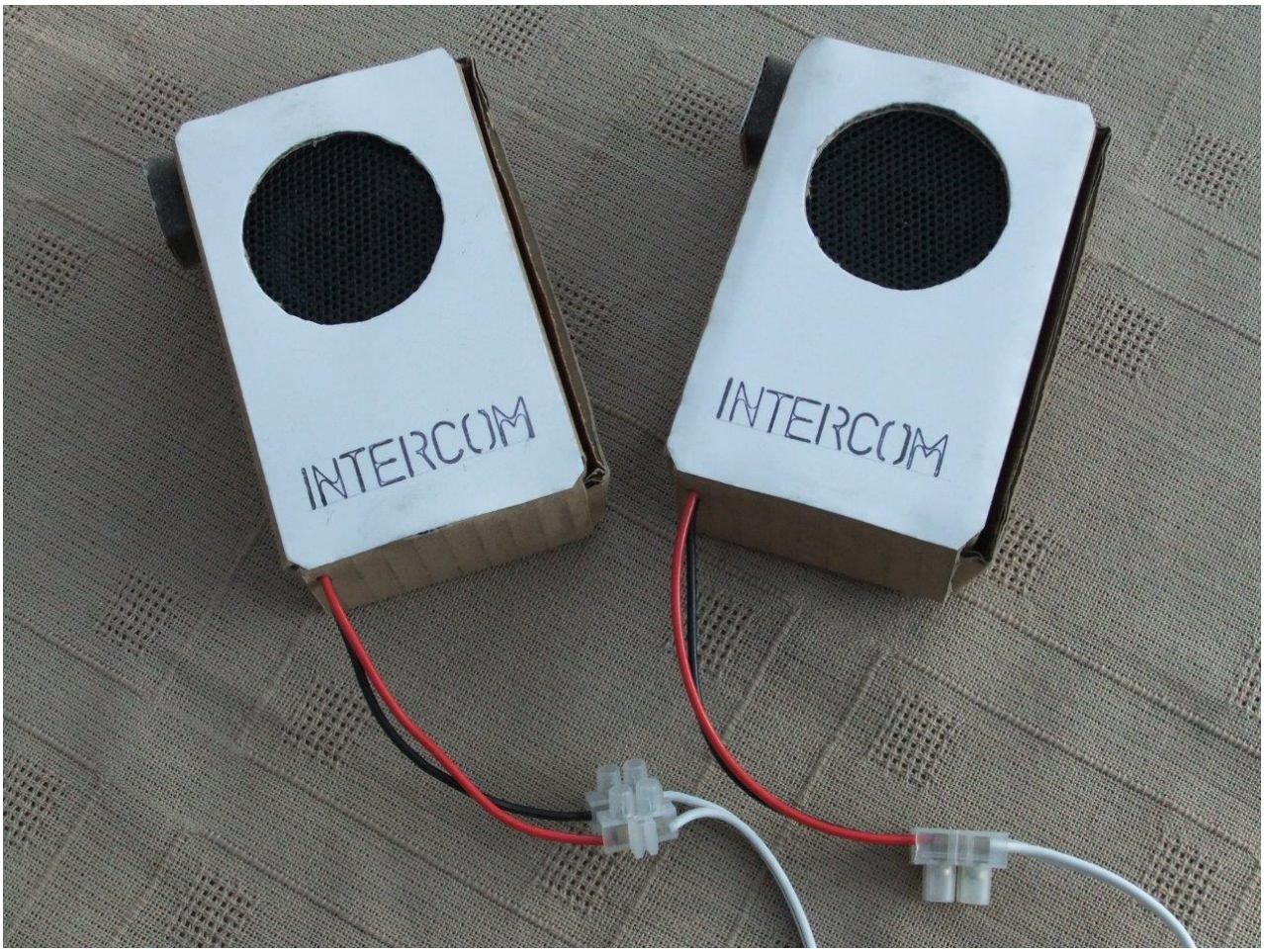
YATE MEN'S SHED



Introduction

This intercom has been designed as a low-cost science toy, but it might also be put to good use, for example to provide voice communications between an outbuilding and a house. If a more robust case is used to house the handset, it could also be adapted as a front-door intercom.

Intercom circuit description

The starting point for the circuit design of the YMS intercom was a design published on-line.[1] Several issues with the starting point design do not negate its basic simplicity, elegance and advantages, namely:

1. The handset design only draws battery power when the push-to-talk (PTT) switch is operated.
2. Communication is via a simple 2-wire interface.
3. Requires few readily available low-cost components.

1 See http://schematics.circuitdiagram.net/viewer.php?id=rgh1333330186v.jpg

Intercom circuit operation

The intercom circuit schematic can be found in an associated file. In talk mode the speaker in the local handset is used as a microphone. A single-ended audio amplifier is used to amplify the low-level audio signal produced by the speaker. In talk mode, the local handset's audio amplifier is powered from an identical remote handset connected to the far end of the 2-wire interface. The speaker in the remote handset also serves as the output device for the local audio amplifier. In this way, when the PTT switch is operated, the voice signal of anyone speaking near the local handset is amplified and reproduced by the remote handset. Whilst neither local nor remote PTT is pressed, the Schottky diode in series with the 6 Volt battery prevents any current flows between local and remote handset batteries. In listen mode, nothing happens until the PTT is operated on a remote handset. When a remote PTT is pressed, the speaker in the local handset reproduces the amplified voice signal from a remote handset.

Audio amplifier design

The basic 3-stage design found in the starting point has been re-used here: Two NPN transistor emitter-follower amplification stages are followed by a PNP common collector current amplifier which is used to drive the 8 Ohm speaker. The circuit of the starting-point amplifier has been modified, allowing the intercom to operate more consistently as the battery voltage changes: A 4.7 Volt Zener diode voltage regulator has been used to achieve this aim. The DC operating voltages and currents of the amplifier stages have been adjusted to ensure that the PNP common collector output stage conducts a current for a wide range of battery voltages, even when there is no voice signal present. This change reduces voice signal distortion in the audio amplifier. Two 10 nF capacitors have been added to the design. These capacitors have little effect below 10 kHz, but they prevent unwanted high frequency oscillation. Likewise the values of the other capacitances have been optimised for an audio bandwidth of about 200 – 10,000 Hz.

Circuit construction

Any construction technique can be used to fabricate the intercom circuit according to personal taste, but the Manhattan construction technique[2] was used in the prototype. An enlarged image of the small 48 x 34 mm intercom circuit board is shown below.

Other construction techniques may also be suitable to implement the intercom circuit. These include Veroboard, or making a printed circuit board. However, since there are no protrusions on the reverse side, the Manhattan approach has the advantage that it is easier to mount in the case; it can just be stuck down to some convenient surface using contact adhesive.

2 See the following article for details: http://www.unixnut.net/files/manart.pdf

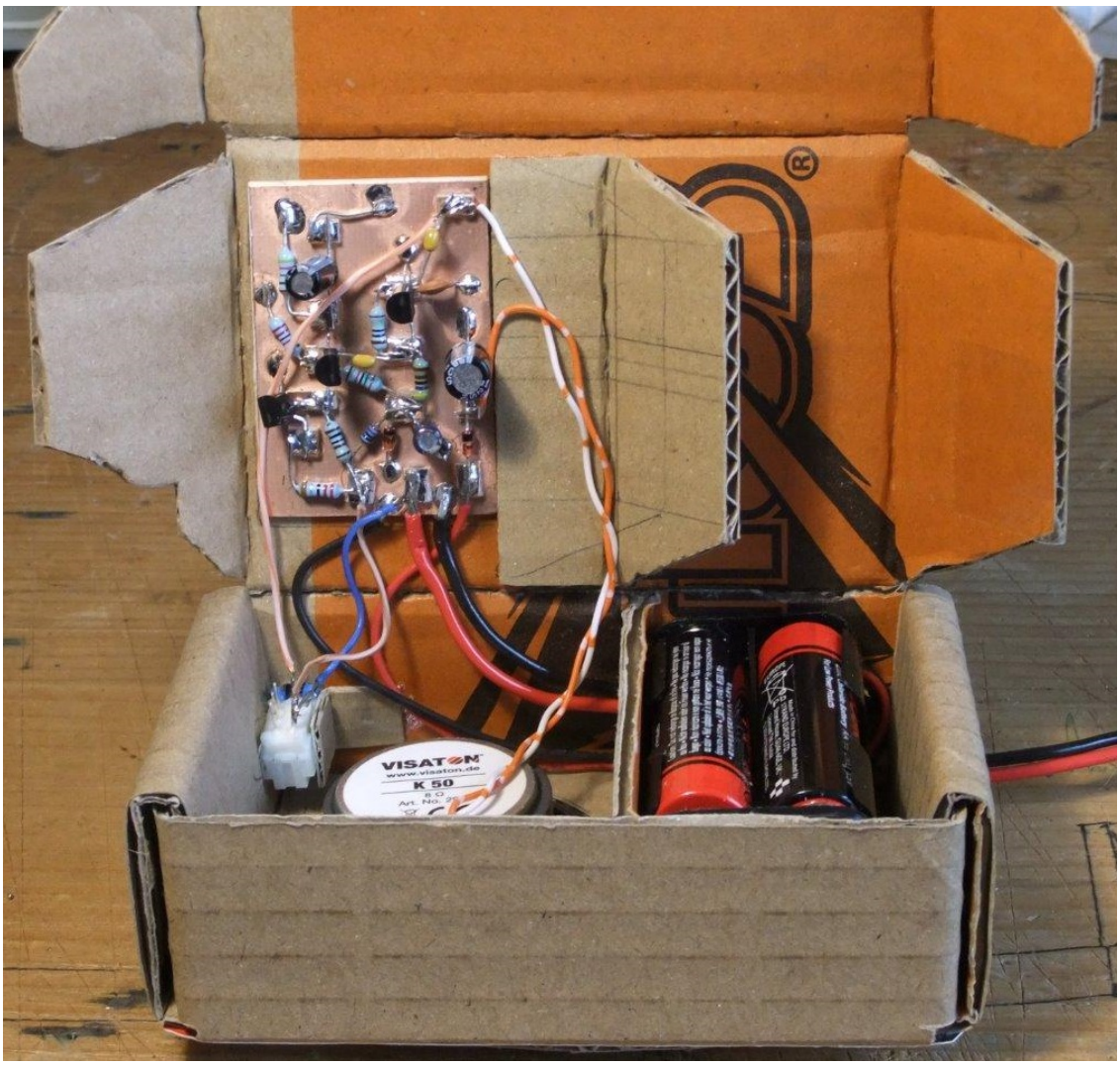
To use the Manhattan technique, insulating solder pads are fabricated from small squares of PCB material which are super glued down to the copper laminate circuit board. These small squares of PCD material can be conveniently made by cutting 5 mm wide strips from another piece of copper laminate using a small hacksaw. The squares can then be cut off these strips using an ordinary pair of side-cutters. The underlying copper laminate forms the zero-volt rail in the intercom circuit. Twelve 5 mm square solder pads are required to fabricate the intercom circuit.

Intercom case design

The intercom could be fitted into a variety of plastic or metal cases, but the prototype has been built into a cardboard case constructed from waste materials at zero cost. A drawing showing the cut-out plan for a cardboard case fabricated from 3 mm thick single wall cardboard can be found in a separate file. This drawing could be adapted slightly to accommodate other cardboard thicknesses, or other materials.

Intercom case wiring

The wiring of the intercom circuit board into the case is illustrated below in a photograph of the prototype:



The PTT switch is biased with a spring towards the listen position. Suitable 8 Ohm speakers and speaker grills can often be salvaged from other equipment and the case size can be adapted according to the dimensions of available speakers. The two wire interface can be connected to some suitable twin-core cable with two ways of terminal connector block. A 15 meter length of twin-core speaker cable was used to connect the two handsets in the prototype, but longer runs should also be feasible.

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