DAC Project

EE 537 Report

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By

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Abstract:

Designing a multichannel data acquisition device using an Arduino MEGA, Motorola DAC08HP, and BLE Bluetooth for wireless communication. The device displays channel data on an LCD and includes high voltage protection. Programming in Arduino Sketch with C# .

Section A:

1. ***Project Description:***

This project involves designing and developing a multichannel data acquisition system using an Arduino MEGA and Motorola DAC08HP. The system features BLE Bluetooth connectivity to communicate with smartphones or tablets, displaying multiple channel outputs on an LCD. Output protection is incorporated to manage high voltage, and the system is programmed in Arduino Sketch. The total project cost is constrained to $100.

Key criteria for successful outcome: (Listed significant outcomes)

- Accurate multichannel analog signal generation
- Effective BLE Bluetooth communication with a mobile device
- Clear display of channel data on an LCD

Significant Components list: (Listed significant outcomes)

- Arduino Mega
- HC08 Bluetooth Module
- Motorola DAC08HP
- Arducam SSD1306 LCD Display
- 16-Key Keyboard

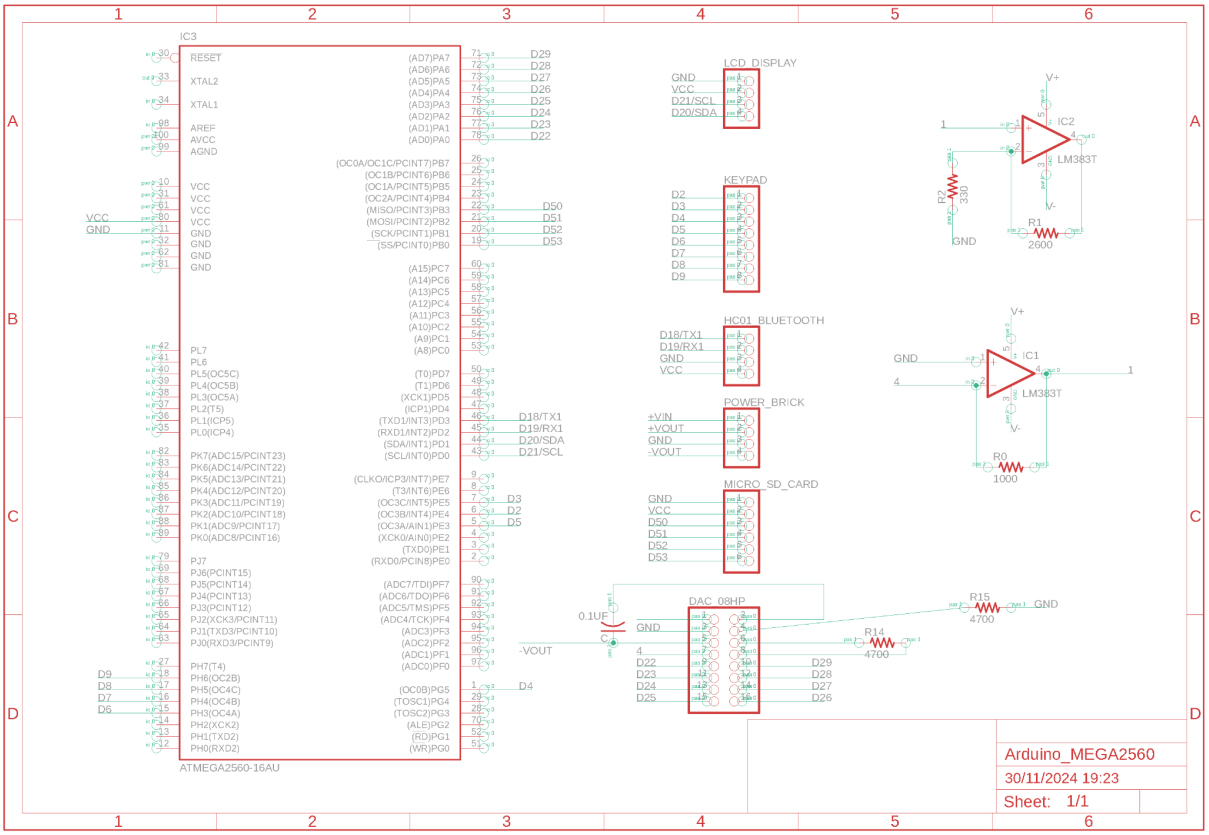
2. ***Constraint Analysis:***

This project is subject to several constraints, primarily focused on budget, power, and functionality. The total cost is limited to $100, which requires careful selection of components. Only Arduino or its compatible clones may be used, and the operating voltage must not exceed 5V, which is essential for preventing device damage and ensuring safety. Bluetooth communication is facilitated through a BLE module to allow seamless connectivity with smartphones and tablets.

3. ***Hardware Interface:***

The hardware includes the Arduino MEGA interfaced with the DAC08HP for analog output, an LCD for displaying channel information, and an HC-05 module for Bluetooth

communication. All connections will be kept within the 5V operating limit to avoid damage. A detailed wiring diagram will be provided to show precise connections between the Arduino, DAC, LCD, and Bluetooth module to ensure reliability. Below is an electrical schematic of the system:



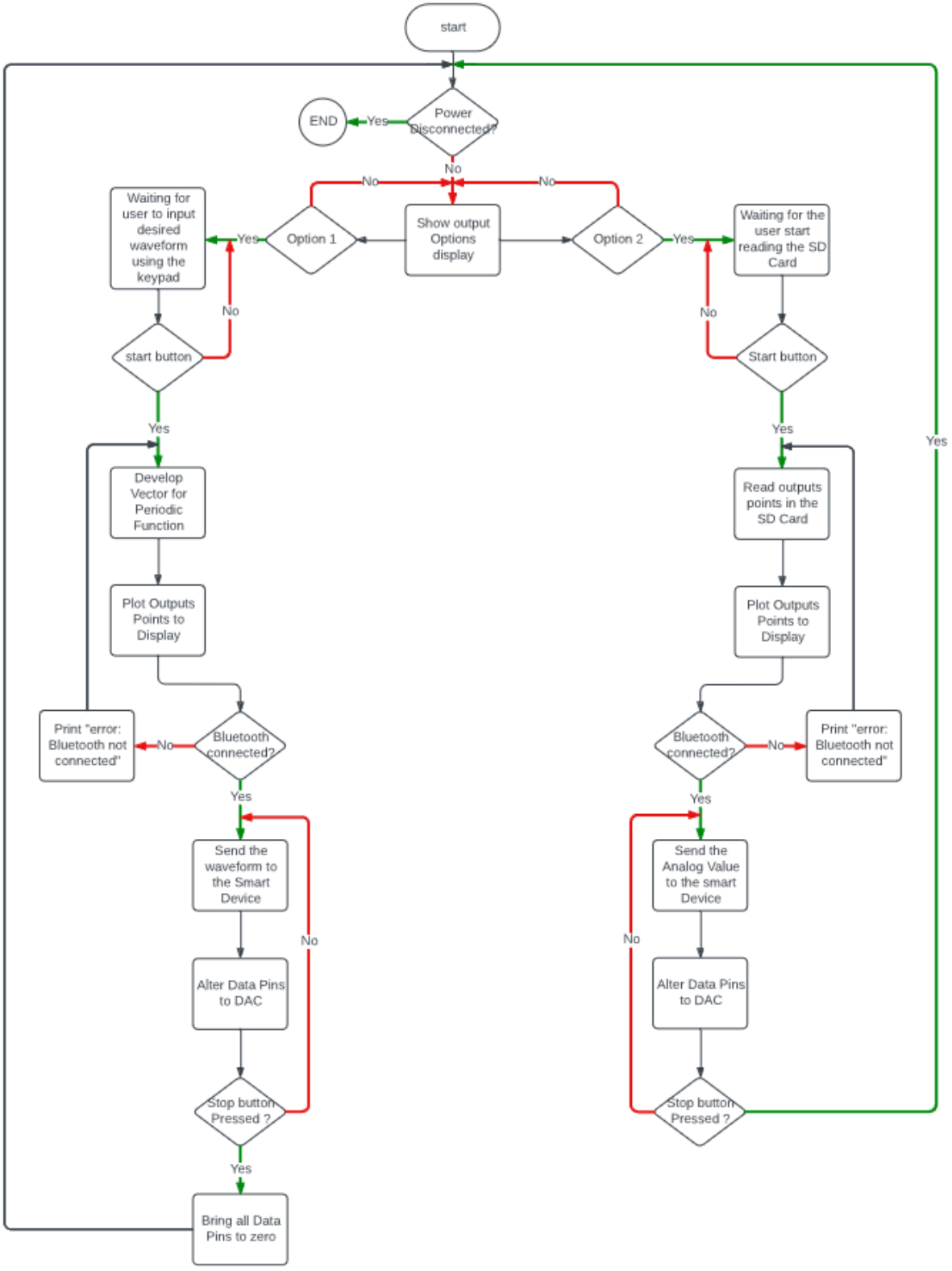
4. ***Software Interface:***

The software is developed in Arduino Sketch for the main control system, with BLE communication managed via C# interface on the mobile device.

Libraries used include the following:
keypad.h – Used to interface with the keypad
ArducamSSD1306.h – Used to interface with the LCD Display
Adafruit_GFX.h – Provides an image creation library for LCD displays
Wire.h – Provides I2C communication, used by the LCD display and bluetooth module
stdio.h – General library for i/o
stdlib.h – General library for necessary datatypes and comparisons
string.h – Supports string object
SD.h – Used to interface with the SD card module
CSV_Parser.h – Used to parse the .CSV file required to import waveform from a file
SPI.h – Provides SPI communication, used with the SD card reader

avr/io.h – Helps with support for hardware interrupt triggers
avr/interrupt.h – Helps with support for interrupts on Mega board

Below is a flow chart of the software:



5. ***Power Constraints and Efficiency:***

The system operates on a dual power supply, firstly with a +/-12V USB-Input power supply, as well as a USB input to power the Arduino Mega and its associated 5V output.. The 12V power supply supplies only the DAC08 and the operational amplifier. This is to achieve a maximum output voltage of 10V from the signal generator.

The 5V output from the Arduino Mega powers all peripheral components, including the SD card reader, the bluetooth transceiver, the LCD display, and the keyboard.

The nominal power consumption for the system is 1.75W with an open load on the signal generator. With a load on the signal generator, the power consumption of the system may increase a significant amount, depending on the input resistance of the circuit applied to the output terminals of the signal generator.

6. ***Cost Constraints:***

With a $100 budget, each component was chosen for cost-efficiency. Estimated component costs: Arduino MEGA ($15), DAC08HP ($5), HC-01 Bluetooth Module ($10), LCD Display ($10), protection circuitry ($5), and additional wiring ($5), staying within budget.

7. ***Component Selection Rationale:***

The Arduino MEGA was chosen for its processing capability and extensive I/O, essential for managing multiple analog channels. The DAC08HP provides accurate analog output, while the HC-01 BLE module supports easy communication with mobile devices. The LCD ensures a clear display of outputs.

Section B:

1. ***Detailed project Description:***

Significant system components: (explain each component with 30-100 words, model, name, made by etc.)

Component 1: Arduino MEGA 2560

Component 2: Motorola DAC08HP

Component 3: HC08 Bluetooth Module

Component 4: Arducam SSD1306 LCD Display

Component 5: Micro SD Card Reader Module

2. Project Description:

Step 1: First, project requirements were gathered, and an initial project plan was discussed.

Step 2: Components were selected to meet gathered requirements.

Step 3: Once components were gathered, testing and prototyping with each components was done to ensure a good understanding of all components and how the interact with the system as a whole.

Step 4: Software block diagram was created to show general flow of the software and interactions between different software blocks.

Step 5: Full circuit was assembled on the breadboard to allow for testing of the full software system on a completed circuit.

Step 6: Full system software was finalized through troubleshooting with circuit, as well as final touches and details were added.

Step 7: Testing of all of the system's features was completed.

3. Results/Conclusions:

The system is capable of producing a customized waveform, either fully custom waveform through an imported CSV file, or a partially customizable selection of pre-made waveforms, able to adjust the amplitude and wave type from a list. The maximum amplitude that can be produced by the waveform generator is 10V due to both hardware and software limitations.

The system also interfaces with a keyboard to provide user I/O and easy selection of waveform. Furthermore, results and selection screens are displayed to the user through a GUI on the LCD display. The system also communicated information about the waveform that is created through bluetooth communication with a smart

device, such as the waveform amplitude, wave type, and whether the waveform was inputted through the selection screen or the user-made CSV file.

Lastly, the system uses a timer interrupt to trigger an ISR that updates the DAC pins. This is for more accurate and controllable timing of the DAC updates. Furthermore, it reduces the likelihood of dropped information due to other important tasks done by software.

4. Future Improvements:

Future improvements for the system may include period or frequency adjustment or selection, which could be accomplished via adjusting timer interrupt prescales with a user input. Another improvement would be upgrading the processing power of the microcontroller; currently, the microcontroller is not powerful enough to transfer information over serial or bluetooth while outputting the waveform. An upgrade of the microcontroller would also allow for a better GUI and display support, where the system could possibly update the display in real time. Lastly, the system could improve with a better data and file structure, namely in the imported CSV file.

Section C: (Additional Documents and Datasheets)

a. Detailed part list: Quantity, part description, part order number, vendor link or vendor's name. Use a table with 5-6 columns.

Part Number	Part Description	Quantity	Vendor	Link
Arducam SSD1306	LCD Display	1	Amazon	HERE
DAC08HP	DAC	1	Digikey	HERE
LM324AN	Op Amp	1	Digikey	HERE
HX-453	Keypad	1	Amazon	HERE
HC-08	Bluetooth Module	1	Amazon	HERE
B01IPCAP72	SD Card Module	1	Amazon	HERE

b. Attach the program code

Due to program code being in excess of 20 pages, the .ino file is included in the .zip file included with submission.

c. List of used libraries

All libraries without an associated link are available in the built-in arduino library manager.

keypad.h – Used to interface with the keypad
ArducamSSD1306.h – Used to interface with the LCD Display
Adafruit_GFX.h – Provides an image creation library for LCD displays
Wire.h – Provides I2C communication, used by the LCD display and bluetooth module
stdio.h – General library for i/o
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avr/io.h – Helps with support for hardware interrupt triggers
avr/interrupt.h – Helps with support for interrupts on Mega board

d. Create a "**zip-file"** for **ALL** data sheets and libraries with "**original names"** and deliver it on mini/micro SD-Card (**Tape SD-Card on Title Page.**)