

# Physical Computing

## What We've Learned So Far @ITP



Tom Igoe

ITP

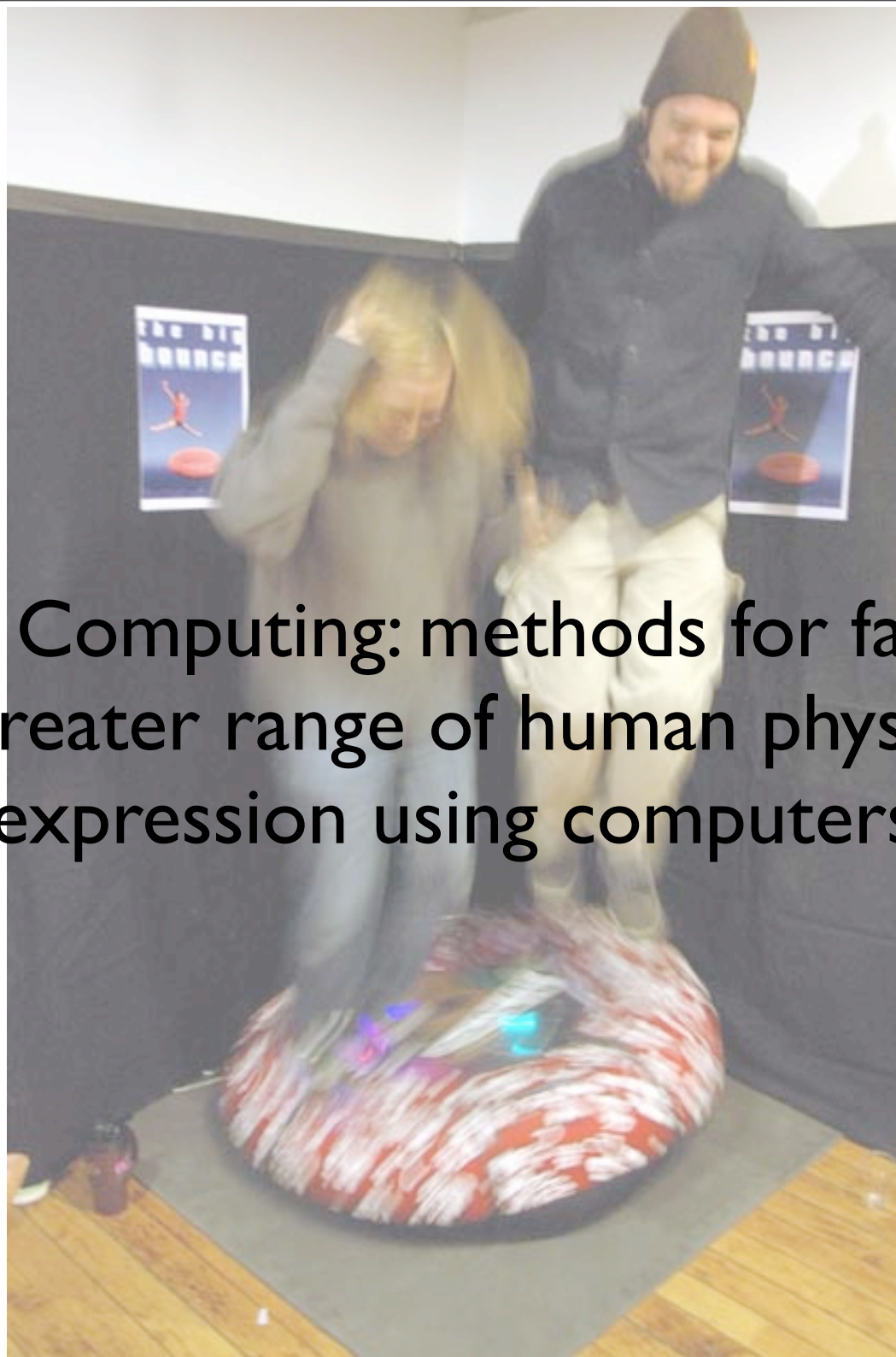
Tisch School of the Arts

NYU

# ITP

- 2-year grad program, 230 students
- No technical requirements to admissions:
  - Artists, designers, musicians, dancers, chefs, therapists, sword swallows, sandwich artists, engineers, butchers, bakers, candlestick makers, etc.
- Collaboration is central to the program
- A plurality of voices and a large community makes for better interactive design work

Physical Computing: methods for facilitating a greater range of human physical expression using computers.







# Sensor-to-Screen



Foosball  
Dennis Crowley

# Through the Looking Glass...

Gabriela Richard, Vanessa Khan, Tom Ainslie



# Ramps



John Schimmel, Tristan Perich, Wlodek Koss



# Standalone Objects

SmartHug

Heather Dewey-Hagborg

Vaishali Khandare



# VOCquet

Jennifer Kirchherr



# Therapy Incentives Through Play

Stephen Kerrigan, Mike Bukhin



# Wireless Objects



Needies

Brett Shulz, Daniel Perlin, Amos Bloomberg



**2 Fast 4 Tracks**  
Chris Hall

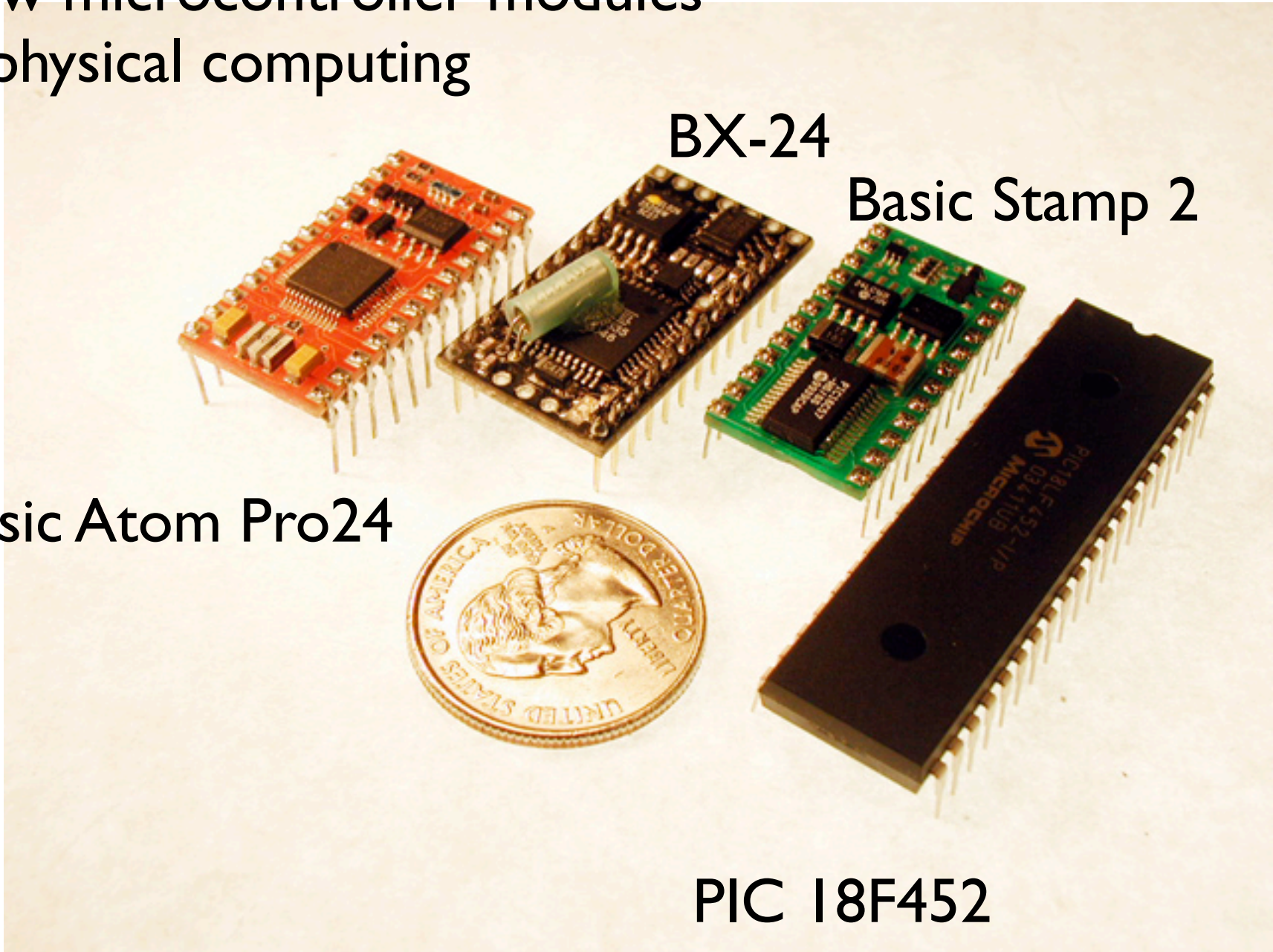
# A few microcontroller modules for physical computing

BX-24

Basic Stamp 2

Basic Atom Pro24

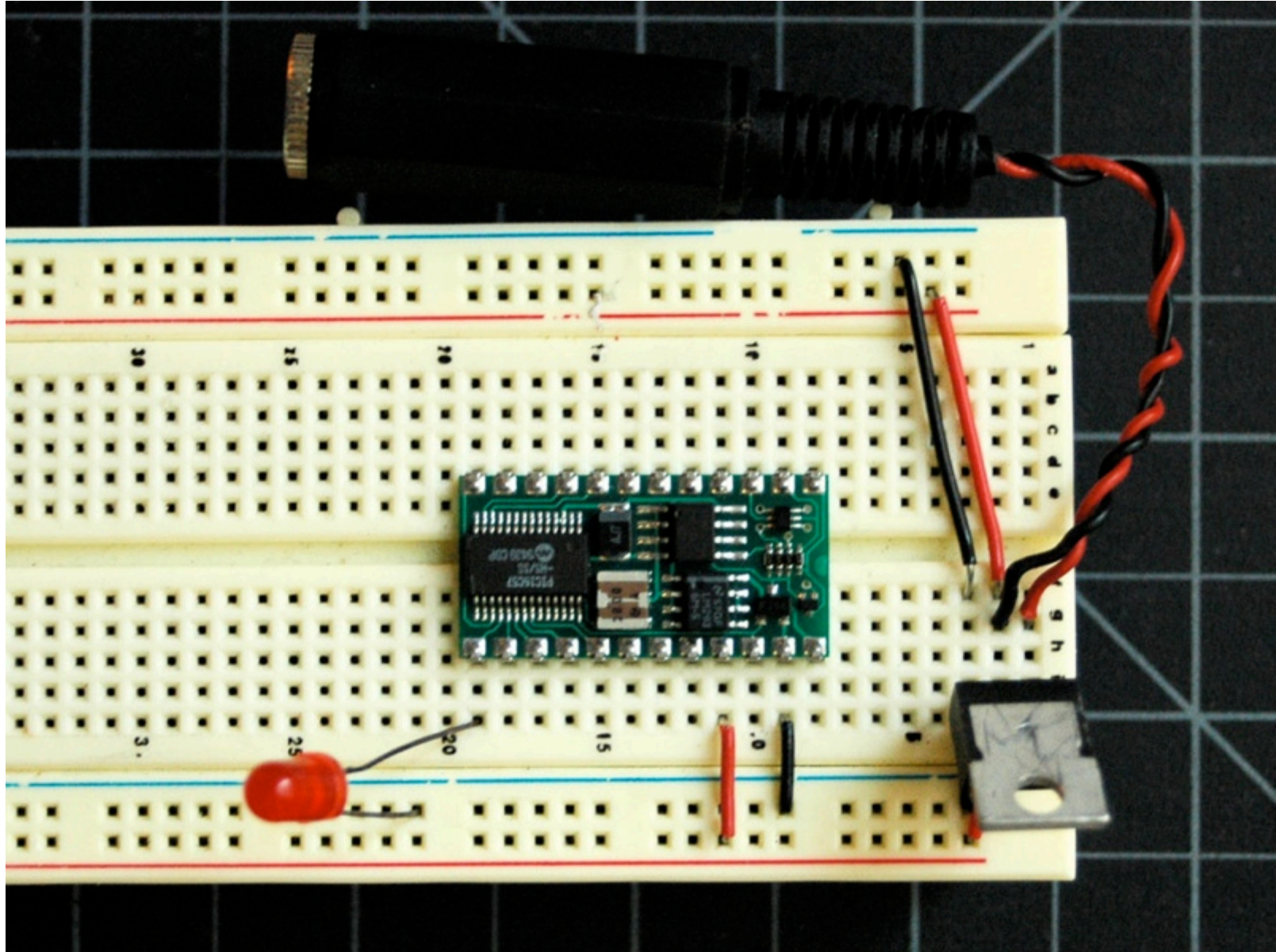
PIC 18F452



# Hardware is Hard

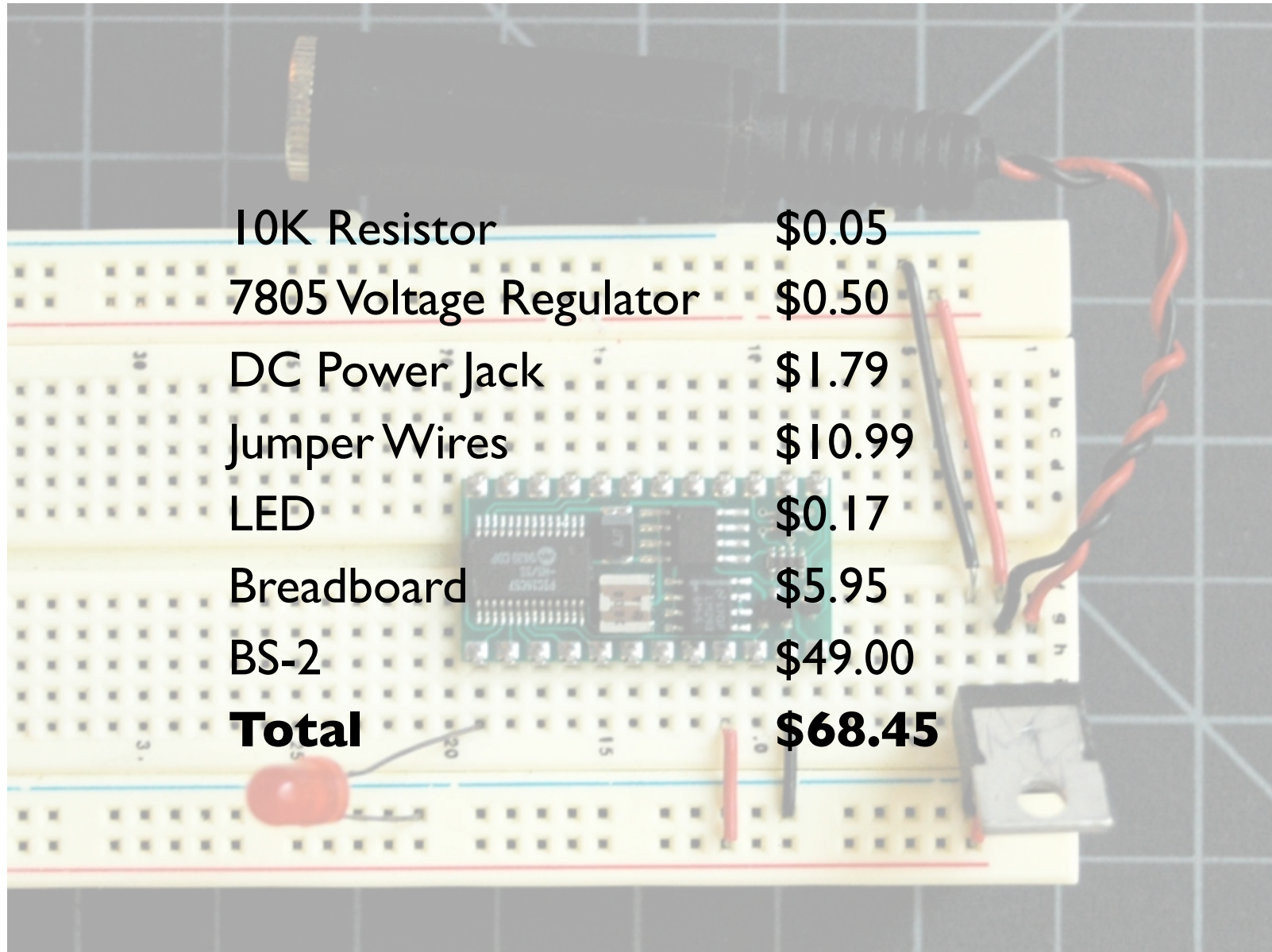
- Keep setup cost really low
- Consider the cost of multiple controllers
- The fewer components, the better
- The things that seem most minor to experienced people are the most major stumbling blocks for beginners
- Abstract the housekeeping, focus on the interface

# Basic Stamp 2



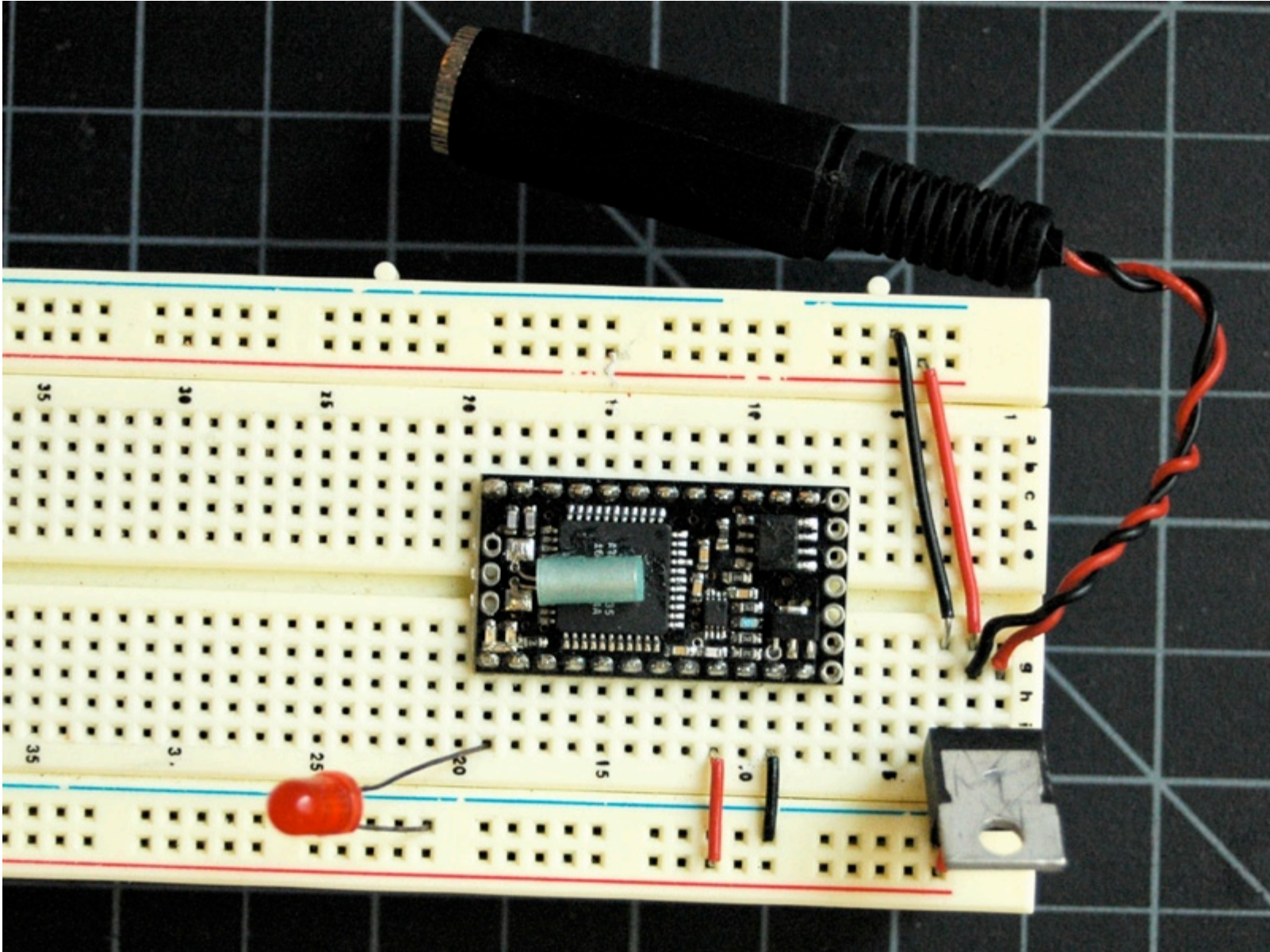


# Basic Stamp 2

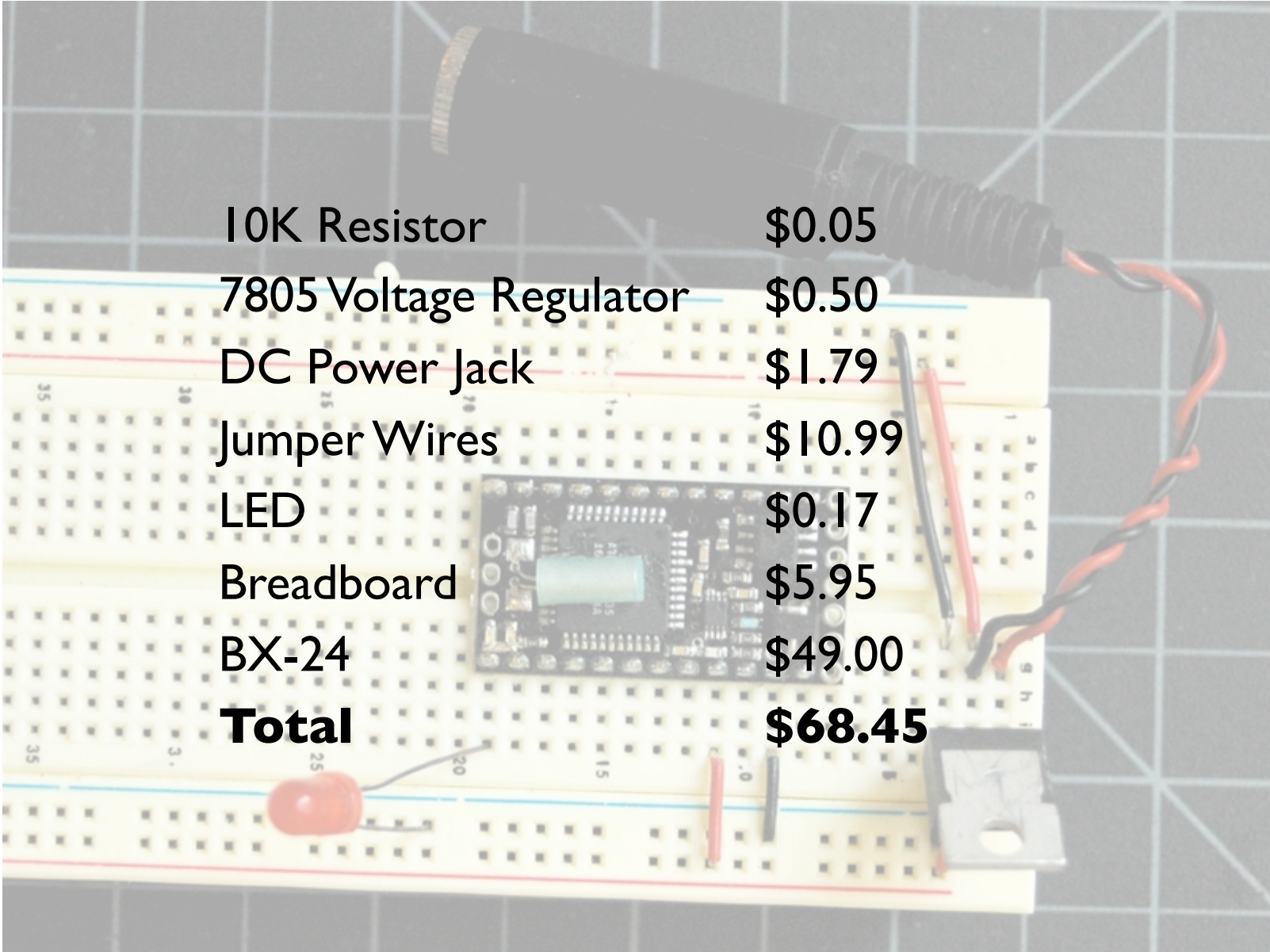


10K Resistor	\$0.05
7805 Voltage Regulator	\$0.50
DC Power Jack	\$1.79
Jumper Wires	\$10.99
LED	\$0.17
Breadboard	\$5.95
BS-2	\$49.00
<b>Total</b>	<b>\$68.45</b>

# NetMedia BX-24

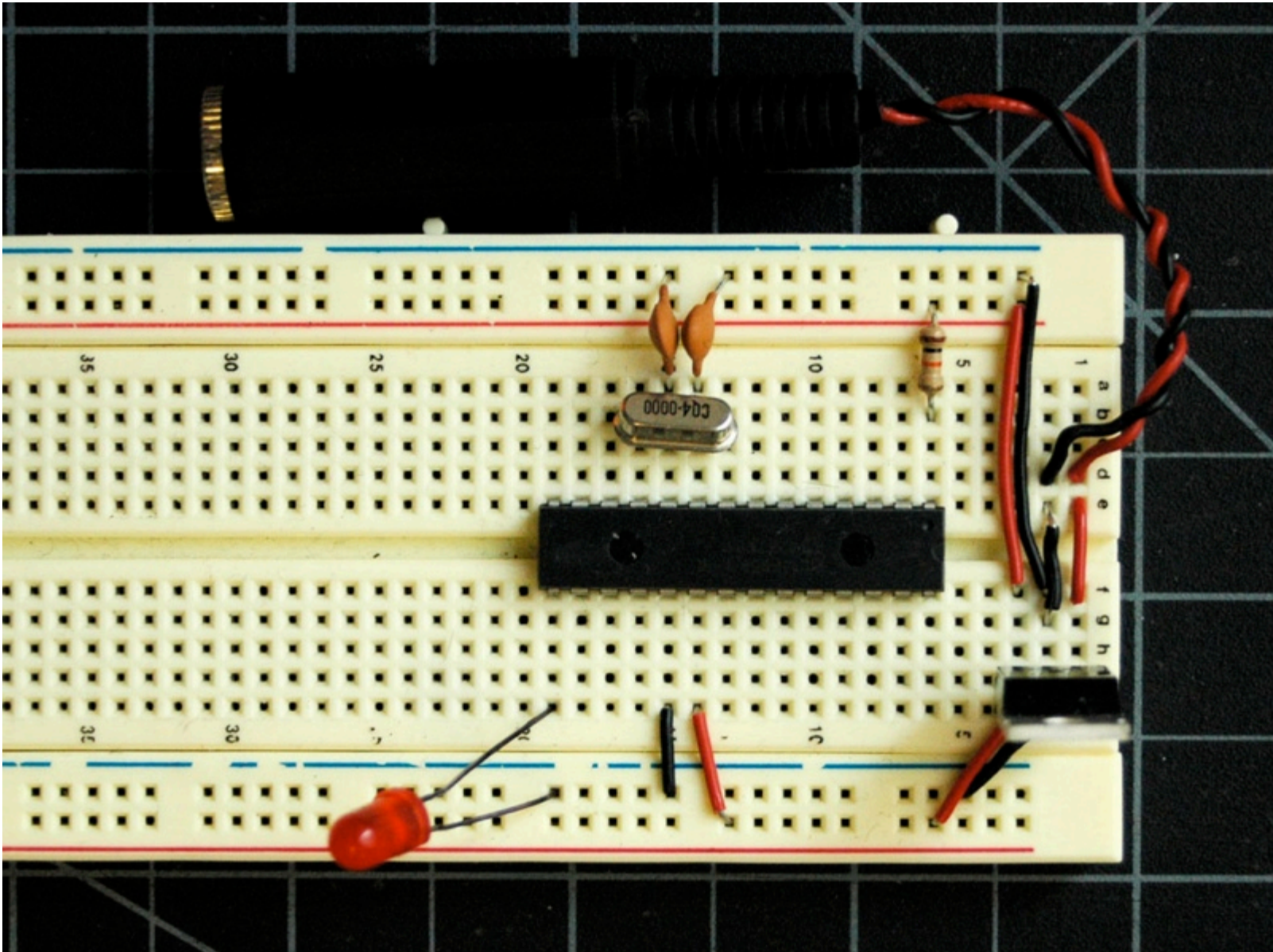


# NetMedia BX-24

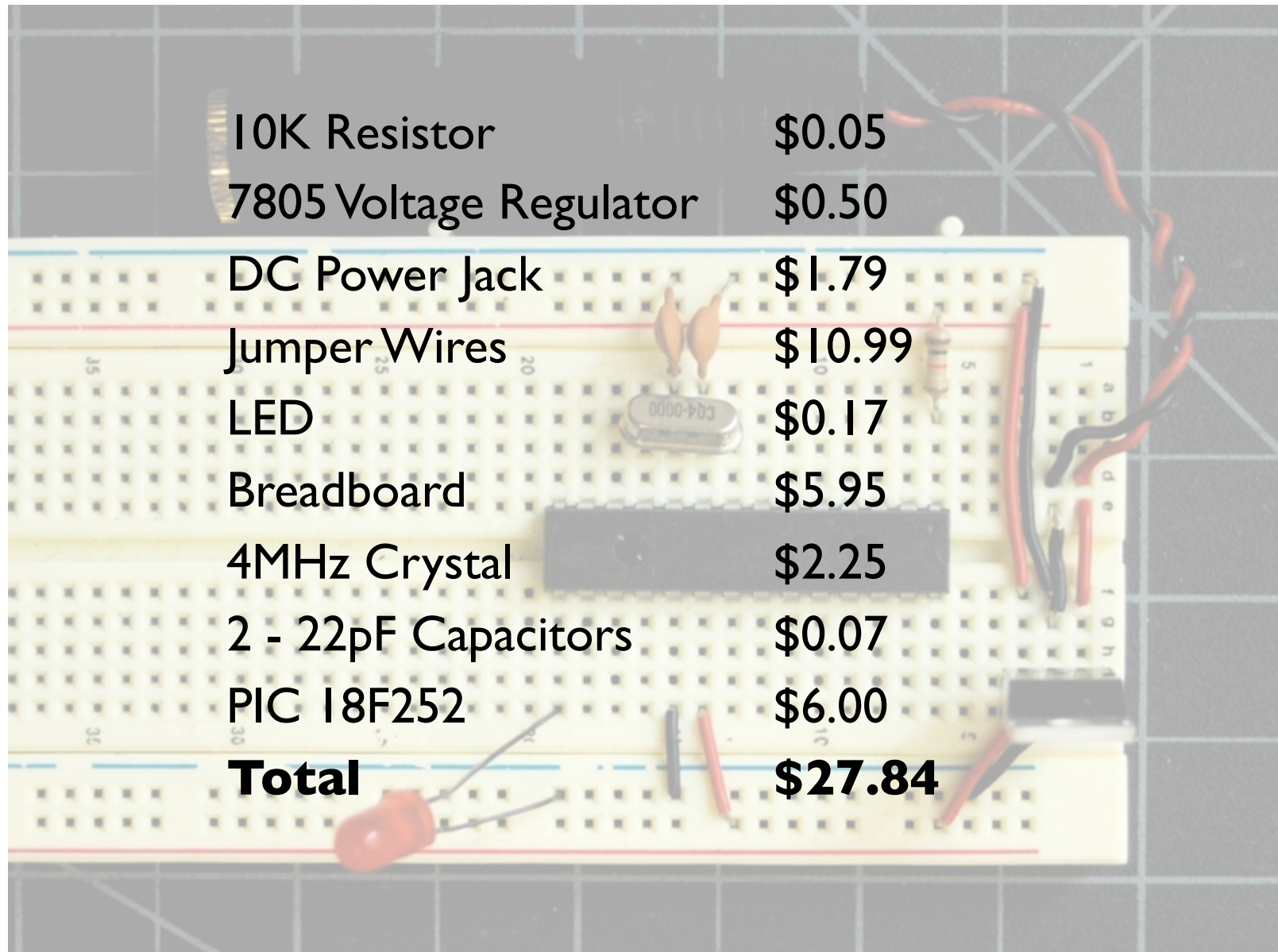


10K Resistor	\$0.05
7805 Voltage Regulator	\$0.50
DC Power Jack	\$1.79
Jumper Wires	\$10.99
LED	\$0.17
Breadboard	\$5.95
BX-24	\$49.00
<b>Total</b>	<b>\$68.45</b>

# Microchip PIC 18F252

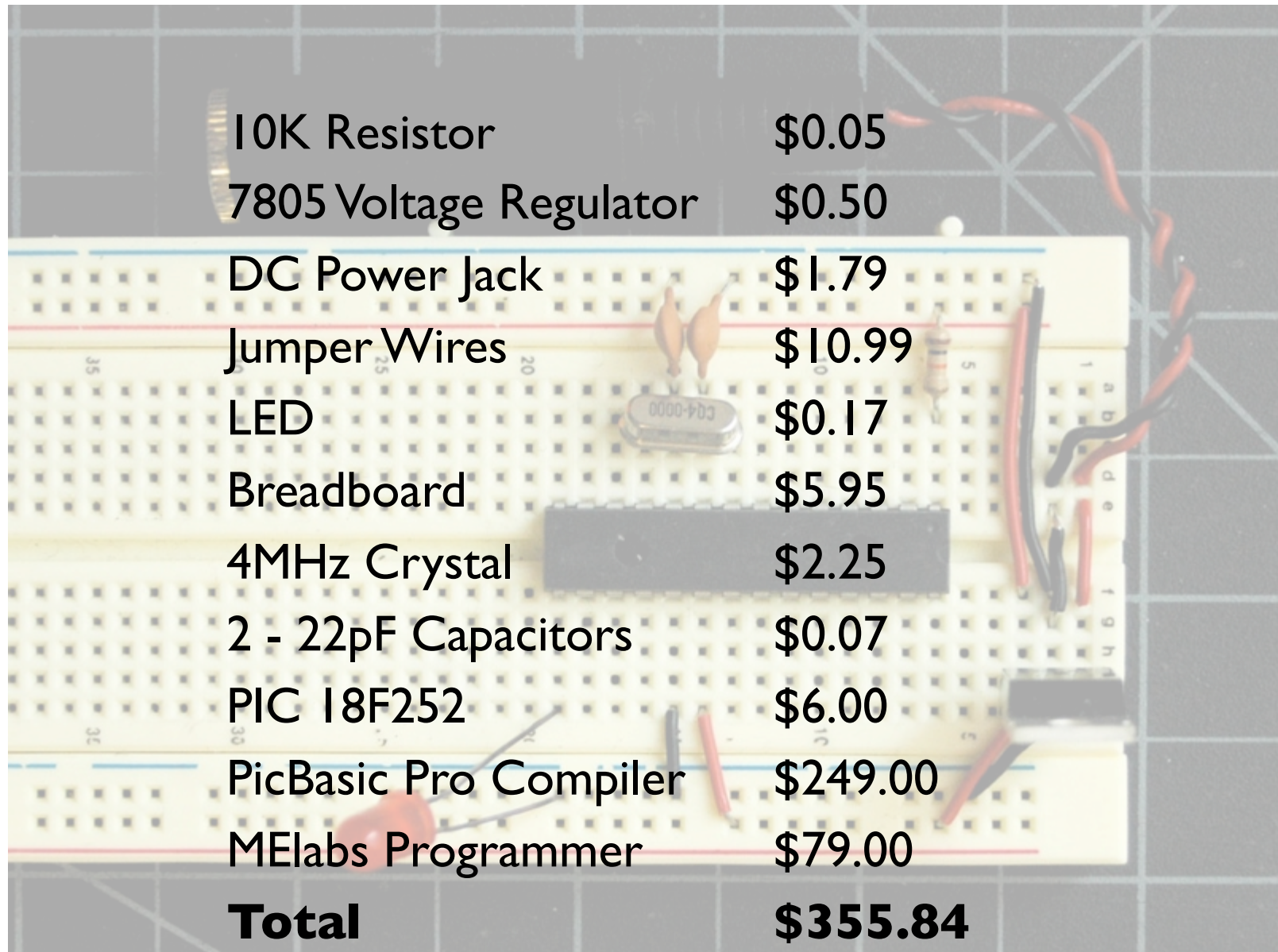


# Microchip PIC 18F252



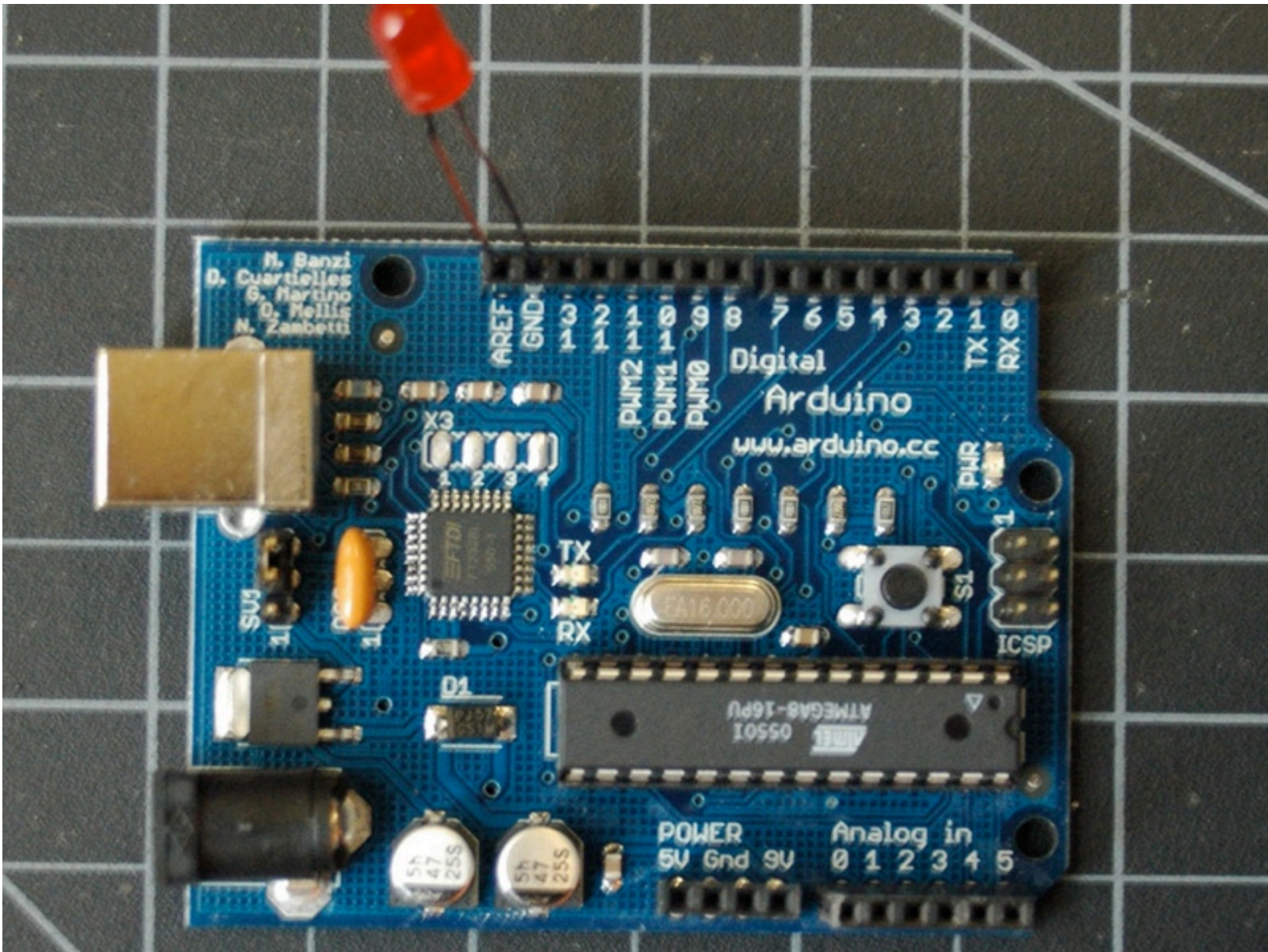
10K Resistor	\$0.05
7805 Voltage Regulator	\$0.50
DC Power Jack	\$1.79
Jumper Wires	\$10.99
LED	\$0.17
Breadboard	\$5.95
4MHz Crystal	\$2.25
2 - 22pF Capacitors	\$0.07
PIC 18F252	\$6.00
<b>Total</b>	<b>\$27.84</b>

# Microchip PIC 18F252

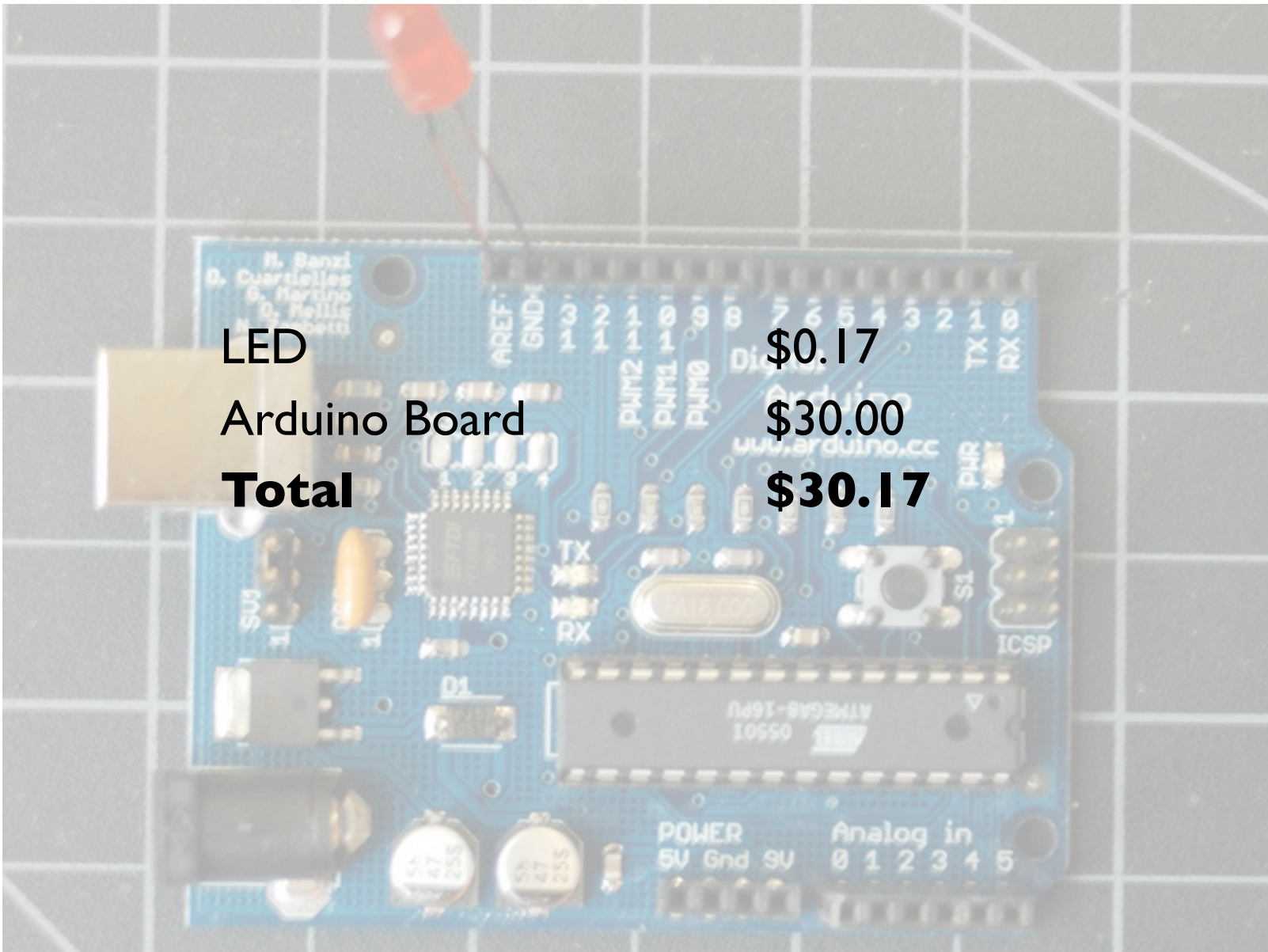


10K Resistor	\$0.05
7805 Voltage Regulator	\$0.50
DC Power Jack	\$1.79
Jumper Wires	\$10.99
LED	\$0.17
Breadboard	\$5.95
4MHz Crystal	\$2.25
2 - 22pF Capacitors	\$0.07
PIC 18F252	\$6.00
PicBasic Pro Compiler	\$249.00
MElabs Programmer	\$79.00
<b>Total</b>	<b>\$355.84</b>

# Arduino



# Arduino



LED

\$0.17

Arduino Board

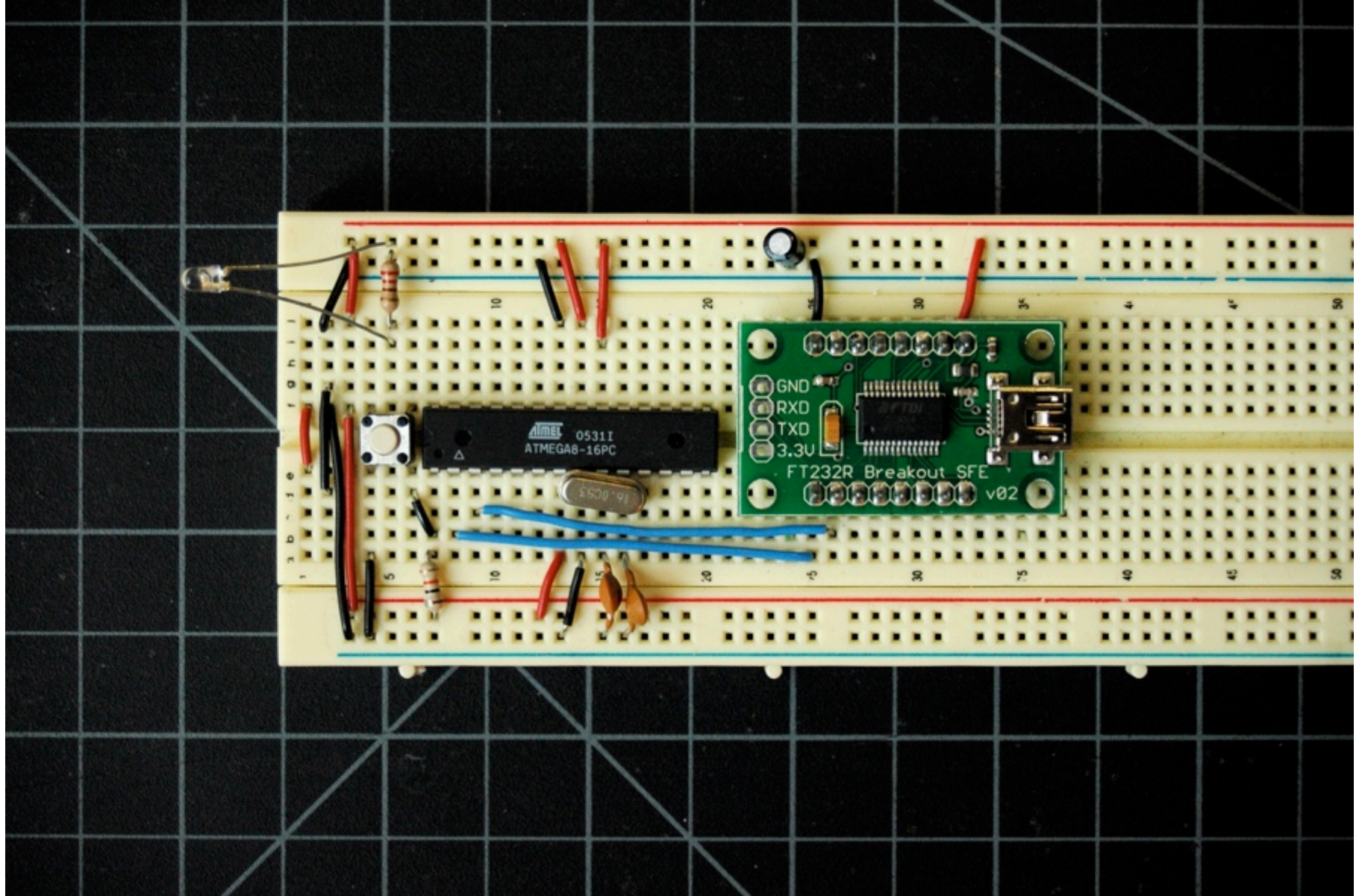
\$30.00

**Total**

**\$30.17**



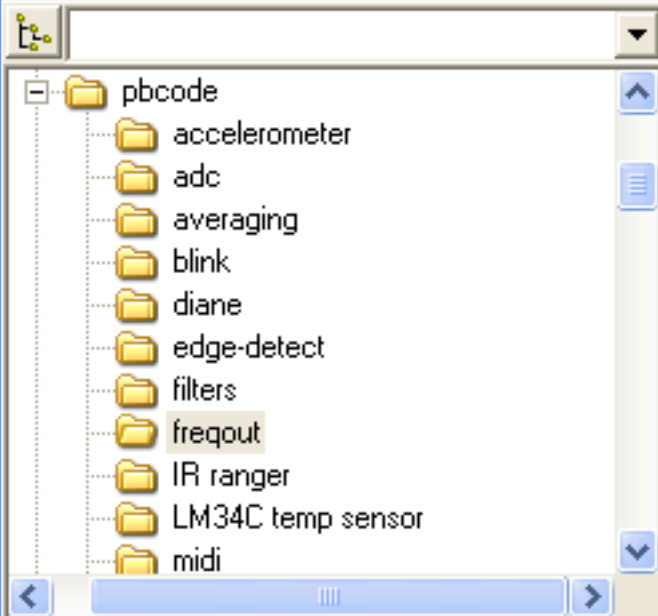
# Arduino



# Software Must Be Soft

(Because Hardware is Hard)

- Simple interface is important
- Simple language is important
- Big function/feature list isn't so important
- Minor language elements are major stumbling blocks
- Abstract the housekeeping, focus on the interface



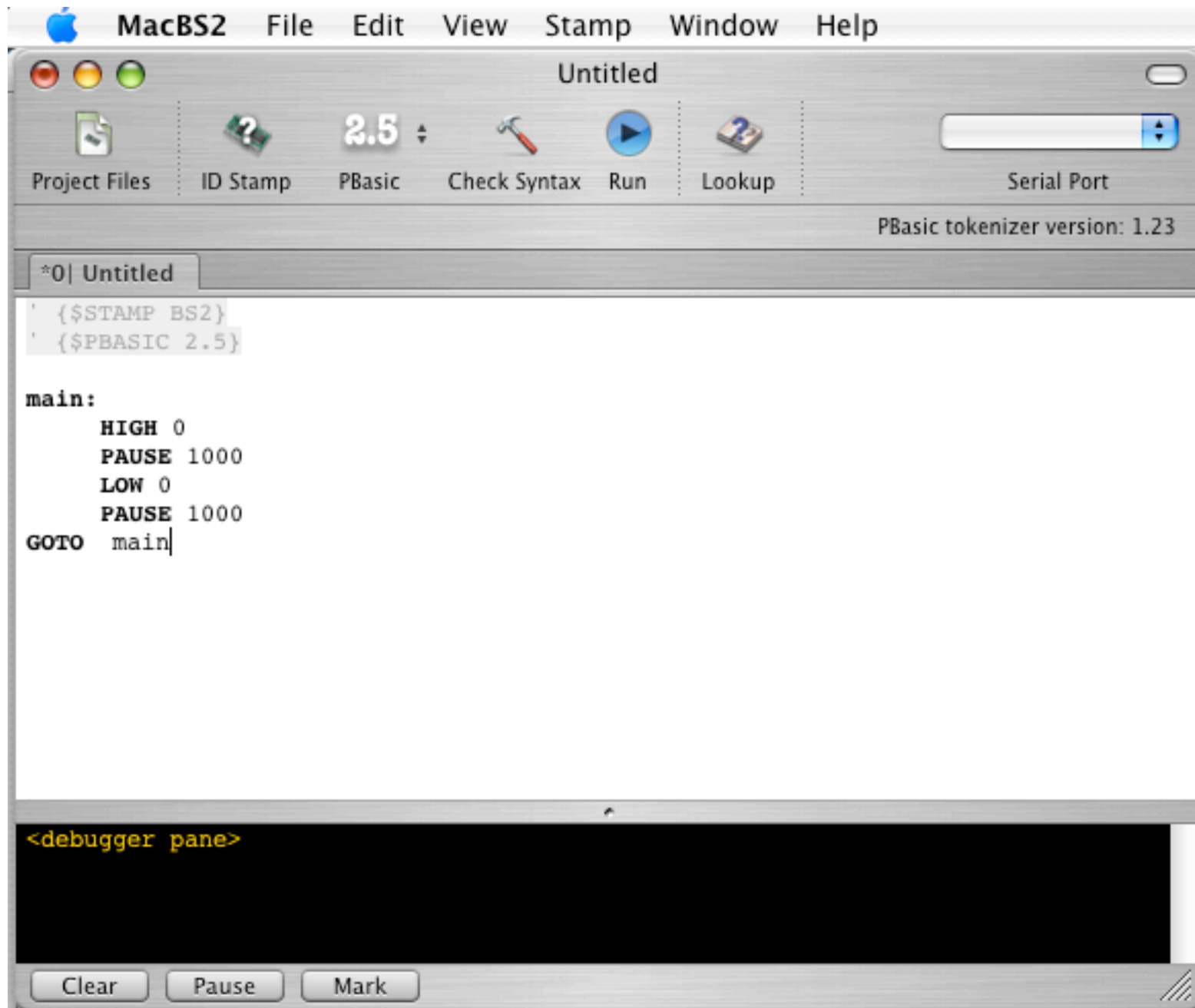
blink.bs2

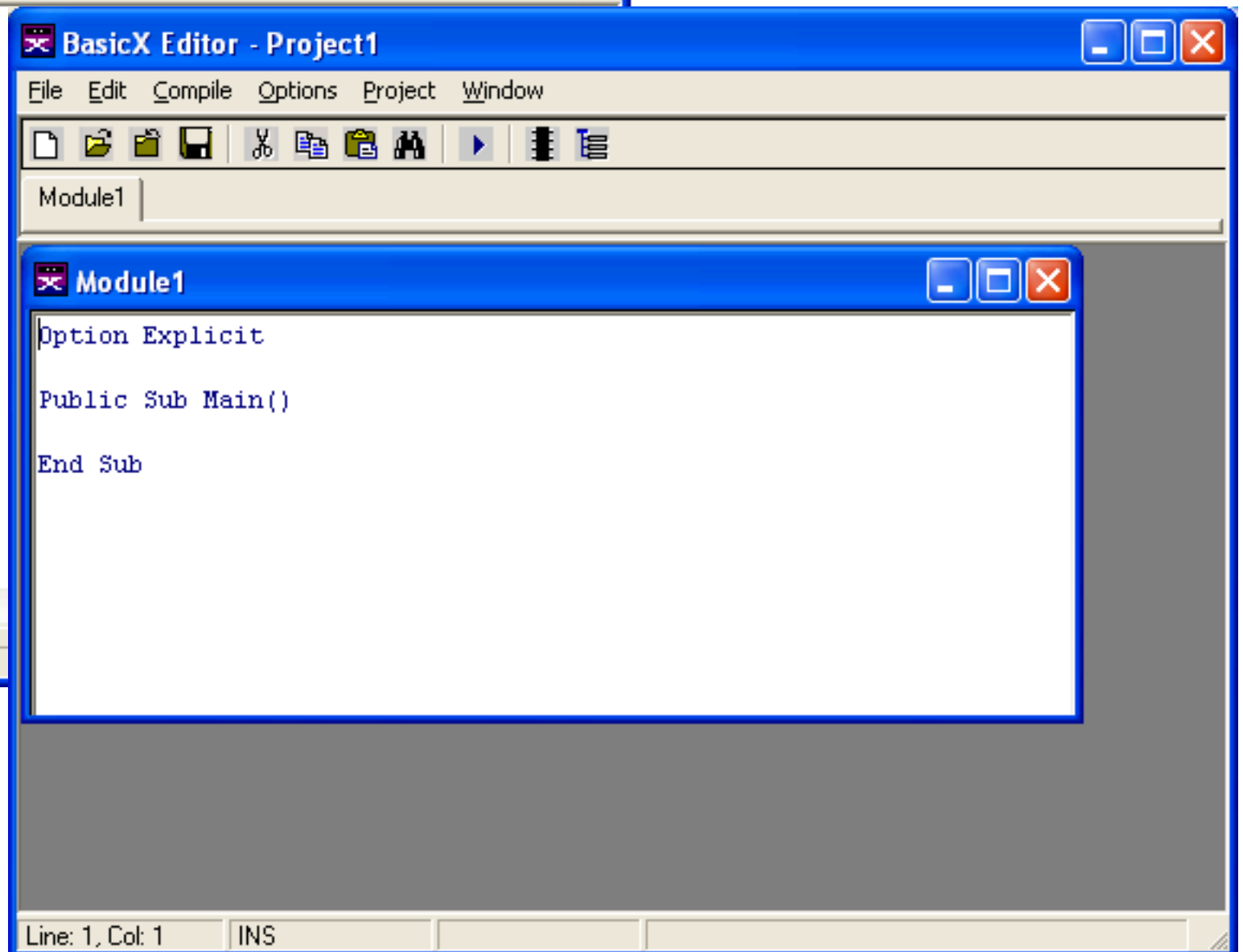
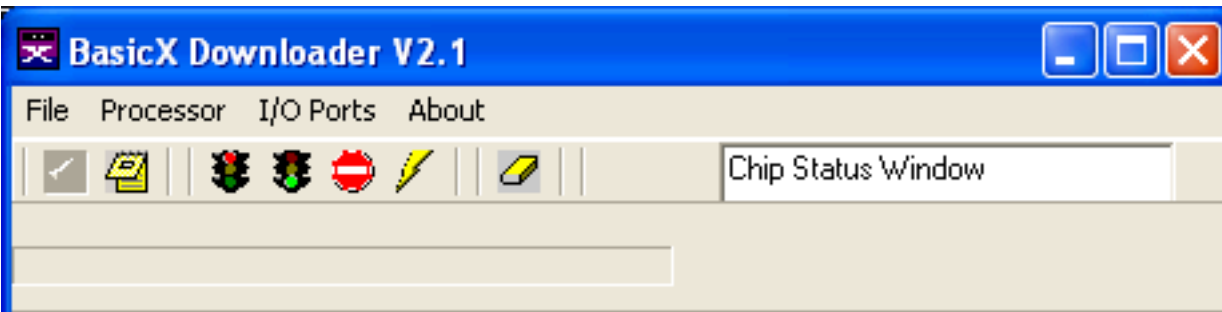
```
' {$STAMP BS2}
' {$PBASIC 2.5}

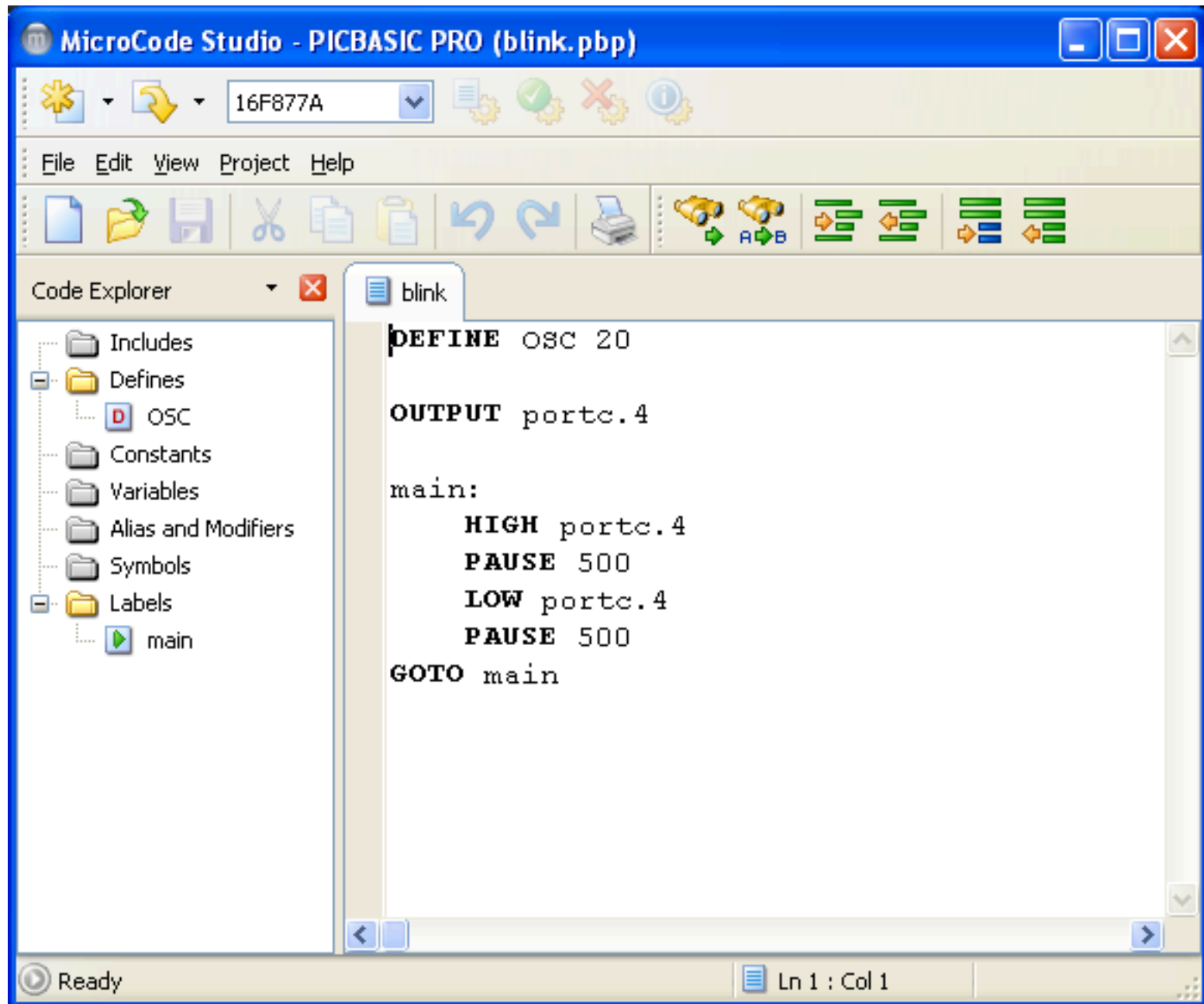
main:
    HIGH 0
    PAUSE 1000
    LOW 0
    PAUSE 1000
    GOTO main
```

freqout.bas

BASIC Stamp files (\*.bs1;\*.bas;\*.bs2;\*.bse;\*.bsx)









The image shows the Arduino IDE interface. The title bar reads "Arduino - 0004 Alpha". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for running, stopping, saving, undo, redo, and uploading. The sketch name "led\_blink" is displayed in the top left of the editor. The code is as follows:

```
int ledPin = 13;           // LED connected to digital pin 13

void setup()
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}

void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000);                // waits for a second
  digitalWrite(ledPin, LOW);  // sets the LED off
  delay(1000);                // waits for a second
}
```

The status bar at the bottom left shows the line number "1".







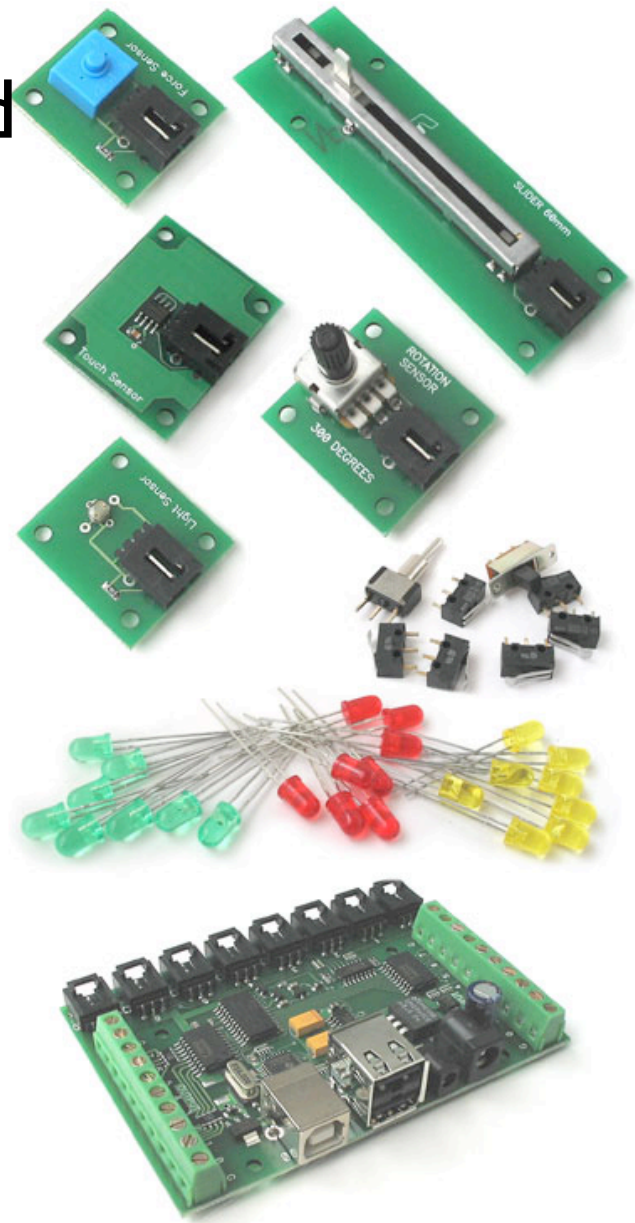
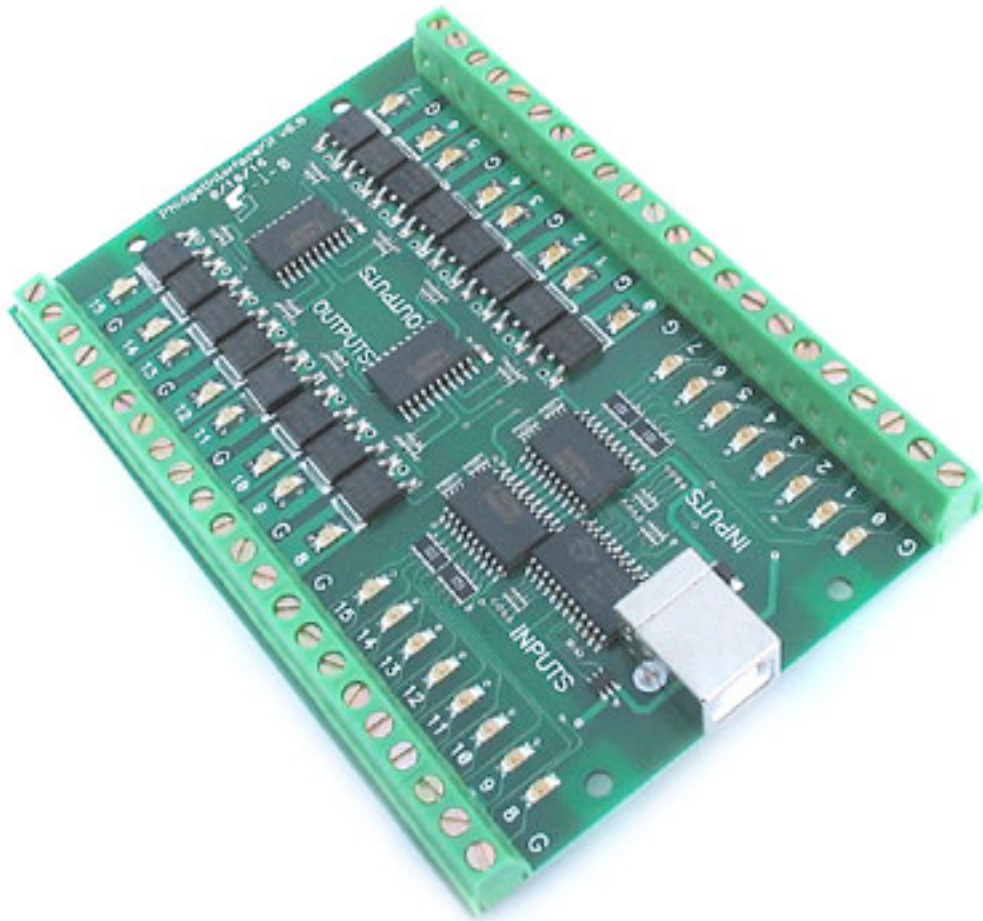
# Phidgets

- Love that there's no need to program hardware

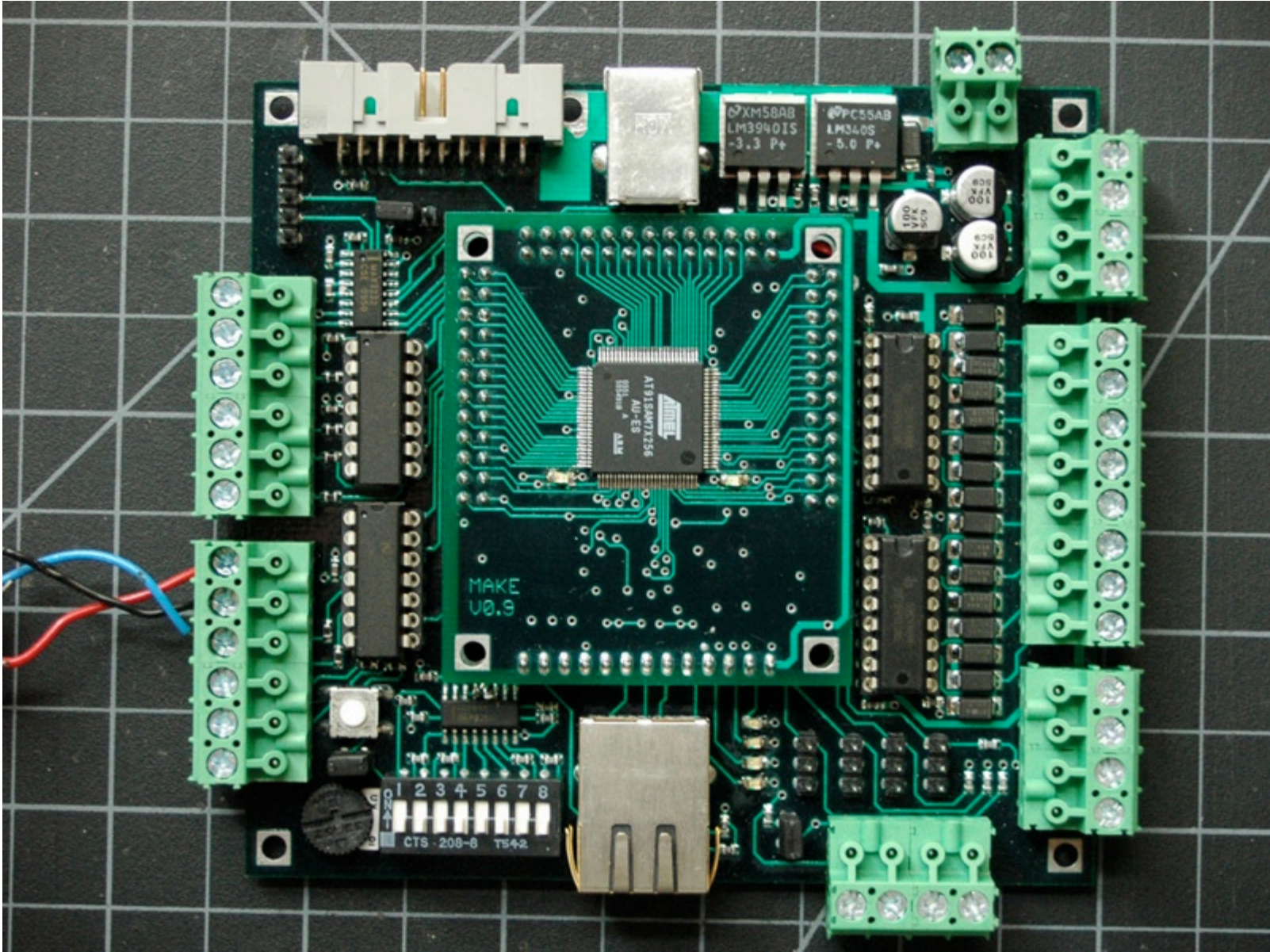


# Phidgets

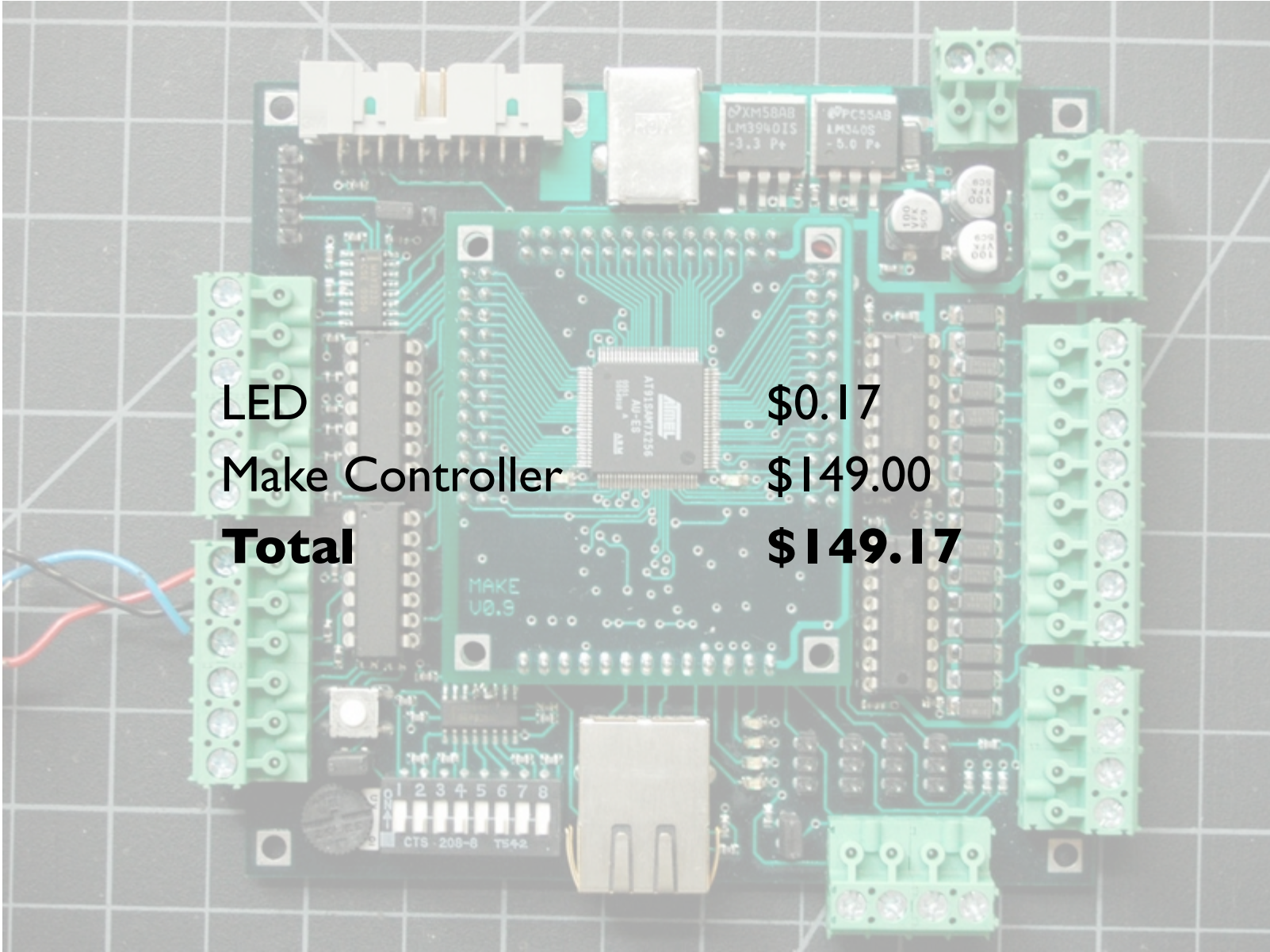
- Love that there's no need to program hardware
- Standalone?



# Make Controller



# Make Controller



LED

\$0.17

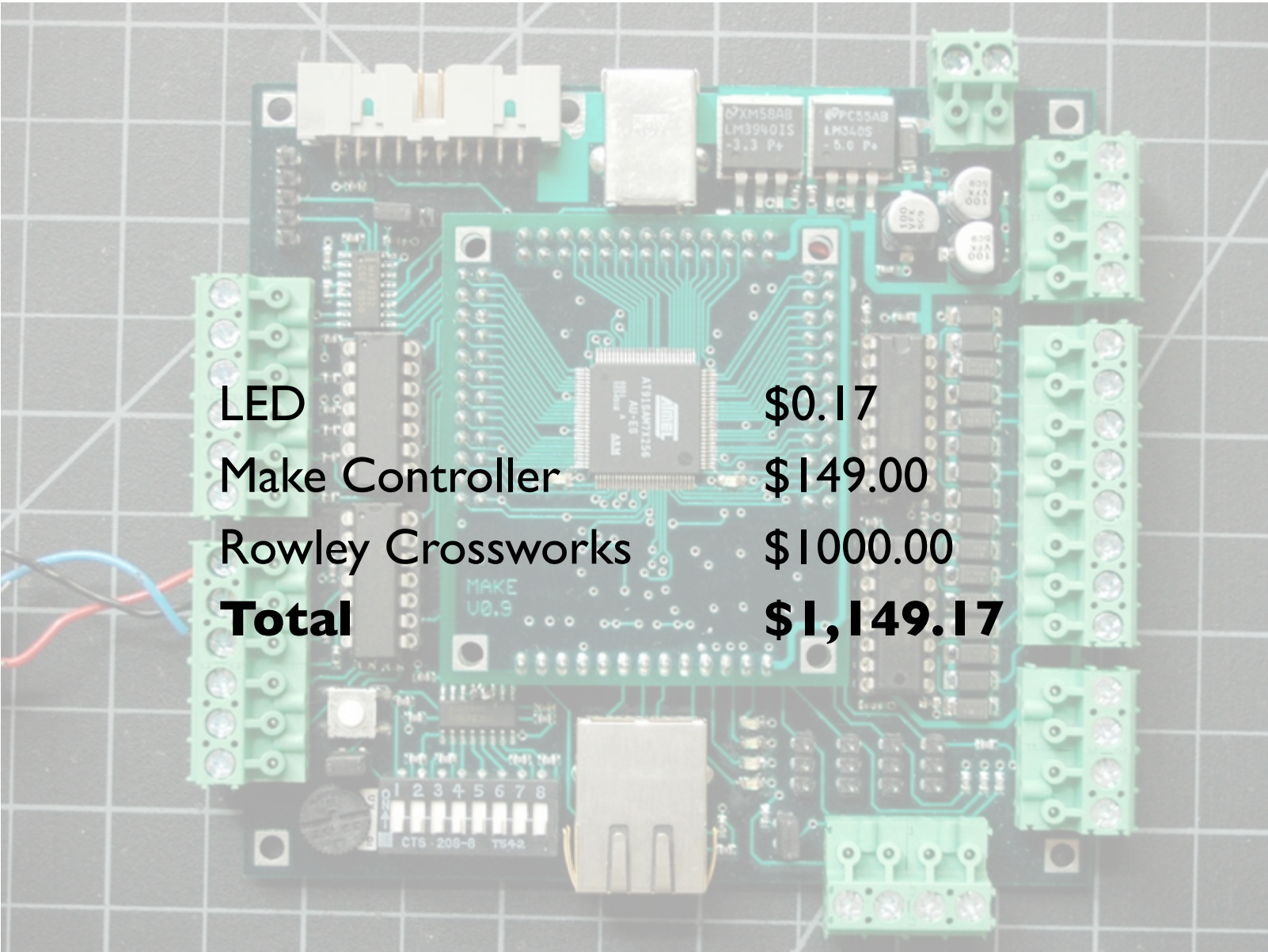
Make Controller

\$149.00

**Total**

**\$149.17**

# Make Controller



LED	\$0.17
Make Controller	\$149.00
Rowley Crossworks	\$1000.00
<b>Total</b>	<b>\$1,149.17</b>

# Make Controller

The screenshot displays the CrossStudio for ARM IDE interface. The main window shows a 'Welcome!' dialog with the following text:

**Welcome!**

**Welcome to CrossStudio for ARM**

CrossStudio for ARM is a streamlined integrated development environment (IDE) for building, testing, and deploying ARM applications.

CrossStudio provides:

- **Source Code Editor** - A powerful source code editor with multi-level undo and redo, makes editing your code a breeze.
- **Project System** - A complete project system organises your source code and build rules.
- **Build System** - With a single key press you can build all your applications in a solution, ready for them to be loaded onto a developer card or into the debugger.
- **JTAG Interface Support** - You can download and debug your applications using the **Rowley USB CrossConnect for ARM, Macraigor Wiggler or Segger JLINK.**
- **ARM Simulator** - The simulator mimics the behaviour of the ARM CPU, so you can test your applications without hardware.
- **Integrated Debugger** - The debugger will help you to quickly find problems in your applications.
- **ARM Flash Programming and Debug** - You can download your programs directly into Flash and debug them seamlessly from within the IDE.
- **Integrated Help system** - The built-in help system provides context-sensitive help and a complete reference to the CrossStudio IDE and tools.

**Getting Started**

The [CrossStudio Tutorial](#) section gives an overview of how to get started with CrossWorks for ARM.

**Tip of the Day**

Did you know... **Ctrl+Tab** cycles through the open editors. **Ctrl+Shift+Tab** cycles through them backwards. [Next tip](#)

**Project Explorer**

Project Items	Code	Data
rtosdemo	102,460	63,892
Source F...		
App...		
r	744	80
Fre...		
l	584	
p	592	
p	676	4
q	2,028	
t	5,200	356
lvwIP		
a	5,696	
a	5,164	104

**Properties**

Environment Properties

Build Options

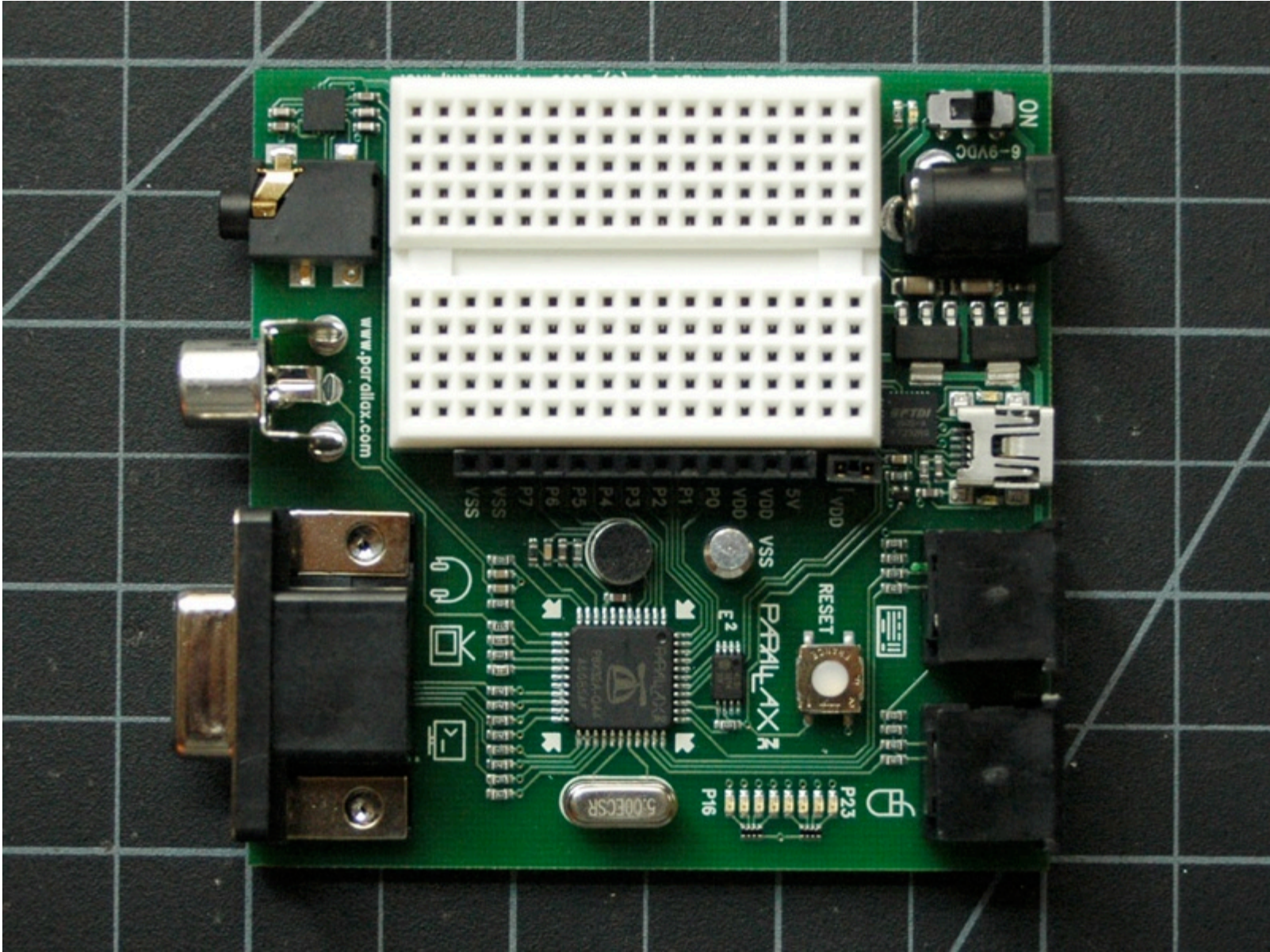
Always Build Before ...	No
Build Macros	
Echo Build Comman...	No
Echo Raw Error/W...	No
Find Error After Build	Yes
Inhibit Debugger St...	Yes
Save Project File O...	Yes
Show Build Informati...	No
Show Dependencies	Yes
Tool Chain Root Dir...	\$(StudioDir)/gcc/bin

**Always Build Before Debug**

Enables auto-building of a project before downloading if it is out of date.

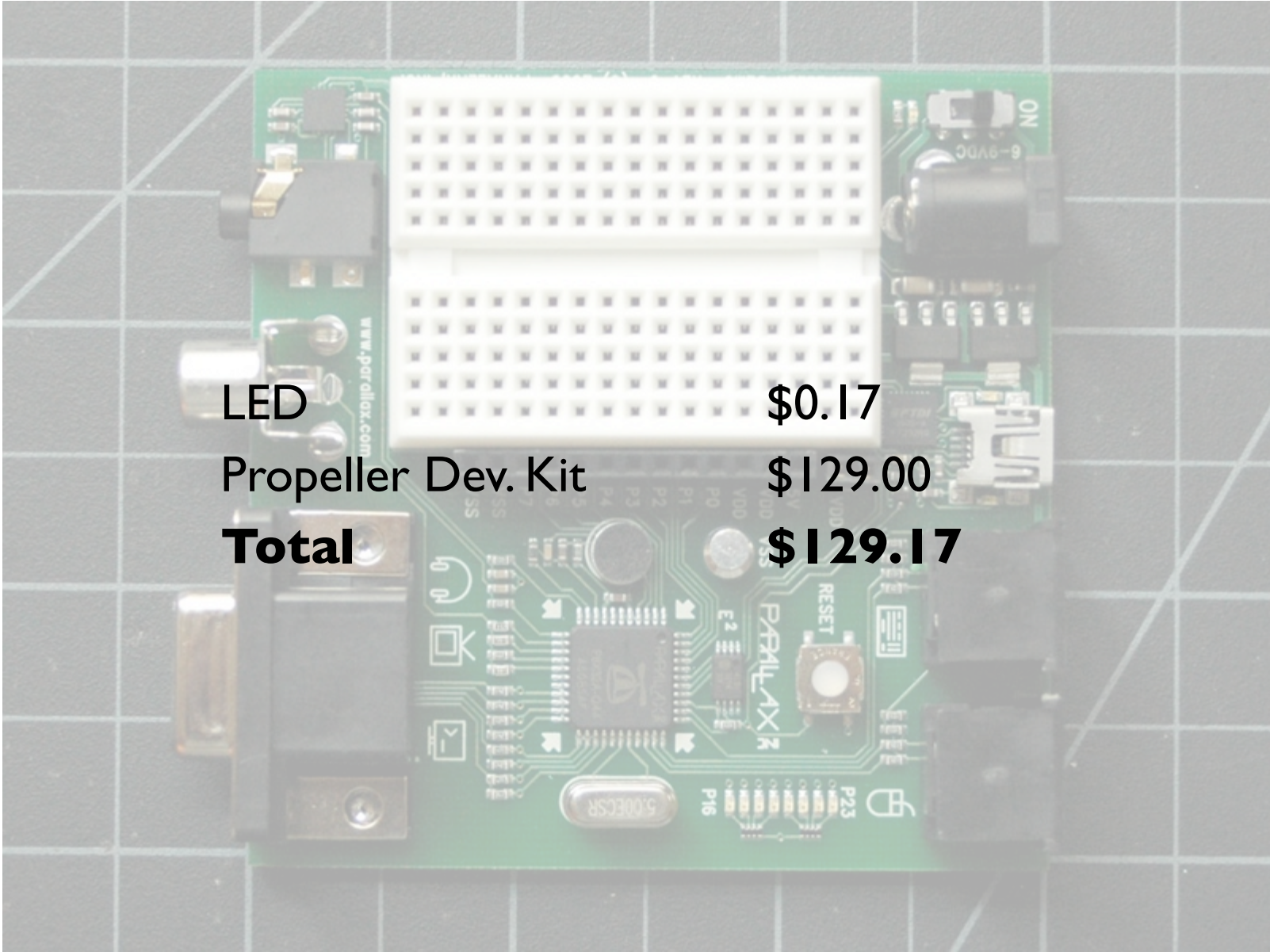
Disconnected Built OK OVR READ

# Parallax Propeller





# Parallax Propeller



LED

\$0.17

Propeller Dev. Kit

\$129.00

**Total**

**\$129.17**

# Parallax Propeller

Propeller Tool - Ping

File Edit Run Help

Simple\_Serial Ping

Full\_Source Condensed Summary Documentation

```
*****
*      Ping))) Object V1.0      *
*      (C) 2006 Parallax, Inc.  *
* Author: Chris Savage & Jeff Martin *
* Started: 05-08-2006          *
*****

Interface to Ping))) sensor and measure its ultrasonic travel time. Measureme
Each method requires one parameter, Pin, that is the I/O pin that is connected

Connection To Propeller
Remember PING))) Requires
+5V Power Supply

COM

TO_IN = 73_746
TO_CM = 29_034

PUB Ticks(Pin) = Microseconds | cnt1, cnt2
'Return Ping)))'s one-way ultrasonic travel time in microseconds

outa[Pin] =
dira[Pin] =
outa[Pin] =
```

Propeller Library

- Outlook Express
- Parallax Inc
  - Propeller Tool v0.95.1
  - Stamp Editor v2.2.5
- PuTTY
- ReaMNC
- Rowley Associates Limited
- Sigmatel

Keyboard.spin  
MCP3208.spin  
Monitor.spin  
Mouse.spin  
Numbers.spin  
Ping.spin  
Rotary Encoder.spin  
Serial\_Lcd.spin  
Simple\_Numbers.spin  
Simple\_Serial.spin  
Stack Length.spin

Propeller Source (\*.spin)

1:1 Insert

# The Future





# Thanks!



More info:

<http://itp.nyu.edu>

<http://tigoe.net/pcomp/>