PLEASE NOTE:

This *INFRA-RED CONTROL UNIT – 4 band (IRCU)* consists of Infra-red Transmitter and Infra-red Receiver assemblies, and all other parts required to operate the unit. It can be used for numerous applications.

Please read the new "*INFRA-RED - 4 band*" instructions carefully. If using this kit as part of the *JOUSTER* kit, this unit needs to be read together with those instructions.

OPTIONS: this kit is available in 2 versions – with the Transmitter and Receiver assembled, or with the Transmitter and Receiver un-assembled.

SUGGESTION: if you are ordering a batch with Un-assembled Transmitters and Receivers, we suggest that you order at least ONE assembled set. This will assist you, if you need to identify problems, if any students experience trouble when assembling and testing their Transmitter and Receiver.

Thank you, and good luck!

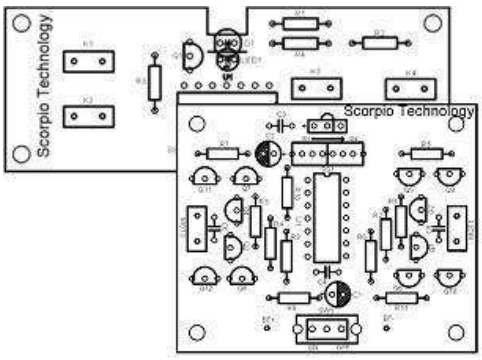
PS. We would appreciate your feedback on these units.

Infrared Control UNIT - 4 band (IRCU)

CONTENTS:

DESCRIPTION

The *INFRARED CONTROL UNIT* consists of the Transmitter and the Receiver assemblies (the PCBs with all their electronic components soldered in place), and all other parts required to operate the unit. The *INFRARED CONTROL UNIT* can transmit on four (4) bands, so that 4 different devices can be operated at the same time, by selecting different bands, using the band selection switch.



The Transmitter is used to transmit 4 different commands to the Receiver, which is mounted on a vehicle or whatever device you choose to make.

The *IRCU* is for indoor use only and will not operate outdoors. It can operate up to a distance of approximately 20 metres.

PLEASE NOTE: The INFRA-RED CONTROL units are available in two variations *– either with the Transmitters and Receivers fully assembled, or unassembled.*

SECTION 1: GENERAL AND PLANNING INFORMATION

THE PROJECT

Some suggested topics for investigation are:

- Look at Infrared waves.
- Investigate Infrared Transmission and Reception principles and uses.
- How does a TV remote control work?
- The choice and suitability of various materials for making the control unit housing, and for mounting the PCBs (aluminium, PVC, perspex, etc.).

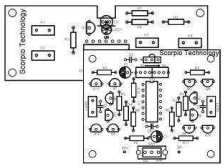
DESCRIPTION OF THE *INFRA RED CONTROLS* AND THEIR FUNCTION

This *INFRARED CONTROL* unit's Transmitter and Receiver each incorporates a band selector switch, to select one of the 4 frequency bands available (both the Transmitter and Receiver PCBs have to be set to the same band). This allows up to 4 devices to be used at the same time – eg. ideal for racing four vehicles, or playing soccer etc.

The Transmitter is used to transmit up to 4 different commands to the Receiver. For example, for a vehicle this would control:

- the vehicle's forward and reverse motion
- the steering – left or right

USES FOR THE INFRARED CONTROL



Possible uses for the INFRARED CONTROL

This *INFRARED CONTROL* unit is designed to control a small device or vehicle. It can have numerous uses, for example:

- to operate a device for a disabled person
- to operate a Solenoid, for a mechanical device (eg. a door latch)
- to make a door entry alarm
- Volume control for an old style radio
- operate Relays to switch things on / off

Batteries and current usage

Many electric devices, such as motors, draw a relatively large current. This needs to be considered when deciding what to control – the maximum that this unit will allow is to draw up to 2.0 Amps. Thus, not all controllable items are suitable for this project – any item requiring more than this will not function.

Note: because of the potentially large current draw, for consistent performance alkaline batteries are recommended, as low battery voltage can cause erratic performance.

DECIDING WHICH TYPE OF INFRARED CONTROL UNIT KIT TO USE…

The *INFRARED CONTROL* units are available in two forms – either the Transmitter and Receiver fully assembled, or unassembled (as below). The Planning stage should also include a review of the student's skill level, and the available time, to determine which of these assembly levels is most appropriate:

1) **TYPE A:** the Receiver and Transmitter units are fully assembled (ie. All the components are assembled and soldered onto the PCBs).

2) **TYPE U:** the Transmitter and Receiver PCBs with all the electronic components loose, in bags. Parts have to be identified, located onto the PCBs and soldered to the PCB's – the time for these tasks needs to be factored into the project.

SUGGESTION: if buying a class set of unassembled IRCUs, we recommend that at least one set of assembled units is purchased, to allow testing of student assembled units.

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.

NOTE: depending on whether you have chosen the ASSEMBLED or the UN-ASSEMBLED the Transmitter and Receiver Kits, you need to refer to either section 2.1A (Assembled) or section 2.1B (un-assembled)

2.1 COMPONENTS SUPPLIED IN THE KIT:

2.1A TYPE A: KIT WITH *ASSEMBLED TRANSMITTER AND RECEIVER*:

1 x	Assembled Transmitter - IR	4 x	Pushbutton Switch
1 x	Assembled Receiver - IR	1 x	Slide switch (small)
1 x	Infra red Transmitter globe	4 x	M3x 12mm Bolts
2 x	3AA Battery holder	8 x	M3 Nuts

2.1B TYPE U: KIT & COMPONENTS for ***UN-ASSEMBLED*** *TRANSMITTER AND RECEIVER*:

2 x 3AA Battery holder
1 x Infra red Transmitter globe
4 x Pushbutton Switch
1 x Slide switch (small)
4 x M3x 12mm Bolts
8 x M3 Nuts

INFRARED TRANSMITTER PARTS (in one bag)

1x PCB (FC1212 – ODLY-IRTX)
1x IC (FC1212-TX)
1x 14 Pin IC Socket
1x S8050 Transistor (Q1)
1x Infra-Red Transmitting diode (IR)
1x 4 Position Slide switch
1x 47uF/10V Electrolytic Capacitor (C1)
1x 0.1uF (104) Ceramic Capacitor (C2)
2x 10R Resistors (R1, R2)
1x 10R Resistors (R1, R2)
1x 2.2K Resistor (R4)
1x 3mm LED - bright red (LED1)

INFRARED RECEIVER PARTS (in one bag)

1x PCB (FC1212 – ODLY-IRRX)
1x IC (FC1212-RX) (U1)
1x 14 Pin IC Socket
4x 2SA1300 Transistor (Q1,Q2,Q3, Q4)
4x S8050 Transistor (Q5,Q6,Q7 Q8)
4x 2SC3279 Transistor (Q9,Q10,Q11, Q12)
1x Infra-Red Transmitter Diode (IR)
1x 4 Position Slide Switch (SS1)
1x On-off Switch (slide switch)
1x 100uF/10V Electrolytic Capacitor (C1)
1x 22uF/10V Electrolytic Capacitor (C2)
4x 0.1uF (104) Ceramic Capacitor (C3,C4,C5, C6)
4x 220R Resistor (R1,R2,R3, R4)
4x 2.2K Resistor (R5,R6,R7, R8)
1x 10R Resistor (R9)
2x 47R Resistor (R10,R11)

2.2 ADDITIONAL REQUIREMENTS

2.2.1 The additional requirements are: fine multi-strand electric wire (different colours), 6 x AA batteries (3 each for the Transmitter and Receiver) - Alkaline batteries are recommended

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

SECTION 3: PCB ASSEMBLY

PLEASE NOTE: THIS SECTION ONLY applies if you have *UN-ASSEMBLED TRANSMITTER & RECEIVER* KITS

NOTES: General information and identification of the various components is provided in Section 6 - both the transmitter and receiver PCBs have a printed silk screen overlay on the PCBs, to indicate component locations.

3.1 GENERAL COMMENT

Constructing the Transmitter and Receiver is relatively straight forward. 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.

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. 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.

NOTE: the section on COMPONENT IDENTIFICATION (Section 6) also has important information describing component orientation.

Component assembly sequence…

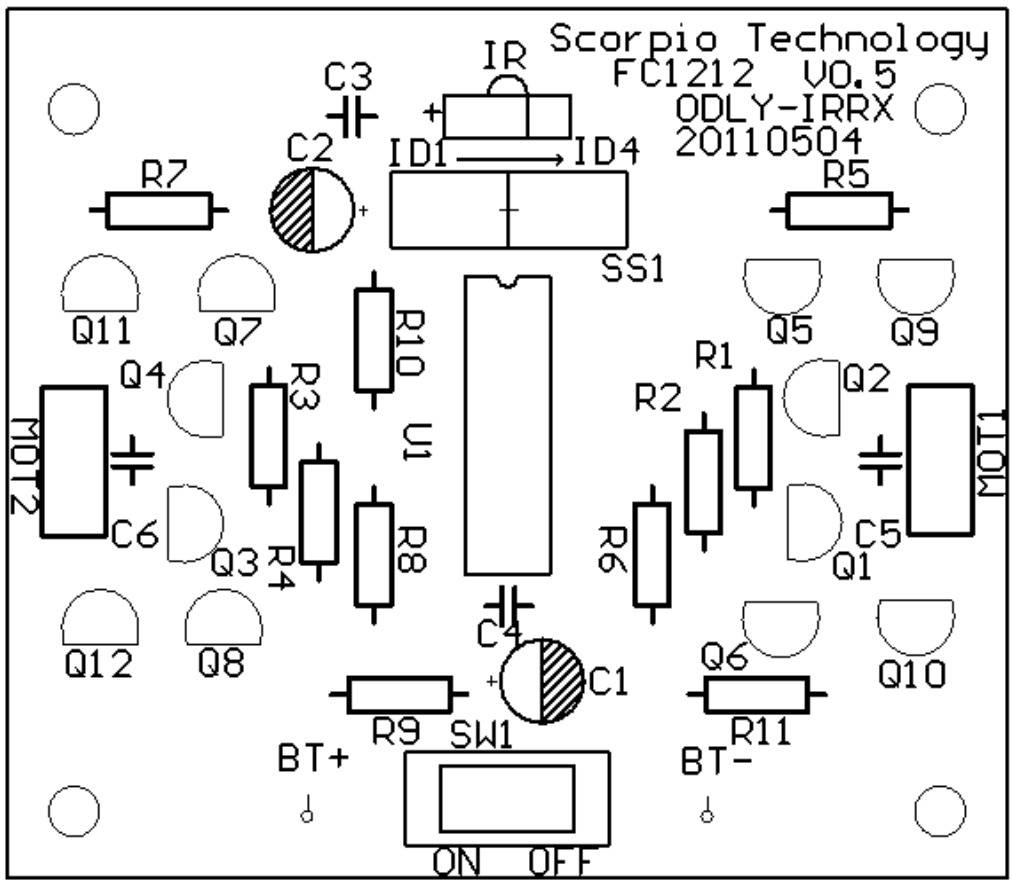
The assembly of all the components to the PCB should be completed before soldering the components in place.

Begin by placing the components that sit lowest on to the PCB.

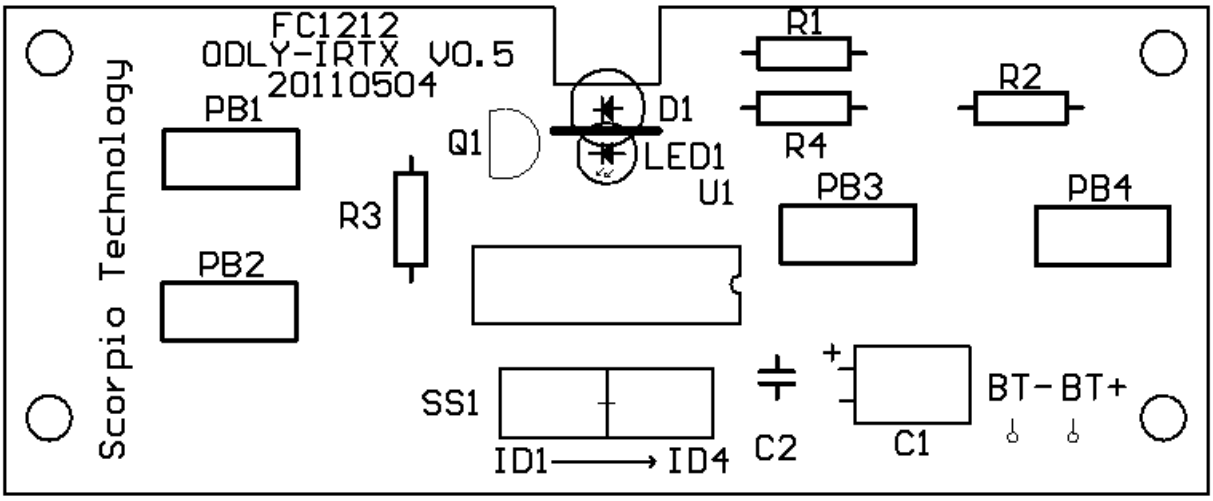
- Mount the resistors in place. Resistors are non-polarised components and do not need to be placed in any particular direction. However, the convention is that horizontal resistors are mounted with the gold (tolerance) band to the right and vertical resistors to the bottom.
- Insert the IC socket next. Make sure the NOTCH on one end of the IC socket is facing in the correct direction as shown on the overlay.
- All Transistors, LED's, Infrared Transmitters and Receivers MUST be in the correct direction or the completed Receiver and Transmitter will not work.

SUGGESTION: When all the components are in place, but before soldering, <u>check them carefully</u> against the printed circuit board or drawings.

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.



RECEIVER PCB



TRANSMITTER PCB

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' locations are checked and confirmed, 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 for the I.C. socket and the transistors mounting. Solder bridges must be removed before connecting power to the PCB. Failure to do so may result in damage to some of the circuit or components.

The last stage – installing the IC…

- After all the soldering has been completed, insert 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 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 TO THE TRANMSITTER & RECEIVER

4.1 GENERAL INFORMATION

4.1.1 WIRING UP THE PCBs

A number of parts need to be wired to the completed Transmitter and Receiver. The following is a general description, which needs to be tailored to your specific application.

4.1.2 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.
- WIRES: Use different colour wires. This makes it easier to follow wires for connecting items, and easier to trace wiring problems. Use multi-stranded wires, as single stranded wires break off after they have been bent a few times.

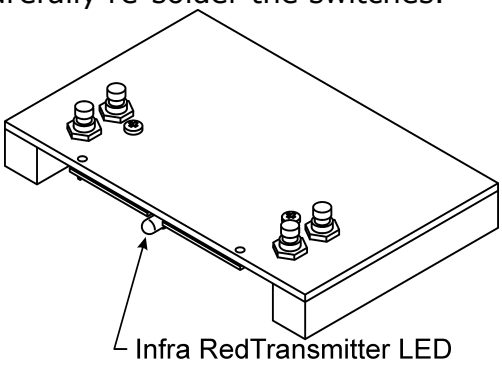
4.1.3 THINGS TO LOOK OUT FOR

- Switches should be clamped when connecting wires to them (a printed circuit board 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.

4.2 THE TRANSMITTER

4.2.1 THE HAND HELD CONTROL UNIT

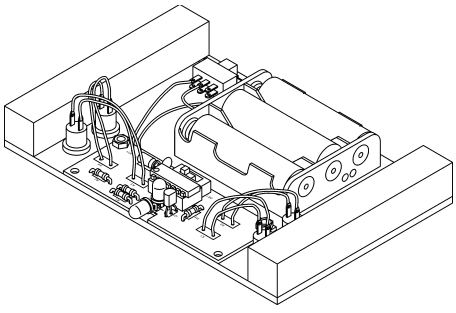
- The Transmitter, switches and 3AA battery holder are installed in a housing, to make a compact Control unit.
- The housing is not described, as the appearance / size / shape plays no part in its function.
  Note: the Housing can be made from a variety of materials – our prototype was made from timber.



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

- Drill 7 mm holes for mounting the push-button switches.
- Sides on the Control unit are important, as they allow the control unit to be put down, 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.

4.2.2 THE TRANSMITTER CONTROL UNIT consists of:



- the Transmitter (that is, the PCB with all components assembled and soldered to it)
- The Infrared transmitter globe
- the On-off switch
- one 3AA Battery Holder
- the Band Selector switch (assembled to the PCB)
- the Push button switches (SW1 to SW4) – these control 2 motors or other output devices.

For example, for a vehicle with one drive motor and steering, these would control Forward-Reverse, and Left-Right steering.

4.2.3 THE TRANSMITTER (CONTROL UNIT):

- 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 legs first – check the orientation of negative and positive leads).
- insert the leads into the holes in the PCB.
- solder the leads and cut them.

USING AN ENCLOSED CONTROL UNIT

If you use an enclosed case for the Control unit:

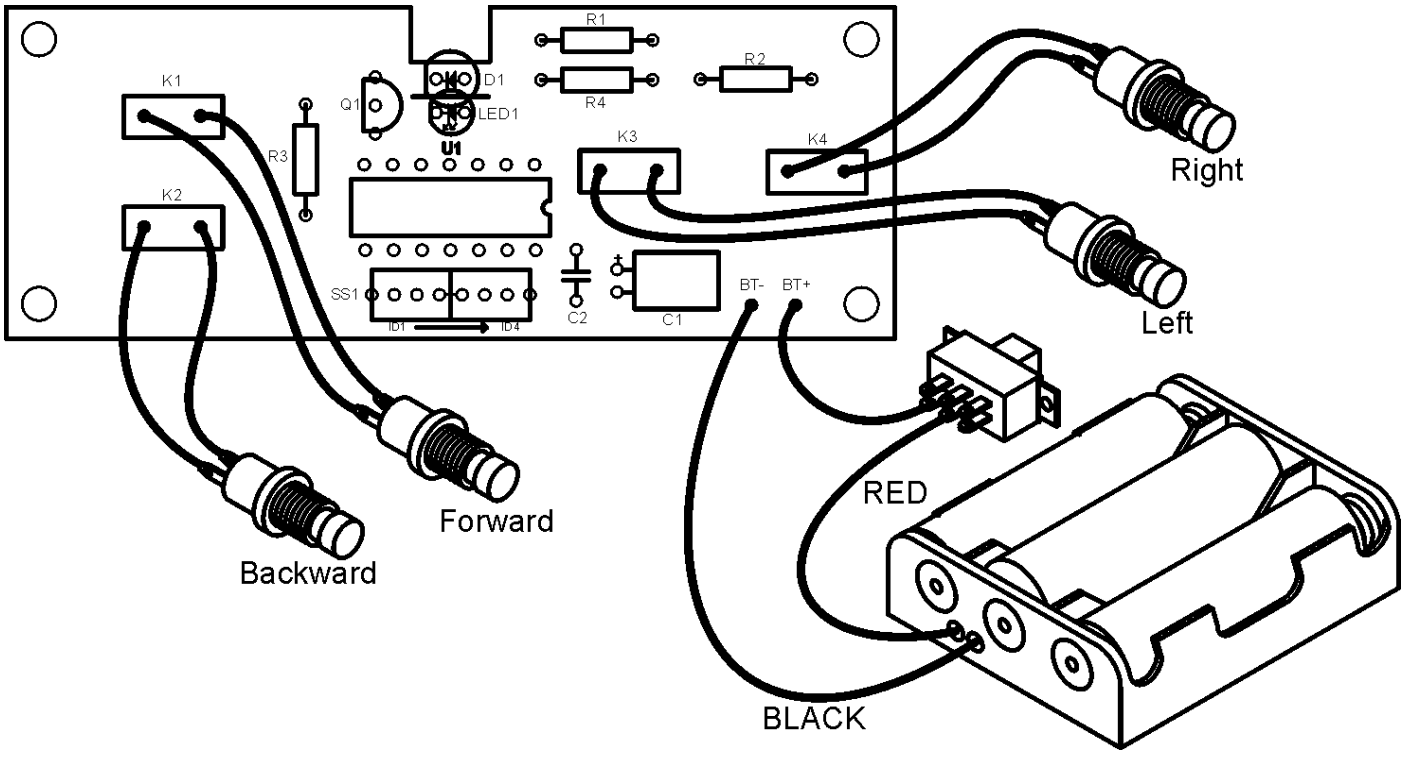
- drill a 5mm hole in the case, and insert the LED, so that the LED portion is outside the case, and not hidden.
- connect wires to the leads.
- solder the wires to the correct holes on the PCB.

4.2.4 WIRING UP THE TRANSMITTER PCB

- An On/Off switch is mounted off 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 for the pushbutton switches and one red 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 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 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.

4.2.5 MOUNTING THE TRANSMITTER UNIT

- To mount the Transmitter, use the PCB as a template and mark where to drill the mounting holes – using diagonally located mounting holes is best. We have provided 2 bolts and 4 nuts for this (one nut is used as a spacer)

4.3 THE RECEIVER PCB

4.3.1 THE RECEIVER AS PART OF THE VEHICLE OR DEVICE OF YOUR CHOICE

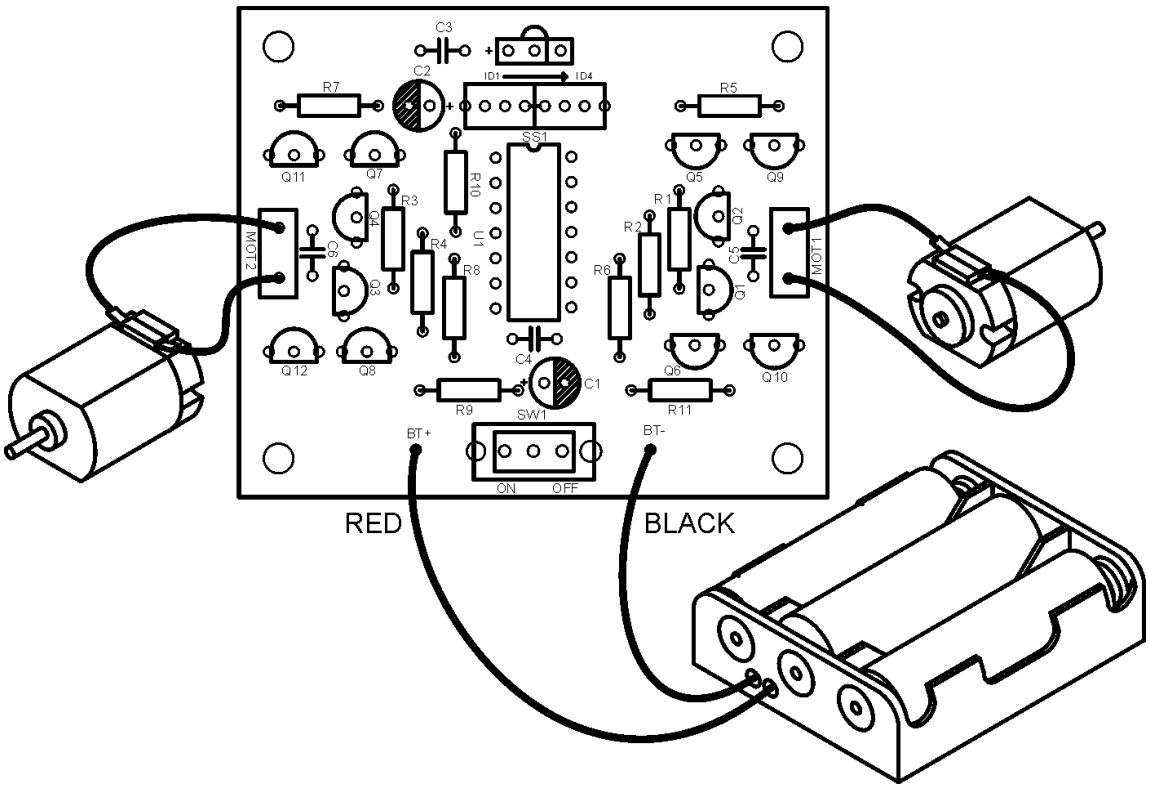
The Receiving unit mounted on the vehicle or device consists of:

- the Receiver (that is, the PCB with all components assembled and soldered to it)
- one 3AA Battery Holder

4.3.2 WIRING UP THE RECEIVER PCB

Wiring should be carried out as shown in the wiring diagram (we have shown motors, but these output devices will be whatever you have selected to use):

- Solder the battery connections.
- Solder the wires to the output device you've chosen to use - after testing that the direction of movement is correct.



WIRING INSTRUCTIONS

- Cut four wires the same length - these wires are to connect the PCB to the output devices. Strip 5mm off the insulation from both ends of the wires, and twist the bare strands together tightly.
- Connect the other ends of the wires to the output device terminals.. 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 the correct way round.

4.5 MOUNTING THE RECEIVER

- To mount the Receiver, use the PCB as a template and mark where to drill the mounting holes – using diagonally located mounting holes is best. We have provided 2 bolts and 4 nuts to use.
- When designing the platform and mounting the Receiver assembly, take care that the Infrared-Receiver is not hidden – it works by "line-of-sight" from the Transmitter (the same as a TV remote).

SECTION 5: TESTING THE PCBS

After completing the wiring of both the Transmitter and Receiver units, 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 a bit of time and give 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 TESTING AND TROUBLESHOOTING:

When the Transmitter and Receiver units are assembled and soldered, you need to connect the Receiver to the motors (if building a *JOUSTER* or other motorised device), relays or whatever you have selected to control.

If the red Indicator LED does not glow when the pushbutton switches are operated 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
- 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 PCB is faulty, and cross check the correct component placement.

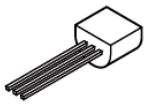
SECTION 6: COMPONENT IDENTIFICATION

6.1 GENERAL INFORMATION

To construct these PCBs a good understanding of the various components and their symbols is important, before the students begin their project.

6.2 COMPONENT DESCRIPTIONS

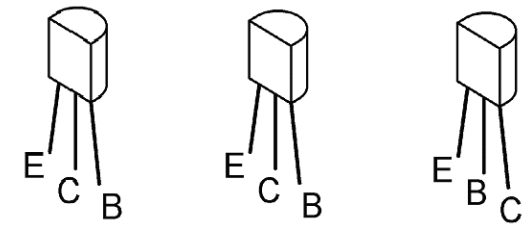
Transistors



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:

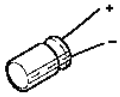
- Disk Ceramic Capacitor
- Electrolytic Capacitor

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 code that is marked is:

100nF 104

Electrolytic Capacitor

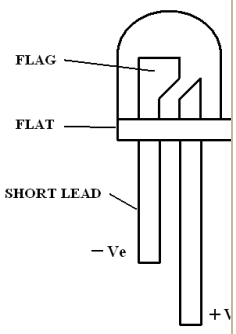


These have a cylindrical body with a stripe down one side. The stripe indicates the negative lead and the other lead is positive - these must be connected correctly or the PCB will not work.

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.

Infrared Transmitter LED

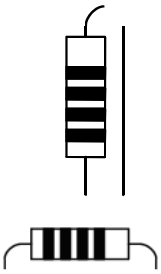
This component is a type of LED that works in the invisible light spectrum. You will not know if it is working by looking at it. It has 2 leads and will not work if incorrectly positioned on the PCB. It uses the same methods as the LED shown above to identify the negative lead

Infrared Receiver

This component has 3 leads and a surface bump. The bump MUST face towards the closest edge of the PCB.

Resistors

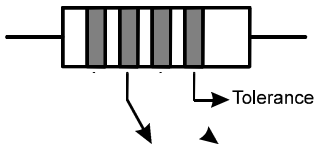
Resistors are marked on the PCB as R1, R2, etc.



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.

Resistance	Preferred Notation			
10 Ohm	10R	Brown	Black	Black
47 Ohm	47R	Yellow	Violet	Black
220 Ohm	220R	Red	Red	Brown
1k Ohm	1k	Brown	Black	Red
2.2k Ohm	2k2	Red	Red	Red

The resistors values are marked with coloured bands. These are the resistor colour codes. The coloured bands are given in the table to the right.

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	

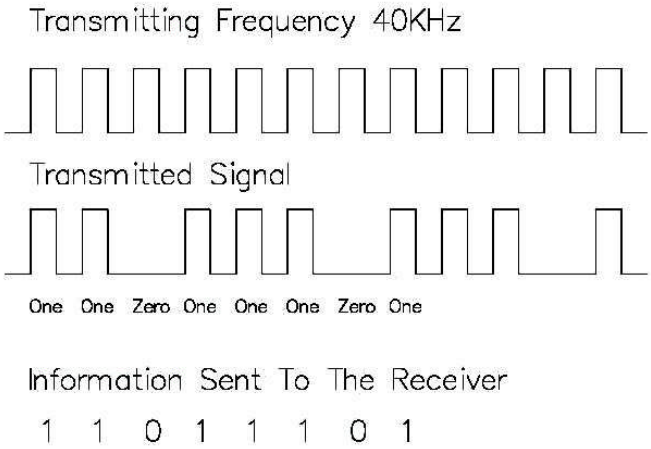
SECTION 7: THEORY - HOW DOES THE INFRARED CONTROL WORK

Light is a form of electro-magnetic radiation. Light can be visible or invisible to the naked eye, depending on the wave length. For example, red light is visible light. On the other hand, Infra-red light has a longer wave length, of between 390 to 740 nm, and is invisible to us.

Infrared controls are widely used to control TV's/VCRs/DVD etc. and many other devices. The signal from the controller only operates on the "line of sight" principle. In other words unless you can see the object you are controlling, the signal from the controller (Transmitter) will not be received. For example, if your Infrared Controlled vehicle turns behind a couch and you can no longer see it, the controller will no longer control the vehicle.

The signal sent from the transmitter is a series of pulses sent at around 40KHz. The band selector switch allows the frequency to be either slightly higher or lower than 40KHz. Once the transmitter's band selector switch is set to a particular value it will only work with the receiver if the receiver's band selector switch is set to the same position.

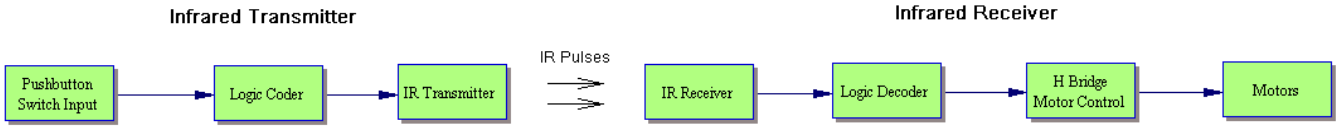
The pulses sent by the transmitter are in the form of pulses of infrared light. When infrared light is sent this represents a logic level of 1. The spaces when no infrared light is sent, represent a logic level of 0.



Using this method of information it is possible to have 256 different commands. The controller with this kit has only 4 commands to allow you to control the forward and reverse operation of 2 different motors.

This information is sent to the infra-red Receiver (the actual component). The receiver then sends the signals to the Receiver's IC, which interprets the signals and sends commands to the circuitry controlling the output devices (eg. the motors).

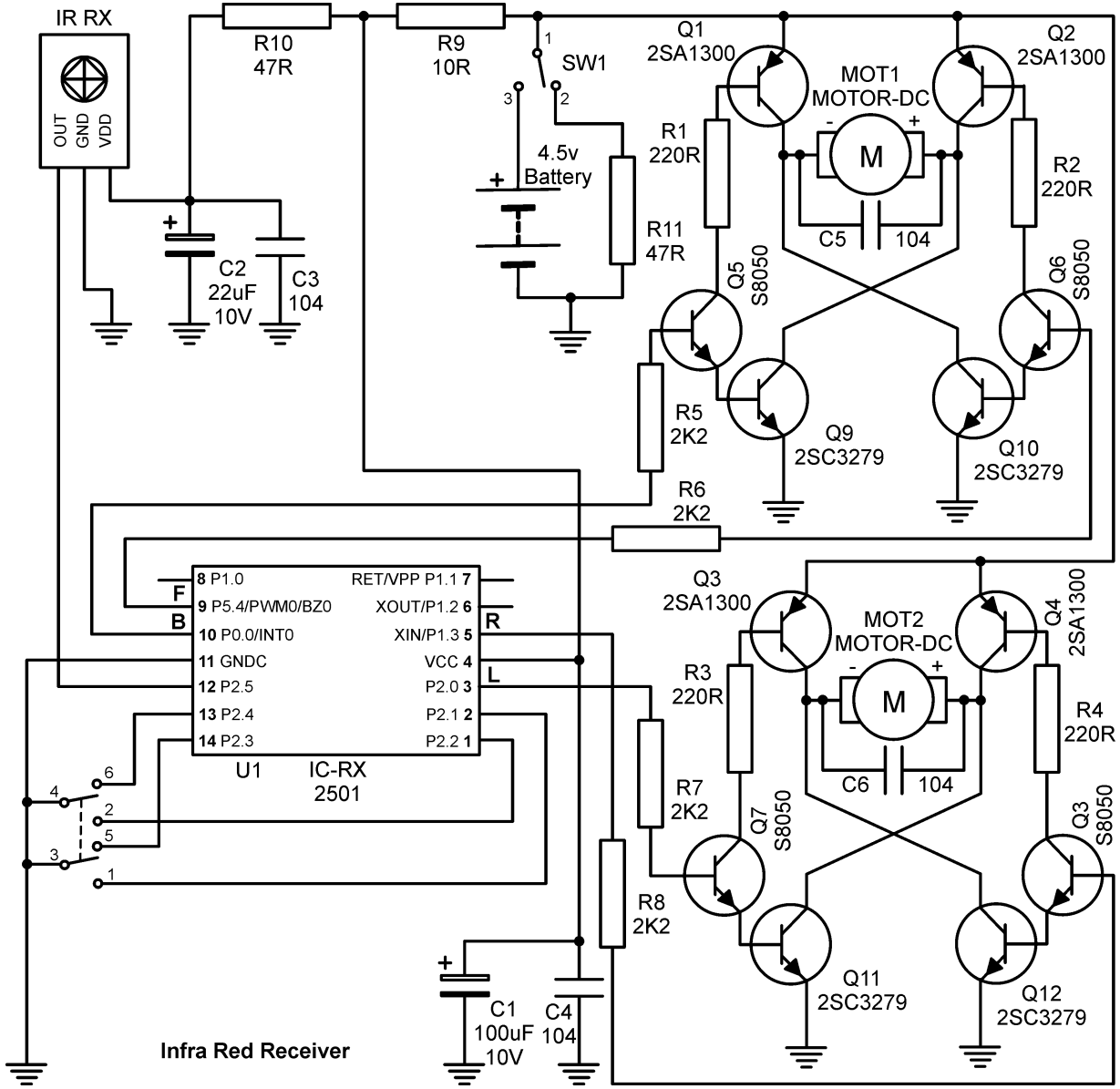
Block Diagram Showing Major Sub-Systems



System Description

When power is applied to the circuit (that is, when one of the pushbuttons is pressed), it causes a coded series of pulses to be generated by the logic controller. These pulses are sent to the IR Transmitter LED, which sends the signal to the IR Receiver. The IR Receiver picks up the IR pulses. These are sent to the Logic Decoder where the signals are decoded and logic signals are applied to the H Bridge's input. The H Bridge is made up of a number of power transistors. These transistors are used to control the presence and polarity of the voltage applied to the output devices. If no voltage is present the output device is stopped. When a voltage is present the output device will operate. If the polarity of the voltage is reversed the output device's direction of rotation will also reverse.

SCHEMATIC DIAGRAM - INFRA-RED RECEIVER



SCHEMATIC DIAGRAM -- INFRA-RED TRANSMITTER