Lecture 2

Mechatronics 1

- Synergistic integration of
  - Mechanical engineering
  - Control theory
  - Computer science
  - Electronics
- To manage complexity, uncertainty, and communication in engineered systems

Mechatronics 2

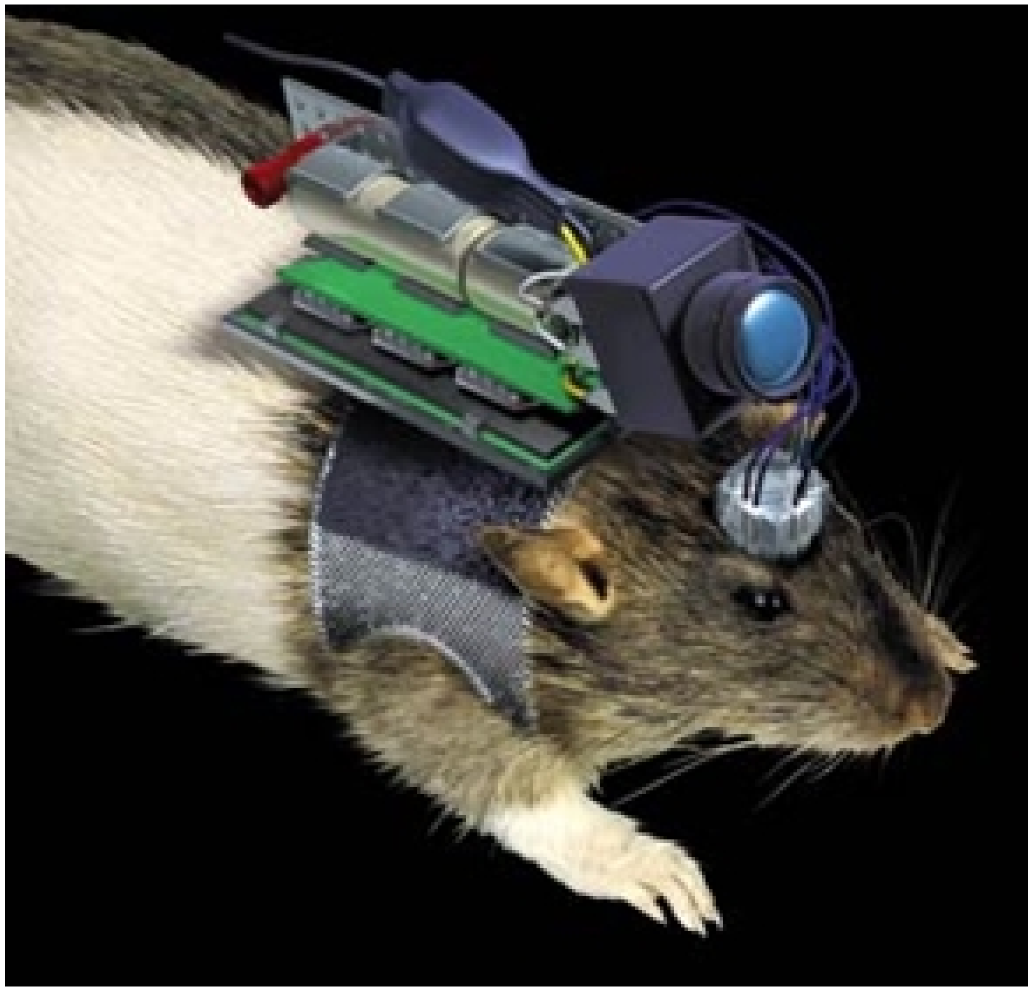
- Typical knowledgebase for optimal design and operation of mechatronic systems comprises of
  - Dynamic system modeling and analysis
  - Decision and control theory
  - Sensors and signal conditioning
  - Actuators and power electronics
  - Hardware interfacing
  - Rapid control prototyping
  - Embedded computing

Mechatronic Applications

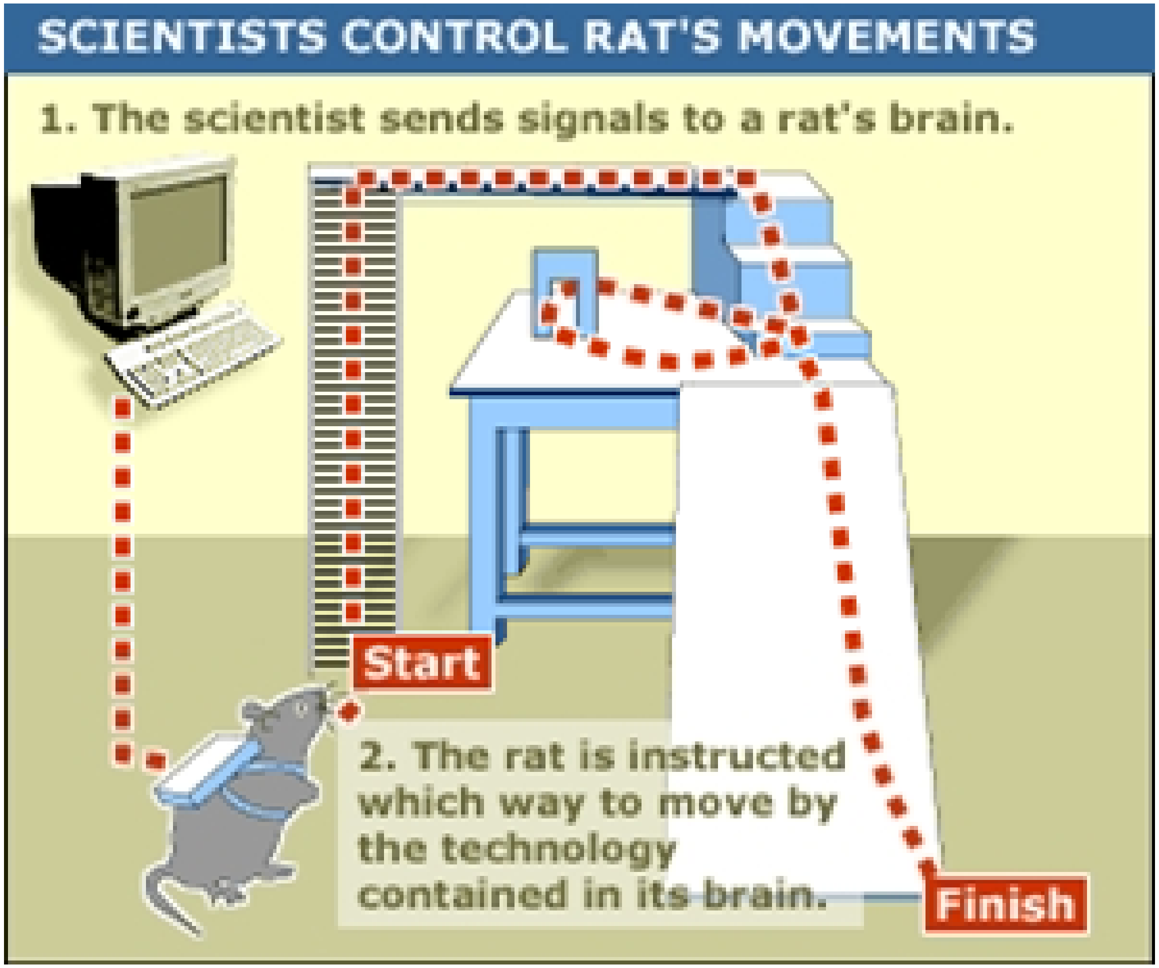
- **Smart consumer products**: home security, camera, microwave oven, toaster, dish washer, laundry washer-dryer, climate control units, etc.
- **Medical**: implant-devices, assisted surgery, haptic, etc.
- **Defense**: unmanned air, ground, and underwater vehicles, smart munitions, jet engines, etc.
- **Manufacturing**: robotics, machines, processes, etc.
- **Automotive**: climate control, antilock brake, active suspension, cruise control, air bags, engine management, safety, etc.
- **Network-centric, distributed systems**: distributed robotics, tele-robotics, intelligent highways, etc.

Roborat 1

Roborat 2

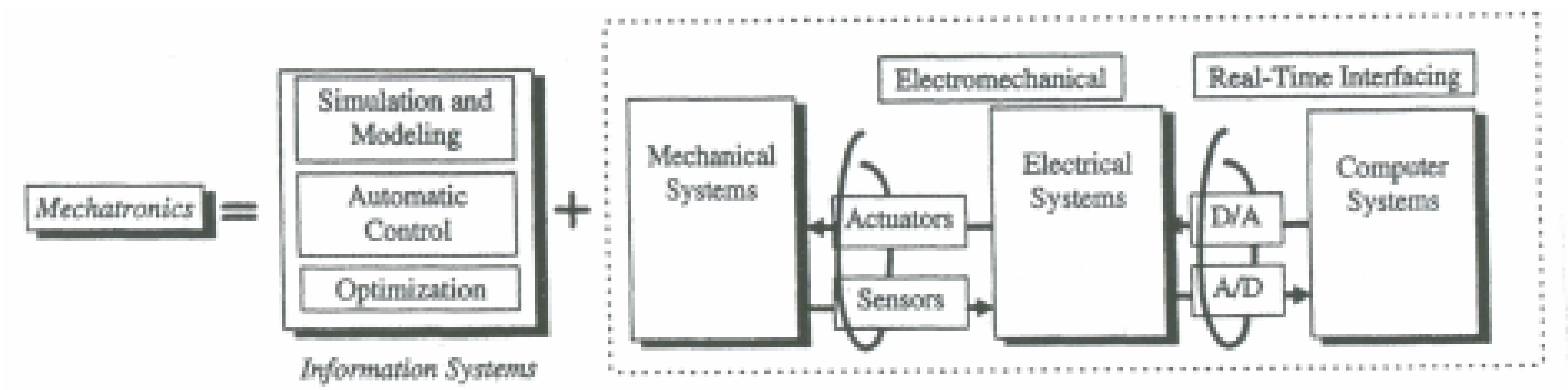


Roborat 3


SCIENTISTS CONTROL RAT'S MOVEMENTS
1. The scientist sends signals to a rat's brain.
Start
2. The rat is instructed which way to move by the technology contained in its brain.
Finish

Robocockroach

Key Elements of Mechatronics



Elements of Mechatronics 1

- Mechanical elements

Elements of Mechatronics 2

- Electromechanical elements

Elements of Mechatronics 3

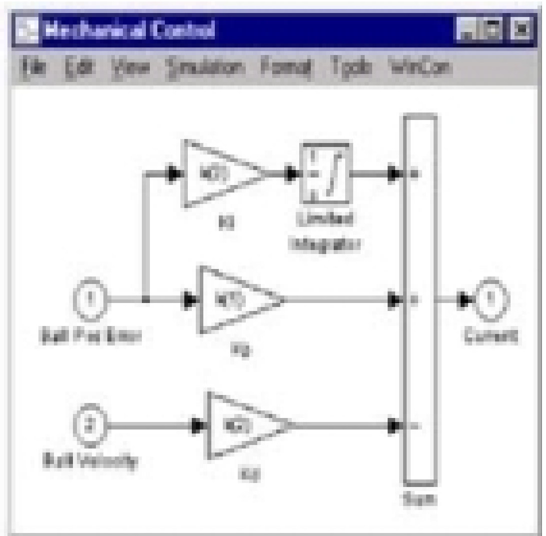
- Electrical/Electronic elements

Elements of Mechatronics 4

- Control interface/computing hardware elements

Elements of Mechatronics 4

- Computer elements



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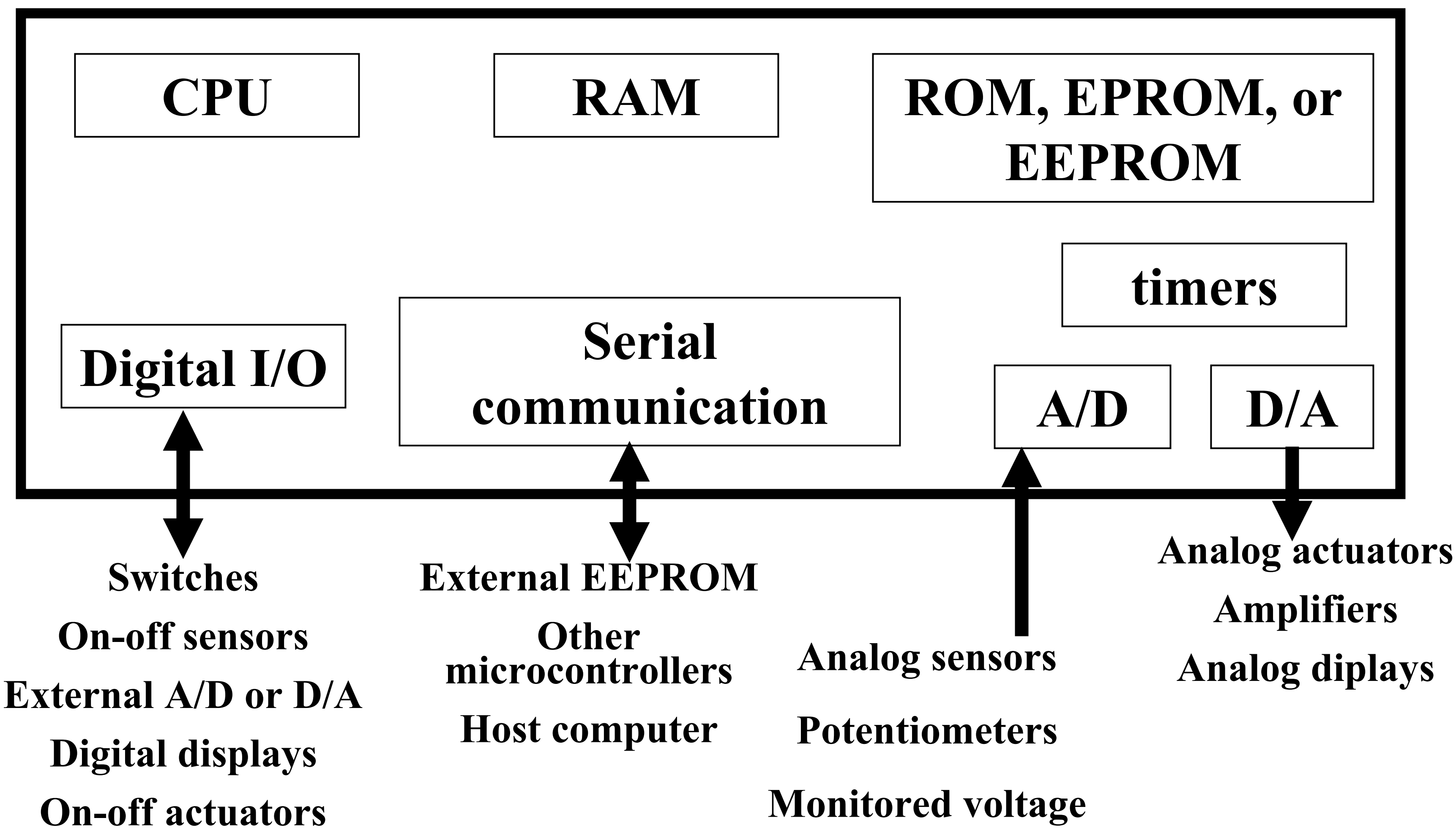
Microprocessors

- Perform arithmetic, logic, communication, an control function
- Arithmetic/logic unit(ALU)
- Instruction registers and decoders
- Data registers
- Control unit
- Intel 4004 (4bit microprocessor), Intel 8080 (8bit microprocessor)

Microcontrollers

- Special purpose miniaturized computers
- Single integrated circuit containing many specialized and sophisticated circuits and functions
- Two primary components
  - RAM
  - CPU with instruction set

Microcontroller Architecture



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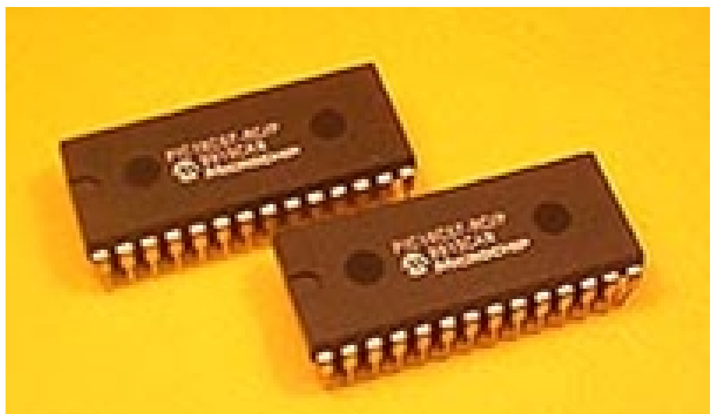
PIC Microcontrollers

- PIC 16C57 (unit price: $7.50 in single quantities, $3.50 in quantities of 1000 or more)



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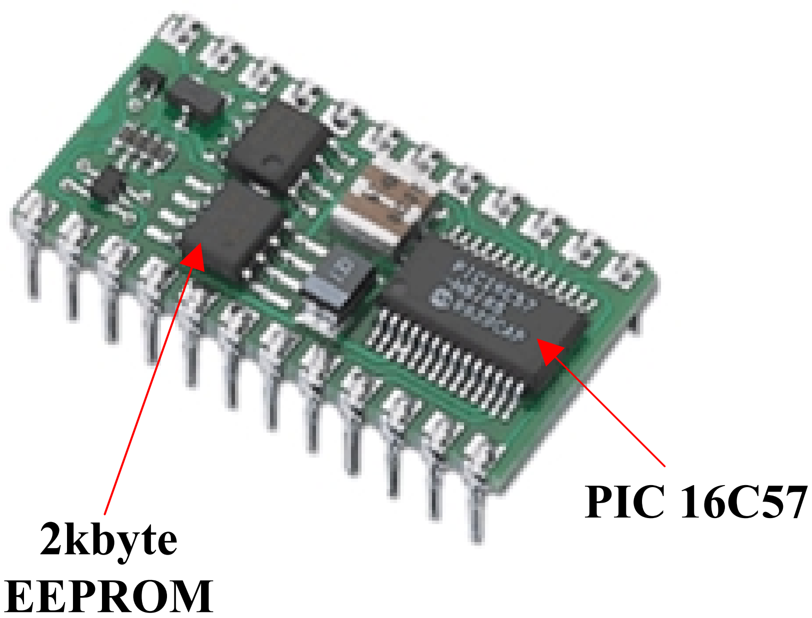
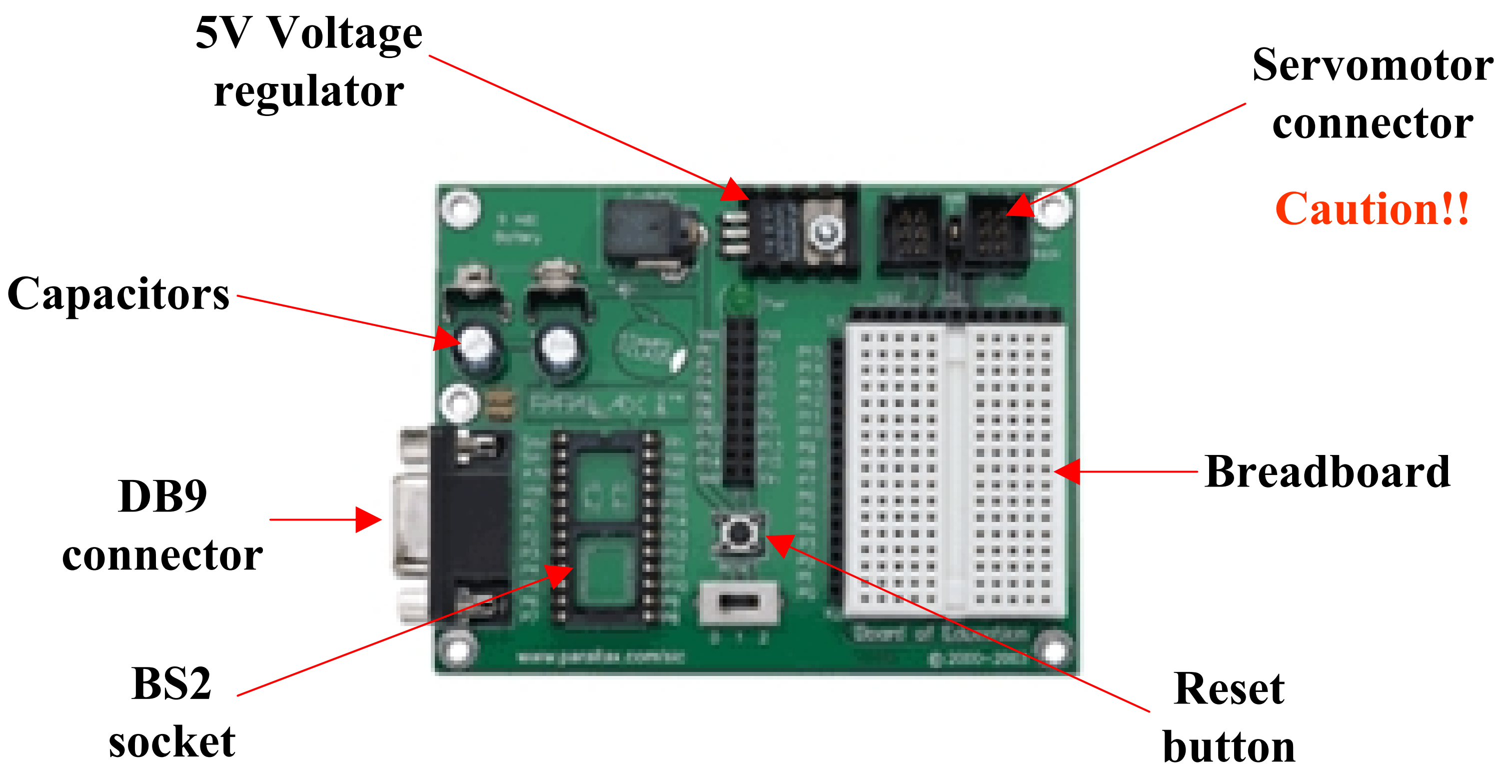
Basic Stamp 2



– Simple and easy to use
– PIC-based PBASIC interpreter on ROM
– 16 digital I/O

http://www.parallax.com/Downloads/Documentation/bs/mod/BASIC_Stamp_2_Schematic_Rev_F.pdf

Stamp Development Board

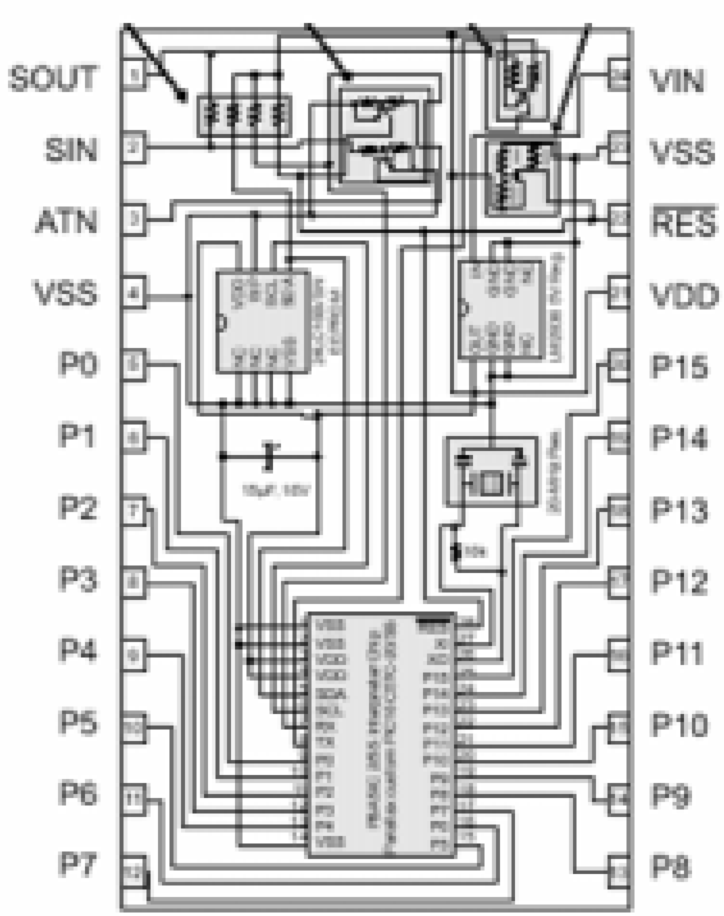


Board of education

Hardware Considerations

- Power requirements
  - BS2 requires regulated 5DCV and draws about 8mA
- Each I/O pin of BS2 can
  - Source up to **20mA**
  - Sink up to **25 mA**
- When the voltage regulator on BOE is being used, all I/O pin as a group can
  - Source up to **40mA**
  - Sink up to **50mA**

BS2 Pin Descriptions



Pin	Name	Description
1	SOUT	Serial out
2	SIN	Serial in
3	ATN	Attention
4	VSS	System ground
5-20	P0-P15	Input/Output pins
21	VDD	5DC V
22	RES	Reset
23	VSS	System ground
24	VIN	Unregulated power in

BS2 Variable Types

Var type	Size	Range of value
bit	1 bit	0, 1
nib	4 bits	0-15
byte	8 bits	0-255
word	16 bits	0-65535

OnOff var bit

InOutPins var nib

ADCin var byte

Count var word

Binary, Decimal, and Hexadecimal Numbers

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7

Binary	Decimal	Hexadecimal
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

Variable Command

b0=10

b0= %00001010

b0=$0A

$(375)_2$ is 00000001 01110111

b3 var byte

b3=375

Debug DEC b3

Result is 119

$$01110111 = 2^7(0)+2^6(1)+2^5(1)+2^4(1)$$
$$+2^3(0)+2^2(1)+2^1(1)+2^0(1)$$
$$= 119$$

Assigning Pins for I/O

DIRS: 1 for output, 0 for input

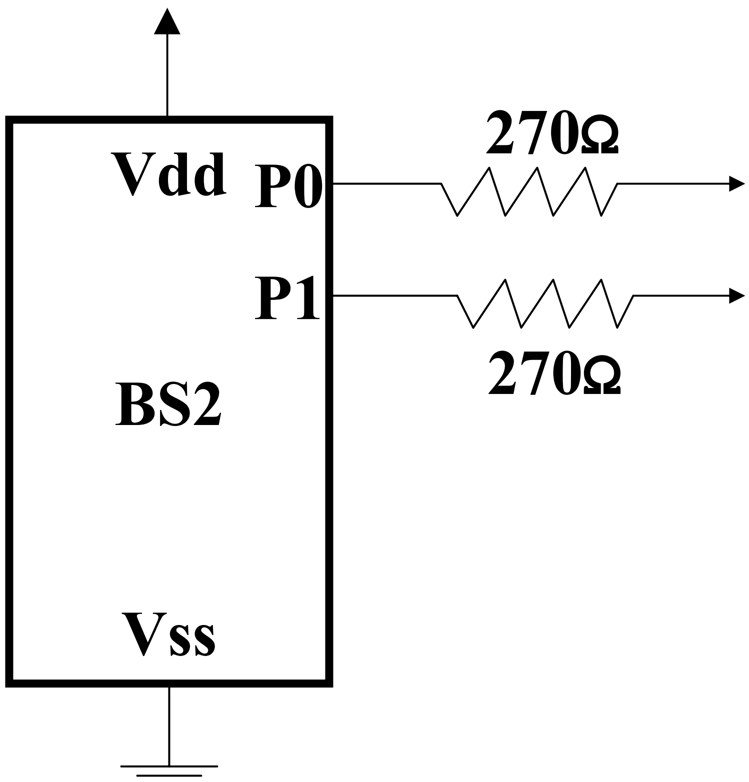
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DIR D				DIR C				DIR B				DIR A			
DIR H								DIR L							

OUTS

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OUT D				OUT C				OUT B				OUT A			
OUT H								OUT L							

Same as for INS

How to Protect the I/O Pins



$$I = \frac{5}{270} \approx 19mA$$

Variables Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	
Earth measurements	
Robotics	
StampWorks	
Others	On coming slides

Experiment Details 1

```
myCon   CON 10
myVar1 VAR Byte
myVar2 VAR Byte
myVar3 VAR word
myVar4 VAR word
```

```
myVar1=5
myVar2=25
myVar3=375
myVar4=400
```

Experiment Details 2

```
debug "myCon= ", DEC myCon, cr
debug "myVar1= ", DEC myVar1, cr
debug "myVar2= ", DEC myVar2, cr
debug "myVar3= ", DEC myVar3, cr
debug "myVar4= ", DEC myVar4, cr
debug "myVar3 in BIN= ", BIN myVar3, cr
debug "Low byte of 375=", BIN myVar3.byte0, cr
debug "High byte of 375=", BIN myVar3.byte1, cr
```

Experiment Details 3

```
b0=10
debug "b0 input in DEC.", cr
debug "b0 in DEC= ", DEC b0, cr
debug "b0 in BIN= ", BIN b0, cr
debug "b0 in HEX= ", HEX b0, cr
```

Experiment Details 4

```
b0=%00001010
debug "b0 input in BIN.", cr
debug "b0 in DEC= ", DEC b0, cr
debug "b0 in BIN= ", BIN b0, cr
debug "b0 in HEX= ", HEX b0, cr
```

Experiment Details 5

```
b0=$0A
debug "b0 input in HEX.", cr
debug "b0 in DEC= ", DEC b0, cr
debug "b0 in BIN= ", BIN b0, cr
debug "b0 in HEX= ", HEX b0, cr
```

Experiment Details 6

```
b0=10

b1=20

b2=b0+b1

b3=375


debug "b0 in DEC= ", DEC b0, cr

debug "b1 in DEC= ", DEC b1, cr

debug "b2 in DEC= ", DEC b2, cr

debug "b3 in DEC= ", DEC b3, cr
```

Experiment Details 7

```
debug "b0 in BIN= ", BIN b0, cr
debug "b1 in BIN= ", BIN b1, cr
debug "b2 in BIN= ", BIN b2, cr
debug "b3 in BIN= ", BIN b3, cr
```

Experiment Details 8

```
w2=375

debug "w2 in DEC= ", DEC w2, cr
debug "w2 in BIN= ", BIN w2, cr
debug "b4 in BIN= ", BIN b4, cr
debug "b5 in BIN= ", BIN b5, cr
```

Experiment Details 9

•Please read "**BASIC Stamp Frequently Asked Questions** "

•Please read and run all programs on "**BASIC Stamp User's Manual** " from page 1 to page 75

•And DEBUG on page 97