Review Questions *(Week 1)*

CS397

Review Questions

General:

1. What is an embedded system? Give a few examples of it.
   - An embedded system is an integrated microcontroller system that is designed for a specific function. Examples include washing machines, printers, mobile phones, digital cameras and setop boxes.
2. List 2 differences in characteristics of microcontrollers versus microprocessors.
   - Microcontrollers are self-contained and complete micro-computer units with integrated memory, peripherals, power management and so on. Microprocessors do not usually have integrated peripherals and would require external interfacing to work as a complete computer system.
   - Microcontrollers are used in well-defined application like mobile phones, washing machines, automobiles, … Microprocessors are for general-purpose computing like desktop computers, data servers, …

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3. Differentiate between the Harvard & Von-Neumann architectures of memory system. What architecture does the Cortex-M4 uses?

    * In the Harvard architecture, program and data memory can be separately accessed and therefore can be accessed in parallel. In the Von-Neumann architecture, the program and data memory shared the same memory space.
    * The Cortex-M4 implements separate buses for instruction (Icode bus) & data (Dcode bus) - *see below*. Therefore, it implements a Harvard architecture.

Separate I- & D-buses =>
Harvard architecture
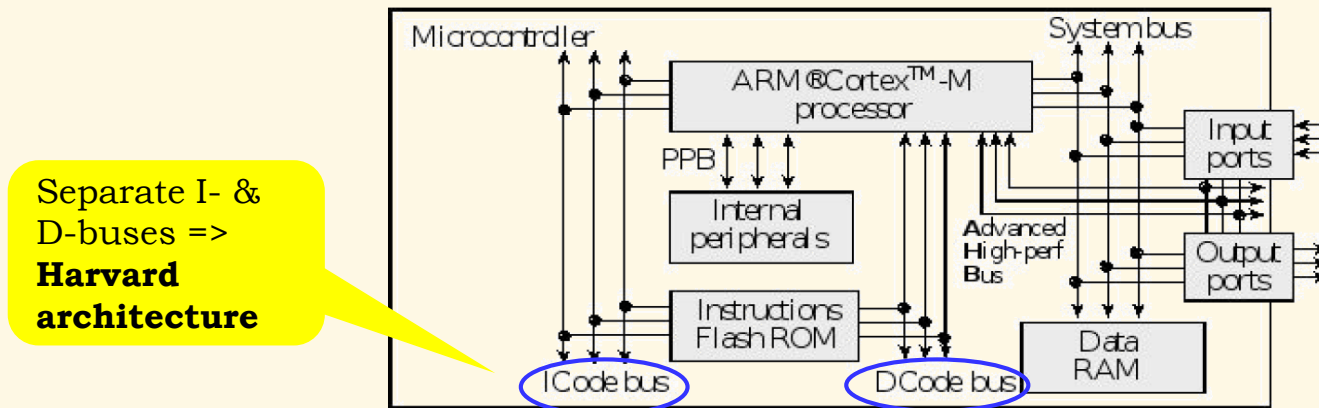
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4. What is the name of the microcontroller used on the Tiva LaunchPad TMC123G?
    *   TM4C123GH6PM from Texas Instruments.
    *   Core processor is an ARM Cortex-M4F.
5. Explain the operating states & operating modes of the ARM Cortex-M4 CPU.
    *   Operating States: Debug & Thumb
        *   **Debug** state is entered when the CPU is halted (by the debugger, or after hitting a breakpoint) and the CPU stops executing instructions.
        *   **Thumb** state the state where the CPU is running program code.
    *   Operating Modes: Thread & Handler
        *   **Thread** mode is the mode the CPU is in when executing normal program code
        *   **Handler** mode is entered when the CPU is handling exceptions, for example, ISR. When the processor finishes exception handling, it returns to Thread mode.

Review Questions

Tiva LaunchPad TMC123G:

6. What is the maximum CPU clock speed programmable on the Tiva LaunchPad?
   - 80MHz

7. What is the maximum program size possible on the Tiva LaunchPad?
   - 256K bytes.

8. Do the LaunchPad connects (J1 to J4) provide +5V and +3.3V outputs? Specify which ones.
   - Yes, both.

9. How many GPIO ports do the LaunchPad has? List them.
   - Up to 43 GPIOs with 35 brought out to the connectors
   - PA[7:0]; PA0 & PA1 used for Virtual COM port (not brought out on LaunchPad).
   - PB[7:0]
   - PC[7:0]; PC[3:0] used for JTAG debug (not brought out on LaunchPad).
   - PD[7:0]; PD[5:4] used for USB signals (not brought out on LaunchPad).
   - PE[5:0] – 6 pins
   - PF[4:0] – 5 pins

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Tiva LaunchPad TMC123G:

10. Which GPIO pins are SW1 and SW2 connected to?
11. Which GPIO pins is the color LED connected to?

GPIO Pin	Pin Function	USB Device
PF4	GPIO	SW1
PF0	GPIO	SW2
PF1	GPIO	RGB LED (Red)
PF2	GPIO	RGB LED (Blue)
PF3	GPIO	RGD LED (Green)

12. Is PC[3:0] available on the LaunchPad connectors (J1 to J4)? What are they used for?
    - No; used for ICDI (debugging).
13. Which GPIO pins can be used for analog inputs (Ain)? List all of them.
    - PB4 (Ain10), PB5 (Ain11), PD0 – PD3 (Ain7 - Ain4), PE0 – PE5 (Ain3 – Ain0, Ain9 – Ain 8).
14. What is the Alternate Function for GPIO port pin PA0?
    - U0Rx & CAN1Rx

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Tiva LaunchPad TMC123G:

15. Explain how the GPIO Port Control (GPIOCTL) register bits are used to select an alternate GPIO function.
    - GPIOCTL register has a 4-bit field to select which alternate GPIO function to map to.

| J1 Pin | GPIO | Analog Function | On-board Function | Tiva C Series MCU Pin | GPIOPCTL Register Setting | | | | | | | | | | |
		GPIO AMSEL			1	2	3	4	5	6	7	8	9	14	15
1.01					3.3 V										
1.02	PB5	AIN11	–	57	–	SSI2Fss	–	M0PWM3	–	–	T1CCP1	CAN0Tx	–	–	–
1.03	PB0	USB0ID	–	45	U1Rx	–	–	–	–	–	T2CCP0	–	–	–	–
1.04	PB1	USB0VBUS	–	46	U1Tx	–	–	–	–	–	T2CCP1	–	–	–	–
1.05	PE4	AIN9	–	59	U5Rx	–	I2C2SCL	M0PWM4	M1PWM2	–	–	CAN0Rx	–	–	–
1.06	PE5	AIN8	–	60	U5Tx	–	I2C2SDA	M0PWM5	M1PWM3	–	–	CAN0Tx	–	–	–
1.07	PB4	AIN10	–	58	–	SSI2Clk	–	M0PWM2	–	–	T1CCP0	CAN0Rx	–	–	–
1.08	PA5	–	–	22	–	SSI0Tx	–	–	–	–	–	–	–	–	–
1.09	PA6	–	–	23	–	–	I2C1SCL	–	M1PWM2	–	–	–	–	–	–
1.10	PA7	–	–	24	–	–	I2C1SDA	–	M1PWM3	–	–	–	–	–	–

(1) Shaded cells indicate configuration for compatibility with the MSP430 LaunchPad.
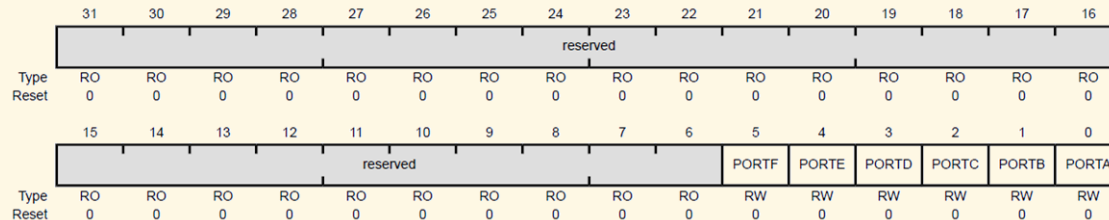
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16. What is the difference between the APB and the AHB bus?
    - APB bus is legacy bus for backward compatibility. It is a slower bus. GPIO port pins connected to the APB bus can change/toggle every 2 clock cycles.
    - GPIO pins connected to the AHB bus can can change every clock cycle.
17. How do we select a GPIO port to be connected to the APB or AHB bus?
    - We select through the GPIO High-Performance Bus Control (GPIOHBCTL) register (*below*).
    - If bit for the GPIO port is a '1', the port is connected to AHB. If it is '0', the port is connected to APB.

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
								reserved								
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
					reserved						PORTF	PORTE	PORTD	PORTC	PORTB	PORTA
Type	RO	RO	RO	RO	RO	RO	RO	RO	RO	RO	RW	RW	RW	RW	RW	RW
Reset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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18. Name the 3 SysTick registers and briefly describe their functions.
    - **Reload register** (STRELOAD): loads the starting value of SysTick Timer Counter.
    - **Current register** (STCURRENT): returns the current value of SysTick Timer Counter.
    - **Control Register** (STCTRL): sets SysTick Timer functions including enable & interrupts.
19. List the base address of the SysTick registers?
    - 0xE000.E000.
20. What is the maximum count for the SysTick timer? How does this value come about?
    - 16,777,216. Total count = 2^{24} (24 bit counter)
21. If the CURRENT SysTick count is 0x00FF.1234. What is the next count value?
    - 0x00FF.1233 (count down).
22. If the CURRENT SysTick count is 0x0100.1000. What is the next count value?
    - The SysTick Timer is a 24-bit counter. This is an invalid value.
    - If the SysTick CURRENT value = 0x0010.1000, the next count value = 0x000F.FFFF.

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23. What happens when we write to the STCURRENT register?
    - It resets the COUNT bit in the SysTick CONTROL register.
24. If 300 SysTicks are needed between SysTick interrupts, what is the value of RELOAD to use?
    - 300 – 1 = 299.
25. If bus frequency is 50MHz and we require a SysTick interrupt interval of 1ms, what is the RELOAD value to use?
    - RELOAD = 1ms X 50MHz -1 = 50,000 – 1 = 49,999.