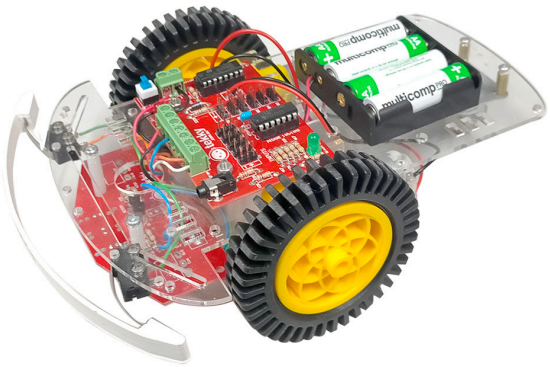

The Line Tracker/Bump Buggy Kit is supplied with two PCB's, a Project Board PC9138 using a PICAXE 14M2 microprocessor and a L293D dual motor driver chip. The 2nd PCB PC9138S is supplied as a sensor PCB which has both Infrared (Line Tracking) and Microswitches (Bump Sensing) capabilities.

Figure 1. Assembled Buggy

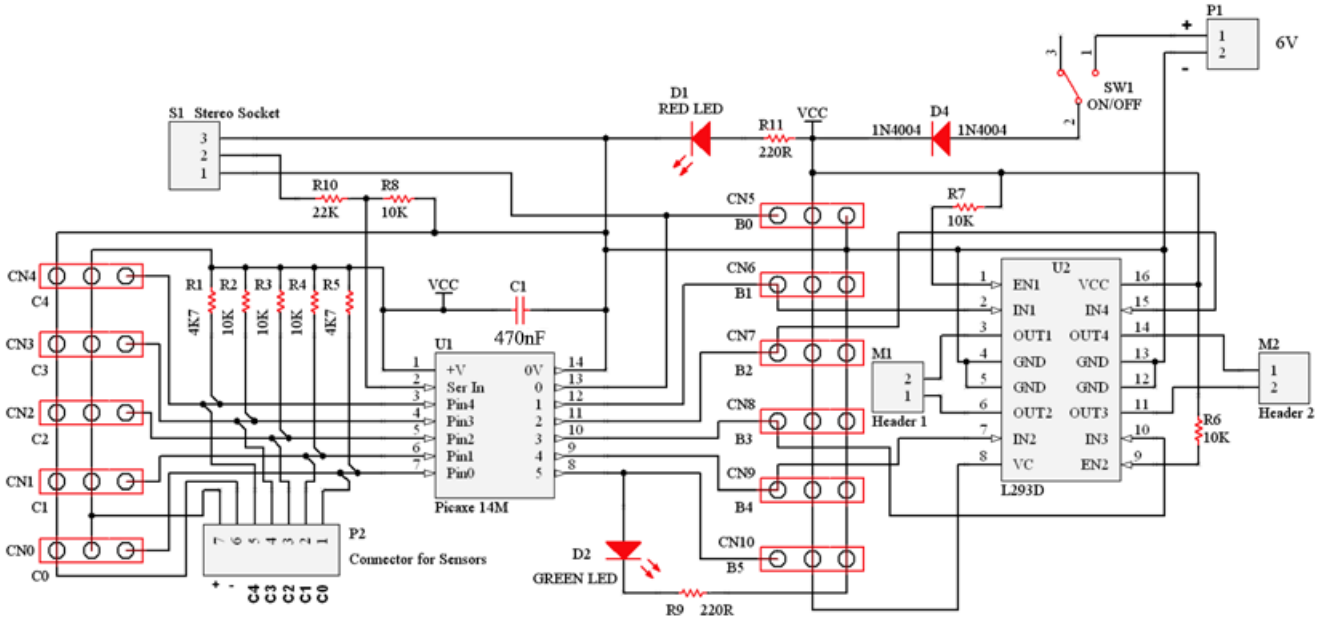

Figure 2. Circuit Diagram - Main PCB (PC9138)

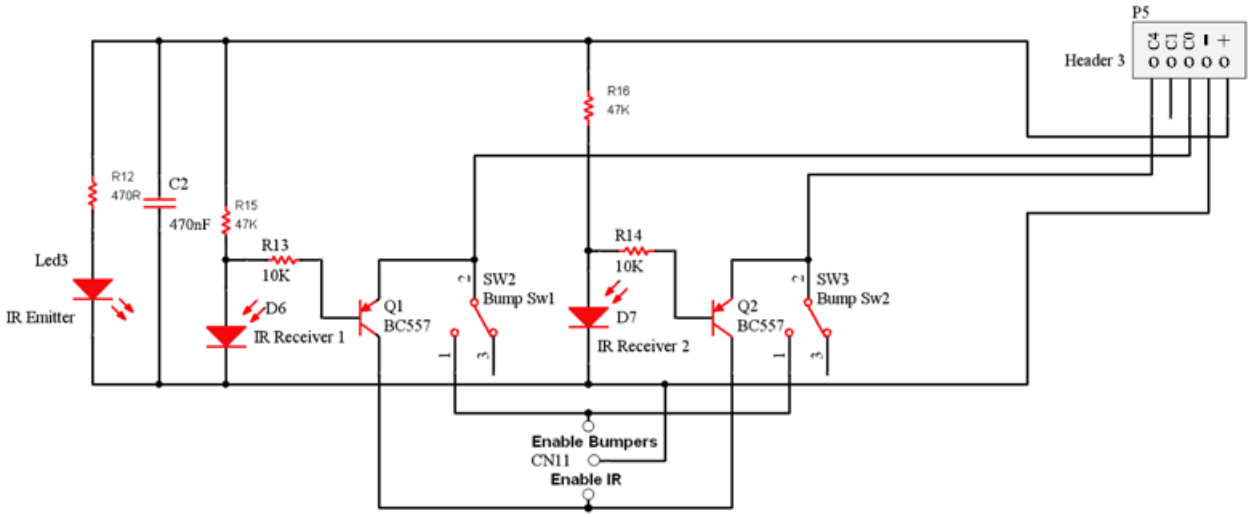

Figure 3. Circuit Diagram - Sensor PCB (PC9138S)

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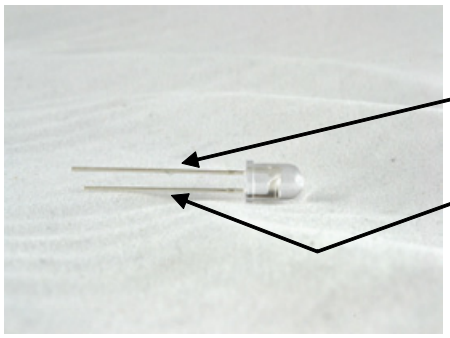

Figure 4. CQY89A

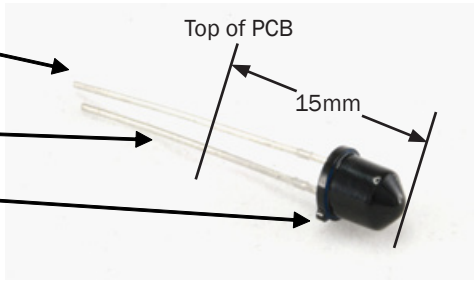

Figure 5. QSD723

COMPONENT LIST

Qty	Part No.	Description	Designator
1	LED-5MM/G	5mm Green Led	D2
1	LED-5MM/R	5mm Red Led	D1
1	SW1845	DPDT PUSH ON-OFF PCB SWITCH	SW1
1	P-AXE017M2	Picaxe 14M2	U1
1	CQY89A	INFRARED 5MM LED WATERCLEAR(Sensor PCB)	IR TX
1	CN2402	SCJ-C JUMPER CLOSED TOP(Sensor PCB)	JP1
1	CN2240	TB53 3 WAY PCB CONN 5mm L.S.	P4
1	L293D	L293D Motor Driver Chip	U2
1	RS1445	470R CR25 CARB RESISTOR	R12
1	RS1645	22K CR25 CARB RESISTOR	R10
1	IC1014	14Pin Dual Wipe IC Socket	U1 Socket
1	IC1016	16Pin Dual Wipe IC Socket	U2 Socket
1	452-0100	5 Pin Sub Miniature Male Polarised Header(Sensor PCB)	P5
1	PL6114	SOCKT 3.5MM STEREO PCB MINI (Program)	S1
1	1N4004	1N4004 Rectifier Diode	D4
2	BC557	BC557 PNP Transistor	Q1,Q2
2	QSD723	IR 5MM DETECTOR(Sensor PCB)	RX1, RX2
2	RS1405	220R CR25 CARB RESISTOR	R9, R11
2	RS1565	4K7 CR25 CARB RESISTOR	R1, R5
2	RS1685	47K CR25 CARB RESISTOR	R15, R16
2	CC0049	470nF 50V Ceramic	C1,C2
3	CN2238	TB52 2 WAY PCB CONN.5mm L.S.	P1,P2,P3
8	RS1605	10K CR25 CARB RESISTOR	R2-R4,R6,R7,R8,R13,R14
1	CN2515	40way	C0-C4,B0-B5,Input Select
		Bag 2	
1	R02815	2WD Motor on Smart Chassis c/w items listed below	
		2 by Wheels	
		4 by 3mm Bolt Pan Phillips x 30mm for motors	
		2 by 3mm Bolt Csk Phillips x 8mm for Battery holder	
		6 by 3mm Nuts	
		4 by 3mm tapped 12mm spacer for castor Wheel	
		8 by 3mm Bolt pan Phillips x 8mm for Castor Wheel	
		Bag 3	
1	PC9138	Main Picaxe Pcb	PCB1
1	PC9138S	Sensor Pcb	PCB2
1	Instruction	KI2138DC1v1 Instruction sheet (4Pages Double sided)	
1	452-0200	5 Way Loom	Loom1
2	SW6038	Ultra Mini Micro Switch(bend Lever as per Instruction)	SW2, SW3
3	HA0062	3mm untapped 6mm long Round Metal spacer	Picaxe PCB Hardware
3	HA3148	3mm R/H Bolt x 15mm	Picaxe PCB Hardware
5	HAM3-0010	3mm Nuts	Picaxe PCB and Sensor Pcb Hardware

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COMPONENT LIST

Qty	Part No.	Description	Designator
1	452PN2-0200	Bumper for Buggy	
1	452PN2-0300	150mm CB0100	(M1 Wire Stripe to M1)
1	452PN2-0400	130mm CB0100	(M2 Wire Stripe to M2)
2	HA0042	3mm untapped 20mm long Round Nylon spacer	Sensor PCB Hardware
2	452PN2-0900	3mm Bolt Pan Phillips x 30mm	Sensor PCB Hardware
2	452PN2-0500	2 by 100mm CB0100	Left and Right Microswitch wire
4	HAM2.5-0015	2.5mm x 12mm Pan Phillips	Microswitch Hardware
4	HAM2.5-0025	2.5mm Nuts	Microswitch Hardware

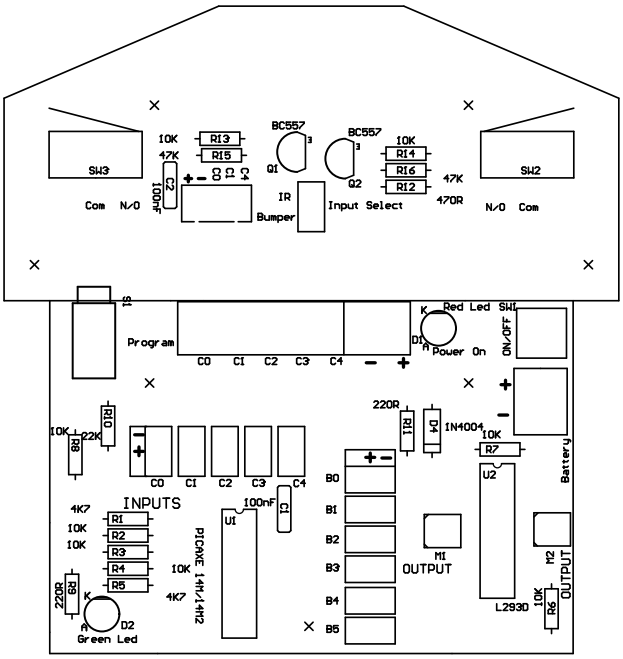


Figure 6. Top Overlay Project and Sensor PCB's

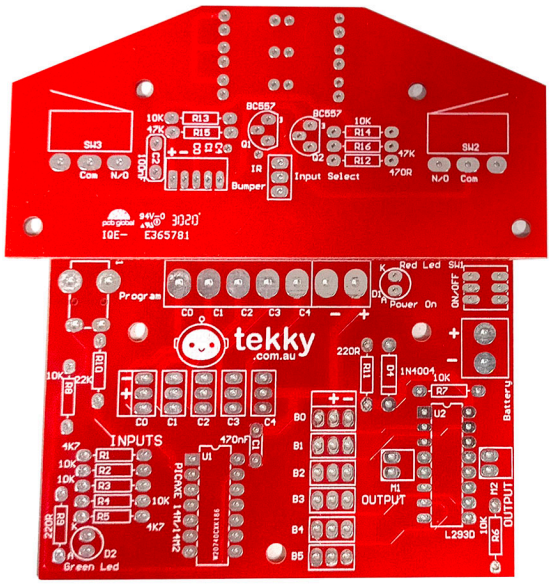


Figure 7. Project and Sensor PCB's

Construction of Project and Sensor PCB's

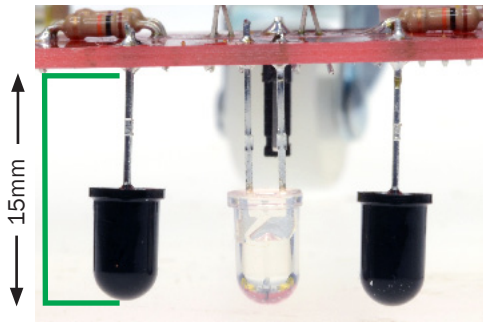
Insert components and solder in this order.

1. Place and solder the resistors on the board R1 – R16
2. Place and solder the diode D4 (Note polarity Cathode is the end with the printed band)
3. Place and solder the IC sockets U1 Socket & U2 Socket (Note polarity, they have a Notch in one end)
4. Place and solder the transistors Q1,Q2 (Note polarity insert with Flat side to Flat on PCB Overlay)
5. Place and solder the Red and Green Leds D1, D2 (Note polarity insert with Short Leg Cathode to K on Overlay and Long Leg Anode to A on Overlay)
6. Place and solder the 3 way Header Pins for Inputs and Out-puts (C0-C4,B0-B5,Input Select). Snap 12 X 3 pin from 40 way CN2515 Header Pin blocks
7. Place and solder the 470nF capacitors (C1, C2) NO Polarity
8. Place and solder the 7way Input Terminal Block (+,-,C4,C3,C2,C1,C0)(clip 2 x CN2238 and 1x CN2240 together first) (Note which way Terminals end up facing)
9. Place and solder the 2 way Battery Terminal Block CN2238 (Note direction it faces)
10. Place and solder ON/OFF Switch SW1 and Program Socket S1
12. The IR Sensors are mounted underneath the Sensor PCB (PC9138S) with tip of body sitting approx. 15mm from PCB. (See Figure 8)
13. Place and solder the Clear Transmitting IR Led, IR TX (Note polarity see Figure 4.) Long leg to A, Short leg to K.
14. Place and solder Darker IR Receiving Diodes, RX1 and RX2 (Note polarity see Figure 5.) Long leg to A, Short leg to K.

NOTE: If leads have already been cut and you are unsure of Polarity you can still tell the difference between Cathode and Anode. On the CQY89A the Cathode lead "K" is the one connected to the larger piece of metal inside the Clear Plastic body as in Figure 8. On the QSD723 the Cathode lead "K" is the one closest to the tab sticking out on Dark Plastic body as in Figure 5. If there is no "tab" the Cathode "K" will be towards Flat on Body.

15. Fit & solder 452PN2-0500 100mm CB0100 Fig 8 Microswitch wires used for Bumper SW2 and SW3 to PCB (See Pic 12)
16. Fit & solder 452PN2-0300 150mm CB0100 Fig. 8 wire to PCB M1 Output with Black Stripe to M1 Marking Side - see pics 6, 7 & 8
17. Fit & solder 452PN2-0400 130mm CB0100 Fig 8 wire to PCB M2 output with Black Stripe to M2 marking side - see pics 6, 7 & 8

DO NOT Fit IC's U1 and U2 into Sockets at this stage.



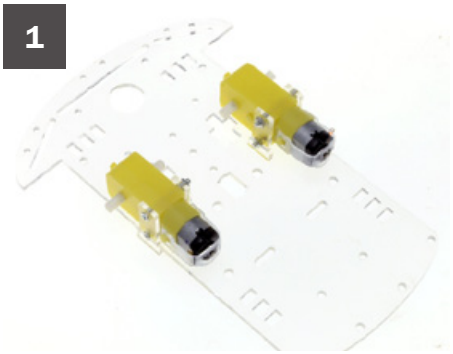
The Main Project PCB needs to have Nylon Nuts inserted underneath between PCB and Plastic Posts on Chassis to raise PCB and avoid fouling Motor and Wheels.

For IR option it is necessary to fit JP1 the closed 2 way header to IR side of Input Select 3 way header on Sensor PCB (PC9138S).

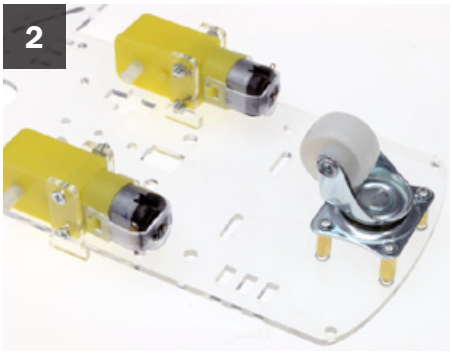
Set height from top of LED to PCB to approx 15mm.

Figure 8. IR Sensor Mounting on underside of sensor PCB

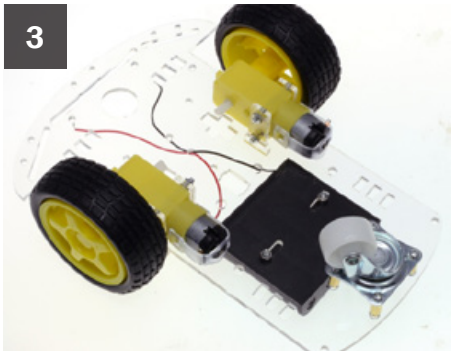
Assembly
Images: Refer to construction instructions 1 to 17.



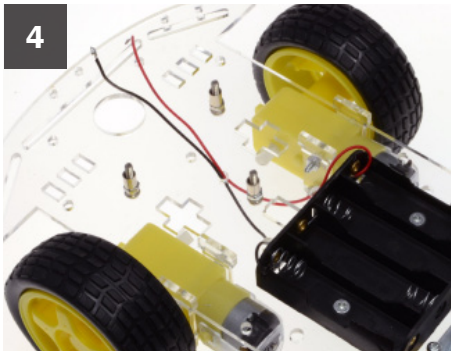
Attach motors to buggy chassis.



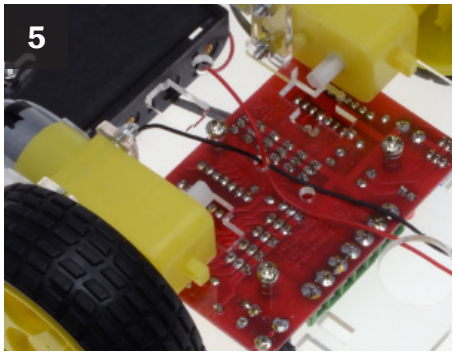
Attach rear wheel to chassis with spacers, nuts and screws.



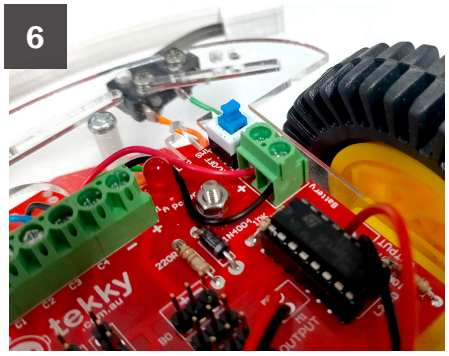
Fix battery holder to chassis. Battery wire has 2-way plug which needs to be removed.



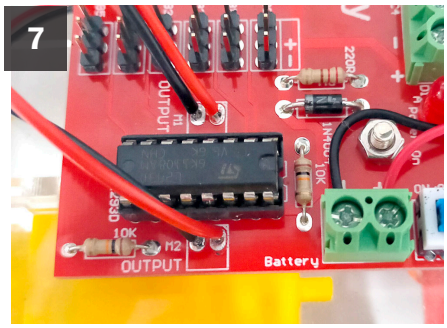
Red and Black wires must be stripped 5mm and twisted. Thread the battery holder wires through the holes in the chassis as shown.



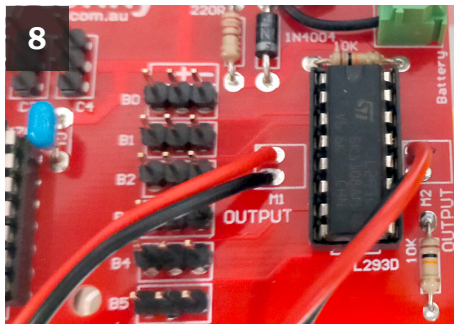
Attach main PCB to chassis using 3 X HA0062 6mm spacers as pictured in Pic 4 & 5.



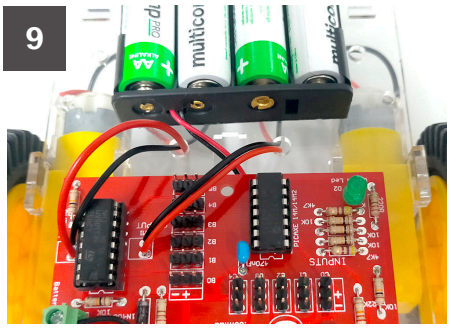
Insert Black wire into Negative & Red wire into Positive on Battery Terminal Block.



The 2 motors need to be wired to PCB stripe to M1 & M2. Stripe position on motor is opposite on either side.



Close up of motor wires soldered to main PCB.



Thread motor wires through chassis like so.

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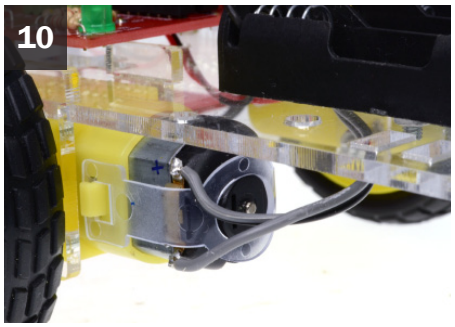
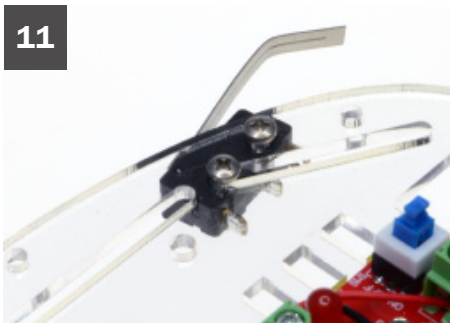
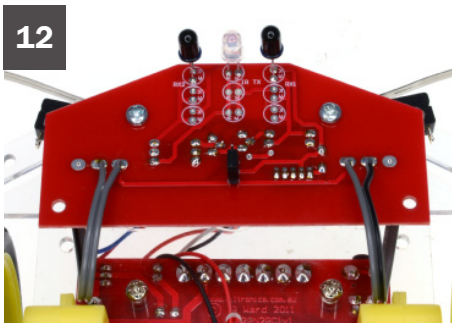


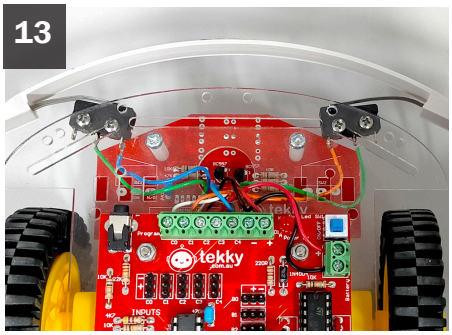
Solder motor wires to motor as shown.



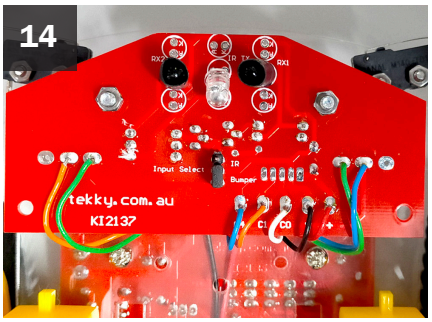
Place microswitches and bend actuating lever as shown.



Attach sensor board to chassis and solder wires to the left & right microswitches.



The bare wired end of the 5-way loom may then be wired into 7-way Input Terminal Block (+,–, C4, C3, C2, C1, C0), Red into +, Black into –, White to C0, Orange to C1, Blue to C4. The other end of 5 way loom



The other end of 5 way loom will then need to be soldered to pads on Sensor PCB.

Slot bumper on to microswitches as shown.

Preliminary Testing of Circuit Boards
We are now ready to insert four AA Batteries (Not Supplied) into the battery holder, take care they are inserted correct polarity. Polarity is indicated inside Battery Holder; make sure the battery contacts make good contact with the batteries, if required bend the –ve battery contact inwards slightly. Check that the batteries are in good condition before insertion. If the ON/OFF switch is already in ON position, the red LED should light when last battery is inserted; if switch not ON push to bring LED ON. This will indicate power getting to circuit board correctly; if switch was ON push to make sure it will turn OFF correctly. If red LED cannot be made to go ON and OFF with SW1 operation, refer to Fault Finding on Page 8.

At this stage it is also possible to check IR operation; this can be done even without IC's inserted as a quick check of partial operation prior to programming. The IR Transmitting Diode may be simply checked with a mobile phone camera when the PCB is switched on by pushing SW1; when D1 red LED comes ON you should see a bright light coming from IR Transmitting Diode when looking at it with camera. If this does not happen refer to Fault Finding on Page 8.

After confirming IR Transmitting Diode is working the IR Receiving Diodes can be checked by monitoring Anode of RX1, then Anode of RX2 with a DC Multimeter set to measure DC Voltage of 6V, connect black lead of meter to Battery Negative and Positive Lead of meter to respective Anode as mentioned previously. Turn the board ON again by pushing S1, D1 red LED should come ON, the voltage indicated on meter should be 3V–6V and fall when IR reflected into respective IR Receiver. This can be achieved by moving the Transmitter and Receivers from over dark surface to bright surface i.e. black piece of paper to white piece of paper. The white piece should reflect more IR from transmitter into Receiver and cause voltage to drop. If this does not happen refer to Fault Finding on Page 8.

Fitting the 2 X IC's: PICAXE 14M & motor driver L293D
After checking all above make sure Buggy is switched OFF, fit the two IC's U1 and U2, ensuring correct Polarity and Static Control are adhered to.

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Programming

Before you begin you will need to go to **www.picaxe.co.uk** and download the FREE PICAXE Programming software, data sheets and tutorials onto a suitable PC. After familiarizing yourself with this software you will then need to enter in one of the following two programs. Before entering check that the header/jumper on the Sensor PCB (PC9138S) matches the program you are going to enter. If you are going to enter the Bump Buggy Program then set Input Select Header to Bumper. If you enter the Line Track Program then set Input Select Header to IR.

Once entered SAVE this program to your PC for future use, you will probably end up entering both eventually so make sure they are saved to prevent having to re-enter them.

Once this is done you will be able to load the program you have selected into the PICAXE® Device on the Buggy with Serial or USB Program Lead via Programming Socket. (Both these are available from Wiltronics Research Pty. Ltd)

The Serial Lead is Part No. P-AXE026 and the USB Lead is Part No. P-AXE027.

Bump Buggy Program

```
'Bump Buggy

'pin0 is RH Bump switch SW2, active 'lo'
'pin4 is LH Bump switch SW3, active 'lo'
'Header Link away from IR LEDs

mainloop:

if pin0=1 and pin4=1 then
    gosub forwards 'no hit
    pause 60
endif

if pin0=0 and pin4=1 then
          'right bumper hit
          gosub backwards
          pause 120
    gosub turnRight
    pause 100
endif

if pin0=1 and pin4=0 then
          'left bumper hit
          gosub backwards
          pause 120
    gosub turnLeft
    pause 100
endif

if pin0=0 and pin4=0 then
          'head on impact, both bumpers
    high 5
    gosub backwards
    pause 200
    random w0 'b0 & b1 = 16bits
    if b0 > 127 then
          gosub turnRight
          else
          gosub turnLeft
    endif
    pause 200
    low 5
endif

goto mainloop

'standard direction routines
forwards: 'RH & LH forwards
    high 1
    high 3
    low 4 'direction change
    low 2
return

backwards: 'RH & LH backwards
    high 4
    high 2
    low 1 'direction change
    low 3
return

turnLeft: 'RH forwards, LH backwards
    high 1
    high 2
    low 4 'direction change
    low 3
return

turnRight: 'RH backwards, RH forwards
    high 4
    high 3
    low 1 'direction change
    low 2
return

brake: 'RH & LH stopped
    high 1
    high 3
    high 2
    high 4
    pause 10
return
```


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Line Tracker Program

```
'Line following Buggy

'Use 30mm lines in MS-Word to
'draw black lines for track,
'1-2 curves per A4 laser print,
'tape together to make track.
'(Don't use Inkjet printer or pens)
'NB: Jumper link closest to IR LEDs

symbol level = 160 '~mid way?
'check the analogue readings
'eg 250~black and 60~white
'Note this is the inverse
'High IR reflected gives low number
'Low IR reflected gives high number

mainloop:
readadc 4,b4 'right eye reading
readadc 0,b0 'left eye reading
low 5 'Turn off Green LED

'both Sides Low-IR (on track)
if b0 > level AND b4 >level then
    gosub forwards
    pause 10
    gosub brake
endif

'both Sides High-IR (Lost!!)
if b0 < level AND b4 <level then
          high 5 'light up "Help me LED"
    gosub forwards
    pause 10
    gosub brake
endif

'Error: Off track, adjust to left
if b0 < level AND b4 > level then
          'Calculate error and turn
          b4 = 256-b4
          b4=b4/3
    gosub turnLeft
    pause b4 'proportional to error
endif

'Error: Off track, adjust to right
if b0 > level AND b4 < level then
          'Calculate error and turn
          b0 = 256-b0
          b0 = b0/3
    gosub turnRight
    pause b0 'proportional to error
endif

goto mainloop

'standard direction routines
forwards: 'RH & LH forwards
    high 1
    high 3
    'pause 10
    low 4 'direction change
    low 2
return

backwards: 'RH & LH backwards
    high 4
    high 2
    'pause 10
    low 1 'direction change
    low 3
return

turnLeft: 'RH forwards, LH backwards
    high 1
    high 2
    'pause 10
    low 4 'direction change
    low 3
return

turnRight: 'RH backwards, RH forwards
    high 4
    high 3
    'pause 10
    low 1 'direction change
    low 2
return

brake: 'RH & LH stopped
    high 1
    high 3
    high 2
    high 4
    pause 10
return
```

NOTE: When using the Buggy as a Line Tracker, the detectors (two darker IR LEDs) will work even more effectively if shrouded with a short length of black or dark-coloured plastic tube i.e. 14mm long. The emitter puts a broad cone of light down, the shrouds over receivers reduce the effect of incidental sideways light and ambient light. This makes the level change greater when a boundary is detected. Use indoors away from direct sunlight.

Fault Finding:

- Check all Components are correctly inserted correct position with correct polarity if needed.
- Check that there are no soldering defects i.e. shorts or not quite soldered properly
- Recheck batteries are inserted correctly and are in good condition i.e. NOT flat

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Additional Note:

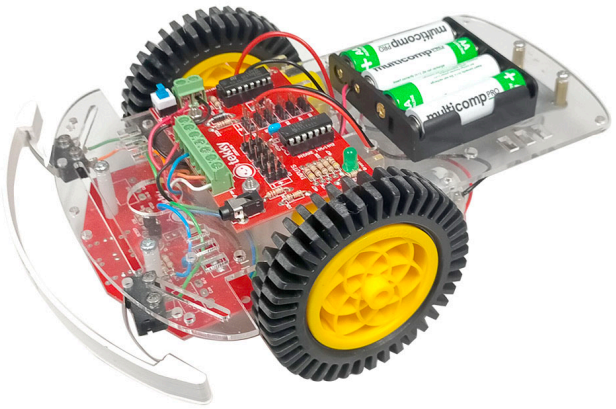
As you have purchased The Wiltronics Research Line Tracker / Bump Buggy Kit and may want to get more from it, we can recommend our Buggy Extensions CDROM with ten experiments fully documented, including detailed descriptions of the previous two programs. See below for more details.

Line Tracker/Bump Buggy Kit using PICAXE 14M2

This low cost kit, designed using the PICAXE 14M2 microprocessor has it all. Set up on a RoboBlock base with dual motors and gearboxes the base has built in battery holders. The kit is supplied with a Project Board using a PICAXE 14M2 microprocessor and a L293D dual motor driver chip. A 2nd PCB is supplied as a sensor PCB which has both a Infrared (IR) LED/ Photo Transistor set for Line Tracking and 2 x Microswitches for Bump sensing. The Buggy Kit is available in 2 different formats. A full kit is supplied at component level and requires PCB assembly including soldering (KI2138). Alternatively the (KI2138ASM) version is supplied with fully assembled & tested PCB's and only requires a screw driver for assembly. Changing the Buggy from a Line Tracker to a Bump Buggy is done by shifting the 2 Pin Jumper Plug. Assembly instructions include sample PICAXE 14M2 programming for both the line tracking and bump buggy applications.

The buggy takes 4 x AA batteries (not included). Programs are downloaded into the PICAXE 14M2 chip via a AXE027 USB cable which is available separately.

PICAXE Programming software, data sheets and tutorials are available as a FREE DOWNLOAD from www.picaxe.co.uk



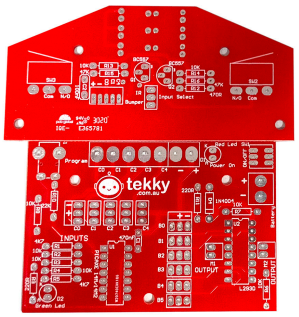
Cat No	
KI2138	BUGGY KIT using PICAXE 14M2 (Soldering Required)

Project Board to suit PICAXE 14M2

This project board was designed as the PICAXE 14M2 motherboard for our Line Tracker/Bump Buggy Kit. However as a Project Board it can be applied to many other uses, and it makes available most of the features of the PICAXE 14M2.

The PCB is configured with a L293D dual motor driver IC and a Green LED driven from Output 5, all inputs and outputs are available on standard 3 pin "Servo" Style connectors. This project board is a great basis for many applications. The kit is supplied with a 4 x AAA battery holder (batteries not included). Programs are downloaded into the PICAXE 14M2 chip via an AXE027 USB cable which is available separately.

PICAXE Programming software, data sheets and tutorials are available as a FREE DOWNLOAD from **www.picaxe.co.uk**
The Project Board is available as kit of components (KI5125) or Fully Assembled & Tested (No Soldering Required) (KI1125ASM).



Cat No	
KI5125	Project Board Kit (PICAXE 14M2) (Soldering Required)

Also Available:

Line Tracker/Bump Buggy Workbook – Using Picaxe 14M2 (On CD)

The Workbook (on CD) is designed for teachers and students as an extension of the KI2138 Line Tracker/Bump Buggy Kit and contains curriculum support material including an additional 10 experiments with sample programming, using the KI2138 Buggy Kit. It also includes other projects based around the KI5125 Project Board and the KI2138 Buggy Kit.

(Note: This Workbook is ©Copyright 2011-Rob Ward – The copyright owner authorises the printing of this material for educational use only within the schools that purchase the CD).

Cat No	
KI2139	LineTracker/Bump Buggy Workbook - Using PICAXE 14M2 - $29.95

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