

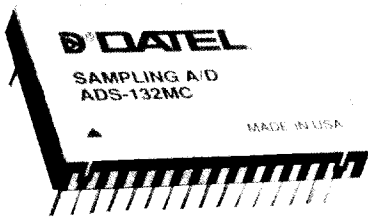
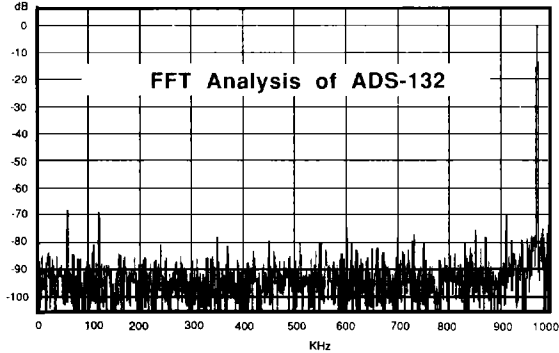
**ADS-132**  
12-Bit, 2.0 MHz, Low-Power  
Sampling A/D Converter

FEATURES

- 12-Bit resolution
- Internal sample hold
- 2.0 MHz minimum throughput
- Functionally complete
- Small 32-pin DIP
- Low-power, 2.9 Watts
- Three-state output buffers
- Samples up to Nyquist

GENERAL DESCRIPTION

DATEL's ADS-132 is a 12-bit, functionally complete, sampling A/D converter that is packaged in a small 32-pin DIP. The ADS-132 digitizes sinusoidal signals at a 2.0 MHz minimum throughput rate while dissipating only 2.9 Watts.



MECHANICAL DIMENSIONS  
INCHES (mm)

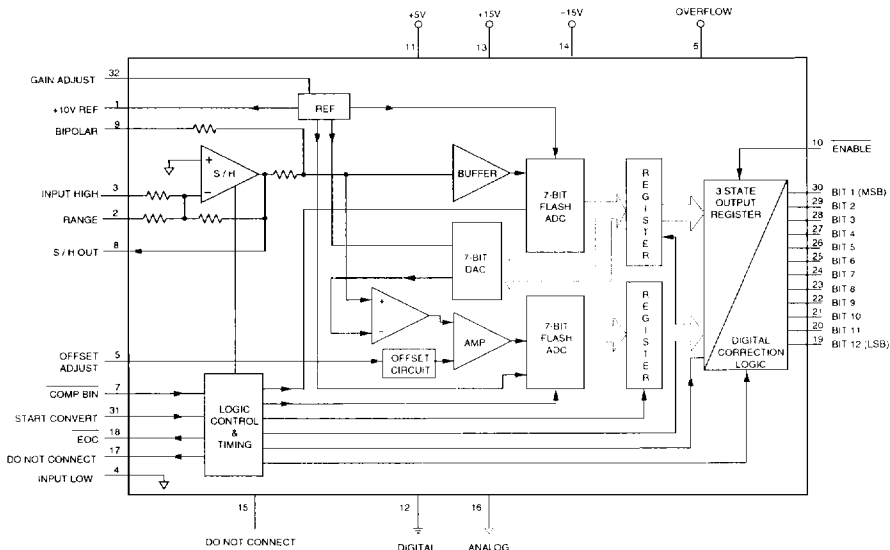
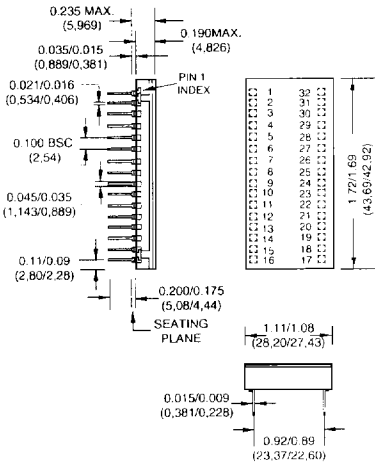


Figure 1. ADS-132 Simplified Block Diagram

| PIN | FUNCTION         |
|-----|------------------|
| 1   | +10V REF. OUT    |
| 2   | RANGE            |
| 3   | INPUT HIGH       |
| 4   | INPUT LOW        |
| 5   | OFFSET ADJUST    |
| 6   | OVERFLOW         |
| 7   | COMP. BIN        |
| 8   | S/H OUT          |
| 9   | BIPOLAR          |
| 10  | ENABLE (1 - 12)  |
| 11  | +5               |
| 12  | DIGITAL GROUND   |
| 13  | +15V             |
| 14  | -15V             |
| 15  | DO NOT CONNECT   |
| 16  | ANALOG GROUND    |
| 17  | DO NOT CONNECT   |
| 18  | EOC              |
| 19  | BIT 12 OUT (LSB) |
| 20  | BIT 11 OUT       |
| 21  | BIT 10 OUT       |
| 22  | BIT 9 OUT        |
| 23  | BIT 8 OUT        |
| 24  | BIT 7 OUT        |
| 25  | BIT 6 OUT        |
| 26  | BIT 5 OUT        |
| 27  | BIT 4 OUT        |
| 28  | BIT 3 OUT        |
| 29  | BIT 2 OUT        |
| 30  | BIT 1 OUT (MSB)  |
| 31  | START CONVERT    |
| 32  | GAIN ADJUST      |

ABSOLUTE MAXIMUM RATINGS

| PARAMETERS                         | LIMITS                       | UNITS    |
|------------------------------------|------------------------------|----------|
| +15V Supply (Pin 13)               | 0 to +18                     | Volts dc |
| −15V Supply (Pin 14)               | 0 to −18                     | Volts dc |
| +5V Supply (Pin 11)                | −0.5 to +7.0                 | Volts dc |
| Digital Inputs<br>(Pins 7, 10, 31) | −0.3 to V <sub>DD</sub> +0.3 | Volts dc |
| Analog Input (Pin 3)               | −15 to +15                   | Volts dc |
| Lead Temp. (10 Sec.)               | 300 max                      | °C       |
| Thermal Resistance<br>@ J-C        | 2.7                          | °C/W     |
| @ CA                               | 11.2                         | °C/W     |

FUNCTIONAL SPECIFICATIONS

Apply over the operating temperature range and at ±15V dc and ±5V dc unless otherwise specified.

| ANALOG INPUTS                                                                                   | MIN.                           | TYP.                                         | MAX.                    | UNITS                                                    |
|-------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------------------|-------------------------|----------------------------------------------------------|
| Input Voltage Range<br>ADS-132 (see Table 1 also)                                               | —                              | 0 to −5<br>0 to −10<br>0 to +10<br>±5<br>±10 | —                       | Volts dc<br>Volts dc<br>Volts dc<br>Volts dc<br>Volts dc |
| Input Impedance<br>Input Ranges:<br>(0 to −10, +10, ±10)<br>(0 to −5, ±5V)                      | 800<br>400                     | 1000<br>500                                  | —                       | Ohms<br>Ohms                                             |
| Input Capacitance                                                                               | —                              | 2                                            | —                       | pf                                                       |
| DIGITAL INPUTS                                                                                  |                                |                                              |                         |                                                          |
| Logic Levels<br>Logic "1"<br>Logic "0"<br>Logic Loading "1"<br>Logic Loading "0"                | 2.0<br>—<br>—<br>—             | —<br>—<br>—<br>—                             | —<br>0.5<br>5.0<br>−600 | Volts dc<br>Volts dc<br>μA<br>μA                         |
| PERFORMANCE                                                                                     |                                |                                              |                         |                                                          |
| Integral Non-Linearity<br>@ <i>f</i> <sub>IN</sub> = 1 MHz<br>0 to +70 °C<br>−55 to +125 °C     | —<br>—                         | —<br>—                                       | ±1<br>±2                | LSB<br>LSB                                               |
| Differential Non-Linearity<br>@ <i>f</i> <sub>IN</sub> = 1 MHz<br>0 to +70 °C<br>−55 to +125 °C | —<br>—                         | —<br>—                                       | ±3/4<br>±1.5            | LSB<br>LSB                                               |
| FS Absolute Accuracy †<br>0 to +70 °C<br>−55 to +125 °C                                         | —<br>—                         | ±0.1<br>±0.2                                 | ±0.32<br>±0.5           | %FSR<br>%FSR                                             |
| Unipolar Zero Error †<br>0 to +70 °C<br>−55 to +125 °C                                          | —<br>—                         | ±0.05<br>±0.18                               | ±0.25<br>±0.37          | %FSR<br>%FSR                                             |
| Bipolar Zero Error †<br>0 to +70 °C<br>−55 to +125 °C                                           | —<br>—                         | ±0.05<br>±0.18                               | ±0.25<br>±0.37          | %FSR<br>%FSR                                             |
| Bipolar Offset Error †<br>0 to +70 °C<br>−55 to +125 °C                                         | —<br>—                         | ±0.1<br>±0.53                                | ±0.38<br>±0.73          | %FSR<br>%FSR                                             |
| Gain Error †<br>0 to +70 °C<br>−55 to +125 °C                                                   | —<br>—                         | ±0.1<br>±0.53                                | ±0.38<br>±0.73          | %FSR<br>%FSR                                             |
| No Missing Codes (12 Bits)                                                                      | Over the Operating Temp. Range |                                              |                         |                                                          |

† See Technical Note 1

| OUTPUTS                                                                                                               | MIN.                                                                                         | TYP.                   | MAX.                      | UNITS                                |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------|---------------------------|--------------------------------------|
| Resolution<br>Output Coding                                                                                           | 12 Bits<br>Straight binary/offset binary<br>Complementary binary/Complementary offset binary |                        |                           |                                      |
| Logic Levels<br>Logic "1"<br>Logic "0"<br>Logic Loading "1"<br>Logic Loading "0"                                      | 2.4<br>—<br>—<br>—                                                                           | —<br>—<br>—<br>—       | —<br>0.4<br>−160<br>4.8   | Volts dc<br>Volts dc<br>μA<br>mA     |
| Internal Reference Voltage<br>+25 °C<br>Drift<br>External Current                                                     | +9.98<br>—<br>—                                                                              | +10.0<br>±5<br>—       | +10.02<br>+30<br>2        | Volts dc<br>ppm/°C<br>mA             |
| DYNAMIC PERFORMANCE                                                                                                   |                                                                                              |                        |                           |                                      |
| Conversion Rate, 12-Bits<br>Total Harm. Distort. (−0.5 dB)<br>DC to 100 kHz<br>100 kHz to 500 kHz<br>500 kHz to 1 MHz | 2<br>—<br>—<br>—                                                                             | —<br>−80<br>−75<br>−71 | —<br>−72<br>−68<br>−67    | MHz<br>FS, −dB<br>FS, −dB<br>FS, −dB |
| Signal to Noise Ratio<br>(w/o distort., −0.5 dB)<br>DC to 100 kHz<br>100 kHz to 500 kHz<br>500 kHz to 1 MHz           | 70<br>68<br>66                                                                               | 72<br>70<br>68         | —<br>—<br>—               | FS, −dB<br>FS, −dB<br>FS, −dB        |
| Signal to Noise Ratio ①<br>(and distort., −0.5 dB)<br>DC to 100 kHz<br>100 kHz to 500 kHz<br>500 kHz to 1 MHz         | 68<br>66<br>65                                                                               | 70<br>68<br>67         | —<br>—<br>—               | FS, −dB<br>FS, −dB<br>FS, −dB        |
| Spurious Free Dynamic ②<br>Range (−0.5 dB)<br>DC to 100 kHz<br>100 kHz to 500 kHz<br>500 kHz to 1 MHz                 | —<br>—<br>—                                                                                  | −81<br>−76<br>−72      | −73<br>−69<br>−68         | FS, −dB<br>FS, −dB<br>FS, −dB        |
| Two-Tone Intermodulation<br>Distort. ( <i>f</i> <sub>IN</sub> = 490 kHz,<br>480 kHz, FS = 2 MHz, −0.5 dB)             | —                                                                                            | −70                    | −67                       | FS, −dB                              |
| Input Bandwidth<br>Small Signal (−20 dB input)<br>Large Signal (−3 dB input)                                          | 16<br>8                                                                                      | —<br>—                 | —<br>—                    | MHz<br>MHz                           |
| Slew Rate<br>Aperture Delay Time<br>Feedthrough Rejection<br>Overvoltage Recovery Time                                | —<br>—<br>—<br>—                                                                             | 300<br>6<br>−74<br>—   | —<br>—<br>—<br>1,000      | V / μSec.<br>nSec.<br>dB<br>nSec.    |
| S/H Acquisition Time<br>to 0.01% FS (10V step)<br>S/H Acquisition Time<br>to 0.1% FS (10V step)                       | —<br>—<br>—                                                                                  | 160<br>—<br>100        | 200<br>—<br>170           | nSec.<br>—<br>nSec.                  |
| POWER REQUIREMENTS                                                                                                    |                                                                                              |                        |                           |                                      |
| Power Supply Range<br>+15V dc Supply<br>−15V dc Supply<br>+5V dc Supply                                               | +14.25<br>−14.25<br>+4.75                                                                    | +15.0<br>−15.0<br>+5.0 | +15.75<br>−15.75<br>+5.25 | Volts dc<br>Volts dc<br>Volts dc     |
| Power Supply Current<br>+15V dc Supply<br>−15V dc Supply<br>+5V dc Supply ③                                           | —<br>—<br>—                                                                                  | +75<br>−60<br>+155     | +82<br>−75<br>+200        | mA<br>mA<br>mA                       |
| Power Dissipation<br>Power Supply Rejection                                                                           | —<br>—                                                                                       | 2.9<br>—               | 3.2<br>0.01               | Watts<br>%FSR/%V                     |
| PHYSICAL/ENVIRONMENT                                                                                                  |                                                                                              |                        |                           |                                      |
| Operating Temperature Range<br>−MC (case)<br>−MM (case)                                                               | 0<br>−55<br>−65                                                                              | —<br>—<br>—            | +70<br>+125<br>+150       | °C<br>°C<br>°C                       |
| Storage Temperature Range<br>Package Type<br>Weight                                                                   | 32-pin DIP<br>0.42 ounces (12 grams)                                                         |                        |                           |                                      |

① Effective bits is equal to:  
(SNR + Distortion) — 1.76 +  $\left[ 20 \log \frac{\text{Full Scale Amplitude}}{\text{Actual Input Amplitude}} \right]$   
6.02

② Spurious Free Dynamic Range (SFDR); same specifications for In-Band Harmonics.  
③ +5V power usage at 1 TTL logic loading per data output bit.

Specifications subject to change without notice.

TECHNICAL NOTES

1. Use external potentiometers to remove system errors or the small initial errors to zero. Use a 20K trimming potentiometer for gain adjustment with the wiper tied to pin 32 (ground pin 32 for operation without adjustments.) Use a 20K trimming potentiometer with the wiper tied to pin 5 for zero/offset adjustment (leave pin 5 open for operation without adjustment.) See Figure 3.
2. Always connect the analog and digital grounds to a ground plane beneath the converter for best performance. The analog and digital grounds are not connected internally.
3. Bypass the analog and digital supplies and the +10V reference (pin 1) to ground with a 4.7  $\mu$ F, 25V tantalum electrolytic capacitor in parallel with a 0.1  $\mu$ F ceramic capacitor. Bypass the +10V reference (pin 1) to ANALOG GROUND (pin 16)
4. To enable the three-state outputs, connect  $\overline{\text{ENABLE}}$  (pin 10) to a logic "0" (low). To disable, connect pin 10 to a logic "1" (high).
5. The ADS-132 is in the sample mode when the internal S/H CONTROL pin is high (power-up state). The START CONVERT pulse should occur at a time delay equal to the desired acquisition time minus the 10 ns delay from START CONVERT high to S/H CONTROL low. This assures the sample-hold has the minimum required acquisition time for the particular application mode.
6. Upon going into the hold mode there will be a 85 ns maximum delay before  $\overline{\text{EOC}}$  goes high and the A/D conversion begins. This consists of the remaining 50 ns of the START CONVERT (10 ns is part of the acquisition time) and a 20 ns maximum delay from START CONVERT low to  $\overline{\text{EOC}}$  high. The hold mode settling time requirement is met during this time.
7. Figure 2 shows the relationship between the various input signals. The timing shown applies over the operating temperature range and over the operating power supply range. These times are guaranteed by design.
8. Re-initiating the START CONVERT (pin 16) while  $\overline{\text{EOC}}$  is a logic "1" (high) results in a new conversion sequence. Subsequent data will then be valid after the minimum acquisition time is observed.

CALIBRATION PROCEDURE

1. Connect the converter per Figure 3, Table 1, and Table 4 for the appropriate full-scale range (FSR). Apply a pulse of 60 nanoseconds minimum to the START CONVERT input (pin 31) at a rate 500 kHz. This rate reduces flicker if using LED's on the outputs for calibration purposes.
2. Zero Adjustments  
Apply a precision voltage reference source between the amplifier's analog input and ground. Adjust the output of the reference source per Table 2. For unipolar, adjust the zero trimming potentiometer so that the output code flickers equally between 0000 0000 0000 and 0000 0000 0001 (straight binary) or between 1111 1111 1111 and 1111 1111 1110 (complementary binary).  
  
For bipolar operation, adjust the trimpot until the code flickers equally between the 1000 0000 0000 and 1000 0000 0001 (offset binary) or between 0111 1111 1111 and 0111 1111 1110 (complementary offset binary).
3. Full-Scale Adjustment  
Set the output of the voltage reference used in step 2 to the value shown in Table 2. Adjust the gain trimming potentiometer until the output code flickers equally between 1111 1111 1110 and 1111 1111 1111 (offset binary) or between 0000 0000 0001 and 0000 0000 0000 (complementary offset binary)
4. To confirm proper operation of the device, vary the precision reference voltage source to obtain the output coding listed in Table 3.

Table 1. ADS-132 Input Range Selection

| INPUT RANGE   | INPUT PIN | TIE TOGETHER                                    |
|---------------|-----------|-------------------------------------------------|
| 0 to -5V dc   | Pin 3     | Pins 8 and 9; pins 2 and 3                      |
| 0 to -10V dc  | Pin 3     | Pins 8 and 9                                    |
| 0 to +5V dc   | Pin 3     | Pins 8 and Pin 9; pin 2 to a -5 volt Reference  |
| 0 to +10V dc  | Pin 3     | Pins 8 and 9, pin 2 to an EXT. -10V Reference * |
| $\pm 5$ V dc  | Pin 3     | Pins 1 and 9, pins 2 and 3                      |
| $\pm 10$ V dc | Pin 3     | Pins 1 and 9                                    |

\* EXT. -10V REF. may be referenced to pin 1, INT. +10V REF.

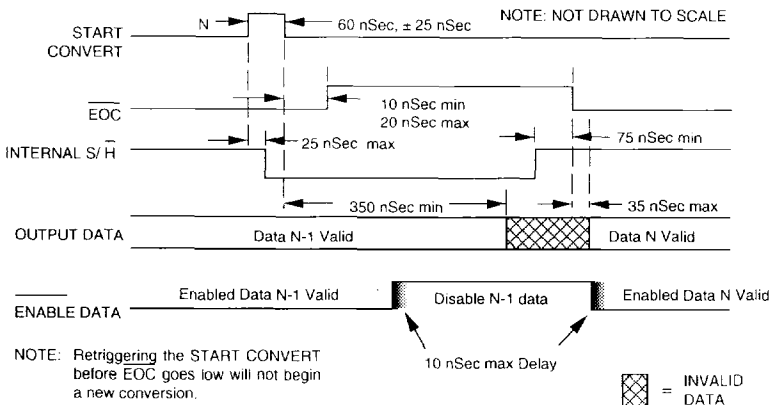


Figure 2. ADS-132 Timing Diagram

Table 3. Output Coding

|                |                    |           |          |           | STRAIGHT BIN.  |     | COMP. BINARY    |     |              |          |               |
|----------------|--------------------|-----------|----------|-----------|----------------|-----|-----------------|-----|--------------|----------|---------------|
| UNIPOLAR SCALE | INPUT RANGES, V dc |           |          |           | OUTPUT CODING  |     |                 |     | INPUT RANGES |          | BIPOLAR SCALE |
|                | 0 to +5V           | 0 to +10V | 0 to -5V | 0 to -10V | MSB            | LSB | MSB             | LSB | ±5V dc       | ±10V dc  |               |
| +FS - 1 LSB    | +4.998V            | +9.9976V  | -4.998V  | -9.9976V  | 1111 1111 1111 |     | 0000 0000 0000  |     | +4.9976V     | +9.9951V | +FSB - 1 LSB  |
| 7/8 FS         | +4.375V            | +8.7500V  | -4.375V  | -8.7500V  | 1110 0000 0000 |     | 0001 1111 1111  |     | +3.7500V     | +7.5000V | +3/4 FS       |
| 3/4 FS         | +3.750V            | +7.5000V  | -3.750V  | -7.5000V  | 1100 0000 0000 |     | 0011 1111 1111  |     | +2.5000V     | +5.0000V | +1/2 FS       |
| 1/2 FS         | +2.500V            | +5.0000V  | -2.500V  | -5.0000V  | 1000 0000 0000 |     | 0111 1111 1111  |     | 0.0000V      | 0.0000V  | 0             |
| 1/4 FS         | +1.250V            | +2.5000V  | -1.250V  | -2.5000V  | 0100 0000 0000 |     | 1011 1111 1111  |     | -2.5000V     | -5.0000V | -1/2 FS       |
| 1/8 FS         | +0.625V            | +1.2500V  | -0.625V  | -1.2500V  | 0010 0000 0000 |     | 1101 1111 1111  |     | -3.7500V     | -7.5000V | -3/4 FS       |
| 1/LSB          | +0.0012V           | +0.0024V  | 0.0012V  | -0.0024V  | 0000 0000 0001 |     | 1111 1111 1110  |     | -4.9976V     | -9.9951V | -FS + 1 LSB   |
| 0              | 0.0000V            | 0.0000V   | 0.0000V  | 0.0000V   | 0000 0000 0000 |     | 1111 1111 1111  |     | -5.0000V     | -10.000V | -FS           |
|                |                    |           |          |           | OFFSET BINARY  |     | COMP. OFF. BIN. |     |              |          |               |

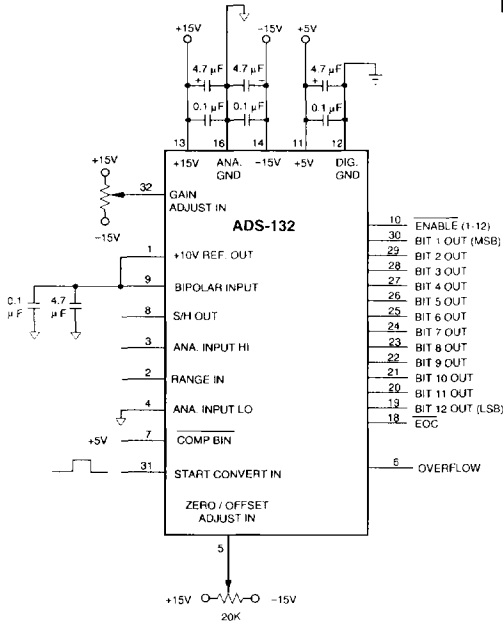


Figure 3. Typical ADS-132 Connection Drawing

Table 4. COMP BIN (Pin 7) Connection

| INPUT RANGE | BINARY              | COMPLEMENTARY BINARY |
|-------------|---------------------|----------------------|
|             | Pin 7 Logic State * |                      |
| 0 to +5V    | Low                 | High                 |
| 0 to +10V   | Low                 | High                 |
| 0 to -5V    | High                | Low                  |
| 0 to -10V   | High                | Low                  |
| ±5V         | Low                 | High                 |
| ±10V        | Low                 | High                 |

\* For logic state low, connect to +5V. For logic state high, leave open.

Table 2. ADS-132 Zero and Gain Adjust

| FSR          | ZERO ADJUST<br>+1/2 LSB | GAIN ADJUST<br>+FS -1 1/2 LSB |
|--------------|-------------------------|-------------------------------|
| 0 to -5V dc  | -0.61 mV                | -4.9982V dc                   |
| 0 to -10V dc | -1.22 mV                | -9.9963V dc                   |
| 0 to +5V dc  | +0.61 mV                | +4.9982V dc                   |
| 0 to +10V dc | +1.22 mV                | +9.9963V dc                   |
| ±5V dc       | +1.22 mV dc             | +4.9963V dc                   |
| ±10V dc      | +2.44 mV dc             | +9.9927V dc                   |

ORDERING INFORMATION

| MODEL       | OPERATING TEMP. RANGE          |
|-------------|--------------------------------|
| ADS-132MC   | 0 °C to +70 °C                 |
| ADS-132MM   | -55 °C to +125 °C              |
| ADS-132/883 | -55 °C to +125 °C              |
| ADS-EVAL1   | Evaluation Board (w/o ADS-132) |

Receptacle for PC board mounting can be ordered through Amp. Inc., PN 3-331272-8 (Component lead socket), 24 required.

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