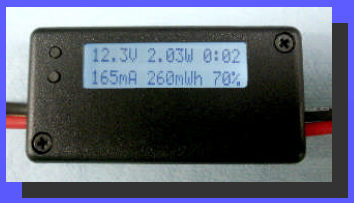
Rights & Permission



Battery Monitor

Hardware Description

BatteryMonitor Objectives

Low Current Consumption

- Typically 2mA with backlight off & under 5mA with backlight high

Good Accuracy

- 2% voltage and current, 3-5% power & battery use (Ah, Wh)

Small Footprint

- Easily tucked away in a kit for portable operations
- Keep cost down by using small low cost enclosure

Lots of information on a compact display

- Six values –Source Voltage, Load Current, Load Power, Battery use in Watt Hours or Amp hours, % remaining battery capacity, session time

Low Current, Power, Battery Use, Measuring Ranges

- 1mA, 10mW,1mWh, 1mAh, resolution

BatteryMonitor Objectives

Wide current measuring range

- Auto ranging current sense circuit measures 1mA to 40A

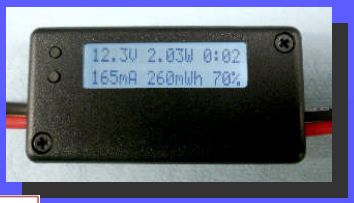
Easy to navigate user interface using 2 pushbuttons

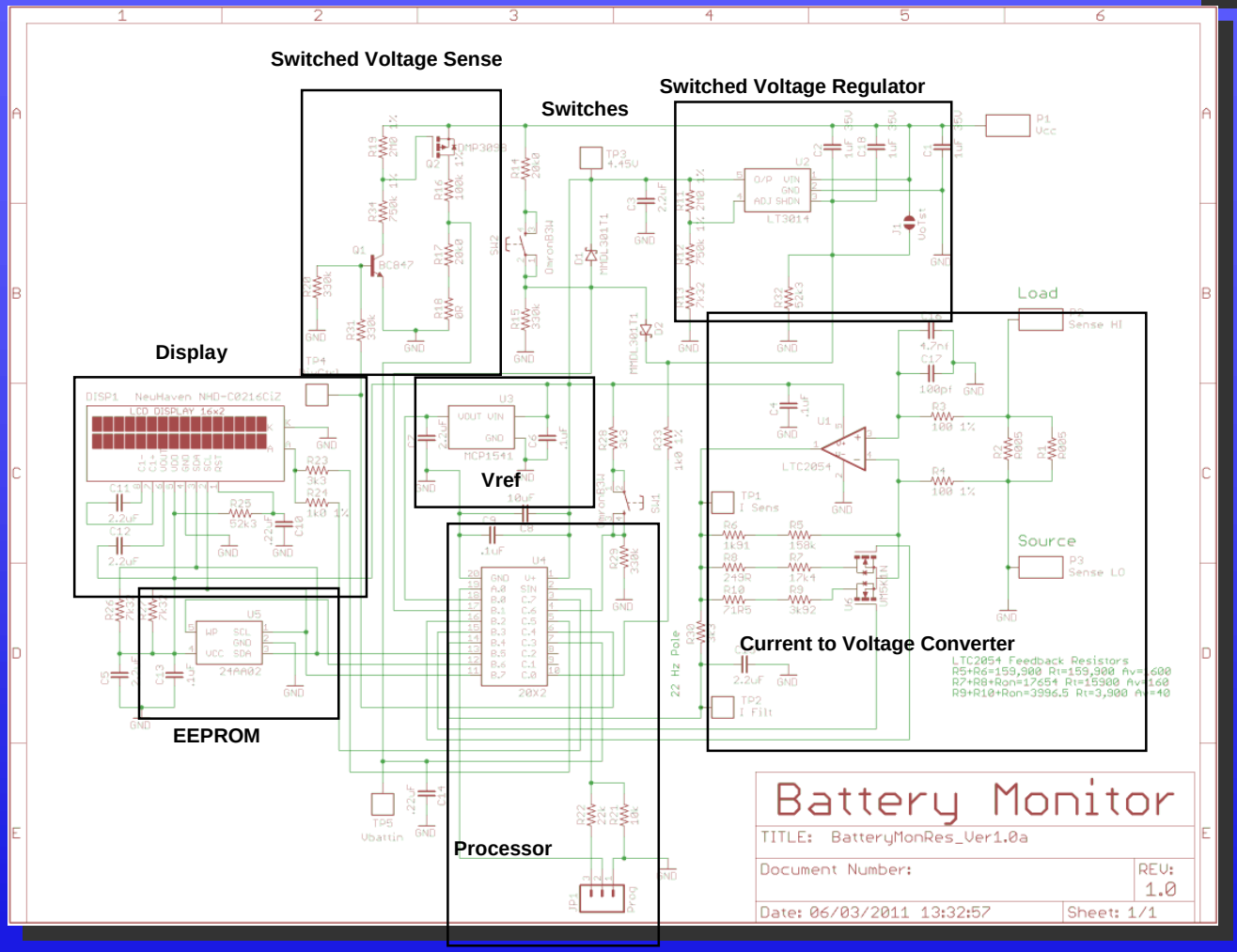
- Switches make additional features possible
  - Clear Readings
  - View and/or restart minimum source voltage and peak load current
  - Set backlight to one of four levels
  - Select one of eight batteries for % remaining battery capacity
  - Turn unit off / on / hibernate

Stop monitoring, store kit, and pick up later where you left off

- Hibernate mode saves key readings in external EEPROM to be restored at start-up
- Low hibernate supply current typically about 2uA

Overview

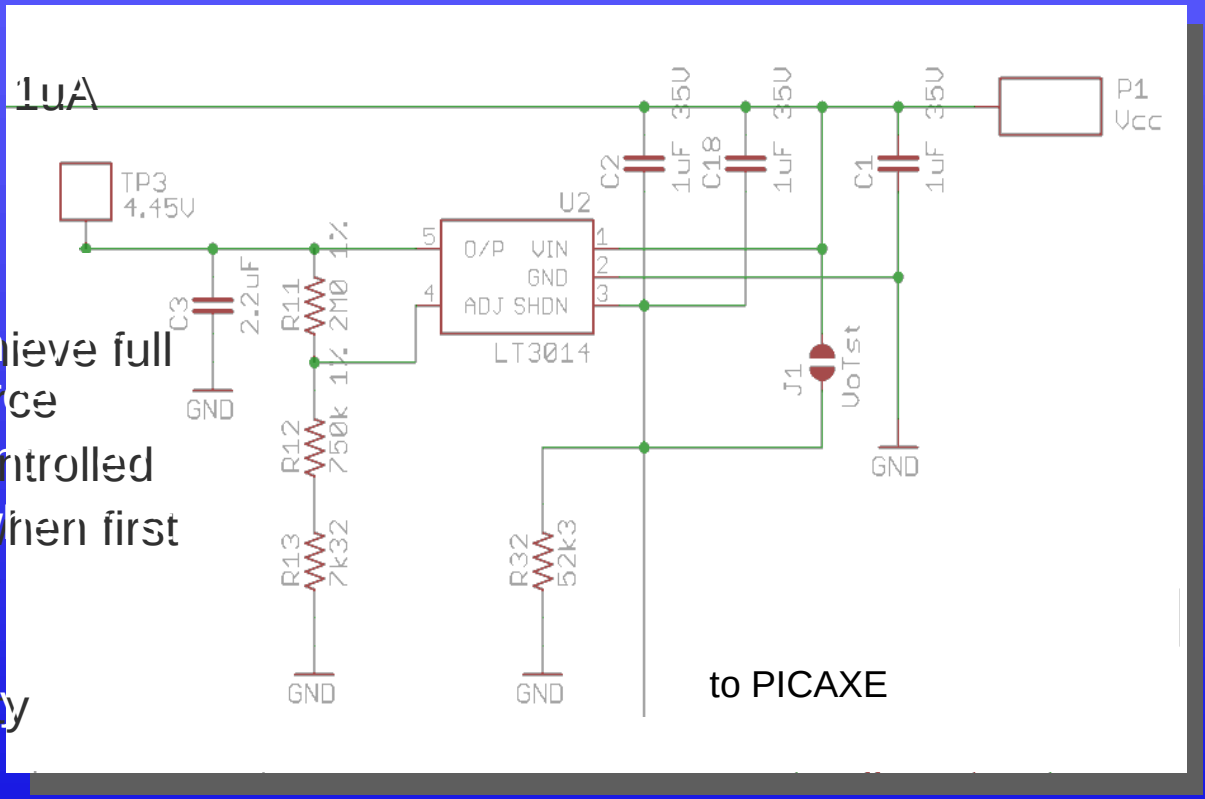




Battery Monitor 8 Functional Blocks

LT3014 Regulator

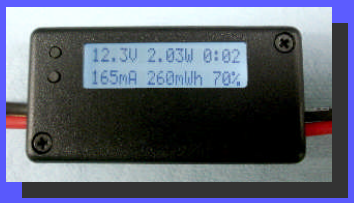
- Ultra low quiescent current 7uA
- Wide input voltage to 80V
- Adjustable output
- Low shutdown current 1uA
- Low dropout 300mV
- SOT23-5 package



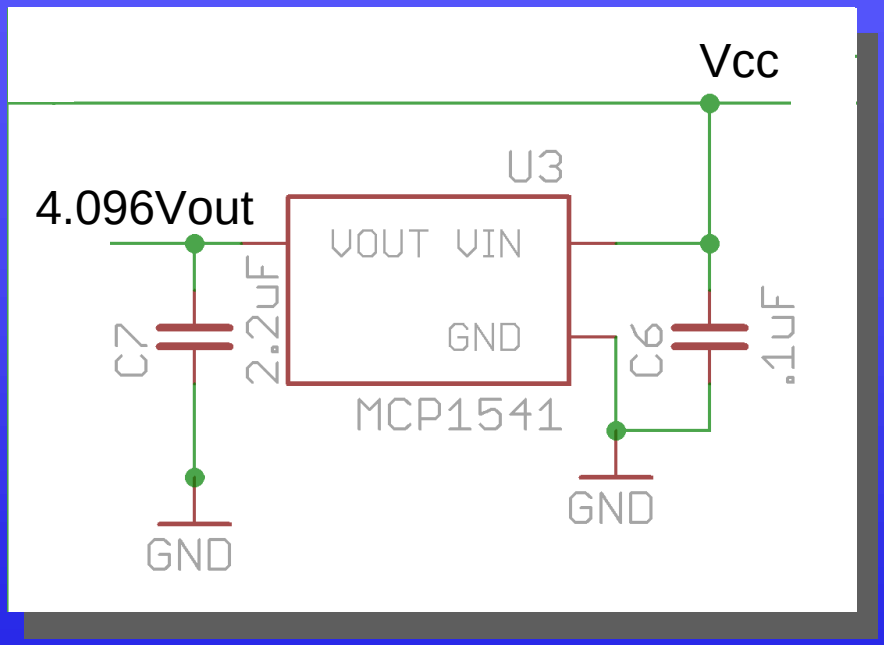
- Vout set to 4.45 to achieve full operation with 5V source
- Shutdown PICAXE controlled
- C2//C18 turn unit on when first connected to a source
- R11,12,13 set Vout
- C1 & C3 insure stability

- Functional Verification Test 1

MCP1541 Voltage Reference



- 4.096V 1% Voltage Reference
- 4mV / bit with 10bit A-D
- Low IQ 100uA
- Low Vin to Vout voltage 137mV
- SOT23-5 package



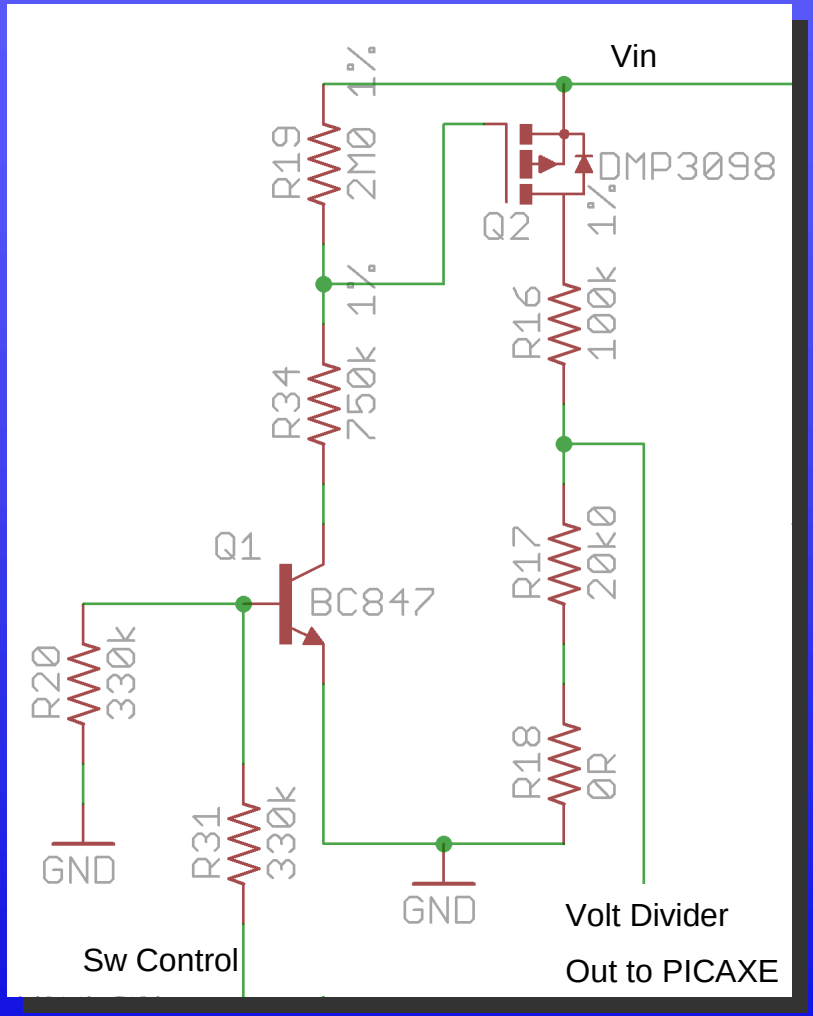
- Consistent accurate A-D reference voltage results in 4mV / bit making calculation intensive BatteryMonitor application code much more efficient

- Functional Verification Test 2

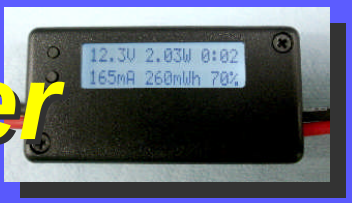
Switched Voltage Sense

- R16, R17, R18 form a 6:1 voltage divider.
- Output at junction R16 R17 drives the uP A-D input.
- Sensitivity is 24mV per bit (4mV x 6)
- Q2 30V 120mOhm Pch MOSFET used to turn off the voltage divider when in hibernation
- Q1 45V NPN controls Q2 and is in turn controlled by the uP

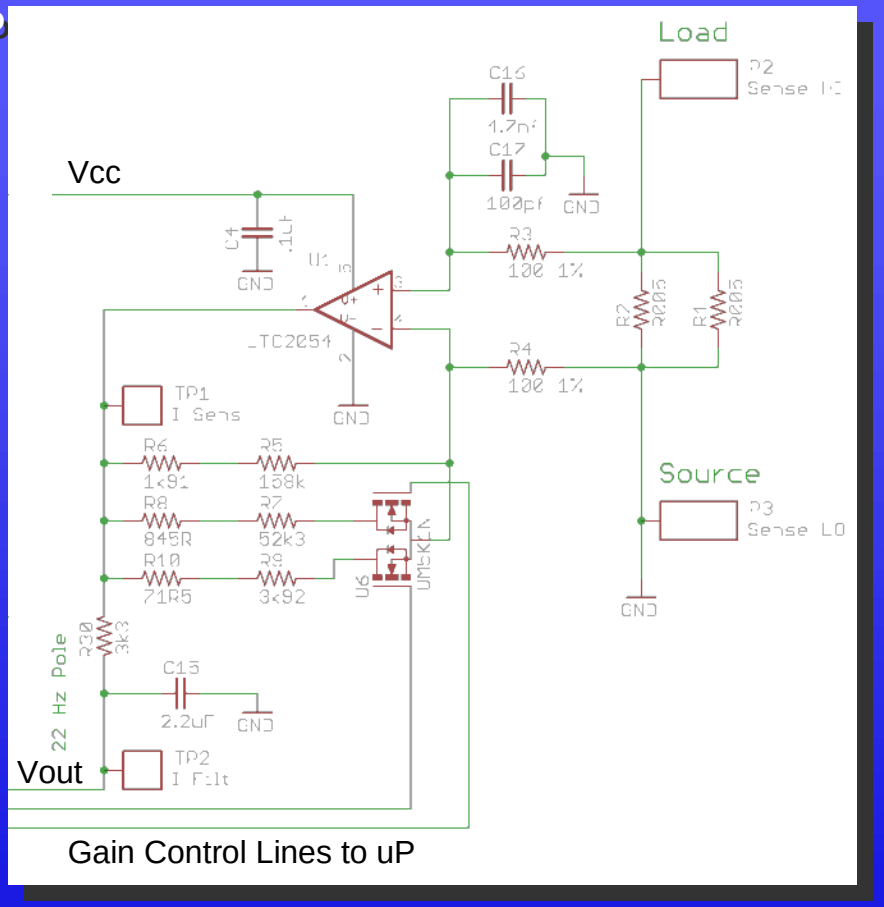
- Functional Verification Test 3



Current to Voltage Converter



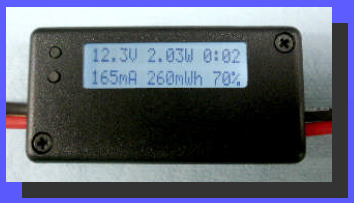
- U4 LTC2054 Chopper OP-Amp
  - Rail-Rail O/P, Gnd to Vcc -.5V I/P
  - Vcc 2.5-6V Vos 3uV Ib 1pA
  - Isupply 140uA SOT23-5 pkg
- U5 UM5K1N Dual Nch MOSFET
  - $R_{DS(ON)}$ 5 ohms @ Vgs=4V
- 2.5 mOhm sense resistor drops 100mV at 40A



- 3 gain ranges driven by uP
  - Av=1600 for 1 mA / bit
  - Av=160 for 10 mA / bit
  - Av=40 for 40mA / bit 40.9A max
- C15 & R30 filter output for A-D
- Note 4uV across Rsense = 1mA

- Functional Verification Test 4

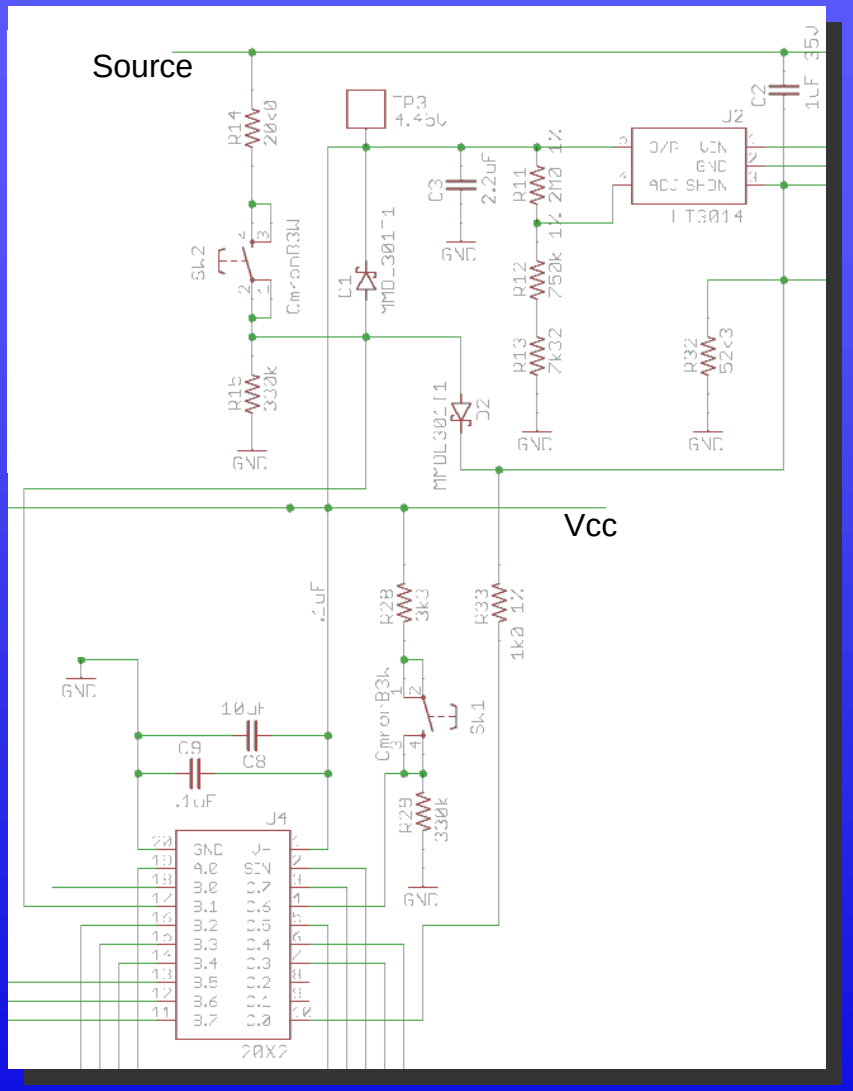
Function Switches



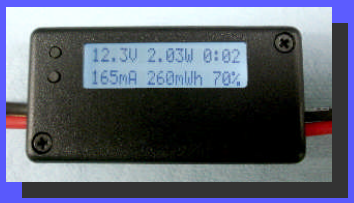
- Sw1 – Hibernate and Utilities
- Sw2 – Power off / on

- Sw1 starts the circuit by raising the voltage on the LT3014 SHDN pin through D2 which turns the regulator on starting the processor which then holds the SHDN high through R33. When Sw2 is released D2 blocks current from U4 pin C.0 output allowing the voltage at U4 B.1 input to go low. D1 clamps U4 B.1

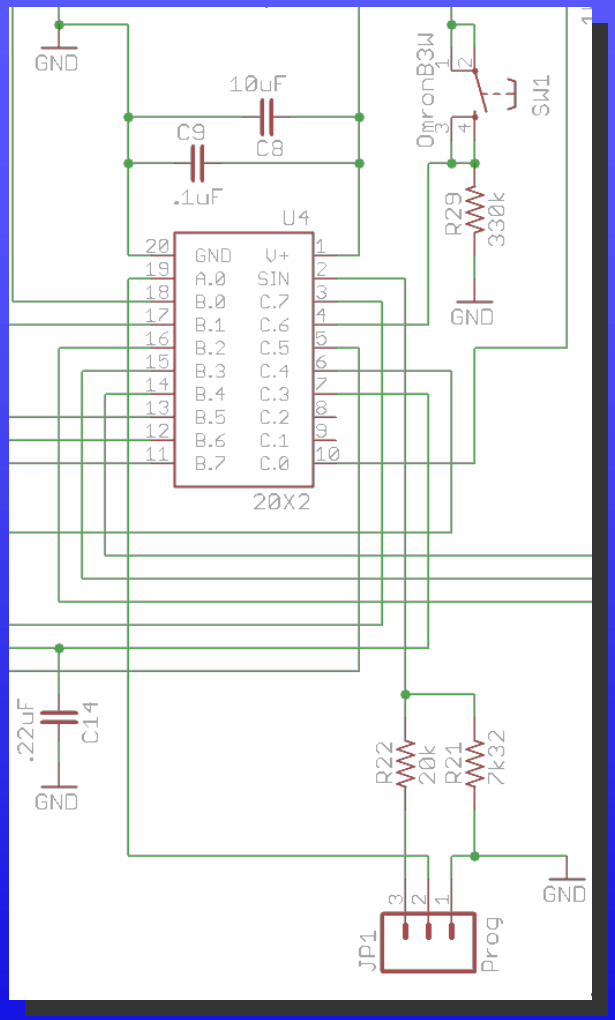
- Functional Verification Test 5



Micro Processor



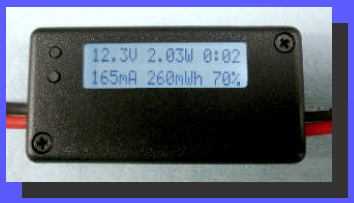
- PICAXE 20X2 in 20 pin SO pkg
- Low current consumption at 4MHz clock – about1.5 mA
- Internal oscillator factory trimmed to better than 1% accuracy
- 10 bit A-D converter
- Interrupt driven timer
- Flexible I/0 most pins can be assigned as IP, OP, A-D, Timer
- Output switches 10mA capable



- C8-C9 bypass capacitors
- JP1 R21 R22 programming port

- Functional Verification Test 6

EEPROM & Display



- Newhaven NHD-C0216CiZ display
  - Inexpensive, compact, & good viewing angle
  - Efficient backlight low=0.5mA medium=1.5mA high=2mA
  - 300uA Icc at 4.45V
  - 8 custom characters
- 24AA02 EEPROM
  - 128 byte I2C Stores configuration data restored at start-up
  - Byte addressable so saves code space
  - Icc=0.01uA standby, 50uA read
- Functional Verification Test 7