiation to sensors, physical phenomenon, communication protocol)
- **Analysis of ultrasonic sensors for distance** (experimental initiation to sensors, physical phenomenon, communication protocol)
- **Analysis of FSR force sensors** (experimental initiation to sensors, physical phenomenon, experimental comparison between two acquisition set)
- **Analysis of MRE angular position sensors** (experimental initiation to sensors, physical phenomenon, experimental testing of linearity and accuracy, influence of the XY position error)

➢ *Key points:*
- Ideal training support for electronic solutions used in robotics
- **Electronic diagrams** for studying constructive solutions using sensor behavior patterns

➢ *References:* **NA15+PR00+PR30+PR31+PR32:** NAOtronics "Detection" pack - See Ermaboard page H7

NAOtronics Motorization - Humanoid finger: studying the technologies used in NAO robot for motorization

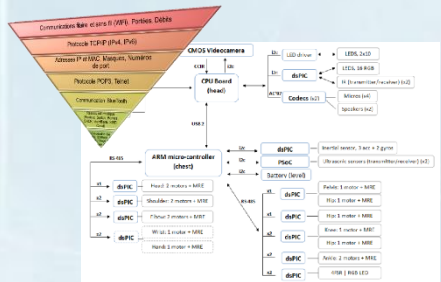
➢ *Features:*
- **DC motor** with reducer
- **Servo motor**
- **Electric cylinder**
- Humanoid finger
- Arduino and Raspberry Pi boards, to control the actuators
- Human-Machine Interface (LCD screen, keyboard…)

➢ *Training activities:*
- Studying the mechanical connections, kinematics, mechanical transmissions, motors and control
- **SED programming** in Python on Raspberry Pi and Arduino on microcontroller
- **Project: creating a 3 DOF motorized finger (based on a finger prototype made of ABS) replicating the exact movement of a human finger with tendons (strings) and able to dial a telephone number on a keyboard**
- Prototyping **3D mechanical parts** (mounting board, adaptors…)

➢ *Key points:*
- **Large variety of parts for different constructive solutions**
- **Delivered with the "answers"** (one solution is completely explained and functional)

➢ *References:* **DR10**: Humanoid finger (NAOtronics Motorization)

NAOtronics Communication - Platform for the study of electronic communication technologies implemented in the NAO humanoid robot



Communication architecture in the NAO robot

➢ *Features:*
- **SPI/I2C communication**
- **RS485/CAN communication**
- **Ethernet communication**
- **WiFi communication**
- Arduino UNO development pack

➢ *Training activities:*
- **Study and analysis of the main protocols**
- **Communication: analyzing/modelling and experimenting** on the information chain
- **Experimenting** with different network technologies

➢ *Key points:*
- Ideal training support for communication solutions in multi-technology systems
- **Electronic diagrams** for studying constructive solutions

➢ *References:* **PR00+PR10+PR11+PR18:** NAOtronics "Communication" pack – **PR09:** USB logic analyzer (to see frame circulation in SPI/I2C buses) – See Ermaboard page H7

HexaCopter Drone - *Studies and projects on a 6-propeller drone*

In partnership with E-COPTER

Drone in a safety enclosure for testing

➢ *Features:*

- Flight control (**gyroscope**, **accelerometer** and air pressure sensor)
- Motorization & Energy (**Lithium-ion polymer battery**, 6 propellers with **brushless motors**)
- Video and image processing (video, OSD telemetry data)
- Communication (USB, **Bluetooth** and RF 2.4GHz)
- Flight navigation (compass, **GPS**)
- **Servo-control** (servo-controlled camera mount)
- Software for flight following and data acquisition

HexaCopter drone flight in Marseilles with route outlined on Google Earth

➢ *Training activities:*

- **System study** (components, operation)
- **Energy chain analysis** (motor consumption, motor / propeller torque according to weight)
- Analysis of the **information and communication chain**
- **Control** (drone position controlled with P parameter, with D parameter)
- **Design and fabrication of a block plan** (shielding) to increase GPS signal
- **Impact of balancing mass flywheels ,** vibration generation and their consequences on the flight
- **Data processing of locations** saved by the GPS after a flight
- **Comparative study of behaviors with several landing gears**

Software for data acquisition

➢ *Projects:*

- Design and assemble a **foldaway or demountable frame** to make storage easier
- Design and assemble a **rescue parachute**
- Design a **shield for the GPS antenna**
- **Improve the drone power**
- Improve drone performances (masses and propellers balance, altimeter protection to improve measurements)

Resources for projects

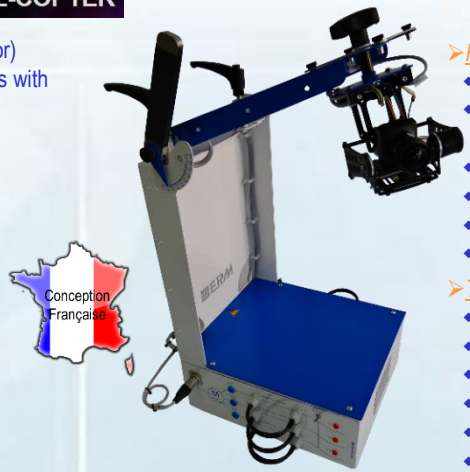
Project: Design a mount

➢ *Key points:*

- Safety enclosure for indoor tests
- Open solution for development projects
- Professional drone with many available spare parts

➢ *References:* **HX10**: HexaCopter drone with safety enclosure – **HX11**: Flight navigator with compass and GPS (Optional) – **HX12**: 2 axis-servo-controlled camera mount (Optional) – **HX13**: OSD Real-time video with telemetry data (Optional) – **HX15**: Behavioral model of the HexaCopter drone, developed with Scilab Xcos and Matlab – **PR00+PR20:** Ermaboard GPS kit

Aerial imaging gimbal – Studies and projects on a 2-axis controlled gimbal mounted on a drone



Conception Française

➢ *Features:*

- Inertial measurement unit (accelerometer and gyroscope)
- Motorization & Energy (**brushless, DC and stepper motors, industrial motor controller board**)
- **Mechanical linkage** solutions
- Video and image processing (camera)
- **Real-time LabVIEW** control (MyRIO board)
- Communication (CAN bus)

Video control camera

➢ *Training activities:*

- Testing of **gimbal performance**
- Motorization impact on gimbal behavior
- **Behavior pattern of the controlled pitch axis** of the gimbal
- **Impact of axis balancing** on performance
- **Image** control and **recognition**
- Impact of **control sampling frequency**
- **Sensor impact** on gimbal performance
- Analysis of **coupling phenomena**
- Analysis of **gravity** (direction) **impact**
- **Power supply impact** on performance
- Designing a **camera stabilization system**
- Study of sensors (**accelerometer, gyroscope**)
- **Real-time LabVIEW** programming
- **Configuration of industrial motor controllers**
- Study and **configuration of a CAN bus**
- Projects: **Design of a third axis** (mechanical linkage – brushless, DC or stepper motor - **Arduino/Python** electronics and **programming**)

➢ *Key points:*

- Opportunity to **compare different technologies and motor powers**
- **Image analysis** and integration in the **position control loop**
- Opportunity to implement projects using a **third motorized axis**
- Control programming/modification in Python
- Two types of control: ❶ Embedded electronics ❷ Real-time industrial electronic platform, based on NI myRIO

Compatible with the "Motors & Motion Lab" bench

Page H7

➢ *References:* **NC10:** Aerial imaging gimbal – **NC10+NC15:** Aerial imaging gimbal with real-time video camera – **NC10+NC00+NC09:** Aerial imaging gimbal with real-time electronic platform (NI myRIO board and controller for 2 brushless motors) – **NC10+NC15+NC00+NC09:** Aerial imaging gimbal with video control camera and real-time electronic platform (NI myRIO board and controller for 2 brushless motors) – **NC11:** Gimbal with more powerful motors (Optional) – **NC15:** Video control camera – **NC16:** Third-axis motorization kit with brushless/DC/stepper motor controller (Optional) – **NC00+NC09:** Real-time electronic platform (NI myRIO kit and controller for 2 brushless motors)

Interface for configuration, measurement and image analysis with LabVIEW

Cable robot for lifting assistance and 2D/3D positioning – Studies and projects on a cable-driven robot

Real-life setting: camera on a stadium

➢ *Features:*

- Position, speed and load control
- Motorization & Energy (**brushless and DC motors, industrial motor controller board**)
- Measurement of loads and torques
- Mechanical solutions for cross-winding (orderly cable rolling)
- Video and image processing
- **Real-time LabVIEW** control (myRIO board)
- Communication (CAN bus)

➢ *Training activities:*

- **SysML** description: choice of motor, performance and efficiency
- Kinematics (**connection modelling** and maximum speed)
- **Statics** (determining the direction of cable pull based on the two load sensors)
- State graph (**load control with self-calibration** to assist in lifting a variable mass)
- Studying the operation of **brushless motors (phase control curves)** and comparison with DC motors
- **Study of sensors** (hall effect, incremental optical encoder, load sensor based on strain gauge, on/off limit switch)
- Study of **mechanical solutions for cross-winding**
- **Analysis of position, speed and load control** (e.g., torque control, experimental and theory-based determination)
- **Experimental optimization** of control parameters (**Autotune**)
- Integration of **image analysis** in control
- **Real-time LabVIEW** programming
- Study and **configuration of a CAN bus**
- **Generation and optimization of 1D, 2D or 3D trajectories** of the gimbal compatible with the motorization
- Project: Control development for solutions using **1 winding head (lifting assistance) or 3 winding heads (2D/3D positioning)**
- Project: Design of a gimbal

MATLAB SIMULINK · Scilab · NATIONAL INSTRUMENTS LabVIEW

Lifting assistance (1 head) configuration

Load control

➢ *Key points:*

- Product evolution (**scenarios using 1 / 3 winding heads**, same control)
- **Complex mechanics** of winding heads (cross-winding)
- Comparison of DC and brushless motorizations
- The test area can be placed horizontally (application type: **Stadium camera movement**) or vertically (application type: **Painting robot**)
- Dual use of the camera: **analysis of dynamic performance** (fixed camera facing the robot), **target tracking** (camera on the gimbal of the robot)

2D/3D positioning (3 heads) configuration

➢ *References:* **WR00+WR11:** Cable robot for lifting assistance **(one brushless winding head)** – **WR10+NC00+NC01 +WR11+WR11+WR11:** Cable robot for 2D/3D positioning **(three brushless heads)** with real-time industrial electronic prototyping platform (NI myRIO with CAN board) – **WR11:** Winding head with brushless motorization – **WR12:** Winding head with DC motorization

Tri'ode 6-axis platform – 6-axis platform for inertial measurement unit certification

New

In partnership with Véléance Véhicules électriques

6-axis certification test bench for inertial measurement unit

➢ *Features:*

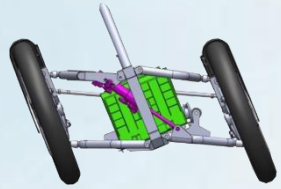
- Controlled mechatronic platform with **6 degrees of freedom**
- **Inertial measurement unit** (3-axis accelerometer, 3-axis gyroscope)
- **Digital servomotors with** communication bus (SED)
- Control/Command/Acquisition in **LabVIEW**

Modular training

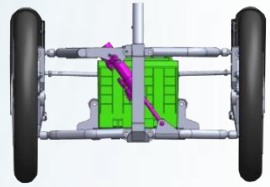
➢ *Training activities:*

- Description and analysis of the system in **SysML**
- Information chain/Energy chain
- **Kinematic modelling** and geometric configuration (direct and reverse)
- Modelling of **controlled systems**
- **Configuration of a controller** (compliance/PID)
- Study of **communication networks**

Mounted on a real electric scooter



TCS: Patented tilt control system



ARDUINO · python · MATLAB SIMULINK · Scilab

➢ *Key points:*

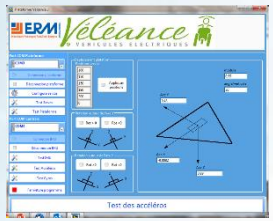
- **TCS-based system that controls scooter tilt (patented)**
- **Platform with 6 degrees of freedom** for qualifying and certifying an inertial measurement unit
- **Practical exercises** developed for **training modules**
- **Plenty of models and sizes** (modelling/engineer-like experimenting)
- Open solution for Matlab/Scilab control
- Programming is possible with Python/Arduino board

➢ *Reference:* **CI10:** Tri'ode 6-axis platforrm – For other ranges and subsystems, contact us.

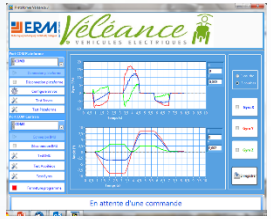
NATIONAL INSTRUMENTS LabVIEW

Home

Servomotor configuration



Accelerometer qualification



Gyroscope qualification

Robotics, Mechatronics & Connected objects

Motors & Motion Lab – Platform for the study of DC, brushless and stepper motors from ERM systems

New

May be used with:
- *NAO and NAO Ankle*
- *Gimbal*
- *Cable robot*
- *Instrumented 3D printer*

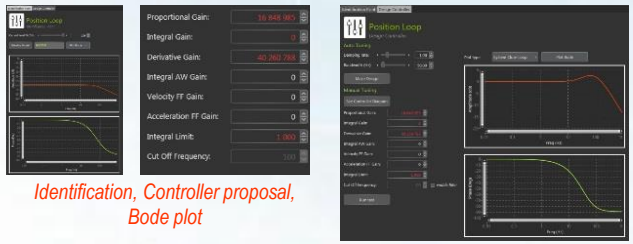
➢ *Features:*
- DC motor with incremental encoder (NAO / Cable robot or other)
- Brushless motor (Cable robot / Imaging gimbal or other)
- Stepper motor (Cable robot or other)
- Linear DC motor (Voice Coil)
- USB, CAN and CANopen communication
- Embedded electronic circuits for motor control and I/O management
- **Position, speed, torque control** with **P, PI, PID** controllers
- Software suite for configuration, experimenting, data acquisition and processing

Resources for projects

MATLAB SIMULINK Scilab

➢ *Possible training activities:*
- Theoretical study: **Multiphysics modelling of electric motors**
- **Comparison between simulation models and real motors**
- **Interpretation of differences** and model improvement proposals
- Identification of electrical and mechanical characteristics by **open loop control** (constant speed and sinusoidal control)
- **System stability** prediction by analyzing open-loop **frequency response** (open-loop Bode plot)
- Impact and optimization of **P, PI, PID** controllers for **speed, position and torque control**
- Using an optimization method for automated controllers (**autotuning**)
- Analysis of **CAN** and **CANopen communication** protocols
- **Programming** and **setup** of embedded electronic components

➢ *Key points:*
- Advanced platform for **analysis**, **modelling** and **experimenting** on motorizations of our systems
- **Flexible** and **fast** implementation of the **software suite for configuration and testing (Ingenia Motion Lab)**
- Many experiments using **flywheels** and **active motor load**



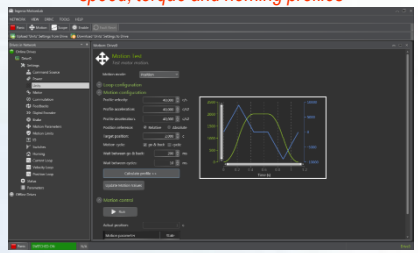
Identification, Controller proposal, Bode plot

➢ *References:* **MT10:** Motors & Motion Lab (basic package with DC and brushless motor) – **MT11:** Linear DC motor (Voice coil) – **MT12:** Stepper motor – **MT15:** CAN/USB gateway for implementing a CAN/CANOpen bus

Ingenia MotionLab Configuration Software: The collection of applications let you configure, program, test and run your bench in ways that are intuitive and simple.
Examples:

Fast configuration of motor control settings, with screen and intuitive dialog boxes

Movement configuration according to position, speed, torque and homing profiles



Virtual scope for signal registration and monitoring

Macro programming environment for a motion combination (stand-alone mode)

Didactic 3D printer – Didactic instrumented 3D printer

New

➢ *Features:*
- 3-axis mechanics including motors, transmissions and guides
- Extruder with temperature control
- Control/command board with microcontroller
- Instrumentation with additional sensors (accelerometer, displacement, etc.)
- Software for the data acquisition and processing

➢ *Training activities:*
- SysML description and analysis of the printer
- Temperature control in the presence of disturbances
- Kinematic and geometric study of the printer
- Study of control and power
- Axis control configuration and impact on the manufacturing of parts

MATLAB SIMULINK Scilab

➢ *Key points:*
- **Professional printer with instrumentation, for teaching use**
- Many adjustments and configuration (speed, PID temperature, motor parameters, etc.)
- Dissymetric control of extruder heating and cooling
- **G-Code Interpreter**, with prior acceleration planning, for smooth and accurate movement
- Transparent case for safe observation of movements

➢ *Reference:* **OE//ALTO333:** Didactic instrumented 3D printer

ErmaBoard – Electronics prototyping platform (control circuits, communication, sensors, HMI, robotics, multimedia)

➢ *Features:*

- Electronic control (**microcontrollers, FPGA, ARM9**…)
- Power supply (battery, solar cell)
- Communication (**Ethernet, Bluetooth, RFID, Zigbee, GPS, WiFi, CAN**…)
- **Sensors** (temperature, accelerometer, proximity…)
- **Human-Machine Interface** (LCD, keyboard, voice recognition…)
- **Robotics/Mechatronics** (relays, servomotors, mobile robot chassis….)
- **Multimedia** (MicroSD card, JPEG imager, MP3 decoder…)
- **USB logic analyzer** for the study of serial protocols

➢ *Training activities:*

- **Architecture of electronic control systems**
- **Principles of microcontrollers, FPGA and microprocessors (ARM9) operating principles** as well as their applications
- Programming the microcontroller, FPGA, and microprocessor ARM9 with the provided libraries
- **Communications protocols**
- **Prototyping electronic control systems**
- Project 1 : **Design and fabrication of a 2-wheel robot controlled by:**
  1. **a human-machine interface on LabVIEW,**
  2. **a joystick** (Nunchuk of the Wii console) **and a LabVIEW or Arduino application,**
  3. the Wiimote **accelerometer** (Wii console) **and a LabVIEW application**
- Project 2 : **Design, fabrication and commissioning a firefighter robot**
- **Other projects are available**

Resources for projects

➢ *Key points:*

- **Electronic circuits compatible with modular** systems
- Ideal for **projects in the fields of electronics, information processing, communications and robotics**
- Provides introduction to and practice of **several programming languages** (graphics or text)
- May be studied with the **tutorial work provided, or as a resource for other instructional systems** (e.g. : Prototyping a motor control unit with motorized hinges or a 4-wheel vehicle for NAO robot …)

➢ *Programming environment :*

ARDUINO™ RaspberryPi python™

	Arduino IDE	Minibloq	LIFA LabVIEW	Flowcode	MPLAB IDE	GCC	PhP	Python	Quartus II	Terminal
PR00 : Arduino UNO (Atmel Atmega)	✓	✓	✓	✓						
PR01 : Arduino compatible **ERM** (PIC 18)				✓	✓					
PR05 : Raspberry PI (ARM Cortex A7)						✓	✓	✓		
PR02 : FoxBoard (ARM9)						✓	✓	✓		
PR03 : FPGA Altera (Cyclone 4)									✓	
PR04 : Bus Pirate (PIC 24)										✓

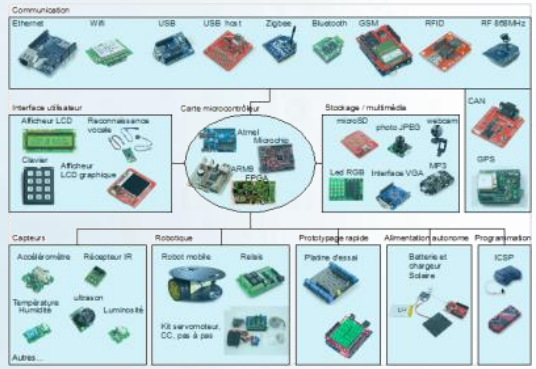
Electronic control

PR00	Arduino UNO development kit (Atmel Microcontroller)
PR01	Arduino, compatible ERM (PIC18 Microcontroller Microchip)
PR05	Raspberry Pi development kit (ARM microcontroller)
PR02	Foxboard development kit (ARM microcontroller)
PR03	FPGA development board
PR04	Interface board for components on bus i2c, SPI, UART (no programming)
PR08	Kit with lithium-ion polymer battery and solar cell
PR09	USB logic analyzer – Protocol analyzer CAN, SPI, I2C, RS232

PR10 – Ethernet kit

Communication

PR10	Ethernet Kit
PR11	Wi-Fi Kit
PR12	USB device and USB host Kit
PR13	Zigbee Kit
PR14	Bluetooth Kit
PR15	GSM Communications Module
PR16	RFID Kit
PR17	RF 868 MHz Kit
PR18	CAN Communications Module
PR20	GPS Kit
PR21	NFC Kit



Sensors

PR30	Sensor kit (temperature, brightness, infrared, capacitive sensing) with connectors
PR31	Sensor kit with accelerometer, gyroscope, compass
PR32	Sensor kit for distance, proximity and color detection

Human-Machine Interface

PR42	Speech recognition kit
PR43	RGB led matrix
PR44	LCD color display

PR30 - Sensor Kit with connectors

Robotics

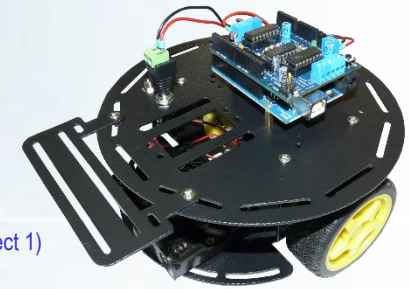
PR50	4-relay board with opto-isolated control
PR51	Servo and motor kit
PR52	Chassis for 2-wheel robot with DC motor

Multimedia

PR60	Storage on microSD card
PR61	JPEG imager
PR62	VGA Interface
PR63	MP3 Decoder
PR64	USB Webcam

Project kits

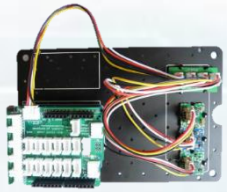
PJ00	Project kit "Remote-controlled 2-wheel robot" (Project 1)

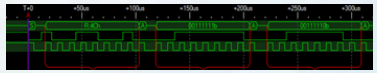


PJ00: Prototyping a 2-wheel robot

Robotics, Mechatronics & Connected objects

ErmaBoard Sensors & Motors – Pack for the study of motor control and sensor technologies





➢ *Features:*
- Microcontrollers (Atmel/Arduino or Microchip PIC18)
- **Sensors** (temperature, light, infrared, capacitive sensing, accelerometer, gyroscope, compass, distance, proximity, color detection, etc.)
- **Motors** (DC, servomotor and stepper)

➢ *Training activities:*
- Control of various motors (servomotors, DC, etc.)
- Sensor setup (accelerometer, ultrasound, color detection, etc.) (analysis of **sensor communication protocols -** I2C, SPI, etc.)
- **Signal processing** and impact of sampling frequency on measurement accuracy

➢ *Key point:* Economical solution for learning sensor and motor technologies

➢ *References:* **PR00+PR30+PR31+PR32+PR51:** ErmaBoard Sensors & Motors – **PR09:** USB logic analyzer

ErmaBoard RFID / Bluetooth / Zigbee - Pack for the study of RFID, Bluetooth and ZigBee communication protocols

➢ *Features:*
- Microcontrollers (Atmel/Arduino or Microchip PIC18)
- Communication (RFID, Bluetooth and Zigbee)

➢ *Training activities:*
- Study and **comparison of Bluetooth, ZigBee and RFID communication principles**
- Study of electronic circuits and communication protocols
- Signal recovery and analysis, **frame decoding** and protocol-related operations

➢ *Key point:* Economical solution for learning RFID, Bluetooth and Zigbee protocols

➢ *References:* **PR00+PR13+PR14+PR16:** ErmaBoard RFID / Bluetooth / Zigbee

ErmaBoard Wi-Fi & GSM - Pack for the study of Wi-Fi and GSM communication protocols

➢ *Features:*
- Microcontrollers (Atmel/Arduino or Microchip PIC18)
- Communication (Wi-Fi and GSM)

➢ *Training activities:*
- Study of the operation of GSM and Wi-Fi communication protocols
- **SMS sending** application
- Study of circuits and source code for using Wi-Fi and GSM cards
- **Wi-Fi Hotspot creation** (Connectify software) and configuration (**WPA2 encryption**)

➢ *Key point:* Economical solution for learning Wi-Fi and GSM protocols

➢ *References:* **PR00+PR11+PR15:** ErmaBoard Wi-Fi & GSM

ErmaBoard Ethernet - Pack for the study of the Ethernet communication protocol

➢ *Features:*
- Microcontrollers (Atmel/Arduino or Microchip PIC18)
- Communication (Ethernet)

➢ *Training activities:*
- Studying the components and **architecture of an Ethernet network**
- Organization and communication protocols (**frame analysis**)
- Network securing

➢ *Key point:* Economical solution for learning the Ethernet protocol

➢ *References:* **PR00+PR10:** ErmaBoard Ethernet – **PR09:** USB logic analyzer

ErmaBoard GPS - Pack for the study of GPS geolocation

➢ *Features:*
- Microcontrollers (Atmel/Arduino or Microchip PIC18)
- GPS geolocation

➢ *Training activities:*
- Study of **GPS principles** (triangulation methods, navigation, accuracy, etc.)
- Study of electronic circuits and of the GPS sensor
- Recovery and analysis of GPS reception signals, **frame decoding and operation**
- Analysis of the impact that the **number of satellite signals** has on **accuracy**

➢ *Key point:* Economical solution for GPS learning

➢ *Reference:* **PR00+PR20:** ErmaBoard GPS

Humanoid finger – Multi-technologies project

Page H3

➢ *Features:*
- Sensors, microcontrollers, HMI
- DC motor, servomotor, electric cylinder, mechanical transmissions

➢ *Training activities:*
- Prototyping 3D mechanical parts (3D printing)
- SED programming in Python (Raspberry/Arduino)
- Projects: Create a motorized finger

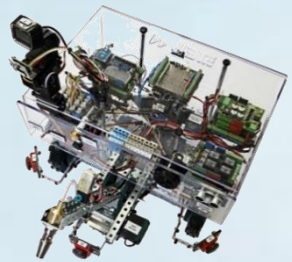
Resources for projects

➢ *Key points:*
- Large variety of parts for different constructive solutions
- Assembly kit project with a correction

➢ *References:* **DR10**: Humanoid finger

Fire fighter robot – Multi-application assembly kit to design a fire fighter robot

Page G9



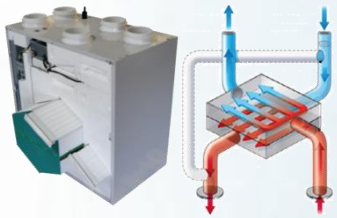
➢ *Features:*
- Electronic control (**microcontrollers, ARM9**…)
- Power supply (battery)
- Communication (RF 868MHz, **WiFi**)
- **Sensors** (proximity, ultrasound, temperature…)
- **Motors** (DC, servo motors)
- **Mechanics** (chassis for mobile robot, VEX Robotics parts…)
- **Multimedia** (cameras…)

➢ *Training activities*
- **Designing a ¼ scale model of a fire fighter robot** to study mechanics, electrical power and electronic controls
- Designing **6 project kits** and the **architecture of the whole robot** in 7 two-person teams
- Designing and testing mechanical transmissions
- Prototyping **3D mechanical parts**

➢ *Key points:*
- Possibility of having up to **14 students in groups of 2** working on the project
- Project can be **taken up and improved every year**
- **Large variety of assembly kits and parts for different constructive solutions**
- **Delivered with the "answers"** (one solution is completely explained and functional)

➢ *References:* **PJ10+PJ11+PJ12+PJ13+PJ14+PJ15+PJ16:** Fire fighter robot – **PJ11**: Project kit "make the robot move" – **PJ12**: Project kit "Guide the robot by following a line" – **PJ13**: Project kit "Detect obstacles" – **PJ14**: Project kit "Find the source of the fire"– **PJ15**: Project kit "Communication" – **PJ16**: Project kit "Fire alert and fire extinguishing"

Double flow Controlled Mechanical Ventilation system & Thermal regulations – Studying a Controlled Mechanical Ventilation system for low energy consumption buildings



➢ *Features:*

- Double Flow CMV (heat exchanger, DC motors, regulation and RF control)
- Air flow circuits (pressure loss...)
- Data acquisition: **temperature, pressure, air flow, hygrometry, rotation speed, power and consumption**

➢ *Training activities:*

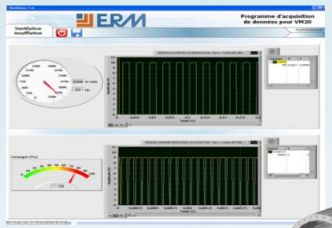
- Analysis and simulation of **performance constraints imposed by thermal regulations**
- Comparison of mechanical ventilation systems and studying speed variation
- Studying **mechanical ventilation systems** seeking to reach low energy consumption levels
- **Heat exchangers**
- Regulation (e.g. Bypass for night-time ventilation)
- Studying the impact of ventilation on indoor air quality
- Designing and dimensioning ventilation systems for the proposed case studies

➢ *Key points:*

- Use of the training system for the lab's ventilation enabling **real measurements**
- Ideal for **experiments with heat exchangers**
- Emphasis on ventilation which is essential in the evolution of thermal solutions for buildings

➢ *References:* **VM30:** Double flow CMV & Thermal regulations with the following sensors: pressure (x2), flow (x1), hygrometry (x1), temperature (x4) to be connected to a data logger – **VM21**: Portable instrument for operational, thermal and air flow data logging – **VM23:** Case with mechanical parts for the Double flow CMV – **VM24**: Hot and cool air generator for indoor use (without external air inlet) – **VM26+PC22:** Instrumentation for pressure (HP and LP) and temperature (8 sensors and 4-channel thermometer with display and PC acquisition) to study the hot and cool air generator VM24 – **AQ10**: USB Data logger – **AQ11:** Differential voltage probe for USB data logger – **AQ12:** AC current clamp for USB data logger

USB data logger with Labview



Hot and cool air generator for indoor use

Solidworks 3D-modeling for various mechanical parts

Air/Water heat pump with inverter & fan coil unit – Studying a reversible air/water heat pump with a high performance fan coil unit

➢ *Features:*

- **Thermodynamic domestic** equipment (R410 refrigerating unit, inverter technology, electronic expansion valve)
- Thermal and electrical measurements (voltage, current, **12 temperatures**, refrigeration and hydraulic **pressure**, water and air **flow**, **electronic control signals**)
- **Heat exchangers** (multitube-in-tube, finned tube)
- Variable flow (compressor, water circulator with PWM control, brushless motor fan)
- Hydraulic distribution (expansion valve, valve, bleeder…)
- **Eco-designed** fan coil unit
- Radio and/or KNX control

➢ *Training activities:*

- Performance analysis and simulation of a building equipped with a air/water heat pump. Comparison with other heat generators.
- Functional analysis of a air/water heat pump
- **Energy savings** for motors, exchangers and regulation
- Heat pump **control** (water logic, compensation, monitoring controls, …) and fan coil unit **control**
- **Refrigerating circuit**, enthalpy chart, calculating the **coefficient of performance (COP) of the heat pump**
- **Eco-design strategy** of the fan coil unit
- Studying the **"multitube-in-tube" stainless steel/copper exchanger**
- Studying the **Vortex flow meter** (additional flow meter supplied)
- **Electronic architecture** of the heat pump controller
- Studying the fan coil controller (wire, KNX) and PID control
- **Mechanical study of 3D components** (compressor, 4V valve, circulator, motor-fan…)
- Project: Operate the fan coil unit with a KNX controller

➢ *Key points:*

- **Thermodynamic heating/cooling** (heat pump) is widely used
- **Actual dimensioning of the heat pump** (5kW thermal power) and fan coil unit, for a low-energy house
- Many thermal and electrical measuring points
- **Refrigerating, hydraulic and air flow** circuits on the same system
- **Executables with Labview** and **3D Solidworks models** of the parts are supplied

➢ *References:* **PC40-PC42:** Air/water heat pump & fan coil unit (with HP/BP manometers and power consumption analyzer) – **GD12:** KNX home automated controller and supervision – **MO21:** Data logger and telemonitoring via Ethernet – **AQ10**: USB data logger – **AQ11:** Differential voltage probe for USB data logger – **AQ12:** AC current clamp for USB data logger

USB data logger with LabView (Reference AQ10)

KNX home automated controller and supervision (Optional GD12)

3D Solidworks models

Heat exchanger and Vortex flow meter are supplied

Monosplit reversible air-conditioner with inverter – Training system to study a monosplit reversible air-conditioner DC inverter using R410

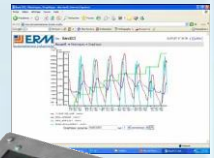
➢ *Features:*
- **Thermodynamic residential** equipment (R410 refrigerating unit)
- Measurements (**voltage, amperage, temperature, hygrometry, HP and LP manometers**)

➢ *Training activities:*
- Electric and thermal measurements, data acquisition and interpretation
- Energy balance and air conditioning efficiency
- Enthalpy chart, humid air chart
- Inverter technology (speed regulation of the compressor)
- Control: study of the regulator

➢ *Products advantages:*
- Studying a monosplit reversible inverter air conditioner in real conditions
- **User-friendly data-acquisition of operating parameters on Labview**

➢ *Reference:* **MO20** Monosplit reversible air conditioner with inverter – **MO21** Data logger and tele-monitoring via Ethernet **(embedded web server)** – **AQ10** USB data logger – **AQ11** Differential voltage probe for USB data logger – **AQ12** AC current clamp for USB data logger – **PC22:** 4-channel thermometer with PC acquisition and display (delivered with 8 thermocouple probes and PC acquisition software)

Measuring console for voltage, temperature and hygrometry



MO21: Data logging and tele-monitoring

Data acquisition on Labview

Solerm CESI – Solar water heater – Communication-capable instrumented domestic solar water heater

➔Domestic solar heater, **installed in real operating conditions**

➔**Exhaustive measurements** (flow and energy of the solar and sanitary circuits, insolation, temperature of panel, exchanger, water tank, faucet…. solar circulator pressure)

➔**Real-time** data access and acquisition by **USB and/or Ethernet** (embedded web server)

➔Possibility of sharing data with other schools and institutions, by **putting the data online** through the web server

Page F4

Drinking water control and distribution – Trainer for level, flow and pressure control in drinking water systems and tanks

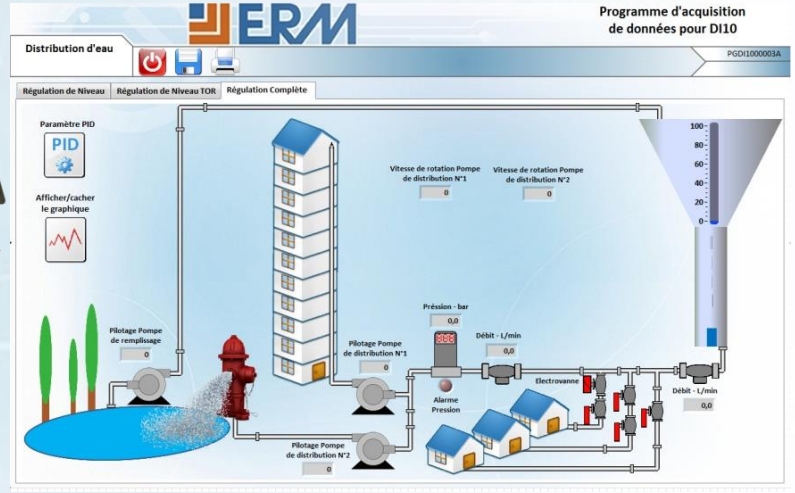
➢ *Features:*
- Process measurements (water **level** in the tank by ultrasounds)
- **Tanks** (**water tank** simulating a natural water reservoir, **storage tank** simulating a water tower)
- Variable-flow pumps **(circulator pump with brushless motor, compressor)**
- **Valves (quarter-turn manual valves, solenoid valve** for flow disturbance)
- Control unit (Labview interface, variable speed drive)

➢ *Training activities:*
- **Functional analysis**: drinking water storage and distribution systems
- **Measurement principles** (physical laws, sensors, transmitters..)
- **Variable-flow pumps**
- **Identification of a stable open-loop and closed-loop system**
- **Unstable OL and CL systems**
- **Simple water level control,** responding to a **set point change**, responding to **disturbances**
- **Integrator level control**
- Pressure and flow control, split-range control
- **Energy savings** in drinking water systems management

➢ *Key points:*
- Ideal for studying process instrumentation, water level regulation, flow control and pressure regulation
- Simple and complex regulation systems (split-range optional)
- System based on an actual application (**drinking water distribution with water tower**)

➢ *Reference:* **DI10** Drinking water control and distribution – **DI11:** Complex water control and forced feed (flow/pressure) of drinking water (Optional) – **DI15:** Acquisition and control unit with NI 6009 input/output cards – **DI16:** Faulty components for diagnostic activities – **AQ11**: Differential voltage probe for USB data logger - **AQ13:** AC + DC current clamp for USB data logger

DI15 Acquisition and control unit with NI 6009 input/output cards



Synoptic view of the system on Labview

ModuloSolaire - Modular system for off-grid solar study


➢ *Features:*
- Electricity generation (solar panels: mono-crystalline, poly-crystalline, amorphous, thin-film)
- Energy storage (12V 13Ah batteries and digital-display charge regulator)
- AC/DC electrical distribution (12-230V 150VA inverter, circuit-breakers)

➢ *Training activities:*
- Energy transformation, storage and distribution
- Measurements, efficiency study of the 4 types of solar panels
- Comparison of **4 different solar panels** (mono, poly, amorphous, thin-film), **3 different regulators** (PWM, MPPT) and **2 inverters** (quasi-sine, sine)
- Project: Case study about supplying power to electrical loads (dimensioning of the parts)

Resources for projects

➢ *Key points:* Parts are connected with stackable plugs to offer maximum modularity

➢ *References:* **OR01:** 30Wp Mono-crystalline panel with inclinable stand - **OR02 :** 30Wp Poly-crystalline panel with inclinable stand - **OR03:** 14Wp Amorphous panel with inclinable stand - **OR04:** 12Wp Thin-film panel with inclinable stand - **OR10:** 12/24V 10A/10A Standard regulator- **OR11:** 12/24V 20A/10A MPPT regulator - **OR12:** 12/24V 35A Regulator with Ethernet communication and solar sensor - **OR20:** 13Ah 12V Battery in a structured wired box - **OR30:** 12V/230V 175W Sine inverter in a structured wired box - **OR31:** 12V/230V 150W Quasi-sine inverter in a structured wired box - **OR40:** Battery charger in a structured wired box - **OR55**: Matlab model

OCS fuel cell – Study and projects on a fuel cell and related electronics



➢ *Features:*
- **50W fuel cell,** 10.2 to 15.3V, type PEMFC
- Thermocouple **management electronics**
- **Hydrogen tank** and charge solution
- **DC-to-DC converters and hybridization modules**

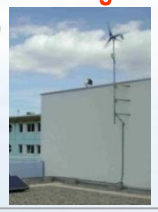
➢ *Training activities:*
- Study of hydrogen storage and **energy production**
- Study of **fluidics** and **heat transfers**
- Study of **power electronics**, signal processing and sensors
- Project: **Design and implementation of a power supply system based on a fuel cell** used independently, combined with a power storage buffer (stationary battery) or with another power source (photovoltaic, wind generator, etc.)

Resources for projects

➢ *Key points:*
- **Labview measurement executable supplied** (with AQ10 option)
- **Compatible with "Modulosolaire"** (modular system for the study of off-grid solar photovoltaics) and the ErmaBoard electronic prototyping platform
- **Project implementation guide** and **resource file** on the theory of fuel cells

➢ *References:* **PI10:** 50W 12V OCS fuel cell with management electronics, hydrogen (hydrides) tank and accessories – **PI11:** 12V output DC-to-DC converter – **PI12:** 9V output DC-to-DC converter – **PI13:** 12V battery charger – **AQ10:** USB data logger

Photovoltaic and wind generator kit – Studies and projects involving the production of solar photovoltaic and wind energy

→ High capacity and wattage, programmable and communication-capable data logger

→ System close to reality, possibility of installation in real-use conditions

Page E10

3,5kW wind generator characterization bench – Studying a grid-connected 3,5kW wind generator

→ Measurements (voltage and current in the energy chain, rotation speed, turning torque of the wind generator)

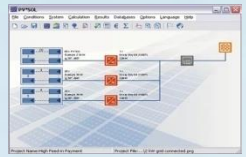
→ Constructive solutions of wind generators (mechanical control of the rotation speed)

→ Measurements and efficiency study of each part of the system: wind generator, regulator, inverter

→ Effect of modifying the load curve of the inverter on power production by the wind generator

Page E9

Software for calculation and dynamic simulation of photovoltaic systems



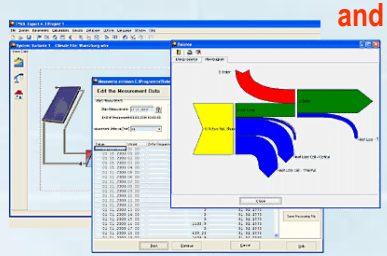

Resources for projects

➢ *Training activities:*
- Dimensioning, performance and efficiency of grid-connected and off-grid photovoltaic systems
- Simulation of shade impact
- **Studying the impact of parameter variations**

➢ *Key points:* **Case studies and training resources are provided**

➢ *Reference:* **PL13:** Software for calculation and dynamic simulation of grid-connected and off-grid photovoltaic systems

Software for calculation and dynamic simulation of solar heating, photovoltaic and heat pump systems



➢ *Training activities:*
- Dimensioning and efficiency of solar heating systems (domestic hot water and heating), photovoltaic systems (grid-connected) and heat pumps
- Fast time simulation with value display
- **Studying the impact of parameter variations**
- Energy balance

➢ *Key points:* **Case studies and Training resources are provided**

➢ *Reference:* **PL12:** Software for calculation and dynamic simulation of solar heating, photovoltaic and heat pump systems

KNX eco-energy – KNX energy management and efficiency of a hotel

"Hall" side

➢ *Features:*
- **Electrical distribution** (KNX…)
- Building safety (fire detection)
- Thermic (heating, thermostat, ventilation)
- Lighting (fluocompact, halogen, LED, metal iodine)
- Lighting control (light variation, timer, proximity detector)
- Access control (programmable encoded keyboard, openings control)
- **Communication** (Ethernet / KNX interface)
- Bus configuration (ETS4 Lite) and supervision

Resources for projects

➢ *Training activities:*
- Assembly of KNX components
- Configuration of components' addresses via ETS4 Lite software
- Development and upgradeability of hotel supervision
- **Measuring energy consumption, voltage and current**
- **Analysis of KNX frames**
- Introduction to different types of lighting and light variation
- Estimation of energy savings and savings during installation and maintenance compared to a traditional installation

➢ *Key points:*
- Real-life application (hotel) and introduction to the main electrical functions in buildings
- **Commissioning of the new standardized communication-capable bus for intelligent buildings**
- Modularity, multiple workstations
- **Extension kit for projects**

➢ *References:* **KN20**: KNX Eco-energy (with configuration and supervision software) – **KN15**: Extension kit for outdoor lighting (Optional)– **KN21**: Touch screen tablet used as a remote control (with DOMOVEA software and Wi-Fi router) (Optional) – **KN13**: KNX ETS4 configuration software (Professional edition) – **KX00**: 24Vdc Power supply – **KX01**: KNX module with 4 on/off outputs – **KX02**: KNX module with 4 on/off inputs – **KX03**: 4-button KNX switch – **KX04**: KNX sensor box to detect CO2, humidity and temperature – **KX10**: KNX module for classic light variation with halogen spotlight and 230Vdc plug – **KX11**: KNX module for DALI light variation with halogen spotlight and 230Vdc plug – **KX12**: Light box with fluocompact power (24Vdc) – **KX13**: Light box with LED (24Vdc) – **KX20**: Irrigation solenoid valve (24Vdc) – **KX21**: Ventilation box (24Vdc) – **KX22**: IP Camera for video monitoring

"Room" side

Extension to EnOcean (Page H13)

"Control cabinet" side


KNX module 4 digital outputs (KX01)


Solenoid Valve (KX20)


Supervision screen

Motorized shutter – Studying a motorized hinge and its remote control or home automation KNX

➢ *Features:*
- Opening elements (doors, windows) with a motorized hinge
- Communication (wired, 868Mhz RF, **home automation** KNX)
- Control solutions (push button, **clock**, **CTM**, **brightness sensor**)
- **Electromagnetic locks** (shutter locking)
- Strain, voltage and amperage measurements

Resources for projects

➢ *Training activities:*
- Overall analysis (mechanics, RF remote control…), **measurements** (voltage, current, closing time, acoustics)
- Creativity, patent, anteriority. Inventory of products with similar functions
- Functional analysis of the **electronic circuits** for hinge control (power, intensity control ...)
- Studying the 868Mhz remote control (performances, range, transmission security, encryption)
- **Motor control unit** (torque, current requirements), study of H-bridges
- **Network pollution, electro-magnetic field**
- **KNX protocol**, frame measuring, configuration
- Electromagnetic **performance measurements**, closing effort, releasing effort, current requirements
- Overall energy balance, energy consumption of one cycle, thermal impact on the building
- **Airtightness and sealing** functions
- **Mechanical solutions** with digital 3D model, simulation of operation conditions
- Studying the complete chain (Energy, gears, torques) and its irreversibility
- **Materials, methods for obtaining parts** (aluminum and plastic molding, surfacing, milling)
- Projects: Addition of the **Zigbee** feature / **System control development** and integrating it into a KNX bus system, configuration, adding comfort features (clock, brightness sensor) / **Electromagnetic lock design**

➢ *Key points:*
- Systems integrating **building**, **electricity**, **electronics** and **communications technologies**
- Modular and upgradeable system

➢ *References:* **GD10** Motorized hinge mechanical kit, sliding system and electromagnetic lock – **GD11** Motorized hinge system with wired control, remote control, electromagnetic lock and system control – **GD12** Home automation control with KNX (ErmaDomo) - **AQ10** USB data logger - **AQ11** Differential voltage probe – **AQ13** Current clamp (AC and DC)

KNX ErmaDomo module – Home automation control unit with KNX and supervision

➢ *Features:*
- **Communication** (USB / KNX Interface)
- **Electrical distribution** (modular KNX, KNX switches…)
- **Sensors** (KNX temperature and brightness)

Resources for projects

➢ *Training activities:*
- **Scripting commands**
- **Addressing and configuration** of KNX parts
- **Frame reading** on KNX bus
- **Developing home automation supervision**

➢ *Key points:*
- Compatible with ERM products "**Motorized shutter**", "**Air/Water Heat Pump & Fan coil unit**"
- KNX projects with ErmaDomo KNX peripherals (24Vdc actuators and fast connectors for easy wiring)
- This system may be used as the core of any **KNX Home automation project** (lighting…)

➢ *Reference:* **GD12** ErmaDomo KNX module (home automation remote control with KNX and supervision)

EnOcean wireless, battery-free home automation – Study and implementation of EnOcean wireless, battery-free home automation solutions

➢ *Features:*

- **Wireless communication using ultra-low power**
- Piezoelectric, thermoelectric and solar **microgenerators**
- Power **micro-storage**
- Building security, fire detection
- HVAC (heating, thermostat, ventilation)
- **Lighting control** (light variator, light and occupancy sensors, etc.)
- **Access and opening control** (window contact, EnOcean window handle, card/badge reader)
- Supervision and **home automation box**

Resources for projects

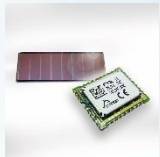
➢ *Training activities:*

- Mechatronic study of EnOcean solutions (**mechanics, electronics, communication**)
- **Setup of EnOcean home automation installations** (configuration and parametrization, supervision, etc.)
- **Configuration of a home automation box**
- Measurement of electricity consumption and **analysis of savings made** with EnOcean home automation
- **Mechatronic prototyping of EnOcean sensors or controllers**
- **Prototyping of a home automation box** with supervision application and configuration
- Integration of **EnOcean** components **in a KNX installation** (via the KNX/EnOcean gateway)

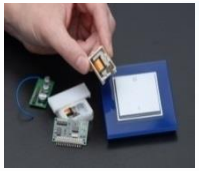
➢ *Key points:*

- Many study, design and implementation activities
- Initiation to a **booming home automation technology**, adapted to both residential and tertiary sector
- **Complementarity between the EnOcean solution and KNX** (EnOcean = proximity technology)
- Compatible with the "KNX Eco-Energy" and "KNX ErmaDomo module" ERM products for advanced home automation scenarios

➢ *References:* **EN00:** EnOcean starter kit – **EN01:** EnOcean developer kit – **EN02:** EnOcean thermal kit – **EN03:** EnOcean home automation box prototyping and supervision kit – **EN10:** EnOcean lighting kit (sensors and controllers) – **EN11:** Opening management kit (sensors and controllers) – **EN12:** Heat management kit (sensors and controllers) – **EN15:** EnOcean controller box (counter, lighting, sockets) – **EN16:** KNX/EnOcean gateway module – **EN17:** Wi-Fi / Ethernet / EnOcean home automation box



EnOcean starter kit



Magneto-resistance

Solar energy

Heating

EnOcean controller box (EN15)

Home automation & supervision box

Performance and Entertainment Technology - Lighting, sound, effects and displacement systems in show business

USB/DMX controller and a measuring unit

➢ *Features:*

- **Communications bus (DMX)**
- Lighting (halogen, LED) and lighting control **(dimming, color-changing, zooming)**
- Lighting effects **(motorized moving head)**
- **Sound equipment (HF microphone, amplifier, speakers...)**
- **Lifting and transfer of objects (AC and DC motors, PID loop control)**
- **Stage control interfaces (DMX console, USB/DMX controller and programming software for 3D stages)**
- Ceiling frames (made of aluminium wire mesh)

➢ *Training activities:*

- Situation scenario and introduction to show business technology
- **Measurements (voltage, current, power, communication frames, luminous flux, acoustics, positions, speed...)**
- **Studying PID loop control for hoists and lateral displacement systems**
- **Installing, connecting and networking equipment**
- **System adjustment and configuration**
- Diagnostic and maintenance
- Software configuration for stages

Resources for projects

➢ *Key points:*

- **Modular system** of a common, friendly and technical application
- Many **mechanical and energy studies**
- **Ideal for projects** (lighting, performance comparison of motors)

➢ *References for the basic configuration:* **DM10+AQ14** Stage controllers (DMX console and USB/DMX controller and programming software for 3D stages), power box with 2P+T plugs and measuring unit for control signals and power - **DM16** 4-channel DMX power block/dimmer, provided with PAR56 halogen projector - **LE11** PAR 56 LED color-changing projector controlled by DMX - **LE12** PAR 56 halogen projector with Fresnel lens - **LE10** DMX motorized moving head - **LF11** DMX lifting system, 10kg (DC motor) – **CX11**: Ceiling frame (3m) made of aluminium to suspend projectors and actuators.

➢ *Additional references for projects:* **DM12** DMX splitter - **DM18** W-DMX wireless connection - **LF10** DMX system to open/close a curtain (DC motor) - **LF12** DMX lifting system, 20kg (AC motor) - **LE13** Projector stand - **AU10** HF sound system - **CX10** Square ceiling frame (2x2x2m) made of aluminum to suspend projectors and actuators – **PJ02**: Mechatronics project kit "Mobile element/Tilt in DMX mode for LED lighting or camera" (With ErmaBoard prototyping platform)

➢ *Reference for measuring units and signal analysis:* See technical datasheet

Mechatronics project kit "Mobile element/Tilt in DMX mode for LED lighting or camera" (PJ02)

DMX Lifting system (LF11)

Blower door – Introduction to building airtightness testing

➢ *Features:*

- Adjustable aluminium door frame and panel with viewing window
- Fan, variable fan speed and pressure control
- Tubing
- **Pressure and flow gauge** (connected or wireless)
- **Smoke puffer** for **diagnosing air leakage sites**
- **Software** for airtightness test results including leakage areas, estimated natural and design infiltration rates and estimated savings of air-sealing.

➢ *Training activities:*

- Building airtightness testing (**leak detection**…)
- Studying commonplace leaks (windows/doors, plugs...) impact on the **airtightness of a building**
- Implementation of standardized tests (**LCB**...) with calculation of **air permeability** and **surface of leakage area**
- Project: **Conduct airtightness testing within the school**

Resources for projects

➢ *Key points:*

- Tutorial work is supplied

➢ *References:* **BW10:** Blower door with accessories and software - **BW11**: Smoke generator for blower door

Thermal infrared camera & Test bench - Introduction to infrared thermal imaging

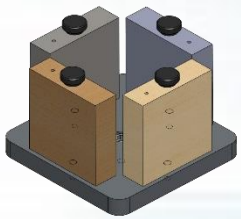
➢ *Training activities:*

- **Thermal diagnostic of buildings** (leak detection, thermal bridges, insulation defects…)
- **Preventive maintenance of electrical cabinets and parts** (overheating of parts, wires…)
- Maintenance of industrial parts (bearing failures, alignment, pipe leakage …)

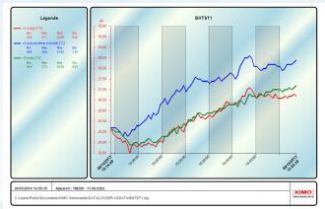
➢ *Key points:*

- **Test bench for a better comprehension** of infrared thermal imaging fundamentals, to be used as a complement to other machines and equipment
- Tutorial work is supplied

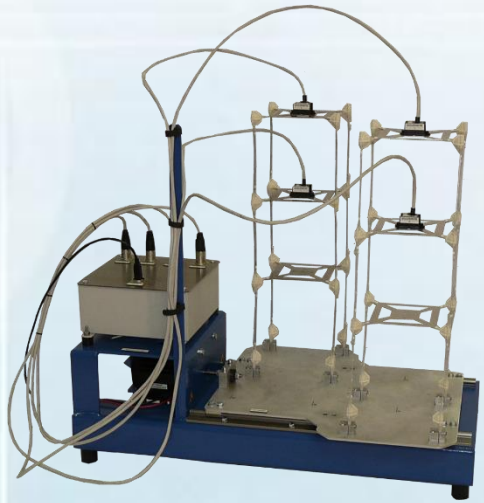
➢ *References:* **Flir** industrial infrared camera (consult us) – **NS12:** Test bench for heat conductivity and emissivity, with 6 bars (painted PVC, aluminium, steel and brass, raw aluminium, galvanized steel) – **NS14**: Insulating materials (Optional), wood, wood wool, glass wool, polystyrene, polyurethane.



Insulating materials (NS14)



Earthquake simulator - Experiments on building behavior in earthquake-like conditions

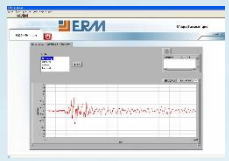


➢ *Features:*

- Shake table with vibration generator (frequency: 3 to 30Hz)
- Modular parts representing several building techniques (pole, beam, bracing, floor, wall, vibration absorber)
- 4 accelerometers
- Software for control and data acquisition
- USB camera (optional)

➢ *Training activities:*

- **Building resistance to earthquakes** (according to its shape, support, reinforcement mechanisms, weight distribution…)
- **Examples of experimental protocol** (questioning, hypotheses, building designs, observation, interpretation)
- Parameters modification (frequency and magnitude)
- Determining characteristics (magnitude, frequency, stiffness)
- Comparative study of structures according to weight



➢ *Key points:*

- Adjustable vibrating frequency (3 to 30Hz) and amplitude with the PC interface
- Modular and easy to set-up system
- Shake table faithfully replicating seismic vibrations
- Measurements and data acquisition with the Labview interface on PC

➢ *References:* **SQ10** Earthquake simulator and datalogger with 4 MEMs accelerometers – **SQ11**: HF USB camera with software to capture accelerometer measurements via image analysis

Modular system (no tool required)

Example of building

Structure with suspended weight

3-axis accelerometer

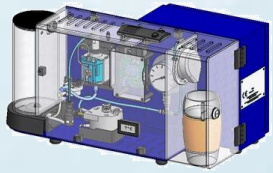
Images analysis with LabVIEW interface

Materials, Structures, Mechanics & Eco-design

Coffee maker using Nespresso® capsules

➢ *Features:*
- **Water circuit** with tank, pump, safety valve
- **Electric resistance** for immediate water heating, triac controlled
- **Mechanical sub-system** for capsule piercing
- Electronic circuit for control, with **PIC microcontroller**

➢ *Training activities:*
- History of coffee makers and the Nespresso coffee maker, coffee maker market, TRIZ interactive matrix
- Functional analysis, **patents**
- **Materials and design**
- Eco-design of the capsule, recycling process
- Studying the water circuit (**tank, pump, flow meter, heater, temperature sensor, safety valve, water tightness**)
- Studying how the capsule is held and pierced (mechanism and **kinematics**)
- Mechanical lever (pressure, material…)
- Studying and measuring **power consumption during operation and on standby**



- Project: Design and assemble a water supply for the coffee maker with tap water
- Project: Design a capsule dispenser
- Project: Automatic dropping and holding of capsules

Mechanics – Thermic - Electronics

➢ *Other possible training activities* Electronic card for the coffee maker with PIC and triac

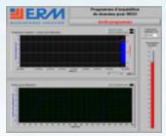
➢ *Key points:*
- Consumer product
- "Dismantled" coffee maker on a stand with a manometer on the water circuit, digital output for water temperature, load resistance and flowmeter voltage data

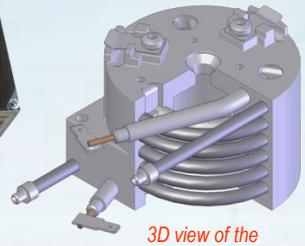
➢ *References:* **NS10**: Coffee maker trainer with measurements – **NS11**: "Commercial" coffee maker (Optional) - **NS12**: Test bench for heat conductivity and emissivity – **NS13**: Eco-design case for coffee maker using capsules – **AQ10+AQ11**: USB data logger (Optional)

Sub-unit to pierce the capsule

Test bench for heat conductivity

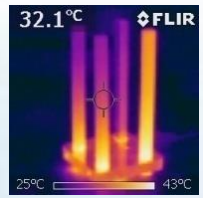
USB datalogger





3D view of the heater

Conductivity and emissivity test bench – Study of thermal transfer, thermal properties and emissivity of materials



Thermal vision of the test bench

➢ *Features:*
- Materials (**conductivity and thermal insulation**)
- Thermal measurements (**thermal camera**…)

➢ *Training activities:*
- Visualization of thermal **conductivity** and thermal **transfer** on bars made of different materials
- Visualization of thermal **emissivity** on bars with different surface treatments

➢ *Key points:*
- **Test bench for a better comprehension** of infrared thermal imaging fundamentals
- Study of materials (PVC, aluminium, brass, steel, wood, polystyrene…)
- Ideal for using an infrared camera

➢ *References:* **NS12:** Test bench for heat conductivity and emissivity, with 6 bars (painted PVC, aluminium, steel and brass, raw aluminium, galvanized steel) – **NS14**: Insulating materials (Optional), wood, wood wool, glass wool, polystyrene, polyurethane – **OA10:** 4-channel thermometer with datalogger - **All Flir thermal cameras**

Manual silicone moulding kit – Prototyping of moulded parts

→ Making **silicone moulds**, then moulding two-component polyurethane and **low-melting-point alloy** parts in a silicone mould

→ **Efficient** and **low-cost** prototyping

Page A4

Zortrax M200 3D Printer

New

→ Good quality and speed, for a cost-effective use

→ Build volume: **200 x 200 x 185 mm**

→ **Free Z-Software suite**

→ Totally **autonomous** with LCD display and SD card.

Page A3

Materials characterization equipment – Test bench for mechanical testing of materials (5 or 20kN) with data acquisition

➢ *Technical specifications:*

- Manual or automatic dual column machine with motor driven positioning
- **Test load of up to 20kN** and **test run of up to 614mm**
- PC data acquisition: **Force/Time** (20Hz) and **Force/Displacement** (6Hz)

➢ *Training activities*

- Basic test bench: **tensile**, **compression** and **Brinell hardness** testing
- Optional: **flexure**, **shear**, **impact**
- Metal comparison, designing parts…

Resources for projects

➢ *Key points:*

- **Simple and sturdy** system for training activities
- **Data accuracy** 10N (for 20kN dynamometer) and 0.1N (for 500N dynamometer)

➢ *References:* **EM00/EM05** Materials characterization equipment **20kN/5kN** including basic test bench with force (**20kN/5kN**) and displacement datalogger, software, accessories for compression (20kN, 60mm plates), tensile (5kN) and Brinell hardness testing (5mm ball – 2.5 to 7.5kN), and samples of materials (backpack loops, straps…) – **EM01** 500N force sensor to be connected to the datalogger, for testing brittle materials - **EP00** Test samples for hardness – **EM02** Measuring magnifier for Brinell pattern cavity - **EM10** Tools for 3-point flexure tests, up to 20kN, adjustable supports from 4 to 150mm – **EP10/EP11** Test samples for flexure - **EM20** Tools for tensile testing, up to 20kN, 35mm opening for all products and standard flat panels – **EM22** Self-fastening tools for tensile testing, up to 5kN, 5mm opening for all products - **EM23** Tools for tensile testing, up to 20kN, 35mm opening (excluding inserts) for all products, with inserts for standard flat and cylindrical test samples – **EM24** Tools for tensile testing, up to 20kN, for standard flat and cylindrical specimens only – **EP20/EP21** Flat/cylindrical test samples for tensile testing – **EM30** Tools for shearing tests, up to 20kN – **EP30** Test samples for shearing – **EM40** Tools for impact tests, 8mm diameter, up to 20kN – **EP40** Test samples for impact

Example of curves with the acquisition software

Tensile test

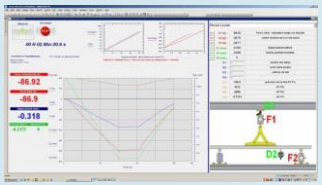
Shearing test

Materials and structures test bench – Studying materials and structures resistance

➢ *Contents and technical specifications of the basic configuration (EW10):*

- **Electric cylinder** (2500N) **with incremental encoder** for displacement measurement
- **Digital comparator** for displacement measurement
- **3 force and torque sensors** (with associated device)
- **Mounting bases**
- **Tension clamping jaws**
- **Simple** (semi-cylindrical) **fulcrums, pivots** and **fittings**
- **Ceiling-mount with distribution plates**
- **Controller and datalogger** (force and displacement) **with software**
- Set for simple tests **(support beams, Portal frames, Truss).**
- **Safety enclosure for testing** (EW09 version)

Resources for projects



PC interface for control and measurements

➢ *Training activities:*

- Static studies of **beam bending** (simple with two fulcrums, simple with fittings at one end, simple with 4 points of which two are fulcrums**)**
- Static studies of **traction**
- Static studies of **compression**
- Static studies of **support beams** (two forces and momentum applied to a solid…)
- Static studies of portal frames and truss (vertical force applied to a solid)
- Studying frames made of wire mesh, e.g. rail bridge
- Studying arches, e.g. rail bridge
- Studying the structure of buildings, e.g. metal building with flat roof
- Studying the structure of buildings, e.g.. metal building with slanted roof
- Studying an mountain bike crankset with pedals
- Distortion of a mountain bike rod, subjected to 3 concurrent forces

➢ *Key points:*

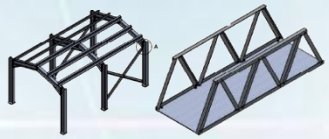
- **Test control** and **measurements** (force, displacement and constraint) on PC interface
- **Huge test enclosure** (LxBxH=1500x700x1000mm) enabling tests on 3D structures
- Possibility of combining forces applied by two cylinders
- Tensile, compression, bending, torque and torsion measurements
- Many available mechanical parts and frames (standard or optional)
- Possibility of performing tests safely on any structure

Measuring torsional momentum

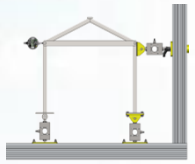
➢ *Reference:* **EW09**: Materials and structures test bench with safety enclosure - **EW10**: Materials and structures test bench – **EW11**: Device to measure torsional momentum – **EW12**: Extra electric cylinder with displacement and force sensor and simple (semi-cylindrical) fulcrum for tests – **EW13**: Extra displacement sensor (digital comparator) to be placed anywhere on the tested structure – **EW14**: Extra force sensor with flat base and simple (semi-cylindrical) fulcrum and pivot

SW10: Modular portal frame with 4 strain gauges and datalogger to measure distortion in the structures – **SW11**: Test model to study complex structures (“Trestle bridge” and “Arch bridge”) – **SW12**: Test model to study a complex structure “Industrial metal building with 3 spans” – **SW13**: Test model to study cranksets with pedal and rods on mountain bikes – **SW14**: Beam for tension coefficient experiments

Complex structures (depot, bridge…)



eg: Testing 3 concurrent forces



eg:Truss testing

Materials, Structures, Mechanics & Eco-design

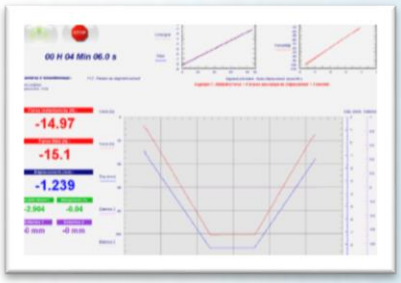
New

TangoKit – Test bench for materials and structures

Torsion test

➢ *Technical specifications:*

- **Electric cylinder for** tensile, flexure and compression **2,5 kN**
- Travel speed 100 mm/mn
- Travel 100 mm
- Cylinder adjustable in height
- **Work-bench 1000 x 160 mm**
- Maximum height of the tested sample 300 mm
- Displacement accuracy 0,05 mm
- Force sensor 5 kN, resolution 0,1 N
- USB connection
- **« Oscar » software for data logging and processing**



Data logging and processing software

Flexure test

➢ *Training activities:*

- **Studying beams**
- **Studying structures**
- **Studying tensile strengths**
- **Studying compression**
- Materials comparison

➢ *Key points:*

- Possibility to measure tensile strength and compression with the same bench
- Compact design
- Many mechanical parts and frames (standard or optional)

➢ *References:* **TK10**: TangoKit test bench for materials and structures, with frame, electric cylinder 2500N, 3 simple (semi-cylindrical) fulcrums, software – **TK11**: Extra displacement sensor (digital comparator) – **TK12**: Device to measure torsional momentum – Test samples : consult us

Control / Acquisition / Instrumentation

Industrial command prototyping platform - Prototyping of control parts based on a real-time NI myRIO core and industrial motor controller boards

LabVIEW Real-Time
Graphical Development, Real-Time Results

CANopen

➢ *Features:*

- Real-time **LabVIEW** control (**myRIO** board)
- Communication (**CAN** bus)
- Motorization & Energy (**industrial controller for brushless, DC and stepper motors**)
- **Load measurement**
- **Video and image processing**
- **Inertial measurement unit** (accelerometer and gyroscope)

➢ *Training activities and projects:*

- **Real-time** programming in **LabVIEW**
- **Motor controller board configuration**
- Study and configuration of a **CAN bus**
- Experimental **optimization** of control parameters via **autotune**
- Integration of **image analysis** in a control system
- Project: **System control design or upgrade** (position, speed and load control)

Resources for projects

Controller board for brushless / stepper / DC motors

Video control camera

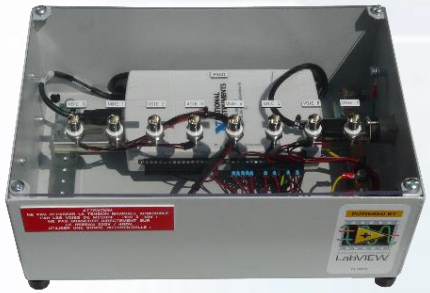
Programming and control interface with video feedback

➢ *Key points:*

- The solution is open to development projects on your existing systems
- Examples of applications with LabVIEW files provided (Aerial imaging gimbal, Cable-driven robot)
- **Compatible with C-Series boards** from National Instruments (for upgrades and projects)

➢ *References:* **NC00:** National Instruments myRIO kit for real-time control and acquisition – **NC09:** Controller board for 2 brushless motors – **NC08:** Controller board for stepper, DC and brushless motors – **NC01:** CAN communication card for myRIO – **NC15:** Video control camera – **NC20:** S-beam load cell with signal conditioner – **NC21:** Inertial measurement unit with accelerometer and gyroscope – **SQ11:** 96 fps USB camera with configuration software (LabVIEW analysis) – **SQ12:** 500 fps USB camera

USB NI 6210 data logger – Temperature datalogging, 0/10V sensors, 0 to 500V voltage, amperage, constraint



➢ *Specifications:*
- **8 Analog Inputs** ± 10V (1- bits, 250 kS/s)
- 8 Digital Inputs/Outputs
- Two 32-bit counter/timers
- Software configuration for thermocouples
- **Isolated input channels by external conditioners**
- User-friendly datalogging software (datalogging, display and analysis)

➢ *Types of measurable data and Conditioners:*
- 0/10V sensors (without conditioner)
- AC and DC voltage: 0/500V (with AC and DC voltage input conditioner)
- AC and DC amperage (with AC and DC amperage conditioner)
- Other sensors (with conditioners)

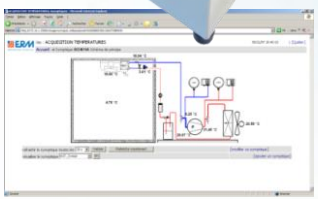
Resources for projects

LabVIEW

➢ *Key points:*
- May be used on ERM systems and any other didactic system
- **User-friendly data logging software: Sysma WinATS** (software in French)
- Possible interface with Labview (executable files supplied for ERM systems, Labview software)
- Possible use of Labview Signal Express, free data logging software
- **Wide range of adjustable sensors and conditioners**

➢ *References:* **AQ10** USB data logger – **AQ11** Differential voltage probe for USB data logger – **AQ12** AC current clamp for USB data logger – **AQ13** AC+DC current clamp for USB data logger – **AQ00** Sysma WinATS data logging software – Many conditioners and sensors are available (See the product's technical data sheet)

Data-logging and tele-monitoring unit



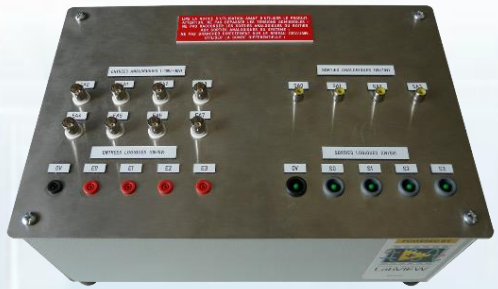
➢ *Technical specifications:*
- Data-acquisition and logging box for any type of measurement
- **16 universal analog entries (0/10V, 4/20mA with external shunt, PT1000, PT100, CTN…)**
- Data export via **USB**, RS232 and Ethernet
- **Tele-monitoring software** (49 variables, Web server, history, alerts…)

➢ *Training activities:*
- Implementation of acquisition and tele-monitoring of thermal engineering systems
- Study of industrial communication solutions

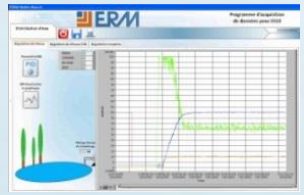
➢ *Key points:* Many I/O and communication possibilities

➢ *Reference:* **MO21:** Data logger and tele-monitoring via Ethernet

Acquisition and control unit with NI 6009 input/output cards



➢ *Specifications of the USB acquisition and control unit:*
- **8 analog input channels** ±10V (14 bits, 48 kS/s)
- 2 analog output channels 0-10V (12 bits, 150 S/s)
- 12 digital I/O
- 32-bit counter
- User-friendly acquisition software (data logging, visualization and analysis)



➢ *Types of measurable data and conditioners:*
- 0/10V sensors (without conditioner)
- 0/500V AC and DC voltages (with AC/DC voltage conditioner)
- AC and DC current (with AC/DC current conditioner)
- Other sensors (with conditioners)

Resources for projects

LabVIEW

➢ *Key points:*
- **Practical and cost-effective solution for interfacing your systems with LabVIEW**
- May be used with ERM systems, and any other training system
- Possible use of LabVIEW Signal Express (free acquisition software)
- **Wide range of available sensors and measurement conditioners**

➢ *References:* **DI15:** Acquisition and control unit with NI 6009 input/output cards – **AQ11:** Differential voltage probe for the USB data logger – **AQ12:** AC current clamp for the USB data logger – **AQ13:** AC+DC current clamp for the USB data logger – Many conditioners and sensors are available (contact us)

High-speed USB cameras - Image analysis and study of physical phenomena

LabVIEW

➢ *Specifications:*
- USB video camera (96fps or 500fps)
- Camera configuration software and examples of video processing on LabVIEW

➢ *Training activities:*
- Analysis of **motion, speed and acceleration** (studying free fall, a pendulum, etc.)
- Analysis of fluid motion and flow (**fluid mechanics**)
- **Image analysis** (camera configuration, filters, shape recognition, etc.)

➢ *Key point:* Easy to install and configure

➢ *References:* **SQ11:** 96fps USB camera with configuration software and examples of LabVIEW image analysis applications – **SQ12:** 500fps USB camera

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