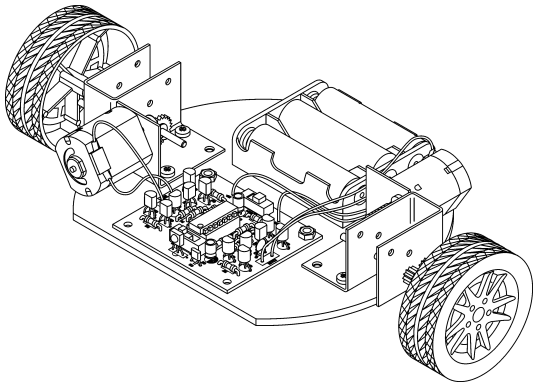
The JOUSTER

CONTENTS:

Section 1: General and Planning information
Section 2: Components and Material required
Section 3: Control Unit assembly and wiring
Section 4 The Transmitter control
Section 5: Making & assembling *JOUSTER*
Section 6: The Receiver and wiring
Section 7: Testing and Troubleshooting
Section 8: Possible applications

DESCRIPTION



The JOUSTER is a small agile vehicle that is controlled and steered by Infra-red remote control. There is a Receiver PCB assembly mounted on the vehicle and a Transmitter in a hand held control box. The *INFRA-RED CONTROL UNIT (IRCU)* can transmit on four (4) bands, which allows 4 *JOUSTERs* to be operated at the same time, by selecting one of the 4 bands.

The JOUSTER has two independent motor driven gearboxes, each driving one wheel. The remote control unit controls the vehicle through the use of push button switches – for each motor there are 2 push button switches, one to apply forward and the other to apply reverse motions. If both forward motion buttons are pushed simultaneously the vehicle travels forward in a straight line. However, if one forward push button switch and one reverse switch are pushed, the vehicle turns on the spot!

The Infra red controls are for indoor use only – it is not suitable for outdoor use. It requires line-of-sight and can operate up to a distance of approximately 20 metres.

SECTION 1: GENERAL AND PLANNING INFORMATION

THE PROJECT

The major aspects of this project are the planning, design, construction, assembly and evaluation stages – key competencies or requirements under the VELS and other educational programs.

DESIGN STAGE

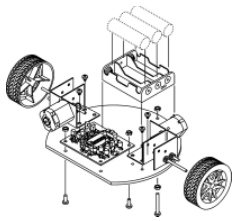
The drawings in this unit show the construction of our prototype *JOUSTER*.
NOTE: *The JOUSTER's* teaching unit should be used in conjunction with the *INFRA-RED CONTROL UNIT -4 Band (IRCU)* teaching unit – it has additional required information about the electronic components, that make up the control unit, as well as installation instructions for the Transmitter and Receiver – if required.

The design stage is crucial. At this stage the shape of the vehicle, as well as the locations of all the components must be worked out - the designer must look at the vehicle as a complete unit - not just as a collection of separate parts. For information to help with design, please read the entire unit first for ideas – as many sections have useful information

DESIGN ELEMENTS

The following points are given as pointers to be taken into consideration during planning.

1.1 DESIGN OF THE VEHICLE'S PLATFORM



As there are many possible different shapes, it is suggested that the class decide as a group, if they wish to participate in any competition or competitions with the completed *The JOUSTERs*. For example, at the end of this unit are some ideas for such sports as the "Balloon Buster" or "Soccer Player" options – refer the section on Possible Applications.

- *The JOUSTER* consists of a platform / chassis on which the components are mounted. Before starting, the component location needs to be carefully planned and laid out. For best functionality of the vehicle, the designer must look at the vehicle as a complete unit - not just as a collection of separate parts. The exploded view shows the overall design of our prototype vehicle, although each designer has scope for originality and innovation in their design.
- When designing the platform, the size of the Receiver, battery holder and the gear box / motor assemblies must be taken into consideration.
- When designing the platform, take care that the Infrared Receiver is not hidden – it works by "line-of-sight" from the Transmitter (the same as a TV remote).
- A small bolt may also be used for a rear support (balancing peg), if desired (for details refer the exploded diagram). Is this required? Or is the device stable enough without the rear support?
- For the prototype vehicle 3 mm Plywood was used. This material was chosen as it is easily cut, shaped, drilled and glued. Balsa wood, PVC, and acrylic are some other options (acrylics provide a choice of colours, but it is brittle).

1.2 THE TRANSMITTER CONTROL UNIT

- The control unit's design can take whatever shape is preferred. However, the student must design the unit to accommodate the Transmitter, switches and battery holder.
- The shape, at its most basic, would be either a square or a rectangle. However, you may wish to make it a smaller version of the vehicle itself.

SECTION 2: COMPONENTS & MATERIAL REQUIRED

2. COMPONENTS & MATERIAL REQUIRED

2.1 COMPONENTS SUPPLIED (IN THE KIT)

1 x	*INFRA-RED CONTROL UNIT* kit	4 x	3x5mm long wood screws
2 x	Jouster Gearbox / motor assemblies	1 x	M3 x 16mm long bolt
2 x	52 mm dia. Wheels	2 x	M3 Nut

NOTE: if you have the UN-assembled *INFRA-RED CONTROL UNIT* kit, you will need to refer to the *INFRA-RED CONTROL UNIT* teaching unit for the following:

- The list of Components supplied
- Assembly information
- Component identification

Note: if you don't have a copy of that unit, it can be downloaded from our website, or we can send it to you.

2.2 ADDITIONAL REQUIREMENTS

2.2.1 Available from us are 3.5mm diameter drill bits (for 3mm bolts), and if required, these need to be ordered seperately.

2.2.2 The additional requirements are: fine multistrand electric wire, 6x AA batteries (Alkaline batteries are recommended).
HINT: Multi-stranded wires are best, as single stranded wires break off after they have been bent a few of times. Use different colour wires. This makes it easier to follow wires for connecting items, and easier to trace wiring problems.

2.3 COMPONENTS TO BE MADE

In addition, a variety of materials are required to allow fabrication of all the Platform body and Control unit housing. For our prototype we used 3.0 mm thick PVC sheet for the platform, and 3mm plywood and 12mm wood for the Control unit.

Note: it is suggested that, before you commence construction, you check the components supplied in your kit, and ensure that you have everything else required as well.

2.4 TOOLS REQUIRED

The majority of tools required for construction of this vehicle are hand tools, eg. scroll and hand saws, a Stanley knife, small hammer, wire strippers. A Hot glue gun and hair dryer can be useful. In addition, a soldering iron is required.
Note: at various stages of construction, items need to be glued together (and sometimes removed and relocated!).

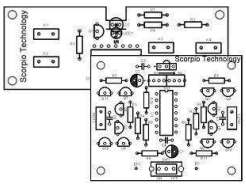
- We have found hot glue guns give good results, but extreme care needs to be exercised when using hot glue as it really burns if it gets on the skin.

HINT: It is useful to have a hair dryer available during construction work.

- Using the hair dryer on its hottest setting will allow students to heat up the hot glue to soften it, and will allow students to reposition or remove incorrectly positioned or faulty components.

SECTION 3: CONTROL UNIT ASSEMBLY AND WIRING

3.1 ASSEMBLING THE TRANSMITTER AND RECEIVER



If you have a set of un-assembled Transmitter and Receiver components, you will need to refer to the *INFRA-RED CONTROL UNIT – 4 Band* unit for instructions and component information.
NOTE: even if you have the assembled Transmitter and Receiver, there is useful component information in that unit.

3.2 GENERAL - WIRING UP THE TRANSMITTER AND RECEIVER

A number of parts need to be wired to the assembled Transmitter and Receiver.
The following instructions may need to be tailored to your individual *JOUSTER*.

3.2.1 THE WIRES

- When cutting wires, make them slightly longer than you need - but avoid making them too long, or the unit will look untidy.
- CONVENTION: It is best to follow standard wiring conventions for all battery connections: that is RED for POSITIVE and BLACK for NEGATIVE.

3.2.2 THINGS TO LOOK OUT FOR WHEN SOLDERING

- Switches should be clamped when connecting wires to them (a PCB holder is ideal). Alternatively a small vice or a pair of pliers, with an elastic band around the handles, may be suitable - but be careful not to damage the switch.

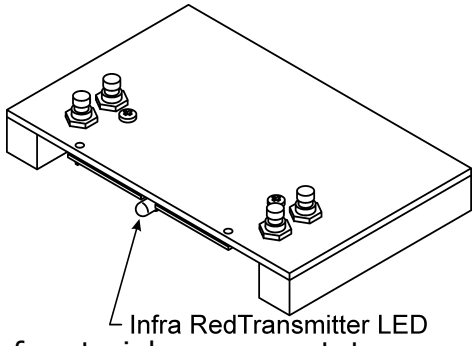
- When soldering wires to the switches, take care not to overheat the switch terminals (overheating could cause the plastic part of the switch to melt).
- If you experience solder blobs between the terminals, carry out the following: unclamp the switch and hold it upright. Heat the solder blob with the tip of the soldering iron until it melts. Then lower the soldering iron away from the switch (gravity should pull the solder away with the soldering iron). After that, very carefully re-solder the switches.

SECTION 4: THE TRANSMITTER

4.1 THE HAND HELD CONTROL UNIT (TRANSMITTER)

The hand held Transmitter control unit consists of the following components, installed in a housing:

- the Transmitter
- The Infrared transmitter LED
- the On-off switch
- one 3x AA Battery Holder
- the Band Selector switch (assembled to the PCB)
- the Push button switches (SW1 to SW4)



NOTE: The housing is not described in detail, as the appearance / size / shape plays no part in its function. The Housing can be made from a variety of materials – our prototype was made from timber.

Some things to note, when making the housing for the Transmitter:

- Drill 7 mm holes for mounting the 4 push-button switches.
- Sides on the Control unit are important, as they allow the control unit to be placed on a surface, without damaging the switches.
- If gluing the battery holder in position, its surface may need to be roughened with sandpaper to get the glue to stick to it.

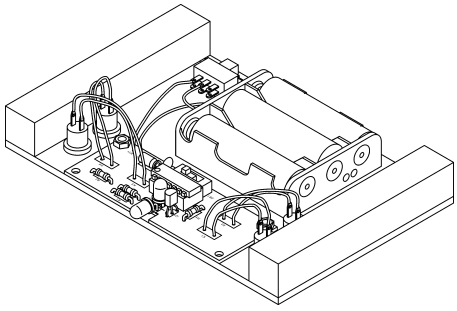
4.2 THE INFRARED TRANSMITTER LED:

- The type of case designed, will determine how you will mount the Infrared Transmitter LED.
- Identify the LED's positive and negative legs (Section 6 of the *IRCU* will help)
- Install the Infrared Transmitter LED so that it is easy to point at the Receiver.

USING AN OPEN CONTROL UNIT

If you use an open Control unit similar to the prototype we show in our illustrations:

- bend the LEDs leads about 5mm from the LEDs body (make sure that you check which way you need to bend the leads first – check the orientation of negative and positive leads)
- insert the leads into the holes in the PCB
- solder the leads and cut off the excess



USING AN ENCLOSED CONTROL UNIT

If you use an enclosed case for the Control unit:

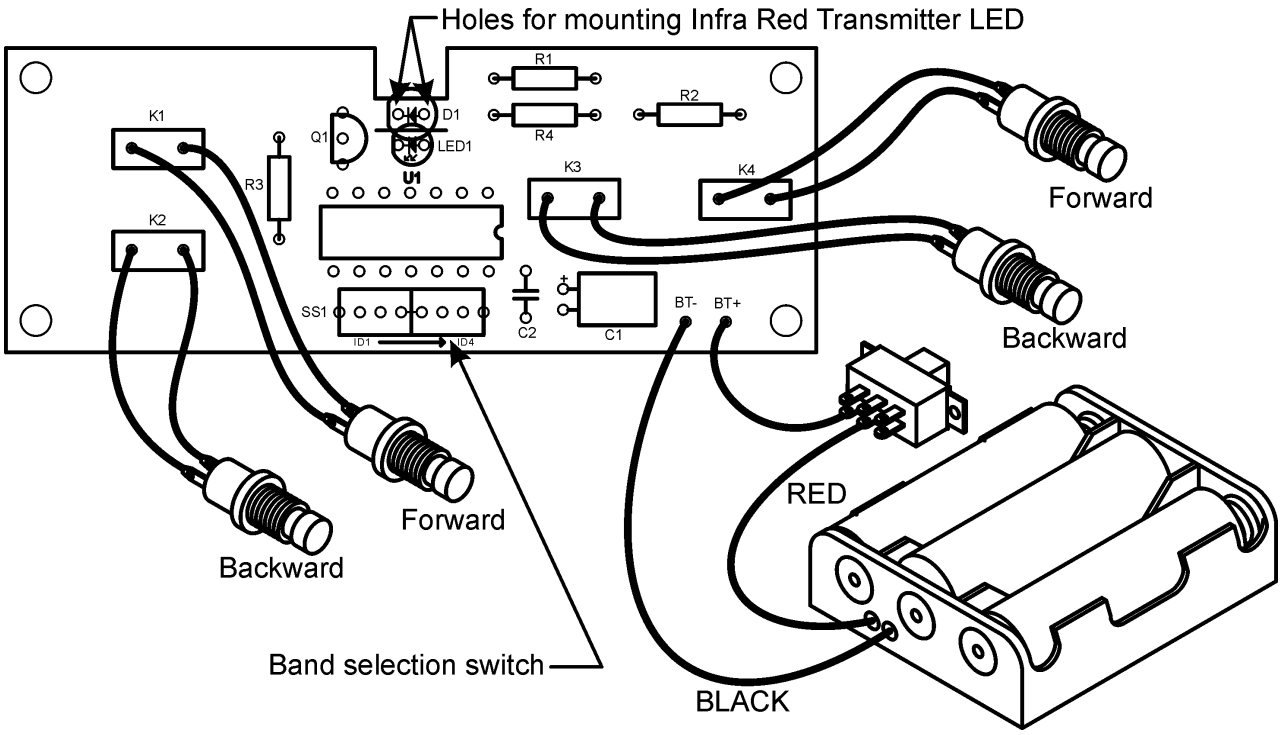
- drill a 5mm hole in the case, and insert the LED
- connect wires to the leads
- solder the wires to the correct holes on the PCB

4.3 WIRING UP THE TRANSMITTER PCB

An On/Off switch is mounted separately from the PCB and must be wired up. Note that even if not being used, the circuit draws some current, and the batteries will eventually discharge.

Note: The Red LED on the PCB is used to indicate when any of the push buttons are operated. This should not be obscured, as it provides visible confirmation that the unit is transmitting.

Connect the wires to the switches and battery holder as shown in the wiring diagram below.



WIRING INSTRUCTIONS

- Cut eight wires the same length (around 150mm) for the pushbutton switches and one red wire (also 150mm) for the On/Off switch. Strip 5 mm off the insulation from both ends of the wires. Twist the bare strands together tightly.
- Place one end of each wire in the holes shown on the wiring diagram (use different colour wires to each switch to aid identification) and solder them in place.
- Put the other ends of the wires through the holes of the switch terminals. Solder the wires (do this as quick as possible, as too much heat can melt the switch body) and cut off the excess wire as close to the terminal as possible.

Note: Take care to ensure the *Positive (Red)* and *Negative (Black)* wires are the correct way round.

4.4 MOUNTING THE TRANSMITTER UNIT

- To mount the Transmitter, use the PCB as a template and mark where to drill the mounting holes – using diagonal mounting holes is best (2 holes are adequate). We have provided 2x M3x12 bolts and 4 nuts for this (one nut on each bolt is used as a spacer)

SECTION 5: MAKING & ASSEMBLING THE *JOUSTER*

5.1 PLATFORM

- Cut out the platform as designed

5.2 SELECTING THE GEARBOX RATIOS AND MOUNTING THE GEARBOXES

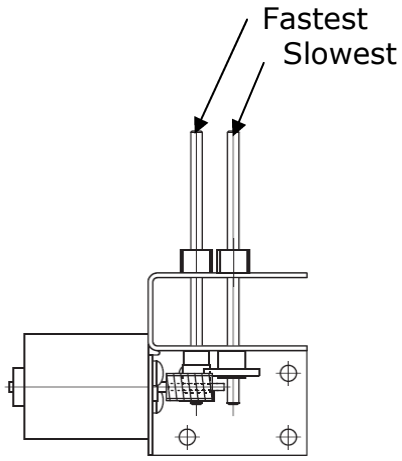
- **The gearbox has 2 output shafts.** Only one of these can be used, and it is up to the designer to determine if they will use the faster or slower gearbox option.

Note: as shown in the illustration, the output shaft which is closest to the motor, is the faster of the two.

- **Decide which gearbox ratio** is to be used. The other shaft needs to be cut short, so as not to interfere with the wheel's rotation.

On our prototype, we used the slower speed, as it makes the *JOUSTER* easier to control.

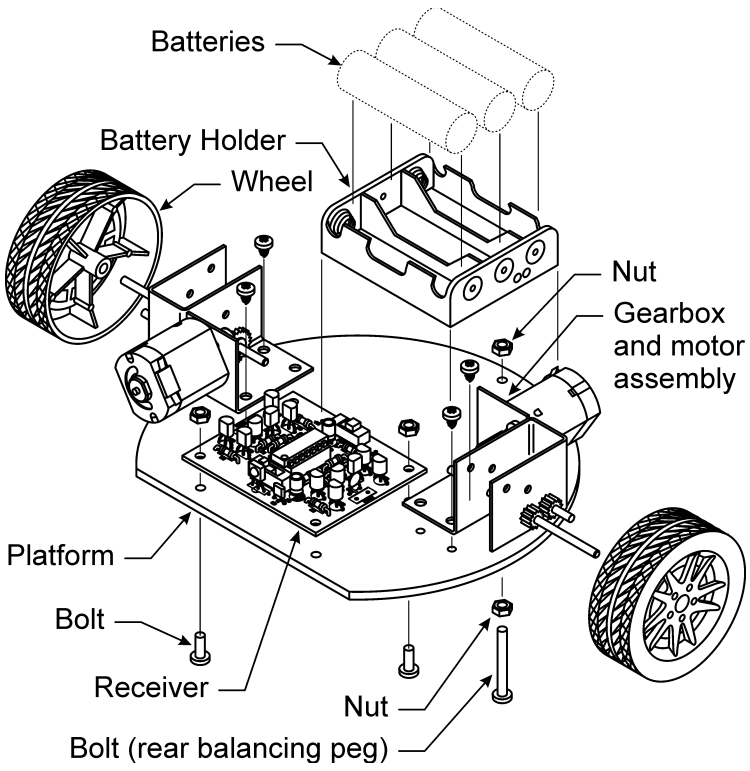
- **Determine if the driving shaft** needs to be shortened as well. Hint: measure how deep into the wheel the rod will be inserted (use a straightened paper clip, or something similar). If required, cut the shafts to the required length.
- **Locate the gearbox** and motor assemblies on the platform. Make sure the gearbox output shafts are both in line, to ensure that the vehicle travels in a straight direction.
- **Mark the location** of the gearbox attaching holes, and drill them (2 diagonally located holes per gearbox). 3x5mm long wood screws are supplied for this.



Which Output shaft to use?

5.3 MOUNTING THE OTHER COMPONENTS

- **Press the wheels** on to the gearbox shafts.
- **Mount the battery holder** – if gluing it you may need to roughen it with sanpaper, to aid adhesion.
- **Install the balancing peg.** This is used to keep the platform level.



5.4 MOUNTING THE RECEIVER

- When the other components are in place, use the Receiver as a template and mark where to drill the Receiver's mounting holes.
- Use 2 off M3x12 bolts and 4 nuts to mount the Receiver – the additional nut is placed between the receiver and the platform as a spacer. Care must be taken to mount the Receiver firmly but not over tight, to ensure that the corners are not broken (the soldered component ends on the Receiver's bottom side need to be kept off the platform's surface).

SECTION 6: THE RECEIVER AND WIRING

6.1 THE RECEIVER AS PART OF THE VEHICLE

The Receiving unit mounted on *The JOUSTER* consists of:

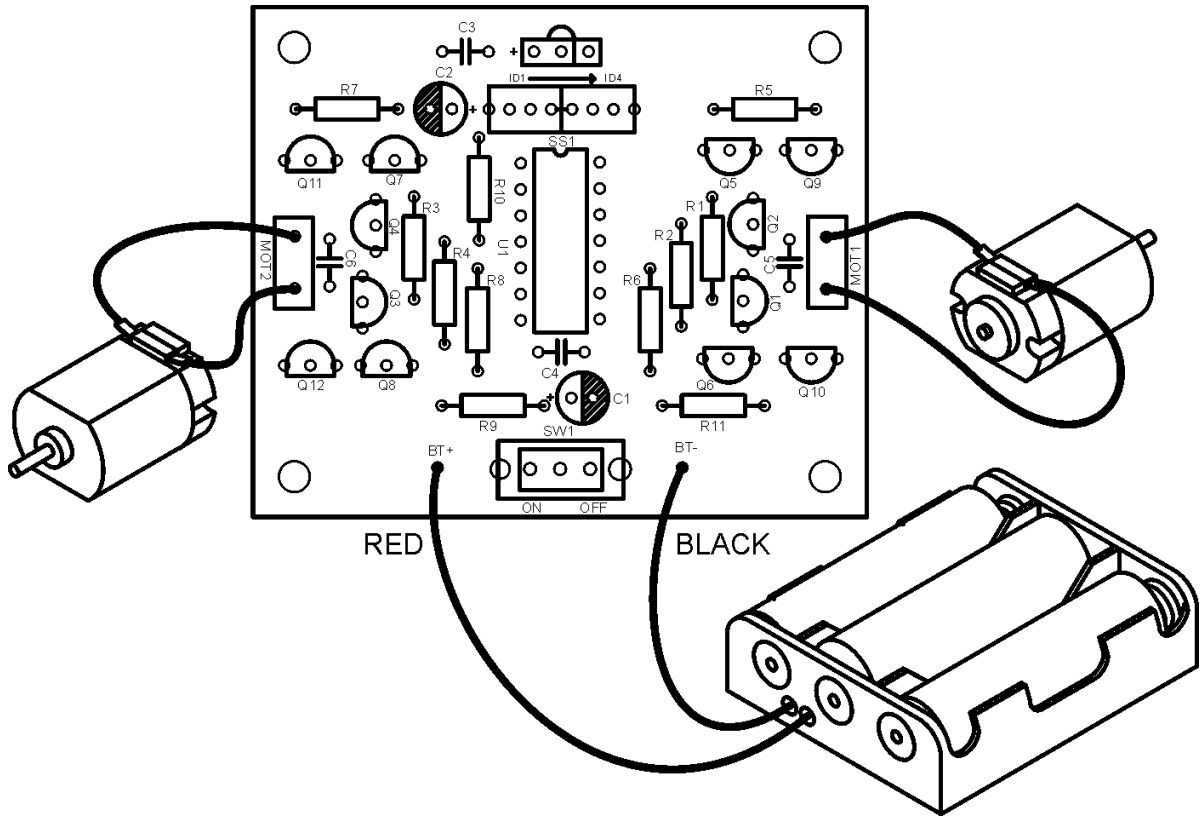
- the Receiver
- 3 x AA Battery Holder

6.2 WIRING UP THE RECEIVER PCB

Wiring should be carried out as shown in the wiring diagram:

- Cut four wires the same length (around 150mm) - strip 5mm off the insulation from both ends of the wires, and twist the bare strands together tightly.
- Connect one end of each wire to the PCB and solder them in place.
- Connect the other ends of the wires to the motor terminals. After testing (refer to section 7) that the motor's direction of rotation is correct, solder the wires and cut off the excess wire as close to the terminal as possible.

Note: Take care to ensure the *Positive (Red)* and *Negative (Black)* wires are correctly connected.



SECTION 7: TESTING AND TROUBLE SHOOTING

After completing the *JOUSTER*, you need to test the units.

7.1. BEFORE TESTING

***WARNING**: CHECK ALL WIRING AND CONNECTIONS THOROUGHLY BEFORE INSERTING THE BATTERIES.*

- *It is worth spending a bit of time and give the wiring and soldering a thorough visual check.*
- If you experience any problems, recheck the wires and soldering (if another working unit is available, compare it to yours).

7.2 WHAT TO EXPECT IN YOUR TESTING

When both motors are driven, they will draw up to 2.0 Amps from the batteries. Because of the large currents drawn, Alkaline batteries are recommended for the motors. Low battery voltage can cause erratic performance.

7.3 TESTING *THE JOUSTER*

Insert the batteries, move the Receiver's On-off switch to the "ON" position, and check that the following occur:

- If the Transmitter's red Indicator LED does not glow when the pushbutton switches are operated or the motors don't operate, turn off the power **immediately**
- when the Transmitter's switches are pushed *The JOUSTER* 's wheels turn in the desired directions (either forward or reverse). If not reverse the wiring direction of the switch on the hand held Control unit.

7.4 TROUBLESHOOTING:

If either of the above don't happen, turn off the power **immediately** and check the following:

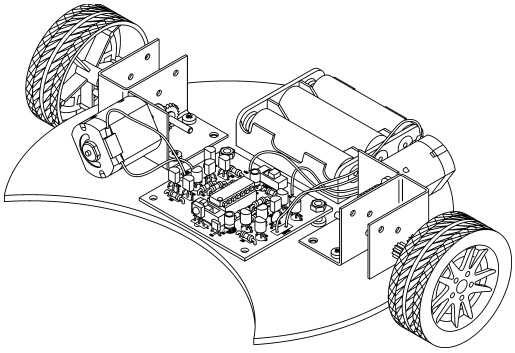
- that the batteries have adequate charge.
- that all the Transmitter and Receiver components are correctly located and oriented.
- that the +ve (red) and –ve (black) from the battery connectors go to the correct positions on the Transmitter's PCB and the Receiver's PCB.
- bare wire ends do not touch other wires or connections on the Transmitter and Receiver.
- check that there are no solder bridges between the terminals.
- that all the wiring is connected as per instructions.
- Make sure there are no dry joints - the soldering may look dry or lumpy or you may notice the solder does not actually connect to the wire. This will look like a dark ring around the wire: try pulling the wire to see if the lead comes out or moves (a magnifying glass or eye piece will help).

NOTE: at this stage, one set of pre-assembled units (Transmitter and Receiver) is useful, as it helps to quickly identify which unit is faulty, and cross check the correct component placement.

SECTION 8: POSSIBLE APPLICATIONS

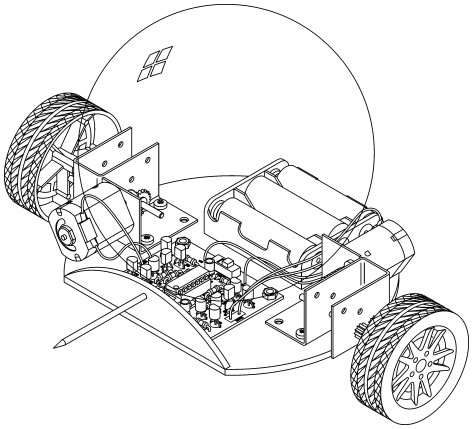
Now that the design and construction stages have been completed, it's time to put *The JOUSTER* through its paces! The basic design of this vehicle is quite zippy, and is fun to steer around obstacles. Taking into account, the fact that (as stated at the start of this unit) four vehicles can operate at the same time, by selecting different bands, the design can be taken further and developed for more specific purposes. These could be used by making an attachment, to allow various fronts to be used and trialled. For example:

SOCCER PLAYER



- By changing the front of *The JOUSTER* to a crescent shape, a game of soccer or other ball game can be played using a tennis ball.
- When the crescent shape is made some experimentation is necessary. If the crescent is made narrow and deep it is difficult to dislodge the ball from another player's control. If the crescent is too shallow then it is difficult to control the ball.

BALLOON BUSTER



- Fix a vertical plate across the front of *The JOUSTER* with a protruding spike. The front plate should have some supports to increase the plates strength.
- The spike can be made from a bamboo skewer (purchased at supermarkets). The skewer may need to be sharpened. The spikes on all competitors should be the same length. If the balloons being used have a tough skin (some helium types do) then a needle can be fixed to the end of the spike.
- Drill a 3mm hole and a 6mm hole approximately 3mm apart. Cut or file a narrow channel between the two holes.
- Blow up a balloon and tie off the neck of the balloon.
- Insert the neck through the large hole. Stretch the neck and slide the balloon through the narrow channel into the small hole. The balloon should now be fixed in place. Try and defeat your opponent by popping their balloon.

QUESTIONS / IDEAS:

- How big should the balloon be inflated?
- Should the spike be horizontal, or angled upwards, for best effect?
- Would you use a normal balloon, or a water balloon?

ROBOT WARS

- What other form of "Robot wars" can you design??

That's it - You have now successfully built your *JOUSTER*!!! Have fun!