

Allegro Microsystems Europe  
74650 CHAVANOD  
<http://www.allegromicro.com>



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Year 2016

## Internship Report

## Annexes

## **Table of contents**

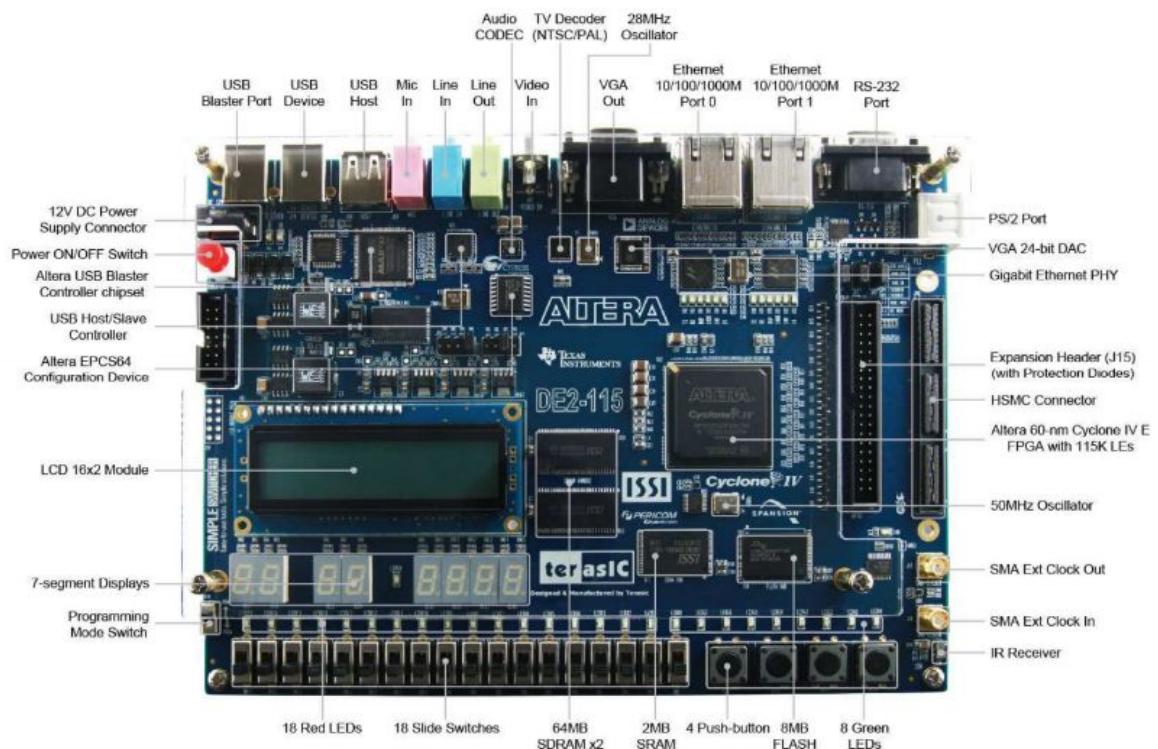
|             |  |             |
|-------------|--|-------------|
| <b>I.</b>   | <b><u>FPGA</u></b>                         | <b>p.3</b>  |
| <b>II.</b>  | <b><u>C# Class Diagram</u></b>             | <b>p.8</b>  |
| <b>III.</b> | <b><u>Allegro sensors tests system</u></b> | <b>p.14</b> |
| <b>IV.</b>  | <b><u>Allegro sensors and products</u></b> | <b>p.15</b> |

## I. FPGA

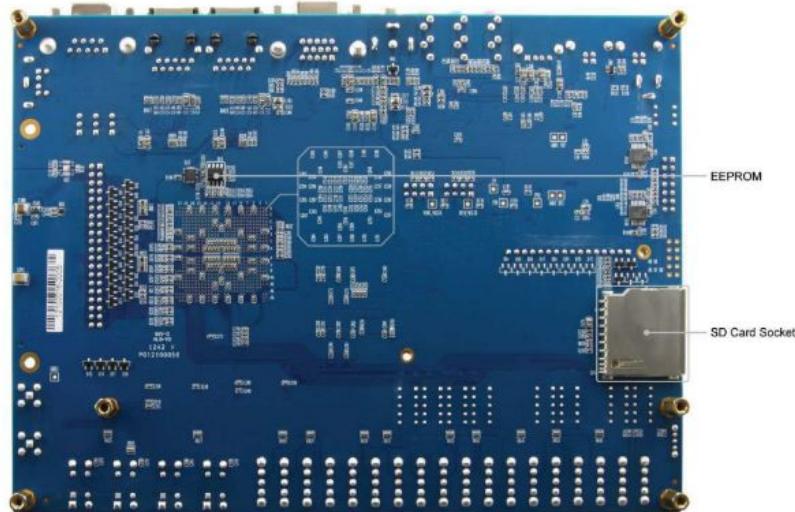
An extract of the FPGA user manual given by Texas Instruments that shows the main components and performances of the DE2-115 board can be found here.

### Layout and Components

A photograph of the DE2-115 board is shown in **Figure 2-1** and **Figure 2-2**. It depicts the layout of the board and indicates the location of the connectors and key components.



**Figure 2-1 The DE2-115 board (top view)**



**Figure 2-2 The DE2-115 board (bottom view)**

The DE2-115 board has many features that allow users to implement a wide range of designed circuits, from simple circuits to various multimedia projects.

The following hardware is provided on the DE2-115 board:

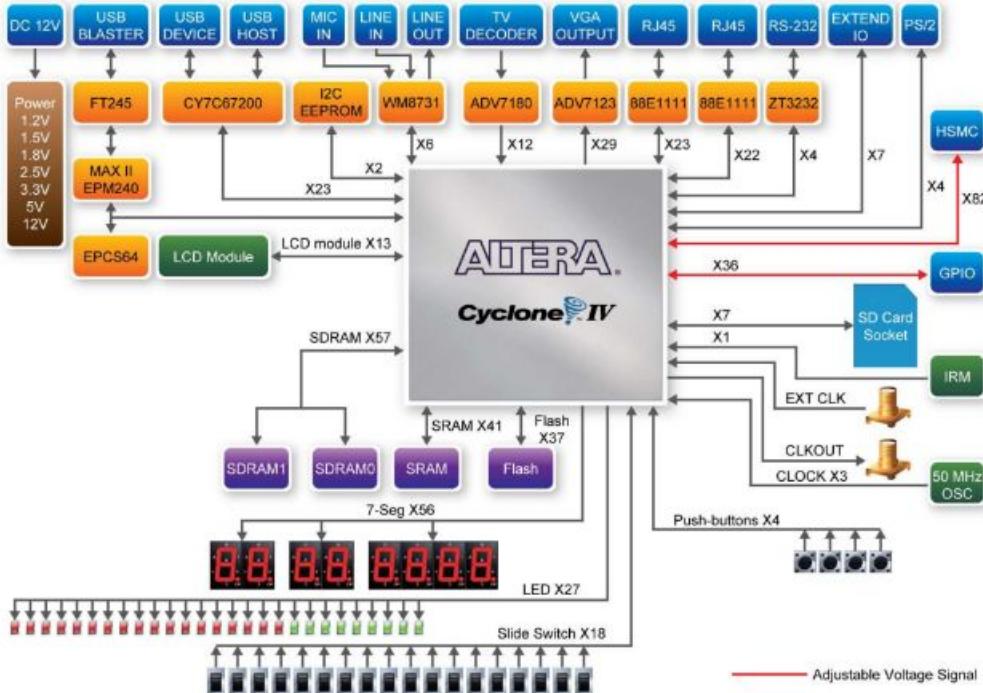
- Altera Cyclone® IV 4CE115 FPGA device
- Altera Serial Configuration device – EPCS64
- USB Blaster (on board) for programming; both JTAG and Active Serial (AS) programming modes are supported
- 2MB SRAM
- Two 64MB SDRAM
- 8MB Flash memory
- SD Card socket
- 4 Push-buttons
- 18 Slide switches
- 18 Red user LEDs
- 9 Green user LEDs
- 50MHz oscillator for clock sources
- 24-bit CD-quality audio CODEC with line-in, line-out, and microphone-in jacks
- VGA DAC (8-bit high-speed triple DACs) with VGA-out connector
- TV Decoder (NTSC/PAL/SECAM) and TV-in connector
- 2 Gigabit Ethernet PHY with RJ45 connectors
- USB Host/Slave Controller with USB type A and type B connectors
- RS-232 transceiver and 9-pin connector

- PS/2 mouse/keyboard connector
- IR Receiver
- 2 SMA connectors for external clock input/output
- One 40-pin Expansion Header with diode protection
- One High Speed Mezzanine Card (HSMC) connector
- 16x2 LCD module

In addition to these hardware features, the DE2-115 board has software support for standard I/O interfaces and a control panel facility for accessing various components. Also, the software is provided for supporting a number of demonstrations that illustrate the advanced capabilities of the DE2-115 board.

In order to use the DE2-115 board, the user has to be familiar with the Quartus II software. The necessary knowledge can be acquired by reading the tutorials “*Getting Started with Altera’s DE2-115 Board*” (tut\_initialDE2-115.pdf) and “*Quartus II Introduction*” (which exists in three versions based on the design entry method used, namely Verilog, VHDL or schematic entry). These tutorials are provided in the directory DE2\_115\_tutorials on the **DE2-115 System CD** that accompanies the DE2-115 kit and can also be found on Terasic’s DE2-115 web pages.

**Figure 2-3** gives the block diagram of the DE2-115 board. To provide maximum flexibility for the user, all connections are made through the Cyclone IV E FPGA device. Thus, the user can configure the FPGA to implement any system design.



**Figure 2-3 Block Diagram of DE2-115**

Following is more detailed information about the blocks in Figure 2-3:

## FPGA device

- **Cyclone IV EP4CE115F29 device**
- **114,480 LEs**
- **432 M9K memory blocks**
- **3,888 Kbits embedded memory**
- **4 PLLs**

## FPGA configuration

- **JTAG and AS mode configuration**
- **EPCS64 serial configuration device**
- **On-board USB Blaster circuitry**

## Memory devices

- **128MB (32Mx32bit) SDRAM**
- **2MB (1Mx16) SRAM**
- **8MB (4Mx16) Flash with 8-bit mode**
- **32Kb EEPROM**

## SD Card socket

- **Provides SPI and 4-bit SD mode for SD Card access**

## Connectors

- **Two Ethernet 10/100/1000 Mbps ports**
- **High Speed Mezzanine Card (HSMC)**
- **Configurable I/O standards (voltage levels:3.3/2.5/1.8/1.5V)**
- **USB type A and B**
  - Provide host and device controllers compliant with USB 2.0
  - Support data transfer at full-speed and low-speed
  - PC driver available
- **40-pin expansion port**
  - Configurable I/O standards (voltage levels:3.3/2.5/1.8/1.5V)
- **VGA-out connector**
  - VGA DAC (high speed triple DACs)
- **DB9 serial connector for RS-232 port with flow control**
- **PS/2 mouse/keyboard**

## Clock

- Three 50MHz oscillator clock inputs
- SMA connectors (external clock input/output)

## Audio

- 24-bit encoder/decoder (CODEC)
- Line-in, line-out, and microphone-in jacks

## Display

- 16x2 LCD module

## Switches and indicators

- 18 slide switches and 4 push-buttons switches
- 18 red and 9 green LEDs
- Eight 7-segment displays

## Other features

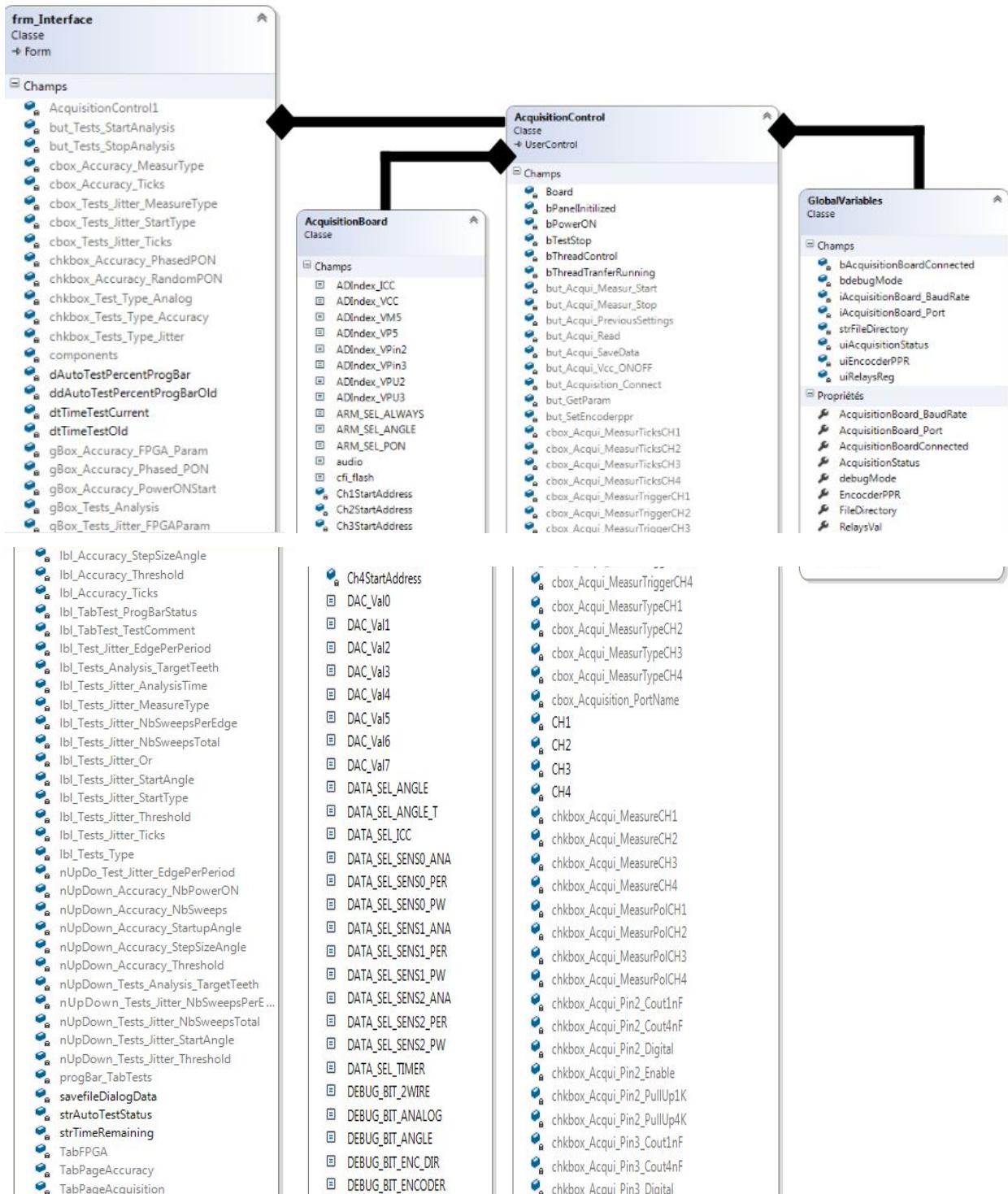
- Infrared remote-control receiver module
- TV decoder (NTSC/PAL/SECAM) and TV-in connector

## Power

- Desktop DC input
- Switching and step-down regulators LM3150MH

To update the current firmware that is inside the FPGA, use the Altera software Quartus II Programmer and upload the new firmware thanks to the USb Blaster Port.

## II. C# Class Diagram



|   |  |  |
|---|--|--|
|   |  |  |
| <ul style="list-style-type: none"> <li>TabPageAnalog</li> <li>TabPageJitter</li> <li>TabPageTests</li> <li>TabTestType</li> <li>tbox_TabTest_TestComment</li> <li>tbox_Tests_AnalysisStatus</li> <li>tbox_Tests_Jitter_AnalysisTime</li> <li>ThreadStartAnalysis</li> <li>TimerAccuracyStatus</li> <li>uiEdgePerPeriod</li> </ul>   | <ul style="list-style-type: none"> <li>DEBUG_BIT_PW</li> <li>DEBUG_BIT_SENS</li> <li>DEBUG_BIT_SENS_EM</li> <li>DEBUG_BIT_SPEED</li> <li>digital_in_2WIRE_bit</li> <li>digital_in_DIG2_bit</li> <li>digital_in_DIG3_bit</li> <li>digital_in_PON_bit</li> <li>eep_I2C_scl</li> <li>eep_I2C_sda</li> <li>i2c_scl</li> <li>i2c_sda</li> <li>ir</li> <li>jtag_uart</li> <li>key</li> <li>lcd</li> <li>ledg</li> <li>ledr</li> <li>mem_DAC</li> <li>onchip_memory2</li> <li>pio_AD_1</li> <li>pio_AD_2</li> <li>pio_AD_3</li> <li>pio_AD_4</li> <li>pio_AD_5</li> <li>pio_AD_6</li> <li>pio_AD_7</li> <li>pio_AD_8</li> </ul>                         | <ul style="list-style-type: none"> <li>chkbox_Acqui_Pin3_Enable</li> <li>chkbox_Acqui_Pin3_PullUp1K</li> <li>chkbox_Acqui_Pin3_PullUp4K</li> <li>chkbox_Acqui_VccExternal</li> <li>chkbox_Acqui_VccInternal</li> <li>components</li> <li>gBox_Acqui_Measure</li> <li>gbox_Acqui_Pin2</li> <li>gbox_Acqui_Pin3</li> <li>gbox_Acqui_Vcc</li> <li>gBox_Encoder</li> <li>iNbError</li> <li>lbl_Acqui_Angle</li> <li>lbl_Acqui_Channels</li> <li>lbl_Acqui_Icc_CompThreshold</li> <li>lbl_Acqui_IccmA</li> <li>lbl_Acqui_IccmA_Threshold</li> <li>lbl_Acqui_Measur</li> <li>lbl_Acqui_Pin2_CompThreshold</li> <li>lbl_Acqui_Pin2_Cout</li> <li>lbl_Acqui_Pin2_Pullup</li> <li>lbl_Acqui_Pin2_PullupRes</li> <li>lbl_Acqui_Pin2_PullUpvolt</li> <li>lbl_Acqui_Pin2_threshVolt</li> <li>lbl_Acqui_Pin2Out</li> <li>lbl_Acqui_Pin2volt</li> <li>lbl_Acqui_Pin3_CompThreshold</li> <li>lbl_Acqui_Pin3_Cout</li> </ul>       |
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| ■ pio_data_sel1      | ■ nUpDo_Acqui_MeasurAngleCH4         |
| ■ pio_data_sel2      | ■ nUpDo_Acqui_MeasurTimeTickCH1      |
| ■ pio_data_sel3      | ■ nUpDo_Acqui_MeasurTimeTickCH2      |
| ■ pio_debug          | ■ nUpDo_Acqui_MeasurTimeTickCH3      |
| ■ pio_digital_in     | ■ nUpDo_Acqui_MeasurTimeTickCH4      |
| ■ pio_ena0           | ■ nUpDo_Acqui_Pin2_Comp              |
| ■ pio_ena1           | ■ nUpDo_Acqui_Pin2_PullUpVolt        |
| ■ pio_ena2           | ■ nUpDo_Acqui_Pin3_Comp              |
| ■ pio_ena3           | ■ nUpDo_Acqui_Pin3_PullUpVolt        |
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| ■ pio_fpga_version   | ■ nUpDo_Acqui_SetVcc                 |
| ■ pio_Icc_Limit      | ■ nUpDo_Acqui_SetVcc_Threshold       |
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| ■ pio_max1           | ■ nUpDo_Acqui_SweepsCH2              |
| ■ pio_max2           | ■ nUpDo_Acqui_SweepsCH3              |
| ■ pio_max3           | ■ nUpDo_Acqui_SweepsCH4              |
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| ■ pio_pw1            | ■ panel_Acquisition                  |
| ■ pio_relay          | ■ saveFileDialog1                    |
| ■ pio_sens_pol0      | ■ saveFileDialogData                 |
| ■ pio_sens_pol1      | ■ statusStrip1                       |
| ■ pio_sens_pol2      | ■ strAutoTestStatus                  |
| ■ pio_sens_pol3      | ■ strError                           |
| ■ pio_speed          | ■ tableLayoutPanel_Acqui             |
| ■ pio_ssim_last_addr | ■ ThreadAutoTest                     |
| ■ pio_start          | ■ ThreadTransferData                 |
| ■ pio_start_addr0    | ■ timer RefreshDataAcquisition       |
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| ■ pio_start_addr2    |                                      |
| ■ pio_start_addr3    |                                      |
| ■ pio_status0        |                                      |
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| ■ pio_status3        |                                      |
| ■ pio_SW_Ena         |                                      |
| ■ pio_SW_Reset       |                                      |
| ■ pio_SW_Version     |                                      |
| ■ pio_timer0         |                                      |
| ■ pio_timer1         |                                      |
| ■ pio_timer2         |                                      |
| ■ pio_timer3         |                                      |
| ■ pio_TP_Mux         |                                      |
| ■ pio_trig_ang0      |                                      |
| ■ pio_trig_ang1      |                                      |
| ■ pio_trig_ang2      |                                      |
| ■ pio_trig_ang3      |                                      |
| ■ pio_VDAC_Mux       |                                      |
| ■ pio_VDAC_Scale     |                                      |
| ■ pll                |                                      |
| ■ RELAY_1_OnF_MASK   |                                      |
| ■ RELAY_1_2K_MASK    |                                      |
| ■ RELAY_4_7K_MASK    |                                      |
| ■ RELAY_4_7nf_MASK   |                                      |
| ■ RELAY_Address      |                                      |
|                      | ■ tool_lblProgBar                    |
|                      | ■ tool_ProgBar                       |
|                      | ■ toolTip1                           |
|                      | ■ txt_Acqui_Icc_Threshold_mARead     |
|                      | ■ txt_Acqui_IccRead                  |
|                      | ■ txt_Acqui_MeasurFrequencySweepsCH1 |
|                      | ■ txt_Acqui_MeasurFrequencySweepsCH2 |
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|                      | ■ txt_Acqui_MeasurRemainingSweepsCH3 |
|                      | ■ txt_Acqui_MeasurRemainingSweepsCH4 |
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|                      | ■ txt_Acqui_MeasurStatusCH3          |
|                      | ■ txt_Acqui_MeasurStatusCH4          |
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|                      | ■ txt_Acqui_Pin2_PullUpVoltRead      |
|                      | ■ txt_Acqui_Pin3_OutRead             |
|                      | ■ txt_Acqui_Pin3_PullUpVoltRead      |
|                      | ■ txt_Acqui_Vcc_ThresholdVoltRead    |
|                      | ■ txt_Acqui_VccRead                  |
|                      | ■ txt_MotorSpeed                     |
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|                      | ■ uiTargetNbTeeth                    |

|                                     |   |  |
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|                                     | <input type="checkbox"/> timer                      | <input checked="" type="checkbox"/> chkbox_Pin3_Enable     |
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|                                     | <input type="checkbox"/> TRIG_ENA_FALL0             | <input checked="" type="checkbox"/> nUpDo_MeasurAngleCH4   |
|                                     | <input type="checkbox"/> TRIG_ENA_FALL1             | <input checked="" type="checkbox"/> nUpDo_Pin2_Comp        |
|                                     | <input type="checkbox"/> TRIG_ENA_FALL2             | <input checked="" type="checkbox"/> nUpDo_Pin2_PullUpVolt  |
|                                     | <input type="checkbox"/> TRIG_ENA_NONE              | <input checked="" type="checkbox"/> nUpDo_Pin3_Comp        |
|                                     | <input type="checkbox"/> TRIG_ENA_RISE0             | <input checked="" type="checkbox"/> nUpDo_Pin3_PullUpVolt  |
|                                     | <input type="checkbox"/> TRIG_ENA_RISE1             | <input checked="" type="checkbox"/> nUpDo_SetIcc_Threshold |
|                                     | <input type="checkbox"/> TRIG_ENA_RISE2             | <input checked="" type="checkbox"/> nUpDo_SetVcc           |
|                                     | <input type="checkbox"/> TRIG_SEL_ALWAYS            | <input checked="" type="checkbox"/> nUpDo_SetVcc_Threshold |
|                                     | <input type="checkbox"/> TRIG_SEL_ANGLE             | <input checked="" type="checkbox"/> nUpDo_SweepsCH1        |
|                                     | <input type="checkbox"/> TRIG_SEL_PON               | <input checked="" type="checkbox"/> nUpDo_SweepsCH2        |

|  |                             |
|--|-----------------------------|
| uart_USB                                     |                             |
| Méthodes                                     |                             |
| ClockDivider                                 | nUpDo_SweepsCH3             |
| ClockSelection                               | nUpDo_SweepsCH4             |
| closeSerial                                  | nUpDown_Encoderppr          |
| DataCaptureCycleStatus                       | nUpDown_MeasurTimeTickCH1   |
| DataMaximumCount                             | nUpDown_MeasurTimeTickCH2   |
| DataSelection                                | nUpDown_MeasurTimeTickCH3   |
| DataStartAddress                             | nUpDown_MeasurTimeTickCH4   |
| DataStartAddressDefault                      | strControlAutoTestStatus    |
| EncoderSpeedCount                            | strFileDirectory            |
| Get_DUT2Thresh_Voltage                       | txt_MeasurStatusCH1         |
| Get_DUT3Thresh_Voltage                       | txt_MeasurStatusCH2         |
| Get_PONIccThresh_Voltage                     | txt_MeasurStatusCH3         |
| Get_PONVccThresh_Voltage                     | txt_MeasurStatusCH4         |
| Get_ppr                                      | uiControlCurrentCycle       |
| GetNumberOfSweeps                            | uiControlCurrentCycleStatus |
| InitBoard                                    | uiNbTargetTeeth             |
| InitSerial                                   |                             |
| Polarity                                     |                             |
| Pulsewidth                                   |                             |
| Read_DUT_DigitalInput                        |                             |
| Read_DUT_IccmA                               |                             |
| Read_DUT_Vcc                                 |                             |
| Read_Pin2                                    |                             |
| Read_Pin2_PullUp                             |                             |
| Read_Pin3                                    |                             |
| Read_Pin3_PullUp                             |                             |
| Read_Relys                                   |                             |
| ReadFIFO                                     |                             |
| ReadMemory (+ 1 surcharge)                   |                             |
| set_2Wire_Current                            |                             |
| set_AllRelaysOFF                             |                             |
| Set_DUT_Vcc                                  |                             |
| set_DUT2Pullup_Voltage                       |                             |
| set_DUT2Thresh_Voltage                       |                             |
| set_DUT3Pullup_Voltage                       |                             |
| set_DUT3Thresh_Voltage                       |                             |
| set_PONThresh_Voltage                        |                             |
| Set_ppr                                      |                             |
| StartDataCaptureCyde                         |                             |
| TriggerAngleSelection                        |                             |
| TriggerSelection                             |                             |
| Write_Relys                                  |                             |
| WriteMemory                                  |                             |
| Méthodes                                     |                             |
| AcquisitionControl                           |                             |
| but_Acqui_Measur_Start_Click                 |                             |
| but_Acqui_Measur_Stop_Click                  |                             |
| but_Acqui_PreviousSettings_Click             |                             |
| but_Acqui_Refresh_Click                      |                             |
| but_Acqui_SaveData_Click                     |                             |
| but_Acqui_Vcc_ONOFF_Click                    |                             |
| but_Acquisition_Connect_Click                |                             |
| but_GetParamEncoder_Click                    |                             |
| But_Set_Encoderppr_Click                     |                             |
| button1_Click                                |                             |
|  |                             |
| cbox_Acqui_MeasurTicks_SelectedIndexChang... |                             |
| cbox_Acqui_MeasurTrigger_SelectedIndexCha... |                             |
| cbox_Acqui_MeasurType_SelectedIndexChang...  |                             |
| cbox_ComPort_DropDown                        |                             |
| chkbox_Acqui_MeasureChannel_CheckedChan...   |                             |
| chkbox_Acqui_Pin_ResistorOrCapa_Click        |                             |
| chkbox_Acqui_Pin2_Digital_CheckedChanged     |                             |
| chkbox_Acqui_Pin2_Enabled_CheckedChanged     |                             |
| chkbox_Acqui_Pin3_Digital_CheckedChanged     |                             |
| chkbox_Acqui_Pin3_Enable_CheckedChanged      |                             |
| chkbox_Acqui_VccExternal_Click               |                             |
| chkbox_Acqui_VccInternal_Click               |                             |
| CloseControl                                 |                             |
| DataCollection                               |                             |
| DimAcquisitionControl                        |                             |
| Dispose                                      |                             |
| fct_Acqui_RefreshDUT                         |                             |
| fct_Acqui_RefreshStatus                      |                             |
| fct_Acqui_SaveAcquisitionParam               |                             |
| fct_Acqui_SetRelays                          |                             |
| fct_Acqui_UpdatePinControls                  |                             |
| fct_InitAcquisitionPanel                     |                             |
| fct_UpdateChannelsQuantumAndItemNumber       |                             |
| InitializeComponent                          |                             |
| Jitter                                       |                             |
| Multiple_Acqui_Measur_Start                  |                             |
| nUpDo_Acqui_MeasurCompThreshIcc_ValueC...    |                             |
| nUpDo_Acqui_MeasurCompThreshPin2_Value...    |                             |
| nUpDo_Acqui_MeasurCompThreshPin3_Value...    |                             |
| nUpDo_Acqui_MeasurCompThreshVcc_ValueC...    |                             |
| nUpDo_Acqui_MeasurTimeTicks_Value_Chang...   |                             |

```

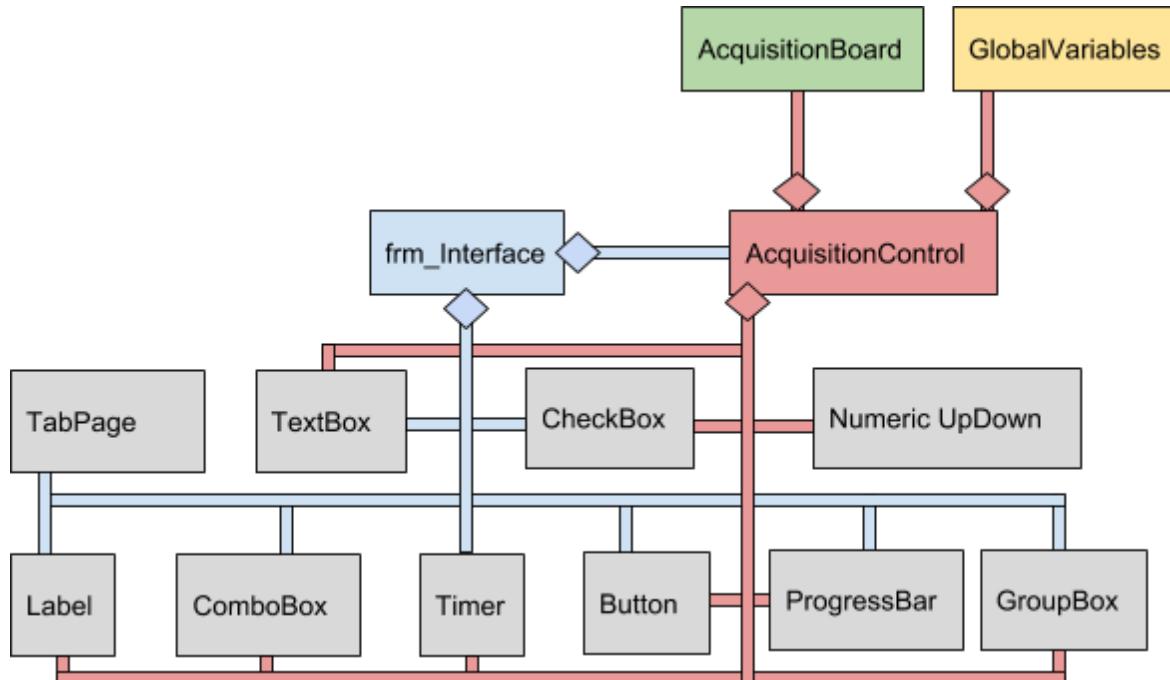
❷ nUpDo_Acqui_Pin2_PullUpVolt_ValueChanged
❷ nUpDo_Acqui_Pin3_PullUpVolt_ValueChanged
❷ PowerOFF
❷ PowerON
❷ releaseObject
❷ RePower
❷ SaveAcquisitionData
❷ SaveAcquisitionDataMultipleCycle
❷ SaveDataToExcelFile
❷ SetControlPropertyThreadSafe
❷ StartupAccuracy
❷ StopTest
❷ timer_RefreshDataAcquisition_Tick
❸ Types imbriqués

```

frm\_Interface and Acquisition Control are internally using classic controls from Visual Studio :

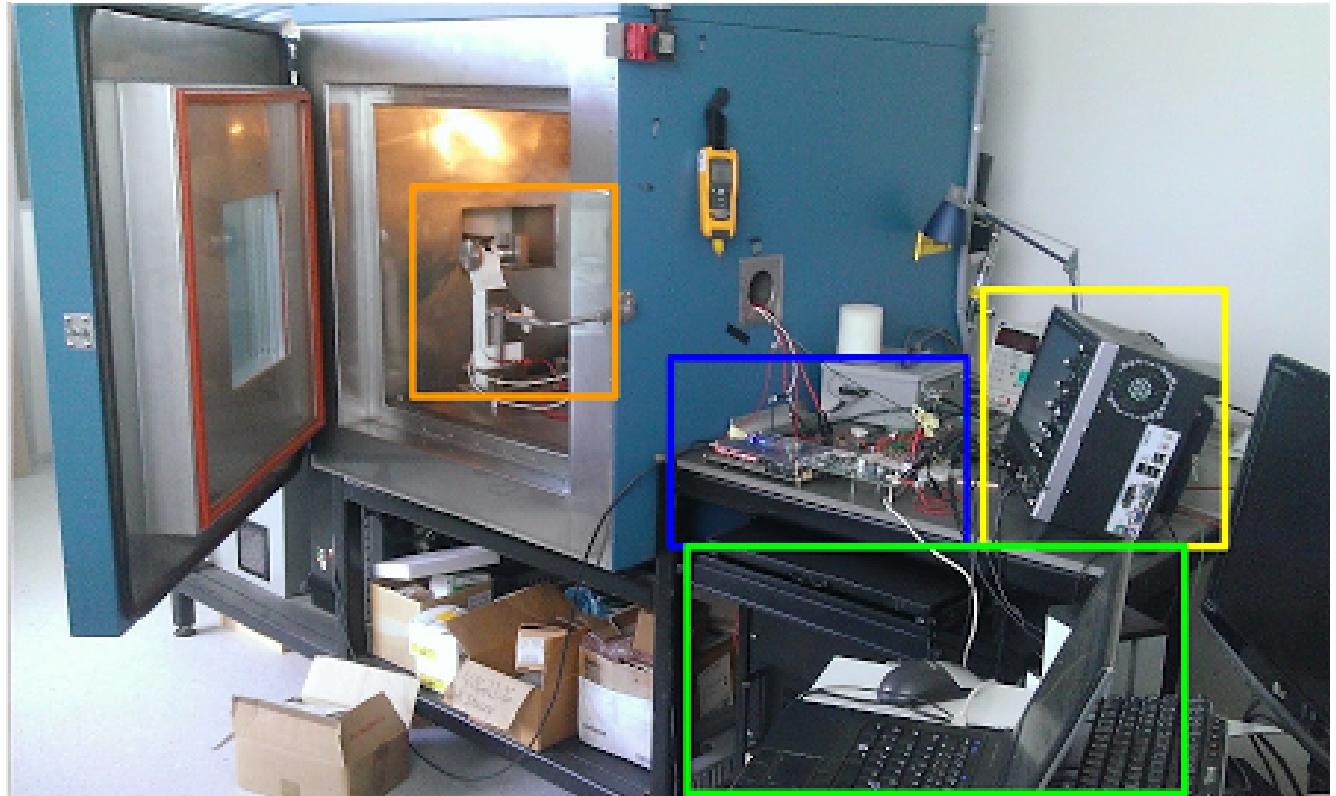
- Numeric UpDowns
- Labels
- TextBoxes
- Progress Bars
- CheckBoxes
- ComboBoxes
- Timers
- Buttons
- GroupBoxes
- TabPages

A simplified version can be done in order to show the links between the different classes.



### **III. Allegro sensors tests system**

The picture below shows one of the sensors tests system where Allegro wants to implement the project.



Blue = Acquisition Board (FPGA + Allegro DaughterBoard)

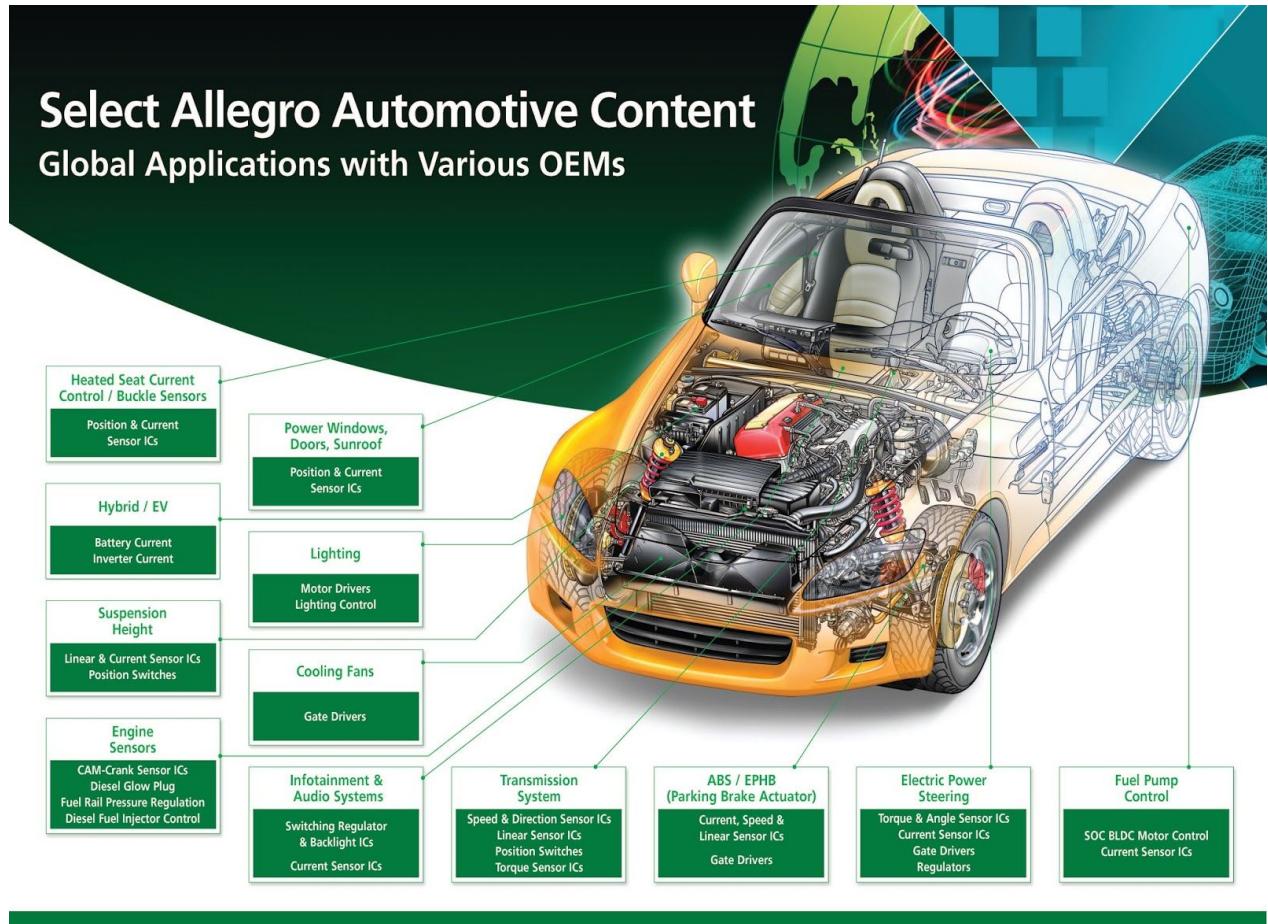
Yellow = Oscilloscope

Orange = Sensor + Target

Green = Computer with the C# program

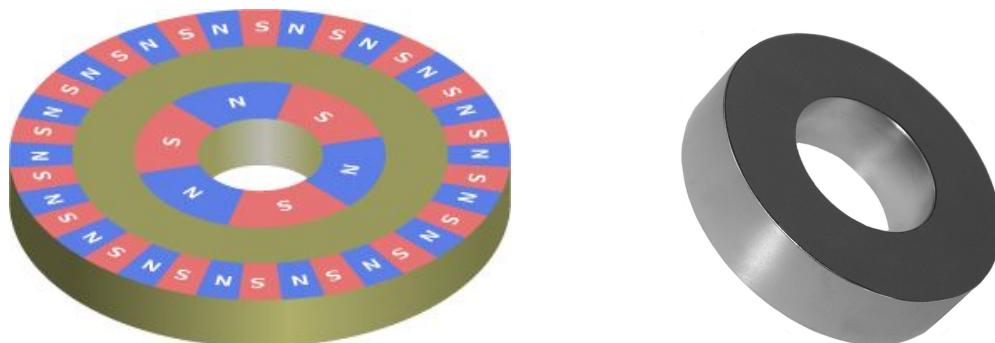
## IV. Allegro sensors and products

Allegro sensors and products have multiple application. The picture below, shows where Allegro products can be found in the automotive market.



### Targets :

- Magnetic target : ring magnet



- Ferromagnetic target : crankshaft, camshaft...

