**Assignment 2 – Computer Organization**

**Part A – System Architecture.**

**A:** ATMEGA4809 Micro-controller.

An integrated chip that houses all the core components of a basic computer system including a processor, RAM, flash storage and EEPROM for storing the basic program (IoT Guider, Para 2).

**B:** ISP Flash and USB Controller.

Contains ISP flash and a USB controller to enable interaction between the USB I/O and the Micro-controller (IoT Guider, Para 5).

**C:** I2C SMBus (System Management Bus).

Provides a bus that can be used to link one Arduino device as a master to one or many slave or other master devices. Controls the interaction between these devices and sends data between them (How To Mechatronics).

**D:** Capacitors.

Like a battery in function but can supply power quicker and holds less charge. Used to maintain consistency of power throughout the system (The Engineering Mindset).

**E:** Power port.

Supplies 7V – 12V of power to the Arduino from an external power device. Either an AC to DC adapter or a battery (IoT Guider, Para 4).

**F:** Step-Down Converter.

Receives up to 21V of power and provides and output of 5V at 1.2A (MPS, Para 1) to be used by other Arduino components at the correct voltage for the system.

**G:** SMB Diode.

A diode for maintaining the flow of power through the device. Has a high resistance on one side, and low on the other to control the flow of electricity to only move in one direction.

**H:** RGB LED.

A programmable RGB LED light that can be controlled by the microcontroller (IoT Guider, Para 7).

**I:** RX/TX LED.

LED lights that flash when data is being transferred to or from the USB chip and a computer (IoT Guider, Para 9).

**J:** Voltage Regulator.

Regulates the power going into the Arduino unit to avoid damage to the system due to too much power ( > 12V ) (IoT Guider, Para 14).

**K:** IMU (Inertial Measurement Unit).

Can be used to measure external movement, temperature or orientation using an accelerometer and gyroscope (IoT Guider, Para 8).

**L:** Monostable Vibrator.

Has a set of flip-flop transistors that change between outputs based on input from another source. Has three methods of controlling output pulse duration. When A input is low and B is high, when A is high and B is low, and when A is low, B is high and a clear input (CLR) goes high (Reichelt, para 2).

**M:** SMD Crystal Resonator.

Uses a quartz crystal and a piezoelectrical current to set the clock timing for the device (16MHz).

**N:** Master reset button.

Sends a pulse to the reset pin of the micro-controller to reset the Arduino unit to the start of the program (IoT Guider, Para 10).

**O:** Crypto Chip

An onboard crypto processor that handles encryption, tamper and intrusion detection, and key protection for the device (Semi Engineering, Para 1).

**P:** Small Outline Transistor.

A very small transistor used to correct the flow of current in the system. Increases the voltage when it drops below the required value necessary to the system.

**Q:** Digital Potentiometers.

Adjusts the level of the signal passing through it by using a “stepping ladder” architecture. Often used to control volume levels, speed of a motor, or brightness levels of external LED’s (Core Electronics, Para 1).

**R:**

1. USB Connector.
2. A computer for programming the Micro-controller, a power lead for powering the unit.
3. A USB type-B connector used as the main connection to a Computer for programming the Micro-controller using the boot loader (IoT Guider, para 3). Can also be connected to an external power device to supply power to the Arduino system. Provides 7 – 12 volts of power and 60MB/s bandwidth (Wikipedia).

**S:**

1. Digital I/O Pins
2. Connect to external devices e.g., motors, LED’s, sensors, switches, speakers etc.
3. The primary I/O ports for the Arduino device. A set of serial digital input/output ports that can be connected to a wide variety of external devices to provide data transmission or up to 40mA of power. Some plugs provide full digital output, and others simulate analog output. Send one bit worth of data at a time, for each plug, or more accurately, a constant stream of either high or low voltage that is read as one bit per hertz cycle (Arduino).

**T:**

1. ICSP Header Pins.
2. Connects to a computer.
3. Used to program the Arduino’s microcontroller without requiring the bootloader. Instructions can be sent directly to the microcontroller. Often used if the bootloader is damaged, or not present (IoT Guider, Para 15).

**U:**

1. Wi-Fi Module
2. Connects to Wi-Fi networks and Bluetooth enabled devices.
3. Uses a NINA-W10 Wi-Fi chip to connect to Wi-Fi networks and Bluetooth enabled devices. Maximum Wi-Fi throughput of the module is 25Mbit/s with a range of 400meters and it can maintain 8 Bluetooth connections (U-Blox, para 1).

**V:**

1. Analog Pins.
2. Connect to external devices e.g., motors, LED’s, sensors, switches, speakers etc.
3. Digital I/O pins that convert analogue input into a digital integer representation with 10-bit resolution (0 top 1023), or replicate analogue output using PWM (pulse width modulation). Though analogue pins are primarily useful for analogue I/O, they can be used as digital GPIO pins when required (Arduino, para 1).

**W:**

1. Power Pins.
2. Connect to external devices e.g., motors, LED’s, sensors, switches, speakers etc.
3. Used to power low voltage external devices. Made up of 5V, 3.3V, IOREF (pin with shield to select appropriate output voltage) and ground outputs. Also has a VIN pin to allow power from external sources if the other power mediums are not viable (IoT Guider, Para 13).

**3.**

1. The ATMega4809 microcontroller utilizes RISC (Reduced Instruction Set Computing) architecture (Microchip, Para 30), it runs at 20MHZ, and has an 8-bit bus width (Microchip, Para 1).
2. The microcontroller has 48KB of Flash memory, 6KB SRAM, and 256 bytes of EEPROM (Microchip, Para 1).

|  |  |
| --- | --- |
| **AVR** | **ARM** |
| 8-bit or 32-bit bus width. | 32-bit or 64-bit bus width. |
| Single manufacturer (Atmel). | Many manufacturers (Apple, Nvidia, Qualcomm, Samsung, TI). |
| Cheap and effective for low-cost systems. | Performs high speed operations but is more expensive. |
| Can perform less complex functions. | Permforms more complex function. |
| Used SRAM (Static Random-Access Memory) | Used SDRAM (Synchronous Dynamic Random-Access Memory) |

(Satyabrata Jena)

1. Programming an Arduino UNO to perform three threads (Multithreading).

By taking advantage of downtime during loop executions Drew Alden was able to get an Arduino UNO to replicate multithreading using a function called Protothreading. The Arduino device simultaneously pulsed the backlight of a LCD screen, incremented an Integer displayed on the screen, and intermittently displayed a string message to the screen.

<https://create.arduino.cc/projecthub/reanimationxp/how-to-multithread-an-arduino-protothreading-tutorial-dd2c37?ref=tag&ref_id=arduino&offset=7>

1. Using an Arduino to water your garden.

YouTube user “Practical Engineering” could not simply grow herbs, he felt it necessary to automate the process and take as much data as he possibly could because, in his words “I want to make cool graphs”. He achieved this using an Arduino device, aptly named a “Garduino”, connected to a capacitive soil moisture sensor, soil temperature sensor, sunlight sensor, and a sensor to measure air temperature and humidity then connected it all to an electrical solenoid valve to water his garden based on the time of the day and the data recorded by the sensors.

<https://www.youtube.com/watch?v=O_Q1WKCtWiA>

1. Creating a mobile robot using an Arduino.

Learn Robotics explains how to build your own mobile robot in the following article. The robot is made of many complex parts, is highly mobile with four individually controlled motors attached to wheels and contains sensors to monitor its own surroundings. This is a highly complex Arduino project and requires substantial knowledge in electronics, programming, and Arduino usability.

<https://www.learnrobotics.org/blog/how-to-build-a-mobile-robot-using-arduino-part-1/>

**Pricing Question.**

1. The cheapest Uno Wifi Rev2 I could find was from the Arduino official store, with the cheapest shipping option: 58 for Arduino + 6.3 Tax + 11.61 Shipping = $75.91.

<https://store.arduino.cc/usa/arduino-uno-wifi-rev2?queryID=undefined>

**Part B – Building a Recommended Platform Machine.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parts** | **Model** | **Cost** | **Link** |
| **Motherboard** | Asus Z10PE-D16 WS | $238.45 | Asus Motherboard |
| **CPU** | Intel Xeon E5-2699 X 4 | $5,074 X 2 = $10,148 | [Intel CPU](https://www.amazon.com/dp/B01BRCKNWY?tag=pcpapi-20&linkCode=ogi&th=1&psc=1) |
| **Memory** | Kingston KVR21R15D4K4/64 4 X 16GB DDR4 X 4 (16 Total) | $500 X 4 = $2,000 | [Kingston Memory](https://www.amazon.com/dp/B00NLZANJO?tag=pcpapi-20&linkCode=ogi&th=1&psc=1) |
| **Storage** | Samsung QVO 870 8TB SSD X 4 | $1,428 X 4 = $5,712 | [Samsung SSD](https://rosmancomputers.com.au/ssd-870-qvo-8tb-samsung-v-nand-2-5-7mm-sata-iii-6gb-s-r-w-max-560mb-s-530mb-s-98k-88k-iops-2-880tbw-3-years-warranty/) |
| **Graphics** | NVIDIA GeForce RTX 3090 X 2 | $2,839 X 2 = $5,678 | [NVIDIA Graphics](https://www.scorptec.com.au/product/graphics-cards/nvidia/85145-geforce-rtx-3090-ventus-3x-24g-oc?msclkid=5d3f38e352cc1aa7cf6358c64841b6fb&utm_source=bing&utm_medium=cpc&utm_campaign=DC.ORetailShopping02_Video%20Cards_MSI_Brand%20Category&utm_term=4578022826107545&utm_content=Video%20Cards_NVIDIA_MSI) |
| **Display** | Samsung Odyssey G9 C49G97T 48.8” 5120 X 1440 240Hz X 1  Samsung C24RG50 23.5” 1920 X 100 144Hz X 2 | $1,350 X 1  +  $295 X 2  = $1,940 | [Samsung Odyssey](https://www.bhphotovideo.com/c/product/1578217-REG/samsung_lc49g97tssnxdc_49_monitor_hdr_color.html)  [Samsung C24RG50](https://www.newegg.com/global/au-en/matte-black-samsung-crg50-series-c24rg50-24/p/N82E16824022761?Item=N82E16824022761&nm_mc=AFC-RAN-COM&cm_mmc=AFC-RAN-COM&utm_medium=affiliates&utm_source=afc-PCPartPicker&AFFID=2558510&AFFNAME=PCPartPicker&ACRID=1&ASID=https%3a%2f%2fpcpartpicker.com%2f&ranMID=44583&ranEAID=2558510&ranSiteID=8BacdVP0GFs-9hjhwWVnKnnF3kIz2i0pyA) |
| **Total Cost** | $25,716.45 | | |

**A screenshot of a computer

Description automatically generated**

As you can see from figure 1.1, according to pcbuilder.com there are no compatibility issues found in this build.

*Figure 1.1 – Compatibility Test*

The most appropriate form of RAID system for such a high-performance workstation would be RAID 5. The main issue with installing a RAID 5 system using RAID software is that the CPU’s are required to perform the storage calculations for the parity bits, taking processing power from other operations. The most efficient way of avoiding this issue is by installing a RAID Controller like the Intel RS3DC080 RAID Controller Chip ([Intel Raid Controller](https://www.mwave.com.au/product/intel-raid-controller-rs3dc080-ac14579)). This expansion card is attached to one of the available PCIe slots and holds a dedicated CPU, memory and storage that handles all RAID parity and striping operations for the system. Once installed the user is required to enable to controller using the BIOS and install any required drivers. The controller will then set up all available storage devices with RAID 5.

As this is such a high-performance system, with dual CPU’s and GPU’s the most efficient cooling system would be a liquid cooled one like the Corsair H100x 57.2 CFM liquid cooling system ([Corsair Liquid Cooling System](https://www.corsair.com/us/en/Categories/Products/Liquid-Cooling/Hydro-Series-H100x-High-Performance-Liquid-CPU-Cooler/p/CW-9060040-WW?utm_source=PCPartPicker_79301&utm_medium=Affiliate&utm_campaign=497986_CORSAIR%20US%20Product%20Catalog%20Ad&utm_content=Corsair&clickid=VU3wWT3ZPxyLWIYwUx0Mo3kSUkEWN0S9tTgVWg0&irgwc=1)). The GPU’s will be too close to each other to install a water block to both, so they will be cooled by the cooling fans installed by the manufacturer, with additional air flow from the high-powered fans on the Corsair system. The CPU’s will both have a water block attached to the CPU itself, connected to a Corsair Hydro X Series XD5 Water pump and reservoir ([Pump Reservoir](https://www.corsair.com/us/en/Categories/Products/Water-Cooling-PC-%7C-Water-Cooling-Kit-%7C-CORSAIR/Pump-Reservoir/Hydro-X-Series-XD5-RGB-Pump-Reservoir-Combo/p/CX-9040002-WW)).

**Part C – Junk Yard Special.**

1. **F**
   1. It was most notable featured in the IBM PC-XT (Red Hill, Para 1).
   2. The Seagate is 5.25 inch, and the modern hard drive is 2.5 inch (Wikipedia).
   3. MFM was also commonly used for encoding data to flop disks (Techopedia, Para 2).

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