Propeller Robot Control Board (#28230)

The Propeller Robot Control Board from Parallax Inc. provides an excellent development platform for mid-size robotics projects and experiments. The Propeller P8X32A-Q44 is the brains of the board, providing a multiprocessor control system capable of performing multiple tasks at the same time. The Propeller Robot Control Board also provides a 3.3V/5 V dual switching power supply, dual full bridge driver and 24 discrete I/O pins on servo headers buffered by 5 V translators. 64 KB of EEPROM means there is extra non-volatile storage for user data and a USB interface provides a convenient connection to a PC for programming or communication.

Features

- Multi-core Propeller chip based control board
- Extra capacity EEPROM (64 KB) for storing additional data
- On-board 3.3 V & 5 V switching power supply
- 5 V I/O translators to simplify interfacing to 5 V sensors/devices
- Integrated dual full bridge driver
- Free online Propeller Tool programming software for Windows (requires Win2K/XP/Vista or higher, IE7 or higher, and USB port)
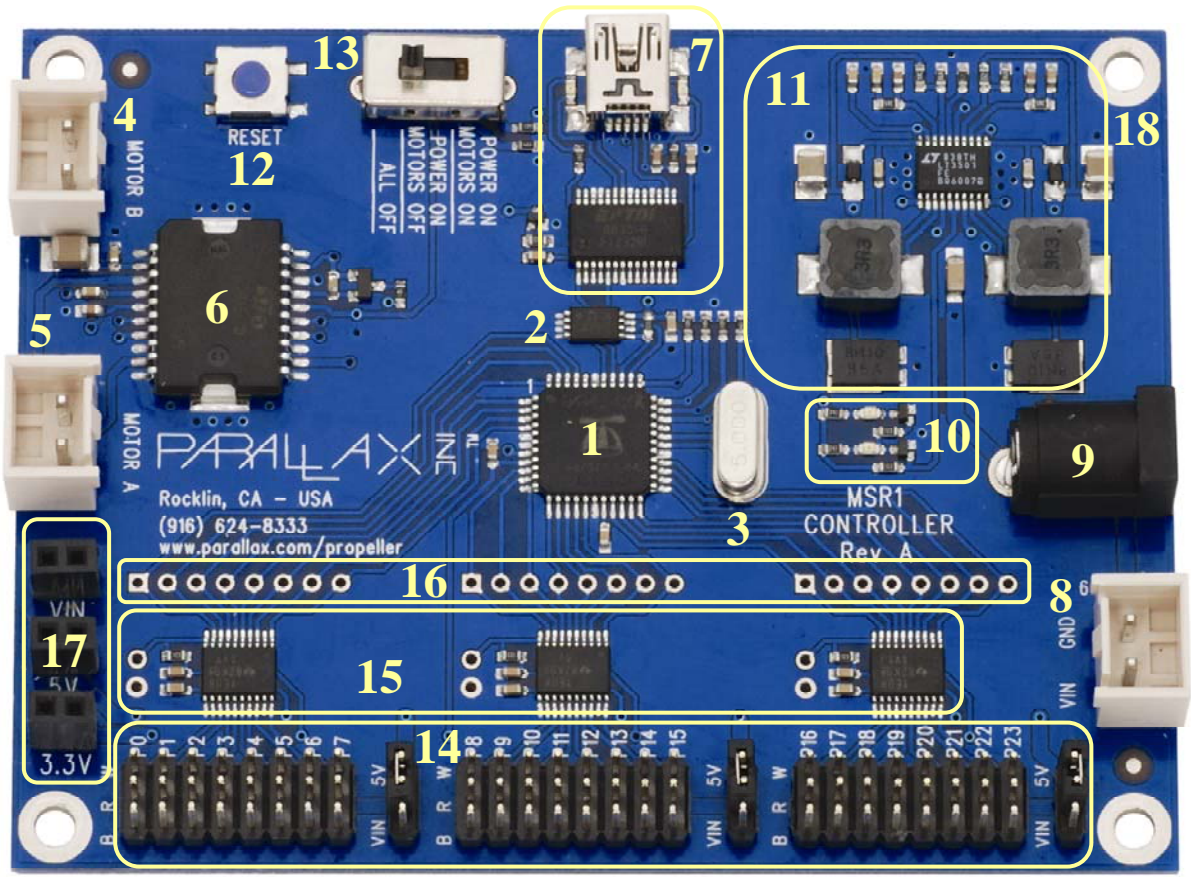
Key Specifications

- Power requirements: 6.5 to 15 VDC
- Communication: USB A to Mini B Cable
- Operating temperature: 32 to 158 °F (0 to 70 °C)
- Dimensions: 3.05 x 4.05 x 0.53 in. (77.5 x 102.9 x 13.4 cm)

Application Ideas

- Control board for mid-sized robots
- Replacement for less powerful control board in existing design
- Electronic art controller
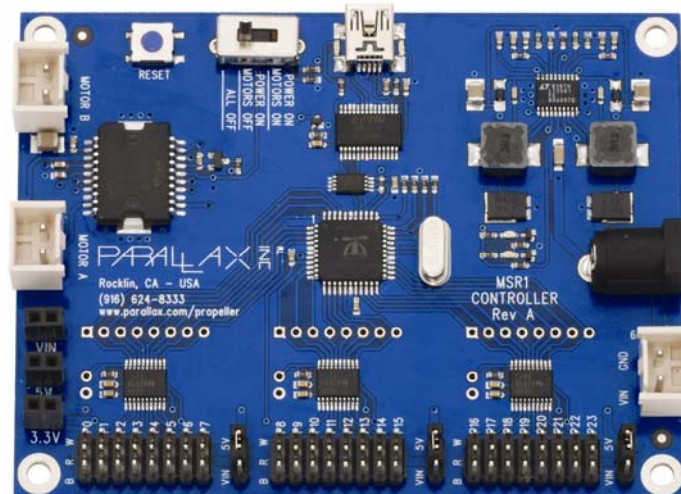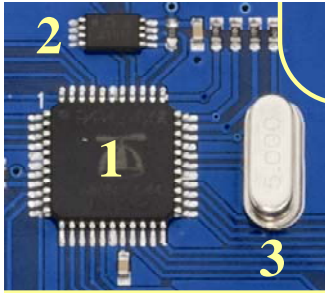
Propeller Robot Control Board

1. Propeller P8X32A-Q44
2. 64 KB EEPROM
3. Socketed 5 MHz Crystal
4. Motor B (right) Socket
5. Motor A (left) Socket
6. L6205 H-Bridge Driver
7. USB Connector/Circuit
8. Battery Pack Socket
9. Barrel Jack, 2.1 mm
10. Power Good/Fail LEDs
11. Dual Switching Power Supply
12. Reset Button
13. 3-Position Power Switch
14. Headers to I/O P0-P23
15. Voltage Translators for I/O
16. Direct I/O Access Vias
17. VIN, 5V, 3.3V Sockets
18. Ground/Mounting Vias

Control Board Details

The Propeller Robot Control Board provides all the necessary base circuits needed to build a very powerful mid-size robotics platform. The control board has an on-board USB serial interface to facilitate programming and communication with the Propeller chip. A dual switching supply provides 3.3 V and 5 V @ up to 3 A each. The on-board dual full bridge driver makes it possible to directly drive DC brushed gear motors. The 24 available I/O pins are buffered through three 8-bit bidirectional voltage level translators providing direct 5 V interface capability. Finally, the input voltage can come from a battery pack or a wall adapter using a standard 2.1 mm barrel plug. See below for details of the on-board hardware and connections.

Propeller P8X32A-Q44 [1]

The multi-core Propeller chip contains 8 cogs (processors) that can operate simultaneously, both independently and cooperatively with other cogs, sharing access to global memory and the system clock in a round-robin fashion through a central hub. Each cog has access to all 32 I/O pins, with pin states tracked in its own I/O output and direction registers. Each cog also has its own memory, as well as two counter modules and a video generator. See the Propeller Manual and datasheet in the Propeller Tool Help for more information.

64KB EEPROM (P28 – P29) [2]

The AT24C512 EEPROM (see the figure at left) chosen for the Propeller Robot Control Board is 64 KB instead of 32 KB, allowing for extra memory to store user data. This extra memory could be used for custom settings, GPS lookup tables, map data or whatever you choose. This extra 32 KB is not overwritten when programming the EEPROM via the Propeller Tool software. This means that when you download a new program to the EEPROM the data in the upper 32K is not lost. The SCL line is connected to P28 and the SDA line is connected to P29.

Socketed Crystal [3]

A 5 MHz crystal is included in the socket next to the Propeller chip. With the included crystal the Propeller chip can run at 5, 10, 20, 40 and 80 MHz. By exchanging the crystal for one of a different value other operating frequencies can be achieved. Refer to the Propeller datasheet for more information about using external crystals.

L6205 Dual Full Bridge Driver (P24 – P27); Motor Sockets [4, 5, 6]

The L6205 driver is connected to the Propeller chip via I/O pins P24–P27. P24 and P25 control Motor A while P26 and P27 control Motor B.

The L6205 used on the Propeller Robot Control Board is a Dual Full Bridge Driver that offers many advantages in comparison to a simple H-Bridge circuit alone. As a dual driver it can handle two motors at up to 2.8 A (5.6 A peak) with an operating frequency of up to 100 kHz. The L6205 also provides non-dissipative over-current protection and thermal shutdown. Internal logic eliminates the possibility of an improper configuration of the driver that might cause a short circuit. Connections to the output of the H-Bridge are made through the Motor A and Motor B socket's connectors (Molex #0351560200).
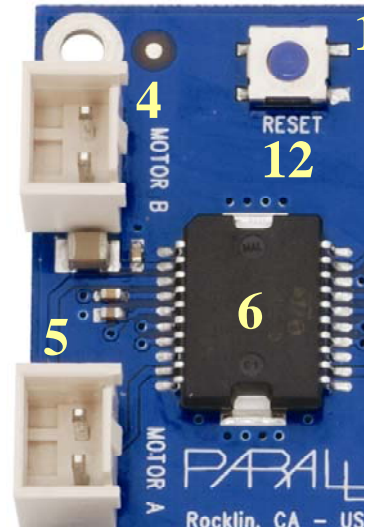
The L6205 inputs are connected to P24 through P27 on the Propeller chip. When the power switch on the control board is set for POWER ON/MOTORS ON, the L6205 is enabled and the outputs are connected to the motors. The truth table for controlling the L6205 is shown below in Table 1. P24 and P25 control Motor A while P26 and P27 control Motor B. This table assumes the motors are connected to the control board such that the left motor is connected to the Motor A connection and the right motor is connected to the Motor B connection. Polarity should be the same on both connectors. The motor polarity may need to be reversed to match the table, depending on the motor.

| Table 1: Motor Truth Table					
P24	**P25**	**P26**	**P27**	**Left Motor**	**Right Motor**
0	0	0	0	Brake	Brake
1	0	0	0	Reverse	Brake
0	1	0	0	Forward	Brake
1	1	0	0	Brake	Brake
0	0	1	0	Brake	Forward
1	0	1	0	Reverse	Forward
0	1	1	0	Forward	Forward
1	1	1	0	Brake	Forward
0	0	0	1	Brake	Reverse
1	0	0	1	Reverse	Reverse
0	1	0	1	Forward	Reverse
1	1	0	1	Brake	Reverse
0	0	1	1	Brake	Brake
1	0	1	1	Reverse	Brake
0	1	1	1	Forward	Brake
1	1	1	1	Brake	Brake

Note that it may be more intuitive to look at the table as two groups consisting of P24/P25 and P26/P27. In this manner you have 4 possible combinations for each motor as shown in Table 2.

Table 2					
P24	**P25**	**Left Motor**	**P26**	**P27**	**Right Motor**
0	0	Brake	0	0	Brake
1	0	Reverse	1	0	Forward
0	1	Forward	0	1	Reverse
1	1	Brake	1	1	Brake

Pulse-width modulating one of the inputs in the opposite state of the other pin will cause that motor to move at a speed proportional to the duty cycle of the signal. A wide range of frequencies could be used for pulse-width modulating DC brushed motors.

**The USB Serial Interface (P30 – P31)**

The USB interface (see the figure at right) provides a serial connection to the Propeller chip through the USB port of your PC. This interface is used for both programming and communication with the control board and is based on the FTDI FT232RL. A green LED indicates data coming into the control board and a red LED indicates data being sent to the PC. Data coming into the control board goes to P31 on the Propeller chip while data being sent comes from P30.
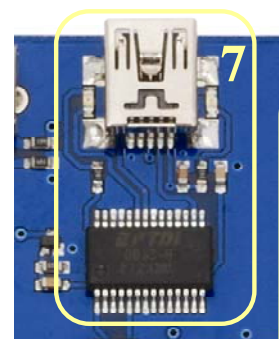
## Battery Pack Socket [8] and Barrel Jack Connector [9]

The Battery Pack Socket is a Molex part and accepts Molex part #0351560200. The Barrel Jack Connector is for use with a 6-15 VDC wall-mount power supply, with a center positive 2.1 mm barrel connector. NOTE: Using the Barrel Jack Connector temporarily disables the Battery Pack Socket.

CAUTION: The input voltage (VIN) is also the motor voltage. For this reason you should not use a wall adapter or battery higher than the maximum voltage of the motors when enabling the motors (power switch moved to the third (right) position, see below) or you may damage or reduce the life of the motors.
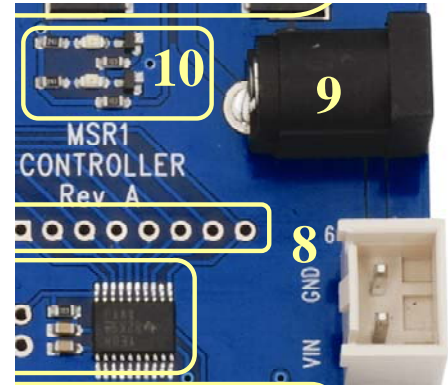
Power Good/Fail Indicator LEDs [10]

There are actually two LEDs for power indication on the control board, one red and one green (see 10 in the figure above). The green LED means the power is good. If the input voltage falls below approximately 6 VDC the green LED goes out and the red LED above it comes on. You may also notice when switching the power on/off that the red LED briefly blinks while the power supply rails stabilize.
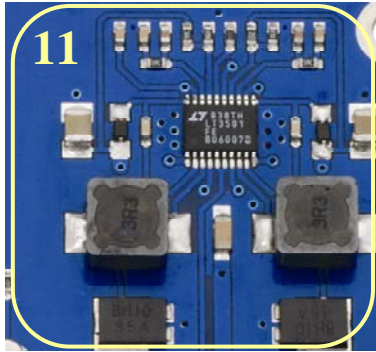
LT3501-based Dual Switching Supply [11]

The power supply uses the LT3501 Dual Tracking 3 A Switching Regulator to provide the 3.3 V and 5 V used on the control board. This supply regulates the 6 – 15 VDC on the input down to the desired voltages at up to 3 A of current per supply.

Reset Button [12]

This button resets the Propeller chip, initiating its boot up procedure (see the Propeller Help). Be aware that if the motors are running, this will cause them to go into brake mode (see Table 1 on page 4).

3-position Power Switch [13]
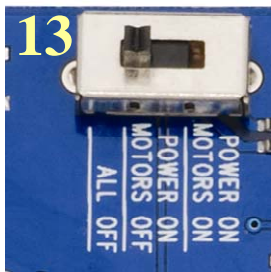
The first (left) position, marked ALL OFF, turns off power to the Control Board, I/O headers when set to 5 V, and motors. In this position the power LED is out. The second (middle) position, marked POWER ON / MOTORS OFF, turns on power to the control board and I/O headers, but disables the H-Bridge, effectively turning the motors off. The last (right) position on the power switch, marked POWER ON / MOTORS ON, turns on power to the control board, I/O headers and motors. Note that the 3-position switch has no effect on VIN availability at the I/O headers set to VIN, nor at the VIN power supply tap (see VIN, 5 V, and 3.3 V Power Access Headers [17] on page 6).

Headers to 24 Available I/O Pins (P0 – P23) [14]; Voltage Translators [15]

The 24 available I/O pins are connected to three TXB0108 8-bit bidirectional voltage level translators that convert the voltage from 3.3 V at the Propeller chip to 5 V at the I/O headers and provides some short circuit protection with built-in 4 kΩ resistors. These fully bidirectional pins are grouped as three ports with eight I/O lines each: P0–P7, P8–P15 and P16–P23.
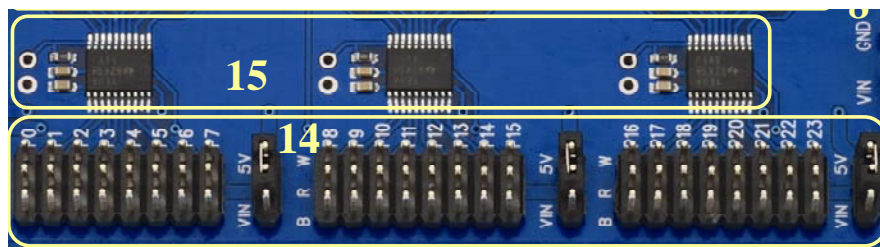
Each group is brought out to I/O headers. These pins are labeled W, R and B, referring to the typical colors of a servo extension cable. W (white) is the signal pin, R (red) is the power pin and B (black) is the ground connection for each port.

To the right of each group of I/O headers is a jumper that allows either 5 V or VIN to be available at the center (power) pin of that group. By default this is set to 5 V for all three groups. NOTE: When the jumper is in the VIN position the I/O headers will have power at the R row regardless of the position of the power switch.
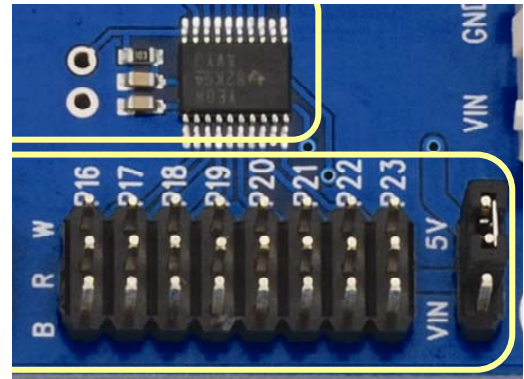

All data at the I/O header signal (W) pins is at 5 V signal levels, however if you should need direct access to the Propeller chip I/O for 3.3 V interfacing, it is possible to disable a translator and gain direct access to the eight I/O pins connected to it. Doing this requires the addition of some headers which would need to be soldered to the control board. The following section describes how to complete this procedure.

NOTE: While a translator has been disabled, all eight I/O pins in that group are affected and cannot be accessed from the I/O header pins. The translators require a minimum of 4.7K impedance on their output when connected.

Direct I/O Access Vias [16]

In the figures below, the control board has had headers soldered into the unpopulated pads above and to the left of the center translator IC. This will allow you to connect pluggable wires to P8 through P15, however the translator chip itself will interfere unless it is disabled. In the right figure a jumper (also called a shorting block or shunt) has been placed over the 2-pin header to the left of the translator. This effectively disables the translator and all connections for P8 through P15 at the I/O header. Once a translator is disabled you can connect directly to the Propeller I/O pins. Always use caution when connecting directly to the I/O pins that you're using the correct signal voltage (3.3 V) and that the I/O pin direction is set properly since there is no additional protection for the I/O lines when connecting directly to them. Jumper: Parallax #452-00009; 40-pin male/male header: Parallax #451-04001.
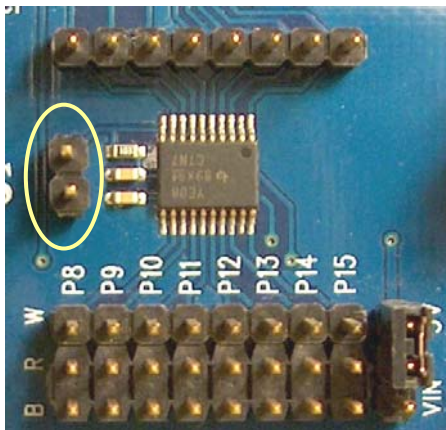
Translator Enabled

8-pin bypass header and 2-pin translator header installed. Jumper *not* installed.
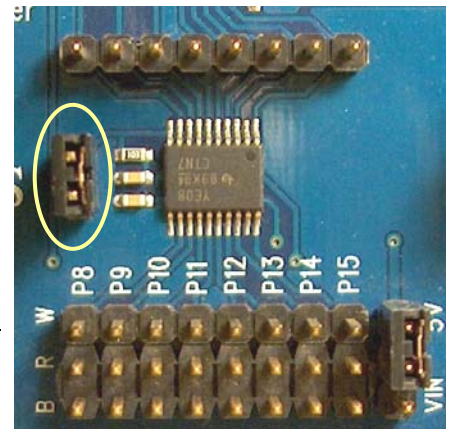
Translator Disabled

Jumper installed on 2-pin translator header.

VIN, 5 V, and 3.3 V Power Access Headers [17]

These sockets provide convenient access to the 3 power rails and can typically be jumpered over to the power bus on the breadboard using standard jumper wires. NOTE: VIN access on this header always has power when a power source is connected to the board, regardless of the position of the 3-position switch.

Ground/Mounting Vias [18]

The Mounting Vias are sized and positioned to be compatible with many of our popular microcontroller development platforms. All four of these holes are connected to the PCB's ground plane.

Testing Communication

Parts Required

- USB A to Mini B Cable

✓ Download and install the latest version of the Propeller Tool Software from the Downloads link at www.parallax.com/Propeller. Be sure to permit the installation/update of the FTDI USB drivers during installation.

✓ Be sure the power switch on the control board is set to ALL OFF.

✓ Connect the USB A connector to the PC and the Mini B side to the control board. Your PC should detect a new device and complete the installation of the drivers already available on the PC from when you installed the Propeller Tool if this has not already been done previously.

✓ Run the Propeller Tool software. The first time you run the Propeller Tool you may be prompted with a file association dialog box. If so, click 'Yes" to associate the common extensions for Propeller programs with the Propeller Tool software.

✓ Slide the power switch to the POWER ON / MOTORS OFF (middle) position to turn on the control board. You should see the green power LED light up, as shown at right.

   o If it does not, slide the power switch to ALL OFF to turn the control board off. Double check all your connections and try again.

   o If you see a red LED instead this is an indicator that your batteries input voltage is below 6V. This usually indicates low batteries; replace your batteries.

✓ With the control board powered and the Propeller Tool running on your PC press the F7 key to identify connected hardware. You may also do this from the Propeller Tool menu system by clicking Run → Identify Hardware…

The Propeller Tool will scan all COM ports searching for a connected Propeller chip and display a message similar to the figure at right. Once scanning is complete you will see a message box like the one in the figure below left if a Propeller chip is detected or like figure below right if no Propeller chips were found.

✓ If you are unable to detect your Propeller chip recheck your connections and try again.

✓ If you continue to have difficulty please contact our Tech Support using the resources located at the end of this documentation.

Conserve energy! Be sure to turn off the power when not downloading or running a program on the control board. This will help conserve batteries and prevent accidents when wiring new circuits or connecting accessories to the control board.

Protect your hardware! You should also turn off power to the board when building a new circuit to prevent damaging any components.

Driving Brushed DC Motors

This section will guide you through connecting and testing DC Brushed Gear Motors. DC motors are by the L6205 H-Bridge on the Propeller Robot Control Board. Understanding how to control this H-Bridge is the key to controlling the direction, speed and duration that the motors are on or off.

Parallax has released a Propeller object called, "PWM_32" which makes it easy to drive servos as well as control motors using pulse width modulation. This object can be used with the Propeller Robot Control Board to drive the on-board H-Bridge, which in turn drives the DC motors. This object can be downloaded from the Propeller object exchange listed in the Useful Websites section at the end of this document.

Testing the Motors

- ✓ Load the programs **Left Motor Test.spin** and **Right Motor Test.spin** into the Propeller Tool.
- ✓ Slide the power switch on the control board to the second position (POWER ON/MOTORS ON).
- ✓ Select each program one at a time and download it to the Stingray robot by pressing the F10 key.
- ✓ Observe the results. Each motor should rotate forward for two seconds, stop for 2 seconds and rotate reverse for 2 seconds.

```
'' File: Left Motor Test.spin

CON
_xinfreq = 5_000_000              ' External Crystal Frequency
_clkmode = xtal1 + pll16x         ' Enabled External Crystal and PLL X16

PUB Main
  dira[27..24] := %1111           ' Set P24 Through P27 To Output

  outa[25] := 1                   ' Left Motor Forward
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[25] := 0                   ' Left Motor Stop
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[24] := 1                   ' Left Motor Reverse
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[24] := 0                   ' Left Motor Stop
  repeat
```

```
'' File: Right Motor Test.spin

CON
_xinfreq = 5_000_000              ' External Crystal Frequency
_clkmode = xtal1 + pll16x         ' Enabled External Crystal and PLL X16

PUB Main
  dira[27..24] := %1111           ' Set P24 Through P27 To Output

  outa[26] := 1                   ' Right Motor Forward
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[26] := 0                   ' Right Motor Stop
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[27] := 1                   ' Right Motor Reverse
  waitcnt(clkfreq * 2 + cnt)      ' 2 Second Pause
  outa[27] := 0                   ' Right Motor Stop
  repeat
```

Troubleshooting the Motors

If the motors do not respond as expected then the following troubleshooting steps should help you correct most issues. If none of these troubleshooting steps solves your issue or if your issue is not listed you may contact our Tech Support using the resources listed at the bottom of this page.

Symptom: The motors do not move at all, but the program downloads successfully.
Check: The power switch may be in the POWER ON/MOTORS OFF position instead of POWER ON/MOTORS ON.

Symptom: The motor rotates in reverse for two seconds, stops for two seconds then rotates forward for two seconds.
Check: The motor leads may be reversed on the motor. Remove the top plate from the chassis and swap the wires on the motor terminals for the side that was affected.

Symptom: The motor starts to turn forward then stops, then starts to turn forward again.
Check: The batteries may be running low. Try a fresh set of batteries.

Additional Resources

Resources for the Propeller Robot Control Board such as example code are posted to the product page on our website. Go to our website at www.parallax.com and type the product number (28230) into the search box and click the Go button. The example code will be in a ZIP file located under the heading Downloads and Resources. Save the contents of the ZIP file to a known folder for use in later activities in the book.

Useful Websites

In addition to the resources available on the product page you can get additional resources such as useful objects for sensors from the following links:

- Propeller Home Page: http://www.parallax.com/propeller
- Object Exchange: http://obex.parallax.com
- Support/Discussion Forums: http://forums.parallax.com → Propeller Chip

Tech Support Resources

Parallax Inc. offers several options for obtaining technical support for your product:
- Email: support@parallax.com
- Fax: (916) 624-8003
- Phone: (916) 624-8333 or toll-free in the U.S. at (888) 99-STAMP. Phone support is available Monday through Friday from 7:00 AM to 5:00 PM Pacific time or you can leave a message and a tech support representative will return your call as soon as possible.
- Forums: http://forums.parallax.com. Our support forums are available 24 hours a day, 7 days a week and are frequented by both Parallax customers and employees. You can often find fast answers to questions by searching previous posts or posting your question to the Propeller chip forum.