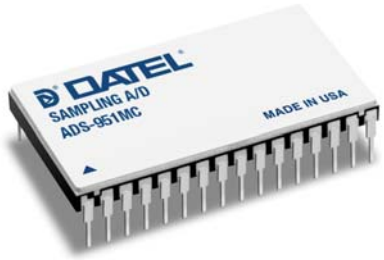
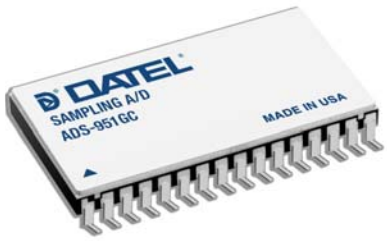
ADS-951

18-Bit, 1MHz, Low-Power Sampling A/D Converters





FEATURES

- 18-bit resolution
- 1MHz minimum sampling rate
- No missing codes over full HI-REL temperature range
- Very low power, 390mW
- Small, 32-pin, SMT or side-brazed, ceramic package
- Edge-triggered, no pipeline delays
- Excellent performance
- Ideal for both time and frequency-domain applications
- Low cost

PRODUCT OVERVIEW

The ADS-951 is an 18-bit, 1MHz sampling A/D converter. This device provides low noise performance and dynamic specifications up to 100 kHz with no missing codes. This, combined with excellent signal-to-noise ratio (SNR) and total harmonic distortion (THD), makes the ADS-951 the ideal choice for both time-domain (medical imaging, scanners, process control) and frequency-domain (radar, telecommunications, spectrum analysis) applications.

Packaged in a 32-pin, SMT or side-brazed, metal-sealed, ceramic package, the functionally complete ADS-951 contains a fast-settling sample-hold amplifier, an A/D converter, an internal reference, and timing/control logic. Digital input and output levels are TTL, and the ADS-951 only requires the rising edge of the start convert pulse to operate.

The ADS-951 typically dissipates 390mW. The device is offered with a bipolar (±5V) analog input range. Models are available for use in commercial (0 to +70°C), extended (–40 to +110°C), or HI-REL (–55 to +125°C) operating temperature ranges.

Contact DATEL for converters with input ranges of ±10V (ADS-951-1) or 0 to +10V (ADS-951-2).

BLOCK DIAGRAM

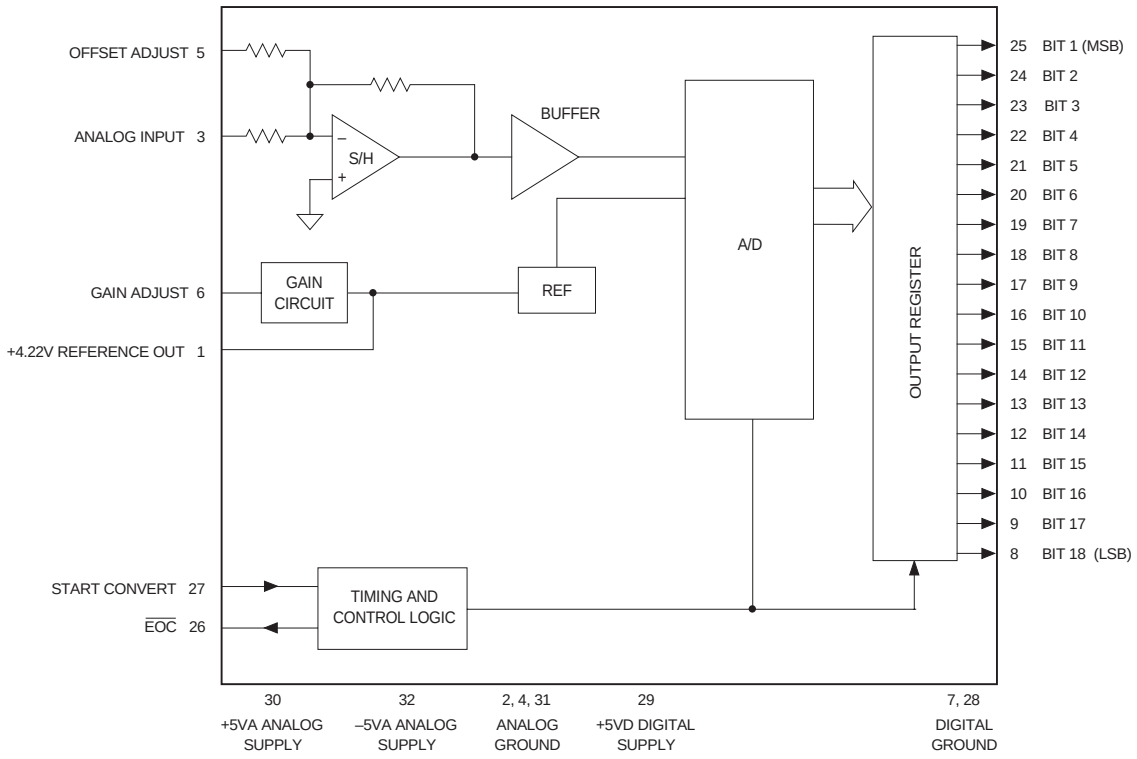


Figure 1. ADS-951 Functional Block Diagram

ABSOLUTE MAXIMUM RATINGS		
PARAMETERS	LIMITS	UNITS
+5VA Supply (Pin 30)	0 to +6	Volts
+5VD Supply (Pin 29)	0 to +6	Volts
–5VA Supply (Pin 32)	0 to –6	Volts
Digital Input (Pin 27)	–0.3 to +5VD +0.3	Volts
Analog Input (Pin 3)	±7	Volts
Lead Temperature (10 seconds)	+300	°C

PHYSICAL/ENVIRONMENTAL				
PARAMETERS	MIN.	TYP.	MAX.	UNITS
Operating Temp. Range, Case				
ADS-951MC, MC-C, GC, GC-C	0	—	+70	°C
ADS-951ME, ME-C, GE, GE-C	–40	—	+110	°C
ADS-951MM, MM-C, GM, GM-C	–55	—	+125	°C
Thermal Impedance				
θjc	—	14.9	—	°C/Watt
θca	—	22.6	—	°C/Watt
Storage Temperature Range	–65	—	+150	°C
Package Type	32-pin, side-brazed, metal-sealed, ceramic TDIP			
Weight	0.46 ounces (13 grams)			

FUNCTIONAL SPECIFICATIONS

(T_A = +25°C, +5VA = +5V, –5VA = –5V, +5VD = +5V, 1MHz sampling rate, and a minimum 1 minute warmup ① unless otherwise specified.)

	0 TO +70°C			–40 TO +110°C			–55 TO +125°C			
ANALOG INPUT	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Input Voltage Range ②	—	±5	—	—	±5	—	—	±5	—	Volts
Input Resistance	—	500	—	—	500	—	—	500	—	Ω
Input Capacitance	—	7	15	—	7	15	—	7	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	20	500	—	20	500	—	20	500	—	ns
STATIC PERFORMANCE										
Resolution	—	18	—	—	18	—	—	18	—	Bits
Integral Nonlinearity (fin = 10kHz)	—	±1.25	—	—	±1.25	—	—	±1.25	—	LSB
Differential Nonlinearity (fin = 10kHz)	–0.95	±0.3	+0.95	–0.95	±0.3	+0.95	–0.95	±0.3	+0.95	LSB
Full Scale Absolute Accuracy	—	±0.05	±0.15	—	±0.1	±0.25	—	±0.2	±0.47	%FSR
Bipolar Zero Error (Tech Note 2)	—	±0.01	±0.025	—	±0.04	±0.056	—	±0.05	±0.70	%FSR
Gain Error (Tech Note 2)	—	±0.1	±0.2	—	±0.15	±0.25	—	±0.2	±0.30	%
No Missing Codes (fin = 10kHz)	18	—	—	18	—	—	18	—	—	Bits
DYNAMIC PERFORMANCE										
Peak Harmonics (–0.5dB)										
dc to 100kHz	—	–110	–99	—	–100	–99	—	–100	–95	dB
Total Harmonic Distortion (–0.5dB)										
dc to 100kHz	—	–98	–95	—	–98	–95	—	–98	–94	dB
Signal-to-Noise Ratio (w/o distortion, –0.5dB)										
dc to 100kHz	92	94	—	92	94	—	91	93	—	dB
Signal-to-Noise Ratio ④ (& distortion, –0.5dB)										
dc to 100kHz	90	91	—	90	91	—	—	89	—	dB
DC Noise	—	90	—	—	90	—	—	90	—	µVrms
Two-Tone Intermodulation Distortion										
(fin = 100kHz, 240kHz, fs = 1MHz, –0.5dB)	—	–96	—	—	–96	—	—	–96	—	dB
Input Bandwidth (–3dB)	6.2	—	—	6.2	—	—	6.2	—	—	
Slew Rate	—	110	—	—	110	—	—	110	—	V/µs
Aperture Delay Time	—	12	—	—	12	—	—	12	—	ns
Aperture Uncertainty	—	3.5	—	—	3.5	—	—	3.5	—	ps rms
S/H Acquisition Time (to ±0.003%FSR, 10V step)	—	260	—	—	260	—	—	260	—	ns
Overvoltage Recovery Time ⑤	—	750	—	—	750	—	—	750	—	ns
A/D Conversion Rate	1	—	—	1	—	—	1	—	—	MHz
ANALOG OUTPUT										
Internal Reference										
Voltage	+4.195	+4.220	+4.245	+4.192	—	+4.248	+4.191	—	+4.250	Volts
External Current	—	—	0.1	—	—	0.1	—	—	0.1	mA

	0 TO +70°C			–40 TO +110°C			–55 TO +125°C			
DIGITAL OUTPUTS	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
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	Complementary Offset Binary									
POWER REQUIREMENTS										
Power Supply Ranges										
+5VA, +5VD Supplies	+4.75	+5.0	+5.25	+4.75	+5.0	+5.25	+4.75	+5.0	+5.25	Volts
–5VA Supply	–4.75	–5.0	–5.25	–4.75	–5.0	–5.25	–4.75	–5.0	–5.25	Volts
Power Supply Currents										
+5VD	—	+3.8	+5	—	+3.8	+5	—	+3.8	+5	mA
+5VA Supply	—	+71	+80	—	+71	+80	—	+71	+80	mA
–5VA Supply	—	–3.5	–6.5	—	–3.5	–6.5	—	–3.5	–6.5	mA
Power Dissipation	—	390	420	—	390	420	—	390	420	mW
Power Supply Rejection	—	±0.005	±0.02	—	±0.005	±0.02	—	±0.005	±0.02	%FSR/%V

Footnotes:

① All power supplies should be on before applying a start convert pulse. All supplies and the clock (START CONVERT) must be present during warmup periods. The device must be continuously converting during this time.

② Contact DATEL for other input voltage ranges.

③ A 1MHz clock with a 500nsec positive pulse width (50% duty cycle) is used for all production testing. Any duty cycle may be used as long as a minimum positive pulse width of 20nsec is maintained. For applications requiring lower sampling rates, clock frequencies lower than 1MHz may be used.

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.

INPUT/OUTPUT CONNECTIONS			
PIN	FUNCTION	PIN	FUNCTION
1	+4.22V REF OUT	32	–5VA ANALOG SUPPLY
2	ANALOG GROUND	31	ANALOG GROUND
3	ANALOG INPUT	30	+5VA ANALOG SUPPLY
4	ANALOG GROUND	29	+5VD DIGITAL SUPPLY
5	OFFSET ADJUST	28	DIGITAL GROUND
6	GAIN ADJUST	27	START CONVERT
7	DIGITAL GROUND	26	$\overline{\text{EOC}}$
8	BIT 18 (LSB)	25	BIT 1 (MSB)
9	BIT 17	24	BIT 2
10	BIT 16	23	BIT 3
11	BIT 15	22	BIT 4
12	BIT 14	21	BIT 5
13	BIT 13	20	BIT 6
14	BIT 12	19	BIT 7
15	BIT 11	18	BIT 8
16	BIT 10	17	BIT 9

TECHNICAL NOTES

1. Obtaining fully specified performance from the ADS-951 requires careful attention to pc-card layout and power supply decoupling. The device's analog and digital ground systems are not connected to each other internally. For optimal performance, tie all ground pins (2, 4, 7, 28, and 31) directly to a large **analog** ground plane beneath the package.

   Bypass all power supplies to ground with 10µF tantalum capacitors in parallel with 0.1µF ceramic capacitors. Locate the bypass capacitors as close to the unit as possible. The +4.22V REFERENCE OUTPUT (pin 1) **should not** be bypassed externally. If needed to drive external circuitry, pin 1 should be buffered close to the unit.

2. The ADS-951 achieves its specified accuracies without the need for external calibration. If required, the device's small initial errors can be reduced to zero using the adjustment circuitry shown in Figure 2. When using this circuitry, or any similar offset and gain calibration hardware, make adjustments following warmup. To avoid interaction, always adjust offset before gain. Connect pins 5 and 6 to ground if not using offset and gain adjust circuits.

3. Applying a start convert pulse while a conversion is in progress ($\overline{EOC}$ = logic "1") will initiate a new and probably inaccurate conversion cycle. Data for the interrupted and subsequent conversions will be invalid.

THERMAL REQUIREMENTS

All DATEL sampling A/D converters are fully characterized and tested over operating temperature (case) ranges of 0 to +70°C, –40 to +110°C, and –55 to +125°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.

CALIBRATION PROCEDURE

Any offset/gain calibration procedures should not be implemented until the device is fully warmed up. To avoid interaction, adjust offset before gain. The ranges of adjustment for the circuits in Figure 2 are guaranteed to compensate for the ADS-951's initial accuracy errors and may not be able to compensate for additional system errors. If Gain and Offset adjustment pins are not used they should be left floating.

A/D converters are calibrated by positioning their digital outputs exactly on the transition point between two adjacent digital output codes. This is accomplished by connecting LED's to the digital outputs and performing adjustments 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-951, offset adjusting is normally accomplished when the analog input is 0 minus ½LSB (–19µV). See Table 2 for the proper bipolar output coding.

Gain adjusting is accomplished when the analog input is at nominal full scale minus 1½LSB's (–4.999943V).

Zero/Offset Adjust Procedure

1. Apply a train of pulses to the START CONVERT input (pin 27) so that the converter is continuously converting.
2. For bipolar zero/offset adjust, apply –19µV to the ANALOG INPUT (pin 3).
3. Adjust the offset potentiometer until the output code flickers equally between 01 1111 1111 1111 1111 and 10 0000 0000 0000 0000.

Gain Adjust Procedure

1. Apply –4.999943V to the ANALOG INPUT (pin 3).
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 applied input voltage to obtain the output coding listed in Table 2.

INPUT VOLTAGE RANGE	ZERO ADJUST (–½ LSB)	GAIN ADJUST (–FS +1½ LSB)
±5V	–19µV	–4.999943

Table 1. Input Connections

COMPLEMENTARY OFFSET BINARY		
BIPOLAR SCALE	INPUT RANGE ±5V	OUTPUT CODING MSB LSB
+FS –1 LSB	+4.999962	00 0000 0000 0000 0000
+3/4 FS	+3.750000	00 0111 1111 1111 1111
+1/2 FS	+2.500000	00 1111 1111 1111 1111
0	+0.000000	01 1111 1111 1111 1111
–1/2 FS	–2.500000	10 1111 1111 1111 1111
–3/4 FS	–3.750000	11 0111 1111 1111 1111
–FS +1 LSB	–4.999962	11 1111 1111 1111 1110
–FS	–5.000000	11 1111 1111 1111 1111

Table 2. Output Coding

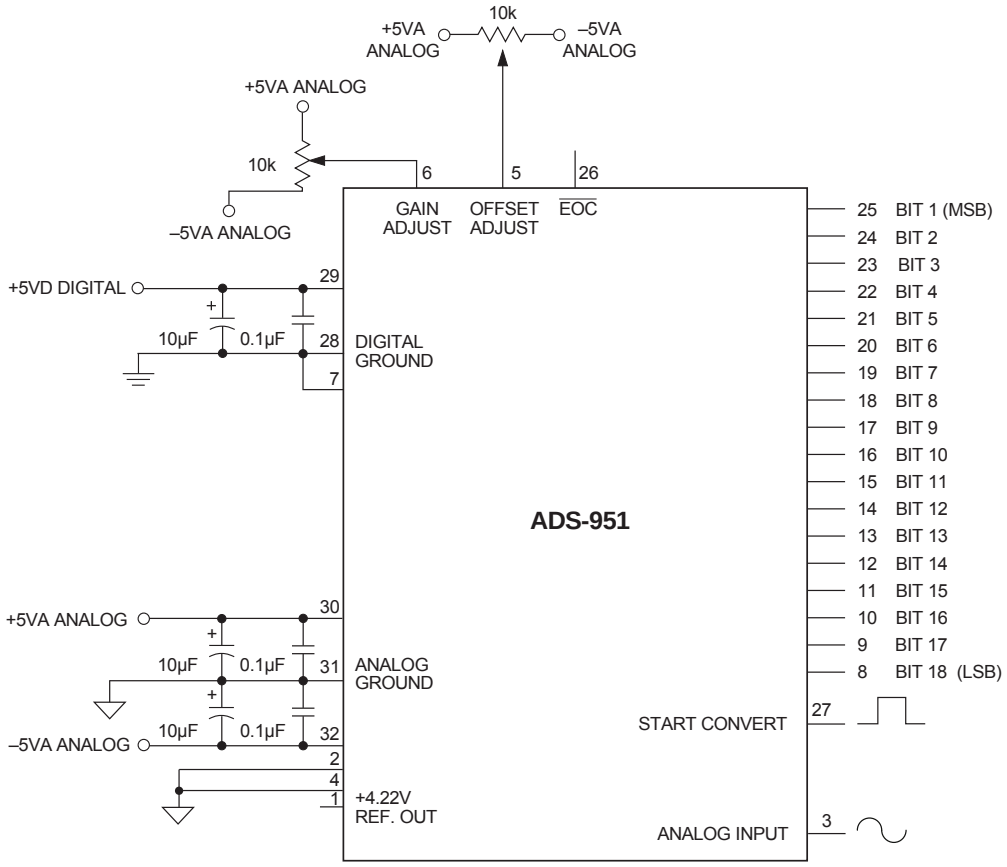


Figure 2. Typical ADS-951 Connection Diagram

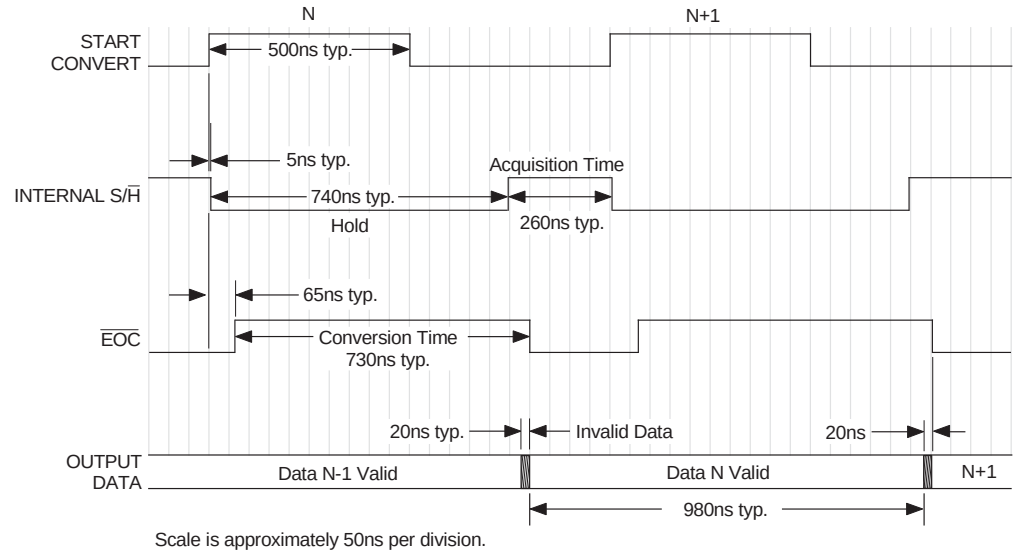
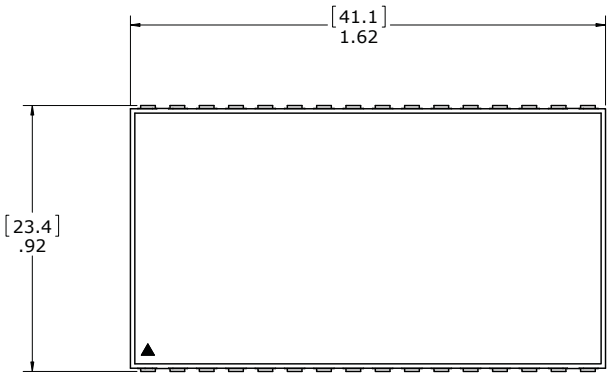
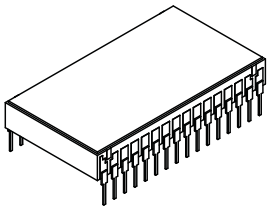


Figure 3. ADS-951 Timing Diagram

MECHANICAL DIMENSIONS – TDIP PACKAGE – INCHES (mm)



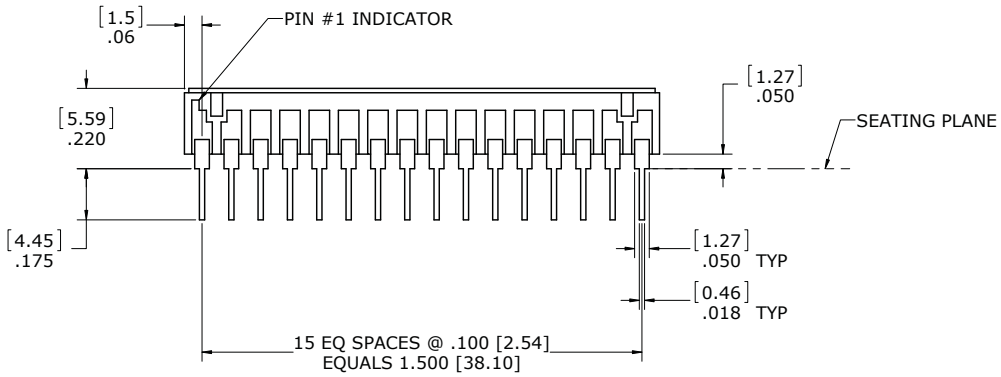


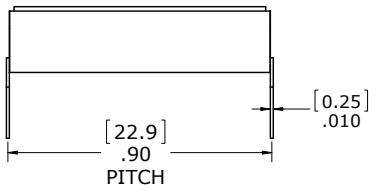
THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED:

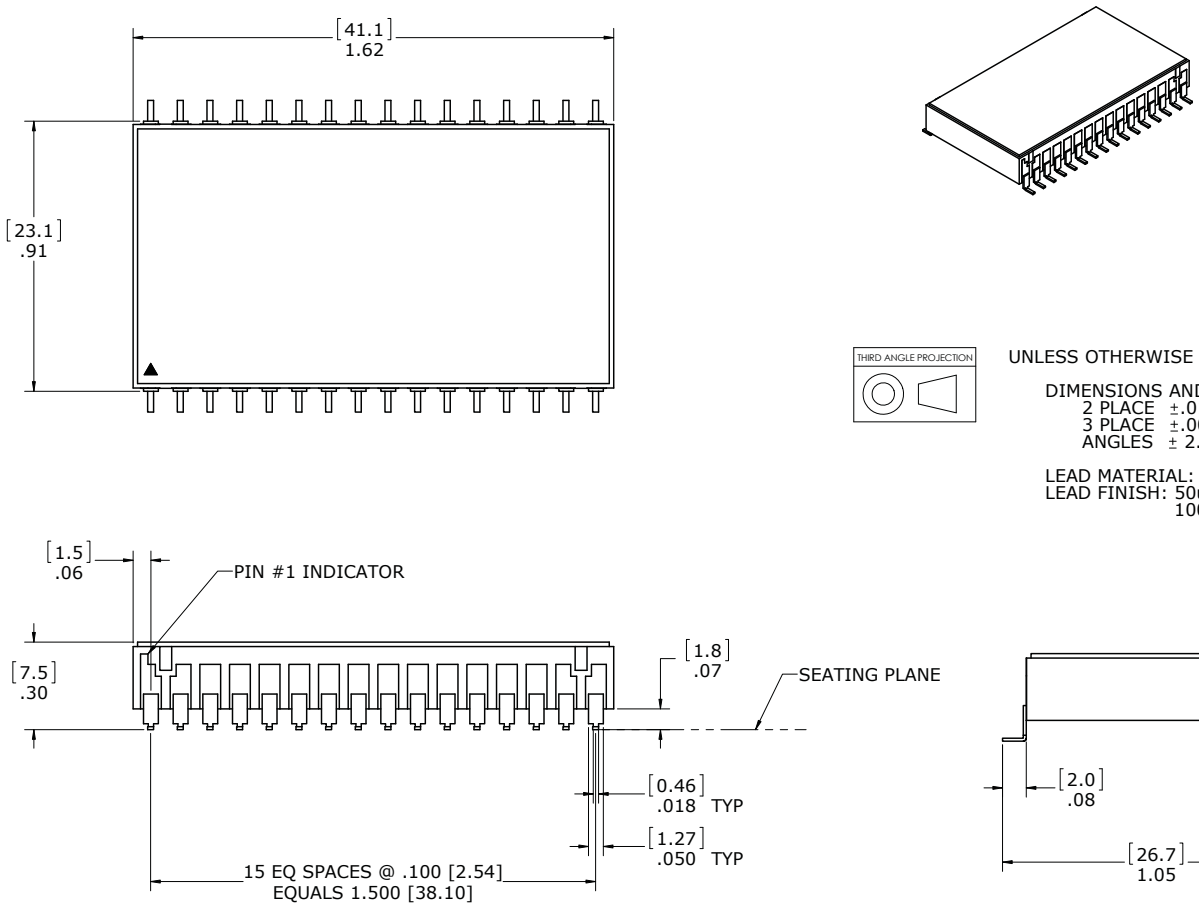
DIMENSIONS AND TOLERANCES:
2 PLACE ±.01 [0.25mm]
3 PLACE ±.005 [0.13mm]
ANGLES ± 2.0°

LEAD MATERIAL: KOVAR ALLOY
LEAD FINISH: 50u" MIN GOLD OVER
100u" NOM NICKEL





MECHANICAL DIMENSIONS – SURFACE MOUNT PACKAGE – INCHES (mm)



ORDERING INFORMATION				
MODEL NUMBER	**OPERATING TEMP. RANGE**	**32-PIN PACKAGE**	**ROHS**	**ACCESSORIES**
ADS-951MC	0 to +70°C	TDIP	No	
ADS-951ME	–40 to +110°C	TDIP	No	
ADS-951MM	–55 to +125°C	TDIP	No	
ADS-951MC-C	0 to +70°C	TDIP	Yes	
ADS-951ME-C	–40 to +110°C	TDIP	Yes	
ADS-951MM-C	–55 to +125°C	TDIP	Yes	
ADS-951GC	0 to +70°C	SMT	No	ADS-B951 – Evaluation Board (without ADS-951)
ADS-951GE	–40 to +110°C	SMT	No	
ADS-951GM	–55 to +125°C	SMT	No	
ADS-951GC-C	0 to +70°C	SMT	Yes	
ADS-951GE-C	–40 to +110°C	SMT	Yes	
ADS-951GM-C	–55 to +125°C	SMT	Yes	
Receptacles for PC mounting can be ordered through AMP Inc., Part # 3-331272-8 (Component Lead Socket), 32 required. For availability of MIL-STD-883 product, contact DATEL.				

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