



DESIGN NOTES

New 5V and 3V, 12-Bit ADCs Sample at 300kHz on 75mW and 140kHz on 12mW - Design Note 66

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Four new sampling A/D converters from Linear Technology stand out above the rest of the crowd. These new 5V and 3V 12-bit ADCs offer the best speed/power performance available today (see Figure 1). They also provide precision reference, internally trimmed clock, and fast sample-and-hold. With additional features such as single supply operation and high impedance analog inputs, they reduce system complexity and cost. This article will describe the new ADCs, discuss the 5V performance of the LTC[®]1273/5/6 and then the 3V performance of the LTC1282.

Complete ADCs Provide Lowest Power and Highest Speed on Single or Dual Supplies

The LTC1273/5/6 and LTC1282 provide complete A/D solutions at previously impossible speed/power levels. As shown in Table 1, the LTC1273/5/6 all have the same 300kHz maximum sampling rate and 75mW typical power dissipation. The LTC1273 digitizes 0V to 5V inputs from a single 5V rail. The LTC1275 and LTC1276 operate on $\pm 5V$ rails and digitize $\pm 2.5V$ and $\pm 5V$ inputs, respectively.

Table 1. Four New Complete ADCs Offer High Supplies and Low Power on Single or Dual 5V or 3V Supplies

DEVICE	POWER SUPPLIES	INPUT RANGE	SAMPLE RATE	S/(N + D) at F_{INPUT}	P_{DISS} (Typ)
LTC1273	Single 5V	0V to 5V	300kHz	70dB at 100kHz	75mW
LTC1275/6	$\pm 5V$	$\pm 2.5/\pm 5V$	300kHz	70dB at 100kHz	75mW
LTC1282	Single 3V or $\pm 3V$	0V to 2.5V or ± 1.25	140kHz 140kHz	68dB at 70kHz	12mW

The LTC1282 samples at 140kHz and typically dissipates only 12mW from either 3V or $\pm 3V$ supplies. It digitizes 0V to 2.5V inputs from a single 3V supply or $\pm 1.25V$ inputs from $\pm 3V$ supplies.

Complete function is provided by the on-chip sample-and-holds, precision references, and internally trimmed clocks. The high impedance analog inputs are easy to drive and can be multiplexed without buffer amplifiers.

A single 5V or 3V power supply is all that is needed to digitize unipolar inputs. (Bipolar inputs require $\pm 5V$ or $\pm 3V$ supplies but the negative supply draws only microamperes of current). But most significant are the speed/power ratios which are higher than any other ADC in this speed range.

5V ADCs Sample at 300kHz on 75mW of Power

The LTC1273/5/6 have excellent DC specs, including $\pm 1/2$ LSB linearity and 25ppm/ $^{\circ}C$ full-scale drift. In addition, they have excellent dynamic performance. As Figure 2 shows, the ADCs provide 72dB of signal-to-noise + distortion (11.7 effective bits) at the maximum sample rate of 300kHz. The S/(N + D) ratio is over 70dB (11.3 effective bits) for input frequencies up to 100kHz.

This 300kHz sample rate and dynamic performance comes at a power level that is more stingy than any other ADC in this speed range. Figure 1 shows a graph of speed/power ratio for the competitive ADCs. The speed/power ratio is defined as the maximum sample rate in kHz divided by the typical power dissipation in mW. The 4.0 kHz/mW of the LTC1273/5/6 is better than the best competitive ADC.

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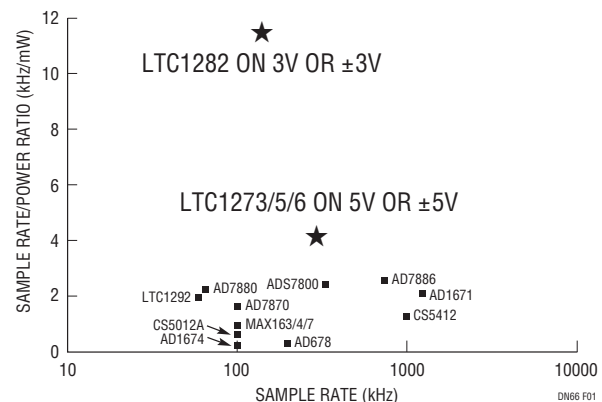


Figure 1. The LTC1273/5/6 and LTC1282 Have Up to 45 Times Higher Speed/Power Ratios Than Competitive ADCs

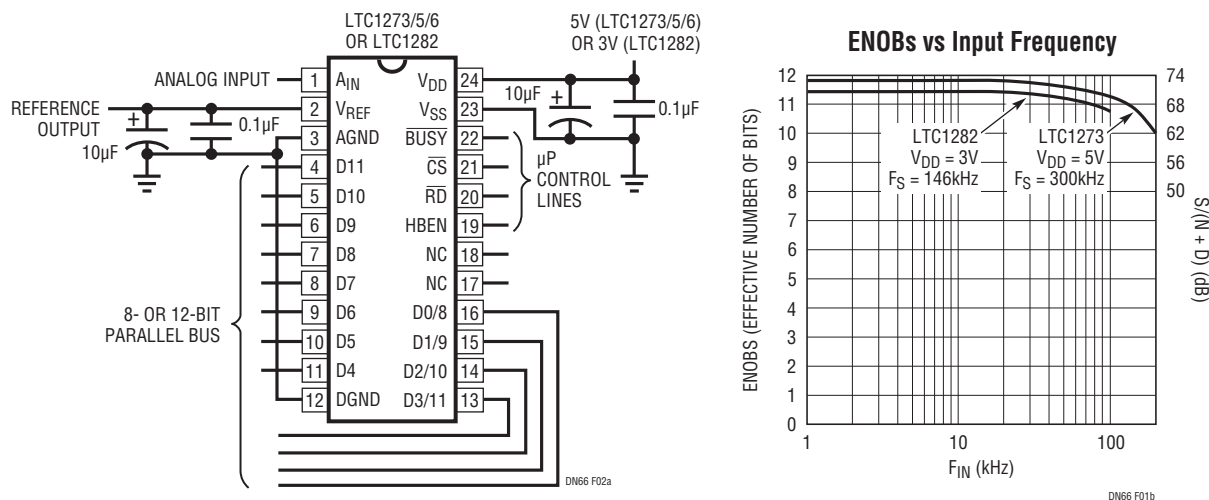


Figure 2. The 300kHz LTC1273 Gives 70dB S/(N + D) with 100kHz Inputs. The 140kHz LTC1282 Gives 68dB S/(N + D) at Nyquist.

Even More Power Savings: 3V ADC Samples at 140kHz on 12mW

The low power, 3V LTC1282 provides even more impressive speed/power performance. As fast and dynamically accurate as many power hungry, dual and triple supply ADCs, this complete 3V or $\pm 3V$ sampling ADC provides extremely good performance on only 12mW of power! DC specs include $\pm 1/2$ LSB maximum linearity and the internal reference provides 25ppm maximum full-scale drift. Figure 2 shows 11.4 effective bits at 140kHz sample rate with 11 effective bits at the nyquist frequency of 70kHz. The speed/power ratio, as shown in Figure 1, is an outstanding 11.7kHz/mW.

The LTC1282 is ideal for 3V systems but will also find uses in 5V designs where the lowest possible power consumption is required. It interfaces easily to 3V logic but can also talk well to 5V systems. The LTC1282 can receive 5V CMOS levels directly and its 0V to 3V outputs can meet 5V TTL levels and connect directly to 5V systems.

The performance comparison in Table 2 shows that using the 3V LTC1282 gives great savings in power with only modest reductions in speed, accuracy and noise. The power dissipation has been reduced 6 times with only a 50% reduction in speed. Linearity and drift don't

Table 2. 5V and 3V Reference Comparison

PARAMETER	LTC1273 on a 5V SUPPLY	LTC1282 on a SINGLE 3V or $\pm 3V$ SUPPLIES
Power Dissipation (Typ)	75mW	12mW
Sample Rate	300kHz	140kHz
Conversion Time (Max)	2.7 μ s	6 μ s
INL (Max)	1/2 LSB	$\pm 1/2$ LSB
Typical ENOBs	11.7	11.4
Linear Input Bandwidth (ENOBs > 11 Bits)	125kHz	70kHz

degrade at all in going to the 3V device. The noise of the LTC1282 is slightly higher, due to the reduced input span and the lower operating current, but the converter still gives more than 70dB S/(N + D).

Conclusion

These new 5V and 3V ADCs offer the best speed/power performance available today. They also provide precision reference, internally trimmed clock, and fast sample-and-hold. With additional features such as single supply operation and high impedance analog inputs, they reduce system complexity and cost. For performance, power and cost, these new ADCs must be considered for new designs.

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