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A Microphone Audio Test Source For Your Ham Shack

During a QSO, have you ever had the other party comment on your audio quality or lack of it? For example: *"…hey OM, you are not making it….your audio is weak! Get closer to the mic or turn up your mic gain ! "* Or the reverse *"… hey OM, your audio is really distorted. You are overdriving and spattering all over the band. Get further from the mic and/or turn down the audio gain !!!."*

Embarrassing, yes! And the question is what to do about it?

I am sure some of us have found ourselves trying to whistle, or even "hum" into the microphone, while peering at the ALC meter on the rig in order to help judge and set the audio level.
I don't know about you, but I *neither hum or whistle very well*. So I thought it would be handy to have a simple ***audio test source or tone generator*** in a small box with a small speaker, that can be picked up anytime, held in front of your 'mic' and used to provide a repeatable reference audio "check" source. Such a device is shown in photo 1.

Now that I have hopefully grabbed your interest, I will proceed to describe the device in more detail and explain how you should probably build it, but just a little bit differently!

The task of making a compatible audio test source is not as simple as it first seems – there are many different type of microphones that are used in many different ways –
The most common microphone types favoured by hams are:

1. a handheld microphone on the end of a curly cord
2. a headset mounted microphone
3. a desk mounted communications microphone
4. a boom mounted professional microphone

Types 1 and 2 above are what we might describe as "close-talking" microphones, where the distance from your mouth to the microphone is typically 1 - 3 inches. These "mics" are especially suited for use in noisy operating environments.

Types 3 and 4 on the other hand, tend to be used where the distance from mouth to mic is typically 6 - 12 inches or more. Also, they are best used in an operating environment that is quieter and more controlled, otherwise nearby sounds may be picked up and broadcast. (examples: fan or A/C noise, background radio music, nearby conversations, or worse!)

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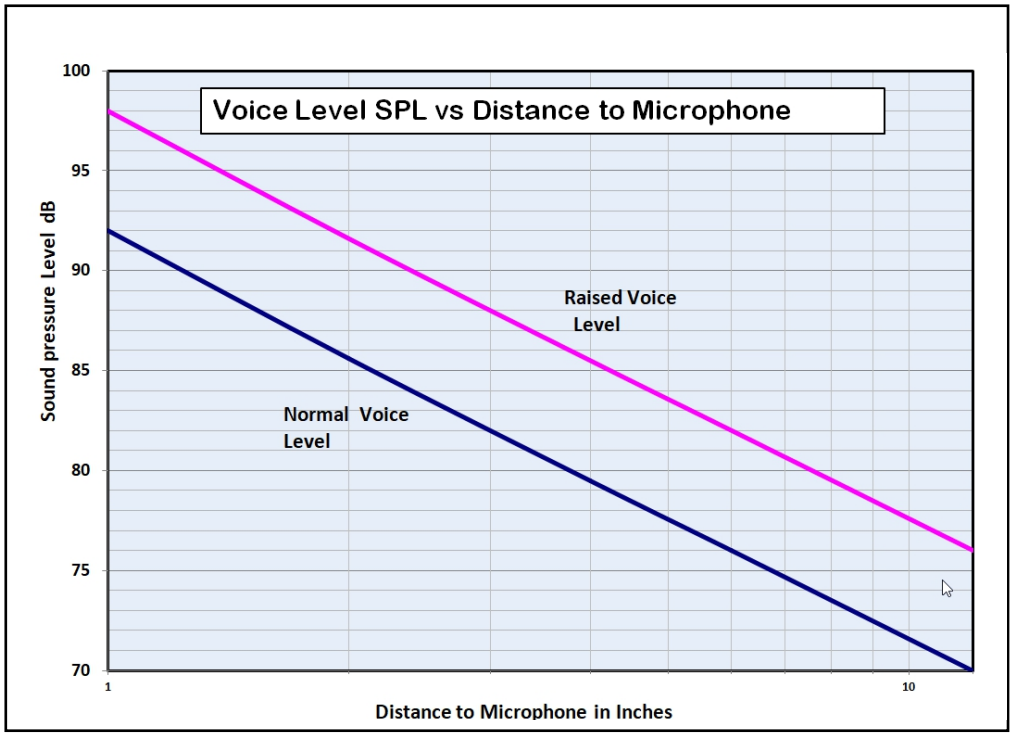
Voice Sound Pressure Levels (SPL) and distance to Microphone



It seems to be well established that talking with a “normal” voice approximates a sound pressure level (SPL) of 70 dB, when measured at a distance of 1 foot. Note that the same “normal” voice, measured instead at 2 inches, becomes a SPL of 86 db! This is because sound pressure level decreases in inverse proportion to the distance from the sound source to the measuring point. (sorry, no square law involved!)
The above graph of voice SPL vs distance to microphone can be readily derived from the simple 70db @ 1 foot definition for normal voice level. Now you can look at your own situation, and decide on what SPL you would like your ‘reference” source to emulate. (ref 1)
For example, I decided that my audio reference source should emulate ~86db at a distance of 2”.This can also be measured as ~92 at a distance of 1”.

How create the tone

Someone is likely to suggest that there are audio oscillator applications one can download for free to a laptop, tablet or ‘smart’ phone. This may be true, but there are problems with using this kind of source: a) the chosen tone cannot be easily referenced or adjusted to a known sound pressure level (SPL) and b) the speaker found in such devices is usually tiny and quite directional.
So when you get down to it, an ideal microphone audio test source should possess some basic characteristics in order to be useful.
They are:

1. to be stand-alone, be handheld, and ready to go at the push of a button.
2. have a low cost, low, and preferably be something you can make yourself.
3. couple to the microphone at a similar distance that you/your mouth does when speaking
4. not be overly directional – we don’t want a bench setup to be necessary for use.
5. have an audio level that is at least measureable and repeatable, using typical sound level meters available today.

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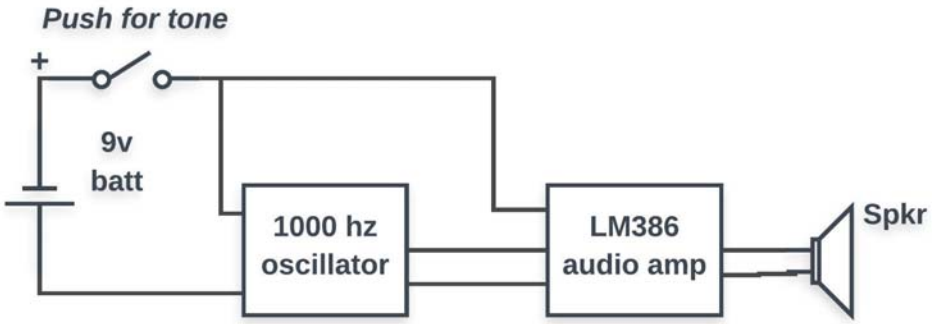
In this project I will show you how I built a simple and low cost 1 kHz audio tone generator with a speaker output, that allows me to reference the tone SPL back to a known sound level meter reading and allows more accurate setting of the microphone and rig audio levels.

Note: *The audio source described here, is not intended to be a substitute for professional audio test instrumentation found in good laboratories. However, with care in the set up, it should allow the amateur to make intelligent adjustments to microphone gain levels and avoid having to say things like "Hey ! I don't know…!" if questioned re his mic performance.*

Block Diagram of Audio Tone Generator
Referring to the block diagram below, a momentary contact switch is used to key the tone generator. The switch I used was momentary if pressed half way, but would lock on if pressed fully. Note that an LM386 audio amplifier has been added to better match the low impedance speaker.



1000 hz Oscillator

I think many of us perhaps have a favourite sine wave audio oscillator type, perhaps a Wien bridge, a twin-T, or something else that we always go to.
My favourite is what may be lesser known, the single op-amp phase shift[2] oscillator, that I have used in the past and in this project. The phase shift oscillator has some advantages like simplicity, frequency stability, reliability and relatively low distortion. The main proviso is to use components that are sufficiently stable themselves. The oscillator is formed around a basic phase shift network consisting of three RC sections which provide a steep change in phase with frequency. These are R6(C6), R5(C5) and R4+R3(C4). The 3rd section is fitted here with a variable R (R3) in order to allow setting the frequency closer to 1000 hz.

Either a TL082 or the LM358 dual op-amp work well and as bonus provide a 2nd op amp in the same package. I used the 2nd amp as a buffer and a simple 5X amplifier so that the output is boosted to approximately 1v rms (2.8v pp)

Note: If gain adjustment is to be done on the LM386 amplifier, then R10 is not needed and can be replaced by a fixed resistor, for example 100 ohms. (value not critical)
Running the tone generator from a fresh 9v battery is convenient or better still from a regulated 9v "wall-wart".

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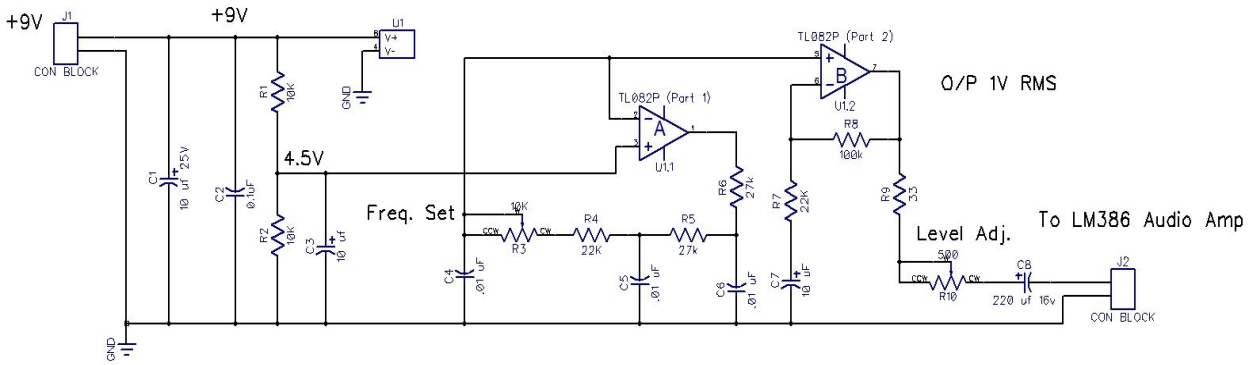
See schematic below:

1000Hz Phase-Shift Oscillator Schematic



Phase Shift Oscillator Parts list

Reference	Part description	Notes
C1, C3, C7	10 uf, 20% 16v electrolytic or tantalum capacitor	
C2	0.1 uf 50v ceramic capacitor	
C4, C5, C6	0.01 uf 5% film capacitor	
C8	220uf 16v electrolytic capacitor	
R1, R2	10K 1/4W CF resistor, 5%	
R3	10K trimpot, 25T, 10%	Bourns 3296 or equiv
R4, R7	22K 1/4W CF resistor, 5%	
R5, R6	27K 1/4W CF resistor, 5%	
R8	100K 1/4W CF resistor, 5%	
R9	33R 1/4W CF resistor, 5%	
R10	50K trimpot, 25T (see text)	Bourns 3296 or equiv
U1	TL082CP or LM358 dual op-amp	
J1, J2	.1” single in-line headers	
SW1	N.O. SPST momentary contact push button switch	
PCB	See text	
SPKR	Robot shop/Sparkfun RB-Spa-704 8 ohm pcb mount spkr, as shown	Jameco 135722, Sanko EMB-3008A, COM-11089 are the same
Enclosure	Plastic case - to suit	(approx 3”x2”x1.1”)
Audio amplifier	LM386 (20X gain) module	

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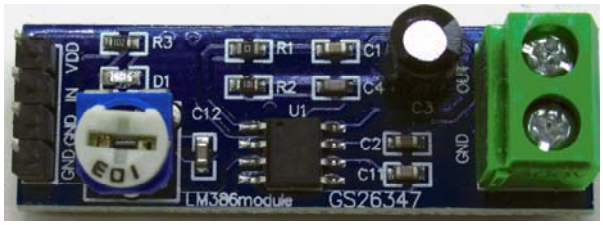
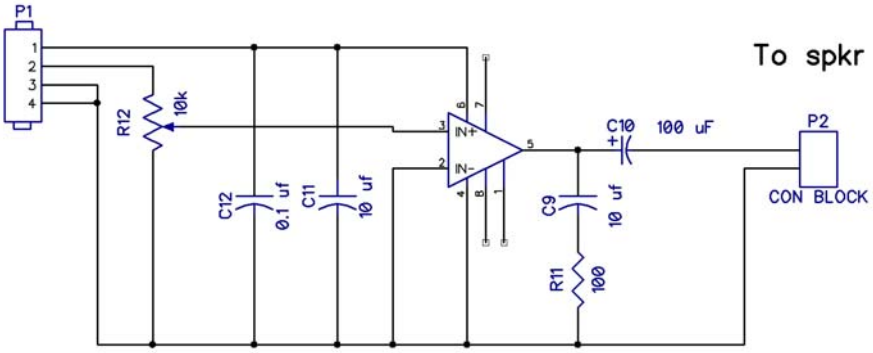
LM386 Audio Amplifier



As an alternative to building up your own LM386 circuit, consider purchasing it ready-made.
The LM386 audio amplifier IC and its basic application circuit has become almost a de facto standard, and is available at low cost, as a ready-made module, by several vendors on-line, at flea-markets etc. The minimum parts count version, with a gain of 20, is more than sufficient for use in this project. However, if you can only get the version described as 200X gain, (see photo) you can easily remove a few of the parts to convert it back to the basic 20x gain. Shown here is the 200X version, where you should remove C1, C2, R1. Also D1 is an LED which you may not wish to have so you may remove it if you like.



Choice of Speaker

I tested a range of potentially suitable audio transducers or speakers with the oscillator and soon discovered that the op amps like TL082/LM358 are not suited to directly drive low impedance speakers; ie; 8 to 30 ohms.
The photo below shows some of the speakers I tested, including several taken from low cost computer and airline headsets and even a typical Amateur Radio desktop speaker.

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Sound Level Meters and Reference Calibration Sources

Today there are environmental laws about maximum permissible sound levels in workplaces. As a result, good quality and low cost sound level meters have become almost commonplace. You may be able to borrow one if you ask around.
The photo above shows 2 that I have in my lab. On the left, the Scott Laboratories 453A-1 that I purchased on eBay, and on the right the Radio Shack 33-2055. The Scott sound level meter even came complete with a well made audio tone calibrator module (center) that can be used to verify the meter reading at 94 dB, 1 kHz. I was both pleased and surprised to find that both meters measured to within +/- 0.5 db of the calibrator setting

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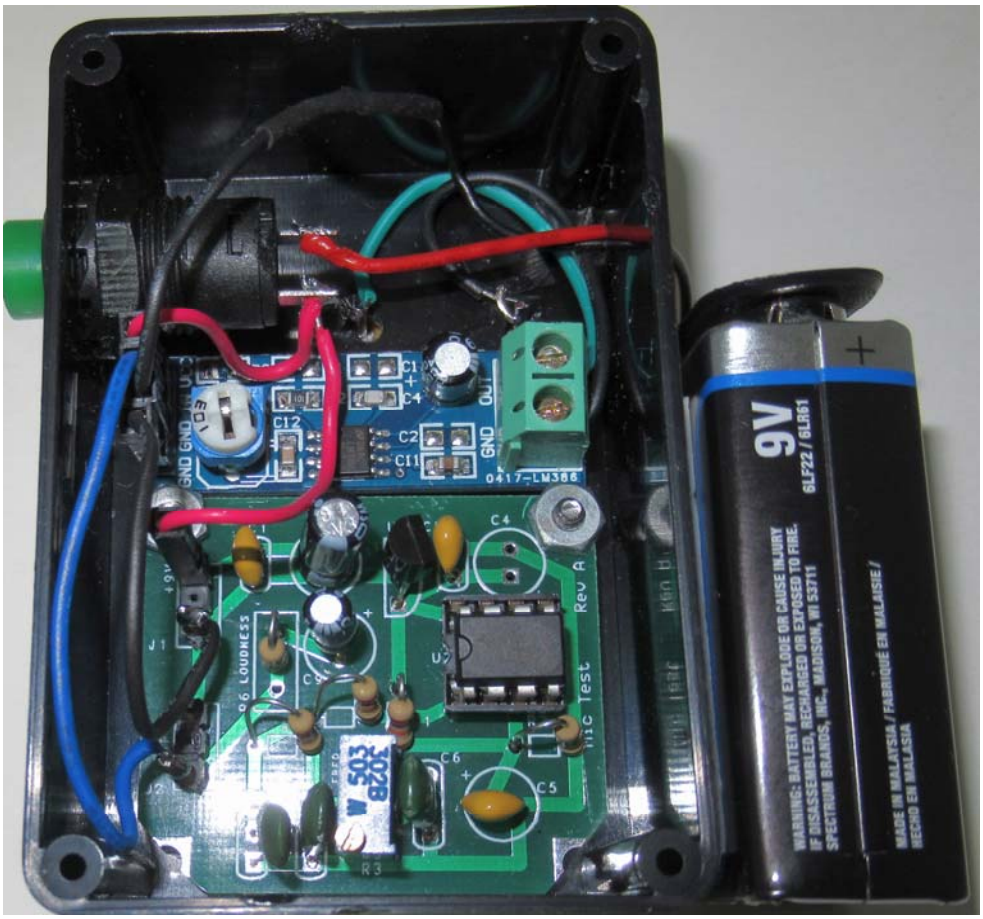
Construction details

The oscillator is simple enough to build on a piece of strip board. From an earlier project, I had made a custom pc board (ref 3) which you see in the photo with the LM386 amplifier above it. A small plastic case holds both pcb assemblies and the switch, with the speaker mounted on the front. (see lead photo, showing the RB-Spa-704 speaker)

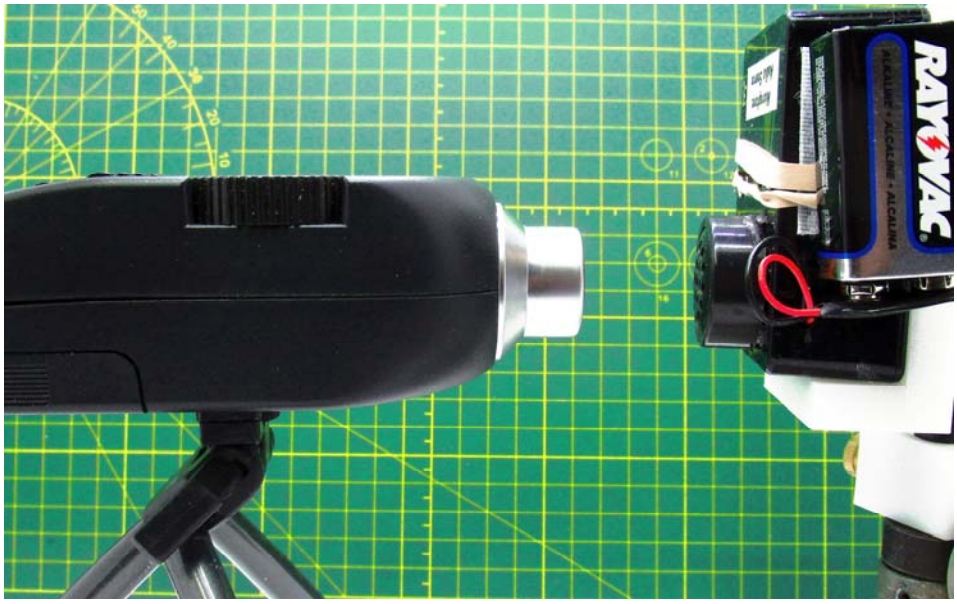
For easy access, the 9V battery is mounted outside the case using hook and loop fasteners. The photo shows the unit without the back cover which is normally installed. Be sure to include an adjustment hole in the back cover to allow easy setting of the output SPL.



Setting the SPL Level

In order to adjust the sound pressure level, it is necessary to ‘cobble’ some kind of mount for both the meter and the tone generator. Take care to line up and center the speaker on the tone generator with the pickup microphone on the sound level meter.

I used a small camera tripod for the sound level meter and stand made from an old microphone base to hold the tone generator.(see elastic band in photo)



In order to minimize errors from pickup of reflections etc, its best to set up in a relatively open area with 1 inch spacing distance microphone to speaker. Set

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the SPL meter to the “A” weighting, fast response. With the oscillator on, carefully adjust the alignment for maximum SPL on the meter.

Finally, adjust the gain trim-pot on the LM386 amplifier for the SPL you want to use. (at 1”, 92 dBA normal voice or 98 dBA raised voice, or in between as you choose)

Using the Tone Generator

Now you no longer have to try and hum or whistle when setting your rigs audio level.
Just pick up the Tone Generator, key it on and bring it in line with your microphone at the distance you have chosen. With the small 8 ohm speaker described, some care is needed to point it correctly. This is especially true using it with a hand held microphone where the pick-up “hole” may be off to one side.

Note: I found that if I used a larger diameter speaker (like the MFJ-281 shown above), then directional effects were much less critical. The down side is of course the loss of portability.

References:

1. Engineering Toolbox: www.engineering toolbox.com
2. “Design of Op Amp sine wave oscillators”, by Ron Mancini in the August 2000 issue of the Texas Instruments Inc. Analog Applications Journal
3. Please contact the author about the oscillator pcb. A limited quantity available at low cost.

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