

Final Assignment – Coffee Vending Machine

The task for the final assignment is to create a controller for a coffee vending machine.

The machine consists of a coffee grinder, milk frother, brewer, display, keypad, coin slot, dispensing area, etc. It is designed to brew three types of coffee: espresso, latte, and filter coffee. The default prices on these items are 18DKK, 26DKK and 2DKK per centiliter, respectively. The per centiliter price only applies to filter coffee, while the other prices are for the whole drink.

The first step in operating the machine is selecting one of the three types of drinks using the keypad and display. Once selected, payment needs to be made. There are two ways to pay: cash or card. If cash is selected (again using the display and keypad), the machine only accepts 5DKK or 20DKK coins for some reason. An insertion of 5DKK is simulated by turning the digital encoder one step counter-clockwise, while 20DKK with a step clockwise. If there is a difference between the prepaid amount and the drink price, the machine gives change in the form of 1DKK coins. The change is simulated by flashing the green LED as many times as many coins are due back. If filter coffee is ordered, change is not given, as the amount of coffee depends on the user (see below). If card payment is selected, first one needs to enter a 16-digit card number, followed by a 4-digit PIN number. The combination is accepted if the card number is odd and the PIN odd or when the card number is even and the PIN even. In other cases, the card payment is rejected.



Once payment is finished, drink production can start, but only when a cup is placed under the dispenser and a start button is pressed. Cup presence is simulated by pressing switch button 1, while start is switch button 2. If start is pressed without a cup present, the machine displays an instruction to place the cup in place. Espresso is made by grinding the coffee for 8 seconds (indicated by the yellow LED) and brewing for 15 seconds (indicated by the red LED). Cappuccino starts the same way, but frothed milk is produced at the end for 5 seconds and added to the espresso (frothing indicated by green LED). Finally filter coffee is produced from coffee concentrate sludge (this can be real, check it out at TEK), by brewing (yellow LED). In this case coffee is dispensed as long as the start button is pressed or until the prepaid cash amount is reached. The display shows amount dispensed, unit price and total price. The dispensing starts at a slow rate (0.5cl per second) for 2 seconds and then jumps to 1cl per second. More coffee can be added by repeated pushes of the start button, but after 5 seconds of inactivity, the coffee dispensing is finished. Once coffee production is done, the machine notifies the user of the final price and to take the coffee until the cup is removed.

Every time a transaction is finished data is logged (time of day, product type, price, amount (in the case of espresso or cappuccino this value is 1, while for filter coffee it is the number of dispensed centiliters), payment card number or "CASH"). The shop owner should be able to set the price of each product from a PC. Also from their PC, they must be able to query a report containing the total sales of coffee sorted by product, the sum of all cash purchases, sum of all card purchases and the total operating time for the machine. All logging and communication with the PC is done through the UART.

This assignment must be solved **within EMP groups**. The solution must be based on **FreeRTOS**, and it must utilize FreeRTOS objects for inter-task communication, synchronization and protection of shared resources. The solution can only rely on code provided by the instructors or code written by group members themselves!

The solution must include:

- A **zip file** containing ALL files of your solution which are needed for verification by the teacher.
- A **PDF** of the poster presentation of your solution. PowerPoint can be used to prepare it, for example. The presentation must include a task diagram and any state machine diagram(s) of your solution. It could also show a sketch of the system, a list of modules, interesting examples of the code, a screen dump of the PC terminal dialog, etc. On top of the poster names of all group members who **contributed** to the solution should be clearly mentioned.
- A **link to a video recording** of the system working in not absolutely required but appreciated. No high production values are needed, just the basics showing the coffee machine working.

The above 2-3 items need to be provided through itslearning's assignment submission system before **12:15** (Central European Daylight Time) on **Thursday, May 19th, 2022**. The submission system will be open at least 7 days before the deadline and an announcement will be sent for how to submit the files.

Details of minimum requirements will be provided orally in class and as an announcement on itslearning.

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