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Laboration 4

DA326A

Software Engineering 2

15 hp (HT18)

Content

Preparation for Lab 4 –Arduino and the Smart House

To be able to fulfil the Arduino lab in 4 hours it is required from you to make some preparations. That is, you should do those preparations before you enter Lab 4. The preparations may take about 1 to 2 hours.

- Study the Lab4_SmartHouse description.

- Download the Processing Arduino development tool from http://arduino.cc/en/Main/Software. Typically, you should use the download for Windows. Note that once you have done that you don't have to install anything. Just unpack the file, and you will see the Arduino development tool, through *arduino.exe*, in the unpacked folder. Double click that, and the development tool is ready to use. The programming language will be java, however, in this lab the use of objects and classes will probably not be necessary.

- There are a number of examples to study for learning purposes, and for purposes of starting points for further developments. You shall study the following simple examples that you find from the arduino development tool:

- File→ Examples → Basics → Blink
- File→ Examples → Basics → AnalogReadSerial
- File→ Examples → Basics → DigitalReadSerial
- File→ Examples → Digital → BlinkWithoutDelay
- File→ Examples → Analog → AnalogInOutSerial

Note that there is no point in running those examples since they should be uploaded and executed at an arduino microprocessor board. Still, study to get an idea on the principles of programming the arduino. Use some time to think about how to solve the lab tasks with respect to the examples.

Lab 4- A Smart House description

Functionalities in a Smart House:

- *Brandvarnare* Automatic fire alarm
- *Inbrottslarm* Housebreaking alarm
- *Vattenläckage* Water leakage
- *Temperatur inomhus* Temperature indoors
- *Temperatur utomhus* Temperature outdoors
- *Spisen* ON Stove ON
- *Fönster öppet* Window open
- *Timer* T1 Timer T1
- *Timer* T2 Timer T2
- *Inomhusbelysning* Lighting indoors
- *Utomhusbelysning* Lighting outdoors
- *Elavbrott* Power cut
- *Indikering inbrottslarm, sirén* Indicating housebreaking alarm, siren
- *Indikering inbrottslarm, "saftblandare"* Indicating housebreaking alarm, "juice mixer"
- *Elförbrukning* Electricity consumption
- *Skymningautomatik* Twilight automatic system
- *Fläkt på vinden (endast i hus A och B)* Fan (only in houses A and B)
- *Värmeelement* Radiator

Smart House front panel

There are four switches: *Fönster, Brand, Spis* and *Vattenläckage* (Window, Fire, Stove and Water leakage respectively) on the front panel with two functions: *Aktiv* = ON, *Inaktiv* = OFF, and two LED lamps: Timer1 and Timer2.

Input signals (for more details see **Electrical Interface**)

- ***Brandvarnare* Automatic fire alarm**

This signal is simulated with a switch on the front panel.

- ***Inbrottslarm* Housebreaking alarm**

This input is realized by using a magnetic switch mounted at the house door.

- ***Vattenläckage* Water leakage**

This signal is simulated with a switch on the front panel.

- ***Temperatur inomhus* Temperature indoors**

This signal is realized using an analog temperature sensor mounted inside the house (on the first and the second floor)

- ***Temperatur utomhus* Temperature outdoors**

This signal is realized using a digital temperature sensor mounted outside the house

- ***Spisen* ON Stove ON**

This signal is simulated with a switch on the front panel

- ***Fönster öppet* Window open**

This signal is simulated with a switch on the front panel

- ***Elförbrukning* Electricity consumption**

This input is realized by measuring the supply voltage deliver to the house (an analog signal)

- ***Skymningautomatik* Twilight automatic system**

This input is realized by Light-to-Voltage sensor (outdoors)

- ***Elavbrott* Power cut**

This input is realized by controlling the presence of supply voltage

Output signals

- ***Timer* T1**

This output signal is simulated with an LED lamp on the front panel

- ***Timer* T2**

This output signal is simulated with an LED lamp on the front panel

- ***Inomhusbelysning* Lighting indoors**

This function is realized with a lamp mounted inside the house

- ***Indikering inbrottslarm, sirén* Indicating housebreaking alarm, siren**

This function is realized by using a loudspeaker mounted on the house gable

- ***Indikering inbrottslarm, "saftblandare"* Indicating housebreaking alarm, "juice mixer"**

This function is realized with an LED lamp mounted on the roof

- ***Fläkt på vinden* Fan**

This function is realized with a fan mounted on the house's loft

- ***Värmeelement* Radiator**

Four power resistors are connected in series to realize the heating of the house. The resistors are mounted in pairs, two at each long side wall

Electrical Interface

- **Switch**

There exist the necessary security functions like in loop current (quiescent current). This means that a current flows as long as everything is normal. When an alarm or if someone cut a cable, the alarm is activated. Electrically matched for the following:

Switch ON - Voltage 0 V; Switch OFF - Voltage 12 V.

Power consumption from 12 V supply must not exceed 50 mA per switch.

- **Temperature indoors**

This temperature measurement is made with donor LM35C, which has the following connections: $+V_s$, GND and V_{out}.

- **Temperature outdoors**

This temperature measurement is made with donor SMT160-30, which has the following connections: $+V_s$, GND and Out.

- **Electricity consumption**

The electricity consumption is measured by an analog input signal, where the consumed power is proportional to the measured voltage. The relationship effect - a voltage is linear, as follows:

0 V <--> 0 kW respective 4 V <--> 16 kW.

- **Power cut**

The supply voltage (230V) in the house is simulated by the supply voltage +12 V. This voltage is used to indicate the power failure.

- **Twilight automatic system**

Measurement of brightness is made with donor TSL250, which has the following connections: V_{DD}, GND and Out.

- **Digital Output**

To operate this type of output, a TTL compatible signal (0 respectively 5V) with an operating capacity of 0.8 mA minimum is required. The output (function) is active at 5V and idle at 0V.

- **Radiator**

To control the heat, a TTL compatible signal (0 respectively 5V) with an operating capacity of 0.8 mA minimum is required. The output (function) is active at 5V and idle at 0V.

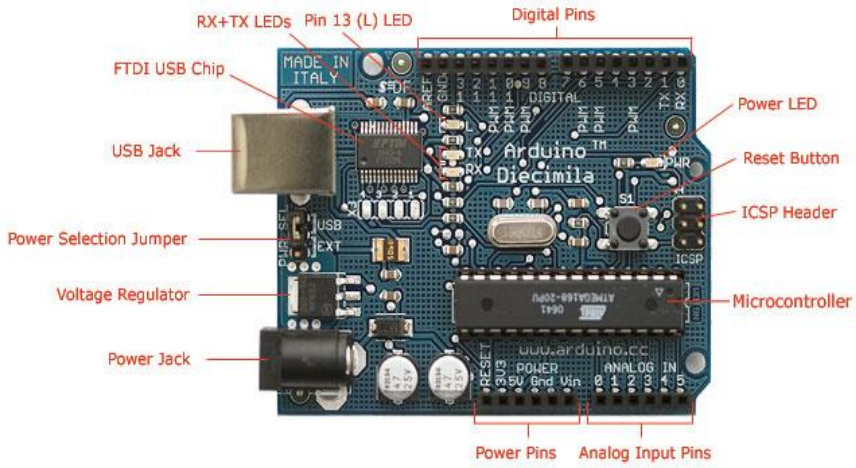
A Smart House <---> Interface <---> Arduino

For detailed description on ***Arduino Diecimila***see**:** http://arduino.cc/

Arduino software: download

For details, see the referenceand tutorials

Following Tables show the connections to Arduino:



Photograph by SparkFun Electronics. Used under the Creative Commons Attribution Share-Alike 3.0 license.

Port nr in Smart House	Smart House	Arduino	Port nr in Arduino
1	GND		
2	GND		
3	Brandvarnare	Input digital	PD2
4	Inbrottslarm	Input digital	PD3
5	Vattenläckage	Input digital	PD4
6	Temperatur inomhus rum Vout	Input analog LM350CZ	PC1
7	Temperatur inomhus vind Vout	Input analog LM350CZ	PC2
8	LDR		PC3
9	Temperatur Utomhus Vout	Input digital	PB1
10	Utomhusbelysning	output digital 74HC238	Y7
11	Spis ON	Input digital	PD5
12	Fönster Öppet	Input digital	PD6
13	Elförbrukning	Input analog	PC0
14			
15			
16	5V	Arduino +5V	
17	Elavbrott	Input digital	PD7
18	Timer 1	output digital 74HC238	Y6
19	Timer 2	output digital 74HC238	Y1
20	Inomhusbelysning	output digital 74HC238	Y2
21	Indikering inbrottslarm siren	output digital-analog	PB4
22	Indikering inbrottslarm lampa	output digital 74HC238	Y3
23	Värmeelement vind	output digital 74HC238	Y4
24	Fläkt	output digital-analog PWM	PB2
25	Värmeelement	output digital 74HC238	Y5
26	GND		

Smart House	Arduino	On	Off
RX	PD0		
TX	PD1		
Brandvarnare	PD2	1	0
Inbrottslarm	PD3	0	1
Vattenläckage	PD4	1	0
Spis ON	PD5	1	0
Fönster Öppet	PD6	1	0
Elavbrott	PD7	1	0
A1 74HC238	PB0	output digital	
Temp UTomhus Vout	PB1	input digital	
Fläkt	PB2	PWM	
A3 74HC238	PB3	output digital	
Indikering inbrottslarm siren	PB4	PWM	
A3 74HC238	PB5	output digital	
Elförbrukning	PC0	input analog	
Temp rum Vout	PC1	input analog	
Temp rum Vout vind	PC2	input analog	
LDR	PC3		
	PC4		
	PC5		

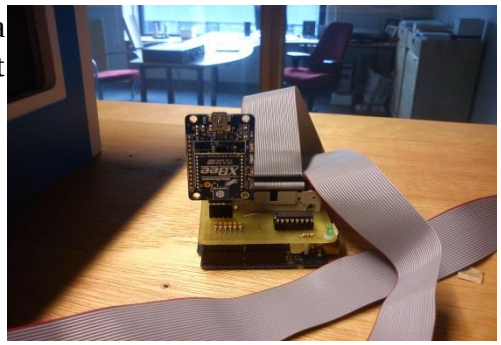
74HC238

	B5	B3	B0		Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7		
0	0	0	0		1								y0	
1	0	0	1			1							y1	Timer 2
2	0	1	0				1						y2	Inomhusbelysning
3	0	1	1					1					y3	Indikering inbrottslarm lampa
4	1	0	0						1				y4	Värmeelement vind
5	1	0	1							1			y5	Värmeelement
6	1	1	0								1		y6	Timer 1
7	1	1	1									1	y7	Utomhusbelysning

1--> ON

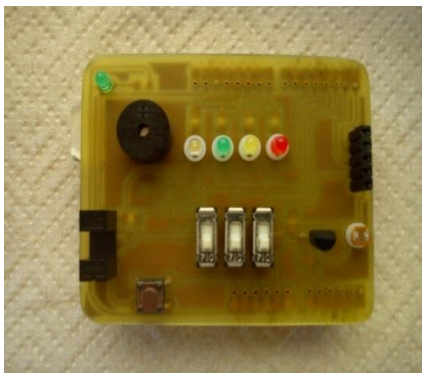
Further connection:

With other microcontrolers Arduino can have a contact with the Internet, e.g. Arduino Ethernet Shield or XBee (see http://arduino.cc/).



There is Xbee installed in Smart Houses.

The prototype



The prototype consists off:

- one LED-G lamp = power
- four LED (W, G, Y, R) lamps
- three switches SW1-SW3
- sound SP
- photointerrupter Ph
- temperatur sensor T
- LDR sensor L
- TX, RX XBee Wireless
- reset button

Connections to Arduino

Digital pins/ports

AREF	GND	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Arduino PORT
		PB5	PB4	PB3	PB2	PB1	PB0	PD7	PD6	PD5	PD4	PD3	PD2	PD1	PD0	Atmega168
			SP	LED -W	LED -G	LED -Y	LED -R			Ph	SW1	SW2	SW3	TX	RX	Prototyp

Analog pins/ports

0	1	2	3	4	5	Arduino
PC0	PC1	PC2	PC3	PC4	PC5	Atmga168
T	L					Prototyp
T = Temperature Sensor , L = LDR sensors						

The aim of the Lab:

Establish a connection between your computer and a prototype or a smart house.

Learn how to program in Arduino environment.

Pre-lab:

Download and install Arduino Software: http://arduino.cc/en/Main/Software (on Windows platform)

Read a description of Arduino Software: http://arduino.cc/en/Reference/HomePage

Read the examples: http://arduino.cc/en/Tutorial/HomePage (you can also find them directly in the software)

Lab on prototype:

Connect Arduino to the PC through the USB port (after installation of Software). You will be asked twice reg. the new hardware installation: about FT23 FAT and about USB port. This is that you shall install the drivers corresponding to the software that you will use.

NOTE:

Now that you have installed the corresponding drivers, you can start your Arduino Playground software tool → Go to Tools → Board → select the corresponding Arduino board that you are working on. Pay attention to select the right port also, in the same way (Tool → Serial Port → choose the port that is in use by the Arduino board connected to your computer.)

Now do the following assignments:

1. Send a signal to each of LED lamp with different functionalities, i.e. the LED-W will blink, LED-G will shine, LED-Y will shine during 5 s, LED-R will blink 10 times
2. Activate LED-W and LED-R when switch1 is ON (both lamps will shine together)
3. Activate LED-G and LED-Y when switch2 is ON (both are blink)
4. Activate Sound when switch3 is ON
5. T – Temperature sensor, show the temperature on Serial Monitor (you should translate the results with the actual temperature in the room, i.e. Celsius)
6. L – LDR sensor = LED-W should shine when it is dark. Try to show the value on Serial Monitor
7. Photo-interrupter: put a paper in between and activate a sensor, e.g. a sound or a lamp
8. Optional: You will leave the house and should activate the alarm. You should follow the following steps. You are at home and the alarm is not activate. You should activate the alarm. Use the Photo-interrupter as a door, e.g. ”open” a door = put a piece of paper in between.

1. When you open a door, you activate LED-G (blink) until the door is closed.
2. When the door is closed, LED-Y is shining.
3. When you again open a door, activate the alarm and LED-R (blink).

Lab on a Smart House:

When you will finish with the prototype you can do the practice directly with the smart house. Think about the ports and the functionality.