



**PRODUCT OVERVIEW**

The ADS-947 is a 14-bit, 10MHz sampling A/D converter. This device accurately samples full-scale input signals up to Nyquist frequencies with no missing codes. Excellent differential nonlinearity error (DNL), signal-to-noise ratio (SNR), and total harmonic distortion (THD) make the ADS-947 the ideal choice for both time-domain (CCD/FPA imaging, scanners, process control) and frequency-domain (radar, telecommunications, spectrum analysis) applications.

The functionally complete ADS-947 contains a fast-settling sample/hold amplifier, a subranging (two-pass) A/D converter, an internal reference,

timing/control logic, and error-correction circuitry. Digital input and output levels are TTL. The ADS-947 only requires the rising edge of a start convert pulse to operate.

Requiring only +5V and -5V supplies, the ADS-947 typically dissipates just 2.2 Watts. The device is offered with a bipolar input range of ±2V. Models are available for use in either commercial (0 to +70°C) or industrial (-40 to +100°C), operating temperature ranges. A proprietary, auto-calibrating, error-correcting circuit allows the device to achieve specified performance over the extended temperature range.

**FEATURES**

- 14-bit resolution
- 10MHz minimum sampling rate
- No missing codes
- Ideal for both time and frequency-domain applications
- Edge-triggered
- Small, 24-pin, ceramic DDIP or SMT
- Requires only +5V supplies
- Low-power, 2.2 Watts

INPUT/OUTPUT CONNECTIONS			
PIN	FUNCTION	PIN	FUNCTION
1	BIT 1 (MSB)	24	ANALOG GROUND
2	BIT 2	23	OFFSET ADJUST
3	BIT 3	22	+5V ANALOG SUPPLY
4	BIT 4	21	ANALOG INPUT
5	BIT 5	20	-5V SUPPLY
6	BIT 6	19	ANALOG GROUND
7	BIT 7	18	START CONVERT
8	BIT 8	17	DATA VALID
9	BIT 9	16	BIT 14 (LSB)
10	BIT 10	15	BIT 13
11	BIT 11	14	DIGITAL GROUND
12	BIT 12	13	+5V DIGITAL SUPPLY

**BLOCK DIAGRAM**

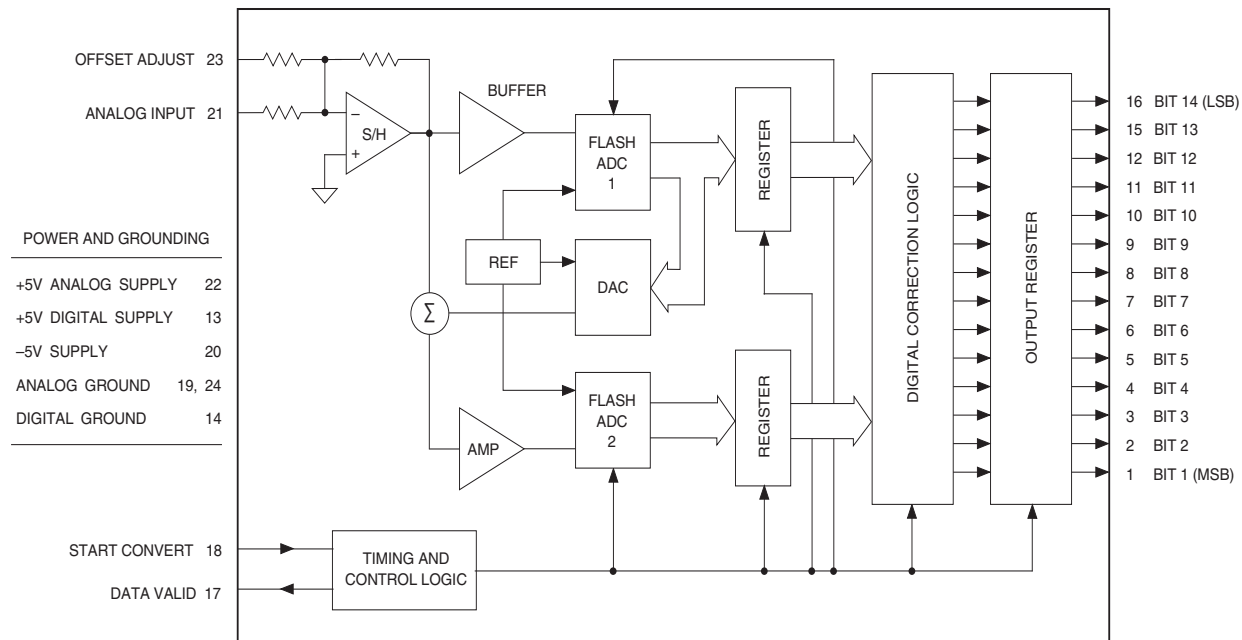


Figure 1. ADS-947 Functional Block Diagram

ABSOLUTE MAXIMUM RATINGS		
PARAMETERS	LIMITS	UNITS
+5V Supply (Pins 13, 22)	0 to +6	Volts
-5V Supply (Pin 20)	0 to -6V	Volts
Digital Input (Pin 18)	-0.3 to +VDD +0.3	Volts
Analog Input (Pin 21)	±5	Volts
Lead Temperature (10 seconds)	+300	°C

PHYSICAL/ENVIRONMENTAL				
PARAMETERS	MIN.	TYP.	MAX.	UNITS
Operating Temp. Range, Case				
ADS-947MC, GC, MC-C, GC-C	0	—	+70	°C
ADS-947ME, GE, ME-C, GE-C	-40	—	+100	°C
ADS-947ME-QL, ME-QL-C	-40	—	+100	°C
Thermal Impedance				
θ <sub>jc</sub>	—	6	—	°C/Watt
θ <sub>ca</sub>	—	23	—	°C/Watt
Storage Temperature Range	-65	—	+150	°C
Package Type	24-pin, metal-sealed, ceramic DDIP or SMT			
Weight	0.46 ounces (13 grams)			

### FUNCTIONAL SPECIFICATIONS

(T<sub>A</sub> = +25°C, +V<sub>DD</sub> = +5V, -V<sub>DD</sub> = -5V, 10MHz sampling rate, and a minimum 3 minute warmup ① unless otherwise specified.)

ANALOG INPUT	+25°C			0 TO +70°C			-40 TO +100°C			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Input Voltage Range ②	—	±2	—	—	±2	—	—	±2	—	Volts
Input Resistance	—	300	—	—	300	—	—	300	—	Ω
Input Capacitance	—	6	15	—	6	15	—	6	15	pF
<b>DIGITAL INPUT</b>										
Logic Levels										
Logic "1"	+2.0	—	—	+2.0	—	—	+2.0	—	—	Volts
Logic "0"	—	—	+0.8	—	—	+0.8	—	—	+0.8	Volts
Logic Loading "1"	—	—	+20	—	—	+20	—	—	+20	μA
Logic Loading "0"	—	—	-20	—	—	-20	—	—	-20	μA
Start Convert Positive Pulse Width ③	10	20	—	10	20	—	10	20	—	ns
<b>STATIC PERFORMANCE</b>										
Resolution	—	14	—	—	14	—	—	14	—	Bits
Integral Nonlinearity (fin = 10kHz)	—	±0.75	—	—	±0.75	—	—	±1	—	LSB
Differential Nonlinearity (fin = 10kHz)	-0.95	±0.5	+1.25	-0.95	±0.5	+1.25	-0.95	±0.75	+1.5	LSB
Full Scale Absolute Accuracy	—	±0.15	±0.4	—	±0.15	±0.4	—	±0.4	±0.8	%FSR
Bipolar Zero Error (Tech Note 2)	—	±0.2	±0.4	—	±0.2	±0.4	—	±0.4	±0.65	%FSR
Gain Error (Tech Note 2)	—	±0.2	±0.75	—	±0.2	±0.75	—	±0.4	±1.25	%
No Missing Codes (fin = 10kHz)	14	—	—	14	—	—	14	—	—	Bits
<b>DYNAMIC PERFORMANCE</b>										
Peak Harmonics (-0.5dB)										
dc to 1MHz	—	-83	-72	—	-83	-75	—	-75	-71	dB
1MHz to 2.5MHz	—	-78	-69	—	-78	-72	—	-73	-68	dB
2.5MHz to 5MHz	—	-76	-69	—	-76	-71	—	-69	-65	dB
Total Harmonic Distortion (-0.5dB)										
dc to 1MHz	—	-81	-74	—	-81	-74	—	-75	-70	dB
1MHz to 2.5MHz	—	-76	-71	—	-76	-71	—	-72	-66	dB
2.5MHz to 5MHz	—	-75	-68	—	-75	-68	—	-69	-64	dB
Signal-to-Noise Ratio (w/o distortion, -0.5dB)										
dc to 1MHz	73	77	—	73	77	—	71	76	—	dB
1MHz to 2.5MHz	73	77	—	73	77	—	71	76	—	dB
2.5MHz to 5MHz	73	77	—	73	77	—	71	76	—	dB
Signal-to-Noise Ratio ④ (& distortion, -0.5dB)										
dc to 1MHz	70	74	—	70	74	—	68	73	—	dB
1MHz to 2.5MHz	68	73	—	68	73	—	66	71	—	dB
2.5MHz to 5MHz	68	73	—	68	73	—	65	70	—	dB
Noise	—	150	—	—	150	—	—	150	—	μVrms
Two-Tone Intermodulation Distortion										
(fin = 2.45MHz, 1.975MHz, fs = 10MHz, -0.5dB)	—	-78	—	—	-78	—	—	-78	—	dB
Input Bandwidth (-3dB)										
Small Signal (-20dB input)	—	24	—	—	24	—	—	24	—	MHz
Large Signal (-0.5dB input)	—	22	—	—	22	—	—	22	—	MHz
Feedthrough Rejection (fin = 2.45MHz)	—	85	—	—	85	—	—	85	—	dB
Slew Rate	—	±276	—	—	±276	—	—	±276	—	V/μs
Aperture Delay Time	—	+5	—	—	+5	—	—	+5	—	ns
Aperture Uncertainty	—	7	—	—	7	—	—	7	—	ps rms
S/H Acquisition Time (to ±0.003%FSR, 4V step)	—	30	—	—	30	—	—	30	—	ns
Overshoot Recovery Time ⑤	—	100	125	—	100	125	—	100	125	ns
A/D Conversion Rate	10	—	—	10	—	—	10	—	—	MHz

DIGITAL OUTPUTS	+25°C			0 TO +70°C			-40 TO +100°C			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Logic Levels										
Logic "1"	+2.4	—	—	+2.4	—	—	+2.4	—	—	Volts
Logic "0"	—	—	+0.4	—	—	+0.4	—	—	+0.4	Volts
Logic Loading "1"	—	—	-4	—	—	-4	—	—	-4	mA
Logic Loading "0"	—	—	+4	—	—	+4	—	—	+4	mA
Output Coding	Offset Binary									
<b>POWER REQUIREMENTS</b>										
Power Supply Ranges										
+5V Supply	+4.75	+5.0	+5.25	+4.75	+5.0	+5.25	+4.9	+5.0	+5.25	Volts
-5V Supply	-4.75	-5.2	-5.45	-4.75	-5.0	-5.45	-4.9	-5.0	-5.45	Volts
Power Supply Currents										
+5V Supply	—	+250	+270	—	+250	+270	—	+250	+270	mA
-5V Supply	—	-150	-170	—	-150	-170	—	-150	-170	mA
Power Dissipation	—	2.2	2.2	—	2.2	2.2	—	2.2	2.2	Watts
Power Supply Rejection	—	—	±0.05	—	—	±0.05	—	—	±0.05	%FSR/%V

Footnotes:

- ① All power supplies should be on before applying a start convert pulse. All supplies and the clock (start convert pulses) must be present during warmup periods. The device must be continuously converting during this time.
- ② Contact DATEL for other input voltage ranges; the range for ADS-947MC-31122 is ±0.5 Volts.
- ③ A 10MHz clock with a 20ns positive pulse width is used for all production testing. See Timing Diagram, figure 4, for more details.

- ④ Effective bits is equal to:

$$\frac{(\text{SNR} + \text{Distortion}) - 1.76 + \left[ 20 \log \frac{\text{Full Scale Amplitude}}{\text{Actual Input Amplitude}} \right]}{6.02}$$

- ⑤ This is the time required before the A/D output data is valid once the analog input is back within the specified range. This time is only guaranteed if the input does not exceed ±2.2V (S/H saturation voltage).

**TECHNICAL NOTES**

1. Obtaining fully specified performance from the ADS-947 requires careful attention to pc card layout and power supply decoupling. The device's analog and digital ground systems are connected to each other internally. For optimal performance, tie all ground pins (14, 19 and 24) directly to a large analog ground plane beneath the package.

Bypass all power supplies to ground with 4.7µF tantalum capacitors in parallel with 0.1µF ceramic capacitors. Locate the bypass capacitors as close to the unit as possible.

- 2. The ADS-947 achieves its specified accuracies without the need for external calibration. If required, the device's small initial offset and gain errors can be reduced to zero using the adjustment circuitry shown in Figures 2 and 3. When using this circuitry, or any similar offset and gain calibration hardware, make adjustments following warmup. To avoid interaction, always adjust offset before gain.
- 3. A passive bandpass filter is used at the input of the A/D for all production testing.

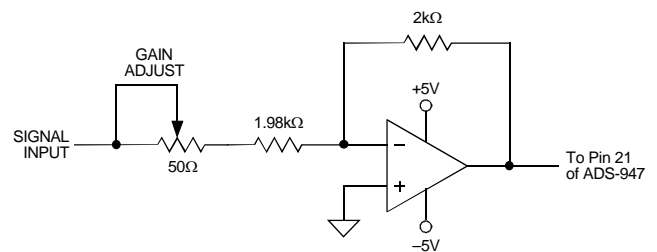


Figure 2. Optional ADS-947 Gain Adjust Calibration Circuit

**CALIBRATION PROCEDURE**

Any offset and/or gain calibration procedures should not be implemented until devices are fully warmed up. To avoid interaction, offset must be adjusted before gain. The ranges of adjustment for the circuits in Figures 2 and 3 are guaranteed to compensate for the ADS-947's initial accuracy errors and may not be able to compensate for additional system errors.

A/D converters are calibrated by positioning their digital outputs exactly on the transition point between two adjacent digital output codes. This can be accomplished by connecting LED's to the digital outputs and adjusting until certain LED's "flicker" equally between on and off. Other approaches employ digital comparators or microcontrollers to detect when the outputs change from one code to the next.

Offset adjusting for the ADS-947 is normally accomplished at the point where the MSB is a 1 and all other output bits are 0's and the LSB just changes from a 0 to a 1. This digital output transition ideally occurs when the applied analog input is +½ LSB (+122µV).

Gain adjusting (see technical note 2) is accomplished when all bits are 1's and the LSB just changes from a 1 to a 0. This transition ideally occurs when the analog input is at +full scale minus 1½ LSB's (+1.99963V).

**Zero/Offset Adjust Procedure**

1. Apply a train of pulses to the START CONVERT input (pin 18) so the converter is continuously converting.
2. Apply +122µV to the ANALOG INPUT (pin 21).
3. Adjust the offset potentiometer until the output bits are 10 0000 0000 0000 and the LSB flickers between 0 and 1.

**Gain Adjust Procedure (see technical note 2)**

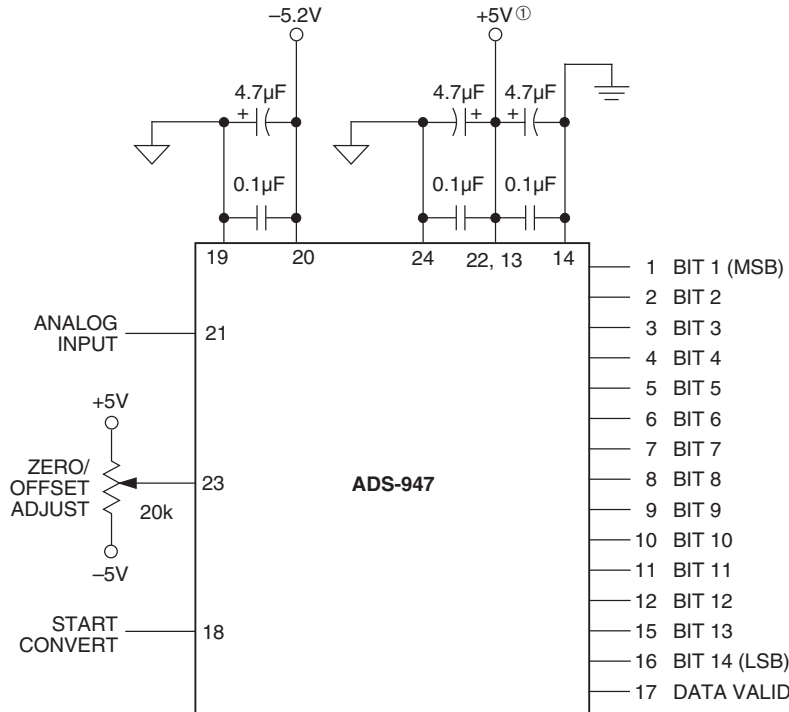
1. Apply +1.99963V to the ANALOG INPUT (pin 21).
2. Adjust the gain potentiometer until all output bits are 1's and the LSB flickers between 1 and 0.
3. To confirm proper operation of the device, vary the input signal to obtain the output coding listed in Table 2.

INPUT VOLTAGE RANGE	ZERO ADJUST +½ LSB	GAIN ADJUST +FS -1½ LSB
±2V	+122µV	+1.99963V

Table 1. Gain and Zero Adjust

BIPOLAR SCALE	INPUT RANGE (±2V RANGE)	OFFSET BINARY MSB	LSB
+FS -1 LSB	+1.99976	11 1111 1111	1111
+3/4 FS	+1.50000	11 1000 0000	0000
+1/2 FS	+1.00000	11 0000 0000	0000
0	0.00000	10 0000 0000	0000
-1/2 FS	-1.00000	01 0000 0000	0000
-3/4 FS	-1.50000	00 1000 0000	0000
-FS +1 LSB	-1.99976	00 0000 0000	0001
-FS	-2.00000	00 0000 0000	0000

Table 2. Output Coding for Bipolar Operation



① A single +5V supply should be used for both the +5V analog and +5V digital. If separate supplies are used, the difference between the two cannot exceed 100mV.

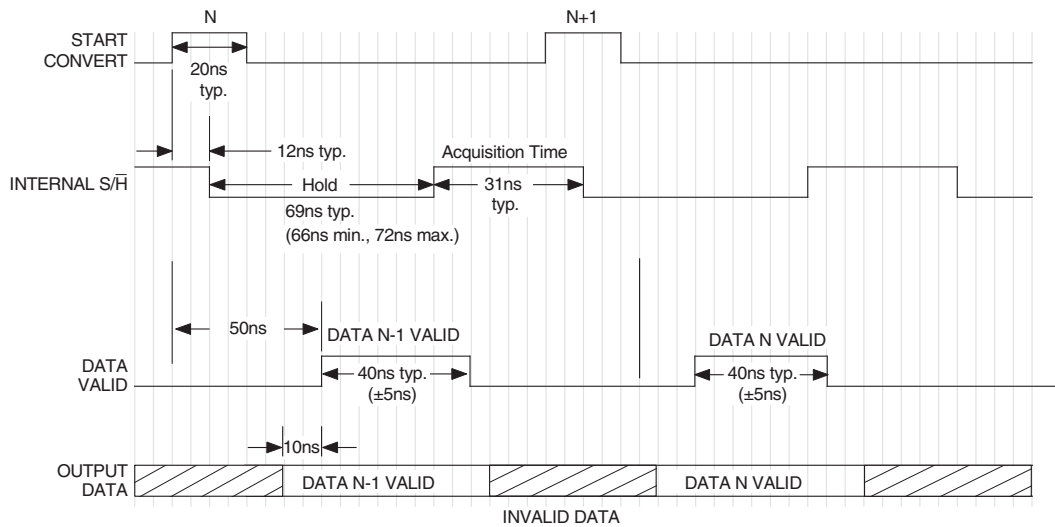
Figure 3. Typical ADS-947 Connection Diagram

**THERMAL REQUIREMENTS**

All DATEL sampling A/D converters are fully characterized and specified over operating temperature (case) ranges of 0 to +70°C and -40 to +100°C. All room temperature (TA = +25°C) production testing is performed without the use of heat sinks or forced air cooling. Thermal impedance figures for each device are listed in their respective specification tables. These devices do not normally require heat sinks; however, standard precautionary design and layout procedures should be used to ensure devices do not overheat. The ground and power planes beneath the package, as well as all pcb signal runs to and from

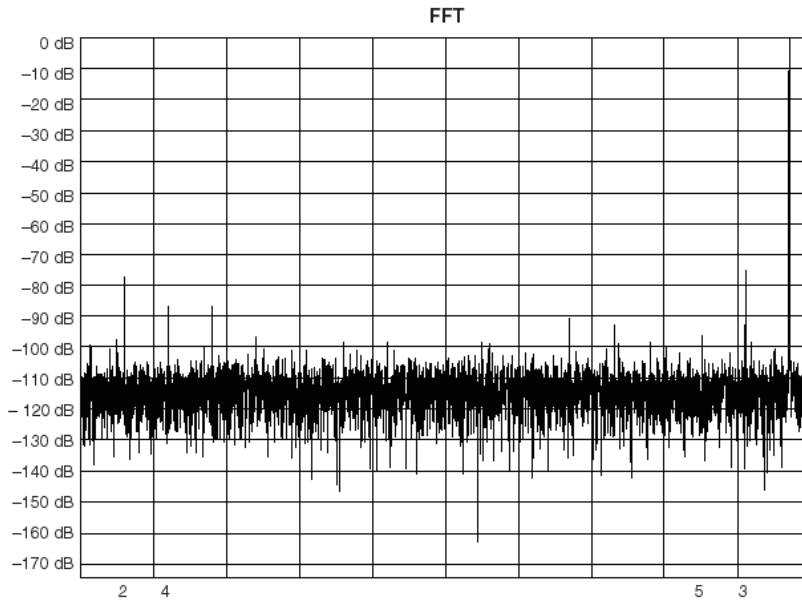
the device, should be as heavy as possible to help conduct heat away from the package.

Electrically insulating, thermally conductive "pads" may be installed underneath the package. Devices should be soldered to boards rather than socketed, and of course, minimal air flow over the surface can greatly help reduce the package temperature.



- Notes:
1. Scale is approximately 5ns per division. Sampling rate = 10MHz.
  2. The start convert pulse must be between 20 and 50ns wide or between 80 and 100ns wide (when sampling at 10MHz) to ensure proper operation. For sampling rates less than 10MHz, the start pulse can be wider than 85nsec, however a minimum pulse width low of 15nsec should be maintained. A 10MHz clock with a 20nsec positive pulse width is used for all production testing.
  3. For no latency delay and an input range of ±0.5 Volts, order ADS-947MC-31122.

Figure 4. ADS-947 Timing Diagram



(fs = 8MHz, fin = 3.85MHz, Vin = -0.5dB, 16,384 point FFT)

Figure 5. FFT Analysis of ADS-947

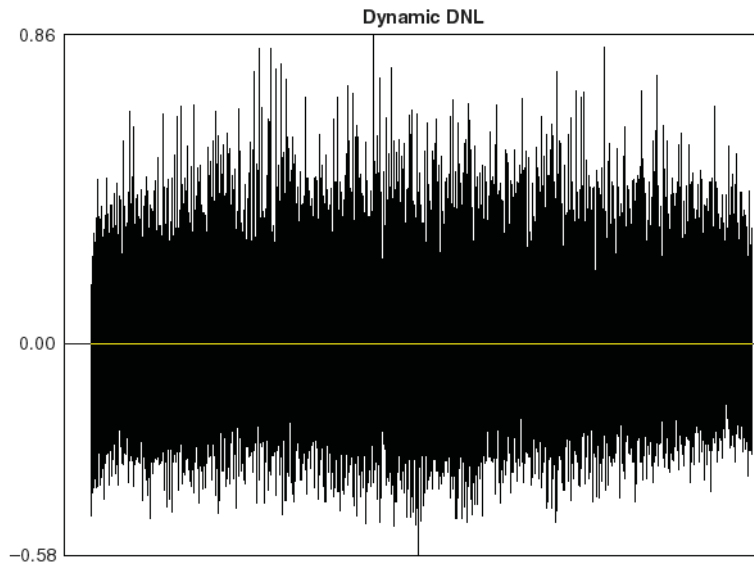
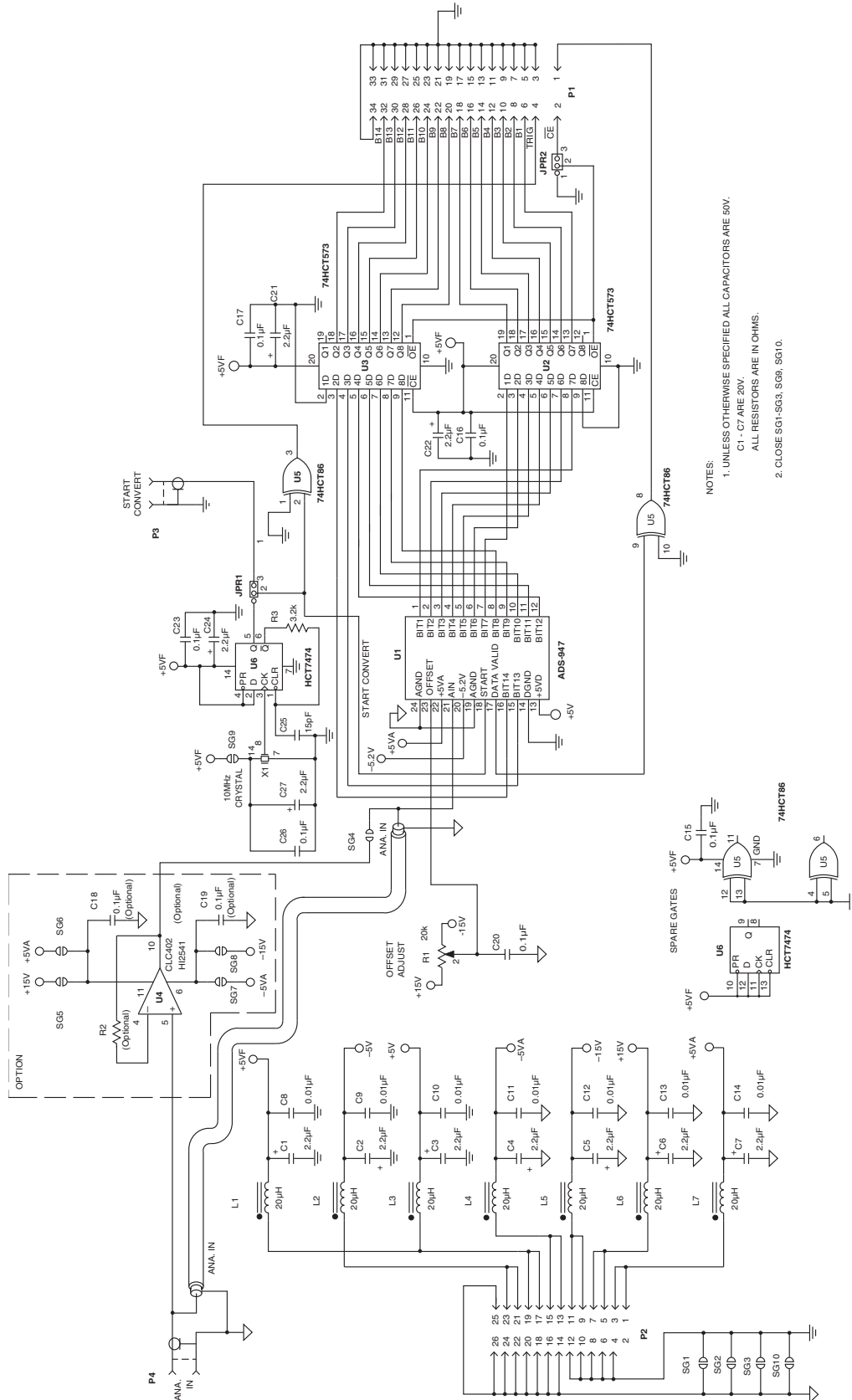


Figure 6. ADS-947 Histogram and Differential Nonlinearity



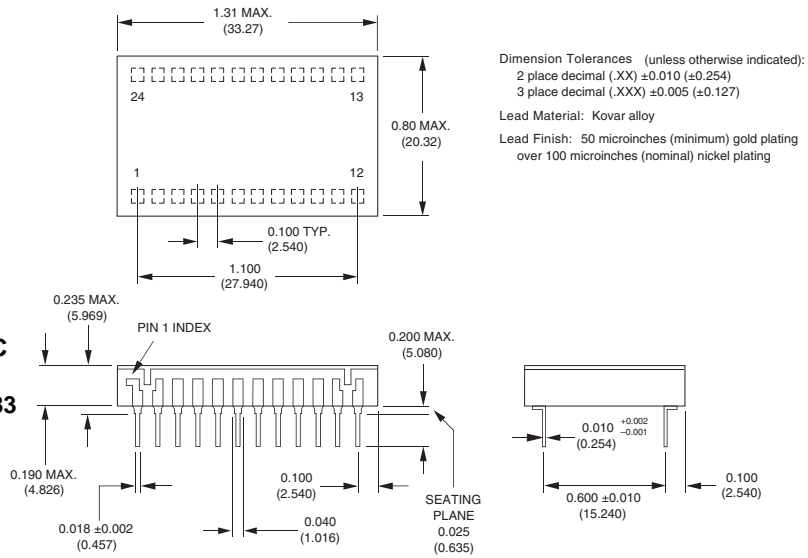
NOTES:  
1. UNLESS OTHERWISE SPECIFIED ALL CAPACITORS ARE 50V.  
C1 - C7 ARE 20V.  
ALL RESISTORS ARE IN OHMS.  
2. CLOSE SGT-SG3, SGT8, SGT10.

Figure 7. ADS-947 Evaluation Board Schematic (ADS-B947)

MECHANICAL DIMENSIONS INCHES (mm)

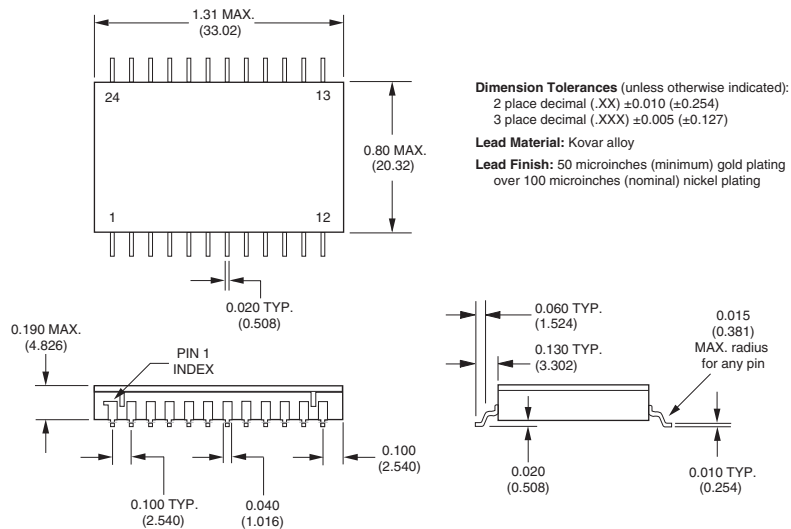
**24-Pin TDIP Versions**

- ADS-947MC**
- ADS-947ME**
- ADS-947ME-QL**
- ADS-947MM**
- ADS-947/883**
- ADS-947MC-C**
- ADS-947ME-C**
- ADS-947ME-QL-C**
- ADS-947MM-C**
- ADS-947MM-C/883**



**24-Pin Surface Mount Versions**

- ADS-947GC**
- ADS-947GE**
- ADS-947GM**
- ADS-947G/883**
- ADS-947GC-C**
- ADS-947GE-C**
- ADS-947GM-C**
- ADS-947G-C/883**





ORDERING INFORMATION					
MODEL NUMBER	OPERATING TEMP. RANGE	PACKAGE	ROHS	ACCESSORIES	
ADS-947MC	0 to +70°C	DDIP	No	ADS-B947	Evaluation Board (without ADS-947)
ADS-947MC-C	0 to +70°C	DDIP	Yes	HS-24	Heat Sink for all ADS-947 DDIP models
ADS-947ME	-40 to +100°C	DDIP	No	Receptacles for pc board mounting can be ordered through AMP, Inc., Part # 3-331272-8 (Component Lead Socket), 24 required.	
ADS-947ME-C	-40 to +100°C	DDIP	Yes		
ADS-947ME-QL	-40 to +100°C	DDIP	No	For MIL-STD-883 product specification, contact DATEL.	
ADS-947ME-QL-C	-40 to +100°C	DDIP	Yes		
ADS-947GC	0 to +70°C	SMT	No		
ADS-947GC-C	0 to +70°C	SMT	Yes		
ADS-947GE	-40 to +100°C	SMT	No		
ADS-947GE-C	-40 to +100°C	SMT	Yes		
ADS-947GE-QL	-40 to +100°C	SMT	No		
ADS-947GE-QL-C	-40 to +100°C	SMT	Yes		
ADS-947MM	-55 to +125°C	DDIP	No		
ADS-947MM-C	-55 to +125°C	DDIP	Yes		
ADS-947/883	-55 to +125°C	DDIP	No		
ADS-947-C/883	-55 to +125°C	DDIP	Yes		
ADS-947GM	-55 to +125°C	SMT	No		
ADS-947GM-C	-55 to +125°C	SMT	Yes		
ADS-947G/883	-55 to +125°C	SMT	No		
ADS-947G-C/883	-55 to +125°C	SMT	Yes		