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Multi-Range ADC Use Voltage Reference Scaling Techniques

A data acquisition board, in order to provide flexibility, must be able to accommodate various input voltage ranges. Handling low amplitude signals generally requires an increase in the number of bits of resolution, increasing cost.

This application note describes a simple circuit that uses a low cost 10-bit ADC but increases the virtual accuracy to 13-bit.

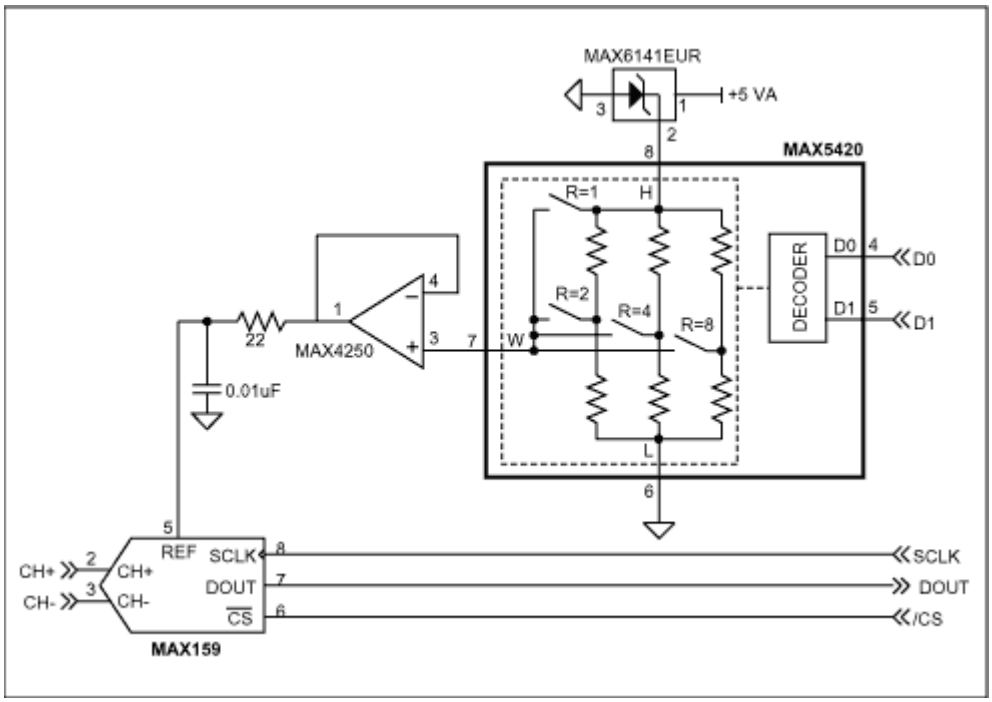

Figure 1.

1 LSB (least significant bit) for an ADC is FSR/2^n, where n is the number of bit. FS (Full Scale Range) depends from the amplitude of the voltage reference. The input voltage range of the external reference for MAX159, a low power, 108ksps serial ADC available in µMAX-8 package, is 0 to Vdd + 50mV. This large input range permits to accommodate different input range using a scaling technique.

The output of a low-cost 3-pin voltage reference is scaled using a digitally programmable voltage divider (MAX5420). This device provides four precision divider ratios of 1, 2, 4, 8. The ratio accuracy span from 0.025% to 0.5% according to the grade (A,B,C). The ratio is selected using the digital inputs D1, D0 as follows:

Table 1

DIGITAL INPUTS		
D1	D0	DIVIDER RATIO
0	0	1
0	1	2
1	0	4
1	1	8

The reference voltage MAX6141 provides an output voltage of 4.096V. The size of 1 LSB using a divider ratio of 1 will be 4.096/1024=4mV. This size change according the following table:

Table 2

VREF (V)	DIVIDER RATIO	LSB (mV)	VIRTUAL ACCURACY TO 4.096V FS
4.096	1	4	10-bit
2.048	2	2	11-bit
1.024	4	1	12-bit
0.512	8	0.5	13-bit

The effective resolution remains at 10 bits. But compared to a 4.096V FSR system, the virtual accuracy is improved. The size of 1LSB remains greater than the typical converter noise floor (300µV), also with divider ratio of 8. This ensures that the ADC performances are not limited by the LSB's reduced size.

MORE INFORMATION

MAX159:	QuickView	-- Full (PDF) Data Sheet (248k)	-- Free Sample
MAX5420:	QuickView	-- Full (PDF) Data Sheet (336k)	-- Free Sample