Directions for Wiring and Using The GEARS II (2) Channel Combination Controllers

PWM Input Signal Cable for the Valve Controller

Plugs into the RC Receiver or Microprocessor Signal line.

White = PWM Input Signal
Red = Positive + 5 volts
Black = Negative – 5 volts

PWM Input Signal Cable for the Motor Controller

Plugs into the RC Receiver or Microprocessor Signal line.

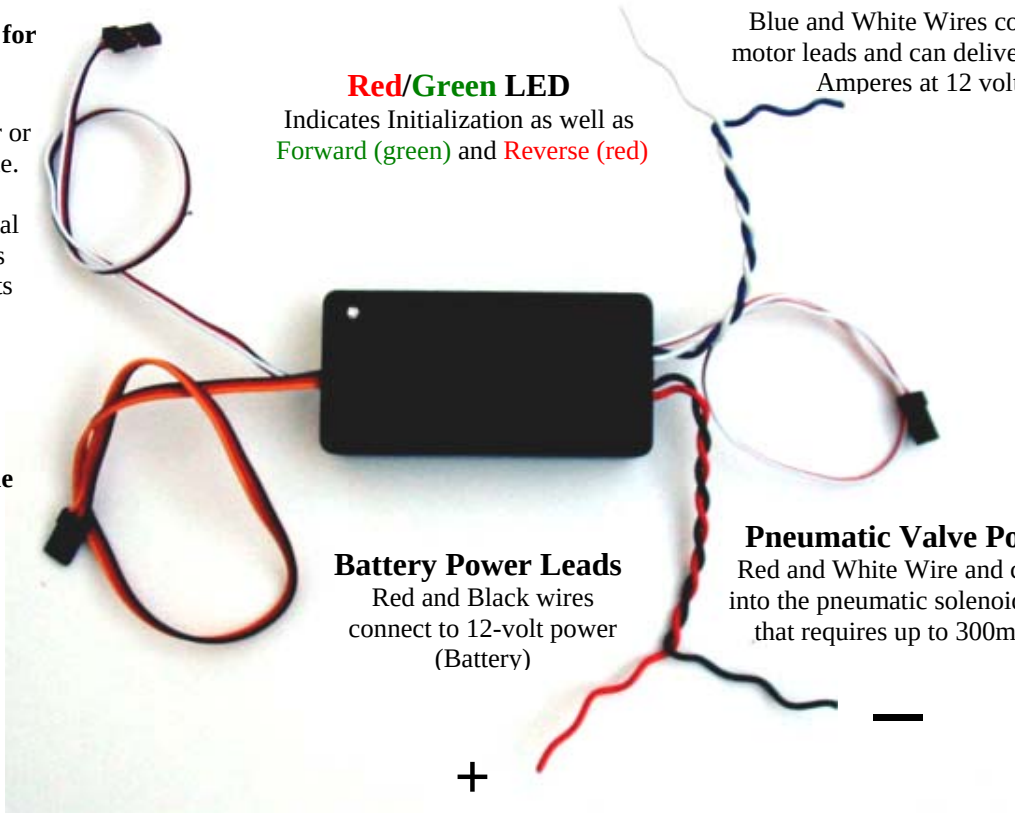
Orange = PWM Input Signal
Red = Positive + 5 Volt
Brown = Negative – 5 Volt

Red/Green LED

Indicates Initialization as well as Forward (green) and Reverse (red)

Motor Power Leads

Blue and White Wires connect to motor leads and can deliver up to 15 Amperes at 12 volts.



Battery Power Leads

Red and Black wires connect to 12-volt power (Battery)

Pneumatic Valve Power Leads

Red and White Wire and connector plug into the pneumatic solenoid valve or relay that requires up to 300ma at 12 volts.

The GEARS-II (2) Channel Combination Controller offers These Advantages:

- 400 steps forward, and 400 steps of reverse resolution provide a total of 800 steps of smooth response from either joystick or microcontroller inputs.
- Frame (Refresh) rate for the FET's is 10 KHz
- Reverse polarity protection on the battery power leads.
- 1 Ampere BEC.
- LED feedback for initialization and current direction.
- Supports continuous current draw of 10-12 Amperes at 12 volts.
- Integrated PWM controlled, current reversing switch rated at 300MA, 12 volts. This switch operates at about 80% of full forward or full reverse, or at a PWM signal value of 1.100ms or less for reverse current, and 1.900ms or greater for forward current.
- 500ms "Latching" of last PWM signal before "timing out" insures that the motor controller will deactivate ½ second after a radio or microcontroller failure. This provides a margin of safety for radio controlled operation and minimizes the serial controller workload by reducing the required signal refresh rate by a factor of 25X.

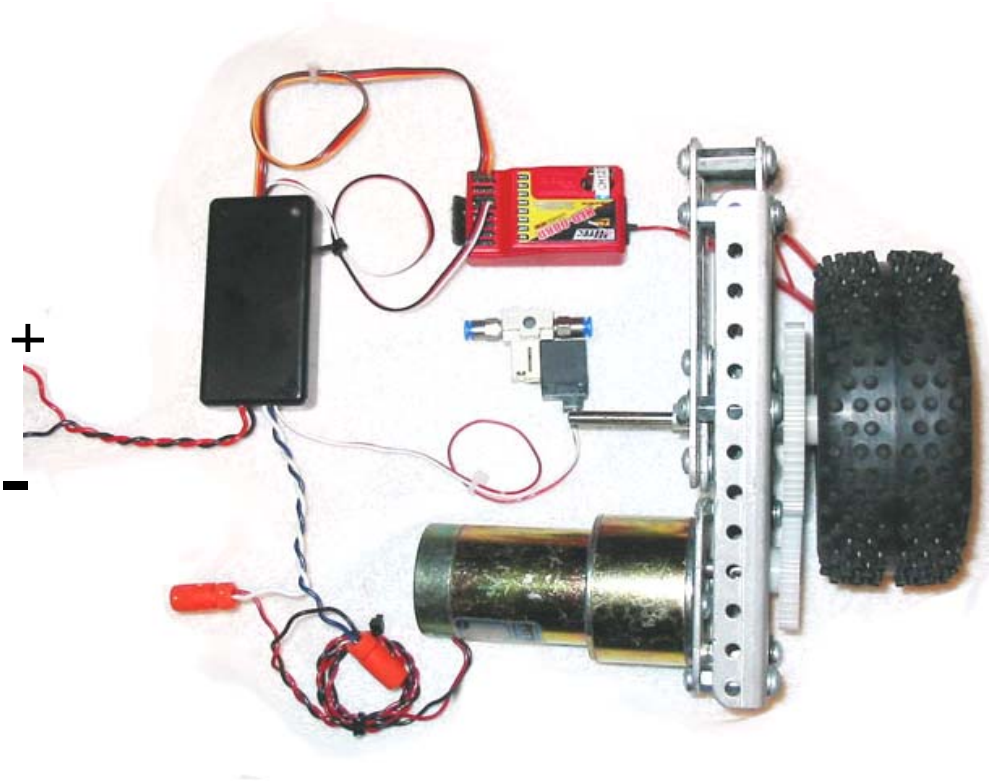
Safety Protocols

The GEARS II Combination Controllers are programmed with a built in safety protocol and will not become operational until they detect a neutral (~1.520ms) signal from either an RC radio or a microcontroller. This is done to minimize the chances that a robot or other GEARS projects, will inadvertently move at start up.

The radio, or microcontroller must initialize the speed controller by sending a neutral (stop) signal, thus ensuring that the mechanism begins operation in a stopped position. Moreover, the GEARS II Combination Controller will default to "Dead End" condition if a PWM signal is not detected after a period of more than 500ms. In this case the LED indicator will blink red and the unit will have to be restarted by cycling the power off and on (rebooting the unit). This "Dead End" condition ensures that the speed control unit becomes inoperative in the event of radio failure or failure of the microcontroller circuit.

LED Indicator

The LED glows red during power-up. If a PWM signal is detected on channel 1 (motor control) the LED signifies this with one green blink. If a PWM signal is detected on channel 2 (valve control), the LED signals this with two quick green blinks. If both channels are active then the LED will give one slow green blink, followed by two quick green blinks. After the signal is detected, the led glows red until the unit is initialized with a neutral signal on the motor control channel. The neutral signal (~1.520ms) should be repeated several times to ensure the Speed Controller recognizes it. Once the neutral signal is recognized the controller becomes operational and the led will go dark. When the motor control is operated the led will show green for forward and red for reverse. The intensity of the led indicates the motor speed—dim for slow and bright for fast.



Note: If the motor control channel is not activated or used, then a neutral signal is not required for operation of the 300mA PWM, Current Reversing switch. If neither channel is active the GEARS II Combination Controller will dead end into a deactivated state and the led will continuously blink red. The power must be cycled to restart the unit once it is in the deactivated state.

The picture above illustrates how to connect the GEARS II Combination Controller to the RC receiver, Gear Head Motor, Pneumatic Solenoid Valve and the Battery (Not Shown).

Programming with the GEARS II Combination Speed Controller (Channel 1)
If you've already programmed GEARS robots with the original speed controllers, you will find the that the new GEARS II Combination Controller will behave a little different. Programs written for the original controllers will not work with the new GEARS II Combination Controllers. Don't worry about it! Here is a new, sample code to get your GEARS II Combination Controllers up and running easily and quickly.

Understanding the Basics
The GEARS II Combination Controllers are used to run motors and pneumatic solenoid valves using Pulse Width Modulation, PWM for short. PWM signals are a series of short +5v pulses separated by 20ms pauses. The length of each pulse can range from 1 to 2 ms (Milliseconds or 1/1000 of a second).

A pulse width of 1 ms sent to the speed controller will drive a motor full speed in reverse, a pulse width of approximately 1.5ms will stop the motor, and a pulse width of 2 ms will drive a motor full speed forward.

The pulse widths can be varied within the range of 1-2 ms to directly vary the speed and direction of the motor. The Basic Stamp microcontroller can be easily programmed to generate PWM signals using the PULSOUT command.

The PULSOUT Command
PULSOUT values represent units of 2µs (Millionths of a second) each, thus a PULSOUT value of 1 = 2 µs or 2 millionths of a second. A PULSOUT value of 500 is therefore equal to 1000 µs, (1000 millionths of a second) or 1 ms, (Microsecond) and a PULSOUT value of 1000 equals 2 ms.

Basic Stamp microcontroller are programmed using the P-Basic programming language. The P-Basic command: PULSOUT 14,500 would make a GEARS II Combination Speed Controller connected to pin 14 drive a motor at high speed in reverse. Likewise, the command: PULSOUT 14,750 would slow the motor to a near stop.

The full reverse, neutral and full forward PULSOUT values for the GEARS II Combination Controllers are 560, 760, and 960, respectively.

Programming with the GEARS II Combination Solenoid Valve Controller (Channel 2)
To control the GEARS II Combination Solenoid Valve Controller, the controller uses a 760 off or neutral value and 960 or 460 PULSOUT value to toggle the current direction of the solenoid valve controller.

Using a Sample Program
The GEARS II Combination Controllers has several safety features that help to prevent a robot from starting at full speed and that cause the robot to shut down in the event that a control signal is lost. The latter feature helps to prevent "Run Away Robots"

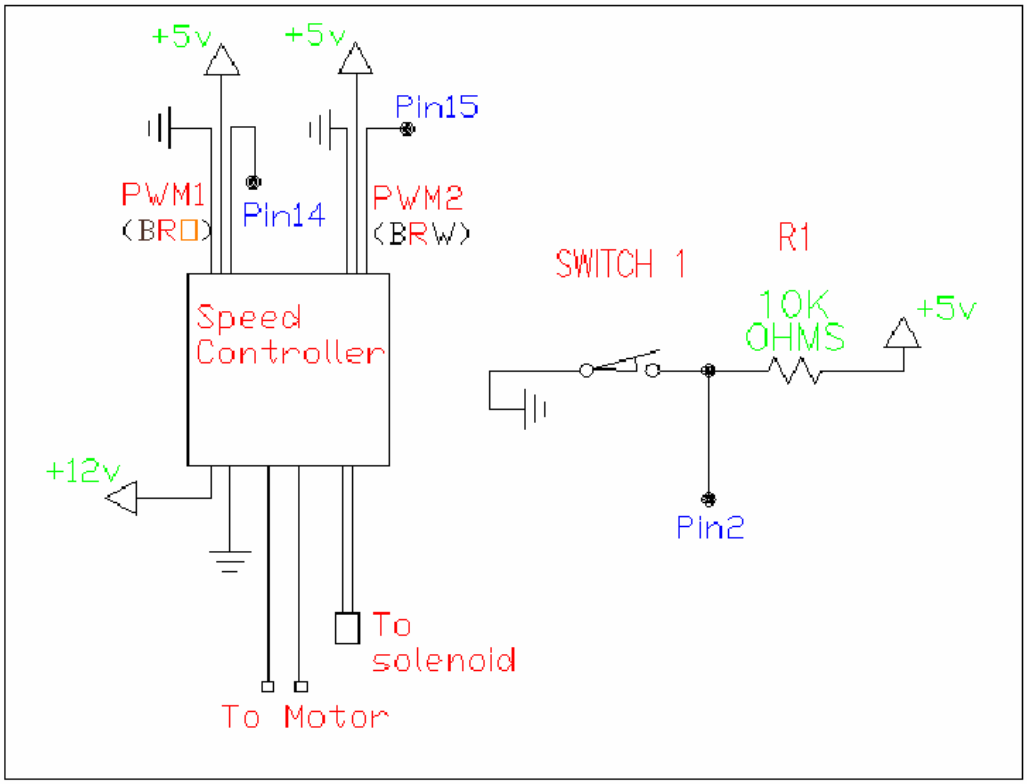
If the motor control feature is used it is necessary for the unit to be “initialized” after power up. This means you have to send a neutral PWM value (A PULSOUT value of 760) on the motor control channel for a certain amount of time before they will drive the motors. This prevents the robot from moving inadvertently at start up. If the motor control feature is not used then this initialization step is not required before the controller will operate a pneumatic cylinder with the valve control feature.

The initialization requirement prevents accidents with both radio controlled and microprocessor controlled mechanisms; GEARS II Combination Controllers have been specifically designed so they will not operate a robot device until the radio control joystick has been centered or until a microprocessor has given the controller a neutral signal.

GEARS II Combination Controllers also prevent accidents in the event of a loose wire or an interrupted signal. The controllers will automatically turn off if they do not receive a signal every 500ms (half a second) or less. This is not a problem using radio control since the radio systems refresh the signals every 20ms. However, programmers must be conscious of the program run times: Program loops cannot exceed 500ms (½ second) without sending at least one PWM signal to both the speed control and to the valve control of the GEARS II Combination Controller. This should not be a problem given the operating speeds of the current generation of micro controllers or Basic Stamps.

Sample Program

Still not making sense? No problem! Let’s try an example program to see how this works. For this program, wire up an integrated speed/valve controller and a bump switch as pictured in the diagram below.



What the Program Does
The program must initialize the GEARS II Combination Controller after giving it time to complete the start up sequence. The initialization sequence causes the GEARS II Combination Controller to recognize which functions are being used (speed control and/or valve control) and sets them both to a neutral position. The program must then execute the command sequences contained in the program loop while continuing to refresh the signals sent to both the speed and valve control every 500ms or less.

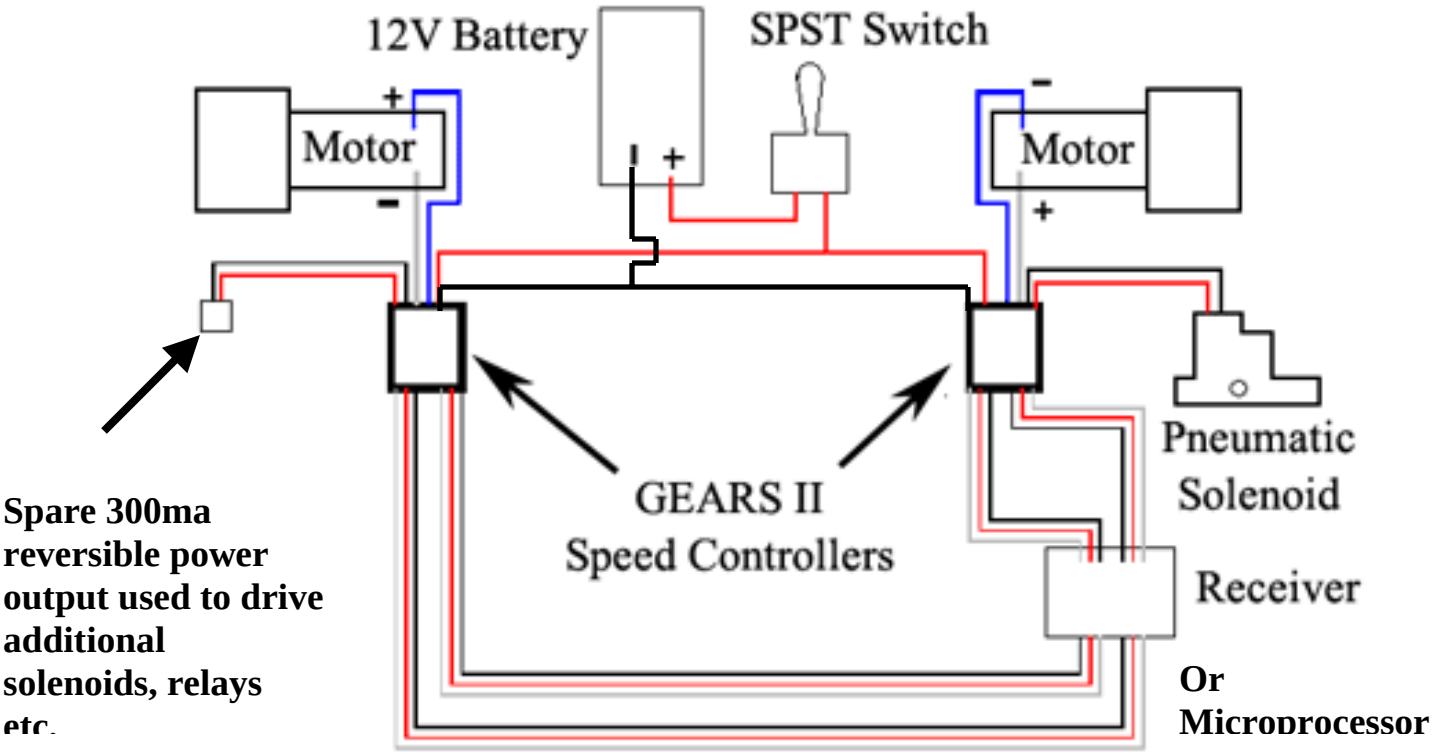
Study the Program Example
Since the motor control feature is used, the sample program starts with an initialization routine, labeled "Init." Next, the program enters the main program loop and begins to drive the motor. The program is a continuous loop; during this loop the motor accelerates to top speed and decelerates back to zero, then starts again. Each time through the loop, the program directs the Basic Stamp microprocessor to send a PWM signal to both the motor controller and the valve controller. This way, both the speed controller signal and valve controller signal are refreshed and neither will cause a "time out" and force the system to reset or to "dead end".

If the bump switch is depressed, the valve controller operates the solenoid. When the bump switch is released the program reverts to sending the valve controller a PWM value of 1520ms or a PULSOUT value of 760.

Build and program your own electro-pneumatic system. Download the demonstration program from the GEARS Educational Systems website. Open it and download it to your Basic Stamp using the Basic Stamp editor. Once you have the program working correctly, it will be easy to experiment with changes by modifying the values and noting how the mechanisms behave. The program is written below and can be found on the GEARS web site at this address:
http://www.gearseds.com/files/GEARSII_DOC_TUTORIAL.zip

```
'{$STAMP BS2}
'{$PBASIC 2.5}
'
'Title: GEARS II Integrated Speed Controller Tutorial
'Author: Rob Block
'Date Created: 7/29/05
'
'------------------Variables and Constants------------------'
DLAY CON 20
MOTOR_1 CON 14
PISTON_1 CON 15

X VAR Word
'----------------------Initialization----------------------'

Init:                   'This Init: routine initializes both speed controller
                        'and solenoid channels.
PAUSE 100
```

```
FOR x = 1 TO 100        'The controller first looks for a string of pulses from each
PULSOUT MOTOR_1,760              'input and recognizes which channels need to be active

PULSOUT PISTON_1,760             ' Use mid or neutral values for these pulses(760).
PAUSE 20
NEXT
PAUSE 100

FOR x = 1 TO 100                 'Next, the controller needs to see a string of neutral
                                 ‘pulses for
 PULSOUT MOTOR_1, 760            'each input. This insures that the mechanism is in a
                                 ‘stop mode.
PULSOUT PISTON_1, 760            'This FOR NEXT loop should run 2 seconds (100
                                 ‘cycles * 20ms)
PAUSE 20                         ‘Less time might work, so experiment.
NEXT


'MAKE SURE YOU SEND A PWM TO EACH CHANNEL EVERY 500ms or sooner! It's
best to
'update the valve whenever you update the speed control.

'----------------------Main Program-----------------------'
Main:
  FOR X = 760 TO 960             'This loop will repeat 200 times. from rest,
  PULSOUT MOTOR_1,X              'MOTOR_1 will increment speed each time
  IF IN2 = 0 THEN                'until it reaches the maximum value of 960
  PULSOUT PISTON_1,960
  ELSE                           'if the switch is pressed, the solenoid fires,
     PULSOUT PISTON_1,760        'if not, the solenoid receives a neutral value
  ENDIF                          'of 760
  PAUSE 20
  NEXT

  FOR X = 960 TO 760             'same as above, except this time the motor
  PULSOUT MOTOR_1,X              'will decelerate from full speed to stop
  IF IN2 = 0 THEN
  PULSOUT PISTON_1,960
  ELSE
  PULSOUT PISTON_1,760
  ENDIF
 PAUSE 20
  NEXT

  GOTO Main
```

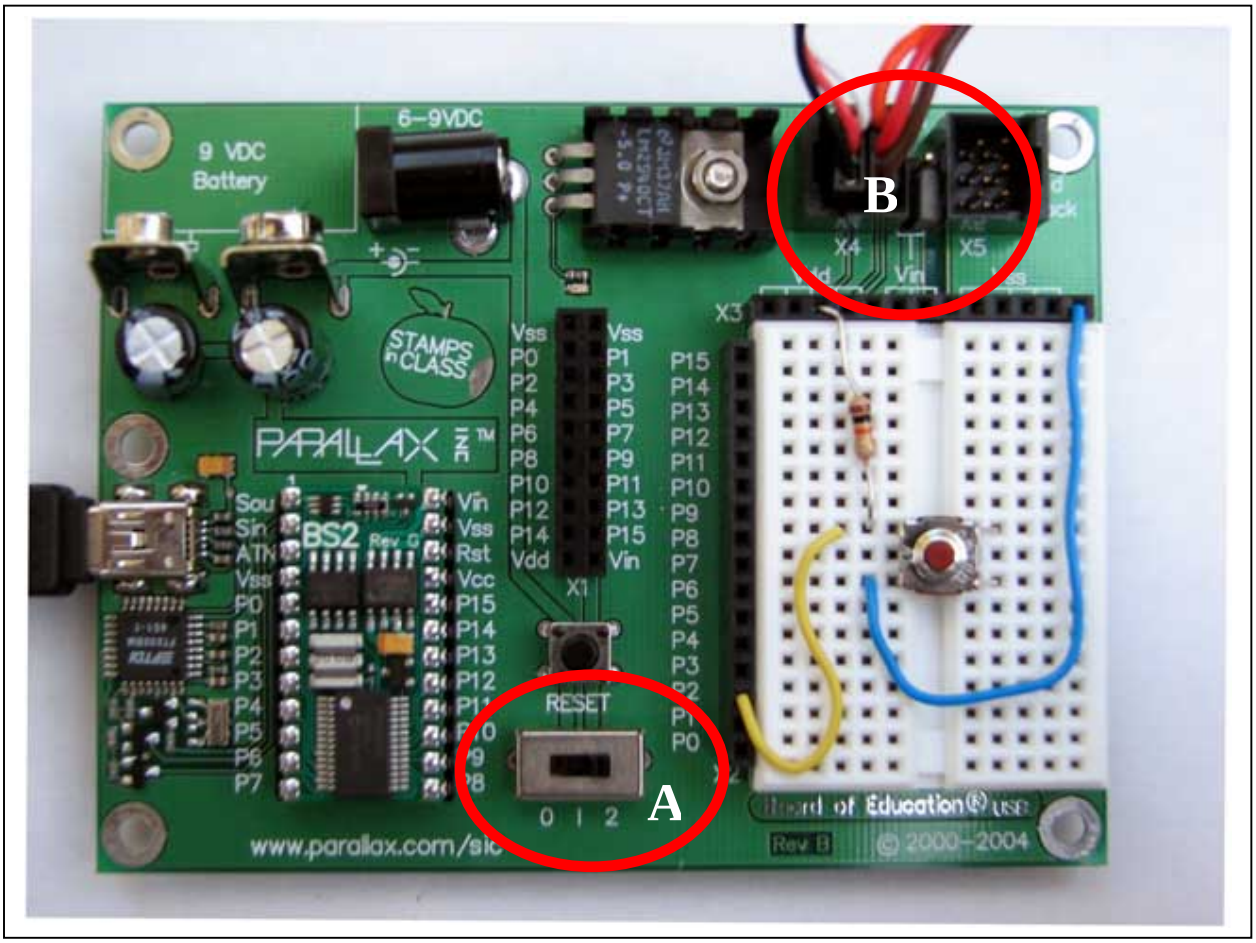


Using the GEARS-II Speed Controllers with the Parallax Rev A, B and C Boards of Education

The photograph on the following page illustrates the wiring, jumper and switch position used with the Parallax BOE boards and the sample code provided above. These settings apply to the REV A, B and C boards.

NOTE: Pay particular attention to the settings of the Vin jumper and the position of the BOE 3 position switch. It is important to remember that while you can power the BOE using the GEARS-II Speed Controllers, you should never use them in combination with any other power source such as a power supply or 9 volt battery attached to the BOE.

Note: The wiring colors of the PWM cables used on the GEARS-II Speed Controllers changes from time to time. The color combinations most often used are red, white and black and/or Orange, Brown and Red. Always remember that the dark colors, brown and black are equivalent and the light colors orange and white are equivalent . Red is always red.



This is the wiring that allows the example code to operate the two channels of a GEARS-II Speed Controller. The circuit on the breadboard is the same circuit shown in the schematic on page 4.

Be certain that the 3 position switch (A) is on the Number #2 position.

Be certain that the jumper (B) is in the V_{in} position as shown in the picture above.

If you are uncertain of how to move the jumper (B) consult the documentation that came with your Parallax products.