Microcontroller Selection Rationale

Bring draft to class on Monday, January 29 (40 points)

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| --- | --- | --- | --- | --- | --- | --- |
| **Considerations** | **My Project Requirement**  (9 points) | [**Microchip AVR (formerly Atmel)**](http://www.microchip.com/selection-tools)  (16 points) | [**Cypress**](http://www.cypress.com/psoc/?source=CY-ENG-HEADER)  (16 points) | [**Microchip PIC**](http://www.microchip.com/selection-tools)  (16 points) | [**NXP Semiconductors**](http://www.nxp.com/webapp/parametricSelector.sp)  (16 points) | [**Texas Instruments**](http://www.ti.com/ww/en/parametric_selection_tool/index.html)  (16 points) |
| URL to product page |  | [www.microchip.com](http://www.microchip.com/wwwproducts/en/ATxmega16D4) | <http://www.cypress.com/part/cy8c29466-24sxi> | <http://www.microchip.com/wwwproducts/en/PIC18F47K40> | <https://www.nxp.com/part/S9S08RN32W1CLF> | [www.mouser.com](https://www.mouser.com/ProductDetail/Texas-Instruments/TM4C1231D5PMT7?qs=sGAEpiMZZMuoKKEcg8mMKHR%2fPwIi1PQcwTzbmZyqs%252bJu1hzUlMo4ZQ%3d%3d) |
| Part Number[[1]](#footnote-1) |  | ATXMEGA32D4-AU | CY8C29466-24SXI | PIC18F47K40 | S9S08RN32W1CLF | TM4C1231D5PMT7 |
| Unit Cost[[2]](#footnote-2) |  | $2.75 | $4.86 | $1.37 | $1.39 | $7.46 |
| # of GPIO Pins[[3]](#footnote-3) | >=20 | 34 | 24 | 40 | 39 | 43 |
| Architecture[[4]](#footnote-4) | 8 bit | 8/16 bit AVR | 8-bit | 8-bit | 8 bit | 32-bit ARM |
| Power Consumption[[5]](#footnote-5) | 3.3V - relatively low current b/c battery-powered | 1.6-3.6V | 3.0-5.25V | 1.8-5.5V | 2.7-5.5V | 1.08-3.63V |
| Internal Features Required[[6]](#footnote-6) | >= 1 I2C, >= 2 SPI, (UART and 3 I2C would be nice) | 2 I2C, 4 SPI, 2 UART | 1 I2C, 4 SPI, 4 UART | 2 SPI / I2C  2 UART | 2 SPI, 1 I2C | 6 I2C, 4 SPI, 8 UART |
| IDE[[7]](#footnote-7) Name, Cost, and URL |  | Atmel Studio 7  (free)  [www.microchip.com](http://www.microchip.com/avr-support/atmel-studio-7) | PSoC Creator  (free)  <http://www.cypress.com/documentation/software-and-drivers/psoc-programmer-archive> | MPLAB X IDE/MPLAB Code Configurator  (free)  <http://www.microchip.com/mplab/mplab-x-ide> | CodeWarrior (Eclipse)  (free)  [https://www.nxp.com/support/developer-resources/software-development-tools/codewarrior-development-tools/](https://www.nxp.com/support/developer-resources/software-development-tools/codewarrior-development-tools/codewarrior-legacy/codewarrior-development-studios/codewarrior-for-microcontrollers/codewarrior-for-mcus-eclipse-ide-coldfire-56800-e-dsc-kinetis-qorivva-56xx-rs08-s08-s12z-v11.0:CW-MCU10?tab=Design_Tools_Tab#nogo) | [GNU C/C++ Compiler](http://gcc.gnu.org/) (Eclipse)  (free)  [https://developer.arm.com](https://developer.arm.com/open-source/gnu-toolchain/gnu-rm) |
| Compiler Availability | C or C++ | C/C++ | C/C++ | C/C++ | C | C/C++ |
| Programming Hardware Cost and URL | Cheaper is better Hopefully cheap enough to get more than 1 | USB ISP 3.3V / 5V AVR Programmer  ($3.95)  [www.oddwires.com](http://www.oddwires.com/usb-isp-3-3v-5v-avr-programmer/?gclid=EAIaIQobChMIwtSvqfP72AIVTlp-Ch06kA5EEAQYBCABEgL00fD_BwE) | ICE-Cube  ($99)  <http://www.cypress.com/documentation/development-kitsboards/cy3215a-dk-circuit-emulation-lite-development-kit> | PICkit 3  ($47.95)  <http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=PG164130> | UMultilink  ($200)  <https://www.nxp.com/products/processors-and-microcontrollers/additional-processors-and-mcus/8-16-bit-mcus/8-bit-s08-mcus/8-bit-eeprom-with-tsi-for-body-electronics-mcus:S08RN?fpsp=1&tab=Design_Tools_Tab> | ST-Link v2 Programmer  ($12.50)  [www.adafruit.com](https://www.adafruit.com/product/2548?gclid=EAIaIQobChMIuP-Z_bD82AIVDId-Ch0CqATAEAQYBCABEgJsqfD_BwE) |
| ISP[[8]](#footnote-8) Capability and Type |  | AVR067: JTAGICE mkII Communication Protocol | Emulator, debugging, programming | PICkit 3 In-Circuit Debugger/Programmer | Emulator, debugging, programming | eTM4C1231D5PM JTAG |
| Available IC Packages[[9]](#footnote-9) |  | AU, AUR, CU, CUR, M7, MH, M7R, MHR (surface mount) | SOIC | PDIP & TQFP | LQFP | SMD/SMT |
| Link(s) to Data Sheets |  | <http://www.microchip.com/wwwproducts/en/ATxmega32D4> | <http://www.cypress.com/file/139271/download> | <http://ww1.microchip.com/downloads/en/DeviceDoc/40001816E.pdf> | <https://www.nxp.com/products/processors-and-microcontrollers/additional-processors-and-mcus/8-16-bit-mcus/8-bit-s08-mcus/8-bit-eeprom-with-tsi-for-body-electronics-mcus:S08RN?tab=Documentation_Tab&linkline=Data%20Sheet&fpsp=1> | [www.ti.com](http://www.ti.com/lit/ds/symlink/tm4c1231d5pm.pdf) |
| Link(s) to Application Notes |  | <http://www.microchip.com/wwwproducts/en/ATxmega32D4> | <http://www.cypress.com/part/cy8c29466-24sxi#technical-documents> | <http://www.microchip.com/wwwproducts/en/PIC18F26K40> | <https://www.nxp.com/products/processors-and-microcontrollers/additional-processors-and-mcus/8-16-bit-mcus/8-bit-s08-mcus/8-bit-eeprom-with-tsi-for-body-electronics-mcus:S08RN?fpsp=1&tab=Documentation_Tab> | [www.ti.com](http://www.ti.com/product/TM4C1231D5PM/technicaldocuments) |
| Link(s) to Code Examples |  | <http://ww1.microchip.com/downloads/en/DeviceDoc/50002633A.pdf>    <http://ww1.microchip.com/downloads/en/DeviceDoc/50002712A.pdf> | <http://www.cypress.com/documentation/code-examples/psoc-1-code-examples> | <https://www.microchip.com/doclisting/TechDoc.aspx?type=CodeExamples> | <https://www.nxp.com/products/processors-and-microcontrollers/additional-processors-and-mcus/8-16-bit-mcus/8-bit-s08-mcus/8-bit-eeprom-with-tsi-for-body-electronics-mcus:S08RN?fpsp=1&tab=Documentation_Tab> | [www.ti.com](http://www.ti.com/product/TM4C1231D5PM/technicaldocuments) |
| Link(s) to Additional Documentation |  | [www.microchip.com/wwwproducts/en/ATxmega32D4](http://www.microchip.com/wwwproducts/en/ATxmega32D4) | <http://www.cypress.com/part/cy8c29466-24sxi#technical-documents> | <http://www.microchip.com/wwwproducts/en/PIC18F26K40> | <https://www.nxp.com/products/processors-and-microcontrollers/additional-processors-and-mcus/8-16-bit-mcus/8-bit-s08-mcus/8-bit-eeprom-with-tsi-for-body-electronics-mcus:S08RN?fpsp=1&tab=Documentation_Tab> | [www.ti.com](http://www.ti.com/product/TM4C1231D5PM/technicaldocuments) |
| Additional Considerations[[10]](#footnote-10)  *(optional)* | Program Flash Memory | 16kB | 32kB | 128kB | 32kB | 2kB |
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| Overall Pros |  | Meets wire requirements, low operating voltage, 8-bit control (simple programming) | Meets internal features required, Built in FPGA | Good website, plenty of pins and UART, cheap, free samples in 1 week, wide operating voltage range, available in both surface mount and through-hole packages | Meets internal features required, low price point, can run 3.3V and 5V, 8-bit control for simple programming | Contains more of the needed features than required. |
| Overall Cons |  | Small size (10mmx10mmx1mm) | Expensive programmer, higher cost, higher operating voltage (>3V) | More expensive programmer | Expensive programmer, only available in small package | 32-bit and MCU is more expensive than competitors. |
| Ranking  (1 low - 5 high) |  | 4 | 3 | 5 | 2 | 1 |

**Final Microcontroller Choice** *(10 points)*: PIC18F47K40

**Rationale** *(11 points)*: The PIC is the best because it has a wide input voltage range, adequate serial communication interfaces, plenty of I/O pins, and it uses 8-bit architecture. Additionally, it is the cheapest of the five options and Microchip provides plenty of documentation as well as a nice IDE and programmer/debugger. The PIC also has the most program storage space of the 5 options in addition to a large amount of RAM and EEPROM.

1. No PIC16F887, PIC16F917, dsPIC30F3014, ATMEGA128, or commercial kits allowed. Also note that the Arduino, Beaglebone Black, Raspberry Pi, etc. are development boards and are not allowed for this course). [↑](#footnote-ref-1)
2. In quantity, based on your Target Market from the Business Model Canvas. [↑](#footnote-ref-2)
3. General Purpose Input/Output Pins - calculate based on your block diagram and include at least 20% more than you need. Avoid using In-System Programming (ISP) pins for GPIO. [↑](#footnote-ref-3)
4. The higher the number of bits, the harder the microcontroller typically is to program. 8- or 16-bit microcontrollers are highly recommended. [↑](#footnote-ref-4)
5. Supply voltage and/or current draw. [↑](#footnote-ref-5)
6. e.g., analog to digital converters (ADCs), external interrupts, pulse-width modulation (PWM), serial-peripheral interface (SPI), universal asynchronous receiver-transmitter (UART). [↑](#footnote-ref-6)
7. Integrated Development Environment - the software used to program the microcontroller (e.g., PSoC® Creator, MPLAB X). [↑](#footnote-ref-7)
8. In-System Programming - ability for the microcontroller to be programmed without removing it from the circuit board [↑](#footnote-ref-8)
9. Recommended: Choose a microcontroller with both surface mount and DIP/through-hole packages available. Avoid Ball-Grid Array (BGA) or Flip Chips/dies [↑](#footnote-ref-9)
10. Additional considerations specific to the criteria and constraints for your project [↑](#footnote-ref-10)