

TC35096P 8 BIT 4-CH SERIAL I/O ANALOG TO DIGITAL CONVERTER

GENERAL DESCRIPTION

The TC35096P is a monolithic CMOS 8 bit successive approximation A/D converter with serial I/O and 4 channel multiplex inputs.

Conversion start when \overline{CS} is set low and start bit ("L" level) and channel select bit (two bits) are given to serial input DI.

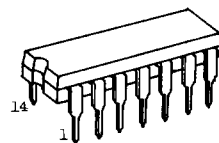
In case that \overline{SE} is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

In case that \overline{SE} is low, after the conversion is completed a start bit, 8 bit conversion data (LSB first) and a stop bit appear at DO.

The TC35096P has features of high speed, high accuracy and microprocessor compatible I/O which make the device well suited to a broad application field such as process and machine control and automotive equipment.

FEATURES

- High accuracy $\pm \frac{3}{4}$ LSB MAX
- High speed conversion 32.5 μ s MAX @ f_{CP} =400 kHz
- Single power supply 5V \pm 10%
- Low power consumption 5 mW MAX @ T_a =25°C
- Serial I/O
- 4 channel analog multiplex input
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free

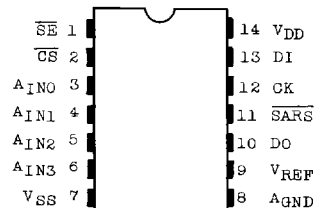


DIP14 (DIP14-P-300)

MAXIMUM RATINGS

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage Range	VDD	VSS-0.5 ~ VSS+7	V
DC Input Voltage	VIN	VSS-0.5 ~ VDD+0.5	V
DC Output Voltage	VOUT	VSS-0.5 ~ VDD+0.5	V
Reference Voltage	VREF	VSS-0.5 ~ VDD+0.5	V
Analog Ground Voltage	AGND	VSS-0.5 ~ VDD+0.5	V
DC Input Current	IIN	\pm 10	V
Power Dissipation	PD	300	mA
Storage Temperature	Tstg	-65 ~ 150	°C
Lead Temperature 10 sec.	TL	300	°C

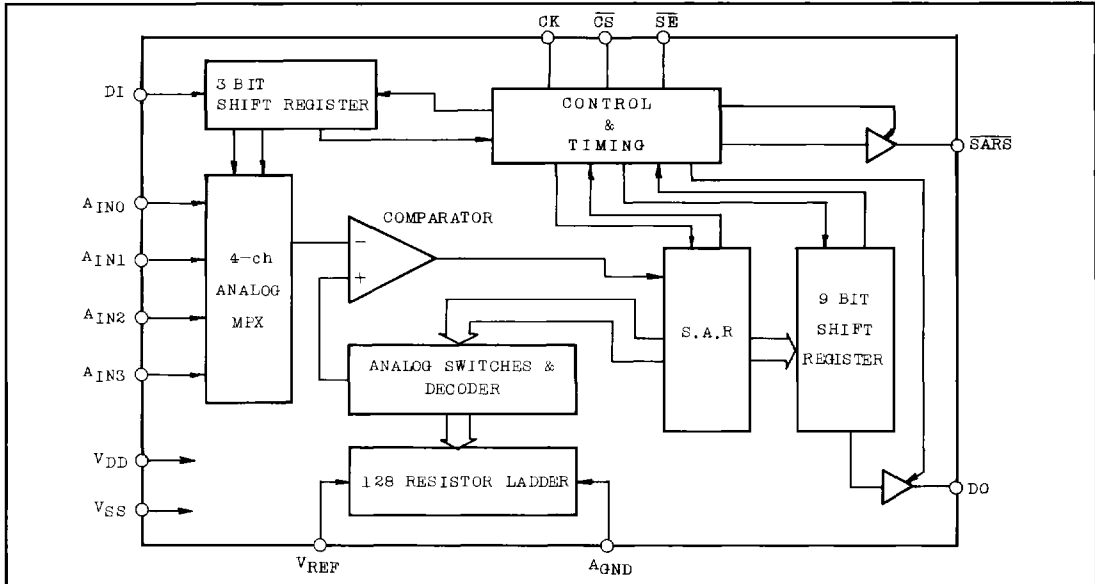
PIN ASSIGNMENT



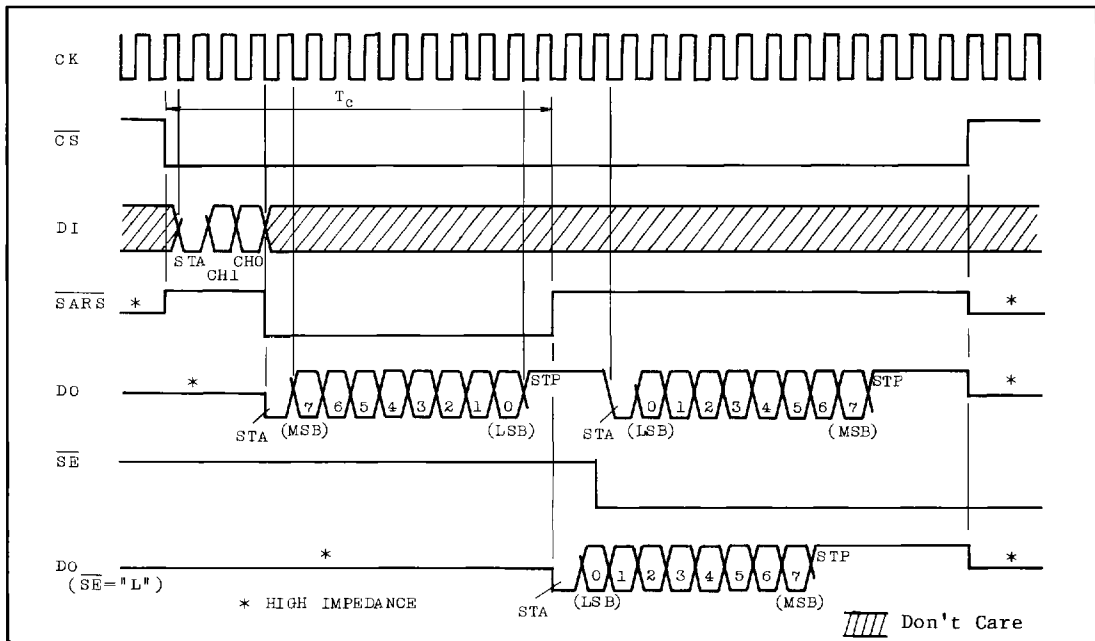
(TOP VIEW)

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BLOCK DIAGRAM



TIMING CHART



PIN & FUNCTION

PIN NO.	SYMBOL	PIN NAME & FUNCTION	PIN NO.	SYMBOL	PIN NAME & FUNCTION
1	\overline{SE}	[SELECT] \overline{SE} determines the order of output data. $\overline{SE} = "L" \dots$ LSB first $\overline{SE} = "H" \dots$ MSB first	8	AGND	[ANALOG GROUND] AGND defines the zero level of AIN.
2	\overline{CS}	[CHIP SELECT] At the falling edge of \overline{CS} , the device is set stand-by for conversion. When CS is "H" the device is reset and all outputs become high impedance.	9	VREF	[REFERENCE VOLTAGE] VREF defines the full scale of AIN.
3	A _{IN0}	[ANALOG INPUT] One of A _{IN0} ~ A _{IN3} is selected according to the serial channel select bit applied on DI input. Full range of input signal is to be from AGND to VREF.	10	DO	[DATA OUTPUT] Output data is sent out in series.
4	A _{IN1}		11	\overline{SARS}	[SAR STATUS] When a start bit ("L" level) is detected at DI input, \overline{SARS} is set "L" level and conversion starts. When conversion is completed \overline{SARS} returns to "H" level.
5	A _{IN2}		12	CK	[CLOCK INPUT] Basic system clock. Duty cycle is to be 50%.
6	A _{IN3}		13	DI	[DATA INPUT] For starting conversion, a start bit ("L" level) and channel select bit (from CH1 to CH0 in order) are to be applied.
7	V _{SS}	[DIGITAL GROUND]	14	V _{DD}	[POWER SUPPLY] 5V ± 10%

ON Channel	DI Serial Data	
	CH1	CH0
A _{IN0}	L	L
A _{IN1}	L	H
A _{IN2}	H	L
A _{IN3}	H	H

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RECOMMENDED OPERATING CONDITIONS (V_{SS}=0V)

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		4.5	5.0	5.5	V
Input Voltage	V _{IN}		0	-	V _{DD}	V
Reference Voltage	V _{REF}	V _{DD} =5V, AGND=0V	2.0	V _{DD}	V _{DD}	V
Analog Ground Voltage	AGND	V _{DD} =5V, V _{REF} =5V	0.0	0.0	3.0	V
Voltage Between V _{REF} and AGND		V _{DD} =5V ± 10%	2.0	V _{DD}	V _{DD}	V
Clock Frequency	f _{CP}	V _{DD} =5V ± 10%	-	-	400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V ± 10%	1.00	1.25	-	μs
Operating Temperature	t _{opr}		-40	-	+85	°C

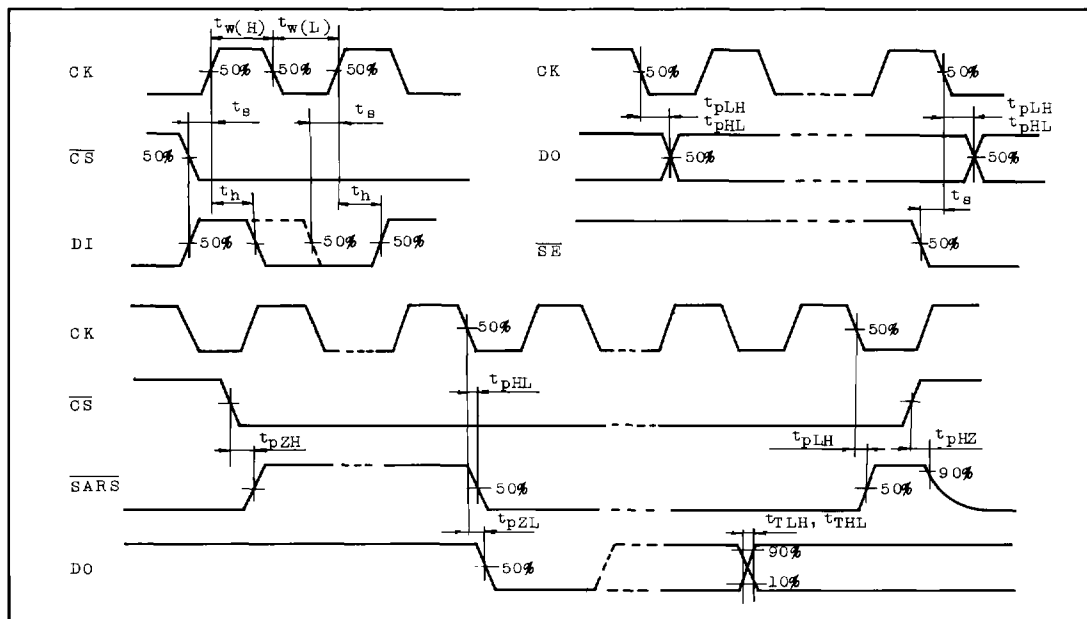
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V)

CHARACTERISTIC	SYMBOL	TEST CONDITION	25°C			-40~85°C		UNIT
			MIN.	TYP.	MAX.	MIN.	MAX.	
High Level Output Voltage	V _{OH}	I _{OUT} < 1μA V _{IN} =V _{SS} , V _{DD}	V _{DD} -0.05	V _{DD}	-	V _{DD} -0.05	-	V
Low Level Output Voltage	V _{OL}	I _{OUT} < 1μA V _{IN} =V _{SS} , V _{DD}	-	0.00	0.05	-	0.05	V
High Level Output Current	I _{OH}	V _{OH} =V _{DD} -0.4V V _{IN} =V _{SS} , V _{DD}	-0.44	-	-	-0.36	-	mA
Low Level Output Current	I _{OL}	V _{OL} =0.4V V _{IN} =V _{SS} , V _{DD}	2.0	-	-	1.6	-	mA
High Level Input Voltage	V _{IH}	I _{OUT} < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	0.7 × V _{DD}	-	-	0.7 × V _{DD}	-	V
Low Level Input Voltage	V _{IL}	I _{OUT} < 1μA V _{OUT} =0.5V, V _{DD} -0.5V	-	-	0.3 × V _{DD}	-	0.3 × V _{DD}	V
3-State Output Disable Current	I _{DH} I _{DL}	V _{OH} =V _{DD} or V _{OL} =0.0V	-	-	±0.5	-	±1	μA
Digital Input Current	I _{IH} I _{IL}	V _{IH} =V _{DD} or V _{IL} =0.0V	-	-	±0.3	-	±1	μA
ON Channel Input Current	I _{ON}	V _{IH} =V _{REF} or V _{IL} =0.0V f _{CP} =400kHz	-	-	±5	-	±7	μA
OFF Channel Input Current	I _{OFF}	V _{IH} =V _{DD} or V _{IL} =0.0V	-	-	±0.2	-	±1	μA
Operating Current	I _{DD}	f _{CP} =400kHz	-	-	1.1	-	1.4	mA
Reference Resistance	R _{REF}		1.4	2.6	3.8	1.2	4.2	kΩ
Quiescent Supply Current	I _{DDs}	CK=V _{DD} , V _{SS} CS=V _{DD}	-	-	1	-	100	μA

SWITCHING CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V, T_a=25°C)

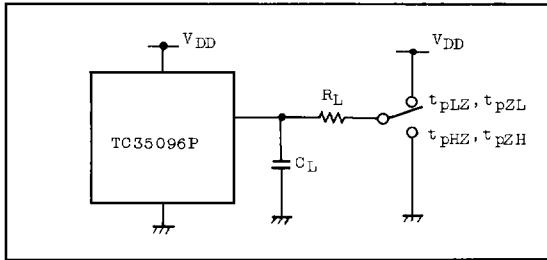
CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-	30	100	nS
Propagation Delay Time (CK-Data)	t _{pLH} t _{pHL}	C _L =50pF	-	80	250	
Propagation Delay Time (CK- $\overline{\text{SARS}}$)	t _{pLH} t _{pHL}	C _L =50pF	-	80	250	
3-State Output Enable Time ($\overline{\text{CS}}$ - $\overline{\text{SARS}}$, $\overline{\text{SARS}}$ -Data)	t _{pZH} t _{pZL}	C _L =50pF R _L =1kΩ	-	30	200	
3-State Output Disable Time ($\overline{\text{CS}}$ - $\overline{\text{SARS}}$, Data)	t _{pHZ} t _{pLZ}		-	60	200	
Minimum Pulse Width ($\overline{\text{CS}}$)	t _{w(H)}	C _L =50pF	-	30	100	
Minimum Set-up Time ($\overline{\text{CS}}$, $\overline{\text{SE}}$, DI)	t _s	C _L =50pF	-	-10	150	
Minimum Hold Time (DI)	t _h	C _L =50pF	-	10	50	
Input Capacitance	C _{IN1}	Digital Input	-	5	-	
Input Capacitance	C _{IN2}	Analog In(ON)	-	5	-	
Input Capacitance	C _{IN3}	Analog In(OFF)	-	5	-	
Output Capacitance	C _{OUT}	3-State Out	-	10	-	

SWITCHING CHARACTERISTICS TEST WAVEFORM



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3-STATE OUTPUT TEST CIRCUIT



SYSTEM CHARACTERISTICS ($T_a = -40 \sim 85^\circ\text{C}$)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	EZR	$V_{DD} = 5.0\text{V}$ $V_{REF} = 5.000\text{V}$ $f_{cp} = 400\text{kHz}$ Duty = 50%	-	$\pm 1/4$	$\pm 1/2$	LSB
Full Scale Error	EFS		-	$\pm 1/4$	$\pm 1/2$	
Nonlinearity Error	E _{LI}		-	$\pm 1/4$	-	
Total Error	E _T		-	$\pm 1/4$	$\pm 3/4$	
Conversion Time	TC	$f_{cp} = 400\text{kHz}$	-	32.5	34	μS

APPLICATION CIRCUIT (EXAMPLE)

$$T_c = \frac{13}{f_{cp}} \pm \alpha \quad 0 < \alpha < \frac{1}{2f_{cp}}$$

