What to look for when the distortion in 2180s doesn't match the specs on the data sheet

All too often, we get frantic calls from designers measuring THD and/or noise well above the specifications on the 2180XX and 2181XX data sheets, wondering if layout is a factor. Well, sometimes it is, but it could be the result of other factors as well.

All 2180XXs and 2181XXs are 100% tested for noise and THD+N, in addition to a number of other parameters. Their specifications are conservative, and most should perform substantially better than "worst case".

Before attempting major design or layout changes, we suggest you look at these few things first:

• The measurement bandwidth for the THD+N measurement should be 10 Hz-to-20 kHz. If the measurement BW is large enough, high frequency noise can dominate the measurement.

• Make sure the power supply is quiet.

• Make sure that the circuit is isolated from any RFI. Cover the circuit with a medium sized box covered with aluminum foil, and see if this alleviates the problem. You'll probably want to ground the foil.

• As an experiment, try letting pin 4 of the VCA float. Even our untrimmed VCAs should be better than 1% THD!

• Make sure that there is no signal on the control port, as this will result in a significant amount of second harmonic distortion. Also, make sure there is a minimal amount of noise on the control port, as this will be multiplied by the signal in the gain cell, producing what we call noise modulation.

• Make sure the driving impedance of the control voltage is sufficiently low, and that it is non-inductive. A source impedance of more than $20\,\Omega$ will begin to de-grade the THD+N performance, and more than $100\,\Omega$ will begin cause serious problems. Also note that this impedance should be resistive or capacitive. An inductive source impedance at this point may cause the VCA gain cell to oscillate, and the output of all op-amps is, to some extent, inductive. This is especially pronounced in lower bandwidth op-amps. We normally recommend low noise, wide-band op-amps like the NE5532 or the OP-275 in this application. We sometimes recommend that the output of the buffer be shunted with a $51\,\Omega$ resistor in series with a 2.2 nF capacitor to counteract the inductive output impedance of the op-amps used in this application. Remember, even if the device is oscillating well above the audio band, non-linearities in the circuit can produce audible artifacts in the audible band.

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• *Look for oscillations in the circuit. Make sure the 22 pF capacitor in the feedback loop of the VCA's trans-impedance amplifier is properly connected, and that all the op-amps are properly bypassed. Do NOT try to evaluate this circuit on a solderless breadboard! If your circuit has a threshold amplifier, make sure that there is a capacitor in its feedback loop, since these circuits can oscillate near the threshold and inject their oscillations through the control port.*

Problems like those listed above are more common than one would think, and probably contribute to the perception that "VCAs have this certain sound...". Customers in the process of evaluating our VCAs may want to purchase one of our evaluation boards, which we know works, and at $100.00 US, they can't go wrong. Of course, you'll still want to build your own breadboard to develop an understanding of the requirements for a superior layout. If these suggestion fail to help, be sure to give us a call.

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