Introduction

The following is a list of industry best-practice suggestions that our research indicates may help improve system-level ESD protection. You may wish to independently confirm these suggestions.

The suggestions have been broken down into four main categories, and the suggestions within each category have been noted as follows:

(Recommended) – Potentially effective for little or no additional cost.

(Desirable) – Should be included in systems which can tolerate higher system cost (such set top boxes, etc)

Sensory highly recommends that this procedure be used to design and test ALL new product designs.

A. Making Your Circuits More Resistant To ESD:

1. (Recommended) Put clamp diodes such as 1N4148 (D1 and D2) and a 510 ohm series resistor (R3) and a 0.1 uF shunt capacitor (C10) in the microphone circuit as shown in Figure 1:
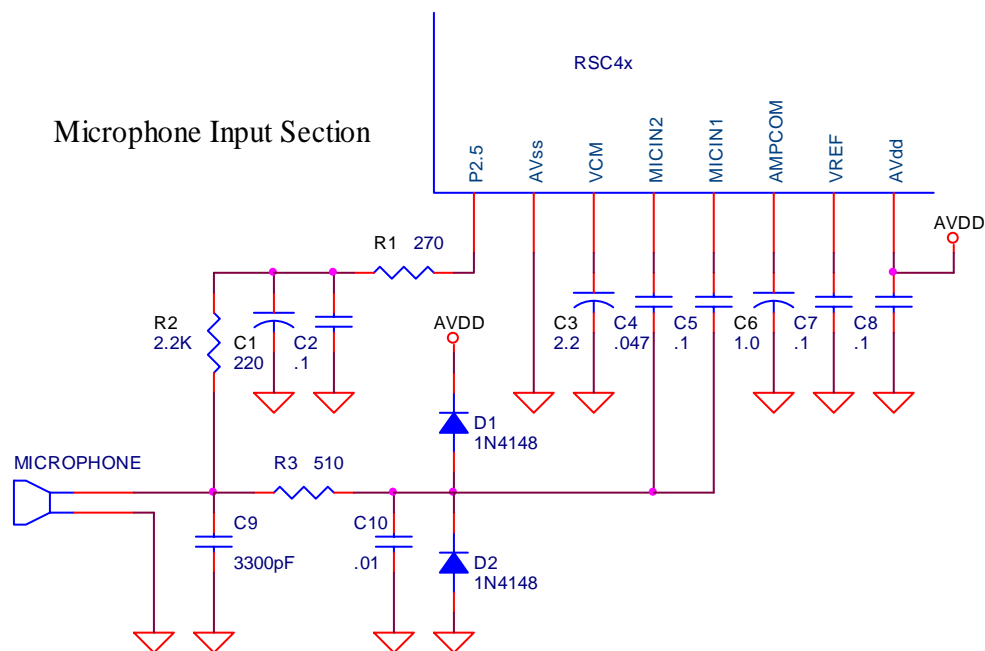

Figure 1 – Microphone ESD protection

2. (Recommended) Put 0.1uF capacitors across all pushbutton inputs.
3. (Recommended) Put 1K to 10K ohm series resistors on input signals if they travel to the outside or travel long distances.
4. (Recommended) Put a 10K ohm series resistor and a 1N4148 diode to ground at the reset pin as shown in Figure 2 if it travels to the outside (usually via a user reset pushbutton) or otherwise travels a long distance.
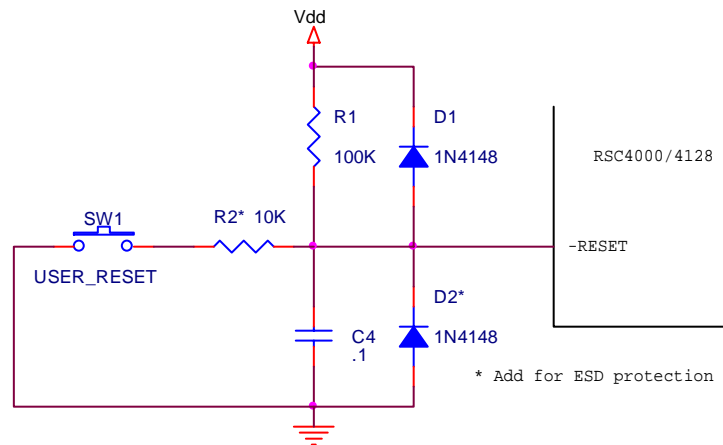
Figure 2 – Reset ESD protection

5. (Desirable) Put 100 ohm series resistors on output pins if they travel to the outside or travel long distances (with the exception of PWM pins). If adding 100 ohm series resistance causes the signal to slow or degrade unacceptably, decrease the resistance or use an optoisolator or some other higher speed ESD protection instead.

6. (Desirable) Put a 0.1uF capacitor across the supply pins on the board (not to be confused with decoupling capacitors, which should be as close to IC's as possible.)

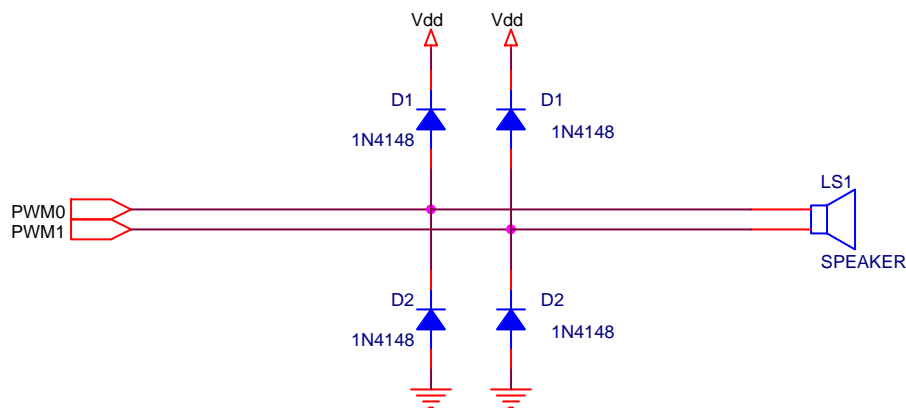7. (Desirable) Put clamp diodes (such as1N4148) PWM as shown in Figure 2:

Figure 3 - PWM ESD Protection

8. (Desirable) Put a clamp diode (such as1N4148) reverse biased across any power supply.

9. (Desirable) Put a high-frequency 1 kV capacitor between each power pin and chassis ground close to the electronics.

10. (Desirable) If a battery enclosure is used, put a 0.1uF capacitor across the supply as close to the battery connection as possible.

B. Making Your PCB Layout More Resistant To ESD:

Proper layout and design of a PCB can be a very effective weapon against ESD. Use the following PCB layout techniques:

1. (Recommended) If a multi-layer PCB is used, then create a separate ground plane. If possible, also create a separate power plane.

2. (Recommended) If a ground plane is not practical, then use copper pour grounds on the PCB. Do not create any isolated copper pour islands! It is mandatory that all large copper pour ground sections have at least two connections to the rest of ground.

3. (Recommended) Put solid vias into power planes and ground planes and copper pours. Use thermal vias for plated through-holes for components.

4. (Recommended) Keep bypass capacitors close to each power pin of all ICs.

5. (Desirable) Keep the loop area between power and ground as short as possible.

6. (Desirable) Keep areas that can be most affected by ESD (typically ICs) away from the edges of the board and away from external wires, connectors and power.

7. (Desirable) Place all external wires and connectors on one edge.

8. (Desirable) Bring power into the center of the PCB.

9. (Desirable) Create a star grounded guard ring around the outside of the PCB, with no components on the outer edge of the PCB. The PCB should contain no other ground loops.

The current from an ESD arc first charges the parasitic capacitance of the metal it hits, and then it follows every conductive path available. This current prefers to flow in sheets, or short, wide straps, instead of wires. Bonding establishes low-impedance paths between pieces of metal, minimizing the voltages between them, while grounding provides a path to eventually drain off the accumulated charge. For grounding and bonding to be effective against ESD, keep the ESD current density and ESD current path impedance as low as possible by:

1. (Recommended) Use multipoint and thicker grounds where you want ESD current to flow.

2. (Desirable) Use single-point and thinner grounds where you don't want ESD current to flow.

C. Component Selection and Construction to Improve ESD Resistance:

The choice of components and package types and the techniques used in manufacturing can be a big factor in ESD protection:

1. (Recommended) Microphone wiring must be a shielded cable. Foil shield is preferable to braid shield.

2. (Recommended) Ensure that all bare metal on external components, such as microphones, switches, speakers, etc, are shielded with non-conductive plastic (perhaps heat shrink.)

3. (Recommended) Use ICs in the smallest available package. Bonded die is the best choice for ESD protection.

4. (Recommended) Avoid bonding out any signals in a die that will not be used.

5. (Recommended) Keep cables as short as practical.

6. (Recommended) Use surface mount and short-lead components whenever practical. Lead inductance runs about 0.6 to 1.0 nH/mm.

7. (Recommended) Tightly twist power wires and their returns together. The main power source in the system is often a prime target for inductive coupling from ESD. Wires from a battery box are an example of this.

8.   (Desirable) Try to use the following for all signals: twisted pair cable, coaxial cable or flat cable instead of single wires. Put shrink tubing on wires if extra shielding is required.

9. (Desirable) Choose ESD safe components, like thick-film and carbon composition resistors instead of thin-film resistors, if practical

10. (Desirable) Beware of substitute and second-source components that may be functionally equivalent, but lack the ESD-immunity of the preferred components.

D. Making Your Enclosure More Resistant To ESD:

For enclosure design, the overall goal is to keep all ESD outside the enclosure. The best way to do this is to use an electrically nonconductive (typically plastic) enclosure.

Plastic and other nonconductive enclosures, air space, and insulation can prevent ESD arcs from penetrating inside the system (direct ESD). However, they provide no protection against ESD arcs outside the enclosure (indirect ESD). To protect against these arcs, ensure greater than or equal to 20 mm path length between the electronics and:

1. (Recommended) Any points that the user can touch, including seams, ventilation openings and mounting holes. (ESD arcs can travel farther over the surface of a dielectric than they can through open air.)

2. (Recommended) Any ungrounded metal that the user can touch, including fasteners, switches, controls, and indicators.

If practical and system cost allows, it's better to design with provisions for adding shields made of one of the following materials:

1. (Desirable) Conductive filler in the plastic.
2. (Desirable) Silver, copper or nickel paint.
3. (Desirable) Mylar/copper or Mylar/aluminum laminates.
4. (Desirable) Zinc arc spray.
5. (Desirable) Thermoformed metal mesh with bonded junctions.
6. (Desirable) Sheet metal.
7. (Desirable) Vacuum metallizing.

Optimal shielding is less than or equal to 1 ohm/square resistance. Joints and edge treatment are critical, as are arrangements for connecting bonding jumpers/wires.

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 Phyton 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.

Important notices:

Safety Policy:

⟳ S E N S O R Y ®

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