ANALOG DEVICES

High Speed Hybrid
Track-and-Hold Amplifiers
HTC-0500

FEATURES
700ns Acquisition Time
<750mW Power Dissipation
14-Pin DIP
0.01% Linearity

APPLICATIONS
Data Acquisition Systems
Data Distribution Systems
Analog Delay and Storage
Peak Amplitude Measurements

GENERAL DESCRIPTION

The Analog Devices HTC-0500 Track/Sample Hold is a remarkable combination of speed and low power dissipation in a 14-pin DIP. Its low cost makes it extremely attractive for a wide range of applications which were often uneconomical until now.
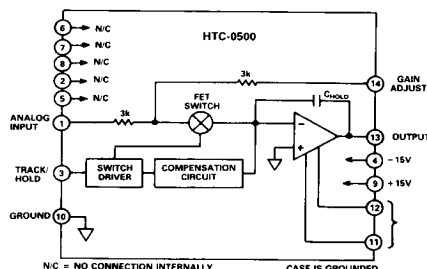
Exceptional speed and minimum power in a small, cost-effective package are not the only characteristics which make this unit worth serious consideration for a variety of uses. The innovative design ideas which have been included make it possible for the user to vary the gain of this inverting amplifier.

In many instances, Track/Sample-Hold devices may allow the user to decrease the gain, but increasing the gain is impossible. This is because the majority of these units close the feedback loop internally.

The HTC-0500, however, gives the designer flexibility when it is incorporated into its system application because it can be varied around its normal unity gain. In fact, as shown in the functional block diagram, the user must close the feedback loop externally with a strap to get proper operation.

Figure 2 shows a suggested method for changing gain over a range which is approximately 8 percent below to approximately 17 percent above nominal. This kind of potential gain variation can be an important element when the HTC-0500 is combined with other components in a system design. The gain of the HTC-0500 can be changed as necessary to compensate for variations in other portions of the system. External adjustments also allow the offset to be nulled.

HTC-0500 FUNCTIONAL BLOCK DIAGRAM

The HTC-0500 is a perfect choice for use with Analog Devices' converters such as the HAS-1202, AD578, and AD579 in applications which do not require the speed of the model HTC-0300 Track-and-Hold, but require higher speed than the ADSHC-85.

The standard unit is housed in a metal dual in-line package; its model number is HTC-0500AM. A temperature range of −55°C to +125°C is available with model HTC-0500SM.
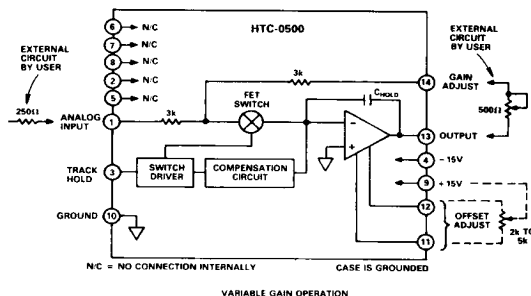

Figure 2.

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

	UNITS	HTC-0500AM	HTC-0500SM
ANALOG INPUT			
Voltage Range	V (min)	± 12 (± 10)	*
Overvoltage, no damage	V, max	± 15	*
Impedance	Ω (max)	3000 (± 15)	*
Initial Offset Voltage	mV, max	± 5, adjustable to zero	*
DIGITAL INPUT (TTL Compatible)	Voltage	Current	
Mode Control			
"Sample/Track" Logic "0"	0V to + 0.8V	2 Standard TTL Loads	*
"Hold" Logic "1"	+ 2.0V to + 5.5V	2 Standard TTL Loads	*
ANALOG OUTPUT			
Voltage	V (min)	± 12 (± 10)	*
Current	mA (min)	± 15 (± 10)	*
Impedance	Ω, max	1	*
Noise			
dc to 100kHz } Track Mode	μV rms	15	*
dc to 1.0 MHz }	μV rms	60	*
DC ACCURACY/STABILITY			
Gain	V/V	− 1.00	*
Gain Error	% (max)	± 0.1 (± 0.2)	*
Gain Nonlinearity (± 10V Output)	% (max)	± 0.01 (± 0.02)	*
Gain Temperature Coefficient	ppm/°C (max)	10 (15)	*
Input Offset vs. Temperature (Track)	μV/°C (max)	100 (200)	*
SAMPLE (TRACK) MODE DYNAMICS			
Frequency Response			
Small Signal (− 3dB)	MHz (min)	2 (1.5)	*
Large Signal (− 3dB)	MHz (min)	1.5 (1)	*
Slew Rate	V/μs (min)	55 (40)	*
SAMPLE (TRACK)-TO-HOLD SWITCHING			
Aperture Time	ns (max)	30 (± 5)	*
Aperture Uncertainty (Jitter)	ps (max)	60 (100)	*
Offset Step (Pedestal)	mV, max	± 5	*
Variation with Temperature	μV/°C, max	25	*
Switching Transient			
Amplitude	mV, max	100	*
Settling to 1mV	ns (max)	400 (600)	*
HOLD MODE DYNAMICS			
Droop Rate	μV/μs (max)	0.5 (2)	*
Variation with Temperature		Doubles/10°C Change	*
Feedthrough Rejection			
(10V p-p @ 300kHz)	dB (min)	80 (75)	*
HOLD-TO-SAMPLE (TRACK) DYNAMICS			
Acquisition Time (to ± 0.1%)			
10V Step	ns (max)	700 (800)	*
20V Step	ns (max)	900 (1100)	*
Acquisition Time (to ± 0.01%)			
10V Step	ns (max)	850 (1000)	*
20V Step	ns (max)	1100 (1300)	*
POWER REQUIREMENTS[1]			
Nominal Voltages	V (%)	± 15 (± 3)	*
Current	mA (max)	± 25 (± 27)	*
Power Supply Rejection			
(dc – 50kHz)	mV/V (max)	1.5 (3)	*
Pedestal Sensitivity to			
Power Supply			
+ 15V	mV/V (max)	3 (5)	*
− 15V	mV/V (max)	3 (5)	*
Power Dissipation	mW (max)	750 (810)	*
TEMPERATURE RANGE			
Operating (Case)	°C	− 25 to + 85	− 55 to + 125
Storage	°C	− 55 to + 125	*
THERMAL RESISTANCE[2]			
Junction to Air, θja (free air)	°C/W	53	*
Junction to Case, θjc	°C/W	12	*
MTBF			
Mean Time Between Failures	hours		5.48 × 10⁵
PACKAGE OPTION[3]			
14-Pin Metal DIL		HY14D	*

NOTES
*Specifications same as HTC-500AM.
[1]Recommended power supply ADI Model 902-2 ± 15V @ ± 100mA.
[2]Maximum junction temperature is 150°C.
[3]See Section 19 for package outline information.
Specifications subject to change without notice.

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APPLICATIONS

The HTC-0500 Track-and-Hold amplifier bridges the gap in price/performance trade-offs between monolithic Sample-Hold amplifiers such as the Analog Devices AD582 and AD583; and high-speed hybrid T/Hs such as the Analog Devices HTC-0300 and HTS-0025.

Designs which require faster acquisition speeds than those available with the AD582, AD583 or ADSHC-85, but do not need the high performance capabilities of either the HTC-0300 or HTS-0025, are ideal candidates for the HTC-0500.

The hallmarks of the HTC-0500 family are outstanding performance in a small 14-pin hybrid package at an economical price, which provides the designer with a cost-effective solution to digitizing applications.

TRACK-AND-HOLD (T/H) MODE

The HTC-0500, like other track-and-hold units, is a circuit which can continuously follow a changing analog signal; but can quickly switch into a hold mode to "capture" or "freeze" the signal at a point selected by the user. After the desired hold interval is completed, it is returned to the track mode of operation and reacquires the input signal.

Generally speaking, the HTC-0500 is used ahead of analog-to-digital converters to allow digitizing signals whose bandwidth is too high for the A/D alone to handle. It can also be used as a deglitcher on the output of D/A converters; analog holding functions, and for other processing of analog signals.

The T/H used with an A/D directly affects multiple parameters of performance within the system; resolution, accuracy, signal-handling capabilities, and multiple other characteristics are dependent on both the track-and-hold and the converter. The user needs to understand the interactions between the devices to assure optimum system use.

In the "track" mode, the HTC-0500 operates as an amplifier with a gain of −1, following all changes in the analog input.

The user determines the point at which the analog input will be "captured" by applying a TTL digital "1" logic signal to the

Track/Hold (Pin 3) input of the HTC-0500. The inverted analog output of the HTC-0500 is "held" at the value which was present at the time of the Hold Command, plus the aperture time.

The time relationships and the characteristics which affect the performance are illustrated in Figure 3.
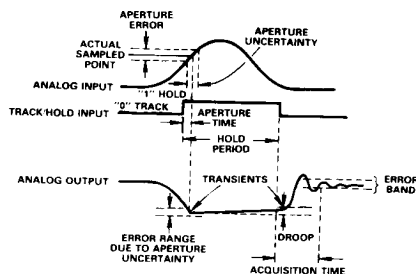

Figure 3. Track-and-Hold Operation

As shown, aperture time is a predictable, repeatable delay between the application of the Hold Command and the instant the analog input is sampled. Because of its characteristics, aperture delay should not be considered an error source, since it can be negated with correct system timing. Careful attention to the timing used within the system will assure the "freezing" of the signal being digitized will occur at the optimum point on the changing analog input.

Aperture uncertainty (or "jitter"), on the other hand, is a valid error source which has an effect on the sample point. This uncertainty is the result of noise signals of various kinds which modulate the phase of the hold command; its results show up as variations in the value of the signal being "captured," on a sample-to-sample basis. These variations manifest themselves as an effective aperture error on the input signal and a corresponding range of errors in the analog output which is "held".

The width of the aperture error (and, consequently, the output error range) is directly related to the dV/dt of the analog input. If one assigns a fixed aperture error for purposes of illustration, it is easy to visualize the effect of increasing the dV/dt of the analog signal; the error range at the output increases as the bandwidth of the input increases.

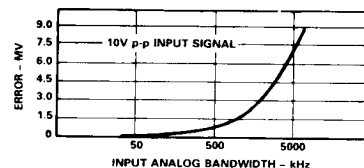The amount of error vis-a-vis bandwidth is illustrated in Figure 4.

Figure 4. HTC-0500 Error Due to Aperture Uncertainty

The droop shown in Figure 3 is the amount the analog output changes during the hold period and is the result of loading on the internal hold capacitor. The exceptionally low droop rate of the HTC-0500 is a "plus" for the system designer interested in using the unit with high-resolution A/D converters. Excessive droop rates in a T/H can cause converters of 10 or 12 bits or more to perform at less than their rated accuracies; the lower-order bits might be in error if there is a change at the converter input during the conversion cycle. Using the HTC-0500 for these kinds of applications decreases that possibility.

The acquisition time shown in Figure 3 is the interval from the change of state of the Hold Command to the time when the analog output has been reacquired and remains within a specified error band around its final value. Nyquist sampling is the most stringent application, since this would cause the maximum change from one sample to the next.

As shown in the SPECIFICATIONS section, the acquisition time of the HTC-0500 is truly remarkable for a unit in its price category, even when settling to accuracies of 0.01%. This characteristic makes it extremely attractive for the user who cannot compromise technical performance, but must also consider the economic consequences of his design.

The transients which are called out in Figure 3 are "spikes" which occur on the output of the T/H at the beginning and end of the hold period; they are the result of switching transients within the unit.

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Refer to Figure 5, which illustrates these switching transients, and pedestal voltage; and their time relationships to the Hold
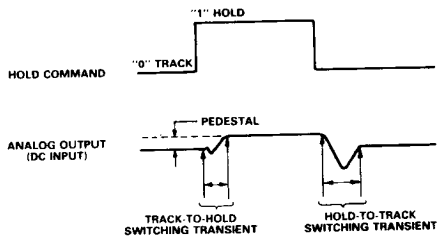

Figure 5.

Command. No inference should be drawn from the illustration regarding the relative amplitudes of the Hold Command, transients, and pedestal; refer elsewhere in this data sheet for actual values.

Pedestal during the hold period is a sample-to-hold offset caused by charge dumps when electronic switches are opened; coupling of the logic signal transients; and other phenomena. This pedestal can be eliminated with calibration when using the HTC-0500 with an A/D converter, since it shows up as an offset.

SAMPLE-AND-HOLD (S/H) MODE

Although it is classified as a track-and-hold unit and is usually operated in that mode as described above, the HTC-0500 can also be used as a sample-and-hold device.

When used in this manner, the output of the unit remains in the "hold" mode most of the time, but is switched to the "sample" (track) mode for brief intervals.
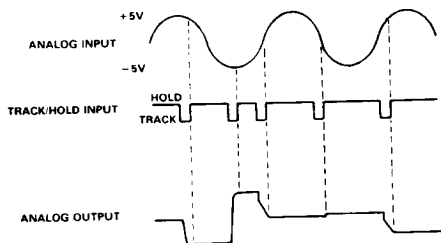
Refer to Figure 6.

Figure 6. Sample/Hold Operation

When operating as a S/H, the signal applied to the Track/Hold (Pin 3) input will usually be a digital logic "1" which holds the HTC-0500 output at the input value present at the time of the leading edge of the Track/Hold pulse.

Figure 6 shows asynchronous pulses applied to cause the output to reslew to new values. The trailing edge establishes the sample (track) mode; the leading edge returns the output to "hold".

The exceptional acquisition time of the HTC-0500 makes it attractive for sample-hold applications because of its ability to

acquire new output values quickly. This characteristic allows the width of the sample pulse to be considerably narrower than might be possible if using competing units.

The width of the sampling pulse applied at the Track/Hold input will be dependent on:

A. The acquisition time of the HTC-0500
B. The desired accuracy of the sample output
C. The amount of change which has occurred since the preceding sample.

Settling accuracy versus acquisition time is shown pictorially in Figure 7.
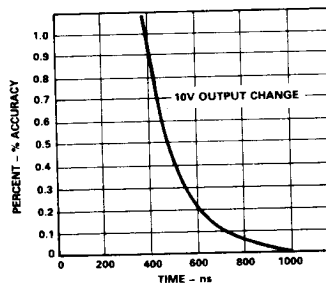

Figure 7. Settling Accuracy vs. Acquisition Time – HTC-0500

When operating in the track mode, the HTC-0500 is no different from any other amplifier; phase and gain are important to assure stable operation. In Figure 8, these charcteristics are plotted as a function of input frequency.
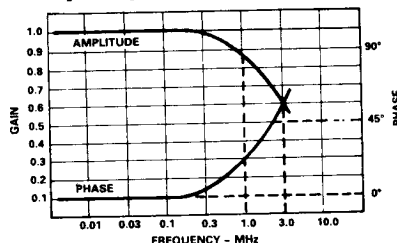

Figure 8. Amplitude and Phase Response – HTC-0500

ORDERING INFORMATION

All versions of the HTC-0500 are housed in 14-pin metal dual in-line packages. For commercial applications operating over a case temperature range of $-25°C$ to $+85°C$, specify model HTC-0500AM. For a temperature range of $-55°C$ to $+125°C$, specify model HTC-0500SM.

Mating individual pin sockets are available from AMP. Knock-out end type are part number 6-330808-0; open end type are 6-330808-3.