

APPLICATION NOTE 6646

EFFECTS OF DIFFERENT RESISTOR TOLERANCES IN A DIFFERENTIAL ADC FOR THD PERFORMANCE

Abstract: This application note explains how the different tolerances of the same value resistors at the inputs can alter the THD performance of the fully differential ADC. The cost of resistors changes significantly with each lower increment in tolerance

Overview

The [MAX11905](#) is a 20-bit, fully differential SAR analog-to-digital converter (ADC) that samples at 1.6MSPS. Picking the lowest tolerance resistor at the input can achieve the best THD performance. But, what if the lowest tolerance is not cost effective? Will the THD be reasonable if a higher tolerance resistor is selected? To answer these questions, we will perform a design test and note the findings in this application note.

Analog Front-End (AFE)

The analog front-end (AFE) consists of a half-gain stage using the [MAX44205](#) differential amplifier. Six resistors are used on the differential amplifier and two additional resistors are required at the [MAX11905](#)'s inputs. **Figure 1** shows the ADC's input circuit. By changing the tolerance of the eight resistors, we see the change in THD.

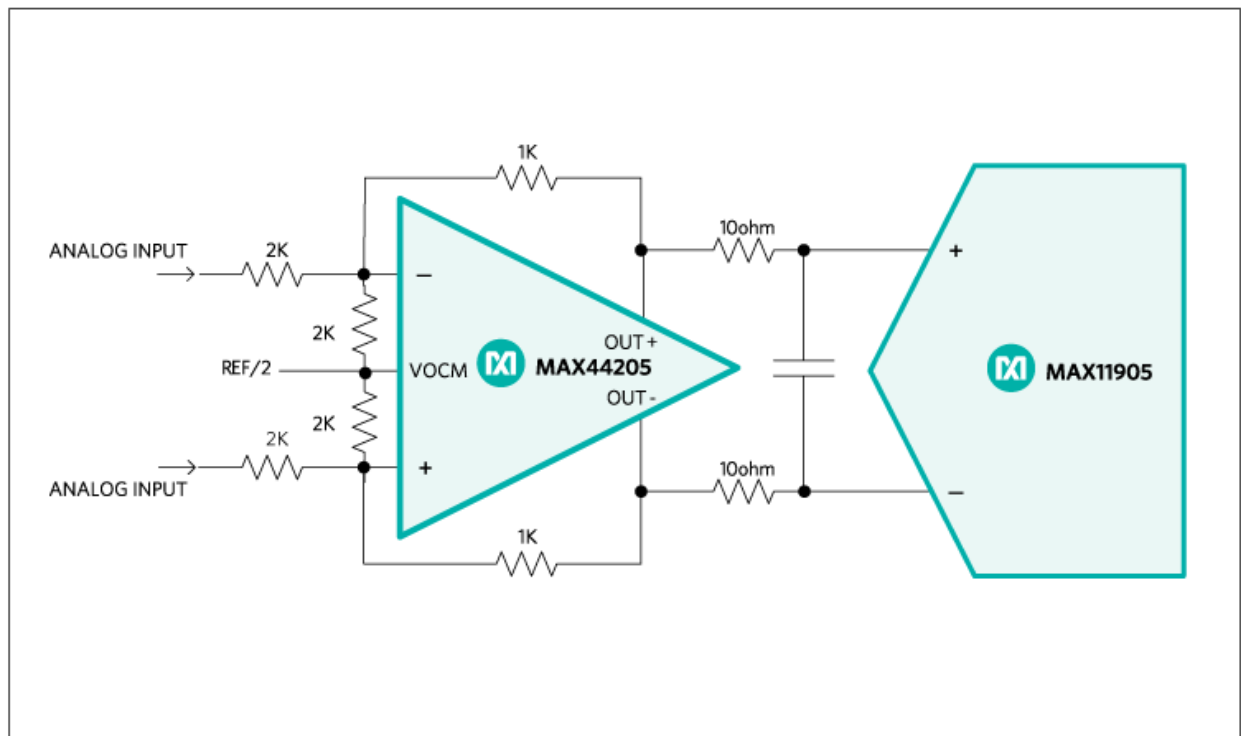


Figure 1. ADC input circuit.

Test Condition for the Analog Inputs and ADC

Table 1 and Table 2 show the power supplies and voltage reference in the design for the test.

Table 1. MAX11905 Voltage Supplies and Reference Input

MAX11905 SUPPLIES	VOLTAGE (V)
AVDD	1.8
OVDD	3.3
REFVDD	3.3
REFIN	3.0

Table 2. MAX44205 Voltage Supplies

MAX44205 SUPPLIES	VOLTAGE (V)
V_{S+}	+5
V_{S-}	-5

A close-to-full-scale 10kHz sine-wave input is applied at the MAX44205's analog inputs. We collected 32,768 samples at the 1.5Msps sampling rate. The equipment and the system were set up for coherent sampling to achieve the THD results.

Results

Table 3 displays the THD for the resistor's tested tolerances. Also included in the table is the cost multiplier for each resistor using $\pm 5\%$ as the base tolerance.

Table 3. THD Performance for Different Resistor Tolerances

RESISTOR TOLERANCE (%)	THD (dB)	COST FACTOR
± 5 (base)	-108	x 1
± 1	-113	x 1.5
± 0.1	-118.4	x 25
± 0.05	-120	x 45

Because the AFE consists of eight resistors, the cost multiplies by the number of resistors on the board of the design. If the design requires the $\pm 0.05\%$ tolerance resistors, the resistors' cost factor is 360 compared with 8 in the design with $\pm 5\%$ tolerance resistors.

Conclusion

Designers need to understand the cost involved when changing resistor tolerance on the AFE. The expected THD performance is based on what the designer is willing to spend since there is a budget for every design.

Related Parts		
MAX11905	20-Bit, 1.6Msps, Low-Power, Fully Differential SAR ADC	Free Samples
MAX44205	180MHz, Low-Noise Fully Differential SAR ADC Driver	

More Information

For Technical Support: <https://www.maximintegrated.com/en/support>

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