**Exercise Set 3. EE5167, Aug-Dec 2023**.
Date: 30/09/23. Submission date: 07/10/23.
The exercise set will not be marked, but can be used in quizzes and the final exam.

I2C spec: https://www.i2c-bus.org/fileadmin/ftp/i2c_bus_specification_1995.pdf

**1**. Consider a test setup in which 3 devices are connected in a JTAG loop. The size of IR for them are 4, 6 and 5 respectively and the IDCODE instruction is 10..01 for all of them (.. equals 0 as many needed). The ID strings for them are 20, 30 and 23 bits long respectively.
A. Draw a schematic showing the connections between the devices and the JTAG wiring.
B. Write pseudo code to be executed on the computer to change the JTAG lines to extract the ID strings from all the devices.

**2**. From the description of the UART (8,N,1), I2C (7bit addressing) and Flexray protocols (only static slots considered).
A. Plot data efficiency (data bits sent / total bits sent) vs the size of data. The range of data size should be from 1B to 10kB.
B. Plot energy needed to transmit vs the packet size. Make assumption if needed and use online resources to find missing parameters.The data size should vary from 1B to 10MB (i.e. a short video clip).

**3**. Suppose you are given a mass flow controller (MFC) which measures and controls the rate of flow of gases passing through a steel pipe (about 6mm diameter). These are very commonly used in semiconductor processing as well as other precision chemical processes. It measures the flow by passing a small part of the flowing gas through a heated area where the heat captured by the gas is proportional to its mass. At a later point it measures the heat captured to back calculate the flow. Feedback control is used to allow more or less gas to pass through a small opening, operated by a solenoid.

Due to non-ideal behaviour of the gases, the heat capture and flow characteristics are not linear and one needs to use calibration matrices to find the size of the opening.

You are going to design/specify an I2C interface for it. The MFC offers the following functionality.
- Get and set the value of the flow
- Get and set the type of gas flowing
- Get and set the temperature of the main flow tube as well as the temperature of the side tube (used to determine the flow rate)
- Get and set the calibration matrix (assume n x m dimensional rectangular)
- Get and set PID control parameters (say p1, p2, p3)
- Start a calibration process which takes 10 s to finish and the device can’t accept any commands during that period

- Get and set the I2C address of the device (initially all devices have address 0x60).
- Reset to factory settings and reboot

Multiple of these (say ~8) MFCs will be connected on the same I2C bus as slaves.

Make reasonable assumptions and design the register interface (register address and command strings) of the MFCs. For each of the functions described above, show how the interaction between the master (computer) and slave (MFCs) will occur.