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Prop-2 Programming Basics

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Why Use a Microcontroller?

- No off-the-shelf product exists that meets the requirements of your application
- Off-the-shelf product is price-prohibitive
- Control requirement will evolve
- You're an OEM with several products and want to simplify control inventory
- Custom control = Unique product

Microcontroller Essentials

- A microcontroller is a "computer on a chip"
- Handles Input, Processing (instructions), and Output
- Flexible I/O (Input-Output) structure
- Advanced microcontrollers offer simple and sophisticated I/O control

The BASIC Stamp® Microcontroller

- Single-Board-Computer
- Handles Input, Processing (instructions), and Output
- Flexible I/O (Input-Output) structure
- Simple and Sophisticated I/O commands
- Program storage is non-volatile
  - will not be lost when power removed
- Programming Language: PBASIC
  - specialized, yet easy-to-use variant of BASIC

The BASIC Stamp Microcontroller

BASIC

Beginner's

All-purpose

Symbolic

Instruction

Code

The BASIC Stamp Microcontroller

Parallax

Beginner's

All-purpose

Symbolic

Instruction

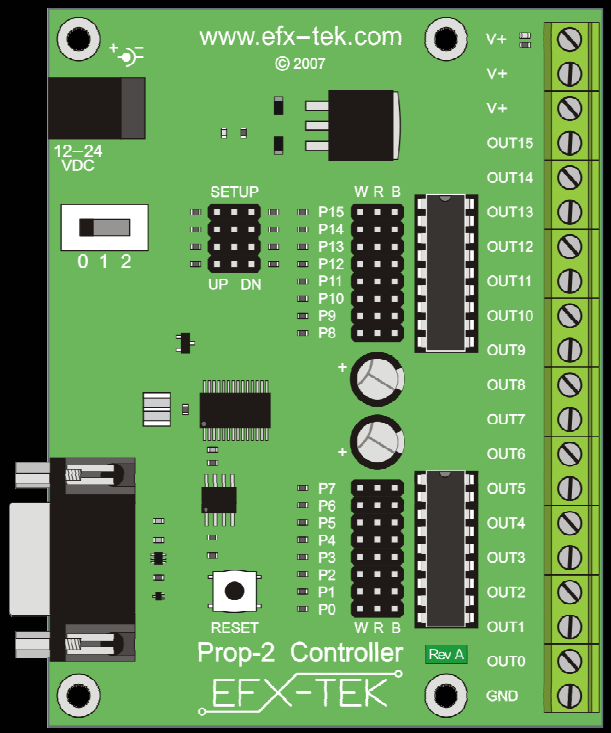
Code

Prop-1/Prop-2 Tech Specs

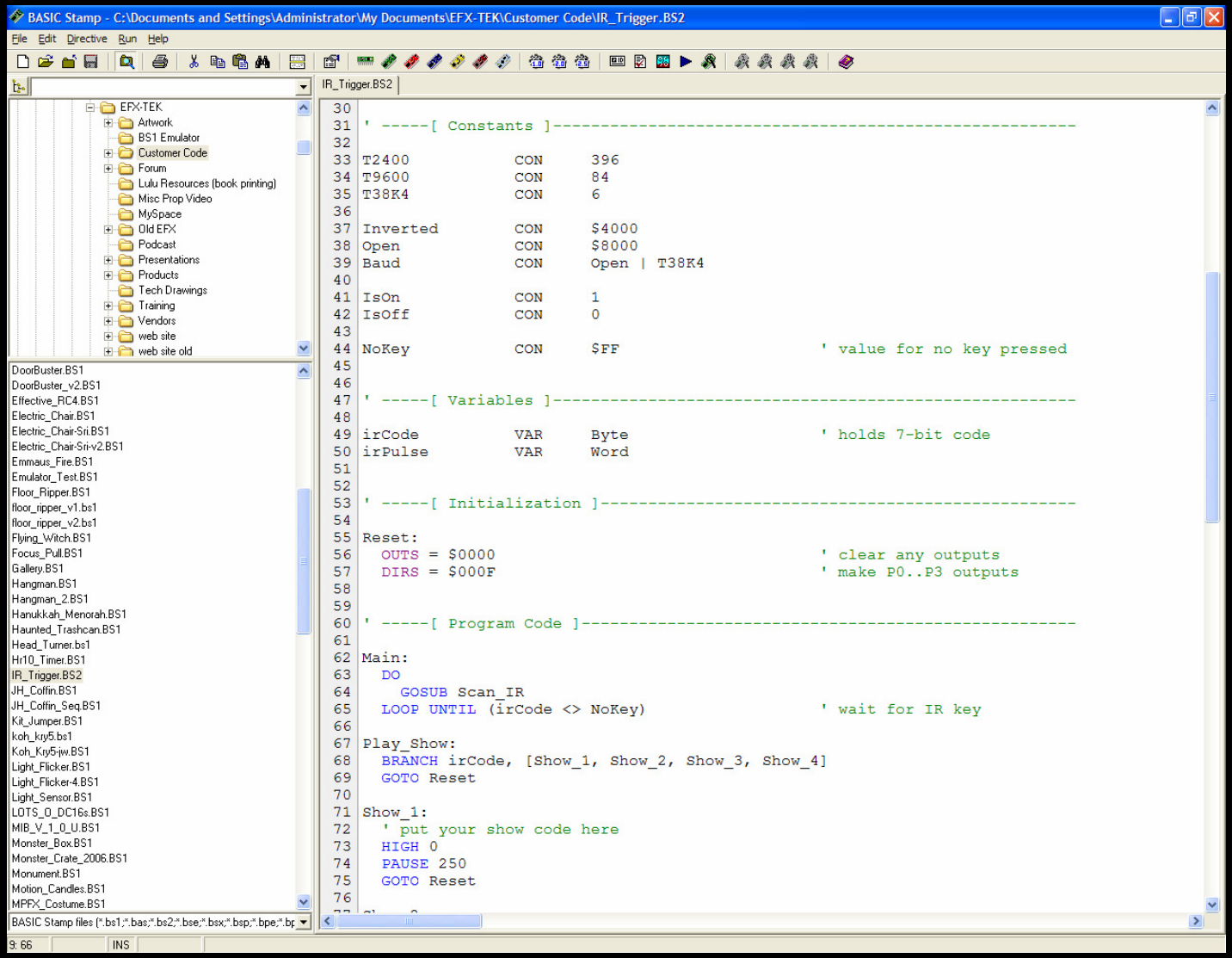
	Prop-1	Prop-2
Speed (instructions / second)	~2,000	~4,000
Input / Output Connections	8	16 + Serial
RAM Variables (bytes)	14* + 2	26 + 6
Program Memory (bytes)	256	2048
Program Length (instructions)	~80	~500
PBASIC Commands	32	42
Programming Connection	Serial 4.8k	Serial 9.6k

Prop-2 Controller

- 9 to 24 vdc input
- TTL I/O, and high-current (Vin) outputs
- Program with BASIC Stamp Editor, v2.1+

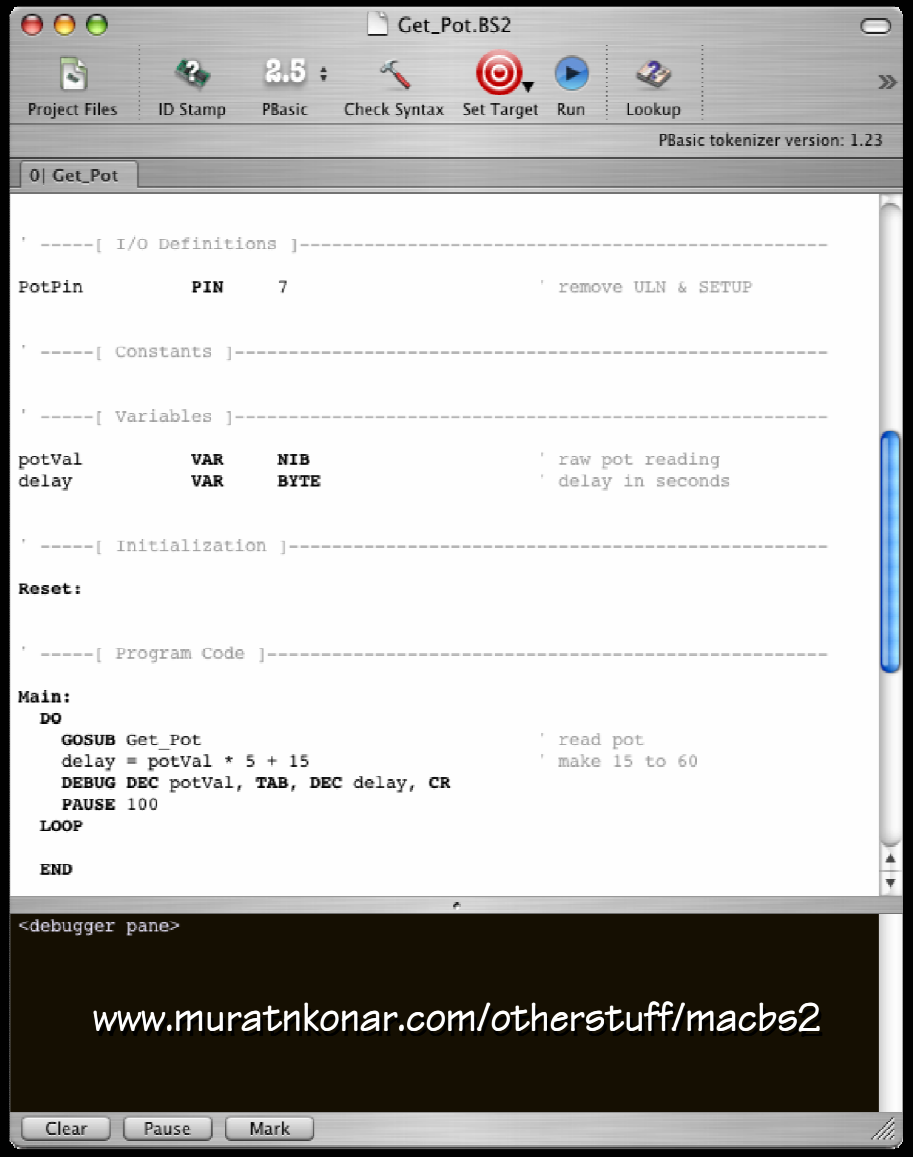


Parallax BASIC Stamp Editor




```
30
31 ' -----[ Constants ]-------------------------------------------------------
32
33 T2400           CON     396
34 T9600           CON     84
35 T38K4           CON     6
36
37 Inverted        CON     $4000
38 Open            CON     $8000
39 Baud            CON     Open | T38K4
40
41 IsOn            CON     1
42 IsOff           CON     0
43
44 NoKey           CON     $FF                     ' value for no key pressed
45
46
47 ' -----[ Variables ]-------------------------------------------------------
48
49 irCode          VAR     Byte                    ' holds 7-bit code
50 irPulse         VAR     Word
51
52
53 ' -----[ Initialization ]---------------------------------------------------
54
55 Reset:
56   OUTS = $0000                                  ' clear any outputs
57   DIRS = $000F                                  ' make P0..P3 outputs
58
59
60 ' -----[ Program Code ]-----------------------------------------------------
61
62 Main:
63   DO
64     GOSUB Scan_IR
65   LOOP UNTIL (irCode <> NoKey)                  ' wait for IR key
66
67 Play_Show:
68   BRANCH irCode, [Show_1, Show_2, Show_3, Show_4]
69   GOTO Reset
70
71 Show_1:
72   ' put your show code here
73   HIGH 0
74   PAUSE 250
75   GOTO Reset
76
```

MacBS2 Editor (3rd Party Software)



Prop-2 Programming

```
Name      PIN      PinNum
Name      CON      SomeValue
Name      VAR      Type
```

PIN, **CON**, and **VAR** are used to give meaningful names to I/O pins, to constant values, and to variables.

```
Pir       PIN      14
IsOn      CON      1
pntr      VAR      Byte
```

Prop-2 Variable Types

Variables used to store values that change. All variables are cleared to zero on reset and are lost when power is removed.

Bit : (0 to 1)
Nib : 4 bits (0 to 15)
Byte : 8 bits, 2 nibs (0 to 255)
Word : 16 bits, 4 nibs, 2 bytes (0 to 65,535)

Prop-2 Programming

HIGH *Pin*

HIGH is used to make an I/O pin an output and set it to a high (+5 vdc) state.

```
HIGH 0
```

Better example:

```
HIGH Eyes                       ' eyes on
```

Prop-2 Programming

LOW *Pin*

LOW is used to make an I/O pin an output and set it to a low (0 vdc) state.

```
LOW 0
```

Better example:

```
LOW Eyes                        ' turn off
```

Prop-2 Programming

PAUSE *Period*

PAUSE is used to suspend program operation for the specified period (in milliseconds; 1/1000 second). After the **PAUSE**, program operation is automatically resumed.

```
PAUSE 1000                    ' hold for 1 second
```

Prop-2 Programming

GOTO *Label*

GOTO is used to redirect the program to the specified program label.

```
GOTO Main                       ' back to Main
```

Prop-2 Example

```
Led     PIN     8                   ' LED is connected to P8

Main:
  HIGH Led                          ' turn LED on
  PAUSE 500                         ' hold for 1/2 second
  LOW Led                           ' turn LED off
  PAUSE 500                         ' hold for 1/2 second
  GOTO Main                         ' back to Main
```

Prop-2 Programming

IF *Condition* THEN *Label*

IF-THEN is used to redirect the program to the a specified program label if the *condition* evaluates as True.

```
Main:
  IF (Pir = IsOff) THEN Main
```

When using PBASIC 2.5, the Prop-2 also supports **IF-THEN-ELSE-ENDIF**.

Prop-2 Example (Triggered Flasher)

```
Pir     PIN     14
Led     PIN     8
IsOff   CON     0

Main:
  IF (Pir = IsOff) THEN Main    ' wait for PIR activity
  HIGH Led                      ' turn LED on
  PAUSE 500                     ' hold for 1/2 second
  LOW Led                       ' turn LED off
  PAUSE 500                     ' hold for 1/2 second
  GOTO Main                     ' back to Main
```

Prop-2 Example (Triggered Event & Delay)

```
MatSw   PIN     14
Valve   PIN     8
No      CON     0

Main:
  IF (MatSw = No) THEN Main     ' wait for "victim"
  PAUSE 3000                    ' 3 second pre-delay
  HIGH Valve                    ' lift prop
  PAUSE 5000                    ' hold for 5 seconds
  LOW Valve                     ' retract prop
  PAUSE 20000                   ' 20 second post-delay
  GOTO Main                     ' back to Main
```

Prop-2 Programming (Advanced)

FOR *Var* = *StartVal* TO *EndVal*

NEXT

FOR–NEXT is used to repeat a section of code for a specific number of iterations.

```
FOR cycles = 1 TO 10
   ' statement(s)
NEXT
```

Prop-2 Example (Triggered Chaser)

```
MatSw   PIN     14
No      CON     0
pinNum  VAR     Nib

Main:
  IF (MatSw = No) THEN Main      ' wait for "victim"
  FOR pinNum = 8 TO 13           ' cycle through trainer LEDs
    HIGH pinNum                  ' turn selected pin on
    PAUSE 100                    ' hold for 0.1 second
    LOW pinNum                   ' turn selected pin off
  NEXT
  GOTO Main                      ' back to Main
```

Prop-2 Programming (Advanced)

RANDOM *Variable*

RANDOM is used to generate the next pseudo-random value in *variable*.

```
RANDOM timer
```

Prop-2 Example (Random Pre-Event Delay)

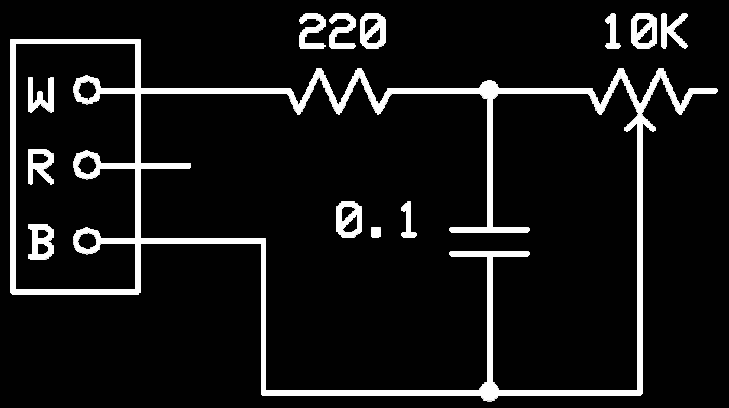
```
MatSw   PIN     14
Valve   PIN     8
No      CON     0
timer   VAR     Word
delay   VAR     Word

Main:
  RANDOM timer                      ' stir random generator
  IF (MatSw = No) THEN Main         ' wait for "victim"
  delay = timer // 5 + 1            ' create delay, 1 to 5 seconds
  delay = delay * 1000              ' convert to milliseconds
  PAUSE delay                       ' hold for random delay
  HIGH Valve                        ' open solenoid to lift prop
  PAUSE 5000                        ' hold for 5 seconds
  LOW Valve                         ' retract prop
  PAUSE 20000                       ' 20 second post-delay
  GOTO Main                         ' back to Main
```

Prop-2 Programming (Advanced)

RCTIME *Pin, Mode, Variable*

RCTIME is used to read a variable resistance (e.g., potentiometer, photo-resistor, etc.). *Mode* defines the RC circuit configuration.

```
RCTIME Dial, 1, level
```



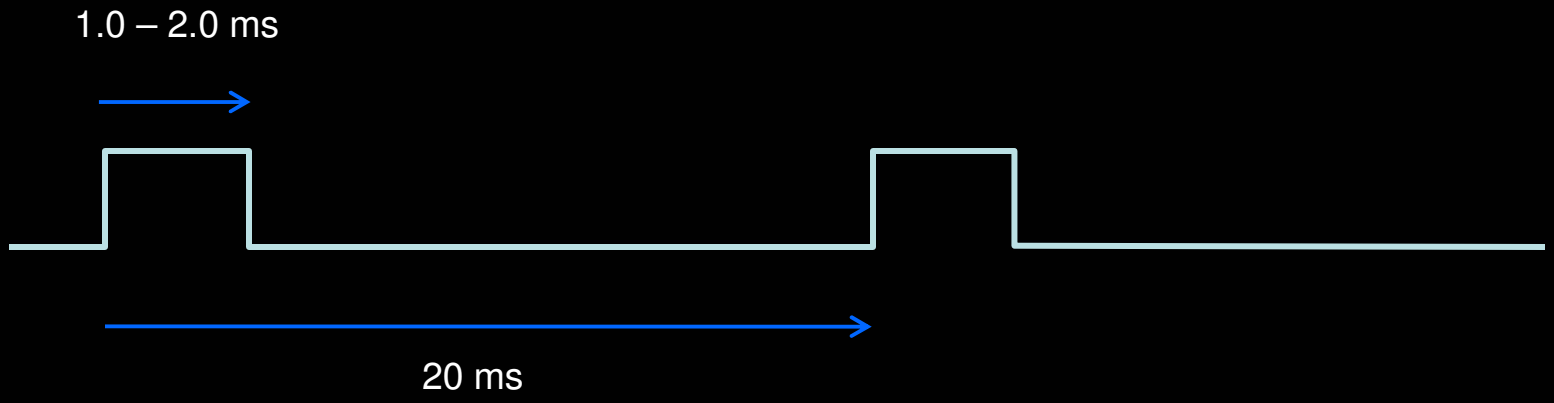
Prop-2 Example (Light-Activated Chaser)

```
LSense  PIN     15              ' light sensor
level   VAR     Word            ' light level
pinNum  VAR     Nib

Main:
  DO
    HIGH LSense                 ' charge capacitor
    PAUSE 1                     '   for 5 x R x C (min)
    RCTIME LSense, 1, level     ' get current light level
  LOOP UNTIL (level > 150)      ' wait for dark
  FOR pinNum = 8 TO 13          ' cycle through trainer LEDs
    HIGH pinNum                 ' LED on
    PAUSE 100                   ' hold 0.1 second
    LOW pinNum                  ' LED off
  NEXT
  GOTO Main                     ' back to Main
```

Hobby Servos

Servo Control

- 5 vdc power input (nominal)
- 1.0 ms to 2.0 ms (typical) control pulse
- Refresh every 20 ms (nominal)



Prop-2 Programming (Advanced)

PULSOUT *Pin, Period*

PULSOUT is used to generate a pulse on an I/O pin. The output state will be inverted for the specified period (in 2 µs units).

```
PULSOUT Servo, 750          ' 1.5 ms pulse (center servo)
```

Prop-2 Example (Servo Direct)

```
Servo   PIN     0
pos     VAR     Word            ' servo position
delay   VAR     Nib

Setup:
  LOW Servo                     ' P0 is output, all others inputs

Main:
  FOR pos = 500 TO 1000 STEP 4  ' sweep left-to-right
    FOR delay = 1 TO 3          ' hold position
      PULSOUT Servo, pos        ' refresh servo
      PAUSE 20
    NEXT
  NEXT
  GOTO Main                     ' back to Main
```

Prop-2 Programming (Advanced)

SEROUT *Pin, Baudmode, [Data]*

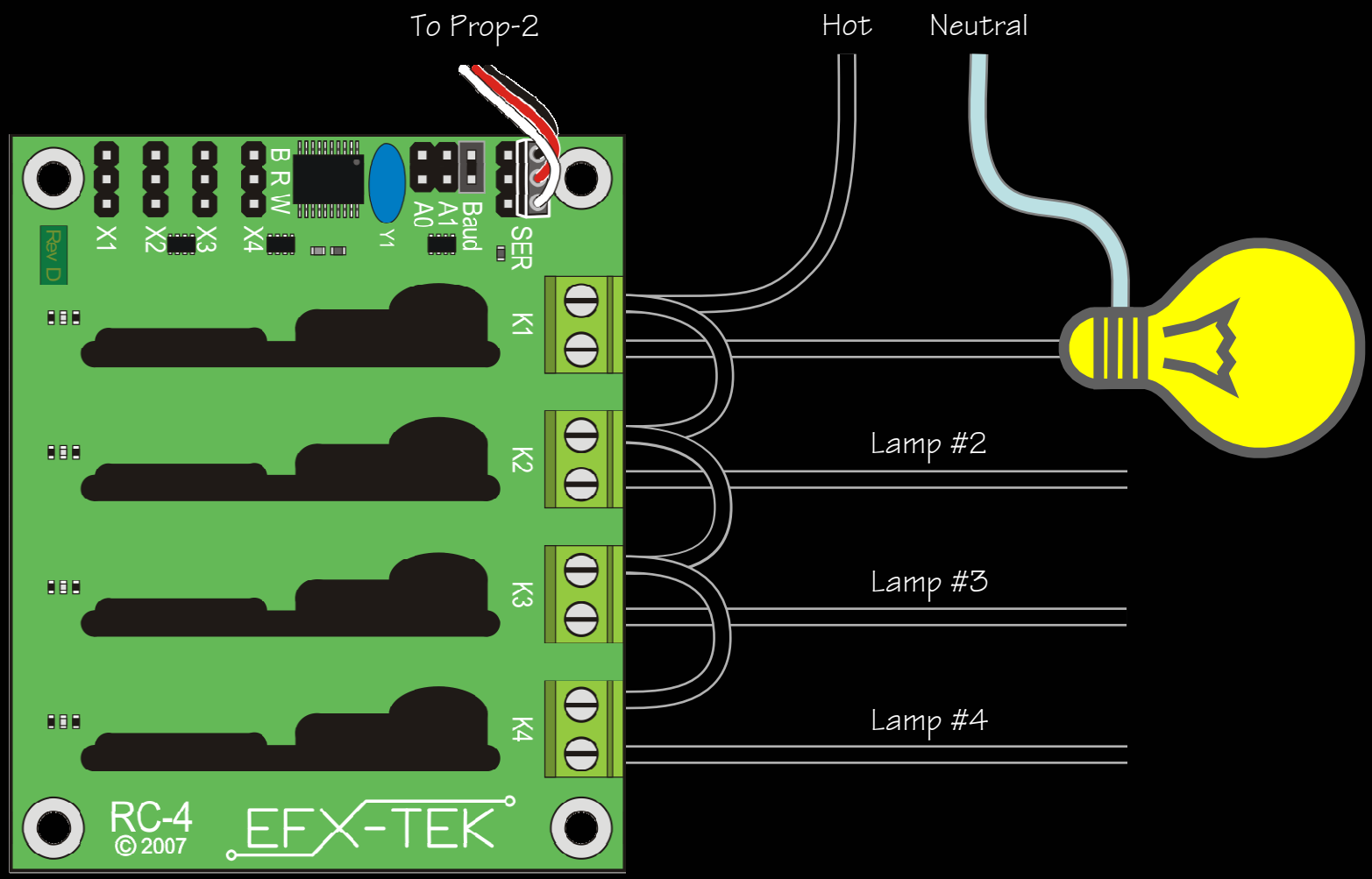
SEROUT is used to transmit asynchronous serial data on an I/O pin at the specified baud rate and mode.

```
SEROUT Lcd, Baud, ["Props are FUN!"]
```

Prop-2 Example (RC-4 Control)

```
TX      PIN     15
MatSw   PIN     14
Baud    CON     $8000 | 6       ' OT38400
No      CON     0
idx     VAR     Nib
lights  VAR     Byte
delay   VAR     Byte
lotto   VAR     Word

Main:
  FOR idx = 1 TO 3
    RANDOM lotto                ' stir random generator
  NEXT
  SEROUT TX, Baud, ["!RC4", %00, "X"]
  IF (MatSw = No) THEN Main     ' wait for "victim"
  lights = lotto.NIB0           ' randomize lights
  SEROUT TX, Baud, ["!RC4", %00, "S", lights]
  delay = lotto // 201 + 50     ' create 50 to 250 ms delay
  PAUSE delay                   ' hold lights
  GOTO Main                     ' back to Main
```

Prop-2 Example (RC-4 Control)



Prop-2 Programming (Advanced)

GOSUB *Label* ... RETURN

GOSUB is used to redirect the program to the specified code section that ends with **RETURN**, which sends the program back to the line that follows the calling **GOSUB**.

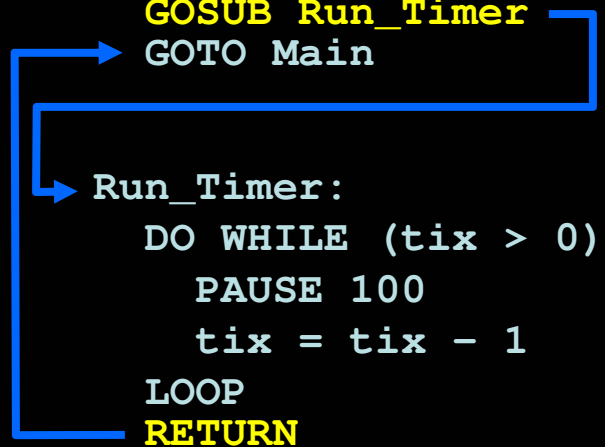
```
tix = 35                        ' timer = 3.5 seconds
GOSUB Run_Timer                 ' run the timer
```

Prop-2 Example (Timer Subroutine)

```
Led     PIN     8
tix     VAR     Byte

Main:
  HIGH Led                      ' Led on
  tix = 23                      ' set timer for 2.3 seconds
  GOSUB Run_Timer               ' start the timer
  LOW Led                       ' Led off
  tix = 7                       ' set timer for 0.7 seconds
  GOSUB Run_Timer               ' start the timer
  GOTO Main


Run_Timer:
  DO WHILE (tix > 0)            ' check for end of timer
    PAUSE 100                   ' hold for 1 tic (0.1 secs)
    tix = tix - 1               ' update tix count
  LOOP                          ' re-check for end of timer
  RETURN                        ' go back to main program
```

Prop-2 Example (Timer Subroutine)

```
Led     PIN     8
tix     VAR     Byte

Main:
  HIGH Led                      ' Led on
  tix = 23                      ' set timer for 2.3 seconds
  GOSUB Run_Timer               ' start the timer
  LOW Led                       ' Led off
  tix = 7                       ' set timer for 0.7 seconds
  GOSUB Run_Timer               ' start the timer
  GOTO Main


Run_Timer:
  DO WHILE (tix > 0)            ' check for end of timer
    PAUSE 100                   ' hold for 1 tic (0.1 secs)
    tix = tix - 1               ' update tix count
  LOOP                          ' re-check for end of timer
  RETURN                        ' go back to main program
```



Prop-2 Programming – Review

Essentials

```
PIN, CON, VAR
HIGH Pin
LOW Pin
PAUSE Period
GOTO Label
IF Condition THEN Label
FOR Variable = StartVal TO EndVal ... NEXT
```

Advanced

```
RANDOM Variable
RCTIME Pin, Mode, Variable
PULSOUT Pin, Period
SEROUT Pin, Baudmode, [Data]
GOSUB Label ... RETURN
DO Statements LOOP
```

Prop-2 Programming – More

Additional Instructions

```
DEBUG Data, ...
DATA {@Location,} {Word} Value, ...
READ Location, {Word} Variable {, Variable, ...}
PWM Pin, Duty, Cycles
FREQOUT PIn, Duration, Freq1 {, Freq2}
SERIN Pin, Baudmode, [Variable, ...]
TOGGLE Pin
```

Advanced Programming Techniques

- Learn to use **DIRS** and **OUTS** for I/O setup and control
- Master the **//** (modulus) operator
- Learn to use ****** and **/*** to multiply by fractional values
- Learn to use **ON *Variable* GOSUB *Label*...** for state-driven programs

Contact

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