SAR ADC Input Types

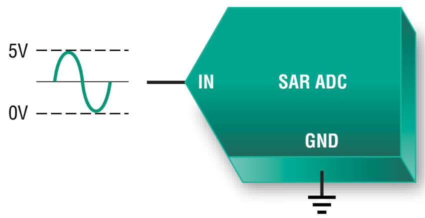

Figure 1a. Single-Ended Unipolar

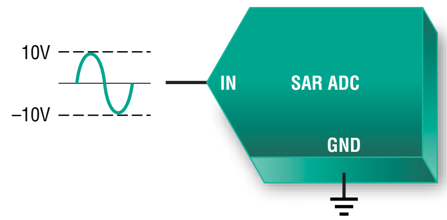

Figure 1b. Single-Ended True Bipolar

Single-Ended Inputs

An ADC with single-ended inputs digitizes the analog input voltage relative to ground. Single-ended inputs simplify ADC driver requirements, reduce complexity and lower power dissipation in the signal chain. Single-ended inputs can either be unipolar or bipolar, where the analog input on a single-ended unipolar ADC swings only above GND (0V to V_{FS}, where V_{FS} is the full-scale input voltage that is determined by a reference voltage) (Figure 1a) and the analog input on a single-ended bipolar ADC also called true bipolar, swings above or below GND ($\pm V_{FS}$) (Figure 1b).

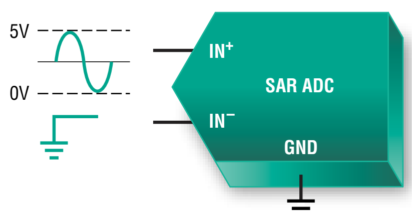

Figure 2a. Pseudo-Differential Unipolar

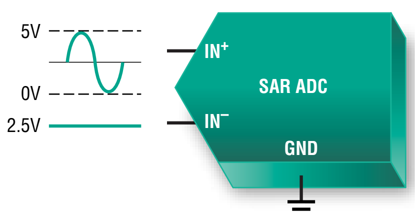

Figure 2b. Pseudo-Differential Bipolar

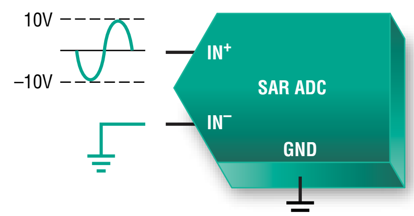

Figure 2c. Pseudo-Differential True Bipolar

Pseudo-Differential Inputs

An ADC with pseudo-differential inputs digitizes the differential analog input voltage ($IN^+ – IN^–$) over a limited range. The IN^+ input has the actual analog input signal, while the $IN^–$ input has a restricted range.

A pseudo-differential unipolar ADC digitizes the differential analog input voltage ($IN^+ – IN^–$) over a span of 0V to V_{FS}. In this range, a single-ended unipolar input signal, driven on the IN^+ pin, is measured with respect to the signal ground reference level, driven on the $IN^–$ pin. The IN^+ pin is allowed to swing from GND to V_{FS}, while the $IN^–$ pin is restricted to around GND ± 100mV (Figure 2a).

A pseudo-differential bipolar ADC digitizes the differential analog input voltage ($IN^+ – IN^–$) over a span of $\pm V_{FS}/2$. In this range, a single-ended bipolar input signal, driven on the IN^+ pin, is measured with respect to the signal mid-scale reference level, driven on the $IN^–$ pin. The IN^+ pin is allowed to swing from GND to V_{FS}, while the IN– pin is restricted to around $V_{FS}/2$ ± 100mV (Figure 2b).

A pseudo-differential true bipolar ADC digitizes the differential analog input voltage ($IN^+ – IN^–$) over a span of $\pm V_{FS}$. In this range, a true bipolar input signal, driven on the IN^+ pin, is measured with respect to the signal ground reference level, driven on the $IN^–$ pin. The IN^+ pin is allowed to swing above or below GND to $\pm V_{FS}$, while the $IN^–$ pin is restricted to around GND ± 100mV (Figure 2c).

Pseudo-differential inputs help separate signal ground from the ADC ground, allowing small common-mode voltages to be cancelled. They also allow single-ended input signals that are referenced to ADC ground. Pseudo-differential ADCs are ideal for applications that require DC common-mode voltage rejection, for single-ended input signals and for applications that do not want the complexity of differential drivers. Pseudo-differential inputs simplify the ADC driver requirement, reduce complexity and lower power dissipation in the signal chain.

LINEAR TECHNOLOGY

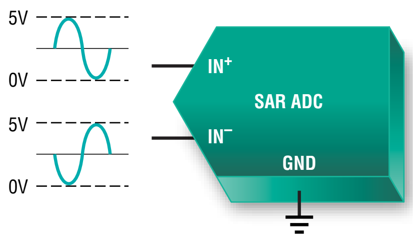

Figure 3a. Fully Differential

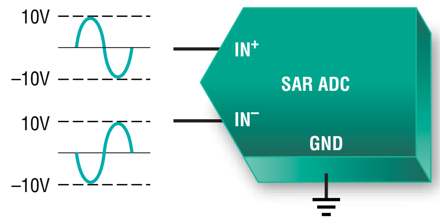

Figure 3b. Fully Differential True Bipolar

Fully Differential Inputs

An ADC with fully-differential inputs digitizes the differential analog input voltage (IN$^+$ – IN$^-$) over a span of $\pm V_{FS}$. In this range, the IN$^+$ and IN$^-$ pins should be driven 180º out-of-phase with respect to each other, centered on a fixed common mode voltage, for example, $V_{REF}/2 \pm 50mV$. In most fully-differential ADCs, both the IN$^+$ and IN$^-$ pins are allowed to swing from GND to V_{FS} (Figure 3a), while in fully-differential true bipolar ADCs, both the IN$^+$ and IN$^-$ pins are allowed to swing above or below GND to $\pm V_{FS}$ (Figure 3b).

Fully-differential inputs offer wider dynamic range and better SNR performance over single-ended or pseudo-differential inputs. Fully differential ADCs are ideal for applications that require the highest performance.

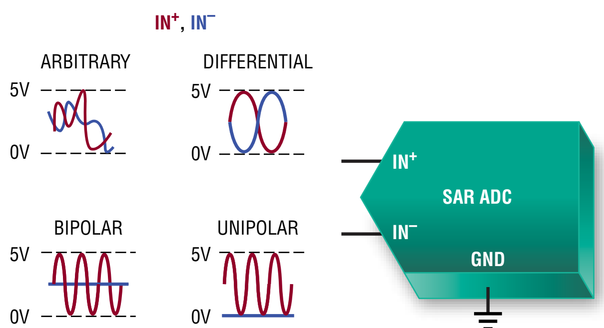

Figure 4a. Differential with Wide Input Common Mode

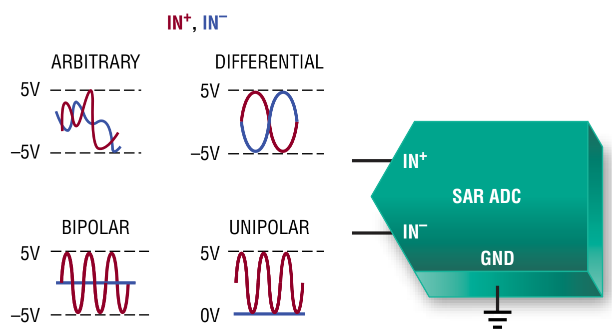

Figure 4b. Differential True Bipolar

Differential Inputs with Wide Input Common Mode

An ADC with differential inputs digitizes the voltage difference between the IN$^+$ and IN$^-$ pins while supporting a wide common mode input range. The analog input signals on IN$^+$ and IN$^-$ can have an arbitrary relationship to each other. In most differential ADCs, both IN$^+$ and IN$^-$ remain between GND and V_{FS} (Figure 4a), while in differential true bipolar ADCs, both the IN$^+$ and IN$^-$ pins are allowed to swing above or below GND to $\pm V_{FS}$ (Figure 4b). Differential inputs are ideal for applications that require a wide dynamic range with high common mode rejection. Being one of the most flexible ADC input types, an ADC with differential inputs can also digitize other types of analog input signals such as single-ended unipolar, pseudo-differential unipolar/bipolar and fully-differential.

Input Types		Linear Technology SAR ADCs
Single-Ended	Single-Ended Unipolar	LTC1865, LTC2314, LTC2315, LTC2360, LTC2361, LTC2362, LTC2365, LTC2366
	Single-Ended True Bipolar	LTC1400, LTC1404, LTC1605, LTC1606, LTC1609
Pseudo-Differential	Pseudo-Differential Unipolar	LTC1864, LTC2305, LTC2306, LTC2308, LTC2309, LTC2364, LTC2367, LTC2368, LTC2369, LTC2370, LTC2389, LTC2372, LTC2373
	Pseudo-Differential Bipolar	LTC2305, LTC2306, LTC2308, LTC2309, LTC2389, LTC2372, LTC2373
	Pseudo-Differential True Bipolar	LTC1414, LTC1419, LTC1854, LTC1855, LTC1856, LTC1857, LTC1858, LTC1859, LTC2328, LTC2327, LTC2326
Fully Differential	Fully Differential	LTC2376, LTC2377, LTC2378, LTC2379, LTC2380, LTC2383, LTC2389, LTC2393, LTC2372, LTC2373
	Fully Differential True Bipolar	LTC2338, LTC2337, LTC2336
Differential with Wide Input Common Mode	Differential	LTC1403, LTC1407, LTC1408, LTC2351, LTC2355, LTC2356, LTC2323, LTC2321, LTC2348
	Differential True Bipolar	LTC1604, LTC1608, LTC2348