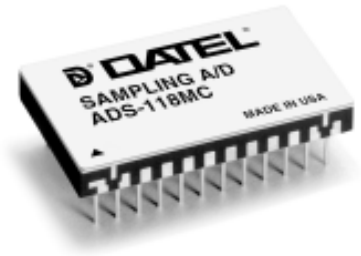
ADS-118, ADS-118A

12-Bit, 5MHz, Low-Power Sampling A/D Converters

FEATURES

- **12-bit resolution**
- **5MHz minimum sampling rate**
- **Functionally complete**
- **Small 24-pin DDIP**
- **Requires only ±5V supplies**
- **Low-power, 1.8 Watts**
- **Outstanding dynamic performance**
- **No missing codes over full military temperature range**
- **Edge-triggered, no pipeline delay**
- **Ideal for both time and frequency-domain applications**



GENERAL DESCRIPTION

DATEL's ADS-118 and ADS-118A are 12-bit, 5MHz, sampling A/D converters packaged in space-saving 24-pin DDIP's. The ADS-118 offers an input range of ±1V and has three-state outputs. The ADS-118A has an input range of ±1.25V and features direct adjustment of offset error.

These functionally complete low-power devices (1.8 Watts) contain an internal fast-settling sample/hold amplifier, a 12-bit subranging A/D converter, a precise voltage reference, timing/control logic, and error-correction circuitry. All timing and control logic operates from the rising edge of a single start convert pulse. Digital input and output levels are TTL. Models are available for use in either commercial (0 to +70°C) or military (–55 to +125°C) operating temperature ranges.

Applications include radar, transient signal analysis, process control, medical/graphic imaging, and FFT spectrum analysis.

INPUT/OUTPUT CONNECTIONS

PIN	FUNCTION	PIN	FUNCTION
1	BIT 12 (LSB)	24	NO CONNECTION
2	BIT 11	23	ANALOG GROUND
3	BIT 10	22	NO CONNECTION
4	BIT 9	21	+5V ANALOG SUPPLY
5	BIT 8	20	–5V SUPPLY
6	BIT 7	19	ANALOG INPUT
7	BIT 6	18	ANALOG GROUND
8	BIT 5	17*	$\overline{\text{ENABLE}}$/OFFSET ADJ.
9	BIT 4	16	START CONVERT
10	BIT 3	15	$\overline{\text{EOC}}$
11	BIT 2	14	DIGITAL GROUND
12	BIT 1 (MSB)	13	+5V DIGITAL SUPPLY

* ADS-118, Pin 17 is $\overline{\text{ENABLE}}$
ADS-118A, Pin 17 is OFFSET ADJUST

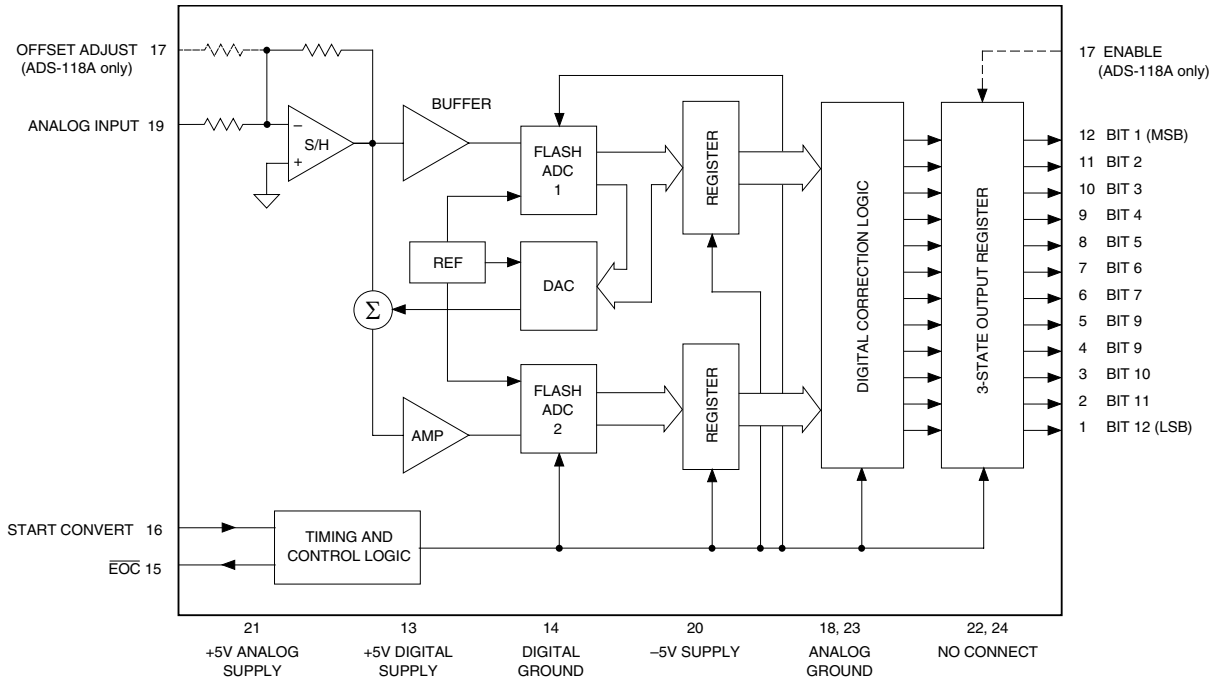


Figure 1. ADS-118/118A Functional Block Diagram

DATEL, Inc., 11 Cabot Boulevard, Mansfield, MA 02048-1151 (U.S.A.) • Tel: (508) 339-3000 Fax: (508) 339-6356 • For immediate assistance: (800) 233-2765

ABSOLUTE MAXIMUM RATINGS

PARAMETERS	LIMITS	UNITS
+5V Supply (Pins 13, 21)	0 to +6	Volts
–5V Supply (Pin 20)	0 to –6	Volts
Digital Input (Pin 16, 17)	–0.3 to +V_{DD} +0.3	Volts
Analog Input (Pin 19)	±5	Volts
Lead Temperature (10 seconds)	+300	°C

PHYSICAL/ENVIRONMENTAL

PARAMETERS	MIN.	TYP.	MAX.	UNITS
Operating Temp. Range, Case				
ADS-118/118AMC	0	—	+70	°C
ADS-118/118AMM, GM, 883	–55	—	+125	°C
Thermal Impedance				
θjc	—	2	—	°C/Watt
θca	—	23	—	°C/Watt
Storage Temperature Range	–65	—	+150	°C
Package Type	24-pin, metal-sealed, ceramic DDIP or SMT			
Weight	0.42 ounces (12 grams)			

FUNCTIONAL SPECIFICATIONS

(T_A = +25°C, ±V_{DD} = ±5V, 5MHz sampling rate, and a minimum 3 minute warmup ① unless otherwise specified.)

	+25°C			0 to +70°C			–55 to +125°C			
ANALOG INPUT	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Input Voltage Range, ADS-118 ②	—	±1	—	—	±1	—	—	±1	—	Volts
Input Resistance	475	500	—	475	500	—	475	500	—	Ω
Input Capacitance	—	6	15	—	6	15	—	6	15	pF
DIGITAL INPUT										
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	50	100	—	50	100	—	50	100	—	ns
STATIC PERFORMANCE										
Resolution	—	12	—	—	12	—	—	12	—	Bits
Integral Nonlinearity (f_{in} = 10kHz)	—	±0.75	—	—	±1.0	—	—	±1.5	—	LSB
Differential Nonlinearity (f_{in} = 10kHz)	—	±0.5	+0.75	—	±0.5	±0.95	—	±0.75	+0.95	LSB
Full Scale Absolute Accuracy	—	±0.1	±0.5	—	±0.5	±0.75	—	±0.75	±1.5	%FSR
Bipolar Zero Error (Tech Note 2)	—	±0.1	±0.5	—	±0.5	±0.85	—	±0.85	±2.0	%FSR
Bipolar Offset Error (Tech Note 2)	—	±0.1	±0.5	—	±0.5	±1.5	—	±1.5	±2.5	%FSR
Gain Error (Tech Note 2)	—	±0.1	±0.5	—	±0.5	±1.0	—	±1.0	±2.5	%
No Missing Codes (f_{in} = 10kHz)	12	—	—	12	—	—	12	—	—	Bits
DYNAMIC PERFORMANCE										
Peak Harmonics (–0.5dB)										
dc to 500kHz	—	–76	–71	—	–74	–70	—	–72	–66	dB
500kHz to 1MHz	—	–75	–71	—	–74	–70	—	–70	–65	dB
1MHz to 2.5MHz	—	–69	–69	—	–73	–67	—	–66	–60	dB
Total Harmonic Distortion (–0.5dB)										
dc to 500kHz	—	–72	–68	—	–71	–67	—	–70	–65	dB
500kHz to 1MHz	—	–71	–67	—	–70	–66	—	–67	–63	dB
1MHz to 2.5MHz	—	–70	–66	—	–69	–65	—	–66	–60	dB
Signal-to-Noise Ratio										
(w/o distortion, –0.5dB)										
dc to 500kHz	67	69	—	66	69	—	64	67	—	dB
500kHz to 1MHz	66	69	—	65	68	—	63	66	—	dB
1MHz to 2.5MHz	66	69	—	65	68	—	63	66	—	dB
Signal-to-Noise Ratio ④										
(& distortion, –0.5dB)										
dc to 500kHz	65	68	—	64	67	—	62	66	—	dB
500kHz to 1MHz	65	68	—	64	67	—	61	65	—	dB
1MHz to 2.5MHz	64	67	—	63	66	—	60	64	—	dB
Noise	—	195	—	—	195	—	—	195	—	µVrms
Two-tone Intermodulation Distortion (f_{in} = 1MHz, 975kHz, f_s = 5MHz, –0.5dB)	—	–74	—	—	–74	—	—	–74	—	dB
Input Bandwidth (–3dB)										
Small Signal (–20dB input)	—	20	—	—	20	—	—	20	—	MHz
Large Signal (–0.5dB input)	—	10	—	—	10	—	—	10	—	MHz
Feedthrough Rejection (f_{in} = 2.5MHz)	—	80	—	—	80	—	—	80	—	dB
Slew Rate	—	±400	—	—	±400	—	—	±400	—	V/µs
Aperture Delay Time	—	+10	—	—	+10	—	—	+10	—	ns
Aperture Uncertainty	—	3	—	—	3	—	—	3	—	ps rms

DYNAMIC PERFORMANCE (Cont.)	+25°C MIN.	+25°C TYP.	+25°C MAX.	0 to +70°C MIN.	0 to +70°C TYP.	0 to +70°C MAX.	–55 to +125°C MIN.	–55 to +125°C TYP.	–55 to +125°C MAX.	UNITS
S/H Acquisition Time										
(to ±0.001%FSR, 10V step)	—	85	90	—	85	90	—	85	90	ns
Overvoltage Recovery Time ⑤	—	200	—	—	200	—	—	200	—	ns
A/D Conversion Rate	5	—	—	5	—	—	5	—	—	MHz
DIGITAL OUTPUTS										
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
Delay, Falling Edge of $\overline{EOC}$ to Output Data Valid	—	—	20	—	—	20	—	—	20	MHz
Delay, Falling Edge of $\overline{ENABLE}$ to Output Data Valid	—	—	10	—	—	10	—	—	10	MHz
Output Coding	Offset Binary									
POWER REQUIREMENTS										
Power Supply Ranges ⑥										
+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	–5.0	–5.25	–4.75	–5.0	–5.25	–4.9	–5.0	–5.25	Volts
Power Supply Currents										
+5V Supply	—	+205	+220	—	+205	+220	—	+205	+220	mA
–5V Supply	—	–180	–205	—	–180	–205	—	–180	–205	mA
Power Dissipation	—	1.8	2.1	—	1.8	2.1	—	1.8	2.1	Watts
Power Supply Rejection	—	—	±0.1	—	—	±0.1	—	—	±0.1	%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 Input voltage ranges for ADS-118A is ±1.25V

③ A 100ns wide start convert pulse is used for all production testing. For applications requiring less than an 5MHz sampling rate, wider start convert pulses can be used.
NOTE: The device only requires the rising edge of a start convert pulse to operate.

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.

⑥ The minimum supply voltages of +4.9V and –4.9V for $\pm V_{DD}$ are required for –55°C operation only. The minimum limits are +4.75V and –4.75V when operating at +125°C

TECHNICAL NOTES

1. Obtaining fully specified performance from the ADS-118 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, 18, and 23) 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-118 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 2a and 2b. For operation without adjustment, tie pin 17 to analog ground. 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. To enable the three-state outputs, connect $\overline{ENABLE}$ (pin 17) to a logic "0" (low). To disable, connect pin 17 to logic "1" (high). The three-state outputs are permanently enabled in the ADS-118A.

4. Applying a start convert pulse while a conversion is in progress ($\overline{EOC}$ = logic "1") will initiate a new and inaccurate conversion cycle.

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 2a and 2b are guaranteed to compensate for the ADS-118'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.

For the ADS-118, offset adjusting 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 +½LSB (+244μV for ADS-118; +305μV for ADS-118A).

Gain adjusting 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 (+0.99927V for ADS-118; +1.249085V for ADS-118A).

Zero/Offset Adjust Procedure

1. Apply a train of pulses to the START CONVERT input (pin 16) so the converter is continuously converting.
2. Apply +244μV (ADS-118) or +305μV (ADS-118A) to the ANALOG INPUT (pin 19).
3. Adjust the offset potentiometer until the output bits are 1000 0000 00000 and the LSB flickers between 0 and 1.

Gain Adjust Procedure

1. Apply +0.99927V (ADS-118) or +1.249085V (ADS-118A) to the ANALOG INPUT (pin 19).
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 1.

Table 1. Output Coding for Bipolar Operation

BIPOLAR SCALE	ADS-118 INPUT RANGE (±1V)	OUTPUT CODING OFFSET BINARY MSB LSB	ADS-118A INPUT RANGE (±1.25V)
+FS –1 LSB	+0.99951V	1111 1111 1111	+1.2494V
+3/4 FS	+0.75000V	1110 0000 0000	+0.9375V
+1/2 FS	+0.50000V	1100 0000 0000	+0.6250V
0	0.00000V	1000 0000 0000	0.0000V
–1/2 FS	–0.50000V	0100 0000 0000	–0.6250V
–3/4 FS	–0.75000V	0010 0000 0000	–0.9375V
–FS +1 LSB	–0.99951V	0000 0000 0001	–1.2494V
–FS	–1.00000V	0000 0000 0000	–1.2500V

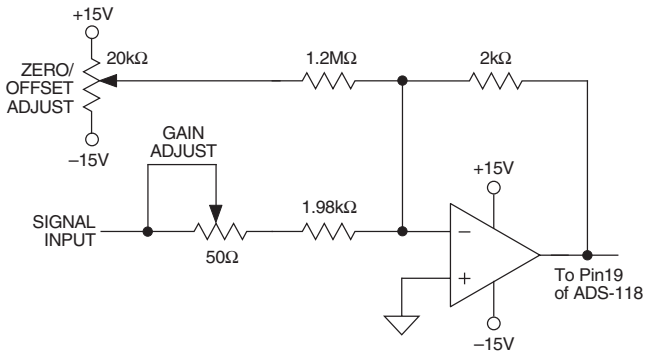


Figure 2a. Optional ADS-118 External Gain and Offset Adjust Circuits

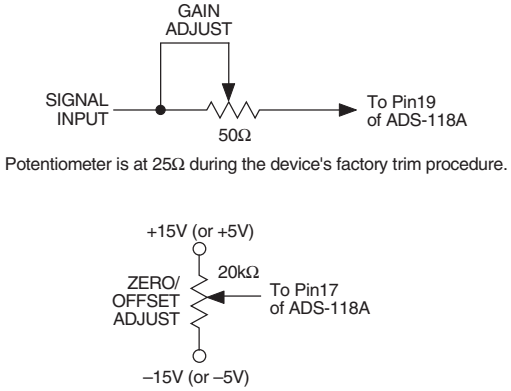
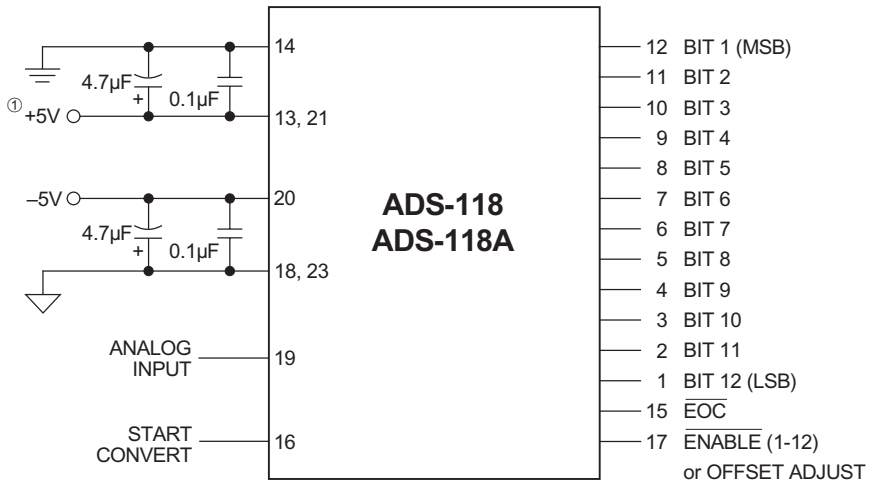


Figure 2b. Optional ADS-118A Gain and Offset Adjust Circuits



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 Connection Diagram

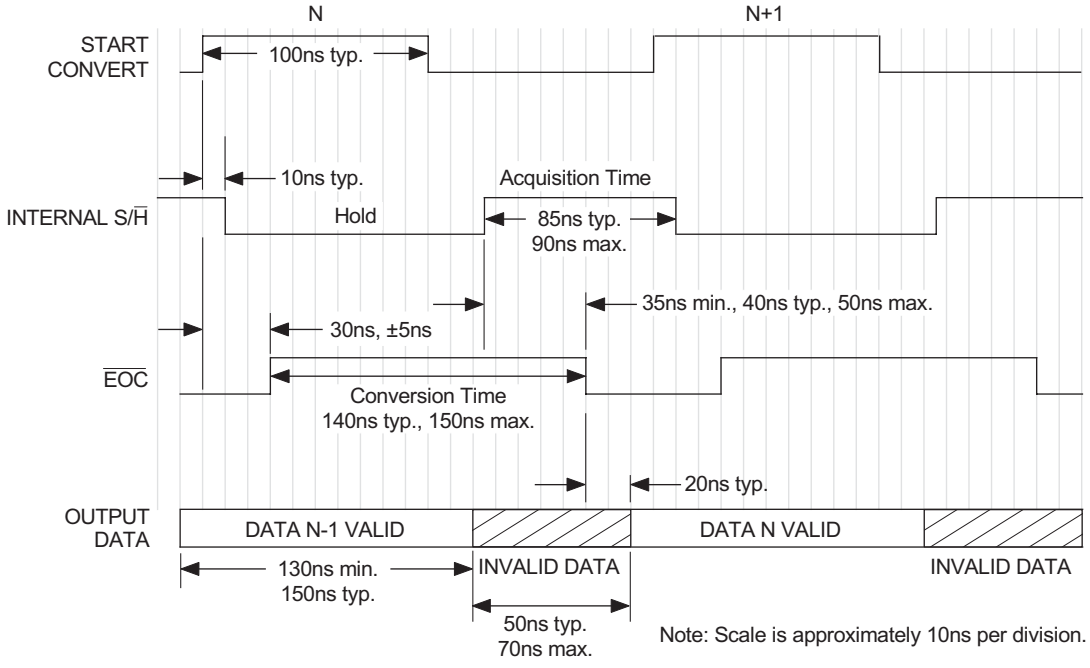


Figure 4. ADS-118/118A Timing Diagram

THERMAL REQUIREMENTS

All DATEL sampling A/D converters are fully characterized and specified over operating temperature (case) ranges of 0 to +70°C and –55 to +125°C. All room temperature (T_A = +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.

In more severe ambient conditions, the package/junction temperature of a given device can be reduced dramatically (typically 35%) by using one of DATEL's HS Series heat sinks. See Ordering Information for the assigned part number. See page 1-183 of the DATEL Data Acquisition Components Catalog for more information on the HS Series. Request DATEL Application Note AN8, "Heat Sinks for DIP Data Converters",
or contact DATEL directly, for additional information.

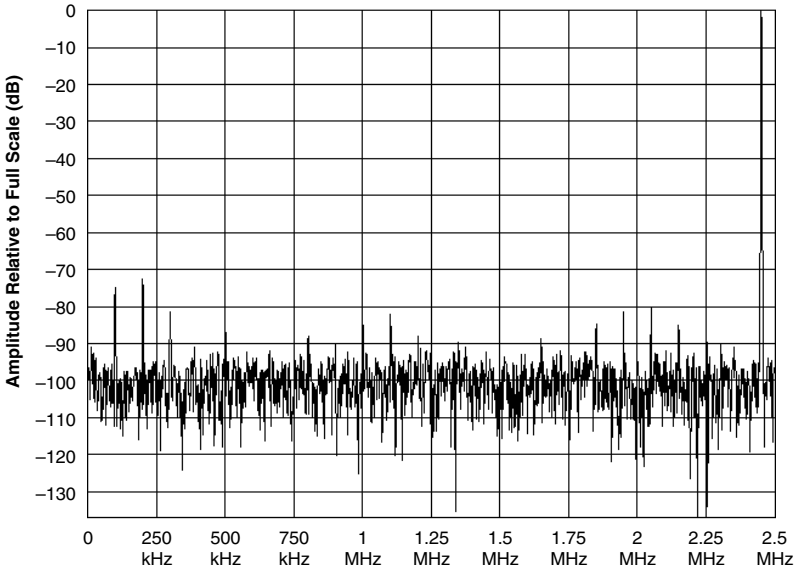


Figure 5. FFT Analysis of ADS-118

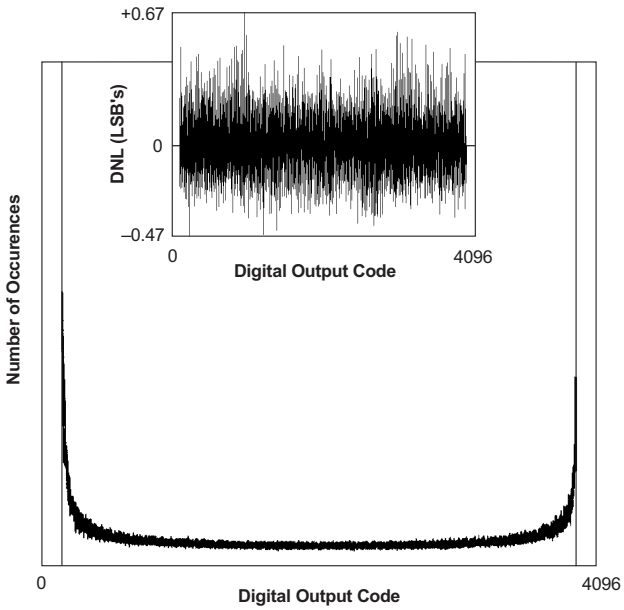


Figure 6. ADS-118 Histogram and Differential Nonlinearity

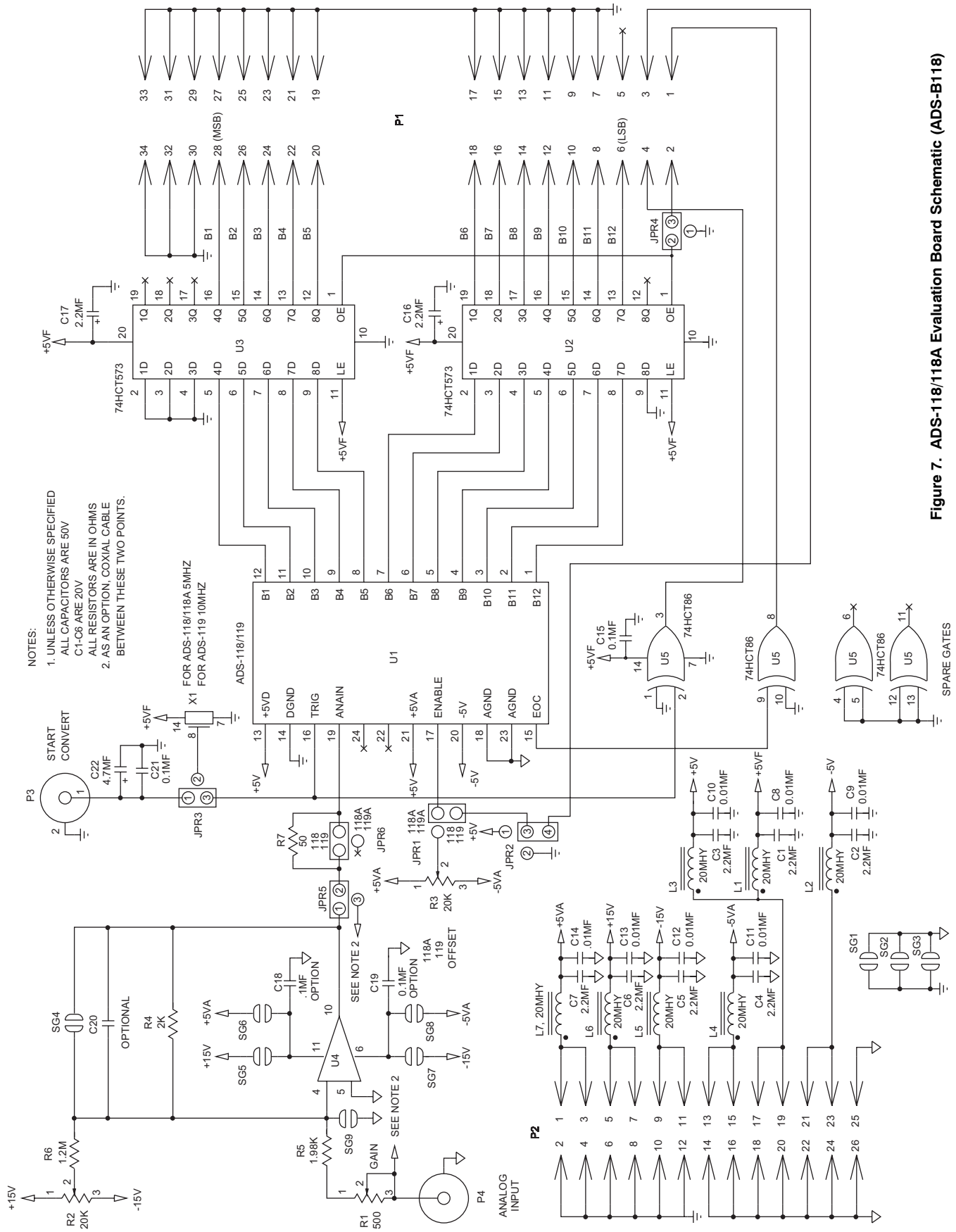
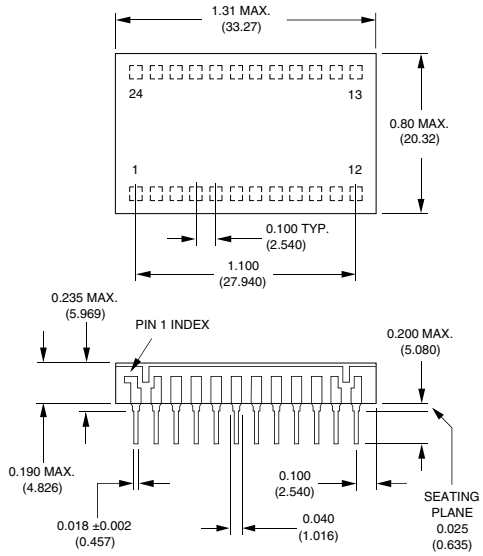


Figure 7. ADS-118/118A Evaluation Board Schematic (ADS-B118)

MECHANICAL DIMENSIONS INCHES (mm)

24-Pin DDIP Versions

ADS-118MC
ADS-118MM
ADS-118AMC
ADS-118AMM

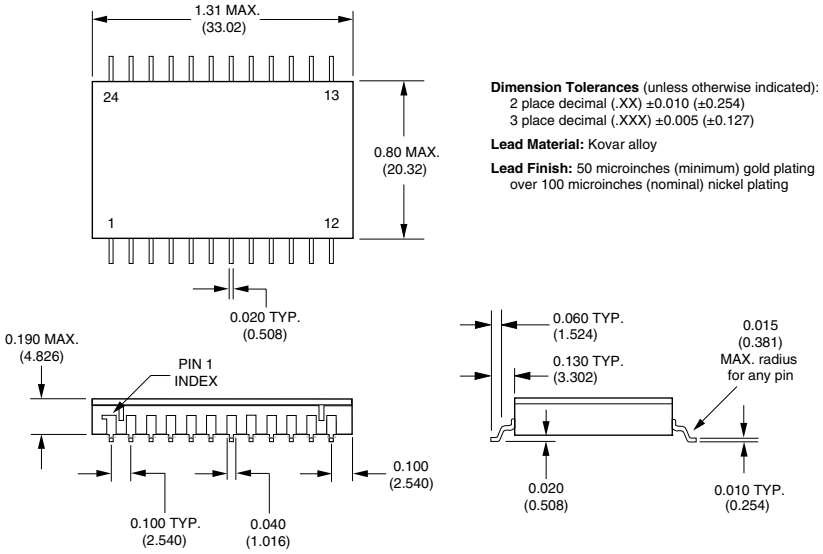


Dimension Tolerances (unless otherwise indicated):
2 place decimal (.XX) ±0.010 (±0.254)
3 place decimal (.XXX) ±0.005 (±0.127)

Lead Material: Kovar alloy

Lead Finish: 50 microinches (minimum) gold plating over 100 microinches (nominal) nickel plating

24-Pin Surface Mount Versions



Dimension Tolerances (unless otherwise indicated):
2 place decimal (.XX) ±0.010 (±0.254)
3 place decimal (.XXX) ±0.005 (±0.127)

Lead Material: Kovar alloy

Lead Finish: 50 microinches (minimum) gold plating over 100 microinches (nominal) nickel plating

ORDERING INFORMATION

MODEL NUMBER	OPERATING TEMP. RANGE	24-PIN PACKAGE
ADS-118MC	0 to +70°C	DDIP
ADS-118MM	–55 to +125°C	DDIP
ADS-118AMC	0 to +70°C	SMT
ADS-118AMM	–55 to +125°C	SMT

ACCESSORIES

ADS-B118	Evaluation Board (without ADS-118)
HS-24	Heat Sink for all ADS-118 DDIP models

Receptacles for PC board mounting can be ordered through AMP, Inc., Part # 3-331272-8 (Component Lead Socket), 24 required. For MIL-STD-883 product, or surface mount packaging, contact DATEL.

INNOVATION and EXCELLENCE

ISO 9001 REGISTERED