C4µC - Examination

- Thermal blanket controller:
  - You are asked to design a uC circuit control a thermal blanket with the functionalities of a timer (auto-shutdown) and heat level regulation.
    The circuit, other than the uC, will have a button, a rotary encoder, a display (to visualize the time and the heat level), a buzzer.
  - The functionalities should be as following:
    - The circuit, when first powered, is in standby (STDBY) (display and outputs OFF)
    - When the button is pressed, the output to the heater (HEATER) is activated and default values are shown on the display (DISPLAY_ON); the values are 50% (heat lev.) and 30 minutes (MM:SS countdown)
      - At display_on, heat level is shown for 2 seconds, then the decreasing time
    - 10 seconds after the last event, the display turns off (DISPLAY_OFF), but the out to the heater is still active
    - At display_off, at the 1st event (button or 1st encoder step) the display turns on [as in previous subpoint]
    - At display_on:
      - When the button is pressed, the time is increased by 30 minutes (max time tot. 600 minutes)
      - When the encoder is rotated, heat level is changed (± 10% each step, according to rotation)
    - 10 seconds before the time is over (==0), the buzzer (BUZZER) is activated
    - When the time is over, everything is off and the system is in standby again

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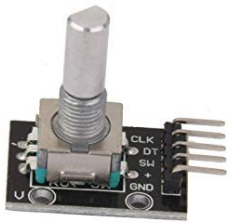
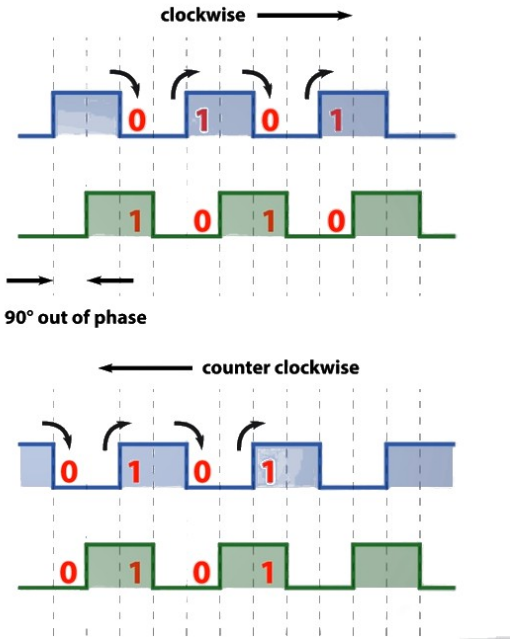
- And:
  - If the system is activated again (not the first power-on) the heat level is the last one selected
  - The heat level corresponds to a variable duty-cycle on the heater output, with ON and OFF duration at 100ms steps and a constant period of 1 second
    (e.g. 30% = 300ms ON, 700ms OFF)
  - To control the display (TM1637), the following functions are provided:
    - **`setBrightness(uint8_t bright)`** with bright ϵ [0, 255]
    - **`show_duty(uint8_t level)`** with level ϵ [0, 10]
    - **`show_time(uint16_t sec)`** with sec ϵ [0, 6000]

- The rotary encoder has 2 signals (CLK, DT) with the following levels at each step:
  - (0,0) (1,0) (1,1) (0,1) (0,0) ... clockwise rotation
    (0,0) (0,1) (1,1) (1,0) (0,0) ... counter clockwise rotation





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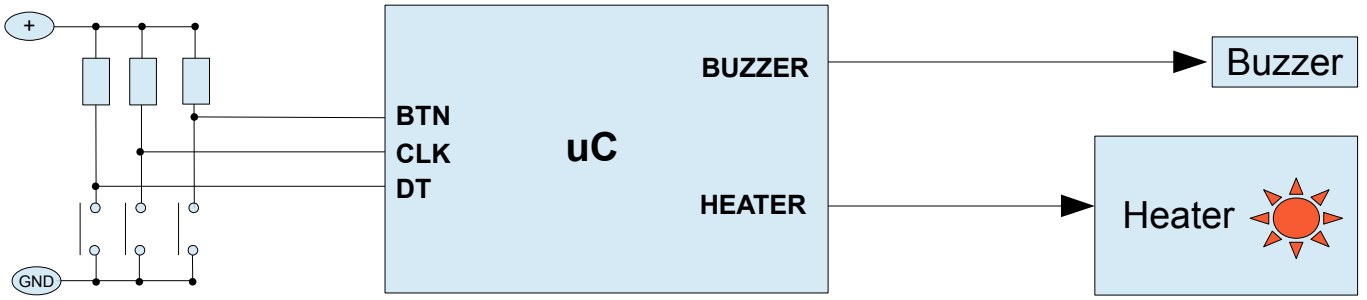
- The system is connected as in the following scheme:



- All inputs and outputs are digital

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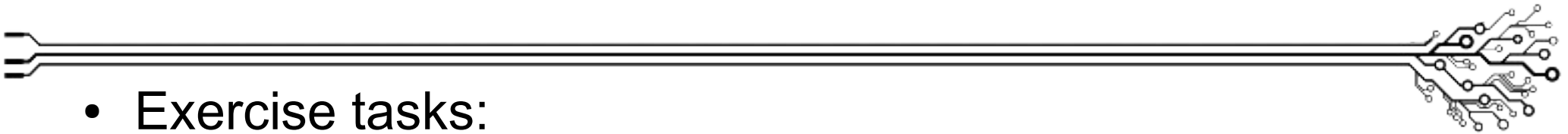

- Exercise tasks:
  1) Define inputs and outputs for the reference µC 328p [1 pt.]
  2) Draw the state-chart for the system [2 pt.]
  3) To implement all the functionalities described, write down the code for the init function (e.g. s*etup()*), the main function (or *loop()*) and other functions, if any, declaring all the needed variables [7 pt.]
  4) Add the functionality to turn off everything (back to STDBY), if the button is kept pressed for more than 2 seconds [2 pt.]
- General note:
  - Write any comment to justify a choice when the system requirements leave a degree of uncertainty