



# *SpeedPLUS™* 8-Bit, 30MHz Sampling ANALOG-TO-DIGITAL CONVERTER

## FEATURES

- +3V TO +5V SUPPLY OPERATION
- INTERNAL REFERENCE
- SINGLE-ENDED INPUT RANGE: 1V to 2V
- LOW POWER: 66mW at +3V
- HIGH SNR: 46dB
- LOW DNL: 0.4LSB
- SSOP-28 PACKAGE

## APPLICATIONS

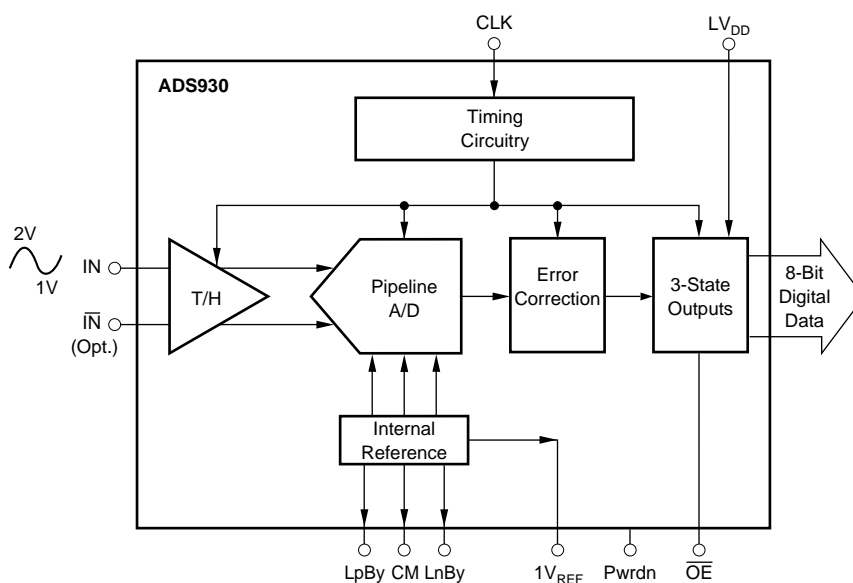
- BATTERY POWERED EQUIPMENT
- CAMCORDERS
- PORTABLE TEST EQUIPMENT
- COMPUTER SCANNERS
- COMMUNICATIONS

## DESCRIPTION

The ADS930 is a high speed pipelined Analog-to-Digital Converter (ADC) specified to operate from nominal +3V or +5V power supplies with tolerances of up to 10%. This complete converter includes a high bandwidth track/hold, a 8-bit quantizer and an internal reference.

The ADS930 employs digital error correction techniques to provide excellent differential linearity for demanding imaging applications. Its low distortion and high SNR give the extra margin needed for telecommunications, video and test instrumentation applications.

This high performance ADC is specified for performance at a 30MHz sampling rate. The ADS930 is available in a SSOP-28 package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## ABSOLUTE MAXIMUM RATINGS

|                            |                       |
|----------------------------|-----------------------|
| +V <sub>S</sub> .....      | +6V                   |
| Analog Input .....         | +V <sub>S</sub> +0.3V |
| Logic Input .....          | +V <sub>S</sub> +0.3V |
| Case Temperature .....     | +100°C                |
| Junction Temperature ..... | +150°C                |
| Storage Temperature .....  | +150°C                |



## ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## PACKAGE/ORDERING INFORMATION

| PRODUCT | PACKAGE | PACKAGE DRAWING NUMBER | SPECIFIED TEMPERATURE RANGE | PACKAGE MARKING | ORDERING NUMBER <sup>(1)</sup> | TRANSPORT MEDIA |
|---------|---------|------------------------|-----------------------------|-----------------|--------------------------------|-----------------|
| ADS930E | SSOP-28 | 324                    | -40°C to +85°C              | ADS930E         | ADS930E                        | Rails           |
| "       | "       | "                      | "                           | ADS930E         | ADS930E/1K                     | Tape and Reel   |

NOTE: (1) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /1K indicates 1000 devices per reel). Ordering 1000 pieces of "ADS930E/1K" will get a single 1000-piece Tape and Reel.

## ELECTRICAL CHARACTERISTICS

At T<sub>A</sub> = +25°C, V<sub>S</sub> = +3V, Single-ended Input and Sampling Rate = 30MHz, unless otherwise specified.

| PARAMETER  | CONDITIONS                               | TEMP   | ADS930E                             |  |               | UNITS   |
|--|--|--|-------------------------------------|--|---------------|---|
|  |  |  | MIN                                 | TYP  | MAX           |   |
| <b>RESOLUTION</b><br>Specified Temperature Range   | Ambient Air                              |  | -40                                 | 8  | +85           | Bits<br>°C  |
| <b>ANALOG INPUT</b><br>Differential Full Scale Input Range<br>Single-Ended Full Scale Input Range<br>Common-mode Voltage<br>Analog Input Bias Current<br>Input Impedance   | 0.5Vp-p<br>1Vp-p                         |  | +1.25<br>+1.0                       | 1.5<br>1<br>1.25    5  | +1.75<br>+2.0 | V<br>V<br>V<br>μA<br>MΩ    pF   |
| <b>DIGITAL INPUTS</b><br>Logic Family<br>High Input Voltage, V <sub>IH</sub><br>Low Input Voltage, V <sub>IL</sub><br>High Input Current, I <sub>IH</sub><br>Low Input Current, I <sub>IL</sub><br>Input Capacitance   |  | Full   | TTL/HCT Compatible CMOS<br>2.0      |  |               | V<br>V<br>μA<br>μA<br>pF  |
| <b>CONVERSION CHARACTERISTICS</b><br>Start Conversion<br>Sample Rate<br>Data Latency   |  | Full   | Rising Edge of Convert Clock<br>10k |  |               | Samples/s<br>Clk Cyc  |
| <b>DYNAMIC CHARACTERISTICS</b><br>Differential Linearity Error<br>f = 500kHz<br>f = 12MHz<br>No Missing Codes<br>Integral Nonlinearity Error, f = 500kHz<br>Spurious Free Dynamic Range <sup>(1)</sup><br>f = 500kHz (-1dBFS input)<br>f = 12MHz (-1dB input)<br>Two-Tone Intermodulation Distortion <sup>(3)</sup><br>f = 3.4MHz and 3.5MHz (-7dBFS each tone)<br>Signal-to-Noise Ratio (SNR)<br>f = 500kHz (-1dBFS input)<br>f = 12MHz (-1dBFS input)<br>Signal-to-(Noise + Distortion) (SINAD)<br>f = 500kHz (-1dBFS input)<br>f = 3.58MHz (-1dBFS input)<br>f = 12MHz (-1dBFS input) | Largest Code Error<br>Largest Code Error | Full<br>Full<br>Full<br>Full<br>Full<br>Full<br>Full<br>Full<br>Full<br>Full<br>Full | 46                                  | ±0.4<br>±0.4<br>Guaranteed<br>51<br>50<br>54<br>46<br>46<br>45<br>45<br>45 | ±1<br>±2.5    | LSB<br>LSB<br>LSB<br>dBFS <sup>(2)</sup><br>dBFS<br>dBc<br>dB<br>dB<br>dB<br>dB<br>dB |

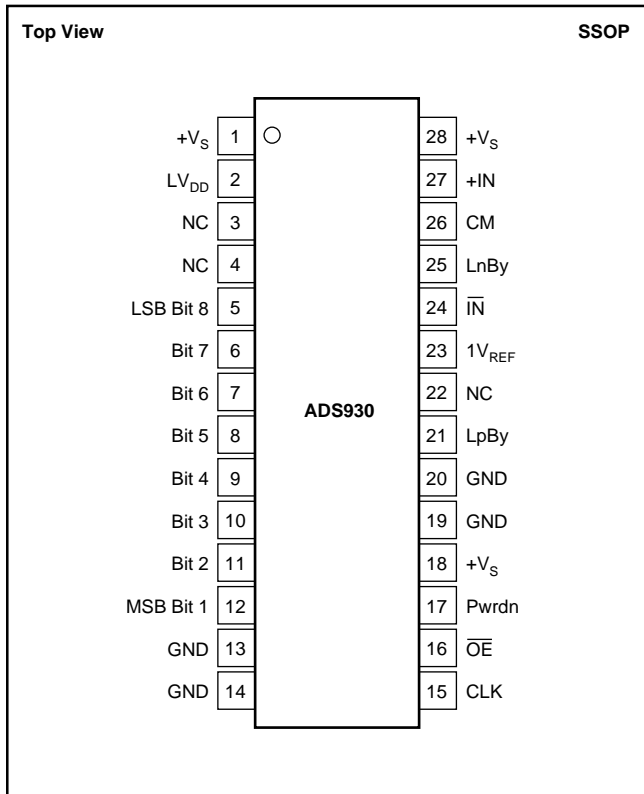
# ELECTRICAL CHARACTERISTICS (Cont.)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +3\text{V}$ , Single-ended Input and Sampling Rate = 30MHz, unless otherwise specified.

| PARAMETER                                | CONDITIONS                 | TEMP | ADS930E                 |          |          | UNITS              |
|--|----------------------------|------|-------------------------|----------|----------|--------------------|
|  |                            |      | MIN                     | TYP      | MAX      |                    |
| Differential Gain Error                  | NTSC, PAL                  |      |                         | 2.3      |          | %                  |
| Differential Phase Error                 | NTSC, PAL                  |      |                         | 1        |          | degrees            |
| Output Noise                             | Input Grounded             |      |                         | 0.2      |          | LSBs rms           |
| Aperture Delay Time                      |                            |      |                         | 2        |          | ns                 |
| Aperture Jitter                          |                            |      |                         | 7        |          | ps rms             |
| Analog Input Bandwidth                   |                            |      |                         |          |          |                    |
| Small Signal                             | -20dBFS Input              |      |                         | 350      |          | MHz                |
| Full Power                               | 0dBFS Input                |      |                         | 100      |          | MHz                |
| Overvoltage Recovery Time <sup>(4)</sup> |                            |      |                         | 2        |          | ns                 |
| <b>DIGITAL OUTPUTS</b>                   | $C_L = 15\text{pF}$        |      |                         |          |          |                    |
| Logic Family                             |                            |      | TTL/HCT Compatible CMOS |          |          |                    |
| Logic Coding                             |                            |      | Straight Offset Binary  |          |          |                    |
| High Output Voltage, $V_{OH}$            |                            |      | +2.4                    |          | $V_{DD}$ | V                  |
| Low Output Voltage, $V_{OL}$             |                            |      |                         |          | 0.4      | V                  |
| 3-State Enable Time                      | $\overline{OE} = L$        |      |                         | 20       | 40       | ns                 |
| 3-State Disable Time                     | $OE = H$                   |      |                         | 2        | 10       | ns                 |
| Internal Pull-Down                       |                            |      |                         | 50       |          | k $\Omega$         |
| Power-Down Enable Time                   | PwrDn = L                  |      |                         | 133      |          | ns                 |
| Power-Down Disable Time                  | PwrDn = H                  |      |                         | 18       |          | ns                 |
| Internal Pull-Down                       |                            |      |                         | 50       |          | k $\Omega$         |
| <b>ACCURACY</b>                          | $f_s = 2.5\text{MHz}$      |      |                         |          |          |                    |
| Gain Error                               |                            | Full |                         | 5.9      | 10       | %FS                |
| Input Offset                             | Referred to Ideal Midscale | Full |                         | $\pm 10$ | $\pm 60$ | mV                 |
| Power Supply Rejection (Gain)            | $\Delta V_S = +10\%$       | Full |                         | 56       |          | dB                 |
| Power Supply Rejection (Offset)          |                            | Full |                         | 56       |          | dB                 |
| Internal Positive Reference Voltage      |                            | Full |                         | +1.75    |          | V                  |
| Internal Negative Reference Voltage      |                            | Full |                         | +1.25    |          | V                  |
| <b>POWER SUPPLY REQUIREMENTS</b>         |                            |      |                         |          |          |                    |
| Supply Voltage: $+V_S$                   | Operating                  | Full | +2.7                    | +3.0     | +5.25    | V                  |
| Supply Current: $+I_S$                   | Operating, +3V             | Full |                         | 22       |          | mA                 |
| Power Dissipation                        | Operating, +3V             | Full |                         | 66       | 84       | mW                 |
|  | Operating, +5V             | Full |                         | 168      |          | mW                 |
| Power Dissipation (Power Down)           | Operating, +3V             | Full |                         | 10       |          | mW                 |
|  | Operating, +5V             | Full |                         | 15       |          | mW                 |
| Thermal Resistance, $\theta_{JA}$        |                            |      |                         |          |          |                    |
| SSOP-28                                  |                            |      |                         | 89       |          | $^\circ\text{C/W}$ |

NOTES: (1) Spurious Free Dynamic Range refers to the magnitude of the largest harmonic. (2) dBFS means dB relative to full scale. (3) Two-tone intermodulation distortion is referred to the largest fundamental tone. This number will be 6dB higher if it is referred to the magnitude of the two-tone fundamental envelope. (4) No "Rollover" of bits.

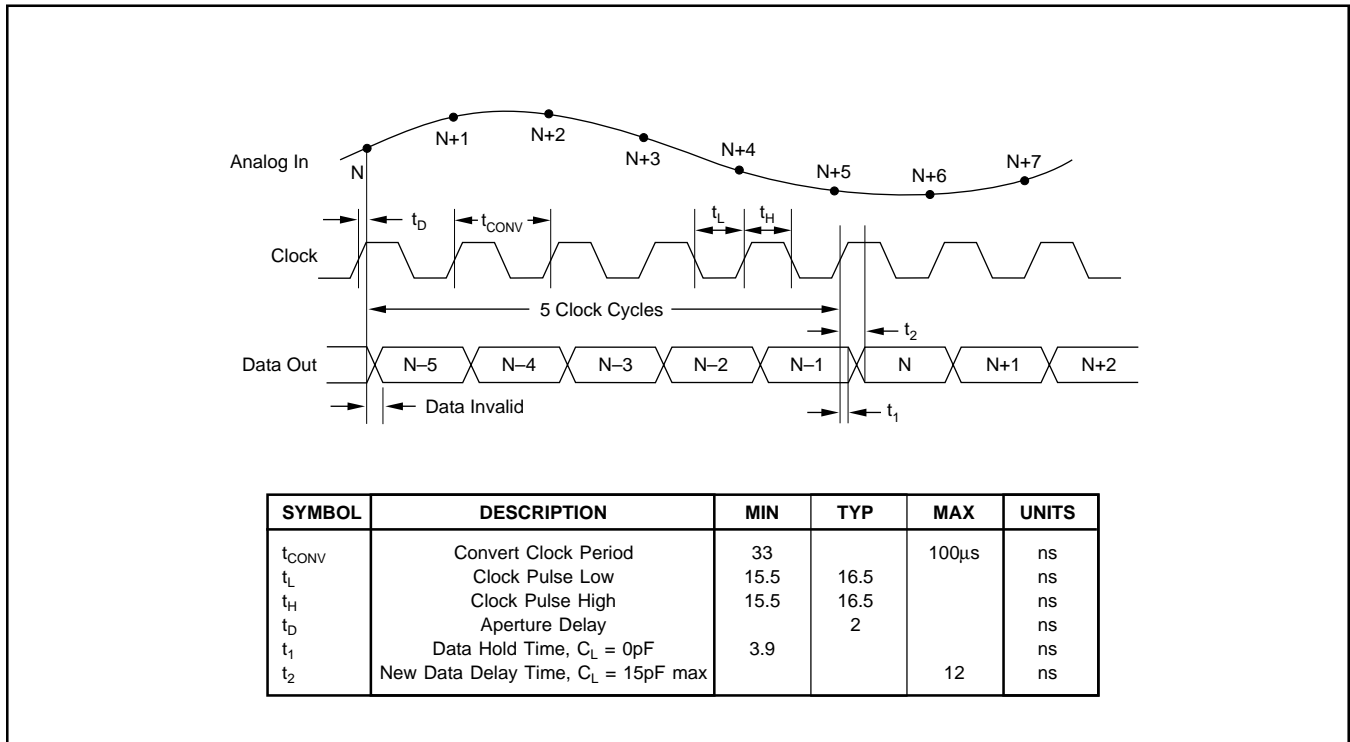
## PIN CONFIGURATION



## PIN DESCRIPTIONS

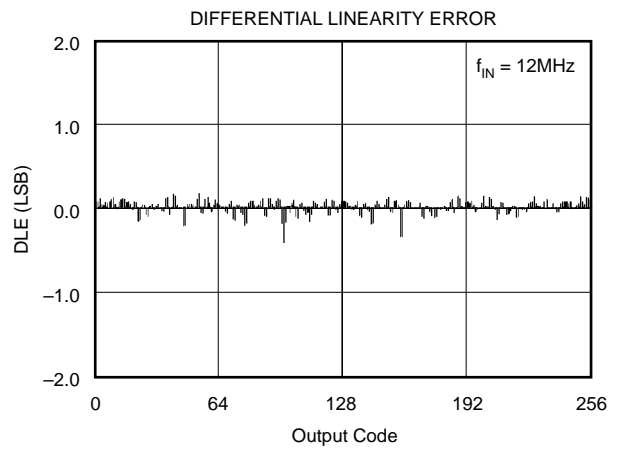
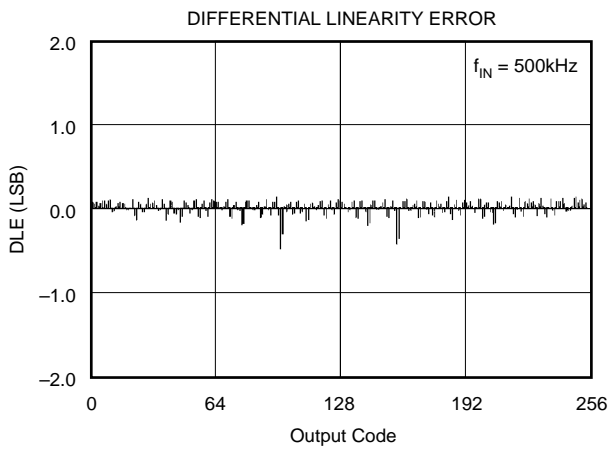
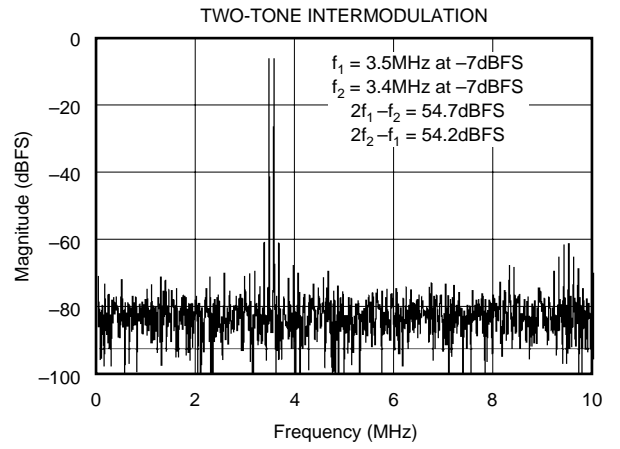
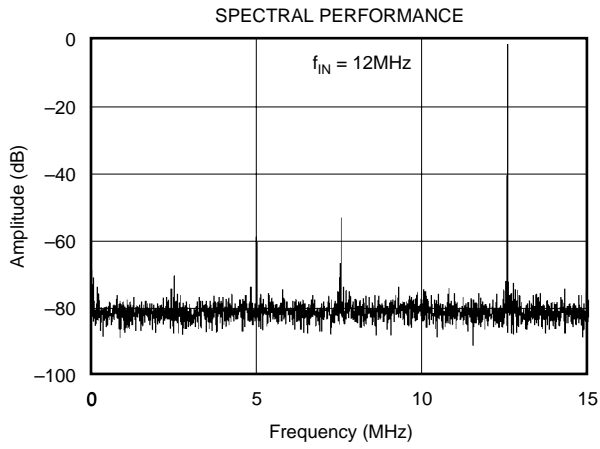
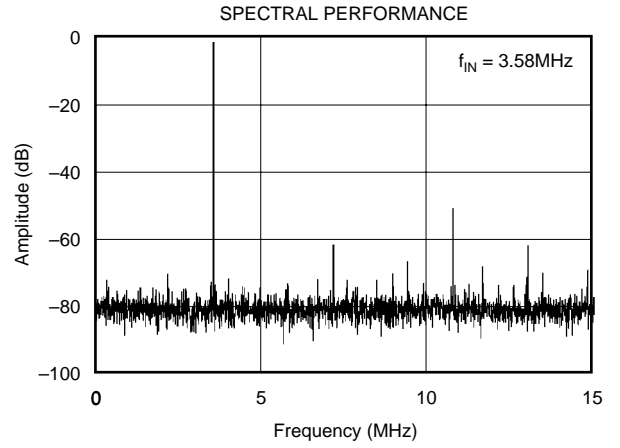
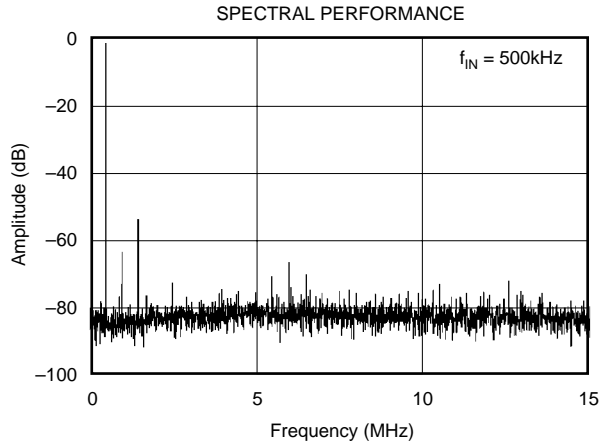
| PIN | DESIGNATOR        | DESCRIPTION                        |
|-----|-------------------|------------------------------------|
| 1   | +V <sub>S</sub>   | Analog Supply                      |
| 2   | LV <sub>DD</sub>  | Output Logic Driver Supply Voltage |
| 3   | NC                | No Connection                      |
| 4   | NC                | No Connection                      |
| 5   | Bit 8 (LSB)       | Data Bit 8 (D7)                    |
| 6   | Bit 7             | Data Bit 7 (D6)                    |
| 7   | Bit 6             | Data Bit 6 (D5)                    |
| 8   | Bit 5             | Data Bit 5 (D4)                    |
| 9   | Bit 4             | Data Bit 4 (D3)                    |
| 10  | Bit 3             | Data Bit 3 (D2)                    |
| 11  | Bit 2             | Data Bit 2 (D1)                    |
| 12  | Bit 1(MSB)        | Data Bit 1 (D0)                    |
| 13  | GND               | Analog Ground                      |
| 14  | GND               | Analog Ground                      |
| 15  | CLK               | Convert Clock Input                |
| 16  | OE                | Output Enable, Active Low          |
| 17  | PwrDn             | Power Down Pin                     |
| 18  | +V <sub>S</sub>   | Analog Supply                      |
| 19  | GND               | Analog Ground                      |
| 20  | GND               | Analog Ground                      |
| 21  | LpBy              | Positive Ladder Bypass             |
| 22  | NC                | No Connection                      |
| 23  | 1V <sub>REF</sub> | 1V Reference Output                |
| 24  | IN                | Complementary Input                |
| 25  | LnBy              | Negative Ladder Bypass             |
| 26  | CM                | Common-Mode Voltage Output         |
| 27  | +IN               | Analog Input                       |
| 28  | +V <sub>S</sub>   | Analog Supply                      |

## TIMING DIAGRAM



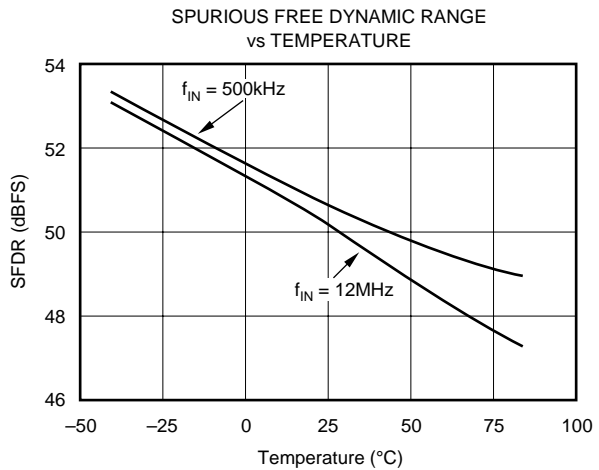
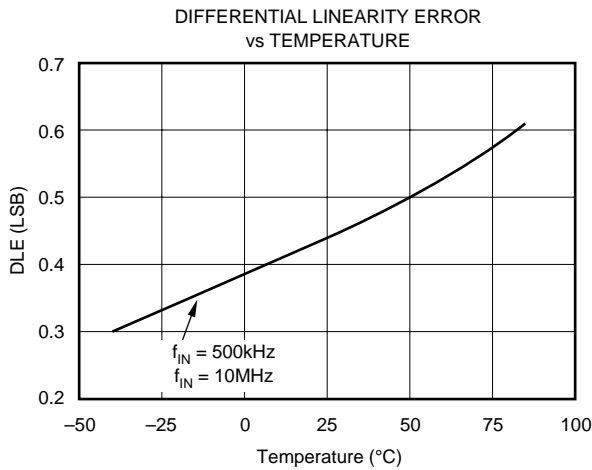
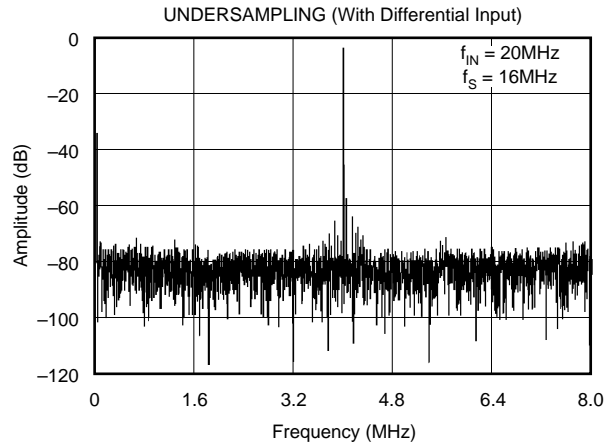
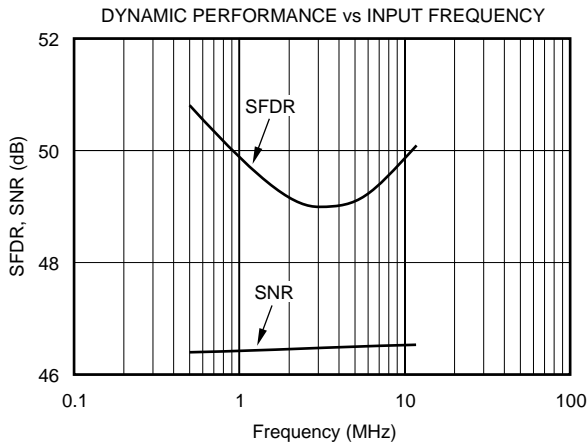
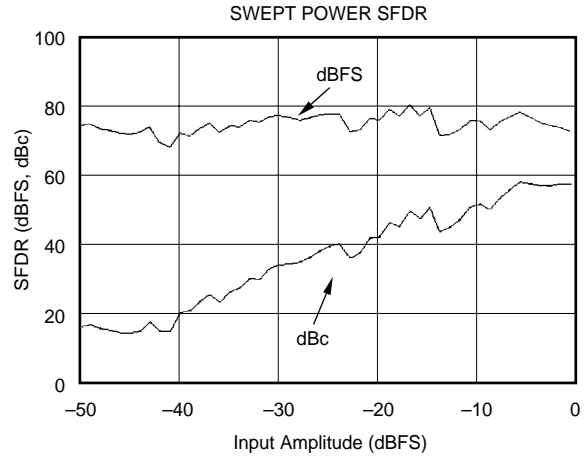
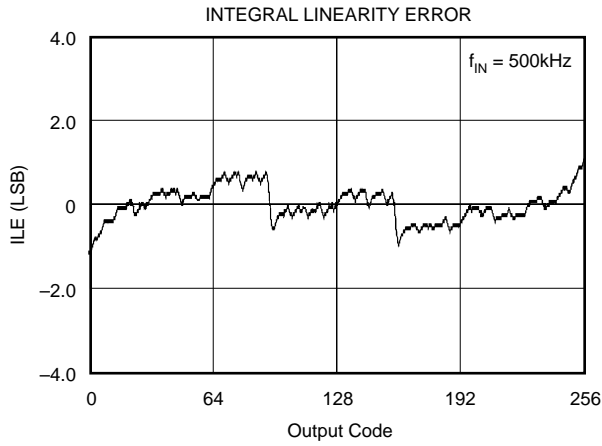
# TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +3\text{V}$ , Single-ended Input and Sampling Rate = 30MHz, unless otherwise specified.



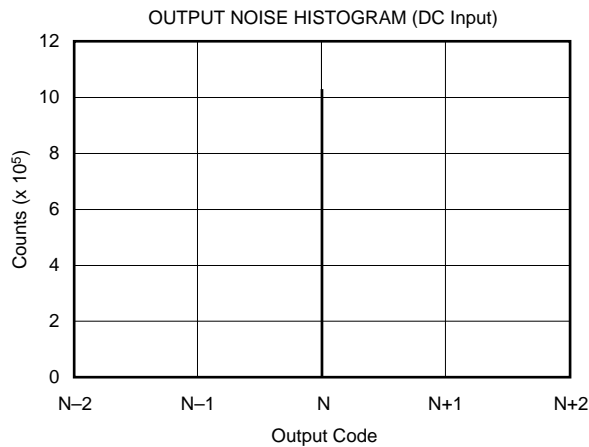
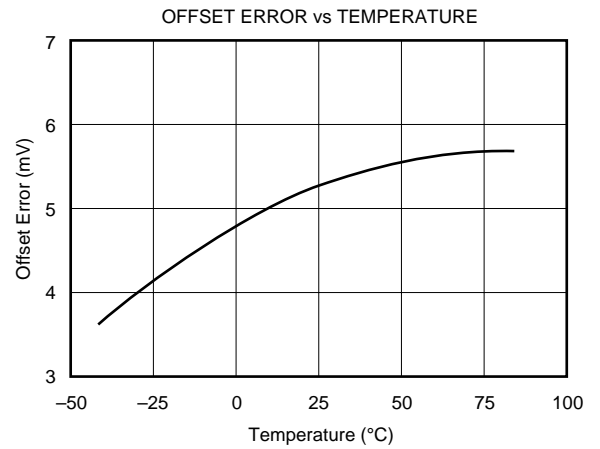
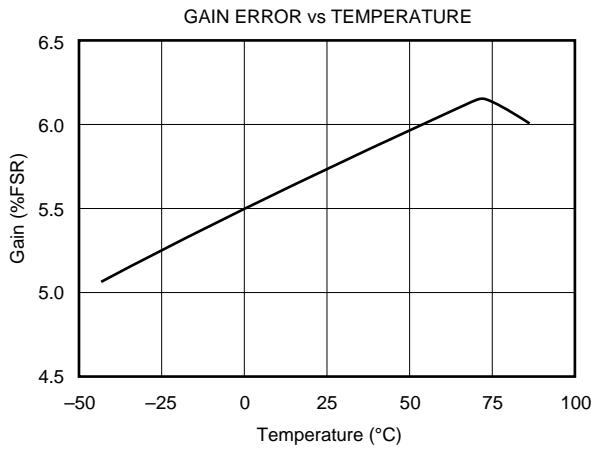
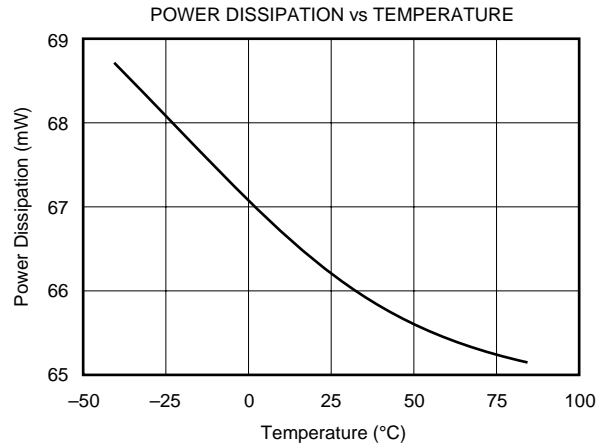
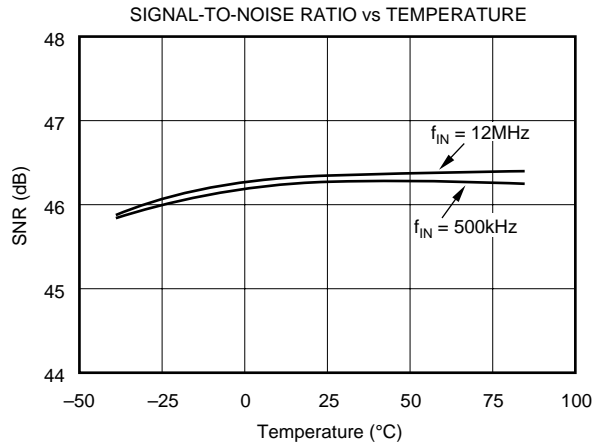
# TYPICAL CHARACTERISTICS (Cont.)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +3\text{V}$ , Single-ended Input and Sampling Rate = 30MHz, unless otherwise specified.



# TYPICAL CHARACTERISTICS (Cont.)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = +3\text{V}$ , Single-ended Input and Sampling Rate = 30MHz, unless otherwise specified.



# THEORY OF OPERATION

The ADS930 is a high speed sampling ADC that utilizes a pipeline architecture. The fully differential topology and digital error correction guarantee 8-bit resolution. The track/hold circuit is shown in Figure 1. The switches are controlled by an internal clock which has a non-overlapping two phase signal,  $\phi 1$  and  $\phi 2$ . At the sampling time the input signal is sampled on the bottom plates of the input capacitors. In the next clock phase,  $\phi 2$ , the bottom plates of the input capacitors are connected together and the feedback capacitors are switched to the op amp output. At this time the charge redistributes between  $C_I$  and  $C_H$ , completing one track/hold cycle. The differential output is a held DC representation of the analog input at the sample time. In the normal mode of operation, the complementary input is tied to the common-mode voltage. In this case, the track/hold circuit converts a single-ended input signal into a fully differential signal for the quantizer. Consequently, the input signal gets amplified by a gain or two, which improves the signal-to-noise performance. Other parameters such as small-signal and full-power bandwidth, and wideband noise are also defined in this stage.

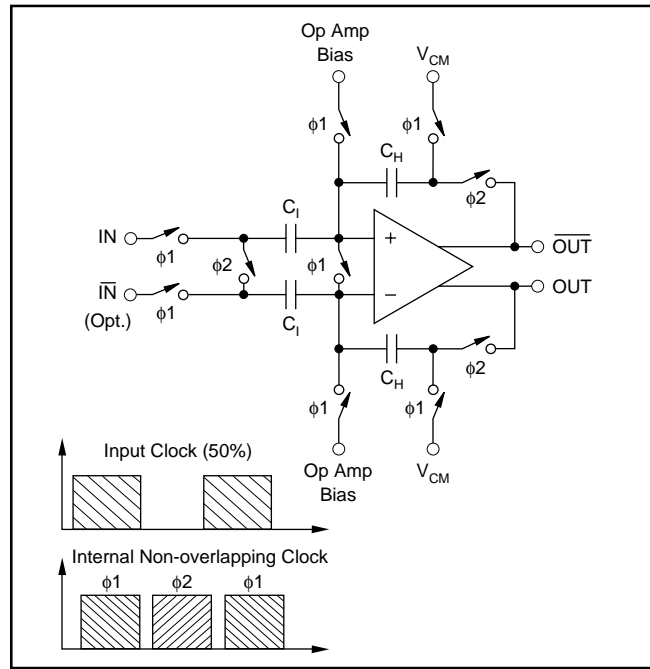


FIGURE 1. Input Track/Hold Configuration with Timing Signals.

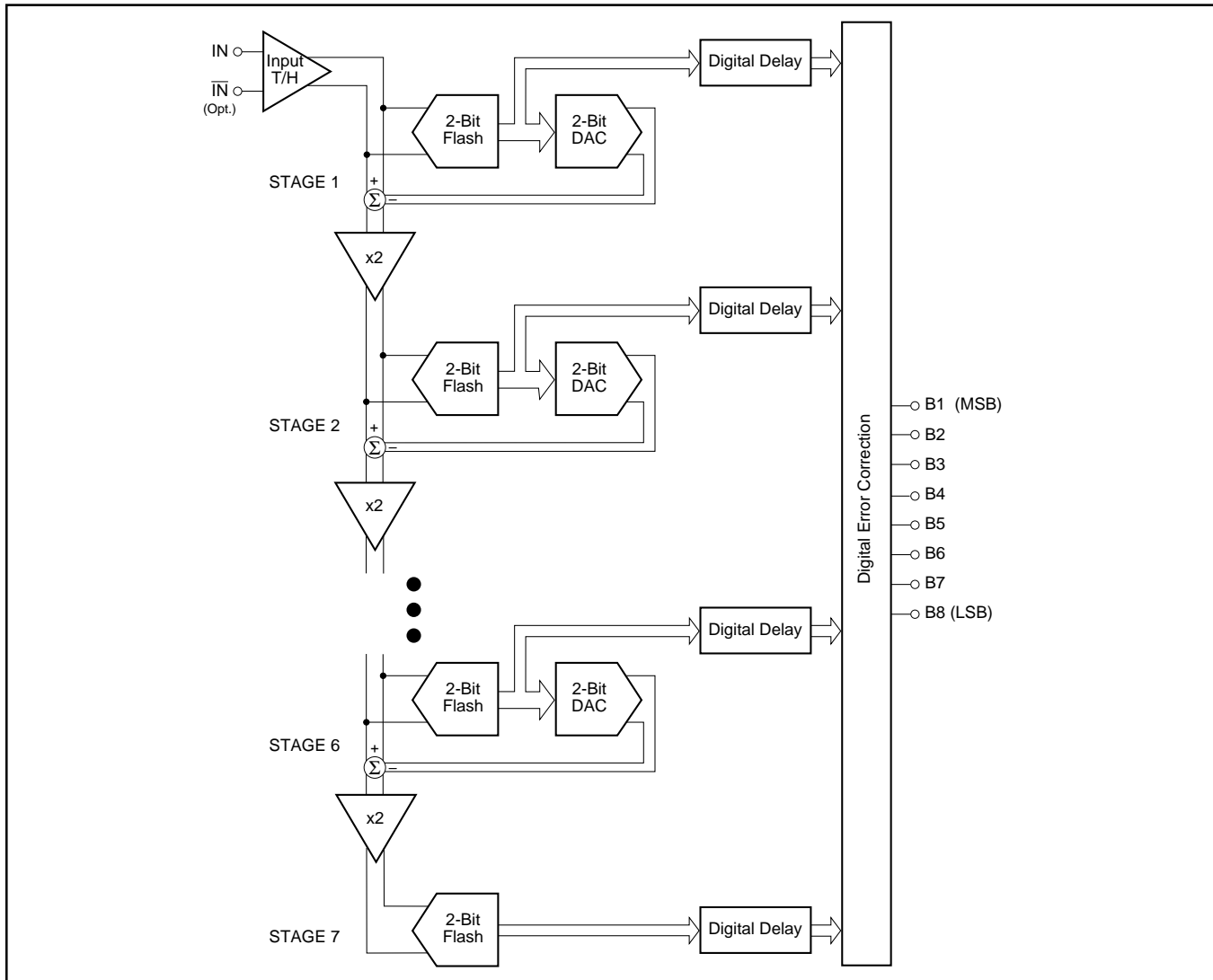


FIGURE 2. Pipeline ADC Architecture.

The pipelined quantizer architecture has 7 stages with each stage containing a two-bit quantizer and a two bit Digital-to-Analog Converter (DAC), as shown in Figure 2. Each two-bit quantizer stage converts on the edge of the sub-clock, which is the same frequency of the externally applied clock. The output of each quantizer is fed into its own delay line to time-align it with the data created from the subsequent quantizer stages. This aligned data is fed into a digital error correction circuit which can adjust the output data based on the information found on the redundant bits. This technique provides the ADS930 with excellent differential linearity and guarantees no missing codes at the 8-bit level.

The ADS930 includes an internal reference circuit that provides the bias voltages for the internal stages (for details see “Internal Reference”). A midpoint voltage is established by the built-in resistor ladder which is made available at pin 26 “CM”. This voltage can be used to bias the inputs up to the recommended common-mode voltage or to level shift the input driving circuitry. The ADS930 can be used in both a single-ended or differential input configuration. When operated in single-ended mode, the reference midpoint (pin 26) should be tied to the inverting input, pin 24.

To accommodate a bipolar signal swing, the ADS930 operates with a common-mode voltage ( $V_{CM}$ ) which is derived from the internal references. Due to the symmetric resistor ladder inside the ADS930,  $V_{CM}$  is situated between the top and bottom reference voltage. The following equation can be used for calculating the common-mode voltage level:

$$V_{CM} = (REFT + REFB)/2 \quad (1)$$

## APPLICATIONS

### DRIVING THE ANALOG INPUTS

Figure 3 shows an example of an ac-coupled, single-ended interface circuit using high-speed op amps which operate on dual supplies (OPA650, OPA658). The mid-point reference voltage, ( $V_{CM}$ ), biases the bipolar, ground-referenced input

signal. The capacitor  $C_1$  and resistor  $R_1$  form a high-pass filter with the  $-3\text{dB}$  frequency set at

$$f_{-3\text{dB}} = 1/(2 \pi R_1 C_1) \quad (2)$$

The values for  $C_1$  and  $R_1$  are not critical in most applications and can be set freely. The values shown in Figure 3 correspond to a corner frequency of 1.6kHz.

Figure 4 depicts a circuit that can be used in single-supply applications. The mid-reference biases the op amp up to the appropriate common-mode voltage, for example  $V_{CM} = +1.5\text{V}$ . With the use of capacitor  $C_G$ , the DC gain for the non-inverting op amp input is set to  $+1\text{V/V}$ . As a result, the transfer function is modified to

$$V_{OUT} = V_{IN} \{(1 + R_F/R_G) + V_{CM}\} \quad (3)$$

Again, the input coupling capacitor  $C_1$  and resistor  $R_1$  form a high-pass filter. At the same time, the input impedance is defined by  $R_1$ . Resistor  $R_S$  isolates the op amp’s output from the capacitive load to avoid gain peaking or even oscillation. It can also be used to establish a defined bandwidth to reduce the wideband noise. Its value is usually between  $10\Omega$  and  $100\Omega$ .

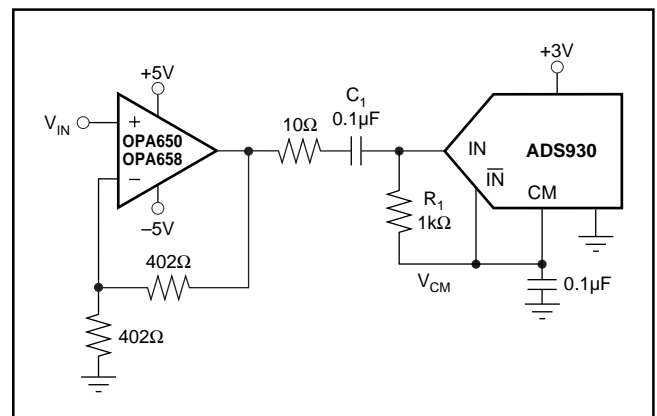


FIGURE 3. AC-Coupled Driver.

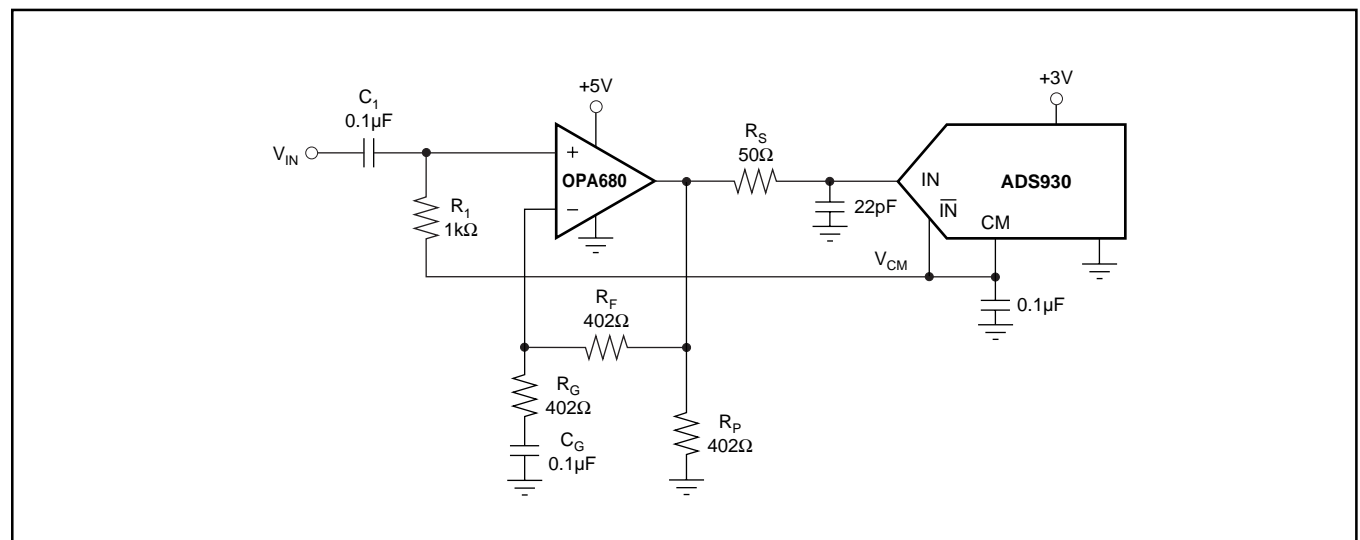


FIGURE 4. Interface Circuit Example Using the Voltage Feedback Amplifier OPA680.

## DC-COUPLED INTERFACE CIRCUIT

Figure 5 illustrates an example of a DC-coupled interface circuit using one high-speed op amp to level-shift the ground-referenced input signal. This serves to condition it for the input requirements of the ADS930. With a +3V supply the input signal swings 1Vp-p centered around a typical common-mode voltage of +1.5V. This voltage can be derived from the internal bottom reference (REFB) and then fed back through a resistor divider ( $R_1$ ,  $R_2$ ) to level-shift the driving op amp ( $A_1$ ). A capacitor across  $R_2$  will shunt most of the wideband noise to ground. Depending on the configured gain, the values of resistors  $R_1$  and  $R_2$  must be adjusted since the offsetting voltage ( $V_{OS}$ ) is amplified by the non-inverting gain,  $1 + (R_F/R_{IN})$ . This example assumes the sum of  $R_1$  and  $R_2$  to be  $5k\Omega$ , drawing only  $250\mu A$  from the bottom reference. Considerations for the selection of a proper op amp should include its output swing, input common-mode range, and bias current. This circuit can easily be modified for a +5V operation of the ADC, requiring a higher common-mode level (+2.5V).

## INTERNAL REFERENCE

The ADS930 features an internal reference that provides fixed reference voltages for the internal stages. As shown in

Figure 6, each end of the resistor ladder (REFT and REFB) are driven by a buffer amplifier. The ladder has a nominal resistance of  $4k\Omega$  ( $\pm 15\%$ ). The two outputs of the buffers are brought out at pin 21 (LpBy) and pin 25 (LnBy), primarily to connect external bypass capacitors, typically  $0.1\mu F$ . They will shunt the high frequency switching noise that is fed back into the reference circuit and improve the performance. The buffers can drive limited external loads, for example level-shifting of the converter's interface circuit. However, the current draw should be limited to approximately 1mA.

Derived from the top reference of +1.75V is an additional voltage of +1.0V. Note that this voltage, available on pin 23, is not buffered and care should be taken when external loads are applied. In normal operation, this pin is left unconnected and no bypassing components are required.

## CLOCK INPUT

The clock input of the ADS930 is designed to accommodate either +5V or +3V CMOS logic levels. To drive the clock input with a minimum amount of duty cycle variation and support the maximum sampling rate (30MSPS), high speed or advanced CMOS logic should be used (HC/HCT, AC/ACT). When digitizing at high sampling rates, a 50% duty cycle, along with fast rise and fall times (2ns or less),

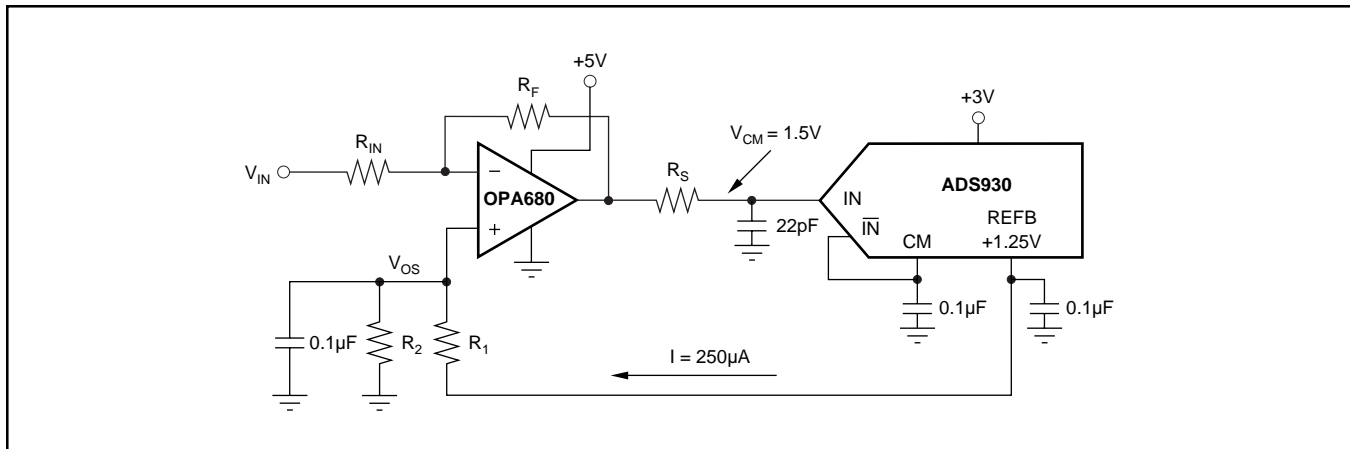


FIGURE 5. Single-supply, DC-coupled Interface Circuit.

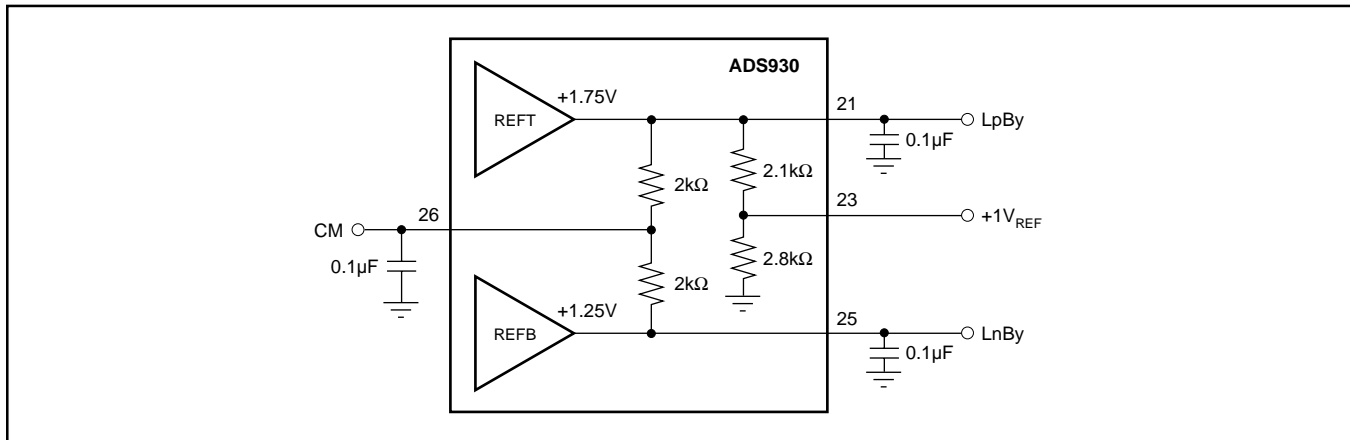


FIGURE 6. Internal Reference Structure and Recommended Reference Bypassing.

are recommended to meet the rated performance specifications. However, the ADS930 performance is tolerant to duty cycle variations of as much as  $\pm 10\%$ , which should not affect the performance. For applications operating with input frequencies up to Nyquist ( $f_{CLK}/2$ ) or undersampling applications, special considerations must be made to provide a clock with very low jitter. Clock jitter leads to aperture jitter ( $t_A$ ) which can be the ultimate limitation in achieving good SNR performance. The following equation shows the relationship between aperture jitter, input frequency and the signal-to-noise ratio:

$$SNR = 20 \log_{10} [1/(2 \pi f_{IN} t_A)] \quad (4)$$

| SINGLE-ENDED INPUT<br>( $\overline{IN} = 1.5V$ DC) | STRAIGHT OFFSET BINARY<br>(SOB)<br>PIN 12<br>FLOATING or LO |
|--|---|
| +FS ( $IN = +2V$ )                                 | 11111111  |
| +FS -1LSB  | 11111111  |
| +FS -2LSB  | 11111110  |
| +3/4 Full Scale                                    | 11100000  |
| +1/2 Full Scale                                    | 11000000  |
| +1/4 Full Scale                                    | 10100000  |
| +1LSB  | 10000001  |
| Bipolar Zero ( $IN +1.5V$ )                        | 10000000  |
| -1LSB  | 01111111  |
| -1/4 Full Scale                                    | 01100000  |
| -1/2 Full Scale                                    | 01000000  |
| -3/4 Full Scale                                    | 00100000  |
| -FS +1LSB  | 00000001  |
| -FS ( $IN = +1V$ )                                 | 00000000  |

TABLE I. Coding Table for the ADS930.

## DIGITAL OUTPUTS

There is a 5.0 clock cycle data latency from the start convert signal to the valid output data. The standard output coding is Straight Offset Binary where a full scale input signal corresponds to all “1”s at the output. The digital outputs of the ADS930 can be set to a high impedance state by driving the  $\overline{OE}$  (pin 16) with a logic “HI”. Normal operation is achieved with pin 16 “LO” or Floating due to internal pull-down resistors. This function is provided for testability purposes but is not recommended to be used dynamically.

The digital outputs of the ADS930 are standard CMOS stages and designed to be compatible to both high speed TTL and CMOS logic families. The logic thresholds are for low-voltage CMOS:  $V_{OL} = 0.4V$ ,  $V_{OH} = 2.4V$ , which allows the ADS930 to directly interface to 3V-logic. The digital output driver of the ADS930 uses a dedicated digital supply pin (pin 2,  $LV_{DD}$ ) see Figure 7. By adjusting the voltage on

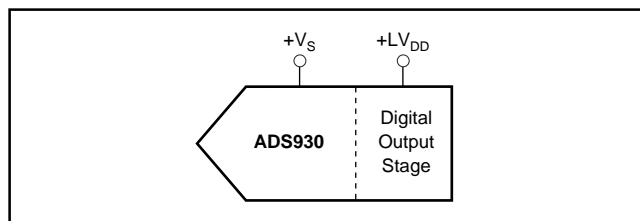


FIGURE 7. Independent Supply Connection for Output Stage.

$LV_{DD}$ , the digital output levels will vary respectively. It is recommended to limit the fan-out to one in order to keep the capacitive loading on the data lines below the specified 15pF. If necessary, external buffers or latches may be used to provide the added benefit of isolating the ADC from any digital activities on the bus coupling back high frequency noise which degrades the performance.

## POWER-DOWN MODE

The ADS930's low power consumption can be reduced even further by initiating a power-down mode. For this, the Power Down Pin (Pin 17) must be tied to a logic “High” reducing the current drawn from the supply by approximately 70%. In normal operation, the power-down mode is disabled by an internal pull-down resistor (50k $\Omega$ ).

During power-down, the digital outputs are set in 3-state. With the clock applied, the converter does not accurately process the sampled signal. After removing the power-down condition, the output data from the following 5 clock cycles is invalid (data latency).

## DECOUPLING AND GROUNDING CONSIDERATIONS

The ADS930 has several supply pins, one of which is dedicated to supply only the output driver ( $LV_{DD}$ ). The remaining supply pins are not divided into analog and digital supply pins since they are internally connected on the chip. For this reason, it is recommended that the converter be treated as an analog component and to power it from the analog supply only. Digital supply lines often carry high levels of noise which can couple back into the converter and limit performance.

Because of the pipeline architecture, the converter also generates high frequency transients and noise that are fed back into the supply and reference lines. This requires that the supply and reference pins be sufficiently bypassed. Figure 8 shows the recommended decoupling scheme for the analog supplies. In most cases 0.1 $\mu$ F ceramic chip capacitors are adequate to keep the impedance low over a wide frequency range. Their effectiveness largely depends on the proximity to the individual supply pin. Therefore, they should be located as close as possible to the supply pins.

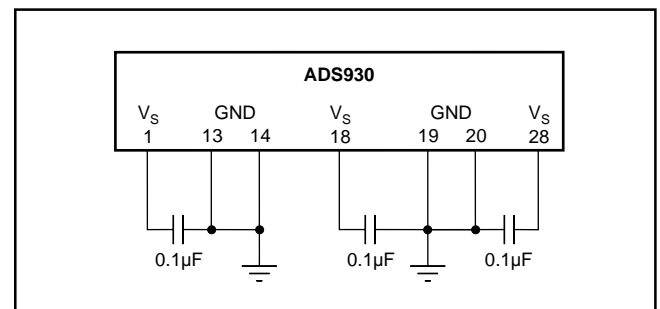


FIGURE 8. Recommended Bypassing for Analog Supply Pins.

**PACKAGING INFORMATION**

| Orderable part number      | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|----------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">ADS930E</a>    | Last Time Buy | Production           | SSOP (DB)   28 | 50   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ADS930E             |
| ADS930E.B                  | Last Time Buy | Production           | SSOP (DB)   28 | 50   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 85    | ADS930E             |
| <a href="#">ADS930E/1K</a> | Active        | Production           | SSOP (DB)   28 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | ADS930E             |
| ADS930E/1K.B               | Active        | Production           | SSOP (DB)   28 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | ADS930E             |
| ADS930E/1KG4               | Active        | Production           | SSOP (DB)   28 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | ADS930E             |
| ADS930E/1KG4.B             | Active        | Production           | SSOP (DB)   28 | 1000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 85    | ADS930E             |

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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**TUBE**


\*All dimensions are nominal

| Device    | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-----------|--------------|--------------|------|-----|--------|--------|--------|--------|
| ADS930E   | DB           | SSOP         | 28   | 50  | 530    | 10.5   | 4000   | 4.1    |
| ADS930E.B | DB           | SSOP         | 28   | 50  | 530    | 10.5   | 4000   | 4.1    |

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