



# BIO PROZESSTECHNIK

## Messen- und Regeln in der Biotechnologie

Reglerprogrammierung / Ergänzung  
010\_002



### Westfälische Hochschule - Standort Recklinghausen - Sommersemester 2016



# PID - Workspace



# Mikrocontroller – Arduino UNO

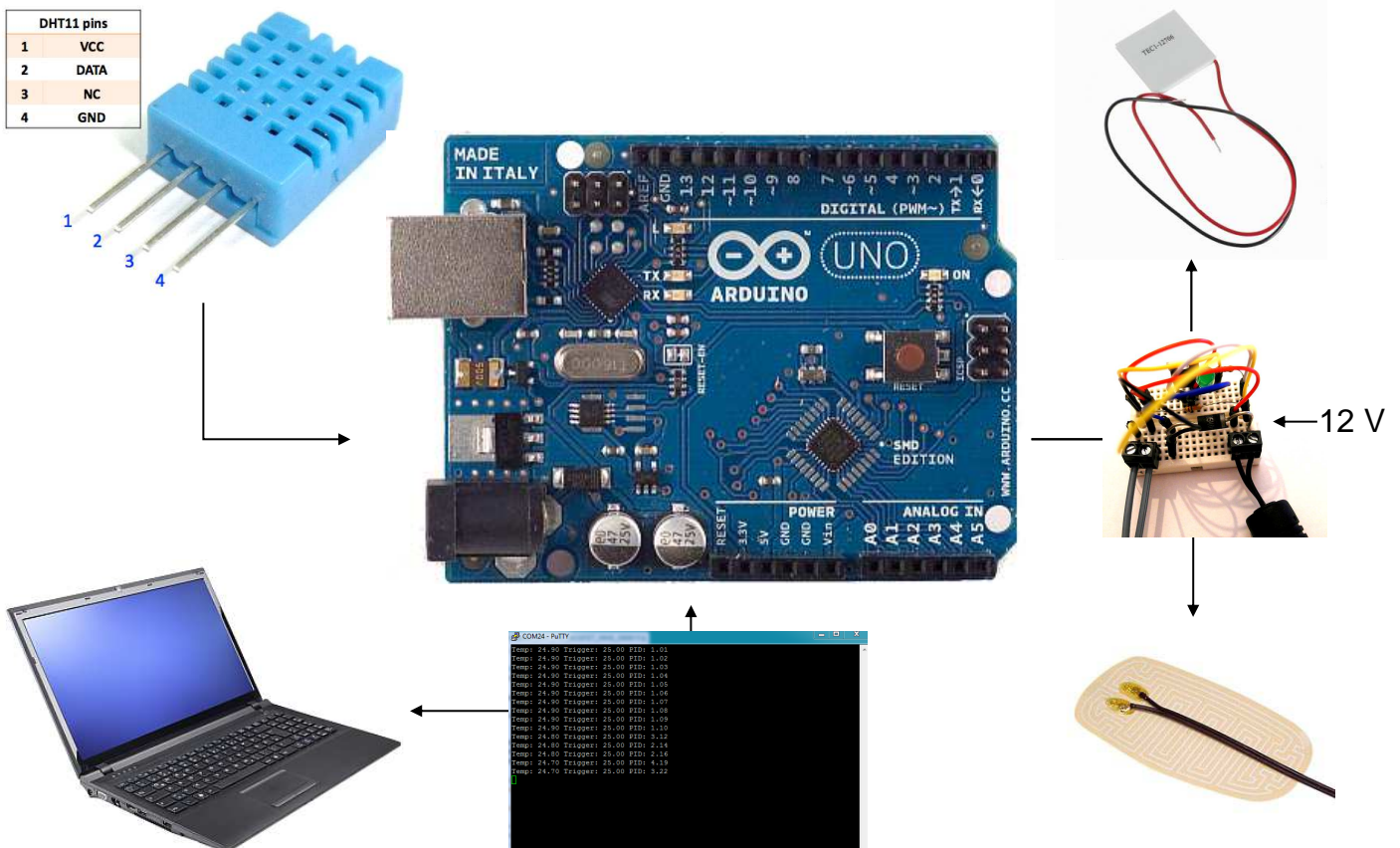
## Technical specs

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g



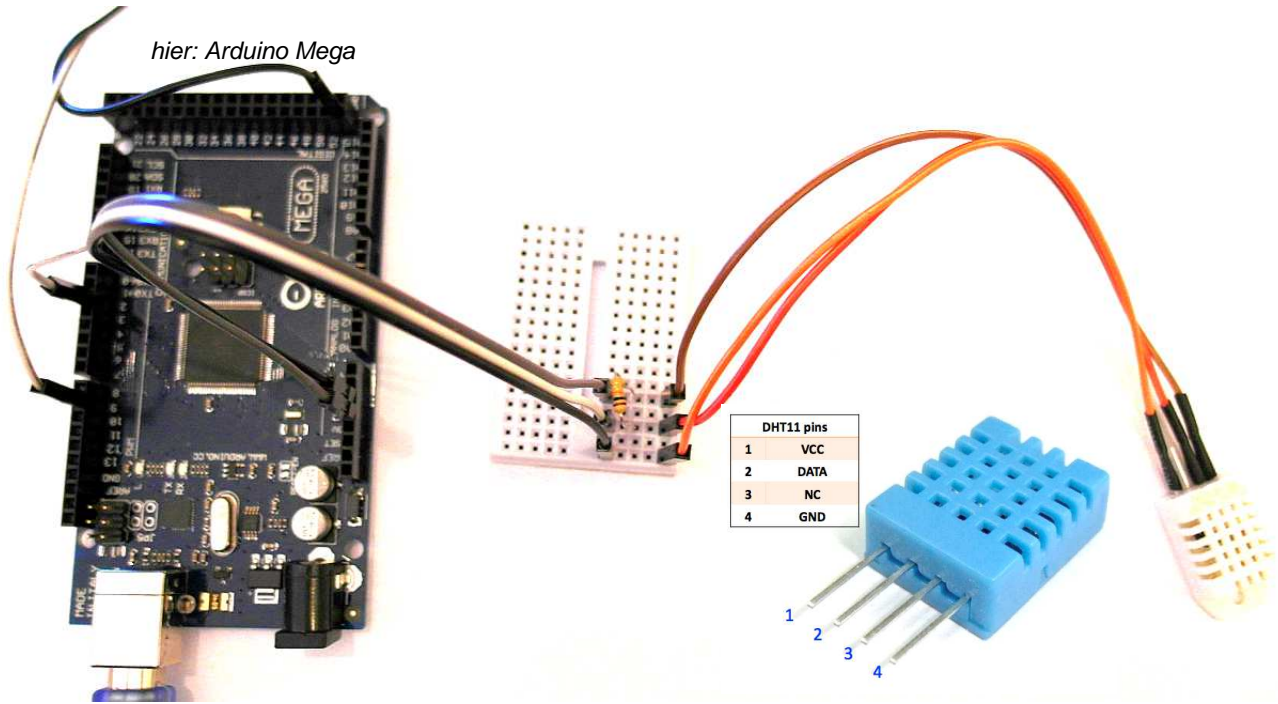
# Aufbau

DHT11 pins	
1	VCC
2	DATA
3	NC
4	GND



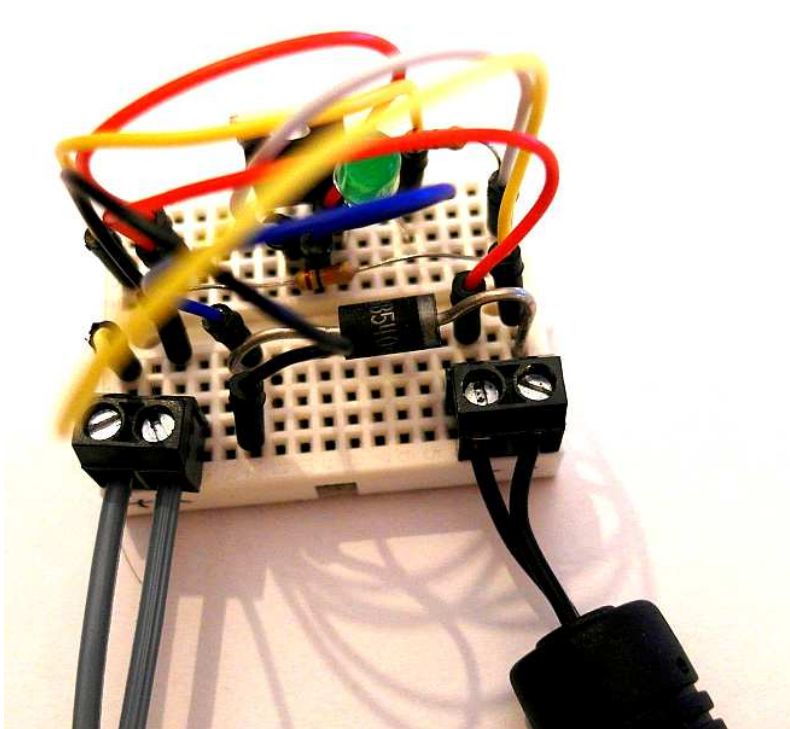


# Verbindung: Thermometer (DHT 22)



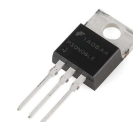
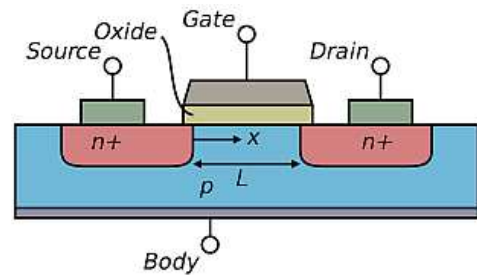
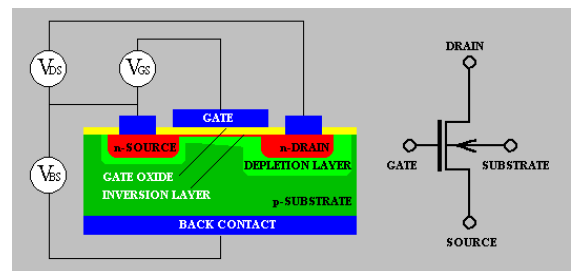
Arduino <-> DHT 11  
 GND <-> GND (4)  
 Pin 2 <-> Data (2) 10 k Ohm  
 5 V <-> VCC

# MOSFet-Schaltung



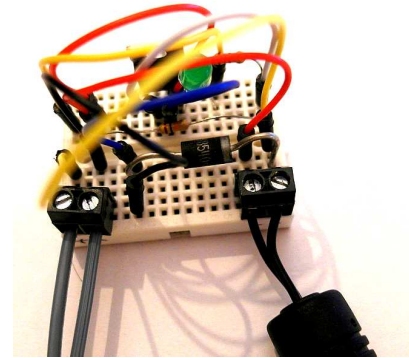
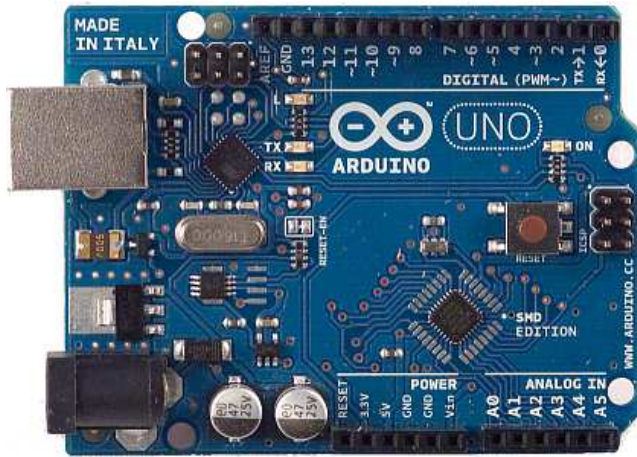
Peltier  
Heizelement

12 V



IRLZ44N

# Verbindung: MOSFET – Peltier/Heizelement



Arduino <-> MOSFET  
GND <-> GND (4)  
Pin 9 <-> I(nput)

# Arduino-IDE / Putty (serielle Kommunikation)

```

..._10594_DHT16M_DHT_PID_MOSFET_PID_000455
//Feb 052214 - mit DHT 22 und PID-Steuerung

#include "DHT.h"
#include <PID_v1.h>

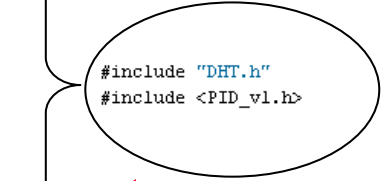
//DHT DHT16M, Input, Output;
DHT dht(DHT16M, 2, DIRECT);

//PID
PID myPID(4, input, 4, output, 10, 1, 1, DIRECT);

void setup() {
  Serial.begin(9600);
  dht.begin();
  float t = dht.readTemperature();
  float h = dht.readHumidity();
  float f = dht.readFahrenheit();
  output = 25.0;
  myPID.setMode(AUTOMATIC);
}

void loop() {
  delay(2000);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float f = dht.readFahrenheit(t);
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  Serial.print("Temp: ");
  Serial.print(t);
  Serial.print(" ");
  Serial.print(h);
  Serial.print(" ");
  Serial.print("F:");
  Serial.print(f);
  Serial.print(" ");
  Serial.print(output);
}

```



```

COM24 - PuTTY
Temp: 24.90 Trigger: 25.00 PID: 1.01
Temp: 24.90 Trigger: 25.00 PID: 1.02
Temp: 24.90 Trigger: 25.00 PID: 1.03
Temp: 24.90 Trigger: 25.00 PID: 1.04
Temp: 24.90 Trigger: 25.00 PID: 1.05
Temp: 24.90 Trigger: 25.00 PID: 1.06
Temp: 24.90 Trigger: 25.00 PID: 1.07
Temp: 24.90 Trigger: 25.00 PID: 1.08
Temp: 24.90 Trigger: 25.00 PID: 1.09
Temp: 24.90 Trigger: 25.00 PID: 1.10
Temp: 24.80 Trigger: 25.00 PID: 3.12
Temp: 24.80 Trigger: 25.00 PID: 2.14
Temp: 24.80 Trigger: 25.00 PID: 2.14
Temp: 24.70 Trigger: 25.00 PID: 4.19
Temp: 24.70 Trigger: 25.00 PID: 3.22

```

Library EINBINDEN

# Library Einbindung

R:\006\_arduino\Arduino

Name ↑ Größe Geändert

- drivers
- examples
- hardware
- java
- lib
- libraries
- reference
- tools
- arduino.exe
- cygconv-2.dll
- cygwin1.dll
- libusb0.dll
- revisions.txt
- rxSerial.dll
- uninstall.exe

R:\100\_Store\009\_FH\_Paket\_090615\libraries

Name ↑

- ..
- DHT
- PID\_v1

Tools: Datei Bearbeiten Sketch Tools Hilfe

Tools: Add Library... Adafuit\_GFX Adafuit\_ST7735 AF arduinoappmaster DHT DHT\_old ESP8266 Esp8266 Ethernet Firmata GSM Keypad LiquidCrystal LiquidCrystal\_LDC LiquidCrystal\_old modbusino NewSoftSerial PID\_v1 phy4 ethernet PCwitch Robot\_Motor SD Servo SSI145 SoftwareSerial SPI Stepper TCS34725 TFT TFT16 TFTLCD TouchScreen UTFT UTTouch VirtualWire WiFi Wire

```
#include "DHT.h"
#include <PID_v1.h>

double Setpoint, Input, Output;
PID myPID(<input, <output, <setpoint, 0,1,1,);

#define DHTPIN 2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

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

float t = dht.readTemperature();
Input = t;
Setpoint = 25.0;
myPID.SetMode(AUTOMATIC);

void loop() {
  delay(2000);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float f = dht.readTemperature(true);

  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor.");
    return;
  }

  Serial.print("Temp: ");
  Serial.print(t);
  Serial.print(" ");
  Serial.print("Trigger: ");
  Serial.print(Setpoint);
}
```

#include "DHT.h"  
#include <PID\_v1.h>

# Auswahl: Board

Tools: Datei Bearbeiten Sketch Tools Hilfe

Tools: Automatisch formatieren Strg+T Sketch archivieren Kodierung reparieren & neu laden Serial Monitor Strg+Umschalt+M Board Serieller Port Programmierer Bootloader installieren

Board: Arduino Uno Arduino Duemilanove w/ ATmega328 Arduino Duemilanove or Duemilanove w/ ATmega168 Arduino Nano w/ ATmega328 Arduino Nano w/ ATmega168 Arduino Mega 2560 or Mega ADK Arduino Mega (ATmega1280) Arduino Leonardo Arduino Esplora Arduino Micro Arduino Mini w/ ATmega328 Arduino Mini w/ ATmega168 Arduino Ethernet Arduino Fio Arduino BT w/ ATmega328 Arduino BT w/ ATmega168 LilyPad Arduino USB LilyPad Arduino w/ ATmega328 LilyPad Arduino w/ ATmega168 Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega328 Arduino Pro or Pro Mini (5V, 16 MHz) w/ ATmega168 Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega328 Arduino Pro or Pro Mini (3.3V, 8 MHz) w/ ATmega168 Arduino NG or older w/ ATmega168 Arduino NG or older w/ ATmega8 Arduino Robot Control Arduino Robot Motor

```
#include "DHT.h"
#include <PID_v1.h>

double Setpoint, Input, Output;
PID myPID(<input, <output, <setpoint, 0,1,1,);

#define DHTPIN 2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

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

float t = dht.readTemperature();
Input = t;
Setpoint = 25.0;
myPID.SetMode(AUTOMATIC);

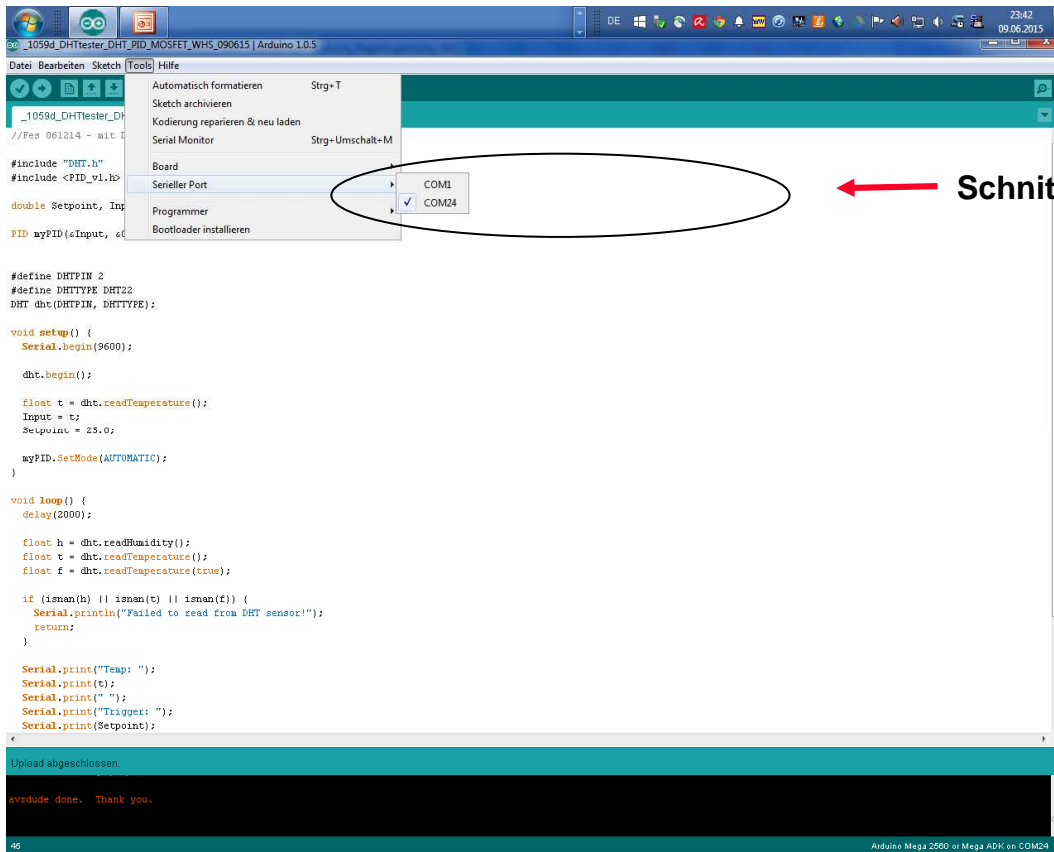
void loop() {
  delay(2000);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float f = dht.readTemperature(true);

  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor.");
    return;
  }

  Serial.print("Temp: ");
  Serial.print(t);
  Serial.print(" ");
  Serial.print("Trigger: ");
  Serial.print(Setpoint);
}
```

Board auswählen Arduino Uno

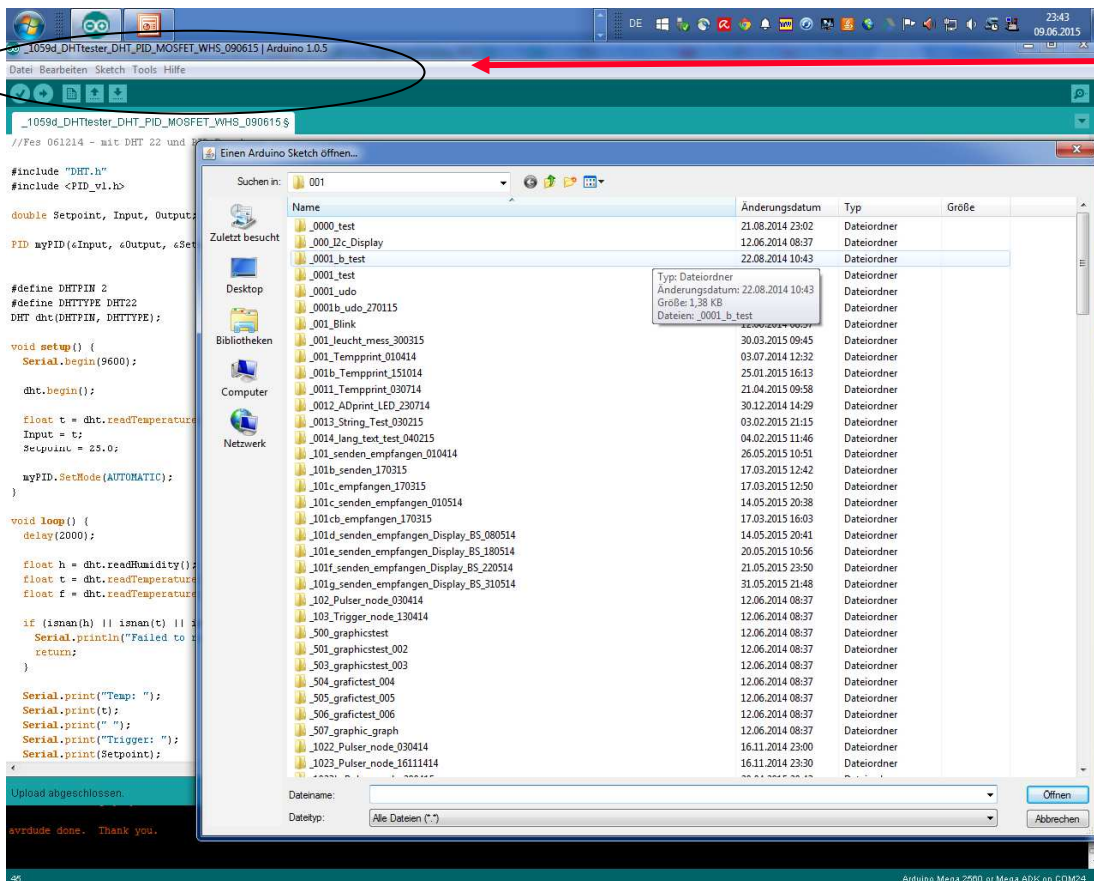
# Auswahl: Schnittstelle



Schnittstelle auswählen

# Auswahl: Programm

## \_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615



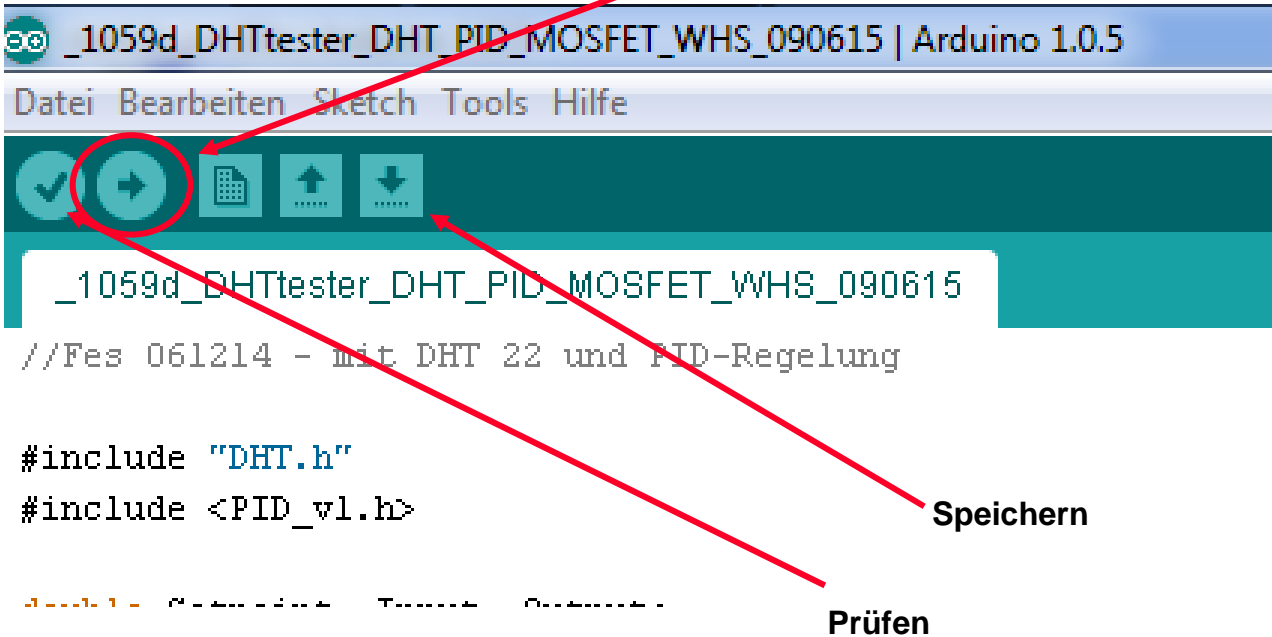
Programm einladen unter „Datei“



# Compilieren

## \_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615

Programm compilieren und hochladen (auf Mikrocontroller)



\_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615 | Arduino 1.0.5  
 Datei Bearbeiten Sketch Tools Hilfe

✓ → 📄 ⬆️ ⬇️

\_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615

```

//Fes 061214 - mit DHT 22 und PID-Regelung

#include "DHT.h"
#include <PID_v1.h>

double Setpoint, Input, Output;

PID myPID(&Input, &Output, &Setpoint,10,1,1, DIRECT);

#define DHTPIN 2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

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

  dht.begin();

  float t = dht.readTemperature();
  Input = t;
  Setpoint = 25.0;

  myPID.SetMode(AUTOMATIC);
}
  
```

**Prüfen** (points to compile button)  
**Speichern** (points to upload button)

# Arduino – C-Programm



Datei Bearbeiten Sketch Tools Hilfe

✓ → 📄 ⬆️ ⬇️

\_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615\$

```

//Fes 061214 - mit DHT 22 und PID-Regelung

#include "DHT.h"
#include <PID_v1.h>

double Setpoint, Input, Output;

PID myPID(&Input, &Output, &Setpoint,10,1,1, DIRECT);

#define DHTPIN 2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

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

  dht.begin();

  float t = dht.readTemperature();
  Input = t;
  Setpoint = 25.0;

  myPID.SetMode(AUTOMATIC);
}

void loop() {
  delay(2000);

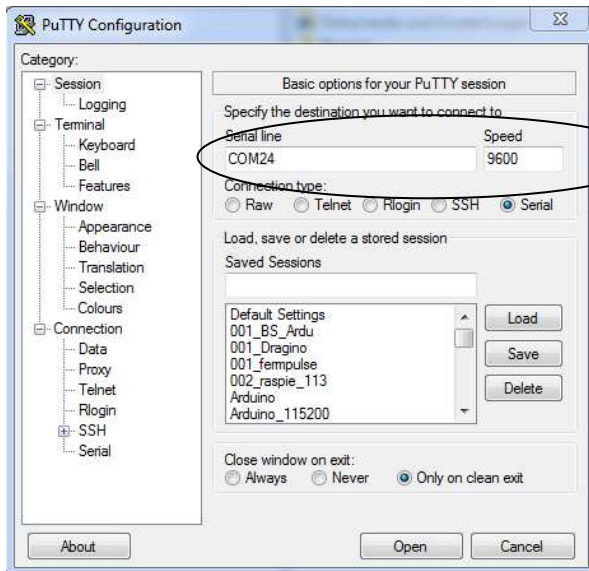
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float f = dht.readTemperature(true);

  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }

  Serial.print("Temp: ");
  Serial.print(t);
  Serial.print(" ");
  Serial.print("Trigger: ");
  Serial.print(Setpoint);
  Serial.print(" ");

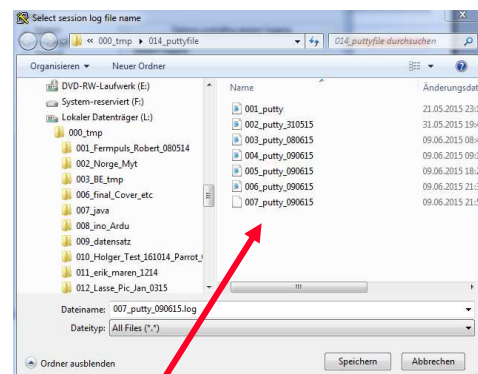
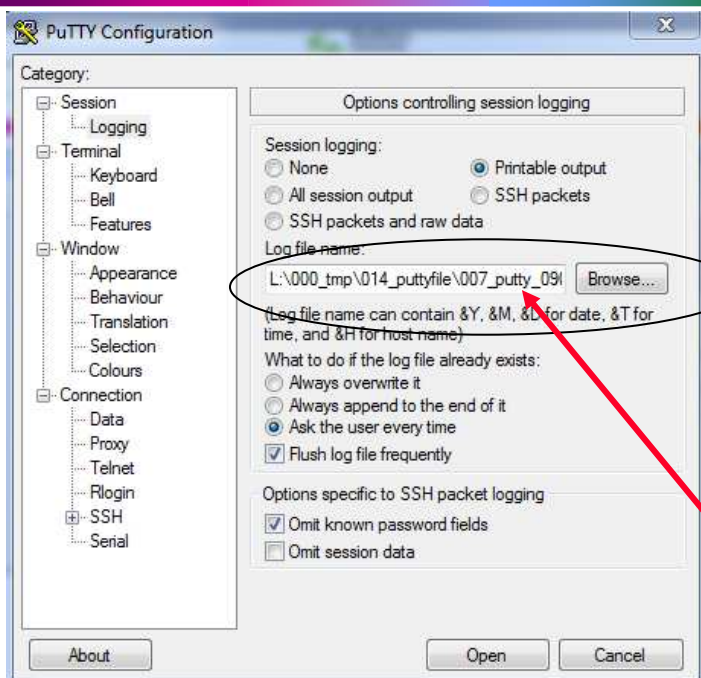
  Input = t;
  myPID.Compute();
  analogWrite(9,Output);
  Serial.print("PID: ");
  Serial.println(Output);
}
  
```

# Putty



← Schnittstelle einstellen (und Baud-Rate)

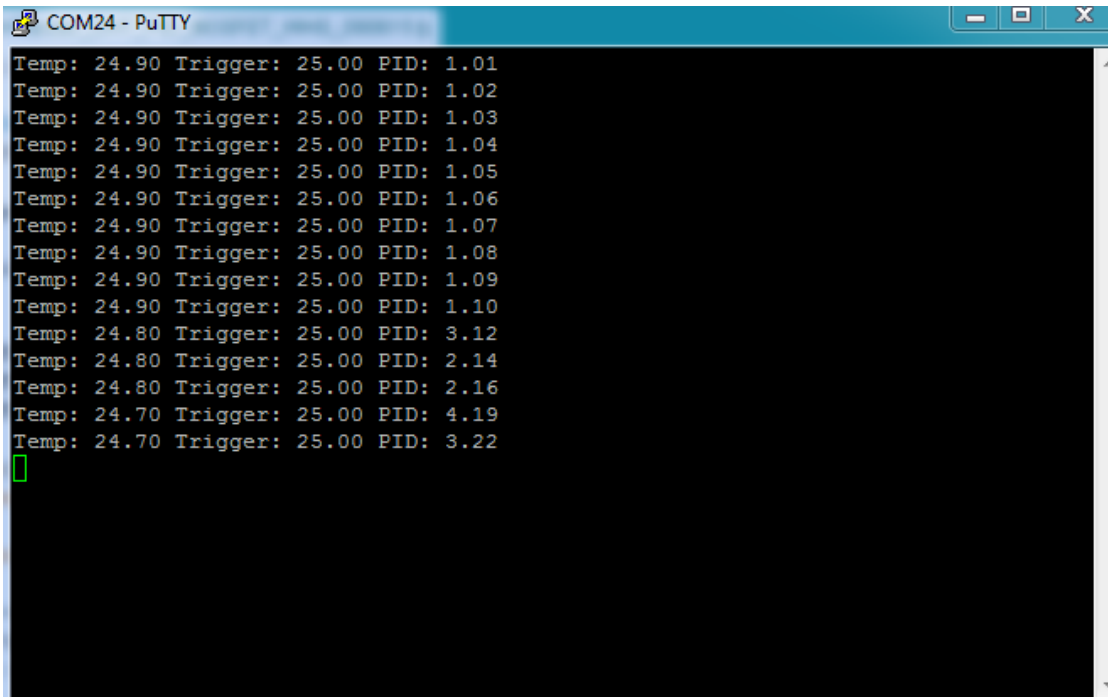
# Putty



Speicherort einstellen  
WICHTIG: Dateiname+ .log



# Putty



```

COM24 - PuTTY
Temp: 24.90 Trigger: 25.00 PID: 1.01
Temp: 24.90 Trigger: 25.00 PID: 1.02
Temp: 24.90 Trigger: 25.00 PID: 1.03
Temp: 24.90 Trigger: 25.00 PID: 1.04
Temp: 24.90 Trigger: 25.00 PID: 1.05
Temp: 24.90 Trigger: 25.00 PID: 1.06
Temp: 24.90 Trigger: 25.00 PID: 1.07
Temp: 24.90 Trigger: 25.00 PID: 1.08
Temp: 24.90 Trigger: 25.00 PID: 1.09
Temp: 24.90 Trigger: 25.00 PID: 1.10
Temp: 24.80 Trigger: 25.00 PID: 3.12
Temp: 24.80 Trigger: 25.00 PID: 2.14
Temp: 24.80 Trigger: 25.00 PID: 2.16
Temp: 24.70 Trigger: 25.00 PID: 4.19
Temp: 24.70 Trigger: 25.00 PID: 3.22
  
```

# PID-Variablen anpassen

```
_1059d_DHTtester_DHT_PID_MOSFET_WHS_090615$
```

```
//Fes 061214 - mit DHT 22 und PID-Regelung
```

```
#include "DHT.h"
```

```
#include <PID_v1.h>
```

```
double Setpoint, Input, Output;
```

```
PID myPID(&Input, &Output, &Setpoint,10,1,1, DIRECT);
```

```
#define DHTPIN 2
```

```
#define DHTTYPE DHT22
```

```
DHT dht(DHTPIN, DHTTYPE);
```

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

```
  dht.begin();
```

```
  float t = dht.readTemperature();
```

```
  Input = t;
```

```
  Setpoint = 25.0;
```

```
  myPID.SetMode(AUTOMATIC);
```

```
}
```

**PID-Variablen verändern !!!**

# Temperatur-Trigger anpassen

Datei Bearbeiten Sketch Tools Hilfe



\_1059d\_DHTtester\_DHT\_PID\_MOSFET\_WHS\_090615.\$

//Fes 061214 - mit DHT 22 und PID-Regelung

```

#include "DHT.h"
#include <PID_v1.h>

double Setpoint, Input, Output;

PID myPID(&Input, &Output, &Setpoint,10,1,1, DIRECT);

#define DHTPIN 2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);

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

  dht.begin();

  float t = dht.readTemperature();
  Input = t;
  Setpoint = 25.0;

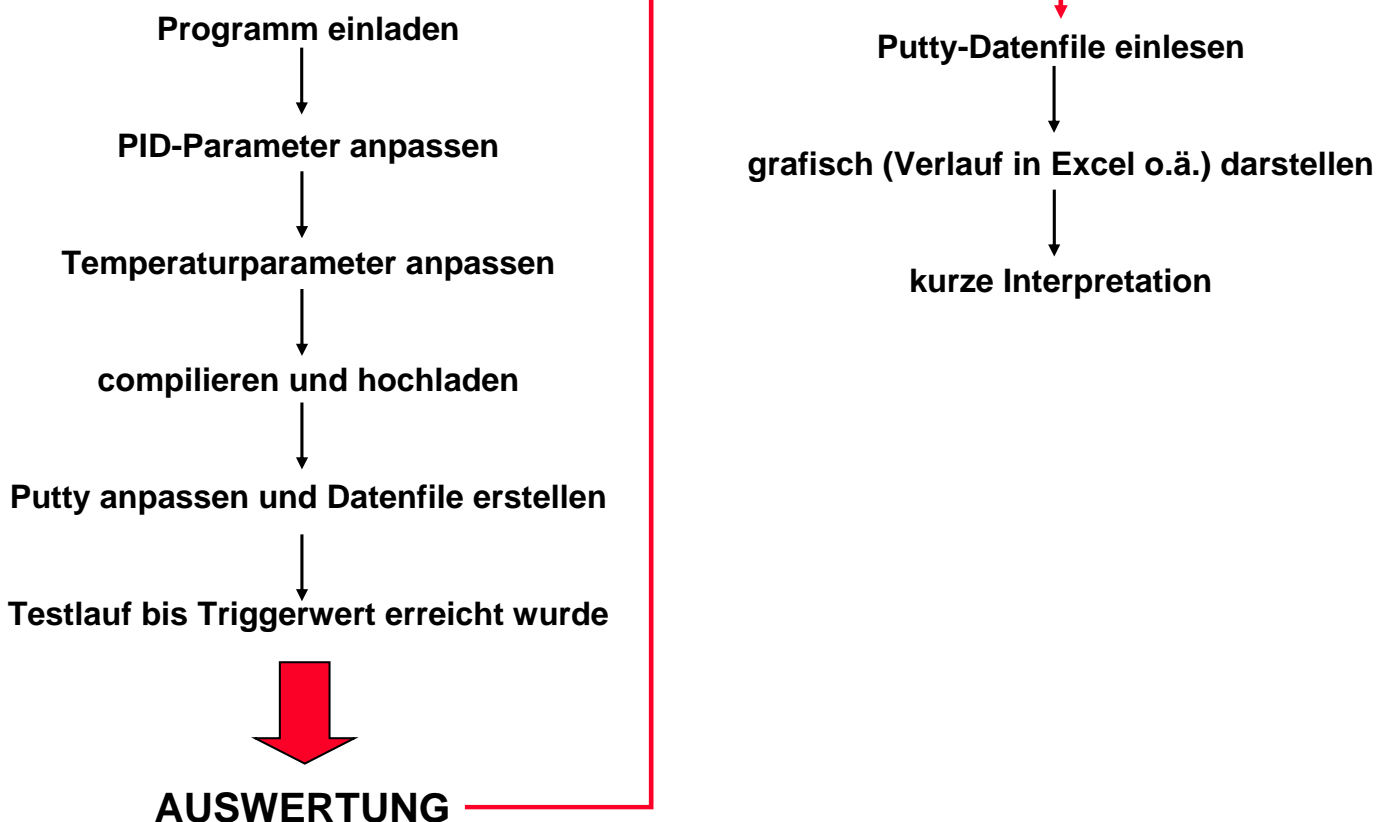
  myPID.SetMode(AUTOMATIC);
}

```

Temperatur-Trigger  
(Setpoint)



## Ablauf



## Aufgaben und ABGABE

3 Temperaturen einstellen (setpoint)  
30 Grad / 35 Grad  
*individuell, je nach Außentemp.*

PID-Parameter verändern  
(1 => 10)  
pro Temperatur

Beispiel:  
Temp.: 25 Grad  
Start: P=1, I=1, D=1

P=10, I=1, D=1  
P=1, I=10, D=1  
P=1, I=1, D=10

=> 4 Messungen pro Temperatur  
=> *Ansatz, kann angepasst werden*

**08.06.16**

insgesamt:

2 (Temp) mal 4 (PID-Einstellungen)  
= 8 Messungen

**> Screenshots und NOTIZEN  
erstellen <**

„Phantasie ist wichtiger als Wissen, denn Wissen ist begrenzt.“  
Albert Einstein

