TC35096P

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.

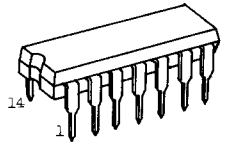
In case that $\overline{SE}$ is high, as soon as the conversion starts a start bit ("L" level) appears at serial output DO and 8 bit conversion data (MSB first) and a stop bit ("H" level) follow continuously.

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 μs MAX @ f_{cp}=400 kHz
- Single power supply ..... 5V ±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

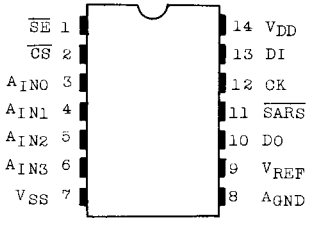


DIP 14(3D14A-P)

ABSOLUTE MAXIMUM RATINGS

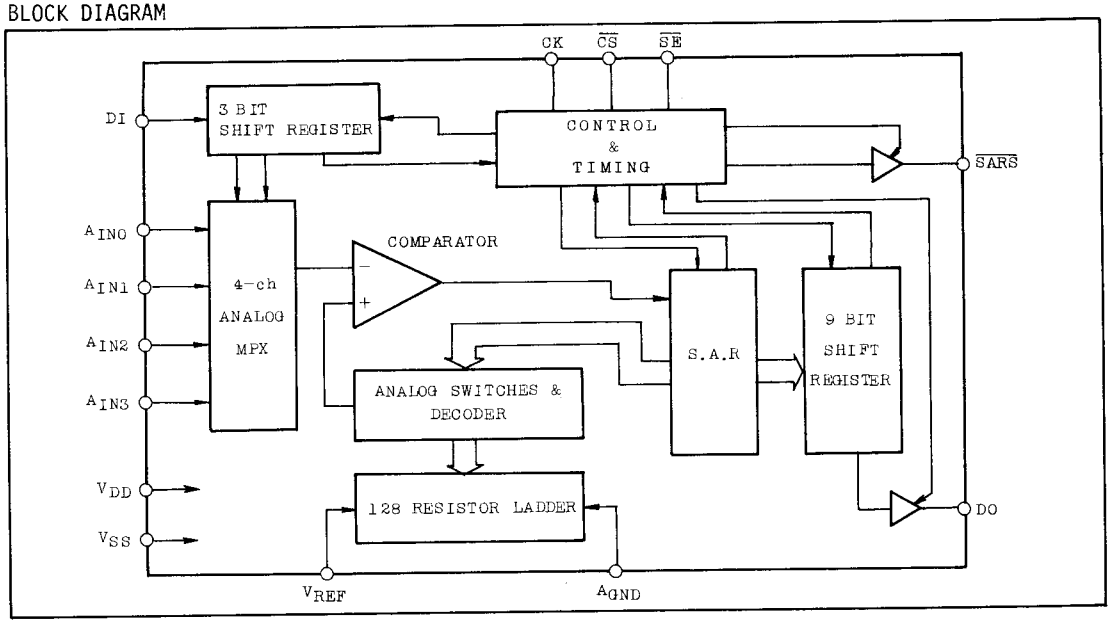
PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	V_{DD}	V_{SS}-0.5 ∿V_{SS}+7	V
DC Input Voltage	V_{IN}	V_{SS}-0.5 ∿V_{DD}+0.5	V
DC Output Voltage	V_{OUT}	V_{SS}-0.5 ∿V_{DD}+0.5	V
Reference Voltage	V_{REF}	V_{SS}-0.5 ∿V_{DD}+0.5	V
Analog Ground Voltage	AGND	V_{SS}-0.5 ∿V_{DD}+0.5	V
DC Input Current	I_{IN}	±10	V
Power Dissipation	P_D	300	mA
Storage Temperature	T_{stg}	-65 ∿ 150	°C
Lead Temperature 10 sec.	T_L	300	°C

PIN ASSIGNMENT

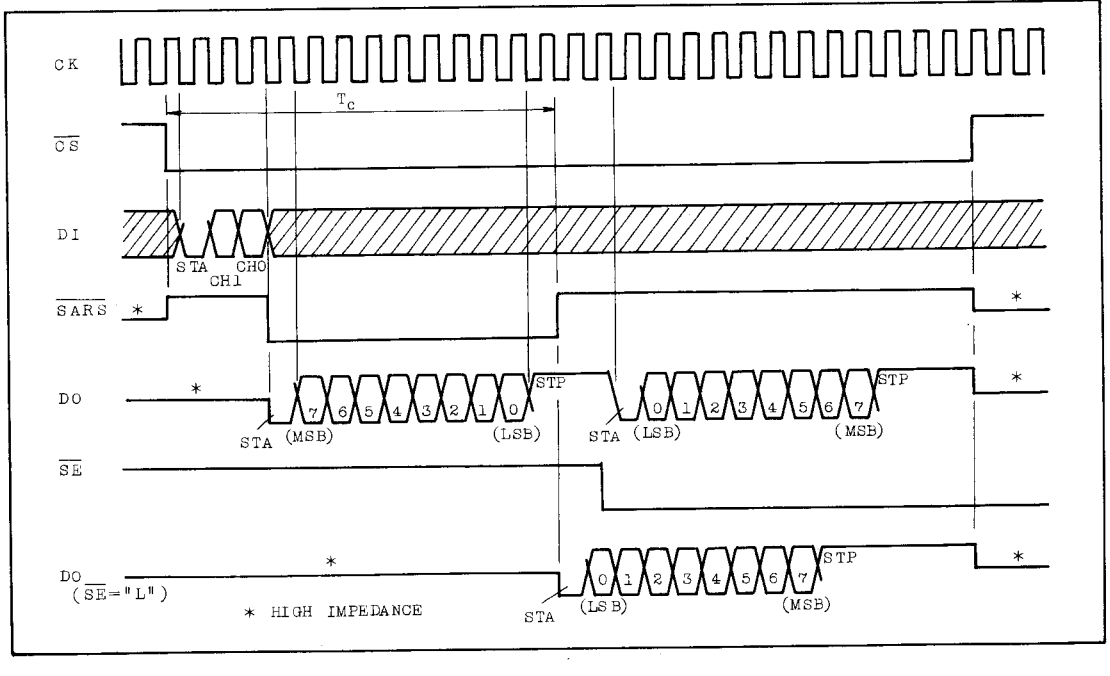


(TOP VIEW)

BLOCK DIAGRAM



TIMING CHART



PIN & FUNCTION

<table>
<tr><th>PIN NO.</th><th>SYMBOL</th><th>PIN NAME & FUNCTION</th><th>PIN NO.</th><th>SYMBOL</th><th>PIN NAME & FUNCTION</th></tr>
<tr><td>1</td><td>$\overline{SE}$</td><td>[SELECT]
$\overline{SE}$ determines the order of output data.
$\overline{SE}$ = "L" .... LSB first
$\overline{SE}$ = "H" .... MSB first</td><td>8</td><td>A_{GND}</td><td>[ANALOG GROUND]
A_{GND} defines the zero level of A_{IN}.</td></tr>
<tr><td>2</td><td>$\overline{CS}$</td><td>[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.</td><td>9</td><td>V_{REF}</td><td>[REFERENCE VOLTAGE]
V_{REF} defines the full scale of A_{IN}.</td></tr>
<tr><td></td><td></td><td></td><td>10</td><td>DO</td><td>[DATA OUTPUT]
Output data is sent out in series.</td></tr>
<tr><td>3</td><td>A_{IN0}</td><td rowspan="4">[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}.
<table><tr><th rowspan="2">ON Channel</th><th colspan="2">DI Serial Data</th></tr><tr><th>CH1</th><th>CH0</th></tr><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></table></td><td rowspan="2">11</td><td rowspan="2">$\overline{SARS}$</td><td rowspan="2">[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.</td></tr>
<tr><td>4</td><td>A_{IN1}</td></tr>
<tr><td>5</td><td>A_{IN2}</td><td>12</td><td>CK</td><td>[CLOCK INPUT]
Basic system clock. Duty cycle is to be 50%.</td></tr>
<tr><td>6</td><td>A_{IN3}</td><td>13</td><td>DI</td><td>[DATA INPUT]
For starting conversion, a start bit ("L" level) and channel select bit (from CH1 to CH0 in order) are to be applied.</td></tr>
<tr><td>7</td><td>V_{SS}</td><td>[DIGITAL GROUND]</td><td>14</td><td>V_{DD}</td><td>[POWER SUPPLY]
5V ± 10%</td></tr>
</table>

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_{REE}	V_{DD}=5V, A_{GND}=0V	2.0	V_{DD}	V_{DD}	V
Analog Ground Voltage	A_{GND}	V_{DD}=5V, V_{REE}=5V	0.0	0.0	3.0	V
Voltage Between V_{REF} and A_{GND}		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%	0.63	1.25	-	μS
Operating Temperature	t_{opr}		-40	-	+85	°C

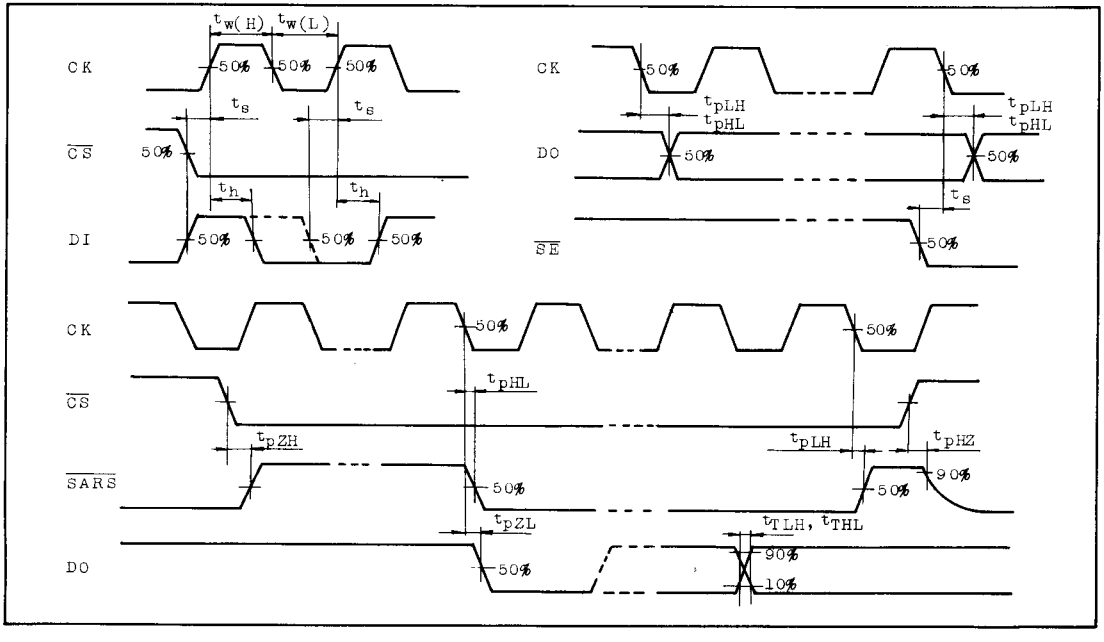
DC ELECTRICAL CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V)

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

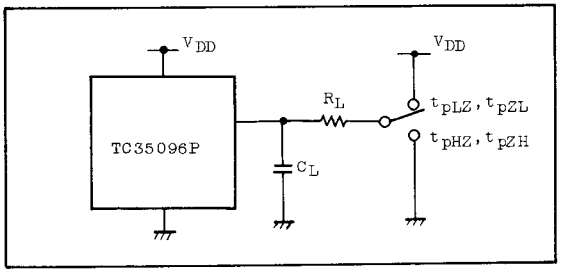
SWITCHING CHARACTERISTICS (V_{DD}=5V±10%, V_{SS}=0V, Ta=25°C)

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)	tpLH tpHL	C_L=50pF	-		250	
Propagation Delay Time (CK-$\overline{SARS}$)	tpLH tpHL	C_L=50pF	-		250	
3-State Output Enable Time ($\overline{CS}$-$\overline{SARS}$, $\overline{SARS}$-Data)	tpZH tpZL	C_L=50pF R_L=1kΩ	-		200	
3-State Output Disable Time ($\overline{CS}$-$\overline{SARS}$, Data)	tpHZ tpLZ		-		200	
Minimum Pulse Width ($\overline{CS}$)	$t_{w(H)}$	C_L=50pF	-		100	
Minimum Set-up Time ($\overline{CS}$, $\overline{SE}$, 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



3-STATE OUTPUT TEST CIRCUIT



SYSTEM CHARACTERISTICS (Ta=-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_{FS}		-	±1/4	±1/2	
Nonlinearity Error	E_{LI}		-	±1/4	-	
Total Error	E_T		-	±1/4	±3/4	
Conversion Time	Tc	f_{cp}=400kHz	-	32.5	34	μS

APPLICATION CIRCUIT (EXAMPLE) $Tc=\frac{13}{fcp}\pm\alpha \quad 0<\alpha<\frac{1}{2fcp}$