Arduino™ Workshop

Door Ralph Bosmeier (PA1RB)

24 November 2014

Doelstelling van deze workshop

- Kennismaken met het Arduino™ “eco-system”
- Een aantal toepassingen voor zendamateurs
- Zelf aan de slag met de basis I/O functies
- Gebruik van libraries
- De werking van de LC-meter
- Tips en bronnen voor verdere verdieping

De bedenkers van Arduino

http://spectrum.ieee.org/geek-life/hands-on/the-making-of-arduino

Het Arduino eco-systeem

- De Arduino ™ microcontroller hardware en beschikbare “shields”
- De Interactive Development Environment (IDE) en de bootloader
- De http://arduino.cc/ website
- Afgeleide “-duino” microcontroller hardware
- De enorme hoeveelheid aan periferie hardware
- Beschikbaarheid van talloze code libraries
- Zeer ruime beschikbaarheid van documentatie

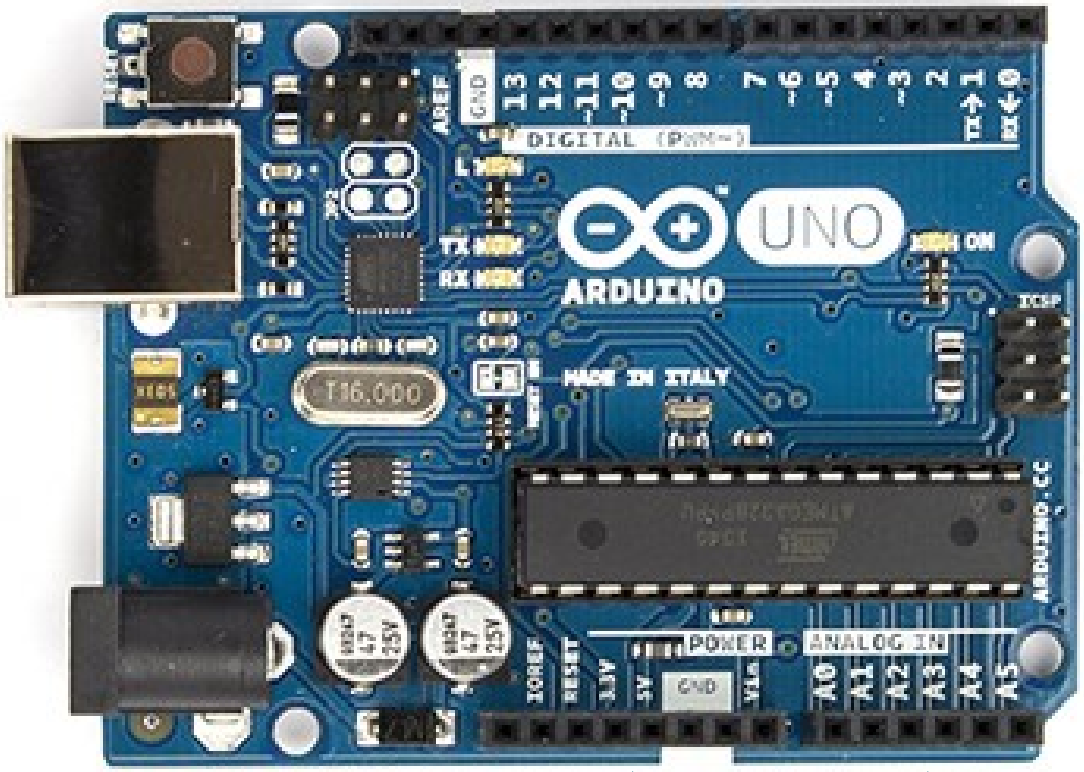
De Arduino UNO (rev 3)

http://arduino.cc/en/Main/arduinoBoardUno

0 – 13: Digital I/O
3, 5, 6, 9, 10, 11: can do PWM
0, 1: Hardware serial I/O
2,3: External interrupt
10, 11, 12, 13: SPI-bus

Digital

USB + Power



Power 6-20V

VIN (6-20V)
GND
5 Volt (source / input)
3.3V (source)
Reset

Power

Analog

A0 - A5: Analog in
A4, A5: I2C-bus (“two-wire”)

De Arduino Mega (2560)

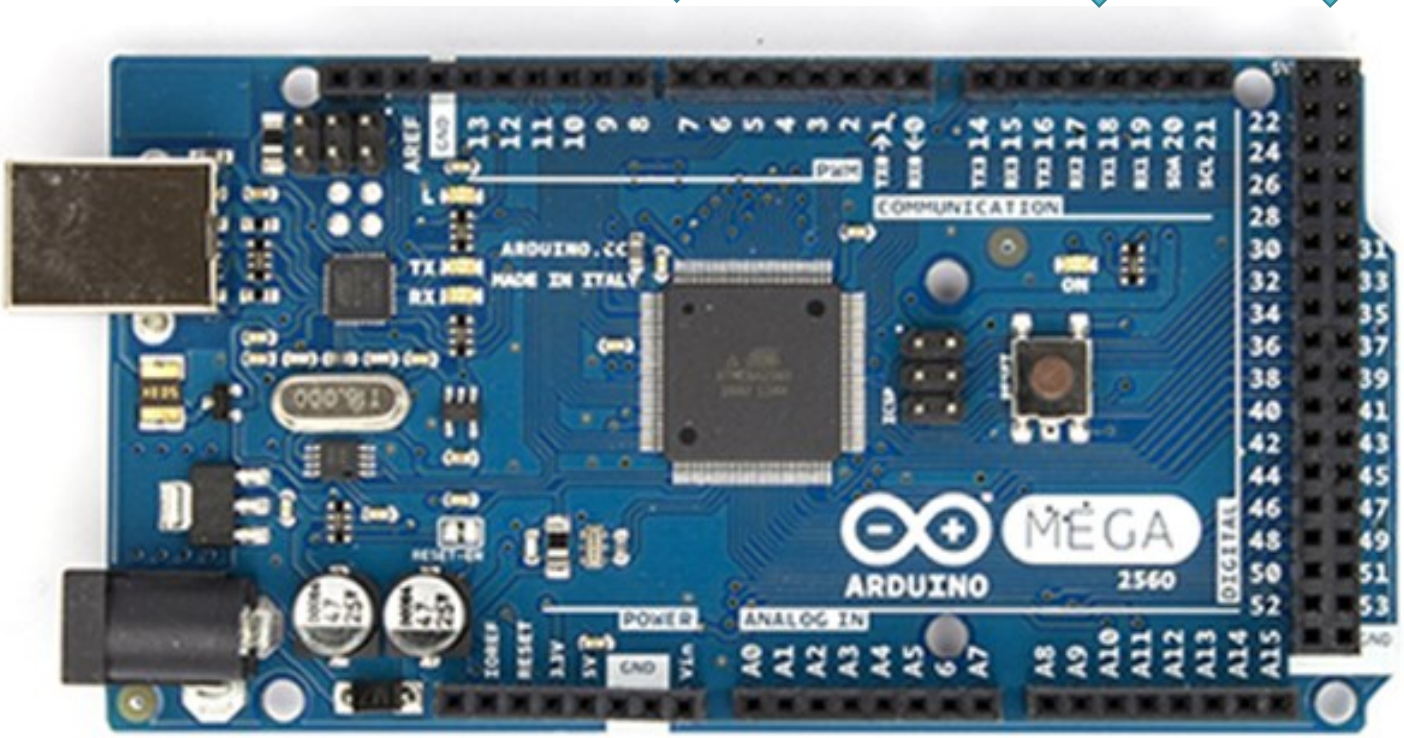
http://arduino.cc/en/Main/arduinoBoardMega2560

Digital

Digital

Digital

USB + Power



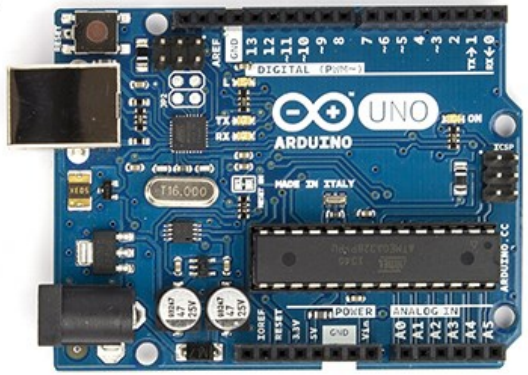
Power 6-20V

VIN (6-20V)
GND
5 Volt (source / input)
3.3V (source)
Reset

Power

Analog

Analog

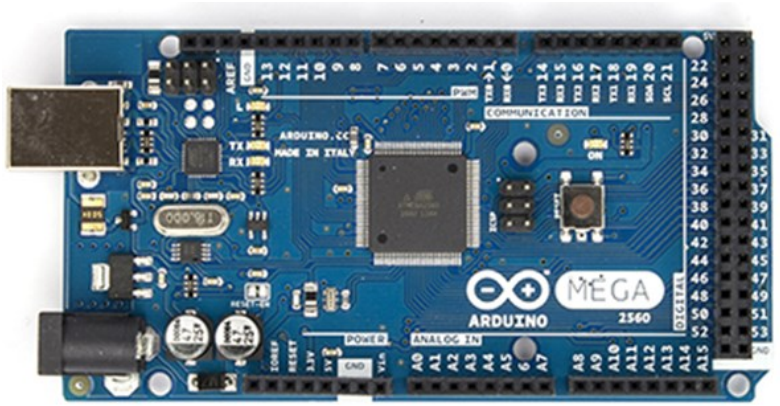


Arduino UNO (rev 3)

CONRAD : € 23,90 AliExpress : € 5,90

Processor: ATmega328 - 16 MHz
Flash: 32 KB (0,5 KB bootloader)
SRAM: 2 KB
EEPROM: 1 KB
Digital I/O: 14 (6 PWM)
Analog In: 6
Serial: SPI, I2C, 1 x UART

- Serial naar USB bridge
- 5 Volt I/O spanning



Arduino Mega (2560)

CONRAD : € 49,99 AliExpress : € 10,30

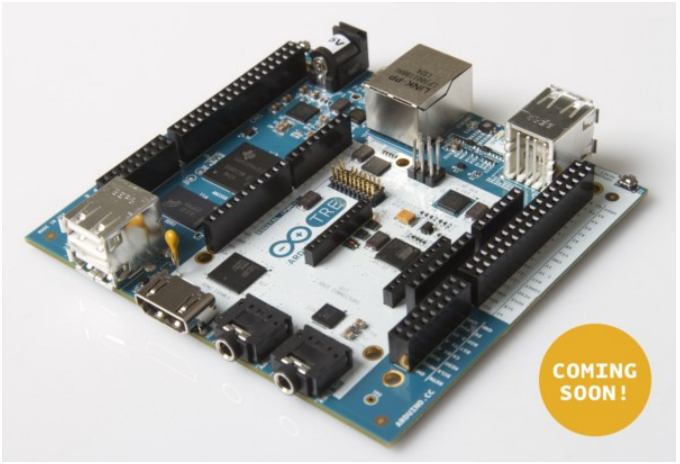
Processor: ATmega2560 - 16 MHz
Flash: 256 KB (8 KB bootloader)
SRAM: 8 KB
EEPROM: 4 KB
Digital I/O: 54 (15 PWM)
Analog In: 16
Serial: SPI, I2C, 4 x UART

- Serial naar USB bridge
- 5 Volt I/O spanning

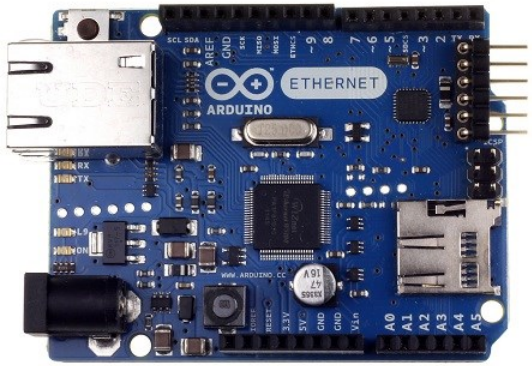
http://www.atmel.com/products/microcontrollers/avr/megaavr.aspx

Enkele Arduino varianten

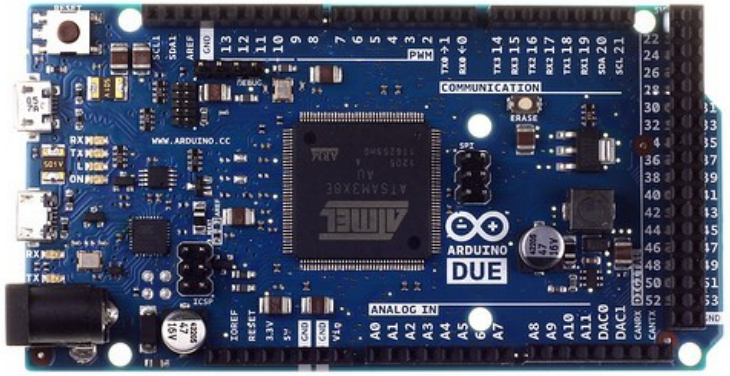
Arduino Yún



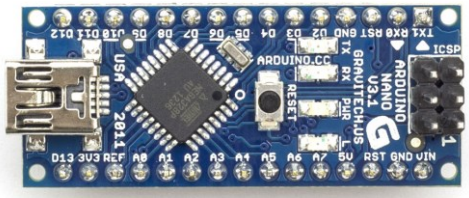
Arduino TRE



Arduino Ethernet



Arduino DUE

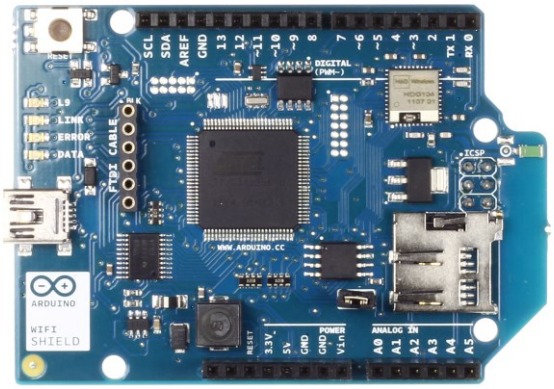


Arduino Nano

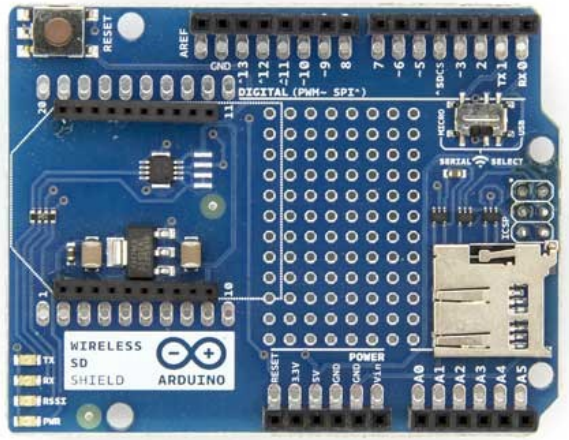
Enkele Arduino shields

GSM Shield

Grafisch TFT shield

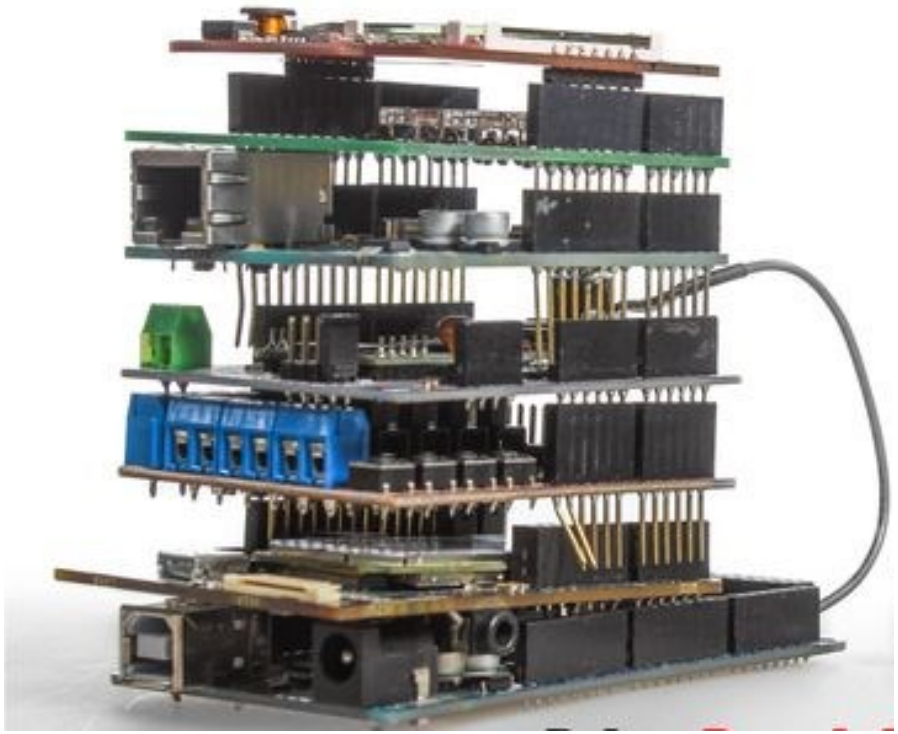


WiFi Shield



Wireless SD Shield
(o.a. Zigbee)

Prototyping levert mooie dingen op!



KICKSTARTER

https://www.kickstarter.com/projects/2080282237/phoenard-the-arduino-compatible-prototyping-gadget
http://www.electronics-lab.com/blog/?p=31605

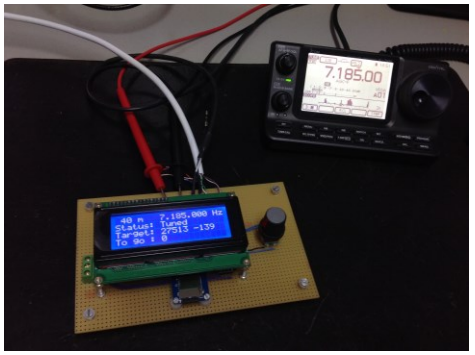
https://www.kickstarter.com/projects/mopusworks/tweeq-micro-sized-arduino-compatible-platform-and

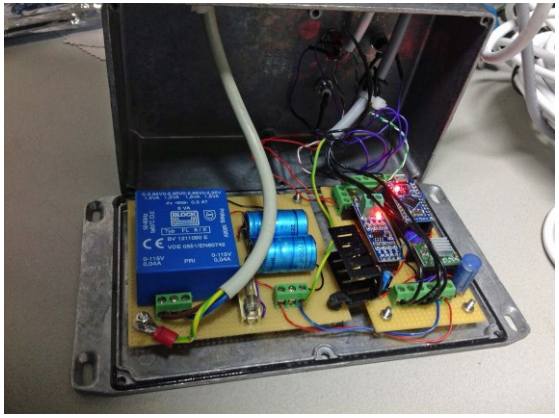
Toepassingen voor zendamateurs

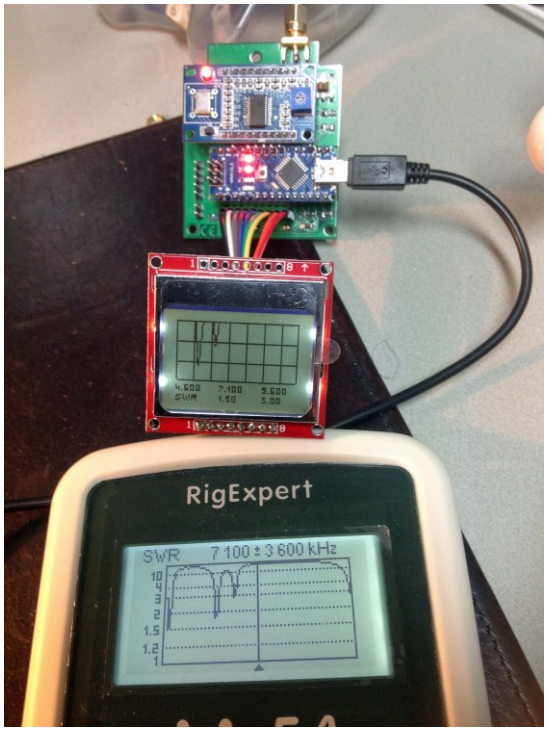
http://www.arrl.org/ham-radio-for-arduino-and-picaxe

- APRS Data Logger
- QRSS Beacon
- Multimode Transmitter Shield
- High Voltage, High Frequency, and High Temperature Data Logger
- Receive-Only, Low-Power APRS iGate
- PICAXE Keyer and CW Beacon Keyer
- Solar Tracker
- Nanokeyer
- Handheld Radio Talk Timer
- APRS Messenger
- DTMF Controlled SSTV Camera
- APRS Display
- Waterfall
- SWR Scanner

Wat ik er zelf mee heb gedaan:



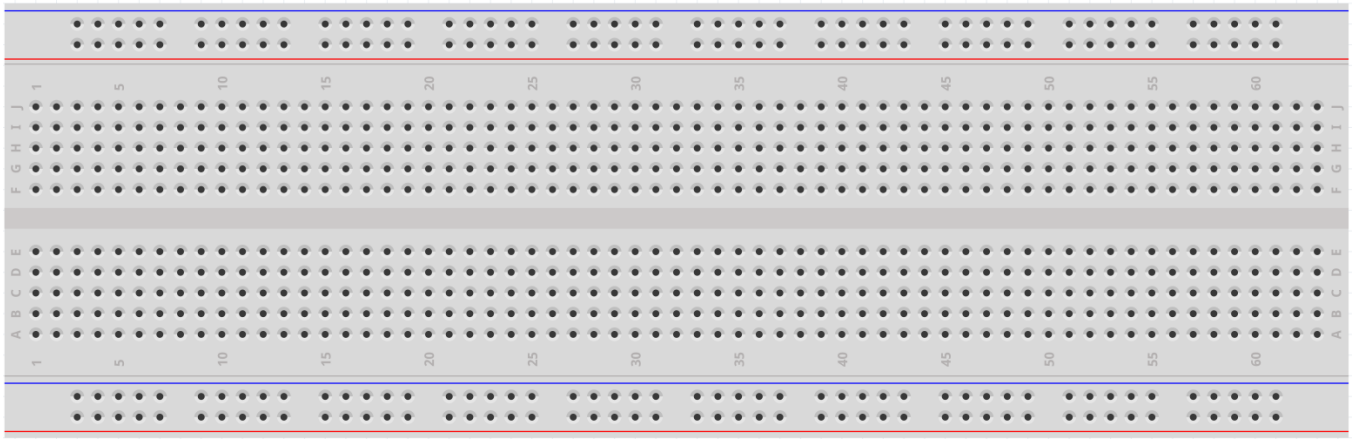


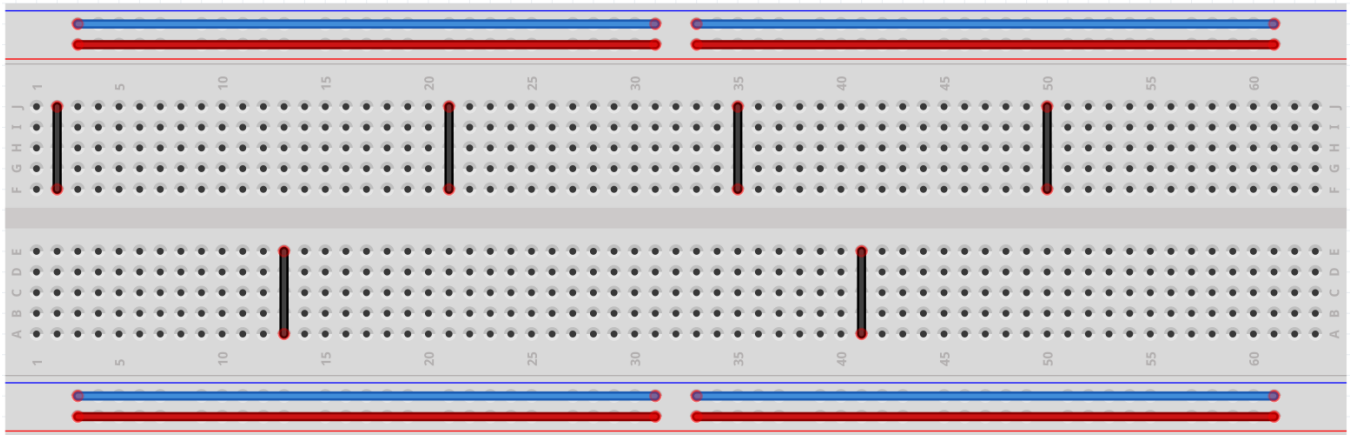


Besturing Magnetic Loop Antenne en een Antenne analyzer

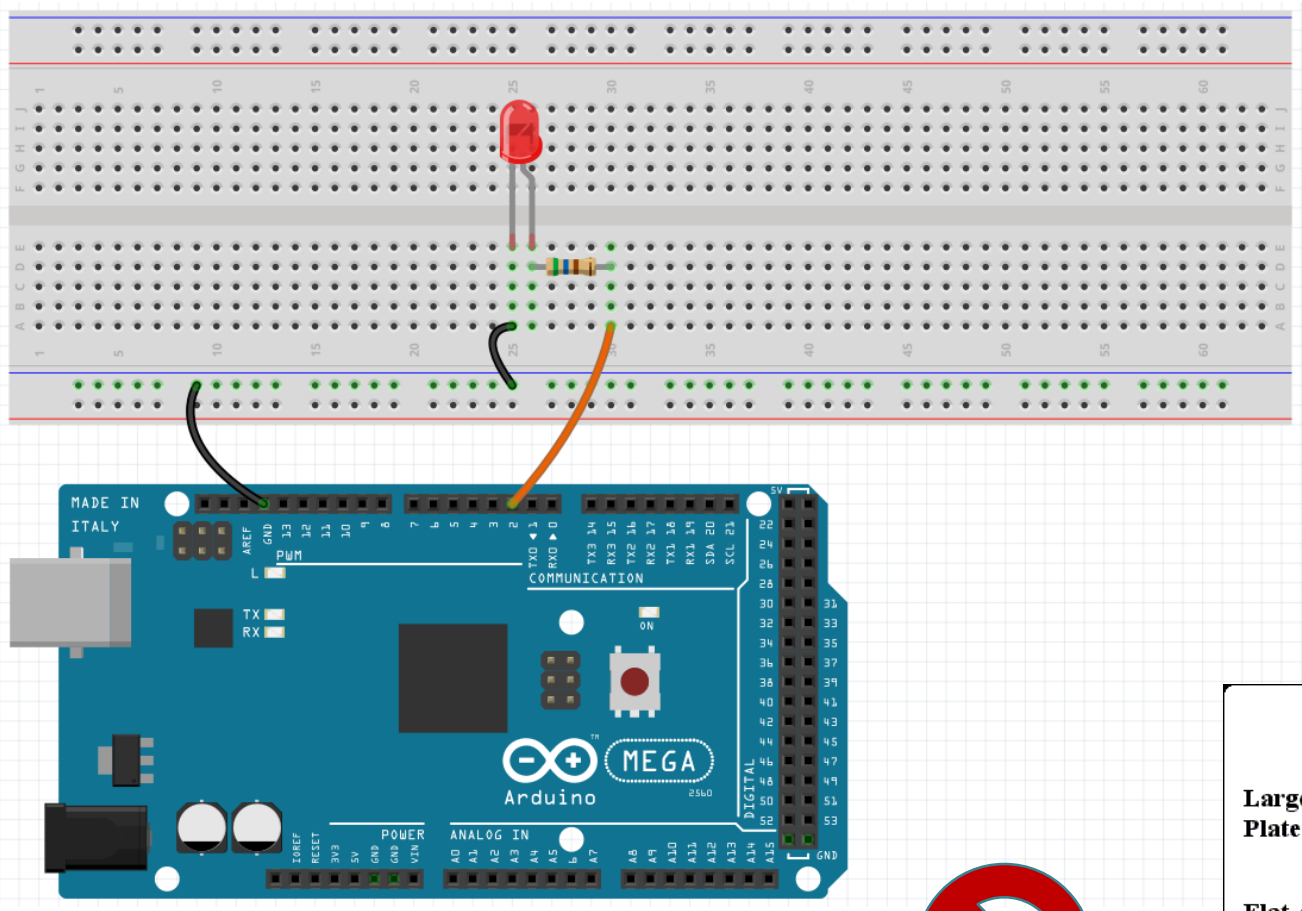
Aan de slag !

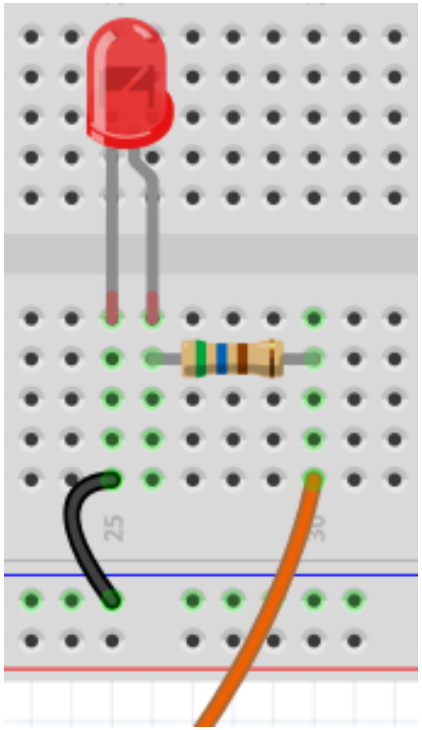
Het MB-102 Breadboard

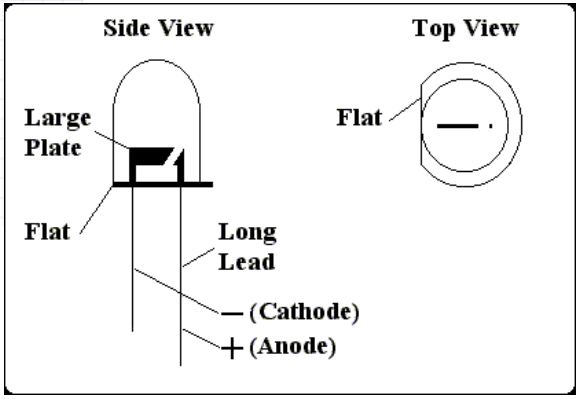




Circuit voor LED_Blink





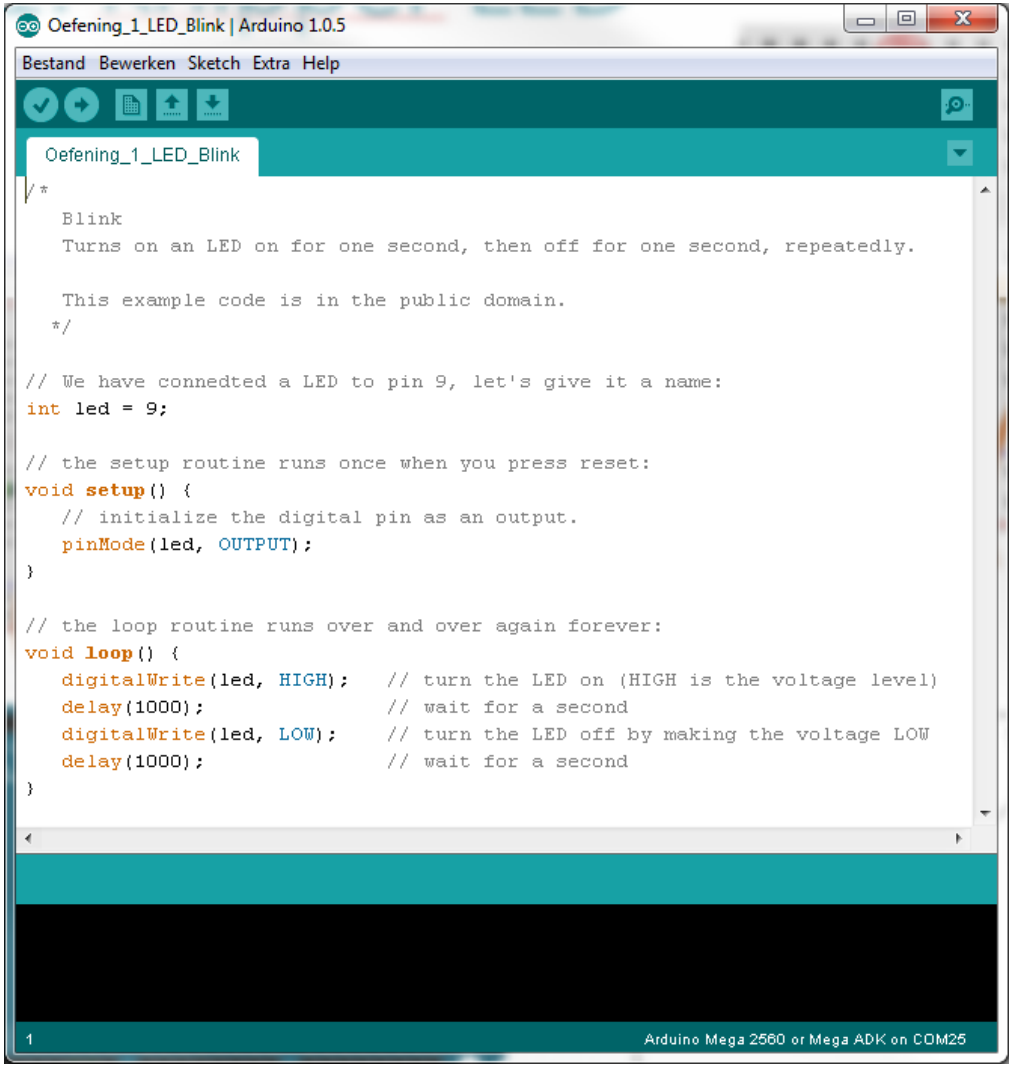


Absoluut maximum van 40 mA souce / sink per I/O pin
Maximum van 20 mA source / sink per pin wordt echter aanbevolen
5 V / 560 Ω = 9 mA, (*buffering is dus niet nodig in dit geval*).

Zie: http://arduino-info.wikispaces.com/ArduinoPinCurrent

De Arduino IDE

(Integrated Development Environment)

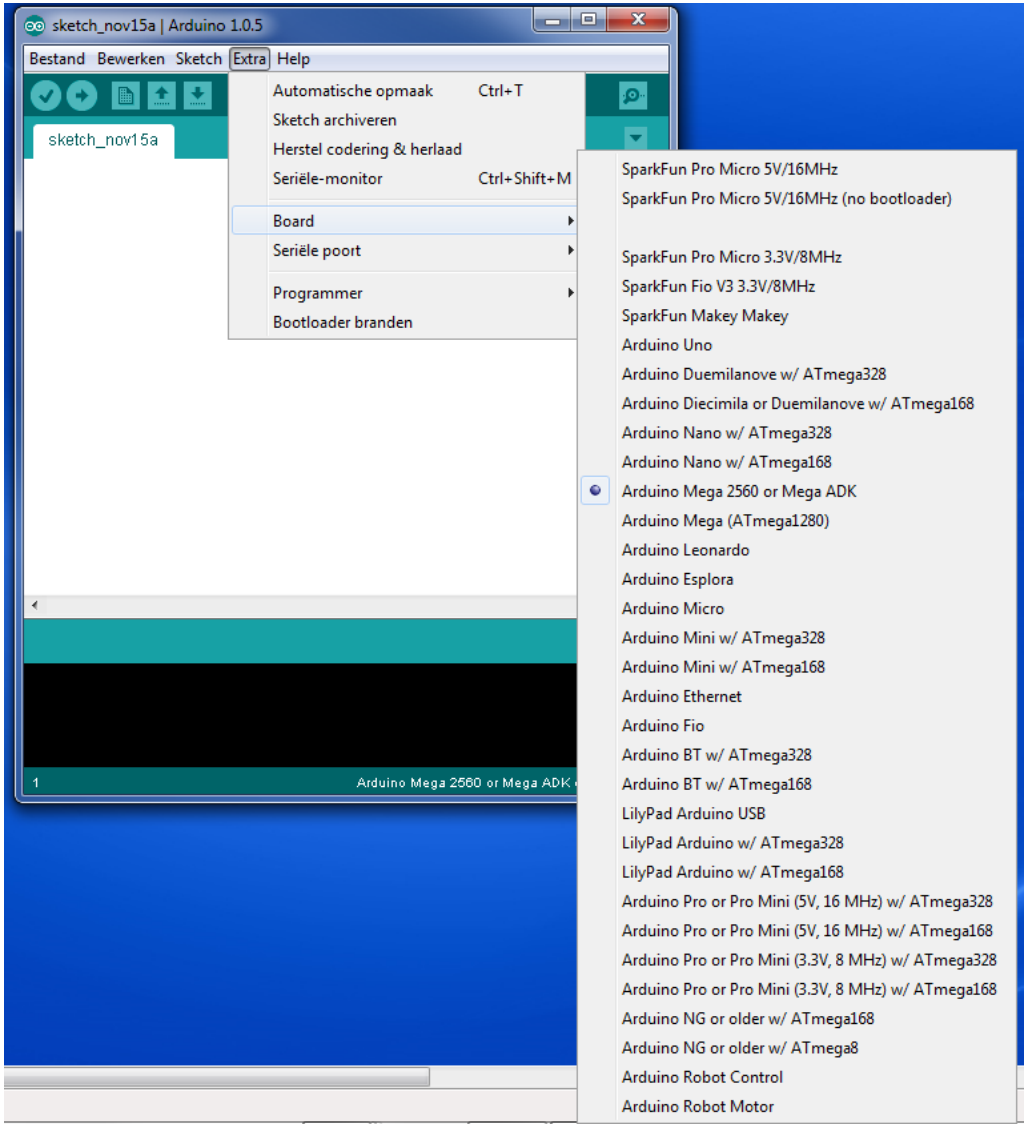


De Arduino “Sketch”
(= het C++ -programma)

Error window

Verbonden board

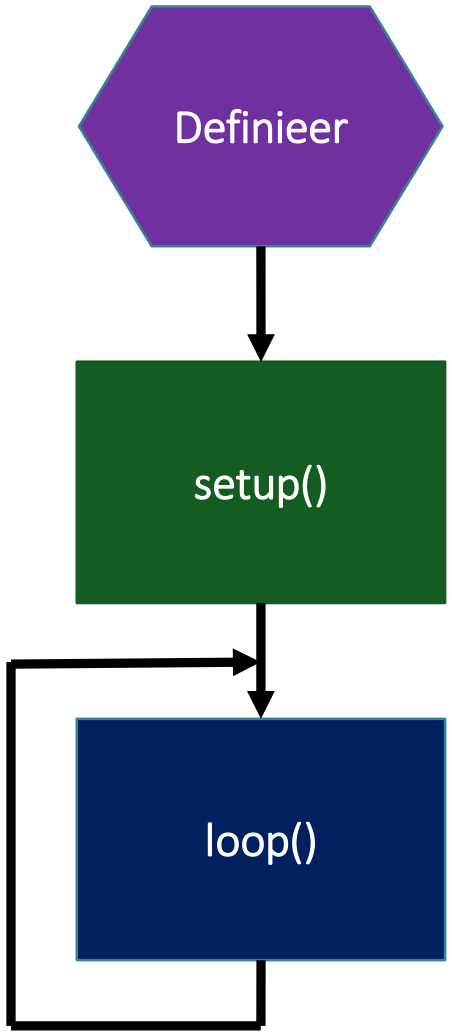
De IDE instellen voor de MEGA 2560



Oefening 1: LED_Blink

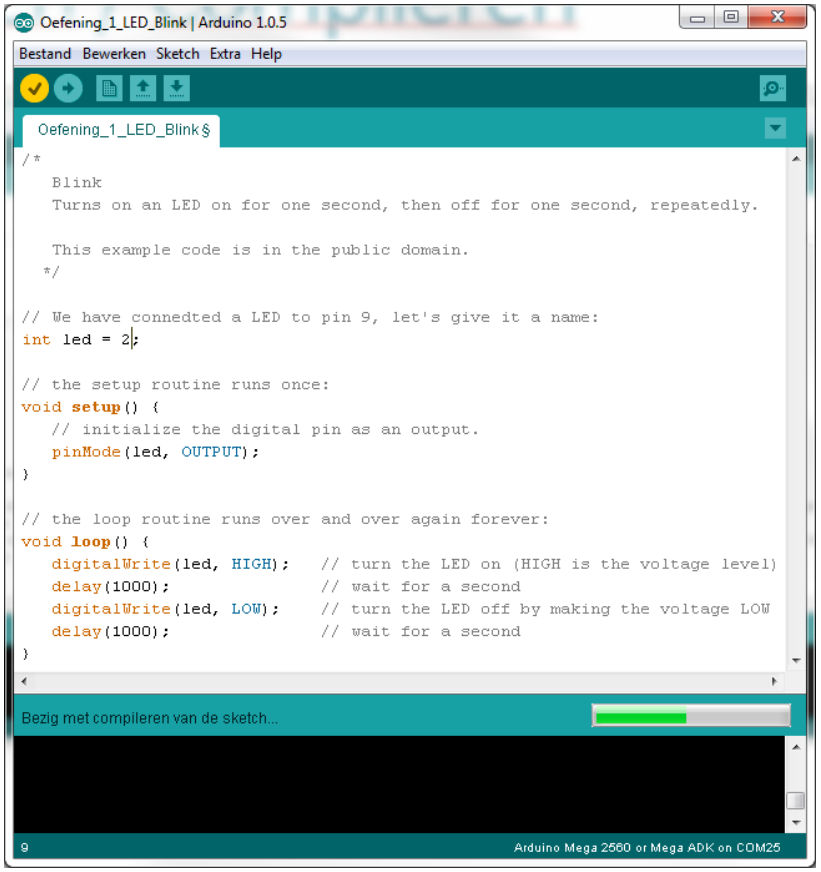
Digitale uitgang (digitalWrite())

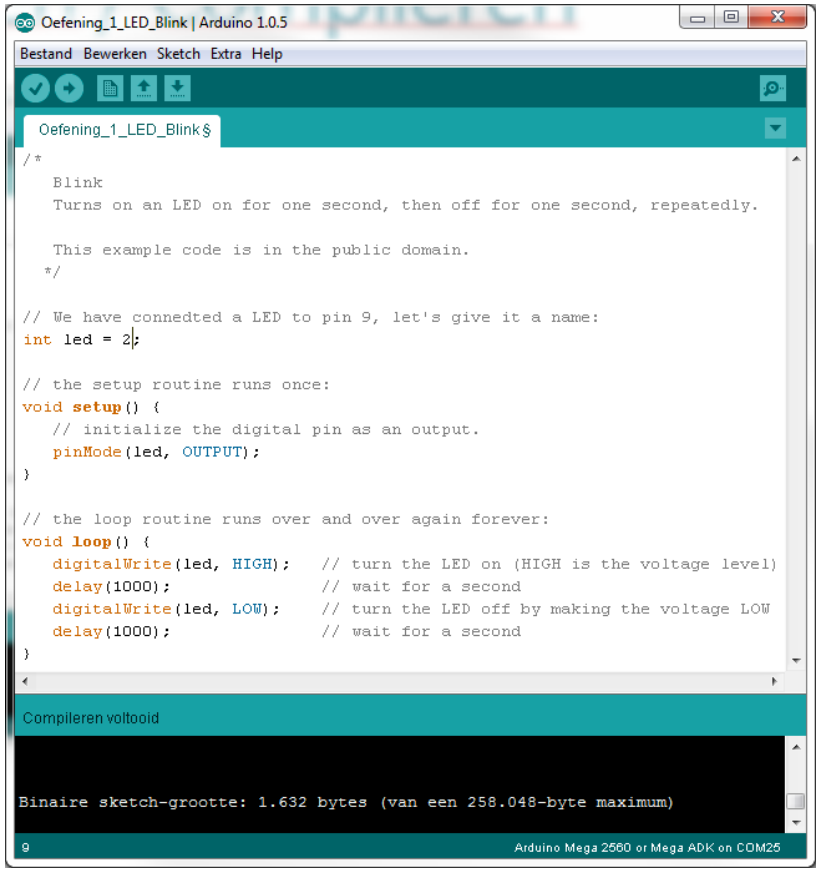
```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

// We have connected a LED to pin 2, let's give it a name:
int led = 2;

// the setup routine runs once:
void setup()
{
pinMode(led, OUTPUT);  // initialize the digital pin as an output.
}

// the loop routine runs over and over again forever:
void loop()
{
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);               // wait for a second
}
```



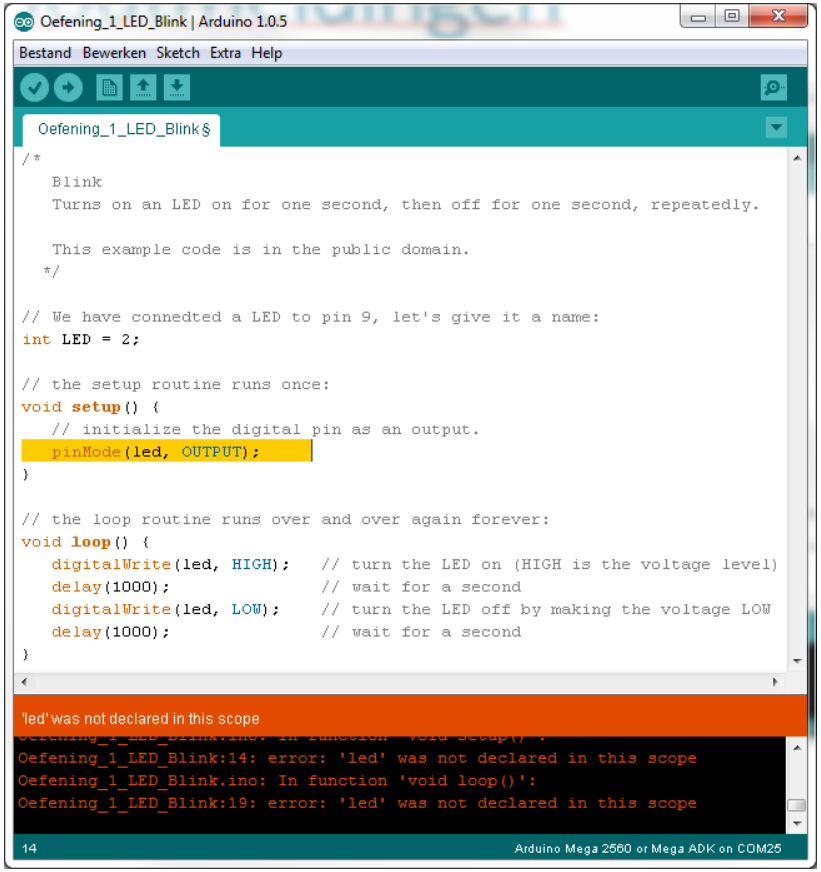
http://arduino.cc/en/Tutorial/DigitalPins
http://arduino.cc/en/Reference/digitalWrite

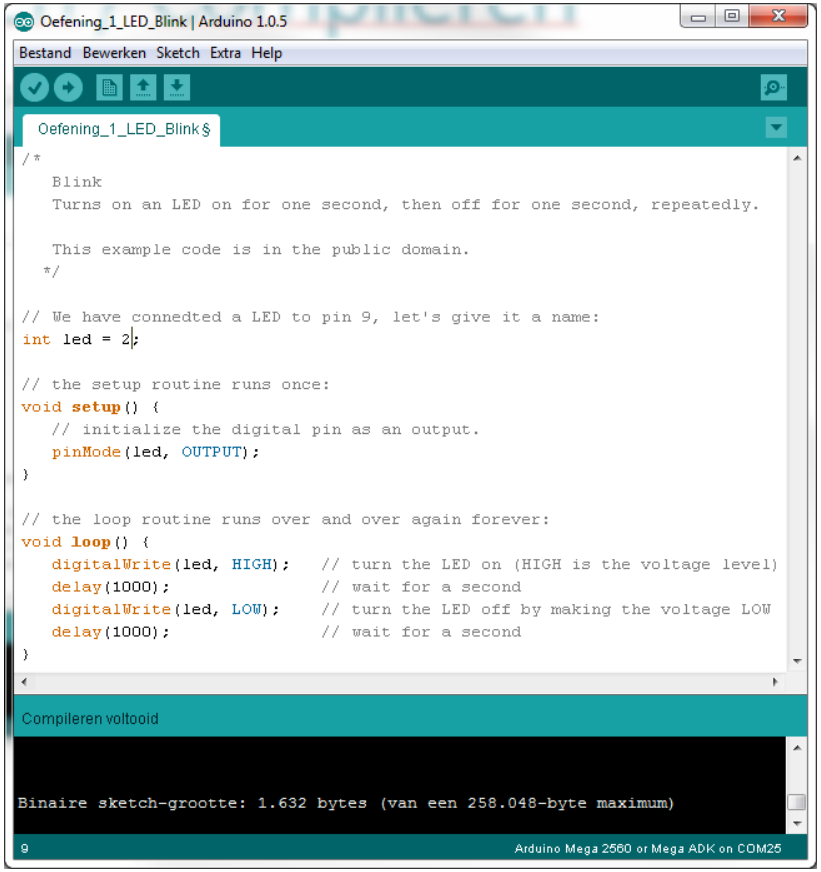
Controleren / Compileren





Eventuele foutmeldingen

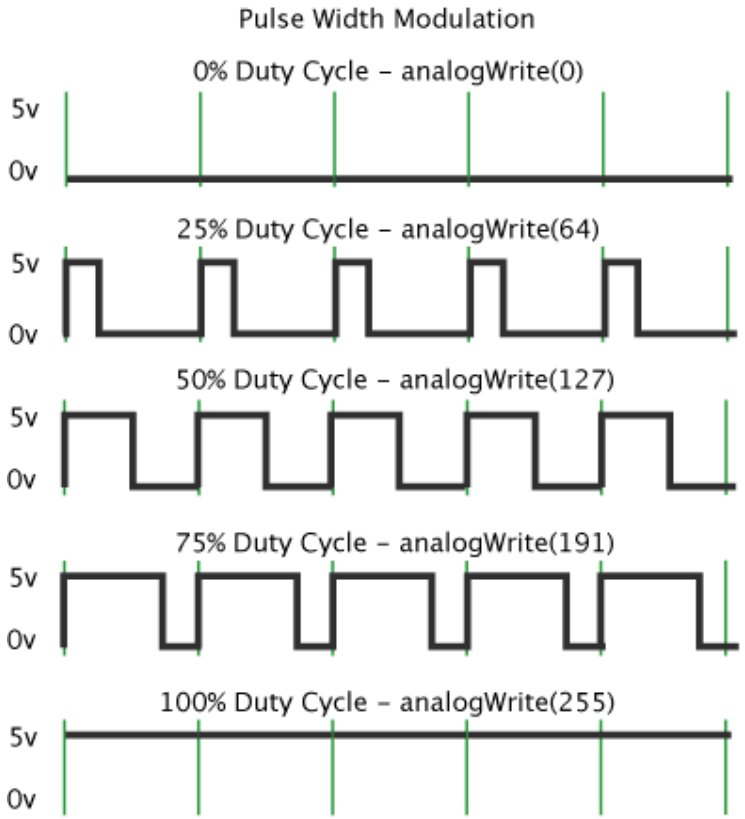




Uploaden van een sketch

Oefening 2: LED_Dimmer

PWM uitgang (analogWrite())



De Arduino UNO / Mega hebben geen “echte” D/A convertor aan boord, maar veel pinnen kunnen wel Pulse Wide Modulation (PWM) uitsturen (490 / 980 Hz)

We gebruiken hetzelfde circuit als voor LED_Blink, maar nu met een andere sketch.

http://arduino.cc/en/Tutorial/PWM
http://arduino.cc/en/Reference/analogWrite

Oefening 2: LED_Dimmer

PWM uitgang (analogWrite())

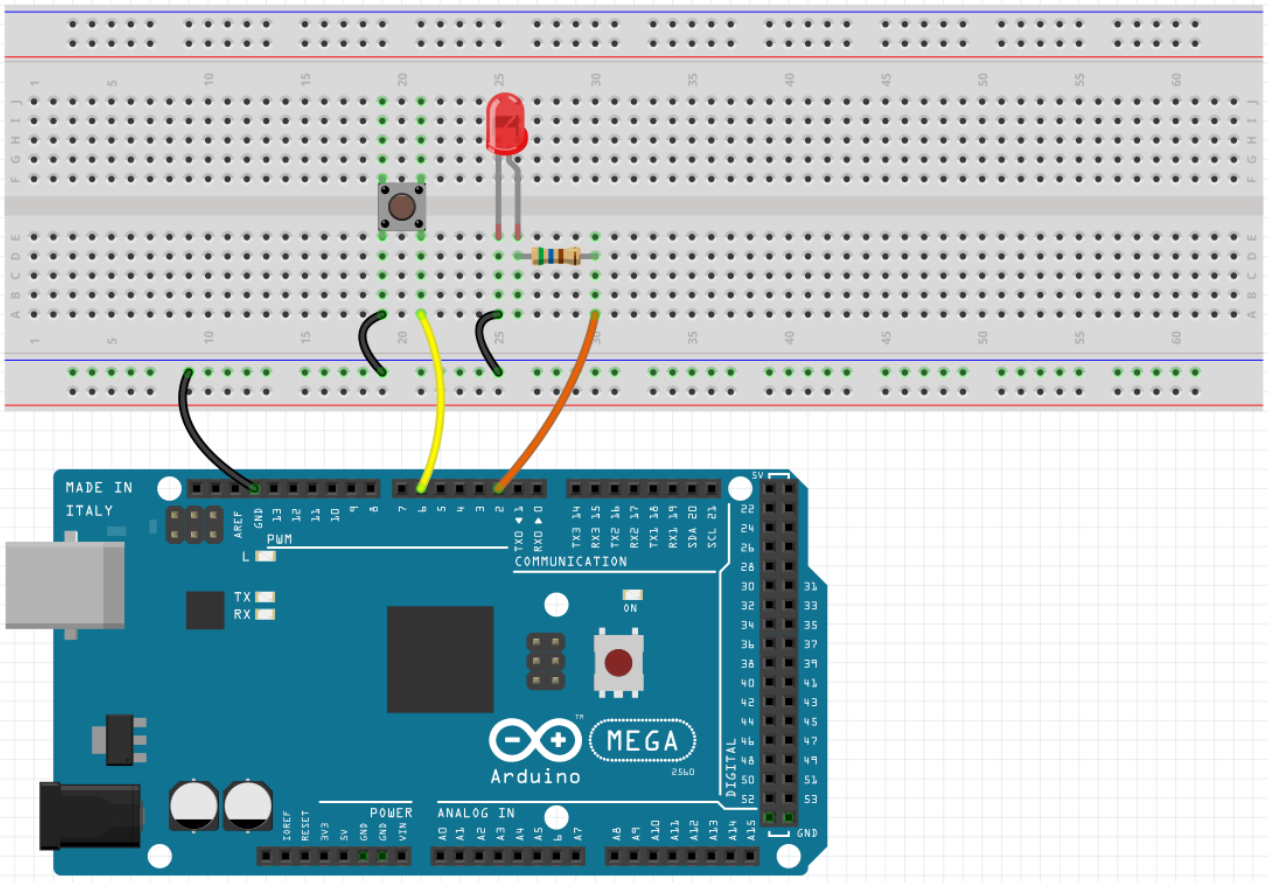
```
int ledPin = 2;                  // LED connected to digital pin 2
int counter = 0;                 //  counter value
boolean countingUp = true;       // Track the direction

void setup()
{
  pinMode(ledPin, OUTPUT);       // sets the pin as output
}

void loop()
{
  if (countingUp == true && counter < 255)
  {
    counter++;                   // counter = counter + 1
    analogWrite(ledPin, counter);// analogWrite values from 0 to 255
    delay(10);                   // delay in ms
  }
…
```

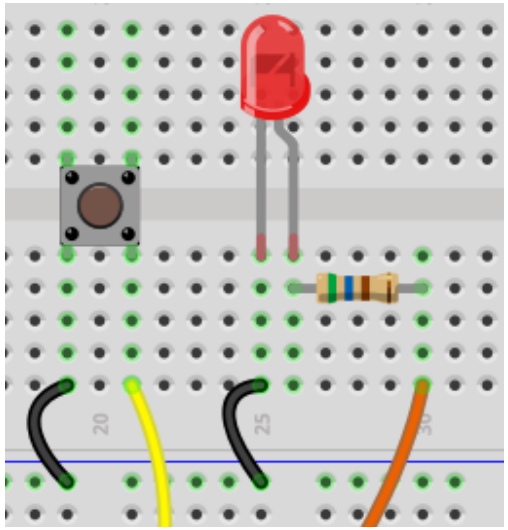
Definitie van pinnen en variabelen

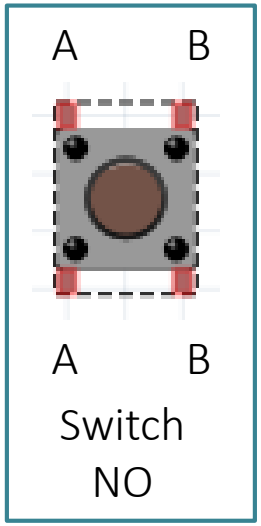
Zet pin in output mode

Zet de PWM duty–cycle met analogWrite()

Circuit voor Digital_Input

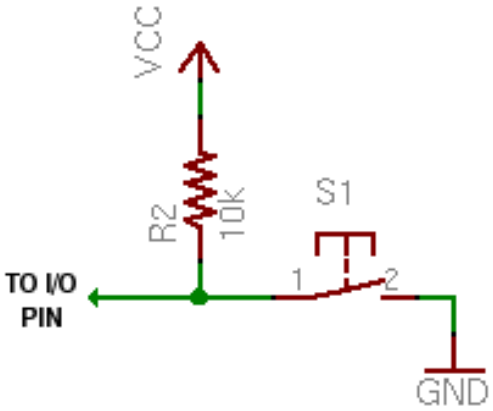






Oefening 3: Digital_Input (digitalRead())

```
void setup()
{
   …
   pinMode(buttonPin, INPUT_PULLUP);
   …
}


void loop()
{
  if (digitalRead(buttonPin) == HIGH)
  {
       …
  }
  …
}
```

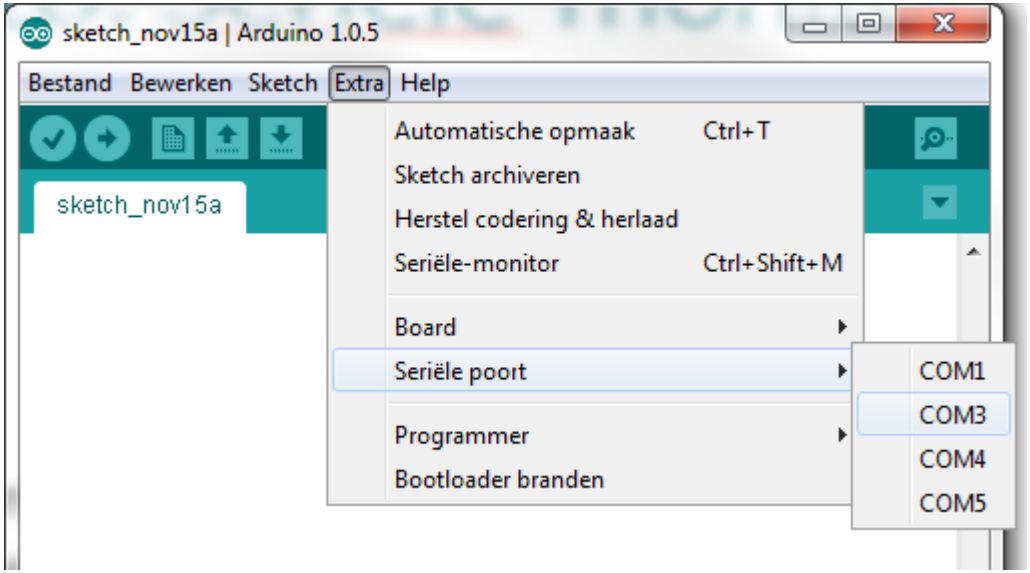


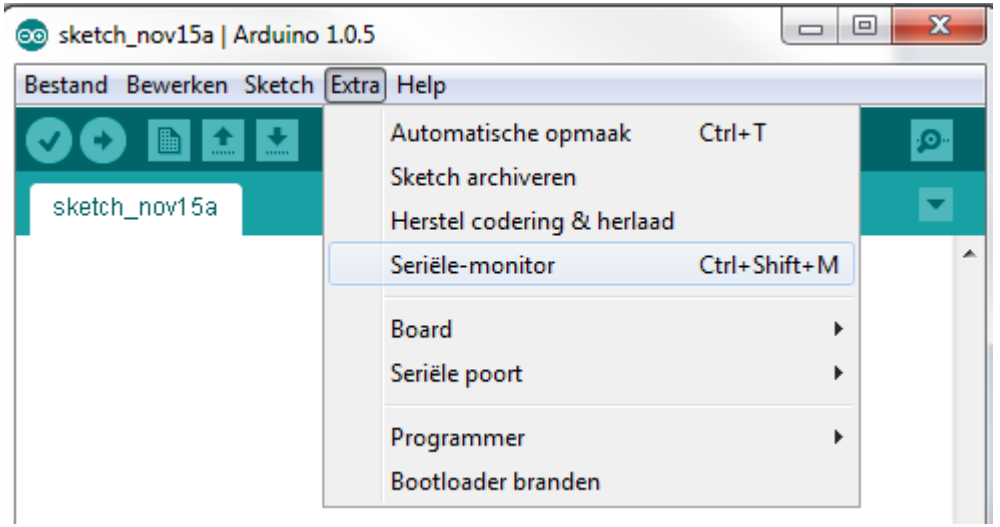
Je kunt zelf een pull-up weerstand in de schakeling opnemen
(aanbevolen waarde 10K Ohm),
of een interne pull-up weerstand in de microcontroller inschakelen, (waarde ligt typisch tussen 20K en 50K Ohm)

http://arduino.cc/en/Tutorial/DigitalPins
http://arduino.cc/en/Reference/pinMode
http://arduino.cc/en/Reference/digitalRead

Intermezzo 1: Seriële-monitor

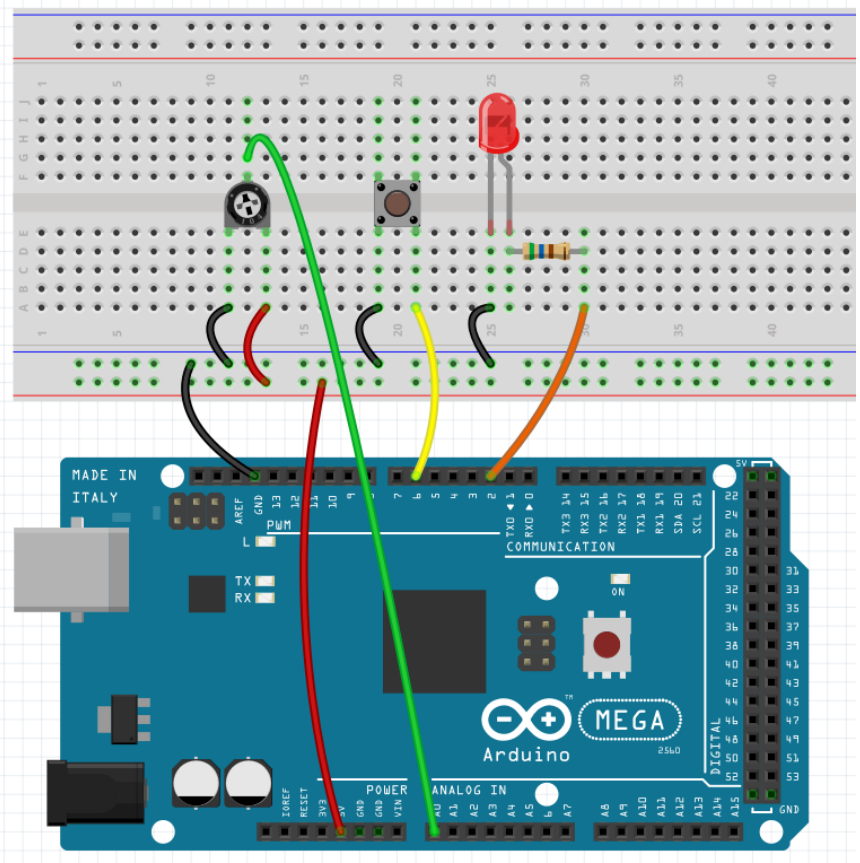
```
int counter = 0;

void setup()
{
  // initialize serial communication
  // at 9600 bits per second
  Serial.begin(9600);
}

void loop()
{
  Serial.println(counter);
  counter++;
  delay(1000);
}
```

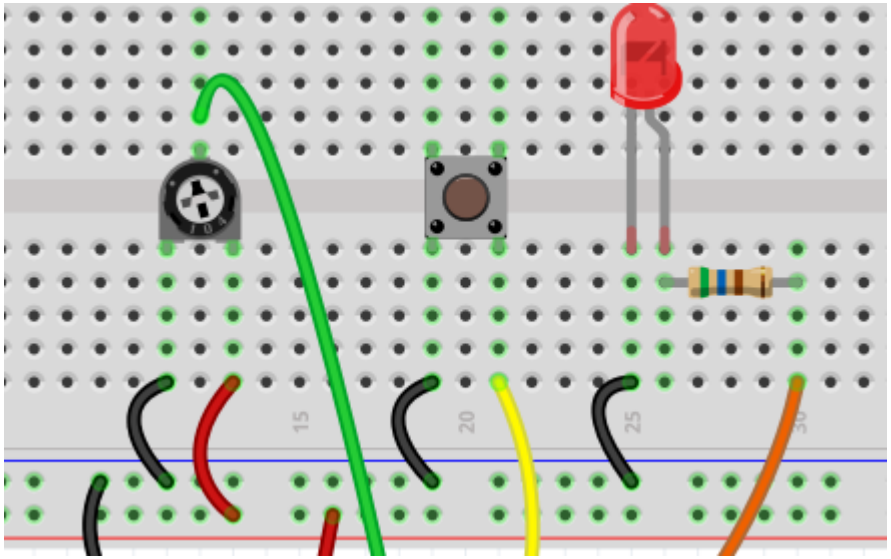




http://www.ladyada.net/learn/arduino/lesson4.html

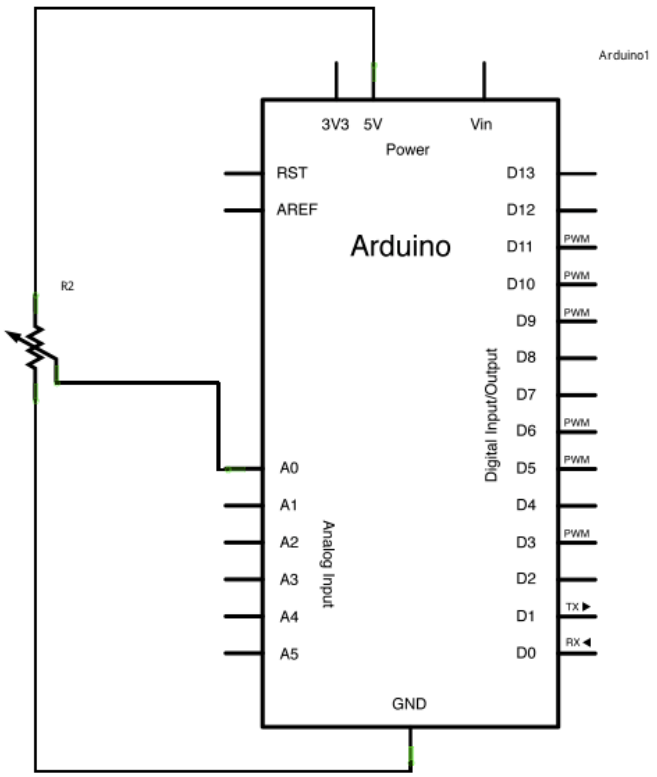
Circuit voor Analog_Input





Oefening 4: Analog_Input (analogRead())

```
int sensorValue;
float voltage;

void setup()
{
Serial.begin(9600);
}

void loop()
{
  sensorValue = analogRead(A0);
  voltage = sensorValue * (5.0 / 1023.0);
  Serial.println(voltage);
  delay(500);
}
```



http://arduino.cc/en/Tutorial/AnalogInputPins
http://arduino.cc/en/Reference/analogRead
http://arduino.cc/en/Tutorial/ReadAnalogVoltage

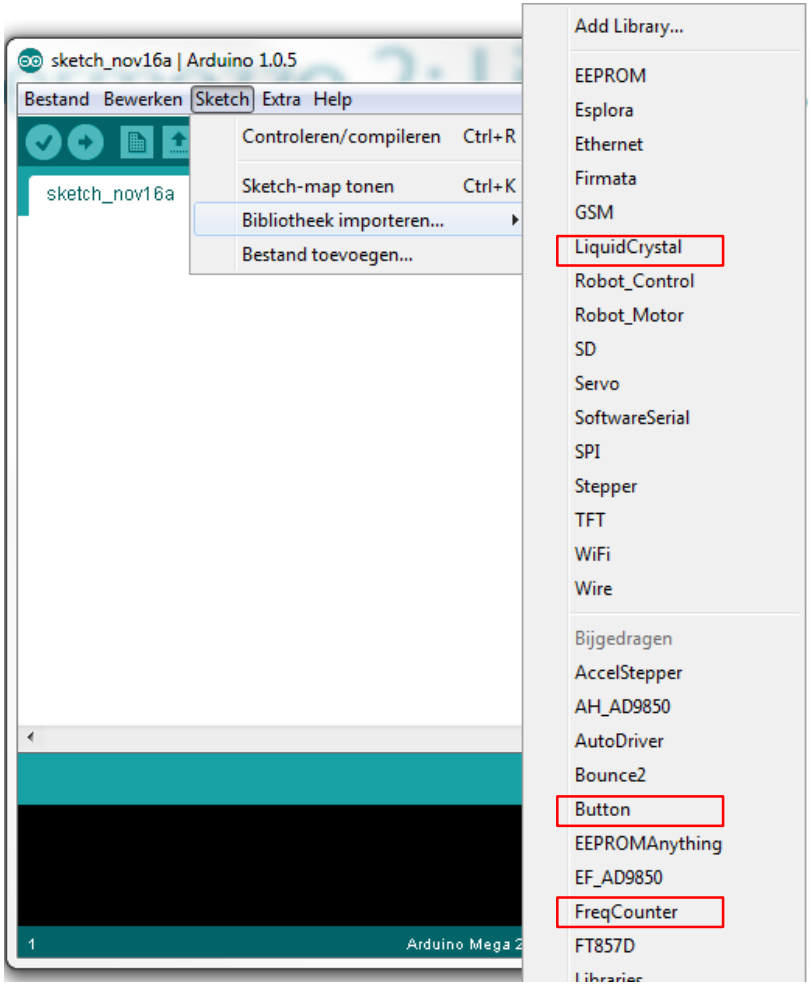
Tussenstand van de workshop

1. De Integrated Development Environment (IDE)
2. Digitale output digitalWrite()
3. PWM output analogWrite()
4. Digitale input digitalRead()
5. Analoge input analogRead()
6. De seriële monitor

Even pauze !

10 minuten welverdiende bio-break

Intermezzo 2: Libraries



Libraries bevatten herbruikbare code waardoor het gebruik van allerlei hardwarecomponenten een heel stuk eenvoudiger wordt.

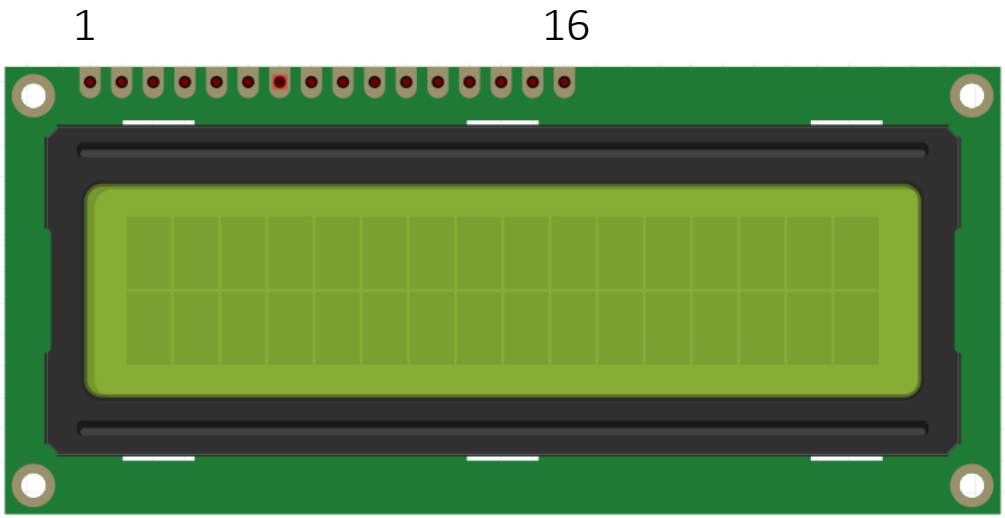
De Arduino IDE komt standard met een aantal veelgebruikte libraries, ondermeer LiquidCrystal voor alfanumierieke LCD's.

Andere libraries zijn eenvoudig toe te voegen.

Wij voegen de Button en FreqCounter libraries toe.

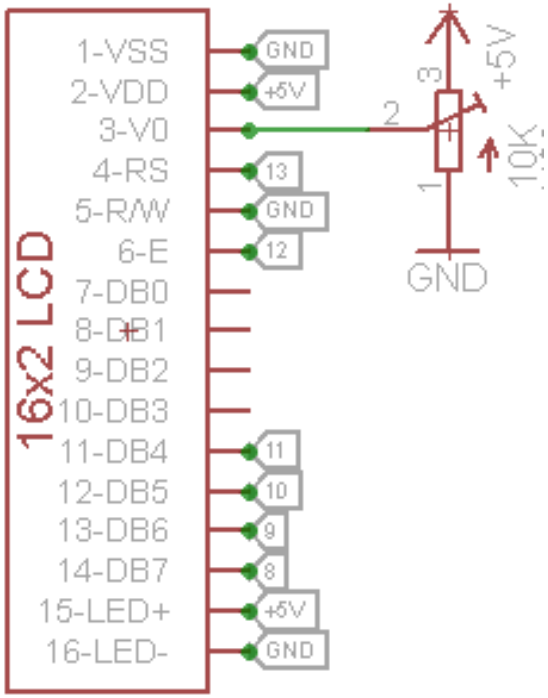
http://arduino.cc/en/Reference/Libraries

Circuit voor LCD 1602 (16x2)



2 regels * 16 karakters alfanumeriek display
Aan te sturen via 4-bit of 8-bit databus
Met backlight

Gebaseerd op Hitachi HD44780 controller
(of compatible).



Aansluitschema op L/C shield

https://www.sparkfun.com/datasheets/LCD/HD44780.pdf

Oefening 5: LCD_display

```
#include <LiquidCrystal.h>  // include the library code

// initialize the library with the numbers of the interface pins
// parameters: (rs, enable, d4, d5, d6, d7)
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

void setup()
{
  // set up the LCD's number of columns and rows:
  lcd.begin(16, 2);
  lcd.print("Hello, world!");  // Print a message to the LCD.
}

void loop()
{
  // set the cursor to column 0, line 1
  // (note: counting begins with 0):
  lcd.setCursor(0, 1);
  // print the number of seconds since reset:
  lcd.print(millis()/1000);
}
```

Voeg de library code in

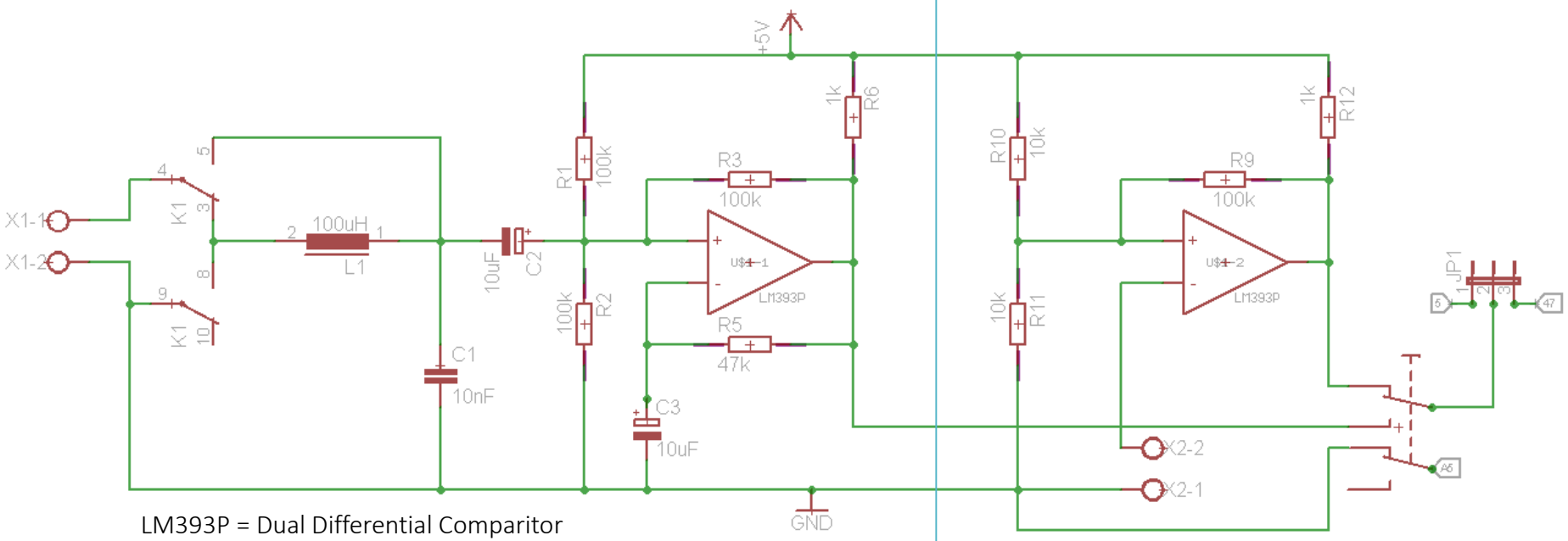
Creeer een object “lcd”, en geeft daarbij aan hoe deze met de hardware is verbonden.

Gebruik het object middels zijn methoden, zoals:

- lcd.begin()
- lcd.print()
- lcd.setCursor()
- …

http://arduino.cc/en/Tutorial/LiquidCrystal
http://arduino.cc/en/Reference/LiquidCrystal

L/C-meter shield



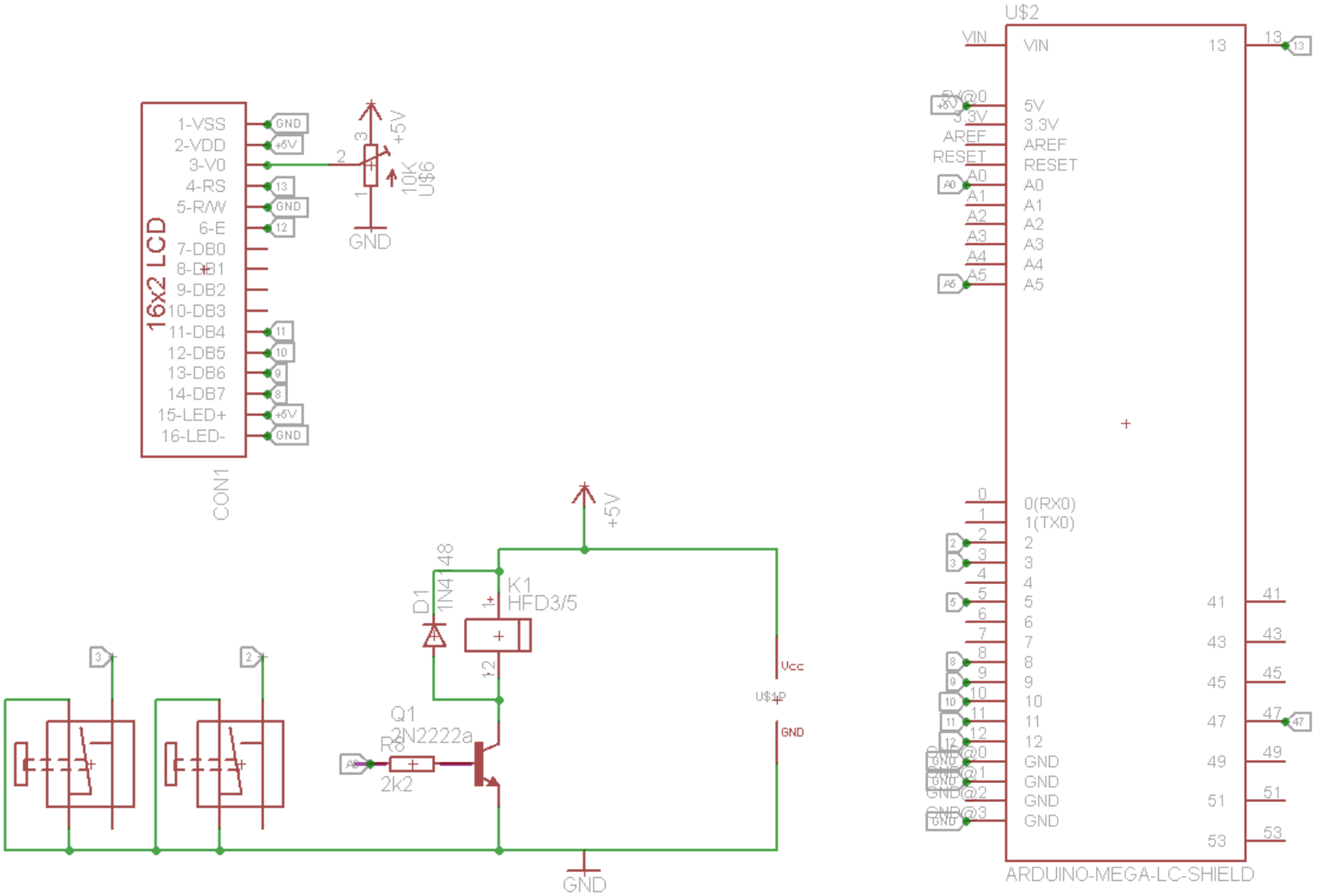
LM393P = Dual Differential Comparitor

$$f_{res} = \frac{1}{2\Pi\sqrt{LC}} = 159\ \text{Khz}$$

C_{ref} is gegeven, L_{ref} wordt berekend

http://www.kerrywong.com/2010/10/16/avr-lc-meter-with-frequency-measurement/
http://langster1980.blogspot.nl/2013/07/arduino-lc-meter-shield.html
http://www.ti.com.cn/cn/lit/ds/symlink/lm393.pdf

L/C-meter shield



De FreqCounter Library

```
//Measure the frequency

 FreqCounter::f_comp=10;   // Calibrate Value
 FreqCounter::start(1000);  // 1000 ms Gate Time

 while (FreqCounter::f_ready == 0);

frq=FreqCounter::f_freq;

lcd.setCursor(0, 0);
lcd.print("Frequency ");
lcd.setCursor(0, 1);
lcd.print(frq);
```

Let op, deze library maakt gebruik van een vast gedefinieerde hardware counter pin.

Arduino UNO: pin 5
Arduino Mega: pin 47

http://interface.khm.de/index.php/lab/experiments/arduino-frequency-counter-library/
http://forum.arduino.cc/index.php?topic=38126.10;wap2 (Mega 2560 patch)

Wat hebben we vanavond gedaan:

- Overzicht van het Arduino eco-system
- Toepassingen voor zendamateurs
- De Arduino IDE (Integrated Development Environment)
- Gebruik van de basis I/O functies
- De serieële monitor

  pauze

- Het gebruik van libraries en de relatie met hardware
- Alfanumierieke LCD aansturen (liquidCrystal library)
- De werking van het L/C shield

Ik wil meer !

Verder aan de slag

http://www.ladyada.net/learn/arduino/index.html

Hardware uitzoeken / kopen

http://www.ladyada.net/learn/arduino/index.html

http://www.pighixxx.com/

https://www.sparkfun.com/

http://www.adafruit.com/

http://www.aliexpress.com/

http://www.banggood.com/

http://www.vanallesenmeer.nl/

http://floris.cc/shop/nl/

Leuker kunnen we het niet maken…

Tabel: Wel of geen belastingen bij invoer betalen?

Waar komen de goederen vandaan?	Waarde van de zending (exclusief verzekerings- en vervoerskosten)	Belastingen bij invoer
Uit een EU-land	Waarde onbeperkt	Geen douanerechten Wel omzetbelasting, u betaalt de omzetbelasting aan de ondernemer van wie u de goederen ontvangt, niet aan de Nederlandse Douane
Uit een niet-EU-land	Tot € 22	Geen douanerechten Geen omzetbelasting
Uit een niet-EU-land	Van € 22 tot € 150	Geen douanerechten Wel omzetbelasting
Uit een niet-EU-land	€ 150 of meer	Wel douanerechten Wel omzetbelasting

Douane
Belastingdienst

http://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/prive/douane/goederen_ontvangen_uit_het_buitenland/van_organisaties_en_bedrijven/moet_ik_belastingen_bij_invoer_betalen_zo_ja_hoe_bereken_ik_dat