Application Report
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ADC Input Protection

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Digital/Analog Converters

ABSTRACT

Analog-to-Digital Converters (ADC's) are at the heart of any design which involves capturing the analog signal. This is usually the most important and highest-cost component in the signal chain. Since the signal chain is interfaced to the varying analog world signals, it is critical to protect the ADC inputs. This application note lists different techniques to protect the ADC inputs from the signals which can be beyond the ADC specifications.

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1 Introduction

The ADC inputs can get damaged by signals exceeding the input range specified in the electrical parameters. The inputs need to be protected all the time (during powered up as well as powered down state) to avoid damaging the ADC. The damage due to overstress can be catastrophic, that is, the ADC will not be functional, or there will be performance degradation to the extent that expected system performance cannot be achieved.

The methods discussed below are applicable to ADCs which have the front end as the sample and hold block or the max input range is limited by analog supply voltage. There are ADCs in the market which can support higher input voltage than the analog supply voltage. These ADCs use resistive input combination to level shift the actual ADC input. It is recommended to have a operational amplifier buffer drive these inputs and the buffer power supply should fall within absolute max input ratings of the ADC.

2 Operational Amplifier Power Supply

Most ADC inputs are preceded by an operational amplifier stage. Check if the operational amplifier can be operated with same input supply as that of the ADC. This configuration ensures that the input to ADC will never go beyond the ADC supply range since the operational amplifier will get saturated when the output gets close to supply rails, thus protecting the ADC inputs. This is the simplest way of protecting the inputs. Please refer the configuration shown in Figure 1.

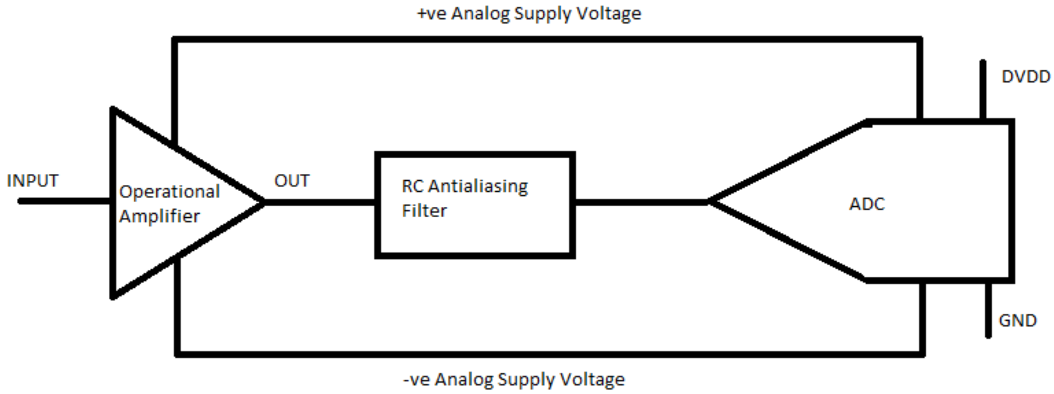

Figure 1. Operational Amplifier Power Supply

3 Input Protection Using Clamps

This protection method can be employed if the input is directly connected to the ADC input or the signal conditioning amplifiers are operating at voltages greater than the ADC analog supply voltage. Most ADC inputs have the internal diodes, which conduct when the input voltage goes beyond the supply voltage. These diodes are not designed to carry large current for a longer amount of time. The clamp structure emulates the ADC internal diode structure with external clamp diodes which are capable of higher continuous current conduction. Placing these clamps after the input anti-aliasing RC filter provides an additional advantage. The resistance acts as a current limiting device if the input voltage goes beyond allowed input range. If the current is too high, this resistance will get damaged due to heat dissipation and will protect the clamp diodes as well as ADC.

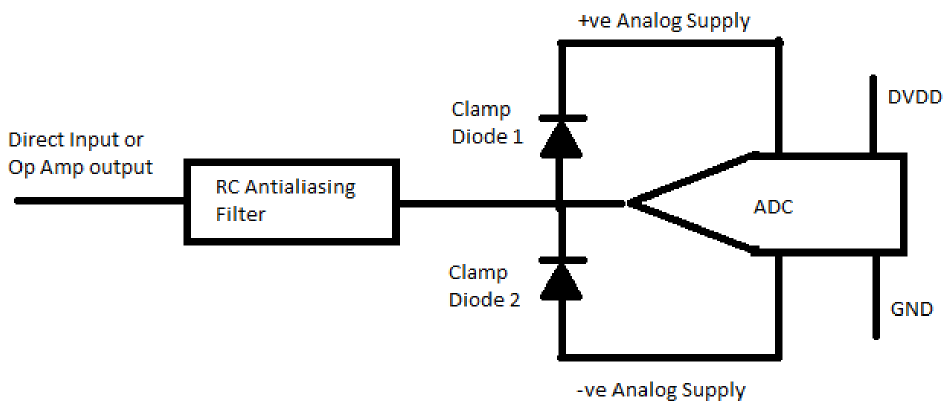

Figure 2. Input Protection Using Clamps

4 Operational Amplifiers With Output Clamp

Clamp diodes have an important parameter to consider “reverse recovery time”. Once the ADC input gets back in the normal range from overdrive condition, the diodes are expected to turn off immediately and normal operation restored. During reverse recovery period the clamp diode will still conduct. If it is important to have a short reverse recovery time, consider using operational amplifiers with programmable output clamp levels. OPA698 is one such device with ultra-fast overdrive recovery (1 ns) and wide operating bandwidth. The circuit configuration shown in Figure 3 illustrates the OPA698 interface with ADS822 ADC.

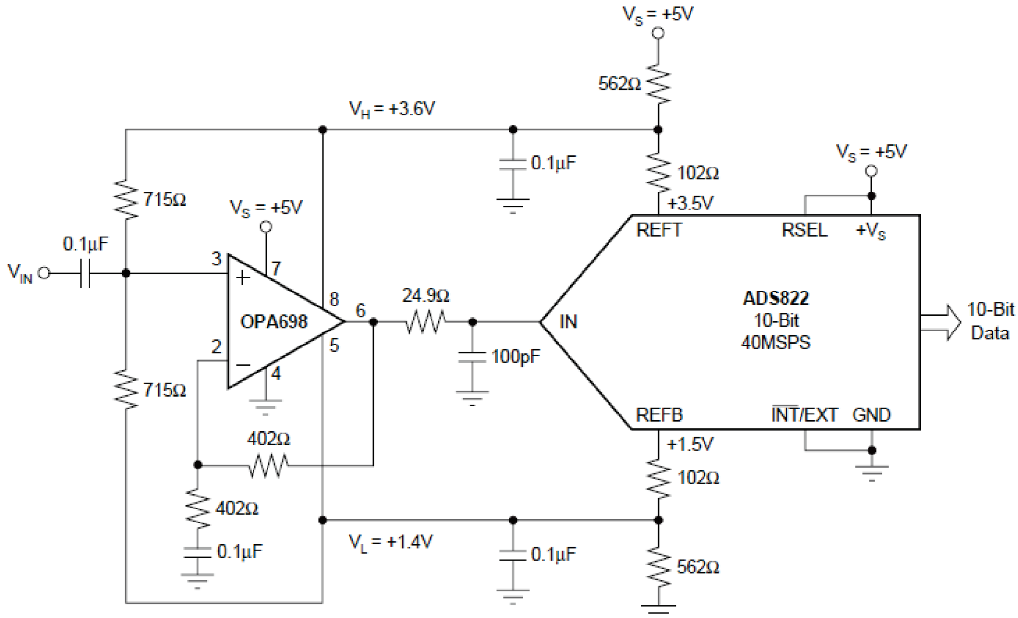

Figure 3. Single-Supply Limiting ADC Input Driver

5 Conclusion

It is important to protect the ADC, an integral part of the data acquisition system, from all possible input scenarios. The methods described in this application report help in designing a system which will be protected from unwanted signal fluctuations. Before implementing any of these methods, it is important to know ADC specifications as well as ADC input structure and signal path processing requirements.

6 References

1. *OPA698 datasheet* SBOS258

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