# SAMPLE-AND-HOLD AMPLIFIERS
## SHA-1A, 2A, 3, 4, 5, 6




**GENERAL DESCRIPTION**
Analog Devices' wide selection of Sample-and-Hold Amplifiers (SHA's) permits the selection of a SHA that is well suited for virtually any application. Each type offers a unique combination of speed, accuracy, and cost.

**SHA-1A**
The SHA-1A is a general purpose SHA offering moderately high speed and accuracy at a reasonable price. It settles to 0.01% in under 5μs, and its droop rate (decay when in HOLD) is no greater than 50μV/μs.

**SHA-2A**
The SHA-2A is a very fast Sample-and-Hold module with accuracy and dynamic performance that make it appropriate for use with very fast 12 bit A/D converters. It settles to 0.1% in less than 300ns, and to 0.01% in less than 500ns.

**SHA-3 and SHA-4**
These two SHA's were designed for high accuracy at longer hold times. They settle to 0.01% in 75μs or less. The two differ in that when switched from HOLD to SAMPLE, the SHA-4 settles more rapidly than does the SHA-3.

**SHA-5**
The SHA-5 is a low cost general purpose sample-and-hold that offers good performance at a very low price. It settles to 0.01% in 15μs, and has a droop rate of only 5μV/ms.

**SHA-6**
The SHA-6 was designed as a companion to the high resolution ADC-16Q A/D converter. It will acquire a signal to 16 bit accuracy (0.00075%) in 5ms, and then hold it long enough for the ADC-16Q to convert it to a 16 bit digital word. It features excellent gain stability over both time and temperature.

**BLOCK DIAGRAM**
**SHA-2A**

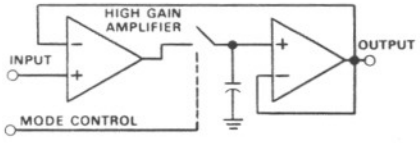
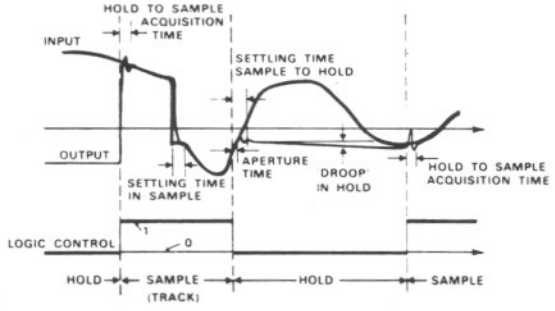



**ILLUSTRATION OF SPECIFICATIONS**




**PIN DESIGNATIONS: SHA-5**

| | |
|---|---|
| 1. ANALOG GROUND | 8. LOGIC GROUND |
| 2. -15V | 9. N.C. |
| 3. +15V | 10. N.C. |
| 4. N.C. | 11. N.C. |
| 5. N.C. | 12. ANALOG OUTPUT |
| 6. SIGNAL IN | 13. NO PIN |
| 7. CONTROL IN | 14. N.C. |

**SPECIFICATION SUMMARY** (Typical @ +25°C unless otherwise noted)

| APPLICATIONS | General Purpose | Fast | Low Droop Slow Settle | Low Droop Fast Settle | Low Cost | High Resolution |
|---|---|---|---|---|---|---|
| Model[1] | SHA-1A | SHA-2A[2] | SHA-3[3] | SHA-4[3] | SHA-5 | SHA-6 |
| Acquisition Time | 5μs to 0.01% | 500ns to 0.01% | 75μs to 0.01% | 75μs to 0.01% | 15μs to 0.01% | 5ms to 0.00075% |
| Droop Rate | 50μV/ms max | 10μV/μs | 10μV/ms | 10μV/ms | 5μV/ms | 10mV/sec max |
| Input Range | ±10V | ±10V | ±10V | ±10V | ±10V | ±11V |
| Gain | 1 | 1 | 1 | 1 | 1 | 1 to 1000 |
| Gain Error | +0, -0.05% | +0, -0.01% | ±0.01% | ±0.01% | ±0.01% | ±0.2%[4] |
| Input Impedance | $10^{12}\Omega$ | $10^{11}\Omega$ | $10^{8}\Omega$ | $10^{8}\Omega$ | $4 \times 10^{9}\Omega$ | $10^{9}\Omega$ |
| Aperture Delay | 40ns | 10ns | 50ns | 50ns | 40ns | -1.7μs |
| Aperture Jitter | 5ns | 0.25ns | 5ns | 5ns | 4ns | 10ns |
| Power Requirements ±15V @ | 15mA | 100mA | 15mA | 18mA | 25mA | 17mA |
| Package Size | 2" x 2" x 0.4" | 2" x 3" x 0.4" | 1 1/8" x 2" x 0.4" | 1 1/8" x 2" x 0.4" | 1 1/8" x 2" x 0.4" | 2" x 4" x 0.4" |
| Package Style | C-1 | C-2 | C-4 | C-4 | C-4 | C-3 |
| Price (1-9) | $150. | $225. | $95. | $120. | $47. (100+) $32. | $375. |

[1] Mode control input on all SHA's is TTL/DTL compatible. On all models except SHA-6, Logic "1" is sample and Logic "0" is hold. On SHA-6, Logic "0" is sample and Logic "1" is hold.
[2] SHA-2A may be used as a follower or inverter. It can also be used at gains higher than unity with appropriate degradation in bandwidth.
[3] SHA-3 and SHA-4 differ only in that SHA-4 settles much faster when switched from HOLD to SAMPLE. Settling Time to ±1mV is 100μs for SHA-3 and 20μs for SHA-4.
[4] Gain error from formula used to calculate value of gain resistor. Gain stability is ±0.0002%/month and ±0.0002%/°C.



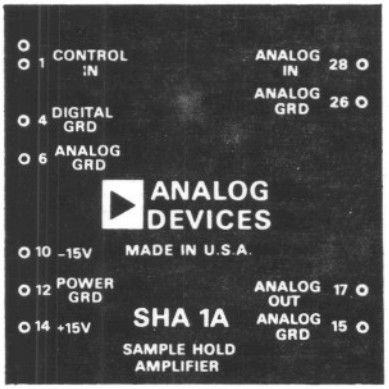
**PIN DESIGNATIONS: SHA-6**

3. $+E_{OUT}$
5. $-E_{OUT}$
16. -15V
18. ANALOG COMMON
19. +15V
36. MODE CONTROL INPUT
37. MODE CONTROL COMMON
59. $-E_{IN}$
64. GAIN CONTROL
67. $+E_{IN}$
69. GAIN CONTROL

NOTE: The pins listed above are the only pins that appear on the SHA-6.

SHA-1A

Top View




SHA-5

Top View


SHA-2A Top View

## GENERAL DESCRIPTION

The SHA IA is a fast sample-and-hold module with low droop rate and overall accuracy compatible with 12-bit A/D conversion systems operating to ½LSB accuracy. When in the "sample" mode, the module appears as a fast amplifier with 5μs settling time to 0.01%, 1nA input current, 25μV/°C drift, and unity gain with ±10V at ±20mA output current capability. When in the "hold" mode, the droop rate is 50μV/ms max, so the SHA IA will hold an input signal to 0.01% of full scale (20V p-p) for 40ms, sufficient for 12-bit A/D conversion.

## SAMPLE TO HOLD CHARACTERISTICS

Of prime importance in selecting Sample-and-Hold amplifiers is the transition characteristics when the module is commanded into hold by the digital control line. A finite delay will occur between initiation of the hold command, and actual disconnection of the hold capacitor from the input buffer amplifier. In the SHA IA, this delay time is 40ns maximum. The uncertainty, or jitter over which this delay time will vary from cycle to cycle, as the module is repeatedly commanded into hold, is ±5ns. In most systems, the jitter specification is the limiting factor on overall system speed for a given accuracy, since fixed delays can be removed by adjusting the system timing. The 5ns jitter specification means the SHA IA can track a signal slewing up to 0.2V/μs, and "capture" that signal to within a 1mV accuracy for A/D conversion.

## OVERALL ACCURACY

The SHA IA is guaranteed to have an overall throughput non linearity of 2mV max over a ±10V input range, or 1mV max over 0 to +10V inputs. This specification combines the effects of common mode errors, gain non linearity and sample to hold offset non linearity. It is no longer necessary to guess at the combined effects of individual errors since the SHA IA specification guarantees that its total non-linearity errors are sufficiently low to insure ½LSB accuracy in 12-bit systems.

## GROUNDING

Many data acquisition systems suffer from digital ground induced noise appearing in the analog system. To counteract this problem, the SHA IA has three separate ground systems. The digital ground is actually one side of a differential amplifier, with the Sample/Hold digital control input being the other input of this amplifier. This effectively prevents digital ground noise from being impressed into the analog signal channel. The power ground and analog input/output grounds are also separate, so that power supply ground noise is reduced by the rejection coefficients of the amplifiers, normally well over 90dB. Ground connection instructions are given in Figure 1.

A DC path must exist between the Analog, Digital, and power supply grounds. Multiple grounds on signal and power return lines should be avoided. If possible, only one external ground should exist on the Analog ground system

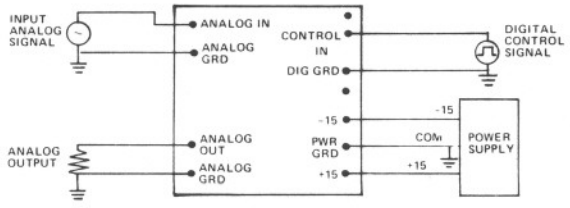



*Fig. 1 SHA IA Connections and Grounding*

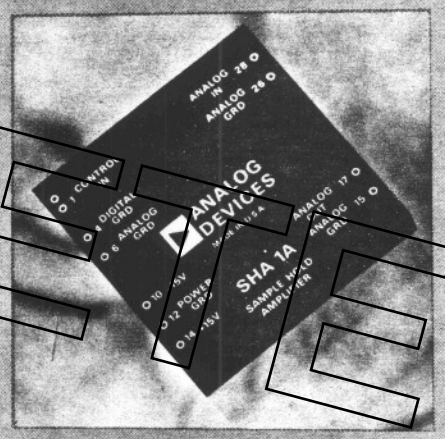


SHA IA

**SAMPLE AND HOLD MODULE**

## FEATURES

- 12-Bit System Compatible
- Throughput Non-Linearity 2mV Max Over ±10V Input Range
- Acquisition Time 5μs Max
- Input Buffer, $10^{12}\Omega$ $R_{in}$
- Independent Digital, Analog, and Power Grounds
- Modular 0.4" High Construction
- Standard ±15VDC Power
- No External Adjustments Required




## APPLICATIONS

- Data Acquisition Systems
- Data Distribution Systems
- Track and Hold
- Sample and Hold
- Peak Measurement Systems

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ANALOG DEVICES



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## SHA IA

SPECIFICATIONS (typical @ +25°C and nominal supply voltages, unless otherwise noted)

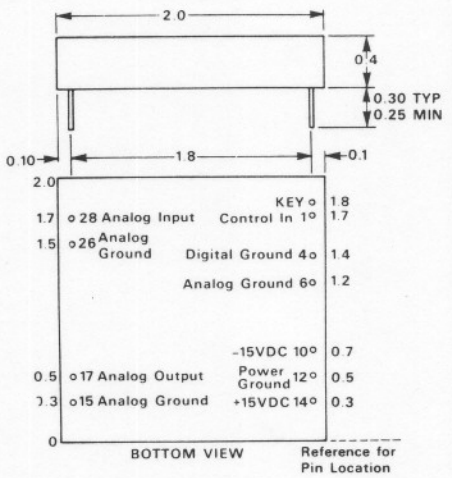
| | |
|---|---|
| **ACCURACY** | |
| Gain | +1 |
| Gain Error | +0.0,–0.05% max |
| Total Throughput Non Linearity | 2mV max over ±10V input range |
| (Includes Gain and Sample to Hold Offset Non Linearities) | 1mV max over 0 to +10V or 0 to –10V input range |
| **FREQUENCY RESPONSE IN SAMPLE MODE** | |
| Small Signal–3dB | 500kHz min |
| Slew Rate | 4V/μs |
| Settling Time to 0.01% for 20 Volt Input Step | 5μs max |
| **SAMPLE TO HOLD SWITCHING** | |
| Aperture Delay Time | 40ns max |
| Jitter (Cycle to Cycle Variance in Delay) | 5ns peak |
| Switching Transient Settling Time (to ±1mV) | 300ns |
| **HOLDING CHARACTERISTICS** | |
| Droop Rate | 50μV/ms max |
| Droop Rate vs. Temp. | X2/10°C |
| Feedthrough (10kHz, 20V p-p input) | 0.005% max |
| **HOLD TO SAMPLE SWITCHING** | |
| Acquisition Time to 0.01% of Full Scale | 5μs max |
| **INPUT CHARACTERISTICS** | |
| Input Resistance | $10^{12}$ ohms |
| Input Capacitance | 5pF max |
| Input Bias Current | 10nA max, 1nA typ |
| Initial Input Offset | 1mV max |
| Offset vs. Supply | 100μV/% |
| Offset vs. Temp. | 25μV/°C max |
| Input Voltage, Max. Safe | ±15V |
| Input Voltage, Normal Operation | ±10V |
| **OUTPUT CHARACTERISTICS** | |
| Output Voltage, Current | ±10V min at ±20mA min |
| Maximum Load Capacitance at Output | 500pF |
| **DIGITAL CONTROL** | |
| Logic Levels (DTL/TTL Comp.) | |
| ("1") Sample | +2V to +5.5V at 40nA |
| ("0") Hold | –0.5V to +0.8V at 20μA |
| **POWER REQUIREMENTS** | ±15VDC at +10mA,–15mA (±3% tolerance on voltage) |
| **TEMPERATURE RANGE** | |
| Rated Accuracy | 0°C to +70°C |
| Storage | –55°C to +85°C |

Specifications subject to change without notice



## OUTLINE DIMENSIONS AND PIN CONNECTIONS

(In Inches)




Pins: 0.019 ±.001 dia, Gold plated half-hard brass, per MIL-G-45204.

Pin designations are shown on bottom view for reference only.

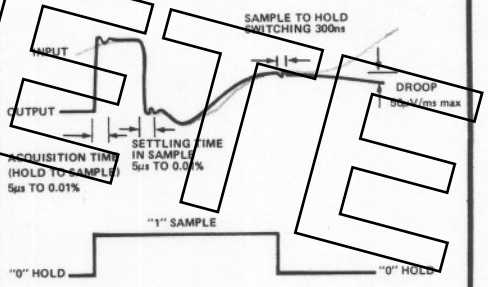



*Fig. 2 Illustration of Dynamic Specifications (not to scale)*

## OTHER PRODUCTS

**Multiplexer MPX-8A**
Available with 8 channels, digital addressing, expandable to 64 channels. Input range ±10V with standard ±15VDC supplies. Mosfet design prevents burn out due to power failure, –80dB cross-talk, 2μs max switching time. Accuracy to 0.01%.

**Analog to Digital Converter ADC-QM**
Available in 8-, 10-, or 12-bit resolution and accuracy. A 25μs conversion time and low 5ppm/°C gain TC. 2" x 4" x 0.4" package.

**Analog to Digital Converter ADC-12QZ**
An economical 12 bit device with a 40μs conversion time. Package size is 2" x 4" x 0.4"