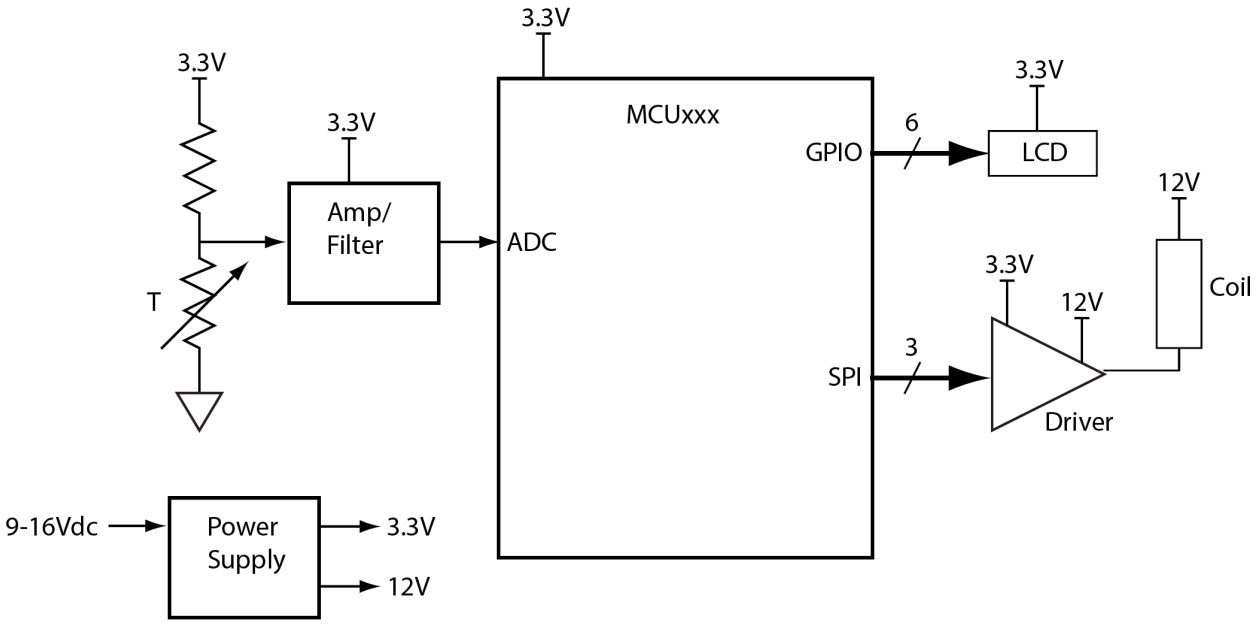
System Design Example

- **Based on requirements, the following block diagram was created**



Supply Currents

Part	I_D (3.3V)	I_D (12V)	Dissipation
MCU (K32L2)	8.7 mA		
MCU (K22)	35.6 mA		
LCD	2.5 mA		
OpAmp (LME49721)	3.25 mA		
SallenKey R's	4x(3.3/20k)= 660µA		
Temp R's	(10k + 1k) 300µA		
MC33879(RUN)	700 µA	24 mA	1.4
MC33879(Sleep)	700 µA	5 µA	
Coil (20Ω)		600 mA	
Regulator (Iq)			
Total (K32L2)	16.1 mA	624 mA	

With the numbers shown above, the 3.3V regulator must be able to provide 16.1mA and the 12V regulator (if needed) must provide 624mA.

We still need to determine device power dissipation to see if they'll get too hot and fail.

Power Dissipation

MCU: While the absolute max IO current of +/-25mA, calculations will need to be made to determine if the device will get too hot due to internal R's in the IOs.

Coil Driver: MC33879, $P_{D,\,max}$ =1.7W, $R_{DS,on}$=1.4Ω, $I_{out,max}$=1.2A, IxR=1.68W

Coil out, 20ohms, 12/20=600mA, P_{DIO}=600mAx1.4ohms=840mW

150 – 840mWx71 = 90C

Two coils: 30C

Power Supply

- **The requirements say that the system must work with a DC input voltage between 9V and 16V**

  This allows the use of a wide variety of wall adaptors.

- **There are two DC output levels required, 3.3V and 12V.**

- **First, check carefully to see if the coil and driver output supply will work with anything between 9V and 16V. If that is the case, we could go directly to the source without voltage regulation.**

  Many coil-type devices, solenoids, relays, motors, etc, may work over a wide range of voltages. It may even be worth a reduction in input voltage range if requirements allow.

Regulator 1 – 3.3V, 20mA out, Linear

- **Linear – low cost, small size.**
- **Power out: 3.3 x 20mA = 66mW**
- **Power in: 16 x 20mA = 320mW**
- **Power dissipation in regulator: 254mW + Iq**
- **Efficiency: 66mW/254mW = 26% !**

Regulator 1 – 3.3V, 20mA out, Switching

- **Power out: 3.3 x 20mA = 66mW**
- **Efficiency: 85%**
- **Power in: 77mW, 16 V -> 4.9mA**
- **Power dissipation in regulator: 11mW + Iq**

Battery Life

- **Requirement: 4 weeks**
- **Assume coil duty cycle is 0.1, Iavg = 60mA**
- **Regulator 2, buck-boost, 80% efficient, 75mA in.**
- **What size battery in mAHr?**

  With linear regulator 1: Iin = 75mA+20mA = 95mA

  Requires: 95mA x 672Hr = 65mAHr

  With switching regulator 1: Iin = 75mA+4.9mA = 80mA

  Requires: 80mA x 672Hr = 54mAHr