SBAS068B – JANUARY 1997 – REVISED AUGUST 2002

12-Bit, 10MHz Sampling ANALOG-TO-DIGITAL CONVERTER

FEATURES

- HIGH SFDR: 80dB at NYQUIST
- HIGH SNR: 69dB
- LOW POWER: 180mW
- LOW DLE: ±0.3LSB
- FLEXIBLE INPUT RANGE
- OVERRANGE INDICATOR

APPLICATIONS

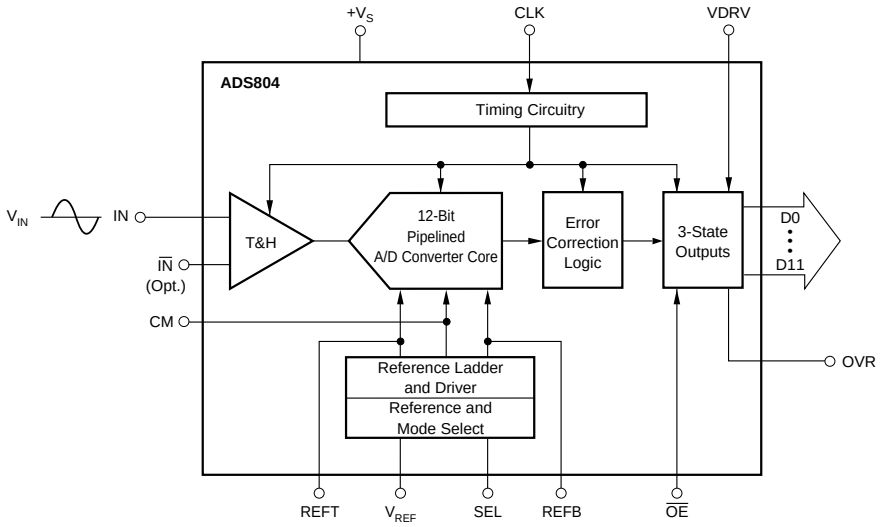
- IF AND BASEBAND DIGITIZATION
- CCD IMAGING
- SCANNERS
- TEST INSTRUMENTATION

DESCRIPTION

The ADS804 is a high-speed, high dynamic range, 12-bit, pipelined Analog-to-Digital (A/D) converter. This converter includes a high-bandwidth track-and-hold that gives excellent spurious performance up to and beyond the Nyquist rate. This high-bandwidth, linear track-and-hold minimizes harmonics and has low jitter, leading to excellent SNR performance. The ADS804 is also pin-compatible with the 5MHz ADS803 and the 20MHz ADS805.

The ADS804 provides an internal reference and can be programmed for a 2Vp-p input range for the best spurious performance and ease of driving. Alternatively, the 5Vp-p input range can be used for the lowest input referred noise of 0.09LSBs rms giving superior imaging performance. There is also a capability to set the input range in between the 2Vp-p and 5Vp-p input ranges or to use external reference. The ADS804 also provides an over-range indicator flag to indicate an input range that exceeds the full-scale input range of the converter. This flag can be used to reduce the gain of the front end gain-ranging circuitry.

The ADS804 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 communications, medical imaging, video, and test instrumentation applications. The ADS804 is available in a SSOP-28 package.



ABSOLUTE MAXIMUM RATINGS[1]

$+V_S$, VDRV	+6V
Analog Input	(–0.3V) to ($+V_S$ + 0.3V)
Logic Input	(–0.3V) to ($+V_S$ + 0.3V)
Case Temperature	+100°C
Junction Temperature	+150°C
Storage Temperature	+150°C

NOTE: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability.

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-LEAD	PACKAGE DESIGNATOR[1]	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
ADS804	SSOP-28	DB	–40°C to +85°C	ADS804E	ADS804E	Rails, 48
"	"	"	"	"	ADS804E/1K	Tape and Reel, 1000

NOTE: (1) For the most current specifications and package information, refer to our web site at www.ti.com.

ELECTRICAL CHARACTERISTICS

At T_A = full specified temperature range, V_S = +5V, specified input range = 1.5V to 3.5V, single-ended input, and sampling rate = 5MHz, unless otherwise specified.

PARAMETER	CONDITIONS	ADS804E MIN	ADS804E TYP	ADS804E MAX	UNITS
RESOLUTION			12		Bits
SPECIFIED TEMPERATURE RANGE			–40 to +85		°C
CONVERSION CHARACTERISTICS					
Sample Rate		10k		10M	Samples/s
Data Latency			6		Clk Cycles
ANALOG INPUT					
Single-Ended Input Range		1.5		3.5	V
Single-Ended Input Range (Optional)		0		5	V
Common-Mode Voltage			+2.5		V
Input Impedance			1.25 || 16		MΩ || pF
Track-Mode Input Bandwidth	–3dBFS Input		270		MHz
DYNAMIC CHARACTERISTICS					
Differential Linearity Error (Largest Code Error)					
f = 500kHz			±0.3	±0.75	LSB
No Missing Codes			Tested		
Spurious-Free Dynamic Range[1]					
f = 4.8MHz		73	80		dBFS
2-Tone Intermodulation Distortion[3]					
f = 3.5MHz and 4.0MHz (–7dBFS each tone)			76		dBc
Signal-to-Noise Ratio (SNR)					
f = 4.8MHz		66.5	69		dBFS
Signal-to-(Noise + Distortion) (SINAD)					
f = 4.8MHz		65	68		dBFS
Effective Number of Bits at 4.8MHz[4]			11		Bits
Input Referred Noise	0V to 5V Input		0.09		LSBs rms
	1.5V to 3.5V Input		0.23		LSBs rms
Integral Nonlinearity Error					
f = 500kHz			±1	±2	LSB
Aperture Delay Time			1		ns
Aperture Jitter			4		ps rms
Over-Voltage Recovery Time	1.5 • FS Input		2		ns
Full-Scale Step Acquisition Time			30		ns

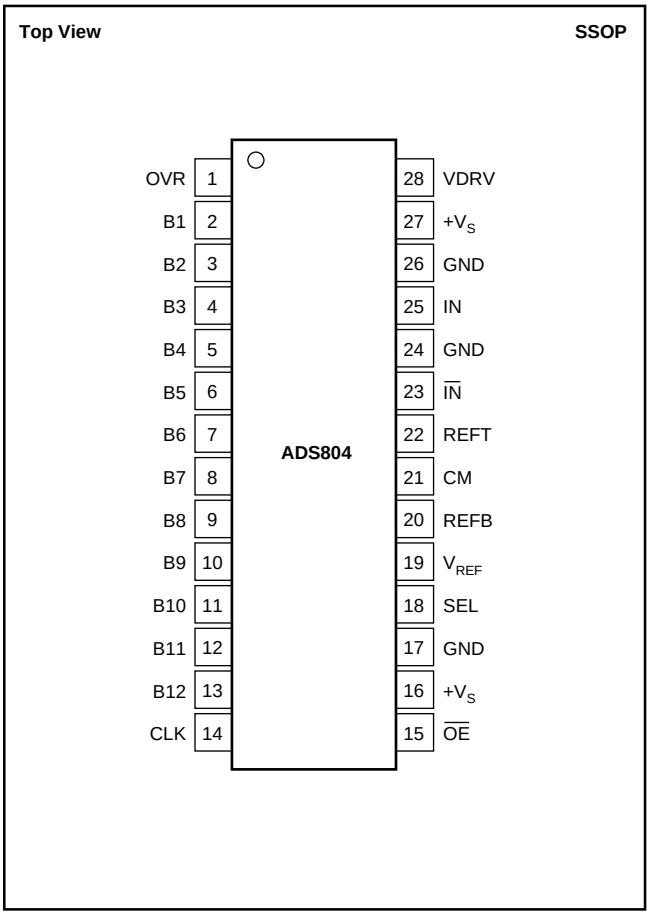
ELECTRICAL CHARACTERISTICS (Cont.)

At T_A = full specified temperature range, V_S = +5V, specified single-ended input range = 1.5V to 3.5V, and sampling rate = 10MHz, unless otherwise specified.

PARAMETER	CONDITIONS	ADS804E MIN	ADS804E TYP	ADS804E MAX	UNITS
DIGITAL INPUTS					
Logic Family			CMOS Compatible		
Convert Command	Start Conversion		Rising Edge of Convert Clock		
High Level Input Current (V_{IN} = 5V)[5]				100	µA
Low Level Input Current (V_{IN} = 0V)				10	µA
High Level Input Voltage		+3.5			V
Low Level Input Voltage				+1.0	V
Input Capacitance			5		pF
DIGITAL OUTPUTS					
Logic Family			CMOS/TTL Compatible		
Convert Command			Straight Offset Binary		
Output Voltages, V_{DRV} = +5V					
Low Level	I_{OL} = 50µA			+0.1	V
High Level	I_{OH} = 50µA	±4.6			V
Low Level	I_{OL} = 1.6mA			+0.4	V
High Level	I_{OH} = 0.5mA	±2.4			V
Output Voltages, V_{DRV} = +3V					
Low Level	I_{OL} = 50µA			+0.1	V
High Level	I_{OH} = 50µA	+2.5			V
3-State Enable Time	$\overline{OE}$ = L		20	40	ns
3-State Disable Time	$\overline{OE}$ = H		2	10	ns
Output Capacitance			5		pF
ACCURACY (5Vp-p Input Range)	f_S = 2.5MHz				
Zero Error (Referred to –FS)	At 25°C		0.2	±1.5	%FS
Zero Error Drift			±5		ppm/°C
Gain Error[6]	At 25°C			±2.0	%FS
Gain Error Drift[6]			±15		ppm/°C
Gain Error[7]	At 25°C			±1.5	%FS
Gain Error Drift[7]			±15		ppm/°C
Power-Supply Rejection of Gain	ΔV_S = ±5%	60	82		dB
Reference Input Resistance			1.6		kΩ
Internal Voltage Reference Tolerance (V_{REF} = 2.5V)	At 25°C			±35	mV
Internal Voltage Reference Tolerance (V_{REF} = 1.0V)	At 25°C			±14	mV
POWER-SUPPLY REQUIREMENTS					
Supply Voltage: $+V_S$		+4.7	+5.0	+5.3	V
Supply Current: $+I_S$			36	40	mA
Power Dissipation			180	200	mW
Thermal Resistance, θ_{JA}					
SSOP-28			50		°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) 2-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 2-tone fundamental envelope. (4) Effective number of bits (ENOB) is defined by (SINAD – 1.76)/6.02. (5) Internal 50kΩ pull-down resistor. (6) Includes internal reference. (7) Excludes internal reference.

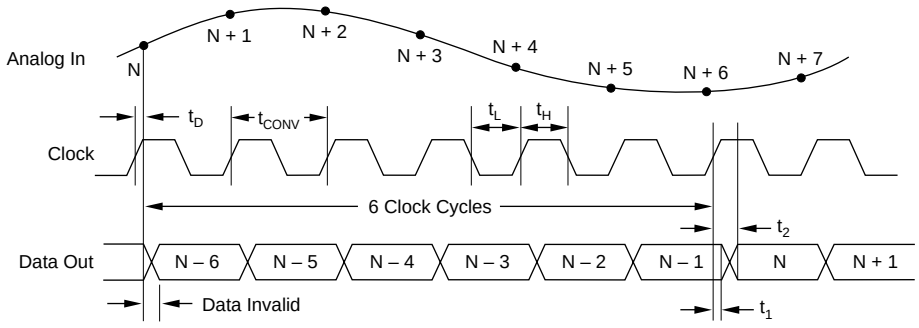
PIN CONFIGURATION



PIN DESCRIPTIONS

PIN	DESIGNATOR	DESCRIPTION
1	OVR	Over-Range Indicator (See Application Section)
2	B1	Data Bit 1(D11) (MSB)
3	B2	Data Bit 2 (D10)
4	B3	Data Bit 3 (D9)
5	B4	Data Bit 4 (D8)
6	B5	Data Bit 5 (D7)
7	B6	Data Bit 6 (D6)
8	B7	Data Bit 7 (D5)
9	B8	Data Bit 8 (D4)
10	B9	Data Bit 9 (D3)
11	B10	Data Bit 10 (D2)
12	B11	Data Bit 11 (D1)
13	B12	Data Bit 12 (D0) (LSB)
14	CLK	Convert Clock Input
15	$\overline{OE}$	Output Enable. H = High Impedance State. L = Low or floating, normal operation (Internal pull-down resistor).
16	$+V_S$	+5V Supply
17	GND	Ground
18	SEL	Input Range Select (See Application Section)
19	V_{REF}	Reference Voltage Select (I/O)
20	REFB	Bottom Reference
21	CM	Common-Mode Voltage
22	REFT	Top Reference
23	$\overline{IN}$	Analog Input (–)
24	GND	Ground
25	IN	Analog Input (+)
26	GND	Ground
27	$+V_S$	+5V Supply
28	VDRV	Output Driver Voltage (See Application Section)

TIMING DIAGRAM

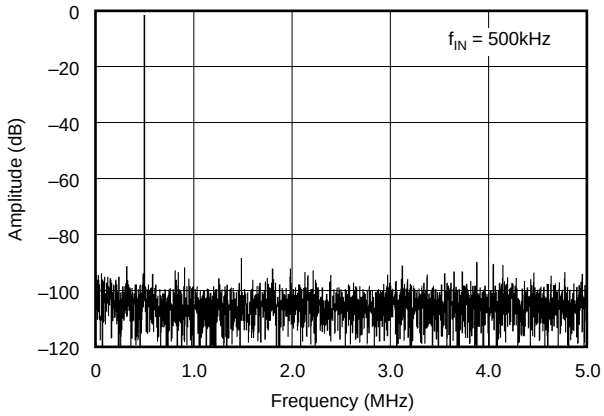


SYMBOL	DESCRIPTION	MIN	TYP	MAX	UNITS
t_{CONV}	Convert Clock Period	100		100µs	ns
t_L	Clock Pulse LOW	48	49		ns
t_H	Clock Pulse HIGH	48	49		ns
t_D	Aperture Delay		2		ns
t_1	Data Hold Time, C_L = 0pF	3.9			ns
t_2	New Data Delay Time, C_L = 15pF max			12	ns

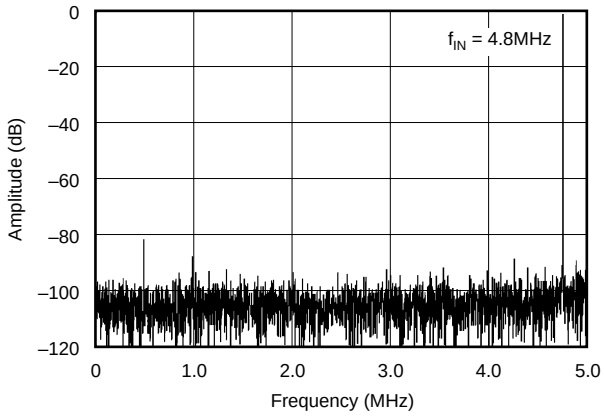
TYPICAL CHARACTERISTICS

At T_A = full specified temperature range, V_S = +5V, specified single-ended input range = 1.5V to 3.5V, and sampling rate = 10MHz, unless otherwise specified.

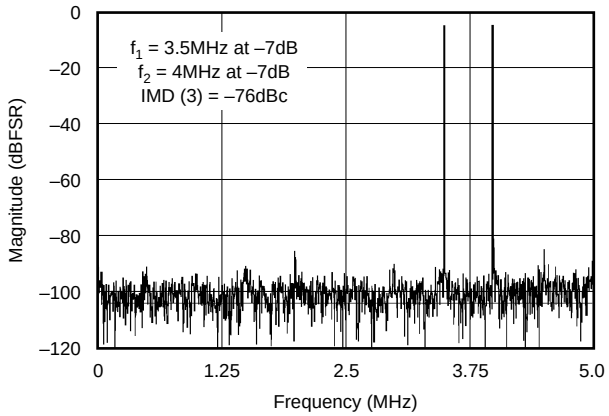
SPECTRAL PERFORMANCE



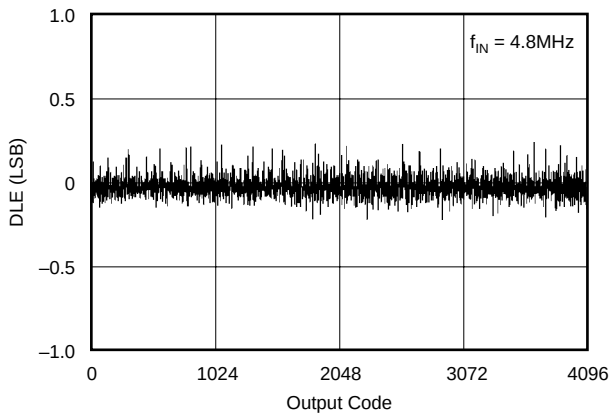
SPECTRAL PERFORMANCE



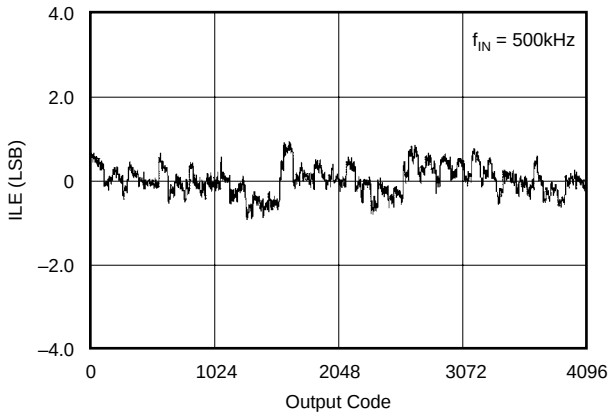
2-TONE INTERMODULATION



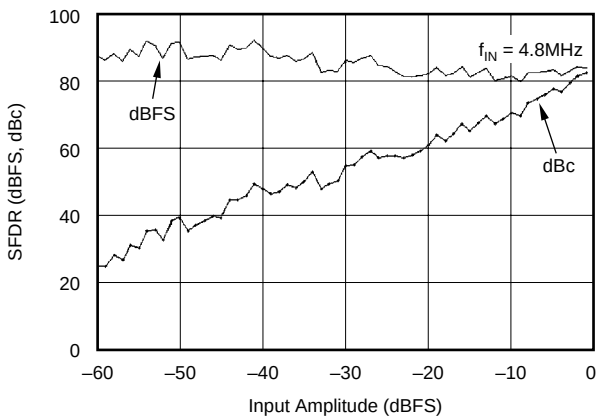
DIFFERENTIAL LINEARITY ERROR



INTEGRAL LINEARITY ERROR



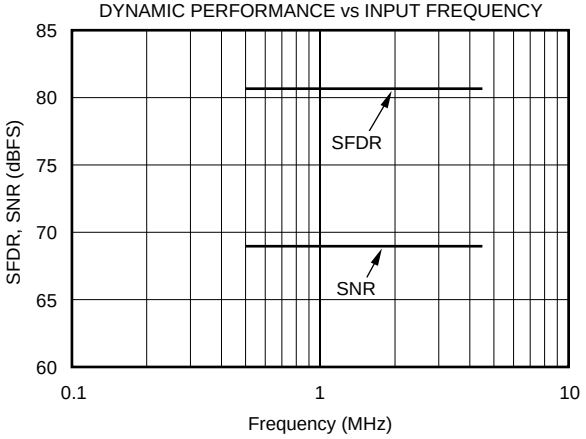
SWEPT POWER SFDR



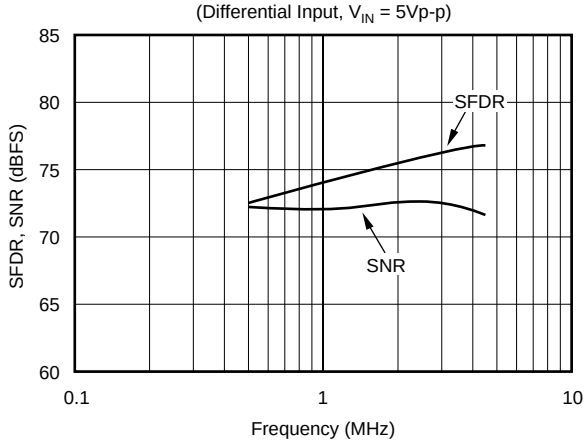
TYPICAL CHARACTERISTICS (Cont.)

At T_A = full specified temperature range, V_S = +5V, specified single-ended input range = 1.5V to 3.5V, and sampling rate = 10MHz, unless otherwise specified.

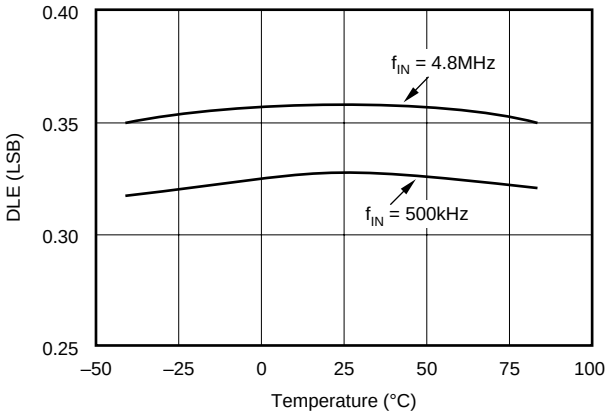
DYNAMIC PERFORMANCE vs INPUT FREQUENCY



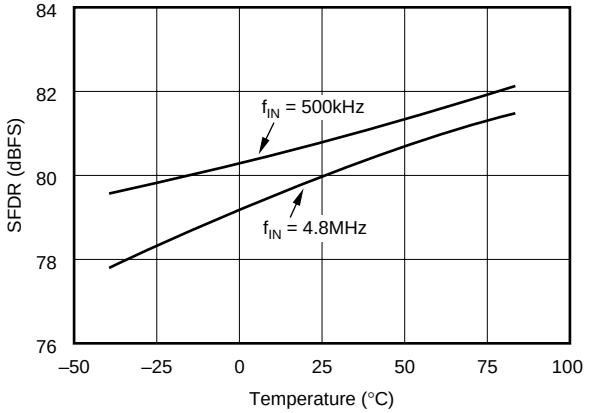
DYNAMIC PERFORMANCE vs INPUT FREQUENCY
(Differential Input, V_{IN} = 5Vp-p)



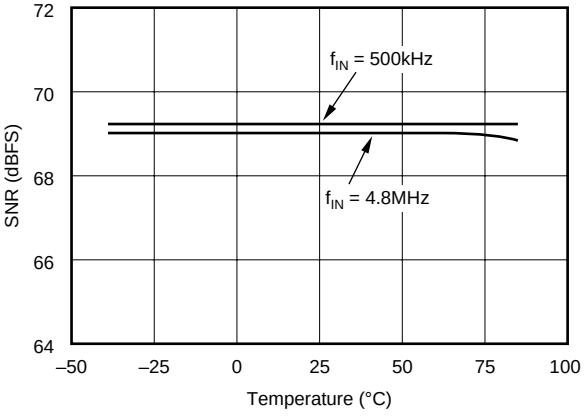
DIFFERENTIAL LINEARITY vs TEMPERATURE



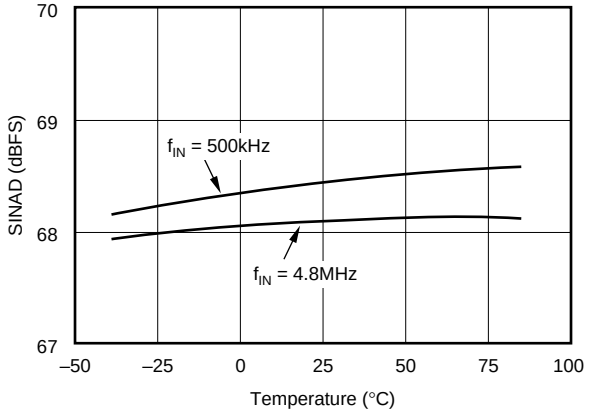
SPURIOUS-FREE DYNAMIC RANGE
vs TEMPERATURE



SIGNAL-TO-NOISE RATIO vs TEMPERATURE



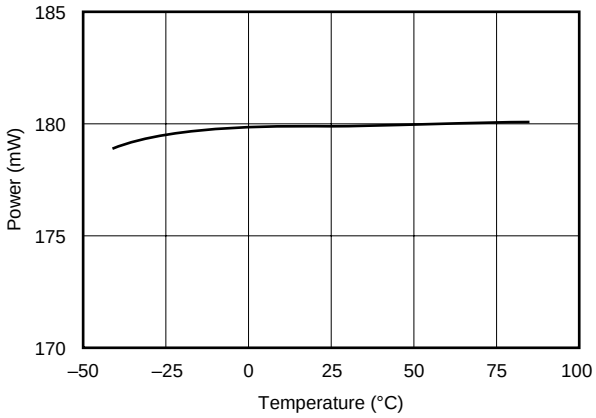
SIGNAL-TO-(NOISE + DISTORTION)
vs TEMPERATURE



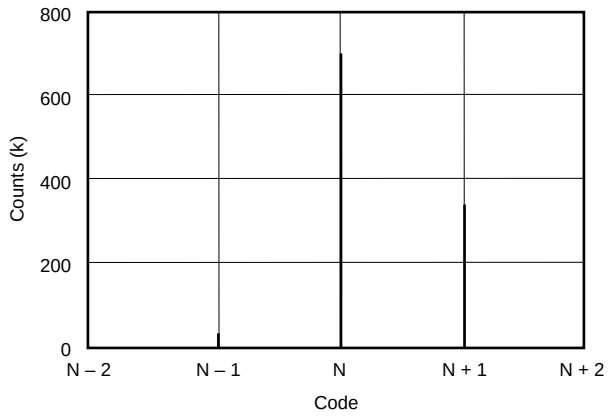
TYPICAL CHARACTERISTICS (Cont.)

At T_A = full specified temperature range, V_S = +5V, specified single-ended input range = 1.5V to 3.5V, and sampling rate = 10MHz, unless otherwise specified.

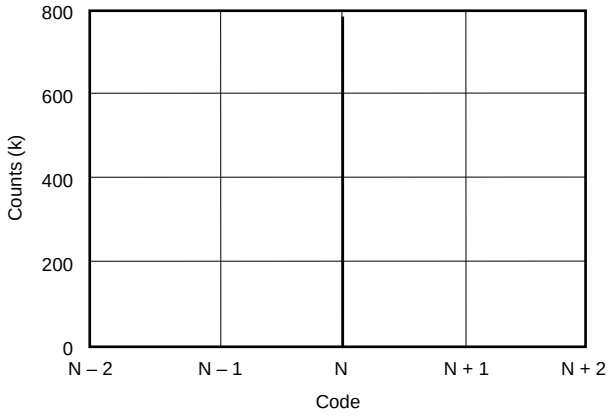
POWER DISSIPATION vs TEMPERATURE



OUTPUT NOISE HISTOGRAM (DC INPUT)



OUTPUT NOISE HISTOGRAM
(DC Input, V_{IN} = 5Vp-p Range)



APPLICATION INFORMATION

DRIVING THE ANALOG INPUT

The ADS804 allows its analog inputs to be driven either single-ended or differentially. The focus of the following discussion is on the single-ended configuration. Typically, its implementation is easier to achieve, and the rated specifications for the ADS804 are characterized using the single-ended mode of operation.

AC-COUPLED INPUT CONFIGURATION

Given in Figure 1 is the circuit example of the most common interface configuration for the ADS804. With the V_{REF} pin connected to the SEL pin, the full-scale input range is defined to be 2Vp-p. This signal is ac-coupled in single-ended form to the ADS804 using the low distortion voltage- feedback amplifier OPA642. As is generally necessary for single-supply components, operating the ADS804 with a full-scale input signal swing requires a level-shift of the amplifier's zero-centered analog signal to comply with the A/D converters input range requirements. Using a DC blocking capacitor between the output of the driving amplifier and the converter's input, a simple level-shifting scheme can be implemented. In this configuration, the top and bottom references (REFT, REFB) provide an output voltage of +3V and +2V, respectively. Here, two resistor pairs (2 • 2kΩ) are used to create a common-mode voltage of approximately +2.5V to bias the inputs of the ADS804 (IN, $\overline{IN}$) to the required DC voltage.

An advantage of ac-coupling is that the driving amplifier still operates with a ground-based signal swing. This will keep the distortion performance at its optimum since the signal swing stays within the linear region of the op amp and sufficient headroom to the supply rails can be maintained. Consider using the inverting gain configuration to eliminate CMR induced errors of the amplifier. The addition of a small series resistor (R_S) between the output of the op amp and the input of the ADS804 will be beneficial in almost all interface configurations. This will decouple the op amp's output from the capacitive load and avoid gain peaking, which can result in increased noise. For best spurious and distortion performance, the resistor value should be kept below 100Ω. Furthermore, the series resistor together with the 100pF capacitor establish a passive low-pass filter, limiting the bandwidth for the wideband noise thus, help improving the SNR performance.

DC-COUPLED WITHOUT LEVEL SHIFT

In some applications the analog input signal may already be biased at a level which complies with the selected input range and reference level of the ADS804. In this case, it is only necessary to provide an adequately low source impedance to the selected input, IN or $\overline{IN}$. Always consider wideband op amps since their output impedance will stay low over a wide range of frequencies. For those applications requiring the driving amplifier to provide a signal amplification, with a gain ≥ 3, consider using the decompensated voltage feedback op amp OPA643.

DC-COUPLED WITH LEVEL SHIFT

Several applications may require that the bandwidth of the signal path include DC, in which case the signal has to be DC-coupled to the A/D converter. In order to accomplish this, the interface circuit has to provide a DC-level shift. See the circuit of Figure 2 which employs an op amp, to sum the ground-centered input signal with a required DC offset. The ADS804 typically operates with a +2.5V common-mode voltage, which is established at the center tap of the ladder and connected to the $\overline{IN}$ input of the converter. Amplifier A1 operates in inverting configuration. Here resistors R_1 and R_2 set the DC-bias level for A1. Because of the op amp's noise gain of +2V/V, assuming $R_F = R_{IN}$, the DC offset voltage applied to its noninverting input has to be divided down to +1.25V, resulting in a DC output voltage of +2.5V.

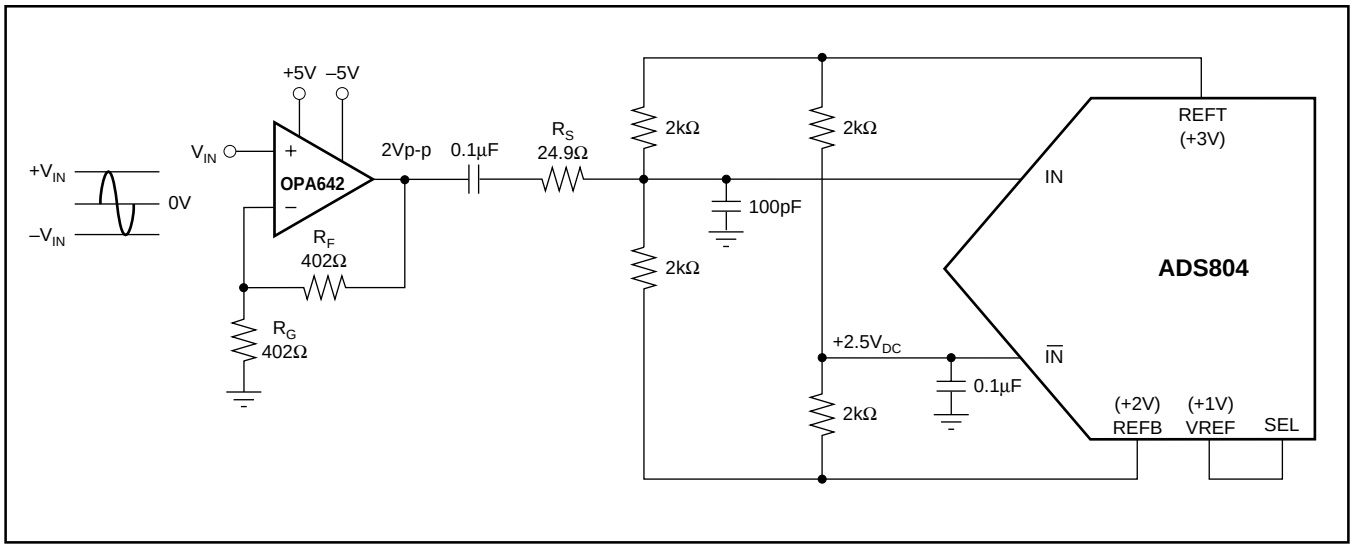


FIGURE 1. AC-Coupled Input Configuration for 2Vp-p Input Swing and Common-Mode Voltage at +2.5V Derived from Internal Top and Bottom Reference.

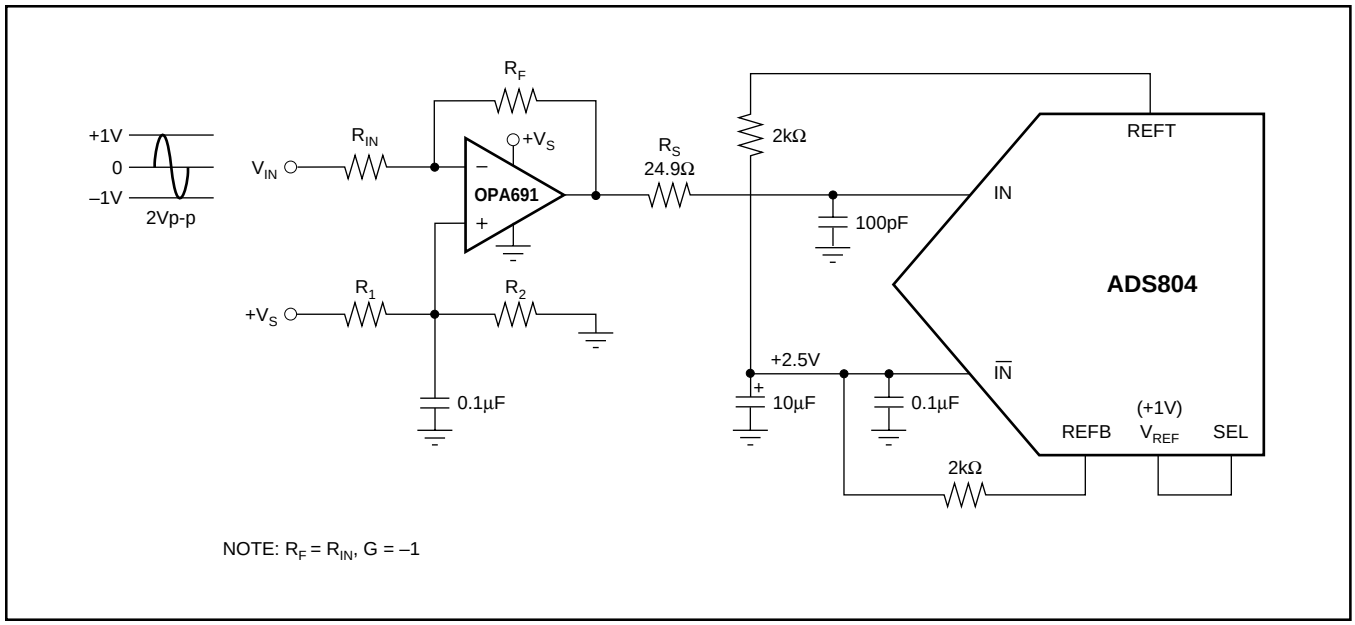


FIGURE 2. DC-Coupled, Single-Ended Input Configuration with DC-Level Shift.

DC voltage differences between the IN and $\overline{IN}$ inputs of the ADS804 effectively will produce an offset, which can be corrected for by adjusting the values of resistors R_1 and R_2. The bias current of the op amp may also result in an undesired offset. The selection criteria of the appropriate op amp should include the input bias current, output voltage swing, distortion, and noise specification. Note that in this example the overall signal phase is inverted. To re-establish the original signal polarity it is always possible to interchange the IN and $\overline{IN}$ connections.

SINGLE-ENDED-TO-DIFFERENTIAL CONFIGURATION (TRANSFORMER COUPLED)

In order to select the best suited interface circuit for the ADS804, the performance requirements must be known. If an ac-coupled input is needed for a particular application, the next step is to determine the method of applying the signal; either single-ended or differentially. The differential input configuration may provide a noticeable advantage of achieving good SFDR performance based on the fact that in the differential mode, the signal swing can be reduced to half of the swing required for single-ended drive. Secondly, by driving the ADS804 differentially, the even-order harmonics will be reduced. Figure 3 shows the schematic for the suggested transformer-coupled interface circuit. The resistor across the secondary side (R_T) should be set to get an input impedance match (e.g., $R_T = n^2 \bullet R_G$).

REFERENCE OPERATION

Integrated into the ADS804 is a bandgap reference circuit including logic that provides either a +1V or +2.5V reference output, by simply selecting the corresponding pin-strap configuration. Different reference voltages can be generated by the use of two external resistors, which will set a different

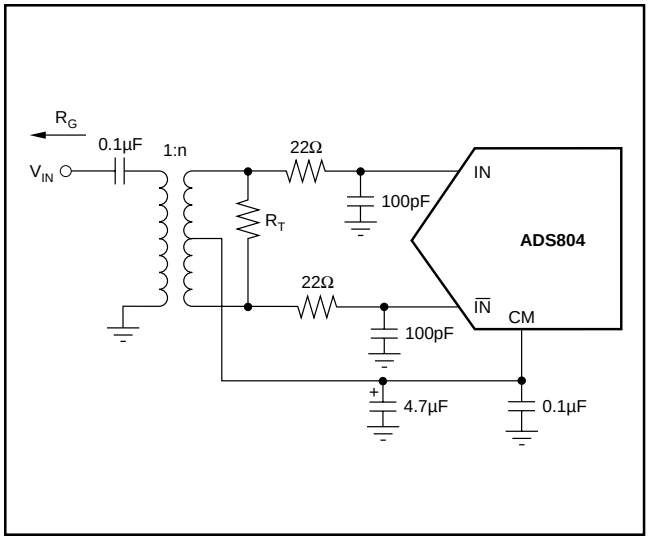


FIGURE 3. Transformer-Coupled Input.

gain for the internal reference buffer. For more design flexibility, the internal reference can be shut off and an external reference voltage used. Table I provides an overview of the possible reference options and pin configurations.

MODE	INPUT FULL-SCALE RANGE	REQUIRED V_{REF}	CONNECT	TO
Internal	2Vp-p	+1V	SEL	V_{REF}
Internal	5Vp-p	+2.5V	SEL	GND
Internal	2V ≤ FSR < 5V FSR = 2 • V_{REF}	1V < V_{REF} < 2.5V $V_{REF} = 1 + (R_1/R_2)$	R_1 R_2	V_{REF} and SEL SEL and Gnd
External	1V < FSR < 5V	0.5V < V_{REF} < 2.5V	SEL V_{REF}	$+V_S$ Ext. V_{REF}

TABLE I. Selected Reference Configuration Examples.

A simple model of the internal reference circuit is shown in Figure 4. The internal blocks are a 1V-bandgap voltage reference, buffer, the resistive reference ladder, and the drivers for the top and bottom reference which supply the necessary current to the internal nodes. As shown, the output of the buffer appears at the V_{REF} pin. The full-scale input span of the ADS804 is determined by the voltage at V_{REF}, according to equation (1):

$$\text{Full-Scale Input Span} = 2 \bullet V_{REF} \quad (1)$$

Note that the current drive capability of this amplifier is limited to about 1mA and should not be used to drive low loads. The programmable reference circuit is controlled by the voltage applied to the select pin (SEL). Refer to Table I for an overview.

The top reference (REFT) and the bottom reference (REFB) are brought out mainly for external bypassing. For proper operation with all reference configurations, it is necessary to provide solid bypassing to the reference pins in order to keep the clock feedthrough to a minimum. Figure 5 shows the recommended decoupling network.

In addition, the common-mode voltage (CMV) may be used as a reference level to provide the appropriate offset for the driving circuitry. However, care must be taken not to appreciably load this node, which is not buffered and has a high impedance. An alternate method of generating a common-mode voltage is given in Figure 6. Here, two external precision resistors (tolerance 1% or better) are located between the top and bottom reference pins. The common-mode level will appear at the midpoint. The output buffers of the top and bottom reference are designed to supply approximately 2mA of output current.

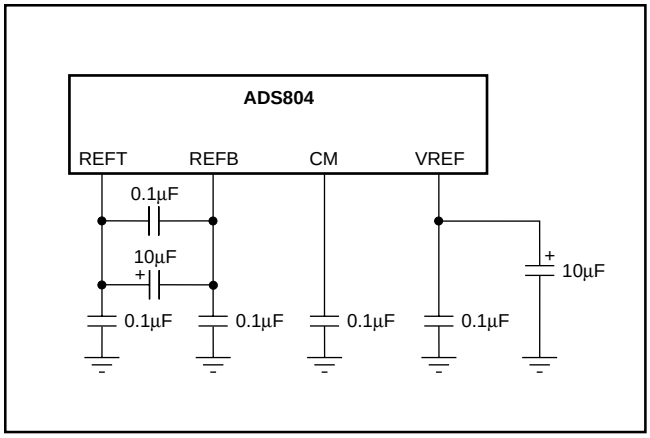


FIGURE 5. Recommended Reference Bypassing Scheme.

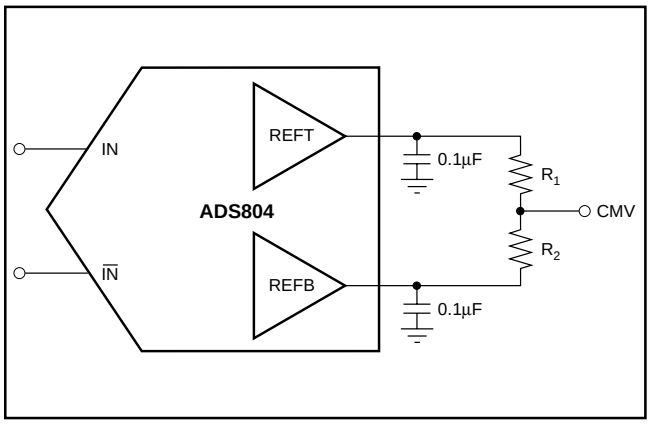


FIGURE 6. Alternative Circuit to Generate Common-Mode Voltage.

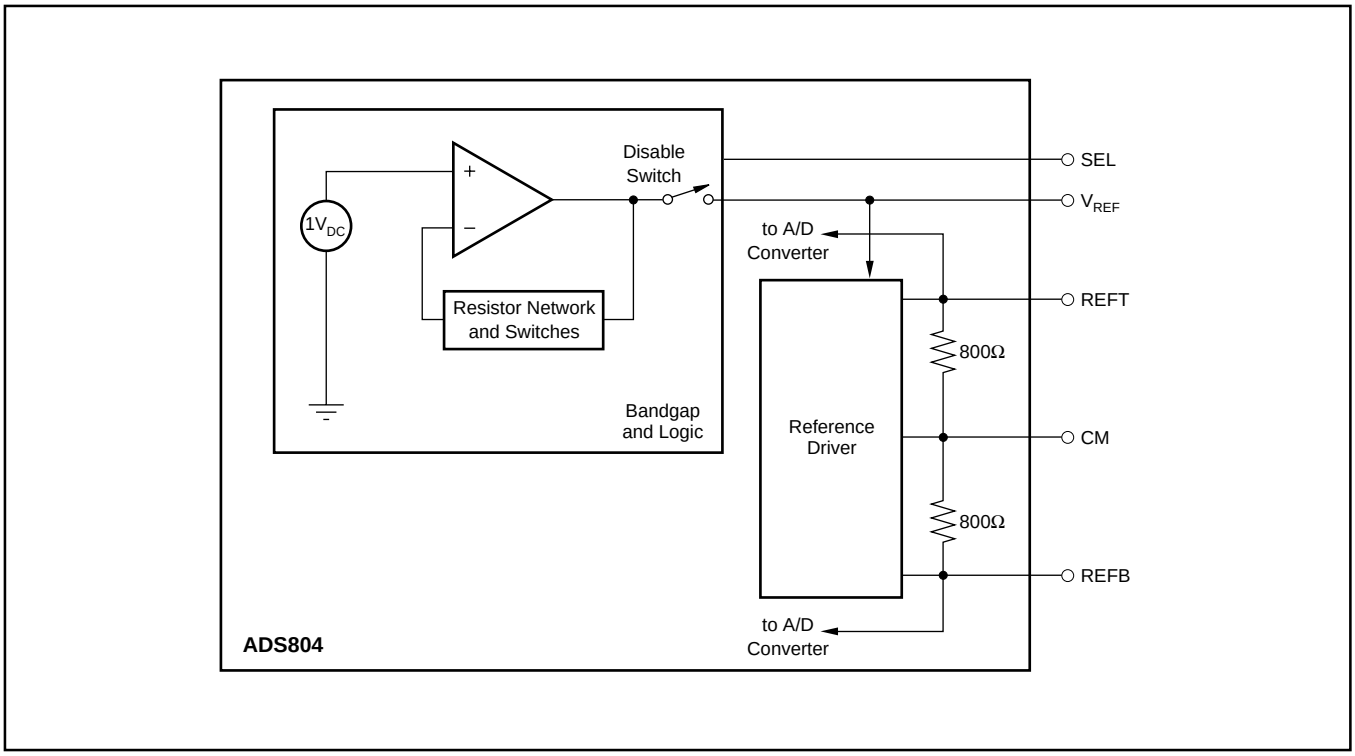


FIGURE 4. Equivalent Reference Circuit.

SELECTING THE INPUT RANGE AND REFERENCE

Figures 7 through 9 show a selection of circuits for the most common input ranges when using the internal reference of the ADS804. All examples are for single-ended input and operate with a nominal common-mode voltage of +2.5V.

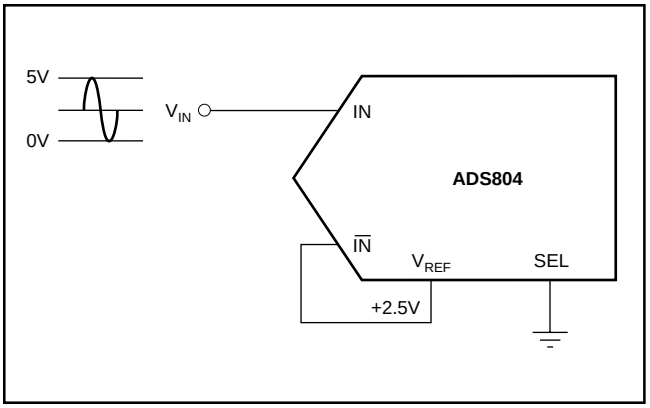


FIGURE 7. Internal Reference with 0V to 5V Input Range.

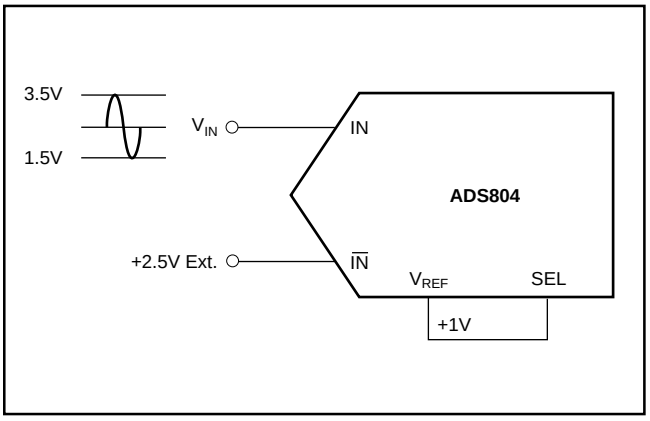


FIGURE 8. Internal Reference with 1.5V to 3.5V Input Range.

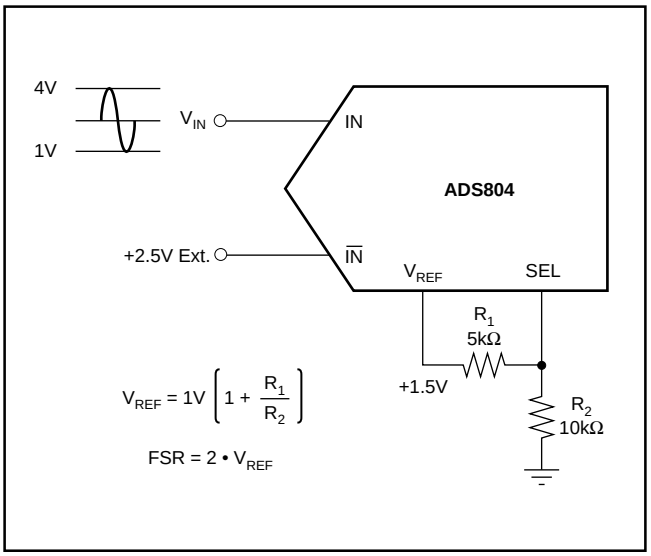


FIGURE 9. Internal Reference with 1V to 4V Input Range.

EXTERNAL REFERENCE OPERATION

Depending on the application requirements, it might be advantageous to operate the ADS804 with an external reference. This may improve the DC accuracy if the external reference circuitry is superior in its drift and accuracy. To use the ADS804 with an external reference, the user must disable the internal reference (as shown in Figure 10). By connecting the SEL pin to $+V_S$, the internal logic will shut down the internal reference. At the same time, the output of the internal reference buffer is disconnected from the V_{REF} pin, which now must be driven with the external reference. Note that a similar bypassing scheme should be maintained as described for the internal reference operation.

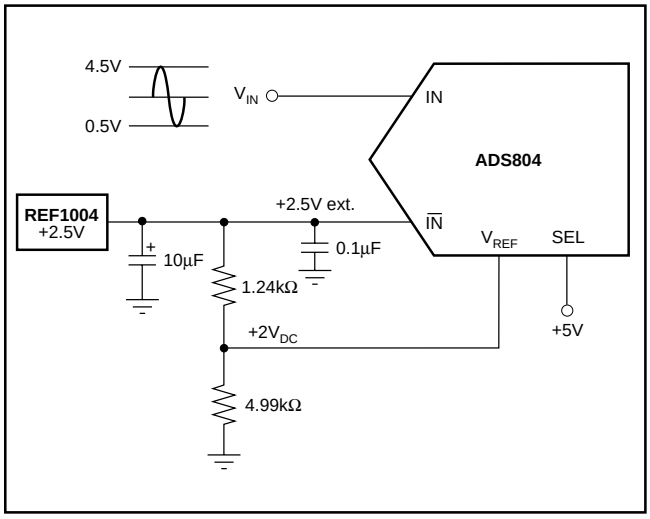


FIGURE 10. External Reference, Input Range 0.5V to 4.5V (4Vp-p), with +2.5V Common-Mode Voltage.

DIGITAL INPUTS AND OUTPUTS

Over-Range (OVR)

One feature of the ADS804 is its 'Over-Range' digital output (OVR). This pin can be used to monitor any out-of-range condition, which occurs every time the applied analog input voltage exceeds the input range (set by V_{REF}). The OVR output is LO when the input voltage is within the defined input range. It becomes HI when the input voltage is beyond the input range. This is the case when the input voltage is either below the bottom reference voltage or above the top reference voltage. OVR will remain active until the analog input returns to its normal signal range and another conversion is completed. Using the MSB and its complement in conjunction with OVR a simple clue logic can be built that detects the over-range and under-range conditions, (see Figure 11). It should be noted that OVR is a digital output which is updated along with the bit information corresponding to the particular sampling incidence of the analog signal. Therefore, the OVR data is subject to the same pipeline delay (latency) as the digital data.

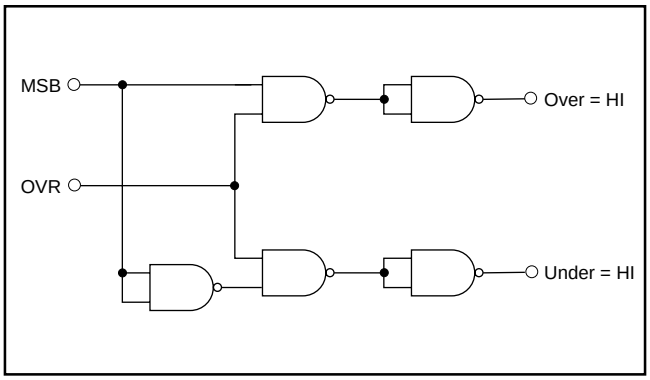


FIGURE 11. External Logic for Decoding Under- and Over-range Conditions.

CLOCK INPUT REQUIREMENTS

Clock jitter is critical to the SNR performance of high speed, high resolution A/D converters. It leads to aperture jitter (t_A) which adds noise to the signal being converted. The ADS804 samples the input signal on the rising edge of the CLK input. Therefore, this edge should have the lowest possible jitter. The jitter noise contribution to total SNR is given by the following equation. If this value is near your system requirements, input clock jitter must be reduced.

$$\text{JitterSNR} = 20\log\frac{1}{2\pi f_{IN} t_A}\ \text{rms signal to rms noise}$$

Where: f_{IN} is Input Signal Frequency

t_A is rms Clock Jitter

Particularly in undersampling applications, special consideration should be given to clock jitter. The clock input should be treated as an analog input in order to achieve the highest level of performance. Any overshoot or undershoot of the clock signal may cause degradation of the performance. When digitizing at high sampling rates, the clock should have a 50% duty cycle ($t_H = t_L$), along with fast rise and fall times of 2ns or less.

DIGITAL OUTPUTS

The digital outputs of the ADS804 are designed to be compatible with both high-speed TTL and CMOS logic families. The driver stage for the digital outputs is supplied through a separate supply pin, VDRV, which is not connected to the analog supply pins. By adjusting the voltage on VDRV, the digital output levels will vary respectively. Therefore, it is possible to operate the ADS804 on a +5V analog supply while interfacing the digital outputs to 3V logic.

It is recommended to keep the capacitive loading on the data lines as low as possible (≤ 15pF). Larger capacitive loads demand higher charging currents as the outputs are changing. Those high current surges can feed back to the analog portion of the ADS804 and influence the performance. If necessary, external buffers or latches may be used which provide the added benefit of isolating the ADS804 from any digital noise activities on the bus coupling back high frequency noise. In addition, resistors in series with each data line may help maintain the ac performance of the ADS804. Their use depends on the capacitive loading seen by the converter. Values in the range of 100Ω to 200Ω will limit the instantaneous current the output stage has to provide for recharging the parasitic capacitances, as the output levels change from LO-to-HI or HI-to-LO.

GROUNDING AND DECOUPLING

Proper grounding and bypassing, short lead length, and the use of ground planes are particularly important for high-frequency designs. Multi-layer PC boards are recommended for best performance since they offer distinct advantages like minimizing ground impedance, separation of signal layers by ground layers, etc. It is recommended that the analog and digital ground pins of the ADS804 be joined together at the IC and be connected only to the analog ground of the system.

The ADS804 has analog and digital supply pins, however, the converter should be treated as an analog component and all supply pins should be powered by the analog supply. This will ensure the most consistent results, since digital supply lines often carry high levels of noise that would otherwise be coupled into the converter and degrade the achievable performance.

Because of the pipeline architecture, the converter also generates high-frequency current 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 12 shows the recommended decoupling scheme for the analog supplies. In most cases, 0.1µF 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 to the supply pins as possible. In addition, a larger size bipolar capacitor (1µF to 22µF) should be placed on the PC board in close proximity to the converter circuit.

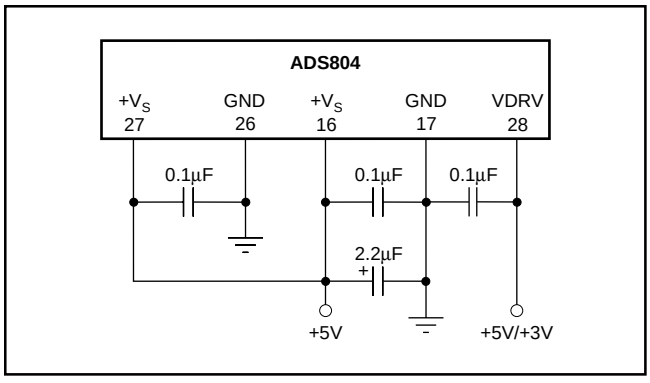


FIGURE 12. Recommended Bypassing for Analog Supply Pins.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
ADS804E	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ADS804E	Samples
ADS804E/1K	ACTIVE	SSOP	DB	28	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ADS804E	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
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Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

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TAPE AND REEL INFORMATION

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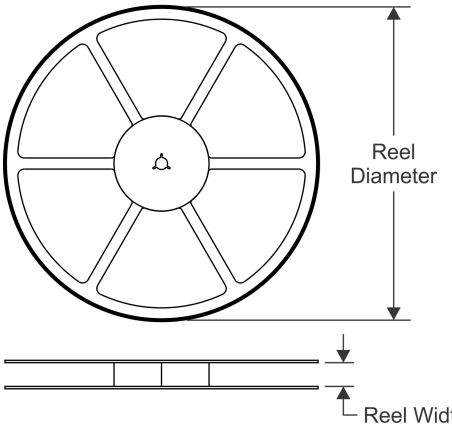
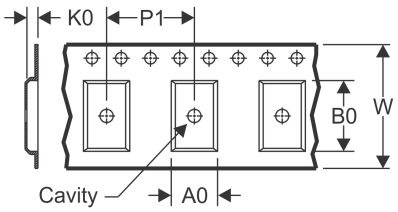
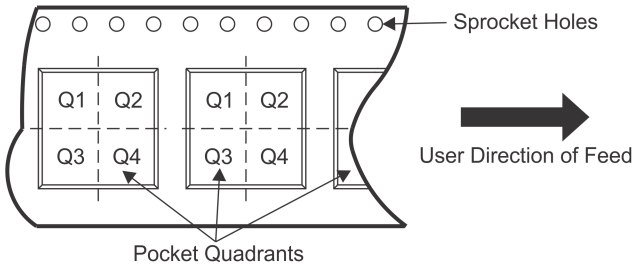


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

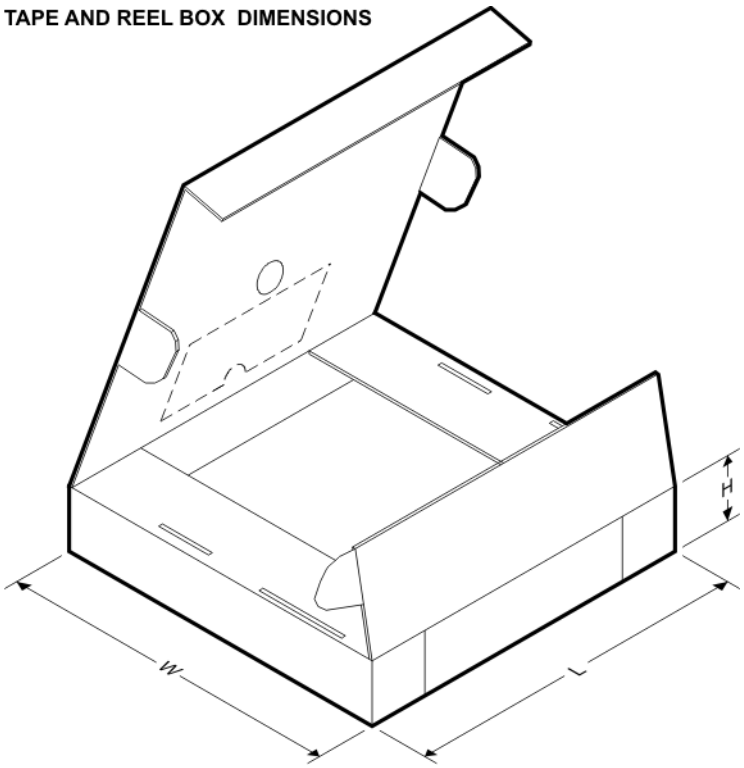
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ADS804E/1K	SSOP	DB	28	1000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
ADS804E/1K	SSOP	DB	28	1000	367.0	367.0	38.0

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