Arduino Solarmeter

Hardware Manual

Use this document to install the Arduino and the sensors.

1/26/2013 Revision 10

Arduino Solar Meter

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Introduction

The *Arduino Solar Meter* is a program that runs on an Arduino controller.

This program started in 2009 when I got my first set of solar panels and wanted to log the production of the set. In the last 3 years, several additions and improvements were made.

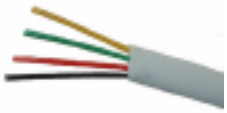
The program can read information from various devices in your meter cabinet at home.
It will store this information on the onboard SD card and can send it to PvOutput to make nice graphics.

This document is intended as a guide to install and connect the controller and the sensors.

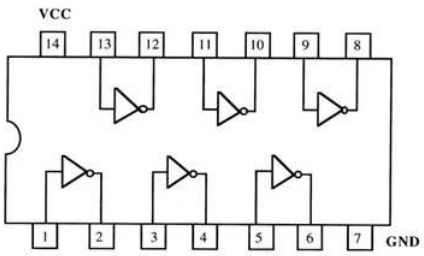
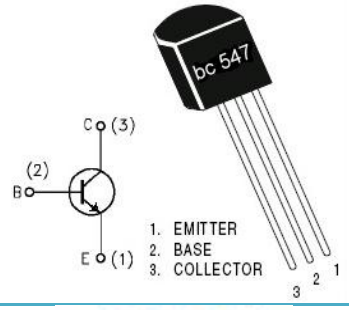
The software manual explains how to install and configure the software in the controller.

Shopping List

Image	Name	Comment
	Arduino Uno or Arduino Mega	Newer boards like the Arduino Due or Leonardo will probably also work but have not been tested. The Arduino Ethernet board also works but it needs an extra usb-serial adapter and a different USB cable.
	Arduino Ethernet shield (W5100)	The software only works with this type of chip. Not needed if you use an Arduino Ethernet

	DC power adapter	Use a USB version that can deliver 500mA or more.
	USB cable A-B	Used to power the Arduino when running stand-alone and to download new software.
	Ethernet cable	This is used to connect the Arduino to the internet. Usually this is one of the wired ports on your router. Wireless is also possible but is not supported in the software.
	Micro-SD card	Optional. If you want to log all data to SD also.
	kWh meter with S0 output	Any meter will do but a resolution of 1000 or more pulses per kWh is preferred. ⚠ Some meters use a different resolution for the onboard LED and the S0 pulse. Make sure the S0 resolution is ok.
	Cable or wire	Used to connect the sensors to the Arduino. I used a 4 wire telephone cable that was lying around.

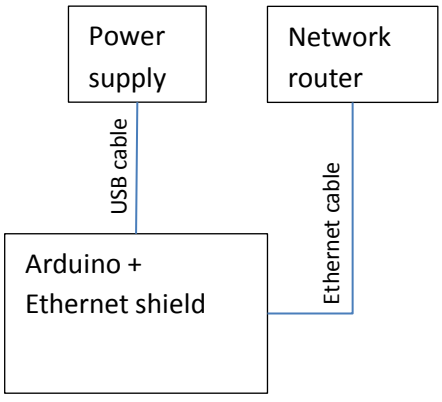
Optional		Used for Gasmeter and Ferrarismeter (2xneeded)
	Blue Led 5mm	Any type will do
	Phototransistor	L-53P3BT or equivalent. This type uses the same package as a 5mm LED. This makes mounting easier.
	Resistors	470 ohm (yellow, purple, brown) for LED, 47K (yellow, purple, orange) for phototransistor

Optional			Used for Smart meter P1 port
		RJ11 connector, 6P4C	6 pole connector with 4 contacts (the outer 2 positions are not used)
		Hex inverter 74LS04	Available at any electronic store
Alternative for 74LS04		Standard NPN transistor	Alternative for the 74LS04
		Resistors	2 x 10K ohm (brown, black, orange) for the transistor option

Connecting the Hardware

Arduino

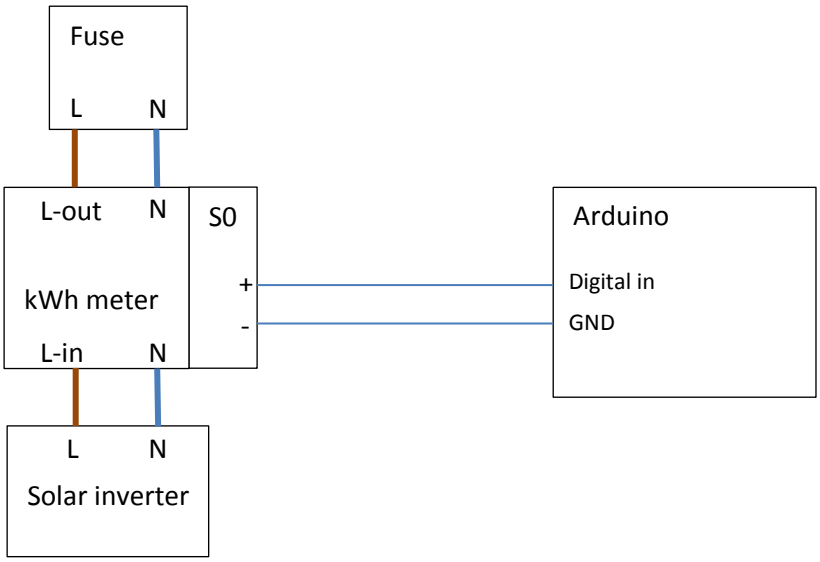
Start by finding a good place for the Arduino. In my case it is mounted in the meter cabinet near to all meters. Make sure there is a wall outlet to power the Arduino. Also estimate the needed cable lengths.



kWh meter

If you are not comfortable with working in the meter cabinet, make sure you find someone that can connect the kWh meter(s) for you as it involves working with 230V!

An external pull-up resistor for the input is not needed. The Arduino has one of its own. The software will configure the input port so that the internal 20K resistor is connected from the input to the 5V.



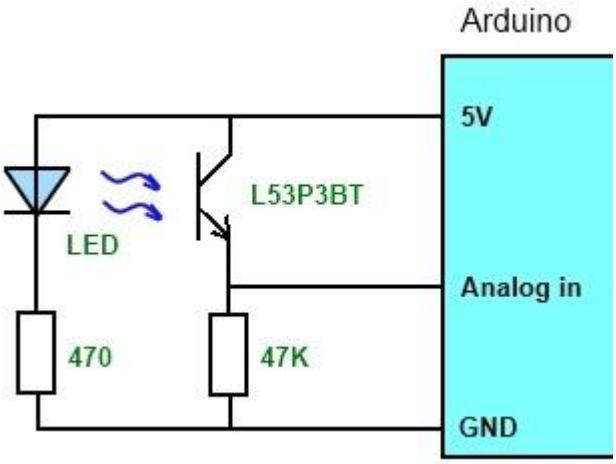
Here you see the kWh meter installed.

Gas meter sensor

The gas meter sensor is in fact a homemade optocoupler. It consists of a blue LED and a phototransistor that is sensitive to blue light.

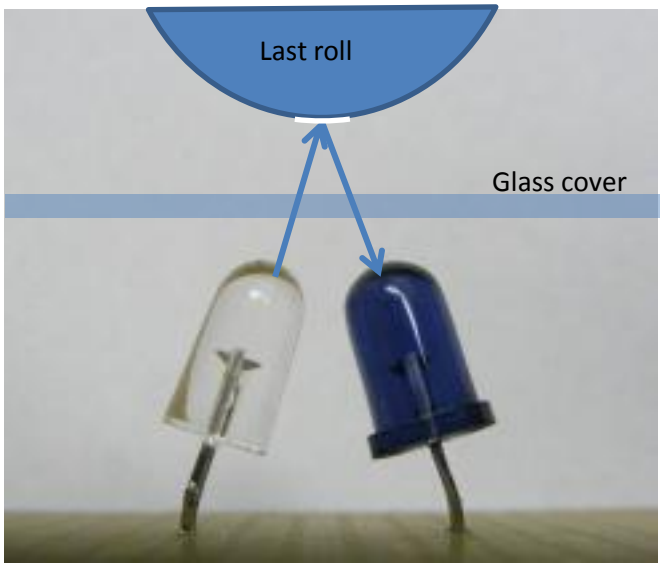
The intention is to detect a reflecting marker on the last roll of the gas meter. This marker is usually present on the 0 or on the 6 digit. First check if your meter has such a marker.

The marker will reflect the light from the LED into the phototransistor. This will switch on and generate a pulse for every 10 liters (one revolution of the last roll) of gas used.



The short lead (collector) of the phototransistor is connected to 5V.
The long lead (anode) of the LED is connected to 5V.

The schematic of the sensor is not complex. Mounting the LED and phototransistor however is somewhat critical. The angles should be as shown in the next picture to optimize sensitivity and prevent unwanted pulses.



Because the sensitivity of the sensor varies under different conditions (distance, angle, glass thickness and marker type) the output of the phototransistor is connected to an analog input. In this way the software can determine the switching level and do some filtering on the analog signal.

Prototype of the sensor on the Gas meter.

Water meter sensor

To monitor your water meter you can use exactly the same schematic as for the gas meter sensor.

Most water meters have a half-moon shaped disc that makes one revolution per liter water.

By mounting the sensor so that it can detect the rotating half-moon, you have a resolution of 1 liter.

Ferraris meter sensor

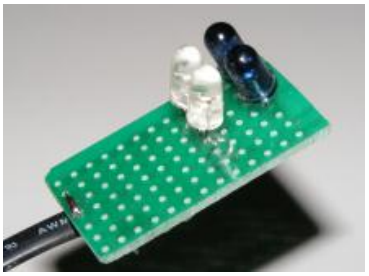
The Ferraris meter consists of a disc that is rotating according to the used power. The disc is connected to a counter. The counter will display the used kilowatt-hours.

The nice thing about this meter is that it can also count backwards. A negative current will let the disc rotate in the other direction and the counter value will decrease.

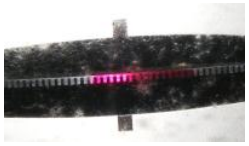
Some meters have a blocking mechanism to prevent running backwards. These meters have this symbol:

Make sure your meter does not have this symbol if you want to measure solar production.

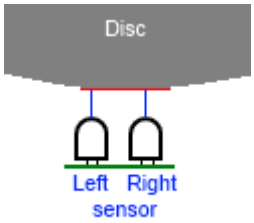
The Ferraris sensor consists of 2 LED-Phototransistor combinations described in the Gas meter sensor. You need 2 signals so the direction of the wheel can be determined.


Here you see the two sensors mounted on a prototype board.

Because my ferraris wheel has a red marking on it, I use blue LED's. The contrast between the reflecting disc and the red marking is the largest. If you have a black marking, any color will do.

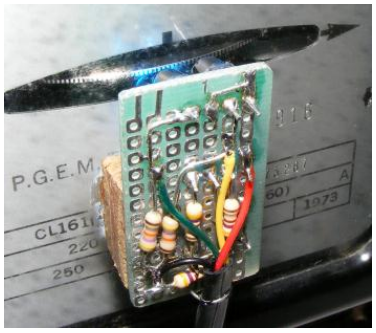

Red marking can be seen with blue light.

Mounting the sensors on the meter is done by trial and error. Try to set the angles and distances so that the LED and the phototransistor both look to the same point on the disc. The distance between the left and the right sensor should be less than the width of the marking. The software requires one sensor to switch on before the other switches off.



Top view of the sensors. Both look at the marking.

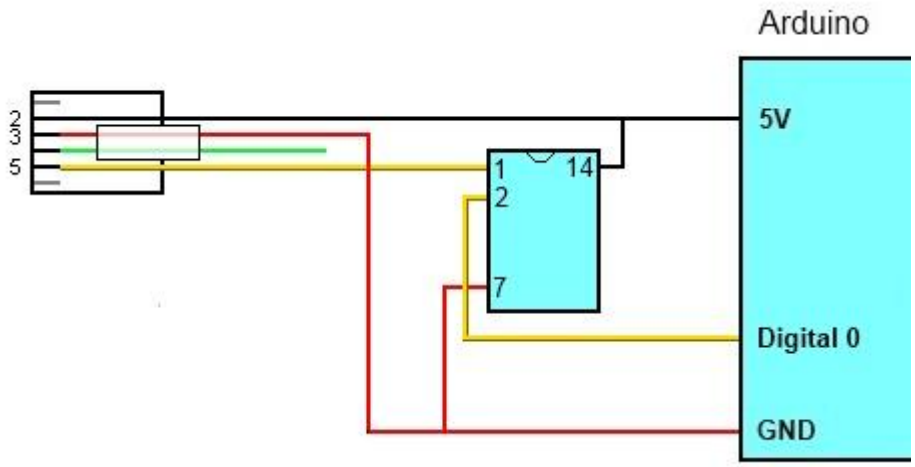
Like the Gas sensor, the Ferraris sensor uses analog inputs.


The finished sensor mounted on the meter.

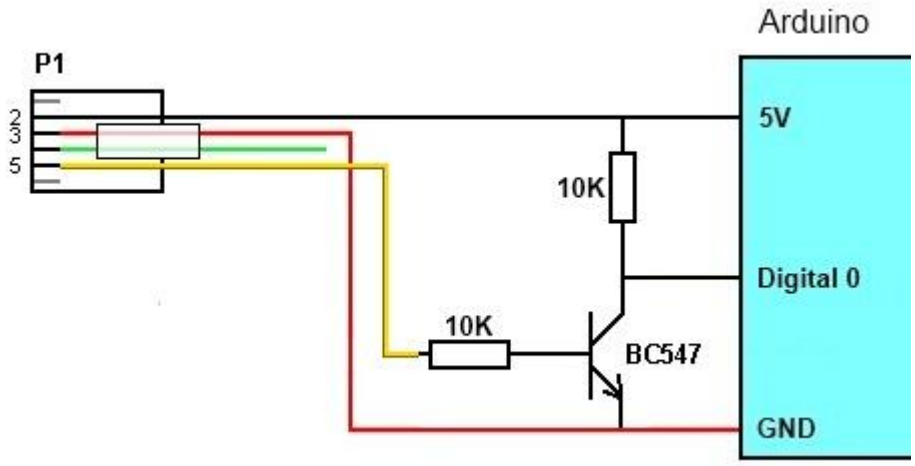
Smart meter P1 Port

The Smart meter P1 port is a serial port that will transmit all counter values every 10 seconds. To read this port with the standard Arduino serial port, the signal has to be inverted. Use one of the schematics below to connect the meter to the Arduino.

Option 1 is to use the 74LS04 to invert the data from the port:



Option 2 is to use a standard NPN transistor to achieve the same effect:



The Arduino UNO only has one serial port, connected to pin 0.

Be careful that this serial port is also used to download new programs so you have to disconnect the USB plug when using the P1 port.

When you are using an Arduino MEGA, you can use one of the four available ports.

Port 1 is on digital pin 0

Port 2 is on pin 53

Port 3 is on pin 8 and

Port 4 is on pin 6.