

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.

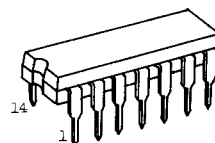
In case that $\overline{SE}$ is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

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

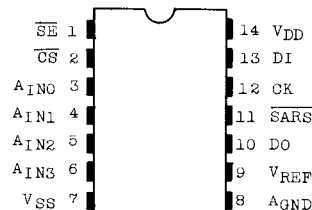


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ABSOLUTE MAXIMUM RATINGS

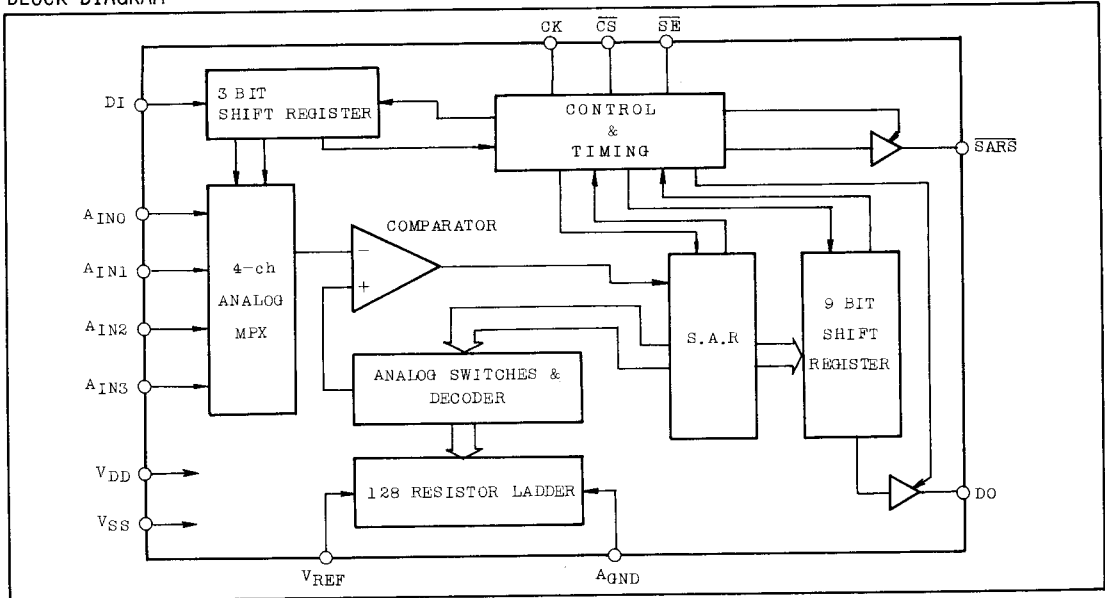
PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	VDD	VSS-0.5 ~ VSS+7	V
DC Input Voltage	VIN	VSS-0.5 ~ VDD+0.5	V
DC Output Voltage	VOUT	VSS-0.5 ~ VDD+0.5	V
Reference Voltage	VREF	VSS-0.5 ~ VDD+0.5	V
Analog Ground Voltage	AGND	VSS-0.5 ~ VDD+0.5	V
DC Input Current	IIN	± 10	V
Power Dissipation	PD	300	mA
Storage Temperature	T _{stg}	-65 ~ 150	°C
Lead Temperature 10 sec.	T _L	300	°C

PIN ASSIGNMENT

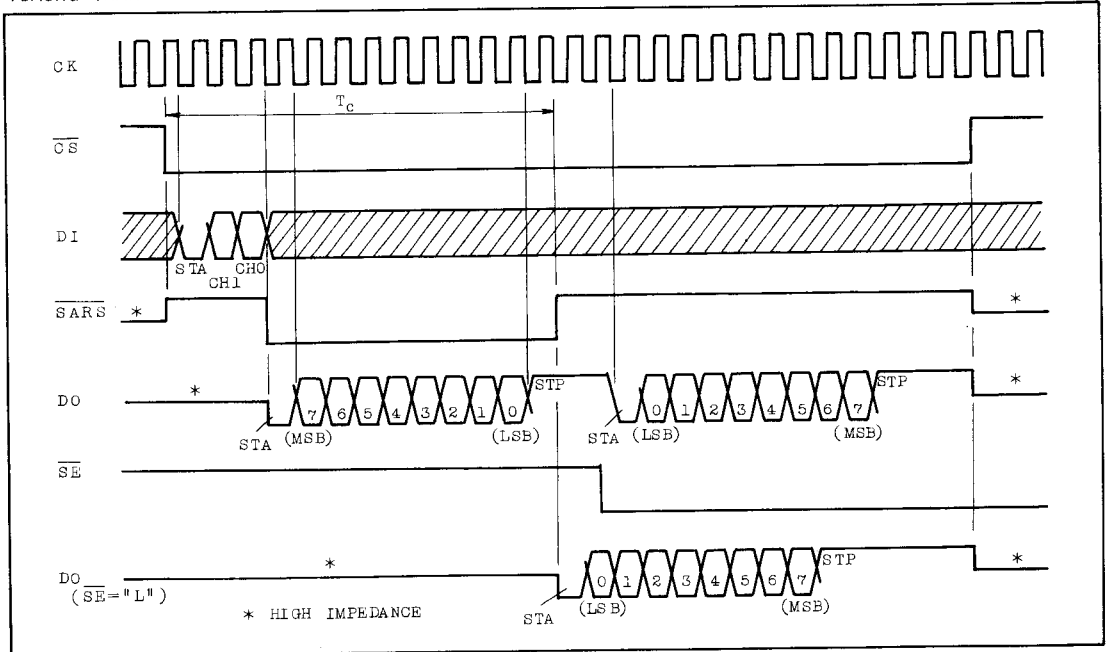


(TOP VIEW)

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} .
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} .	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 $\pm$ 10%

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

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

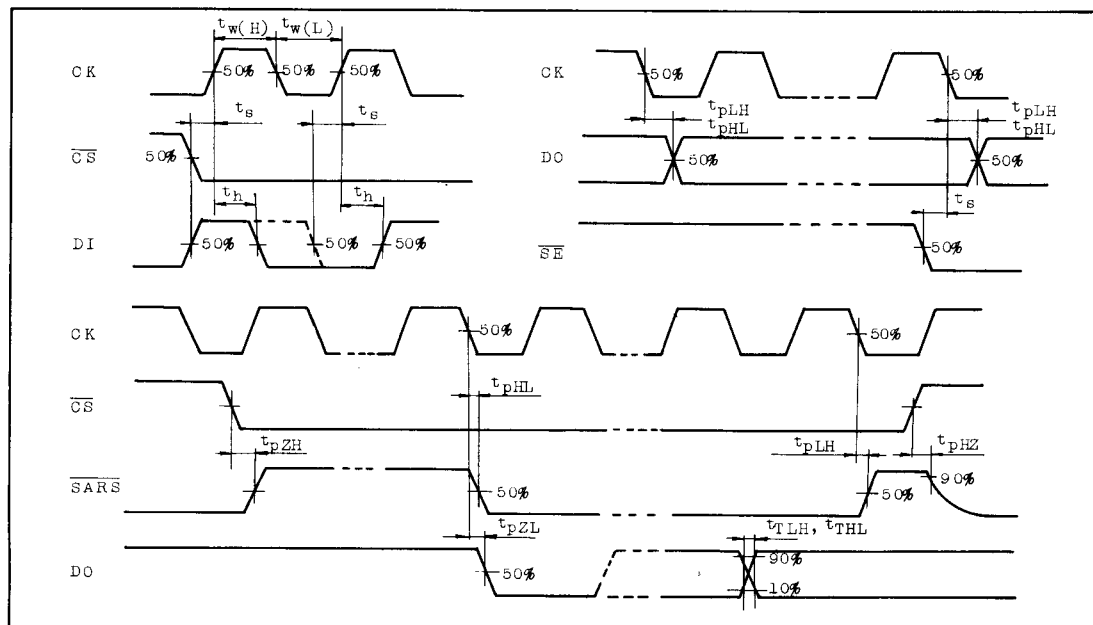
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V)

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

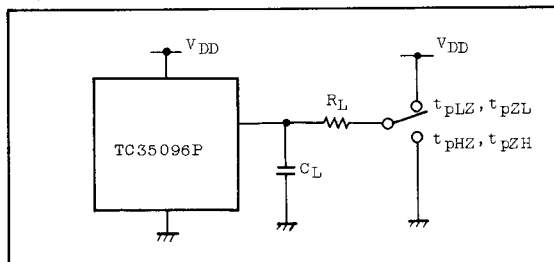
SWITCHING CHARACTERISTICS ($V_{DD}=5V\pm10\%$, $V_{SS}=0V$, $T_a=25^\circ C$)

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-SARS)	t_{pLH} t_{pHL}	$C_L=50pF$	-		250	
3-State Output Enable Time ($\overline{CS}$ -SARS, SARS-Data)	t_{pZH} t_{pZL}	$C_L=50pF$ $R_L=1k\Omega$	-		200	
3-State Output Disable Time ($\overline{CS}$ -SARS, Data)	t_{pHZ} t_{pLZ}		-		200	
Minimum Pulse Width ($\overline{CS}$)	$t_w(H)$	$C_L=50pF$	-		100	
Minimum Set-up Time ($\overline{CS}$, SE, DI)	t_s	$C_L=50pF$	-		150	
Minimum Hold Time (DI)	t_h	$C_L=50pF$	-		50	pF
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



3-STATE OUTPUT TEST CIRCUIT



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

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Zero Point Error	E_{ZR}	$V_{DD}=5.0\text{V}$ $V_{REF}=5.000\text{V}$ $f_{cp}=400\text{kHz}$ Duty=50%	-	$\pm 1/4$	$\pm 1/2$	LSB
Full Scale Error	E_{FS}		-	$\pm 1/4$	$\pm 1/2$	
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)

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

