(18/20)

First Name: Patrick   Last Name: Llanos
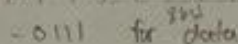
This test has total 20 points. Please be sure to provide a step-by-step result for the questions that involve calculation.

1. (5 points) Answer the following questions:

1.1 (1 point) What is the function of special purpose registers for ARM CPU (e.g., LPC1769), what is SSP1CR0, how many bits are functional usable for this register?

- The function of the special purpose register is for the initialization and configuration of SSP in the CPU
- SSP1CR0 is the used for enabling the SSP1 port for use.   (16 - bit functional)

1.2 (1 point) Given the following design requirement (technical specifications), use datasheet to fill in a binary pattern for (1) SPI interface; (2) 8 bit data packets; and (3) use other default clock settings to realize this interfaces (suppose SCR=128).

| * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

- 0111 for data

SCR = 129

[7 6] [5:4]   clock setting
[3:0]   data bits size for 8-bit
SPI interface

1.3 (1 point) Suppose SPI Flash serial interface is designed with 66Mhz clock rate, estimate the highest possible data read rate? Can it be used for 104x768 8bit (5 frames per second) video display?

$104 \times 768 \times 8 bit \times 5$ frames $= 3194880 = 3.2$ Mb

yes it can be used for this video display

1.4 (1 point) In your prototyping board power unit design, LED is needed when the power connection is on, design a simple circuit to realize this function and calculate the resistor value if needed (Suppose I = 8mA)?

assume $V_{LED} = 1.8V$, $V_{cc} = 5V$
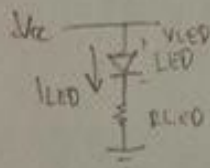
$V_{cc} = I_{LED} R_{LED} + V_{LED}$ ⟹ $R_{LED} = \dfrac{V_{cc} - V_{LED}}{I_{LED}} = \dfrac{5V - 1.8V}{8 \times 10^{-3}A} \approx 400\,\Omega$

1.5 (1 point) Suppose the address for SSP1CR0 is 0x40030000, which memory bank holds this special purpose register? find the starting address of this memory bank?

32 - bit memory Bank ✗

starting address : 0 ✗

−1   4/5

1

2. (5 points). Complete CPU to SPI serial flash interface design by answering the following questions:
  2.1   (1 point) Name each of the SPI pin of the CPU for interface design?
  2.2   (1 point) Design CPU to SPI serial flash interface by drawing detailed schematics, be sure to name each pin functionality (no pin number needed)?
  2.3   (2 points) Draw a protocol timing diagram for SPI buffer write operation, use dashed line to divide them to 3 functional segments according to the SPI interface protocol, and explain the function for each segment?
  2.4   (1 point) What is the hex command for reading manufacturer ID and device ID read, calculate the time interval for this command if SPI is operating at 1 MHz speed?

2.1) MOSI - Master output Slave input
     MISO - Master input Slave output
     SCK   - serial clock
     SSEL - Slave select

2.2)
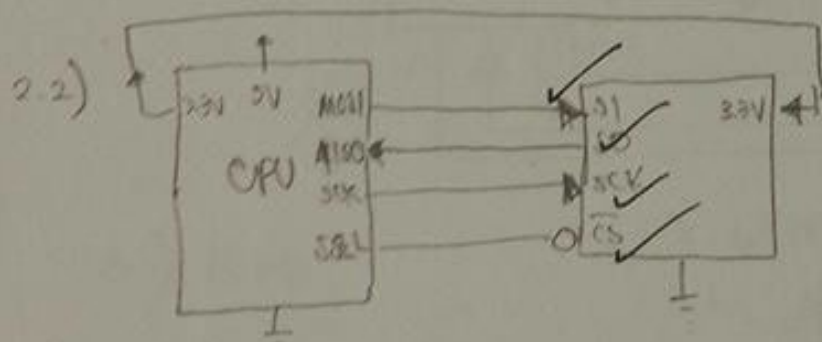
SI - serial input
SO - serial output
C̄S̄ - chip select (active low)

2.3)

opcode
write

3 byte address
+
don't cares

payload
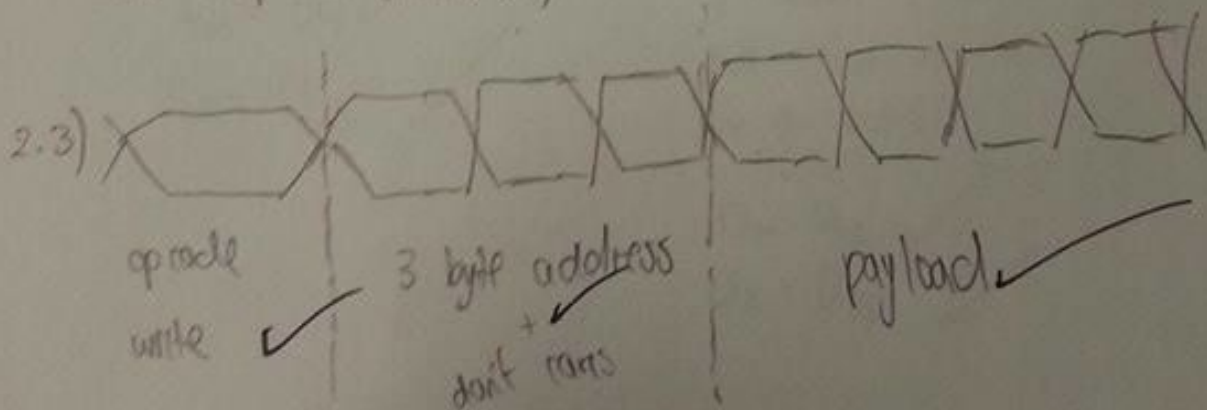
good
5/5

2.4) hex command for manufacturer ID and Device ID is $0x9F$

$T_b = \frac{1}{1\,MHz} = 1\times10^{-6}\ sec \times 8\ bits = 8\times10^{-6}\ sec$

2

3. (5 points) Given below is a unfinished ROM memory interface design, suppose CPU is on the left and ROM is on the right, answer the following questions,

3.1 (1 point) Suppose the ROM is 16 MB (8 bit data width), what is Ax=? And Am=?

3.2 (3 points) If 64 MB ROM is to be designed with duplication of four ROMs above, find Ax=? And Am=?

3.3 (1 point) Complete the schematic below for 3.1 design with control signals, be sure to design the control signal with proposer active high or active low (add small circle on each active low signal in your design).

$D_n = B_7$

Dn — Am — a_0

CPU — Ax — a_{23}

nCS — nWR — nRD

$D_n = D_7$ — Am — $A_m = a_0$

ROM — Ax — $A_x = a_{23}$
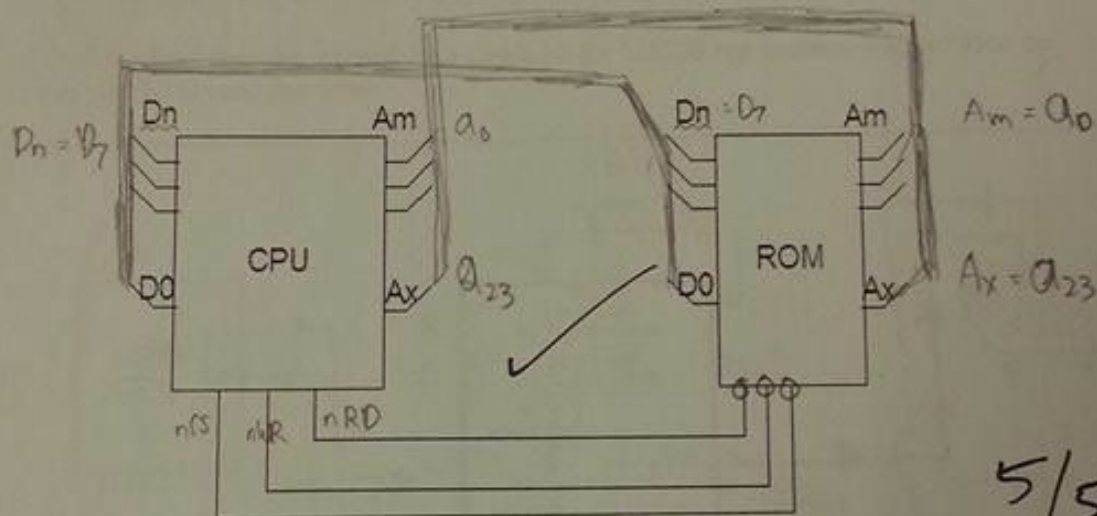
3.1) 16 MB
$= 2^4 \cdot 2^{20} = 2^{24}$
↓   ↓
16   1MB

$A_m = a_0$ ✓
$A_x = a_{23}$ ✓

3.2) 64 MB
$2^6 \cdot 2^{20} = 2^{26}$
↓   ↓
64   MB

because we are using
4 ROMs, we use the
first 2 bits as selects
for the ROMs.
$\%_0 a_1 a_2 \cdots a_{25}$
$a_m = a_2$ ✓
$a_x = a_{25}$ ✓

5/5

3.3) nCS — chip select
nWR — write enable
nRD — read enable ✓

n indicates active low signal

4. (5 points) RS232 serial interface is one of the key interfaces for debugging the microprocessor system, based on the system block diagram below, answer the following questions:

4.1 (1 pt) Suppose a letter with hex 0xF3 to be send, what is the first bit (LSB) voltage value at CPU TX? And what is the voltage value at MAX T_out?

4.2(2 pts) complete the un-finished design below (a) draw the pins with pin number for Tx and Rx of the CPU; (b) form a serial data bus by connecting these pins to MAX232; (c) then connect the MAX232 output to DB9 connector (assume the connector is the one on your prototype board, not on the host computer side, and assume null modem cable is used).

4.3(2 pts) Find the time interval for a single bit for 115200 bps communication? Find the time needed to send this letter?

pin 2 DB9- Rx
pin 3 DB9-Tx

4/5
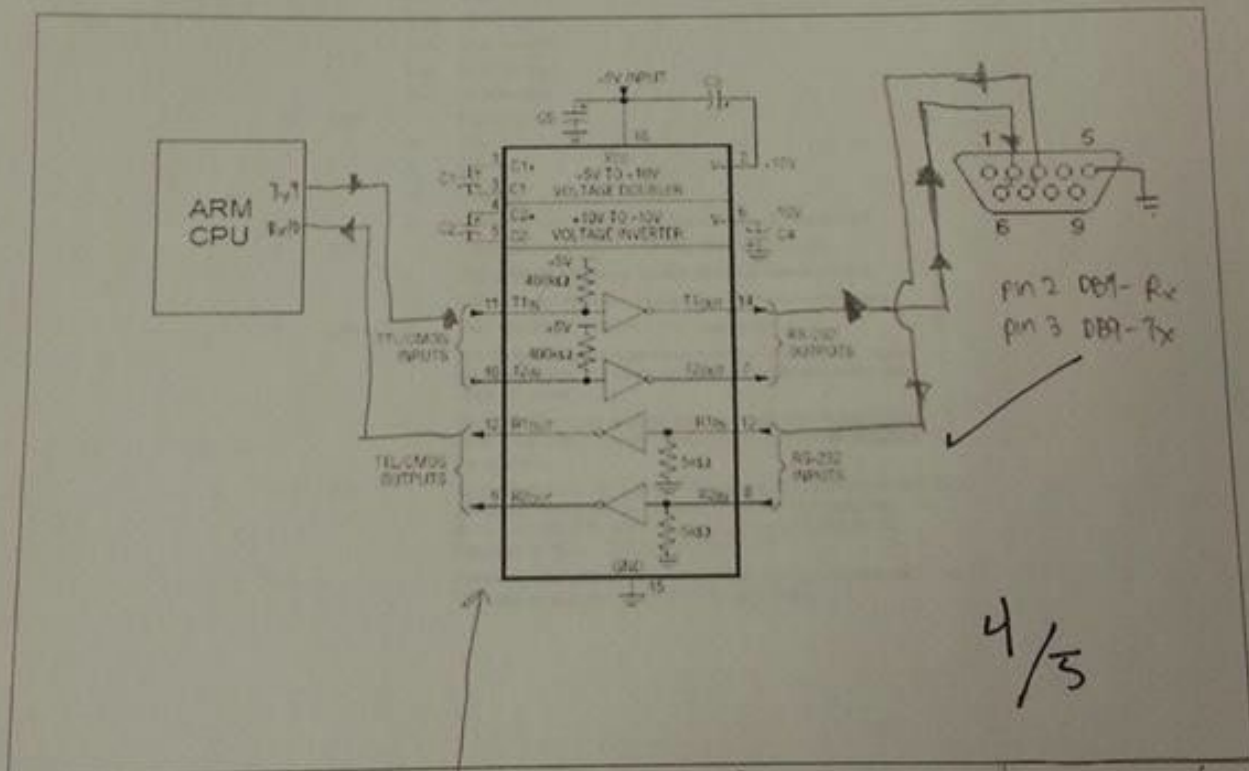
4.1) MAX232

logic 1 -2.5V - -18V
logic 0 2.5V - 18V

0x F 3
→ 0.1111 011 1 | 1 ← stop bit
start bit
LSB   MSB
X -1

CPU Tx = 0V
MAX T_out = 2.5V - 18V

4.2)

4.3) $\dfrac{1}{115200}\dfrac{s}{bit}$ = $\boxed{8.681 \times 10^{-6}\ \dfrac{sec}{bit}}$

time needed to send letter 0x F3
w/ start and stop bit = 10 bits total

$\left(10\right)bits \times 8.861 \times 10^{-6}\dfrac{sec}{bit}$ = $\boxed{8.681 \times 10^{-5}\ seconds}$