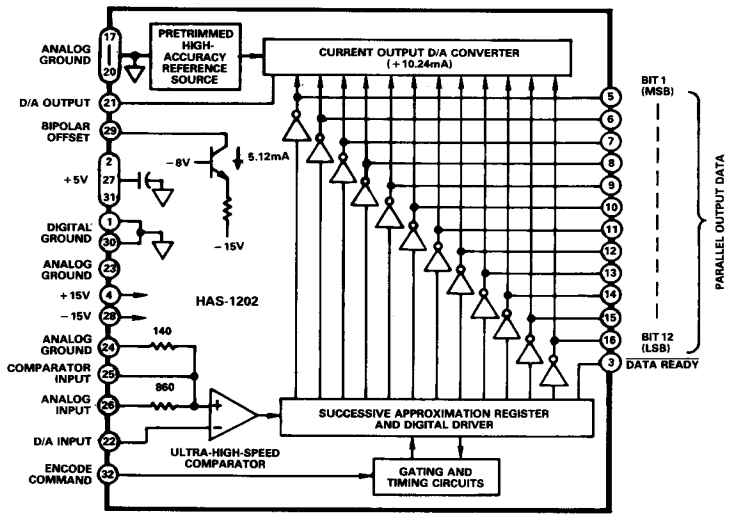
Ultrafast Hybrid Analog-to-Digital Converters

HAS-1202/HAS-1202A

FEATURES
Conversion Time of 1.56μs (HAS-1202A)
12-Bit Resolution
Conversion Rates to 641kHz
Adjustment-Free Operation

APPLICATIONS
Waveform Analysis
Fast Fourier Transforms
Radar Systems

HAS-1202 FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The HAS-1202 and improved HAS-1202A A/D converters are thick-film hybrid 12-bit converters housed in 32-pin ceramic or metal DIP packages. They can be used with high-performance track-and-hold (T/H) amplifiers to solve high-speed, high-resolution digitizing problems economically and feature conversion times of 2.86μs (HAS-1202) and 1.56μs (HAS-1202A).

These converters and the Analog Devices Model HTC-0300A T/H offer designers an opportunity to go from analog to digital with savings in power, board space, design time, and component costs.

They are ideally suited for applications which require excellent performance with a minimum of adjustments. Included in these potential uses are radar systems, PCM, data acquisition systems, and digital signal processing (DSP) systems of various kinds.

The HAS-1202 and HAS-1202A are rated over an operating temperature range of 0 to +70°C and are packaged in 32-pin DIP ceramic housings. The HAS-1202M and HAS-1202AM are rated over a range of −55°C to +85°C and are packaged in metal cases. For metal case units with an operating range of −55°C to +100°C and military screening, order part numbers HAS-1202MB or HAS-1202AMB. Their performance characteristics are identical except for differences in conversion rates; the HAS-1202 is specified for a maximum rate of 349kHz, while the HAS-1202A is capable of operating up to 641kHz.

SPECIFICATIONS (typical @ +25°C with nominal power supplies unless otherwise noted)

	HAS-1202A	HAS-1202
MAXIMUM RATINGS		
Positive Supply (Pin 4)	+16VDC	*
Negative Supply (Pin 28)	−16VDC	*
Logic Supply (Pins 2, 27, 31)	+7VDC	*
Analog Input (Pin 26)	20V	*
Logic Input (Encode Command @ Pin 32)	+7V	*
Temperature		
Operating (Case)	−55°C to +100°C	*
Storage	−55°C to +125°C	*

Parameter	Units	HAS-1202A	HAS-1202
RESOLUTION (FS = Full Scale)	Bits (%FS)	12 (0.025)	*
LEAST SIGNIFICANT BIT (LSB) WEIGHT	mV	2.5	*
ACCURACY			
Monotonicity		Guaranteed	*
Integral Nonlinearity	LSB	±1/2	*
Differential Nonlinearity	LSB	±1/2	*
Nonlinearity vs. Temperature	ppm/°C	3.5	*
Gain Error	%FS, max	0.08 (0.18)	*
Gain vs. Temperature	ppm/°C	60	*
Gain vs. Power Supply Changes	ppm/mV	2.2	*
DYNAMIC CHARACTERISTICS			
Conversion Rate	kHz, max	641	349
Conversion Time[1]	μs, max	1.56	2.86
vs. Temperature	%/°C	0.08	*
ANALOG INPUT			
Voltage Ranges			
Bipolar	V	±5.12	*
Unipolar	V	0 to +10.24	*
Overvoltage	V, max	20	*
Impedance	Ω, max	1,000 (±20)	*
Offset[2]			
Initial	mV, max	7 (38)	*
vs. Temperature			
Unipolar Input	ppm/°C	7	*
Bipolar Input	ppm/°C	35	*
ENCODE COMMAND INPUT[3]			
Logic Levels, TTL-Compatible	V	"0" = 0 to +0.4	*
		"1" = +2.4 to +5	*
Impedance	TTL Loads	1 "S" and 1 "LS"	*
Rise and Fall Times	ns, max	10	*
Width			
Min	ns	50	*
Frequency	kHz	dc to 641	dc to 349
DIGITAL OUTPUT			
Format	Data Bits	12 Parallel; NRZ	
	$\overline{\text{Data Ready}}$	1; RZ	*
Logic Levels, TTL-Compatible	V	"0" = 0 to +0.4	*
		"1" = +2.4 to +5	*
Drive	TTL Loads	5 Standard	*
Coding		Binary (BIN) Offset Bin. (OBN)	
POWER REQUIREMENTS			
+15V ±0.5V	mA (max)	48 (60)	*
−15V ±0.5V	mA (max)	30 (46)	*
+5V ±0.25V	mA (max)	150 (232)	*
Power Dissipation	W, max	1.9 (2.75)	*
TEMPERATURE RANGE[4]			
Operating	°C	0 to +70	*

NOTE: For operating range of −25°C to +85°C, specify HAS-1202M or HAS-1202AM; for operating range of −55°C to +100°C and military screening, specify HAS-1202MB or HAS-1202AMB.

THERMAL RESISTANCE[5]			
Junction to Air, θ_{JA} (Free Air)	°C/W	38	*
Junction to Case, θ_{JC}	°C/W	18	*
PACKAGE OPTION[6]			
M-32		HAS-1202A	HAS-1202

For applications assistance, call Computer Labs Division @ (919) 668-9511.

NOTES
*Specifications same as HAS-1202A.
[1]Measured from leading edge of Encode Command to trailing edge of $\overline{\text{Data Ready}}$ with 50ns encode pulse. Conversion time increases equally with increasing width of Encode Command.
[2]Externally adjustable to zero.
[3]Transition from digital "0" to digital "1" initiates encoding.
[4]Case temperature. Metal case HAS-1202M/HAS-1202AM have operating ranges of −25°C to +85°C; HAS-1202MB/HAS-1202AMB have operating ranges of −55°C to +100°C and military screening.
[5]Maximum junction temperature = 150°C.
[6]See Section 14 for package outline information.

Specifications subject to change without notice.

HAS-1202/HAS-1202A PIN DESIGNATIONS

(As viewed from bottom)

PIN	FUNCTION	PIN	FUNCTION
32	ENCODE COMMAND	1	DIGITAL GROUND
31	+5V	2	+5V
30	DIGITAL GROUND	3	$\overline{\text{DATA READY}}$
29	BIPOLAR OFFSET	4	+15V
28	−15V	5	BIT 1 (MSB)
27	+5V	6	BIT 2
26	ANALOG INPUT	7	BIT 3
25	COMPARATOR INPUT	8	BIT 4
24	ANALOG GROUND	9	BIT 5
23	ANALOG GROUND	10	BIT 6
22	D/A INPUT	11	BIT 7
21	D/A OUTPUT	12	BIT 8
20	ANALOG GROUND	13	BIT 9
19	ANALOG GROUND	14	BIT 10
18	ANALOG GROUND	15	BIT 11
17	ANALOG GROUND	16	BIT 12

NOTE
Analog Ground (Pins 17-20; 23; 24) and Digital Ground (Pins 1 and 30) Are Electrically Independent of Each Other. Connect Together Externally and to Low-Impedance Ground Plane as Close to Device as Possible.

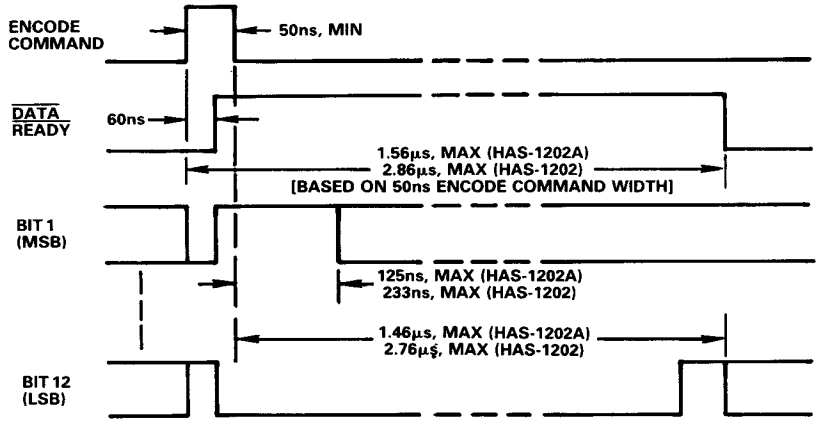


Figure 1. HAS-1202/1202A Timing Diagram

HAS-1202 TIMING

Refer to Figure 1, HAS-1202/1202A Timing Diagram.

The TTL-compatible Encode Command pulse (applied to Pin 32) has a minimum width of 50 nanoseconds. As the width of the Encode Command is increased from this minimum, the width of the Data Ready pulse (and the conversion time) is increased by an equal amount. For the HAS-1202, maximum encode frequency is 349kHz; for the HAS-1202A, maximum encode rate is 641kHz.

When the leading edge of the encode signal arrives, data outputs resulting from the preceding encode command will be at their previous values; the Data Ready pulse, being RZ, will be at a digital "0" logic level.

The Data Ready pulse will typically transition from digital "0" to digital "1" 60 nanoseconds after the leading (positive-going) edge of the Encode Command. It will remain at logic "1" until all data outputs have established levels indicative of the input analog value which is present during the conversion period.

As expected, and as shown in Figure 1, the length of the Data Ready pulse and the corresponding availability of digital output data are different for the two models of HAS-1202 converters because of their differences in speed capabilities.

CALIBRATION PROCEDURE

Input connections for the HAS-1202 and HAS-1202A A/D Converters are shown in Figure 2.

The values for resistors R_A, R1, and R2 in the Gain Adjust portion of Figure 2 are a function of the desired analog input range.

For full-scale inputs ≥10.496 volts:

$R1 = (FS\ p\text{-}p \times 97.66) - 1050$

R2 = Not used

$R_A = 100\Omega$

For full-scale inputs <10.496 volts:

$R1 = 0\Omega$

$$R2 = 860\left[\frac{(FS\ p\text{-}p \times 97.66) - 165}{1025 - (FS\ p\text{-}p \times 97.66)}\right]$$

$R_A = 50\Omega$

The dotted lines between Pins 21 and 29 and ground in Figure 2 are used to show differences in connections for unipolar and bipolar modes. For unipolar, ground Pin 29; for bipolar, connect Pins 21, 22, and 29 together without grounding.

When calibrating for either unipolar or bipolar operation, an encode command at a frequency of 200kHz should be applied to Pin 32. Zero Adjust must always be adjusted before Gain Adjust, no matter which mode of operation is being calibrated.

Connect a precision voltage reference source between the analog input and ground.

If the converter is to be operated in a unipolar mode, adjust the output of the voltage reference to the desired full-scale positive input voltage, as described in Table I. After adjusting the Zero Adjust control per the directions in Table I, reset the reference and calibrate Gain Adjust.

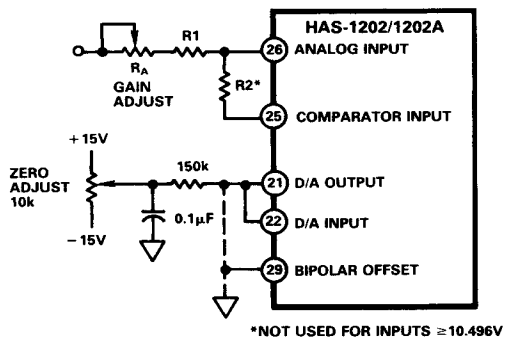


Figure 2. Gain and Offset Adjust

UNIPOLAR INPUT CALIBRATION
(For Analog Input Range 0V to + Full-Scale)

Apply Reference	And Adjust	For "Dither" Between
$+FS \times (1.22 \times 10^{-4})$	Zero	0 000 000 000 and 0 000 000 001
$+FS \times (0.99963)$	Gain	1 111 111 110 and 1 111 111 111

Table I.

If the converter is to be operated in a bipolar mode, refer to Table II.

BIPOLAR INPUT CALIBRATION
(For Analog Input Range − FS to + FS)

Apply Reference	And Adjust	For "Dither" Between
$-FS \times (0.99976)$	Zero	0 000 000 000 and 0 000 000 001
$+FS \times (0.99927)$	Gain	1 111 111 110 and 1 111 111 111

Table II.

Note that Zero Adjust is set using the negative input voltage for bipolar operation, while Gain Adjust is calibrated with the positive bipolar input.

USING HAS-1202 WITH TRACK/HOLD

Figure 3 and Figure 4 illustrate possible combinations of the HAS-1202 or HAS-1202A A/D Converter with the HTC-0300A Track-and-Hold amplifier.

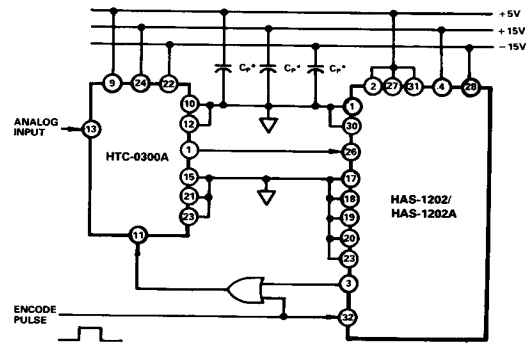
As shown, the upper word rate of the combination will be a function of which converter is used. When comparing the maximum word rates shown in the Specifications Table and the ones shown in the illustrations, there seems to be a disparity in encode rate capabilities.

The word rates shown in Figures 3 and 4, however, are correct and are based on "real-life" circuits using a T/H. The T/H needs sufficient time to acquire and/or settle to 12-bit accuracy. This interval is longer than the conversion time of the HAS-1202, and the result is a lower word rate for the combination than that which is possible with only the converter.

Note in Figure 3 that the encode pulse is applied, via an OR gate, to the ENCODE COMMAND input of the HTC-0300A. In Figure 4, it is applied directly to the ENCODE COMMAND input.

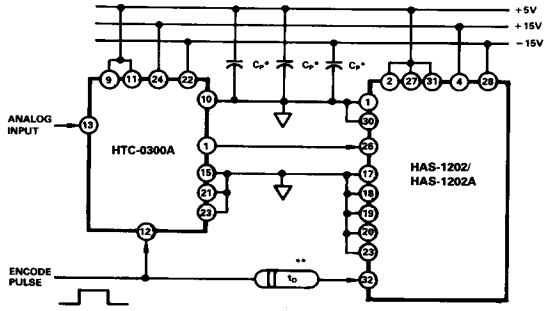
Circuit layout is extremely critical in using a high-speed converter and T/H to accomplish digitizing of analog signals; this is especially true with 12-bit systems of the type shown here.

In this context, "circuit layout" encompasses all of the important items which need to be considered. This includes, but is not limited to, precautions such as establishing low-impedance grounds; careful routing of analog and digital signal paths to avoid interference; and keeping all signal paths as short as possible. Bypassing of all power supplies is mandatory for best performance.



MODEL	ENCODE PULSE WIDTH (MIN.)	ENCODE FREQ. (MAX.)
HAS-1202	100ns	322kHz
HAS-1202A	100ns	552kHz

Figure 3. 12-Bit A/D Conversion System



MODEL	**t_D (MIN.)	ENCODE PULSE WIDTH (MIN.)	ENCODE FREQ. (MAX.)
HAS-1202	40ns	250ns	328kHz
HAS-1202A	80ns	250ns	560kHz

Figure 4. 12-Bit A/D Conversion System

For optimum performance in noisy environments, 2k pulldown resistors should be connected to Bits 1 through 4.

ORDERING INFORMATION

With the exception of conversion rates, the specifications are the same for the HAS-1202 and HAS-1202A A/D Converters; both units are housed in 32-pin DIP ceramic packages. For metal case versions with extended temperature ranges of −25°C to +85°C, order model number HAS-1202M or HAS-1202AM. For metal case versions with extended temperature ranges of −55°C to +100°C and military screening, order model number HAS-1202MB or HAS-1202AMB. Consult factory for details.