Table of Contents

List of Acronyms	
AGC	Automatic gain control
FET	Field-effect transistor
IC	Integrated circuit
SPL	Sound pressure level
A/D	Analog-to-Digital

1. Overview

The Handspring Visor includes a built-in electret condenser microphone suitable for a wide range of sound pickup applications. This application note provides hints to assist Springboard module developers in making the best use of the microphone in their products.

When designing an analog front-end to accept signals from the microphone, the developer should make every effort to:

- Produce a low-noise power source for the microphone
- Select a gain structure appropriate for the expected sound level
- Select equalization (if necessary) for best intelligibility

2. Specifications

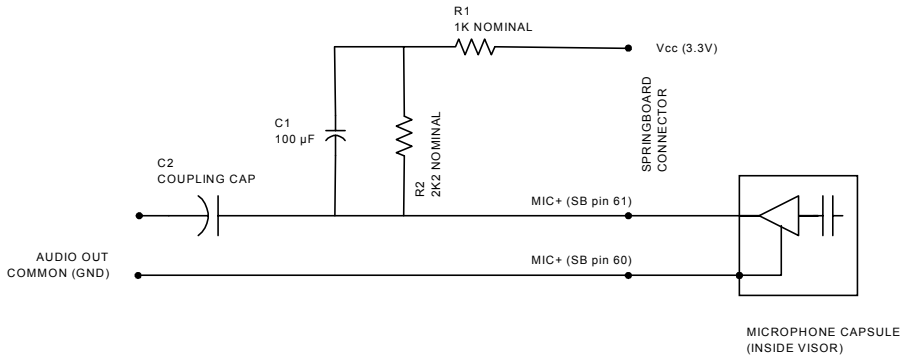
The Visor microphone is similar to the Panasonic WM-060 series. It uses a nickel-chrome metallized Mylar diaphragm, and a prepolarized (electret) backplate. Internal to the microphone housing is an impedance converter FET-IC. The source of the FET is typically connected to ground, and the drain is brought out to connect to the module's audio input stage. Both of these connections (MIC- and MIC+) are brought out to the Springboard module connector. The FET is kept in a conducting state by a small current fed into the gate along with the audio signal from the backplate. Characteristics of the microphone are as follows:

Feature	**Characteristics**
Frequency Response	50-12,000 Hz ±3 dB
Pickup Pattern	Omni-directional
Output Level	4 mV/Pa ±4 dB (4 mV output for 94 dB SPL input)
Supply Voltage	1.5 - 5 V, 200-500µA nominal
Equivalent Noise Level	35 dB SPL, A-weighted
Maximum Sound Pressure Level	125 dB SPL

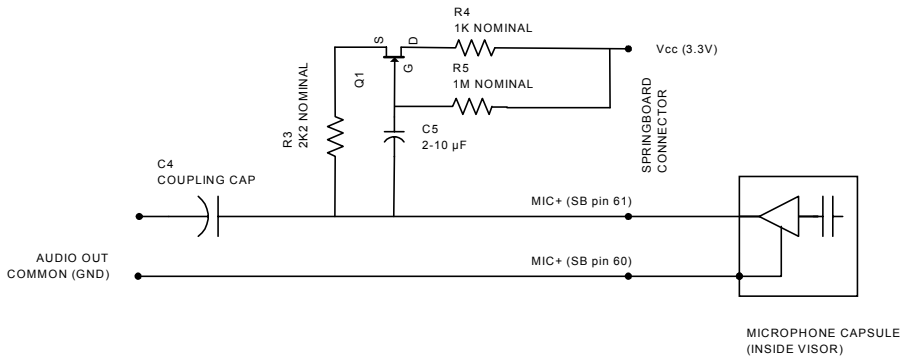
3. Design Considerations

3.1. Interface Circuit

The circuit in Figure 1 is normally used to provide power to and take output from the microphone. The component values are not critical. Output level will vary somewhat with supply voltage and loading. The specified output level should be reached with the component values shown and a load impedance of >20Kohms.



Coupling cap value chosen with input impedance of audio amplifier stage to provide suitable LF rolloff.



Two methods for providing noise filtering for microphone supply current.

Top circuit is simpler, needs 100 µF (or greater) elcap.

Bottom circuit is suitable if there is a spare JFET in the ASIC, for example. Only a small elcap is needed.

In either case, choose a value for R1/C1 or R5/C5 to provide a filter rolloff frequency no higher than 1/10 of the audio LF rolloff frequency set by the coupling capacitor and audio amplifier stage impedance.

Figure 1

3.2. Power Supply Considerations

When reviewing the microphone specifications above, note that the microphone sensitivity results in a 4 mV output signal for 94 dB SPL of incident sound. Quiet office background sounds of 40 to 50 dB SPL will produce an output level of 8 to 25 microvolts. The microphone has no power supply noise rejection, which means that 8 to 25 microvolts of noise on the supply voltage to the microphone will produce a noise level the same as or louder than the ambient signal.

Handspring suggests a worst-case noise floor of 40 dB SPL (A-weighted) for the completed Springboard product including the microphone, which means that the power supply voltage must be clean (< 2µV within the audio band at least from a few Hz up to 20 kHz, or to the Nyquist limit of the A/D converter in use).

The 3.3 volt power from the Handspring Visor Deluxe Springboard connector has several tens of millivolts of noise riding on it and cannot be used to power the analog circuitry or the microphone directly. The analog circuitry may have some inherent power supply noise rejection, but it is very important for the developer to characterize the contribution of each part of the circuit to the total noise budget, in order to stay below the recommended 40 dB(A) maximum. The microphone requires less than 0.5 mA of current, and the voltage can be as low as 1.8 V, so a simple RC network consisting of a 1K resistor and 100µF capacitor as shown in Figure 1 is usually sufficient to keep the noise level down. Once again, the noise on the power supply line may vary greatly, depending on the other devices inside the Springboard module being developed. Because of this, it is important to characterize the noise and filtering characteristics of the circuit being designed.

3.3. Choosing a Gain Structure

The microphone system should be set up to allow normal use in a variety of different noise environments. This may require the use of automatic gain control (AGC) or at least some form of limiting to prevent exceeding the range of the A/D converter used.

Microphone sensitivity is around 4 mV/Pa, and 1 Pascal is equivalent to 94 dB sound pressure level. Typical SPLs include:

90: Noisy factory floor

80: Vacuum cleaner, 1 meter

70: Busy traffic

60: Two-person conversation, 1 meter

50: Quiet restaurant

SPL varies greatly with distance from the sound source. People speaking will raise their voice to overcome the background noise level, or lower it when the background is quiet. If the Handspring Visor is left on a table or approximately in free space (we might call this “speakerphone mode”) a good estimate of average voice SPL would be within 50 to 70 dB. However, if the Visor is held up to the mouth (“handset mode”) the SPL at the microphone might be as much as 90 dB.

3.4. Equalization for Improved Intelligibility

The Handspring Visor microphone has an essentially flat frequency response and has no proximity effect; the response remains constant regardless of the distance from the sound source. Shaping this response may be desirable to get rid of excessive noise in the ambient environment. Such response shaping is typically applied in two areas of the audio spectrum, and one or both can be very helpful in producing easy-to-understand sound files of speech in noisy environments.

Bass rolloff can be used to attenuate low frequency rumble and even the fundamental frequency of speech. The lower cutoff frequency is typically 300 Hz with a 12 dB per octave (or steeper) slope below that. Speech processed with bass rolloff may sound “tinny” or telephone-like, but much of the interference from other sounds in the environment can be eliminated. A value in the range of 80 to 150 Hz is a good compromise bass rolloff frequency that results in more natural sounding speech, while retaining some of the benefits of rolling off ambient rumble.

A presence boost of 3 to 8 dB, centered on 3 to 5 kHz, can also help to accentuate the portions of the audio spectrum critical to intelligibility.

4. History

Date	Revision #	Description of changes
12 Feb 2001	1.00	Initial Release.