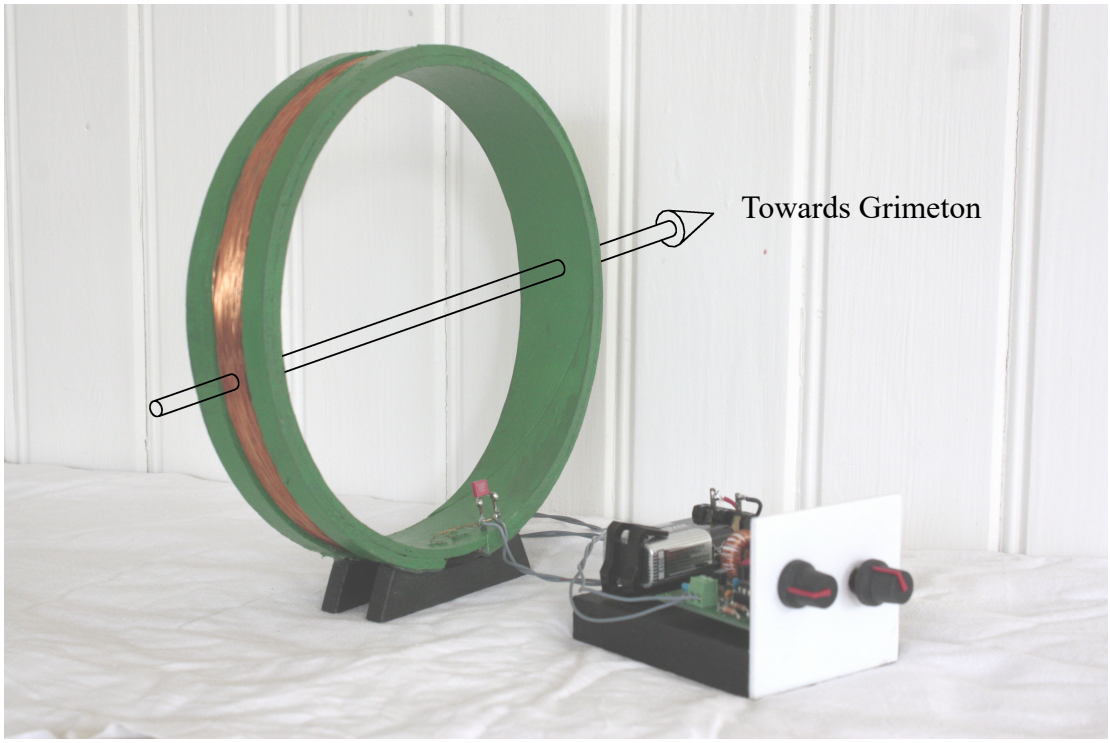
RECEIVER KIT FOR SAQ

THE VLF MORSE TRANSMITTER IN GRIMETON

Manual Ver. 3



How to turn the antenna coil towards Grimeton for maximun signal strength to the receiver.

Some familiarity with soldering is recommended. See also section 4.

Except soldering equipment, you will need cutting nippers, flat nippers and a schrewdriver, not wider than 2 mm.

The World Heritage of Grimeton/
Arne Sikö, Execubic AB, 2021.

1. Contents

Printed circuit card
Bobbin for antenna coil, L1. Diameter 20 cm.
Wooden socket with panel and battery holder
Bobbin with isolated copper wire for L1 and L2
Wire for antenna connection
2 IC sockets
2 knobs
Toroidal core for L2
Ferrite core for L3, grey. See capacitor C9 below.

3 jacks		J1, J2, J3	
Ear phone jack		J4	
Potentiometer 10 kΩ, logarithmic		P1	
Potentiometer 10 kΩ, linear		P2	
Diode 1N4001		D1, black with grey ring	
Zener diode BZX55C 5V1		D2, reddish, black ring	
Integrated circuit LM386		IC1	
Integrated circuit 555 (7555)		IC2	
Choke 22 mH		Dr1, red-red-orange-gold	
Choke 100 mH		Dr2, black, round	
2 transistors BC550C		Q1, Q2	Colour code etc:
Resistors	R1, R3	1 MΩ	Brown-black-green
	R2	68 Ω	Blue-grey-black
	R4	82 Ω	Grey-red-black
	R5	33 kΩ	Orange-orange-orange
	R6	1 kΩ	Brown-black-red
	R7	270 Ω	Red-violet-brown
Capacitors	C1	3.3 nF and 10 nF together	
	C2	1 µF	Red, 1µK63
	C3	470 pF	Red, 470/100
	C4, C10	1 nF	Brown, round, 102
	C5, electrolytic	1 µF	Violet
	C6	47 nF	Yellow-brown, 473
	C7, C8, electrolytic	100 µF	Blue 100 µF
	C9, electrolytic	100 µF	Together with L
	C11, electrolytic	12 µF	Black, 12µ

Not included: 9 volt battery and ear phone plug – standard 3.5 mm

Since the markings of the resistors might be hard to discern, they have been put on a paper with their resistances.

The receiver is switched on and off by the battery. Make sure that the battery voltage does not go below about 8.6 volts. Alternatively, the receiever can be fed from other sources as well; it will work down to about 8 volts and up to 12 volts.

2. Scheme and function

For those interested

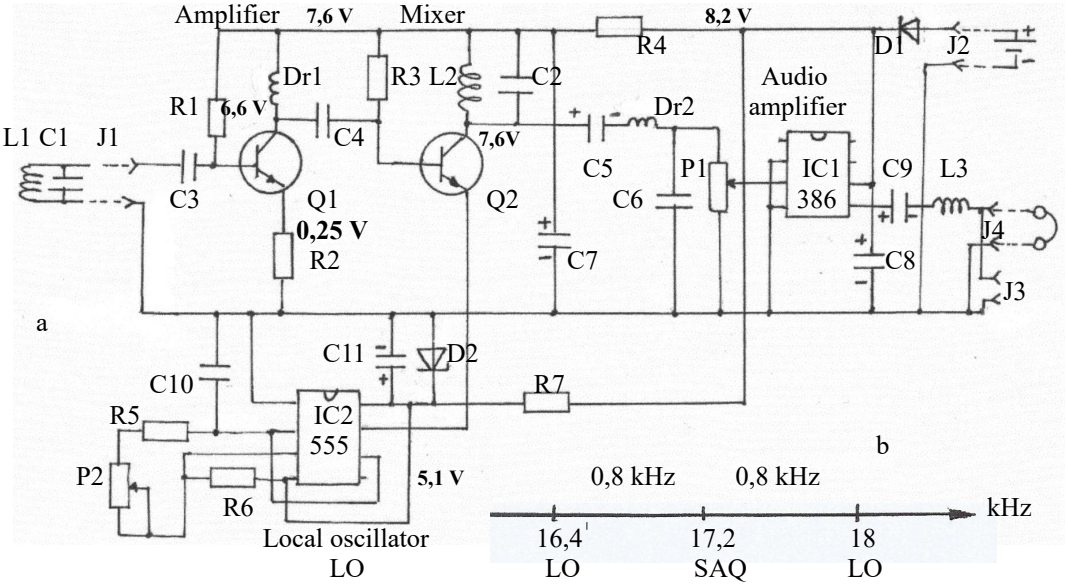


Figure 1. a) Scheme. Potentiometer P1 is volume control and P2 in the local oscillator is to be adjusted for maximum signal strength. Voltages with bold style: See ”To test the receiver”. b) The frequency mixing.

The antenna coil L1 is a loop antenna, generating a voltage from the incoming magnetic field from the transmitter, increasing with the number of turns. Together with C1, it makes up a resonance circuit for the frequency of SAQ, 17.2 kHz, incerasing the voltage about ten times.

The voltage from the antenna circuit at J1 is amplified in the circuit around Q1. The receiver has to take down the frequency from 17.2 kHz to about 0.8 kHz, much better suited to our ears. That is done in the mixer circuit around Q2, also connected to a signal source, the local ooscillator LO with IC2. Q2 generates the difference between 17.2 kHz and that of the local oscillator, which is adjusted by means of P2. If it is i.e. 18 kHz (figure 1b) the difference will be (18 – 17.2) kHz = 0.8 kHz. L2/C2 is a bandpass filter, letting signals only with frequencies at and around 0.8 kHz pass. The 0.8 kHz signal then goes to the volume control P1, audio amplifier IC1 and the output jack J3. Also to J4, where a loudspeaker can be conncted. The output power, however, is rather small.

As shown i figure 1b, the mixing will work also if the local oscillator frequency be 16.4 kHz, making it possible to tune in for SAQ for two different adjustements of P2.

3. The coils

Let´s start with the smallest one, L2 (figure 2a), which is to be wound with 90 turns around its toroid core. Cut off two meters from the wire in the bobbin and thread it halfway through the toroid. Then, first wind 45 turns with one part and after that as many with the other. Wind the wire fairly tight, not letting it get slack, but turns crossing each other is no problem. One or two turns more or less do not matter. Perhaps you want to avoid ”knots” along the wire.

Then, cut off the wire, leaving a little more than one centimer free ends, which are to be carefully tinned. The thin wire shall not be scrapped, but the heat from the soldering iron is enough. Still, if the tinning does not succees the first time, the wire can be scrapped carefully with a piece of sandpaper. Good tinning is important, since otherwise too much heating might be nessesary, easily damaging the printed card. It is covered with protecting varnish, but too much heat might still cause damages, hard to repair.

The antenna coil L1 (figure 2b and c) is wound with 244 turns. It must not be painted over with anything, since that will alter its electrical properties. However, as with L2, one or two turns more or less do not matter.

Start by threading the wire through the three adjacent holes, leaving some centimeters free ends to be soldered to one of the tinned nails. Then, wind 61 turns to the other edge and as many back. After that, the same procedure with two times 61 turns, ending with totally 244. The same direction of winding all the time. This is one way not to get lost while counting (more important than one might believe). Unavoidably, many turns will cross each other, which is no problem. Still, wind as as evenly as practically possible, but be careful keeping the wire firmly stretched to make the winding compact. If, during winding, some piece of wire is seen to have come outside the edge, move it inwards with following turns over it. With the 244 turns complete, cut the wire and put it through the other three holes.

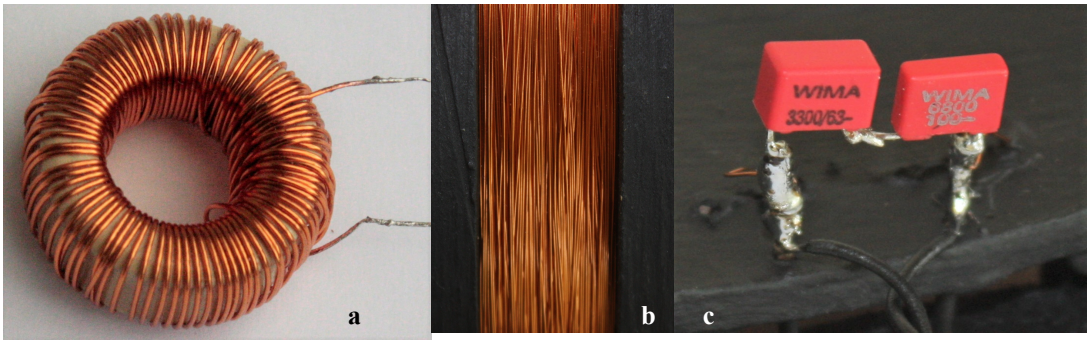


Figure 2. a) L2 with tinned wire ends. b) Part of L1. There is no reason trying to put following turns closely beside each other. The author usually winds 2 to 3 turns a minute. c) Capacitor C1 soldered on top of the wires. (With this two-capacitor arrangement as much as possible ot the wire in the bobbin comes to use.)

Tin the two ends and solder them to the nails. Turn the isolated wire double and solder it to the wires. With C1, two capacitors in series, in place, the antenna circuit is finished.

The combination of the 244 turns, winded as described, and C1 makes the resonance frequency of the circuit close to 17.2 kHz, thus making the signal as strong as possible.

Before starting with the printed circuit card, perhaps glancing through ”on soldering” might be an idea.

4. The printed circuit card

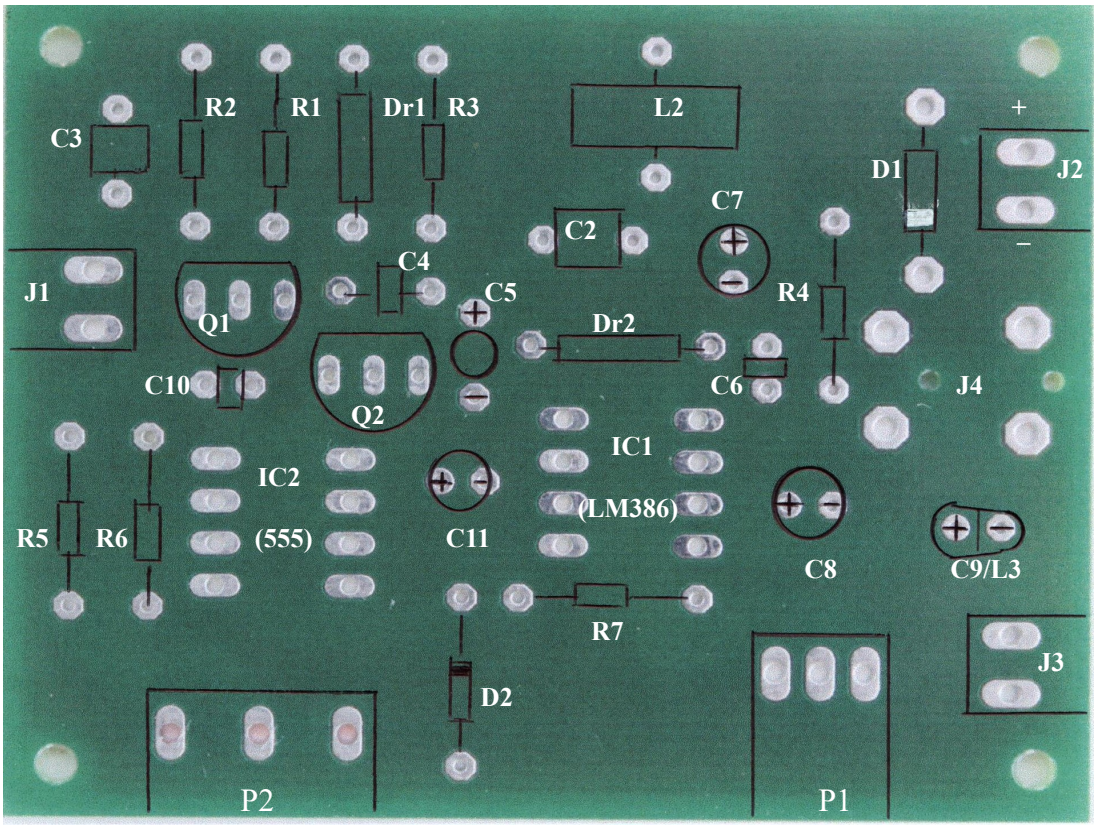
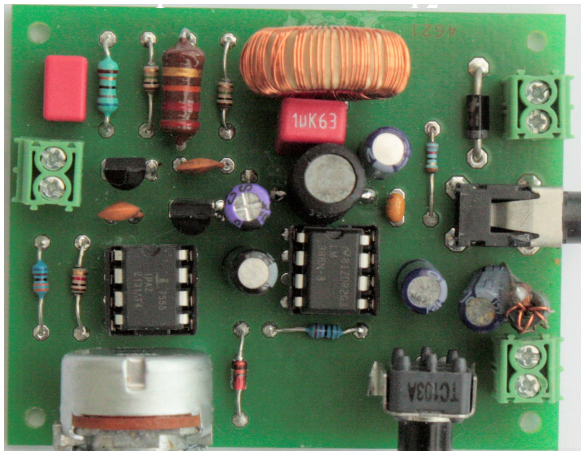


Figure 3, the printed cicuit card.
a) Components on the card. Transistors Q1 and Q2 are mounted with their flat sides upwards. The electrolytic capacitors are marked with plus and minus. The diodes, D1 and D2, are mounted accordinng to their ring markings.

b) The integrated circuits are put in place with their ring markings (or similar) upwards. Then, their type, number etc. can be read from the left.

Note the choke Dr2 between IC1 and C2.



Starting with the lowest components will be practical: the diodes, resistors and the choke Dr2. The latter, like Dr1, has replaced resistors for better function, but do not fit the card so well, making it necessary to twist their legs a little. Note the ring markings of the diodes. (The function of D1 is to protect the receiver if the polarity of the applied voltage happens to be reversed.) The IC sockets should be placed with their incisions upwards like the markings of the IC:s.

The original choke Dr2 is no more available and has been replaced with a an a little mote clumsy one. This makes it necessary to mount the IC1 socket first. The choke pins must be folded outwards to fit the holes, unfortunately a tricky job,

and it is a good idea to solder from above, too.

The polarity of the electrolytic capacitors, C5, C7, C8 and C11, is marked, also with long legs for plus poles. C9 is soldered with its plus pole to the left accordning to figure 3a, but its minus pole has been connected to the little ferrite coil L3, the free end of which is soldered to the hole for the minus pole.

Leave at least half a centimeter between the heat sensitive transistors and the card.

Now, solder the ear phone jack and the three others. (The author remember having once put a jack with its connection holes inwards...) Put on L2, standing tightly on the card. You might, now or later, fasten the coil to the card with some glue and do the same with C9/L3.

When putting the IC:s in their sockets, make sure that none of their pins be bent and that their symbols are to be read from the left side of the card. If interchanged or put upside down, they will probably be damaged. The potentiometers are soldered as close to the card as possible.

After this, it is time to put the card on the socket by attaching potentiometer P1 to the panel. Place the biggest washer behind the panel, the other ouside and tighten the nut. When putting on the knobs, press the potentiometers firmly on their rear sides not to bend them back.

Note that the upper part of jack J2 is its plus pole and likewise the outer battery connection. They should be connected by the short red, isoleted wire.

As a final inspection it might be a good idea checking the soldering points on the back side, maybe with a magnifying glass, and make sure that no tin happens to connect adjacent solderings. Now, all wire ends on the back side should be cut short.

With the wires from the antenna circuit has been attached to the antenna jack J2, the receiver is ready for use.

<u>On soldering</u>

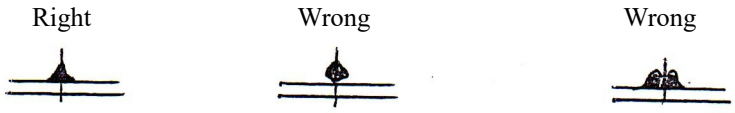


Figure 5. In the middle, the wire has been tinned, but not the soldering point on the card, the opposite case shown to the right. Left, both parts are shown correctly tinned and electrically connected.

The tip of the soldering iron should be reasonably pointed. To avoid faulty soldering, both wire and soldering point must be heated simultaneously. ”Cold” solderings might work in the beginning, then loose electric contact and might be hard to discover. Tin, shaped like droplets or volcanoes, indicates such conditions.

5. To test the receiver

Connect a standard 3.5 mm earphone plug into J4. Turn the volume control potentiometer counterclockwise, put the battery in its place and slowly increase the sound level. Different sounds should be heard, like humming and crackling, and might be quite strong at maximum. They should vary when the antenna coil or frequency knob are turned. All kinds of electrical gears, like flourescent lamps, computers, refrigerators and motors, will add unwanted sound and in the countryside, electric fences might cause clicking pulses. If the receiver remains slilent:

- Make sure that the battery is reasonably fresh and has not been inserted with reversed polariy. A voltage below about 8.6 volts indicates that it should be replaced.
- Check the polarities of diodes and transistors.
- Has the earphone plug been properly plugged in?
- Have the IC:s been put in place as they should?
- A possible fault is lacking contact for L2, so, check its soldering points once again. An ohmmeter connected between them should read very close to zero ohms.
- Otherwise, take the battery out and check everything again.

If a frequency meter is available, the frequency range of the IC2 circuit, the local oscillator, can be checked; measure between the minus pole and pin 3. P1 maximally clockwise will give about 15 kHz and counterclockwise 19 kHz. (If then set at about 18 kHz, you will be close to the right position for SAQ.) The voltage is a square wave.

You might also check the voltages, noted with bold style in the scheme. They can vary slightly, among other things with the battery voltage. Be careful, e.g. not to shortcut transistor legs!

As a final test, use the site https://vimeo.com/347579497 , where you will find a morse transmission at 17.2 kHz. Put an earphone, connected to the computer, close to the antenna. When the program is played up, the antenna feels the magnetic field from the earphone, giving a signal to the receiver. (With thanks to Filip Wahlberg.)

6. Reception

The first page shows how to turn the antenna coil, but some deviation does not matter. What limits the possibilities of reception in this part of the frequency spectrum – VLF, Very Low Frequency – is to a high degree noise from all possible electrical arrangements, added to the unavoidable disturbances from lightnings of thunderstorms all over the Earth. Therefore, the problem with this fairly simple receiver is mainly not the signal strength from the transmitter, but instead the signal having to compete with noise.

Checking the local noise field by listening to the receiver in the surroundings might be a good idea. Perhaps then, reception is found to be better outside the house and also at safe distance from the traffic. The length of VLF radio waves – about ten miles for SAQ – makes them readily pass smaller objects, but large blocks of buildings in the

neighbourhood might stop them, as can huge formations of the terrain. The radiation will pass wooden walls without very much attenuation, but stone walls are worse, not to speak of metallic walls.

The receiver has been successfully tried at several locations in Europe, e.g. in Switzerland, Moskow and the north of Sweden.

The transmissions from SAQ are announced at the homepage of the supporting association Alexander, www.alexander.n.se, usually given in local Swedish time (middle European time) as well as in UTC.

There are about three transmissions anually, the common occations being on the Alexander Day around the turn of the month june-july, the morning of Christmas Eve and often also on he UN Day on October 24.

At the announced time, a message, taking about ten minutes to key, is sent. It always starts with a general call:

CQ CQ CQ DE SAQ SAQ , repeated a couple of times. Those not accustomed to Morse telegraphy might acquire som experience according to this:

dah-di-dah-di dah-dah-di-dah (three times or so) dah-di-di di
C *Q* *D* *E*

di-di-di di-dah dah-dah-di-dah
S *A* *Q*

”di” is a short sound, ”dah” three times as long. The time between signs (letters, numbers) corresponds to a dah and between words (e.g. CQ and DE) about two dah:s.

CQ is the general call code (”seek you”) and DE means ”from”.

The start-up procedure of the transmitter begins about half an hour before the announced message start and the motor is speeded up. About a quarter before that, the transmitter will be on air. Then, by means of a punched tape, the call signal is sent regularly together with the letter V, V indicating start-up conditions with frequency adjustment and antenna tuning. Maybe this is the easiest part of the transmision for an untrained ear to interpret. V, keyed di-di-di-dah, is fairly easy to discern.

7. Service

We hope that you have made the receiver work well, but if there be any problem or question, please call us at info@execubic.se . You are always very welcome to call the designer directly, 46 (0)70-2790048 (in English or German).