

Dag1

Welkom!

Bij de arduino workshop voor beginners



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Welkom

Waar ben ik terecht gekomen

Wie zijn wij :-)



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Welkom

Wie zijn jullie
(kennis en ervaring?)



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Welkom

Huisregels

- Gebruik materieel
- Hapjes/drankjes
- Wifi:
- SSID: Bitlair-5Ghz
- User: guest / Wachtwoord: eurosnoeren
- (Linux: No CA certificate is required)



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Workshop Agenda

Dag 1 - Intro, theorie en kleine digitale projectjes

Dag 2 - Theorie en Analoge projecten

Dag 3 - Optional interfaces



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Agenda Dag1

- Wat zit er in het pakket
- Arduino - Algemeen
 - Theorie
 - Basis kennis programmeren
 - basis theorie elektronica
 - Praktijk



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Wat zit er in het pakket

- Arduino UNO
- Breadboard
- Jumper wires
- - temp sensor
- LDR
- led matrix display
- Servo
- Relais
- PIR
- RGB led 10 mm
- Schakelaars
- piezo speaker
- rode ledjes
- weerstanden 470, 4K7, 10K
- LED ring



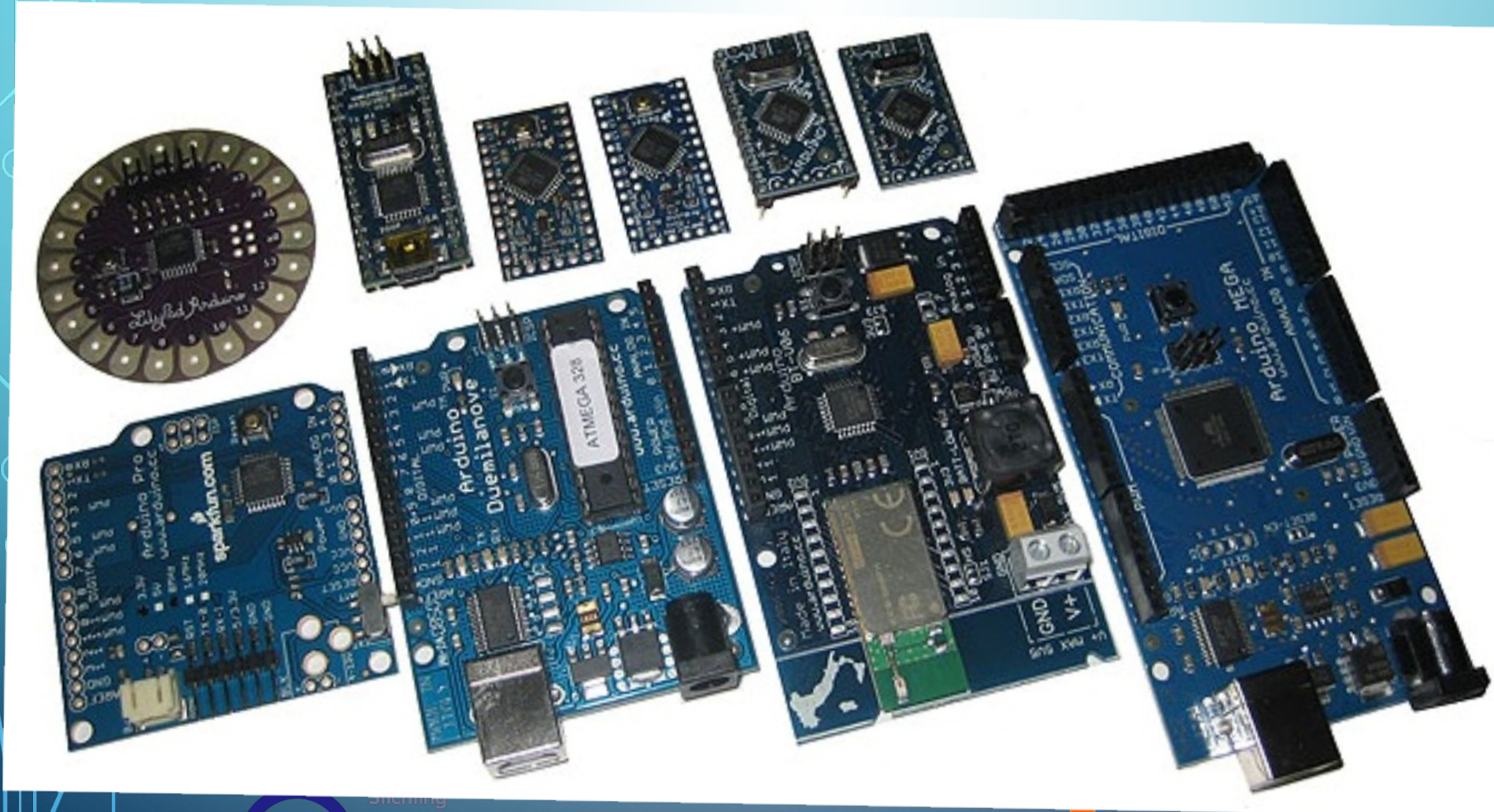
Arduino

- Soorten
- Eigenschappen
- Cheat Sheet
- info op internet
- Installeren arduino omgeving
- Voorbeelden / libraries



Dag1

Arduino (soorten)



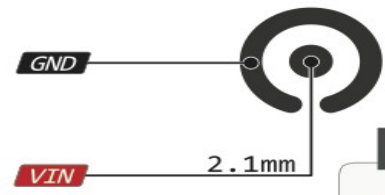
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UNO PINOUT

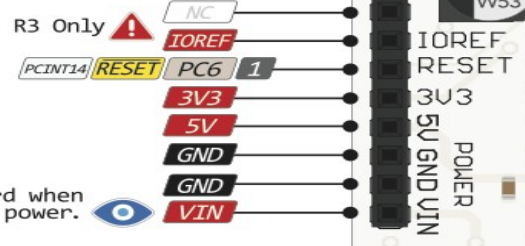
7-12V Depending on current drawn



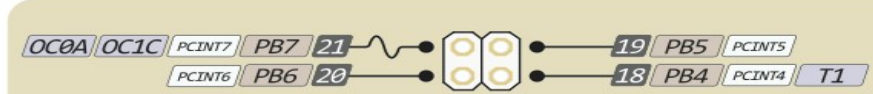
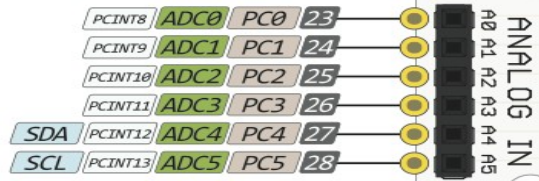
⚠ Absolute MAX per pin 40mA recommended 20mA

⚡ Absolute MAX 200mA for entire package

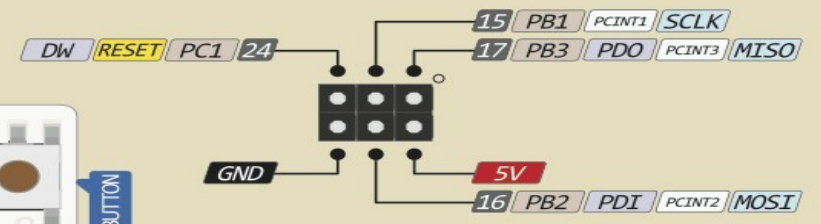
IOREF provides a logic reference voltage for shields that use it. It is connected to the 5V bus.



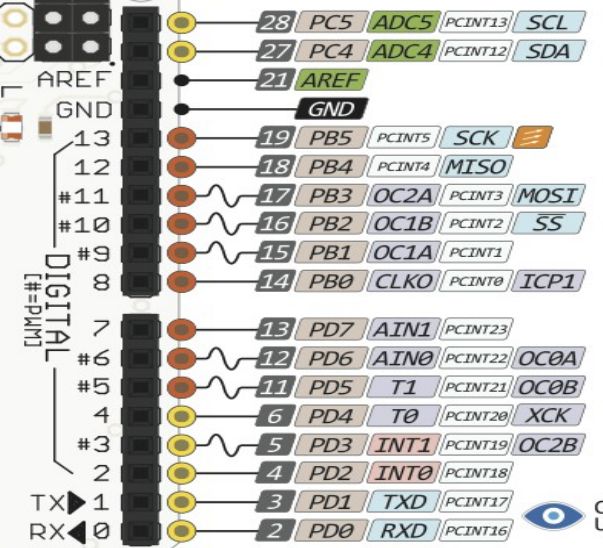
The input voltage to the board when it is running from external power. Not USB bus power.



ATMEGA 82U/16U2 ICSP



Cut to disable autoreset

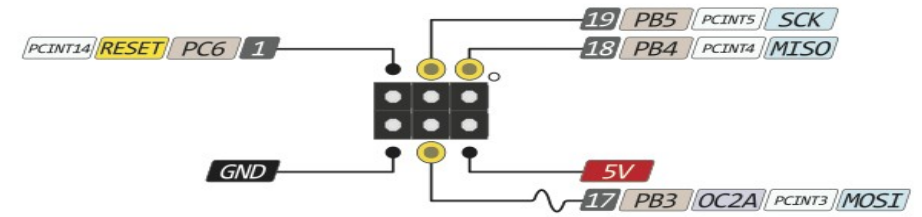


⚠ R3 Only

- Power
- GND
- Serial Pin
- Analog Pin
- Control
- INT
- Physical Pin
- Port Pin
- Pin function
- Interrupt Pin
- PWM Pin
- Port Power

Connected to the ATmega and used for USB program and communicating with it

⚠ The power sum for each pin's group should not exceed 100mA



ARDUINO CHEAT SHEET V.02B

Mostly taken from the extended reference:
<http://arduino.cc/en/Reference/Extended>
 Gavin Smith – Robots and Dinosaurs, The Sydney Hackspace



Structure
 void setup() void loop()

Control Structures

```
if (x<5){ } else { }
switch (myvar) {
  case 1:
    break;
  case 2:
    break;
  default:
}
for (int i=0; i <= 255; i++){ }
while (x<5){ }
do { } while (x<5);
continue; //Go to next in do/for/while loop
return x; // Or 'return;' for voids.
goto // considered harmful :-)
```

Further Syntax

```
// (single line comment)
/* (multi-line comment) */
#define DOZEN 12 //Not baker's!
#include <avr/pgmspace.h>
```

General Operators

```
= (assignment operator)
+ (addition) - (subtraction)
* (multiplication) / (division)
% (modulo)
== (equal to) != (not equal to)
< (less than) > (greater than)
<= (less than or equal to)
>= (greater than or equal to)
&& (and) || (or) ! (not)
```

Pointer Access

```
& reference operator
* dereference operator
```

Bitwise Operators

```
& (bitwise and) | (bitwise or)
^ (bitwise xor) ~ (bitwise not)
<< (bitshift left) >> (bitshift right)
```

Compound Operators

```
++ (increment) -- (decrement)
+= (compound addition)
-= (compound subtraction)
*= (compound multiplication)
/= (compound division)
&= (compound bitwise and)
|= (compound bitwise or)
```

Constants

```
HIGH | LOW
INPUT | OUTPUT
true | false
143 // Decimal number
0173 // Octal number
B11011111 // Binary (8-bits only)
0x7B // Hex number
7U // Force unsigned
10L // Force long
15UL // Force long unsigned
10.0 // Forces floating point
2.4e5 // 245,000
```

Data Types

```
boolean (0, 1, false, true)
char (e.g. 'a' -128 to 127)
unsigned char (0 to 255)
byte (0 to 255)
int (-32,768 to 32,767)
unsigned int (0 to 65535)
word (0 to 65535)
long (-2,147,483,648 to 2,147,483,647)
unsigned long (0 to 4,294,967,295)
float (-3.4028235E+38 to 3.4028235E+38)
double (currently same as float)
sizeof(myint) // returns 2 bytes
```

Strings

```
char S1[15];
char S2[8] = {'a','r','d','u','i','n','o'};
char S3[8] = {'a','r','d','u','i','n','o','\0'};
//Included \0 null termination
char S4[] = "arduino";
char S5[8] = "arduino";
char S6[15] = "arduino";
```

Arrays

```
int myInts[6];
int myPins[] = {2, 4, 8, 3, 6};
int mySensVals[6] = {2, 4, -8, 3, 2};
```

Conversion

```
char() byte()
int() word()
long() float()
```

Qualifiers

```
static // persists between calls
volatile // use RAM (nice for ISR)
const // make read-only
PROGMEM // use flash
```

Digital I/O

```
pinMode(pin, [INPUT,OUTPUT])
digitalWrite(pin, value)
int digitalRead(pin)
//Write High to inputs to use pull-up res
```

Analog I/O

```
analogReference([DEFAULT,INTERNAL,EXTERNAL])
int analogRead(pin) //Call twice if switching pins from high Z source.
analogWrite(pin, value) // PWM
```

Advanced I/O

```
tone(pin, freqhz)
tone(pin, freqhz, duration_ms)
noTone(pin)
shiftOut(dataPin, clockPin, [MSBFIRST,LSBFIRST], value)
unsigned long pulseIn(pin, [HIGH,LOW])
```

Time

```
unsigned long millis() // 50 days overflow.
unsigned long micros() // 70 min overflow
delay(ms)
delayMicroseconds(us)
```

Math

```
min(x, y) max(x, y) abs(x)
constrain(x, minval, maxval)
map(val, fromL, fromH, toL, toH)
pow(base, exponent) sqrt(x)
sin(rad) cos(rad) tan(rad)
```

Random Numbers

```
randomSeed(seed) // Long or int
long random(max)
long random(min, max)
```

Bits and Bytes

```
lowByte() highByte()
bitRead(x,bit) bitWrite(x,bit,bit)
bitSet(x,bit) bitClear(x,bit)
bit(bitn) //bitn: 0-LSB 7-MSB
```

External Interrupts

```
attachInterrupt(interrupt, function, [LOW,CHANGE,RISING,FALLING])
detachInterrupt(interrupt)
interrupts()
noInterrupts()
```

Libraries:

```
Serial.
  begin([300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200])
  end()
  int available()
  int read()
  flush()
  print()
  println()
  write()
```

```
EEPROM (#include <EEPROM.h>)
  byte read(intAddr)
  write(intAddr, myByte)
```

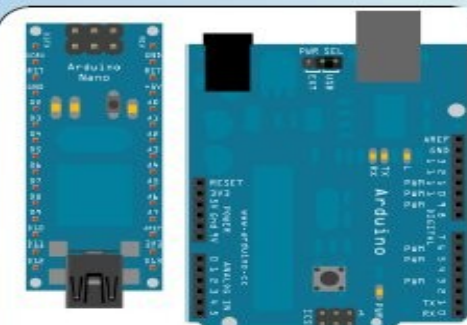
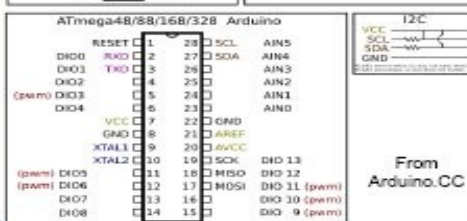
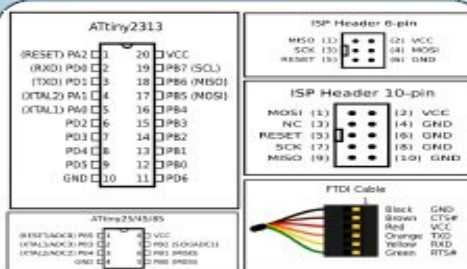
```
Servo (#include <Servo.h>)
  attach(pin, [min_uS, max_uS])
  write(angle) // 0-180
  writeMicroseconds(uS) //1000-2000, 1500 is midpoint
  read() // 0-180
  attached() //Returns boolean
  detach()
```

```
SoftwareSerial(RxPin,TxPin)
// #include <SoftwareSerial.h>
begin(longSpeed) // up to 9600
char read() // blocks till data
print(myData) or println(myData)
```

```
Wire (#include <Wire.h>) // For I2C
begin() // Join as master
begin(addr) // Join as slave @ addr
requestFrom(addr, count)
beginTransmission(addr) // Step 1
send(mybyte) // Step 2
send(char * mystring)
send(byte * data, size)
endTransmission() // Step 3
byte available() // Num of bytes
byte receive() //Return next byte
onReceive(handler)
onRequest(handler)
```

	ATmega168	ATmega328	ATmega1280
Flash (2K for bootloader)	16KB	32KB	128KB
SRAM	1KB	2KB	8KB
EEPROM	512B	1KB	4KB

	Due/milanov/ Nano/ Pro/ ProMini	Mega
# of IO	14 + 6 analog (Nano has 14+8)	54 + 16 analog
Serial Pins	0 - RX 1 - TX	0 - RX1 1 - TX1 19 - RX2 18 - TX2 17 - RX3 16 - TX3 15 - RX4 14 - TX4
Ext interrupts	2 - (Int 0) 3 - (Int 1)	2,3,21,20,19,18 (IRQ0- IRQ5)
PWM pins	5,6 - Timer 0 9,10 - Timer 1 3,11 - Timer 2	0-13 53 - SS 51 - MOSI 50 - MISO 52 - SCK 20 - SDA 21 - SCL
SPI	10 - SS 11 - MOSI 12 - MISO 13 - SCK	
I2C	Analog4 - SDA Analog5 - SCL	



Pics from Fritzing.Org under C.C. license

Installeren arduino omgeving

- Installeer software
arduino.cc ==> Download
- Bord kiezen
Arduino/Genuino Uno
- Driver <http://sparks.gogo.co.nz/ch340.html>
- Poort kiezen
windows device manager (devmgmt.msc)
linux /dev/ttyUSBx
 /dev/ttyACMx
apple/peer
 /dev/cu.usbmodem1421 (Arduino/Genuino
Uno)



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Voorbeelden / libraries

Open Arduino

Gebruik voorbeelden

Open File-Examples

Gebruik libraries

Open Sketch – Include Library



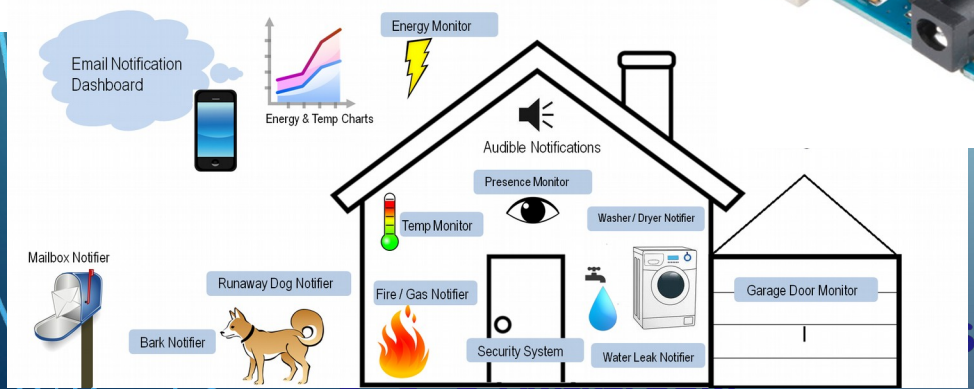
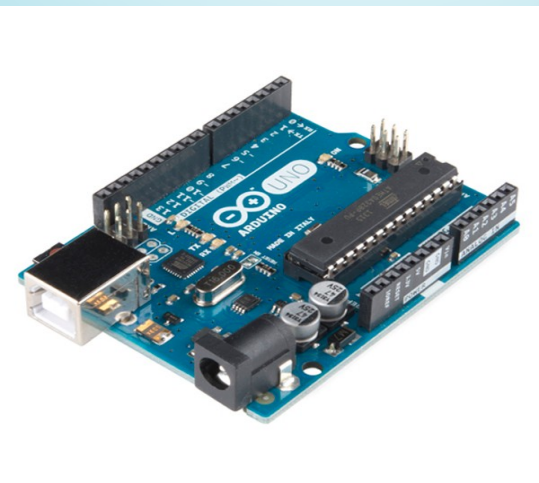
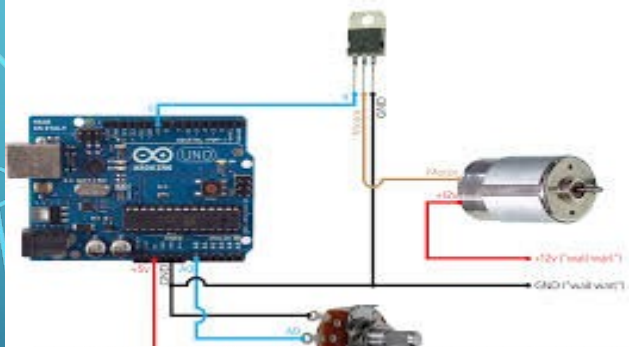
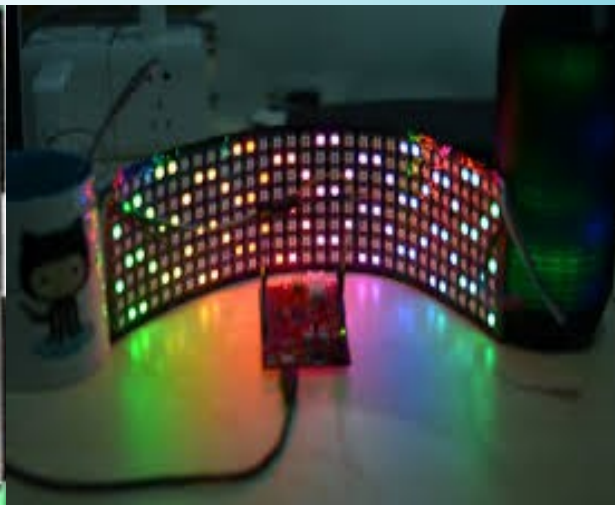
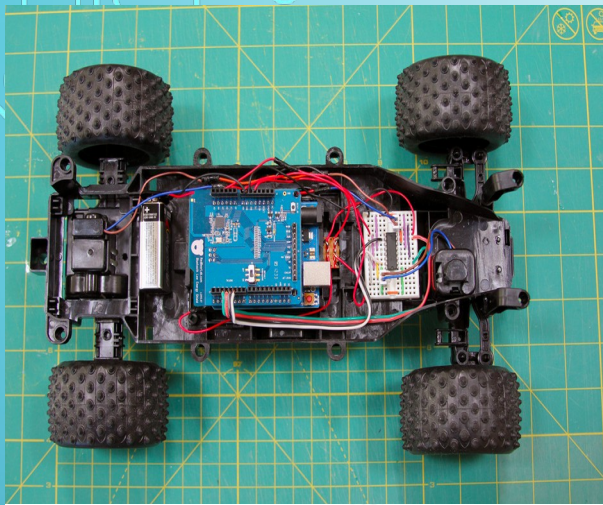
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Dag1



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Programmeren

Globale variabelen declareren

Constanten declareren

```
void setup()
{
  ...
}
void loop()
{
  ...
}
```



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Variabelen

int	geheel getal	-32,768 tot 32,767
long	geheel getal	-2,147,483,648 tot 2,147,483,647
float	reëel getal	+/-3.4028235E+38 (6-7 getallen nauwkeurigheid)
char	karakter	bijv: 'a', '-', '('
[]	array	bijv: int getallen[3]; int getallen[] = {1, 2, 3, 4};
"string"	char array	bijv: char s[20]; char s[] = "hallo"; // lengte = 6 !!



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Constanten

Naam: Traditioneel met hoofdletters gescheiden door underscores '_'.
Bijv. uit de Arduino omgeving:

HIGH, LOW, INPUT, OUTPUT, INPUT_PULLUP, LED_BUILTIN

Zelf definiëren:

```
#define <naam> <waarde>
```

Bijv:

```
#define PIN_LED1 9
```

```
#define PIN_LED2 12
```

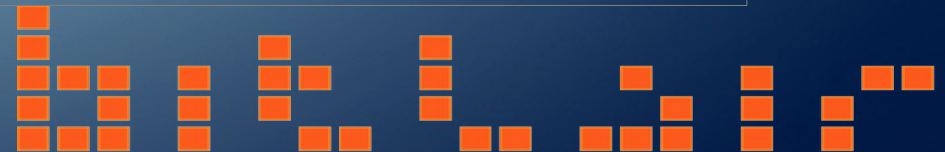
```
#define STR_LEN_MAX 20
```



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Functies

Belangrijke standaard functies:

`pinMode(pin, mode)`

`delay(ms)`

`millis()`

`digitalRead(pin)` // resultaat: HIGH of LOW

`digitalWrite(pin, waarde)`

`analogRead(pin)` // resultaat: 0 - 1023

`analogWrite(pin, waarde)` // waarde: 0 - 255, pin: 3, 5, 6, 9, 10, 11

`random()`



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Functies

Definieer een blok code en geef het een naam zodat deze meerdere keren gebruikt kan worden.

```
void func1(int p1, int p2)
{
}

int func2(int p1)
{
    return p1 * 2;
}
```



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If ... then ... else ...

Voer code uit als conditie 'cond' waar is en anders ...

```
if (cond)
```

```
{
```

```
}
```

```
else
```

```
{
```

```
}
```



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If ... then ... else ...

Condities:

$x == y$ (x is equal to y)

$x != y$ (x is not equal to y)

$x < y$ (x is less than y)

$x > y$ (x is greater than y)

$x <= y$ (x is less than or equal to y)

$x >= y$ (x is greater than or equal to y)



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If ... then ... else ...

```
if (cond1)
{ ... }
else if (cond2)
{ ... }
else if (cond3)
{ ... }
else
{ ... }
```



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For loop

Herhaal de volgende code een aantal keer

```
for (i = 0; i < 10; i++) { ... }
```

ophogen

```
i++
```

```
i = i + 1
```

```
i++, j++
```

```
i = i + x
```

voortijdig afbreken: break

meteen volgende: continue



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While loop

Herhaal code zolang conditie 'cond' waar is

```
while (cond) { ... }
```

voortijdig afbreken: `break`

meteen volgende: `continue`



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Commentaar

```
// Dit is commentaar op 1 regel
```

```
/* Dit is commentaar  
   op meerdere  
   regels  
*/
```



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Elektronica

- Weerstand
- LED (diode)
- Breadboard



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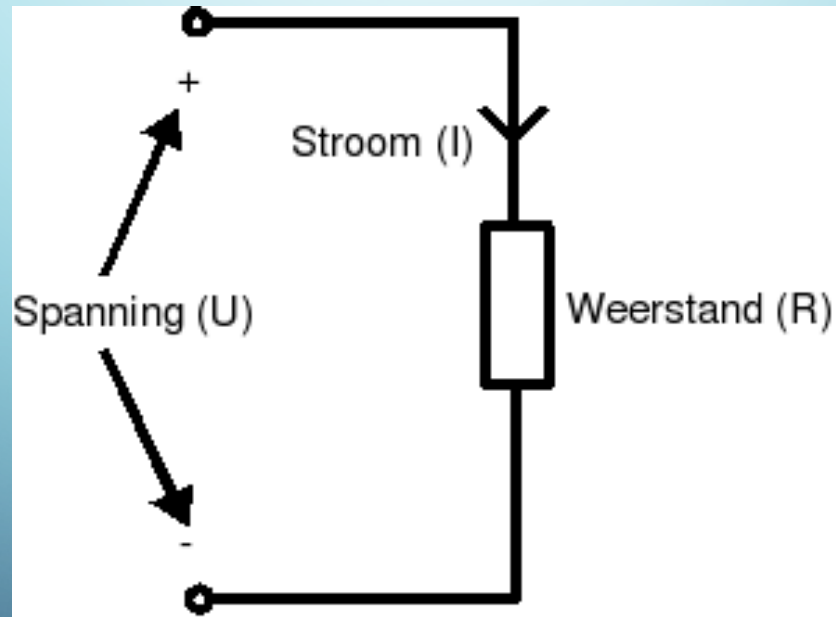
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Dag1

Weerstand

- Spanning
- Stroom
- Weerstand



■ zwart 0	■ groen 5
■ bruin 1	■ blauw 6
■ rood 2	■ paars 7
■ oranje 3	■ grijs 8
■ geel 4	□ wit 9

ring 1 = cijfer
ring 2 = cijfer
ring 3 = aantal nullen



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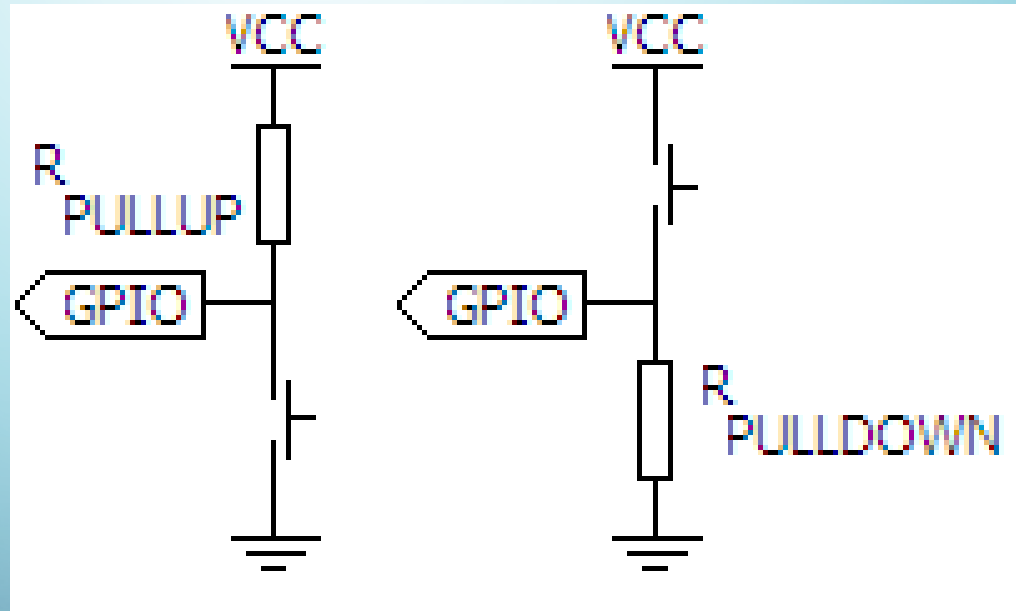
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Dag 1

Weerstand

- Pull-up
- Pull-down
-
- Interne pull-up



Weerstanden waarom hoog en laag

LED 470 Ohm -> datasheet

Digitaal 10.000 Ohm (10k Ohm) -> tussen 10k en 100k

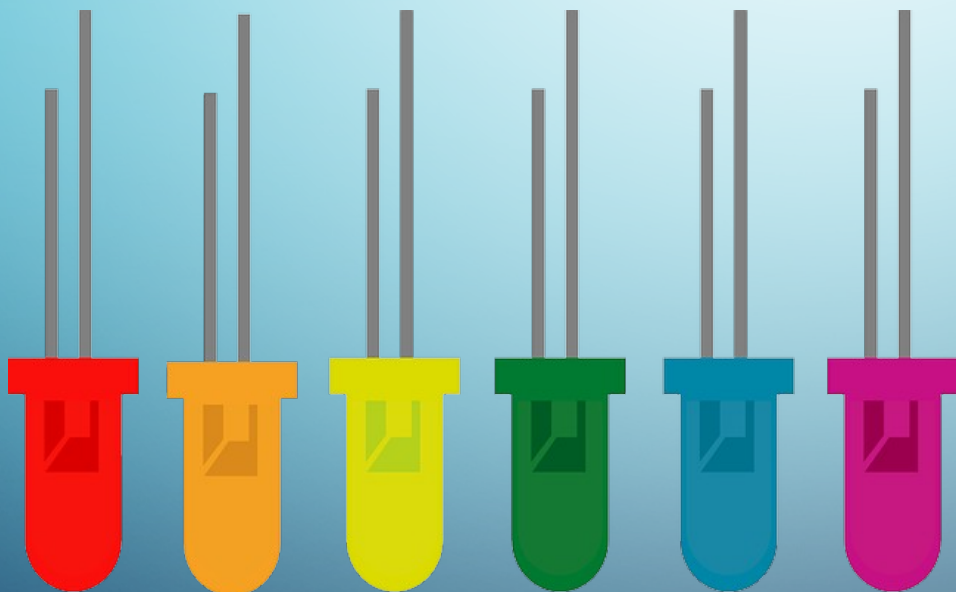
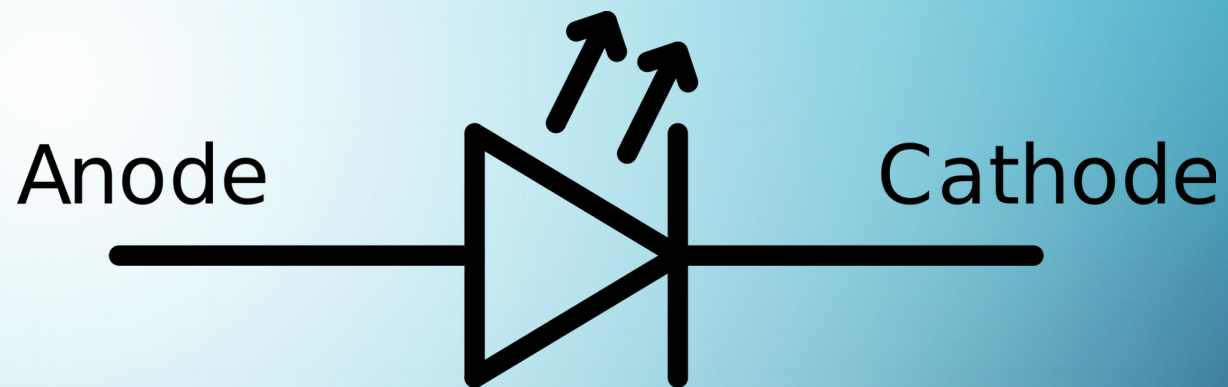
Temperatuur sensor 4700 Ohm (4k7) -> datasheet



Dag1

LED (diode)

- Éénrichtingsverkeer
-
-
-



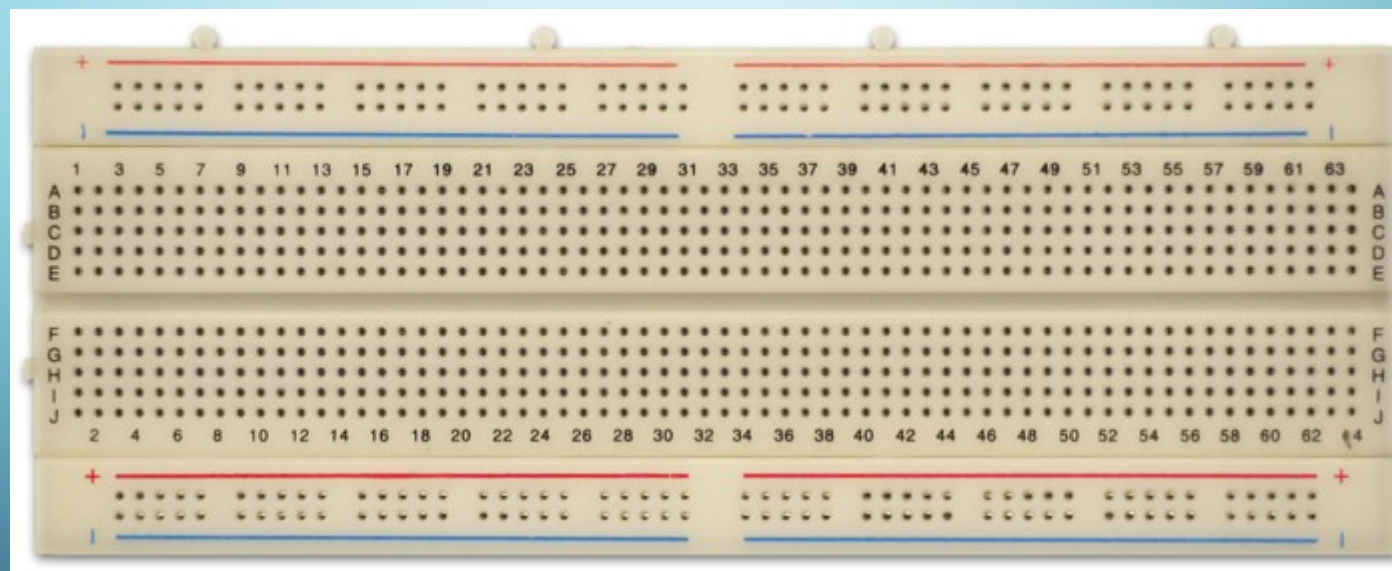
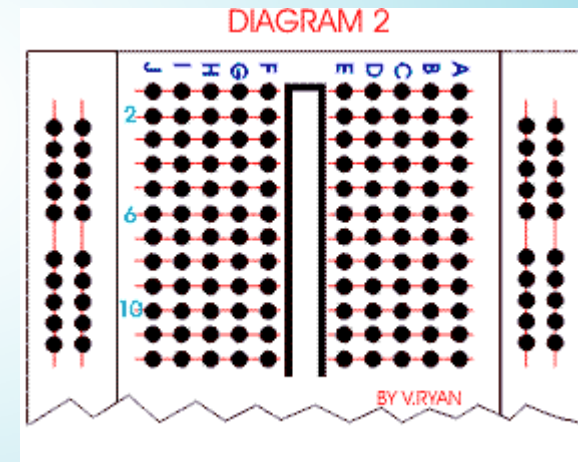
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Breadboard



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Oefeningen



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Dag2

Welkom!

Bij de arduino workshop voor beginners Dag 2



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Dag2

Workshop Agenda

Dag 1 – Intro, theorie en kleine digitale projectjes

Dag 2 – Theorie en Analoge projecten

Dag 3 – Optional interfaces



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Dag2

Agenda Dag2

- Hoe liep dag 1
- Correcties?
- Vragen dag1?
- Functies
- PWM
- Oefeningen



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Hoe liep dag 1

- Huiswerk?
- Wie heeft wat vorige week gedaan
- Vragen n.a.v. Vorige week
- nieuwe ideeën



Dag2

Correcties?



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Dag2

vragen van dag1?



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Builtin constants (arduino.h)

```
#define HIGH 0x1  
#define LOW 0x0
```

```
#define INPUT 0x0  
#define OUTPUT 0x1  
#define INPUT_PULLUP 0x2
```

```
#define PI 3.1415926535897932384626433832795  
#define HALF_PI 1.5707963267948966192313216916398  
#define TWO_PI 6.283185307179586476925286766559  
#define DEG_TO_RAD  
0.017453292519943295769236907684886  
#define RAD_TO_DEG  
57.295779513082320876798154814105  
#define EULER 2.718281828459045235360287471352
```

```
#define SERIAL 0x0  
#define DISPLAY 0x1
```

```
#define LSBFIRST 0  
#define MSBFIRST 1
```



Builtin constants (binary.h)

```
#define B0 0
#define B00 0
#define B000 0
#define B0000 0
#define B00000 0
#define B000000
0
#define B0000000
0
#define
B00000000 0
#define B1 1
#define B01 1
#define B001 1
#define B0001 1
#define B00001 1
#define B000001
1
#define B0000001
1
#define
B00000001 1
#define B10 2
#define B010 2
#define B0010 2
#define B00010 2
#define B000010
2
#define B0000010
2
```



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Mostly taken from the extended reference:
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 Gavin Smith – Robots and Dinosaurs, The Sydney Hackspace



Structure
 void setup() void loop()

Control Structures

```
if (x<5){ } else { }
switch (myvar) {
  case 1:
    break;
  case 2:
    break;
  default:
}
for (int i=0; i <= 255; i++){ }
while (x<5){ }
do { } while (x<5);
continue; //Go to next in do/for/while loop
return x; // Or 'return;' for voids.
goto // considered harmful :-)
```

Further Syntax

```
// (single line comment)
/* (multi-line comment) */
#define DOZEN 12 //Not baker's!
#include <avr/pgmspace.h>
```

General Operators

```
= (assignment operator)
+ (addition) - (subtraction)
* (multiplication) / (division)
% (modulo)
== (equal to) != (not equal to)
< (less than) > (greater than)
<= (less than or equal to)
>= (greater than or equal to)
&& (and) || (or) ! (not)
```

Pointer Access

```
& reference operator
* dereference operator
```

Bitwise Operators

```
& (bitwise and) | (bitwise or)
^ (bitwise xor) ~ (bitwise not)
<< (bitshift left) >> (bitshift right)
```

Compound Operators

```
++ (increment) -- (decrement)
+= (compound addition)
-= (compound subtraction)
*= (compound multiplication)
/= (compound division)
&= (compound bitwise and)
|= (compound bitwise or)
```

Constants

```
HIGH | LOW
INPUT | OUTPUT
true | false
143 // Decimal number
0173 // Octal number
B11011111 // Binary (8-bits only)
0x7B // Hex number
7U // Force unsigned
10L // Force long
15UL // Force long unsigned
10.0 // Forces floating point
2.4e5 // 245,000
```

Data Types

```
boolean (0, 1, false, true)
char (e.g. 'a' -128 to 127)
unsigned char (0 to 255)
byte (0 to 255)
int (-32,768 to 32,767)
unsigned int (0 to 65535)
word (0 to 65535)
long (-2,147,483,648 to 2,147,483,647)
unsigned long (0 to 4,294,967,295)
float (-3.4028235E+38 to 3.4028235E+38)
double (currently same as float)
sizeof(myint) // returns 2 bytes
```

Strings

```
char S1[15];
char S2[8] = {'a','r','d','u','i','n','o'};
char S3[8] = {'a','r','d','u','i','n','o','\0'};
//Included \0 null termination
char S4[] = "arduino";
char S5[8] = "arduino";
char S6[15] = "arduino";
```

Arrays

```
int myInts[6];
int myPins[] = {2, 4, 8, 3, 6};
int mySensVals[6] = {2, 4, -8, 3, 2};
```

Conversion

```
char() byte()
int() word()
long() float()
```

Qualifiers

```
static // persists between calls
volatile // use RAM (nice for ISR)
const // make read-only
PROGMEM // use flash
```

Digital I/O

```
pinMode(pin, [INPUT,OUTPUT])
digitalWrite(pin, value)
int digitalRead(pin)
//Write High to inputs to use pull-up res
```

Analog I/O

```
analogReference([DEFAULT,INTERNAL,EXTERNAL])
int analogRead(pin) //Call twice if switching pins from high Z source.
analogWrite(pin, value) // PWM
```

Advanced I/O

```
tone(pin, freqhz)
tone(pin, freqhz, duration_ms)
noTone(pin)
shiftOut(dataPin, clockPin, [MSBFIRST,LSBFIRST], value)
unsigned long pulseIn(pin, [HIGH,LOW])
```

Time

```
unsigned long millis() // 50 days overflow.
unsigned long micros() // 70 min overflow
delay(ms)
delayMicroseconds(us)
```

Math

```
min(x, y) max(x, y) abs(x)
constrain(x, minval, maxval)
map(val, fromL, fromH, toL, toH)
pow(base, exponent) sqrt(x)
sin(rad) cos(rad) tan(rad)
```

Random Numbers

```
randomSeed(seed) // Long or int
long random(max)
long random(min, max)
```

Bits and Bytes

```
lowByte() highByte()
bitRead(x,bit) bitWrite(x,bit,bit)
bitSet(x,bit) bitClear(x,bit)
bit(bitn) //bitn: 0-LSB 7-MSB
```

External Interrupts

```
attachInterrupt(interrupt, function, [LOW,CHANGE,RISING,FALLING])
detachInterrupt(interrupt)
interrupts()
noInterrupts()
```

Libraries:

```
Serial.
  begin([300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200])
  end()
  int available()
  int read()
  flush()
  print()
  println()
  write()
```

```
EEPROM (#include <EEPROM.h>)
  byte read(intAddr)
  write(intAddr, myByte)
```

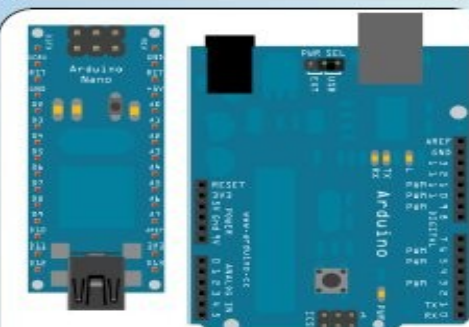
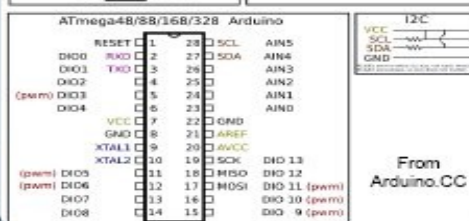
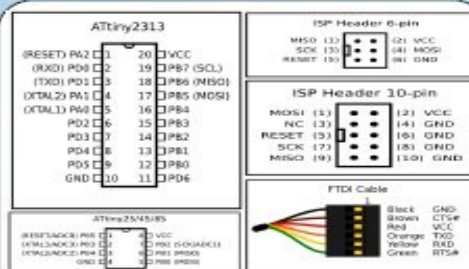
```
Servo (#include <Servo.h>)
  attach(pin, [min_uS, max_uS])
  write(angle) // 0-180
  writeMicroseconds(uS) //1000-2000, 1500 is midpoint
  read() // 0-180
  attached() //Returns boolean
  detach()
```

```
SoftwareSerial(RxPin,TxPin)
// #include<SoftwareSerial.h>
begin(longSpeed) // up to 9600
char read() // blocks till data
print(myData) or println(myData)
```

```
Wire (#include <Wire.h>) // For I2C
begin() // Join as master
begin(addr) // Join as slave @ addr
requestFrom(address, count)
beginTransmission(addr) // Step 1
send(mybyte) // Step 2
send(char * mystring)
send(byte * data, size)
endTransmission() // Step 3
byte available() // Num of bytes
byte receive() //Return next byte
onReceive(handler)
onRequest(handler)
```

	ATmega168	ATmega328	ATmega1280
Flash (2K for bootloader)	16KB	32KB	128KB
SRAM	1KB	2KB	8KB
EEPROM	512B	1KB	4KB

	Due/milanov/ Nano/ Pro/ ProMini	Mega
# of IO	14 + 6 analog (Nano has 14+8)	54 + 16 analog
Serial Pins	0 - RX 1 - TX	0 - RX1 1 - TX1 19 - RX2 18 - TX2 17 - RX3 16 - TX3 15 - RX4 14 - TX4
Ext interrupts	2 - (Int 0) 3 - (Int 1)	2,3,21,20,19,18 (IRQ0- IRQ5)
PWM pins	5,6 - Timer 0 9,10 - Timer 1 3,11 - Timer 2	0-13 53 - SS 51 - MOSI 50 - MISO 52 - SCK 20 - SDA 21 - SCL
SPI	10 - SS 11 - MOSI 12 - MISO 13 - SCK	
I2C	Analog4 - SDA Analog5 - SCL	



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Functies

Definieer een blok code en geef het een naam zodat deze meerdere keren gebruikt kan worden.

```
void func1(int p1, int p2)
{
}

int func2(int p1)
{
    return p1 * 2;
}
```



Functies - gebruik

```
int getal;  
getal = gemiddelde(5,6,8);  
.....  
getal = gemiddelde(1,4,5);  
.....  
getal = gemiddelde(9,3,3);
```



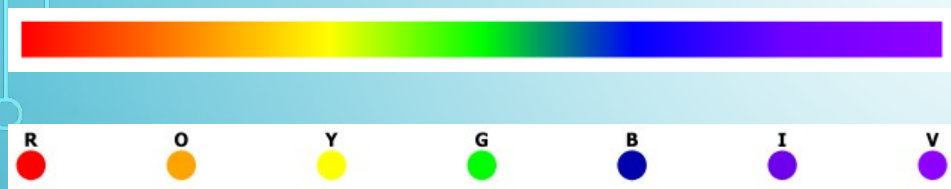
Functies - gebruik

```
int getal;  
getal = gemiddelde(5,6,8);  
.....  
getal = gemiddelde(1,4,5);  
.....  
getal = gemiddelde(9,3,3);
```

```
int function gemiddelde(int a,int  
b,int c)  
{ int resultaat = (a+b+c)/3;  
  return resultaat;  
}
```

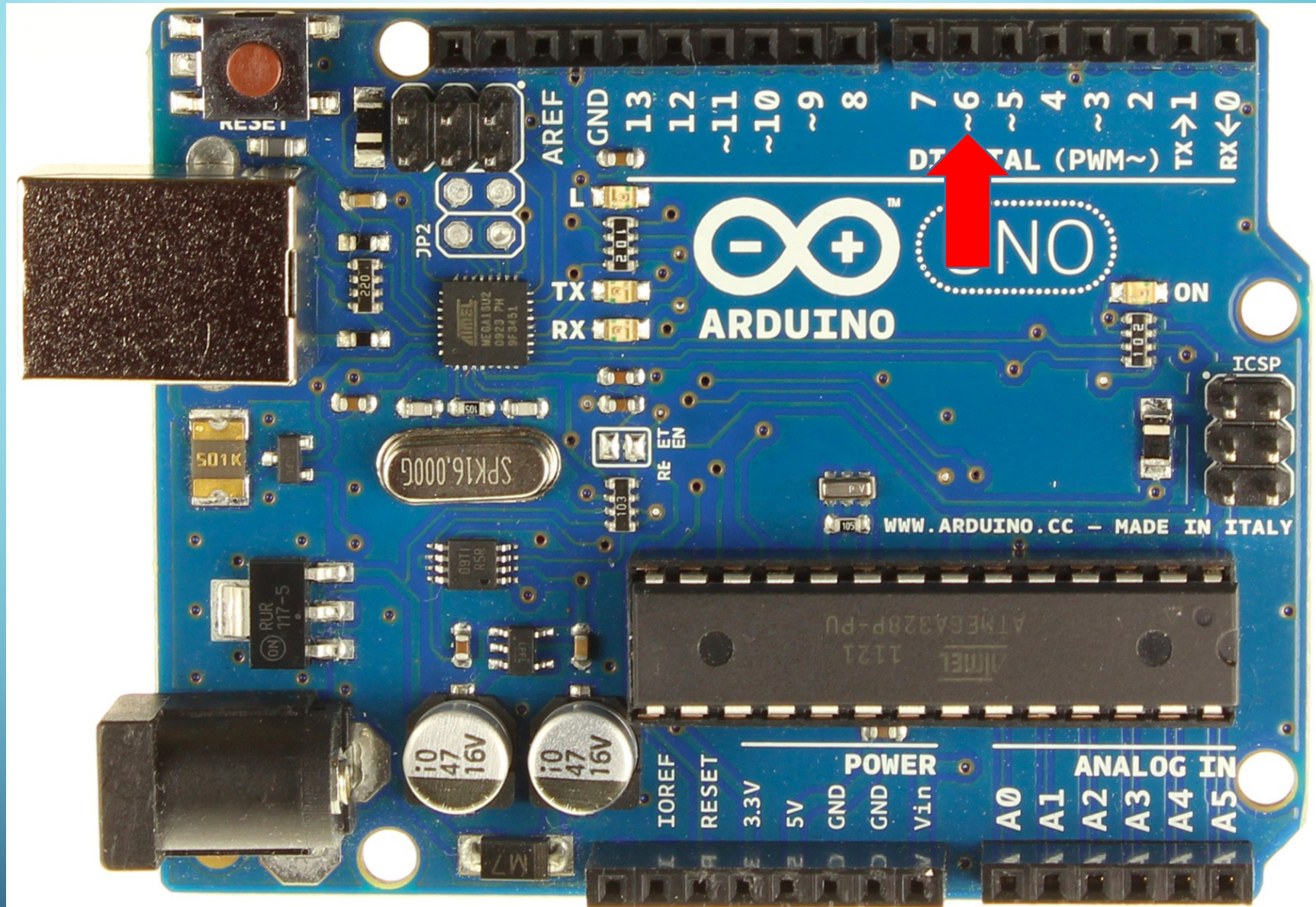


PWM - RGB mengen



Dag2

PWM



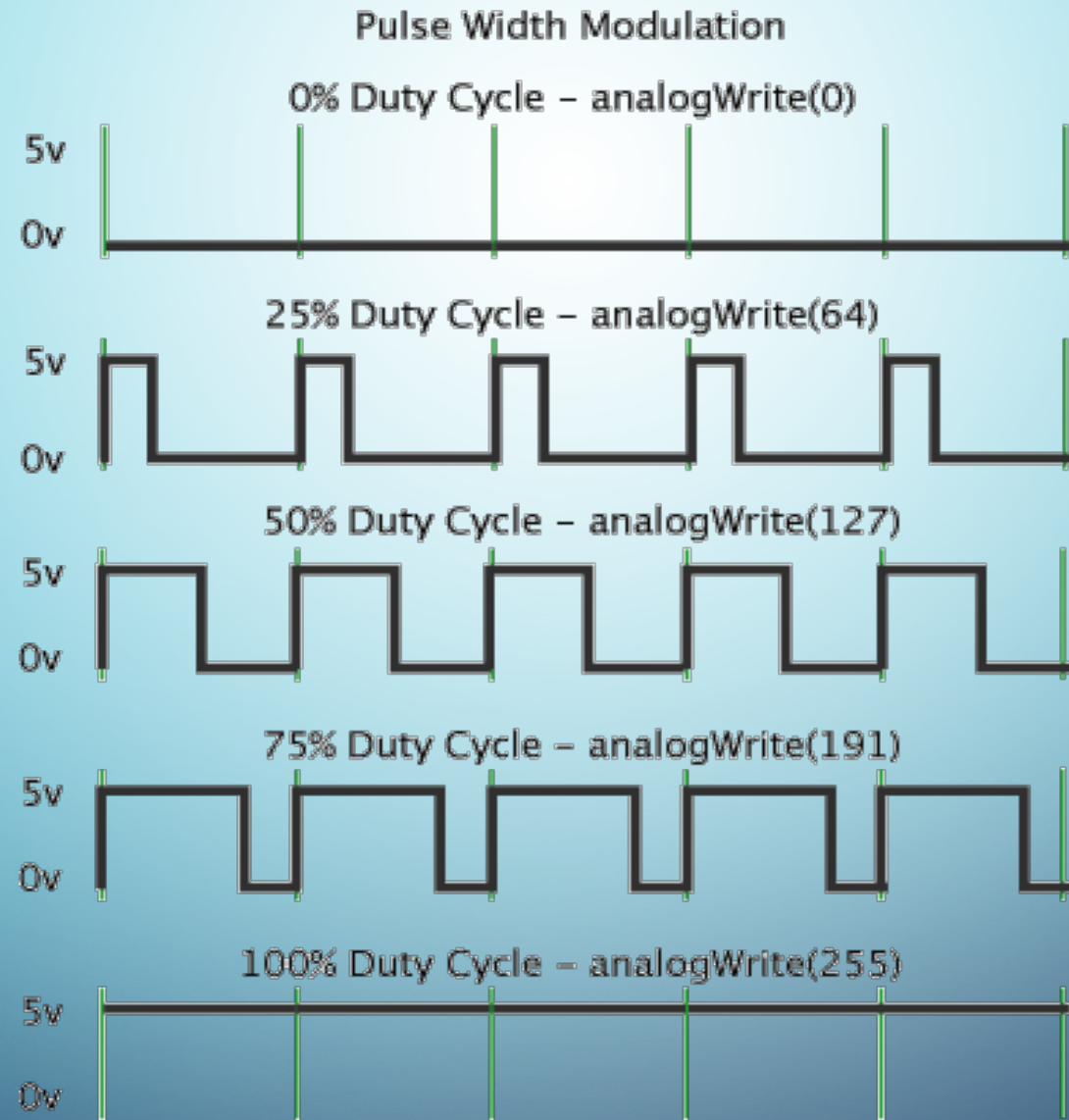
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PWM

(Super blink)



Dag2

Oefeningen



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Dag 3

Welkom!

Bij de arduino workshop voor beginners Dag 3



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Dag 3

Workshop Agenda

Dag 1 – Intro, theorie en kleine digitale projectjes

Dag 2 – Theorie en Analoge projecten

Dag 3 – Optional interfaces



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Agenda Dag 3

- Hoe liep dag 2
- Correcties?
- Vragen?
- herhaling dag 2
- I2C/SPI/OneWire/Serial
- Oefeningen



Dag 3

Correcties?



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Dag 3

vragen van dag 2?

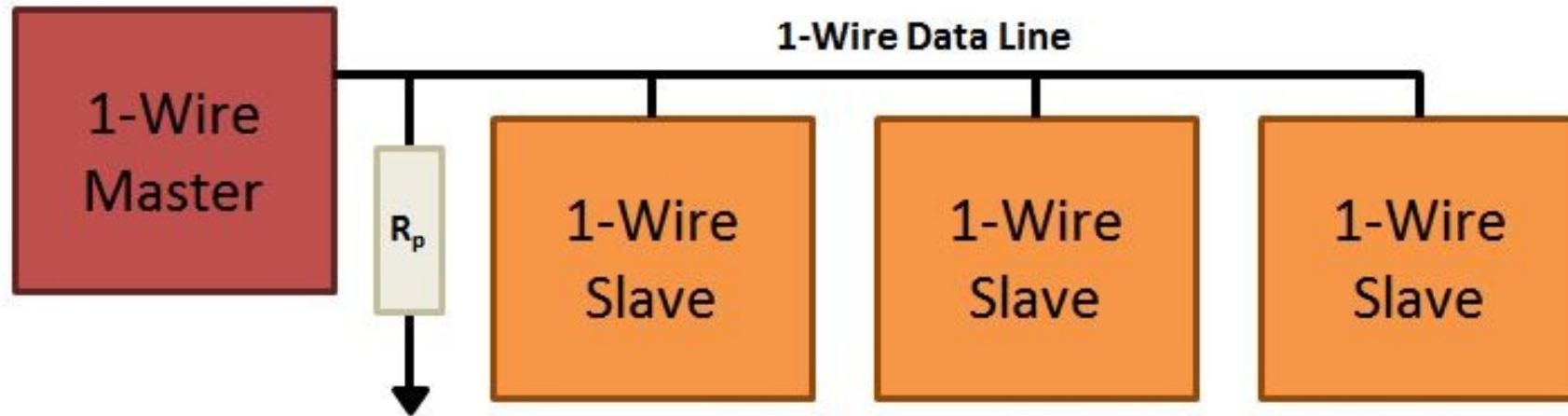


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I2C/SPI/OneWire/Serial



- **1-Wire Data line** is the master data output, slave data input, and it carries data from the master to the slave.
- R_p are 4.7K pull-up resistor
- Slave address by unique 64-bit code, consisting of an 8-bit family code, a 48-bit serial number, and an 8-bit CRC.



Dag 3

Oefeningen



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Dag 3

Afsluiting

- Hoe liep dag 3?
- Wat na dag 3?



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Dag 3

Extra oefeningen

Communiceren, bijv. WeMos Mqtt

Motoren etc.



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