Digital Multimeter

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Project Scope:

- Have high / low leads and rotary dial similar to the ones in Lab
- Voltage, current, and resistance measurements
- Display on an LCD screen
- Relatively close values for our resolution
- Verified with Fluke Multimeter

Plan of Attack

1. Figure out the measurement circuits for V, I, and R
2. Incorporate multiple channels on the A/D Converter
3. Determination of Resolution

Hardware Components

Hardware from Lab:

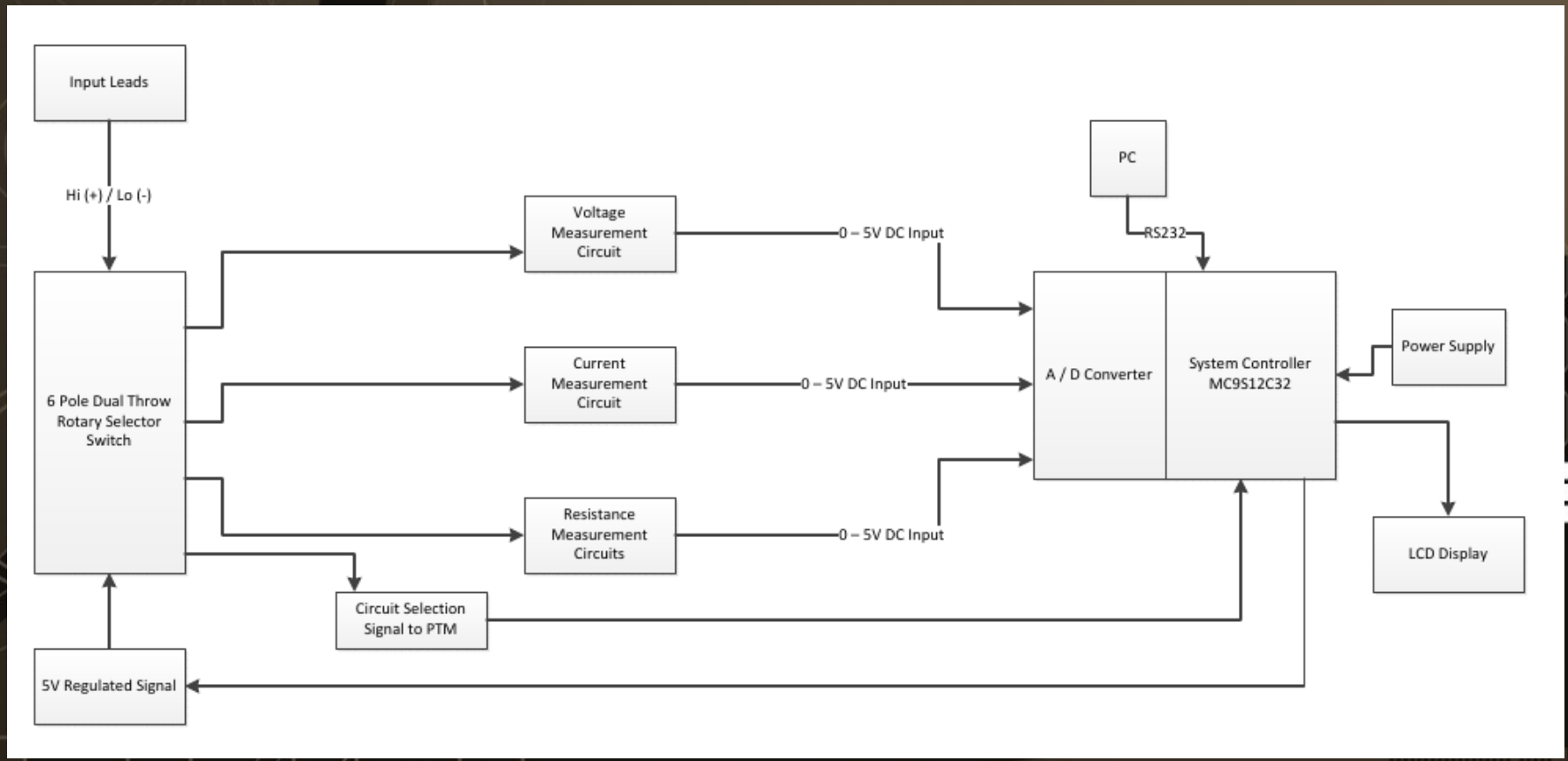
- LCD Screen
- A/D Converter
- Potentiometer
- Discrete Circuit Components (Resistors)

Additional Hardware:

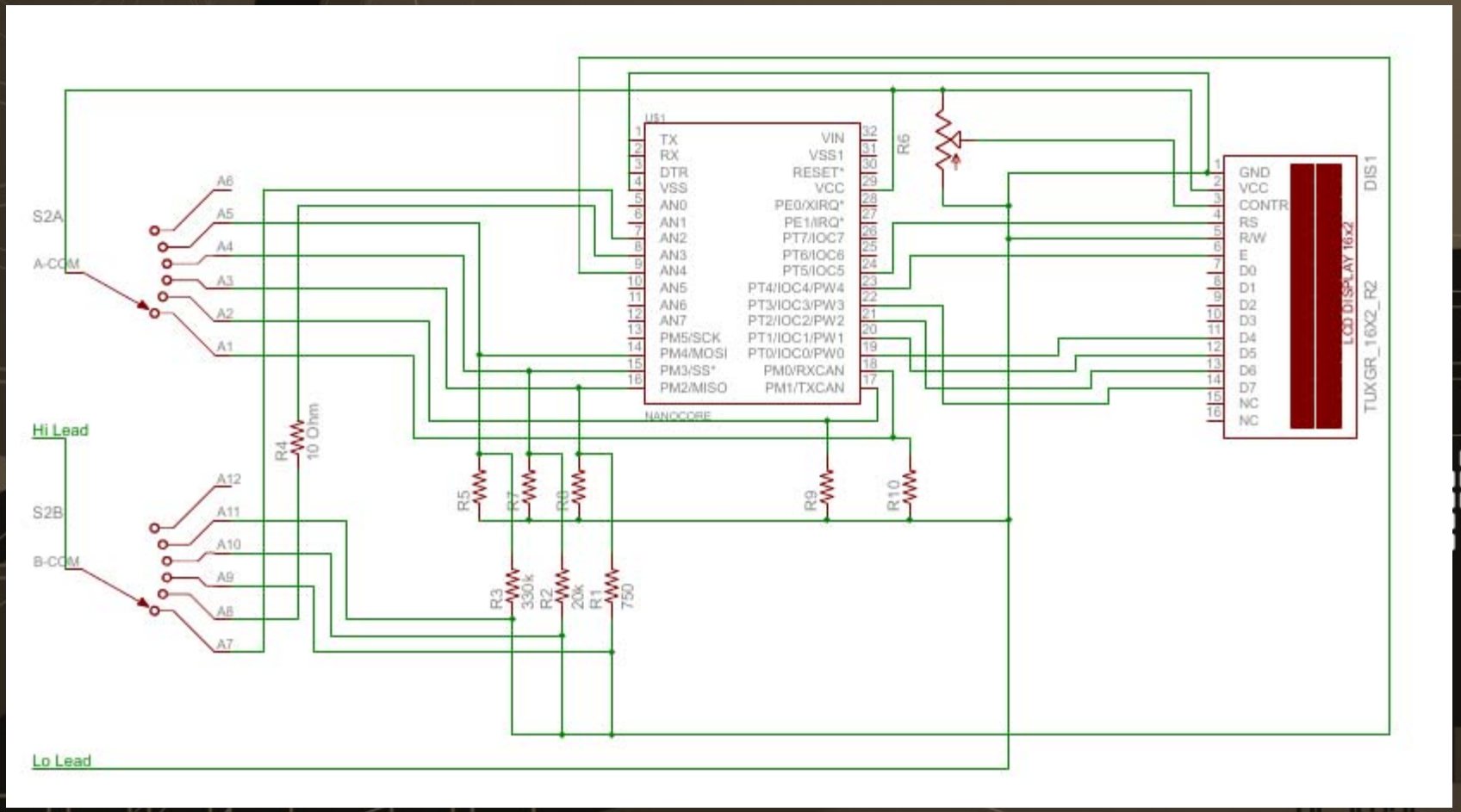
- 6-Position Rotary Switch
- Knob
- Leads

- Awesome Case

Hardware Block Diagram



Schematic


S2A
A-COM
A6
A5
A4
A3
A2
A1
Hi Lead
S2B
B-COM
A12
A11
A10
A9
A8
A7
Lo Lead
R4
10 Ohm
R5
R7
R8
R9
R10
R3
330k
R2
20k
R1
750
R6
U$1
TX
RX
DTR
VSS
AN0
AN1
AN2
AN3
AN4
AN5
AN6
AN7
PM5/SCK
PM4/MOSI
PM3/SS*
PM2/MISO
VIN
VSS1
RESET*
VCC
PE0/XIRQ*
PE1/IRQ*
PT7/IOC7
PT6/IOC6
PT5/IOC5
PT4/IOC4/PW4
PT3/IOC3/PW3
PT2/IOC2/PW2
PT1/IOC1/PW1
PT0/IOC0/PW0
PM0/RXCAN
PM1/TXCAN
NANOCORE
DIS1
GND
VCC
CONTR
RS
R/W
E
D0
D1
D2
D3
D4
D5
D6
D7
NC
NC
LCD DISPLAY 16x2
TUXGR_16X2_R2

Pseudocode

```
Function Declarations (delay, printLCD, etc)
Void main(void){
DDRT = 00 (pins PT7/PT6 input) 11 1111 (pins PT5 – PT0 output)
DDRM = 0x00 (all are input)
Initialize A/D Converter:
        ATD Control Registers 2, 3 and 4 (same as in Lab 7)
        ATD Control Register 5 determines Analog Input(s)
                AN2: Voltage, AN3: Current, AN4: Resistance
Set up RTI for slowest rate
Clear the flag
InitializeLCD();
Enable Interrupts;
For {
Main loop is empty
}
Interrupt RTI Vector
Initialize Float variables:
        DisplayVal: Number output to LCD
        Vread: Conversion from int ATDDR0L into a Voltage
        Other Variables (Vin, R, etc for calculating)
char mystr[20] for string output to LCD
Clear the RTI Flag
```

```
If PM1
   ATD Control 5 to set analog input to AN2
   InputVal = ATDDR0L;
   Vread =  (inputVal*Vconv);
   displayVal = Vread;
   buffer = sprintf (mystr, "%f V", displayVal);
If PM2
   ATD Control 5 to set analog input to AN3
   InputVal = ATDDR0L;
   Vread = (inputVal*Vconv);
   displayVal = (Vread/R4);
   buffer = sprintf (mystr, "%f A", displayVal);
If PM3
   ATD Control 5 to set analog input to AN4
   InputVal = ATDDR0L;
   Vread = (inputVal*Vconv);
   displayVal = (Vread*R1)/(Vin - Vread);
   buffer = sprintf (mystr, "%f Ohm", displayVal);
else
   buffer = sprintf (mystr, "Error taking measurement.", inputVal);
end if statements

printLCD(mystr);
End
```

Results

- Reads:
  - Voltage 0 – 5V
  - Current 0.002 – 0.498 A
  - Resistance
    - 5 – 5kOhm
    - 5k – 50kOhm
    - 50k – 500kOhm

- Accuracy (Best):
  - +/- 20mV
  - +/- 2 mA

  - +/- 3 Ohm
  - +/- 81 Ohm
  - +/- 1324 Ohm

Obstacles and Opportunities for Improvement

Obstacles:

- Didn't start in small steps, had to start new
- Figuring out A/D values corresponding to Voltages
- Floating inputs to PTM needed to be pulled down
- Limitations in circuit measuring techniques from lo lead node

Improvements:

- Better accuracy with signal conditioning
  - Op Amps, diodes, etc.
- Inclusion of AC signals with AC/DC rectifier
- Continuity function
- Frequency Measurement of AC signals

Questions