

Project 3

Digital multimeter

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## Link to Video

# Purpose

# System Requirements

* The Digital Multimeter (DMM) shall measure voltage.
  + Voltage measurements shall be limited to 0 to 3.3 volts.
  + Voltage measurements shall be limited to 0 to 1000 Hz.
  + Voltage measurements shall be accurate to +/- 1 mv for AC and DC.
  + The DMM shall have a DC setting
    - DC measurements shall average over a 1 ms time period
    - DC measurements of a sinusoidal waveform should be equivalent to the DC offset of the sinusoid
  + The DMM shall have a AC setting
    - AC measurements shall be true-RMS
    - AC measurements shall display the various components.
      * AC voltage measurements shall give the TrueRMS (includes DC offset)
      * AC voltage measurements shall give the CalcRMS (TrueRMS – DC offset)
      * AC voltage measurements shall give the peak-to-peak value.
    - AC measurements shall work for various waveforms
      * Sine waves shall be measurable.
      * Triangular waves shall be measurable
      * Square waves shall be measurable
      * Other periodic waveforms shall be measurable
    - AC measurements shall work for waveforms of various amplitudes and offsets
      * The maximum voltage that shall be measured is 3V
      * The minimum voltage that shall be measured is 0V
      * The minimum peak-to-peak voltage that shall be measured is 0.5V
      * Offset values of up to 2.75V shall be measurable
* The DMM shall measure frequency
  + Frequency measurements shall be limited to 1 to 1000 HZ.
  + Frequency measurements shall be accurate to within 1 Hz.
  + Frequency measurements shall work for various waveforms.
    - Sine waves shall be measurable.
    - Triangular waves shall be measurable.
    - Square waves shall be measurable.
    - Other periodic waves shall be measurable.
* The DMM shall have a terminal-based interface
  + The terminal shall operate at a frequency greater than 9600 baud
  + The terminal shall utilize the VT100 protocol.
    - The terminal shall display all fields in non-changing locations.
  + The terminal shall display AC voltages as described above.
  + The terminal shall display DC voltages as described above.
  + The terminal shall display frequency as described above.
  + The terminal shall organize the presentation of information.
    - AC, DC, and frequency shall be simple to read.
    - The display may use horizontal and vertical lines (borders) to organize the presentation of information.
  + The terminal shall use bar-graphs for voltages being measured.
    - The terminal shall have a bar-graph for “Calc-RMS”.
    - The terminal shall have a bar-graph for DC voltages.
    - The bar graphs shall be shall have delineators, e.g. a scale, indicating the equivalent voltage being measured.
    - The bar graphs shall be a single line of pixels, characters, etc.
    - The bar graphs shall have length that is proportional to the voltage being measured.
    - The bar graphs shall respond in real-time to changes in AC or DC voltage

# System Specifications

|  |  |  |
| --- | --- | --- |
| Component | Spec | Value |
| MSP432 | Model | MSP432P401R |
|  | Frequency | 24 MHz |
|  | Interrupts | Enabled |
|  | Input Power | 5 V |
| UART | Baud Rate | 115200 |
|  | UART Data Bits | 8 |
|  | UART Parity | Off |

*Table 1 – System Specifications.*

## Waveform Accuracies

*Table 2 –Waveform Accuracies.*

# System Architecture

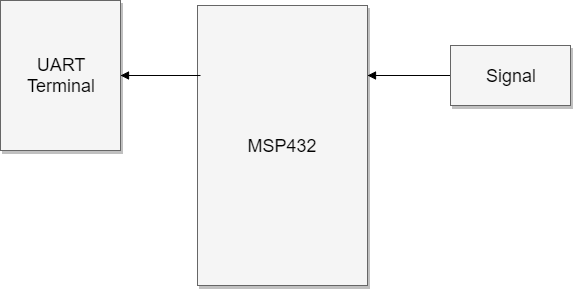


Figure 1 – System Architecture Diagram

Figure 2 – System Software Diagram

# Component Design

All setting are default settings of MSP432P401R Launchpad running at 3 MHz with interrupts enabled.

//todo code description thingy

## Schematic

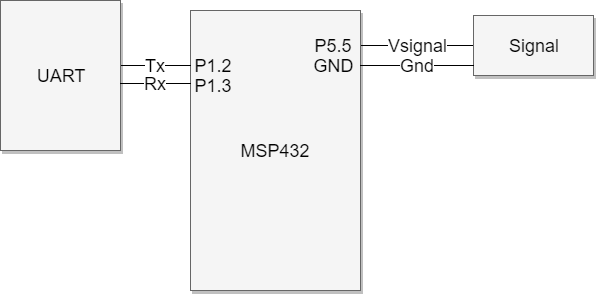


Figure 3 – Schematic Diagram

# Bill of Materials

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Item # | Part # | Supplier | Quantity | Price Ea | Total Price $ |
| MSP432 Launchpad | 1 | MSP432P401R | Digikey | 1 | 13.03 | 13.03 |
| Jumper cables | 2 | 0 | Amazon | 3 | .01 | .03 |
| Breadboard | 5 | 352 | Pololu | 1 | 3.97 | 3.97 |
| Total |  |  |  |  |  | 17.03 |

### main.c