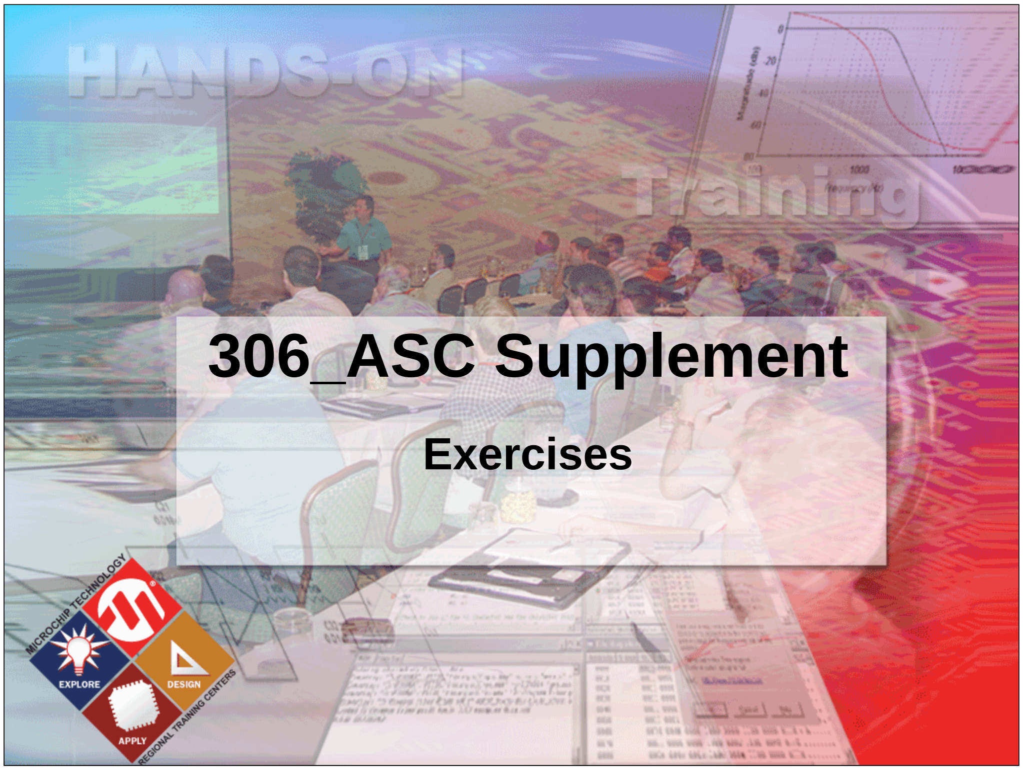
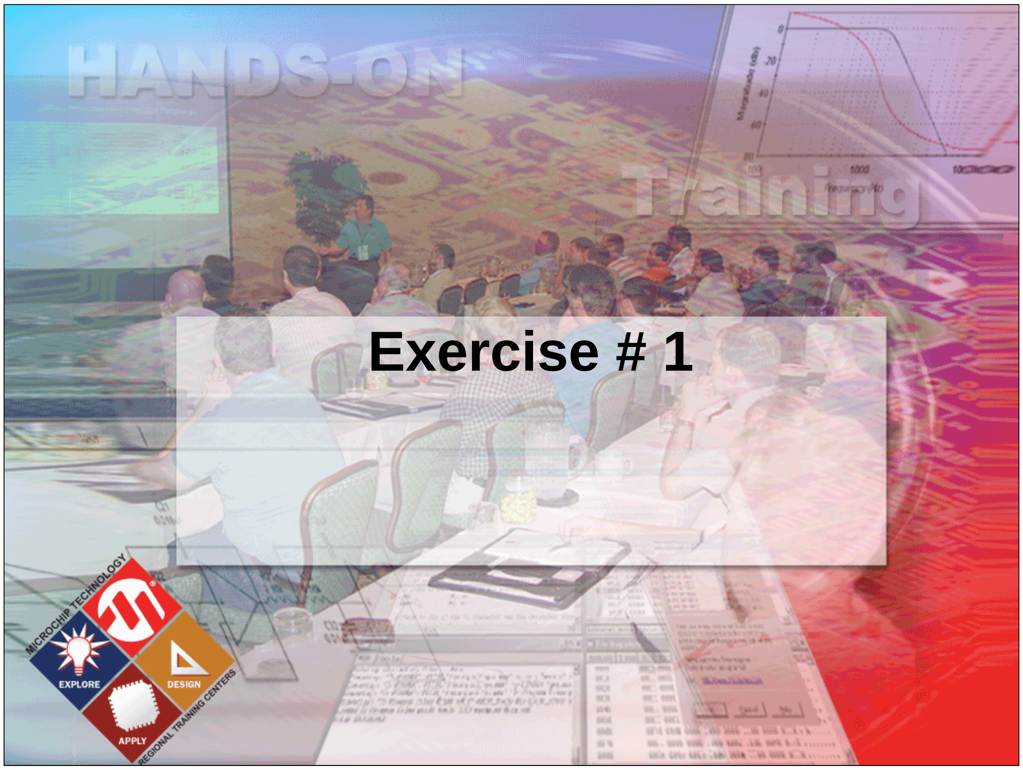
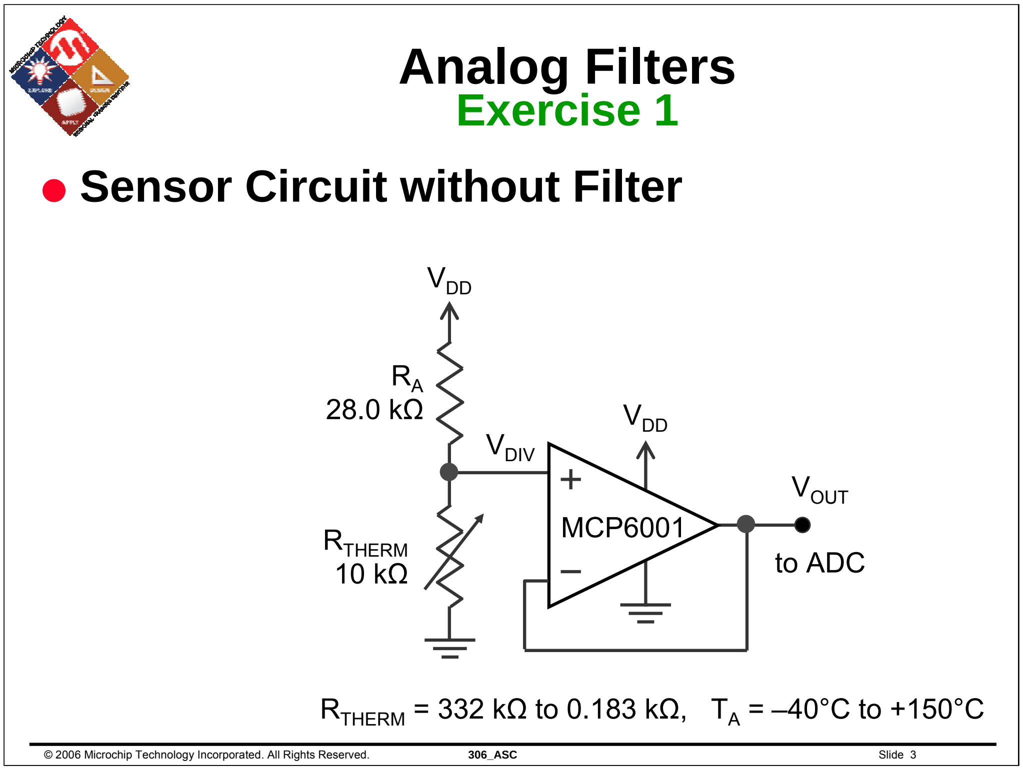


The Exercise Handouts for 306_ASC are print from this file; use the Notes View option on the print driver.

Display the Notes view on the screen, not the presentation view.



Students can use several methods to reach a result, and can pick many different criteria for the design. The important thing is to find a way to connect the design requirements to the filter specifications, then design an acceptable filter.



10 minutes to:

- Set up FilterLab
- Do filter design
- Class discussion

Given:

- $V_{DD} = 5.0V$
- Noise at V_{DIV}
  - 50 $mV_{P\text{-}P}$ at 60 Hz (line/mains)
  - 20 $mV_{P\text{-}P}$ at 500 kHz (SMPS)
- 10-bit ADC
- $\tau_{THERM} \approx 1.7$ s

Select:

- ADC's f_{SMPL}
- Filter
  - Approximation
  - BW
  - order

Analog Filters
Exercise 1

Parameter	Value
V_{DD}	5.0V
Noise at V_{DIV}	50 $mV_{P\text{-}P}$ @ 60 Hz
	20 $mV_{P\text{-}P}$ @ 500 kHz
ADC Resolution	10 bit
τ_{THERM}	1.7 s
Filter Approximation	
Filter BW	
Filter Order	
Filter f_S	
Filter A_S	
ADC's f_{SMPL}	

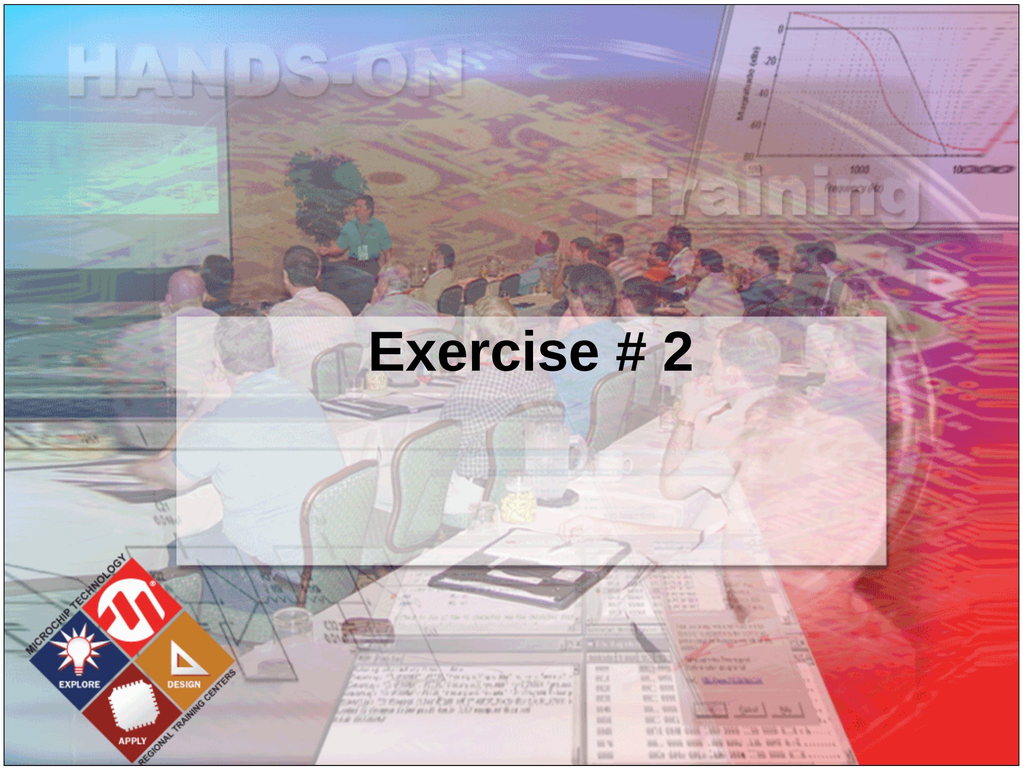
 306_ASC Slide 4

Scratch Space:

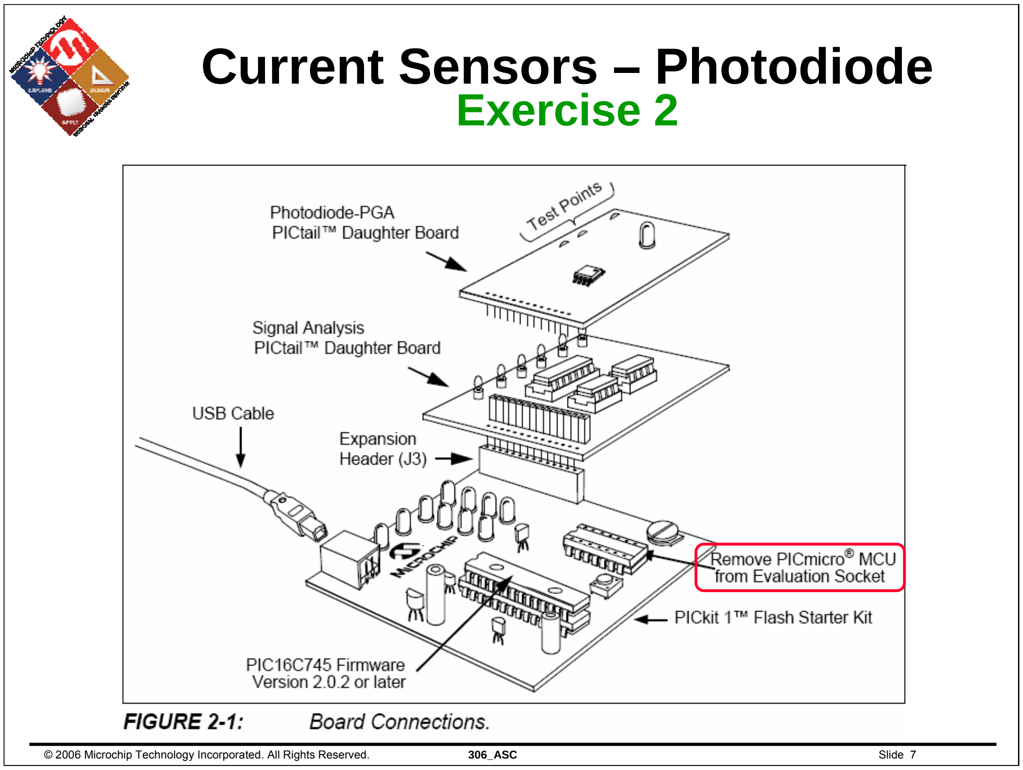
Analog Filters
Exercise 1

 306_ASC Slide 5

Scratch Space:



Students can use several methods to reach a result, and can pick many different criteria for the design. The important thing is to find a way to connect the design requirements to the filter specifications, then design an acceptable filter.



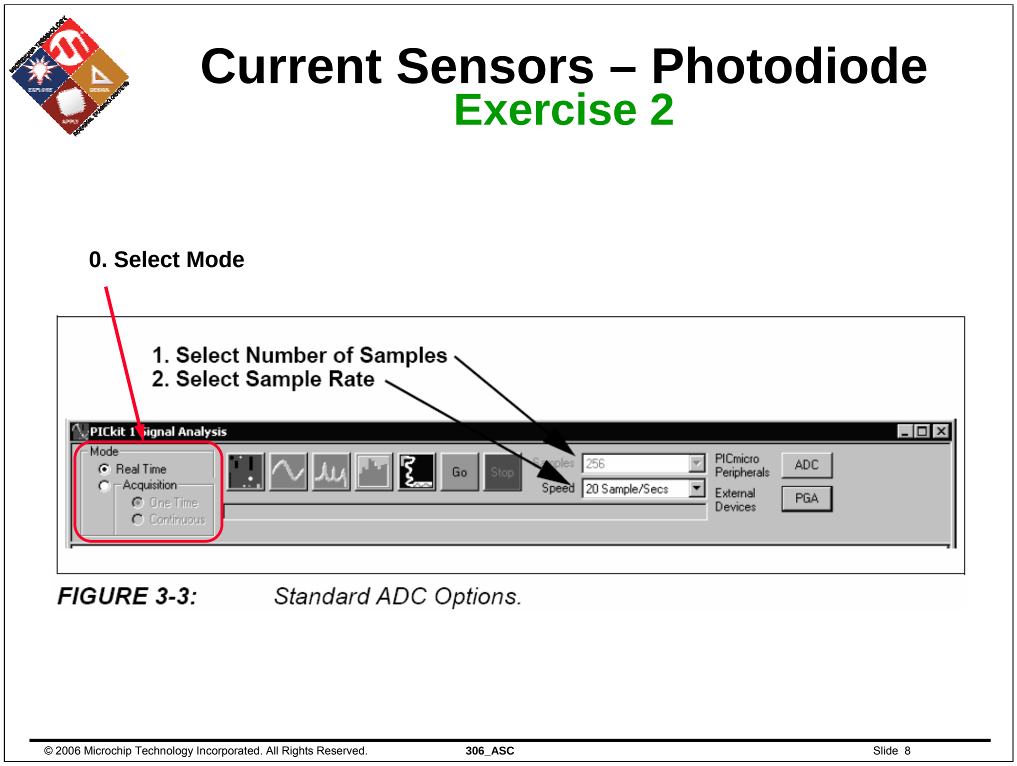
15 minutes to:

- Set up boards
- Set up Signal Analysis GUI
- Experiment with photodiode board
- Class discussion

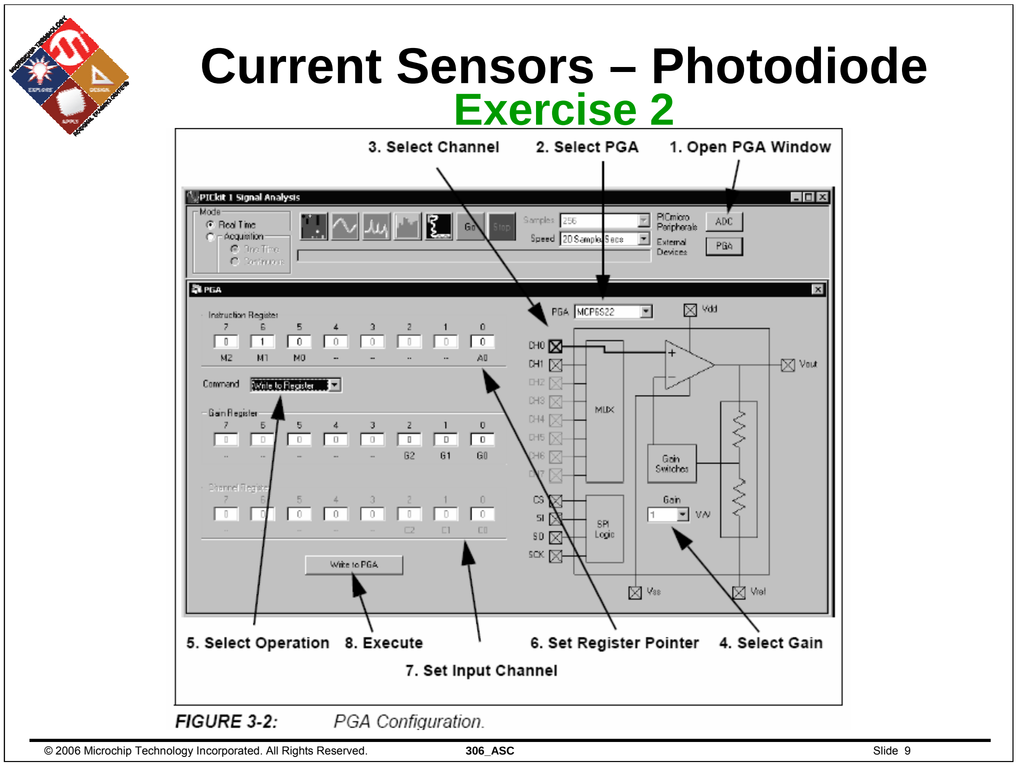
Given:

- Photodiode Demo Board
- Signal Analysis Board
- PICkit 1 Flash Starter Kit
    - Demo Board
    - GUI (PICkit 1 Signal Analysis)

1. Set up boards:
   a. Remove PIC from PICkit 1 board
   b. Stack boards / connect 14-pin headers
   c. Connect USB cable to PC



2. Start up GUI
3. Set up for Strip Chart; see screen shot above
   a. Select Real Time mode
   b. Set sample speed
4. Set up for Oscilloscope, Histogram, and FFT
   a. Select Acquisition mode
   b. Set sample speed
   c. Set number of Samples to adquire

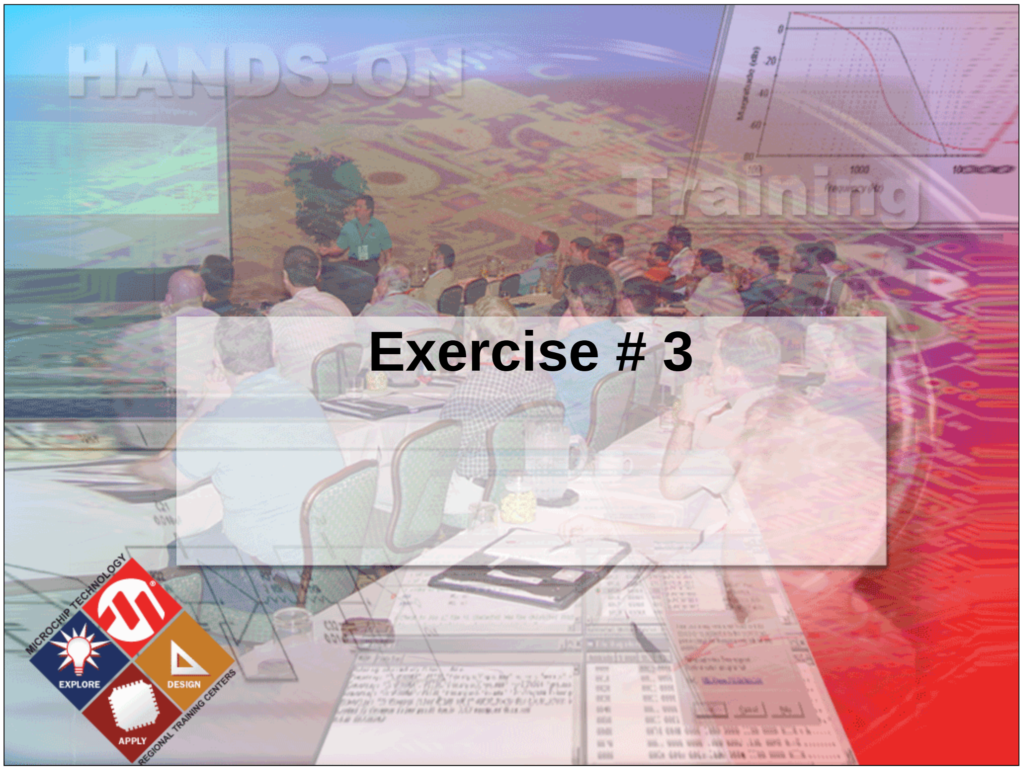


5. Set up PGA (MCP6S22); see screen shot above:
    1. Click PGA button
    2. Select MCP6S22
    3. (ignore)
    4. Select Gain as needed for lighting level
    5. Select Write to Register
    6. Leave at 0 (toggle with mouse click; 0 = Gain Register, 1 = Channel Register)
    7. Leave alone (board only uses CH0)
    8. Click Write to PGA button
6. Make some measurements
    a. Click Go button
    b. Measure in dark
    c. Measure w/ bright, DC light
    d. Measure w/ florescent light
    e. Click Stop button
7. Interpret/Analyze results

Current Sensors – Photodiode
Exercise 2

 306_ASC Slide 10

Scratch Space:



Students can use several methods to reach a result, and can pick many different criteria for the design. The important thing is to find a way to connect the design requirements to the filter specifications, then design an acceptable filter.

Resistive Sensors – Thermistor
Exercise 3

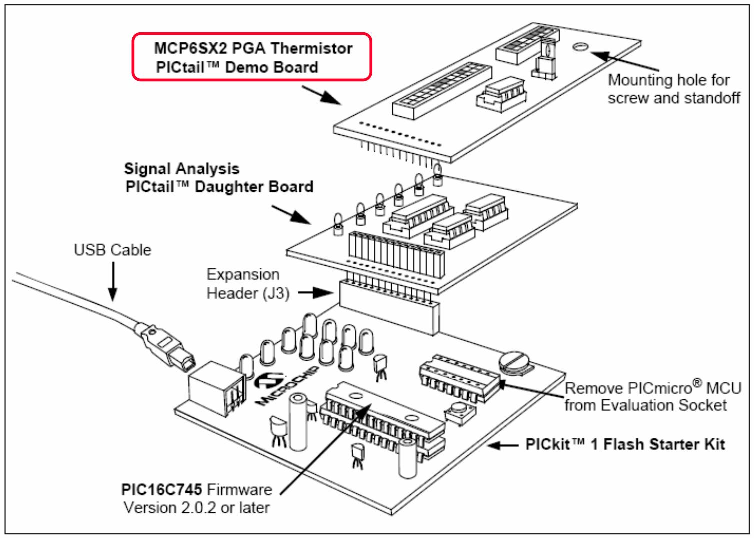


FIGURE 2-1: *Board Connections.*

10 minutes to:

• Swap demo boards

• Put Photodiode board pieces away (for next class)

• Experiment with thermistor board

• Class discussion

Given:

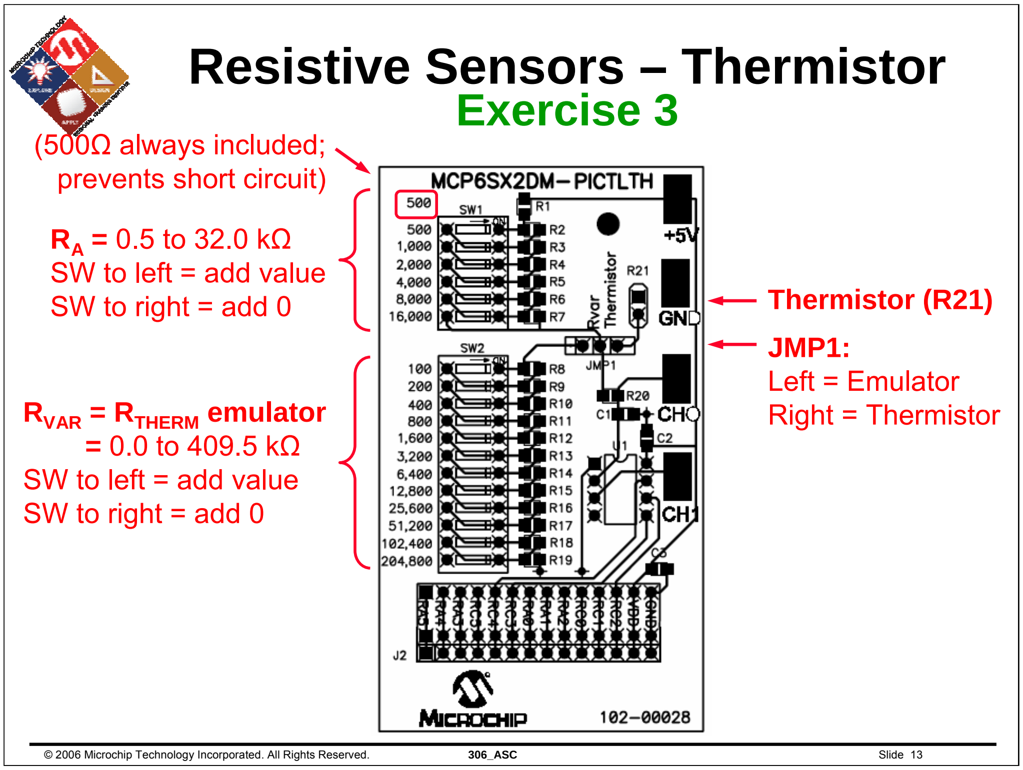
• Setup already in place for photodiode

• Thermistor Demo Board

1. Exchange Thermistor board for the Photodiode board

   <u>Put Photodiode Demo Board's pieces away</u> (for next class)

2. PGA and GUI setup doesn't change



3. Experiment with the thermistor emulator

a. Place shunt on JMP1 to the Left

b. Select R_A and R_{THERM} emulator (R_{VAR}) values by changing the switches on SW1 and SW2 (all going top to bottom), respectively

SW1	value (kΩ)	SW2	value (kΩ)
R	0.5	R	0.1
R	1.0	R	0.2
R	2.0	L	0.4
L	4.0	R	0.8
L	8.0	R	1.6
L	16.0	L	3.2
Total =	28.0	L	6.4
		R	12.8
		R	25.6
		R	51.2
		R	102.4
		R	204.8
		Total =	10.0

Resistive Sensors – Thermistor
Exercise 3

Convert V_{OUT} to Temperature

V_{DD} = 5.0V
R_A = 28.0 kOhm
PGA Gain = 1.0 V/V

Convert (°C) to (°F) and Back

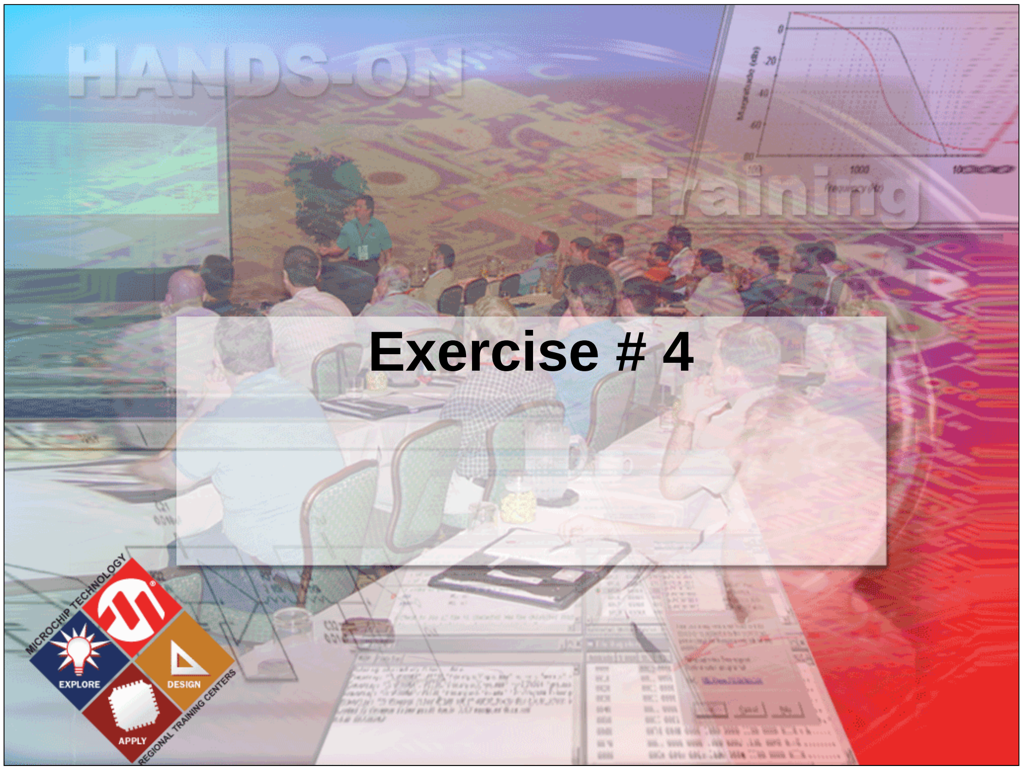
$T_C = (T_F - 32°F)\ (5°C / 9°F)$
$T_F = T_C\ (9°F / 5°C) + 32°F$

ADC Code (LSb)	V_{OUT} (V)	T_{TH} (°C)	T_{TH} (°F)
425	2.075	10.00	50.00
368	1.797	14.99	58.98
316	1.543	19.98	67.96
269	1.313	25.06	77.11
229	1.118	29.98	85.96
194	0.947	34.97	94.95
164	0.801	39.96	103.93
138	0.674	45.06	113.11
117	0.571	49.95	121.91

3. (cont.)
   c. Try "high temperature" (e.g., R_{THERM} = 1.75 kΩ at T_A = 70°C, giving V_{DIV} = 0.2941V when V_{DD} = 5.0V); set the PGA gain (e.g., 8 V/V)
4. Experiment with the thermistor
   a. Place shunt on JMP1 to the Right
   b. Measure V_{OUT} (PGA gain = 1)
      i. At ambient temperature
      ii. Breath on thermistor
      iii. Hold thermistor with fingers

Resistive Sensors – Thermistor
Exercise 3

Scratch Space:



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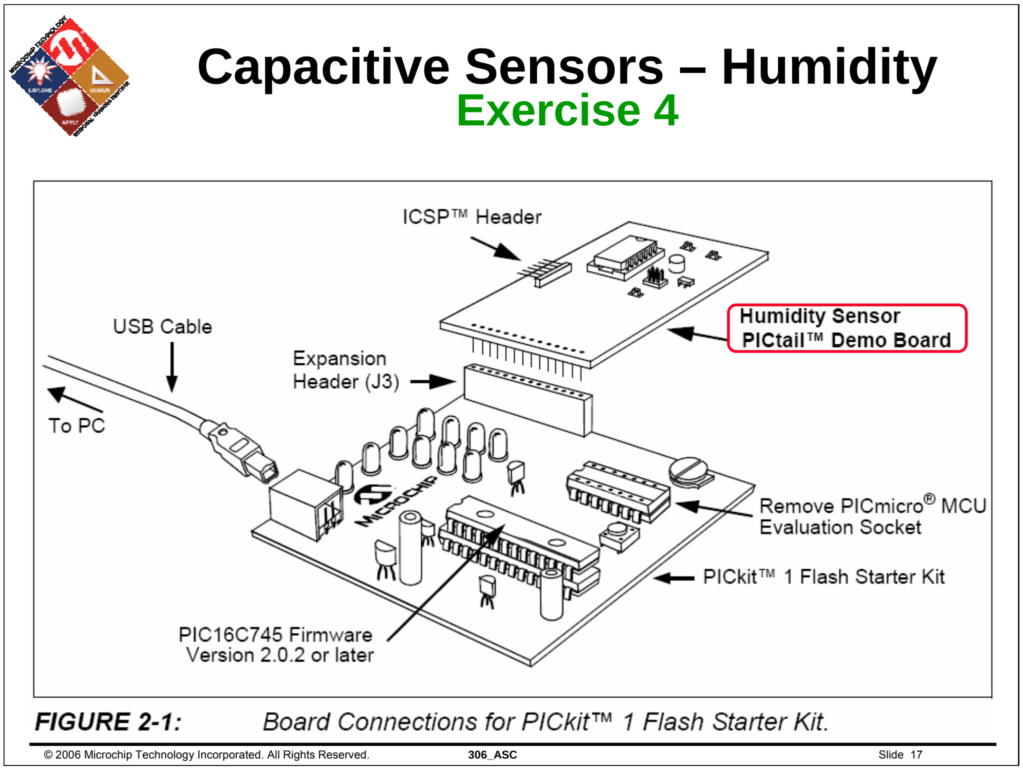


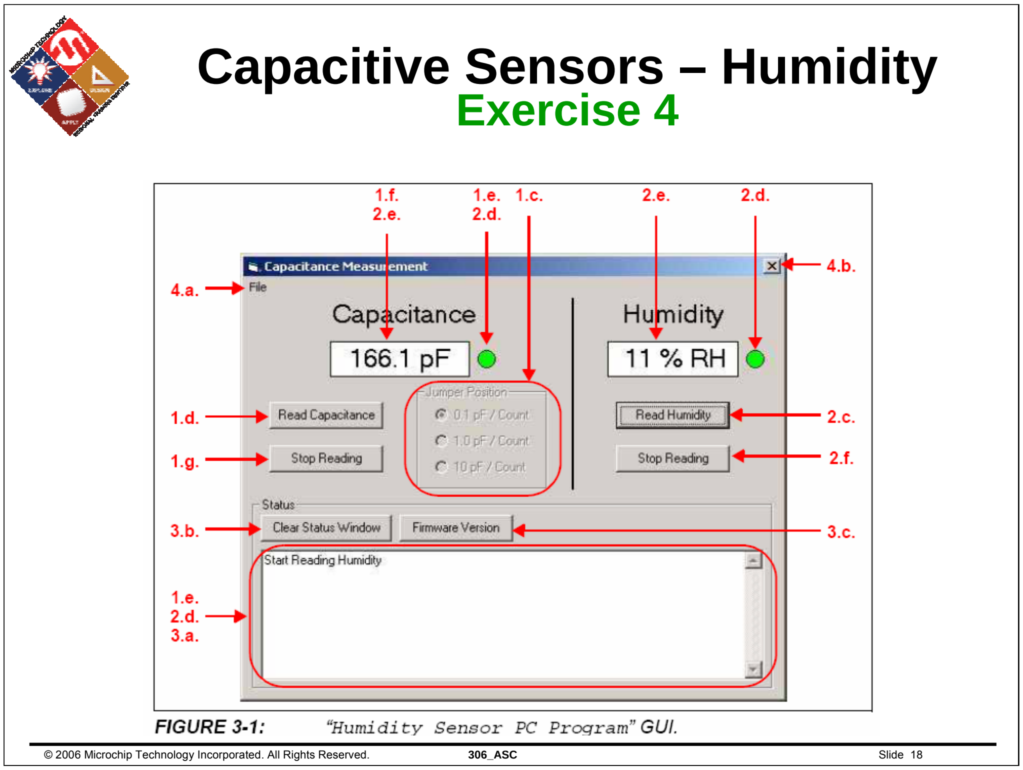
10 minutes to:

- Swap demo boards
- Put Thermistor board pieces away (for next class)
- Experiment with humidity sensor board
- Class discussion

Given:

- Humidity Sensor Demo Board

1. Remove and <u>put Thermistor Demo Board's pieces away</u> (for next class)
2. Remove and <u>put Signal Analysis Board away</u> (for next class)
3. Exit GUI (PICkit 1 Signal Analysis)
4. Connect Humidity Sensor Demo Board



5. Start up new GUI for Humidity Sensor Demo Board
   a. If not installed, run the installer program (AN1016 install.exe)
   b. Run capacitance.exe
6. Make measurements on capacitors and the humidity sensor; the following #s correspond to the figure above:

Measure Capacitance (C_{SEN}).

1.a. Put capacitor in C_{SEN}'s socket on the board.

1.b. Select desired resolution on the board (set by shunt and JP1 – JP3).

1.c. Input the resolution.

1.d. Click on the READ CAPACITANCE button.

1.e. The green light turns on and the status window is updated.

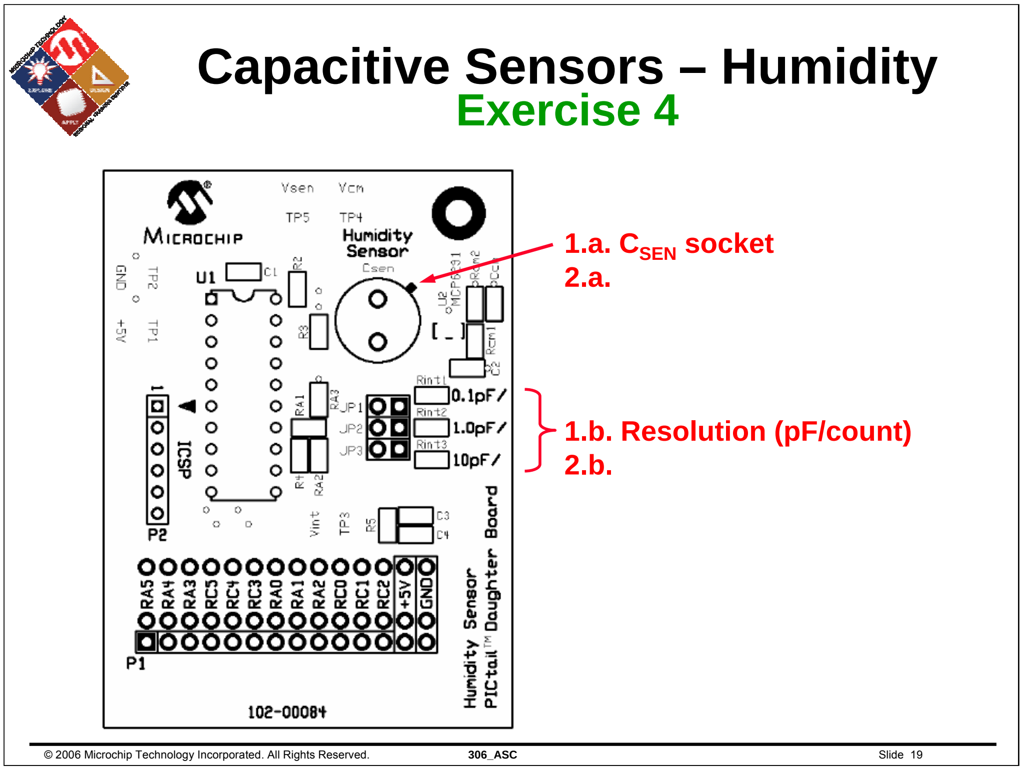
1.f. Read the current capacitance value (which is updated about once a second).

1.g. Click on the STOP READING button.

Measure Humidity (RH).

2.a. Put the HS1101LF sensor in C_{SEN}'s socket on the board.

2.b. Select the 0.1 pF / count resolution on the board (put shunt across JP1).



2.c. Click on the READ HUMIDITY button (a resolution of 0.1 pF / count is assumed by the GUI).

2.d. The green lights turn on and the status window is updated.

2.e. Read the current capacitance value and relative humidity (which are updated about once a second).

2.f. Click on the STOP READING button.

2.g. Check Program Status.

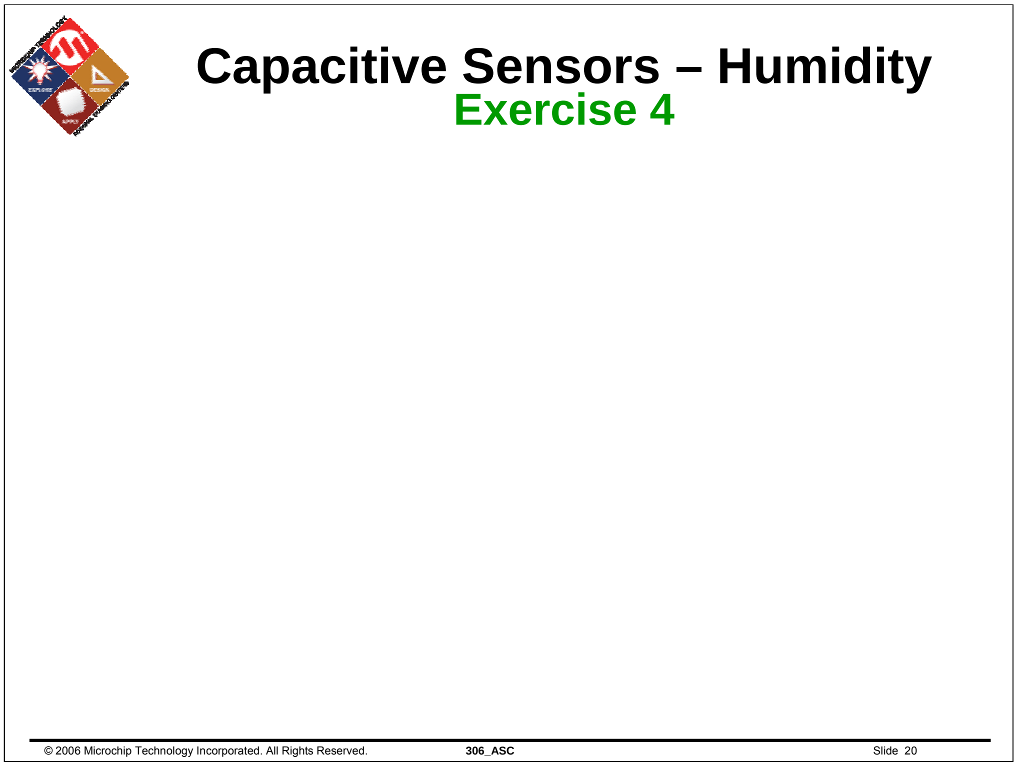
Read the status history in the status window.

3.a. Click the CLEAR STATUS WINDOW button to clear the status history.

3.b. Click the FIRMWARE VERSION button to see the version displayed in the status window.

Quit the Program.

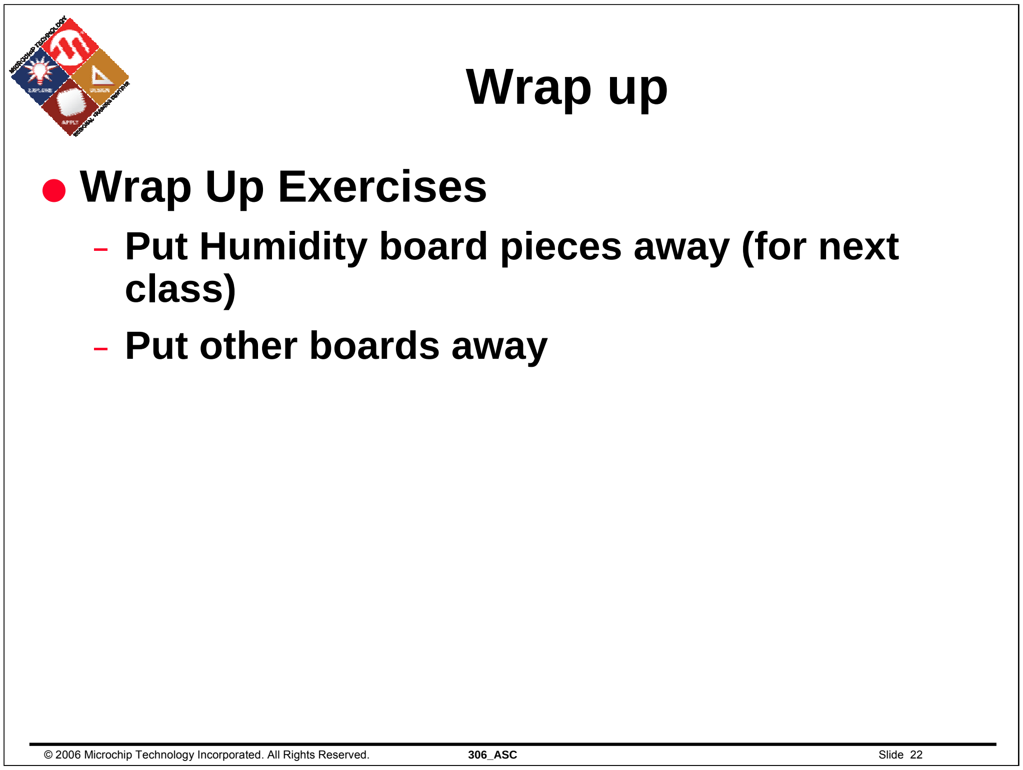
4.a. Click the FILE button, then the EXIT button that pops up. Or click on the WINDOWS' EXIT button.



7. Make the following measurements
   a. Measure 10 pF, 180 pF, 1 nF, and 100 nF capacitors.
   b. Measure HS (breath on it).

Scratch Space:

A couple of minutes work by each student can save the teachers hours of time after the class.



2 minutes to:

- Put Humidity board pieces away (for next class)
- Put other boards away