

Soil moisture and temperature sensor SMT-01

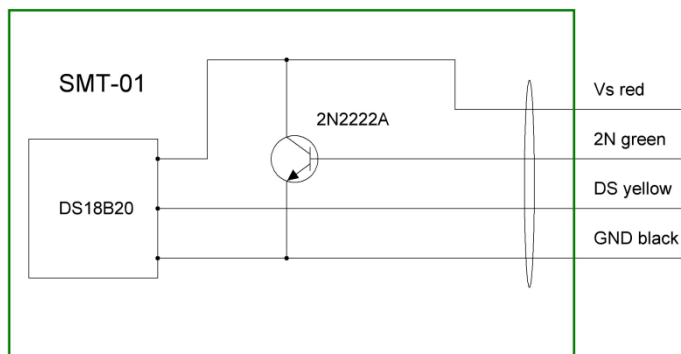
The Design

We know that warm objects cool much faster in water than in air. This known fact is used in the design of the sensor.

The design of the SMT-01 is based on measuring the rate of dissipation of thermal energy depending on the moisture content in the soil.

The SMT-01 sensor is simple in design and consists of several components (see Photo 1):

- Heater - bipolar transistor **2N2222A**;
- Thermometer – digital 1-Wire sensor **DS18B20**;
- Cable - 4-wire, shielded;
- PSB for electrical connection of components;
- Epoxy body (diameter 9 mm, length 40 mm).



Electrical circuit.

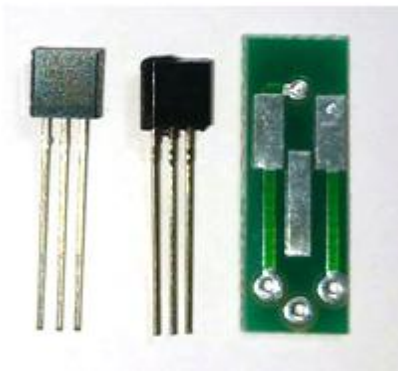


Photo 1. Components of SMT-01 before soldering.

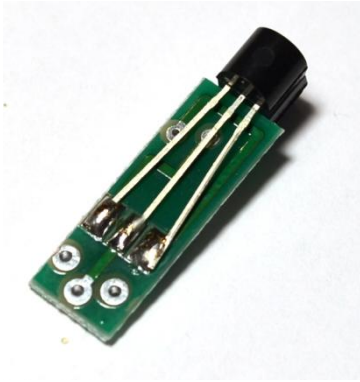


Photo 2. Components of SMT-01 after soldering.

DS18B20 and 2N2222A are arranged flat surfaces to each other at a distance of about 1 mm.

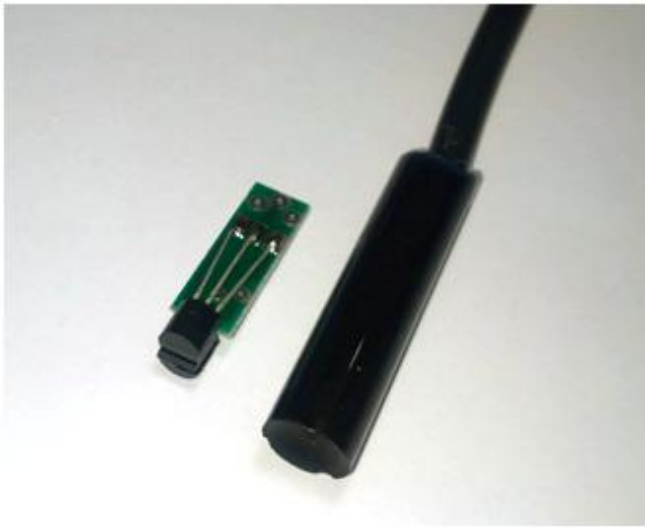
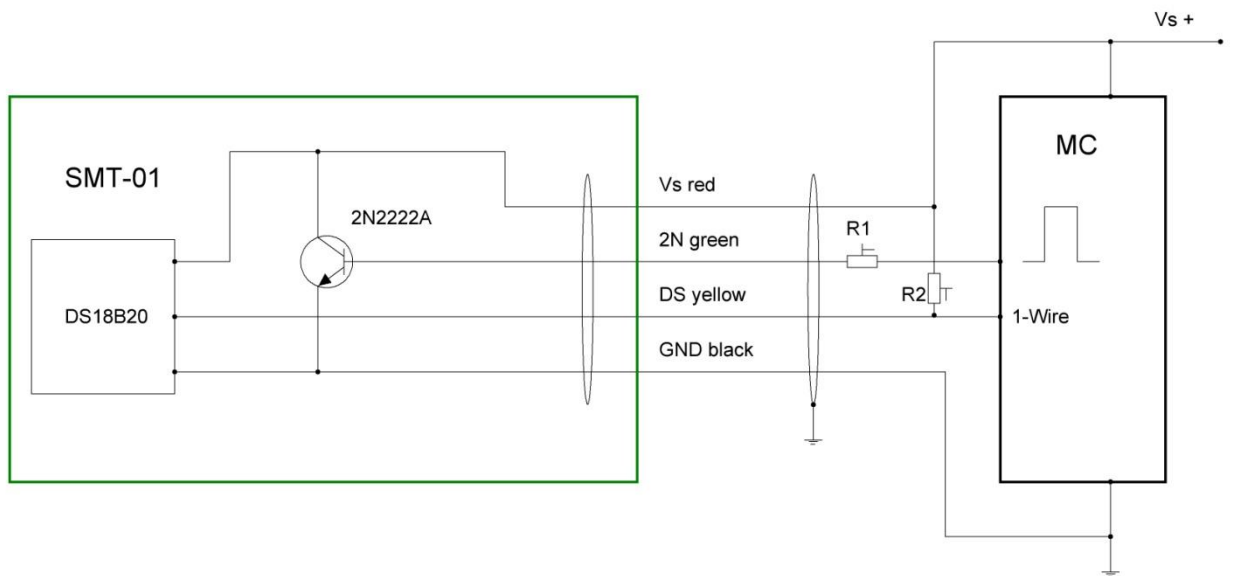


Photo 3. Components of SMT-01 without and with epoxy coating

For measurements, the sensor must be connected to the microcontroller.

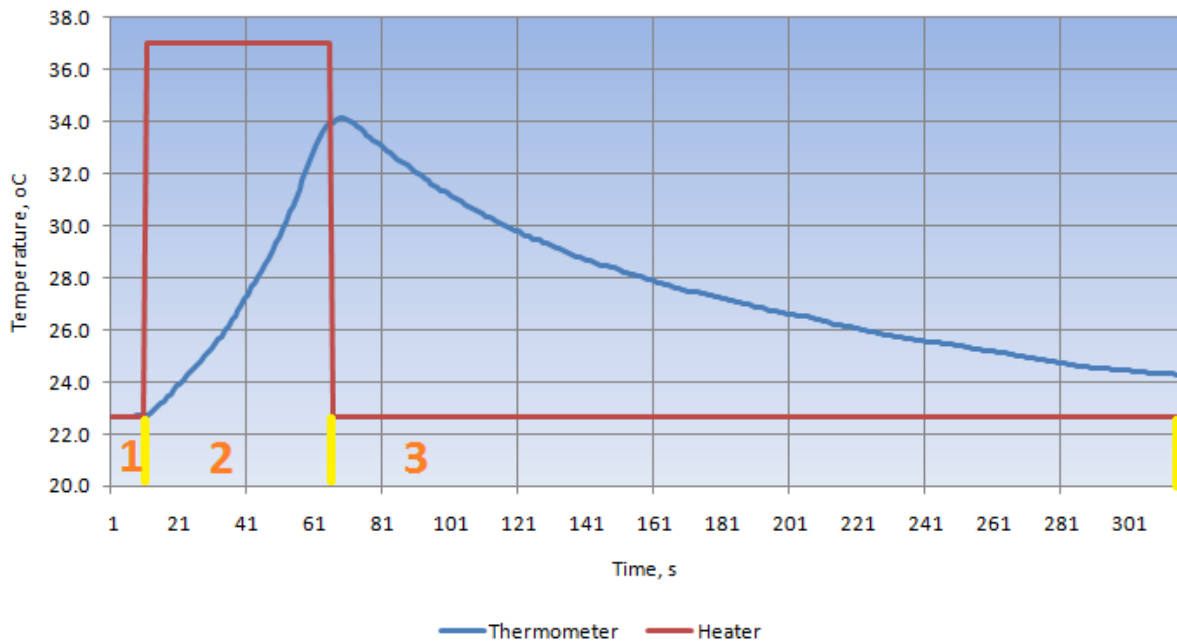


Electrical circuit.

How it works

The SMT-01 has four main stages:

1. Temperature measurement
2. Heating
3. Heating dissipation
4. Calculation of soil moisture

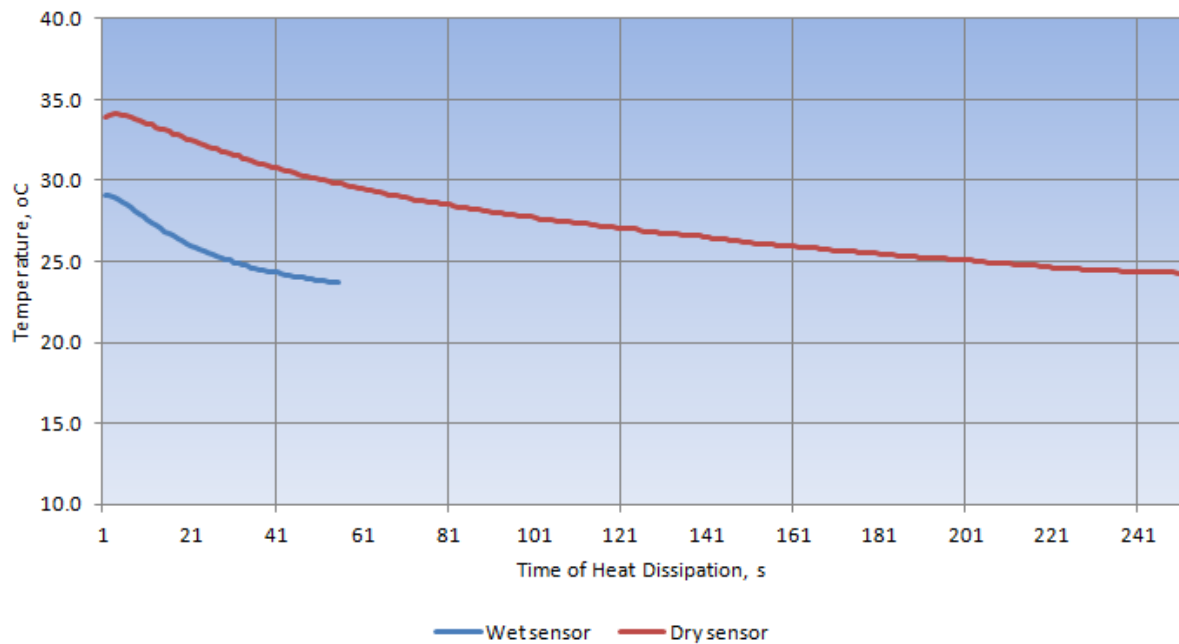


Timing of stages 1-3

1. **Measurement of soil temperature T_{sm}** (10 seconds): Using **DS18B20** sensor and **1-Wire** protocol.
2. **Heating** (60 seconds): through the resistor R1 voltage (logical 1) is applied to the base **2N2222A**. The collector current is no more 100 mA. The sensor temperature increases about on 10° C.
3. **Heating dissipation** (30-250 seconds): through the resistor R1 voltage (logical 0) is applied to the base **2N2222A**. The collector current is near to 0 mA. While the temperature drops to **$T_{sm} + 1^{\circ}$** C using **DS18B20** sensor and **1-Wire** protocol for temperature measurement.

Soil Moisture calculation

Soil moisture is calculated over time of Heat dissipation. For practical purposes, for automatic irrigation systems, the dependence of Soil Moisture from Time of Heat dissipation time can assume to be linear. For accurate calculations, calibration is required for each soil type.



Time of Heat dissipation for Wet and Dry sensor

Time of Heat dissipation 55 seconds: corresponds to soil moisture 100%.

Time of Heat dissipation 250 seconds: corresponds to soil moisture 0%.