Heating water in a solar collector with Cobra SMARTsense Code

In this experiment, water is heated in a solar collector and the rise in temperature is monitored. The Cobra SMARTsense code shows whether the desired temperature range is reached or not and interrupts the circuit as soon as the water becomes too hot.

Physics | Energy | Renewable energies: Sun

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/68cbd78e2981420002977a10

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Teacher information

Application

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Experimental setup

Water is one of the most diverse and important resources in industry. It can be used as a cleaning agent or solvent and other purposes. It also plays a fundamental role in the household, including washing up, showering and flushing toilets. It is also used for heat transport. Without water, radiators and underfloor heating would not work. One way of generating heat is solar thermal energy, in which water is heated using solar energy. Such a system will be simulated in this experiment.

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Other teacher information (1/2)

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Prior knowledge

The students should be familiar with the using a student network device and it is recommended to have some experience with the measureAPP and the features of the Cobra SMARTsense code.

Principle

In this experiment, water is heated in a solar collector and the rise in temperature is monitored. The Cobra SMARTsense code shows whether the desired temperature range is reached or not and interrupts the circuit as soon as the water becomes too hot.

Other teacher information (2/2)

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Learning objectives

The students learn about the operating principle of a solar thermal system, which offers a way of utilizing renewable solar energy. They will also be familiarized with the simple programming of a device for temperature monitoring and switching relays.

Tasks

The students heat water in a solar collector using the light from a lamp. They observe how the temperature of the water changes and program the Cobra SMARTsense Code so that it indicates when the desired temperature is reached and the lamp switches off if the temperature is too high.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

Furthermore, caution is advised with these sources of danger:

- The light bulb and its holder heat up during operation. Therefore, you must not touch them once they have been switched on.

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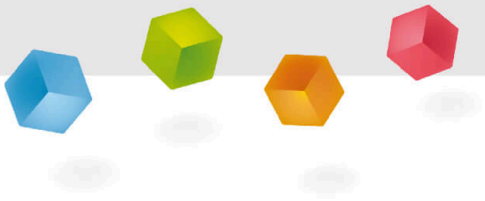

Student information

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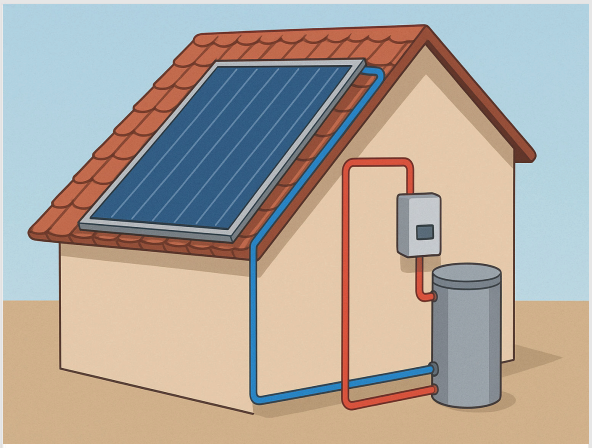
Motivation



Sketch of a solar thermal system

Wouldn't it be nice to store the heat from a warm summer's day and use it for heating or a hot shower on cooler days? This is exactly what solar thermal energy does: solar collectors on the roof of a house absorb sunlight to heat water which can later be used as hot water in the household.

This method saves heating and electricity costs and is also environmentally friendly. This is why solar thermal energy is increasingly being used in homes.

Tasks

Experimental setup

1. Heat a small amount of water in the solar collector by illuminating it with the spotlight.
2. Monitor the heating of the water using the Cobra SMARTsense Temperature and the measureApp. Use the Cobra SMARTsense Code to show when the desired temperature has been reached.
3. Install overheating protection with the Cobra SMARTsense Code and Cobra SMARTsense Temperature according to the instructions.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
3	Solar collector for student experiments	05760-00	1
4	Halogen lamp with reflector, 12V / 20W	05780-00	1
5	Mount for halogen lamp with reflector	05781-00	1
6	Beaker, black	05904-01	1
7	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
8	Slide mount for optical bench	09822-00	1
9	Measuring tape, l = 2 m	09936-00	1
10	Cobra SMARTsense Temperature - Sensor for measuring temperature -40 ... 125 °C (Bluetooth)	12903-00	1
11	Cobra SMARTsense Code - Output device for switching relays, LEDs, display	12953-00	1
12	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Setup (1/5)

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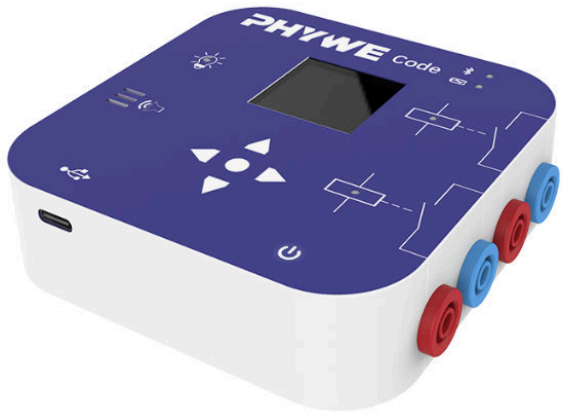

Cobra SMARTsense Code

In this experiment, you will use the Cobra SMARTsense code. This is a control unit that can output specific signals. Possible signal forms are, for example: Illumination of an LED, display indication or sound. In this experiment, we use the relay control, the LED and the screen of the Cobra SMARTsense Code. In this case, a relay is nothing more than a switch. It can be used to open and close circuits in a targeted manner.

Setup (2/5)

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1. Firstly, screw the two-part tripod rods together to form two long rods. Assemble the tripod bench from the variable tripod base and the two rods (Fig. 1).

2. Clamp the lamp into the left part of the tripod base (Fig. 2).

3. Remove the small piece of foam from the solar panel. Insert the black plate, making sure that the measuring socket is in the correct position and push the plate all the way back (Fig. 2).

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Setup (3/5)

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Setup with collector and cables

4. Fill the black metal cup just under halfway with cold water (approx. 15 ml). Place the metal cup directly in front of the black plate and close your solar collector with the transparent pane.

5. Connect the red plug of the halogen lamp to the 12V socket of the power supply unit and the black plug to the red socket of the first relay of the Cobra SMARTsense codes. Now use a blue cable to connect the blue socket of the relay to the 0 socket of the power supply unit.

Setup (4/5)

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Complete experimental setup

6. Carefully place the collector on the stand bench, the distance from the lamp should be about 5 cm. Then push the temperature sensor through the top hole in the solar collector to the bottom of the cup.

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Setup (5/5)

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To measure with the **Cobra SMARTsense sensors**, the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the respective app store (QR codes below). Please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC) before starting the app.

measureAPP for Android operating systems

measureAPP for iOS operating systems

measureAPP for tablets / PCs with Windows

Procedure (1/5)

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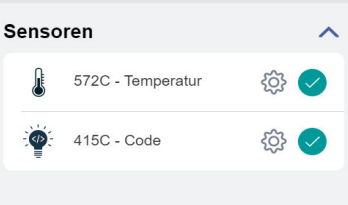

Sensors in the measureApp

Temperature sensor

- For the following steps you will need the **PHYWE measureAPP**.
- Activate the Cobra SMARTsense code (also called code actuator) and the temperature sensor by pressing and holding the power button for a few seconds until the Bluetooth symbol lights up.
- Now open the measureAPP and connect the two devices by clicking on the white circle next to the sensor. A green tick appears to confirm that the device is connected.

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Procedure (2/5)

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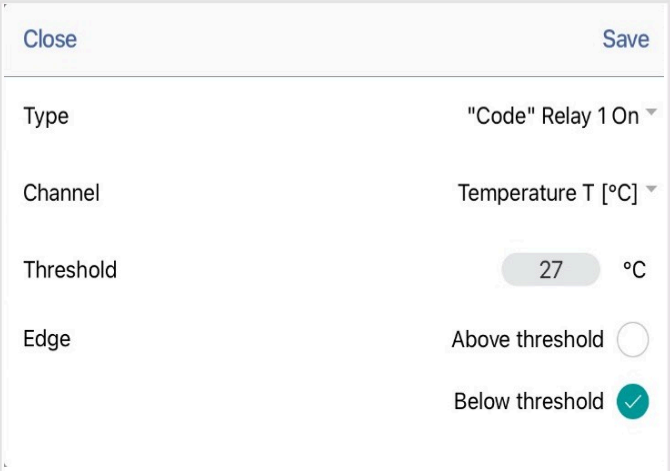
- In the app, go to "Triggers" at the bottom left, then to Select action and then select **"Code" Relay 1 On**.
- Then click on Save and the action window will open.
- Select the temperature as the measurement channel, 27 °C as the threshold value and "Below threshold" as edge and then click on "Save".

These settings cause the relay to close, interrupting the circuit so that the lamp switches off as soon as the water reaches a temperature of 27 °C.



Programming the code actuator

Procedure (3/5)

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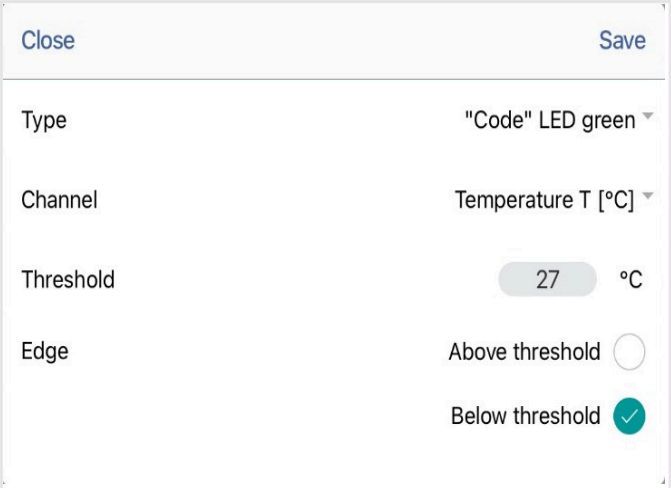
The LED of the code actuator can be used to indicate whether the relay is currently switched on or off.

- In the "Trigger" menu, select "Code LED red" as action, measurement channel "Temperature", 27 °C as the threshold value and "Exceeded threshold value" as edge and then click "Save".
- Repeat these steps with "Code LED green" and "Undercut threshold value".

The LED now lights up green when the relay is open and red when it is closed due to "overheating" of the water.



Programming the code actuator

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Procedure (4/5)

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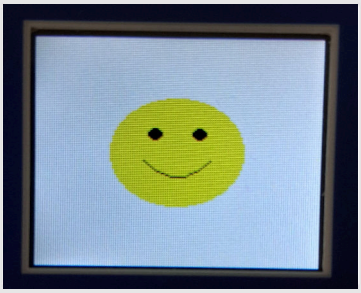

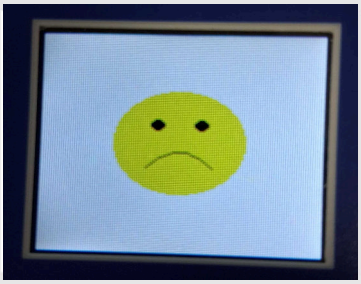

We also use the code actuator to indicate whether the desired temperature range between 25 and 27 °C has been reached.

- In the "Trigger" menu, select the action "Code" with the sad smiley, measuring channel "Temperature", threshold value 25 °C and as trigger "Below threshold value" and then save.
- Repeat these steps with the happy smiley and "Exceeded threshold".

The settings made here cause the code actuator to display a sad smiley when the water is (too) cold and a happy smiley when the water is warm.

Procedure (5/5)

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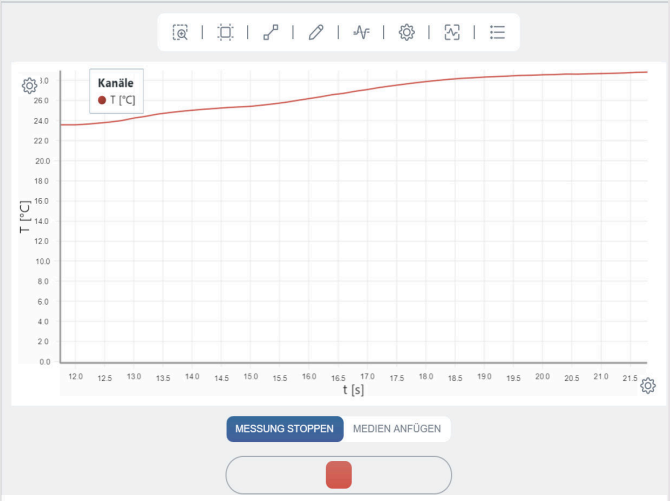
- Now select "Start measurement" in the measureAPP and switch on the power supply unit. Now the halogen lamp should light up and the measure app should display the temperature as a function of time.
- Now observe the temperature curve and the behavior of the code actuator. If the water used is significantly warmer or colder than 23-24 °C, the temperature limits in the actuator triggers can be adjusted to avoid long waiting times.



Measuring process in the measureAPP

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Report

Task 1

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Which advantages does the temperature sensor have compared to a "normal" thermometer?

- [ ] It provides more accurate temperature values.
- [ ] It can heat up water.
- [ ] It displays the exact temperature progression over time using the measureApp.

Check

Cobra SMARTsense Temperature

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Task 2

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What is the code actuator **not** used for in our experiment?

- ○ To act as a switch.
- ○ To indicate whether the desired water temperature has been reached.
- ○ To control the temperature of the water.

Check

Cobra SMARTsense Code

Task 3

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Drag the words into the correct gaps.

This experiment simulates a solar thermal system. The halogen lamp represents the _____, which _____ the water in the solar collector. The code actuator prevents the water from _____ and _____ the water temperature in the solar collector. This is done using the _____ sensor. In a real solar thermal system, the _____ is located on the roof of the house and a solar controller monitors the _____.

water temperature
temperature
sun
solar collector
heats up
monitors
overheating

Check

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Slide	Score / Total
Slide 21: Temperature sensor	0/2
Slide 22: Code actuator	0/1
Slide 23: Solar thermal energy	0/7

Total amount 0 / 10

Solutions Repeat

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