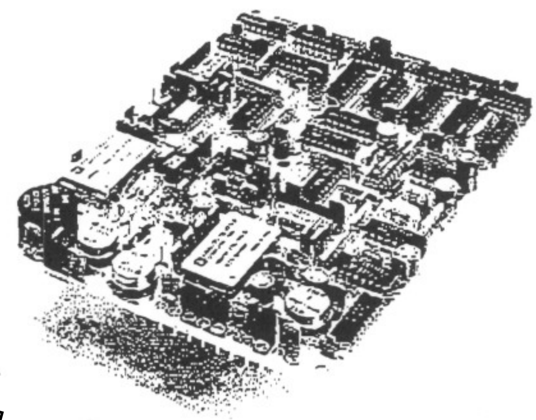
ANALOG DEVICES

10-Bit Video Analog-to-Digital Converter

FEATURES
10-Bit Resolution
25MHz Word Rates
Single 35-In^2 PC Board
ECL Compatible
No External Components Required

APPLICATIONS
Radar Digitizing
Medical Instrumentation
Digital Communications
Spectrum Analysis



GENERAL DESCRIPTION

The Analog Devices model CAV-1020 A/D converter is a "system solution" which combines performance, size, and economy to solve high-speed digitizing problems. Its design is based on proven concepts introduced in the MOD-1020 and CAV-1210 A/D converters and takes advantage of recent technology to achieve exceptional cost/performance tradeoffs.

The unit is pin-for-pin compatible with the industry's first 10-bit, 20MHz A/D, the MOD-1020. But the CAV-1020 is capable of 10 bits of resolution at word rates through 25MHz.

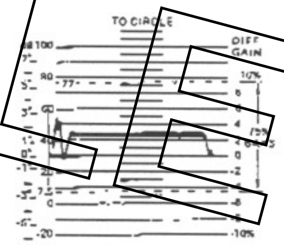
It is a complete answer to the question of digitizing radar, video, and/or other high-frequency inputs. It includes a proprictary track-and-hold, along with custom encoding and timing circuits. The CAV-1020 is an ideal solution for the designer who wants to avoid combining all the necessary components to make IC encoders operate as functional A/D converters.

Digital Correcting Subranging (DCS), pioneered by Analog Devices, virtually eliminates the errors normally associated with subranging A/D converters and is an integral part of the design technique used in the CAV-1020.

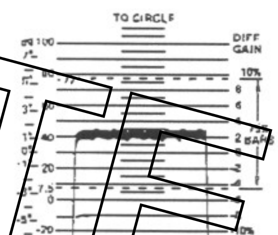
The unit is constructed on a single PC board intended for mounting on a mother board in the user's system. The CAV-1020's small size makes it adaptable to a wide range of mother board sizes and allows room for including signal conditioning, processing, memory, or other circuits adjacent to the converter.

All inputs and outputs are ECL compatible; analog input impedance is 1000Ω. The A/D requires only an encode command and external power supplies for operation.

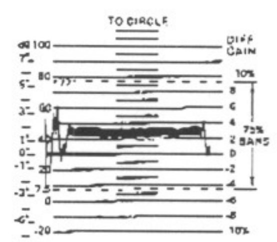
Special hybrid microcircuits, unique ICs, and discrete components are combined to obtain the maximum benefits of all technologies. The CAV-1020 is repairable and backed by Analog Devices' limited one-year warranty.



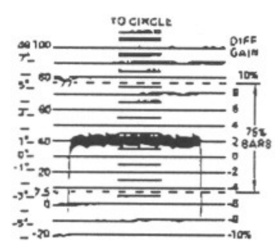
Differential Phase – Generator and Vectorscope Back-to-Back; No A/D Conversion



Differential Gain – Generator and Vectorscope Back-to-Back No A/D Conversion



Differential Phase – Model CAV-1020 and HDS-1015E D/A Back-to-Back, with HTS-0010 T/H as Deglitcher; Word Rate = 14.3MHz



Differential Gain – Model CAV-1020 and HDS-1015E D/A Back-to-Back, with HTS-0010 T/H as Deglitcher; Word Rate = 14.3MHz

The above waveforms were obtained utilizing a Tektronix Model 149A N.T.S.C. Test Signal Generator with a 20 IRE unit TV test signal output. The display (output) was obtained using a Tektronix Model 520A Vectorscope.

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

Model	Units	CAV-1020
RESOLUTION (FS = Full Scale)	Bits	10
	%FS	0.1
LSB WEIGHT		
1V p-p FS	mV	1
2V p-p FS	mV	2
ACCURACY		
(Including Linearity) @ dc	% FS ± 1/2LSB	0.05
Monotonicity		Guaranteed 0 to +70°C
Nonlinearity vs. Temperature	% of FS/°C	0.0005
Gain vs. Temperature	% of FS/°C	0.015
DYNAMIC CHARACTERISTICS		
In-Band Harmonics[1]		
(dc to 1MHz)	dB below FS	60
(1MHz to 5MHz)	dB below FS	55
(5MHz to 10MHz)	dB below FS	50
Conversion Time[2]	ns (max)	140 (±20)
Maximum Conversion Rate[3]	MHz (Guaranteed)	25 (20)
Aperture Uncertainty (Jitter)	ps (rms) max	±5
Aperture Time (Delay)	ns	5
Signal to Noise Ratio (SNR)[4]	dB	63
Noise Power Ratio (NPR)[5]	dB	45
Transient Response[6]	ns (max)	50 (75)
Overvoltage Recovery[7]	ns, max	50
Input Bandwidth		
Small Signal, 3dB[8]	MHz	30
Large Signal, 3dB[9]	MHz	15
Two-Tone Linearity (@ Input Frequencies)		
(60kHz; 62kHz)	dB below FS, min	57
(2.498MHz; 2.500MHz)	dB below FS, min	53
(4.996MHz; 4.998MHz)	dB below FS, min	52
Differential Gain[10]		
(20 IRE Unit Reference)	%	1
Differential Phase[10]		
(20 IRE Unit Reference)	degrees	0.5
ANALOG INPUT		
Voltage Range		
Input Pins 9 & 10 Connected	V, p-p FS	1
Input Pin 9 or 10	V, p-p FS	2
	V, max	±4
Input Type	Either Unipolar or Bipolar	
Impedance		
1V Input Range	Ω	500
2V Input Range	Ω	1000
Offset	Adjustable to Zero with On-Card Potentiometer	
vs. Temperature	% of FS/°C	0.01
ENCODE COMMAND INPUT[11]		
Logic Levels, ECL-Compatible	V	"0" = −1.7
(Balanced Input)	V	"1" = −0.9
Impedance (Line-to-Line)	Ω, max	100
Rise and Fall Times	ns, max	5
Width		
Min	ns	10
Max	70% of Encode Command Period	
Frequency	MHz (max)	20 (25)
(Customer-Specified; See Ordering Information.)		
DIGITAL OUTPUT		
Format	Bits	10 Parallel; NRZ
Logic Levels, ECL-Compatible	V	"0" = −1.7
(Balanced Output)	V	"1" = −0.9
Drive (Line-to-Line)	Ω, min	75
Time Skew	ns, max	5
Coding		Binary (BIN); 2's Complement (2SC)
DATA READY OUTPUT		
Format	Bits	1; RZ
Logic Levels, ECL-Compatible	V	"0" = −1.7
(Balanced Output)	V	"1" = −0.9
Drive (Line-to-Line)	Ω, min	75
Rise and Fall Time	ns, max	5
Duration	ns (max)	25 (±5)
POWER REQUREMENTS		
+15V ±5%	mA (max)	180 (200)
−15V ±5%	mA (max)	180 (200)
+5V ±5%	mA (max)	160 (180)
−5.2V ±5%	A (max)	1.9 (2.1)
Power Consumption	W (max)	16 (17.8)
TEMPERATURE RANGE		
Operating	°C	0 to +70
Storage	°C	−55 to +85
Cooling Air Requirements	LFPM (Linear Feet Per Minute)	500
CONSTRUCTION		
Single Printed Circuit Card	Inches	7.0 × 5.0 × 0.5

NOTES:

[1] In-Band Harmonics expressed in terms of spurious in-band signals generated at 10MHz encode rate at analog inputs shown in ( ).

[2] Measured from leading edge Encode Command to trailing edge Data Ready; use trailing edge to strobe output data into external circuits.

[3] To be specified by customer. See Ordering Information.

[4] Peak-to-peak signal to rms noise ratio with 500kHz analog input.

[5] DC to 8.2MHz white noise bandwidth with slot frequency of 3.886MHz; and encode rate of 20MHz.

[6] For full-scale step input, 10-bit accuracy attained in specified time.

[7] Recovers to 10-bit accuracy in specified time after 2 × FS input overvoltage.

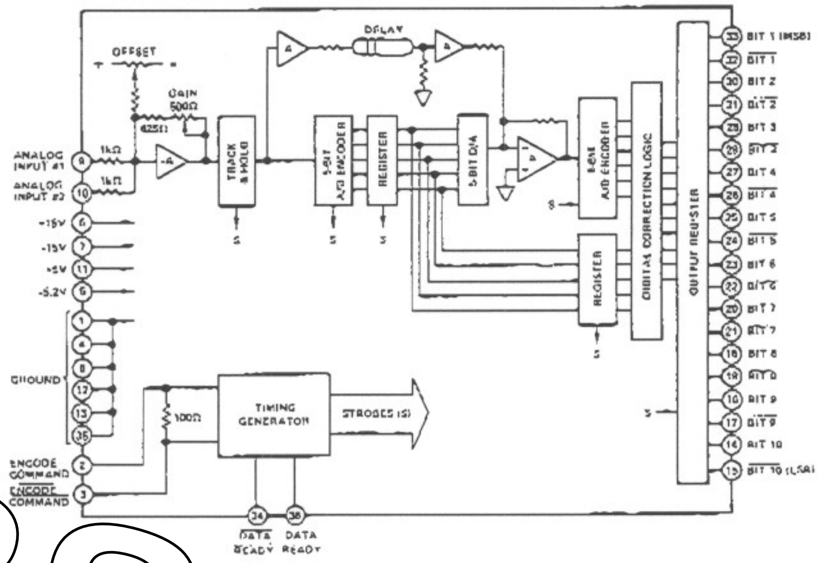
[8] With analog input 40dB below FS.

[9] With FS analog input. (Large-signal bandwidth flat within 0.2dB, dc to 8MHz.

[10] Applies to units optimized for video applications.

[11] Transition from digital "0" to digital "1" initiates encoding.

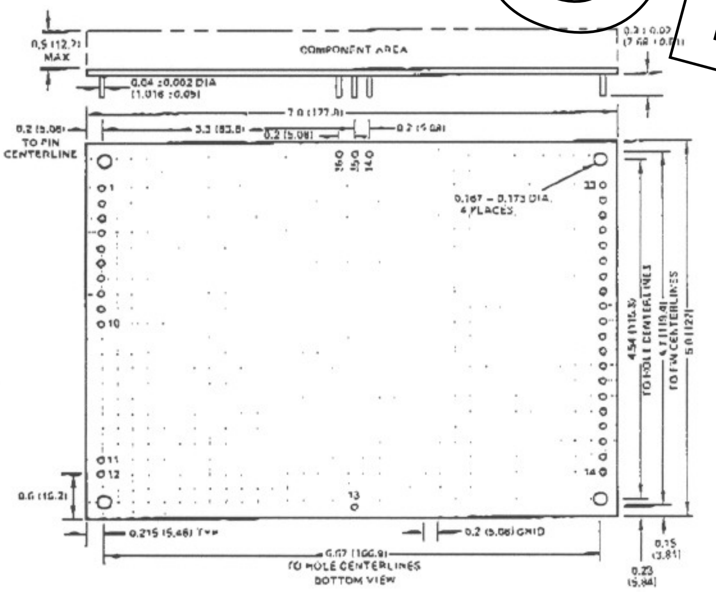
Specifications subject to change without notice.



CAV-1020 Block Diagram

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).



PIN DESIGNATIONS

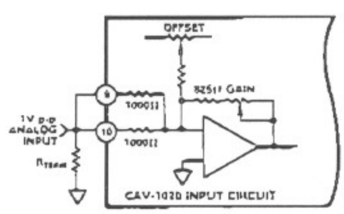
PIN	FUNCTION	PIN	FUNCTION
1	GROUND	19	$\overline{\text{BIT 8}}$
2	ENCODE COMMAND	20	BIT 7
3	$\overline{\text{ENCODE COMMAND}}$	21	$\overline{\text{BIT 7}}$
4	GROUND	22	$\overline{\text{BIT 6}}$
5	-5.2V	23	BIT 6
6	+15V	24	$\overline{\text{BIT 5}}$
7	-15V	25	BIT 5
8	GROUND	26	$\overline{\text{BIT 4}}$
9	ANALOG INPUT #1	27	BIT 4
10	ANALOG INPUT #2	28	BIT 3
11	+5V	29	$\overline{\text{BIT 3}}$
12	GROUND	30	BIT 2
13	GROUND	31	$\overline{\text{BIT 2}}$
14	BIT 10	32	$\overline{\text{BIT 1}}$
15	$\overline{\text{BIT 10}}$	33	BIT 1
16	BIT 9	34	$\overline{\text{DATA READY}}$
17	$\overline{\text{BIT 9}}$	35	GROUND
18	BIT 8	36	DATA READY

ALL GROUND PINS ARE CONNECTED TOGETHER WITHIN THE ADC.

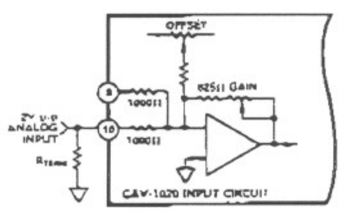
CAV-1020 ANALOG INPUT RANGE OPTIONS

For 1V p-p input range, connect analog input to pin 10, and connect pins 9 and 10 together. Unterminated input impedance is 500Ω. For 2V p-p input range, connect analog input to pin 10; pin 9 is left disconnected. Unterminated input impedance is 1,000Ω.

To obtain the desired terminated input impedance, connect the appropriate external terminating resistor between the analog input pin(s) and ground as shown in Figure 1. Input impedances higher than 1,000Ω will result in loss of input bandwidth and should be avoided.



1V p-p Input Option



2V p-p Input Option

(R_{TERM} RESISTORS ARE 1%, 1/4W, MF)

Z_{IN}	R_{TERM} (ohms)
50	[illegible]
75	88.7
93	115.0

Z_{IN}	R_{TERM} (ohms)
50	52.3
75	80.6
93	102.0

Figure 1. CAV-1020 Input Options

THEORY OF OPERATION

Refer to the block diagram of the CAV-1020.

Analog input signals to be digitized are applied through a buffer amplifier to a track-and-hold T/H) amplifier, which is normally operating as a buffer amplifier in the "track" mode, following all changes in input as they occur. The user of the CAV-1020 determines the point at which the analog signal is to be digitized by applying an Encode Command.

The leading edge of the encode command causes the track-and-hold circuit to switch momentarily to the "hold" mode of operation, "freezing" the analog input long enough to begin the digitizing process. The "held" value of the analog signal is applied to a 5-bit A/D encoder, and (through a buffer amplifier) to an analog delay circuit whose delay is equal to the time required for the first digitizing/reconstruction step of the encoding process.

After being digitized and resolved to 5-bit accuracy, the output of the T/H is applied through registers to a 5-bit D/A converter, which has 10-bit accuracy. Via a second set of registers, the same 5-bit digitized signal is applied to the digital correction logic circuits. The value stored in the second bank of registers will ultimately represent Bits 1-5 of the final digital output of the CAV-1020.

The digitized signal applied to the fast-settling D/A converter is reconverted to an inverted analog signal. This is applied with the delayed analog input to a wideband, fast-settling operational amplifier. The op amp output represents the residue signal which remains after a 5-bit representation of the analog input has been subtracted from that input.

This residue, or error, signal is digitized by a second encoder to a resolution of 6 bits and applied to the digital correction logic circuits along with Bits 1-5.

The correction circuits use a combination of the 5-bit and 6-bit signals to compensate for possible nonlinearities and other errors to assure the final 10-bit digital output will be 10-bit accurate.

Oversimplified, the digital correction circuits use the information contained in the 6-bit signal to determine whether or not Bits 1-5 need to be modified.

Basically, the correction circuits use the information contained in the MSB of the 6-bit byte to determine what action needs to be taken with regard to the first five bits. Depending upon its value, the circuits will pass the 5-bit information as it is, or add a value of binary "1" to it. Bits 2-6 of the 6-bit information become Bits 6-10 of the digital output of the CAV-1020.

This innovative use of 11 bits to achieve an accurate 10 bits of resolution compensates for a multitude of potential errors which otherwise could be eliminated only by incorporating expensive, high precision parts into the design. Digitally corrected subranging (DCS) used in the CAV-1020 does not prevent such anomalies as gain error, track/hold droop error, linearity error, or offset error. But it obviates the effects of these problems and makes high-speed, high-resolution digitizing an economic reality.

OFFSET AND GAIN ADJUSTMENT

When adjusting offset and gain of the A/D in the system, the OFFSET control is adjusted first. It has sufficient range to allow the user to operate the A/D in either the unipolar or bipolar mode. The adjustment sequence is:

1. Apply desired maximum positive voltage to analog input.
2. Adjust OFFSET control while observing LSB (Bit 10) and adjust until digital output has Bits 1–9 solid "1" with LSB "toggling".
3. Apply desired maximum negative voltage to analog input.
4. Adjust GAIN control while observing LSB (Bit 10) and adjust until digital output has Bits 1-9 solid "0" with LSB "toggling".

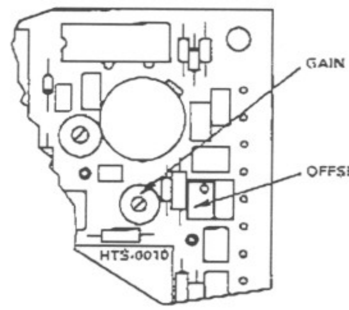


Figure 2. CAV-1020 Adjustment Controls

ORDERING INFORMATION

For standard CAV-1020 units intended to operate at word rates through 10MHz, order model number CAV-1020-100.

If desired, the unit can be calibrated at the factory for optimum performance at a higher word rate for those applications in which the unit will generally be operated above 10MHz.

Order by model number CAV-1020-XXX; in this model number, XXX is specified by the customer to indicate the desired optimized word rate. The decimal place is assumed (but not shown) between the second and third places. CAV-1020-120, for example, indicates final calibration and, consequently, optimum peformance at 12MHz. But the unit will operate at word rates to the 25MHz capabilities of the converter.

Optimum performance will be achieved within a band of frequencies approximately ±12% around the selected word rate. The user must keep in mind the upper performance specification of 20MHz. "Optimum" final calibration at 19MHz, for example, is not meant to imply optimum peformance at word rates above 20MHz. The unit will operate beyond 20MHz, but accuracy, NPR, SNR, and/or other specifications may be outside the limits shown on Specifications page.

If later applications require word rates beyond the limits of the original optimum frequency, the unit can be returned to the factory for calibration; there is a nominal charge for this service.

Mating sockets for the CAV-1020 are model number MSB-2 (thru hole) or MSB-3 (closed end). These are individual solder-type pin sockets for mounting in PC boards; one is required for each of the 36 pins of the converter.

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