

I. Overview

Selecting a proper microphone and its source or biasing resistor are essential for achieving good recognition results. This design guide describes the procedures for calculating the optimal resistor value, and provides a list of recommended microphones and optimal resistor values for each one.

II. System Gain

A. Algorithm for determining the optimal overall system gain:

1. If the program source code is configured for "headset" microphone distance, where the microphone distance is typically a few inches from the user's mouth, then the overall system gain (G) should be -49 dB (0dB=1v/Pa@1KHz).
2. If the program source code is configured for "arms_length" microphone distance, where the microphone distance is typically 2-3 feet from the user's mouth, then the overall system gain (G) should be -44 dB.
3. If the program source code is configured for "far_mic" microphone distance, where the microphone distance is up to 10 feet from the user's mouth, then the overall system gain (G) should be -43 dB.
4. If MICIN2 is not connected to the microphone, then decrease the overall system gain (G) by 1 dB, (G = G - 1).
5. Apply G to the following formula:

$$R_s = I \times 10^{\left(\frac{(G - \text{Sensitivity})}{20}\right)}$$

Where

- ▶ **G** is the desired overall system gain,
- ▶ **Sensitivity** is the sensitivity rating of the microphone you want to use, and it is specified in -dB in the microphone's specification,
- ▶ **I** is the impedance rating of the microphone,
- ▶ **RS** is the optimal microphone bias

B. Example:

Assume a microphone with -42 dB sensitivity and 2.2 K ohms Impedance is used in an "arms_length" design in which MICIN2 is connected to the microphone.

G = -44 dB; Sensitivity = -42 dB; I = 2200

$$\begin{aligned} R_s &= 2200 \times 10^{\left(\frac{(-44 - (-42))}{20}\right)} \\ &= 1748 \end{aligned}$$

Use the closest standard 5% resistor to Rs. In this example, it would be 1.8 K ohms.

C. Microphone Bias Resistor Tables:

Impedance (I) = 2.2K		2200	2200	2200	2200	2200	2200	2200	2200	2200	2200
Mic Sensitivity (S)		-36	-38	-39	-40	-41	-42	-43	-44	-45	-46
(Far) with MICIN2	-43 dB	1.0K	1.2K	1.3K	1.5K	1.8K	2.0K	2.2K	2.4K	2.7K	3.0K
(Far) w/o MICIN2	-44 dB	910	1.1K	1.2K	1.3K	1.5K	1.8K	2.0K	2.2K	2.4K	2.7K
(Arms) with MICIN2	-44 dB	910	1.1K	1.2K	1.3K	1.5K	1.8K	2.0K	2.2K	2.4K	2.7K
(Arms) w/o MICIN2	-45 dB	750	1.0K	1.1K	1.2K	1.3K	1.5K	1.8K	2.0K	2.2K	2.4K
(Headset) with MICIN2	-49 dB	510	620	680	750	910	1.0K	1.1K	1.2K	1.3K	1.5K
(Headset) w/o MICIN2	-50 dB	430	620	620	680	750	910	1.0K	1.1K	1.2K	1.3K

Impedance (I) = 2.0K		2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Mic Sensitivity (S)		-36	-38	-39	-40	-41	-42	-43	-44	-45	-46
(Far) with MICIN2	-43 dB	910	1.1K	1.2K	1.5K	1.5K	1.8K	2.0K	2.2K	2.4K	2.7K
(Far) w/o MICIN2	-44 dB	820	1.0K	1.1K	1.2K	1.5K	1.5K	1.8K	2.0K	2.2K	2.4K
(Arms) with MICIN2	-44 dB	820	1.0K	1.1K	1.2K	1.5K	1.5K	1.8K	2.0K	2.2K	2.4K
(Arms) w/o MICIN2	-45 dB	710	910	1.0K	1.1K	1.2K	1.5K	1.5K	1.8K	2.0K	2.2K
(Headset) with MICIN2	-49 dB	448	580	620	710	820	910	1.0K	1.1K	1.2K	1.5K
(Headset) w/o MICIN2	-50 dB	380	510	580	620	710	820	910	1.0K	1.1K	1.2K

The RSC4128 chip has two microphone inputs: MICIN1 and MICIN2. MICIN1 is used for normal speech recognition, while MICIN2 is used only for the "clapper" audio wakeup feature. Typically, designs will either leave MICIN2 unconnected if this feature is not needed, or the microphone signal will be split and connected to both inputs (with separate AC coupling capacitors). In this case, the microphone bias resistor should be slightly higher to compensate for the small loading effect of MICIN2.

III. Recommended Microphones

The following is a list of Recommended Microphones and Source Resistors. All gain values in Pascals (0dB=1v/Pa@1KHz)

Manufacturer	Model	Sensitivity	Impe- dance	Rs (Arms, Far)	Rs (Arms, Far)	RS (Head)	GAIN & RS
				(G = -44 dB)	(w/o MICIN2) (G = -43 dB)	(G = -49 dB)	(Head) (w/o MICIN2) (G = -50 dB)
Primo	EM-4114	-43 dB	2.0 K	Rs = 1.8 K	Rs = 2.0 K	Rs = 1.0 K	Rs = 910
Primo	EM-150	-44 dB	2.0 K	Rs = 2.0 K	Rs = 2.4 K	Rs = 1.1 K	Rs = 1.0 K
Primo	EM-8001	-40 dB	2.0 K	Rs = 1.2 K	Rs = 1.5 K	Rs = 750	Rs = 680
Knowles	MB6022ASC-2	-44 dB	2.2 K	Rs = 2.2 K	Rs = 2.7 K	Rs = 1.2 K	Rs = 1.1 K
Ningbo Booyii	CZN-15E(-44)	-44 dB	2.2 K	Rs = 2.2 K	Rs = 2.7 K	Rs = 1.2 K	Rs = 1.1 K
Panasonic	WM-64AT	-44 dB	2.2 K	Rs = 2.2 K	Rs = 2.7 K	Rs = 1.2 K	Rs = 1.1 K
Horn Elec.	EM9745P-442	-44 dB	2.2 K	Rs = 2.2 K	Rs = 2.7 K	Rs = 1.2 K	Rs = 1.1 K

Warning: Miniature electret microphones (with a diameter <10 mm) should **NOT** be used in any design that uses Sensory's Speaker Verification (SV) technology. SV technology is susceptible to minor differences in microphone response and miniature microphones have a greater angular dependence in their response to incoming speech than larger electrets,

Miniature microphones can safely be used with any other Sensory technology."

IV. Units Of Measurement

Converting uBars to Pascal

Microphone manufacturers specify the sensitivity referencing to uBars or Pascal. If the microphone sensitivity is referenced to uBars, simply add 20 dB to the rating.

For example, $-75 \text{ dB/uBars} + 20\text{dB} = -55 \text{ dBV/Pa}$.

V. Verifying Microphone System Gain

An easy way to verify your microphone system gain is using the Sensory's RSC-4x Demo/Evaluation Board Version 2 (60-0239) or (60-0252) with the following procedure:

- ▶ Assemble your microphone with a mono audio, and connect it to microphone input (J4) of RSC-4x Demo/Evaluation Board Version 2.
- ▶ Solder the calculated optimal microphone resistor in R12 of RSC-4x Demo/Evaluation Board Version 2.
- ▶ Replace the shorting block for MIC GAIN SEL to JP9 (CUST).
- ▶ Activate the Karaoke/Audio Input Peak Indicator by:
 - ▶ Move the jumper at JP21 from DOWNLOAD to KARAOKE,
 - ▶ Press and release PROGRAM Button
- ▶ While the program is running, press C-Button, and try talking to the microphone from about 1/2 to 2 feet away. As you talk, four LEDs turn on as a peak detector or VU meter.
- ▶ In the nominal distance, you should see the green and two yellow LED's turn on when you imitate a person who talks loud.

VI. Using Port Pin for Sourcing the Microphone

You can use a port pin to source the microphone to save the power while microphone is not being used. With firmware, you can make the port pin high when the microphone is used or make it low when it is not in use.

WARNING:

Because of the time constant of the RC filter (220 uF and 270 Ohms) at the microphone source, turn on the microphone at least 60 mS before the program attempts any voice recognition or voice recording.

The Interactive Speech™ Product Line

The Interactive Speech line of ICs and software was developed to “bring life to products” through advanced speech recognition and audio technologies. It is designed for cost-sensitive consumer-electronic applications such as home electronics, home automation, toys, and personal communication. The product line includes the award-winning RSC-4x general-purpose microcontrollers and tools, the *VR Stamp™* 40 pin DIP module and tools, the SC series of speech and music synthesis microcontrollers. Our suite of software development kits are designed to run on non-Sensory processors and DSP's, and support most popular operating systems.

RSC Microcontrollers and Tools

The RSC product family contains low-cost 8-bit speech-optimized microcontrollers designed for use in consumer electronics. All members of the RSC family are fully integrated and include A/D, pre-amplifier, D/A, ROM, and RAM circuitry. The RSC family can perform a full range of speech/audio functions including speech recognition, speaker verification, speech and music synthesis, and voice recording/playback. The family is supported by a complete suite of evaluation and development toolkits.

Speech Recognition Modules and Tools

The VR Stamp™ is a complete speech recognition module based on the RSC-4x and is ideal for fast design and easy production. A low-noise audio channel and standardized 40-pin DIP footprint allow rapid prototyping, less debugging, and shorter time to market. The *VR Stamp Toolkit* includes everything needed to get started today, including VR Stamps, Module Programming Board, sample applications, and a complete set of development tools featuring the Python IDE and limited-life C compiler, QuickSynthesis™ 4 and Quick T2SI-Lite™ speech tools.

SC Microcontrollers and Tools

The SC-6x product family features the highest quality speech synthesis ICs at the lowest data rate in the industry. The line includes a 12.32 MIPS processor for high-quality, low data-rate speech compression and MIDI music synthesis, with plenty of power left over for other processing and control functions. Members of the SC-6x line can store as much as 37 minutes of speech on-chip and include as many as 64 I/O pins for external interfacing. Integrating this broad range of features into a single chip enables developers to create products with high quality, long duration speech at very competitive price points.

FluentSoft™ Technology

FluentSoft™ Recognizer is the engine powering the FluentSoft™ SDK. It provides a noise-robust, large-vocabulary, speaker-independent solution with continuous digit recognition and word-spotting capabilities. This small-footprint software recognizes up to 5,000 words; runs on non-Sensory processors including Intel XScale, TI OMAP, and ARM9 platforms; and supports operating systems such as MS Windows, Linux, and Symbian.

3Dmsg™ Technology

3Dmsg's (www.3Dmsg.com) Animated Speech technology offers animated avatars with advanced speech recognition and synthesis capabilities for use in smartphones, language trainers, and kiosk applications. Facial expressions can be configured to show emotions and lip synchronization can be automatically driven from voice or text data.

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