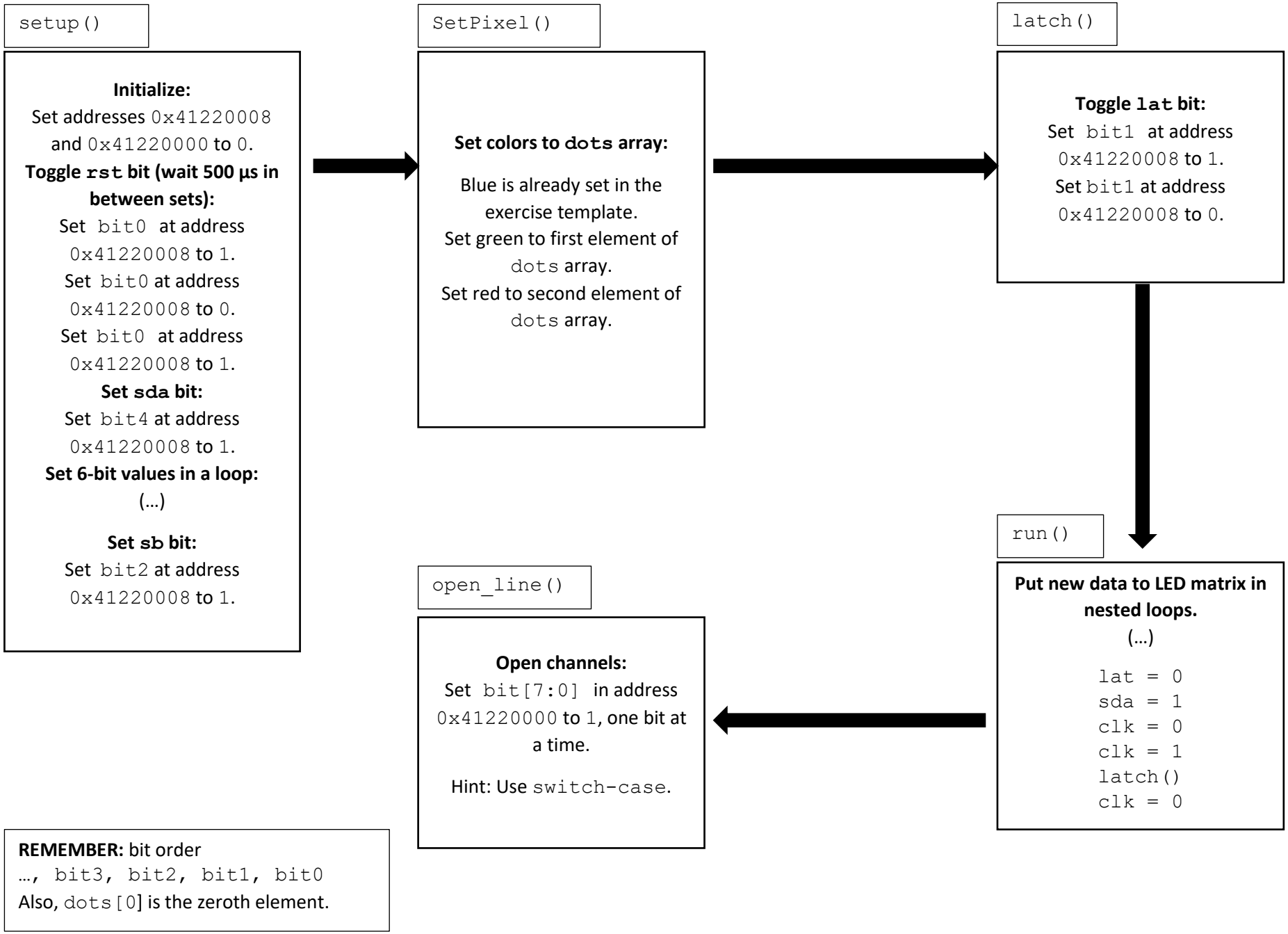
Tampere University

LED matrix block diagram

COMP.CE.100 Introduction to Embedded Systems

LED MATRIX BLOCK DIAGRAM



`setup():`

- This function will make the necessary initializations to setup the LED matrix for further use.
- Address `0x41220008` is for control signals and address `0x41220000` is for channels. We need to first initialize them by setting them to zero.
- After initializing the addresses, the LED matrix should be reset. This is done by toggling the `rst` bit ON and OFF.
- `SDA` bit should be set to 1 to be able to send serial data.
- Next 6-bit values should be set in the register of the DM163 chip. All bits in the register should be set to `1` because the values in the 6-bit register will be multiplied with an 8-bit register. 24 (3*8, for R, G and B) "bytes" should be transferred, so in total 24*6 bits should be sent in a loop structure.
- Finally, the `SB` bit should be set to 1 to transfer the data to the serial bank.
- For setting the bits, see for example COMP.CE.100_exercise_guide.pdf, page 16, 19-20.

`SetPixel():`

- In this function the color and location of the pixels in LED matrix is set in the `dots` array.
- The blue color is already set in the example. Green and red colors should be set (in this order) to the matrix as well.

`latch():`

- We need to toggle the latch bit ON and OFF to store the pixel data values to the register bank.
- Latch bit is `bit1` of control signals.

`run()`:

- Here we need to write the pixel data to the LED matrix driver.
- 3 nested loops are needed: the outermost loop should loop through pixels. The next loop should loop for colors (in order B, G, R) and the innermost loop should loop through the actual color data. Before loops, latch should be 0 (see `latch()`).
- In the innermost loop `SDA` should be set to 1 if `bit8` is set in the `dots` array. `SDA` bit is the `bit4` of the control signal address.
- Else, SDA should be set to 0.
- Finally, CLK should be toggled from 0 to 1 and the dots array should be shifted left by 1. CLK is the bit3 of the control signal address.

`open_line()`:

- We need to set all the bits in the channel address to 1 to open the columns and show the pixel data on the matrix.
- To do this, a switch-case statement can be used. The cases should be channel numbers from 0 to 7 and the channel bits should be set to 1 accordingly: channel number is the bit position, so channel 0 is bit0, etc.
- The default case should close all channels, so channels should be set to 0.

INTERRUPT HANDLERS

BUTTON/SWITCH INTERRUPT

`ButtonHandler()`

Check `Status` variable for button presses and switch toggles:

Buttons are `bit[3:0]`.

Switches are `bit[5:4]`.

Hint: Use `if`-statement.

REMEMBER: bit order
`…, bit3, bit2, bit1, bit0`

TIMER INTERRUPTS

`TickHandler()`

Refresh the LED matrix screen:

The channels should be turned ON individually.

Close all channels.
Call `run()` and `open_line()` on channel.
Increment channel.

`TickHandler1()`

Handle alien and shooting:

Call functions for alien movement and shooting here, according to your game logic.

Interrupt basics:

- Do not have to wait for button presses etc. in a loop (this is called *polling*).
- Instead, the normal program execution will be stopped and the execution time is given to interrupt handlers.
- After the interrupt, the normal program execution will continue from the point where it was before calling the interrupt.
- Some info is available in the exercise guide: COMP.CE.100_exercise_guide.pdf, page 11.
- More information will be given in the course `EE.ELE.250 Microcontrollers (5 cr)`.
- There are also some slides available in Finnish on Moodle `COMP.CE.100 Johdatus sulautettuihin järjestelmiin (5 cr)`.

`TickHandler():`

- This function is the timer interrupt handler for the LED matrix screen. The refresh rate is 800 Hz.
- This makes it look like there are many LEDs on at the same time, although they are ON individually and just updated very fast.
- To update the matrix, it should be first checked that the channel is not greater than 7.
- Next, all channels should be closed with the default case of `open_line()`.
- After this, the current channel should be run and opened, and the channel should be incremented.

`TickHandler1():`

- This function is the timer interrupt for the gameplay, i.e. moving the alien, shooting with the gun etc. The refresh rate is 10 Hz by default.
- The refresh rate can be changed by calling `change_freq()` function inside `ButtonHandler()`. It can be assigned to `SW1`, for example.
- It would be good to implement the gameplay functions in `Pixel.c` and call them in this timer interrupt function.

`ButtonHandler():`

- This function is the button/switch interrupt for the gameplay controls, i.e. moving the alien, shooting with the gun etc. The frequency is 10 Hz by default.

- Use `Status` parameter to check which button caused the interrupt.
- `BTN0` is bit0, `BTN1` is bit1, `BTN2` is bit2, `BTN3` is bit3, `SW0` is bit4, `SW1` is bit5
- Bank information is not needed.
- Call ship movement functions accordingly.
- The frequency can be changed with `change_freq()` function. It can be assigned to `SW1`, for example.