EECS 395/495 Engineering System Design 1

Task 1

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3.

Components	Recommended Operating Voltage Limits		
	I/O	Analog	Core
SAM4S8B (MCU)	1.62V to 3.6V	1.62V to 3.6V	1.08V to 1.32V
AMW136 (WiFi Card)	min: 3.0V; max: 3.6V; typical voltage: 3.3V (all for MCU VBAT pin, MCU subsystem and WLAN subsystem)		
	I/O	Analog	Core
OV2640 (Camera Chip)	1.7V to 3.3V; typical voltage: 2.8V	2.5~3.0VDC	1.2VDC ± 5%

They are compatible. Because these three components have common operating voltage region.

4. We want a 12MHz crystal with load capacitance of 18pF.
According to Digikey, we choose:
ABLS-12.000MHZ-B4-T

Packing	Series	Type	Frequency	Frequency Stability
Cut Tape (CT)	ABLS	MHz Crystal	12MHz	± 50 ppm
Frequency Tolerance	Load Capacitance	ESR	Operating Mode	Package/Case
± 30 ppm	18 pF	50 Ohms	Fundamental	HC49/US

5.
1) If we use single power supply strategy:
  a) Considering about the **typical voltage**:
For MCU, since its main supply should be no less than 3V to make it usable, we can provide 3.3V to it. For AMW136, we should provide the typical voltage 3.3V to it. Therefore, these two components can share 1 voltage regulator.
For OV2640, we should provide the typical voltage 2.8V to it. Therefore we need an extra 1 voltage regulator for this chip.
Also, for OV2640, we should provide 1.2VDC to its core, since there is no internal voltage regulator in it.
Therefore, we need **3** voltage regulators under single power supply strategy.
  b) Considering about the voltage limits, we only need 2 voltage regulators.

2) If we use dual power supply strategy:
  a) Considering about the **typical voltage**:
For MCU and AMW136, we can use the same voltage regulator to provide their Main Supply

(3.3V). This needs 1 voltage regulator. Note that this regulator can also provide Analog Supply to MCU.

For OV2640, we should provide the typical voltage 2.8V to it. Therefore we need an extra 1 voltage regulator for this chip. Note that this regulator can also provide Analog Supply to OV2640.

For MCU and OV2640, we also need 1 voltage regulator to provide its Core. We can provide 1.2V to both of them.

Therefore, we need **3** voltage regulators under dual power supply strategy.

b) Considering about the voltage limits, we only need 2 voltage regulators.

However, in order to get a more stable system, we will use typical voltage to design our system. Thus, we need **3** voltage regulators under single power supply strategy, or **3** voltage regulators under dual power supply strategy.

6. We choose **ISL80510IRAJZ-T7A**

Number of Regulators	Voltage Input (Max)	Voltage Output (Min)	Voltage Output (Max)	Current Output
1	6V	0.8V	5.5V	1A

7. According to Digikey and Amazon, we find the price for each component:

Components	Numbers of units in One System	Costs per Unit
ATSAM4S8BA-AU-ND (MSU)	1	$ 4.67 for 1 unit
AMW136-3.2.0R	1	$ 24.68 for 1 unit; $ 16.659 for 500 units
OV2640	1	$ 10 for 1 unit
ABLS-12.000MHZ-B4-T	1	$ 0.25 for 1 unit; $ 0.12216 for 1000 units
ISL80510IRAJZ-T7A	3	$ 1.19 for 1 unit; $ 0.75 for 250 units

Therefore, the system cost of producing 1 unit is:

$$4.67+24.68+10+0.25+1.19\times 3=\$43.17$$

The single unit cost for producing 5000 units is:

$$4.67+16.659+10+0.122+0.75\times 3=\$33.7$$

8. 500 mAh battery. All of the calculation is under typical condition with temperature = 25℃.

(a) According to Digikey and data sheet, we can find and calculate the current consumption for 3 main components when the system is constantly awake:

Components	Awake Current
MCU	6 mA
AMW136	Current Transmitting: 11.4 mA
OV2640	71 mA

Therefore:

$$T = \frac{500mAh}{(6+11.4+71)mA} = \frac{500mAh}{88.4mA} = 5.66h$$

The battery can last 5.66 hours.

(b) According to the data sheet, we can find the stand-by current for 3 components:

Components	Stand-by Current
MCU	1 μ A
AMW136	3.8 μ A
OV2640	600 μ A

Therefore:

$$T = \frac{500mAh}{604.8\mu A} = 826.7h$$

The battery can last 826.7 hours in the lowest power sleep mode.

(c) When the system works in full power for 5 seconds and then sleep for 55 seconds in every minute,

$$P = 88.4mA \times \frac{5}{3600}h + 604.8 \times 10^{-3} mA \times \frac{55}{3600}h = 0.132mAh$$

this system will consume 0.132mAh in every minute.

Therefore,

$$T = \frac{500mAh}{0.132mAh \times 60} = 63.13h$$

The battery can last 63.13 hours.