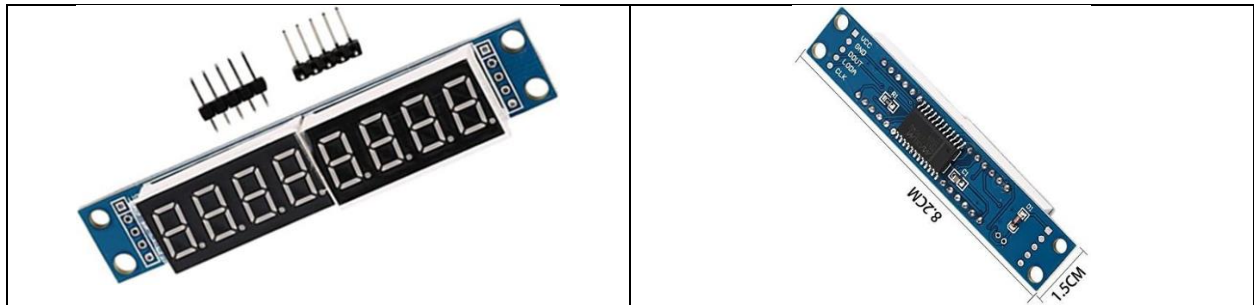# TECH 4243
Lab #2
Ver 1.0

Objective: to create a simple voltmeter using the ADC and a SPI Digital Display

Background: In this lab we will be using SPI to communicate with a MAX7219 8-Digital Segment Digital LED Display:

The individual displays are controlled by the MAX7219 IC. This IC communicates with the Arduino via the Serial Peripheral Interface (SPI). This interface used a total of 5 pins:

Atmel Pin	Arduino Pin	Purpose	LED Module
PB 2	10	CS	CS
PB3	11	MOSI	Din
PB5	13	SCK	CLK
5V			VCC
GND			GND

Data is sent to the module in 16 bit packets formatted as follows:

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	ADDRESS				MSB	DATA						LSB

The address refers to the registers in the MAX7219:

REGISTER	ADDRESS					HEX CODE
	D15–D12	D11	D10	D9	D8	
No-Op	X	0	0	0	0	0xX0
Digit 0	X	0	0	0	1	0xX1
Digit 1	X	0	0	1	0	0xX2
Digit 2	X	0	0	1	1	0xX3
Digit 3	X	0	1	0	0	0xX4
Digit 4	X	0	1	0	1	0xX5
Digit 5	X	0	1	1	0	0xX6
Digit 6	X	0	1	1	1	0xX7
Digit 7	X	1	0	0	0	0xX8
Decode Mode	X	1	0	0	1	0xX9
Intensity	X	1	0	1	0	0xXA
Scan Limit	X	1	0	1	1	0xXB
Shutdown	X	1	1	0	0	0xXC
Display Test	X	1	1	1	1	0xXF

The data portion of the packet is the data to write to the selected register. For digits 0-7 (registers 1-8) we send the value to display (0-9).

Procedure: Hook up the Display as shown above. In addition connect a Potentiometer to 5V, Gnd and A3 (PC3)

First write a function that will handle send the 16 bit packets to the Display. The function should take in two unsigned 8 bit integers (register and data defined as a uint8_t), set the CS pin low, send the register value (by putting it into the Atmel SPDR register), wait for the complete flag (SPIF in SPSR register), send the 8 bits of data, wait for the complete flag, then set CS High then return.

In main, set up the SPI and ADC as follows:

For SPI: MODE 0 (CPOL=0, CPHA=0), it should be set as Master, MSB is transmitted first, and the clock rate should be as closed to 10MHz as possible without going over. You might want to use SPI2X in SPSR to double the speed.

For ADC: please use A3 for the input and set up as we did in Lab 5 in TECH 3233.

Before we can write digits to the display, we must set up the device by setting up the control registers: Shutdown, Scan Limit, Decode Mode and Intensity by calling the previously written function (above).

- To activate the display, the Shutdown register (0x0C) must be set to Normal Operation (0x01).
- Next we need to set the Decode Mode (0x09) to Code B decode for digits 7-0 (0xFF).

- Next we need to set the Scan Limit (0x0B) to Scan Digit 7 – 0 (0x07)
- We also need to set the Intensity (0x0A) to a reasonable value (0x0C) aprox 75% intensity.

In the while loop, read the ADC pin, convert it to a voltage (see hint) and then display it on the LED Display. Please display in the following format

<div align="center">

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Hints:

- To turn on the DP, turn on the MSB digit data by or'ing the data value with 0x80.
- It is best to do the voltage value calculation in mV instead of volts and use integer math. Then you can use mathematics to convert 0 – 5000mV into each digit to display using division and/or modulus (remainder). When you display the most significant digit, you can turn on the decimal point when you send it to the display to make it look like Volts instead of mV.
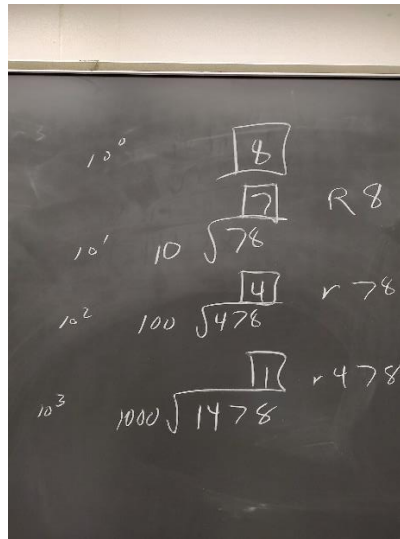
- To display a "blank" instead of a digit, send a 0x10 to the digit.