

Harnessing a Piezo-Electric Transducer for Deep Signal Penetration

Application Notes

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11/13/09

Introduction

A piezo-electric transducer is a device that can translate changes in shape into a change in voltage. At its heart is a piezo-electric crystal that changes size when there is a change in electric potential. Thus by transitive properties if you disturb the crystal it will create a potential voltage, which can then be used in a circuit. The return voltage will have frequencies that vary with depth and the size of any disturbances. This system must be built so that it can: send a signal, read a signal out, and protect the rest of the circuit.

Input Signal

The input signal will depend greatly on the design objectives and which model transducer is used in the operation. Many shallow depth transducers need only a small sine wave to operate. For deeper signal penetration it is best to use a large negative voltage spike. Making the signal a spike will allow higher voltages without violating the maximum power limits of the transducer, and making it negative will make processing easier later. It is important that you only send one large spike at a time. *You can easily destroy the transducer with just a few of these pulses. Check the voltage and power requirements. Make sure to get a plot of the input impedance with purchase.*

The two main factors that affect both the quality of the signal and its penetration depth are frequency and voltage. The larger both are the better reading you will receive. The transducer will have a maximum voltage and a power rating it can tolerate, however it is not always ideal to use maximum values as the reading can become 'too accurate' and will give you unnecessary information that will pollute signal. Industry representatives often recommend that the system be tested, or make the voltage variable, in order to make the system ideal for use.

Filters And Booster

Depending on the expected return signal, and how it will be analyzed, filters may need to be used. Ideally, these filters will remove portions of the signal that are generated from the walls of the tested material. Attaching a display to the PIC will allow for human analysis of the signal. However, it is considerably cheaper to filter the signal. If the transducer has more than one use, a programmable filter should be used.

Despite the large input voltage the return voltage very small, typically less than a volt. It is best to boost the return voltage to a level friendly to the PIC. The gain of this amplifier will depend on the system and return signal. Even, with a display a voltage booster should be used.

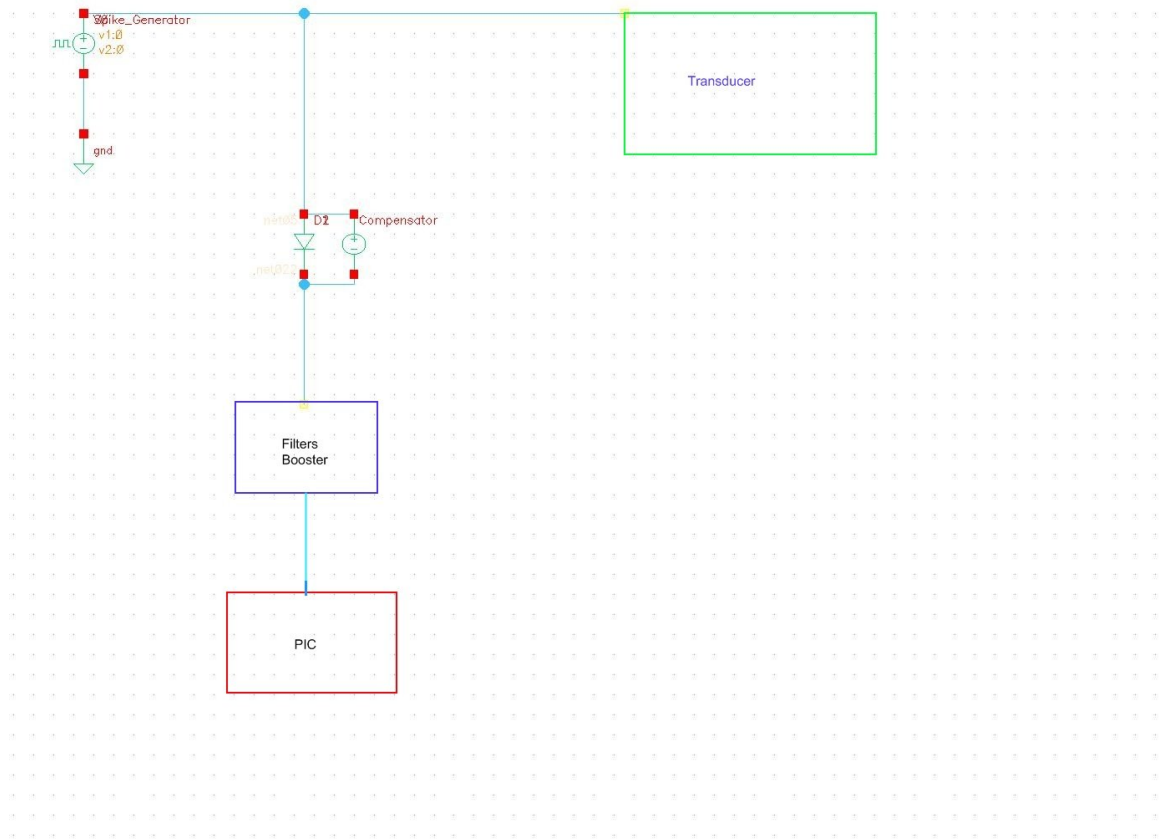
Diode and Compensator

The diode is crucial for protecting the PIC against the large negative voltage spike. Piezo-electric transducers share a common input and output node. Since the desired return signal will be a small positive voltage, the diode will let the signal pass. There is a V_{eff} for the diode, usually around .7 volts. Build a small gain amplifier to produce the V_{eff} of the diode. This will prevent any signal degradation that the diode might cause. Attach the compensator in parallel with the diode, thus it can't affect another part of the system. When the large negative voltage spike comes its potential will dominate and turn off the diode.

Wiring The System

- Gather the PIC, spike generator, filters/booster, an A3 diode, small gain amplifier and the transducer.
- Attach the diode to the amplifier.
- Attach the filters/booster to the diode.
- Attach the spike generator to the diode. Make sure the spike generator is attached to the diodes anode as to block negative voltage.
- Test the circuit. Make sure you are stopping the negative spike with the diode.
- Finally attach the PIC and the transducer.
- Make all proper power connections for the PIC to operate and attach the output of the transducer should go to the input of the PIC's A to D converter.

The design should follow this diagram.



Summary

This application note purpose was to teach how to design, create and assemble the input/output control from a high penetration piezo-electric transducer. It has shown what type of input signal to use. It has shown why the signal needs to be filtered and boosted. It has given you a method of separating the input and output signals. Using this information and the knowing the requirements of the transducer, a fully functional ultrasound machine can be wired.