

16-Bit CCD/CIS Analog Signal Processor

Features

- Operating voltage: 5V
- Low power consumption at 400mW (Typ.)
- Power-down mode: Under 2mA (Typ.)
- 16-bit 6 MSPS A/D converter
- Guaranteed won't miss codes
- 1~6 programmable gain
- Correlated Double Sampling
- $\pm 250\text{mV}$ programmable offset
- Input clamp circuitry
- Internal voltage reference
- Multiplexed byte-wide output (8+8 format)
- Programmable 3-wire serial interface
- 3V/5V digital I/O compatibility
- 3-channel operation up to 30 MSPS
- 2-channel (Even-Odd) operation up to 30 MSPS
- 1-channel operation up to 25 MSPS
- 28-pin SSOP package

Applications

Flatbed document scanners
Film scanners

Digital color copiers
Multifunction peripherals

General Description

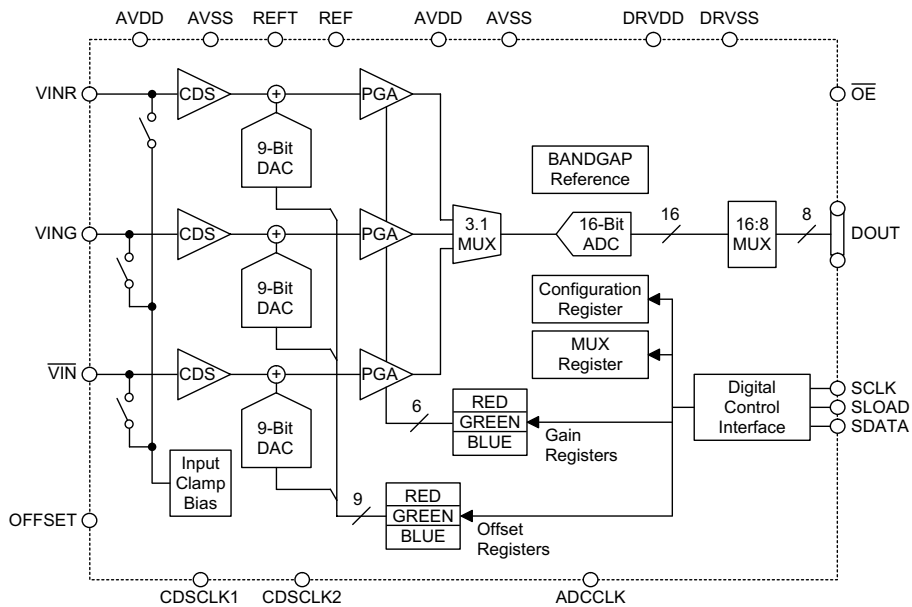
The HT82V26 is a complete analog signal processor for CCD imaging applications. It features a 3-channel architecture designed to sample and condition the outputs of tri-linear color CCD arrays. Each channel consists of an input clamp, Correlated Double Sampler (CDS), offset DAC and Programmable Gain Amplifier (PGA), and a high performance 16-bit A/D converter.

The CDS amplifiers may be disabled for use with sensors such as Contact Image Sensors (CIS) and CMOS active pixel sensors, which do not require CDS.

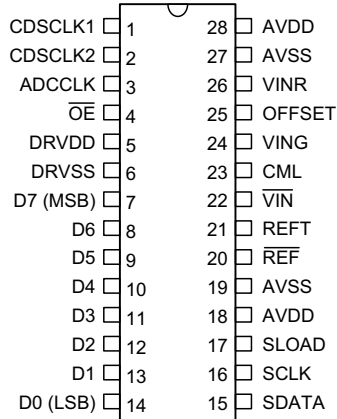
The 16-bit digital output is multiplexed into an 8-bit output word that is accessed using two read cycles. The internal registers are programmed through a 3-wire serial interface, which provides gain, offset and operating mode adjustments.

The HT82V26 operates from a single 5V power supply, typically consumes 400mW of power.

Block Diagram

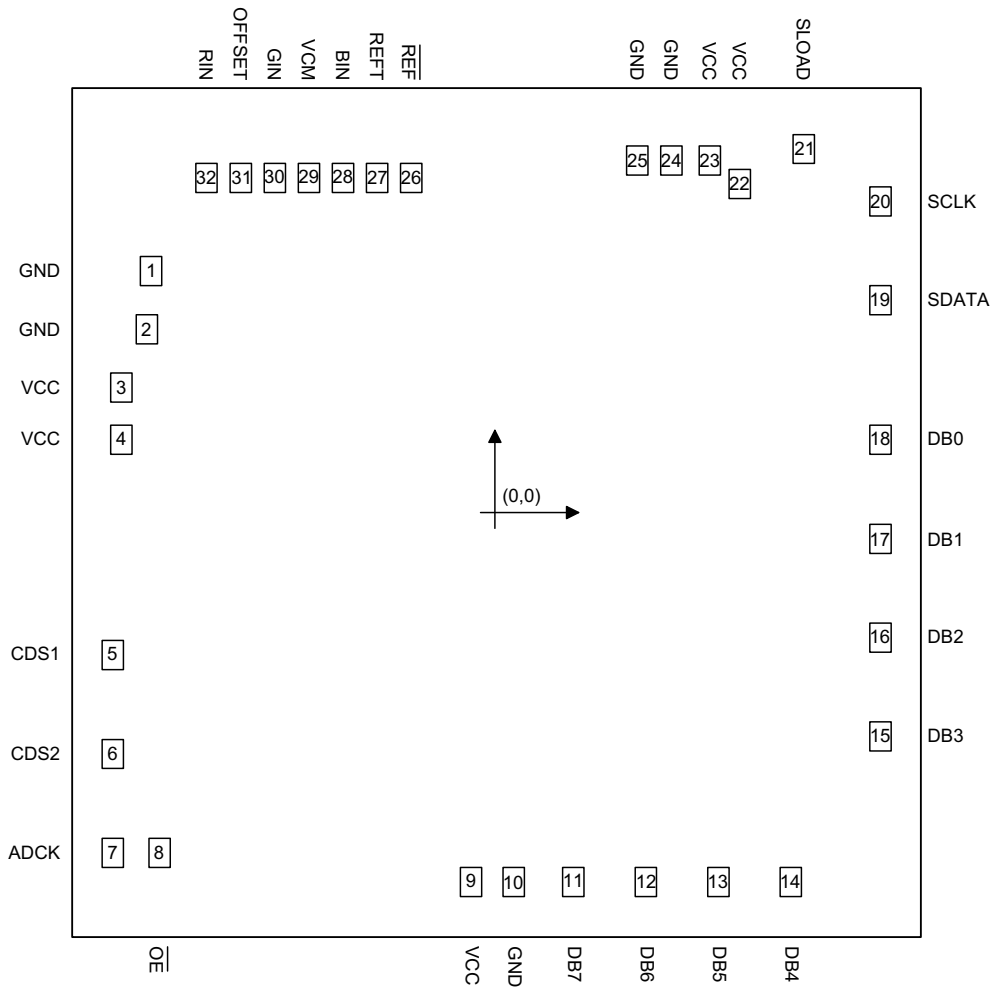


Pin Assignment



HT82V26
- 28 SSOP-A

Pad Assignment



Chip size: 3070×2270 (μm)²

* The IC substrate should be connected to VDD in the PCB layout artwork.

Pad Coordinates

Pad No.	X	Y	Pad No.	X	Y
1	-1222.950	623.056	17	1370.600	-72.794
2	-1240.800	474.756	18	1370.600	186.806
3	-1328.750	328.506	19	1370.600	552.656
4	-1331.550	183.756	20	1370.600	812.256
5	-1370.650	-374.194	21	1097.250	945.656
6	-1370.650	-633.794	22	876.075	857.531
7	-1370.650	-893.394	23	758.875	913.431
8	-1199.050	-885.394	24	633.775	913.431
9	-86.525	-967.869	25	504.775	913.431
10	58.475	-965.669	26	-304.900	877.456
11	276.525	-971.169	27	-425.450	877.456
12	536.125	-971.169	28	-546.050	877.456
13	795.725	-971.169	29	-665.450	877.456
14	1055.325	-971.169	30	-786.050	877.456
15	1370.600	-591.994	31	-906.650	877.456
16	1370.600	-332.394	32	-1026.150	877.456

Pad Description

Pad No.	Pad Name	I/O	Description
1	CDSCLK1	DI	CDS reference clock pulse input
2	CDSCLK2	DI	CDS data clock pulse input
3	ADCCLK	DI	A/D sample clock input for 3-channels mode
4	OE	DI	Output enable, active low
5	DRVDD	P	Digital driver power
6	DRVSS	P	Digital driver ground
7~14	D7~D0	DO	Digital data output
15	SDATA	DI/DO	Serial data input/output
16	SCLK	DI	Clock input for serial interface
17	SLOAD	DI	Serial interface load pulse
18, 27	AVSS	P	Analog ground
19, 28	AVDD	P	Analog supply
20	REF	AO	Reference decoupling
21	REFT	AO	Reference decoupling
22	VIN	AI	Analog input, blue
23	CML	AO	Internal reference output
24	VING	AI	Analog input, green
25	OFFSET	AO	Clamp bias level decoupling
26	VINR	AI	Analog input, red

Absolute Maximum Ratings

Supply Voltage	$V_{SS}-0.3V$ to $V_{SS}+5.5V$	Storage Temperature	$-50^{\circ}C$ to $125^{\circ}C$
Input Voltage	$V_{SS}-0.3V$ to $V_{DD}+0.3V$	Operating Temperature	$-25^{\circ}C$ to $75^{\circ}C$

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

D.C. Characteristics

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
Logic Inputs							
V _{IH}	High Level Input Voltage	—	—	0.8×V _{DD}	—	—	V
V _{IL}	Low Level Input Voltage	—	—	—	—	0.2×V _{DD}	V
I _{IH}	High Level Input Current	—	—	—	10	—	μA
I _{IL}	Low Level Input Current	—	—	—	10	—	μA
C _{IN}	Input Capacitance	—	—	—	10	—	pF
Logic Outputs							
V _{OH}	High Level Output Voltage	—	—	V _{DD} -0.5	—	—	V
V _{OL}	Low Level Output Voltage	—	—	—	—	0.5	V
I _{OH}	High Level Output Current	—	—	—	1	—	mA
I _{OL}	Low Level Output Current	—	—	—	1	—	mA

A.C. Characteristics

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
Power Supplies							
V _{ADD}	AVDD	—	—	4.75	5	5.25	V
V _{DRDD}	DRVDD	—	—	3	5	5.25	V
Maximum Conversion Rate							
t _{MAX3}	3-channel Mode with CDS	—	—	30	—	—	MSPS
t _{MAX2}	2-channel Mode with CDS	—	—	30	—	—	MSPS
t _{MAX1}	1-channel Mode with CDS	—	—	25	—	—	MSPS
Accuracy (Entire Signal Path)							
	ADC Resolution	—	—	—	16	—	Bits
	Integral Nonlinear (INL)	—	—	—	±32	—	LSB
	Differential Nonlinear (DNL)	—	—	-1	—	1	LSB
	Offset Error	—	—	-100	TBD	100	mV
	Gain Error	—	—	—	TBD	—	%FSR
Analog Inputs							
R _{FS}	Full-scale Input Range	—	—	—	2.0	—	V _{p-p}
V _i	Input Limits	—	—	A _{VDD} -0.3	—	A _{VDD} +0.3	V
C _i	Input Capacitance	—	—	—	TBD	—	pF
I _i	Input Current	—	—	—	TBD	—	μA
Amplifiers							
	PGA Gain at Minimum	—	—	—	1	—	V/V
	PGA Gain at Maximum	—	—	—	5.85	—	V/V
	PGA Gain Resolution	—	—	—	6	—	Bits
	Programmable Offset at Minimum	—	—	—	-250	—	mV
	Programmable Offset at Maximum	—	—	—	250	—	mV
	Offset Resolution	—	—	—	9	—	Bits

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
Temperature Range							
t _A	Operating	—	—	0	—	70	°C
Power Consumption							
P _{tot}	Total Power Consumption	—	—	—	400	—	mW

Timing Specification

Symbol	Parameter	Min.	Typ.	Max.	Unit
Clock Parameters					
t _{PRA}	3-channel pixel rate	100	—	—	ns
t _{PRB}	2-channel (Even-Odd) pixel rate	66	—	—	ns
t _{PRC}	1-channel pixel rate	40	—	—	ns
t _{ADCLK}	Pixel Rate Clock	16	—	—	ns
t _{C1}	CDSCLK1 Pulse Width	12	—	—	ns
t _{C2}	CDS Mode CDSCLK2 Pulse Width	12	—	—	ns
t _{C1C2}	CDSCLK1 Falling to CDSCLK2 Rising	0	—	—	ns
t _{ADC1}	ADCCLK Rising to CDSCLK1 Falling	0	—	—	ns
t _{ADC2}	ADCCLK Rising to CDSCLK2 Falling	0	—	—	ns
t _{AD}	Analog Sampling Delay	5	—	—	ns
3-Channel Mode Only					
t _{aC2C1}	CDSCLK2 Falling to CDSCLK1 Rising	30	—	—	ns
t _{aC2ADR}	CDSCLK2 Falling to ADCCLK Rising	30	—	—	ns
2-Channel Mode Only					
t _{bC2ADR}	CDSCLK2 Falling to ADCCLK Rising	30	—	—	ns
t _{bC1ADR}	CDSCLK1 Rising to ADCCLK Rising	15	—	—	ns
t _{bC2C1}	CDSCLK2 Falling to CDSCLK1 Rising	15	—	—	ns
1-Channel Mode Only					
t _{cC2C1}	CDSCLK2 Falling to CDSCLK1 Rising	15	—	—	ns
t _{cC1ADF}	CDSCLK1 Rising to ADCCLK Falling	0	—	—	ns
t _{cC2ADR}	CDSCLK2 Falling to CDSCLK1 Rising	20	—	—	ns
Serial Interface					
f _{SCLK}	Maximum SCLK Frequency	10	—	—	MHz
t _{LS}	SLOAD to SCLK Setup Time	133	—	—	ns
t _{LH}	SCLK to SLOAD Hold Time	50	—	—	ns
t _{DS}	SDATA to SCLK Rising Setup Time	16	—	—	ns
t _{DH}	SCLK Rising to SDATA Hold Time	15	—	—	ns
t _{RDV}	Falling to SDATA Valid	50	—	—	ns
Data Output					
t _{OD}	Output Delay	—	8	—	ns
	Latency (Pipeline Delay)	—	9	—	Cycles

Functional Description

Integral Nonlinear (INL)

Integral nonlinear error refers to the deviation of each individual code from a line drawn from zero scale through a positive full scale. The point used as zero scale occurs 1/2 LSB before the first code transition. A positive full scale is defined as a level 1/2 LSB beyond the last code transition. The deviation is measured from the middle of each particular code to the true straight line.

Differential Nonlinear (DNL)

An ideal ADC exhibits code transitions that are exactly 1 LSB apart. DNL is the deviation from this ideal value. Thus every code must have a finite width. No missing codes guaranteed for the 16-bit resolution indicates that all the 4096 codes respectively, are present in the over-all operating range.

Offset Error

The first ADC code transition should occur at a level 1/2 LSB above the nominal zero scale voltage.

The offset error is the deviation of the actual first code transition level from the ideal level.

Gain Error

The last code transition should occur for an analog value of 1/2 LSB below the nominal full-scale voltage.

Gain error is the deviation of the actual difference between the first and the last code transitions and the ideal difference between the first and the last code transitions.

Aperture Delay

The aperture delay is the time delay that occurs when a sampling edge is applied to the HT82V26 until the actual sample of the input signal is held. Both CDSCLK1 and CDSCLK2 sample the input signal during the transition from high to low, so the aperture delay is measured from each clock's falling edge to the instant the actual internal sample is taken.

Internal Register Descriptions

Register Name	Address			Data Bits								
	A2	A1	A0	D8	D7	D6	D5	D4	D3	D2	D1	D0
Configuration	0	0	0	0	0	1	3-CH	CDS on	Clamp Voltage	Enable Power Down	Output Delay	1 byte out
MUX	0	0	1	0	RGB/BGR	Red	Green	Blue	Delay enable	CDS1 delay	CDS2 delay	ADCK delay
Red PGA	0	1	0	0	0	0	MSB					LSB
Green PGA	0	1	1	0	0	0	MSB					LSB
Blue PGA	1	0	0	0	0	0	MSB					LSB
Red Offset	1	0	1	MSB								LSB
Green Offset	1	1	0	MSB								LSB
Blue Offset	1	1	1	MSB								LSB

Internal register map

Configuration Register

The configuration register controls the HT82V26's operating mode and bias levels. Bits D6 should always be set high. Bit D5 will configure the HT82V26 for the 3-channel (high) mode of operation. Setting the bit D4 high will enable the CDS mode of operation, and setting this bit low will enable the SHA mode of operation.

Bit D3 sets the dc bias level of the HT82V26's input clamp. This bit should always be set high for the 4V clamp bias, unless a CCD with a reset feed through transient exceeding 2V is used. If the 3V clamp bias level is used, the peak-to-peak input signal range to the HT82V26 is reduced to 3V maximum. Bit D2 controls the power-down mode. Setting bit D2 high will place the HT82V26 into a very low power "sleep" mode. All register contents are retained while the HT82V26 is in the power-down state. Setting bit D1 high will configure the HT82V26 for the digital output (D0~D7) delay 2ns. Bit D0 controls the output mode of the HT82V26. Setting bit D0 high will enable a single byte output mode where only 8 MSBS of the 16b ADC is output. If bit D0 is set low, then the 16b ADC output is multiplexed into two bytes.

D8	D7	D6	D5	D4	D3	D2	D1	D0
Set to 0	Set to 0	Set to 1	3 channels	CDS operation	Clamp bias	Power-down	Output delay	1 byte out
			1=On*	1=CDS mode*	1=4V*	1=On	1=On	1=On
			0=Off	0=CIS mode	0=3V	0=Off (Normal)*	0=Off*	0=Off*

Configuration register settings

Note: * Power-on default value

MUX Register

The MUX register controls the sampling channel order in the HT82V26. Bits D8 should always be set low. Bit D7 is used when operating in 3-channel mode. Setting bit D7 high will sequence the MUX to sample the red channel first, then the green channel, and then the blue channel. When in this mode, the CDSCLK2 pulse always resets the MUX to sample the red channel first (see timing figure). When bit D7 is set low, the channel order is reversed to blue first, green second, and red third. The CDSCLK2 pulse will always reset the MUX to sample the blue channel first. Bits D6, D5 and D4 are used when operating in 1-channel mode. Bit D6 is set high to sample the red channel. Bit D5 is set high to sample the green channel. Bit D4 is set high to sample the blue channel. The MUX will remain stationary during 1-channel mode. Bits D3, D2, D1 and D0 are used for controlling CDS1, CDS2 and ADCK internal delay. D3 is set '0' to be compatible with AD9826.

D8	D7	D6	D5	D4	D3	D2	D1	D0
Set to 0	3-Channel	1-Channel	1-Channel	1-Channel	Enable Delay	CDS1 Delay	CDS2 Delay	ADCK Delay
	1=R-G-B 0=B-G-R	1=RED* 0=Off	1=GREEN 0=Off*	1=BLUE 0=Off*	0=Off 1=On*	0=2ns* 1=4ns	0=2ns* 1=4ns	0=0ns* 1=2ns

MUX register settings

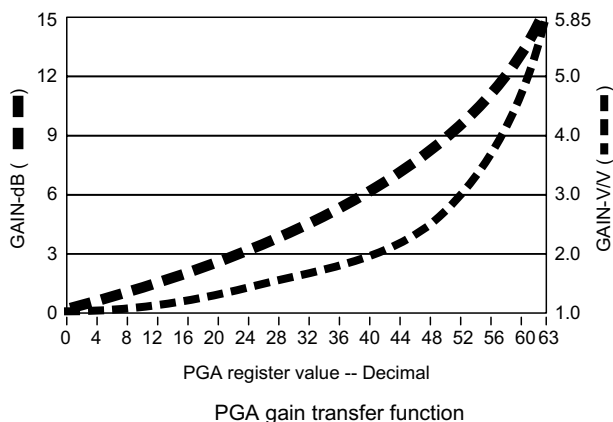
Note: * Power-on default value

PGA Gain Registers

There are three PGA registers for use in individually programming the gain in the red, green and blue channels. Bits D8, D7 and D6 in each register must be set low, and bits D5 through D0 control the gain range in 64 increments. See figure for a graph of the PGA gain versus PGA register code. The coding for the PGA registers is a straight binary, with an all zero words corresponding to the minimum gain setting (1x) and an all one word corresponding to the maximum gain setting (5.85x).

The HT82V26 uses one Programmable Gain Amplifier (PGA) for each channel. Each PGA has a gain range from 1x (0dB) to 5.85x (15.3dB), adjustable in 64 steps. The Figure shows the PGA gain as a function of the PGA register code. Although the gain curve is approximately linear in dB, the gain in V/V varies in nonlinear proportion with the register code, according to the following the equation:
$$\text{Gain} = \frac{5.85}{1 + 4.85 \times \left(\frac{63 - G}{63}\right)}$$

Where G is the decimal value of the gain register contents, and varies from 0 to 63.



D8	D7	D6	D5	D4	D3	D2	D1	D0	Gain (V/V)	Gain (dB)
Set to 0	Set to 0	Set to 0	MSB					LSB		
0	0	0	0	0	0	0	0	0*	1.0	0.0
0	0	0	0	0	0	0	0	1	1.013	0.12
					.				.	.
					.				.	.
0	0	0	1	1	1	1	1	0	5.43	14.7
0	0	0	1	1	1	1	1	1	5.85	15.3

PGA gain register settings

Note: * Power-on default value

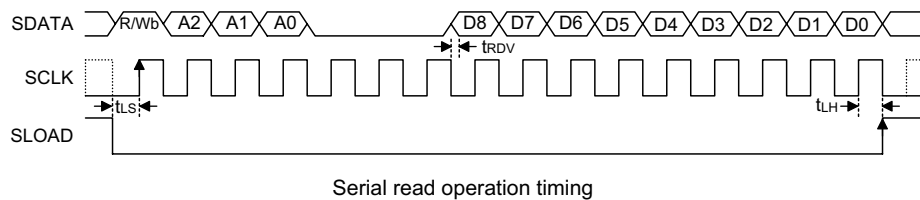
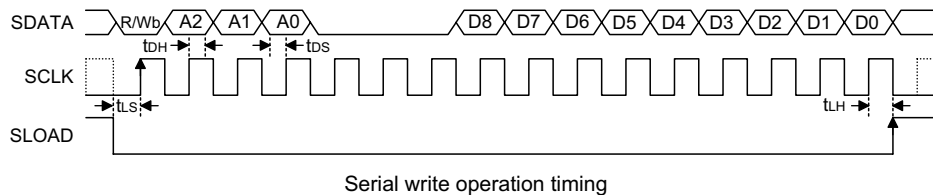
Offset Registers

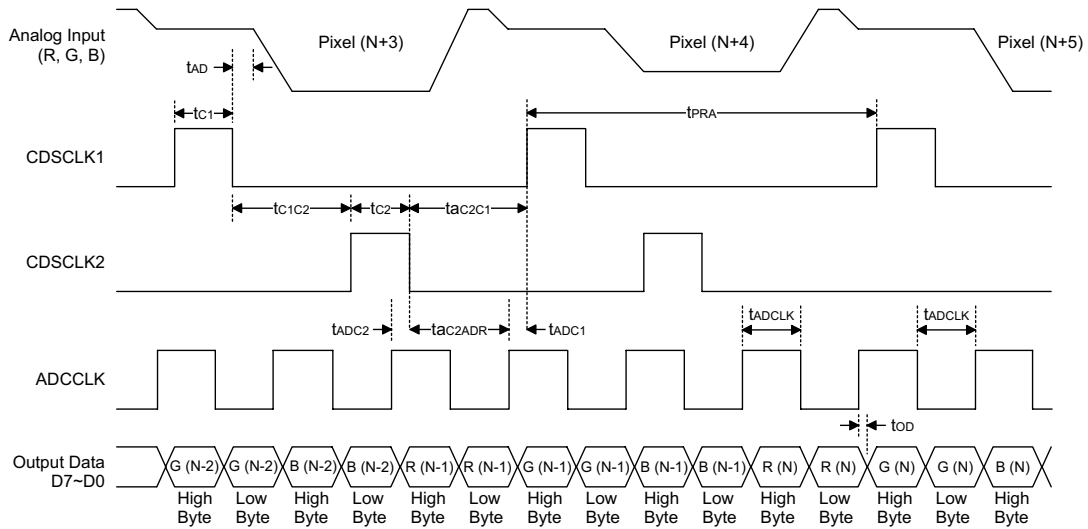
 There are three PGA registers for use in individually programming the offset in the red, green, and blue channels. Bits D8 through D0 control the offset range from -350mV to 350mV in 512 increments.

The coding for the offset registers is sign magnitude, with D8 as the sign bit. The Table shows the offset range as a function of the bits D8 through D0.

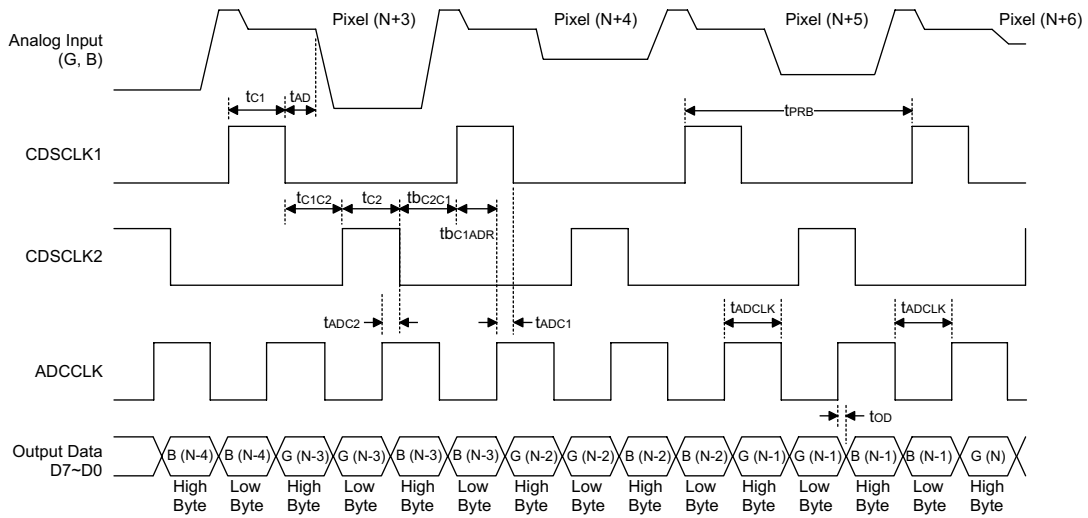
D8	D7	D6	D5	D4	D3	D2	D1	D0	Offset (mV)
MSB								LSB	
0	0	0	0	0	0	0	0	0*	0
0	0	0	0	0	0	0	0	1	0.98
					.				.
					.				.
0	1	1	1	1	1	1	1	1	250
1	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	-0.98
					.				.
					.				.
1	1	1	1	1	1	1	1	1	-250

Note: * Power-on default value

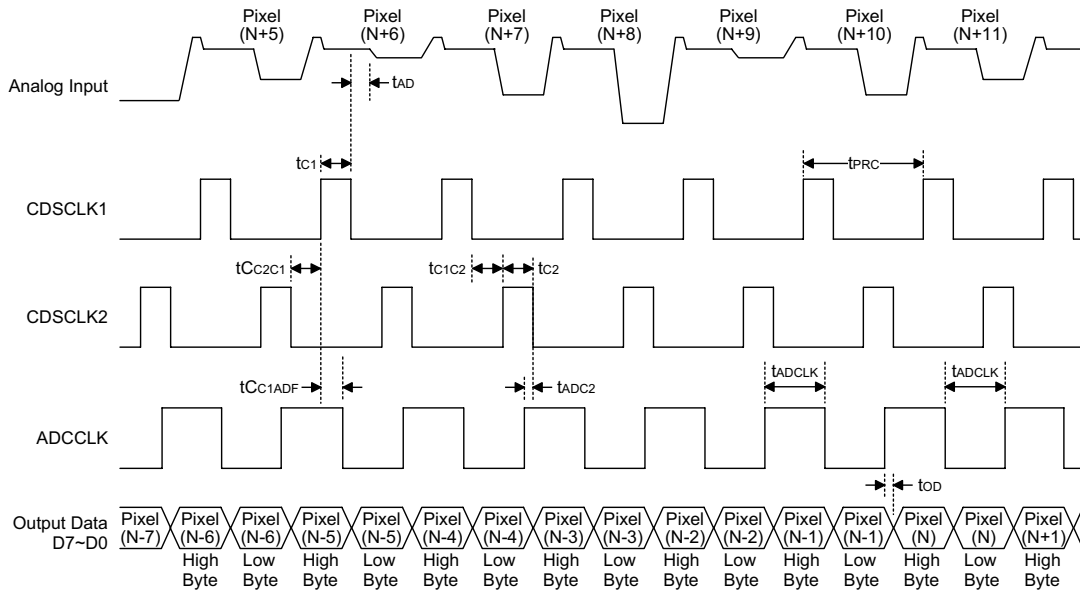
Timing Diagrams




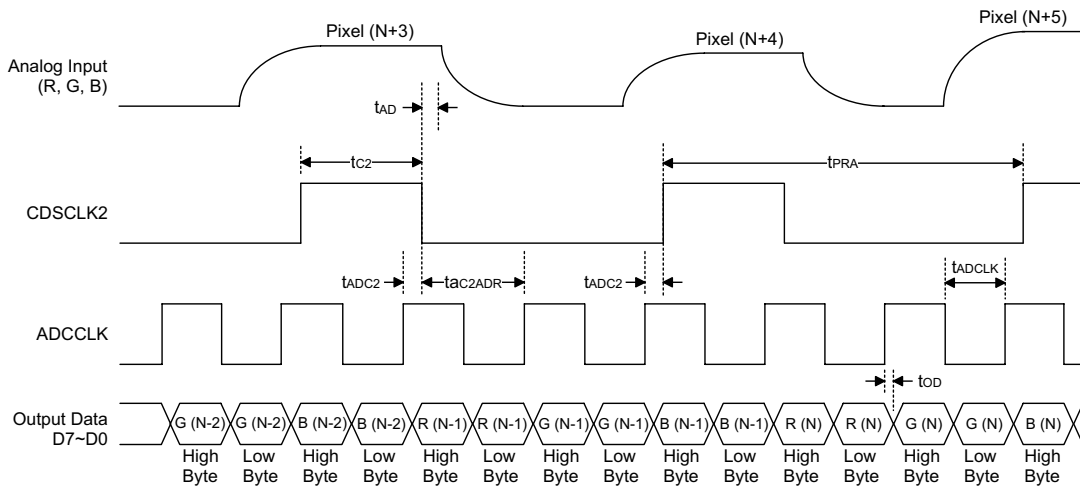
3-channel CCD mode timing (select R-G-B mode)



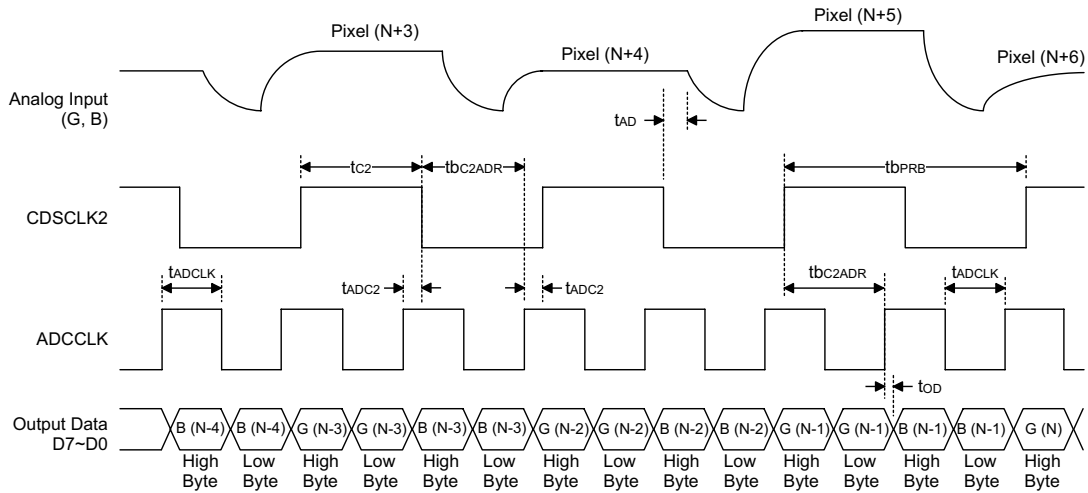
2-channel CCD mode timing (select G-B mode)



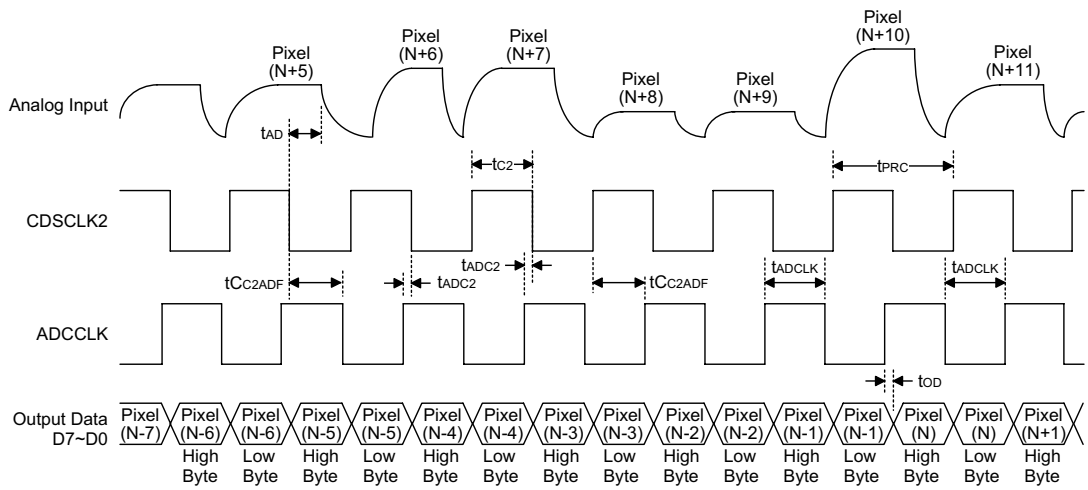
1-channel CCD mode timing



3-channel SHA mode timing (select R-G-B mode)



2-channel SHA mode timing (select G-B mode)



1-channel SHA mode timing

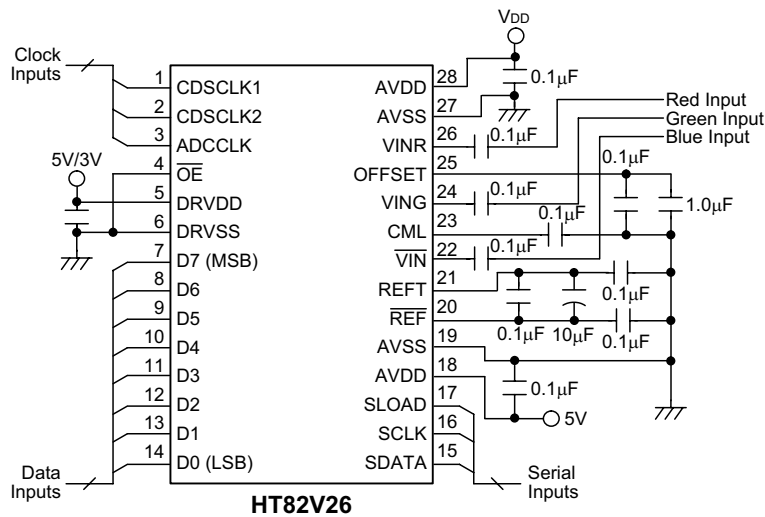
Application Circuits

Circuit and Layout Recommendations

The recommended circuit configuration for the 3-channel CDS mode operation is shown in the figure. The recommended input coupling capacitor value is 0.1 μ F (see circuit operation section for more details).

A single ground plane is recommended for the HT82V26. A separate power supply may be used for DRVDD, the digital driver supply, but this supply pin should still be decoupled to the same ground plane as with the rest of the HT82V26. The loading of the digital outputs should be minimized, either by using short traces to the digital ASIC, or by using external digital buffers. To minimize the effect of digital transients during major output code transitions, the falling edge of the CDSCLK2 should occur in coincidence with or before the rising edge of ADCCLK (see figures for timing). All 0.1 μ F decoupling capacitors should be located as close as possible to the HT82V26 pins. When operating in a single channel mode, the unused analog inputs should be grounded.

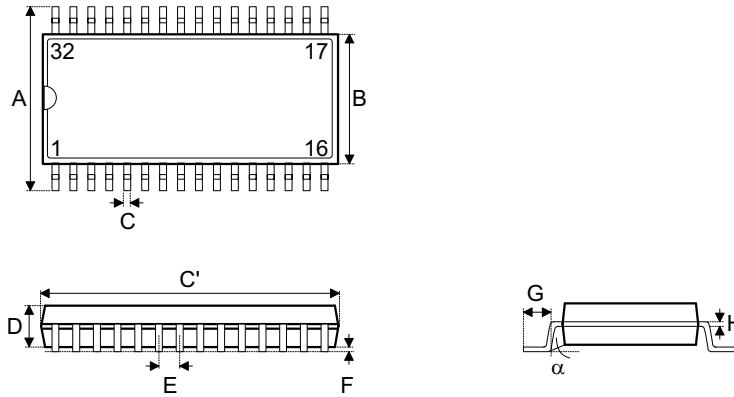
The Figure shows the recommended circuit configuration for the 3-channel SHA mode. All of the above considerations also apply for this configuration, except that the analog input signals are directly connected to the HT82V26 without the use of coupling capacitors. The analog input signals must already be dc-biased between 0V and 2V.



Note: The recommended circuit configuration for 1-channel CDS mode operation is shown. The recommended input coupling capacitor value is 0.1 μ F (see circuit operation section for more details). A single ground plane is recommended for the HT82V26. A separate power supply may be used for DRVDD, the digital driver supply, but this supply pin should still be decoupled to the same ground plane as with the rest of the HT82V26. The loading of the digital outputs should be minimized, either by using short traces to the digital ASIC, or by using external digital buffers. All 0.1 μ F decoupling capacitors should be located as close as possible to the HT82V26 pins.

Package Information

28-pin SSOP (150mil) Outline Dimensions



Symbol	Dimensions in mil		
	Min.	Nom.	Max.
A	228	—	244
B	150	—	157
C	8	—	12
C'	386	—	394
D	54	—	60
E	—	25	—
F	4	—	10
G	22	—	28
H	7	—	10
α	0°	—	8°

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