

Development of an Environmental Monitoring System Based on Arduino and WinCC_OA

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Outline

- 1 Introduction
- 2 Arduino
- 3 Sensors
- 4 OPC Server
- 5 WinCC_OA



1 Introduction

2 Arduino

3 Sensors

4 OPC Server

5 WinCC_OA



- Development of a low cost system capable of measuring the environmental parameters during test beams
- The Arduino microcontroller was used
- WinCC_OA was used for data monitoring and elaboration
- Integration of the system into the RD51 SLOW Control SYstem



Outline

1 Introduction

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5 WinCC_OA



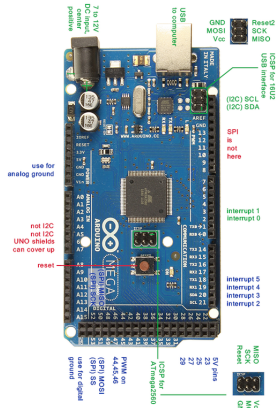
Arduino: Microcontroller,
input/output pins

Variety of Arduino boards



Arduino Mega 2560

- 54 digital pins (input or output)
- 16 analog input pins
- USB port
- power jack
- 5V, 3.3V, GND
- Various functions (PWM, Interrupts, I²C, SPI etc.)



Arduino Ethernet Shield

Expansion boards (shields)

Extra functionalities
(ethernet, wifi etc)

Arduino Ethernet Shield

Wiznet W5100 Ethernet
Chip(TCP, UDP)

RJ45 jack

SD card jack



Interacting with the Arduino

Write and upload code
Arduino IDE(Integrated
Development Environment)
Sketch, ".ino" file
Libraries
Menus
Buttons
Serial Monitor

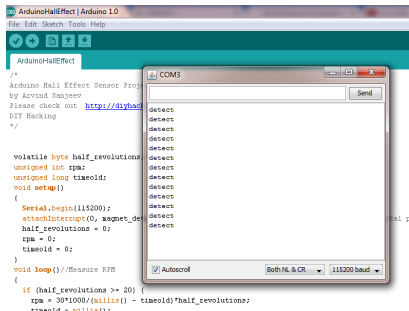


```
sketch_jan24a | Arduino 1.6.0
File Edit Sketch Tools Help
sketch_jan24a
void setup() {
  // put your setup code here, to run once:
}
void loop() {
  // put your main code here, to run repeatedly:
}
Done compiling.
Sketch uses 450 bytes (1%) of program storage space. Maximum is
32,256 bytes. Global variables use 9 bytes (0%) of dynamic memory,
leaving 2,039 bytes for local variables. Maximum is 2,048 bytes.
Arduino Uno on COM1
```



Interacting with the Arduino

Write and upload code
Arduino IDE(Integrated
Development Environment)
Sketch, ".ino" file
Libraries
Menus
Buttons
Serial Monitor



The screenshot shows the Arduino IDE interface. The main window displays a sketch titled "ArduinoHallEffect" with the following code:

```
/*  
Arduino Hall Effect Sensor Project  
by Arvind Sanjeev  
Please check out http://diyhacks.us  
DIY Hacking  
*/  
  
volatile byte half_revolutions;  
unsigned int rps;  
unsigned long timeold;  
void setup()  
{  
  Serial.begin(115200);  
  attachInterrupt(0, magnet_detect, RISING);  
  half_revolutions = 0;  
  rps = 0;  
  timeold = 0;  
}  
void loop()//Measure RPM  
{  
  if (half_revolutions >= 20) {  
    rps = 30*1000/(millis() - timeold)*half_revolutions;  
    timeold = millis();  
  }  
}
```

Overlaid on the IDE is the Serial Monitor window, titled "COM3". It shows a list of "detect" messages being received from the Arduino board. The window includes a "Send" button, an "Autoscroll" checkbox, and a baud rate dropdown menu set to "115200 baud".



1 Introduction

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A total of 4 sensors was used

2 digital temperature and pressure sensors

1 analog pressure sensor

1 digital temperature and humidity sensor



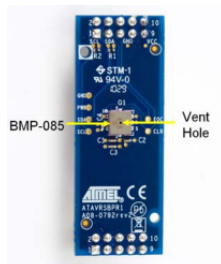
BMP085 Sensor

- Digital sensor, pressure and temperature
- High precision, Pressure: ± 1 mbar, Temperature: ± 1 °C
- Low consumption
- Communication via the I²C protocol
- 3.3V power supply



BMP085 Sensor

- Digital sensor, pressure and temperature
- High precision, Pressure: ± 1 mbar, Temperature: ± 1 °C
- Low consumption
- Communication via the I²C protocol
- 3.3V power supply
- Atmel AVR4201



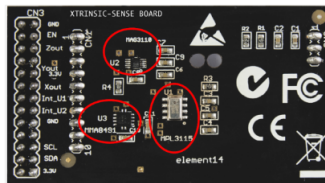
MPL3115A2 Sensor

- Digital sensor pressure and temperature
- High precision, Temperature: ± 1 °C, Pressure: ± 4 mbar
- Low consumption
- Communication via the I²C protocol
- 3.3V power supply

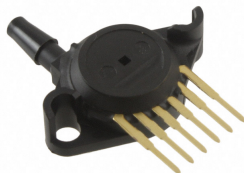


MPL3115A2 Sensor

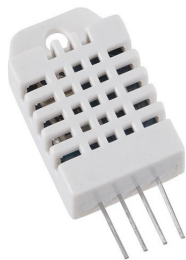
- Digital sensor pressure and temperature
- High precision, Temperature: ± 1 °C, Pressure: ± 4 mbar
- Low consumption
- Communication via the I²C protocol
- 3.3V power supply
- Xtrinsic Sensor Board Element14



- Analog pressure sensor
- Accuracy: $\pm 2.5\% V_{FSS}$
- 5V operating voltage
- Transfer function, conversion voltage to pressure



- Digital temperature and humidity sensor
- High precision, Temperature: ± 0.2 °C, Humidity: $\pm 2\%$
- Low consumption
- Long-term stability, long transmission distance
- 5V power supply



1 Introduction

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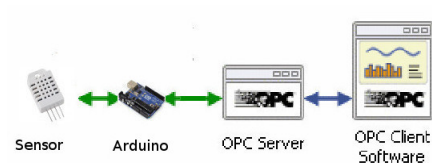
4 OPC Server

5 WinCC_OA



OPC Protocol

- OPC (Open Platform Communication)
- Specifications
- OLE (Object Linking and Embedding) for Process Control
- SCADA/PLC
- Server/Client
- Universal, open



- Idefonso Martinez Marchena, <http://www.st4makers.com>
- In total compliance with the OPC specifications
- Ability to use multiple Arduino boards of any type simultaneously
- Serial, wifi, ethernet communication



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SCADA (Supervisory Control And Data Acquisition)

A tool for the development of control system

- Database
- GEDI (Graphics EDItor)
- Control Scripts
- Connection with hardware devices (OPC, Modbus, DIM)

JCOP (Joint COntrols Project) framework



RD51 Slow Control System (SLOCSY)

Channel	Min	Max	V	A	I	Min	Max	V	A	I	Min	Max	V	A	I	Min	Max	V	A	I
11-01	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	420.0	420.0	0.00	0.00	0.00	420.0	420.0	0.00	0.00	0.00
11-02	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	400.0	400.0	0.00	0.00	0.00	400.0	400.0	0.00	0.00	0.00
11-03	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	420.0	420.0	0.00	0.00	0.00	420.0	420.0	0.00	0.00	0.00
11-04	2.6	2.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	600.0	600.0	0.00	0.00	0.00	600.0	600.0	0.00	0.00	0.00
11-05	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	200.0	200.0	0.00	0.00	0.00	200.0	200.0	0.00	0.00	0.00
11-06	2.6	2.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	100.0	100.0	0.00	0.00	0.00	100.0	100.0	0.00	0.00	0.00
11-07	2.6	2.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	800.0	800.0	0.00	0.00	0.00	800.0	800.0	0.00	0.00	0.00
11-08	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	700.0	700.0	0.00	0.00	0.00	700.0	700.0	0.00	0.00	0.00
11-09	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	200.0	200.0	0.00	0.00	0.00	200.0	200.0	0.00	0.00	0.00
11-10	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	90.0	90.0	0.00	0.00	0.00	90.0	90.0	0.00	0.00	0.00
11-11	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00
11-12	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	600.0	600.0	0.00	0.00	0.00	600.0	600.0	0.00	0.00	0.00
11-13	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00
11-14	0.6	0.6	0.04	0.04	0.04	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-15	0.6	0.6	0.04	0.04	0.04	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-16	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-17	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00
11-18	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-19	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00	300.0	300.0	0.00	0.00	0.00
11-20	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-21	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-22	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-23	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-24	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-25	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-26	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-27	0.5	0.5	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-28	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-29	1.8	1.8	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-30	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-31	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00
11-32	0.6	0.6	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00	0.1	0.1	0.00	0.00	0.00



RD51 Slow Control System (SLOCSY)

The screenshot displays the RD51 Slow Control System (SLOCSY) interface. The main window shows a table of sensor data for various modules (06_00 to 06_03) across different groups (group1 to group5). A red arrow points to the 'Environmental Parameters' button in the top menu bar. The table displays parameters like 'iMon', 'V iMon', and 'iA' with numerical values. The status bar at the bottom indicates 'Windows 7 Build 7600' and 'This copy of Windows is not genuine'.

Module	Group	iMon	V iMon	iA	Module	Group	iMon	V iMon	iA	Module	Group	iMon	V iMon	iA	Module	Group	iMon	V iMon	iA
06_00	group1	1.0	0.000	0.000	06_04	group1	0.0	0.000	0.000	10_03	group4	0.0	0.000	0.000	12_07	group5	0.0	0.000	0.000
06_01	group1	1.0	0.000	0.000	06_05	group1	0.0	0.000	0.000	10_04	group4	0.0	0.000	0.000	12_08	group5	1.3	0.000	0.000
06_02	group1	1.0	0.000	0.000	06_06	group1	0.0	0.000	0.000	10_05	group4	0.0	0.000	0.000	12_09	group5	0.0	0.000	0.000
06_03	group1	2.0	0.000	0.000	06_07	group1	0.0	0.000	0.000	10_06	group4	0.0	0.000	0.000	12_10	group5	0.8	0.000	0.000
06_04	group1	1.0	0.000	0.000	06_08	group1	0.0	0.000	0.000	10_07	group4	0.0	0.000	0.000	12_11	group5	1.3	0.000	0.000
06_05	group1	2.0	0.000	0.000	06_09	group1	0.0	0.000	0.000	10_08	group4	0.0	0.000	0.000	12_12	group5	0.0	0.000	0.000
03_00	group2	1.0	0.000	0.000	06_10	group2	1350.3	0.000	405.400	10_09	group4	0.0	0.000	0.000	14_01	group5	0.0	0.000	0.000
03_01	group2	1.0	0.000	0.000	06_11	group2	2099.3	0.000	1613.000	10_10	group4	0.0	0.000	0.000	14_02	group5	0.0	0.000	0.000
03_02	group2	1.0	0.000	0.000	06_12	group2	0.0	0.000	0.000	10_11	group4	0.0	0.000	0.000	14_03	group5	1.0	0.000	0.000
03_03	group2	1.0	0.000	0.000	06_13	group2	0.0	0.000	0.000	12_00	group4	0.0	0.000	0.000	14_04	group5	0.0	0.000	0.000
03_04	group2	1.0	0.000	0.000	06_14	group2	0.0	0.000	0.000	12_01	group4	0.0	0.000	0.000	14_05	group5	0.0	0.000	0.000
03_05	group2	2.0	0.000	0.000	06_15	group2	0.0	0.000	0.000	12_02	group4	0.0	0.000	0.000	14_06	group5	1.0	0.000	0.000
06_06	group3	0.0	0.000	0.000	06_16	group3	0.0	0.000	0.000	12_03	group4	0.0	0.000	0.000	14_07	group5	0.0	0.000	0.000
06_07	group3	0.0	0.000	0.000	06_17	group3	0.0	0.000	0.000	12_04	group4	0.0	0.000	0.000	14_08	group5	0.0	0.000	0.000
06_08	group3	0.0	0.200	0.000	16_00	group3	0.0	0.000	0.000	12_05	group4	0.0	0.000	0.000	14_09	group5	0.0	0.000	0.000
06_09	group3	0.0	0.000	0.000	16_01	group3	0.0	0.000	0.000	12_06	group4	0.0	0.000	0.000	14_10	group5	0.0	0.000	0.000
					16_02	group3	0.0	0.000	0.000	14_11	group5	0.0	0.000	0.000					

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a desktop background with various icons. The main window is titled "Environmental Parameters" and contains two data tables, each labeled "Arduino0".

Arduino0 (Top Table):

Time	Pressure1	Humidity1	Temperature1
00 00	988.80 mbar	45.96 %	15.76 C
00 01	988.80 mbar	45.96 %	15.76 C
00 02	988.80 mbar	45.96 %	15.76 C
00 03	988.80 mbar	45.96 %	15.76 C
00 04	988.80 mbar	45.96 %	15.76 C
00 05	988.80 mbar	45.96 %	15.76 C

Arduino0 (Bottom Table):

Time	Pressure1	Humidity1	Temperature1
03 00	988.00 mbar	41.20 %	15.96 C
03 01	988.00 mbar	41.20 %	15.96 C
03 02	988.00 mbar	41.20 %	15.96 C
03 03	988.00 mbar	41.20 %	15.96 C
03 04	988.00 mbar	41.20 %	15.96 C
03 05	988.00 mbar	41.20 %	15.96 C
06 00	988.00 mbar	41.20 %	15.96 C
06 01	988.00 mbar	41.20 %	15.96 C
06 02	988.00 mbar	41.20 %	15.96 C
06 03	988.00 mbar	41.20 %	15.96 C

The window also features a menu bar with "Configure", "Export", "Archiving", "Plot all", and "Close" options. The desktop background shows a taskbar with icons for "e", "Internet Explorer", "Google Chrome", "Skype", and "Windows Defender". The system tray at the bottom right shows the time "1:30 PM" and date "11/7/2015".

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom. The desktop background is dark with various icons. The main window is titled "Environmental Parameter Monitoring" and contains a table of sensor data. A dialog box titled "Environmental Parameter Monitoring" is open in the foreground, with a red arrow pointing to the "Configure" button. The dialog box contains two sections, each labeled "Arduino0". Each section displays a grid of sensor data for different sensors: BMP085, DHT22, MPL315A2, and MPX5700. The data is presented in a grid format with columns for sensor type and value.

Time	Sensor	Value	Unit
00:00	BMP085	988.80	mbar
00:01	DHT22	45.00	%
00:02	MPL315A2	15.70	mbar
00:03	MPX5700	977.00	mbar
00:04	BMP085	989.00	mbar
00:05	DHT22	45.80	%
00:06	MPL315A2	979.30	mbar
00:07	MPX5700	979.30	mbar
03:00	BMP085	982.00	mbar
03:01	DHT22	61.20	%
03:02	MPL315A2	986.10	mbar
03:03	MPX5700	984.00	mbar
03:04	BMP085	982.00	mbar
03:05	DHT22	61.20	%
06:00	BMP085	982.00	mbar
06:01	DHT22	61.20	%
06:02	MPL315A2	986.10	mbar
06:03	MPX5700	984.00	mbar

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a sidebar of icons on the left. The main window is titled "Environmental Parameters" and contains a table of sensor data. A dialog box titled "subConfigure" is open over the table, showing options to "Configure Arduino", "Connect to OPC", and "Close".

Time	Pressure1	Humidity1	Temperature1	Pressure1	Temperature1	Pressure1
00:00	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
00:01	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
00:02	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
00:03	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
00:04	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
00:05	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:00	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:01	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:02	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:03	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:04	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
03:05	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
06:00	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
06:01	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
06:02	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar
06:03	960.80 mbar	45.96 %	19.80 °C	975.76 mbar	975.30 °C	977.06 mbar

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop environment with a taskbar at the bottom and a Start menu on the left. The main application window, titled "Environmental Parameters", is open. It features a menu bar with "File", "View", "Tools", "Help", and "About". Below the menu bar are buttons for "Configure", "Export", "Archiving", "Plot all", and "Close". The main area displays a table of sensor data with columns for time, sensor type, and value. A "Configure" dialog box is overlaid on the table, showing a "Number of Arduinos" input field and "Apply" and "Close" buttons. A "Delete Previous Configuration" button is also visible at the bottom of the dialog.

Time	Sensor	Value	Unit
00:00	IM		
00:01	IM		
00:02	IM		
00:03	IM		
00:04	IM		
00:05	IM		
03:00	IM		
03:01	IM		
03:02	IM		
03:03	IM		
03:04	IM		
03:05	IM		
06:00	IM		
06:01	IM		
06:02	IM		
06:03	IM		

Configuration Dialog Box:

Number of Arduinos:

Buttons: Apply, Close, Delete Previous Configuration

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom. The desktop background is dark with various icons. The main application window is titled "Environmental Parameters" and contains a table of sensor data. A "Configure" dialog box is open in the foreground, showing a list of sensors to be selected for the Arduino.

Time	Pressure1	Humidity1	Temperature1	Pressure2	Temperature2	Pressure3
00:00	988.80 mbar	45.96 %	19.80 °C	978.00 mbar	979.30 °C	0.000 uA
00:01						0.000 uA
00:02						0.000 uA
00:03						0.000 uA
00:04						0.000 uA
00:05						0.000 uA
03:00						0.000 uA
03:01	982.05 mbar		26.18 °C			0.000 uA
03:02						0.000 uA
03:03						0.000 uA
03:04						0.000 uA
03:05						0.000 uA
06:00						0.000 uA
06:01						0.000 uA
06:02						0.000 uA
06:03						0.000 uA

The "Configure" dialog box shows a list of sensors to be selected for the Arduino:

- Arduino0
- Arduino1
- Arduino2

The dialog box also has buttons for "Apply", "Close", and "Delete Previous Configuration".

Slow Control System

Environmental parameter monitoring window

The screenshot displays a Windows desktop environment with a dark theme. The desktop is populated with various icons, including folders like 'wincc', 'Gantt', and 'TestProject...', and applications like 'wincc.exe', 'Acrobat Reader DC', 'Skype', 'Google Chrome', and 'Diner Updater'. The taskbar at the bottom shows the Start button and several application icons. The system tray in the bottom right corner shows the date and time as 1:33 PM on 11/7/2015.

The main application window, titled 'Environmental Parameters', is open. It features a toolbar with buttons for 'Configure', 'Export', 'Archiving', 'Plot all', and 'Close'. Below the toolbar, there are several sensor data displays for different sensors: BMP085, DHT22, MPL315A2, and MPX5700. Each sensor display shows its name, a numerical value, and a unit. For example, the BMP085 sensor shows 'Pressure1: 760.80 mbar' and 'Temperature1: 19.90 C'. The DHT22 sensor shows 'Humidity1: 45.90 %' and 'Temperature1: 19.80 C'. The MPL315A2 sensor shows 'Pressure1: 15.70 mbar' and 'Temperature1: 19.90 C'. The MPX5700 sensor shows 'Pressure1: 977.00 mbar' and 'Temperature1: 19.90 C'. A 'Configure' dialog box is open in the foreground, titled 'SensorSelection'. It contains a table for selecting sensors for an Arduino:

Sensors	Number Of Senses
BMP085	1
DHT22	1
MPL315A2	1
MPX5700	1

Below the table, there is a green circular button labeled 'STBy', an 'Apply' button, and a 'Close' button. A yellow note at the bottom of the dialog reads: 'If you are not using a sensor just, set the number of sensors tab equal to 0'.

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom. The desktop background is dark with various icons. The main application window is titled "Environmental Parameters" and contains a table of sensor data. A dialog box titled "subConfigure" is open over the table, showing configuration options for an "Arduino" sensor.

Time	Pressure1	Humidity1	Temperature1	Pressure1	Temperature1	Pressure1
00 00	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
00 01	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
00 02	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
00 03	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
00 04	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
00 05	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 06	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 01	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 02	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 03	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 04	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
03 05	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
06 00	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
06 01	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
06 02	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar
06 03	988.80 mbar	45.96 %	19.80 C	979.30 mbar	979.30 C	977.06 mbar

The "subConfigure" dialog box contains the following options:

- Configure Arduino
- Connect to OPC
- Close

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a sidebar of icons on the left. The main window is titled "Environmental Parameters" and contains a table of sensor data. The table has columns for time, sensor type, and value. A "subConfigure" dialog box is open, showing a dropdown menu with "Arduino0" and "Arduino1" options, and an "Apply" button.

Time	Sensor	Value	Unit
00:00	Arduino0		
00:01	BMP280		mbar
00:02	DHT22		%
00:03	MPL3115A2		mbar
00:04	MPX5700		mbar
00:05	Pressure1	988.80	mbar
00:06	Humidity1	45.96	%
00:07	Pressure1	975.76	mbar
00:08	Temperature1	19.90	°C
00:09	Temperature1	19.80	°C
00:10	Temperature1	19.76	°C
00:11	Temperature1	19.70	°C
03:00	Arduino1		
03:01	BMP280		mbar
03:02	DHT22		%
03:03	MPL3115A2		mbar
03:04	MPX5700		mbar
03:05	Pressure1	982.05	mbar
03:06	Humidity1	45.96	%
03:07	Pressure1	964.09	mbar
03:08	Temperature1	26.19	°C
03:09	Temperature1	26.19	°C
03:10	Temperature1	26.19	°C
06:00	Pressure1	986.29	mbar
06:01	Humidity1	45.96	%
06:02	Pressure1	964.09	mbar
06:03	Temperature1	26.19	°C
06:04	Temperature1	26.19	°C
06:05	Temperature1	26.19	°C

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop environment with a taskbar at the bottom and a sidebar of icons on the left. The main application window is titled "Environmental Parameters" and contains a table of sensor data. A configuration dialog box titled "OPC Configuration for Arduino0" is open in the foreground.

Time	Unit	Value	Unit	Value	Unit	Value	Unit
00:00	IM						
00:01	IM						
00:02	IM						
00:03	IM	Pressure1	760.80	mbar	Humidity1	45.96	%
00:04	IM	Temperature1	19.90	°C	Temperature1	19.80	°C
00:05	IM						
03:00	IM						
03:01	IM	Pressure1	762.05	mbar	Humidity1	45.96	%
03:02	IM	Temperature1	20.18	°C	Temperature1	20.18	°C
03:03	IM						
03:04	IM						
03:05	IM						
06:00	IM						
06:01	IM						
06:02	IM						
06:03	IM						

The configuration dialog box "OPC Configuration for Arduino0" contains the following fields:

- Server: ArduinoOPCServer
- OP Element: BMP085.Pressure1
- Driver Number: 0
- Group: ArduinoGroup
- Direction: Input, Output
- OPC Item Name: ArduinoFun
- Arduino Type: ArduinoFun
- Address Active:

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a Start menu on the left. The main window is titled "Environmental Parameters" and contains two identical sensor node displays, each labeled "Arduino0". A red arrow points to the "Archiving" button in the top menu bar of the window.

The sensor node displays the following data:

Node	Parameter	Value	Unit
Arduino0 (Top)	Pressure1	988.80	mbar
	Humidity1	45.96	%
	Temperature1	19.80	°C
	Temperature1	979.30	°C
Arduino0 (Bottom)	Pressure1	982.05	mbar
	Humidity1	61.25	%
	Temperature1	15.96	°C
	Temperature1	15.26	°C

The window also features a menu bar with "Configure", "Export", "Archiving", "Plot all", and "Close" buttons. The "Archiving" button is highlighted with a red arrow. The window title bar shows "Arduino0" and "en_US-GR-01".

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop environment with a taskbar at the bottom and a Start menu on the left. The main window is titled "Environmental Parameters" and displays a grid of sensor data. A dialog box titled "Configure Archiving for arduino" is open in the foreground, showing a dropdown menu with "Arduino0" selected and "APPLY" and "CLOSE" buttons.

Time	Pressure1	Humidity1	Temperature1	Pressure2	Pressure3	Pressure4
00:00	988.80 mbar	45.96 %	25.99 C	95.76 mbar	977.86 mbar	0.000 uA
00:01						0.000 uA
00:02						0.000 uA
00:03						0.000 uA
00:04						0.000 uA
00:05						0.000 uA
03:00						0.000 uA
03:01	982.05 mbar					0.000 uA
03:02			26.18 C			0.000 uA
03:03						0.000 uA
03:04						0.000 uA
03:05						0.000 uA
06:00						0.000 uA
06:01						0.000 uA
06:02						0.000 uA
06:03						0.000 uA

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop environment with a taskbar at the bottom and a sidebar of icons on the left. The main application window is titled "Environmental Parameters" and contains a data table with columns for time, sensor type, and value. A modal dialog box titled "Archiving Arduino" is overlaid on the application, listing the following sensors:

alias	STBy
BMP085.Pressure1	
BMP085.Temperature1	
DHT22.Humidity1	
DHT22.Temperature1	
MPX115A2.Pressure1	
MPX115A2.Temperature1	
MPX3700.Pressure1	

The dialog box also includes buttons for DELETE, STOP, CONFIGURE, START, SELECT ALL, and CLOSE.

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a Start menu on the left. The main window is titled "Environmental Parameters" and contains two identical sensor node displays, each labeled "Arduino0". Each node shows a grid of parameters with their current values and units. A red arrow points to the "Plot all" button in the top right corner of the window.

Time	Pressure1	Humidity1	Temperature1	Pressure2	Humidity2	Temperature2
00:00	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
00:01	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
00:02	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
00:03	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
00:04	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
00:05	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:00	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:01	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:02	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:03	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:04	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
03:05	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
06:00	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
06:01	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
06:02	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C
06:03	960.80 mbar	45.00 %	19.80 C	975.70 mbar	45.70 %	19.30 C

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop environment with a taskbar at the bottom and a desktop with various icons. The main application window is titled "Environmental Parameters" and displays data for two Arduino boards. The data is organized into columns for different sensors: BMP085, DHT22, MPL3115A2, and MPX5700. Each sensor column shows a reading for Pressure, Humidity, and Temperature. A dialog box titled "plotSelection.plt" is open, showing a list of plots to be displayed: "All Plots", "All Sensors", "Temperature", "Humidity", and "Pressure".

Time	Pressure1	Humidity1	Temperature1	Pressure1	Humidity1	Temperature1	Pressure1	Humidity1	Temperature1
00:00	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
00:01	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
00:02	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
00:03	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
00:04	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
00:05	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:00	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:01	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:02	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:03	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:04	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
03:05	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
06:00	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
06:01	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
06:02	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C
06:03	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	45.96 %	19.80 °C	977.00 mbar	45.96 %	19.80 °C

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom and a Start menu on the left. The main window is titled "Environmental Parameters" and contains two identical sensor monitoring panels, each labeled "Arduino0".

Arduino0 (Top):

- BMP085: Pressure1 960.80 mbar, Temperature1 19.00 C
- DHT22: Humidity1 45.00 %, Temperature1 19.80 C
- MPL115A2: Pressure1 15.70 mbar, Temperature1 19.30 C
- MPX5700: Pressure1 977.00 mbar

Arduino0 (Bottom):

- BMP085: Pressure1 982.00 mbar, Temperature1 20.10 C
- DHT22: Humidity1 61.20 %, Temperature1 19.00 C
- MPL115A2: Pressure1 980.10 mbar, Temperature1 19.20 C
- MPX5700: Pressure1 984.00 mbar

Buttons at the top of the window include "Configure", "Export" (highlighted with a red arrow), "Archiving", "Plot all", and "Close". The right side of the window shows a vertical list of values, all currently at 0.000.

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows desktop with a taskbar at the bottom. The desktop background is dark with various icons. The main application window is titled "Environmental Parameters" and contains a table of sensor data. A dialog box titled "export" is open in the foreground, showing a dropdown menu with "Arduino" selected and "APPLY" and "CLOSE" buttons.

Time	Pressure1	Humidity1	Temperature1	Pressure2	Temperature2	Pressure3
00:00	988.80 mbar	45.96 %	19.80 °C	978.30 mbar	979.30 °C	0.000 uA
00:01						0.000 uA
00:02						0.000 uA
00:03	988.80 mbar	45.96 %	19.80 °C	978.30 mbar	979.30 °C	0.000 uA
00:04	988.80 mbar	45.96 %	19.80 °C	978.30 mbar	979.30 °C	0.000 uA
00:05						0.000 uA
03:00						0.000 uA
03:01	988.80 mbar	45.96 %	19.80 °C	978.30 mbar	979.30 °C	0.000 uA
03:02	988.80 mbar	45.96 %	19.80 °C	978.30 mbar	979.30 °C	0.000 uA
03:03						0.000 uA
03:04						0.000 uA
03:05						0.000 uA
06:00						0.000 uA
06:01						0.000 uA
06:02						0.000 uA
06:03						0.000 uA

Slow Control System

Environmental parameter monitoring window

The screenshot shows a Windows 7 desktop with a taskbar at the bottom. The desktop background is dark blue. On the left side, there is a vertical list of icons for folders and applications. The main window is titled "Environmental Parameters" and contains several data fields. A red box labeled "Arduino0" is visible in the top right corner of the application window. An "export" dialog box is open in the foreground, showing a list of data fields to be exported, start and end time selection fields, and a folder name input field.

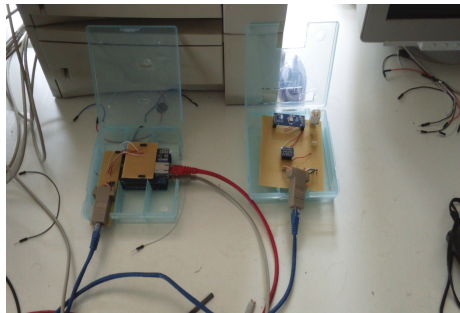
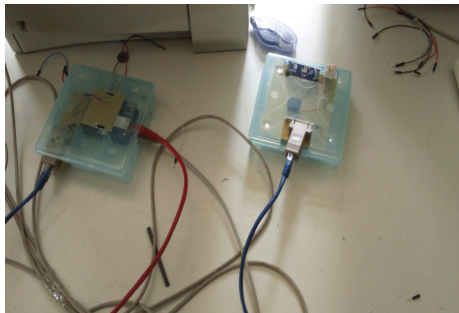
Time	Pressure1	Humidity1	Temperature1	Pressure2	Temperature2
00:00	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	19.30 °C
00:01					
00:02					
00:03	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	19.30 °C
00:04	988.80 mbar	45.96 %	19.80 °C	979.30 mbar	19.30 °C
00:05					
03:00					
03:01	988.05 mbar				
03:02	988.05 mbar				
03:03					
03:04					
03:05					
06:00					
06:01					
06:02					
06:03					

export dialog box details:

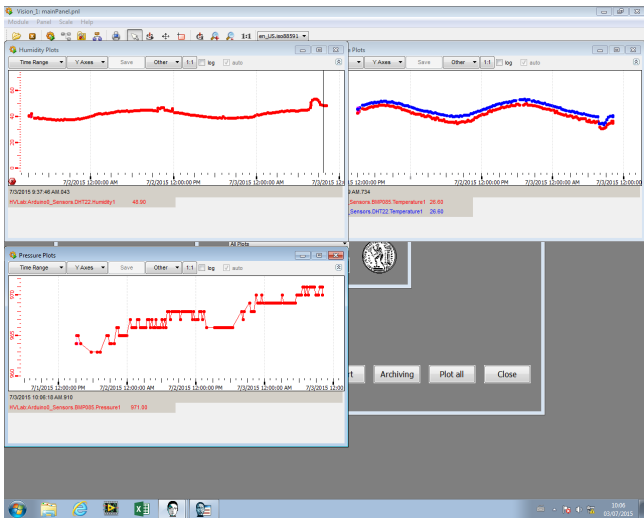
- START TIME: Day: 7, Month: 12, Year: 2015, Hour: 13, Minute: 53
- END TIME: Day: 7, Month: 12, Year: 2015, Hour: 13, Minute: 33
- FOLDER NAME: folder_name

RD51 Test Beam

The system was used in the test beam conducted at the beginning of July at the facilities of the RD51 collaboration at CERN

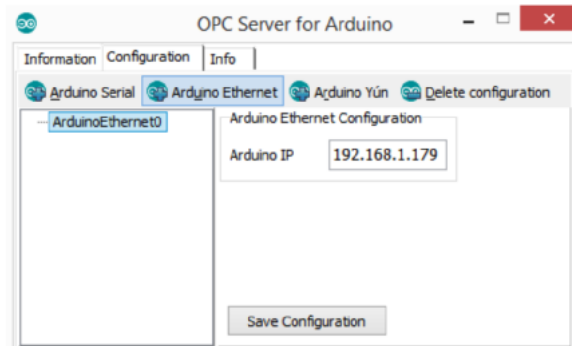


Environmental plots during Test Beam

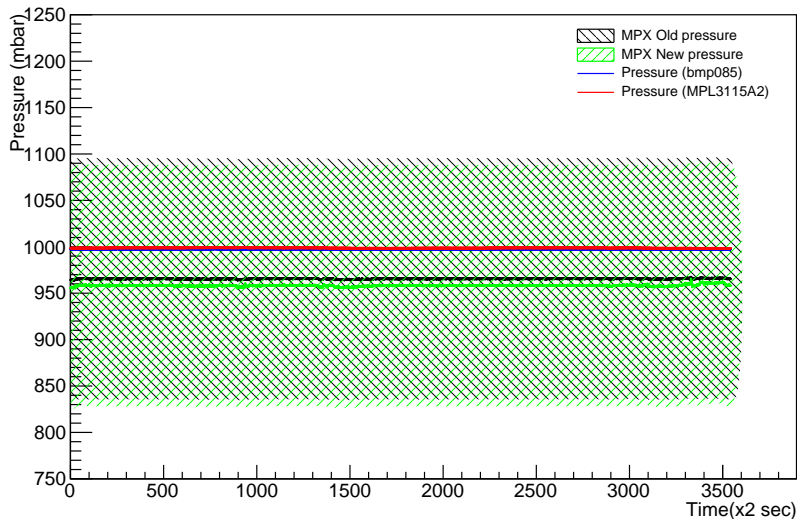


- A low cost system capable of monitoring the environmental parameters was developed
- Supports 4 different sensors measuring temperature, pressure, humidity
- Completely dynamic
- The system has been fully integrated in the RD51 Slow Control System
- It was used and tested at test beams at the RD51 facilities at CERN
- Ongoing process, wifi data transmission, PCB

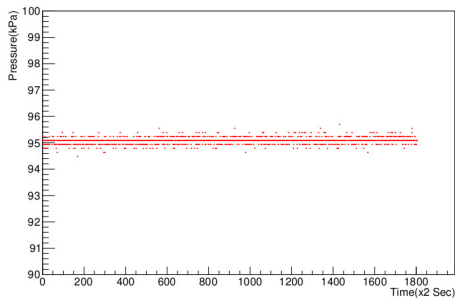




Pressure vs Time



Pressure vs Time



Pressure vs Time

