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Using LAUD with **ACCELEROMETERS**

(NOTE: The ACH-01 device, mentioned below is now a product of Measurement Specialties Inc. (no longer supplied by AMP). Some particularly good news is that the accelerometer has dropped *dramatically* in price and can also now be ordered from DigiKey Corporation)

This same basic information and technique also can be used with PRAXIS. PRAXIS also provides a means to apply a correction file for an accelerometers, see the PRAXIS Help)

We are asked from time to time about how LAUD might be used with an accelerometer to measure loudspeaker cabinet vibrations. An accelerometer is used to detect vibrations induced on its body, rather than those propagated in air. The process of using an accelerometer with LAUD is quite simple.

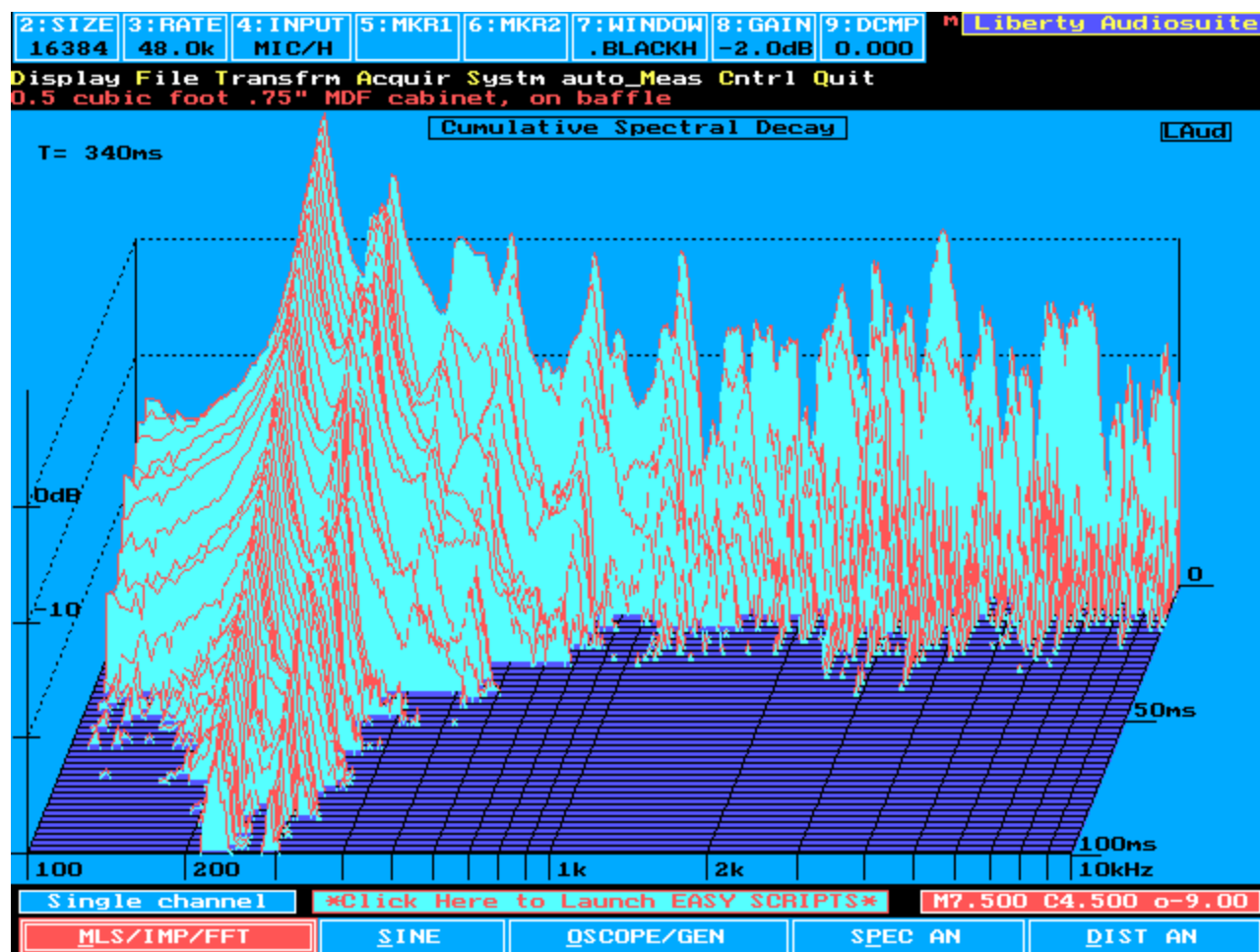


Figure 1: Waterfall plot of cabinet vibration on baffle of small speaker - this one has a significant resonance at 220Hz and 310Hz

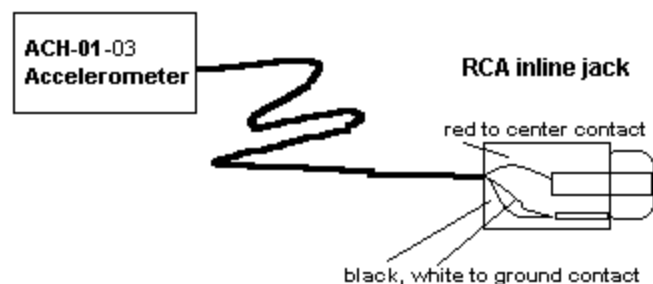
If the accelerometer is electrically compatible with the LAUD input circuitry's impedance and sensitivity, you can use the accelerometer essentially the same way as you would a microphone. Just feed the accelerometer's signal to where your microphone normally connects and drive the speaker with a stimulus

signal (with the cal probes sensing the speaker's drive signal). Measure the result from the accelerometer mounted on the cabinet face you are investigating, rather than from a microphone placed in front of the speaker as you would normally do. **You are in effect measuring a frequency response**, but rather than one "from drive signal to sound output", it is "from drive signal to cabinet vibration" -- with the less measured in general, the better. When using an accelerometer into LAUD's mic input, you should temporarily disable your mic correction file (by the menu sequence: [* File Micdat], then type "NONE" and press the [Enter] key).

A simple piezo element, as might be removed from a cheap piezo tweeter, can be used effectively as an accelerometer. Even with its high impedance badly mismatched by the FIJI's (or Mic/Probe Preamp's) input, the piezo's output level is still adequate for making comparative measurements of the vibrational characteristics of loudspeaker cabinets. The main difficulty with this technique is that you can't be sure which of the response peaks that you see are from the piezo and which are due to the cabinet (and cabinet vibrations do tend to be very peaky). Another problem is in finding a way to mount the piezo to the cabinet -- you can't press the piezo with much force onto adhesive or wax without breaking the ceramic disk. One approach that works well is to glue the piezo to a small piece of wood, and then attach the wood to the cabinet with clay or wax. But there's no reason to put yourself through this kind of trouble.

The real hot ticket among accelerometers for audio frequency measurements is the ACH-01, now made by Measurement Specialties (see their website at <http://www.msusa.com/piezo/accelerometers.htm>). The ACH-01 device is just about perfect for the job: very wideband response (specified within 3dB from 2Hz to 20kHz), internally buffered for low output impedance, and already housed in a small, rugged, flat package and supplied with a nice, limp shielded cable. And it is very reasonably priced - **about \$21!** Sensitivity of the device, though slightly on the low side if used without further amplification, is adequate for direct usage with the LAUD hardware, needing nothing more in the way of assembly than to solder the wires to an RCA connector. At this low price, it also seems to be a natural for use as a motional feedback sensor.

The ACH-01 requires a bias voltage to power its internal FET buffer. When powered from the FIJI card (or the PRAXIS AudPod) as shown in figure 2 (connected directly to the FIJI's or AudPod's mic input), sensitivity is about 4.7mV/g and signal handling is about 60g(p-p). The ACH-01-03 model comes with a shielded cable and a connector - just cut the connector off at the far end and solder the wires as shown directly into an RCA inline jack. This provides a very simple hookup, relieves the user of the need to be concerned about batteries for the device, and is very well suited for loudspeaker cabinet investigations. This same hookup also works when connected to the MIC input of the Mic/Probe Preamp (for ECHO-based LAUD systems) or to the IMP's mic input.



For connection to and bias from Turtle Beach Fiji card (jumper card for "condenser mic"). Use accelerometer as you would a microphone, but disable the mic correction file.

figure 2: Biasing the ACH-01 directly from a FIJI card

If you'd like higher sensitivity or lower output impedance, or wish to use the ACH-01 for higher acceleration levels (such as in a motional feedback loudspeaker system), figure 3 shows a battery operated booster/buffer circuit that will provide about 26dB greater sensitivity (100mV/g). This circuit will also drive the mic inputs of the FIJI, Mic/Probe Preamp, AudPod, or IMP, with sensitivity to spare.

For you poor, misguided souls out there with other measurement systems such as CLIO, MLSSA or LMS (just kidding), the figure 3 circuit can be used with those mic inputs as well (the inverting output can be configured for driving the other half of a balanced input in cases where that is needed). If you wish lower sensitivity and higher signal handling (up to about 300g p-p), short the 200k ohm resistor between pins 1 and 2 of the opamp -- but if you use a switch to do this, the lead length from pin 2 must be VERY short to avoid noise pickup and instability!

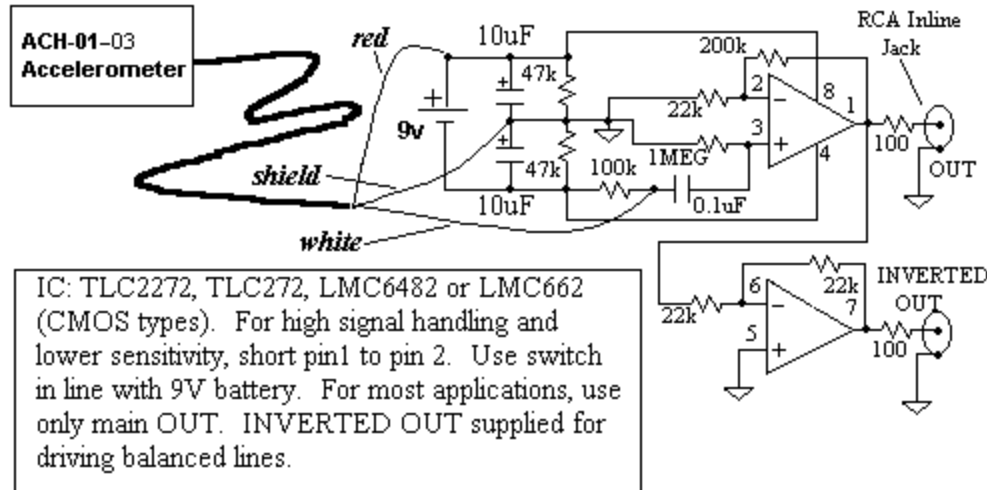


figure 3: amplified/buffered circuit (battery powered) for the ACH-01

If you want a separate accelerometer preamp/bias supply and don't want to take on a new circuit project, you can instead order a specially made amplifier box IB-ACH-01 for the ACHY-01 from DigiKey (part number MSP1003-ND) or from Measurement Specialties (part number 0-1003-058-0). Cost is about \$105. You can probably use this to adapt the ACH-01 to about any competent measurement system.

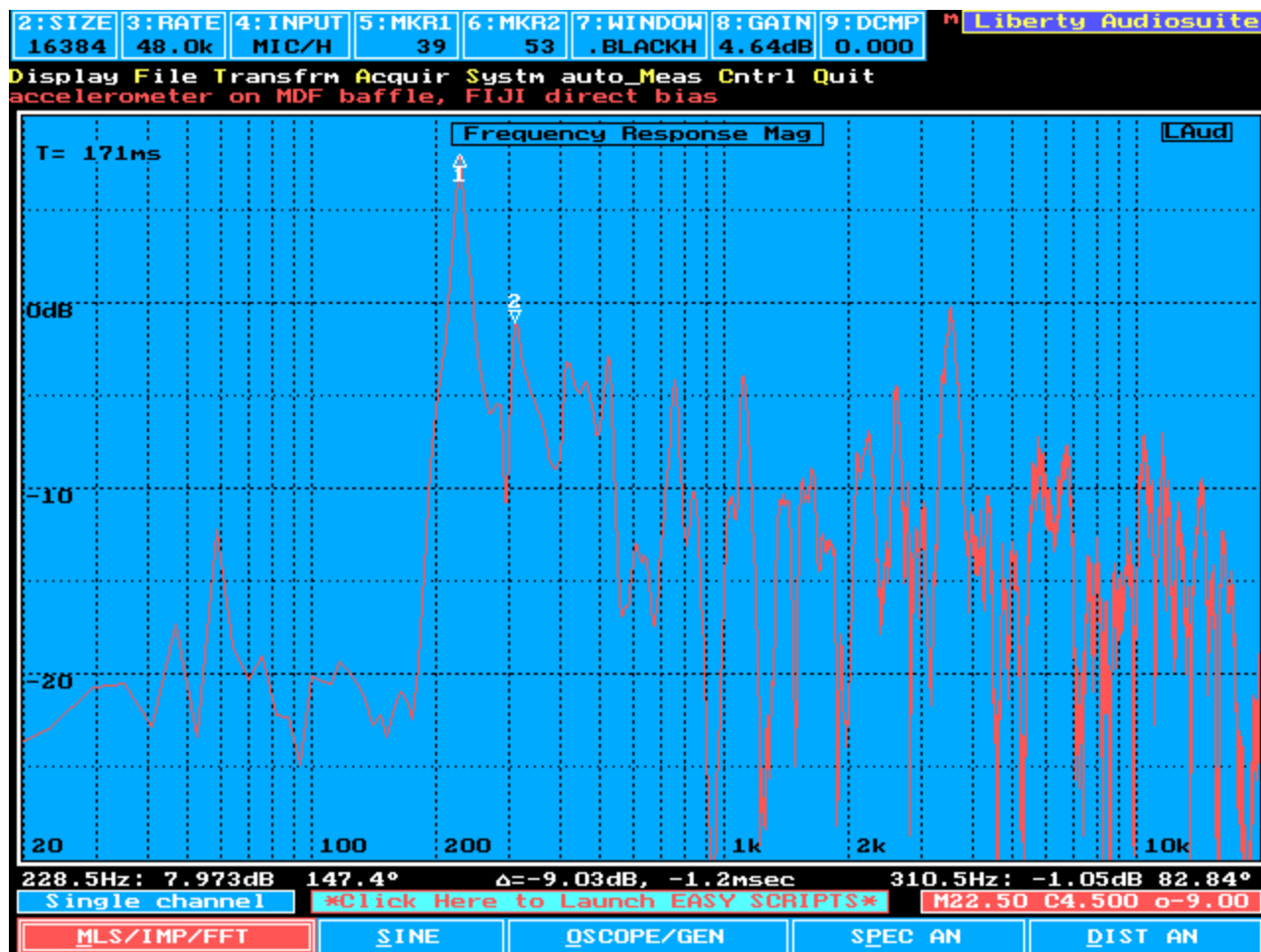
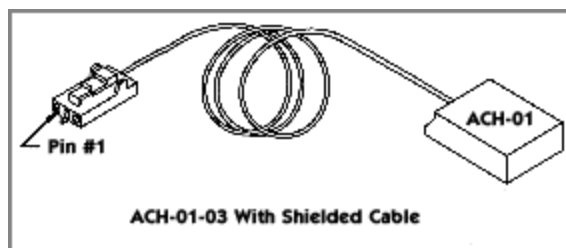
You may find yourself questioning the shielding of the ACH-01 --often a strong component at 60Hz will be seen on accelerometer plots of speaker cabinet surfaces. I ran into this with the ACH-01, but quickly discovered the real cause -- the speaker I was measuring was sitting on a bench with other equipment. The power transformers in that equipment were vibrating at the line frequency and inducing a vibration into the speaker cabinet, and this vibration was faithfully picked up by the ACH-01. So when doing these measurements, it may be advantageous to place the speaker being tested on a solid concrete surface -- the ACH-01 can be very revealing...

The manufacturer recommends mounting the accelerometer permanently with epoxy or cyanocrylate ("Super") glue. This is not practical for those of us who want to use the device as a movable probe or to test a number of speaker surfaces. A very good alternative is to get some "MINI-HOLD" wax adhesive (Handcraft Designs, Inc., Hatfield, PA 19440) from a doll-house store or a hobby store that sells doll-house supplies. This wax is made for mounting tiny accessories in dollhouses, but makes a great solid, yet removable adhesive for bonding between cabinets and the flat surface of the ACH-01 accelerometer.

The ACH-01 can now be ordered from DigiKey Corporation (www.digikey.com part number MSP1001-ND) or directly from Measurement Specialties

(http://www.measspec.com/piezo_film_manual.htm) . You'll also find some interesting articles about making piezo film speakers at the Measurement Specialties site mentioned above.

Please note that **Liberty Instruments** does **NOT** sell or stock these accelerometer or preamp devices -- please order from one of the above companies!



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