

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.

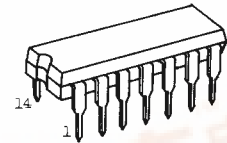
In case that \overline{SE} is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

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 @ $T_a=25^\circ\text{C}$
- Serial I/O
- 4 channel analog multiplex input
- Easy interface to all microprocessors
- 3-state output
- Zero or full scale adjustment free

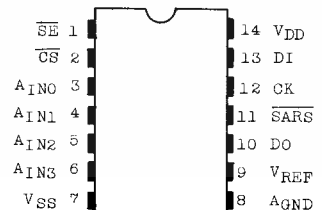


DIP 14(3D14A-P)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V _{DD}	V _{SS} -0.5 ~ V _{SS} +7	V
DC Input Voltage	V _{IN}	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Output Voltage	V _{OUT}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Reference Voltage	V _{REF}	V _{SS} -0.5 ~ V _{DD} +0.5	V
Analog Ground Voltage	AGND	V _{SS} -0.5 ~ V _{DD} +0.5	V
DC Input Current	I _{IN}	\pm 10	V
Power Dissipation	P _D	300	mA
Storage Temperature	T _{stg}	-65 ~ 150	$^\circ\text{C}$
Lead Temperature 10 sec.	T _L	300	$^\circ\text{C}$

PIN ASSIGNMENT

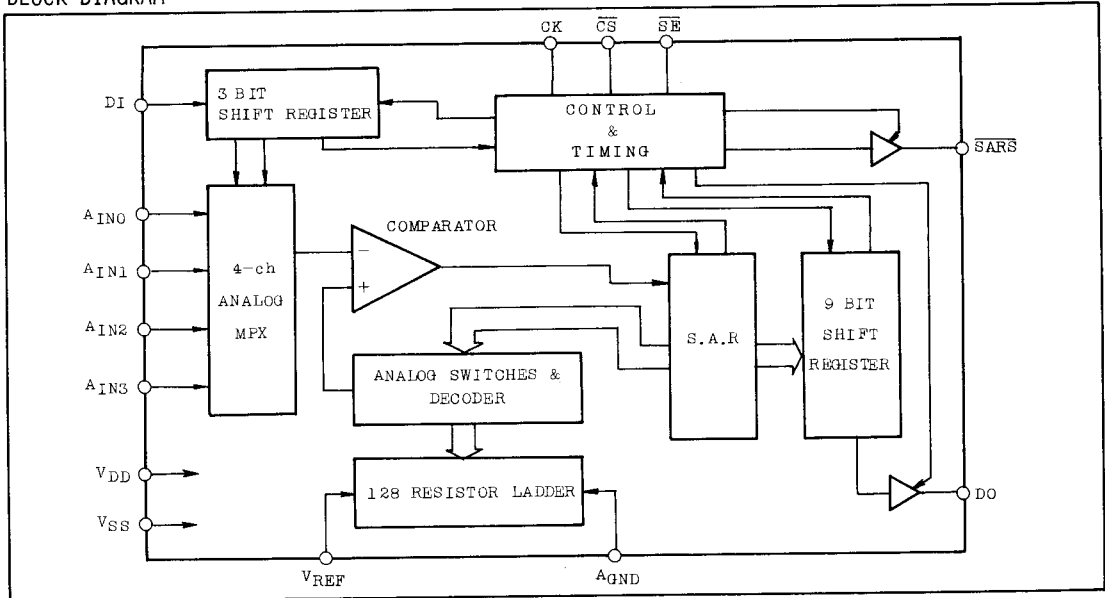


(TOP VIEW)

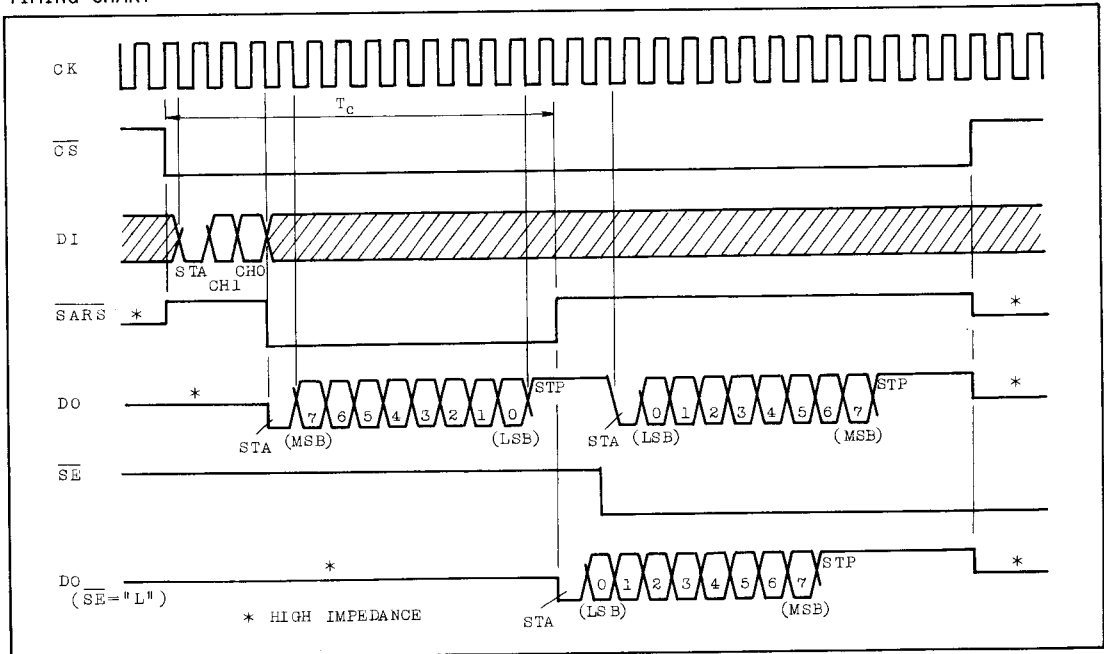


TC35096P

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" LSB first \overline{SE} = "H" MSB first	8	A_{GND}	[ANALOG GROUND] A_{GND} defines the zero level of A_{IN} .																		
2	\overline{CS}	[CHIP SELECT] At the falling edge of \overline{CS} , the device is set stand-by for conversion. When \overline{CS} is "H" the device is reset and all outputs become high impedance.	9	V_{REF}	[REFERENCE VOLTAGE] V_{REF} defines the full scale of A_{IN} .																		
			10	DO	[DATA OUTPUT] Output data is sent out in series.																		
3	A_{IN0}	[ANALOG INPUT] One of $A_{IN0} \sim A_{IN3}$ is selected according to the serial channel select bit applied on DI input. Full range of input signal is to be from A_{GND} to V_{REF} .	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.																		
4	A_{IN1}																						
5	A_{IN2}		<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">ON Channel</th> <th colspan="2">DI Serial Data</th> </tr> <tr> <th>CH1</th> <th>CH0</th> </tr> </thead> <tbody> <tr> <td>A_{IN0}</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN1}</td> <td>L</td> <td>H</td> </tr> <tr> <td>A_{IN2}</td> <td>L</td> <td>L</td> </tr> <tr> <td>A_{IN3}</td> <td>H</td> <td>H</td> </tr> </tbody> </table>	ON Channel	DI Serial Data		CH1	CH0	A_{IN0}	L	L	A_{IN1}	L	H	A_{IN2}	L	L	A_{IN3}	H	H	12	CK	[CLOCK INPUT] Basic system clock. Duty cycle is to be 50%.
					ON Channel	DI Serial Data																	
CH1	CH0																						
A_{IN0}	L	L																					
A_{IN1}	L	H																					
A_{IN2}	L	L																					
A_{IN3}	H	H																					
6	A_{IN3}																						
7	V_{SS}	[DIGITAL GROUND]	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.																		
						14	V_{DD}	[POWER SUPPLY] 5V ±10%															

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

PARAMETER	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 _{CD}	V _{DD} =5V ± 10%	-	-	400	kHz
Clock Pulse Width	t _{w(H)} t _{w(L)}	V _{DD} =5V ± 10%	0.63	1.25	-	μs
Operating Temperature	t _{opr}		-40	-	+85	°C

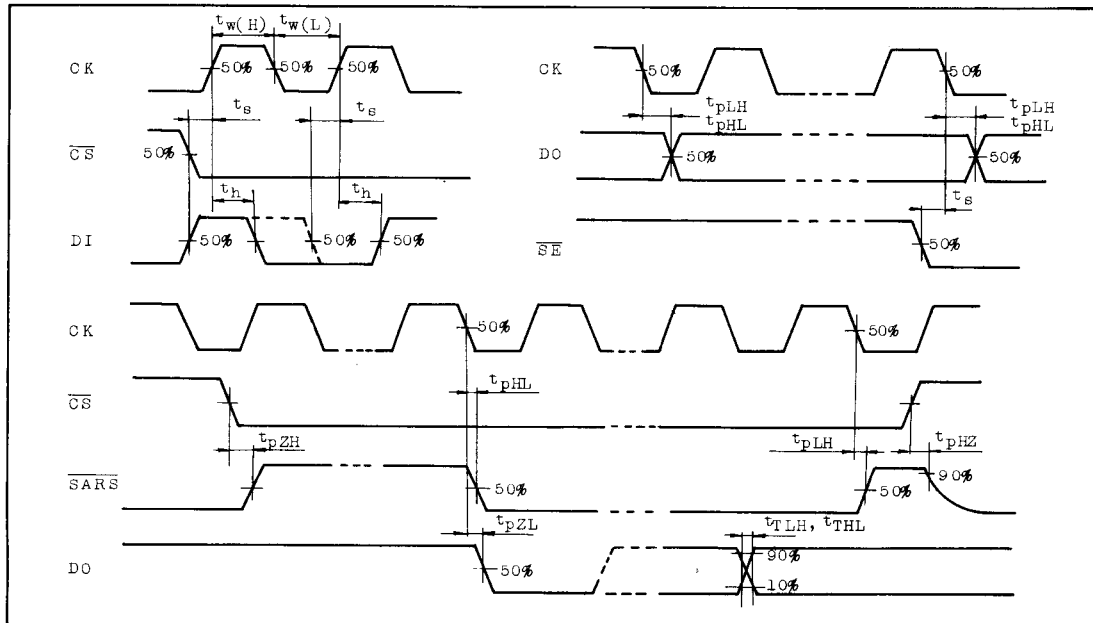
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V)

PARAMETER	SYMBOL	TEST CONDITION	25°C			-40 85°C		
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	-	-	±2	-	±5	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

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

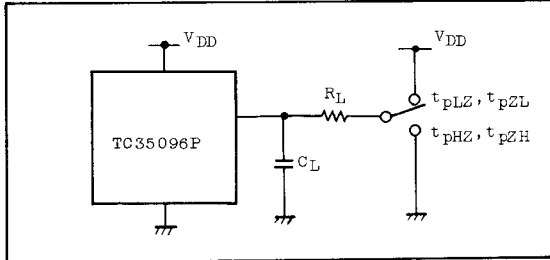
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	t _{TLH} t _{THL}	C _L =50pF	-		100	nS
Propagation Delay Time (CK-Data)	t _{pLH} t _{pHL}	C _L =50pF	-		250	
Propagation Delay Time (CK- $\overline{\text{SARS}}$)	t _{pLH} t _{pHL}	C _L =50pF	-		250	
3-State Output Enable Time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



TC35096P

3-STATE OUTPUT TEST CIRCUIT



SYSTEM CHARACTERISTICS (T_a = -40 ~ 85°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E _{ZR}	V _{DD} =5.0V V _{REF} =5.000V f _{cp} =400kHz Duty=50%	-	±1/4	±1/2	LSB
Full Scale Error	E _{FSS}		-	±1/4	±1/2	
Nonlinearity Error	E _{LI}		-	±1/4	-	
Total Error	E _T		-	±1/4	±3/4	
Conversion Time	T _C	f _{cp} =400kHz	-	32.5	34	μS

APPLICATION CIRCUIT (EXAMPLE)

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

