

Wildlife Sound Recording Society

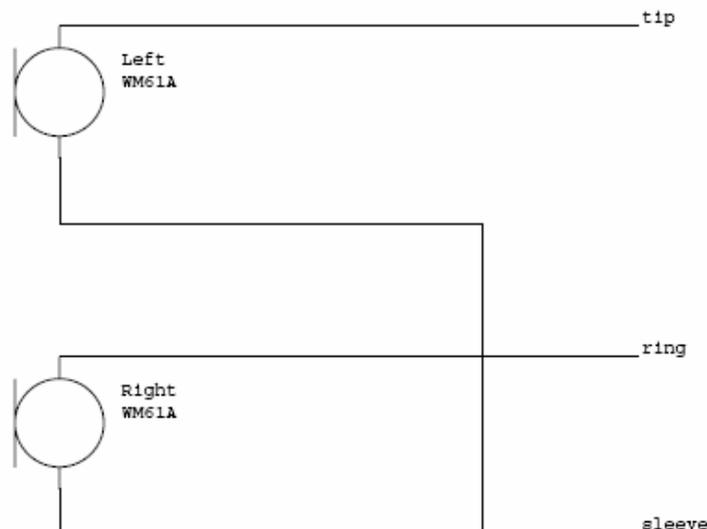
Panasonic WM61 homebrew microphone design

This is all about saving money, particularly for enterprising but cash-strapped budding recordists. These days you can get a decent recorder for a reasonable price - scour ebay for used minidisc recorders and you may pick up a bargain for about £50 (take a look at the [recorder section](#) of our newcomer's guide for what you are looking for). Good microphones are harder to pick up at knockdown prices. To get a microphone of the performance needed for wildlife sound use is expensive - of the order of about £100 (US\$150), and decent wind protection can easily double that.

Fortunately you can save a lot of money if you are prepared to homebrew your microphones, but you have to be prepared to do some fairly elementary soldering and mechanical construction work. DIY wind protection is another area where you can lower costs dramatically. Of course you won't be matching the performance of \$1000 microphones, but you will be able to come up with something that will give you very good lifelike recordings under good conditions for about £20 in parts new.

The reason for this is that the basic element of a entry level microphone, the electret capsule, is very widely used item in consumer electronics. These are made in their millions by anonymous Chinese factories, finding their way into all sorts of devices, and these can be bought retail for about 30-50p each at the cheaper end of the market.

The part selected for this design is the Panasonic WM61A, an omnidirectional capsule which can be had for about £1.50 each retail in the UK (search ebay, or FEL Electronics will sell small quantities at the time of writing). This part has a number of advantages - it has a known performance, which matches minidisc plug-in-power inputs quite well. The curious may wish to inspect the [datasheet](#) The current consumption is low at 0.5mA - other common capsules such as the [Rapid Electronics](#) ones can require 1mA which is not available from some of the newer minidisc inputs.



WM61A to unbalanced minidisc jack schematic

Wiring the electret capsules to the minidisc input is straightforward - you simply connect the +ve terminals of each capsule to the tip and ring of the 3.5mm minijack, and wire both -ve terminals to the sleeve of the minijack. You can use standard audio single screened cable of about 5m to connect the mics to the plug - if you use thin enough cable both cables can go into the plug. Alternatively, you can use individual 3.5mm stereo plugs for each mic, wiring one to screen and tip, the other to screen and ring, and use a 3.5mm stereo splitter (commonly sold for two people to be able to listen on one portable mp3 player). Alternatively you can use mono jacks and use a

stereo-to-mono breakout splitter. An example of the electret mics constructed by WSRS member James How uses that technique



James's solution was to create two mics and use a combiner.

The WM61A mics have been field-tested by two members, Roger Boughton and James How. Because Roger normally uses 48V phantom powered mics and his gear is set up for that I constructed a P48 adapter for the electrets - his description and recordings were made using this adapter and 48V phantom power for convenience. However, you will get very similar results using a minidisc player like the Sony RH1 but you should note that some of the cheaper CF card recorders on the market at the time of writing (2007) have insufficient gain and too much preamp noise to give good results.

Roger field-tested the mics at home and on Colonsay - his report follows:

A £20 stereo omni pair

Roger Boughton

An omni is a good first choice for a recordist constructing his first mic [1]. Although you do not get any directionality this makes the omni the least coloured in terms of sound quality, and least sensitive to handling noise. If you do want directionality, you can then use this in a parabolic dish without needing to make another mic.

The microphone is often the most expensive component in the newcomer's wildlife sound recording equipment list. Of the microphones we list in our newcomers' guide, the cheapest is around £70. This article describes an alternative approach, constructing a microphone using the inexpensive Panasonic WM61A electret capsule.

A microphone constructed in this way gives you an omnidirectional pickup pattern, which makes this a good basis for natural-sounding stereo soundscapes. Team this up with a parabolic reflector, and you get a highly directional microphone for single species recording. Your component costs should be less than £20 new, and in practice you should be able to reduce this if you have some common household materials to hand. If you



electret capsule and 5p (coin dia 18mm)

A few months ago we created a section on the website called **Experimenters Corner**. This followed a set of interesting entries on the thread of making microphones and would they be up to the task?

Unfortunately this thread came to a end, and therefore Richard Mudhar and I thought we would take up the cudgels and try to make microphones that could be made by anybody with a modicum of DIY skills. The

requirements were simple - the end result needed to

1. Sound OK and
2. Be cheap.

His question of cost was important as we wished to show that with that little bit of personal effort a person newly interested in wildlife sound recording could set himself or herself up with the basic equipment for £100 to £150, and microphones were given a £25 budget!

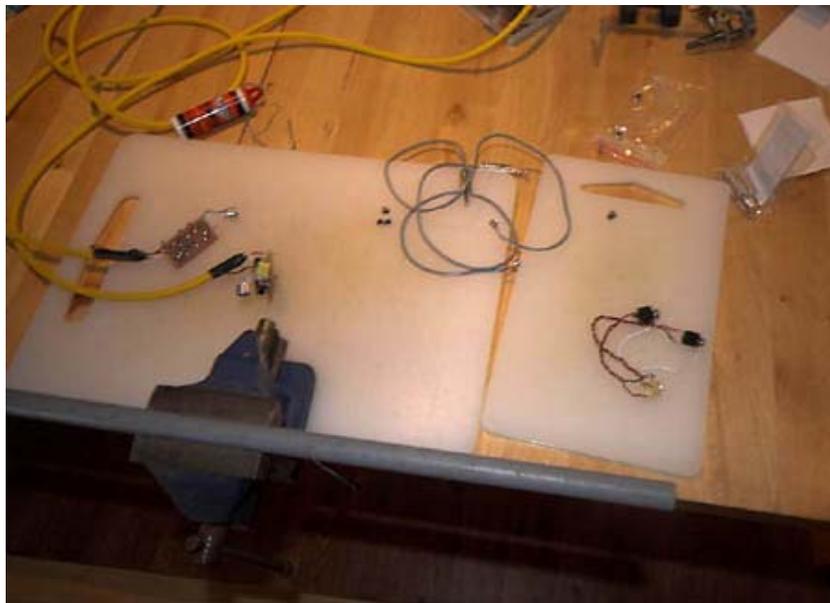
Richard asked me to make the microphone(s) as he knew that 1. I was pretty inept with a soldering iron, so if I could do it anybody could, 2. I have made many comments about the quality of sound some microphones provide, and 3. It would make me think about the beginners in the wildlife sound recording game, which as Vice Chairman I should.

We reviewed what microphone capsules are available, and initially Richard reviewed a Rapid electronics capsule which others around the world had used with some success. We eventually decided to use a Panasonic WM 61A which is also well-thought of, which not only gave a better frequency response, but was significantly smaller (see photo 1), which would enable us to progress using twins, triplets or even quads of capsules should we decide so to do. Paralleling up the capsules in this manner increases the signal level, at the cost of increased power consumption, without increasing the mic self-noise as much as the gain in signal.

Another design criterion was that the microphone should be able to be powered from a minidisc plug-in-power microphone supply as our recommended starter recording device would be a HiMD machine bought second-hand. The HiMD has the ability to record linear PCM and therefore avoid any problems associated with audio compression. for this to be the case only a single capsule can be used per channel - the plug-in-power available is not generally enough to power more than one capsule per channel

Assembly.

What tube did I have at hand? What diameter should this microphone be? I adopted some left over plastic tubing. Some 10 mm external diameter stuff that I proposed to use for a single capsule, and some 22mm external diameter which could be used for those twins, triplets and quads, should I ever get that far.



The workplace. The grey plastic pipe is in the vice ready for cutting. In the middle across the two cutting boards are the mic inserts soldered to shielded cable and fitted to 3.5mm jack plugs. on the small cutting board is a small adapter to connect the two mono electrets to a single stereo minidisc input to test the mics. Because Roger used P48 powering, he had to go place the P48 power supply in line to the recorder.

The plastic tubing can be easily cut to the required length, and has the advantage of being electrically insulating, so that any mishaps with bare wires or capsule sides touching the case and shorting things out are avoided.



The capsule fitted to the wire is now threaded through the tube,

For the ease of using with mini discs, it was decided to terminate the microphones with a mini-jack flying lead. (In future I will adapt an XLR plug at the end of the mics as it presents a more standard connection, once the 48V circuit is inside the mic.) This flying lead would eventually need to be attached to the 48v capsule powering circuitry and that circuitry would need to be attached to my recorders.

So the tasks would be:-

Solder capsule(s) to 5mm diameter microphone wire.

Solder mini-jack to the other end of the wire.

Cut plastic tubing to length.

Carefully position capsule(s) in tube.

Plug other end of tube to provide anchorage for the cable.

To provide anchorage for the capsule and lead I decided to use an elastic epoxy resin putty, which is available from most model shops, but I am sure you could use a silicone mastic to do the same job. What you must avoid is getting the mastic all over the capsule(s), and we decided that the capsule(s) should be flush with the end of the tube with the resin as flush as possible as well.



close up of capsules mounted in the putty

This “flushness” would give the capsule the best presentation to the sound, if sunk in , resonant cavities might exist at mid-high frequencies that we would not want. As you can see from the photos I have not yet worked out any physical sound transparent shielding above the capsules, but I am thinking about it.

Soldering the capsules which are 6mm in diameter was easier than expected, but having a small pointed soldering bit helped a great deal, as did a temperature controlled soldering iron. This is not necessary but proved useful. This is not to say that I got it right first time, but a little practice on other bits and pieces before attacking the capsules helped. As you can see my soldering still leaves a lot to be desired!

For the minidisc version, this is as far as the constructor needs to go. At the other end of the cable from the microphone, you can either wire both microphones into one stereo plug going to the recorder, or make up an adaptor to connect the two 3.5mm jacks on the end of the microphones into one 3.5mm jack to the recorder. The latter has more flexibility for slightly greater constructional work.

I needed P48 powering to match my recorders, so I introduced the P48 powering circuit that Richard had made. This enabled me to experiment with parallelling up the capsules for greater output and lower noise.



wiring of two capsules together in parallel

There are two tabs on each capsule, one tab is attached to the casing the other is not. When attaching 2 or more together it is important for all the same type of tab to be connected together. I used a table vice with small crocodile clips to position the pieces before soldering, and I used an appropriate thin solder wire as well. (For those who do this all the time, I apologise for stating things that you deem obvious. For me they became obvious.)

Once the capsules were soldered to the cable, the mini-jacks were connected. The tabbed connection on the capsule connected to the ring of the mini-jack, and the other capsule connection connected to the tip of the mini-jack. The earth of the cable was soldered to the sleeve of the mini-jack. (Please note that if I used a metal tube for the microphone, then the cable earth would be soldered to the metal casing of the microphone as well.)

Now that everything was soldered, I checked to make sure everything worked. When that was achieved the task of positioning the capsule(s) could begin. The epoxy resin I used, as showed in photo* came in a circular stick form, like a stick of flexible rock. You cut off as much as you need and then mix the outer layer with the inner, until blended to a uniform colour. You can then position the capsule(s) in it, and then position the whole sticky lump into the tube. Practice does make things better, (certainly not perfect yet), and the avoidance of getting the filler on the front of the capsule(s) is all important. The plug of filler probably filled the top 20mm of the tube. I finished off the top of the filler around the capsule(s) with a small flat screwdriver.



Twin capsules, set in epoxy and just before that stage

Its worth noting here that the only tools I had apart from the soldering iron were my leatherman and my Swiss army knife. A decent pair of wire strippers and a very sharp modelling knife would have been very useful, but it just goes to show what you can do with the basics. One other thing was that I had a pair of magnifying specs. Those capsules are very small!!!

Once the capsules were positioned, I checked everything worked again, as the positioning of the capsule(s) could have created havoc with my basic soldering. When checked and working I blocked up the other end of the tube and allowed everything to set. The epoxy putty I was using was the type that does stay a little flexible.

P48 Phantom powering

Although not required for use with a minidisc recorder, thinking of the next step up for recording I asked Richard to provide details of the electronics for taking a 48volt phantom supply that is provided by most solid state recorders, and making it usable for the capsules we wanted to use. From the [micbuilders mailing list](#) I found a circuit diagram purporting to be from to be from a major microphone manufacturer, which would do the job and it was this circuit that was used. Richard helped me here by making up the circuit for me so that I could test everything out within a decent period of time (see photo, right). All I had to do know was test the newly made microphones. Hear what you think.

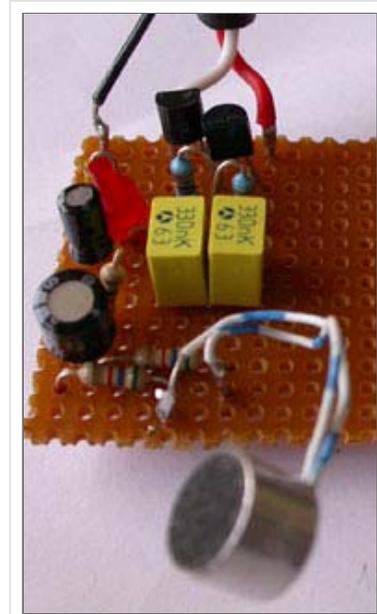
(Listing of recorded cuts.)

My initial thoughts are that when compared with my bought mics, they are:-

1. Have a greater self noise.
2. Do not sound as rounded or as detailed.

But

3. Cost less than £20 a pair.



P48 circuit

And, if I didn't give the A-B comparisons, would you have found the sound acceptable.

To conclude these "hand made" microphones would provide a beginner with a more than adequate collector of sounds.

For the person who already has "quality" microphones they would provide the basis of a "disposable" microphone, one that can be left in a hazardous place with little worry about it being lost or broken.

In the future attention of finding a cheap solution to the problem of wind shielding as the results without it, as with all mics, would be very disappointing.

Recordings

Listen to some recordings, comparing the WM61A with Roger's much more expensive Schoeps omnidirectional mic in a binaural dummy head.



Wren and robin, WM61A



as above, Schoeps mics



House Sparrows, WM61A



as above, Schoeps mics

Conclusion

I was surprised to find that these performed as well as they did, and I wouldn't hesitate in recommending this route for the cash-strapped recordist who can do the basic soldering. You don't need expensive test gear - a digital multimeter which can be had for about £10 or borrowed is all you need, and the ability to listen. The construction is reasonably straightforward and the results are surprisingly good.

From a purist's perspective, it is possible to nit-pick. These capsules lack audio transparency - when there are a lot of different things going on it is harder to separate the different strands out than with a good mic. They tend to have an uneven response in the high frequencies, which can lend a harshness to the sound or dull the top end, depending on the nature of the response. The sparrows sound a little bit less like individuals and more generic than on the Schoeps. And yet for all that, at the price you can afford to experiment, and you can get into the field and start recording.

The spaced pair technique also lends itself well to large open ambiances - you get some sense of the 'air' of the open forest behind the chaffinch and the spread of the tern colony, even though that is too far away for these mics. The lack of directionality can be frustrating if you are targeting a particular individual, but to address that kind of situation you can team these mics up with a parabolic dish.

There is the natural temptation to see if you can improve the design, and there is much that *can* be improved. Whether this is a cost-effective route is more questionable. You can get better capsules, but as these are specialised items and you want them in small numbers the costs tend to rise rapidly. One of the favourites is the Panasonic WM-61A which retails at £3 to £5. There is a e-group on Yahoo called [micbuilders](#) who aim somewhat higher than I did in building microphones and take a lot more care over the visual appearance.

Constructing microphones can be a fascinating hobby, and I am sure many of the members of that list achieve a much higher performance than this. However, if you are a sound recordist looking for significantly better performance you will probably use your time and money more effectively scanning the secondhand market and saving for something like the Sennheiser ME series, while in the meantime getting out into the field and recording with a pair of these omnis. You will gain valuable experience and some good recordings when the conditions are right, and have a much better idea of what you want to record and how when it does come to making a purchase.

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1. Homebrewing a cardioid mic of this forward facing style is harder than an omni, because a cardioid capsule receives the signal from the back of the capsule as well as the front. It is easy to keep the front of your mic free of mechanical resonances by keeping the front flat, but you have to mount it somehow so there is a much higher risk of colouration from tube cavities to the rear.

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Sitemap