

How To Test the Performance Characteristics of Piezoelectric Contact Microphones

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Most audio enthusiasts and sound recordists have a pretty good idea of how condenser and dynamic microphones work, and how to read their performance specifications. Some are familiar with the laboratory test rigs used for measuring microphone performance. It is convenient that all such microphones have something in common: the medium within which they function, that is, the atmosphere. Though sound propagation varies pretty dramatically with atmospheric conditions, at least we are able to choose a standard temperature and pressure, and in most parts of the world it is not difficult to create a standard environment.

But all this convenience goes down the stinking toilet when we turn to contact microphones. Sure, a contact mic has a frequency response, a bandwidth, a noise floor, sensitivity – but how can I go about measuring them? Contact mics do not respond to pressure changes in a gaseous medium; they respond to vibration in a solid medium. Where is the “standard temperature and pressure” equivalent for contact mics? As far as I can tell, it does not exist. When I review performance literature for piezo transducers, I can only find test results when the transducer is being used as a sound source – a loudspeaker or buzzer. I have found no test results for piezos as microphones. I found one medical application of piezos as microphones, in which case the experimenters simply compared the performance of several piezos to a local standard, as measured with a reference condenser mic¹.

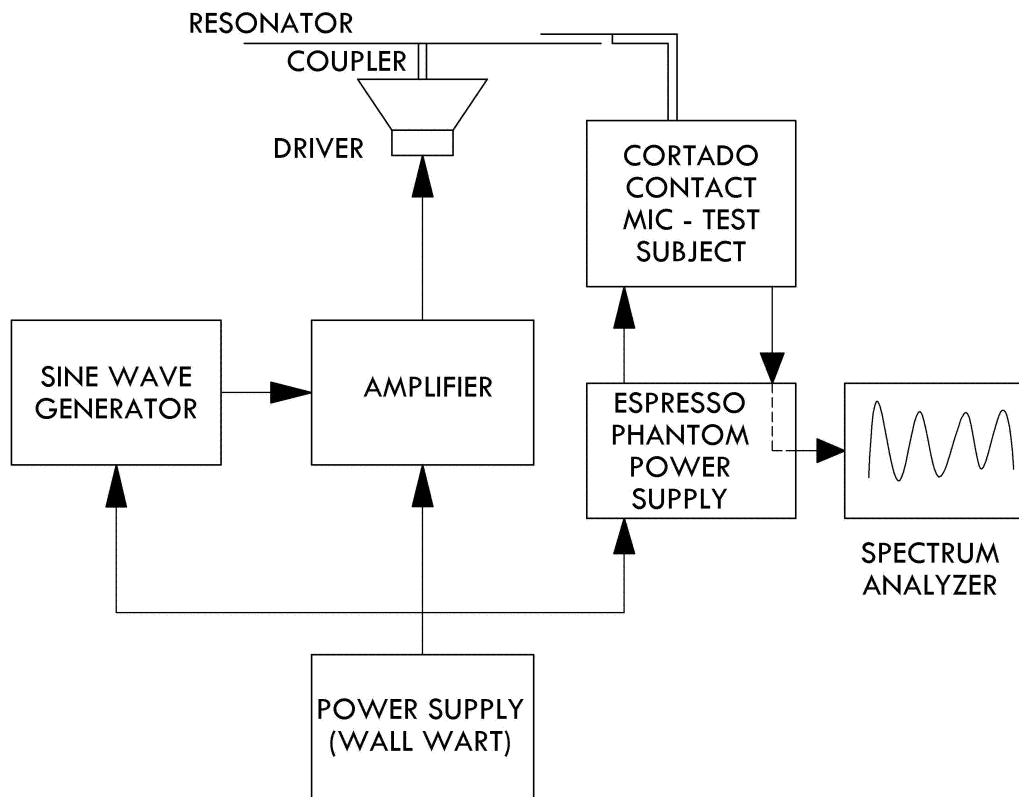
Here at Zeppelin Design Labs, we make a nifty, popular contact mic, the Cortado, with an integral preamp circuit that balances the signal from the piezo and matches its high impedance to that of a typical recording device. Customers sometimes ask, “So what’s the frequency response?” I know what they mean, but how shall I measure it? What should I stick it to? It seems to me its frequency response will be a measure of the frequency response of the thing I stick it to, rather than the transducer itself.

To take a first step toward a standardized testing regime, we started by devising a test fixture that at least quantifies whether a new contact mic works or not. But in the absence of a universal standard, all I can do here is pick a reference contact microphone and compare all others to it. So that’s what we did; and the following describes how we did it. If you have experience evaluating the performance of contact mics, or ideas how to go about it, please share your thoughts.

Who’s Gonna Drive You Home?

We wanted to drive (vibrate) the piezo sensor in some (arbitrary) manner that we could control and measure, across a range of frequencies. We designed the test fixture described in the following block diagram, Figure 1.

Figure 1



The components are a power supply, tone generator, amplifier, driver (speaker), coupler, and resonator plate. The tone generator creates a sine wave with variable frequency; the amplifier controls the amplitude. The Cortado Contact Mic runs on phantom power, so we included an Espresso Phantom Power Supply to provide 48V phantom power. The contact mic's piezo is clamped to the resonator. The signal passes through the Espresso to a spectrum analyzer. For these test purposes, we found it is satisfactory – and convenient – to use a SmartPhone with the FreqenSee app.

The particulars of the fixture construction are shown in cross section Figure 2, and in the following photos.

Figure 2

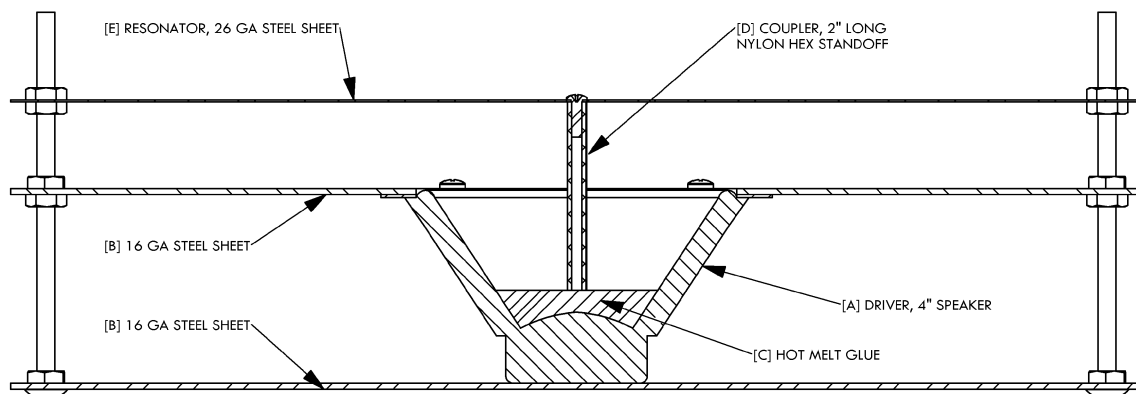
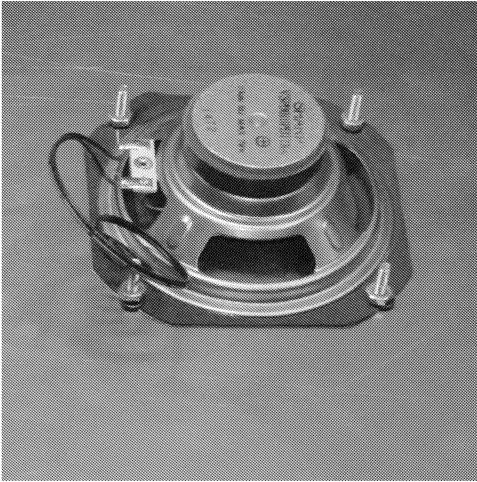
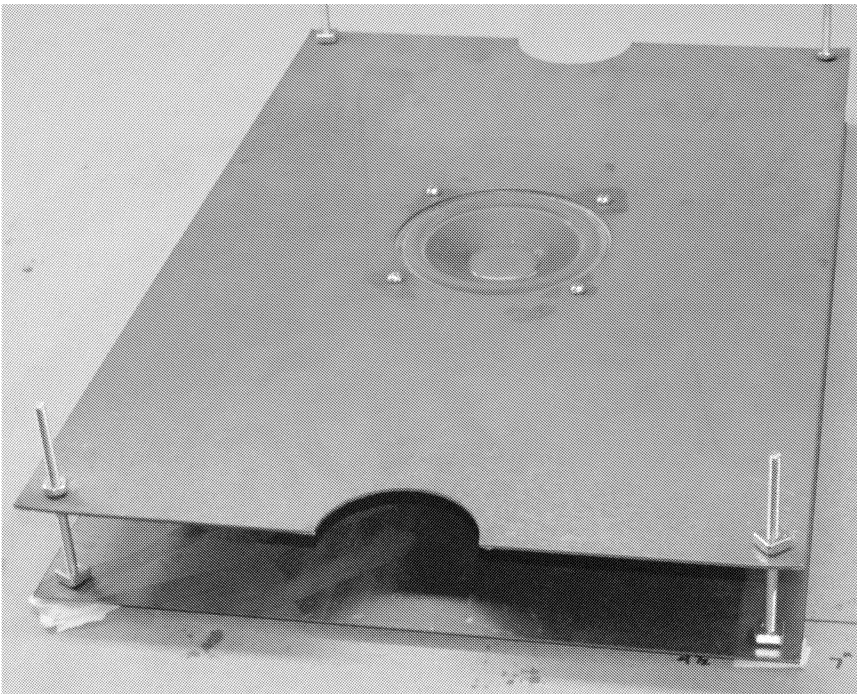


Figure 3



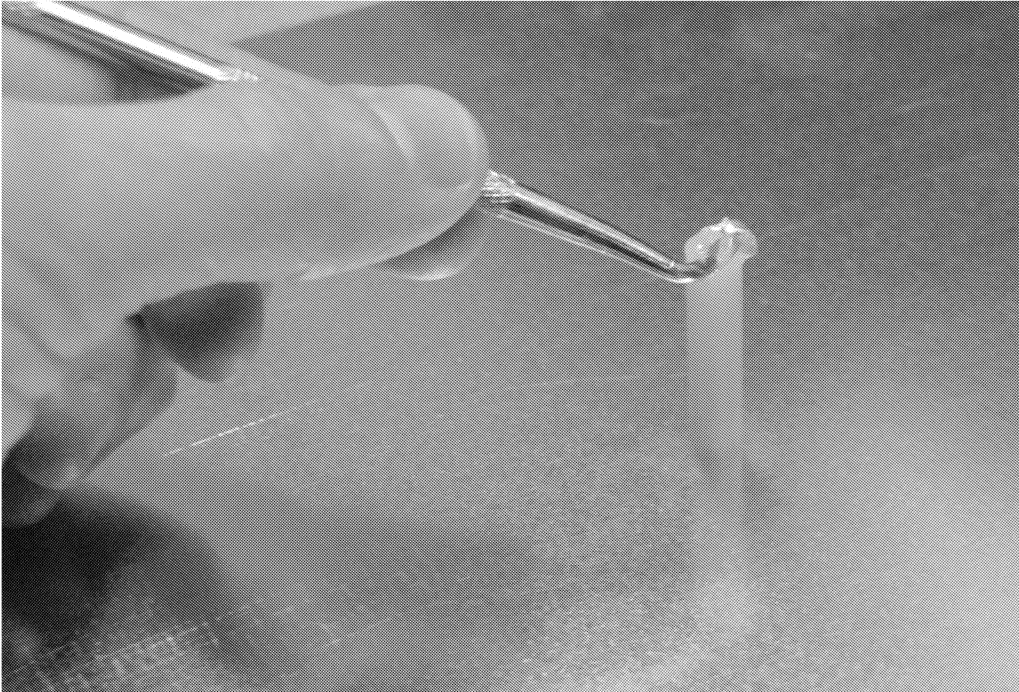
The driver [A] is a 4" (10 cm) speaker we had on hand. It is rigidly mounted between a pair of 16 gauge steel plates [B].

Figure 4



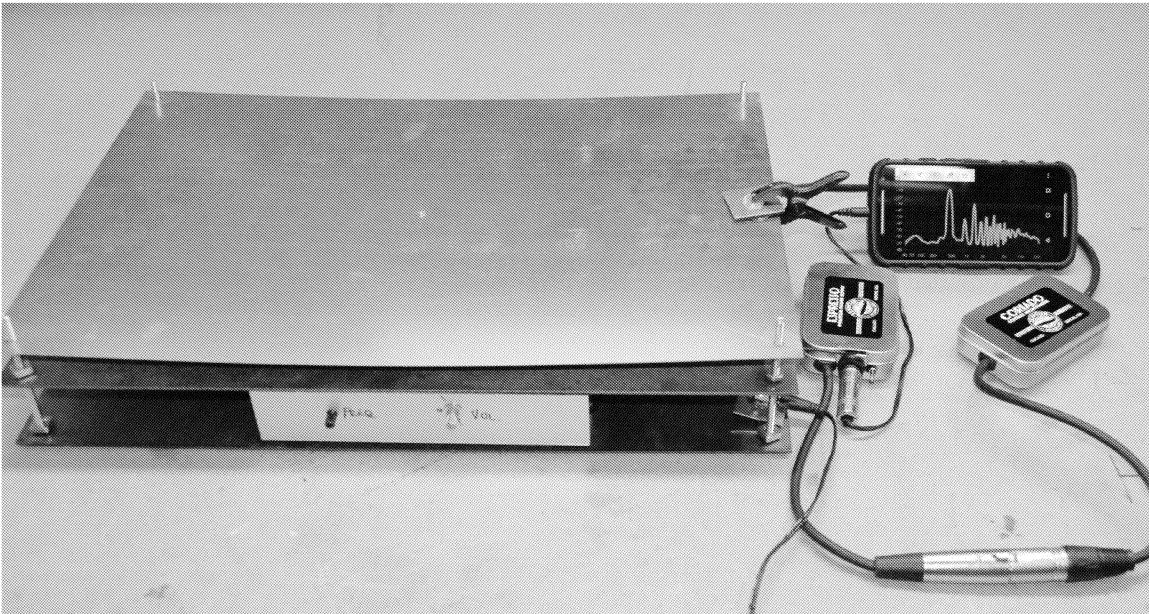
The speaker dome is capped with a pool of hot-melt glue [C] to create a stable platform to which to bond the coupler.

Figure 5



We mounted the coupler, a long standoff [D], to the center of the resonator. Then we applied a blob of glue to the standoff, flipped over the resonator and carefully lowered it until the coupler just contacted the hot melt glue.

Figure 6

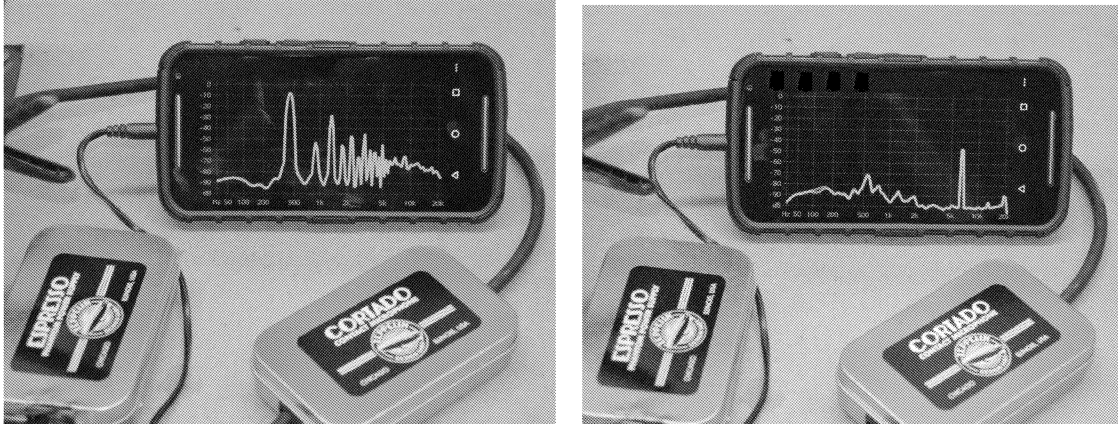


The resonator is a 26 gauge, 12" x 18" (30 x 45 cm) galvanized steel sheet [E]. At rest, the plate and coupler rest neutrally upon the driver. Theoretically, the driver is presented with similar stress when driving the plate either upward or downward.

Shakin' All Over

So there's our setup, Figure 6. We picked a microphone to be the shop reference and clamped the piezo to the midpoint of one short side of the resonator. We chose a standard volume level, one that gave a strong signal across the available bandwidth. We measured the mic's performance at a couple of reference frequencies: -9dB at 450 Hz and -47 dB at 6500 Hz. Now we have a quantitative in-house standard for testing.

Figure 7



Relatively Useful = Absolutely Useless

So I now have an absolute standard, relative to a local reference; but how to translate this to a universal standard? With contact mics, all measurements are medium-dependent. I can't even accurately comment on resonant peaks or flatness-of-response for this mic, because what I am actually measuring is the response of the resonator! So I ask you: How can I measure the frequency response of a contact mic? I can think of ways to measure signal-to-noise, and bandwidth, and sensitivity (articles to follow), but not frequency response. We are open to suggestions and welcome your comments on our forum (www.zeppelinlabs.com).