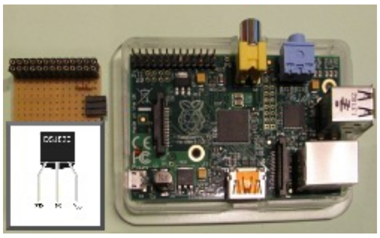
Home > Weather en | **de**

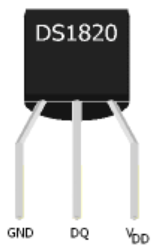
1-wire temperature sensor DS1820 at Raspberry Pi (GPIO directly)

Martin Kompf ↗



To measure the indoor or outdoor temperature with the Raspberry Pi, there are several possibilities. This article describes the version with the minimal amount of external components. This is based on the DS18S20 temperature sensor and the software emulation of the 1-wire protocol.

Temperature sensor DS1820



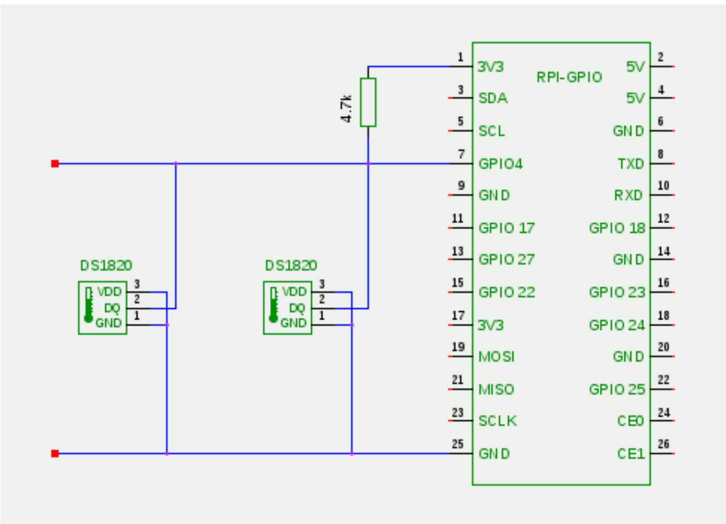
The **DS18S20 ↗** and related **DS18B20 ↗** and **DS1822 ↗** are integrated circuits in a TO-92 housing containing the temperature sensor, analog-to-digital converter and 1-wire interface. The types mentioned are pin and software compatible, they differ substantially in the measurement accuracy and price. The three connectors (see picture left) are ground (GND, pin 1), data (DQ pin 2) and operating voltage (V_{DD}, pin3). You can connect V_{DD} and GND and operate the sensor with a parasitic power supply of 3-5 volts. The connection of the circuit with the computer is then possible with a simple two-wire twisted pair cable.

At this cable - the 1-wire bus - you may connect several DS1820 parallel. Each sensor has a unique code assigned by the manufacturer to identify itself.

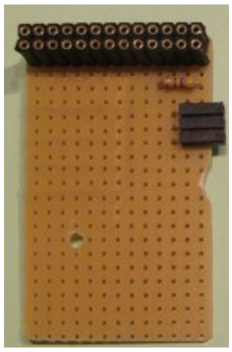
Raspberry Pi and 1-wire

Temperature measurement with the Raspberry Pi and the 1-wire temperature sensor DS1820 contains a list of different ways to drive a 1-wire bus from the Raspberry Pi. This paper describes the solution (1) with the least amount of external circuitry. You need apart from the sensors only a single resistor, as this solution completely simulates the 1-wire protocol in software.

Only one resistor



Connecting the DS18020 to the GPIO port of the Raspberry Pi



On the breadboard is still plenty of room for expansion

The data port DQ of the DS1820 is connected directly to the port GPIO4 of the GPIO interface of the Raspberry Pi. GND and V_{DD} are at ground terminal GND. The parasitic power supply accomplished a pull-up resistor of 4k7 between the 3.3 volt connection 3V3 and GPIO4.

The resistor, a female connector for attachment to the GPIO port and the 1-wire connection is soldered to a small breadboard, which sits directly on the GPIO port. The 1-wire connection can be realized with a space-saving angled female connector. All this fits into the TEK-BERRY housing of the Raspberry Pi.

1-wire software drivers

The kernel modules required for the activation of the 1-wire temperature sensor are part of the Linux distribution **Raspbian "wheezy" ↗**. You should, however, explicitly load them:

```
sudo modprobe w1-gpio pullup=1
sudo modprobe w1-therm
```

Important is the parameter **pullup = 1**, which tells the module that a parasitic power supply via a pull-up resistor is present. The modules create a subdirectory for each sensor found just below **/sys/bus/w1/devices**. The directory name is composed of the Family Code of the sensor and its unique identification number. Sensors of the type DS1820 and DS18S20 have the Family Code 10, DS18B20 has Code 28 and DS1822 the 22. In each subdirectory there is the file **w1_slave** containing the sensor status and measured temperature value:

```
cd /sys/bus/w1/devices
cd 10-000801b5*
cat w1_slave

0f 00 4b 46 ff ff 06 10 0c : crc=0c YES
0f 00 4b 46 ff ff 06 10 0c t=7375
```

The file consists of two lines, each containing the hexadecimal register-dump of the sensor IC. At the end of the first line is the checksum (CRC) and the information whether it is a valid reading (YES). The second line ends with the temperature reading in thousandths of a degree Celsius. In the example, the temperature is thus 7.375 °C. The accuracy to three places after the decimal point is of course only apparent; the **datasheet of DS18S20 ↗** states, for example, that the measurement accuracy is only ± 0.5° C. The actual temperature is so anywhere from 6.8 to 7.9° C.

If everything works so far, you should enter the two required modules into the file **/etc/modules** to make them automatically loading at boot time:

```
# /etc/modules
w1-gpio pullup=1
w1-therm
```

Round Robin Database RRDtool

For a long-term recording of temperature readings and comfortable generation of graphics, the use of **RRDtool ↗** is recommended. The articles **Weather data acquisition with the USB WDE1** and **Temperature measurement with the Raspberry Pi (USB-serial)** explain this tool in detail.

First you have to install RRDtool with the aid of the Package Manager at the Raspberry Pi:

```
sudo apt-get install rrdtool python-rrdtool
```

The second installed package **python-rrdtool** is a Python interface to RRDtool, which is used later. At the beginning of the work with RRDtool is the definition of the database. The following example creates a database for two temperature sensors **temp0** und **temp1**. The aim is to store one value per quarter hour (900 seconds). After ten days (= 960 values), a reduction takes place to one average, minimum, and maximum value per day. The retention time of these daily values is ten years (= 3600 values):

```
rrdtool create temperature.rrd --step 900 \
DS:temp0:GAUGE:1200:-40:80 \
DS:temp1:GAUGE:1200:-40:80 \
RRA:AVERAGE:0.5:1:960 \
RRA:MIN:0.5:96:3600 \
RRA:MAX:0.5:96:3600 \
RRA:AVERAGE:0.5:96:3600
```

Data Acquisition with Python

A Python scripts reads the special files **w1_slave** and inserts the temperature values into the round-robin database:

```
#!/usr/bin/python
# -*- coding: utf-8 -*-
```

```
import re, os, rrdtool, time

# function: read and parse sensor data file
def read_sensor(path):
  value = "U"
  try:
    f = open(path, "r")
    line = f.readline()
    if re.match(r"([0-9a-f]{2} ){9}: crc=[0-9a-f]{2} YES", line):
      line = f.readline()
      m = re.match(r"([0-9a-f]{2} ){9}t=([+-]?[0-9]+)", line)
      if m:
        value = str(float(m.group(2)) / 1000.0)
    f.close()
  except (IOError), e:
    print time.strftime("%x %X"), "Error reading", path, ": ", e
  return value

# define pathes to 1-wire sensor data
pathes = (
  "/sys/bus/w1/devices/10-000801b5a7a6/w1_slave",
  "/sys/bus/w1/devices/10-000801b5959d/w1_slave"
)

# read sensor data
data = 'N'
for path in pathes:
  data += ':'
  data += read_sensor(path)
  time.sleep(1)

# insert data into round-robin-database
rrdtool.update(
  "%s/temperature.rrd" % (os.path.dirname(os.path.abspath(__file__))),
  data)
```

The reading of **w1_slave** is made in the function `read_sensor`. It tests whether the first line ends with YES and thus there exists a valid checksum. If so, then the function extracts the temperature value from the second line of the file and returns the value in degrees Celsius. In case of error, it returns the value U, which is interpreted as "Unknown" by RRDtool.

In the main program are first the definitions of the paths to the temperature sensors - these of course you need to change! Then the script reads in all of the sensors by calling the function `read_sensor`. The waiting time of one second is to improve the transient response of the parasitic power on the data bus. At the end of the insertion of the measured values into the round robin database is done. The construction of the path to the database assumes that the script and the database are in the same directory.

The script is stored in the executable file **gettemp.py** and you may execute it on the command line. The result can be checked using `rrdtool lastupdate`. This ouputs the time stamp and the values of the last update of the database:

```
chmod +x gettemp.py
./gettemp.py
rrdtool lastupdate temperature.rrd
 temp0 temp1

1386777156: 18.937 5.687
```

You may put the script call into your crontab:

```
echo '2-57/5 * * * * $HOME/temperature/gettemp.py >> $HOME/temperature/gettemp.log 2>&1' | crontab -
```

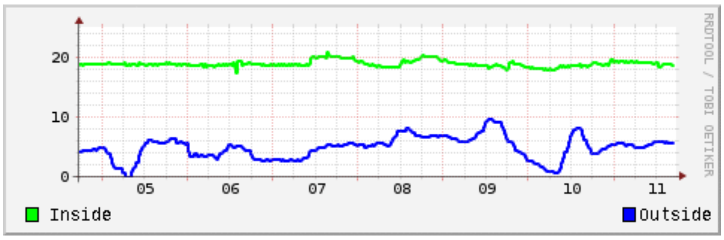
With this definition, the cron daemon executes every five minutes the script, starting with the second minute after the hour. An output redirection sends error messages into the file **gettemp.log**. Because the database is defined with the smallest measurement interval of 15 minutes, an averaging of three readings takes place.

Graphics and more

Did hardware and software for a while diligently collected temperature readings, then RRDtool can create nice graphics, for example, visualize the history of the temperature of the last week as a line graph:

```
rrdtool graph tempweek.png \
  -s 'now - 1 week' -e 'now' \
  DEF:temp0=temperature.rrd:temp0:AVERAGE \
  LINE2:temp0#00FF00:Inside \
  DEF:temp1=temperature.rrd:temp1:AVERAGE \
  LINE2:temp1#0000FF:Outside
```

More about "Graphics with RRDtool" and the building a web application for data presentation can be found in the blogs **Weather data acquisition with the USB WDE1** and **Temperature measurement with the Raspberry Pi**.



With rrdtool graph generated diagram of the temperature of the last week

Conclusion

The proposed project implements a temperature measuring station based on the Raspberry Pi with minimal external hardware. The parasitic power supply of the sensors requires only a two-wire cable, but the maximum possible cable length is likely to be limited compared to an active power. If you need to measure temperatures above 70° C, then you should definitely provide an active power supply with a three-wire cable. The GPIO ports on the Raspberry Pi are connected without further buffering with the 1-wire bus. Therefore, the coupling of interference by parallel routed power lines is particularly to be avoided! The solution works for several month reliably with two sensors and a total cable length of about ten meters at my home.

Interesting links

Raspberry Pi ↗ Wiki at eLinux.org
Raspberry Pi Foundation ↗
OWFS 1-Wire File System ↗ - Comprehensive reference to 1-wire hardware and software
RRDtool ↗ - Open Source data acquisition and visualization tool