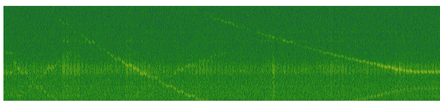
# Cheap Microphones for Ultrasound



This page documents my experiments using inexpensive microphone capsules to record ultrasound signals. I tested several capsules using a 192kHz audio recorder and cheap piezo tweater. For each mic you'll see a spectrograph showing a frequency sweep through the ultrasound range from 100kHz down to 28kHz. This shows the maximum frequency each mic can detect, along with the relative noise floor and the consistency of the response across the tested frequency range. I will update this page periodically as I test more mics.
(Created June 2018)

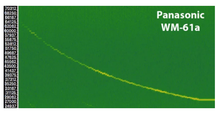
# The Summary

**All of the tested mics have usable response into the 40kHz range.** Overall I recommend the Primo EM258 since it's easily available, cheap, and works like any other electret mic capsule. (It's not much better than the older Panasonic WM-61a capsules so there's no reason to upgrade if you already have access to those.) The Knowles MEMS mic reaches highest, but has a more uneven response and is quite difficult to solder, power and mount.

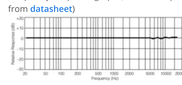
# The Mics

## Panasonic WM-61a (discontinued)

This inexpensive 6mm omni capsule was ubiquitous in commercial and DIY mic designs for years, but is sadly discontinued around 2013. They will be available on eBay for the foreseeable future, but beware of counterfeits. JLI and PUI both make modern clones but I haven't tried them.




- Frequency Response graph (audible frequencies, from datasheet)

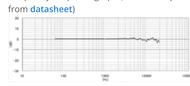


- Sensitivity: -35dB
- Signal to Noise Ratio: >62dB

## Primo EM258

This is Primo's clone of the Panasonic WM-61a. It is also a 6mm omni capsule, and very similarly specified.


- Price & Availability: £ 4.13 from FEL in the UK (ships worldwide)
- Frequency Response graph (audible frequencies, from datasheet)

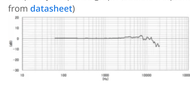


- Sensitivity: -32dB
- Signal to Noise Ratio: >74dB

## Primo EM172

Primo's amazingly low-noise 10mm omni capsule, popular for DIY mics including my low-noise binaurals and the commercially available FEL Clippy.

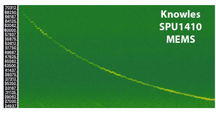

- Price & Availability: £ 10.50 from FEL in the UK (ships worldwide)
- Frequency Response graph (audible frequencies, from datasheet)



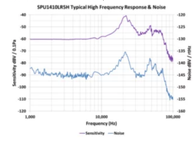
- Sensitivity: -28dB
- Signal to Noise Ratio: 80dB

## Knowles SPU1410

This is a MEMS mic, not a typical condenser capsule like the rest. MEMS microphones are built using microchip fabrication techniques so they can be made cheaply, tightly calibrated, and soldered directly onto circuit boards. (Analog Devices has a nice guide.) They are typically noisier than electrets and many sound pretty unremarkable. They are designed for automated assembly, but they can be hand-soldered with fine wire, a magnifier, and a careful hand. The datasheet doesn't mention ultrasound, but Knowles Application Note 17 shows high frequency data for several microphones, including this one. Also see the interactive tutorial version.




- Price & Availability: approx $2 from DigiKey
- Frequency Response graph (**ultrasonic frequencies**, from Knowles Applications Note 17. Also see datasheet.)




- Sensitivity: -38dB
- Signal to Noise Ratio: 63dB

# Testing Method

My improvised test rig is bad for measuring absolute frequency response, but it seems adequate for comparing different mics. It consists of:

- DSO Quad Oscilloscope (running the "Wildcat" replacement firmware). The waveform generator was set to sine at 1.5v amplitude and manually swept from 100kHz down to 28kHz for each test. (These frequencies are based on the scope's limits. I couldn't do a continuous sweep from 100kHz down to audible frequencies without switching ranges, so 28kHz was the lowest frequency I tested.)
- GRS PZ1005 piezo "bullet" tweeter driven directly by the scope. I could hear some audible noises during the sweep, probably a combination of speaker distortion and digital aliasing from the scope's limited waveform generator.
- Sound Devices MixPre-6 recorder (set to record at 192kHz, 24 bit).

Each recording was high-pass filtered to reduce audible frequencies and adjusted so the level of the 28kHz tone was matched. They were analyzed in the excellent (free) Sonic Visualiser. Some of the peaks and dips in frequency response are doubtlessly caused by the nonlinearities of the tweeter, so don't trust these measurements as absolutes!

# Further Research

I wrote about my earlier bat recording experiments with an inexpensive handheld recorder.

Richard Mudhar of the Wildlife Sound Recording Society has an excellent page of ultrasonic bat recordings, as well as a low-cost guide to recording ultrasound: A low-cost approach to recording ultrasonic vocalisations

I haven't tried the Knowles FG-23329 capsule (a tiny electret, used in many commercial ultrasonic microphones). They're expensive though, around $25.

I would love to compare the results to a dedicated ultrasound recording solution like the Ultramic range from Dodotronic. (They use the Knowles MEMS and FG electret capsules.)

Wildlife Acoustics makes several commercial bat detectors, including the excellent Echo Meter Touch series for mobile devices. They used a Knowles FG electret in the first version, but I'm not sure what's inside the Echo Meter Touch 2 or the Echo Meter Touch 2 Pro (which seems to have a much better signal to noise ratio). Their 2014 document Detecting Bats with Ultrasonic Microphones is worth a read.

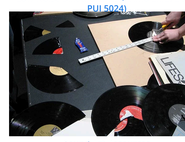
The UltraSoundGate transducer combinations from Avisoft look pretty amazing.

## Related Posts:

Zach's Recorder Recommendations

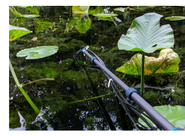
Low-Noise Binaural Mics (Primo EM272 and PUI 5024)

Choosing a Contact Mic For Field Recording



Sound Art Resources

Hydrophone Experiments II



Choosing a Hydrophone For Field Recording

*I am a media artist, educator, and life-long tinkerer based in New York City. This site shares my artwork and the software and resources I develop in the course of my research.*

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