Please note:

This is a NEW DESIGN of *RADIO CONTROL UNIT* (*RC*), and consists of Transmitter and Receiver Printed Circuit Board (PCB) assemblies, and all other parts required to operate the unit.

Please read the new "*RADIO CONTROL 27.145mHz PCB (2 band)*" instructions carefully. If using this kit as part of the "*RADIO CONTROLLED VEHICLE*" (*RCV*), this needs to be read together with those (revised) instructions.

WARNING:

1. this kit and these instructions CANNOT be used with previously supplied versions of the *RADIO CONTROL VEHICLE (Mark 3)* or the earlier *27&40 mHz RCV PCBs*.
2. previously issued Teaching units (prior to October 2010 issue) will NOT work with this current kit.

Note: apart from the *RC* and its instructions, there are also changes to the *RADIO CONTROLLED VEHICLE* and its kit.

- These instructions are matched to that REVISED *RCV* design.

Thank you, and good luck!

RADIO CONTROL UNIT - 2 band

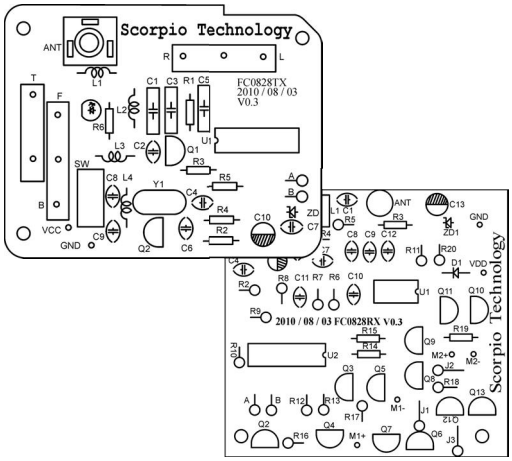
CONTENTS:

DESCRIPTION

The 27.145 mHz *RADIO CONTROL UNIT (RC)* - consisting of the Transmitter and the Receiver PCB assemblies - enables you to control whatever device you are constructing.

The Transmitter PCB is used to transmit 3 commands to the Receiver PCB, which is mounted on a vehicle or other device of your making.

The radio transmission distance is up to 25 metres, and under favourable conditions it may be more.



PLEASE NOTE: The RADIO CONTROL units are available in two variations – either with the PCBs fully assembled, or with the PCBs unassembled.

SECTION 1: GENERAL AND PLANNING INFORMATION

THE PROJECT

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

This project provides a number of possible topics which may be investigated, either individually or in pairs or teams.

Some suggested topics for investigation are:

- Look at Radio waves (what different wave types and bands are there?).
- Investigate Radio Transmission and Reception principles and uses.
- What are the Radio Transmission Regulations? Do they affect radio controlled vehicles of any sort?
- The choice and suitability of various materials for making the control unit housing, and for mounting the PCBs (aluminium, PVC, perspex, etc.).

DESCRIPTION OF THE PCBs AND THEIR FUNCTION

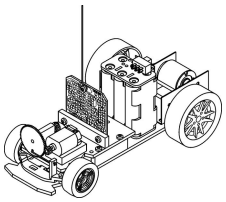
This *RADIO CONTROL* unit transmits on the 27.145 mHz frequency, and has 2 bands available, so that 2 devices can be used at the same time – eg. ideal for racing two RCVs at a time.

NOTE: to use 2 sets of RCs at the same time, the PCBs incorporate a band selector switch, to select one of the 2 frequency bands - both the Transmitter and Receiver PCBs have to be set to the same band.

The Transmitter can transmit 3 commands to the Receiver. For example, for a vehicle this would control:

- the vehicle's forward and reverse motion
- the steering – left or right
- the "turbo" function, to increase the vehicle's or devices speed

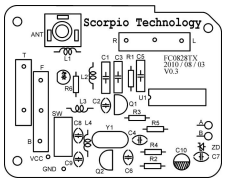
INCORPORATING THE RC UNIT INTO A DEVICE OR VEHICLE



The "WIRING UP THE PCBs" section describes how to wire up the PCB assemblies, to incorporate them into the working device. This describes the connection of components such as the battery clip, battery holder, and eg. steering and drive motors. This section also details how to incorporate the PCBs into *Scorpio Technology's RADIO CONTROLLED VEHICLE (RCV*), and if making a RCV, must be used together with the RCV teaching unit.

However, when using these PCBs for other electronics projects, the information provided in the second part may need to be adapted or modified, to suit your specific application.

USES FOR THE RADIO CONTROL PCBs



This *RADIO CONTROL* unit can be utilized for a large variety of electronic projects.

Possible uses for the RADIO CONTROL

This *RADIO CONTROL* unit is designed to control a small vehicle. That is not the only use you could put them to. If you use your imagination, you should be able to think up lots of other uses for them. Some examples are:

- a model garage door opener (with lock?)
- to operate a device for a disabled person
- Model Rocket launcher control
- Volume control for an old style radio

What does it control?

For the *RCV*, the PCBs control small electric motors. For other projects, you could replace the motors with other types of devices, such as:

- Relays: to switch things on and off
- Solenoids: To operate a mechanical device (eg. a door latch)
- Buzzer: for a door bell
- Globes: eg. Door "bell" for a deaf person

Batteries and current usage

Many electric devices, such as motors, draw large current. For this reason, alkaline batteries are recommended, as low battery voltage can cause erratic performance.

NOTE: The selection of motors or other items being controlled can have an effect on current draw, and affect (reduce) the transmission distance. Thus, not all controllable items are suitable for this project.

How else could you operate it?

You could also identify other useful applications for the *RADIO CONTROL* unit, by using different methods to operate the transmitter (instead of using the switches). Some ideas are:

- Temperature sensor: could could trigger an alarm

- Moisture sensor: by coupling a moisture sensor to the transmitter's input and a buzzer on the receiver's output, you could make an alarm to remind you to bring in the clothes when it begins to rain
- Light sensor: by putting a light sensor on the entrance of your letter box you can be alerted to the delivery of mail, or use a light sensor on a model train track to activate boom crossing gates
- Sound sensor

PLANNING STAGE

Questions to ask before starting...

At the start, the teacher and student should also pose a number of questions before commencing the project, to be evaluated at the completion of the work. The questions could be in a variety of fields, including:

- Technical questions regarding the device's function
- Aesthetic questions regarding the device's appearance
- Practical questions: for example: How can the design be improved?
- Self-critique: for example: is the quality of finish and workmanship satisfactory? How could the execution of the project be improved? Would a different design be created second time around?
- Assessment of the project: what difficulties were experienced? What caused them? Can they be reduced or eliminated in future projects? How long did the project actually take?
- Critique of the Teaching unit: was anything vital missed which would have been of value? (please tell us if you do identify possible improvements)

Planning the project...

Before commencing work the student should spend time planning the project. Draw up a plan describing:

- The decision whether to use an assembled or un-assembled set of PCBs, and the anticipated extra time required for the assembly. This decision should be based on a review of the student's skill level, and the available time, to determine which of these assembly levels is most appropriate.
- The sequence of work required to complete the entire project – the PCBs and the device that they will control. This could be set out as a timeline showing the anticipated completion dates for each section of work. This timeline can be used to properly manage classroom time.
- How the device will function.

These plans should also take into account what items should be recorded on an ongoing basis, throughout the life of the project. These could include:

- Completion of a Log Book, recording such items as: the results of individual and team research; Recording progress on a weekly or daily basis etc..
- Detailed information about problems encountered, measurements taken and observations made. These will be used in the evaluation process.
- Assessment on progress and completion in relation to the planned timeline.

Deciding which type of Radio Control unit kit to use...

PLEASE NOTE: The RADIO CONTROL units are available in two variations – either with the PCBs fully assembled, or with the PCBs unassembled.

1) TYPE A: the Receiver and Transmitter PCB's are fully assembled.

2) TYPE U: the PCBs and their electronic components are unassembled, and each PCB and all their components are in separate bags. Parts have to be identified, located and soldered to the PCB's.

SUGGESTION: if buying a class set of RC UNITs, we recommend that at least one set of assembled PCBs is purchased, to allow testing of student assembled PCBs.
NOTE: if not specified when ordering, the un-assembled PCBs will be supplied as

SECTION 2: COMPONENTS & MATERIAL REQUIRED

Before you commence, ensure that you have ALL components – both the supplied parts, as well as all the additional requirements listed below.

2.1 COMPONENTS SUPPLIED IN THE KIT:

1 x Transmitter PCB ****Ref. 2.3*
1 x Receiver PCB ****Ref. 2.3*
1 x 9 Volt Battery clip
1 x 6x AA Battery holder
1 x Toggle switch (MTS203) – SW2
1 x Pushbutton Switch (green) – SW1
2 x Pushbutton Switch (black) – SW3, SW4
3 x Slide switch (small)
2 x M3 x 8mm long bolt
2 x M3 Nut

2.2 ADDITIONAL REQUIREMENTS

2.2.1 The additional requirements are: fine electric wire (different colours), 6x AA batteries (for the Receiver) and one 9 volt battery (for the Transmitter). Alkaline batteries are recommended

2.2.2 In addition, other materials are required for all the other parts to be made: Platform pieces, Antennas, Transmitter Control unit housing, Battery mount and all other material for your device!

2.3 COMPONENTS SUPPLIED FOR UNASSEMBLED PCBS

If you have selected the UN-assembled PCBs, the following is the list of parts you will receive in 2 separate bags (one for the Transmitter PCB and its parts, the other for the Receiver PCB and its parts)

TRANSMITTER PCB PARTS LIST

REF NO.	*SPECIFICATION*	*QTY*
PRINTED CIRCUIT BOARD		
PCB	FC0828TX	1
INTEGRATED CIRCUIT		
U1	HH2051	1
CRYSTAL		
Y1	27.145MHZ	1
TRANSISTORS		
Q1, Q2	C1815GR	2
DIODES		
ZD	3V3 Zener Diode	1
LED		
	RED LED 5 mm	1
INDUCTORS		
L1	4.7uH ±5%	1
L2	1.5uH ±5%	1
L3,L4	2.2uH ±5%	2
SW	Slide switch	

REF NO.	*SPECIFICATION*	*QTY*
CAPACITORS		
C1	10P ±5% NPO Disc Ceramic	1
C2	56P ±5% NPO Disc Ceramic	1
C3	33P ±5% NPO Disc Ceramic	1
C4	68P ±5% NPO Disc Ceramic	1
C5	121P ±5% NPO Disc Ceramic	1
C6	15P ±5% NPO Disc Ceramic	1
C7,C8,C9	104P X7R Disc Ceramic	3
C10	220uF/16V Electrolytic	1
RESISTORS		
R1	4.7Ω ±5% 1/4W	1
R2	270Ω ±5% 1/4W	1
R3	20K ±5% 1/4W	1
R4	100K ±5% 1/4W	1
R5	470Ω ±5% 1/4W	1
R6	1.5K ±5% 1/4W	1

RECEIVER PCB PARTS LIST

REF NO.	*SPECIFICATION*	*QTY*
PRINTED CIRCUIT BOARD		
PCB	FC0828RX	1
INTEGRATED CIRCUIT		
U1	SCAX-1	1
U2	2051	1
TRANSISTOR		
Q1	C1815GR	1
Q2,Q3,Q8,Q9	S8050D TO-92	4
Q4,Q5, Q10, Q11	A1300 TO-92	4
Q6,Q7, Q12,Q13	C3279GR TO-92	4
DIODES		
D1	1N4148 Diode	1
ZD1	3V3 Zener Diode	1
INDUCTOR		
L1	0.7uH Inductor ±5% Adjustable	1
OSC COIL		
L2	4.7uH Oscillator coil ±5%	1

REF NO.	*SPECIFICATION*	*QTY*
CAPACITORS		
C1	12P ±5% NPO Disc Ceramic	1
C2,C3,C10	30P ±5% NPO Disc Ceramic	3
C4	222P ±5% NPO Disc Ceramic	1
C5	4.7uF/16V Electrolytic	1
C6,C7,C8	103P ±5% NPO Disc Ceramic	3
C9,C11,C12	104P ±5% NPO Disc Ceramic	3
C13	220uF/16V Electrolytic	1
RESISTORS		
R1,R11	220K ±5% 1/4W	2
R2	680Ω ±5% 1/4W	1
R3	4.3K ±5% 1/4W	1
R4,R5,R7,R9	2.2K ±5% 1/4W	4
R6,R8	2.2M ±5% 1/4W	2
R10	100K ±5% 1/4W	1
R12～R15	1K ±5% 1/4W	4
R16～R19	100Ω ±5% 1/4W	4
R20	330Ω ±5% 1/4W	1

SECTION 3: PCB ASSEMBLY

3.1 INSTRUCTIONS FOR TEACHERS

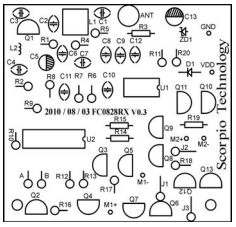
Constructing these PCBs is reasonably difficult and time consuming. Students who undertake this should have some previous experience at constructing and testing electronic projects. It is important that students also understand the symbols, designations and general principles of the various electronic components before they begin their project.

NOTES: General information and identification of the various components is provided in Section 6.

3.2 POSITIONING THE COMPONENTS

What is shown on the PCB...

Check and identify all the components for the PCB before commencing assembly. The location of the components is printed on the PCB (PCBs have a silk screen overlay, to identify the component locations). The copper tracks are on the underside of the PCB, and the outline of the tracks is visible through the PCB. These will act as a guide, to help locate the components onto the PCB.



Component assembly sequence...

The assembly of the components to the PCB should be completed before soldering the components in place. Begin by placing the components that sit lowest on to the PCB.

- Mount the resistors in place. Resistors are non-polarised components and do not need to be placed in any particular direction. However, the convention is that horizontal resistors are mounted with the gold (tolerance) band to the right and vertical resistors to the bottom.

SUGGESTION: When all the components are in place, but before soldering, check them carefully against the printed circuit board.
HINT: it's much better to spend time now, making sure all the components are in the correct position, than to waste time later on, trying to figure out why the device doesn't work. If required, unsoldering and replacing damaged or wrongly positioned components will waste considerable time.

3.3 SOLDERING AND ASSEMBLING THE PCB

What to use... A good quality soldering iron, with a fine tip and the use of 0.71mm 60/40 solder is recommended.

Preparation and soldering...

- Once all the components are correctly located, carefully turn the circuit board over and bend the component leads outwards, away from the component's body (about 15 degrees from vertical). This will prevent the components from slipping down while soldering them in position.

WARNING: Don't bend them too far or you will have considerable trouble removing them if it becomes necessary later on).

- Carefully solder all the component leads. If you find it difficult to get to all the leads, cut off any that are in the way, after they have been soldered. When all the soldering is complete, cut the leads as close to the solder as possible (1 to 2 mm from the PCB).

Possible problems when soldering...

- When soldering, hold the wire still while the solder cools, otherwise the solder may fracture, causing a *dry joint.* A dry joint may look OK, but it is a poor electrical connection. This could cause your model to not work, or not work properly.
- Check the soldering for any poor joints or solder bridges between tracks. Solder bridges are most likely to occur between tracks that are close together, so pay careful attention to the solder tracks where the I.C. socket and the transistors are mounted. Solder bridges must be removed before connecting power to the PCB. Failure to do so may result in damage to the circuit.

The last stage – installing the IC...

- After all the soldering has been completed, install the I.C. in its place in the socket. Ensure the notch on the end faces in the same direction as on the socket. Check that the legs line up with the I.C. sockets holes and then press down firmly with your thumb. Note: it may be necessary to push the I.C.'s legs together slightly to line them up with the socket holes.

SECTION 4: WIRING UP THE PCBS

4.1 GENERAL INFORMATION

4.1.1 WIRING UP THE TRANSMITTER AND RECEIVER PCBs

After the PCBs and all their components have been assembled, a number of additional parts (switches, battery holders, motors etc) need to be connected to the PCBs. This section details what is connected, and where.

Note: if the *RADIO CONTROL UNIT* will be used to control the *RADIO CONTROLLED VEHICLE*, this section needs to be used in conjunction with the *RCV* Teaching unit (the location of the PCBs on the vehicle affects the length of the wires)

Wiring up the transmitter and receiver is fairly straight forward. This should present no problems if, before beginning any wiring up, you carefully read through, and follow, all the instructions in this section.

- information printed on the reverse side of the PCB (ie. the component layout) provides soldering instructions for all of the components. When soldering the wires, be careful to use a minimal amount of solder (to avoid overrun of the solder onto any other pads).

4.1.2 THE WIRES

- When cutting wires, make them slightly longer than you need - but avoid making them too long, as 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.
- WIRES: Use six different colour wires. This avoids confusion to make it easier to follow wires, when connecting items, and easier to trace wiring problems. Use multi-stranded wires, as single stranded wires break off after they have been bent a couple of times.

4.1.3 THINGS TO LOOK OUT FOR

- While connecting wires to switches, it is necessary to clamp the switches to hold them still (a printed circuit board holder is ideal). If you don't have access to one of these, 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 resolder the switches.

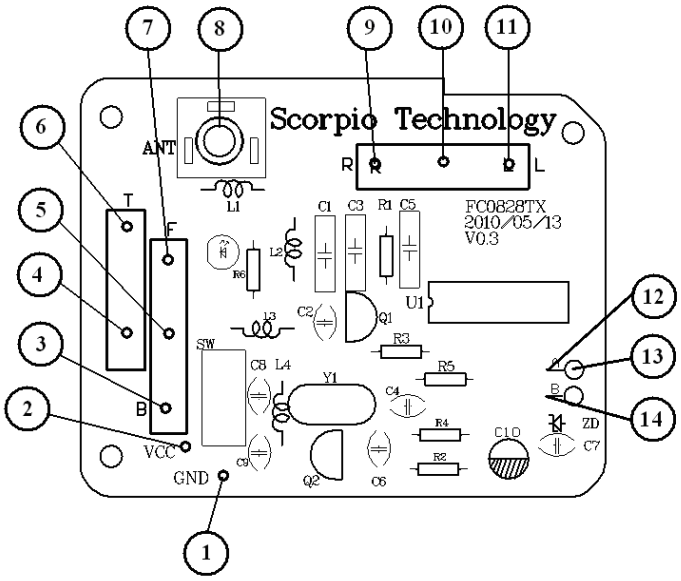
4.2 THE TRANSMITTER

4.2.1 THE CONTROL UNIT consists of:

- the Transmitter PCB
- the green Pushbutton switch (SW1) controls the turbo function
- the Toggle switch (SW2) – for the RC vehicle these control Forward-Stop-Reverse, with the centre position being Power off.
- the 2 black Push button switches (SW3 & SW4) – for the RC vehicle this controls the steering to the Right or Left (when neither is pressed, the vehicle should re-align the steering to straight ahead).
- the Band Selector switch (SW5)
- the Antenna (described later in this section)
- one 9 Volt Battery and battery clip

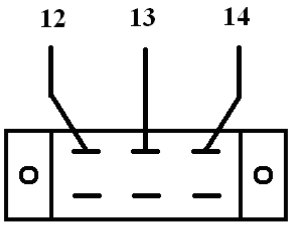
4.2.2 WIRING UP THE TRANSMITTER PCB

Connect the numbers marked on this PCB diagram to the like numbered points on the switches.

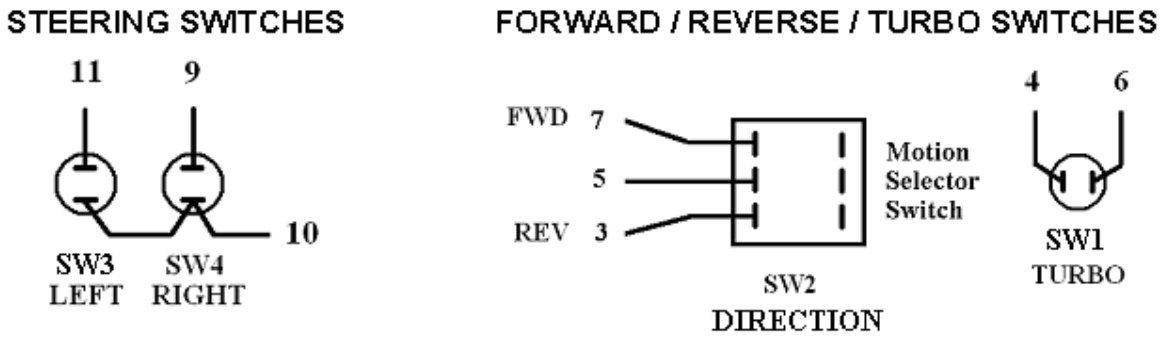


PCB CONNECTIONS:

1. To 9V Battery –ve (Black)
2. To 9V Battery +ve (Red)- via On/Off Switch
12. To Band selection switch
13. To Band selection switch
14. To Band selection switch



BAND SELECTOR SWITCH



Note: All switches are shown looking at their terminals (i.e. from the rear of the switch)

WIRING INSTRUCTIONS

NOTE: Take care to ensure the Positive and Negative wires are connected the correct way before soldering each wire.

- Cut eleven wires the same length (around 150mm) and one a shorter length (around 30mm). Strip 5 mm off the insulation from both ends of the wires. Twist the bare strands together tightly.
  - three wires and the short wire are for the steering switches (SW4 & SW5)
  - the remainder are for the Forward/ Reverse switch (SW2) and the turbo switch (SW1).
- 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 and cut off the excess wire as close to the terminal as possible.

NOTE: With this current configuration, the 2 motors used will operate at different speeds. The turbo switch enables the second motor to operate at the same speed as the first motor – while the turbo button is held on.
To permanently enable turbo operation (that is – both devices / motors running at the same speed), you need to replace SW1 (Turbo switch) with a wire link between holes 4 & 6 on the transmitter PCB

4.2.3 THE HOUSING

- The PCB, switches, 9V battery and antenna need to be installed in a housing.
- The Control Unit's housing is not drawn or described in this unit, as the design (appearance / size / shape) of this plays no part in its function. However, the preferred material should be either plastic or wood - as ferrous materials may affect radio transmission.
  Note 1: the Battery Mounting can be made from a variety of materials. We used a short length of rigid plastic pipe, with a section removed along its length - this allows it to clamp the battery in place, while still allowing the battery to be easily removable.
  Note 2: If you make a metal box for the housing, it is especially important that the antenna does not touch the case, as this will affect its ability to transmit.

4.3 THE RECEIVER PCB

4.3.1 THE RECEIVER AS PART OF THE VEHICLE OR DEVICE

The Receiving unit mounted on the vehicle or device consists of:

- the Receiver PCB
- a sliding Two-way switch (Power On/Off)
- the Band Selector switch

- the Antenna

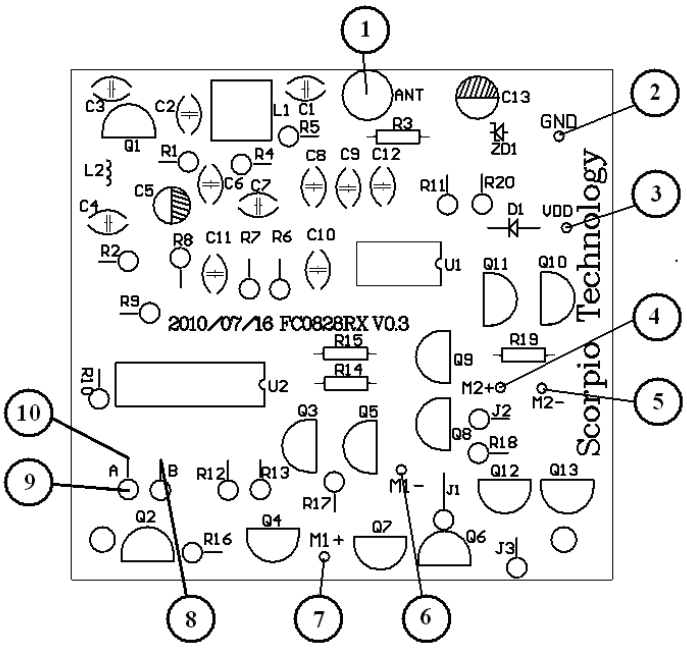
Note: the PCB is connected to the 6 x AA Battery Holder

4.3.2 WIRING UP THE RECEIVER PCB

Connect the numbers marked on the PCB drawing to the identified components.
Soldering should be carried out in the following order:

- Wire the switches in place as shown in the diagram.
- Solder the switches, battery connections and antenna.
- Solder the wires to the motors (after testing the direction of the motor / wheel rotation).

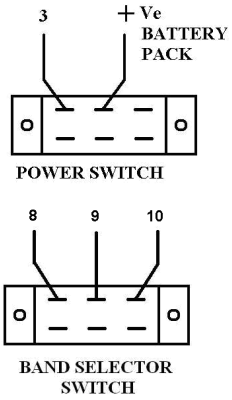
NOTES: Take care to ensure the Positive and Negative wires are connected the correct way before soldering each wire.



PCB CONNECTIONS:

1. To Antenna
2. To 6xAA Battery –ve (Black)
3. To 6xAA Battery +ve (Red)-via On/Off Switch
4. Steering motor / Output device
5. Steering motor / Output device
6. Drive motor
7. Drive motor

SWITCHES



WIRING INSTRUCTIONS

- Cut nine wires the same length (around 150mm). Strip 5mm off the insulation from both ends of the wires. Twist the bare strands together tightly.

Note: the wire length may vary, depending on the relative locations of the various components on the vehicle.

- three wires are for the band selector switch
- one wire (Red) is for the Power (on-off) Switch.
- the remaining wires are for the motors and antenna.

- Place one end of the 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 respective switch terminals. Solder the wires and cut off the excess wire as close to the terminal as possible.

4.4 THE ANTENNAS & CONNECTIONS

4.4.1 MAKING BOTH ANTENNAS

- Both antennas should be made from stiff wire, and should be about 400 mm long.
  Note: Spring steel wire 0.7mm diameter (approx.) or thin brazing rod are suitable materials.

- Bend the end of the antenna into the shape of a ring 3mm inside diameter, for attachment to the PCB.

WARNING: For safety, the antennas' other ends should be doubled over or bent into a small loop.

4.4.2 ATTACHING THE ANTENNAS TO THE PCBs

- For the Transmitter: use a M3 x 8mm bolt to attach the antenna to the antenna bracket on the PCB.
- For the Receiver there are a few choices:
  - attach the antenna using a M3 x 8mm bolt and nut in the appropriate hole, in the PCB. Consider how you will mount the PCB onto your device, as this affects the 3rd PCB mounting point (we mounted our prototype *RCVs* PCB vertically, requiring the use of only 2 mounting points, thus raising the antenna height)
  - make a PCB mounting spacer and attach the antenna to the PCB, using a M3x8mm bolt and nut.

NOTE: regardless of the method used, the contact between each antenna and its respective pad needs to be very good.

4.5 MOUNTING THE RECEIVER PCB

- To mount the Receiver PCB, use the Receiver PCB as a template and mark where to drill the PCBs mounting holes.
- Care must be taken when mounting the Receiver PCB, to ensure that neither the antenna nor the attaching screws and spacers can short across any tracks. This is done by the use of insulating spacers between the PCB and the platform - fibre, plastic or wooden spacers should provide sufficient insulation. This prevents the soldered side of the PCB from shorting out if the base is made from a conducting material, such as aluminium. Attach the PCB, using 3mm x 10mm long self tappers, or in some other suitable way

SECTION 5: TUNING & TESTING THE PCBS

After completing the wiring of PCB assemblies, and mounting them, some testing and adjustment still needs to be carried out.

5.1. BEFORE TESTING - WARNINGS:

CHECK ALL WIRING THOROUGHLY BEFORE CONNECTING THE BATTERIES

- It is worth spending time and giving the wiring and soldering a thorough visual check.
- Connecting positive (+ve) and negative (-ve) incorrectly can result in permanent damage to some components.
- If you experience any problems, recheck the wires and soldering (if another working unit is available, compare it to yours).

5.2 TUNING THE PCBs

NOTE: If you have pre-assembled PCBs, you should ignore this section – the PCBs have been pre-tuned in the factory.

When you have assembled and soldered the 2 PCBs, you need to connect the Receiver to the motors (if building a *RCV*), relays or whatever you have selected to control. This will allow you to tune the PCBs to each other.

In order to adjust the reception of the Receiver for the maximum distance, inductor L1 must be adjusted.

WARNING: The inductor L1 has a small slot in the top of the ferrite slug for adjusting the inductor. You MUST NOT use a metal screwdriver to make this adjustment (the metal of the screwdriver shaft will affect the adjustment). An alignment tool must be used – you can make one from a plastic knitting needle with a flat screwdriver type tip filed onto its end, or purchase one (available from Altronics - part no. T1400).

- The band selector switches, on both the Receiver and Transmitter PCBs must be set to the same band (either 1 or 2).
- The Transmitter and Receiver must both be turned on (the red LED light should glow).
- With the receiver in close proximity to the transmitter you should be able to operate the motors etc.
- Slowly move the transmitter away from the receiver until the Receiver no longer responds.
- Adjust inductor L1 until the reception is improved.
- Repeat this procedure until the maximum reception distance is achieved.

5.3 TESTING AND TROUBLESHOOTING:

If the red LED does not glow or the motors don't operate, turn off the power immediately and check that:

- the batteries have adequate charge (low battery voltage can cause erratic performance)
- all the components are correctly located and oriented and the wiring is connected as per instructions
- the +ve (red) and –ve (black) from the battery connectors go to the correct positions on the PCB
- bare wire ends do not touch other wires or connections on the PCB
- check that there are no solder bridges between the terminals
- the antenna attachment is not shorting across any components
- 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: in this section, one set of pre-assembled PCBs is useful, as it helps to quickly identify which PCB is faulty, and cross check the correct component placement.

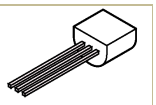
SECTION 6: COMPONENT IDENTIFICATION

6.1 THE TRANSMITTER

Crystal

The crystal has a bright metal body with 27.145 marked on it, and can be connected either way.

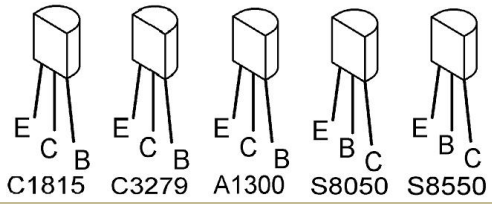
Transistors



Many transistors are used in this kit. Be careful that the numbers marked are the same as on the parts list and the PCB. They may look the same, but if any transistors are wrongly placed the PCB won't work.

The transistors have 3 leads (legs). The Emitter (E), Base (B) and the Collector (C).

Connect the leads as per the markings, and refer to the illustrations below to identify the leads for each type of transistor – connecting these correctly is critical.



Integrated Circuits (IC)

These components look like beetles with lots of legs! They have a notch (or dimple) at one end.

ICs must be placed on the PCB with the notch facing in the direction, as shown on the PCB. If power is connected to the PCB with these facing the wrong way, the PCB will not work and the Integrated Circuit will be permanently damaged.

Capacitors

There are 2 types of capacitors used:

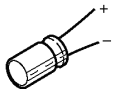
- Disk Ceramic Capacitor
- Electrolytic Capacitor

Disk Ceramic Capacitor

These are like a round disk with two leads. They can be placed either way round. The value is marked on one side. The codes that are marked are shown below.

Value	Code	Value	Code
10pF	10	68pF	68
12pF	12	120pF	120 or 121
15pF	15	10nF	103
30pF	30	47nF	473
33pF	33	100nF	104
56pF	56		

Electrolytic Capacitor

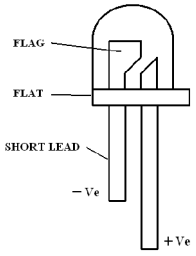


These have a cylindrical body with a stripe down one side. The stripe indicates the negative lead and the other lead is positive - these must be connected correctly or the PCB will not work.

Light Emitting Diode (LED)

This light globe is used to indicate when the transmitter is on. The negative lead can be identified in one of three ways (although not all LEDs use methods 2 & 3. The methods are :

1. The flag (the larger connection inside the body) identifies the negative lead. This is visible when the LED is held up to the light
2. The short leg is negative
3. A flat on the ridge, around the base of the LED is on the negative side.



The negative lead goes to the end that D1's arrow symbol (on the PCB) points towards.

Inductors

There are four inductors used on the Transmitter PCB. They look like large resistors, and can be mounted in either direction. They are:

L1	Yellow, Violet, Gold, Silver
L2	Brown, Green, Gold, Gold
L3 and L4	Red, Red, Gold, Silver

Resistors

Resistors are marked on the PCB as R1, R2, etc.

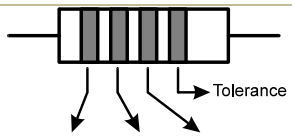
Depending on how the resistor is to be mounted (horizontally or vertically), bend one or both leads as shown on the left.

Insert the leads through holes in the PCB until the resistor's body rests just above or on the PCB..

Bend the leads out slightly on the track

side. This will prevent the resistors from slipping out when the board is turned upside down for soldering.

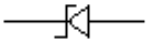
Use the colour code chart (below) to determine the value of each resistor.

Resistance	Preferred Notation			
4.7 Ohm	4R7	Yellow	Violet	Gold
100 Ohm	100R	Brown	Black	Brown
270 Ohm	370R	Red	Violet	Brown
330 Ohm	330R	Orange	Orange	Brown
470 Ohm	470R	Yellow	Violet	Brown
680 Ohm	680R	Blue	Grey	Brown
1k Ohm	1k	Brown	Black	Red
1.5k Ohm	1k5	Brown	Green	Red
2.2k Ohm	2k2	Red	Red	Red
4.3K Ohm	4K3	Yellow	Orange	Red
20k Ohm	20k	Red	Black	Orange
100k Ohm	100k	Brown	Black	Yellow
220k Ohm	220K	Red	Red	Yellow
2.2M Ohm	2M2	Red	Red	Green

The resistors values are marked with coloured bands. These are the resistor colour codes.
The coloured bands are given below.

0 - Black	5 - Green		20% - No stripe
1 - Brown	6 - Blue		10% - Silver stripe
2 - Red	7 - Violet		5% - Gold stripe
3 - Orange	8 - Grey		Multiplier - Gold x 0.1
4 - Yellow	9 - White		

Zener Diode
ZD1 is a 3.3v Zener diode. It has 3v3 marked on its body - a magnifying glass is needed to read it. Note: The diode has a black band on one end. This corresponds to the end that D2's arrow symbol points to - this must be mounted in the correct direction.



6.2 THE RECEIVER

For information on the following component types, refer to the information in the Transmitter section.

- Transistors
- Integrated Circuits (IC)
- Resistors
- Capacitors

Inductors
There are 2 types of Inductors used on the Receiver PCB:

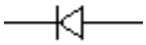
- Variable Inductor
- Fixed Inductor

Variable Inductor
L1 is a variable type of Inductor. This has a plastic body with copper wire wound around its body. It will only fit on the PCB one way round.

Fixed Inductor
L2 is a fixed type. It looks like a large resistor, and can be mounted in either direction. The coloured bands are:
L2: Yellow, Violet, Gold, Silver

Zener Diode
ZD1 is a 3.3v Zener diode.
Refer to the description and information in Section 6.1.

Diode
D1 is a small signal diode. It looks similar to the zener diode. It has 1N4148 marked on its body
- a magnifying glass is needed to read it.
Warning: The Signal diode and the Zener diode must NOT be mixed up or the receiver will not work.
Note: The diode has a black band on one end.

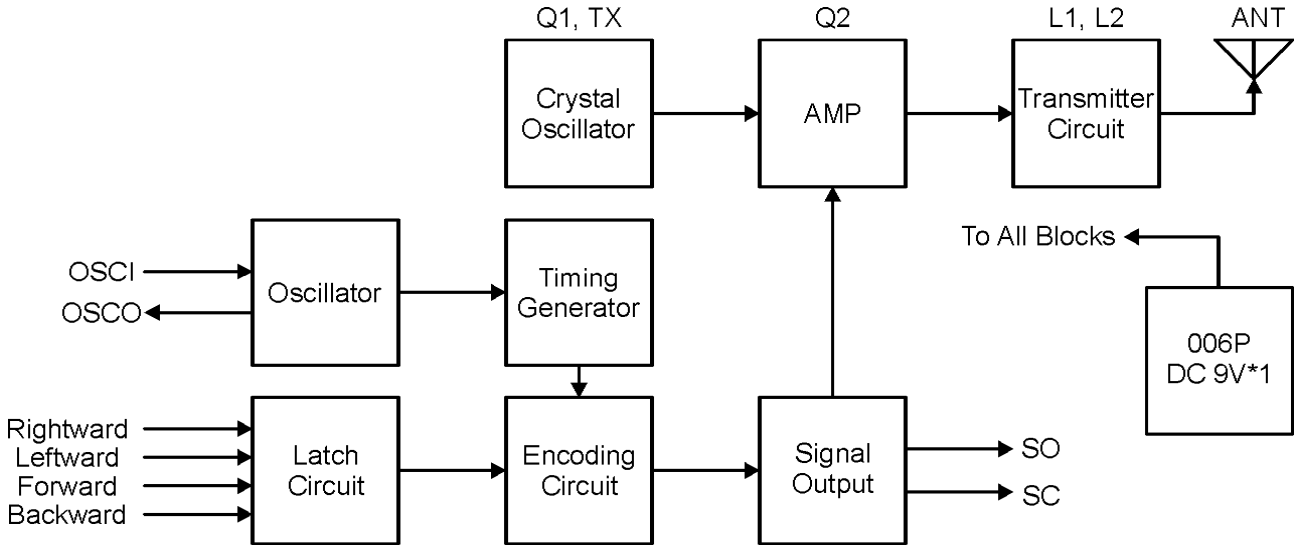


This end corresponds to the end that D1's arrow symbol points to. - this must be mounted in the correct direction.

SECTION 7: THE THEORY OF RADIO CONTROL

7.1 THE TRANSMITTER - HOW THE ELECTRONICS WORKS

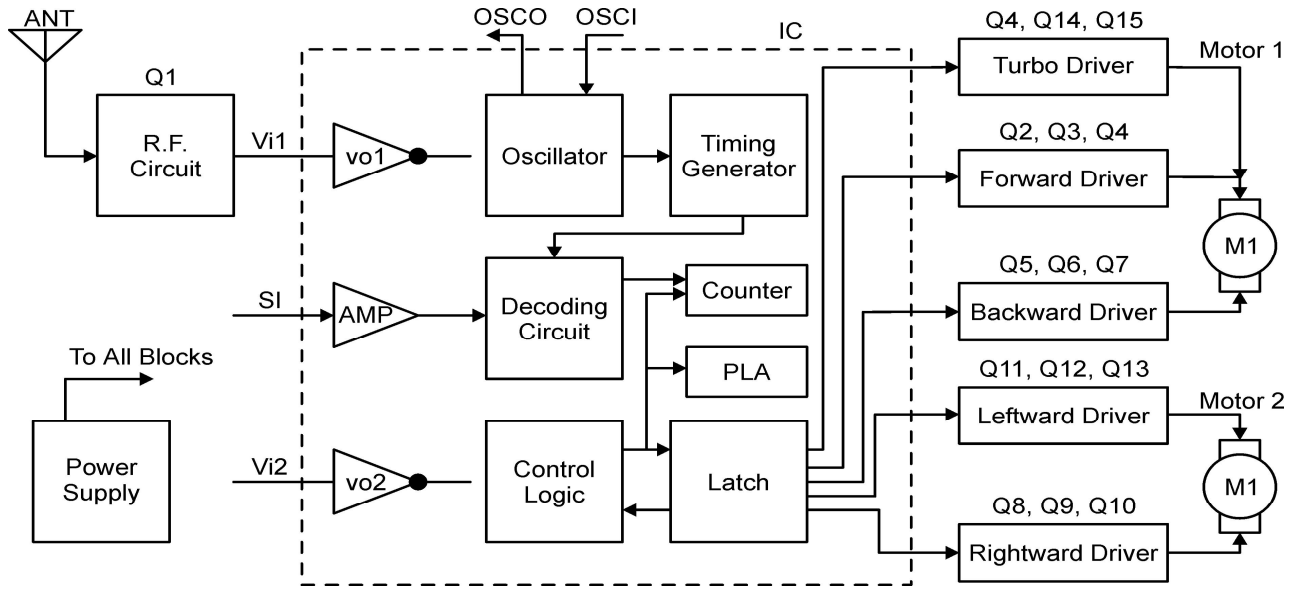
Each switch in the Transmitter is connected to an encoder, which produces a different frequency for each switch position. The encoded signal output is modulated (mixed) with the RF oscillator signal. This modulated signal is transmitted via the antenna. Block diagrams showing the sub-systems are below.



BLOCK DIAGRAM—TRANSMITTER

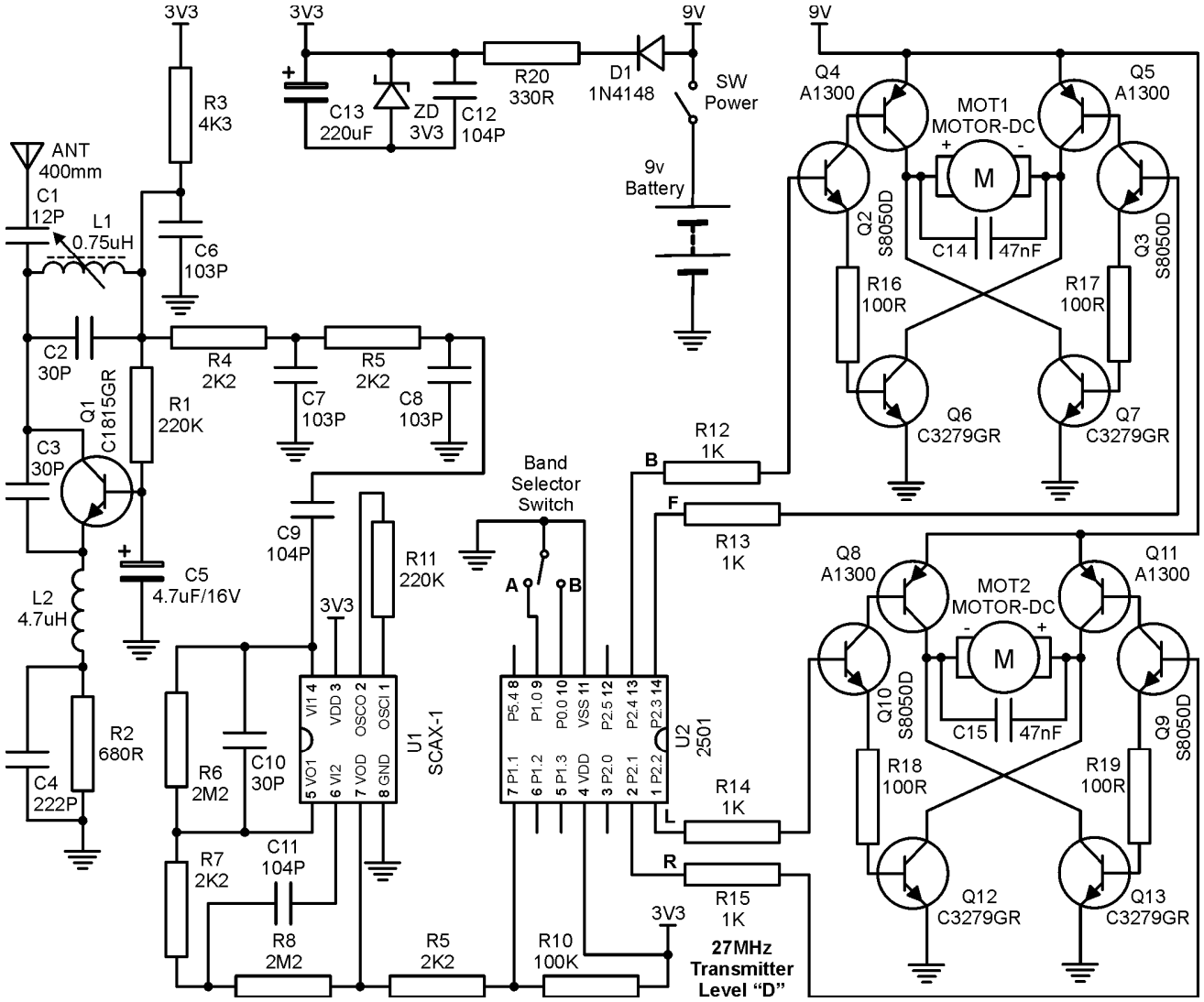
7.2 THE RECEIVER - HOW THE ELECTRONICS WORKS

The receiver's antenna picks up the radio waves, which are then fed to the RF circuit. There the waves are increased in strength (amplified), and sent to the oscillator, where the information encoded in the radio wave is separated from the RF signal (demodulated). This signal is then decoded into the separate signals used to control the direction of the steering and driving motors.



BLOCK DIAGRAM -- THE RECEIVER

SCHEMATIC DIAGRAM - RECEIVER (27.145 MHz)



Note: Two Motors are shown on the Schematic Diagram, and the two motors each have one 473Z Capacitor soldered across the motor's terminals. The capacitors are used to dampen out interference ("noise").

Note: these capacitors, and motors, are supplied as part of the *RADIO CONTROL VEHICLE* kit.

If using the *RADIO CONTROL UNIT* for other purposes, your selected Output devices needs to be substituted for the motors.

SCHEMATIC DIAGRAM -- TRANSMITTER (27.145 MHz)