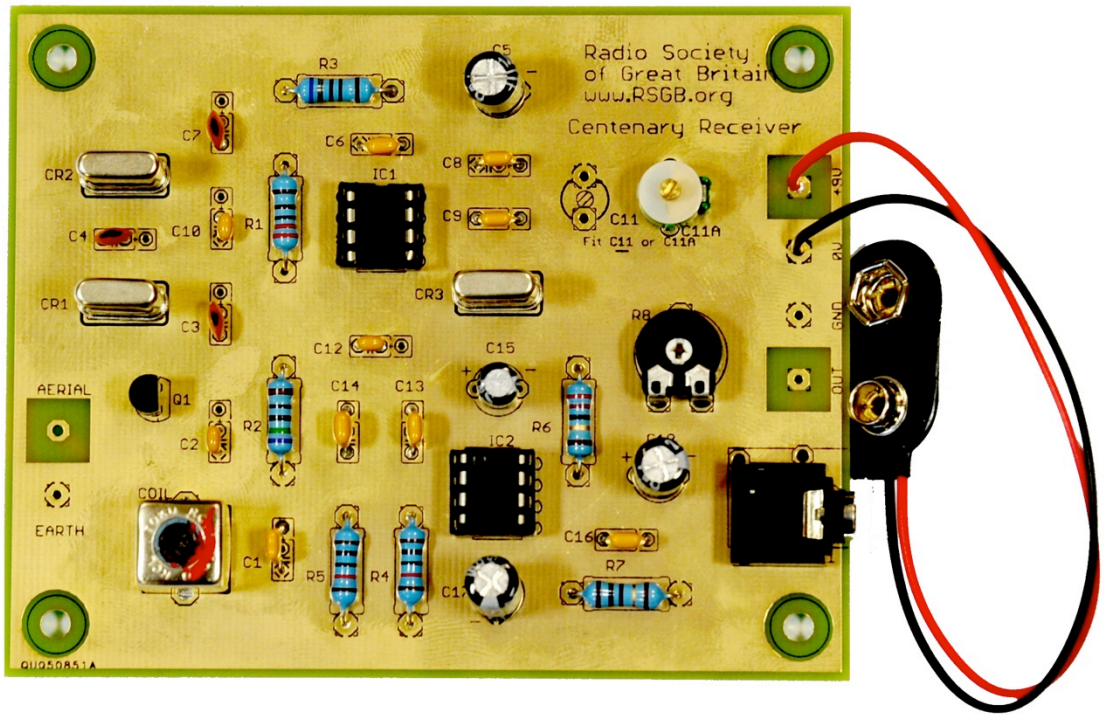
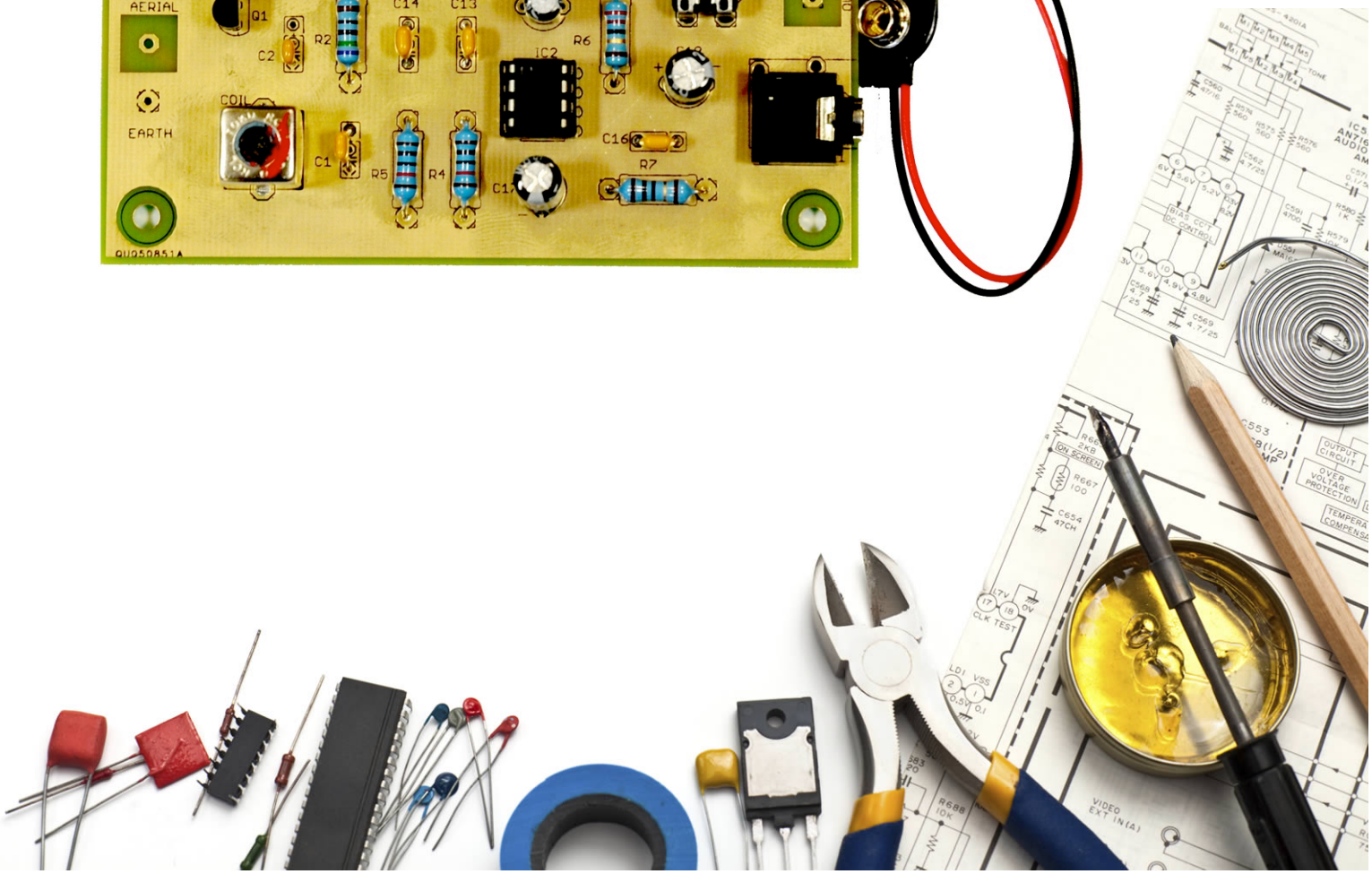
The RSGB Centenary Receiver Project

Construction Manual





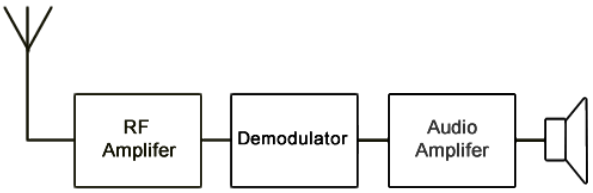
Introduction

This project is intended for those new to radio construction. It is a fairly simple receiver for the 14MHz (20m) amateur radio band and is specifically for the reception of data signals known as PSK31.

A computer is required to decode the data signals. That can be a PC, a laptop, a Raspberry Pi, a tablet or a smart phone. The project shows how radio equipment and computers can and do work together in the 21st century.

The receiver works in three stages, as depicted in the block diagram below:

- The first stage selects the 14MHz radio frequency data signals from all of the thousands that are present in the air. A tuned circuit and two crystals are used to ensure that only the wanted signals are selected and a small transistor amplifier increases the signal strength ready for the next stage.
- The second stage demodulates; it turns the radio frequency data signals into audio frequency data signals that we can hear. An integrated circuit is used to carry out this function and another crystal is used to ensure the demodulator stays on the correct frequency.
- The final stage amplifies the audio frequency signals so that they are strong enough for a computer to decode the data and display it as text on a screen. Another integrated circuit is used with an adjustable gain control so we can set the audio output to the correct level.



Construction is carried out in reverse order in that the audio frequency amplifier is built first and tested. Once we know the audio frequency amplifier is working, the demodulator is added and tested. When we know that the first two stages are working properly, the radio frequency amplifier and selection stage is added so the whole project can then be tested and used.

This method of building and testing in stages is commonly used to enable any errors or faulty parts to be identified in a small stage rather than trying to find a fault in a completed project. It would be possible to build and test the stages starting at the radio frequency end, but the testing would require some fairly complex equipment.

There are several software programs and applications available to decode the data; most of them are available free of charge. Which one you use depends on which computer you are going to use. Advice on where to obtain them and how to use them is provided after the construction instructions.

The receiver is constructed on a Printed Circuit Board, or PCB. Component locations are shown on the top side and they are inserted from this side. The connections are soldered on the underside. A ready made PCB is available from the RSGB Shop. There are other methods of construction but the PCB method has been used here for ease as this intended to be a project for the newcomer. It is assumed that those building the project will know how to solder, either through school work, or from an amateur radio training course.

Notes to the builder

Check Before you Solder!

It is important to get the electronic components in the right places for the circuit work properly and changing them after you have soldered them can be difficult. So, check and double check that you have the right part in the right place before you solder it in place.

Once each part is soldered in place, tick off the check box so you do not forget where you are up to.

Capacitors

Pay close attention when fitting the capacitors. Electrolytic capacitors (larger cylindrical bodies) need to be installed the correct way around. Each Electrolytic capacitor has a white stripe down one side. This is the negative and needs to be aligned with the (-) on the circuit board. The positive lead is a little longer too.

The ceramic capacitors (smaller flat disc bodies) also require some attention when installing. The circuit board gives the option to install different types of capacitor; observe the circuit board and ensure the capacitor is installed each side of the | | sign on the board, but there are no positive or negative leads.

Headphone Socket

Installing the headphone socket may require some tape to hold the component in place while soldering. Again, holes are provided for different types of socket. If you find there is not quite enough pin to solder onto you can remove the small plastic lugs on the body of the socket to allow more pin to protrude from the PCB.

Coil

There are 3 pins on one side and two on the other, and two side tabs. Ensure you have the pins/tabs correctly aligned before pushing into position. This will require some gentle pressure to fit. Some coils can be quite tight and need care to install onto the board. Start by aligning just one side of the can and ensuring the pins can go through the board. Repeat this process with the other side and gently wiggle the whole coil into position until the can is firmly in place. This is a little tricky so if you are having difficulty, please ask for assistance.

Variable Resistor (potentiometer)

The Variable Resistor (P1) can also be quite tight and may not fully fit flush on the circuit board. Gently push the component into position ensuring none of the pins are folding over.

Integrated circuits

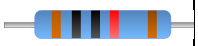
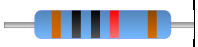
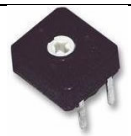
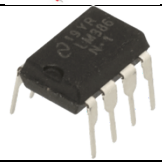
You will need to squeeze the 2 rows of the pins together a little. Do this by resting 4 pins on the table and applying a little pressure. Do the same on the other side of the IC. Once you have the pins lined up and the notch in the IC holder lined up push in place.

Antenna connection

During the build we will connect an antenna using crocodile clips. It is best to use a piece of resistor lead you have cut off and bend it around to create a loop. The hole will be quite wide so bending the component over on the solder side will stop the wire from falling through.

Part 1. The Audio Frequency Amplifier

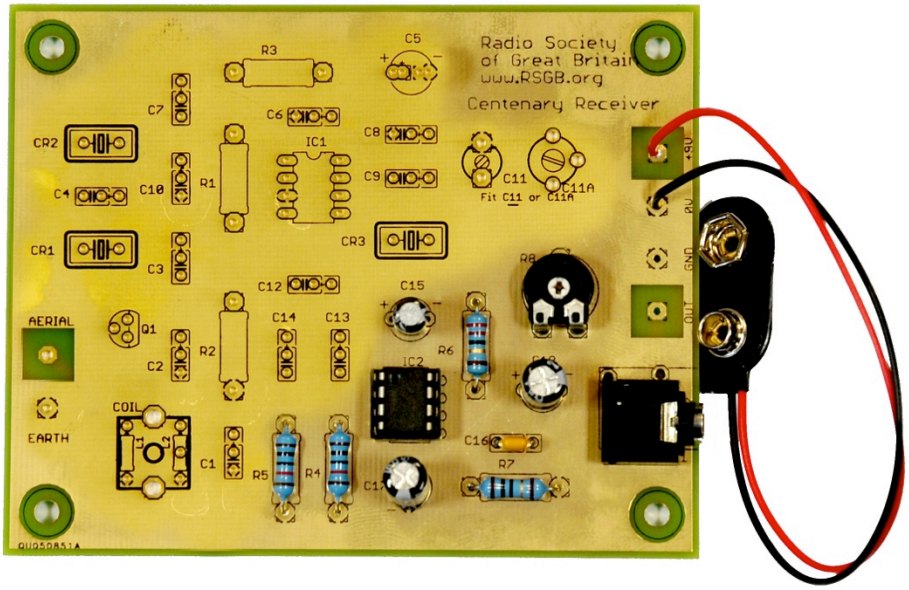
Construction

Component	Task	Complete
	**R4.** Fit 10kohm resistor (Coloured Brown, Black, Black, Red) and solder in place.	❑
	**R5.** Fit 10kohm resistor (Coloured Brown, Black, Black, Red) and solder in place	❑
	**R7.** Fit 10ohm Resistor (Coloured Brown, Black, Black, Gold) and solder in place.	❑
	**R6.** Fit 22ohm Resistor (Coloured red, red, black, gold). Solder it in place.	❑
	**C15.** Fit 10uF Capacitor. ***(See Notes to the builder)***	❑
	**C17.** Fit 100uF Capacitor. ***(See Notes to the builder)***	❑
	**C18.** Fit 100uF Capacitor. ***(See Notes to the builder)***	❑
	**C16.** Fit 100nF Capacitor. Marked 104. Solder in place.	❑
	**R8.** Fit 4.7kohm or 5kohm variable resistor. ***(See Notes to the builder)*** Solder in place.	❑
	**SK1.** Fit the 3.5mm audio output socket into position and solder. ***(You may need to use some tape to hold it in place while you solder the pins).***	❑
	**IC2 socket.** Fit the integrated Circuit socket for IC2. ***(There is a notch at one end, make sure it lines up with the outline on the circuit board).***	❑
	**Battery Snap.** Make sure the red wire goes in the (+) hole on the circuit board and the black wire connects to the negative (-) on the circuit board. Solder in place.	❑
	**IC2.** Fit the Integrated circuit LM386 into the socket. ***(See Notes to the builder).***	❑

Part 1. The Audio Frequency Amplifier

Testing

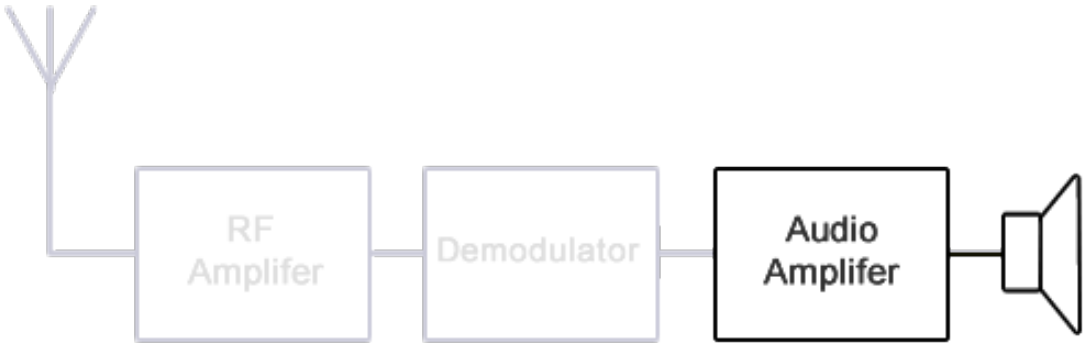
Your circuit should now look like this.



Complete the following tests before moving onto the next stage.

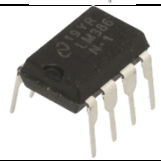
	Test	Complete
1	Check over your soldering. Make sure all wires are trimmed, and no short circuits are present.	❑
2	Connect up a speaker or headphones to SK1.	❑
3	Connect a 9v battery to the battery snap and confirm you can hear a hiss or slight hum. ***(Touching the top of R4 or R5 with a metal screwdriver blade should make it louder).***	❑
4	Confirm that adjusting R8 increases and decreases the hiss / hum.	❑
5	Disconnect the battery.	❑

The audio Frequency Amplifier is now complete. Move onto Part 2.



Part 2. The Demodulator

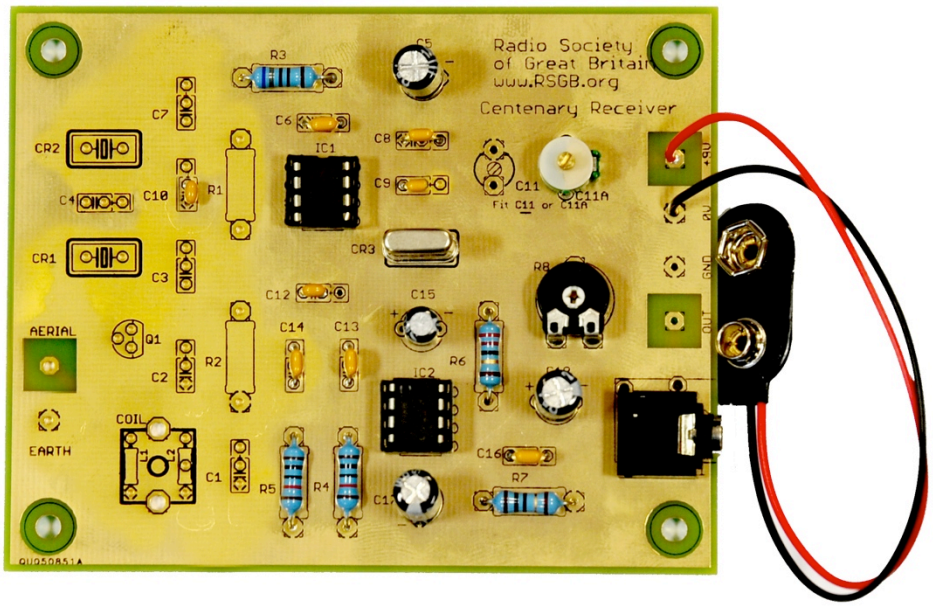
Construction

Component	Task	Complete
	**IC1 socket.** Fit the integrated Circuit socket for IC1. ***(There is a notch at one end, make sure it lines up with the outline on the circuit board).***	❑
	**R3.** Fit 680ohm resistor (Coloured Blue, Grey, Black, Black) and solder in place.	❑
	**C5.** Fit Capacitor. Marked 100uF. Solder in place ***(See Notes to the builder)***	❑
	**C6.** Fit 100nF Capacitor. Marked 104. Solder in place.	❑
	**C8.** Fit 47pF Capacitor Marked 470. Solder in place.	❑
	**C9.** Fit 47pF Capacitor Marked 470. Solder in place.	❑
	**C10.** Fit 47nF Capacitor Marked 473 . Solder in place.	❑
	**C11.** Fit 2 – 30pF Variable Capacitor (Green body). Solder in place. ***(C11A is provided for alternative component style; do not use both).***	❑
	**C12.** Fit 47nF Capacitor Marked 473. Solder in place.	❑
	**C13.** Fit 100nF Capacitor. Marked 104. Solder in place.	❑
	**C14.** Fit 100nF Capacitor. Marked 104. Solder in place.	❑
	**CR3.** Fit 14.070MHz Crystal. Solder in place.	❑
	**IC1.** Fit the Integrated circuit SA602 into the socket. ***(See Notes to the builder)***	❑

Part 2. The Demodulator

Testing

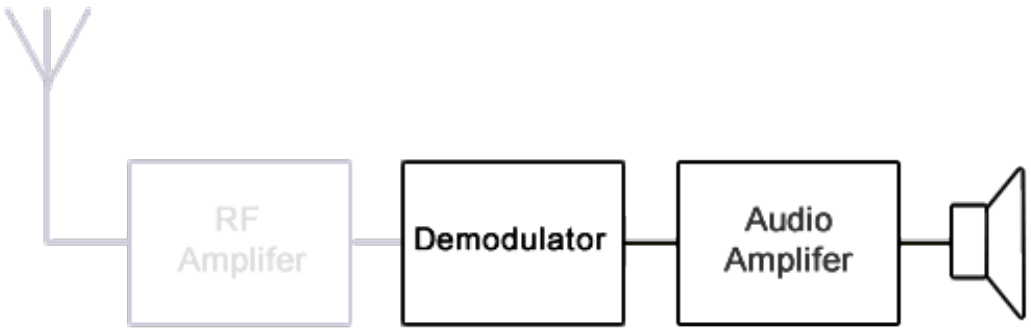
Your circuit should now look like this.



Complete the following tests before moving onto the next stage.

	Test	Complete
1	Check over your soldering. Make sure all wires are trimmed, and no short circuits are present.	❑
2	Connect up a speaker or headphones to SK1.	❑
3	Connect a 9v battery to the battery snap and confirm you can still hear a hiss or slight hum.	❑
4	Place a 14.071Mhz signal source close to the receiver and confirm that you can hear an audio tone. Or, listen for the oscillator on 14.070MHz SSB/CW.	❑
5	Confirm that adjusting C11 trimmer changes the frequency a little.	❑
6	Disconnect the battery.	❑

The demodulator is now complete. Move onto Part 3



Part 3. The RF Amplifier

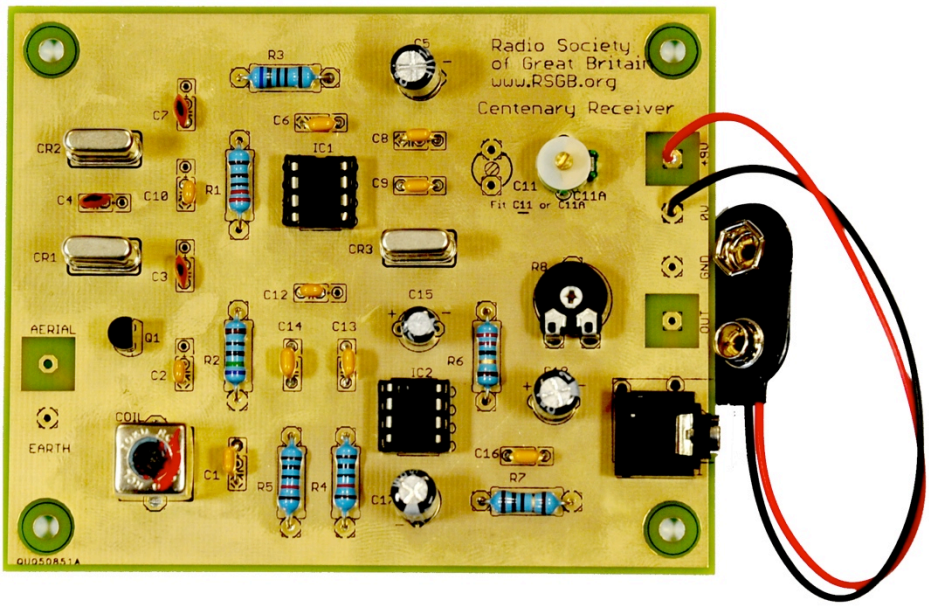
Construction

Component	Task	Complete
	**CR1.** Fit 14.070MHz Crystal. Solder in place.	❑
	**CR2.** Fit 14.070MHz Crystal. Solder in place.	❑
	**C3.** Fit 10pF Capacitor Marked 10p. Solder in place.	❑
	**C4.** Fit 10pF Capacitor Marked 10p. Solder in place.	❑
	**C7.** Fit 10pF Capacitor Marked 10p. Solder in place.	❑
	**R1.** Fit 2.2kohm resistor (Coloured Red, Red, Black, Brown, Gold) and solder in place.	❑
	**R2.** Fit 750ohm resistor (Coloured Violet, Green, Black, Black, Gold) and solder in place	❑
	**C2.** Fit 47nF Capacitor Marked 473. Solder in place.	❑
	**C1.** Fit 47pF Capacitor Marked 47p (or 470, depending on manufacturer). Solder in place.	❑
	**Q1.** Fit the Transistor marked 2N3819. Note the flat side of the transistor. This aligns with the circuit board. You will need to gently bend the middle leg back to fit in the board – do not push too far; body about 5mm above surface is fine.	❑
	**Coil 1.** Fit Coil – Marked 2u6. ***(See Notes to the builder)***	❑
	AERIAL & EARTH. Using a discarded component leg, solder the wire in place to allow an antenna wire to be connected.	❑

Part 3. The RF Amplifier

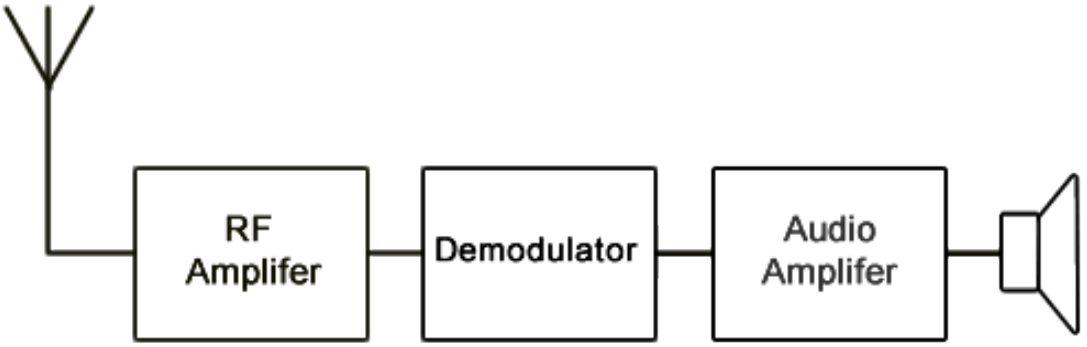
Testing

Your circuit should now look like this.



Complete the following tests before connecting the circuit to a computer.

	Test	Complete
1	Check over your soldering. Make sure all wires are trimmed, and no short circuits are present.	❑
2	Connect up a speaker or headphones to SK1.	❑
3	Connect a 9v battery to the battery snap and confirm you can still hear a hiss or slight hum.	❑
4	Place a 14.070Mhz signal source close to the receiver and confirm that you can still hear an audio tone.	❑
5	Using a non-metallic screwdriver, adjust the core of the Coil 1 for maximum sound in the headphones / speaker.	❑
6	With a test receiver close by set your circuit to 14.071MHz, adjust C11 gently until you hear a tone on the test receiver/zero beat on 14.071MHz.	❑
7	Your receiver is now ready to receive some PSK31 data signals!	❑



Acknowledgements and Further Information

About this kit

The RSGB Centenary receiver project was conceived and brought together by Steve Hartley, G0FUW. The circuit is based on a number of previously published designs:

- The Warbler, an 80m PSK transceiver by Dave Benson, K1SWL, published in March 2001 QST magazine and produced by at the Small Wonder Labs for many years. The kits are no longer available but details can be found here: http://smallwonderlabs.com/Warbler.htm
- The Sudden Receiver, by George Dobbs, G3RJV. This circuit has been around for over twenty years and continues to evolve. The original was designed for Morse code and voice reception and G-QRP Club sell kits to build different versions for different amateur radio bands. Details can be found here: http://www.gqrp.com/sudden.htm
- A simple PSK receiver, published on the Internet by Nuts & Volts. This version is very similar to our version. Details can be found here: http://www.nutsvolts.com/uploads/magazine_downloads/A_Universal_Direct_Conversion_Receiver_For_PSK-31.pdf

PCB design was by Giles Read, G1MFG.

This instruction booklet was prepared by Dan Trudgian, M0TGN.

Test builds using these instructions were carried out by Dan Trudgian, M0TGN, Lewis Thomas, G4YTN, Mike Coombs, G3VTO and Carlos Eavis, G3VHF.

Many of the components for the RSGB Centenary Day Buildathon kits were provided at reduced rates by the G-QRP Club and we would like to thank Graham Firth, G3MFJ, for his assistance. The remaining components came from Rapid Electronics and CPC

Useful links

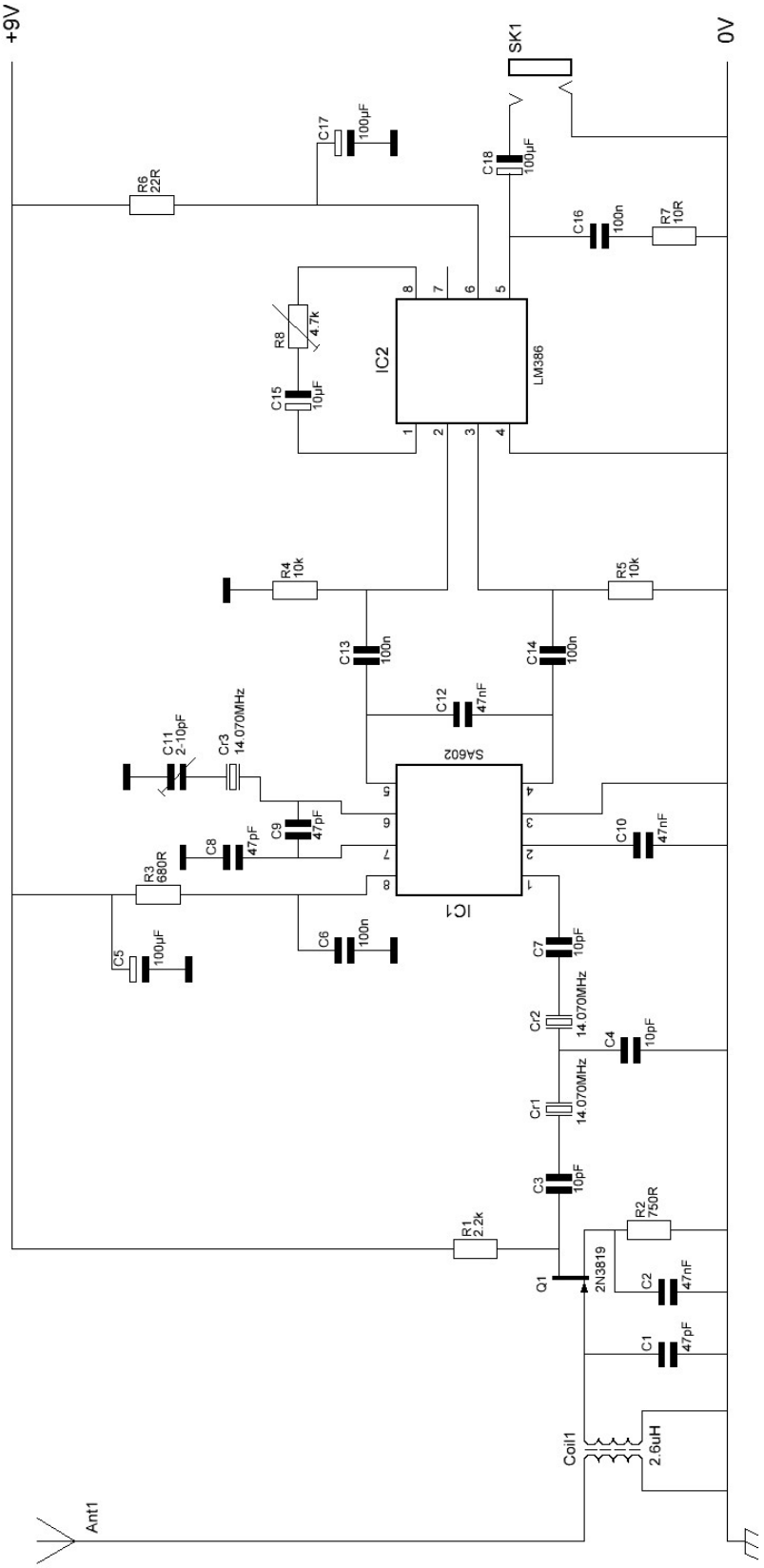
- GQRP club http://www.gqrp.com/
- Rapid Electronics: http://www.rapidonline.com
- CPC: http://cpc.farnell.com
- Digipan http://www.mixwusa.com
- Ham radio deluxe http://www.ham-radio-deluxe.com
- PSK31 background http://en.wikipedia.org/wiki/PSK31

Buildathons

This kit is just one of many kits that the Bath Buildathon Crew has introduced to new radio amateurs, shortwave listeners and people with a general interest in electronics. The Bath Crew run a Buildathon in the January of each year to help students on Intermediate training courses in Bath. However, the buildathons are also open to anyone who would like to build a fun radio project.

For further information on upcoming buildathons, projects and training for amateur radio both in class and via distance learning, please email Steve g0fuw@tiscali.co.uk

Circuit diagram



Parts List

Resistors

1 x 10ohm
1 x 22ohm
1 x 680ohm
1 x 750ohm
1 x 2.2kohm
2 x 10kohm
1 x 4.7kohm Horizontal Pre-set

Capacitors

3 x 10pF
3 x 47pF
3 x 47nF
4 x 100nF
1 x 10uF
3 x 100uF
1 x 2-30pF variable trimmer

Semiconductors

1 x LM386
1 x SA612
1 x 2N3819

Crystals

3 x 14.070MHz

Coil/Transformer

1 x Spectrum 2.6uH

Hardware

1 x 3.5mm mono headphone socket
2 x 8 pin DIL IC socket
1 x 9V PP3 Battery snap
1 x Printed Circuit Board