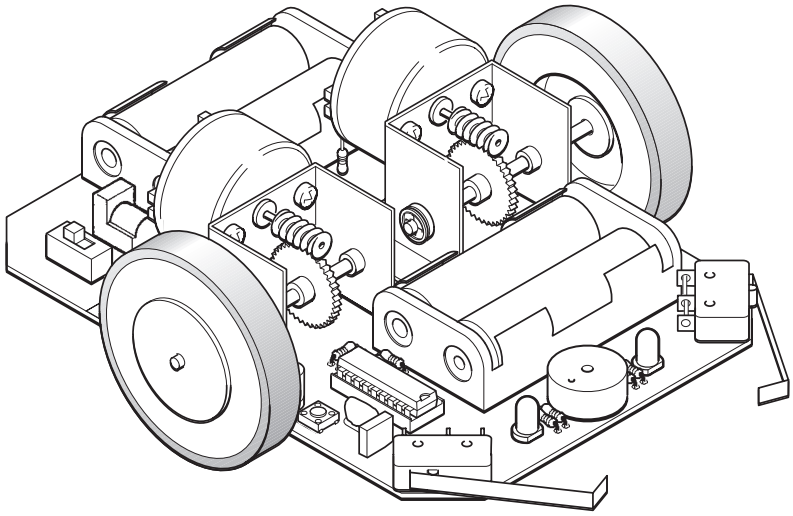
PIC BUGGY SELF-ASSEMBLY KIT

Order Codes:

CHI007 PIC Buggy Self-Assembly Kit
MOD001 PICAXE Buggy Kit (with pre-fitted PICAXE-18 micro and cable).



Features

- centrally located wheels for maximum mobility
- worm drive gearboxes with solar motors
- microswitch 'bumpers' for obstacle detection
- LED 'eyes' and piezo sound generator
- reprogrammable PIC16F627 microcontroller
- PICAXE connector for direct cable re-programming
- simple construction

Also required: 4x AA batteries
soldering iron and solder
side cutters and small cross-head screwdriver

Assembly requires soldering and takes approximately 30 minutes

Contents:

1	part-populated pcb chassis	
2	solar motor and gearbox	
2	long lever microswitch	
6	zero-ohm resistor links	*marked with single black line*
2	polythene wheels	*slides onto motor shaft*
2	rubber bands	*for use as tyres on wheels*
2	rubber feet	*stick to bottom of pcb as 'castors'*
14	M3 6mm screws	
10	M3 nut	

NOTE: This product is not a toy and should be kept away from small children due to small parts and sharp edges. Soldering is a hazardous activity and should be carried out under adult supervision in a well ventilated area.

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Assembly Instructions

Tools Required: Soldering iron and solder
Wire cutters or side cutters
Small cross-head screwdriver

Refer to the diagram and component table on page 1.

1. Using a zero-ohm resistor, connect *either* LK1, LK2 or LK3 (do not connect more than one). Use LK1 to connect to PIC pin RA2, LK2 to connect the piezo sounder to PIC pin RA4 (e.g. for the 'Chip Factory') or LK3 to connect the piezo sounder to PIC pin RB0 (e.g. for PICAXE or 'PIC-Logicator'). Retain the resistor off-cuts for later use.
2. Lay the two gearboxes in position. Ensure the circular dot indentation (in the plastic next to one of the contacts) on the back of the motors are both facing inwards. If one or both of the dots is facing outwards loosen the motor support screws and turn the motor(s) through 180 degrees. This is important - the buggy will not respond as expected if the dots are not facing inwards!
3. Pass M3 bolts up through the pcb and gearboxes. Tighten into position with M3 nuts. Ensure both gearboxes are 'square' to the pcb.
4. Use four zero-ohm resistors to join the motor contacts to the pcb. Retain the resistor off-cuts for later use.
5. Pass four M3 screws up through the holes at the front corners of the pcb and screw the microswitches into position (on top of the pcb). The screws are tightened directly into the plastic switch housing. The left-hand side is harder to start and it may be useful to slightly open up the holes before commencing (the holes through the switch are conical so that it can be easily removed from the injection moulding machine during manufacture.) Use a pair of pliers to bend the ends of the 2 microswitch levers as shown in the diagram on page 1.
6. Using wire off-cuts from the resistor legs, solder the microswitch contacts to the pcb.
7. Use the additional nuts and bolts to secure the battery boxes in position.
8. Carefully push the two wheels onto the gearbox shafts, using a gentle turning motion. Take care to ensure the wheels are square on the shaft. Also ensure the wheels are the same distance from the pcb on each side.
9. If available, lubricate the gears with grease or petroleum jelly (e.g. 'Vaseline').
10. Place the rubber band 'tyres' onto the wheels.
11. Stick the two self-adhesive feet in a central position at the front and back of the pcb to form 'castors'.

Insert four AA batteries (not supplied) and then switch the buggy on using the slide switch.

CHIP FACTORY USERS- Note that because of the different way the Chip Factory generates sounds, it is necessary to solder a 1k resistor (not supplied) across the two piezo sounder contacts on the bottom of the pcb in order to generate sounds when using this system (in addition to LK2 from step 1).

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Initial Testing

The reprogrammable PIC16F627 microcontroller supplied is pre-programmed to make the buggy move forward until either switch is hit. It then reverses, spins and moves off in another direction.

If the buggy fails to operate check:

- All solder joints are good, and there are no accidental solder bridges.
- All polarised components, including the two chips, are correctly inserted.
- The batteries are correctly inserted.
- The PIC16F627 is programmed correctly.

If the buggy moves incorrectly, or veers to one side, check:

- All solder joints are good, and there are no accidental solder bridges.
- The red dots on the rear of the two motors are both facing inwards.
- The gearboxes rotate freely.
- The gearboxes are both square on the pcb.
- The worm gear is correctly located on the motor shaft.
- The wheels are square and equal distance from the pcb on each side.

Input/Output Configuration

Microswitch A	- RA0	- Input 0	The spare microcontroller input /
Microswitch B	- RA1	- Input 1	output pins are connected to pads
Piezo via LK1	- RA2		above the microcontroller IC. This
Piezo via LK2	- RA4		enables connection of additional
Piezo via LK3	- RB0		input sensors or output devices as
LED A	- RB1	- Output 1	desired.
LED B	- RB2	- Output 2	
Motor A	- RB4/5	- Output 4/5	
Motor B	- RB6/7	- Output 6/7	

Movement

	Switch on (high)	Switch off (low)
Forwards	4 and 6	5 and 7
Reverse	5 and 7	4 and 6
Spin <	4 and 7	5 and 6
Spin >	5 and 6	4 and 7

Other Notes

- The ICs may be damaged if any power supply other than 6V DC (centre +ve) is applied to the power socket. The power socket automatically 'over-rides' the on-board batteries.
- The L293D motor driver IC is designed to run warm in use - this is normal.
- Alkaline AA cells are recommended for this application.
- If using a PIC16F84A chip, a 4MHz 3 pin ceramic resonator must be soldered to the board in position X1.

Safety

This product is designed as an educational teaching aid. It is not a toy and should not be handled by young children due to sharp edges and small parts. THIS PRODUCT IS NOT A TOY.

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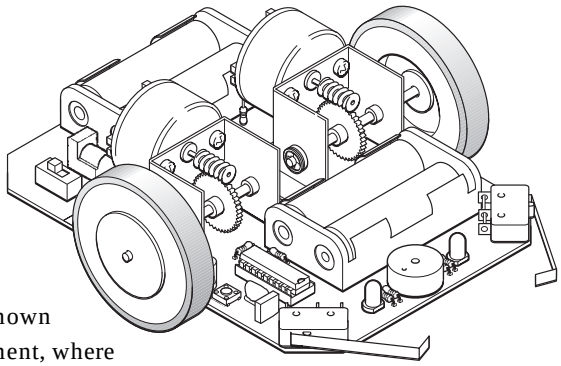
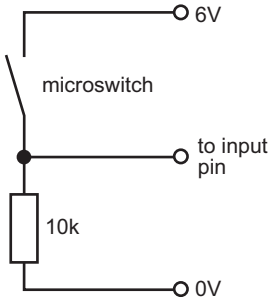
PIC ROBOT BUGGY



The PIC Robot Buggy has been designed to aid and encourage investigations into the use of PIC microcontrollers.

Microswitch 'Bumpers'

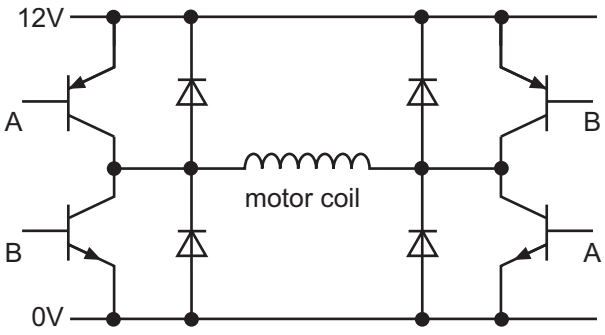
The two micro-switches are connected as shown below. This is the standard switch arrangement, where a 10k pull-down resistor keeps the input in a 'low' condition until the switch is pushed. When the switch is pushed the input changes to the 'high' condition.

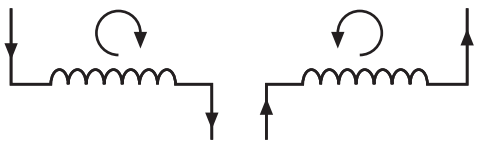


Controlling the Motors

The motors could be interfaced via Darlington transistors, FETs or relays, but a much neater solution is to use an H bridge driver from the L293D motor driver integrated circuit.

The following diagram shows how the H bridge works. When the transistors labelled **'A'** are switched on, current flows through the motor in one direction. When the transistors labelled **'B'** are switched on current flows in the other direction, so that the motor spins in reverse. Naturally it is important not to switch both sets of transistors on at the same time, as this would create a short-circuit between the power rails! The L293D provides all the circuitry required to control two motors in this manner, and also prevents the short circuit condition.





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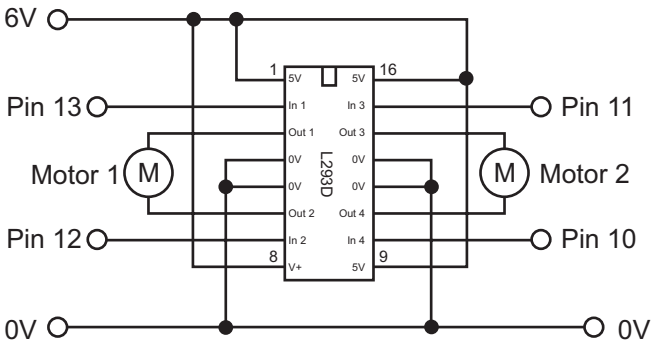
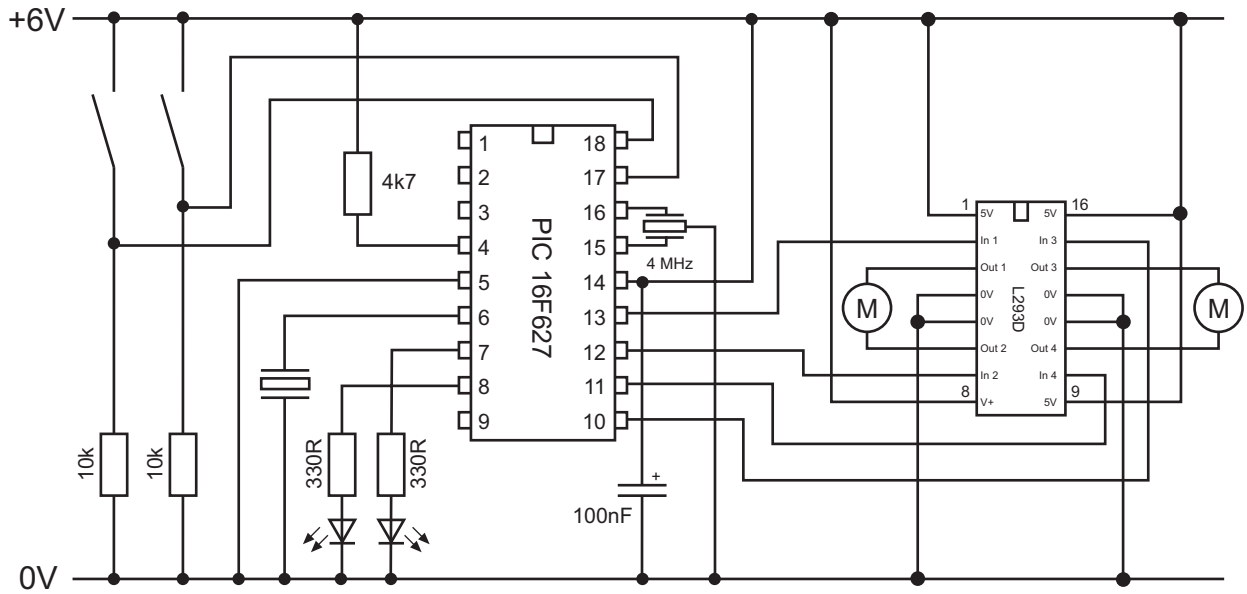
The diagram below shows the full circuit diagram for the L293D motor driver.



The microcontroller pins can drive the two LED 'eyes' and piezo transducer directly. A piezo is much preferable to a buzzer as it can be used to generate a number of different tones, and also draws much less current than the buzzer.

Full Circuit Diagram

The full circuit diagram is shown below. The only extra here is a 4k7 pull-up resistor to disable the microcontroller 'RESET' pin. A three-pin 4MHz ceramic resonator (outer legs connected to pins 15, 16, centre leg to 0V) is used to set the microcontroller clock frequency (older PIC16F84A only).



(Note: the resonator is not required for the PIC16F627)

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Programming The Robot Buggy

The circuit diagram gives the following input/output pin arrangement:

I/O	PIC16F84A Pin	Function
Input 0	RA0 pin 17	Microswitch
Input 1	RA1 pin 18	Microswitch
Output 0	RB0 pin 6	Piezo sounder
Output 1	RB1 pin 7	LED 'Eye'
Output 2	RB2 pin 8	LED 'Eye'
Outputs 4/5	RB4-5 pins 10-11	Motor A
Outputs 6/7	RB6-7 pins 12-13	Motor B

A first simple procedure may involve the following sequence:

"Move forward until a microswitch is hit. When the switch is hit move backwards for two seconds, spin for one second and then move off forwards in the new direction."

When analysed this procedure has three main parts:

1. *Move forwards.*
   To do this we must set output pins 4 and 6 high so that both the L293D motor driver spins both motors forwards.

2. *Wait until a microswitch is hit.*
   To do this we must keep checking inputs 0 and 1 until they switch high.

3. *Reverse/Turn Sequence.*
   To reverse outputs 5 and 7 must be set high for 2 seconds. Then outputs 5 and 6 must be set high so the buggy spins for 1 second. Then the program should jump back to step 1, so that the buggy starts moving forwards again.

Chip Factory Program

```
(Mode 18-PIC16F84A)
00    high   4
01    high   6
02    if 0 on goto  06
03    if 1 on goto  06
04    goto  02
05
06    low    4
07    low    6
08    high   5
09    high   7
10    wait 020
11    low    7
12    high   6
13    wait 010
14    low    5
15    low    6
16    goto  00
```

```
(Mode 18L-PIC16F627)
00    high   4                ' Both motors forward
01    high   6
02    if a>100 goto  06       ' Test for bumper 0
03    if b>100 goto  06       ' Test for bumper 1
04    goto  02                ' No bumper so loop
05
06    low    4                ' Stop motors
07    low    6
08    high   5                ' Both motors back
09    high   7
10    wait 020                ' Wait 2 seconds
11    low    7                ' Turn buggy by spinning
12    high   6
13    wait 010                ' Wait 1 second
14    low    5                ' Stop motors
15    low    6
16    goto  00                ' Back to start
```


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Buggy Test Program For PICAXE18 microcontroller

```
'start going forwards
'testing switches as you go

main:
      let pins = %01010000
      if pin0 = 1 then left
      if pin1 = 1 then right
      goto main

'left switch hit
'so stop, light LED, beep, reverse, turn

left:
      let pins =%00000100
      sound 0,(100,150)
      let pins =%10100100
      pause 2000
      let pins =%10010100
      pause 1500
      goto main

'right switch hit
'so stop, light LED, beep, reverse, turn other way

right:
      let pins =%00000010
      sound 0,(50,150)
      let pins =%10100010
      pause 2000
      let pins =%01100010
      pause 1500
      goto main
```


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