EMERGENCY MEASURES RADIO GROUP	**EMERGENCY MEASURES RADIO GROUP**
AMATEUR RADIO RAC EMERGENCY SERVICE	**OTTAWA ARES**

Two Names - One Group - One Purpose

Headphone Control
EMRG-212

Version: 1.1

EMRG PUBLIC

This document is classified as PUBLIC, meaning the document can be copied and shared by the documents recipient. Public documents do not contain any personal information or other information such as site details that should not be circulated outside of EMRG or its partners.

Public Documents may be posted on the EMRG WEB site without modification.

Written by: Peter Gamble for the EMRG Management Team

TABLE OF CONTENTS

1.0 REVISION SUMMARY

Date of Change	Revision Number	Summary of Changes (Section #, type of change)
2005-02-25	0.1	Create initial document
2005-03-02	0.2	Add extension cables & misc cleanup
2005-03-23	0.3	Update per review comments
2005-03-25	1.0	Official Release
2005-04-03	1.1	Move jacks 0.5mm to improve tolerance to errors. Add diagrams of jack connection points

2.0 PURPOSE OF THIS DOCUMENT

This document provides the information necessary to build a headphone control unit that plugs into the speaker jack on a radio. The control provides jacks and volume controls for 2 sets of headphones and 1 external speaker.

3.0 OVERVIEW

3.1 INTRODUCTION

Most amateurs have heard the suggestion that there should be 2 operators at a location such as a shelter, one as operator and one as logger. They have also heard the suggestion that radio operators should wear headphones at a location such as a shelter, due to the noise and so the radio is not a creator of noise.

Knowing this information, how many Amateurs have a solution for connecting two sets of headphones to their radio?

This project was originally developed as a beginning to a larger user interface project, which includes headphone and microphone connections. The headphone control unit described in this document can be built as a stand alone, unit or can be incorporated as a module in other projects.

3.2 CAIRO

The design for this project is taken from some excellent work done by UK amateurs. The need for unification, through the standardisation of radio equipment (and operating techniques), was first identified within RAYNET - the Radio Amateurs' Emergency Network (UK) and **CAIRO** was developed as a practical solution for members of that organisation to adopt.

CAIRO, being the **C**ommunications **A**udio **I**nterface for **R**emote **O**perations, is a standard connection between two-way radio transceivers and the various forms of microphone, loudspeaker, headphone or headset accessory which an operator may employ for vocal telecommunications. It allows the operator to select the most appropriate accessory for a particular communications need, and operate any available and appropriate transceiver to provide a communications service in a wide variety of circumstances.

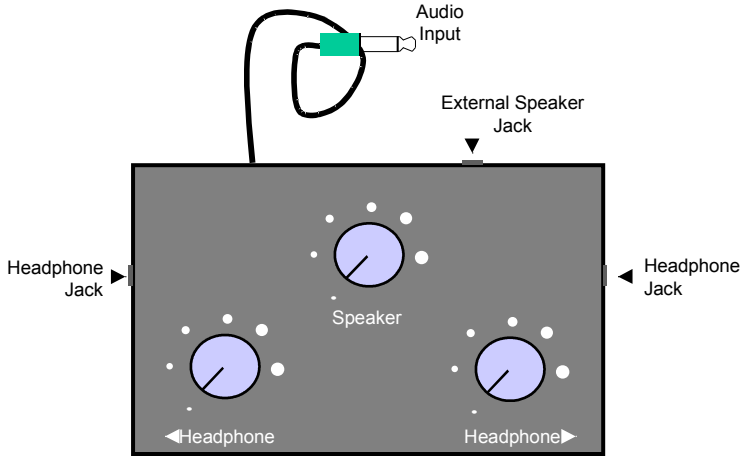
For an interesting read, plus some great information and ideas, the CAIRO web site is located at; http://www.cs.aston.ac.uk/%7Ebestpj/cairo/

4.0 DESIGN

4.1 OBJECTIVES

The original project was built to test the design from the CAIRO web site as a beginning to designing a full functionality user interface. Here is the design criteria for each of the components;

- **CASE:** The case was selected based on being the smallest box that all the parts would fit into. Larger boxes will allow modifications to add additional features.
- **VOLUME CONTROLS:** The volume controls were based on the 100 ohm, 2 watt values used in the CAIRO system.
- **HEADPHONE JACKS:** The headphone jacks are 3.5mm (1/8”) stereo to match the typical headphones that are in use today for portable radios and players. In this project, the left and right sides are wired together.
  - The jack is located high on the side of the box, so that a headset with microphone, that uses a 3.5mm plug for the headset, will be able to plug in, with the microphone portion of the plug clearing the top of the box.
  - The future plan is to include a switch so the user can listen to one radio in both sides, or flip a switch to allow one side to monitor an auxiliary input, such as a scanner or a second radio.
- **SPEAKER JACK:** The speaker jack is 3.5mm (1/8”) mono to match the plug typically used on extension speakers. This is the same type of jack that is in the back of most radios.
- **INPUT PLUG & CABLE:** The input to the headphone controller is a short cable about 1 metre (1yd) , with a 3.5mm (1/8”) mono plug. The plug will fit the external speaker jack on most radios. The input cable is wired directly to the unit, rather than plugging into a jack. Direct wiring avoids the need for a separate cable from the radio to the headphone controller, so the headphone control unit is one piece, so nothing can get lost or forgotten.



4.2 CONSIDERATIONS

4.2.1 DRILLING THE CASE

When drilling the plastic case, start with a very small bit and work up through the sizes. Drilling too large a hole at one time will cause the plastic to tear.

4.2.2 INSTALLING JACKS

The plastic case has ridges inside, which keep the jack from fitting flush against the inside of the case. This does not leave enough of the treaded portion of the jack exposed on the outside of the case. There are two options;

- Use a power tool to cut away the inside ridges
- Use a larger bit than the hole (try 3/8”) to create a slight indent in the outside of the case. The nut will sit into the indent. Be careful, to turn the bit by hand, not in a drill. If the bit is used in a drill it will probably go through, making the hole too large. Patience is important.

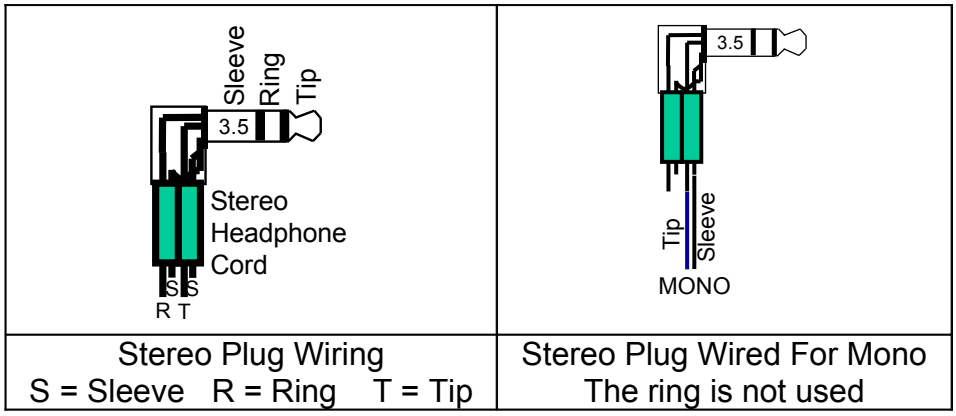
4.2.3 WIRE

There are no special requirements for the wire used in this project. Find a good flexible wire for the input cable. The length of the input wire can be made to suit personal preference. Make it at least 1m (appx 36”) so the controls can be brought out away from the radio for easy access.

4.3 OPTIONS

4.3.1 INPUT PLUG

There are a few radios that have the external speaker jack slightly recessed in the case. The speaker plug must fit through a hole in the case in order to plug into the jack. The typical 3.5mm plug may be too large to fit through the hole in the radio case. One option is to use the cord from an old set of headphones. The moulded plug on the headphone cord is typically small enough to fit. Be careful, because the really cheap headphones use really cheap wire and it can be too fine to work with easily.



Stereo Plug Wiring S = Sleeve R = Ring T = Tip	Stereo Plug Wired For Mono The ring is not used

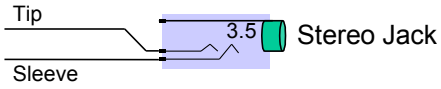
4.3.2

4.3.3 HEADPHONE JACKS

Most headphones today are wired for stereo, although some communications headphones are still wired for monaural (mono). There are two ways to wire the headphone jacks so both mono and stereo headsets can be supported.

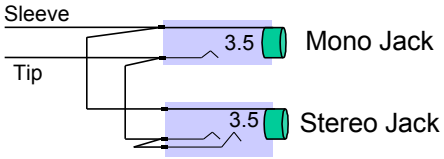
SERIES

By wiring the tip connection to the tip and the sleeve connection to the ring, on a stereo jack, both stereo and mono headsets can be plugged into the jack. This wiring puts the left and right sides of stereo headphones in series. Mono headsets will work as normal. This is the recommended solution and is what is shown in the wiring schematic.



PARALLEL

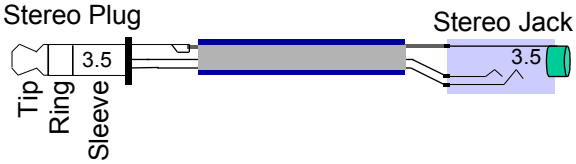
It is possible to wire a stereo and mono headphone jack in parallel. This will allow the user to plug in either type of headphone. This is meant to be used as one or the other, not both. It will work if two sets of headphones are plugged in, but it might affect the volume.



On the stereo jack, the Tip and Ring are wired together, so the right and left headphones are wired in parallel.

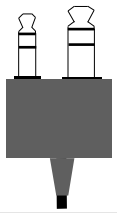
4.3.4 EXTENSIONS

Headphone cables may not be long enough for convenient operation. Adding an extension cable allows easier cable routing and greater movement or separation of radio operators. Some electronic stores sell extension cables with a 3.5mm (1/8”) stereo jack on one end and a plug on the other end. If not, an extension cable can be made from a length of 2 wire shielded cable (2 wires + shield).



Extension cables can be made any length. Use a good flexible wire.

4.3.5 MOULDED HEADSET PLUG

Some radios use a speaker mic or headset plug that has a 3.5mm speaker plug and a 2.5mm microphone + PTT plug, moulded into a single unit. It is possible to plug the speaker jack into one of the headphone jacks, with the other plug clearing the top of the case	

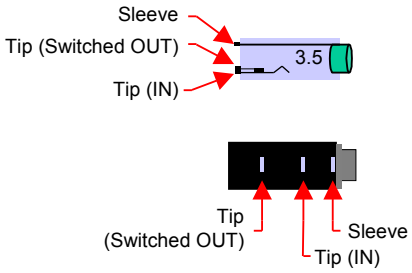
4.4 MATERIALS LIST

#	QTY	DESCRIPTION	DIGIKEY PART #
1	3	100 Ohm, 2 watt, linear taper pot	RV4N101C-ND
2	2	3.5mm (1/8”) stereo jack	CP-3533-ND
3	1	3.5mm (1/8”) mono jack	CP-3502MJ-ND
4	1	3.5mm (1/8”) mono plug	CP-3501-ND
5	1	Mini case (112 x 27 x 66 mm)	HM103-ND
6	3	Control knobs*	8555K-ND
7	1m	2 Wire speaker cable (length as desired)	

* Suggested part number. Any control knobs will work.

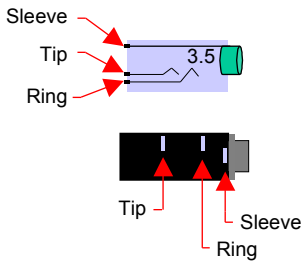
4.4.1 MONO JACK CONNECTIONS

Audio jacks can be switched on non switched. The switch is used to disconnect something when a plug is inserted. In most radios, the speaker is disconnected when a plug is inserted into the extension speaker jack. The switched connection is not used in this project, but the mono jack in the materials list is equipped for it.



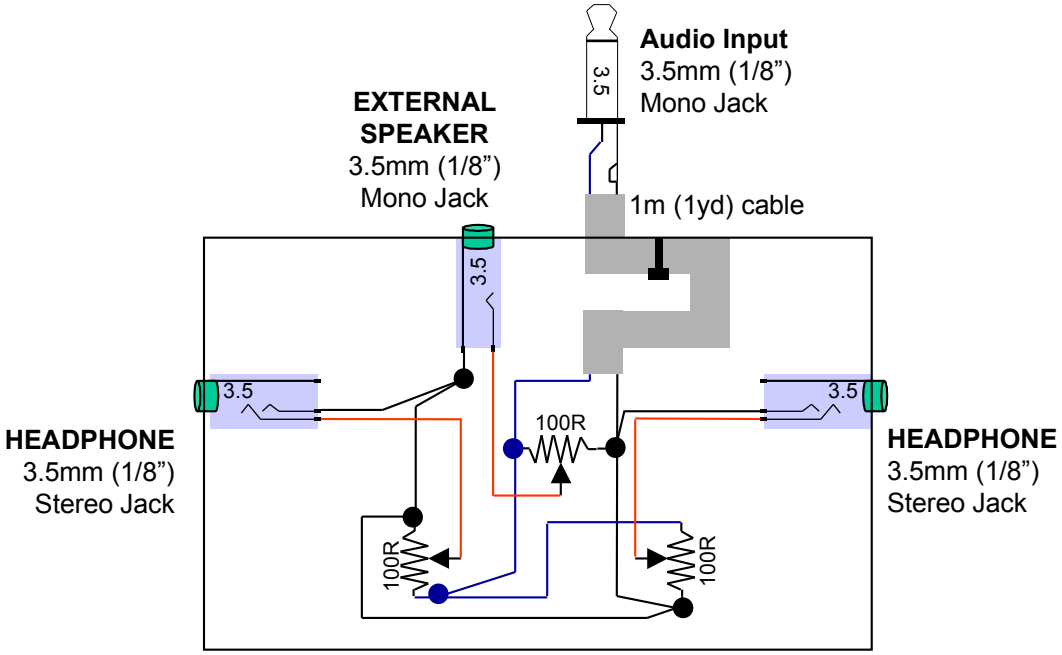
4.4.2 STEREO Jack CONNECTIONS

The stereo jack in the materials list is non switched. There are three connections as shown below. In this project, only the Tip and Ring are used.



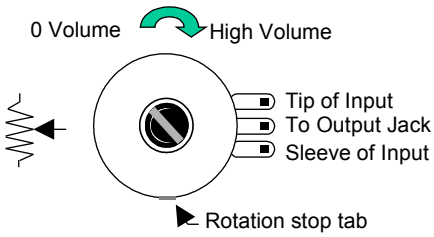
4.5 SCHEMATIC

The wiring for the headphone controller is fairly simple. It makes a good starter project, since the components are rugged and relatively easy to work with.



Back view, looking inside with the cover removed

Schematic layout, viewed as if looking in through the open back of the case



The drawing on the left is a top view (looking at the shaft) of the 100 ohm potentiometer (pot). The three connection points on the pot match the top, middle and bottom connections shown in the schematic symbol.

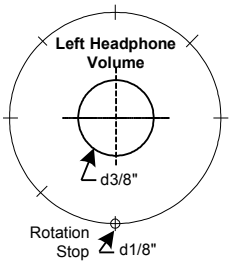
4.6 DRILLING

The drilling template provides the location for each of the holes. Print this page, then cut along the dotted lines. Using the plastic case as a mold, fold the edges of the paper over the box, taping the paper corners to form a cover over the box.

Drill small pilot holes for each of the holes shown on the paper. Remove the paper and drill the holes to the correct size. Remember to go slow and increase the drill bit sizes a little at a time. Drilling too large a hole at one time will cause the plastic to tear.

4.6.1 Potentiometer Drilling

There are several holes required for each Potentiometer (volume control).



Centre Shaft
The main hole is the centre of the drawing which requires a 3/8” hole for the threaded shaft. This secures the pot into the mini case.

Rotation Stop
The next hole is a 1/8” rotation stop. On the pot there is a small metal tab that sticks upright on the side of the metal case. This tab goes through the 1/8” hole to keep the pot from rotating. The nut will generally hold it in place, but if the nut becomes loose at all, the pot will start to rotate.

Volume Indicators
The outer circle on the template has 6 small lines that cross it at different spots, starting with the first one in the lower left corner. The points where the lines intersect the circle can be used to drill dimples into the case to show the low volume spot as well as to indicate increasing volume. Do not drill a hole, just drill a small dimple (indent) into the plastic. The dimple can be filled with a drop of white model paint. Make the first dimple in the lower left corner. Use a small drill bit for all the holes or use progressively larger bits so the dimples get larger to indicate increasing volume.

On the speaker and right headphone volume, the Rotation stop hole will be where one dimple should be. Add a little white paint to this hole once the potentiometer is installed.

4.6.2 CABLE TIE FOR WIRE RETAINER

The input cable is held in place by a plastic tie wrap. From inside the box, route the tie wrap out one hole and back in the other hole. Push the cable against the inside of the box and use the tie wrap to hold it in place.

4.6.3 DRILLING TEMPLATE