FORKLIFT

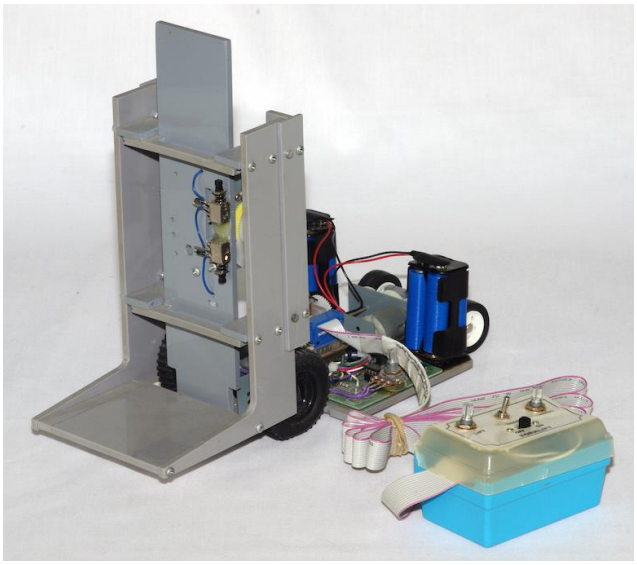
CONTENTS:

DESCRIPTION

The FORKLIFT is a motorised vehicle that can drive, steer and lift a load. These motions are controlled by a tethered control box.

This unit details the construction of our prototype FORKLIFT, which is 300mm long x 140mm wide x 250mm high. The design and size of the vehicle depends on the student's choices in design and construction.

The major aspects of this project are planning, design, component identification, part manufacture, maximizing effective use of materials, assembly, testing and evaluation.



SECTION 1: GENERAL AND PLANNING INFORMATION

1. DESIGN CONSIDERATIONS

1.1 GENERAL

The design and size of the vehicle are determined by the student, with the creation of a FORKLIFT requiring the student to design and build a vehicle capable of driving, steering and lifting a load.

The drawings at the end of this unit show our prototype FORKLIFT. The student may choose if desired, to make a FORKLIFT as per those drawings.

The project requires the student to:

- Design the platform, steering mechanism and lifting mechanism. For optimum functionality, the vehicle as a complete unit should be considered, and not just the components.
- Layout, mark-out, cut, shape, drill and assemble the components.
- Interconnect and assemble and solder the electronic and electrical components.
- Test and evaluate the completed vehicle.

At the design / planning stage, the student can draw up a plan describing:

- The work sequence necessary to complete the FORKLIFT - this could be a timeline with each section's anticipated completion dates. The student can use this to manage class time.
- How the FORKLIFT operates (principles / functions).
- What Log Book items to record, e.g. (1) progress on a daily /weekly basis, (2) Detailed information: problems encountered, measurements taken, observations made, to be used in the evaluation process (3) Assessment on progress in relation to the (projected) timeline.
- A number of questions, agreed upon by the teacher and student, for evaluation of the project.

1.2 ITEMS FOR INVESTIGATION

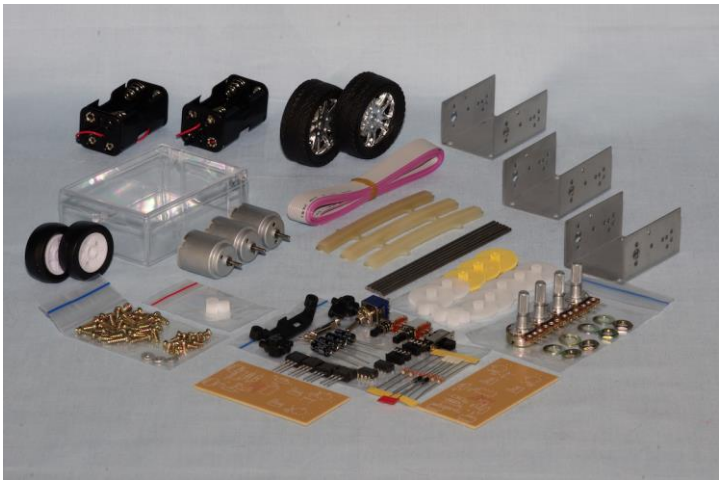
This project provides a number of different aspects of the FORKLIFT for investigation. Some ideas are listed below.

- The FORKLIFT you design may be evaluated for vehicle balance, turning circle, component layout and space efficiency. You can compare this to our prototype for efficiency.
- Evaluate the suitability of various materials. For example: Aluminium, PVC and Perspex.
- What other devices could use three bi-directional motors and be controlled in a similar manner.

SECTION 2: COMPONENTS & MATERIAL REQUIRED

2.1 COMPONENTS SUPPLIED

The following components are supplied in the kit:



2.2 ADDITIONAL REQUIREMENTS

The following items are required and are available from Scorpio Technology:

- Battery – AA, 8 required (BATTAA)
- Drill Bit – 2.3mm (DB2.3)
- Drill Bit – 2.6mm (DB2.6)

The following material is to be supplied by the student / designer:

- Label – Sticky-back – A4 sheet, label size DL01
- Vinyl - Clear self-adhesive (optional)
- Electric hook-up wire – Multi-strand in assorted colours
- Material for the components (PVC or acrylic sheet, plywood, etc.). We used 4.5mm thick grey PVC.

- NOTE: Plastic materials can be purchased from plastics suppliers (in the Yellow Pages under the heading "Plastics Fabricators" or search the Internet.)

2.3 TOOLS REQUIRED

The following tools are required:

- Assorted hand tools
- Soldering equipment and solder

SECTION 3: DESIGN

NOTE: When referring to the drawings in this unit, some dimensions (such as locating holes) are critical for the correct functioning of the FORKLIFT.

3.1 PLATFORM

- The platform must carry all of the components (except for the control box).
- The batteries should be located at the rear of the vehicle, serving as a counterweight for the load.
- The batteries should be located symmetrically about the centre line to provide balance.

3.2 STEERING MECHANISM

- The distance between the steering gear rack and the driving pinion is critical for correct operation.
- The feedback potentiometer gear must correctly mesh with the pinion gear on the steering gearbox.
- To change the distance between the wheels, an alternative steering linkage can be designed.

3.3 DRIVING MECHANISM

The gearbox may need to positioned off-centre to provide wheel and/or gear clearance.

3.4 LIFTING MECHANISM

- The absolute maximum lifting height is limited to the length of the gear rack minus the diameter of the driving pinion.
- The height of the vertical guide needs to be at least twice the length of the gear rack to provide stability of operation.

3.5 CONTROL BOX

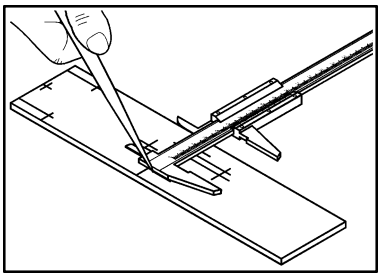
- The control box is linked to the vehicle by a ribbon cable.
- The control box label should describe each control, using text and/or graphical symbols.
- To prevent strands on the ribbon cable being broken during use, the end of the ribbon cable should be secured to the FORKLIFT. The other end should be secured to the control box.

3.6 GEARBOX (RATIOS)

- The designer needs to define the desired gearbox ratios, prior to starting assembly of the 3 gearboxes.
- We recommend the triple-reduction version (especially for lifting and steering).

SECTION 4: MAKING THE COMPONENTS

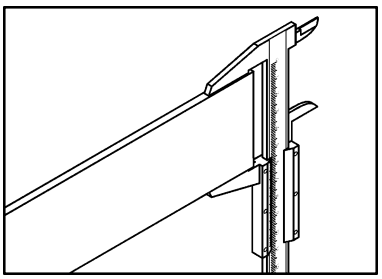
4.1 HINTS



Marking Out Detail

- Always measure from the same side of the component, even if the part is nominally symmetrical. This minimises the magnitude of errors, as all measurements are made from the same datum (reference) line. The drawings are dimensioned using this method.
- Lay out the components to minimise wastage, and where possible, to cut common dimensions at the same time.

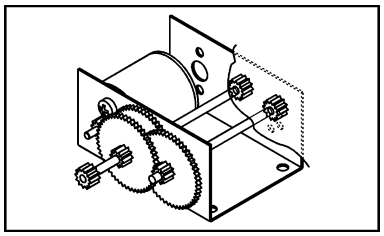
4.2 MARKING OUT AND CUTTING



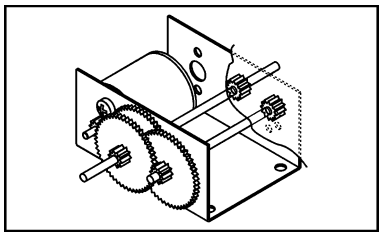
Measuring a Component

- Use a scriber to mark the outside shape of the component onto the sheet of raw material and cut out the part.
- Cut the outside of each component, leaving sufficient material for finishing.
- Use a centre punch and hammer to mark the centre of each hole. When starting to drill, this prevents the drill bit from wandering.
- File the edges so that they are square, flat, parallel and at the required size.
- Use a file to remove burrs from the component edges. Use a countersink bit to remove burrs from drilled holes.
- Accuracy better than ±0.5mm is required for some dimensions.
- Use a vernier to check small dimensions (usually up to 150mm).
- Use a steel rule for larger dimensions, and to check straightness.
- Use a square to check that sides are perpendicular.

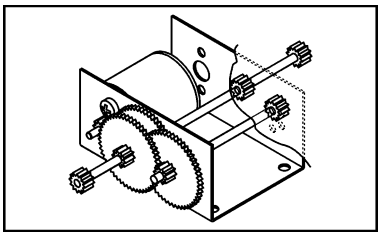
SECTION 5: ASSEMBLING THE MULTI-RATIO GEAR BOX



Steering Gear Case Arrangement



Drive Gear Case Arrangement



Lifting Gear Case Arrangement

Assemble the three gearboxes. Refer to illustrations above and the information below.

- Each gearbox can be made with one of 3 ratios - the ratios to be used for each gearbox must be selected before assembly is started, as this defines the parts to be used, and the assembly procedure. The choice of the gearbox ratio will be determined by how the vehicle will be used.

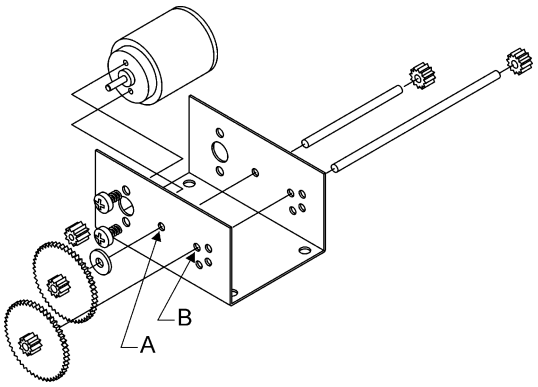
WARNING: Choosing a high speed drive gear ratio may cause damage to your vehicle if it bumps into an object (we suggest you use the triple-reduction version of the gearbox).

The choice of ratios available at the "Output" shaft are:

- Single reduction (shaft A) = 1:5
- Double reduction (shaft B) = 1:25
- Triple reduction (shaft A) = 1:125

The motor, under load, turns at approximately these speeds.

- with 3 Volts (2xAA batteries) = 6,500 RPM
- with 6 Volts (4xAA batteries) = 12,600 RPM



- Once the ratios have been chosen, assemble the gearbox as per the instructions below.

NOTE: The white gears are press fit on to the shafts and have either 2.4 or 1.9 holes. The yellow spur gear is freewheeling on the shaft and has a 2.6 diameter hole. The 12T pinions are used as locators.

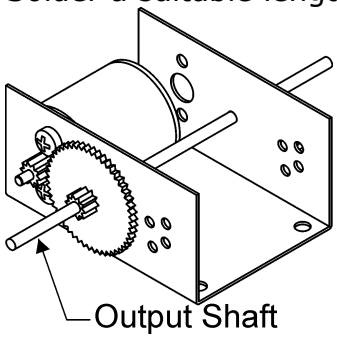
NOTE: Before starting assembly, determine the length of the axle shaft. Cut and deburr the steel rod to that length.

- Assemble the steel rod, and all the gears, to the gearcase - as shown in the drawings.
- Press the 10T pinion onto the motor shaft.

NOTE: Place the gear on the bench, insert the motor shaft into the worm gear's hole and gently tap the end of the shaft (where it exits the motor) with a small hammer. Stop when the pinion gear is 3mm from the motor's body.

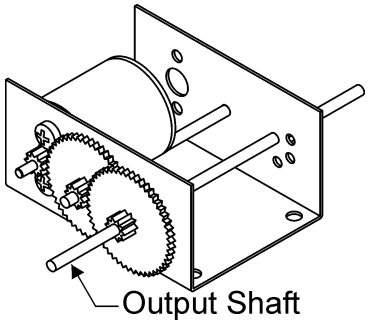
WARNING: Don't just push the motor down by hand as this can push the motor armature out of its bearings and jam the motor.

- Secure the motor to the gearbox case using the two self-tapping screws.
- Solder a suitable length of wire to each of the motor's terminals.

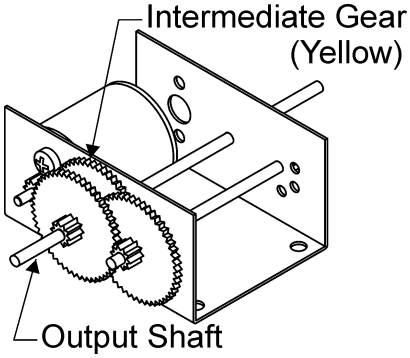


SINGLE REDUCTION

(Low ratio = high speed)



DOUBLE REDUCTION

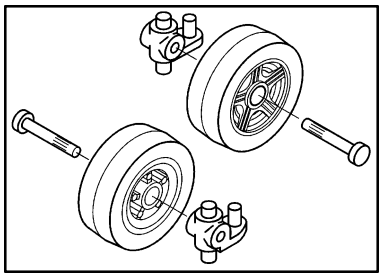


TRIPLE REDUCTION

(High ratio = low speed)

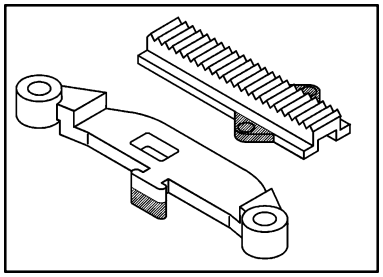
SECTION 6: MECHANICAL ASSEMBLY

6.1 STEERING MECHANISM / WHEELS



Steering Wheel Assembly

- Push the axle through the wheel's centre hole and into the steering knuckle. Assemble the steering knuckle with the angled side away from the wheel.
- Ensure that there is about 0.5mm clearance between the wheel and the steering knuckle, and the wheel should turn freely.
- Cut a length of gear rack to suit the steering linkage.
- Remove the steering gear rack lugs and the steering linkage lug (shaded in illustration).
- If required, construct a suitable spacer between the rack and the steering linkage
- Glue the rack to the steering link. Use a vernier to check that the top of the gear rack is parallel to the bottom of the steering link.
- Fasten the steering spacer to the platform using two 10mm screws.

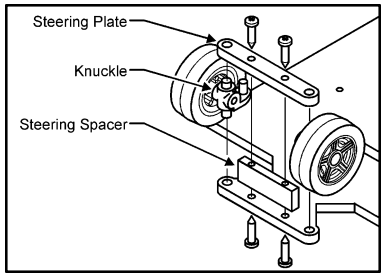


Steering Linkage Lug and Rack Lug Removal

- Insert the knuckles into the 4mm diameter holes in the platform. Ensure that the steering linkage pivots point upwards
- Fasten the steering plate to the steering spacer using two 10mm screws. Check that the wheels pivot freely.

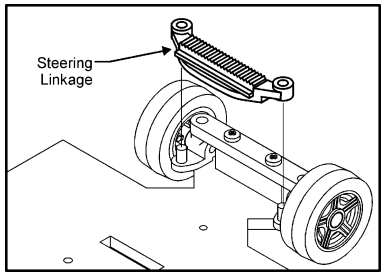
If the wheels are tight to steer:

- Check the height of the steering spacer.
- Check that the top and bottom faces of the steering spacer are square and parallel.
- Check that the holes in the platform, steering spacer and steering plate line up.



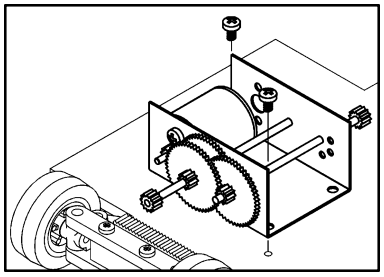
Steering Wheels to Platform Assembly

NOTE: If required, reassemble the steering mechanism without the wheel knuckles in place. Use a 4.0mm diameter drill to remove misalignment from each pair of holes. Reassemble the steering mechanism.

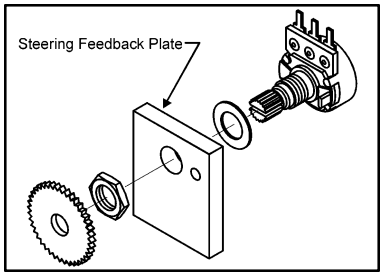


Steering Linkage Assembly

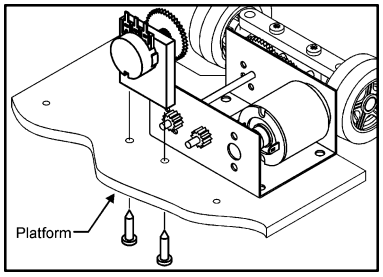
- Assemble the steering linkage and the steering knuckles.
- Check that the wheels move freely from side to side when the steering link is moved.
- Assemble the steering gear case to the platform using two 4mm screws.
- Test the operation of the steering in both directions - use four AA batteries in a battery case.



Steering Gear Case to Platform Assembly



Steering Feedback Potentiometer Assembly



Steering Feedback Potentiometer to Platform Assembly

- Assemble the potentiometer to the steering feedback plate.
- Modify the gear (as shown in the drawings at the end). Push the modified gear onto the potentiometer shaft. Check that the gear fits firmly onto the shaft and is centrally located.

To ensure that the steering feedback potentiometer functions correctly:

- With the wheels pointing straight ahead, the potentiometer should be in the middle position (neutral position).
- Assemble the feedback potentiometer assembly to the platform using two 10mm screws.
- Using four batteries in a battery case, test the steering in both directions.

6.2 DRIVING SYSTEM (WHEELS & GEAR CASE)

- Assemble the gear case assembly to the platform using two 4mm screws.
- Push the axle through the centre of each 52mm wheel.
- Attach (glue if required) the wheels to the shaft.

NOTE: When pressing the wheels onto the shaft, support the other end of the shaft to avoid moving the gears.

HINT: If the wheel slips on the shaft score the shaft using a hammer and cold chisel.

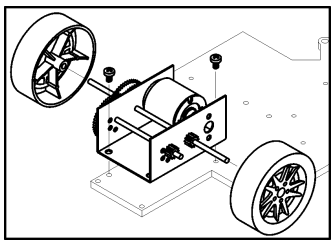
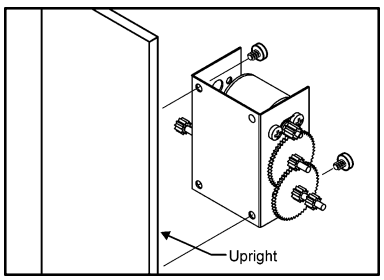


Figure 5.8 Driving Gear Case to Platform

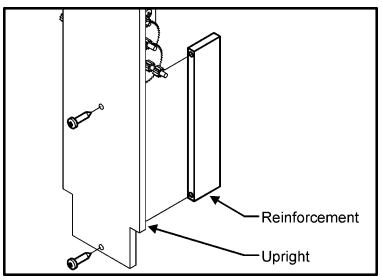
- Test the operation of the gear case in both directions by using batteries in a battery case.

6.3 LIFTING MECHANISM

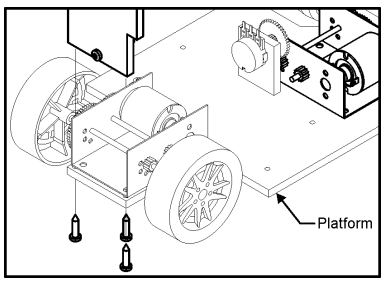
- Use two 4mm screws to assemble the lifting gear case to the upright.
- Use two 10mm screws to assemble the reinforcement plate to the upright.
- Use three 10mm screws to assemble the upright and reinforcement plate to the platform.
- Assemble each gear rack to the rack mounting plate using four 4mm screws, and assemble each of the fork's sides to the rack mounting using two 10mm screws.



Gear Case to Upright



Reinforcement to Upright



Vertical Guide to Platform

- Assemble the lifting plate to the side plates using four 10mm screws.
- Slide one guide bearing onto the upright from the front wheel end, and the other onto the top of the upright. The guide should have a sliding fit without being too loose. If one of the lifting guides is too tight on the upright, then file the lifting guide to suit. If a lifting guide is too loose, then make a replacement component.
- Assemble the fork's sides to the lifting guide.

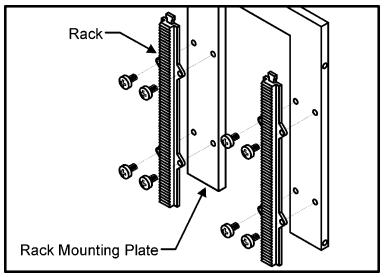


Fig 5.12 Rack and Mounting Plates

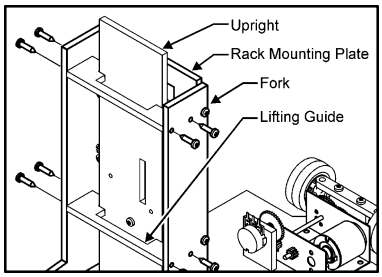


Fig 5.13 Guide Bearing to Upright

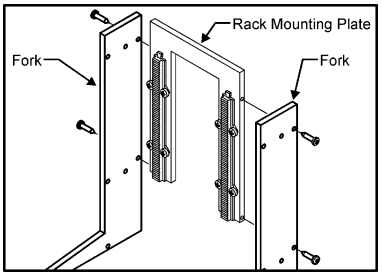


Fig 5.14 Fork to Lifting Guide

- Using four batteries in a battery case, test the lifting gear case in both directions.
- If the uprights stick, check that the lifting guide's sides are straight and parallel within ±0.5mm.
- If the operation is too tight, then check that the lifting guides have a sliding fit on the upright.
- If the 12T pinion is too tight or too loose against the rack, then elongate the holes that are used to attach the lifting guide.
- The FORKLIFT has two limit switches, and the aim is to prevent the upright travelling too far in either direction – when operated, the limit switches stop the electric motor. The limit switches and their diodes are mounted on the upright, so that the limit switches are activated by contacting the lifting guide.

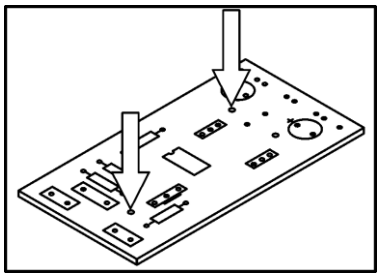
SECTION 7: PCB ASSEMBLY

- NOTE: The PCB has the name "White Line follower" as it was designed for a different vehicle. As a result some PCB component locations are not used.

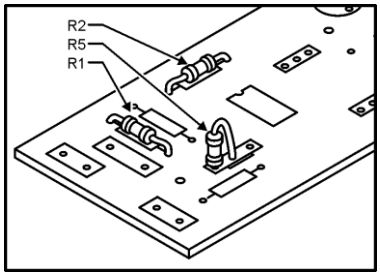
WARNING: Do not overheat the PCB or components when soldering.

The construction of both Printed Circuit Boards (PCB) is the same.

- The component overlay is on the top of the PCB. The copper tracks (gold plated) are on the underside of the PCB.
- Drill two 3.0mm holes in the PCB. These holes are used to mount the PCBs to the platform.


Position of Mounting Holes

- Insert the three resistors (R1, R2, R5) into the PCB in the locations identified as R1, R2 and the LH centre and LH end holes of VR1. The resistors are non-polarised components. (i.e. they don't need to be placed in any particular direction). Solder the resistors to the PCB. Trim the legs close to the solder.

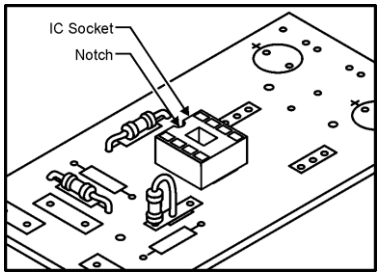


Location of Resistors

NOTE: The values and positions of the resistors are different to those printed on the PCB overlay.

- Insert the Integrated Circuit (IC) socket. Ensure that the notch faces the direction indicated on the PCB. Do not mount the IC as it may be damaged during soldering.
- Solder the IC socket to the PCB. Do not trim the IC socket's legs.

- Insert the two capacitors into positions C2 and C3. The two capacitors are polarised: that is, they have both positive and negative leads. These must be connected the correct way or the model will not work. The capacitor's positive and negative leads can be identified by two methods: (1) The stripe on the capacitor's body marks the negative lead or (2) the short lead is negative. Refer to the PCB to determine the positions of the leads.
- Solder the capacitors to the PCB. Trim the legs close to the solder.



Location of IC Socket

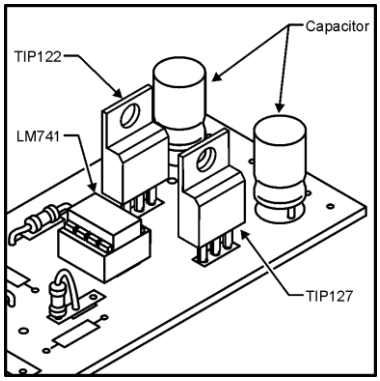
WARNING: Electrolytic capacitors will be damaged if they are installed in the wrong direction and power is applied.

NOTE: Correct positioning of the transistors is important. Although the transistors appear to be the same, they are not interchangeable and must be placed in the correct position and orientation. The back of the transistors (the metal face, without writing) must face towards the top of the PCB.

NOTE: The transistor leads are a snug fit and it may be necessary to wiggle them gently from side to side to fit them into the holes. Solder the transistors to the PCB. Trim the legs.

- Insert the two (Darlington) transistors – (T1) and (T2).
- Solder the Transistors in place.

- Insert the IC into its socket. Ensure that the notch or hole at one end of the IC faces in the same direction as the notch in the socket. Note that the notch or hole identifies the location of pin 1. Check that the legs line up with the IC socket holes and press down firmly with your thumb.



Location of other Components

NOTE: It may be necessary to bend the legs of the IC slightly to line them up with the socket holes.

WARNING: Integrated circuits will be damaged if they are installed in the wrong direction and power is applied.

WARNING: The circuit will not work and some of the electronic components will be damaged if the wiring is not correct. It is much better to spend time to ensure that all the components are in the correct positions, than to figure out why the vehicle does not work. In addition, unsoldering and replacing damaged or wrongly positioned components wastes time.

- Check the soldering for any poor joints or solder bridges between the tracks. Solder bridges are most likely to occur between tracks that are close together, so pay careful attention to the solder tracks where the IC socket and the transistors are mounted. Ensure that solder bridges are removed before connecting power to the PCB. Failure to do this may result in damage to the components.

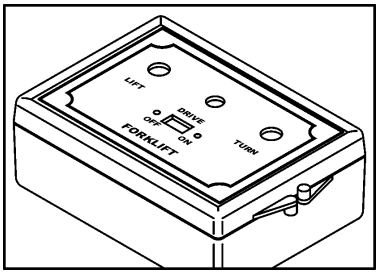
SECTION 8: MECHANICAL ASSEMBLY

To assemble the FORKLIFT, the following points need to be taken into consideration:

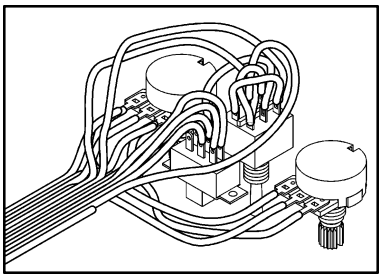
- Determine the approximate wire lengths that are required. Allow sufficient length of wire to allow individual components to be moved during testing.
- When soldering wires, strip approximately 5 mm of insulation from each wire and twist the stripped wire strands. Use a hot soldering iron to tin the ends of the stripped wires.
- While soldering, hold the component or wire still until the solder cools, otherwise the solder may fracture, causing a dry joint. A dry joint may look OK, but may have poor mechanical strength and may have poor electrical conductivity.
- Do not overheat the PCB, wires or components while soldering.
- It is suggested that different coloured wires are used. This will help in tracing wires during fault finding.

8.1 CONTROL BOX

- Design and make a label for the control box. Ensure that the switches and potentiometers can be operated with sufficient clearance between the components. When designing the label, include the centre lines and outlines of the holes.
- Print the label on a suitable sticky-backed material, and protect the label using clear self-adhesive vinyl.
- Assemble the label to the control box lid.
- Use a hot soldering iron to tin each of the terminals on the switches and potentiometers. Drill and cut holes for the switches and potentiometers in the control box lid.
- Separate the strands of one end of the ribbon cable for approximately 30mm.

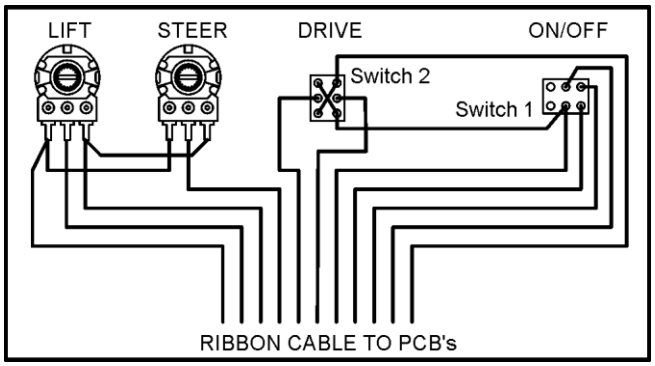


Control Box Lid Label



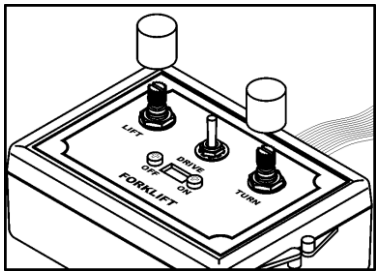
Soldering Wires to Switches and Potentiometer

- Referring to the wiring diagram, solder the wire and the ribbon cable to the potentiometers and switches.
- If required, you may cut unused wires(s) from the ribbon cable.



Wiring Diagram for Control Box

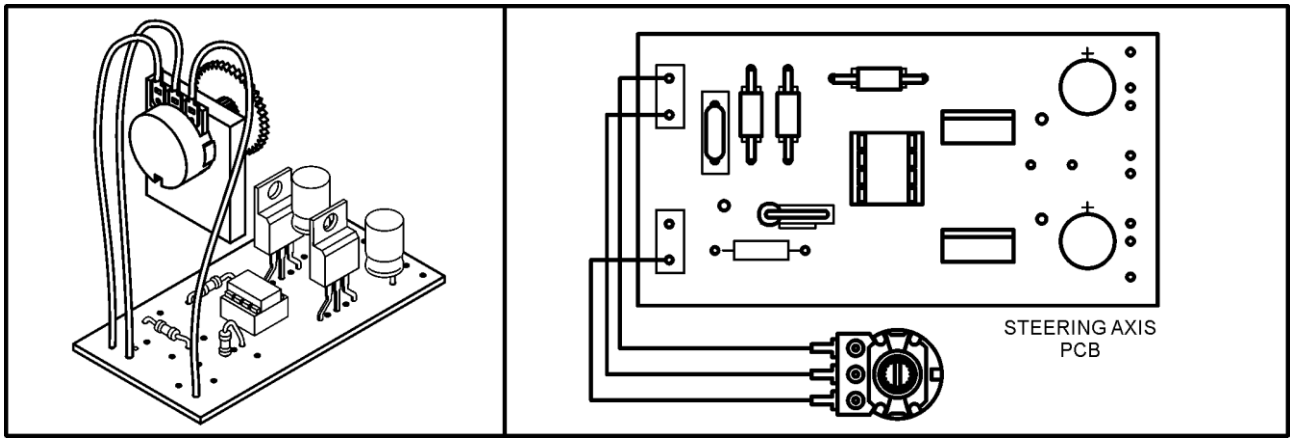
- Assemble the switches to the control box lid.
- Trim the tabs from both potentiometers. These prevent the potentiometers sitting flush against the inner surface of the control box.
- Assemble the potentiometers to the control box lid.
- Make and assemble the potentiometer knobs to the potentiometers.



Assembly of Switches and Potentiometers to Control Box Lid

8.2 STEERING FEEDBACK POTENTIOMETER

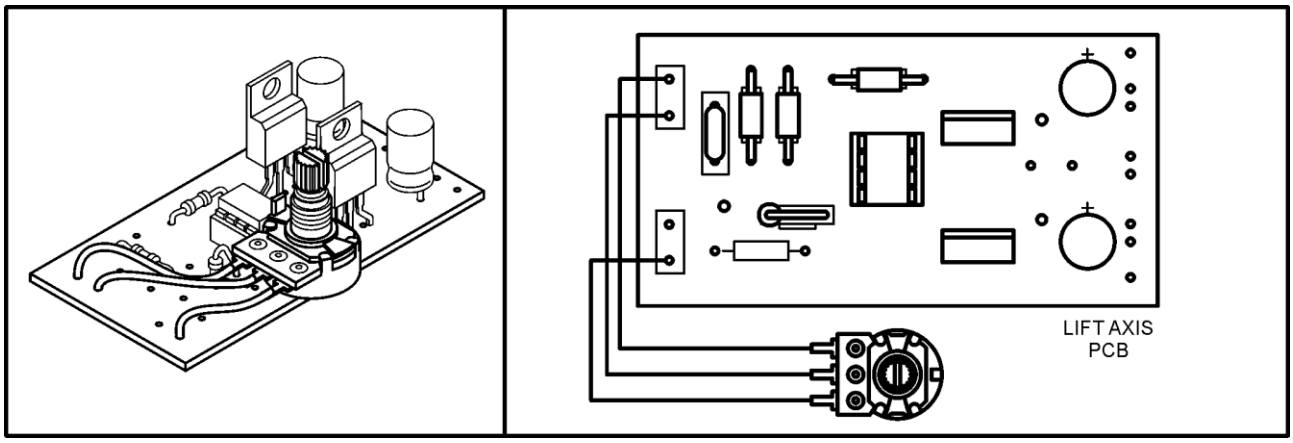
- Solder wires to the steering feedback potentiometer.
- Allow sufficient length of wire from the steering mount to the PCB.
- Solder wires to the PCB as shown in the wiring diagram.



Soldering Wires Between Steering Feedback Potentiometer and PCB

8.3 LIFT OFFSET POTENTIOMETER

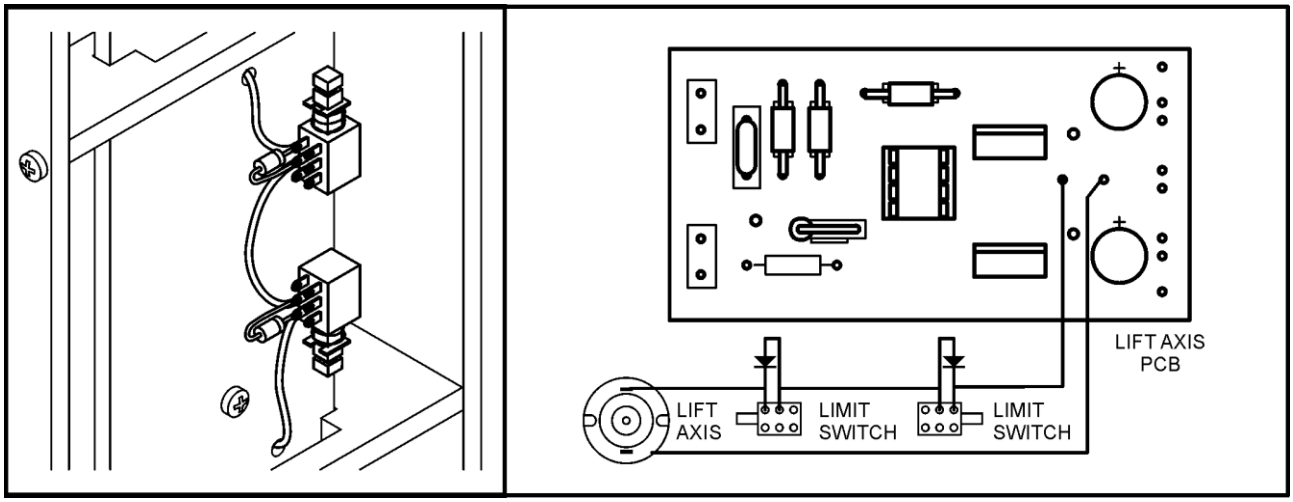
- Solder wires to the lift offset feedback potentiometer.
- Glue the lift system offset potentiometer to the PCB. Hot-melt glue works well.
- Solder wires to the PCB as shown in the wiring diagram.



Soldering Wires Between Steering Feedback Potentiometer and PCB

8.4 LIMIT SWITCHES AND DIODES

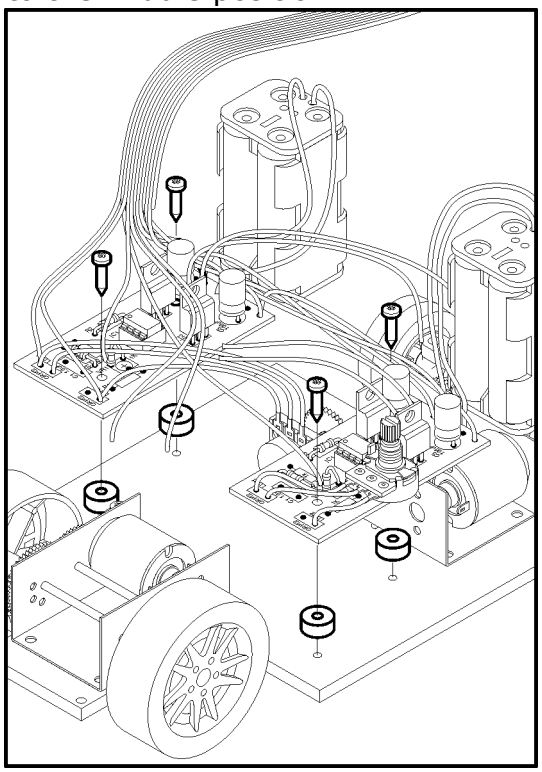
- The function of the limit switches is to limit travel of the lifting axis.
- The purpose of the diodes is to allow direction of motion only in one direction (away from the switch) when the corresponding switch is triggered.
- The limit switches should be positioned during testing.
- The limit switches should be located to provide maximum travel whilst minimising the slide mechanism jamming
- A suitable position for the limit switches is adhered to the wall on the inside of the slide mechanism.
- Allow sufficient wire length to allow the limit switches to be repositioned, if necessary.



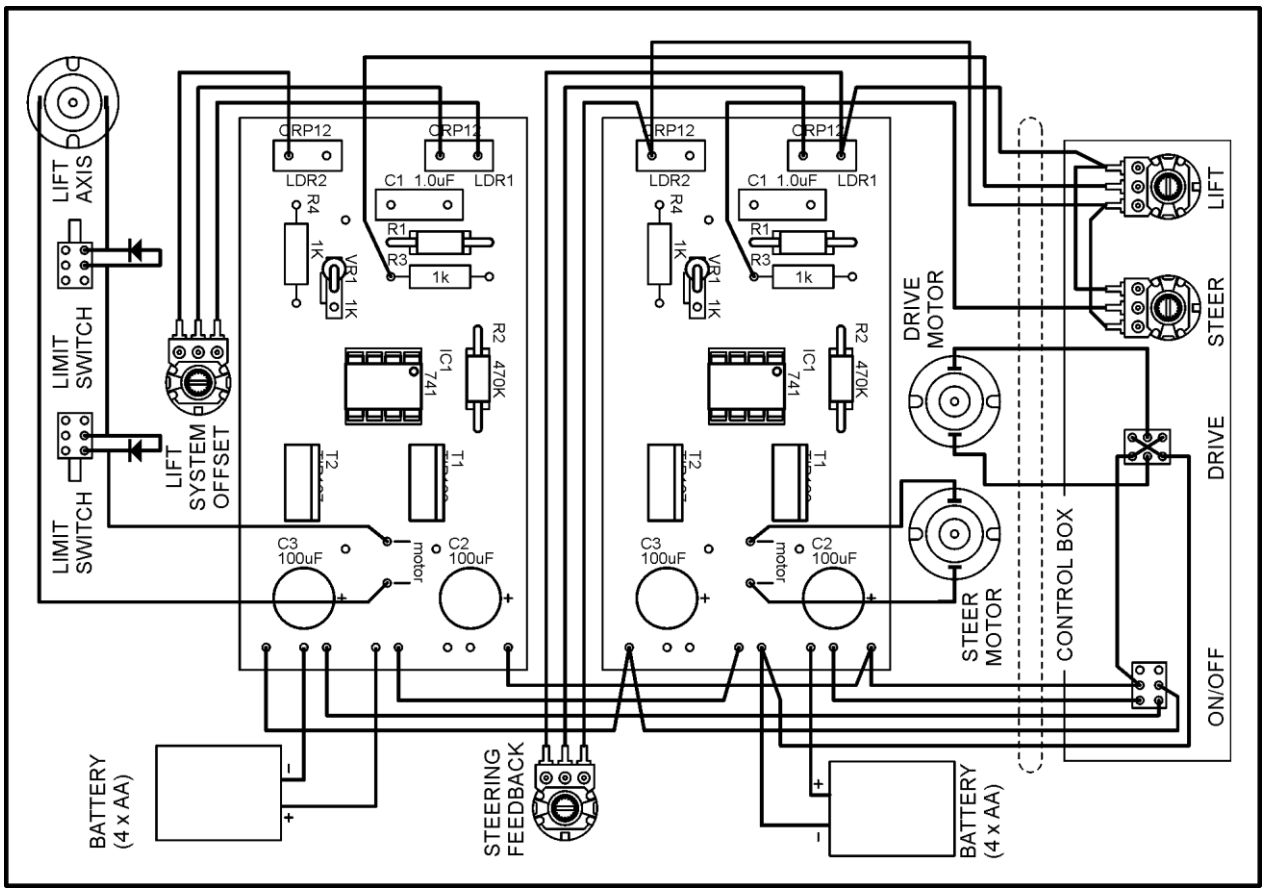
Soldering Wires to Limit Switches, Diodes, Motor and PCB

SECTION 9: CONNECTING PCBS AND WIRING

- Refer to the wiring diagram to interconnect the components.
- Solder battery holder or battery clip wires to the PCBs. The red wire is positive and the black wire is negative.
- Solder wires between the lift system offset potentiometer and the lift system PCB. Set the lift system offset potentiometer to the middle position.
- Solder wires between the steering feedback potentiometer and the corresponding positions on the steering system PCB.
- Solder wires for the steering motor to the PCBs and lift system motor. Solder the motor wires to the motors.
- Referring to the wiring diagram, solder wires between the PCBs and drive motors.
- Assemble the PCBs to the platform. Use two 10mm screws and spacers for each PCB (glue the spacers to the platform).
- Connect and solder the limit switches and their diodes into the circuit.
- Insert four batteries into each battery holder.
- Use a multimeter to check that 6 volts is present on the leads of each AA battery holder. Assemble the battery holders to the platform using "hook and loop" tape or glue.



Assembling PCBs to the Platform



Wiring Diagram

SECTION 10: TESTING

10.1On/Off Switch

Step	Test	Expected Result	True	False
1	Place the on/off switch in the off position.	None of the motors operate and 6V is not present across the capacitor terminals.	Next step.	Turn the on/off switch around.
2	Place the on/off switch in the on position.	6V is present across the terminals of each capacitor. (The motors may operate.)	On/off switch and battery holders are OK.	Check that 6V is available on each battery holder. Check wiring between the battery holder, on/off switch and the PCB. Check for a short circuit.

10.2Drive System

Step	Test	Expected Result	True	False
1	Place the drive switch in the middle position.	The drive axis motor does not turn.	Next step.	Check for bridged wires on the drive switch. Check that the wiring at the switch is as per the circuit diagram.
2	Place the drive switch in the forward position.	The drive axis wheels propel the vehicle forwards.	Next step.	Swap the wires on the motor. Check the wiring between the drive switch and the motor.

Step	Test	Expected Result	True	False
3	Place the drive switch in the reverse position.	The drive axis wheels propel the vehicle backwards.	The drive switch is OK.	Check that 6V is available on each battery holder.

10.3Steering System

Step	Test	Expected Result	True	False
1	Turn the steering axis potentiometer on the control box in one direction and then the other.	The steering axis motor rotates to the left and right.	Next step.	Check that 6V is present across each of the battery holders. Check that the steering feedback potentiometer is in the middle when the wheels are pointing straight ahead.
2	Turn the steering axis potentiometer to the right (clockwise).	The steering axis steers the vehicle to the right.	Next step.	Swap the direction of the wires on the motor.
3	Turn the steering axis potentiometer to the left (anti-clockwise).	The steering axis steers the vehicle to the left.	The steering axis is OK.	Check the wiring to each of the steering axis potentiometers. Check that 6V is available on each battery holder.

10.4Lifting System

Step	Test	Expected Result	True	False
1	Turn the lifting potentiometer on the control box in one direction and then the other.	The lifting axis motor rotates in one direction and then the other.	Next step.	Check that 6V is present across each of the battery holders. Check that the lift axis offset potentiometer is in the middle.
2	Turn the lifting potentiometer on the control box in one direction and then the other.	The lifting axis does not move.	Next step.	Check that the steering feedback potentiometer is in the middle position.
3	Turn the lifting potentiometer to the right (clockwise).	The platform is raised, until the limit switch is activated – the platform stops.	Next step.	Check the Diode direction and wiring.
4	Turn the lifting potentiometer to the left (anti-clockwise).	The platform is lowered, until the limit switch is activated – the platform stops	Next step.	Check the Diode direction and wiring.
5	Turn the lifting potentiometer to the right (clockwise).	The platform is raised.	Next step.	Swap the direction of the wires on the motor.
6	Turn the lifting potentiometer to the left (anti-clockwise).	The platform is lowered.	The lifting axis is OK.	Check the wiring to each of the potentiometers. Check that 6V is available on each battery holder.

SECTION 11: THEORY

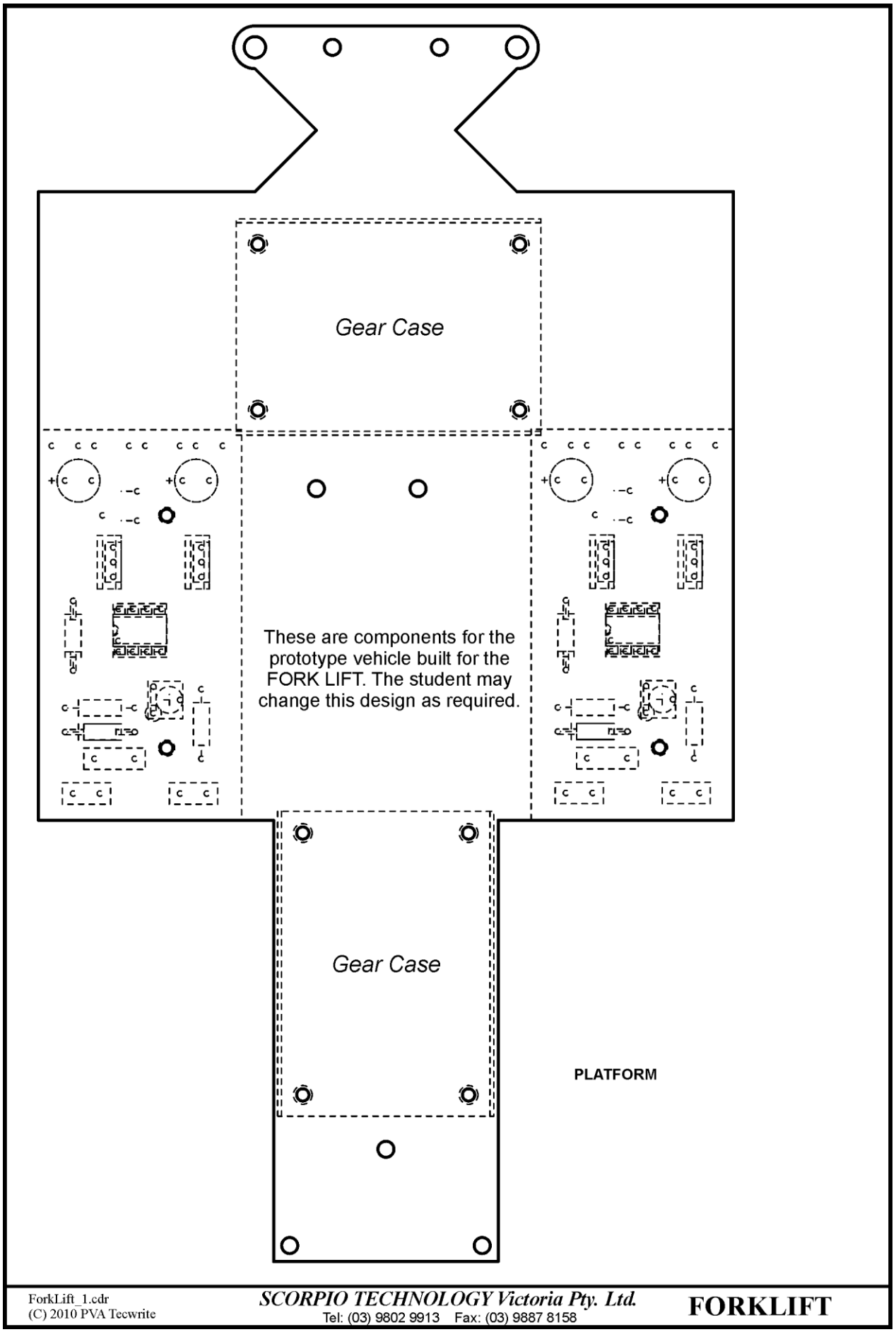
11.1OPERATION OF THE FORKLIFT

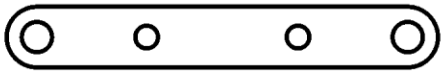
- The FORKLIFT consists of a horizontal platform and a vertical lifting structure. It has three types of motion: drive, steer and lift, and each of these is controlled in a different manner.
- For the drive system (forward/reverse): the two-way switch has a central "off" position, forward motion position and a reverse motion position (open loop control).
- For the control of lifting motion, two potentiometers are used – one is connected to the PCB and the other is in the control box. The potentiometer located on the PCB is used to set the zero (neutral) speed position of the potentiometer in the control box. The potentiometer in the control box is used to control the motor's speed and direction of rotation (open loop control).
- For the control of steering motion, two potentiometers are used – one is connected to the steering motor and the other is in the control box. The potentiometer in the control box sets the desired position of the steering. The potentiometer connected to the steering motor provides position feedback to the circuit (closed loop control).

11.2HOW THE CIRCUIT WORKS

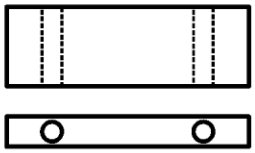
- The forward/reverse motion of the drive mechanism is achieved by swapping the direction of the current to each motor.
- The steering system and lifting system circuits operate in a similar manner, but by using transistors instead of a mechanical switch.
- Both potentiometers on each PCB are set up to be voltage dividers. The wiper arm of one potentiometer (VR2) is connected to the inverting input of the Op-Amp and the wiper arm of the other potentiometer (VR3) is connected to the non-inverting input.
- The Op-Amp amplifies the voltage difference between the inverting and non-inverting inputs and provides an output that is fed to the two transistors.
- The transistors are of complementary types, and a positive voltage on the base allows one transistor to conduct, whilst a negative voltage allows the other to conduct. Therefore, the motor turns in response to the current that is flowing through either of the transistors. If the voltage on the two potentiometers is equal, neither transistor conducts and the motor does not turn.
- Two limit switches with diodes are present on the lift system. When a limit switch is activated (opened), the corresponding diode interrupts current flow in one direction to the lifting motor.

SECTION 12: TECHNICAL DRAWINGS

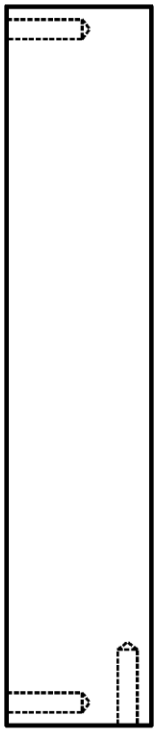




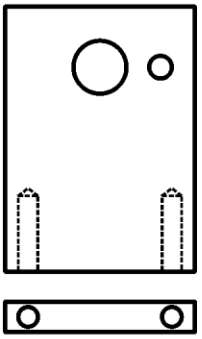
STEERING PLATE



STEERING SPACER

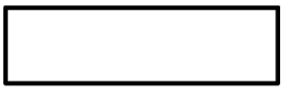


REINFORCMENT PLATE

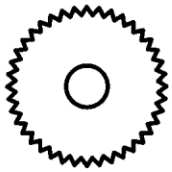


STEERING FEEDBACK PLATE

PCB SPACER

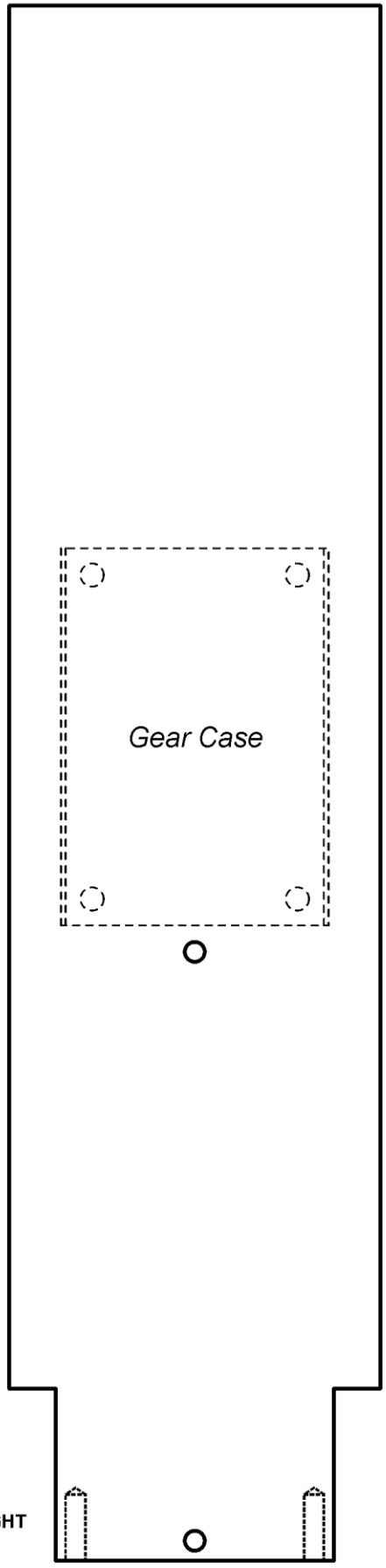


GEAR RACK SPACER



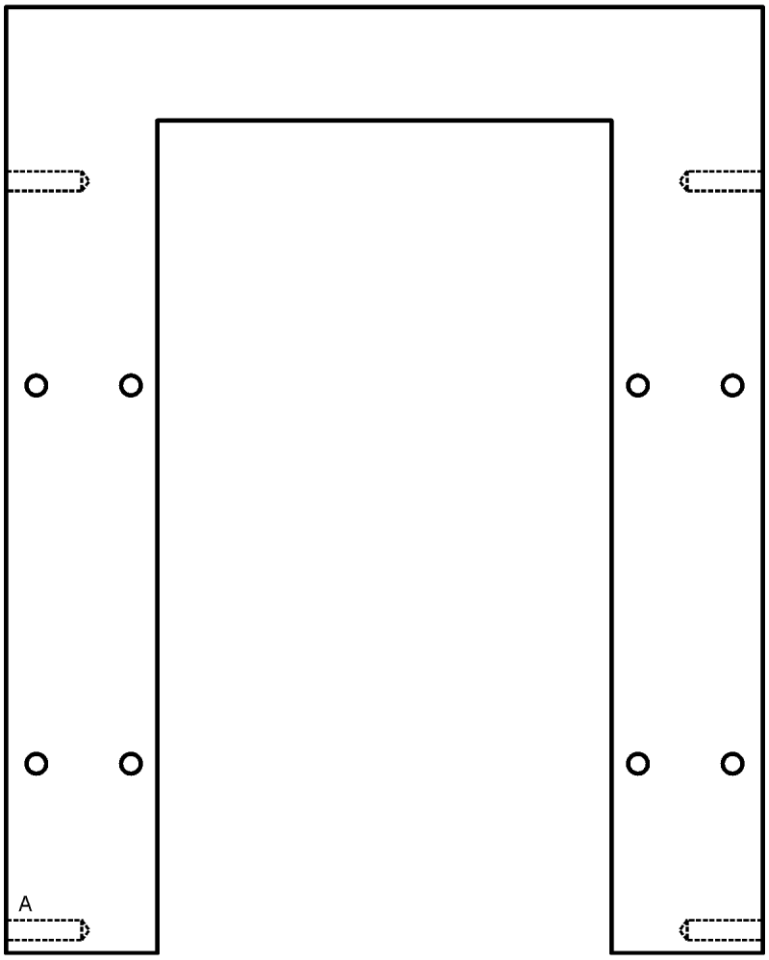
STEERING FEEDBACK GEAR

These are components for the
prototype vehicle built for the FORK LIFT.
The student may change this design as required.

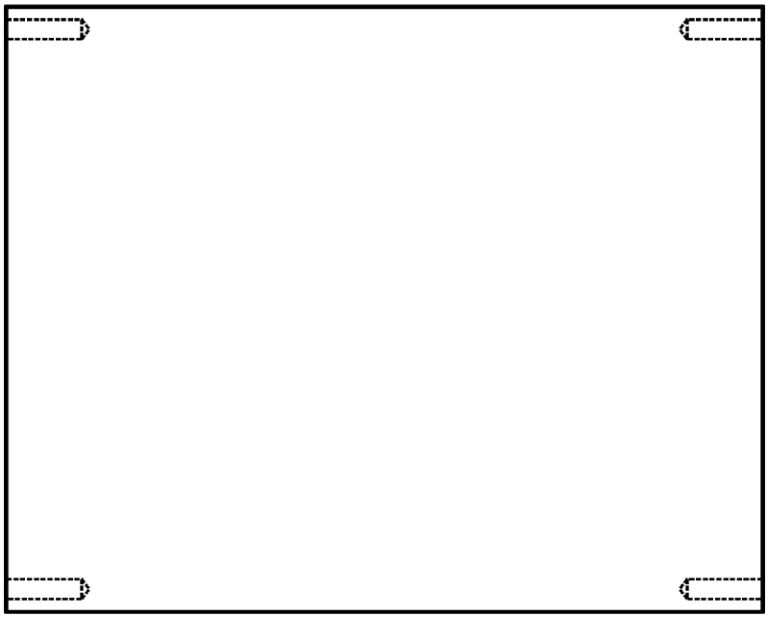


UPRIGHT

These are the components for the prototype vehicle built for the FORK LIFT. The student may change this design as required.



RACK MOUNTING PLATE



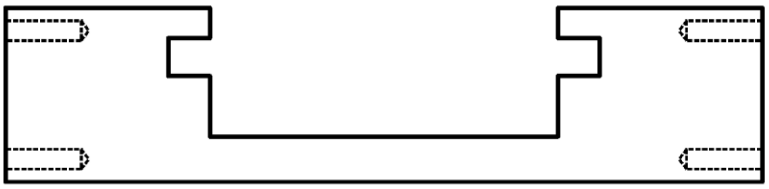
LIFTING PLATE

ForkLift_3

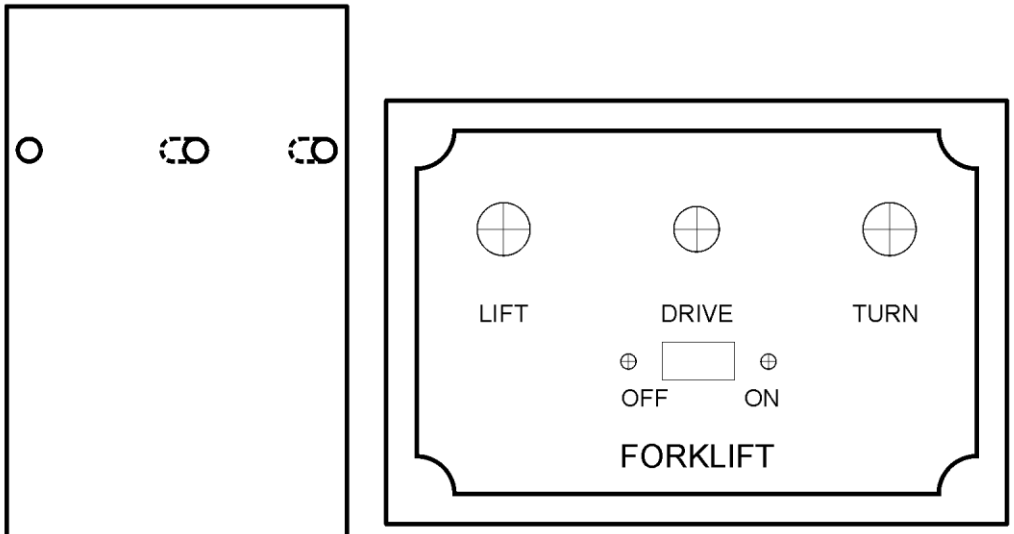
SCORPIO TECHNOLOGY Victoria Pty. Ltd.
Tel: (03) 9802 9913 Fax: (03) 9887 8158

FORKLIFT

NOTE: For neat assembly, fitting with the upright may be required.



LIFTING GUIDE
QUANTITY: 2



CONTROL BOX LABEL
MATERIAL: STICKY-BACK LABEL
WITH CLEAR SELF-ADHESIVE VINYL

These are components for the prototype vehicle built for the FORK LIFT. The student may change this design as required.

FORK
QUANTITY: 2